

Magnetic Contactors and Magnetic Motor Starters  
TECHNICAL NOTES

**MS-T Series**



HOTLINE: 1900.6536

# Magnetic Motor Starter

## TECHNICAL NOTES

MS-T Series Magnetic Contactors and Magnetic Motor Starters

This document introduces the types, characteristics and performances (Type test results) of the magnetic motor starter, for the purpose of being generally utilized as a basic document by all the users including the administrators, designers, and those responsible for construction.

Note a) Note that the described contents are subject to change without notice.

b) The described content is only for reference and it cannot be guaranteed.

HOTLINE: 1900.8536

**The units are described in SI units.**

# Table of Contents

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## Standard Series Magnetic Motor Starter and Magnetic Contactor

|                                                                  |    |
|------------------------------------------------------------------|----|
| Kinds and Ratings .....                                          | 2  |
| Characteristics and Performance (Type test results) .....        | 5  |
| 1. Structure .....                                               | 5  |
| 2. Type Test .....                                               | 5  |
| 2.1 Type Tests and Test Sequences .....                          | 5  |
| 2.2 Test Sequence I .....                                        | 6  |
| 2.2.1 Temperature Rise and Dielectric Properties .....           | 6  |
| 2.2.2 Operating Limits .....                                     | 7  |
| (1) Operating Limits of the Magnetic Contactor .....             | 7  |
| (2) Operating Characteristics of Thermal Overload Relay .....    | 8  |
| 2.3 Test Sequence II .....                                       | 9  |
| 2.3.1 Test of Making and Breaking Capacities .....               | 9  |
| (1) Test of Making Capacity .....                                | 9  |
| (2) Test of Making and Breaking Capacities .....                 | 10 |
| (3) The Switching Capacity and Reversibility .....               | 10 |
| 2.3.2 The Operating Performance .....                            | 12 |
| (1) Non-reversing .....                                          | 12 |
| (2) Reversing .....                                              | 13 |
| 2.4 Test Sequence III .....                                      | 14 |
| 2.4.1 Performance under Short-circuit Conditions .....           | 14 |
| 2.5 Test Sequence IV .....                                       | 15 |
| 2.5.1 Ability of Contactors to Withstand Overload Currents ..... | 15 |
| 2.6 Test Sequence V .....                                        | 16 |
| 2.6.1 Mechanical Properties of Terminals .....                   | 16 |
| (1) Tests of Mechanical Strength of Terminals .....              | 16 |
| (2) Flexion and Pull-out Tests .....                             | 17 |

## Special Magnetic Contactor

|                                                        |    |
|--------------------------------------------------------|----|
| DC-operated Magnetic Contactor <Type SD-T> .....       | 20 |
| 1. Structure .....                                     | 20 |
| 2. Rating .....                                        | 20 |
| 3. Type Test .....                                     | 20 |
| 3.1 Type Tests and Test Sequences .....                | 20 |
| 3.2 Test Sequence I .....                              | 21 |
| 3.2.1 Temperature Rise and Dielectric Properties ..... | 21 |
| 3.2.2 Operating Limits .....                           | 22 |

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|                                                                        |    |
|------------------------------------------------------------------------|----|
| 3.3 Test Sequence II .....                                             | 23 |
| 3.3.1 Test of Making and Breaking Capacities .....                     | 23 |
| (1) Test of Making Capacity .....                                      | 23 |
| (2) Test of Making and Breaking Capacities .....                       | 23 |
| (3) The Switching Capacity and Reversibility .....                     | 24 |
| 3.3.2 The Operating Performance .....                                  | 25 |
| (1) Non-reversing .....                                                | 25 |
| (2) Reversing .....                                                    | 25 |
| 3.4 Test Sequence III .....                                            | 26 |
| 3.4.1 Performance under Short-circuit Conditions .....                 | 26 |
| 3.5 Test Sequence IV .....                                             | 26 |
| 3.5.1 Ability of Contactors to Withstand Overload Currents .....       | 26 |
| 3.6 Test Sequence V .....                                              | 27 |
| 3.6.1 Mechanical Properties of Terminals .....                         | 27 |
| (1) Tests of Mechanical Strength of Terminals .....                    | 27 |
| (2) Flexion and Pull-out Tests .....                                   | 28 |
| <br>Mechanical Latch Type Magnetic Contactor <Type SL-T, SLD-T > ..... | 29 |
| 1. Usage .....                                                         | 29 |
| 2. Rating .....                                                        | 29 |
| 3. Type Test .....                                                     | 30 |
| 3.1 Type Tests and Test Sequences .....                                | 30 |
| 3.2 Test Sequence I .....                                              | 31 |
| 3.2.1 Temperature Rise and Dielectric Properties .....                 | 31 |
| 3.2.2 Operating Limits .....                                           | 31 |
| 3.3 Test Sequence II .....                                             | 32 |
| 3.3.1 Test of Making and Breaking Capacities .....                     | 32 |
| (1) Test of Making Capacity .....                                      | 32 |
| (2) Test of Making and Breaking Capacities .....                       | 32 |
| (3) The Switching Capacity and Reversibility .....                     | 33 |
| 3.3.2 The Operating Performance .....                                  | 34 |
| (1) Non-reversing .....                                                | 34 |
| (2) Reversing .....                                                    | 34 |
| 3.4 Test Sequence III .....                                            | 35 |
| 3.4.1 Performance under Short-circuit Conditions .....                 | 35 |
| 3.5 Test Sequence IV .....                                             | 35 |
| 3.5.1 Ability of Contactors to Withstand Overload Currents .....       | 35 |
| 3.6 Test Sequence V .....                                              | 36 |
| 3.6.1 Mechanical Properties of Terminals .....                         | 36 |
| (1) Tests of Mechanical Strength of Terminals .....                    | 36 |
| (2) Flexion and Pull-out Tests .....                                   | 36 |

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## Environmental Characteristics and Special Performance

|                                                                           |    |
|---------------------------------------------------------------------------|----|
| 1. Surrounding Environment of the Magnetic Starter .....                  | 38 |
| 2. Application to the Special Environment .....                           | 39 |
| 2.1 High Temperature .....                                                | 39 |
| 2.2 Low Temperature .....                                                 | 40 |
| 3. Instantaneous Voltage Drop Tolerance .....                             | 41 |
| 3.1 SEMI-F47 Standard .....                                               | 41 |
| 3.2 Instantaneous Power Failure Tolerance .....                           | 41 |
| 4. Operating Characteristics of the Thermal Relay .....                   | 42 |
| 4.1 Operations in a Balanced Circuit (Ambient Temperature: 20°C) .....    | 42 |
| 4.2 Operations in an Unbalanced Circuit (Ambient Temperature: 20°C) ..... | 42 |
| 5. Noise Characteristics .....                                            | 43 |
| 5.1 Noise during the ON State .....                                       | 43 |
| 5.2 Noise during Opening and Closing .....                                | 44 |
| 6. Impact during Opening and Closing .....                                | 44 |
| 7. Insulation Resistance and Withstand Voltage .....                      | 45 |
| 8. Vibration .....                                                        | 45 |
| 8.1 Contact Malfunction Vibration .....                                   | 45 |
| 8.2 Constant Vibration Endurance .....                                    | 45 |
| 9. Impact .....                                                           | 46 |
| 10. Mechanical Endurance .....                                            | 46 |
| 11. Electrical Endurance .....                                            | 47 |
| 12. Short Time Current Overload Tolerance of the Magnetic Contactor ..... | 48 |

HOTLINE: 1900.6536

**Standard Series  
Magnetic Motor Starter and  
Magnetic Contactor**



HOTLINE: 1900.6536

## ■ Kinds and Ratings

Type MS-T magnetic motor starter consists of a type S-T magnetic contactor, type TH-T thermal overload relay and an outer case. Type MSO-T magnetic motor starters are also available as a unit for power distributor panels and control panels.

Table 1 Constitutional Elements of Type MS-T Magnetic Motor Starters

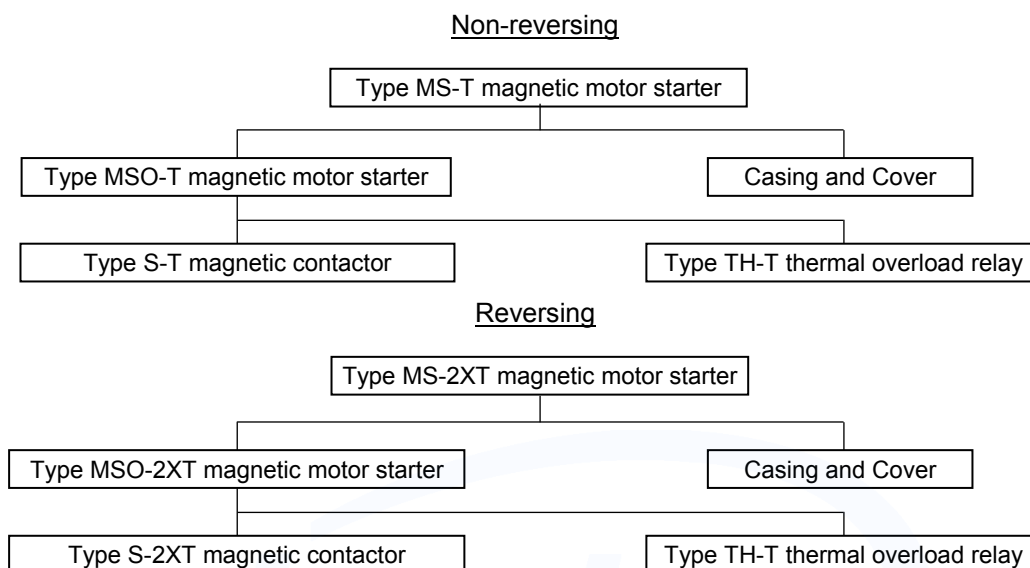


Table 2 Kinds and Composition

| Frame | Type                |               |                          |                 | Constituent elements   |           |                                                                                                                         |
|-------|---------------------|---------------|--------------------------|-----------------|------------------------|-----------|-------------------------------------------------------------------------------------------------------------------------|
|       | MS-, with enclosure |               | MSO-, with-out enclosure |                 | S-, magnetic contactor |           | Thermal overload relay                                                                                                  |
|       | Non-reversing       | Reversing     | Non-reversing            | Reversing       | Non-reversing          | Reversing |                                                                                                                         |
| T10   | MS-T10 (KP)         | -             | MSO-T10 (KP)             | MSO-2xT10 (KP)  | S-T10                  | S-2xT10   | TH-T18(KP)                                                                                                              |
| T12   | MS-T12 (KP)         | -             | MSO-T12 (KP)             | MSO-2xT12 (KP)  | S-T12                  | S-2xT12   |                                                                                                                         |
| T20   | -                   | -             | MSO-T20 (KP)             | MSO-2xT20 (KP)  | S-T20                  | S-2xT20   |                                                                                                                         |
| T21   | MS-T21 (KP)         | MS-2xT21 (KP) | MSO-T21 (KP)             | MSO-2xT21 (KP)  | S-T21                  | S-2xT21   | TH-T25(KP)                                                                                                              |
| T25   | -                   | -             | MSO-T25 (KP)             | MSO-2xT25 (KP)  | S-T25                  | S-2xT25   |                                                                                                                         |
| T32   | -                   | -             | -                        | -               | S-T32                  | S-2xT32   |                                                                                                                         |
| T35   | MS-T35(KP)          |               | MSO-T35 (KP)             | MSO-2xT35 (KP)  | S-T35                  | S-2xT35   | TH-T25(KP) (Nominal current of the heater: 22 A or less)<br>TH-T50(KP) (Nominal current of the heater: 29 A)            |
| T50   | MS-T50(KP)          |               | MSO-T50 (KP)             | MSO-2xT50 (KP)  | S-T50                  | S-2xT50   | TH-T25(KP) (Nominal current of the heater: 22 A or less)<br>TH-T50(KP) (Nominal current of the heater: 29 A or higher)  |
| T65   | MS-T65(KP)          |               | MSO-T65 (KP)             | MSO-2xT65 (KP)  | S-T65                  | S-2xT65   | TH-T65(KP)                                                                                                              |
| T80   | MS-T80(KP)          |               | MSO-T80 (KP)             | MSO-2xT80 (KP)  | S-T80                  | S-2xT80   | TH-T65(KP) (Nominal current of the heater: 54 A or less)<br>TH-T100(KP) (Nominal current of the heater: 67 A)           |
| T100  | MS-T100(KP)         |               | MSO-T100 (KP)            | MSO-2xT100 (KP) | S-T100                 | S-2xT100  | TH-T65(KP) (Nominal current of the heater: 54 A or less)<br>TH-T100(KP) (Nominal current of the heater: 67 A or higher) |

Table 3 Rated Capacity

| Application<br>Frame | Motor load                                                                                |             |      |                                                                                             |          | Resistance load                            |             |
|----------------------|-------------------------------------------------------------------------------------------|-------------|------|---------------------------------------------------------------------------------------------|----------|--------------------------------------------|-------------|
|                      | Category AC-3 [kW]<br>( Three-phase squirrel-cage motor load<br>standard responsibility ) |             |      | Category AC-4 [kW]<br>( Three-phase squirrel-cage<br>motor load inching<br>responsibility ) |          | Category AC-1 [kW]<br>(Resistance, heater) |             |
|                      | 220 to 240V                                                                               | 380 to 440V | 500V | 220 to 240V                                                                                 | 500V     | 220 to 240V                                | 380 to 440V |
| T10                  | 2.5                                                                                       | 4           | 4    | 1.5                                                                                         | 2.7(2.2) | 7.5                                        | 7           |
| T12                  | 3.5                                                                                       | 5.5         | 7.5  | 2.2                                                                                         | 5.5(4)   | 7.5                                        | 8.5         |
| T20                  | 4.5                                                                                       | 7.5         | 7.5  | 3.7                                                                                         | 5.5      | 7.5                                        | 8.5         |
| T21                  | 5.5                                                                                       | 11          | 11   | 3.7                                                                                         | 5.5      | 12                                         | 20          |
| T25                  | 7.5                                                                                       | 15          | 15   | 4.5                                                                                         | 7.5      | 12                                         | 20          |
| T32                  | 7.5                                                                                       | 15          | 15   | 5.5                                                                                         | 7.5(11)  | 12                                         | 20          |
| T35                  | 11                                                                                        | 18.5        | 18.5 | 5.5                                                                                         | 11       | 20                                         | 35          |
| T50                  | 15                                                                                        | 22          | 25   | 7.5                                                                                         | 15       | 30                                         | 50          |
| T65                  | 18.5                                                                                      | 30          | 37   | 11                                                                                          | 22       | 35                                         | 65          |
| T80                  | 22                                                                                        | 45          | 45   | 15                                                                                          | 30       | 45                                         | 78          |
| T100                 | 30                                                                                        | 55          | 55   | 19                                                                                          | 37       | 55                                         | 90          |

Note a) Brackets ( ) in the inching operation indicate the rating of 380V to 440V.

Table 4 Rated Operation Current

| Application<br><br><br>Frame | Motor load         |                |      |                    |                |      | Resistance load   |                | Rated<br>Continuous<br>current<br>I th<br>[A] |
|------------------------------|--------------------|----------------|------|--------------------|----------------|------|-------------------|----------------|-----------------------------------------------|
|                              | Category AC- 3 [A] |                |      | Category AC- 4 [A] |                |      | Category AC- 1[A] |                |                                               |
|                              | 220 to<br>240V     | 380 to<br>440V | 500V | 220 to<br>240V     | 380 to<br>440V | 500V | 220 to<br>240V    | 380 to<br>440V |                                               |
| T10                          | 11                 | 9              | 7    | 8                  | 6              | 6    | 20                | 11             | 20                                            |
| T12                          | 13                 | 12             | 9    | 11                 | 9              | 9    | 20                | 13             | 20                                            |
| T20                          | 18                 | 18             | 17   | 18                 | 13             | 10   | 20                | 13             | 20                                            |
| T21                          | 25                 | 23             | 17   | 18                 | 13             | 10   | 32                | 32             | 32                                            |
| T25                          | 30(26)             | 30(26)         | 24   | 20                 | 17             | 12   | 32                | 32             | 32                                            |
| T32                          | 32                 | 32             | 24   | 26                 | 24             | 17   | 32                | 32             | 32                                            |
| T35                          | 40                 | 40             | 32   | 26                 | 24             | 17   | 60                | 60             | 60                                            |
| T50                          | 55                 | 48             | 38   | 35                 | 32             | 24   | 80                | 80             | 80                                            |
| T65                          | 65                 | 65             | 60   | 50                 | 47             | 38   | 100               | 100            | 100                                           |
| T80                          | 85                 | 85             | 75   | 65                 | 62             | 45   | 120               | 120            | 120                                           |
| T100                         | 105                | 105            | 85   | 80                 | 75             | 55   | 150               | 150            | 150                                           |

Note a) Rated operational current is the maximum applicable current that satisfies the making capacity, breaking capacity, switching frequency, and life at the rated operational voltage.

Note b) Rated Continuous current is a current that can conduct the electricity for 8 hours without raising the temperature above the stated level for all the parts, without switching the magnetic contactor.

Note c) The values of rated operational current in brackets ( ) apply to the magnetic contactor (without thermal overload relay).

Table 5 DC rated working current

| Frame    | Rated voltage DC [V] | Category DC2, and DC4 (DC motor load) [A] |                | Category DC1 (Resistance load) [A] |                | Category DC-13 (DC coil load) [A] |                |                |
|----------|----------------------|-------------------------------------------|----------------|------------------------------------|----------------|-----------------------------------|----------------|----------------|
|          |                      | 2-pole series                             | 3- pole series | 2- pole series                     | 3- pole series | Single pole                       | 2- pole series | 3- pole series |
| T10      | 24                   | 8                                         | 8              | 10                                 | 10             | 5                                 | 8              | 8              |
|          | 48                   | 4                                         | 6              | 10                                 | 10             | 3                                 | 4              | 6              |
|          | 110                  | 2.5                                       | 4              | 6                                  | 8              | 0.6                               | 2              | 3              |
|          | 220                  | 0.8                                       | 2              | 3                                  | 8              | 0.2                               | 0.3            | 0.8            |
| T12      | 24                   | 12                                        | 12             | 12                                 | 12             | 7                                 | 12             | 12             |
|          | 48                   | 6                                         | 10             | 12                                 | 12             | 5                                 | 6              | 10             |
|          | 110                  | 4                                         | 8              | 10                                 | 12             | 1.2                               | 3              | 5              |
|          | 220                  | 1.2                                       | 4              | 7                                  | 12             | 0.2                               | 0.5            | 2              |
| T20      | 24                   | 18                                        | 18             | 18                                 | 18             | 10                                | 14             | 15             |
|          | 48                   | 15                                        | 18             | 18                                 | 18             | 5                                 | 7              | 12             |
|          | 110                  | 8                                         | 15             | 13                                 | 18             | 1.2                               | 3              | 5              |
|          | 220                  | 2                                         | 8              | 8                                  | 18             | 0.2                               | 0.5            | 2              |
| T21      | 24                   | 20                                        | 20             | 20                                 | 20             | 12                                | 20             | 20             |
|          | 48                   | 15                                        | 20             | 20                                 | 20             | 8                                 | 12             | 15             |
|          | 110                  | 8                                         | 15             | 15                                 | 20             | 1.5                               | 3              | 10             |
|          | 220                  | 2                                         | 8              | 10                                 | 20             | 0.25                              | 1.2            | 4              |
| T25, T32 | 24                   | 25                                        | 25             | 25                                 | 25             | 15                                | 25             | 25             |
|          | 48                   | 20                                        | 25             | 25                                 | 25             | 10                                | 15             | 25             |
|          | 110                  | 10                                        | 20             | 25                                 | 25             | 1.5                               | 4              | 12             |
|          | 220                  | 3                                         | 10             | 12                                 | 22             | 0.25                              | 1.2            | 4              |
| T35      | 24                   | 35                                        | 35             | 35                                 | 35             | 15                                | 35             | 35             |
|          | 48                   | 20                                        | 30             | 35                                 | 35             | 10                                | 15             | 25             |
|          | 110                  | 10                                        | 20             | 25                                 | 35             | 1.5                               | 4              | 12             |
|          | 220                  | 3                                         | 10             | 12                                 | 30             | 0.25                              | 1.2            | 4              |
| T50      | 24                   | 45                                        | 50             | 50                                 | 50             | -                                 | -              | -              |
|          | 48                   | 25                                        | 35             | 40                                 | 50             | -                                 | -              | -              |
|          | 110                  | 15                                        | 30             | 35                                 | 50             | -                                 | -              | -              |
|          | 220                  | 3.5                                       | 12             | 15                                 | 40             | -                                 | -              | -              |
| T65      | 24                   | 45                                        | 50             | 50                                 | 65             | -                                 | -              | -              |
|          | 48                   | 25                                        | 35             | 40                                 | 65             | -                                 | -              | -              |
|          | 110                  | 15                                        | 30             | 35                                 | 65             | -                                 | -              | -              |
|          | 220                  | 3.5                                       | 12             | 15                                 | 50             | -                                 | -              | -              |
| T80      | 24                   | 65                                        | 80             | 80                                 | 80             | -                                 | -              | -              |
|          | 48                   | 40                                        | 60             | 65                                 | 80             | -                                 | -              | -              |
|          | 110                  | 20                                        | 50             | 50                                 | 80             | -                                 | -              | -              |
|          | 220                  | 5                                         | 20             | 20                                 | 60             | -                                 | -              | -              |
| T100     | 24                   | 93                                        | 93             | 93                                 | 93             | -                                 | -              | -              |
|          | 48                   | 60                                        | 90             | 93                                 | 93             | -                                 | -              | -              |
|          | 110                  | 40                                        | 80             | 80                                 | 93             | -                                 | -              | -              |
|          | 220                  | 30                                        | 50             | 50                                 | 70             | -                                 | -              | -              |

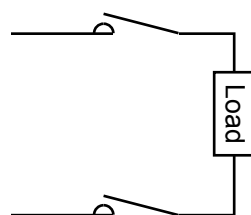
Note a) DC2, DC4, and DC1 are the gradings of JEM1038 that are to be applied for starting and stopping the DC shunt-wound motor, starting and stopping the DC series motor, and resistance load respectively.

Note b) DC- 13 is the grading of IEC60947-5-1 which is to be applied to the induction (coil) load (time constant L/R = 100ms).

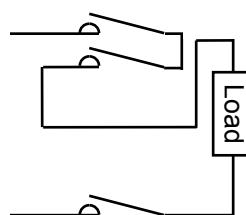
Note c) The Switching of the electrical switch can be done up to 500,000 times.

Note d) The closed current capacity of the DC2 and DC4 is four times of the above table while the frequency is 100 times and the breaking current capacity is four times of the above table while the frequency is 25 times.

Note e) The 2-pole series and 3-pole series connections are shown in the following diagram.



2- pole series



3- pole series

# ■ Characteristics and Performance (Type test results)

## 1. Structure

It is compatible with JISC8201-4-1, IEC60947-4-1, EN60947-4-1, UL60947-4-1, CSA C22.2 No.60947-4-1, and GB14048.4.

## 2. Type Test

Applicable Standard IEC60947-1 (2011) Low voltage switchgear and control gear  
Part 1: General Rule  
IEC60947-4-1 (2012) Low voltage switchgear and control gear  
Part 4: Contactor and Motor Starter  
Section 1: Electro-mechanical Contactor and Motor Starter

### 2.1 Type Tests and Test Sequences

| Test Sequences  | Test Name                                                                 | Test Conditions                                                                             |
|-----------------|---------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| a) Sequence I   | 1) Temperature rise                                                       | According to the IEC60947-4-1 9.3.3.3 "Temperature Rise".                                   |
|                 | 2) Operation and operating limits                                         | According to the IEC60947-4-1 9.3.3.1 "Operation" and 9.3.3.2 "Operating Limits".           |
|                 | 3) Dielectric properties                                                  | According to the IEC60947-4-1 9.3.3.4 "Dielectric Properties".                              |
| b) Sequence II  | 1) Rated making breaking capacity<br>Switching capacity and reversibility | According to the IEC60947-4-1 9.3.3.5 "Making and Breaking Capacity".                       |
|                 | 2) Conventional operating performance                                     | According to the IEC60947-4-1 9.3.3.6 "Operating Performance Capability".                   |
| c) Sequence III | 1) Performance under short-circuit conditions                             | According to the IEC60947-4-1 9.3.4 "Performance under Short-circuit Conditions".           |
| d) Sequence IV  | 1) Ability of contactors to withstand overload currents                   | According to the IEC60947-4-1 9.3.5 "Ability of Contactors to Withstand Overload Currents". |
| e) Sequence V   | 1) Mechanical properties of terminals                                     | According to the IEC60947-1 8.2.4 "Mechanical Properties of Terminals".                     |

Note a) Tests were conducted with the following coil designation: 200VAC (Rated voltage 200 to 240V 50Hz/60Hz)

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## 2.2 Test Sequence I

### 2.2.1 Temperature Rise and Dielectric Properties

These tests were conducted according to the test conditions indicated in Table 1 and Note a) to e). The temperature rise of each part met the standard criteria of temperature rise limit. Also the operations and dielectric properties after the temperature tests met the standard criteria.

Table 1

| Item          | Combined Thermal Overload Relay |                           |                        | Test Conditions |                   |                                                                    | Results<br>Note a)          |              |                   |              |                                                              |                          |                            |                   |    | Judgment |
|---------------|---------------------------------|---------------------------|------------------------|-----------------|-------------------|--------------------------------------------------------------------|-----------------------------|--------------|-------------------|--------------|--------------------------------------------------------------|--------------------------|----------------------------|-------------------|----|----------|
|               | Model Name                      | Heater designation<br>[A] | Setting Current<br>[A] | Current [A]     |                   | Main Circuit Connection Wire Size<br>[mm <sup>2</sup> ]<br>Note b) | Temperature Rise [K]        |              |                   |              | Operation<br>Three times opening and closing thermal No trip | Dielectric Properties    |                            |                   |    |          |
|               |                                 |                           |                        | Main Circuit    | Auxiliary Circuit |                                                                    | Coil<br>[Resistance method] | Terminal     |                   | Contact      |                                                              | Impulse<br>Note d)       | Power Frequency<br>Note d) |                   |    |          |
|               |                                 |                           |                        |                 |                   |                                                                    |                             | Main Circuit | Auxiliary Circuit | Main Circuit |                                                              |                          |                            | Auxiliary Circuit |    |          |
|               |                                 |                           |                        |                 |                   |                                                                    |                             |              |                   |              |                                                              |                          |                            |                   |    |          |
| Standard      | -                               | -                         | -                      | -               | -                 | -                                                                  | 100 or less                 | 65 or less   | 65 or less        | Note c)      | -                                                            | 7.3kV 1.2/50 μs x5 times | 1890V 5 seconds            |                   |    |          |
| Model Name    |                                 |                           |                        |                 |                   |                                                                    |                             |              |                   |              |                                                              |                          |                            |                   |    |          |
| MSO-T10 (KP)  | TH-T18 (KP)                     | 9                         | 11                     | 11              | 10                | 1.5                                                                | 47                          | 48           | 39                | 50           | 52                                                           | OK                       | OK                         | OK                | OK |          |
| MSO-T12 (KP)  | TH-T18 (KP)                     | 11                        | 13                     | 13              | 10                | 2.5                                                                | 47                          | 56           | 41                | 55           | 54                                                           | OK                       | OK                         | OK                | OK |          |
| MSO-T20 (KP)  | TH-T18 (KP)                     | 15                        | 18                     | 18              | 10                | 2.5                                                                | 53                          | 58           | 42                | 72           | 54                                                           | OK                       | OK                         | OK                | OK |          |
| MSO-T21 (KP)  | TH-T25 (KP)                     | 15                        | 18                     | 18              | 10                | 2.5                                                                | 43                          | 51           | 41                | 43           | 47                                                           | OK                       | OK                         | OK                | OK |          |
| MSO-T25 (KP)  | TH-T25 (KP)                     | 22                        | 26                     | 26              | 10                | 6                                                                  | 43                          | 53           | 40                | 57           | 47                                                           | OK                       | OK                         | OK                | OK |          |
| MSO-T35 (KP)  | TH-T50 (KP)                     | 29                        | 34                     | 34              | 10                | 10                                                                 | 67                          | 47           | 30                | 58           | 42                                                           | OK                       | OK                         | OK                | OK |          |
| MSO-T50 (KP)  | TH-T50 (KP)                     | 42                        | 50                     | 50              | 10                | 10                                                                 | 67                          | 58           | 30                | 68           | 43                                                           | OK                       | OK                         | OK                | OK |          |
| MSO-T65 (KP)  | TH-T65 (KP)                     | 54                        | 65                     | 65              | 10                | 16                                                                 | 57                          | 49           | 25                | 60           | 42                                                           | OK                       | OK                         | OK                | OK |          |
| MSO-T80 (KP)  | TH-T100 (KP)                    | 67                        | 80                     | 80              | 10                | 25                                                                 | 63                          | 58           | 25                | 75           | 42                                                           | OK                       | OK                         | OK                | OK |          |
| MSO-T100 (KP) | TH-T100 (KP)                    | 82                        | 100                    | 100             | 10                | 35                                                                 | 51                          | 56           | 34                | 70           | 49                                                           | OK                       | OK                         | OK                | OK |          |
| S-T10         | -                               | -                         | -                      | 20              | 10                | 2.5                                                                | 45                          | 46           | 38                | 71           | 52                                                           | -                        | OK                         | OK                | OK |          |
| S-T12         | -                               | -                         | -                      | 20              | 10                | 2.5                                                                | 41                          | 55           | 38                | 76           | 52                                                           | -                        | OK                         | OK                | OK |          |
| S-T20         | -                               | -                         | -                      | 20              | 10                | 2.5                                                                | 41                          | 55           | 38                | 75           | 52                                                           | -                        | OK                         | OK                | OK |          |
| S-T21         | -                               | -                         | -                      | 32              | 10                | 6                                                                  | 31                          | 34           | 30                | 46           | 47                                                           | -                        | OK                         | OK                | OK |          |
| S-T25         | -                               | -                         | -                      | 32              | 10                | 6                                                                  | 31                          | 34           | 30                | 46           | 47                                                           | -                        | OK                         | OK                | OK |          |
| S-T32         | -                               | -                         | -                      | 32              | 10                | 6                                                                  | 29                          | 33           | -                 | 45           | -                                                            | -                        | OK                         | OK                | OK |          |
| S-T35         | -                               | -                         | -                      | 60              | 10                | 16                                                                 | 62                          | 35           | 30                | 45           | 46                                                           | -                        | OK                         | OK                | OK |          |
| S-T50         | -                               | -                         | -                      | 80              | 10                | 25                                                                 | 64                          | 41           | 29                | 58           | 45                                                           | -                        | OK                         | OK                | OK |          |
| S-T65         | -                               | -                         | -                      | 100             | 10                | 35                                                                 | 56                          | 39           | 25                | 61           | 42                                                           | -                        | OK                         | OK                | OK |          |
| S-T80         | -                               | -                         | -                      | 120             | 10                | 50                                                                 | 62                          | 45           | 25                | 71           | 42                                                           | -                        | OK                         | OK                | OK |          |
| S-T100        | -                               | -                         | -                      | 150             | 10                | 50                                                                 | 43                          | 46           | 34                | 83           | 49                                                           | -                        | OK                         | OK                | OK |          |

Note a) The test of temperature rise and operation was conducted by operating at an ambient temperature of 40°C, in open state with the iron plate mounted and by applying a voltage of 240V and a frequency of 60Hz to the operating coil.

Note b) The connection wire size of the auxiliary circuit: 1.5 mm<sup>2</sup>

Note c) The temperature rise of the contacts was checked at a temperature that is not harmful to the surrounding components. (In short 100K)

Note d) The application points of the impulse withstand voltage performance and the power frequency withstand voltage performance were as follows. However in the power frequency withstand voltage test, (c) was not implemented.

Measurement Points: (a) Between all terminals of the main circuit and grounded metal body when the contact element was closed.

(b) Between one pole of the main circuit and all other poles connected altogether to the grounded metal body when the contact element was closed.

(c) Between the supply side terminals and the load side terminals of the main circuit when the contact element was opened.

(d) Between one circuit of the operating circuit and auxiliary circuit, and all other circuits/grounded metal body.

Note e) Number of Samples: 1 per machine

## 2.2.2 Operating Limits

### (1) Operating Limits of the Magnetic Contactor

The operating voltage (hot condition) and open-circuit voltage after the temperature test met the standard criteria by operating and opening without hindrance in the set voltage.

