Cutler-Hammer

February 1997
Supersedes Application Data 32-650 D,
pages 1-44, dated March 1996
Mailed to: E, C/32-000B

Type DSII Metal-Enclosed Low-Voltage Switchgear

EATON

Type DSII Metal-Enclosed Low-Voltage Switchgear

Type DSII Low-Voltage Switchgear

Modern design Type DSII Metal-Enclosed Low-Voltage Switchgear and Circuit Breakers provide:

- 100% rated, fully selective protection.
- Integral microprocessor-based breaker tripping systems.
- Two-step stored-energy breaker closing.
- 100 kA short circuit bracing standard.
- Optional 200 kA short circuit bracing, without preceeding current limiting fuses.
- Standard metal barriers isolate cable and bus compartments.

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

Maximum Ratings
600 Volts ac
5000 Amperes continuous
200,000 Amperes short circuit capacity

Features

Standard Finish—Medium Gray (ANSI 61) using a modern completely automated and continuously monitored electrostatic powder coating. The paint type and process meets UL1332 standard for organic coating of steel enclosures for outdoor electrical equipment. This continually monitored system includes Spray de-grease and clean, spray rinse, Iron phosphate spray coating stray rinse, non-chemical seal, oven drying, electrostatic powder spray paint coating and oven curing.

Four Position Drawout—Breakers can be in connected, test, disconnected or removed position with compartment doors closed.

Plug-in Terminal Blocks—At each shipping split, the control connections are made with plug-in terminal blocks rated 600 Volts, 40 Amperes and accept a wire range of #22 to #8. The terminal blocks interlock mechanically without removing the line or load connections. This method of making the shipping split control connections increases the speed of installation and reduces the potential of incorrect connections.

Integral Base—Rugged formed base suitable for rolling. Includes slots for jacking and handling.

Front Terminal Block Tray—Unitized wiring system utilizes pull-out trays above each breaker compartment for terminal blocks and control fuses.

Removable Doors—Each breaker door is mounted with hinge pins. Removal of the door is easily accomplished by just lifting the hinge pin. This allows easy access to the breaker and compartment for inspection and maintenance.

Current Transformers for metering and instrumentation are mounted in the breaker compartments and are front accessible.

Short Circuiting Terminal Blocks—One provided for each set of instrumentation or relaying application current transformers.

Standard Silver-Plated Copper Bus—(Tin-plated copper bus available).

Lug Pad—The lugs are located on the breaker run-backs at a 45° angle to reduce the bending of the cable when making the connections, thus reducing installation and maintenance time.

Cable Lashing—Feeder cable lashing is not required on DSII Switchgear Assemblies when standard factory lugs and cable installation methods are used. Tests were conducted and approved by UL to verify the integrity of the DSII cable termination system.

If the customer uses other type lugs or cable installation methods, cable lashing is required. For these instances, cable lashing instructions are given in the instructions supplied with each assembly.

Glass Reinforced Polyester and Ultramid① Stand-Off Insulation System—Type DSII Switchgear provides an industry leading design for short circuit withstand levels through 200 kA, without the need for preceeding current limiting devices. Glass reinforced polyester has been used on both low- and medium-voltage switchgear for decades. By combining this industry proven material with Ultramid insulation, a total system providing exceptional mechanical and dielectric withstand strength, as well as high resistance to heat, flame, and moisture, is produced. Substantial testing to demonstrate accelerated effects of heating and cooling on the mechanical and dielectric properties of this system prove it to provide superior performance for decades of trouble-free operation.

Optional Conductor Insulation Covering—For applications requiring additional bus protection in harsh environments, Type DSII Switchgear is designed for the addition of optional conductor insulation covering, in addition to providing full UL air clearance without insulation. This non-PVC material is applied during the assembly of the bus and covers all vertical and horizontal phase bus bars. Removable non-PVC boots provide access to bus joints for inspection and maintenance purposes.

Closing Spring Automatic Discharge—Mechanical interlocking automatically discharges the closing springs when the breaker is removed from its compartment.

Breaker Inspection—When withdrawn on the rails, breaker is completely accessible for visual inspection; tilting is not necessary. The rails are permanent parts of every breaker compartment.

Key Interlock—Breaker can be stored in compartment, and completely removed for maintenance or for use as a spare without disturbing the interlock. No modification of the breaker required. This mechanism holds the breaker mechanically trip-free to prevent electrical or manual closing.

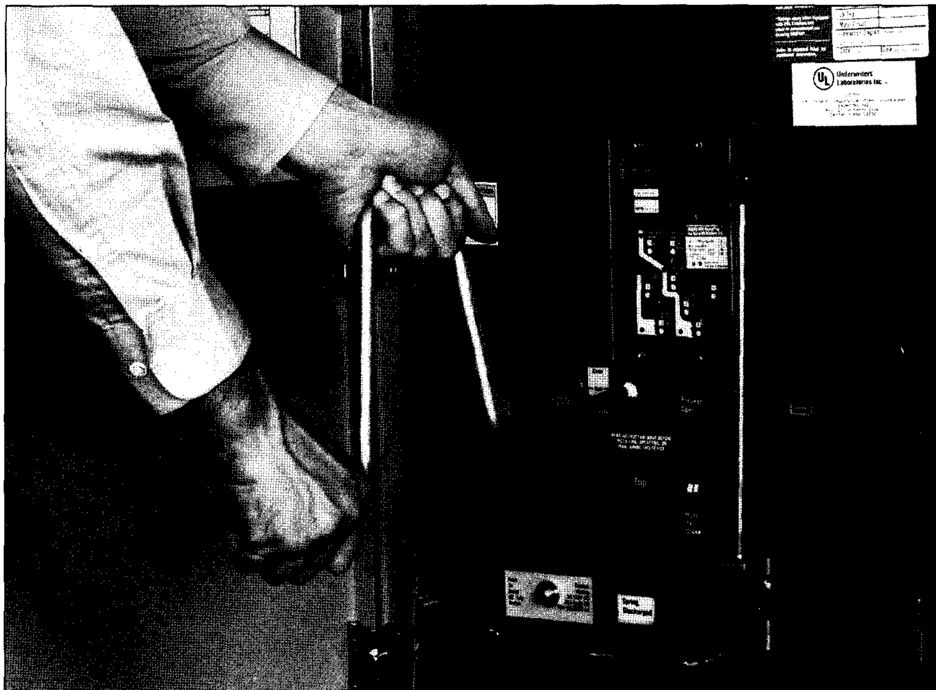
Mechanical Interlock—Available between adjacent breakers, 2000A and below, in the same structure.

Conformity to Standards—Type DSII Switchgear conforms to the following standards: NEMA SG3 and SG5; ANSI C37.20.1, C37.51, and UL Standard 1558.

① A product of BASF.

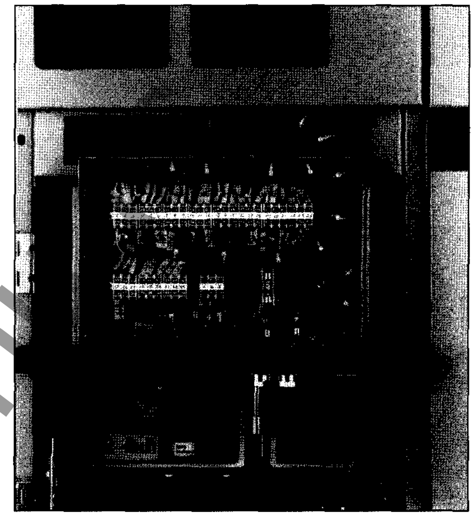
Type DSII Metal-Enclosed Low-Voltage Switchgear

Design and Construction Features



Outer door with quick-opening latches closes compartment completely with breaker connected or disconnected. Full-sized metal shield on breaker face protects operator from live parts while operating, racking or checking trip unit settings. Double interlocked device prevents racking until contacts are open; contacts can't be closed until racking is complete. Isolated cable entrance and bus compartments are provided as standard; removable metal barriers give access to bus compartment for inspection or cleaning.

Metal-Clad Safety Features

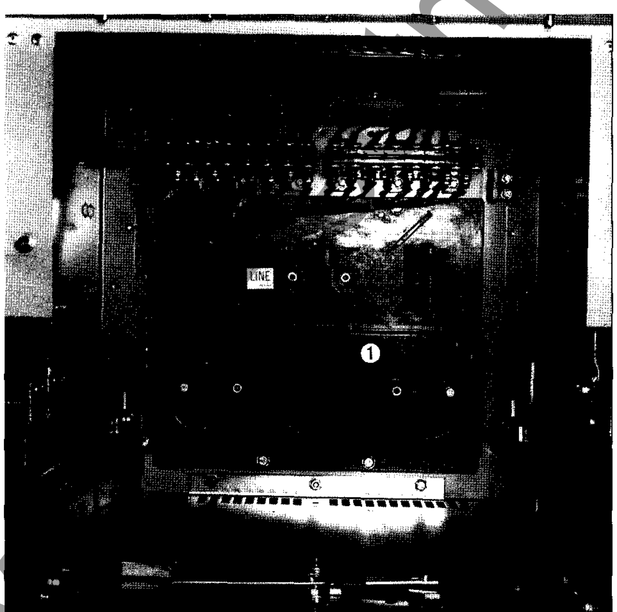


Front Terminal Block Tray

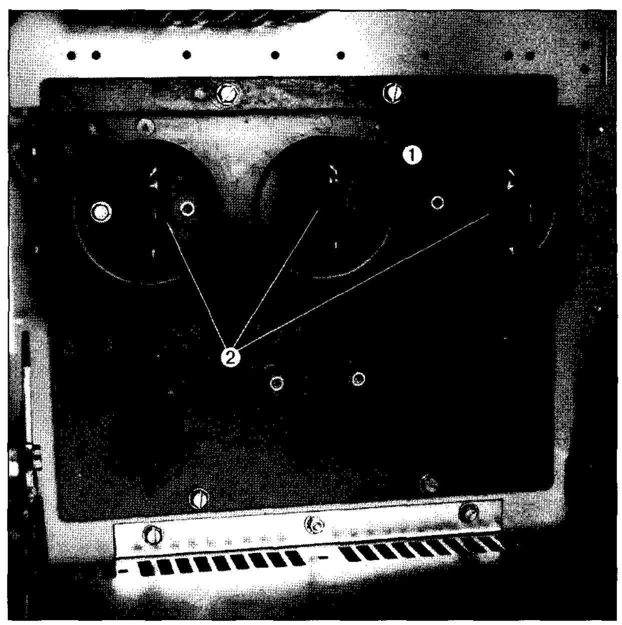
Wiring

Control circuit terminal blocks are mounted as standard in pull-out trays located above each circuit breaker. The terminal blocks are rated 600 Volts, 40 Amperes. Circuit-to-circuit spacing is slightly greater than 3/8" for easy wire installation. Extruded loops punched in side sheets of the terminal block tray allow securing of customer control wiring without the use of adhesive wire anchors.

For applications involving excessive wiring, or nonstandard terminal blocks, terminal blocks are mounted on the rear frame with the power cables where they are readily accessible for customer's connections and inspection.



① 3-Phase Current Transformers



② Insulating Boots

Type DSII Metal-Enclosed Low-Voltage Switchgear

Buses and Connections

Vertical and cross bus ratings in Type DSII Switchgear are 2000, 3200, 4000 and 5000 Amperes. All ratings are based on a UL and ANSI standard temperature rise of 65°C above a maximum ambient air temperature 40°C.

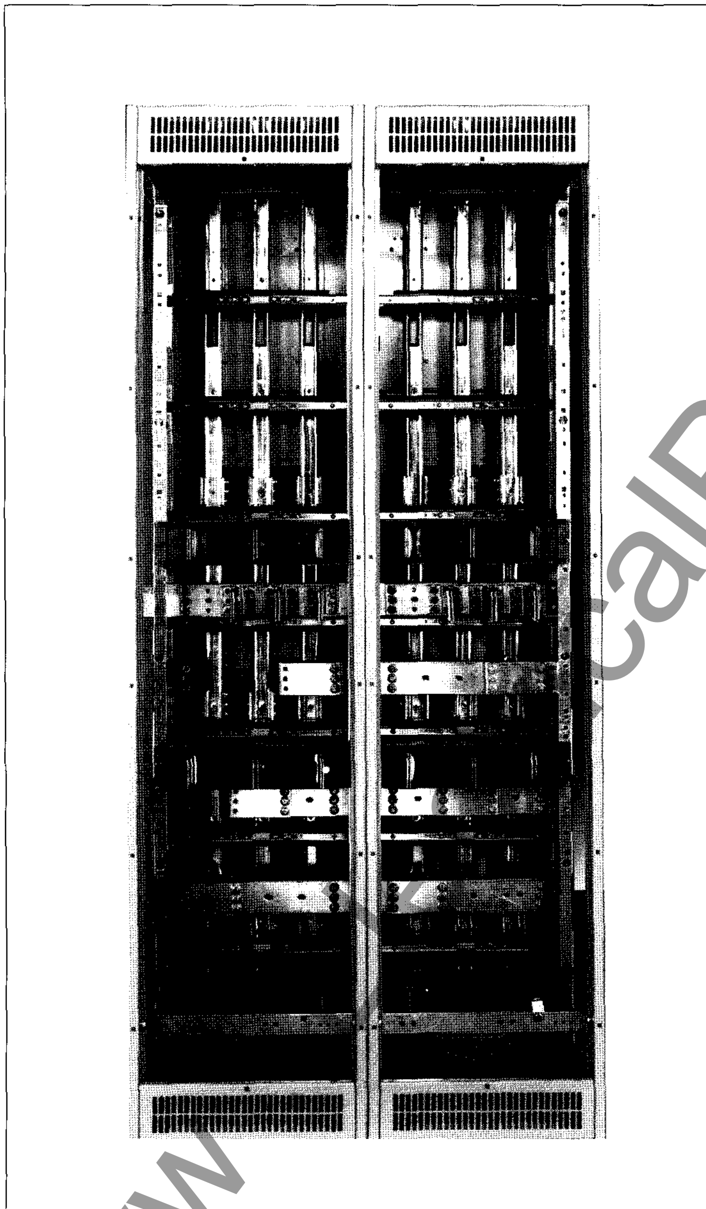
Bolted, silver-plated copper main buses are standard. All bus joints are secured with Belleville-type spring washers for maximum joint integrity.

Optional copper main buses with tin-plated, bolted joints are available.

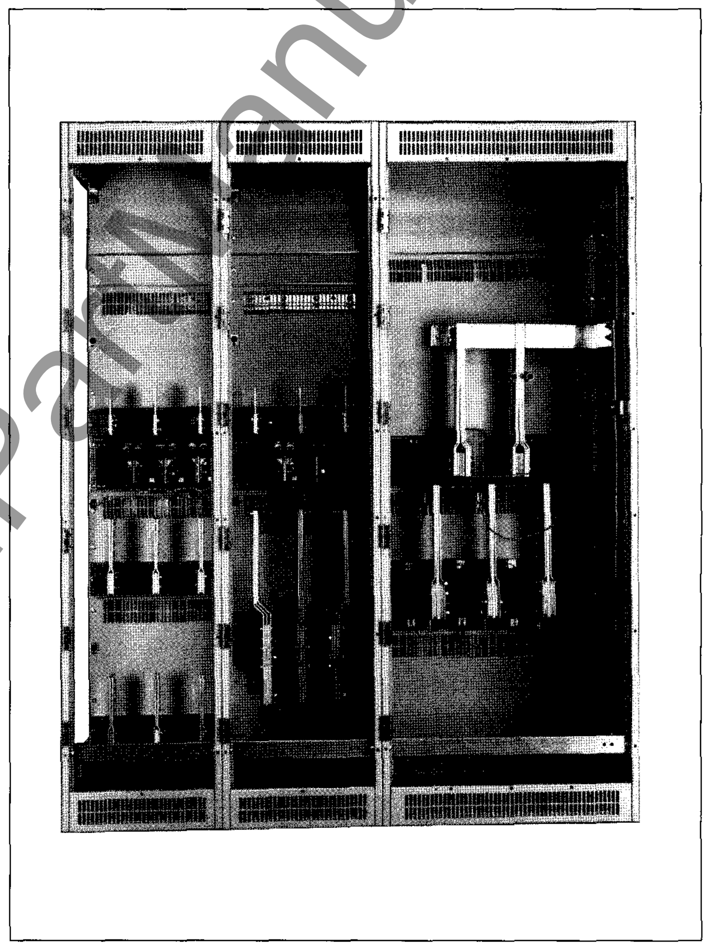
The rear portion of the switchgear assembly houses the main bus, connections, and primary terminals.

A ground bus is furnished the full length of the switchgear assembly and is fitted with terminals for purchaser's connections.

Standard rear covers with captive hardware are the bolt-on type. They are split into two horizontal sections to facilitate handling during removal and installation. Optional rear doors are also available.



Bus and Cable Compartment with Barriers Removed



Cable Connection Compartment with Barriers in Place

Type DSII Metal-Enclosed Low-Voltage Switchgear

Table 1: Metering Type Current Transformers for Mounting in Circuit Breaker Compartments

For Breaker Type					ANSI Meter Accuracy Classification		
DSII-308, DSII-608 DSII-508, DSLII-308	DSII-516, DSII-616 DSLII-516	DSII-620 DSLII-620	DSII-632 DSLII-632	DSII-840, DSII-850 DSLII-840	Ratio	B-0.1	B-0.2
					100/5	1.2	—
					150/5	1.2	—
					200/5	1.2	1.2
					300/5	0.6	0.6
					400/5	0.6	0.6
					600/5	0.6	0.6
					800/5	0.3	0.3
					1200/5	0.3	0.3
					1500/5	0.3	0.3
					1600/5	0.3	0.3
					2000/5	0.3	0.3
					2500/5	0.3	0.3
					3000/5	0.3	0.3
					4000/5	0.3	0.3
					5000/5	0.3	0.3

Current transformers with meter accuracy classifications at higher burdens and/or suitable for relaying are also available. They will be mounted in the rear cable connection compartment.

Voltage Transformers

Voltage transformers are rated 10 kV BIL and are protected by both primary and secondary fuses. The primary fuses are current limiting type.

Control Power Transformers

Control transformers are provided when required for ac control of circuit breakers, space heaters, and/or transformer fans. Like potential transformers, they are protected by current limiting primary fuses. Non-current limiting fuses are used on the secondary side to protect branch circuits.

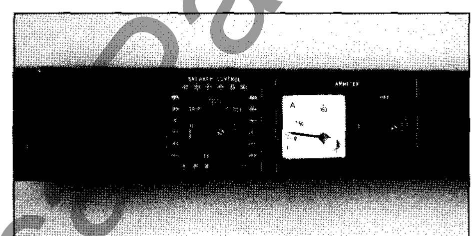
Switchgear Accessories

Standard accessories furnished with each Type DSII switchgear assembly include:

- One breaker levering crank.
- Insulating covers or "boots" are furnished on live main stationary disconnecting contacts in compartments equipped for future breakers.

Miscellaneous

For feeder circuit instrumentation, 2% accuracy ammeters and ammeter switches can be mounted on the terminal block tray between the breaker compartment doors. The ammeters and switches are immediately associated with definite breaker circuits. Other devices, such as control pushbuttons, breaker control switches, indicating lights, and test switches can be mounted on these panels, within space limitations.



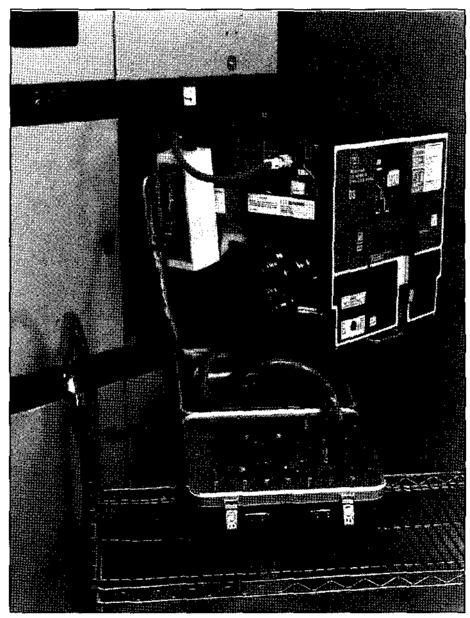
Breaker Control Switch, Ammeter and Switch

Interference interlocks are supplied on breakers and in compartments where the compartments are of the same physical size to assure an incorrect breaker cannot be inserted.

Standard wire is Type SIS insulated, stranded copper, extra flexible No. 14 AWG minimum.

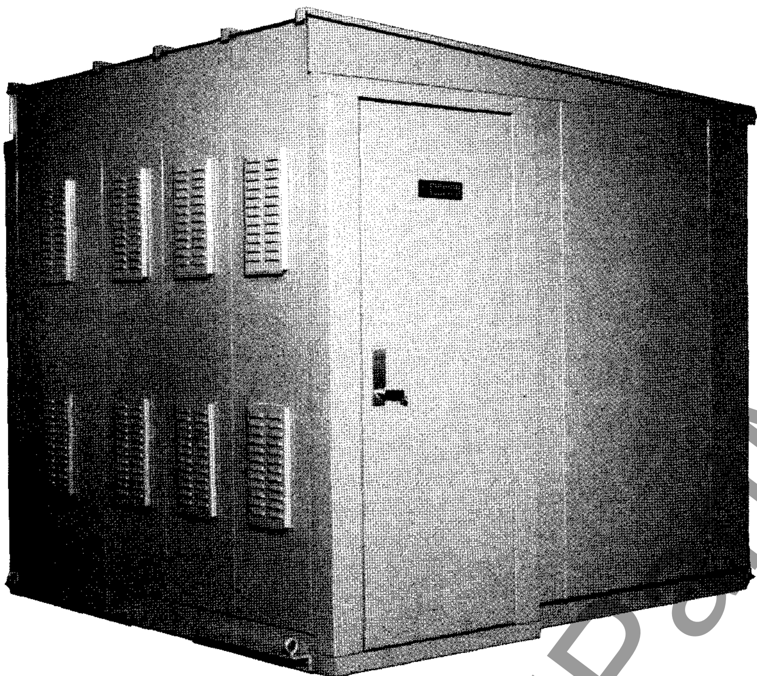
Optional Accessories

- Traveling type circuit breaker lifter, rail-mounted on top of switchgear.
- Floor running portable circuit breaker transfer truck with manual lifting mechanism. Requires approximate 60" deep front aisle space.
- Test cabinet for electrically operated breakers, with pushbuttons, control cable and receptacle, for separate mounting.
- Portable test kit for testing and verification of trip units. Utilizes standard 120-Volt, 15-Ampere, single-phase, 60 Hz supply, available from any outlet.



Portable Test Kit

Type DSII Metal-Enclosed Low-Voltage Switchgear



Outdoor NEMA 3R switchgear consists of standard Type DSII indoor structures assembled in a heavy gauge outdoor enclosure with a generous internal "walk-in" front operating aisle extending through all units of the assembly. Access doors with provisions for padlocking are provided at each end of the aisle. Commercial grade panic hardware is provided on the interior of each aisle door to permit opening even if the exterior is padlocked.

Standard features also include:

- Padlockable hinged rear doors with wind stops for access to cable and bus compartments.
- Filtered ventilation openings. Filters are removable from the exterior.
- Traveling type breaker lifter.
- A space heater rated 95 Watts at 125 Volts in the cable compartment, bus compartment and bottom breaker compartment of each vertical structure and a space heater rated 250 Watts at 125 Volts in each auxiliary section.
- Lighting and GFCI protected convenience receptacles in aisle.
- Rigid base structure; no channels required.
- Walk-in aisle within shipping group shipped completely assembled.
- Antiskid aisle floor strips.

The standard finish is ANSI No. 61 inside and outside. A corrosion-resistant coating is provided on the underside and base.

Outdoor Aisle Type Switchgear Enclosure

Bus Runs
For connecting sources and loads to switchgear assemblies, low-voltage bus runs in ratings from 800 Amperes to 5000 Amperes are available. These buses can also be used for bus tie circuits between separate low-voltage switchgear assemblies. Type DSII assemblies accommodate both Pow-R-Way busway and metal enclosed non-segregated phase bus ducts.

Non-segregated bus design and construction follow ANSI C37.23 Standards, with bare aluminum or copper conductors with silver-plated bolted joints and glass polyester supports. Momentary ratings (minimum 50,000 Amperes) are as required. Standard finish color is ANSI No. 61 light gray indoor and outdoor.

Pow-R-Way Busway is totally enclosed, non-ventilated and meets the latest applicable standards of NEMA BU.1 and UL 857.

Seismic Applications

Type DSII Assemblies have undergone an extensive seismic qualification program. Representative DSII assemblies were placed on a triaxial seismic table and tested. The test program utilized ANSI standard C37.81, the Uniform Building Code (UBC), and the California Building Code (CBC) as a basis for the test program. Although C37.81 is specifically used for the qualification of assemblies for Class 1E applications, there are many elements of this standard applicable to the qualification of commercial grade switchgear.

The required response spectrum developed for the test covered a frequency range through 35 Hz and was based upon a 5% damping factor. The actual test response spectrum enveloped the UBC Zone 4, as well as the more stringent CBC Zone 4 levels of a 0.45g ZPA and 1.8g peak, with margin.

A mutual responsibility between the manufacturer, system designer, and installer is necessary to provide an installation consistent with the requirements of the UBC and CBC. Installation and application guidelines, based upon the actual test results, are provided with each submittal requiring compliance with these standards. Assembly modifications are also provided.

Type DSII Metal-Enclosed Low-Voltage Switchgear

DSII Circuit Breakers Mixed With DSLII

Due to the eight-inch additional depth of DSLII circuit breakers over DSII breakers, they cannot be mixed within the same section. The only exception is the ability to mix DSII-632 breakers with DSLII breakers. In this application, the DSII-632 "sits" eight inches further from the front of the enclosure than the DSLII breaker. If other combinations are necessary, a 13-inch (330 millimeters) transition between the sections containing the DSII and DSLII breakers is required.

5000A Circuit Breaker Applications

For circuit breaker applications demanding continuous ratings between 4000 and 5000 Amperes, the DSII-850 package is available. The application consists of a switchgear mounted fan package and a DSII-850 circuit breaker, and is UL approved.

The DSII-850 has a self-cooled continuous rating of 4000 Amperes. It is equipped with 5000 Ampere sensors, a Digitrip RMS trip unit, and a 5000 Ampere rating plug.

The associated switchgear system consists of 3 fans mounted to a draw-out tray assembly and a current relay to switch the fans on or off when the load exceeds or drops below 4000 Amperes. Two temperature activated contacts are also provided—the first contact provides an alarm and the second a trip if excessive temperatures are sensed.

Type DSII Circuit Breakers

Type DSII Switchgear Assemblies utilize Westinghouse Type DSII draw-out air power circuit breakers exclusively. These circuit breakers provide:

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.

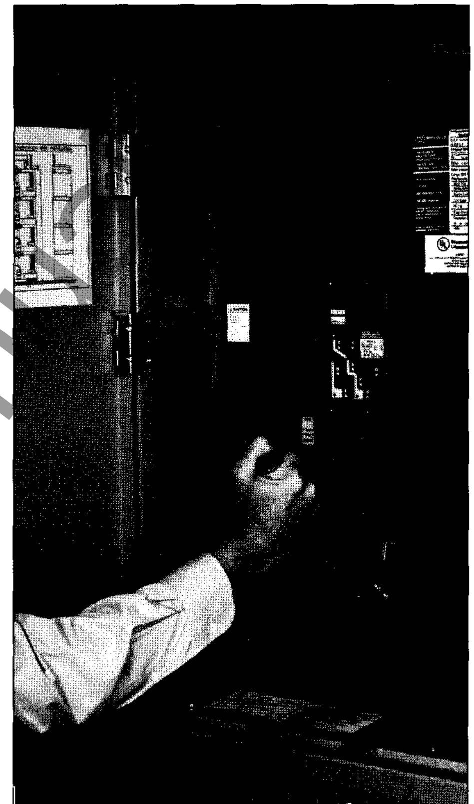
Digitrip RMS Integral Microprocessor-Based Breaker Overcurrent Trip Systems— Provides maximum reliability, true RMS sensing as standard, excellent repeatability, and requires minimum maintenance. No external control source is required.

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 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.

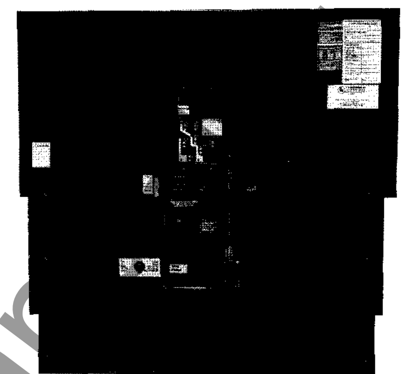
On manual breakers, the spring mechanism is manually charged by one downward stroke of the lever without pumping, and released by the mechanical "push-to-close" release button. On electrically operated breakers, the mechanism is normally charged and released electrically, but can be charged manually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

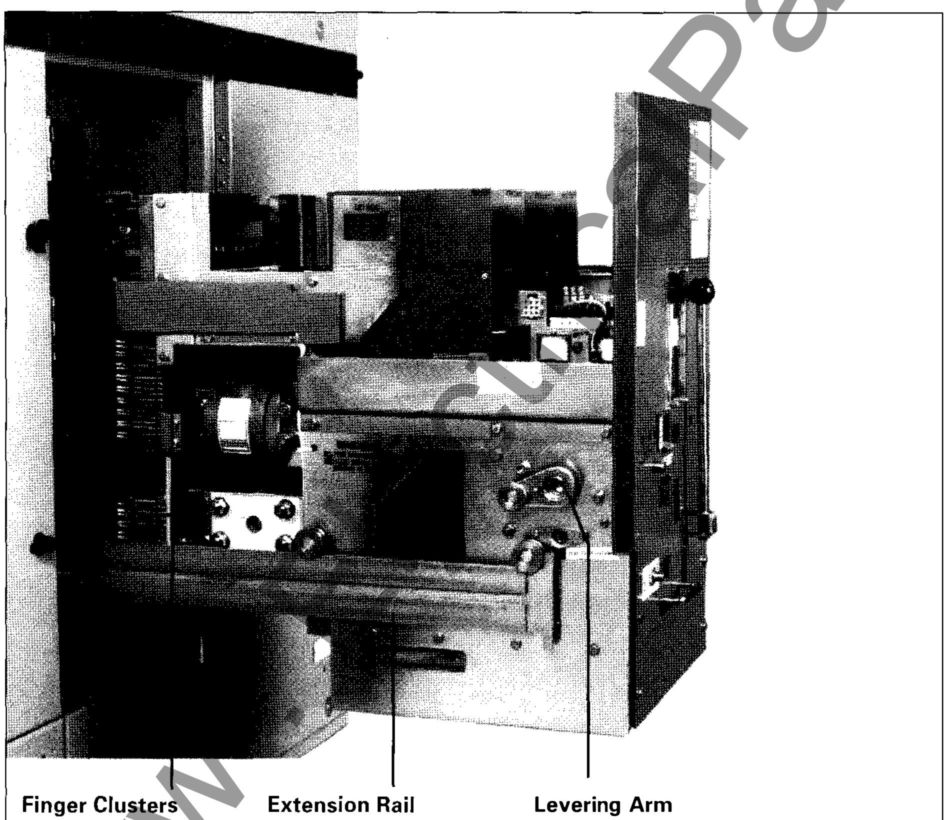
Two-Step Stored-Energy Closing

Type DSII Metal-Enclosed Low-Voltage Switchgear

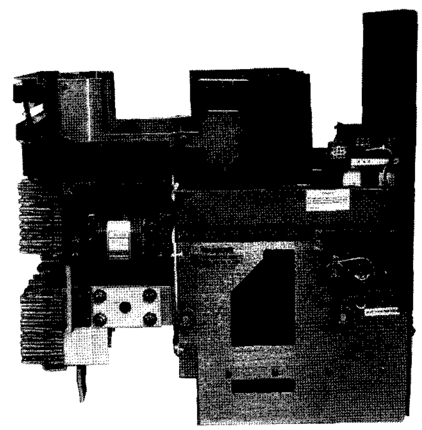
DSII Breaker Levering Operation



DSII Breaker Faceplate



DSII Breaker on Extension Rails



Type DSLII breakers are coordinated combinations of Type DSII breakers and series connected current limiting fuses. 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.

DSLII Breakers and Combinations

Type DSII Metal-Enclosed Low-Voltage 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 draw-out 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.

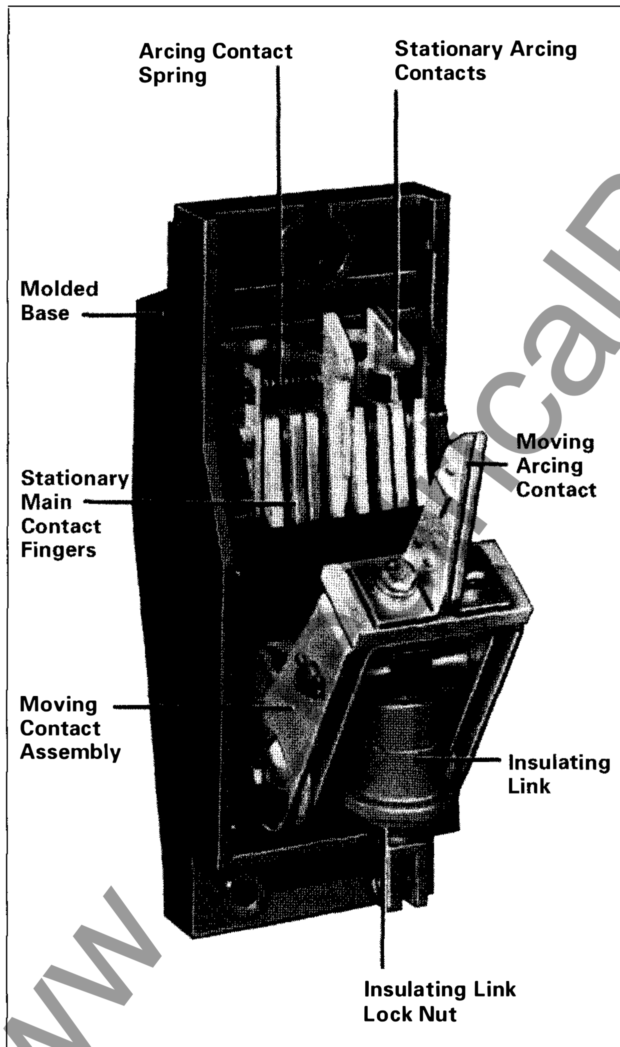
Mechanical interlocking is arranged so that levering cannot be accomplished unless the breaker is in the opened position.

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.

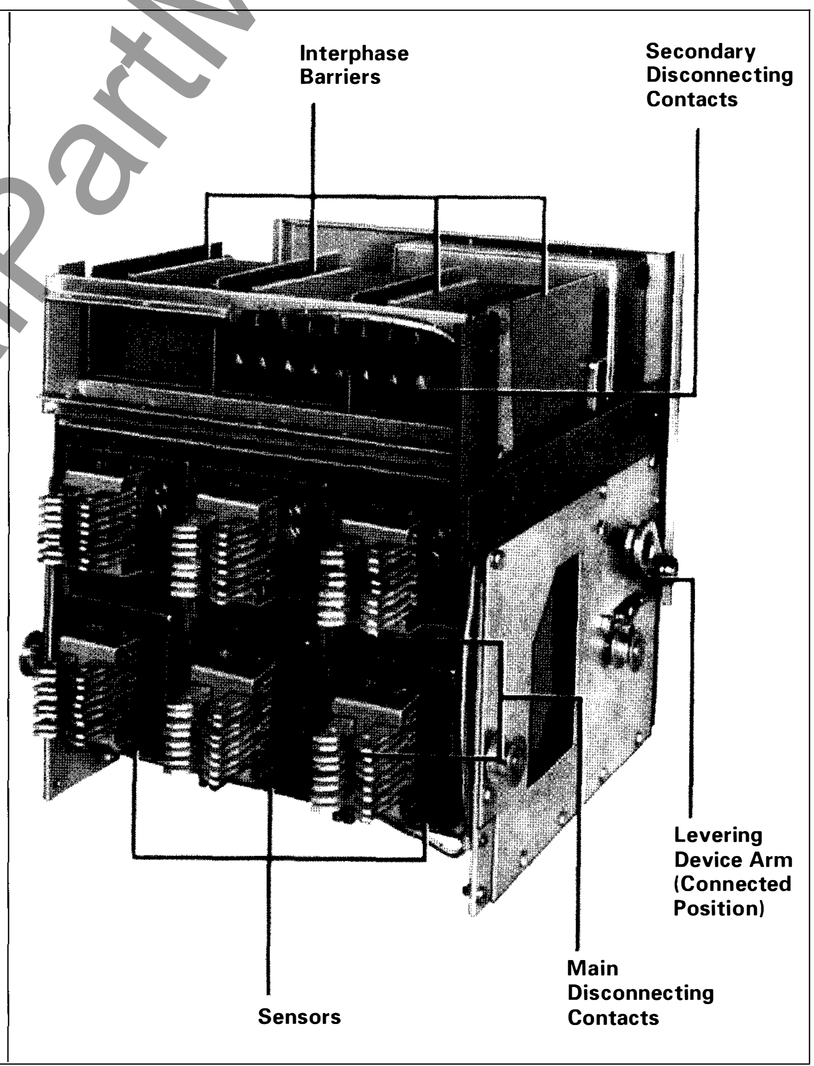
Release of the stored energy is accomplished by manually depressing a bar on the front of the breaker or electrically energizing a releasing solenoid.

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 critical.



DSII Breaker Pole Unit



DSII Breaker Rear View

Type DSII Metal-Enclosed Low-Voltage Switchgear

Table 2: Control Voltages and Currents

Control Voltage	48 Dc	125 Dc	250 Dc	120 Ac	240 Ac
Close current (SR), amp.	5.0	2.0	1.0	3.0	2.0
Shunt trip current, amp.	5.0	2.0	1.0	2.0	1.0
Spring charge motor amp.	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

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

Table 3: Interrupting Ratings of Type DSII Breakers

Breaker Type	Frame Size, Amp.	Interrupting Ratings, RMS Symmetrical Amperes					
		With Instantaneous Trip			Without Instantaneous Trip ① ②		
		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

● Also short-time ratings.
② Short circuit ratings of non-automatic breakers except the DSII-840 and DSII-850 which are 65,000.

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 ½ second each, with a 15-second interval of zero current between the two periods.

Digitrip RMS Trip Unit

The Digitrip RMS trip units feature a dependent curve which is depicted in the nameplate by a blue shaded area of the trip curve. The new dependent curve affords better protection flexibility. Additionally, all of the trip units have, as standard, thermal memory, 50/60 hertz operation, thermal self-protection at 90°C and interchangeability with existing 500, 600 and 800 trip units.

Also, the 610 and 810 trip units have a larger display window and 2% metering accuracy. The 810 features IMPACC communication and additional energy monitoring capability.

Table 4: 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 5A: Available Digitrip RMS Rating Plugs Marked 50/60 Hertz①

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, 3000②, 3200
4000	2000, 2400, 3200, 4000
5000	3200, 4000, 5000

① The Rating Plug is for 50 and 60 Hertz applications. Rating Plugs are not interchangeable with 60 Hertz or 50 Hertz only Rating Plugs.
② Not available on 840 Frame.

The narrow-band characteristic curves graphically illustrate the close coordination obtainable in breaker systems with Digitrip RMS tripping devices. Repeatability is within 2%.

The maximum breaker current rating for any breaker frame size is determined by the rating of the sensor used.

The breaker current rating for any frame size can be changed by simply changing the sensors, which are easily removed from the breaker draw-out element. The wide range of long-delay pickup makes one set of sensors suitable for a number of current ratings. The Digitrip RMS itself need not be changed when the associated sensors are changed.

