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Magnum DS Breakers are power circuit breakers designed and engineered specifically for use in Magnum DS Low Voltage Switchgear assemblies applied at nominal voltages of 240, 480, and 600 Vac. Six continuous ratings – 800 amperes through 5000 amperes – are covered by only two physical breaker sizes.

Controls and indicators are functionally grouped on the front of the breakers and the through-the-door design means they are easily viewed and accessible.

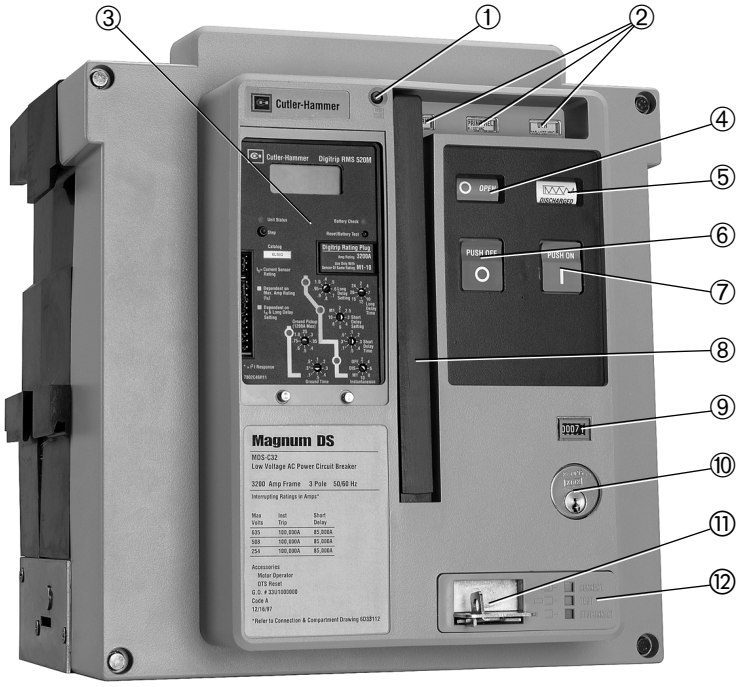
① Trip Flag
② Three Accessory Windows
③ Digitrip RMS Trip Unit
④ Contact Status Indicator (Open or Closed)
⑤ Spring Status Indicator (Charged or Discharged)
⑥ “Push Off” to Open Breaker Button
⑦ “Push On” to Close Breaker Button
⑧ Manual Charging Handle
⑨ Optional Operations Counter
⑩ Optional “Off” Key Lock
⑪ Padlockable Levering Device
⑫ Color-Coded Breaker Position Indicators

Magnum DS Breakers are 100 percent rated, UL listed, and are built and tested in an ISO 9000 certified facility to applicable standards including:

- ANSI C37.13
- ANSI C37.16
- ANSI C37.17
- ANSI C37.50
- NEMA SG3
- UL 1066
- CSA 22.2

Magnum DS is also suitable for use in:

- UL 1558 Low Voltage Switchgear
- UL 891 Low Voltage Switchboards
- CSA 22.2.31 Low Voltage Assemblies



Integrally designed breaker steel cassette for drawout breakers provides clear indication of connect, test, and disconnect positions.

The breaker can be conveniently racked in or out, stopping at the various positions with the door closed.

Faceplate controls facilitate operation of the breaker, and the three accessory mounting windows provide for easy identification.

The breaker spring charging handle is designed with sufficient space for operation even with a gloved hand.

Designed for Easy Access, Inspection, and Minimal Maintenance

The stored energy mechanism, control devices, accessories, and secondary contacts are easily accessible by removing the front cover that is held in place by four captive screws. This can only be done when the breaker is in the disconnect position or removed from the cell.

The current sensor viewing window on the rear of the breaker allows for easy identification of the current sensor mounted inside.

The contact wear indicator eliminates the need for elaborate testing to determine if the contact assembly needs replaced.

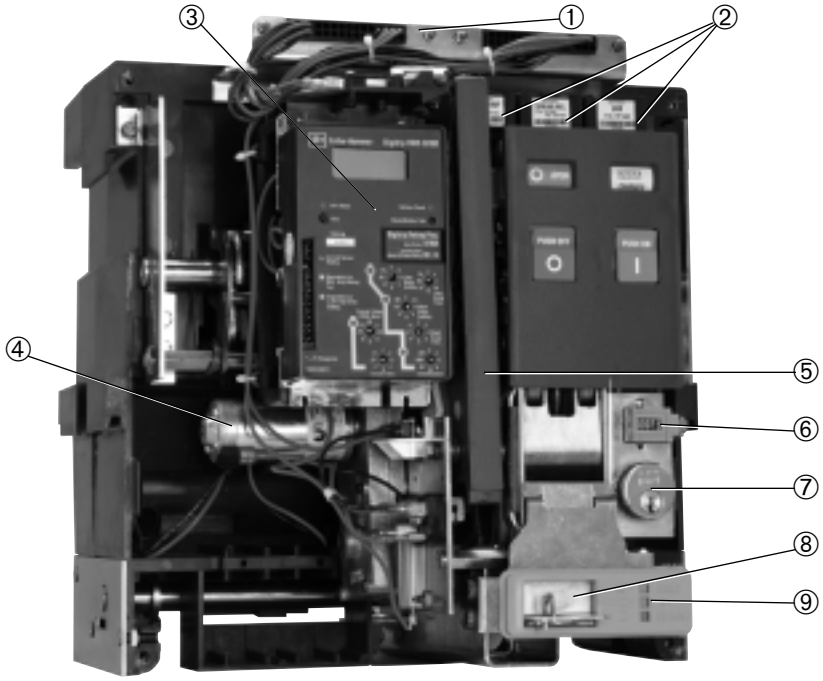
Many minor replacement functions involving the mechanism, control, and/or accessories can be easily accomplished.

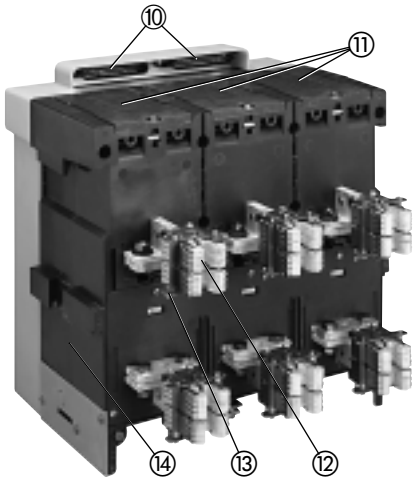
Two-Step Stored Energy Mechanism for Manually and Electrically Operated Breakers

The potential energy is stored in the mechanism to close the breaker in 5 cycles or less. Sufficient energy to open the breaker remains available following the closing operation.

After closing, the charging spring can be recharged to provide potential energy for reclosing following a fault, providing high continuity of service. This feature allows for the following sequence: charge – close – recharge – open – close – open.

On manually operated breakers, closing springs are charged by hand. For electrically operated breakers, springs are charged by an electric motor but can be manually charged if no power is available.





This rear view of a Magnum DS drawout breaker shows the designed-in safety feature of locating the secondary contacts away from the primary disconnects.

Increased Short Time and Interrupting Ratings

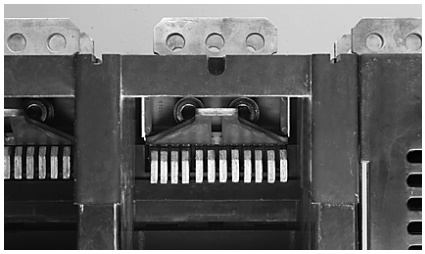
Magnum DS Power Circuit Breakers are available with short time ratings up to 85,000 amperes RMS symmetrical and interrupting ratings up to 100,000 amperes RMS symmetrical. These increased ratings far exceed ratings previously available on power circuit breakers.

① Secondary Wiring Points
② Field Installable Accessories (Three Maximum)
③ Digitrip RMS Trip Unit
④ Optional Electric Charging Motor
⑤ Manual Charging Handle
⑥ Optional Operations Counter
⑦ Optional “Off” Key Lock
⑧ Padlockable Levering Device
⑨ Breaker Position Indicator
⑩ Secondary Contacts
⑪ Arc Chute Covers
⑫ Primary Finger Cluster Disconnects
⑬ Current Sensor Window
⑭ Rigid Frame Housing

Positioning of the secondary contact subassembly is dedicated for installation, maintenance, and testing. Top view shown with breaker cover removed, bottom of photo is front of breaker.

Flexible Current Path Increases Current Carrying Capability in Less Space

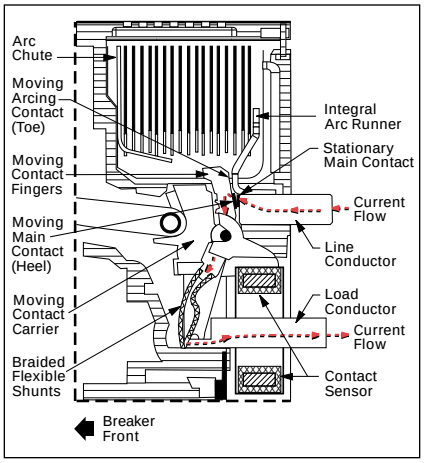
- Multi-finger contact structure divides the current flow, increasing the thermal carrying capability



Visual contact wear indicator shows when contact replacement is necessary.

- **Flexible braided current path** to the contact fingers reduces necessary current carrying space and provides a smooth connection, eliminating bolted joints and contact springs. This design helps increase breaker service life by reducing localized heat buildup and mechanical stress inherent in conventional bolted joints.

Cross-Section of Magnum DS Heel-Toe Contact



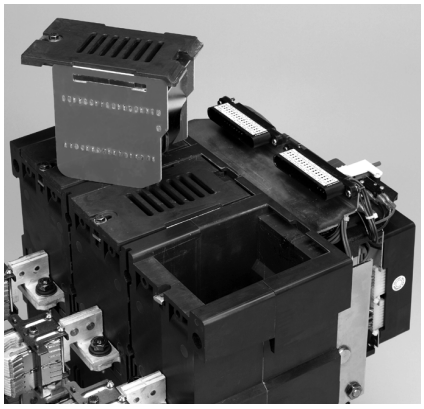
Unlike conventional power breaker designs utilizing separate arcing and main current carrying contacts, Magnum DS Circuit Breakers perform both functions on different parts of the same contact finger. Each finger has a moving main contact (heel) and a moving arcing contact (toe). A complete movable contact is merely the combination of a number of individual fingers.

As the circuit breaker is called upon to open, the toe and heel simultaneously touch. At that point, the current changes its path from the main contact to the arcing contact. As the heel lifts off, any remaining current is driven to the toe. The result is minimal arcing damage to the main contact (heel) providing for longer main contact life.

Upon closing, the toe absorbs most of the impact and deals with any arcing by touching down before the heel. Once again, the main contact (heel) is protected resulting in longer life.

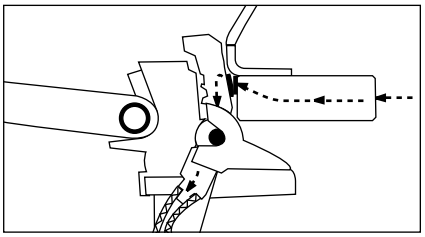
Arc Running System Provides Higher Interrupting Capacity in Less Space

- **Heel-toe contact structure is a single** contact finger design that performs both main and arcing contact functions by controlling the arc direction. This design provides for longer contact life.
- **Integral arc runner** enhances the magnetic action of the arc chute by drawing the arc into the chute with increased efficiency, reducing arcing at the toe of the contacts. This exclusive design allows for higher arcing in a smaller space, resulting in increased interrupting ratings. Alternating V Arc Chute™ quickly divides and extinguishes the arc. The V Arc Chute reaction speed protects contact material, extending contact life.



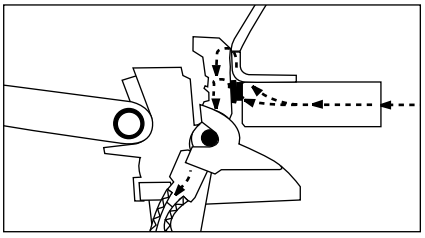
Arc chutes can be easily removed and inspected. The contact wear indicator on the main contact assembly can also be inspected.

Isolated View of Contact Opening Sequence



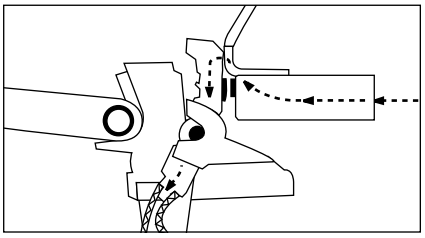
1. Fully Closed Position

Only the main contact (heel) touches and all current flow is through the main contact.



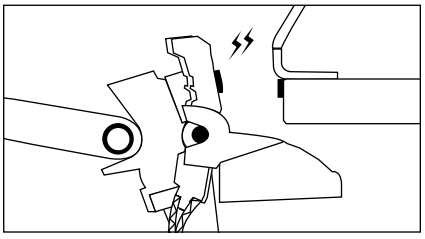
2. Simultaneous Touching of All Contacts

The arcing contact (toe) touches down before the main contact (heel) lifts off with current flow dividing between main (heel) and arcing (toe) contacts.



3. Toe (Arcing) Contacts Touching

The main contact (heel) lifts off with the arcing contact (toe) still touching to deal with any arcing. Current flow is only through the arcing contact (toe).



