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Temperature derating

A derating of the rated operational current of the Susol TD and TS molded case circuit breaker is necessary if the ambient temperature is greater than 40℃. Namely, when the ambient temperature is greater than 40℃, overload-protection characteristics are slightly modified.
Electronic trip units are not affected by variations in temperature.
But, the maximum permissible current in the circuit breaker depends on the ambient temperature.

Derating chart

- Connection type: Standard
- Trip unit: FTU, FMU, ATU

MCCB	Rating	Fixed MCCB (c/w Thermal-magnetic trip unit)							
	(A)	10℃	20℃	30℃	40℃	45℃	50℃	60℃	70℃
TD100 TD160	16	16	16	16	16	16	15	14	13
	20	20	20	20	20	19	19	18	16
	25	25	25	25	25	24	23	22	21
	32	32	32	32	32	31	30	28	26
	40	40	40	40	40	39	38	35	33
	50	50	50	50	50	48	47	44	41
	63	63	63	63	63	61	59	56	52
	80	80	80	80	80	78	75	71	66
	100	100	100	100	100	97	94	88	82
	125	125	125	125	125	121	117	110	103
	160	160	160	160	160	155	150	141	131
TS100 TS160	40	40	40	40	40	39	38	35	33
	50	50	50	50	50	48	47	44	41
	63	63	63	63	63	61	59	56	52
	80	80	80	80	80	78	75	71	66
	100	100	100	100	100	97	94	88	82
	125	125	125	125	125	121	117	110	103
	160	160	160	160	160	155	150	141	131
TS250	200	200	200	200	200	194	188	176	164
	250	250	250	250	250	242	234	220	205
TS400	300	300	300	300	300	291	281	264	246
	400	400	400	400	400	388	375	353	328
TS630	500	500	500	500	500	484	469	441	410
	630	630	630	630	630	610	591	555	517
TS800	800	800	800	800	800	775	750	705	656

Note) TD160 1pole MCCB is not applied to temperature derating.

Temperature derating

Derating chart

- Connection type: Plug-in
- Trip unit: FTU, FMU, ATU

MCCB	Rating (A)	Fixed MCCB (c/w Thermal-magnetic trip unit)							
		10℃	20℃	30℃	40℃	45℃	50℃	60℃	70℃
TD100 TD160	16	16	16	16	16	16	15	14	13
	20	20	20	20	20	19	19	18	16
	25	25	25	25	25	24	23	22	21
	32	32	32	32	32	31	30	28	26
	40	40	40	40	40	39	38	35	33
	50	50	50	50	50	48	47	44	41
	63	63	63	63	63	61	59	56	52
	80	80	80	80	80	78	75	71	66
	100	100	100	100	100	97	94	88	82
	125	125	125	125	125	121	117	110	103
	160	144	144	144	144	140	135	127	118
TS100 TS160	40	40	40	40	40	39	38	35	33
	50	50	50	50	50	48	47	44	41
	63	63	63	63	63	61	59	56	52
	80	80	80	80	80	78	75	71	66
	100	100	100	100	100	97	94	88	82
	125	125	125	125	125	121	117	110	103
	160	160	160	160	160	155	150	141	131
TS250	200	200	200	200	200	194	188	176	164
	250	235	235	235	235	228	220	207	193
TS400	300	300	300	300	300	291	281	264	246
	400	400	400	400	400	388	375	353	328
TS630	500	500	500	500	500	484	469	441	410
	630	540	540	540	540	523	506	476	443
TS800	800	740	740	740	740	717	694	652	607

Size of busbar

Temperature derating

The table below indicates the maximum rated current value for each type of connection, depending on the ambient temperature.

Connection	Front or horizontal rear						
T	40	45	50	55	60	65	70
TS1000	800	800	800	800	800	800	800
	1000	1000	1000	1000	1000	1000	1000
TS1250	1250	1250	1250	1250	1250	1240	1090
TS1600	1600	1600	1560	1510	1470	1420	1360

Connection	Vertical rear						
T	40	45	50	55	60	65	70
TS1000	800	800	800	800	800	800	800
	1000	1000	1000	1000	1000	1000	1000
TS1250	1250	1250	1250	1250	1250	1250	1180
TS1600	1600	1600	1600	1600	1600	1510	1460

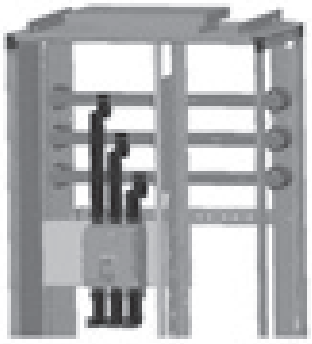
Derating table

The following tables are based on the following assumptions;
- T : Temperature around the circuit breaker and its connections

Note) 1. The values presented in the tables are the result of trials and theoretical calculations on the basis of the assumption mentioned above.
2. These tables are intended as an aid in designing connection, however, the actual values must be confirmed by tests on the installation.

TS1000 to TS1600 mounted
Using bar connection
- Cross section of bar: 1000 mm^2
- Limit of temperature rising at terminal connection: 70k



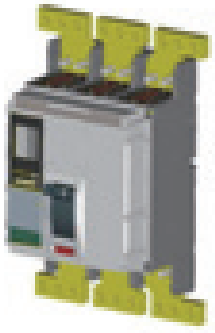


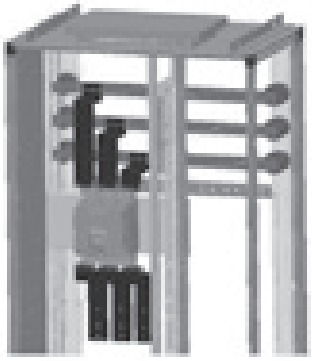
Using the data below, it is possible to determine the maximum permissible currents when making the connections to busbars for a Vertical, TS1000/TS1600, taking into account the ambient temperature around the switchboard and the IP value. Connection to be made according to the busbar drawings supplied.

Permissible current at switchboard condition using above external terminal connections

Model	T: 25℃	T: 30℃	T: 35℃	T: 40℃	T: 45℃	T: 50℃
	IP40	IP40	IP40	IP40	IP40	IP40
TS1000 N/H/L	1000	1000	1000	1000	1000	1000
TS1250 N/H	1250	1250	1250	1250	1250	1250
TS1600 N/H	1350	1350	1300	1250	1200	1150

TS1000 to TS1600 mounted
Using busbar connecting
- Cross section of bar: 1000 mm^2
- Limit of temperature rising at terminal connection: 70k





Permissible current at switchboard condition using above external terminal connections

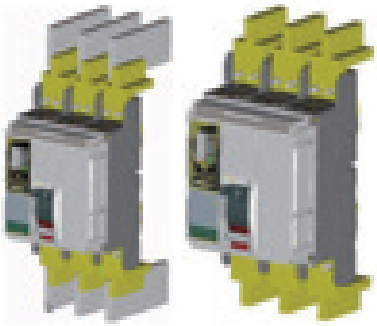
Model	T: 25℃	T: 30℃	T: 35℃	T: 40℃	T: 45℃	T: 50℃
	IP40	IP40	IP40	IP40	IP40	IP40
TS1000 N/H/L	1000	1000	1000	1000	1000	1000
TS1250 N/H	1250	1250	1250	1250	1250	1200
TS1600 N/H	1450	1400	1350	1300	1250	1200

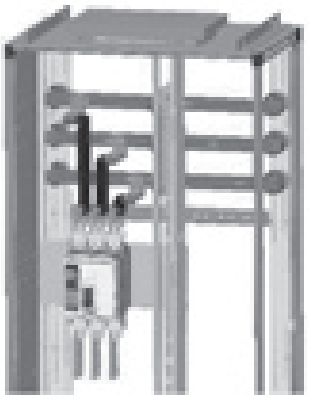
Derating table

The following tables are based on the following assumptions;
- T : Temperature around the circuit breaker and its connections

Note) 1. The values presented in the tables are the result of trials and theoretical calculations on the basis of the assumption mentioned above.
2. These tables are intended as an aid in designing connection, however, the actual values must be confirmed by tests on the installation.

TS1000 to TS1600 mounted
using special external connections
- Cross section of bar: 1000 mm^2
- Limit of temperature rising at terminal connection: 70k





Using the data below, it is possible to determine the permissible current for a specified connection between TS1000/TS1600, fixed and busbars depending on the ambient temperature around the switchboard and the IP value.

Permissible current at switchboard condition using above external terminal connections

Model	T: 25℃	T: 30℃	T: 35℃	T: 40℃	T: 45℃	T: 50℃
	IP40	IP40	IP40	IP40	IP40	IP40
TS1000 N/H/L	1000	1000	1000	1000	1000	1000
TS1250 N/H	1250	1250	1250	1250	1250	1250
TS1600 N/H	1600	1600	1600	1550	1500	1450

Installation recommendation

Protection degree provided by enclosures (IP Code) IEC 60529

IP □ □

- First characteristic numeral ×(numerals 0 to 6, or letter ×)
- Second characteristic numeral ×(numerals 0 to 8, or letter ×)
- Code letters (international Protection)

First characteristic numeral

	Degree of protection	
	Brief description	Definition
0	Non-protected	-
1	Protected against solid foreign objects of 50mm ø and greater	The object probe sphere of 50mm ø, shall not fully penetrate
2	Protected against solid foreign objects of 12.5mm ø and greater	The object probe sphere of 12.5mm ø, shall not fully penetrate
3	Protected against solid foreign objects of 2.5mm ø and greater	The object probe sphere of 2.5mm ø, shall not penetrate at all
4	Protected against solid foreign objects of 1.0mm ø and greater	The object probe of 1.0mm ø, shall not penetrate at all
5	Dust-protected	Ingress of dust is not totally prevented, but dust shall not penetrate in a quantity to interfere with satisfactory operation of the apparatus or to impair safety
6	Dust-tight	No ingress of dust

Second characteristic numeral

	Degree of protection	
	Brief description	Definition
0	Non-protected	-
1	Protected against vertically falling water drops	Vertically falling drops shall have no harmful effects
2	Protected against vertically falling water drops when enclosure tilted up to 15°	Vertically falling drops shall have no harmful effects when the enclosure is tilted at any angle up to 15° on either side of the vertical
3	Protected against spraying water	Water sprayed at an angle up to 60° on wither side of the vertical shall have no harmful effects
4	Protected against spraying water	Water splashed against the enclosure from and direction shall have no harmful effects
5	Protected against spraying jets	Water projected in powerful jets against the enclosure from and direction shall have no harmful effects
6	Protected against powerful water jets	Water projected in powerful jets against the enclosure from any direction shall have no harmful effects
7	Protected against the effects of temporary immersion in water	Ingress of water in quantities causing harmful effects shall not be possible when the enclosure is temporarily immersed in water under standardized conditions of pressure and time
8	Protected against the effects of continuous immersion in water	Ingress of water in quantities causing harmful effects shall not be possible when the enclosure is continuously immersed in water under conditions which shall be agreed between manufacturer and used but which are more severs than for numeral 7

Power dissipation / Resistance

Susol TD & TS series up to 1600A

	AF	TD100 (3P & 4P)								
	Rating (A)	16	20	25	32	40	50	63	80	100
Fixed MCCB	R (mΩ)	5.60	5.60	3.80	3.80	1.84	1.34	1.10	0.91	0.70
	Watt single pole	1.43	2.24	2.38	3.89	2.94	3.35	4.37	5.82	7.00
	Watt three poles	4.30	6.72	7.13	11.67	8.83	10.05	13.10	17.47	21.00
Plug-in MCCB	R (mΩ)	5.68	5.68	3.88	3.88	1.92	1.42	1.18	0.99	0.78
	Watt single pole	1.45	2.27	2.43	3.97	3.07	3.55	4.68	6.34	7.80
	Watt three poles	4.36	6.82	7.28	11.92	9.22	10.65	14.05	19.01	23.40

	AF	TD160 (3P & 4P)		
	Rating (A)	100	125	160
Fixed MCCB	R (mΩ)	0.70	0.61	0.50
	Watt single pole	7.00	9.53	12.80
	Watt three poles	21.00	28.59	38.40
Plug-in MCCB	R (mΩ)	0.78	0.69	0.58
	Watt single pole	7.80	10.78	14.85
	Watt three poles	23.40	32.34	44.54

	AF	TS100,TS160,TS250 (3P & 4P)								
	Rating (A)	40	50	63	80	100	125	160	200	250
Fixed MCCB	R (mΩ)	3.37	2.86	2.86	1.36	0.96	0.76	0.62	0.52	0.25
	Watt single pole	5.39	7.15	11.35	8.70	9.60	11.88	15.87	20.80	15.79
	Watt three poles	16.18	21.45	34.05	26.11	28.80	35.63	47.62	62.40	47.38
Plug-in MCCB	R (mΩ)	3.43	2.92	2.92	1.42	1.02	0.82	0.68	0.58	0.31
	Watt single pole	5.49	7.30	11.59	9.09	10.20	12.81	17.41	23.20	19.54
	Watt three poles	16.46	21.90	34.77	27.26	30.60	38.44	52.22	69.60	58.63

	AF	TS400, TS630 (3P, 4P)				TS800 (3P, 4P)	
	Rating (A)	300	400	500	630	700	800
Fixed MCCB	R (mΩ)	0.30	0.30	0.26	0.21	0.12	0.12
	Watt single pole	26.82	47.68	65.25	83.35	73.81	73.81
	Watt three poles	80.46	143.04	195.75	250.05	221.44	221.44
Plug-in MCCB	R (mΩ)	0.34	0.34	0.30	0.25	0.14	0.14
	Watt single pole	30.42	54.08	75.25	99.23	86.61	86.61
	Watt three poles	91.26	162.24	225.75	297.68	259.84	259.84

	AF	TS1000N/H, TS1250N/H, TS1600N/H					TS1000L		
	Rating (A)	630	800	1000	1250	1600	630	800	1000
Fixed MCCB	R (mΩ)	0.027	0.027	0.027	0.027	0.027	0.046	0.046	0.046
	Watt single pole	10.7	17.3	27.8	45.1	76.0	18.3	30.0	48.3
	Watt three poles	32.1	51.8	83.4	135.4	228.1	54.8	90.1	144.9

- Power dissipated per pole (P/pole): Watts (W).
- Resistance per pole (R/pole): Milliohms (mΩ) (measured cold).
- Total power dissipation is the value measured at In, 50/60 Hz, for a 3 pole or 4 pole circuit breaker (Power= $3I^2R$)

Application
Primary use of transformer

Application for transformer protection

Transformer excitation surge current may possibly exceed 10 times rated current, with a danger of nuisance tripping of the MCCB. The excitation surge current will vary depending upon the supply phase angle at the time of switching, and also on the level of core residual magnetism.

So, it's recommended to select proper circuit breakers according to the continuous current carrying capacity of transformer. It requires to consider separately whether transformer is single phase or three phase. The below table indicates the proper molded case circuit breaker suitable for each transformer.

AC220V

Capacity of 3 phase transformer (kVA)		Below 1500	Below 1500	Below 2000	Below 3000
Capacity of single phase transformer (kVA)		Below 300	-		
Breaking capacity (kA) (sym)		42	85	100	120 / 200
Frame (A)	100	TD100N	TD100H TS100N	TS100H	TD100L TS100L
	160	TD160N	TD160H TS160N	TS160H	TD160L TS160L
	250	TS250N		TS250H	TS250L
	400	TS400N		TS400H	TS400L
	630	TS630N		TS630H	TS630L
	800	TS800N		TS800H	TS800L

AC460V

Capacity of 3 phase transformer (kVA)		Below 2000		Below 3000		Below 4000
Breaking capacity (kA) (sym)		50	65	70	85	100 / 130
Frame (A)	100	TD100N TS100N	TD100H TS100H	TD100L TS100L		
	160	TD160N TS160N	TD160H TS160H	TD160L TS160L		
	250	TS250N	TS250H	TS250L		
	400	TS400N		TS400H		TS400L
	630	TS630N		TS630H		TS630L
	800	TS800N		TS800H		TS800L

Application
Primary use of transformer

Application for transformer protection (MCCBs for Transformer-Primary Use)

Transformers are used to change in the supply voltage, for both medium and low voltage supplies. The choice of the protection devices should be considered transient insertion phenomena, during which the current may reach values higher than the rated full load current; the phenomenon decays in a few seconds.

The peak value of the first half cycle may reach values of 15 to 25 times the effective rated current. For a protective device capable of protecting these units this must be taken into account. Manufacturers data and tests have indicated that a protective device feeding a transformer must be capable of carrying the following current values without tripping.

TD100/160, TS100~800 equipped with Thermal magnetic trip units

Transformer ratings (kVA)			MCCB rated current (A)	Trip unit
1 phase 230V	3 phase 230V 1 phase 400V	1 phase 400V		
3 to 4	5 to 6	9 to 11	16	
4 to 5	6 to 8	11 to 14	20	
5 to 6	8 to 10	14 to 17	25	
6 to 7	10 to 13	18 to 22	32	
7 to 9	13 to 16	22 to 28	40	
9 to 12	16 to 20	28 to 35	50	
12 to 14	20 to 25	35 to 44	63	
15 to 18	26 to 32	44 to 55	80	
18 to 23	32 to 40	55 to 69	100	FTU
23 to 29	40 to 50	69 to 87	125	FMU
29 to 37	51 to 64	89 to 111	160	ATU
37 to 47	64 to 80	111 to 138	200	
46 to 58	80 to 100	138 to 173	250	
55 to 69	96 to 120	166 to 208	300	
74 to 92	128 to 160	221 to 277	400	
92 to 115	160 to 200	277 to 346	500	
116 to 145	202 to 252	349 to 436	630	
129 to 161	224 to 280	388 to 484	700	
147 to 184	256 to 320	443 to 554	800	

TS100~800 equipped with electronic trip units

Transformer ratings (kVA)			MCCB rated current (A)	Trip unit	Ir max setting
1 phase 230V	3 phase 230V 1 phase 400V	3 phase 400V			
4 to 7	6 to 13	11 to 22	40		0.8
9 to 19	16 to 32	27 to 56	100		0.8
15 to 30	25 to 52	44 to 90	160		0.8
23 to 46	40 to 80	70 to 139	250	ETS ETM	0.8
37 to 74	64 to 128	111 to 222	400		0.8
58 to 115	100 to 200	175 to 346	630		0.8
74 to 184	127 to 319	222 to 554	800		1

Application
Protection of lighting & heating circuits

In the lighting & heating circuits, switching-surge magnitudes and times are normally not sufficient to cause serious tripping problems. But, in some cases, such as incandescent lamps, mercury arc lamps, metal halide and sodium vapour, or other large starting-current equipment, the proper selection should be considered.