Table 2

| Model Name    | Item<br>Standard | Test Conditions and Results                               |                                                     |                                                     | Judgment |
|---------------|------------------|-----------------------------------------------------------|-----------------------------------------------------|-----------------------------------------------------|----------|
|               |                  | Operating Voltage (40°C Hot)                              |                                                     | Open-circuit Voltage (-5°C Cold)                    |          |
|               |                  | Operation at 85% (170V or less) of the coil rated voltage | Operation at 110% of the coil rated voltage Note a) | Open at 20 to 75% of the coil rated voltage Note b) |          |
| MSO-T10 (KP)  | 50Hz             | 129                                                       | OK                                                  | 90                                                  | OK       |
|               | 60Hz             | 142                                                       | OK                                                  | 107                                                 | OK       |
| MSO-T12 (KP)  | 50Hz             | 149                                                       | OK                                                  | 95                                                  | OK       |
|               | 60Hz             | 164                                                       | OK                                                  | 109                                                 | OK       |
| MSO-T20 (KP)  | 50Hz             | 151                                                       | OK                                                  | 96                                                  | OK       |
|               | 60Hz             | 165                                                       | OK                                                  | 112                                                 | OK       |
| MSO-T21 (KP)  | 50Hz             | 144                                                       | OK                                                  | 104                                                 | OK       |
|               | 60Hz             | 156                                                       | OK                                                  | 115                                                 | OK       |
| MSO-T25 (KP)  | 50Hz             | 147                                                       | OK                                                  | 108                                                 | OK       |
|               | 60Hz             | 159                                                       | OK                                                  | 118                                                 | OK       |
| MSO-T35 (KP)  | 50Hz             | 137                                                       | OK                                                  | 107                                                 | OK       |
|               | 60Hz             | 146                                                       | OK                                                  | 117                                                 | OK       |
| MSO-T50 (KP)  | 50Hz             | 137                                                       | OK                                                  | 107                                                 | OK       |
|               | 60Hz             | 146                                                       | OK                                                  | 117                                                 | OK       |
| MSO-T65 (KP)  | 50Hz             | 146                                                       | OK                                                  | 85                                                  | OK       |
|               | 60Hz             | 148                                                       | OK                                                  | 77                                                  | OK       |
| MSO-T80 (KP)  | 50Hz             | 146                                                       | OK                                                  | 85                                                  | OK       |
|               | 60Hz             | 148                                                       | OK                                                  | 77                                                  | OK       |
| MSO-T100 (KP) | 50Hz             | 157                                                       | OK                                                  | 100                                                 | OK       |
|               | 60Hz             | 159                                                       | OK                                                  | 93                                                  | OK       |
| S-T10         | 50Hz             | 128                                                       | OK                                                  | 89                                                  | OK       |
|               | 60Hz             | 142                                                       | OK                                                  | 106                                                 | OK       |
| S-T12         | 50Hz             | 145                                                       | OK                                                  | 90                                                  | OK       |
|               | 60Hz             | 161                                                       | OK                                                  | 107                                                 | OK       |
| S-T20         | 50Hz             | 145                                                       | OK                                                  | 90                                                  | OK       |
|               | 60Hz             | 161                                                       | OK                                                  | 108                                                 | OK       |
| S-T21         | 50Hz             | 130                                                       | OK                                                  | 103                                                 | OK       |
|               | 60Hz             | 141                                                       | OK                                                  | 112                                                 | OK       |
| S-T25         | 50Hz             | 131                                                       | OK                                                  | 104                                                 | OK       |
|               | 60Hz             | 142                                                       | OK                                                  | 114                                                 | OK       |
| S-T32         | 50Hz             | 142                                                       | OK                                                  | 96                                                  | OK       |
|               | 60Hz             | 156                                                       | OK                                                  | 108                                                 | OK       |
| S-T35         | 50Hz             | 135                                                       | OK                                                  | 107                                                 | OK       |
|               | 60Hz             | 148                                                       | OK                                                  | 117                                                 | OK       |
| S-T50         | 50Hz             | 135                                                       | OK                                                  | 107                                                 | OK       |
|               | 60Hz             | 148                                                       | OK                                                  | 117                                                 | OK       |
| S-T65         | 50Hz             | 146                                                       | OK                                                  | 85                                                  | OK       |
|               | 60Hz             | 148                                                       | OK                                                  | 77                                                  | OK       |
| S-T80         | 50Hz             | 146                                                       | OK                                                  | 85                                                  | OK       |
|               | 60Hz             | 148                                                       | OK                                                  | 77                                                  | OK       |
| S-T100        | 50Hz             | 153                                                       | OK                                                  | 98                                                  | OK       |
|               | 60Hz             | 155                                                       | OK                                                  | 91                                                  | OK       |

Note a) The operation at 110% of the coil rated voltage of standard value was possible at 264V 50Hz/60Hz.

Note b) The operation at 20 to 75% of the coil rated voltage of standard value was possible at 48V to 150V 50Hz/60Hz.

Note c) Number of Samples: 1 per machine

### <Reference Test>

#### Coil characteristics (20°C cold condition)

| Model Name | Input [VA] |       | Con-<br>sumption<br>Power<br>[W] | Operating Voltage [V] |           | Coil Current [mA] |       | Operating Time [ms] |                        |                         |                  |                         |                        |
|------------|------------|-------|----------------------------------|-----------------------|-----------|-------------------|-------|---------------------|------------------------|-------------------------|------------------|-------------------------|------------------------|
|            | Instant    | Usual |                                  | Operation             | Open      | Instant           | Usual | Coil ON →           |                        |                         | Coil OFF →       |                         |                        |
|            |            |       |                                  |                       |           |                   |       | Main Contact ON     | Auxiliary Contact a ON | Auxiliary Contact b OFF | Main Contact OFF | Auxiliary Contact a OFF | Auxiliary Contact b ON |
| S-T10      | 45         | 7     | 2.2                              | 120 to 150            | 75 to 115 | 200               | 30    | 12 to 18            | 12 to 18               | -                       | 5 to 20          | 5 to 20                 | -                      |
| S-T12      | 45         | 7     | 2.2                              | 120 to 150            | 75 to 115 | 200               | 30    | 12 to 18            | 12 to 18               | 9 to 16                 | 5 to 20          | 5 to 20                 | 7 to 22                |
| S-T20      | 45         | 7     | 2.2                              | 120 to 150            | 75 to 115 | 200               | 30    | 12 to 18            | 12 to 18               | 9 to 16                 | 5 to 20          | 5 to 20                 | 7 to 22                |
| S-T21      | 75         | 7     | 2.4                              | 125 to 155            | 80 to 115 | 340               | 30    | 13 to 20            | 13 to 20               | 8 to 14                 | 5 to 15          | 5 to 15                 | 8 to 18                |
| S-T25      | 75         | 7     | 2.4                              | 125 to 155            | 80 to 115 | 340               | 30    | 13 to 20            | 13 to 20               | 8 to 14                 | 5 to 15          | 5 to 15                 | 8 to 18                |
| S-T32      | 55         | 4.5   | 1.8                              | 125 to 155            | 80 to 115 | 250               | 20    | 15 to 22            | -                      | -                       | 5 to 15          | -                       | -                      |
| S-T35      | 110        | 10    | 3.8                              | 120 to 150            | 80 to 115 | 500               | 45    | 10 to 20            | 10 to 20               | 8 to 15                 | 5 to 14          | 5 to 14                 | 8 to 18                |
| S-T50      | 110        | 10    | 3.8                              | 120 to 150            | 80 to 115 | 500               | 45    | 10 to 20            | 10 to 20               | 8 to 15                 | 5 to 14          | 5 to 14                 | 8 to 18                |
| S-T65      | 115        | 20    | 2.2                              | 110 to 135            | 60 to 100 | 520               | 67    | 20 to 30            | 20 to 30               | 13 to 24                | 35 to 65         | 35 to 65                | 50 to 79               |
| S-T80      | 115        | 20    | 2.2                              | 110 to 135            | 60 to 100 | 520               | 67    | 20 to 30            | 20 to 30               | 13 to 24                | 35 to 65         | 35 to 65                | 50 to 79               |
| S-T100     | 210        | 23    | 2.8                              | 110 to 135            | 60 to 100 | 950               | 85    | 20 to 35            | 20 to 35               | 18 to 28                | 50 to 100        | 50 to 100               | 54 to 104              |

Note a) The above table shows the standard values of the properties of the 200VAC coil.

Note b) Coil current is the average value when 220V 60Hz was applied.

## (2) Operating Characteristics of Thermal Overload Relay

### 1) Operations in a Balanced Circuit (Ambient Temperature: 20°C)

- (a) If the thermal overload relay does not function at 105% of settling current in cold conditions for more than 2 hours, the operation should be performed with 120% of the settling current for less than 2 hours after the constant temperature is maintained.
- (b) When 150% of the settling current is passed after the settling current is passed and the constant temperature is maintained, the relay should operate within the limits shown in the table below with respect to the corresponding trip class.
- (c) The operation should be performed within the limits shown in the table below with respect to the corresponding trip class, when 720% of the settling current is passed in cold conditions.

| Trip Class | 150% of the settling current | 720% of the settling current |
|------------|------------------------------|------------------------------|
| 5          | Less than 2 minutes          | $TP \leq 5$ seconds          |
| 10A        | Less than 2 minutes          | $2 < TP \leq 10$ seconds     |
| 10         | Less than 4 minutes          | $4 < TP \leq 10$ seconds     |
| 20         | Less than 8 minutes          | $6 < TP \leq 20$ seconds     |
| 30         | Less than 12 minutes         | $9 < TP \leq 30$ seconds     |

TP : Operating time at the time of constraint

Result: All the frames satisfy the above conditions.

### 2) Operations in an Unbalanced Circuit (Ambient Temperature: 20°C)

- (a) If the open phase detection function does not execute when settling current is passed to all poles at the same time for 2 hours, the operation should be performed within 2 hours when 1-pole is disconnected and 132% of settling current is passed to the other 2-pole after the constant temperature is maintained.
- (b) If the open phase detection function does not execute when settling current is passed to 2-pole and 90% of settling current to 1 pole for 2 hours, the operation should be performed within 2 hours when 1-pole is disconnected and 115% of settling current is passed to the other 2-pole after the constant temperature is maintained.
- (c) The operation should be performed within the limits shown in the table below with respect to the corresponding trip class, when 720% of the settling current is passed in cold conditions.

Result: MSO-T□KP types satisfy the above conditions.

HOTLINE: 1900.6536

## 2.3 Test Sequence II

### 2.3.1 Test of Making and Breaking Capacities

#### (1) Test of Making Capacity

These tests were conducted according to the test conditions indicated in Table 4 and Note a) to c). No abnormalities such as welding of contacts were found, and the results met the standard criteria.

Table 4

| Item<br>Model Name | Rated Value (AC- 3)           |                               | Test Conditions (making) |                     |                                                                          |                                       |                      |                       | Results            | Judgment |
|--------------------|-------------------------------|-------------------------------|--------------------------|---------------------|--------------------------------------------------------------------------|---------------------------------------|----------------------|-----------------------|--------------------|----------|
|                    | Voltage U <sub>e</sub><br>[V] | Current I <sub>e</sub><br>[A] | Voltage U<br>[V]         | Current I<br>[A]    | Power Factor<br>cosφ                                                     | Operation Cycle<br>[Times]<br>Note b) | ON time<br>[seconds] | OFF time<br>[seconds] |                    |          |
|                    | -                             | -                             | 1.05 x U <sub>e</sub>    | 10 x I <sub>e</sub> | I <sub>e</sub> ≤100A:<br>0.45±0.05<br>I <sub>e</sub> >100A:<br>0.35±0.05 | 50                                    | 0.05                 | 10                    | Contact<br>Welding |          |
| S-T10              | 220                           | 11                            | 231                      | 110                 | 0.45                                                                     | 50                                    | 0.05                 | 10                    | None               | OK       |
|                    | 440                           | 9                             | 462                      | 90                  | 0.45                                                                     | 50                                    | 0.05                 | 10                    | None               | OK       |
| S-T12              | 220                           | 13                            | 231                      | 130                 | 0.45                                                                     | 50                                    | 0.05                 | 10                    | None               | OK       |
|                    | 440                           | 12                            | 462                      | 120                 | 0.45                                                                     | 50                                    | 0.05                 | 10                    | None               | OK       |
| S-T20              | 220                           | 18                            | 231                      | 180                 | 0.45                                                                     | 50                                    | 0.05                 | 10                    | None               | OK       |
|                    | 440                           | 18                            | 462                      | 180                 | 0.45                                                                     | 50                                    | 0.05                 | 10                    | None               | OK       |
| S-T21              | 220                           | 25                            | 231                      | 250                 | 0.45                                                                     | 50                                    | 0.05                 | 10                    | None               | OK       |
|                    | 440                           | 23                            | 462                      | 230                 | 0.45                                                                     | 50                                    | 0.05                 | 10                    | None               | OK       |
| S-T25              | 220                           | 30                            | 231                      | 300                 | 0.45                                                                     | 50                                    | 0.05                 | 10                    | None               | OK       |
|                    | 440                           | 30                            | 462                      | 300                 | 0.45                                                                     | 50                                    | 0.05                 | 10                    | None               | OK       |
| S-T32              | 220                           | 32                            | 231                      | 320                 | 0.45                                                                     | 50                                    | 0.05                 | 10                    | None               | OK       |
|                    | 440                           | 32                            | 462                      | 320                 | 0.45                                                                     | 50                                    | 0.05                 | 10                    | None               | OK       |
| S-T35              | 220                           | 40                            | 231                      | 400                 | 0.45                                                                     | 50                                    | 0.05                 | 10                    | None               | OK       |
|                    | 440                           | 40                            | 462                      | 400                 | 0.45                                                                     | 50                                    | 0.05                 | 10                    | None               | OK       |
| S-T50              | 220                           | 55                            | 231                      | 550                 | 0.45                                                                     | 50                                    | 0.05                 | 10                    | None               | OK       |
|                    | 440                           | 48                            | 462                      | 480                 | 0.45                                                                     | 50                                    | 0.05                 | 10                    | None               | OK       |
| S-T65              | 220                           | 65                            | 231                      | 650                 | 0.45                                                                     | 50                                    | 0.05                 | 10                    | None               | OK       |
|                    | 440                           | 65                            | 462                      | 650                 | 0.45                                                                     | 50                                    | 0.05                 | 10                    | None               | OK       |
| S-T80              | 220                           | 85                            | 231                      | 850                 | 0.45                                                                     | 50                                    | 0.05                 | 10                    | None               | OK       |
|                    | 440                           | 85                            | 462                      | 850                 | 0.45                                                                     | 50                                    | 0.05                 | 10                    | None               | OK       |
| S-T100             | 220                           | 105                           | 231                      | 1050                | 0.35                                                                     | 50                                    | 0.05                 | 10                    | None               | OK       |
|                    | 440                           | 105                           | 462                      | 1050                | 0.35                                                                     | 50                                    | 0.05                 | 10                    | None               | OK       |

Note a) Main circuit frequency: 60Hz

Note b) Among 50 operating cycles, 110% of the rated value (264V 60Hz) was applied to the coil for 25 cycles, and 85% of the rated value (170V 60Hz) was applied to the coil for the other 25 cycles.

Note c) Number of Samples: 1 per machine

HOTLINE: 1900.6536

## (2) Test of Making and Breaking Capacities

These tests were conducted according to the test conditions indicated in Table 5 and Note a) to c) after the making capacity test (1). No abnormalities such as welding of contacts and phase-to-phase short circuits were found, and the results met the standard criteria.

Table 5

| Item       | Rated Value<br>(AC- 3) |                   | Test Conditions (making and breaking capacity) |                   |                                                |                            |                      |                                                                                                                          | Results                                                        | Judgment |
|------------|------------------------|-------------------|------------------------------------------------|-------------------|------------------------------------------------|----------------------------|----------------------|--------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|----------|
|            | Voltage Ue<br>[V]      | Current Ie<br>[A] | Voltage Ur<br>[V]                              | Current Ic<br>[A] | Power Factor<br>cosφ                           | Operation Cycle<br>[Times] | ON time<br>[seconds] | OFF time<br>[seconds]                                                                                                    |                                                                |          |
|            | -                      | -                 | 1.05 x Ue                                      | 8 x Ie            | Ie≤100A:<br>0.45±0.05<br>Ie>100A:<br>0.35±0.05 | 50                         | 0.05                 | Ic≤100: 10<br>100<Ic≤200: 20<br>200<Ic≤300: 30<br>300<Ic≤400: 40<br>400<Ic≤600: 60<br>600<Ic≤800: 80<br>800<Ic≤1000: 100 |                                                                |          |
| Model Name |                        |                   |                                                |                   |                                                |                            |                      |                                                                                                                          | Contact<br>Welding and<br>Phase-to-<br>phase<br>Short-circuits |          |
| S-T10      | 220                    | 11                | 231                                            | 88                | 0.45                                           | 50                         | 0.05                 | 10                                                                                                                       | None                                                           | OK       |
|            | 440                    | 9                 | 462                                            | 72                | 0.45                                           | 50                         | 0.05                 | 10                                                                                                                       | None                                                           | OK       |
| S-T12      | 220                    | 13                | 231                                            | 104               | 0.45                                           | 50                         | 0.05                 | 20                                                                                                                       | None                                                           | OK       |
|            | 440                    | 12                | 462                                            | 96                | 0.45                                           | 50                         | 0.05                 | 10                                                                                                                       | None                                                           | OK       |
| S-T20      | 220                    | 18                | 231                                            | 144               | 0.45                                           | 50                         | 0.05                 | 20                                                                                                                       | None                                                           | OK       |
|            | 440                    | 18                | 462                                            | 144               | 0.45                                           | 50                         | 0.05                 | 20                                                                                                                       | None                                                           | OK       |
| S-T21      | 220                    | 25                | 231                                            | 200               | 0.45                                           | 50                         | 0.05                 | 20                                                                                                                       | None                                                           | OK       |
|            | 440                    | 23                | 462                                            | 184               | 0.45                                           | 50                         | 0.05                 | 20                                                                                                                       | None                                                           | OK       |
| S-T25      | 220                    | 30                | 231                                            | 240               | 0.45                                           | 50                         | 0.05                 | 30                                                                                                                       | None                                                           | OK       |
|            | 440                    | 30                | 462                                            | 240               | 0.45                                           | 50                         | 0.05                 | 30                                                                                                                       | None                                                           | OK       |
| S-T32      | 220                    | 32                | 231                                            | 256               | 0.45                                           | 50                         | 0.05                 | 30                                                                                                                       | None                                                           | OK       |
|            | 440                    | 32                | 462                                            | 256               | 0.45                                           | 50                         | 0.05                 | 30                                                                                                                       | None                                                           | OK       |
| S-T35      | 220                    | 40                | 231                                            | 320               | 0.45                                           | 50                         | 0.05                 | 40                                                                                                                       | None                                                           | OK       |
|            | 440                    | 40                | 462                                            | 320               | 0.45                                           | 50                         | 0.05                 | 40                                                                                                                       | None                                                           | OK       |
| S-T50      | 220                    | 55                | 231                                            | 440               | 0.45                                           | 50                         | 0.05                 | 60                                                                                                                       | None                                                           | OK       |
|            | 440                    | 48                | 462                                            | 384               | 0.45                                           | 50                         | 0.05                 | 40                                                                                                                       | None                                                           | OK       |
| S-T65      | 220                    | 65                | 231                                            | 520               | 0.45                                           | 50                         | 0.05                 | 60                                                                                                                       | None                                                           | OK       |
|            | 440                    | 65                | 462                                            | 520               | 0.45                                           | 50                         | 0.05                 | 60                                                                                                                       | None                                                           | OK       |
| S-T80      | 220                    | 85                | 231                                            | 680               | 0.45                                           | 50                         | 0.05                 | 80                                                                                                                       | None                                                           | OK       |
|            | 440                    | 85                | 462                                            | 680               | 0.45                                           | 50                         | 0.05                 | 80                                                                                                                       | None                                                           | OK       |
| S-T100     | 220                    | 105               | 231                                            | 840               | 0.35                                           | 50                         | 0.05                 | 100                                                                                                                      | None                                                           | OK       |
|            | 440                    | 105               | 462                                            | 840               | 0.35                                           | 50                         | 0.05                 | 100                                                                                                                      | None                                                           | OK       |

Note a) Main circuit frequency: 60Hz

Note b) The operation was conducted by applying a voltage of 240V and a frequency 60Hz to the operating coil.

Note c) Number of Samples: 1 per machine

## (3) The Switching Capacity and Reversibility

These tests were conducted according to the test conditions indicated in Table 6, 7 and Note a) to d). No abnormalities such as welding of contacts and phase-to-phase short circuits were found, and the results met the standard criteria.

Table 6

| Item       | Rated Value<br>(AC- 4) |                   | Test Conditions (making) |                   |                                                |                            |                      |                       | Results                                                        | Judgment |
|------------|------------------------|-------------------|--------------------------|-------------------|------------------------------------------------|----------------------------|----------------------|-----------------------|----------------------------------------------------------------|----------|
|            | Voltage Ue<br>[V]      | Current Ie<br>[A] | Voltage Ur<br>[V]        | Current Ic<br>[A] | Power Factor<br>cosφ                           | Operation Cycle<br>[Times] | ON time<br>[seconds] | OFF time<br>[seconds] |                                                                |          |
|            | -                      | -                 | 1.05 x Ue                | 12 x Ie           | Ie≤100A:<br>0.45±0.05<br>Ie>100A:<br>0.35±0.05 | 50                         | 0.05                 | 10                    |                                                                |          |
| Model Name |                        |                   |                          |                   |                                                |                            |                      |                       | Contact<br>Welding and<br>Phase-to-<br>phase<br>Short-circuits |          |
| S-2 x T10  | 220                    | 8                 | 231                      | 96                | 0.45                                           | 50                         | 0.05                 | 10                    | None                                                           | OK       |
|            | 440                    | 6                 | 462                      | 72                | 0.45                                           | 50                         | 0.05                 | 10                    | None                                                           | OK       |
| S-2 x T12  | 220                    | 11                | 231                      | 132               | 0.45                                           | 50                         | 0.05                 | 10                    | None                                                           | OK       |
|            | 440                    | 9                 | 462                      | 108               | 0.45                                           | 50                         | 0.05                 | 10                    | None                                                           | OK       |
| S-2 x T20  | 220                    | 18                | 231                      | 216               | 0.45                                           | 50                         | 0.05                 | 10                    | None                                                           | OK       |
|            | 440                    | 13                | 462                      | 156               | 0.45                                           | 50                         | 0.05                 | 10                    | None                                                           | OK       |
| S-2 x T21  | 220                    | 18                | 231                      | 216               | 0.45                                           | 50                         | 0.05                 | 10                    | None                                                           | OK       |
|            | 440                    | 13                | 462                      | 156               | 0.45                                           | 50                         | 0.05                 | 10                    | None                                                           | OK       |
| S-2 x T25  | 220                    | 20                | 231                      | 240               | 0.45                                           | 50                         | 0.05                 | 10                    | None                                                           | OK       |
|            | 440                    | 17                | 462                      | 204               | 0.45                                           | 50                         | 0.05                 | 10                    | None                                                           | OK       |
| S-2 x T35  | 220                    | 26                | 231                      | 312               | 0.45                                           | 50                         | 0.05                 | 10                    | None                                                           | OK       |
|            | 440                    | 24                | 462                      | 288               | 0.45                                           | 50                         | 0.05                 | 10                    | None                                                           | OK       |
| S-2 x T50  | 220                    | 35                | 231                      | 420               | 0.45                                           | 50                         | 0.05                 | 10                    | None                                                           | OK       |
|            | 440                    | 32                | 462                      | 384               | 0.45                                           | 50                         | 0.05                 | 10                    | None                                                           | OK       |
| S-2 x T65  | 220                    | 50                | 231                      | 600               | 0.45                                           | 50                         | 0.05                 | 10                    | None                                                           | OK       |
|            | 440                    | 47                | 462                      | 564               | 0.45                                           | 50                         | 0.05                 | 10                    | None                                                           | OK       |
| S-2 x T80  | 220                    | 65                | 231                      | 780               | 0.45                                           | 50                         | 0.05                 | 10                    | None                                                           | OK       |
|            | 440                    | 62                | 462                      | 744               | 0.45                                           | 50                         | 0.05                 | 10                    | None                                                           | OK       |
| S-2 x T100 | 220                    | 80                | 231                      | 960               | 0.45                                           | 50                         | 0.05                 | 10                    | None                                                           | OK       |
|            | 440                    | 75                | 462                      | 900               | 0.45                                           | 50                         | 0.05                 | 10                    | None                                                           | OK       |

Table 7

| Item<br><br><br><br><br>Standard<br><br><br>Model Name | Rated Value<br>(AC- 4) |                   | Test Conditions (making and breaking capacity) |                   |                                              |                            |                                         |                      |                                                                                                      | Results                                                        | Judgment |
|--------------------------------------------------------|------------------------|-------------------|------------------------------------------------|-------------------|----------------------------------------------|----------------------------|-----------------------------------------|----------------------|------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|----------|
|                                                        | Voltage Ue<br>[V]      | Current Ie<br>[A] | Voltage Ur<br>[V]                              | Current Ic<br>[A] | Power Factor<br>cosφ                         | Operation Cycle<br>[Times] |                                         | ON time<br>[seconds] | OFF time<br>[seconds]                                                                                |                                                                |          |
|                                                        |                        |                   |                                                |                   |                                              |                            | Simulta-<br>neous<br>Excitation<br>Test |                      |                                                                                                      |                                                                |          |
|                                                        |                        |                   |                                                |                   |                                              |                            |                                         |                      |                                                                                                      |                                                                |          |
|                                                        | -                      | -                 | 1.05 x Ue                                      | 10 x Ie           | Ie≤100A<br>0.45±0.05<br>Ie>100A<br>0.35±0.05 | 50                         | 10                                      | 0.05                 | Ic≤100: 10<br>100<Ic≤200: 20<br>200<Ic≤300: 30<br>300<Ic≤400: 40<br>400<Ic≤600: 60<br>600<Ic≤800: 80 | Contact<br>Welding and<br>Phase-to-<br>phase<br>Short-circuits |          |
| S-2 x T10                                              | 220                    | 8                 | 231                                            | 80                | 0.45                                         | 50                         | 10                                      | 0.05                 | 10                                                                                                   | None                                                           | OK       |
|                                                        | 440                    | 6                 | 462                                            | 60                | 0.45                                         | 50                         | 10                                      | 0.05                 | 10                                                                                                   | None                                                           | OK       |
| S-2 x T12                                              | 220                    | 11                | 231                                            | 110               | 0.45                                         | 50                         | 10                                      | 0.05                 | 20                                                                                                   | None                                                           | OK       |
|                                                        | 440                    | 9                 | 462                                            | 90                | 0.45                                         | 50                         | 10                                      | 0.05                 | 10                                                                                                   | None                                                           | OK       |
| S-2 x T20                                              | 220                    | 18                | 231                                            | 180               | 0.45                                         | 50                         | 10                                      | 0.05                 | 20                                                                                                   | None                                                           | OK       |
|                                                        | 440                    | 13                | 462                                            | 130               | 0.45                                         | 50                         | 10                                      | 0.05                 | 20                                                                                                   | None                                                           | OK       |
| S-2 x T21                                              | 220                    | 18                | 231                                            | 180               | 0.45                                         | 50                         | 10                                      | 0.05                 | 20                                                                                                   | None                                                           | OK       |
|                                                        | 440                    | 13                | 462                                            | 130               | 0.45                                         | 50                         | 10                                      | 0.05                 | 20                                                                                                   | None                                                           | OK       |
| S-2 x T25                                              | 220                    | 20                | 231                                            | 200               | 0.45                                         | 50                         | 10                                      | 0.05                 | 20                                                                                                   | None                                                           | OK       |
|                                                        | 440                    | 17                | 462                                            | 170               | 0.45                                         | 50                         | 10                                      | 0.05                 | 20                                                                                                   | None                                                           | OK       |
| S-2 x T35                                              | 220                    | 26                | 231                                            | 260               | 0.45                                         | 50                         | 10                                      | 0.05                 | 30                                                                                                   | None                                                           | OK       |
|                                                        | 440                    | 24                | 462                                            | 240               | 0.45                                         | 50                         | 10                                      | 0.05                 | 30                                                                                                   | None                                                           | OK       |
| S-2 x T50                                              | 220                    | 35                | 231                                            | 350               | 0.45                                         | 50                         | 10                                      | 0.05                 | 40                                                                                                   | None                                                           | OK       |
|                                                        | 440                    | 32                | 462                                            | 320               | 0.45                                         | 50                         | 10                                      | 0.05                 | 40                                                                                                   | None                                                           | OK       |
| S-2 x T65                                              | 220                    | 50                | 231                                            | 500               | 0.45                                         | 50                         | 10                                      | 0.05                 | 60                                                                                                   | None                                                           | OK       |
|                                                        | 440                    | 47                | 462                                            | 470               | 0.45                                         | 50                         | 10                                      | 0.05                 | 60                                                                                                   | None                                                           | OK       |
| S-2 x T80                                              | 220                    | 65                | 231                                            | 650               | 0.45                                         | 50                         | 10                                      | 0.05                 | 80                                                                                                   | None                                                           | OK       |
|                                                        | 440                    | 62                | 462                                            | 620               | 0.45                                         | 50                         | 10                                      | 0.05                 | 80                                                                                                   | None                                                           | OK       |
| S-2 x T100                                             | 220                    | 80                | 231                                            | 800               | 0.45                                         | 50                         | 10                                      | 0.05                 | 80                                                                                                   | None                                                           | OK       |
|                                                        | 440                    | 75                | 462                                            | 750               | 0.45                                         | 50                         | 10                                      | 0.05                 | 80                                                                                                   | None                                                           | OK       |

Note a) The test was conducted using reversible-type magnetic contactor.

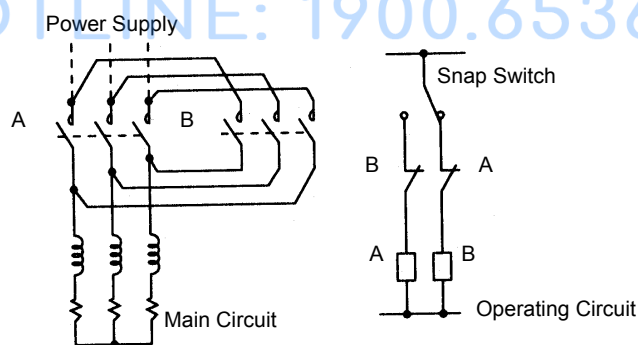
Note b) The operation was conducted at main circuit frequency of 60Hz by applying a voltage of 240V and a frequency of 60Hz to the operating coil.

Note c) Making A → Open circuit A, then immediately making B → Open circuit B → OFF time (above table) pause → Making B → Open circuit B, then immediately making A → Open circuit A → OFF time (above table) pause, this makes 1 cycle. 50 cycles were performed in this way.

Here, (1) "A" shows the forward rotation contactor and "B" shows the reverse rotation contactor.

(2) "Immediately" refers to the shortest reversible exchange time.

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Note d) Number of Samples: 1 per machine

## 2.3.2 The Operating Performance

### (1) Non-reversing

These tests were conducted according to the test conditions indicated in Table 8 and Note a) to c). No abnormalities such as welding of contacts and phase-to-phase short circuits were found, and the results met the standard criteria. After the test, the withstand voltage performance was checked by applying a voltage of 1000V and a frequency of 60Hz for 5 seconds. The results were acceptable.