4. Fully Open Position

Both the main (heel) and arcing (toe) contacts are open and there is no current flow. The arc dissipates up into the arc chute.

Rigid Frame Housing

The Magnum DS Breaker utilizes a rigid frame housing – an ANSI power breaker exclusive. This housing provides the strength and stability required in the mounting of the current path and operating mechanism.

- **Increased Uptime.** Because the current path is isolated and insulated inside a two-piece interconnected housing, any potential damage that may occur during arc interruption between the poles or outside of the breaker is minimized.
- **Increased Breaker Life.** By providing rigid support for the operating mechanism and the contact structure, mechanical stress is reduced, increasing reliability.
- **Design Reliability.** The housing reduces the number of frame parts in comparison with conventional ANSI power breakers, providing increased reliability.
- **Rigid Frame.** The engineered thermoset composite resin provides excellent structural properties, dielectric strength, and arc track resistance helping to provide the higher interrupting and short time (withstand) ratings in a smaller size.

Built-in Safety Features Provide Optimum Operator Safety and System Security

- **Improved C-loop current path design** provides dramatic improvements in both safety and efficiency. Higher current ratings increase the blow-on forces on the contact surfaces, allowing the proper downstream protective device to open, isolating the fault and increasing uptime.
- **Positive on** is indicated on the breaker faceplate. This unique interlocking feature prevents the levering door from being opened if the contacts are welded, protecting personnel from exposure to live primary contacts.
- **Making current release** prevents the breaker from closing in on a fault exceeding 15 times the nominal current.
- **Keyed sensor plug** insures error-free installation of the sensor in the field.
- **Deadfront faceplate** isolates the operator from the primary voltage when the breaker is energized.
- **Anti-pump** prevents any attempts to reclose the breaker on a short circuit fault if the close signal (mechanical or electrical) is maintained.
- **Interlocked levering door** cannot be opened until the contacts are in the open condition.
- **Three position indicators** on the faceplate for drawout mounting. Specific colors identify the breaker position.

- **Connect.** Both main and secondary contacts are connected and the breaker is ready for normal operation.
- **Test.** Main disconnects are disengaged, secondary contacts are engaged. All functions of the breaker and trip unit can be tested in this position.
- **Disconnect.** A storage position in the compartment but the breaker is open and disconnected.

Quality and Reliability

Cutler-Hammer performs consistent endurance and reliability tests on Magnum DS Breakers.

- **Mini-Life Tests.** A breaker is randomly selected from the production line daily, and tested for an average of 50 mechanical operations to assure performance as required.
- **Maxi-Life Tests.** MTBF testing continuously tests Magnum DS Breakers until they fail. This identifies potential performance issues with the breaker and provides statistical analysis for further improvement.

A Common Family of Accessories for Both Frame Sizes

Magnum DS accessories fit all frame sizes.

Magnum DS through-the-window accessories are installed near the right front of the breaker. The unique windows in the breaker cover enable accessories to be quickly identified by name and rating.

Accessories are plug-in, providing for easy mounting and wiring to save both installation time and cost. This feature facilitates accessory changes and replacements by user personnel, eliminating the need to use factory trained personnel or outside service companies.

Modular accessories are keyed for fast error-free mounting in the field. For example, the spring release can only be mounted in the center cavity.

The accessory cavity design, unique to ANSI power breakers, is accessible in the front of the breaker. Up to three accessories can be easily installed and wired in the field.

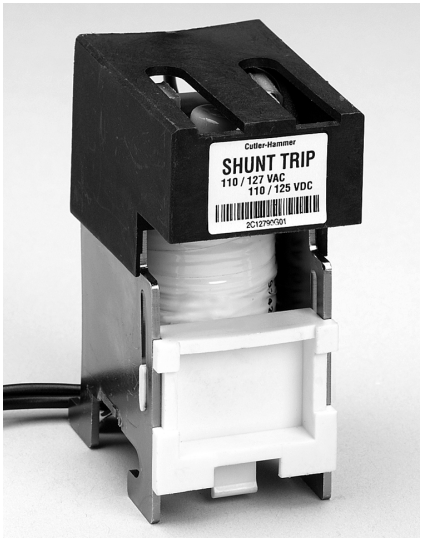
Factory Installed or Available as UL Listed Field Installable Kits

Through-the-Window Electrical Accessories

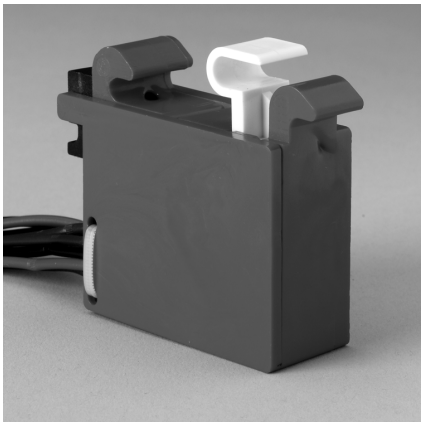
- **Shunt Trip** – Provides remote controlled circuit breaker opening when energized by a voltage input.
- **Spring Release** – Remotely closes the breaker when its coil is energized by a voltage input.
- **Undervoltage Release (UVR)** – Trips the breaker remotely when an existing voltage signal is lost or drops below an established threshold.

Internal Accessories

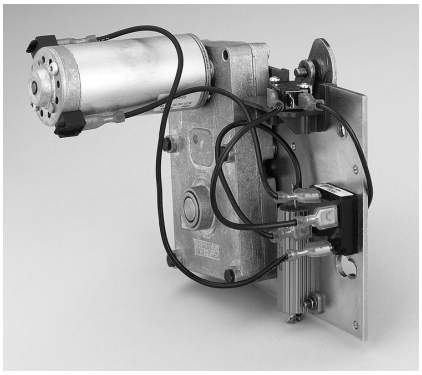
- **Auxiliary Switch** – Provides the capability to remotely indicate if the breaker is open or closed. Up to six normally open and six normally closed auxiliary contacts are available for customer use.
- **Overcurrent Trip Switch (Bell Alarm)** – A set of normally open and normally closed contacts that indicate when a breaker trips.
- **Electrical Operator** – A universal type electric motor, internally mounted in the circuit breaker, that charges the closing springs automatically, facilitating remote or local closing.



Through-the-window electrical accessories are identically sized, yet keyed for error-free mounting.



The auxiliary switch is an internal accessory that provides remote electrical indication if the breaker is open or closed.



An electric motor automatically charges the closing springs. In absence of control power, the springs can be manually charged.

Magnum DS modular design allows customers to mount accessories in the field.

Electronic Trip Units

Cutler-Hammer introduced the first microprocessor-based trip unit and has advanced the technology into a new family of UL and CSA listed Digitrip RMS Electronic and Programmable Trip Units designed and engineered exclusively for Magnum DS Breakers.

- Digitrip RMS 520 enables the user as many as nine phase and ground current protection settings for maximum flexibility in trip-curve shaping and multi-unit coordination, and adds ground current protection settings.
- Digitrip RMS 520M adds phase, neutral, and ground current metering with a four-character LCD display window.

Programmable Trip Units

- Digitrip RMS 1150 provides programmability for more sophisticated distribution systems
  - Increased protection and coordination capabilities.
  - Systems monitoring information including power factor, voltage, current, harmonic distortion values, and waveform capture with a three-line, (eight characters per line) LED display.
  - Two programmable contacts for customer use.
  - Time stamping of trip events for improved troubleshooting and diagnostics.
  - Accuracy of 1% on current and voltage values and 2% on energy and power.
  - Systems diagnostic information.
  - IMPACC/PowerNet communications.

DS II with 910

Type DSII Low-Voltage Power Circuit Breakers

Type DSII Low-Voltage Power Circuit Breakers provide:

- 100% rated, fully selective protection.
- Integral microprocessor-based breaker tripping systems.
- Two-step stored-energy breaker closing.

and many other features for coordinated, safe, convenient, trouble-free and economical control and protection of low-voltage distribution systems.

Maximum Ratings

600 Vac
5000 amperes continuous
200,000 amperes short circuit capacity

Type DSII Circuit Breaker Features

Protection During Levering Operation — When levering the breaker between the connected, test and disconnected positions, the operator is protected by a steel barrier (faceplate) from contact with live parts.

Two-Step Stored Energy Closing Mechanism — Spring charging (1) and spring release to close breaker (2) are independent operations, and always give positive control of the instant of closing.

Motor Operated Stored-Energy Closing Mechanisms are supplied on electrically operated breakers. Standard control voltages are 48, 125 and 250 dc, and 120 and 240 ac.

Remote Closing and Tripping can be accomplished with manually operated breakers by charging the closing mechanism manually, then closing and tripping it remotely through electric spring release and shunt trip coils; available as optional attachments.

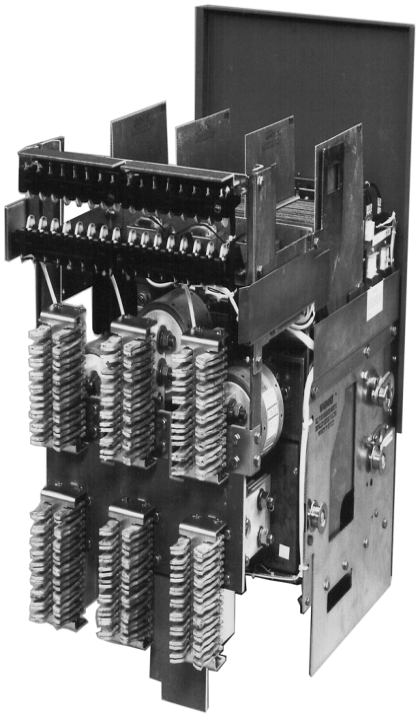
Digitrip RMS Integral Microprocessor-Based Breaker Overcurrent Trip Systems — Provides maximum reliability, true RMS sensing as standard, excellent repeatability, and requires minimum maintenance. No external control source is required.

Change in Trip Rating — The overcurrent trip pickup range is established by a combination of trip unit rating plugs and the rating of the current sensors on the breaker.

Interphase Barriers on breakers provide maximum insulation security. The barriers are easily removable for breaker inspection.

Provision for Padlocking — All breakers include provision for padlocking open to prevent electrical or manual closing. This padlocking also secures the breaker in the connected, test or disconnected position by preventing levering.

Ease of Inspection and Maintenance — Type DSII breakers are designed for maximum accessibility and the utmost ease of inspection and maintenance.



Two-Step Stored-Energy Closing

Two-step stored energy closing gives operator positive control of closing after spring mechanism is charged. Breaker can't close while still being charged. Operation is optional—full manual, full electric, or manual charge and electric close.

On manual breakers, the spring mechanism is manually charged by one downward stroke of the lever without pumping, and released by the mechanical "push-to-close" release button. On electrically operated breakers, the mechanism is normally charged and released electrically, but can be charged manually by pumping the charging lever 10 to 12 times and released mechanically.

An interlock discharges the closing springs as the breaker is removed from the compartment. The system is patterned after 5 kV and 15 kV Metal-Clad switchgear.

Arc Chute

There are three basic means of extinguishing an arc: lengthening the arc path; cooling by gas blast or contraction; deionizing or physically removing the conduction particles from the arc path. It was the discovery by Westinghouse of this last method which made the first large power air circuit breaker possible.

The De-ion® principle is incorporated in all of these circuit breakers. This makes possible faster arc extinction for given contact travel; ensures positive interruption and minimum contact burning.

Levering Mechanism

The worm gear levering mechanism is self-contained on the breaker
drawout element and engages slots in the breaker compartment. A removable crank is used to lever the breaker between the Connected-Test-Disconnected and Removed positions.

Mechanical interlocking is arranged so that levering cannot be accomplished unless the breaker is in the opened position.

Stored-Energy Mechanism

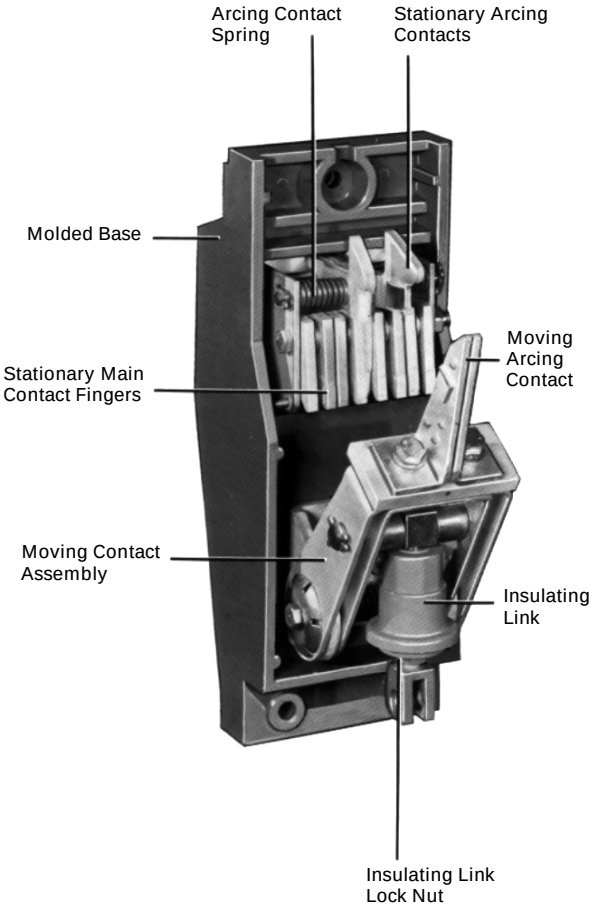
A cam-type closing mechanism closes the breaker. It receives its energy from a spring which can be charged by a manual handle on the front of the breaker or by a universal electric motor.