Digitrip RMS can be supplied in various combinations of four independent, continuously adjustable, overcurrent tripping functions:

Long delay (L) Instantaneous (I)
Short delay (S) Ground (G)

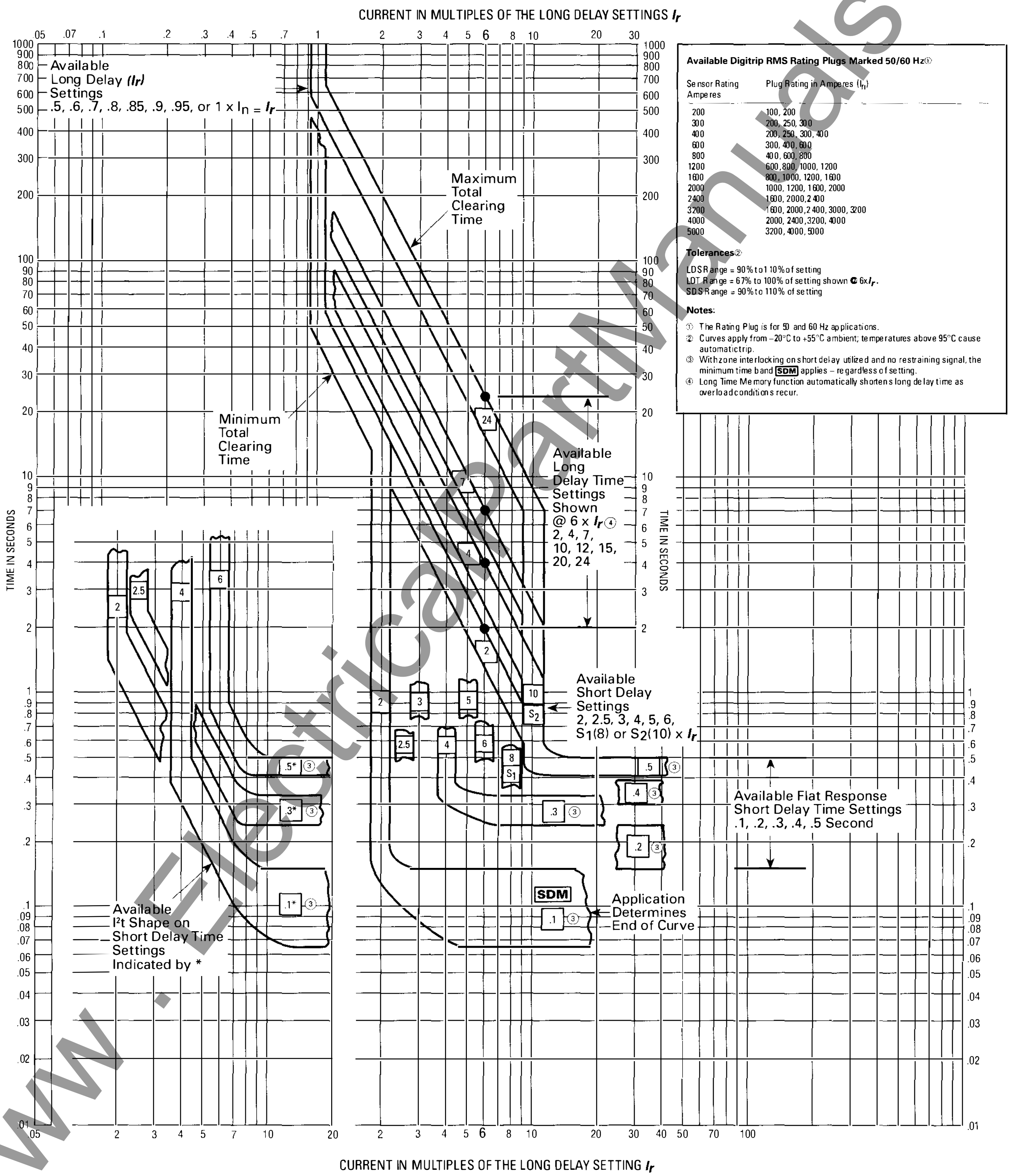
Table 5B: Digitrip RMS Adjustable Trip Settings

Time/Current Characteristic	Pick-Up Setting	Pick-Up 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 pick-up 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 Max.)	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 Valve
I_r = Long Delay Pickup Setting x I_n

Type DSII Metal-Enclosed Low-Voltage Switchgear

Types DSII and DSLII Circuit Breakers with DIGITRIP RMS 510/610/810/910 Trip Units
Typical Long Delay and Short Delay Time-Phase Current Characteristic Curve (LS)
For DIGITRIP OPTIM Trip Units refer to AD 32-880



Available Digitrip RMS Rating Plugs Marked 50/60 Hz①

Sensor Rating 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

Tolerances②

LDS Range = 90% to 110% of setting
LDT Range = 67% to 100% of setting shown @ 6x I_r.
SDS Range = 90% to 110% of setting

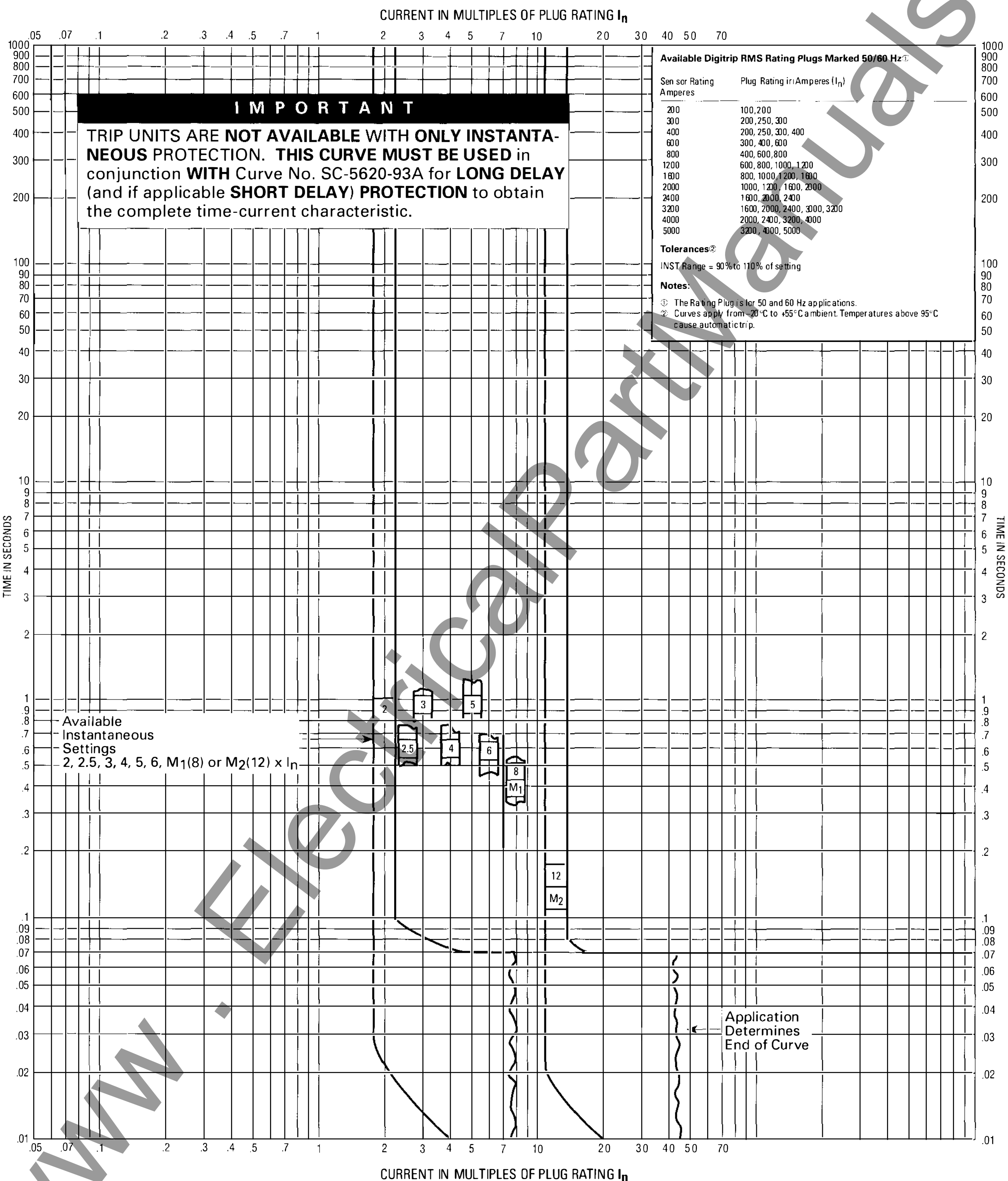
Notes:

① The Rating Plug is for 50 and 60 Hz applications.
② Curves apply from −20°C to +55°C ambient; temperatures above 95°C cause automatic trip.
③ With zone interlocking on short delay utilized and no restraining signal, the minimum time band SDM applies – regardless of setting.
④ Long Time Memory function automatically shortens long delay time as overload conditions recur.

Curve No. SC-5620-93A
Printed in U.S.A. January 1997

Type DSII Metal-Enclosed Low-Voltage Switchgear

Types DSII and DSLII Circuit Breakers with DIGITRIP RMS 510/610/810/910 Trip Units
Typical Instantaneous Time-Phase Current Characteristic Curve (I)
For DIGITRIP OPTIM Trip Units refer to AD 32-880



Available Digitrip RMS Rating Plugs Marked 50/60 Hz ①

Sensor Rating 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

Tolerances ②

INST Range = 90% to 110% of setting

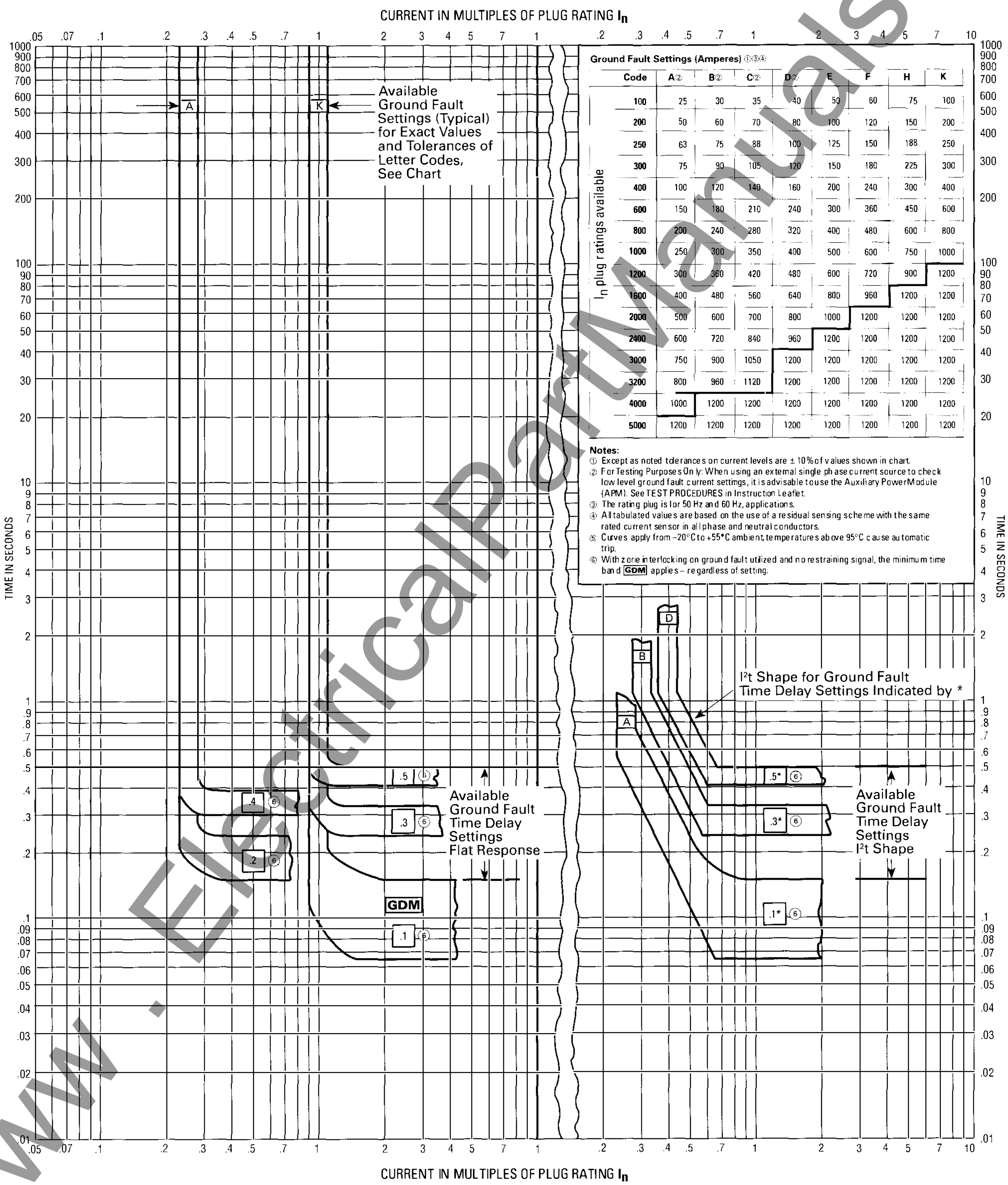
Notes:

① The Rating Plug is for 50 and 60 Hz applications.
② Curves apply from −20°C to +55°C ambient. Temperatures above 95°C cause automatic trip.

Curve No. SC-5619-93A
Printed in U.S.A. January 1997

Type DSII Metal-Enclosed Low-Voltage Switchgear

Types DSII and DSLII Circuit Breakers with DIGITRIP RMS 510/610/810/910 Trip Units
Typical Ground Fault/Protection Time-Phase Current Characteristic Curve (G)
For DIGITRIP OPTIM Trip Units refer to AD 32-880



Ground Fault Settings (Amperes) ①③④

I_n plug ratings available / Code	A②	B②	C②	D②	E	F	H	K
100	25	30	35	40	50	60	75	100
200	50	60	70	80	100	120	150	200
250	63	75	88	100	125	150	188	250
300	75	90	105	120	150	180	225	300
400	100	120	140	160	200	240	300	400
600	150	180	210	240	300	360	450	600
800	200	240	280	320	400	480	600	800
1000	250	300	350	400	500	600	750	1000
1200	300	360	420	480	600	720	900	1200
1600	400	480	560	640	800	960	1200	1200
2000	500	600	700	800	1000	1200	1200	1200
2400	600	720	840	960	1200	1200	1200	1200
3000	750	900	1050	1200	1200	1200	1200	1200
3200	800	960	1120	1200	1200	1200	1200	1200
4000	1000	1200	1200	1200	1200	1200	1200	1200
5000	1200	1200	1200	1200	1200	1200	1200	1200

Notes:
① Except as noted tolerances on current levels are ± 10% of values shown in chart.
② For Testing Purposes Only: When using an external single phase current source to check low level ground fault current settings, it is advisable to use the Auxiliary Power Module (APM). See TEST PROCEDURES in Instruction Leaflet.
③ The rating plug is for 50 Hz and 60 Hz, applications.
④ All tabulated values are based on the use of a residual sensing scheme with the same rated current sensor in all phase and neutral conductors.
⑤ Curves apply from −20°C to +55°C ambient; temperatures above 95°C cause automatic trip.
⑥ With zone interlocking on ground fault utilized and no restraining signal, the minimum time band **GDM** applies – regardless of setting.

Curve No. SC-5621-93A
Printed in U.S.A. January 1997

Type DSII Metal-Enclosed Low-Voltage Switchgear

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.

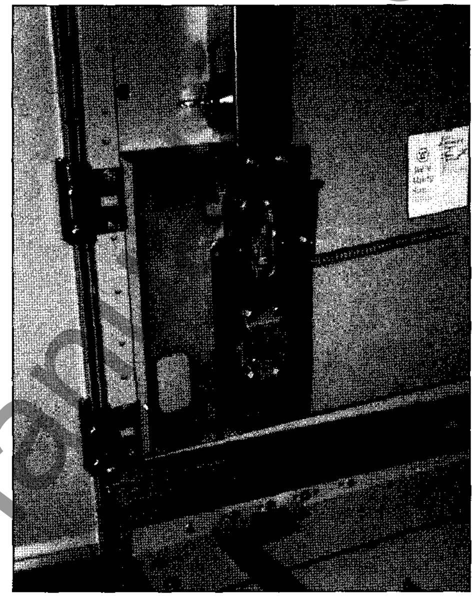
(e) Overcurrent trip switch (OTS). A latching type switch with two independent contacts either normally open or normally closed. Operates only when the breaker is tripped automatically on an overload or fault condition. It may be used for alarm and/or interlocking circuits. Resetting is done by a pushbutton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

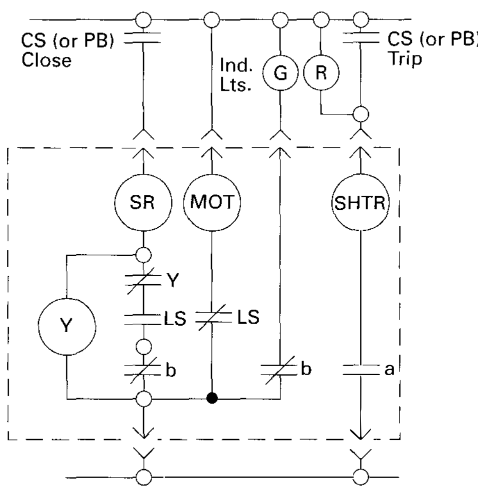


Key Interlock and Linkage

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.



Standard Control Diagram

Type DSII Metal-Enclosed Low-Voltage Switchgear

Application—Type DSII Switchgear And Air Circuit Breakers

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

System Voltage and Frequency
Type 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 take into consideration the maximum anticipated current demand, initial and future, including temporary overloads.

The continuous rating of any Type DSII breaker is limited to the sensor rating, or the frame size current rating, whichever is the lesser. For instance, a Type DSII-516 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:

Altitude (ft)	Voltage Correction	Current Correction
≤6600	1.0	1.0
8500	0.95	0.99
13,000	0.80	0.96

For intermediate elevations, interpolation is required.

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:

Type DSII-308—1400
Type DSII-516—400

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

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:

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

   The 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.

   Type 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.

Unit Substations
Most Type DSII Switchgear Assemblies are configured as unit substations.

A Unit Substation, as referred to in this publication, is defined as a coordinated assembly consisting of 3-phase transformers with high voltage incoming line sections and an assembly of low-voltage distribution sections, with the following parameters:

Transformer kVA—112.5 thru 3750
Low-Voltage—208, 240, 480 or 600 V

Unit Substations may be indoor or outdoor, with a selection of high voltage incoming sections, a choice of transformer types and an arrangement of Type DSII Switchgear to suit the application.

Why Unit Substations?
Unit substations follow the system concept of locating transformers as close as practicable to areas of load concentration at utilization voltages, thus minimizing the lengths of secondary distribution cables and buses. This concept provides several basic advantages, such as:

- Reduced power losses.
- Improved voltage regulation.
- Improved service continuity.
- Reduced likelihood of faults.
- Increased flexibility.
- Minimized installation expense.
- Availability of non-flammable types of transformers eliminates necessity of vaults.
- Efficient space utilization.

Type DSII Metal-Enclosed Low-Voltage Switchgear

Advantages of DSII Unit Substations

- Complete coordination, both mechanical and electrical.
- Extreme flexibility with wide choice of components and ratings to meet exact application requirements.
- Optimum safety to operators.
- Modern design.
- Meets all applicable ANSI, IEEE, NEMA and UL Standards.

Transition Sections

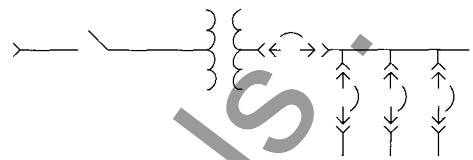
All indoor Unit Substations utilizing liquid filled transformers require a 21 inch (533 millimeters) wide transition section. The center-line location of the low-voltage throat is based upon the depth of the DSII assembly.

In many indoor applications, it is desirable to minimize floor space by eliminating the need for a transformer transition section. For these situations, DSII switchgear is designed to accommodate close coupling to dry type transformers if their low-voltage terminations conform to a specific vertically oriented arrangement. This configuration may be provided if: additional space is not required for auxiliary devices such as grounding resistors, instrumentation, etc.; zero sequence ground fault is not applied on main breakers; connection to assemblies with no main breaker do not utilize "A" or "B" position feeder breakers; adequate conduit space is available for any top exit cable connections in this section.

Types of Systems

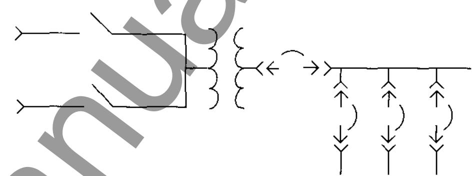
A. Simple Radial

- Simplest and least costly.
- Easy to coordinate.
- No idle parts.



B. Primary Selective Radial

Similar to simple radial, with added advantage of spare primary incoming cable circuit. By switching to spare circuit, duration of outage from cable failure is limited.



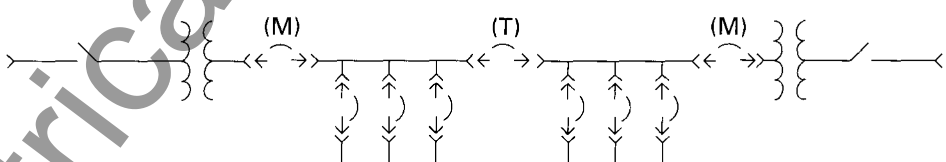
C. Secondary Selective

Normally operates as two electrically independent unit substations, with bus tie breaker (T) open, and with approximately half of total load on each bus. In case of failure of either primary incoming circuit, only one bus is affected, and service can be promptly restored by opening main breaker (M) on dead bus and closing tie breaker (T). This operation can be made automatic, with duration of outage on either bus limited to a few seconds.

Since the transformers are not continuously paralleled, secondary fault currents and breaker application are similar to those on radial unit substations.

If required, and equipped with the appropriate relaying, either transformer can be removed from service and isolated with no interruption of service on either bus, by first closing the tie breaker and then opening the associated main breaker.

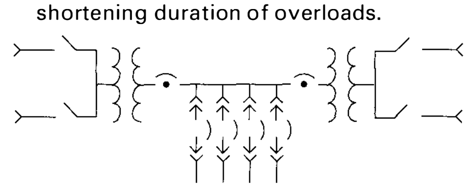
Service continuity and substation capacity can be further improved by substituting selector type primary switches, as in B.



D. Spot Network

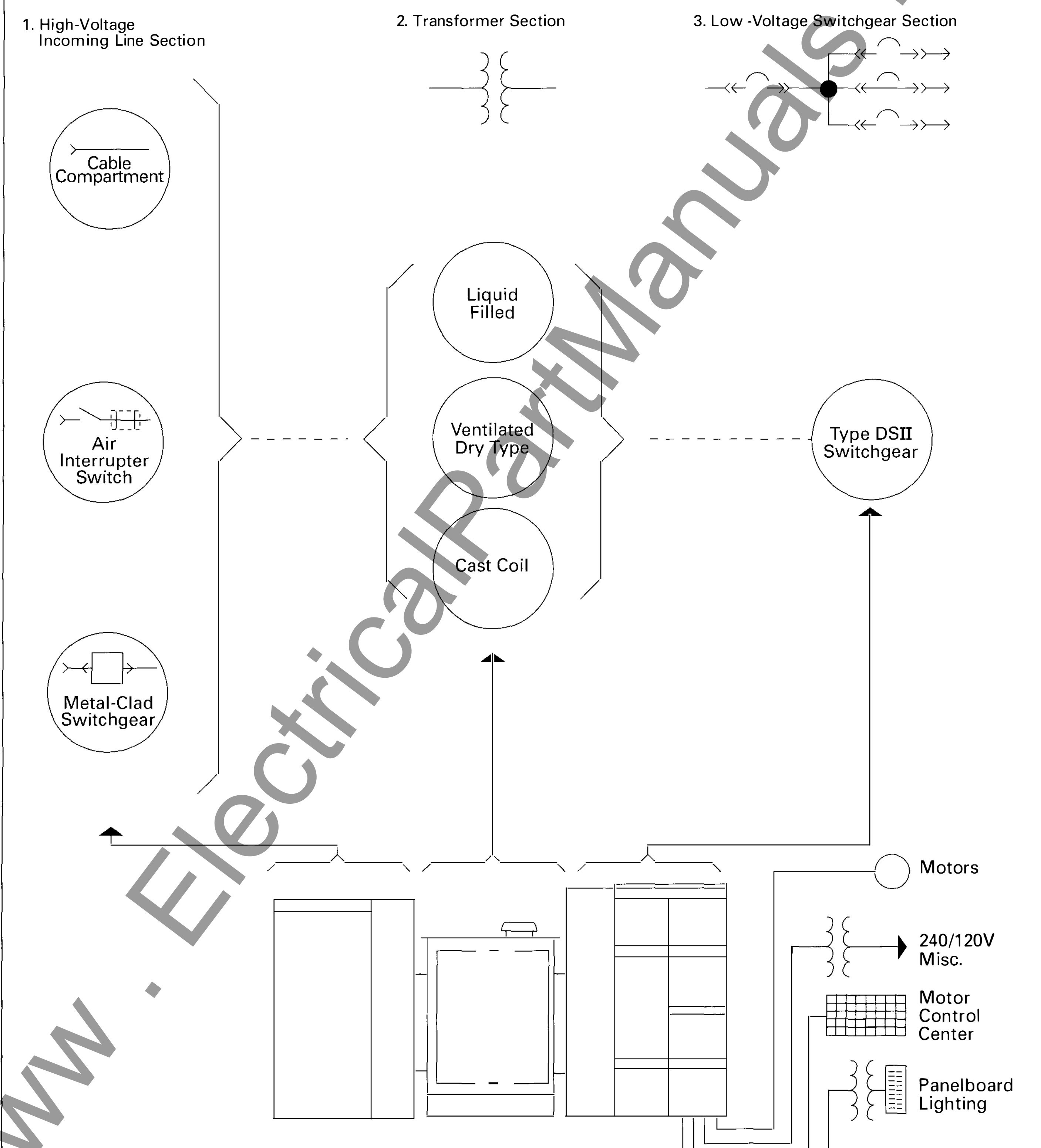
The transformers are paralleled through network protectors. In case of primary voltage failure, the associated protector automatically opens. The other protector remains closed, and there is no "dead time" on the bus, even momentarily. When primary voltage is restored, the protector automatically checks for synchronism and recloses.

- Secondary voltage regulation is improved by paralleled transformers.
- Secondary fault capability is increased by paralleled transformers, and the feeder breakers and bus bracing must be selected accordingly.
- Primary switches are usually selector or duplex type, so that transformers can be transferred to alternate live sources, thus shortening duration of overloads.



Type DSII Metal-Enclosed Low-Voltage Switchgear

Components of Unit Substations



Typical Indoor Unit Substation

Type DSII Metal-Enclosed Low-Voltage Switchgear

System Application

Most DSII Switchgear is fed from power transformers. To facilitate minimum breaker sizing,Tables 8A through 8D list the calculated secondary short circuit currents and applicable main secondary and feeder breakers for various transformer sizes and voltages.

The short circuit currents are calculated by dividing the transformer basic (100%) rated amperes by the sum of the transformer and primary system impedances, expressed in "per unit." The transformer impedance percentages are standard for most secondary unit substation transformers. The primary impedance is obtained by dividing the transformer base (100%) kVA by the primary short-circuit kVA. The motor contributions to the short circuit currents are estimated as approximately 4 times the motor load amperes, which in turn are based upon 50% of the total load for 208 volts and 100% for all other voltages.

High transformer impedances and/or lower percentages of motor loads will reduce the short circuit currents correspondingly. Supplementary transformer cooling and temperature ratings will not increase the short circuit currents, provided the motor loads are not increased.

The tables do not apply for 3 phase banks of single phase distribution transformers, which usually have impedances of 2% to 3% or even lower. The short circuit currents must be recalculated for all such applications, and the breakers selected accordingly.

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, as selected in Tables 8A through 8D, 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, main breaker trip units should not be equipped with instantaneous tripping, as they typically can not be coordinated with down-stream devices.

Maximum capabilities of transformers of various types, in terms of kVA and secondary current, are given in Tables 8A through 8D. 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 not be equipped with instantaneous tripping.

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 devices are 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, antimotoring reverse power relays (device 32) are recommended for protection of the prime movers, particularly piston type engines. For larger generators requiring Type DSII-632 or DSII-840 breakers, voltage-restraint type overcurrent relays (device 51V) are recommended.

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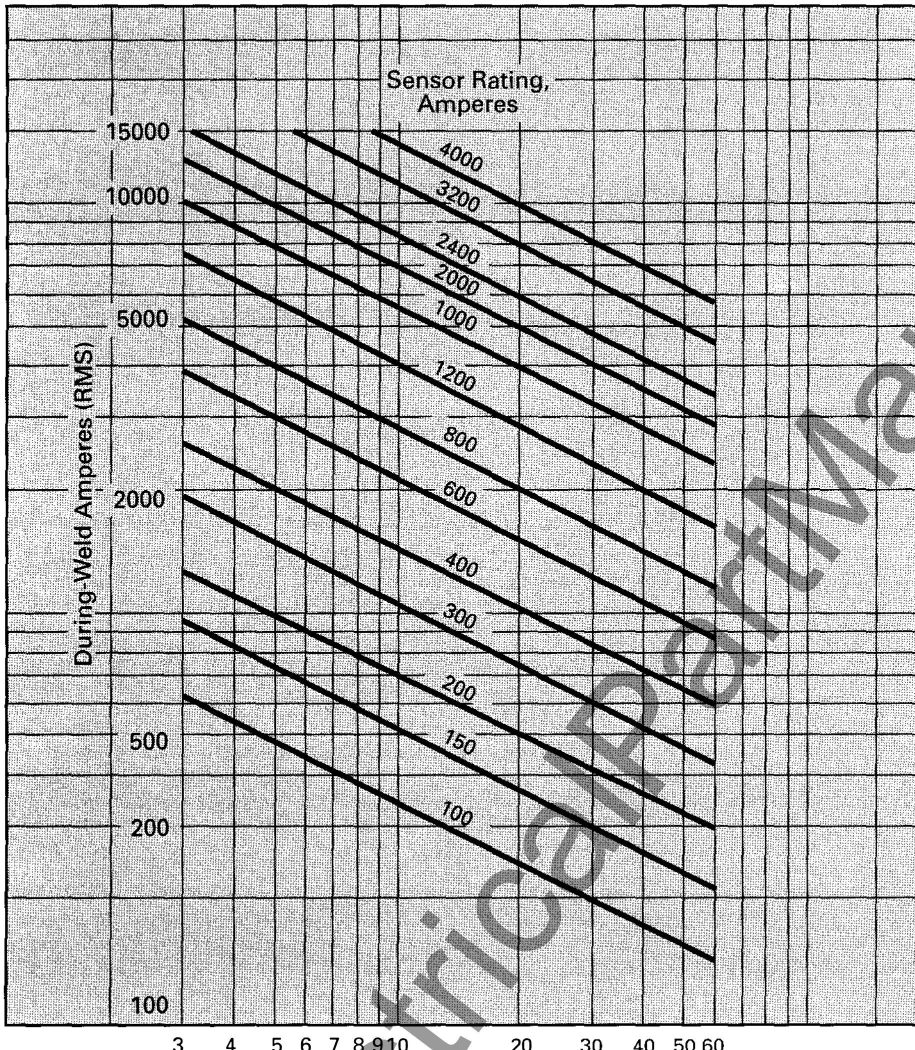
Type DS Breaker Sensor Selection Guide for Resistance Welding Applications



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.

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 2 times the average weld Amperes (weld Amperes times percent duty cycle) or higher.

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 8A through 8D 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.

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.

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 devices 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.

Ground Fault Protection

Distribution Systems
The power distribution in three phase low-voltage systems can be three or four wire distribution. The three wire distribution can be served from either delta or wye sources, but the four wire distribution is obtained from wye source only. Fig. No. 1 shows three wire distribution with delta source and Fig. No. 2 shows three wire distribution with wye source. It is significant on Fig. No. 2, that the wye connection of a transformer secondary does not necessarily mean four wire distribution in switchgear. This is worthwhile to note because four wire distribution is quite frequently assumed when

Type DSII Metal-Enclosed Low-Voltage Switchgear

the transformer secondary is wye connected. The low-voltage system is three phase four wire distribution only if a fourth wire is carried through the switchgear, the transformer neutral is solidly grounded, and single phase loads are connected to feeder breakers. This fourth wire is the neutral bus. The neutral bus is connected to the neutral of the wye connected transformer secondary as shown on Fig. No. 3. The standard neutral bus capacity is one half of the phase bus current carrying capacity, but full capacity and oversized neutral buses through 6000 Amperes are also available on request.

Three or four wire sources can be grounded or ungrounded in service. Generally where the source is delta connected it is ungrounded, but in some very rare cases it is grounded at one corner of the delta, or at some other point. When the source is wye connected it can be grounded or ungrounded, and when grounded, the grounding is at the neutral. When low-voltage systems are grounded they are generally solidly grounded, however, occasionally the grounding is through a resistor. Three and four wire solidly grounded systems are shown on Fig. No. 4 and 5. Most installations are solidly grounded. Solidly grounded systems have the advantage of being the easiest to maintain, yet have the potential for producing extremely high fault levels.

When feeding critical facilities, or continuous industrial processes, it is sometimes preferable to allow the system to continue operating when a phase conductor goes to ground. There are two methods of accommodating this application; the source transformer may either be left ungrounded or high resistance grounded. If the correct system conditions of inductance and capacitance manifests themselves, arcing grounds on ungrounded systems can produce escalating line-to-ground voltages, which in turn can lead to insulation breakdown in other devices. This condition is known as ferro-resonance. The high resistance grounded system does not suffer from this potential phenomenon. Regardless of which system is selected, both require the application of an appropriate UL recognized ground detection method. Upon grounding of one of the phase conductors, the detection device alerts operators of the condition. Personnel trained to locate these grounds can do so and remove the ground when the process permits, and before a second ground occurs on another phase.

Since ungrounded and resistance grounded systems produce minimal ground current, no damage occurs to the grounded equipment. These ground currents are also too low for detection by integral trip unit ground elements, therefore serve no ground fault tripping function if applied on these systems. Ground fault elements on these types of systems can, however, provide supplemental protection. If a second ground occurs on another phase, and exceeds the ground element pickup setting, the ground element can serve as a more sensitive short delay trip.

Ungrounded or resistance grounded systems can not be applied as 4-wire networks. Even if supplied from a 4-wire source, no line-to-neutral loads may be served. These applications are limited to 3-wire distribution systems only.

Need For Ground Fault Protection
If the magnitude of all ground currents would be large enough to operate the short delay or instantaneous elements of the phase overcurrent trip devices, there would be no need for separate ground fault protection on solidly grounded systems. Unfortunately, because low magnitude ground currents are quite common, this is not the case. Low level ground currents can exist if the ground is in the winding of a motor or a transformer, or if it is a high impedance ground. Low level ground currents may also be due to an arcing type ground. The arcing type grounds are the source of the most severe damages to electrical equipment. The lower limit of the arcing ground currents is unpredictable and the magnitude may be considerably below the setting of the breaker phase overcurrent trip devices. It is for this reason that the National Electric Code, and UL, require ground fault protection for all service disconnect breakers rated 1000 Amperes and greater, applied on systems with greater than 150 Volts line-to-ground.

Since the breaker phase overcurrent trip devices cannot provide sensitive enough protection against low magnitude ground faults, there is a need for an additional protective device. This additional device is not to operate on normal overloads and it is to be sensitive and fast enough to protect against low magnitude grounds. It is also important that this additional ground protecting device be simple and reliable. If the DSII breaker solid-state tripping system including an optional "ground element" is selected, good ground fault protection will be assured.

The Ground Element
The ground element of the solid-state trip unit is in addition to the usual phase protection. The ground element has adjustable pickup with calibrated marks as shown in Tables 6A and 6B and adjustable time delay. The input current to the trip unit can be provided by:

(a) Residual connection of phase sensors, with the residual circuit connected to the ground element terminals.This is the Type DSII Low-Voltage Switchgear standard ground protection system for 3-wire systems. On 4-wire systems, standard ground fault protection includes a fourth "neutral sensor." It is connected to vectorally subtract from the residual current of the phase sensors. Its only function is to sense neutral currents. It does not sense ground current. These systems produce pickup values as shown in Tables 6A and 6B.

(b) External ground sensing current transformers connected to the ground element terminals. This means that this external ground sensor will trip the breaker whenever its secondary output current exceeds the values shown in Tables 6A and 6B. Tripping is independent of phase currents. The lower the CT ratio, the more sensitive the ground fault protection.

Ground Fault Protection Application and Coordination
In all power systems, continuity of service is very important. For reliable service continuity, selective tripping is applied between main, tie, and feeder breakers, and downstream protecting devices, for phase-to-phase faults. Similar selective tripping is desirable when breakers trip on grounds. The application of ground protection only to main breakers may assure good ground protection. However, it will not provide good service continuity because the main breaker will trip on grounds which should have been cleared by feeder breakers. For proper protection and for good service continuity, main, tie and feeder breakers all should be equipped with ground fault protection.

In view of the above, it is evident that properly applied ground protection requires ground elements as far down the system to the loads as practical. For best results, downstream molded case breakers should have individual ground protection. This would result in excellent ground protection because ground elements of DSII and downstream breakers having similar tripping characteristics can be coordinated.

Depending on the sensitivity of the ground fault protection method applied, coordinaion between DSII Breaker ground elements and downstream branch circuit fuses is sometimes impractical. This is due to the basic fact that the blowing of one phase fuse will not clear a ground on a three phase system. The other two phase fuses will let the load "single-phase," and also continue to feed the ground through the load as shown in Figure 6.

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 potenital 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 pick-up 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 pick-up 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.

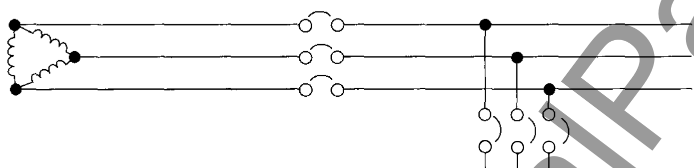


Figure 1. Three-Wire Distribution, Delta Source (Ungrounded)

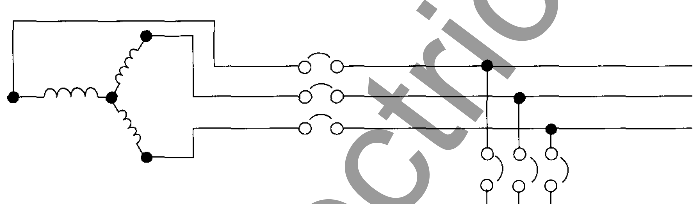


Figure 2. Three-Wire Distribution, Wye Source (Ungrounded)

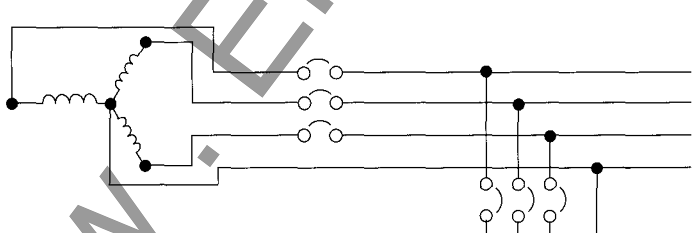


Figure 3. Four-Wire Distribution

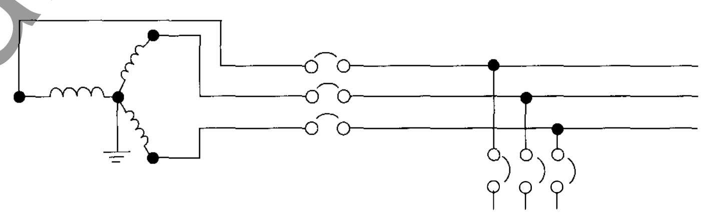


Figure 4. Three-Wire Distribution, Solidly Grounded System

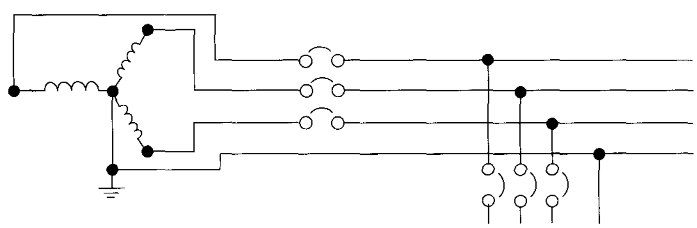


Figure 5. Four-Wire Distribution, Solidly Grounded System

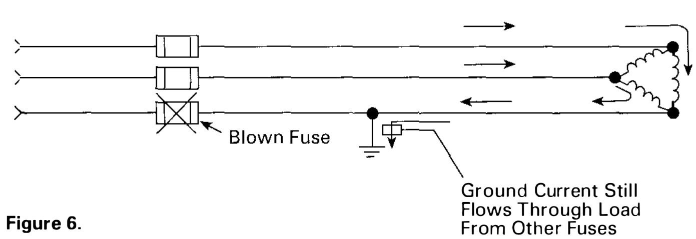


Figure 6.

Type DSII Metal-Enclosed Low-Voltage Switchgear

Application-Type DSII Air Circuit Breakers, *Continued*

Table 6A: Digitrip Ground Fault Current Pickup Settings

INSTALLED RATING PLUG (AMPERES) I_n	PICKUP SETTINGS – GROUND FAULT CURRENTS (AMPERES)① A②	B②	C②	D②	E②	F	H	K
100	25	30	35	40	50	60	75	100
200	50	60	70	80	100	120	150	200
250	63	75	88	100	125	150	188	250
300	75	90	105	120	150	180	225	300
400	100	120	140	160	200	240	300	400
600	150	180	210	240	300	360	450	600
800	200	240	280	320	400	480	600	800
1000	250	300	350	400	500	600	750	1000
1200	300	360	420	480	600	720	900	1200
1600	400	480	560	640	800	960	1200	1200
2000	500	600	700	800	1000	1200	1200	1200
2400	600	720	840	960	1200	1200	1200	1200
3000	750	900	1050	1200	1200	1200	1200	1200
3200	800	960	1120	1200	1200	1200	1200	1200
4000	1000	1200	1200	1200	1200	1200	1200	1200
5000	1200	1200	1200	1200	1200	1200	1200	1200

Table 6B: Digitrip Ground Fault Pickup Values In Secondary Amperes

Installed Rating Plug	Sensor Rating	Pickup (Dial) Setting Values In Secondary Amperes● A② 25%	B② 30%	C② 35%	D② 40%	E② 50%	F 60%	H 75%	K 100%
100	200	.63	.75	.88	1.0	1.25	1.5	1.88	2.5
200		1.25	1.5	1.75	2.0	2.5	3.0	3.75	5.0
200	300	.83	1.0	1.17	1.33	1.67	2.0	2.5	3.33
250		1.04	1.25	1.46	1.67	2.08	2.5	3.13	4.17
300		1.25	1.5	1.75	2.0	2.5	3.0	3.75	5.0
200	400	.63	.75	.88	1.0	1.25	1.5	1.88	2.5
250		.78	.94	1.09	1.25	1.56	1.88	2.34	3.13
300		.94	1.13	1.31	1.5	1.86	2.25	2.81	3.75
400		1.25	1.5	1.75	2.0	2.5	3.0	3.75	5.0
300	600	.63	.75	.88	1.0	1.25	1.5	1.88	2.5
400		.83	1.0	1.17	1.33	1.67	2.0	2.5	3.34
600		1.25	1.5	1.75	2.0	2.5	3.0	3.75	5.0
400	800	.63	.75	.88	1.0	1.25	1.5	1.88	2.5
600		.94	1.13	1.31	1.5	1.88	2.25	2.81	3.75
800		1.25	1.5	1.75	2.0	2.5	3.0	3.75	5.0
600	1200	.63	.75	.88	1.0	1.25	1.5	1.88	2.5
800		.83	1.0	1.17	1.33	1.67	2.0	2.5	3.33
1000		1.04	1.25	1.46	1.67	2.08	2.5	3.12	4.17
1200		1.25	1.5	1.75	2.0	2.5	3.0	3.75	5.0
800	1600	.63	.75	.88	1.0	1.25	1.5	1.88	2.5
1000		.78	.94	1.09	1.25	1.56	1.88	2.34	3.13
1200		.94	1.13	1.31	1.5	1.88	2.25	2.81	3.75
1600		1.25	1.5	1.75	2.0	2.5	3.0	3.75	3.75
1000	2000	.63	.75	.88	1.0	1.25	1.5	1.88	2.5
1200		.75	.90	1.05	1.2	1.5	1.8	2.25	3.0
1600		1.0	1.2	1.4	1.6	2.0	2.4	3.0	3.0
2000		1.25	1.5	1.75	2.0	2.5	3.0	3.0	3.0
1600	2400	.83	1.0	1.17	1.33	1.67	2.0	2.5	2.5
2000		1.04	1.25	1.46	1.67	2.08	2.5	2.5	2.5
2400		1.25	1.5	1.75	2.0	2.5	2.5	2.5	2.5
1600	3200	.63	.75	.88	1.0	1.25	1.5	1.88	1.88
2000		.78	.94	1.09	1.25	1.56	1.88	1.88	1.88
2400		.94	1.13	1.31	1.5	1.88	1.88	1.88	1.88
3000		1.17	1.41	1.64	1.76	1.88	1.88	1.88	1.88
3200		1.25	1.5	1.75	1.88	1.88	1.88	1.88	1.88
2000	4000	.63	.75	.88	1.0	1.25	1.5	1.5	1.5
2400		.75	.9	1.05	1.2	1.5	1.5	1.5	1.5
3200		1.0	1.2	1.4	1.5	1.5	1.5	1.5	1.5
4000		1.25	1.5	1.5	1.5	1.5	1.5	1.5	1.5
5000	5000	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2

① Tolerance on pickup levels are ±10% of values shown in chart.

