MOLDED CASE CIRCUIT BREAKERS

Thermal-Magnetic Circuit Breakers

F01 / F02 (16A ... 250A)

F11 / F12 (16A ... 160A)
F12N (16A ... 160A)

F21 (16A ... 160A)

F31 / F32 / F33 (16A ... 250A)
F31N / F32N / F33N (16A ... 250A)

F51 / F52 / F53 (125A ... 400A)
F51N / F52N / F53N (125A ... 400A)

F61 / F62 (160A ... 500A)

F71 / F72 (300A ... 800A)

F81 / F82 (300A ... 800A)
F81N / F82N (300A ... 800A)

Electronic Circuit Breakers

F61E / F62E (160A ... 500A)

F82E / F83E (300A ... 800A)
F82EN / F83EN (300A ... 800A)

F91E / F92E (800A ... 1250A)
F91EN / F92EN (800A ... 1250A)

F101E / F102E (1000A ... 1600A)

F111 / F112 (1250A ... 2500A)

Earth-Leakage Circuit Breakers

F12R (16A ... 160A)

F31R (80A ... 250A)

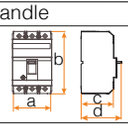
IEC / EN 60947-2
CE

Mounting Position	: Free
Altitude	: 2000 m (max)
Relative Humidity	: %90 (55°C)
Ambient Temperature	: between -25°C and +60°C①
Pollution Degree	: III
Protection Degree	: IP40 (at assembly lever area)

①: In given current load capacities for Circuit breakers on catalogue are valid for according to defined temperature conditions on norms. Current load capacities of products shall decrease in case of the Indoor conditions (non-ventilated)

FEDERAL

THERMAL-MAGNETIC CIRCUIT BREAKERS (IEC / EN 60947-2)

1 - 2 - 3 POLES											
TYPE					**F01**	**F02**	**F12**	**F21**	**F31**	**F32**	**F33**
Rated Current - In				A	16-225		16-160	16-160	16-250		
Number of Poles⑦					1		2 / 3	2 / 3	2 / 3		
Rated Insulation Voltage - U_i (50-60 Hz)				V	1000		1000	1000	1000		
Rated Impulse Withstand Voltage - U_{imp}				kV	8		8	8	8		
Test Voltage - AC 50-60 Hz (1 minute)				V	3000		3000	3000	3000		
Rated Ultimate Short Circuit Breaking Capacity - (I_{cu})①	50-60 Hz	220/240 V		kA	35	65	35	50	65	85	100
	50-60 Hz	380/415 V		kA	12	14	25	25	36	50	70
	50-60 Hz	440 V		kA	--	--	20	20	25	32	40
	50-60 Hz	500 V		kA	--	--	12	12	18	22	25
	50-60 Hz	690 V		kA	--	--	8	8	12	13	14
	DC (2P Series)⑤	250 V		kA	--	--	15	15	20	20	20
	DC (3P Series)⑤	500 V		kA	--	--	15	15	20	20	20
Rated Short Circuit Breaking Capacity – I_{cs}②					%100Icu		%100Icu	%100Icu	%100Icu		
Category (IEC / EN 60947-2)					A		A	A	A		
Trip Mechanism & Protection Characteristics	Thermal Magnetic	Thermal Fixed			In		□	□	□		
		Thermal Adjusted			--		(0,8-1)In	16-125A: (0,7-1)In 160A: (0,8-1)In	(0,7-1)In		
		Magnetic Fixed			16-25A: 300A 32-63A: 10In 80A: 12In 100A: 10In 125-250A: 8In		16-63A: 600A 80-160A: 8In, 10In③	16-20A: 200A 25-160A: 8In, 10In③ 40-160A: 3In④	16-25A: 300A 32-63A: 10In 80A: 12In, 100A: 10In 125-250A: 8In, 10In③ 160-250A: 3In④		
		Magnetic Adjusted			--		--	--	□80-250A: (5-10)In		
Current Limiting					E		E	E	E		
Mechanical Life				Op.	15000		15000	15000	15000		
Electrical Life				Op.	3000		5000	3000	3000		
Weight				kg	0,85		1	1,7	2,3		
Connection Terminal Capacity	Box Type Terminal				95 mm²		16-100A: 50 mm² 125-160A: 70 mm²	16-100A: 50 mm² 125-160A: 70 mm²	16-100A: 50 mm² 125-160A: 70 mm² 200-250A: 120 mm²		
	Terminal for Busbar / Cable Lug	Cable Lug (Standard / Narrow)			□50/70 mm² (M8)		□50/70 mm² (M5)	--	□95/120 mm² (M8)		
		Busbar Width			□18 mm		□20 mm	--	□24 mm		
	Box-type Terminal on Extension Busbar				--		--	--	185 mm²		
Min. Max. Tightening Torque					7-10 Nm		4-6 Nm	4-6 Nm	16-160A: 4-6 Nm 200-250A: 7-10 Nm		
Undervoltage Release					--		□	□	□		
Shunt Trip Release					--		□	□	□		
Auxiliary Contact Block					--		□	□	□		
Motor Control Mechanism					--		□	--	□		
Extended Rotary Handle					--		--	--	□		
Lock Mechanism with Key					--		□	□	□		
Extension Bar					□		□	□	□		
Therminal Cover					--		□	□	□		
Trip Contact					--		□	□	□		
Inverser (Mechanical) Lock					--		--	--	□		
Phase Barrier					--		■	■	■		
Extension Handle					--		--	--	--		
Dimensions 			a	mm	40		90	90	105		
			b	mm	169		130	156	165		
			c	mm	90		71	66	91		
			d	mm	109		92	93	116		

■ : Standard □ : Upon Request

① Icu: O-t-CO test (O: Open maneuver, t: Waiting duration, CO: Close-Open maneuver
② Ics: O-t-CO-t-CO test (O: Open maneuver, t: Waiting duration, CO: Close-Open maneuver)
③ Motor circuit protection type (upon request)
④ Generator circuit protection type (upon request)
⑤ When two and three poles of the circuit breaker are connected in series.
⑥ For 300A and 400A: 121,5mm.
⑦ 2P breaker has same dimension as 3P breaker, but the middle pole is removed.
⑧ F53 series MCCB are produced up to 315A.

THERMAL-MAGNETIC CIRCUIT BREAKERS (IEC / EN 60947-2)

								
F51	**F52**	**F53**	**F61**	**F62**	**F71**	**F72**	**F82**	**F83**
125-400④			160-500		300-800		300-800	
2 / 3			2 / 3		2 / 3		2 / 3	
1000			1000		1000		1000	
8			8		8		8	
3000			3000		3000		3000	
65	85	100	52	70	52	70	75	100
36	50	70	36	50	36	50	50	70
25	35	50	30	40	30	40	40	50
20	25	40	25	35	25	35	30	42
14	16	18	20	25	20	25	20	25
20	20	20	20	20	20	20	20	20
20	20	20	20	20	20	20	20	20
%100Icu	%100Icu	%100Icu	%100Icu	%100Icu	%100Icu	%100Icu	%100Icu	%75Icu
A			A		A		A	
□			□		□		□	
(0,7-1)In			(0,7-1)In		(0,7-1)In		300-630A: (0,7-1)In 800A: (0,6-1)In	
□			□		□		□	
125: (6-12)In, 160-315A: (5-10)In 320-400A: (4-8)In 320-400A: (5-10)In③			(5-10)In		(5-10)In		300-630A: (5-8)In 800A: (4-6)In	
E			E		--		E	
15000			15000		15000		15000	
3000			3000		3000		3000	
4,7			5,5		8		10	
□250A: 120 mm²			□240 mm²		--		--	
125-250A: 95/120 mm² (M8) 300-400A: 240 mm² (M12)			2x(120/150) mm² (M10)		2x240 mm² (M10)		2x240 mm² (M10)	
125-250A: 24 mm 300-400A: 40 mm			30 mm		50 mm		50 mm	
300 mm²			--		--		--	
19-25 Nm			19-25 Nm		30-40 Nm		30-40 Nm	
□			□		□		□	
□			□		□		□	
□			□		□		□	
--			□		□		□	
□			□		□		□	
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■			■		■		■	
--			--		■		■	
105⑥			140		210		210	
255			257		270		280	
105			103		111		111	
145			140		159		162	

ELECTRONIC CIRCUIT BREAKERS (IEC / EN 60947-2)

2 - 3 POLES																
TYPE					**F61E**	**F62E**	**F82E**	**F83E**	**F91E**	**F92E**	**F101E**	**F102E**	**F111E**	**F112E**
Rated Current - I_n				A	160 - 500		300 - 800		800 - 1250		1000 -1600		1250 - 2500	
Number of Poles ③					2 / 3		2 / 3		2 / 3		2 / 3		2 / 3	
Rated Insulation Voltage - U_i (50-60 Hz)				V	1000		1000		1000		1000		1000	
Rated Impulse Withstand Voltage - U_{imp}				kV	8		8		8		8		8	
Test Voltage - AC 50-60 Hz (1 minute)				V	3000		3000		3000		3000		3000	
Rated Ultimate Short Circuit Breaking Capacity (I_{cu}) ①	50-60 Hz	220/240 V		kA	52	70	75	100	80	100	80	100	85	125
	50-60 Hz	380/415 V		kA	36	50	50	70	50	70	50	70	50	70
	50-60 Hz	440 V		kA	30	40	40	50	35	45	40	45	35	50
	50-60 Hz	500 V		kA	25	35	30	42	25	35	25	35	30	42
	50-60 Hz	690 V		kA	20	25	20	25	18	25	20	25	20	25
Rated Short Circuit Breaking Capacities - I_{cs} ② 380/415 V					%100Icu	%100Icu	%100Icu	%75Icu	%100Icu	%100Icu	%100Icu	%100Icu	%100Icu	%75Icu
Rated Short Time Withstand Capacities - I_{cw} - 380 / 415 V					12In	12In	12In	12In	12In	12In	12In	12In	12In	12In
Category (IEC/EN 60947-2)					A/B		A/B		A/B		A/B		A/B	
Trip Mechanism & Protection Characteristics	Thermal-Magnetic		Thermal Fixed		--		--		--		--		--	
			Thermal Adjusted		--		--		--		--		--	
			Magnetic Fixed		--		--		--		--		--	
			Magnetic Adjusted		--		--		--		--		--	
	Electronic		Long Time Delay		I1: (0,4-1)In t1: 4s (6I1) □t1:0,5-20s(6I1)		I1: (0,4-1)In t1: 4s (6I1) □t1:0,5-20s(6I1)		I1: (0,4-1)In t1: 4s (6I1) □t1:0,5-20s(6I1)		I1: (0,4-1)In t1: 4s (6I1) □t1:0,5-20s(6I1)		I1: (0,4-1)In t1: 4s (6I1) □t1:0,5-20s(6I1)	
			Short Time Delay		□I2= (2-10)I1 □t2= 0,05-0,3s		□I2= (2-10)I1 □t2= 0,05-0,3s		□I2= (2-10)I1 □t2= 0,05-0,3s		□I2= (2-10)I1 □t2= 0,05-0,3s		□I2= (2-10)I1 □t2= 0,05-0,3s	
			Instantaneous		I3= (2-10)I1		I3= (2-10)I1		I3= (2-10)I1		I3= (2-10)I1		I3= (2-10)I1	
			Graund Fault		--		--		--		--		--	
Arc Contact					--		--		--		■		■	
Current Limiting					■		■		--		■		■	
Mechanical Life				Op.	15000		15000		10000		10000		10000	
Electrical Life (380V/415V)				Op.	3000		3000		3000		3000		3000	
Weight				kg	5,5		10		18		27		54	
Connection Terminal Capacity	Box-type Terminal				□240 mm²		--		--		--		--	
	Terminal for Busbar / Cable Lug	Cable Lug (Standard / Narrow)			2x(120/150)mm² (M10)		2x240 mm² (M10)		2x400 mm² (M12)		2x400 mm² (M12)		4x400 mm² (M12)	
		Busbar Width			30 mm		50 mm		50 mm		50 mm		80 mm	
	Box-type Terminal on extension busbar				--		--		--		--		--	
Min. Max. Tightening Torque					19-25 Nm		30-40 Nm		35-50 Nm		35-50 Nm		35-50 Nm	
Undervoltage Release					□		□		□		□		□	
Shunt Trip Release					□		□		□		□		□	
Auxiliary Contact Block					□		□		□		□		□	
Motor Control Mechanism					□		□		□		□		□	
Extended Rotary Handle					□		□		□		--		--	
Lock Mechanism with Key					□		□		□		■		■	
Extension Bar					□		□		■		■		■	
Terminal Cover					□		□		□		□		□	
Trip Contact					□		□		□		□		□	
Inverser (Mechanical) Lock					--		□		□		□		□	
Phase Barrier					■		■		■		■		■	
Extension Handle					--		■		■		■		■	
Dimensions				a	140		210		210		210		392	
				b	257		280		370		370		412	
				c	103		111		124		155		250	
				d	140		162		180		203		320	

■ : Standard □ : Upon Request

① Icu: O-t-CO test (O: Open maneuver, t: Waiting duration, CO: Close-Open maneuver

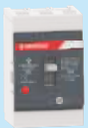
② Ics: O-t-CO-t-CO test (O: Open maneuver, t: Waiting duration, CO: Close-Open maneuver)

③ 2P breaker has same dimension as 3P breaker, but the middle pole is removed.

• As an additional protection against short circuit current in Federal electronic circuit breakers, mechanical opening mechanism operating with magnetic field of the short circuit current has been placed on each phase. At this way, mechanical opening unit is tripping in over currents such as short circuit and risk of not tripping in case of electronic card failure has been eliminated. This is a great advantage of Federal circuit breakers.

THERMAL-MAGNETIC & ELECTRONIC CIRCUIT BREAKERS (IEC / EN 60947-2)

4 POLE

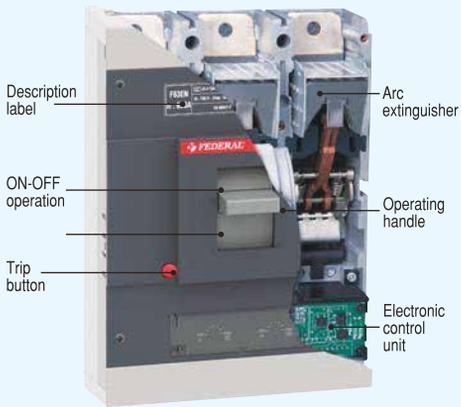


TYPE				F12N	F31N	F32N	F33N	F51N	F52N	F53N	F82N	F83N	F82EN	F83EN	F91EN	F92EN
Rated Current - I_n			A	16 -160	16-250			125-400⑦			300-800		300-800		800 -1250	
Number of Poles				4	4			4			4		4		4	
Rated Insulation Voltage - U_i (50-60 Hz)			V	1000	1000			1000			1000		1000		1000	
Rated Impulse Withstand Voltage - U_{imp}			kV	8	8			8			8		8		8	
Test Voltage - AC 50-60 Hz (1 minute)			V	3000	3000			3000			3000		3000		3000	
Rated Ultimate Short Circuit Breaking Capacity (I_{cu})①	50-60 Hz	220/240 V	kA	35	65	85	100	65	85	100	75	100	75	100	80	100
	50-60 Hz	380/415 V	kA	25	36	50	70	36	50	70	50	70	50	70	50	70
	50-60 Hz	440 V	kA	20	25	32	40	25	35	50	40	50	40	50	35	45
	50-60 Hz	500 V	kA	12	18	22	25	20	25	40	30	42	30	42	25	35
	50-60 Hz	690 V	kA	8	12	13	14	14	16	18	20	25	20	25	18	25
	DC (2P Series) ③	250 V	kA	15	20	20	20	20	20	20	20	20	--	--	--	--
	DC (3P Series) ③	500 V	kA	15	20	20	20	20	20	20	20	20	--	--	--	--
Rated Short Circuit Breaking Capacities - I_{cs}				%75Icu	%100Icu			%100Icu	%100Icu	%75Icu	%100Icu	%75Icu	%100Icu	%75Icu	%100Icu	%100Icu
Rated Short Time Withstand Capacities - I_{cw} - 380 / 415 V				--	--			--	--	--	--	--	12In	12In	12In	12In
Category (IEC/EN 60947-2)				A	A			A			A		A/B		A/B	
Trip Mechanism & Protection Characteristics	Thermal-Magnetic	Thermal Fixed		□	□			□			□		--		--	
		Thermal Adjusted		(0,8-1)In	(0,7-1)In			(0,7-1)In			300-630A: (0,7-1)In 800A: (0,6-1)In		--		--	
		Magnetic Fixed		16-63A: 600A 80-160A: 8In	16-25A: 300A 32-63A: 10In 80A: 12In, 100A: 10In 125-250A: 8In, 10In⑤			□			□		--		--	
		Magnetic Adjusted		--	--			125: (6-12)In, 160-315A: (5-10)In 320-400A: (4-8)In			300-630A: (5-8)In 800A: (4-6)In		--		--	
	Elektronik	Long Time Delay		--	--			--			--		I1: (0,4-1)In t1: 4s (6I1) □t1:0,5-20s(6I1)		I1: (0,4-1)In t1: 4s (6I1) □t1:0,5-20s(6I1)	
		Short Time Delay		--	--			--			--		□I2= (2-10)I1 □t2= 0,05-0,3s		□I2= (2-10)I1 □t2= 0,05-0,3s	
		Instantaneous		--	--			--			--		I3= (2-10)I1		I3= (2-10)I1	
		Graund Fault		--	--			--			--		--		--	
Current Limiting				E	E			E			E		E		--	
Mechanical Life			Op.	15000	15000			15000			15000		15000		10000	
Electrical Life			Op.	3000	3000			3000			3000		3000		3000	
Weight			kg	1,5	3,1			6,3			13		13		24	
Connection Terminal Capacity	Box-Type Terminal			16-100A: 50 mm² 125-160A: 70 mm²	□120mm²			□250A: 120 mm²			--		--		--	
	Bara / Kablo Pabucu için Terminal	Cable Lug (Standard / Narrow)		□16/25 mm² (M5)	95/120 mm² (M8)			125-250A: 95/120mm²(M8) 300-400A: 240mm²(M12)			2x240 mm² (M10)		2x240 mm² (M10)		2x400 mm² (M10)	
		Busbar Width		□13 mm	24 mm			125-250A: 24 mm 300-400A: 40 mm			50 mm		50 mm		50 mm	
	Box-Type Terminal on Extension Busbar			--	--			300 mm²			--		--		--	
Min. Max. Tightening Torque				4-6 Nm	7-10 Nm			19-25 Nm			30-40 Nm		30-40 Nm		35-50 Nm	
Undervoltage Release				□	□			□			□		□		□	
Shunt Trip Release				□	□			□			□		□		□	
Auxiliary Contact Block				□	□			□			□		□		□	
Motor Control Mechanism				□	□			--			□		□		□	
Extended Rotary Handle				--	□			□			□		□		□	
Lock Mechanism with Key				□	□			□			□		□		□	
Extension Bar				□	□			□			□		□		■	
Terminal Cover				□	□			□			□		□		□	
Trip Contact				□	□			□			□		□		□	
Inverser (Mechanical) Lock				--	□			--			□		□		□	
Phase Barrier				■	■			■			■		■		■	
Extension Handle				--	--			--			■		■		■	
Dimensions			a mm	120	140			140④			280		280		280	
			b mm	157	204			255			280		280		370	
			c mm	71	91			105			111		111		124	
			d mm	92	116			145			162		162		180	

■ : Standard □ : Upon Request

① Icu: O-t-CO test (O: Open maneuver, t: Waiting duration, CO: Close-Open maneuver
② Ics: O-t-CO-t-CO test (O: Open maneuver, t: Waiting duration, CO: Close-Open maneuver)
③ When two and three poles of the circuit breaker are connected in series.
④ For 300A and 400A: 121,5mm.
⑤ “E” modeller Elektronik Devre Kesicileri ifade etmektedir.
⑥ Motor circuit protection type (upon request)
⑦ F53 series MCCB are produced up to 315A.

MOLDED CASE CIRCUIT BREAKER



Pic-1

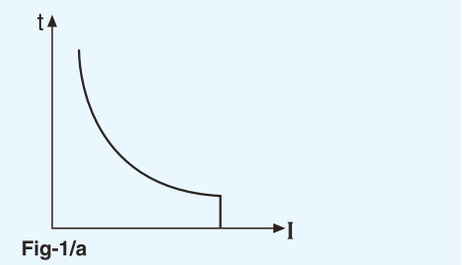


Fig-1/a

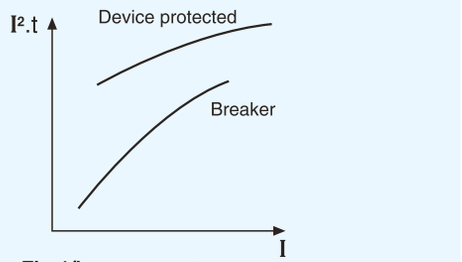


Fig-1/b

I= Current passing through
t= Current passing duration

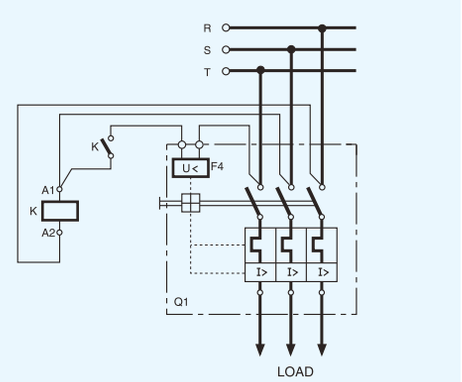


Fig-2

K : Contactor (Coil AC 380 V)
F4: Under voltage release (UVR)
Q1: Circuit breaker

The circuit breaker is a mechanical opening-closing device, which is used for closing, breaking, separating circuit and carrying current of that circuit under ordinary conditions and for automatically breaking the circuit under extraordinary conditions like short circuit and over current.

Operating Principle of the Circuit Breaker:
The most important function of the circuit breaker, in addition to opening-closing the circuit, is to protect the circuit under extraordinary conditions.
There are some units inside the device to let the breaker fulfill its protection functions. Opening units of LV circuit breakers are described as release mechanism in TS EN 60947-2 standard.

Releases :
- Over current releases (Over current opening unit)
- Under voltage releases (Low voltage opening unit)
- Shunt Trip releases (Remote release unit)

All the circuit breakers are equipped with over current releases. However, under voltage and shunt trip-release coil is not a standard accessory and added to the circuit breaker as per requirement.

Over Current Option:
All the values exceeding rated current value are called over current.

Formation of Over Current:
Over currents in electrical circuits result from increase of power expended or a short circuit. Both over currents are very dangerous for electrical devices. Over currents lead to thermal and dynamic forcing in electrical circuit.
- Although over currents, which are a result of increase in power expended, are not usually too high, they can go up to (2-3) time more than the rated current.
- Currents resulting from short circuit depend on characteristic of the electrical circuit. For example, they can go up to 3,2 kA in a transformer of 100 kVA; or 60kA in a transformer of 2500 kVA. Electrical devices such as transformer, generator, motor, cable etc. have a thermal forcing value I2 to resist without damage due to the heat caused by over current. As it can be seen in the formula, both current value and current delay time is very important. In order to keep $I^2.t$ value under a particular value, flow duration of the current should decrease as the current increases. LV circuit breakers open the circuit below $I^2.t$ value of the protected device to provide safe protection (Figure-1).

Over Current Release are divided into two:
1. Releases opened under over load conditions,
2. Releases opened under short circuit conditions.

Releases opened under over load conditions: These are the releases that operate when the current expended in the circuit exceeds the rated current value of the breaker. They operate on reverse time delay basis. As current value increases, opening duration decreases.

Releases opened under short circuit conditions:
These are the releases that open the circuit in a very short time when the short circuit current exceeds the adjustment value of the release.

Undervoltage Releases:
Voltage going below a particular value in electrical circuits or failure of any phase in tri-phase circuits may result in failure of devices. For example, failure of any phase in tri-phase motor shall overload other phases and result in failure of the motor. When required, low voltage coil can be assembled to the breaker to prevent occurrence of such failures. As under voltage coil is usually supplied by two phases, control of other phase is performed by a contactor (Figure-2).

Shunt Trip Releases
They are used for remote-release of the circuit breaker. When a voltage is applied to a shunt trip release, opening should be made up to 70% and %110 of the supply voltage.

TYPES OF CIRCUIT BREAKERS:
LV circuit breakers are manufactured in two different types depending on the release type. These are thermal-magnetic and electronic circuit breakers.

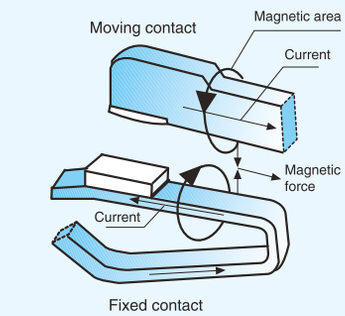
Thermal - Magnetic Circuit Breakers:
Thermal protection function, (1,1-3) x In: (For protection under over load conditions)

Bimetal, which provides thermal protection, consists of combination of two metals with different extension coefficients under heat. When bimetal is heated, it bends towards the metal with less extension. In this way, a notch that assists opening of the breaker mechanism is released to disable the breaker. Bending speed of bimetal is in direct proportion with size of the current passing through the breaker. Because, increase of current means increase of heat. In this way, over current protection function of the breaker is fulfilled by bimetal at load currents higher than the rated current.

Magnetic protection function, >3 x In: (For protection under short circuit conditions)

Another function of the breaker is to protect the connected circuit against short circuits. Short circuit may occur as a result of contact of phases with each other or contact of phase-ground. Since a very high current shall pass through the cables in case of short circuit, system energy should be broken in a shorter

MOLDED CASE CIRCUIT BREAKER



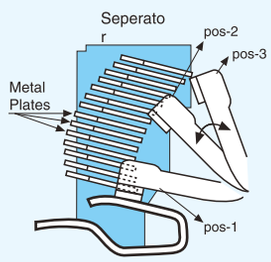


Fig - 3

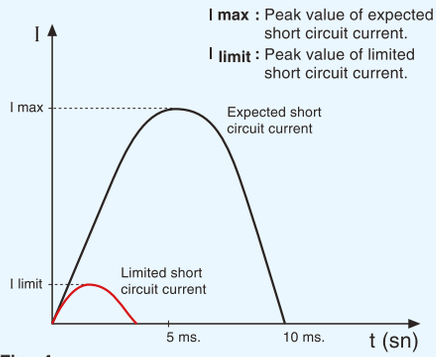
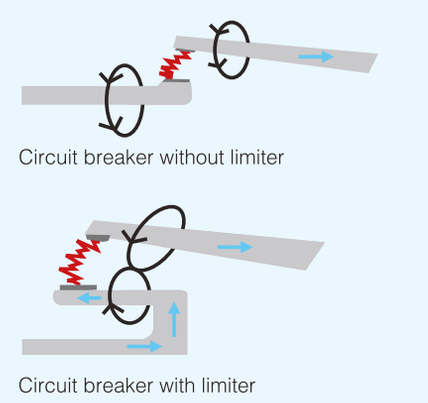


Fig - 4



The difference between circuit breakers with and without limiters is in the construction of fixed contacts. Fixed contacts of circuit breakers with limiters are in the structure to reverse the direction of current and form reverse magnetic force to push the moving contact.

time due to thermal protection. Breaker should perform instant opening to protect load it is connected to. The part fulfilling this function is a mechanical opening mechanism that operates with magnetization caused by the magnetic area formed by the short circuit current.

Circuit Breakers with Electronic Over Current Release:
The feature discriminating electronic circuit breakers from thermal-magnetic breakers is to control the over current releases with electronic circuit. Electronic control is performed via microprocessor. During design of the electronic circuit, worst possibilities to encounter in operation have been taken into consideration. In high circuit currents, direct opening has been ensured without operating electronic circuit. In this way, possibility of failure in the electronic circuit has been eliminated.
-Computer memory can be used instead of current recording devices.
-Maximum, minimum, average etc. values of the drawn current at various time intervals (day-night) can be taken.
-Statistical information can be accessed any time.
-Opening period of the breaker can be adjusted in case of over current formation.
-Rated current and instant opening current of the breaker can be changed on computer.
-External opening control can be provided.
Rated and instant opening current adjustment areas of electronic circuit breakers are quite wide. This feature allows wide use opportunity to the breaker. Furthermore, electronic circuit breakers are not affected from ambient temperatures.

Operating principle of limiter circuit breaker:
While breaker is opened and closed with lever, moving contact should be in ON position in pos-1, in OFF position in pos-3 (Figure - 3). The short circuit current that comes into existence when there is a short circuit in a breaking current without limiter opens the breaker by enabling the breaking mechanism via releases and takes breaking lever to trip position. Opening duration varies between 10-20 ms. In Federal limiter breakers, reverse magnetic area where short circuit occurs takes moving contact from pos-1 to pos-2 and contact remains in this position. That is, contact does not come to ON position again. Opening of the moving contact starts with the first millisecond of the short circuit. The contact arrives pos-2 in the first two milliseconds and complete cut-off of the arc lasts in 3-5 milliseconds maximum. Magnetic releases, which get into operation with start of the short circuit, take the breaking mechanism to OFF position; the mechanism takes the moving contact in pos-2 to pos-3 and the breaking lever remains in trip position. The current, which takes the moving contact from pos-1 to pos-2, is a lower current than the expected short circuit current. Limited current is at one-eighth and even one-tenth of the expected current (Figure- 4), The expected short circuit current would flow in a shorter time than the current if there was no limiter circuit breaker.

Advantages of Federal limiter circuit breaker:
-They protect transformers, cables and other devices in circuit by limiting the current up to 90% depending on the breaker type.
-As explosions and arcs remain at a very low level, critical safety is guaranteed in order not to give damage to other devices in the panel.

PARTS OF CIRCUIT BREAKERS

Body and Cover: Fiber-glass polyester resin has been used as the body and cover material in accordance with EN 60512-20-2 standard. This material, which is called BMC (Bulk Molding Compound) in the literature, is preferred due to high electrical and mechanical values and can resist to a temperature of 160°C continuously. BMC material does not burn when in contact with wire at a temperature of 960°C in accordance with IEC 695-2-1.

Bimetal: Bimetal is a material consisting of combination of two plate metals with different extension coefficients against heat. The current passing through the breaker heats up bimetal. Due to effect of this heat, bimetal bends towards the less-extending plate. Since heat increases as the current passing through the breaker increases, bimetal is heated more and bends more. In this way, it controls the opening mechanism to open the breaker.

Contacts: Contact alloy is determined for breakers by considering broken and carried current values and construction. Usually silver, graphite, nickel, wolfram alloy contacts are used in breakers. Contacts, which are made of silver-graphite alloys with a smoothers structure, are used in fixed (bottom) contacts, silver - wolfram contacts, which are harder, are used in moving (top) contacts. A swaged structure has been ensured in moving contacts. In this way, swaged and hard alloy contacts have a place on soft fixed contacts in each opening-closing. In this way, the lowest resistance is ensured. Moving contact should touch the fixed contact very well in order to have low contact resistance. However, excessive contact pressure force results in damage of contacts in a shorter period than normal. Contact alloys are very important for a healthy opening-closing.

