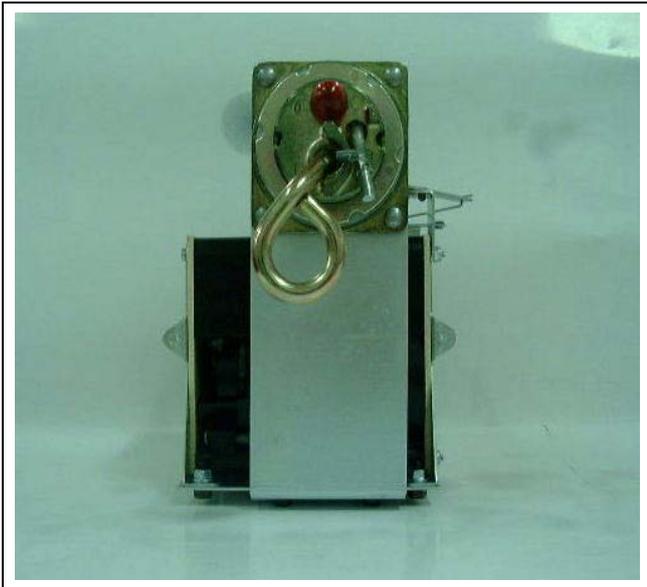


General Information :

- LR Breaker
- SQR Breaker
- LQR Breaker, HQR Breaker
- Wall-Mounting Type

CSP Circuit Breaker Three Phase

Three Phase CSP Circuit Breaker For Distribution Transformers—General Information For Selection of Breaker Type



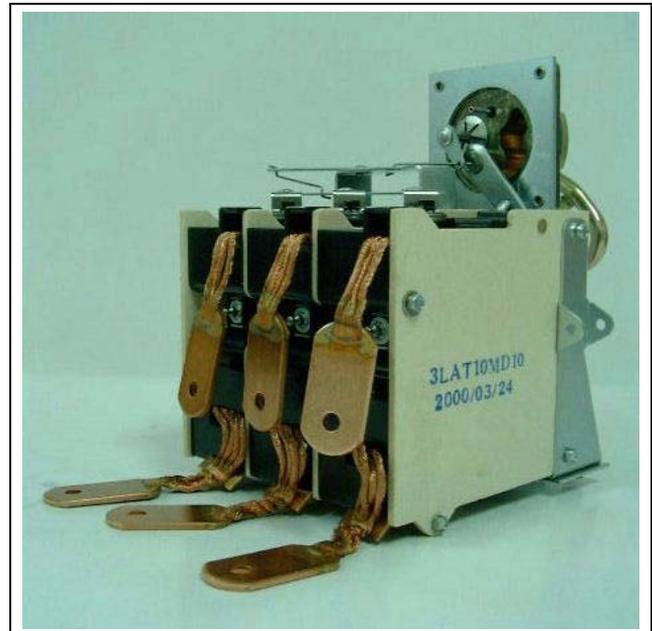
Wall-Mounted R Breaker (Front View)



Wall-Mounted R Breaker (Left Side View)



Wall-Mounted R Breaker (Back View)



Wall-Mounted R Breaker (Isometric Side View)

Designed & Licensed By
ABB Power T&D Company

P&A Power Products Inc.



Introduction

Three phase "CSP" type distribution transformers require an internal three phase "CSP" breaker for proper operation. P&A manufactures a full line of three phase breakers; these are designated as the "R" series (LR, SQR, LQR and HQR) All have been designed for service under oil within the distribution transformer. The circuit breakers can handle continuous loads up to 1000 amperes and 480Y/277 volts.

Technical Detail

The CSP breaker is connected to the transformer between the low voltage winding and the secondary bushing's internal terminals (please refer to the schematic diagram shown in Figure 1). The connections are made so that the secondary load current flows through both the breaker bimetal and contact. This is necessary to properly monitor the secondary transformer current and load levels.