Table 8

| Item   | Rated Value<br>(AC- 3) |                   | Test Conditions (making and breaking capacity) |                   |                                                    |                            |                      |                                                | Results                                             |                                              | Judgment |
|--------|------------------------|-------------------|------------------------------------------------|-------------------|----------------------------------------------------|----------------------------|----------------------|------------------------------------------------|-----------------------------------------------------|----------------------------------------------|----------|
|        | Voltage Ue<br>[V]      | Current Ie<br>[A] | Voltage Ur<br>[V]                              | Current Ic<br>[A] | Power Factor<br>cosφ                               | Operation Cycle<br>[Times] | ON time<br>[seconds] | OFF time<br>[seconds]                          | Making and<br>Breaking Capacity                     | Withstand Voltage                            |          |
|        | -                      | -                 | 1.05 x Ue                                      | 2 x Ie            | Ie≤100A:<br>0.45±0.05<br><br>Ie>100A:<br>0.35±0.05 | 6000                       | 0.05                 | Ic≤100: 10<br>100<Ic≤200: 20<br>200<Ic≤300: 30 | Contact Welding and<br>Phase-to-phase Short-circuit | 2 x Ue provided 1000V or higher<br>5 seconds |          |
| S-T10  | 220                    | 11                | 231                                            | 22                | 0.45                                               | 6000                       | 0.05                 | 10                                             | None                                                | OK                                           | OK       |
|        | 440                    | 9                 | 462                                            | 18                | 0.45                                               | 6000                       | 0.05                 | 10                                             | None                                                | OK                                           | OK       |
| S-T12  | 220                    | 13                | 231                                            | 26                | 0.45                                               | 6000                       | 0.05                 | 10                                             | None                                                | OK                                           | OK       |
|        | 440                    | 12                | 462                                            | 24                | 0.45                                               | 6000                       | 0.05                 | 10                                             | None                                                | OK                                           | OK       |
| S-T20  | 220                    | 18                | 231                                            | 36                | 0.45                                               | 6000                       | 0.05                 | 10                                             | None                                                | OK                                           | OK       |
|        | 440                    | 18                | 462                                            | 36                | 0.45                                               | 6000                       | 0.05                 | 10                                             | None                                                | OK                                           | OK       |
| S-T21  | 220                    | 25                | 231                                            | 50                | 0.45                                               | 6000                       | 0.05                 | 10                                             | None                                                | OK                                           | OK       |
|        | 440                    | 23                | 462                                            | 46                | 0.45                                               | 6000                       | 0.05                 | 10                                             | None                                                | OK                                           | OK       |
| S-T25  | 220                    | 30                | 231                                            | 60                | 0.45                                               | 6000                       | 0.05                 | 10                                             | None                                                | OK                                           | OK       |
|        | 440                    | 30                | 462                                            | 60                | 0.45                                               | 6000                       | 0.05                 | 10                                             | None                                                | OK                                           | OK       |
| S-T32  | 220                    | 32                | 231                                            | 64                | 0.45                                               | 6000                       | 0.05                 | 10                                             | None                                                | OK                                           | OK       |
|        | 440                    | 32                | 462                                            | 64                | 0.45                                               | 6000                       | 0.05                 | 10                                             | None                                                | OK                                           | OK       |
| S-T35  | 220                    | 40                | 231                                            | 80                | 0.45                                               | 6000                       | 0.05                 | 10                                             | None                                                | OK                                           | OK       |
|        | 440                    | 40                | 462                                            | 80                | 0.45                                               | 6000                       | 0.05                 | 10                                             | None                                                | OK                                           | OK       |
| S-T50  | 220                    | 55                | 231                                            | 110               | 0.45                                               | 6000                       | 0.05                 | 20                                             | None                                                | OK                                           | OK       |
|        | 440                    | 48                | 462                                            | 96                | 0.45                                               | 6000                       | 0.05                 | 10                                             | None                                                | OK                                           | OK       |
| S-T65  | 220                    | 65                | 231                                            | 130               | 0.45                                               | 6000                       | 0.05                 | 20                                             | None                                                | OK                                           | OK       |
|        | 440                    | 65                | 462                                            | 130               | 0.45                                               | 6000                       | 0.05                 | 20                                             | None                                                | OK                                           | OK       |
| S-T80  | 220                    | 85                | 231                                            | 170               | 0.45                                               | 6000                       | 0.05                 | 20                                             | None                                                | OK                                           | OK       |
|        | 440                    | 85                | 462                                            | 170               | 0.45                                               | 6000                       | 0.05                 | 20                                             | None                                                | OK                                           | OK       |
| S-T100 | 220                    | 105               | 231                                            | 210               | 0.35                                               | 6000                       | 0.05                 | 30                                             | None                                                | OK                                           | OK       |
|        | 440                    | 105               | 462                                            | 210               | 0.35                                               | 6000                       | 0.05                 | 30                                             | None                                                | OK                                           | OK       |

Note a) Main circuit frequency: 60Hz

Note b) The operation was conducted by applying a voltage of 240V and a frequency of 60Hz to the operating coil.

Note c) Number of Samples: 1 per machine

(2) Reversing

These tests were conducted according to the test conditions indicated in Table 9 and Note a) to e). No abnormalities such as welding of contacts and phase-to-phase short circuits were found, and the results met the standard criteria. After the test, the withstand voltage performance was checked by applying a voltage of 1000V and a frequency of 60Hz for 5 seconds. The results were acceptable.

Table 9

| Item       | Rated Value<br>(AC- 4)        |                               | Test Conditions (making and breaking capacity) |                               |                                                                              |                                       |                      |                                                                                                                                                     | Results                                             |                                                          | Judgment |
|------------|-------------------------------|-------------------------------|------------------------------------------------|-------------------------------|------------------------------------------------------------------------------|---------------------------------------|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|----------------------------------------------------------|----------|
|            | Voltage U <sub>e</sub><br>[V] | Current I <sub>e</sub><br>[A] | Voltage U <sub>r</sub><br>[V]                  | Current I <sub>c</sub><br>[A] | Power Factor<br>cosφ                                                         | Operation Cycle<br>[Times]<br>Note d) | ON time<br>[seconds] | OFF time<br>[seconds]                                                                                                                               | Making and<br>Breaking Capacity                     | Withstand Voltage                                        |          |
|            | -                             | -                             | 1.05 x U <sub>e</sub>                          | 6 x I <sub>e</sub>            | I <sub>e</sub> ≤100A:<br>0.45±0.05<br><br>I <sub>e</sub> >100A:<br>0.35±0.05 | 6000                                  | 0.05                 | I <sub>c</sub> ≤100: 10<br>100<I <sub>c</sub> ≤200: 20<br>200<I <sub>c</sub> ≤300: 30<br>300<I <sub>c</sub> ≤400: 40<br>400<I <sub>c</sub> ≤600: 60 | Contact Welding and<br>Phase-to-phase Short-circuit | 2 x U <sub>e</sub> Provided 1000V or higher<br>5 seconds |          |
| Model Name |                               |                               |                                                |                               |                                                                              |                                       |                      |                                                                                                                                                     |                                                     |                                                          |          |
| S-2 x T10  | 220                           | 8                             | 231                                            | 48                            | 0.45                                                                         | 6000                                  | 0.05                 | 10                                                                                                                                                  | None                                                | OK                                                       | OK       |
|            | 440                           | 6                             | 462                                            | 36                            | 0.45                                                                         | 6000                                  | 0.05                 | 10                                                                                                                                                  | None                                                | OK                                                       | OK       |
| S-2 x T12  | 220                           | 11                            | 231                                            | 66                            | 0.45                                                                         | 6000                                  | 0.05                 | 10                                                                                                                                                  | None                                                | OK                                                       | OK       |
|            | 440                           | 9                             | 462                                            | 54                            | 0.45                                                                         | 6000                                  | 0.05                 | 10                                                                                                                                                  | None                                                | OK                                                       | OK       |
| S-2 x T20  | 220                           | 18                            | 231                                            | 108                           | 0.45                                                                         | 6000                                  | 0.05                 | 20                                                                                                                                                  | None                                                | OK                                                       | OK       |
|            | 440                           | 13                            | 462                                            | 78                            | 0.45                                                                         | 6000                                  | 0.05                 | 10                                                                                                                                                  | None                                                | OK                                                       | OK       |
| S-2 x T21  | 220                           | 18                            | 231                                            | 108                           | 0.45                                                                         | 6000                                  | 0.05                 | 20                                                                                                                                                  | None                                                | OK                                                       | OK       |
|            | 440                           | 13                            | 462                                            | 78                            | 0.45                                                                         | 6000                                  | 0.05                 | 10                                                                                                                                                  | None                                                | OK                                                       | OK       |
| S-2 x T25  | 220                           | 20                            | 231                                            | 120                           | 0.45                                                                         | 6000                                  | 0.05                 | 20                                                                                                                                                  | None                                                | OK                                                       | OK       |
|            | 440                           | 17                            | 462                                            | 102                           | 0.45                                                                         | 6000                                  | 0.05                 | 20                                                                                                                                                  | None                                                | OK                                                       | OK       |
| S-2 x T32  | 220                           | 26                            | 231                                            | 156                           | 0.45                                                                         | 6000                                  | 0.05                 | 20                                                                                                                                                  | None                                                | OK                                                       | OK       |
|            | 440                           | 24                            | 462                                            | 144                           | 0.45                                                                         | 6000                                  | 0.05                 | 20                                                                                                                                                  | None                                                | OK                                                       | OK       |
| S-2 x T35  | 220                           | 26                            | 231                                            | 156                           | 0.45                                                                         | 6000                                  | 0.05                 | 20                                                                                                                                                  | None                                                | OK                                                       | OK       |
|            | 440                           | 24                            | 462                                            | 144                           | 0.45                                                                         | 6000                                  | 0.05                 | 20                                                                                                                                                  | None                                                | OK                                                       | OK       |
| S-2 x T50  | 220                           | 35                            | 231                                            | 210                           | 0.45                                                                         | 6000                                  | 0.05                 | 30                                                                                                                                                  | None                                                | OK                                                       | OK       |
|            | 440                           | 32                            | 462                                            | 192                           | 0.45                                                                         | 6000                                  | 0.05                 | 20                                                                                                                                                  | None                                                | OK                                                       | OK       |
| S-2 x T65  | 220                           | 50                            | 231                                            | 300                           | 0.45                                                                         | 6000                                  | 0.05                 | 30                                                                                                                                                  | None                                                | OK                                                       | OK       |
|            | 440                           | 47                            | 462                                            | 282                           | 0.45                                                                         | 6000                                  | 0.05                 | 30                                                                                                                                                  | None                                                | OK                                                       | OK       |
| S-2 x T80  | 220                           | 65                            | 231                                            | 390                           | 0.45                                                                         | 6000                                  | 0.05                 | 40                                                                                                                                                  | None                                                | OK                                                       | OK       |
|            | 440                           | 62                            | 462                                            | 372                           | 0.45                                                                         | 6000                                  | 0.05                 | 40                                                                                                                                                  | None                                                | OK                                                       | OK       |
| S-2 x T100 | 220                           | 80                            | 231                                            | 480                           | 0.45                                                                         | 6000                                  | 0.05                 | 60                                                                                                                                                  | None                                                | OK                                                       | OK       |
|            | 440                           | 75                            | 462                                            | 450                           | 0.45                                                                         | 6000                                  | 0.05                 | 60                                                                                                                                                  | None                                                | OK                                                       | OK       |

Note a) The test was conducted using reversible-type magnetic contactor.

Note b) Main circuit frequency: 60Hz

Note c) The operation was conducted by applying a voltage of 240V and frequency of 60Hz to the operating coil.

Note d) The operation was performed based on the cycle mentioned in Note c) of 2.3.1 (3).

Note e) Number of Samples: 1 per machine

## 2.4 Test Sequence III

### 2.4.1 Performance under Short-circuit Conditions

These tests were conducted according to the test conditions indicated in Table 10 and Note a) to d).

There was no damage to the conductors and terminals. The leakage detection fuse was not melted, and the results were acceptable.

Table 10

| Model Name    | Item<br>Thermal Overload Relay<br>Model Name and Nominal Current of the Heater<br>Standard | Rated Current of SCPD [A]<br>Note a) | Rated Value (AC-3)         |                            | Test Conditions |                |                   |                   | Results           |                           |                                       | Judgment |
|---------------|--------------------------------------------------------------------------------------------|--------------------------------------|----------------------------|----------------------------|-----------------|----------------|-------------------|-------------------|-------------------|---------------------------|---------------------------------------|----------|
|               |                                                                                            |                                      | Voltage U <sub>e</sub> [V] | Current I <sub>e</sub> [A] | Voltage [V]     | Current I [kA] | Power Factor cosφ | Number of Samples | O or CO Operation | Conductor/Terminal Damage | Melting of the Leakage Detection Fuse |          |
|               |                                                                                            |                                      | -                          | -                          | U <sub>e</sub>  | Note c)        | Note d)           | [machine]         | Note b)           | None                      | None                                  |          |
| MSO-T10 (KP)  | TH-T18 9A                                                                                  | 20                                   | 220/440                    | 11/9                       | 440             | 1              | 0.95              | 1                 | O                 | None                      | None                                  | OK       |
|               |                                                                                            |                                      |                            |                            |                 |                |                   | 1                 | CO                | None                      | None                                  |          |
| MSO-T12 (KP)  | TH-T18 11A                                                                                 | 25                                   | 220/440                    | 13/12                      | 440             | 1              | 0.95              | 1                 | O                 | None                      | None                                  | OK       |
|               |                                                                                            |                                      |                            |                            |                 |                |                   | 1                 | CO                | None                      | None                                  |          |
| MSO-T20 (KP)  | TH-T18 15A                                                                                 | 32                                   | 220/440                    | 18/18                      | 440             | 3              | 0.9               | 1                 | O                 | None                      | None                                  | OK       |
|               |                                                                                            |                                      |                            |                            |                 |                |                   | 1                 | CO                | None                      | None                                  |          |
| MSO-T21 (KP)  | TH-T25 15A                                                                                 | 32                                   | 220/440                    | 25/23                      | 440             | 3              | 0.9               | 1                 | O                 | None                      | None                                  | OK       |
|               |                                                                                            |                                      |                            |                            |                 |                |                   | 1                 | CO                | None                      | None                                  |          |
| MSO-T25 (KP)  | TH-T25 22A                                                                                 | 50                                   | 220/440                    | 30/30                      | 440             | 3              | 0.9               | 1                 | O                 | None                      | None                                  | OK       |
|               |                                                                                            |                                      |                            |                            |                 |                |                   | 1                 | CO                | None                      | None                                  |          |
| MSO-T35 (KP)  | TH-T50 29A                                                                                 | 63                                   | 220/440                    | 40/40                      | 440             | 3              | 0.9               | 1                 | O                 | None                      | None                                  | OK       |
|               |                                                                                            |                                      |                            |                            |                 |                |                   | 1                 | CO                | None                      | None                                  |          |
| MSO-T50 (KP)  | TH-T50 42A                                                                                 | 100                                  | 220/440                    | 55/48                      | 440             | 3              | 0.9               | 1                 | O                 | None                      | None                                  | OK       |
|               |                                                                                            |                                      |                            |                            |                 |                |                   | 1                 | CO                | None                      | None                                  |          |
| MSO-T65 (KP)  | TH-T65 54A                                                                                 | 100                                  | 220/440                    | 65/65                      | 440             | 5              | 0.7               | 1                 | O                 | None                      | None                                  | OK       |
|               |                                                                                            |                                      |                            |                            |                 |                |                   | 1                 | CO                | None                      | None                                  |          |
| MSO-T80 (KP)  | TH-T100 67A                                                                                | 125                                  | 220/440                    | 85/85                      | 440             | 5              | 0.7               | 1                 | O                 | None                      | None                                  | OK       |
|               |                                                                                            |                                      |                            |                            |                 |                |                   | 1                 | CO                | None                      | None                                  |          |
| MSO-T100 (KP) | TH-T100 82A                                                                                | 160                                  | 220/440                    | 105/105                    | 440             | 5              | 0.7               | 1                 | O                 | None                      | None                                  | OK       |
|               |                                                                                            |                                      |                            |                            |                 |                |                   | 1                 | CO                | None                      | None                                  |          |
| S-T10         | -                                                                                          | 40                                   | 220/440                    | 11/9                       | 440             | 1              | 0.95              | 1                 | O                 | None                      | None                                  | OK       |
|               |                                                                                            |                                      |                            |                            |                 |                |                   | 1                 | CO                | None                      | None                                  |          |
| S-T12         | -                                                                                          | 40                                   | 220/440                    | 13/12                      | 440             | 1              | 0.95              | 1                 | O                 | None                      | None                                  | OK       |
|               |                                                                                            |                                      |                            |                            |                 |                |                   | 1                 | CO                | None                      | None                                  |          |
| S-T20         | -                                                                                          | 40                                   | 220/440                    | 18/18                      | 440             | 3              | 0.9               | 1                 | O                 | None                      | None                                  | OK       |
|               |                                                                                            |                                      |                            |                            |                 |                |                   | 1                 | CO                | None                      | None                                  |          |
| S-T21         | -                                                                                          | 80                                   | 220/440                    | 25/23                      | 440             | 3              | 0.9               | 1                 | O                 | None                      | None                                  | OK       |
|               |                                                                                            |                                      |                            |                            |                 |                |                   | 1                 | CO                | None                      | None                                  |          |
| S-T25         | -                                                                                          | 80                                   | 220/440                    | 30/30                      | 440             | 3              | 0.9               | 1                 | O                 | None                      | None                                  | OK       |
|               |                                                                                            |                                      |                            |                            |                 |                |                   | 1                 | CO                | None                      | None                                  |          |
| S-T32         | -                                                                                          | 80                                   | 220/440                    | 32/32                      | 440             | 3              | 0.9               | 1                 | O                 | None                      | None                                  | OK       |
|               |                                                                                            |                                      |                            |                            |                 |                |                   | 1                 | CO                | None                      | None                                  |          |
| S-T35         | -                                                                                          | 100                                  | 220/440                    | 40/40                      | 440             | 3              | 0.9               | 1                 | O                 | None                      | None                                  | OK       |
|               |                                                                                            |                                      |                            |                            |                 |                |                   | 1                 | CO                | None                      | None                                  |          |
| S-T50         | -                                                                                          | 100                                  | 220/440                    | 55/48                      | 440             | 3              | 0.9               | 1                 | O                 | None                      | None                                  | OK       |
|               |                                                                                            |                                      |                            |                            |                 |                |                   | 1                 | CO                | None                      | None                                  |          |
| S-T65         | -                                                                                          | 100                                  | 220/440                    | 65/65                      | 440             | 5              | 0.7               | 1                 | O                 | None                      | None                                  | OK       |
|               |                                                                                            |                                      |                            |                            |                 |                |                   | 1                 | CO                | None                      | None                                  |          |
| S-T80         | -                                                                                          | 125                                  | 220/440                    | 85/85                      | 440             | 5              | 0.7               | 1                 | O                 | None                      | None                                  | OK       |
|               |                                                                                            |                                      |                            |                            |                 |                |                   | 1                 | CO                | None                      | None                                  |          |
| S-T100        | -                                                                                          | 160                                  | 220/440                    | 105/105                    | 440             | 5              | 0.7               | 1                 | O                 | None                      | None                                  | OK       |
|               |                                                                                            |                                      |                            |                            |                 |                |                   | 1                 | CO                | None                      | None                                  |          |

Note a) SCPD: Short Circuit Protection Device

Note b) O operation: Breaking of the circuit by the SCPD resulting from closing the circuit on the equipment under test which is in the closed position.

CO operation: Breaking of the circuit by the SCPD resulting from closing the circuit by the equipment under test.

Note c) The test current specified in the standards for rated operational current was as follows. (I<sub>e</sub> indicates the maximum current applied to the motor)

When  $1 < I_e \leq 16$ : 1 kA

When  $16 < I_e \leq 63$ : 3 kA

When  $63 < I_e \leq 125$ : 5 kA

Note d) The power factor specified in the standards for test current was as follows.

When  $I \leq 1.5$  kA:  $0.95 \pm 0.05$

When  $1.5 \text{ kA} < I \leq 3 \text{ kA}$ :  $0.9 \pm 0.05$

When  $4.5 \text{ kA} < I \leq 6 \text{ kA}$ :  $0.7 \pm 0.05$

## 2.5 Test Sequence IV

### 2.5.1 Ability of Contactors to Withstand Overload Currents

The current indicated in Table 11 was applied for 10 seconds in making conditions of the magnetic contactor. All the parts met the standard criteria without abnormality.

Table 11

| Item<br>Model Name | Rated Current [A]                | Test Conditions                                             |                                | Results                 | Judgment |
|--------------------|----------------------------------|-------------------------------------------------------------|--------------------------------|-------------------------|----------|
|                    |                                  | Current [A]                                                 | Current Passage Time [seconds] |                         |          |
| Standard           | Rated Operational Current (AC-3) | $I_e \leq 630A: 8 \times I_e$<br>$I_e > 630A: 6 \times I_e$ | 10                             | Abnormality in the part |          |
| S-T10              | 11                               | 88                                                          | 10                             | None                    | OK       |
| S-T12              | 13                               | 104                                                         | 10                             | None                    | OK       |
| S-T20              | 18                               | 144                                                         | 10                             | None                    | OK       |
| S-T21              | 25                               | 200                                                         | 10                             | None                    | OK       |
| S-T25              | 30                               | 240                                                         | 10                             | None                    | OK       |
| S-T32              | 32                               | 256                                                         | 10                             | None                    | OK       |
| S-T35              | 40                               | 320                                                         | 10                             | None                    | OK       |
| S-T50              | 55                               | 440                                                         | 10                             | None                    | OK       |
| S-T65              | 65                               | 520                                                         | 10                             | None                    | OK       |
| S-T80              | 85                               | 680                                                         | 10                             | None                    | OK       |
| S-T100             | 105                              | 840                                                         | 10                             | None                    | OK       |

Note a) The test was conducted only for the magnetic contactor.

Note b) Number of Samples: 1 per machine

HOTLINE: 1900.6536

## 2.6 Test Sequence V

### 2.6.1 Mechanical Properties of Terminals

#### (1) Tests of Mechanical Strength of Terminals

The crimp terminal indicated in Table 12 was tightened with the following tightening torques, and was tested by connection and disconnection 5 times. All the parts met the standard criteria without looseness or damage.

Table 12

| Item<br>Standard<br>Model Name | Target Terminal Position | Crimp Terminal Size                           | Manufacturer Standard Tightening Torque [N·m] | Tested Tightening Torque [N·m]                               | Results                         | Judgment |
|--------------------------------|--------------------------|-----------------------------------------------|-----------------------------------------------|--------------------------------------------------------------|---------------------------------|----------|
|                                | -                        | Conductor of the Maximum Cross-Sectional Area | -                                             | 110% of the Manufacturer Standard Tightening Torque (Note a) | Looseness or Damage to the Part |          |
| MSO-T10(KP)                    | S-T10: 1/L1              | 2-3.5                                         | 0.9 to 1.5                                    | 1.65                                                         | None                            | OK       |
|                                | TH-T18(KP): 6/T3         | 2-3.5                                         | 0.9 to 1.5                                    | 1.65                                                         | None                            | OK       |
| MSO-T12(KP)                    | S-T12: 1/L1              | 2-3.5                                         | 0.9 to 1.5                                    | 1.65                                                         | None                            | OK       |
|                                | TH-T18(KP): 6/T3         | 2-3.5                                         | 0.9 to 1.5                                    | 1.65                                                         | None                            | OK       |
| MSO-T20(KP)                    | S-T20: 1/L1              | 2-3.5                                         | 0.9 to 1.5                                    | 1.65                                                         | None                            | OK       |
|                                | TH-T18(KP): 6/T3         | 2-3.5                                         | 0.9 to 1.5                                    | 1.65                                                         | None                            | OK       |
| MSO-T21(KP)                    | S-T21: 1/L1              | 5.5-4                                         | 1.2 to 1.9                                    | 2.09                                                         | None                            | OK       |
|                                | TH-T25(KP): 6/T3         | 5.5-4                                         | 1.2 to 1.9                                    | 2.09                                                         | None                            | OK       |
| MSO-T25(KP)                    | S-T25: 1/L1              | 5.5-4                                         | 1.2 to 1.9                                    | 2.09                                                         | None                            | OK       |
|                                | TH-T25(KP): 6/T3         | 5.5-4                                         | 1.2 to 1.9                                    | 2.09                                                         | None                            | OK       |
| MSO-T35(KP)                    | S-T35: 1/L1              | 22-S5                                         | 2.0 to 3.3                                    | 3.63                                                         | None                            | OK       |
|                                | TH-T50(KP): 6/T3         | 14-5                                          | 2.0 to 3.3                                    | 3.63                                                         | None                            | OK       |
| MSO-T50(KP)                    | S-T50: 1/L1              | 22-S5                                         | 2.0 to 3.3                                    | 3.63                                                         | None                            | OK       |
|                                | TH-T50(KP): 6/T3         | 14-5                                          | 2.0 to 3.3                                    | 3.63                                                         | None                            | OK       |
| MSO-T65(KP)                    | S-T65: 1/L1              | 60-S6                                         | 3.5 to 5.7                                    | 6.27                                                         | None                            | OK       |
|                                | TH-T65(KP): 6/T3         | 22-6                                          | 3.5 to 5.7                                    | 6.27                                                         | None                            | OK       |
| MSO-T80(KP)                    | S-T80: 1/L1              | 60-S6                                         | 3.5 to 5.7                                    | 6.27                                                         | None                            | OK       |
|                                | TH-T100(KP): 6/T3        | 38-S6                                         | 3.5 to 5.7                                    | 6.27                                                         | None                            | OK       |
| MSO-T100(KP)                   | S-T100: 1/L1             | 60-6                                          | 3.5 to 5.7                                    | 6.27                                                         | None                            | OK       |
|                                | TH-T100(KP): 6/T3        | 38-S6                                         | 3.5 to 5.7                                    | 6.27                                                         | None                            | OK       |
| S-T10                          | 2/T1, 6/T3               | 2-3.5                                         | 0.9 to 1.5                                    | 1.65                                                         | None                            | OK       |
| S-T12                          | 2/T1, 6/T3               | 2-3.5                                         | 0.9 to 1.5                                    | 1.65                                                         | None                            | OK       |
| S-T20                          | 2/T1, 6/T3               | 2-3.5                                         | 0.9 to 1.5                                    | 1.65                                                         | None                            | OK       |
| S-T21                          | 2/T1, 6/T3               | 5.5-4                                         | 1.2 to 1.9                                    | 2.09                                                         | None                            | OK       |
| S-T25                          | 2/T1, 6/T3               | 5.5-4                                         | 1.2 to 1.9                                    | 2.09                                                         | None                            | OK       |
| S-T32                          | 2/T1, 6/T3               | 5.5-4                                         | 1.2 to 1.9                                    | 2.09                                                         | None                            | OK       |
| S-T35                          | 2/T1, 6/T3               | 22-S5                                         | 2.0 to 3.3                                    | 3.63                                                         | None                            | OK       |
| S-T50                          | 2/T1, 6/T3               | 22-S5                                         | 2.0 to 3.3                                    | 3.63                                                         | None                            | OK       |
| S-T65                          | 2/T1, 6/T3               | 60-S6                                         | 3.5 to 5.7                                    | 6.27                                                         | None                            | OK       |
| S-T80                          | 2/T1, 6/T3               | 60-S6                                         | 3.5 to 5.7                                    | 6.27                                                         | None                            | OK       |
| S-T100                         | 2/T1, 6/T3               | 60-6                                          | 3.5 to 5.7                                    | 6.27                                                         | None                            | OK       |

Note a) The test was conducted by applying 110% of the maximum value of the manufacturer standard tightening torque.

Note b) Number of Samples: 1 per machine

## (2) Flexion and Pull-out Tests

In the flexion tests, the wire was rotated 135 times continuously by placing weight on its pointed end under the conditions (the following tightening torques were checked by using the minimum value of the manufacturer standard tightening torque) indicated in Table 13-1 and 13-2. The results met the standard criteria without pullout or breaking of the conductor. Then, the pull-out strength indicated in Table 13-1 and 13-2 was applied for 1 minute. The results met the standard criteria without pullout or breaking of the conductor.