Arc Extinguisher Cell (Separator): Separators are used to extinct the arc which is formed during operation of the breaker operating under energy. While moving

MOLDED CASE CIRCUIT BREAKER

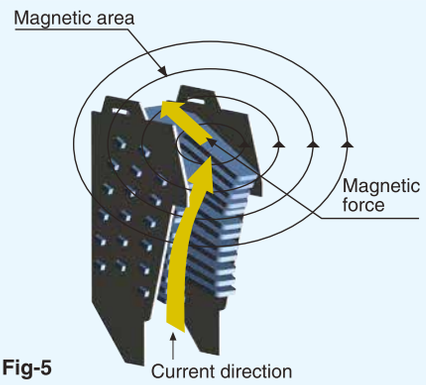


Fig-5

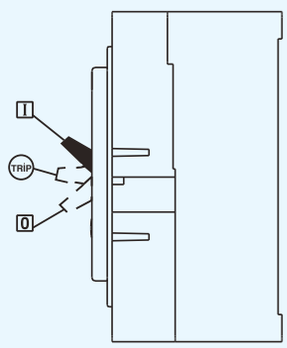
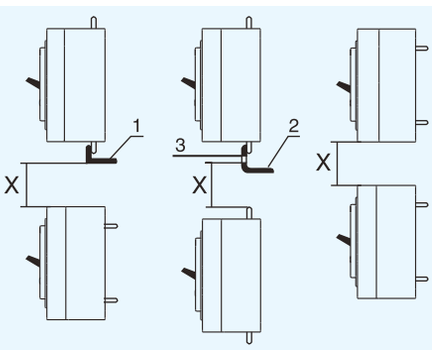


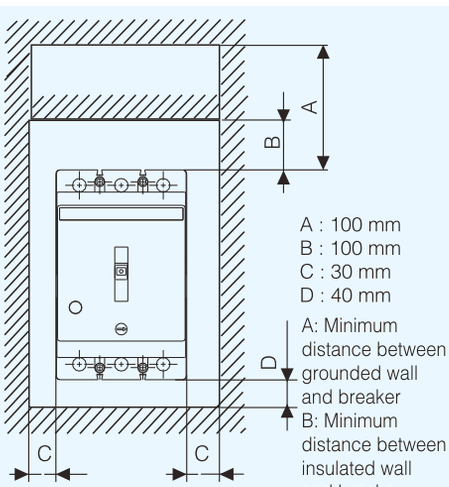
Fig-6



1) Busbar
2) Cable
3) Cable Terminal

Type	x (mm)
F12 F31-F32-F33 F51-F52-F53	140
F61-F62/F71 F82-F83/F82E-F83E	180
F92E F101E-F102E F111E-F112E	

Fig-7



A : 100 mm
B : 100 mm
C : 30 mm
D : 40 mm

A: Minimum distance between grounded wall and breaker
B: Minimum distance between insulated wall and breaker

Fig-8

contact is separated from fixed contact, current continues to flow between contacts for a while and this is called arc. This arc should be extinct in a very short time.

Extinction of Arc:
Arc is pushed towards separators due to magnetic field formed around the arc. In this way, arc is extended and becomes slim and broken off between separator plates (Figure-5). Due to characteristic of the material used on side walls of the separators, a gas comes out due to high temperature caused by the arc. This gas has an important effect on extinction of the arc.

Utilization Type of the Circuit Breaker:
There are 3 positions indicating position of the breaker. These positions are shown in Figure-6.

ON/I Position: It indicates that contacts of the breaker are closed. In this position, the breaker lever is in the top position.

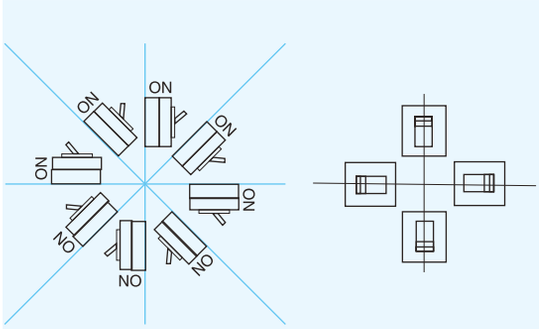
TRIP Position: It indicates that the breaker is opened due to any failure (over load or short circuit). In this case, breaker lever is in the middle position between ON and OFF positions. In order to take the breaker, which is in trip position, to ON position; push the breaker lever downwards as shown by the OFF sign. Breaker shall be set with "click" sound. After that, pull the lever as shown by ON sign to close the breaker.

OFF/0 Position: It indicates that contacts of the breaker are open. In this way, the breaker lever is in the bottom position.

Assembly: Important considerations during assembly are listed below.
- The place to assemble the breaker should be free of dust and moisture.
-Breaker should be assembled in a way not to be subject to gas and vapor. - If the environment is dusty and moist, the breaker must be assembled in a housing with appropriate protection degree.
- While the breaker is in operation, it should not be exposed to vibration and sudden impacts.
- Minimum distances between two breakers assembled one on another should be as shown in Figure-7.
- Minimum distances between grounded or insulated wall and the breaker should be as shown in Figure-8.
- Assembly method of the connectors (for F31 and F51 type switches) vary according to connection at the front or at the back. Connector may be demounted, reversed and mounted again if required.
- Cable connections of measurement devices should be made through busbars, no connection should be made through terminals of the breaker (Please request extension busbars from factory for connections to be made with cable shoes.)
- End insert should be used in connections of multi-wire cables to breaker connector and no brazing should be made at cable ends.
- In connection is made to the breaker via copper busbars, busbars should be painted and feather edges should be rounded to minimize the risk of jumping.
- Phase curtains must be placed in the conduit between two busbars in the breaker body.
- Grounding should be made in accordance with the regulations.

Against earth leakage currents resulting from the low voltage circuits, with combination of fault current sensor relay and toroidal transformer are detected and the protection can be achieved by controlling of shunt trip coil or under voltage release coil on the mounted circuit breakers, such as protection can be achieved by residual current protected type circuit breakers.

Toroidal transformer, sensors relay and shunt trip are placed into circuit breakers. Without the need any external accessory connector can be installed only by connecting the input and output terminals. For leakage current protection selectivity, the leakage current threshold and leakage current time delay can be set by user. There is test button for leakage current protection function as separately from trip test button. In this way, the earth leakage protection function can also be tested. Earth
- leakage circuit breakers have also high thermal-magnetic protection like as our other compact type circuit breakers.
• Led indicating neutral is connected.
• Thermal and magnetic protection on 4th pole(neutral). (optional)
• Available for auxiliary contact connection



Assembly can be made in any angle.


Line can be connected to Federal circuit breakers at underside or upperside but connection at upperside should be preferred.

EARTH - LEAKAGE CIRCUIT BREAKERS (IEC / EN 60947-2)

4 POLE					F12R	F31R
TYPE					**F12R**	**F31R**
Rated Current - I_n				A	16 - 160	80-250
Number of Poles					4	4
Rated Insulation Voltage - U_i (50-60 Hz)				V	1000	1000
Rated Impulse Withstand Voltage - U_{imp}				kV	8	8
Test Voltage - AC 50-60 Hz (1 minute)				V	3000	3000
Rated Ultimate Short Circuit Breaking Capacity ①	50-60 Hz	220/240 V		kA	35	65
	50-60 Hz	380/415 V		kA	25	36
	50-60 Hz	440 V		kA	20	25
	50-60 Hz	500 V		kA	12	18
	50-60 Hz	690 V		kA	8	12
Rated Short Circuit Breaking Capacities - I_{cs} ②					%75Icu	%100Icu
Rated Short Time Withstand Capacities - I_{cw} - 380/415 V					--	--
Category (IEC/EN 60947-2)					A	A
Trip Mechanism & Protection Characteristics	Thermal-Magnetic	Termal Fixed			□	□
		Thermal Adjusted			(0,8-1)In	(0,7-1)In
		Magnetic Fixed			16-63A: 600A 80-160A: 8In	80A: 12In 100A: 10In 125-250A: 8In
		Magnetic Adjusted			--	--
Residual Current Threshold				mA	30-100-300	300-500-1000-1500
Residual Current Time Delay				ms	50-150-300	50-150-300
Current Limiting					E	E
Mechanical Life				Op.	15000	15000
Electrical Life				Op.	3000	3000
Weight					kg 1,7	3,3
Connection Terminal Capacity	Box-Type Terminal				16-100A: 50 mm² 125-160A: 70 mm²	□120 mm²
	Terminal for Busbar / Cable Lug	Cable Lug (Standard / Narrow)			□16/25 mm² (M5)	95/120 mm² (M8)
		Busbar Width			□13 mm	24 mm
	Box-Type Terminal on Extension Busbar				--	--
Minimum - Maximum Tightening Torque					4-6 Nm	7-10 Nm
Undervoltage Release					□	--
Shunt Trip Release					■	■
Auxiliary Contact Block					□	--
Motor Control Mechanism					--	--
Extended Rotary Handle					--	--
Lock Mechanism with Key					--	--
Extension Busbar					□	□
Terminal Cover					□	□
Trip Contact					□	□
Inverser (Mechanical) Lock					--	--
Phase Seperator					■	■
Extension Handle					--	--
Dimensions				a mm	120	140
				b mm	157	204
				c mm	71	91
				d mm	92	116

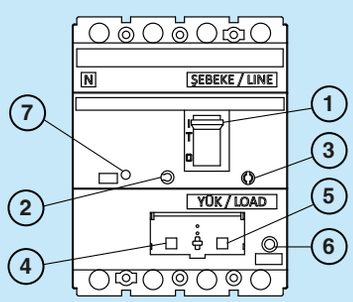
■ : Standard □ : Upon Request

① Icu: O-t-CO test (O: Open maneuver, t: Waiting duration, CO: Close-Open maneuver

② Ics: O-t-CO-t-CO test (O: Open maneuver, t: Waiting duration, CO: Close-Open maneuver).

When earth leakage current arises from low voltage circuits, the breaker detects the fault with combination of current sensor relay and toroidal transformer then protects the system by controlling of shunt trip coil or under voltage release coil which are mounted on the breaker. This process is similar with residual current protected type circuit breakers.

Federal leakage current protected switches are produced from 16A-250A. Toroidal transformer, sensors relay and shunt trip are placed into circuit breakers. Without the need any external accessory connector can be installed only by connecting the input and output terminals. For leakage current protection selectivity, the leakage current threshold and leakage current time delay can be set by user. There is test button for leakage current protection function as separately from trip test button. In this way, the earth leakage protection function as separately from trip test button. In this way, the earth leakage current protection function can also be tested. Earth-leakage circuit breakers have also high thermal-magnetic protection like as our other molded case circuit breakers.



1-Operation Handle

2-Trip Button

3-Rated Current (Thermal) Setting Course

4-Residual Current Threshold (mA)

5-Residual Current Time Delay (s)

6-Residual Current Circuit Test Button

7-Coil Reset Button

TOROIDAL & RECTANGLE TRANSFORMER

Protection System Against Earth Leakage Currents With Circuit Breakers:

Even small values (>30mA) of earth fault currents to occur in electrical circuits are quite dangerous in terms of safety of life and fire. As normal breakers can't detect such small earth leakage, no additional protection is provided against earth leakages. Earth leakage protection relay can be added to electronic breakers without an additional mechanism. With this system, protection at (0,1 - 1)xI_n sensitivity can be provided. Protection against earth leakage in non-electronic breakers and electronic breakers require protection against leakage currents lower than the aforementioned value mentioned above is provided with combination of toroidal transformer and earth leakage protection relays.

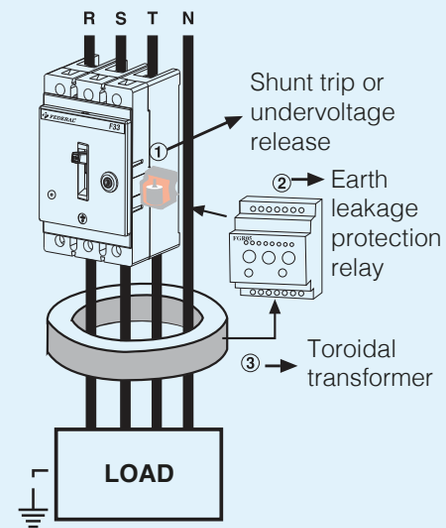
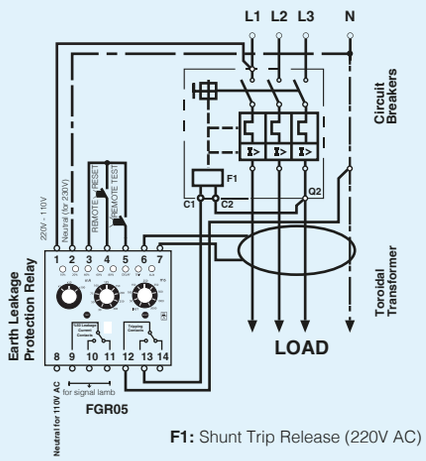
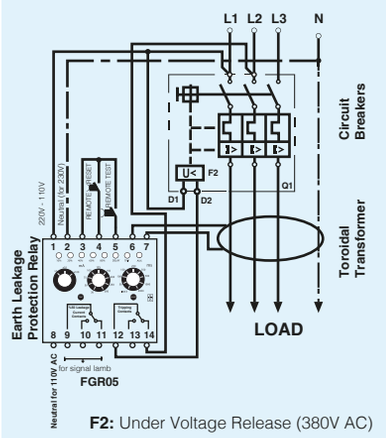


Figure-2 Protection system in the circuit breakers against earth leakage current



F1: Shunt Trip Release (220V AC)

Figure-3 Use of earth leakage protection relay with circuit breaker equipped with shunt trip release.



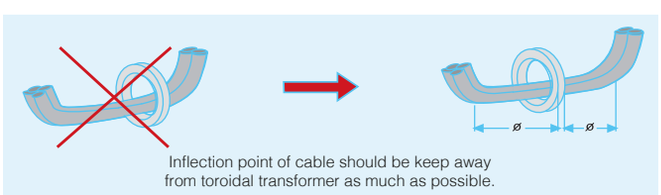
F2: Under Voltage Release (380V AC)

Figure-4 Use of earth leakage protection relay with circuit breaker equipped with under voltege release.

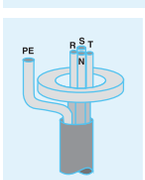
However, in this system, in order to let the circuit breaker open in terms of earth leakage currents, one of shunt trip or undervoltage release must be mounted to the breaker (Figure-2). Fault current rating of earth leakage protection relay should be adjusted according to protection type and appropriate values to ensure selectivity among other protection relays. According to the standards, this values has been determined as 30mA for life protection and (300-500)mA for fire protection. If shunt trip is connected to the circuit breaker, energy supplied to the shunt trip, should be supplied through open contact of the earth leakage relay normal open detection coil.

Assembly

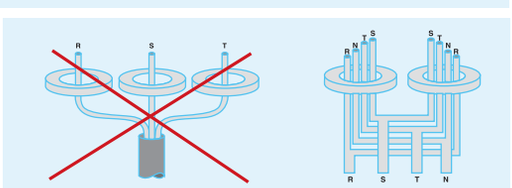
All the phases and neutral cable, if any, shall pass through the toroidal transformer. earth cable should not pass through the toroidal. Secondary cables of toroidal shall be connected to earth leakage protection relay (6-7) terminals and appropriate voltage written on the relay is supplied to energy input terminals of the relay. Shunt trip and undervoltage release must be connected to the breaker to trip circuit breaker in case of earth leakage (Figure-3). If undervoltage release is connected to the circuit breaker, energy supplied to the undervoltage release should be supplied through normal close contact of earth leakage release and incoming side of circuit breaker (Figure-4).



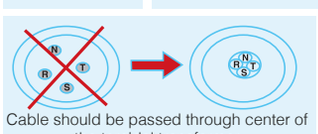
Inflection point of cable should be keep away from toroidal transformer as much as possible.



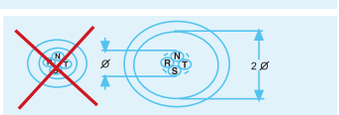
Ground cable should not be passed through toroidal transformer.



Parallel connection of more than one toroidal transformers to the earth leakage relay.



Cable should be passed through center of the toroidal transformer



Important Considerations in Assembly:

-If cables cannot pass through a toroid with high diameter, several toroids can be connected parallel to the same earth protection relay. However, this transaction can be reduced sensitivity of the device and increases opening threshold.

-If it is not available to mount toroidal transformers on the primary busbars, it can be placed on neutral-ground connection of the transformer for balanced loads.

EARTH LEAKAGE PROTECTION RELAYS

Earth Leakage Protection Relays
When a fault current is detected in the system according to the signal coming from toroidal transformer, the circuit breaker controls the shunt trip or the undervoltage release to open the circuit breaker. Fault current value and time to operate the relay can be adjusted on the relay.

TYPE		FGR05	FGR06
Fault Current Adjustment		0,03 ... 30A	0,03 ... 30A
Order Code		8AT-N0000-0500	8AT-N0000-0600
Opening Time Adjustment		0,05 - 3 sec.	0,05 - 3 sec.
Supply ①		110V / 220V - 240V AC (50/60Hz) ①	220V / 380V-415V AC (50/60Hz) ①
Output Relay		3A, 250V AC	3A, 250V AC
Reset		Manual / Electrical (Remote)	Manual / Electrical (Remote)
Current Tolerance		(0,5 - 1) -IΔn	(0,5 - 1) -IΔn
Time Tolerance		±%15	±%15
Time Characteristic		Fixed	Fixed
Temperature	Storage	-30°C / +70°C	-30°C / +70°C
	Operating	-20°C / +60°C	-20°C / +60°C
Humidity		%40 - 85 RH non condensing	%40 - 85 RH non condensing
Installation		Board / 35 mm DIN - Rail	Board / 35 mm DIN - Rail

① FGR05 and FGR06 earth leakage protection relays have the same detection features but different supply voltage ranges. FGR05 has 110/220-240 VAC alternative supply voltage value, FGR06 has 220/380-415 VAC alternative supply voltage value.

TOROIDAL & RECTANGLE TRANSFORMER

Earth fault relay and toroidal transformer are used with circuit breakers to detect even small earth leakages and open the circuit breaker.

Toroidal Transformer

Rectangle Transformer

TYPE	Window Size (mm)	Circuit Breaker				
		With Cable		With Busbar		
Toroidal	Ø60	Max. 4x70mm	F12 / F12N / F21	-		
	Ø110	Max. 4x240mm	F31 / F32 / F33 F31N / F32N / F33 NF51 / F52 / F53 F51N / F52N / F53N F61 / F62	-		
	Ø160	Max. 8x240mm	F71 / F72 F82 / F83 / F82E / F83E F82N / F83N / F82E-N / F83E-N	F12 / F12N / F21/ F31 / F31N / F32 / F32N / F33 F33N / F51 / F51N / F52 / F52N / F53 / F53N		
	Ø210	Max. 16x240mm	F91E / F91E-N / F92E / F92E-N (with the one Torodial Transformer)	F12 / F12N / F21 / F31 / F31N / F32 / F32N / F33 F33N / F51 / F51N / F52 / F52N / F53 / F53N / F61 / F62		
			F101E / F102E / F111E / F112E (with the two paralel Torodial Transformer)			
Rectangle	280x120	Max. 16x240mm	F71 / F72 F82 / F83 / F82E / F83E F82N / F83N / F82E-N / F83E-N F91E / F92E / F91E-N / F92E-N	Busbar	Horizontal Connection	F71 / F72 / F82 / F83 / F82E / F83E F82N / F83N / F82E-N / F83E-N F91E / F92E / F91E-N / F92E-N F101E / F102E
				(Busbar with 70mm spaced) 2x100x5 busbar (max.1600A) 3x100x5 busbar (max. 2000A)	Vertical Connection	F121E / F122E / F123E
	370x120	Max. 20x240mm	F91E / F92E F91E-N / F92E-N F101E / F102E	(Busbar with 100mm spaced) 2x100x10 busbar (max. 2500A) 3x100x10 busbar (max. 3200A)	Horizontal Connection	F121E / F122E / F123E
					Vertical Connection	F111E / F112E F131E / F132E / F133E
	500x120	Max. 28x240mm	F111E / F112E F121E / F122E / F123E	(Busbar with 100mm spaced) 2x100x10 busbar (max. 2500A) 3x100x10 busbar (max. 3200A)	Horizontal Connection	F111E / F112E F131E / F132E / F133E
				(Busbar with 140mm spaced) 4x100x10 busbar	Vertical Connection	F141E / F142E / F143E

MOLDED CASE CIRCUIT BREAKER ACCESSORIES

	**Motor Control Mechanisms**	Used for opening – closing the circuit breaker remotely. Moreover, thanks to the notch on it, manual opening – closing can be done. Motor control mechanism is assembled on top cover of the circuit breaker. It has mechanical locking feature.
	**Changeover Relays**	Used to ensure automatic transition between network and generator at places where two circuit breakers are used for inverter purposes. Line, supply, circuit breaker statuses can be monitored on the relay. Alarm and shunt trip coil connection can be made with fault contact.
	**Extended Rotary Handles**	Used for opening- closing the circuit breaker. It is used for rotating the circuit breaker, not pushing-pulling it upwards-downwards.
	**Undervoltage Releases**	Used for tripping the circuit breaker when the energy is cut off or voltage goes below the operating voltage. When no energy is supplied to the under voltage coil, the circuit breaker can't get open position.
	**Lock Mechanism with Key**	Lock mechanism mechanically locks the circuit breaker, which is on (trip) position due to service and prevent to get ON and OFF positions.
	**Operating Extention Handles**	Extension handle is mounted directly on the operating handle of the circuit breaker. It provides ease of use according to the mounting volume inside the panel and the position of circuit breaker.
	**Shunt Trip Releases**	Used for tripping the circuit breaker remotely. When the breaker is on closed (ON) position, when voltage is supplied to the shunt trip relay the circuit breaker is tripped and got trip position.
	**Auxiliary Contact Blocks**	Used for supplying electrical signaling of the circuit breaker according to the operating position. They open and close with the main contacts and perform the warning and locking functions.
	**Mechanical Lock**	It is important to make the network-generator automation also known for automatic inverter system; because an error will cause the network and the generator to remain active at the same time, causing a short circuit and a phase coincidence. A mechanical lock is used to eliminate this possibility of error and provide operational safety.
	**Extension Bars**	Extension bars allow easy and healthy cable or busbar connections to the terminals of the circuit breaker. They are manufactured of electrolytic copper material with silver coating.
	**Connection Terminals**	They are dispatched as screwdriver or allen screw head as per customer requirements.
	**Terminal Covers**	Provides a safe insulation by preventing contact to the terminal (busbar or cable) sections of the circuit breaker. Furthermore, terminal cover also insulates terminals from each other by passing through channels between poles. It is available in all our circuit breakers as a standard.
	**Trip Contacts**	When the circuit breaker is tripped, alarm/trip contact gets triggered mechanically and circuit breaker closes the energy of the circuit that it is connected by switching. So the system intended to be activated is energized. These contacts are used in automatic transfer systems. They only provide the information of trip position.
	**Panel Frames**	It is the cover mounted to the front face of the circuit breaker as the operating handle to be on the surface of the panel. It is used to create a more aesthetic and uniform appearance within the panel.
	**Phase Barriers**	It is the material that provides the isolation between the terminals of the circuit breaker. By placing them between phases, the terminals are separated from each other and arc jumps are prevented.
	**Plug-In**	Plug-in technology is a mold box technology developed for easy assembly and disassembly of the product mounted in a panel. This simplify extracting and/or replacing the circuit breaker rapidly without touching the connections on the base.
	**Withdrawable**	In addition to the advantages provided by the base, thanks to the drawer handle, the circuit breaker can be easily and qucikly affixed and removed from the chassis. The maintenance position of the withdrawable design is intended for the maintenance of the auxiliary circuits.

AIR TYPE CIRCUIT BREAKERS (IEC / EN 60947-2)

Network Protection Breakers: Big powerful motor, load with starting resistance don't exist in main networks and lines are quite long. LV circuit breaker should open in short circuit currents to occur by the end of these lines. Therefore, magnetic adjustments of the circuit breakers utilized in main lines should be between (4 - 8)xIn.

Three-phase thermal-magnetic circuit breakers / For protection of main networks:

Nominal current In (A)	Rated current adjustment area I1 (A)	Short circuit opening current I2 (A)	Type	Order Code	Type	Order Code	Type	Order Code
16 - 75 80 - 160	(0,8-1)In (0,8-1)In	600A 8 In	F12 25kA	9AR-TSS43-0□□□	F12R 25kA	9AR-TSS43-0□□□		
160	Sabit	8 In	F12S 25kA	9AR-TDS43-0160				
16 - 25 32-100 125 - 250 160 - 250	(0,7-1)In (0,7-1)In (0,7-1)In (0,7-1)In	200A 10 In 8 In (5-10) In	F31 35kA F31R 35kA	9AB-TSS43-0□□□ 9AB-TSS#3-D	F32 50kA	9AB-TMS43-0□□□	F33 70kA	9AB-THS43-0□□□
100 - 250	Sabit	8 In	F31S 35kA	9AB-TSS43-0□□□				
125 - 175 200 - 320 400	(0,7-1)In (0,7-1)In (0,7-1)In	(5-10) In (4-10) In (3-8) In	F51 35kA	9AD-TSS43-0□□□	F52 50kA	9AD-TMS43-0□□□	F53 70kA	9AD-THS43-0□□□
300 - 400	(0,7-1)In (0,7-1)In	(5-10) In	F61 25kA	9AP-TSS43-0□□□	F62 35kA	9AP-TMS43-0□□□		
300 - 800	(0,7-1)In	(5-10) In	F71 35kA	9AF-TSS43-0□□□	F72 50kA	9AF-TSH43-0□□□		
300 - 630 800	(0,7-1)In (0,6-1)In	(5-8) In (5-8) In	F82 50kA	9AG-TMS43-0□□□	F83 70kA	9AG-THS43-0□□□		

□□□: Enter amper value

Generator Circuit Protection Breakers: As the short circuit current to occur in the generators is at very low values, magnetic adjustments of the circuit breaker to be used for protection of generators should be (3 - 5)xIn

Three-phase thermal-magnetic circuit breakers / For protection of generator circuits :

Nominal current In (A)	Rated current adjustment area I1 (A)	Short circuit opening current I2 (A)	Type	Order Code	Type	Order Code	Type	Order Code
200 - 250	(0,7-1)In	1000 A	F31 35kA	9AB-TSJ43-0□□□	F32 50kA	9AB-TMJ43-0□□□	F33 70kA	9AB-THJ43-0□□□

□□□: Enter amper value D: Enter 0 for domestic market, D for foreign market #: Enter 4 for ambient operational temperature 40°C, 5 for 50°C

Short circuit current of a generator

S_{rg} : Rated power (kVA)
U_r : Rated voltage (V)
I_{kg} : Short circuit current (A)
I_{rg} : Rated current (A)
X''_d : Temporary reactance (%)
(Reactance observed around 5-20% of the impedance value for 5-30 ms)

Is calculated with the following formula.

$$I_{kg} = \frac{I_{rg} \cdot 100}{X''_d\,\%} \qquad I_{rg} = \frac{S_{rg}}{\sqrt{3} \cdot U_r}$$

Circuit breakers should be selected according to the following formula in order to protect the generator circuits.

For single generator Icu ⩾ Ikg
For n pieces of identical generator connected parallel, Icu ⩾ Ikg x (n-1)
For generator connected to network parallel, Icu ⩾ Iknet.

Generator			Breaker
kVA	kW	A	A
9.4	7.5	13.6	16
12.5	10	18.2	20
18.7	15	27.3	32
25	20	36.4	40
31.3	25	45.5	50
37.5	30	54.6	63
50	40	73	80
62.5	50	91	100
75	60	109	125
100	80	146	160
125	100	182	200
156	125	228	250
187	150	273	300
250	200	364	400
312	250	455	500
375	300	546	630
500	400	730	800
625	500	910	1000
750	600	1090	1250
1000	800	1460	1600
1250	1000	1820	2000
1563	1250	2280	2500

AIR TYPE CIRCUIT BREAKERS (IEC / EN 60947-2)

Motor Circuit Protection Breakers: Motors draw very high current for a short time during first start-up. In order to ensure operating continuity and to protect the system, magnetic adjustment area of the breaker to be selected should be (8 - 12)xIn.

Three-phase thermal-magnetic circuit breakers / For protection of motor circuits:

Nominal current In (A)	Rated current adjustment area I1 (A)	Short circuit opening current I2 (A)	Type	Order code	Type	Order code	Type	Order code
125 - 250	(0,7-1)In	10 In	F31 35kA	9AA-TSM43-0□□□	F32 50kA	9AB-TMM43-0□□□	F33 70kA	9AB-THM43-0□□□

□□□: Enter amper value D: Enter 0 for domestic market, D for foreign market #: Enter 4 for ambient operational temperature 40°C, 5 for 50°C

Motor Power		Motor Rated Current	Breaker Rated Current
(kW)	(Hp)	(A)	(A)
5,5	7,5	11,5	16
9	12	18,5	20
11	15	22,5	25
15	20	30	32
18,5	25	36	40
22	30	43	50
30	40	58	63
37	50	72	80
40	54	79	100
51	70	98	100

Motor Power		Motor Rated Current	Breaker Rated Current
(kW)	(Hp)	(A)	(A)
59	80	112	125
80	110	147	160
100	136	188	200
132	175	243	250
140	190	260	300
160	220	292	300
200	270	368	400
250	340	465	500
315	430	580	630

Note: These circuit breakers provide short circuit protection. Overload protection should be provided via thermal relays connected to the contactors.

Three-phase electronic circuit breakers :

Nominal current In (A)	Rated current adjustment area I1 (A)	Short circuit opening current I2 (A)	Type	Order code	Type	Order code
300 - 800	(0,4-1)In	(2-10)xI1	F82E 50kA	9AG-EMS43-□□□□	F83E 70kA	9AG-EHS43-□□□□
1000 - 1250			F91E 50kA	9AG-EMS43-□□□□	F92E 65kA	9AG-EHS43-□□□□
1000 - 1600			F101E 50kA	9AI-EMS43-□□□□	F102E 70kA	9AI-EHS43-□□□□
1600 - 2500			F111E 50kA	9AG-EMS43-□□□□	F112E 70kA	9AG-EHS43-□□□□

Delay time of the short circuit opening current (when required) can be adjusted as t2 : 50-100-200-300 ms..
□□□: Enter amper value D: Enter 0 for domestic market, D for foreign market #: Enter 4 for ambient operational temperature 40°C, 5 for 50°C

Mono-phase thermal-magnetic circuit breakers:

Nominal current In (A)	Rated current adjustment area I1 (A)	Short circuit opening current I2 (A)	Type	Order code	Type	Order Code
16	In	10 In	F01 35kA	9AB-TSS41-0□□□	F02 65kA	9AB-THS43-0□□□
20 - 63		8 In				
80		10 In				
100 - 225		8 In				

Reasons For Over Voltages Occurring at L.V. Facilities And The Measures That Must Be Taken:

As known, over voltages may develop at power plants from time to time. These over voltages develop as a sudden impact for a very short time during the engagement and disengagement of equipment such as transformers, condensers, coils, etc., and this is also called lightning stroke or switching. During these temporary incidents that occur from time to time, by a jump between phases or phase-earth, they may turn into short circuits. Dirt, dust and moisture on the insulating material increase the probability of occurrence.

