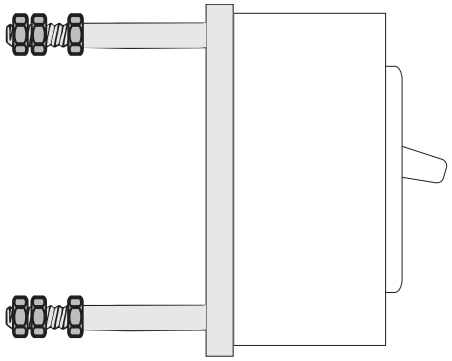
External Accessories

External accessories make circuit breakers suitable for specific applications. A variety of external accessories are available.

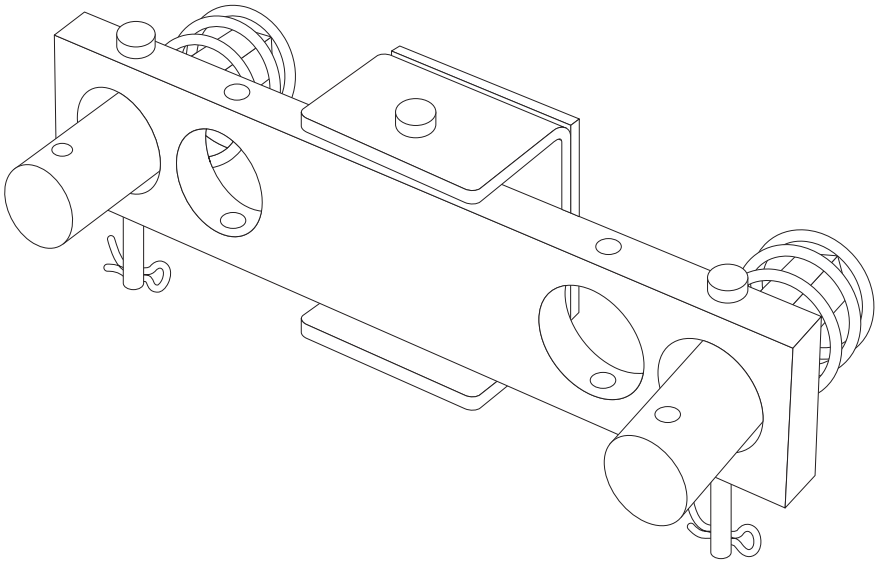
Rear Connecting Studs

Rear connecting studs are used for switchboard mounting of circuit breakers. Rear connecting studs are available in various lengths of either bus or cable connections.



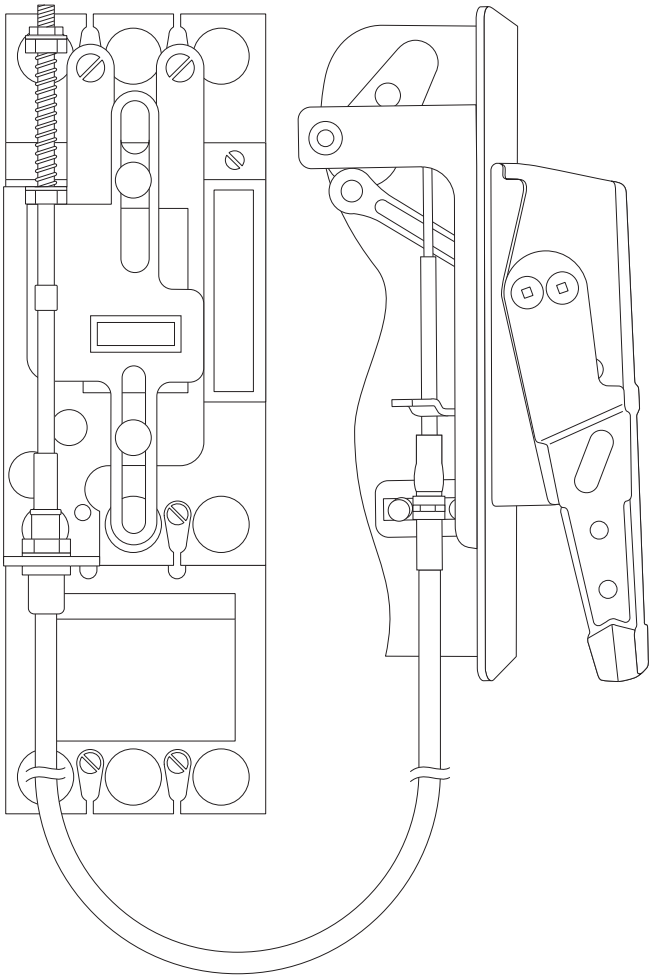
Rocker Arm Assembly

The rocker arm assembly is used to mechanically interlock two adjacent circuit breakers of the same frame configuration. Both circuit breakers can be open at the same time, but this allows only one breaker to be closed at any time.



