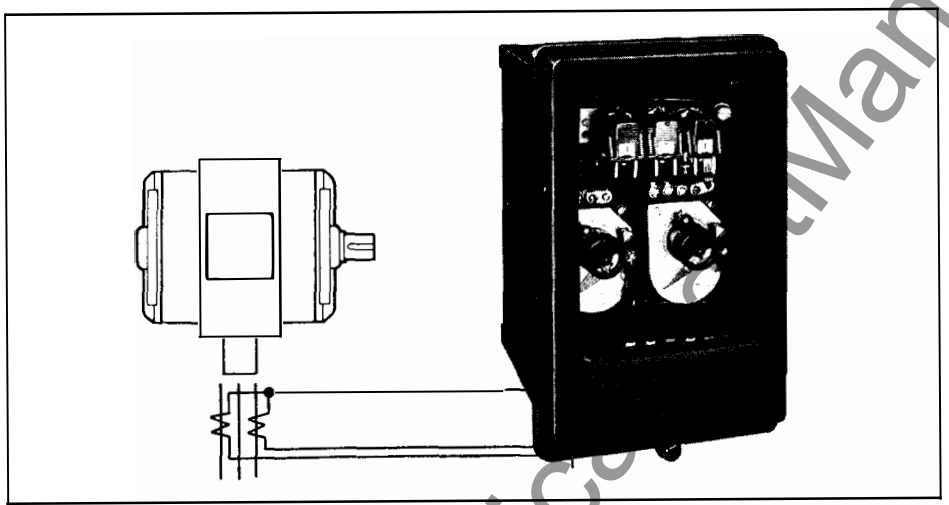
ABB Power T&D Company Inc.
Relay Division
Coral Springs, FL
Allentown, PA

September, 1990
Supersedes Descriptive Bulletin 41-550, pages 1-12, dated December, 1987
Mailed to: E, D, C/41-500A

For Protection of Ac Motors, Ac Generators, and Transformers
Device Number: 49

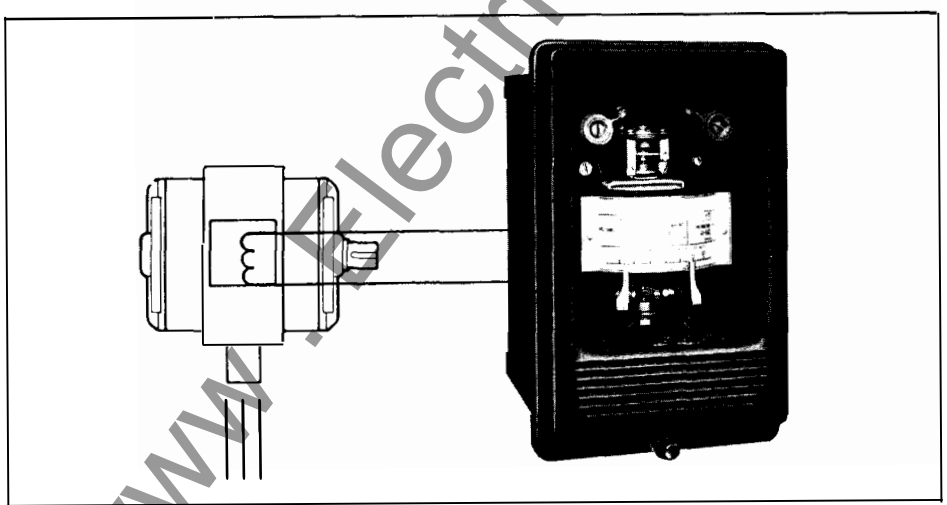
Types BL-1 and DT-3 Temperature Relays



Type BL-1

For thermal overload and short-circuit protection of transformers and ac motors, usually rated 50 horsepower or more.

The BL-1 relay consists of a heater unit and an instantaneous trip unit. The operating curve of the heater unit closely duplicates the average heating curve of electrical machinery over a wide enough range that additional use of a "long-time" overcurrent relay is not required for many applications. Ambient temperature compensation in the BL-1 minimizes the effect of temperature differences between the protected apparatus location and the relay location. The BL-1 relay can be supplied with one thermal unit for single phase ac applications; or with two thermal units for polyphase ac applications. See page 2.



