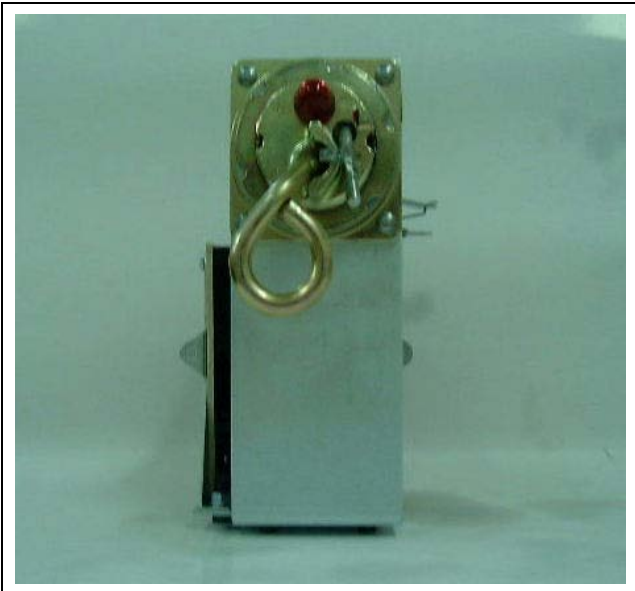


General Information :
LR Breaker
SQR Breaker
LQR Breaker, HQR Breaker
Wall-Mounting Type

CSP Circuit Breaker Single Phase

Single Phase CSP Circuit Breaker For Distribution
Transformers :
General Information for Selection of Breaker Type



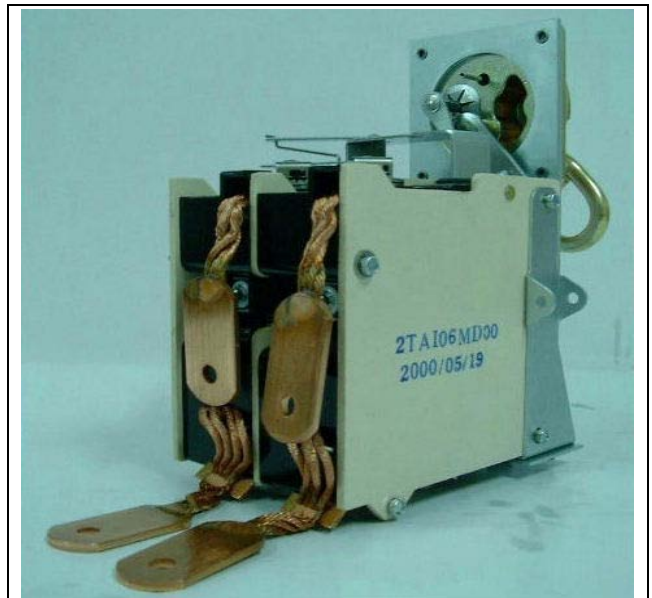
Wall-Mounted R Breaker (Front View)



Wall-Mounted R Breaker (Isometric Side View)



Wall-Mounted R Breaker (Rear View)



Wall-Mounted R Breaker (Isometric Side View)

Designed & Licensed By
ABB Power T&D Company

P&A Power Products Inc.



ISO 9001
March, 2000

Introduction

The CSP protection concept is generally applied to Single phase transformers up to 200kVA (where a 120/240 and 240/480 volts low voltage winding is typical). The CSP concept is applied to systems where the low voltage of the transformer might be in the range of 400 to 480 volts.

P&A offers four different oil circuit breaker designs: the type LR breakers, generally applied from 10KVA through 25KVA ; the type SQR breakers, generally applied from 37.5kVA through 50kVA ; the type LQR breaker which is generally applied from 75kVA through 100kVA ; and type HQR breaker generally applied to 167kVA and 200kVA transformers. The rated current of the transformer determines which breaker family is appropriate. For values of low voltage outside of the 120/240 V class the corresponding KVA range of transformer sizes are in table 3&4

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).