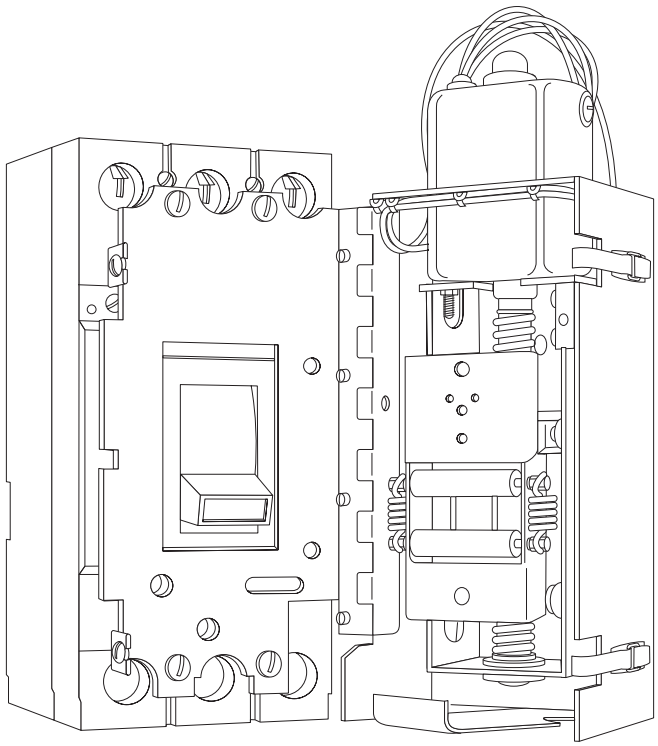
Max-Flex™

The I-T-E ® Max-Flex™ flange-mount handle operator is a flexible cable control device used for remote switching of a circuit breaker within an enclosure. The flexible cable is connected directly to the breaker switch handle at one end and a factory installed switch at the other end. The remote handle operator located on the enclosure is used to perform mechanical open/close switching operations. The cable comes in standard 3 or 4 foot lengths, however, lengths up to 20 feet can be ordered. When using a standard circuit breaker handle extension, it is necessary to exactly align the breaker with the extension. With the Max-Flex handle operator this exact alignment isn't necessary.



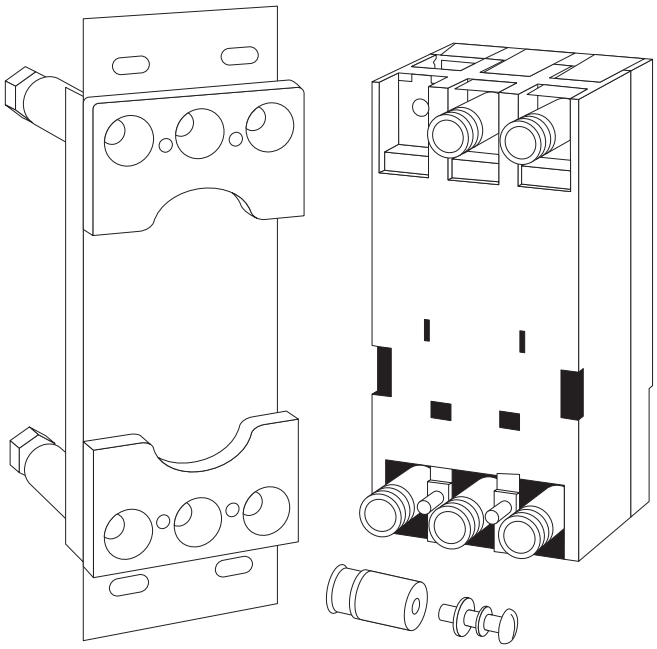
Telemand® Electric Motor Operator

The I-T-E Telemand® electric motor operator is designed to open, close, and reset a circuit breaker by remote control. It is mounted on the face of the circuit breaker so that it can engage the breaker's operating handle. The built-in motor is connected to remote pushbuttons. Pressing the "ON" pushbutton causes the electric motor to move the circuit breaker to the "ON" position. Pressing the "OFF" pushbutton causes the electric motor to move the circuit breaker to the "OFF" position. To reset the circuit breaker from the tripped position, press the "OFF" pushbutton to move the handle to the "OFF" position. Then press the "ON" pushbutton to the close the breaker contacts.