Table 13-1

| Item         | Target Terminal Position | Screw Size | Wire Specifications |                     | Number of Connections         | Manufacturer Standard Tightening Torque [N·m] | Tested Tightening Torque [N·m] | Bushing Hole Diameter [mm]                                                                                                                                                                                                                        | Height [mm]                                                                                                                                                                                                                                    | Weight [kg]                                                                                                                                                                                                                                    | Pulling Force [N]                                                                                                                                                                                                                      | Judgment                         |
|--------------|--------------------------|------------|---------------------|---------------------|-------------------------------|-----------------------------------------------|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
|              |                          |            | Type                | Size                |                               |                                               |                                |                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                        |                                  |
| Standard     | -                        | -          | -                   | -                   | Maximum Number of Connections | -                                             | Specified Tightening Torque    | 0.75mm <sup>2</sup> : 6.5<br>1.25mm <sup>2</sup> : 6.5<br>2.5mm <sup>2</sup> : 9.5<br>4mm <sup>2</sup> : 9.5<br>6mm <sup>2</sup> : 9.5<br>14mm <sup>2</sup> : 13.0<br>16mm <sup>2</sup> : 13.0<br>φ1.6: 9.5<br>φ2: 9.5<br>φ2.6: 9.5<br>φ3.6: 13.0 | 0.75mm <sup>2</sup> : 260<br>1.25mm <sup>2</sup> : 260<br>2.5mm <sup>2</sup> : 280<br>4mm <sup>2</sup> : 280<br>6mm <sup>2</sup> : 280<br>14mm <sup>2</sup> : 300<br>16mm <sup>2</sup> : 300<br>φ1.6: 280<br>φ2: 280<br>φ2.6: 280<br>φ3.6: 300 | 0.75mm <sup>2</sup> : 0.4<br>1.25mm <sup>2</sup> : 0.4<br>2.5mm <sup>2</sup> : 0.7<br>4mm <sup>2</sup> : 0.9<br>6mm <sup>2</sup> : 1.4<br>14mm <sup>2</sup> : 2.9<br>16mm <sup>2</sup> : 2.9<br>φ1.6: 0.7<br>φ2: 0.9<br>φ2.6: 1.4<br>φ3.6: 2.9 | 0.75mm <sup>2</sup> : 30<br>1.25mm <sup>2</sup> : 40<br>2.5mm <sup>2</sup> : 50<br>4mm <sup>2</sup> : 60<br>6mm <sup>2</sup> : 80<br>14mm <sup>2</sup> : 100<br>16mm <sup>2</sup> : 100<br>φ1.6: 50<br>φ2: 60<br>φ2.6: 80<br>φ3.6: 100 | Pullout or Breaking of Conductor |
| MSO-T10 (KP) | 2/T1 (S-T10)             | M3.5       | Stranded Wire       | 0.75mm <sup>2</sup> | 2                             | 0.9 to 1.5                                    | 0.9                            | 6.5                                                                                                                                                                                                                                               | 260                                                                                                                                                                                                                                            | 0.4                                                                                                                                                                                                                                            | 30                                                                                                                                                                                                                                     | OK                               |
|              |                          |            | Single Wire         | 2.5mm <sup>2</sup>  | 2                             | 0.9 to 1.5                                    | 0.9                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.7                                                                                                                                                                                                                                            | 50                                                                                                                                                                                                                                     | OK                               |
|              | 6/T3 (TH-T18 (KP))       | M3.5       | Stranded Wire       | 0.75mm <sup>2</sup> | 2                             | 0.9 to 1.5                                    | 0.9                            | 6.5                                                                                                                                                                                                                                               | 260                                                                                                                                                                                                                                            | 0.4                                                                                                                                                                                                                                            | 30                                                                                                                                                                                                                                     | OK                               |
|              |                          |            | Single Wire         | 2.5mm <sup>2</sup>  | 2                             | 0.9 to 1.5                                    | 0.9                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.7                                                                                                                                                                                                                                            | 50                                                                                                                                                                                                                                     | OK                               |
| MSO-T12 (KP) | 2/T1 (S-T12)             | M3.5       | Stranded Wire       | 0.75mm <sup>2</sup> | 2                             | 0.9 to 1.5                                    | 0.9                            | 6.5                                                                                                                                                                                                                                               | 260                                                                                                                                                                                                                                            | 0.4                                                                                                                                                                                                                                            | 30                                                                                                                                                                                                                                     | OK                               |
|              |                          |            | Single Wire         | 2.5mm <sup>2</sup>  | 2                             | 0.9 to 1.5                                    | 0.9                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.7                                                                                                                                                                                                                                            | 50                                                                                                                                                                                                                                     | OK                               |
|              | 6/T3 (TH-T18 (KP))       | M3.5       | Stranded Wire       | 0.75mm <sup>2</sup> | 2                             | 0.9 to 1.5                                    | 0.9                            | 6.5                                                                                                                                                                                                                                               | 260                                                                                                                                                                                                                                            | 0.4                                                                                                                                                                                                                                            | 30                                                                                                                                                                                                                                     | OK                               |
|              |                          |            | Single Wire         | 2.5mm <sup>2</sup>  | 2                             | 0.9 to 1.5                                    | 0.9                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.7                                                                                                                                                                                                                                            | 50                                                                                                                                                                                                                                     | OK                               |
| MSO-T20 (KP) | 2/T1 (S-T20)             | M3.5       | Stranded Wire       | 0.75mm <sup>2</sup> | 2                             | 0.9 to 1.5                                    | 0.9                            | 6.5                                                                                                                                                                                                                                               | 260                                                                                                                                                                                                                                            | 0.4                                                                                                                                                                                                                                            | 30                                                                                                                                                                                                                                     | OK                               |
|              |                          |            | Single Wire         | 2.5mm <sup>2</sup>  | 2                             | 0.9 to 1.5                                    | 0.9                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.7                                                                                                                                                                                                                                            | 50                                                                                                                                                                                                                                     | OK                               |
|              | 6/T3 (TH-T18 (KP))       | M3.5       | Stranded Wire       | 0.75mm <sup>2</sup> | 2                             | 0.9 to 1.5                                    | 0.9                            | 6.5                                                                                                                                                                                                                                               | 260                                                                                                                                                                                                                                            | 0.4                                                                                                                                                                                                                                            | 30                                                                                                                                                                                                                                     | OK                               |
|              |                          |            | Single Wire         | 2.5mm <sup>2</sup>  | 2                             | 0.9 to 1.5                                    | 0.9                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.7                                                                                                                                                                                                                                            | 50                                                                                                                                                                                                                                     | OK                               |
| MSO-T21 (KP) | 2/T1 (S-T21)             | M4         | Stranded Wire       | 1.25mm <sup>2</sup> | 2                             | 1.2 to 1.9                                    | 1.2                            | 6.5                                                                                                                                                                                                                                               | 260                                                                                                                                                                                                                                            | 0.4                                                                                                                                                                                                                                            | 40                                                                                                                                                                                                                                     | OK                               |
|              |                          |            | Single Wire         | 6mm <sup>2</sup>    | 2                             | 1.2 to 1.9                                    | 1.2                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 1.4                                                                                                                                                                                                                                            | 80                                                                                                                                                                                                                                     | OK                               |
|              |                          |            | Single Wire         | φ1.6                | 2                             | 1.2 to 1.9                                    | 1.2                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.7                                                                                                                                                                                                                                            | 50                                                                                                                                                                                                                                     | OK                               |
|              |                          |            | Single Wire         | φ2.6                | 2                             | 1.2 to 1.9                                    | 1.2                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 1.4                                                                                                                                                                                                                                            | 80                                                                                                                                                                                                                                     | OK                               |
|              | 6/T3 (TH-T25 (KP))       | M4         | Stranded Wire       | 1.25mm <sup>2</sup> | 2                             | 1.2 to 1.9                                    | 1.2                            | 6.5                                                                                                                                                                                                                                               | 260                                                                                                                                                                                                                                            | 0.4                                                                                                                                                                                                                                            | 40                                                                                                                                                                                                                                     | OK                               |
|              |                          |            | Single Wire         | 6mm <sup>2</sup>    | 2                             | 1.2 to 1.9                                    | 1.2                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 1.4                                                                                                                                                                                                                                            | 80                                                                                                                                                                                                                                     | OK                               |
|              |                          |            | Single Wire         | φ1.6                | 2                             | 1.2 to 1.9                                    | 1.2                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.7                                                                                                                                                                                                                                            | 50                                                                                                                                                                                                                                     | OK                               |
|              |                          |            | Single Wire         | φ2.6                | 2                             | 1.2 to 1.9                                    | 1.2                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 1.4                                                                                                                                                                                                                                            | 80                                                                                                                                                                                                                                     | OK                               |
| MSO-T25 (KP) | 2/T1 (S-T25)             | M4         | Stranded Wire       | 1.25mm <sup>2</sup> | 2                             | 1.2 to 1.9                                    | 1.2                            | 6.5                                                                                                                                                                                                                                               | 260                                                                                                                                                                                                                                            | 0.4                                                                                                                                                                                                                                            | 40                                                                                                                                                                                                                                     | OK                               |
|              |                          |            | Single Wire         | 6mm <sup>2</sup>    | 2                             | 1.2 to 1.9                                    | 1.2                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 1.4                                                                                                                                                                                                                                            | 80                                                                                                                                                                                                                                     | OK                               |
|              |                          |            | Single Wire         | φ1.6                | 2                             | 1.2 to 1.9                                    | 1.2                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.7                                                                                                                                                                                                                                            | 50                                                                                                                                                                                                                                     | OK                               |
|              |                          |            | Single Wire         | φ2.6                | 2                             | 1.2 to 1.9                                    | 1.2                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 1.4                                                                                                                                                                                                                                            | 80                                                                                                                                                                                                                                     | OK                               |
|              | 6/T3 (TH-T25 (KP))       | M4         | Stranded Wire       | 1.25mm <sup>2</sup> | 2                             | 1.2 to 1.9                                    | 1.2                            | 6.5                                                                                                                                                                                                                                               | 260                                                                                                                                                                                                                                            | 0.4                                                                                                                                                                                                                                            | 40                                                                                                                                                                                                                                     | OK                               |
|              |                          |            | Single Wire         | 6mm <sup>2</sup>    | 2                             | 1.2 to 1.9                                    | 1.2                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 1.4                                                                                                                                                                                                                                            | 80                                                                                                                                                                                                                                     | OK                               |
|              |                          |            | Single Wire         | φ1.6                | 2                             | 1.2 to 1.9                                    | 1.2                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.7                                                                                                                                                                                                                                            | 50                                                                                                                                                                                                                                     | OK                               |
|              |                          |            | Single Wire         | φ2.6                | 2                             | 1.2 to 1.9                                    | 1.2                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 1.4                                                                                                                                                                                                                                            | 80                                                                                                                                                                                                                                     | OK                               |
| MSO-T35 (KP) | 2/T1 (S-T35)             | M5         | Stranded Wire       | 1.25mm <sup>2</sup> | 2                             | 2.0 to 3.3                                    | 2.0                            | 6.5                                                                                                                                                                                                                                               | 260                                                                                                                                                                                                                                            | 0.4                                                                                                                                                                                                                                            | 40                                                                                                                                                                                                                                     | OK                               |
|              |                          |            | Single Wire         | 16mm <sup>2</sup>   | 2                             | 2.0 to 3.3                                    | 2.0                            | 13.0                                                                                                                                                                                                                                              | 300                                                                                                                                                                                                                                            | 2.9                                                                                                                                                                                                                                            | 100                                                                                                                                                                                                                                    | OK                               |
|              |                          |            | Single Wire         | φ1.6                | 2                             | 2.0 to 3.3                                    | 2.0                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.7                                                                                                                                                                                                                                            | 50                                                                                                                                                                                                                                     | OK                               |
|              |                          |            | Single Wire         | φ3.6                | 2                             | 2.0 to 3.3                                    | 2.0                            | 13.0                                                                                                                                                                                                                                              | 300                                                                                                                                                                                                                                            | 2.9                                                                                                                                                                                                                                            | 100                                                                                                                                                                                                                                    | OK                               |
|              | 6/T3 (TH-T50 (KP))       | M5         | Stranded Wire       | 4mm <sup>2</sup>    | 2                             | 2.0 to 3.3                                    | 2.0                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.9                                                                                                                                                                                                                                            | 60                                                                                                                                                                                                                                     | OK                               |
|              |                          |            | Single Wire         | 14mm <sup>2</sup>   | 2                             | 2.0 to 3.3                                    | 2.0                            | 13.0                                                                                                                                                                                                                                              | 300                                                                                                                                                                                                                                            | 2.9                                                                                                                                                                                                                                            | 100                                                                                                                                                                                                                                    | OK                               |
|              |                          |            | Single Wire         | φ2                  | 2                             | 2.0 to 3.3                                    | 2.0                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.9                                                                                                                                                                                                                                            | 60                                                                                                                                                                                                                                     | OK                               |
|              |                          |            | Single Wire         | φ3.6                | 2                             | 2.0 to 3.3                                    | 2.0                            | 13.0                                                                                                                                                                                                                                              | 300                                                                                                                                                                                                                                            | 2.9                                                                                                                                                                                                                                            | 100                                                                                                                                                                                                                                    | OK                               |
| MSO-T50 (KP) | 2/T1 (S-T50)             | M5         | Stranded Wire       | 1.25mm <sup>2</sup> | 2                             | 2.0 to 3.3                                    | 2.0                            | 6.5                                                                                                                                                                                                                                               | 260                                                                                                                                                                                                                                            | 0.4                                                                                                                                                                                                                                            | 40                                                                                                                                                                                                                                     | OK                               |
|              |                          |            | Single Wire         | 16mm <sup>2</sup>   | 2                             | 2.0 to 3.3                                    | 2.0                            | 13.0                                                                                                                                                                                                                                              | 300                                                                                                                                                                                                                                            | 2.9                                                                                                                                                                                                                                            | 100                                                                                                                                                                                                                                    | OK                               |
|              |                          |            | Single Wire         | φ1.6                | 2                             | 2.0 to 3.3                                    | 2.0                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.7                                                                                                                                                                                                                                            | 50                                                                                                                                                                                                                                     | OK                               |
|              |                          |            | Single Wire         | φ3.6                | 2                             | 2.0 to 3.3                                    | 2.0                            | 13.0                                                                                                                                                                                                                                              | 300                                                                                                                                                                                                                                            | 2.9                                                                                                                                                                                                                                            | 100                                                                                                                                                                                                                                    | OK                               |
|              | 6/T3 (TH-T50 (KP))       | M5         | Stranded Wire       | 4mm <sup>2</sup>    | 2                             | 2.0 to 3.3                                    | 2.0                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.9                                                                                                                                                                                                                                            | 60                                                                                                                                                                                                                                     | OK                               |
|              |                          |            | Single Wire         | 14mm <sup>2</sup>   | 2                             | 2.0 to 3.3                                    | 2.0                            | 13.0                                                                                                                                                                                                                                              | 300                                                                                                                                                                                                                                            | 2.9                                                                                                                                                                                                                                            | 100                                                                                                                                                                                                                                    | OK                               |
|              |                          |            | Single Wire         | φ2                  | 2                             | 2.0 to 3.3                                    | 2.0                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.9                                                                                                                                                                                                                                            | 60                                                                                                                                                                                                                                     | OK                               |
|              |                          |            | Single Wire         | φ3.6                | 2                             | 2.0 to 3.3                                    | 2.0                            | 13.0                                                                                                                                                                                                                                              | 300                                                                                                                                                                                                                                            | 2.9                                                                                                                                                                                                                                            | 100                                                                                                                                                                                                                                    | OK                               |

Note a) Since MSO-T65(KP) higher models cannot be connected to the unprocessed exposed conductor, this evaluation is not applicable.

Table 13-2

| Item<br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br>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Note a) Since S-T65 or higher models cannot be connected to the unprocessed exposed conductor, this evaluation is not applicable.

## **Special Magnetic Contactor**



HOTLINE: 1900.6536

# ■ DC-operated Magnetic Contactor <Type SD-T>

Type SD-T DC operating magnetic contactor is used to supply DC to the electromagnetic portion of type S-T magnetic contactor.

## 1. Structure

Since the SD-T12 to T100 electromagnets limit the current with just the resistor of the coil by directly applying all the voltage, their operation is stable with no inrush current. The SD-T12 to T32 electromagnets are high efficiency polarized electromagnets that combine the coil and permanent magnet.

## 2. Rating

Contact rated value is the same as that of AC operating type S-T.

## 3. Type Test

Applicable Standard IEC60947-1 (2011) Low voltage switchgear and control gear  
Part 1: General Rule  
IEC60947-4-1 (2012) Low voltage switchgear and control gear  
Part 4: Contactor and Motor Starter  
Section 1: Electro-mechanical Contactor and Motor Starter

### 3.1 Type Tests and Test Sequences

| Test Sequences  | Test Name                                                                     | Test Conditions                                                                             |
|-----------------|-------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| a) Sequence I   | 1) Temperature rise                                                           | According to the IEC60947-4-1 9.3.3.3 "Temperature Rise".                                   |
|                 | 2) Operation and operating limits                                             | According to the IEC60947-4-1 9.3.3.2 "Operating Limit".                                    |
|                 | 3) Dielectric properties                                                      | According to the IEC60947-4-1 9.3.3.4 "Dielectric Properties".                              |
| b) Sequence II  | 1) Rated making and breaking capacity<br>Switching capacity and reversibility | According to the IEC60947-4-1 9.3.3.5 "Making and Breaking Capacity".                       |
|                 | 2) Conventional operating performance                                         | According to the IEC60947-4-1 9.3.3.6 "Operating Performance Capability".                   |
| c) Sequence III | 1) Performance under short-circuit conditions                                 | According to the IEC60947-4-1 9.3.4 "Performance under Short-circuit Conditions".           |
| d) Sequence IV  | 1) Ability of contactors to withstand overload currents                       | According to the IEC60947-4-1 9.3.5 "Ability of Contactors to Withstand Overload Currents". |
| e) Sequence V   | 1) Mechanical properties of terminals                                         | According to the IEC60947-1 8.2.4 "Mechanical Properties of Terminals".                     |

Note Tests were conducted with the following coil designation:

Test Sequence I : SD-T12 to SD-T32: 24VDC, 100VDC  
SD-T35 to SD-T100: 24VDC

Test Sequence II to V : 24VDC

## 3.2 Test Sequence I

### 3.2.1 Temperature Rise and Dielectric Properties

For the temperature rise, these tests were conducted according to the test conditions indicated in Table 1 and Note a) to d), and the temperature rise of each portion met the standards. The dielectric properties after the temperature test also met the standard criteria.

Table 1

| Item<br><br><br><br>Model<br>Name<br>Coil<br>Nominal<br>Value |        | Test Conditions |                      |                                               |                      |                        | Results Note a)                    |                      |                |                       |               |                    |                               | Judgment |
|---------------------------------------------------------------|--------|-----------------|----------------------|-----------------------------------------------|----------------------|------------------------|------------------------------------|----------------------|----------------|-----------------------|---------------|--------------------|-------------------------------|----------|
|                                                               |        | Current [A]     |                      | Connection<br>Wire<br>Size [mm <sup>2</sup> ] |                      | Coil<br>Voltage<br>[V] | Maximum Temperature Rise Value [K] |                      |                | Dielectric Properties |               |                    |                               |          |
|                                                               |        |                 |                      |                                               |                      |                        | Coil<br>[Resistance<br>Method]     | Terminal             |                | Contact               |               | Impulse<br>Note c) | Power<br>Frequency<br>Note c) |          |
|                                                               |        | Main<br>Circuit | Auxiliary<br>Circuit | Main<br>Circuit                               | Auxiliary<br>Circuit | Main<br>Circuit        |                                    | Auxiliary<br>Circuit |                |                       |               |                    |                               |          |
|                                                               |        | Standard        |                      | Open<br>Thermoelectric<br>Current             |                      | -                      | -                                  | -                    | 100<br>or less | 65<br>or less         | 65<br>or less | Note b)            |                               |          |
| SD-T12                                                        | 24VDC  | 20              | 10                   | 2.5                                           | 1.5                  | 24                     | 29                                 | 52                   | 34             | 77                    | 52            | OK                 | OK                            | OK       |
| SD-T12                                                        | 100VDC | 20              | 10                   | 2.5                                           | 1.5                  | 100                    | 38                                 | 52                   | 34             | 77                    | 52            | OK                 | OK                            | OK       |
| SD-T20                                                        | 24VDC  | 20              | 10                   | 2.5                                           | 1.5                  | 24                     | 29                                 | 43                   | 34             | 65                    | 52            | OK                 | OK                            | OK       |
| SD-T20                                                        | 100VDC | 20              | 10                   | 2.5                                           | 1.5                  | 100                    | 38                                 | 43                   | 34             | 65                    | 52            | OK                 | OK                            | OK       |
| SD-T21                                                        | 24VDC  | 32              | 10                   | 6                                             | 1.5                  | 24                     | 27                                 | 35                   | 27             | 45                    | 46            | OK                 | OK                            | OK       |
| SD-T21                                                        | 100VDC | 32              | 10                   | 6                                             | 1.5                  | 100                    | 38                                 | 35                   | 27             | 45                    | 46            | OK                 | OK                            | OK       |
| SD-T32                                                        | 24VDC  | 32              | -                    | 6                                             | -                    | 24                     | 36                                 | 31                   | -              | 40                    | -             | OK                 | OK                            | OK       |
| SD-T32                                                        | 100VDC | 32              | -                    | 6                                             | -                    | 100                    | 46                                 | 31                   | -              | 40                    | -             | OK                 | OK                            | OK       |
| SD-T35                                                        | 24VDC  | 60              | 10                   | 16                                            | 1.5                  | 24                     | 67                                 | 35                   | 30             | 46                    | 45            | OK                 | OK                            | OK       |
| SD-T50                                                        | 24VDC  | 80              | 10                   | 25                                            | 1.5                  | 24                     | 71                                 | 40                   | 32             | 55                    | 46            | OK                 | OK                            | OK       |
| SD-T65                                                        | 24VDC  | 100             | 10                   | 35                                            | 1.5                  | 24                     | 63                                 | 39                   | 28             | 58                    | 43            | OK                 | OK                            | OK       |
| SD-T80                                                        | 24VDC  | 120             | 10                   | 50                                            | 1.5                  | 24                     | 66                                 | 54                   | 25             | 68                    | 43            | OK                 | OK                            | OK       |
| SD-T100                                                       | 24VDC  | 150             | 10                   | 50                                            | 1.5                  | 24                     | 62                                 | 57                   | 46             | 92                    | 59            | OK                 | OK                            | OK       |

Note a) The test of temperature rise was conducted by operating at an ambient temperature of 40°C, in open state with the iron plate mounted.

Note b) The temperature rise of the contacts was checked at a temperature that is not harmful to the surrounding components. (In short 100K)

Note c) The application points of the impulse withstand voltage performance and the power frequency withstand voltage performance were as follows. However in the power frequency withstand voltage test, (c) was not implemented.

Measurement Points: (a) Between all terminals of the main circuit and grounded metal body when the contact element was closed.

(b) Between 1-pole of the main circuit and all other poles connected altogether to the grounded metal body when the contact element was closed.

(c) Between the supply side terminals and the load side terminals of the main circuit when the contact element was opened.

(d) Between one circuit of the operating circuit (control circuit) and auxiliary circuit, and all other circuits/grounded metal body.

Note d) Number of Samples: 1 per machine

### 3.2.2 Operating Limits

The operating voltage (hot condition) and open-circuit voltage after the temperature test met the standard criteria by operating and opening without hindrance in the set voltage.

Table 2

| Item<br><br>Standard<br><br>Coil Model Name<br>Nominal Value | Test Conditions and Judgment                       |                                             |                                             | Judgment |
|--------------------------------------------------------------|----------------------------------------------------|---------------------------------------------|---------------------------------------------|----------|
|                                                              | Operating Voltage (40°C Hot)                       |                                             | Open-circuit Voltage (-5°C Cold)            |          |
|                                                              | Operation at 85% or less of the coil rated voltage | Operation at 110% of the coil rated voltage | Open at 10 to 75% of the coil rated voltage |          |
| SD-T12 24VDC                                                 | 18.6                                               | OK                                          | 4.9                                         | OK       |
| SD-T12 100VDC                                                | 72                                                 | OK                                          | 20                                          | OK       |
| SD-T20 24VDC                                                 | 18.5                                               | OK                                          | 5.2                                         | OK       |
| SD-T20 100VDC                                                | 71                                                 | OK                                          | 21                                          | OK       |
| SD-T21 24VDC                                                 | 17.1                                               | OK                                          | 4.5                                         | OK       |
| SD-T21 100VDC                                                | 64                                                 | OK                                          | 18                                          | OK       |
| SD-T32 24VDC                                                 | 18.1                                               | OK                                          | 4.3                                         | OK       |
| SD-T32 100VDC                                                | 70                                                 | OK                                          | 17                                          | OK       |
| SD-T35 24VDC                                                 | 17.8                                               | OK                                          | 5.7                                         | OK       |
| SD-T50 24VDC                                                 | 18.2                                               | OK                                          | 6.1                                         | OK       |
| SD-T65 24VDC                                                 | 19.0                                               | OK                                          | 5.8                                         | OK       |
| SD-T80 24VDC                                                 | 20.1                                               | OK                                          | 6.2                                         | OK       |
| SD-T100 24VDC                                                | 17.5                                               | OK                                          | 5.5                                         | OK       |

Note a) Coil rated voltage is 24V when coil nominal voltage is 24VDC, and is 100V when coil nominal voltage is 100VDC.

#### <Reference Test>

Coil characteristics (20°C cold condition)

| Model Name | Coil Properties  |                       |                         | Operating Voltage |          | Operating Time [ms]     |                         |                         |                  |                         |                        |
|------------|------------------|-----------------------|-------------------------|-------------------|----------|-------------------------|-------------------------|-------------------------|------------------|-------------------------|------------------------|
|            | Coil Current [A] | Consumption Power [W] | Coil Time Constant [ms] | Operation         | Open     | Coil ON →               |                         |                         | Coil OFF →       |                         |                        |
|            |                  |                       |                         |                   |          | Main Contact ON         | Auxiliary Contact a ON  | Auxiliary Contact b OFF | Main Contact OFF | Auxiliary Contact a OFF | Auxiliary Contact b ON |
| SD-T12     | 0.033            | 3.3(2.2)              | 40(45)                  | 60 to 75          | 10 to 30 | 55 to 75<br>(75 to 95)  | 55 to 75<br>(75 to 95)  | 50 to 70<br>(70 to 90)  | 5 to 15          | 5 to 15                 | 10 to 20               |
| SD-T20     | 0.033            | 3.3(2.2)              | 40(45)                  | 60 to 75          | 10 to 30 | 55 to 75<br>(75 to 95)  | 55 to 75<br>(75 to 95)  | 50 to 70<br>(70 to 90)  | 5 to 15          | 5 to 15                 | 10 to 20               |
| SD-T21     | 0.033            | 3.3(2.2)              | 50(40)                  | 60 to 75          | 10 to 30 | 60 to 80<br>(80 to 100) | 60 to 80<br>(80 to 100) | 55 to 75<br>(75 to 95)  | 5 to 15          | 5 to 15                 | 10 to 20               |
| SD-T32     | 0.033            | 3.3(2.2)              | 50(40)                  | 60 to 75          | 10 to 30 | 65 to 85<br>(85 to 105) | -                       | -                       | 5 to 15          | -                       | -                      |
| SD-T35     | 0.09             | 9                     | 40                      | 50 to 65          | 15 to 35 | 45 to 55                | 45 to 55                | 38 to 48                | 6 to 10          | 6 to 10                 | 9 to 13                |
| SD-T50     | 0.09             | 9                     | 40                      | 50 to 65          | 15 to 35 | 45 to 55                | 45 to 55                | 38 to 48                | 6 to 10          | 6 to 10                 | 9 to 13                |
| SD-T65     | 0.18             | 18                    | 65                      | 52 to 63          | 20 to 35 | 45 to 55                | 45 to 55                | 40 to 50                | 9 to 16          | 9 to 16                 | 12 to 19               |
| SD-T80     | 0.18             | 18                    | 65                      | 52 to 63          | 20 to 35 | 45 to 55                | 45 to 55                | 40 to 50                | 9 to 16          | 9 to 16                 | 12 to 19               |
| SD-T100    | 0.24             | 24                    | 80                      | 50 to 65          | 15 to 30 | 70 to 80                | 70 to 80                | 63 to 73                | 14 to 21         | 14 to 21                | 18 to 25               |

Note a) The standard values of the properties of the 100VDC coil. The values in brackets ( ) for SD-T12 to SD-T32 are property values of the 24VDC coil.

## 3.3 Test Sequence II

### 3.3.1 Test of Making and Breaking Capacities

#### (1) Test of Making Capacity

These tests were conducted according to the test conditions indicated in Table 3 and Note a) to c). No abnormalities such as welding of contacts were found, and the results met the standard criteria.

Table 3

| Item<br>Standard<br>Model Name | Rated Value<br>(AC-3)         |                               | Test Conditions (making) |                     |                      |                                       |                      |                       | Results         | Judgment |
|--------------------------------|-------------------------------|-------------------------------|--------------------------|---------------------|----------------------|---------------------------------------|----------------------|-----------------------|-----------------|----------|
|                                | Voltage U <sub>e</sub><br>[V] | Current I <sub>e</sub><br>[A] | Voltage U<br>[V]         | Current I<br>[A]    | Power Factor<br>cosφ | Operating Cycle<br>[Times]<br>Note b) | ON time<br>[seconds] | OFF time<br>[seconds] |                 |          |
|                                | -                             | -                             | 1.05 x U <sub>e</sub>    | 10 x I <sub>e</sub> | 0.45<br>±0.05        | 50                                    | 0.05                 | 10                    | Contact Welding |          |
| SD-T12 24VDC                   | 220                           | 13                            | 231                      | 130                 | 0.45                 | 50                                    | 0.05                 | 10                    | None            | OK       |
|                                | 440                           | 12                            | 462                      | 120                 | 0.45                 | 50                                    | 0.05                 | 10                    | None            | OK       |
| SD-T20 24VDC                   | 220                           | 18                            | 231                      | 180                 | 0.45                 | 50                                    | 0.05                 | 10                    | None            | OK       |
|                                | 440                           | 18                            | 462                      | 180                 | 0.45                 | 50                                    | 0.05                 | 10                    | None            | OK       |
| SD-T21 24VDC                   | 220                           | 25                            | 231                      | 250                 | 0.45                 | 50                                    | 0.05                 | 10                    | None            | OK       |
|                                | 440                           | 23                            | 462                      | 230                 | 0.45                 | 50                                    | 0.05                 | 10                    | None            | OK       |
| SD-T32 24VDC                   | 220                           | 32                            | 231                      | 320                 | 0.45                 | 50                                    | 0.05                 | 10                    | None            | OK       |
|                                | 440                           | 32                            | 462                      | 320                 | 0.45                 | 50                                    | 0.05                 | 10                    | None            | OK       |
| SD-T35 24VDC                   | 220                           | 40                            | 231                      | 400                 | 0.45                 | 50                                    | 0.05                 | 10                    | None            | OK       |
|                                | 440                           | 40                            | 462                      | 400                 | 0.45                 | 50                                    | 0.05                 | 10                    | None            | OK       |
| SD-T50 24VDC                   | 220                           | 55                            | 231                      | 550                 | 0.45                 | 50                                    | 0.05                 | 10                    | None            | OK       |
|                                | 440                           | 48                            | 462                      | 480                 | 0.45                 | 50                                    | 0.05                 | 10                    | None            | OK       |
| SD-T65 24VDC                   | 220                           | 65                            | 231                      | 650                 | 0.45                 | 50                                    | 0.05                 | 10                    | None            | OK       |
|                                | 440                           | 65                            | 462                      | 650                 | 0.45                 | 50                                    | 0.05                 | 10                    | None            | OK       |
| SD-T80 24VDC                   | 220                           | 85                            | 231                      | 850                 | 0.45                 | 50                                    | 0.05                 | 10                    | None            | OK       |
|                                | 440                           | 85                            | 462                      | 850                 | 0.45                 | 50                                    | 0.05                 | 10                    | None            | OK       |
| SD-T100 24VDC                  | 220                           | 105                           | 231                      | 1050                | 0.35                 | 50                                    | 0.05                 | 10                    | None            | OK       |
|                                | 440                           | 105                           | 462                      | 1050                | 0.35                 | 50                                    | 0.05                 | 10                    | None            | OK       |

Note a) Main circuit frequency: 60Hz

Note b) Among 50 operating cycles, 110% of the rated value (26.4V) was applied to the coil for 25 cycles, and 85% of the rated value (20.4V) was applied to the coil for the other 25 cycles.

Note c) Number of Samples: 1 per machine

#### (2) Test of Making and Breaking Capacities

These tests were conducted according to the test conditions indicated in Table 4 and Note a) to c) after the making capacity test (1). No abnormalities such as welding of contacts and phase-to-phase short circuits were found, and the results met the standard criteria.

Table 4

| Item<br>Standard<br>Model Name | Rated Value<br>(AC-3)         |                               | Test Conditions (making and breaking capacity) |                    |                      |                            |                      |                                                                                                                                                                                                                                        | Results                                           | Judgment |
|--------------------------------|-------------------------------|-------------------------------|------------------------------------------------|--------------------|----------------------|----------------------------|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|----------|
|                                | Voltage U <sub>e</sub><br>[V] | Current I <sub>e</sub><br>[A] | Voltage U<br>[V]                               | Current I<br>[A]   | Power Factor<br>cosφ | Operating Cycle<br>[Times] | ON time<br>[seconds] | OFF time<br>[seconds]                                                                                                                                                                                                                  |                                                   |          |
|                                | -                             | -                             | 1.05 x U <sub>e</sub>                          | 8 x I <sub>e</sub> | 0.45<br>±0.05        | 50                         | 0.05                 | I <sub>c</sub> ≤ 100: 10<br>100 < I <sub>c</sub> ≤ 200: 20<br>200 < I <sub>c</sub> ≤ 300: 30<br>300 < I <sub>c</sub> ≤ 400: 40<br>400 < I <sub>c</sub> ≤ 600: 60<br>600 < I <sub>c</sub> ≤ 800: 80<br>800 < I <sub>c</sub> ≤ 1000: 100 | Contact Welding and Phase-to-phase Short-circuits |          |
| SD-T12 24VDC                   | 220                           | 13                            | 231                                            | 104                | 0.45                 | 50                         | 0.05                 | 20                                                                                                                                                                                                                                     | None                                              | OK       |
|                                | 440                           | 12                            | 462                                            | 96                 | 0.45                 | 50                         | 0.05                 | 10                                                                                                                                                                                                                                     | None                                              | OK       |
| SD-T20 24VDC                   | 220                           | 18                            | 231                                            | 144                | 0.45                 | 50                         | 0.05                 | 20                                                                                                                                                                                                                                     | None                                              | OK       |
|                                | 440                           | 18                            | 462                                            | 144                | 0.45                 | 50                         | 0.05                 | 20                                                                                                                                                                                                                                     | None                                              | OK       |
| SD-T21 24VDC                   | 220                           | 25                            | 231                                            | 200                | 0.45                 | 50                         | 0.05                 | 20                                                                                                                                                                                                                                     | None                                              | OK       |
|                                | 440                           | 23                            | 462                                            | 184                | 0.45                 | 50                         | 0.05                 | 20                                                                                                                                                                                                                                     | None                                              | OK       |
| SD-T32 24VDC                   | 220                           | 32                            | 231                                            | 256                | 0.45                 | 50                         | 0.05                 | 30                                                                                                                                                                                                                                     | None                                              | OK       |
|                                | 440                           | 32                            | 462                                            | 256                | 0.45                 | 50                         | 0.05                 | 30                                                                                                                                                                                                                                     | None                                              | OK       |
| SD-T35 24VDC                   | 220                           | 40                            | 231                                            | 320                | 0.45                 | 50                         | 0.05                 | 40                                                                                                                                                                                                                                     | None                                              | OK       |
|                                | 440                           | 40                            | 462                                            | 320                | 0.45                 | 50                         | 0.05                 | 40                                                                                                                                                                                                                                     | None                                              | OK       |
| SD-T50 24VDC                   | 220                           | 55                            | 231                                            | 440                | 0.45                 | 50                         | 0.05                 | 60                                                                                                                                                                                                                                     | None                                              | OK       |
|                                | 440                           | 48                            | 462                                            | 384                | 0.45                 | 50                         | 0.05                 | 40                                                                                                                                                                                                                                     | None                                              | OK       |
| SD-T65 24VDC                   | 220                           | 65                            | 231                                            | 520                | 0.45                 | 50                         | 0.05                 | 60                                                                                                                                                                                                                                     | None                                              | OK       |
|                                | 440                           | 65                            | 462                                            | 520                | 0.45                 | 50                         | 0.05                 | 60                                                                                                                                                                                                                                     | None                                              | OK       |
| SD-T80 24VDC                   | 220                           | 85                            | 231                                            | 680                | 0.45                 | 50                         | 0.05                 | 80                                                                                                                                                                                                                                     | None                                              | OK       |
|                                | 440                           | 85                            | 462                                            | 680                | 0.45                 | 50                         | 0.05                 | 80                                                                                                                                                                                                                                     | None                                              | OK       |
| SD-T100 24VDC                  | 220                           | 105                           | 231                                            | 840                | 0.35                 | 50                         | 0.05                 | 100                                                                                                                                                                                                                                    | None                                              | OK       |
|                                | 440                           | 105                           | 462                                            | 840                | 0.35                 | 50                         | 0.05                 | 100                                                                                                                                                                                                                                    | None                                              | OK       |

Note a) Main circuit frequency: 60Hz

Note b) The operation was conducted by applying a voltage of 24V to the operating coil.

Note c) Number of Samples: 1 per machine

### (3) The Switching Capacity and Reversibility

These tests were conducted according to the test conditions indicated in Table 5, 6 and Note a) to c). No abnormalities such as welding of contacts and phase-to-phase short circuits were found, and the results met the standard criteria.

