

General Description

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Type DSII Low Voltage
Power Circuit Breakers

DSII with 910 Trip Unit

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

- 600V AC.
- 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. 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. Eaton's Cutler-Hammer 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.

General Description

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

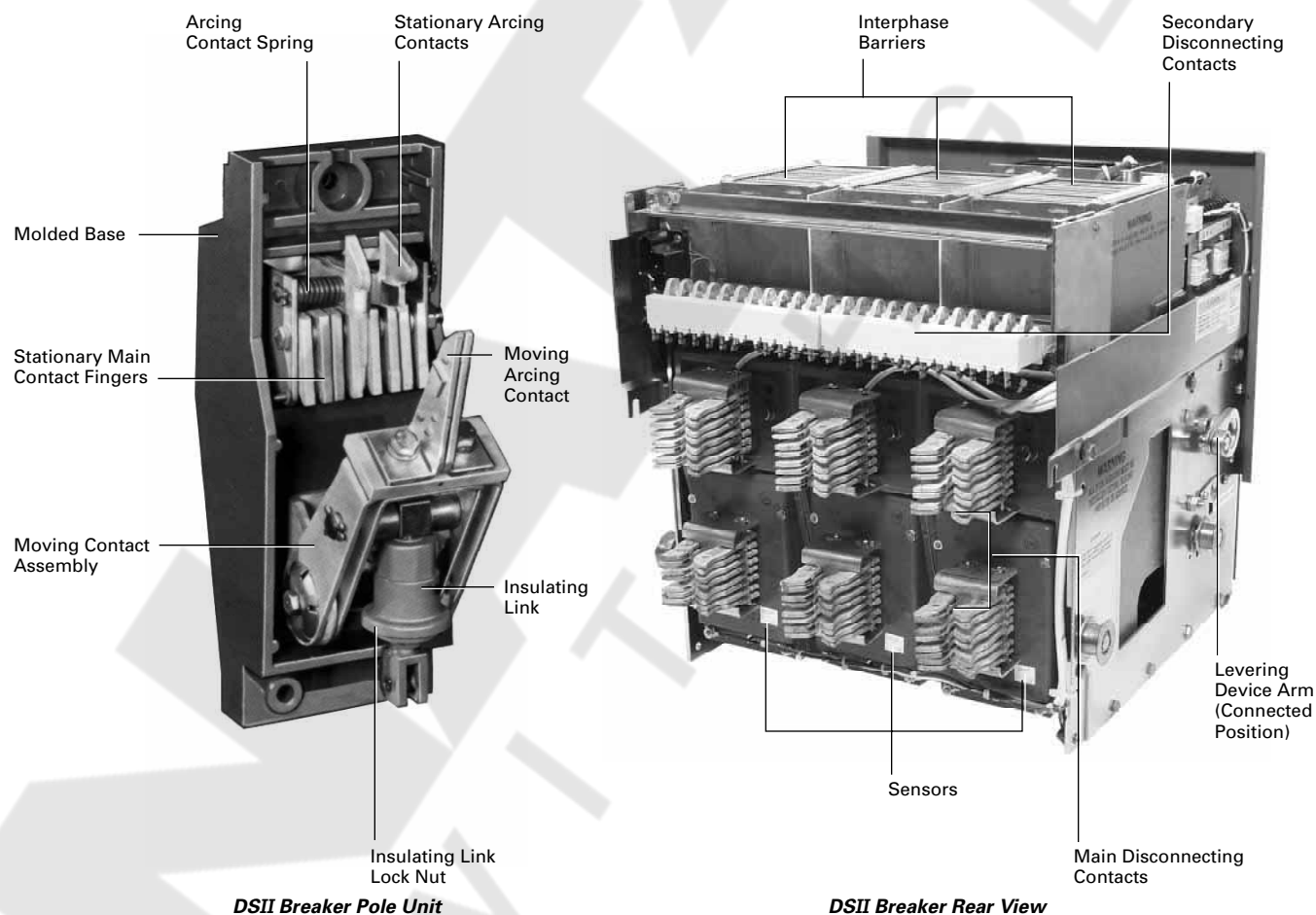
A cam-type closing mechanism closes the breaker. It receives its energy from a spring which can be charged by a manual handle on the front of the breaker or by a universal electric motor.

