TECHNICAL APPLICATION GUIDE

RELIAGEAR® SB SWITCHBOARD

ENGINEERED
TO OUTRUN

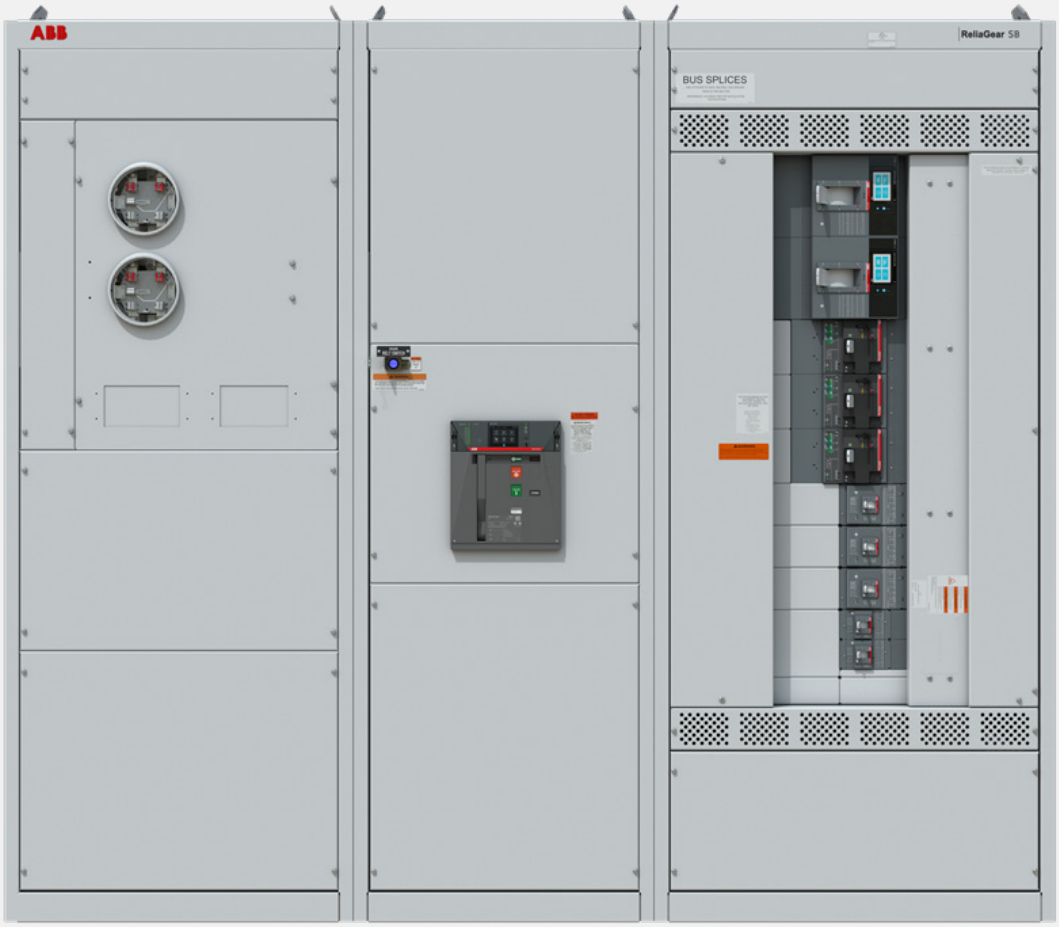


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INTRODUCTION

RG1 switchboards
RG1 switchboards, with an integrated ReliaGear® group mounted distribution panel, were designed with the flexibility to move and/or add Tmax® XT and Record Plus molded case circuit breakers in the field with ease. With ratings up to 4000 A and rear aligned sections, RG1 switchboards provide the option for quick installation against a wall with easy access from the front.

Attributes
- Main lugs up to 4000 A
- Group mounted main circuit breakers up to 1200 A
- Group mounted feeder circuit breakers from 15 to 1200 A
- Suitable for distribution or service entrance
- NEMA type 1 or 3R enclosures
- Front accessible connections
- Rear aligned sections; may be mounted against a wall
- Up to 100 kAIC interruption rating @ 480 V

RG2 switchboards
RG2 switchboards allow for a variety of individually mounted main circuit breakers and the same group mounted distribution panels as RG1 switchboards. With ratings up to 6000 A and front or rear aligned sections, RG2 switchboards are suitable for a variety of applications from light commercial to industrial.

Attributes
- Main lugs up to 6000 A
- Individually mounted main circuit breakers up to 6000 A
- Group mounted feeder circuit breakers from 15 to 1200 A
- Suitable for distribution or service entrance
- NEMA type 1 or 3R enclosures
- Front or rear accessible connections
- Rear or front and rear aligned sections
- Up to 200 kAIC interruption rating @ 480 V
- Hot or cold sequence utility metering compartments

RG5 switchboards
RG5 switchboards feature individually mounted main and/or feeder circuit breakers. With ratings up to 6000 A, RG5 switchboards are capable of handling the most demanding applications.

Attributes
- Individually mounted power circuit breakers up to 6000 A, insulated case circuit breakers up to 4000 A, and molded case circuit breakers up to 1200 A
- Suitable for distribution or service entrance

NEMA type 1 or 3R enclosures
Applies to all ReliaGear switchboard types:
- Front or rear accessible connections
- Rear or front and rear aligned sections
- Up to 100 kAIC interruption rating @ 480 V
- ANSI 61 gray color

Seismic compliance certification
Applies to all ReliaGear switchboard types:
- Qualified to IEEE-693-2018 High Level
- Qualification performed in accordance to IBC-2021/CBC-2025 and ICC-ES-AC156-24
- Class 1 (group mounted switchboard sections): Sds = 2.00g, Ip - 1.5, for z/h = 1 , Sds = 2.50g, Ip - 1.5, for z/h = 0
- Class 2 (Individually mounted switchboard sections): Sds = 1.56g, Ip - 1.5, for z/h = 1, Sds = 2.50g, Ip - 1.5, for z/h = 0

TIP
Lineups with individually mounted circuit breakers, are classified as Class 2 for seismic ratings. Reference OSHPD OSP-0044-10 for additional details.

Environmental Product Declaration (EPD)
- Registration number ABBG-00410-V01.01-EN

TABLE 1: RG1

Device usage	Device type	Amperage rating	Mounting
Main	Tmax® XT (MCCB)	400–1200 A	Group
Feeder	Tmax XT (MCCB)	15–1200 A	Group
	Record Plus (MCCB)	15–100 A (1P and 2P only)	Group

TABLE 2: RG2

Device usage	Device type	Amperage rating	Mounting
Main	Emax 3 (Power Circuit Breaker)	250–6000 A	Individually
	Emax 2 Power Circuit Breaker (ACB)	250–6000 A	Individually
	Power Break® II (ICCB)	300–4000 A	Individually
	HPC II (HPC)	800–4000 A	Individually
	Bolted Pressure Switches (BPS)	800–4000 A	Individually
	Tmax XT (MCCB)	125–1200 A	Group
Feeder	Tmax XT (MCCB)	15–1200 A	Group
	Record Plus (MCCB)	15–100 A	Group

TABLE 3: RG5

Device usage	Device type	Amperage rating	Mounting
Main/ Feeder	Emax 3 (Power Circuit Breaker)	250–6000 A	Individually
	Emax 2	250–6000 A	Individually
	Power Break II (ICCB)	800–4000 A	Individually
	Tmax XT (MCCB)	100–1200 A	Individually

TABLE 4: MAIN DEVICES

Switchboard type	Mounting		Power circuit breaker	Insulated case circuit breaker	High pressure contact switches	Bolted pressure switches	Molded case circuit breakers
	Individual	Group					
RG1	No	Yes	—	—	—	—	125–1200 A
RG2	Yes	No	300–6000 A	300–4000 A	800–4000 A	800–4000 A	125–1200 A
RG5	Yes	No	250–6000 A	300–4000 A	—	—	—

TABLE 5: FEEDER DEVICES

Switchboard type	Mounting		Power circuit breaker	Insulated case circuit breaker	Molded case circuit breakers
	Individual	Group			
RG1	No	Yes	-	-	15–1200 A
RG2	Yes	No	-	300–4000 A	-
	No	Yes	-	-	15–1200 A
RG5	Yes	No	250 – 6000 A	-	-

TABLE 6: CIRCUIT BREAKER 100% RATED APPLICATIONS

Frame	Max. ampacity	Wire insulation temperature rating
FB	-	-
XT1	-	-
XT4	200	75°C
XT5	400	75°C
XT5[1]	600[2]	75°C
XT6	-	-
XT7	800	75°C
XT7	1200	90°C[3]
SS[4]	4000	75°C
SH[4]	4000	75°C
Emax 2[5]	6000	75°C
Emax 3[5]	6000	75°C
BPS	4000	75°C

1 - Individually mounted only
2 - 600 A is only available when using bus mounted lug provisions
3 - May use 75°C insulated cable when using bus mounted lug provisions
4 - 4000 A must be draw-out construction
5 - 6000 A must be draw-out construction
5 - 6000 75˚C

TABLE 8: VOLTAGE CHART

Configuration*	RG1	RG2	RG5
208Y/120 3Ø, 4W AC	✓	✓	✓
240D 3Ø, 3W AC	✓	✓	✓
240Y/120 3Ø, 4W AC B phase high leg	✓	✓	✓
240Y/120 3Ø, 4W AC C phase high leg	✓	✓	✓
480D 3Ø, 3W AC	✓	✓	✓
480Y/277 3Ø, 4W AC	✓	✓	✓
600D 3Ø, 3W AC	✓	✓	✓
600Y/347 3Ø, 4W AC	✓	✓	✓

* Additional voltages may be available. Consult ABB.

TABLE 7: DISTRIBUTION SECTIONS

Switchboard type	Access	Heights	Widths by bus location			Dimensions in. Depths
		Standard	Center	Offset	One-sided	
RG1	Front or front/rear	90	30, 35, 45, 50	40, 45, 50, 55, 60	30, 35, 40, 45	25, 30, 35, 40, 45, 50, 55, 60
RG2	Front or front/rear	90				

SIZING AND DIMENSIONS

Switchboard sizing considerations
The following rules and arrangements must be considered when sizing and dimensioning ReliaGear® SB switchboards.

Switchboard width and depth will depend on the type, size, feed direction, and the combination of devices required. Section width and depth can be increased in 5-inch increments, up to 60 inches, to accommodate unusual arrangements, large number of conduits, or when an existing footprint needs to be matched. For ease of installation, a consistent section depth is recommended for the entire lineup.

The 90-inch switchboard height is standard but in some cases can be reduced down to 66 to 78 inches, if applicable due to space constraints.

Group mounted
The group mounted sections utilize a panelboard mount arrangement like that used in ReliaGear neXT distribution panelboards. Group mounted circuit breakers can be used as feeders or mains for switchboard sections of 1200 A and below.

Group mounted circuit breakers are typically standard rated for up to 80 percent of the rated amperage for a period of three hours. 100 percent rated circuit breakers are available in Tmax XT4, XT5, and XT7 circuit breakers, with some limitations.

In addition to circuit breakers, surge protection devices (SPD), metering and adaptive protection accessories are available for use in group mounted sections.

Sizing
Group mounted circuit breakers are sized by X space requirements where X = 1.385 inches in height. Smaller frame circuit breakers require less X spacing than larger circuit breakers. See Table 9 for information on allowable placement of circuit breakers in various widths of ReliaGear SB switchboards. For standard lug sizes, see tables 9.A and 9.B.

TABLE 9: CIRCUIT BREAKER X SPACING REQUIREMENTS

Circuit breaker name	Number of poles requirements	Maximum circuit breaker amperage	X spacing
Record Plus FB	1	100	1X
Record Plus FB	2	100	2X
Tmax® XT1	3	125	3X standard, also offered in a 2 pack at 5X or 5 pack at 11X Tmax XT2, 3, 125 A, 3X
Tmax XT4	3	250	3X, 4X for Touch, Hi-Touch
Tmax XT5	3	600	4X standard, 5X if it contains a bell alarm, auxiliary contact, shunt trip, undervoltage release; Touch, or Hi-Touch trip units
Tmax XT6	3	800	6X
Tmax XT7	3	1200	6X

TABLE 9.A: LUG SIZES AND QUANTITY

Standard bus mounted lug provisions	
Ampere	**Quantity and size**
Rating	Per Ø and Ñ
800	(3) 250–600 kcmil
1000	(4) 250–600 kcmil
1200	(4) 250–600 kcmil
1600	(6) 250–600 kcmil
2000	(7) 250–600 kcmil
2500	(9) 250–600 kcmil
3000	(10) 250–600 kcmil
4000	(13) 250–600 kcmil
5000	(15) 250–600 kcmil
6000	(18) 250–600 kcmil

Note: Lug sizes do not apply to Class I group mounted MCCB mains. Quantity will vary. Chart based on 500 kcmil AL cable rated at 310 amps per cable.

TABLE 9.B: STANDARD LUG SIZES UNLESS OTHERWISE NOTED

Lugs	Cable range	Cable material	Qty. holes
Aluminum mechanical	#14–1/0	CU/AL	1
	#6–2/0	CU/AL	1
	#6–350 kcmil	CU/AL	1
	1/0–600 kcmil	CU/AL	1
	3/0–800 kcmil	CU/AL	1
	500–1000 kcmil	CU/AL	2
Copper mechanical	#14–2/0	CU	1
	#6–350 kcmil	CU	1
	300–800 kcmil	CU	1
Aluminum compression	#8–1/0	CU/AL	1
	2/0–4/0	CU/AL	1
	#4–300 kcmil	CU/AL	1
	250–350 kcmil	CU/AL	1
	2/0–500 kcmil	CU/AL	1 or 2
	400–600 kcmil	AL	1 or 2
	500–750 kcmil	AL	1 or 2
	750–1000 kcmil	AL	2
Copper compression	#6–1/0	CU	1
	2/0–300 kcmil	CU	1
	250–500 kcmil	CU	1 or 2
	500–750 kcmil	CU	1

The section width will determine the largest amperage circuit breaker that can be placed in a group mounted section. Table 10 shows the available X height panel and associated top and bottom cover dimensions.

Table 11 has the ReliaGear® SB switchboard sections widths and the associated circuit breakers that each width will accommodate. There are three possible bus configurations for ReliaGear SB switchboards: center, offset, and one-sided.

The center configuration has the vertically mounted distribution bus centered in the panel from left to right allowing for the same sized circuit breakers to be placed on each side of the bus.

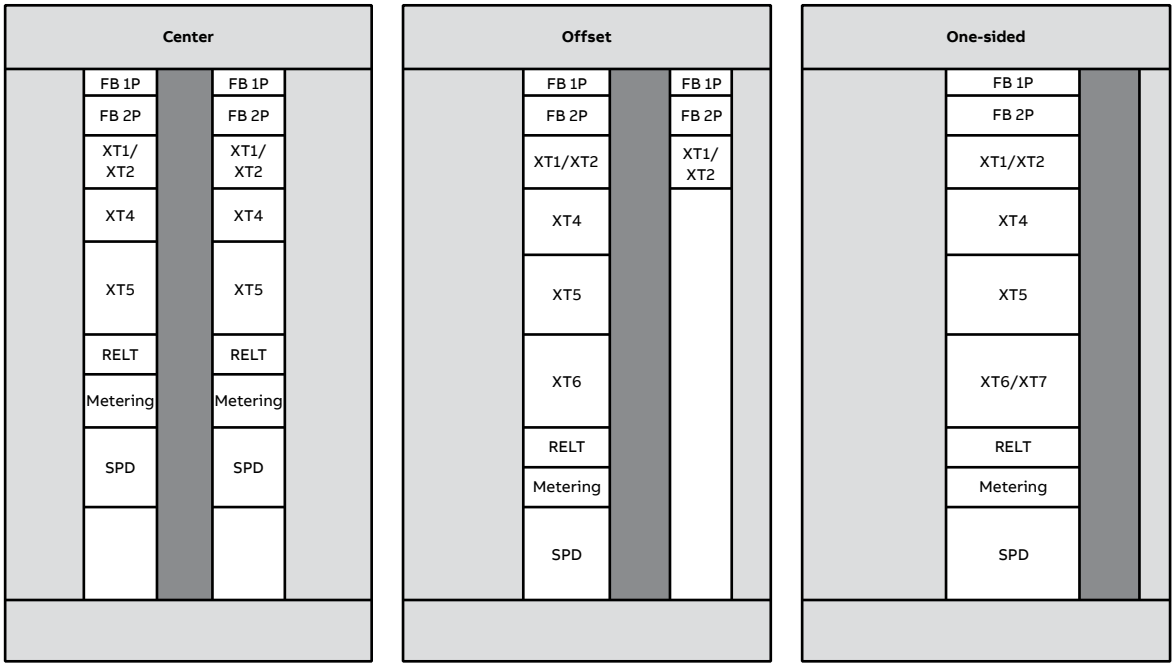
The offset configuration is manufactured with the distribution bus offset slightly to the right of center allowing for larger circuit breakers to be placed to the left of the distribution bus.

For center and offset panelboard configurations with ratings up to 2000 A have a single connection per phase to the switchboard bussing taking up 5X of device mounting space, which is reflected in the empower configurator. Panelboard ratings above 2000 A and up to 4000 A have two connections per phase to the switchboard bussing taking up 10X of device mounting space, which is reflected in the empower configurator.

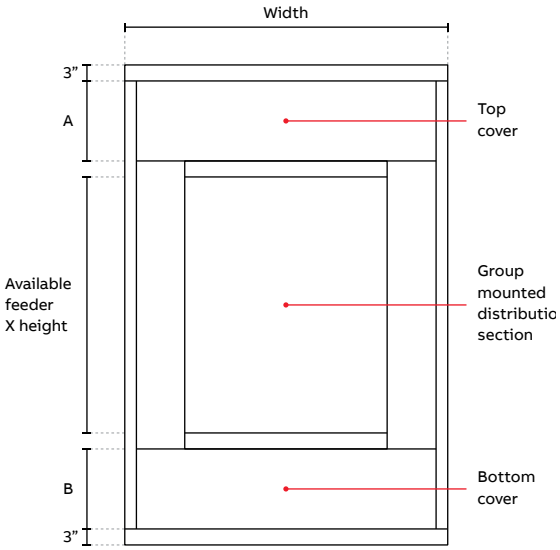
Lastly, the one-sided configuration has the distribution bus on the right side of the switchboard. Devices can only be mounted on the left side of the distribution bus in a one-side configuration, which can greatly reduce the overall width of the switchboard.

For one-sided panelboard configurations with ratings up to 2000 A have a single connection per phase to the switchboard bussing which does not affect device mounting space. Panelboard ratings above 2000 A and up to 4000 A have two connections per phase to the switchboard bussing which does not affect device mounting space.

TIP
Devices shown do not represent all configurations.



01 Center, offset, one-sided distribution bus configurations



02 Group mounted distribution top and bottom cover dimensions

TABLE 10: TOP AND BOTTOM COVER DIMENSIONS

Panel X height	A (in.)	B (in.)
16X	26	26
24X	20	20
32X	14	14
40X	10	10
48X	4	4
56X	0	0

The dimensional values shown in the table are examples based on the center mounted panel configuration, reference project drawings for actual values.

TABLE 11: SECTION WIDTHS AND ASSOCIATED CIRCUIT BREAKERS

Bus stack location	Circuit breaker	Widths available (in.)						
		30	35	40	45	50	55	60
Center	Record Plus FB	←→	←→	←→	←→	←→		
	Tmax® XT1	←→	←→	←→	←→	←→		
	Tmax XT4		←→	←→	←→	←→		
	Tmax XT5				←→[1]	←→[4]		
Offset	Record Plus FB			←→	←→	←→	←→	←→
	Tmax XT1			←→	←→	←→	←→	←→
	Tmax XT4			←→[3]	←	←→	←→	←→
	Tmax XT5			←[4]	←	←	←→[5]	←→[6]
	Tmax XT6				←	←	←	←
	Tmax XT7				←[2]	←	←[2]	←
One-sided (Can only mount on left of one sided bus stack)	Record Plus FB	←	←	←	←			
	Tmax XT1/XT2	←	←	←	←			
	Tmax XT4	←	←	←	←			
	Tmax XT5		←[7]	←	←			
	Tmax XT6			←	←			
	Tmax XT7			←[2]	←			

← Circuit breakers can be added to the left of the bus stack

→ Circuit breakers can be added to the right of the bus stack

[1] Limited to 1-500 kcmil cable or 2-250 kcmil cables

[2] Limited to 4–500kcmil cables

[3] Max 300 kcmil cables on right side

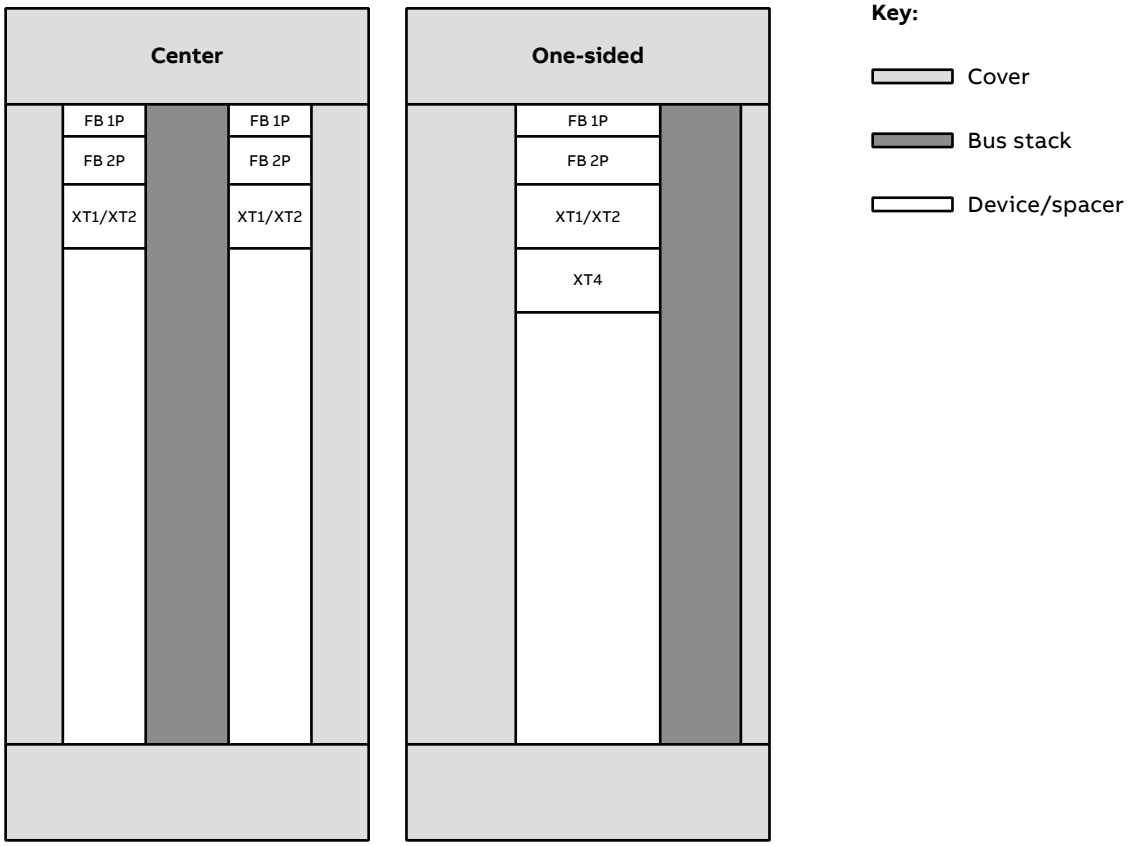
[4] Limited to 2-500 kcmil cables

[5] Limited to 2-500 kcmil cables on right side

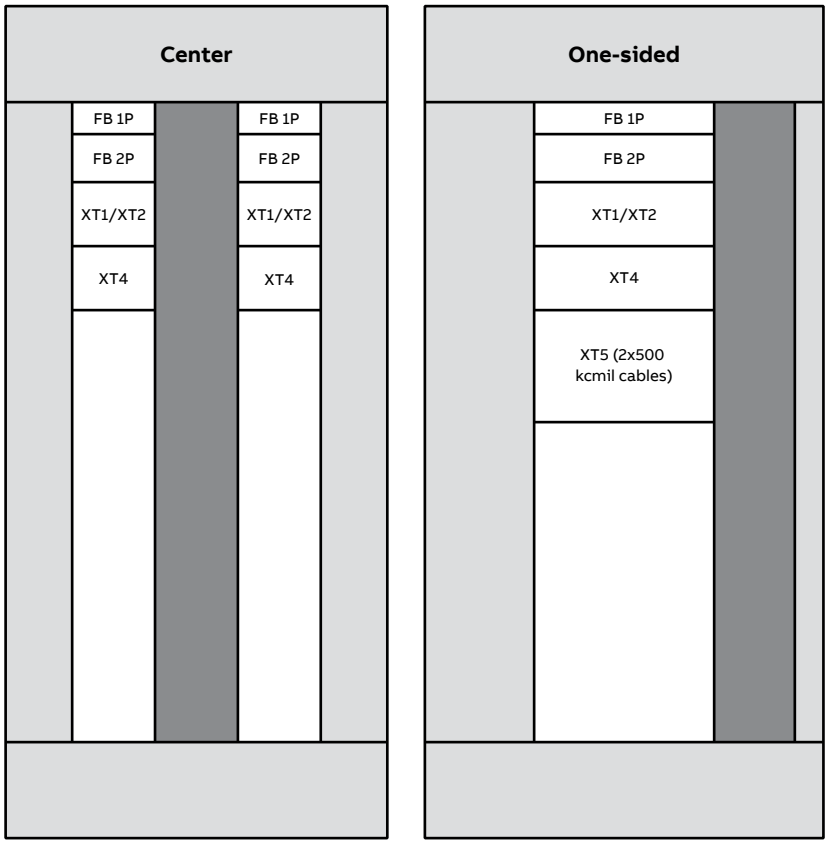
[6] Limited to 2-600 kcmil cables on right side