The breaker is available with two auxiliary features: a signal light contact and an emergency control setting. The signal light contact is connected into the signal light circuit and is used to provide an early warning of transformer overload. The signal light operates on approximately 4 to 6 volts (14 volts optional), picked up by an auxiliary winding of consisting of one or two turns through the core. (The signal light contact is an optional feature of the circuit breaker and should be specified, if desired). The emergency control mechanism is a mechanical linkage inside the breaker which moves the breaker to a higher calibration of the temperature setting when placed into the emergency position. (This is also an optional feature and should be specified, if desired)

Preliminary Breaker Selection

In order to determine which basic breaker design is appropriate for the transformer, the transformer's rated current is calculated and compared to the circuit breaker's Nominal Current Rating (shown in table1); the Nominal Current Rating of the breaker, in most cases, should be equal to or greater than the transformer's rated secondary current.

The Nominal Current Rating is only used as a guide for the preliminary breaker selection. The breaker's current carrying parts are designed to accommodate significant transformer overload current above the Nominal Current Rating as predicted by ANSI standards. It should be noted that adjustments to this table may be appropriate for transformers not designed to ANSI standard.

Once the preliminary selection is complete, calculations must be made to determine the specific technical details necessary to completely specify the breaker. All of the major technical and application parameters of the breakers are presented in Table 1.

The R-series breaker is constructed using the unit pole concept. This construction method allows each pole of the breaker to operate independently. The advantage of this method of construction is that it allows the breaker designer to minimize the amount of mechanical work that must be done by the bimetal because the bimetal only has to work against one pole of the latching system. The R-series of breaker also features a low force latching and tripping mechanism, which further reduces the required bimetal mechanical work. Because of its intended application range, the LQR and HQR breaker always contains a magnetic trip element in addition to the thermal trip provided by the bimetal. General dimensional and mounting informations for the R-series of breakers are contained in Dimension Sheet series 44-882.

Construction Details

Each pole of the breaker is contained completely by a rugged glass reinforced molded thermoset polyester housing. The housing accurately locates all of the critical linkage and alignment points as well as provides the mechanical protection for all of the working parts of the breaker. The design of the R-series breaker isolates the bimetal from the contact toggle forces. This reduces the required bimetal force and increases the precision and repeatability of the breaker. Each pole of the breaker is mechanically linked through the trip arm pin and interlock bar to the other pole of the breaker. This mechanical linkage ensures that all poles of the breaker will open simultaneously regardless of which pole is the trip initiating pole. The breaker is manually opened, closed, and set via linkage which connects the external operating mechanism to the breakers operating handle.

Contact Structure

The breaker contacts are refractory type (copper-tungsten or silver-tungsten) in order to withstand the high current arcing which occurs during fault current interruption. The contacts are silver plated to ensure reliable low resistance contact under all conditions.