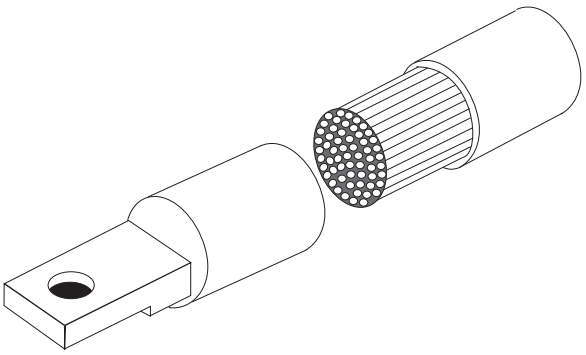
Plug-In Assemblies

Plug-in mounting assemblies provide means for a quick change out of circuit breakers and molded case switches without disturbing the power connections.



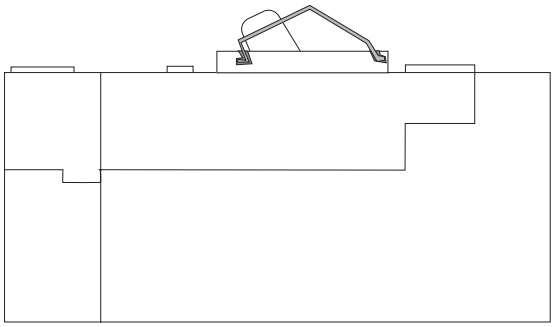
Terminal Connectors

Various terminal connectors are available to permit easy front connection of either copper or aluminum insulated conductors to the terminal of a circuit breaker or molded case switch. Terminal connectors are designed and tested to accommodate the conductors or requirements outlined within the related UL standards.



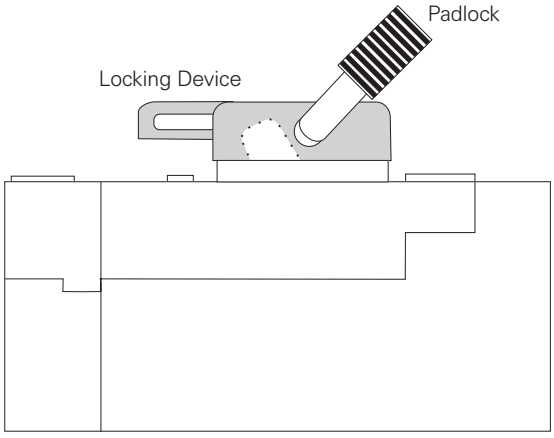
Handle Blocking Device

A handle blocking device is a non-lockable device that may be added to a circuit breaker to secure the handle in either the "ON" or "OFF" position. The device slides into slots provided on the circuit breaker. This device prevents accidental operation of the handle. The device will not prevent the circuit breaker from tripping when blocked in the "ON" position. The following illustration shows the handle blocked in the "ON" position.



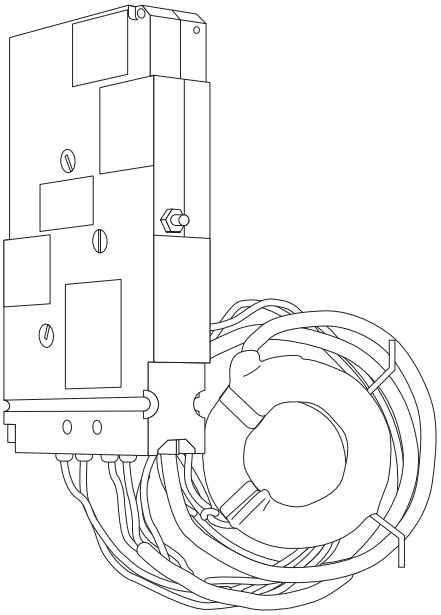
Handle Padlocking Device

The handle padlocking device is used to padlock the circuit breaker in the "ON" or "OFF" position. The device mounts over the handle and a customer supplied padlock is used to lock the handle. The breaker will still trip if locked in the "ON" position.



Ground Fault Sensor

An external ground fault sensor is available for the ED frame circuit breakers. The relay functions to de-energize a circuit within an established period of time when the current to ground exceeds a predetermined value. This is done by detecting a 5 mA ± 1 mA or 30 mA ± 6mA current difference between two or more load conductors passing through the sensor.



Review 6

1. A _____ - _____ option is used when it is necessary to trip a breaker from a remote location, but cannot be used to reset the breaker.

