Susol

Super Solution

North American Edition

Low voltage circuit breakers

LS Industrial Systems
www.lsis.biz

Susol Low voltage circuit breakers

Susol LV circuit breakers

Super Solution

Contents :

Susol
UL 489 listed
MCCB

product
design
award
2007

■ Recognized Susol Design

Susol product represents simultaneously simple and complicated design for using cut diamond motive to emphasis on the hardness of industrial product. And we applied the identity of product image by designing same concept MCCB and Contactor which are installed to cubicle.

Susol Series acquire the competitive power By obtaining the prestigious "IF Design Award"

Super Solution

For power distribution

- High breaking capacity
- Optimum coordination technique (Cascading & discrimination)
- Powerful engineering tools

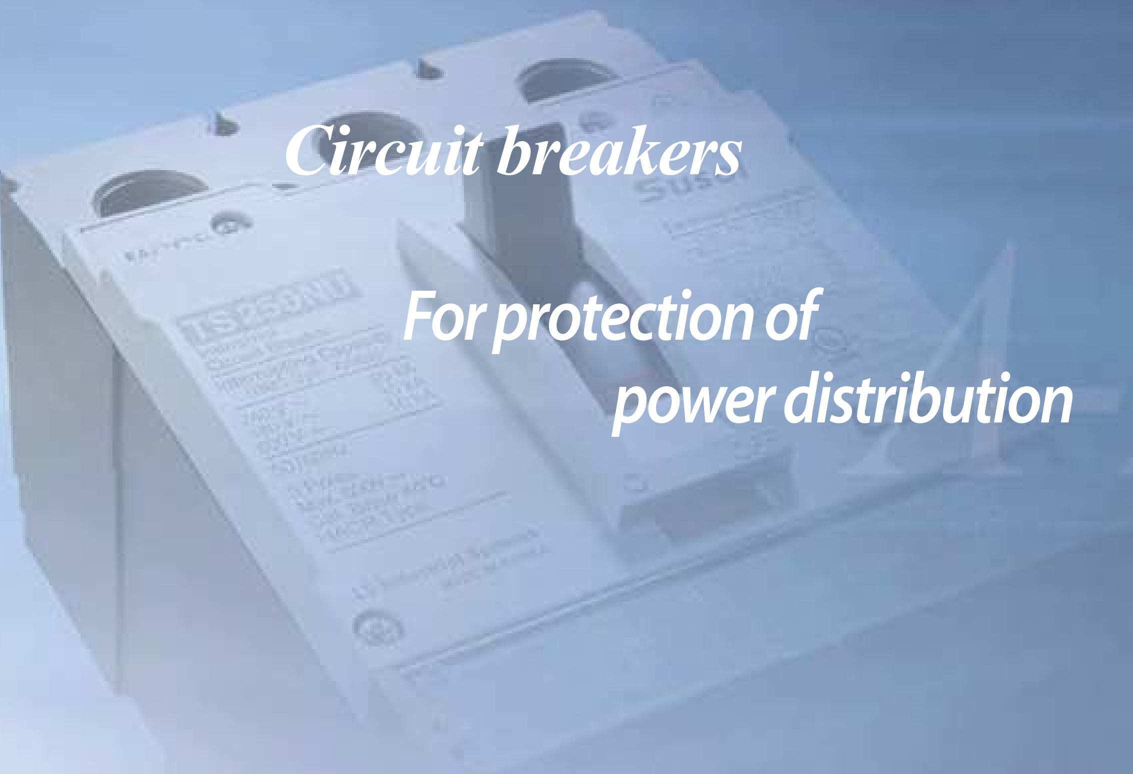
For protection of motor & its control device

- Optimal overload protection
- Guaranteed Short Circuit Current Ratings

For controlling and disconnecting circuits

For extensive applications

- Wide range of optimized auxiliaries and accessories



Circuit breakers

For protection of power distribution

A-2-1

Molded Case Switch

For protecting and disconnecting circuits

A-2-17

Susol MCCB

Beyond the limits...

The circuit breaker will supply more stable, reliable, upgraded systems to customer with high breaking capacity.

Susol TD and TS series

Molded Case Circuit Breakers

Susol MCCB

■ Simplified product range

- AF: 125AF, 250AF, 400AF, 800AF
- Ampere Range: 15A ~ 800A

■ High performance

- Ultimate breaking capacity (kA rms)
  Icu: Max 65kA @480VAC

■ Standards

- World class with UL489, CE approvals

■ Variable accessories

- Electrical auxiliaries
- Extended rotary handle
- Flange handle
- Locking devices

■ Various trip units

- FTU: Fixed thermal & Magnetic unit
- ATU: Adjustable thermal & Magnetic unit
- FMU: Adjustable thermal, Fixed magnetic unit
- MCS: Molded Case Switch

MCCB

8 Models in 4 Frames

Susol TD and TS circuit breakers are rated from 15 through 800 amperes and are available in four frame sizes.

UL 489 Listed Circuit Breakers Family TD/TS

65kA at 480VAC / 8 models in 4 frames

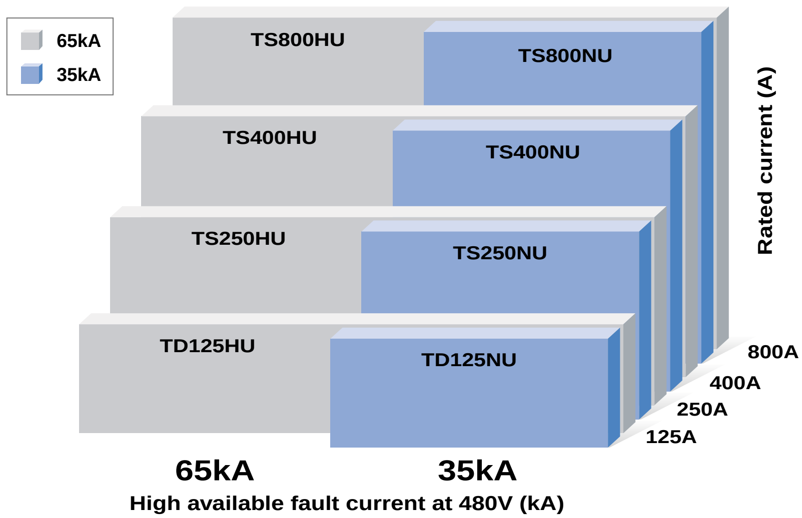
TD125U

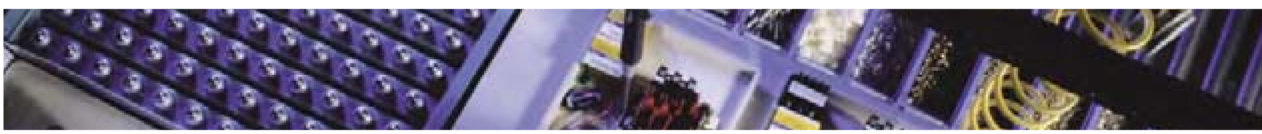
In 15~125A
Icu: 35kA(NU), 65kA(HU)
90(W) x 164(H) x 86mm(D)

Enhanced high performance

N Type - 35kA, H Type - 65kA

Maximum breaking capacity for all Ampere Frame is 65kA at 480VAC.





TS250U

In 150~250A
Icu: 35kA(NU), 65kA(HU)
105(W) x 178(H) x 86mm(D)

TS400U

In 300~400A
Icu: 35kA(NU), 65kA(HU)
140(W) x 292(H) x 110mm(D)

TS800U

In 500~800A
Icu: 35kA(NU), 65kA(HU)
210(W) x 428(H) x 135mm(D)

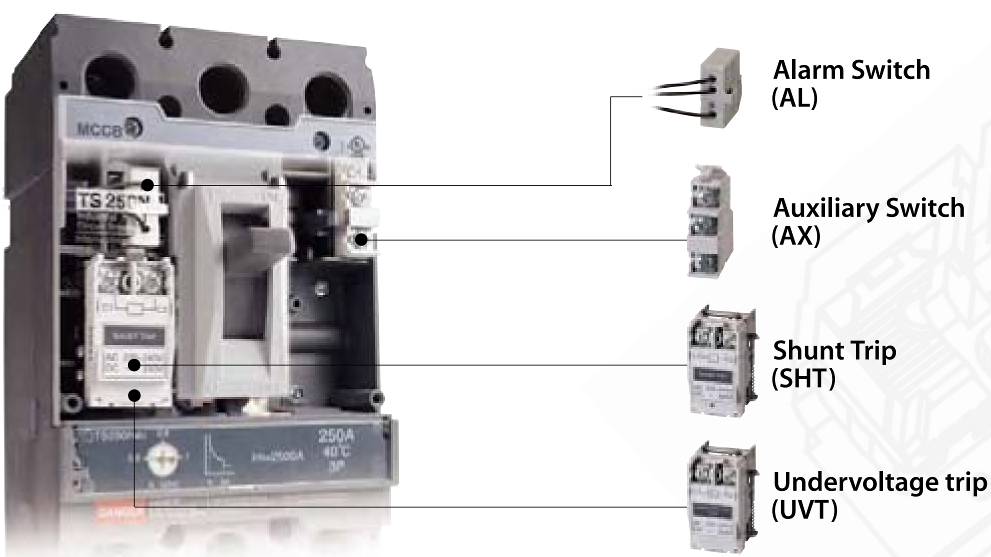
MCCB Accessories

A complete range of convenient internal and external accessories for Susol TD and TS series

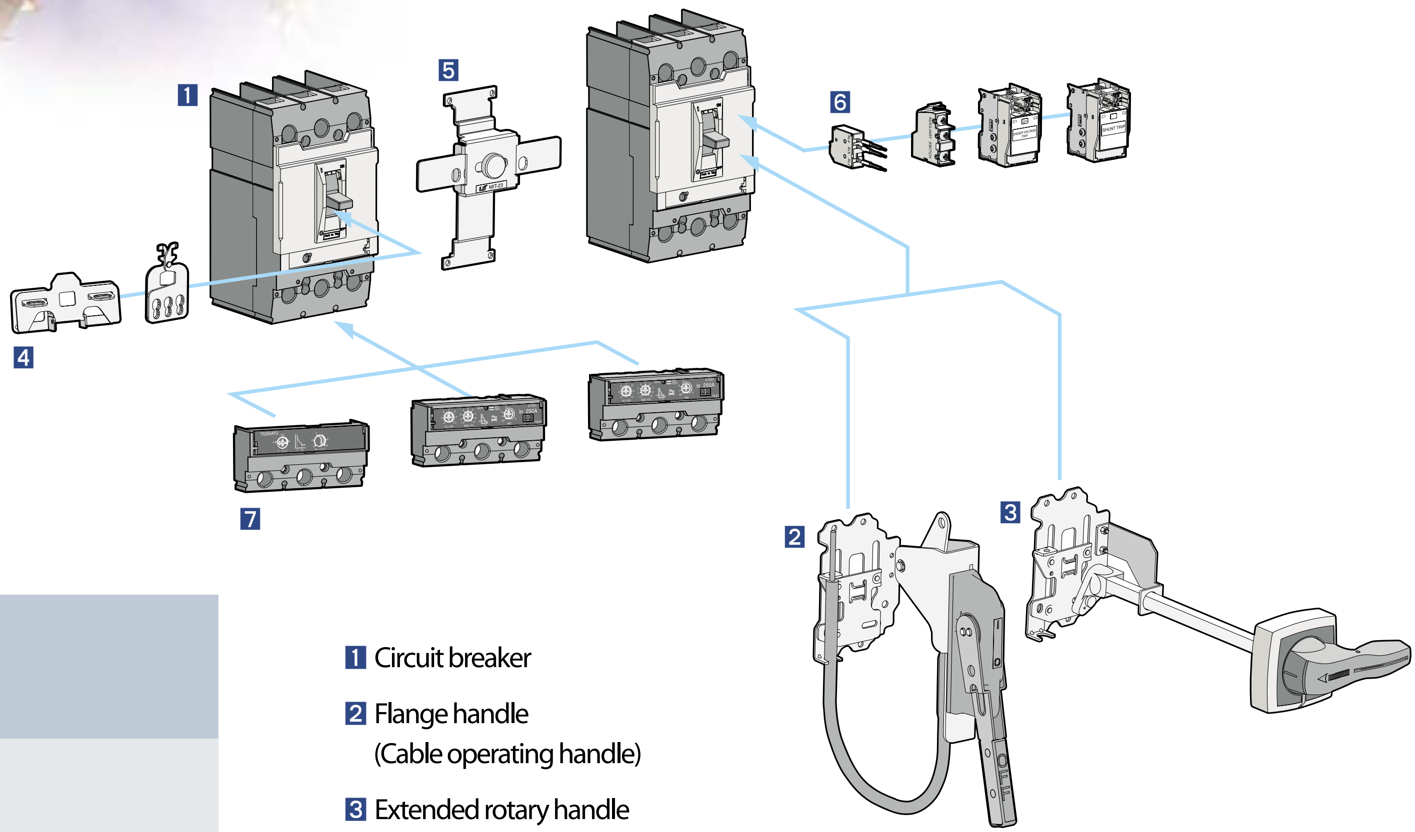
Simplicity & Flexibility

Various kinds of accessories for user convenience

Internal auxiliaries (AX, AL, SHT, UVT) are the same for all frame size. And trip units, Handles, Locking devices are the same for a given frame size.



Susol Circuit Breaker System Overview



1 Circuit breaker

2 Flange handle
(Cable operating handle)

3 Extended rotary handle

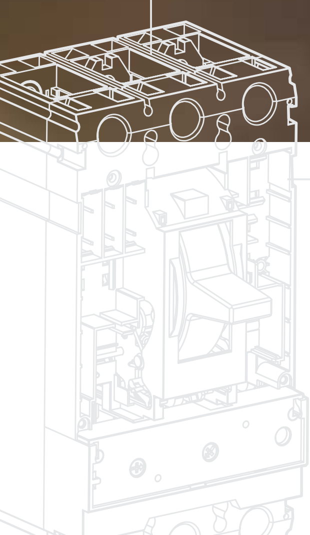
4 Locking devices
(Removable, Fixed)

5 Mechanical interlock device

6 Accessories device
(AL, AX, UVT, SHT)

7 Trip units

Susol MCCB Trip units



Interchangeable trip unit *

Susol TS series circuit breakers provide several kinds of protection function according to selected trip unit and thanks to interchangeable trip unit concept, user can change the trip unit easily and rapidly.

* Only available in factory

Interchangeable trip units

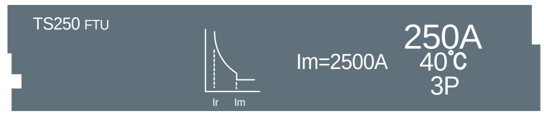
Thermal Magnetic Trip Unit - FTU

Thermal Magnetic Trip Unit - FMU

Thermal Magnetic Trip Unit - ATU

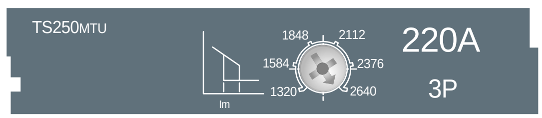
Protection of power distribution systems

1. Thermal Magnetic trip units
   - FTU: Fixed thermal and Fixed magnetic trip unit
   - FMU: Adjustable thermal and Fixed magnetic trip unit
   - ATU: Adjustable thermal and Adjustable magnetic trip unit



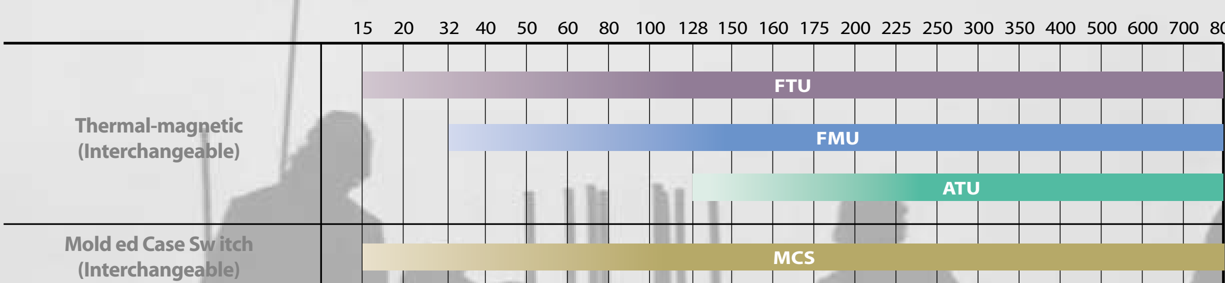
Motor Protection

- MTU: Magnetic only trip unit

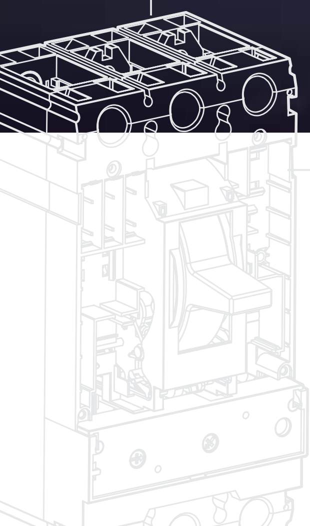


Control and disconnection

- MCS: Molded case switch



Susol MCCB Internal accessories

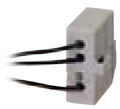


■ Simplicity

The range of internal accessories of TD & TS series circuit breakers is characterized by common use regardless of frame size and is allowing reduction of stocks.

Common use to all Susol TD and TS circuit breakers

Electrical auxiliaries that are installed internally are common from 15A to 800A.



Alarm Switch (AL)

Alarm switches offer provisions for immediate audio or visual indication of a tripped breaker due to overload, short-circuit, operation of shunt trip, or undervoltage trip conditions, operation of push button.

They are particularly useful in automated plants where operators must be signaled about changes in the electrical distribution system. This switch features a closed contact when the circuit breaker is tripped automatically. In other words, this switch does not function when the breaker is operated manually. Its contact is open when the circuit breaker is reset.

Auxiliary Switch (AX)

Auxiliary switch is for applications requiring remote "ON" and "OFF" indication. Each switch contains two contacts having a common connection. One is open and the other closed when the circuit breaker is open, and vice-versa.

Undervoltage trip (UVT)

The undervoltage trip automatically opens a circuit breaker when voltage drops to a value ranging between 35% to 70% of the line voltage. The operation is instantaneous, and the circuit breaker cannot be reclosed until the voltage returns to 85% of line voltage. Continuously energized, the undervoltage trip must be operating be fore the circuit breaker can be closed.

Shunt Trip (SHT)

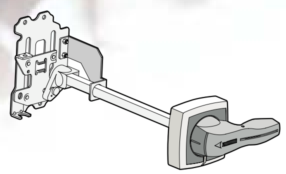
The shunt trip opens the mechanism in response to an externally applied voltage signal. LS shunt trips include coil clearing contacts that automatically clear the signal circuit when the mechanism has tripped.

Susol MCCB External accessories

■ Convenience

Wide range of external accessories provides convenient solution for easy installation.

External accessories

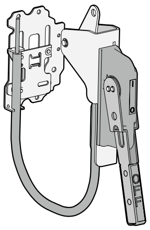


Extended rotary handle

There are 3 types of length

12/16/24inch

UL50 type 1, 3(R), 12 and 4(X) option available

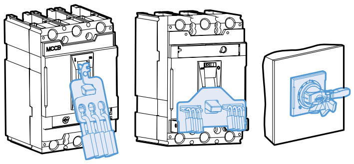


Flange handle (Cable operating handle)

There are 4 types of length

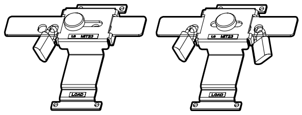
36/48/60/72inch at each AF

UL50 type 1, 3(R), 12 and 4(X) option available



Locking device

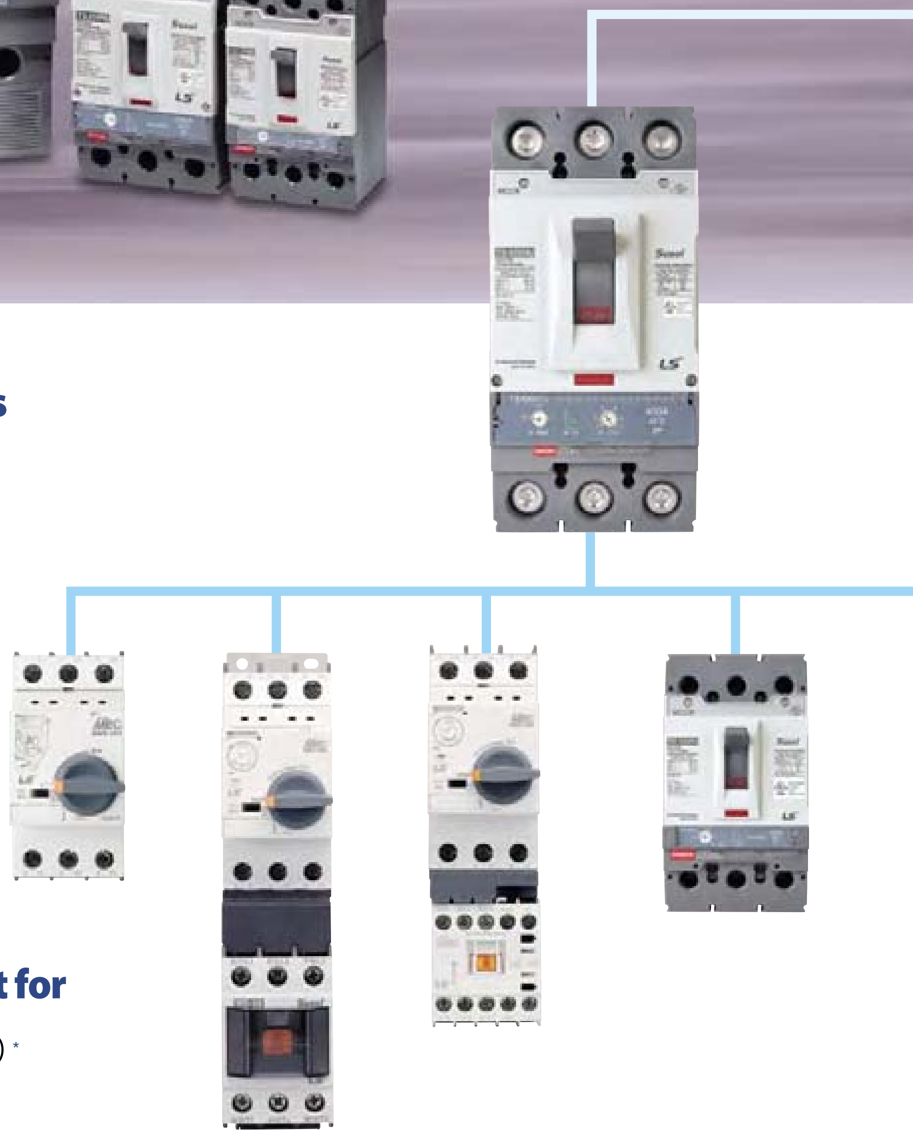
- Fixed padlock
- Removable padlock
- Key lock device on direct handle



Mechanical interlocking device

Interlocks prevent connection to both sources at the same time, even momentarily.

Susol MCCB Main characteristics



■ Susol series circuit breakers are suitable for

- Protection of power distribution
- Controlling and disconnecting circuits

■ Optimum technical support for

(Cascading, Discrimination, Type 2 coordination) *

- Selecting economical protection system
- Quarantee safety of the installation
- Reducing the stress on components and damage
- Guarantee service continuity

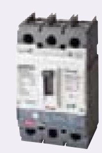
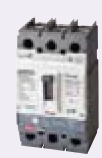
* Certificate under process


Susol
LS
MCCB


MCCB
Susol
LS

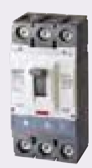
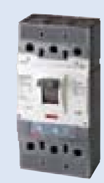
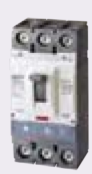
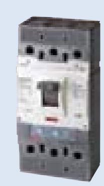
A-1. Overview

Range of Susol products

	125AF	250AF
	Susol TD circuit breakers	
For power distribution		
	TD125U	
	Thermal magnetic trip unit	
	FTU (Fixed thermal, Fixed magnetic trip unit)	
	FMU (Adjustable thermal, Fixed magnetic trip unit)	
	Susol TS circuit breakers	
For power distribution		
		TS250U
		Thermal magnetic trip unit
		FTU (Fixed thermal, Fixed magnetic trip unit)
		FMU (Adjustable thermal, Fixed magnetic trip unit)
		ATU (Adjustable thermal, Adjustable magnetic trip unit)
	Susol switch-disconnectors	
Molded Case Switch		
	TS125U	TS250U
	Molded case switch unit	
	MCS (Molded Case Switch)	

Range of Susol products

Susol

	400AF	800AF
	Susol TD circuit breakers	
For power distribution		
	Susol TS circuit breakers	
For power distribution		
	TS400U	TS800U
	Thermal magnetic trip unit	
	FTU (Fixed thermal, Fixed magnetic trip unit)	
	FMU (Adjustable thermal, Fixed magnetic trip unit)	
	ATU (Adjustable thermal, Adjustable magnetic trip unit)	
	Susol switch-disconnectors	
Molded Case Switch		
	TS400U	TS800U
	Molded case switch unit	
	MCS (Molded Case Switch)	

Overview of TD/TS family

Susol

TD series

				TD125U	
Frame size			[AF]	125	
Rated current In			[A]	15, 20, 30, 40, 50, 60, 80, 100, 125	
No. of Poles				2, 3	
Rated operational voltage, Ue AC			[V]	600	
UL interrupting rating			[kA]	NU	HU
	AC 50/60Hz	240 V		50	100
		480 V		35	65
		600 V		10	14
Reference standard				UL 489	
Trip unit (Thermal-Magnetic)					
	● Fixed-thermal, Fixed-magnetic		FTU	●	
	● Adjustable-thermal, Fixed-magnetic		FMU	●	
	● Adjustable-thermal, Adjustable-magnetic (3Pole)		ATU	-	
	● Molded Case Switch		MCS	●	
Variable accessories					
	AX			●	
	AL			●	
	SHT			●	
	UVT			●	
	Extended rotary handle			●	
	Flange handle			●	
	Locking devices (Removable, Fixed)			●	
	Mechanical interlock device			●	
Mechanical life			[operations]	4,000	
Electrical life @600V AC			[operations]	4,000	
Weight 3-Pole			[lbs/kg]	2.65/1.2	
Basic dimension, W × H × D 3-Pole			[inch/m]	3.54 × 6.46 × 3.39/0.90 × 1.64 × 0.86	

Overview of TD/TS family

Susol

TS series

TS250U		TS400U		TS800U	
250		400		800	
150, 160, 175, 200, 225, 250		300, 350, 400		500, 600, 700, 800	
2, 3		2, 3		2, 3	
600		600		600	
NU	HU	NU	HU	NU	HU
50	100	50	100	50	100
35	65	35	65	35	65
10	14	10	14	10	14
UL 489		UL 489		UL 489	
●		●		●	
●		●		●	
●		●		●	
●		●		●	
●		●		●	
●		●		●	
●		●		●	
●		●		●	
●		●		●	
●		●		●	
●		●		●	
●		●		●	
5,000		5,000		3,000	
1,000		1,000		500	
4.19/1.9		12.57/5.7		29.98/13.6	
4.13×7.01×3.39/1.05×1.78×0.86		5.51×11.50×4.33/1.40×2.92×1.10		8.27×16.85×5.31/2.10×4.28×1.35	

Marking and configuration

Rated frequency

Standard

Manufacturer

Utilization category

UL listed number

Terminal Information

Symbol indicating suitability for isolation as defined by UL489

Marking and configuration

Susol

Model (Rating and breaking capacity)

- TS: Series
- 250: Max. Ampere rating
- NU: Normal (Standard)
- HU: High

	125AF	250AF	400AF	800AF
NU	TD125NU	TS250NU	TS400NU	TS800NU
HU	TD125HU	TS250HU	TS400HU	TS800HU

Standardized characteristics:

- Ui: Rated insulation voltage
- Uimp: Impulse withstand voltage
- Ue: Rated operational voltage
- Icu: Ultimate breaking capacity
- Ics: Service breaking capacity

NU	50kA	50kA	50kA	50kA
HU	100kA	100kA	100kA	100kA

Product: Molded Case Circuit Breaker

Upstream connections

Fixing hole

Certificate plate

Indication of closed (I/ON) position

Brand name

Operating handle

Indication of open (O/OFF) position

Company logo

"push to trip" button

Rating of trip unit

Trip unit

Fixing hole

Downstream connections

Overview of trip units

On TD100U to TS800U circuit breakers, the thermal-magnetic trip units are interchangeable and may be rapidly fitted to the circuit breakers.