During the closing of the circuit when L.V. transformers are taken into operation, very short-period high magnetization currents occur. The initial peak value of these currents may go up to 16-35- fold of the nominal current in transformers between 50kVA and 1500 kVA, and 10-16-fold in power transformers over 1500kVA. Temporary magnetization currents fade away within a very short period of time (several milliseconds). When selecting switching devices for transformers, these magnetization currents have to be taken into consideration. Additionally, some electronic devices, at starting (engines running in idle, transformers running in idler, industrial welding devices, fluorescent lights with electronic ballasts and electronic equipment) from harmonic currents and voltages in multiples of the basic mains frequency.

For the protection of facilities from such harmonic currents and voltages, Harmonic Filter Reactors must be installed at the input of the low voltage panels and thus measures should be taken against damages on equipment

AIR TYPE CIRCUIT BREAKERS (IEC / EN 60947-2)

by harmonic currents and voltages.
In order to prevent the high voltage, described in the adjacent text and may occur due to many other reasons in addition to these, reaching dangerous levels, primarily suitable (approved quality) surge arrests must be installed at the M.V. and L.V. side of the transformer and the system earthing has to be made very well.
As an example, let us assume that the total resistance of the earthing network surrounding transformer center for protective earthing is represented by RE and the earthing resistance is RE=5. When a phase-earth short circuit occurs on the medium voltage side of the transformer center, the short circuit current that will be developed will run into the ground and form a potential in the ground.
If the short circuit current is 6,000 amperes, a voltage of 5 x 6000 = 30,000 volts will be distirbuted within the transformer center earthing networks. If the L.V. facility earthing has been connected to the M.V. protective earthing by mistake, the low voltage equipment connected to the facility earthing will be affected by the developed 30,000 volt potential and this will cause serious damages in the low voltage equipment. The value of the over voltage developed by the phase-earth short circuit current on the medium voltage side diminishes considerably at 20m distance from the transformer center and becomes affectless. Therefore, the operating earthing at the transformer center must be installed at least 20m way from the protective earthing.

Temperature effect on circuit breakers:

Thermal overload protection characteristics change due to the effect of temperature in thermo-magnetic circuit breakers. Circuit breaker trips earlier than its nominal value if it operates in a warmer environment than the calibrated temperature, and if it works in a cooler environment it trip later than it norm.

Federal thermo-magnetic circuit breakers are calibrated at 40°C as it's Standard. When requested, according to other different ambient temperature can be calibrated. The table below clarifies the operating currents for different ambient temperatures calibrated to 55°C. The working current at 40°C of the 100A circuit breaker calibrated to ambient temperature of 55°C can be found in the table as 106.8A.

In (A)	Operating Currents According to Ambient Temperature (Calibration Temperature 55°C)						
	10°C	**20**°C	**30**°C	**40**°C	**50**°C	**55**°C	**60**°C
16	19,2	18,5	17,8	17,1	16,4	16,0	15,6
20	24,1	23,2	22,3	21,4	20,5	20,2	19,6
25	30,1	28,9	27,8	26,7	25,6	25,0	24,4
30	36,1	34,7	33,4	32,0	30,7	30,0	29,3
32	38,5	37,0	35,6	34,2	32,7	32,0	31,3
40	48,1	46,3	44,5	42,7	40,9	40,0	39,1
50	60,1	57,9	55,6	53,4	51,1	50,0	48,9
60	72,2	69,5	66,8	64,1	61,4	60,0	58,7
63	75,8	72,9	70,1	67,3	64,4	63,0	61,6
80	96,2	92,6	89,0	85,4	81,8	80,0	78,2
100	120,3	115,8	111,3	106,8	102,3	100,0	97,8
125	150,3	144,7	139,1	133,4	127,8	125,0	122,2
150	180,4	173,6	166,9	160,1	153,4	150,0	146,6
160	192,4	185,2	178,0	170,8	163,6	160,0	156,4
200	240,5	231,5	222,5	213,5	204,5	200,0	195,5
225	270,6	260,4	250,3	240,2	230,1	225,0	219,9
250	300,6	289,4	278,1	166,9	255,6	250,0	244,4
300	360,8	347,3	333,8	320,3	306,8	300,0	293,3
400	481,0	463,0	445,0	427,0	409,0	400,0	391,0
500	601,3	578,8	556,3	533,8	511,3	500,0	488,8
630	757,6	729,2	700,9	672,5	644,2	630,0	615,8
800	962,0	926,0	890,0	854,0	818,0	800,0	782,0

Utilization of Circuit Breakers in Direct Current Circuits:
Non-electronic thermal-magnetic circuit breakers can be safely used in switching of DC currents.
As it is seen in Figure-12, 2 or 3 poles are connected serially for voltages higher than 250V and voltage per pole is reduced.

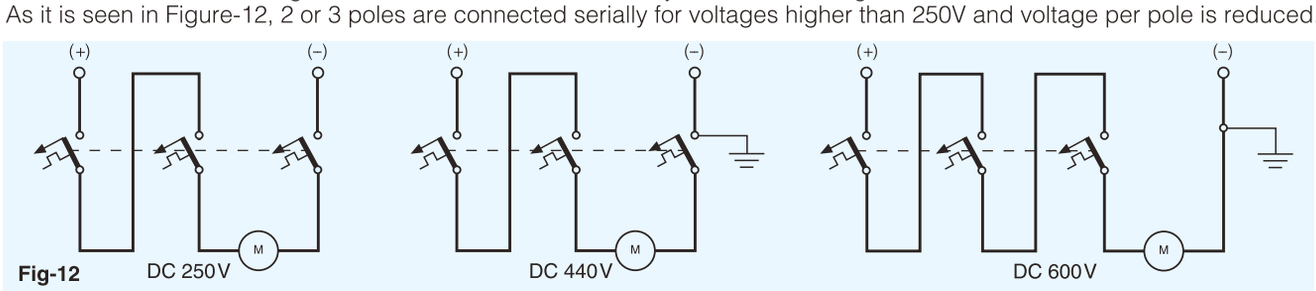


Fig-12

AIR TYPE CIRCUIT BREAKERS (IEC / EN 60947-2)

Breaker Selection Table Used for Protection of 3-Phase Capacitor Circuits:
(400 V, for Ambient Temperature 40°C)

Capacitor		Breaker
Power (kVAr)	Rated Current (A)	Rated Current In (A)
5	7.6	**16**
10	15.2	**25**
15	22	**40**
20	29	**63**
25	36	**80**
30	43	**100**
40	58	**100**
50	72	**125**
60	87	**125**
80	115	**160**
100	144	**200**
150	216	**300**
200	288	**400**
250	361	**500**
300	433	**630**
350	505	**800**
400	577	**800**
500	722	**1000**
550	793	**1250**
600	866	**1250**

Circuit breakers protecting capacitor circuits :
They should resist temporary currents during enablement and disablement of the capacitors.
They should resist currents at 15% more than capacity value and periodical and permanent over currents arising due to voltage harmonics.
They should have high mechanical and electrical life.
They should be selected to protect contactors after them.
They should break short circuit currents to occur in capacitor connectors.

According to IEC 60831-1 standard

Capacitors can operate continuously at currents 1.3 times more than rated currents and capacity value can be 15% more.

Accordingly, the highest current to pass through the circuit can reach 1,5 x Irc.

Icmax = 1.3 x 1.15 x Irc

Icmax : Maximum current to pass through the capacitor
Irc : Capacitor rated current

Therefore

Rated current of the circuit breaker to be selected should be higher than 1.5 x Irc.
Thermal adjustment should be at 1.5 x Irc value.
Magnetic adjustment should not be lower than 15 x Irc.

Breakers Used in LV Main Distribution Panels of Distribution Transformers:
(up to 36kV voltage)

Transformer power Sn (kVA)	Nominal current In (A)	Breaker rated current In (A)	Short circuit current Usc (%)	3-phase short circuit current Isc (rms) (A)
40	58	63	4,5	1283
50	72	80	4,5	1603
63	91	100	4,5	2020
80	115	125	4,5	2566
100	144	160	4,5	3207
125	180	200	4,5	4009
160	231	250	4,5	5132
200	289	300	4,5	6415
250	361	400	4,5	8019
315	455	500	4,5	10103
400	578	630	4,5	12830
500	723	800	4,5	16038
630	910	1000	4,5	20207
800	1156	1250	6	19245
1000	1445	1600	6	24057
1250	1805	2000	6	30071
1600	2312	2500	6	38491
2000	2900	3000	6	48113
2500	3600	4000	6	60142

Example: Rated current of the primary circuit breaker to be connected to the main distribution panel of a 1600 kVA transformer should be 2500A; short circuit breaking capacitor should be at least 50 kA. Short circuit breaking capacities of breakers at secondary outputs should be selected to be at least 50 kA.

Highest short circuit current of a distribution transformer on load side:
Tri-phase short circuit current of a transformer, with 36kV medium voltage side and 0.4kV output side, between low voltage ends is found with the following formula.

Sn : Nominal power of the transformer (kVA)
In : Rated current of the transformer (A)
Un : Output voltage between phases when transformer is unloaded (V)
Usc : Short circuit voltage of the transformer (%)
Isc : 3-phase maximum short circuit current at secondary side of the transformer (rms) (A)

$$Isc(rms) = \frac{S \times 100}{1{,}73 \times Un \times Usc}$$

Example:
What would be the continuous short circuit current when (Un: 400 V, Usc: %4,5) secondary of 630 kVA transformer is subject to short circuit?

$$Isc\ (rms) = \frac{630 \times 100}{1{,}73 \times 400 \times 4{,}5}$$

$$= 20207\ A$$

MOLDED CASE CIRCUIT BREAKER

Calculation of short circuit at any point of the line:

$$Isc = \frac{Un}{\sqrt{3}.\sqrt{Rt^2 + Xt^2}} \quad (kA)$$

Rt: Total resistance (mW)
Xt: Total reactance (mW)

Note: Rms value is an expression used in alternative voltage and current measurement and this value is the AC (alternative current) value equivalent to effective or DC (direct current) value. For example, AC voltage giving light amount of a lamp, on which 12V DC voltage is applied, is called 12V ACrms voltage. AC rms value = AC peak value / 1.41

Detailed calculation of short circuit at any point of the facility :

Facility zone	Resistance (mW)	Reactance (mW)
At network side	$R_1 = Z_1 \times \cos\varphi \times 10^{-3}$ $\cos\varphi = 0.15$ $Z_1 = \frac{U^2}{P_1}$ (Network impedance of the interconnected system)	$X_1 = Z_1 \times \sin\varphi \times 10^{-3}$ $\sin\varphi = 0.98$
Transformer	$R_2 = \frac{Pc \times U^2}{S^2} \times 10^{-3}$ Pc=cupper loss (W) S=apparent power of transformer (kVA)	$X_2 = \sqrt{Z_2^2 - R_2^2}$ $Z_2 = \frac{Usc}{100} \times \frac{U^2}{S}$ Z_2= impedance of transformer
Cables (1)	$R_3 = \frac{L}{k.S} \times 10^3$ k=56 (Cu) or 36 (Al) k=self-conductivity $\left(\frac{m}{Wmm^2}\right)$	X_3=0.07L (tri-phase cables) X3=0.15L (mono-phase cables) L : cable length (m) S : cable section (mm^2)
Busbars	$R_3 = \frac{L}{k.S} \times 10^3$ k=56 (Cu) or 36 (Al) k=self-conductivity $\left(\frac{m}{Wmm^2}\right)$	X_3=0.15 L L : busbar length (m) S : busbar section (mm^2)
Circuit breaker	R_4 negligible	X_4 negligible

Calculation of short circuit currents (kA)

	Resistance (mW)	Reactance (mW)	Short circuit current (kA)
M1	$Rt_1 = R_1 + R_2 + R_3$ $Rt_1 = 2.61$	$Xt_1 = X_1 + X_2 + X_3$ $Xt_1 = 12.2$	$\frac{400}{\sqrt{3}\sqrt{(2.61^2 + 12.2^2)}} = 18.52kA$
M2	$Rt_2 = Rt_1 + R_4 + R_5$ $Rt_2 = 2.71$	$Xt_2 = Xt_1 + X_4 + X_5$ $Xt_2 = 12.65$	$\frac{400}{\sqrt{3}\sqrt{(2.71^2 + 12.65^2)}} = 17.86kA$
M3	$Rt_3 = Rt_2 + R_6 + R_7$ $Rt_3 = 9.46$	$Xt3 = Xt2 + X6 + X7$ $Xt_3 = 17.55$	$\frac{400}{\sqrt{3}\sqrt{(9.46^2 + 17.55^2)}} = 11.58kA$

(1) If there are more than one parallel cable per phase, divide resistance and reactance of one cable into number of cables.

Single line diagram	Facility zone	Resistance (mW)	Reactance (mW)
	network side P1=500 MVA	$R_1 = \frac{400^2}{500} \times 0.15 \times 10^{-3}$ R_1=0.05 mW	$X_1 = \frac{400^2}{500} \times 0.98 \times 10^{-3}$ X_1=0.31 mW
	Transformer S=800 kVA Usc=%6 U=400 V Pc=9700 W	$R_2 = \frac{9700 \times 40^2 \times 10^{-3}}{0 \quad 800^2}$ R_2=2.42 mW	$X_2 = \sqrt{\left(\frac{6}{100} \times \frac{400^2}{800}\right)^2 - (2.42)^2}$ X_2=11.75 mW
	Connection cables From transformer to Circuit breaker 2 (3x240) mm2 Copper per phase L=4 m	$R_3 = \frac{4 \times 10^3}{56 \times 240 \times 2}$ R_3=0.14 mW	$X_3 = 0.07 \times \frac{4}{2}$ X_3=0.14 mW
M1	circuit breaker	R_4=0	X_4=0
main switchboard 1 2 3	output busbar no2 (Al) 10x80 mm2 Per phase L=3 m	$R_5 = \frac{3 \times 10^3}{36 \times 800}$ R_5=0.10 mW	X_5=0.15 x 3 X_5=0.45 mW
M2	circuit breaker	R_6=0	X_6=0
secondary switchboard M3	Connection between secondary panel and primary low voltage panel (cables)(3x185 mm copper per phase L= 70 m	$R_7 = \frac{70 \times 10^3}{56 \times 185}$ R_7=6.75 mW	X_7=0.07 x 70 X_7=4.9 mW

MOLDED CASE CIRCUIT BREAKER

Calculation of short circuit at any point of the network:
The following tables allow fast calculation of the short circuit current at any point in the network, if short circuit current at network side, cable section, type and length are known.

Reading of diagram:
Cable section and short circuit current on network side is marked in the table. Cable length is found on the cable section row. Cable length and short circuit current at network side are intersected and marked. This value gives the short circuit current to occur at the end of the cable.

380 V										
Cable (mm^2) Cu	Al	Cable length (m)								
1,5	2,5	—	—	—	1	—	—	2	—	3
2,5	4	—	—	1	—	—	2	3	4	5
4	6	—	1	—	—	2	3	4	6	8
6	10	1	—	—	2	3	4	6	9	12
10	16	1	2	—	3	5	7	10	15	20
16	25	2	—	3	5	8	11	16	24	32
25	35	3	4	5	8	13	18	25	38	50
35	50	4	5	7	11	18	25	35	53	70
50	70	5	8	10	15	25	35	50	75	100
70	120	7	11	14	21	35	49	70	105	140
95	150	10	14	19	29	48	67	95	143	190
120	185	12	18	24	36	60	84	120	180	240
150	240	13	20	26	39	65	91	130	195	260
185	300	15	23	30	46	77	108	154	231	308
240		19	28	38	57	96	136	192	283	284
300		24	36	48	72	120	168	240	360	480
Isc network (kA)		Isc Short circuit current at Isc load side (kA)								
100		65	51	42	30	19	14	10	7	5
90		62	49	41	29	19	14	10	7	5
80		58	47	39	29	18	13	10	7	5
70		52	44	37	28	18	13	10	6	5
60		47	40	35	27	18	13	9	6	5
50		41	36	32	25	17	13	9	6	5
45		38	34	30	24	17	13	9	6	5
40		35	32	28	23	16	13	9	6	5
35		31	28	26	21	16	12	9	6	5
30		27	25	23	20	15	12	9	6	5
25		23	22	20	18	14	11	9	6	5
22		21	20	19	18	13	11	9	6	5
15		14	14	13	12	11	9	7	6	4
10		10	10	9	9	8	7	6	5	4
7		7	7	7	6	6	5	5	4	3
5		5	5	5	5	5	4	4	3	3
4		4	4	4	4	4	3	3	3	2

415 V										
Cable (mm^2) Cu	Al	Cable length (m)								
1,5	2,5	—	—	—	—	1	—	2	3	5
2,5	4	—	—	—	1	2	3	4	5	8
4	6	—	—	1	2	3	4	6	8	12
6	10	—	1	2	3	4	6	9	13	19
10	16	—	2	3	5	7	10	15	20	30
16	25	2	3	5	8	11	16	24	32	48
25	35	4	5	8	13	17	25	38	50	75
35	50	5	7	11	18	24	35	53	70	105
50	70	9	12	18	30	42	60	89	120	179
70	120	11	15	23	38	53	75	113	151	226
95	150	14	19	29	48	66	95	143	190	285
120	185	18	24	36	60	84	120	180	240	360
150	240	19	26	39	65	91	130	195	260	391
185	300	23	30	46	77	107	154	231	308	462
240		28	38	57	96	134	192	288	384	576
300		36	48	72	120	168	240	360	480	720
Isc network (kA)		Isc Short circuit current at Isc load side (kA)								
100		45	40	25	20	12	8	5	4	3
90		45	35	25	20	12	8	5	4	3
80		45	35	25	15	12	8	5	4	3
70		40	35	25	15	12	8	5	4	3
60		40	35	25	15	12	8	5	4	3
50		35	30	25	15	12	8	5	4	3
45		35	30	25	15	12	8	5	4	3
40		30	30	25	15	12	8	5	4	3
35		30	25	20	15	10	8	5	4	3
30		25	25	20	15	10	7	5	4	3
25		25	20	20	12	10	7	5	4	3
22		22	20	17	12	10	7	5	4	3
15		15	15	12	10	8	6	5	4	3
10		10	10	10	8	7	6	4	3	2
7		7	6	6	6	5	4	4	3	2
5		5	5	4	4	4	3	3	2	2
4		4	4	4	3	3	3	2	2	2

Example:
A value (67m) lower than 70 m cable length is selected on the row corresponding to 95 mm^2 cable (Cu) section in 380V panel. Short circuit current is found as 11 kA by intersection this column with the row giving a higher value (Isc: 22 kA) of the 20 kA short circuit current at network direction. Short circuit breaking capacity of the circuit breaker to be used at this point should be higher than (Icu) 11 kA.

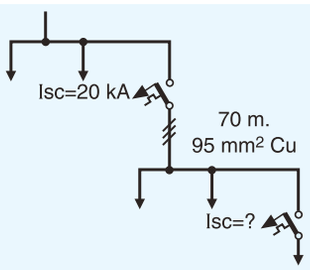


Fig-13

MOLDED CASE CIRCUIT BREAKER

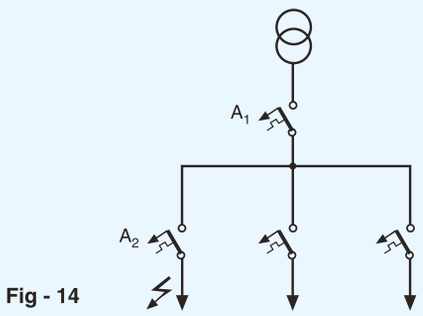


Fig - 14

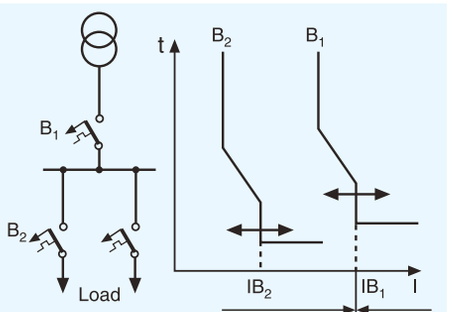


Fig - 15

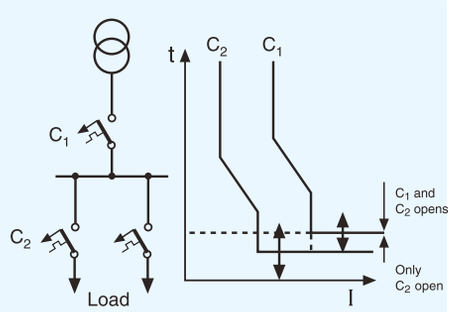
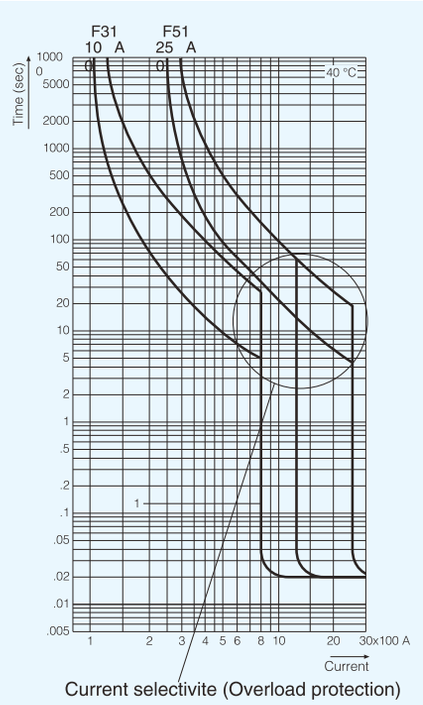


Fig - 16



Selectivity:
When there is a fault at any point within the network, coordination of the automatic protection elements, which eliminates the fault only via the protection device located on the top or near the fault, is called selectivity. For example, when there is a fault in the load side controlled by A2 circuit breaker due to any reason such as over load or short circuit, if A2 is opened first and A1 remains closed, there is full selectivity for this system (Figure-14). If the above-mentioned condition cannot be met to the nominal short circuit current, there is partial selectivity. Selectivity ensures operating continuity, which is mandatory at many industrial, commercial or similar facilities. Selectivity is ensured with opening current (I1) and opening time (t) parameters of the circuit breaker. These are;

Current Selectivity:
Let suppose that IB1 rated current of B1 circuit breaker is higher than IB2 rated current of B2 circuit breaker in Figure-15. B2 circuit breaker opens the circuit in fault currents lower than IB1 current to provide current selectivity. This selectivity may be upgraded to full selectivity by using a circuit breaker with current limiter in B2. Because, limiter breakers limit the short circuit current and open the circuit in a very short time (less than 10 ms). That is, selectivity should be provided both in over loads and in short circuits.

Time Selectivity:
Thanks to short-time delay adjustment of the circuit breaker, selectivity is provided by comparing opening times with other breakers in the system. As it is seen in Figure-16, operating curves of C1 and C2 breakers are intersected and delay time adjustment of C1 breaker is increased according to C2 breaker to provide selectivity. Here, C1 circuit breaker should have an electrodynamic resistance in compliance with the resistance current during short-time delay. It should be like delay (at transformer side) > delay (load side).

Selectivity Chart:
Selectivity chart shows the current values at which the circuit breaker closest to the load shall open. Combinations providing selectivity are shown in dark areas. Within these areas, thermal and magnetic opening curves of the circuit breakers at transformer and load sides have been designed to avoid intersections. That is, selectivity tables have been arranged to have the maximum instant opening current of the breaker at the network side at 1.5 times or more than the instant opening current of the breaker at the load side.

I_2 = Short circuit tripping current of circuit breaker (A)

$$\frac{I_2 \text{ (On transformer side)}}{I_2 \text{ (On load side)}} \geq 1{,}5$$

Selectivity Limit:
This is the current value at which both protection elements shall open at the same time when selectivity limit is exceeded. Selectivity limit currents in the tables have been given as the top limit of the short circuit opening current of the circuit breaker at the network side.

Current Time Curve of 400A NH Fuse with 400A Circuit Breaker:
A circuit breaker, in accordance with EN 60947-2 standard:
Should operate without opening for 2 hours at 1,05xIn,
Should open within 2 hours at 1,3xIn.
In practice, this time is adjusted as, 5-10 minutes.
However a NH fuse, in accordance with EN 60269-1 standard:
Should operate without opening for 3 hours at 1,25xIn.
Should open within 3 hours at 1,6xIn.
Accordingly, a circuit breaker opens earlier than NH Fuses in over currents and provides better protection especially in over currents.
(Figure - 17)
NH fuses are protection devices which mainly provide protection against short circuit.

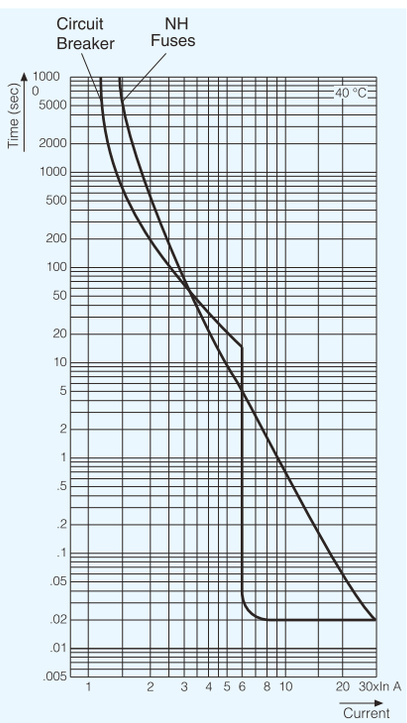
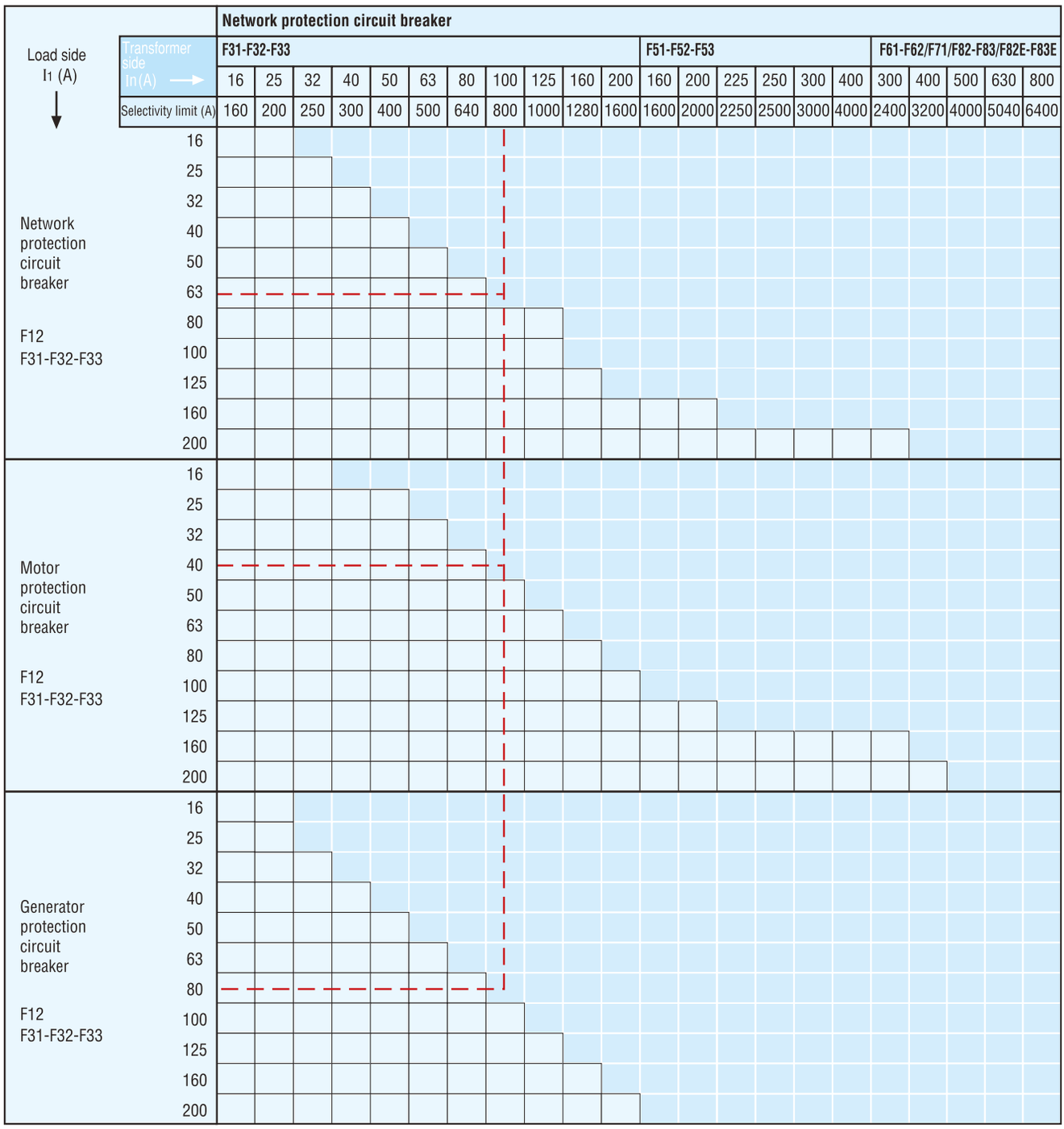


Fig-17
Current Time Curve of 400A NH Fuse with 400A Circuit Breaker

MOLDED CASE CIRCUIT BREAKER



Example :
If there is a network protection circuit breaker with 100 A nominal current at the transformer side, the following circuit breakers should be utilized at the secondary outputs (load side) right below the breaker to provide full selectivity;

Network protection : maximum 63 A
Motor protection : maximum 40 A
Generator protection: maximum 80 A

MOLDED CASE CIRCUIT BREAKER

Network protection circuit breaker

Load side I_1 (A)	Transformer side In (A) →	F51-F52-F53						F61-F62/F71/F82-F83/F82E-F83E					F91E-F92E F101E-F102E		F111E-F112E		
		160	200	225	250	300	400	300	400	500	630	800	1000	1250	1600	2000	2500
	Selectivity limit (A)	1600	2000	2250	2500	3000	4000	2400	3200	4000	5040	6400	10000	12500	16000	20000	25000
Network protection circuit breaker F51-F52-F53 F61-F62 F71-F72 F82-F83	200																
	250																
	300																
	400																
	500																
	630																
	800																
Motor protection circuit breaker F51-F52-F53 F61-F62 F71-F72 F82-F83	200																
	250																
	300																
	400																
	500																
	630																
	800																
Generator protection circuit breaker F51-F52-F53 F61-F62 F71-F72 F82-F83	200																
	250																
	300																
	400																
	500																
	630																
	800																

Motor protection circuit breaker

Load side I_1 (A)	Transformer side In (A) →	F51-F52-F53						F61-F62/F71/F82-F83/F82E-F83					F91E-F92E F101E-F102E		F111E-F112E		
		160	200	225	250	300	400	300	400	500	630	800	1000	1250	1600	2000	2500
	Selectivity limit (A)	1920	2400	2700	3000	3600	4800	3600	4800	6000	7560	9600	10000	12500	16000	20000	25000
Network protection circuit breaker F51-F52-F53 F61-F62 F71-F72 F82-F83 F82E-F83E	200																
	250																
	300																
	400																
	500																
	630																
	800																
Motor protection circuit breaker F51-F52-F53 F61-F62 F71-F72 F82-F83 F82E-F83E	200																
	250																
	300																
	400																
	500																
	630																
	800																
Generator protection circuit breaker F51-F52-F53 F61-F62 F71-F72 F82-F83 F82E-F83E	200																
	250																
	300																
	400																
	500																
	630																
	800																

MOLDED CASE CIRCUIT BREAKER

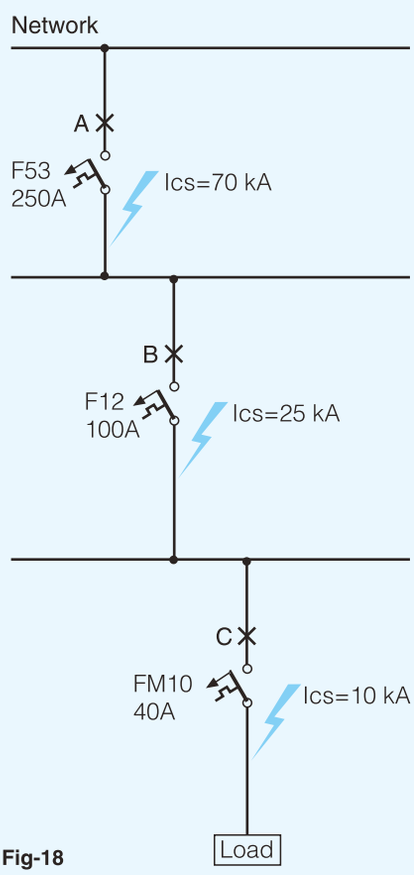


Fig-18

Sequential Connection:
Sequential connection is a utilization type which allows use of lower-cost circuit breakers at the load side by using the current limiting feature of circuit breakers.
Compact circuit breakers at the network side provide protection against over load and short circuit currents. These elements allow circuit breakers with a breaking capability lower than the short circuit current to operate within rated breaking capability limit. As the current is kept under control of the limiter circuit breaker in the whole circuit, sequential connection is useful for all the switching devices at load side of the circuit breaker.