② For Testing Purposes Only: When using an external single-phase current source to test low level ground fault current settings, it is advisable to use the Auxiliary Power Module (APM). Especially when the single-phase current is low, without the APM it may appear as if the trip unit does not respond until the current is well above the set value, leading the tester to believe there is an error in the trip unit when there is none. The reason this occurs is that the single-phase test current is not a good simulation of the normal three-phase circuit. If three-phase had been flowing, the trip unit would have performed correctly. Use the APM for correct trip unit performance when single-phase tests are made.

Type DSII Metal-Enclosed Low-Voltage Switchgear

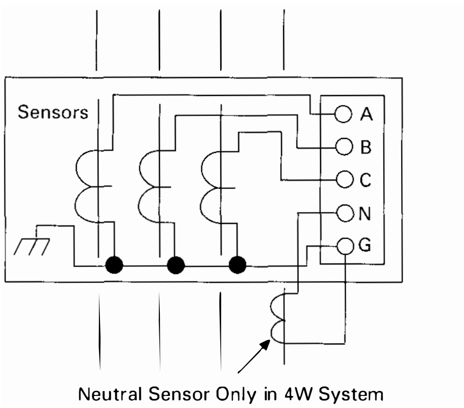
The Following Provides Guideline for Ground Fault Protection.

System	Advantages	Disadvantages	Equipment Available for Protection			
			Main Breaker	Tie Breaker	Fdr. Breaker	Notes
Un-grounded (3 Wire)	Minimum disturbance to service continuity. Currents for the majority of grounds will be limited to capacitance charging current of the system. Can operate with the first ground until it is removed during a regular shutdown. Low cost.	When ground detector shows that a ground exists corrective action must be taken at the earliest possible shutdown. However, experience indicates that this attention is not always possible. Therefore, these systems tend to operate with one phase grounded through the first uncleared ground. A high impedance ground on another part of the system would result in low values of current, which would not operate a breaker phase trip, and could produce fire damage. High voltages from arcing grounds are possible.	Lamp type ground detector or ground detecting voltmeters with or without vts. If vts are used, a ground alarm relay can be added for remote or local alarming.			With proper maintenance this system would result in the minimum disturbance to service continuity.
	Supplemental protection for an ungrounded system utilizing trip unit ground element.		3W residual protection, minimum pickup. .50 sec. time delay. See SK No. 1, No. 4, and No. 6.	3W residual protection, minimum pickup. .35 sec. time delay. See sketch No. 4 and No. 6.	3W protection, minimum pickup. .22 sec. time delay. See SK No. 1, No. 4, and No. 6.	Ground fault protection on this system could trip the breaker when the second ground occurs and current is lower than the short delay pick-up, but exceeds minimum ground pick-up setting.
Solid Grounded	Psychologically safer. Practically results in good continuity of service. Isolation of faults automatic through ground protection system; no overvoltages due to ferroresonance or switching.	Probability of very high ground current and extensive damage; however, normally these high currents are not obtained. Grounds are automatically isolated and continuity of service is interrupted.	Standard residual ground protection for single source systems, and source ground, per SK 5, for multiple ground sources. Minimum pickup. .50 sec. time delay.	Ground 3W or 4W (as required) fault protection. Minimum pickup. .35 sec. time delay. See SK No. 4 or 5.	Ground 3W or 4W (as required) fault protection. Minimum pickup. .22 sec. time delay or zero sequence current transformer feeding Into trip unit. See SK No. 1, No., 2 and No. 6.	This is the most common system in use today. As long as it is not necessary to coordinate with phase devices down the line, it will give very good main bus and feeder protection.
High Resistance Grounded (3 Wire)	Ground fault current is limited. Ungrounding can result in high voltages during arcing grounds, and this is corrected by high resistance grounding. Can operate with the first ground until it is removed during a regular shutdown.	Very sensitive detection is required to detect the limited fault current. When the ground detector shows that a ground exists, corrective action must be taken at the earliest possible shutdown. However, experience indicates that this attention is not always possible, therefore, these systems tend to operate with one phase grounded through the first uncleared ground. A high impedance ground on another part of the system would result in low values of current, which would not operate a breaker phase trip, and could produce fire damage. Higher cost than ungrounded.	Same as for ungrounded except ground voltage alarm relay is connected across grounding resistor, or current relay between resistor and ground.	Same as for ungrounded.	Same as for ungrounded.	Same as for ungrounded. This system is most effective when supplied with a pulsing option.
	Supplemental protection for an ungrounded system utilizing trip unit ground element.		3W residual protection, minimum pickup. .50 sec. time delay. See SK No. 1, No. 4, and No. 6.	3W residual protection, minimum pickup. .35 sec. time delay. See sketch No. 4 and No. 6.	3W protection, minimum pickup. .22 sec. time delay. See SK No. 1, No. 4, and No. 6.	Ground fault protection on this system could trip the breaker when the second ground occurs and current is lower than the short delay pick-up, but exceeds minimum ground pickup setting.

Type DSII Metal-Enclosed Low-Voltage Switchgear

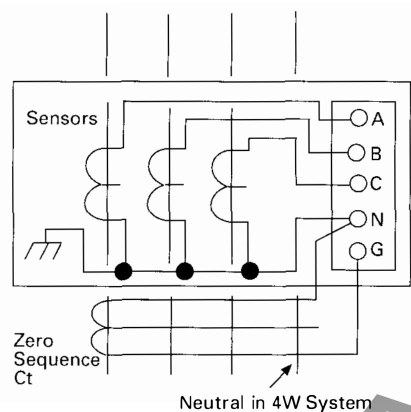
Sketch 1.②

Residual Main and Feeder Breaker



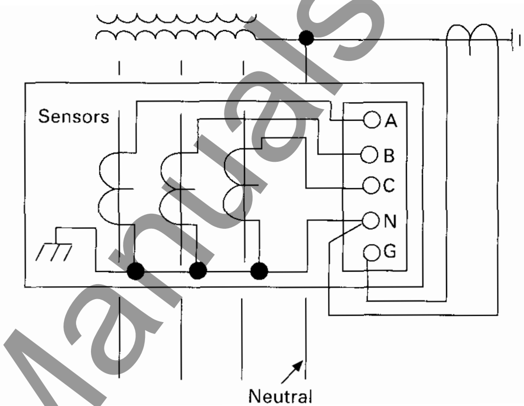
Sketch 2.

Zero Sequence Feeder Breaker



Sketch 3.

Source Neutral Main Breaker

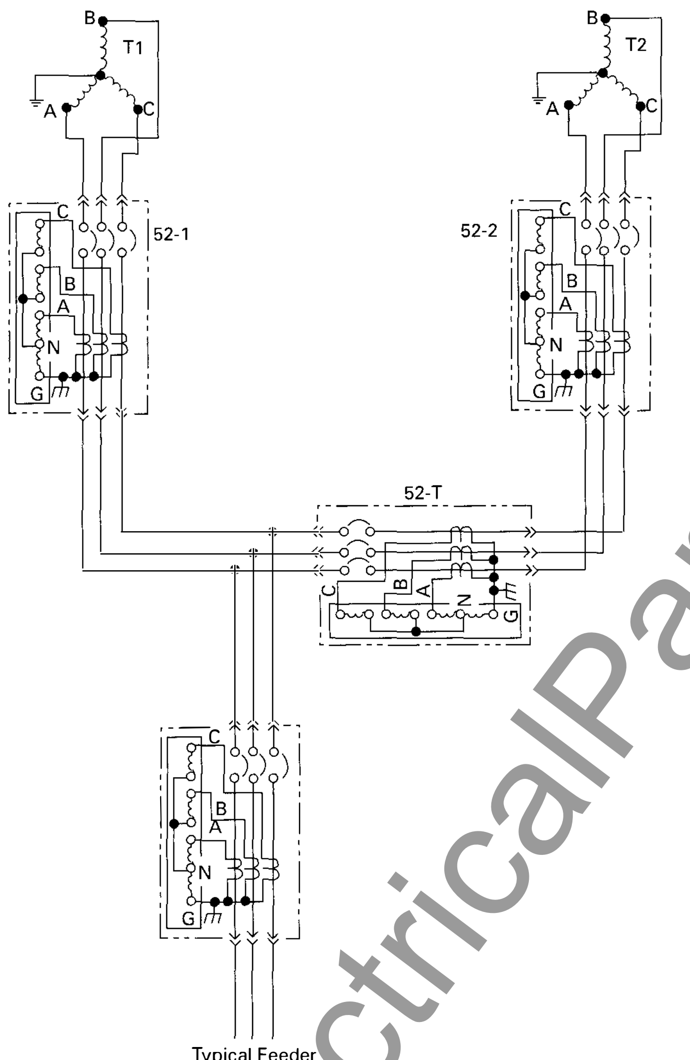


② Apply in 4-Wire Systems for Main Breaker only when no other grounded sources are connected to the same system.

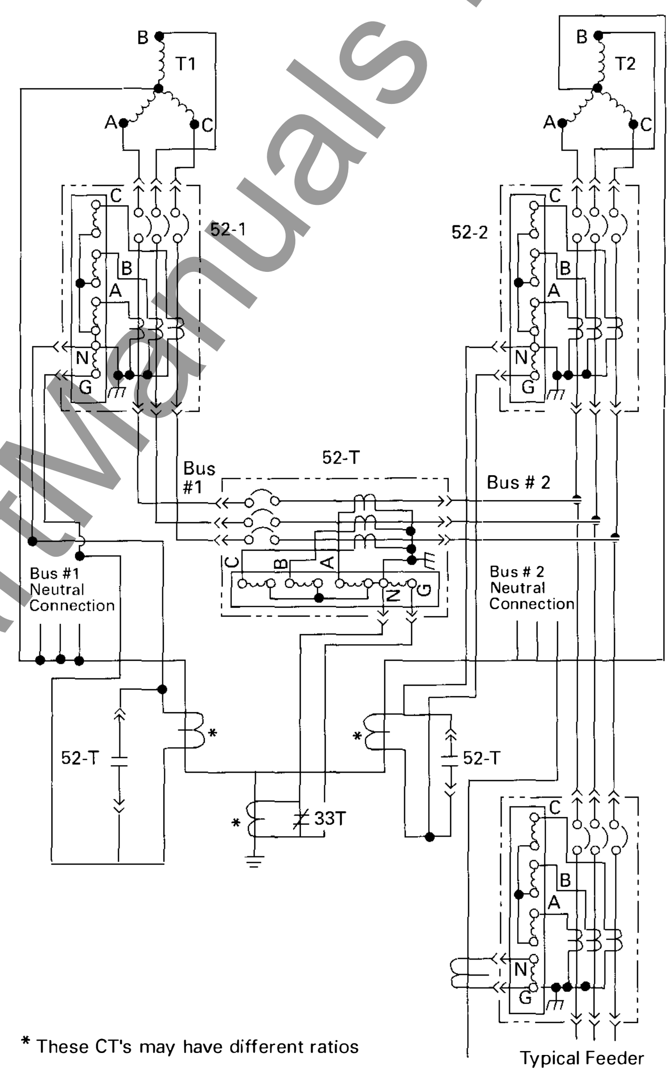
Note: For double-ended secondary unit substations, ground fault protection should be as indicated on sketches No. 4 and No. 5; however for this type of application, Cutler-Hammer should be consulted for the actual bill of materials to be used. The application becomes rather complex if single phase to neutral loads are being served.

Type DSII Metal-Enclosed Low-Voltage Switchgear

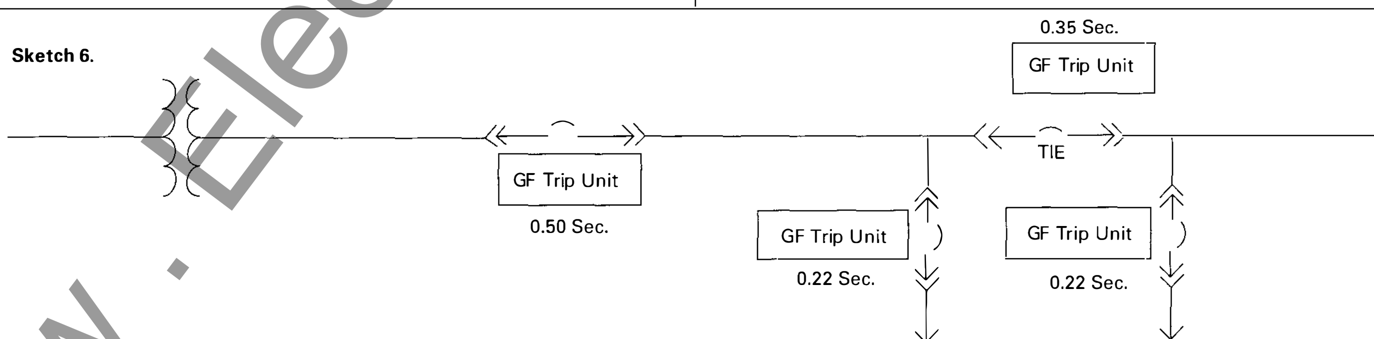
Sketch 4. Three-Wire Double-Ended Unit Substation



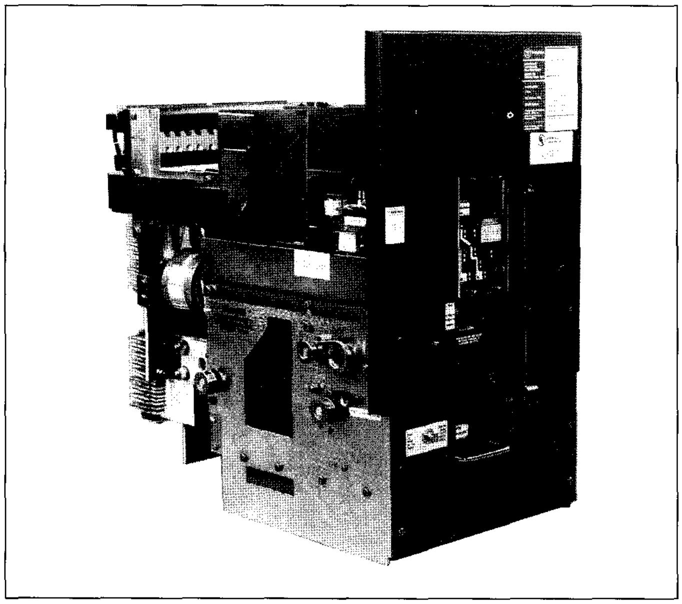
Sketch 5. Four-Wire Double-Ended Unit Substation



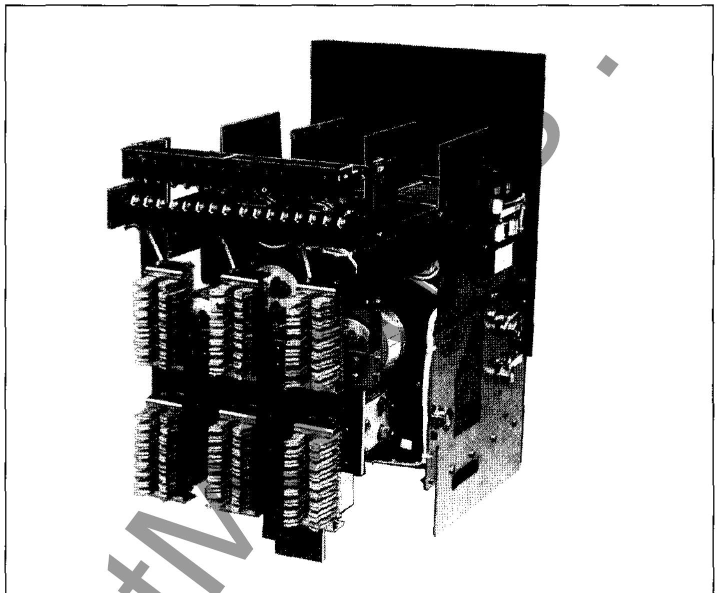
Sketch 6.



Type DSII Metal-Enclosed Low-Voltage Switchgear



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 draw-out breaker elements in series with the upper terminals.

Current limiters used in Types DSLII-632 and DSLII-840 combinations are mounted on separate draw-out 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 7: 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
Max. Interrupting Rating, RMS Symm. Amp., System Voltage 600 or Below	200,000	200,000	200,000	200,000	200,000

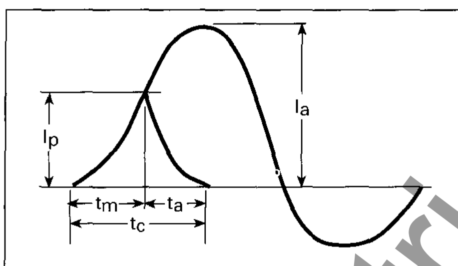
Notes: DSLII-308, DSLII-516, and DSLII-620 include limiters integral with draw-out breaker elements. DSLII-632 includes DSII-632 breaker and DSII-FT32 draw-out fuse truck, in separate interlocked compartmnents. DSLII-840 includes DSII-840 breaker and DSII-FT40 draw-out fuse truck, in separate interlocked compartments.

Type DSII Metal-Enclosed Low-Voltage Switchgear

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.

Breaker Type	Sensor Rating Amperes	Limiter Rating, Amperes Minimum ①	Recom-mended 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.

DSLII-632 and DSLII-840 Available Limiters

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

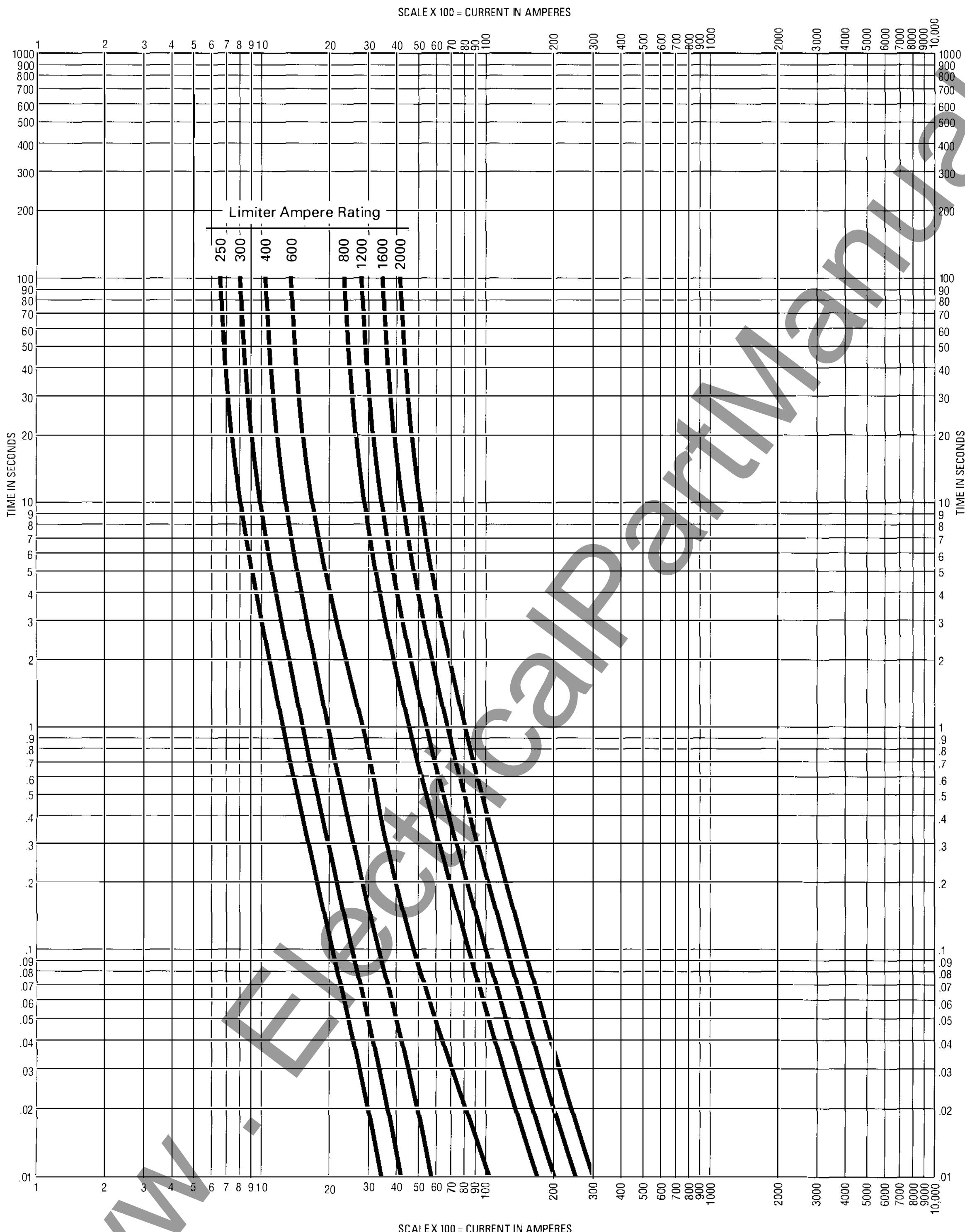
Sensor, Plug and Limiter Selection

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

④ 2000 amp is the only sensor available for DSLII-620.
⑤ 3000 amp is the only limiter available for DSLII-620.

Type DSII Metal-Enclosed Low-Voltage Switchgear

DSLII-308 Average Melting Time-Current Characteristics



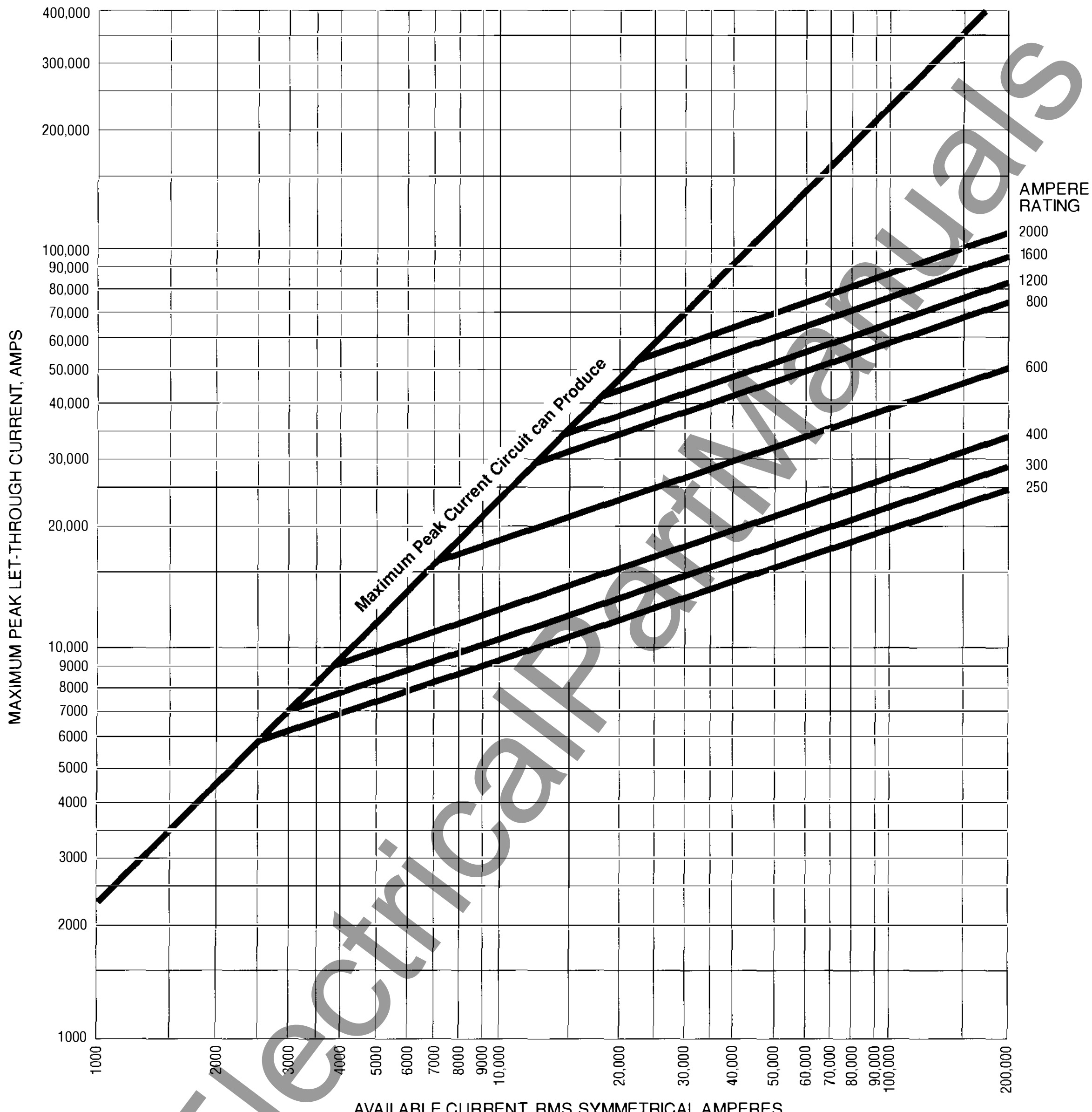
Ref. Curve No. 639771
Supersedes AD 36-783
dated April 1980

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

January 1997

Type DSII Metal-Enclosed Low-Voltage Switchgear

DSLII-308 Let-Through Characteristics



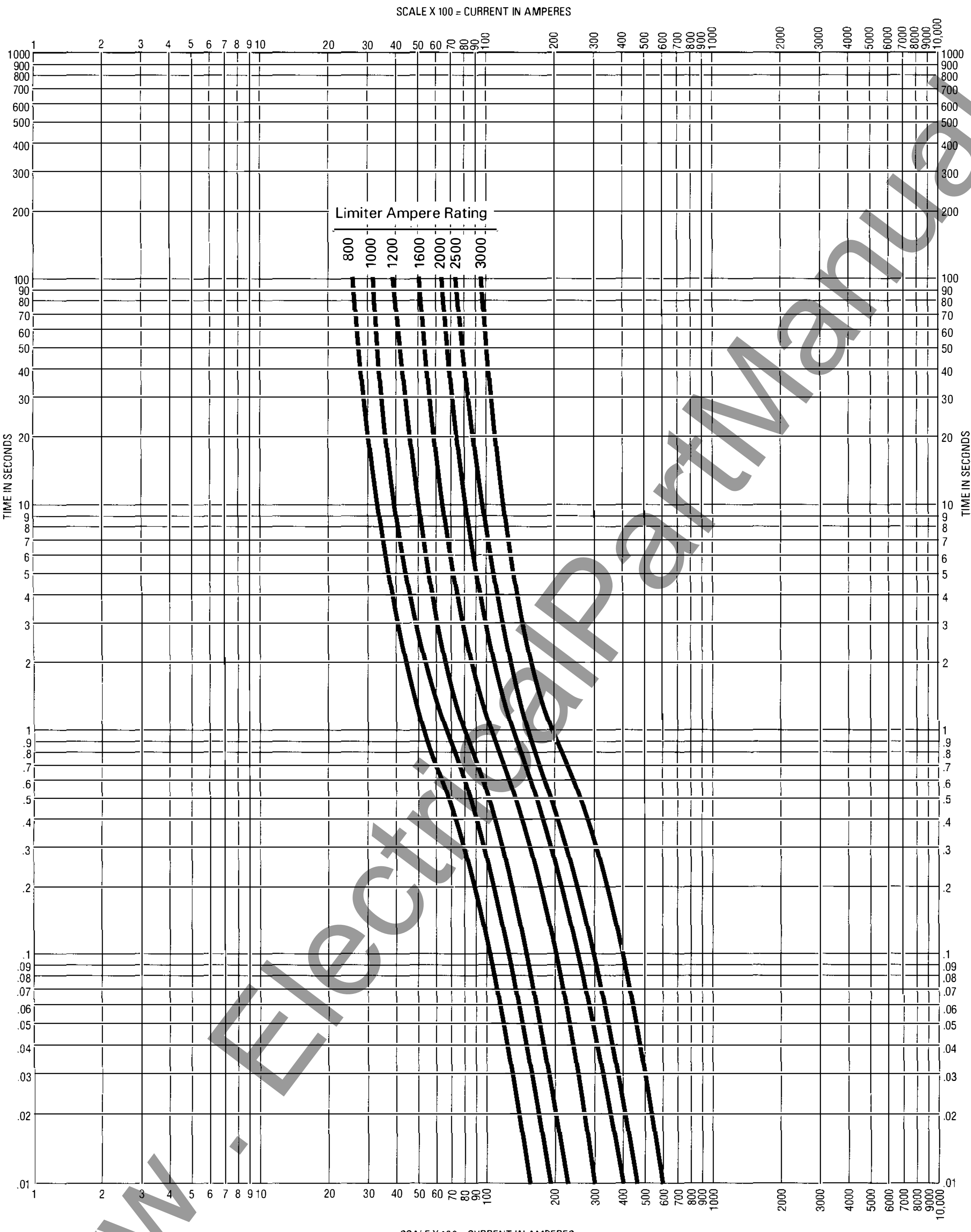
Ref. Curve No. 639772
Supersedes AD 36-783
dated April 1980

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

January 1997

Type DSII Metal-Enclosed Low-Voltage Switchgear

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



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

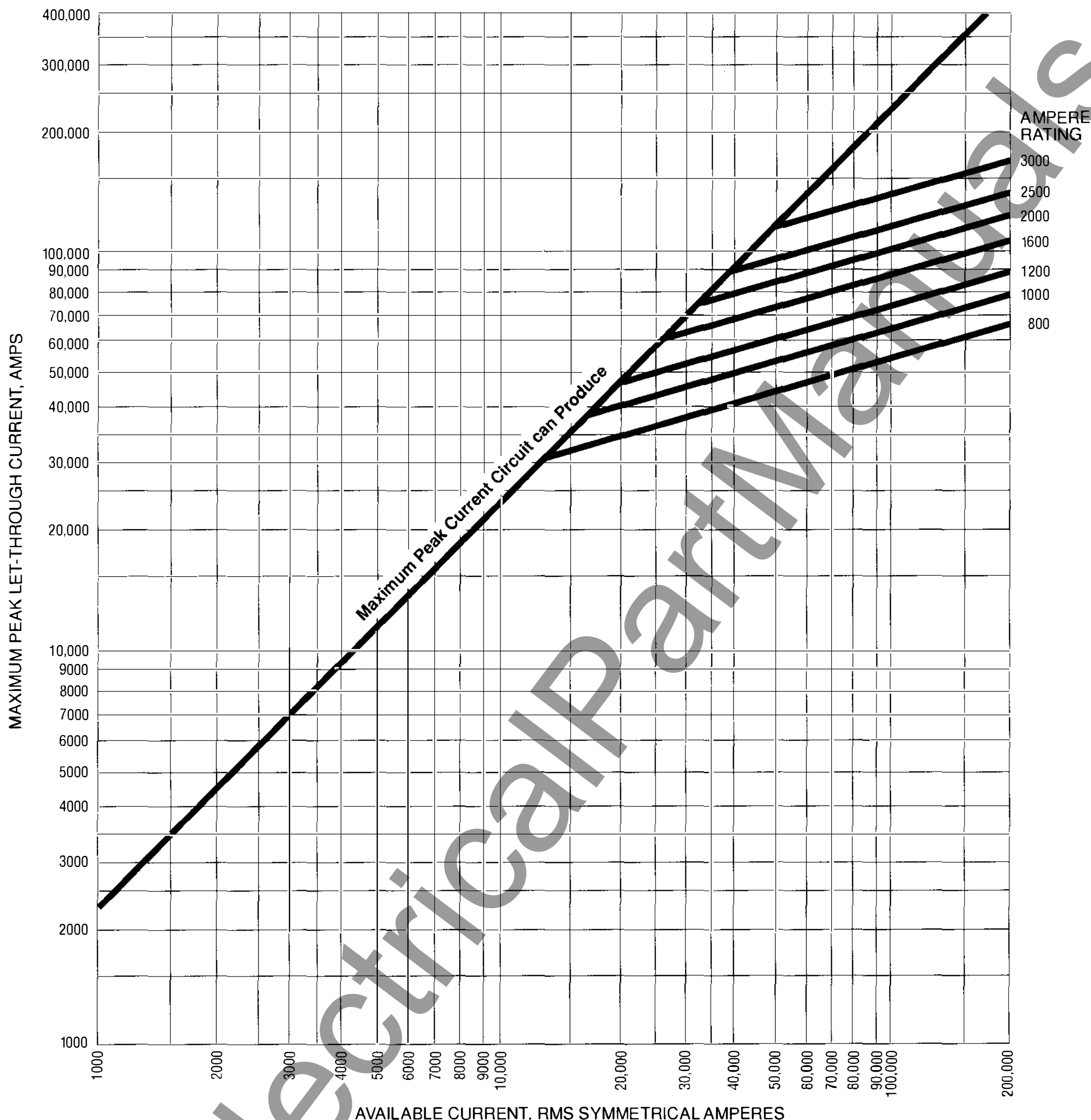
Ref. Curve No. 639431
Supersedes AD 36-783
dated April 1980

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

January 1997

Type DSII Metal-Enclosed Low-Voltage Switchgear

DSLII-516 and DSLII-620 Let-Through Characteristics



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

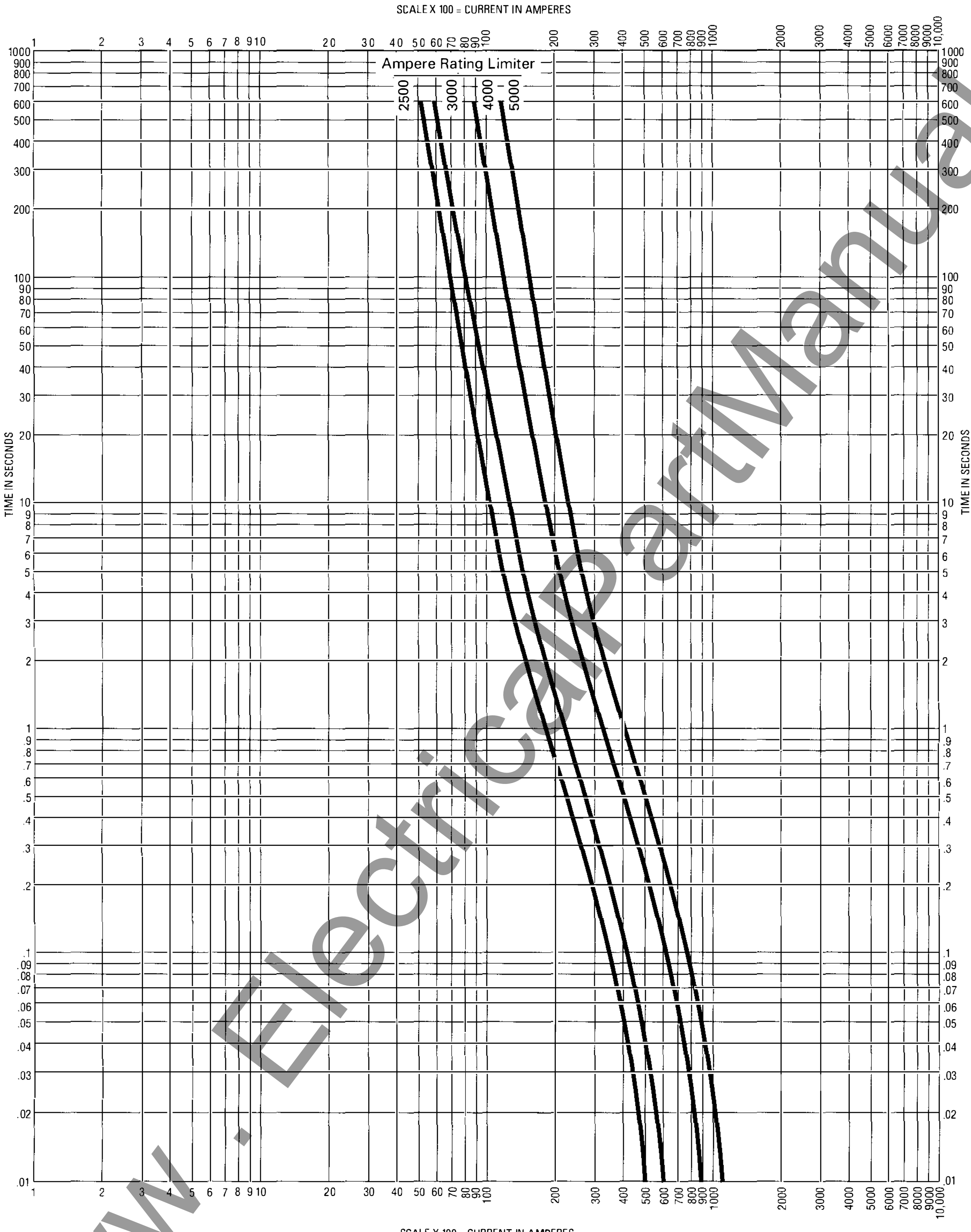
Ref. Curve No. 639432
Supersedes AD 36-783
dated April 1980

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

January 1997

Type DSII Metal-Enclosed Low-Voltage Switchgear

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



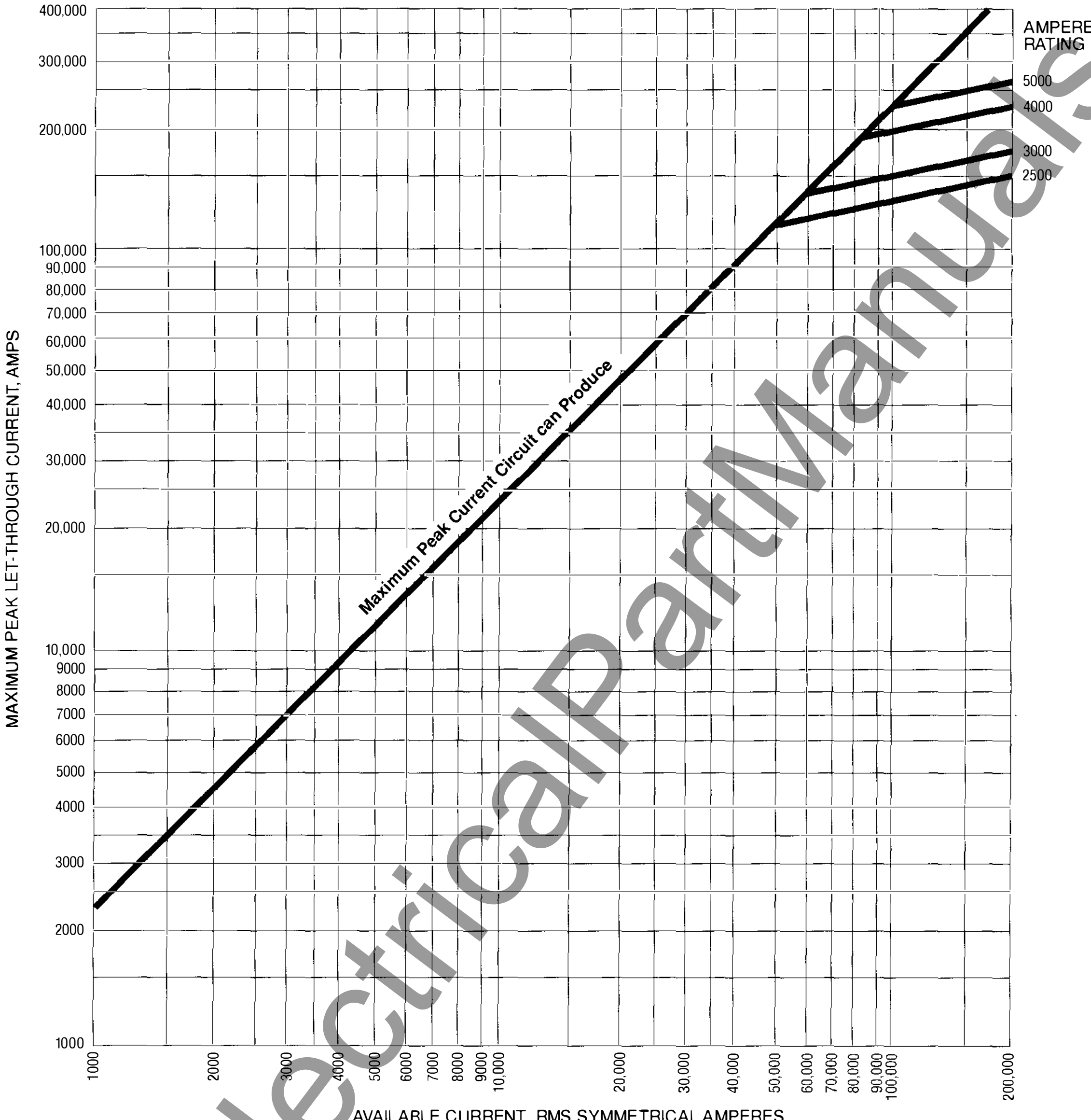
Ref. Curve No. 705503
Supersedes AD 36-783
dated April 1980

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

January 1997

Type DSII Metal-Enclosed Low-Voltage Switchgear

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

Type DSII Metal-Enclosed Low-Voltage Switchgear

Application of Type DSII Air Circuit Breakers With Standard Three-Phase Transformers—Fluid Filled and Ventilated Dry Types

Transformer Base (100%) Rating			Secondary Short-Circuit Currents RMS Symmetrical Amperes			Minimum Size Breakers for Selective Trip Systems		
kVA and Percent Impedance	Amperes①	Maximum Short Circuit kVA Available from Primary System	Through Transformer Only	Motor Contribution	Combined	Main Breaker Short Delay Trip	Feeder Breaker Short Delay Trip	Feeder Breaker Instantaneous Trip
Table 8A: 208 Volts Three-Phase—50% Motor Load								
300 5.0%	833	50000	14900	1700	16600	DSII-516	DSII-308	DSII-308
		100000	15700		17400		DSII-308	DSII-308
		150000	16000		17700		DSII-308	DSII-308
		250000	16300		18000		DSII-308	DSII-308
		500000	16500		18200		DSII-308	DSII-308
		Unlimited	16700		18400		DSII-308	DSII-308
500 5.0%	1389	50000	23100	2800	25900	DSII-516②	DSII-308	DSII-308
		100000	25200		28000		DSII-308	DSII-308
		150000	26000		28800		DSII-308	DSII-308
		250000	26700		29500		DSII-308	DSII-308
		500000	27200		30000		DSII-308	DSII-308
		Unlimited	27800		30600		DSII-508	DSII-308
750 5.75%	2083	50000	28700	4200	32900	DSII-632	DSII-508	DSII-308
		100000	32000		36200		DSII-508	DSII-308
		150000	33300		37500		DSII-508	DSII-308
		250000	34400		38600		DSII-508	DSII-308
		500000	35200		39400		DSII-508	DSII-308
		Unlimited	36200		40400		DSII-508	DSII-308
1000 5.75%	2778	50000	35900	5600	41500	DSII-632②	DSII-508	DSII-308
		100000	41200		46800		DSII-508	DSII-508
		150000	43300		48900		DSII-508	DSII-508
		250000	45200		50800		DSII-608	DSII-508
		500000	46700		52300		DSII-608	DSII-508
		Unlimited	48300		53900		DSII-608	DSII-508
Table 8B: 240 Volts Three-Phase—100% Motor Load								
300 5.0%	722	50000	12900	2900	15800	DSII-308②	DSII-308	DSII-308
		100000	13600		16500		DSII-308	DSII-308
		150000	13900		16800		DSII-308	DSII-308
		250000	14100		17000		DSII-308	DSII-308
		500000	14300		17200		DSII-308	DSII-308
		Unlimited	14400		17300		DSII-308	DSII-308
500 5.0%	1203	50000	20000	4800	24800	DSII-516②	DSII-308	DSII-308
		100000	21900		26700		DSII-308	DSII-308
		150000	22500		27300		DSII-308	DSII-308
		250000	23100		27900		DSII-308	DSII-308
		500000	23600		28400		DSII-308	DSII-308
		Unlimited	24100		28900		DSII-308	DSII-308
750 5.75%	1804	50000	24900	7200	32100	DSII-620②	DSII-508	DSII-308
		100000	27800		35000		DSII-508	DSII-308
		150000	28900		36100		DSII-508	DSII-308
		250000	29800		37000		DSII-508	DSII-308
		500000	30600		37800		DSII-508	DSII-308
		Unlimited	31400		38600		DSII-508	DSII-308
1000 5.75%	2406	50000	31000	9600	40600	DSII-632②	DSII-508	DSII-308
		100000	35600		45200		DSII-508	DSII-508
		150000	37500		47100		DSII-508	DSII-508
		250000	39100		48700		DSII-508	DSII-508
		500000	40400		50000		DSII-508	DSII-508
		Unlimited	41800		51400		DSII-608	DSII-508

① At transformer self-cooled rating.
② Next larger frame size main breaker may be required for 55/65°C rise and/or forced air-cooled (FA) transformer. Check Transformer Secondary Ampere Rating.