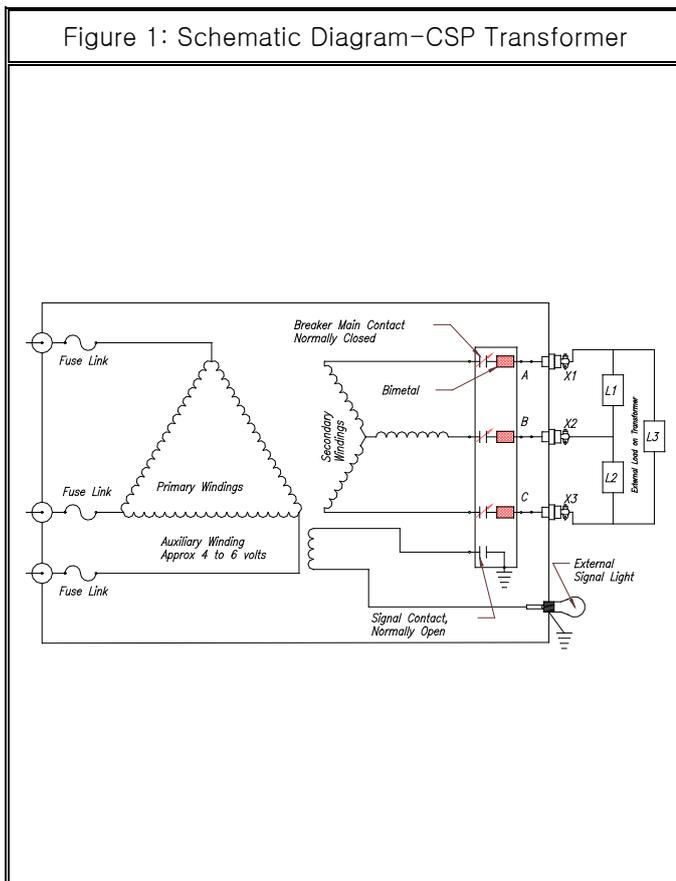
Emergency Control Feature

When the Emergency Control linkage is activated, the linkage rotates the calibration screw in the direction of increasing trip temperature setting. Thereby, in effect, recalibrating the breaker to a higher trip temperature. The amount of trip temperature increase is presented in Table 1. Add this value to the breaker's calibration temperature for the EC increased trip temperature.

Frame Mounting

The R-series breaker is mounted in an upright position; traditionally, on top of the core/coil superstructure. Sufficient electrical clearance must be provided; information concerning electrical clearances is given in dimension sheet series #44- 882. The breaker operating lever, attached to the breaker, can be supplied on either the left hand side or the right hand side of the breaker. The hand side of the Breaker must be specified at the time of ordering. The hand side is determined by viewing the breaker from the lead end. The breaker is also available in a center operated version.

Figure 1: Schematic Diagram—CSP Transformer



Frame Mount Signal Light

The signal lamp is a nominal 6 volt bulb (14 volts optional) with a screw base. The electrical circuit for the bulb passes through the center contact of the bulb into a crimp termination for attachment to the signal circuit on the inside of the transformer. The other side of the bulb's electric circuit passes through the bulb's threads into the lock nut and washer. The signal circuit depends on a reliable connection between the mounting boss and the tank ground circuit.

CAUTION: Mounting The SQR, LQR and HQR breaker can only be mounted in the upright position because their internal magnet trip relies on the force of gravity to provide the reset action.

Wall-Mounted Breaker

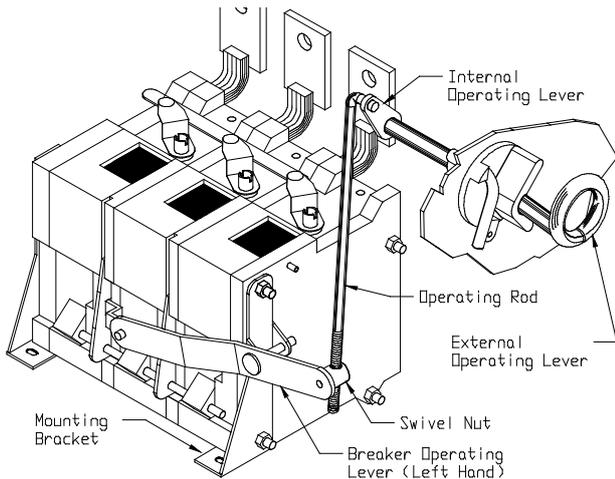
The R-series breaker can be supplied in a unitized wall mount configuration. The breaker is pre-assembled to the external operating mechanism and all mechanical connections, including the opening and closing mechanism and emergency control linkage (if specified), are assembled at the factory. Installation to the transformer only requires that the wall mount assembly be passed through the transformer tank mounting hole and secured in place with its mounting nut.

No other mechanical assembly is required. The standard electrical connection between the winding and the breaker leads and between the low voltage bushings and the breaker leads are made to complete the basic installation into the transformer. When the signal light function is desired, the auxiliary winding connections between the signal light terminal and between the auxiliary winding and the breakers signal contact terminal must be made.

Wall Mounted Mounting Boss

The mounting boss is a zinc die casting with a yellow chromate seal coating. The mounting boss contains the main operating handle, the emergency control operating lever and the signal light. The mounting boss passes through the tank mounting hole (Approximately 2.25 inches or 57.2 mm) from the inside and is secured to the tank with a rugged conduit type nut. The mounting nut is also a coated die-casting. The entire external portion of the mechanism has been designed for superior corrosion resistance and shows negligible effect after 1,500 hours of salt spray testing.