Release of the stored energy is accomplished by manually depressing a bar on the front of the breaker or electrically energizing a releasing solenoid.

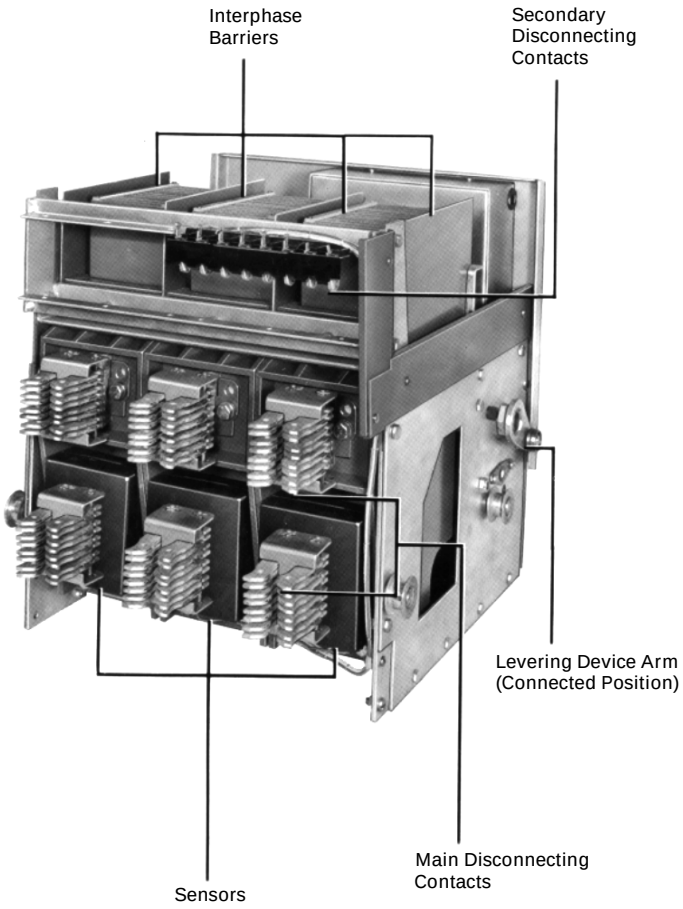
Contacts

All air circuit breakers have solid block, silver tungsten, inlaid main contacts. This construction ensures lasting current-carrying ability, which is not seriously impaired even after repeated fault interruptions or repeated momentary overload.

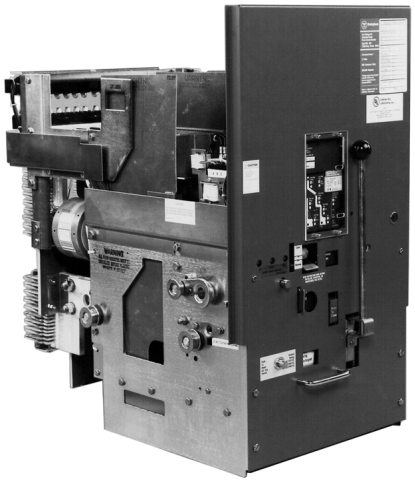
The main contacts are of the butt type and are composed of a multiplicity of fingers to give many points of contact without alignment being



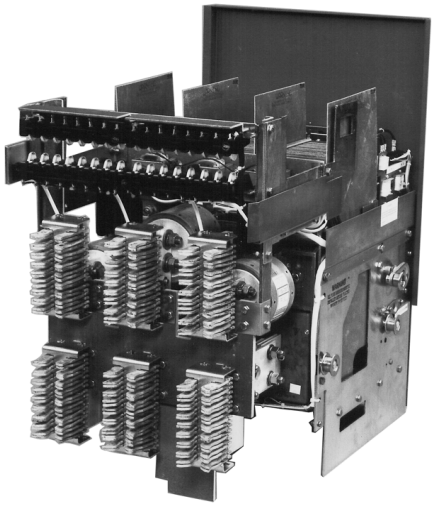
DSII Breaker Pole Unit



DSII Breaker Rear View



DSLII-620 Front View



DSLII-620 Rear View

Type DSLII Limiter Type Air Circuit Breakers

Application

Type DSLII breakers are coordinated combinations of Type DSII breakers and series connected current limiters. They are intended for applications requiring the overload protection and switching functions of air circuit breakers on systems whose available fault currents exceed the interrupting rating of the breakers alone, and/or the withstand ratings of "downstream" circuit components.

Sizes and Arrangements

Types DSLII-308 (800 ampere), DSLII-516 (1600 ampere), and DSLII-620 (2000 ampere) frame breakers include the limiters integrally mounted on the drawout breaker elements in series with the upper terminals.

Current limiters used in Types DSLII-632 and DSLII-840 combinations are mounted on separate drawout
trucks in an additional equal size compartment.

Scope of Fault Interruption

With properly selected and coordinated limiters, it is expected that the breaker itself will clear overloads and faults within its interrupting rating, leaving the limiters intact and undamaged. The limiters will provide fast interruption of fault currents beyond the breaker rating, up to a maximum of 200,000 amperes symmetrical. Thus, on overloads and faults within the breaker interrupting rating, the breaker protects the limiters; on higher fault currents exceeding the breaker rating, the limiters protect the breaker.

Protection Against Single Phasing

Loads are protected against single phase operation by interlock arrangements which trip the circuit breaker whenever any one limiter blows. The breaker cannot be reclosed on a live source until there are three unblown limiters in the circuit.

On the Types DSLII-308, DSLII-516, and DSLII-620 breakers, the primaries of small auxiliary transformers are connected in parallel with the limiters. The voltage between the ends of an unblown limiter is zero, but when any limiter blows, the associated transformer is energized and (1) operates an indicator identifying the blown fuse and (2) picks up a solenoid which raises the breaker trip bar, holding the breaker mechanically trip-free.

The DSLII-632 and DSLII-840 combinations with separately mounted limiters operate on the same principle except that the solenoid operates a micro-switch which trips the breaker electrically through a shunt trip coil.

Safety Features

The integral fuses on Types DSLII-308, DSLII-516, and DSLII-620 breakers are inaccessible until the breaker is completely withdrawn from its compartment, thereby assuring complete isolation.

Likewise, the Types DSLII-632 and DSLII-840 fuses are inaccessible until the separate fuse truck is completely withdrawn and the fuses isolated. The fuse truck is key interlocked with the breaker to prevent withdrawal or insertion unless the breaker is locked open.

Table 1 – Interrupting Ratings of Type DSLII Breakers

Type	DSLII-308	DSLII-516	DSLII-620	DSLII-632	DSLII-840
Frame Size, Amperes	800	1600	2000	3200	4000
Maximum Interrupting Rating, RMS Symmetrical Ampere, System Voltage 600 or Below	200,000	200,000	200,000	200,000	200,000

Optional Breaker Attachments and Accessories

(a) Shunt trip on manually operated breakers, for any standard control voltage.

(b) Auxiliary contacts on manually or electrically operated breakers. Maximum of 5 normally open and 5 normally closed contacts are available on any breaker, manually or electrically operated. The contact rating is 10 amperes.

(c) Compartment position switch, 6 or 12 contact, actuated by movement of drawout breaker between the connected and test positions. Most common uses are for disconnecting remote control circuits of electrically operated breaker, and for bypassing "b" interlocking auxiliary contacts, when breaker is withdrawn to test position.

(d) Undervoltage trip (ac and dc available). Acts to trip the breaker when the voltage on its solenoid coil is insufficient to restrain a spring-loaded core. The dropout point is within 30 to 60 percent of the nominal coil voltage and is not adjustable. Available as either instantaneous or time delay type. The time delay is within 2 to 7 seconds after zero voltage occurs, and is not adjustable. The device automatically resets when the breaker opens; approximately one minute is required for resetting of the time delay type.

(e) Overcurrent trip switch (OTS). A latching type switch with two independent contacts either normally open or normally closed. Operates only when the breaker is tripped automatically on an overload or fault condition. It may be used for alarm and/or interlocking circuits. Resetting is done by a pushbutton on the breaker faceplate, or by a remote switch through an optional reset coil.

(f) Electric Lockout (optional on manual breakers). In order to close the breaker after manually charging the closing mechanism, it is necessary to operate an electrical pushbutton on the breaker faceplate. This pushbutton is wired-out to the secondary contacts so it may be wired in series with any required external interlocking. The mechanical "push-to-close" bar is made inoperative when the breaker is in the connected position.

(g) Electric close release on manually operated breakers, for any standard control voltage. Breaker can be closed by remote control switch or pushbutton after the closing spring is manually charged.

(h) Operation counter.

(i) Latch check switch.

Electronic Trip Units

Cutler-Hammer offers the most comprehensive range of electronic trip units in the industry for power circuit breakers.

Digitrip electronic trip units are ac devices that employ microprocessor-based technology that provides a true RMS current sensing means for proper correlation with thermal characteristics of conductors and equipment. The primary function of the Digitrip electronic trip unit is to provide circuit protection. This is achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip unit when pre-set current levels and time delay settings are exceeded. By sampling the current waveform at various points on the wave and calculating true RMS current, the Digitrip is able to reduce nuisance tripping events due to non-sinusoidal wave shapes.

Electronic trip units are applied to distribution systems when high standards of protection and coordination are called for. In addition, electronic trip units can provide further enhanced features such as alarming, diagnostics, system monitoring and communications.

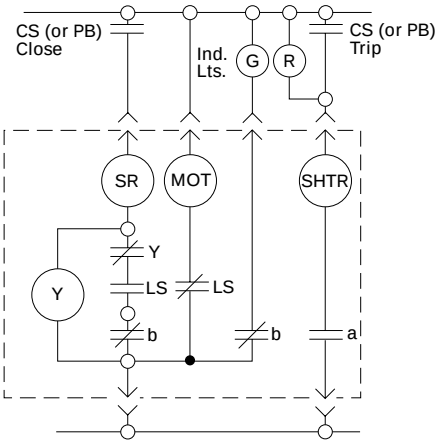
Cutler-Hammer RMS sensing trip units for power breakers fall into two main categories:

- Front adjustable trip units: Digitrip RMS 510, 610, 810, 910
- Programmable trip units: Digitrip OPTIM 750, 1050

Standard Control Diagram for Type DSII Electrically Operated Breaker, for Ac or Dc Control Source.

Legend
LS — Limit Sw. for Closing Spring
MOT — Motor for Spring Charging
SH TR — Shunt Trip
SR — Spring Release
Y — Anti-Pump Relay

Description of Operation
1 – Motor is energized through LS contact.
2 – Motor runs and charges Closing Spring.
3 – When Closing Spring fully charged, LS contacts reverse.
4 – Closing CS-C contact energizes SR Coil through Y, LS & "b" contacts.
5 – When Breaker closes, "b" opens and Y Coil is energized in series with SR Coil.
6 – Y contact opens to open SR Coil circuit & prevent pumping should breaker open while CS-C is held closed. Y Coil has very low drop-out voltage.
7 – LS contacts reverse and motor recharges closing springs.



Magnum DS Ratings

Table 2 – Ratings of Magnum DS Breakers

Breaker Type	Frame Amperes	Ratings, RMS Symmetrical Amperes (000)					
		Interrupting Rating			Short Time Rating①		
		208-240V	480V	600V	208-240V	480V	600V
MDS-408	800	42	42	42	42	42	42
MDS-608	800	65	65	65	65	65	65
MDS-808	800	85	85	85	85	85	85
MDS-C08	800	100	100	100	85	85	85
MDS-616	1600	65	65	65	65	65	65
MDS-816	1600	85	85	85	85	85	85
MDS-C16	1600	100	100	100	85	85	85
MDS-620	2000	65	65	65	65	65	65
MDS-820	2000	85	85	85	85	85	85
MDS-C20	2000	100	100	100	85	85	85
MDS-632	3200	65	65	65	65	65	65
MDS-832	3200	85	85	85	85	85	85
MDS-C32	3200	100	100	100	85	85	85
MDS-840	4000	130	85	85	85	85	85
MDS-C40	4000	130	100	100	100	100	100
MDS-850	4000	130	85	85	85	85	85
MDS-C50	5000	130	100	100	100	100	100

Maximum voltages at which the interrupting ratings in Table 2 apply are:

System Voltage	Maximum Voltage
208 or 240	254
480	508
600	635

These interrupting ratings are based on the standard duty cycle consisting of an opening operation, a 15-second interval and a close-open operation, in succession, with delayed tripping in case of short-delay devices.

The standard duty cycle for short-time ratings consists of maintaining the rated current for two periods of 1/2 second each, with a 15-second interval of zero current between the two periods.