[7] Limited to 2-500 kcmil cables

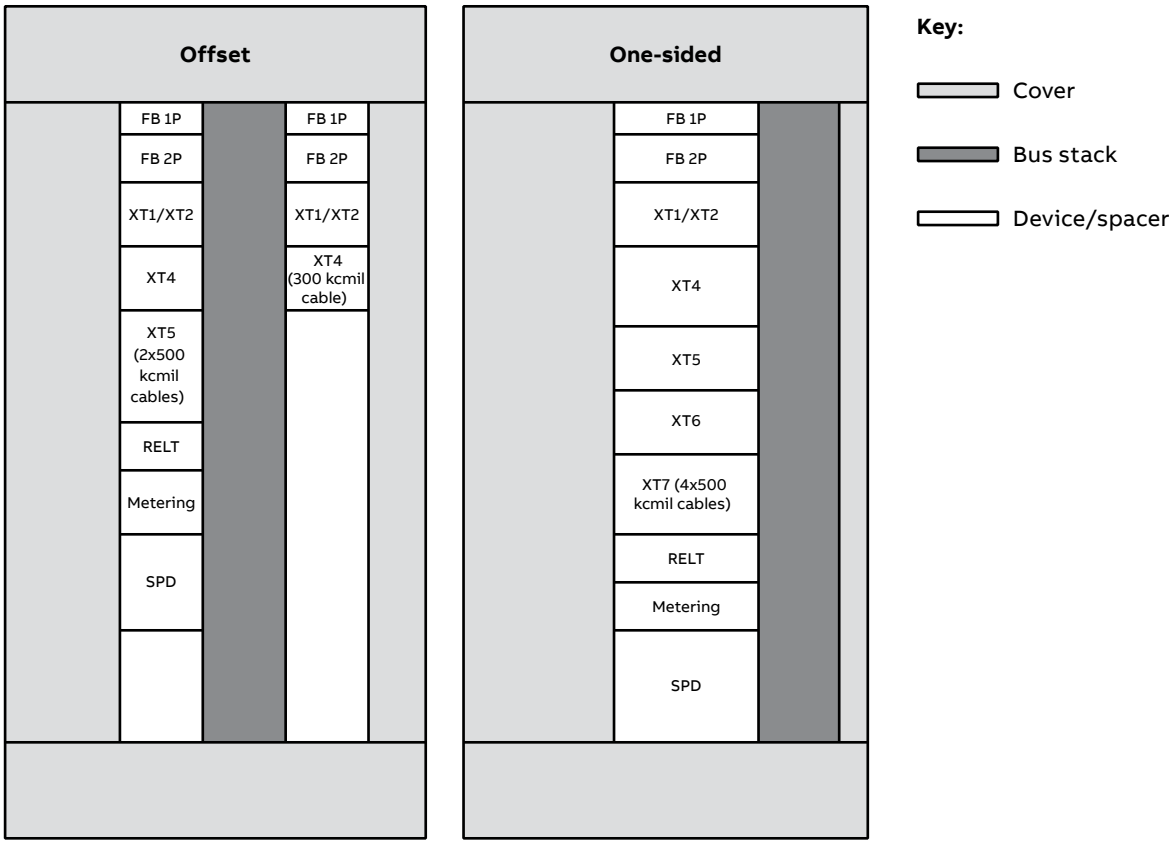
Device fitting per configuration and section width



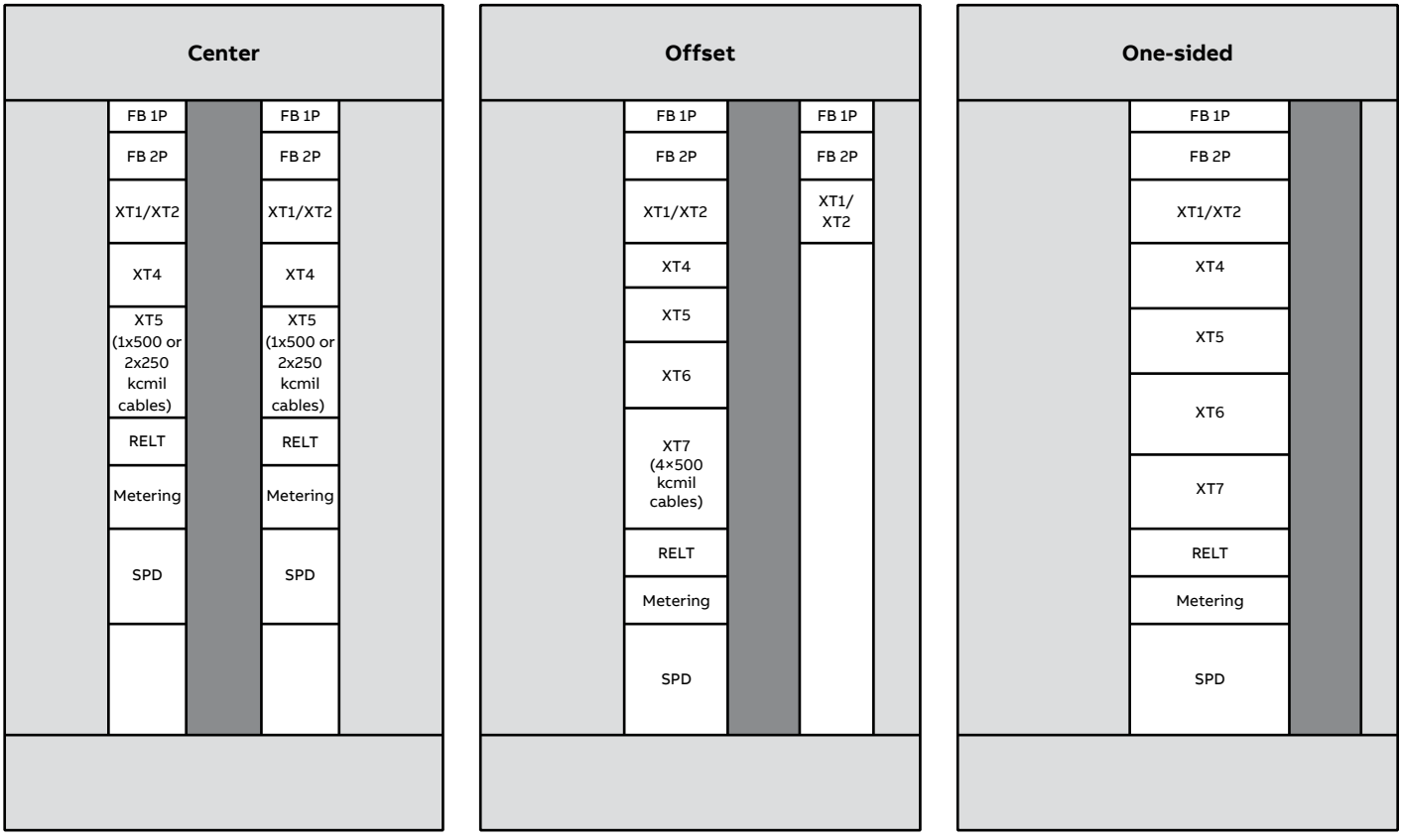
03 Switchboard width and circuit breaker options 30 W



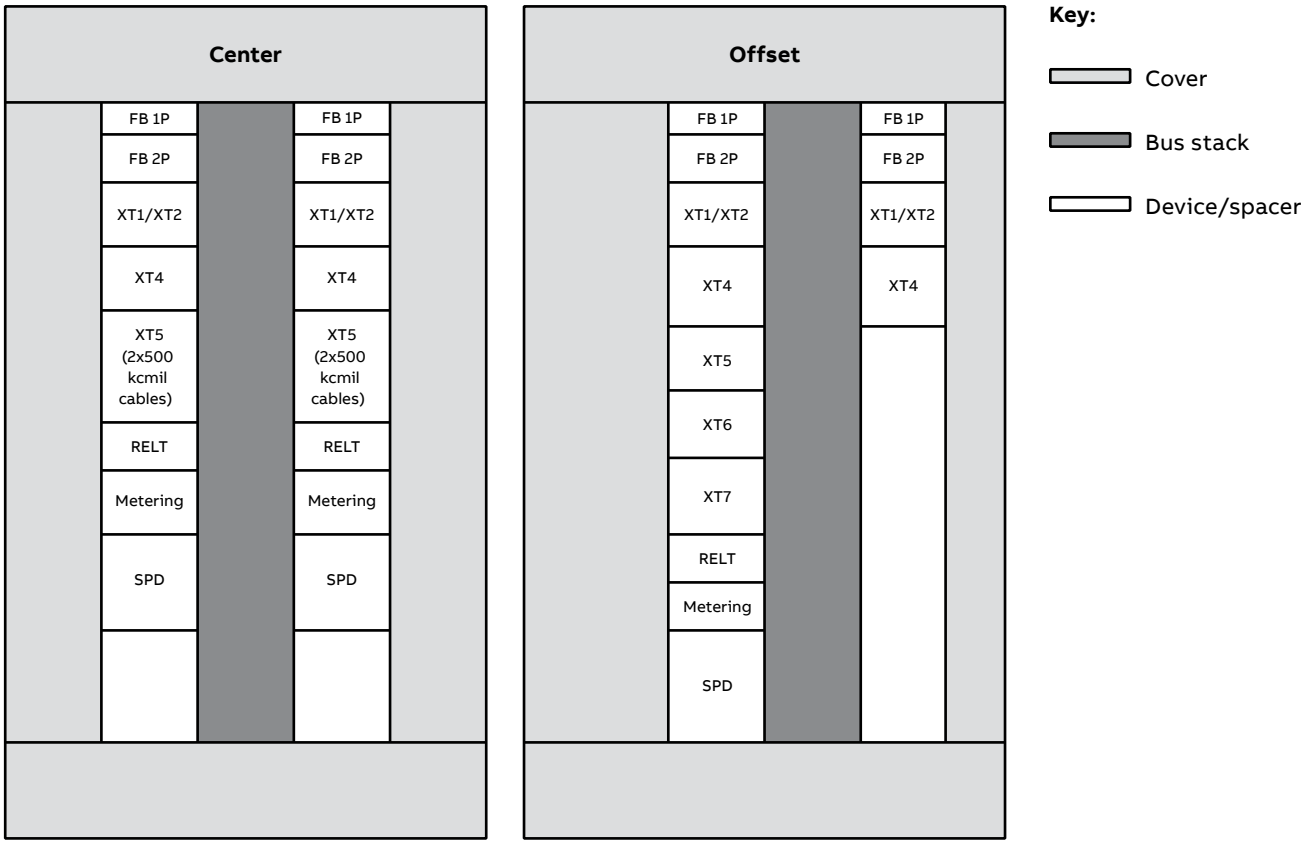
04 Switchboard width and circuit breaker options 35 W



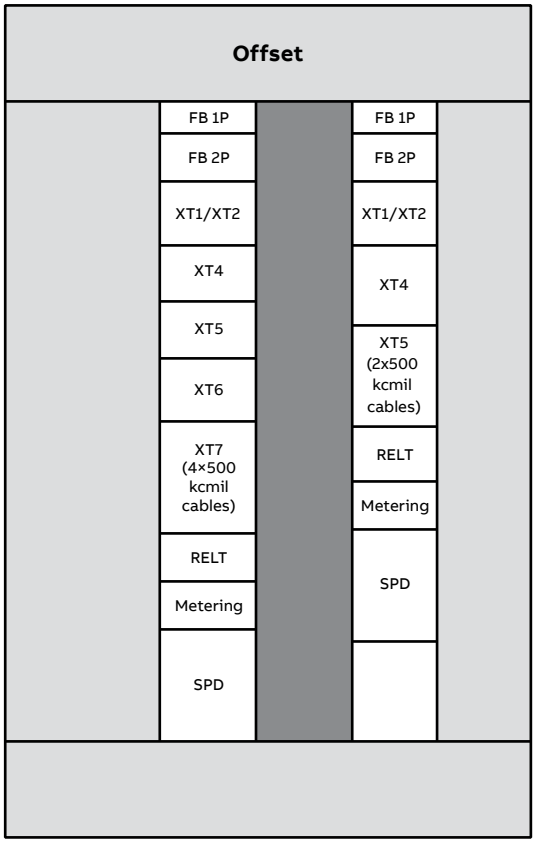
05 Switchboard width and circuit breaker options 40 W



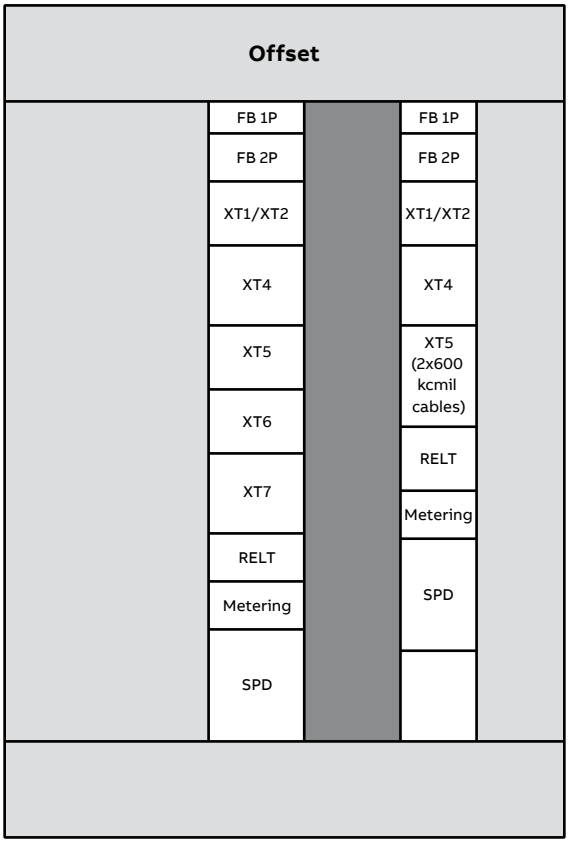
06 Switchboard width and circuit breaker options 45 W



07 Switchboard width and circuit breaker options 50 W



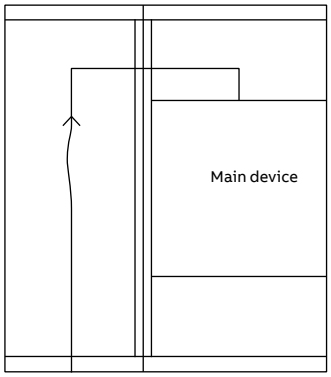
08 Switchboard width and circuit breaker options 55 W



09 Switchboard width and circuit breaker options 60 W

Bussed pull section

A bussed pull section has a cross bus that connects to the adjacent main section bus. This allows for more room when connecting incoming cables to the main device. A bussed pull section is top or bottom entry only. Bussed pull sections be used for bus tap for line and load connections.



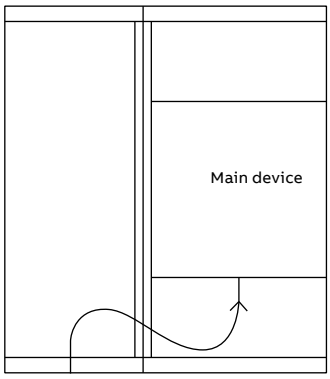
10 Bussed pull section

TABLE 12: BUSSED PULL SECTIONS

	Standard (in.)		Minimum (in.)	
Amperage	**Width**	**Depth**	**Width**	**Depth**
800	35	25	35	25
1000	35	25	35	25
1200	35	25	35	25
1600	35	25	35	30
2000	35	25	35	30
2500	35	25	35	30
3000	35	25	35	35
4000	40	30	40	35
5000	45	50	45	50
6000	45	50	45	50

Blank pull section

Blank pull sections are available in widths and depths from 15 inches to 60 inches in 5 inches increments. Depth will be the same as the main device section. The blank pull section provides space for pulling and installing cables. It is also used in bottom feed applications when reverse feed devices cannot be used. A barrier is provided for service entrance applications to meet NEC requirements. Busing and lugs are not provided.



11 Blank pull section

TABLE 13: BLANK PULL SECTIONS

Amperage	Width	Depth
800–1200	15	Depth is driven by the dimensions of the main device section
1600–2000	20	
2500	25	
3000	30	
4000	35	

EUSERC pull sections

Pull sections for EUSERC utility requirements are available in widths from 30 inches to 50 inches. The minimum widths for each amperage are shown in Table 14. The standard landing uses two ½ inches steel studs on 1¼ inches vertical centers per 400A of rating.

Multiple positions are separated by 2 inches. These sections are designed for bottom entry. A barrier is provided for service entrance to meet NEC requirements. Busing for landings is included.

TABLE 14: EUSERC PULL SECTION SIZING

Amperes	Landing positions	Minimum width (in.)	Minimum depth (in.)
400	1	30	25
800	2	30	25
1200	3	35	25
1600	4	40	25
2000	5	40	25
2500	7	50[1]	35
3000	8	50[1]	40
4000	10	50[1]	40
5000	13	50[1]	50
6000	15	50[1]	50

[1] Refer to local utility specification



12 Typical ReliaGear® SB switchboard lineup with main disconnect and distribution section

RG1: Switchboard - group mounted
Main lug

TABLE 15: STANDARD MAIN LUG TERMINATION

Ampere rating	Quantity and size per Ø and N	Panel "X"	Minimum width (W")[2]
400 & 600	(2) 1/0–600 kcmil	16–56X[1]	35
800 & 1000	(3) 1/0–600 kcmil	16–56X[1]	35
1200	(4) 1/0–600 kcmil	16–56X[1]	35
1600	(5) 1/0–600 kcmil	16–56X[1]	35
2000	(6) 1/0–600 kcmil	16–56X[1]	35

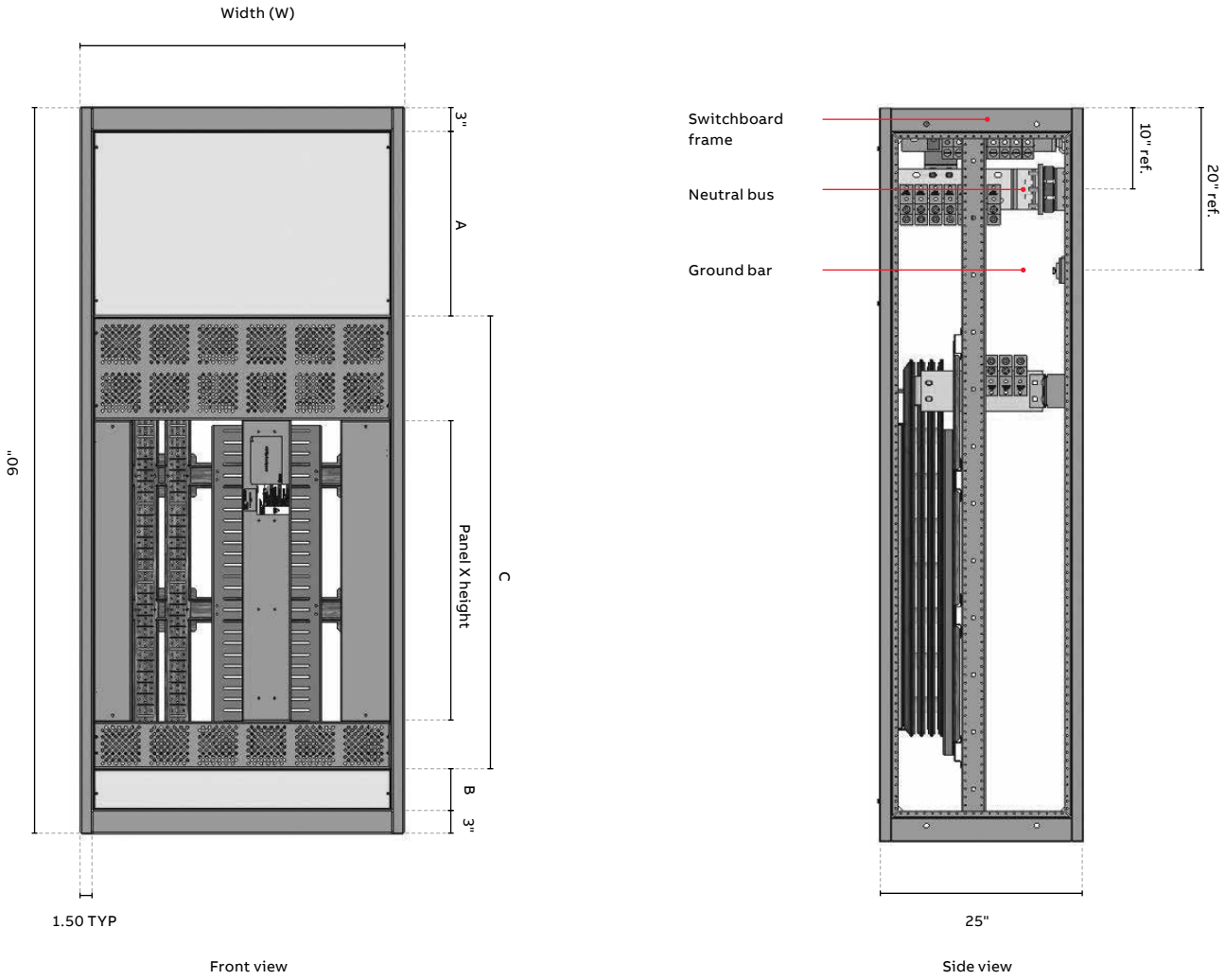
1 Bus stacks provided in 8X increments; rear access required for 48-56X.

[2] Minimum section width shown. Wider Section may be required. Refer to branch sizing tables.

TABLE 16: MAIN LUG UPPER AND LOWER COVER HEIGHTS (INCHES) (SEE FIGURE 13)

Panel rating	Panel X height (X=1.385")	A	B	C
400–4000 A	16X	21	28	35
	24X	21	14	49
	32X	21	7	56
	40X	21	0	63
	48X			
	56X			

Note: For bottom feed, reverse A & B dimensions.



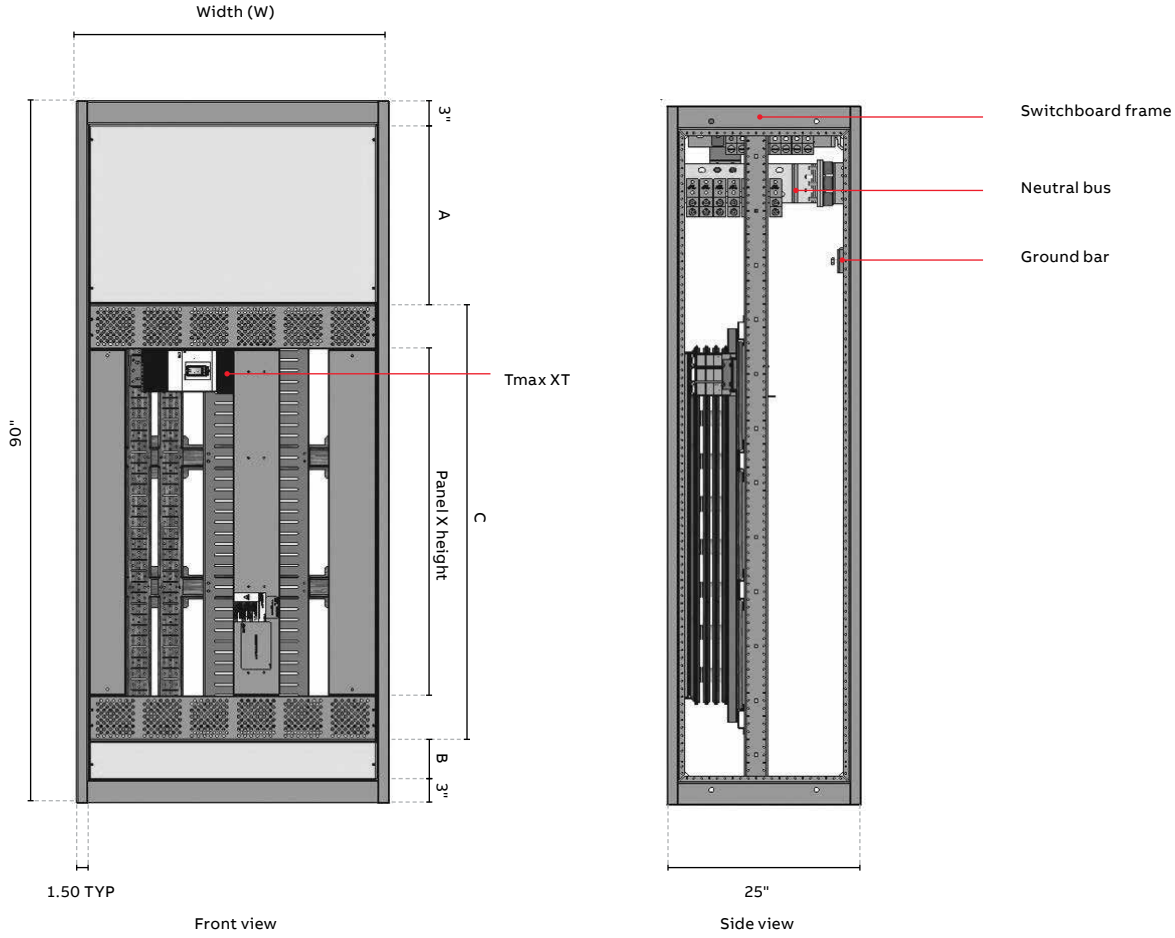
13 Main lug section dimensions

Main device

TABLE 17: MAIN CIRCUIT BREAKER UPPER AND LOWER COVER HEIGHTS (INCHES) (SEE FIGURE 14)

Type	Device	Amp range	Main "X" height	Minimum width (W")	Panel "X" height	Top main			Bottom main		
						A	B	C	A	B	C
Circuit breakers	Tmax® XT5	400–600	4	35	16–56X[1]	14	21	49	14	21	49
	Tmax XT7	600–1200	6	40	16–56X[1]	14	14	56	23	21	56

[1] Bus stacks provided in 8X increments; rear access required for 48-56X.



14 Main device section dimensions

Distribution section

Distribution section front view same as main lug section. Distribution section side view same as main lug section side view except omit lugs.

TABLE 18: GROUP MOUNTED DISTRIBUTION SECTION UPPER AND LOWER COVER HEIGHTS (INCHES) (SEE FIGURE 14)

Panel "X" height	A	B	C
16X	21	28	35
24X	14	21	49
32X	14	14	56
40X	7	14	63
48X[1]	7	0	77
56X[1]	0	0	84

[1] Rear access required.