"R" Series Breaker Frame Mounting



Main Operating Handle

The main operating handle is fabricated from steel with a yellow chromate sealer over zinc plating for corrosion resistance. It is sealed into the mounting boss with a high temperature elastomeric gasket. The exterior portion of the operating handle formed into an operating eye with a one inch inside diameter.

Emergency Control Operating Lever

This lever is fabricated from the strength, corrosion resistant aluminum. It is also sealed into the mounting boss with a high temperature elastomeric gasket.

Sealing System

As mentioned above, all shaft seals are high temperature elastomeric gaskets. The cylindrical seal within the signal light housing is also made from this material. The gasket, which seals the mounting boss to the tank, is fabricated from nitrile.

Wall Mounted Breaker External Boss Assembly



Wall Mount Signal Light

The signal lamp is a nominal 6 volt bulb (14 volt optional) with a screw base. The electrical circuit for the bulb passes through the center contact of the bulb into a crimp termination for attachment to the signal circuit on the inside of the transformer. The other side of the bulb's electric passes through the bulb's threads into the mounting boss.

CAUTION : Transformer Processing

If the breaker is to be fixed to the transformer and then processed along with the winding, P&A should be consulted for recommendations. In general, it is acceptable for the breaker to be subjected to processing temperatures in the range of 125°C. After processing, the contacts should be cleaned to remove any oil residue. If a wall-mounted breaker is to be processed, the signal light lens and gasket and the tank-mounting gasket should be removed prior to processing. These gaskets should not be subjected to the heat of processing. All internal seals are constructed of high temperature elastomers and may be processed.

CAUTION : Large motor Loads

When the CSP transformer is connected to a large, dedicated motor load, special considerations must be observed. If the motor horsepower is equal to or greater than 50 percent of the transformer rated KVA, a special breaker must be used to prevent unnecessary breaker trips. Please consult P&A for further details.

3 Pole Wall-Mounted Breaker "R" Series Breaker



Application Data

Application information is contained in the dimension sheets, which are supplied as part of this technical information. These dimension sheets should be carefully studied for details regarding mounting, electrical clearances, and linkage set-ups. P&A should be consulted whenever additional information is required. Thermal application of the circuit breaker to the transformer is done in accordance with the principles outlined in ANSI/IEEE Standard #C57.91-1981, *Guide for Loading Mineral-Oil-Immersed Overhead and Pad-Mounted Distribution Transformer*.

Bimetal Temperature

The equation governing the temperature rise in the bimetal due to the flow of load current through it is given by:

$$\text{LR/SQR/LQR/HQR breakers : } \Theta b = JI^2$$

Where:

Θb = Bimetal temperature rise due to current in $^{\circ}\text{C}$

J = Bimetal Ampere Response Factor in $^{\circ}\text{C}/\text{A}^2$

I = Current Flow through the Bimetal

The total temperature of the bimetal (T_b) is given by the following equation:

$$T_b = T_o + \Theta b$$

Where:

T_o = Temperature of the oil in the vicinity of the bimetal in $^{\circ}\text{C}$

When T_b reaches the trip temperature setting of the breaker (T_B), the breaker trips.

The J constants for the various bimetal are given in Table 2. Short time performances of the circuit breakers are described by various curve sets listed in Table 2.

The following tables present the suggested P&A CSP breaker selection for proper coordination in self-protected transformers.