Table 3 – Available Sensor Ratings and Rating Plugs for Digitrip RMS②

Breaker Frame	Available Ratings
800	200, 250, 300, 400, 600, 800
1600	200, 250, 300, 400, 600, 800, 1000, 1200, 1600
2000	200, 250, 300, 400, 600, 800, 1000, 1200, 1600, 2000
3200	2500, 3000, 3200
4000	3200, 4000
5000	3200, 4000, 5000

Table 4 – Digitrip RMS Adjustable Trip Settings

Time/Current Characteristics	Pickup Setting	Pickup Point (see note)	Time Band, Seconds
Long Delay	0.4, 0.5, 0.6, 0.7, 0.8 0.9, 0.95, 1.0	I_n Times Long Delay Setting	2, 4, 7, 10, 12, 15, 20, 24 (at 6 times pickup value)
Instantaneous	Off, 2, 3, 4, 6, 10 M1	I_n Times Instantaneous Setting	
Short Delay	2, 2.5, 3, 4, 6, 8, 10 M_1	I_r Times Short Delay Setting	0.1, 0.2, 0.3, 0.4, 0.5 (Flat Response) 0.1*, 0.3*, 0.5* *(I^2t Response)
Ground Fault	0.25, 0.3, 0.35, 0.4, 0.5, 0.6, 0.75, 1.00 (1200A Maximum)	I_n Times Ground Fault Setting	0.1, 0.2, 0.3, 0.4, 0.5 (Flat Response) 0.1*, 0.3*, 0.5* *(I^2t Response)
Note: I_n = Rating Plug Value I_r = Long Delay Pickup Setting Times I_n			

Table 5 – Magnum DS Breaker Control Voltages and Currents

Control Voltage	24 Dc	48 Dc	125 Dc	120 Ac	240 Ac
Close current (SR), ampere	2.70	1.30	0.67	0.59	0.34
Shunt trip current, ampere	2.70	1.30	0.67	0.59	0.34
Spring charge motor ampere	8.00	4.00	3.00	3.00	3.00
Control voltage range:					
Close –	18-26	38-56	100-140	104-127	208-254
Trip –	18-26	28-56	70-140	60-127	208-254
Motor currents are running currents. Inrush is approximately 400%. Motor running time to charge spring approximately 5 seconds.					

① Also ratings without instantaneous trip.
② The rating plug is for 50 and 60 Hz applications. Rating plugs are not interchangeable with 60 Hz or 50 Hz only rating plugs.

DSII Ratings

Table 6 – Interrupting Ratings of Type DSII Breakers

Breaker Type	Frame Size, Amperes	Ratings, RMS Symmetrical Amperes					
		Interrupting Rating			Short Time Rating ①		
		208-240V	480V	600V	208-240V	480V	600V
DSII-308	800	42,000	30,000	30,000	30,000	30,000	30,000
DSII-508	800	65,000	50,000	42,000	50,000	50,000	42,000
DSII-608	800	65,000	65,000	50,000	65,000	65,000	50,000
DSII-516	1600	65,000	50,000	42,000	50,000	50,000	42,000
DSII-616	1600	65,000	65,000	50,000	65,000	65,000	50,000
DSII-620	2000	65,000	65,000	50,000	65,000	65,000	50,000
DSII-632	3200	85,000	65,000	65,000	65,000	65,000	65,000
DSII-840	4000	130,000	85,000	85,000	85,000	85,000	85,000
DSII-850	5000	130,000	85,000	85,000	85,000	85,000	85,000

Table 7 – Digitrip RMS Adjustable Trip Settings

Time/Current Characteristic	Pickup Setting	Pickup Point (see note)	Time Band, Seconds
Long Delay	0.5, 0.6, 0.7, 0.8, 0.85, 0.9, 0.95, 1.0	I_n Times Long Delay Setting	2, 4, 7, 10, 12, 15, 20, 24 (at 6 times pickup value)
Instantaneous	2, 2.5, 3, 4, 5, 6 M_1=8, M_2=12	I_n Times Instantaneous Setting	
Short Delay	2, 2.5, 3, 4, 5, 6 S_1=8, S_2=10	I_r Times Short Delay Setting	0.1, 0.2, 0.3, 0.4, 0.5 (Flat Response) 0.1*, 0.3*, 6.5* *(I^2t Response)
Ground Fault	A (.25), B (.3), C (.35), D (.4), E (.5), F (.6), H (.75), K (1.0) (1200A Maximum)	I_n Times Ground Fault Setting	0.1, 0.2, 0.3, 0.4, 0.5 (Flat Response) 0.1*, 0.3*, 0.5 *(I^2t Response)
Note: I_n= Rating Plug Value I_r = Long Delay Pickup Setting x I_n			

Table 8 – Control Voltages and Currents

Control Voltage	48 Dc	125 Dc	250 Dc	120 Ac	240 Ac
Close current (SR), ampere	5.0	2.0	1.0	3.0	2.0
Shunt trip current, ampere	5.0	2.0	1.0	2.0	1.0
Spring charge motor ampere	7.5	3.0	1.5	3.0	1.5
Control voltage range:					
Close –	38-56	100-140	200-280	104-127	208-254
Trip –	28-56	70-140	140-280	60-127	208-254
Note: Motor currents are running currents; inrush is approximately 400%. Motor running time to charge spring approximately 5 seconds.					

Table 9 – Estimated Heat Loss Per Breaker

Breaker	Watts
DSII-308 (DSLII-308)	400 (600)
DSII-516 (DSLII-516)	1000 (1500)
DSII-620 (DSLII-620)	1500 (2250)
DSII-632	2400
DSII-840	3000
DSII-850	4700
DSII-FT32	3600
DSII-FT40	4500

① Short circuit ratings of non-automatic breakers except the DSII-840 and DSII-850 which are 65,000.

② The rating plug is for 50 and 60 Hz applications. Rating plugs are not interchangeable with 60 Hz or 50 Hz only rating plugs.

Maximum voltages at which the interrupting ratings in Table 3 apply are:

System Voltage	Maximum Voltage
208 or 240	254
480	508
600	635

These interrupting ratings are based on the standard duty cycle consisting of an opening operation,a 15-second interval and a close-open operation, in succession, with delayed tripping in case of short-delay devices.

The standard duty cycle for short-time ratings consists of maintaining the rated current for two periods of 1⁄2 second each, with a 15-second interval of zero current between the two periods.

Table 10 – Available Sensor Ratings for Digitrip RMS

Breaker	Frame Size, Amperes	Sensor Ratings, Amperes
DSII-308, DSLII-308, DSII-508 or DSII-608	800	200, 300, 400, 600, 800
DSII-516, DSLII-516 or DSII-616	1600	200, 300, 400, 600, 800, 1200, 1600
DSII-620	2000	200, 300, 400, 600, 800, 1200, 1600, 2000
DSLII-620	2000	2000
DSII-632, DSLII-632	3200	2400, 3200
DSII-840, DSLII-840	4000	3200, 4000
DSII-850	5000	5000

Table 11 – Available Digitrip RMS Rating Plugs Marked 50/60 Hertz②

Sensor Ratings, Amperes	Plug Rating in Amperes (I_n)
200	100, 200
300	200, 250, 300
400	200, 250, 300, 400
600	300, 400, 600
800	400, 600, 800
1200	600, 800, 1000, 1200
1600	800, 1000, 1200, 1600
2000	1000, 1200, 1600, 2000
2400	1600, 2000, 2400
3200	1600, 2000, 2400, 3000, 3200
4000	2000, 2400, 3200, 4000
5000	3200, 4000, 5000

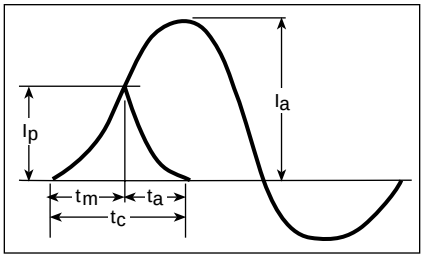
The following curves illustrate the ratings, melting time-current characteristics and current limiting, or let-through characteristics, of limiters for Type DSLII breakers.

The let-through current for a given limiter application is readily determined by extending a vertical line from the applicable maximum available symmetrical fault amperes at the bottom margin to the characteristic line for the particular limiter, and from this intersection extending a horizontal line to the left margin and reading the peak current. The withstand rating of any circuit elements protected by the limiters should be at least equal to this peak current.

It will be noted that the let-through current increases with the limiter size or ampere rating; in other words, the maximum current limiting effect is obtained with the smallest size. This effect is to be expected, since the resistance decreases as the rating increases. If the vertical line from the bottom margin as described in the previous paragraph does not intersect the limiter characteristic line, it is indicated that the available system fault current is below the "threshold" current of that limiter, and it will offer no current limiting effect.

The current limiting principle is illustrated below.

I_a = The Available Peak Fault Current
t_m = The Melting Time
I_p = The Peak Let-Through Current
t_a = The Arcing Time
t_c = The Total Interrupting (Clearing) Time



Limiter Selection

The selection of a suitable limiter rating for a given application is generally governed by a choice of the following types of protection:

A. Maximum protection of "downstream" components. Type DSLII breakers are often used for this purpose even when the maximum available fault currents are within the interrupting rating of the corresponding Type DSII unfused breakers.

B. Protection of the circuit breaker only.

Case A would tend to use the smallest available limiter; Case B the largest. When downstream protection is required, the selection is usually a compromise, since certain small limiters cannot be coordinated with the breaker to avoid nuisance blowing on overloads or small and moderate short circuits.

Minimum, recommended, and maximum limiter sizes for Types DSLII-308, DSLII-516, and DSLII-620 breakers are given in the following table.

Table 12

Breaker Type	Sensor Rating Amperes	Limiter Rating, Amperes		
		Minimum ①	Recommended ②	Maximum ③
DSLII-308	200	250	1200	2000
DSLII-308	300	400	1200	2000
DSLII-308	400	600	1200	2000
DSLII-308	600	800	1200	2000
DSLII-308	800	1200	1600	2000
DSLII-516	600	800	2000	3000
DSLII-516	800	1000	2000	3000
DSLII-516	1200	2000	2500	3000
DSLII-516	1600	–	3000	–
DSLII-620	2000	–	3000	–

Table 13 – DSLII -632 and DSLII -840 Available Limiters

Breaker Type	Available Limiters
DSLII-632	2500, 3000, 4000A
DSLII-840	2500, 3000, 4000, 5000A

Table 14 – Sensor, Plug and Limiter Selection

DSII Breakers	Sensor Rating	Plug Rating	Limiter Rating (Applicable only to DSLII Breakers)
308, 508, 608	200	100, 200	250, 300, 400, 600, 800, 1200, 1600, 2000
	300	200, 250, 300	400, 600, 800, 1200, 1600, 2000
	400	200, 250, 300, 400	600, 800, 1200, 1600, 2000
	600	300, 400, 600	800, 1200, 1600, 2000
	800	400, 600, 800	1200, 1600, 2000
516, 616	200	100, 200	800, 1000, 1200, 1600, 2000, 2500, 3000
	300	200, 250, 300	800, 1000, 1200, 1600, 2000, 2500, 3000
	400	200, 250, 300, 400	800, 1000, 1200, 1600, 2000, 2500, 3000
	600	300, 400, 600	800, 1000, 1200, 1600, 2000, 2500, 3000
	800	400, 600, 800	1000, 1200, 1600, 2000, 2500, 3000
	1200	600, 800, 1000, 1200	2000, 2500, 3000
	1600	800, 1000, 1200, 1600	3000
620	200	100, 200	Not Applicable
	300	200, 250, 300	Not Applicable
	400	200, 250, 300, 400	Not Applicable
	600	300, 400, 600	Not Applicable
	800	400, 600, 800	Not Applicable
	1200	600, 800, 1000, 1200	Not Applicable
	1600	800, 1000, 1200, 1600	Not Applicable
	2000①	1000, 1200, 1600, 2000④.	3000⑤
632	2400	1600, 2000, 2400	2500, 3000, 4000
	3200	1600, 2000, 2400, 3000, 3200	2500, 3000, 4000
840	3200	1600, 2000, 2400, 3200	2500, 3000, 4000, 5000
	4000	2000, 2400, 3200, 4000	2500, 3000, 4000, 5000
850	5000	3200, 4000, 5000	Not Applicable

① For use only when protection of downstream equipment is required. Not completely coordinated with breaker to avoid nuisance blowing.

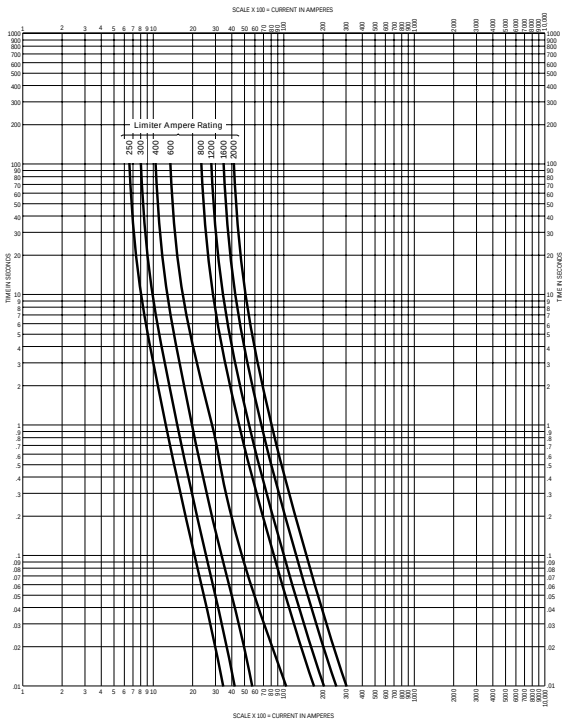
② Lowest rating which can be coordinated with breaker to minimize nuisance blowing.