6'7" Handle rule

The National Electrical Code (Article 240.24) requires that circuit breakers shall be installed with the center of the operating handle no higher than 6'7" above the floor or working platform above the floor or working platform, whichever is higher. Housekeeping pads that elevate the switchboard above the standing surface may violate this rule. If housekeeping pads are specified, the pad may have to be extended for the full working space to comply.

Device mounting restrictions due to 6'7" handle rule

There are two methods to determine if a device can be installed in the desired location in the distribution section and meet the 6'7" handle rule.

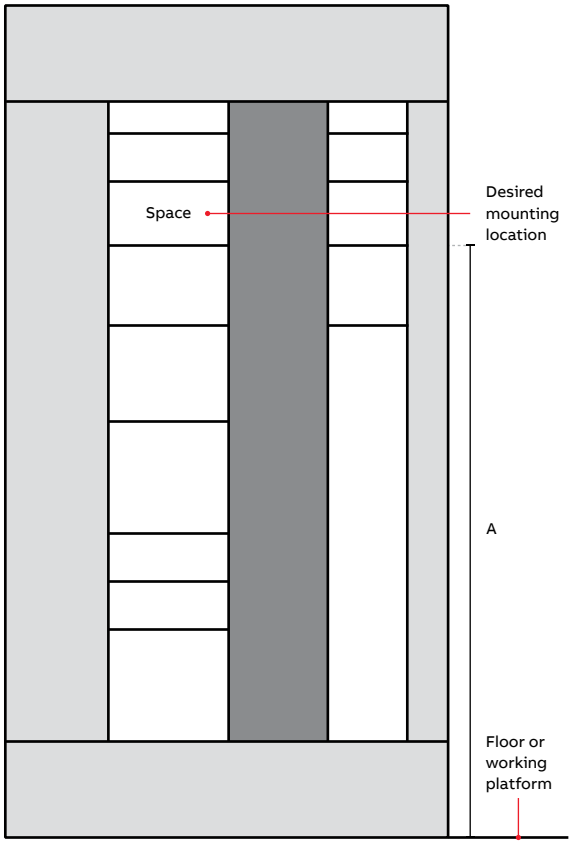
Method 1 – Measuring mounting location on physical section

Measure the distance from the floor, or working platform if there is one different than the floor height, to the bottom of the desired mounting location (dimension A). The installation will meet the 6'7" handle rule if the measured dimension does not exceed the value shown in table below.

TABLE 19: MAXIMUM CIRCUIT BREAKER MOUNTING HEIGHT IN GROUP MOUNTED SWITCHBOARDS TO COMPLY WITH 6'7" RULE

Device type	Dimension A (in.)
FB 1 Pole	78 ⅛
FB 2 Pole (Mounted on left side)	77
FB 2 Pole (Mounted on right side)	78 ¼
XT1	77 ⅛
XT2/XT4	76 ½
XT5	76 ¼
XT6/XT7	74 ⅞

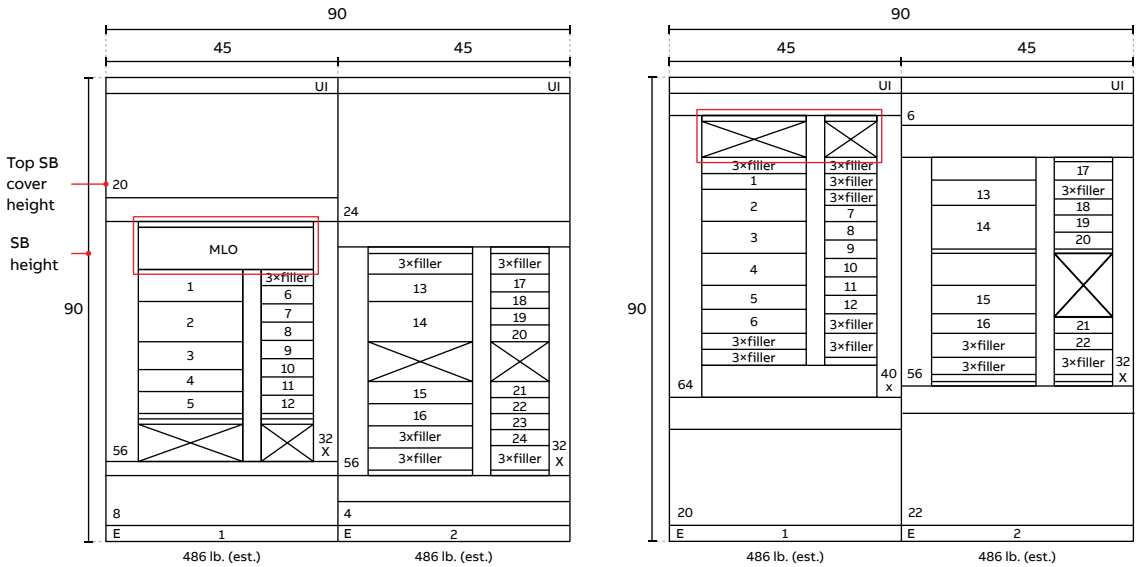
Note: Dimensions in this table are measured to the bottom of mounting position.



15 6'7" Handle rule

Method 2 – Configurator drawings

The equation on the following page needs to be utilized to determine if a device will meet the 6'7" handle rule. The dimensions used in the equation are available from the configurator drawing.



SB Height = Switchboard height from configurator drawing
Top SB Cover Height = Cover height above panel from configurator drawing (if applicable)
Device Height Factor = Value from Device Height Factor tables below:
Utilize the Top Connected Panel table if there is MLO or X mark in the top of the panel area as shown in the configurator drawing
Utilize the Center or Bottom Connected Panel table if there is no MLO or X mark in the top of the panel area as shown in the configurator drawing
"X" Height = Value from the "X" height table based on number of "X" spaces above the desired device mounting location (if applicable)
Pad Height = Height of pad that elevates the switchboard above standing surface (if applicable)

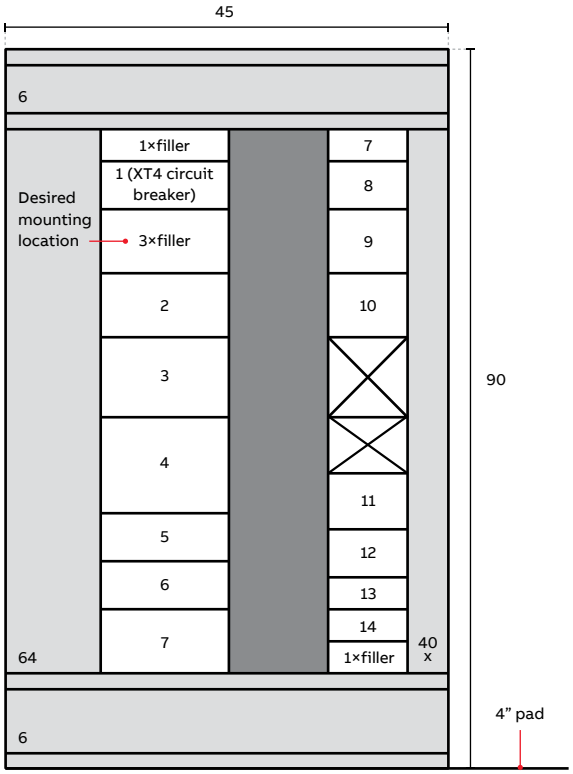
16 SB Height – Top SB Cover Height – Device Height Factor – "X" Height + Pad Height ≤ 79 in.

TABLE 20: DEVICE HEIGHT FACTOR (IN.) - CENTER OR BOTTOM CONNECTED PANEL

						Panel "X" height
Device type	**16X**	**24X**	**32X**	**40X**	**48X**	**56X**
FB 1 pole	8.76	8.22	8.68	8.14	8.60	7.06
FB 2 pole (Mounted on left side)	9.98	9.44	9.90	9.36	9.82	8.28
FB 2 pole (Mounted on right side)	8.60	8.06	8.52	7.98	8.44	6.90
XT1	9.77	9.23	9.69	9.15	9.61	8.07
XT2/XT4	10.33	9.79	10.25	9.71	10.17	8.63
XT5	10.69	10.15	10.61	10.07	10.53	8.99
XT6/XT7	12.05	11.51	11.97	11.43	11.89	10.35

TABLE 21: DEVICE HEIGHT FACTOR (IN) - TOP CONNECTED PANEL

						Panel "X" height
Device type	**16X**	**24X**	**32X**	**40X**	**48X**	**56X**
FB 1 pole	16.69	15.15	16.61	15.07	16.53	12.99
FB 2 pole (Mounted on left side)	17.91	16.37	17.83	16.29	17.75	14.21
FB 2 pole (Mounted on right side)	16.53	14.99	16.45	14.91	16.37	12.83
XT1	17.70	16.16	17.62	16.08	17.54	14.00
XT2/XT4	18.26	16.72	18.18	16.64	18.10	14.56
XT5	18.62	17.08	18.54	17.00	18.46	14.92
XT6/XT7	19.98	18.44	19.90	18.36	19.82	16.28



17 Device height factor

TABLE 22: "X" HEIGHT

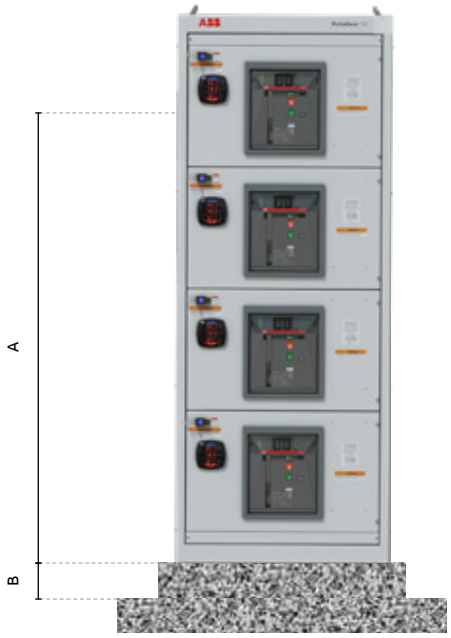
Number of "X" spaces	Height
1	1.39
2	2.77
3	4.16
4	5.54
5	6.93
6	8.31
7	9.70
8	11.08
9	12.47
10	13.85

Example

Consider the configurator drawing shown in the left and the shown 3X desired mounting location where an Tmax® XT4 circuit breaker will be evaluated for meeting the 6'7" handle rule.

SB height		**Top SB cover height**		**Device height factor**		**"X" height**		**Pad height**	**≤ 79 in.**
90"	–	6"	–	9.71"	–	5.54"	+	4"	= 72.79 ≤ 79 in.
From configurator drawing				From device height factor table for center or bottom connected panel		From "X" height table considering the Tmax XT4 circuit breaker (3X) and 1X filler mounted above the desired mounting location		Customer specification	

17 Device height factor



18 Pad height allowance

6'7" rule for individually mounted circuit breakers

TABLE 23: MAXIMUM PAD HEIGHT ALLOWED

Device type	Dimension A[1] (in.)	Dimension B (in.)
Tmax® XT7	72	7
Emax E1.3/E1.2 fixed	73.5	5.5
Emax E1.3/E1.2 withdrawable	74	5
Emax E2.3/E2.2 fixed	75	4
Tmax XT5	77.5	1.5
Emax E2.3/E2.2 withdrawable	78	1

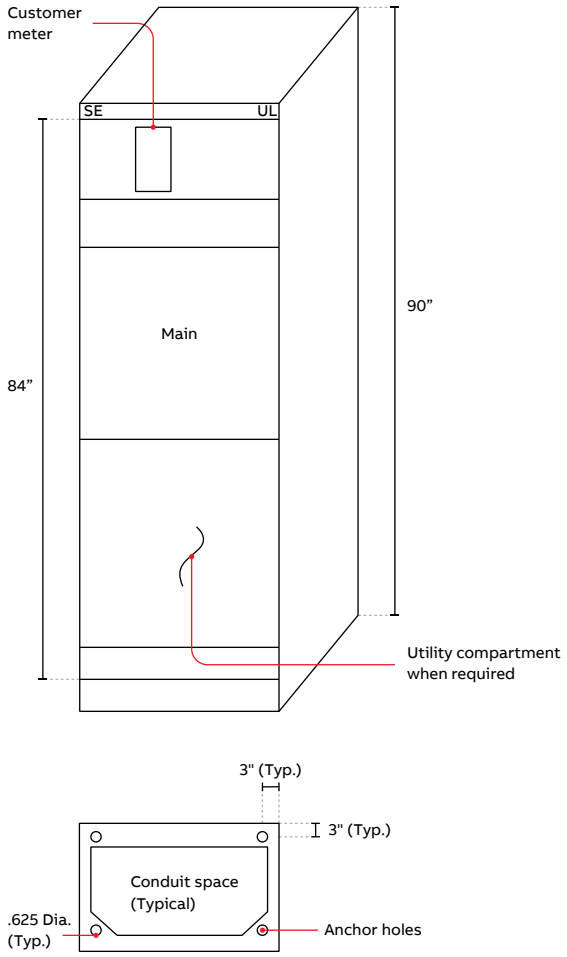
Dimension A represents the height from the bottom of the switchboard to the center-line of the circuit breaker toggle handle or on/off button

Dimension B represents the maximum height of a pad without a working platform

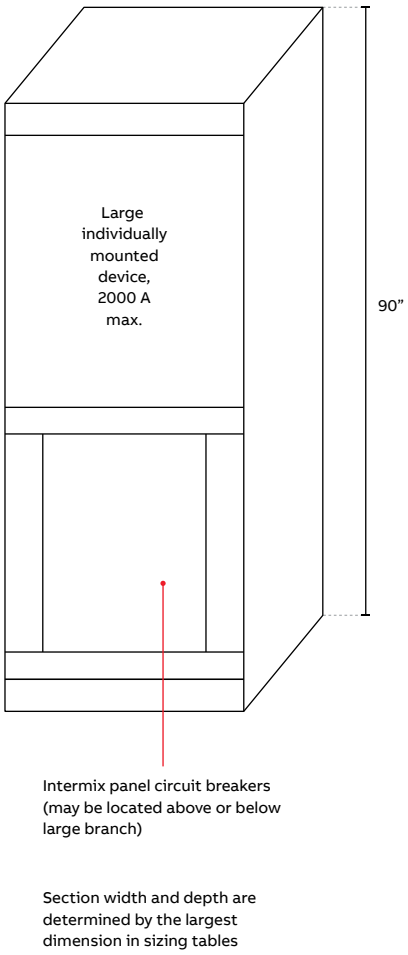
[1] Circuit breaker is in the highest position when there is no cover above the circuit breaker



RG2 switchboard – Individually mounted main with group mounted feeders/RG5 Individually mounted main and/or feeders



19 Main section arrangement



20 Intermix design – side or rear access required. Cable exit must be same as end panel.

TIP
Refer to project-specific factory drawings for dimensions.

TABLE 24: MAIN DEVICE DIMENSIONS - INDIVIDUALLY MOUNTED (IN)

					Fixed			Withdrawable
Type	**Designation**	**Frame rating**	**Min. unit height**	**Min. section width**	**Min. section depth**	**Min. unit height**	**Min. section width**	**Min. section depth****
High pressure contact switches	HPCII	800	20	30	25	20	30	40
		1600	20	30	30	20	30	40
		2000	20	30	30	20	30	40
		2500	40	40	35	32	30	40
		3000	40	40	35	32	40	40
		4000	40	40	40	40	40	45
Bolted pressure switches	QA or CBC	800	28	25	30	-	-	-
		1200	32	32	30	-	-	-
		1600	32	32	30	-	-	-
		2000	32	32	30	-	-	-
		2500	36	36	35	-	-	-
		3000	48	48	35	-	-	-
		4000	48	48	35	-	-	-
Molded case circuit breaker	Tmax XT5	400–600	20	30	25	-	-	-
	Tmax XT7	600–1200	28	30	25	-	-	-
Insulated case circuit breaker	Power Break II	800	20	30	30	20	30	40
		1600	20	30	35	20	30	40
		2000	20	30	35	20	30	40
		2500	40	40	35	32	35	40
		3000	40	40	35	32	40	40
		4000	40	40	40	40	40	45
Power circuit breaker	Emax E1.3/E1.2	250	20	30	30	20	30	30
		400	20	30	30	20	30	30
		800	20	30	30	20	30	30
		1200	20	30	30	20	30	30
	Emax E2.3/E2.2	250	24	30	35	20	30	35
		400	24	30	35	20	30	35
		800	24	30	35	20	30	35
		1200	24	30	35	20	30	35
		1600	24	30	35	20	30	35
		2000	24	30	35	20	30	35
	Emax E4.3/E4.2	800	24	35	40	24	35	40
		1600	24	35	40	24	35	40
		2000	24	35	40	24	35	40
		2500	24	35	40	24	35	40
		3000	24	35	40	24	35	40
	Emax E6.3/E6.2	4000	24	40	40	24	40	40
		5000	24	40	45	24	40	45
		6000	33	50	50	33	50	50

*Circuit breaker amperages are assumed to be 80% of frame ratings. Exceptions are shown in Table 55.

** Add 5" to depth when busway entrance is required.

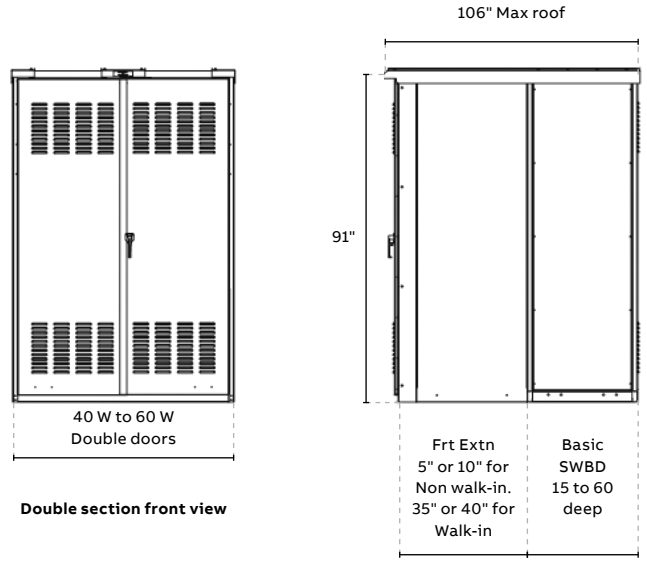
Outdoor enclosures

NEMA 3R outdoor enclosures consist of standard indoor cubicles and components enclosed with a front frame and roof assembly to provide a weather resistant structure. Any number of sections may be bolted together. However, all sections must be of the same depth. Standard outdoor construction consists of:

- Flat roof standard; front or rear sloping roof optional
- Section height of 91 inches
- Front and rear venting
- Galvanized end caps, front/rear louvered doors and rear covers
- Standard screen behind louvers
- Single door 15–35 inches wide
- Double door 40–60 inches wide
- Wind stop on each door
- 3-point catch provisions for padlocks
- Front extensions: non-walk-in 5 inches and 10 inches, walk-in 35 inches and 40 inches widths
- 110 mph wind rating

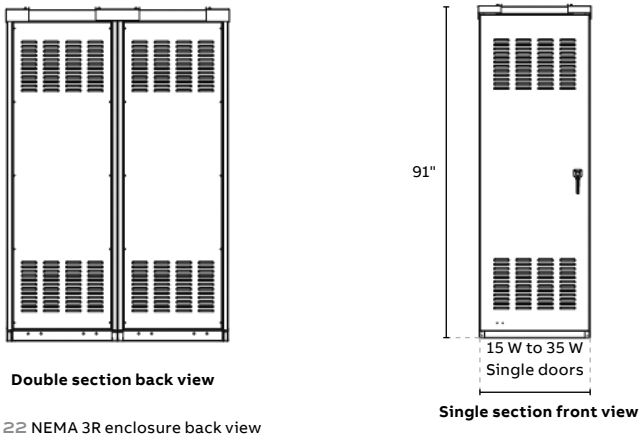
Options available:

- Gasketing
- LED 120 V AC, 15 A and grounded convenience outlet
- Rodent guards
- Rear doors the same as front with wind stops
- Lifting brackets
- Inside, movable, 4-way hoist and trolley (walk-in only)
- Busway entrance
- 130 mph wind rating
- Filters
- Space heaters available with thermostat and humidistat controls
- Floor sills at 1.5 inches high



Double section front view **Double section side view**

21 NEMA 3R enclosure front view



Double section back view **Single section front view**

22 NEMA 3R enclosure back view

Instrument and metering arrangements

Instruments and metering for main and feeder devices can be provided in top compartments of switchboards. Minimum height and width dimensions for different types of switchboards can be found in table 25. The minimum height should be increased in indicated increments as necessary to accommodate required instruments and/or meters. A hinged door is standard on all metered doors.

The available meters are detailed on pages 55–58. Although the meters and current transformers have specific individual accuracy claims, the overall system accuracy may vary.

TABLE 25: INSTRUMENT OR METERING DIMENSIONS (IN.)

Device type	Minimum door height
Analog ammeter	8
Analog voltmeter	8
Ammeter switch	8
Voltmeter switch	8
Pilot light	8
Push button	8
RGM 2200	8
RGM 6000	8
RGM 6010	8
RGM 7000	8
RGM 8000	8
RGM 9700	12
RGM 9900	12

Busway entrance

The ReliaGear® SB busway switchboard stub may connect to the switchboard top main bus or the line or load terminals of a device in the switchboard section into which it enters. All dimensions shown are to centerline of the busway. The above is based on individually-mounted devices in switchboards. For a main lug connection to group mounted switchboards, refer to the factory. When two busway runs enter the same switchboard section, refer to the factory.

Switchboard stubs

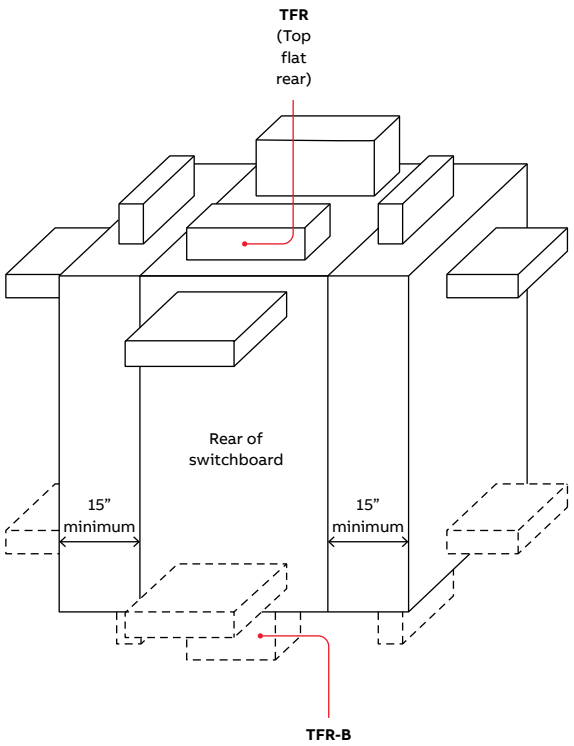
Both top and bottom entrance is available, however, Top Flat Rear (TFR) is the recommended standard entrance position. Dimensions for bottom entrance are the same as top entrance. For other entrance options, please contact the factory. Please see publication 1VAL098202-HT for ReliaGear busway switchboard stub connection instructions.

Low voltage transition sections

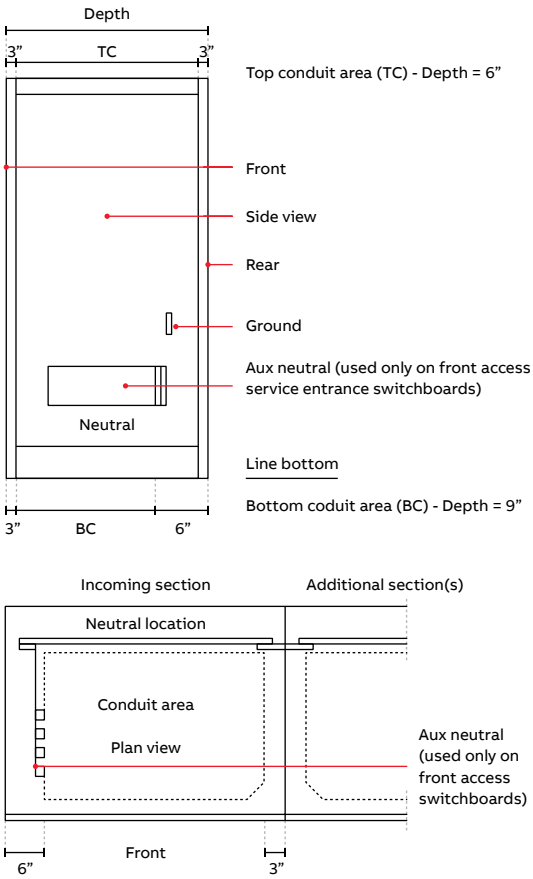
Transition sections are required for connections of ReliaGear SB switchboards to all liquid-filled transformers and motor control centers. Transformer and transition sections are always aligned on the center depth of both sections. Transition depth is determined by device and circuitry of the service entrance section. Transformer depth can be deeper, the same, or shallower than the transition section depth. Note that the minimum allowable switchboard depth is 35 inches for a connection to a transformer. For 1500 and 2000 kVA, 95BiL transformers, a 100 inches high transition section is required; the switchboard remains 90 inches high. Transition sections are 15 inches wide. Consult the factory for non-standard applications.

Conduit entrance space

For conduit entrance space refer to the factory drawings for exact dimensions.



23 Busway entrance locations



24 Typical conduit area

Switchboard weights

Estimated switchboard weights

Due to the variety of sections, devices and circuitry, it is not feasible to give total weights for specific combinations. However, an estimate may be made by selecting section enclosure, bussing and device weights. The resulting total weights are in a ±20 percent range and should be used for estimating purposes only. The following tables and sections may be used to estimate the switchboard weight.

Switchboard enclosure

Use the following tables to determine the weigh of the steel only for each switchboard section, based on the width and depth and whether indoor or outdoor.