Type DT-3

For temperature protection of transformers, or dc generators, and motors, usually rated 1,000 horsepower or more.

The DT-3 relay is an adjustable contact-making ac or dc milliammeter, calibrated in degrees Centigrade. The relay operates to initiate an alarm or tripping function (most commonly through an auxiliary type SG or MG-6 relay) when the stator temperature of the protected machine reaches the temperature setting of the relay. The relay is applied as the center leg of a Wheatstone dc energized bridge circuit consisting of balancing resistors within the relay and a temperatuer search coil embedded in the stator of the machine. See page 8.

Type BL-1

Construction

(1) Operation Indicators

One for each instantaneous trip unit, and a third operated by either of the two heater units. 0.2 amp coil is rated at 2.8 ohms, and the 1.0 amp coil is rated at 0.16 ohm.

(2) Instantaneous Trip Unit

Has an adjustable solenoid plunger which can be set to trip at any current from 6 to 50 amperes ac as indicated on the calibrated scale. See page 6, for additional details.

(3) Contactor Switch

Used to seal-in around the heater unit contacts. Will pickup at 2.0 amperes, and has a coil resistance of 0.23 ohm dc.

(4) Heater Unit Tap Link

Provides a double range of operation with relay settings as follows:

Tap link open: 2.5 to 3.5 amps full load setting.

Tap link closed: 3.75 to 5 amps full load setting.

The heater unit will carry 35 amps at 3.5 amp setting and 50 amps at 5.0 amp setting for sufficient time to close the relay contacts.

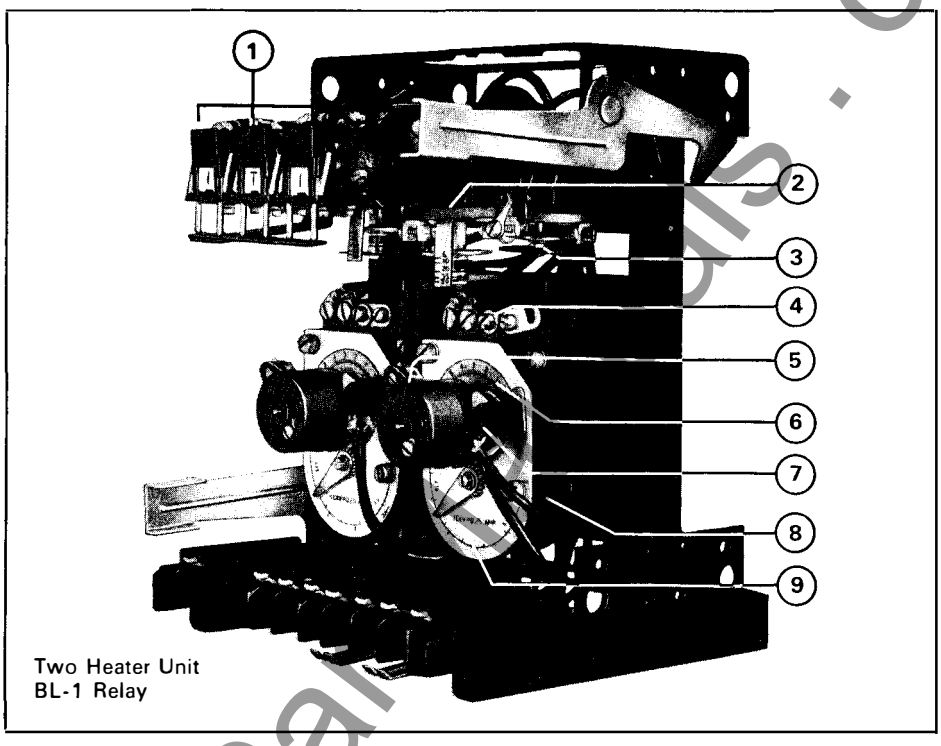
(5) Moving Contact

This silver contact bridges two stationary butt contacts to complete the control circuit. The moving contact plate is mounted on a pivot so as to be self-aligning with the stationary contacts. Initial position is non-adjustable. See page 6, for further contact data.