Table 5

| Item<br><br>Standard<br><br>Model Name | Rated Value<br>(AC- 4) |                   | Test Conditions (making) |                   |                      |                               |                      |                       | Results                                                    | Judgment |
|----------------------------------------|------------------------|-------------------|--------------------------|-------------------|----------------------|-------------------------------|----------------------|-----------------------|------------------------------------------------------------|----------|
|                                        | Voltage Ue<br>[V]      | Current Ie<br>[A] | Voltage Ur<br>[V]        | Current Ic<br>[A] | Power Factor<br>cosφ | Operation<br>Cycle<br>[Times] | ON time<br>[seconds] | OFF time<br>[seconds] |                                                            |          |
|                                        | -                      | -                 | 1.05 x Ue                | 12 x Ie           | 0.45±0.05            | 50                            | 0.05                 | 10                    | Contact<br>Welding and<br>Phase-to-phase<br>Short-circuits |          |
| SD-2 x T12                             | 220                    | 11                | 231                      | 132               | 0.45                 | 50                            | 0.05                 | 10                    | None                                                       | OK       |
|                                        | 440                    | 9                 | 462                      | 108               | 0.45                 | 50                            | 0.05                 | 10                    | None                                                       | OK       |
| SD-2 x T20                             | 220                    | 18                | 231                      | 216               | 0.45                 | 50                            | 0.05                 | 10                    | None                                                       | OK       |
|                                        | 440                    | 13                | 462                      | 156               | 0.45                 | 50                            | 0.05                 | 10                    | None                                                       | OK       |
| SD-2 x T21                             | 220                    | 18                | 231                      | 216               | 0.45                 | 50                            | 0.05                 | 10                    | None                                                       | OK       |
|                                        | 440                    | 13                | 462                      | 156               | 0.45                 | 50                            | 0.05                 | 10                    | None                                                       | OK       |
| SD-2 x T32                             | 220                    | 26                | 231                      | 312               | 0.45                 | 50                            | 0.05                 | 10                    | None                                                       | OK       |
|                                        | 440                    | 24                | 462                      | 288               | 0.45                 | 50                            | 0.05                 | 10                    | None                                                       | OK       |
| SD-2 x T35                             | 220                    | 26                | 231                      | 312               | 0.45                 | 50                            | 0.05                 | 10                    | None                                                       | OK       |
|                                        | 440                    | 24                | 462                      | 288               | 0.45                 | 50                            | 0.05                 | 10                    | None                                                       | OK       |
| SD-2 x T50                             | 220                    | 35                | 231                      | 420               | 0.45                 | 50                            | 0.05                 | 10                    | None                                                       | OK       |
|                                        | 440                    | 32                | 462                      | 384               | 0.45                 | 50                            | 0.05                 | 10                    | None                                                       | OK       |
| SD-2 x T65                             | 220                    | 50                | 231                      | 600               | 0.45                 | 50                            | 0.05                 | 10                    | None                                                       | OK       |
|                                        | 440                    | 47                | 462                      | 564               | 0.45                 | 50                            | 0.05                 | 10                    | None                                                       | OK       |
| SD-2 x T80                             | 220                    | 65                | 231                      | 780               | 0.45                 | 50                            | 0.05                 | 10                    | None                                                       | OK       |
|                                        | 440                    | 62                | 462                      | 744               | 0.45                 | 50                            | 0.05                 | 10                    | None                                                       | OK       |
| SD-2 x T100                            | 220                    | 80                | 231                      | 960               | 0.45                 | 50                            | 0.05                 | 10                    | None                                                       | OK       |
|                                        | 440                    | 75                | 462                      | 900               | 0.45                 | 50                            | 0.05                 | 10                    | None                                                       | OK       |

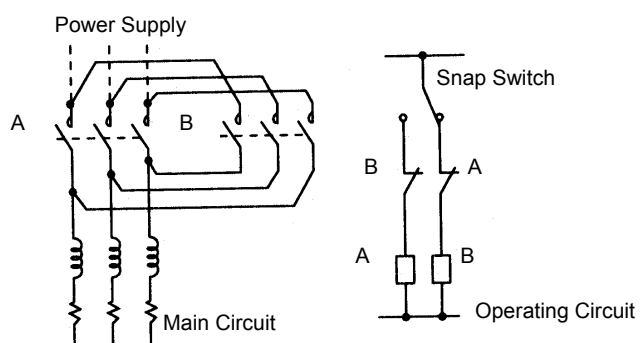
Table 6

| Item<br><br><br><br>Standard<br><br><br>Model<br>Name | Rated Value<br>(AC- 4) |                   | Test Conditions (making and breaking capacity) |                   |                      |                               |                      |                       |                                                                                                      | Results                                                    | Judgment |
|-------------------------------------------------------|------------------------|-------------------|------------------------------------------------|-------------------|----------------------|-------------------------------|----------------------|-----------------------|------------------------------------------------------------------------------------------------------|------------------------------------------------------------|----------|
|                                                       | Voltage Ue<br>[V]      | Current Ie<br>[A] | Voltage Ur<br>[V]                              | Current Ic<br>[A] | Power Factor<br>cosφ | Operation<br>Cycle<br>[Times] | ON time<br>[seconds] | OFF time<br>[seconds] |                                                                                                      |                                                            |          |
|                                                       |                        |                   |                                                |                   |                      |                               |                      |                       | Simul-<br>taneous<br>Excitation<br>Test                                                              |                                                            |          |
|                                                       | -                      | -                 | 1.05 x Ue                                      | 10 x Ie           | 0.45±0.05            | 50                            | 10                   | 0.05                  | Ic≤100: 10<br>100<Ic≤200: 20<br>200<Ic≤300: 30<br>300<Ic≤400: 40<br>400<Ic≤600: 60<br>600<Ic≤800: 80 | Contact<br>Welding and<br>Phase-to-phase<br>Short-circuits |          |
| SD-2 x T12                                            | 220                    | 11                | 231                                            | 110               | 0.45                 | 50                            | 10                   | 0.05                  | 20                                                                                                   | None                                                       | OK       |
|                                                       | 440                    | 9                 | 462                                            | 90                | 0.45                 | 50                            | 10                   | 0.05                  | 10                                                                                                   | None                                                       | OK       |
| SD-2 x T20                                            | 220                    | 18                | 231                                            | 180               | 0.45                 | 50                            | 10                   | 0.05                  | 20                                                                                                   | None                                                       | OK       |
|                                                       | 440                    | 13                | 462                                            | 130               | 0.45                 | 50                            | 10                   | 0.05                  | 20                                                                                                   | None                                                       | OK       |
| SD-2 x T21                                            | 220                    | 18                | 231                                            | 180               | 0.45                 | 50                            | 10                   | 0.05                  | 20                                                                                                   | None                                                       | OK       |
|                                                       | 440                    | 13                | 462                                            | 130               | 0.45                 | 50                            | 10                   | 0.05                  | 20                                                                                                   | None                                                       | OK       |
| SD-2 x T32                                            | 220                    | 26                | 231                                            | 260               | 0.45                 | 50                            | 10                   | 0.05                  | 30                                                                                                   | None                                                       | OK       |
|                                                       | 440                    | 24                | 462                                            | 240               | 0.45                 | 50                            | 10                   | 0.05                  | 30                                                                                                   | None                                                       | OK       |
| SD-2 x T35                                            | 220                    | 26                | 231                                            | 260               | 0.45                 | 50                            | 10                   | 0.05                  | 30                                                                                                   | None                                                       | OK       |
|                                                       | 440                    | 24                | 462                                            | 240               | 0.45                 | 50                            | 10                   | 0.05                  | 30                                                                                                   | None                                                       | OK       |
| SD-2 x T50                                            | 220                    | 35                | 231                                            | 350               | 0.45                 | 50                            | 10                   | 0.05                  | 40                                                                                                   | None                                                       | OK       |
|                                                       | 440                    | 32                | 462                                            | 320               | 0.45                 | 50                            | 10                   | 0.05                  | 40                                                                                                   | None                                                       | OK       |
| SD-2 x T65                                            | 220                    | 50                | 231                                            | 500               | 0.45                 | 50                            | 10                   | 0.05                  | 60                                                                                                   | None                                                       | OK       |
|                                                       | 440                    | 47                | 462                                            | 470               | 0.45                 | 50                            | 10                   | 0.05                  | 60                                                                                                   | None                                                       | OK       |
| SD-2 x T80                                            | 220                    | 65                | 231                                            | 650               | 0.45                 | 50                            | 10                   | 0.05                  | 80                                                                                                   | None                                                       | OK       |
|                                                       | 440                    | 62                | 462                                            | 620               | 0.45                 | 50                            | 10                   | 0.05                  | 80                                                                                                   | None                                                       | OK       |
| SD-2 x T100                                           | 220                    | 80                | 231                                            | 800               | 0.45                 | 50                            | 10                   | 0.05                  | 80                                                                                                   | None                                                       | OK       |
|                                                       | 440                    | 75                | 462                                            | 750               | 0.45                 | 50                            | 10                   | 0.05                  | 80                                                                                                   | None                                                       | OK       |

Note a) Main circuit frequency: 60Hz

Note b) In the operating cycle, making A - open circuit A - making B - open circuit B - OFF time, makes 1 cycle.  
The switching from open circuit A to making B was performed in the shortest time on the control system.

Note c) Number of Samples: 1 per machine



### 3.3.2 The Operating Performance

#### (1) Non-reversing

These tests were conducted according to the test conditions indicated in Table 7 and Note a) to c). No abnormalities such as welding of contacts and phase-to-phase short circuits were found, and the results met the standard criteria. After the test, the withstand voltage performance was checked by applying a voltage of 1000V and a frequency of 60Hz for 5 seconds, and the results were acceptable.

Table 7

| Item<br>Standard<br>Model Name | Rated Value<br>(AC-3)   |                         | Test Conditions (making and breaking capacity) |                         |                               |                               |                      |                                                | Results                                                    |                                                               | Judgment |
|--------------------------------|-------------------------|-------------------------|------------------------------------------------|-------------------------|-------------------------------|-------------------------------|----------------------|------------------------------------------------|------------------------------------------------------------|---------------------------------------------------------------|----------|
|                                | Voltage<br>$U_e$<br>[V] | Current<br>$I_e$<br>[A] | Voltage<br>$U$<br>[V]                          | Current<br>$I_c$<br>[A] | Power<br>Factor<br>$\cos\phi$ | Operating<br>Cycle<br>[Times] | ON time<br>[seconds] | OFF time<br>[seconds]                          | Making and<br>Breaking<br>capacity                         | Withstand<br>Voltage                                          |          |
|                                | -                       | -                       | $1.05 \times U_e$                              | $2 \times I_e$          | $0.45 \pm 0.05$               | 6000                          | 0.05                 | $I_c \leq 100: 10$<br>$100 < I_c \leq 200: 20$ | Contact<br>Welding and<br>Phase-to-phase<br>Short-circuits | $2 \times U_e$<br>provided<br>1000V or<br>higher<br>5 seconds |          |
| SD-T12 24VDC                   | 220                     | 13                      | 231                                            | 26                      | 0.45                          | 6000                          | 0.05                 | 10                                             | None                                                       | OK                                                            | OK       |
|                                | 440                     | 12                      | 462                                            | 24                      | 0.45                          | 6000                          | 0.05                 | 10                                             | None                                                       | OK                                                            | OK       |
| SD-T20 24VDC                   | 220                     | 18                      | 231                                            | 36                      | 0.45                          | 6000                          | 0.05                 | 10                                             | None                                                       | OK                                                            | OK       |
|                                | 440                     | 18                      | 462                                            | 36                      | 0.45                          | 6000                          | 0.05                 | 10                                             | None                                                       | OK                                                            | OK       |
| SD-T21 24VDC                   | 220                     | 25                      | 231                                            | 50                      | 0.45                          | 6000                          | 0.05                 | 10                                             | None                                                       | OK                                                            | OK       |
|                                | 440                     | 23                      | 462                                            | 46                      | 0.45                          | 6000                          | 0.05                 | 10                                             | None                                                       | OK                                                            | OK       |
| SD-T32 24VDC                   | 220                     | 32                      | 231                                            | 64                      | 0.45                          | 6000                          | 0.05                 | 10                                             | None                                                       | OK                                                            | OK       |
|                                | 440                     | 32                      | 462                                            | 64                      | 0.45                          | 6000                          | 0.05                 | 10                                             | None                                                       | OK                                                            | OK       |
| SD-T35 24VDC                   | 220                     | 40                      | 231                                            | 80                      | 0.45                          | 6000                          | 0.05                 | 10                                             | None                                                       | OK                                                            | OK       |
|                                | 440                     | 40                      | 462                                            | 80                      | 0.45                          | 6000                          | 0.05                 | 10                                             | None                                                       | OK                                                            | OK       |
| SD-T50 24VDC                   | 220                     | 55                      | 231                                            | 110                     | 0.45                          | 6000                          | 0.05                 | 20                                             | None                                                       | OK                                                            | OK       |
|                                | 440                     | 48                      | 462                                            | 96                      | 0.45                          | 6000                          | 0.05                 | 10                                             | None                                                       | OK                                                            | OK       |
| SD-T65 24VDC                   | 220                     | 65                      | 231                                            | 130                     | 0.45                          | 6000                          | 0.05                 | 20                                             | None                                                       | OK                                                            | OK       |
|                                | 440                     | 65                      | 462                                            | 130                     | 0.45                          | 6000                          | 0.05                 | 20                                             | None                                                       | OK                                                            | OK       |
| SD-T80 24VDC                   | 220                     | 85                      | 231                                            | 170                     | 0.45                          | 6000                          | 0.05                 | 20                                             | None                                                       | OK                                                            | OK       |
|                                | 440                     | 85                      | 462                                            | 170                     | 0.45                          | 6000                          | 0.05                 | 20                                             | None                                                       | OK                                                            | OK       |
| SD-T100 24VDC                  | 220                     | 105                     | 231                                            | 210                     | 0.35                          | 6000                          | 0.05                 | 20                                             | None                                                       | OK                                                            | OK       |
|                                | 440                     | 105                     | 462                                            | 210                     | 0.35                          | 6000                          | 0.05                 | 20                                             | None                                                       | OK                                                            | OK       |

Note a) Main circuit frequency: 60Hz

Note b) The operation was conducted by applying 24VDC to the operating coil.

Note c) Number of Samples: 1 per machine

#### (2) Reversing

These tests were conducted according to the test conditions indicated in Table 8 and Note a) to d). No abnormalities such as welding of contacts and phase-to-phase short circuits were found, and the results met the standard criteria. After the test, the withstand voltage performance was checked by applying a voltage of 1000V and a frequency of 60Hz for 5 seconds, and the results were acceptable.

Table 8

| Item<br>Standard<br>Model Name | Rated Value<br>(AC-4)   |                         | Test Conditions (making and breaking capacity) |                         |                               |                                       |                      |                                                                                                                                    | Results                                                    |                                                               | Judgment |
|--------------------------------|-------------------------|-------------------------|------------------------------------------------|-------------------------|-------------------------------|---------------------------------------|----------------------|------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|---------------------------------------------------------------|----------|
|                                | Voltage<br>$U_e$<br>[V] | Current<br>$I_e$<br>[A] | Voltage<br>$U_r$<br>[V]                        | Current<br>$I_c$<br>[A] | Power<br>Factor<br>$\cos\phi$ | Operation Cycle<br>[Times]<br>Note c) | ON time<br>[seconds] | OFF time<br>[seconds]                                                                                                              | Making and<br>Breaking<br>capacity                         | Withstand<br>Voltage                                          |          |
|                                | -                       | -                       | $1.05 \times U_e$                              | $6 \times I_e$          | $0.45 \pm 0.05$               | 6000                                  | 0.05                 | $I_c \leq 100: 10$<br>$100 < I_c \leq 200: 20$<br>$200 < I_c \leq 300: 30$<br>$300 < I_c \leq 400: 40$<br>$400 < I_c \leq 600: 60$ | Contact<br>Welding and<br>Phase-to-phase<br>Short-circuits | $2 \times U_e$<br>provided<br>1000V<br>or higher<br>5 seconds |          |
| SD-2 x T12                     | 220                     | 11                      | 231                                            | 66                      | 0.45                          | 6000                                  | 0.05                 | 10                                                                                                                                 | None                                                       | OK                                                            | OK       |
|                                | 440                     | 9                       | 462                                            | 54                      | 0.45                          | 6000                                  | 0.05                 | 10                                                                                                                                 | None                                                       | OK                                                            | OK       |
| SD-2 x T20                     | 220                     | 18                      | 231                                            | 108                     | 0.45                          | 6000                                  | 0.05                 | 20                                                                                                                                 | None                                                       | OK                                                            | OK       |
|                                | 440                     | 13                      | 462                                            | 78                      | 0.45                          | 6000                                  | 0.05                 | 10                                                                                                                                 | None                                                       | OK                                                            | OK       |
| SD-2 x T21                     | 220                     | 18                      | 231                                            | 108                     | 0.45                          | 6000                                  | 0.05                 | 20                                                                                                                                 | None                                                       | OK                                                            | OK       |
|                                | 440                     | 13                      | 462                                            | 78                      | 0.45                          | 6000                                  | 0.05                 | 10                                                                                                                                 | None                                                       | OK                                                            | OK       |
| SD-2 x T32                     | 220                     | 26                      | 231                                            | 156                     | 0.45                          | 6000                                  | 0.05                 | 20                                                                                                                                 | None                                                       | OK                                                            | OK       |
|                                | 440                     | 24                      | 462                                            | 144                     | 0.45                          | 6000                                  | 0.05                 | 20                                                                                                                                 | None                                                       | OK                                                            | OK       |
| SD-2 x T35                     | 220                     | 26                      | 231                                            | 156                     | 0.45                          | 6000                                  | 0.05                 | 20                                                                                                                                 | None                                                       | OK                                                            | OK       |
|                                | 440                     | 24                      | 462                                            | 144                     | 0.45                          | 6000                                  | 0.05                 | 20                                                                                                                                 | None                                                       | OK                                                            | OK       |
| SD-2 x T50                     | 220                     | 35                      | 231                                            | 210                     | 0.45                          | 6000                                  | 0.05                 | 30                                                                                                                                 | None                                                       | OK                                                            | OK       |
|                                | 440                     | 32                      | 462                                            | 192                     | 0.45                          | 6000                                  | 0.05                 | 20                                                                                                                                 | None                                                       | OK                                                            | OK       |
| SD-2 x T65                     | 220                     | 50                      | 231                                            | 300                     | 0.45                          | 6000                                  | 0.05                 | 30                                                                                                                                 | None                                                       | OK                                                            | OK       |
|                                | 440                     | 47                      | 462                                            | 282                     | 0.45                          | 6000                                  | 0.05                 | 30                                                                                                                                 | None                                                       | OK                                                            | OK       |
| SD-2 x T80                     | 220                     | 65                      | 231                                            | 390                     | 0.45                          | 6000                                  | 0.05                 | 40                                                                                                                                 | None                                                       | OK                                                            | OK       |
|                                | 440                     | 62                      | 462                                            | 372                     | 0.45                          | 6000                                  | 0.05                 | 40                                                                                                                                 | None                                                       | OK                                                            | OK       |
| SD-2 x T100                    | 220                     | 80                      | 231                                            | 480                     | 0.45                          | 6000                                  | 0.05                 | 60                                                                                                                                 | None                                                       | OK                                                            | OK       |
|                                | 440                     | 75                      | 462                                            | 450                     | 0.45                          | 6000                                  | 0.05                 | 60                                                                                                                                 | None                                                       | OK                                                            | OK       |

Note a) Main circuit frequency: 60Hz

Note b) The operation was conducted by applying 24VDC to the operating coil.

Note c) The operation was performed based on the cycle mentioned in Note b) of 3.3.1 (3).

Note d) Number of Samples: 1 per machine

### 3.4 Test Sequence III

#### 3.4.1 Performance under Short-circuit Conditions

These tests were conducted according to the test conditions indicated in Table 9 and Note a) to d). There was no damage to the conductors and terminals. The leakage detection fuse was not melted, and the results were acceptable.

Table 9

| Item<br>Standard<br>Model Name | Rated Current of SCPD [A]<br>Note a) | Rated Value (AC-3) |                | Test Conditions |                |                   | Results           |                            |                                       | Judgment |
|--------------------------------|--------------------------------------|--------------------|----------------|-----------------|----------------|-------------------|-------------------|----------------------------|---------------------------------------|----------|
|                                |                                      | Voltage Ue [V]     | Current Ie [A] | Voltage [V]     | Current I [kA] | Power Factor cosφ | O or CO Operation | Conductor/ Terminal Damage | Melting of the Leakage Detection Fuse |          |
|                                | -                                    | -                  | -              | Ue              | Note b)        | Note c)           | Note d)           | None                       | None                                  |          |
| SD-T12                         | 40                                   | 220/440            | 13/12          | 440             | 1              | 0.95              | O<br>CO           | None<br>None               | None<br>None                          | OK       |
| SD-T20                         | 40                                   | 220/440            | 18/18          | 440             | 3              | 0.9               | O<br>CO           | None<br>None               | None<br>None                          | OK       |
| SD-T21                         | 80                                   | 220/440            | 25/23          | 440             | 3              | 0.9               | O<br>CO           | None<br>None               | None<br>None                          | OK       |
| SD-T32                         | 80                                   | 220/440            | 32/32          | 440             | 3              | 0.9               | O<br>CO           | None<br>None               | None<br>None                          | OK       |
| SD-T35                         | 100                                  | 220/440            | 40/40          | 440             | 3              | 0.9               | O<br>CO           | None<br>None               | None<br>None                          | OK       |
| SD-T50                         | 100                                  | 220/440            | 55/48          | 440             | 3              | 0.9               | O<br>CO           | None<br>None               | None<br>None                          | OK       |
| SD-T65                         | 100                                  | 220/440            | 65/65          | 440             | 5              | 0.7               | O<br>CO           | None<br>None               | None<br>None                          | OK       |
| SD-T80                         | 125                                  | 220/440            | 85/85          | 440             | 5              | 0.7               | O<br>CO           | None<br>None               | None<br>None                          | OK       |
| SD-T100                        | 160                                  | 220/440            | 105/105        | 440             | 5              | 0.7               | O<br>CO           | None<br>None               | None<br>None                          | OK       |

Note a) SCPD: Short Circuit Protection Device

Note b) The test currents of specified standards for rated operational current were as follows. (Ie indicates the maximum current to be applied to the motor.)

In the case of  $1 < I_e \leq 16$ : 1 kA In the case of  $16 < I_e \leq 63$ : 3 kA In the case of  $63 < I_e \leq 125$ : 5 kA

Note c) The power factors of specified standards for test current are as follows.

In the case of  $I \leq 1.5$  kA:  $0.95 \pm 0.05$  In the case of  $1.5$  kA  $< I \leq 3$  kA:  $0.9 \pm 0.05$  In the case of  $4.5$  kA  $< I \leq 6$  kA:  $0.7 \pm 0.05$

Note d) O operation: Breaking of the circuit by the SCPD resulting from closing the circuit on the equipment under test which is in the closed position.

CO operation: Breaking of the circuit by the SCPD resulting from closing the circuit by the equipment under test.

### 3.5 Test Sequence IV

#### 3.5.1 Ability of Contactors to Withstand Overload Currents

The current indicated in Table 10 was applied for 10 seconds in making conditions of the contactor. All the parts met the standard criteria without abnormality.

Table 10

| Item<br>Standard<br>Model Name | 200 to 220V<br>Rated Current [A]<br>Ie (AC-3) | Test Conditions |                                | Results                 | Judgment |
|--------------------------------|-----------------------------------------------|-----------------|--------------------------------|-------------------------|----------|
|                                |                                               | Current [A]     | Current Passage Time [seconds] |                         |          |
|                                |                                               | $I_e \times 8$  | 10                             | Abnormality in the part |          |
| SD-T12                         | 13                                            | 104             | 10                             | None                    | OK       |
| SD-T20                         | 18                                            | 144             | 10                             | None                    | OK       |
| SD-T21                         | 25                                            | 200             | 10                             | None                    | OK       |
| SD-T32                         | 32                                            | 256             | 10                             | None                    | OK       |
| SD-T35                         | 40                                            | 320             | 10                             | None                    | OK       |
| SD-T50                         | 55                                            | 440             | 10                             | None                    | OK       |
| SD-T65                         | 65                                            | 520             | 10                             | None                    | OK       |
| SD-T80                         | 85                                            | 680             | 10                             | None                    | OK       |
| SD-T100                        | 105                                           | 840             | 10                             | None                    | OK       |

Note a) Number of Samples: 1 per machine

## 3.6 Test Sequence V

### 3.6.1 Mechanical Properties of Terminals

#### (1) Tests of Mechanical Strength of Terminals

The crimp terminals described in Table 11 were tightened using the following tightening torques and tested by connection and disconnection 5 times. All the parts met the standard criteria without looseness or damage.

Table 11

| Item<br>Standard<br>Model Name | Target Terminal Position | Crimp Terminal Size                           | Manufacturer Standard Tightening Torque [N·m] | Tested Tightening Torque [N·m]                      | Results                         | Judgment |
|--------------------------------|--------------------------|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------------|---------------------------------|----------|
|                                | -                        | Conductor of the Maximum Cross-Sectional Area | -                                             | 110% of the Manufacturer Standard Tightening Torque | Looseness or Damage to the Part |          |
| SD-T12                         | 2/T1, 6/T3               | 2-3.5                                         | 0.9 to 1.5                                    | 1.65                                                | None                            | OK       |
| SD-T20                         | 2/T1, 6/T3               | 2-3.5                                         | 0.9 to 1.5                                    | 1.65                                                | None                            | OK       |
| SD-T21                         | 2/T1, 6/T3               | 5.5-4                                         | 1.2 to 1.9                                    | 2.09                                                | None                            | OK       |
| SD-T32                         | 2/T1, 6/T3               | 5.5-4                                         | 1.2 to 1.9                                    | 2.09                                                | None                            | OK       |
| SD-T35                         | 2/T1, 6/T3               | 22-S5                                         | 2.0 to 3.3                                    | 3.63                                                | None                            | OK       |
| SD-T50                         | 2/T1, 6/T3               | 22-S5                                         | 2.0 to 3.3                                    | 3.63                                                | None                            | OK       |
| SD-T65                         | 2/T1, 6/T3               | 60-S6                                         | 3.5 to 5.7                                    | 6.27                                                | None                            | OK       |
| SD-T80                         | 2/T1, 6/T3               | 60-S6                                         | 3.5 to 5.7                                    | 6.27                                                | None                            | OK       |
| SD-T100                        | 2/T1, 6/T3               | 60-6                                          | 3.5 to 5.7                                    | 6.27                                                | None                            | OK       |

Note a) The test was conducted by applying 110% of the maximum value of the manufacturer standard tightening torque

Note b) Number of Samples: 1 per machine

HOTLINE: 1900.6536

## (2) Flexion and Pull-out Tests

In the flexion tests, the wire was rotated 135 times continuously by placing weight on its pointed end under the conditions (the following tightening torques were checked by using the minimum value of the manufacturer standard tightening torque) indicated in Table 12. The results met the standard criteria without pullout or breaking of the conductor. Then, the pull-out strength indicated in Table 12 was applied for 1 minute. The results met the standard criteria without pullout or breaking of the conductor.

Table 12

| Item       | Target Terminal Position | Screw Size | Wire Specifications |                     | Number of Connections         | Manufacturer Standard Tightening Torque [N·m] | Tested Tightening Torque [N·m] | Diameter of the Bushing Hole [mm]                                                                                                                                                                                                                 | Height [mm]                                                                                                                                                                                                                                    | Weight [kg]                                                                                                                                                                                                                                    | Pulling Force [N]                                                                                                                                                                                                                      | Judgment                         |
|------------|--------------------------|------------|---------------------|---------------------|-------------------------------|-----------------------------------------------|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
|            |                          |            | Type                | Size                |                               |                                               |                                |                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                        |                                  |
| Standard   | -                        | -          | -                   | -                   | Maximum Number of Connections | -                                             | Specified Tightening Torque    | 0.75mm <sup>2</sup> : 6.5<br>1.25mm <sup>2</sup> : 6.5<br>2.5mm <sup>2</sup> : 9.5<br>4mm <sup>2</sup> : 9.5<br>6mm <sup>2</sup> : 9.5<br>14mm <sup>2</sup> : 13.0<br>16mm <sup>2</sup> : 13.0<br>φ1.6: 9.5<br>φ2: 9.5<br>φ2.6: 9.5<br>φ3.6: 13.0 | 0.75mm <sup>2</sup> : 260<br>1.25mm <sup>2</sup> : 260<br>2.5mm <sup>2</sup> : 280<br>4mm <sup>2</sup> : 280<br>6mm <sup>2</sup> : 280<br>14mm <sup>2</sup> : 300<br>16mm <sup>2</sup> : 300<br>φ1.6: 280<br>φ2: 280<br>φ2.6: 280<br>φ3.6: 300 | 0.75mm <sup>2</sup> : 0.4<br>1.25mm <sup>2</sup> : 0.4<br>2.5mm <sup>2</sup> : 0.7<br>4mm <sup>2</sup> : 0.9<br>6mm <sup>2</sup> : 1.4<br>14mm <sup>2</sup> : 2.9<br>16mm <sup>2</sup> : 2.9<br>φ1.6: 0.7<br>φ2: 0.9<br>φ2.6: 1.4<br>φ3.6: 2.9 | 0.75mm <sup>2</sup> : 30<br>1.25mm <sup>2</sup> : 40<br>2.5mm <sup>2</sup> : 50<br>4mm <sup>2</sup> : 60<br>6mm <sup>2</sup> : 80<br>14mm <sup>2</sup> : 100<br>16mm <sup>2</sup> : 100<br>φ1.6: 50<br>φ2: 60<br>φ2.6: 80<br>φ3.6: 100 | Pullout or Breaking of Conductor |
| Model Name | SD-T12                   | 2/T1       | Stranded Wire       | 0.75mm <sup>2</sup> | 2                             | 0.9 to 1.5                                    | 0.9                            | 6.5                                                                                                                                                                                                                                               | 260                                                                                                                                                                                                                                            | 0.4                                                                                                                                                                                                                                            | 30                                                                                                                                                                                                                                     | OK                               |
|            |                          |            |                     | 2.5mm <sup>2</sup>  | 2                             | 0.9 to 1.5                                    | 0.9                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.7                                                                                                                                                                                                                                            | 50                                                                                                                                                                                                                                     | OK                               |
|            |                          |            | Single Wire         | φ1.6                | 2                             | 0.9 to 1.5                                    | 0.9                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.7                                                                                                                                                                                                                                            | 50                                                                                                                                                                                                                                     | OK                               |
|            | 6/T3                     | M3.5       | Stranded Wire       | 0.75mm <sup>2</sup> | 2                             | 0.9 to 1.5                                    | 0.9                            | 6.5                                                                                                                                                                                                                                               | 260                                                                                                                                                                                                                                            | 0.4                                                                                                                                                                                                                                            | 30                                                                                                                                                                                                                                     | OK                               |
|            |                          |            |                     | 2.5mm <sup>2</sup>  | 2                             | 0.9 to 1.5                                    | 0.9                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.7                                                                                                                                                                                                                                            | 50                                                                                                                                                                                                                                     | OK                               |
|            |                          |            | Single Wire         | φ1.6                | 2                             | 0.9 to 1.5                                    | 0.9                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.7                                                                                                                                                                                                                                            | 50                                                                                                                                                                                                                                     | OK                               |
| SD-T20     | 2/T1                     | M3.5       | Stranded Wire       | 0.75mm <sup>2</sup> | 2                             | 0.9 to 1.5                                    | 0.9                            | 6.5                                                                                                                                                                                                                                               | 260                                                                                                                                                                                                                                            | 0.4                                                                                                                                                                                                                                            | 30                                                                                                                                                                                                                                     | OK                               |
|            |                          |            |                     | 2.5mm <sup>2</sup>  | 2                             | 0.9 to 1.5                                    | 0.9                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.7                                                                                                                                                                                                                                            | 50                                                                                                                                                                                                                                     | OK                               |
|            |                          |            | Single Wire         | φ1.6                | 2                             | 0.9 to 1.5                                    | 0.9                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.7                                                                                                                                                                                                                                            | 50                                                                                                                                                                                                                                     | OK                               |
|            | 6/T3                     | M3.5       | Stranded Wire       | 0.75mm <sup>2</sup> | 2                             | 0.9 to 1.5                                    | 0.9                            | 6.5                                                                                                                                                                                                                                               | 260                                                                                                                                                                                                                                            | 0.4                                                                                                                                                                                                                                            | 30                                                                                                                                                                                                                                     | OK                               |
|            |                          |            |                     | 2.5mm <sup>2</sup>  | 2                             | 0.9 to 1.5                                    | 0.9                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.7                                                                                                                                                                                                                                            | 50                                                                                                                                                                                                                                     | OK                               |
|            |                          |            | Single Wire         | φ1.6                | 2                             | 0.9 to 1.5                                    | 0.9                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.7                                                                                                                                                                                                                                            | 50                                                                                                                                                                                                                                     | OK                               |
| SD-T21     | 2/T1                     | M4         | Stranded Wire       | 1.25mm <sup>2</sup> | 2                             | 1.2 to 1.9                                    | 1.2                            | 6.5                                                                                                                                                                                                                                               | 260                                                                                                                                                                                                                                            | 0.4                                                                                                                                                                                                                                            | 40                                                                                                                                                                                                                                     | OK                               |
|            |                          |            |                     | 6mm <sup>2</sup>    | 2                             | 1.2 to 1.9                                    | 1.2                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 1.4                                                                                                                                                                                                                                            | 80                                                                                                                                                                                                                                     | OK                               |
|            |                          |            | Single Wire         | φ1.6                | 2                             | 1.2 to 1.9                                    | 1.2                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.7                                                                                                                                                                                                                                            | 50                                                                                                                                                                                                                                     | OK                               |
|            | 6/T3                     | M4         | Stranded Wire       | φ2.6                | 2                             | 1.2 to 1.9                                    | 1.2                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 1.4                                                                                                                                                                                                                                            | 80                                                                                                                                                                                                                                     | OK                               |
|            |                          |            |                     | 1.25mm <sup>2</sup> | 2                             | 1.2 to 1.9                                    | 1.2                            | 6.5                                                                                                                                                                                                                                               | 260                                                                                                                                                                                                                                            | 0.4                                                                                                                                                                                                                                            | 40                                                                                                                                                                                                                                     | OK                               |
|            |                          |            | Single Wire         | 6mm <sup>2</sup>    | 2                             | 1.2 to 1.9                                    | 1.2                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 1.4                                                                                                                                                                                                                                            | 80                                                                                                                                                                                                                                     | OK                               |
| SD-T32     | 2/T1                     | M4         | Stranded Wire       | φ1.6                | 2                             | 1.2 to 1.9                                    | 1.2                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.7                                                                                                                                                                                                                                            | 50                                                                                                                                                                                                                                     | OK                               |
|            |                          |            |                     | φ2.6                | 2                             | 1.2 to 1.9                                    | 1.2                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 1.4                                                                                                                                                                                                                                            | 80                                                                                                                                                                                                                                     | OK                               |
|            |                          |            | Single Wire         | 1.25mm <sup>2</sup> | 2                             | 1.2 to 1.9                                    | 1.2                            | 6.5                                                                                                                                                                                                                                               | 260                                                                                                                                                                                                                                            | 0.4                                                                                                                                                                                                                                            | 40                                                                                                                                                                                                                                     | OK                               |
|            | 6/T3                     | M4         | Stranded Wire       | 6mm <sup>2</sup>    | 2                             | 1.2 to 1.9                                    | 1.2                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 1.4                                                                                                                                                                                                                                            | 80                                                                                                                                                                                                                                     | OK                               |
|            |                          |            |                     | φ1.6                | 2                             | 1.2 to 1.9                                    | 1.2                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.7                                                                                                                                                                                                                                            | 50                                                                                                                                                                                                                                     | OK                               |
|            |                          |            | Single Wire         | φ2.6                | 2                             | 1.2 to 1.9                                    | 1.2                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 1.4                                                                                                                                                                                                                                            | 80                                                                                                                                                                                                                                     | OK                               |
| SD-T35     | 2/T1                     | M5         | Stranded Wire       | 1.25mm <sup>2</sup> | 2                             | 2.0 to 3.3                                    | 2.0                            | 6.5                                                                                                                                                                                                                                               | 260                                                                                                                                                                                                                                            | 0.4                                                                                                                                                                                                                                            | 40                                                                                                                                                                                                                                     | OK                               |
|            |                          |            |                     | 16mm <sup>2</sup>   | 2                             | 2.0 to 3.3                                    | 2.0                            | 13.0                                                                                                                                                                                                                                              | 300                                                                                                                                                                                                                                            | 2.9                                                                                                                                                                                                                                            | 100                                                                                                                                                                                                                                    | OK                               |
|            |                          |            | Single Wire         | φ1.6                | 2                             | 2.0 to 3.3                                    | 2.0                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.7                                                                                                                                                                                                                                            | 50                                                                                                                                                                                                                                     | OK                               |
|            | 6/T3                     | M5         | Stranded Wire       | φ3.6                | 2                             | 2.0 to 3.3                                    | 2.0                            | 13.0                                                                                                                                                                                                                                              | 300                                                                                                                                                                                                                                            | 2.9                                                                                                                                                                                                                                            | 100                                                                                                                                                                                                                                    | OK                               |
|            |                          |            |                     | 1.25mm <sup>2</sup> | 2                             | 2.0 to 3.3                                    | 2.0                            | 6.5                                                                                                                                                                                                                                               | 260                                                                                                                                                                                                                                            | 0.4                                                                                                                                                                                                                                            | 40                                                                                                                                                                                                                                     | OK                               |
|            |                          |            | Single Wire         | 16mm <sup>2</sup>   | 2                             | 2.0 to 3.3                                    | 2.0                            | 13.0                                                                                                                                                                                                                                              | 300                                                                                                                                                                                                                                            | 2.9                                                                                                                                                                                                                                            | 100                                                                                                                                                                                                                                    | OK                               |
| SD-T50     | 2/T1                     | M5         | Stranded Wire       | φ1.6                | 2                             | 2.0 to 3.3                                    | 2.0                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.7                                                                                                                                                                                                                                            | 50                                                                                                                                                                                                                                     | OK                               |
|            |                          |            |                     | φ3.6                | 2                             | 2.0 to 3.3                                    | 2.0                            | 13.0                                                                                                                                                                                                                                              | 300                                                                                                                                                                                                                                            | 2.9                                                                                                                                                                                                                                            | 100                                                                                                                                                                                                                                    | OK                               |
|            |                          |            | Single Wire         | 1.25mm <sup>2</sup> | 2                             | 2.0 to 3.3                                    | 2.0                            | 6.5                                                                                                                                                                                                                                               | 260                                                                                                                                                                                                                                            | 0.4                                                                                                                                                                                                                                            | 40                                                                                                                                                                                                                                     | OK                               |
|            | 6/T3                     | M5         | Stranded Wire       | 16mm <sup>2</sup>   | 2                             | 2.0 to 3.3                                    | 2.0                            | 13.0                                                                                                                                                                                                                                              | 300                                                                                                                                                                                                                                            | 2.9                                                                                                                                                                                                                                            | 100                                                                                                                                                                                                                                    | OK                               |
|            |                          |            |                     | φ1.6                | 2                             | 2.0 to 3.3                                    | 2.0                            | 9.5                                                                                                                                                                                                                                               | 280                                                                                                                                                                                                                                            | 0.7                                                                                                                                                                                                                                            | 50                                                                                                                                                                                                                                     | OK                               |
|            |                          |            | Single Wire         | φ3.6                | 2                             | 2.0 to 3.3                                    | 2.0                            | 13.0                                                                                                                                                                                                                                              | 300                                                                                                                                                                                                                                            | 2.9                                                                                                                                                                                                                                            | 100                                                                                                                                                                                                                                    | OK                               |

Note a) Since SD-T65 or higher models cannot be connected to the unprocessed exposed conductor, this evaluation is not applicable.