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

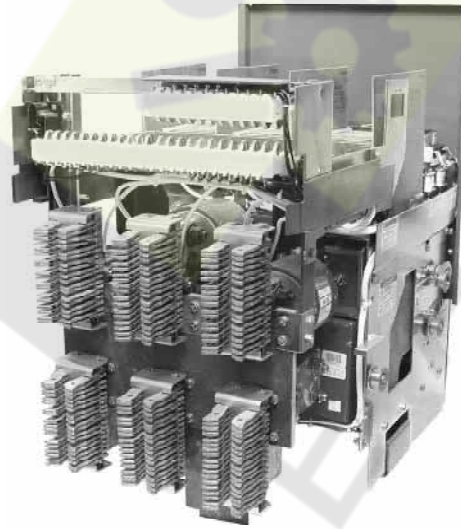
Contacts

All Eaton's Cutler-Hammer 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 critical.



Type DSLII Limiter Type Air Circuit Breakers

*DSLII-620 Front View**DSLII-620 Rear View*

Application

Eaton's Cutler-Hammer 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.

General Description — Accessories/Trip Units

Optional Breaker Attachments and Accessories

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- A. Shunt trip on manually operated breakers, for any standard control voltage.
- B. Auxiliary contacts on manually or electrically operated breakers. Maximum of five normally open and five normally closed contacts are available on any breaker, manually or electrically operated. The contact rating is 10 amperes.
- C. Compartment position switch, six or 12 contacts, 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% of the nominal coil voltage and is not adjustable. Available as either instantaneous or time delay type. The time delay is within two to seven 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

The Eaton's Cutler-Hammer business 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 preset 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.

For additional information on trip units see **Section 21.5**.

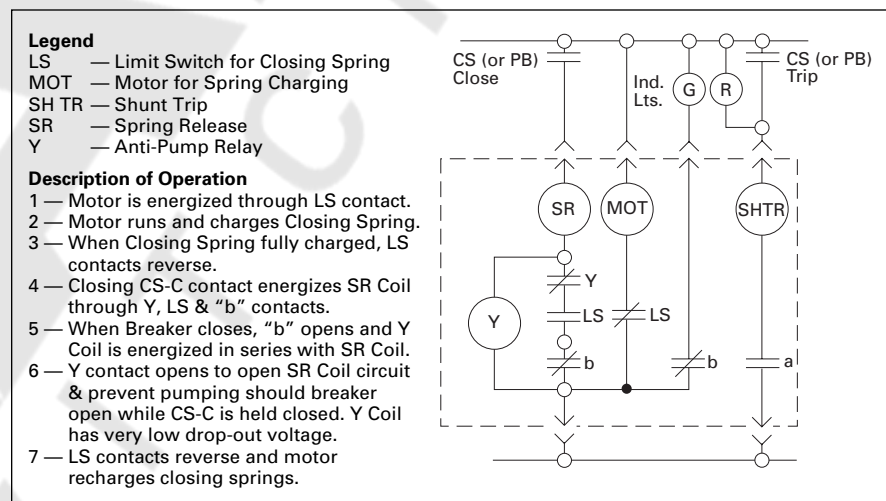


Figure 21.2-1. Standard Control Diagram for Type DSII Electrically Operated Breaker, in DSII Switchgear, for AC or DC Control Source

DSII Ratings

Table 21.2-1. 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

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

Table 21.2-2. 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 ^② , 0.3 ^② , 6.5 ^②
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 ^② , 0.3 ^② , 0.5

^② I^2t Response.

Note: I_n = Rating Plug Value

I_r = Long Delay Pickup Setting $\times I_n$.

Table 21.2-3. 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 Amperes, System Voltage 600 or Below	200,000	200,000	200,000	200,000	200,000

Table 21.2-4. 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:	38 – 56	100 – 140	200 – 280	104 – 127	208 – 254
Close —	28 – 56	70 – 140	140 – 280	60 – 127	208 – 254
Trip —					

Note: Motor currents are running currents; inrush is approximately 400%. Motor running time to charge spring approximately 5 seconds.

Table 21.2-5. Estimated Heat Loss Per Breaker

Breaker Type	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

Maximum voltages at which the interrupting ratings in Table 21.2-1 apply are:

Table 21.2-6. Maximum Voltage Rating

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 21.2-7. Available Sensor Ratings for Digitrip RMS

Breaker Type	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 21.2-8. Available Digitrip RMS Rating Plugs Marked 50/60 Hertz

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 ^③
2400	1600, 2000, 2400
3200	1600, 2000, 2400, 3000, 3200
4000	2000, 2400, 3200, 4000
5000	3200, 4000, 5000

^③ 2000 ampere is the only plug available for DSLII-620.