(6) Fixed Scale

For Circuit Opening (Back) Contact Position Reference

This scale indicates the relative position reference for various settings of the circuit opening contact which is mounted to the left of the moving contact. It is adjustable with respect to its initial position and the position of the moving contact assembly The circuit opening contact can be set independently of the circuit closing (front) contact.



Two Heater Unit
BL-1 Relay

Fig. 1

The circuit opening contact is used to: (a) sound an alarm, (b) act as an interposing contact in a motor starting circuit, or (c) start fans, blowers, etc., to cool the protected motor.

(7) Heater Unit Contacts

These silver contacts are adjustable in position with respect to the moving contact. They are rotated in position by movement of the index pointers to the desired position on the indexed scales. Rotation of the pointer does not change the spacing between the make and break stationary contacts. The adjustable break contact can be used to prevent restarting of a motor until a desired time interval has elapsed after the motor has been disconnected due to overload. The break contact can also be used to initiate an alarm on opening, thus warning of overload. For contact data, see page 6.

(8) Heater Unit

Consists of a bimetallic spring mounted between two heaters in a plastic housing. The spring, one end of which is fixed and the other free to expand and contract with changes in heater temperature, rotates the moving contact shaft. An additional bimetallic spring, mounted outside the heater housing but attached to the moving contact shaft is wound in the opposite direction of the internal spring. Differential action of these two springs provide effective ambient temperature compensation. A high permeability reactor is provided in shunt with the heaters. This reactor does not affect the time curve of the relay up to 1000% of setting, but provides protection from very high currents of short duration.

(9) Scale Plate

Calibrated in amperes for initial positioning of the circuit closing contact.

Shipping Weights and Dimensions

Case	Units Per Case	Weight, Lbs. Net	Weight, Lbs. Shipping	Domestic Shipping Carton Dims, Inches
FT-21	1	12	16	9 x 12 x 12
	2	14	18	9 x 12 x 12

Application Guide and Typical Settings

The BL-1 relay is designed to have a time-current operating curve which closely approaches the heating curve of a motor when it is subjected to more than load current. Having a replica type thermal unit, it also considers the amount of heating present in the motor prior to overload.

If the motor heating curve (a plot of multiples of rated current versus tolerable overload time duration) is available, the relay can be set so that its operating time curve (figures 4 to 9) most nearly approaches the overload limit curve of the motor. Generally, the BL-1 is set to close its contacts at 115% of rated current for motors of 100% service factor, and would be set to operate at about 125% of rated current for motors with a 115% service factor.

The relay contacts can either initiate tripping or sound an alarm. Frequently, the back contacts initiate an alarm, and the front contacts cause tripping.

In addition, the BL-1 is equipped with high-speed instantaneous trip units. Setting of these is somewhat more difficult because of the effect of dc transients which may occur particularly when starting large motors. Setting is best obtained by successive starts of the motor to determine the minimum operating pickup setting of the instantaneous unit, and then increasing this setting by 10%. Typical settings may be 160 to 170% of locked rotor current, although settings as high as 250% may be required.

Typical Settings

Assume the rated or full load current on the motor (secondary values) to be 3.75 amperes ac. Set the relay as follows:

(a) close tap link

(b) move the pointer on the index scale to 3.75 index mark on the inner scale

(c) set the instantaneous trip to pickup at about 40 amperes.

By referring to the operating time curves on page 4, figure 6, with rated current (3.75 amps) applied, the relay will trip in four minutes with 200% of rated current (7.50 amps) applied.

If the relay is equipped with a circuit opening or back contact, this "break" contact can be set to open for a value of current between rated contact and the setting of the front, or "make", contact.

As noted on the bottom of page 4, after rated current has been applied, the relay will also close its contacts in 60 minutes when 125% of the 3.75 ampere setting (4.69 amps) is applied.