# ■ Mechanical Latch Type Magnetic Contactor

## <Type SL-T, SLD-T>

Type SL-T, SLD-T mechanical latch type magnetic contactors are type S-T magnetic contactors with mechanical latch feature. This instant excitation type magnetic contactor is composed of a closing coil and tripping coil. At the time of closing, the closing coil is energized and the ON state is mechanically held. At the time of opening, the tripping coil is energized to remove the joining element of the latch.

## 1. Usage

- Can be used as a memory circuit in which the contactor maintains the making state at the time of power failure, instantaneous power failure or voltage drop.
- The switchboard can be used as a circuit in facilities sensitive to noise (hospitals, buildings etc.).
- The circuit can be used for long time power supply such as road lighting.
- The switching frequency is done less often resulting in saving the continuous power consumption of coil.

## 2. Rating

| Model Name          | Rated operating current of AC- 3 [A] |             |      | Open Thermoelectric Current I <sub>th</sub> [A] | Auxiliary Contact |                          | Switching Frequency | Life         |              |
|---------------------|--------------------------------------|-------------|------|-------------------------------------------------|-------------------|--------------------------|---------------------|--------------|--------------|
|                     | 220 to 240V                          | 380 to 440V | 500V |                                                 | Valid             | For Self-Demagnetization |                     | Mechanical   | Electrical   |
| SL-T21<br>SLD-T21   | 25                                   | 23          | 17   | 32                                              | 2a2b              | 1a1b                     | 1200 time/hour      | 500000 times | 500000 times |
| SL-T35<br>SLD-T35   | 40                                   | 40          | 32   | 60                                              | 2a2b              | 1a1b                     | 1200 time/hour      | 500000 times | 500000 times |
| SL-T50<br>SLD-T50   | 55                                   | 48          | 38   | 80                                              | 2a2b              | 1a1b                     | 1200 time/hour      | 250000 times | 250000 times |
| SL-T65<br>SLD-T65   | 65                                   | 65          | 60   | 100                                             | 2a2b              | 1a1b                     | 1200 time/hour      | 250000 times | 250000 times |
| SL-T100<br>SLD-T100 | 105                                  | 105         | 85   | 150                                             | 2a2b              | 1a1b                     | 1200 time/hour      | 250000 times | 250000 times |

HOTLINE: 1900.6536

### 3. Type Test

Applicable Standard IEC60947-1 (2011) Low voltage switchgear and control gear  
Part 1: General Rule  
IEC60947-4-1 (2012) Low voltage switchgear and control gear  
Part 4: Contactor and Motor Starter  
Section 1: Electro-mechanical Contactor and Motor Starter

#### 3.1 Type Tests and Test Sequences

| Test Sequences  | Test Name                                               | Test Conditions               |                                                               |
|-----------------|---------------------------------------------------------|-------------------------------|---------------------------------------------------------------|
| a) Sequence I   | 1) Temperature rise                                     | According to the IEC60947-4-1 | 9.3.3.3 "Temperature Rise".                                   |
|                 | 2) Operation and operating limits                       | According to the IEC60947-4-1 | 9.3.3.1 "Operation" and 9.3.3.2 "Operating limit".            |
|                 | 3) Dielectric properties                                | According to the IEC60947-4-1 | 9.3.3.4 "Dielectric Properties".                              |
| b) Sequence II  | 1) Rated making and breaking capacity                   | According to the IEC60947-4-1 | 9.3.3.5 "Making and Breaking Capacity".                       |
|                 | 2) Conventional operating performance                   | According to the IEC60947-4-1 | 9.3.3.6 "Operating Performance Capability".                   |
| c) Sequence III | 1) Performance under short-circuit conditions           | According to the IEC60947-4-1 | 9.3.4 "Performance under Short-circuit Conditions".           |
| d) Sequence IV  | 1) Ability of contactors to withstand overload currents | According to the IEC60947-4-1 | 9.3.5 "Ability of Contactors to Withstand Overload Currents". |
| e) Sequence V   | 1) Mechanical properties of terminals                   | According to the IEC60947-1   | 8.2.4 "Mechanical Properties of Terminals".                   |

Note a) As only the operating coils differ in type SL-T and type SLD-T (AC operation coil for type SL-T and DC operation coil for type SLD-T), the items that do not affect the operation were carried out with type SL-T.

Note b) For type SL-T, the coil with nominal voltage 200VAC (200-240V, 50Hz/60Hz) was used. For type SLD-T, the coil with nominal voltage 100VDC (Rated voltage 100-110V) was used.

HOTLINE: 1900.6536

## 3.2 Test Sequence I

### 3.2.1 Temperature Rise and Dielectric Properties

These tests were conducted according to the test conditions indicated in Table 1 and Note a) to f), the temperature rise of each part met the standard criteria of temperature rise limit. Also the operations, dielectric properties, and insulation resistances after the temperature tests met the standard criteria.

Table 1

| Model Name | Item<br><br><br><br>Standard | Test Conditions             |                   | Results Note a)                                 |                                    |                   |              |                   |                          | Judgment |                         |
|------------|------------------------------|-----------------------------|-------------------|-------------------------------------------------|------------------------------------|-------------------|--------------|-------------------|--------------------------|----------|-------------------------|
|            |                              | Current [A]                 |                   | Connection Wire Size [mm <sup>2</sup> ] Note b) | Maximum Temperature Rise Value [K] |                   |              |                   | Dielectric Properties    |          |                         |
|            |                              |                             |                   |                                                 | Terminal                           |                   | Contact      |                   | Impulse Note e)          |          | Power Frequency Note e) |
|            |                              | Main Circuit                | Auxiliary Circuit |                                                 | Main Circuit                       | Auxiliary Circuit | Main Circuit | Auxiliary Circuit |                          |          |                         |
|            |                              | Open Thermoelectric Current |                   | -                                               | 65 or less                         | 65 or less        | Note d)      |                   | 7.3kV 1.2/50 μs x5 times |          | 1890V 5 seconds         |
| SL-T21     |                              | 32                          | 10                | 6                                               | 27                                 | 30                | 36           | 36                | OK                       | OK       | OK                      |
| SL-T35     |                              | 60                          | 10                | 16                                              | 35                                 | 30                | 45           | 46                | OK                       | OK       | OK                      |
| SL-T50     |                              | 80                          | 10                | 25                                              | 41                                 | 29                | 58           | 45                | OK                       | OK       | OK                      |
| SL-T65     |                              | 100                         | 10                | 35                                              | 39                                 | 25                | 61           | 42                | OK                       | OK       | OK                      |
| SL-T85     |                              | 120                         | 10                | 50                                              | 45                                 | 25                | 71           | 42                | OK                       | OK       | OK                      |
| SL-T100    |                              | 150                         | 10                | 50                                              | 46                                 | 34                | 83           | 49                | OK                       | OK       | OK                      |

Note a) The test of temperature rise was conducted by operating at an ambient temperature of 40°C, in open state with the iron plate mounted.

Note b) The connection wire size of the auxiliary circuit: 1.5 mm<sup>2</sup>

Note c) The operating coils were not measured because they are instant excitation type.

Note d) The temperature rise of the contacts was checked at a temperature that is not harmful to the surrounding components. (In short 100K)

Note e) The application points of the impulse withstand voltage performance and the power frequency withstand voltage performance were as follows. However in the power frequency withstand voltage test, (c) was not implemented. Measurement Points: (a) Between all terminals of the main circuit and grounded metal body when the contact element was closed.

(b) Between 1- pole of the main circuit and all other poles connected altogether to the grounded metal body when the contact element was closed.

(c) Between the supply side terminals and the load side terminals of the main circuit when the contact element was opened.

(d) Between one circuit of the operating circuit and auxiliary circuit, and all other circuits/grounded metal body.

Note f) Number of Samples: 1 per machine

### 3.2.2 Operating Limits

The input voltage and trip voltage after the temperature test met the standard criteria by operating without hindrance in the set voltage.

Table 2

| Item<br>Model Name | Standard | Test Conditions and Judgment                               |                                                     |                                                            | Judgment |
|--------------------|----------|------------------------------------------------------------|-----------------------------------------------------|------------------------------------------------------------|----------|
|                    |          | Input Voltage (40°C Cold)                                  |                                                     | Trip Voltage (-5°C Cold)                                   |          |
|                    |          | Operation at 85% or less of the Coil Rated Voltage Note a) | Operation at 110% of the Coil Rated Voltage Note b) | Operation at 85% or less of the Coil Rated Voltage Note a) |          |
| SL-T21             | 50Hz     | 131                                                        | OK                                                  | 90                                                         | OK       |
|                    | 60Hz     | 157                                                        | OK                                                  | 105                                                        | OK       |
| SL-T35             | 50Hz     | 113                                                        | OK                                                  | 83                                                         | OK       |
|                    | 60Hz     | 136                                                        | OK                                                  | 99                                                         | OK       |
| SL-T50             | 50Hz     | 113                                                        | OK                                                  | 83                                                         | OK       |
|                    | 60Hz     | 136                                                        | OK                                                  | 99                                                         | OK       |
| SL-T65             | 50Hz     | 120                                                        | OK                                                  | 68                                                         | OK       |
|                    | 60Hz     | 125                                                        | OK                                                  | 82                                                         | OK       |
| SL-T85             | 50Hz     | 120                                                        | OK                                                  | 68                                                         | OK       |
|                    | 60Hz     | 125                                                        | OK                                                  | 82                                                         | OK       |
| SL-T100            | 50Hz     | 118                                                        | OK                                                  | 67                                                         | OK       |
|                    | 60Hz     | 125                                                        | OK                                                  | 88                                                         | OK       |
| SLD-T21            | -        | 68.5                                                       | OK                                                  | 52                                                         | OK       |
| SLD-T35            | -        | 56                                                         | OK                                                  | 63                                                         | OK       |
| SLD-T50            | -        | 56                                                         | OK                                                  | 63                                                         | OK       |
| SLD-T65            | -        | 66                                                         | OK                                                  | 47                                                         | OK       |
| SLD-T80            | -        | 66                                                         | OK                                                  | 47                                                         | OK       |
| SLD-T100           | -        | 64                                                         | OK                                                  | 45                                                         | OK       |

Note a) The operation at 85% or less of the coil rated voltage of standard value was possible at 170V 50Hz/60Hz for SL-T21. The operation was also possible at 85VDC for SLD-T21.

Note b) The operation at 110% of the coil rated voltage of standard value was possible at 264V 50Hz/60Hz for SL-T21. The operation was also possible at 121VDC for SLD-T21.

## 3.3 Test Sequence II

### 3.3.1 Test of Making and Breaking Capacities

#### (1) Test of Making Capacity

These tests were conducted according to the test conditions indicated in Table 3 and Note a) to c). No abnormalities such as welding of contacts were found, and the results met the standard criteria.

Table 3

| Item<br>Standard<br>Model Name | Rated Value<br>(AC-3)   |                         | Test Conditions (making) |                    |                                                               |                                          |                      |                       | Results            | Judgment |
|--------------------------------|-------------------------|-------------------------|--------------------------|--------------------|---------------------------------------------------------------|------------------------------------------|----------------------|-----------------------|--------------------|----------|
|                                | Voltage<br>$U_e$<br>[V] | Current<br>$I_e$<br>[A] | Voltage $U$<br>[V]       | Current $I$<br>[A] | Power Factor<br>$\cos\phi$                                    | Operating<br>Cycle<br>[Times]<br>Note b) | ON time<br>[seconds] | OFF time<br>[seconds] |                    |          |
|                                | -                       | -                       | $1.05 \times U_e$        | $10 \times I_e$    | $I_e \leq 100A: 0.45 \pm 0.05$<br>$I_e > 100A: 0.35 \pm 0.05$ | 50                                       | 0.05                 | 10                    | Contact<br>Welding |          |
| SL-T21                         | 220                     | 25                      | 231                      | 250                | 0.45                                                          | 50                                       | 0.05                 | 10                    | None               | OK       |
|                                | 440                     | 23                      | 462                      | 230                | 0.45                                                          | 50                                       | 0.05                 | 10                    | None               | OK       |
| SL-T35                         | 220                     | 40                      | 231                      | 400                | 0.45                                                          | 50                                       | 0.05                 | 10                    | None               | OK       |
|                                | 440                     | 40                      | 462                      | 400                | 0.45                                                          | 50                                       | 0.05                 | 10                    | None               | OK       |
| SL-T50                         | 220                     | 55                      | 231                      | 550                | 0.45                                                          | 50                                       | 0.05                 | 10                    | None               | OK       |
|                                | 440                     | 48                      | 462                      | 480                | 0.45                                                          | 50                                       | 0.05                 | 10                    | None               | OK       |
| SL-T65                         | 220                     | 65                      | 231                      | 650                | 0.45                                                          | 50                                       | 0.05                 | 10                    | None               | OK       |
|                                | 440                     | 65                      | 462                      | 650                | 0.45                                                          | 50                                       | 0.05                 | 10                    | None               | OK       |
| SL-T80                         | 220                     | 85                      | 231                      | 850                | 0.45                                                          | 50                                       | 0.05                 | 10                    | None               | OK       |
|                                | 440                     | 85                      | 462                      | 850                | 0.45                                                          | 50                                       | 0.05                 | 10                    | None               | OK       |
| SL-T100                        | 220                     | 105                     | 231                      | 1050               | 0.35                                                          | 50                                       | 0.05                 | 10                    | None               | OK       |
|                                | 440                     | 105                     | 462                      | 1050               | 0.35                                                          | 50                                       | 0.05                 | 10                    | None               | OK       |

Note a) Main circuit frequency: 60Hz

Note b) Among 50 operating cycles, 110% of the rated value (264V 60Hz) was applied to the coil for 25 cycles, and 85% of the rated value (170V 60Hz) was applied to the coil for the other 25 cycles.

Note c) Number of Samples: 1 per machine

#### (2) Test of Making and Breaking Capacities

These tests were conducted according to the test conditions indicated in Table 4 and Note a) to c). No abnormalities such as welding of contacts and phase-to-phase short circuits were found, and the results met the standard criteria.

Table 4

| Item<br>Standard<br>Model Name | Rated Value<br>(AC-3)   |                         | Test Conditions (making and breaking capacity) |                    |                                                               |                               |                      |                                                | Results                                                    | Judgment |
|--------------------------------|-------------------------|-------------------------|------------------------------------------------|--------------------|---------------------------------------------------------------|-------------------------------|----------------------|------------------------------------------------|------------------------------------------------------------|----------|
|                                | Voltage<br>$U_e$<br>[V] | Current<br>$I_e$<br>[A] | Voltage $U$<br>[V]                             | Current $I$<br>[A] | Power Factor<br>$\cos\phi$                                    | Operating<br>Cycle<br>[Times] | ON time<br>[seconds] | OFF time<br>[seconds]                          |                                                            |          |
|                                | -                       | -                       | $1.05 \times U_e$                              | $8 \times I_e$     | $I_e \leq 100A: 0.45 \pm 0.05$<br>$I_e > 100A: 0.35 \pm 0.05$ | 50                            | 0.05                 | $I_c \leq 100: 10$<br>$100 < I_c \leq 200: 20$ | Contact<br>Welding and<br>Phase-to-phase<br>Short-circuits |          |
| SL-T21                         | 220                     | 25                      | 231                                            | 200                | 0.45                                                          | 50                            | 0.05                 | 20                                             | None                                                       | OK       |
|                                | 440                     | 23                      | 462                                            | 184                | 0.45                                                          | 50                            | 0.05                 | 20                                             | None                                                       | OK       |
| SL-T35                         | 220                     | 40                      | 231                                            | 320                | 0.45                                                          | 50                            | 0.05                 | 40                                             | None                                                       | OK       |
|                                | 440                     | 40                      | 462                                            | 320                | 0.45                                                          | 50                            | 0.05                 | 40                                             | None                                                       | OK       |
| SL-T50                         | 220                     | 55                      | 231                                            | 440                | 0.45                                                          | 50                            | 0.05                 | 60                                             | None                                                       | OK       |
|                                | 440                     | 48                      | 462                                            | 384                | 0.45                                                          | 50                            | 0.05                 | 40                                             | None                                                       | OK       |
| SL-T65                         | 220                     | 65                      | 231                                            | 520                | 0.45                                                          | 50                            | 0.05                 | 60                                             | None                                                       | OK       |
|                                | 440                     | 65                      | 462                                            | 520                | 0.45                                                          | 50                            | 0.05                 | 60                                             | None                                                       | OK       |
| SL-T80                         | 220                     | 85                      | 231                                            | 680                | 0.45                                                          | 50                            | 0.05                 | 80                                             | None                                                       | OK       |
|                                | 440                     | 85                      | 462                                            | 680                | 0.45                                                          | 50                            | 0.05                 | 80                                             | None                                                       | OK       |
| SL-T100                        | 220                     | 105                     | 231                                            | 840                | 0.35                                                          | 50                            | 0.05                 | 100                                            | None                                                       | OK       |
|                                | 440                     | 105                     | 462                                            | 840                | 0.35                                                          | 50                            | 0.05                 | 100                                            | None                                                       | OK       |

Note a) Main circuit frequency: 60Hz

Note b) The operation was conducted by applying a voltage of 240V and a frequency of 60Hz to the operating coil.

Note c) Number of Samples: 1 per machine

### (3) The Switching Capacity and Reversibility

These tests were conducted according to the test conditions indicated in Table 5, 6 and Note a) to c). No abnormalities such as welding of contacts and phase-to-phase short circuits were found, and the results met the standard criteria.

Table 5

| Item        | Rated Value (AC-4)         |                            | Test Conditions (making)   |                            |                                                                              |                         |                   |                    | Results                                           | Judgment |
|-------------|----------------------------|----------------------------|----------------------------|----------------------------|------------------------------------------------------------------------------|-------------------------|-------------------|--------------------|---------------------------------------------------|----------|
|             | Voltage U <sub>e</sub> [V] | Current I <sub>e</sub> [A] | Voltage U <sub>r</sub> [V] | Current I <sub>c</sub> [A] | Power Factor cosφ                                                            | Operation Cycle [Times] | ON time [seconds] | OFF time [seconds] |                                                   |          |
|             | -                          | -                          | 1.05 x U <sub>e</sub>      | 12 x I <sub>e</sub>        | I <sub>e</sub> ≤ 100A<br>0.45 ± 0.05<br>I <sub>e</sub> > 100A<br>0.35 ± 0.05 | 50                      | 0.05              | 10                 |                                                   |          |
| Model Name  | -                          | -                          | -                          | -                          | -                                                                            | -                       | -                 | -                  | Contact Welding and Phase-to-phase Short-circuits |          |
|             | -                          | -                          | -                          | -                          | -                                                                            | -                       | -                 | -                  | -                                                 | -        |
| SL-2 x T21  | 220                        | 18                         | 231                        | 216                        | 0.45                                                                         | 50                      | 0.05              | 10                 | None                                              | OK       |
|             | 440                        | 13                         | 462                        | 156                        | 0.45                                                                         | 50                      | 0.05              | 10                 | None                                              | OK       |
| SL-2 x T35  | 220                        | 26                         | 231                        | 312                        | 0.45                                                                         | 50                      | 0.05              | 10                 | None                                              | OK       |
|             | 440                        | 24                         | 462                        | 288                        | 0.45                                                                         | 50                      | 0.05              | 10                 | None                                              | OK       |
| SL-2 x T50  | 220                        | 35                         | 231                        | 420                        | 0.45                                                                         | 50                      | 0.05              | 10                 | None                                              | OK       |
|             | 440                        | 32                         | 462                        | 384                        | 0.45                                                                         | 50                      | 0.05              | 10                 | None                                              | OK       |
| SL-2 x T65  | 220                        | 50                         | 231                        | 600                        | 0.45                                                                         | 50                      | 0.05              | 10                 | None                                              | OK       |
|             | 440                        | 47                         | 462                        | 564                        | 0.45                                                                         | 50                      | 0.05              | 10                 | None                                              | OK       |
| SL-2 x T80  | 220                        | 65                         | 231                        | 780                        | 0.45                                                                         | 50                      | 0.05              | 10                 | None                                              | OK       |
|             | 440                        | 62                         | 462                        | 744                        | 0.45                                                                         | 50                      | 0.05              | 10                 | None                                              | OK       |
| SL-2 x T100 | 220                        | 80                         | 231                        | 960                        | 0.45                                                                         | 50                      | 0.05              | 10                 | None                                              | OK       |
|             | 440                        | 75                         | 462                        | 900                        | 0.45                                                                         | 50                      | 0.05              | 10                 | None                                              | OK       |

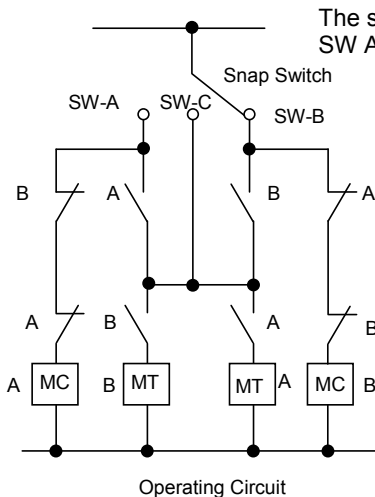
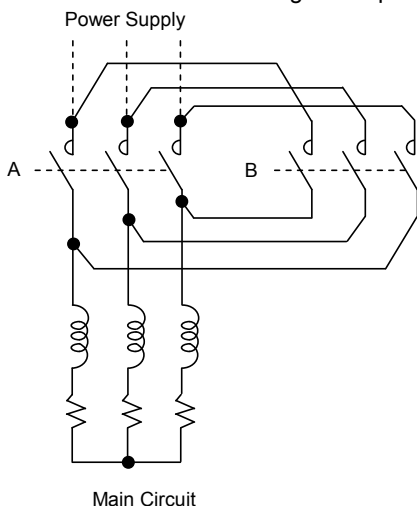
Table 6

| Item<br><br><br>Standard<br><br>Model Name | Rated Value<br>(AC-4)            |                                  | Test Conditions (making and breaking capacity) |                                  |                                                                        |                            |                                    |                      |                                                        | Results                                                    | Judgment |
|--------------------------------------------|----------------------------------|----------------------------------|------------------------------------------------|----------------------------------|------------------------------------------------------------------------|----------------------------|------------------------------------|----------------------|--------------------------------------------------------|------------------------------------------------------------|----------|
|                                            | Voltage<br>U <sub>e</sub><br>[V] | Current<br>I <sub>e</sub><br>[A] | Voltage<br>U <sub>r</sub><br>[V]               | Current<br>I <sub>c</sub><br>[A] | Power Factor<br>cosφ                                                   | Operation Cycle<br>[Times] |                                    | ON time<br>[seconds] | OFF time<br>[seconds]                                  |                                                            |          |
|                                            |                                  |                                  |                                                |                                  |                                                                        |                            | Simultaneous<br>Excitation<br>Test |                      |                                                        |                                                            |          |
|                                            | -                                | -                                | 1.05 x<br>U <sub>e</sub>                       | 10 x I <sub>e</sub>              | I <sub>e</sub> ≤100A<br>0.45±0.05<br>I <sub>e</sub> >100A<br>0.35±0.05 | 50                         | 10                                 | 0.05                 | I <sub>c</sub> ≤100: 10<br>100<I <sub>c</sub> ≤200: 20 | Contact Welding<br>and<br>Phase-to-phase<br>Short-circuits |          |
| SL-2 x T21                                 | 220                              | 18                               | 231                                            | 180                              | 0.45                                                                   | 50                         | 10                                 | 0.05                 | 20                                                     | None                                                       | OK       |
|                                            | 440                              | 13                               | 462                                            | 130                              | 0.45                                                                   | 50                         | 10                                 | 0.05                 | 20                                                     | None                                                       | OK       |
| SL-2 x T35                                 | 220                              | 26                               | 231                                            | 260                              | 0.45                                                                   | 50                         | 10                                 | 0.05                 | 20                                                     | None                                                       | OK       |
|                                            | 440                              | 24                               | 462                                            | 240                              | 0.45                                                                   | 50                         | 10                                 | 0.05                 | 20                                                     | None                                                       | OK       |
| SL-2 x T50                                 | 220                              | 35                               | 231                                            | 350                              | 0.45                                                                   | 50                         | 10                                 | 0.05                 | 20                                                     | None                                                       | OK       |
|                                            | 440                              | 32                               | 462                                            | 320                              | 0.45                                                                   | 50                         | 10                                 | 0.05                 | 20                                                     | None                                                       | OK       |
| SL-2 x T65                                 | 220                              | 50                               | 231                                            | 500                              | 0.45                                                                   | 50                         | 10                                 | 0.05                 | 20                                                     | None                                                       | OK       |
|                                            | 440                              | 47                               | 462                                            | 470                              | 0.45                                                                   | 50                         | 10                                 | 0.05                 | 20                                                     | None                                                       | OK       |
| SL-2 x T80                                 | 220                              | 65                               | 231                                            | 650                              | 0.45                                                                   | 50                         | 10                                 | 0.05                 | 20                                                     | None                                                       | OK       |
|                                            | 440                              | 62                               | 462                                            | 620                              | 0.45                                                                   | 50                         | 10                                 | 0.05                 | 20                                                     | None                                                       | OK       |
| SL-2 x T100                                | 220                              | 80                               | 231                                            | 800                              | 0.45                                                                   | 50                         | 10                                 | 0.05                 | 20                                                     | None                                                       | OK       |
|                                            | 440                              | 75                               | 462                                            | 750                              | 0.45                                                                   | 50                         | 10                                 | 0.05                 | 20                                                     | None                                                       | OK       |

Note a) Main circuit frequency: 60Hz

Note b) In the operating cycle, making A - open circuit A - making B - open circuit B - OFF time, makes 1 cycle.

The switching from open circuit A to making B was performed in the shortest time on the control system.



The snap switches were switched in the sequence of SW A → SW B → SW C → SW B → SW A → SW C →

Note c) Number of Samples: 1 per machine

### 3.3.2 The Operating Performance

#### (1) Non-reversing

These tests were conducted according to the test conditions indicated in Table 7 and Note a) to c). No abnormalities such as welding of contacts and phase-to-phase short circuits were found, and the results met the standard criteria. After the test, the withstand voltage performance was checked by applying a voltage of 1000V and a frequency of 60Hz for 5 seconds, and the results were acceptable.

Table 7

| Item<br>Standard<br>Model Name | Rated Value (AC-3)         |                            | Test Conditions (making and breaking capacity) |                            |                                                                          |                         |                   |                          | Results                                           |                                                       | Judgment |
|--------------------------------|----------------------------|----------------------------|------------------------------------------------|----------------------------|--------------------------------------------------------------------------|-------------------------|-------------------|--------------------------|---------------------------------------------------|-------------------------------------------------------|----------|
|                                | Voltage U <sub>e</sub> [V] | Current I <sub>e</sub> [A] | Voltage U <sub>r</sub> [V]                     | Current I <sub>c</sub> [A] | Power Factor cosφ                                                        | Operating Cycle [Times] | ON time [seconds] | OFF time [seconds]       | Making and Breaking capacity                      | Withstand Voltage                                     |          |
|                                | -                          | -                          | 1.05 x U <sub>e</sub>                          | 2 x I <sub>e</sub>         | I <sub>e</sub> ≤ 100A: 0.45 ± 0.05<br>I <sub>e</sub> > 100A: 0.35 ± 0.05 | 6000                    | 0.05              | I <sub>c</sub> ≤ 100: 10 | Contact Welding and Phase-to-phase Short-circuits | 2 x U <sub>e</sub> provided 1000V or higher 5 seconds |          |
| SL-T21                         | 220                        | 25                         | 231                                            | 50                         | 0.45                                                                     | 6000                    | 0.05              | 10                       | None                                              | OK                                                    | OK       |
|                                | 440                        | 23                         | 462                                            | 46                         | 0.45                                                                     | 6000                    | 0.05              | 10                       | None                                              | OK                                                    | OK       |
| SL-T35                         | 220                        | 40                         | 231                                            | 80                         | 0.45                                                                     | 6000                    | 0.05              | 10                       | None                                              | OK                                                    | OK       |
|                                | 440                        | 40                         | 462                                            | 80                         | 0.45                                                                     | 6000                    | 0.05              | 10                       | None                                              | OK                                                    | OK       |
| SL-T50                         | 220                        | 55                         | 231                                            | 110                        | 0.45                                                                     | 6000                    | 0.05              | 20                       | None                                              | OK                                                    | OK       |
|                                | 440                        | 48                         | 462                                            | 96                         | 0.45                                                                     | 6000                    | 0.05              | 10                       | None                                              | OK                                                    | OK       |
| SL-T65                         | 220                        | 65                         | 231                                            | 130                        | 0.45                                                                     | 6000                    | 0.05              | 20                       | None                                              | OK                                                    | OK       |
|                                | 440                        | 65                         | 462                                            | 130                        | 0.45                                                                     | 6000                    | 0.05              | 20                       | None                                              | OK                                                    | OK       |
| SL-T80                         | 220                        | 85                         | 231                                            | 170                        | 0.45                                                                     | 6000                    | 0.05              | 20                       | None                                              | OK                                                    | OK       |
|                                | 440                        | 85                         | 462                                            | 170                        | 0.45                                                                     | 6000                    | 0.05              | 20                       | None                                              | OK                                                    | OK       |
| SL-T100                        | 220                        | 105                        | 231                                            | 210                        | 0.45                                                                     | 6000                    | 0.05              | 30                       | None                                              | OK                                                    | OK       |
|                                | 440                        | 105                        | 462                                            | 210                        | 0.45                                                                     | 6000                    | 0.05              | 30                       | None                                              | OK                                                    | OK       |

Note a) Main circuit frequency: 60Hz

Note b) The operation was conducted by applying a voltage of 240V and a frequency 60Hz to the operating coil.