2. An _____ _____ device is used to automatically trip a circuit breaker when the supply voltage drops.

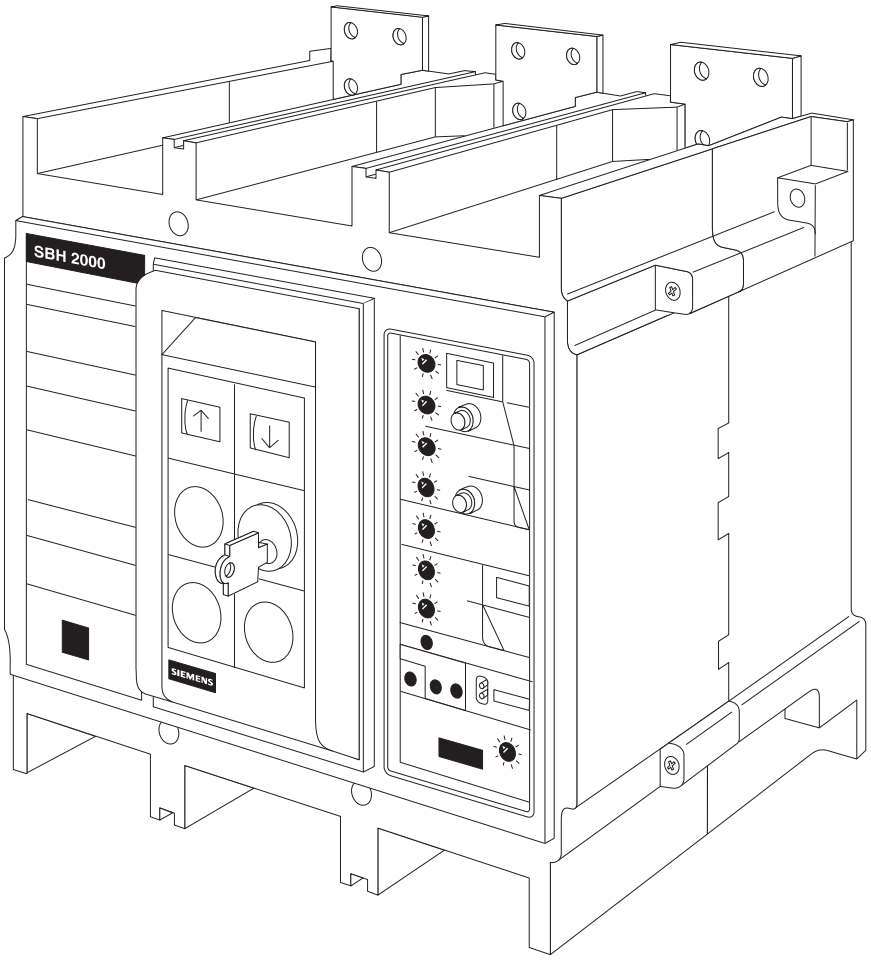
3. The advantage of the Max-Flex flange-mount handle operator versus a handle extender is that _____ _____ isn't necessary.

4. A _____ _____ is used to prevent two adjacent circuit breakers from being "ON" at the same time.

5. _____ - _____ mounting assemblies provide a means for a quick change out of circuit breakers without disturbing the power connections.

Insulated Case Circuit Breakers

The discussion to this point has been on molded case circuit breakers. Another type of circuit breaker is the low voltage air circuit breaker. Instead of having a molded case, the operating mechanism of a low voltage air circuit breaker is assembled on a metal frame for use in switchboards and switchgear. The components of a low voltage air breaker are larger and heavier for severe duty applications. Unlike molded case circuit breakers, low voltage air breakers have high short time withstand capabilities (breaker's ability to "ride through" a short circuit event). Molded case circuit breakers, on the other hand, have high interrupting ratings. A circuit breaker was needed that could supply high short time withstand and high interrupting ratings. Insulated Case circuit breakers (ICCBs) were designed to fill that need.



Ampere Ratings

There are six frames: 800, 1200, 2000, 3200, 4000, and 5000 amps. Interchangeable rating plugs and a continuous current adjustment are provided with each trip unit. ICCBs can be applied in applications from 100 to 5000 amps through 600 VAC. The frame ampere rating is determined by the current sensors in the breaker.

Breaker Frame Size	Breaker Frame Ampere Rating (In)
800 A	400 A
	800 A
1200 A	1200 A
2000 A	1600 A
	2000 A
3200 A	2500 A
	3200 A
4000 A	2500 A
	3200 A
	4000 A
5000 A	5000 A