Utilization of Sequential Connection:
In sequential connections, circuit breaker elements can be placed in different panels. In this way, sequential connection makes it possible to use circuit breakers with lower capacity than the possible Ics operating short circuit current to occur in the area of the device. Important point is that a circuit breaker at the capacity to break this short circuit current should be connected at the network side.

Coordination Among Circuit Breakers:
Utilization of a circuit breaker, which has a breaking capacity lower than the short circuit current, is allowed only when another circuit breaker with the required breaking capacity is placed at the network side. In this case, characteristics of both elements should be coordinated with each other in a way not to give any damage to the element at the load side and cables protected by these elements.

3-Step Sequential Connection:
Criteria about sequential connection of serially connected A, B and C circuit breakers are fulfilled in two conditions. A breaker placed at the network side is used for both B and C breakers for sequential connection. Here, it should be checked whether (A+B and A+C) and (A+B and B+C) combinations have the required breaking capacity or not. (Figure - 18)

Short Circuit Breakintg Capacity kA		F12	F61	F31	F51	F62	F71	F32	F52	F72	F82	F91E	F101E	F111E	F92E	F33	F53	F83	F102E	F112E
		25		35				50							65	70				
F12	25		25	35	35	35	35	50	50	40	50	25	25	-	25	70	70	60	25	-
F61		-			35	35	35	-	50	40	50	25	25	-	25	-	70	60	25	-
F31	35	-	-		35	35	35	50	50	50	50	35	35	35	35	70	70	70	30	35
F51		-	-	-		35	35	-	50	50	50	35	35	35	35	-	70	70	30	35
F62		-	-	-	-		35	-	50	50	50	35	35	35	35	-	70	70	30	35
F71		-	-	-	-	-		-	-	50	50	35	35	35	35	-	70	70	30	35
F32	50	-	-	-	-	-	-		50	50	50	50	50	50	65	70	70	70	50	50
F52		-	-	-	-	-	-	-		50	50	50	50	50	65	-	70	70	50	50
F72		-	-	-	-	-	-	-	-		50	50	50	50	65	-	-	70	50	50
F82		-	-	-	-	-	-	-	-	50		50	50	50	65	-	-	70	50	50
F91E		-	-	-	-	-	-	-	-	-	-		50	50	65	-	-	-	50	50
F101E		-	-	-	-	-	-	-	-	-	-	-		50	-	-	-	-	50	50
F111E		-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	50
F92E	65	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	70	70
F33	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-		70	70	70	70
F53		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		70	70	70
F83		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		70	70
F102E		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		70
F112E		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

NOTE: The sequential connection option allows the switch on the load side to take advantage of the current limiting capability of the switch on the network side, It allows the switch to be connected to a point with a higher short-circuit power than the capacity. The values ??written to the switches are determined by the switch indicates the point with the highest short circuit power that can be installed when used.

MOLDED CASE CIRCUIT BREAKER ACCESSORIES

F71 Undervoltage Release

Undervoltage Release :

It is used for opening the circuit breaker when energy is cut off or voltage goes below 70% of the operating voltage. In order to close the breaker, the voltage should be equal to or higher than 85% of the operating voltage. When no energy is supplied to the low voltage coil, the circuit breaker does not open.

Type	Ampere Ranges	Order Code
F12	16A - 160A	8AR-CA000-0□□□
F31 - F32 - F33	16A - 250A	#AB-CA000-0□□□
F51 - F52 - F53	125A-400A	#AD-CA000-0□□□
F61 - F62	300A-400A	#AE-CA000-0□□□
F71 - F72	300A-800A	#AF-CA000-0□□□
F82 - F83	400A - 800A	8AG-CA001-0□□□
F82E - F83E	300A - 800A	8AG-CA001-0□□□
F91E - F92E	1000A-1250A	#AH-CA000-0□□□
F101E - F102E	1000A-1600A	#AI-CA000-0□□□
F111E - F112E	1250A-2500A	#AK-CA000-0□□□

Not : Where seen □□□ please write the feeding voltage (230-400). # For plug-in 9, attached to product please write 8. The undervoltage coils supply voltage is AC. Low voltage bobbin does not set up circuit breaker without power. In 3-phase systems, 400V supply voltage should be preferred for control of all phases.

"–" DC, "~" AC, "⎓" DC-AC

F31-F32-F33
Extended Rotary Handle

Extended Rotary Handle:

It is used for opening - closing the circuit breaker. It is used for rotating the circuit breaker, not pushing-pulling it upwards-downwards.

Type	Ampere Ranges	Order Code
F31 - F32 - F33	160A - 250A	8AB-G000-0000
F51 - F52 - F53	125A - 400A	8AD-G000-0000
F71 - F72	300A - 800A	8AF-G000-0000
F82 - F83 / F82E - F83E	300A - 800A	8AG-G000-000□
F91E - F92E	1000A - 1250A	8AH-G00△-0000

Note : It's not plug-in. □: 0 for F82-F83, 1 for F82E-F83E.
△: 1 for F91E, 0 for F92E.

Operating Handle Extention

Operating Handle Extention:

Type	Ampere Ranges	Order Code
F71-F72-F82-F83	300A - 800A	8AG-UK000-0000
F82E - F83E - F91E - F92E - F101E - F102E	300A - 1600A	8AG-UK100-0000
F111E - F112E	1250A - 2500A	8AG-UK000-0000

F71

Lock Mechanism with key

Lock Mechanism with key:

Lock mechanism mechanically locks the circuit breaker, which is on (trip) position due to service, and avoids ON and OFF positions.

Type	Ampere Ranges	Order Code
F12	16A - 160A	8AL-E0000-0000
F31-F32-F33	160A - 250A	8AB-E0000-0000
F51-F52-F53	125A - 400A	8AD-E0000-0000
F61-F62	300A - 400A	8AE-E0000-0000
F71-F72	300A - 800A	8AF-E0000-0000
F82-F83/F82E-F83E	300A- 800A	8AG-E0000-0000
F91E-F92E	1000A - 1250A	8AH-E0000-0000
F101E-F102E	1000A - 1600A	Standard
F111E-F112E	1250A - 2500A	Standard

Note : It's not plug-in

Shunt Trip Release

Shunt Trip Release :

It is used for opening the circuit breaker remotely. When the breaker is in closed (ON) position, when voltage is supplied to the opening relay the breaker is opened and got Trip position. Opening relay may be manufactured at different voltages set out in the table in order to operate in AC and DC voltages. Operation of opening coil is guaranteed between 70% and 110% of the nominal voltage according to standards.

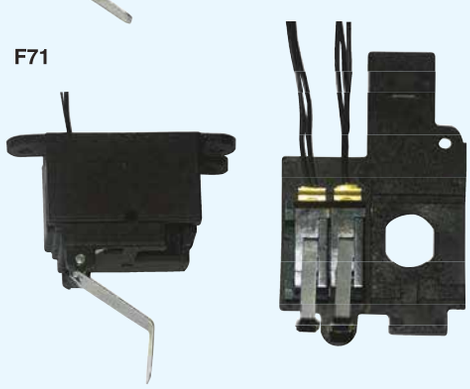
MOLDED CASE CIRCUIT BREAKER ACCESSORIES

Operating voltages	F12	F31-F32-F33	F51-F52-F53	F61-F62	F71-F72	F82-F83 F82E-F83E	F91E-F92E	F101E F102E	F11E-F112E
110 V ~	8AM-BA000-0110	8AB-BA000-0110	8AD-BA000-0110	8AP-BA000-0110	8AF-BA000-0110	8AG-BA000-0110	8AH-BA000-0110	8AI-BA000-0110	8AK-BA000-0110
220 V ~	8AM-BA000-0220	8AB-BA000-0220	8AD-BA000-0220	8AP-BA000-0220	8AF-BA000-0220	8AG-BA000-0220	8AH-BA000-0220	8AI-BA000-0220	8AK-BA000-0220
380 V ~	8AM-BA000-0380	8AB-BA000-0380	8AD-BA000-0380	8AP-BA000-0380	8AF-BA000-0380	8AG-BA000-0380	8AH-BA000-0380	8AI-BA000-0380	8AK-BA000-0380
24 V –	8AM-BD000-0024	8AB-BD000-0024	8AD-BD000-0024	8AP-BD000-0024	8AF-BD000-0024	8AG-BD000-0024	8AH-BD000-0024	8AI-BD000-0024	8AK-BD000-0024
48 V –	8AM-BD000-0048	8AB-BD000-0048	8AD-BD000-0048	8AP-BD000-0048	8AF-BD000-0048	8AG-BD000-0048	8AH-BD000-0048	8AI-BD000-0048	8AK-BD000-0048
110 V –	8AM-BD000-0110	8AB-BD000-0110	8AD-BD000-0110	8AP-BD000-0110	8AF-BD000-0110	8AG-BD000-0110	8AH-BD000-0110	8AI-BD000-0110	8AK-BD000-0110
220 V –	8AM-BD000-0220	8AB-BD000-0220	8AD-BD000-0220	8AP-BD000-0220	8AF-BD000-0220	8AG-BD000-0220	8AH-BD000-0220	8AI-BD000-0220	8AK-BD000-0220

F31-F32-F33 / F51-F52-F53

F92E

F71



Auxiliary Contact Block

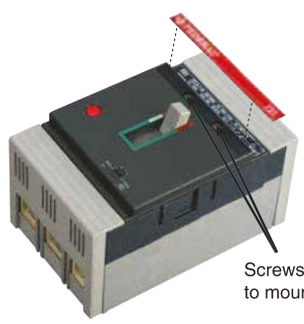
Auxiliary Contact Block:

It is used for supplying electrical signaling of the circuit breaker according to the operating position. Auxiliary contacts are opened and closed with primary contacts to fulfill warning and locking functions.

NO : Normally open contact
NC : Normally closed contact

Type	Ampere Ranges	Contact Equipment NO	NC	Operating Voltage	Rated Current	Order Code
F12	16A - 160A	1	1	250 V~	2 A	8AL-A0011-0000
F31-F32-F33	16A - 250A	1	1	250 V~	2 A	8AB-A0011-0000
		2	2	250 V~	2 A	8AB-A0022-0000
F51-F52-F53	125A - 400A	1	1	250 V~	2 A	8AD-A0011-0000
		2	2	250 V~	2 A	8AD-A0022-0000
F61-F62	300A - 400A	1	1	400 V~	4 A	8AE-A0011-0000
F71-F72	300A - 800A	1	1	400 V~	4 A	8AF-A0011-0000
		2	2	400 V~	4 A	8AF-A0022-0000
F82-F83 F82E-F83E	300A - 800A	1	1	400 V~	4 A	8AG-A0011-0000
		2	2	400 V~	4 A	8AG-A0022-0000
		4	4	400 V~	4 A	8AG-A0044-0000
F92E	1000A - 1250A	1	1	400 V~	4 A	8AH-A0011-0000
		2	2	400 V~	4 A	8AH-A0022-0000
F101E-F102E	1000A - 1600A	1	1	400 V~	4 A	8AJ-A0011-0000
		2	2	400 V~	4 A	8AJ-A0022-0000
		4	4	400 V~	4 A	8AJ-A0044-0000
F111E-F112E	1250A - 2500A	1	1	400 V~	4 A	8AK-A0011-0000
		2	2	400 V~	4 A	8AK-A0022-0000

"–" DC, "~" AC, "⎓" DC-AC



Screws should be removed to mount accessories

Terminal cover

Terminal cover:

It provides a safe insulation by preventing contact of the terminal (busbar or cable) sections of the circuit breaker. Furthermore, terminal protective cover also insulates terminals from each other by passing through channels between poles. It is available in all our circuit breakers as a standard.

Type	Ampere Ranges	Order Code
F12	16A - 160A	8AR-F0000-0000
F31-F32-F33	160A - 250A	8AB-F□000-0000
F51-F52-F53	125A - 400A	8AD-F000△-0000
F61-F62	300A - 400A	8AP-F0000-0000
F71-F72	300A - 800A	8AF-F0000-0000
F82-F83/F82E-F83E	300A - 800A	8AG-F000△-0000
F91E-F92E	1000A - 1250A	8AH-F0000-0000
F101E-F102E	1000A - 1600A	8AI-F0000-0000
F111E-F112E	1250A - 2500A	8AK-F0000-0000

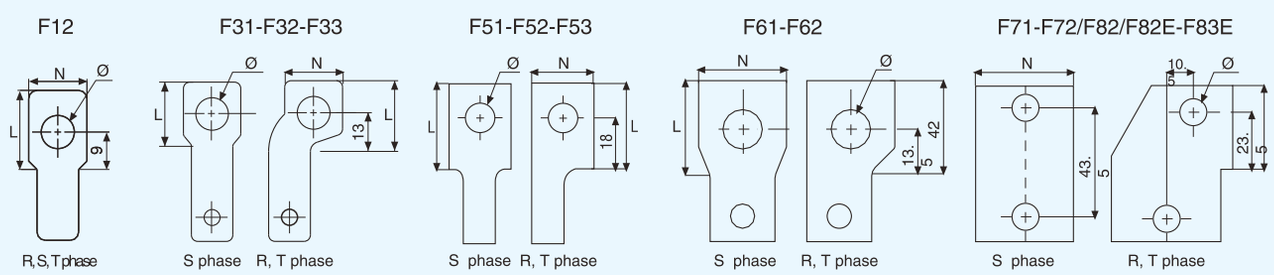
□ : It is 1 for the long terminal cover and 0 for the short terminal cover.
△: 0 for 3 poles, 4 for 4 poles.

MOLDED CASE CIRCUIT BREAKER ACCESSORIES

Extension Bars :
Extension busbars allow easy and healthy cable or busbar connections to the terminals of the breaker. Busbars are manufactured of electrolytic copper material with silver coating.

Type	Lenght L (mm)	Width N (mm)	Thickness P (mm)	Hole Diameter Ø	Tightening Torque (Nm)	Nominal Current (A)	Quantity (Pieces)	Order Code
F12	36	14	3	M8	10	16 A - 160 A	6	8AM-H3000-0125
F31-F32-F33	35	18	5	M8	10	125 - 250 A	6	8AB-H5000-0125
F51-F52-F53	35	25	5	M12	25	125 A - 400 A	6	8AD-H5001-0250
F61-F62	42	38	8	M10	25	300 A - 400 A	6	8AE-H5000-0300
F71-F72 F82-F83 F82E-F83E	31	40	5	M10	40	300 A	6	8AF-HΔΔΔ00-0□□□
	31	40	6	M10	40	400 A - 500 A	6	
	31	40	8	M10	40	630 A	6	8AG-HΔΔΔ00-0□□□
	31	40	12	M10	40	800 A	6	

□□□: Write ampere value.
ΔΔΔ : Write busbar thickness. (Enter 5 for 300A , 6 for 400A - 500A, 8 for 630A and 12 for 800A .)



Uzatma baraları

Connection Terminals: They are dispatched with screwdriver or allen screw head.

Type	Cable Number	Cable Section (mm^2)	Cable Diameter Ø (mm)	Tightening Torque (Nm)	Bolt Type	Quantity (pieces)
F12	1	2.5...70	6	6	Screwdriver	3
F31-F32-F33	1	2,5...120	12	10	Allen	3
F31-F32-F33	1	2,5...95	12	6	Screwdriver	3
F31-F32-F33	1	10...120	13	12	Allen	3
F51-F52-F53	1	95...120	13	25	Allen	3

Note: Connection terminal of F31-F32-F33 type circuit breaker can be manufactured as allen or screw head upon request.
Without fixing extention bars cable locks have 95 mm^2 cable section can be directly mounted to body of F31-F32-F33 / F51- F52 - F53 Type Circuit Breakers

Screwdriver / Allen screw head
Screwdriver / Allen screw head
Allen screw head
Star cylinder head
Allen screw head
Connection Terminals

MOLDED CASE CIRCUIT BREAKER ACCESSORIES

F31-F32-F33/F51

Motor Control Mechanisms:
They are used for opening - closing the circuit breaker remotely. Moreover, thanks to the notch on it, manual opening-closing can be made. Motor control mechanism is assembled on top cover of the circuit breaker. It has mechanical locking feature.

F31-F32-F33 Motor Control Mechanisms:
Technical Specification:

Order Code	8AB-DA000-0220 (From 16A to 250A)
Operating voltage	220 V AC
Power	100 W
Opening time	1 s
Closing time	1 s


F71-F72/F82-F83/F82E-F83E
F92E/F101E-F102E

F71/F82-F83/F82E-F83E/F91E-F92E/F101E-F102E Motor Control Mechanisms:

Type	Ampere Ranges	Order Code
F71-F72	300A ... 800A	8AF-DA000-0220
F82-F83	400A ... 800A	8AG-DA001-0220
F82E-F83E	300A ... 800A	8AG-DA000-0220
F91E-F92E	1000A ... 1250A	8AH-DA000-0220
F101E-F102E	1000A ... 1600A	8AN-DA000-0220

Technical Specification:

Operating voltage	220 V AC
Power	100 W
Opening time	4 s
Closing time	3.5 s

F111E-F112E

F111E-F112E Motor Control Mechanisms:

Technical Specification:

F111E-F112E	8AK-DA000-0220 (from 1250A to 2500A)
Operating voltage	220 V AC
Power	500 W
Opening time	1.5 s
Closing time	1.5 s

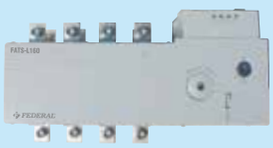
Mechanical Lock
It is very easy and important to make the network-generator automation also known for automatic inverter system; because an error to be made will cause the network and the generator to remain active at the same time, thus causing a short circuit, as opposed to phase coincidence.
A mechanical lock is used to eliminate this possibility of error and provide operational safety.
Since the locking is made mechanically and not electrically, it is absolutely prevented that both circuit breakers in the ON or OFF position are in error in the control system.

Mechanical Lock Order Codes:

Type	Ampere Ranges	Order Code
F31	160A - 250A	8AB-V0000-0000
F71-F72	300A - 800A	8AF-V0000-0000
F82-F83	300A - 800A	8AG-V0000-0000
F82E-F83E	300A - 800A	8AG-V1000-0000
F82EN-F83EN	300A - 800A	8AG-V0000-0001
F91E-F92E	1000A - 1250A	8AH-V0000-0000
F101E-F102E	1000A - 1600A	8AI-V0000-0000
F111E-F112E	1250A - 2500A	8AK-V0000-0000

MOLDED CASE CIRCUIT BREAKER ACCESSORIES

In the enterprises where power cuts are frequent, where uninterrupted power is needed and where interruption can cause huge damages (such in hospitals, shopping centers, banks, factories etc...), these can be securely used in order to realize the load transfer.

			
TYPE	**MCCB**	**MCB**	**SWITCH**
Standard	EN 60947-6-1	EN 60947-6-1	EN 60947-6-1
Circuit Breaker Rated Current (In)	16A ... 1600A	0,5A ... 125A	100A ... 3200A
Number of Poles	3, 4	1, 2, 3, 4	3, 4
Control Voltage	140 - 270V	140 - 270V	220 - 240V
Auxiliary Control Voltage	10-15V DC	10-15V DC	-
Generator Start-Stop Time Adjustment	0,5 - 90 sec.(adjustable)	0,5 - 90 sec.(adjustable)	2 - 3 sec.
Operating Voltage	415V	415V	415V
Mechanical Life	10.000	10.000	3.000
Operating Temperature	-20 ... +60	-20 ... +60	-20 ... +60
Protection Class	IP20	IP20	IP20
Pollution Level	3	2	3

Remote Controller:
If the user requiring to conducting separated controller, choosing Remote Controller install to cabinet panel, through 2m serial data cable linked. ATS main controller on switch body, all operations and display functions are all forbiding state (switch body display switches off automatically), external controller starting work, users could observed the ATS control of the switch running status through the external controller to operate when they can't open the cabinet. Adopt digital and indicator to show status, two state orads supply voltage and frequency. Through button to choose the manual transfer mode and set parameters.

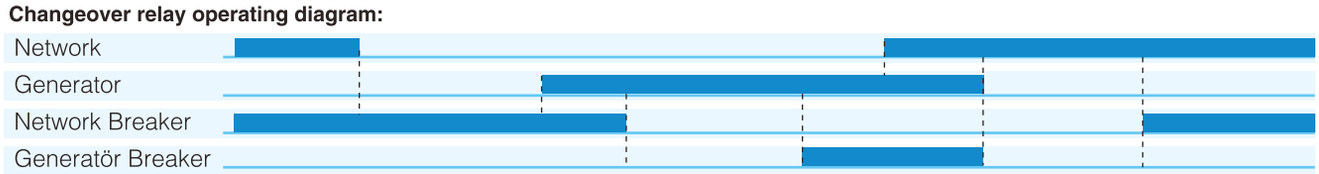
Network - Generator Changeover Relay FER96 (For MCCB & ACB):
It is used ensure automatic transfer between network and generator at places where the circuit breaker is used for inverter purposes. Line, supply, switch status can be monitored on the relay. Fault contact and alarm and opening coil connection can be made.

Technical Specification	
Output Contacts	250V AC 10A
Supply Voltage	12V DC
Input Voltage	220V AC
Dimensions	96x96 mm

Transfer Control Unit FER72 (For Contactors):
Microprocessor-controlled device that sends a remote start signal that monitors the three-phase mains voltage and transfers the load between the network and the generator.

Technical Specification	
Alternator Voltage	300V AC max
Mains Voltage	300V AC max (phase-neutral)
Network Contactor Time	0,75 seconds
Dimensions	72x72 mm

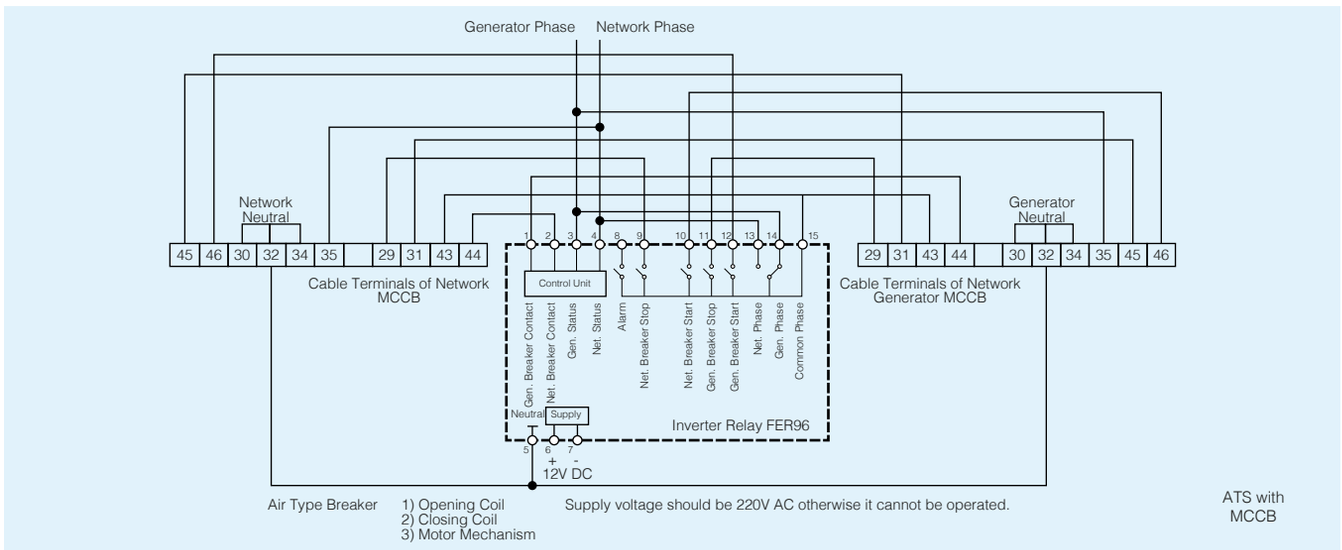
Changeover relay operating diagram:



AUTOMATIC TRANSFER SYSTEMS (IEC / EN 60947-2)

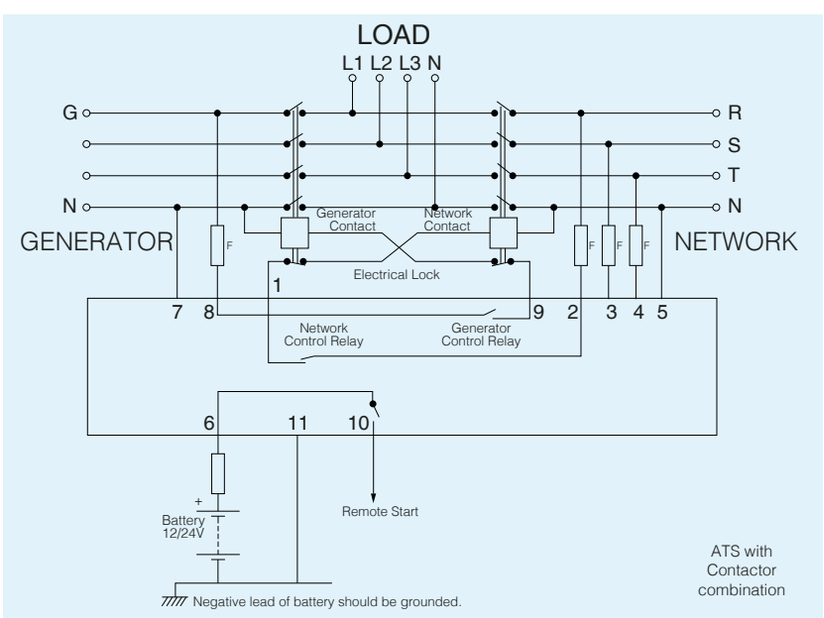
AIR TYPE CIRCUIT BREAKER
AUTOMATIC TRANSFER SYSTEM:

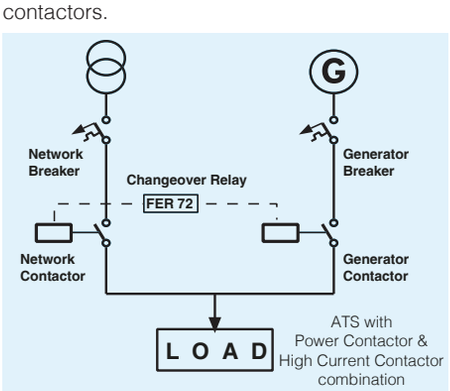
Automatic transfer system could be made by using Air Circuit Breakers up to 630 amps like Molded Case Circuit Breaker. The Automatic Transfer System made by using Air Circuit Breakers have electrical and mechnical locking feature.
To make an Automatic Transfer System by Air Circuit Breakers, following components are required;
Two Air Circuit Breakers, Two motors mechanism, Two opening coil, Two closing coil, One Network Changeover Relay (FER96), One mechanical interlock



CONTACTOR WITH AUTOMATIC TRANSFER SYSTEM:

As an alternative, Automatic Transfer System could be also made by using a combination of Molded Case Circuit Breaker and Contactor. In this Automatic Transfer System, the Molded Case Circuit Breakers is used for overcurrent and short circuit protection. For switching, contactors are used in the system according to the current values. Power Contractors are used in the system up to 750 amps. The changeover system made by using contactors from 115A(FC115D) to 750A(FC750D) has only electrical locking feature while the changeover system made by using contactors up to 95A(FC95D) has electrical and mechanical locking feature. Changeover systems made by using high current contactors from 300A to 2500A has electrical and mechanical locking feature. FER72 network changeover relay is used in automatic changeover systems that is made by contactors.

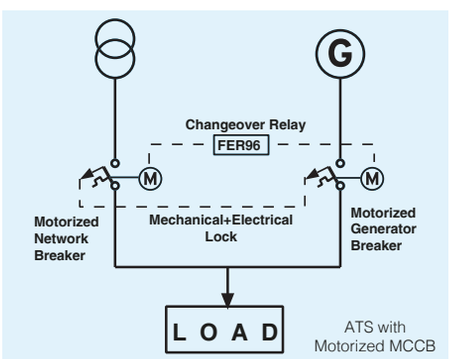




AUTOMATIC CHANGEOVER SYSTEM
WITH MOTORIZED MOLDED CASE CIRCUIT BREAKER

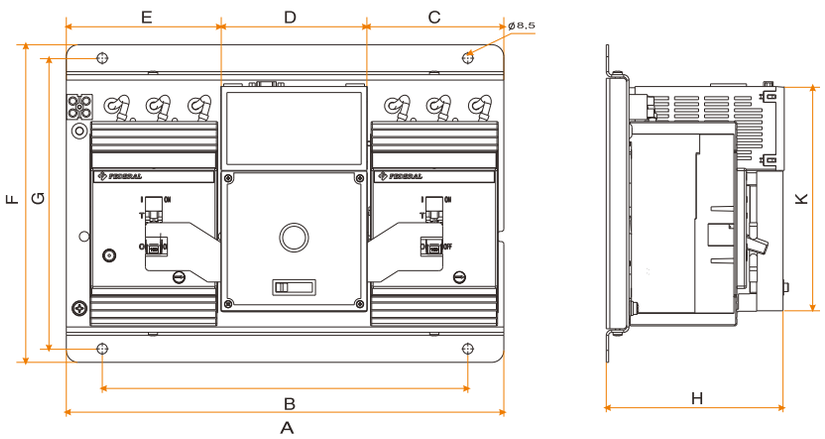
Another alternative automatic changeover system can be made by using motorized molded case circuit breaker.
To make an Automatic Transfer System, following components are required;
two motorized molded case circuit breakers, one mechanical interlock, one network changeover relay (FER96), two auxiliary contact (for electrical interlock)

Will be enough. As long as one of network or generator circuit breaker is put in use, electrical and mechanical lockings continuously active to prevent other circuit breaker is put in use.