Type DSII Metal-Enclosed Low-Voltage Switchgear

Application of Type DSII Air Circuit Breakers With Standard Three-Phase Transformers Fluid Filled and Ventilated Dry Types, *Continued*

Table 8C: 480 Volts Three-Phase—100% Motor Load

Transformer Base (100%) Rating			Secondary Short-Circuit Currents RMS Symmetrical Amperes			Minimum Size Breakers for Selective Trip Systems		
kVA and Percent Impedance	Amperes①	Maximum Short Circuit kVA Available from Primary System	Through Transformer Only	Motor Contribution	Combined	Main Breaker Short Delay Trip	Feeder Breaker Short Delay Trip	Feeder Breaker Instantaneous Trip
500 5-0%	601	50000	10000	2400	12400	DSII-308②	DSII-308	DSII-308
		100000	10900		13300		DSII-308	DSII-308
		150000	11300		13700		DSII-308	DSII-308
		250000	11600		14000		DSII-308	DSII-308
		500000	11800		14200		DSII-308	DSII-308
		Unlimited	12000		14400		DSII-308	DSII-308
750 5.75%	902	50000	12400	3600	16000	DSII-516	DSII-308	DSII-308
		100000	13900		17500		DSII-308	DSII-308
		150000	14400		18000		DSII-308	DSII-308
		250000	14900		18500		DSII-308	DSII-308
		500000	15300		18900		DSII-308	DSII-308
		Unlimited	15700		19300		DSII-308	DSII-308
1000 5.75%	1203	50000	15500	4800	20300	DSII-516②	DSII-308	DSII-308
		100000	17800		22600		DSII-308	DSII-308
		150000	18700		23500		DSII-308	DSII-308
		250000	19600		24400		DSII-308	DSII-308
		500000	30200		25000		DSII-308	DSII-308
		Unlimited	20900		25700		DSII-308	DSII-308
1500 5.75%	1804	50000	20600	7200	27800	DSII-620②	DSII-308	DSII-308
		100000	24900		32100		DSII-508	DSII-508
		150000	26700		33900		DSII-508	DSII-508
		250000	28400		35600		DSII-508	DSII-508
		500000	29800		37000		DSII-508	DSII-508
		Unlimited	31400		38600		DSII-508	DSII-508
2000 5.75%	2406	50000	24700	9600	34300	DSII-632②	DSII-508	DSII-508
		100000	31000		40600		DSII-508	DSII-508
		150000	34000		43600		DSII-508	DSII-508
		250000	36700		46300		DSII-508	DSII-508
		500000	39100		48700		DSII-508	DSII-508
		Unlimited	41800		51400		DSII-608	DSII-608
2500 5.75%	3008	50000	28000	12000	40000	DSII-632②	DSII-508	DSII-508
		100000	36500		48500		DSII-508	DSII-508
		150000	40500		52500		DSII-608	DSII-608
		250000	44600		56600		DSII-608	DSII-608
		500000	48100		60100		DSII-608	DSII-608
		Unlimited	52300		64300		DSII-608	DSII-608
3000 5.75%	3609	50000	30700	14000	44700	DSII-840②	DSII-508	DSII-508
		100000	41200		55200		DSII-608	DSII-608
		150000	46600		60600		DSII-608	DSII-608
		250000	51900		65900		DSLII-308	DSLII-308
		500000	56800		70800		DSLII-308	DSLII-308
		Unlimited	62800		76800		DSLII-308	DSLII-308
3750 5.75%	4511	50000	34000	18000	52000	DSII-850	DSII-608	DSII-608
		100000	47500		65500		DSLII-308	DSLII-308
		150000	54700		72700		DSLII-308	DSLII-308
		250000	62200		80200		DSLII-308	DSLII-308
		500000	69400		87400		DSLII-308	DSLII-308
		Unlimited	78500		96500		DSLII-308	DSLII-308

① At transformer self-cooled rating.
② Next larger frame size main breaker may be required for 55/65°C rise and/or forced-air cooled (FA) transformer. Check Transformer Secondary Ampere Rating.

Type DSII Metal-Enclosed Low-Voltage Switchgear

Application of Type DSII Air Circuit Breakers With Standard Three-Phase Transformers Fluid Filled and Ventilated Dry Types, *Continued*

Transformer Base (100%) Rating			Secondary Short-Circuit Currents RMS Symmetrical Amperes			Minimum Size Breakers for Selective Trip Systems		
kVA and Percent Impedance	Amperes①	Maximum Short Circuit kVA Available from Primary System	Through Transformer Only	Motor Contribution	Combined	Main Breaker Short Delay Trip	Feeder Breaker Short Delay Trip	Feeder Breaker Instantaneous Trip
Table 8D: 600 Volts Three-Phase—100% Motor Load								
500	481	50000	8000	1900	9900	DSII-308	DSII-308	DSII-308
5.0%		100000	8700		10600		DSII-308	DSII-308
		150000	9000		10900		DSII-308	DSII-308
		250000	9300		11200		DSII-308	DSII-308
		500000	9400		11300		DSII-308	DSII-308
		Unlimited	9600		11500		DSII-308	DSII-308
750	722	50000	10000	2900	12900	DSII-308②	DSII-308	DSII-308
5.75%		100000	11100		14000		DSII-308	DSII-308
		150000	11600		14500		DSII-308	DSII-308
		250000	11900		14800		DSII-308	DSII-308
		500000	12200		15100		DSII-308	DSII-308
		Unlimited	12600		15500		DSII-308	DSII-308
1000	962	50000	12400	3900	16300	DSII-516	DSII-308	DSII-308
5.75%		100000	14300		18200		DSII-308	DSII-308
		150000	15000		18900		DSII-308	DSII-308
		250000	15600		19500		DSII-308	DSII-308
		500000	16200		30100		DSII-308	DSII-308
		Unlimited	16700		20600		DSII-308	DSII-308
1500	1443	50000	16500	5800	22300	DSII-516②	DSII-308	DSII-308
5.75%		100000	20000		25800		DSII-308	DSII-308
		150000	21400		27200		DSII-308	DSII-308
		250000	22700		28500		DSII-308	DSII-308
		500000	23900		29700		DSII-308	DSII-308
		Unlimited	25100		30900		DSII-508	DSII-508
2000	1924	50000	19700	7700	27400	DSII-620②	DSII-308	DSII-308
5.75%		100000	24800		32500		DSII-508	DSII-508
		150000	27200		34900		DSII-508	DSII-508
		250000	29400		37100		DSII-508	DSII-508
		500000	31300		39000		DSII-508	DSII-508
		Unlimited	33500		41200		DSII-508	DSII-508
2500	2406	50000	22400	9600	32000	DSII-632②	DSII-508	DSII-508
5.75%		100000	29200		38800		DSII-508	DSII-508
		150000	32400		42000		DSII-508	DSII-508
		250000	35600		45200		DSII-608	DSII-608
		500000	38500		48100		DSII-608	DSII-608
		Unlimited	41800		51400		DSLII-308	DSLII-308
3000	2886	50000	24600	11500	36100	DSII-632②	DSII-508	DSII-508
5.75%		100000	33000		44500		DSII-608	DSII-608
		150000	37300		48800		DSII-608	DSII-608
		250000	41500		53000		DSLII-308	DSLII-308
		500000	45500		57000		DSLII-308	DSLII-308
		Unlimited	50200		61700		DSLII-308	DSLII-308
3750	3608	50000	27200	14400	41600	DSII-840②	DSII-508	DSII-508
5.75%		100000	38000		52400		DSLII-308	DSLII-308
		150000	43700		58100		DSLII-308	DSLII-308
		250000	49800		64200		DSLII-308	DSLII-308
		500000	55500		69900		DSLII-308	DSLII-308
		Unlimited	62800		77200		DSLII-308	DSLII-308

① At transformer self-cooled rating.
② Next larger frame size main breaker may be required for 55/65°C rise and/or forced-air cooled (FA) transformer. Check Transformer Secondary Ampere Rating.

Type DSII Metal-Enclosed Low-Voltage Switchgear

Table 9A: Typical Dimensions in Inches (Millimeters) - Indoor DSII Breakers ① ② ③

DSII Mains - Close Coupled to Transformer

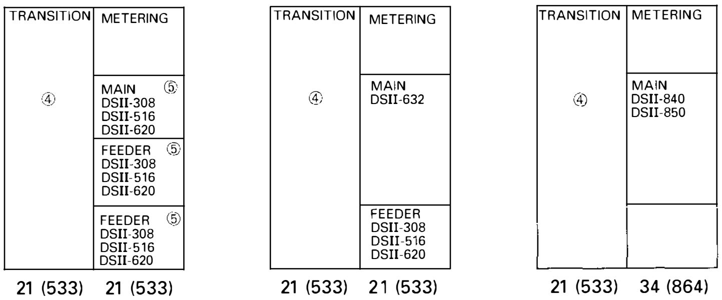


Fig. 1 **Fig. 2** **Fig. 3**

DSII Mains - Cable or Bus Duct Connected

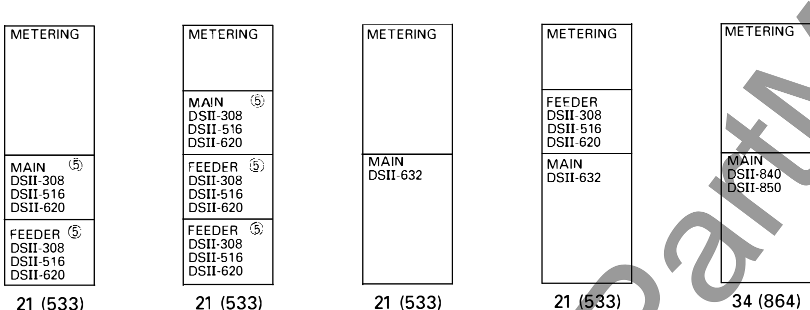


Fig. 4 **Fig. 5** **Fig. 6** **Fig. 7** **Fig. 8**

DSII Ties

Miscellaneous

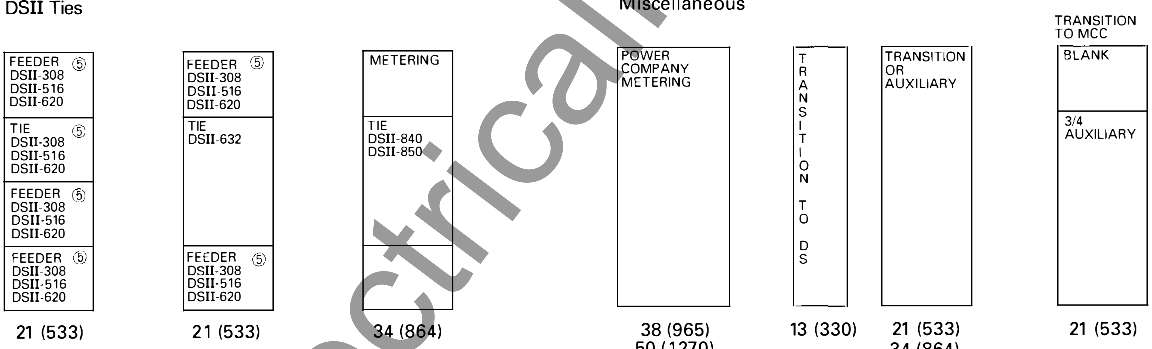


Fig. 9 **Fig. 10** **Fig. 11** **Fig. 12** **Fig. 13** **Fig. 14** **Fig. 15**

DSII Feeders

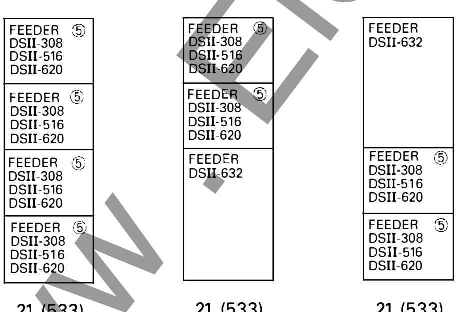


Fig. 16 **Fig. 17** **Fig. 18**

NOTES

①- Maximum indoor shipping width is 5 vertical sections or 120 inches (3048 mm), whichever is smaller. Maximum outdoor shipping width is 96 inches (2438 mm) including aisle doors, any transformer connections, etc.

②- All vertical sections are 92 inches (2339 mm) high plus 4 inch (102 mm) ventilators and non-removable lifting angle. When the top-of-gear breaker lifter is used, height is 104 inches (2642 mm) over the lifter and 97.38 inches (2473 mm) over the lifter rail.

③- When bus ducts out of feeder sections are required, the depth of the lineup may increase and vertical stacking may be effected. Refer to Cutler-Hammer.

④- Transition may be omitted if: standard dry type transformer is used; auxiliary and metering devices are not located in transition ; no fire pump breaker; no zero sequence ground fault.

⑤- Also DSII-508, DSII-608, DSII-616 (Max. of 2 fully loaded DSII-620 breakers per section).

Note: Blank may be substituted for any breaker position.

Note: Auxiliary may be substituted for any transition.

Frame	Breaker Designation
800 A	DSII-308, -508, -608, DSLII-308*
1600 A	DSII-516, -616, DSLII-516*
2000 A	DSII-620, DSLII-620*
3200 A	DSII-632, DSLII-632**
4000 A	DSII-840, DSLII-840**
5000 A	DSII-850

* These breakers have the current limiters mounted on the breaker.
** These breakers have the current limiters mounted separately.

Type DSII Metal-Enclosed Low-Voltage Switchgear

Table 9B: Typical Dimensions in Inches (Millimeters) - Indoor - DSLII Breakers ① ② ③

DSLII Mains - Close Coupled to Transformers

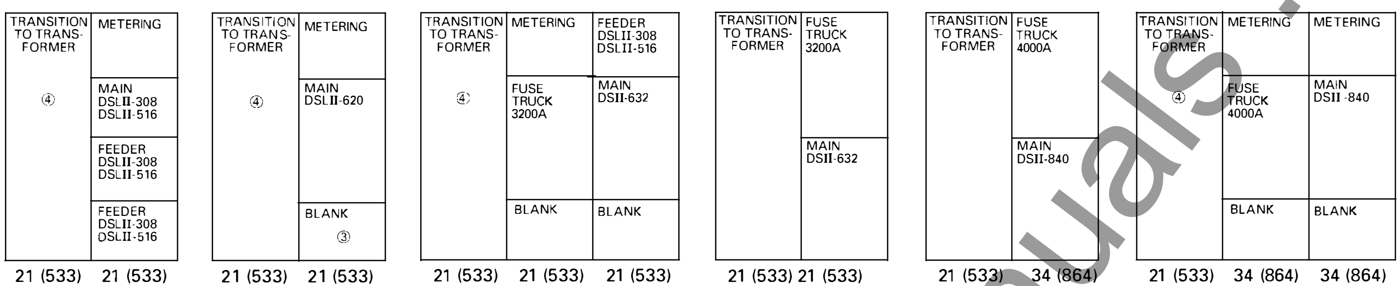


Fig. 1 **Fig. 2** **Fig. 3** **Fig. 4** **Fig. 5** **Fig. 6**

DSLII Mains - Cable or Bus Duct Connected

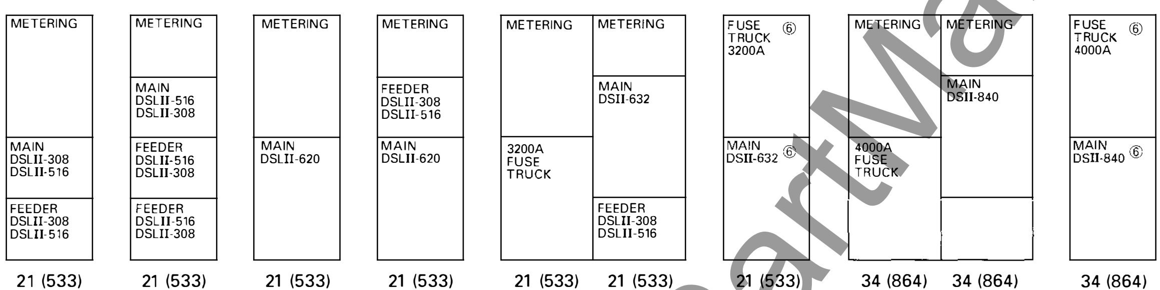


Fig. 7 **Fig. 8** **Fig. 9** **Fig. 10** **Fig. 11** **Fig. 12** **Fig. 13** **Fig. 14**

DSLII Ties

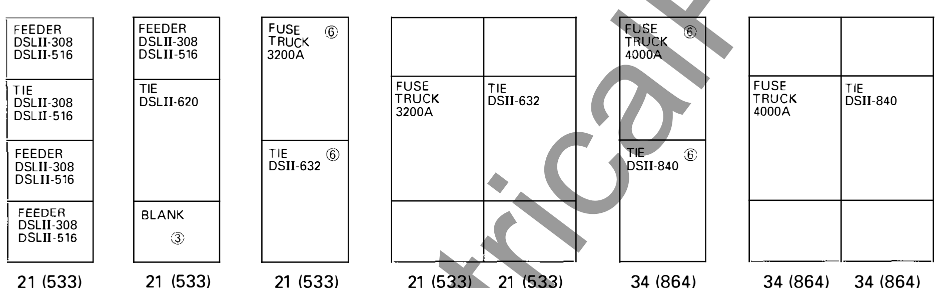


Fig. 15 **Fig. 16** **Fig. 17** **Fig. 18** **Fig. 19** **Fig. 20**

DSLII Feeders

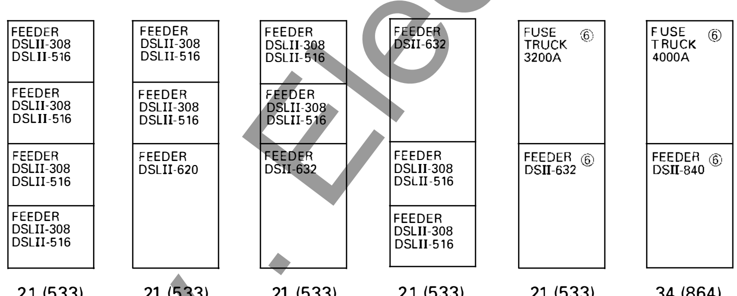


Fig. 21 **Fig. 22** **Fig. 23** **Fig. 24** **Fig. 25** **Fig. 26**

NOTES

①- Maximum indoor shipping width is 5 vertical seconds or 120 inches (3048 mm), whichever is smaller. Maximum outdoor shipping width is 96 inches (2438 mm) including aisle doors, any transformer connections, etc.

②- All vertical sections are 92 inches (2339 mm) high plus 4 inch (102 mm) ventilators and non-removable lifting angle. When top-of-gear breaker lifter is used, height is 104 inches (2642 mm) over the lifter and 97.38 inches (2473 mm) over the lifter rail.

③- When bus ducts out of feeder sections are required, the depth of the lineup may increase and vertical stacking may be effected. Refer to Cutler-Hammer.

④- Transition may be omitted if: standard dry type transformer is used; auxiliary and metering devices are not located in transition; no fire pump breaker; no zero sequence ground fault.

⑤- No breakers allowed below a DSLII-620.

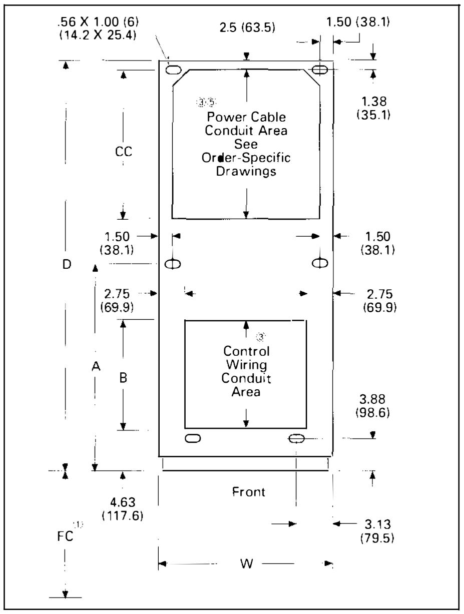
⑥- Refer to Cutler-Hammer for availability.

Note: Blank may be substituted for any breaker position.

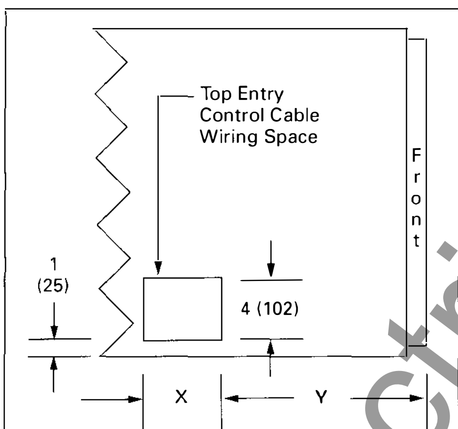
Note: Auxiliary may be substituted for any transition.

Type DSII Metal-Enclosed Low-Voltage Switchgear

Table 9C: Dimensions, in Inches (Millimeters)



Floor Plan



Breaker	"X"	"Y"
DSII Except DSII-840, DSII-FT40, DSII-850	5.5 (140)	23.5 (597)
DSII-840, DSII-FT40, DSII-850	8.72 (221)	26.27 (667)
DSLII	5.5 (140)	31.5 (800)

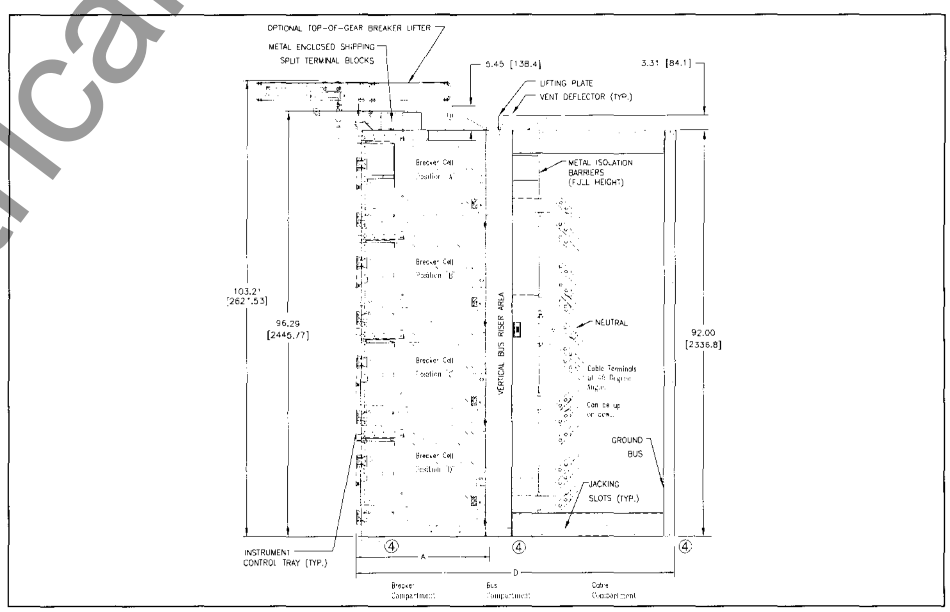
Top View

Center of Gravity

For seismic calculations, the following dimensions should be used to locate the center of gravity for Type DSII Switchgear.

Vertical..................... 60 inches (1524 mm)
Left-to-right .... center of lineup
From the front .... 24 inches (610 mm)
(28 inches (711 mm) for assemblies containing DSLII, DSII-840 and DSII-850 Breakers)

Type of Breakers In Section	① FC	W	D	② CC	④ A	B	Recommended③ No. of Power Conduits (Max.) 3.5"	4"
All DSII, Except DSII-840 DSII-850	36 (914)	21 (533)	60 (1524) 66 (1676) 72 (1829) 78 (1981) 84 (2134) 90 (2286)	10 (254) 16 (406) 22 (559) 28 (711) 34 (864) 40 (1016)	30.50 (775)	17.5 (445)	6 9 12 15 18 21	3 6 9 12 15 18
DSII-840 DSII-850	44 (1118)	34 (864)	72 (1829) 78 (1981) 84 (2134) 90 (2286)	14 (356) 20 (508) 26 (660) 32 (813)	38.50 (978)	23.5 (597)	14 18 23 32	10 15 23 28
DSLII-308 DSLII-516 DSLII-620	44 (1118)	21 (533)	66 (1676) 72 (1829) 78 (1981) 84 (2134) 90 (2286)	8 (203) 14 (356) 20 (508) 26 (660) 32 (813)	38.50 (978)	25.5 (648)	4 8 10 15 18	3 6 9 12 15
DSLII-632 DSII-FT32 (non stacked)	44 (1118)	21 (533)	72 (1829) 78 (1981) 84 (2134) 90 (2286)	14 (356) 20 (508) 26 (660) 32 (813)	38.50 (978)	25.5 (648)	8 10 15 18	6 9 12 15
DSLII-632 DSII-FT32 (stacked)	44 (1118)	21 (533)	72 (1829) 78 (1981) 84 (2134) 90 (2286)	0 (0) 6 (152) 12 (305) 18 (457)	38.50 (978)	25.5 (648)	0 3 6 9	0 3 6 9
DSLII-840 DSII-FT40 (non stacked)	44 (1118)	34 (864)	72 (1829) 78 (1981) 84 (2134) 90 (2286)	14 (356) 20 (508) 26 (660) 32 (813)	38.50 (978)	23.5 (597)	14 18 23 32	10 15 23 28
DSLII-840 DSII-FT40 (stacked)	44 (1118)	34 (864)	72 (1829) 78 (1981) 84 (2134) 90 (2286)	0 (0) 6 (152) 12 (305) 18 (457)	38.50 (978)	23.5 (597)	0 5 10 15	0 5 10 15



Section View of Typical Structure

① FC is the recommended front clearance for breaker removal with top-of-switchgear-mounted breaker lifter. If a portable breaker lifter is to be used, allow at least 60 inches (1624 mm) of aisle space.
② When a zero-sequence ground-fault CT is mounted on line-side or load-side of a breaker, reduce CC dimension by 10 inches (254 mm).
③ Stub conduit 2 inches (50 mm) maximum in power cable area, 1-inch (25 mm) maximum in control wiring area.
④ Bolt hole location for mounting the center floor channel when required. Floor channels not included. Note that when there is an assembly containing structures with different channel locations, a channel must be used for each of the locations.
⑤ For available area for bus duct connection contact Cutler-Hammer.

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Type DSII Metal-Enclosed Low-Voltage Switchgear

Table 9C: Dimensions, in Inches (Millimeters), *Continued*

Estimated Heat Loss Per Breaker (Watts) (See Note Below)

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
DSLII-FT32	3600
DSLII-FT40	4500

Note: Add heat loss of structure per following.

Main bus through 3200 Amps	4000
Main bus 4000 Amps maximum	5000
Main bus 5000 Amps maximum	7000

Type DSII Indoor Switchgear Approximate Weights—Pounds (Kilograms)

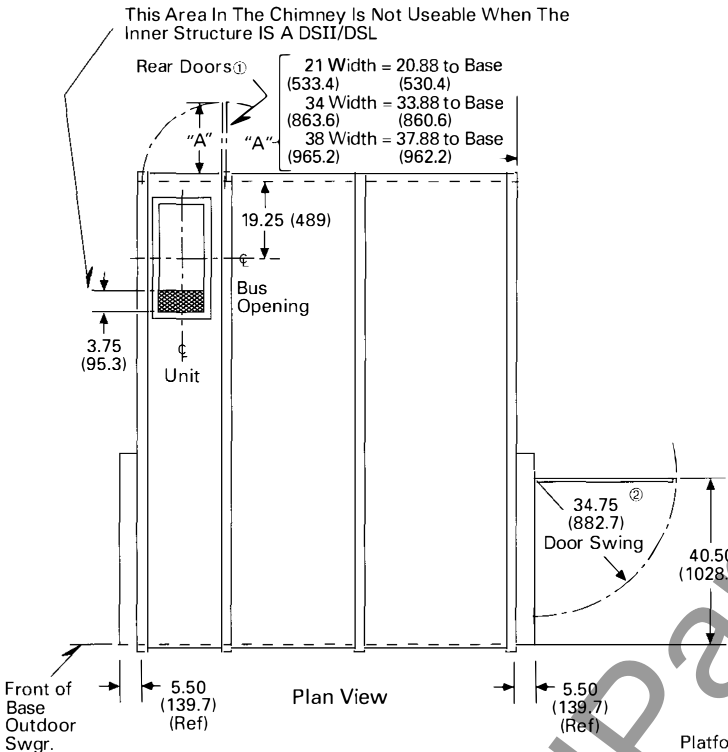
Stationary Structures	
21 in. (533 mm) wide breaker structure less breakers:	
66 in. (1676 mm) maximum depth	1300 (591)
78 in. (1981 mm) maximum depth	1400 (636)
90 in. (2286 mm) maximum depth	1500 (682)
34 in. (864 mm) wide breaker structure less breakers:	
66 in. (1676 mm) maximum depth	1500 (682)
78 in. (1981 mm) maximum depth	1600 (727)
90 in. (2286 mm) maximum depth	1700 (773)
21 in. (533 mm) wide auxiliary structure less breakers:	
66 in. (1676 mm) maximum depth	1000 (455)
78 in. (1981 mm) maximum depth	1100 (500)
90 in. (2286 mm) maximum depth	1200 (545)
34 in. (864 mm) wide auxiliary structure less breakers:	
66 in. (1676 mm) maximum depth	1100 (500)
78 in. (1981 mm) maximum depth	1200 (545)
90 in. (2286 mm) maximum depth	1300 (591)
13 in. (330 mm) wide Bus Transition structure	700 (318)
21 in. (533 mm) wide Transformer Transition structure	1000 (455)

Drawout Elements	
DSII-308 Breaker①	150 (68)
DSII-508 Breaker①	195 (87)
DSII-608 Breaker①	200 (91)
DSII-516 Breaker①	195 (89)
DSII-616 Breaker①	200 (91)
DSII-620 Breaker①	200 (91)
DSII-632 Breaker①	300 (136)
DSII-840 Breaker①	400 (182)
DSII-850 Breaker①	400 (182)
DSLII-308 Breaker①	200 (91)
DSLII-516 Breaker①	260 (118)
DSLII-620 Breaker①	325 (148)
DSLII-FT32	325 (148)
DSLII-FT40	430 (195)

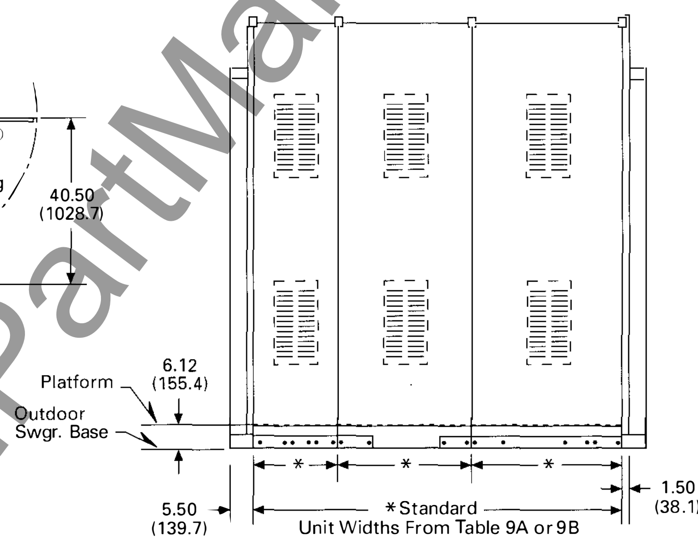
① Manually or electronically operated. For approximate impact weight, add 50% of breaker weight.

Type DSII Metal-Enclosed Low-Voltage Switchgear

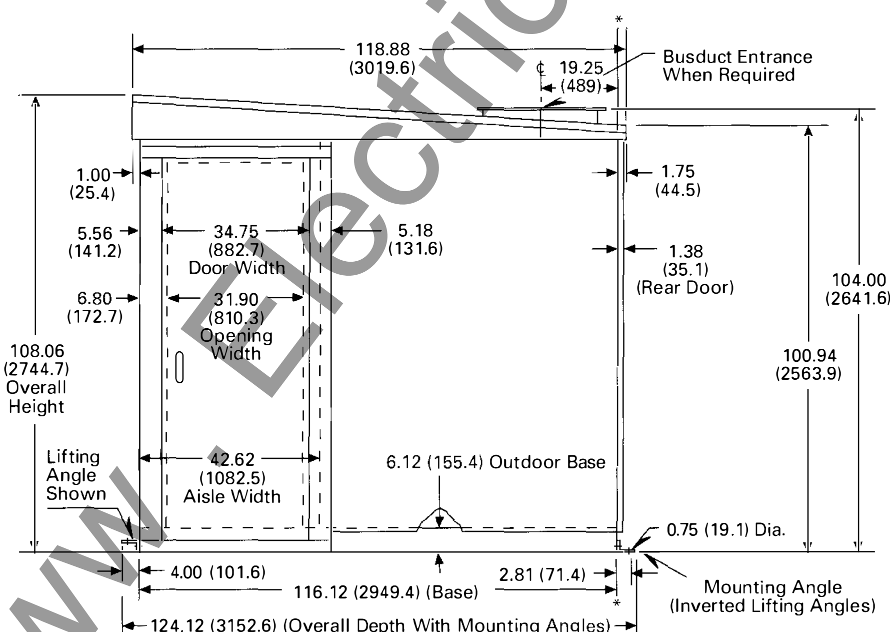
Table 9D: Typical Dimensions - Inches (Millimeters) Outdoor



Plan View



Front View



Right-Hand End View

Note: * Denotes rear of base and frame.

Weights of Outdoor Structures

Stationary Structures③	Weight – lbs (kg)
End trims (one set per lineup)	1500 (682)
21 in. wide breaker section	2600 (1182)
34 in. wide breaker section	2700 (1227)
21 in. wide aux. section	2300 (1045)
34 in. wide auxiliary section	2400 (1091)
38 in. wide utility section	2700 (1227)
50 in. wide utility section	3200 (1455)
21 in. bus transition section	2500 (1136)
Transformer throat	150 (68)

① Rear doors are standard.
② Enclosures equipped with hinged door on each end of aisle.
③ Weight of structure is less breakers.

Dimensions for Estimating Purposes Only.

Type DSII Metal-Enclosed Low-Voltage Switchgear

Outgoing Low-Voltage Switchgear Section

Typical Specification

General—Type DSII indoor (outdoor) low-voltage metal-enclosed switchgear shall consist of a stationary structure assembly and one or more removable "De-ion" air circuit breaker units fitted with disconnecting devices and other necessary equipment. The switchgear shall be suitable for 600 Volts maximum service and shall withstand a 2200 Vac dielectric test in accordance with ANSI standards. It shall be designed, manufactured and tested in accordance with the latest standards of IEEE, NEMA, ANSI, and UL.

Stationary Structure—Each steel unit forming part of the stationary assembly shall be a self-contained housing having one or more individual breaker or instrument compartments and a rear compartment for the bare buses and outgoing cable connections.

Jacking slots shall be provided for ease of lifting in equipment rooms for the purpose of removing shipping skids and the addition or removal of equipment rollers.

A rigid integral steel base shall be provided for each section which will allow movement of shipping groups directly on rollers without a separate skid.

Barriers shall be provided which isolate the cable compartment from the horizontal and vertical bus compartments.

Each circuit breaker compartment shall be equipped with primary and secondary contacts, draw-out extension rails, stationary levering mechanism parts and required instrument current transformers. A formed steel door equipped with an emergency trip button, and supported on concealed hinges with removable pins shall be provided for each circuit breaker compartment.

The top of the unit shall be enclosed with removable steel sheets which include necessary hooded ventilation openings. A separate removable roof sheet shall be provided for drilling of control conduit hubs. A metal wireway with removable covers shall be provided for shipping-split wiring. Pull-apart type terminal blocks shall also be provided for rapid, error-free, shipping split assembly.

The structure shall be so designed that future additions may readily be made at any time. The steel structure shall be thoroughly cleaned and phosphatized prior to the application of the light gray ANSI No. 61 finish.

A white, laminated, plastic engraved circuit designation nameplate shall be provided on each circuit breaker door.

Buses and Connections—Each circuit shall include the necessary three-phase bus and connections between the bus and one set of circuit breaker studs. NEMA 2-hole cable lugs attached to silver-plated copper extensions for the outgoing cables shall be provided on the other set of circuit breaker studs. This system shall be designed such that full short circuit withstand ratings through 65 kA are retained without the need for lashing of power cables. The buses and connections shall consist of high-conductivity (silver-plated) (tin-plated) copper bar mounted on heavy-duty supports, and having bolted joints. All bolted joints shall utilize Belleville type spring washers to maintain maximum joint integrity through continuous thermal cycling. The bus system shall be suitable for applications on power systems requiring a (100) (200) kA short circuit withstand rating without upstream current limiting fuses. Shipping breaks and provisions for future bus extensions shall have silver-plated bolted connections.

Terminal blocks with integral-type barriers shall be provided for secondary circuits. The terminal blocks shall be front accessible through a removable tray above each circuit breaker.

All control wiring shall be securely fastened to the switchgear assembly without the use of adhesive wire anchors. A dedicated wiring path shall be provided for purchaser's installed control wiring. Nonadhesive anchors shall also be provided for purchaser's installed wiring.

Disconnecting Devices—The stationary part of the primary disconnecting devices for each circuit breaker shall consist of a set of contacts extending through a glass polyester insulating base. Buses and outgoing cable terminals shall be directly connected to them. The corresponding moving contacts shall consist of a set of contact fingers suitably spaced on the circuit breaker studs. In the "connected" position, these contacts shall form a current-carrying bridge. The assembly shall provide a multitude of silver-to-silver high-pressure point contacts. High uniform pressure on each finger shall be maintained by springs. The entire assembly shall be full floating and shall provide ample flexibility between the stationary and moving elements. Contact engagement shall be maintained only in the "connected" positon.

The secondary disconnecting devices shall consist of floating fingers mounted on the removable unit and engaging contacts located at the rear of the compartment. The secondary disconnecting devices shall be silver-plated to insure permanence of contact. Contact engagement shall be maintained in the "connected" and "test" positions.

Removable Element—The removable element shall consist of a type DSII De-ion air circuit breaker equipped with the necessary disconnecting contacts, wheels, and interlocks for draw-out application. The removable element shall have four-position features and shall permit closing the compartment door with the breaker in the "connected," "test," "disconnected," and "remove" positions.

Air Circuit Breakers—The air circuit breaker shall be Type DSII (DSLII) operating on the De-ion arc interruption principle. These breakers shall incorporate specially designed circuit-interrupting devices which provide high interrupting efficiency and minimize the formation of arc flame and gases.

The air circuit breakers shall have silver-tungsten butt type contacts which operate under high pressure. The arcing contacts shall be arc-resisting silver-tungsten. The breaker shall be equipped with "De-ion" arc chutes which effectively enclose the arcing contacts and confine the arc to reduce the disturbance caused by short-circuit interruption. Each breaker shall be equipped with a position indicator, mechanically connected to the circuit breaker mechanism.

Include when DSLII breakers specified above: Circuit breakers shall include current limiters, integrally or separately mounted, coordinated with the breaker trip device so as to avoid unnecessary blowing of the current limiters. Breaker 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 reclosed on a single phase condition due to missing or blown limiters.

[Specifier note: Include only the tripping functions below necessary for the specific application. Requirements for mains, ties, and feeders may be different.]

Each breaker shall be equipped with a microprocessor-based, true RMS sensing trip device. The adjustments shall be long delay pickup between 50% and 100% of the trip rating, long time delay between 4 and 36 seconds at 6 times trip rating, short delay pickup between 2 and 10 times trip rating, short time delay between 0.18 and 0.5 seconds at 2.5 times short delay pickup, instantaneous pickup between 2 and 12 times trip rating, ground fault pickup approximately 20% of trip rating and

Type DSII Metal-Enclosed Low-Voltage Switchgear

ground fault time between 0.22 and 0.5 seconds.