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

Technical Data

The following curves illustrate the ratings, melting time-current characteristics and current limiting, or let-through characteristics, of limiters for Eaton's Cutler-Hammer 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

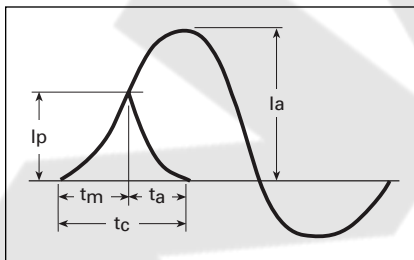


Figure 21.2-2. Current Limiting

Table 21.2-9. DSLII-632 and DSLII-840 Available Limiters

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

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 Eaton's Cutler-Hammer Types DSLII-308, DSLII-516, and DSLII-620 breakers are given in table.

Table 21.2-10. DSLII Limiter Selection

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	—

- 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.

Table 21.2-11. Sensor, Plug and Limiter Selection

DSII Breakers	Sensor Rating, Amperes	Plug Rating, Amperes	Limiter Rating, Amperes (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
	2000	1000, 1200, 1600, 2000 ^④	3000 ^⑤
	632	2400	1600, 2000, 2400
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

- ④ 2000 ampere is the only plug available for DSLII-620.
- ⑤ 3000 ampere is the only limiter available for DSLII-620.