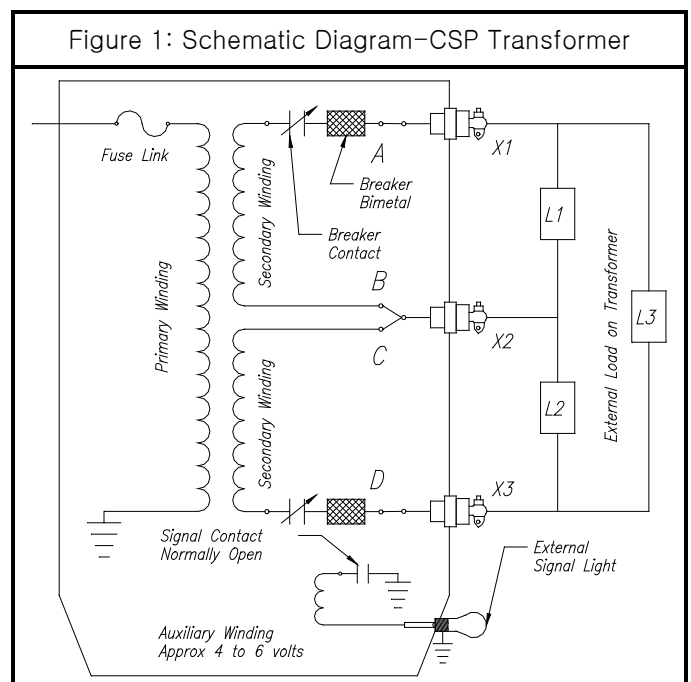
The emergency control mechanism is a mechanical linkage inside the breaker which moves the breaker to a higher calibration temperature setting when placed into the emergency position. (This is also an optional feature and should be specified, if desired)

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 and in accordance with common design practice in the United States and related countries. It should be noted that adjustments to this table may be appropriate for transformers and designed to ANSI standards or which differ from generally accepted U S practice. 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.

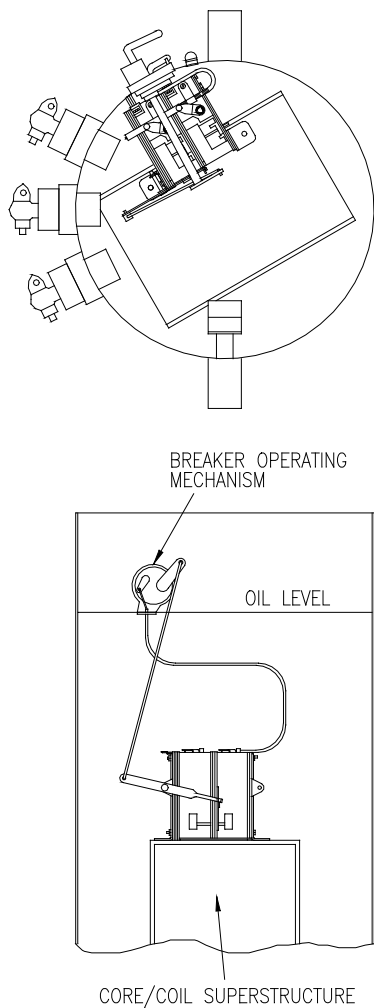
The normal load cycle of a distribution transformer is characterized by a relatively light load during the greater part of the day, with one or two peaks lasting up to a few hours. This permits operation of the CSP transformer at loads exceeding its continuous self-cooled rating during short-time peaks, since the heat-storage capacity of the CSP transformer results in a slow increase of internal temperatures.



LR and SQR Breakers for 50KVA and below General Information

The type LR and SQR circuit breakers have been developed for use in single phase, oil filled, distribution transformers as part of the CSP concept of distribution transformer protection. The breaker is mounted inside the transformer and connected between the secondary winding and the secondary bushings. The breaker provides both fault and overload protection to the transformer. The LR breakers are available as a thermal trip only style and the SQR breakers are available as a thermal and magnetic trip style. The fault duty and transformer's nominal rated current generally determine whether a thermal trip or a thermal/magnetic breaker is required for the application. General dimensional and mounting information can be found in the appropriate outline drawing.