Upon supply of a lighting installation, for a brief period an initial current exceeding the rated current (corresponding to the power of the lamps) circulates on the network. This possible peak has a value of approximately 15÷20 times the rated current, and is present for a few milliseconds; there may also be an inrush current with a value of approximately 1.5÷3 times the rated current, lasting up to some minutes. The correct dimensioning of the switching and protection devices must take these problems into account. Generally, it is recommended to make the maximum operating current not to exceed 80% of the related current.

AC220V

The maximum operating current (A)	The rated current of MCCB (A)	Breaking capacity (kA) sym 85	100	120	200
12	16	TD100N	TD100H	TD100L	
16	20				
20	25				
25	32				
32	40				
40	50		TD100H TS100N	TD100L TS100H	TD100L TS100L
50	63				
64	80				
80	100				
100	125	TD160N	TD160H TS160N	TS160H	TD160L TS160L
128	160				
160	200	TS250N		TS250H	TS250L
200	250				
240	300	TS400N		TS400H	TS400L
320	400				
400	500	TS630N		TS630H	TS630L
504	630				
560	700	TS800N		TS800H	TS800L
640	800				

AC460V

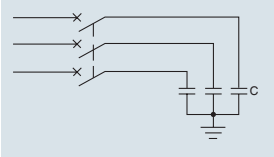
The maximum operating current (A)	The rated current of MCCB (A)	Breaking capacity (kA) sym 50	65	70	85	100	130
12	16	TD100N TS100N	TD100H TS100H		TD100L TS100L		
16	20						
20	25						
25	32						
32	40						
40	50						
50	63						
64	80						
80	100						
100	125	TD160N TS160N	TD160H TS160H		TD160L TS160L		
128	160						
160	200	TS250N	TS250H		TS250L		
200	250						
240	300	TS400N		TS400H		TS400L	
320	400						
400	500	TS630N		TS630H		TS630L	
504	630						
560	700	TS800N		TS800H		TS800L	
640	800						

Application
Protection of resistance welding circuits

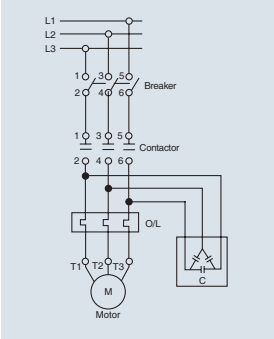
Short circuit protection for resistance welding devices can be obtained by applying molded case circuit breaker properly. These breakers permit normally high welding currents, but trip instantaneously if a short circuit develops.
It's recommended to select proper circuit breaker according to the characteristics of welding devices as the follow table.

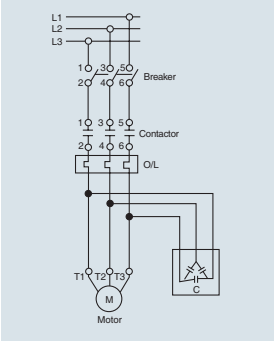
Characteristics of welding device		Applied circuit breaker (MCCB 2P)	
Capacity (kVA)	Maximum input (kVA)	220V (Single phase)	400V (Single phase)
15	35	TD100N/H/L 100A TS100N/H/L 100A TD160N/H/L 100A TS160N/H/L 100A	TD100N/H/L 50A TS100N/H/L 50A
30	65	TD160N/H/L 125A TS160N/H/L 125A TS250N/H/L 125A	TD100N/H/L 100A TS100N/H/L 100A TD160N/H/L 100A TS160N/H/L 100A
55	140	TS250N/H/L 250A	TD160N/H/L 125A TS160N/H/L 125A TS250N/H/L 125A

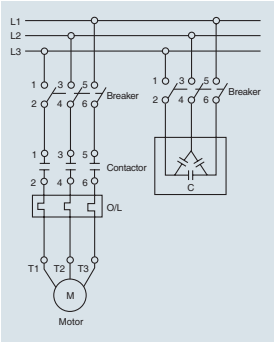
Application
Use of circuit-breakers for capacitor banks



Capacitor circuit







Usual connection diagram

Application for protection of capacitor circuit

In order to reduce system losses (less than 0.5W/kvar in low voltage) and voltage drops in the power distribution system, reactive power compensation or power factor correction is generally undertaken. As a result, the power fed into the system is used as active power and costs will be saved through a reduction in the capacitive and inductive power factors. The compensation can be carried out by the fixed capacitors and automatic capacitor banks. However, the disadvantages of installing capacitors are sensitivity to over-voltages and to the presence of nonlinear loads.

Examples of equipment which consume reactive energy are all those receivers which require magnetic fields or arcs in order to operate, such as:

- Asynchronous motors: An asynchronous motor is a large consumer of inductive reactive energy. The amount of reactive power consumed is between 20% and 25% of the rated power of the motor (depending on its speed).

- Power Transformers: Power transformers are normally always connected. This means that reactive energy is always consumed. Also, as a consequence of its inductive nature, the reactive energy increases when the transformer is loaded.

- Discharge lamps, Resistance-type soldering machines, Dielectric type heating ovens, Induction heating ovens, Welding equipments, Arc furnaces

At the instant of closing a switch to energize a capacitor, the current is limited only by the impedance of the network upstream of the capacitor, so that high peak values of current will occur for a brief period, rapidly falling to normal operating values.

According to the relevant standards IEC 60831-1/IEC 70, capacitors must function under normal operating conditions with the current having a RMS value up to 1.3 times the rated current of the capacitor. Additionally, a further tolerance of up to 15% of the real value of the power must be taken into consideration. The maximum current with which the selected circuit-breaker can be constantly loaded, and which it must also be able to switch, is calculated as follows:

Maximum expected rated current= Rated current of the capacitor bank × 1.5 (RMS value)

Application
Use of circuit-breakers for capacitor banks

220V, 50/60Hz Circuit

Capacitor rating kVAR	Single-phase circuit		Three-phase circuit	
	Capacitor rated current (A)	MCCB rated current (A)	Capacitor rated current (A)	MCCB rated current (A)
5	22.7	40	13.1	20
10	45.5	80	26.2	40
15	68.2	125	39.4	63
20	90.9	160	52.5	80
25	113.6	200	65.6	100
30	136.4	225	78.7	125
40	181.8	300	105.0	160
50	227.3	400	131.2	200
75	340.9	630	196.8	300
100	454.5	700	262.4	400
150	681.8	-	393.7	630
200	909.1	-	524.9	800
300	1363.6	-	787.3	-
400	1818.2	-	1049.8	-

Notes) 1. The MCCB rated current should be approx. 150% of the capacitor rated current.
2. The MCCB short-circuit capacity should be adequate for the circuit short-circuit capacity.

Application
Use of circuit-breakers for capacitor banks

440V, 50/60Hz Circuit

Capacitor rating kVAR	Single-phase circuit		Three-phase circuit	
	Capacitor rated current (A)	MCCB rated current (A)	Capacitor rated current (A)	MCCB rated current (A)
5	11.4	20	6.6	16
10	22.7	40	13.1	20
15	34.1	63	19.7	32
20	45.5	80	26.2	40
25	56.8	100	32.8	50
30	68.2	125	39.4	63
40	90.9	160	52.5	80
50	113.6	200	65.6	100
75	170.5	300	98.4	160
100	227.3	400	131.2	200
150	340.9	500	196.8	300
200	454.5	700	262.4	400
300	681.8	-	393.7	630
400	909.1	-	524.9	800

Notes) 1. The MCCB rated current should be approx. 150% of the capacitor rated current.
2. The MCCB short-circuit capacity should be adequate for the circuit short-circuit capacity.

Application
Using circuit-breakers in DC networks

Susol circuit-breakers for protection of power distribution with thermal overload and magnetic short-circuit trip units are suitable for usage in DC networks.
The circuit-breakers with electronic overcurrent releases are not suitable for DC networks.

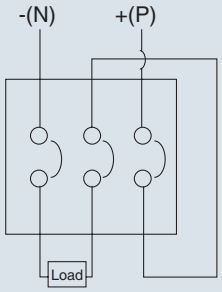
Circuit-breaker selection criteria

The followings are the most important criteria for selection of suitable circuit breaker for DC networks.
- The rated current determines the rating and size of the circuit-breaker (Equipment)
- The rated voltage determines the number of poles in series necessary for breaking
- The maximum short-circuit current at the connection point determines the breaking capacity

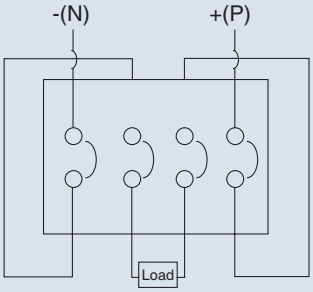
Setting range of the trip values

- Thermal overload protection: Same setpoints as in 50/60Hz circuits
- Instantaneous short-circuit protection: The response threshold increases by maximum 40%.

The following wiring diagrams are recommended since the current must flow through all current paths in order to conform to the thermal tripping characteristic curve.



Recommended wiring method
for DC500V circuit



Recommended wiring method
for DC600V circuit

	Model	Trip unit	Applicable to DC circuits	Breaking capacity (kA)
Thermal magnetic	TD100N,TD160N	FTU FMU ATU	○	42
	TS100N,TS160N, TS250N TS400N, TS630N TS800N		○	50
	TD100H, TD160H		○	65
	TS100H, TS160H, TS250H TS400H, TS630H TS800H		○	85
	TD100L, TD160L TS100L, TS160L, TS250L TS400L, TS630L TS800L		○	100
Electronic	TS250, TS630, TS800	ETS, ETM	Impossible to use to DC circuits	

Application
Circuit breakers for 400Hz networks

When circuit breakers are used at high frequencies, the breakers in many cases require to be derated as the increased resistance of the copper sections resulting from the skin effect produced by eddy currents at 400Hz.

- Standard production breakers can be used with alternating currents with frequencies other than 50/60 Hz (the frequencies to which the rated performance of the device refer, with alternating current) as appropriate derating coefficients are applied.

Thermal magnetic trip units

Thermal trip

As can be seen from the data shown in below, the tripping threshold of the thermal element (In) decreases as the frequency increases because of the reduced conductivity of the materials and the increase of the associated thermal phenomena.
Rated current (A) at 400Hz= K1 × rated current (A) at 50/60Hz

Instantaneous trip

The magnetic threshold increases with the increase in frequency.
Instantaneous current (A) at 400Hz= K2 × Instantaneous current (A) at 50/60Hz

Thermal magnetic trip units

TD and TS series performance table at 400Hz

Rated current (A) in 400 Hz	Applied circuit breaker (MCCB)	Trip unit	Multiplier factors (K1, K2)	
			K1 (Thermal trip units)	K2 (Magnetic trip units)
16	TD100N, TD100H, TD100L TS100N, TS100H, TS100L TD160N, TD160H, TD160L TS160N, TS160H, TS160L	FTU FMU ATU	0.8	2
20			0.8	2
25			0.8	2
32			0.8	2
40			0.8	2
50			0.8	2
63			0.8	2
80			0.8	2
100			0.8	2
125			0.8	2
160	TS250N, TS250H, TS250L		0.8	2
200			0.8	2
250	TS400N, TS400H, TS400L TS630N, TS630H, TS630L		0.8	2
300			0.8	2
400			0.8	2
500			0.8	2
630	TS800N, TS800H, TS800L		0.8	2
700			0.8	2

Note) K1 × Multiplier factor of rated current (In)
K2-Multiplier factor of instantaneous current due to the induced magnetic fields
FTU-Fixed Thermal and magnetic trip unit
FMU × Adjustable thermal and fixed magnetic trip unit
ATU × Adjustable thermal and magnetic trip unit

Application
Circuit breakers for 400Hz networks

Electronic trip units

The use of electronics offers the advantage of greater operating stability when the frequency is varied. However, the devices are still subjected to frequency related temperature effects which may sometimes pose restrictions on their use. Column K1 of the table below gives the maximum permissible current to be used for the current setting (knob position).

Rated current (A) in 400 Hz	Applied circuit breaker (MCCB)	Trip unit	Multiplier factors (K1, K2)	
			K1 (Thermal trip units)	K2 (Magnetic trip units)
40	TS100N, TS100H, TS100L TS160N, TS160H, TS160L TS250N, TS250H, TS250L TS400N, TS400H, TS400L TS630N, TS630H, TS630L TS800N, TS800H, TS800L	ETS ETM	0.4 to 1	1
80			0.4 to 1	1
160			0.4 to 0.9	1
250			0.4 to 0.9	1
400			0.4 to 0.8	1
630			0.4 to 0.8	1
800			0.4 to 0.75	0.97

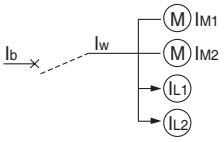
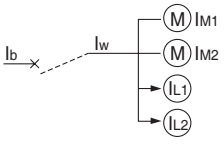
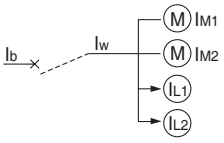
Note) ATU×Adjustable thermal and magnetic trip unit
K1×Multiplier factor of rated current (In)
K2-Multiplier factor of instantaneous current due to the induced magnetic fields
ETS×Electronic trip unit (Standard)
ETM×Electronic trip unit (Multi-function)

Application
Protection of several kinds of loads

Application for protection of several kinds of loads

It requires to select proper circuit breakers according to the characteristics of loads when they are installed to protect several kinds of loads. It's needed to consider the maximum operating current and the capacity of loads in total so as to select the rated current of breakers.

Selection of circuit breaker protecting the several loads simultaneously

The kind of loads (I_M: motors, I_L: others)	Permissible current in cable or wire: I_W	The rated current of circuit breaker: I_b
In case of, $\Sigma I_M \leq \Sigma I_L$ 	$I_W \geq \Sigma I_M + \Sigma I_L$	Choose the low value among two formulas: $I_b \geq 3\Sigma I_M + \Sigma I_L$. and $I_b \leq 2.5 I_W$ It's permitted to select the above value only if I_W (above 100A) isn't subject to the rated current of circuit breaker.
In case of, $\Sigma I_M > \Sigma I_L$, $\Sigma I_M \leq 50A$ 	$I_W \geq 1.25\Sigma I_M + \Sigma I_L$	
In case of, $\Sigma I_M > \Sigma I_L$, $\Sigma I_M > 50A$ 	$I_W \geq 1.1\Sigma I_M + \Sigma I_L$	

The rated current of breakers as the main circuit of 3 phase inductive loads (AC 220V)

Capacity of loads In total (below kW)	The maximum operating current (below A)	Capacity of the highest motor (kW / A)															
		0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5	22	30	37	45	55	75	90
		4.8	8	11.1	17.4	26	34	48	65	79	93	125	160	190	230	310	360
3	15	20	32	32													
4.5	20	32	32	32	50												
6.3	30	40	40	40	50	63											
8.2	40	50	50	50	50	80	100										
12	50	63	63	63	63	80	100										
15.7	75	100	100	100	100	100	100	125	160								
19.5	90	100	100	100	100	100	100	125	160	200							
23.2	100	125	125	125	125	125	125	125	160	200	200						
30	125	160	160	160	160	160	160	160	160	200	250						
37.5	150	200	200	200	200	200	200	200	200	200	250	300					
45	175	200	200	200	200	200	200	200	200	200	250	300	400				
52.5	200	250	250	250	250	250	250	250	250	250	250	300	400	500			
63.7	250	300	300	300	300	300	300	300	300	300	300	300	400	500	500		
75	300	400	400	400	400	400	400	400	400	400	400	400	400	500	500		
86.2	350	400	400	400	400	400	400	400	400	400	400	400	400	500	500	630	
97.5	400	500	500	500	500	500	500	500	500	500	500	500	500	500	500	630	700
112.5	450	500	500	500	500	500	500	500	500	500	500	500	500	500	500	700	700
125	500	630	630	630	630	630	630	630	630	630	630	630	630	630	630	700	700
150	600	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	800
175	700	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800

Application
Protection of several kinds of loads

The rated current of breakers as the main circuit of 3 phase inductive loads (AC 440V)

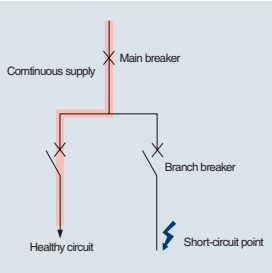
Capacity of loads In total (below kW)	The maximum operating current (below A)	Capacity of the highest motor (kW / A)																
		0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5	22	30	37	45	55	75	90	110	132
		4.8	8	11.1	17.4	26	34	48	65	79	93	125	160	190	230	310	360	220	250
3	7.5	16	16	16															
4.5	10	16	16	16	32														
6.3	15	20	20	20	32	40													
8.2	20	32	32	32	32	40	50												
12	25	32	32	32	32	40	50												
15.7	38	50	50	50	50	50	50	63	80										
19.5	45	50	50	50	50	50	50	63	80	100									
23.2	50	63	63	63	63	63	63	63	80	100	125								
30	63	80	80	80	80	80	80	80	100	100	125								
37.5	75	100	100	100	100	100	100	100	100	100	125	160							
45	88	100	100	100	100	100	100	100	100	100	125	160	200						
52.5	100	125	125	125	125	125	125	125	125	125	125	160	200	250					
63.7	125	160	160	160	160	160	160	160	160	160	160	160	200	250	250				
75	150	200	200	200	200	200	200	200	200	200	200	200	200	250	250				
86.2	175	200	200	200	200	200	200	200	200	200	200	200	200	250	300	400			
97.5	200	250	250	250	250	250	250	250	250	250	250	250	250	250	300	400	400	500	
112.5	225	250	250	250	250	250	250	250	250	250	250	250	250	250	300	400	400	500	500
125	250	300	300	300	300	300	300	300	300	300	300	300	300	300	300	400	400	500	500
150	300	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	500	500
175	350	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	500	630	630
200	400	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	700	700
250	500	630	630	630	630	630	630	630	630	630	630	630	630	630	630	630	630	800	800
300	600	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	800	800
350	700	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	-	-
400	700	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	-	-

Notes) The above mentioned technical data is defined under the usage conditions as follows ;
1. The circuit breaker is tripped within 10seconds in 600% of the current of the fully operating loads.
2. The start-up input current is set within 1700% of the current of the fully operating loads.
3. The capacity of highest motor is also applied when several loads starts up simultaneously.