Interrupting Ratings

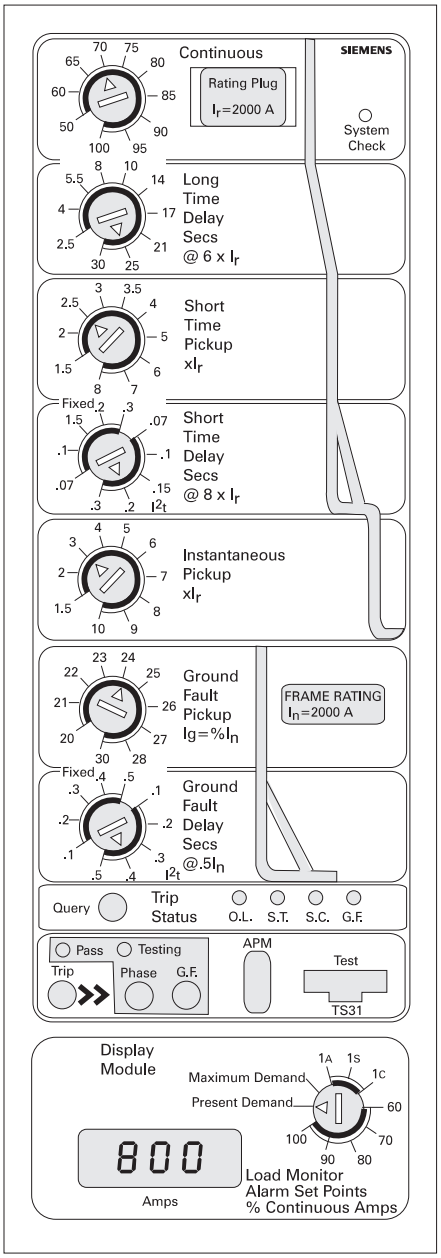
ICCBs use color coded labels to clearly identify the interrupting class of each breaker. A removable rating plug installed on the trip unit allows a user to select a current rating from 50 to 100 percent of the current sensor value. The following chart reflects the RMS ampere interrupting rating of Siemens insulated case circuit breakers.

Optional Ratings and Application Voltages	Breaker Frame Sizes		
	800 A 1200 A	2000 A	3200 A 4000 A 5000 A
Alternate AIR (Blue Label - "SBA"			
@240 Vac	65 kA	85 kA	NA
@480 VAC	65 kA	65 kA	NA
@600 VAC	42 kA	50 kA	NA
Standard AIR (Black Label - "SBS")			
@240 Vac	100 kA	100 kA	150 kA
@480 VAC	100 kA	100 kA	100 kA
@600 VAC	65 kA	65 kA	85 kA
High Air (Red Label - "SBH")			
@240 Vac	200 kA	200kA	200 kA
@480 VAC	150 kA	150 kA	150 kA
@600 VAC	100 kA	100 kA	100 kA
Short Time Ratings (30 cycles)	25 kA	35 kA	65 kA*

*Short Time Rating for 3200 A is 50 kA

ICCB Electronic Trip Unit

The electronic trip unit uses a microprocessor to execute the numerous functions programmed in the unit. The adjustments on the trip unit allow the user to select which values are to be used by the microprocessor in performing its protective function.

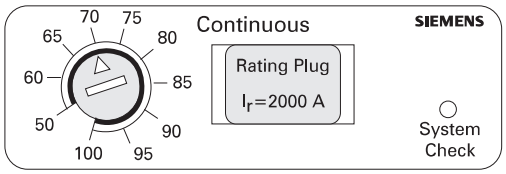


Interchangeable Rating Plugs

The trip unit is designed to use field interchangeable rating plugs. Rating plugs allow the effective ampere rating of the circuit breaker to be modified within a range of 50-100 percent of the breaker's frame ampere rating.

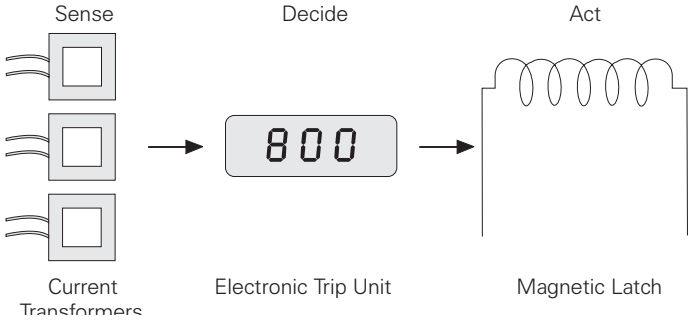
Breaker Frame Size	Frame Ampere Rating	Rating Plugs (Amperes)
800 A	400	200, 225, 250, 300, 350, 400
	800	400, 450, 500, 600, 700, 800
1200 A	1200	600, 700, 800, 1000, 1200
2000 A	1600	800, 1000, 1200, 1600
	2000	1000, 1200, 1600, 2000
3200 A	2500	1600, 2000, 2500
	3200	1600, 2000, 2500, 3000, 3200
4000 A	2500	1600, 2000, 2500
	3200	1600, 2000, 2500, 3000, 3200
	4000	2000, 2500, 3000, 3200, 4000
5000 A	5000	2500, 3000, 3200, 4000, 5000

The interchangeable rating plug is located at the top of the electronic trip unit.