Note c) Number of Samples: 1 per machine

#### (2) Reversing

These tests were conducted according to the test conditions indicated in Table 8 and Note a) to d). No abnormalities such as welding of contacts and phase-to-phase short circuits were found, and the results met the standard criteria. After the test, the withstand voltage performance was checked by applying a voltage of 1000V and a frequency of 60Hz for 5 seconds, and the results were acceptable.

Table 8

| Item<br>Standard<br>Model Name | Rated Value (AC-4)         |                            | Test Conditions (making and breaking capacity) |                            |                                                                          |                                    |                   |                                                            | Results                                           |                                                       | Judgment |
|--------------------------------|----------------------------|----------------------------|------------------------------------------------|----------------------------|--------------------------------------------------------------------------|------------------------------------|-------------------|------------------------------------------------------------|---------------------------------------------------|-------------------------------------------------------|----------|
|                                | Voltage U <sub>e</sub> [V] | Current I <sub>e</sub> [A] | Voltage U <sub>r</sub> [V]                     | Current I <sub>c</sub> [A] | Power Factor cosφ                                                        | Operating Cycle [Times]<br>Note c) | ON time [seconds] | OFF time [seconds]                                         | Making and Breaking capacity                      | Withstand Voltage                                     |          |
|                                | -                          | -                          | 1.05 x U <sub>e</sub>                          | 6 x I <sub>e</sub>         | I <sub>e</sub> ≤ 100A: 0.45 ± 0.05<br>I <sub>e</sub> > 100A: 0.35 ± 0.05 | 6000                               | 0.05              | I <sub>c</sub> ≤ 100: 10<br>100 < I <sub>c</sub> ≤ 200: 20 | Contact Welding and Phase-to-phase Short-circuits | 2 x U <sub>e</sub> provided 1000V or higher 5 seconds |          |
| SL-2 x T21                     | 220                        | 18                         | 231                                            | 108                        | 0.45                                                                     | 6000                               | 0.05              | 20                                                         | None                                              | OK                                                    | OK       |
|                                | 440                        | 13                         | 462                                            | 78                         | 0.45                                                                     | 6000                               | 0.05              | 10                                                         | None                                              | OK                                                    | OK       |
| SL-2 x T35                     | 220                        | 26                         | 231                                            | 156                        | 0.45                                                                     | 6000                               | 0.05              | 20                                                         | None                                              | OK                                                    | OK       |
|                                | 440                        | 24                         | 462                                            | 144                        | 0.45                                                                     | 6000                               | 0.05              | 20                                                         | None                                              | OK                                                    | OK       |
| SL-2 x T50                     | 220                        | 35                         | 231                                            | 210                        | 0.45                                                                     | 6000                               | 0.05              | 30                                                         | None                                              | OK                                                    | OK       |
|                                | 440                        | 32                         | 462                                            | 192                        | 0.45                                                                     | 6000                               | 0.05              | 20                                                         | None                                              | OK                                                    | OK       |
| SL-2 x T65                     | 220                        | 50                         | 231                                            | 300                        | 0.45                                                                     | 6000                               | 0.05              | 30                                                         | None                                              | OK                                                    | OK       |
|                                | 440                        | 47                         | 462                                            | 282                        | 0.45                                                                     | 6000                               | 0.05              | 30                                                         | None                                              | OK                                                    | OK       |
| SL-2 x T80                     | 220                        | 65                         | 231                                            | 390                        | 0.45                                                                     | 6000                               | 0.05              | 40                                                         | None                                              | OK                                                    | OK       |
|                                | 440                        | 62                         | 462                                            | 372                        | 0.45                                                                     | 6000                               | 0.05              | 40                                                         | None                                              | OK                                                    | OK       |
| SL-2 x T100                    | 220                        | 80                         | 231                                            | 480                        | 0.45                                                                     | 6000                               | 0.05              | 60                                                         | None                                              | OK                                                    | OK       |
|                                | 440                        | 75                         | 462                                            | 450                        | 0.45                                                                     | 6000                               | 0.05              | 60                                                         | None                                              | OK                                                    | OK       |

Note a) Main circuit frequency: 60Hz

Note b) The operation was conducted by applying a voltage of 240V and a frequency 60Hz to the operating coil.

Note c) The operation was performed based on the cycle mentioned in Note b) of 3.3.1 (3).

Note d) Number of Samples: 1 per machine

### 3.4 Test Sequence III

#### 3.4.1 Performance under Short-circuit Conditions

These tests were conducted according to the test conditions indicated in Table 9 and Note a) to d). There was no damage to the conductors and terminals. The leakage detection fuse was not melted, and the results met the standard criteria.

Table 9

| Item<br>Standard<br>Model Name | Rated Current of SCPD [A]<br>Note a) | Rated Value (AC-3) |                | Test Conditions |                |                   | Results           |                            |                                       | Judgment |
|--------------------------------|--------------------------------------|--------------------|----------------|-----------------|----------------|-------------------|-------------------|----------------------------|---------------------------------------|----------|
|                                |                                      | Voltage Ue [V]     | Current Ie [A] | Voltage [V]     | Current I [kA] | Power Factor cosφ | O or CO Operation | Conductor/ Terminal Damage | Melting of the Leakage Detection Fuse |          |
|                                | -                                    | -                  | -              | Ue              | -              | Note b)           | Note c)           | None                       | None                                  |          |
| SL-T21                         | 80                                   | 220/440            | 25/23          | 440             | 3              | 0.9               | O<br>CO           | None<br>None               | None<br>None                          | OK       |
| SL-T35                         | 100                                  | 220/440            | 40/40          | 440             | 3              | 0.9               | O<br>CO           | None<br>None               | None<br>None                          | OK       |
| SL-T50                         | 100                                  | 220/440            | 55/48          | 440             | 3              | 0.9               | O<br>CO           | None<br>None               | None<br>None                          | OK       |
| SL-T65                         | 100                                  | 220/440            | 65/65          | 440             | 5              | 0.7               | O<br>CO           | None<br>None               | None<br>None                          | OK       |
| SL-T80                         | 125                                  | 220/440            | 85/85          | 440             | 5              | 0.7               | O<br>CO           | None<br>None               | None<br>None                          | OK       |
| SL-T100                        | 160                                  | 220/440            | 105/105        | 440             | 5              | 0.7               | O<br>CO           | None<br>None               | None<br>None                          | OK       |

Note a) SCPD: Short Circuit Protection Device

Note b) The test currents of specified standards for rated operating current were as follows. (Ie indicates the maximum current to be applied to the motor.)  
In the case of  $16 < I_e \leq 63$ : 3 kA

Note c) The power factors of specified standards for test current were as follows.  
In the case of  $1.5 \text{ kA} < I \leq 3 \text{ kA}$ :  $0.9 \pm 0.05$

Note d) O operation: Breaking of the circuit by the SCPD resulting from closing the circuit on the equipment under test which is in the closed position.  
CO operation: Breaking of the circuit by the SCPD resulting from closing the circuit by the equipment under test.

### 3.5 Test Sequence IV

#### 3.5.1 Ability of Contactors to Withstand Overload Currents

The current indicated in Table 10 was applied for 10 seconds in making conditions of the contactor. All the parts met the standard criteria without abnormality.

Table 10

| Item<br>Standard<br>Model Name | 220 to 240V<br>Rated Current [A]<br>Rated Operational Current Ie (AC-3) | Test Conditions                                                                 |                                | Results                 | Judgment |
|--------------------------------|-------------------------------------------------------------------------|---------------------------------------------------------------------------------|--------------------------------|-------------------------|----------|
|                                |                                                                         | Current [A]                                                                     | Current Passage Time [seconds] |                         |          |
|                                |                                                                         | $I_e \leq 630\text{A}$ : $8 \times I_e$<br>$I_e > 630\text{A}$ : $6 \times I_e$ | 10                             | Abnormality in the part |          |
| SL-T21                         | 25                                                                      | 200                                                                             | 10                             | None                    | OK       |
| SL-T35                         | 40                                                                      | 320                                                                             | 10                             | None                    | OK       |
| SL-T50                         | 55                                                                      | 440                                                                             | 10                             | None                    | OK       |
| SL-T65                         | 65                                                                      | 520                                                                             | 10                             | None                    | OK       |
| SL-T80                         | 85                                                                      | 680                                                                             | 10                             | None                    | OK       |
| SL-T100                        | 105                                                                     | 840                                                                             | 10                             | None                    | OK       |

Note a) Number of Samples: 1 per machine

## 3.6 Test Sequence V

### 3.6.1 Mechanical Properties of Terminals

#### (1) Tests of Mechanical Strength of Terminals

The crimp terminals described in Table 11 were tightened using the following tightening torques and tested by connection and disconnection 5 times. All the parts met the standard criteria without looseness or damage.

Table 11

| Item<br>Standard<br>Model Name | Target Terminal Position | Crimp Terminal Size                           | Manufacturer Standard Tightening Torque [N·m] | Tested Tightening Torque [N·m]                      | Results                         | Judgment |
|--------------------------------|--------------------------|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------------|---------------------------------|----------|
|                                | -                        | Conductor of the Maximum Cross-Sectional Area | -                                             | 110% of the Manufacturer Standard Tightening Torque | Looseness or Damage to the Part |          |
| SL-T21                         | 2/T1, 6/T3               | 5.5-4                                         | 1.2 to 1.9                                    | 2.09 (110% of the maximum value)                    | None                            | OK       |
| SL-T35                         | 2/T1, 6/T3               | 22-S5                                         | 2.0 to 3.3                                    | 3.63                                                | None                            | OK       |
| SL-T50                         | 2/T1, 6/T3               | 22-S5                                         | 2.0 to 3.3                                    | 3.63                                                | None                            | OK       |
| SL-T65                         | 2/T1, 6/T3               | 60-S6                                         | 3.5 to 5.7                                    | 6.27                                                | None                            | OK       |
| SL-T80                         | 2/T1, 6/T3               | 60-S6                                         | 3.5 to 5.7                                    | 6.27                                                | None                            | OK       |
| SL-T100                        | 2/T1, 6/T3               | 60-6                                          | 3.5 to 5.7                                    | 6.27                                                | None                            | OK       |

#### (2) Flexion and Pull-out Tests

In the flexion tests, the wire was rotated 135 times continuously by placing weight on its pointed end under the conditions (the following tightening torques were checked by using the minimum value of the manufacturer standard tightening torque) indicated in Table 12. The results met the standard criteria without pullout or breaking of the conductor. Then, the pull-out strength indicated in Table 12 was applied for 1 minute. The results met the standard criteria without pullout or breaking of the conductor.

Table 12

| Item<br>Standard<br>Model Name | Target Terminal Position | Screw Size | Wire Specifications |                     | Number of Connections<br>Maximum Number of Connections | Manufacturer Standard Tightening Torque [N·m] | Tested Tightening Torque [N·m] | Diameter of the Bushing Hole [mm]                                             | Height [mm]                                                                   | Weight [kg]                                                                   | Pulling Force [N]                                                         | Judgment                         |
|--------------------------------|--------------------------|------------|---------------------|---------------------|--------------------------------------------------------|-----------------------------------------------|--------------------------------|-------------------------------------------------------------------------------|-------------------------------------------------------------------------------|-------------------------------------------------------------------------------|---------------------------------------------------------------------------|----------------------------------|
|                                |                          |            | Type                | Size                |                                                        |                                               |                                |                                                                               |                                                                               |                                                                               |                                                                           |                                  |
|                                | -                        | -          | -                   | -                   | -                                                      | -                                             | Specified Tightening Torque    | 1.25mm <sup>2</sup> : 6.5<br>6mm <sup>2</sup> : 9.5<br>φ1.6: 9.5<br>φ2.6: 9.5 | 1.25mm <sup>2</sup> : 260<br>6mm <sup>2</sup> : 280<br>φ1.6: 280<br>φ2.6: 280 | 1.25mm <sup>2</sup> : 0.4<br>6mm <sup>2</sup> : 1.4<br>φ1.6: 0.7<br>φ2.6: 1.4 | 1.25mm <sup>2</sup> : 40<br>6mm <sup>2</sup> : 80<br>φ1.6: 50<br>φ2.6: 80 | Pullout or Breaking of Conductor |
| SL-T21                         | 2/T1                     | M4         | Stranded Wire       | 1.25mm <sup>2</sup> | 2                                                      | 1.2 to 1.9                                    | 1.2                            | 6.5                                                                           | 260                                                                           | 0.4                                                                           | 40                                                                        | OK                               |
|                                |                          |            |                     | 6mm <sup>2</sup>    | 2                                                      | 1.2 to 1.9                                    | 1.2                            | 9.5                                                                           | 280                                                                           | 1.4                                                                           | 80                                                                        | OK                               |
|                                |                          |            | Single Wire         | φ1.6                | 2                                                      | 1.2 to 1.9                                    | 1.2                            | 9.5                                                                           | 280                                                                           | 0.7                                                                           | 50                                                                        | OK                               |
|                                |                          |            |                     | φ2.6                | 2                                                      | 1.2 to 1.9                                    | 1.2                            | 9.5                                                                           | 280                                                                           | 1.4                                                                           | 80                                                                        | OK                               |
|                                | 6/T3                     | M4         | Stranded Wire       | 1.25mm <sup>2</sup> | 2                                                      | 1.2 to 1.9                                    | 1.2                            | 6.5                                                                           | 260                                                                           | 0.4                                                                           | 40                                                                        | OK                               |
|                                |                          |            |                     | 6mm <sup>2</sup>    | 2                                                      | 1.2 to 1.9                                    | 1.2                            | 9.5                                                                           | 280                                                                           | 1.4                                                                           | 80                                                                        | OK                               |
|                                |                          |            | Single Wire         | φ1.6                | 2                                                      | 1.2 to 1.9                                    | 1.2                            | 9.5                                                                           | 280                                                                           | 0.7                                                                           | 50                                                                        | OK                               |
|                                |                          |            |                     | φ2.6                | 2                                                      | 1.2 to 1.9                                    | 1.2                            | 9.5                                                                           | 280                                                                           | 1.4                                                                           | 80                                                                        | OK                               |
| SL-T35                         | 2/T1                     | M5         | Stranded Wire       | 1.25mm <sup>2</sup> | 2                                                      | 2.0 to 3.3                                    | 2.0                            | 6.5                                                                           | 260                                                                           | 0.4                                                                           | 40                                                                        | OK                               |
|                                |                          |            |                     | 16mm <sup>2</sup>   | 2                                                      | 2.0 to 3.3                                    | 2.0                            | 13.0                                                                          | 300                                                                           | 2.9                                                                           | 100                                                                       | OK                               |
|                                |                          |            | Single Wire         | φ1.6                | 2                                                      | 2.0 to 3.3                                    | 2.0                            | 9.5                                                                           | 280                                                                           | 0.7                                                                           | 50                                                                        | OK                               |
|                                |                          |            |                     | φ3.6                | 2                                                      | 2.0 to 3.3                                    | 2.0                            | 13.0                                                                          | 300                                                                           | 2.9                                                                           | 100                                                                       | OK                               |
|                                | 6/T3                     | M5         | Stranded Wire       | 1.25mm <sup>2</sup> | 2                                                      | 2.0 to 3.3                                    | 2.0                            | 6.5                                                                           | 260                                                                           | 0.4                                                                           | 40                                                                        | OK                               |
|                                |                          |            |                     | 16mm <sup>2</sup>   | 2                                                      | 2.0 to 3.3                                    | 2.0                            | 13.0                                                                          | 300                                                                           | 2.9                                                                           | 100                                                                       | OK                               |
|                                |                          |            | Single Wire         | φ1.6                | 2                                                      | 2.0 to 3.3                                    | 2.0                            | 9.5                                                                           | 280                                                                           | 0.7                                                                           | 50                                                                        | OK                               |
|                                |                          |            |                     | φ3.6                | 2                                                      | 2.0 to 3.3                                    | 2.0                            | 13.0                                                                          | 300                                                                           | 2.9                                                                           | 100                                                                       | OK                               |
| SL-T50                         | 2/T1                     | M5         | Stranded Wire       | 1.25mm <sup>2</sup> | 2                                                      | 2.0 to 3.3                                    | 2.0                            | 6.5                                                                           | 260                                                                           | 0.4                                                                           | 40                                                                        | OK                               |
|                                |                          |            |                     | 16mm <sup>2</sup>   | 2                                                      | 2.0 to 3.3                                    | 2.0                            | 13.0                                                                          | 300                                                                           | 2.9                                                                           | 100                                                                       | OK                               |
|                                |                          |            | Single Wire         | φ1.6                | 2                                                      | 2.0 to 3.3                                    | 2.0                            | 9.5                                                                           | 280                                                                           | 0.7                                                                           | 50                                                                        | OK                               |
|                                |                          |            |                     | φ3.6                | 2                                                      | 2.0 to 3.3                                    | 2.0                            | 13.0                                                                          | 300                                                                           | 2.9                                                                           | 100                                                                       | OK                               |
|                                | 6/T3                     | M5         | Stranded Wire       | 1.25mm <sup>2</sup> | 2                                                      | 2.0 to 3.3                                    | 2.0                            | 6.5                                                                           | 260                                                                           | 0.4                                                                           | 40                                                                        | OK                               |
|                                |                          |            |                     | 16mm <sup>2</sup>   | 2                                                      | 2.0 to 3.3                                    | 2.0                            | 13.0                                                                          | 300                                                                           | 2.9                                                                           | 100                                                                       | OK                               |
|                                |                          |            | Single Wire         | φ1.6                | 2                                                      | 2.0 to 3.3                                    | 2.0                            | 9.5                                                                           | 280                                                                           | 0.7                                                                           | 50                                                                        | OK                               |
|                                |                          |            |                     | φ3.6                | 2                                                      | 2.0 to 3.3                                    | 2.0                            | 13.0                                                                          | 300                                                                           | 2.9                                                                           | 100                                                                       | OK                               |

## **Environmental Characteristics and Special Performance**



HOTLINE: 1900.6536

# 1. Surrounding Environment of the Magnetic Starter

There are various environmental conditions that can affect the use of a magnetic starter. It is necessary to clarify these conditions because they greatly affect the performance of the magnetic starter.

Generally, performance validation tests performed by the manufacturer are under the standard usage condition. Therefore, performance is guaranteed in the standard usage conditions. The standard usage conditions refer to the following conditions. The magnetic starter may fail if it is used under environmental or atmospheric conditions other than those described below.

- a. Ambient Temperature : Standard 20°C, range of usage ambient temperature: -10°C to 40°C (Maximum average temperature during a day: 35°C, Maximum average temperature for a year: 25°C)
- b. Maximum temperature inside the control panel : 55°C. For boxed MS type, the ambient temperature should be 40°C (the annual average temperature in the panel should be 40°C or less)  
It is necessary to pay attention to the ambient temperature as it influences the operational properties of the magnetic contactor and the thermal relay. The insulation will proceed to degrade even in normal usage. Especially if the ambient temperature rises, the life span of the insulation shortens. Generally, whenever the ambient temperature rises by 6 to 10°C, the life span of the insulation halves. (Arrhenius law)
- c. Relative Humidity : 45 to 85% RH, provided that there should be no condensation or freezing.
- d. Altitude : 2000m or less
- e. Oscillation : 10 to 55Hz 19.6m/s<sup>2</sup> or less
- f. Impact : 49m/s<sup>2</sup> or less
- g. Atmosphere : Must not contain too much water vapor, oil vapor, dust, smoke, corrosive gases or salt.  
Contact can be interrupted if the magnetic starter is used consecutively for a long time in an airtight environment.  
Never use this magnetic starter in places where there is a possibility of generation of combustible gases.
- h. Storage Temperature : -30°C to 65°C, provided that there should be no condensation or freezing.

The summarized temperature range applicable to the MS-T series is shown in Table 1.

Table 1

| Temperature     |                 | Usage Temperature<br>[°C] | Storage Temperature<br>[°C] |
|-----------------|-----------------|---------------------------|-----------------------------|
| Specification   |                 |                           |                             |
| Standard Models | Boxed MS-T type | -10 to 40                 | -30 to 65                   |
|                 | Open MSO-T type | -10 to 55                 | -30 to 65                   |

Note a) Storage temperature is the ambient temperature during transportation and storage, and it must be within the specified range of usage temperature at the time of commencement of usage.

Note b) Set the conditions such that there is no condensation or freezing due to sudden temperature change.

## 2. Application to the Special Environment

### 2.1 High Temperature

If the magnetic starter is used at high ambient temperature, the temperature is mainly determined by the life span of the operating coil (continuous current life span) and the gradual change of the molding. According to the standard, the temperature rise of the operating coil is specified as follows: 125°C or less for A type insulation and 140°C or less for E type insulation including the ambient temperature. However, to facilitate long term usage for MSO-T and S-T series at 55°C temperature in the panel, the temperature rise using E type insulation or higher is limited to values lower than A type insulation.

In order to estimate the continuous current life span of the operating coil, an acceleration test of continuous current on the electromagnet was performed as indicated below. As a result, there was no abnormality, such as burnout.

Thermostatic Premises Temperature : 80°C

Voltage Applied to Operating Coil : 110% of rated voltage (60Hz)

Continuous Current Passage Time : 5000 hours

Number of Test Items : 5 units of operating electromagnets for each frame

Test Results : No occurrence of burnout, no abnormality in surge comparison test

The continuous current life span of the operating coil is determined by the degradation of the winding material, and it is as shown in Figure 1 according to Arrhenius law. From this result, we can assume that the insulation lifespan of the operating coil is the average ambient temperature + temperature rise of the coil, but it generally has a life span of 10 years.

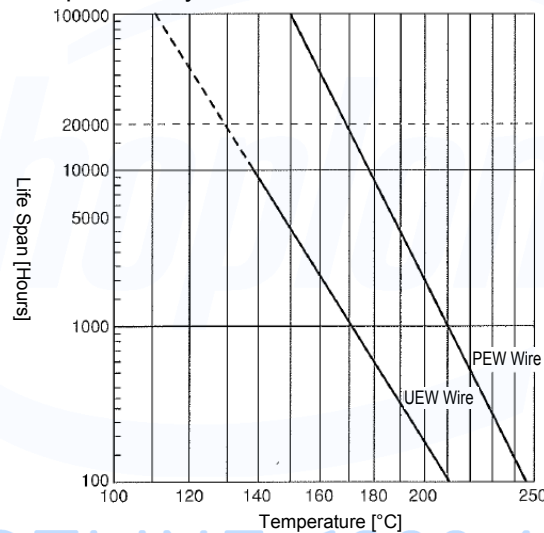


Figure 1: Magnet Wire Heat-resistance Life Span Curve  
(according to the Technical Report of The Institute of Electrical Engineers of Japan)

To investigate the gradual change of the molding, an acceleration test is implemented at 120°C after having a surplus of 105°C over the ambient temperature 40°C and a rated value 65°C of the temperature rise at the terminal. The test time is set to 300 hours because the molding (mainly phenol resin) requires to be saturated at 120°C for 300 hours for gradual change to occur.

The results of the heating test of 300 hours at 120°C are shown in Table 1. This result indicates that there was no problem with the gradual changes due to temperature with respect to the MS-T series.

Table 1: Heating test results for MSO-T type

| Time<br>Properties<br>Model Name | 0                          |                       |                | 300                        |                       |                |
|----------------------------------|----------------------------|-----------------------|----------------|----------------------------|-----------------------|----------------|
|                                  | Operating Voltage [V 60Hz] | Open Voltage [V 60Hz] | Open Time [ms] | Operating Voltage [V 60Hz] | Open Voltage [V 60Hz] | Open Time [ms] |
| MSO-T10                          | 139                        | 88                    | 14             | 142                        | 87                    | 13             |
| MSO-T12                          | 139                        | 95                    | 12             | 140                        | 90                    | 12             |
| MSO-T20                          | 139                        | 106                   | 12             | 140                        | 104                   | 12             |
| MSO-T21                          | 145                        | 90                    | 9              | 145                        | 88                    | 9              |
| MSO-T25                          | 145                        | 90                    | 9              | 146                        | 88                    | 9              |
| MSO-T35                          | 146                        | 115                   | 9              | 151                        | 120                   | 9              |
| MSO-T50                          | 146                        | 115                   | 9              | 151                        | 120                   | 9              |
| MSO-T65                          | 120                        | 65                    | 48             | 123                        | 63                    | 45             |
| MSO-T80                          | 120                        | 65                    | 48             | 123                        | 63                    | 45             |
| MSO-T100                         | 121                        | 75                    | 74             | 124                        | 72                    | 70             |

Note a) A nominal value of 200VAC was used for the rated value of the operating coil.

## 2.2 Low Temperature

The magnetic starter and the magnetic contactor that are installed in a panel may be transported to a cold area or be used in intense cold conditions such as in a cold area or freezing machine. In this case, the cold resistance will be a problem, but the standard S-T type magnetic contactors can be used in low temperatures.

- Storage Temperature -60°C or more

There was no abnormality found in any part when a shelf test was performed at -70°C for 1 month. Therefore, it can be considered that the products can withstand storage at -60°C or more.

Also, the panels transported to cold areas are usually waterproof, and packed against moisture, and when panels packed in warm areas reach cold areas, it is necessary to take into account the potential damage to the utensil due to condensation or freezing. Therefore it is vital to pay attention to the dehumidification inside the packaging, and it is advisable to use silica gel as a drying agent in the amount of 3kg per 1m<sup>2</sup>.

- Usage Temperature -50°C or more

Mechanical durability test was performed according to the following conditions.

|                                       |                                 |
|---------------------------------------|---------------------------------|
| Temperature                           | : -50°C                         |
| Voltage Applied to Coil and Frequency | : 240V and 60Hz for 200VAC coil |
| Switching Frequency                   | : 120 times per hour            |
| Usage Factor                          | : 0.66%                         |
| Usage Frequency                       | : 3 months (250000 times)       |

Since there was no damage to the parts during or after the test, the products can be used at temperatures higher than -50°C.

During usage at cold temperatures or storage, if the temperature suddenly returns to 0°C or higher, condensation occurs, and if the temperature returns to the low temperature again, condensation or freezing occurs. Therefore, it should be noted that an operational failure or contact failure may occur if condensation or freezing forms on the sliding parts of moving components or the contact surface.

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### 3. Instantaneous Voltage Drop Tolerance

The guaranteed range of the operating voltage of the magnetic starter and the magnetic contactor is 85 to 110% of the rated voltage of the operating coil. However, according to the voltage drop during the first current supplied to the motor, the attraction force of the electromagnet drops from the time when the contact surface is touched as shown in Figure 1, and if the attraction force falls below the opposing force, the contact floats, repeating close circuit → voltage recovery → reclosing → voltage drop → open circuit at high frequency (2), and contact welding or contact element fusing may occur. (1) is the state after contact chattering is controlled and contact welding tolerance is improved, by balancing the attraction force and opposing force for enduring as much as possible in such conditions for MS-T series.

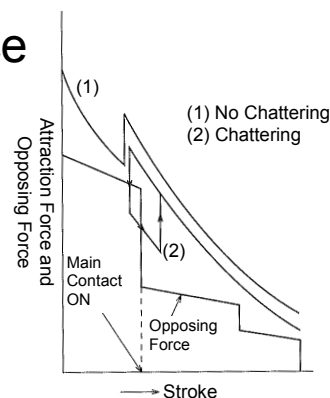
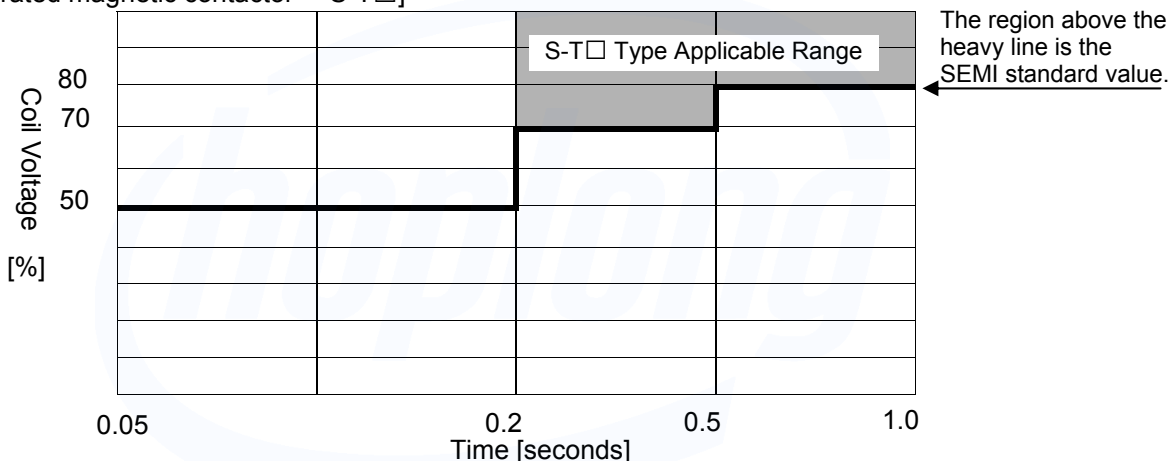


Figure 1: Attraction force property of the electromagnet due to the voltage drop when the motor is started

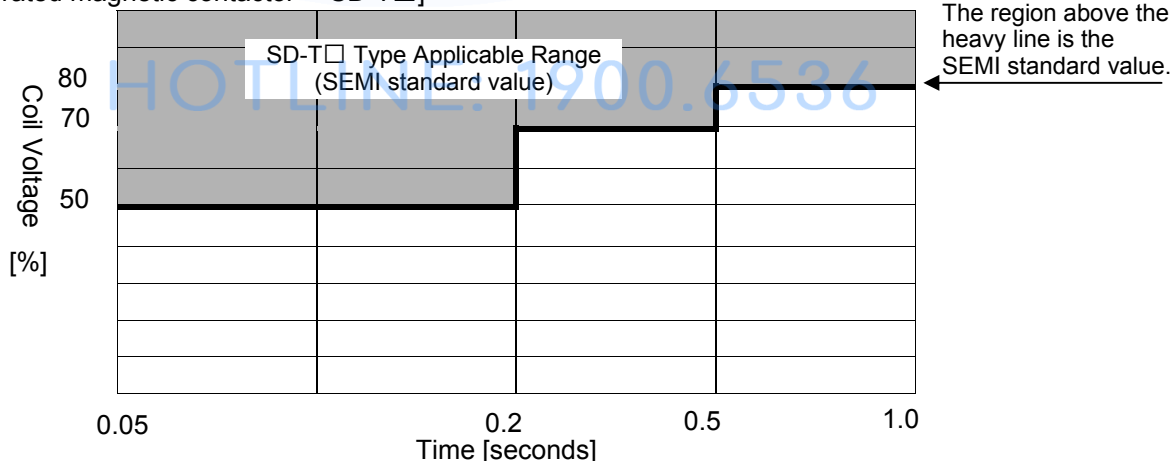
#### 3.1 SEMI-F47 Standard

The magnetic contactor is not directly based on the SEMI standard because this standard demands an instantaneous voltage drop tolerance for the semiconductor equipment. However, the instantaneous voltage drop tolerance (that is tolerance when the contact is not turned off even after instantaneous voltage drop occurs in the coil excitation state) test was conducted for the S-T type and SD-T type magnetic contactors under SEMI-F47 standard. The AC-operated magnetic contactor is applicable in a certain range. The DC-operated magnetic contactor is applicable to the SEMI-F47 standard.

[AC-operated magnetic contactor S-T□]



[DC-operated magnetic contactor SD-T□]



#### 3.2 Instantaneous Power Failure Tolerance

The following table shows the maximum instantaneous power failure time during instantaneous power failure of the MS-T series.

| Model Name | Maximum Instantaneous Power Failure Time [ms] |
|------------|-----------------------------------------------|
| S-T10      | 2                                             |
| S-T12, T20 | 2                                             |
| S-T21, T25 | 2                                             |
| S-T32      | 2                                             |

| Model Name | Maximum Instantaneous Power Failure Time [ms] |
|------------|-----------------------------------------------|
| S-T35, T50 | 2                                             |
| S-T65, T80 | 40                                            |
| S-T100     | 30                                            |

Note. This table shows the maximum instantaneous power failure time when self-maintenance (Auxiliary contact a) is functioning properly.