Protective coordination
Discrimination & Cascading

The primary purpose of a circuit protection system is to prevent damage to series connected equipment and to minimize the area and duration of power loss.
The first consideration is whether an air circuit breaker or molded case circuit breaker is the most suitable. The next is the type of system to be used.
The two major types are: Discrimination and cascading.

Discrimination



<Discrimination>

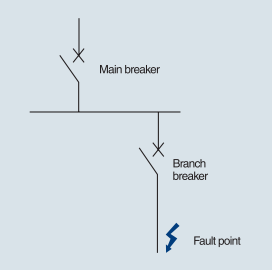
According to IEC60947-2, the discrimination can be defined as follows.

Total discrimination (total selectivity)
Over-current discrimination where, in the presence of two over-current protective devices in series, the protective device on the load side effects the protection without causing the other protective device to operate.

Partial discrimination (partial selectivity)
Over-current discrimination where, in the presence of two over-current protective devices in series, the protective device on the load side effects the protection up to a given level of over-current, without causing the other protective device to operate.

No discrimination
In case of a fault, main and branch circuit breakers open.

Cascading



<Cascading>

This is an economical approach to the use of circuit breakers, whereby only the main (upstream) breaker has adequate interrupting capacity for the maximum available fault current.
The MCCBs downstream cannot handle this maximum fault current and rely on the opening of the upstream breaker for protection.
The advantage of the cascade back-up approach is that it facilitates the use of low cost, low fault level breakers downstream, thereby offering savings in both the cost and size of equipment.
As Susol TD & TS circuit breakers have a very considerable current limiting effect, they can be used to provide this ‘cascade back-up’ protection for downstream circuit breakers.

Protective coordination
Cascading, network 220/240V

Complementary technical information

Main: Susol TD/TS series **Branch: Metasol AB and Susol MCCB**

Branch breaker		Main breaker	TD100N	TD100H	TD100L	TD160N	TD160H	TD160L	TS100N	TS100H	TS100L
		Rated breaking capacity (kArms)	85	100	200	85	100	200	100	120	200
AB	ABS33c	30	50	50	65	50	50	65	65	65	85
	ABN53c	30	50	50	65	50	50	65	85	100	100
	ABS53c	35	65	65	85	65	65	85	100	120	120
	ABH53c	100			120			120			
	ABN63c	30	50	65	85	65	65	85	65	65	85
	ABS63c	35	65	85	100	85	85	100	85	100	100
	ABN103c	35	85	100	120	85	100	120	100	120	120
	ABS125c	85									
	ABH125c	100									
	ABN203c	65									
	ABS203c	85									
	ABH203c	100									
	ABN403c	50									
	ABS403c	75									
	ABH403c	85									
	ABL403c	125									
	ABN803c	50									
	ABS803c	85									
	ABL803c	125									
Susol TD & TS	TD100N	85		100	200		100	200	100	120	200
	TD100H	100			200			200		120	200
	TD160N	85					100	200			
	TD160H	100						200			
	TS100N	100								120	200
	TS100H	120									200
	TS160N	100									
	TS160H	120									
	TS250N	100									
	TS250H	120									
	TS400N	100									
	TS400H	120									
	TS630N	100									
	TS630H	120									
	TS800N	100									
	TS800H	120									
	TS1000N	55									
	TS1000H	75									
	TS1250N	55									
	TS1250H	75									

Protective coordination
Cascading, network 220/240V

Complementary technical information

Main: Susol TS series **Branch: Metasol AB and Susol MCCB**

Branch breaker		Main breaker	TS160N	TS160H	TS160L	TS250N	TS250H	TS250L	TS400N	TS400H	TS400L
		Rated breaking capacity (kArms)	100	120	200	100	120	200	100	120	200
AB	ABS33c	30	65	65	85	50	50	65			
	ABN53c	30	85	100	100	50	50	65			
	ABS53c	35	100	120	120	65	65	85			
	ABH53c	100					120	120			
	ABN63c	30	65	65	85	65	65	85			
	ABS63c	35	85	100	100	85	85	100			
	ABN103c	35	100	120	120	85	100	120			
	ABS125c	85				100	100	120	100	120	150
	ABH125c	100					120	150	100	120	150
	ABN203c	65				85	85	100	85	85	100
	ABS203c	85				100	100	120	100	120	150
	ABH203c	100					120	150	100	120	150
	ABN403c	50							85	100	100
	ABS403c	75							100	120	120
	ABH403c	85							100	120	150
	ABL403c	125									200
	ABN803c	50									
	ABS803c	85									
	ABL803c	125									
Susol TD & TS	TD100N	85	100	120	200	100	120	200	100	120	200
	TD100H	100		120	200		120	200		120	200
	TD160N	85	100	120	200	100	120	200	100	120	200
	TD160H	100		120	200		120	200		120	200
	TS100N	100		120	200		120	200		120	200
	TS100H	120			200			200			200
	TS160N	100		120	200		120	200		120	200
	TS160H	120			200			200			200
	TS250N	100					120	200		120	200
	TS250H	120						200			200
	TS400N	100								120	200
	TS400H	120									200
	TS630N	100									
	TS630H	120									
	TS800N	100									
	TS800H	120									
	TS1000N	55									
	TS1000H	75									
	TS1250N	55									
	TS1250H	75									

Protective coordination
Cascading, network 220/240V

Complementary technical information

Main: Susol TS series **Branch: Metasol AB and Susol MCCB**

Branch breaker		Main breaker	TS630N	TS630H	TS630L	TS800N	TS800H	TS800L
		Rated breaking capacity (kArms)	100	120	200	100	120	200
AB	ABS33c	30						
	ABN53c	30						
	ABS53c	35						
	ABH53c	100						
	ABN63c	30						
	ABS63c	35						
	ABN103c	35						
	ABS125c	85	100	120	150			
	ABH125c	100	100	120	150			
	ABN203c	65	85	85	100			
	ABS203c	85	100	120	150			
	ABH203c	100	100	120	150			
	ABN403c	50	85	100	100	85	100	100
	ABS403c	75	100	120	120	100	120	120
	ABH403c	85	100	120	150	100	120	150
	ABL403c	125			200			200
	ABN803c	50				100	120	120
	ABS803c	85					120	150
	ABL803c	125						200
Susol TD & TS	TD100N	85	100	120	200	100	120	200
	TD100H	100		120	200		120	200
	TD160N	85	100	120	200	100	120	200
	TD160H	100		120	200		120	200
	TS100N	100		120	200		120	200
	TS100H	120			200			200
	TS160N	100		120	200		120	200
	TS160H	120			200			200
	TS250N	100		120	200		120	200
	TS250H	120			200			200
	TS400N	100		120	200		120	200
	TS400H	120			200			200
	TS630N	100		120	200		120	200
	TS630H	120			200			200
	TS800N	100					120	200
	TS800H	120						200
	TS1000N	55						
	TS1000H	75						
	TS1250N	55						
	TS1250H	75						

Protective coordination
Cascading, network 220/240V

Complementary technical information

Main: Susol TS series **Branch: Metasol AB and Susol MCCB**

Branch breaker		Main breaker	TS1000N	TS1000H	TS1000L	TS1250N	TS1250H	TS1600N	TS1600H
		Rated breaking capacity (kArms)	55	75	200	55	75	55	75
AB	ABS33c	30							
	ABN53c	30							
	ABS53c	35							
	ABH53c	100							
	ABN63c	30							
	ABS63c	35							
	ABN103c	35							
	ABS125c	85							
	ABH125c	100							
	ABN203c	65							
	ABS203c	85							
	ABH203c	100							
	ABN403c	50	55	75	200	55	75	55	75
	ABS403c	75			200				
	ABH403c	85			200				
	ABL403c	125			200				
	ABN803c	50	55	75	200	55	75	55	75
	ABS803c	85			200				
	ABL803c	125			200				
Susol TD & TS	TD100N	85			200				
	TD100H	100			200				
	TD160N	85			200				
	TD160H	100			200				
	TS100N	100			200				
	TS100H	120			200				
	TS160N	100			200				
	TS160H	120			200				
	TS250N	100			200				
	TS250H	120			200				
	TS400N	100			200				
	TS400H	120			200				
	TS630N	100			200				
	TS630H	120			200				
	TS800N	100			200				
	TS800H	120			200				
	TS1000N	55			200		75		75
	TS1000H	75			200				
	TS1250N	55			200		75		75
	TS1250H	75			200				

Protective coordination
Cascading, network 380/415V

Complementary technical information

Main: Susol TD/TS series **Branch: Metasol AB and Susol MCCB**

Branch breaker		Main breaker	TD100N	TD100H	TD100L	TD160N	TD160H	TD160L	TS100N	TS100H	TS100L
		Rated breaking capacity (kArms)	50	85	150	50	85	150	50	85	150
AB	ABS33c	14	25	30	30	25	30	30	30	40	40
	ABN53c	14	35	50	50	35	50	50	35	65	65
	ABS53c	18	50	65	65	50	65	65	50	70	70
	ABH53c	50									
	ABN63c	14	25	30	30	25	30	30	30	40	40
	ABS63c	18	35	50	50	35	50	50	35	65	65
	ABN103c	18	50	65	65	50	65	65	50	70	70
	ABS125c	37	50	65	65	50	65	65	50	70	70
	ABH125c	50									
	ABN203c	26									
	ABS203c	37									
	ABH203c	50									
	ABN403c	37									
	ABS403c	50									
	ABH403c	65									
	ABL403c	85									
	ABN803c	37									
	ABS803c	65									
	ABL803b	85									
Susol TD & TS	TD100N	50		85	150		85	150		85	150
	TD100H	85			150			150			150
	TD160N	50					85	150			
	TD160H	85						150			
	TS100N	50								85	150
	TS100H	85									150
	TS160N	50									
	TS160H	85									
	TS250N	50									
	TS250H	85									
	TS400N	65									
	TS400H	85									
	TS630N	65									
	TS630H	85									
	TS800N	65									
	TS800H	85									
	TS1000N	50									
	TS1000H	70									
	TS1250N	50									
	TS1250H	70									

Protective coordination
Cascading, network 380/415V

Complementary technical information

Main: Susol TS series **Branch: Metasol AB and Susol MCCB**

Branch breaker		Main breaker	TS160N	TS160H	TS160L	TS250N	TS250H	TS250L	TS400N	TS400H	TS400L
		Rated breaking capacity (kArms)	50	85	150	50	85	150	65	85	150
AB	ABS33c	14	30	40	40	30	40	40			
	ABN53c	14	35	65	65	35	65	65			
	ABS53c	18	50	70	70	50	70	70			
	ABH53c	50					65	70			
	ABN63c	14	30	40	40	30	40	40			
	ABS63c	18	35	65	65	35	65	65			
	ABN103c	18	50	70	70	50	70	70			
	ABS125c	37	50	70	70	40	65	70	50	70	85
	ABH125c	50		70	70		70	85		85	100
	ABN203c	26				35	50	50	40	50	70
	ABS203c	37				40	65	70	50	70	85
	ABH203c	50					70	85		85	100
	ABN403c	37							50	70	85
	ABS403c	50								85	100
	ABH403c	65								85	120
	ABL403c	85									150
	ABN803c	37									
	ABS803c	65									
	ABL803b	85									
Susol TD & TS	TD100N	50		85	150		85	150	65	85	150
	TD100H	85			150			150			150
	TD160N	50		85	150		85	150	65	85	150
	TD160H	85			150			150			150
	TS100N	50		85	150		85	150	65	85	150
	TS100H	85			150			150			150
	TS160N	50		85	150		85	150	65	85	150
	TS160H	85			150			150			150
	TS250N	50					85	150	65	85	150
	TS250H	85						150			150
	TS400N	65								85	150
	TS400H	85									150
	TS630N	65									
	TS630H	85									
	TS800N	65									
	TS800H	85									
	TS1000N	50									
	TS1000H	70									
	TS1250N	50									
	TS1250H	70									

Protective coordination
Cascading, network 380/415V

Complementary technical information

Main: Susol TS series **Branch: Metasol AB and Susol MCCB**

Branch breaker		Main breaker	TS630N	TS630H	TS630L	TS800N	TS800H	TS800L
		Rated breaking capacity (kArms)	65	85	150	65	100	150
AB	ABS33c	14						
	ABN53c	14						
	ABS53c	18						
	ABH53c	50						
	ABN63c	14						
	ABS63c	18						
	ABN103c	18						
	ABS125c	37	50	70	85			
	ABH125c	50		85	100			
	ABN203c	26	40	50	70			
	ABS203c	37	50	70	85			
	ABH203c	50		85	100			
	ABN403c	37	50	70	85	50	70	85
	ABS403c	50		85	100		85	100
	ABH403c	65		85	120	65	100	120
	ABL403c	85			150		100	150
	ABN803c	37				65	85	100
	ABS803c	65				65	100	120
	ABL803b	85					100	150
Susol TD & TS	TD100N	50	65	85	150	65	100	150
	TD100H	85			150			150
	TD160N	50	65	85	150	65	100	150
	TD160H	85			150			150
	TS100N	50	65	85	150	65	100	150
	TS100H	85			150			150
	TS160N	50	65	85	150	65	100	150
	TS160H	85			150			150
	TS250N	50	65	85	150	65	100	150
	TS250H	85			150			150
	TS400N	65		85	150		100	150
	TS400H	85			150			150
	TS630N	65		85	150		100	150
	TS630H	85			150			150
	TS800N	65					100	150
	TS800H	85						
	TS1000N	50						
	TS1000H	70						
	TS1250N	50						
	TS1250H	70						

Protective coordination
Cascading, network 380/415V

Complementary technical information

Main: Susol TS series **Branch: Metasol AB and Susol MCCB**

Branch breaker		Main breaker	TS1000N	TS1000H	TS1000L	TS1250N	TS1250H	TS1600N	TS1600H
		Rated breaking capacity (kArms)	50	70	150	50	70	50	70
AB	ABS33c	14							
	ABN53c	14							
	ABS53c	18							
	ABH53c	50							
	ABN63c	14							
	ABS63c	18							
	ABN103c	18							
	ABS125c	37							
	ABH125c	50							
	ABN203c	26							
	ABS203c	37							
	ABH203c	50							
	ABN403c	37	50	70	150	50	70	50	70
	ABS403c	50		70	150		70		70
	ABH403c	65		70	150		70		70
	ABL403c	85			150				
	ABN803c	37	50	70	150	50	70	50	70
	ABS803c	65		70	150		70		70
	ABL803b	85			150				
Susol TD & TS	TD100N	50		70	150		70		70
	TD100H	85			150				
	TD160N	50		70	150		70		70
	TD160H	85			150				
	TS100N	50		70	150		70		70
	TS100H	85			150				
	TS160N	50		70	150		70		70
	TS160H	85			150				
	TS250N	50		70	150		70		70
	TS250H	85			150				
	TS400N	65		70	150		70		70
	TS400H	85			150				
	TS630N	65		70	150		70		70
	TS630H	85			150				
	TS800N	65		70	150		70		70
	TS800H	85			150				
	TS1000N	50		70	150		70		70
	TS1000H	70			150				
	TS1250N	50		70	150		70		70
	TS1250H	70			150				

Protective coordination
Motor protection cascading, network 220/240V

Main: Susol TD/TS series

Branch: Susol MCCB

Branch breaker		Main breaker	TD100N	TD100H	TD100L	TD160N	TD160H	TD160L	TS100N	TS100H	TS100L
		Rated breaking capacity (kArms)	85	100	200	85	100	200	100	120	200
Susol TD & TS	TD100N	85		100	200		100	200	100	120	200
	TD100H	100			200			200		120	200
	TD160N	85					100	200			
	TD160H	100						200			
	TS100N	100								120	200
	TS100H	120									200
	TS160N	100									
	TS160H	120									

Branch breaker		Main breaker	TS160N	TS160H	TS160L	TS250N	TS250H	TS250L	TS400N	TS400H	TS400L
		Rated breaking capacity (kArms)	100	120	200	100	120	200	100	120	200
Susol TD & TS	TD100N	85	100	120	200	100	120	200	100	120	200
	TD100H	100		120	200		120	200		120	200
	TD160N	85	100	120	200	100	120	200	100	120	200
	TD160H	100		120	200		120	200		120	200
	TS100N	100		120	200		120	200		120	200
	TS100H	120			200			200			200
	TS160N	100		120	200		120	200		120	200
	TS160H	120			200			200			200
	TS250N	100					120	200		120	200
	TS250H	120						200			200

Branch breaker		Main breaker	TS630N	TS630H	TS630L	TS800N	TS800H	TS800L
		Rated breaking capacity (kArms)	100	120	200	100	120	200
Susol TD & TS	TD100N	85	100	120	200	100	120	200
	TD100H	100		120	200		120	200
	TD160N	85	100	120	200	100	120	200
	TD160H	100		120	200		120	200
	TS100N	100		120	200		120	200
	TS100H	120			200			200
	TS160N	100		120	200		120	200
	TS160H	120			200			200
	TS250N	100		120	200		120	200
	TS250H	120			200			200
	TS400N	100		120	200		120	200
	TS400H	120			200			200
	TS630N	100		120	200		120	200
	TS630H	120			200			200
	TS800N	100					120	200
	TS800H	120						200