Figure 2: Breaker Frame Mounting
(Type EM Breaker Shown in Open Position)



R Breaker



Precision, Accuracy, and Repeatability

The key component in determining breaker precision is the bimetal and its interaction with the latching system. The deflection of the bimetal in response to temperature creates the force to unlatch and trip open the breaker. The smaller the force required to trip the breaker, the more precise can this action be. The design of the LR and SQR breaker's latching mechanisms creates an almost zero force system. This minimizes the mechanical work that the bimetal must do to trip the breaker and maximizes the bimetal's ability to trip at the same point, time after time. As part of the effort to ensure a precise trip point, both the LR breakers and the SQR breakers have been designed so that each bimetal acts independently within the breaker. Thus, the bimetal trip point is not affected by the position of the other bimetal. However, both poles of the breaker are mechanically interlocked so that if one pole trips, the other pole will trip simultaneously.

High Dielectric Strength

All the LR and SQR breakers have been designed with very generous electrical clearances. All series of breakers have been designed with twice the required dielectric strength. The standard requirement for this class of apparatus is 10kVA power frequency voltage withstand capability; these breakers will routinely pass a 20kV power frequency withstand voltage test.

Leads

The input and output leads are very flexible copper cable, terminated in copper terminals for attachment to the transformer's coil and bushing leads. The breaker's leads are securely fastened to the breaker base or cover so that the mechanical stresses placed on the leads during installation and mounting are taken by the cover and/or base assemblies and are not transmitted into working parts of the breaker.

Application Flexibility

The R series breakers are available in two mounting configurations: frame mounted and wall mounted. The frame mounted configuration is the traditional mounting arrangement where the breaker is bolted to the core/coil superstructure and attached by mechanical linkage to a separate external operating mechanism. The wall mounted configuration combines the breaker and its external operating mechanism into one mechanical package which is attached to the transformer tank wall. These two mounting methods are fully explained in the following pages.

Frame Mount Signal Light

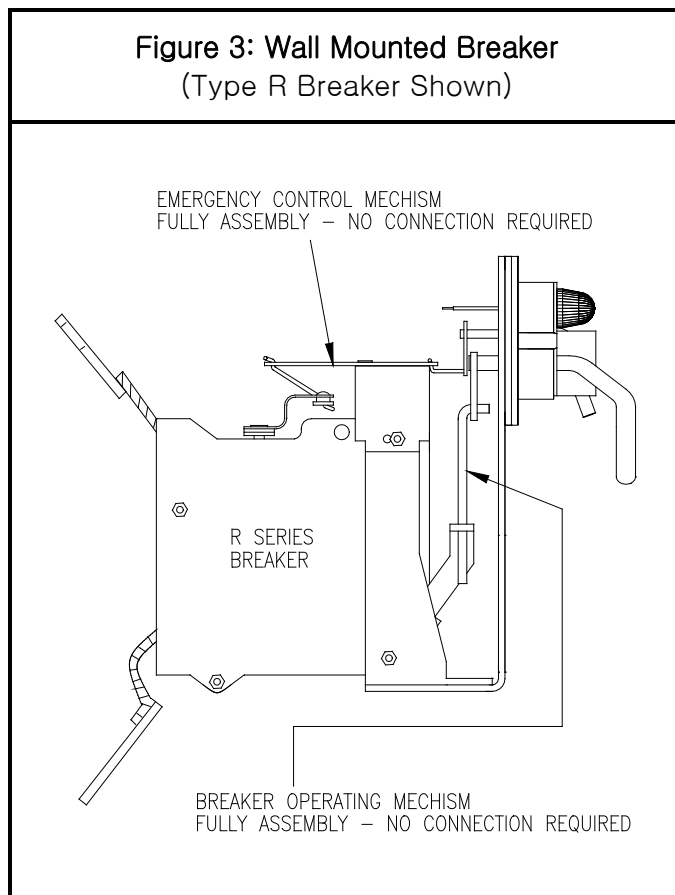
The signal lamp is a nominal 6 volt bulb (14 volts optional) with a screw base. The electrical circuit for the bulb passes through the center contact of the bulb into a crimp termination for attachment to the signal circuit on the inside of the transformer. The other side of the bulb's electric circuit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

Wall-Mounted Breaker

The ultimate in a pre-engineered mounting kit is the unitized breaker/mechanism assembly shown in Figure 3. This product consists of any standard R series breakers pre-mounted into an external operating mechanism/internal bracket assembly. The breakers are furnished as a finished unit complete with all mechanical connections to both the main opening and closing mechanism and to the emergency control mechanism (when ordered). The breakers are installed into the transformer by passing the mounting boss through the tank mounting hole and securing it with the mounting nut. The electrical connections can then be made between the breaker and the transformer winding, and between the breaker and low voltage bushings. If the signal light feature is desired, the wall mount assembly can be ordered with the signal light built into the external mechanism. The only signal installation required is to connect the signal light and signal contact leads into the auxiliary winding circuit.