③ Highest available ratings, for protection of breaker only.

④ 2000 ampere is the only sensor available for DSLII-620.

⑤ 3000 ampere is the only limiter available for DSLII-620.

DSLII -308 Average Melting Time-Current Characteristics

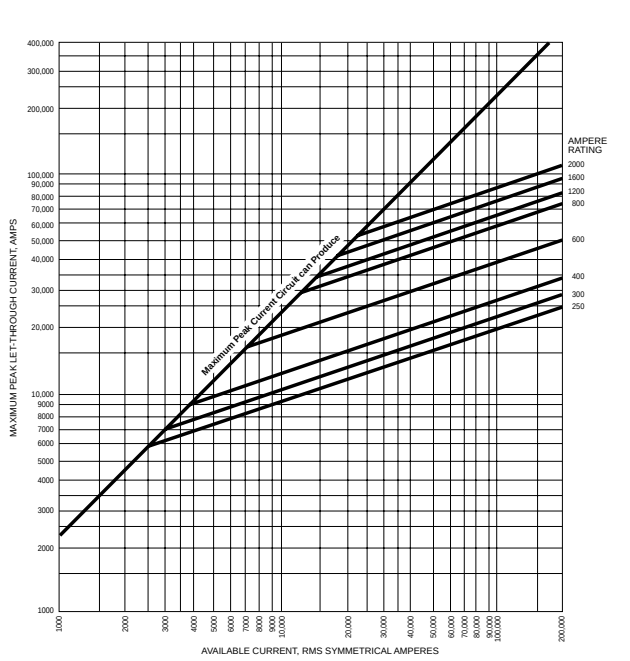


Ref. Curve No. 639771
Supersedes AD 36-783
dated April 1980

Type DSL-206 Limiters – For DSL-206 and DSLII-308 Breakers
Average Melting Time – Current Characteristics

January 1997

DSLII -308 Let-Through Characteristics

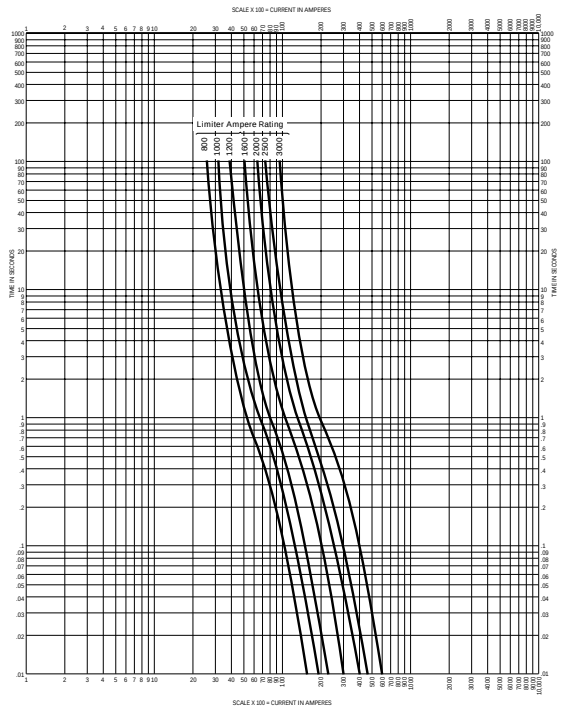


Ref. Curve No. 639772
Supersedes AD 36-783
dated April 1980

Type DSL-206 Limiters – For DSL-206 and DSLII-308 Breakers
Let-Through Characteristics

January 1997

DSLII -516 and DSLII -620 Average Melting Time-Current Characteristics



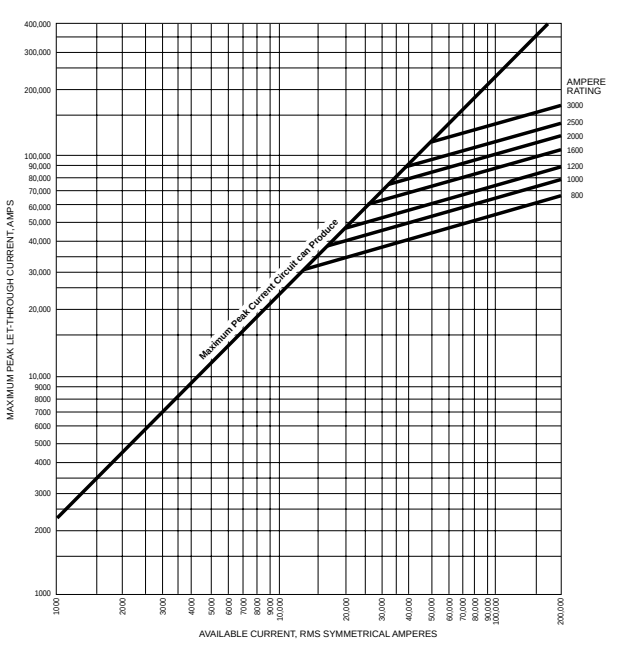
Ref. Curve No. 639431
Supersedes AD 36-783
dated April 1980

Type DSL-416 Limiters – For DSL-416, DSLII-516, DSL-420① and DSLII-620① Breakers
Average Melting Time – Current Characteristics

① DSL-420 and DSLII-620 – use only 3000 limiter.

January 1997

DSLII -516 and DSLII -620 Let-Through Characteristics



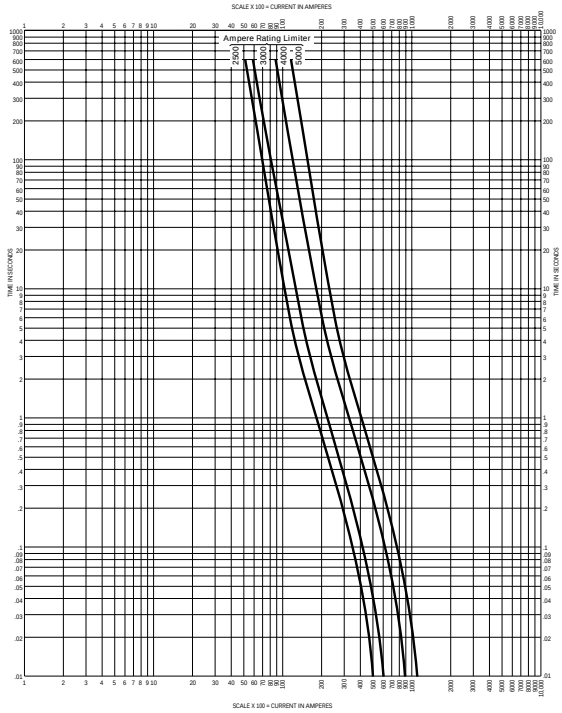
Ref. Curve No. 639432
Supersedes AD 36-783
dated April 1980

Type DSL-416 Limiters – For DSL-416, DSLII-516, DSL-420① and DSLII-620① Breakers

① DSL 420 and DSLII-620 – use only the 3000 limiter.

January 1997

DSLII -632 and DSLII -840 Average Melting Time-Current Characteristics

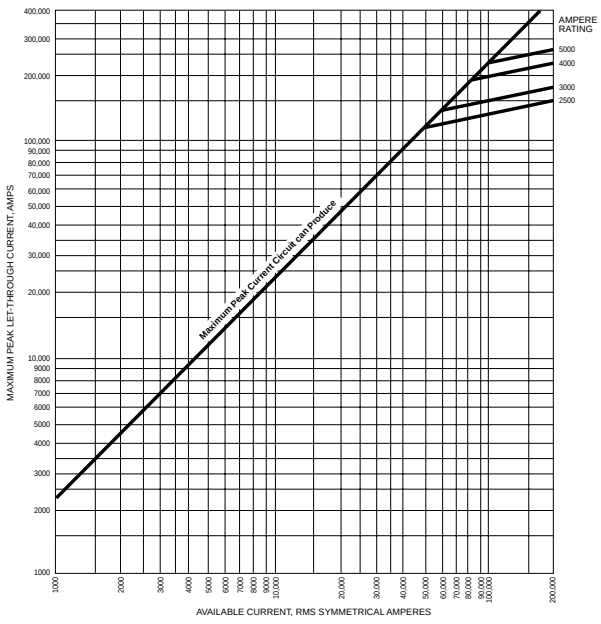


Type DSL-632 Limiters – For DSL-632 and DSLII-632 Breakers
Type DSL-840 Limiters – For DSL-840 and DSLII-840 Breakers
Average Melting Time – Current Characteristics

Ref. Curve No. 705503
Supersedes AD 36-783
dated April 1980

January 1997

DSLII -632 and DSLII -840 Let-Through Characteristics



Type DSL-632 Limiters – For DSL-632 and DSLII-632 Breakers
Type DSL-840 Limiters – For DSL-840 and DSLII-840 Breakers
Let-Through Characteristics

Ref. Curve No. 705504
Supersedes AD 36-783
dated April 1980

January 1997

Application

Standards

Magnum DS and DSII circuit breakers meet or exceed all applicable requirements of ANSI Standards C37.13, C37.17, C37.50 and CSA.

System Voltage and Frequency

Magnum DS and DSII breakers are designed for operation on ac systems only, 60 Hz or 50 Hz, 635 volts maximum.

Continuous Current Ratings

Unlike transformers, generators and motors, circuit breakers are maximum-rated devices and have no built-in temporary overload current ratings. Consequently, it is vital that each application takes into consideration the maximum anticipated current demand, initial and future, including temporary overloads.

The continuous rating of any Magnum DS and DSII breaker is limited to the sensor rating, or the frame size current rating, whichever is the lesser. For instance, an MDS-616 1600 ampere frame breaker with 800 ampere sensors has a maximum continuous rating of 800 amperes, but the same breaker with 1600 ampere sensors is limited to 1600 amperes maximum.

All current ratings are based on a maximum ambient air temperature of 40°C (104°F).

Ambient Temperature

The temperature of the air surrounding the enclosure should be within the limits of:

–30° (–22°F) to +40°C (104°F).

Altitude

The breakers are applicable at their full voltage and current ratings up to a maximum altitude of 6600 feet (2000 meters) above sea level. When installed at higher altitudes, the ratings are subject to the following correction factors in accordance with ANSI C37.20.1:

Table 15 – Altitude Derating Factors

Altitude		Voltage Correction	Current Correction
Feet	Meters		
6,600	2,000	1.000	1.000
7,000	2,150	0.989	0.998
7,500	2,300	0.976	0.995
8,000	2,450	0.963	0.993
8,500	2,600	0.950	0.990
9,000	2,750	0.933	0.987
9,500	2,900	0.917	0.983
10,000	3,050	0.900	0.980
10,500	3,200	0.883	0.977
11,000	3,350	0.867	0.973
11,500	3,500	0.850	0.970
12,000	3,650	0.833	0.967
12,500	3,800	0.817	0.963
13,000	3,950	0.800	0.960

Unusual Environmental and Operating Conditions

Special attention should be given to applications subject to the following conditions:

1. Damaging or hazardous fumes, vapors, etc.
2. Excessive or abrasive dust.

   For such conditions, it is generally recommended that the switchgear be installed in a clean, dry room, with filtered and/or pressurized clean air. This method permits the use of standard indoor switchgear and avoids the derating effect of non-ventilated enclosures.
3. Salt spray, excessive moisture, dripping, etc.

   Drip shields in equipment rooms and space heaters in indoor switchgear, or outdoor weatherproof enclosures, may be indicated, depending upon the severity of the conditions.
4. Excessively high or low ambient temperatures.

   For ambient temperatures exceeding 40°C, and based on a standard temperature rise of 65°C, the continuous current ratings of breaker frame sizes, and also buses, current transformers, etc., will be subject to a derating factor calculated from the following formula:

   $$\sqrt{\frac{\text{105°C Total – Special Ambient, °C}}{\text{105°C Total – 40°C Standard Ambient}}}$$

   Circuit breakers are not adversely affected by very low outdoor ambient temperatures, particularly when energized and carrying load currents. The standard space heaters in weatherproof switchgear will raise the temperature slightly and prevent condensation.

   Electrical components such as relays and instruments, however, must be applied within the manufacturer's specified limits.
5. Exposure to Seismic Shock.

   Magnum DS and DSII assemblies and breakers have been certified for applications through UBC Zone 4 and for the California Building Code. Assembly modifications are required, so such conditions must be specified.
6. Abnormally high frequency of operation.

   In line with above, a lesser number of operations between servicing, and more frequent replacement of parts, may be indicated.

Application

Transformer Main Secondary Breakers

Transformer secondary breakers are required or recommended for one or more of the following purposes:

1. To provide a one-step means of removing all load from the transformer.
2. To provide transformer overload protection in the absence of an individual primary breaker, and/or when primary fuses are used.
3. To provide the fastest clearing of a short circuit in the secondary main bus.
4. To provide a local disconnecting means, in the absence of a local primary switch or breaker, for maintenance purposes.
5. For automatic or manual transfer of loads to alternate sources, as in double-ended secondary selective unit substations.
6. For simplifying key interlocking with primary interrupter switches.
7. To satisfy NEC service entrance requirements when more than six feeder breakers are required.

Main secondary breakers, must have adequate interrupting ratings, but not necessarily adequate continuous current ratings. They should be able to carry continuously not only the anticipated maximum continuous output of the transformer but also any temporary overloads.

For a fully selective system, instantaneous protection on main breakers should be defeated, as they typically cannot be coordinated with down-stream devices.