It shall be possible to test and verify the time and current characteristics and trip circuit by means of a portable plug-in test device.

Both electrically operated and manually operated breakers shall have stored energy operating mechanisms. Only one stroke of the operating handle shall be necessary to charge the stored energy spring when operating the manual breaker. The release of the energy to close the breaker manually shall be by means of a mechanical pushbutton which insures positive control of the closing operation. Electrical close shall be initiated by means of a release solenoid.

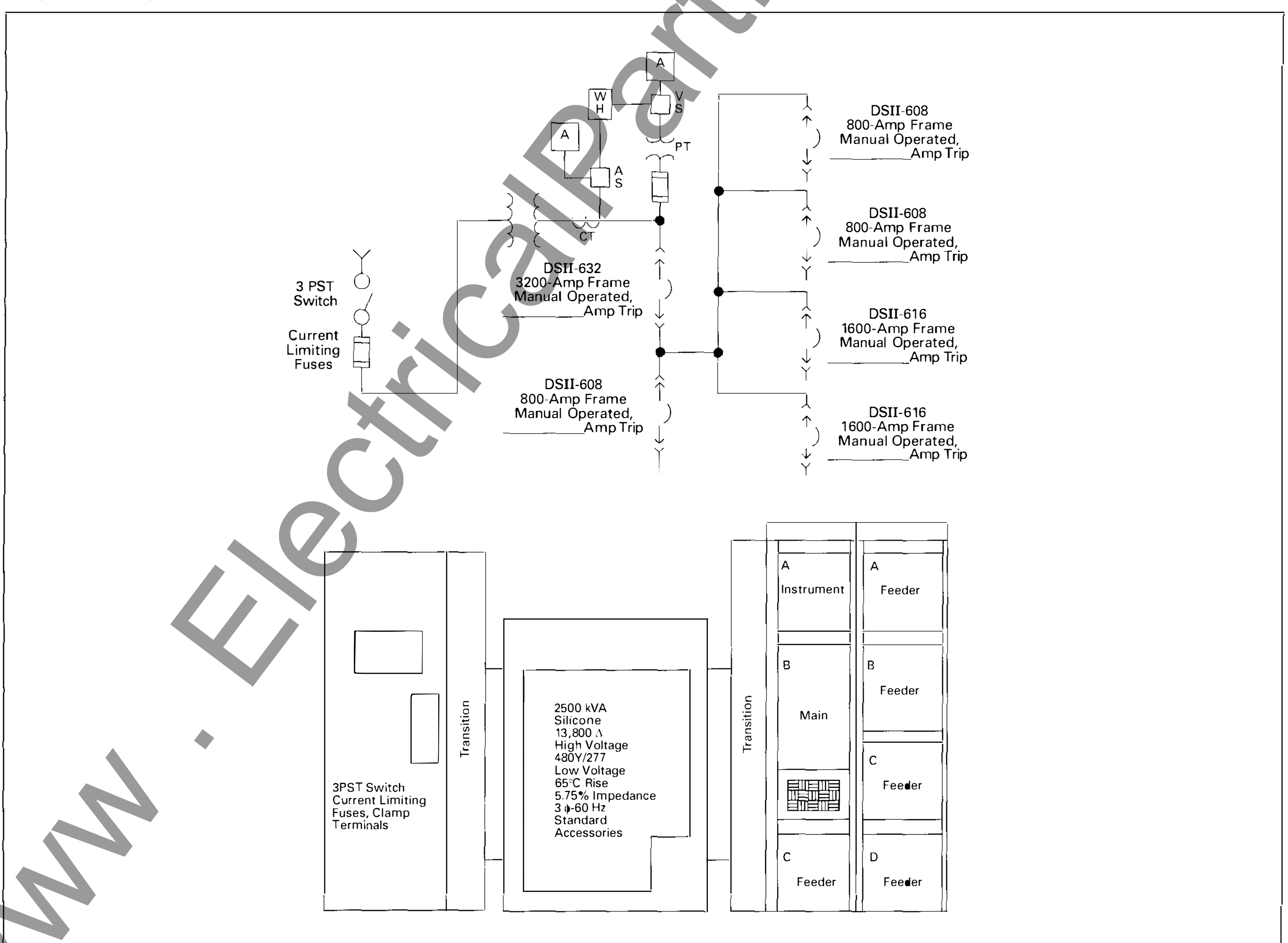
Seismic
The switchgear assembly and circuit breakers shall be suitable for and certified to meet all applicable seismic requirements of (UBC) (The California Building Code) for zone 4 application. Guidelines for the installation consistent with these requirements shall be provided by the switchgear manufacturer and be based upon testing of representative equipment. The test response spectrum shall be based upon a 5% minimum damping factor, (Insert the following for UBC: a peak of 0.75g, and a ZPA of 0.38g), (Insert the following for CBC: a peak of 1.8g, and a ZPA of 0.45g). The tests shall fully envelope this response spectrum for all equipment natural frequencies up to at least 35 Hz.

Factory Assembly and Tests
The switchgear shall be completely assembled, wired, adjusted and tested at the factory. After assembly, the complete switchgear shall be tested for operation under simulated service conditions to assure the accuracy of the wiring and the functioning of the equipment.

The main circuits shall be given a dielectric test of 2200 Volts for one minute between live parts and ground and between opposite polarities. The wiring and control circuits shall be given a dielectric test of 1500 volts for one minute or 1800 volts for one second, between live parts and ground.

Note: Arrangement sketch and single line diagram similar to samples shown should accompany the written specification.

Single Line Diagram and Elevation



Type DSII Metal-Enclosed Low-Voltage Switchgear

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Cutler-Hammer

September 1995
Supersedes Application Data 32-650 B,
pages 1-44, dated May 1995
Mailed to: E, C/32-000B

Type DSII Metal-Enclosed Low-Voltage Switchgear

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Type DSII Metal-Enclosed Low-Voltage Switchgear

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Type DSII Low-Voltage Switchgear

Modern design Type DSII Metal-Enclosed Low-Voltage Switchgear and Circuit Breakers provide:

- 100% rated, fully selective protection.
- Integral microprocessor-based breaker tripping systems.
- Two-step stored-energy breaker closing.
- 100 kA short circuit bracing standard.
- Optional 200 kA short circuit bracing, without preceeding current limiting fuses.
- Standard metal barriers isolate cable and bus compartments.

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

Maximum Ratings
600 Volts ac
5000 Amperes continuous
200,000 Amperes short circuit capacity

Features

Standard Finish—Light gray (ANSI No. 61) using modern electrodeposition (E-Coat) system.

Four Position Drawout—Breakers can be in connected, test, disconnected or removed position with compartment doors closed.

Plug-in Terminal Blocks—At each shipping split, the control connections are made with plug-in terminal blocks rated 600 Volts, 40 Amperes and accept a wire range of #22 to #8. The terminal blocks interlock mechanically without removing the line or load connections. This method of making the shipping split control connections increases the speed of installation and reduces the potential of incorrect connections.

Integral Base—Rugged formed base suitable for rolling. Includes slots for jacking and handling.

Front Terminal Block Tray—Unitized wiring system utilizes pull-out trays above each breaker compartment for terminal blocks and control fuses.

Removable Doors—Each breaker door is mounted with hinge pins. Removal of the door is easily accomplished by just lifting the hinge pin. This allows easy access to the breaker and compartment for inspection and maintenance.

Current Transformers for metering and instrumentation are mounted in the breaker compartments and are front accessible.

Short Circuiting Terminal Blocks—One provided for each set of instrumentation or relaying application current transformers.

Standard Silver-Plated Copper Bus—(Tin-plated copper bus available).

Lug Pad—The lugs are located on the breaker run-backs at a 45° angle to reduce the bending of the cable when making the connections, thus reducing installation and maintenance time.

Cable Lashing—Cable lashing is not required on DSII Switchgear Assemblies for breakers rated above 2000 Amps.

For breakers rated 2000 Amps and below using mechanical pressure type lugs, no cable lashing is required if the lug is a minimum 500 MCM in size, has NEMA 2-hole mounting utilizing two ½ inch hex drive cable holding screws torqued to 500 inch pounds and a minimum of two cables per phase are used.

For breakers rated 2000 Amps and below using compression crimp type lugs, no cable lashing is required if the lug has NEMA 2-hole mounting, is crimped at least two times with a hydraulic crimper using a minimum of 12 tons of compression and a minimum of two cables per phase are used.

The above was determined by tests approved by UL. If the customer uses other type lugs or installation methods, cable lashing is required. For these instances, cable lashing instructions are given in I.B. 32-695 which is supplied with each Assembly.

Glass Reinforced Polyester and Ultramid① Stand-Off Insulation System—Type DSII Switchgear provides an industry leading design for short circuit withstand levels through 200 kA, without the need for preceeding current limiting devices. Glass reinforced polyester has been used on both low- and medium-voltage switchgear for decades. By combining this industry proven material with Ultramid insulation, a total system providing exceptional mechanical and dielectric withstand strength, as well as high resistance to heat, flame, and moisture, is produced. Substantial testing to demonstrate accelerated effects of heating and cooling on the mechanical and dielectric properties of this system prove it to provide superior performance for decades of trouble-free operation.

Optional Conductor Insulation Covering—For applications requiring additional bus protection in harsh environments, Type DSII Switchgear is designed for the addition of optional conductor insulation covering, in addition to providing full UL air clearance without insulation. This non-PVC material is applied during the assembly of the bus and covers all vertical and horizontal phase bus bars. Removable non-PVC boots provide access to bus joints for inspection and maintenance purposes.

Closing Spring Automatic Discharge—Mechanical interlocking automatically discharges the closing springs when the breaker is removed from its compartment.

Breaker Inspection—When withdrawn on the rails, breaker is completely accessible for visual inspection; tilting is not necessary. The rails are permanent parts of every breaker compartment.

Key Interlock—Breaker can be stored in compartment, and completely removed for maintenance or for use as a spare without disturbing the interlock. No modification of the breaker required. This mechanism holds the breaker mechanically trip-free to prevent electrical or manual closing.

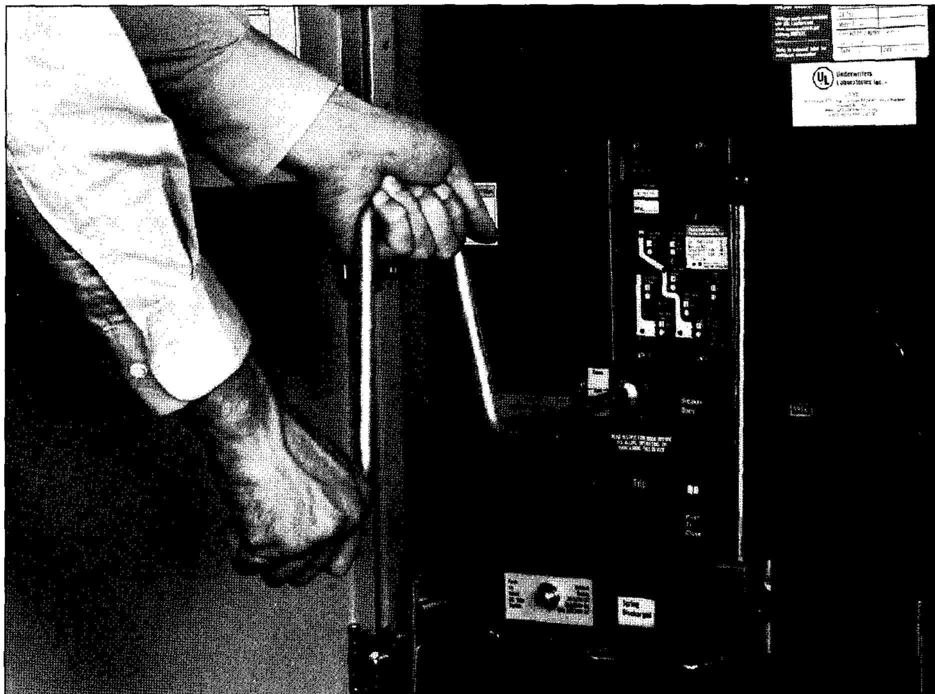
Mechanical Interlock—Available between adjacent breakers, 2000A and below, in the same structure.

Conformity to Standards—Type DSII Switchgear conforms to the following standards: NEMA SG3 and SG5; ANSI C37.20.1, C37.51, and UL Standard 1558.

① A product of BASF.

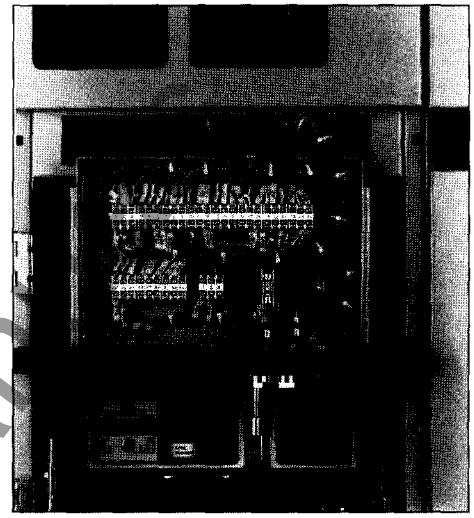
Type DSII Metal-Enclosed Low-Voltage Switchgear

Design and Construction Features



Outer door with quick-opening latches closes compartment completely with breaker connected or disconnected. Full-sized metal shield on breaker face protects operator from live parts while operating, racking or checking trip unit settings. Double interlocked device prevents racking until contacts are open; contacts can't be closed until racking is complete. Isolated cable entrance and bus compartments are provided as standard; removable metal barriers give access to bus compartment for inspection or cleaning.

Metal-Clad Safety Features

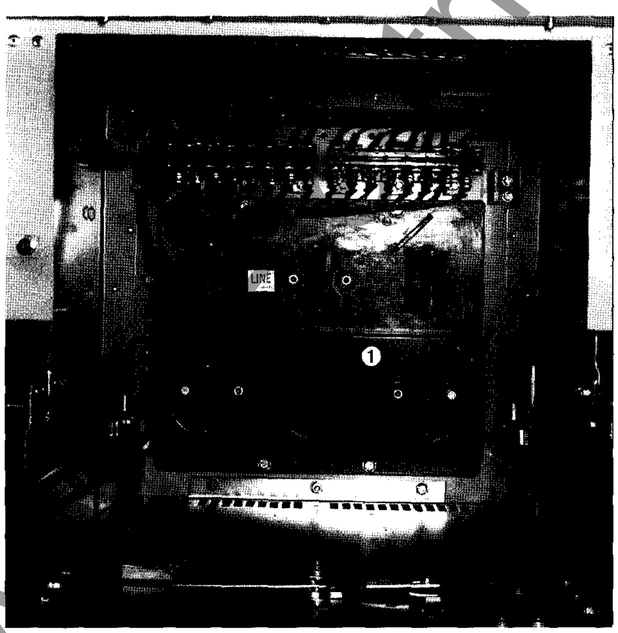


Front Terminal Block Tray

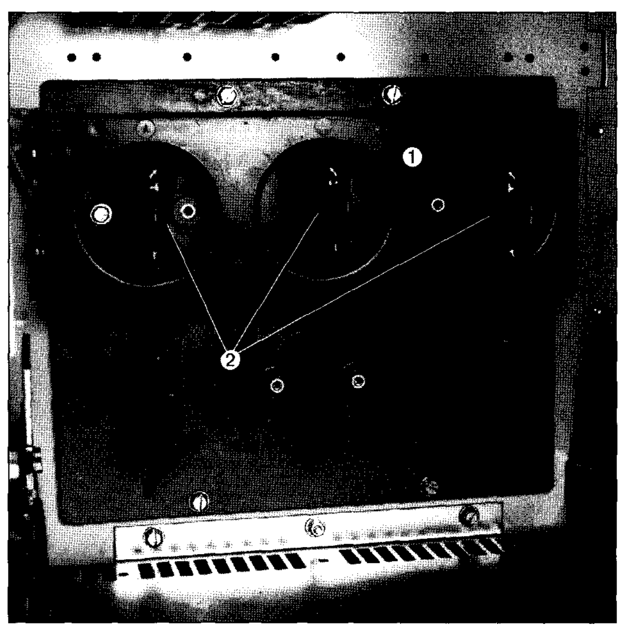
Wiring

Control circuit terminal blocks are mounted as standard in pull-out trays located above each circuit breaker. The terminal blocks are rated 600 Volts, 40 Amperes. Circuit-to-circuit spacing is slightly greater than 3/8" for easy wire installation. Extruded loops punched in side sheets of the terminal block tray allow securing of customer control wiring without the use of adhesive wire anchors.

For applications involving excessive wiring, or nonstandard terminal blocks, terminal blocks are mounted on the rear frame with the power cables where they are readily accessible for customer's connections and inspection.



① **3-Phase Current Transformers**



② **Insulating Boots**

Type DSII Metal-Enclosed Low-Voltage Switchgear

Buses and Connections

Vertical and cross bus ratings in Type DSII Switchgear are 2000, 3200, 4000 and 5000 Amperes. All ratings are based on a UL and ANSI standard temperature rise of 65°C above a maximum ambient air temperature 40°C.

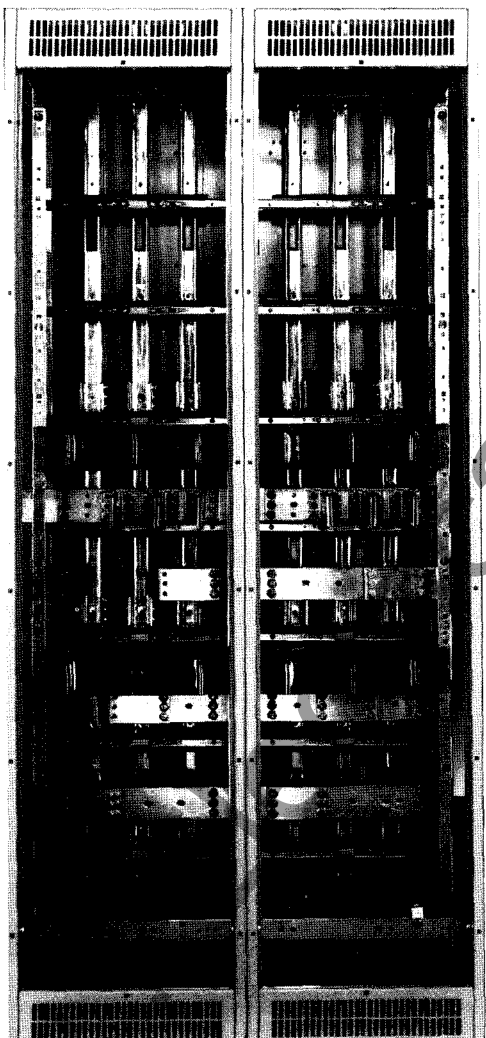
Bolted, silver-plated copper main buses are standard. All bus joints are secured with Belleville-type spring washers for maximum joint integrity.

Optional copper main buses with tin-plated, bolted joints are available.

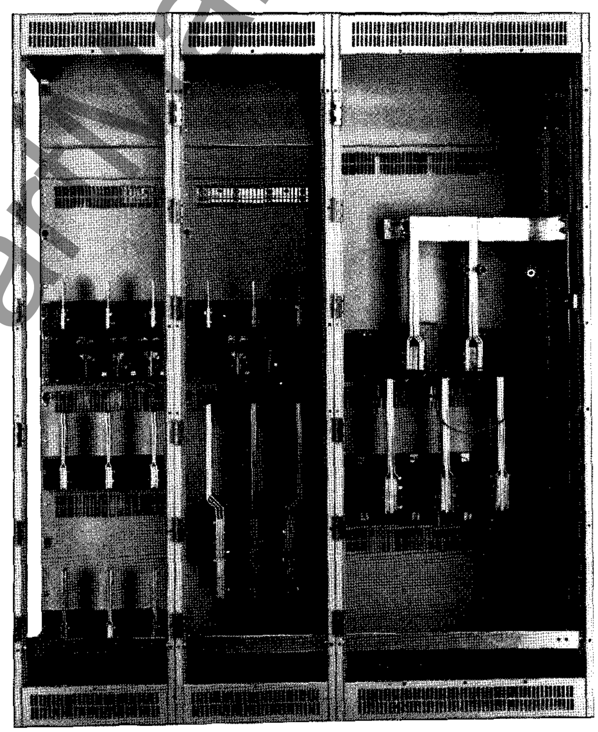
The rear portion of the switchgear assembly houses the main bus, connections, and primary terminals.

A ground bus is furnished the full length of the switchgear assembly and is fitted with terminals for purchaser's connections.

Standard rear covers with captive hardware are the bolt-on type. They are split into two horizontal sections to facilitate handling during removal and installation. Optional rear doors are also available.



Bus and Cable Compartment with Barriers Removed



Cable Connection Compartment with Barriers in Place

Type DSII Metal-Enclosed Low-Voltage Switchgear

Table 1: Metering Type Current Transformers for Mounting in Circuit Breaker Compartments

For Breaker Type					ANSI Meter Accuracy Classification		
DSII-308, DSII-608 DSII-508, DSLII-308	DSII-516, DSII-616 DSLII-516	DSII-620 DSLII-620	DSII-632 DSLII-632	DSII-840, DSII-850 DSLII-840	Ratio	B-0.1	B-0.2
					100/5	1.2	—
					150/5	1.2	—
					200/5	1.2	1.2
					300/5	0.6	0.6
					400/5	0.6	0.6
					600/5	0.6	0.6
					800/5	0.3	0.3
					1200/5	0.3	0.3
					1500/5	0.3	0.3
					1600/5	0.3	0.3
					2000/5	0.3	0.3
					2500/5	0.3	0.3
					3000/5	0.3	0.3
					4000/5	0.3	0.3
					5000/5	0.3	0.3

Current transformers with meter accuracy classifications at higher burdens and/or suitable for relaying are also available. They will be mounted in the rear cable connection compartment.

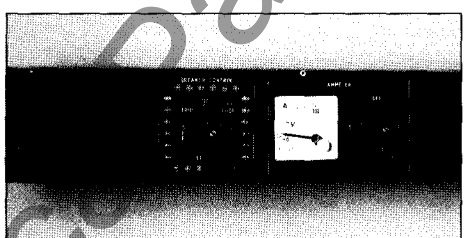
Voltage Transformers
Voltage transformers are rated 10 kV BIL and are protected by both primary and secondary fuses. The primary fuses are current limiting type.

Control Power Transformers
Control transformers are provided when required for ac control of circuit breakers, space heaters, and/or transformer fans. Like potential transformers, they are protected by current limiting primary fuses. Non-current limiting fuses are used on the secondary side to protect branch circuits.

Switchgear Accessories
Standard accessories furnished with each Type DSII switchgear assembly include:

- One breaker levering crank.
- Insulating covers or "boots" are furnished on live main stationary disconnecting contacts in compartments equipped for future breakers.

Miscellaneous
For feeder circuit instrumentation, 2% accuracy ammeters and ammeter switches can be mounted on the terminal block tray between the breaker compartment doors. The ammeters and switches are immediately associated with definite breaker circuits. Other devices, such as control pushbuttons, breaker control switches, indicating lights, and test switches can be mounted on these panels, within space limitations.



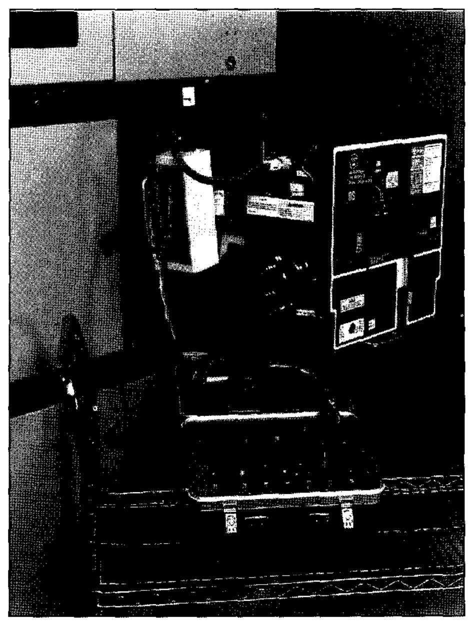
Breaker Control Switch, Ammeter and Switch

Interference interlocks are supplied on breakers and in compartments where the compartments are of the same physical size to assure an incorrect breaker cannot be inserted.

Standard wire is Type SIS insulated, stranded copper, extra flexible No. 14 AWG minimum.

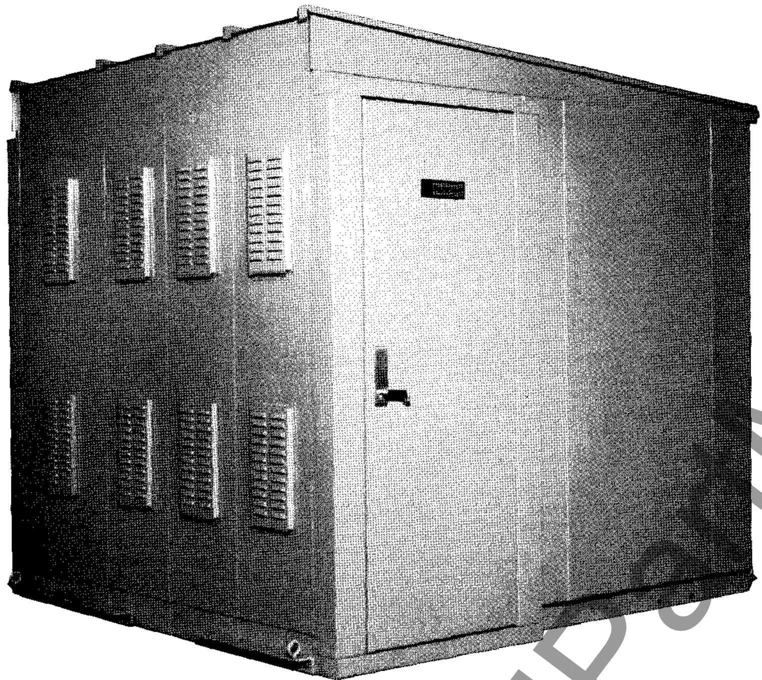
Optional Accessories

- Traveling type circuit breaker lifter, rail-mounted on top of switchgear.
- Floor running portable circuit breaker transfer truck with manual lifting mechanism. Requires approximate 60" deep front aisle space.
- Test cabinet for electrically operated breakers, with pushbuttons, control cable and receptacle, for separate mounting.
- Portable test kit for testing and verification of trip units. Utilizes standard 120-Volt, 15-Ampere, single-phase, 60 Hz supply, available from any outlet.



Portable Test Kit

Type DSII Metal-Enclosed Low-Voltage Switchgear



Outdoor NEMA 3R switchgear consists of standard Type DSII indoor structures assembled in a heavy gauge outdoor enclosure with a generous internal "walk-in" front operating aisle extending through all units of the assembly. Access doors with provisions for padlocking are provided at each end of the aisle. Commercial grade panic hardware is provided on the interior of each aisle door to permit opening even if the exterior is padlocked.

Standard features also include:

- Padlockable hinged rear doors with wind stops for access to cable and bus compartments.
- Filtered ventilation openings. Filters are removable from the exterior.
- Traveling type breaker lifter.
- A space heater rated 95 Watts at 125 Volts in the cable compartment, bus compartment and bottom breaker compartment of each vertical structure and a space heater rated 250 Watts at 125 Volts in each auxiliary section.
- Lighting and GFCI protected convenience receptacles in aisle.
- Rigid base structure; no channels required.
- Walk-in aisle within shipping group shipped completely assembled.
- Antiskid aisle floor strips.

The standard finish is ANSI No. 61 inside and outside. A corrosion-resistant coating is provided on the underside and base.

Outdoor Aisle Type Switchgear Enclosure

Bus Runs
For connecting sources and loads to switchgear assemblies, low-voltage bus runs in ratings from 800 Amperes to 5000 Amperes are available. These buses can also be used for bus tie circuits between separate low-voltage switchgear assemblies. Type DSII assemblies accommodate both Pow-R-Way busway and metal enclosed non-segregated phase bus ducts.

Non-segregated bus design and construction follow ANSI C37.23 Standards, with bare aluminum or copper conductors with silver-plated bolted joints and glass polyester supports. Momentary ratings (minimum 50,000 Amperes) are as required. Standard finish color is ANSI No. 61 light gray indoor and outdoor.

Pow-R-Way Busway is totally enclosed, non-ventilated and meets the latest applicable standards of NEMA BU.1 and UL 857.

Seismic Applications

Type DSII Assemblies have undergone an extensive seismic qualification program. Representative DSII assemblies were placed on a triaxial seismic table and tested. The test program utilized ANSI standard C37.81, the Uniform Building Code (UBC), and the California Building Code (CBC) as a basis for the test program. Although C37.81 is specifically used for the qualification of assemblies for Class 1E applications, there are many elements of this standard applicable to the qualification of commercial grade switchgear.

The required response spectrum developed for the test covered a frequency range through 35 Hz and was based upon a 5% damping factor. The actual test response spectrum enveloped the UBC Zone 4, as well as the more stringent CBC Zone 4 levels of a 0.45g ZPA and 1.8g peak, with margin.

A mutual responsibility between the manufacturer, system designer, and installer is necessary to provide an installation consistent with the requirements of the UBC and CBC. Installation and application guidelines, based upon the actual test results, are provided with each submittal requiring compliance with these standards. Assembly modifications are also provided.

Type DSII Metal-Enclosed Low-Voltage Switchgear

DSII Circuit Breakers Mixed With DSLII

Due to the eight-inch additional depth of DSLII circuit breakers over DSII breakers, they cannot be mixed within the same section. The only exception is the ability to mix DSII-632 breakers with DSLII breakers. In this application, the DSII-632 "sits" eight inches further from the front of the enclosure than the DSLII breaker. If other combinations are necessary, a 13-inch transition between the sections containing the DSII and DSLII breakers is required.

5000A Circuit Breaker Applications

For circuit breaker applications demanding continuous ratings between 4000 and 5000 Amperes, the DSII-850 package is available. The application consists of a switchgear mounted fan package and a DSII-850 circuit breaker, and is UL approved.

The DSII-850 has a self-cooled continuous rating of 4000 Amperes. It is equipped with 5000 Ampere sensors, a Digitrip RMS trip unit, and a 5000 Ampere rating plug.

The associated switchgear system consists of 3 fans mounted to a draw-out tray assembly and a current relay to switch the fans on or off when the load exceeds or drops below 4000 Amperes. Two temperature activated contacts are also provided—the first contact provides an alarm and the second a trip if excessive temperatures are sensed.

Type DSII Circuit Breakers

Type DSII Switchgear Assemblies utilize Westinghouse Type DSII draw-out air power circuit breakers exclusively. These circuit breakers provide:

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.

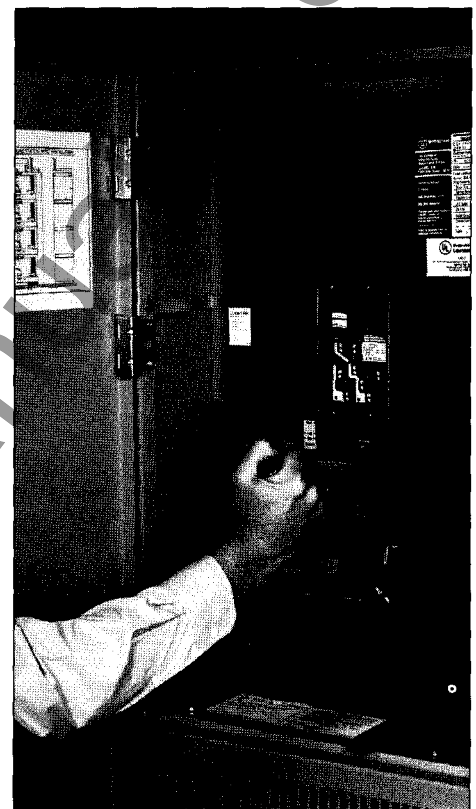
Digitrip RMS Integral Microprocessor-Based Breaker Overcurrent Trip Systems— Provides maximum reliability, true RMS sensing as standard, excellent repeatability, and requires minimum maintenance. No external control source is required.

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 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.

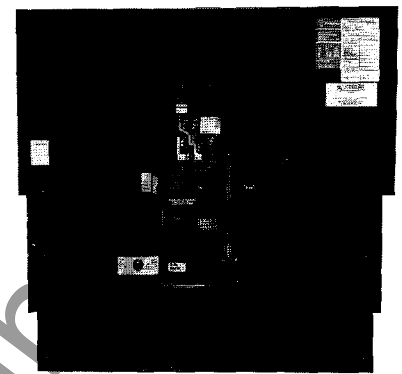
On manual breakers, the spring mechanism is manually charged by one downward stroke of the lever without pumping, and released by the mechanical "push-to-close" release button. On electrically operated breakers, the mechanism is normally charged and released electrically, but can be charged manually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

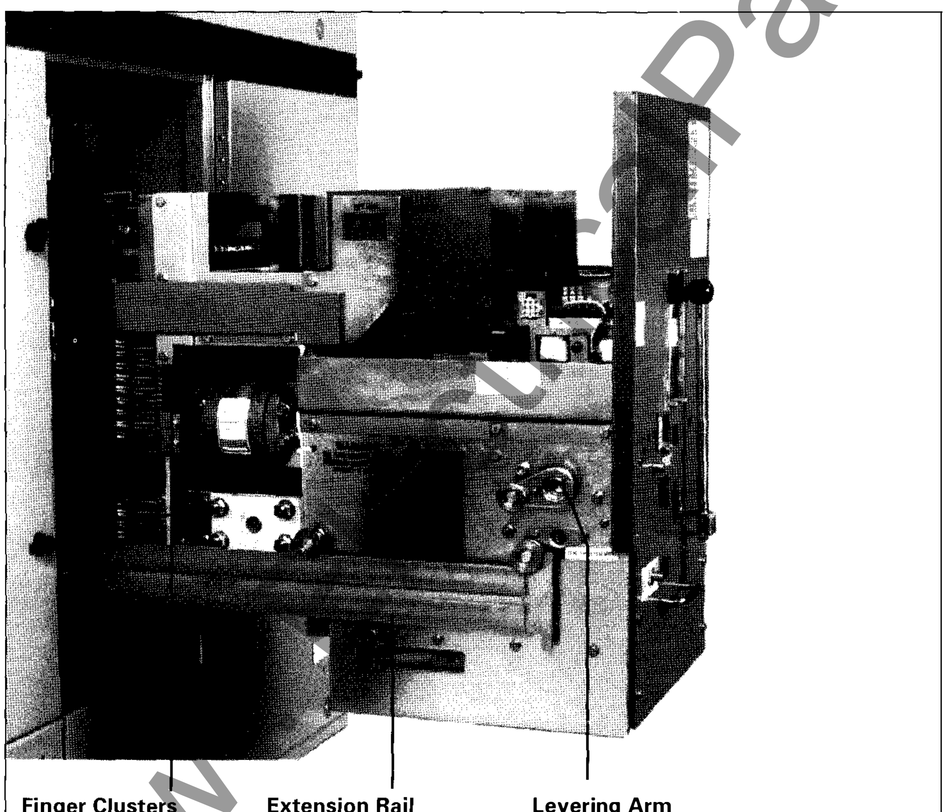
Two-Step Stored-Energy Closing

Type DSII Metal-Enclosed Low-Voltage Switchgear

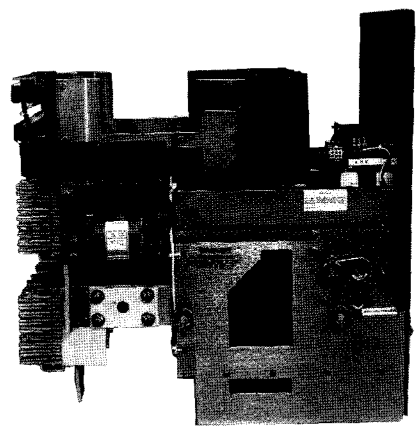
DSII Breaker Levering Operation



DSII Breaker Faceplate



DSII Breaker on Extension Rails



Type DSLII breakers are coordinated combinations of Type DSII breakers and series connected current limiting fuses. 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.

DSLII Breakers and Combinations

Type DSII Metal-Enclosed Low-Voltage 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 draw-out 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.

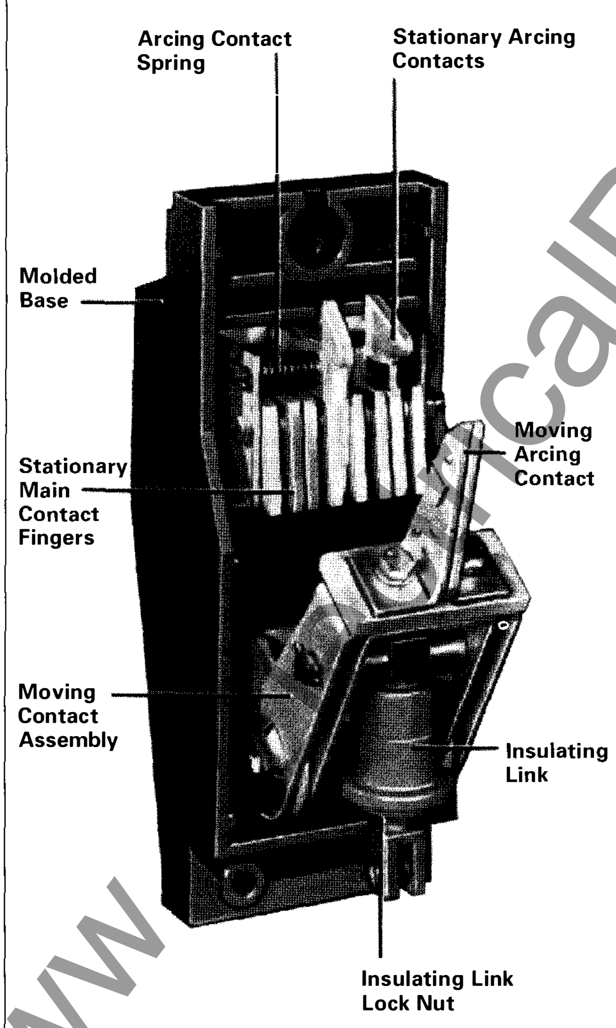
Mechanical interlocking is arranged so that levering cannot be accomplished unless the breaker is in the opened position.

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.

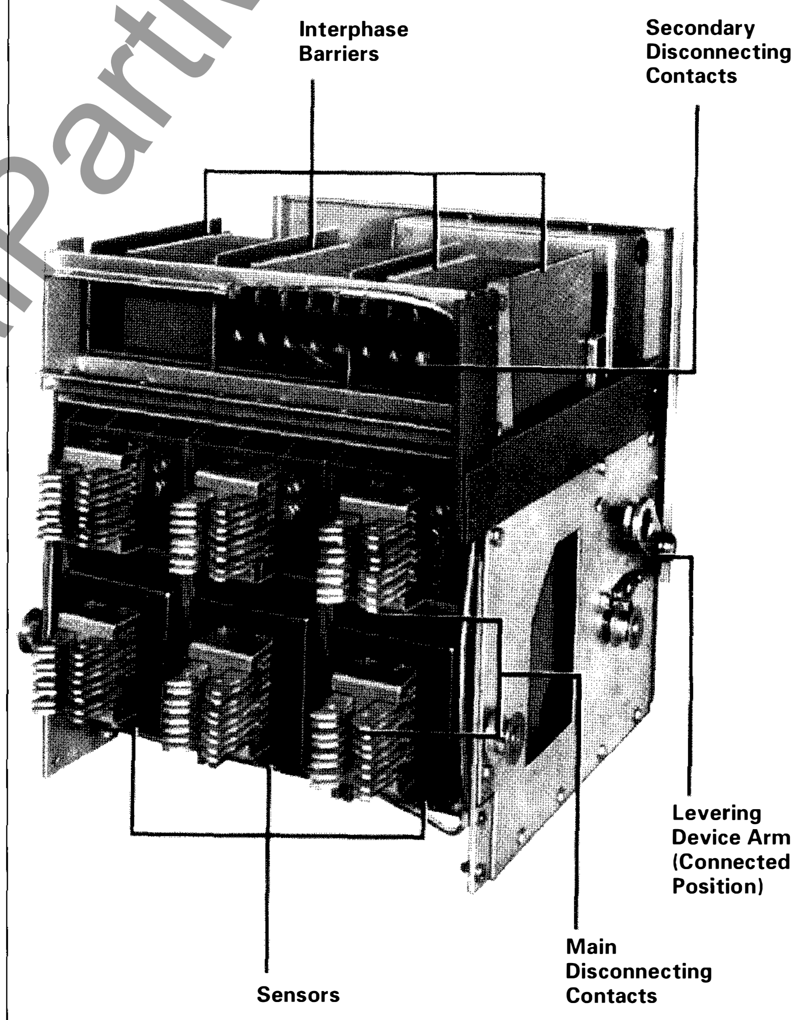
Release of the stored energy is accomplished by manually depressing a bar on the front of the breaker or electrically energizing a releasing solenoid.

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 critical.



DSII Breaker Pole Unit



DSII Breaker Rear View

EATON

Type DSII Metal-Enclosed Low-Voltage Switchgear

Table 2: Control Voltages and Currents

Control Voltage	48 Dc	125 Dc	250 Dc	120 Ac	240 Ac
Close current (SR), amp.	5.0	2.0	1.0	3.0	2.0
Shunt trip current, amp.	5.0	2.0	1.0	2.0	1.0
Spring charge motor amp.	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

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

Table 3: Interrupting Ratings of Type DSII Breakers

Breaker Type	Frame Size, Amp.	Interrupting Ratings, RMS Symmetrical Amperes					
		With Instantaneous Trip			Without Instantaneous Trip ① ②		
		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 Also short-time ratings.
② Short circuit ratings of non-automatic breakers except the DSII-840 and DSII-850 which are 65,000.

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 ½ second each, with a 15-second interval of zero current between the two periods.

Digitrip RMS Trip Unit

The Digitrip RMS trip units feature a dependent curve which is depicted in the nameplate by a blue shaded area of the trip curve. The new dependent curve affords better protection flexibility. Additionally, all of the trip units have, as standard, thermal memory, 50/60 hertz operation, thermal self-protection at 90°C and interchangeability with existing 500, 600 and 800 trip units.

Also, the 610 and 810 trip units have a larger display window and 2% metering accuracy. The 810 features IMPACC communication and additional energy monitoring capability.