Some of the important features of the wall mounted design are noted in the following paragraphs. The operating mechanism, which has been integrated into the breaker and its mounting bracket, has been designed to permit simple and easy mounting to the transformer tank and to provide excellent corrosion resistance and sealing.

**Figure 3: Wall Mounted Breaker
(Type R Breaker Shown)**



Wall Mounted Mounting Boss

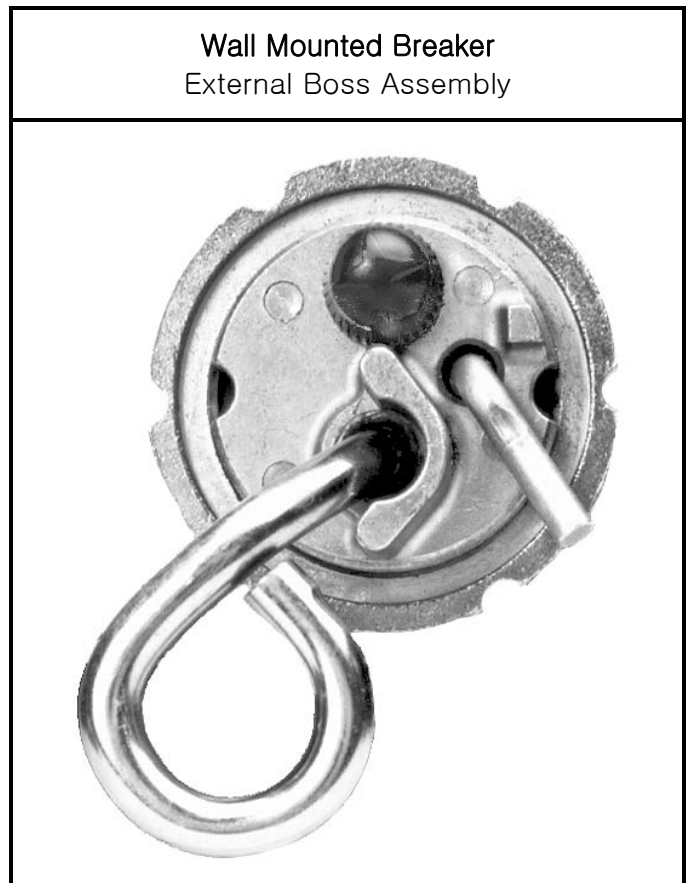
The mounting boss is a zinc die casting with a yellow chromate seal coating. The mounting boss contains the main operating handle, the emergency control operating lever and the signal light. The mounting boss passes through the tank mounting hole (Approximately 2.25 inches or 57.2 mm) from the inside 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.

Main Operating Handle

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

Wall Mount Signal Light

The signal lamp is a nominal 6 volt bulb (14 volt available) 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.



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 (R)

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 gasket should not be subjected to the heat of processing. All internal seals are constructed of high temperature elastomers and may be processed.

Wall Mounted R Breaker
Internal/Back View



The 2-Pole R Series Breaker.

Introduction

LR, SQR, LQR and HQR breakers are designated as the "R" Series. The 2 pole LQR breaker is used on the larger sizes of CSP Transformers. The typical application at 120/240 volts would be on 75 and 100kVA transformers. 2 pole LR and SQR Breakers can be mounted on the less than 50kVA transformers. Especially 2 pole HQR Breakers can be on 167kVA and 200kVA transformers.

- 1) The R-series breakers can only be mounted in the upright position because its internal magnet trip relies on the force of gravity to provide the reset action.
- 2) The R-series frame mounted breakers do not have a centrally located operating handle so the orientation of the operating handle must be specified as either right hand or left hand.