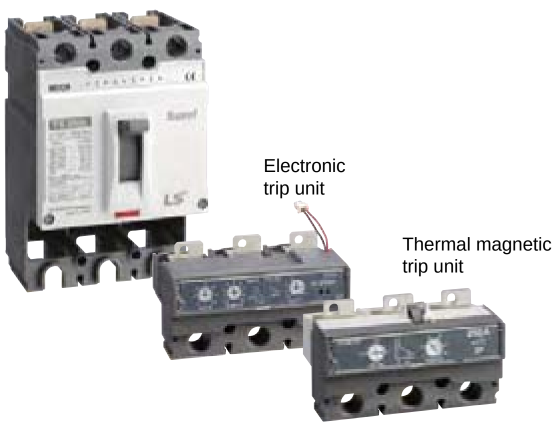
It is therefore easy to change the protection of a given circuit following a modification in an uninstallation.

Ampere ratings

MCCB frame type / Type of trip unit	Rated current, In[A]			
	Thermal magnetic release			MCS
	FTU	FMU	ATU	
TD125U	15, 20, 30, 40, 50, 60, 80, 100, 125	32, 40, 48, 64, 80, 100	-	15, 20, 30, 40, 50, 60, 80, 100, 125
TS250U	150, 175, 200, 225, 250	128, 160, 200	128, 160, 200	150, 160, 175, 200, 225, 250
TS400U	300, 350, 400	240, 320	240, 320	300, 350, 400
TS800U	500, 600, 700, 800	400, 480, 640	400, 480, 640	500, 600, 700, 800

Types of trip units

FTU	• Fixed thermal, Fixed magnetic
FMU	• Adjustable thermal, Fixed magnetic
ATU	• Adjustable thermal, Adjustable magnetic
MCS	• Molded case switch

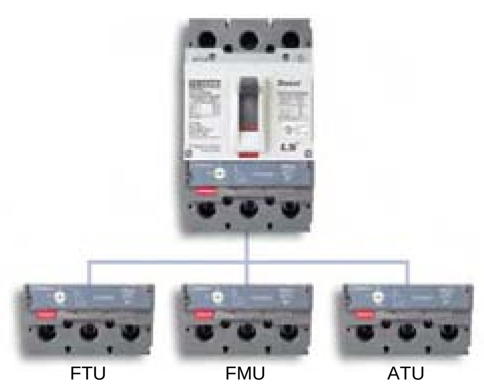


Trip unit identification

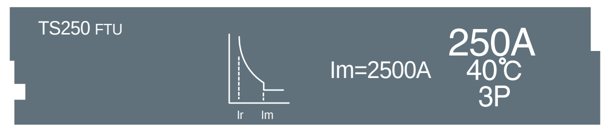
TS250U **FMU**

Trip unit function

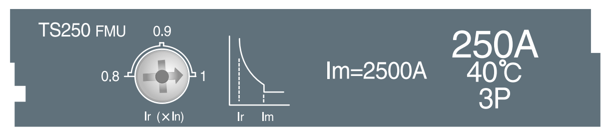
MCCB frame type



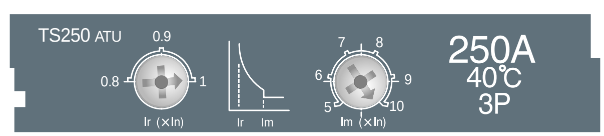
FTU **Fixed-thermal, fixed-magnetic**



FMU **Adjustable-thermal, fixed-magnetic**



ATU **Adjustable-thermal, adjustable-magnetic**



MCS **Molded case switch**

Double contactor structure

Optimize

Repulsion force

Shape of contactor

- Induce easily the arc mobility to grid direction
- Rapidly redeploy the arc from moving contactor
- Prevent contact tip from erosion

Open speed & contact force

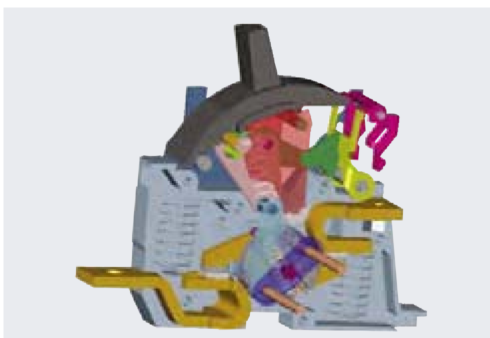


Fig. 3 "ON" position

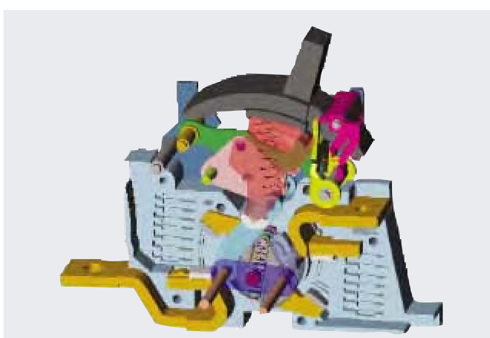


Fig. 4 "OFF" position

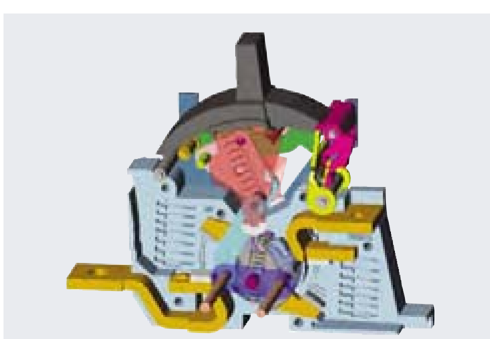
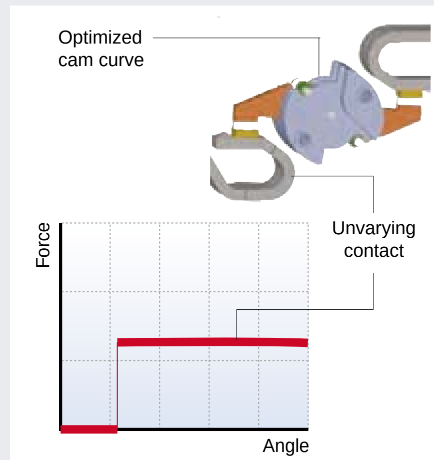


Fig. 5 "TRIP" position

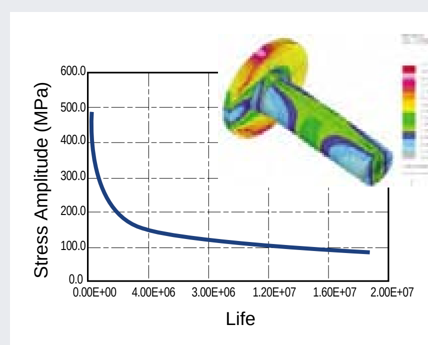
ON position

- Unvarying contact force regardless of over travel
- Open speed of moving contact is rapid by optimized cam curve regardless of trip signal
- Function of trip free



OFF position

- Push to trip in OFF position
  * Reset pin moment < Main spring moment
- Stability of endurance



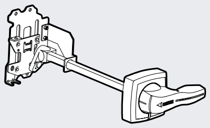
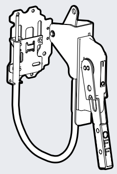
TRIP position

- Enables tripping mechanically from outside, for confirming the operation of the accessory switches and the manual resetting function

Degree of protection

The table indicates the degrees of protection guaranteed by Susol TD and TS circuit-breakers according to several type of installation. Basically, the fixed parts are always preset with IP20 degree of protection.

IP65 degree of protection can be obtained with the circuit-breaker installed in a switchboard fitted with an extended rotary handle operating mechanism transmitted on the compartment door.

Type	Degree of protection	IP	NEMA type	Protection of persons against access to hazardous parts with:
 Extended rotary handle	There are 3 types of length	IP40	1, 3R,12 4X	Wire
 Flange handle (Cable operating handle)	There are 4 types of length	IP40	1, 3R,12 4X	Wire


Susol

A-2. Main characteristics

TD series

		TD125U
Frame size	[AF]	125
No. of Poles		3
Maximum voltage ratings	[V AC]	600
Switch ampere ratings	[A]	125
Magnetic override	[A]	1250
Short circuit withstand ratings	120V AC	100kA
	240V AC	100kA
	480V AC	65kA
	600V AC	14kA
Catalog number of wire connector		LSCA1
Dimensions		Same as MCCB
Shipping weight		Same as MCCB

TS series

		
TS250U	TS400U	TS800U
250	400	800
	3	
600	600	-
250	400	800
2500	4000	8000
-	-	-
100kA	100kA	100kA
65kA	65kA	65kA
18kA	20kA	25kA
LSCA2	LSCA4	LSCA8
	Same as MCCB	
	Same as MCCB	

Thermal magnetic trip units Overview

Susol TD & TS series circuit breakers can be installed with thermal magnetic trip units.
And, there are two kinds of trip units according to way of installation as follows.

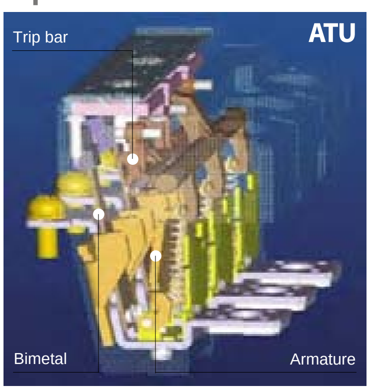
- Built-in trip units for TD series upto 160A
- Interchangeable trip units for TS series upto 800A

Function

Protection of power distribution

- Overload protection: Thermal protection with a fixed or adjustable threshold
- Short-circuit protection: Magnetic protection with a fixed or adjustable pick-up
- Protection of the fourth pole
  4P3T type (neutral unprotected)
  4P4T type 50% (neutral protection at 0.5×In)
  4P4T type 100% (neutral protection at 1×In)

Operation



Thermal magnetic types

- Time-Delay operation
  An overcurrent heats and warps the bimetal to actuate the trip bar by the bimetal characteristic.
- Instantaneous operation
  If the overcurrent is excessive, the armature is attracted and the trip bar actuated by electromagnetic force.

Ratings

Ratings(A)	Thermal magnetic trip units(FTU/FMU/ATU) TD125U to TS800U																					
at 40℃ In	15	20	30	40	50	60	80	100	125	150	160	175	200	225	250	300	350	400	500	600	700	800
TD125U	●	●	●	●	●	●	●	●	●	-	-	-	-	-	-	-	-	-	-	-	-	-
TS250U	-	-	-	-	-	-	-	-	-	●	●	●	●	●	●	-	-	-	-	-	-	-
TS400U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	●	●	●	-	-	-	-
TS800U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	●	●	●	●

Note) Rated current 700A is available for TS800UFTU.

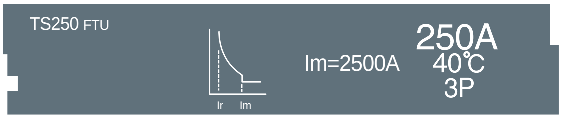
Thermal magnetic trip units
Overview

Characteristics

Fixed thermal, fixed magnetic trip units

FTU

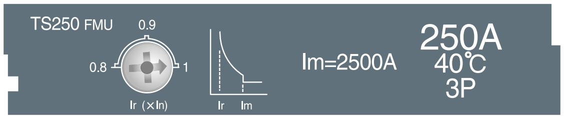
- Fixed thermal
  15A ... 800A rated currents
- Fixed magnetic
  400A ... 8000A tripping currents
- Applicable to TD125U ... TS800U frames



Adjustable thermal, fixed magnetic trip units

FMU

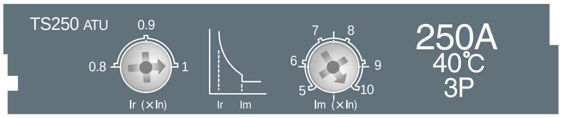
- Adjustable thermal
  40A ... 800A rated currents
  Adjustable : 0.8~1 × In
- Fixed magnetic
  400A ... 8000A tripping currents
- Applicable to TD125U ... TS800U frames



Adjustable thermal, adjustable magnetic trip units

ATU

- Adjustable thermal
  150A ... 800A rated currents
  Adjustable : 0.8~1 × In
- Adjustable magnetic
  500A ... 8000A tripping currents
  Adjustable : 5~10 × In
- Applicable to TS250U ... TS800U frames



Thermal magnetic trip units FTU, FMU for TD125U

Configuration

Trip unit identification

Ratings (A), In at 40°C

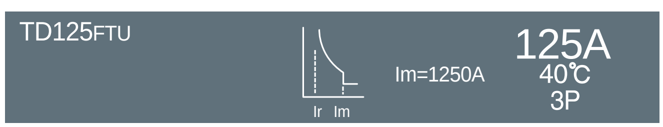
Number of pole

Short circuit protection (magnetic)
Setting current, Im

Overload protection (thermal)
Setting current, Ir

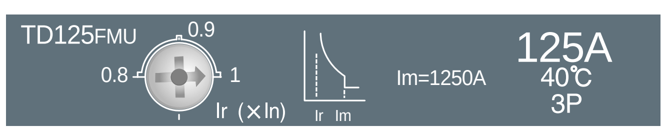
TD125U FTU

- Fixed thermal & magnetic trip unit

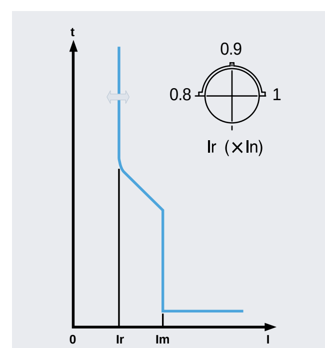


TD125U FMU

- Adjustable thermal & fixed magnetic trip unit



TD125U FMU



Thermal magnetic trip units FTU, FMU for TD125U

Characteristics

Thermal magnetic trip units(FTU/FMU) ... TD125U										
Rating(A)	at 40℃ In	15	20	30	40	50	60	80	100	125
	TD125U	●	●	●	●	●	●	●	●	●

Overload protection(thermal)		
Current setting(A) Ir		
	FTU	Fixed
	FMU	Adjustable 0.8, 0.9, 1 × In (3 settings)

Short - circuit protection(magnetic)			
Current setting(A) Im			
	FTU	Fixed 400A	Fixed 10 × In
	FMU	Fixed 400A	Fixed 10 × In

Catalogue numbering system

TD125U FMU

Trip unit function
- FTU : Fixed thermal & magnetic unit
- FMU : Adjustable thermal, fixed magnetic unit

MCCB frame type
- TD125U : TD125NU, TD125HU

Thermal magnetic trip units
FTU, FMU for TD125U

Setting details

Thermal overload protection

Trip unit type	Setting	Trip unit rating, In (A)								
	Ir	15	20	30	40	50	60	80	100	125
TD125U FTU	Fixed	15	20	30	40	50	60	80	100	125
TD125U FMU	0.8	-	-	-	32	40	48	64	80	100
	0.9	-	-	-	36	45	54	72	90	112.5
	1	-	-	-	40	50	60	80	100	125

Magnetic short-circuit protection

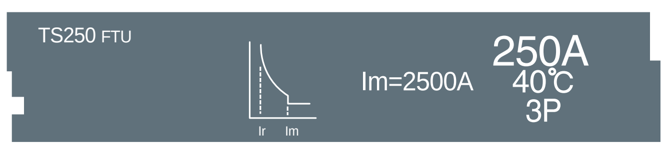
Trip unit type	Setting current, Ir	Setting current, Im		Trip unit rating, In (A)								
				15	20	30	40	50	60	80	100	125
TD125U FTU		Fixed	In × 10	400	400	400	400	500	600	800	1000	1250
TD125U FMU	0.8 × In	Fixed	In × 10	-	-	-	400	500	600	800	1000	1250
	0.9 × In	Fixed	In × 10	-	-	-	400	500	600	800	1000	1250
	1.0 × In	Fixed	In × 10	-	-	-	400	500	600	800	1000	1250

Thermal magnetic trip units
FTU, FMU for TS250U
ATU for TS250U

Configuration

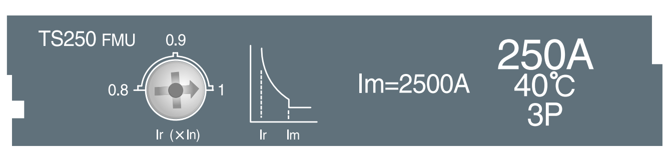
TS250U FTU

- Fixed thermal fixed magnetic trip unit



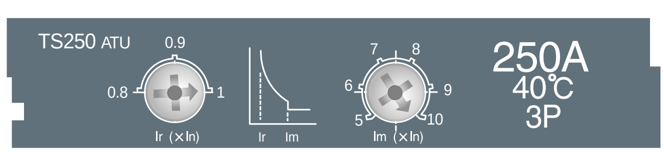
TS250U FMU

- Adjustable thermal fixed magnetic trip unit

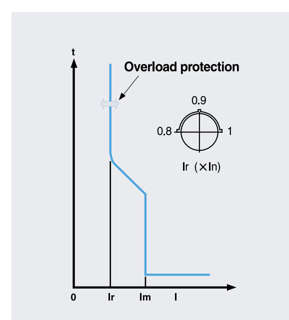


TS250U ATU

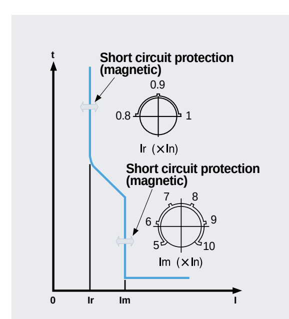
- Adjustable thermal adjustable magnetic trip unit



TS250U FMU



TS250U ATU



Thermal magnetic trip units
FTU, FMU for TS250U
ATU for TS250U

Characteristics

Thermal magnetic trip units(FTU/FMU) ... TS250U							
Rating(A)	at 40℃ In	150	160	175	200	225	250
	TS250U	●	●	●	●	●	●

Overload protection(thermal)		
Current setting(A) Ir		
	FTU	Fixed
	FMU	Adjustable 0.8 to × In
	ATU	Adjustable 0.8 to × In

Short - circuit protection(magnetic)		
Current setting(A) Im		
	FTU	Fixed 10 × In
	FMU	Fixed 10 × In
	ATU	Adjustable 5, 6, 7, 8, 9, 10 × In (6 settings)

Catalogue numbering system

TS250U FTU

Trip unit function
- FTU: Fixed thermal, fixed magnetic unit

MCCB frame type
- TS250U: TS250NU, TS250HU

TS250U FMU

Trip unit function
- FMU: Adjustable thermal, fixed magnetic unit

MCCB frame type
- TS250U: TS250NU, TS250HU

TS250U ATU

Trip unit function
- ATU: Adjustable thermal, adjustable magnetic unit

MCCB frame type
- TS250U: TS250NU, TS250HU

The trip unit ATU is available from 125A

Thermal magnetic trip units FTU, FMU for TS250U ATU for TS250U

Setting details

Thermal overload protection

Trip unit type	Setting Ir	Trip unit rating, In (A) 150	160	175	200	225	250
TS250U FTU	Fixed	150	-	175	200	225	250
TS250U FMU	0.8	-	128	-	160	-	200
	0.9	-	144	-	180	-	225
	1	-	160	-	200	-	250
TS250U ATU	0.8	-	128	-	160	-	200
	0.9	-	144	-	180	-	225
	1	-	160	-	200	-	250

Magnetic short-circuit protection

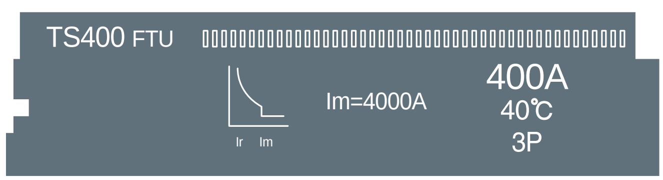
Trip unit type	Setting current, Ir	Setting current, Im		Trip unit rating, In (A) 150	160	175	200	225	250
TS250U FTU		Fixed	In ×10	1500	-	1750	2000	2250	2500
TS250U FMU	0.8 ×In	Fixed	In ×10	-	-	-	2000	-	2500
	0.9 ×In	Fixed	In ×10	-	-	-	2000	-	2500
	1.0 ×In	Fixed	In ×10	-	-	-	2000	-	2500
TS250U ATU	0.8 ×In	Adjustable	In ×5	-	800	-	1000	-	1250
			In ×6	-	960	-	1200	-	1500
			In ×7	-	1120	-	1400	-	1750
			In ×8	-	1280	-	1600	-	2000
			In ×9	-	1440	-	1800	-	2250
			In ×10	-	1600	-	2000	-	2500
	0.9 ×In	Adjustable	In ×5	-	800	-	1000	-	1250
			In ×6	-	960	-	1200	-	1500
			In ×7	-	1120	-	1400	-	1750
			In ×8	-	1280	-	1600	-	2000
			In ×9	-	1440	-	1800	-	2250
			In ×10	-	1600	-	2000	-	2500
	1.0 ×In	Adjustable	In ×5	-	800	-	1000	-	1250
			In ×6	-	960	-	1200	-	1500
			In ×7	-	1120	-	1400	-	1750
			In ×8	-	1280	-	1600	-	2000
			In ×9	-	1440	-	1800	-	2250
			In ×10	-	1600	-	2000	-	2500

Thermal magnetic trip units
FTU, FMU, ATU for TS400U

Configuration

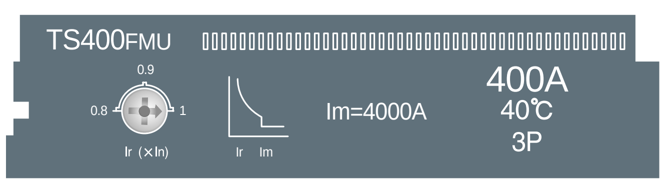
TS400U FTU

- Fixed thermal fixed magnetic trip unit



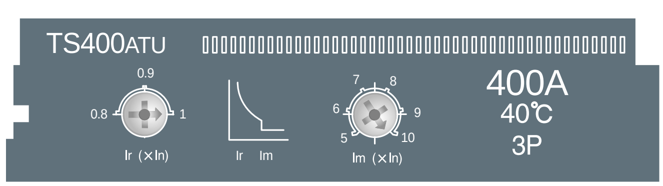
TS400U FMU

- Adjustable thermal fixed magnetic trip unit

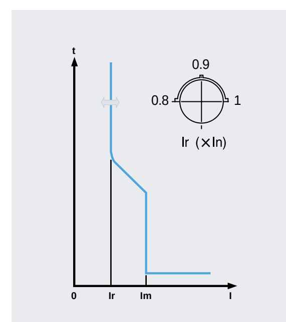


TS400U ATU

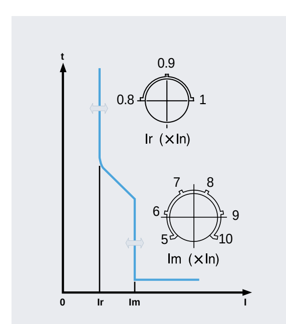
- Adjustable thermal adjustable magnetic trip unit



TS400U FMU



TS400U ATU



Thermal magnetic trip units
FTU, FMU, ATU for TS400U

Characteristics

Thermal magnetic trip units(FTU/FMU/ATU) ... TS400U				
Rating(A)	at 40℃ In	300	350	400
	TS400U	●	●	●

Overload protection(thermal)		
Current setting(A) Ir		
	FTU	In=Ir (Fixed)
	FMU	Adjustable 0.8, 0.9, 1 × In (3 settings)
	ATU	Adjustable 0.8, 0.9, 1 × In (3 settings)

Short - circuit protection(magnetic)		
Current setting(A) Im		
	FTU	Fixed 10 × In
	FMU	Fixed 10 × In
	ATU	Adjustable 5, 6, 7, 8, 9,10 × In(6 settings)

Catalogue numbering system

TS400U ATU

Trip unit function (ATU)
- FTU : Fixed thermal & magnetic unit
- FMU : Adjustable thermal & fixed magnetic unit
- ATU : Adjustable thermal & adjustable magnetic unit

MCCB frame type (TS400U)
- TS400U : TS400NU, TS400HU

Thermal magnetic trip units FTU, FMU, ATU for TS400U

Setting details

Thermal overload protection

Trip unit type	Setting Ir	Trip unit rating, In (A)		
		300	350	400
TS400U FTU	Fixed	300	350	400
TS400U FMU	0.8	240	-	320
	0.9	270	-	360
	1	300	-	400
TS400U ATU	0.8	240	-	320
	0.9	270	-	360
	1	300	-	400

Magnetic short-circuit protection

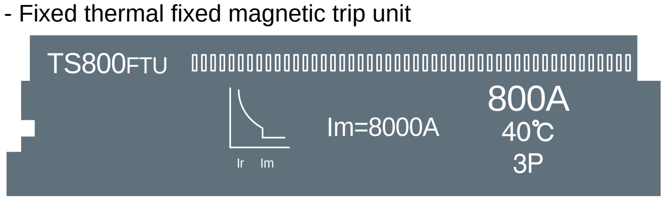
Trip unit type	Setting current, Ir	Setting current, Im		Trip unit rating, In (A)		
				300	350	400
TS400U FTU		Fixed	In × 10	3000	3500	4000
TS400U FMU	0.8 × In	Fixed	In × 10	3000	-	4000
	0.9 × In	Fixed	In × 10	3000	-	4000
	1.0 × In	Fixed	In × 10	3000	-	4000
TS400U ATU	0.8 × In	Adjustable	In × 5	1500	-	2000
			In × 6	1800	-	2400
			In × 7	2100	-	2800
			In × 8	2400	-	3200
			In × 9	2700	-	3600
			In × 10	3000	-	4000
	0.9 × In	Adjustable	In × 5	1500	-	2000
			In × 6	1800	-	2400
			In × 7	2100	-	2800
			In × 8	2400	-	3200
			In × 9	2700	-	3600
			In × 10	3000	-	4000
	1.0 × In	Adjustable	In × 5	1500	-	2000
			In × 6	1800	-	2400
			In × 7	2100	-	2800
			In × 8	2400	-	3200
			In × 9	2700	-	3600
			In × 10	3000	-	4000

Thermal magnetic trip units
FTU, FMU, ATU for TS800U

Configuration

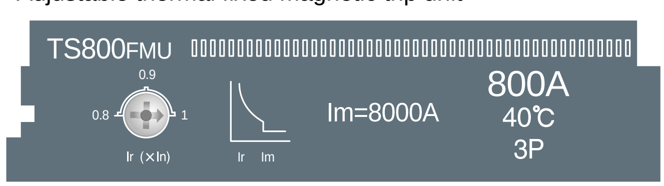
TS800U FTU

- Fixed thermal fixed magnetic trip unit



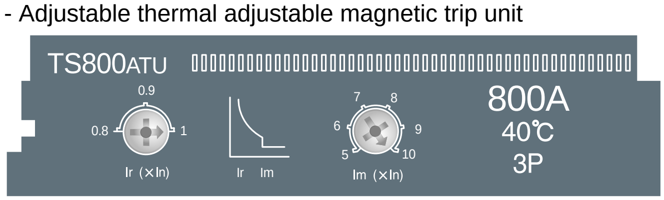
TS800U FMU

- Adjustable thermal fixed magnetic trip unit

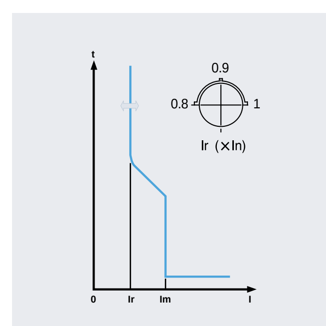


TS800U ATU

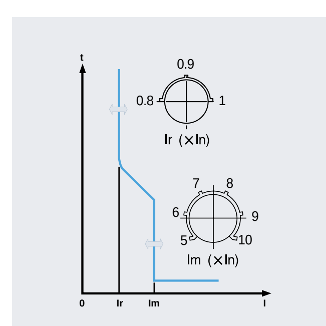
- Adjustable thermal adjustable magnetic trip unit



TS800U FMU



TS800U ATU



Thermal magnetic trip units
FTU, FMU, ATU for TS800U

Characteristics

Thermal magnetic trip units(FTU/FMU/ATU) ... TS800U					
Rating(A)	at 40℃ In	500	600	700	800
	TS800U	●	●	●	●

Overload protection(thermal)		
Current setting(A) Ir		
	FTU	Fixed
	FMU	Adjustable 0.8, 0.9,1 × In (3 settings)
	ATU	Adjustable 0.8, 0.9,1 × In (3 settings)

Short - circuit protection(magnetic)		
Current setting(A) Im		
	FTU	Fixed 10 × In
	FMU	Fixed 10 × In
	ATU	Adjustable 5, 6, 7, 8, 9, 10 × In (6 settings)

Catalogue numbering system

TS800U ATU

Trip unit function
- FTU : Fixed thermal & magnetic unit
- FMU : Adjustable thermal & fixed magnetic unit
- ATU : Adjustable thermal & adjustable magnetic unit

MCCB frame type
- TS800U : TS800NU, TS800HU

Thermal magnetic trip units
FTU, FMU, ATU for TS800U

Setting details

Thermal overload protection

Trip unit type	Setting	Trip unit rating, In (A)			
	Ir	500	600	700	800
TS800U FTU	Fixed	500	600	700	800
TS800U FMU	0.8	400	480	-	640
	0.9	450	540	-	720
	1	500	600	-	800
TS800U ATU	0.8	400	480	-	640
	0.9	450	540	-	720
	1	500	600	-	800

Magnetic short-circuit protection

Trip unit type	Setting current, Ir	Setting current, Im		Trip unit rating, In (A)			
				500	600	700	800
TS800U FTU		Fixed	In ×10	5000	6000	7000	8000
TS800U FMU	0.8 ×In	Fixed	In ×10	5000	6000	-	8000
	0.9 ×In	Fixed	In ×10	5000	6000	-	8000
	1.0 ×In	Fixed	In ×10	5000	6000	-	8000
TS800U ATU	0.8 ×In	Adjustable	In ×5	2500	3000	-	2000
			In ×6	3000	3600	-	4800
			In ×7	3500	4200	-	5600
			In ×8	4000	4800	-	6400
			In ×9	4500	5400	-	7200
			In ×10	5000	6000	-	8000
	0.9 ×In	Adjustable	In ×5	2500	3000	-	2000
			In ×6	3000	3600	-	4800
			In ×7	3500	4200	-	5600
			In ×8	4000	4800	-	6400
			In ×9	4500	5400	-	7200
			In ×10	5000	6000	-	8000
	1.0 ×In	Adjustable	In ×5	2500	3000	-	2000
			In ×6	3000	3600	-	4800
			In ×7	3500	4200	-	5600
			In ×8	4000	4800	-	6400
			In ×9	4500	5400	-	7200
			In ×10	5000	6000	-	8000

Molded case switch

Susol

The Molded case switch are different from the circuit-breakers in the absence of the conventional protection unit. They keep the overall dimensions, connection systems and accessories unchanged from the corresponding circuit-breakers. Installation standards require upstream protection. However, thanks to their high-set magnetic release, TD125U ... TS800U MCS are self protected.