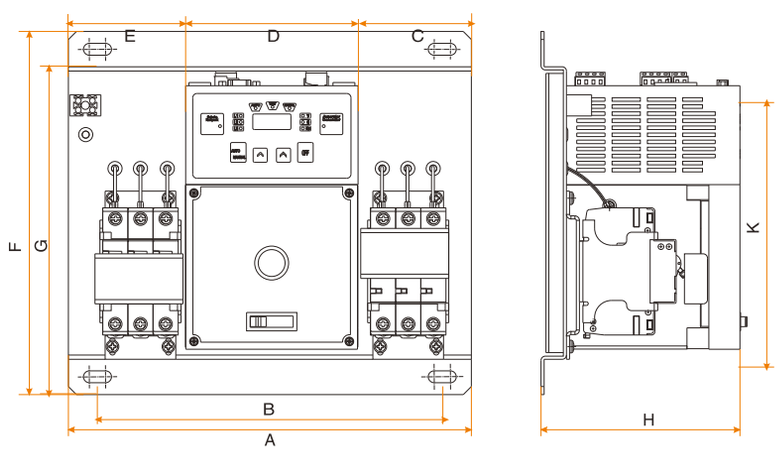


AUTOMATIC TRANSFER SYSTEMS (IEC / EN 60947-2)

Compact Circuit Breakers



Miniature Circuit Breakers



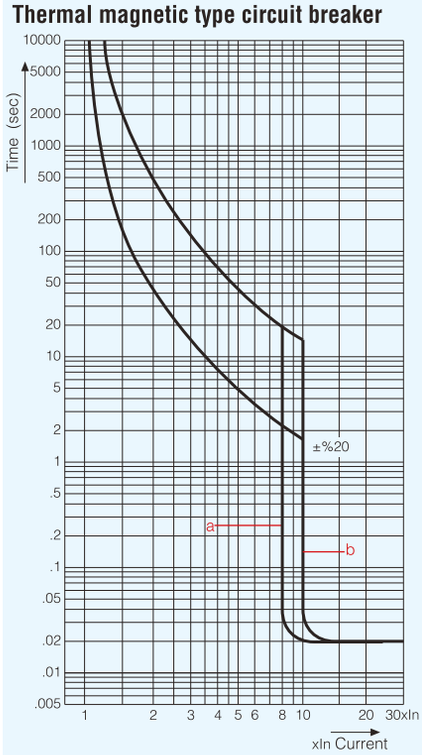
Compact and Miniature Circuit Breaker Measurements

Type	Dimensions									Ampere Ranges	Order Code
	A	B	C	D	E	F	G	H	K		
FATS-F1	365	293	106,4	122	136,6	274,4	224,9	151,5	186,5	16A ... 160A	8AR-ATS00-0000
FATS-F1N	425	353	136,4	122	166,6	259,2	236,7	151,5	186,5	16A ... 160A	8AR-ATS01-0000
FATS-F3	380	340	114	122	145	265	242	147	247	16A ... 250A	8AB-ATS00-0000
FATS-F5	460	419	151	122	187	342	311	206	247	125A ... 400A	8AD-ATS00-0000
FATS-F5N (4 Pole)	495	454	151	122	221	342	311	206	247	125A ... 400A	8AD-ATS04-0000
FATS-F7	600	550	219	122	259	346	315	216	247	300A ... 800A	8AF-ATS00-0000
FATS-F8	600	550	219	122	259	346	315	216	247	400A ... 800A	8AG-ATS00-0000
FATS-F8N (4 Pole)	740	689	296	122	321	346	315	216	247	300A ... 800A	8AG-ATS04-0000
FATS-F9	600	550	219	122	259	436	405	235	247	1000A...1250A	8AH-ATS00-0000
FATS-F9N (4 Pole)	740	689	289	122	329	436	405	235	247	1000A...1250A	8AH-ATS04-0000
FATS-F10	600	550	219	122	259	436	405	260	247	1000A...1600A	8AI-ATS00-0000
FM6	286	244	80	122	83	257	232	141	187	1A ... 63A	8AL-ATS00-0000
FM10	286	244	80	122	83	257	232	141	187	1A ... 63A	
FM10L	390	324	119	122	149	265	242	142	187	80A ... 125A	

(*) Note: If it is desired to check the first movement time while ATS is in the generator position, 10-15V DC supply must be done. If there is no DC supply, the generator start time delay will be "0" seconds. There is no need to supply external DC if this time delay is not requested by the generator.

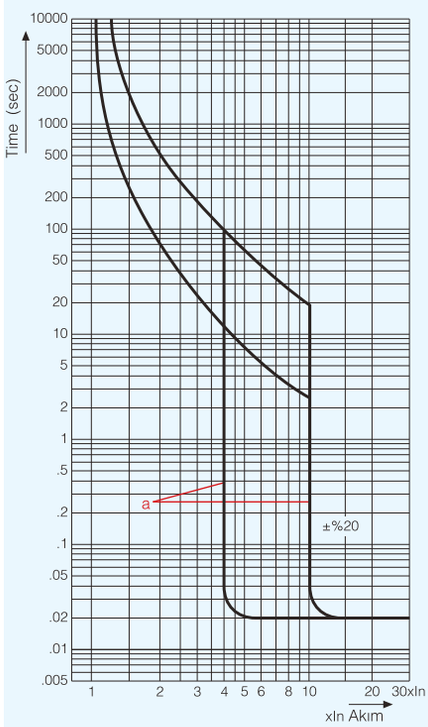
MOLDED CASE CIRCUIT BREAKER

F01-F02-F12
F31-F32-F33
Thermal magnetic type circuit breaker



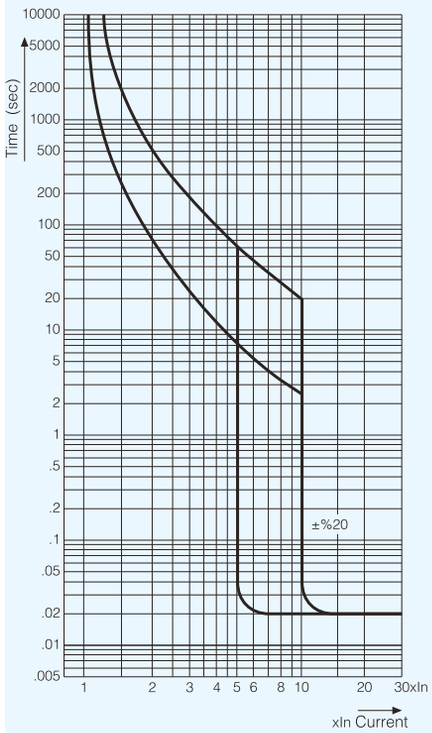
a: Standard Type (min. 600A)
b: Motor Protection Type (min. 600A)

F51-F52-F53
Thermal magnetic type circuit breaker

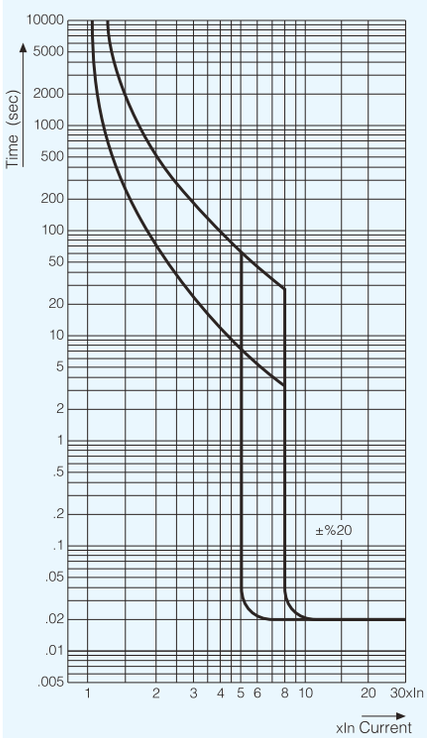


a: 125-160A=5-10In
200-300A=4-10In
400A 3-8In

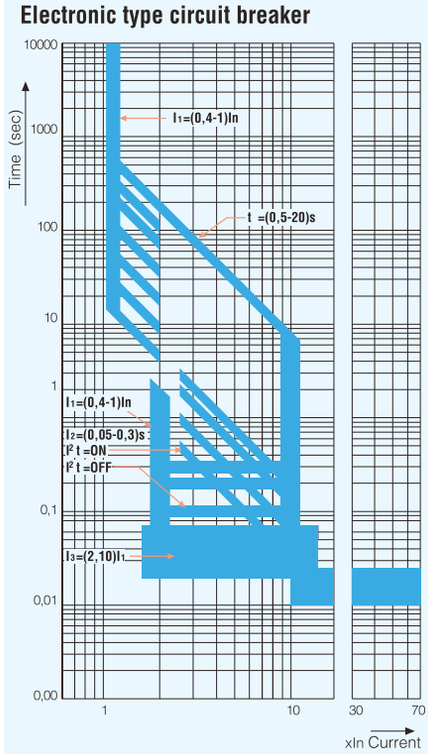
F61-F62/F71-F72
Thermal magnetic type circuit breaker



F82-F83
Thermal magnetic type circuit breaker

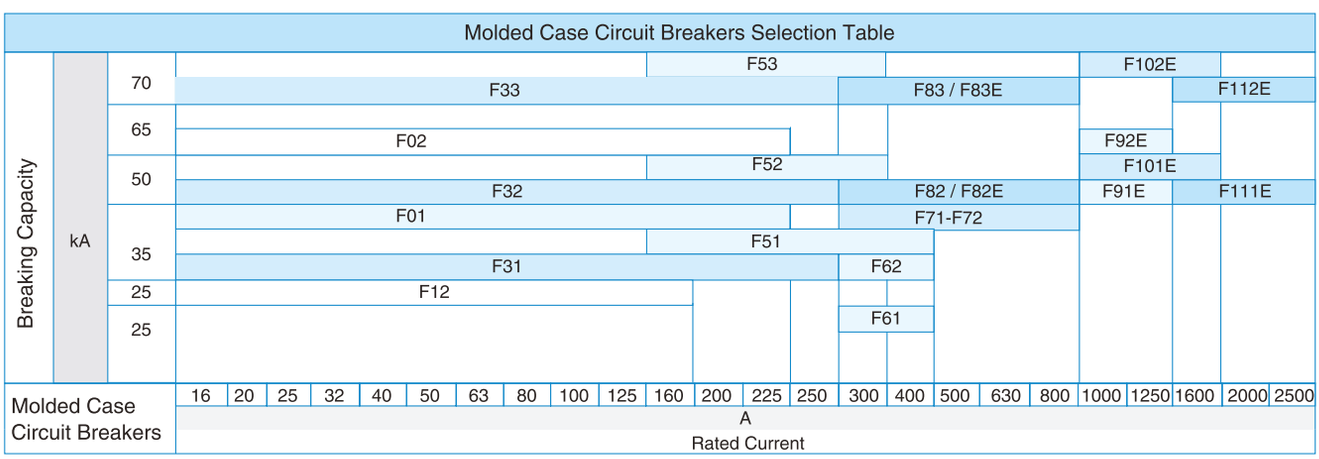


F82E-F83E/F91E-F92E
F101E-F102E/F111E-F112E
Electronic type circuit breaker



MOLDED CASE CIRCUIT BREAKER

Power losses for per pole (W)																								
Rated Current (A)																								
	16	**20**	**25**	**32**	**40**	**50**	**63**	**80**	**100**	**125**	**160**	**200**	**225**	**250**	**300**	**400**	**500**	**630**	**800**	**1000**	**1250**	**1600**	**2000**	**2500**
F12	6.5	6.5	7	5	5	6.5	10	8.5	12.5	13	13													
F31	4	4	4	4.5	5.5	7	9.5	8	10.5	12	15	21	25	28										
F32	4	4	4	4.5	5.5	7	9.5	8	10.5	12	15	21	25	28										
F33	4	4	4	4.5	5.5	7	9.5	8	10.5	12	15	21	25	28										
F51										23	20.5	28	23	25.5	36.5	45								
F52										23	20.5	28	23	25.5	36.5									
F53										23	20.5	28	23	25.5	36.5									
F61															26	40								
F62															26	40								
F71															31	30	39	53	54					
F72															31	30	39	53	54					
F82															32	38	38	53	54					
F83															32	38	38	53	54					
F82E															10	17	26	42	54					
F83E															10	17	26	42	54					
F91E																				55	85			
F92E																				55	85			
F101E																				40	60	100		
F102E																				40	60	100		
F111E																						54	84	132
F112E																						54	84	132

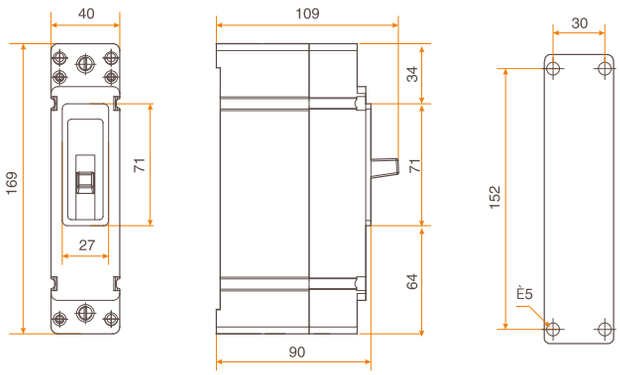


ELECTRICAL SPECIFICATION OF CONDUCTOR MATERIALS:

Material		Self-conductivity (K) m/Ω.mm²
Silver	Ag	63
Copper	Cu	58
Gold	Au	45
Aluminium	Al	36
Magnesium	Mg	23
Molybdenum	Mo	18
Wolfram	W	17
Zinc	Zn	16
Cadmium	Cd	13
Brass	Cu (%86)+Zn (%35)	12
Nickel	Ni	11

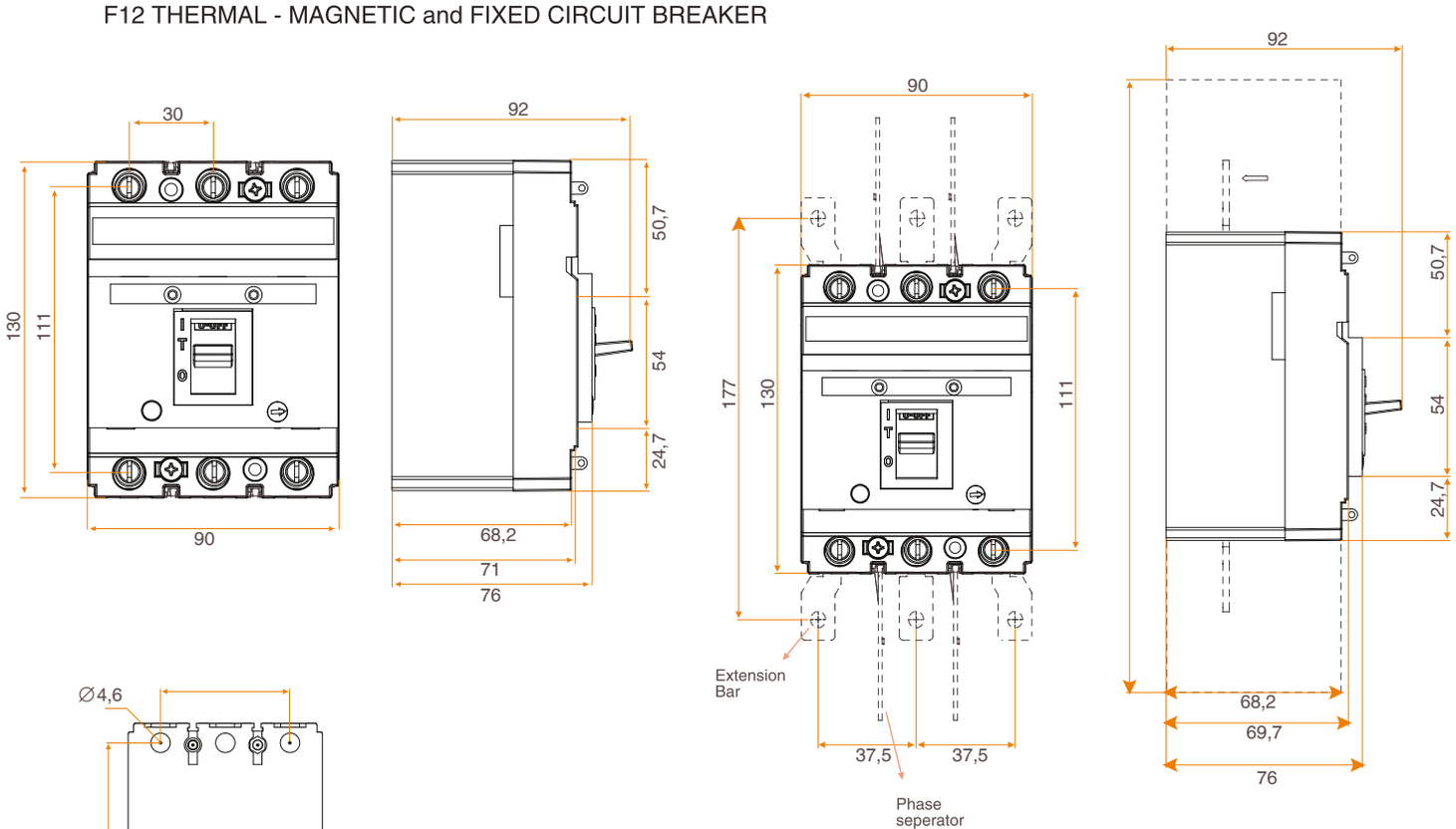
Material		Self-conductivity (K) m/Ω.mm²
Iron	Fe	10
Platinum	Pt	9
Tin	Sn	8
Bronze	Cu (%88)+Sn (%12)	6
Lead	Pb	4.8
Manganin	Cu (%86)+Mn (%12)+Ni (%2)	2.3
Constantan	Cu (%55)+Ni (%45)	2
Bismuth	Bi	0.9
Graphite	C	0.125
Carbon	C	0.025

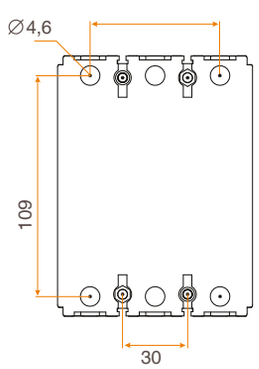
F01 - F02



Assembling Gauge

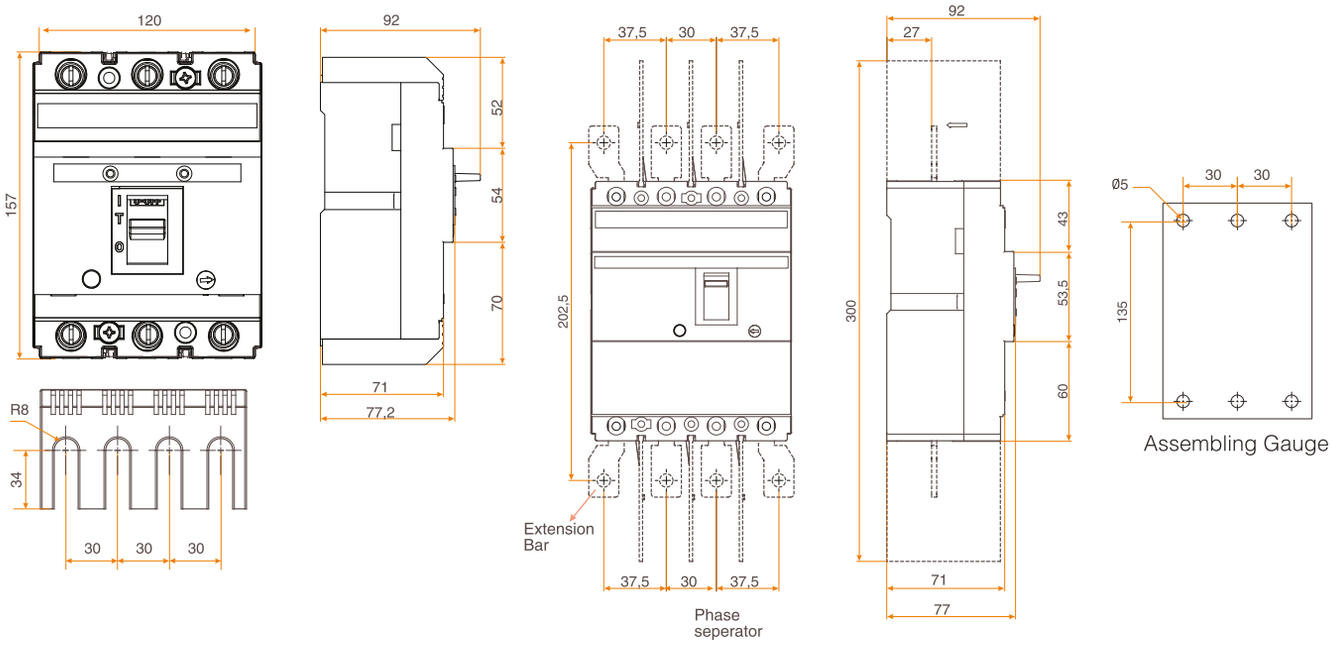
F12 THERMAL - MAGNETIC and FIXED CIRCUIT BREAKER



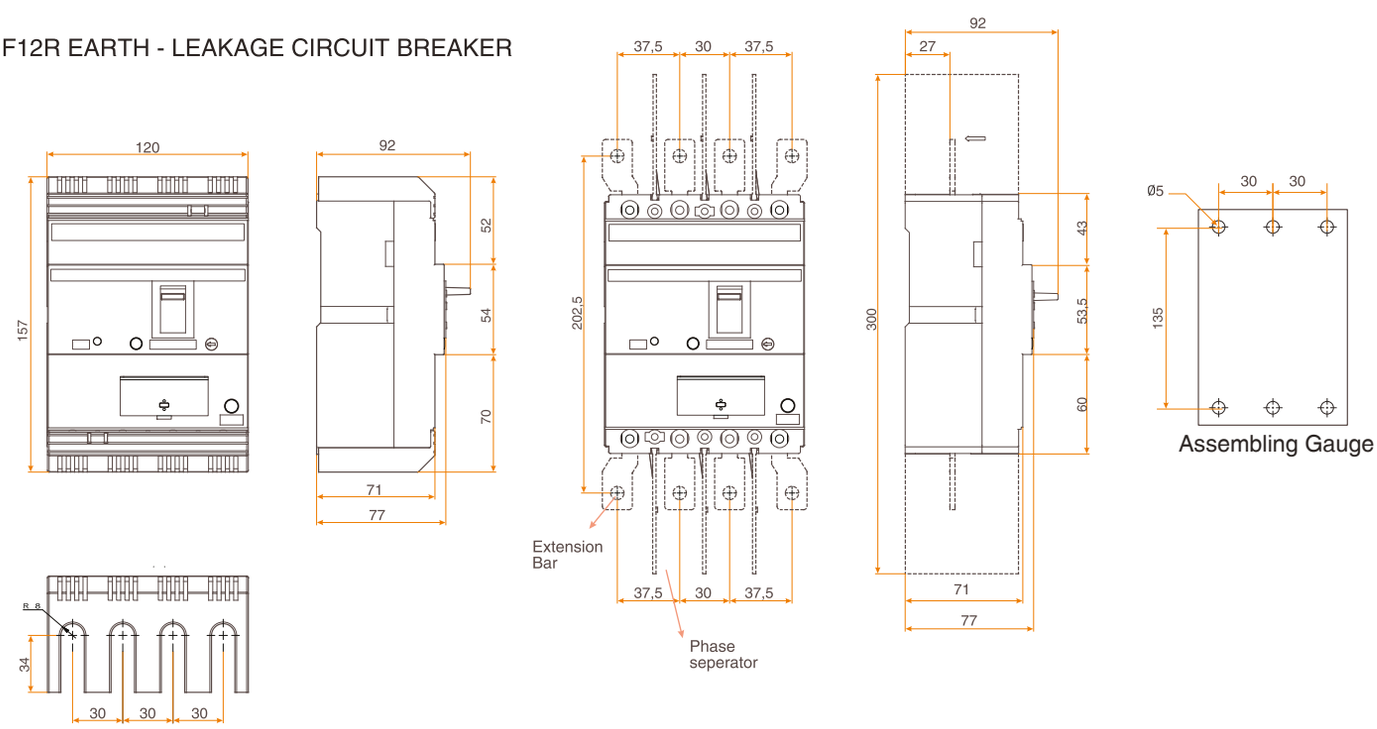


Assembling Gauge

F12N THERMAL ADJUSTABLE (4 Poles)

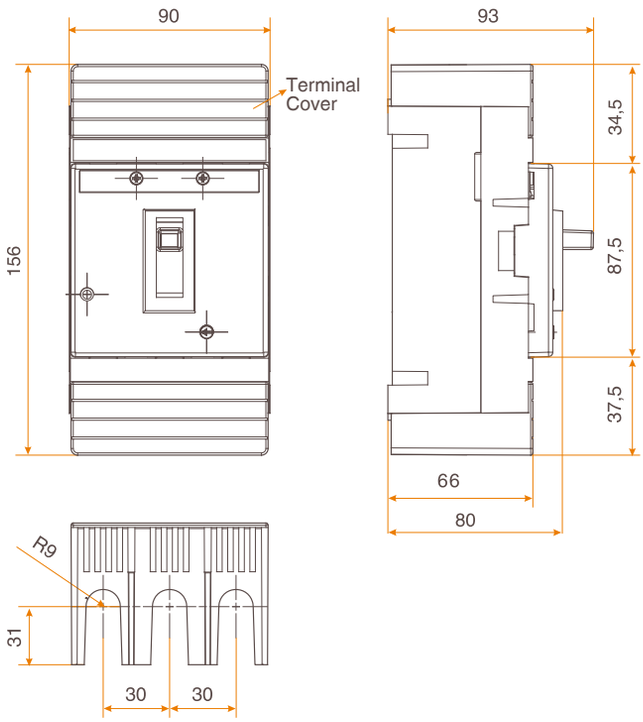


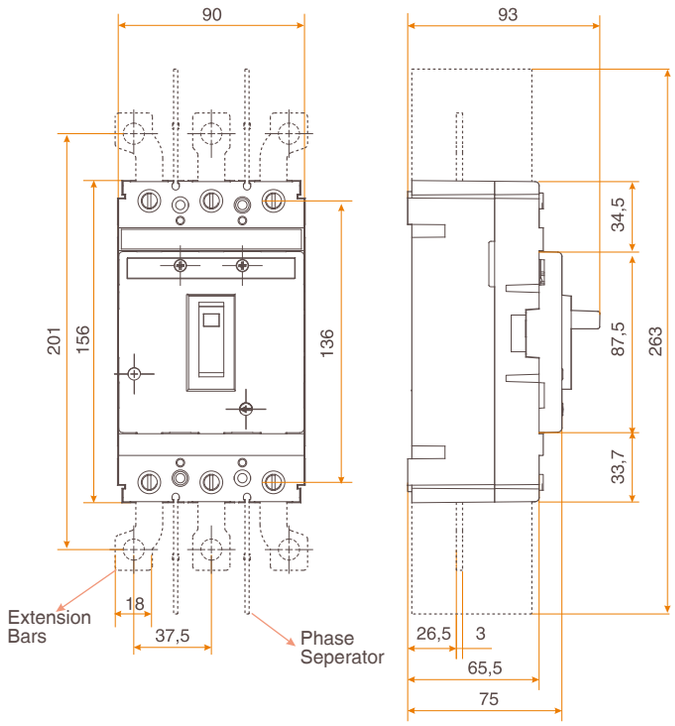
F12R EARTH - LEAKAGE CIRCUIT BREAKER

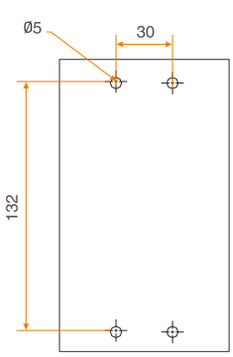


- - - - Shown parts with discrete lines are manufactured as per customer request.

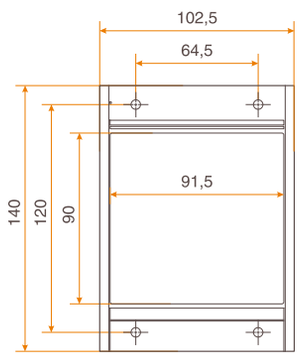
F21







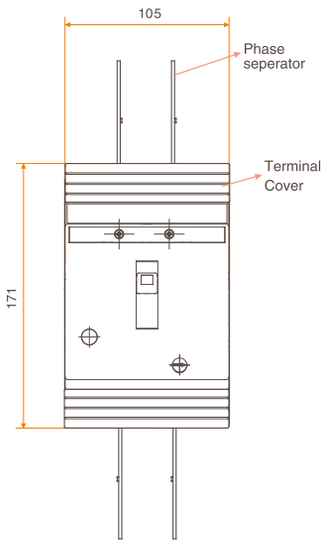
Assembling Gauge

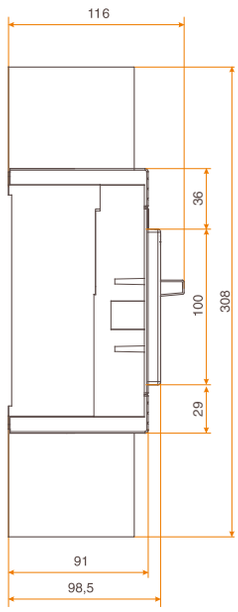


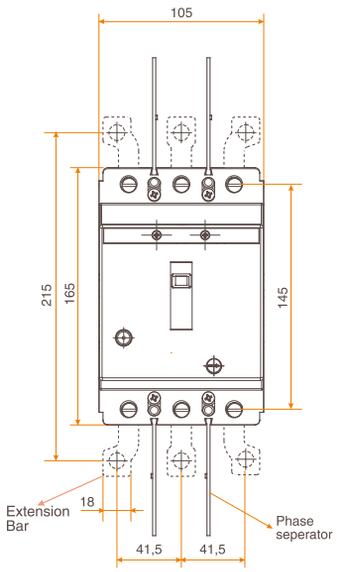
Panel Frame

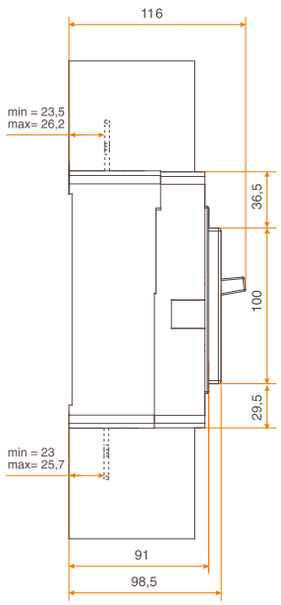
- - - - Shown parts with discrete lines are manufactured as per customer request.