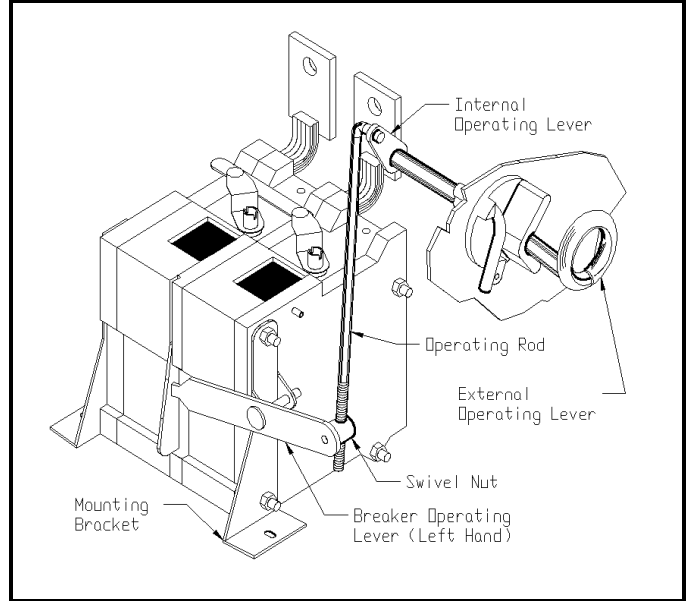
General Description

The R-series breakers are 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 breakers also feature a low force latching and tripping mechanism which further reduces the required bimetal mechanical work. Because of its intended application range, the R-series breakers can contain a magnetic trip element in addition to the thermal trip provided by the bimetal. General dimensional and mounting information for the R-series breakers are contained in Dimension Sheet series 44-825.

2 Pole LQR Breaker



Frame Mounted 'R' Series



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 breakers isolate 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 insures 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 reset via linkage which connects the external operating mechanism to the breakers operating handle.

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. If a transformer circuit breaker has tripped and the bimetals are still at trip temperature, the use of the emergency control feature may allow the operator to close the circuit breaker to restore service.

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.

"R" Series Breaker Frame Mounting

The R-series breakers are 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 #44-825. The breakers are not symmetrical as far as mechanical operation is concerned. The steel operating lever, which is attached to the breaker, can be mounted 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. It is determined by viewing the breaker from the lead end.

Wall-Mounted "R" Series Breaker

The R-series breakers are also offered in unitized wall mount configuration. The breakers are 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 connections between the winding and the breaker lead 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 breaker's signal contact terminal must be made.

Application Notes

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

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, these 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 gasket 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 greater than or equal to 50 percent of the transformer's rated kVA, a special breaker must be used to prevent unnecessary breaker trips. Please consult P&A for further details.

2 Pole Wall Mounted 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 setups. 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:

$$\text{R-series breakers : } \Theta b = JI^2$$

Where :

Θb = Bimetal temperature rise due to current in °C

J = Bimetal Ampere Response Factor in °C/A²

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 °C

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

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

Table 1 : Ordering Information for Wall Mounting Breaker

Parameter	LR Breaker			SQR Breaker		LQR Breaker		HQR Breaker	
	Bimetal	042	063	104	156	208	313	417	696
Nominal Current Rating	45A	65A	110A	160A	210A	350A	450A	780A	970A
Interrupting Current Rating : 5 shots (rms symmetrical)	4000A		7000A	12000A		25000A		30000A	
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)	25°C			30°C		30°C		30°C	
Emergency Control Trip Temperature(Nominal) (degrees greater than breaker trip temperature)	25°C			25°C		25°C		25°C	

Table 2 : Ordering Information for Wall Mounting Breaker

Breaker Type	Bimetal ID	J	Shot Time Curve
LR	021	0.00650	#7357021-A
LR	042	0.00200	#7357022-A
LR	063	0.00120	#7357023-A
LR	104	0.00070	#7357024-A
SQR	156	0.00020	#7357025-A
SQR	208	0.00014	#7357026-A
LQR	313	0.00009	#7357027-A
LQR	417	0.00007	#7357028-A
HQR	696	0.000035	#7357021-C
HQR	833	0.000023	#7357022-C