TD series

				TD125U
Frame size			[AF]	125
Conventional thermal current, Ith			[A]	125
No. of poles				2, 3
Rated operational voltage, Ue	AC		[V]	600
	DC		[V]	
Rated operational current, Ie				
Rated impulse withstand voltage,Uimp			[kV]	
Rated insulation voltage, Ui			[V]	
Rated short-circuit making capacity, Icm			[kA peak]	
Rated short-time withstand current, Icw	1s		[A rms]	
	3s		[A rms]	
	20s		[A rms]	
Isolation behavior				
Trip unit (release)				
	● Molded case switch		MCS	
Connection	fixed	front-connection		
		rear-connection		
	plug-in	front-connection		
		rear-connection		
Mechanical life			[operations]	
Electrical life @415 V AC			[operations]	
Basic dimensions, W×H×D (front connection)	2-pole		[mm]	
	3-pole		[mm]	
Weight (front connection)	2-pole		[kg]	
	3-pole		[kg]	
Reference standard				

TS series		
		
250	400	800
250	400	800
2, 3	2, 3	2, 3
600	600	600

Trip unit identification


MCCB
TS 250N
SHUNT TRIP
AC 220-240V
DC — 250V
TS250FMU
250A
40°C
3P
Im=2500A
DANGER

A-3. Accessories

Electrical auxiliaries

The following devices are installed into all TD & TS circuit breakers regardless of frame size. And, the electrical auxiliaries can be easily installed in the accessory compartment of the circuit breakers which is cassette type.

UVT

Undervoltage release, UVT

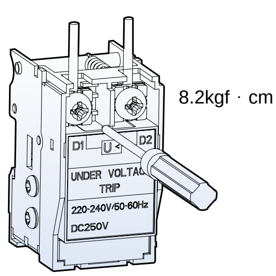
The undervoltage release automatically opens a circuit breaker when voltage drops to a value ranging between 35% to 70% of the line voltage. The operation is instantaneous, and after tripping, the circuit breaker cannot be re-closed again until the voltage returns to 85% of line voltage.

Continuously energized, the undervoltage release must be operating before the circuit breaker can be closed. The undervoltage release can be easily installed in the left accessory compartment of the Susol TD and TS circuit-breakers.

- Range of tripping voltage: 0.35 ~ 0.7Vn
- MCCB making is possible voltage: 0.85Vn (exceed)
- Frequency (only AC): 45Hz ~ 65Hz

Technical data

	Control voltage (V)	Consumption			Applicable MCCBs
		AC (VA)	DC (W)	mA	
Power consumption	AC/DC 24V	0.64	0.65	27	TD125U, TS250U, TS400U, TS800U
	AC/DC 48V	1.09	1.10	23	
	AC/DC 110~130V	0.73	0.75	5.8	
	AC 200~240V/DC 250V	1.21	1.35	5.4	
	AC 380~440V	1.67	-	3.8	
	AC 440~480V	1.68	-	3.5	
Max.opening time (ms)		50			
Tightening torque of terminal screw		8.2kgf · cm			
Transformer operating voltage (V) - Drop (Circuit breaker trips) - Rise (Circuit breaker can be switched on)		 0.7~1.35Vn ~0.85Vn			



Electrical auxiliaries

SHT

Shunt release, SHT

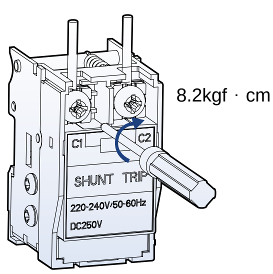
The shunt release opens the mechanism in response to an externally applied voltage signal. The releases include coil clearing contacts that automatically clear the signal circuit when the mechanism has tripped.

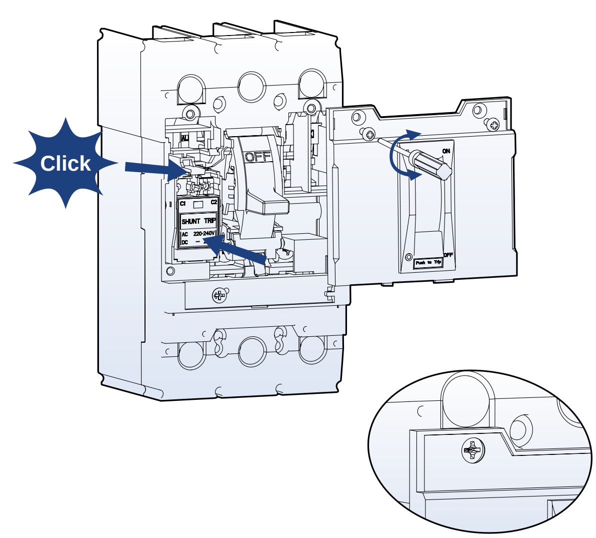
- Range of operational voltage: 0.7 ~ 1.1Vn
- Frequency (only AC): 45Hz ~ 65Hz

The shunt release can be installed in the left accessory compartment of the Susol TD & TS circuit-breakers.

Technical data

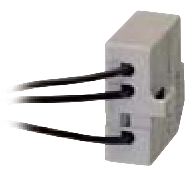
	Control voltage (V)	Consumption			Applicable MCCBs
		AC (VA)	DC (W)	mA	
Power consumption	DC 12V	-	0.36	30	TD125U, TS250U, TS400U, TS800U
	AC/DC 24V	0.58	0.58	24	
	AC/DC 48V	1.22	1.23	25	
	AC/DC 110~130V	1.36	1.37	10.5	
	AC 220~240V/DC250V	1.80	1.88	7.5	
	AC 380~500V	1.15	-	2.3	
Max.opening time (ms)		50			
Tightening torque of terminal screw		8.2kgf · cm			



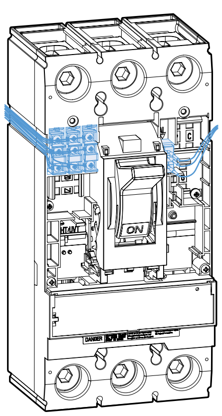


Electrical auxiliaries

AX



AL



Auxiliary switch (AX), Alarm switch (AL)

Auxiliary switch (AX)

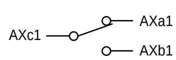
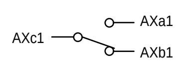
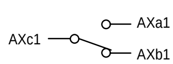
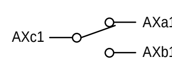
Auxiliary switch is for applications requiring remote “ON” and “OFF” indication.
Each switch contains two contacts having a common connection.
One is open and the other closed when the circuit breaker is open, and vice-versa.

Alarm switch (AL)

Alarm switches offer provisions for immediate audio or visual indication of a tripped breaker due to overload, short circuit, shunt trip, or undervoltage release conditions.
They are particularly useful in automated plants where operators must be signaled about changes in the electrical distribution system.

This switch features a closed contact when the circuit breaker is tripped automatically. In other words, this switch does not function when the breaker is operated manually.
Its contact is open when the circuit breaker is reset.

Contact operation

MCCB	ON	OFF	TRIP
Position of AX			
Position of AL			

Technical data

Conventional thermal current Ith	5A			TD125U, TS250U, TS400U, TS800U
Rated operational current Ie with rated operational voltage Ue	Voltage	Ie		
		Resistance	Inductance	
- Altemating current 50/60Hz AC	125V	5	3	
	250V	3	2	
	500V	-	-	
- Direct current DC	30V	4	3	
	125V	0.4	0.4	
	250V	0.2	0.2	

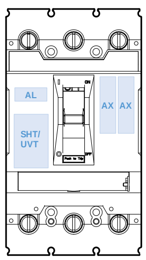
Electrical auxiliaries

Possible configuration of electrical auxiliaries

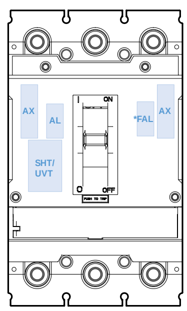
Maximum possibilities

Phase	Accessory	TD125U	TS250U	TS400U	TS800U
R (Left)	AX	-	1	3	3
	AL	1	1	-	-
	SHT or UVT	1	1	1	1
T (Right)	AX	2	1	-	-
	AL	-	-	1	2

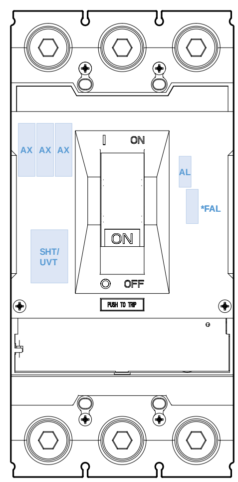
TD125U



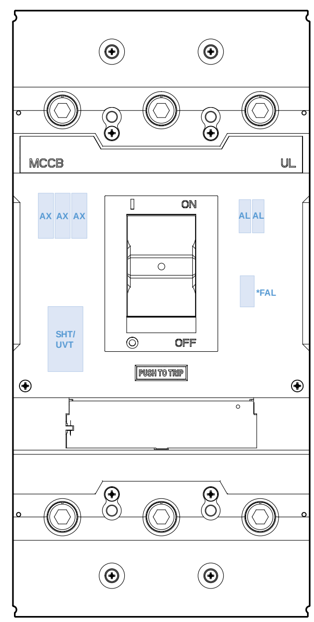
TS250U



TS400U



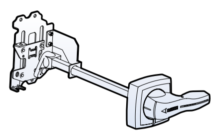
TS800U



Rotary handles

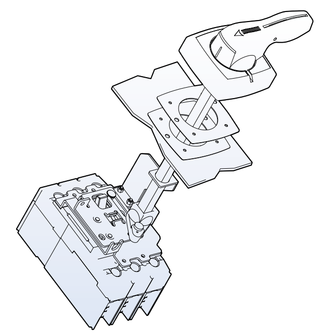
Extended handles

The rotary handle operating mechanism is available in either the direct version or in the extended version on the compartment door.



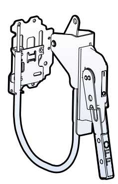
Extended rotary handles

MCCB	Extended Handle
TD125U	EH1
TS250U	EH2
TS400U	EH3
TS800U	EH4



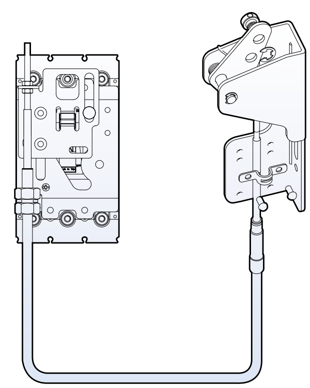
Flange Handle

The flange hanle is operated by cable and can be applied on the compartment door.
This device is designed to easily installed and operated for its own flexibility And, also can be selected various length (4 types) at each frames.



Flange handle
(Cable operating handle)

MCCB	Flange Handle
TD125U	FH1
TS250U	FH2
TS400U	FH3
TS800U	FH4



Locking devices

Removable locking device

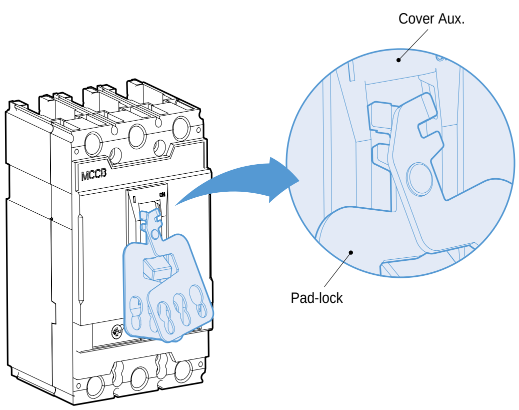
Removable locking device is available for all TD & TS circuit breakers.
The locking device is designed to be easily attached to the circuit-breaker.

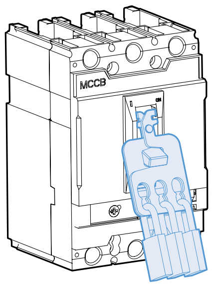
This device allows the handle to be locked in the “OFF” position.
Locking in the OFF position guarantee isolation according to UL489 File E223241.

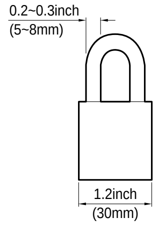
The locking device for the toggle handle can be installed in 2-pole and 3-pole circuit-breakers. Maximum three (3) padlocks with shackle diameters ranging from 0.2~0.3inch(5~8mm) may be used. (Padlocks are not supplied)

Removable locking device

MCCB	Padlockable device	Function
TD125U	PL1	“OFF” position
TS250U	PL2	
TS400U	PL3	
TS800U	PL4	







Padlock dimensions

Locking devices

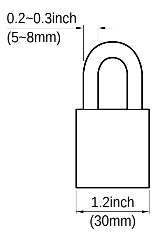
Fixed locking device

Fixed locking device is available for all TD & TS circuit breakers.
This device allows the handle to be locked in the “ON” and “OFF” position.
Locking in the OFF position guarantee isolation according to IEC 60947-2.

The locking device for the toggle handle can be installed in 2-pole and 3-pole circuit-breakers. Maximum three (3) padlocks with shackle diameters ranging from 0.2~0.3inch(5~8mm) may be used. (Padlocks are not supplied)

Fixed locking device

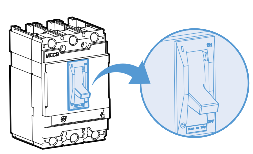
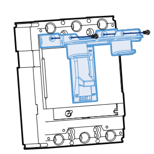
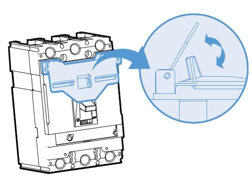
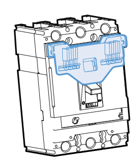
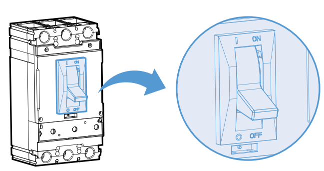
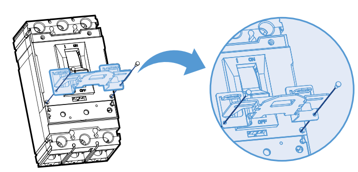
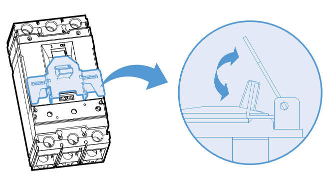
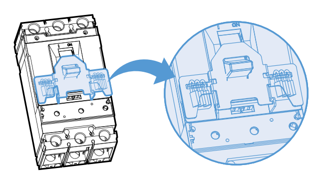
MCCB	Padlockable device	Function
TD125U	PHL1	Lock in Off or On position
TS250U	PHL2	
TS400U	PHL3	
TS800U	PHL4	



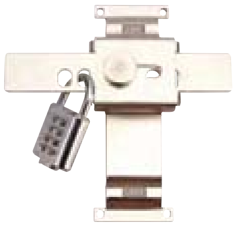
Padlock dimensions

How to use

The locking device for the toggle handle is designed to be easily attached to the front of circuit-breaker.
① Please set the toggle handle in the position of “On” or “Off”.
② Install the lock device onto the front of auxiliary cover of circuit breaker.
③ Folding the wings of lock device as shown in picture 3.
④ The padlock to be used shall be that which is commercially available with the nominal dimension.
(1.2inch (30mm), nominal dimension, 0.2~0.3inch (5~8mm) diameter)

TD125U	① 	② 
	③ 	④ 
TS250U ~ TS800U	① 	② 
	③ 	④ 

Interlock



Mechanical Interlock
(Padlocks are not supplied)

Mechanical interlocking device

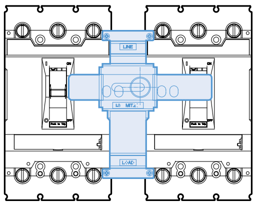
The mechanical interlock (MIT) can be applied on the front of two breakers mounted side by side, in either the 3-pole version and prevents simultaneous closing of the two breakers.

Fixing is carried out directly on the cover of the breakers.

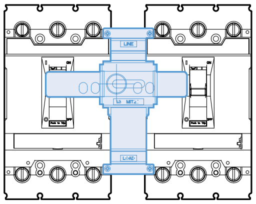
The front interlocking plate allows installation of a padlock in order to fix the position. (possibility of locking in the O-O position as well)

This mechanical interlocking device is very useful and simple for consisting of manual source-changeover system.

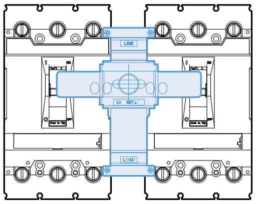
Operation



Left MCCB: ON/OFF is possible
Right MCCB: Off lock

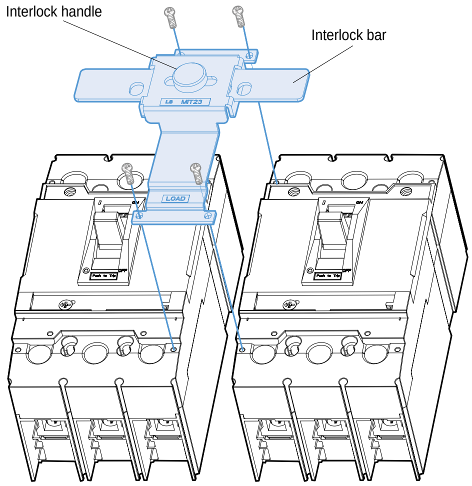


Left MCCB: Off lock
Right MCCB: ON/OFF is possible



Both MCCBs are of locked

MCCB		Interlock
Frame type	Pole	
TD125U	3-pole	MIT13
	4-pole	MIT14
TS250U	3-pole	MIT23
	4-pole	MIT24
TS400U	3-pole	MIT33
	4-pole	MIT34
TS800U	3-pole	MIT43
	4-pole	MIT44




Susol
MCCB
TS 250L
LS

A-4. Technical information

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°C. Namely, when the ambient temperature is greater than 40°C, 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.

Susol TD & TS series MCCB with thermal-magnetic trip units

MCCB	Rating (A)	Fixed MCCB (c/w Thermal-magnetic trip unit)							
		-12.2°F 10°C	-6.7°F 20°C	-1.1°F 30°C	4.4°F 40°C	10°F 50°C	15.6°F 60°C	21.1°F 70°C	26.7°F 80°C
TD125U	15	15	15	15	15	15	14	13	12
	20	20	20	20	20	19	19	18	16
	30	30	30	30	30	29	28	26	24
	40	40	40	40	40	39	38	35	33
	50	50	50	50	50	48	47	44	41
	60	60	60	60	60	58	56	53	49
	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
TS250U	150	150	150	150	150	145	140	131	121
	160	160	160	160	160	155	150	141	131
	175	175	175	175	175	170	165	156	146
	200	200	200	200	200	194	188	176	164
	225	225	225	225	225	219	213	201	189
	250	250	250	250	250	242	234	220	205
TS400U	300	300	300	300	300	291	281	264	246
	350	350	350	350	350	341	331	314	296
	400	400	400	400	400	388	375	353	328
TS800U	500	500	500	500	500	484	469	441	410
	600	600	600	600	600	580	571	525	487
	700	700	700	700	700	680	661	625	587
	800	800	800	800	800	775	750	705	656

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

Power dissipation / Resistance

Susol TD & TS series MCCB with thermal-magnetic trip units

	AF	TD125U (2P & 3P)								
	Rating (A)	15	20	30	40	50	60	80	100	125
Fixed MCCB	R (mΩ)	5.60	5.60	3.80	1.84	1.34	1.10	0.91	0.70	0.61
	Watt single pole	1.43	2.24	3.89	2.94	3.35	4.37	5.82	7.00	9.53
	Watt three poles	4.30	6.72	11.67	8.83	10.05	13.10	17.47	21.00	28.59

	AF	TS250U (2P & 3P)					
	Rating (A)	150	160	175	200	225	250
Fixed MCCB	R (mΩ)	0.62	0.62	0.52	0.52	0.25	0.25
	Watt single pole	13.95	15.87	15.93	20.80	12.66	15.79
	Watt three poles	41.85	47.62	47.78	62.40	37.97	47.38

	AF	TS400U(2P & 3P)		
	Rating (A)	300	350	400
Fixed MCCB	R (mΩ)	0.30	0.30	0.30
	Watt single pole	26.82	36.75	47.68
	Watt three poles	80.46	110.25	143.04

	AF	TS800U (2P & 3P)			
	Rating (A)	500	600	700	800
Fixed MCCB	R (mΩ)	0.49	0.49	0.12	0.12
	Watt single pole	122.50	176.40	58.80	76.80
	Watt three poles	367.50	529.20	176.40	230.40

- 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.

AC240V

Capacity of 3 phase transformer (kVA)		Below 1500	Below 1500	Below 2000
Capacity of single phase transformer (kVA)		Below 300		-
Breaking capacity (kA) (sym)		50	100	
Frame (A)	125	TD125NU	TD125HU	
	250	TS250NU	TS250HU	
	400	TS400NU	TS400HU	
	800	TS800NU	TS800HU	

AC480V

Capacity of 3 phase transformer (kVA)		Below 2000		Below 3000
Breaking capacity (kA) (sym)		35	65	
Frame (A)	125	TD125NU	TD125HU	
	250	TS250NU	TS250HU	
	400	TS400NU	TS400HU	
	800	TS800NU	TS800HU	

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.

TD125U, TS250U~800U equipped with Thermal magnetic trip units

Transformer ratings (kVA)			MCCB rated current (A)	Trip unit
1 phase 240V	3 phase 240V 1 phase 415V	3 phase 415V		
3 to 4	5 to 6	8 to 10	15	FTU FMU ATU
4 to 5	6 to 8	10 to 14	20	
5 to 7	9 to 12	14 to 21	30	
7 to 9	13 to 16	21 to 28	40	
9 to 12	16 to 20	28 to 35	50	
12 to 14	20 to 24	35 to 43	60	
14 to 19	24 to 32	43 to 57	80	
19 to 24	32 to 41	57 to 71	100	
24 to 30	41 to 51	71 to 89	125	
30 to 36	51 to 62	89 to 107	150	
36 to 42	62 to 72	107 to 125	175	
42 to 48	72 to 83	125 to 143	200	
48 to 54	83 to 93	143 to 161	225	
54 to 60	93 to 103	161 to 179	250	
60 to 72	103 to 124	179 to 215	300	
72 to 84	124 to 145	215 to 251	350	
84 to 96	145 to 166	251 to 287	400	
96 to 120	166 to 207	287 to 359	500	
120 to 144	207 to 249	359 to 431	600	
144 to 168	249 to 290	431 to 503	700	
168 to 192	290 to 332	503 to 575	800	

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 50	100
12	15	TD125NU	TD125HU
16	20		
24	30		
32	40		
40	50		
48	60		
64	80		
80	100		
100	125		
120	150	TS250NU	TS250HU
140	175		
160	200		
180	225		
200	250		
240	300	TS400NU	TS400HU
280	350		
320	400		
400	500	TS800NU	TS800HU
480	600		
560	700		
640	800		

Application
Protection of lighting & heating circuits

AC480V

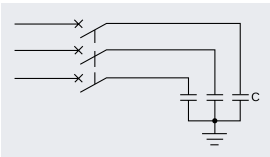
The maximum operating current (A)	The rated current of MCCB (A)	Breaking capacity (kA) sym 35	65
12	15	TD125NU	TD125HU
16	20		
24	30		
32	40		
40	50		
48	60		
64	80		
80	100		
100	125		
120	150	TS250NU	TS250HU
140	175		
160	200		
180	225		
200	250		
240	300	TS400NU	TS400HU
280	350		
320	400		
400	500	TS800NU	TS800HU
480	600		
560	700		
640	800		

Application
Protection of resistance welding circuits

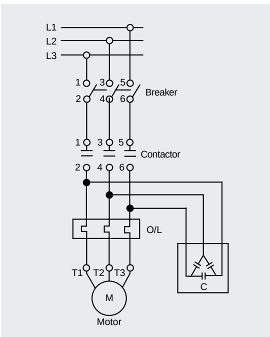
Short circuit protection for resistance welding devices can be obtained by applying molded case circuit breaker properly. These breakers permit normally high welding currents, but trip instantaneously if a short circuit develops. It's recommended to select proper circuit breaker according to the characteristics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

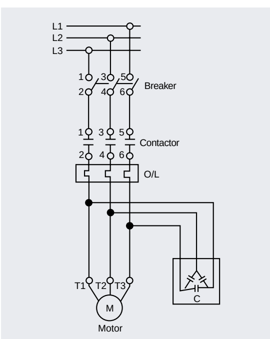
Characteristics of welding device		Applied circuit breaker (MCCB 2P)	
Capacity (kVA)	Maximum input (kVA)	240V (Single phase)	415V (Single phase)
15	35	TD125NU/HU 125A	TD125NU/HU 50A
30	65	TS250NU/HU 150A	TD125NU/HU 125A
55	140	TS250NU/HU 250A	TD125NU/HU 125A

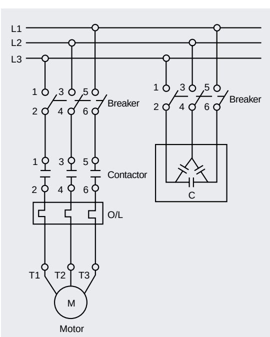
Application
Use of circuit-breakers for capacitor banks



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
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

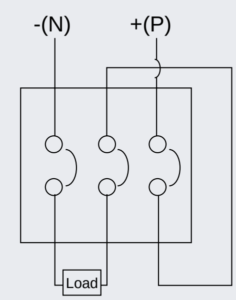
The followings are the most important criteria for selection of suitable circuit breaker for DC networks.