Table 1 : Circuit Breaker Rating & Application Data

Parameter	LR Breaker			SQR Breaker		LQR Breaker		HQR Breaker		
	Bimetal ID	042	063	104	156	208	313	417	577	722
Nominal Current Rating	45A	65A	110A	160A	210A	350A	450A	620A	780A	970A
Interrupting Current Rating : 2 shots (rms symmetrical)	6,000A			12,000A		25,000A		30,000A		
Volts per Pole	240V			240V		240V		240V		
Power Frequency Withstand Voltage	10KV			10KV		10KV		10KV		
Impulse Voltage Withstand	30KV			30KV		30KV		30KV		
Minimum Trip Temperature	100°C			100°C		100°C		100°C		
Maximum Trip Temperature	160°C			160°C		160°C		160°C		
Trip Temperature Increment	10°C			10°C		10°C		10°C		
Tolerance on Trip Temperature(Trip & sig)	±10%			±10%		±10%		±10%		
Signal Circuit Trip Temperature(Nominal) (degrees less than breaker trip temperature)	15°C	25°C	30°C	30°C		30°C		30°C		
Emergency Control Trip Temperature(Nominal) (degrees greater than breaker trip temperature)	15°C	15°C	15°C	25°C		25°C		25°C		

Table 2 : Breaker Application Constants

Breaker Type	Bimetal ID	J	Shot Time Curve
LR	042	0.00200	#735702-A
LR	063	0.00120	#735702-A
LR	104	0.00070	#735702-A
SQR	156	0.00020	#735702-A
SQR	208	0.00014	#735702-A
LQR	313	0.00009	#735702-A
LQR	417	0.00007	#735702-A
HQR	577	0.000045	#735702-B
HQR	722	0.000033	#735702-B
HQR	909	0.000023	#735702-B

**Table 3 : Ordering Information for Frame Mounted Breaker
3-Phase Breaker in Standard Configuration**

Trip	Bimetal ID	Transformer kVA		Signal Circuit	Emergency	Handle Orientation	Style Number
		420V	400V				
Thermal	042	30	30	Yes	Yes	Left	3LAI04MAxx
						Right	3LAI04MBxx
				No	No	Left	3LAI04RAxx
						Right	3LAI04RBxx
				No	Yes	Left	3LAI04EAxx
						Right	3LAI04EBxx
Thermal	063	45	45	Yes	Yes	Left	3LAI06MAxx
						Right	3LAI06MBxx
				No	No	Left	3LAI06RAxx
						Right	3LAI06RBxx
				No	Yes	Left	3LAI06EAxx
						Right	3LAI06EBxx
Thermal	104	75	75	Yes	Yes	Left	3QAI10MAxx
						Right	3QAI10MBxx
				No	No	Left	3QAI10RAxx
						Right	3QAI10RBxx
				No	Yes	Left	3QAI10EAxx
						Right	3QAI10EBxx
Thermal/Magnetic	156	112.5	100	Yes	Yes	Left	3QAI16MAxx
						Right	3QAI16MBxx
				No	No	Left	3QAI16RAxx
						Right	3QAI16RBxx
				No	Yes	Left	3QAI16EAxx
						Right	3QAI16EBxx
Thermal/Magnetic	208	150	150	Yes	Yes	Left	3QAI21MAxx
						Right	3QAI21MBxx
				No	No	Left	3QAI21RAxx
						Right	3QAI21RBxx
				No	Yes	Left	3QAI21EAxx
						Right	3QAI21EBxx

- Note : When ordering, substitute the breaker trip temperature minus 100 °C for the values of "xx" in the above table (i.e. 3LAI10MA50 has a trip temperature of 150 °C)
- Frame mounted LR, SQR, LQR and HQR breaker may be ordered in accordance with table 3, above. For special designs, not covered by the standard styles, please refer to P&A.