Contact Ratings

Unit	Control Voltage	Contact Capacity in Amperes	
		Will Break	Will Close
Heater	125 v dc	0.8	3.0①
	250 v dc	0.6	3.0①
	120 v ac	5.0	5.0①
Instantaneous Trip	120 v dc	1.5	30.0②
	250 v dc	1.0	30.0②
	120 v ac	15.0	30.0②

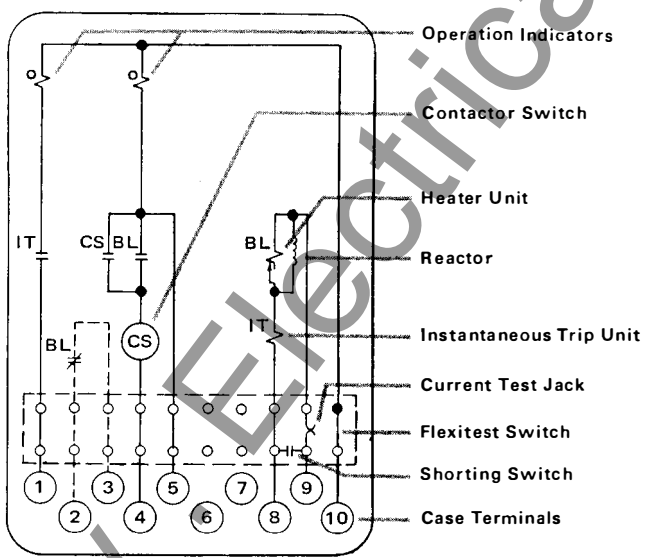
① These values apply when a contactor or seal-in switch is not used to seal-in around the heater unit contact or contacts. For tripping duty, the heater units can close 30 amperes provided the heater contacts are sealed-in by the contactor switch.
② Instantaneous trip contacts will carry 30 amperes for one second.

Coil Burden Data at 5 Amps, 60 Hertz

One Heater Unit and One Instantaneous Trip Unit in Series	Heater Tap Link	
	Open	Closed
Continuous rating, amperes	3.5	5.0
Watts	6.25	3.25
Volt-amperes	6.25	3.25
Power factor	1.0	1.0
Resistance in ohms of heater and trip unit	0.25	0.13
1-second ampere rating of heater unit	70	100

Internal Wiring (Front View)

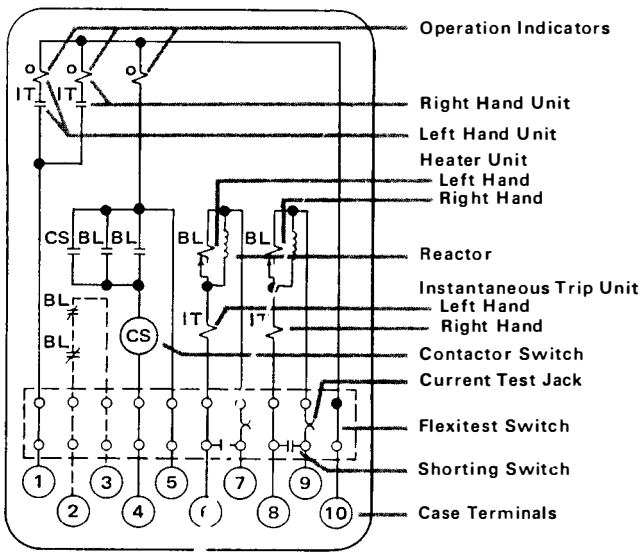
Single Unit BL-1 Relay With Front and Back Contacts in FT-21 Case①



① Dash line circuit is omitted on single unit relays with a front contact only.