Main: Susol TS series

Branch: Susol MCCB

Branch breaker		Main breaker	TS1000N	TS1000H	TS1000L	TS1250N	TS1250H	TS1600N	TS1600H
		Rated breaking capacity (kArms)	55	75	200	55	75	55	75
Susol TD & TS	TD100N	85			200				
	TD100H	100			200				
	TD160N	85			200				
	TD160H	100			200				
	TS100N	100			200				
	TS100H	120			200				
	TS160N	100			200				
	TS160H	120			200				
	TS250N	100			200				
	TS250H	120			200				
	TS400N	100			200				
	TS400H	120			200				
	TS630N	100			200				
	TS630H	120			200				
	TS800N	100			200				
	TS800H	120			200				
	TS1000N	55			200		75		75
	TS1000H	75			200				
	TS1250N	55			200		75		75
	TS1250H	75			200				

Protective coordination
Motor protection cascading, network 380/415V

Main: Susol TD/TS series

Branch: Susol MCCB

Branch breaker		Main breaker	TD100N	TD100H	TD100L	TD160N	TD160H	TD160L	TS100N	TS100H	TS100L
		Rated breaking capacity (kArms)	85	100	200	85	100	200	100	120	200
Susol TD & TS	TD100N	50		85	150		85	150		85	150
	TD100H	85			150			150			150
	TD160N	50					85	150			
	TD160H	85						150			
	TS100N	50								85	150
	TS100H	85									150
	TS160N	50									
	TS160H	85									

Branch breaker		Main breaker	TS160N	TS160H	TS160L	TS250N	TS250H	TS250L	TS400N	TS400H	TS400L
		Rated breaking capacity (kArms)	100	120	200	100	120	200	100	120	200
Susol TD & TS	TD100N	50		85	150		85	150	65	85	150
	TD100H	85			150			150			150
	TD160N	50		85	150		85	150	65	85	150
	TD160H	85			150			150			150
	TS100N	50		85	150		85	150	65	85	150
	TS100H	85			150			150			150
	TS160N	50		85	150		85	150	65	85	150
	TS160H	85			150			150			150
	TS250N	50					85	150	65	85	150
	TS250H	85						150			150

Branch breaker		Main breaker	TS630N	TS630H	TS630L	TS800N	TS800H	TS800L
		Rated breaking capacity (kArms)	100	120	200	100	120	200
Susol TD & TS	TD100N	50	65	85	150	65	100	150
	TD100H	85			150			150
	TD160N	50	65	85	150	65	100	150
	TD160H	85			150			150
	TS100N	50	65	85	150	65	100	150
	TS100H	85			150			150
	TS160N	50	65	85	150	65	100	150
	TS160H	85			150			150
	TS250N	50	65	85	150	65	100	150
	TS250H	85			150			150
	TS400N	65		85	150		100	150
	TS400H	85			150			150
	TS630N	65		85	150		100	150
	TS630H	85			150			150
	TS800N	65					100	150
	TS800H	85						

Main: Susol TS series

Branch: Susol MCCB

Branch breaker		Main breaker	TS1000N	TS1000H	TS1000L	TS1250N	TS1250H	TS1600N	TS1600H
		Rated breaking capacity (kArms)	55	75	200	55	75	55	75
Susol TD & TS	TD100N	50		70	150		70		70
	TD100H	85			150				
	TD160N	50		70	150		70		70
	TD160H	85			150				
	TS100N	50		70	150		70		70
	TS100H	85			150				
	TS160N	50		70	150		70		70
	TS160H	85			150				
	TS250N	50		70	150		70		70
	TS250H	85			150				
	TS400N	65		70	150		70		70
	TS400H	85			150				
	TS630N	65		70	150		70		70
	TS630H	85			150				
	TS800N	65		70	150		70		70
	TS800H	85			150				
	TS1000N	50		70	150		70		70
	TS1000H	70			150				
	TS1250N	50		70	150		70		70
	TS1250H	70			150				

Protective coordination
Protection discrimination table, Discrimination

Complementary technical information

Main: Susol MCCB 100~800AF **Branch: AB type MCCB**

Branch breaker		Main breaker Rating (A)	TD100N/H/L Trip units-Thermal magnetic								TD160N/H/L		
			16	20	25	32	40	50	63	80	100	100	125	160
AB100	N	~10				0.4	0.5	0.5	0.5	0.63	0.8	T	T	T
		15					0.5	0.5	0.5	0.63	0.8	T	T	T
		20					0.5	0.5	0.5	0.63	0.8	9	9	9
		30							0.5	0.63	0.8	9	9	9
		40								0.63	0.8	9	9	9
		50								0.63	0.8	8	8	8
		60									0.8	8	8	8
		75											8	8
		100												8
AB125	S	15						0.5	0.5	0.63	0.8	10	10	10
		20						0.5	0.5	0.63	0.8	9	10	10
		30							0.5	0.63	0.8	9	9	9
		40								0.63	0.8	9	9	9
		50								0.63	0.8	8	8	8
		60									0.8	8	8	8
		75										8	8	8
		100											8	8
		125												8
	H	15					0.5	0.5	0.5	0.63	0.8	10	10	10
		20						0.5	0.5	0.63	0.8	9	10	10
		30						0.5	0.5	0.63	0.8	9	9	9
		40							0.5	0.63	0.8	9	9	9
		50								0.63	0.8	8	8	8
		60								0.63	0.8	8	8	8
		75									0.8	8	8	8
		100											8	8
		125												
AB203	N	100												
		125												
		150												
		175												
		200												
		225												
		250												
	S	100												
		125												
		150												
		175												
		200												
		225												
		250												
	H	100												
		125												
		150												
		175												
		200												
		225												
		250												

Trip units-Thermal magnetic

	TS100N/H/L					TS160N/H/L			TS250N/H/L				TS400N/H/L		TS630N/H/L		TS800N/H/L
	Trip units-Thermal magnetic/Electronic																
	40	50	63	80	100	100	125	160	125	160	200	250	300	400	500	630	800
	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
			T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
				T	T	T	T	T	T	T	T	T	T	T	T	T	T
				T	T	T	T	T	T	T	T	T	T	T	T	T	T
					T	T	T	T	T	T	T	T	T	T	T	T	T
							T	T	T	T	T	T	T	T	T	T	T
								T	T	T	T	T	T	T	T	T	T
	10	10	10	11	11	11	12.5	12.5	15	15	18	18	T	T	T	T	T
	10	10	10	10	11	11	11	12.5	15	15	15	18	T	T	T	T	T
			8	10	11	11	11	11	15	15	15	18	20	T	T	T	T
				8	11	11	11	11	15	15	15	15	20	T	T	T	T
				8	11	11	11	11	15	15	15	15	20	20	T	T	T
					8	8	8	11	12.5	12.5	12.5	12.5	20	20	20	T	T
							8	11	12.5	12.5	12.5	12.5	20	20	20	T	T
								11	12.5	12.5	12.5	12.5	20	20	20	T	T
								11	12.5	12.5	12.5	12.5	20	20	20	T	T
	10	10	10	11	11	11	12.5	12.5	15	15	18	18	25	25	25	25	T
	10	10	10	10	11	11	11	12.5	15	15	15	18	25	25	25	25	T
			8	10	11	11	11	11	15	15	15	18	20	25	25	25	T
				8	11	11	11	11	15	15	15	15	20	25	25	25	T
				8	11	11	11	11	15	15	15	15	20	20	25	25	T
					8	8	8	11	12.5	12.5	12.5	12.5	20	20	20	25	T
							8	11	12.5	12.5	12.5	12.5	20	20	20	25	T
								11	12.5	12.5	12.5	12.5	20	20	20	25	T
								11	12.5	12.5	12.5	12.5	20	20	20	25	T
							8	8			8	8	T	T	T	T	T
								8				8	T	T	T	T	T
													15	15	15	15	T
													12.5	12.5	15	15	T
													11	12.5	12.5	12.5	T
													11	11	12.5	12.5	T
													11	11	12.5	12.5	T
							8	8			8	8	18	18	18	18	T
								8				8	18	18	18	18	T
													15	15	15	15	T
													12.5	12.5	15	15	T
													11	12.5	12.5	12.5	T
													11	11	12.5	12.5	T
													11	11	12.5	12.5	T
							8	8			8	8	18	18	18	18	28
								8				8	18	18	18	18	28
													15	15	15	15	28
													12.5	12.5	15	15	28
													11	12.5	12.5	12.5	28
													11	11	12.5	12.5	28
													11	11	12.5	12.5	28

Protective coordination
Protection discrimination table, Discrimination

Complementary technical information

Main: Susol TD 100/160 **Branch: Susol TD 100/160**

Branch breaker		Main breaker Rating (A)		TD100N/H/L Trip units-Thermal magnetic/Electronic									TD160N/H/L		
				16	20	25	32	40	50	63	80	100	100	125	160
TD100	N	Trip units-Thermal magnetic	16				0.4	0.5	0.5	0.5	0.63	0.8	2	2	2
			20						0.5	0.5	0.63	0.8	2	2	2
			25						0.5	0.5	0.63	0.8	2	2	2
			32							0.5	0.63	0.8	2	2	2
			40								0.63	0.8	2	2	2
			50								0.63	0.8	2	2	2
			63									0.8	2	2	2
			80											1.25	2
			100												1.6
	H		16					0.5	0.5	0.5	0.63	0.8	2	2	2
			20						0.5	0.5	0.63	0.8	2	2	2
			25						0.5	0.5	0.63	0.8	2	2	2
			32							0.5	0.63	0.8	2	2	2
			40								0.63	0.8	2	2	2
			50								0.63	0.8	2	2	2
			63									0.8	2	2	2
			80											1.25	2
			100											1	1.6
	L		16					0.5	0.5	0.5	0.63	0.8	2	2	2
			20						0.5	0.5	0.63	0.8	2	2	2
			25						0.5	0.5	0.63	0.8	2	2	2
			32							0.5	0.63	0.8	2	2	2
			40								0.63	0.8	2	2	2
			50								0.63	0.8	2	2	2
			63									0.8	2	2	2
			80											1.25	2
			100											1	1.6
TD160	N		100											1	1.6
			125												1.25
			160												
	H		100												1.6
			125												1.25
			160												
	L		100												1.6
			125												1.25
			160												

Protective coordination
Protection discrimination table, Discrimination

Complementary technical information

Main: Susol TS 100/160/250(Electronic) **Branch: Susol TD 100/160**

Branch breaker		Main breaker Rating (A)	TS100N/H/L					TS160N/H/L			TS250N/H/L			
			Trip units-Thermal magnetic/Electronic											
			40	50	63	80	100	100	125	160	125	160	200	250
TD100	N	16	0.5	0.5	0.5	0.63	0.8	2	2	2	2	36	36	36
		20	0.5	0.5	0.5	0.63	0.8	2	2	2	2	36	36	36
		25	0.5	0.5	0.5	0.63	0.8	2	2	2	2	36	36	36
		32			0.5	0.63	0.8	2	2	2	2	36	36	36
		40				0.63	0.8	2	2	2	2	36	36	36
		50				0.63	0.8	2	2	2	2	36	36	36
		63					0.8	2	2	2	2	36	36	36
		80					0.8	1	1.25	2	1.25	36	36	36
		100							1	1.6	1	36	36	36
	H	16	0.5	0.5	0.5	0.63	0.8	2	2	2	2	36	36	36
		20		0.5	0.5	0.63	0.8	2	2	2	2	36	36	36
		25		0.5	0.5	0.63	0.8	2	2	2	2	36	36	36
		32			0.5	0.63	0.8	2	2	2	2	36	36	36
		40				0.63	0.8	2	2	2	2	36	36	36
		50				0.63	0.8	2	2	2	2	36	36	36
		63					0.8	2	2	2	2	36	36	36
		80					0.8	1	1.25	2	1.25	36	36	36
		100							1	1.6	1	36	36	36
	L	16	0.5	0.5	0.5	0.63	0.8	2	2	2	2	36	36	36
		20		0.5	0.5	0.63	0.8	2	2	2	2	36	36	36
		25		0.5	0.5	0.63	0.8	2	2	2	2	36	36	36
		32			0.5	0.63	0.8	2	2	2	2	36	36	36
		40				0.63	0.8	2	2	2	2	36	36	36
		50				0.63	0.8	2	2	2	2	36	36	36
		63					0.8	2	2	2	2	36	36	36
		80					0.8	1	1.25	2	1.25	36	36	36
		100							1	1.6	1	36	36	36
TD160	N	100							1	1.6	1	2.6	4	5
		125								1.25		1.25	4	5
		160												5
	H	100							1	1.6	1	2.6	4	5
		125								1.25		1.25	4	5
		160												5
	L	100							1	1.6	1	2.6	4	5
		125								1.25		1.25	4	5
		160												5

Protective coordination
Protection discrimination table, Discrimination

Complementary technical information

Main: Susol TS 400/630/800(Electronic) **Branch: Susol TS 100/160**

Branch breaker		Main breaker		TS400N/H/L		TS630N/H/L		TS800N/H/L
		Rating (A)		Trip units-Thermal magnetic/Electronic				
				300	400	500	630	800
TD100	N	Trip units-Thermal magnetic	16	T	T	T	T	T
			20	T	T	T	T	T
			25	T	T	T	T	T
			32	T	T	T	T	T
			40	T	T	T	T	T
			50	T	T	T	T	T
			63	T	T	T	T	T
			80	T	T	T	T	T
			100	T	T	T	T	T
	H		16	T	T	T	T	T
			20	T	T	T	T	T
			25	T	T	T	T	T
			32	T	T	T	T	T
			40	T	T	T	T	T
			50	T	T	T	T	T
			63	T	T	T	T	T
			80	T	T	T	T	T
			100	T	T	T	T	T
	L		16	T	T	T	T	T
			20	T	T	T	T	T
			25	T	T	T	T	T
			32	T	T	T	T	T
			40	T	T	T	T	T
			50	T	T	T	T	T
			63	T	T	T	T	T
			80	T	T	T	T	T
			100	T	T	T	T	T
TD160	N		100	T	T	T	T	T
			125	T	T	T	T	T
			160	T	T	T	T	T
	H		100	T	T	T	T	T
			125	T	T	T	T	T
			160	T	T	T	T	T
	L		100	T	T	T	T	T
			125	T	T	T	T	T
			160	T	T	T	T	T

Protective coordination
Protection discrimination table, Discrimination

Complementary technical information

Main: Susol 1000/1250/1600 **Branch: Susol TS 100/160**

Branch breaker		Main breaker Rating (A)		TS1000L		TS1000N/H		TS1250N/H	TS1600N/H
				Trip units-Electronic(Instant OFF)					
				800	1000	800	1000	1250	1600
TD100	N	Trip units-Thermal magnetic	16	T	T	T	T	T	T
			20	T	T	T	T	T	T
			25	T	T	T	T	T	T
			32	T	T	T	T	T	T
			40	T	T	T	T	T	T
			50	T	T	T	T	T	T
			63	T	T	T	T	T	T
			80	T	T	T	T	T	T
			100	T	T	T	T	T	T
	H		16	T	T	T	T	T	T
			20	T	T	T	T	T	T
			25	T	T	T	T	T	T
			32	T	T	T	T	T	T
			40	T	T	T	T	T	T
			50	T	T	T	T	T	T
			63	T	T	T	T	T	T
			80	T	T	T	T	T	T
			100	T	T	T	T	T	T
	L		16	T	T	T	T	T	T
			20	T	T	T	T	T	T
			25	T	T	T	T	T	T
			32	T	T	T	T	T	T
			40	T	T	T	T	T	T
			50	T	T	T	T	T	T
			63	T	T	T	T	T	T
			80	T	T	T	T	T	T
			100	T	T	T	T	T	T
TD160	N		100	T	T	T	T	T	T
			125	T	T	T	T	T	T
			160	T	T	T	T	T	T
	H		100	T	T	T	T	T	T
			125	T	T	T	T	T	T
			160	T	T	T	T	T	T
	L		100	T	T	T	T	T	T
			125	T	T	T	T	T	T
			160	T	T	T	T	T	T

Protective coordination
Protection discrimination table, Discrimination

Complementary technical information

Main: Susol TS 100/160/250(Electronic) **Branch: Susol TS 100/160/250**

Branch breaker		Main breaker Rating (A)	TS100N/H/L					TS160N/H/L			TS250N/H/L			
			Trip units-Thermal magnetic/Electronic											
			40	50	63	80	100	100	125	160	125	160	200	250
TS100	N	40				0.63	0.8	2	2	2	2	2.6	4	5
		50				0.63	0.8	2	2	2	2	2.6	4	5
		63					0.8	2	2	2	2	2.6	4	5
		80							1.25	2	2	2.6	4	5
		100							1	1.6	1	2.6	4	5
	H	40				0.63	0.8	2	2	2	2	2.6	4	5
		50				0.63	0.8	2	2	2	2	2.6	4	5
		63					0.8	2	2	2	2	2.6	4	5
		80							1.25	2	2	2.6	4	5
		100							1	1.6	1	2.6	4	5
	L	40				0.63	0.8	2	2	2	2	2.6	4	5
		50				0.63	0.8	2	2	2	2	2.6	4	5
		63					0.8	2	2	2	2	2.6	4	5
		80							1.25	2	2	2.6	4	5
		100							1	1.6	1	2.6	4	5
TS160	N	100								1.6	1	2.6	4	5
		125								1.25		1.25	4	5
		160												5
	H	100								1.6	1	2.6	4	5
		125								1.25		1.25	4	5
		160												5
	L	100								1.6	1	2.6	4	5
		125								1.25		1.25	4	5
		160												5
TS250	N	125											1.25	2.5
		160												2.5
		200												
		250												
	H	125											1.25	2.5
		160												2.5
		200												
		250												
	L	125											1.25	2.5
		160												2.5
		200												
		250												