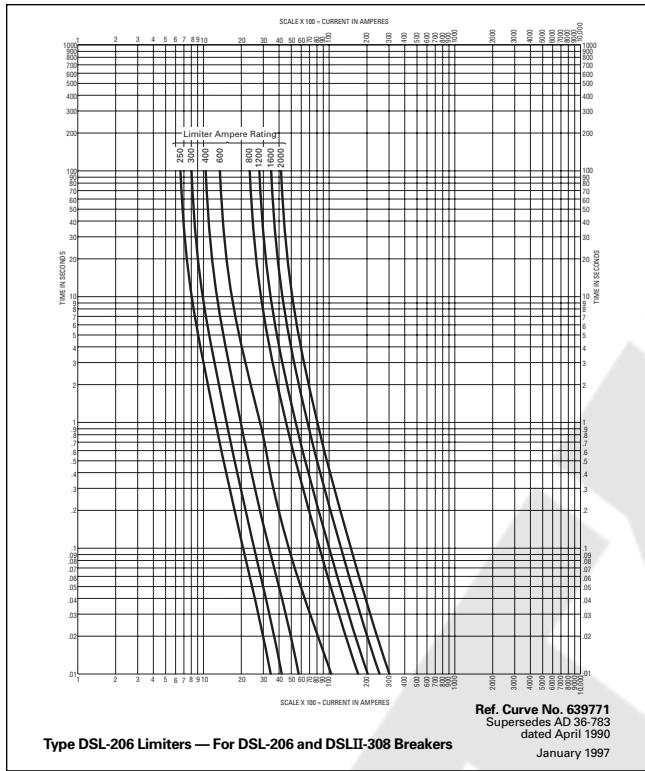


Figure 21.2-3. DSLII-308 Average Melting Time-Current Characteristics

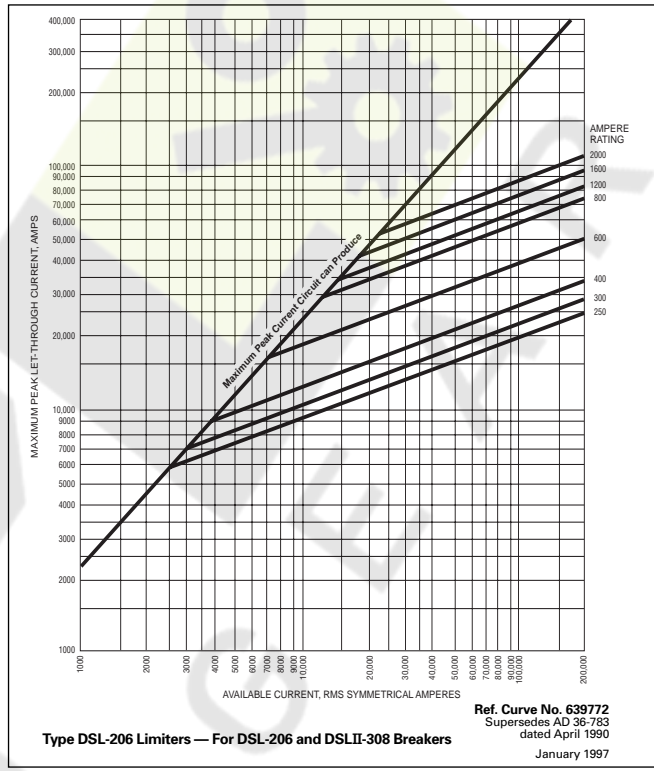


Figure 21.2-5. DSLII-308 Let-Through Characteristics

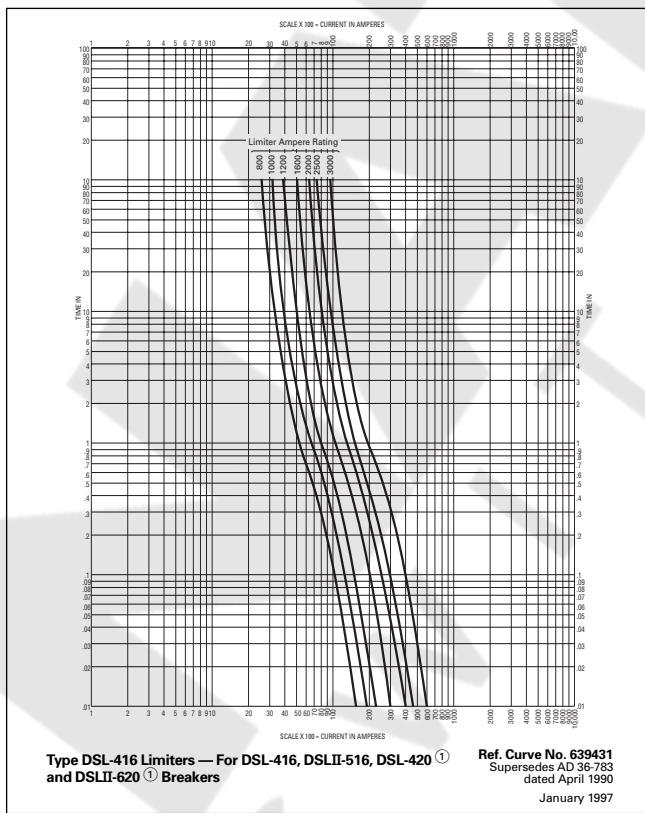


Figure 21.2-4. DSLII-516 and DSLII-620 Average Melting Time-Current Characteristics

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

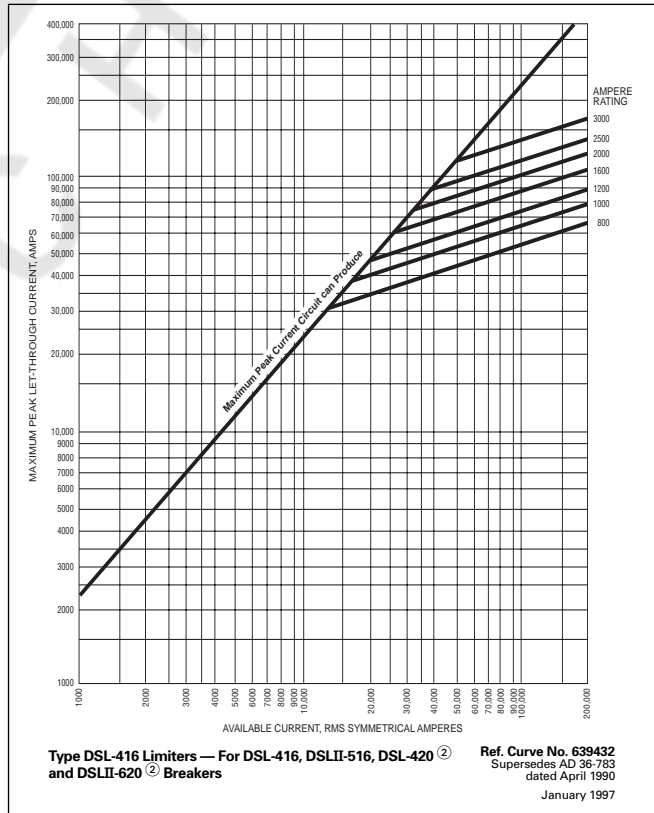


Figure 21.2-6. DSLII-516 and DSLII-620 Let-Through Characteristics

② DSL-420 and DSLII-620 — use only 3000 limiter.