Fig. 2 629A289

Double Unit BL-1 Relay With Front and Back Contacts in FT-21 Case②



② Dash line circuit is omitted on double unit relays with front contacts only

Fig. 3 629A290

Type BL-1, Continued

Operating Time Curves, 60 Minute①

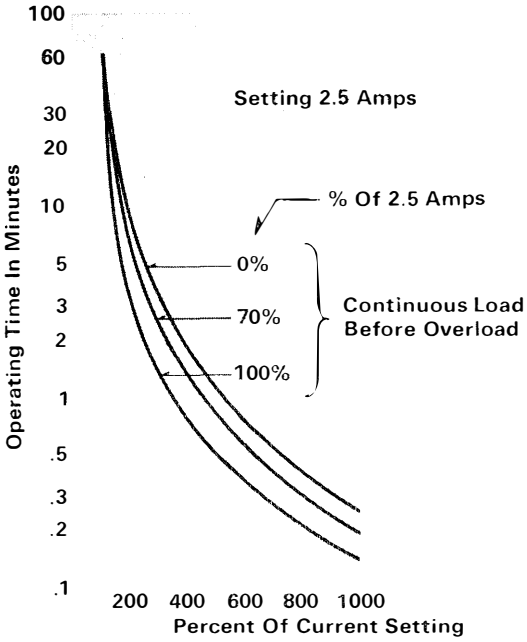


Fig. 4 396065

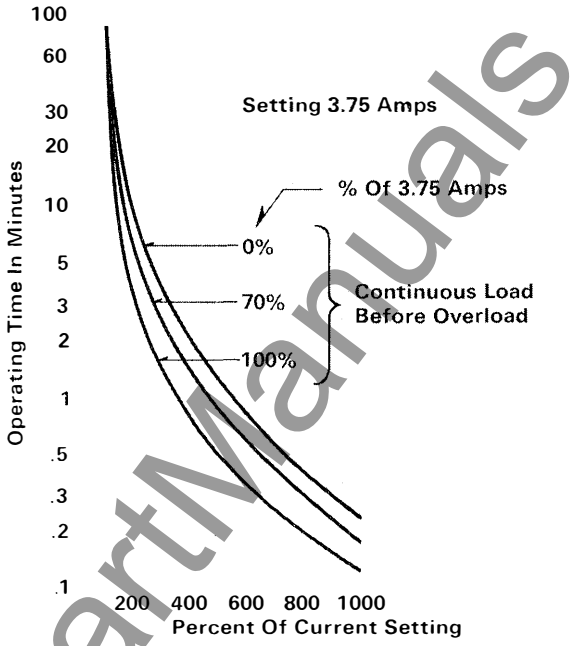


Fig. 6 396066

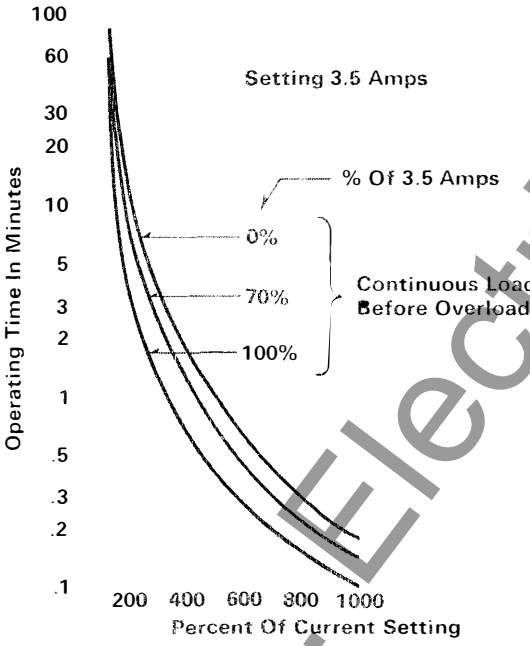


Fig. 5 396065

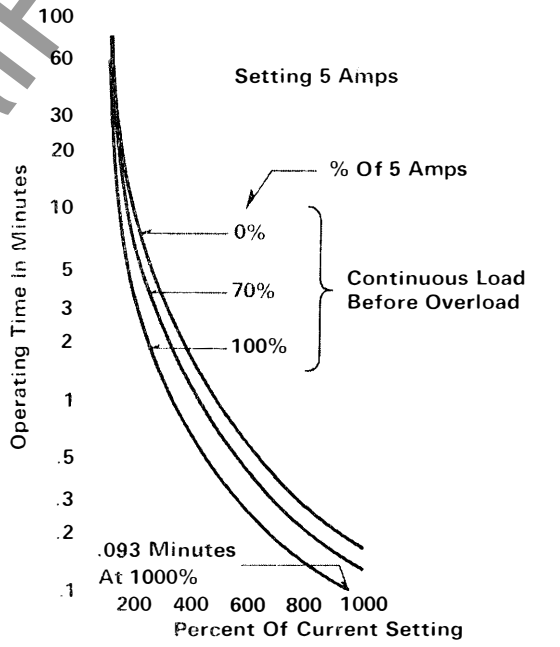


Fig. 7 396066

① BL-1 relay is calibrated to close its contacts in 60 minutes with 125% of current setting applied (after reaching