## 4. Operating Characteristics of the Thermal Relay

### 4.1 Operations in a Balanced Circuit (Ambient Temperature: 20°C)

- If the thermal relay does not function at 105% of settling current in cold conditions for more than 2 hours, the operation should be performed with 120% of the settling current for less than 2 hours after the constant temperature is maintained.
- When 150% of the settling current is passed after the settling current is passed and the constant temperature is maintained, the relay should operate within the limits shown in the table below with respect to the corresponding trip class.
- The operation should be performed within the limits shown in the table below with respect to the corresponding trip class, when 720% of the settling current is passed in cold conditions.

| Trip Class | 150% of the settling current | 720% of the settling current |
|------------|------------------------------|------------------------------|
| 5          | Less than 2 minutes          | $T_P \leq 5$ seconds         |
| 10A        | Less than 2 minutes          | $2 < T_P \leq 10$ seconds    |
| 10         | Less than 4 minutes          | $4 < T_P \leq 10$ seconds    |
| 20         | Less than 8 minutes          | $6 < T_P \leq 20$ seconds    |
| 30         | Less than 12 minutes         | $9 < T_P \leq 30$ seconds    |

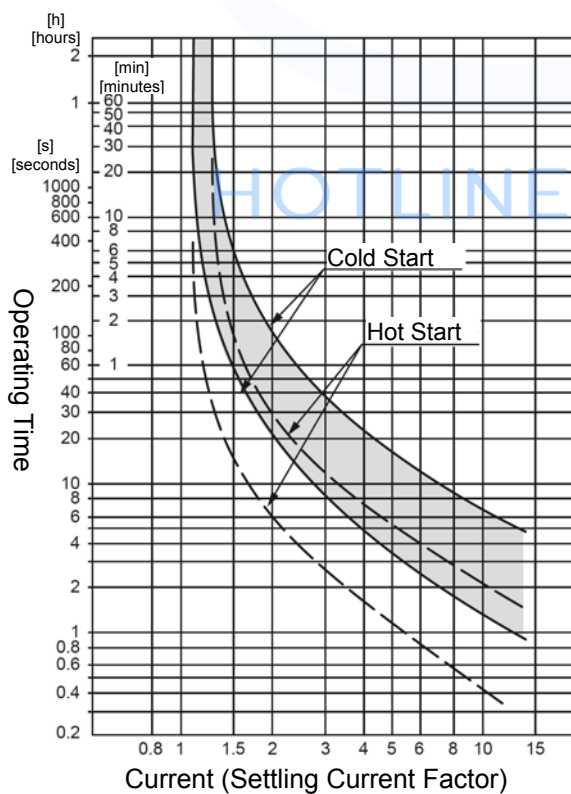
$T_P$  : Operating time at the time of constraint

### 4.2 Operations in an Unbalanced Circuit (Ambient Temperature: 20°C)

- If the open phase detection function does not execute when settling current is passed to all poles at the same time for 2 hours, the operation should be performed within 2 hours when one pole is disconnected and 132% of settling current is passed to the other two poles after the constant temperature is maintained.
- If the open phase detection function does not execute when settling current is passed to 2 poles and 90% of settling current to 1 pole for 2 hours, the operation should be performed within 2 hours when one pole is disconnected and 115% of settling current is passed to the other two poles after the constant temperature is maintained.

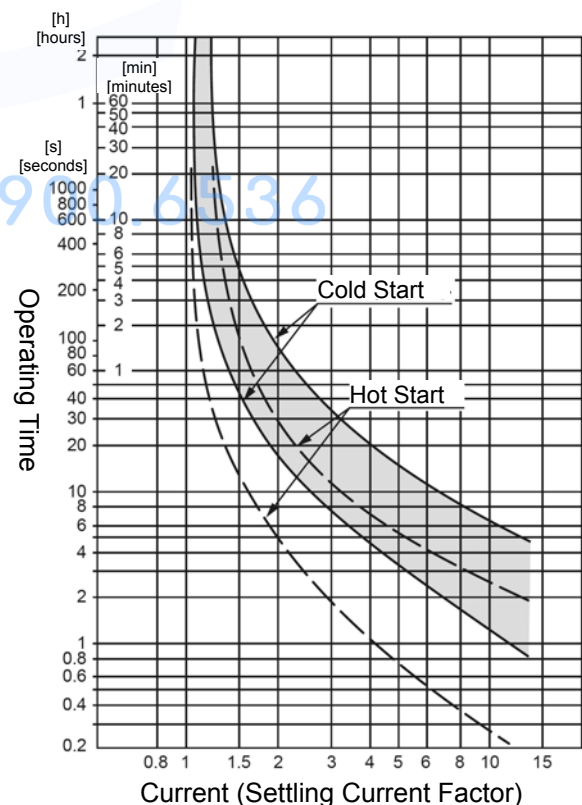
Result: The whole frame satisfies the above condition.

Operational property curve is shown below.



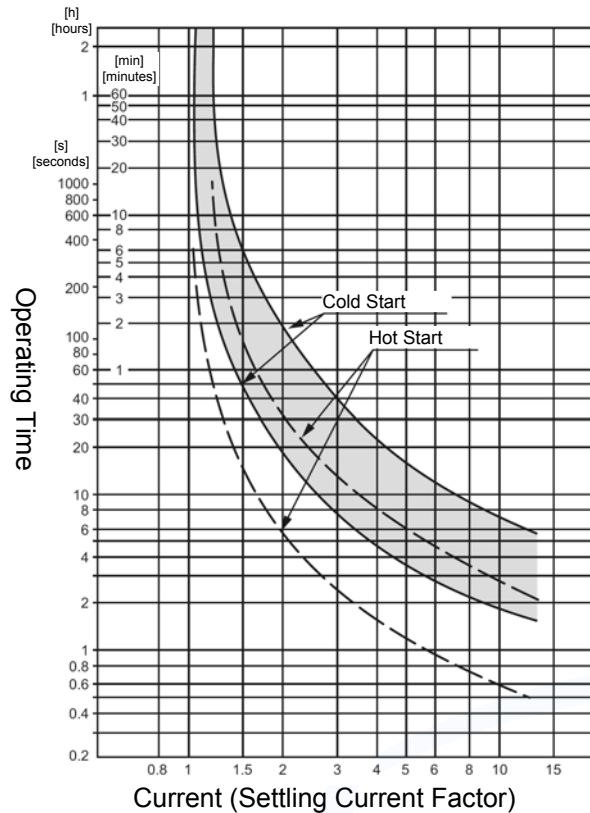
MS/MSO-T10 (KP) Type  
MS/MSO-T12 (KP) Type  
MSO-T20 (KP) Type

TH-T18 (KP) Type  
Thermal Relay



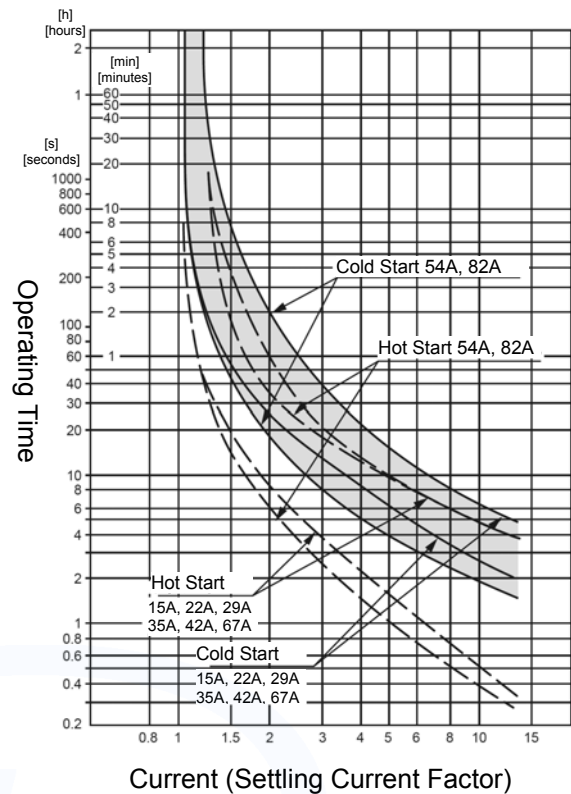
MS/MSO-T21 (KP) Type  
MSO-T25 (KP) Type

TH-T25 (KP) Type  
Thermal Relay



MSO-T35 (KP) Type  
MSO-T50 (KP) Type

TH-T50 (KP) Type  
Thermal Relay



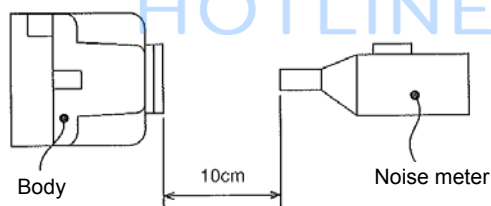
MSO-T65 (KP) Type  
MSO-T80 (KP) Type  
MSO-T100 (KP) Type

TH-T65 (KP) Type  
TH-T100 (KP) Type  
Thermal Relay

## 5. Noise Characteristics

The S-T10 to T50 type magnetic contactors use the optimum design of the electromagnet and oscillation insulation, while the S-T65 to T100 type magnetic contactors use AC-operated and DC excitation electromagnets. Thus, the measures to control the whining sound of core are implemented for a silent series.

### 5.1 Noise during the ON State



Test Conditions: Operating Coil Rated Value 200VAC

Background noise in a soundproof room:

30 dB

Measurement after  
every 30 cycles  
in A-weighting  
characteristic Fast.

Table 1: Noise during the ON state [dB, A-weighting Characteristic Fast]

| Voltage Applied to Coil<br>Model Name | 170V 60Hz     | 200V 60Hz     | 240V 60Hz     |
|---------------------------------------|---------------|---------------|---------------|
|                                       | Average Value | Average Value | Average Value |
| S-T10/T12/T20                         | 33            | 33            | 35            |
| S-T21/T25                             | 30            | 31            | 32            |
| S-T32                                 | 30            | 31            | 30            |
| S-T35                                 | 32            | 32            | 33            |
| S-T50                                 | 32            | 32            | 33            |

Note a) Indicates the average value of every 10 machines.

## 5.2 Noise during Opening and Closing

Table 2 shows the results when noise during opening and closing at 240V and 60Hz was measured from a distance of 10cm (other measurement conditions are the same as that of section 5.1).

Table 2: Noise during opening and closing [dB, A-weighting Characteristic Fast]

| Model Name    | Noise       |             |
|---------------|-------------|-------------|
|               | When closed | When opened |
| S-T10/T12/T20 | 88          | 87          |
| S-T21/T25     | 94          | 92          |
| S-T32         | 91          | 90          |
| S-T35         | 94          | 91          |
| S-T50         | 94          | 91          |
| S-T65         | 98          | 98          |
| S-T80         | 98          | 98          |
| S-T100        | 98          | 98          |

Note a) Indicates the average value of every 4 machines.

## 6. Impact during Opening and Closing

When the magnetic starter/magnetic contactor is installed in the control panel and opened and closed, the kinetic energy at the stop position of the movable part is converted into impact energy, and the control panel vibrates. These vibrations are transmitted to the other controllers installed on the control panel, causing a malfunction. The magnitude of these vibrations (acceleration, frequency) differs according to the magnitude of the opening-closing impact of the magnetic contactor or specifications of the control panel (hardness, number of the installed fixtures, position of installation, etc.). The existence of malfunction cannot be determined unless the measurement is performed for each case. Therefore, the test was conducted for impact acceleration and relay contact malfunctions on the standard panel of the MS-T series as shown in

Figure 1.

Open-close impact values (acceleration [ $\text{m/s}^2$ ] at a frequency of 0 to 2000Hz)

| Model Name | 240V 50Hz    |
|------------|--------------|
| S-T10      | 14.7 to 19.6 |
| S-T12/T20  | 14.7 to 19.6 |
| S-T21/T25  | 14.7 to 19.6 |
| S-T32      | 14.7 to 19.6 |
| S-T35      | 14.7 to 24.5 |
| S-T50      | 14.7 to 24.5 |
| S-T65      | 14.7 to 24.5 |
| S-T80      | 14.7 to 24.5 |
| S-T100     | 24.5 to 39.2 |

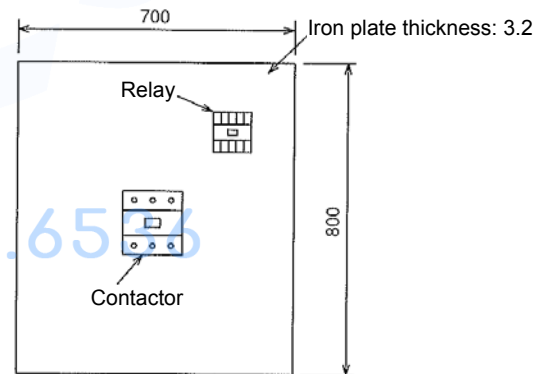


Figure 1: Standard panel for the open and close impact test

Contact malfunction due to open-close impact of the installed plate

|                       |                                                                                      |
|-----------------------|--------------------------------------------------------------------------------------|
| Impact making body    | S-T10 to T100 (by applying voltage of 240V and frequency of 50Hz to the 200VAC coil) |
| Impact receiving body | SR-T9 5a4b                                                                           |
| Results               | The contact b did not malfunction.                                                   |

## 7. Insulation Resistance and Withstand Voltage

|                       | Reference Value                                  | Results                                                          | Measurement Locations                                                                                                                                                                                                                                                                                                                      |
|-----------------------|--------------------------------------------------|------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Insulation Resistance | 5MΩ or more                                      | 100MΩ or more for all frames                                     | (a) Between conducting part and grounded metal body as well as the operating circuit (grounded) when the contact element was closed.<br>(b) Between all poles when the contact element was closed.<br>(c) Between conducting part and grounded metal body as well as the operating circuit (grounded) when the contact element was opened. |
| Withstand Voltage     | Endurance for 1 minute at 2500V and 50Hz or 60Hz | No abnormality for 1 minute at 2500V and 60Hz for all the frames | (d) Between the supply side terminals and the load side terminals when the contact element was opened.<br>(e) Between the conducting part of the operating circuit and the grounded metal body.<br>(f) Between one circuit of the operating circuit, and all other circuits (grounded).                                                    |

## 8. Vibration

### 8.1 Contact Malfunction Vibration

Investigation of resonance point existence and contact malfunction existence by slowly increasing the frequency from 10Hz to 55Hz, and then slowly decreasing it from 55Hz to 10Hz according to the following conditions.

#### Conditions

|                          |                                                                                                                                                                                                                                         |
|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Acceleration             | : Constant at 19.6m/s <sup>2</sup>                                                                                                                                                                                                      |
| Vibration Direction      | : Front-Back, Right-Left, Up-Down                                                                                                                                                                                                       |
| Frequency Variable Speed | : 2Hz per second                                                                                                                                                                                                                        |
| Check Items              | : Resonance point existence, contact malfunction existence (contact malfunction check according to the following points)                                                                                                                |
| Magnetic Contactor       | : The existence of contact b malfunction was checked when the operating coil was OFF.<br>The existence of main or auxiliary contact a malfunction was checked when the operating coil was ON (applying 85% of the rated voltage).       |
| Thermal Relay            | : The existence of contact a malfunction was checked when there was no current trip state.<br>The existence of contact b malfunction was checked after the smallest current of the scale was passed, and the temperature was saturated. |

#### Judgment Conditions

|                     |                                                     |
|---------------------|-----------------------------------------------------|
| Resonance Point     | : Should be none                                    |
| Contact Malfunction | : Contact should not be left open for more than 1ms |

#### Results

There was no malfunction in the resonance point or contact of S-T10 to T100 type and TH-T18 to T100 type.

### 8.2 Constant Vibration Endurance

One-hour test was conducted in each state and in each direction for a total of six hours according to the following conditions to check for change in properties, damage, and looseness before and after the test.

#### Conditions

|                     |                                                                                                                                                                                                                                         |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Frequency           | : 16.7Hz                                                                                                                                                                                                                                |
| Double Amplitude    | : 4mm                                                                                                                                                                                                                                   |
| Vibration Direction | : Front-Back, Right-Left, Up-Down                                                                                                                                                                                                       |
| Check items         | : The existence of change in properties, damage to the parts, loose screws, or contact malfunction (contact malfunction check according to the following points)                                                                        |
| Magnetic Contactor  | : The existence of contact b malfunction was checked when the operating coil was OFF.<br>The existence of main or auxiliary contact a malfunction was checked when the operating coil was ON (applying 85% of the rated voltage).       |
| Thermal Relay       | : The existence of contact a malfunction was checked when there was no current trip state.<br>The existence of contact b malfunction was checked after the smallest current of the scale was passed, and the temperature was saturated. |

Screw Tightening Torque: Tightening at 80% of the reference torque

#### Judgment Conditions

|                     |                                                                                                                                                                   |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Change in Property  | : The change in operating voltage of the magnetic contactor should be ±2% or less UTC (Minimum operating current) change of the thermal relay should be within 5% |
| Damage              | : No part should be damaged                                                                                                                                       |
| Looseness           | : No screw should be loose                                                                                                                                        |
| Contact Malfunction | : Contact should not be left open for more than 1ms                                                                                                               |

#### Results

For S-T10 to T100 type and TH-T18 to T100 type, there was no contact malfunction, or damage to any parts, or looseness of the screws and the property change was within the reference value.

## 9. Impact

Investigation of contact malfunction or damage by applying the sine wave pulse impact.

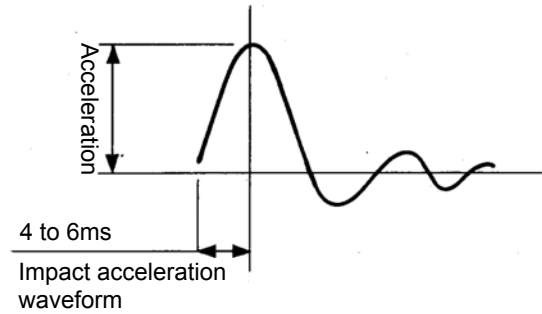
**Impact Waveform:** Figure on right side

**Impact Count:** 5 times per direction (3 times when the operating coil was OFF, and 2 times when it was ON)

**Judgment conditions:**

Contact malfunction:  $49\text{m/s}^2$  or more

Damage to parts:  $490\text{m/s}^2$  or more



| Model Name | Test Conditions   |                        |                |                | Testing Machine | Results                |                     |
|------------|-------------------|------------------------|----------------|----------------|-----------------|------------------------|---------------------|
|            | Thermal Relay     |                        | Operating Coil |                |                 | 49m/s <sup>2</sup>     | 490m/s <sup>2</sup> |
|            | Nominal Value [A] | Passage of Current [A] | Voltage [V]    | Frequency [Hz] |                 |                        |                     |
| MSO-T10    | 9                 | 7                      | 170            | 60             | Pendulum        | No contact malfunction | No damage           |
| MSO-T12    | 11                | 9                      | 170            | 60             | Pendulum        | No contact malfunction | No damage           |
| MSO-T20    | 15                | 12                     | 170            | 60             | Pendulum        | No contact malfunction | No damage           |
| MSO-T21    | 15                | 12                     | 170            | 60             | Pendulum        | No contact malfunction | No damage           |
| MSO-T25    | 22                | 18                     | 170            | 60             | Pendulum        | No contact malfunction | No damage           |
| MSO-T35    | 29                | 24                     | 170            | 60             | Pendulum        | No contact malfunction | No damage           |
| MSO-T50    | 42                | 34                     | 170            | 60             | Pendulum        | No contact malfunction | No damage           |
| MSO-T65    | 54                | 43                     | 170            | 60             | Pendulum        | No contact malfunction | No damage           |
| MSO-T80    | 67                | 54                     | 170            | 60             | Pendulum        | No contact malfunction | No damage           |
| MSO-T100   | 82                | 65                     | 170            | 60             | Pendulum        | No contact malfunction | No damage           |

Note a) A nominal value of 200VAC was used for the rated value of the operating coil.

Note b) The coil was switched on 1 hour after the start of current passage.

## 10. Mechanical Endurance

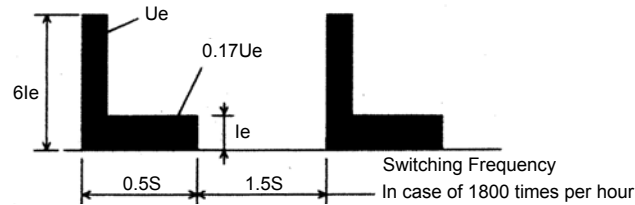
In the test conditions indicated in Table 1, the operation was performed specified number of times. As a result, there was no damage to the parts, etc. There was no abnormality in the operation even after the test, meeting the standard criteria.

Table 1

| Model Name | Test Conditions               |                 |                                      |                                         | Results         |                              |                                                |                                                                                 |
|------------|-------------------------------|-----------------|--------------------------------------|-----------------------------------------|-----------------|------------------------------|------------------------------------------------|---------------------------------------------------------------------------------|
|            | Operating Circuit Voltage [V] | Frequency [Hz]  | Switching Frequency [times per hour] | Number of Switching Times [10000 times] | Damage to Parts | Looseness of tightened parts | Operating Test after Number of Switching Times |                                                                                 |
|            |                               |                 |                                      |                                         |                 |                              | Operating Voltage [V]                          | Open Voltage [V]                                                                |
| Standard   | Rated Voltage                 | Rated Frequency | -                                    | -                                       | None            | None                         | 85% or less of the Coil Rated Voltage          | 20 to 75% (S-T50 or less)<br>10 to 75% (S-T65 or more)<br>of Coil Rated Voltage |
| S-T10      | 240                           | 60              | 14400                                | 1000                                    | None            | None                         | 140 to 150                                     | 108 to 120                                                                      |
| S-T12      | 240                           | 60              | 14400                                | 1000                                    | None            | None                         | 144 to 155                                     | 107 to 130                                                                      |
| S-T20      | 240                           | 60              | 14400                                | 1000                                    | None            | None                         | 144 to 155                                     | 107 to 130                                                                      |
| S-T21      | 240                           | 60              | 14400                                | 1000                                    | None            | None                         | 148 to 151                                     | 109 to 120                                                                      |
| S-T25      | 240                           | 60              | 14400                                | 1000                                    | None            | None                         | 148 to 151                                     | 109 to 120                                                                      |
| S-T32      | 240                           | 60              | 14400                                | 1000                                    | None            | None                         | 147 to 154                                     | 100 to 104                                                                      |
| S-T35      | 240                           | 60              | 14400                                | 1000                                    | None            | None                         | 138 to 149                                     | 110 to 118                                                                      |
| S-T50      | 240                           | 60              | 14400                                | 1000                                    | None            | None                         | 138 to 149                                     | 110 to 118                                                                      |
| S-T65      | 240                           | 60              | 7200                                 | 500                                     | None            | None                         | 108 to 118                                     | 35 to 50                                                                        |
| S-T80      | 240                           | 60              | 7200                                 | 500                                     | None            | None                         | 108 to 118                                     | 35 to 50                                                                        |
| S-T100     | 240                           | 60              | 7200                                 | 500                                     | None            | None                         | 106 to 122                                     | 55 to 85                                                                        |

# 11. Electrical Endurance

AC-3 class



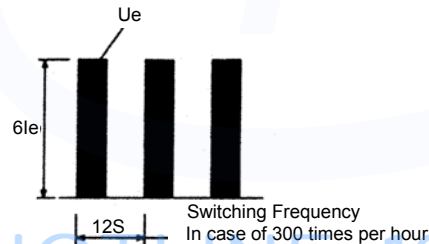
200V/440V

| Item<br>Standard<br>Model Name | Test Conditions          |                      |                                             |                                         | Number of Tests<br>[10000 times] | Insulation Resistance<br>[MΩ] | Withstand Voltage<br>[VAC 1 minute] |
|--------------------------------|--------------------------|----------------------|---------------------------------------------|-----------------------------------------|----------------------------------|-------------------------------|-------------------------------------|
|                                | Voltage<br>$U_r$ [3φ, V] | Current<br>$I_e$ [A] | Power Factor<br>[Delay]                     | Switching Frequency<br>[times per hour] |                                  |                               |                                     |
|                                | *1                       | *2                   | $I_e \leq 17A : 0.65$<br>$I_e > 17A : 0.35$ | -                                       | -                                | -                             | 2 x $U_e$                           |
| S-T10                          | 220<br>440               | 11<br>7              | 0.65<br>"                                   | 1800<br>"                               | 200<br>"                         | 100 or more                   | 2500 OK                             |
| S-T12                          | 220<br>440               | 13<br>9              | 0.65<br>"                                   | 1800<br>"                               | 200<br>"                         | "                             | "                                   |
| S-T20                          | 220<br>440               | 18<br>18             | 0.35<br>"                                   | 1800<br>"                               | 200<br>100                       | "                             | "                                   |
| S-T21                          | 220<br>440               | 20<br>20             | 0.35<br>"                                   | 1800<br>"                               | 200<br>"                         | "                             | "                                   |
| S-T25                          | 220<br>440               | 26<br>25             | 0.35<br>"                                   | 1800<br>"                               | 200<br>"                         | "                             | "                                   |
| S-T32                          | 220<br>440               | 32<br>32             | 0.35<br>"                                   | 1800<br>"                               | 200<br>"                         | "                             | "                                   |
| S-T35                          | 220<br>440               | 35<br>32             | 0.35<br>"                                   | 1800<br>"                               | 200<br>"                         | "                             | "                                   |
| S-T50                          | 220<br>440               | 50<br>48             | 0.35<br>"                                   | 1200<br>"                               | 200<br>"                         | "                             | "                                   |
| S-T65                          | 220<br>440               | 65<br>65             | 0.35<br>"                                   | 1200<br>"                               | 200<br>"                         | "                             | "                                   |
| S-T80                          | 220<br>440               | 80<br>80             | 0.35<br>"                                   | 1200<br>"                               | 100<br>"                         | "                             | "                                   |
| S-T100                         | 220<br>440               | 100<br>93            | 0.35<br>"                                   | 1200<br>"                               | 100<br>"                         | "                             | "                                   |

Note a) \*1 Closed circuit voltage: Rated applicable voltage ( $U_e$ ), break-time voltage:  $U_e \times 0.17$  times

\*2 Closed circuit current: Rated applicable current ( $I_e$ ) x 6 times, break-time current:  $I_e$

AC-4 class



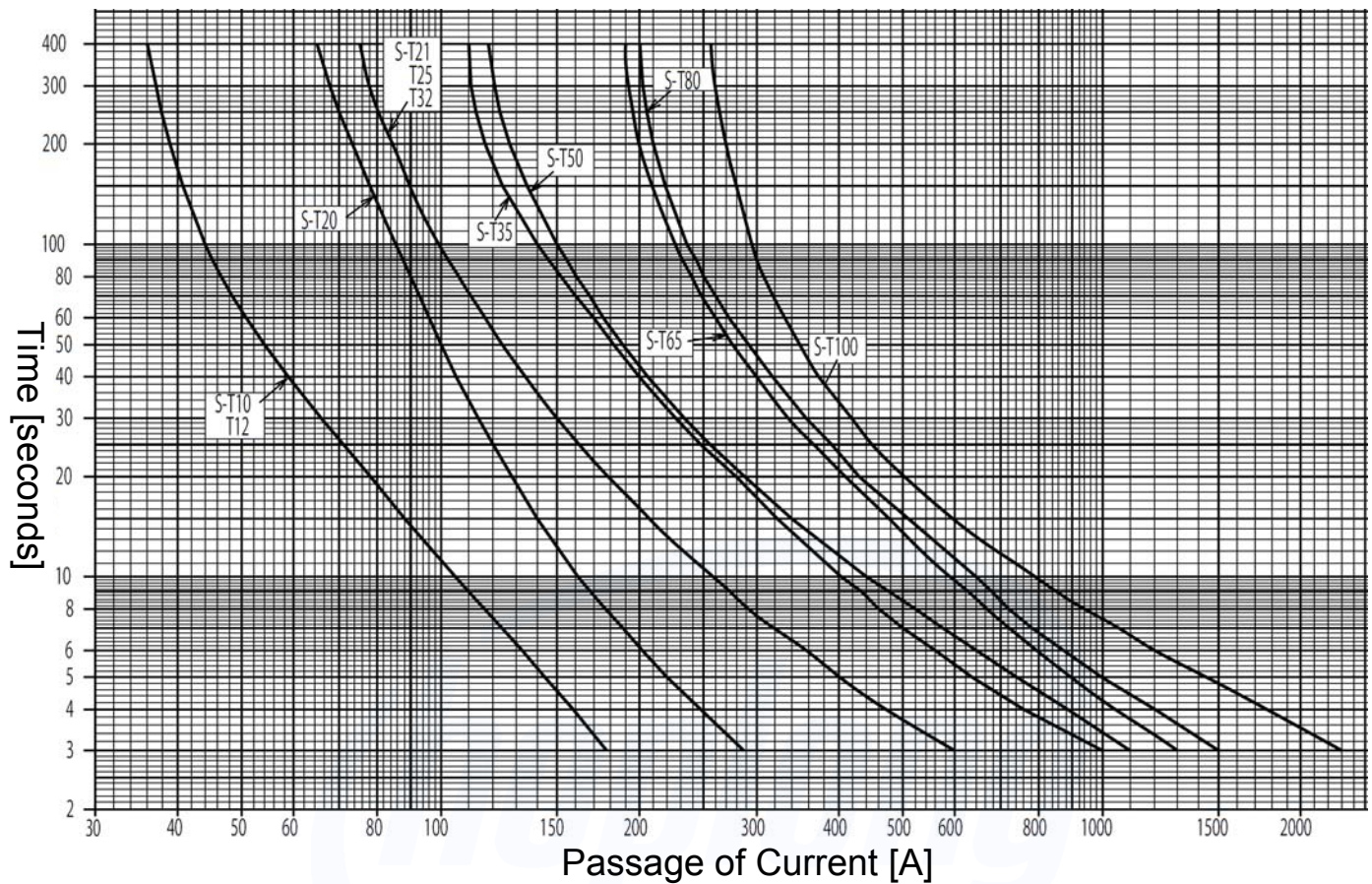
200V/440V

| Item<br>Standard<br>Model Name | Test Conditions          |                      |                                             |                                         | Number of Tests<br>[10000 times] | Insulation Resistance<br>[MΩ] | Withstand Voltage<br>[VAC 1 minute] |
|--------------------------------|--------------------------|----------------------|---------------------------------------------|-----------------------------------------|----------------------------------|-------------------------------|-------------------------------------|
|                                | Voltage<br>$U_r$ [3φ, V] | Current<br>$I_e$ [A] | Power Factor<br>[Delay]                     | Switching Frequency<br>[times per hour] |                                  |                               |                                     |
|                                | *3                       | *4                   | $I_e \leq 17A : 0.65$<br>$I_e > 17A : 0.35$ | -                                       | -                                | -                             | 2 x $U_e$                           |
| S-T10                          | 220<br>440               | 8<br>6               | 0.65<br>"                                   | 300<br>"                                | 3<br>"                           | 100 or more                   | 2500 OK                             |
| S-T12                          | 220<br>440               | 11<br>9              | 0.65<br>"                                   | 300<br>"                                | 3<br>"                           | "                             | "                                   |
| S-T20                          | 220<br>440               | 18<br>13             | 0.35<br>0.65                                | 300<br>"                                | 1.5<br>"                         | "                             | "                                   |
| S-T21                          | 220<br>440               | 18<br>13             | 0.35<br>0.65                                | 300<br>"                                | 3<br>"                           | "                             | "                                   |
| S-T25                          | 220<br>440               | 20<br>17             | 0.35<br>0.65                                | 300<br>"                                | 3<br>"                           | "                             | "                                   |
| S-T32                          | 220<br>440               | 26<br>24             | 0.35<br>"                                   | 300<br>"                                | 3<br>"                           | "                             | "                                   |
| S-T35                          | 220<br>440               | 26<br>24             | 0.35<br>"                                   | 300<br>"                                | 3<br>1.5                         | "                             | "                                   |
| S-T50                          | 220<br>440               | 35<br>32             | 0.35<br>"                                   | 300<br>"                                | 3<br>1.5                         | "                             | "                                   |
| S-T65                          | 220<br>440               | 50<br>47             | 0.35<br>"                                   | 300<br>"                                | 3<br>1.5                         | "                             | "                                   |
| S-T80                          | 220<br>440               | 65<br>62             | 0.35<br>"                                   | 300<br>"                                | 3<br>1.5                         | "                             | "                                   |
| S-T100                         | 220<br>440               | 80<br>75             | 0.35<br>"                                   | 300<br>"                                | 3<br>1.5                         | "                             | "                                   |

Note a) \*3 Closed circuit voltage: Rated applicable voltage ( $U_e$ ), break-time voltage:  $U_e$

\*4 Closed circuit current: Rated applicable current ( $I_e$ ) x 6 times, break-time current:  $I_e \times 6$  times

## 12. Short Time Current Overload Tolerance of the Magnetic Contactor



Note a) Indicates the relationship between the time and the passage of current up to a certain temperature at which the temperature rise value of the contact element of the magnetic contactor will not cause hindrance to the continuous use of the contactor.

HOTLINE: 1900.6536

# Magnetic Contactors and Magnetic Motor Starters

## TECHNICAL NOTES



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### Safety Warning

To ensure proper use of the products listed in this catalog, please be sure to read the instruction manual prior to use.

Mitsubishi Electric Corporation Nagoya Works is a factory certified for ISO14001 (standards for environmental management systems) and ISO9001 (standards for quality assurance management systems)



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