- 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

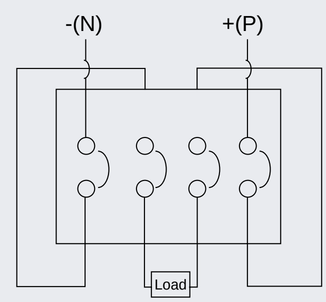
Setting range of the trip values

- 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	TD125NU	FTU FMU ATU	○	42
	TS250NU		○	50
	TS400NU			
	TS800NU			
	TD125HU		○	65
	TS250HU		○	85
	TS400HU			
	TS800HU			

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)
15	TD125NU, TD125HU	FTU FMU ATU	0.8	2
20			0.8	2
30			0.8	2
40			0.8	2
50			0.8	2
60			0.8	2
80			0.8	2
100			0.8	2
125			0.8	2
150	TS250NU, TS250HU		0.8	2
160			0.8	2
175			0.8	2
200			0.8	2
225			0.8	2
250			0.8	2
300	TS400NU, TS400HU		0.8	2
350			0.8	2
400			0.8	2
500	TS800NU, TS800HU		0.8	2
600			0.8	2
700			0.8	2
800			0.8	2

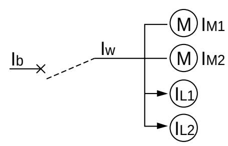
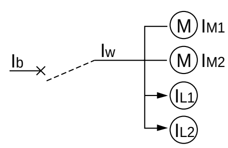
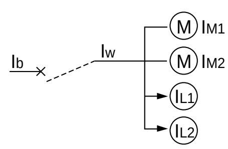
Note) K1 × Multiplier factor of rated current (In)
K2-Multiplier factor of instantaneous current due to the induced magnetic fields
FTU-Fixed Thermal and magnetic trip unit
FMU × Adjustable thermal and fixed magnetic trip unit
ATU × Adjustable thermal and magnetic trip unit

Application
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 (HP/ A) 1kw · 1.3405hp															
		1.005 4.8	2.018	2.950 11.1	4.96 17.4	7.37 26	10.05 34	14.75 48	20.10 65	24.80 79	29.49 93	40.21 125	49.60 160	60.32 190	73.73 230	100.53 310	120.64 360
3	15	20	30	30													
4.5	20	40	40	40	50												
6.3	30	40	40	40	50	80											
8.2	40	50	50	50	50	80	100										
12	50	80	80	80	80	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	700	700	700	700	700	700	700	700	700	700	700	700	700	700	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

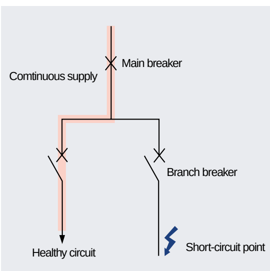
The rated current of breakers as the main circuit of 3 phase inductive loads (AC 440V)

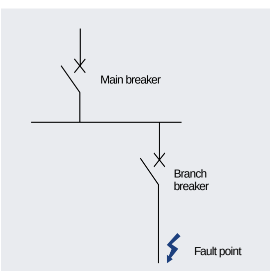
Capacity of loads In total (below kW)	The maximum operating current (below A)	Capacity of the highest motor (HP/ A) 1kw · 1.3405hp																
		1.005 4.8	2.01 8	2.950 11.1	4.96 17.4	7.37 26	10.05 34	14.75 48	20.10 65	24.80 79	29.49 93	40.21 125	49.60 160	60.32 190	73.73 230	100.53 310	120.64 360	147.45 220
3	7.5	20	20	20														
4.5	10	20	20	20	40													
6.3	15	20	20	20	40	40												
8.2	20	40	40	40	40	40	50											
12	25	40	40	40	40	40	50											
15.7	38	50	50	50	50	50	50	80	80									
19.5	45	50	50	50	50	50	50	80	80	100								
23.2	50	80	80	80	80	80	80	80	80	100	125							
30	63	80	80	80	80	80	80	80	80	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
125	250	300	300	300	300	300	300	300	300	300	300	300	300	300	300	400	400	500
150	300	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	500
175	350	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	500	700
200	400	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	700
250	500	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	800
300	600	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	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

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

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 240V

Complementary technical information

Main: Susol UL TD   Branch: Susol UL TD, TS

Branch breaker		Main breaker	TD125NU	TD125HU	TS250NU	TS250HU
		Rated breaking capacity (kArms)	50	100	50	100
Susol TD & TS	TD125NU	50	-	75	-	75
	TD125HU	100	-	-	-	-
	TS250NU	50	-	75	-	75
	TS250HU	100	-	-	-	-
	TS400NU	50	-	75	-	75
	TS400HU	100	-	-	-	-
	TS800NU	50	-	75	-	75
	TS800HU	100	-	-	-	-

Branch breaker		Main breaker	TS400NU	TS400HU	TS800NU	TS800HU
		Rated breaking capacity (kArms)	50	100	50	100
Susol TD & TS	TD125NU	50	-	75	-	75
	TD125HU	100	-	-	--	
	TS250NU	50	-	75	-	75
	TS250HU	100	-	-	-	-
	TS400NU	50	-	75	-	75
	TS400HU	100	-	-	-	-
	TS800NU	50	-	75	-	75
	TS800HU	100	-	-	-	-

Protective coordination
Cascading, network 480V

Complementary technical information

Main: Susol UL TD   Branch: Susol UL TD, TS

Branch breaker		Main breaker	TD125NU	TD125HU	TS250NU	TS250HU
		Rated breaking capacity (kArms)	35	65	35	65
Susol TD & TS	TD125NU	35	-	50	-	50
	TD125HU	65	-	-	-	-
	TS250NU	35	-	50	-	50
	TS250HU	65	-	-	-	-
	TS400NU	35	-	50	-	50
	TS400HU	65	-	-	-	-
	TS800NU	35	-	50	-	50
	TS800HU	65	-	-	-	-

Branch breaker		Main breaker	TS400NU	TS400HU	TS800NU	TS800HU
		Rated breaking capacity (kArms)	35	65	35	65
Susol TD & TS	TD125NU	35	-	50	-	50
	TD125HU	65	-	-	-	-
	TS250NU	35	-	50	-	50
	TS250HU	65	-	-	-	-
	TS400NU	35	-	50	-	50
	TS400HU	65	-	-	-	-
	TS800NU	35	-	50	-	50
	TS800HU	65	-	-	-	-

Protective coordination
Cascading, network 600V

Complementary technical information

Main: Susol UL TD **Branch: Susol UL TD, TS**

Branch breaker		Main breaker	TD125NU	TD125HU	TS250NU	TS250HU
		Rated breaking capacity (kArms)	10	14	10	18
Susol TD & TS	TD125NU	10	-	12	-	14
	TD125HU	14	-	-	-	16
	TS250NU	10	-	12	-	14
	TS250HU	18	-	-	-	-
	TS400NU	14	-	-	-	16
	TS400HU	20	-	-	-	-
	TS800NU	18	-	-	-	-
	TS800HU	25	-	-	-	-

Branch breaker		Main breaker	TS400NU	TS400HU	TS800NU	TS800HU
		Rated breaking capacity (kArms)	14	20	18	25
Susol TD & TS	TD125NU	10	12	15	14	17
	TD125HU	14	-	17	16	19
	TS250NU	10	12	15	14	17
	TS250HU	18	-	19	-	21
	TS400NU	14	-	17	16	19
	TS400HU	20	-	-	-	22
	TS800NU	18	-	19	-	21
	TS800HU	25	-	-	-	-

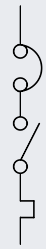
Protective coordination
Protection discrimination table, Discrimination

Complementary technical information

Main: TD125U (Thermal magnetic) **Branch: TD125U (Thermal magnetic)**

Branch breaker			Main breaker	TD125NU/HU									TS 250NU/ HU				
			Rating (A)	Trip units-Thermal magnetic									Trip units-Thermal magnetic				
				15	20	30	40	50	60	80	100	125	150	160	175	200	225
Susol TD & TS	N	Trip units-Thermal magnetic	15				0.5kA	0.5kA	0.5kA	0.63kA	0.8kA	2kA	2kA	2kA	T	T	T
			20					0.5kA	0.5kA	0.63kA	0.8kA	2kA	2kA	2kA	T	T	T
			30						0.5kA	0.63kA	0.8kA	2kA	2kA	2kA	T	T	T
			40							0.63kA	0.8kA	2kA	2kA	2kA	T	T	T
			50							0.63kA	0.8kA	2kA	2kA	2kA	T	T	T
			60								0.8kA	2kA	2kA	2kA	T	T	T
			80									1.25kA	2kA	2kA	T	T	T
			100										1.6kA	1.6kA	T	T	T
			125											1.25kA	1.25kA	4kA	4kA
	H		15				0.5kA	0.5kA	0.5kA	0.63kA	0.8kA	2kA	T	T	T	T	T
			20					0.5kA	0.5kA	0.63kA	0.8kA	2kA	T	T	T	T	T
			30						0.5kA	0.63kA	0.8kA	2kA	50kA	50kA	50kA	50kA	50kA
			40							0.63kA	0.8kA	2kA	50kA	50kA	50kA	50kA	50kA
			50							0.63kA	0.8kA	2kA	50kA	50kA	50kA	50kA	50kA
			60								0.8kA	2kA	50kA	50kA	50kA	50kA	50kA
			80										50kA	50kA	50kA	50kA	50kA
			100										50kA	50KA	50kA	50kA	50kA
			125										1.25kA	1.25kA	1.25kA	4kA	4kA
Susol TD & TS	N	Trip units-Thermal magnetic	150														
			160														
			175														
			200														
			225														
			250														
	H		150														1.25kA
			160														
			175														
			200														
			225														
			250														

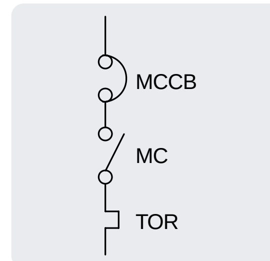
Protective coordination
SCCR according to UL489



Performance: Ue=240V		
MCCB	NU	HU
TD125U	50kA	100kA

Motor		MCCB		Contactor	Thermal overload relay	
hp (kW)	A	Type	Rating Ir (A)	Type	Type	Setting range (A)
0.49 (0.37)	1.8	TD125U	15	MC-9	MT-32	1.6-2.5
0.737 (0.55)	2.75	TD125U	15	MC-32	MT-32	2.5-4
1.005 (0.75)	3.5	TD125U	15	MC-32	MT-32	2.5-4
1.474 (1.1)	4.4	TD125U	15	MC-40	MT-63	4-6
2.01 (1.5)	6.1	TD125U	15	MC-40	MT-63	5-8
2.95 (2.2)	8.7	TD125U	15	MC-40	MT-63	9-13
4.02 (3)	11.5	TD125U	15	MC-40	MT-63	9-13
4.959 (3.7)	13.5	TD125U	15	MC-40	MT-63	12-18
5.36 (4)	14.5	TD125U	15	MC-40	MT-63	12-18
7.37 (5.5)	20	TD125U	20	MC-40	MT-63	16-22
10.05 (7.5)	27	TD125U	30	MC-40	MT-63	24-36
12.06 (9)	32	TD125U	40	MC-85	MT-95	28-40
13.41 (10)	35	TD125U	40	MC-85	MT-95	28-40
14.745 (11)	39	TD125U	40	MC-85	MT-95	34-50
20.11 (15)	52	TD125U	60	MC-85	MT-95	45-65

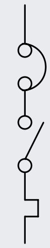
Protective coordination
SCCR according to UL489



Performance: Ue=480V		
MCCB	NU	HU
TD125U	50kA	100kA

Motor		MCCB		Contactor	Thermal overload relay	
hp (kW)	A	Type	Rating Ir (A)	Type	Type	Setting range (A)
0.49 (0.37)	1.03	TD125U	15	MC-9	MT-32	1-1.6
0.737 (0.55)	1.6	TD125U	15	MC-9	MT-32	1-1.6
1.005 (0.75)	2	TD125U	15	MC-9	MT-32	1.6-2.5
1.474 (1.1)	2.6	TD125U	15	MC-32	MT-32	2.5-4
2.01 (1.5)	3.5	TD125U	15	MC-32	MT-32	2.5-4
2.95 (2.2)	5	TD125U	15	MC-40	MT-63	4-6
4.02 (3)	6.6	TD125U	15	MC-40	MT-63	5-8
4.959 (3.7)	7.7	TD125U	15	MC-40	MT-63	6-9
5.36 (4)	8.5	TD125U	15	MC-40	MT-63	7-10
7.37 (5.5)	11.5	TD125U	15	MC-40	MT-63	9-13
10.05 (7.5)	15.5	TD125U	15	MC-40	MT-63	12-18
12.06 (9)	18.5	TD125U	20	MC-40	MT-63	16-22
13.41 (10)	20	TD125U	20	MC-40	MT-63	16-22
14.745 (11)	22	TD125U	30	MC-40	MT-63	16-22
20.11 (15)	30	TD125U	40	MC-85	MT-95	24-36
24.80 (18.5)	37	TD125U	40	MC-85	MT-95	28-40
29.49 (22)	44	TD125U	50	MC-85	MT-95	34-50
33.51 (25)	52	TD125U	80	MC-85	MT-95	45-65

Protective coordination
SCCR according to UL489



Performance: Ue=600V		
MCCB	NU	HU
TD125U	50kA	100kA

Motor		MCCB		Contactor	Thermal overload relay	
hp (kW)	A	Type	Rating Ir (A)	Type	Type	Setting range (A)
0.49 (0.37)	0.6	TD125U	15	MC-9	MT-32	0.4-0.63
0.737 (0.55)	0.9	TD125U	15	MC-9	MT-32	0.63-1
1.005 (0.75)	1.1	TD125U	15	MC-9	MT-32	1-1.6
1.474 (1.1)	1.5	TD125U	15	MC-9	MT-32	1-1.6
2.01 (1.5)	2	TD125U	15	MC-32	MT-32	1.6-2.5
2.95 (2.2)	2.8	TD125U	15	MC-32	MT-32	2.5-4
4.02 (3)	3.8	TD125U	15	MC-32	MT-32	2.5-4
4.959 (3.7)	4.4	TD125U	15	MC-40	MT-63	4-6
5.36 (4)	4.9	TD125U	15	MC-40	MT-63	4-6
7.37 (5.5)	6.6	TD125U	15	MC-40	MT-63	5-8
10.05 (7.5)	8.9	TD125U	15	MC-40	MT-63	7-10
12.06 (9)	10.6	TD125U	15	MC-85	MT-95	9-13
14.745 (11)	11.5	TD125U	15	MC-85	MT-95	9-13
20.11 (15)	14	TD125U	15	MC-85	MT-95	12-18
24.80 (18.5)	17.3	TD125U	20	MC-85	MT-95	16-22
29.49 (22)	21.3	TD125U	25	MC-85	MT-95	18-25
33.51 (25)	25.4	TD125U	32	MC-85	MT-95	24-36

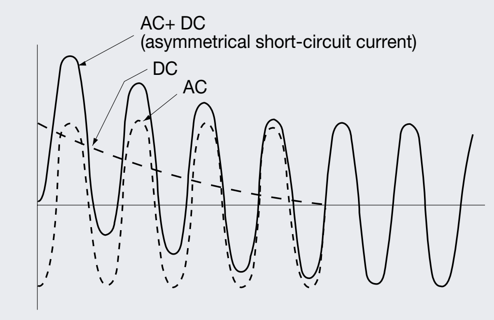
How to calculate short-circuit current value
Various short-circuit

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.

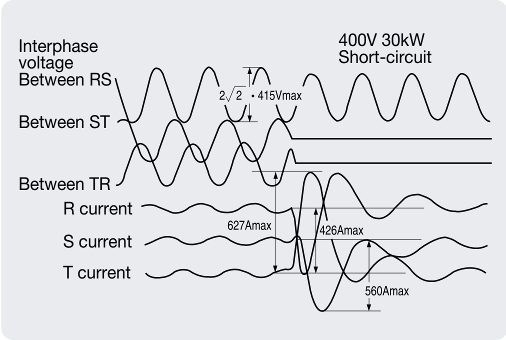
b. Impedance of incoming transformer Its amount is upon the capacity of transformer and primary voltage. Generally this impedance can be regarded as reactance and refer to <Table.4>, <Table.5>.

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

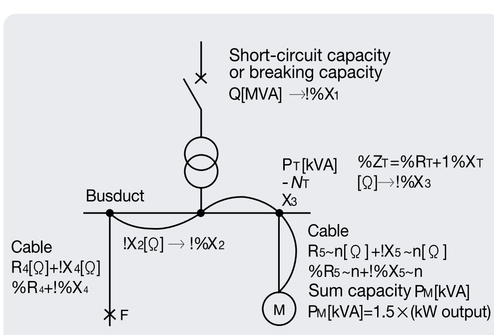
The rated current of transformer shall be the base value.

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.

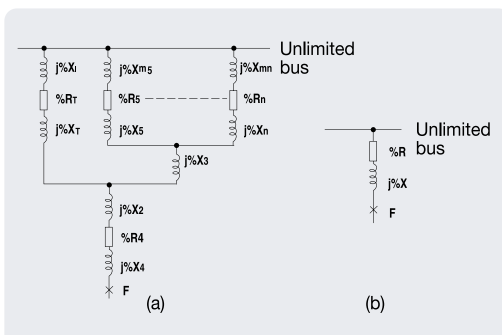
Calculating impedance

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

$I_F(3\phi) = I_F(rms)sym(3\phi)$

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

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

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

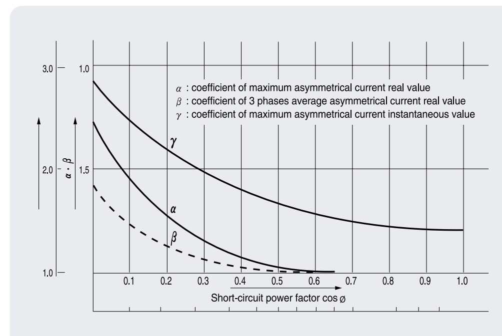
short-circuit power factor $\cos\phi = \frac{\%R}{\%Z}$

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

In case of 1 phase short-circuit

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

Each short-circuit current value $(1\phi) = \frac{\sqrt{3}}{2}$ (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

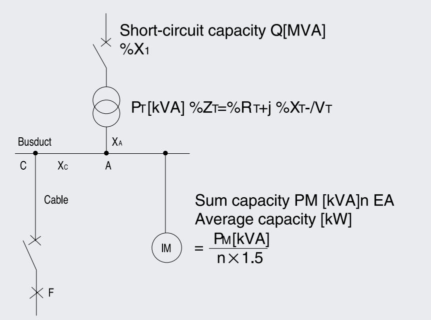
It shall be the rated current of transformer.

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

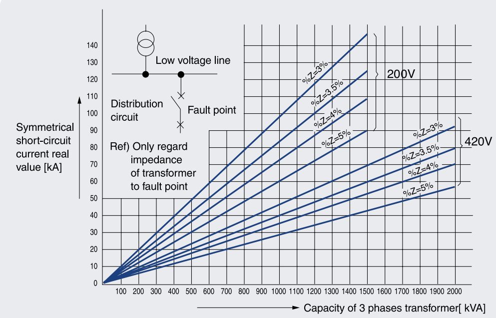
Disregard the impedance value of primary part of transformer. Calculate short-circuit current value according to <Fig.7>.
(If the impedance value of primary part of transformer is considered, calculate the current value as below formula)

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

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

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 $\frac{l\cdot I_A}{10VT}$

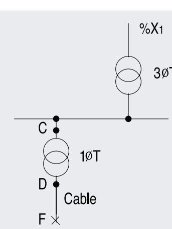
Calculate decreasing coefficient from <Fig.10>

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)



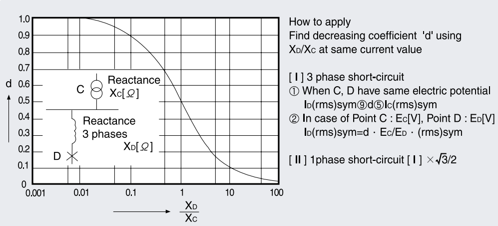
How to calculate short-circuit current value

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 · I_C

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

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

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



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

Coefficient d for cables

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

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>

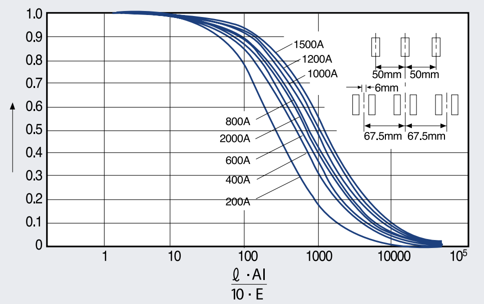
- 3 phases short-circuit asymmetrical current average value
  I_F (rms)ave= βI_F (rms)sym
- Maximum asymmetrical real value
  I_F (rms)ave= αI_F (rms)sym
- Maximum asymmetrical instantaneous value
  I_F (rms)ave= γI_F (rms)sym

<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	Variables: 3 phases short-circuit asymmetrical current average value	Variables: 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

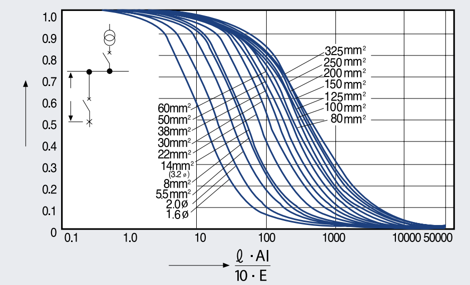
1 phase short-circuit

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

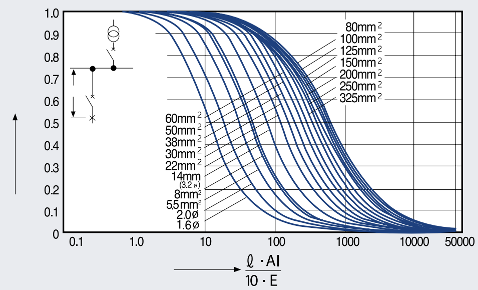


Busduct Ratings (A) Material		General busduct: Size [mm] [Ω/m]	Resistance R [Ω/m]	Reactance X [Ω/m]	Impedance Z [Ω/m]
Cu	200	3×25	2.41×10^{-4}	1.312×10^{-4}	2.74×10^{-4}
	400	6×40	0.751×10^{-4}	1.02×10^{-4}	1.267×10^{-4}
	600	6×50	0.607×10^{-4}	0.91×10^{-4}	1.094×10^{-4}
	800	6×75	0.412×10^{-4}	0.72×10^{-4}	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)



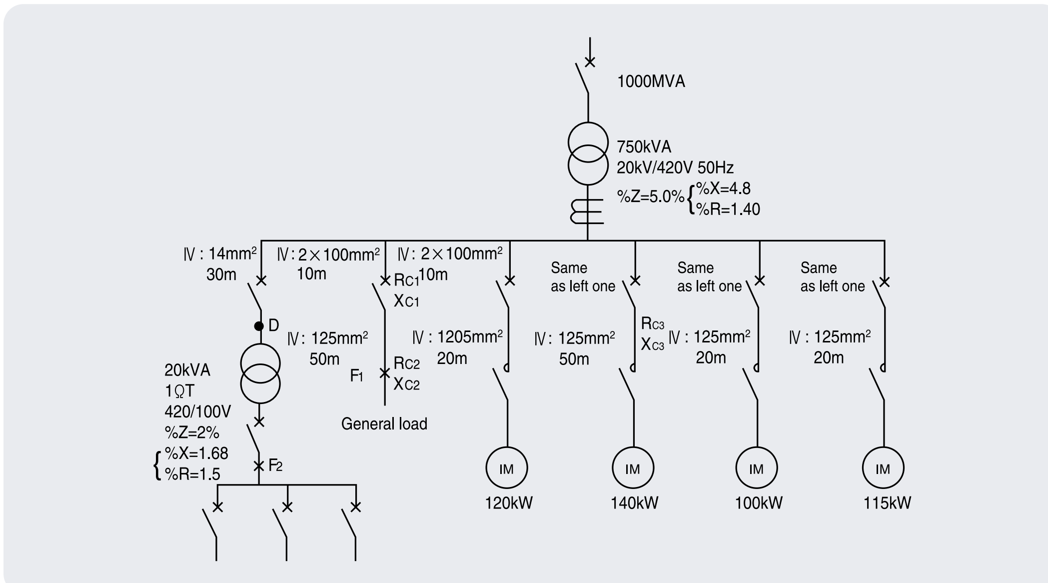
<Fig.11> Decreasing coefficient b in cable (600V IV)



<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 V_B = 420V

I_B = 1031A Z_B = 0.237 Ω

(2) Each impedance

a. Reactance at primary part of transformer

$$\%X_1 = \frac{750}{1000 \times 10^3} \times 100 = 0.075\ [\%]$$

b. Impedance of transformer

$\%R_T$ = 1.4%

$\%X_T$ = 4.8%

c. 1 ø Tr impedance

$$\%R_{T1} = \frac{1.15 \times 750}{20} \times \frac{1}{2} = 21.6\ [\%]$$

$$\%X_{T1} = \frac{1.68 \times 750}{20} \times \frac{1}{2} = 31.5\ [\%]$$

d. Reactance of transformer

$$\%X_{m1} = \frac{750}{120 \times 1.5} \times 25 = 104\ [\%]$$

$$\%X_{m2} = \frac{750}{140 \times 1.5} \times 25 = 89\ [\%]$$

$$\%X_{m3} = \frac{750}{100 \times 1.5} \times 25 = 125\ [\%]$$

$$\%X_{m4} = \frac{750}{115 \times 1.5} \times 25 = 108.7\ [\%]$$

e. Impedance of cable

Converting impedance of whole metal tube

[2×100mm² 10m]

$$\%R_{C1} = \frac{0.00018 \times 10}{0.237} \times \frac{1}{2} \times 100 = 0.38\ [\%]$$

$$\%X_{C1} = \frac{0.00013 \times 10}{0.237} \times \frac{1}{2} \times 100 = 0.27\ [\%]$$

[125mm² 20m]

$$\%R_{C2} = \frac{0.00014 \times 20}{0.237} \times 100 = 1.18\ [\%]$$

$$\%X_{C2} = \frac{0.00013 \times 20}{0.237} \times 100 = 1.09\ [\%]$$

[250mm² 50m]

$$\%R_{C3} = \frac{0.00007 \times 50}{0.237} \times 100 = 1.47\ [\%]$$

$$\%X_{C3} = \frac{0.00013 \times 50}{0.237} \times 100 = 2.74\ [\%]$$

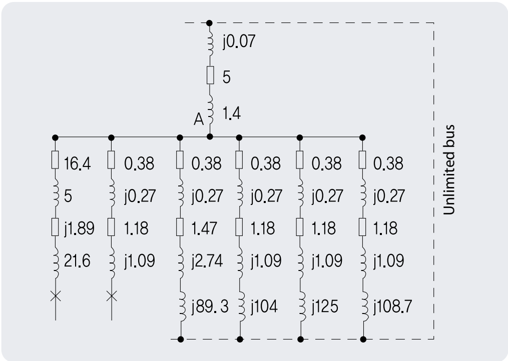
[14mm² 30m]

$$\%R_{C4} = \frac{0.00013 \times 30}{0.237} \times 100 = 16.45\ [\%]$$

$$\%X_{C4} = \frac{0.00015 \times 30}{0.237} \times 100 = 1.88\ [\%]$$

How to calculate short-circuit current value

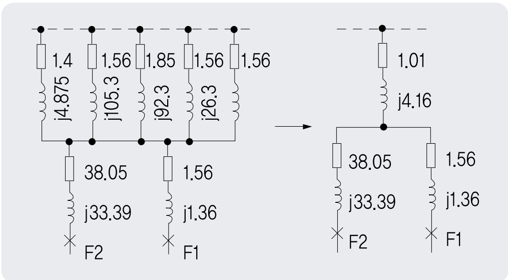
(3) Preparing a impedance map
Connect short-circuit supplier to the unlimited bus.



<Fig.14>

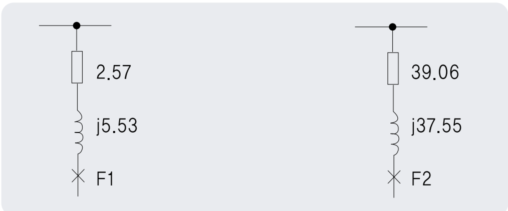
Calculating impedance

Calculate it in serial/parallel type formula



<Fig.15>

a. Fault point F_1 b. Fault point F_2



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

$= 6.1[\%]$ $= 54.2[\%]$

(5) Calculation of asymmetrical short-circuit current

a. Fault point F_1

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

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

b. Fault point F_2 (1 phase circuit)

IF_2 (rms)sym $= \dfrac{1031}{54.2} \times 100 = 1902$ [A] ⋯ (at 100V)

$= \dfrac{1031}{54.2} \times 100 \times \dfrac{420}{100} = 7989$ [A] ⋯ (at 420V)

IF_2 (rms)sym is short-circuit current. Therefore, convert it into 1 phase short-circuit current.