Principle of Operation

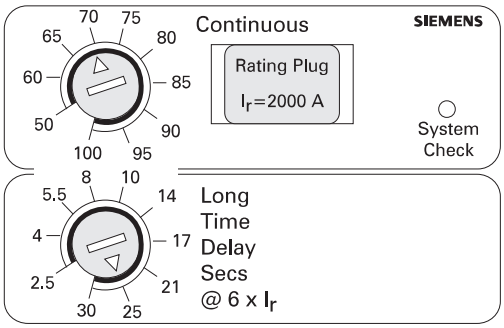
Current is derived from current sensors (transformers) mounted in the breaker. The current signals from the transformers are converted to digital values in the trip unit. The electronic trip unit monitors current levels at an equivalent sampling rate of 353 samples per cycle per phase. It then decides when the circuit breaker should be tripped due to an overcurrent condition. A magnetic latch in the circuit breaker causes the breaker to trip when it receives a trip command from the electronic trip unit.



Continuous Amps and Long-Time Delay

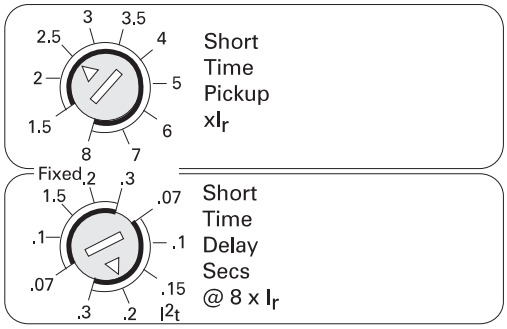
The continuous ampere adjustment sets the current level at which the breaker will continuously operate without tripping. For example, if a rating plug is 2000 amps and the continuous ampere adjustment is set to 50%, the breaker will continuously operate at current levels up to 1000 amps.

The long-time delay adjustment is used to set the tripping delay of the circuit breaker based on the magnitude of the overcurrent condition (6 times Ir). For example, if the rating plug is 2000 amps and long-time delay is set to 10 seconds, a fault current of 12,000 amps (6 x 2000) will cause the breaker to trip after 10 seconds. Long time is an inverse I^2T ramp function. This means the higher the current, the shorter the time the circuit breaker will remain "ON."



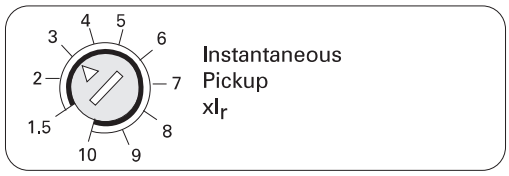
Short-Time Pickup and Short-Time Delay

The short-time pickup adjustment is used to set the level of high current the breaker will carry for a short period of time without tripping. This adjustment is set in multiples of the value of the rating plug (Ir). Together with short-time delay, this adjustment allows downstream breakers time to clear short circuit faults without tripping upstream breakers. Short-time delay is used to set the time interval the breaker will wait before responding to the current value selected by short-time pickup. There are two modes of operation: fixed and I^2T. The I^2T delay has the characteristic of being inversely proportional to the square of the magnitude of the current. This means higher overcurrent conditions have shorter delays.



Instantaneous Pickup and Instantaneous Override

The instantaneous pickup adjustment is used to set the current level at which the breaker will trip without an intentional time delay. Non-delayed tripping as a result of severe overcurrent minimizes potential damage to electrical systems and equipment. This adjustment is set in multiples of I_r.



An instantaneous override function is provided on all trip units. It is nominally set at the short-time rating of the respective breaker frame size. This allows the breaker to ride through high fault currents up to its short-time capability, however, it is self-protecting above these values.

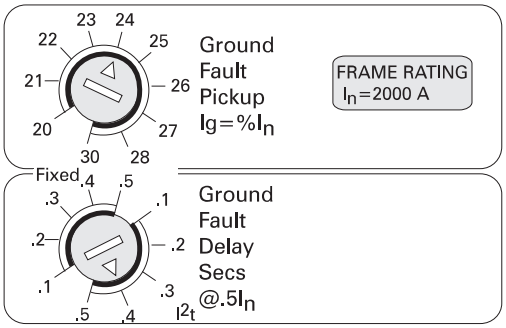
Breaker Frame Size	Short Time kA Rating (0.500 Seconds Max.)
800 A	25
1200 A	25
2000 A	35
4000 A	65
5000 A	65

Ground Fault Pickup and Ground Fault Delay

The ground fault pickup adjustment is used to set the level of ground current at which circuit interruption will be initiated. Together with ground fault delay, this adjustment allows selective tripping between main and feeder or other downstream breakers. The available ground fault pickup settings are given in the following table. In compliance with *NEC*® 230.95 (A), no trip point setting exceeds 1200 amps.