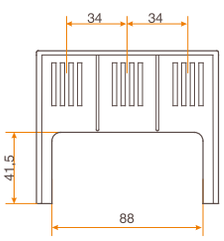
F31 - F32 - F33 - F31S

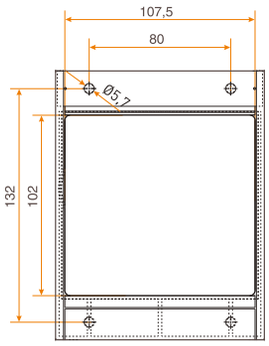




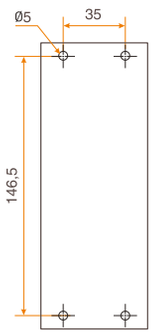






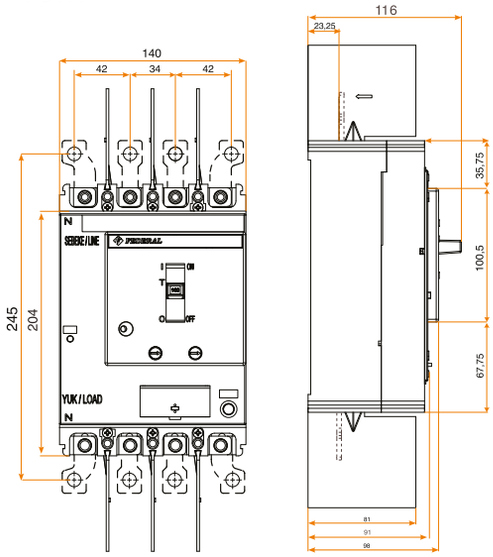


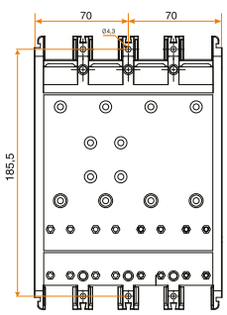
Panel Frame



Assembling Gauge

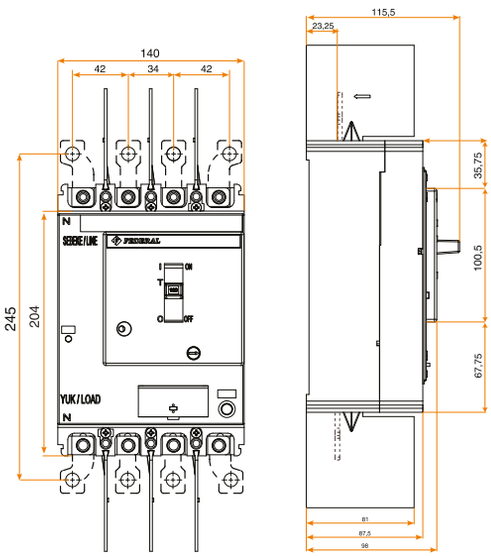
F31R





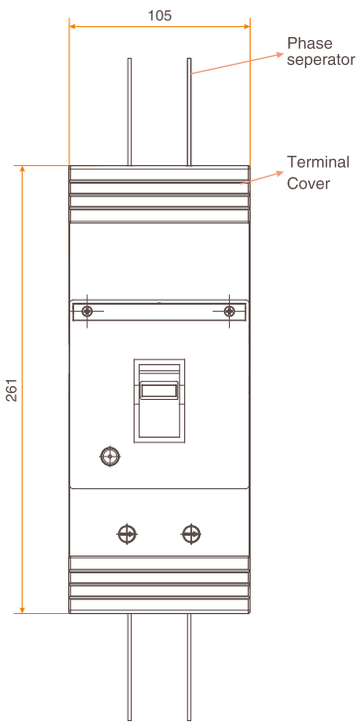
Assembling Gauge

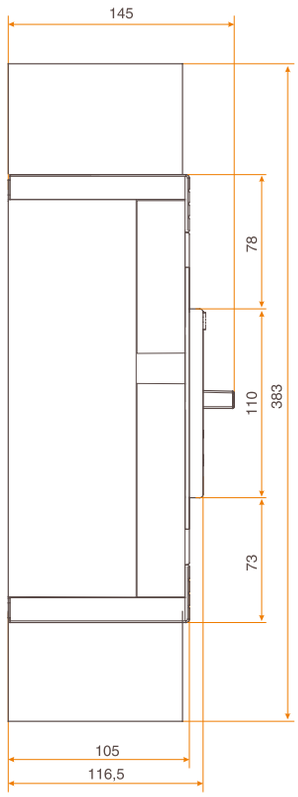
F31N

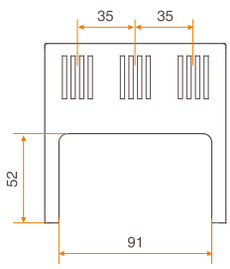


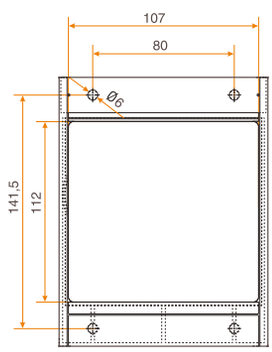
- - - - Shown parts with discrete lines are manufactured as per customer request.

F51 - F52 - F53

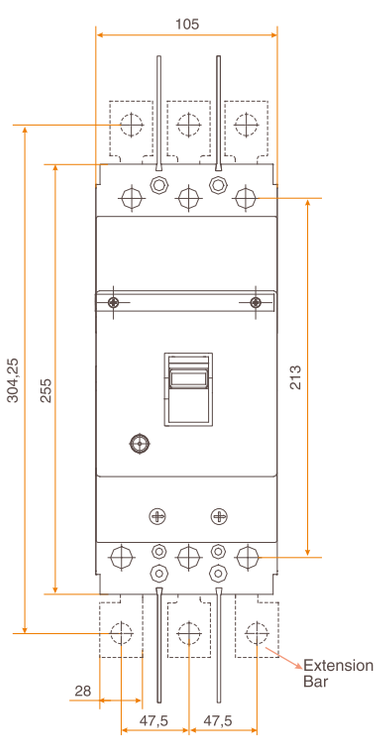


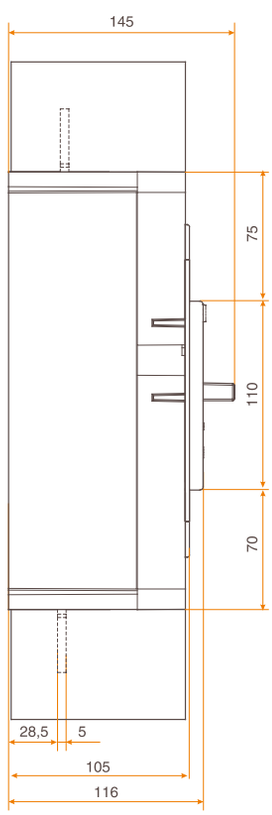


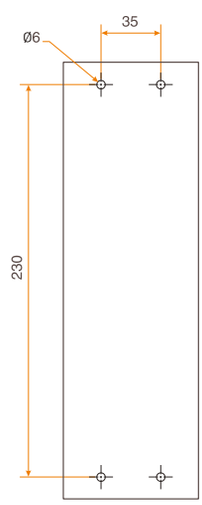




Panel Frame



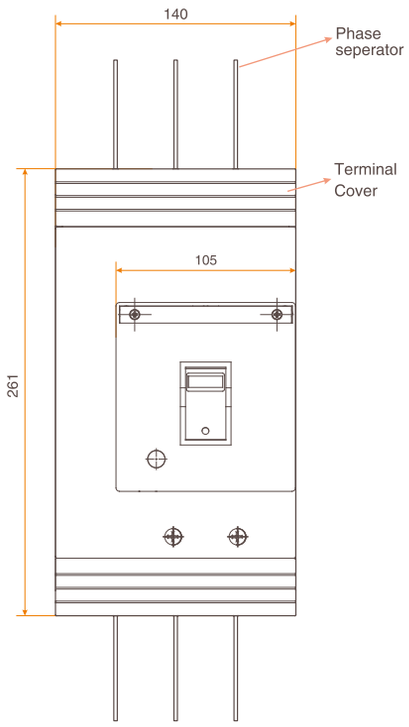


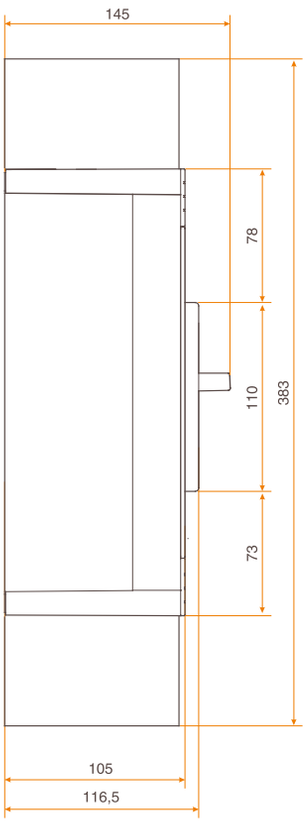


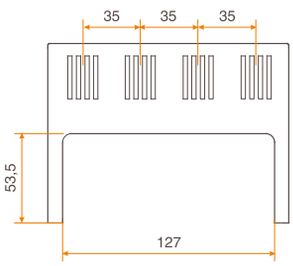
Assembling Gauge

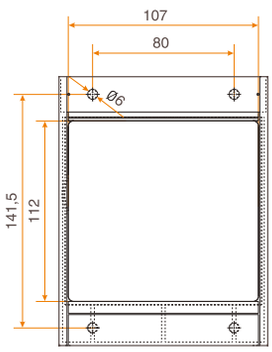
- - - - Shown parts with discrete lines are manufactured as per customer request, (only 300A-400A are produced with extension bar as a standard)

F51N - F52N - F53N (4 Poles)

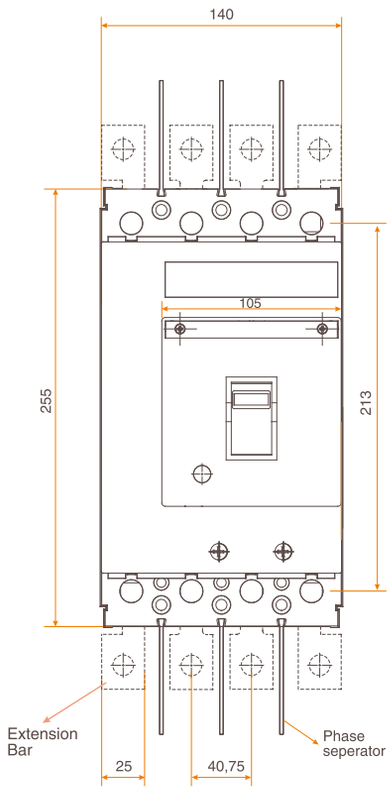


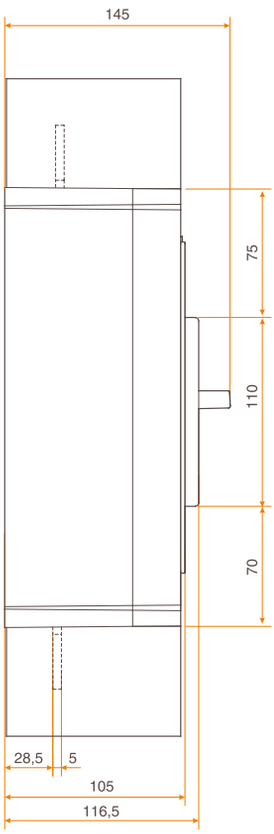


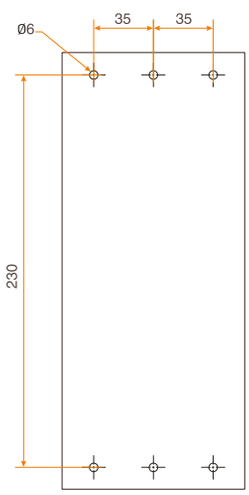




Panel Frame



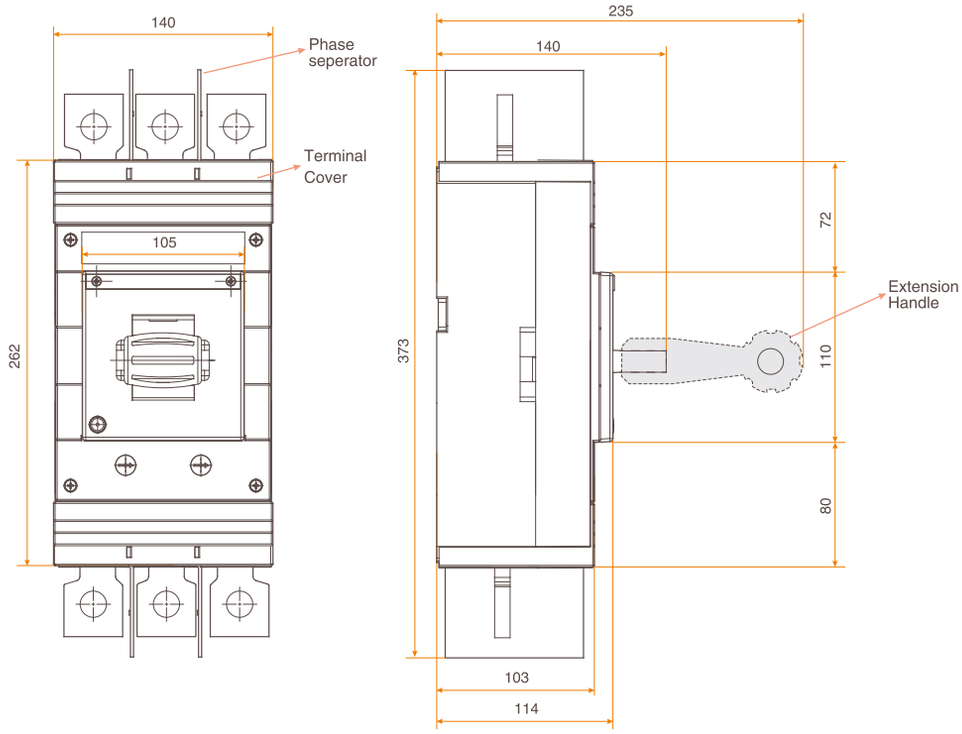


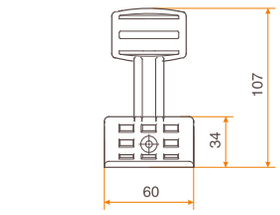


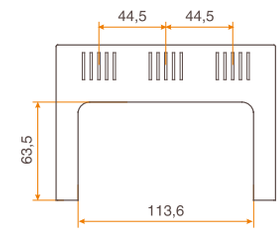
Assembling Gauge

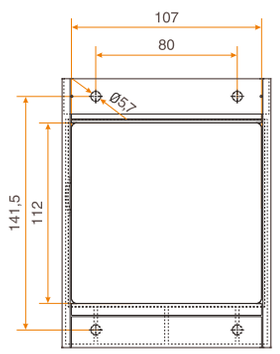
- - - - Shown parts with discrete lines are manufactured as per customer request, (only 300A-400A are produced with extension bar as a standard)

F61 - F62 - F61S

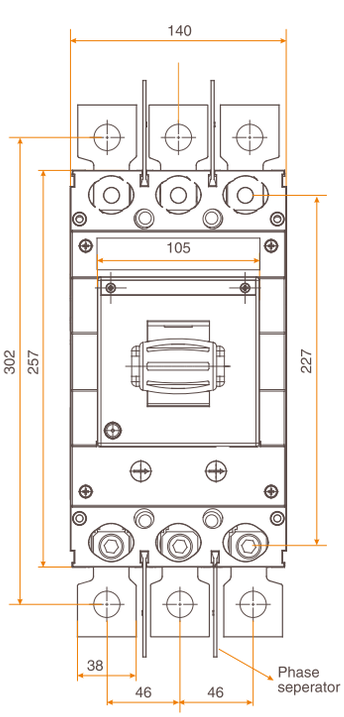


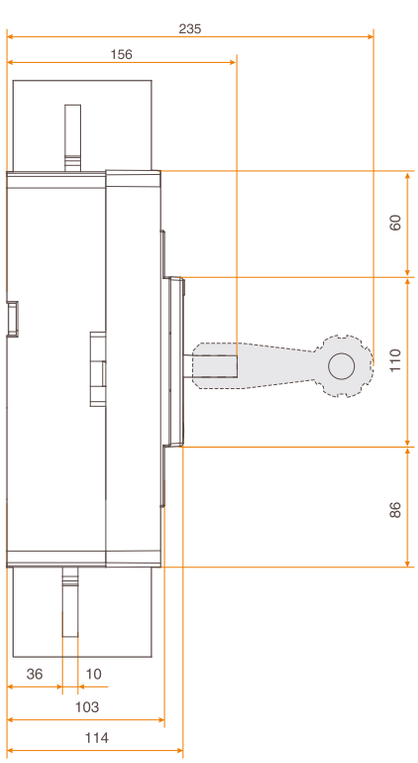


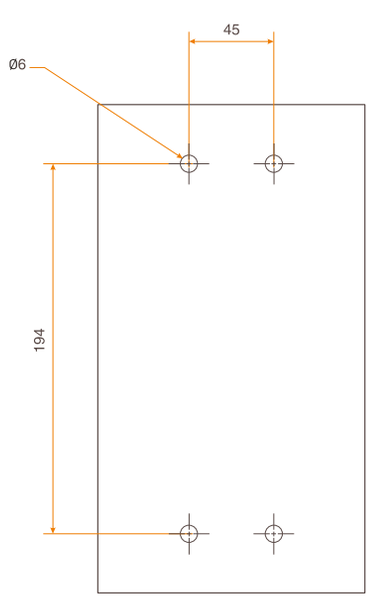




Panel Frame



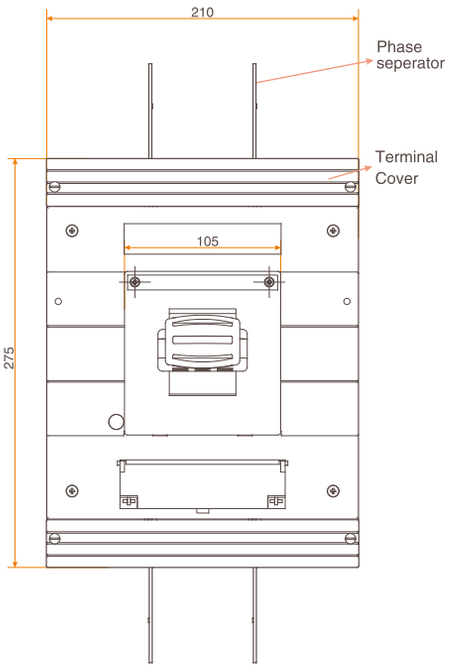


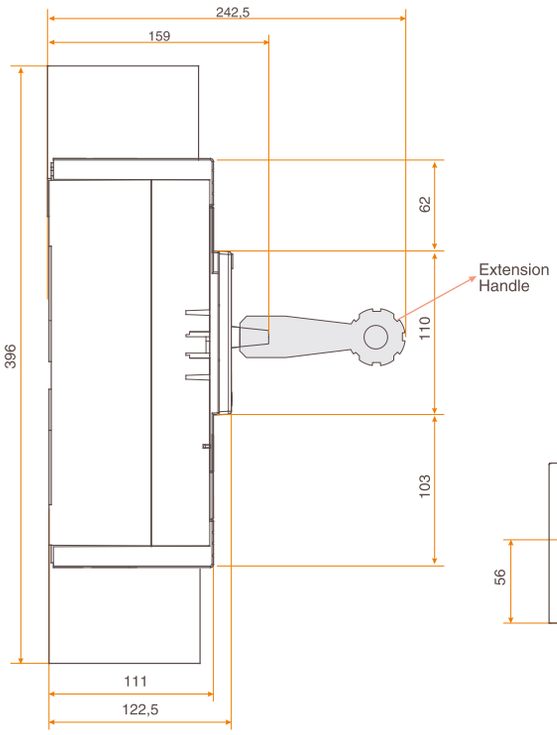


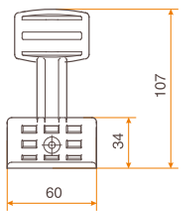
Assembling Gauge

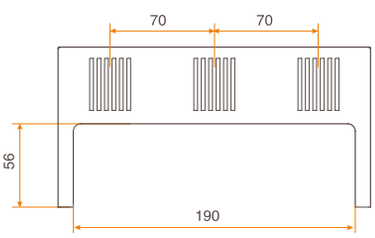
- - - - Shown parts with discrete lines are manufactured as per customer request.

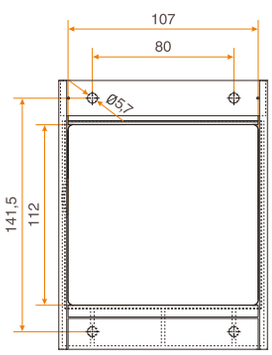
F71-F72



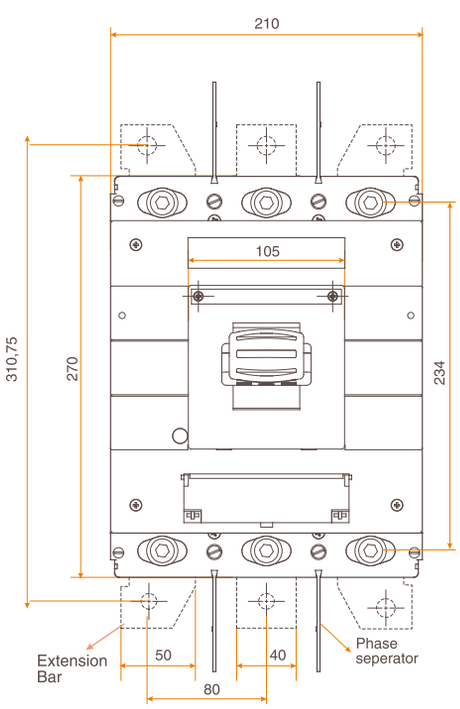


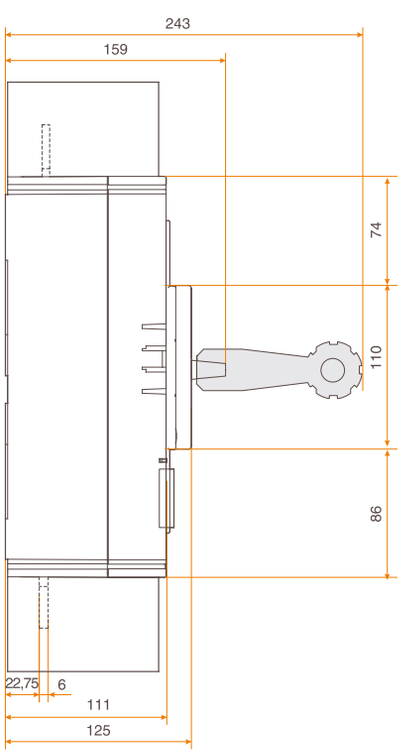


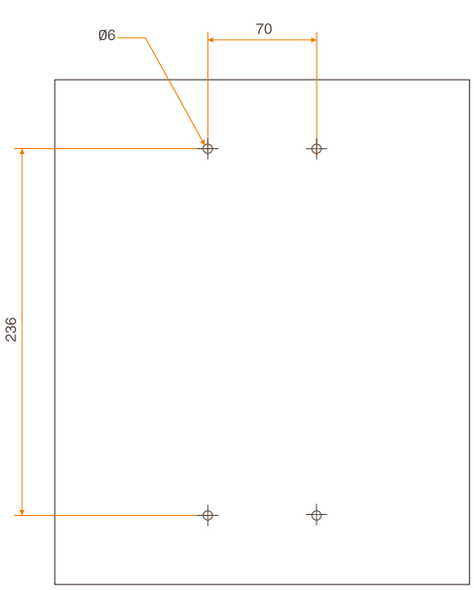




Panel Frame



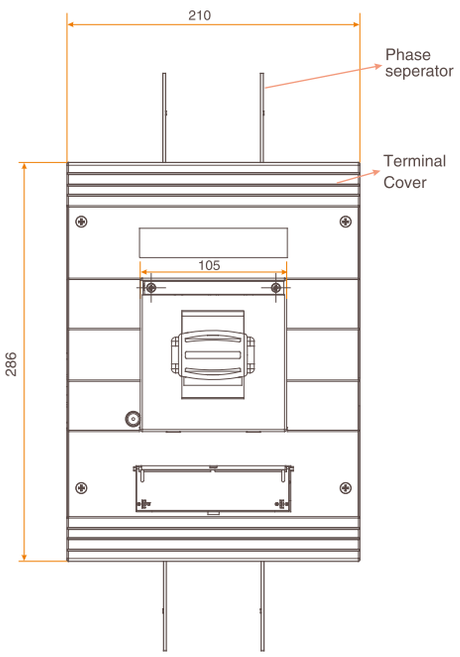


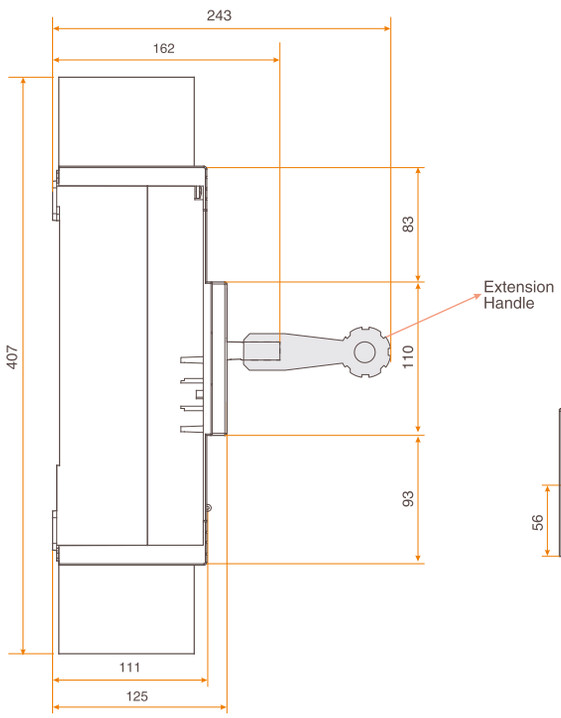


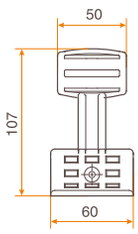
Assembling Gauge

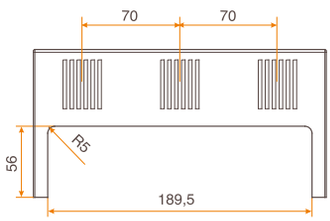
- - - - Shown parts with discrete lines are manufactured as per customer request.

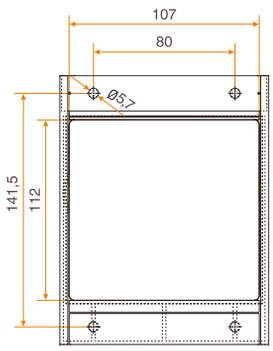
F82 - F83 - F82E - F83E



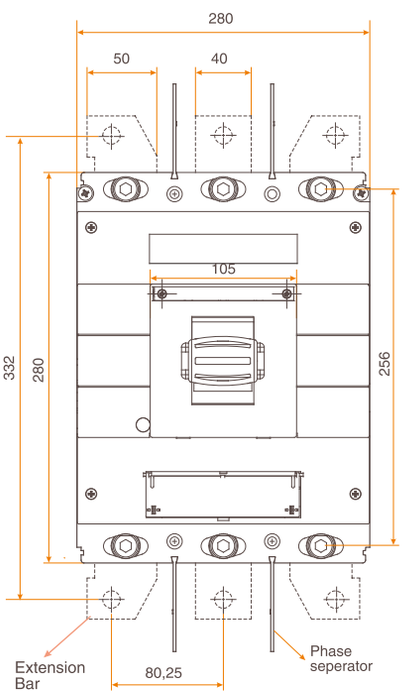


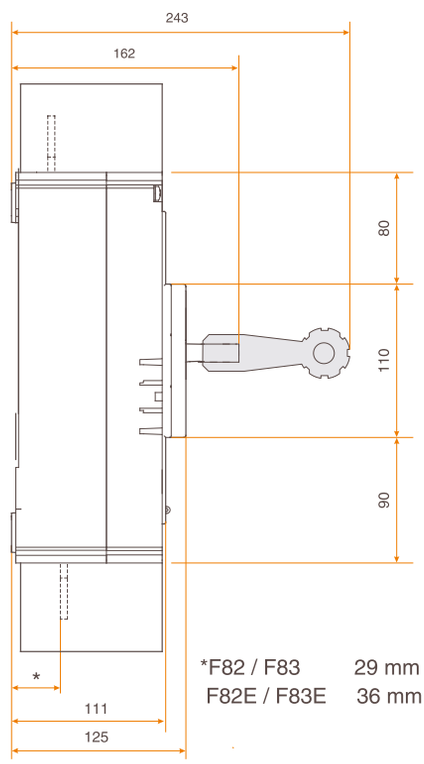




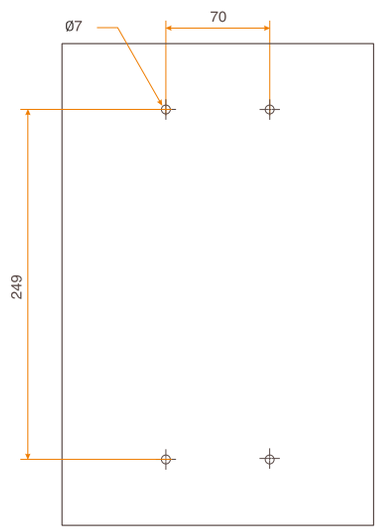


Panel Frame





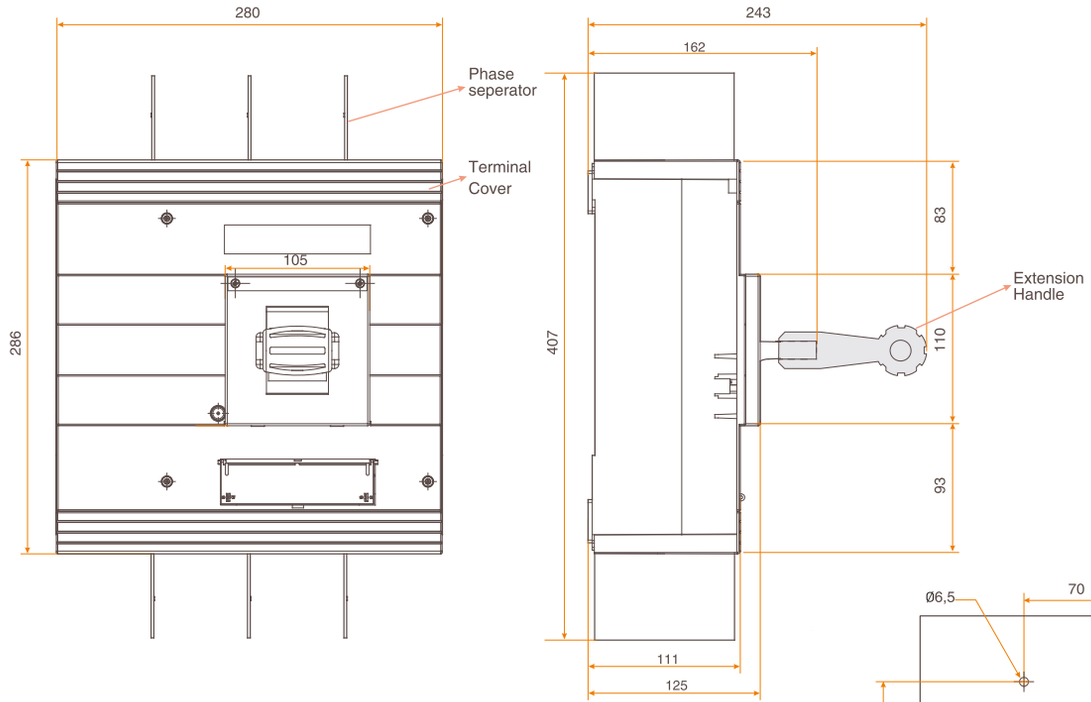
*F82 / F83 29 mm
F82E / F83E 36 mm

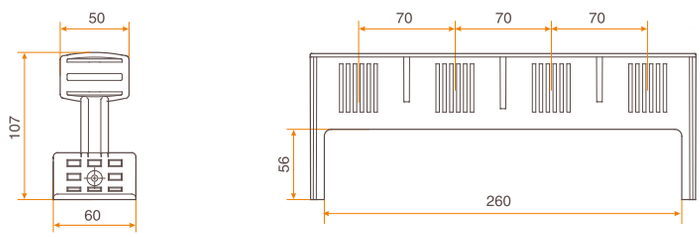


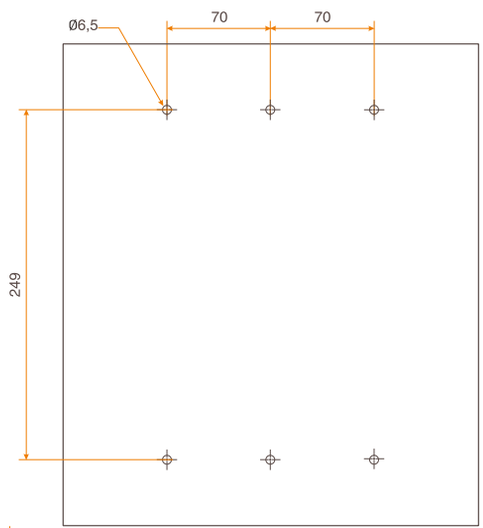
Assembling Gauge

- - - - Shown parts with discrete lines are manufactured as per customer request.