Maximum capabilities of transformers of various types, can be found in section D2. It will be noted that the maximum ratings will often require the substitution of larger frame main breakers than those listed in the tables. Even if a self-cooled transformer only is considered, it should be remembered that with ratings of 750 kVA and higher, provision for the future addition of cooling fans is automatically included. It is recommended that the main breaker have sufficient capacity for the future fan-cooled rating, plus an allowance for overloads, if possible, particularly since load growth cannot always be predicted.

The same considerations should be given to the main bus capacities and main current transformer ratios.

Bus Sectionalizing (Tie) Breakers

The minimum recommended continuous current rating of bus sectionalizing or tie breakers, as used in double-ended secondary selective unit substations, or for connecting two single-ended substations, is one-half that of the associated main breakers. The interrupting rating should be at least equal to that of the feeder breakers. It is common practice to select the tie breaker of the next frame size below that of the main breakers. However, many users and engineers prefer that the tie breaker be identical to and interchangeable with the main breakers, so that under normal conditions it will be available as a spare main breaker.

In general, the tie breaker, like the main breaker, trip unit should have its instantaneous tripping defeated.

Generator Breakers

In most applications where generators are connected through breakers to the secondary bus, they are used as emergency standby sources only, and are not synchronized or paralleled with the unit substation transformers. Under these conditions, the interrupting rating of the generator breaker will be based solely on the generator kVA and sub-transient reactance. This reactance varies with the generator type and rpm, from a minimum of approximately 9% for a 2-pole 3600 rpm turbine driven generator to 15% or 20% or more for a medium or slow speed engine type generator. Thus the feeder breakers selected for the unit substation will usually be adequate for a standby generator of the same kVA as the transformer.

Most generators have a 2-hour 25% overload rating, and the generator breaker must be adequate for this overload current. Selective type long and short delay trip protection only is usually recommended for coordination with the feeder breakers, with the long delay elements set at 125% to 150% of the maximum generator current rating for generator protection.

In the case of two or more paralleled generators, anti-motoring reverse power relays (device 32) are recommended for protection of the prime movers, particularly piston type engines. For larger generators requiring a Magnum MDS-632, DSII-632 or larger, voltage-restraint type overcurrent relays (device 51V) are recommended.

Application

Feeder Breakers – General

Circuit breakers for feeder circuit protection may be manually or electrically operated, with long and short delay or long delay and instantaneous type trip devices, and trip settings, as required for the specific circuit and load requirements.

Feeder breakers as selected in Tables A1 through A4 have adequate interrupting ratings, and are assumed to have adequate continuous current ratings for maximum load demands.

General purpose feeder breakers, such as for lighting circuits, are usually equipped with long delay and instantaneous trip devices, with the long delay pickup set for the maximum load demand in the circuit. Where arcing fault protection is required, the instantaneous trip setting should be as low as practicable consistent with inrush requirements.

Motor Starting Feeder Breakers

These breakers are usually electrically operated, with long delay and instantaneous tripping characteristics for motor running, locked rotor and fault protection. The breaker sensor rating should be chosen so that the long delay pickup can be set at 125% of motor full load current for motors with a 1.15 service factor, or at 115% for all other motors. Contactors are recommended for this application when there are a number of daily operations involved.

When system short circuits are less than 40 times the motor full load current, the motor breaker tripping characteristic should include a short delay characteristic for greater fault protection.

Repetitive Duty

Repetitive breaker opening and closing, such as in frequent motor starting and stopping, are covered by ANSI Standards C37.13 and C37.16. These Standards list the number of operations between servicing (adjusting, cleaning, lubrication, tightening, etc.) and the total numbers of operations under various conditions without requiring replacement of parts, for the various breaker frame sizes.

For motor starting duty, with closing starting currents up to 600% and opening running currents up to 100% of the breaker frame size, at 80% power factor or higher, the endurance or total operations (not requiring parts replacement) will be as follows:

800A Frame: 1400
1600A Frame: 400

The frequency of operation should not exceed 20 starts in 10 minutes or 30 in one hour.

Group Motor Feeder Breakers

Typical loads for such circuits are motor control centers. The feeder breakers may be either manually or electrically operated as preferred, and are usually equipped with long and short delay trip protection only for coordination with the individual motor circuit devices. The minimum long delay pickup setting should be 115% of the running current of the largest motor in the group, plus the sum of the running circuits of all other motors.

Zone Selective Interlocking

By definition, a selectively coordinated system is one where by adjusting trip unit pickup and time delay settings, the circuit breaker closest to the fault trips first. The upstream breaker serves two functions: (1) back-up protection to the downstream breaker and (2) protection of the conductors between the upstream and downstream breakers. These elements are provided for on Digitrip trip units.

For faults which occur on the conductors between the upstream and downstream breakers it is ideally desirable for the upstream breaker to trip with no time delay. This is the feature provided by zone selective interlocking. Digitrip trip units may be specified to utilize this option.

Zone selective interlocking is a communication signal between trip units applied on upstream and downstream breakers. Each trip unit must be applied as if zone selective interlocking were not employed, and set for selective coordination.

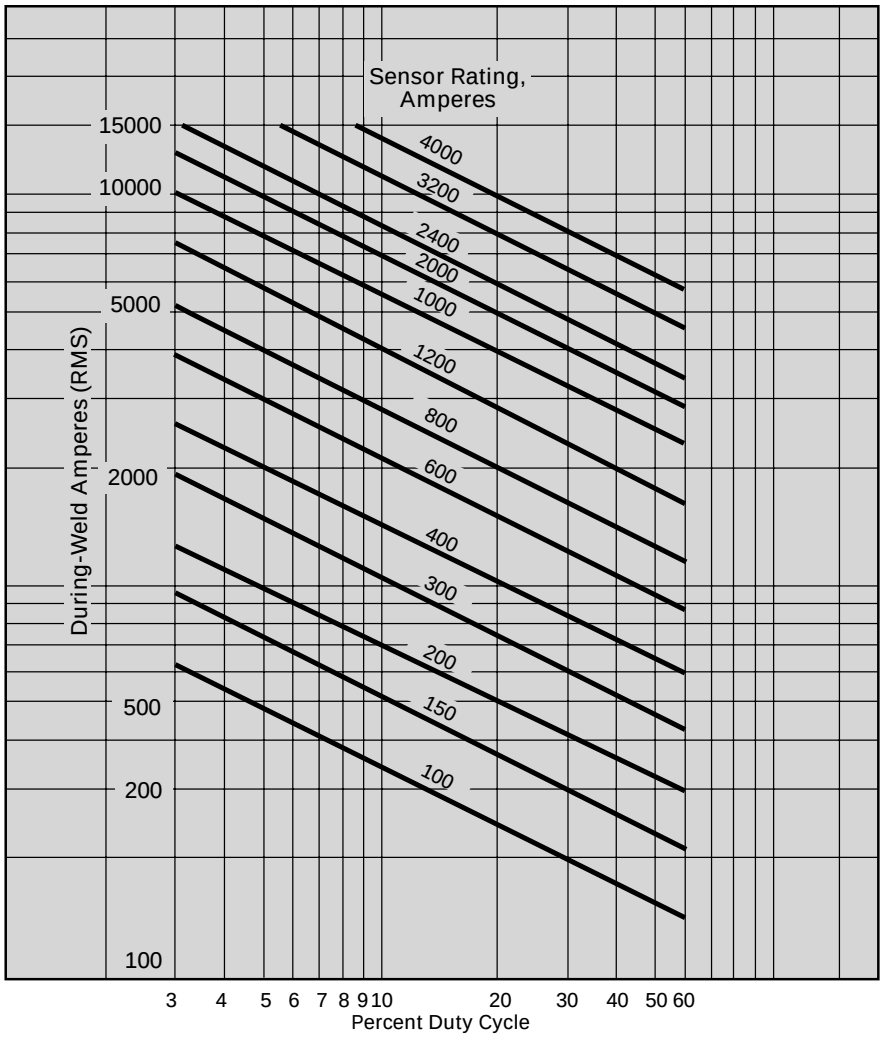
During fault conditions, each trip unit which senses the fault sends a restraining signal to all upstream trip units. This restraining signal results in causing the upstream trip to continue timing as it is set. In the absence of a restraining signal, the trip unit trips the associated breaker with no intentional time delay, minimizing damage to the fault point. This restraining signal is a very low level. To minimize the potential for induced noise, and provide a low impedance interface between trip units, a special secondary connector is added to the DSII breaker, and twisted pair conductors are utilized for interconnection. For this reason, zone selective interlocking must be specified.

Ground fault and short delay pickup on Digitrip Trip Units may be specified with zone selective interlocking. Since most system faults start as arcing ground faults, zone selective interlocking on ground fault pickup only is usually adequate. Zone selective interlocking on short delay pickup may be utilized where no ground fault protection is provided.

Zone selective interlocking may be applied as a type of bus differential protection. It must be recognized, however, that one must accept the minimum pickup of the trip unit for sensitivity.

It must also be recognized that not all systems may be equipped with zone selective interlocking. Systems containing multiple sources, or where the direction of power flow varies, require special considerations, or may not be suitable for this feature. Digitrip zone interlocking has been tested with up to three levels with up to 20 trip units per level.

Type DSII Breaker Sensor Selection Guide for Resistance Welding Applications



These welding applications are based on long delay and instantaneous trip devices with the following settings. The long time delay setting is based on the weld amperes and duty cycle. Instantaneous trip setting is two times the average weld amperes (weld amperes times percent duty cycle) or higher.

Resistance Welding

The application of DSII circuit breakers to resistance welding circuits is shown on the Sensor Selection Guide above. Sensor ratings only are given; the breaker frame must be selected as required for interrupting ratings.

The DSII Digitrip microprocessor-based true RMS sensing devices have a thermal memory and are well suited for this service. The thermal memory functions to prevent exceeding the breaker and cable maximum permissible thermal energy level. The circuit also replicates time dissipation of thermal energy.

The size of the thermal memory is $30\ T\ (I_n / I_n)^2$ unit Amperes^2 seconds. It fills at a rate of $(i_w / I_n)^2$ unit Amperes^2 seconds/second, trips at 30T seconds, and empties at the rate of $(I_n / I_n)^2$ unit Amperes^2 seconds/second, where

T = Long Time Delay Setting in seconds (range is 2-24 seconds)

i_w = RMS value of the welding current in amperes

I_n = Rating plug current value in amperes

The memory is filled during the weld and empties during the non-welding period of the duty cycle.

Power Circuit Breakers - Magnum DS

Circuit Breakers

A. All protective devices shall be low-voltage power circuit breakers, Cutler-Hammer type Magnum DS or approved equal. All breakers shall be UL listed for application in their intended enclosures for 100% of their continuous ampere rating.

B. All power circuit breakers shall be constructed and tested in accordance with ANSI C37.13, C37.16, C37.17, C37.50, UL1066 and NEMA SG-3 standard. The breaker shall carry a UL label.

C. Breakers shall be provided in drawout configuration. The 800, 1600, 2000 and 3200 ampere frame power circuit breakers shall be provided in the same physical frame size, while 4000 and 5000 ampere frame power circuit breakers shall be provided in a second physical frame size. Both physical frame sizes shall have a common height and depth.

D. Power circuit breakers shall utilize a two-step stored-energy mechanism to charge the closing springs. The closing of the breaker contacts shall automatically charge the opening springs to ensure quick-break operation.

E. Breakers shall be manually operated (MO) unless electrically operated (EO) is indicated on the drawing.

F. Electrically operated breakers shall be complete with [120 Vac] [48 Vdc] [250 Vdc] motor operators. The charging time of the motor shall not exceed 10 seconds.

G. To facilitate lifting, the power circuit breaker shall have integral handles on the side of the breaker.

H. The power circuit breaker shall have a closing time of not more than 3 cycles.

I. The primary contacts shall have an easily accessible wear indicator to indicate contact erosion.

J. The power circuit breaker shall have three windows in the front cover to clearly indicate any electrical accessories that are mounted in the breaker. The accessory shall have a label that will indicate its function and voltage.

K. The accessories shall be plug and lock type and UL listed for easy field installation. They shall be modular in design and shall be common to all frame sizes and ratings.

L. The breaker control interface shall have color-coded visual indicators to indicate contact open or closed positions as well as mechanism charged and discharged positions. Manual control pushbuttons on the breaker face shall be provided for opening and closing the breaker.

M. The power circuit breaker shall have a "Positive On" feature. The breaker flag will read "Closed" if the contacts are welded and the breaker is tripped or opened.

N. The current sensors shall have a back cover window that will permit viewing the sensor rating on the back of the breaker. A rating plug will offer indication of the rating on the front of the trip unit.

O. A position indicator shall be located on the faceplate of the breaker. This indicator shall provide color indication of the breaker position in the cell. These positions shall be Connect (Red), Test (Yellow), and Disconnect (Green). The levering door shall be interlocked so that when the breaker is in the closed position, the breaker levering-in door shall not open.

P. Each power circuit breaker shall offer sixty (60) front mounted dedicated secondary wiring points. Each wiring point shall have finger safe contacts, which will accommodate #10 AWG maximum field connections with ring tongue or spade terminals or bare wire.

Utilize the applicable paragraphs for the type of trip unit(s) desired, delete the remaining non-applicable paragraphs.

Digitrip 520 – Basic Protection and curve shaping (Paragraph A-F)

Digitrip 520/M – Same as 520 plus display (Paragraph A-G)

Digitrip 1150 – Programmable curve shaping, load monitoring, power and energy monitoring, harmonics monitoring and communications. (Paragraphs A-F, H-V.)