Table 4: 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
DSLII-620	2000	2000
DSII-632, DSLII-632	3200	2400, 3200
DSII-840, DSLII-840	4000	4000
DSII-850	5000	5000

Table 5A: Available Digitrip RMS Rating Plugs Marked 50/60 Hertz①

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	5000

① The Rating Plug is for 50 and 60 Hertz applications. Rating Plugs are not interchangeable with 60 Hertz or 50 Hertz only Rating Plugs

The narrow-band characteristic curves graphically illustrate the close coordination obtainable in breaker systems with Digitrip RMS tripping devices. Repeatability is within 2%.

The maximum breaker current rating for any breaker frame size is determined by the rating of the sensor used.

The breaker current rating for any frame size can be changed by simply changing the sensors, which are easily removed from the breaker draw-out element. The wide range of long-delay pickup makes one set of sensors suitable for a number of current ratings. The Digitrip RMS itself need not be changed when the associated sensors are changed.

Digitrip RMS can be supplied in various combinations of four independent, continuously adjustable, overcurrent tripping functions:

Long delay (L) Instantaneous (I)
Short delay (S) Ground (G)

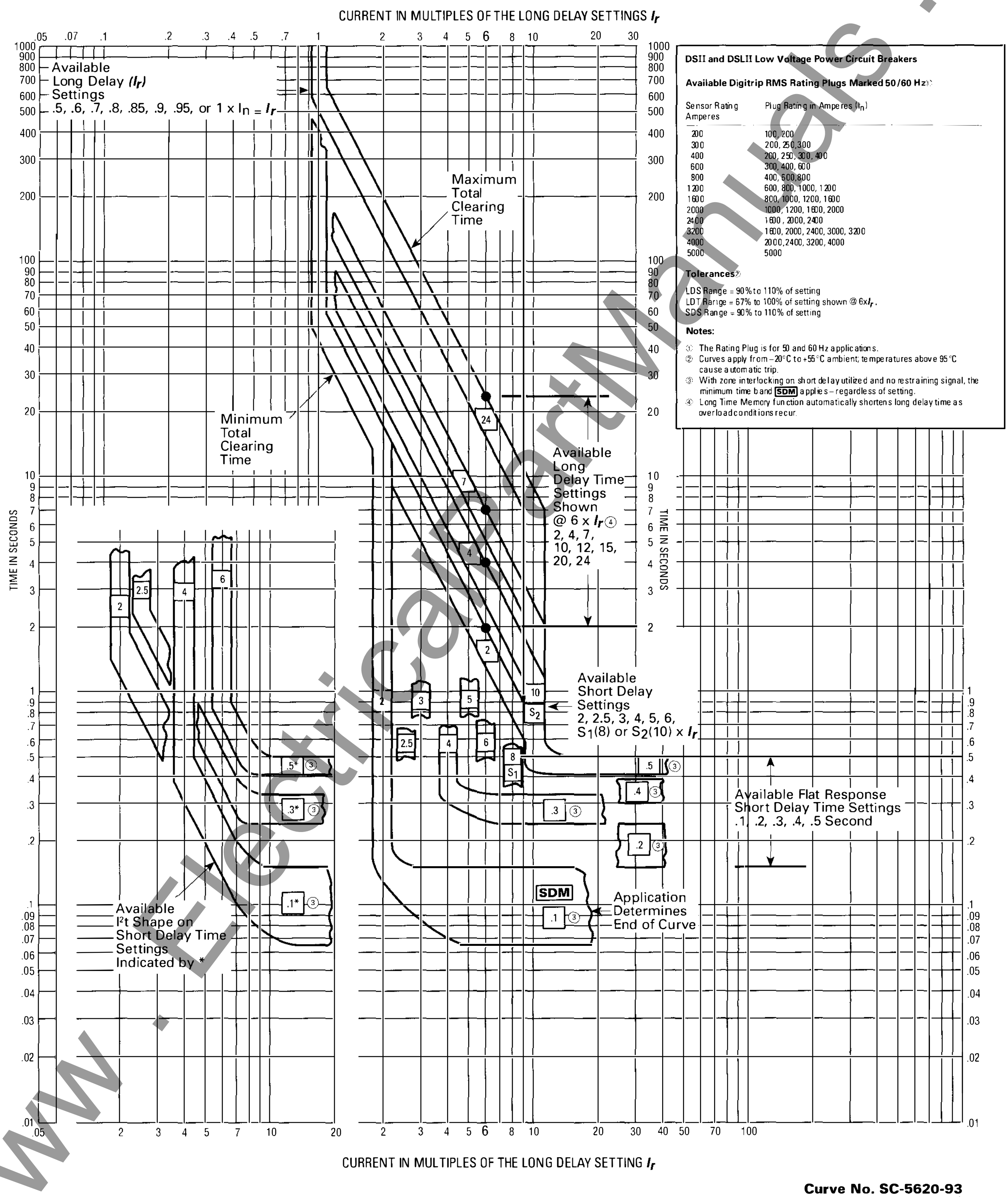
Table 5B: Digitrip RMS Adjustable Trip Settings

Time/Current Characteristic	Pick-Up Setting	Pick-Up 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 pick-up 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 Max.)	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 Valve
I_r = Long Delay Pickup Setting x I_n

Type DSII Metal-Enclosed Low-Voltage Switchgear

Types DSII and DSLII Circuit Breakers with DIGITRIP RMS 510/610/810 Trip Units
Typical Long Delay and Short Delay Time-Phase Current Characteristic Curve (LS)



DSII and DSLII Low Voltage Power Circuit Breakers

Available Digitrip RMS Rating Plugs Marked 50/60 Hz①

Sensor Rating 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	5000

Tolerances②

LDS Range = 90% to 110% of setting
LDT Range = 67% to 100% of setting shown @ 6xI_r.
SDS Range = 90% to 110% of setting

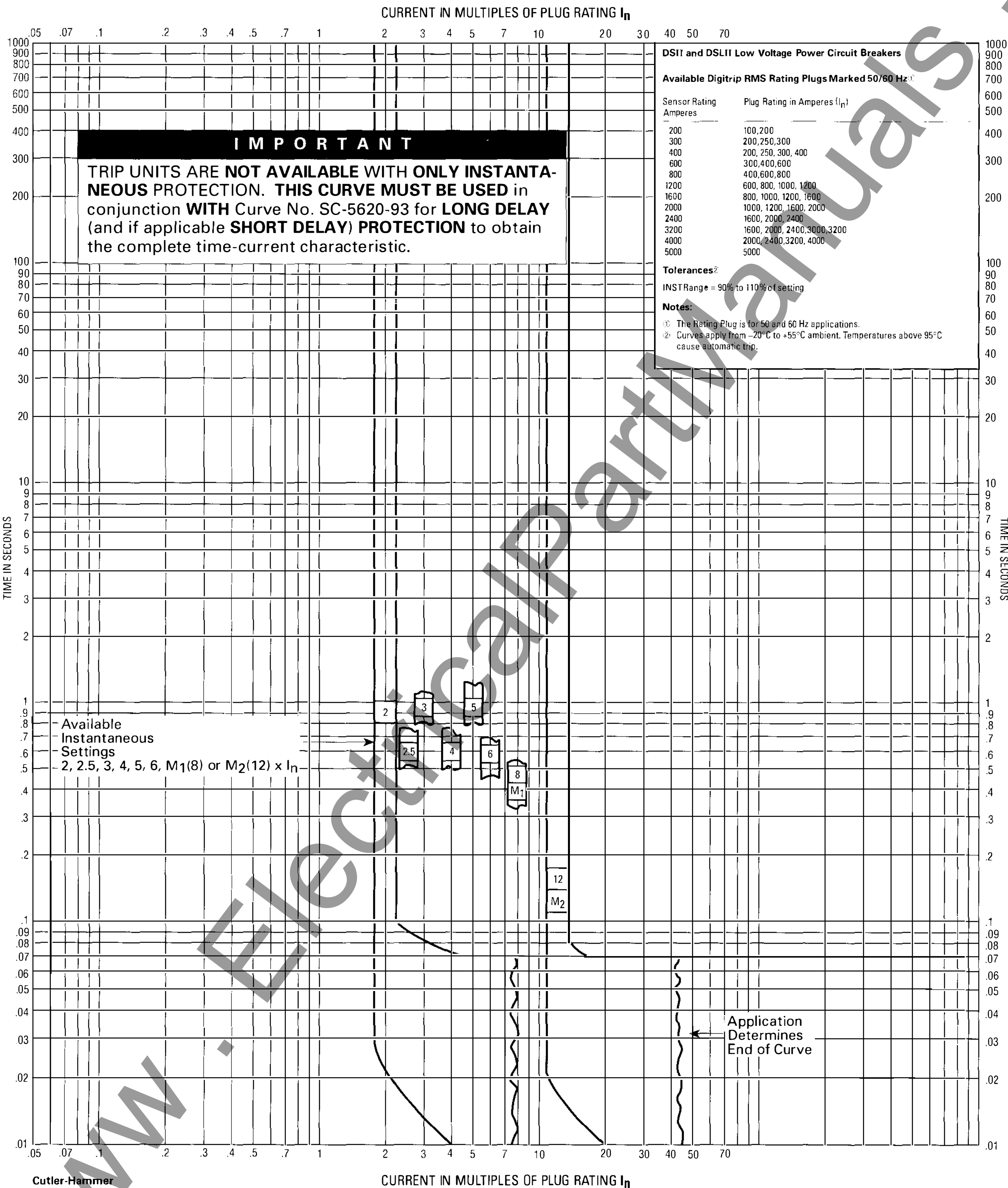
Notes:

① The Rating Plug is for 50 and 60 Hz applications.
② Curves apply from −20°C to +55°C ambient; temperatures above 95°C cause automatic trip.
③ With zone interlocking on short delay utilized and no restraining signal, the minimum time band **SDM** applies – regardless of setting.
④ Long Time Memory function automatically shortens long delay time as overload conditions recur.

Curve No. SC-5620-93
Printed in U.S.A. September 1993

Type DSII Metal-Enclosed Low-Voltage Switchgear

Types DSII and DSLII Circuit Breakers with DIGITRIP RMS 510/610/810 Trip Units
Typical Instantaneous Time-Phase Current Characteristic Curve (I)



IMPORTANT

TRIP UNITS ARE **NOT AVAILABLE** WITH **ONLY INSTANTANEOUS** PROTECTION. **THIS CURVE MUST BE USED** in conjunction **WITH** Curve No. SC-5620-93 for **LONG DELAY** (and if applicable **SHORT DELAY**) **PROTECTION** to obtain the complete time-current characteristic.

DSII and DSLII Low Voltage Power Circuit Breakers

Available Digitrip RMS Rating Plugs Marked 50/60 Hz ①

Sensor Rating 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	5000

Tolerances ②

INST Range = 90% to 110% of setting

Notes:

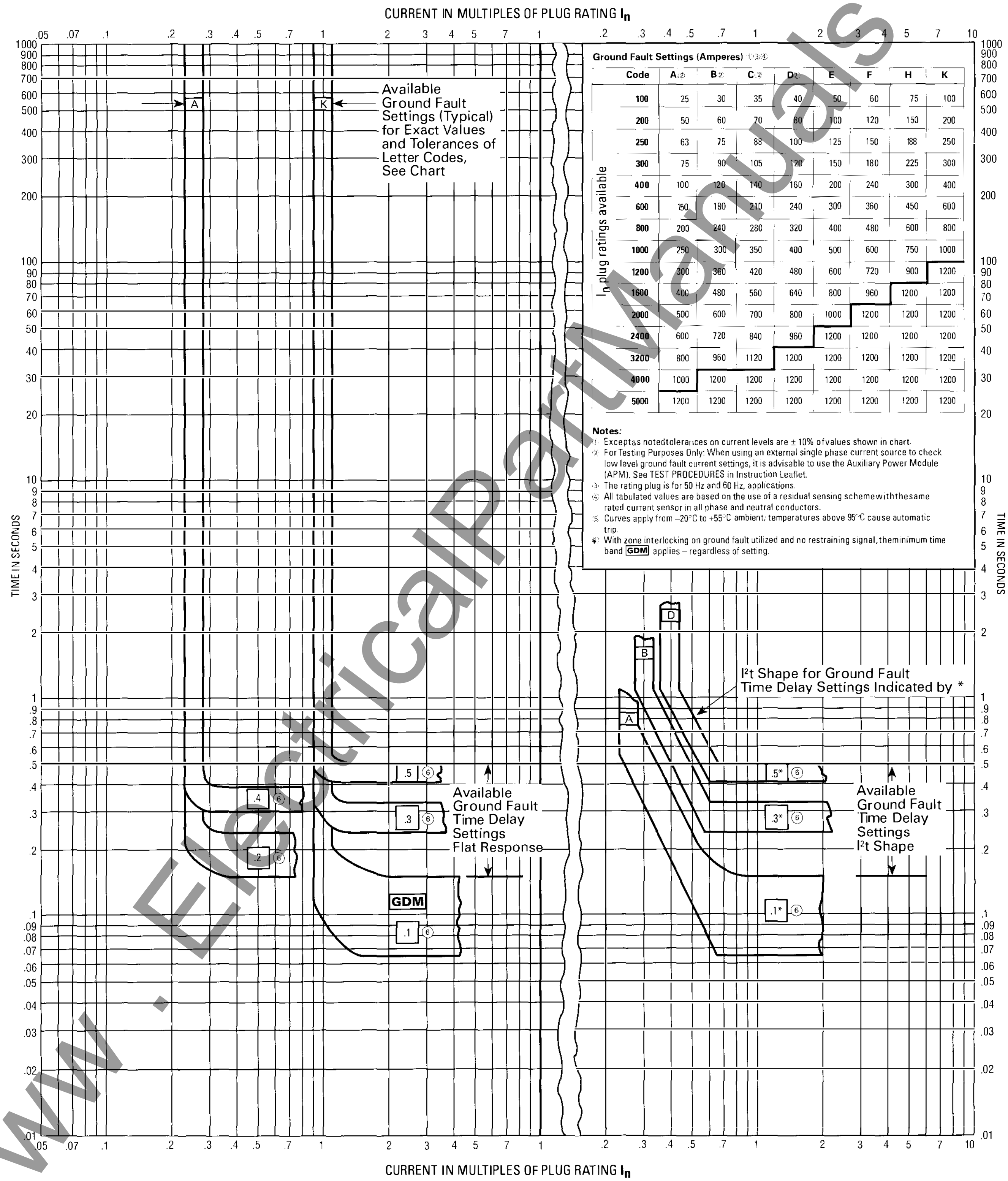
① The Rating Plug is for 50 and 60 Hz applications.
② Curves apply from –20°C to +55°C ambient. Temperatures above 95°C cause automatic trip.

Cutler-Hammer
Westinghouse &
Cutler-Hammer Products
Dwg. 8887C00

Curve No. SC-5619-93
Printed in U.S.A. September 1993

Type DSII Metal-Enclosed Low-Voltage Switchgear

Types DSII and DSLII Circuit Breakers with DIGITRIP RMS 510/610/810 Trip Units
Typical Ground Fault/Protection Time-Phase Current Characteristic Curve (G)



Ground Fault Settings (Amperes) ①③④

I_n plug ratings available / Code	A②	B②	C②	D②	E	F	H	K
100	25	30	35	40	50	60	75	100
200	50	60	70	80	100	120	150	200
250	63	75	88	100	125	150	188	250
300	75	90	105	120	150	180	225	300
400	100	120	140	160	200	240	300	400
600	150	180	210	240	300	360	450	600
800	200	240	280	320	400	480	600	800
1000	250	300	350	400	500	600	750	1000
1200	300	360	420	480	600	720	900	1200
1600	400	480	560	640	800	960	1200	1200
2000	500	600	700	800	1000	1200	1200	1200
2400	600	720	840	960	1200	1200	1200	1200
3200	800	960	1120	1200	1200	1200	1200	1200
4000	1000	1200	1200	1200	1200	1200	1200	1200
5000	1200	1200	1200	1200	1200	1200	1200	1200

Notes:
① Exceptas notedtolerances on current levels are ± 10% ofvalues shown in chart.
② For Testing Purposes Only: When using an external single phase current source to check low level ground fault current settings, it is advisable to use the Auxiliary Power Module (APM). See TEST PROCEDURES in Instruction Leaflet.
③ The rating plug is for 50 Hz and 60 Hz, applications.
④ All tabulated values are based on the use of a residual sensing schemewiththesame rated current sensor in all phase and neutral conductors.
⑤ Curves apply from –20°C to +55°C ambient; temperatures above 95°C cause automatic trip.
⑥ With zone interlocking on ground fault utilized and no restraining signal, theminimum time band **GDM** applies – regardless of setting.

Curve No. SC-5621-93
September 1993

Type DSII Metal-Enclosed Low-Voltage Switchgear

Advantages of DSII Unit Substations

- Complete coordination, both mechanical and electrical.
- Extreme flexibility with wide choice of components and ratings to meet exact application requirements.
- Optimum safety to operators.
- Modern design.
- Meets all applicable ANSI, IEEE, NEMA and UL Standards.

Transition Sections

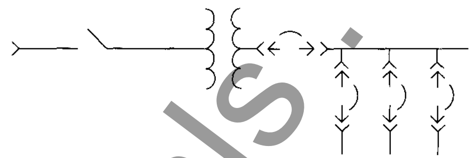
All indoor Unit Substations utilizing liquid filled transformers require a 21 inch wide transition section. The center-line location of the low-voltage throat is based upon the depth of the DSII assembly.

In many indoor applications, it is desirable to minimize floor space by eliminating the need for a transformer transition section. For these situations, DSII switchgear is designed to accommodate close coupling to dry type transformers if their low-voltage terminations conform to a specific vertically oriented arrangement. This configuration may be provided if: additional space is not required for auxiliary devices such as grounding resistors, instrumentation, etc.; zero sequence ground fault is not applied on main breakers; connection to assemblies with no main breaker do not utilize "A" or "B" position feeder breakers; adequate conduit space is available for any top exit cable connections in this section.

Types of Systems

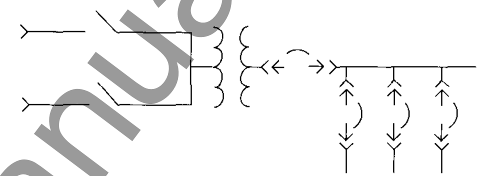
A. Simple Radial

- Simplest and least costly.
- Easy to coordinate.
- No idle parts.



B. Primary Selective Radial

Similar to simple radial, with added advantage of spare primary incoming cable circuit. By switching to spare circuit, duration of outage from cable failure is limited.



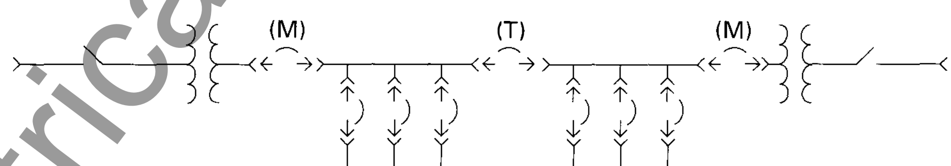
C. Secondary Selective

Normally operates as two electrically independent unit substations, with bus tie breaker (T) open, and with approximately half of total load on each bus. In case of failure of either primary incoming circuit, only one bus is affected, and service can be promptly restored by opening main breaker (M) on dead bus and closing tie breaker (T). This operation can be made automatic, with duration of outage on either bus limited to a few seconds.

Since the transformers are not continuously paralleled, secondary fault currents and breaker application are similar to those on radial unit substations.

If required, and equipped with the appropriate relaying, either transformer can be removed from service and isolated with no interruption of service on either bus, by first closing the tie breaker and then opening the associated main breaker.

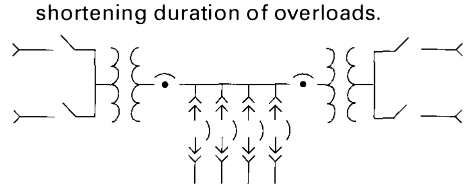
Service continuity and substation capacity can be further improved by substituting selector type primary switches, as in B.



D. Spot Network

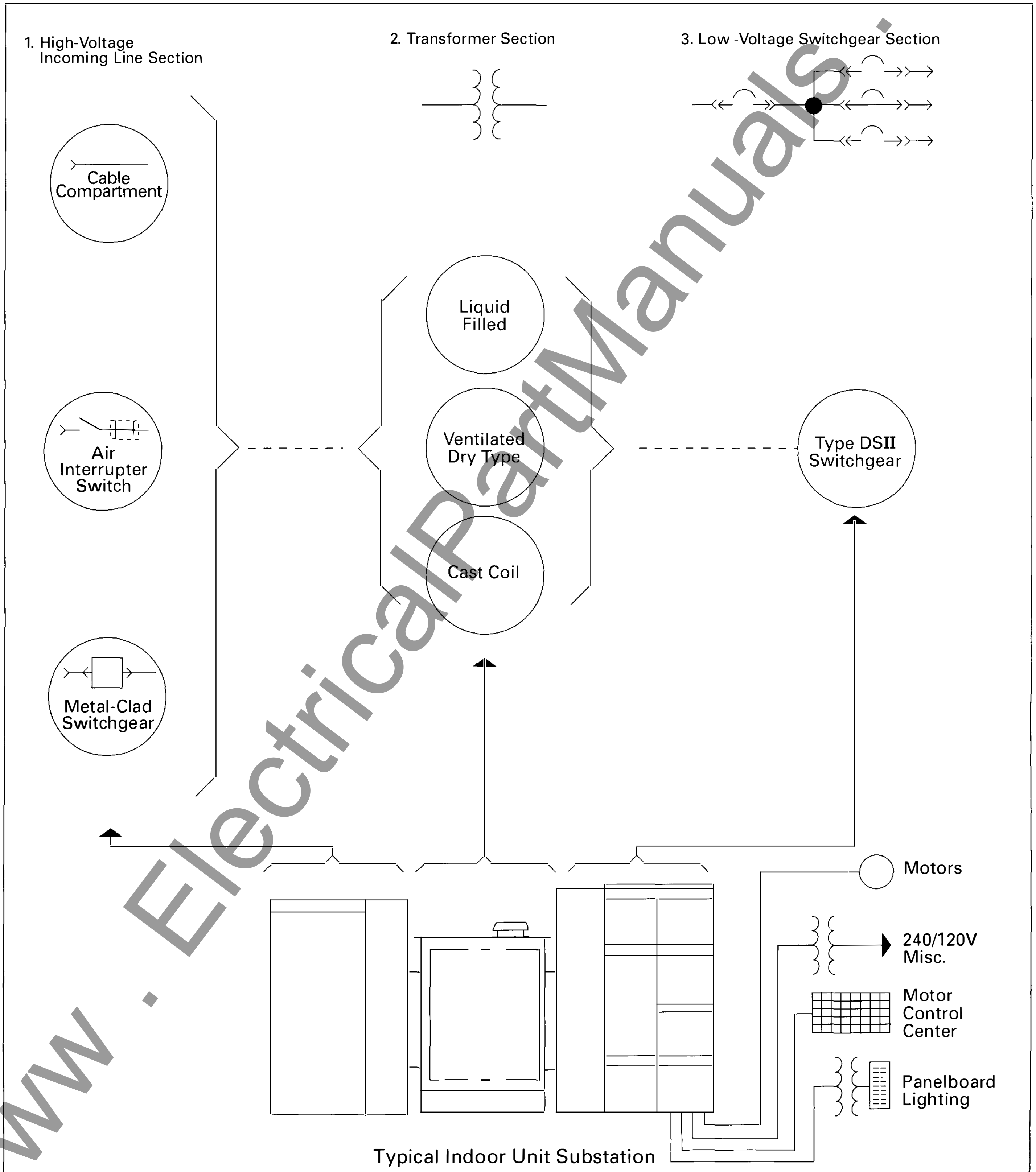
The transformers are paralleled through network protectors. In case of primary voltage failure, the associated protector automatically opens. The other protector remains closed, and there is no "dead time" on the bus, even momentarily. When primary voltage is restored, the protector automatically checks for synchronism and recloses.

- Secondary voltage regulation is improved by paralleled transformers.
- Secondary fault capability is increased by paralleled transformers, and the feeder breakers and bus bracing must be selected accordingly.
- Primary switches are usually selector or duplex type, so that transformers can be transferred to alternate live sources, thus shortening duration of overloads.



Type DSII Metal-Enclosed Low-Voltage Switchgear

Components of Unit Substations



Type DSII Metal-Enclosed Low-Voltage Switchgear

System Application

Most DSII Switchgear is fed from power transformers. To facilitate minimum breaker sizing,Tables 8A through 8D list the calculated secondary short circuit currents and applicable main secondary and feeder breakers for various transformer sizes and voltages.

The short circuit currents are calculated by dividing the transformer basic (100%) rated amperes by the sum of the transformer and primary system impedances, expressed in "per unit." The transformer impedance percentages are standard for most secondary unit substation transformers. The primary impedance is obtained by dividing the transformer base (100%) kVA by the primary short-circuit kVA. The motor contributions to the short circuit currents are estimated as approximately 4 times the motor load amperes, which in turn are based upon 50% of the total load for 208 volts and 100% for all other voltages.

High transformer impedances and/or lower percentages of motor loads will reduce the short circuit currents correspondingly. Supplementary transformer cooling and temperature ratings will not increase the short circuit currents, provided the motor loads are not increased.

The tables do not apply for 3 phase banks of single phase distribution transformers, which usually have impedances of 2% to 3% or even lower. The short circuit currents must be recalculated for all such applications, and the breakers selected accordingly.

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, as selected in Tables 8A through 8D, 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, main breaker trip units should not be equipped with instantaneous tripping, as they typically can not be coordinated with down-stream devices.

Maximum capabilities of transformers of various types, in terms of kVA and secondary current, are given in Tables 8A through 8D. 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 not be equipped with instantaneous tripping.

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 devices are 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, antimotoring reverse power relays (device 32) are recommended for protection of the prime movers, particularly piston type engines. For larger generators requiring Type DSII-632 or DSII-840 breakers, voltage-restraint type overcurrent relays (device 51V) are recommended.

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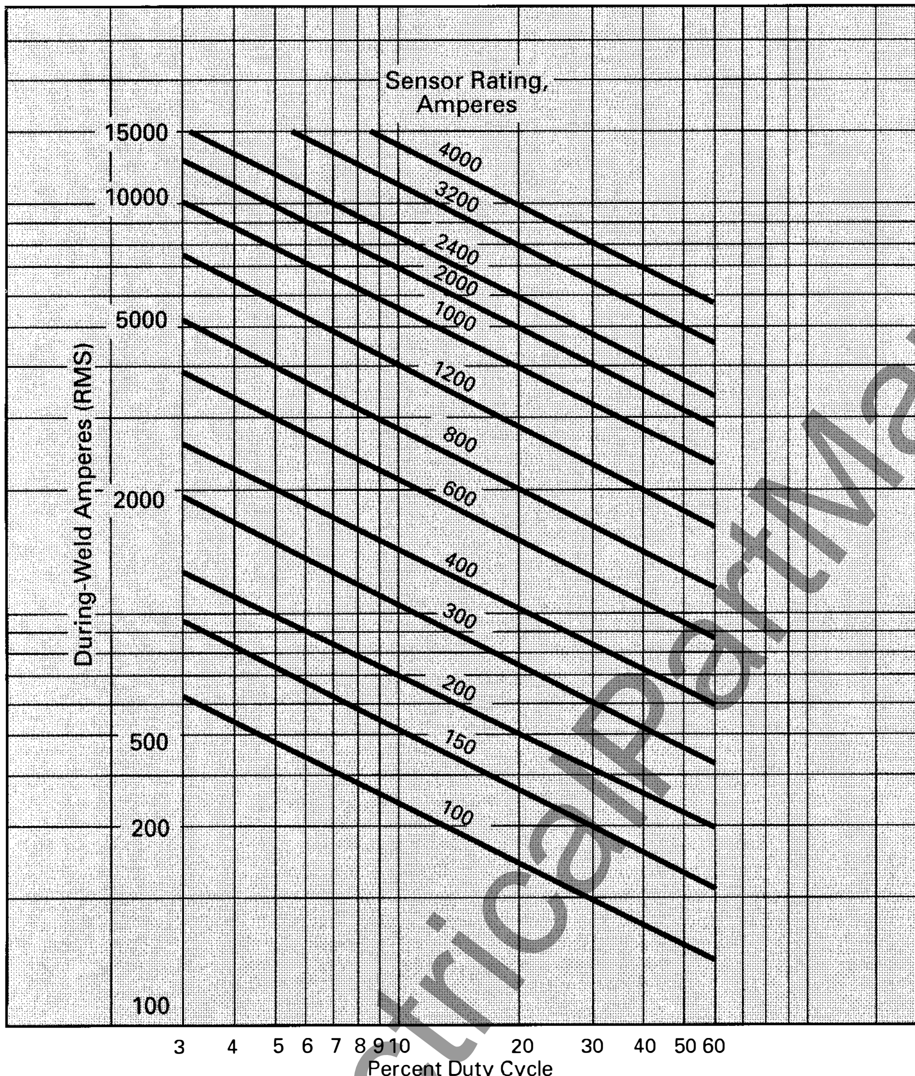
Type DS Breaker Sensor Selection Guide for Resistance Welding Applications



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 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 2 times the average weld Amperes (weld Amperes times percent duty cycle) or higher.

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 8A through 8D 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.

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.

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 devices 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.

Ground Fault Protection

Distribution Systems
The power distribution in three phase low-voltage systems can be three or four wire distribution. The three wire distribution can be served from either delta or wye sources, but the four wire distribution is obtained from wye source only. Fig. No. 1 shows three wire distribution with delta source and Fig. No. 2 shows three wire distribution with wye source. It is significant on Fig. No. 2, that the wye connection of a transformer secondary does not necessarily mean four wire distribution in switchgear. This is worthwhile to note because four wire distribution is quite frequently assumed when

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the transformer secondary is wye connected. The low-voltage system is three phase four wire distribution only if a fourth wire is carried through the switchgear, the transformer neutral is solidly grounded, and single phase loads are connected to feeder breakers. This fourth wire is the neutral bus. The neutral bus is connected to the neutral of the wye connected transformer secondary as shown on Fig. No. 3. The standard neutral bus capacity is one half of the phase bus current carrying capacity, but full capacity and oversized neutral buses through 8700 Amperes are also available on request.

Three or four wire sources can be grounded or ungrounded in service. Generally where the source is delta connected it is ungrounded, but in some very rare cases it is grounded at one corner of the delta, or at some other point. When the source is wye connected it can be grounded or ungrounded, and when grounded, the grounding is at the neutral. When low-voltage systems are grounded they are generally solidly grounded, however, occasionally the grounding is through a resistor. Three and four wire solidly grounded systems are shown on Fig. No. 4 and 5. Most installations are solidly grounded. Solidly grounded systems have the advantage of being the easiest to maintain, yet have the potential for producing extremely high fault levels.

When feeding critical facilities, or continuous industrial processes, it is sometimes preferable to allow the system to continue operating when a phase conductor goes to ground. There are two methods of accommodating this application; the source transformer may either be left ungrounded or high resistance grounded. If the correct system conditions of inductance and capacitance manifests themselves, arcing grounds on ungrounded systems can produce escalating line-to-ground voltages, which in turn can lead to insulation breakdown in other devices. This condition is known as ferro-resonance. The high resistance grounded system does not suffer from this potential phenomenon. Regardless of which system is selected, both require the application of an appropriate UL recognized ground detection method. Upon grounding of one of the phase conductors, the detection device alerts operators of the condition. Personnel trained to locate these grounds can do so and remove the ground when the process permits, and before a second ground occurs on another phase.

Since ungrounded and resistance grounded systems produce minimal ground current, no damage occurs to the grounded equipment. These ground currents are also too low for detection by integral trip unit ground elements, therefore serve no ground fault tripping function if applied on these systems. Ground fault elements on these types of systems can, however, provide supplemental protection. If a second ground occurs on another phase, and exceeds the ground element pickup setting, the ground element can serve as a more sensitive short delay trip.

Ungrounded or resistance grounded systems can not be applied as 4-wire networks. Even if supplied from a 4-wire source, no line-to-neutral loads may be served. These applications are limited to 3-wire distribution systems only.

Need For Ground Fault Protection
If the magnitude of all ground currents would be large enough to operate the short delay or instantaneous elements of the phase overcurrent trip devices, there would be no need for separate ground fault protection on solidly grounded systems. Unfortunately, because low magnitude ground currents are quite common, this is not the case. Low level ground currents can exist if the ground is in the winding of a motor or a transformer, or if it is a high impedance ground. Low level ground currents may also be due to an arcing type ground. The arcing type grounds are the source of the most severe damages to electrical equipment. The lower limit of the arcing ground currents is unpredictable and the magnitude may be considerably below the setting of the breaker phase overcurrent trip devices. It is for this reason that the National Electric Code, and UL, require ground fault protection for all service disconnect breakers rated 1000 Amperes and greater, applied on systems with greater than 150 Volts line-to-ground.

Since the breaker phase overcurrent trip devices cannot provide sensitive enough protection against low magnitude ground faults, there is a need for an additional protective device. This additional device is not to operate on normal overloads and it is to be sensitive and fast enough to protect against low magnitude grounds. It is also important that this additional ground protecting device be simple and reliable. If the DSII breaker solid-state tripping system including an optiona! "ground element" is selected, good ground fault protection will be assured.

The Ground Element
The ground element of the solid-state trip unit is in addition to the usual phase protection. The ground element has adjustable pickup with calibrated marks as shown in Tables 6A and 6B and adjustable time delay. The input current to the trip unit can be provided by:

(a) Residual connection of phase sensors, with the residual circuit connected to the ground element terminals. This is the Type DSII Low-Voltage Switchgear standard ground protection system for 3-wire systems. On 4-wire systems, standard ground fault protection includes a fourth "neutral sensor." It is connected to vectorally subtract from the residual current of the phase sensors. Its only function is to sense neutral currents. It does not sense ground current. These systems produce pickup values as shown in Tables 6A and 6B.

(b) External ground sensing current transformers connected to the ground element terminals. This means that this external ground sensor will trip the breaker whenever its secondary output current exceeds the values shown in Tables 6A and 6B. Tripping is independent of phase currents. The lower the CT ratio, the more sensitive the ground fault protection.

Ground Fault Protection Application and Coordination
In all power systems, continuity of service is very important. For reliable service continuity, selective tripping is applied between main, tie, and feeder breakers, and downstream protecting devices, for phase-to-phase faults. Similar selective tripping is desirable when breakers trip on grounds. The application of ground protection only to main breakers may assure good ground protection. However, it will not provide good service continuity because the main breaker will trip on grounds which should have been cleared by feeder breakers. For proper protection and for good service continuity, main, tie and feeder breakers all should be equipped with ground fault protection.

In view of the above, it is evident that properly applied ground protection requires ground elements as far down the system to the loads as practical. For best results, downstream molded case breakers should have individual ground protection. This would result in excellent ground protection because ground elements of DSII and downstream breakers having similar tripping characteristics can be coordinated.

Depending on the sensitivity of the ground fault protection method applied, coordinaion between DSII Breaker ground elements and downstream branch circuit fuses is sometimes impractical. This is due to the basic fact that the blowing of one phase fuse will not clear a ground on a three phase system. The other two phase fuses will let the load "single-phase," and also continue to feed the ground through the load as shown in Figure 6.

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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 potenital 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 pick-up 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 pick-up 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.

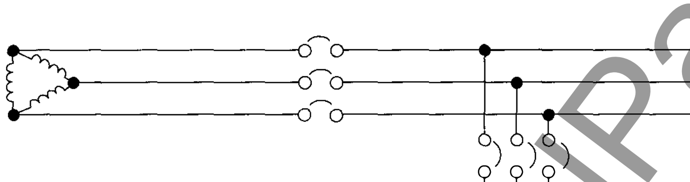

Figure 1. Three-Wire Distribution, Delta Source (Ungrounded)

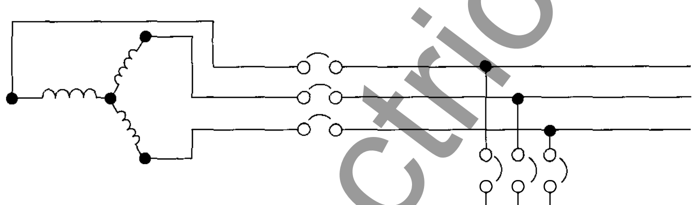

Figure 2. Three-Wire Distribution, Wye Source (Ungrounded)

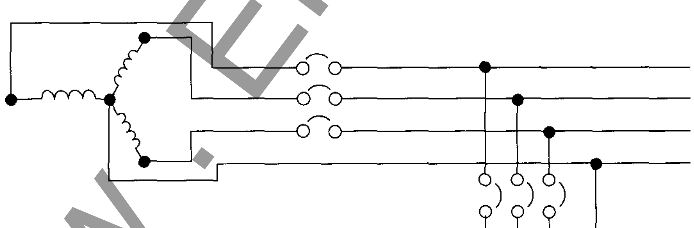

Figure 3. Four-Wire Distribution

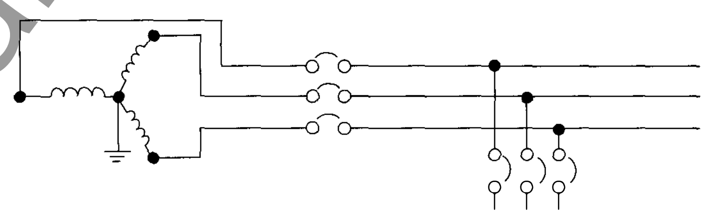

Figure 4. Three-Wire Distribution, Solidly Grounded System

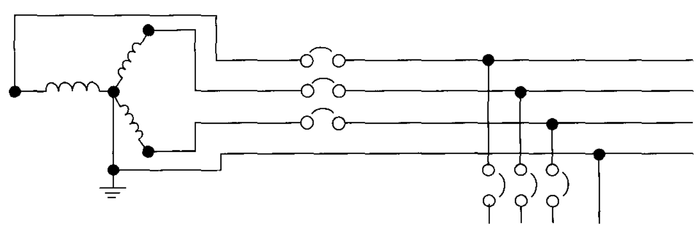

Figure 5. Four-Wire Distribution, Solidly Grounded System

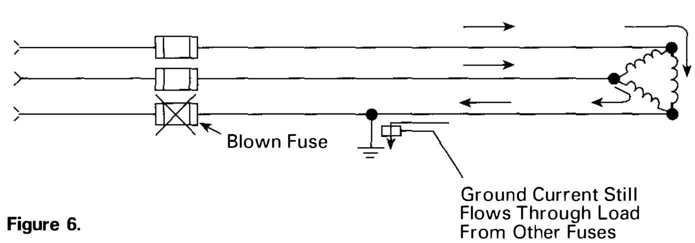

Figure 6.

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Application-Type DSII Air Circuit Breakers, *Continued*

Table 6A: Digitrip Ground Fault Current Pickup Settings

INSTALLED RATING PLUG (AMPERES) I_n	PICKUP SETTINGS – GROUND FAULT CURRENTS (AMPERES)①							
	A②	B②	C②	D②	E②	F	H	K
100	25	30	35	40	50	60	75	100
200	50	60	70	80	100	120	150	200
250	63	75	88	100	125	150	188	250
300	75	90	105	120	150	180	225	300
400	100	120	140	160	200	240	300	400
600	150	180	210	240	300	360	450	600
800	200	240	280	320	400	480	600	800
1000	250	300	350	400	500	600	750	1000
1200	300	360	420	480	600	720	900	1200
1600	400	480	560	640	800	960	1200	1200
2000	500	600	700	800	1000	1200	1200	1200
2400	600	720	840	960	1200	1200	1200	1200
3000	750	900	1050	1200	1200	1200	1200	1200
3200	800	960	1120	1200	1200	1200	1200	1200
4000	1000	1200	1200	1200	1200	1200	1200	1200
5000	1200	1200	1200	1200	1200	1200	1200	1200

Table 6B: Digitrip Ground Fault Pickup Values In Secondary Amperes

Installed Rating Plug	Sensor Rating	Pickup (Dial) Setting Values In Secondary Amperes①							
		A② 25%	B② 30%	C② 35%	D② 40%	E② 50%	F 60%	H 75%	K 100%
100	200	.63	.75	.88	1.0	1.25	1.5	1.88	2.5
200		1.25	1.5	1.75	2.0	2.5	3.0	3.75	5.0
200	300	.83	1.0	1.17	1.33	1.67	2.0	2.5	3.33
250		1.04	1.25	1.46	1.67	2.08	2.5	3.13	4.17
300		1.25	1.5	1.75	2.0	2.5	3.0	3.75	5.0
200	400	.63	.75	.88	1.0	1.25	1.5	1.88	2.5
250		.78	.94	1.09	1.25	1.56	1.88	2.34	3.13
300		.94	1.13	1.31	1.5	1.86	2.25	2.81	3.75
400		1.25	1.5	1.75	2.0	2.5	3.0	3.75	5.0
300	600	.63	.75	.88	1.0	1.25	1.5	1.88	2.5
400		.83	1.0	1.17	1.33	1.67	2.0	2.5	3.34
600		1.25	1.5	1.75	2.0	2.5	3.0	3.75	5.0
400	800	.63	.75	.88	1.0	1.25	1.5	1.88	2.5
600		.94	1.13	1.31	1.5	1.88	2.25	2.81	3.75
800		1.25	1.5	1.75	2.0	2.5	3.0	3.75	5.0
600	1200	.63	.75	.88	1.0	1.25	1.5	1.88	2.5
800		.83	1.0	1.17	1.33	1.67	2.0	2.5	3.33
1000		1.04	1.25	1.46	1.67	2.08	2.5	3.12	4.17
1200		1.25	1.5	1.75	2.0	2.5	3.0	3.75	5.0
800	1600	.63	.75	.88	1.0	1.25	1.5	1.88	2.5
1000		.78	.94	1.09	1.25	1.56	1.88	2.34	3.13
1200		.94	1.13	1.31	1.5	1.88	2.25	2.81	3.75
1600		1.25	1.5	1.75	2.0	2.5	3.0	3.75	3.75
1000	2000	.63	.75	.88	1.0	1.25	1.5	1.88	2.5
1200		.75	.90	1.05	1.2	1.5	1.8	2.25	3.0
1600		1.0	1.2	1.4	1.6	2.0	2.4	3.0	3.0
2000		1.25	1.5	1.75	2.0	2.5	3.0	3.0	3.0
1600	2400	.83	1.0	1.17	1.33	1.67	2.0	2.5	2.5
2000		1.04	1.25	1.46	1.67	2.08	2.5	2.5	2.5
2400		1.25	1.5	1.75	2.0	2.5	2.5	2.5	2.5
1600	3200	.63	.75	.88	1.0	1.25	1.5	1.88	1.88
2000		.78	.94	1.09	1.25	1.56	1.88	1.88	1.88
2400		.94	1.13	1.31	1.5	1.88	1.88	1.88	1.88
3000		1.17	1.41	1.64	1.76	1.88	1.88	1.88	1.88
3200		1.25	1.5	1.75	1.88	1.88	1.88	1.88	1.88
2000	4000	.63	.75	.88	1.0	1.25	1.5	1.5	1.5
2400		.75	.9	1.05	1.2	1.5	1.5	1.5	1.5
3200		1.0	1.2	1.4	1.5	1.5	1.5	1.5	1.5
4000		1.25	1.5	1.5	1.5	1.5	1.5	1.5	1.5
5000	5000	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2

① Tolerance on pickup levels are ±10% of values shown in chart.