IF_2 (rms)1 Ω sym $= 7989 \times \dfrac{\sqrt{3}}{2} =$ 6919 [A]

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

(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 × 16900= 17407 [A]

I_{F1} (rms)asym= 1.05 × 16900= 17745 [A]

I_{F1}max= 1.74 × 16900= 29406 [A]

b. Fault point F_2

$\cos\varnothing_2 =$ 0.72

$\alpha = 1.0$ $\beta = 1.48$

I_{F2}1 ø (rms)asym= 1.0 × 6919 [A]

I_{F2}1 ø max= 1.48 × 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) × 1.5= 713 [kVA]

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

- $2 \times 100mm^2$ 10m

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

  $$\frac{l \; I_A}{10E} = \frac{20 \times 24420}{10 \times 420} = 29.1$$

  Coefficient b= 0.935

  Short-circuit current value at point C

  Ic (rms)sym= 0.935×24420= 22850 [A]

- $125mm^2$ 20m

  $$\frac{l \; I_C}{10E} = \frac{20 \times 22850}{10 \times 420} = 108.9$$

  I_{F1} (rms) sym= 0.785×244850= 17940 [A]

b. At point F_1

- $14mm^2$ 30m

  $$\frac{l \; I_C}{10E} = \frac{30 \times 24420}{10 \times 420} = 174.4$$

  Coefficient b= 0.249

  I_D (rms)3ø sym= 0.24×24420= 6080 [A]

- Decreasing by the reactance (1ø Tr)dp

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

  X_D= $750 \times 2/20$= 75%

  Impedance of primary part at 1ø Tr

  $$XA = \frac{I_B}{I_D} \times 100 = \frac{1031}{6080} \times 100[\%]$$

  Convert X_D to equivalent 3 phases, and

  $$\frac{X_D/2}{X_A} = \frac{750 \times 2 \times 6080}{20 \times 2 \times 1031 \times 100} = 2.21$$

  Coefficient d of <Fig.9> d= 0.32

  I_{F2} (rms)3ø sym= 0.32×6080=1945[A] (400V)

  = $0.32 \times 6080 \times 420/100$

  = 817 [A] (100V)

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

(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= 1.13×17940= 20272 [A]

IF1 (rms)asym= 1.25×17940= 22425 [A]

IF1max= 2.17×17940= 38930 [A]

b. At point F_2

α= 1.13 γ= 1.94

IF21ø (rms)asym= 1.13×7076= 7945 [A]

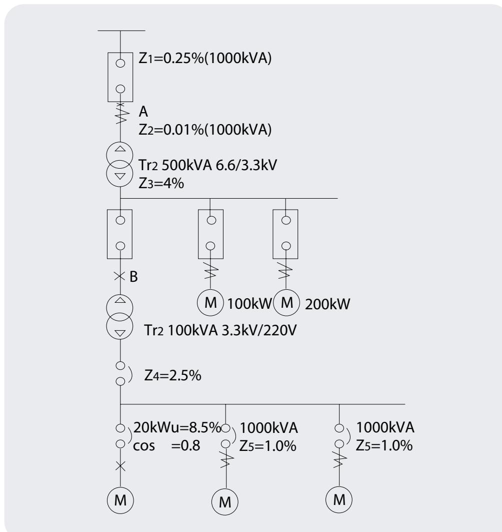
IF21ø max= 1.94×7076= 13727 [A]

<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

$$I_{nA}= \frac{500[kVA]\times 1000}{\sqrt{3}\times 6.6[kV]\times 1000} = 43.7[A]$$

② Rated current I_{nB} at point B

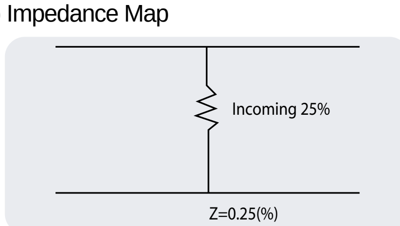
$$I_{nB}= \frac{100[kVA]\times 1000}{\sqrt{3}\times 3.3[kV]\times 1000} = 17.5[A]$$

$$I_{nC}= \frac{20[kW]\times 1000}{\sqrt{3}\times 220[V]\times 0.85\times 0.8} = 77.2[A]$$

(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}

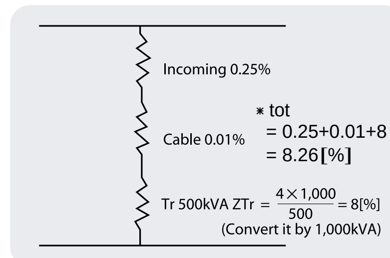
$$I_{SA}= \frac{1000[kVA]\times 1000\times 100}{\sqrt{3}\times 6.6[kV]\times 1000\times 0.25\%} = 34990[A]$$

⁎ 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[%]



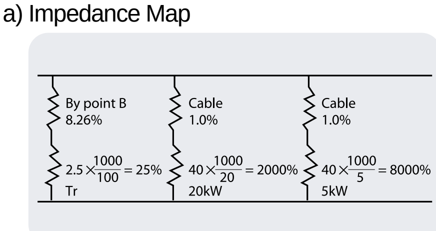
b) Short-circuit current I_{SC}

$$I_{SB}= \frac{1000[kVA]\times 1000\times 100}{\sqrt{3}\times 3.3[kV]\times 1000\times 8.26} = 2118[A]$$

⁎ 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}

$$I_{SC}= \frac{1000[kVA]\times 1000\times 100}{\sqrt{3}\times 220[V]\times 32.58[\%]} = 8055\ [A]$$

Calculation formula

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

$$\text{Short-circuit current Is} = \frac{\text{Transformer capacity}\times 100}{\sqrt{3}\times \text{Rated voltage}\times \%Z}$$

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

<Table. 3> Combination of transformer and impedance

Transformer / Impedance / Transformer capacity (VA)	3 phases transformer											
	6.3kV/210V Oil Tr.			6.3kV/210V Mold Tr.			20kV/420V Mold Tr.			20kV/420V Oil Tr.		
	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 / Transformer capacity (VA)	1 phase transformer					
	6.3kV/210V Oil Tr.			6.3kV/210V Mold Tr.		
	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				0.0089
ø 2mm				0.0056
ø 3.2mm	0.00020	0.00012	0.00031	0.0022
$5.5mm^2$				0.0033
$8mm^2$				0.0023
$14mm^2$				0.0013
$22mm^2$	0.00015	0.00010	0.00026	0.00082
$30mm^2$				0.00062
$38mm^2$				0.00048
$50mm^2$				0.00037
$60mm^2$				0.00030
$80mm^2$				0.00023
$100mm^2$				0.00018
$125mm^2$	0.00013	0.00009	0.00022	0.00014
$150mm^2$				0.00012
$200mm^2$				0.00009
$250mm^2$				0.00007
$325mm^2$				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)

$[\times 10^{-4}\ \Omega/m]$

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

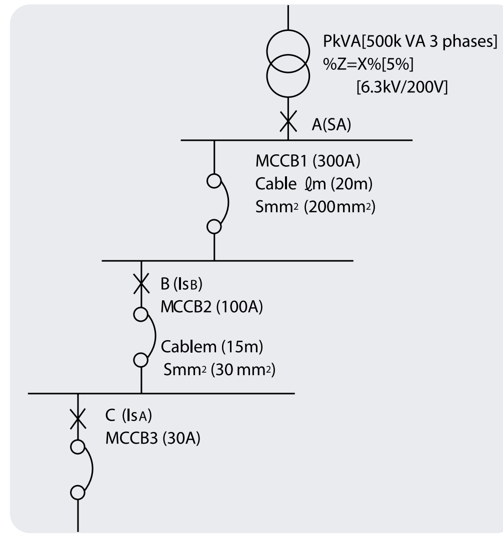
<Table.6> Impedance sample of Bus and busduct (50Hz)

$[\times 10^{-4}\ \Omega/m]$

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 (mm²)
ⓓ 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

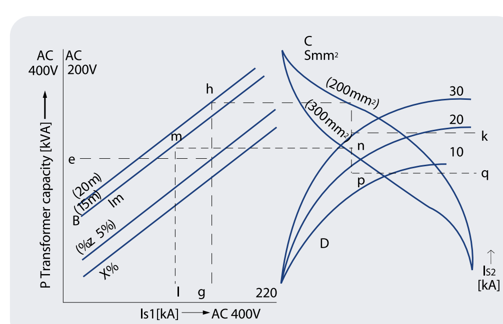
① Short-circuit current value where it is just below transformer. Find the value as same as that of 3 phase transformer and multiply it 3 times. (g'kA)

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.



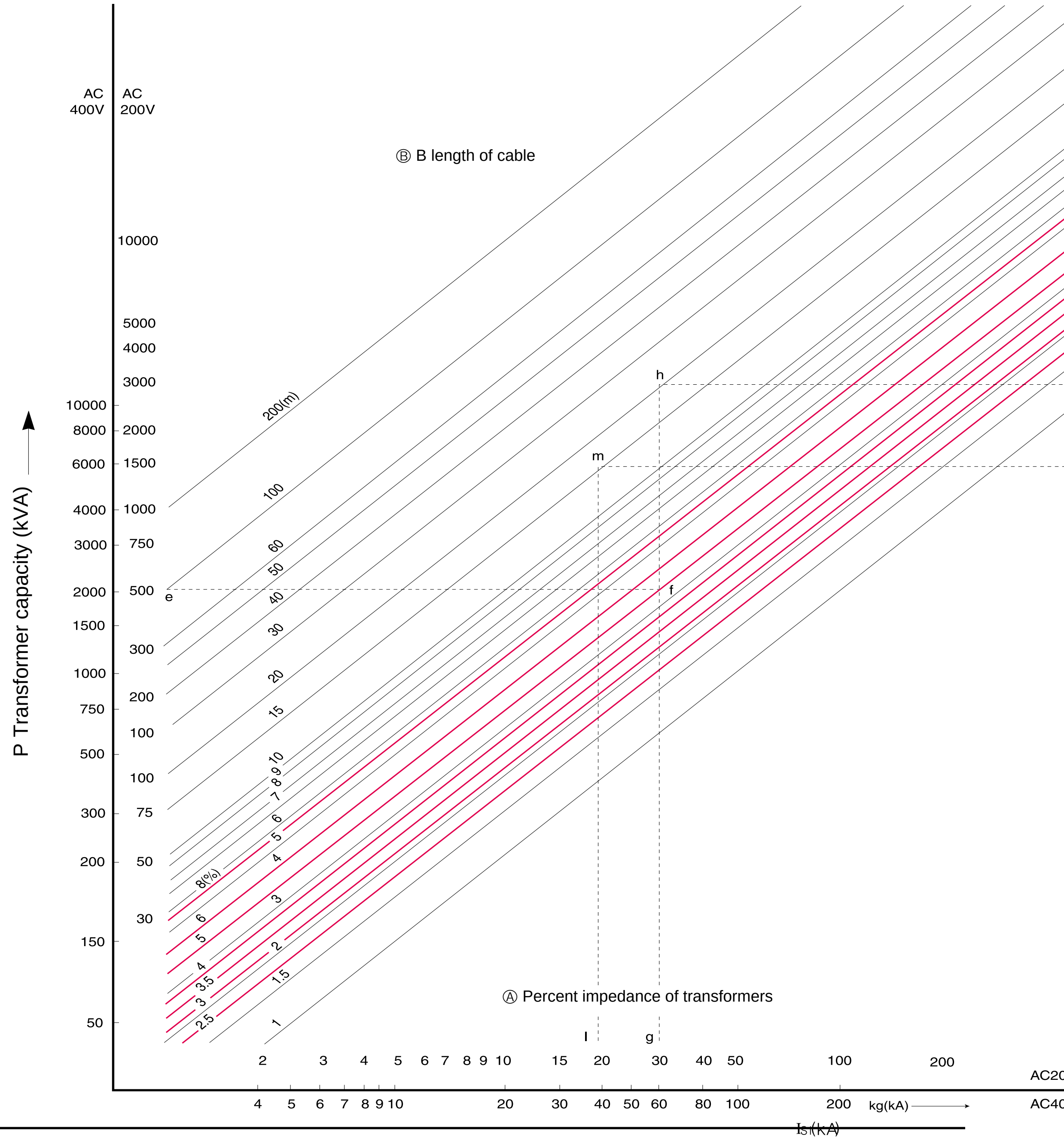
How to calculate short-circuit current value
Calculation graph

(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)

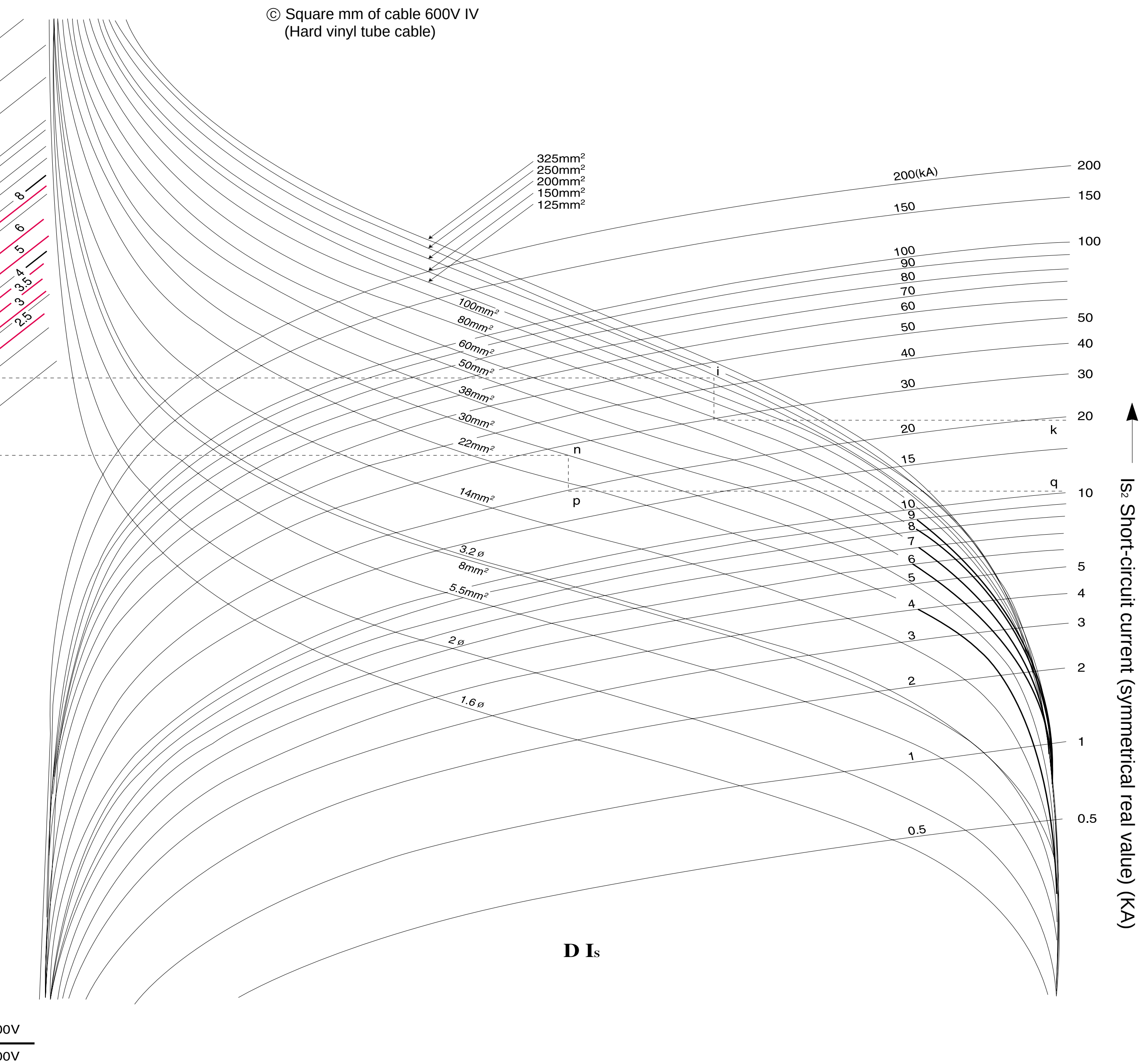
(2) Short-circuit current value at point B (I_{SB})

- 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 (Isc)

- Find Is1 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 Is1 coordinates, and find the cross point n at C line (30mm).
- Move n parallely to the direction of Is1 and find the cross point p of Is2with D line.
- Isc= 10kA (g)

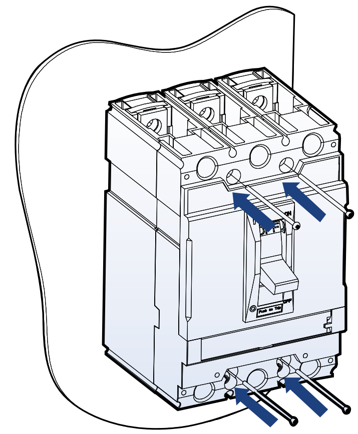


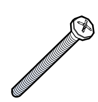
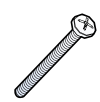
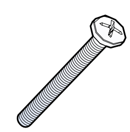
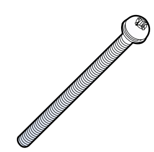
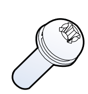
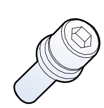

TRIP
OFF
In 250A

A-5. Mounting & Connection

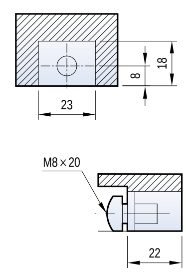
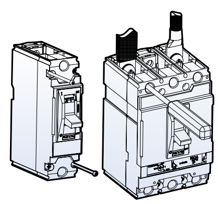
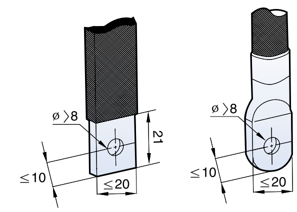
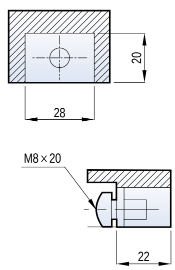
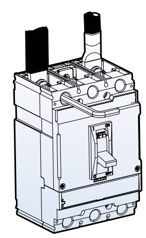
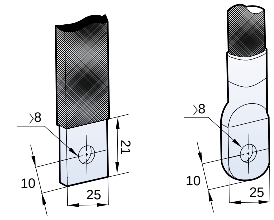
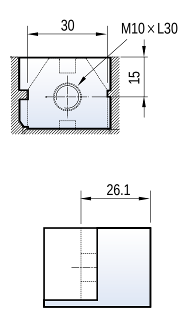
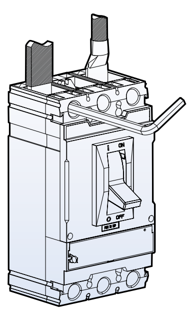
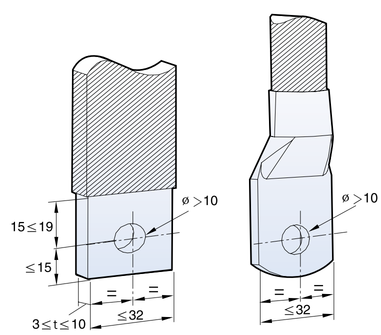
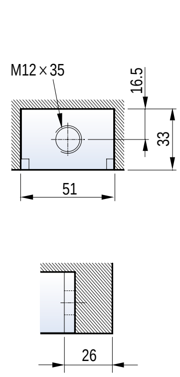
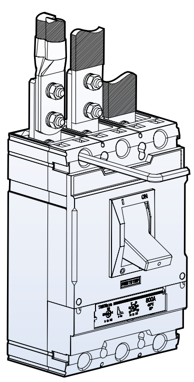
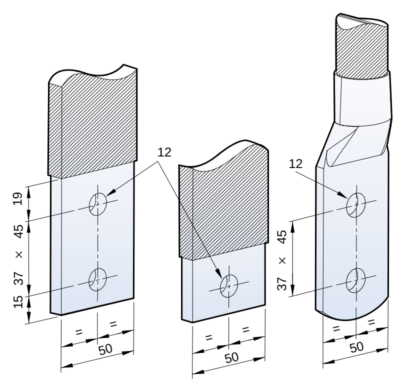
Fixed mounting

Susol TD and TS circuit-breakers can be directly connected to the mounting plate.
If busbars or terminals are used to connect the circuit breaker
on the back of the mounting plate,
the appropriate safety clearances must be observed.



	TD125U	TS250U	TS400U	TS800U
Screw for mounting				
	2/3Pole:4EA (NO.8-32 UNC-2A, L82)		2/3Pole:4EA (NO.10-24 UNC-2A,L90)	2/3Pole:4EA (1/4"-20 UNC2A, L102)
Screw for connection of terminals,	 2Pole:4EA(M5×L16) 3Pole:6EA(M5×L16)	 2Pole:4EA(M8×L20) 3Pole:6EA(M8×L20)		
	Torque: Max 78kgf · cm	Torque: Max 147kgf · cm		

Connecting terminal & conductor

		Terminal (mm)	Conductor (mm)
TD125U		 Max 78kgf · cm	
TS250U		 Max 147kgf · cm	
TS400U		 Max 490kgf · cm	
TS800U		 Max 630kgf · cm	

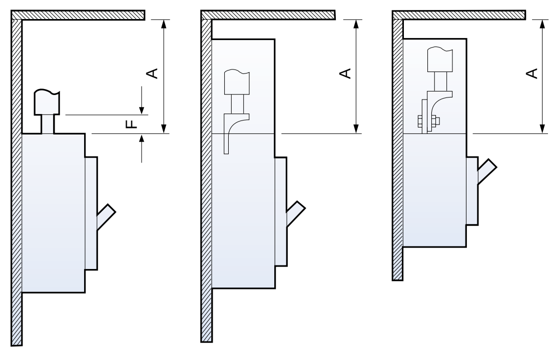
Safety clearance

When installing a circuit breaker, safety clearances must be kept between the breaker and panels, bars and other protection devices installed nearby. These safety clearances are depend on the ultimate breaking capacity and are defined by tests carried out in accordance with standard IEC 60947-2.

When a short circuit interruption occur, high temperatures pressures are present in and above the arc chambers of the circuit-breaker. In order to allow the pressure to be distributed and to prevent fire and arcing or short-circuit currents, safety clearances are required.

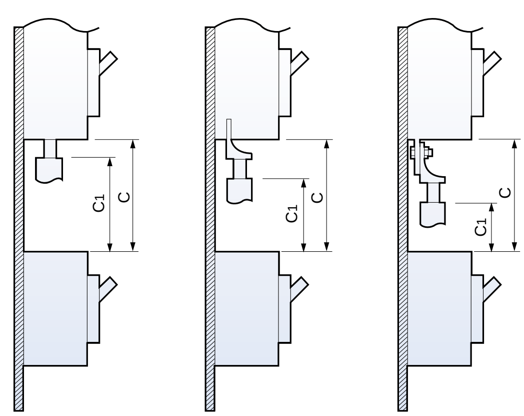
A: Insulation distance to ceiling for installation in metallic cubicle

	A(mm)	
	415V	240V
TD125NU	35	30
TD125NH	35	30
TS250UN	35	30
TS250UH	35	30
TS400UN	60	50
TS400UH	60	50
TS800UN	100	80
TS800UH	100	80



C1: Minimum distance for superimposed circuit breakers
(from lower circuit breaker to uninsulated part of terminal of upper circuit breaker)
C: C1+ the dimension of exposed conducting part (The dimension of exposed conduct)

	C1(mm)		C(mm)
	415V	240V	
TD125NU	35	30	The dimension of exposed conduct
TD125NH	35	30	
TS250UN	35	30	
TS250UH	35	30	
TS400UN	60	50	
TS400UH	60	50	
TS800UN	100	80	
TS800UH	100	80	



Direct connection of cable

Connection by using a cable terminal or ring terminal

Connection by using a cable terminal with extended terminal

Safety clearance

D: Insulated length of main terminal of circuit breaker

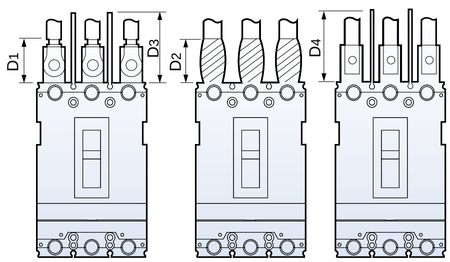
D1: Connection by ring terminal after taping (Larger than the dimension of exposed conducting part)

D2: Connection by bar after taping

D3: Connection by ring terminal using insulation barrier (Larger than the dimension of exposed conduct

D4: Connection by bar using insulation barrier

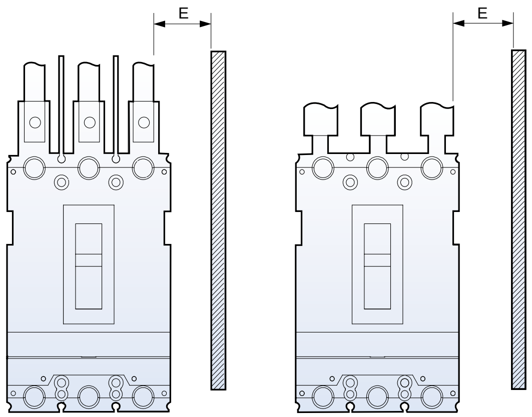
	D1 (mm)	D2 (mm)	D3 (mm)	D4 (mm)
TD125NU	The dimension of exposed conduct + 20	50	The dimension of exposed conduct + 20	50
TD125NH		50		50
TS250UN		100		100
TS250UH		100		100
TS400UN		100		100
TS400UH		200		200
TS800UN		100		100
TS800UH		200		200



Note) If uninsulated conductors are used for connection, please insulate by taping to the point where the conductors overlap with the insulation barrier or to the root of the circuit breaker.

E: Distance from a side of breaker to side plate

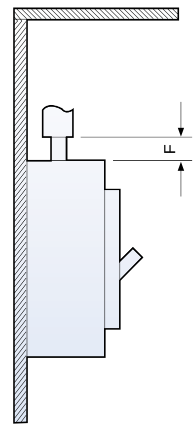
	E(mm)	
	415V	240V
TD125NU	25	15
TD125NH	25	15
TS250UN	25	15
TS250UH	25	15
TS400UN	20	15
TS400UH	20	15
TS800UN	45	20
TS800UH	45	20



Safety clearance

F: The dimension of exposed conducting part

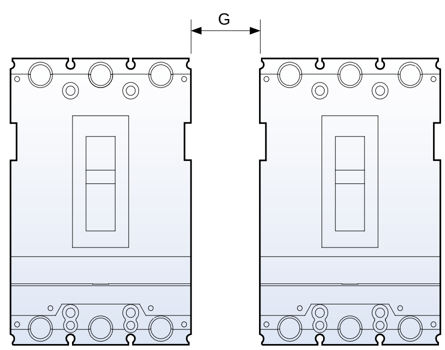
	F (mm)
TD125NU	20
TD125NH	20
TS250UN	10
TS250UH	10
TS400UN	10
TS400UH	10
TS800UN	10
TS800UH	10



G: Minimum center distance for two horizontally installed circuit-breakers

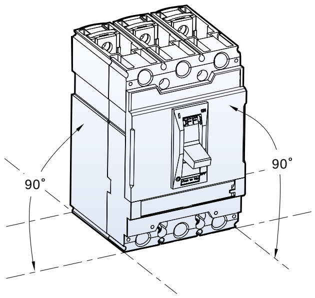
	G (mm)
TD125NU	0
TD125NH	0
TS250UN	0
TS250UH	0
TS400UN	0
TS400UH	0
TS800UN	0
TS800UH	0

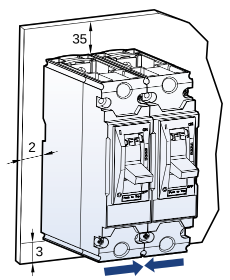
Note) In case of using long or short terminal covers.