Technical Data

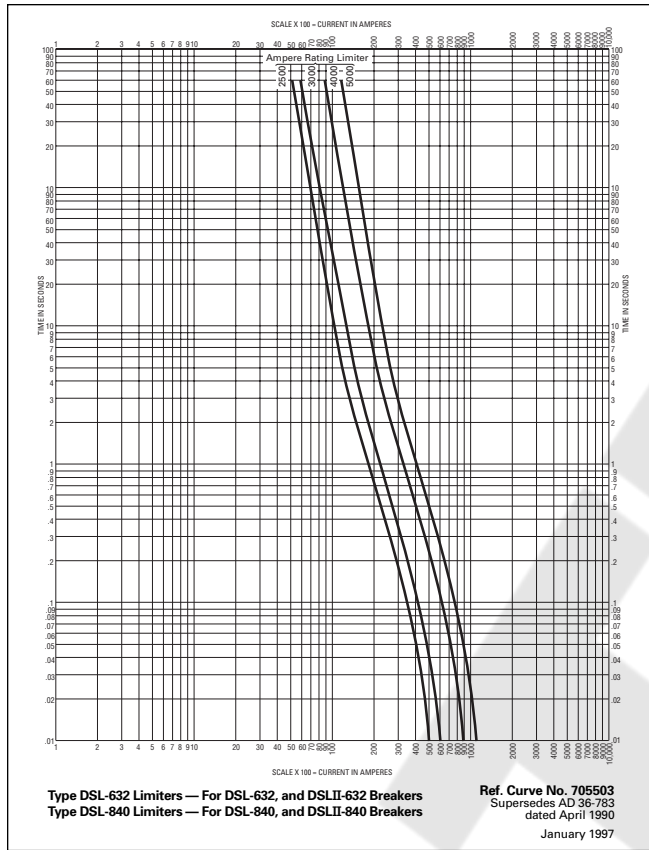


Figure 21.2-7. DSLII-632 and DSLII-840 Average Melting Time-Current Characteristics

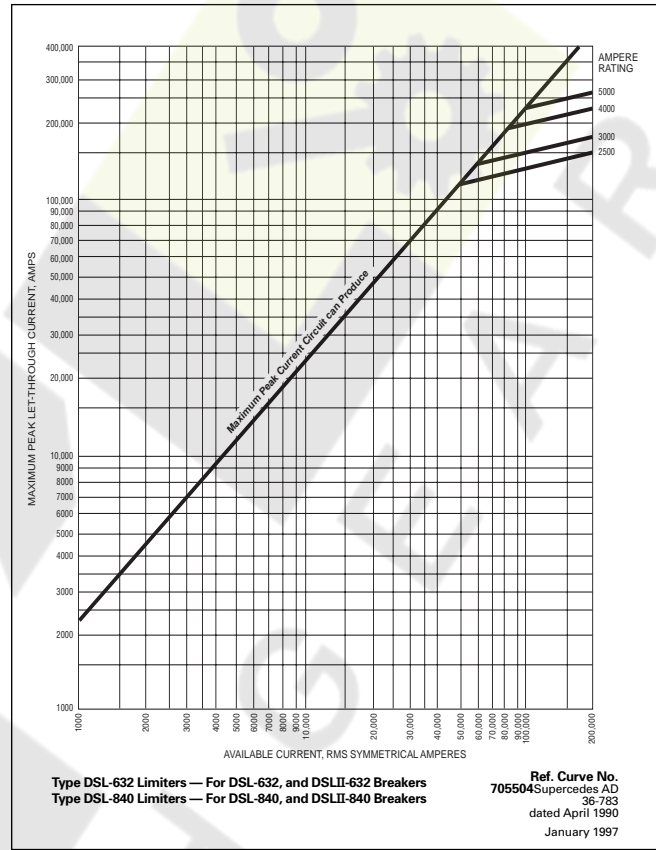


Figure 21.2-8. DSLII-632 and DSLII-840 Let-Through Characteristics

Application Data

Application**Standards**

Eaton's Cutler-Hammer DSII circuit breakers meet or exceed all applicable requirements of ANSI Standards C37.13, C37.17, C37.50 and CSA.