constant temperature at 100% of current setting), and proportionally faster for higher currents shown above.

Operating Time Curves, 15 Minute②

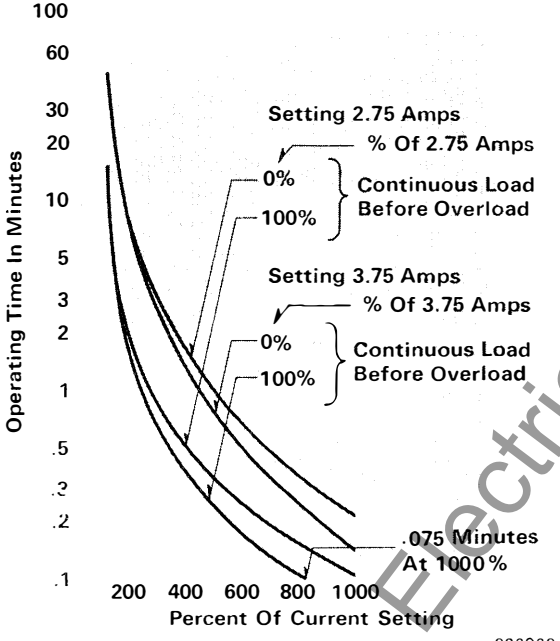


Fig. 8 396063

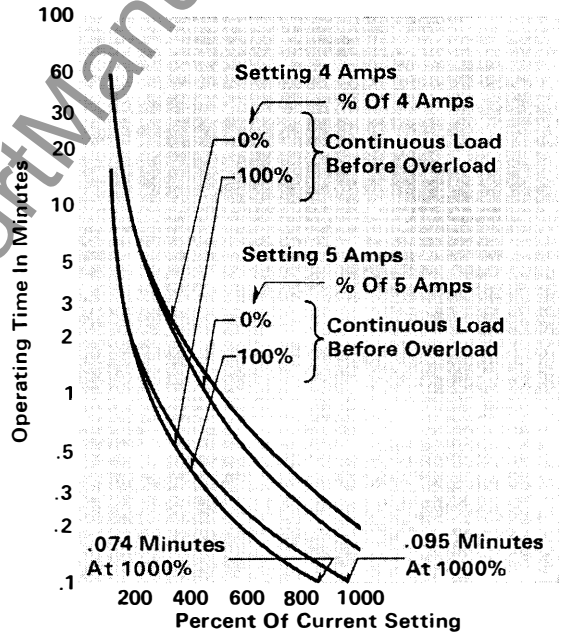


Fig. 9 396064

② BL-1 relay is calibrated to close its contacts in 15 minutes with 125% of current setting applied (after reaching constant temperature at 100% of current setting), and proportionally faster for higher currents shown above.

Type BL-1, Continued

Contact Opening Time Curves
(Applies to circuit closing contacts only).