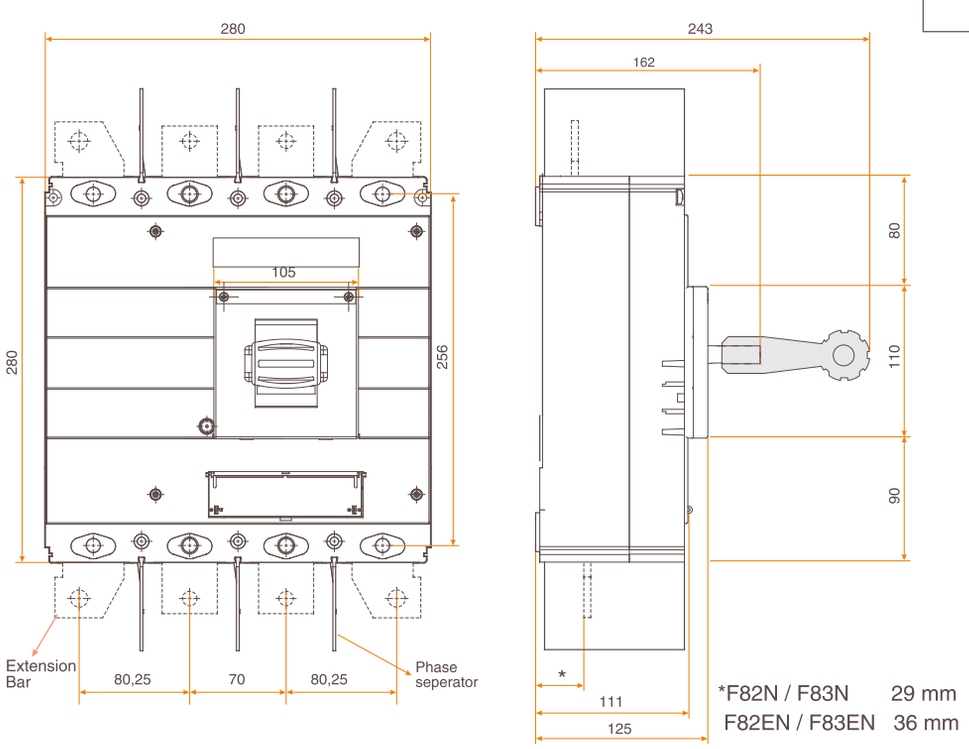
F82N - F83N - F82EN - F83EN



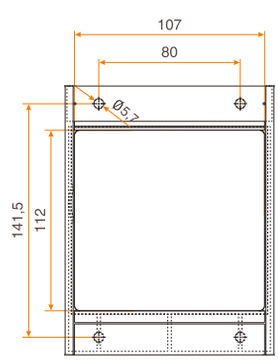




Assembling Gauge



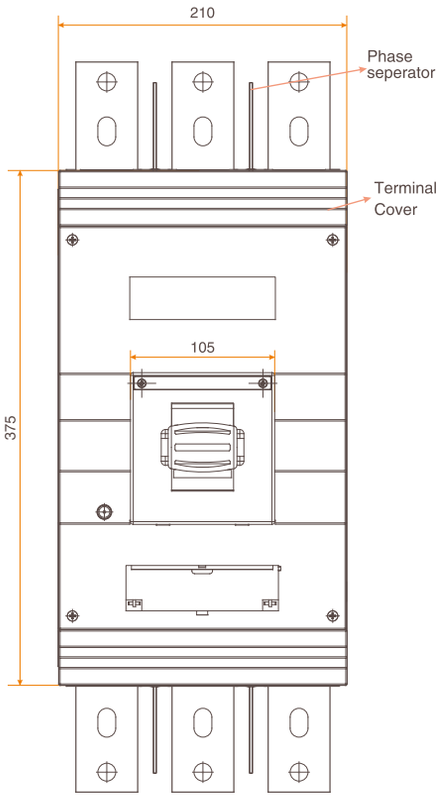
*F82N / F83N 29 mm
F82EN / F83EN 36 mm

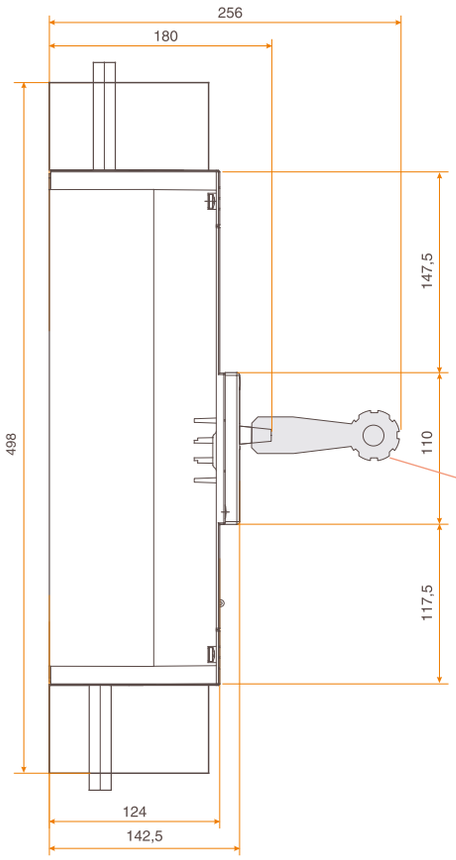


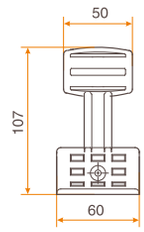
Panel Frame

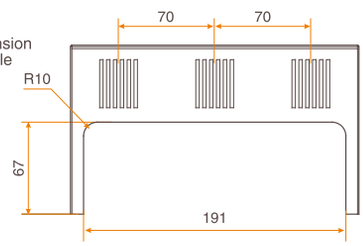
- - - - Shown parts with discrete lines are manufactured as per customer request.

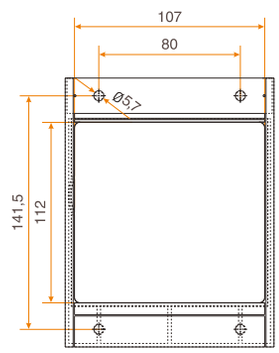
F91E - F92E



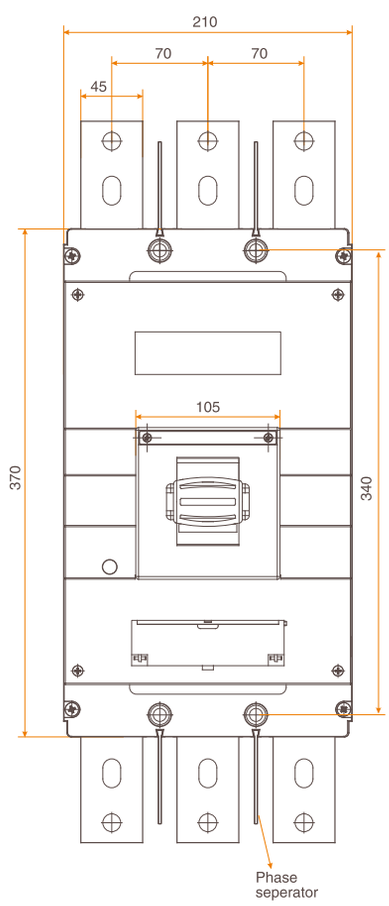


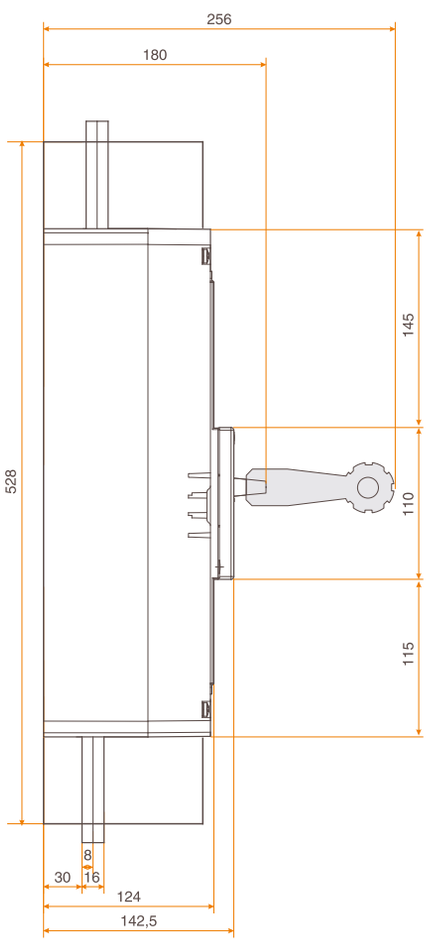


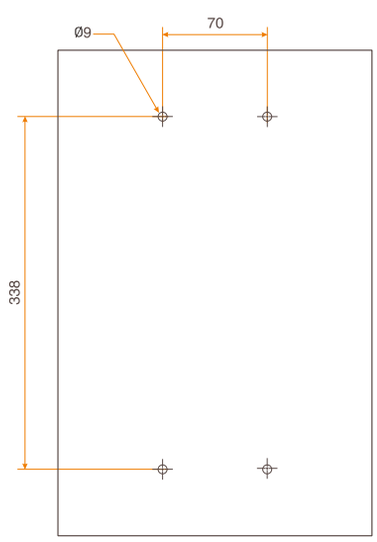




Panel Frame

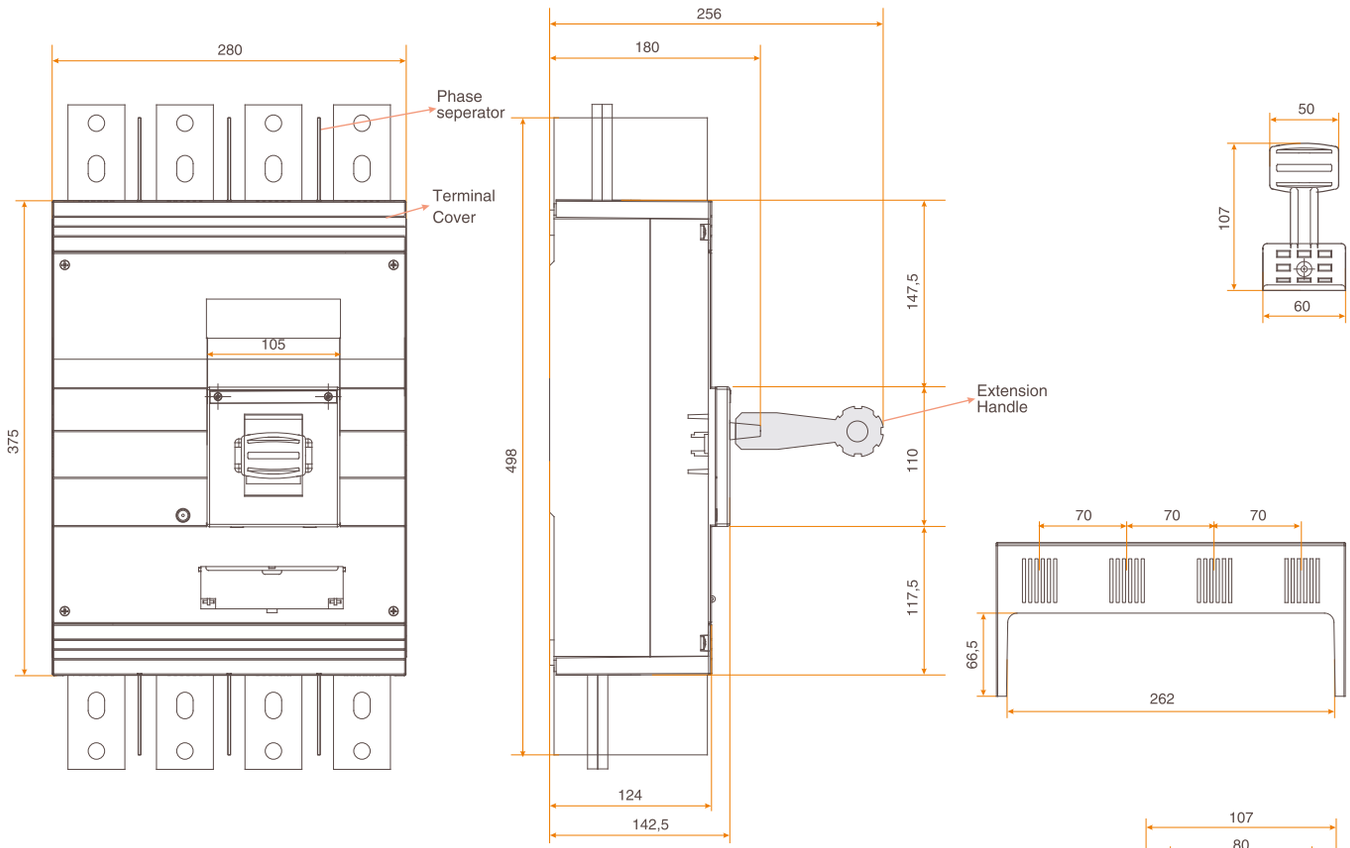


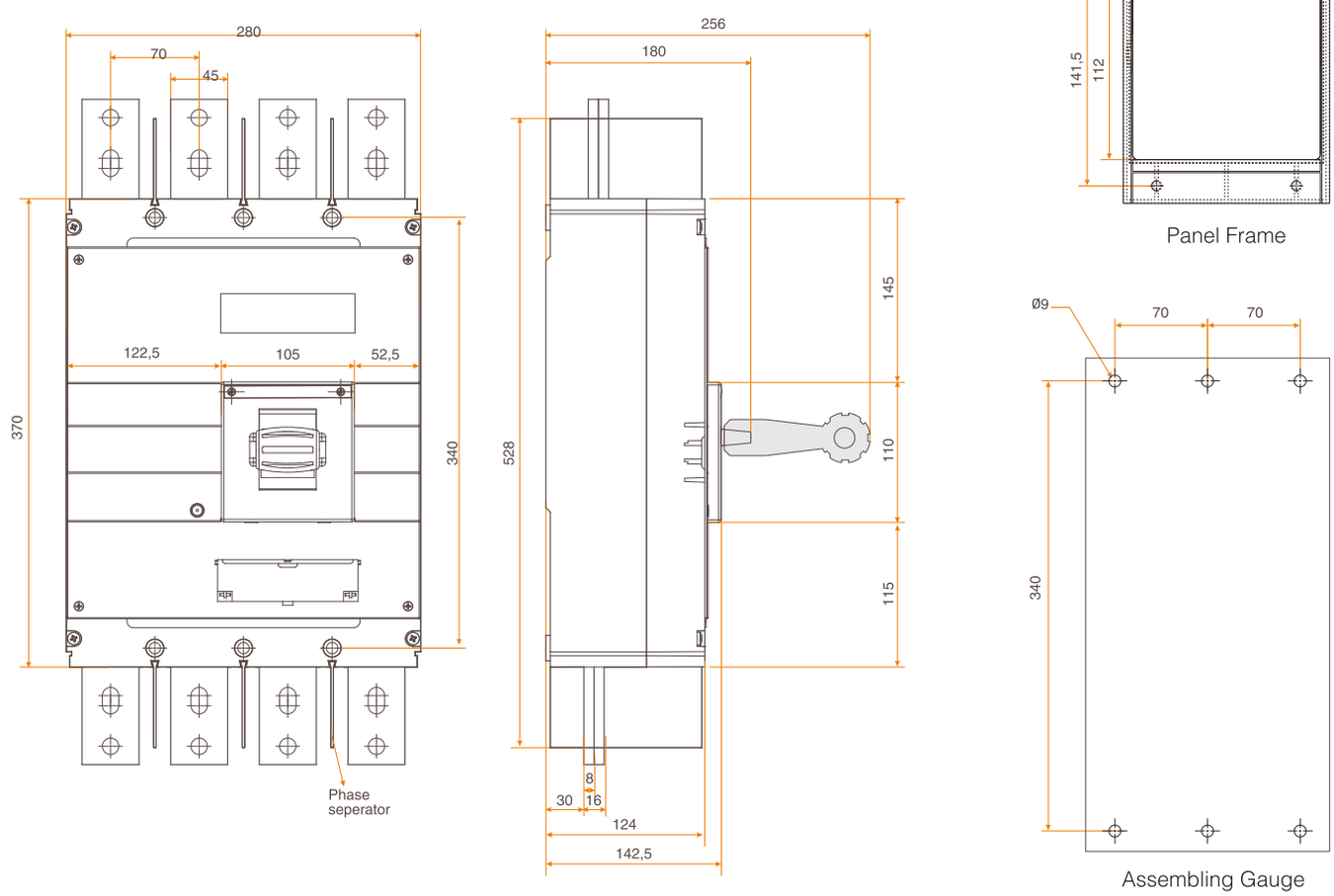




Assembling Gauge

F91EN -F92EN (4 Poles)