Trip Units

A. Each low-voltage power circuit breaker shall be equipped with a solid-state tripping system consisting of three current sensors, microprocessor-based trip device and flux-transfer shunt trip. Current sensors shall provide operation and signal function. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection functions. True rms sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached. Interchangeable current sensors with their associated rating plug shall establish the trip rating of each circuit breaker. The trip unit shall be Cutler-Hammer type Digitrip.

B. The trip unit shall have an information system that provides LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A reset button shall be provided to turn off the LED indication after an automatic trip.

C. The trip unit shall be provided with a display panel, including a

representation of the time/current curve that will indicate the protection functions. The unit shall be continuously self-checking and provide a visual indication that the internal circuitry is being monitored and is fully operational.

D. Complete system selective coordination shall be provided by the addition of the following individually adjustable time/current curve shaping solid-state elements:
   1. All breakers shall have adjustments for long delay pickup and time.
   2. [Main] [Tie] [and Feeders] shall have individual adjustments for short delay pickup and time, and include I^2t settings.
   3. [Main] [Tie] [and Feeders] shall have adjustable instantaneous pickup.
   4. Breakers, where indicated on the drawings, shall have individually adjustable ground fault current pick-up and time, and include I^2t settings or ground alarm only.

E. The trip unit shall be provided with a making-current release circuit. The circuit shall be armed for approximately eight cycles after breaker closing and shall operate for all fault levels above 15 times the ampere value of the rating plug.

F. The trip unit shall have thermal memory for enhanced protection to provide protection against cumulative overheating should a number of overload conditions occur in quick succession.

G. The trip unit shall have a display showing phase, neutral, ground and high load current. The accuracy of these readings shall be ± 2% of full scale.

H. An adjustable high load function shall be provided to avoid nuisance alarms.

I. The trip unit shall contain an integral test pushbutton. A keypad shall be provided to enable the user to select the values of test currents within a range of available settings. The protection functions shall not be affected during test operations. The breaker may be tested in the Trip or No Trip test mode.

J. The trip unit shall include a power/relay module which shall supply control power to the readout display. Following an automatic trip operation of the circuit breaker, the trip unit shall maintain the cause of trip history and the mode of trip LED indication as long as its internal power supply is available. Internal relays shall be programmable to provide contacts for remote indication.

K. Metering display accuracy of the complete system, including current sensors, auxiliary CTs, and the trip unit, shall be ±1% of full scale for current values.

L. The trip unit shall include a voltage transformer module, suitable for operation up to 600V, 50/60 Hz. The primary of the power relay module shall be connected internally to the line side of the circuit breaker through a dielectric test disconnect plug.

M. The trip unit shall provide zone interlocking for the short time delay and ground fault delay trip functions for improved system coordination. The zone interlocking system shall restrain the tripping of an upstream breaker and allow the breaker closest to the fault to trip with no intentional time delay. In the event that the downstream breaker does not trip, the upstream breaker shall trip after the preset time delay.

N. The trip unit shall have an information system that utilizes battery backup LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A test pushbutton shall energize an LED to indicate the battery status.

O. The unit shall be capable of monitoring the following data:
   - Instantaneous value of phase, neutral and ground current.
   - Instantaneous value of line to line voltage
   - Minimum and maximum current values
   - Watts, VARs, VA, Watt-hours, VAR-hours, and VA hours.
   - The energy-monitoring parameter values (peak demand, present demand, and energy consumption) shall be indicated in the trip unit's alpha-numeric display panel.
   - The trip unit shall display the following power quality values: Crest Factor, Power Factor, percent total harmonic distortion, and harmonic values of all phases through the 31st harmonic.

P. Metering display accuracy of the complete system shall be ± 2% of full scale for Power and Energy values.

Q. The display for the advanced trip units shall be LED display.

R. Programming may be done via a keypad at the faceplate of the unit, downloaded via a cable, (Triplink) or via the communication network.

S. System coordination shall be provided by the following microprocessor-based programmable time-current curve shaping adjustments. The short time pickup adjustment shall be dependent on the long delay setting.
   - Programmable long time setting
   - Programmable long time delay with selectable I^2T or I^4T curve shaping
   - Programmable short time setting
   - Programmable short time delay with selectable flat or I^2T curve shaping, and zone selective interlocking

- Programmable instantaneous setting
- Programmable ground fault setting trip or ground fault setting alarm
- Programmable ground fault delay with selectable flat or I^2T curve shaping and zone selective interlocking.

T. The trip unit shall offer a 3 event trip log that will store the trip data, and shall time and date stamp the event.

U. The trip unit shall be equipped to permit communication via a network twisted pair for remote monitoring and control.

V. The trip unit will also have the option of the following advanced features integral to the trip unit:

a. adjustable undervoltage release

b. Adjustable overvoltage release

c. Reverse load and fault current

d. Reverse sequence voltage

e. Under frequency

f. Over frequency

g. Voltage phase unbalance and phase loss during current detection.

Magnum Digitrip Trip Units The next generation of proven Digitrip RMS Trip Units is available exclusively on Magnum DS Breakers. These true rms sensing trip units provide accurate coordination with the conductors and equipment the breaker is designed to protect.				
Trip Unit Type		**Digitrip 520**	**Digitrip 520M**	**Digitrip 1150**
Ampere Range (16)		200A-5000A	200A-5000A	200A-5000A
Interrupting Rating at 48V		42 through 100kA	42 through 100kA	42 through 100kA
rms Sensing		Yes	Yes	Yes
Protection and Coordination				
Protection	Ordering Options	LSI, LSIG	LSI, LSIG, LSIA①	LSI, LSIG, LSIA①
	Fixed Rating Plug (I_n)	Yes	Yes	Yes
	Overtemperature Trip	Yes	Yes	Yes
Long Delay Protection	Adjustable Rating Plug (I_n)	No	No	No
	Long Delay Setting	0.4-1.0 x (I_n)	0.4-1.0 x (I_n)	0.4-1.0 x (I_n)
	Long Delay Time (^{2}t at 6 x I_r)	2-24 Seconds	2-24 Seconds	2-24 Seconds
	Long Delay Time I^4t	No	No	1-5 Seconds
	Long Delay Thermal Memory	Yes	Yes	Yes
	High Load Alarm	No	No	0.5-1.0 x I_r
Short Delay Protection	Short Delay Pick-Up	200-1000% M1 x (I_r)	200-1000% M1 x (I_r)	150% M1 x (I_r)
	Short Delay Time I^2t at 8 x I_r	100-500 ms	100-500 ms	100-500 ms
	Short Delay Time Flat	100-500 ms	100-500 ms	100-500 ms
	Short Delay Time ZSI	Yes	Yes	Yes
Instantaneous Protection	Instantaneous Pick-Up	200-1000% M1 x (I_n)	200-1000% M1 x (I_n)	150-M1 x (I_n)
	Making Current Release	Yes	Yes	Yes
	Instantaneous Override	No	No	No
	Off Position	Yes	Yes	Yes
Ground Fault Protection	Ground Fault Alarm	No	Yes	25% - 1200A UL
	Ground Fault Pick-Up	25-100% x (I_n)①	25-100% x (I_n)①	25-1200A UL
	Ground Fault Delay I^2t at .625 x I_n	100-500 ms	100-500 ms	100-500 ms
	Ground Fault Delay Flat	100-500 ms	100-500 ms	100-500 ms
	Ground Fault ZSI	Yes	Yes	Yes
	Ground Fault Thermal Memory	Yes	Yes	Yes
System Diagnostics				
Cause of Trip LEDs		Yes②	Yes②	Yes②
Magnitude of Trip Information		No	No	Yes
Trip Log (3 Events)		No	No	Yes
Remote Signal Contacts		No	Yes	Yes
Programmable Contacts		No	No	2
System Monitoring				
Digital Display		No	4 Char. LCD	24 Char. LED
Electronic Operations Counter		No	No	Yes
Current (% FS Sensor)		No	Yes (2%)	Yes (1%)
Voltage (%) to L to L		No	No	Yes (1%)
Power and Energy (%)		No	No	Yes (2%)
Apparent Power kVA and Demand		No	No	Yes
Reactive Power kVAR		No	No	Yes
Power Factor		No	No	Yes
Crest Factor		No	No	Yes
Power Quality – Harmonics		No	No	Yes
% THD		No	No	Yes
Waveform Capture		No	No	Yes
System Communications				
IMPACC/PowerNet		No	Yes⑤	Yes③
Testing Method		Test Set	Test Set	Integral and Test Set④
Triplink		No	No	Yes

① Less than 1200 amperes.
② Cause of Trip – L.S.I.G. and making current release.
③ Must utilize NT-based IMPACC/PowerNet software to enable communications.
④ Tester for secondary injection.
⑤ Model - Digitrip 520 MC.

I_n = Rating plug rating.
I_r = LDPU setting.
I_s = Sensor rating.

Power Circuit Breakers - DS II

Circuit Breakers

A. All protective devices shall be drawout low-voltage power air circuit breakers, Cutler-Hammer type "DSII" or approved equal. Frame ratings shall be 800, 1600, 2000, 3200, 4000, or 5000 amperes. All breakers shall be UL listed for application in their intended enclosures for 100% of their continuous ampere rating.

B. Breakers shall be manually operated (MO) unless electrically operated (EO) is indi-cated on the drawings.

C. Electrically operated breakers shall be complete with [120-Vac] [48-Vdc] [125-Vdc] [250-Vdc] operators, [OPEN/CLOSE pushbuttons] [control switch], plus red and green indicating lights to indicate breaker contact position. [DC source shall be supplied from a remote battery system] [AC source shall be taken from a (remote source) (control power transformer internal to the switchgear assembly)].

D. Main power circuit breakers shall be provided with trip units as specified in paragraph [__.__ through __].

E. Tie power circuit breakers shall be provided with trip units as specified in paragraph [__.__ through __].

F. Feeder power circuit breakers shall be provided with trip units as specfied in paragraph [__.__ through__].

Utilize the applicable paragraphs for the type trip unit(s) desired, and delete the remaining non-applicable paragraphs.

Mains, tie, and feeders may utilize different types of trip units depending on features desired for the specific application. Suggested format as follows:

Digitrip RMS510 – Basic protection and curve shaping
Trip Units (Digitrip) Paragraphs A through J

Digitrip RMS610 – Same as 510 plus local current display
Trip Units (Digitrip) Paragraphs A through N

Digitrip RMS810 – Same as 610 plus energy monitoring/display, and remote communications
Trip Units (Digitrip) Paragraphs A through R

Digitrip RMS910 – Same as 810 plus voltage, power factor and harmonic analysis and display
Trip Units (Digitrip) Paragraphs A through S

Digitrip OPTIM 750 – Programmable curve shaping, load monitoring, and communications
Programmable Trip Units (Digitrip OPTIM) Paragraphs A through O

Digitrip OPTIM 1050 – Same as 750 plus power and energy monitoring; harmonic monitoring and analysis.
Programmable Trip Units (Digitrip OPTIM) Paragraphs A through Q

G. [Main] [Tie] [and Feeder] power circuit breakers (where indicated on the drawings) shall include current limiters. Limiters shall be integrally mounted on 800-, 1600- and 2000-ampere breakers. For 3200-ampere and 4000-ampere breakers, limiters shall be mounted on a separate draw-out limiter truck. Current limiters shall be coordinated with the breaker trip device, so as to avoid unnecessary blowing of the current limiters. Breakers shall include an anti-single-phase device that will trip the breaker in the event of a blown limiter, indicate from the front of the breaker which limiter is blown, and prevent the breaker from being re-closed on a single-phase condition due to missing or blown limiters.

1. Current limiters which are integrally mounted with breaker shall be inaccessible until the breaker is completely withdrawn from its compartment assuring complete isolation. Current limiters mounted on a separate truck shall be key interlocked with the breaker to prevent withdrawing or insertion unless the breaker is locked open.

2. Power circuit breakers with current limiting fuses shall have a 200,000-ampere RMS symmetrical interrupting capacity at 600 volts and below.

Trip Units (Digitrip)

A. Each draw-out low-voltage power circuit breaker shall be equipped with a solid-state tripping system consisting of three (3) current sensors, microprocessor-based trip device and flux-transfer shunt trip. Current sensors shall provide operation and signal function. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached.

B. Interchangeable rating plugs shall establish the maximum continuous trip ratings of each circuit breaker. Rating plugs shall be fixed type as indicated. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.

C. Complete system selective coordination shall be provided by the addition of the following individually adjustable time/current curve shaping solid-state elements:

1. All breakers shall have adjustments for long delay pick-up and time.

2. [Main] [Tie] [and Feeders] shall have individual adjustments for short delay pick-up and time, and include selective flat or I^2t curve shaping.

3. [Main] [Tie] [and Feeders] shall have an adjustable instantaneous pick-up.

4. Breakers where indicated on the drawings, shall have individually adjustable ground fault current pick-up and time, and include selective flat or I^2t curve shaping.

D. The microprocessor-based trip unit shall have both powered and unpowered thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession.

E. Trip units to include zone interlocking capability for the short time delay and ground fault delay trip functions for improved system coordination. The zone interlocking system shall restrain the tripping of an upstream circuit breaker and allow the circuit breaker closest to the fault to trip with no intentional time delay. In the event that the downstream breaker does not trip, the upstream breaker shall trip after the pre-set time delay. [Factory wire zone interlocking system for breakers within the switchgear.]