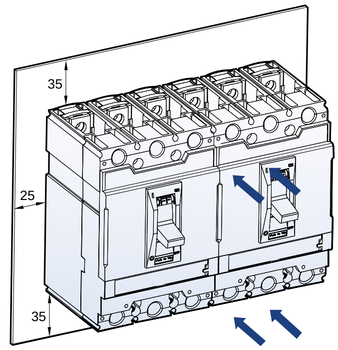


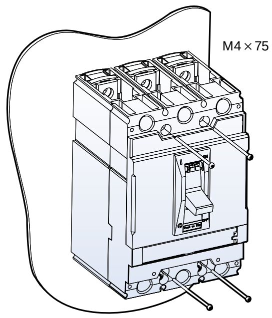
Example of installation

TD125U
TS250U

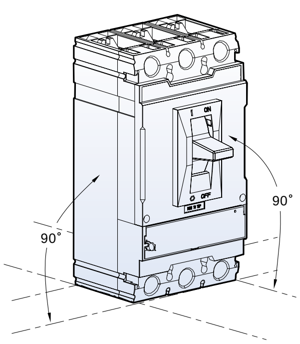


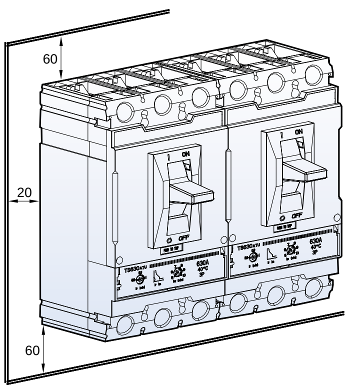


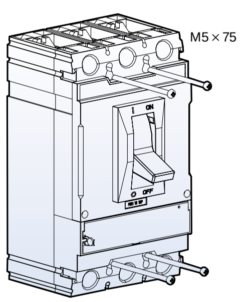




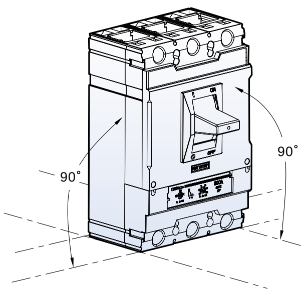
TS400U

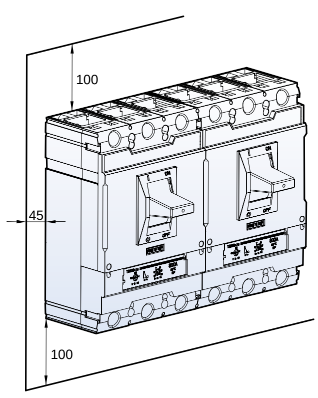


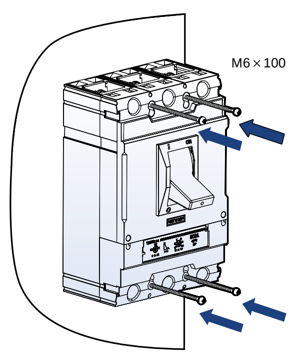




TS600U







Note) In case of using long or short terminal covers,
no need to consider on minimum center distance for two horizontally installed circuit-breakers.


Susol
LS

A-6. Characteristics curves

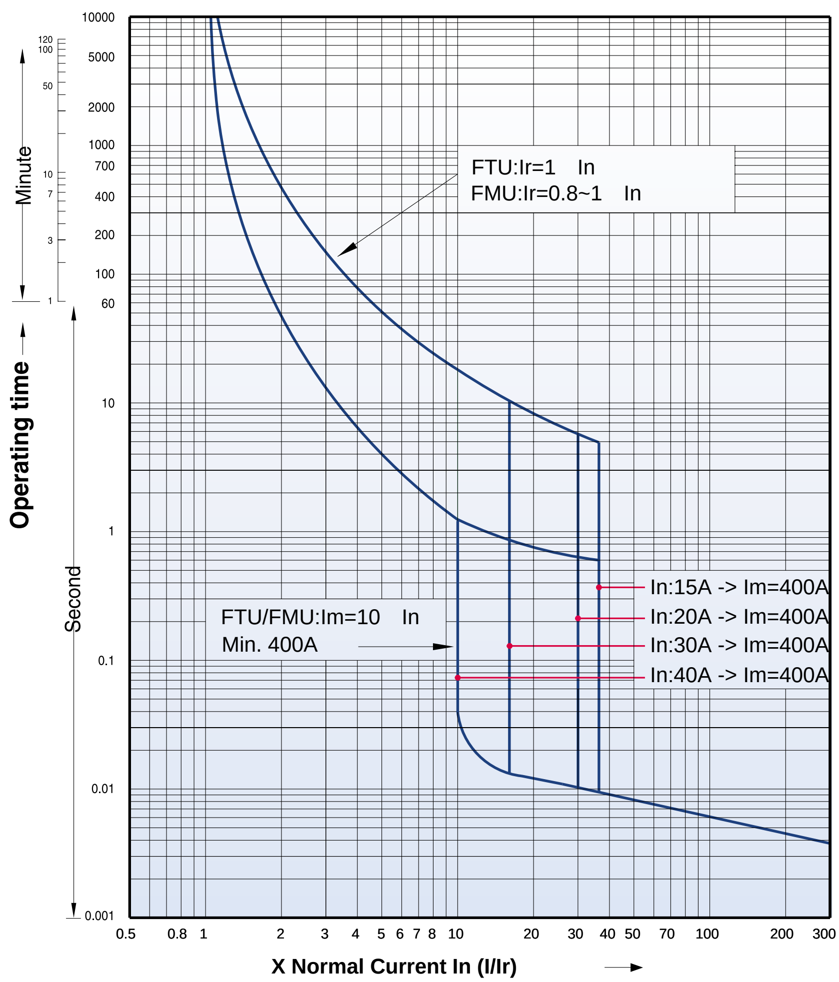
Circuit breakers with thermal-magnetic trip units

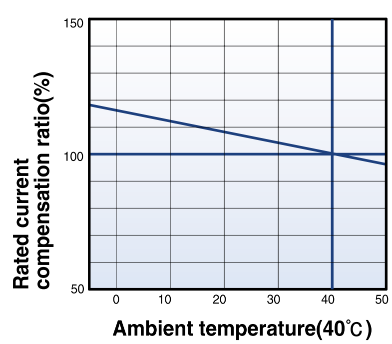
TD125U

FTU

FMU

15~125A





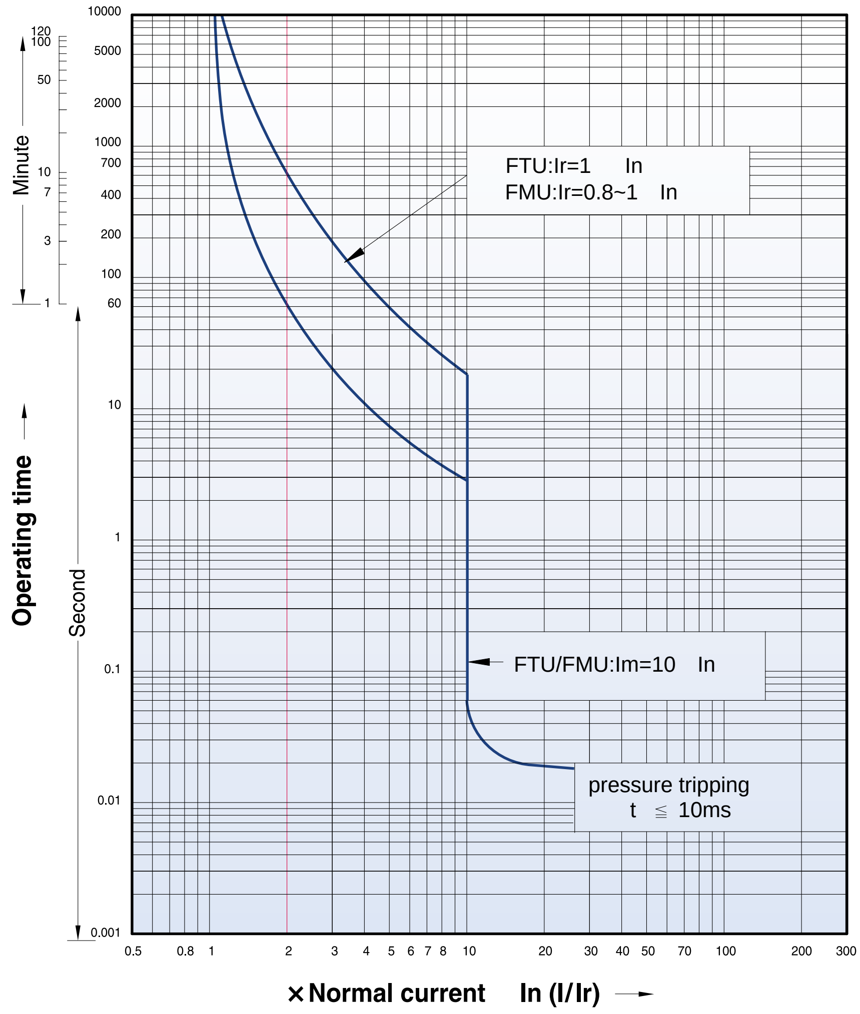
Circuit breakers with thermal-magnetic trip units

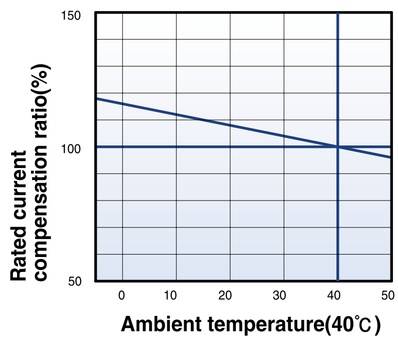
TS250U

FTU

FMU

150~250A



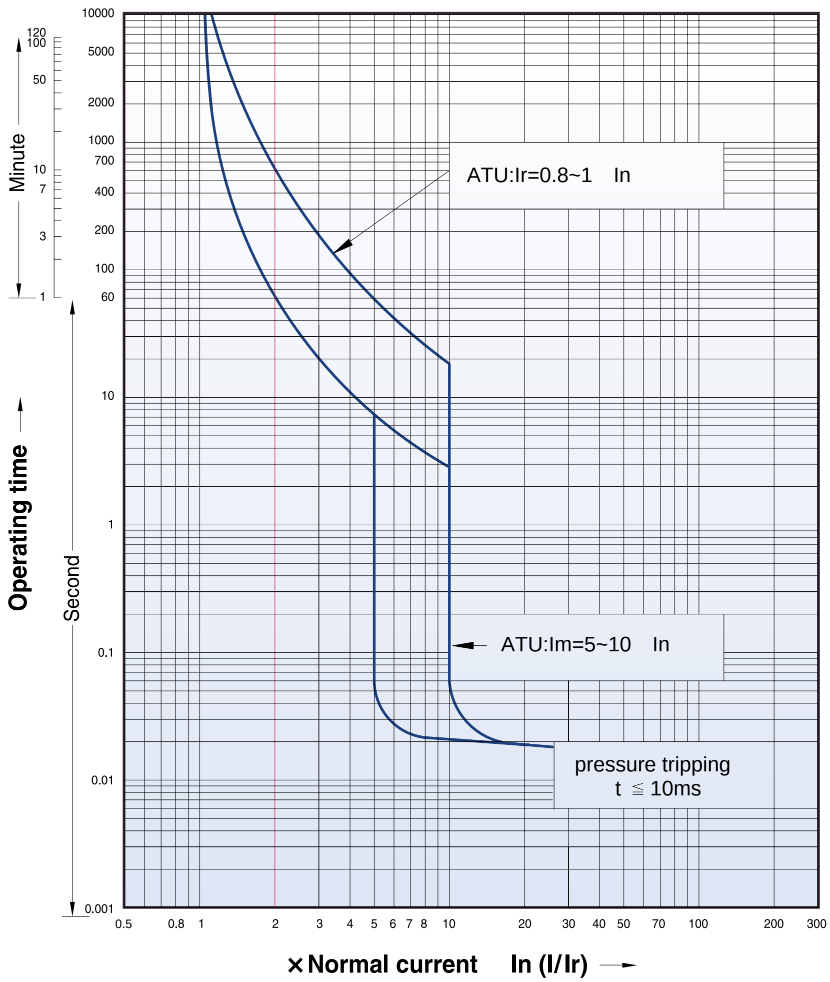


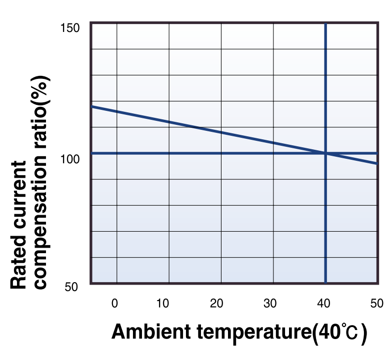
Circuit breakers with thermal-magnetic trip units

TS250U

ATU

160~250A

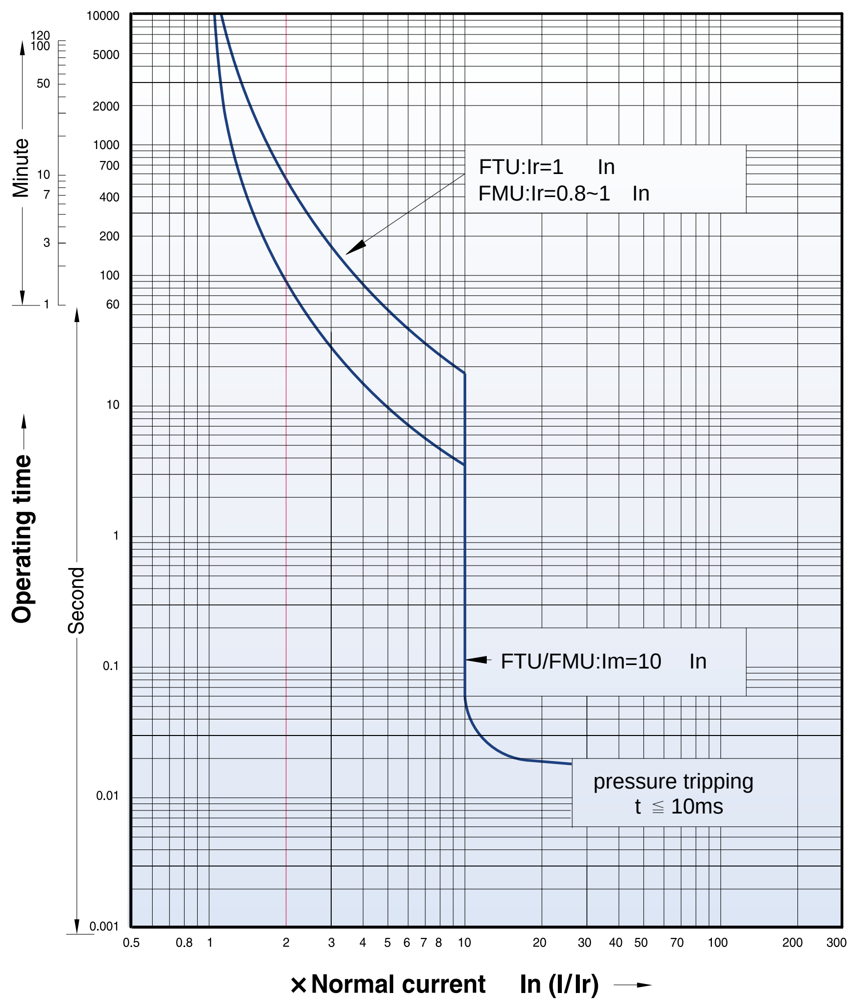


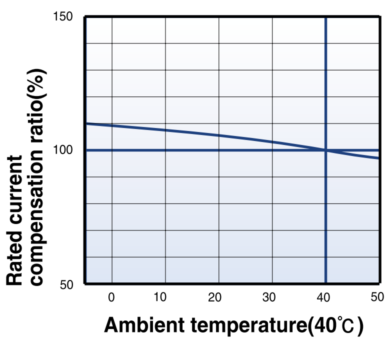


Circuit breakers with thermal-magnetic trip units

TS400U

FTU
FMU
300~400A



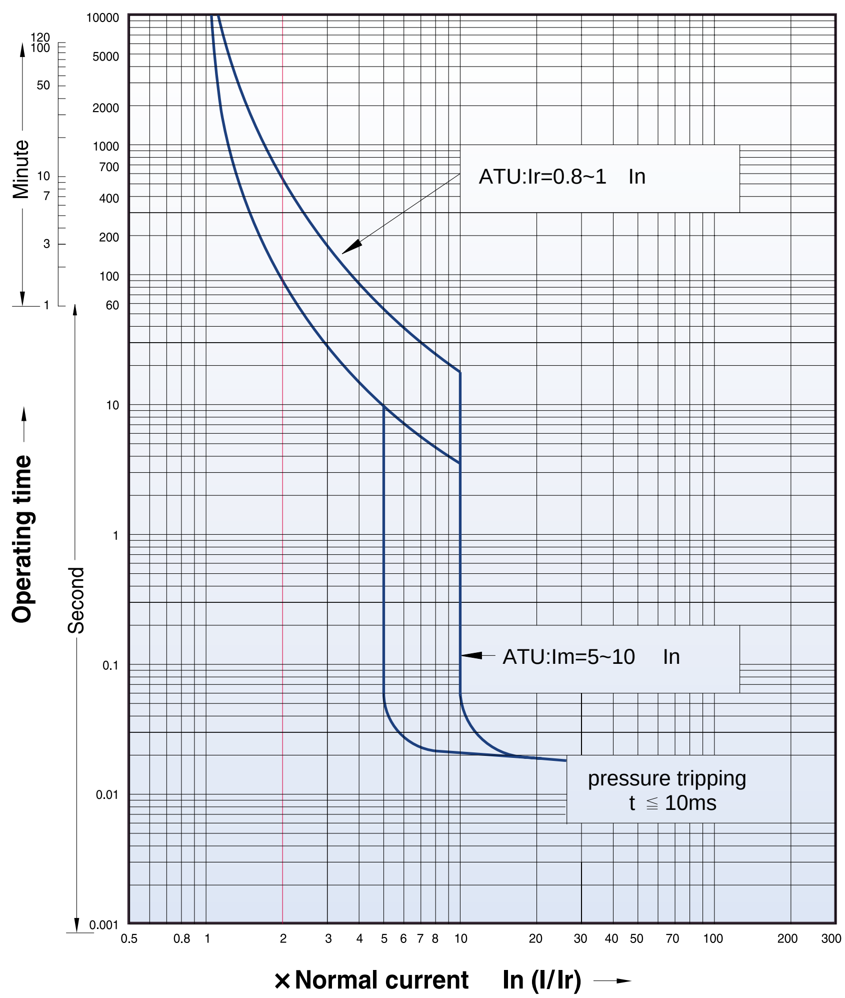


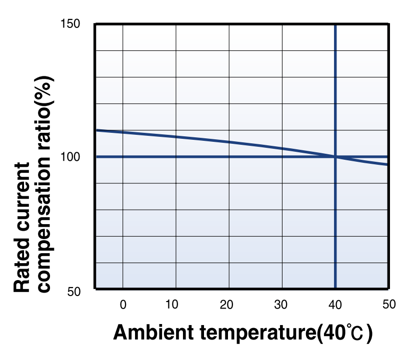
Circuit breakers with thermal-magnetic trip units

TS400U

ATU

300~400A





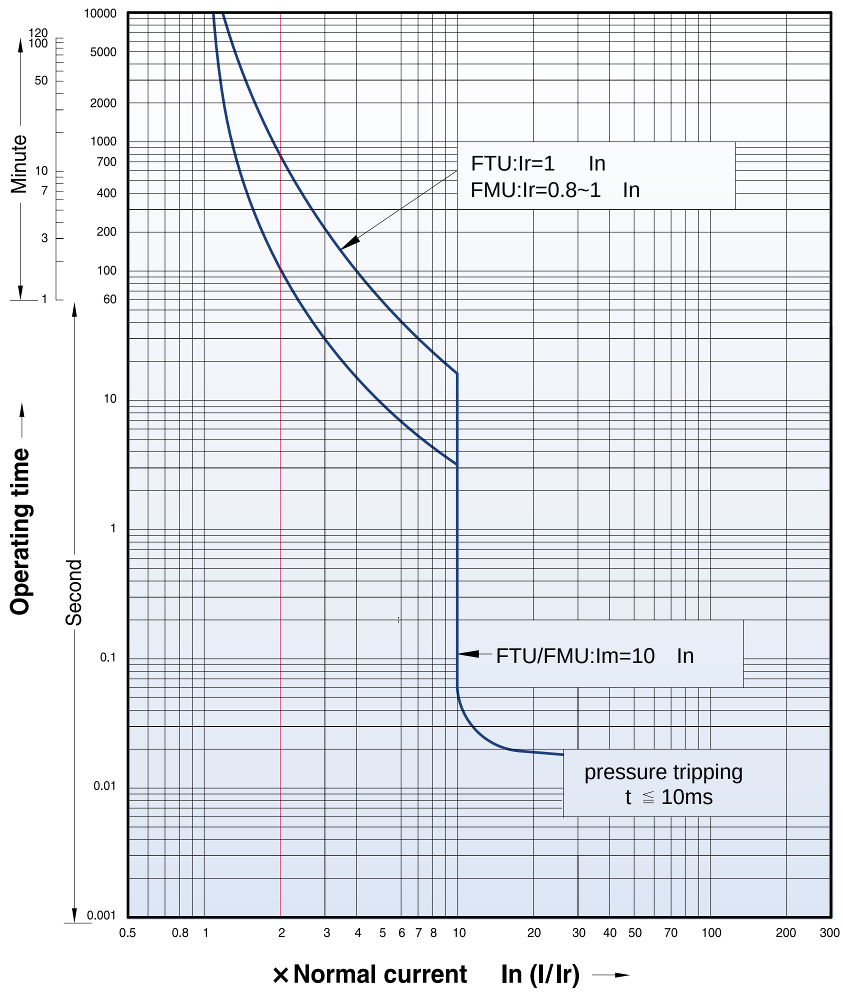
Circuit breakers with thermal-magnetic trip units

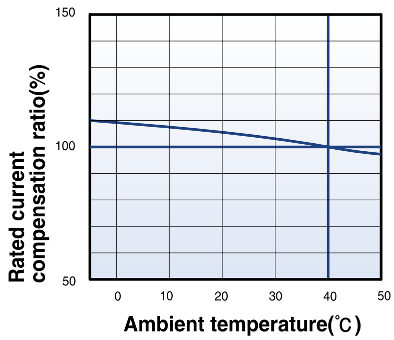
TS800U

FTU

FMU

500~800A



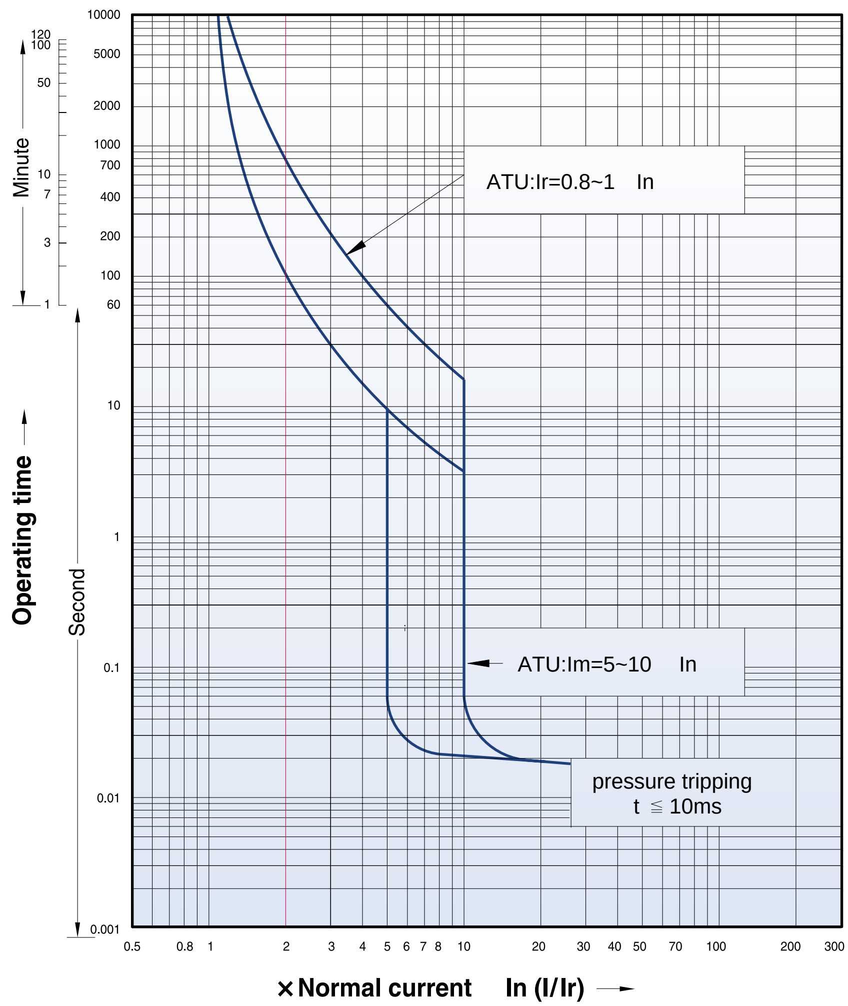


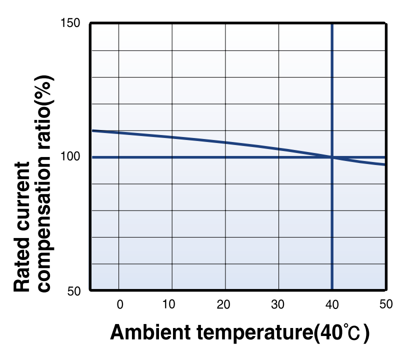
Circuit breakers with thermal-magnetic trip units