② For Testing Purposes Only: When using an external single-phase current source to test low level ground fault current settings, it is advisable to use the Auxiliary Power Module (APM). Especially when the single-phase current is low, without the APM it may appear as if the trip unit does not respond until the current is well above the set value, leading the tester to believe there is an error in the trip unit when there is none. The reason this occurs is that the single-phase test current is not a good simulation of the normal three-phase circuit. If three-phase had been flowing, the trip unit would have performed correctly. Use the APM for correct trip unit performance when single-phase tests are made.

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The Following Provides Guideline for Ground Fault Protection.

			Equipment Available for Protection			
System	Advantages	Disadvantages	Main Breaker	Tie Breaker	Fdr. Breaker	Notes
Un-grounded (3 Wire)	Minimum disturbance to service continuity. Currents for the majority of grounds will be limited to capacitance charging current of the system. Can operate with the first ground until it is removed during a regular shutdown. Low cost.	When ground detector shows that a ground exists corrective action must be taken at the earliest possible shutdown. However, experience indicates that this attention is not always possible. Therefore, these systems tend to operate with one phase grounded through the first uncleared ground. A high impedance ground on another part of the system would result in low values of current, which would not operate a breaker phase trip, and could produce fire damage. High voltages from arcing grounds are possible.	Lamp type ground detector or ground detecting voltmeters with or without vts. If vts are used, a ground alarm relay can be added for remote or local alarming.			With proper maintenance this system would result in the minimum disturbance to service continuity.
	Supplemental protection for an ungrounded system utilizing trip unit ground element.		3W residual protection, minimum pickup. .50 sec. time delay. See SK No. 1, No. 4, and No. 6.	3W residual protection, minimum pickup. .35 sec. time delay. See sketch No. 4 and No. 6.	3W protection, minimum pickup. .22 sec. time delay. See SK No. 1, No. 4, and No. 6.	Ground fault protection on this system could trip the breaker when the second ground occurs and current is lower than the short delay pick-up, but exceeds minimum ground pick-up setting.
Solid Grounded	Psychologically safer. Practically results in good continuity of service. Isolation of faults automatic through ground protection system; no overvoltages due to ferroresonance or switching.	Probability of very high ground current and extensive damage; however, normally these high currents are not obtained. Grounds are automatically isolated and continuity of service is interrupted.	Standard residual ground protection for single source systems, and source ground, per SK 5, for multiple ground sources. Minimum pickup. .50 sec. time delay.	Ground 3W or 4W (as required) fault protection. Minimum pickup. .35 sec. time delay. See SK No. 4 or 5.	Ground 3W or 4W (as required) fault protection. Minimum pickup. .22 sec. time delay or zero sequence current transformer feeding Into trip unit. See SK No. 1, No., 2 and No. 6.	This is the most common system in use today. As long as it is not necessary to coordinate with phase devices down the line, it will give very good main bus and feeder protection.
High Resistance Grounded (3 Wire)	Ground fault current is limited. Ungrounding can result in high voltages during arcing grounds, and this is corrected by high resistance grounding. Can operate with the first ground until it is removed during a regular shutdown.	Very sensitive detection is required to detect the limited fault current. When the ground detector shows that a ground exists, corrective action must be taken at the earliest possible shutdown. However, experience indicates that this attention is not always possible, therefore, these systems tend to operate with one phase grounded through the first uncleared ground. A high impedance ground on another part of the system would result in low values of current, which would not operate a breaker phase trip, and could produce fire damage. Higher cost than ungrounded.	Same as for ungrounded except ground voltage alarm relay is connected across grounding resistor, or current relay between resistor and ground.	Same as for ungrounded.	Same as for ungrounded.	Same as for ungrounded. This system is most effective when supplied with a pulsing option.
	Supplemental protection for an ungrounded system utilizing trip unit ground element.		3W residual protection, minimum pickup. .50 sec. time delay. See SK No. 1, No. 4, and No. 6.	3W residual protection, minimum pickup. .35 sec. time delay. See sketch No. 4 and No. 6.	3W protection, minimum pickup. .22 sec. time delay. See SK No. 1, No. 4, and No. 6.	Ground fault protection on this system could trip the breaker when the second ground occurs and current is lower than the short delay pick-up, but exceeds minimum ground pickup setting.

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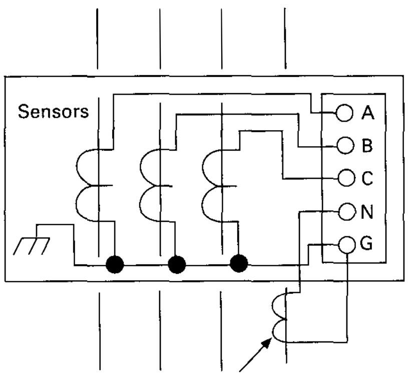
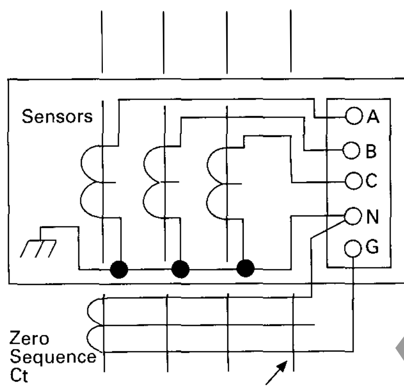
Sketch 1.②

Residual Main and Feeder Breaker



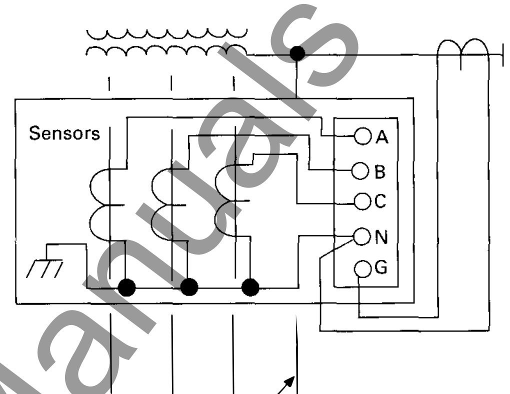
Sketch 2.

Zero Sequence Feeder Breaker



Sketch 3.

Source Neutral Main Breaker

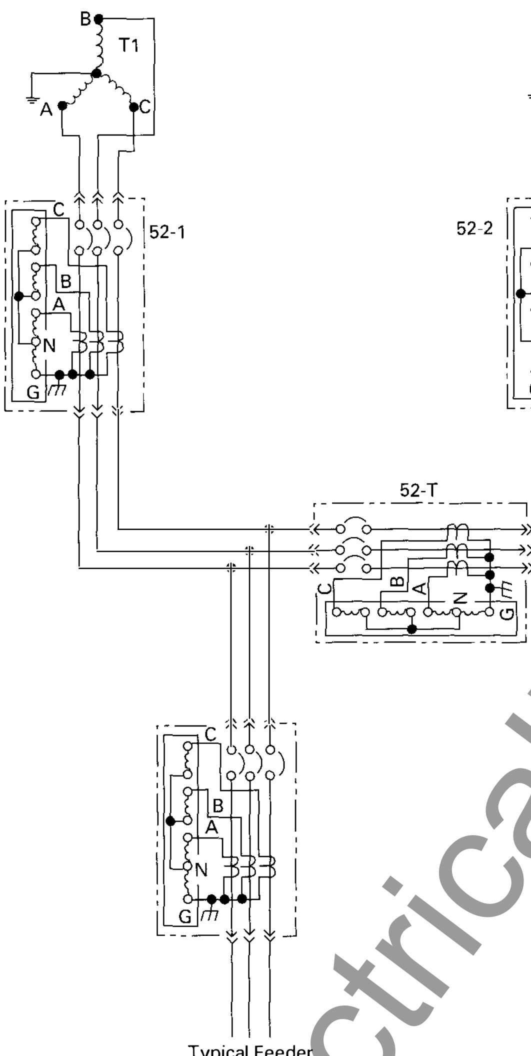


② Apply in 4-Wire Systems for Main Breaker only when no other grounded sources are connected to the same system.

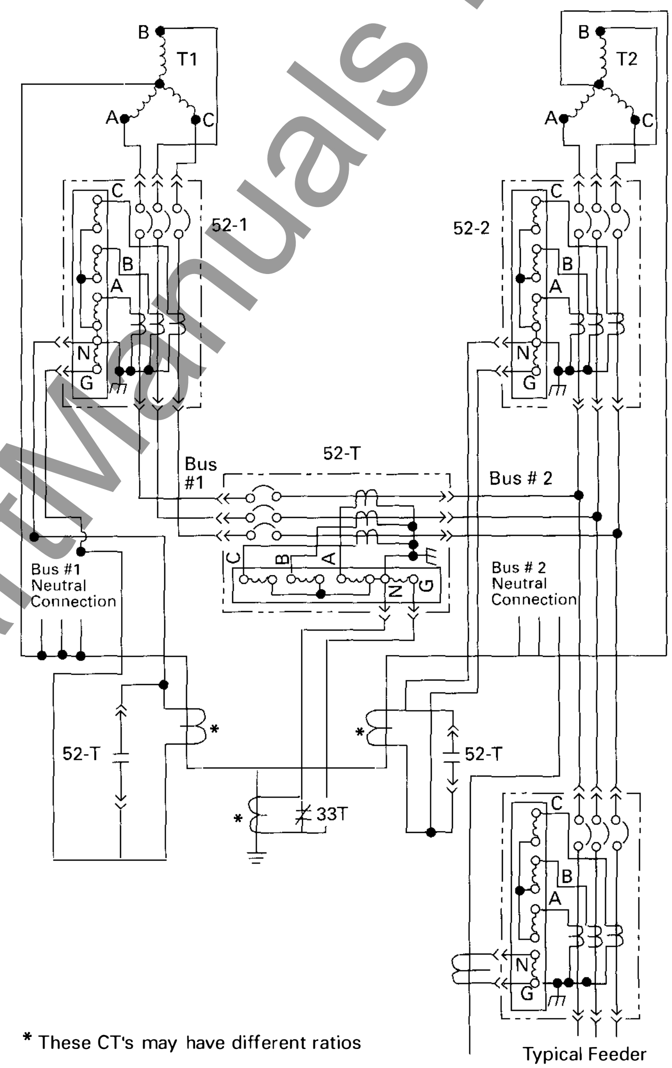
Note: For double-ended secondary unit substations, ground fault protection should be as indicated on sketches No. 4 and No. 5; however for this type of application, Cutler-Hammer should be consulted for the actual bill of materials to be used. The application becomes rather complex if single phase to neutral loads are being served.

Type DSII Metal-Enclosed Low-Voltage Switchgear

Sketch 4. Three-Wire Double-Ended Unit Substation

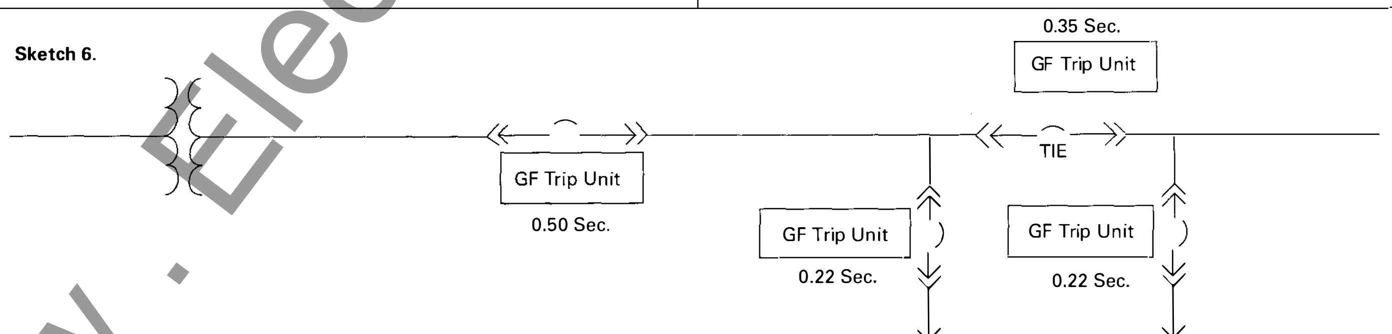


Sketch 5. Four-Wire Double-Ended Unit Substation

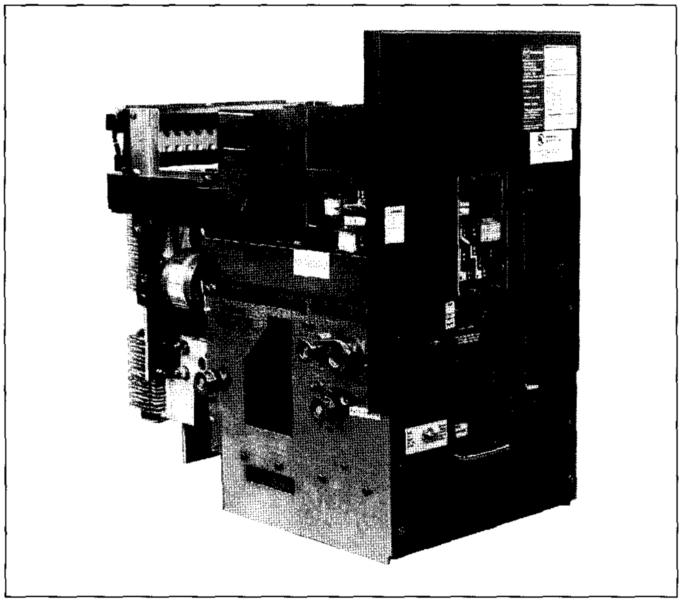


* These CT's may have different ratios

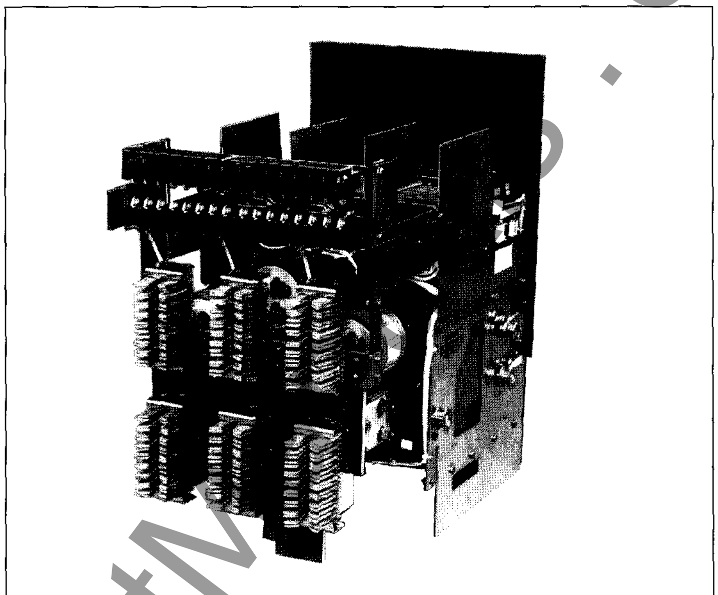
Sketch 6.



Type DSII Metal-Enclosed Low-Voltage Switchgear



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 draw-out breaker elements in series with the upper terminals.

Current limiters used in Types DSLII-632 and DSLII-840 combinations are mounted on separate draw-out 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 7: 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
Max. Interrupting Rating, RMS Symm. Amp., System Voltage 600 or Below	200,000	200,000	200,000	200,000	200,000

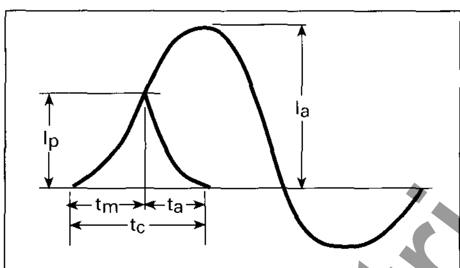
Notes: DSLII-308, DSLII-516, and DSLII-620 include limiters integral with draw-out breaker elements. DSLII-632 includes DSII-632 breaker and DSII-FT32 draw-out fuse truck, in separate interlocked compartmnents. DSLII-840 includes DSII-840 breaker and DSII-FT40 draw-out fuse truck, in separate interlocked compartments.

Type DSII Metal-Enclosed Low-Voltage Switchgear

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.

Breaker Type	Sensor Rating Amperes	Limiter Rating, Amperes		
		Minimum ①	Recom-mended ②	Maximum ③
DSLII-308	100	150	1200	2000
DSLII-308	150	200	1200	2000
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.
● Lowest rating which can be coordinated with breaker to minimize nuisance blowing.
③ Highest available ratings, for protection of breaker only.

DSLII-632 and DSLII-840 Available Limiters

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

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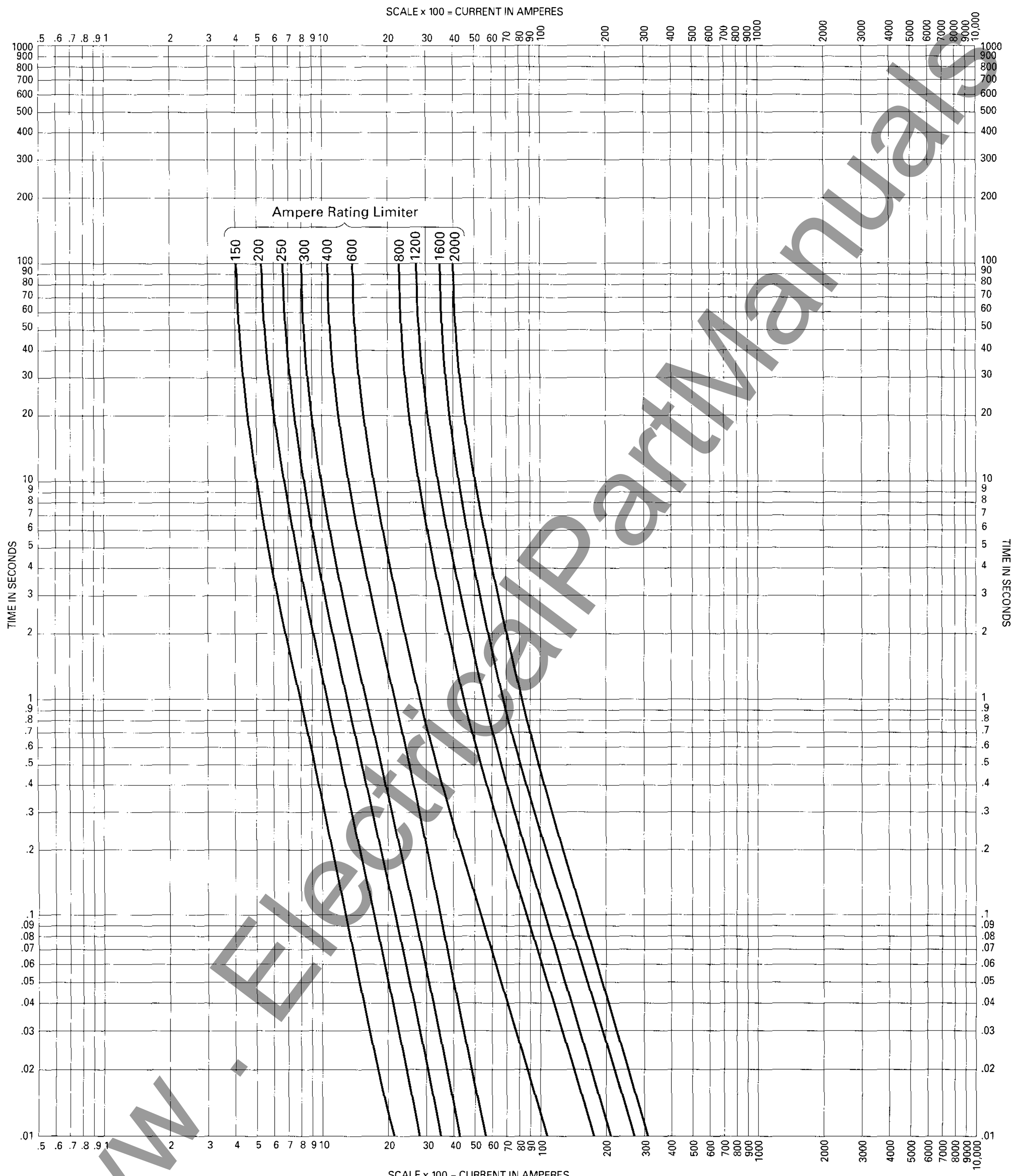
Type DSII Metal-Enclosed Low-Voltage Switchgear

DSLII-308 Average Melting Time-Current Characteristics

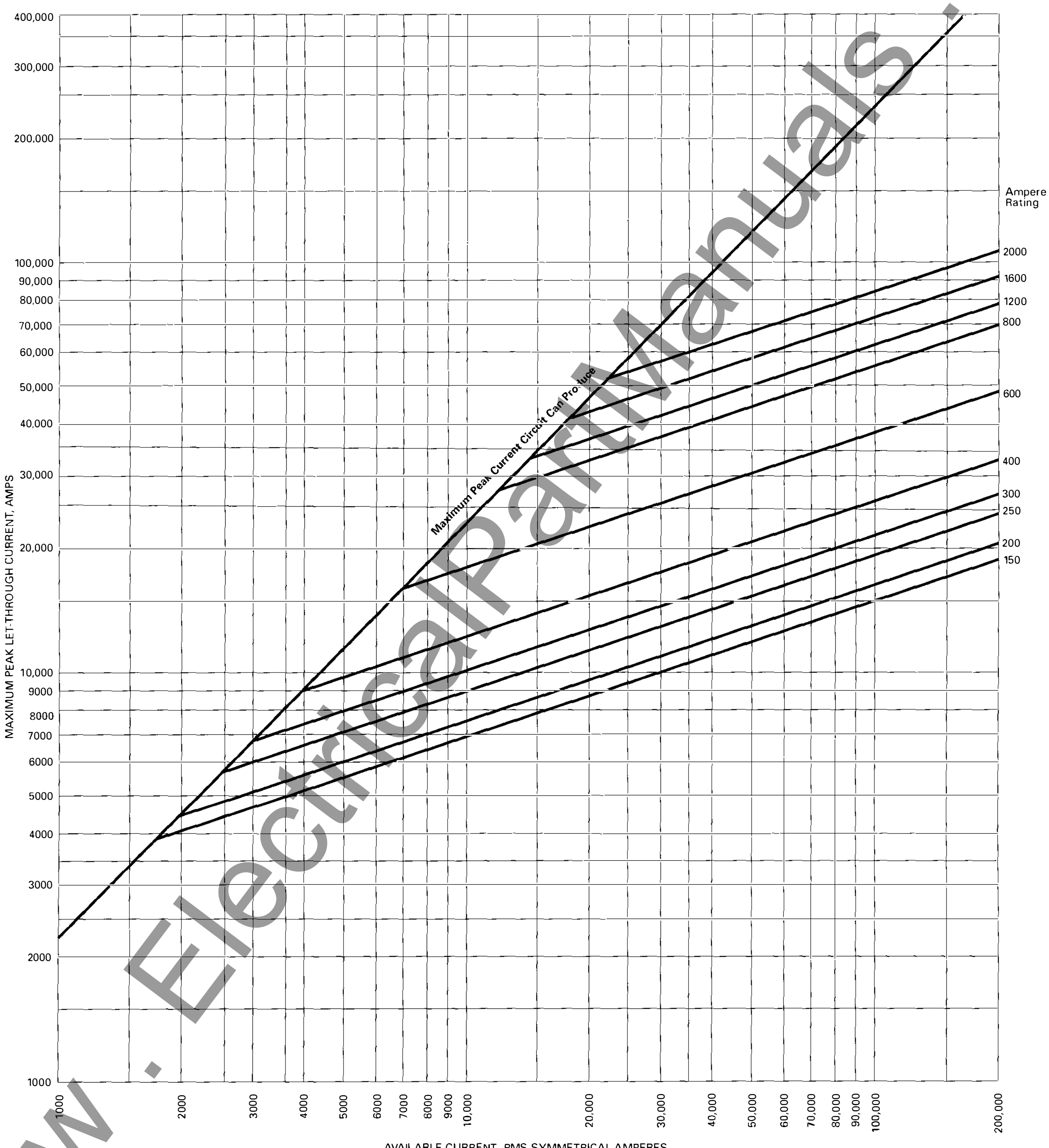


Type DSLII-308 Limiters
Average Melting Time - Current Characteristics

Curve No. 639771
November, 1978

Type DSII Metal-Enclosed Low-Voltage Switchgear

DSLII-308 Let-Through Characteristics

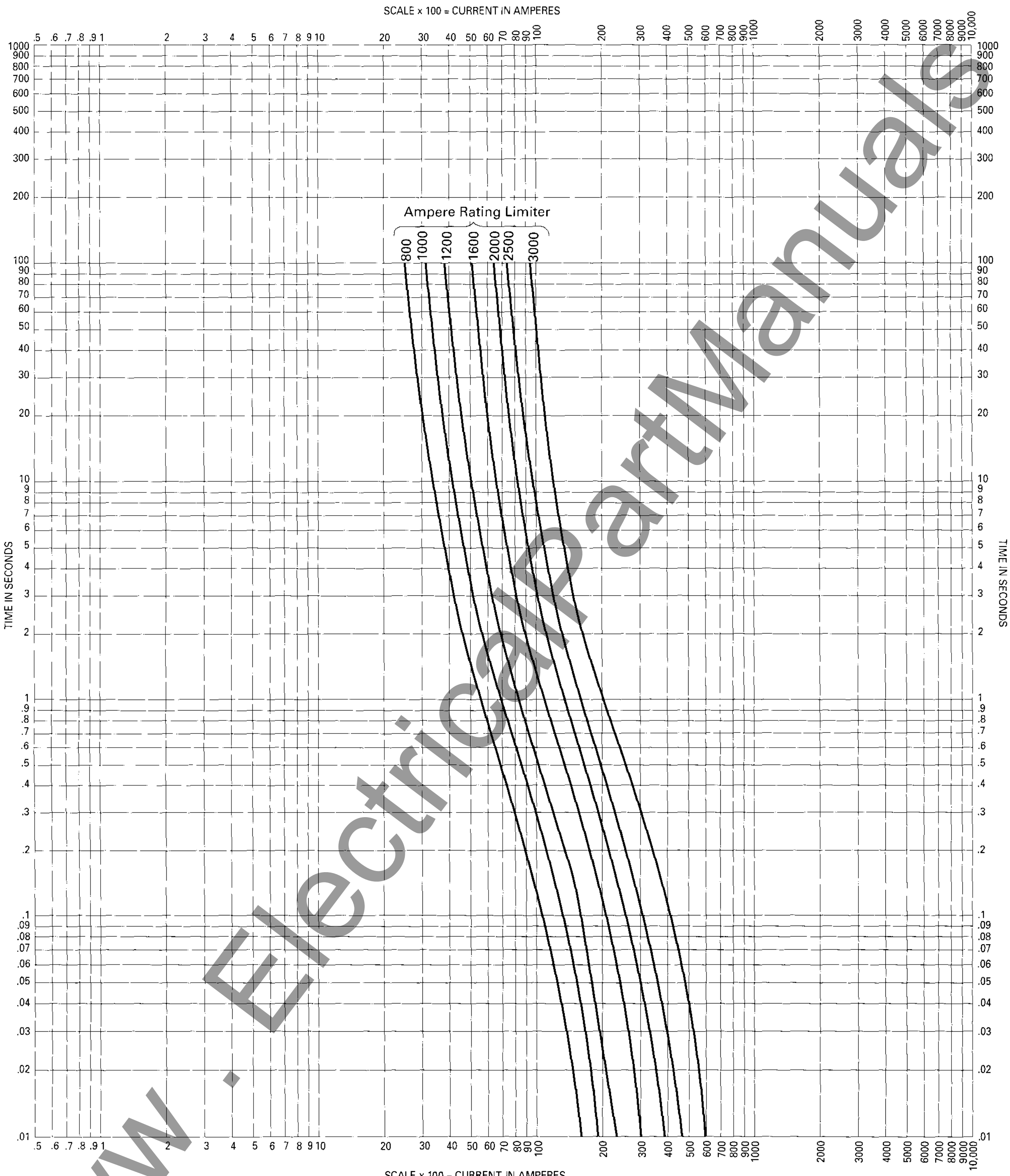


Type DSLII-308 Limiters
Let-Through Characteristics

Curve No. 639772
November, 1978

Type DSII Metal-Enclosed Low-Voltage Switchgear

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

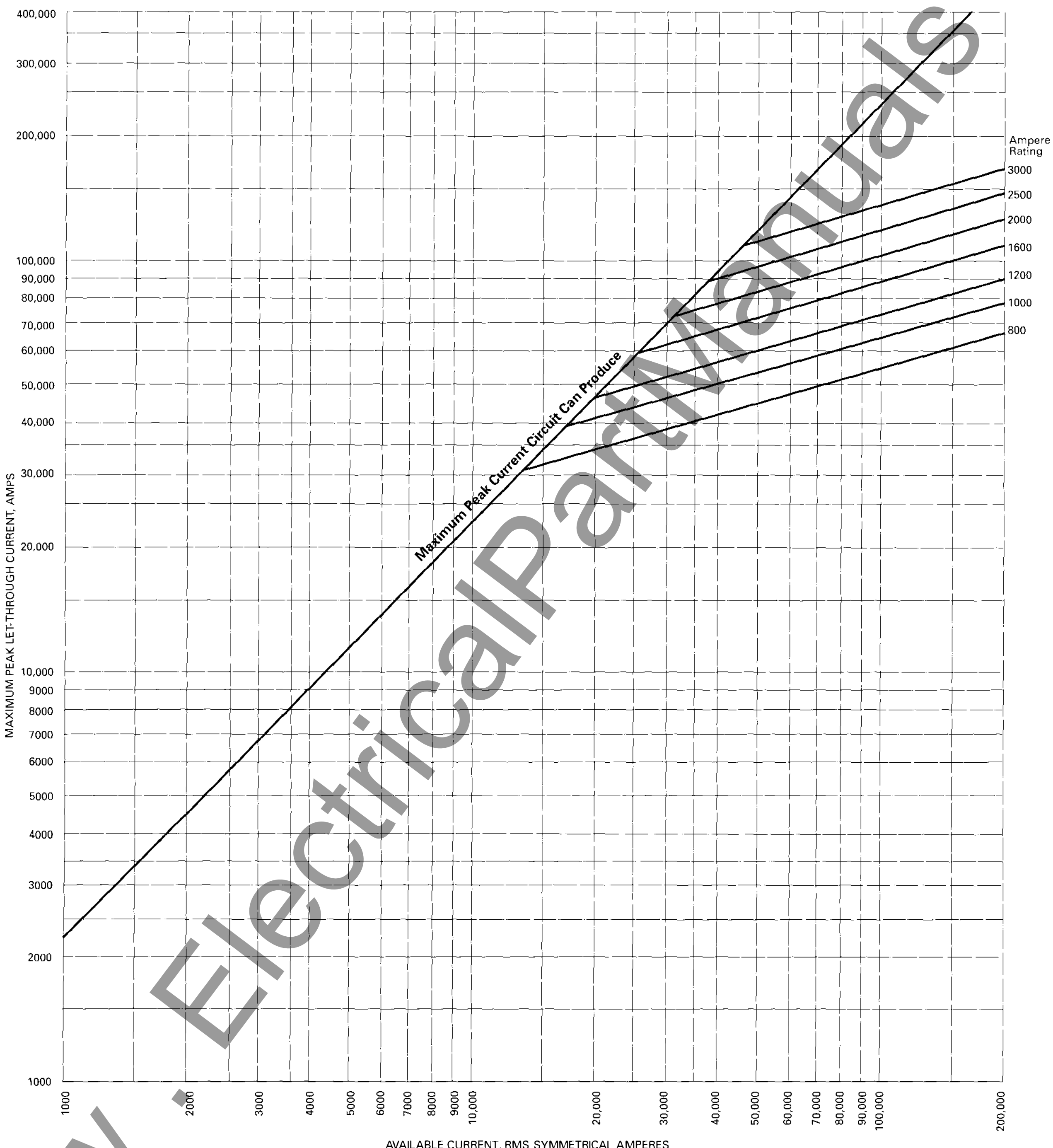


Type DSLII-516 and DSLII-620 Limiters
Average Melting Time - Current Characteristics

Curve No. 639431
November, 1978

Type DSII Metal-Enclosed Low-Voltage Switchgear

DSLII-516 and DSLII-620 Let-Through Characteristics

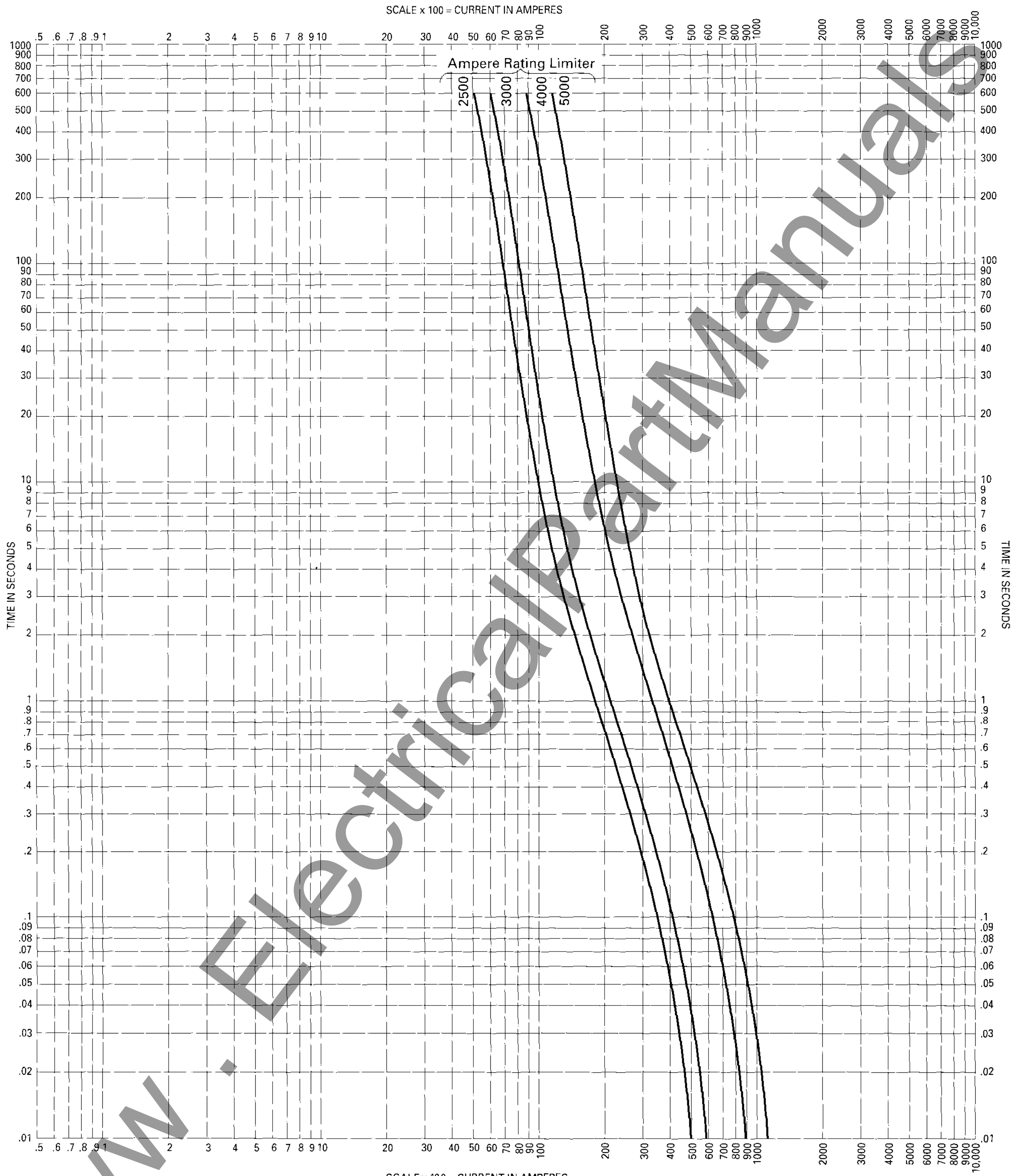


Type DSLII-516 and DSLII-620 Limiters
Let-Through Characteristics

Curve No. 639432
November, 1978

Type DSII Metal-Enclosed Low-Voltage Switchgear

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

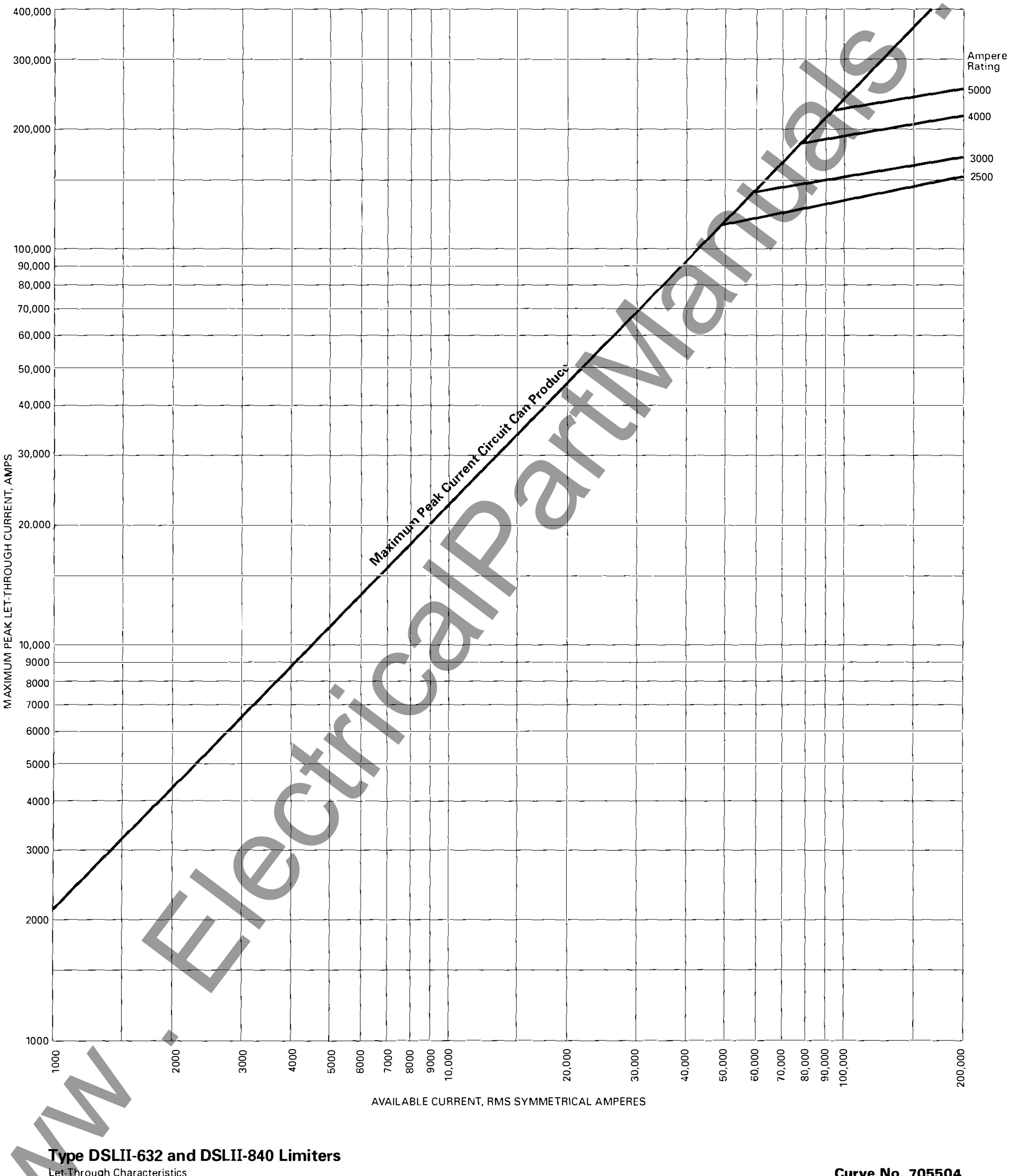


Type DSLII-632 and DSLII-840 Limiters
Average Melting Time - Current Characteristics

Curve No. 705503
November, 1978

Type DSII Metal-Enclosed Low-Voltage Switchgear

DSLII-632 and DSLII-840 Let-Through Characteristics



Type DSLII-632 and DSLII-840 Limiters
Let-Through Characteristics

Curve No. 705504
November, 1978

Type DSII Metal-Enclosed Low-Voltage Switchgear

Application of Type DSII Air Circuit Breakers With Standard Three-Phase Transformers—Fluid Filled and Ventilated Dry Types

Transformer Base (100%) Rating			Secondary Short-Circuit Currents RMS Symmetrical Amperes			Minimum Size Breakers for Selective Trip Systems		
kVA and Percent Impedance	Amperes①	Maximum Short Circuit kVA Available from Primary System	Through Transformer Only	Motor Contribution	Combined	Main Breaker Short Delay Trip	Feeder Breaker Short Delay Trip	Feeder Breaker Instantaneous Trip
Table 8A: 208 Volts Three-Phase—50% Motor Load								
300	833	50000	14900	1700	16600	DSII-516	DSII-308	DSII-308
5.0%		100000	15700		17400		DSII-308	DSII-308
		150000	16000		17700		DSII-308	DSII-308
		250000	16300		18000		DSII-308	DSII-308
		500000	16500		18200		DSII-308	DSII-308
		Unlimited	16700		18400		DSII-308	DSII-308
500	1389	50000	23100	2800	25900	DSII-516②	DSII-308	DSII-308
5.0%		100000	25200		28000		DSII-308	DSII-308
		150000	26000		28800		DSII-308	DSII-308
		250000	26700		29500		DSII-308	DSII-308
		500000	27200		30000		DSII-308	DSII-308
		Unlimited	27800		30600		DSII-508	DSII-308
750	2083	50000	28700	4200	32900	DSII-632	DSII-508	DSII-308
5.75%		100000	32000		36200		DSII-508	DSII-308
		150000	33300		37500		DSII-508	DSII-308
		250000	34400		38600		DSII-508	DSII-308
		500000	35200		39400		DSII-508	DSII-308
		Unlimited	36200		40400		DSII-508	DSII-308
1000	2778	50000	35900	5600	41500	DSII-632②	DSII-508	DSII-308
5.75%		100000	41200		46800		DSII-508	DSII-508
		150000	43300		48900		DSII-508	DSII-508
		250000	45200		50800		DSII-608	DSII-508
		500000	46700		52300		DSII-608	DSII-508
		Unlimited	48300		53900		DSII-608	DSII-508
Table 8B: 240 Volts Three-Phase—100% Motor Load								
300	722	50000	12900	2900	15800	DSII-308②	DSII-308	DSII-308
5.0%		100000	13600		16500		DSII-308	DSII-308
		150000	13900		16800		DSII-308	DSII-308
		250000	14100		17000		DSII-308	DSII-308
		500000	14300		17200		DSII-308	DSII-308
		Unlimited	14400		17300		DSII-308	DSII-308
500	1203	50000	20000	4800	24800	DSII-516②	DSII-308	DSII-308
5.0%		100000	21900		26700		DSII-308	DSII-308
		150000	22500		27300		DSII-308	DSII-308
		250000	23100		27900		DSII-308	DSII-308
		500000	23600		28400		DSII-308	DSII-308
		Unlimited	24100		28900		DSII-308	DSII-308
750	1804	50000	24900	7200	32100	DSII-620②	DSII-508	DSII-308
5.75%		100000	27800		35000		DSII-508	DSII-308
		150000	28900		36100		DSII-508	DSII-308
		250000	29800		37000		DSII-508	DSII-308
		500000	30600		37800		DSII-508	DSII-308
		Unlimited	31400		38600		DSII-508	DSII-308
1000	2406	50000	31000	9600	40600	DSII-632②	DSII-508	DSII-308
5.75%		100000	35600		45200		DSII-508	DSII-508
		150000	37500		47100		DSII-508	DSII-508
		250000	39100		48700		DSII-508	DSII-508
		500000	40400		50000		DSII-508	DSII-508
		Unlimited	41800		51400		DSII-608	DSII-508

① At transformer self-cooled rating.
② Next larger frame size main breaker may be required for 55/65°C rise and/or forced air-cooled (FA) transformer. Check Transformer Secondary Ampere Rating.