TABLE 26: NEMA 1 INDOOR SWITCHBOARD ENCLOSURE WEIGHT (LB.) (WITH SHIPPING SKID AND COVERS ON ALL SIDES)

	Section widths (in.)									
Depth	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
25	270	303	336	369	402	435	470	503	536	569
30	303	336	369	402	435	470	503	536	569	602
35	336	369	402	435	470	503	536	569	602	635
40	369	402	435	470	503	536	569	602	635	668
45	402	435	470	503	536	569	602	635	668	701
50	435	470	503	536	569	602	635	668	701	734
55	470	503	536	569	602	635	668	701	734	767
60	503	536	569	602	635	668	701	734	767	800

TABLE 27: NEMA 3R OUTDOOR (NON-WALK-IN) SWITCHBOARD ENCLOSURE WEIGHT (LB.) WITH SHIPPING SKID AND COVERS ON ALL SIDES)

	Section widths (in.)									
Depth	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
25	488	549	610	671	732	793	854	915	976	1037
30	549	610	671	732	793	854	915	976	1037	1098
35	610	671	732	793	854	915	976	1037	1098	1159
40	671	732	793	854	915	976	1037	1098	1159	1220
45	732	793	854	915	976	1037	1098	1159	1220	1281
50	793	854	915	976	1037	1098	1159	1220	1281	1342
55	854	915	976	1037	1098	1159	1220	1281	1342	1403
60	915	976	1037	1098	1159	1220	1281	1342	1403	1464

Switchboard internal bus weights

The following table is used to determine the weight of the horizontal (through) bus within the switchboard section. The bus material, bus ampacity, and section width determine the weight in pounds for the through bus in each section.

TABLE 28: THROUGH BUS WEIGHTS (LB.) (3P4W)

		Section widths (in.)									
Material	**Ampacity**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
Aluminum	800	10	13	16	19	22	25	28	31	34	37
	1200	13	17	21	25	29	33	37	41	45	49
	1600	15	20	25	30	35	40	45	50	55	60
	2000	18	23	28	33	38	43	48	43	58	63
	2500	21	28	35	42	49	56	63	70	77	84
	3000	25	33	41	49	57	65	73	81	89	97
	4000	31	41	51	61	71	81	91	101	111	121
Copper	800	18	23	28	33	38	43	48	53	58	63
	1200	25	33	41	49	57	65	73	81	89	97
	1600	31	41	51	61	71	81	91	101	111	121
	2000	37	50	63	76	89	102	115	128	141	154
	2500	45	61	78	91	109	125	141	157	173	189
	3000	54	73	92	111	130	149	168	187	206	225
	4000	70	96	122	148	174	200	226	252	278	304
	5000	102	142	182	222	262	302	342	382	422	462
	6000	134	188	242	296	350	404	458	512	566	620

Use the following table to determine the weight of the vertical bussing for group mounted sections.

TABLE 29: INTERIOR WEIGHTS (LB.) (BASED ON 2000 A VERTICAL BUS)

Mounting space (X=1.385")	**2000 A panelboard ampere rating**	**4000 A panelboard ampere rating**
	Weight	**Weight**
16	108	—
24	150	—
32	191	194
40	230	234
48	270	275
56	300	315

Use the following tables to determine the weight of the bus used to connect individually mounted devices to the horizontal bus and the weight of utility compartments.

TABLE 30: BUSSING TO INDIVIDUALLY MOUNTED DEVICES

Device amperage	**Weight (lb.)**	
	Cu	**Al**
600	48	28
800	48	28
1200	73	37
1600	91	45
2000	115	48
2500	141	63
3000	168	73
4000	226	91
5000	285	N/A

TABLE 31: UTILITY COMPARTMENT WEIGHTS (LB.)

Device amperage	Weight (lb.) Cu	Al
1000	80	70
2000	100	80
3000	120	90
4000	150	100

Does not include section weight.

Use the following table to determine the weight of the bussing necessary to connect a device within a switchboard to an external ReliaGear® busway. The weights below do not include the weight of the switchboard stub which is furnished with the busway.

TABLE 32: BUS STUB WEIGHTS

Busway (40" section)	Bus riser Amperage (A)	Weight (lb.) Cu	Al
TFR, TFR-B	800	126	74
	1200	194	98
	1600	242	120
	2000	308	126
	2500	378	168
	3000	450	194
	4000	608	242
	5000	768	—

Switchboard overcurrent device weights

The weight of each individual circuit breaker or fused switch must be added to determine the overall weight of the switchboard.

TABLE 33: SWITCHBOARD OVERCURRENT DEVICE WEIGHTS

Device	Type	Approx (lb.)
Molded case circuit breakers	FB 1-Pole	3
	FB 2-Pole	5
	XT1/XT2	4
	XT4	7
	XT5	15
	XT6	30
	XT7	43

TABLE 34: SWITCHBOARD OVERCURRENT DEVICE WEIGHTS (CONTINUED)

Device	Type	Approx (lb.)
Group mounted fusible switches ADS (does not include fuses)	30–30	15
	60–60	15
	100–100	25
	200–200	65
	100	25
	200	50
	400	50
	600	50
	800	75
	1200	75
Power Break® II stationary	800 A Manual	71
	800 A Electric	80
	1600 A Manual	79
	1600 A Electric	88
	2000 A Manual	79
	2000 A Electric	88
	2500 A Manual	178
	2500 A Electric	187
	3000 A Manual	179
	3000 A Electric	188
	4000 A Manual	320
	4000 A Electric	329
Power Break II Draw-out (includes substructure)	800 A Manual	140
	800 A Electric	155
	1600 A Manual	205
	1600 A Electric	220
	2000 A Manual	233
	2000 A Electric	247
	2500 A Manual	336
	2500 A Electric	376
	3000 A Manual	342
	3000 A Electric	382
	4000 A Manual	464
	4000 A Electric	504

TABLE 35: SWITCHBOARD OVERCURRENT DEVICE WEIGHTS (CONTINUED)

Device			Type	Approx (lb.)
Emax fixed circuit breaker	E1.3/E1.2	250–1200 A	3 pole	31
			4 pole	35
	E2.3/E2.2	250–2000 A	3 pole	115
			4 pole	148
	E4.3/E4.2	800–3000 A	3 pole	201
			4 pole	256
	E6.3/E6.2	4000–5000 A	3 pole	314
			4 pole	406
Emax withdrawable circuit breaker (includes substructure)	E1.3/E1.2	250–1200 A	3 pole	91
			4 pole	103
	E2.3/E2.2	250–2000 A	3 pole	135
			4 pole	239
	E4.3/E4.2	800–3000 A	3 pole	300
			4 pole	377
	E6.3/E6.2	4000–5000 A	3 pole	486
			4 pole	620
	E6.3/E6.2	6000 A	3 pole	818
HPC switches (does not include fuses)			800 A	100
			1600 A	160
			2000 A	190
			2500 A	240
			3000 A	400
			4000 A	450
Bolted pressure switches (does not include fuses)			800 A	140
			1200 A	230
			2000 A	250
			2500 A	330
			3000 A	500
			4000 A	550

Switchboard component weights

Use the following table to determine the weight of any additional components which may be within the switchboard. This weight is added to the total for the switchboard sections.

TABLE 36: SWITCHBOARD COMPONENT WEIGHTS

Type	Weight (lb.)	Type	Weight (lb.)
Ammeter-voltmeter	15	SPD	25
Metering CT Incoming	8–18	PQM II Meter	5
Metering CT ind ckt	2	RGM 2200 Meter	2
Metering VT	10	RGM 4500Q Meter	4
CPT 150 VA	6	RGM 6000 Meter	2
CPT 300 VA	7	RGM 9700 Meter	5
CPT 500VA	13	Modbus Monitor	20
Meter Switch	5	Automatic Throw-over	50
Test Block	5	Kirk Lock	2
ITI GF Relay	1.5	3P Fuse Block w/fuses	3

Special sections

For blank or auxiliary sections, use the enclosure weights for the width and depth of the section required. For bussed pull sections, use the enclosure weights, add the through bus weight for the amperage and bus material, and then add the weight for the lug landing straps based on the amperage of the connection.

TABLE 37: BUSSED PULL SECTIONS ADDER

	Weight (lb.)	
Lug strap amperage	Cu	Al
600	33	19
800	33	19
1200	49	25
1600	61	30
2000	76	33
2500	91	42
3000	111	49
4000	148	61
5000	186	
6000	232	

For any other special sections – which may include automatic transfer switches, transformers or any other devices – please consult the factory.

APPLICATION DATA

Standards/Codes/Ratings/Conditions

System selectivity and protection
The design of a protective system involves two separate but interrelated steps:
1. Selection of the proper device.
2. Selection of the setting for the devices to achieve the degree of protection and selectivity desired.

A protective device is selective with another protective device if the downstream device operates first when both see the same fault current. By the proper selection and setting of protective devices, the system designer can achieve a time current coordination (selectivity) among these devices that provides the maximum circuit and equipment protection consistent with the service continuity requirements. Protective device coordination is generally a compromise between maximum protection and maximum service continuity. To maintain maximum service continuity, only the devices supplying the defective element should open. This may require time delay of upstream devices.

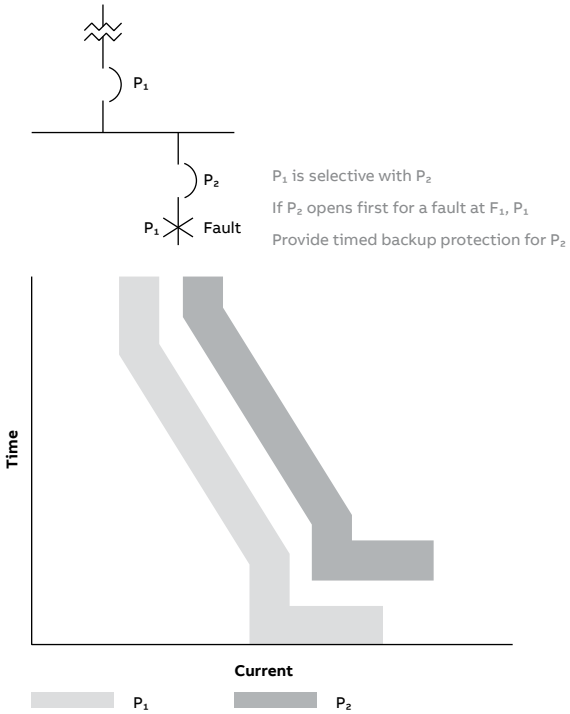
However, this prevents maximum protection that requires the upstream protective device to open instantaneously for a fault anywhere in the system. A coordination study should be performed to determine the degree of selectivity that may be achieved.

Device selection
All protective devices should be applied within their ratings-voltage, frequency, current and short circuit-under usual switchboard service conditions.

Additional device selection considerations may be required if the equipment is part of a system with required selectivity per the NEC. Device selections need to be made carefully to properly fulfill selectivity requirements.

Utilize ABB's CurvesWeb online tool for all information pertaining to time current curves. The tool can be accessed at https://partnerhub.connect.abb.com/. If access to this tool is not available please consult ABB. If any discrepancies are found in the time current curve information from other sources, the ABB's CurvesWeb online tool takes precedence.

Size and number of services
The use of services rated 2000 amperes or less is strongly recommended for better protection, service continuity and lower cost. Smaller transformers permit lower rated protective devices, which provide better protection and service continuity. The National Electrical Code recognized this in Section 230.2(c), which permits two or more services when the capacity requirements are in excess of 2000 amperes at 600 volts or less.



25 Typical time current curve

Service entrance equipment
The National Electric Code has specific rules for the equipment that controls and protects the service or supply of electricity to a building.

The general rule is that a building is to be supplied by only one service. Exceptions include fire pumps, multiple occupancy buildings, high capacity and large areas (NEC 230.2(a)). Each service shall have only one disconnecting means (NEC 230.71), two to six service disconnecting means are permitted if each service disconnect is located within a vertical Switchboard section (NEC 230.71(B)).

The service disconnecting means shall be located either inside only one or outside of a building at a readily accessible location nearest the point of entrance of the service conductors (NEC 230.70).

Switchboards used as service equipment shall be marked "suitable for use as service equipment" and shall provide:
1. A bonding jumper to bond the enclosure and ground bus to the neutral (NEC250.24(a)).
2. A neutral disconnect link to disconnect neutral from premises wiring (NEC 230.75).
3. A barrier to isolate service bus bars and terminals from rest of switchboard.

Ground fault protection shall be provided for solidly grounded wye services with more than 150 volts to ground but not exceeding 600 volts phase-to-phase for each service disconnecting means rated 1000 amperes or more (NEC 230.95).

If the service disconnect is group mounted, then the appropriate service entrance barriers are factory installed to the disconnect terminals. Additional details for these barriers can be found in installation manual number 1SQC900010M0201.

Switchboard enclosure
The standard switchboard enclosure is a NEMA Type 1 general purpose indoor enclosure. It is intended primarily to prevent accidental contact of personnel with live parts and to provide protection against dirt and foreign objects.

NEMA 1 enclosures should be used indoors in dry locations. Devices may require ventilation for operation at rated current. The standard switchboard enclosure should not be used in environments where ventilation is not acceptable.

Outdoor enclosures are available and should be used outdoors to protect the equipment against rain, and indoors where water may intrude, such as beneath fire sprinklers.

Switchboard ratings
Switchboards are designed, tested and rated to Underwriters Laboratories Standard 891 for dead front switchboards and NEMA Standard PB2 for dead-front distribution switchboards.

TABLE 38: SWITCHBOARD RATINGS

System		Voltage rating
No. of phases	No. of wires	AC*
3	4	600/347, 480Y/277, 208Y/120
3	4	240/120
3	3	600, 480, 240, 120

* Additional voltages may be available. Consult ABB.

Current
The continuous current ratings of switchboards are 400, 600, 800, 1000, 1200, 1600, 2000, 2500, 3000, 5000 and 6000 amperes.

Switchboard bus bars are rated on a current density basis – 750 A per square inch for aluminum and 1000 A per square inch for copper or heat rated (tested per standard).

Frequency
AC switchboards are rated 60 Hz and may be applied on 50 Hz services without derating. For other ratings, refer to factory.

Insulation level
Switchboards have an insulation level rating at twice the rated voltage plus 1000 volts. The dielectric test for this rating consists of applying a 60 Hz voltage for 1 minute phase to phase and phase to ground with switching devices closed.

Working space
The National Electrical Code (Article 110.26) requires that sufficient access and working space shall be provided and maintained around electrical equipment to permit ready and safe operation and maintenance of such equipment.

In addition, a minimum clearance of one inch between the back and sides of the switchboard and any walls or obstructions is required.

Access and entrance to working space
At least one entrance of sufficient area shall be provided to give access to the working space around switchboards. For switchboards rated 1200 A or more and over six feet wide, there shall be one entrance not less than twenty-four (24) inches wide and six and one-half (6-1/2) feet high at each end (NEC 110-26(c)).

Exceptions to this are:
1. Where the equipment location permits a continuous and unobstructed way of exit travel.
2. Where work space is double the amount required.

Phase arrangement
The phase arrangement on three-phase buses is A, B, C, from top to bottom, front to back, or left to right as viewed from the front of the switchboard. On three-phase, four-wire delta-connected systems, the B-phase shall have the higher voltage to ground and is marked "Hi-Leg."

Protective device continuous current ratings
The continuous load supplied by a protective device shall not exceed 80 percent of the device rating unless the switchboard, including the protective device, is UL listed for continuous operation at 100 percent of its rating. The non-continuous load may be 100 percent of the device rating. A continuous load is one that continues for three hours or more.

Standard group-mounted molded case circuit breakers (MCCB) are 80 percent rated. 100 percent ratings are available with the Tmax XT5 up to 400 A and Tmax® XT7 up to 1200 A. 100 percent rated MCCBs require 90°C rated wire sized at 75°C to comply with UL. All individually mounted molded case circuit breakers are standard (80 percent) rated only.

Emax 3 and Emax 2 circuit breakers are 100 percent rated. Power Break® II circuit breakers can be 80 percent or 100 percent rated. High pressure contact (HPC II) and bolted pressure switches (BPS) are 100 percent rated in switchboards.

Switchboard short-circuit ratings
Switchboards shall be applied on a system having an available short-circuit current not greater than the short circuit rating of the switchboard. All switchboards are marked with a short circuit rating. The switchboard will be fully rated or series connected rated. When fully rated, the short circuit rating of the switchboard is that of the lowest rated device in the switchboard. Series connected ratings are based on short circuit ratings given to two or more devices connected in series.

In either case, the bus bar bracing must be equal to or exceed the short circuit rating of the switchboard. Bus bar bracings available are 65,000, 100,000, 150,000 and 200,000 rms symmetrical amperes; 65,000 is the standard bracing.

Short-circuit rating tests
Switchboard buses are tested and assigned short-circuit ratings in according with UL Standard No. 891 and NEMA Standard No. PB-2. The test current duration is three cycles and the test circuit power factor is 20 percent.

Devices are tested and rated in accordance with the applicable standards.

If the switchboard, including devices, is applied in a circuit with a power factor less than it is tested at, derating may be required. Refer to applicable standards or the factory.

ABB switchboards meet the following standards, as applicable:
- UL 50 Thirteenth Edition - Enclosures for Electrical Equipment, Non-Environmental Considerations
- UL 50E Second Edition - Enclosures for Electrical Equipment, Environmental Considerations
- UL 67 Thirteenth Edition - Standard for Panelboards
- UL 98 Fourteenth Edition - Enclosed and Dead Front Switches
- UL 489 - Thirteenth Edition - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
- UL 891 Twelfth Edition - Switchboards
- UL 969 Fifth Edition - Standard for Marking and Labeling Systems
- National Electric Code 2023 Edition
- NEMA PB1 2011 Edition - Panelboards
- NEMA PB2 2011 Edition - Deadfront Distribution Switchboards
- CSA C22.2 No. 244:19 Second Edition - Switchboards
- IBC 2024 - International Building Code
- CBC 2025 - California Building Code
- UL 1066 Fourth Edition - Standard for Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures

TIP
Only switchboards containing all UL listed/ recognized devices can be UL labeled.

In addition to meeting or exceeding all applicable standards, ReliaGear® SB switchboards meet ABB's more stringent internal requirements, offering a greater margin or performance and safety (ISO 9001).

The following classifications and limitations of switchboard distribution sections have been established by Underwriters Laboratories and the National Electrical Code.

TIP
An overcurrent protective device is a circuit breaker pole or single fuse.

TABLE 39: APPLICABLE DEVICE STANDARDS

	Standard			Test circuit power factor
Device	**UL**	**ANSI**	**NEMA**	**(%)**
Molded case circuit breakers	489		AB-1	20
Power Break® II circuit breakers	489		AB-1	20
Low voltage power circuit breakers	1066	C37.50		20
High pressure contact switches	977		KS-2	20
Bolted pressure switches	977		KS-2	20
Fusible switches	98			20
Fuses	198 E.B		FU-1	20

Service entrance equipment

- Must be located near the point of entrance of building supply conductors
- Switchboard distribution sections may have up to six operating handles to entirely disconnect switchboards from the source
- Must include connector for bonding and grounding neutral conductor
- A service entrance-type UL label must be factory installed and will be provided on the equipment (when specified)

Service conditions

1. Switchboards are rated for use in a 40°C room ambient per UL 891. For switchboards intended for use in higher ambient temperatures consult the factory.
2. Switchboards can be applied for use in altitudes up to 6600 feet (2000 meters). Above 6600 feet, the derating factors in table 40 apply.
3. Ambient temperature rating of installed protective devices should not be exceeded without derating. The ambient temperature ratings of the most frequently used devices are listed in table 41. This temperature is around the device inside the switchboard enclosure. Refer to the applicable device standard for derating factors in table 40.A.
4. The National Electrical Code (NEC) specifies ampacity of conductors for various temperatures. Standard ratings are based on 40°C (104°F) ambient.
5. All device lugs and equipment lug assemblies are UL listed and rated for use with conductors whose ampacity is based on the ampere rating of 75°C (167°F) conductors, which is in compliance with NEC 11.14. Higher temperature ratings may be used, and in some cases should be used, but it must be applied at its 75°C ampacity. Lugs rated for 90°C (stamped AL9CU). However, cables terminating in the equipment can only be sized to 75°C.
6. Switchboards will withstand seismic forces of up to 2.5G in any direction when installed with structurally certified fasteners in accordance with the installation instructions given the Installation and Maintenance Manual (1VAL088301-MB).
7. For unusual service conditions, such as corrosive atmosphere, vibration, pollution, dust or unique equipment arrangements, consult the factory.
8. Select section heaters option if the switchboard is expected to be stored or operated in cold and/or damp environments.

TABLE 40: DERATING TEMPERATURES

Altitude			
Feet	**Meters**	**Temperature derating**	**Voltage derating**
6600	2000	1.00	1.00
8500	2600	.99	.95
13000	3900	.93	.80

Short circuit ratings are not affected by altitude.

TABLE 40.A: DERATING TEMPERATURES

Room ambient °C	**Switchboard current derating factor**
25–40	1.00
50	0.78

TABLE 41: DEVICE OPERATING TEMPERATURE RATING

Molded case and insulated case circuit breakers	-20°C to +40°C
ADS fusible switches	-40°C to +40°C
Low voltage power circuit breakers	-20°C to +40°C
High pressure contact and bolted pressure switches	-20°C to +40°C

Protective device ratings

Series connected ratings

UL permits assigning a short circuit rating to a combination of molded case circuit breakers or fuses and molded case circuit breakers connected in series that is higher than the lowest rating protective device of the combination. This is defined as series connected ratings. The combination rating cannot exceed the rating of the protective device farthest upstream, although it will exceed the rating of the downstream protector.

The upstream protector can be a molded case circuit breaker or fuse. Device combinations are not limited to those in the same equipment. They can be in different equipment, such as a switchboard feeder or a panelboard main versus panelboard branches. Any distance between devices in different equipment is permitted. Total fault current magnitude must flow through both protectors. Thus, fault current contribution from motors, as well as power source fault current, must flow through upstream and downstream protectors. Molded case circuit breakers may be applied as fully rated or series connected.

In a fully rated system the short circuit rating of all protective devices is equal to, or exceeds, the circuit short circuit requirement and, if mounted in equipment, the bus short circuit withstand rating and equipment short circuit rating exceeds the circuit available.

In a series connected system the short circuit rating of the upstream protector is fully rated but the downstream protector is not fully rated.

UL permits assigning a short circuit rating to a combination of protective devices that is higher than the lowest rating of the downstream device. This rating of two devices in series is defined as a series rating.

Series ratings can exist for a combination of molded case circuit breakers, or a combination of fuses and molded case circuit breakers. The rating of the combination cannot exceed the rating of the upstream device in the combination, but can exceed that of the downstream device.

In series or fully rated combinations, both protectors may open on short circuits. Conversely, in selectively coordinated systems, only the device closest to the overcurrent of fault is permitted to open. In these systems, both devices must be fully rated, and the short circuit level to which they are selective must be known.

Examples where selectivity is desirable (and often required) include:

- Buildings with important loads such as: elevators, emergency lighting, critical ventilation, etc.
- Manufacturing facilities where loss of power can result in economic loss due to production downtime or damage to equipment
- Hospitals and medical facilities where life support is critical

Series ratings are listed in publication DET008. Selectivity Ratings are listed in publication DET-760.

EMAX 3 POWER CIRCUIT BREAKERS

Key front features

SACE® Emax 3 power circuit breakers are engineered to adapt to evolving operational demands, delivering scalable solutions that support both current performance requirements and future system expansion. Its modular design facilitates seamless upgrades, ensuring long-term value and investment protection.

Designed to maximize system uptime, SACE Emax 3 incorporates advanced sensing technology alongside intelligent power and asset management capabilities. These integrated features enable continuous monitoring, predictive maintenance and optimized system reliability—helping to ensure that critical operations remain uninterrupted.

In an era when cybersecurity is essential, SACE Emax 3 is built to meet the highest security standards. It incorporates advanced protection measures aligned with IEC 62443-4-2 Security Level 2, safeguarding sensitive operational data while enhancing the safety of personnel and infrastructure.

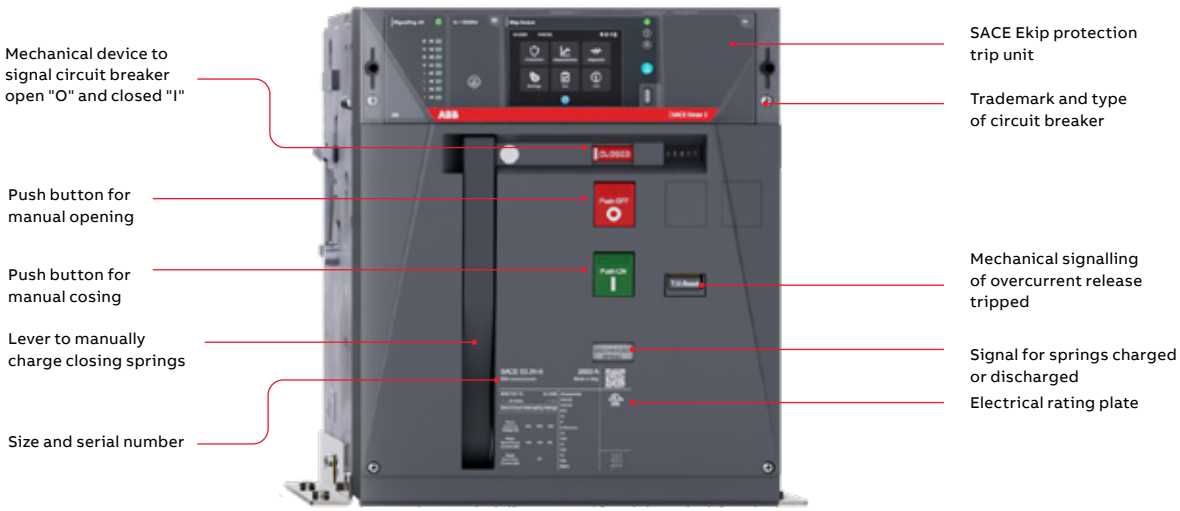
Ekip Aware

SACE Emax 3 provides exceptional flexibility through its fully upgradeable Ekip™ Aware trip unit and optimized communication architecture, enabling users to tailor functionality as system requirements evolve. The platform also delivers industry-leading measurement performance, offering 0.5% accuracy for active power and energy monitoring to support precise energy management and operational insight.