TS800U

ATU

500~800A





Circuit breakers with thermal-magnetic trip units

TD125U

MCS

125A

TS250U

MCS

250A

TS400U

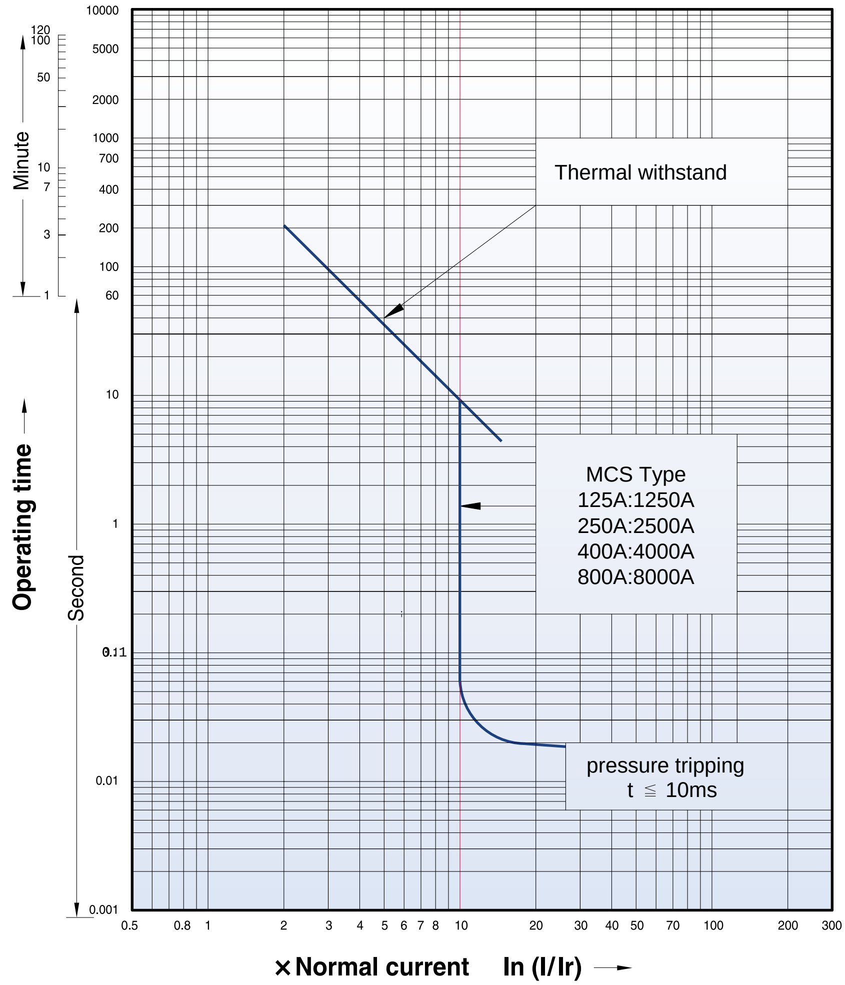
MCS

400A

TS800U

MCS

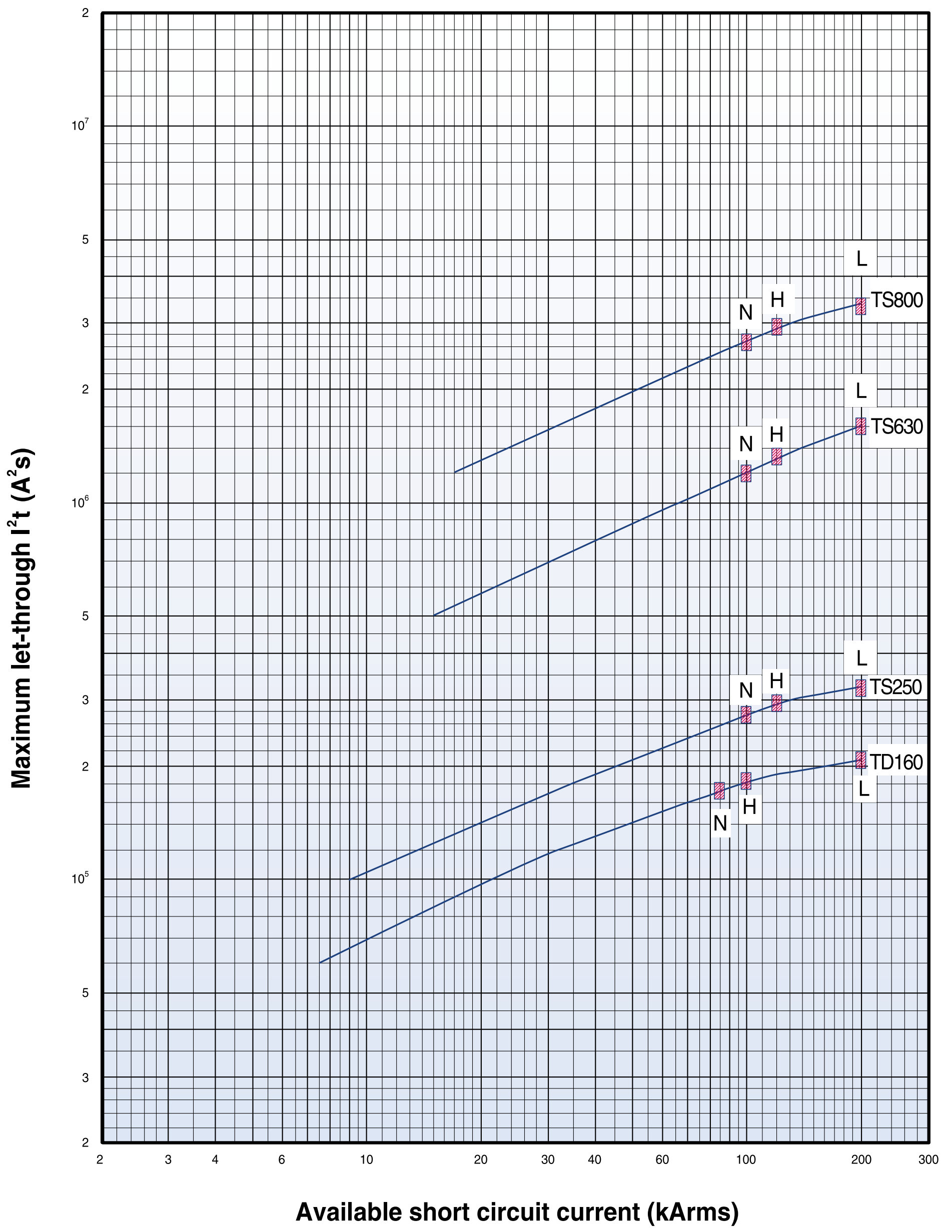
800A



Specific let-through energy curves

240V

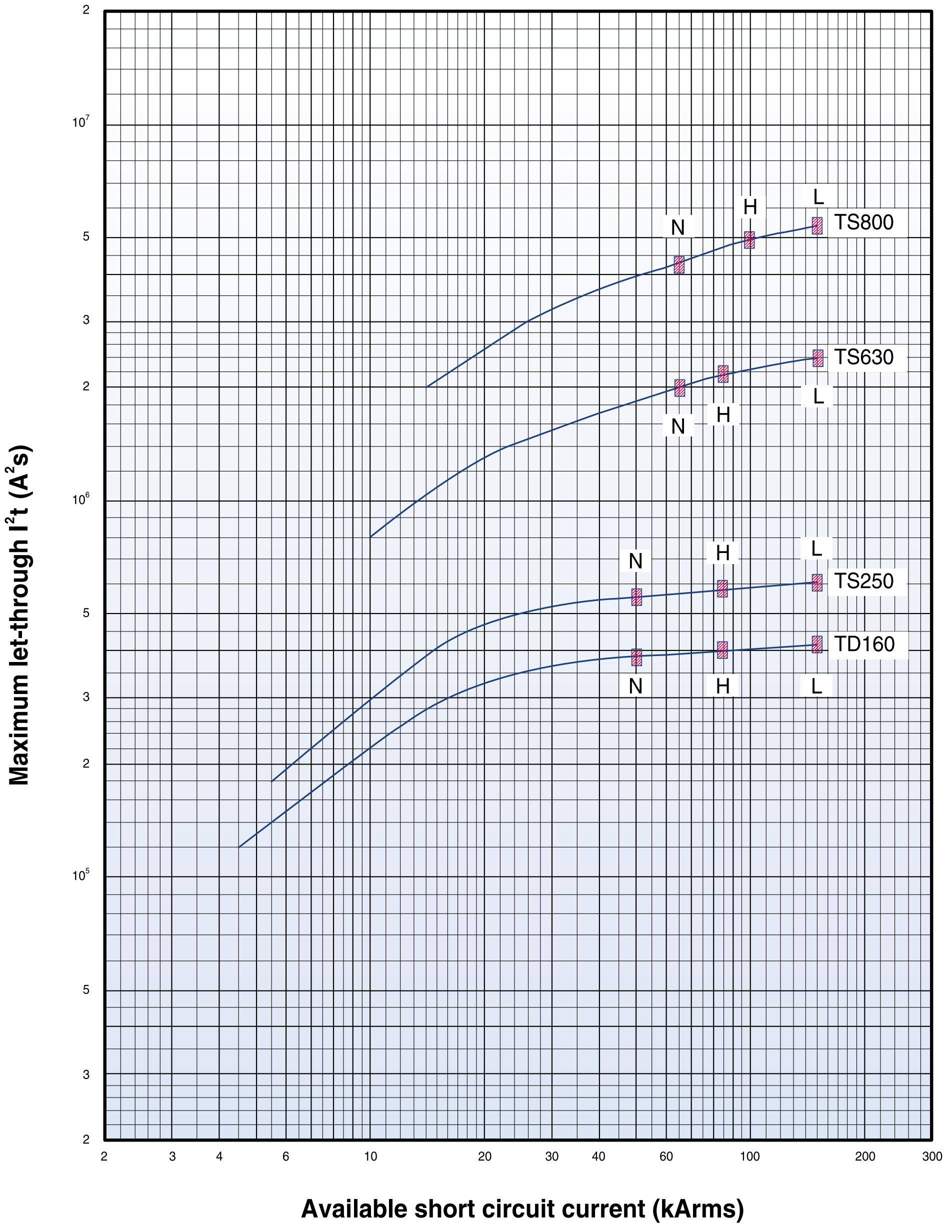
Thermal stress



Specific let-through energy curves

480V

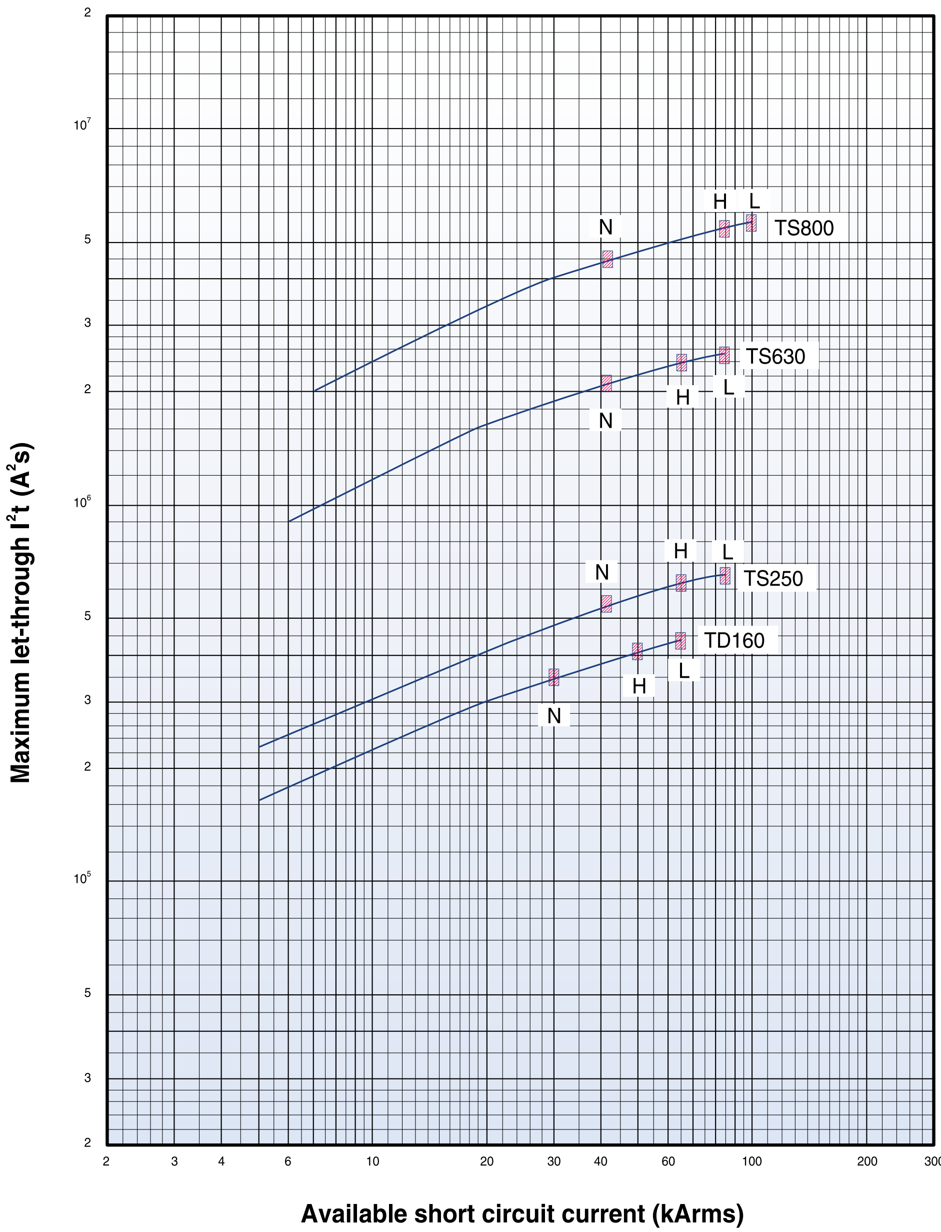
Thermal stress



Specific let-through energy curves

600V

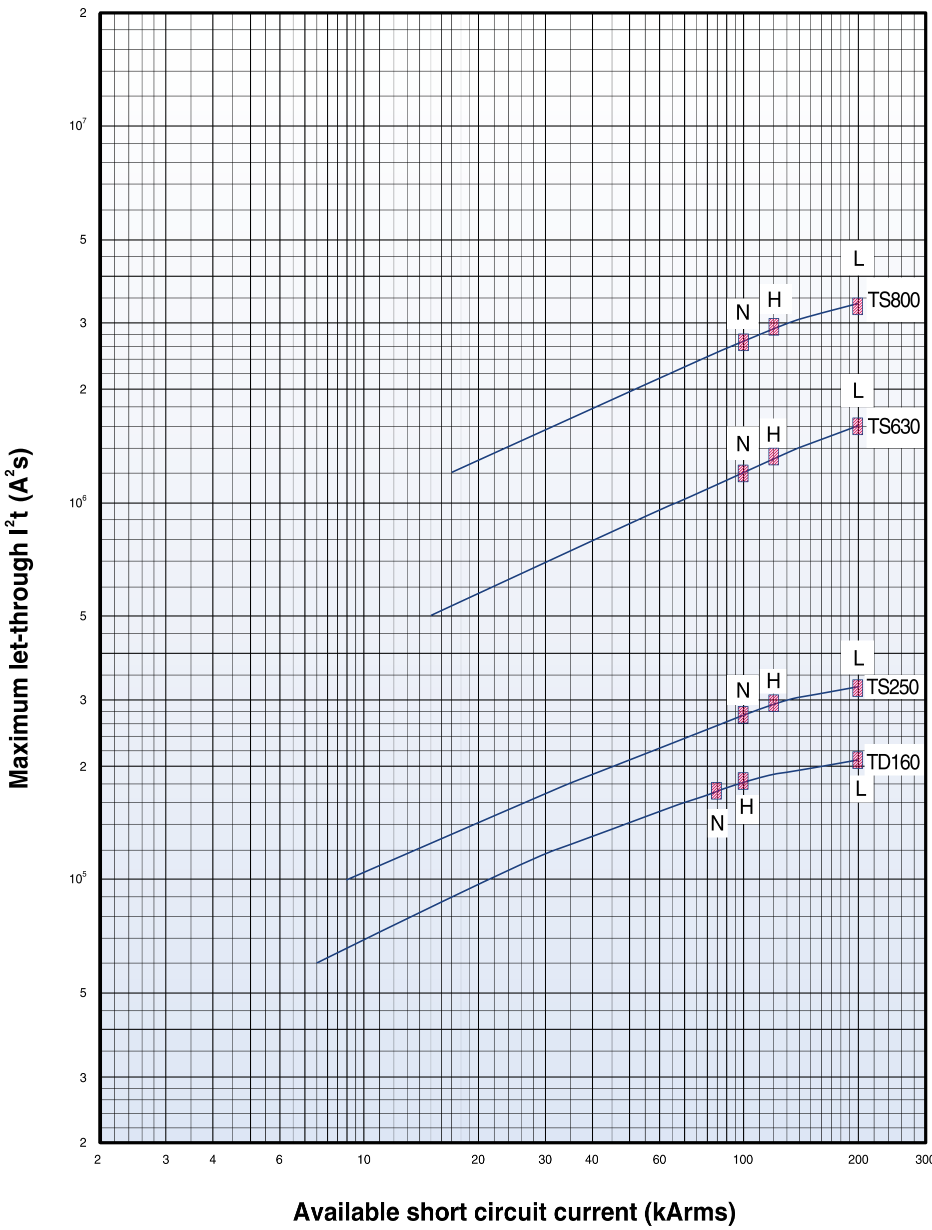
Thermal stress



Current-limiting curves

240V

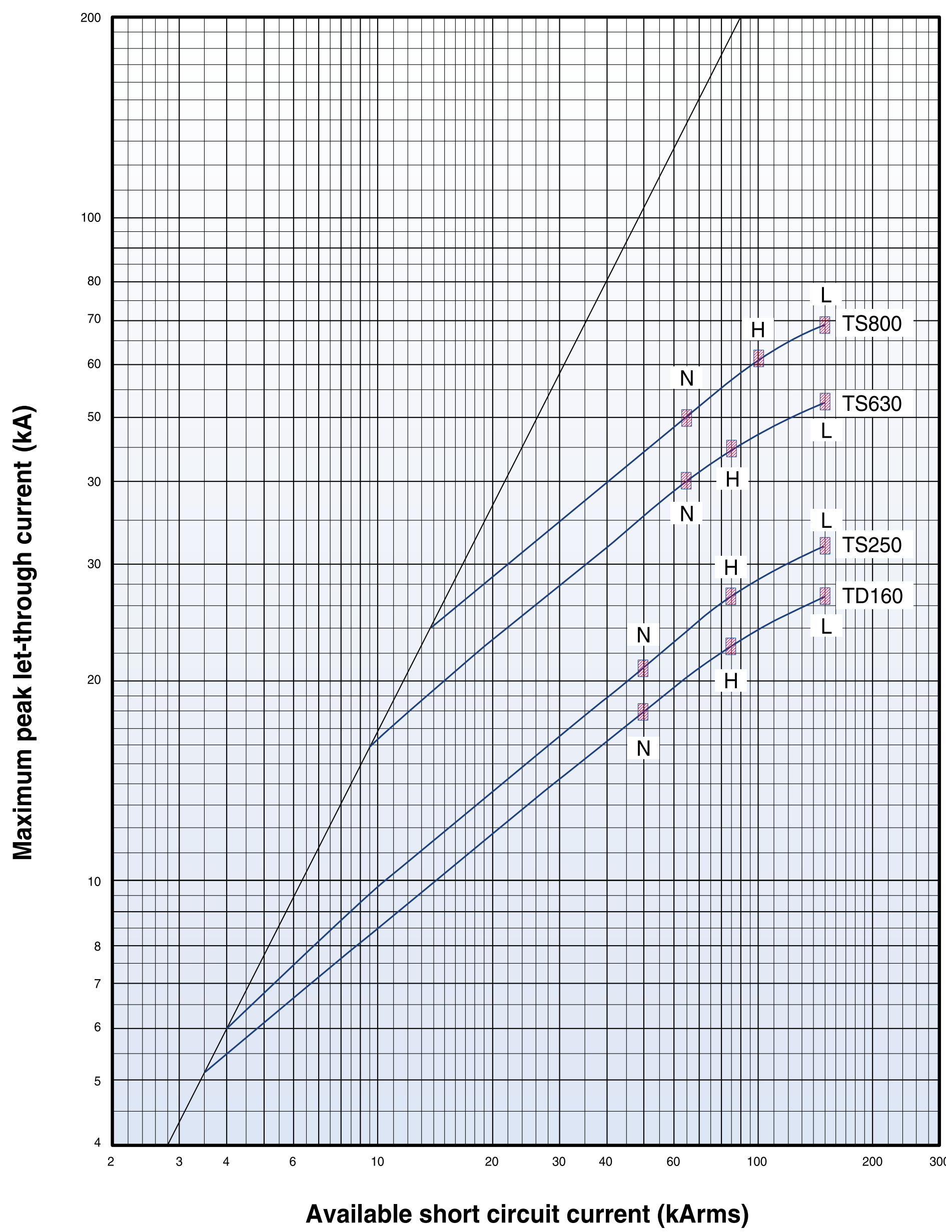
Peak current



Current-limiting curves

480V

Peak current

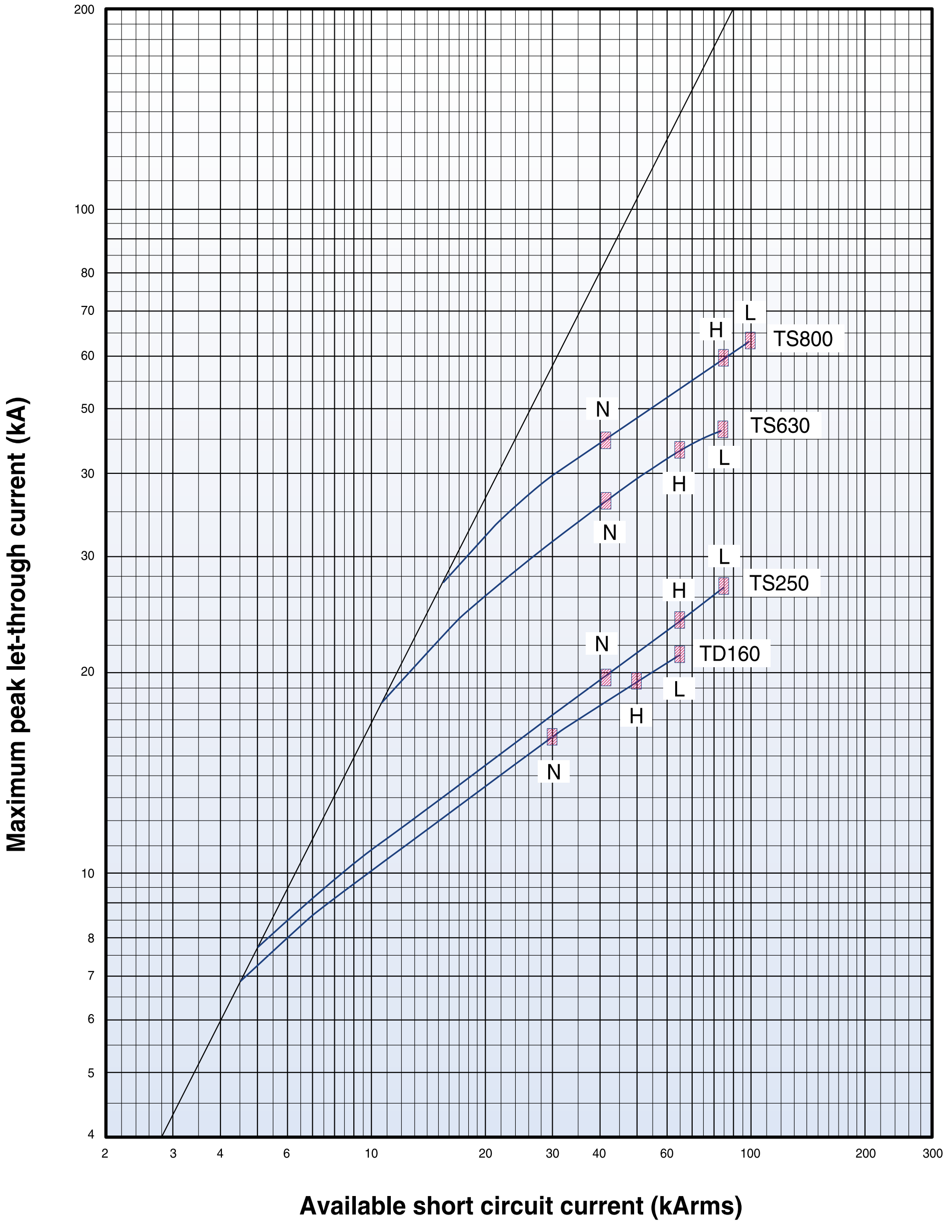


Susol

Current-limiting curves

600V

Peak current




Susol
LS

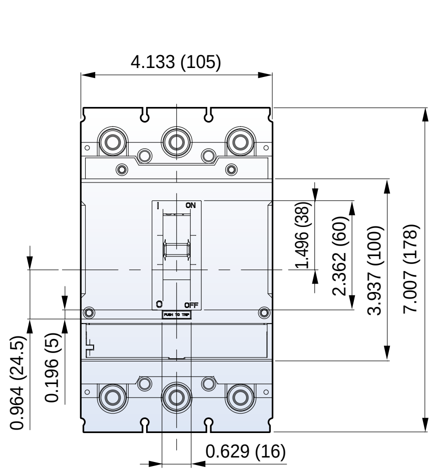
A-7. Dimensions

Overall dimensions

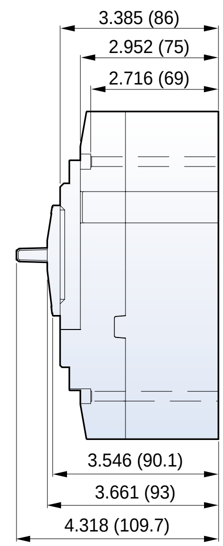
Susol

TD125U

Dimensions : inch
[mm]

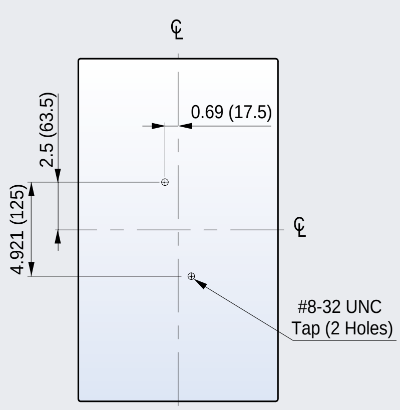


Terminal section

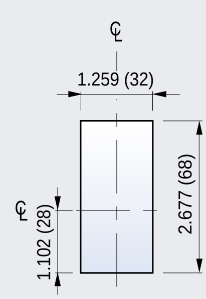


Conductor

Circuit breaker mounting bolt drilling plan



Circuit breaker escutcheon dimensions

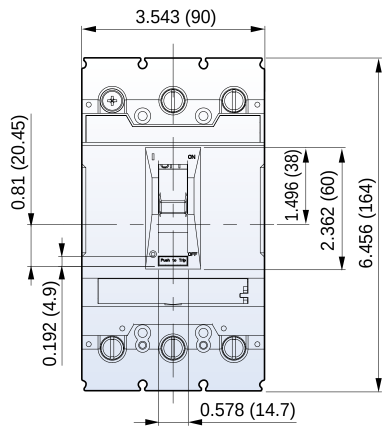


Overall dimensions

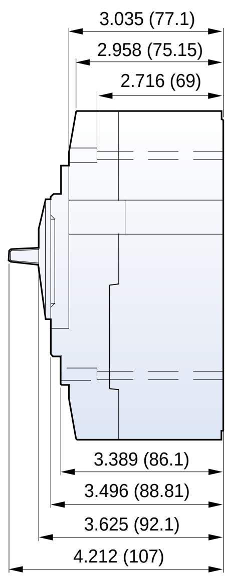
Susol

TS250U

Dimensions : inch
[mm]

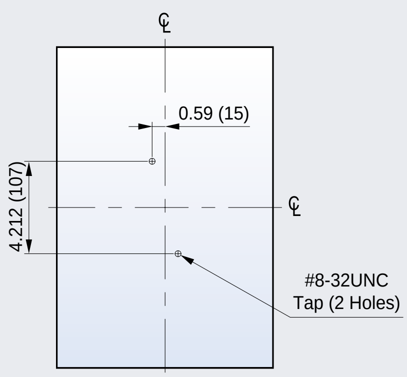


Terminal section

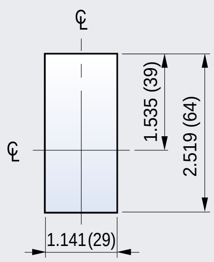


Conductor

Circuit breaker mounting bolt drilling plan

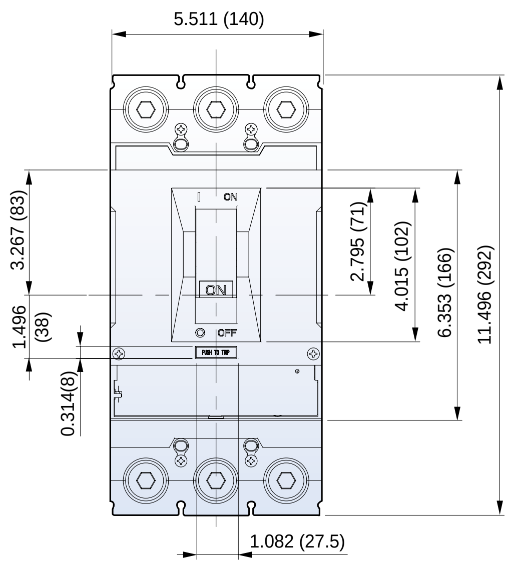


Circuit breaker escutcheon dimensions

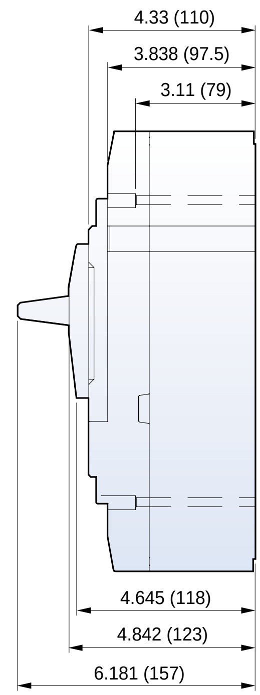


TS400U

Dimensions : inch
[mm]