Table 3 : Ordering Information for Frame Mounted Breaker

Trip	Bimetal ID	Transformer kVA		Signal Circuit	Emergency	Handle Orientation	Style Number
		120/240V	240/480V				
Thermal	021	5	10	Yes	Yes	Left	2TAi02MAxx
						Right	2TAi02MBxx
				No	No	Left	2TAi02RAxx
						Right	2TAi02RBxx
Thermal	042	10	25	Yes	Yes	Left	2TAi04MAxx
						Right	2TAi04MBxx
				No	No	Left	2TAi04RAxx
						Right	2TAi04RBxx
Thermal	063	15	37.5	Yes	Yes	Left	2TAi06MAxx
						Right	2TAi06MBxx
				No	No	Left	2TAi06RAxx
						Right	2TAi06RBxx
Thermal	104	25	50	Yes	Yes	Left	2TAi10MAxx
						Right	2TAi10MBxx
				No	No	Left	2TAi10RAxx
						Right	2TAi10RBxx
Thermal/Magnetic	156	37.5	75	Yes	Yes	Left	2QAI15MAxx
						Right	2QAI15MBxx
				No	No	Left	2QAI15RAxx
						Right	2QAI15RBxx
Thermal/Magnetic	208	50	100	Yes	Yes	Left	2QAI20MAxx
						Right	2QAI20MBxx
				No	No	Left	2QAI20RAxx
						Right	2QAI20RBxx
Thermal/Magnetic	313	75	150	Yes	Yes	Left	2QAI31MAxx
						Right	2QAI31MBxx
				No	No	Left	2QAI31RAxx
						Right	2QAI31RBxx
Thermal/Magnetic	417	100	200	Yes	Yes	Left	2QAI42MAxx
						Right	2QAI42MBxx
				No	No	Left	2QAI42RAxx
						Right	2QAI42RBxx
Thermal/Magnetic	696	167	333	Yes	Yes	Left	2QAI69MAxx
						Right	2QAI69MBxx
				No	No	Left	2QAI69RAxx
						Right	2QAI69RBxx
Thermal/Magnetic	833	200	400	Yes	Yes	Left	2QAI83MAxx
						Right	2QAI83MBxx
				No	No	Left	2QAI83RAxx
						Right	2QAI83RBxx

1. Note : When ordering, substitute the breaker trip temperature minus 100°C for the values of "xx" in the above table (i.e. 2TAi10MA50 has a trip temperature of 150°C)

Table 4 : Ordering Information for Wall Mounted Breaker

Trip	Bimetal ID	Transformer kVA		Signal Circuit	Emergency	Handle Orientation	Style Number
		120/240V	240/480V				
Thermal/Magnetic	060	25	50	Yes	Yes	Center	2WAI060Txx
				No	No	Center	2WAI062Txx
Thermal/Magnetic	030	37.5	75	Yes	Yes	Center	2WAI030Txx
				No	No	Center	2WAI032Txx
Thermal/Magnetic	020	50	100	Yes	Yes	Center	2WAI020Txx
				No	No	Center	2WAI022Txx
Thermal	021	5	10	Yes	Yes	Center	2TAI02MDxx
				No	No	Center	2TAI02RDxx
Thermal	042	10	25	Yes	Yes	Center	2TAI04MDxx
				No	No	Center	2TAI04RDxx
Thermal	063	15	37.5	Yes	Yes	Center	2TAI06MDxx
				No	No	Center	2TAI06RDxx
Thermal	104	25	50	Yes	Yes	Center	2TAI10MDxx
				No	No	Center	2TAI10RDxx
Thermal/Magnetic	156	37.5	75	Yes	Yes	Center	2QAI15MDxx
				No	No	Center	2QAI15RDxx
Thermal/Magnetic	208	50	100	Yes	Yes	Center	2QAI20MDxx
				No	No	Center	2QAI20RDxx
Thermal/Magnetic	313	75	150	Yes	Yes	Center	2QAI31MDxx
				No	No	Center	2QAI31RDxx
Thermal/Magnetic	417	100	200	Yes	Yes	Center	2QAI42MDxx
				No	No	Center	2QAI42RDxx
Thermal/Magnetic	696	167	333	Yes	Yes	Center	2QAI69MDxx
				No	No	Center	2QAI69RDxx
Thermal/Magnetic	833	200	400	Yes	Yes	Center	2QAI83MDxx
				No	No	Center	2QAI83RDxx

- Note : When ordering, substitute the breaker trip temperature minus 100°C for the values of "xx" in the above table (i.e. 2TAI10MD50 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