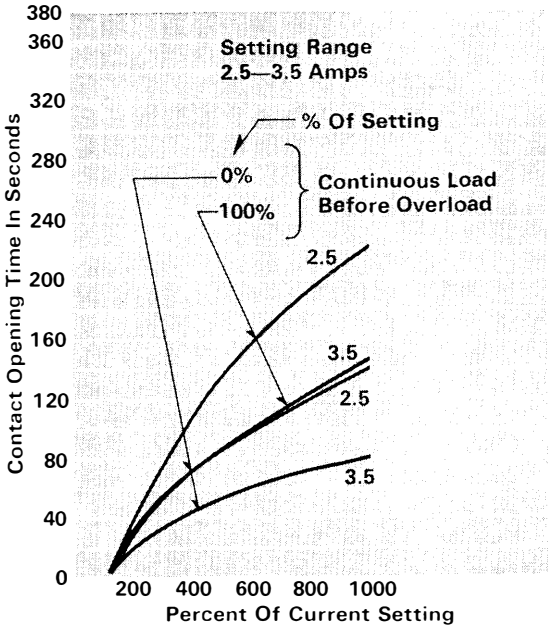


Fig. 10 396061

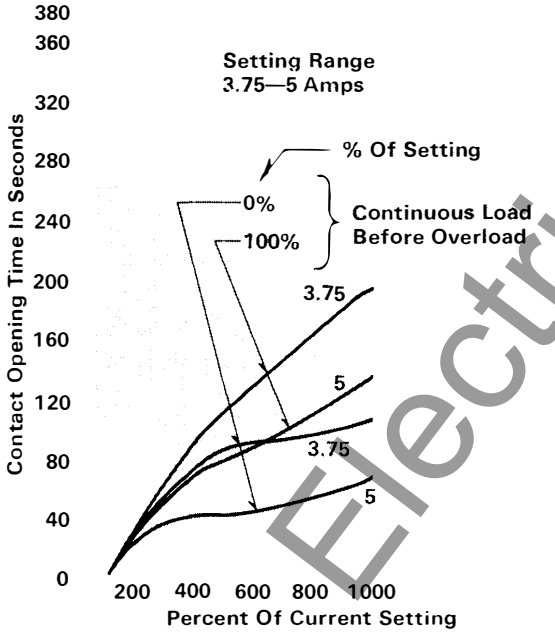


Fig. 11 396062

Reset Time Curves

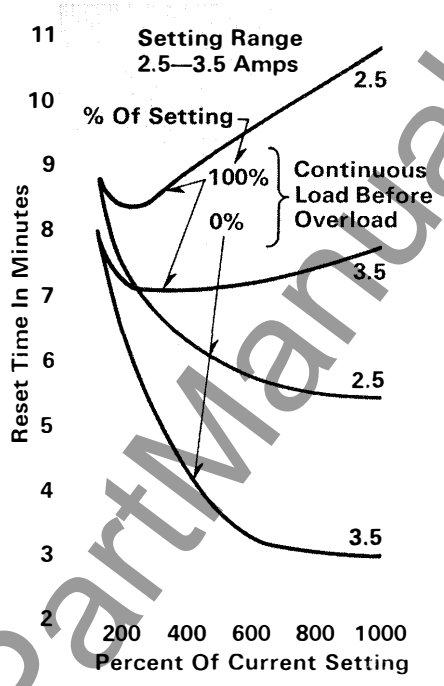


Fig. 12 396061

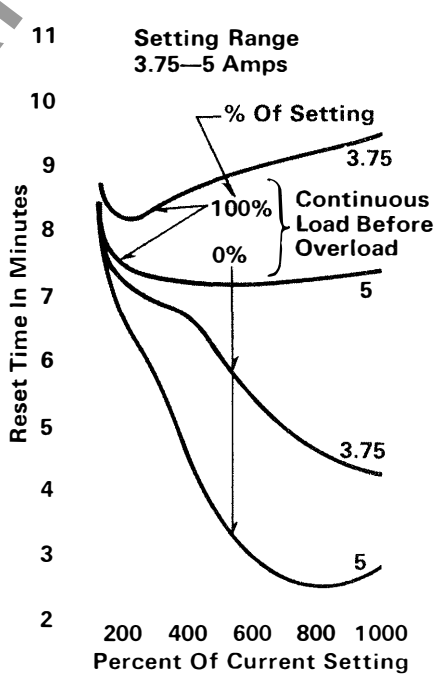
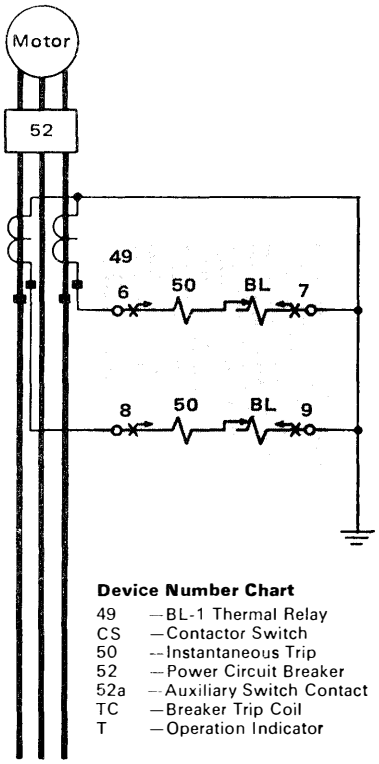