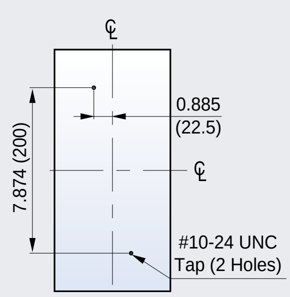


Terminal section

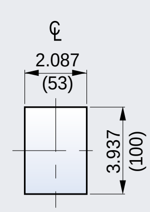


Conductor

Circuit breaker mounting bolt drilling plan



Circuit breaker escutcheon dimensions

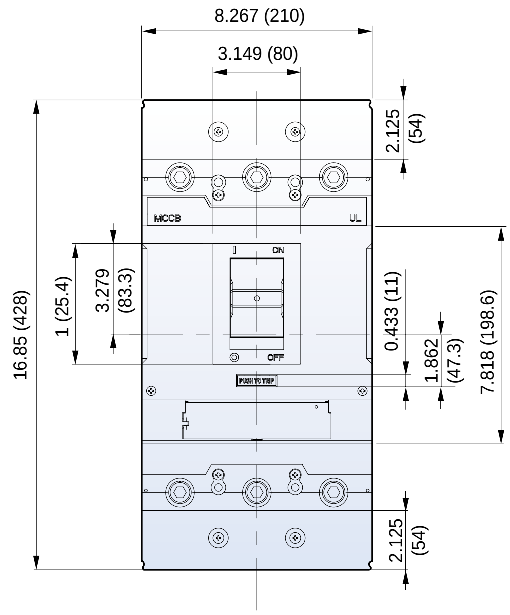


Overall dimensions

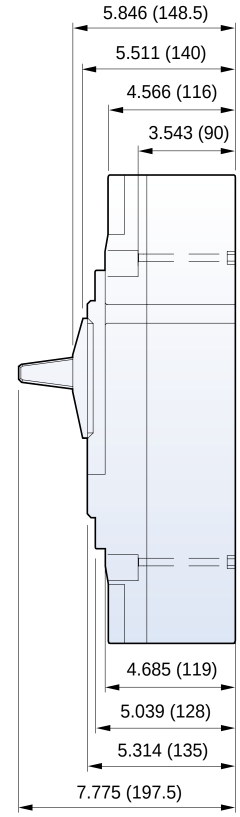
Susol

TS800U

Dimensions : inch
[mm]

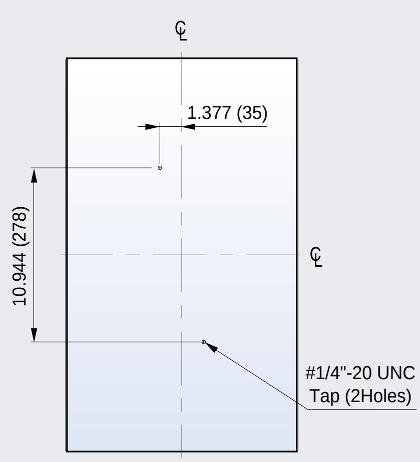


Terminal section

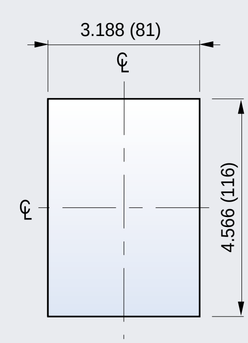


Conductor

Circuit breaker mounting bolt drilling plan

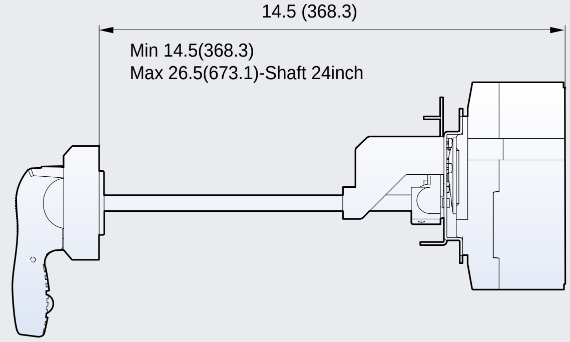


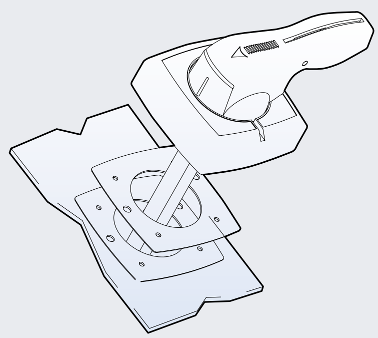
Circuit breaker escutcheon dimensions

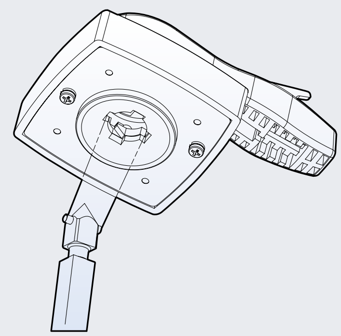


TD125U

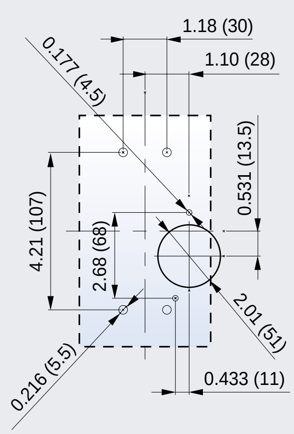
Dimensions : inch
[mm]



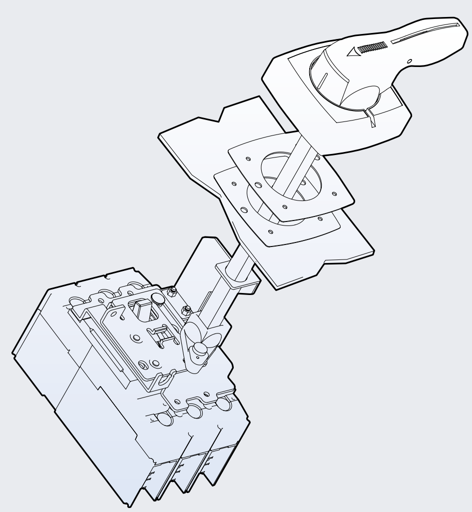




Panel drilling



Way of installation

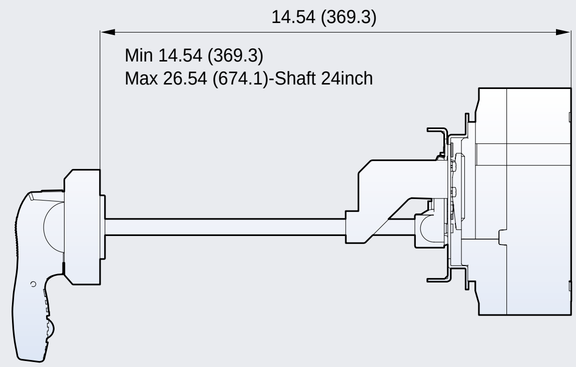


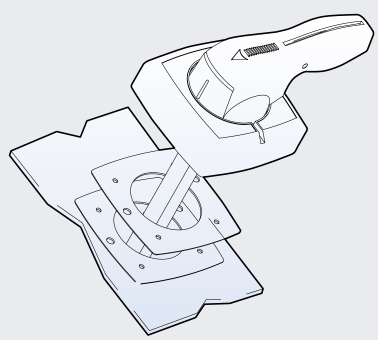
Overall dimensions

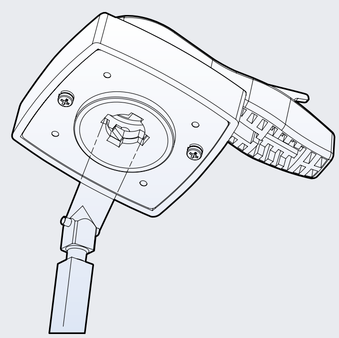
Susol

TS250U

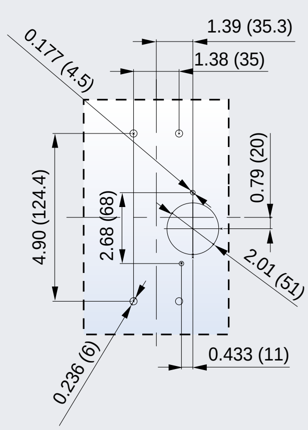
Dimensions : inch
[mm]



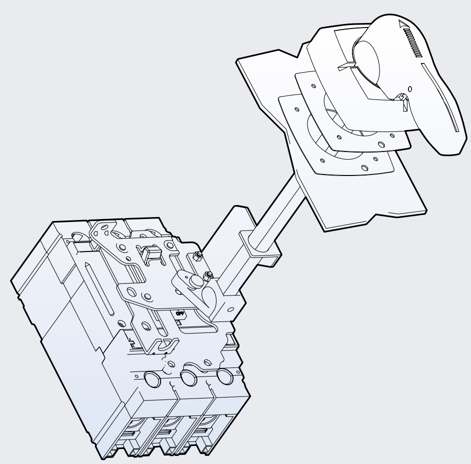




Panel drilling

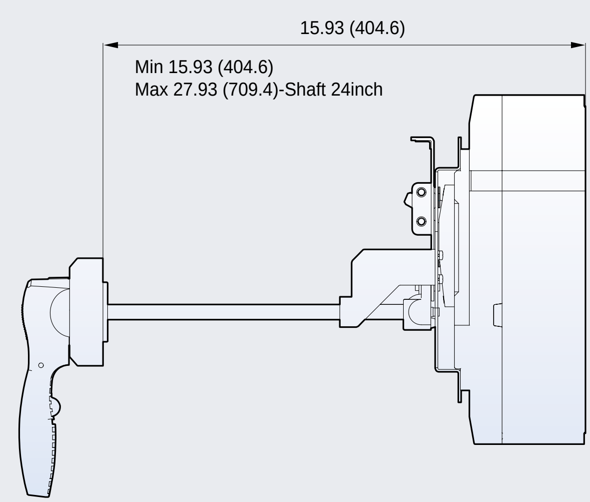


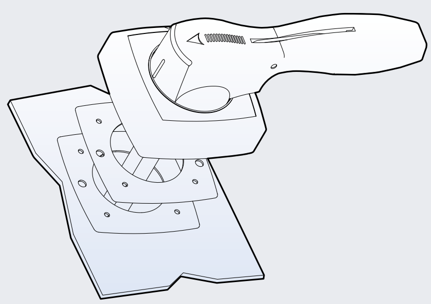
Way of installation

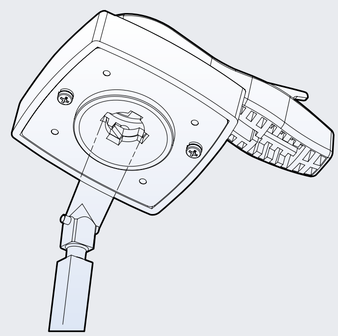


TS400U

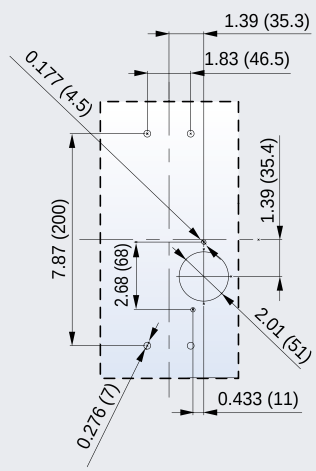
Dimensions : inch [mm]



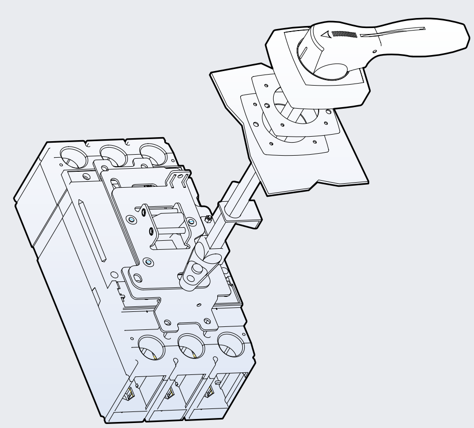




Panel drilling

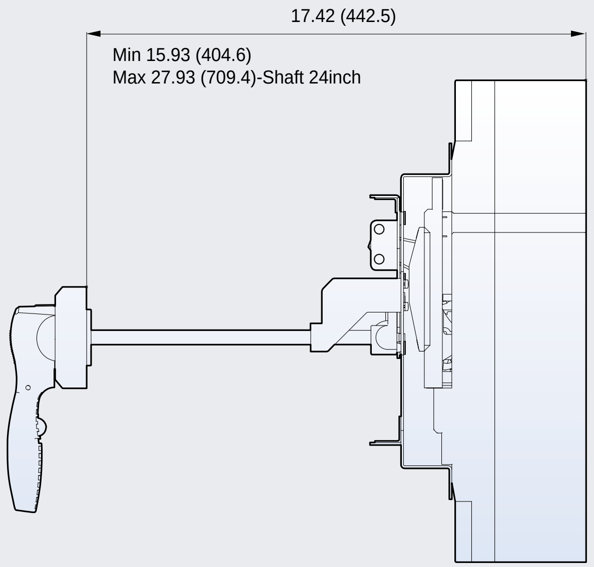


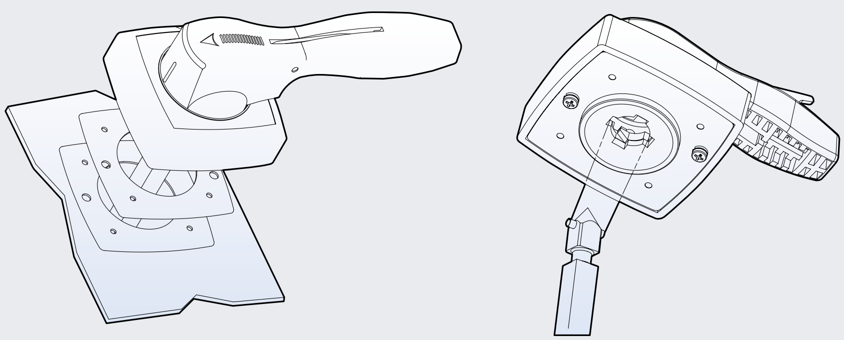
Way of installation



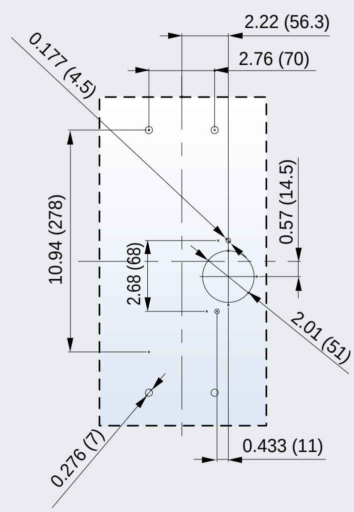
TS800U

Dimensions : inch [mm]

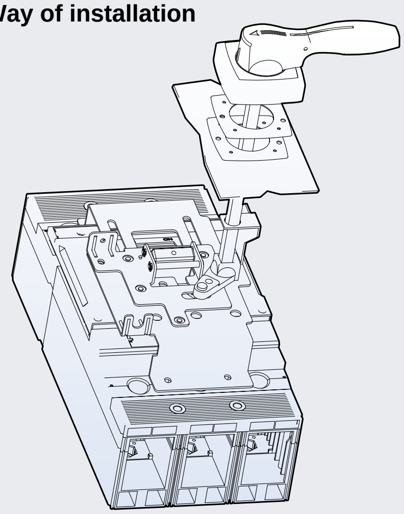




Panel drilling

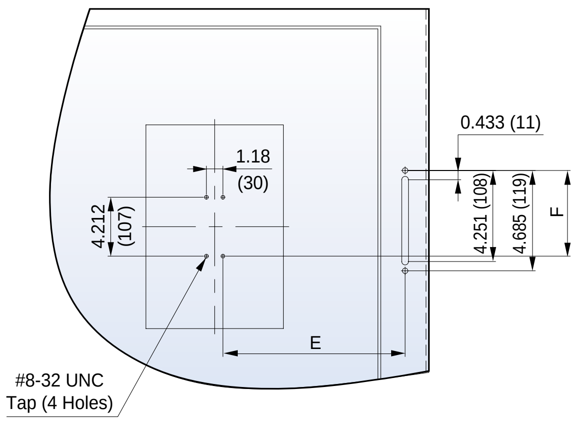


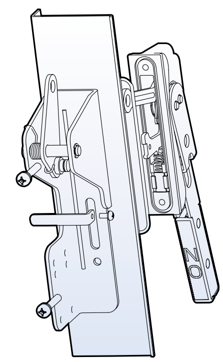
Way of installation



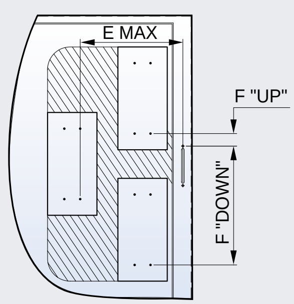
TD125U

Dimensions : inch
[mm]





Panel drilling



Way of installation

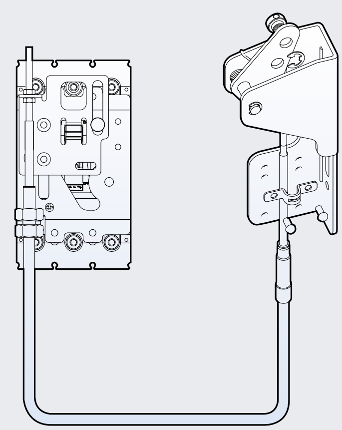
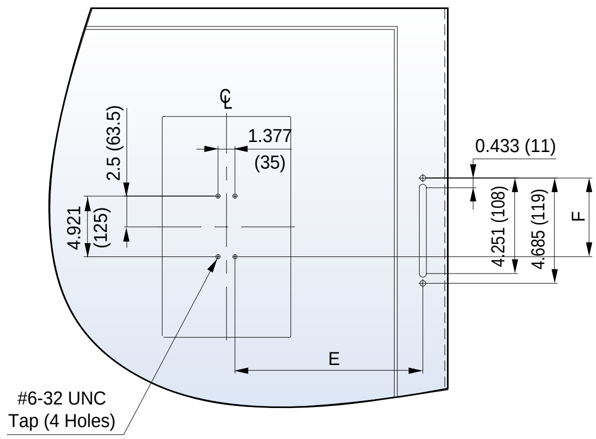


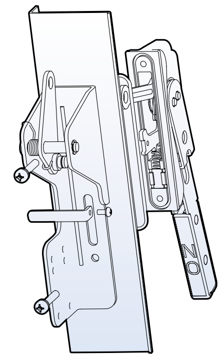
Table 1	Maximum "E" Dimension	
Enclosure Depth	FH1-60	FH1-72
10	25	30
12	24	29
16	23	28
18	22	27
20	21	26
24	20	25
30	19	24
36	18	23

Table 2	Maximum "F" Dimension			
Enclosure	60 cable		72 cable	
Depth	Up	Down	Up	Down
10	17	31	20	34
12	17	31	19	33
16	17	28	19	30
18	17	28	19	30
20	16	26	18	28
24	14	26	16	28
30	11	24	13	26
36	6	21	8	22

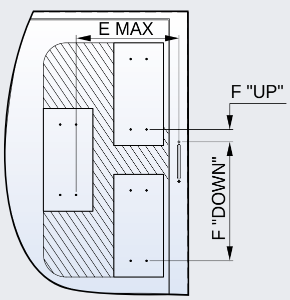
TS250U

Dimensions : inch
[mm]





Panel drilling



Way of installation

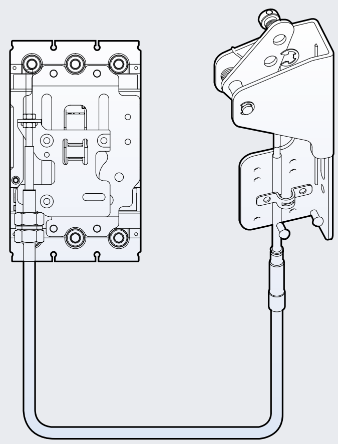
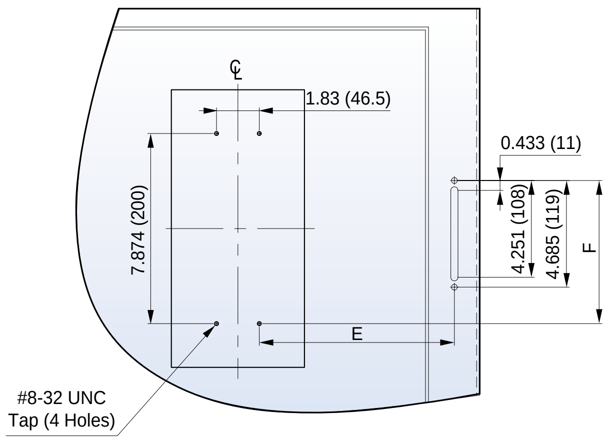


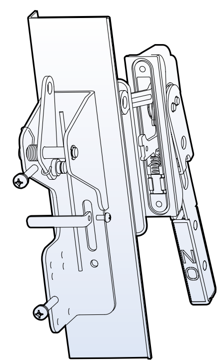
Table 1	Maximum "E" Dimension	
Enclosure Depth	FH2-60	FH2-72
10	25	30
12	24	29
16	23	28
18	22	27
20	21	26
24	20	25
30	19	24
36	18	23

Table 2	Maximum "F" Dimension			
Enclosure	60 cable		72 cable	
Depth	Up	Down	Up	Down
10	17	31	20	34
12	17	31	19	33
16	17	28	19	30
18	17	28	19	30
20	16	26	18	28
24	14	26	16	28
30	11	24	13	26
36	6	21	8	22

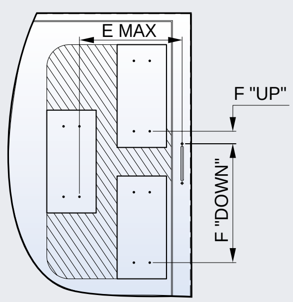
TS400U

Dimensions : inch
[mm]





Panel drilling



Way of installation

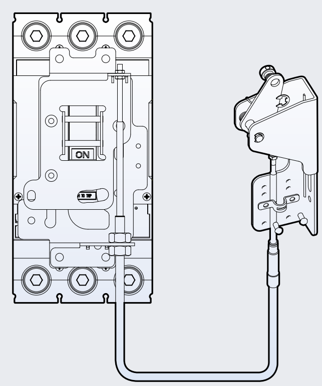


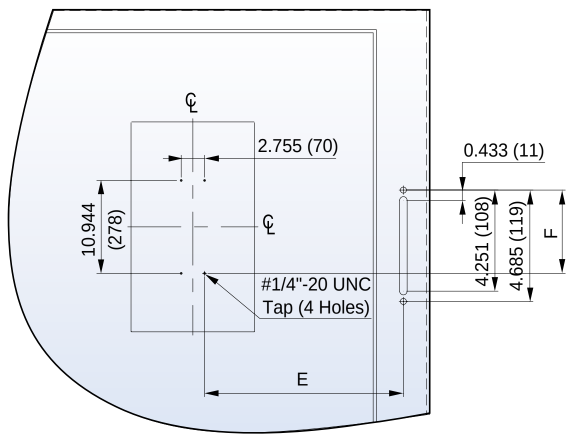
Table 1	Maximum "E" Dimension	
Enclosure Depth	FH2-60	FH2-72
10	25	30
12	24	29
16	23	28
18	22	27
20	21	26
24	20	25
30	19	24
36	18	23

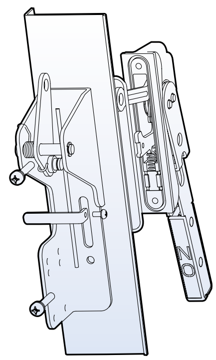
Table 2	Maximum "F" Dimension			
Enclosure	60 cable		72 cable	
Depth	Up	Down	Up	Down
10	17	31	20	34
12	17	31	19	33
16	17	28	19	30
18	17	28	19	30
20	16	26	18	28
24	14	26	16	28
30	11	24	13	26
36	6	21	8	22

Overall dimensions

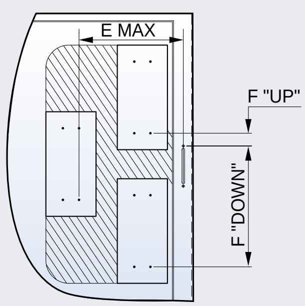
TS800U

Dimensions : inch
[mm]





Panel drilling



Way of installation

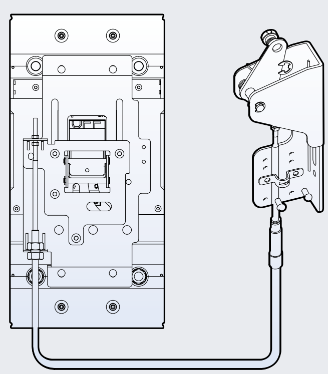


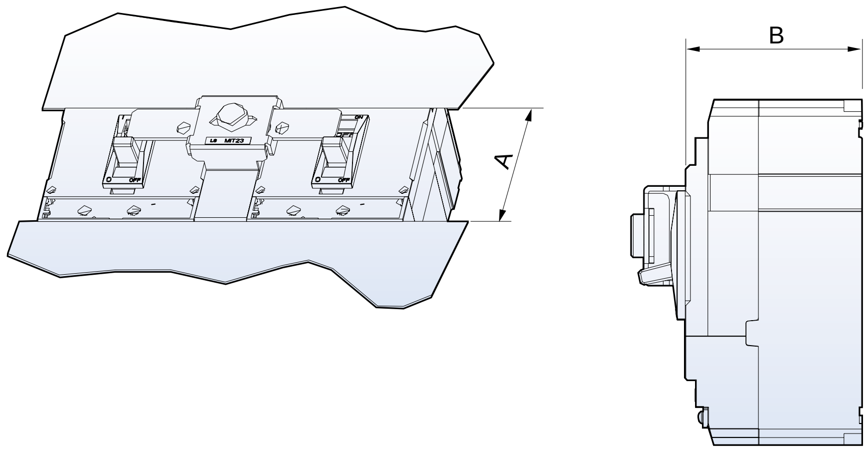
Table 1	Maximum “E” Dimension	
Enclosure Depth	FH2-60	FH2-72
10	25	30
12	24	29
16	23	28
18	22	27
20	21	26
24	20	25
30	19	24
36	18	23

Table 2	Maximum “F” Dimension			
Enclosure Depth	60 cable		72 cable	
	Up	Down	Up	Down
10	17	31	20	34
12	17	31	19	33
16	17	28	19	30
18	17	28	19	30
20	16	26	18	28
24	14	26	16	28
30	11	24	13	26
36	6	21	8	22

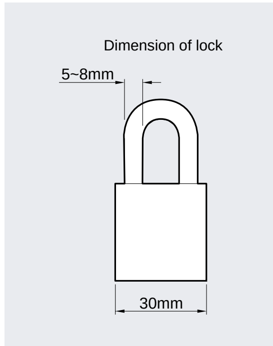
Mechanical interlocking device

MIT13, MIT23, MIT33, MIT43

[mm]



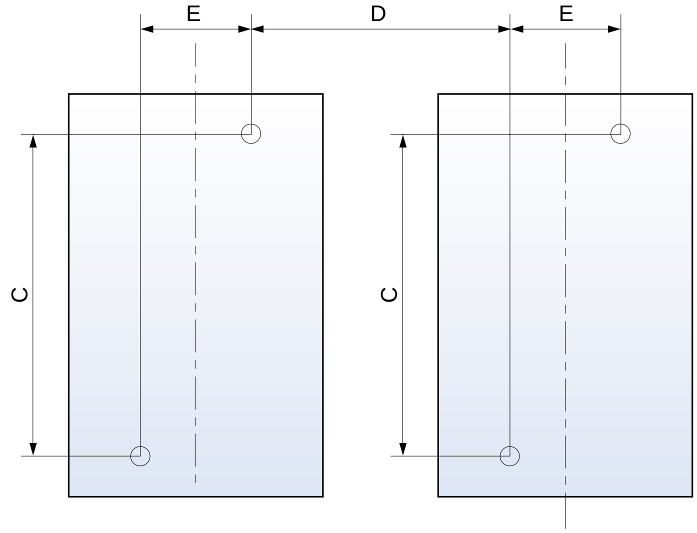
	A (mm)	B (mm)
TD125U	83	86
TS250U	102	86
TS630U	168	110
TS800U	201	135



Mechanical interlocking device

Mounting dimension for MIT

[mm]



2, 3Pole MCCBs	C(mm)	D(mm)	E(mm)
TD125U	107	90	30
TS250U	125	105	35
TS400U	200	139.5	46.5
TS800U	278	210	70

Super Solution

Leader in Electrics & Automation

HEAD OFFICE

Yonsei Jaedan Severance Bldg. 84-11, 5ga, Namdaemun-ro,
Jung-gu, Seoul 100-753, Korea
Tel. (82-2)2034-4870 Fax. (82-2)2034-4713 http://www.lsis.biz

Cheong-Ju Plant

Cheong-Ju Plant #1, Song Jung Dong, Hung Duk Ku,
Cheong Ju, 361-720, Korea
Tel. (82-43)261-6001 Fax. (82-43)261-6410

LS Industrial Systems Co., Ltd.

080601 / STAFF