Protective coordination
Protection discrimination table, Discrimination

Complementary technical information

Main: Susol TS 400/630/800(Electronic) **Branch: Susol TS 100/160/250**

Branch breaker		Main breaker Rating (A)		TS400N/H/L		TS630N/H/L		TS800N/H/L
				Trip units-Thermal magnetic/Electronic				
				300	400	500	630	800
TS100	N	Trip units-Thermal magnetic	40	T	T	T	T	T
			50	T	T	T	T	T
			63	T	T	T	T	T
			80	T	T	T	T	T
			100	T	T	T	T	T
	H		40	T	T	T	T	T
			50	T	T	T	T	T
			63	T	T	T	T	T
			80	T	T	T	T	T
			100	T	T	T	T	T
	L		40	T	T	T	T	T
			50	T	T	T	T	T
			63	T	T	T	T	T
			80	T	T	T	T	T
			100	T	T	T	T	T
TS160	N		100	T	T	T	T	T
			125	T	T	T	T	T
			160	T	T	T	T	T
	H		100	T	T	T	T	T
			125	T	T	T	T	T
			160	T	T	T	T	T
	L		100	T	T	T	T	T
			125	T	T	T	T	T
			160		T	T	T	T
TS250	N		125	5	5	T	T	T
			160		5	T	T	T
			200			T	T	T
			250				T	T
	H		125	5	5	T	T	T
			160		5	T	T	T
			200			T	T	T
			250				T	T
	L		125	5	5	T	T	T
			160		5	T	T	T
			200			T	T	T
			250				T	T

Protective coordination
Protection discrimination table, Discrimination

Complementary technical information

Main: TS1000/1250/1600 **Branch: TS100/160/250**

Branch breaker		Main breaker Rating (A)		TS1000L		TS1000N/H		TS1250N/H	TS1600N/H
				Trip units-Electronic(Instant OFF)					
				800	1000	800	1000	1250	1600
TS100	N	Trip units-Thermal magnetic	40	T	T	T	T	T	T
			50	T	T	T	T	T	T
			63	T	T	T	T	T	T
			80	T	T	T	T	T	T
			100	T	T	T	T	T	T
	H		40	T	T	T	T	T	T
			50	T	T	T	T	T	T
			63	T	T	T	T	T	T
			80	T	T	T	T	T	T
			100	T	T	T	T	T	T
	L		40	T	T	T	T	T	T
			50	T	T	T	T	T	T
			63	T	T	T	T	T	T
			80	T	T	T	T	T	T
			100	T	T	T	T	T	T
TS160	N		100	T	T	T	T	T	T
			125	T	T	T	T	T	T
			160	T	T	T	T	T	T
	H		100	T	T	T	T	T	T
			125	T	T	T	T	T	T
			160	T	T	T	T	T	T
	L		100	T	T	T	T	T	T
			125	T	T	T	T	T	T
			160	T	T	T	T	T	T
TS250	N		125	T	T	T	T	T	T
			160	T	T	T	T	T	T
			200	T	T	T	T	T	T
			250	T	T	T	T	T	T
	H		125	T	T	T	T	T	T
			160	T	T	T	T	T	T
			200	T	T	T	T	T	T
			250	T	T	T	T	T	T
	L		125	T	T	T	T	T	T
			160	T	T	T	T	T	T
			200	T	T	T	T	T	T
			250	T	T	T	T	T	T

Protective coordination
Protection discrimination table, Discrimination

Complementary technical information

Main: Susol TS 400/630/800(Electronic) **Branch: Susol TS 400/630/800**

Branch breaker		Main breaker Rating (A)	TS400N/H/L		TS630N/H/L		TS800N/H/L
			Trip units-Thermal magnetic/Electronic				
			300	400	500	630	800
TS400	N	300			8	8	T
		400				8	10
	H	300			8	8	T
		400				8	10
	L	300			8	8	T
		400				8	10
TS630	N	500				8	10
		630					10
	H	500				8	10
		630					10
	L	500				8	10
		630					10
TS800	N	800					
	H	800					
	L	800					

Trip units-Thermal magnetic

Complementary technical information

Main: Susol TS 1000/1250/1600 **Branch: Susol TS 400/630/800/1000/630/800(Electronic)**

Branch breaker		Main breaker Rating (A)	TS1000L		TS1000N/H		TS1250N/H	TS1600N/H
			Trip units-Electronic(Instant OFF)					
			800	1000	800	1000	1250	1600
TS400	N	300	18	18	T	T	T	T
		400	18	18	T	T	T	T
	H	300	18	18	T	T	T	T
		400	18	18	T	T	T	T
	L	300	30	30	T	T	T	T
		400	30	30	T	T	T	T
TS630	N	500	12	12	T	T	T	T
		630		12		T	T	T
	H	500	12	12	T	T	T	T
		630		12		T	T	T
	L	500	12	12	T	T	T	T
		630		12		T	T	T
TS800	N	800					T	T
	H	800					T	T
	L	800					T	T
TS1000	N	800					25	25
		1000						25
	H	800					25	25
		1000						25
	L	800					50	50
		1000						50

Trip units-Thermal magnetic (TM)

Trip units-Electronic

Protective coordination
Motor protection discrimination table

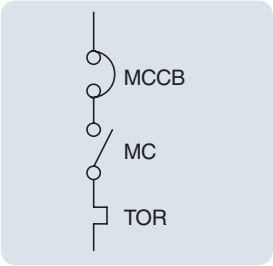
Complementary technical information

Main: Susol MCCB **Branch: Susol MCCB**

Branch breaker	Main breaker		TD100N/H/L									
	Trip unit		Trip units-Thermal magnetic									
		Rating (A)	16	20	25	32	40	50	63	80	100	
TD100N/H/L	FMU	16							5	6.4	8	
		20								6.4	8	
		25								6.4	8	
		32									8	
		40										
		50										
		63										
		80										
		100										
TD160N/H/L	FMU	100										
		125										
		160										
TS100N/H/L	MTU	100										
TS160N/H/L	MTU	150										
TS250N/H/L	MTU	220										
TS400N/H/L	MTU	320										
TS630N/H/L	MTU	500										
TS100N/H/L	ETS	40										
		80										
		100										
TS160N/H/L	ETS	150										
TS250N/H/L	ETS	220										
TS400N/H/L	ETS	320										

	TD160N/H/L			TS250N/H/L		TS100N/H/L		TS160N/H/L TS250N/H/L			TS400N/H/L TS630N/H/L		TS800N/H/L	
	FMU			ATU		ETS		ETS			ETS/ETM		ETS/ETM	
	100	125	160	200	250	40	80	80	160	250	400	630	630	800
	12.5	12.5	12.5	20	25		1	0.9	1.75	36	T	T	T	T
	12.5	12.5	12.5	20	25		1	0.9	1.75	36	T	T	T	T
	12.5	12.5	12.5	20	25		1	0.9	1.75	36	T	T	T	T
	12.5	12.5	12.5	20	25				1.75	36	T	T	T	T
		12.5	12.5	20	25				1.75	36	T	T	T	T
			12.5	20	25				1.75	36	T	T	T	T
				20	25					36	T	T	T	T
					25					36	T	T	T	T
											T	T	T	T
											T	T	T	T
												T	T	T
												T	T	T
											T	T	T	T
												T	T	T
												T	T	T
		12.5	12.5	36	36				1.75	3.6	T	T	T	T
					36					3.6	T	T	T	T
											T	T	T	T
												T	T	T
												T	T	T

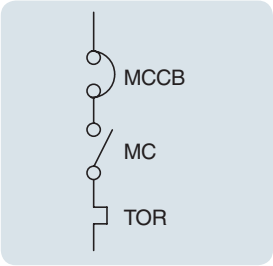
Protective coordination
Type 2 Coordination according to IEC60947-4-1



Performance: Ue=200/240V			
MCCB	N	H	L
TD100	85kA	100kA	200kA
TS100	100kA	120kA	200kA

Motor		MCCB		Contactor	Thermal overload relay	
kW	A	Type	Rating Ir (A)	Type	Type	Setting range (A)
0.37	1.8	TD100	16	MC-9	MT-32	1.6-2.5
0.55	2.75	TD100	16	MC-32	MT-32	2.5-4
0.75	3.5	TD100	16	MC-32	MT-32	2.5-4
1.1	4.4	TD100	16	MC-40	MT-63	4-6
1.5	6.1	TD100	16	MC-40	MT-63	5-8
2.2	8.7	TD100	16	MC-40	MT-63	9-13
3	11.5	TD100	16	MC-40	MT-63	9-13
3.7	13.5	TD100	16	MC-40	MT-63	12-18
4	14.5	TD100	16	MC-40	MT-63	12-18
5.5	20	TD100	20	MC-40	MT-63	16-22
7.5	27	TD100	32	MC-40	MT-63	24-36
9	32	TD100	32	MC-85	MT-95	28-40
10	35	TD100	40	MC-85	MT-95	28-40
11	39	TD100	40	MC-85	MT-95	34-50
15	52	TD100	63	MC-85	MT-95	45-65
18.5	64	TD100 TS100	80	MC-85	MT-95	54-75
22	75	TD100 TS100	80	MC-85	MT-95	63-85
25	85	TD100 TS100	100	MC-85	MT-95	70-95

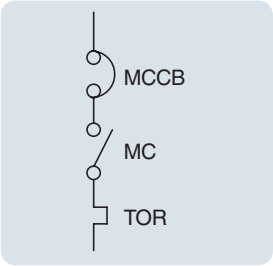
Protective coordination
Type 2 Coordination according to IEC60947-4-1



Performance: Ue=380/415V			
MCCB	N	H	L
TD100	50kA	85kA	150kA
TS100	50kA	85kA	150kA

Motor		MCCB		Contactor	Thermal overload relay	
kW	A	Type	Rating Ir (A)	Type	Type	Setting range (A)
0.37	1.03	TD100	16	MC-9	MT-32	1-1.6
0.55	1.6	TD100	16	MC-9	MT-32	1-1.6
0.75	2	TD100	16	MC-9	MT-32	1.6-2.5
1.1	2.6	TD100	16	MC-32	MT-32	2.5-4
1.5	3.5	TD100	16	MC-32	MT-32	2.5-4
2.2	5	TD100	16	MC-40	MT-63	4-6
3	6.6	TD100	16	MC-40	MT-63	5-8
3.7	7.7	TD100	16	MC-40	MT-63	6-9
4	8.5	TD100	16	MC-40	MT-63	7-10
5.5	11.5	TD100	16	MC-40	MT-63	9-13
7.5	15.5	TD100	16	MC-40	MT-63	12-18
9	18.5	TD100	20	MC-40	MT-63	16-22
10	20	TD100	20	MC-40	MT-63	16-22
11	22	TD100	25	MC-40	MT-63	16-22
15	30	TD100	32	MC-85	MT-95	24-36
18.5	37	TD100 TS100	40	MC-85	MT-95	28-40
22	44	TD100 TS100	50	MC-85	MT-95	34-50
25	52	TD100 TS100	63	MC-85	MT-95	45-65
30	60	TD100 TS100	63	MC-85	MT-95	45-65
33	68	TD100 TS100	80	MC-85	MT-95	54-75
37	72	TD100 TS100	80	MC-85	MT-95	63-85
40	79	TD100 TS100	80	MC-85	MT-95	63-85
45	85	TD100 TS100	100	MC-85	MT-95	70-95

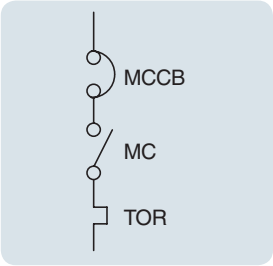
Protective coordination
Type 2 Coordination according to IEC60947-4-1



Performance: Ue=440V			
MCCB	N	H	L
TD100	42kA	72kA	130kA
TS100	42kA	72kA	130kA

Motor		MCCB		Contactor	Thermal overload relay	
kW	A	Type	Rating Ir (A)	Type	Type	Setting range (A)
0.37	0.99	TD100	16	MC-9	MT-32	0.63-1
0.55	1.36	TD100	16	MC-9	MT-32	1-1.6
0.75	1.68	TD100	16	MC-9	MT-32	1.6-2.5
1.1	2.37	TD100	16	MC-9	MT-32	1.6-2.5
1.5	3.06	TD100	16	MC-18	MT-32	2.5-4
2.2	4.42	TD100	16	MC-25	MT-32	4-6
3	5.57	TD100	16	MC-25	MT-32	4-6
3.7	7.1	TD100	16	MC-32	MT-32	5-8
4	7.9	TD100	16	MC-32	MT-32	6-9
5.5	10.4	TD100	20	MC-32	MT-32	9-13
7.5	13.7	TD100	20	MC-32	MT-32	12-18
9	16.9	TD100	20	MC-40	MT-63	12-18
11	20.1	TD100	25	MC-40	MT-63	16-22
15	26.5	TD100	32	MC-40	MT-63	24-36
18.5	32.8	TD100 TS100	40	MC-50	MT-63	28-40
22	39	TD100 TS100	40	MC-50	MT-63	34-50
25	45.3	TD100 TS100	50	MC-50	MT-63	34-50
30	51.5	TD100 TS100	63	MC-65	MT-95	45-65
33	58	TD100 TS100	63	MC-65	MT-95	45-65
37	64	TD100 TS100	80	MC-65	MT-95	54-75
40	67	TD100 TS100	80	MC-85	MT-95	54-75
45	76	TD100 TS100	100	MC-85	MT-95	63-85

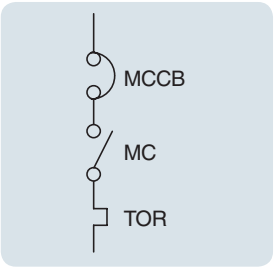
Protective coordination
Type 2 Coordination according to IEC60947-4-1



Performance: Ue=480/500V			
MCCB	N	H	L
TD100	30kA	50kA	65kA
TS100	42kA	65kA	85kA

Motor		MCCB		Contactor	Thermal overload relay	
kW	A	Type	Rating Ir (A)	Type	Type	Setting range (A)
0.37	1	TD100	16	MC-9	MT-32	0.63-1
0.55	1.21	TD100	16	MC-9	MT-32	1-1.6
0.75	1.5	TD100	16	MC-9	MT-32	1-1.6
1.1	2	TD100	16	MC-9	MT-32	1.6-2.5
1.5	2.6	TD100	16	MC-32	MT-32	2.5-4
2.2	3.8	TD100	16	MC-32	MT-32	2.5-4
3	5	TD100	16	MC-40	MT-63	4-6
3.7	5.9	TD100	16	MC-40	MT-63	5-8
4	6.5	TD100	16	MC-40	MT-63	5-8
5.5	9	TD100	16	MC-40	MT-63	7-10
7.5	12	TD100	16	MC-40	MT-63	9-13
9	13.9	TD100	16	MC-40	MT-63	12-18
11	15	TD100	16	MC-85	MT-95	12-18
15	18.4	TD100	20	MC-85	MT-95	16-22
18.5	23	TD100	25	MC-85	MT-95	18-25
22	28.5	TD100	32	MC-85	MT-95	24-36
25	33	TD100 TS100	40	MC-85	MT-95	28-40
30	39.4	TD100 TS100	40	MC-85	MT-95	34-50
33	45	TD100 TS100	50	MC-85	MT-95	34-50
37	50	TD100 TS100	50	MC-85	MT-95	45-65
40	55	TD100 TS100	63	MC-85	MT-95	45-65
45	60	TD100 TS100	63	MC-85	MT-95	54-75

Protective coordination
Type 2 Coordination according to IEC60947-4-1



Performance: Ue=660/690V			
MCCB	N	H	L
TD100	5kA	8kA	10kA
TS100	10kA	15kA	20kA

Motor		MCCB		Contactor	Thermal overload relay	
kW	A	Type	Rating Ir (A)	Type	Type	Setting range (A)
0.37	0.6	TD100	16	MC-9	MT-32	0.4~0.63
0.55	0.9	TD100	16	MC-9	MT-32	0.63-1
0.75	1.1	TD100	16	MC-9	MT-32	1-1.6
1.1	1.5	TD100	16	MC-9	MT-32	1-1.6
1.5	2	TD100	16	MC-32	MT-32	1.6-2.5
2.2	2.8	TD100	16	MC-32	MT-32	2.5-4
3	3.8	TD100	16	MC-32	MT-32	2.5-4
3.7	4.4	TD100	16	MC-40	MT-63	4-6
4	4.9	TD100	16	MC-40	MT-63	4-6
5.5	6.6	TD100	16	MC-40	MT-63	5-8
7.5	8.9	TD100	16	MC-40	MT-63	7-10
9	10.6	TD100	16	MC-85	MT-95	9-13
11	11.5	TD100	16	MC-85	MT-95	9-13
15	14	TD100	16	MC-85	MT-95	12-18
18.5	17.3	TD100	20	MC-85	MT-95	16-22
22	21.3	TD100	25	MC-85	MT-95	18-25
25	25.4	TD100	32	MC-85	MT-95	24-36
30	30.3	TD100	32	MC-85	MT-95	24-36
33	34.6	TD100 TS100	40	MC-85	MT-95	28-40
37	39	TD100 TS100	40	MC-85	MT-95	34-50
40	42	TD100 TS100	50	MC-85	MT-95	34-50
45	44	TD100 TS100	50	MC-85	MT-95	34-50

Protective coordination
Type 2 Coordination according to IEC60947-4-1]

440V - N type

Rated operational power		MCCB		Contactor	Thermal overload relays		Short circuit breaking capacity	
kW	Current[A] 440V	Type	Rating [A]	Type	Type	Setting range [A]	Ir[kA]	Iq[kA]
1.1	2.37	TD100N	16	MC-12b	MT-32	2.5~4	1	50
1.5	3.06	TD100N	16	MC-18b	MT-32	2.5~4	1	50
2.2	4.42	TD100N	16	MC-22b	MT-32	4~6	1	50
3	5.77	TD100N	16	MC-22b	MT-32	5~8	1	50
4	7.90	TD100N	16	MC-32a	MT-32	6~9	1	50
5.5	10.40	TD100N	16	MC-32a	MT-32	9~13	3	50
7.5	13.70	TD100N	20	MC-32a	MT-32	12~18	3	50
11	20.10	TD100N	32	MC-40a	MT-32	18~25	3	50
15	26.50	TD100N	40	MC-40a	MT-32	22~32	3	50
18.5	32.80	TS100N	40	MC-50a	MT-63	28~40	3	50
22	39.00	TS100N	50	MC-50a	MT-63	34~50	3	50
30	51.50	TS100N	63	MC-65a	MT-63	45~65	3	50
37	64.00	TS100N	80	MC-75a	MT-95	54~75	5	50
45	76.00	TS100N	100	MC-85a	MT-95	63~85	5	50
55	90.00	TS100N	100	MC-100a	MT-95	70~95	5	50
59	97.00	TS160N	100	MC-130a	MT-150	80~105	5	50
75	125	TS160N	160	MC-150a	MT-150	110~150	10	50
90	146	TS160N	160	MC-185a	MT-225	120~185	10	50
110	178	TS250N	200	MC-185a	MT-225	160~240	10	50
132	215	TS250N	250	MC-225a	MT-225	160~240	10	65
160	256	TS400N	300	MC-400a	MT-400	200~330	18	65
200	330	TS400N	400	MC-400a	MT-400	260~400	18	65
220	353	TS400N	400	MC-400a	MT-400	260~400	18	65
250	401	TS630N	500	MC-630a	MT-800	260~400	18	65
300	481	TS630N	500	MC-630a	MT-800	400~630	18	65