Fault Ampere Rating In	Avaliable Setting (% In)									
400 A	20	25	30	40	50	60	70	80	90	100
800 A	20	25	30	40	50	60	70	80	90	100
1200 A	20	25	30	40	50	60	70	80	90	100
1600 A	20	26	32	38	44	50	56	62	68	75
2000 A	20	23	27	30	35	40	45	50	55	60
2500 A	20	23	26	29	32	35	38	41	44	48
3200 A	20	21	23	25	27	29	31	33	35	37
4000 A	20	21	22	23	24	25	26	27	28	30

The ground fault delay adjustment is used to set the time interval (in seconds) the breaker will wait before responding once the ground fault pickup level has been reached. There are two modes of operation: inverse time (I^2T) and fixed delay. Above 50 percent of the frame rating the inverse time delay reverts to a fixed delay of the same value.

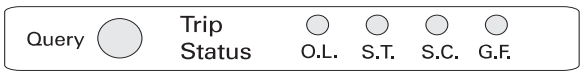


Trip Status

The query button switch and trip status indicator lights provide the user a means for determining what type of fault caused the trip unit to trip the circuit breaker. Fault indicators are provided for:

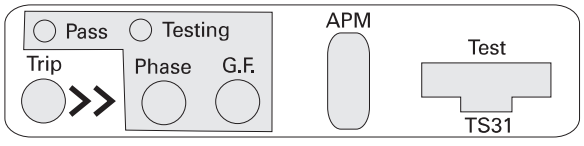
O.L. Overload or Long-Time Fault
S.T. Short-Time Fault
S.C. Short Circuit or Instantaneous Fault
G.F. Ground Fault

When a fault occurs the fault information is stored in the trip unit. When the Query button is pushed the appropriate fault indicator will light.



Integral Test

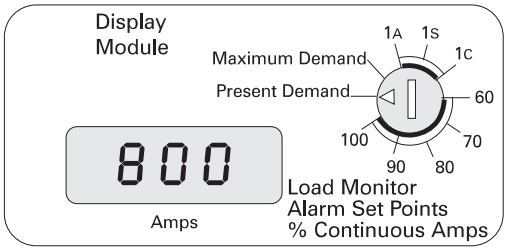
The integral test function enables the user to "exercise" the trip unit electronics, magnetic latch and breaker mechanism. The purpose of the test function is to provide the user with an easy means to conduct a "go/no go" type test before bringing the circuit breaker on-line.



Optional Display Module

The optional display module provides the features for allowing the user to locally monitor the phase currents. The display module plugs into the front of the trip unit. The load monitor alarm feature provides a local alarm display and an output signal for an external alarm when the average of the phase currents exceeds the alarm set point.

The current demand feature provides two ampere demand factors. The present demand setting displays the present ampere demand calculated on 15 minute intervals. The maximum demand setting displays the maximum ampere demand since last reset. To reset the maximum demand memory, the operator should simultaneously press the "Phase" and "G.F." buttons on the integral test function.



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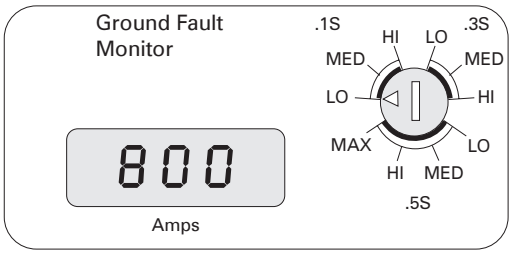
Ground Fault Monitor

The ground fault monitor allows the user to monitor ground fault current. The ground fault delays are divided into three time delay bands: 0.1, 0.3, and 0.5 seconds. There are three ground fault pickup levels available.

"LO" equals 20% of the frame rating.
"HI" equals the frame rating or 1200 A, whichever is less.
"MED" equals the average of "LO" and "HI."

The ground fault monitor displays the ground fault current in amps. When the ground fault current reaches a level 12% below the selected pickup setting the display will start to flash. When ground fault current reaches the selected setting the display will flash "OL"The ground fault monitor can be utilized with a display relay module or a remote indicator panel to provide a set of contacts for ground fault alarm. When used in conjunction with either of these devices and a shunt trip, the ground fault monitor can be used as ground fault sensing and relaying equipment per UL-1053.