Type DSII Metal-Enclosed Low-Voltage Switchgear

Application of Type DSII Air Circuit Breakers With Standard Three-Phase Transformers Fluid Filled and Ventilated Dry Types, *Continued*

Transformer Base (100%) Rating			Secondary Short-Circuit Currents RMS Symmetrical Amperes			Minimum Size Breakers for Selective Trip Systems		
kVA and Percent Impedance	Amperes①	Maximum Short Circuit kVA Available from Primary System	Through Transformer Only	Motor Contribution	Combined	Main Breaker Short Delay Trip	Feeder Breaker Short Delay Trip	Feeder Breaker Instantaneous Trip
Table 8C: 480 Volts Three-Phase—100% Motor Load								
500 5-0%	601	50000	10000	2400	12400	DSII-308②	DSII-308	DSII-308
		100000	10900		13300		DSII-308	DSII-308
		150000	11300		13700		DSII-308	DSII-308
		250000	11600		14000		DSII-308	DSII-308
		500000	11800		14200		DSII-308	DSII-308
		Unlimited	12000		14400		DSII-308	DSII-308
750 5.75%	902	50000	12400	3600	16000	DSII-516	DSII-308	DSII-308
		100000	13900		17500		DSII-308	DSII-308
		150000	14400		18000		DSII-308	DSII-308
		250000	14900		18500		DSII-308	DSII-308
		500000	15300		18900		DSII-308	DSII-308
		Unlimited	15700		19300		DSII-308	DSII-308
1000 5.75%	1203	50000	15500	4800	20300	DSII-516②	DSII-308	DSII-308
		100000	17800		22600		DSII-308	DSII-308
		150000	18700		23500		DSII-308	DSII-308
		250000	19600		24400		DSII-308	DSII-308
		500000	30200		25000		DSII-308	DSII-308
		Unlimited	20900		25700		DSII-308	DSII-308
1500 5.75%	1804	50000	20600	7200	27800	DSII-620②	DSII-308	DSII-308
		100000	24900		32100		DSII-508	DSII-508
		150000	26700		33900		DSII-508	DSII-508
		250000	28400		35600		DSII-508	DSII-508
		500000	29800		37000		DSII-508	DSII-508
		Unlimited	31400		38600		DSII-508	DSII-508
2000 5.75%	2406	50000	24700	9600	34300	DSII-632②	DSII-508	DSII-508
		100000	31000		40600		DSII-508	DSII-508
		150000	34000		43600		DSII-508	DSII-508
		250000	36700		46300		DSII-508	DSII-508
		500000	39100		48700		DSII-508	DSII-508
		Unlimited	41800		51400		DSII-608	DSII-608
2500 5.75%	3008	50000	28000	12000	40000	DSII-632②	DSII-508	DSII-508
		100000	36500		48500		DSII-508	DSII-508
		150000	40500		52500		DSII-608	DSII-608
		250000	44600		56600		DSII-608	DSII-608
		500000	48100		60100		DSII-608	DSII-608
		Unlimited	52300		64300		DSII-608	DSII-608
3000 5.75%	3609	50000	30700	14000	44700	DSII-840②	DSII-508	DSII-508
		100000	41200		55200		DSII-608	DSII-608
		150000	46600		60600		DSII-608	DSII-608
		250000	51900		65900		DSLII-308	DSLII-308
		500000	56800		70800		DSLII-308	DSLII-308
		Unlimited	62800		76800		DSLII-308	DSLII-308
3750 5.75%	4511	50000	34000	18000	52000	DSII-850	DSII-608	DSII-608
		100000	47500		65500		DSLII-308	DSLII-308
		150000	54700		72700		DSLII-308	DSLII-308
		250000	62200		80200		DSLII-308	DSLII-308
		500000	69400		87400		DSLII-308	DSLII-308
		Unlimited	78500		96500		DSLII-308	DSLII-308

① At transformer self-cooled rating.
② Next larger frame size main breaker may be required for 55/65°C rise and/or forced-air cooled (FA) transformer. Check Transformer Secondary Ampere Rating.

Type DSII Metal-Enclosed Low-Voltage Switchgear

Application of Type DSII Air Circuit Breakers
With Standard Three-Phase Transformers Fluid Filled and Ventilated Dry Types, *Continued*

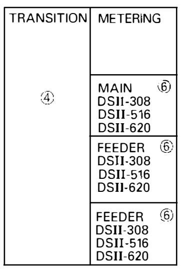
Transformer Base (100%) Rating			Secondary Short-Circuit Currents RMS Symmetrical Amperes			Minimum Size Breakers for Selective Trip Systems		
kVA and Percent Impedance	Amperes①	Maximum Short Circuit kVA Available from Primary System	Through Transformer Only	Motor Contribution	Combined	Main Breaker Short Delay Trip	Feeder Breaker Short Delay Trip	Feeder Breaker Instantaneous Trip
Table 8D: 600 Volts Three-Phase—100% Motor Load								
500 5.0%	481	50000	8000	1900	9900	DSII-308	DSII-308	DSII-308
		100000	8700		10600		DSII-308	DSII-308
		150000	9000		10900		DSII-308	DSII-308
		250000	9300		11200		DSII-308	DSII-308
		500000	9400		11300		DSII-308	DSII-308
		Unlimited	9600		11500		DSII-308	DSII-308
750 5.75%	722	50000	10000	2900	12900	DSII-308②	DSII-308	DSII-308
		100000	11100		14000		DSII-308	DSII-308
		150000	11600		14500		DSII-308	DSII-308
		250000	11900		14800		DSII-308	DSII-308
		500000	12200		15100		DSII-308	DSII-308
		Unlimited	12600		15500		DSII-308	DSII-308
1000 5.75%	962	50000	12400	3900	16300	DSII-516	DSII-308	DSII-308
		100000	14300		18200		DSII-308	DSII-308
		150000	15000		18900		DSII-308	DSII-308
		250000	15600		19500		DSII-308	DSII-308
		500000	16200		30100		DSII-308	DSII-308
		Unlimited	16700		20600		DSII-308	DSII-308
1500 5.75%	1443	50000	16500	5800	22300	DSII-516②	DSII-308	DSII-308
		100000	20000		25800		DSII-308	DSII-308
		150000	21400		27200		DSII-308	DSII-308
		250000	22700		28500		DSII-308	DSII-308
		500000	23900		29700		DSII-308	DSII-308
		Unlimited	25100		30900		DSII-508	DSII-508
2000 5.75%	1924	50000	19700	7700	27400	DSII-620②	DSII-308	DSII-308
		100000	24800		32500		DSII-508	DSII-508
		150000	27200		34900		DSII-508	DSII-508
		250000	29400		37100		DSII-508	DSII-508
		500000	31300		39000		DSII-508	DSII-508
		Unlimited	33500		41200		DSII-508	DSII-508
2500 5.75%	2406	50000	22400	9600	32000	DSII-632②	DSII-508	DSII-508
		100000	29200		38800		DSII-508	DSII-508
		150000	32400		42000		DSII-508	DSII-508
		250000	35600		45200		DSII-608	DSII-608
		500000	38500		48100		DSII-608	DSII-608
		Unlimited	41800		51400		DSLII-308	DSLII-308
3000 5.75%	2886	50000	24600	11500	36100	DSII-632②	DSII-508	DSII-508
		100000	33000		44500		DSII-608	DSII-608
		150000	37300		48800		DSII-608	DSII-608
		250000	41500		53000		DSLII-308	DSLII-308
		500000	45500		57000		DSLII-308	DSLII-308
		Unlimited	50200		61700		DSLII-308	DSLII-308
3750 5.75%	3608	50000	27200	14400	41600	DSII-840②	DSII-508	DSII-508
		100000	38000		52400		DSLII-308	DSLII-308
		150000	43700		58100		DSLII-308	DSLII-308
		250000	49800		64200		DSLII-308	DSLII-308
		500000	55500		69900		DSLII-308	DSLII-308
		Unlimited	62800		77200		DSLII-308	DSLII-308

① At transformer self-cooled rating.
② Next larger frame size main breaker may be required for 55/65°C rise and/or forced-air cooled (FA) transformer. Check Transformer Secondary Ampere Rating.

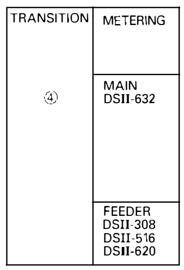
Type DSII Metal-Enclosed Low-Voltage Switchgear

Table 9A: Typical Dimensions - Indoor DS Breakers ① ② ③

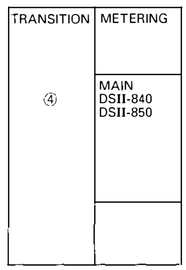
DSII Mains - Close Coupled to Transformer



21 21
Fig. 1



21 21
Fig. 2



21 34
Fig. 3

DSII Mains - Cable or Bus Duct Connected

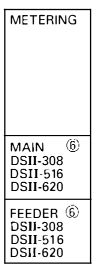


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Fig. 4

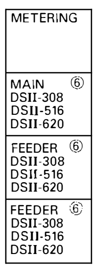

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Fig. 5

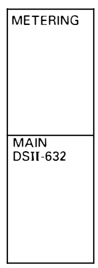

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Fig. 6

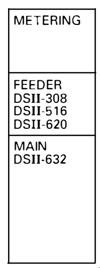

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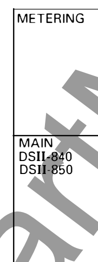
Fig. 7



34
Fig. 8

DSII Ties

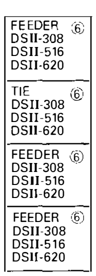


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Fig. 9

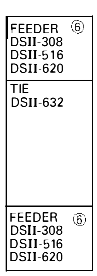

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Fig. 10

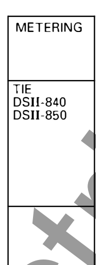

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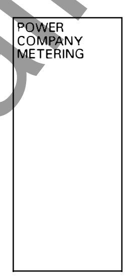
Fig. 11

Miscellaneous



38
50
Fig. 12

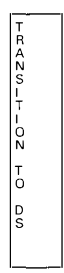


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Fig. 13

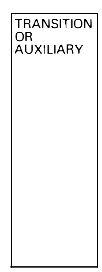

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Fig. 14

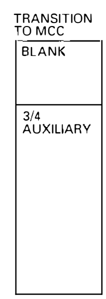

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Fig. 15

DSII Feeders

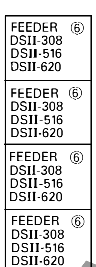

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Fig. 16

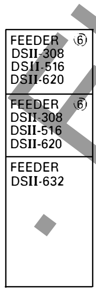

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Fig. 17

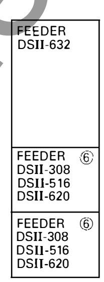

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Fig. 18

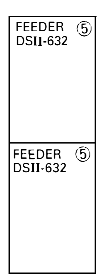

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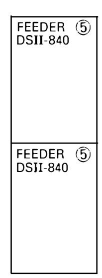
Fig. 19



34
Fig. 20

Frame	Breaker Designation
800 A	DSII-308, -508, -608, DSLII-308*
1600 A	DSII-516, -616, DSLII-516*
2000 A	DSII-620, DSLII-620*
3200 A	DSII-632, DSLII-632**
4000 A	DSII-840, DSLII-840**
5000 A	DSII-850

* These breakers have the current limiters mounted on the breaker.
** These breakers have the current limiters mounted separately.

NOTES

①- Maximum indoor shipping width is 5 vertical sections or 120 inches, whichever is smaller. Maximum outdoor shipping width is 96 inches including aisle doors, any transformer connections, etc.

●- All vertical sections are 92 inches high plus 4 inch ventilators and non-removable lifting angle. When the top-of-gear breaker lifter is used, height is 104 in. over the lifter and 97.38 in. over the lifter rail.

③- When bus ducts out of feeder sections are required, the depth of the lineup may increase and vertical stacking may be effected. Refer to Cutler-Hammer.

④- Transition may be omitted if: standard dry type transformer is used; auxiliary and metering devices are not located in transition ; no fire pump breaker; no zero sequence ground fault.

⑤- Refer to Cutler-Hammer for availability.

⑥- Also DSII-508, DSII-608, DSII-616 (Max. of 2 fully loaded DSII-620 breakers per section).

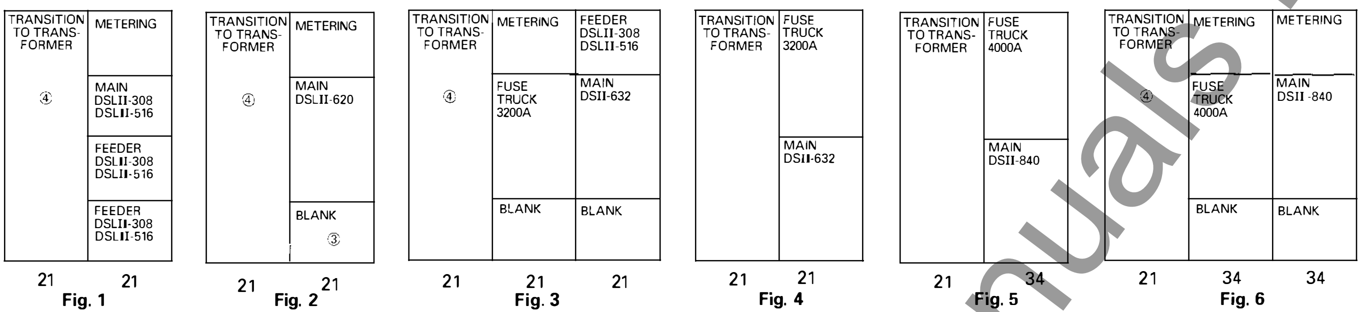
Note: Blank may be substituted for any breaker position.

Note: Auxiliary may be substituted for any transition.

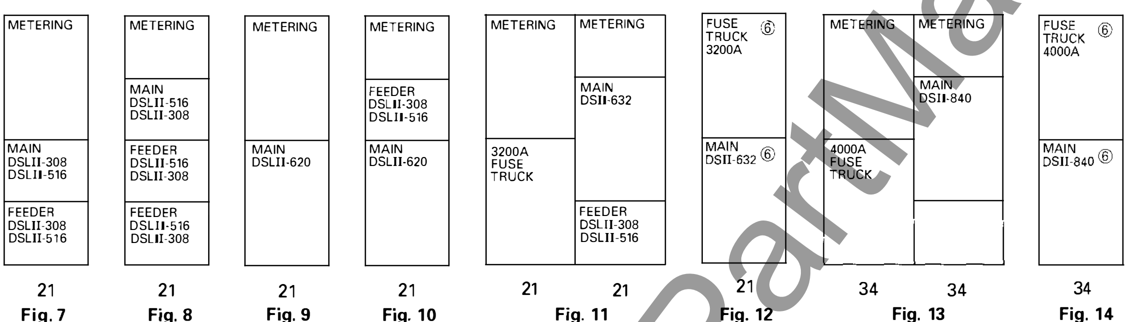
Type DSII Metal-Enclosed Low-Voltage Switchgear

Table 9B: Typical Dimensions - Indoor - DSLII Breakers ① ② ③

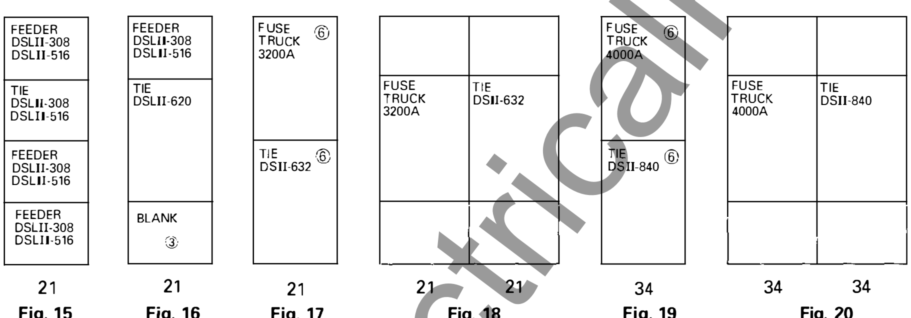
DSLII Mains - Close Coupled to Transformers



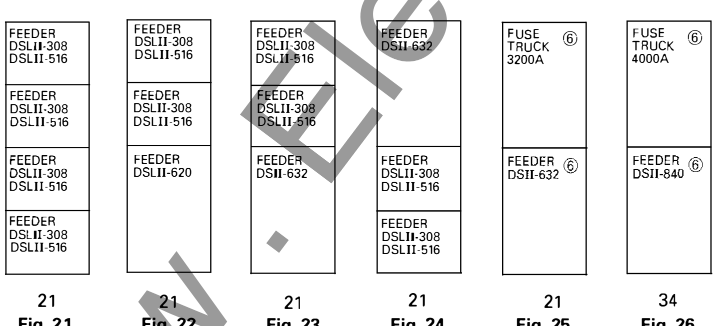
DSLII Mains - Cable or Bus Duct Connected



DSLII Ties



DSLII Feeders



NOTES

①- Maximum indoor shipping width is 5 vertical seconds or 120 inches, whichever is smaller. Maximum outdoor shipping width is 96 inches including aisle doors, any transformer connections, etc.

②- All vertical sections are 92 inches high plus 4 inch ventilators and non-removable lifting angle. When top-of-gear breaker lifter is used, height is 104 in. over the lifter and 97.38 in. over the lifter rail.

③- When bus ducts out of feeder sections are required, the depth of the lineup may increase and vertical stacking may be effected. Refer to Cutler-Hammer.

④- Transition may be omitted if: standard dry type transformer is used; auxiliary and metering devices are not located in transition; no fire pump breaker; no zero sequence ground fault.

⑤- No breakers allowed below a DSLII-620.

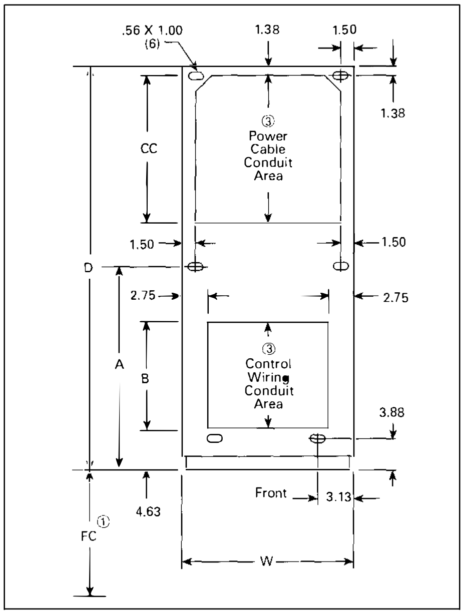
⑥- Refer to Cutler-Hammer for availability.

Note: Blank may be substituted for any breaker position.

Note: Auxiliary may be substituted for any transition.

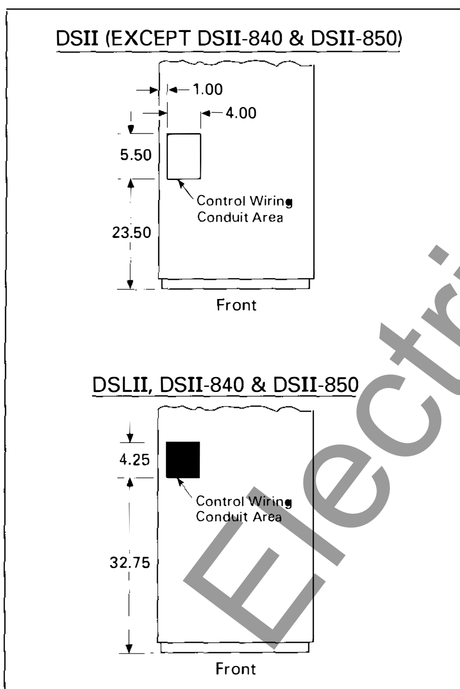
Type DSII Metal-Enclosed Low-Voltage Switchgear

Table 9C: Dimensions, in Inches

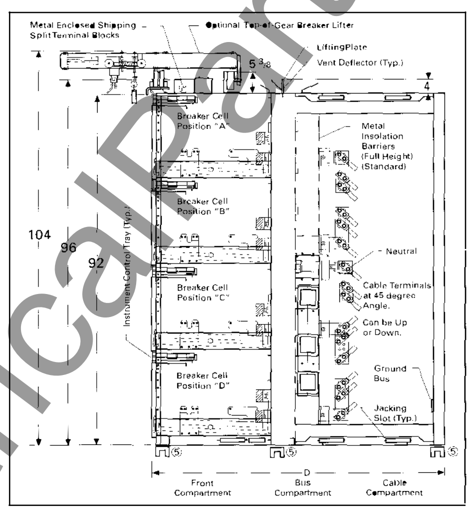


Floor Plan

Type of Breakers In Section	① FC	W	D	② CC	A	B	Recommended③ No. of Power Conduits (Max.) 3.5"	4"
All DSII, Except DSII-840 DSII-850	36	21	60	10	30.50	24.50	6	3
			66	16			9	6
			72	22			12	9
			78	28			15	12
			84	34			18	15
			90	40			21	18
DSII-840 DSII-850 DSLII-840	44	34	72	14	38.50	32.50	14	10
			78	20			18	15
			84	26			23	23
			90	32			32	28
DSLII-308 DSLII-516 DSLII-620	44	21	66	8	38.50	32.50	4	3
			72	14			8	6
			78	20			10	9
			84	26			15	12
			90	32			18	15
DSLII-632	44	21	72	14	38.50	32.50	8	6
			78	20			10	9
			84	26			15	12
			90	32			18	15



Top View



Section View of Typical Structure

Estimated Heat Loss Per Breaker (Watts) (See Note Below)

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
DSLII-FT32	3600
DSLII-FT40	4500

Note: Add heat loss of structure per the following.

Main bus through 3200 Amps	4000
Main bus 4000 Amps maximum	5000
Main bus 5000 Amps maximum	7000

Type DSII Indoor Switchgear Weights—Pounds (Approximate)

Stationary Structures

21 in. wide breaker structure less breakers:	
66 in. maximum depth	1300
78 in. maximum depth	1400
90 in. maximum depth	1500
34 in. wide breaker structure less breakers:	
66 in. maximum depth	1500
78 in. maximum depth	1600
90 in. maximum depth	1700
21 in. wide auxiliary structure less breakers:	
66 in. maximum depth	1000
78 in. maximum depth	1100
90 in. maximum depth	1200
34 in. wide auxiliary structure less breakers:	
66 in. maximum depth	1100
78 in. maximum depth	1200
90 in. maximum depth	1300
13 in. wide Bus Transition structure	700
21 in. wide Transformer Transition structure	1000

Drawout Elements

DSII-308 Breaker④	150
DSII-508 Breaker④	195
DSII-608 Breaker④	200
DSII-516 Breaker④	195
DSII-616 Breaker④	200
DSII-620 Breaker④	200
DSII-632 Breaker④	300
DSII-840 Breaker④	400
DSII-850 Breaker④	400
DSLII-308 Breaker④	200
DSLII-516 Breaker④	260
DSLII-620 Breaker④	325
DSLII-FT32	325
DSLII-FT40	430

Center of Gravity

For seismic calculations, the following dimensions should be used to locate the center of gravity for Type DSII Switchgear.

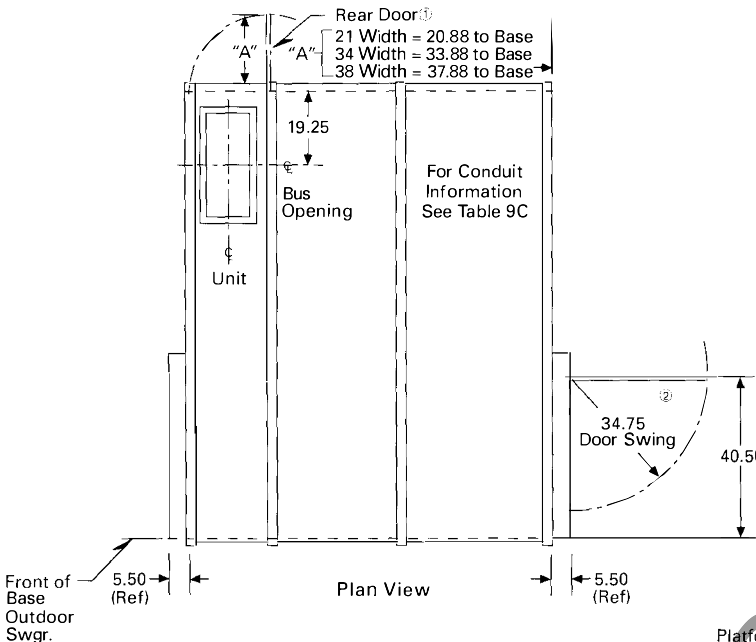
Vertical	60 inches
Left-to-right	center of lineup
From the front	24 inches

(28 inches for assemblies containing DSLII, DSII-840 and DSII-850 Breakers)

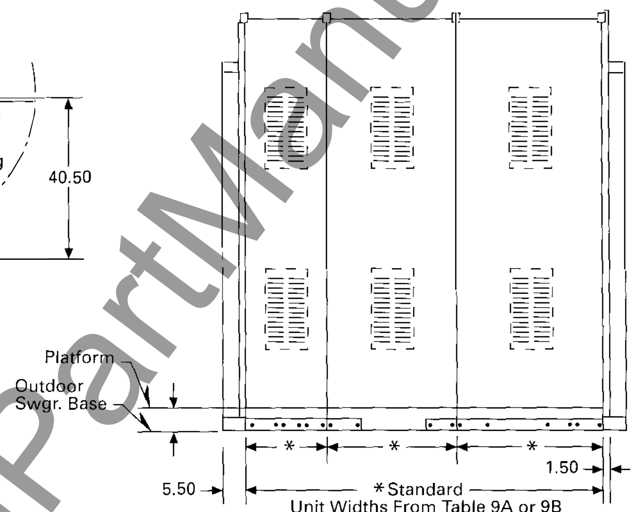
① FC is the recommended front clearance for breaker removal with top-of-switchgear-mounted breaker lifter. If a portable breaker lifter is to be used, allow at least 60" of aisle space.
② When a zero-sequence ground-fault CT is mounted on line-side or load-side of a breaker, reduce CC dimension by 10 inches.
③ Stub conduit 2" maximum in power cable area, 1" maximum in control wiring area.
④ Manually or electronically operated. For approximate impact weight, add 50% of breaker weight.
● Floor channels not included.

Type DSII Metal-Enclosed Low-Voltage Switchgear

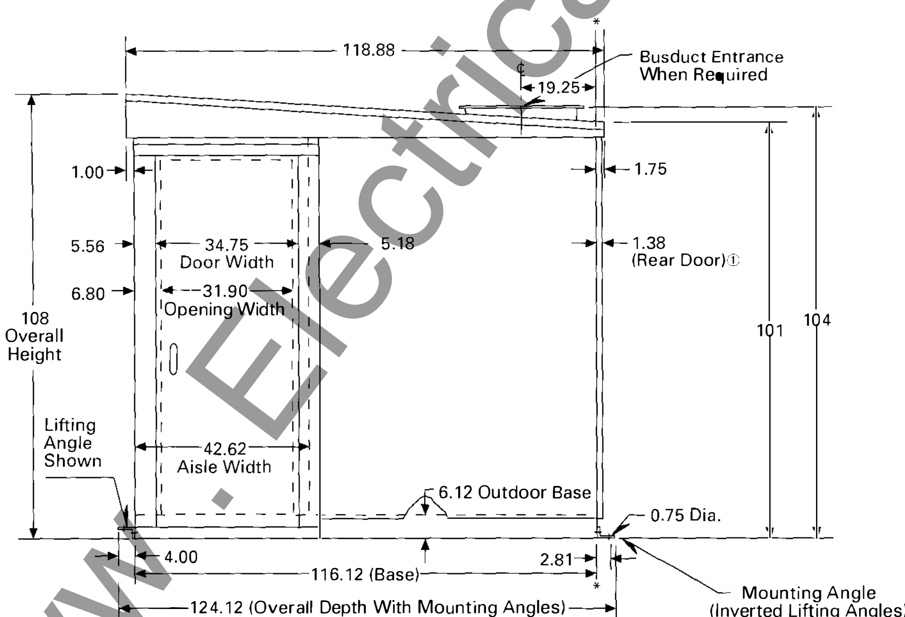
Table 9D: Typical Dimensions - Outdoor



Plan View



Front View



Right-Hand End View

Note: * Denotes rear of base and frame.

Weights of Outdoor Structures

Stationary Structures③	Weight (lbs.)
End trims (one set per lineup)	1500
21 in. wide breaker section	2600
34 in. wide breaker section	2700
21 in. wide aux. section	2300
34 in. wide auxiliary section	2400
38 in. wide utility section	2700
50 in. wide utility section	3200
21 in. bus transition section	2500
Transformer throat	150

① Rear doors are standard.
② Enclosures equipped with hinged door on each end of aisle.
③ Weight of structure is less breakers.

Dimensions for Estimating Purposes Only.

Type DSII Metal-Enclosed Low-Voltage Switchgear

Outgoing Low-Voltage Switchgear Section

Typical Specification

General—Type DSII indoor (outdoor) low-voltage metal-enclosed switchgear shall consist of a stationary structure assembly and one or more removable "De-ion" air circuit breaker units fitted with disconnecting devices and other necessary equipment. The switchgear shall be suitable for 600 Volts maximum service and shall withstand a 2200 Vac dielectric test in accordance with ANSI standards. It shall be designed, manufactured and tested in accordance with the latest standards of IEEE, NEMA, ANSI, and UL.

Stationary Structure—Each steel unit forming part of the stationary assembly shall be a self-contained housing having one or more individual breaker or instrument compartments and a rear compartment for the bare buses and outgoing cable connections.

Jacking slots shall be provided for ease of lifting in equipment rooms for the purpose of removing shipping skids and the addition or removal of equipment rollers.

A rigid integral steel base shall be provided for each section which will allow movement of shipping groups directly on rollers without a separate skid.

Barriers shall be provided which isolate the cable compartment from the horizontal and vertical bus compartments.

Each circuit breaker compartment shall be equipped with primary and secondary contacts, draw-out extension rails, stationary levering mechanism parts and required instrument current transformers. A formed steel door equipped with an emergency trip button, and supported on concealed hinges with removable pins shall be provided for each circuit breaker compartment.

The top of the unit shall be enclosed with removable steel sheets which include necessary hooded ventilation openings. A separate removable roof sheet shall be provided for drilling of control conduit hubs. A metal wireway with removable covers shall be provided for shipping-split wiring. Pull-apart type terminal blocks shall also be provided for rapid, error-free, shipping split assembly.

The structure shall be so designed that future additions may readily be made at any time. The steel structure shall be thoroughly cleaned and phosphatized prior to the application of the light gray ANSI No. 61 finish.

A white, laminated, plastic engraved circuit designation nameplate shall be provided on each circuit breaker door.

Buses and Connections—Each circuit shall include the necessary three-phase bus and connections between the bus and one set of circuit breaker studs. NEMA 2-hole cable lugs attached to silver-plated copper extensions for the outgoing cables shall be provided on the other set of circuit breaker studs. This system shall be designed such that full short circuit withstand ratings through 65 kA are retained without the need for lashing of power cables. The buses and connections shall consist of high-conductivity (silver-plated) (tin-plated) copper bar mounted on heavy-duty supports, and having bolted joints. All bolted joints shall utilize Belleville type spring washers to maintain maximum joint integrity through continuous thermal cycling. The bus system shall be suitable for applications on power systems requiring a (100) (200) kA short circuit withstand rating without upstream current limiting fuses. Shipping breaks and provisions for future bus extensions shall have silver-plated bolted connections.

Terminal blocks with integral-type barriers shall be provided for secondary circuits. The terminal blocks shall be front accessible through a removable tray above each circuit breaker.

All control wiring shall be securely fastened to the switchgear assembly without the use of adhesive wire anchors. A dedicated wiring path shall be provided for purchaser's installed control wiring. Nonadhesive anchors shall also be provided for purchaser's installed wiring.

Disconnecting Devices—The stationary part of the primary disconnecting devices for each circuit breaker shall consist of a set of contacts extending through a glass polyester insulating base. Buses and outgoing cable terminals shall be directly connected to them. The corresponding moving contacts shall consist of a set of contact fingers suitably spaced on the circuit breaker studs. In the "connected" position, these contacts shall form a current-carrying bridge. The assembly shall provide a multitude of silver-to-silver high-pressure point contacts. High uniform pressure on each finger shall be maintained by springs. The entire assembly shall be full floating and shall provide ample flexibility between the stationary and moving elements. Contact engagement shall be maintained only in the "connected" positon.

The secondary disconnecting devices shall consist of floating fingers mounted on the removable unit and engaging contacts located at the rear of the compartment. The secondary disconnecting devices shall be silver-plated to insure permanence of contact. Contact engagement shall be maintained in the "connected" and "test" positions.

Removable Element—The removable element shall consist of a type DSII De-ion air circuit breaker equipped with the necessary disconnecting contacts, wheels, and interlocks for draw-out application. The removable element shall have four-position features and shall permit closing the compartment door with the breaker in the "connected," "test," "disconnected," and "remove" positions.

Air Circuit Breakers—The air circuit breaker shall be Type DSII (DSLII) operating on the De-ion arc interruption principle. These breakers shall incorporate specially designed circuit-interrupting devices which provide high interrupting efficiency and minimize the formation of arc flame and gases.

The air circuit breakers shall have silver-tungsten butt type contacts which operate under high pressure. The arcing contacts shall be arc-resisting silver-tungsten. The breaker shall be equipped with "De-ion" arc chutes which effectively enclose the arcing contacts and confine the arc to reduce the disturbance caused by short-circuit interruption. Each breaker shall be equipped with a position indicator, mechanically connected to the circuit breaker mechanism.

Include when DSLII breakers specified above: Circuit breakers shall include current limiters, integrally or separately mounted, coordinated with the breaker trip device so as to avoid unnecessary blowing of the current limiters. Breaker 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 reclosed on a single phase condition due to missing or blown limiters.

[Specifier note: Include only the tripping functions below necessary for the specific application. Requirements for mains, ties, and feeders may be different.]

Each breaker shall be equipped with a microprocessor-based, true RMS sensing trip device. The adjustments shall be long delay pickup between 50% and 100% of the trip rating, long time delay between 4 and 36 seconds at 6 times trip rating, short delay pickup between 2 and 10 times trip rating, short time delay between 0.18 and 0.5 seconds at 2.5 times short delay pickup, instantaneous pickup between 2 and 12 times trip rating, ground fault pickup approximately 20% of trip rating and

Type DSII Metal-Enclosed Low-Voltage Switchgear

ground fault time between 0.22 and 0.5 seconds.

It shall be possible to test and verify the time and current characteristics and trip circuit by means of a portable plug-in test device.

Both electrically operated and manually operated breakers shall have stored energy operating mechanisms. Only one stroke of the operating handle shall be necessary to charge the stored energy spring when operating the manual breaker. The release of the energy to close the breaker manually shall be by means of a mechanical pushbutton which insures positive control of the closing operation. Electrical close shall be initiated by means of a release solenoid.

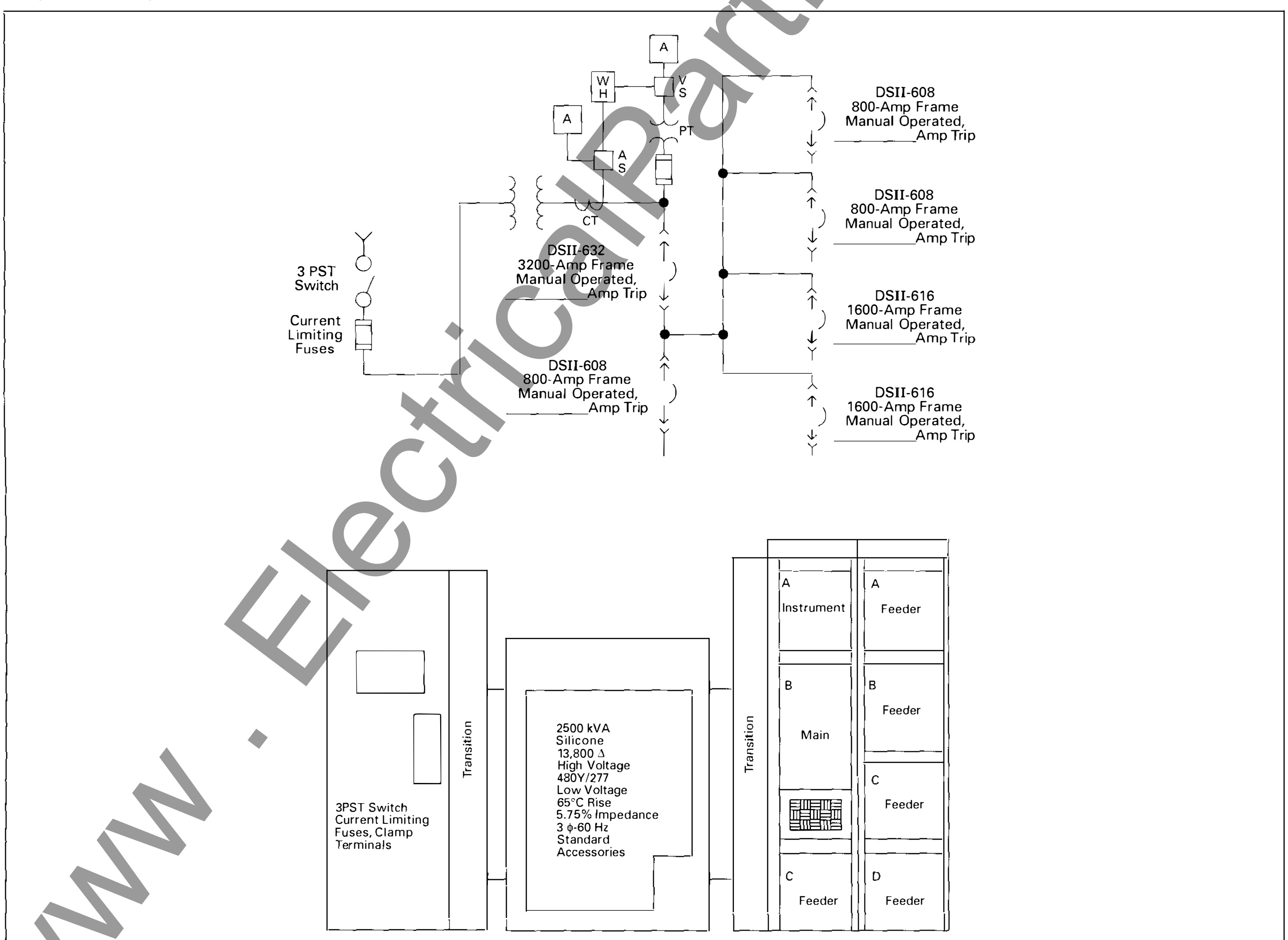
Seismic
The switchgear assembly and circuit breakers shall be suitable for and certified to meet all applicable seismic requirements of (UBC) (The California Building Code) for zone 4 application. Guidelines for the installation consistent with these requirements shall be provided by the switchgear manufacturer and be based upon testing of representative equipment. The test response spectrum shall be based upon a 5% minimum damping factor, (Insert the following for UBC: a peak of 0.75g, and a ZPA of 0.38g), (Insert the following for CBC: a peak of 1.8g, and a ZPA of 0.45g). The tests shall fully envelope this response spectrum for all equipment natural frequencies up to at least 35 Hz.

Factory Assembly and Tests
The switchgear shall be completely assembled, wired, adjusted and tested at the factory. After assembly, the complete switchgear shall be tested for operation under simulated service conditions to assure the accuracy of the wiring and the functioning of the equipment.

The main circuits shall be given a dielectric test of 2200 Volts for one minute between live parts and ground and between opposite polarities. The wiring and control circuits shall be given a dielectric test of 1500 volts for one minute or 1800 volts for one second, between live parts and ground.

Note: Arrangement sketch and single line diagram similar to samples shown should accompany the written specification.

Single Line Diagram and Elevation



Type DSII Metal-Enclosed Low-Voltage Switchgear

Type DSII Metal-Enclosed Low-Voltage Switchgear

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Printed in U.S.A.
September 1995