Protective coordination
Type 2 Coordination according to IEC60947-4-1]

440V - H type

Rated operational power		MCCB		Contactor	Thermal overload relays		Short circuit breaking capacity	
kW	Current[A] 440V	Type	Rating [A]	Type	Type	Setting range [A]	Ir[kA]	Iq[kA]
1.1	2.37	TD100H	16	MC-12b	MT-32	2.5~4	1	50
1.5	3.06	TD100H	16	MC-18b	MT-32	2.5~4	1	50
2.2	4.42	TD100H	16	MC-22b	MT-32	4~6	1	50
3	5.77	TD100H	16	MC-22b	MT-32	5~8	1	50
4	7.90	TD100H	16	MC-32a	MT-32	6~9	1	50
5.5	10.40	TD100H	16	MC-32a	MT-32	9~13	3	50
7.5	13.70	TD100H	20	MC-32a	MT-32	12~18	3	70
11	20.10	TD100H	32	MC-40a	MT-32	18~25	3	70
15	26.50	TD100H	40	MC-40a	MT-32	22~32	3	70
18.5	32.80	TS100H	40	MC-50a	MT-63	28~40	3	70
22	39.00	TS100H	50	MC-50a	MT-63	34~50	3	70
30	51.50	TS100H	63	MC-65a	MT-63	45~65	3	70
37	64.00	TS100H	80	MC-75a	MT-95	54~75	5	70
45	76.00	TS100H	100	MC-85a	MT-95	63~85	5	70
55	90.00	TS100H	100	MC-100a	MT-95	70~95	5	70
59	97.00	TS160H	100	MC-130a	MT-150	80~105	5	70
75	125	TS160H	160	MC-150a	MT-150	110~150	10	70
90	146	TS160H	160	MC-185a	MT-225	120~185	10	70
110	178	TS250H	200	MC-185a	MT-225	160~240	10	70
132	215	TS250H	250	MC-225a	MT-225	160~240	10	70
160	256	TS400H	300	MC-400a	MT-400	200~330	18	85
200	330	TS400H	400	MC-400a	MT-400	260~400	18	85
220	353	TS400H	400	MC-400a	MT-400	260~400	18	85
250	401	TS630H	500	MC-630a	MT-800	260~400	18	85
300	481	TS630H	500	MC-630a	MT-800	400~630	18	100

Protective coordination
Type 2 Coordination according to IEC60947-4-1]

440V - L type

Rated operational power		MCCB		Contactor	Thermal overload relays		Short circuit breaking capacity	
kW	Current[A] 440V	Type	Rating [A]	Type	Type	Setting range [A]	Ir[kA]	Iq[kA]
1.1	2.37	TD100L	16	MC-12b	MT-32	2.5~4	1	50
1.5	3.06	TD100L	16	MC-18b	MT-32	2.5~4	1	50
2.2	4.42	TD100L	16	MC-22b	MT-32	4~6	1	50
3	5.77	TD100L	16	MC-22b	MT-32	5~8	1	50
4	7.90	TD100L	16	MC-32a	MT-32	6~9	1	50
5.5	10.40	TD100L	16	MC-32a	MT-32	9~13	3	50
7.5	13.70	TD100L	20	MC-32a	MT-32	12~18	3	100
11	20.10	TD100L	32	MC-40a	MT-32	18~25	3	100
15	26.50	TD100L	40	MC-40a	MT-32	22~32	3	100
18.5	32.80	TS100L	40	MC-50a	MT-63	28~40	3	130
22	39.00	TS100L	50	MC-50a	MT-63	34~50	3	130
30	51.50	TS100L	63	MC-65a	MT-63	45~65	3	130
37	64.00	TS100L	80	MC-75a	MT-95	54~75	5	130
45	76.00	TS100L	100	MC-85a	MT-95	63~85	5	130
55	90.00	TS100L	100	MC-100a	MT-95	70~95	5	130
59	97.00	TS160L	100	MC-130a	MT-150	80~105	5	130
75	125	TS160L	160	MC-150a	MT-150	110~150	10	130
90	146	TS160L	160	MC-185a	MT-225	120~185	10	130
110	178	TS250L	200	MC-185a	MT-225	160~240	10	130
132	215	TS250L	250	MC-225a	MT-225	160~240	10	130
160	256	TS400L	300	MC-400a	MT-400	200~330	18	130
200	330	TS400L	400	MC-400a	MT-400	260~400	18	130
220	353	TS400L	400	MC-400a	MT-400	260~400	18	130
250	401	TS630L	500	MC-630a	MT-800	260~400	18	130
300	481	TS630L	500	MC-630a	MT-800	400~630	18	130

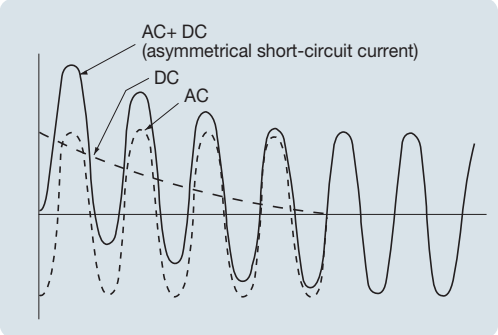
How to calculate short-circuit current value
Various short-circuit

The purpose of calculating short circuit values
- Selection of circuit breakers, fuse.
- Adjusting metering devices
- Consideration for mechanical resistance
- Consideration for thermal resistance

Various value of short-circuit current should be applied to the tests for upper factors.
Symmetrical current for AC and asymmetrical current for DC are used for classifying short circuit current.
Their differences should be essentially considered in the basic step of making network plan.

Symmetrical short-circuit current real value

Short-circuit current is composed of AC and DC as it shows on <Fig.1>. The short-circuit which indicates the real value of AC is called as symmetrical short-current real value, I (rms)sym. This current is the essential factor of selecting MCCB, ACB, fuse.



<Fig.1> Composition of short-circuit current

Maximum asymmetrical short-circuit current real value: I (rms)asym

The short-circuit which indicates the real value of DC is called as asymmetrical short-circuit current real value.
And this current value is changeable upon the short-circuit closing phase.
This current value is treated for checking the thermal resistant strength of wrings, CT and etc.
With symmetrical short-circuit current real value and short-circuit power factor, we can achieve the value, α from <Fig.5>.
and maximum asymmetrical short-circuit current real value is calculated with this formula.

$$I\ (rms)asym = \alpha I\ (rms)sym$$

3-phases average asymmetrical short-circuit current real value: I (rms)ave

Each phase is different in its input current value in 3 phases circuit. So that AC rate for 3 phases is different. This value is the average of asymmetrical short-circuit current of 3 phases.
And with symmetrical short-circuit current real value and short-circuit power factor, we can achieve the value, β, and 3-phases average asymmetrical short circuit current real value is calculated with this formula.

$$I\ (rms)ave = \beta\ I\ (rms)sym$$

Maximum asymmetrical short-circuit current instantaneous value: Imax

Each phase has different instantaneous current value. And when asymmetrical short-circuit current shows its maximum instantaneous value, the current value is called as maximum asymmetrical short-circuit current instantaneous value. This current is to test the mechanical strength of serial equipments.
And with symmetrical short-circuit current real value and short-circuit power factor, we can achieve the value, γ and maximum asymmetrical short-circuit current instantaneous value is calculated with this formula.

$$Imax = \gamma I\ (rms)sym$$

Network impedance for calculating short-circuit current value

Bellows should be considered for the calculation as the impedance components affecting circuit to trouble spot from short-circuit power.

a. Primary part impedance of incoming transformer It's calculated from the short-circuit current data which is provided by power supplier. Calculated value can be regarded as reactance.

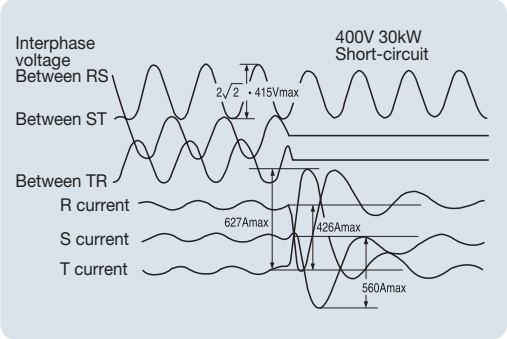
b. Impedance of incoming transformer Its amount is upon the capacity of transformer and primary voltage. Generally this impedance can be regarded as reactance and refer to <Table.4>, <Table.5>.

How to calculate short-circuit current value
Various short-circuit

c. Reactance of motor
Motor works as generator and supply short circuit current in the condition of an accident circuit such as <Fig.2>.
Generation factor of firm motor should be considered in a low voltage circuit where a circuit breaker operates quickly and in a high voltage circuit for the selection of fuse. Reactance of motor can be regarded in the range of 25% normally.

d. Distribution impedance
Impedance of cable and busduct do control short-circuit remarkably in low voltage network. Refer to <Table.5>, <Table.6>.

e. Others
MCCB, ACB CT are equipments for the network of low voltage.
The impedance of these equipment which is calculated from short-circuit current value should be considered.
Generally, the impedance of those equipment is that of rated current (normal condition), if operators apply that impedance value, bigger reactance value may be applied to calculated short-circuit current value.



<Fig.2> Short-circuit of motor

How to calculate short-circuit current value With percent impedance

Ohm formula (Ω), percent impedance formula (%), unit formula (per unit) can be applied to calculate short-circuit current value.

Ohm formula [Ω]

Short-circuit current value is calculated by converting into ohm value [Ω]

Percent impedance formula (%) Each impedance is converted into the impedance of base value and base voltage.

And the required amount for electric demand should be shown as percent unit.
And apply that value in ohm formula.

Unit formula

The base value equals 1.0. and all value of network shows in the way of decimal system. Applying any of upper calculation formulas to achieve short-circuit current value, it shows equal value. To select a certain formula for doing it, operator can select one of those formula which is proper to oneself. Below is percent impedance formula.

Finding base value

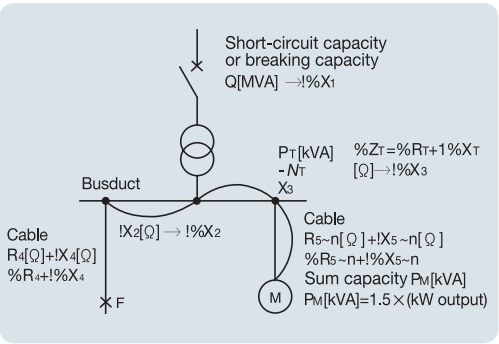
The rated current of transformer shall be the base value.

Base capacity $P_B = P_T$ [kVA]

Base voltage $V_B = V_T$ [V]

Base current $I_B = I_T = \frac{P_T}{\sqrt{3}V_T} \times 10^3$ [A]

Base impedance $Z_B = \frac{V_B^2}{P_B \times 10^3} = \frac{V_T^2}{P_T \times 10^3}$ [Ω]



<Fig.3> Base value

Converting impedance into base value

a. Primary part impedance of transformer: $\%X_1$

$$\%X_1 = \frac{P_B}{Q \times 10^3} \times 100\ [\%]$$

Q: Primary part short-circuit capacity

b. Impedance of transformer: %ZT
It generally indicates as percent impedance.
If base capacity is equal to transformer capacity, %ZT can be used as it is. When base capacity is not equal to transformer capacity, convert values by this formula.

$$\frac{P_T}{\%Z_T} = \frac{P_B}{\%Z_B}$$

%: value converted by base value

1phase transformer should converted into the value of 3 phase transformer, And the percent impedance is equal to $\frac{\sqrt{3}}{2} \times$ calculated urgent value.

c. Reactance of motor: %Xm
Transformer capacity shows the value in kW, so it is converted into unit, kVA.
(kVA value) ≒1.5×(Output of motor, kW)
%Xm= 25% Converting it from base capacity

$$\frac{P_M}{\%Xm} = \frac{P_B}{\%Xm}$$

(Converting formula for different capacity)

d. Impedance of busduct, cable
Cable: Area of cross-section & length
Busduct: Rated current

In <Fig.5>, <Fig.6>
Z_C = (Ω per each unit length)×(length) [Ω]
Convert this value into % value.

$$\%Z_C = \frac{Z_C}{Z_B}$$

(% converting formula)

2cables in same dimension, it's recommendable to divide the length by 2.

How to calculate short-circuit current value

Preparing a impedance map

Prepare impedance map according to the impedance value from (2). Various electricity suppliers like source, motor have same electric potential in impedance map.
As you find it on <Fig.4> (a), extend it from the unlimited bus to fault point, draw impedance map.

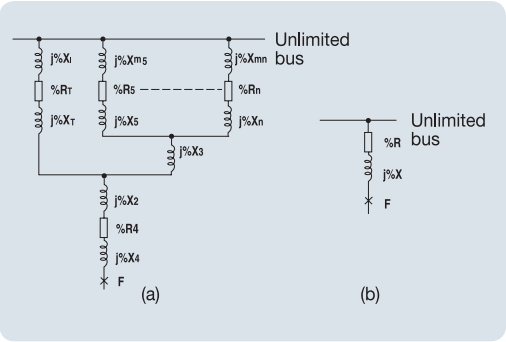
Calculating impedance

Calculate impedance as <Fig.4 (b)> in impedance map < Fig.4 (a)>

$\%Z = \%R + j\,\%X$

$\%Z = \sqrt{(\%R)^2 + (\%X)^2}$

Calculating symmetrical short-circuit current real value



<Fig.4> Base value

Calculating various short-circuit current value

IF (3 ø) = IF (rms)sym (3 ø)

$$= \frac{P_B \times 10^3}{\sqrt{3} V_B \cdot \%Z} \times 100$$

$$= \frac{I_B}{\%Z} \times 100\ [A]$$

Calculate various short-circuit current value with α, β, γ values from <Fig.5> like

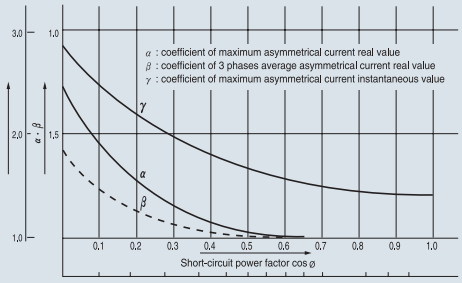
short-circuit power factor cos $\phi = \frac{\%R}{\%Z}$

3 phases average asymmetrical real value
I_F (rms)ave= βI_F (rms)sym
Maximum average asymmetrical real value
I_F (rms)asym= $\Omega\, I_F$ (rms)sym
Maximum asymmetrical instantaneous value
$I_F$max= γI_F (rms)sym

In case of 1 phase short-circuit

Current value from (5) multiplied by $\frac{\sqrt{3}}{2}$

Each short-circuit current value (1 ø) = $\frac{\sqrt{3}}{2}$ (3phases short-circuit current) $\times \alpha$ (or γ)



<Fig.5>

How to calculate short-circuit current value With a simple formula

For its special cases, calculating exact value should be needed, in the other hand, for the practical use, we recommend simple formula.

Finding a base value

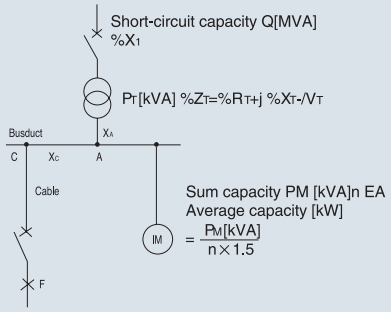
It shall be the rated current of transformer.

P_B= PT [kVA]

V_B= VT [V]

I_B= IT [A]

$$Z_B = \frac{VT_B\,[\Omega]}{PT \times 103}$$



<Fig.6> Base value

Short-circuit current from incoming circuit

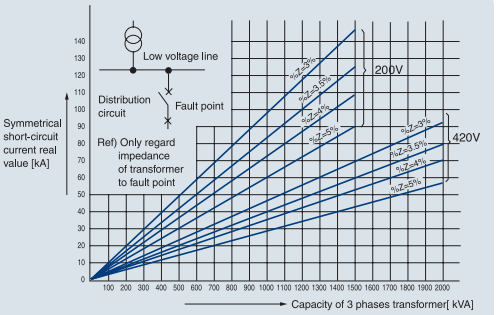
Disregard the impedance value of primary part of transformer. Calculate short-circuit current value according to <Fig.7>.
(If the impedance value of primary part of transformer is considered, calculate the current value as below formula)

$$I_A(R) = \frac{I_B}{\sqrt{(\%R_T)^2 + (\%X_1 + \%X_T)^2}} \times 100\ [A]$$

$$\%X_1 = \frac{P_B}{Q \times 10^3} \times 100\ [\%]$$

If the value of $\%R_T$ is not clear, $\%Z_T \fallingdotseq \%T_T$

$$I_A(R) = \frac{I_B}{\%X_1 + \%X_T} \times 100\ [A]$$



Ref 1) Calculation in the random voltage E Voltage line which is mostly close to E shall be selected to calculate it .
i.e. in case of 220V, (200V line value)÷200/220

Ref 2) Calculation for a certain impedance Zt (%) Impedance line which is mostly close to Zt (%) shall be selected to calculate it.
i.e. 420V, Zt= 4.5%
%Z=4% Line value (or 5% line) × 4 (or 5)/4.5

Ref 3) When the value is out of lines or over 200VA or below 100kA, multiply 10 times to the calculated values.