System Voltage and Frequency

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 DSII breaker is limited to the sensor rating, or the frame size current rating, whichever is the lesser. For instance, a DS-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°C (-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 6,600 feet (2,012 m) 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 21.2-12. Altitude Derating Factors

Altitude		Voltage Correction	Current Correction
Feet	Meters		
6,600	2,012	1.000	1.000
7,000	2,134	.989	.998
7,500	2,286	.976	.995
8,000	2,438	.963	.993
8,500	2,591	.950	.990
9,000	2,743	.933	.987
9,500	2,896	.917	.983
10,000	3,048	.900	.980
10,500	3,200	.883	.977
11,000	3,353	.867	.973
11,500	3,505	.850	.970
12,000	3,658	.833	.967
12,500	3,810	.817	.963
13,000	3,962	.800	.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:

$$\sqrt{\frac{105^{\circ}\text{C Total} - \text{Special Ambient, }^{\circ}\text{C}}{105^{\circ}\text{C Total} - 40^{\circ}\text{C Standard Ambient}}}$$

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.

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

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.

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 operations
1600A Frame: 400 operations

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 currents 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 Eaton's Cutler-Hammer Magnum DS 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.

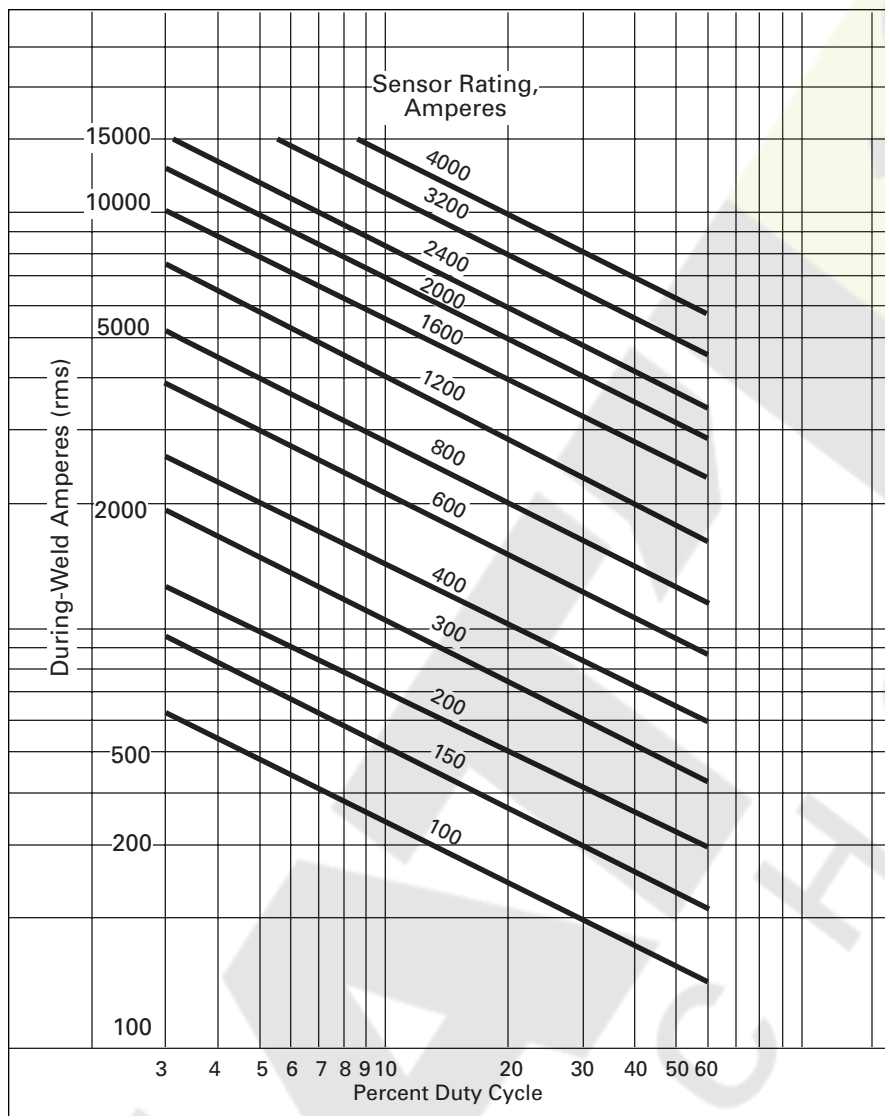


Figure 21.2-9. Type DSII Breaker Sensor Selection Guide for Resistance Welding Applications

Resistance Welding

The application of Eaton’s Cutler-Hammer DSII circuit breakers to resistance welding circuits is shown in **Figure 21.2-9** of the Sensor Selection Guide. 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 Amperes² seconds. It fills at a rate of $(i_w / I_n)^2$ unit Amperes² seconds/second, trips at 30T seconds, and empties at the rate of $(I_n / I_n)^2$ unit Amperes² 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.

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.