Additionally, SACE Emax 3 incorporates innovative safety technologies, including integrated arc flash protection, further safeguarding personnel and equipment in demanding electrical environments.

Emax 3 circuit breaker

- UL 1066 certified, 3 poles, fixed mount only
- Ekip® Aware trip unit with Reduced Energy Let Through (RELT)
- 0.5% accuracy for active power and energy
- Digital rating plug enables configurable nominal current on customer site
- Integrated arc flash sensors, optional
- 3.5" highly readable touch panel



26 Emax 3- features and characteristics

EMAX 3 E1.3 POWER CIRCUIT BREAKERS UL 1066

Common data		
Rated maximum voltage	[V]	635
Rated voltage	[V]	600
Test voltage (1min. 50/60 Hz)	[kV]	2.2
Frequency	[Hz]	50 - 60
Number of poles		3-4
Version		Fixed (F) - Drawout (W)



SACE® Emax 3 UL 1066			E1.3		
Performance levels			**B-A**	**N-A**	**S-A**
Rated uninterrupted current Iu @ 40°C		[A]	800	800	250
		[A]	1200	1200	400
		[A]			800
		[A]			1200
Neutral pole current-carrying capacity for 4-pole CBs		[%Iu]	100	100	100
Interrupting rating at rated maximum voltage	254 V	[kA]	42	50	65
	508 V	[kA]	42	50	65
	635 V	[kA]	42	42	42
Rated short time current (30 cycle/0.5s)		[kA]	42	50	50
Breaking (1)	Breaking time for I<Icw	[ms]	40	40	40
	Breaking time for I>Icw	[ms]	25	25	25

1) Total clearing time is the sum of breaking time and trip time

Dimensions and weight			
Dimensions	H - Fixed/Drawout	[in/mm]	11.65 [in] - 296 [mm]/14.33 [in] - 363.5 [mm]
	D - Fixed/Drawout	[in/mm]	7.20 [in] - 183 [mm]/ 11.06 [in]- 281 [mm]
	W - Fixed 3p/4p	[in/mm]	8.27 [in] - 210 [mm]/ 11.02 [in] -280 [mm]
	W - Drawout 3p/4p	[in/mm]	10.94 [in] - 278 [mm]/13.70 [in] -348 [mm]
Weights (CB with trip unit/current sensors/ standard accessories)	Fixed 3p/4p	[lbs/Kg]	30.9 [lbs] - 14 [kg]/35.3 [lbs] - 16 [kg]
	Drawout 3p/4p including fixed part	[lbs/Kg]	90.4 [lbs]- 41 [kg]/102.5 [lbs] - 46.5 [kg]

SACE Emax 3 UL 1066				E1.3		
Mechanical life with regular ordinary maintenance prescribed by the manufacturer	[Iu]	[A]	< 800	800	1200
		[No. cycles x 1000]	20	20	20
	Frequency	[Oper./Hour]	60	60	60
Electrical life with regular ordinary maintenance prescribed by the manufacturer	508 V	[No. cycles x 1000]	8	8	7
	635 V	[No. cycles x 1000]	8	8	6,5
	Frequency	[Oper./Hour]	30	30	30

EMAX 3 E2.3 POWER CIRCUIT BREAKERS UL 1066

Common data		
Rated maximum voltage	[V]	635
Rated voltage	[V]	600
Test voltage (1min. 50/60 Hz)	[kV]	2.2
Frequency	[Hz]	50 - 60
Number of poles		3-4
Version		Fixed (F) - Drawout (W)



SACE® Emax 3 UL 1066			**E1.3**				
Performance levels			**B-A**	**N-A**	**S-A**	**H-A**	**V-A**
Rated uninterrupted current Iu @ 40°C		[A]	1600	1600	800	800	250
		[A]		2000	1200	1200	400
		[A]			1600	1600	800
		[A]			2000	2000	1200
		[A]					1600
		[A]					2000
Neutral pole current-carrying capacity for 4-pole CBs		[%Iu]	100	100	100	100	100
Interrupting rating at rated maximum voltage	254 V	[kA]	42	50	65	85	100
	508 V	[kA]	42	50	65	85	100
	635 V	[kA]	42	50	65	85	85
Rated short time current (30 cycle/0.5s)		[kA]	42	50	65	85	85
Breaking (1)	Breaking time for I<Icw	[ms]	40	40	40	40	40
	Breaking time for I>Icw	[ms]	25	25	25	25	25

1) Total clearing time is the sum of breaking time and trip time

Dimensions and weight			
Dimensions	H - Fixed/Drawout	[in/mm]	14.61 [in] - 371 [mm]/16.73 [in] - 425 [mm]
	D - Fixed/Drawout	[in/mm]	10.63 [in] - 270 [mm]/15.47 [in]- 393 [mm]
	W - Fixed 3p/4p	[in/mm]	10.87 [in] -276 [mm]/ 14.41 [in] -366 [mm]
	W - Drawout 3p/4p	[in/mm]	12.48 [in] - 317 [mm]/16.02 [in] -407 [mm]
Weights (CB with trip unit/current sensors/ standard accessories)	Fixed 3p/4p	[lbs/Kg]	115 [lbs] - 52 [kg]/148 [lbs] - 67 [kg]
	Drawout 3p/4p including fixed part	[lbs/Kg]	up to 1600A: 128 [lbs] -58 [kg]/150 [lbs] - 68 [Kg] ; 2000A: 135 [lbs] - 61 [kg]/239 [lbs] - 108 [kg]

SACE Emax 3 UL 1066			**E2.3**		
Mechanical life with regular ordinary maintenance prescribed by the manufacturer	[Iu]	[A]	<1600	1600	2000
		[No. cycles x 1000]	25	25	25
	Frequency	[Oper./Hour]	60	60	60
Electrical life with regular ordinary maintenance prescribed by the manufacturer	508 V	[No. cycles x 1000]	15	12	10
	635 V	[No. cycles x 1000]	15	10	8
	Frequency	[Oper./Hour]	30	30	30

EMAX 3 E4.3 POWER CIRCUIT BREAKERS UL 1066

Common data		
Rated maximum voltage	[V]	635
Rated voltage	[V]	600
Test voltage (1min. 50/60 Hz)	[kV]	2.2
Frequency	[Hz]	50 - 60
Number of poles		3-4
Version		Fixed (F) - Drawout (W)



SACE® Emax 3 UL 1066				E1.3		
Performance levels				**S-A**	**H-A**	**V-A**
Rated uninterrupted current Iu @ 40°C			[A]	2500	2500	800
			[A]	3000	3000	1600
			[A]	3200	3200	2000
			[A]			2500
			[A]			3000
			[A]			3200
			[A]			
Neutral pole current-carrying capacity for 4-pole CBs			[%Iu]	100	100	100
Interrupting rating at rated maximum voltage		254 V	[kA]	65	85	100
		508 V	[kA]	65	85	100
		635 V	[kA]	65	85	100
Rated short time current (30 cycle/0.5s)			[kA]	65	85	100
Breaking (1)	Breaking time for I<Icw		[ms]	40	40	40
	Breaking time for I>Icw		[ms]	25	25	25

1) Total clearing time is the sum of breaking time and trip time

Dimensions and weight			
Dimensions	H - Fixed/Drawout	[in/mm]	14.61 [in] - 371 [mm]/16.73 [in]- 425 [mm]
	D - Fixed/Drawout	[in/mm]	10.63 [in]- 270 [mm]/ 15.47 [in]-393 [mm]
	W - Fixed 3p/4p	[in/mm]	15.12[in] - 384 [mm]/20.08 [in]-510 [mm]
	W - Drawout 3p/4p	[in/mm]	16.73 [in] - 425/[mm]/21.69 [in] -551 [mm]
Weights (CB with trip unit/current sensors/ standard accessories)	Fixed 3p/4p	[lbs/Kg]	Up to 2500A: 161[lbs] - 73 [kg]/203 [lbs] - 92 [kg]; 3200A: 201[lbs]-91 [kg]/256 [lbs] -116 [kg] ; 3600A: 210 [lbs] - 95 [kg]
	Drawout 3p/4p including fixed part	[lbs/Kg]	Up to 2500A: 261 [lbs]-118 [kg]/325 [lbs] - 147 [kg]; 3200A: 300 [lbs]- 136 [kg]/377 [lbs] - 171 [kg]

SACE Emax 3 UL 1066				E4.3		
Mechanical life with regular ordinary maintenance prescribed by the manufacturer	[Iu]		[A]	< 800	800	1200
			[No. cycles x 1000]	20	20	20
		Frequency	[Oper./Hour]	60	60	60
Electrical life with regular ordinary maintenance prescribed by the manufacturer		508 V	[No. cycles x 1000]	8	8	7
		635 V	[No. cycles x 1000]	8	8	6,5
		Frequency	[Oper./Hour]	30	30	30

EMAX 3 E6.3 POWER CIRCUIT BREAKERS UL 1066

Common data		
Rated maximum voltage	[V]	635
Rated voltage	[V]	600
Test voltage (1min. 50/60 Hz)	[kV]	2.2
Frequency	[Hz]	50 - 60
Number of poles		3-4
Version		Fixed (F) - Drawout (W)



SACE® Emax 3 UL 1066			**E6.3**	
Performance levels			**H-A**	**V-A**
Rated uninterrupted current Iu @ 40°C		[A]	4000	4000
		[A]	5000	5000
		[A]	6000 (1)	6000 (1)
Neutral pole current-carrying capacity for 4-pole CBs		[%Iu]	50-100	50-100
Interrupting rating at rated maximum voltage	254 V	[kA]	85	100
	508 V	[kA]	85	100
	635 V	[kA]	85	100
Rated short time current (30 cycle/0.5s)		[kA]	85	100
Breaking (2)	Breaking time for I<Icw	[ms]	40	40
	Breaking time for I>Icw	[ms]	25	25

1) Total clearing time is the sum of breaking time and trip time
2) Total clearing time is the sum of breaking time and trip time

Dimensions and weight			
Dimensions	H - Fixed/Drawout	[in/mm]	14.61 [in] - 371 [mm]/16.73 [in]- 425 [mm]
	D - Fixed/Drawout	[in/mm]	10.63 [in]- 270 [mm]/ 15.47 [in]-393 [mm]
	W - Fixed 3p/4p/4p full size	[in/mm]	30 [in]-762[mm]/34.96 [in] - 888 [mm]/39.92 [in] - 1014 [mm]
	W - Drawout 3p/4p/4p full size	[in/mm]	31.61 [in] - 803[mm]/36.57 [in] - 929 [mm]/ 42.09 [in] - 1069 [mm]
Weights (CB with trip unit/current sensors/ standard accessories)	Fixed 3p/4p/4p full size	[lbs/Kg]	314 [lbs]- 142 [kg]/360 [lbs]-163 [kg]/ 406 [lbs] - 184 [kg]
	Drawout 3p/4p/4p full size including fixed part	[lbs/Kg]	Up to 5000A: 486 [lbs]-220 [kg]/ 554 [lbs]-251 [kg]/620 [lbs] -281 [kg] 6000A: 818 [lbs] - 371 [kg]

SACE Emax 3 UL 1066			**E6.3**		
Mechanical life with regular ordinary maintenance prescribed by the manufacturer	[Iu]	[A]	4000	5000	6000
		[No. cycles x 1000]	12	12	12
	Frequency	[Oper./Hour]	60	60	60
Electrical life with regular ordinary maintenance prescribed by the manufacturer	508 V	[No. cycles x 1000]	4	3	2
	635 V	[No. cycles x 1000]	4	2	2
	Frequency	[Oper./Hour]	10	10	10

EMAX 2 POWER CIRCUIT BREAKER

Emax 2 power circuit breakers set a new circuit breaker benchmark for the needs of today and tomorrow, matching all the grid requirements thanks to its distinctive features. It enables a direct communication to the energy management cloud-computing platform, ABB Ability™. Plug and play architecture makes Emax 2 easy to use.

The SACE® Emax 2 range is made up of 4 sizes: E1.2, E2.2, E4.2 and E6.2 up to 6000 A, which enable switchboards of compact dimensions and high ratings to be built with busbars of reduced length and cross-section.

The protection trip units, auxiliary connections, and main accessories are the same throughout the range to simplify design and installation Furthermore, the sizes from E2.2 to E6.2 have the same height and depth.

High short-time currents, together with the efficiency of the protection functions, guarantee complete selectivity in all situations.

Accurate design and choice of materials enable optimization of the overall dimensions of the circuit breaker.

Ekip trip unit
The Emax 2 trip units are designed to be used in a wide range of applications. This complete, flexible protection trip unit can be adapted to the actual level of protection required, independently of the complexity of the system.

The range is available for two levels of performance, to meet any requirement, from simple to advanced applications.
- Ekip DIP, standard applications
- Ekip Touch and Ekip Hi-Touch, the smart trip units

The protection units for power distribution, available in the LSI and LSIG versions, are suited to all distribution systems. These trip units have been designed for a vast range of applications, to be used with transformers, motors and drives. Depending on the complexity of the system, voltage and energy measurements can be also included.



27 Emax 2 features and characteristics

Circuit breaker features

- Designed to meet ANSI C37.13, C37.16, C37.17 and C37.50 standards
- UL 1066 certified
- Four frame sizes: E1.2 (250-1200 A), E2.2 (250-2000 A), E4.2 (800-3000 A), E6.2 (4000-6000 A)
- Nine communications protocols: Modbus® RTU, Profibus, DeviceNet™, Modbus TCP, Profinet, Ethernet/IP, IEC61850, Ekip Com Hub and Bluetooth®
- Fixed and with-drawable versions for all frame sizes
- Double insulation between the front of the switchboard and the live parts to ensure operation in complete safety






TABLE 43: POWER CIRCUIT BREAKERS — EMAX 2

					E1.2					**E2.2**			**E4.2**		**E6.2**
Versions			B-A	N-A	S-A	B-A	N-A	S-A	H-A	V-A	S-A	H-A	V-A	H-A	V-A
Current		[A]	800	800	250	1600	1600	800	800	250	2500	2500	800	4000	4000
		[A]	1200	1200	400	—	2000	1200	1200	400	3000	3000	1600	5000	5000
		[A]	—	—	800	—	—	1600	1600	800	—	—	2000	6000	6000
		[A]	—	—	1200	—	—	2000	2000	1200	—	—	2500	—	—
		[A]	—	—	—	—	—	—	—	1600	—	—	3000	—	—
		[A]	—	—	—	—	—	—	—	2000	—	—	—	—	—
Poles		[No.]			3-4					3-4			3-4		3-41
Versions					Fixed/ Draw out					Fixed/ Draw out			Fixed/ Draw out		Fixed/ Draw out
Interrupt rating at rated maximum voltage	254 V	[kA]	42	50	65	42	50	65	85	100	65	85	100	85	100
	508 V	[kA]	42	50	65	42	50	65	85	100	65	85	100	85	100
	635 V	[kA]	42	42	42	42	50	65	85	85	65	85	100	85	100
Mechanical life	[No. of cycles]				20000					25000			20000		12000
Dimensions - fixed (width x depth x height)	3 poles	[mm]/ [in.]	[210 x 183 x 296] / [8.27 x 7.20 x 11.65]			[276 x 270 x 371] / [10.87 x 10.63 x 14.61]					[384 x 270 x 371] / [15.12 x 10.63 x 14.61]			[762 x 270 x 371] / [30.00 x 10.63 x 14.61]1	
	4 poles	[mm]/ [in.]	[280 x 183 x 296] / [11.02 x 7.20 x 11.65]			[366 x 270 x 371] / [14.41 x 10.63 x 14.61]					[510 x 270 x 371] / [20.08 x 10.63 x 14.61]			[888 x 270 x 371] / [34.96 x 10.63 x 14.61]	
Weight	3 poles	[kg]/ [lb.]			[14] / [30.9]					[52] / [115]			[91] / [201]		[163] / [360]
	4 poles	[kg]/ [lb.]			[16] / [35.3]					[67] / [148]			[116] / [256]		[184] / [406]
Trip units for power distribution					Ekip Touch					Ekip Touch			Ekip Touch		Ekip Touch

TABLE 44: EKIP TOUCH / HI-TOUCH TRIP UNIT PROTECTIONS

Trip unit	Current measurement and protection	Voltage, power, energy measurements	Voltage, power, energy protections	Embedded functions*
Ekip Touch LSIG	•	▫	▫	▫
Ekip Touch Measuring LSIG	•	•	▫	▫
Ekip Hi-Touch LSIG	•	•	•	•

• Default available
▫ Additional features
* Please refer to the Emax 3 catalog 1SDC220101D0201 for more details.

Rating plugs

Rating plugs have rejection features that allow them to be inserted only with circuit breakers containing the correct current sensors. See Table 45.

TABLE 45: RATING PLUG AND CURRENT SENSOR RATINGS

Circuit breaker frame	Frame rating	Rating plug amps
Emax E1.3 / E1.2	250	100/200/250
	400–1200	400/600/800/1000/1200
Emax E2.3 / E2.2	400–2000	400/600/800/1000/1200/1600/2000
Emax E4.3 / E4.2	800–3000	400/600/800/1000/1200/1600/2000/2500/3000
Emax E6.3 / E6.2	4000–6000	400/600/800/1000/1200/1600/2000/2500/3200/3600/4000/5000/6000



POWER BREAK® II INSULATED CASE CIRCUIT BREAKER

Basic configuration
Power Break® II insulated case circuit breakers offer reliable, flexible and easy- to-use circuit protection.

Power Break II circuit breakers are UL Listed and cUL Listed for up to 200,000 amps at 240 volts RMS symmetrical interrupting capacity without fuses or current limiters. These insulated case circuit breakers can be applied on ac power systems through 600 volts. Featuring a 2000 A compact design up to 40 percent smaller than its predecessors, Power Break II circuit breakers consist of three envelope sizes from 800 to 4000 amps.

Greater convenience and operational safety
The controls and status indicators you need most are readily accessible. The flush-mounted handle, ON/OFF buttons, rating plug test receptacles, bell alarm reset buttons (with or without lockout) are easily reached, and all are double-insulated from live components. For added security, a standard padlock device lets you prevent accidental or unauthorized closing of the circuit breaker.

Quick, error-free installation of universal accessories
Drop-in bell alarm, bell alarm with manual lockout, shunt trip (with or without lockout) and undervoltage release install in seconds. No special tools or circuit breaker disassembly are required. Just slide them into place. The modules are universal across all frame sizes, and each is mechanically keyed to its compartment so you make the right connection, every time. These accessories are field installable and upgradeable.

Advanced, solid-state trip units
EntelliGuard™ TU trip units give you new ways to monitor and control the Power Break II circuit breaker with unprecedented ease.

A simple keypad lets you program and display a variety of functions, including tripping characteristics, remote communications, status information and protective relaying.

The trip unit display also allows viewing of many standard metering parameters as well as pickup alarms, trip target indications and fault status information. Tripping characteristics are easily adjusted by a set of simple-to-use switches. The trip unit is upgradable to ground fault by simply inserting a ground fault rating plug. An optional target module allows for fault indication monitoring and also functions as a trip unit health indicator.

Rating plugs
The same interchangeable rating plugs are used in all of the EntelliGuard TU trip units across the entire Power Break II circuit breaker product line. Rating plugs are the key devices that establish the current rating of the circuit breaker. They provide an essential scaling function for the unit's microprocessor and ensure maximum accuracy.

Current sensors
Toroidally wound current sensors are furnished for all major protective functions, and for use with all Power Break II trip units. Toroidal sensors, including a second air-core winding, are provided with the high-range instantaneous function.

Current sensors are factory installed and are not changeable in the field. There are 11 current ratings for the Power Break II circuit breaker line through 4000 amps. Rating plugs must be coordinated with the current sensor rating (S) listed on the face of the rating plug.

Accessory configuration
Activation of the bell alarm - alarm only and bell alarm with lockout are controlled by switch settings on the rear of the trip unit. To change the conditions that activate these accessories, configure the trip unit switch settings as described in Table 46.

TABLE 46: ACCESSORY SWITCH SETTINGS

Switch	Factory setting	Function
1	Disable	Shunt trip activates bell alarm - alarm only
2	Disable	UVR trip activates bell alarm - alarm only
3	Enable	Protection trip activates bell alarm - alarm only
4	Disable	Shunt trip activates bell alarm/lockout
5	Disable	UVR trip activates bell alarm/lockout
6	Enable	Protection trip activates bell alarm/lockout

TABLE 47: ENTELLIGUARD™ TU TRIP UNIT CHARACTERISTICS

			Long time			Short time
				Delay[2] (Seconds)		
Envelope size	Frame max. ampere rating	Sensor rating (amperes) (S)	Current setting (C) (pick-up) multiple of rating plug amperes (X)	Thermal type (C-bands)	Fuse type (F-bands)	Pick-up (multiple of current settings (C)	Delay (seconds)
800	800	200, 400, 800	0.5 thru 1.0 in increments of 0.05	0.20	0.025	1.5 thru 9.0 in increments of 0.5	I^2T in[1] Minimum - .046 Intermediate - .186 Maximum - .418
				0.60	0.025		
				1.21	0.025		
1600	1600	800, 1000, 1600		1.61	0.032		
				2.41	0.044		
				3.21	0.059		I^2T out[2] .025, .033, .042, .058, .092, .117, .158, .183, .217, .350, .417
2000	2000	2000		4.02	0.078		
				4.82	0.100		
				5.62	0.130		
3000	2500	100, 2000, 2500		6.43	0.170		
				7.23	0.220		
				8.04	0.270		
	3000	3000		9.64	0.350		
				11.20	0.440		
				12.90	0.550		
4000	4000	4000		14.50	0.690		
				16.10	0.870		
				17.70	1.100		
				19.30			

TABLE 48: ENTELLIGUARD TU TRIP UNIT SETTINGS

					Ground fault			
Envelope size	Adjustable instantaneous pick-up without ST (multiple of rating plug amperes) (X)	Adjustable instantaneous pick-up with ST (multiple of rating plug amperes) (X)	RELT without ST	RELT with ST	Pick-up (multiple of sensor ampere rating)	Delay with I^2T in seconds	Slope bands	Fixed delay
800	2.0 thru 10.0 in 0.05 increments	2.0 thru 15.0 in 0.05 increments	1.5 thru 10.0 in 0.05 increments	1.5 thru 15.0 in 0.05 increments	0.20 thru 0.60 in increments of 0.01	.44 at 200% of pick-up at lower level of band	I^2T - .385 I^4T - .179 SGF - .553	0.058 0.092 0.117 0.158 0.183 0.217 0.350 0.417 0.517 0.617 0.717 0.817 0.917
1600	2.0 thru 10.0 in 0.05 increments	2.0 thru 15.0 in 0.05 increments	1.5 thru 10.0 in 0.05 increments	1.5 thru 15.0 in 0.05 increments	0.20 thru 0.60 in increments of 0.01			
2000	2.0 thru 10.0 in 0.05 increments	2.0 thru 15.0 in 0.05 increments	1.5 thru 10.0 in 0.05 increments	1.5 thru 15.0 in 0.05 increments	0.20 thru 0.60 in increments of 0.01			
3000	2.0 thru 10.0 in 0.05 increments	2.0 thru 13.0 in 0.05 increments	1.5 thru 10.0 in 0.05 increments	1.5 thru 15.0 in 0.05 increments	0.20 thru 0.37 in increments of 0.01			
4000	2.0 thru 9.0 in 0.05 increments	2.0 thru 9.0 in 0.05 increments	1.5 thru 9.0 in 0.05 increments	1.5 thru 9.0 in 0.05 increments	0.20 thru 0.30 in increments of 0.01			

For complete information on Power Break® II circuit breakers, refer to publication GET-8052.

HIGH PRESSURE CONTACT SWITCHES

ABB type HPC switches are UL Listed in accordance with Standard 977, Fused Power Circuit Devices.

The overcenter toggle mechanism provides stored energy, quick-make/quick-break operation. Multiple spring-loaded, high-pressure current-carrying contacts and an arcing contact arm provide excellent current carrying capability without sacrificing high interrupting fault performance. These switches can interrupt, on a make and break basis, a minimum of 12 times their nameplate ratings without fuse assistance at 600 V AC. Complete HPC switch and Class L fuse coordination is therefore achieved for all levels of fault current up to 200,000 RMS amperes symmetrical at 600 V AC maximum. Type HPC switches used as service disconnects comply with the National Electrical Code Section 230-65 for adequate short-circuit current and ground-fault protection.

- High durability, safety of operation - High dielectric strength. Glass-reinforced insulating case
- High interrupting capability - Arc chute of unique construction suppresses arcs and cools gases rapidly, providing quick arc interrupting and extended switch life
- High transient voltage withstanding - Interphase partitions mesh with switch cover to completely isolate each pole
- Extended switch life - Preloaded constant pressure pivot eliminates braid whip and fraying on high short-circuit currents and repeated operations
- Positive “On-Off” indication - Green (Off), red (On), eliminates any question about the position of the switch contacts
- Easy operation - Quick Make - Extra heavy duty, low torque rotary-operated closing mechanism. L-handle 800–1600 amperes; T-handle 2000 amperes and above
- Emergency Open - Quick Break - Fingertip "Off" button instantly opens the switch contacts
- Positive door and switch interlock - Separate fuse access door is not required

Product forms

- Top Feed - Line terminals at top of switch
- Bottom Feed - Line terminals at bottom of switch; fuses are de-energized when switch is in Off position. Same size switchboard as top feed. When switchboard is bottom fed it permits shallow design. Space for running feed to top terminals is not required

Options available

- Manual Operation - For manual, high-interrupting capacity, disconnects not requiring remote tripping and/or ground-fault protection
- Electric Trip - For remote tripping or for use with Ground Fault. All electric trip switches are the same size as manual devices
- Blown-fuse Protector - Provides single phase protection by tripping switch when a fuse blows or when switch is closed with a blown fuse or no fuse installed. Suitable for system voltages of 208–480 V AC. Mounted internally. Does not provide protection of voltage loss of the power source
- Auxiliary Switch - Provides remote indication of main contact position. Switch elements are Type AB, single pole, double-throw. Switch element ratings are: 0.25 A at 250 V DC; 0.5 A at 125 V DC; 6.0 A at 240 V AC
- External Ground Fault Relay – Ground Fault Relays and Sensors are designed to form a system for detecting a ground fault current on a ground ac power system. When a ground fault exceeds a selected Current level and Time Delay setting, the relay initiates a trip signal for a shunt trip disconnect device to open and clear the fault. This system is designed to provide protection for electrical equipment, not protection for personnel

1. Integral test panel with Push To Test and Shunt Trip Bypass pushing for ease in proper operational testing of the system, with or without tripping the protective device
2. “Power on” LED indicator in cover
3. Positive visual trip indicator, manual reset
4. Infinitely adjustable Time Delay
5. Discrete current threshold adjustment
6. Panel or door mounting
7. Rear terminal kit and clear plastic cover standard with door mounting
8. Electromechanical relay output, positive “ON” and “OFF”
9. Operates with molded case and power circuit breakers, bolted pressure switches or fusible disconnect switches
10. Meets NEC service entrance equipment standards

TABLE 49: ABB HPC SWITCH INTERRUPTING RATINGS

		Available ratings	Contact interrupting rating based on ability to operate on overload unassisted by the fuse	Switch-fuse combination at switch-rated AC volts with class L fuse
Type	**Continuous amperes**	**Maximum AC volts**		
HPC/R	800, 1200, 1600, 2000, 2500, 3000, 4000	600	"Open" - 12X amp rating; "Close-Open" - 12X amp rating	200,000

TMAX® XT MOLDED CASE CIRCUIT BREAKER

The SACE® Tmax XT range offers higher performance, better protection and more precise metering than equivalent units and can handle from 15 A up to 1200 A.