<Fig.7> Transformer capacity and short-circuit current

Short-circuit current to motor

I_A (M)= 4×Σ (Rated current of motor)

Symmetrical short-circuit current at point A

I_A= I_A (R)+I_A (M)

Decreasing coefficient caused by busduct

Obtaining the value of $\frac{\ell \cdot I_A}{10VT}$

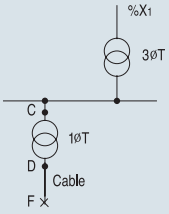
Calculate decreasing coefficient from <Fig.10>

Decreasing short-circuit current by reactance

When there's 1phase transformer in a certain circuit, calculate it in the base of reactance.
Regarding the reactance as pre-impedance at source part at point of <Fig.8>,

$$X_C = \frac{E_B}{\sqrt{3}\, I_C}$$

Reactance C~D: X_D[Ω] (impedance of 1 ø T)



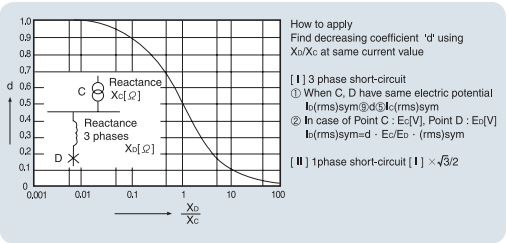
How to calculate short-circuit current value

Calculating the value of X_D/X_C and decreasing coefficient d from the reactance of <Fig.9>.
Current at point D $I_D = d \cdot I_C$

Impedance of 1 phase transformer $X_D = X(1\text{ø}) \frac{1}{2}$

a. Short-circuit current at E_C voltage base
I_D (rms)sym · 3ø = d · I_C (rms)sym · 3ø

b. Short-circuit current at E_D voltage base
I_D (rms)sym · 3ø = d · I_C (rms)sym · 3ø × E_C/E_D



<Fig.9> Decreasing coefficient of short-circuit current by reactance: d

Coefficient d for cables

Calculating the value of $\frac{\ell I_D}{10V_T}$

Decreasing coefficient b value is calculated from <Fig.13>. For insulator drawn wrings, we can find the value directly from <Fig.13>.

Calculating symmetrical short-circuit current real value

I_F (rms)sym= b×I_D[D]

Various short-circuit current

In case of having short-circuit current power factor, find α, β, γ from <Fig.5>, If not find 3 values from <Table.1>

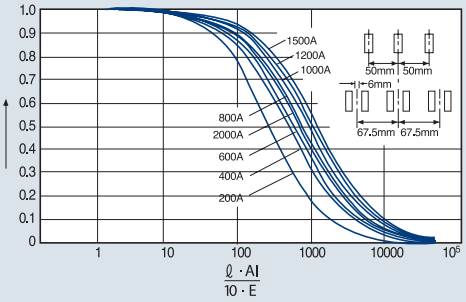
- 3 phases short-circuit asymmetrical current average value
  I_F (rms)ave= βI_F (rms)sym
- Maximum asymmetrical real value
  I_F (rms)ave= αI_F (rms)sym
- Maximum asymmetrical instantaneous value
  I_F (rms)ave= γI_F (rms)sym

<Table.2> α, β, γ values when short circuit power factor value is not definite.

Symmetrical short-circuit real value (A)	Variables		
	Maximum asymmetrical real value	3 phases short-circuit asymmetrical current average value	Maximum asymmetrical instantaneous value
2500	1.0	1.0	1.48
2501~5000	1.03	1.02	1.64
5001~1000	1.13	1.07	1.94
1001~15000	1.18	1.09	2.05
15001~25000	1.25	1.13	2.17
25000	1.33	1.17	2.29

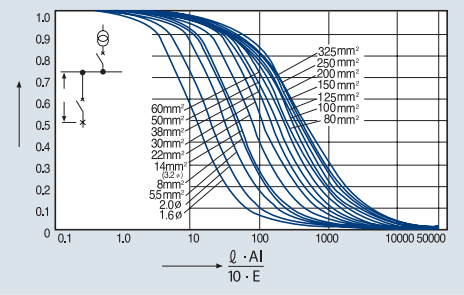
1 phase short-circuit

(Each current)= $\frac{\sqrt{3}}{2}$ ×3 phases short-circuit current ×γ (or α)

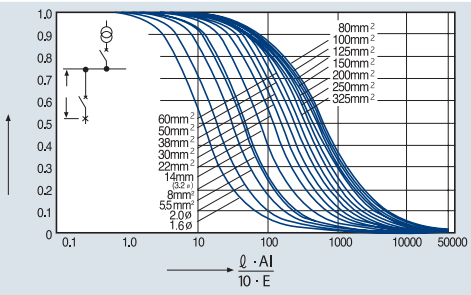


Busduct Ratings (A)	Material	General busduct			
		Size [mm] [Ω/m]	Resistance R [Ω/m]	Reactance X [Ω/m]	Impedance Z [Ω/m]
Cu	200	3×25	2.41×10^{-4}	1.312×10^{-4}	2.74×10^{-4}
	400	6×40	0.751×10^{-4}	1.02×10^{-4}	1.267×10^{-4}
	600	6×50	0.607×10^{-4}	0.91×10^{-4}	1.094×10^{-4}
	800	6×75	0.412×10^{-4}	0.72×10^{-4}	0.830×10^{-4}
	1000	6×100	0.315×10^{-4}	0.60×10^{-4}	0.678×10^{-4}
	1200	6×125	0.261×10^{-4}	0.516×10^{-4}	0.578×10^{-4}
	1500	6×150	0.221×10^{-4}	0.449×10^{-4}	0.500×10^{-4}
	2000	6×125×2	0.129×10^{-4}	0.79×10^{-4}	0.800×10^{-4}

<Fig.10> Decreasing coefficient of general busduct (Cu)



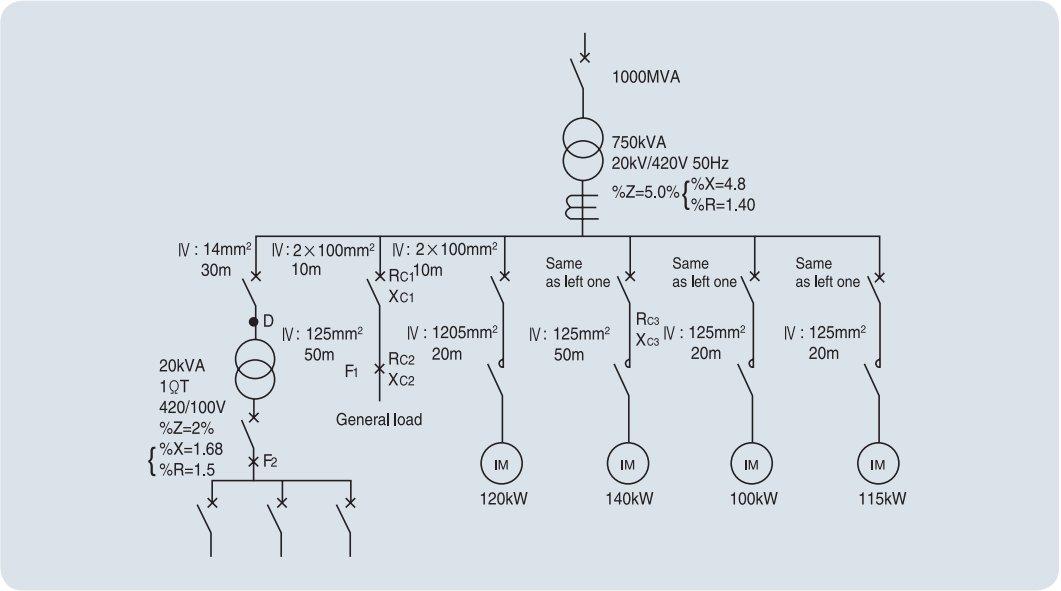
<Fig.11> Decreasing coefficient b in cable (600V Ⅳ)



<Fig.12> Decreasing coefficient b in cable (600V Ⅳ)

How to calculate short-circuit current value Calculation example

Calculation1) Short-circuit current value will be achieved by simple formula and percent impedance formula for <Fig.13>



<Fig.13>

Percent impedance formula

(1) Base value

$P_B = 750kVA \quad V_B = 420V$

$I_B = 1031A \quad Z_B = 0.237\,\Omega$

(2) Each impedance

a. Reactance at primary part of transformer

$$\%X_t = \frac{750}{1000\times10^3} \times 100 = 0.075\,[\%]$$

b. Impedance of transformer

$\%R_T = 1.4\%$

$\%X_T = 4.8\%$

c. 1 ø Tr impedance

$$\%R_{T1} = \frac{1.15\times750}{20}\times\frac{1}{2} = 21.6\,[\%]$$

$$\%X_{T1} = \frac{1.68\times750}{20}\times\frac{1}{2} = 31.5\,[\%]$$

d. Reactance of transformer

$$\%X_{m1} = \frac{750}{120\times1.5}\times25 = 104\,[\%]$$

$$\%X_{m2} = \frac{750}{140\times1.5}\times25 = 89\,[\%]$$

$$\%X_{m3} = \frac{750}{100\times1.5}\times25 = 125\,[\%]$$

$$\%X_{m4} = \frac{750}{115\times1.5}\times25 = 108.7\,[\%]$$

e. Impedance of cable

Converting impedance of whole metal tube

[2×100mm² 10m]

$$\%R_{C1} = \frac{0.00018\times10}{0.237}\times\frac{1}{2}\times100 = 0.38\,[\%]$$

$$\%X_{C1} = \frac{0.00013\times10}{0.237}\times\frac{1}{2}\times100 = 0.27\,[\%]$$

[125mm² 20m]

$$\%R_{C2} = \frac{0.00014\times20}{0.237}\times100 = 1.18\,[\%]$$

$$\%X_{C2} = \frac{0.00013\times20}{0.237}\times100 = 1.09\,[\%]$$

[250mm² 50m]

$$\%R_{C3} = \frac{0.00007\times50}{0.237}\times100 = 1.47\,[\%]$$

$$\%X_{C3} = \frac{0.00013\times50}{0.237}\times100 = 2.74\,[\%]$$

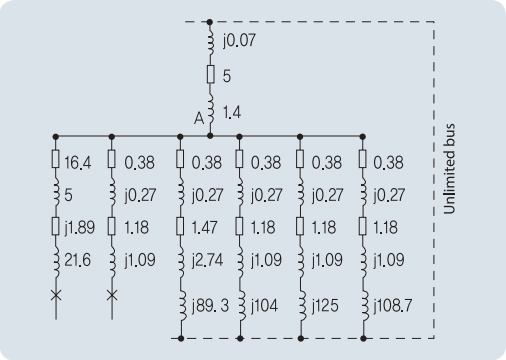
[14mm² 30m]

$$\%R_{C4} = \frac{0.00013\times30}{0.237}\times100 = 16.45\,[\%]$$

$$\%X_{C4} = \frac{0.00015\times30}{0.237}\times100 = 1.88\,[\%]$$

How to calculate short-circuit current value

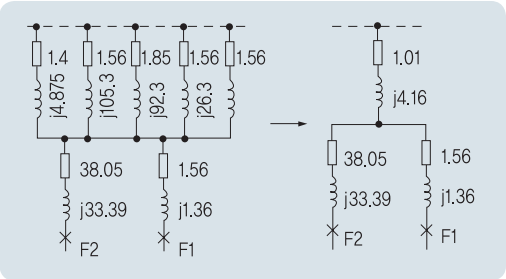
(3) Preparing a impedance map
Connect short-circuit supplier to the unlimited bus.



<Fig.14>

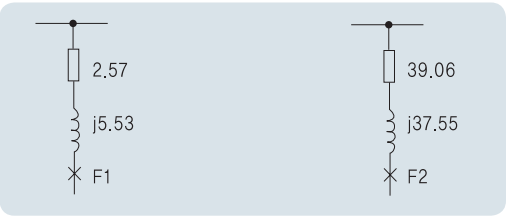
Calculating impedance

Calculate it in serial/parallel type formula



<Fig.15>

a. Fault point F_1 b. Fault point F_2



$\%Z_1 = \sqrt{(2.57)^2 + (5.53)^2} = 6.1[\%]$ $\%Z_2 = \sqrt{(39.06)^2 + (37.55)^2} = 54.2[\%]$

(5) Calculation of asymmetrical short-circuit current

a. Fault point F_1

$$I_{F1}\,(\text{rms})\text{sym} = \frac{1031}{6.1} \times 100 = 16900\ [\text{A}]$$

$$\cos \varnothing_1 = \frac{2.57}{6.1} = 0.422$$

b. Fault point F_2 (1 phase circuit)

$$I_{F2}\,(\text{rms})\text{sym} = \frac{1031}{54.2} \times 100 = 1902\ [\text{A}] \cdots \text{(at 100V)}$$

$$= \frac{1031}{54.2} \times 100 \times \frac{420}{100} = 7989\ [\text{A}] \cdots \text{(at 420V)}$$

I_{F2} (rms)sym is short-circuit current. Therefore, convert it into 1 phase short-circuit current.

$$I_{F2}\,(\text{rms})1\,\Omega\,\text{sym} = 7989 \times \frac{\sqrt{3}}{2} = 6919\ [\text{A}]$$

$$\cos \varnothing_2 = \frac{39.06}{54.2} = 0.72$$

(6) Various short-circuit current
Calculate α, β, γ from <Fig.5>.

a. Fault point F_1
$\cos \varnothing_1 = 0.422$
$\alpha = 1.05$ $\beta = 1.3$ $\gamma = 1.74$
I_{F1} (rms)ave= $1.03 \times 16900 = 17407$ [A]
I_{F1} (rms)asym= $1.05 \times 16900 = 17745$ [A]
I_{F1}max= $1.74 \times 16900 = 29406$ [A]

b. Fault point F_2
$\cos \varnothing_2 = 0.72$
$\alpha = 1.0$ $\beta = 1.48$
$I_{F2}1\,\varnothing$ (rms)asym= 1.0×6919 [A]
$I_{F2}1\,\varnothing$ max= $1.48 \times 6919 = 10240$ [A]

Simple calculation formula

(1) Base value
P_B = 750kVA V_B = 420V
I_B = 1031A Z_B = 0.237 Ω

(2) Short-circuit current of incoming circuit
Disregard the impedance of primary part of transformer
In <Fig.7> $I_{A(R)} = 20500$ A

(3) Short-circuit current of motor
Sum of motor capacity=
$(120+140+100+115) \times 1.5 = 713$ [kVA]

$$I_{A(M)} = \frac{713}{\sqrt{3} \times 420} \times 4 = 3920\ [\text{A}]$$

(4) Symmetrical short-circuit current at point A
I_A = 20500+3920= 24420 [A]

How to calculate short-circuit current value
Calculation example

(5) Decreasing short-circuit current for cable

a. At point F_1

• $2\times100mm^2$ 10m

$2\times100mm^2$ 10m= $100mm^2$ 5m

$$\frac{\ell\, I_A}{10E}=\frac{20\times24420}{10\times420}=29.1$$

Coefficient b= 0.935

Short-circuit current value at point C

Ic (rms)sym= $0.935\times24420=22850$ [A]

• $125mm^2$ 20m

$$\frac{\ell\, I_C}{10E}=\frac{20\times22850}{10\times420}=108.9$$

I_{F1} (rms) sym= $0.785\times244850=17940$ [A]

b. At point F_1

• $14mm^2$ 30m

$$\frac{\ell\, I_C}{10E}=\frac{30\times24420}{10\times420}=174.4$$

Coefficient b= 0.249

I_D (rms)3 ø sym= $0.24\times24420=6080$ [A]

• Decreasing by the reactance (1 ø Tr)dp

Convert the value of '%X of 1 ø Tr' to base capacity

$X_D=750\times2/20=75\%$

Impedance of primary part at 1 ø Tr

$$XA=\frac{I_B}{I_D}\times100=\frac{1031}{6080}\times100\ [\%]$$

Convert X_D to equivalent 3 phases, and

$$\frac{X_D/2}{X_A}=\frac{750\times2\times6080}{20\times2\times1031\times100}=2.21$$

Coefficient d of <Fig.9> d = 0.32

I_{F2} (rms)3 ø sym = $0.32\times6080=1945$ [A] (400V)

$= 0.32\times6080\times420/100$

$= 817$ [A] (100V)

$$\therefore I_{F2}\text{ (rms)}1\text{ ø sym}=8171\times\frac{\sqrt{3}}{2}=7076\text{ [A]}$$

(6) Various short-circuit current

Find α , β , γ from <Table.1>

a. At point F_1

α= 1.25 β = 1.13 γ = 2.17

IF1 (rms)ave= $1.13\times17940=20272$ [A]

IF1 (rms)asym= $1.25\times17940=22425$ [A]

IF1max= $2.17\times17940=38930$ [A]

b. At point F_2

α= 1.13 γ= 1.94

IF21 ø (rms)asym= $1.13\times7076=7945$ [A]

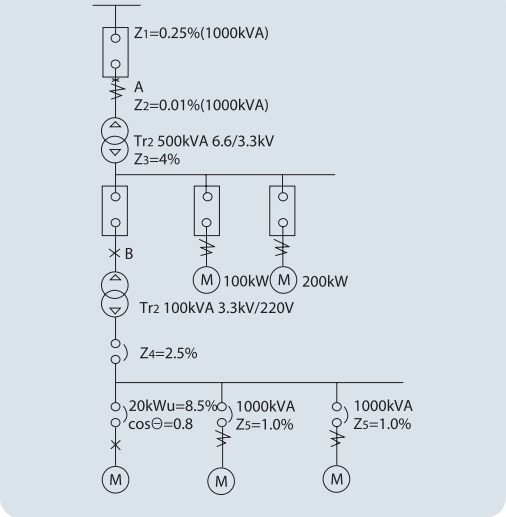
IF21 ø max= $1.94\times7076=13727$ [A]

<Table.2> Comparison of short-circuit

Fault point		F_1	F_2
Symmetrical short-circuit current real value	Percent impedance calculation value	16900A	6919A
	Simple formula calculation value	17940A	7076A
		106%	102%
3 phases average asymmetrical current real value	Percent impedance calculation value	17407A	-
	Simple formula calculation value	20272A	-
		116%	-
Maximum asymmetrical current real value	Percent impedance calculation value	17745A	6919A
	Simple formula calculation value	22425A	7995A
		126%	115%

How to calculate short-circuit current value

Short-circuit current value will be achieved by simple formula for <Fig.16>



<Fig.16>

(1) Calculate rated current at each point

① Rated current I_{nA} at point A

$$I_{nA}=\frac{500[kVA]\times1000}{\sqrt{3}\times6.6[kV]\times1000}=43.7[A]$$

② Rated current I_{nB} at point B

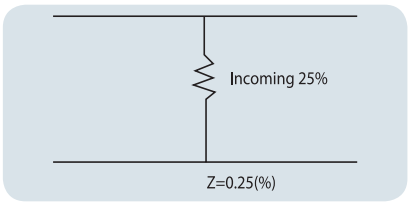
$$I_{nB}=\frac{100[kVA]\times1000}{\sqrt{3}\times3.3[kV]\times1000}=17.5[A]$$

$$I_{nC}=\frac{20[kW]\times1000}{\sqrt{3}\times220[V]\times0.85\times0.8}=77.2[A]$$

(2) Put 1000k VA for base capacity and calculate short-circuit current at each point.