Review 7

1. A red label ICCB at 480 VAC has an interrupting rating of _____ kA.

2. A 600 amp rating plug is available in the _____ and _____ amp breaker frame sizes.

3. The trip unit monitors current levels at an equivalent sampling rate of _____ samples per second.

4. Setting the continuous amp setting of a 1000 amp rating plug to 75% makes the ICCB a _____ amp breaker.

5. In compliance with *NEC*® 230.95, the maximum ground fault trip point setting of an ICCB is _____ _ amps.

Review Answers

Review 1	1) a; 2) overloads, short circuits; 3) short circuit; 4) overload; 5) sense, measure, act.
Review 2	1) contacts; 2) blow-apart; 3) arc chute; 4) over-center; 5) bimetal; 6) electromagnet.
Review 3	1) instantaneous; 2) thermal; 3) 200,000; 4) ampere; 5) overload protection; 6) coordination.
Review 4	1) frame; 2) HFD6; 3) 15 to 125; 4) QD; 5) CQD.
Review 5	1) 2000; 2) red; 3) RMS; 4) 600; 5) 2.2 to 27; 6) 8000.
Review 6	1) shunt trip; 2) undervoltage trip; 3) exact alignment; 4) mechanical interlock; 5) plug-in.
Review 7	1) 150; 2) 800, 1200; 3) 353; 4) 750; 5) 1200.

Final Exam

The final exam is intended to be a learning tool. The book may be used during the exam. A tear-out answer sheet is provided. After completing the test, mail the answer sheet in for grading. A grade of 70% or better is passing. Upon successful completion of the test a certificate will be issued.

Questions

1. With an increase of current, temperature will

   a. decrease b. increase
   c. remain the same d. increase and decrease

2. The amount of current a conductor can carry on a continuous basis is known as

   a. ampacity b. instantaneous current
   c. peak current d. AWG

3. Overcurrent protection is covered by *NEC*® article

   a. 110 b. 430
   c. 240 d. 384

4. A contact design which uses magnetic fields developed around the contacts to help force them apart during an overcurrent condition is known as

   a. straight-through b. single-pivot
   c. dual-pivot d. blow-apart

5. The operating mechanism in Siemens molded case circuit breakers is a/an _____ design.

   a. over-center b. normally open
   c. center-off d. normally closed

6. The "brain" of the circuit breaker is the

   a. arc chute
   b. frame
   c. trip unit
   d. operating mechanism

7. A type of circuit breaker that provides both overload and short circuit protection is a/an _____circuit breaker.

   a. instantaneous magnetic-trip-only
   b. interchangeable trip
   c. molded case switch
   d. thermal-magnetic

8. Siemens Sentron™ Series circuit breakers use a _____ label to identify a high interrupting category circuit breaker.

   a. black
   b. red
   c. blue
   d. yellow

9. The upper-most portion of a time-current curve for a Sensitrip® III circuit breaker shows the _____ performance of a circuit breaker.

   a. short circuit protection
   b. instantaneous trip
   c. continuous current
   d. current interrupting

10. The application of circuit protective devices in series, such that under overload or fault conditions, only the upstream device nearest the fault will open is known as

    a. series-rating
    b. selective coordination
    c. instantaneous trip
    d. current limiting

11. The maximum continuous ampere rating available for the BQ circuit breaker is

    a. 15 amps
    b. 100 amps
    c. 50 amps
    d. 125 amps

12. The QP circuit breaker is a/an _____ circuit breaker

    a. bolt-on
    b. Sentron Series
    c. plug-in
    d. insulated case

13. The type of circuit breaker that mounts on a DIN rail is

    a. BQD
    b. BL
    c. CQD
    d. BQC

14. The maximum continuous ampere range of an ND circuit breaker is

    a. 15-125 amps
    b. 200-400 amps
    c. 800-1200 amps
    d. 1800-2000 amps

15. True RMS sensing

    a. measures peak currents only
    b. provides more accurate picture of true heating
    c. samples current every 1/2 second
    d. measures peak voltages only

16. Which of the following adjustments is not available on a Sensitrip® III circuit breaker?

    a. continuous amps
    b. instantaneous delay
    c. long-time delay
    d. short-time delay

17. An accessory used to indicate a circuit breaker has tripped is a

    a. bell alarm switch
    b. undervoltage trip
    c. auxiliary switch
    d. shunt trip

18. A device used to allow only one of two adjacent circuit breakers to be closed at any time is a

    a. mechanical interlock
    b. Max-Flex™ handle operator
    c. Telemand® electric motor operator
    d. handle blocking device

19. Insulated case circuit breakers provide _____ interrupting ratings and _____ short-time withstand.

    a. high , poor
    b. low, excellent
    c. low, poor
    d. high, excellent

20. In compliance with *NEC*® 230.95, no ground fault trip point setting can exceed ____ amps.

    a. 1200
    b. 10,000
    c. 100,000
    d. 200,000

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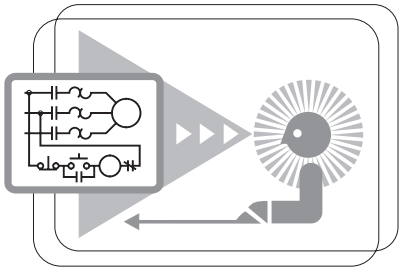

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