Combined with precise electronic trip units in small frames, the new range delivers significant time savings and enhances installation quality. Reliability is further increased, and speed of installation reduced, thanks to Bluetooth® and Ekip connectivity for mobile devices.

Tmax XT circuit breakers and their accessories are constructed in compliance with UL 489 and CSA C22.2 standards.





TABLE 50: SACE® TMAX® XT MOLDED CASE CIRCUIT BREAKERS (MCCBS)

					XT1								**XT2**
Frame size		A			125								125
Poles		No.			3								3
Rated voltage		V			480 Δ (600Y/347)								600
Versions					Fixed								Fixed
Interrupting ratings			N	S	H	N	S	H[1]	L[1]	N	S	H[1]	L[1]
	240 V AC	kA	50	65	100	65	100	150	200	65	100	150	200
	480 V AC	kA	25	35	65	25	35	65	100	25	35	65	100
	600 V AC	kA	18	22	25	18	22	25	35	18	22	25	50
Mechanical life		No. operations			25,000								25,000
		No. hourly operations			240								240
Dimensions – fixed (width x depth x height)		in./mm			3.0 x 7.2 x 10.4 / 77 x 184 x 265								4.1 x 7.8 x 9.8 / 105 x 198 x 249
Weight		lbs./kg			4.2 / 1.9								6.1 / 2.8
Trip units for power distribution													
TMF					●								
TMA													
Ekip DIP													●
Ekip Touch													

[1] Current-limiting circuit breaker in 480 V AC and 600 V AC






					XT4				XT5				XT6	XT7
					250				400–600				800	800-1000-1200
					3				3				3	3
					600				600				600	600
					Fixed				Fixed				Fixed	Fixed
N	S	H[1]	L[1]	V	N	N	S	H[1]	L[1]	N	S	H	H	L
65	100	150	200	200	65	65	100	150	200	65	100	200	100	200
25	35	65	100	150	35	35	50	65	100	35	50	65	65	100
18	22	25	50	65	20	18	25	35	65	20	25	35	50	65
					25,000				20,000				20000	10,000
					240				240				240	240
					4.2 x 7.8 x 9.8 / 105 x 198 x 249				5.6 x 8.1 x 15.2 / 141 x 206 x 387				8.3 x 8.3 x 19.2 / 210 x 211 x 488	8.3 x 10.9 x 19.2 / 211 x 277 x 488
					7.0 / 3.2				15.4 / 7.0				26.5 / 12.0	37.9 / 17.2
					●				●				●	
					●				●				●	●
														●



100 percent rated circuit breakers

Tmax® XT circuit breakers are available both as standard versions, and as 100 percent rated versions. For some 100 percent rated versions the use of specific 90°C rated wires sized per 75°C ampacity may be required.

TABLE 51: CIRCUIT BREAKER 100% RATED APPLICATIONS

Frame	°Max. ampacity	Wire insulation temperature rating
FB	—	—
XT1 / XT2	—	—
XT4	200	75°C
XT5	400	75°C
XT5[1]	600[2]	75°C
XT6	—	—
XT7	800	75°C
XT7	1200	90°C[3]
SS[4]	4000	75°C
SH[4]	4000	75°C
Emax 2[5]	6000	75°C
BPS	4000	75°C

[1] Individually mounted only
[2] 600 A is only available when using bus mounted lug provisions
[3] May use 75°C insulated cable when using bus mounted lug provisions
[4] 4000 A must be draw-out construction
[5] 6000 A must be draw-out construction

Trip units

ABB Ekip trip units represent a new benchmark for molded case circuit breakers, being able to satisfy any performance requirement. Ekip trip units are designed to be used in a wide range of applications.

These complete, flexible protection trip units can be adapted to the actual level of protection required, independently of the complexity of the system. The range is available for three levels of performance to meet any requirement, from simple to advanced applications:

- TM thermal-magnetic trip unit
- Ekip DIP electronic trip unit
- Ekip Touch/Hi-Touch electronic trip units

Thermal-magnetic trip unit

The thermal-magnetic trip unit is an easy solution for protection against overloads and short circuits. Overload protection is ensured by the ABB thermal device, based on a temperature-dependent bimetal heated by current. Protection against short-circuit is realized with a magnetic device.



1. Current threshold for short-circuit protection.
2. Rotary switch for short- circuit protection.
3. Current threshold for overload protection.
4. Rotary switch for overload threshold setting.

28 Thermal-magnetic trip unit features

Rotary switch

Depending on the version, it is possible to set the desired thresholds for protection by turning the front rotary switch.

TABLE 52: THERMAL-MAGNETIC TRIP UNIT PROTECTIONS

	L – overload protection			I – short-circuit protection	
Field of application	**Trip unit**	**Current threshold**	**Trip time**	**Current threshold**	**Trip time**
Power distribution protection	TMF	Fixed	Fixed	Fixed	Fixed instantaneous
	TMA	Adjustable	Fixed	Adjustable	Fixed instantaneous

TABLE 53: THERMAL-MAGNETIC FIXED - TMF

In [A]	15	20	25	30	35	40	45	50	60	70	80	90	100	110	125	150	175	200	225	250
XT1	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•					
XT4			•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•

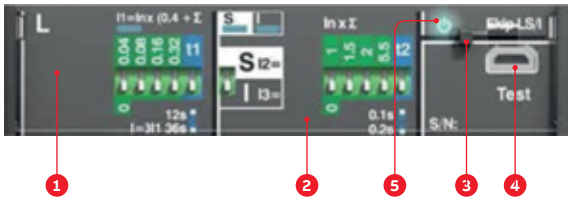
TABLE 54: THERMAL-MAGNETIC ADJUSTABLE - TMA

In [A]	80	90	100	110	125	150	175	200	225	250	300	400	500	600	800
XT4	•	•	•	•	•	•	•	•	•	•					
XT5											•	•	•	•	
XT6															•

Ekip DIP

The first level of electronic trip units, Ekip DIP trip units, are based on microprocessor technologies and guarantee high reliability, protection, adjustability and coordination.

They provide protection against overloads, selective short circuits, short circuits and ground faults. The power required for their operation is provided directly from the current sensors.



1. Overload-protection setting.
2. DIP switches for short-circuit and time-delayed short-circuit.
3. Slot for lead seal.
4. Test connector.
5. Power-on LED.

29 Ekip DIP trip unit features Dip switches

DIP switches

The DIP switches on the front of the trip unit allow manual settings when the trip unit is off.

LEDs

The LEDs on the front indicate the status of the release (on/off) and provide information about the protection tripped when the Ekip TT accessory is connected.

Front connector

The connector on the front of the unit allows the connection of:

- Ekip TT for trip testing, LED-test and signalling of the most recent trip.
- Ekip T&P for connection to a laptop with the Ekip Connect program (thus measurement reading, as well as trip and protection function tests, are made available to the user).

TABLE 57: CHARACTERISTICS OF ELECTRONIC EKIP DIP TRIP UNITS

Operating temperature	**-25°C to +70°C**
Relative humidity	98%
Self-supplied	0.2xIn (single phase)*
Auxiliary supply (where applicable)	24 V DC ± 20%
Operating frequency	45 to 66 Hz
Electromagnetic compatibility	IEC 60947-2 Annex F

*For 10 A: 0.4 in

Thermal memory

All the Ekip DIP trip units include a thermal memory function. The trip unit records the trips that have occurred in the last few minutes. Since the trip causes overheating, to protect the cables and let them cool down, the trip unit imposes a shorter delay-tripping time in case of a fault. Thus, the system is protected against damage due to cumulative overheating. This can be disabled, if needed, by using the Ekip T&P.

TABLE 55: EKIP DIP TRIP UNIT PROTECTIONS

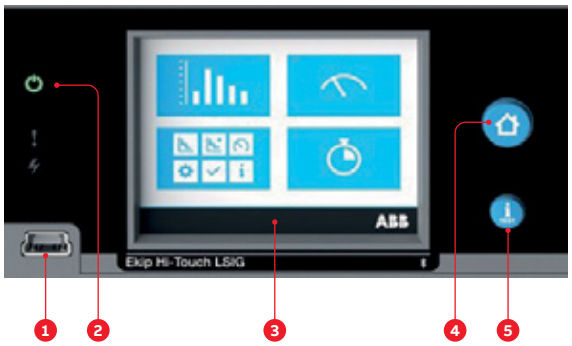
			L – overload protection		**S – selective short-circuit protection**		**I – short-circuit protection**	
Field of application	**Trip unit**		**Current threshold**	**Trip time**	**Current threshold**	**Trip time**	**Current threshold**	**Trip time**
Power distribution protection	Ekip DIP	LS/I	Adjustable	Adjustable	Adjustable	Adjustable	Adjustable	Fixed
		LIG	Adjustable	Adjustable	—	—	Adjustable	Fixed
		LSI	Adjustable	Adjustable	Adjustable	Adjustable	Adjustable	Fixed
		LSIG	Adjustable	Adjustable	Adjustable	Adjustable	Adjustable	Fixed

TABLE 56: POWER DISTRIBUTION PROTECTION

In [A]	**10**	**25**	**40**	**60**	**100**	**125**	**150**	**225**	**250**	**300**	**400**	**600**	**800**	**1000**	**1200**
XT4			•	•	•		•	•	•						
XT5									•	•	•	•			
XT6													•		
XT7												•	•	•	•

Ekip Touch/Hi-Touch

Ekip Touch/Hi-Touch trip units provide a wide series of protections and high accuracy measurements of all electrical parameters. They are intended to integrate perfectly with most common automation and supervision systems.



1. Power-on LED; pre-alarm LED; alarm LED.
2. Test and programming connector.
3. Display.
4. Home push button to return to homepage.
5. Push button for testing and tripping information.

30 Ekip Touch/Hi-Touch trip unit features

Communication and connectivity

The Ekip Touch/Hi-Touch trip units integrate perfectly into most common automation and energy management systems to improve productivity and energy consumption and for remote control. The circuit breakers can be equipped with communication modules for Modbus®, Profibus and DeviceNet™ protocols, as well as Modbus TCP, Profinet and Ethernet/IP. The modules can be easily installed even at a later date.

Furthermore, the IEC 61850 communication module enables connection to automation systems widely used in medium-voltage power distribution to create intelligent networks (smart grids). In addition, with an easy connection thanks to the Ekip Com hub module, the circuit breakers allow the system to be monitored via ABB Ability EDCS.

The integrated display makes interaction with the Ekip Touch/Hi-Touch an easy and intuitive experience for the user, and the embedded Bluetooth® functionality allows fast interaction via EPiC (electrification products intuitive configurator), the new mobile application to configure and check the status of ABB low-voltage circuit breakers.

TABLE 58: EKIP TOUCH/HI-TOUCH TRIP UNIT PROTECTIONS

Trip unit	Current measurement and protection	Voltage, power, energy measurements	Voltage, power, energy protections	Embedded functions*
Ekip Touch LSI	•	▫	▫	▫
Ekip Touch LSIG	•	▫	▫	▫
Ekip Touch Measuring LSI	•	•	▫	▫
Ekip Touch Measuring LSIG	•	•	▫	▫
Ekip Hi-Touch LSI	•	•	•	•
Ekip Hi-Touch LSIG	•	•	•	•

• Default available
▫ Additional features
* Please refer to the Tmax® XT catalog 1SXU210248C0201 for more details

TABLE 59: POWER DISTRIBUTION PROTECTION

In [A]	40	60	100	125	150	225	250	300	400	600	800	1000	1200
XT2	•	•	•	•									
XT4			•		•	•	•						
XT5							•	•	•	•			
XT7										•	•	•	•

RECORD PLUS FB MOLDED CASE CIRCUIT BREAKER

Record Plus FB circuit breakers complete the circuit breaker offering for the ReliaGear® SB switchboard.

The Record Plus FB line features true one- and two-pole construction, has a double-break contact system for fast response and current limitation to help with arc flash and coordination. This non-adjustable thermal-magnetic circuit breaker up to 100 A offers four interrupt tiers — through 100 kA at 480 V AC and 35 kA at 600/347 V AC.

TABLE 60: RECORD PLUS FB CHARACTERISTICS

Poles		1, 2
Amperes		15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100
Trip unit		Fixed thermal-magnetic
		12.5 x ±15%
Endurance/ durability	No load	20,000
	Full load at 240 V AC	20,000
	Full load at 480 V AC	10,000

TABLE 61: INTERRUPTING RATINGS

Ampere rating	Maximum voltage	Type	Poles	UL listed interrupting rating rms symmetrical kA AC voltage				
				240 V	277 V	347 V	480 V	600 V
15–100	600Y/347 V AC	FBV	1	35	35	22	-	-
			2	65	-	-	35	22
		FBN	1	65	65	25	-	-
			2	150	-	-	65	25
		FBH	1	100	100	35	-	-
			2	200	-	-	100	35



31 Record Plus FB 1 pole with the ReliaGear® line side connector (LSC)



32 Record Plus FB 2 pole with the ReliaGear line side connector (LSC)

Mounting space requirements for molded case circuit breakers
Each circuit breaker frame has specific requirements for the number of mounting positions (X-spaces). Thanks to the optimized dimensions of the Tmax® XT1, the mounting positions required are lower when two or five circuit breakers are mounted next to one another. SPD, metering and RELT also require X-space, since they are plug-in modules. Refer to the table below. In main lugs configuration, each set of lug pads occupies 4 X-spaces.

Line-side connectors and lugs for molded case circuit breakers

Line-side connectors
Each circuit breaker horizontally mounted on the bus stack is provided with a line-side connector (LSC) and a mounting bracket. The LSC is designed to ensure an easy and accurate connection between the circuit breakers and the conductive busbars.

A patented clip design with a loaded spring ensures full contact in any circumstance. Each circuit breaker frame has a specific LSC with the right number of clips to ensure the highest performance.

Circuit breaker lugs offering
All ReliaGear® neXT circuit breakers are provided with a set of lugs on the load side. All lugs accept either copper or aluminum wires.

TABLE 62: GROUP MOUNTED DEVICE X-HEIGHT (ONE X HEIGHT EQUALS 1.385")

Frame	Max. ampacity (A)	Poles	X-height
Single XT1/XT2	125	3	3
Two XT1	125	3	5
Five XT1	125	3	11
XT4	250	3	3
XT5	600	3	4
XT6	800	3	6
XT7	1200	3	6
FB	100	1	1
FB	100	2	2
SPD	—	—	10
RELT	—	—	3
Metering	—	—	4

TABLE 63: CIRCUIT BREAKERS LUGS

Frame	Ampacity (A)	Wire size (AWG or kcmil) Cu or Al	Number of cables per lug	Installation
XT1/XT2	125	#10–2/0	1	Horizontal
XT4	25–70	#14–1/0	1	Horizontal
XT4	80–225	#4–300	1	Horizontal
XT4	250	3/0–350	1	Horizontal
XT5	600	2/0–500	2	Horizontal
XT6	800	2/0–400	3	Horizontal
XT7	1200	4/0–500	4	Horizontal
XT7	1200	500–750	3*	Horizontal
FB	15–20	#14–#10	1	Horizontal
FB	25–60	#10–#4	1	Horizontal
FB	70–100	#1–1/0	1	Horizontal

* Refer to page 8 for wire-bending space limitations for 750 kcmil cables.

Accessories for molded case circuit breakers

Internal accessories
Common internal accessories (shunt trips, undervoltage releases, auxiliary switches, etc.) are available in common voltage ratings and are UL listed for field assembly.

Auxiliary contacts — AUX
The SACE® Tmax® XT and Record Plus FB circuit breakers can be equipped with auxiliary contacts that signal the status of the circuit breaker and can be routed outside the circuit breaker itself. The following information is available:

- Open/closed (Q): indication of the status of the circuit breaker power contacts
- Trip (SY): signals that the circuit breaker is opening due to the intervention of the trip unit, or to the opening of undervoltage/ shunt opening releases, or to the use of the test button

Shunt opening release — SOR/YO
This allows the circuit breaker to open by means of a non-permanent electrical control. Release operation is guaranteed for voltage between 70 percent and 110 percent of the rated power supply voltage (Un), in both alternating and direct current. The SOR is equipped with a built-in limit contact to shut off the power supply in the open position with the trip unit tripped. A remote-controlled emergency opening command can be generated by connecting an opening button to the SOR.

TABLE 64: SHUNT OPENING RELEASE CHARACTERISTICS

Frame			Voltage
XT1– XT2– XT4– XT5–XT6	24–30 V AC/DC	110–127 V AC/ 110–125 V DC	220–240 V AC/ 220–250 V DC
XT7	24 V AC/DC	110–120 V AC	220–240 V AC
FB (2-pole only)	24 V AC/DC	110–130 V AC 110–125 V DC	220–240 V AC/ 250 V DC

For accessory voltages above 240 V AC or 250 V DC, consult factory.

Undervoltage release — UVR/YU
This allows the circuit breaker to open when the release is subject either to a power failure or a voltage drop. As prescribed in the standards, opening is guaranteed when the voltage is between 70 percent to 35 percent Un. After tripping, the circuit breaker can be closed again if the voltage exceeds 85 percent of Un. When the undervoltage release is not energized, neither the circuit breaker nor the main contacts can be closed. A remote- controlled emergency opening command can be generated by connecting an opening button to the UVR.

Padlocks and key locks
Padlocks or key locks prevent the circuit breaker from being closed and/or opened. Maximum number of padlocks (PLL) and maximum stem dimensions are the following:

Multiple models of keylocks are offered: Kirk KCAM00010 / KCAM00010S (XT5-XT7), Ronis 1228 (XT1-XT2- XT4-XT5-XT7) and Castell (XT7). Kirk and Castell locks must be customer supplied, while Ronis is provided in the kits. Two options are available for Ronis: same keys and different keys. This allows the customer to create interlocking logics.

TABLE 65: UNDERVOLTAGE RELEASE CHARACTERISTICS

Frame			Voltage
XT1– XT2– XT4– XT5–XT6	24–30 V AC/DC	110–127 V AC/ 110–125 V DC	220–240 V AC/ 220–250 V DC
XT7	24 V AC/DC	110–120 V AC	220–240 V AC
FB (2-pole only)	24 V AC/DC	110–130 V AC 110–125 V DC	220–240 V AC/ 250 V DC

For accessory voltages above 240 V AC or 250 V DC, consult factory.

TABLE 66: PADLOCK CHARACTERISTICS

Frame	Padlocks*	Stem min.÷max.
XT1– XT2– XT4	3	Ø 0.24"÷0.275" / Ø 6÷7 mm
XT5–XT7	3	Ø 0.24÷0.315" / Ø 6÷8 mm
FB	1	Ø 0.25" / Ø 6.35 mm

*Padlocks are not included in the kits. Internal modules

Available with several different communication protocols, the Ekip Com internal module is installed directly inside the circuit breaker. It allows the circuit breaker to be integrated in a communication network for supervision and control. Ekip Com internal modules can be used for both Tmax XT4 and Tmax XT5. They can be connected to the trip unit when Ekip Touch is used.

Protocols supported include:
- Modbus® RTU
- Modbus TCP/IP
- Profinet
- Ethernet/IP
- IEC 61850

Cartridge modules
Cartridge Ekip Com modules, along with the internal modules, allow integration in any communication network. They can be used only on the Tmax XT7 circuit breaker equipped with an Ekip Touch/ Hi-Touch trip unit, mounted directly on the terminal box.

Several modules can be used simultaneously, enabling systems with different protocols. Modbus RTU, Profibus-DP and DeviceNet modules contain a terminating resistor and two DIP switches for optional activation to terminate the serial network or bus. The Profibus-DP module also contains a polarization resistor and two DIP switches for its activation.
- Modbus RTU
- Modbus TCP/IP
- Profinet
- Profibus
- Ethernet/IP
- DeviceNet
- IEC 61850

Ekip Com hub
The Ekip Com hub is the new communication module for cloud connectivity. A circuit breaker equipped with the Ekip Com hub can establish a connection with the ABB Ability Electrical Distribution Control System (EDCS) for the low-voltage power distribution panel. This dedicated module is available for the Tmax XT7 circuit breaker even when other modules are present. For further information on ABB Ability EDCS, please visit new.abb.com/low-voltage/launches/abb-ability-edcs.

Signalling modules
The Ekip 2K signalling cartridge modules, available for Tmax XT7, supply two input and two output contacts for control and remote signalling of alarms and circuit breaker trips.

The Ekip 1K signalling module, available for the Tmax XT5, supplies one input contact and one output contact for control and remote signalling. It is installed inside the circuit breaker in the housing provided on the left down side of the circuit breaker and can be used when an Ekip Touch/Hi-Touch trip unit is present.

Ekip signalling modules can be programmed from the trip unit display or via the Ekip Connect software and app. When using Ekip Connect, combinations of events can be freely configured.

Ekip power supply
The Ekip power supply module supplies all Ekip trip units and modules present on the Tmax XT7 with several auxiliary power sources (in AC or DC).

The cartridge module permits the installation of other advanced modules. It can be field installed at any time. Two versions are available according to the control voltage:
- Ekip supply 110–240 V AC/DC
- Ekip supply 24–48 V DC

This module is always needed with any Ekip Com module or the signalling 2K module.

SURGE PROTECTIVE DEVICES

ReliaGear® SB switchboard

ReliaGear RGSBSP Series SPDs are engineered with smart thermal disconnecting technology that safely removes overstressed components before harmful external effects arise. This preventive approach enhances safety and avoids nuisance OCPD tripping or thermal events. The core suppression system includes proprietary metal oxide varistors (MOVs) for surge energy diversion and metal film capacitors for filtering low-level transient voltages and electrical noise. The design is UL Listed as an open-type SPD, suitable for both factory and field installation or replacement.

Features and benefits

- Mounted on load side on main device
- UL 1449 5th edition, Type 1 and Type 2
- cUL Listed to UL 1449 and CSA C22.2 — ANSI/IEEE C62.62 and C62.72
- 0 to 95 percent relative humidity
- -40 to +149°F (-40 to +65°C) operating temperature
- UL 96A, meets SPD criteria — ANSI/IEEE C62.41 and C62.45
- UL 1283, EMI/RFI noise filter — ANSI/NFPA 70 (Art. 242) — Type 2 only
- Ratings:
  - 80 kA per mode/160 kA per phase
  - 150 kA per mode/300 kA per phase
  - 225 kA per mode/450 kA per phase
  - 300 kA per mode/600 kA per phase
- Thermally protected MOVs eliminate the need for additional upstream over current protection
- NO/NC Form C dry type contacts for remote monitoring
- MOV % loss and disconnection indication lights (Green/Orange/Red); Red service indicator alarm
- Audible alarm
- Standard LCD surge counter

* Individual- or group-mounted versions available.



33 SPD in switchboard with handle



34 SPD in switchboard with door open

POWER METERING

Power metering
Electronic meters offered are the RGM2200, RGM6000, RGM6010, RGM7000, RGM8000, RGM9700 and RGM9900.

RGM2200 digital power meter
The RGM2200 meter measures more than 40 electrical power parameters providing a low-cost, multifunction monitoring solution for industrial and power generation applications. RGM2200 can easily be mounted in a panel for generator monitoring, substation automation and more. This meter supports an optional RS-485 Modbus® or BACnet interface with baud rates ranging from 9600 to 57.6K.

Features and benefits
- Economical meter for circuit monitoring of panels, main feeds, branch circuits, and gensets
- True RMS measurement
- Universal operation - 50 / 60 Hz, user programmable for medium or low voltage circuits
- Mounts in 92 mm DIN and ANSI C39.1 round cut-outs

Applications
- Monitoring of electrical loads such as generator panels, feeders, switchgear, etc.
- Low and medium voltage applications

Monitoring and metering
- Measurements of 3-phase real time amps, volts, power, energy, power factor and frequency
- 0.5 percent accuracy
- Optional RS-485 Modbus, BACnet and KYZ pulse outputs

User interface
- Brilliant 3 line LED display
- Easy-to-use faceplate programming

RGM6000/6010 power meter



35 RGM6000/6010

RGM6000/6010 is the industry's highest performance revenue grade panel meter. Based on the latest technology and an all new platform, RGM6000/6010 has a superior cost to performance ratio and significantly outperforms other metering products many times its price.

RGM6000/6010 can easily by mounted in a panel for generator monitoring, substation automation and more. The unique combined ANSI and DIN mounting structure allows easy installation making it perfect for new metering applications as well as retrofit for existing analog meters.

Through a built-in infrared (IRDA) port, the meter can be programmed through a laptop computer without a physical wire connection to the meter, making programming or data download convenient and safe. Using standard high speed Modbus or BACnet (RGM6010) communications, the meter can also provide data to RTUs, PLCs and other control devices. When used with the ABB Ability, the meter can be remotely monitored.