① Short-circuit current I_{SA} at point A

a) Impedance Map



b) Short-circuit I_{SA}

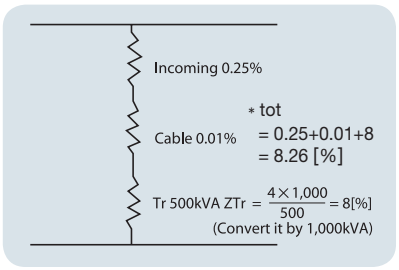
$$I_{SA}=\frac{1000\ kVA\times1000\times100}{\sqrt{3}\times6.6\ kV\times1000\times0.25\%}=34990[A]$$

* Breaking capacity of breaker [MVA]
MVA= 3 short-circuit current[kA] line to line voltage[kV]

② Short-circuit current at point B: I_{SB}

a) Impedance Map

* Serial sum of impedance
Ztot= 0.25+0.01+8= 8.26 [%]



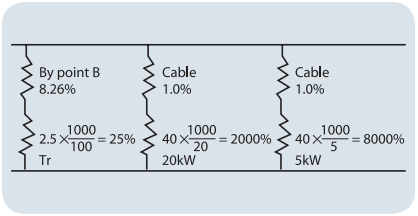
b) Short-circuit current I_{SC}

$$I_{SB}=\frac{1000[kVA]\times1000\times100}{\sqrt{3}\times3.3[kV]\times1000\times8.26}=2118[A]$$

* Breaking capacity of breaker [MVA]
MVA= $\sqrt{3}$ short-circuit current [kA]
line to line voltage [kV]

③ Short-circuit current at point C: I_{SC}

a) Impedance Map



* Parallel sum of impedance

$$Z=\frac{1}{\frac{1}{33.26}+\frac{1}{2001}+\frac{1}{8001}}=32.58[\%]$$

b) Short-circuit current I_{SC}

$$I_{SC}=\frac{1000[kVA]\times1000\times100}{\sqrt{3}\times220[V]\times32.58[\%]}=8055[A]$$

Calculation formula

Rated current In = $\frac{\text{Transformer capacity}}{\sqrt{3}\times\text{Rated voltage}}$

Short-circuit current Is = $\frac{\text{Transformer capacity}\times100}{\sqrt{3}\times\text{Rated voltage}\times\%Z}$

How to calculate short-circuit current value
Combination of transformer and impedance

<Table. 3> Combination of transformer and impedance

Transformer / Impedance	3 phases transformer											
	6.3kV/210V Oil Tr.			6.3kV/210V Mold Tr.			20kV/420V Mold Tr.			20kV/420V Oil Tr.		
Transformer capacity (VA)	ZT[%]	RT[%]	XT[%]	ZT[%]	RT[%]	XT[%]	ZT[%]	RT[%]	XT[%]	ZT[%]	RT[%]	XT[%]
20	2.19	1.94	1.03									
30	2.45	1.92	1.53	4.7	2.27	4.12						
50	2.47	1.59	1.89	4.7	1.94	4.28						
75	2.35	1.67	1.66	4.4	1.56	4.11						
100	2.54	1.65	1.96	4.6	1.5	4.24						
150	2.64	1.64	2.07	4.2	1.29	4.0						
200	2.8	1.59	2.31	4.5	1.17	4.35						
300	3.26	1.46	2.92	4.5	1.2	4.33						
500	3.61	1.33	3.36	4.7	0.08	4.69	5.0	1.56	4.76	6.0	1.0	5.92
750	4.2	1.55	3.9	6.0	0.8	5.95	5.0	1.40	4.80	6.0	0.9	5.93
1000	5.0	1.35	4.82	7.0	0.7	6.96	5.0	1.26	4.84	6.0	0.8	5.95
1500	5.1	1.22	4.95	7.0	0.6	6.97	5.5	1.2	5.37	7.0	0.75	6.96
2000	5.0	1.2	4.85	7.5	0.65	7.47	5.5	1.1	5.39	7.0	0.7	6.96

<Table. 4> Example of transformer impedance

Transformer / Impedance	1 phase transformer					
	6.3kV/210V Oil Tr.			6.3kV/210V Mold Tr.		
Transformer capacity (VA)	ZT[%]	RT[%]	XT[%]	ZT[%]	RT[%]	XT[%]
10				14.9	14.9	0.268
20				14.0	14.0	0.503
30				14.8	14.8	0.523
50				13.6	13.6	0.494
75				11.0	11.0	0.558
100				8.87	8.85	0.562
200				7.70	7.68	0.571
300				5.75	5.69	0.619
500				5.08	4.97	1.05
750				5.05	4.92	1.16
1000				4.03	3.93	0.904
2000				4.55	4.50	0.637
3000				4.29	4.22	0.768
5000				3.26	3.18	0.725
7500				2.72	2.81	0.775
10000	2.5	2.07	1.40	2.33	2.18	0.823
15000	2.37	1.84	1.49	2.04	1.82	0.937
20000	2.57	1.76	1.87	1.90	1.60	1.02
30000	2.18	1.58	1.50			
50000	2.05	1.47	1.42			
75000	2.27	1.46	1.74			
100000	2.48	1.49	1.98			
150000	3.39	1.31	3.13			
200000	3.15	1.31	2.87			
300000	2.23	1.28	2.96			
500000	4.19	1.09	4.03			

<Table. 5> Example of cable impedance (600 vinyl cable)

Cable dimension	Impedance of cable 1m (Ω)			
	Internal insulation wiring or cable of steel tube and duct	Internal vinyl tube wiring of steel tube and duct	Insulator wiring in building	Resistance(Ω) / cable 1meter
ø 1.6mm	0.00020	0.00012	0.00031	0.0089
ø 2mm				0.0056
ø 3.2mm				0.0022
5.5mm²				0.0033
8mm²				0.0023
14mm²	0.00015	0.00010	0.00026	0.0013
22mm²				0.00082
30mm²				0.00062
38mm²				0.00048
50mm²	0.00013	0.00009	0.00022	0.00037
60mm²				0.00030
80mm²				0.00023
100mm²				0.00018
125mm²				0.00014
150mm²				0.00012
200mm²				0.00009
250mm²				0.00007
325mm²				0.00005

<Remark1> At 60Hz, the reactance multiply 2 times itself, so 1/2 reactance of primary part can achieve IB.
<Remark2> When the cable is parallelly 2 or 3ea, reactance and resistance can be calculated in the condition of 1/3 and 1/3 length cable.

How to calculate short-circuit current value
Various short-circuit

<Table.6> Impedance sample of bus and busduct (50Hz)

[×10⁻⁴Ω/m]

Ampere rating (A)	50Hz			60Hz		
	R	X	Z	R	X	Z
600	1.257	0.323	1.297	1.385	0.387	1.438
800	0.848	0.235	0.879	0.851	0.282	0.896
1000	0.641	0.185	0.667	0.645	0.222	0.682
1200	0.518	0.152	0.540	0.523	0.183	0.554
1350	0.436	0.129	0.454	0.443	0.155	0.469
1500	0.378	0.113	0.394	0.386	0.135	0.409
1600	0.360	0.107	0.375	0.367	0.128	0.389
2000	0.286	0.084	0.298	0.293	0.101	0.310
2500	0.218	0.065	0.228	0.221	0.078	0.235
3000	0.180	0.054	0.188	0.184	0.064	0.195
3500	0.143	0.042	0.149	0.146	0.051	0.155
4000	0.126	0.038	0.131	0.129	0.045	0.136
4500	0.120	0.036	0.125	0.122	0.043	0.130
5000	0.095	0.028	0.099	0.098	0.034	0.103

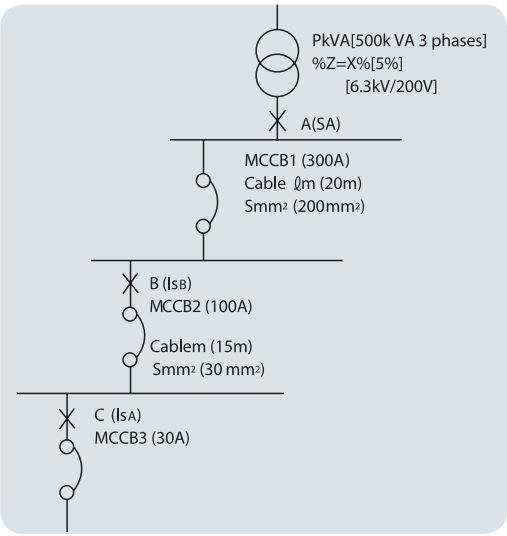
<Table.6> Impedance sample of Bus and busduct (50Hz)

[×10⁻⁴Ω/m]

Ampere rating (A)	50Hz			60Hz		
	R	X	Z	R	X	Z
600	0.974	0.380	1.045	0.977	0.456	1.078
800	0.784	0.323	0.848	0.789	0.387	0.879
1000	0.530	0.235	0.580	0.536	0.282	0.606
1200	0.405	0.185	0.445	0.412	0.222	0.468
1350	0.331	0.152	0.364	0.338	0.183	0.384
1500	0.331	0.152	0.364	0.338	0.183	0.384
1600	0.282	0.129	0.311	0.289	0.155	0.328
2000	0.235	0.107	0.259	0.241	0.128	0.273
2500	0.166	0.076	0.182	0.169	0.091	0.192
3000	0.141	0.065	0.155	0.144	0.078	0.164
3500	0.122	0.056	0.135	0.127	0.068	0.143
4000	0.110	0.051	0.121	0.113	0.061	0.126
4500	0.094	0.043	0.104	0.096	0.052	0.109
5000	0.082	0.038	0.091	0.084	0.045	0.096
5500	0.078	0.035	0.086	0.080	0.043	0.091
6500	0.068	0.028	0.074	0.071	0.031	0.077

How to calculate short-circuit current value Calculation example

Using a certain graph, you can find and calculate the short-circuit current value which is at one position of network. No matter the condition of network is different, you can do the calculation through adjusting variables.



Graph note

P coordinates – Transformer capacity (kVA)
Is_1 coordinates – Short-circuit current value (kA)
Is_2 coordinates – Short-circuit current value affected cable condition (kA)
ⓐ Line - % impedance of transformer (%)
ⓑ Line - Length of cable (m)
ⓒ Line - Square mm of cable (mm^2)
ⓓ Line - Is_2 (kA)

Remark) ⓒ line shows the length of hard vinyl cable (600V IV)

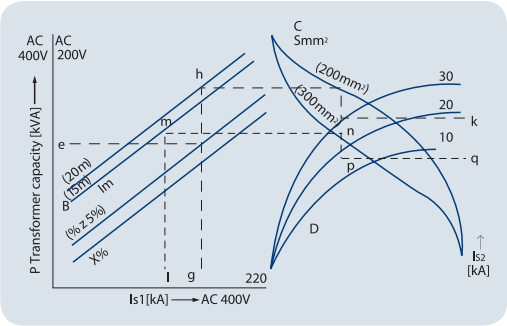
How to calculate short-circuit current value

(1) 3 phases transformer
① Short-circuit current value at (A) where it is just below transformer. At P coordinates, find the coordinates value (g) of the cross point (f) which is from transformer capacity (e) and A line. Disregard primary part impedance of transformer.
② Find the short-circuit current value at Point B, C which are considered cable impedance.
- At short-circuit current g (kA) of Is_1 coordinates, find the value (h) of B line
- Move (h) to parallel direction of Is, and find the cross point (i) to C line.
- Move (i) to parallel direction of Is_2, and find the cross point value (j) to D line (g), finally find (k) of Is_2

(2) 1 phase transformer
① Short-circuit current value where it is just below transformer. Find the value as same as that of 3 phase transformer and multiply it 3 times. (g'kA)
② Find the short-circuit current value where it is considered cable impedance.
- Multiply 2/3 times to g' of Is coordinates
- Find the Is_2 value as same as that of 3 phase transformer and multiply it 3/2 times.

Remark

1. It's not considered the transformer contribution. Multiply 4 times the rated current of transformer in cases.
2. The real short-circuit current value is littler lower that its calculated value by the way we suggest because we take the rated voltage as AC200V, 400V. So the current value should be calculated in the consideration of stability
3. The calculated value is symmetrical real value.



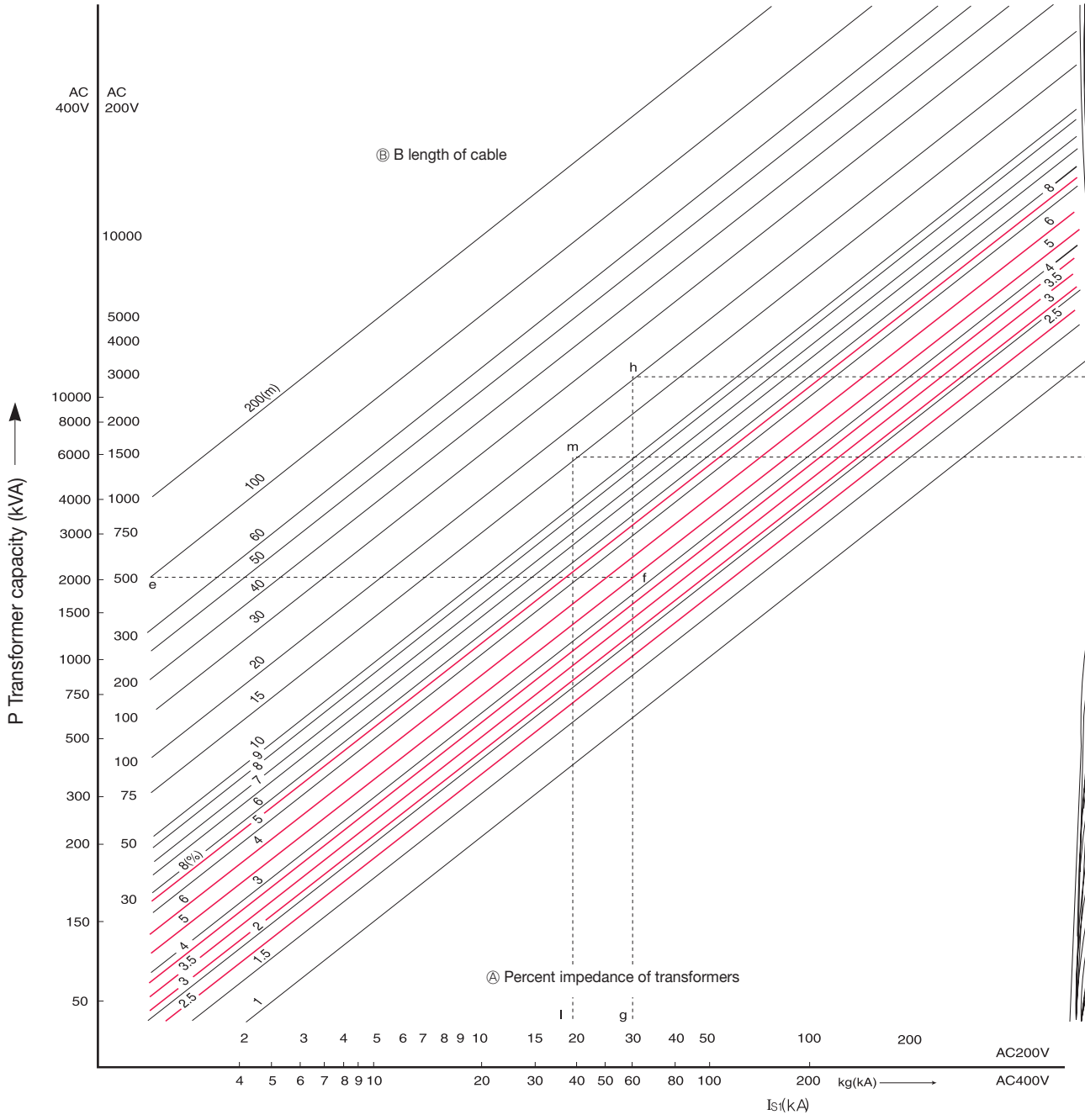
How to calculate short-circuit current value
Calculation graph

(1) Short-circuit current value at point A (I_{SA})

- At P coordinates, find (f) which is the point which is to match transformer capacity 500kVA and A line. Then move (f) to Is_1 direction and finally find (g).
- I_{SA}= 29kVA (g)

(2) Short-circuit current value at point B (I_{SB})

- Find value h of B line (20mm) at g (= 29kA) of Is_1 coordinates
- Move h parallely to the direction of Is_1, and find value I at the cross point with C line (200mm)
- Move I parallely to the direction of Is_2, and find value j at the cross point with D line (g= 29kA)
- I_{SB}= 19kA (k)



(3) Short-circuit current value at point C (I_{sc})

- Find Is_1 coordinates value (19kA) of short-circuit current value k (= 19kA) at Point B. and find cross point m between 19kA and B line.
- Move m parallely to the direction of Is_1 coordinates, and find the cross point n at C line (30mm).
- Move n parallely to the direction of Is_1 and find the cross point p of $Is_2$with D line.
- Isc= 10kA (g)