**Table 3 : Ordering Information for Frame Mounted Breaker
3-Phase Breaker in Standard Configuration**

Trip	Bimetal ID	Transformer kVA		Signal Circuit	Emergency	Handle Orientation	Style Number
		420V	400V				
Thermal/Magnetic	313	225	200	Yes	Yes	Left	3QAI31MAxx
						Right	3QAI31MBxx
				No	No	Left	3QAI31RAxx
						Right	3QAI31RBxx
				No	Yes	Left	3QAI31EAxx
						Right	3QAI31EBxx
Thermal/Magnetic	417	300	300	Yes	Yes	Left	3QAI42MAxx
						Right	3QAI42MBxx
				No	No	Left	3QAI42RAxx
						Right	3QAI42RBxx
				No	Yes	Left	3QAI42EAxx
						Right	3QAI42EBxx
Thermal/Magnetic	577	450	400	Yes	Yes	Left	3QAI58MAxx
						Right	3QAI58MBxx
				No	No	Left	3QAI58RAxx
						Right	3QAI58RBxx
				No	Yes	Left	3QAI58EAxx
						Right	3QAI58EBxx
Thermal/Magnetic	722	500	500	Yes	Yes	Left	3QAI72MAxx
						Right	3QAI72MBxx
				No	No	Left	3QAI72RAxx
						Right	3QAI72RBxx
				No	Yes	Left	3QAI72EAxx
						Right	3QAI72EBxx
Thermal/Magnetic	909	630	630	Yes	Yes	Left	3QAI91MAxx
						Right	3QAI91MBxx
				No	No	Left	3QAI91RAxx
						Right	3QAI91RBxx
				No	Yes	Left	3QAI91EAxx
						Right	3QAI91EBxx

- Note : When ordering, substitute the breaker trip temperature minus 100°C for the values of "xx" in the above table (i.e. 3LAI10MA50 has a trip temperature of 150°C)
- Frame mounted LR, SQR, LQR and HQR breaker may be ordered in accordance with table 3, above. For special designs, not covered by the standard styles, please refer to P&A.

**Table 4 : Ordering Information for Wall Mounted Breaker
3-Phase Breaker in Standard Configuration**

Trip	Bimetal ID	Transformer kVA		Signal Circuit	Emergency	Handle Orientation	Style Number
		420V	400V				
Thermal	042	30	30	Yes	Yes	Standard	3LAI04MDxx
				No	No	Standard	3LAI04RDxx
				No	Yes	Standard	3LAI04EDxx
Thermal	063	45	45	Yes	Yes	Standard	3LAI06MDxx
				No	No	Standard	3LAI06RDxx
				No	Yes	Standard	3LAI06EDxx
Thermal	104	75	75	Yes	Yes	Standard	3LAI10MDxx
				No	No	Standard	3LAI10RDxx
				No	Yes	Standard	3LAI10EDxx
Thermal/Magnetic	104	75	75	Yes	Yes	Standard	3QAI10MDxx
				No	No	Standard	3QAI10RDxx
				No	Yes	Standard	3QAI10EDxx
Thermal/Magnetic	156	112.5	100	Yes	Yes	Standard	3QAI10MDxx
				No	No	Standard	3QAI16RDxx
				No	Yes	Standard	3QAI16EDxx
Thermal/Magnetic	208	150	150	Yes	Yes	Standard	3QAI21MDxx
				No	No	Standard	3QAI21RDxx
				No	Yes	Standard	3QAI21EDxx
Thermal/Magnetic	313	225	200	Yes	Yes	Standard	3QAI31MDxx
				No	No	Standard	3QAI31RDxx
				No	Yes	Standard	3QAI31EDxx
Thermal/Magnetic	417	300	300	Yes	Yes	Standard	3QAI42MDxx
				No	No	Standard	3QAI42RDxx
				No	Yes	Standard	3QAI42EDxx
Thermal/Magnetic	577	450	400	Yes	Yes	Standard	3QAI58MDxx
				No	No	Standard	3QAI58RDxx
				No	Yes	Standard	3QAI58EDxx
Thermal/Magnetic	722	500	500	Yes	Yes	Standard	3QAI72MDxx
				No	No	Standard	3QAI72RDxx
				No	Yes	Standard	3QAI72EDxx
Thermal/Magnetic	909	630	630	Yes	Yes	Standard	3QAI91MDxx
				No	No	Standard	3QAI91RDxx
				No	Yes	Standard	3QAI91EDxx

- Note : When ordering, substitute the breaker trip temperature minus 100°C for the values of "xx" in the above table (i.e. 3LAI10MD50 has a trip temperature of 150°C)
- Wall Mounted breakers may be ordered in accordance with Table 4, above. For special designs, not covered by the standard style, please refer to P&A.