The RGM6000/6010 excels in metering energy accurately exceeding ANSI C12.20 (0.2 percent) and IEC 687 (0.2 percent) energy measurement standards. The unit utilizes high speed DSP technology with high resolution A/D conversion to provide revenue certifiable accuracy for utility billing, substation metering, sub-metering and critical metering applications.

Features and benefits
- High accuracy multifunction power meter
- Superior performance at competitive pricing
- Ultra compact, easy to install, program and use
- 0.2 percent Class Revenue Certifiable energy and demand metering
- Fits both ANSI and DIN cut-out
- Large 3 line .56 inches bright LED display for better visibility and longer life
- User programmable for different system voltages and current measurements

Applications
- Continuous metering of electrical loads such as generator panels, feeders, switchgear, etc.
- Provides remote status when used with EnerVista suite of software
- Low- and medium-voltage applications
- Replaces multiple analog meters saving space and installation costs

Monitoring and metering
- True RMS multifunction measurements including Voltage, Current, Power, Frequency, Energy, etc.
- Meets ANSI C12.20 (0.2 percent) and IEC 687 (0.2 percent)
- Accuracy Classes
- Future field upgradeable for added functionality without removing installed meter
- Load percentage graphical bar for instant load visualization

User interface
- RS-485 Modus® protocol, BACnet up to 57.6K
- 3 Line .56 inches bright red LED Display
- Front IRDA Port laptop communication

RGM9900

The RGM9900 power quality meter provides invaluable power quality analysis using the latest PQ standards to record electrical disturbances, improving power system reliability and reducing downtime costs. It is also a precision revenue meter that collects energy usage with high accuracy. It is a cyber secured power quality meter, featuring multiport communication and is easy to install into existing infrastructure.

Features and benefits

Precision revenue metering

Creates Confidence in Energy Measurement
- Certified ANSI C12.20 0.1 Accuracy Class
- 0.06% energy accuracy
- Extensive load profiling, TOU and line loss compensation
- Multifunction metering, including current, volts, watts and frequency
- Vector/arithmetic sum for VA calculation

Power quality analysis

Eliminating disturbances and outages reduces operating costs.
- Capture power quality events, including surges and sags, and record subcycle transients at 50 MHz resolution
- Monitor voltage reliability to industry-accepted normative standards – IEC 61000-4-30 Class A Ed. 3 Certified
- Provide power quality reliability indices, including CBEMA and SEMI F47
- Quantify system reliability with power quality measurements, such as harmonics, flicker, unbalances, frequency and power factor – IEC 61000-4-15 Class A Flicker Meter and IEC 61000-4-7 Class A Harmonics and Interharmonics analysis Certified power quality meter
- Customize and view EN 50160 power quality compliance reports

Phasor Measurement Unit (PMU)

Synchrophasor measurements improve power system stability.
- Provide system operators with wide-area situational awareness through improved visibility into dynamic grid conditions
- Determine stress points of the electric power system
- Detect and aid in restoring an islanded section of the grid after a storm or major outage disturbance
- Instantaneous measurements provide early warning detection alerts that SCADA systems miss
- Provides built-in system wide PMU analysis for future implementation of big data analytics, artificial intelligence and machine learning to proactively improve power systems and prevent outages. The PMU provides the following synchronized measurements:
  - Individual voltage/current phasors (Va, Vb, Vc, Ia, Ib, Ic)
  - Symmetrical components phasors (V0, V1, V2, I0, I1, I2)
  - Frequency and Rate of Change of Frequency (ROCOF)
  - Built-in digital inputs
  - Analog
    - Fundamental power: (watt total and per phase, VA total and per phase, VAR total and per phase)
    - Displacement power factor: (total and per phase)
- Supports P (Fast Response) or M (Precise Measurement classes, user selectable
- Data frame rates for 50 Hz: 10/25/50 frames per second; for 60 Hz: 10/12/15/20/30/60 frames per second
- Data format: Configurable float or integer, polar or rectangular
- Time sync standard: IRIG-B or IEEE 1588 PTPv2
- Number of sessions: up to 2 simultaneous clients
- Supports Ethernet or Fiber over Ethernet: TCP communication for header, configuration, and command; UDP communication for data, including unicast, broadcast and multicast

Cyber Security

A cyber secured implementation prevents attacks on your power system data.
- 128-bit AES encrypted communication of sensitive data, including passwords, usernames, roles and rights
- 24-character complex passwords with password expiration

- Digital firmware signature with 512-bit encryption and customizable keys
- Eliminate brute force attacks with password fail timeouts
- Customizable role-based authorization with eight configurable roles
- Physical seals requiring physical access to the power quality meter make remote tampering impossible
- Security lockout prevents security from being disabled

Multiport Communication

Six communication ports communicate with SCADA and other software systems simultaneously.

- Communication protocols include Modbus® ASCII/RTU/TCP, DNP3, IEC 61850, GOOSE messaging, IEEE C37.118 (PMU), SNMP, SMTP, SNTP and IEEE 1588 PTPv2
- Up to 64 simultaneous protocol connections
- Built-in webserver to view and analyze real time data
- Two independent ethernet ports, with unique IP addressing, port control for security, DHCP and email on alarm
- Two independent serial ports
- Front panel ANSI optical and USB ports

RGM7000

The RGM7000 power and energy meter is a low cost, powerful metering solution for large scale deployment within an electrical distribution system. Add high accuracy, data logging, power quality functionality, extensive communication and I/O to existing or new power meter applications.

Features and benefits

High accuracy revenue metering

- ANSI C12.20 0.2 CL and IEC 61850 0.2S Class accuracy certification for energy measurements
- 0.007 Hz measurement for frequency control applications
- Verify accuracy using standard energy test pulse
- Compensate for Transformer Line Loss and CT/PT errors
- Meets New York state PSC approval for submetering

Power quality monitoring

- Record waveforms at up to 512 samples per cycle
- Up to 170 events stored before rollover
- View real time voltage and current waveforms
- Monitor THD and record harmonic magnitudes to the 40th order
- Program up to eight limits for alarm and control applications

Extensive communication options

- Standard IrDA port for configuration and direct data download
- Standard RS-485 port
- Modbus® ASCII/RTU/TCP, DNP3, and IEC 61850 protocols
- Up to two Ethernet and IEC 61850 ports with independent IP addresses/email on alarm/data push/embedded web servers/ IP whitelisting

Data logging

- Three independently programmable historical trending logs
- Record 64+ parameters per log
- I/O log, System Events anti-tampering log, Limit Alarm log

Expandable I/O

- Optional communication and I/O can be installed in the factory or added in the field
- The meter can accept up to two communication or I/O cards
- Expandable communication option cards are:
- 100BASE-T Ethernet (INP100S)
- IEC 61850 protocol Ethernet (INP300S)
- Expandable I/O option cards are:
  - Four pulse outputs, four status inputs (PO1S)
  - Two relay outputs/two status inputs (RO1S)
  - Four channel, bi-directional 0-1mA outputs (1mAOS)
  - Four channel 4-20 mA outputs (20mAOS)

RGM8000

The RGM8000 advanced power and energy meter is designed for utility substation and critical industrial applications. Improve the reliability, efficiency and sustainability of your facility with its high accuracy and power quality monitoring capability.

Features and benefits

Precision revenue metering

- Certified ANSI C12.20 0.1 CL and IEC 62053-22 0.2S energy measurement accuracy
- High precision frequency measurements – 0.007 Hz – for frequency control
- Energy test pulse for accuracy testing
- Perpetual time of use with customizable rate structures to meet jurisdictional requirements
- Transformer line loss and CT/PT compensation.
- Test Mode and energy presets
- Pulse accumulators and totalizers
- Up to eight pulse outputs and eight pulse inputs

Cyber security
Prevent tampering with customizable security features.
- For NERC CIP compliance
- An admin and up to eight users
- Encrypted, 30-character passwords
- Role-based authorization
- Password fail timeouts to eliminate brute force attacks
- IP Whitelisting with Ethernet cards

Power quality analysis
- Up to 512 samples/cycle waveform recording
- Storage for up to 319 events in the power and energy meter
- Waveform scope of real time voltage and current
- Independent CBEMA or SEMI F47 log plotting with millisecond time stamp for accuracy
- Harmonic recording to the 40th order
- View and analyze electrical system power factor

Real time SCADA communication capability
Designed for legacy and advanced smart substation applications.
- Standard RS-485 and front panel USB ports
- Two optional simultaneous Ethernet ports with separate IP addresses, email on alarm, data push and embedded web servers
- Optional RS-485/RS-232 serial port
- Modbus® ASCII/RTU/TCP, Level 2 DNP3 and IEC 61850 protocols

Extensive logging
Perform detailed load studies.
- Six independently programmable historical logs for trending
- Log 64+ parameters per log in the power and energy meter
- Over six years of recording and storage for four parameters at 15-minute intervals
- System Events anti-tampering log, I/O change log and Limit/Alarm log

Field expandable I/O and communication
Send data to multiple applications.
- Install up to two cards in meter's option card slots
- Four pulse outputs/four status inputs (PO1S)
- Two relay outputs/two status inputs (RO1S)
- Four channel, bi-directional 0-1mA outputs (1mAOS)
- Four channel 4-20 mA outputs (20mAOS)
- RS-232/RS-485 card (RS1S)
- 100BASE-T Ethernet card (INP100S)
- IEC 61850 protocol Ethernet card (INP300S)

RGM9700 Power quality meter
The RGM9700 is a high performance power quality meter with advanced logging capabilities and flexible communication options. The RGM9700 provides a comprehensive picture of power quality and consumption for metered points within an electrical system, empowering users to make power related analysis and decisions quickly and effectively, as well as recording data for accurate reconciliation. Its versatile transducer and display installation, along with comprehensive and innovative metering and communication features are ideal for utility, industrial and commercial power quality applications.

Features and benefits
- Updated IEC 61000-4-30 Class A Edition 3 Power Quality Measurement and EN50160 Reporting Support
- High resolution waveform recording (up to 1024 samples/cycle) and high accuracy 0.06 percent watt-hour energy metering with demand and time of use capture
- Improved metrology uses high and low gain sensors for high 0.06 percent accuracy as well as installation flexibility using both 1A and 5A secondary CTs
- Large 1.2GB logging memory makes it possible to log years of captured data
- Easy integration with standard 6 ports (4 serial/2 Ethernet) of flexible communications options and protocol support for simultaneous Modbus and DNP3 communications
- Post installation upgradable for future requirements with modular communications external I/O and software option functionality upgrades
- Separate meter unit and optional display for flexible and easy installation

SWITCHBOARD GROUND FAULT PROTECTION

Equipment ground fault protection
The following discussion applies only to solidly grounded wye systems.

Ungrounded and resistance grounded systems require special consideration and should be referred to a local ABB representative. Equipment with service disconnecting means rated 1000 A or more is equipped with ground fault protection as required by NFPA 70 and UL 891 as a standard feature. Optional ground fault protection for service disconnects rated than 1000 A is available.

The NEC requirement is for ground fault protection only on the main protective device. This is satisfactory only if loss of power to the entire system is acceptable under ground fault conditions. If not acceptable, then ground fault protection should be applied on successive downstream protectors until an acceptable level of system outage is obtained. The NEC recognizes this lack of selectivity and requires health care facilities which have ground fault protection to have two levels with selectivity between the main and feeder devices.

Ground fault protection
ReliaGear LV Switchboard supports the G Protection features of the Ekip trip to provide two ground fault solutions for solidly grounded systems requiring ground fault protection. Solidly grounded systems will use either a simple current summation for individual branch feeder circuit breakers or a modified differential scheme for multiple source systems. The modified differential scheme is not available with Tmax® XT circuit breakers. Ground fault for 3-wire branch circuits is accomplished by summing the phase currents from the integral current sensors on the circuit breaker. Branch circuit breakers serving 4-wire loads require the addition of a neutral current sensor compatible with the trip unit or a Emax 2 4-pole circuit breaker to monitor the load neutral current.

The neutral sensor signal is an input to the trip unit summation circuit.

Main and tie circuit breakers used on solidly grounded, 3-wire systems (no neutral bus for branch circuit loads) may also use the same summation ground fault protection system. To learn more about the G Protection feature of the Emax 2 Ekip please refer to 1SXU200040C0201.

Multiple-source systems
Multiple-source systems (or single-source systems with provisions for additional sources) with a neutral bus for branch circuit loads require the use of a modified differential ground fault (MDGF) scheme. The modified differential ground fault scheme, shown in Figure 34 for a typical double-ended configuration, accommodates neutral-to-ground bonding at each source. The scheme monitors all phase and neutral conductors on all source and tie circuit breakers and accounts for ground current flowing on the neutral bus due to the common neutral connection between sources.

The interconnection of the current sensors also accommodates any neutral load current that may appear on the ground bus. Each source and tie circuit breaker will have three standard 5 A relaying-type current transformers mounted in the circuit breaker compartment and a similar current transformer mounted on the neutral conductor. The secondary of these four current transformers are connected to a summing current transformer (CT) in the circuit breaker section. For simplicity, the four current transformers and summing CT are represented by a single current transformer symbol on the three-line diagram (Figure 34). The secondary of the summing CTs are interconnected to allow unbalanced currents to circulate in the loop. Trip units for the source and tie circuit breakers are connected to the summing CT loop through individual auxiliary current transformers. The summing and auxiliary current transformers are designed to allow a mixture of phase current transformer ratings for the source and tie circuit breakers.

For example, in the double-ended configuration, below, one main circuit breaker may be rated 4000 A, the other main rated 3200 A and the tie circuit breaker may be rated 2000 A. The summing and auxiliary CT ratios allow the use of phase and neutral current transformers that match the circuit breaker frame rating rather than requiring all current transformers to have the same primary rating. This solution allows users to optimize the main and tie circuit breakers for their given application.

For correct operation of the MDGF protection, the circuit breaker rating, trip plug, compartment/neutral current transformers and auxiliary/summing CT devices will all match for that circuit breaker. To ensure proper functionality, the following wiring limitations shall be followed:

- Phase and neutral current transformers to primary side of summing current transformer wire to be 14 AWG, twisted pair with a maximum one-way length of 30 ft.
- Auxiliary current transformer to secondary disconnect terminal wiring to be 16 AWG, twisted pair with a maximum one-way length of 49 ft.

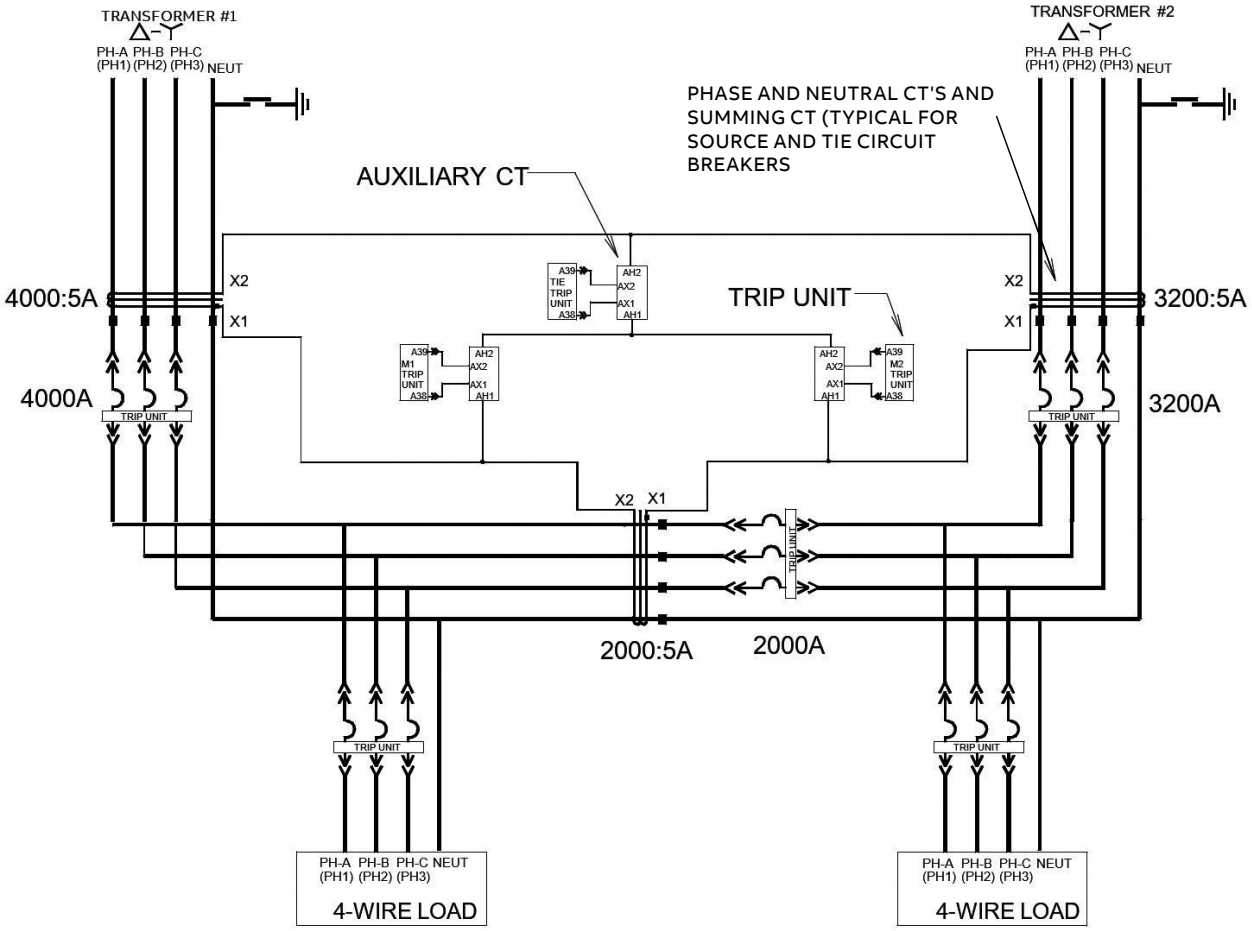
For ground faults on branch circuits, the modified differential ground fault scheme will provide backup tripping for the feeder circuit breaker ground fault protection. The source and tie circuit breakers that are connected to the bus with the ground fault will be signaled to trip should the feeder circuit breaker fail to clear the ground fault.

The same tripping response applies if the ground fault is ahead of the branch circuit breaker, within the switchboard, or on interconnecting cables or busway for multisource systems that are split into multiple lineups. The faulted bus section will be isolated by tripping the source and tie circuit breakers connected to the bus.

Trip unit setup for SACE® Ekip trip unit is detailed in MDGF user guide. All of the trip unit ground fault functions can be specified either to trip the circuit breaker or to provide an alarm when a ground fault is sensed.

All ground fault tripping is self-powered and requires no shunt trip coil or control power source. Ground fault alarms require either a communication connection to the trip unit or use of the programmable contact on the trip unit and a powered alarm circuit.

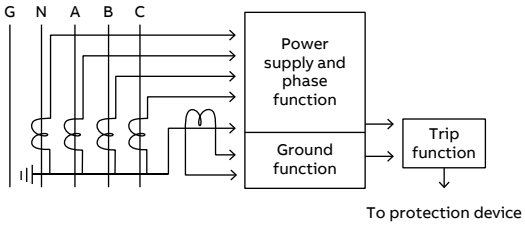
Testing by qualified personnel
Performance testing of the ground fault protection system should be undertaken only by qualified personnel. Particularly in the tests requiring the use of a high-current test set, it is usually necessary to obtain the services of a qualified testing organization. ABB's service teams are well qualified and equipped to provide this testing service.



36 Typical ground fault wiring diagram

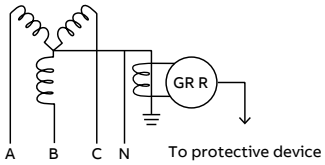
EntelliGuard™ TU trip units

When monitoring the outgoing ground fault current, the currents in each phase and neutral, if used, are summed up vectorially. In the absence of ground fault currents, the vector sum of the phase and neutral currents, IG is zero. When a ground fault occurs, the vector sum, IG corresponds to the ground fault current. When ordering the EntelliGuard TU unit, suffix G provides integral ground fault protection.



37 EntelliGuard TU ground fault circuit

When monitoring the returning ground fault current, the Entelli-Guard TU unit with suffix GR is ordered. The neutral CT is placed in the ground return circuit, not the neutral circuit. The trip unit responds to the current which the CT sees. Extreme care must be taken to insure that the CT is placed to detect all of the returning ground fault currents.



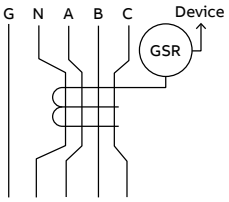
38 ITI ground fault relay diagram

Ground fault relays

Ground fault relays and sensors are designed to form a system for detecting a ground fault current on a ground ac power system. When a ground fault exceeds a selected Current level and Time Delay setting, the relay initiates a trip signal for a shunt trip disconnect device to open and clear the fault. This system is designed to provide protection for electrical equipment, not protection for personnel.

Ground sensor (zero sequence) ground fault protection

In this frequently used application, the CT surrounds all phase conductors and neutral, if existing. The magnetic fluxes produced by current flowing in the power conductors cancel if there is no ground fault current and the output to the relay is zero. This is often referred to as the "zero sequence" method of detecting ground faults.



39 Zero sequence ground fault diagram

Ground fault current detection systems

These Class 1 Ground Fault Relays and Sensors are designed to form a system for detecting a ground fault current on a ground AC power system. When a ground fault exceeds a pre-selected Current level and Time Delay setting, the relay initiates a trip signal for a shunt trip disconnect device to open and clear the fault. This system is designed to provide protection for electrical equipment, not protection for personnel.

- Meets NEC service entrance equipment standards
- Available in three basic styles, “Standard,” “Form C” or “Zone Interlocking” for coordination of single or multiple ground fault devices in system
- Integral test panel with Push To Test and Shunt Trip Bypass pushing for ease in proper operational testing of the system, with or without tripping the protective device
- “Power On” LED indicator in cover
- Positive visual trip indicator, manual reset
- Infinitely adjustable Time Delay
- Discrete current threshold adjustment
- Panel or door mounting
- Rear terminal kit and clear plastic cover standard with door mounting
- Electromechanical relay output, positive “ON” and “OFF”
- Operates with molded case and power circuit breakers, bolted pressure switches, fusible disconnect switches

TABLE 67: GFL SENSOR TECHNICAL DETAILS

Operating range	Trip currents of 5–60, 30–360 or 100–1200 A; time delay from 0.10 to 1 second (adjustable)
Input power	2 VA plus shunt coil requirements, rated @ 120 V AC
Input withstand	200,000 amperes RMS for 3 cycles, 50/60 Hz
Nominal input voltage	120 V AC, 125 V DC, 24 V DC, 48 V DC
Frequency	50/60 Hz
Ambient temperature range	-30 to +60°C

Only for use with GFL sensors. Approximate weight 1.5 lb.

TABLE 68: BGFL CONTACT RATING

Device input power	Inrush	Cont.
120 V AC	10 A	3 A
125 V DC	1 A	1 A
48 V DC	4 A	4 A
24 V DC	8 A	8 A

SWITCHBOARD ATS/ATO OPTIONS

Automatic transfer switches (ATS) options

T-Series transfer switches
Zenith T-Series transfer switches deliver:
- Reliability
- Ease of operation
- Troubleshooting and diagnostics
- Flexibility to adapt to site changes
- Scalability to grow with a facility
- Simple and low-cost facility integration
- Available for 1600 A up to 3000 A, 3-pole or 4-pole

Momentary loss of electric power to critical loads can endanger life, cause severe financial losses or both. Today's 24x7 service centers, critical healthcare facilities and data centers demand more than just continuity of power. The quality of power delivered to the load, the effectiveness of periodic system testing and the ability to diagnose outages and disturbances in the electrical system are issues that have serious implications for critical facilities.

Poor power quality damages equipment and increases maintenance costs. Inherent power problems stay hidden when testing is ineffective or incomplete. Going beyond source switching and addressing the issues of complete power quality requires a whole new level of ATS capability.

T-Series technology solutions
ABB's Zenith T-Series of transfer switches goes beyond just source switching. Integral metering and communications, high level diagnostics and unsurpassed flexibility make the Zenith T-Series a perfect solution for today's critical source switching.

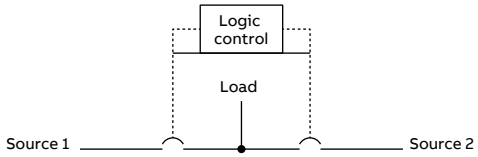
Global service capability
The Zenith T-Series is backed by the global service capabilities and resources of one of the world's largest corporations, capable of providing solutions to all of your power quality needs.

Automatic throwover (ATO) options

Features of ATOs with two circuit breakers

Description
Standard automatic throwover (ATO) units have the functions and features described here. Every effort should be made to apply the standard instead of specifying special features and functions.

Two ATO units
The two-circuit breaker unit is for use with a single bus power circuit where source 1 is the normal source and source 2 is the alternate source (Figure 40).



40 Two-ATO unit

Three methods for ATO logic control
1. Embedded Emax 2
2. Woodward controller
3. Programmable logic controller (PLC)

Circuit breakers
Emax 3/Emax 2 circuit breaker

Reference Embedded Emax 2 ATO Installation & Instructions manual — 1SQC088013M0201

Emax 3/Emax 2 offers pre-designed multiple power scenarios integrated with Lite Panel Pro, a human machine interface (HMI), to monitor open transition power transfers up to 4000 A.

Controller based system
Woodward controller DTSC-200A

Reference Woodward Emax 2 ATO Installation & Instructions manual — 1SQC088014M0201

Woodward controller offers custom parameter programming for open transition up to 6000 A for main-gen power transfer scenarios. Closed transition is available on Woodward designs; however, the request must be factory quoted.