F. For trip units that do not have an instantaneous adjustment, a discriminator circuit shall be provided to prevent the breaker being closed and latched on to a faulted circuit.

G. Internal ground fault protection settings shall not exceed 1200 amperes. Provide neutral ground fault sensor for four-wire loads.

H. The trip unit shall have an information system that utilizes battery backed-up LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A trip reset button shall be provided to turn off the LED indication after an automatic trip. A test pushbutton shall energize an LED to indicate battery status.

I. The trip unit shall be provided with a representation of the time-current curve on the trip unit that indicates the protection function settings. The unit shall be continuously self-checking and provide LED indication that the internal circuitry is being monitored and is fully operational.

J. The trip unit shall contain an integral test panel with a test selector switch and a test pushbutton. The test selector switch shall enable the user to select the values of test current within a range of available settings. The basic protection functions shall not be affected during test operations. The breaker shall be capable of being tested in either the TRIP or NO TRIP test mode. Provide a keyed receptacle for use with an optional auxiliary power module. The auxiliary power module shall allow the breaker trip unit to be tested with a 120-volt external power source.

K. A four-digit, 3/4-inch high, LED alphanumeric display shall be provided to indicate the following data:

1. Cause of trip

2. Instantaneous value of maximum phase and ground current

3. Level of fault current that initiated an automatic trip operation

4. Display shall be high output LED for low-level light readability. LCD displays are unacceptable.

L. The trip unit shall include a power/relay module which shall supply control power to the readout display. Following an automatic trip operation of the circuit breaker, it shall maintain the cause of trip history and the mode of trip LED indication as long as its internal power supply is available. Internal relays shall provide contacts for remote indication of mode of trip and high load.

M. A red LED shall be provided on theface of the trip unit pre-set to turn on when 85% of the trip setting is exceeded (a 40-second delay shall be provided to avoid nuisance alarms).

N. Metering display accuracy of the complete system including current sensors, auxiliary CTs, and the trip unit shall be
+/- 2% of full scale for current values.

O. The trip unit shall include a potential transformer module, suitable for operation up to 600V, 50/60 Hz. The primary of the PTM shall be connected internally to the load side of the circuit breaker through a dielectric disconnect plug. The unit shall calculate energy monitoring parameters as follows:

1. Peak demand (Megawatts)

2. Present demand (Megawatts)

3. Energy consumption (Megawatt-hours).

P. The energy-monitoring parameter values (peak demand, present demand and energy consumption) shall be indicated in the trip unit alphanumeric display panel.

Q. Metering display accuracy of the complete system of full scale shall be +/- 3% for power values, +/- 4% of full scale for energy values.

R. The trip unit shall be equipped to permit communication via a network twisted pair for remote monitoring and control. The trip unit shall be provided with an address register for identification on the network. All monitored values shall be transmittable over the network.

S. For enhanced system analysis the following additional parameter values shall be calculated and indicated in the trip unit alphanumeric display panel:

1. Line-to-line voltage

2. Power factor

3. Percentage harmonic content

4. Total harmonic distortion (THD).

Programmable Trip Units (Digitrip OPTIM)

A. Each draw-out low-voltage power circuit breaker microprocessor-based tripping system shall consist of three (3) current sensors, a trip unit and a flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached.

B. Interchangeable rating plugs shall establish the maximum continuous trip ratings of each circuit breaker. Rating plugs shall be fixed-type as indicated. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.

C. Complete system selective coordination shall be provided by the addition of the following individually adjustable time/current curve shaping solid-state elements:

1. All breakers shall have adjustments for long delay pick-up and time.
2. [Main] [Tie] [and Feeders] shall have individual adjustments for short delay pick-up and time, and include selective flat or I^2t curve shaping.
3. [Main] [Tie] [and Feeders] shall have adjustable instantaneous pick-up.
4. Breakers where indicated on the drawings, shall have individually adjustable ground fault current pick-up and time, and include selective flat or I^2t curve shaping.

D. The microprocessor-based trip unit shall have a powered/unpowered selectable thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in a quick succession.

E. Trip units to include zone interlocking capability for the short-time delay and ground fault delay trip functions forimproved system coordination. The zone interlocking system shall restrain the tripping of an upstream circuit breaker and allow the circuit breaker, closest to the fault to trip with no intentional time delay. In the event that the downstream breaker does not trip, the upstream breaker shall trip after the pre-set time delay. [Factory shall wire zone interlocking system for breakers within the switchgear.]

F. When the instantaneous setting has been deselected, a selectable discriminator circuit shall be provided to prevent the breaker being closed and latched on to a faulted circuit.

G. Internal ground fault protection or alarm settings shall not exceed 1200 amperes. Provide neutral ground fault sensor for four-wire loads.

H. The trip unit shall have an information system that utilizes battery backed-up LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A trip reset button shall be provided to turn off the LED indication after an automatic trip. A test push-button shall energize an LED to indicate battery status.

I. Circuit breakers where required shall be provided with a 30-volt DC power supply mounted within the assembly. In addition, provide a minimum of one auxiliary switch and one bell alarm, each with form C contacts in each breaker. Provide additional auxiliary switches, bell alarms, shunt trips, and undervoltage releases where indicated on the drawings.

J. Circuit breakers shall be provided with a power/relay module to supply control power. Internal relays shall provide contacts for remote indication of the mode of trip (long delay, short-circuit, ground fault) and high load.

K. A red LED shall be provided on the face of the trip unit and pre-set to flash on and off when an adjustable high load level is exceeded. A time delay shall be provided to avoid nuisance alarms. The microprocessor-based trip units shall be capable of monitoring the following data:

1. Instantaneous value of phase, neutral and ground current
2. Minimum and maximum current values
3. Average demand current
4. System diagnostic information such as alarms and cause of trip
5. Approximate level of fault current that initiated an automatic trip operation.

L. The monitored data shall be displayed by a hand-held programmer, a breaker interface module or a remote computer.

M. The trip unit shall be capable of two-way communication via a network twisted pair for remote monitoring and control. The trip unit shall be provided with an address register for identification on the network. All monitored values shall be transmittable over the network.

N. The trip unit shall contain test capability. Testing shall be carried out by using a hand-held programmer, a breaker interface module or a remote computer to select the values of test current within a range of available settings. The basic protection functions shall not be affected during test operations. The breaker may be tested in either the TRIP or NO TRIP test mode. Provide an optional auxiliary power module to allow the breaker trip unit to be tested with a 120-volt external power source.

O. A hand-held programming unit shall be provided to set/change the network communication breaker address for each device, set the system baud rate, distribution frequency, display breaker information, and display monitored values. In addition, provide password protection for programming time current set points and to perform functional testing of phase and ground trip characteristics. The programmer shall be self-powered by an internal battery. Provide as a minimum one (1) hand-held programming unit per assembly.

P. Circuit breakers shall be provided with a potential transformer module suitable for operation up to 600 volts. The primary of the potential transformer module shall be connected internally to the load side of the circuit breaker through a dielectric disconnect plug.

O. For enhanced system analysis the following additional parameter values shall be monitored:

Peak demand (kW)

Present demand (kW)

Reverse energy (kWh)

Forward energy (kWh)

Total energy (kWh)

Power factor

Percentage harmonic content

Total harmonic distortion (THD).

DSII Low Voltage Trip Unit – Selection Data

RMS 510	RMS 610	RMS 810	RMS 910	OPTIM 750	OPTIM 1050
					
9 Functions **—** **Front Adjustable**	**9 Functions** **—** **Front Adjustable** **—** **Load Monitoring** **—** **Diagnostics**	**9 Functions** **—** **Front Adjustable** **—** **Load Monitoring** **—** **Diagnostics** **—** **Communications** **—** **Power and Energy Monitoring**	**9 Functions** **—** **Front Adjustable** **—** **Load Monitoring** **—** **Diagnostics** **—** **Communications** **—** **Power and Energy Monitoring** **—** **Harmonics**	**10 Functions** **—** **Programmable** **—** **Load Monitoring** **—** **Diagnostics** **—** **Communications**	**10 Functions** **—** **Programmable** **—** **Load Monitoring** **—** **Diagnostics** **—** **Communications** **—** **Power and Energy Monitoring** **—** **Harmonics**

Breaker Type							
Frame(s)		All DSII and DSLII	All DSII and DSLII	All DSII and DSLII	All DSII and DSLII	All DSII and DSLII	All DSII and DSLII
Ampere Range		100A-5000A	100A-5000A	100A-5000A	100A-5000A	100A-5000A	100A-5000A
Interrupting Rating @ 480V		30 thru 200 kA	30 thru 200 kA	30 thru 200 kA	30 thru 200 kA	30 thru 200 kA	30 thru 200 kA
Trip Unit Sensing							
rms Sensing		Yes	Yes	Yes	Yes	Yes	Yes
Protection and Coordination							
Protection	Ordering Options	LI, LS, LSI, LIG LSG, LSIG	LI, LS, LSI, LIG LSG, LSIG	LI, LS, LSI, LIG LSG, LSIG	LI, LS, LSI, LIG LSG, LSIG	LSI(A), LSIG	LSI(A), LSIG
	Fixed Rating Plug (I_n)	Yes	Yes	Yes	Yes	Yes	Yes
	Overtemperature Trip	Yes	Yes	Yes	Yes	Yes	Yes
Long Delay	Adjustable Rating Plug (I_n)	No	No	No	No	No	No
	Long Delay Setting	0.5-1.0 (I_r)	0.5-1.0 (I_r)	0.5-1.0 (I_r)	0.5-1.0 (I_r)	0.4-1.0 x (I_n)	0.4-1.0 x (I_n)
	Long Delay Time I^2T	2-24 Seconds	2-24 Seconds	2-24 Seconds	2-24 Seconds	2-24 Seconds	2-24 Seconds
	Long Delay Time I^4T	No	No	No	No	1-5 Seconds	1-5 Seconds
	Long Delay Thermal Memory	Yes	Yes	Yes	Yes	Yes	Yes
	High Load Alarm	No	0.85 x I_r	0.85 x I_r	0.85 x I_r	0.5-1.0 x I_r	0.5-1.0 x I_r
Short Delay	Short Delay Setting	200-600% S1 & S2 (I_r)	200-600% S1 & S2 (I_r)	200-600% S1 & S2 (I_r)	200-600% S1 & S2 (I_r)	150-800% x (I_r)	150-800% x (I_r)
	Short Delay Time I^2T	100-500 ms	100-500 ms	100-500 ms	100-500 ms	100-500 ms	100-500 ms
	Short Delay Time Flat	100-500 ms	100-500 ms	100-500 ms	100-500 ms	100-500 ms	100-500 ms
	Short Delay Time ZSI	Yes	Yes	Yes	Yes	Yes	Yes
Instanta-neous	Instantaneous Setting	200-600% M1 & M2	200-600% M1 & M2	200-600% M1 & M2	200-600% M1 & M2	200-800% x (I_n)	200-800% x (I_n)
	Discriminator	Yes①	Yes①	Yes①	Yes①	Yes	Yes
	Instantaneous Override	Yes (Not Type DSII)	Yes (Not Type DSII)	Yes (Not Type DSII)	Yes (Not Type DSII)	Yes	Yes
Ground Fault	Ground Fault Alarm	No	No	No	No	20/25-100%②	20/25-100%②
	Ground Fault Setting	25-100%(I_n)②	25-100%(I_n)②	25-100%(I_n)②	25-100%(I_n)②	20/25-100%②	20/25-100%②
	Ground Fault Delay I^2T	100-500 ms	100-500 ms	100-500 ms	100-500 ms	100-500 ms	100-500 ms
	Ground Fault Delay Flat	100-500 ms	100-500 ms	100-500 ms	100-500 ms	100-500 ms	100-500 ms
	Ground Fault ZSI	Yes	Yes	Yes	Yes	Yes	Yes
	Ground Fault Thermal Memory	Yes	Yes	Yes	Yes	Yes	Yes
System Diagnostics							
Cause of Trip LEDs		Yes	Yes	Yes	Yes	Yes	Yes
Magnitude of Trip Information		No	Yes	Yes	Yes	Yes	Yes
Remote Signal Contacts		No	Yes	Yes	Yes	Yes	Yes
System Monitoring							
Digital Display		No	Yes	Yes	Yes	Yes③	Yes④
Current		No	Yes	Yes	Yes	Yes	Yes
Voltage		No	No	No	Yes	No	Yes
Power and Energy		No	No	Yes	Yes	No	Yes
Power Quality - Harmonics		No	No	No	Yes	No	Yes
Power Factor		No	No	Yes⑤	Yes	No	Yes
System Communications							
IMPACC/PowerNet		No	No	Yes	Yes	Yes	Yes
Field Testing							
Testing Method		Integral⑤	Integral⑤	Integral⑤	Integral⑤	OPTIMizer, BIM, IMPACC/PowerNet	OPTIMizer, BIM, IMPACC/PowerNet

① LS/LSG Only.
② Not to exceed 1200 Amperes.
③ By OPTIMizer/BIM.
④ Over IMPACC/PowerNet only.
⑤ Secondary injection testing performed for DSII/DSLII.

BIM = Breaker Interface Module
I_S= Sensor Rating
I_n=Rating Plug
I_r= LDPU Setting x I_n
(A) = GF Alarm