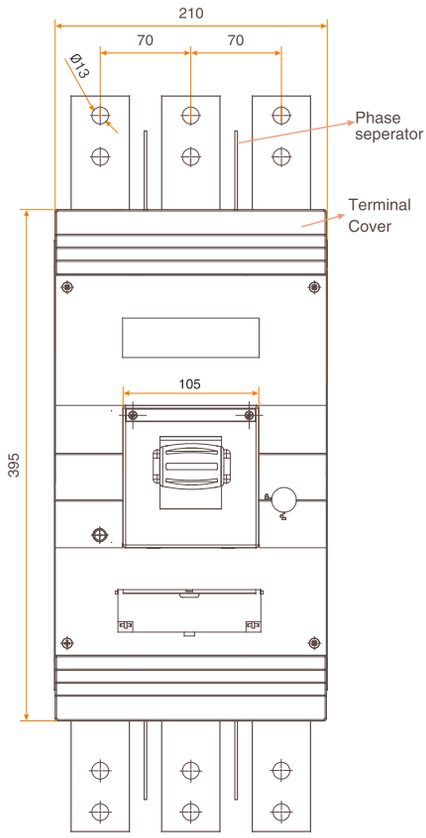


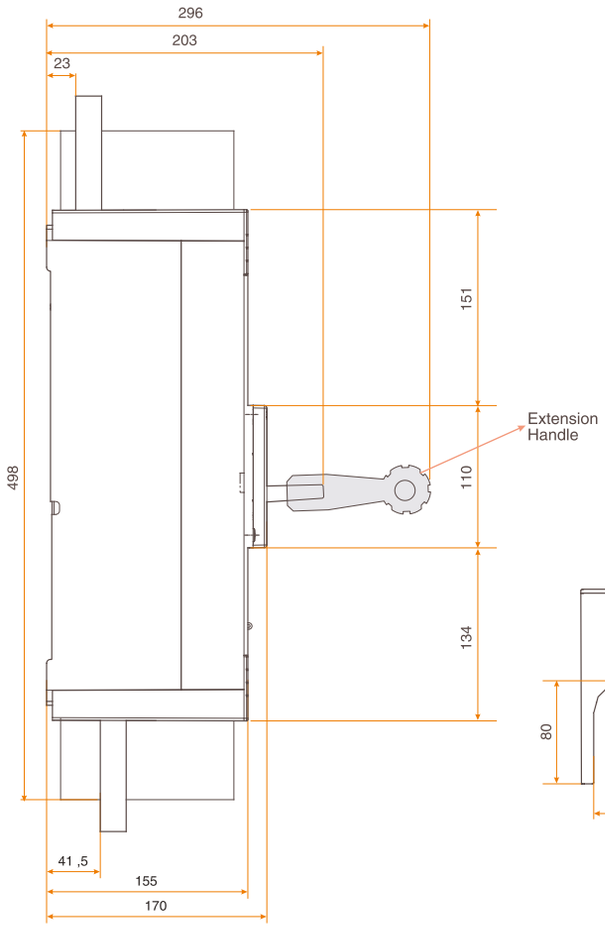


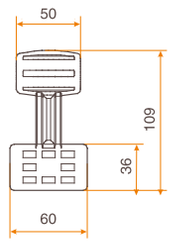
Panel Frame

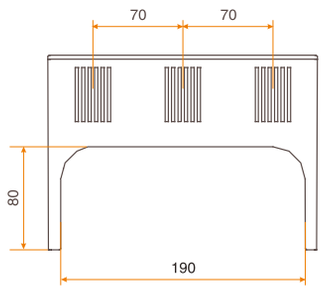
Assembling Gauge

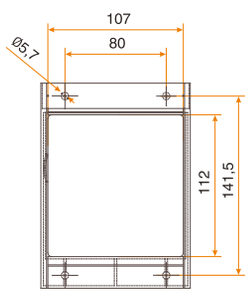
F101E - F102E



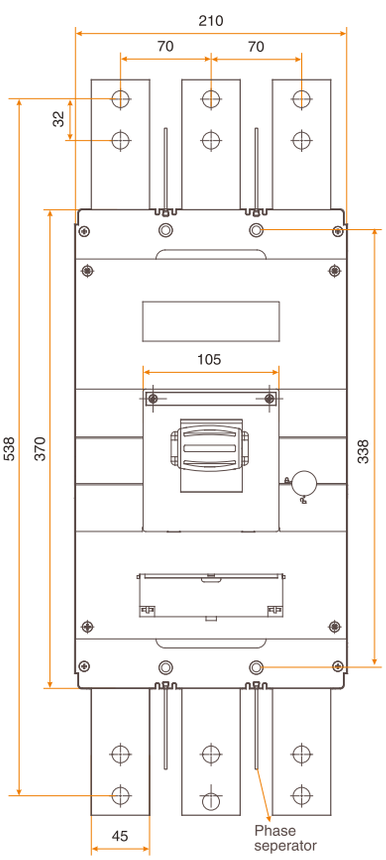


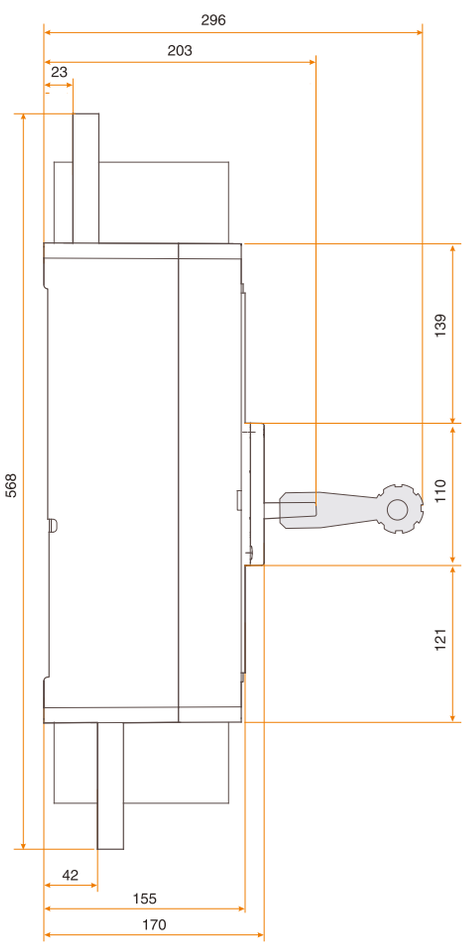


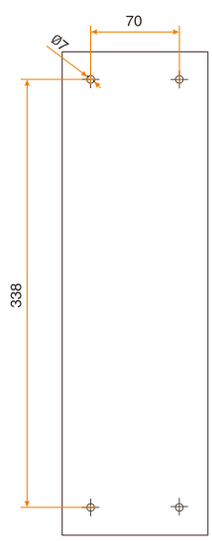




Panel Frame

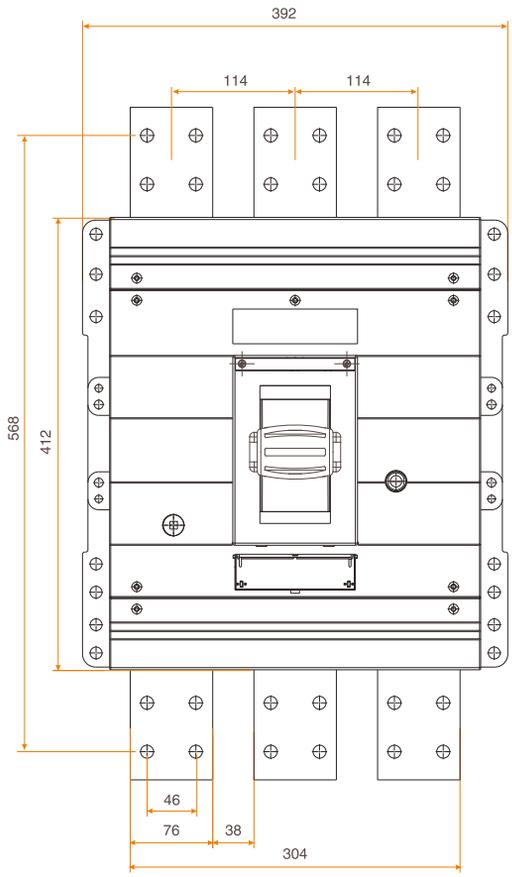


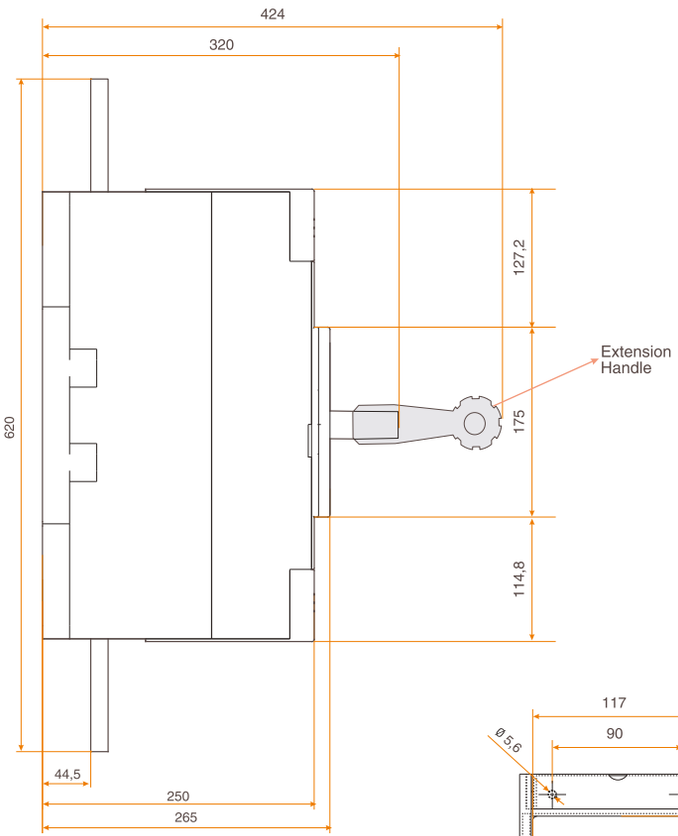


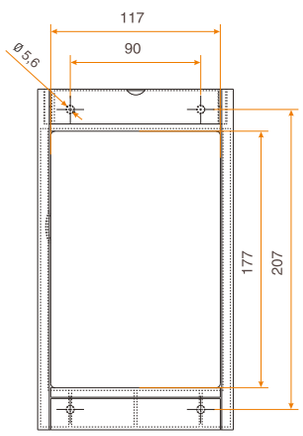


Assembling Gauge

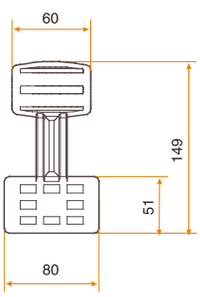
F111E - F112E

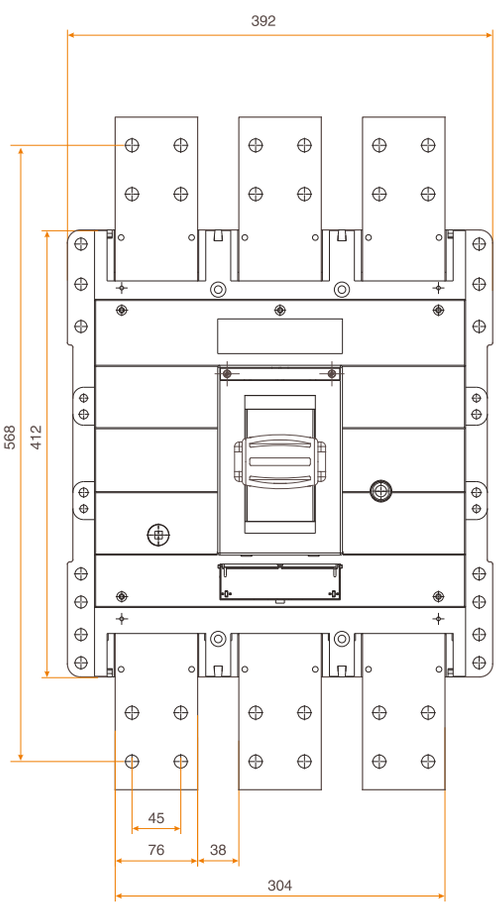


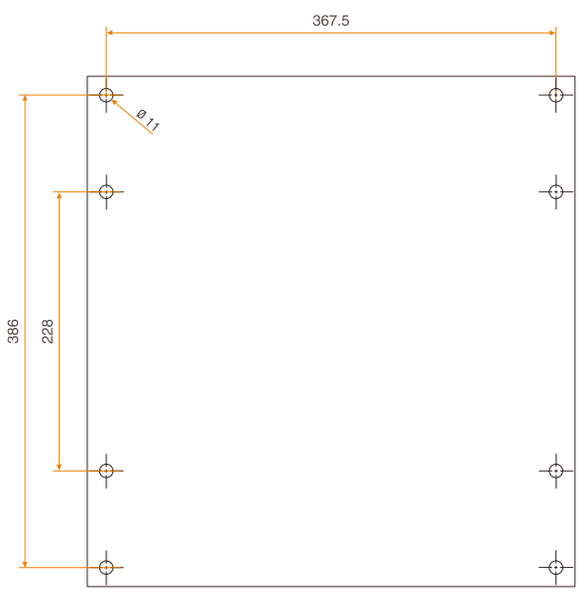




Panel Frame

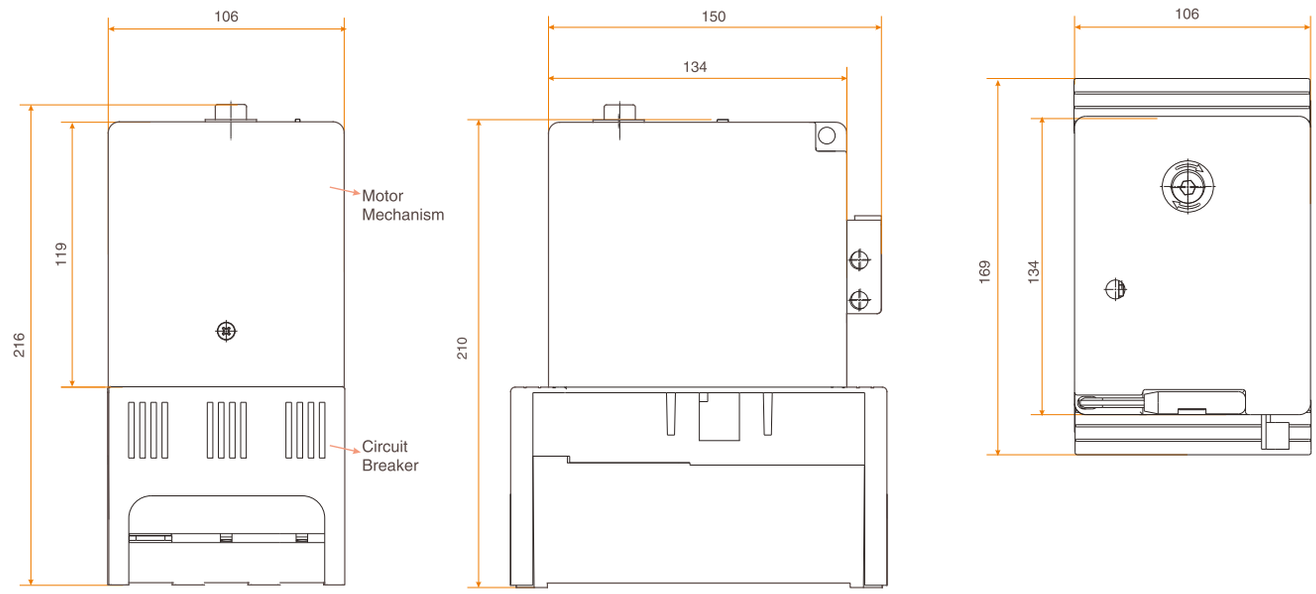




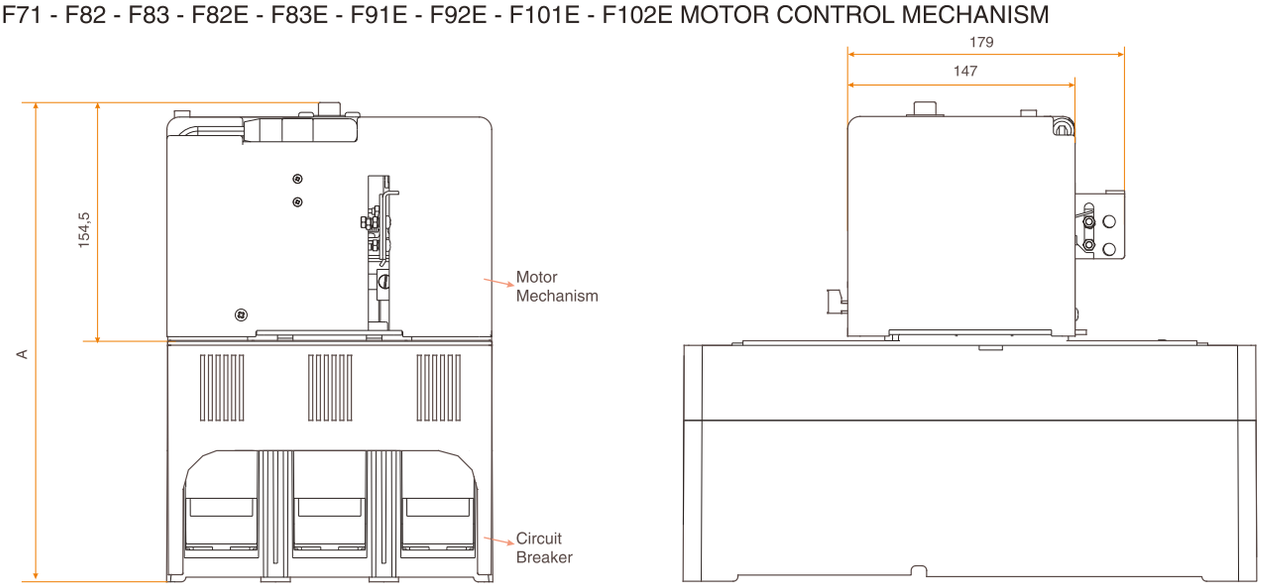


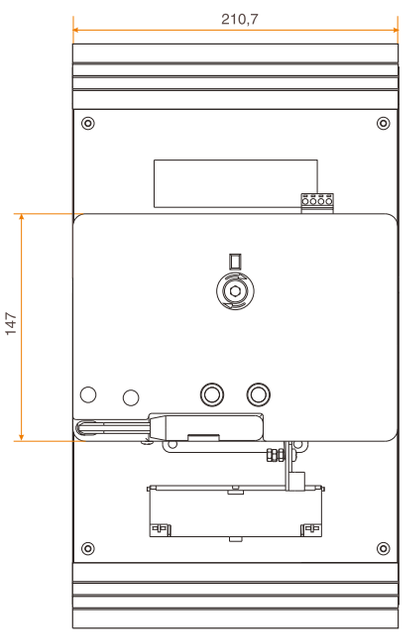
Assembling Gauge

F31 - F32 - F33 - F31S MOTOR CONTROL MECHANISM



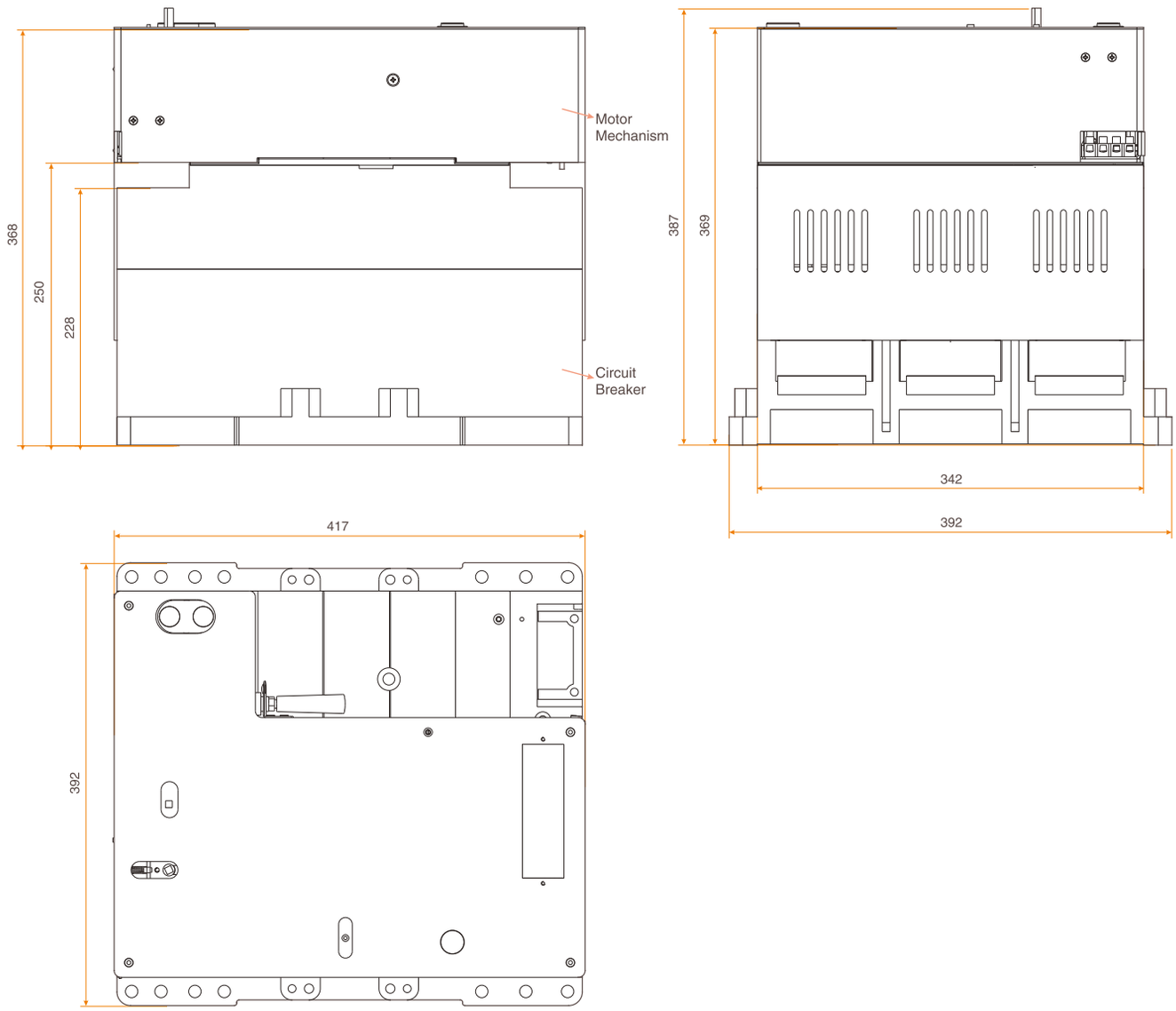
F71 - F82 - F83 - F82E - F83E - F91E - F92E - F101E - F102E MOTOR CONTROL MECHANISM



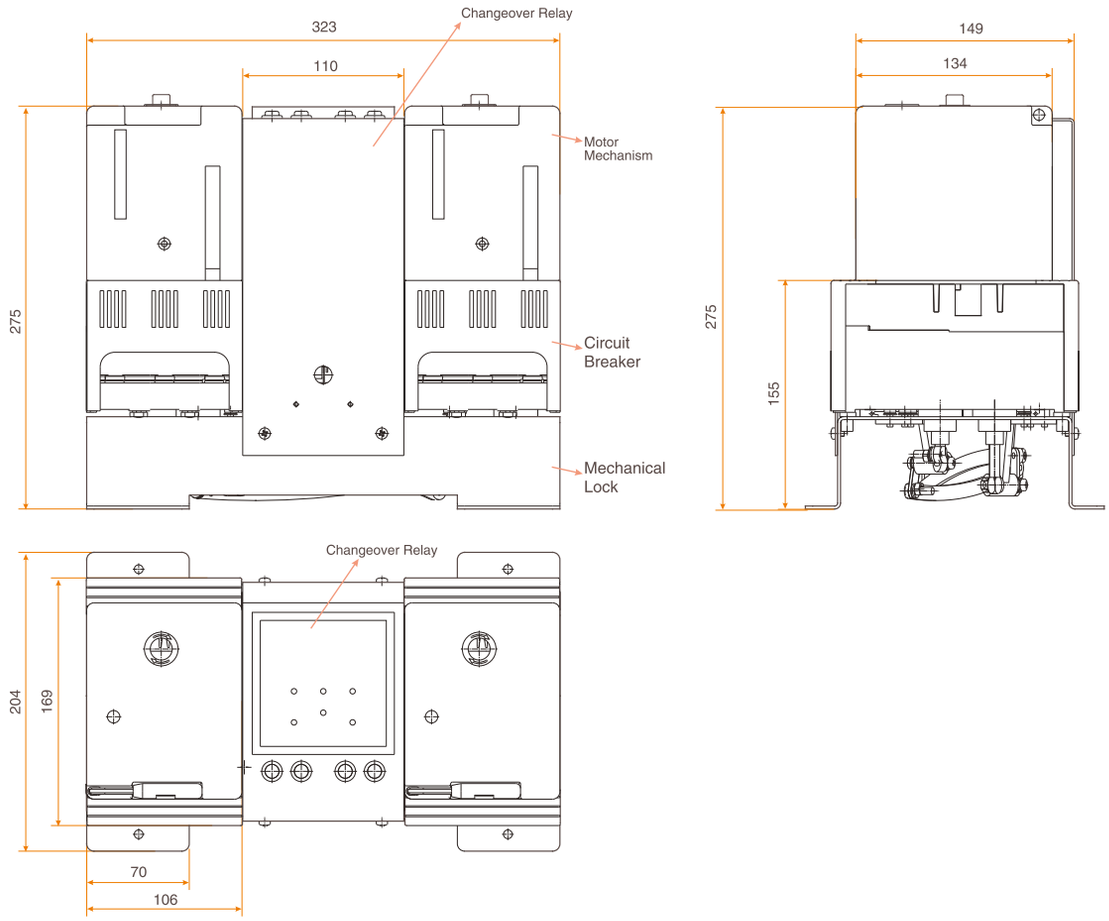


Type	Dimensions
	A
F71	265
F82 - F83 - F82E - F83E	265
F91E - F92E	282
F101E - F102E	309

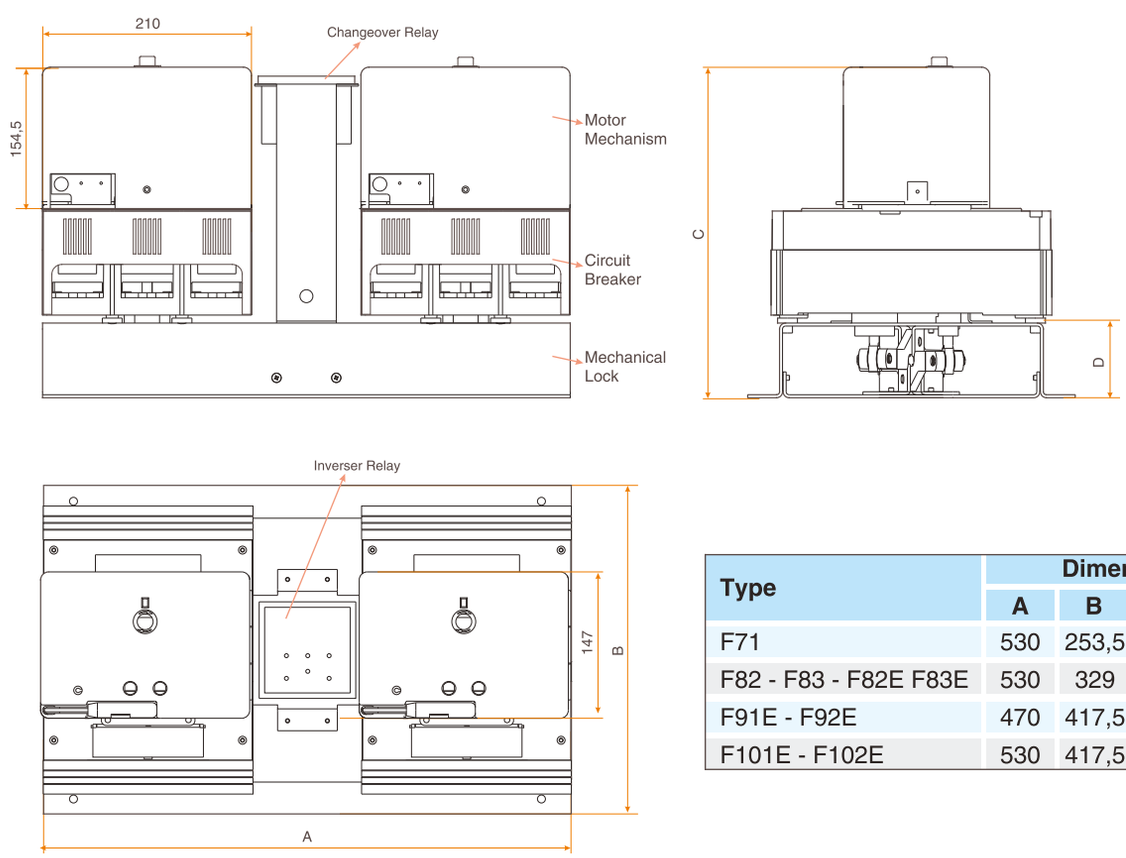
F111E - F112E MOTOR CONTROL MECHANISM



F31 -F32 - F33 - F31S CHANGEOVER SET

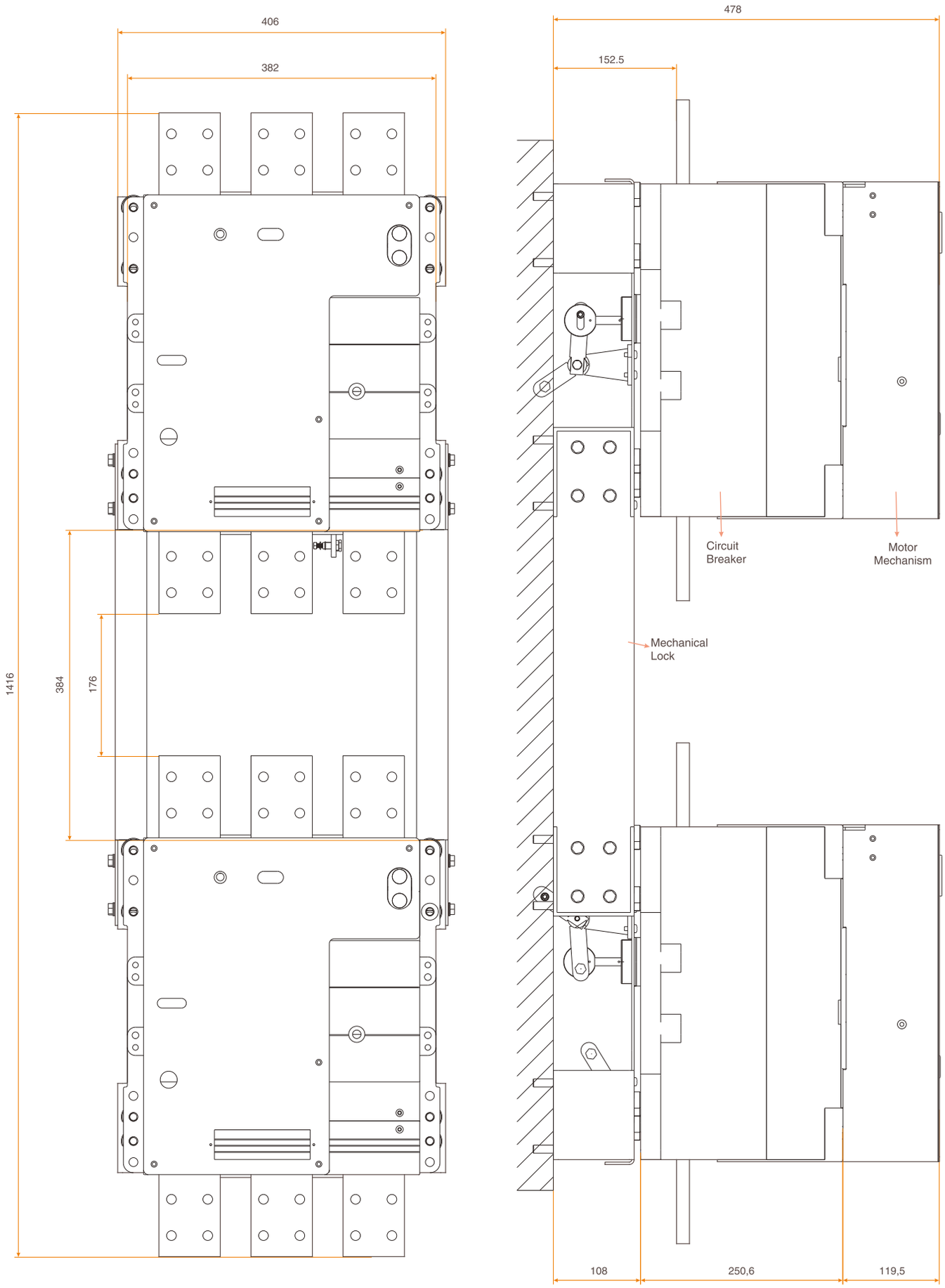


F71 - F82 - F83 - F82E - F83E - F91E - F92E - F101E - F102E INVERSER SET

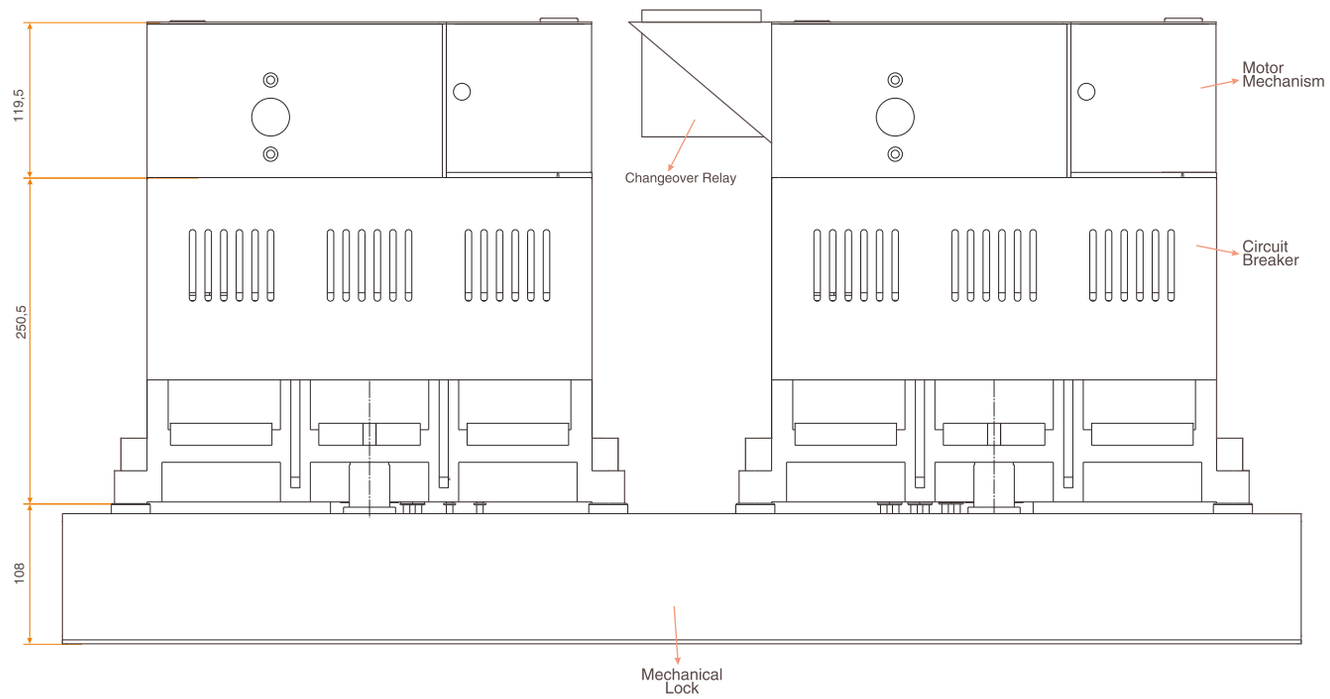


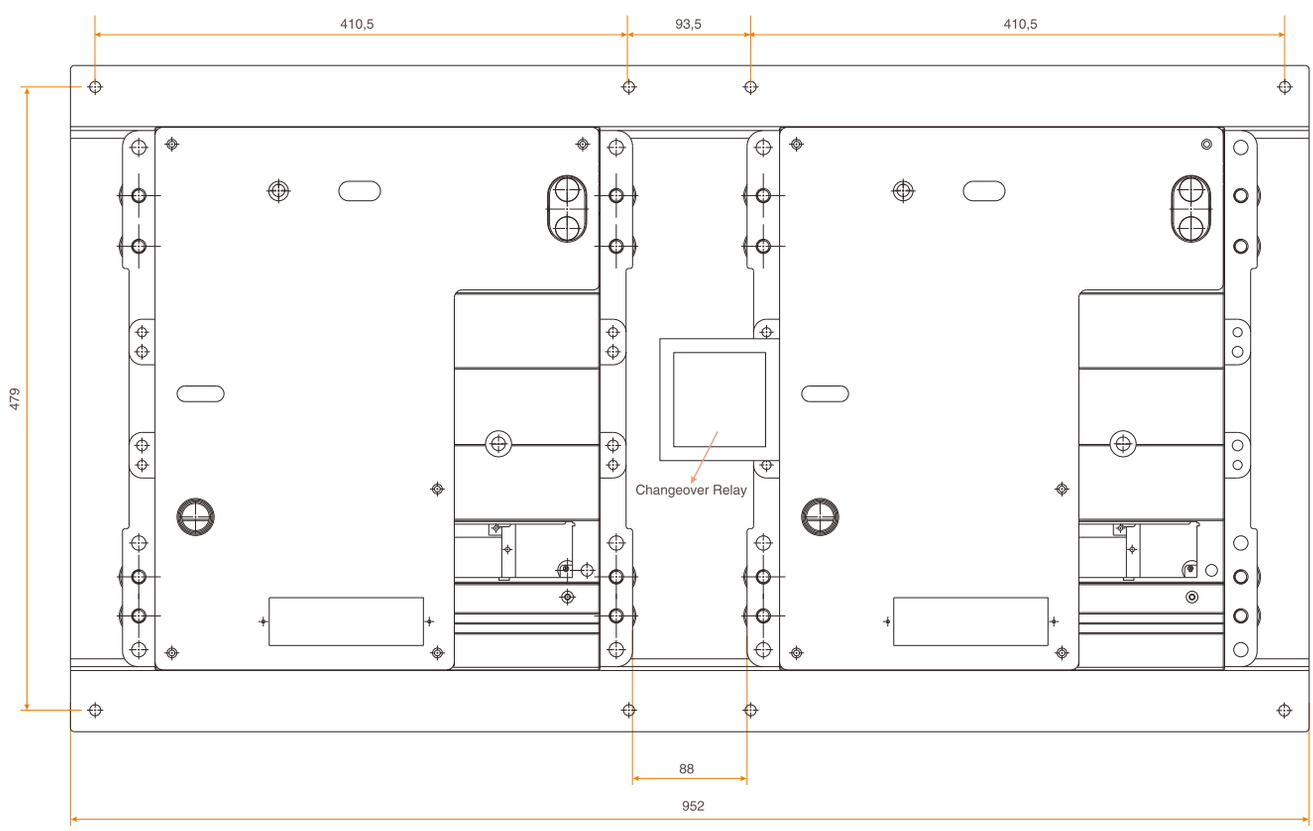
Type	Dimensions			
	A	B	C	D
F71	530	253,5	332	75
F82 - F83 - F82E F83E	530	329	340,5	75
F91E - F92E	470	417,5	363,5	75
F101E - F102E	530	417,5	395	75

F111E - F112E CHANGEOVER SET (VERTICAL)

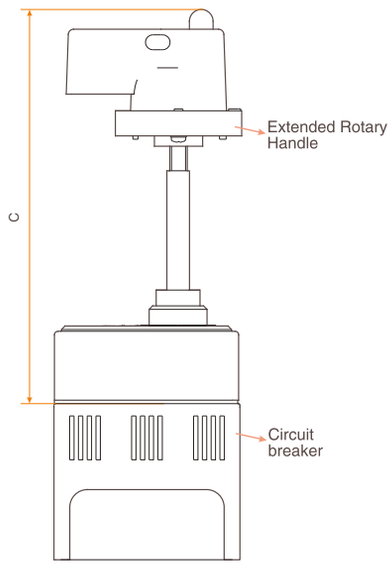


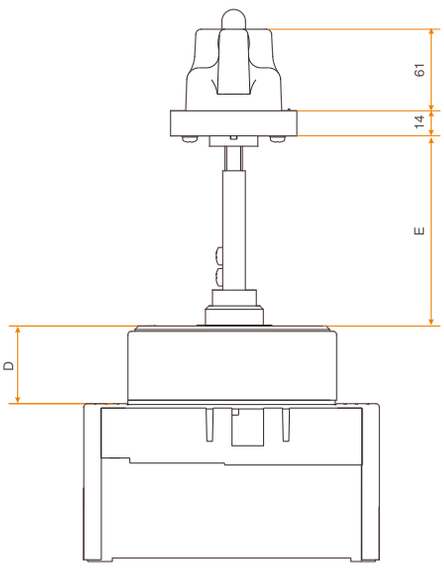
F111E - F112E CHANGEOVER SET (HORIZANTAL)

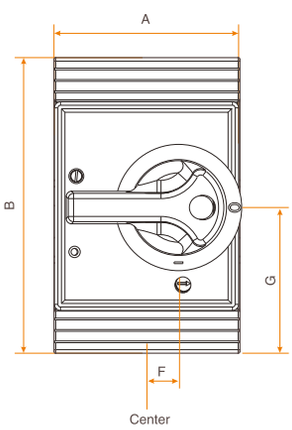




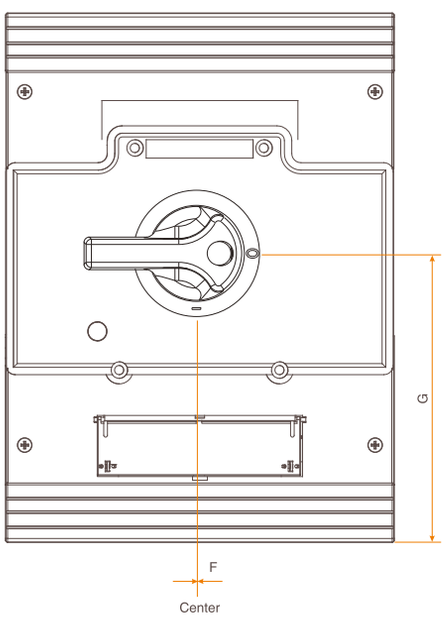
EXTENDED ROTARY HANDLE







Type	Dimensions							
	A	B	C	D	E		F	G
					min	max		
F31 - F32 - F33 - F31S	105	119,5	225	45	100	172	18	85
F51 - F52 - F53	105	119,5	225	45	100	172	18	125
F71 - F72	210	135	310	63,5	100	180	0	145
F82 - F83 - F82E - F83E	210	135	310	63,5	100	180	0	142
F91E - F92E	210	135	310	63,5	100	180	0	180



Please ask for special design dimensions CD, in case needed.