Programmable logic controller (PLC)
RX3i, CPE200, CPE400, AC500

Control panel
- (Std – Hardwire & Lights) Lights & Switches
  - No diagnostic information, to view history
  - Limited light status information is available due to size of section location

- (Std – Remote I/O) HMI (Human Machine Interface)
  - Contains event history and event logs
  - Contains more status details
  - See Profinet Communication Status details
  - Adjustable timers without the need of special software

- (Optional-Remote I/O) Lights, Switches & HMI
  - Some application may be completed, but not all 2 or 3 CB configuration are done
  - Available for many applications, but not all 2 or 3 pole circuit breaker configurations are available
  - May impact width of section

UPS

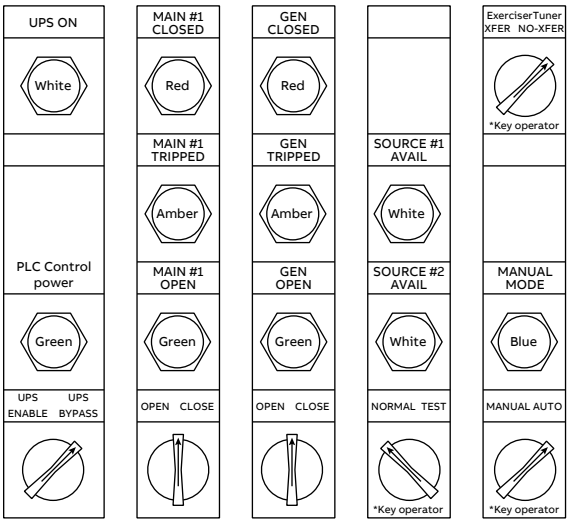
ABB power value UPS 1 kVA, 2 kVA, 3 kVA

Standard features

- Normal sources are monitored by adjustable voltage-sensing relays. They will detect a drop in voltage below a predetermined level. Standard setting is 75 percent dropout, 98 percent pickup. Other calibrations are available in a range of 76 percent to 100 percent for dropout and 85 percent to 99 percent for pickup
- 5 second time delay (PLC and Woodward controller adjustable) prevents automatic throw-over from transferring to alternate source during momentary outages
- Engine-start contact closes after 5 second time delay upon loss of normal source. The 5 second delay is PLC and Woodward controller adjustable. Prevents engine cranking caused by momentary power outages
- 5 minute engine cool-down (PLC adjustable) provides unloaded running time for engine before shutdown
- Voltage-frequency relay for the alternate power source prevents transfer to that source until voltage and frequency are more than 98 percent
- 15 minute retransfer delay (PLC and Woodward controller adjustable) before automatic retransfer from alternate to normal source after normal source is restored. Should normal power be restored and the alternate power source lost during the retransfer timing period, transfer of the load back to "Manual-Auto" keyed selector switch provides choice of manual or automatic mode of operation:
  - Manual position – disconnects automatic control and enables manual control of circuit breakers
  - Auto position – enables fully automatic operation and disconnects manual control of circuit breakers
- Circuit breaker control switch permits closing and tripping of circuit breakers when the manual/auto selector switch is in manual position
- "Test-Norm" keyed test switch. This maintained contact selector switch functions as follows (when the manual-auto selector switch is set for automatic operations):
  - Test position – simulates loss of phase and causes the throwover to alternate source. As long as they keyed test switch is left in the "Test" position, the load will be supplied from the alternate source
  - Returning the keyed test switch to "Norm" position will retransfer the load to the normal power source
  - Normal position – enables normal operation
- Indicating light shows the following:
  ATO:
  - Green – Circuit breakers open
  - Red – Circuit breakers closed
  - Amber – Circuit breaker trip by overcurrent
  - White – Source power available
  - Blue – Manual mode of operation (if used):
    - White – UPS on
    - Green – PLC control power available
- Circuit breakers are electrically interlocked to prevent the sources from being paralleled in open transition
- AUP contacts on circuit breakers can be used for inserted, test and withdrawn positions. Drawn out circuit breaker contacts disconnect automatic closing
- Power Breaker II uses bypass switches
- Manual retransfer to normal instead of automatic retransfer can be accomplished by turning the "Manual-Auto" keyed selector switch to "Manual" any time after an automatic transfer from normal to alternate source, but before the end of the retransfer timing period. Then the load may be transferred back to the normal source by using the circuit breaker control switches to trip the alternate circuit breaker and close the normal circuit breaker

Optional features for PLC method only

A plant exerciser timer keyed switch offers the same function as the keyed test switch except on an automatic basis. It can be set for daily or weekly operation. It can also be set to operate without transferring the load.



NOTE: Ship in UPS Bypass!

*Key operated switch with key removal in both positions

41 Key operated switch for PLC method

Operating instructions

Two-circuit breaker automatic throwover

Automatic operation – keyed selector switch on auto

1. When normal source fails, engine starts and load is transferred to the alternate source.
2. When normal source is restored, retransfer takes place automatically after delay (adjustable).
3. If manual retransfer is preferred, turn the keyed selector switch to manual after transfer to alternate source.
4. Engine shutdown after cool-off (adjustable).
5. Testing – use the keyed test switch to simulate loss of normal source (only available on the Woodward controller and the PLC methods).

Manual operation – keyed selector switch on manual

1. Use circuit breaker control switches to transfer loads.
2. To start engine, turn keyed test switch to test (only available on the PLC method).
3. To shut down engine, turn keyed test switch to normal (only available on the PLC method).

UPS operating instructions

Typical operation – selector switch on UPS enable

1. Upon start-up, UPS will be on and charging without output. The UPS will be bypassed if UPS switch is in UPS enabled or UPS bypass position. PLC control power light should be on.
2. To enable output, press the test button on the UPS until a short beep is heard. The UPS on light will turn on.
3. The switch should now be in the UPS enable position. If not, turn switch to this position.
4. If UPS fails and power is still available, the UPS will be bypassed to allow power to the logic control.
5. If replacing the UPS, turn selector to UPS bypass. This will allow the UPS to be shut down without disturbing the logic control. Caution: Wiring to UPS circuit is still alive!
6. If for some reason the power is lost while the selector switch is in UPS bypass position, the UPS will not supply power to the logic control. Turn selector switch to UPS enable position to allow the UPS to power the logic control.

Automatic control

Normal control

1. When normal source is available at rated voltage and the keyed selector switch is on auto, the normal main circuit breaker will be closed and the load will be served by the normal power source.

Automatic transfer

2. When normal source voltage drops below the dropout setting of the 3-phase undervoltage relay:
   - After an adjustable-second delay, the engine start contact will close.
   - When alternate source is present at more than 98 percent voltage, the normal circuit breaker will open and the alternate circuit breaker will close, transferring the load to the alternate source.

Automatic retransfer

3. When normal service is restored, automatic retransfer will take place after a timing period (logic control adjustable). Should normal power be restored and the alternate power source lost during the retransfer period, the load will be instantaneously transferred back to the normal source. For manual retransfer after automatic transfer, see step 8.

Engine shutdown

4. Following retransfer, the engine will shut down after a cool-off period.

Testing

5. Loss of normal source may be simulated by turning the keyed test switch to “Test.” This will initiate transfer as described in step 2. This load will be supplied from the alternate source as long as the keyed test switch is left in the “Test” position. Return the keyed test switch to “Normal” and retransfer will proceed as described in steps 3 and 4. Testing is only available on the Woodward controller and the PLC methods.

Manual control

Manual transfer

6. To manually transfer load from normal to alternate source (when normal source is still available):
   - Turn the keyed selector switch to “Manual” (only available on the Woodward controller and the PLC methods).
   - Turn the keyed test switch to “Test.” Engine starts if normal source fails, engine will start automatically.
   - Alternate source available light indicates when voltage and frequency are more than 98 percent.
   - Use circuit breaker control switches to trip normal circuit breaker and close alternate circuit breaker.

Manual retransfer

7. To manually retransfer load from alternate to normal source:
   - Turn the keyed selector switch to “Manual.”
   - Turn the keyed test switch to “Normal.” The normal source light will indicate if the source is available
   - Use circuit breaker control switches to open alternate circuit breaker and close normal circuit breaker.
   - Engine will shut down after cool-off period.

Manual retransfer after automatic transfer

8. After an automatic transfer from normal to alternate source, if it is desired to manually retransfer the load to normal, do the following:
   - Turn the keyed selector switch to “Manual” any time after the transfer to alternate source but before the end of the retransfer timing period.
   - After normal source is restored (as indicated by the light), use reference the below figure when the title is applied to it breaker control switches to transfer the load by opening alternate circuit breaker and closing normal circuit breaker.
   - Turn the keyed selector switch to “Auto” if automatic mode of operation is then desired.
   - If the keyed selector switch is left in “Manual,” the manual mode light (blue) will remain on as a reminder that the system is not set to automatic control.

Overcurrent lockout and reset

9. When a circuit breaker trips on overcurrent, it will be locked out mechanically to prevent reclose until hand reset. This is indicated by its amber indicating light. To reset, push the yellow bell alarm button on the circuit breaker.

Interlocking

10. Interlocking provisions prevent interconnections of normal and alternate sources. Both circuit breakers may be in the open position, but both cannot be in the closed position simultaneously for open transition.

Time delay settings

11. All time delay settings are internal to the logic control method selected. They may be adjusted by laptop computer (for the Woodward controller and the PLC methods) or some settings are adjustable via HMI as furnished with the Embedded Emax 2 method.

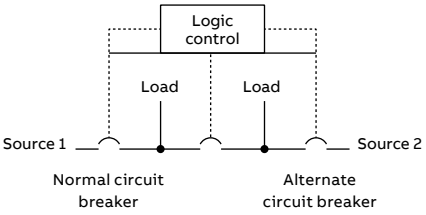
Features of ATOs with 3 circuit breakers

Description

Standard automatic thrower (ATO) units have the functions and features described here. Every effort should be made to apply the standard instead of specifying special features and functions.

Three-circuit breaker ATO units

The 3-circuit breaker ATO unit is for use with a sectionalized bus power circuit where source 1 and 2 are normal sources, usually separate utility services. A normally open bus tie circuit breaker connects the two sections of the main bus (Figure 42).



42 Three-circuit breaker ATO units

Control panel

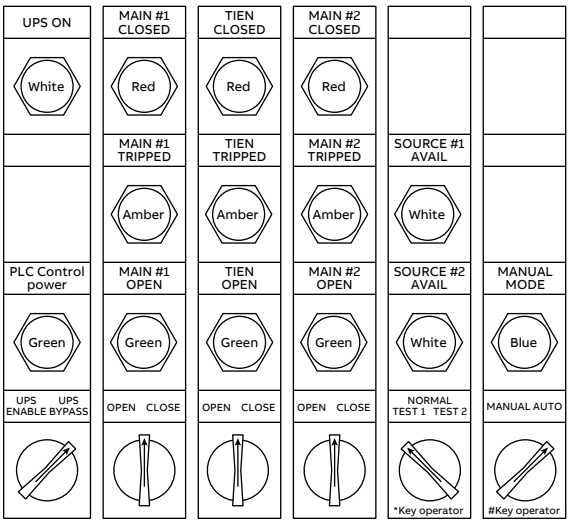
- (Std – Hardwire & Lights) Lights & switches
  - No diagnostic information, to view history
  - Limited light status information is available due to size of section location
- (Std – Remote I/O) HMI (Human Machine Interface)
  - Contains event history and event logs
  - Contains more status details
  - See Profinet Communication Status details
  - Adjustable timers without the need of special software
- (Optional-Remote I/O) Lights, switches & HMI
  - Some application may be completed, but not all 2 or 3 CB configuration are done
  - Available for many applications, but not all 2 or 3 pole circuit breaker configurations are available.
  - May impact width of section

Programmable logic control
RX3i, CPE100, CPE200, CPE400, AC500

UPS
ABB power value UPS 1 kVA, 2 kVA, 3 kVA

Standard and optional features

- Normal sources are monitored by adjustable voltage- sensing relays. They will detect a drop in voltage below a predetermined level. Standard setting is 75 percent dropout, 98 percent pickup. Other calibrations are available in a range of 75 percent to 100 percent for dropout and 85 percent to 99 percent for pickup
- Adjustable time delay (factory set at 5 seconds) before automatic throwover from normal to alternate source is provided to override momentary outages
- Adjustable timing (1 to 30 minutes, factory set at 15 minutes) provides delay before automatic retransfer from alternate to normal source after normal source is restored. Should normal power be restored and the alternate power source lost during the retransfer timing period, transfer of the load back to normal source will occur instantaneously
- "Manual-Auto" keyed selector switch provides choice of manual or automatic mode of operation:
  - Manual position – disconnects automatic control and enables manual control of circuit breakers
  - Auto position – enables fully automatic operation and disconnects manual control of circuit breakers
- Circuit breaker control switch permits closing and tripping of circuit breakers when the manual/auto selector switch is in manual position
- "Test #1-Norm-Test#2" test switch. This maintained keyed selector switch functions as follows (when the manual-auto selector switch is set for automatic operations):
  - Phase failure relay protection. Designed to protect against phase loss and phase unbalance in a power system. The output contacts change their normal state only when a phase loss or unbalance occurs for longer that the preset trip delay. The PFR relay operates in conjunction with the UV relay to initiate the throwover process
  - Test position simulates loss of phase and causes throwover to alternate source, as long as the test switch is left in the "Test" position
  - The load will be supplied from the alternate source. Returning the test switch to the "Norm" position will retransfer the load to the normal power source
- Indicating light show the following: ATO:
  - Green – Circuit breakers open
  - Red – Circuit breakers closed
  - Amber – Circuit breaker trip by overcurrent
  - White – Source power available
  - Blue – Manual mode of operation UPS (if used):
    - White – UPS on
    - Green – PLC control power available
- Circuit breakers are electrically interlocked to prevent the sources from being paralleled
- Bypass switches on drawout circuit breakers disconnect automatic closing and tripping control from a fully withdrawn circuit breaker
- Manual retransfer to normal instead of automatic retransfer is readily accomplished by using the standard controls. This is done by turning the selector switch to manual any time after an automatic transfer from normal to alternate source, but before the end of the retransfer timing period. Then the load may be transferred back to the normal source by using the circuit breaker control switches to trip the alternate (or bus tie) circuit breaker and close the normal circuit breaker



NOTE: Ship in UPS Bypass!

* Key operated switch with key removal in all (3) positions

Key operated switch with key removal in both positions

43 Key operated switch

Operating instructions

Three-circuit breaker automatic throwover

Automatic operation – keyed selector switch on auto

1. When normal source fails, its load is transferred to the alternate source.
2. When normal source is restored, retransfer takes place automatically after delay.
3. If manual retransfer is preferred, turn the keyed selector switch to manual after transfer to alternate source.
4. Testing – use the keyed test switch to simulate loss of normal or alternate source.

Manual operation –selector switch on manual

1. Use circuit breaker control switches to transfer loads.

Interlock prevents closing all three circuit breakers.

Overcurrent trip lockout – to reset, push circuit breaker trip button.

UPS operating instructions

Typical operation – selector switch on UPS enable

1. Upon start-up, UPS will be on and charging without output. The UPS will be bypassed if UPS switch is in UPS enabled or UPS bypass position. PLC control power light should be on.
2. To enable output, press the test button on the UPS until a short beep is heard. The UPS on light will turn on.
3. The switch should now be in the UPS enable position. If not, turn switch to this position.
4. If UPS fails and power is still available, the UPS will be bypassed to allow power to PLC.
5. If replacing the UPS, turn selector to UPS bypass. This will allow the UPS to be shut down without disturbing the PLC. Caution: Wiring to UPS circuit is still alive!
6. If for some reason the power is lost while the selector switch is in UPS bypass position, the UPS will not supply power to the PLC. Turn selector switch to UPS enable position to allow the UPS to power the PLC.

Automatic control

Normal control

1. When both normal sources are available at rated voltage and the selector switch is on auto, the bus tie circuit breaker will be open and both main circuit breakers will be closed, serving their respective loads.

Automatic transfer

2. When source voltage on one of the normal sources drops below the dropout setting of the 3-phase undervoltage relay:
   - After 5 second time delay (PLC adj.), the main circuit breaker will open and the bus tie circuit breaker will close, transferring the load to the alternate source

Automatic retransfer

3. When normal service is restored, automatic retransfer will take place after a timing period of 15 min. (PLC adjustable). Should normal power be restored and the alternate power source lost during the retransfer timing period, the load will be instantaneously transferred back to the normal source. For manual retransfer after automatic transfer, see step 7.

Testing

4. Loss of either normal source may be simulated by turning the keyed test switch to “Test.” This will initiate transfer as described in step 2. The load will be supplied from the alternate source as long as the test switch is left in the “Test” position. Return the keyed test switch to “Normal” and retransfer will proceed as described in steps 3 and 4.

POWER/HEAT LOSSES

Power/heat loss values for switchboard bus components are shown in Tables 69, 70 and 71 as applicable. All values in the tables are shown in watts. To convert to BTU/hour, multiply by 3.42.

TABLE 69: HORIZONTAL/VERTICAL BUS POWER/HEAT LOSSES

Bus rating (A)	Section width (in.)	AL power/heat loss (watts)	CU power/heat loss (watts)
600	15–25	69	73
	30–45	95	101
	50–60	114	120
800	15–25	122	130
	30–45	169	180
	50–60	201	213
1000	15–25	175	182
	30–45	233	243
	50–60	276	288
1200	15–25	226	233
	30–45	291	301
	50–60	339	351
1600	15–25	304	325
	30–45	394	419
	50–60	452	479
2000	15–25	419	435
	30–45	535	555
	50–60	613	634
2500	15–25	633	667
	30–45	773	812
	50–60	874	917
3000	15–25	617	670
	30–45	806	868
	50–60	950	1013
4000	15–25	1004	1067
	30–45	1248	1319
	50–60	1418	1493
5000	15–25	—	1094
	30–45	—	1325
	50–60	—	1488
6000	15–25	—	1376
	30–45	—	1673
	50–60	—	1883

TABLE 70: DEVICE CONNECTING BUS

Type of device	Ampacity (A)	AL power loss (watts)	CU power loss (watts)
Tmax® XT5	600	75	95
Tmax XT7	1200	163	216
Emax E1.3 and E1.2	1200	131	203
Emax E2.3 and E2.2	2000	294	453
Emax E4.3 and E4.2	3000	320	370
Emax E6.3 and E6.2	4000	333	398
Emax E6.3 and E6.2	5000	—	649
Emax E6.3 and E6.2	6000	—	682
Power Break® II	800	129	169
Power Break II	1600	213	280
Power Break II	2000	343	452
Power Break II	2500	278	369
Power Break II	3000	243	358
Power Break II	4000	449	592
Panel	400	15	21
Panel	800	49	83
Panel	1200	115	196
Panel	2000	215	339
Panel	3000	252	354
Panel	4000	465	686

To determine the total power loss of a switchboard section, the losses from the installed circuit breakers or switches need to be considered as well. These are shown in tables 72 and 73.

TABLE 71: PANEL

Ampacity (A)	Height	Power loss (watts)
400	16X	17
	24X	24
	32X	30
	40X	37
	48X	43
	56X	50
800	16X	65
	24X	91
	32X	118
	40X	145
	48X	170
	56X	197
1200	16X	85
	24X	117
	32X	147
	40X	175
	48X	205
	56X	236
2000	16X	191
	24X	255
	32X	317
	40X	374
	48X	428
	56X	481
3000	32X	216
	40X	251
	48X	280
	56X	322
4000	32X	379
	40X	443
	48X	506
	56X	570

TABLE 72

Circuit breaker type		[W]/[A]	250	400	800	1200	1600	2000	2500	3000	4000	5000	6000
Fixed	**E1.3 and E1.2 B-A, N-A, S-A**	W	7	17	59	125							
	E2.3 and E2.2 B-A, N-A, S-A	W		15	48	100	170						
	E2.3 and E2.2 H-A, V-A / E2.2 2000A B-A, N-A, S-A	W		15	48	99	167	250					
	E4.3 and E4.2 S-A, H-A, V-A	W			44	59	143	211	310				
	E4.3 and E4.2 3200A/3600A S-A, H-A, V-A	W			42	81	132	193	280	445			
	E6.3 and E6.2 H-A, V-A	W								323	476	700	
Drawout	**E1.3 and E1.2 B-A, N-A, S-A**	W	14	35	118	250							
	E2.3 and E2.2 B-A, N-A, S-A	W		22	73	152	260						
	E2.3 and E2.2 H-A, V-A / E2.2 2000A B-A, N-A, S-A	W		22	68	138	233	350					
	E4.3 and E4.2 S-A, H-A, V-A	W			58	114	189	279	410				
	E4.3 and E4.2 3200A/3600A S-A, H-A, V-A	W			49	111	181	264	384	610			
	E6.3 and E6.2 H-A, V-A	W								438	646	952	1484

TABLE 73

Trip unit	In [A]	XT1 [watts/pole]	XT2 [watts/pole]	XT3 [watts/pole]	XT4 [watts/pole]	XT5 [watts/pole]	XT6 [watts/pole]
Thermomagnetic trip units: TMF, TMA, TMC	15	1.3	1.1	—	—		
	20	1.8	1.6	—	—		
	25	2.0	1.8	—	2.7		
	30	1.8	2.3	—	3.9		
	35	2.0	2.8	—	4.4		
	40	2.6	3.7	—	4.5		
	45	3.0	—	—	—		
	50	3.7	4.1	—	4.7		
	60	3.9	4.4	3.9	4.8		
	70	3.7	4.4	3.7	5.4		
	80	4.8	5.8	4.8	5.5		
	90	5.7	6.6	4.5	6.0		
	100	7.0	8.1	5.6	6.2		
	110	8.3	8.8	5.8	6.7		
	125	10.7	11.4	6.6	7.4		
	150	—	—	6.9	7.8		
	160	—	—	7.9	8.9		
	175	—	—	10.1	9.1		
	200	—	—	13.2	11.9		
	225	—	—	14.4	13.3		
	250	—	—	—	16.4		
	300					15.4	
	400					24.1	
	500					33.5	
	600					46.0	30.6
	800						54.2
Electronic trip units: Ekip Dip, Ekip Touch	10	—	0.1	—	—		
	25	—	0.8	—	—		
	40	—	0.7	—	0.6		
	60	—	1.5	—	1.3		
	100	—	4.2	—	3.5		
	125	—	6.6	—	—		
	150	—	—	—	7.8		
	200	—	—	—	10.5		
	225	—	—	—	13.3		
	250	—	—	—	16.4	8	
	250	—	—	—	16.4	8	
	300					10.8	
	400					19	
	600					43	30
	800						53.4

The values shown in the tables are at the 100% rated current. Power losses for lower current values may be estimated by the following formula:

$We = WFL(I/IFL)^2$

where:

We = estimated watts loss at load current
WFL = estimated watts loss at 100% rated current
I = load current
IFL = full load current

Other resources
- 1SQC088005C0201 - EXcelerate Design Guide for fast shipping switchboards
- ReliaGear® SB switchboard website

Installation manuals
Additional technical information, instructions and installation manuals can be found in the following documents:
- 1SQC900005M0201 – ReliaGear neXT – Reduced Energy Let-through Unit (RELT)
- 1SQC173264D0201 – ABB RGSBSP Series Surge Protection Device (SPD) for Switchboards
- 1SDH000722R0001 – SACE® Tmax® XT – Installation Instructions XT4
- 1SDH002011A1002 – SACE Tmax XT – Installation Instructions XT5
- 1SDH002012A1002 – SACE Tmax XT – Installation Instructions XT6
- 1SDH002013A1001 – SACE Tmax XT7 – XT7M – Installation Instructions XT7-XT7M
- 1SDH001821A1002 – SACE Tmax XT7 - User manual for use and maintenance of Ekip Touch Trip units for Tmax XT7 low-voltage molded-case circuit breakers
- 1SDH002039A1002 – SACE Tmax XT - Operation and maintenance manual for Ekip Touch Trip Units
- 1SDH002031A1002 – Tmax XT2 - XT4 - User manual for use and maintenance of Ekip Touch Trip units for Tmax XT2 - XT4 low-voltage molded-case circuit breakers
- 1SDH000722R0003 – SACE Tmax XT UL – Installation instructions XT4 UL
- 1SDH002013A1606 – SACE Tmax XT – KLC-A STI, RONIS 1104, Kirk – XT7
- 1SDH000719R0610 – SACE Tmax XT – PLL XT1-XT3 Padlocks Device OP/CL
- 1SDA066592R1 – SACE Tmax XT – PLL XT2-XT4 Padlocks Device OP/CL
- 1SDH002013A1604 – SACE Tmax XT – PLL – Padlock device XT7 in open position
- 1SDC007114G0201 – Arc flash energy reduction using ABB Emax 2 with second I Protection (2I) and Dual Settings
- 1SXU210248C0201 – SACE Tmax XT UL/CSA – Low voltage molded case circuit breakers UL 489 and CSA CS22.2 Standards for the NEMA market
- 1SDH001000R0524 – Ekip Signalling 2K - E1.2-E2.2-E4.2-E6.2-XT2-XT4-XT5-XT7-XT7M
- 1SDC220101D0201 – SACE Emax 3 low voltage power circuit-breakers IEEE C37.13/UL 1066/CSA standards
- 1SDH002311A1002 – Operating instructions for the design engineer - SACE Emax 3
- 1SXU200040C0201 – SACE Emax 2 low voltage power circuit breakers ANSI C37/UL 1066/CSA standards
- GEH6270 – Power Break II circuit breakers 800–4000 A frames, 240–600 V AC
- 1SDH001000R0002 – Installation, operation and maintenance instructions for the installer and the user - Emax 2 E2.2-E4.2-E6.2
- 1SDH000999R0002 – Installation, operation and maintenance instructions for the installer and the user - Emax 2 E1.2
- 1SQC088013M0201 — Embedded Emax 2 ATO Installation & Instructions manual
- 1SQC088014M0201 — Woodward Emax 2 ATO Installation & Instructions manual

In memoriam
Victoriano (Vic) Zamora Ledezma

Vic played a key role on the ReliaGear® SB project and was instrumental in developing this technical guide, which he was working on when he lost his battle with COVID-19 in 2020.

Vic was a humble leader to many, both personally and professionally. During his 20-year career, Vic mentored dozens of young engineers, making friends and earning the respect of his colleagues worldwide. He will be remembered for his professionalism, dedication and selflessness.

ABB Inc.
305 Gregson Drive
Cary, NC 27511 USA

electrification.us.abb.com

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