Fig. 13 396062

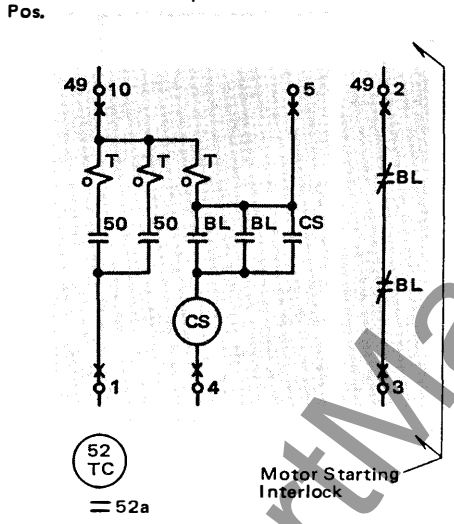
Typical Application



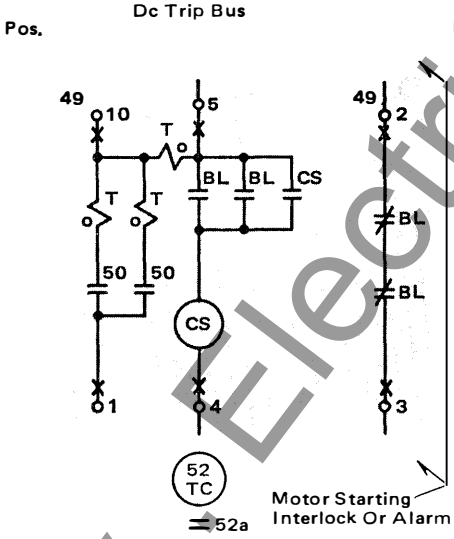
Device Number Chart

49	—BL-1 Thermal Relay
CS	—Contactor Switch
50	—Instantaneous Trip
52	—Power Circuit Breaker
52a	—Auxiliary Switch Contact
TC	—Breaker Trip Coil
T	—Operation Indicator

Thermal And Instantaneous Tripping



Thermal Tripping Only—No Indication



Instantaneous Tripping—Thermal Alarm

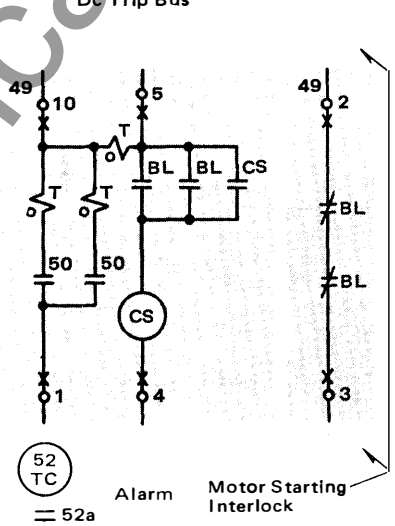


Fig. 14

288B836

Type DT-3

Construction

(1) Internal Series Resistors

See figures 18 and 19, for values.

(2) Moving Coil

Rotates in air gap between magnetic core and frame casting. Supported by sapphire jewel thrust bearing, and aligned by guide-pin bearing at top.

(3) Bridge Resistors

(4) Current Carrying Counter Wound Restraining Springs

(5) Magnetic Core

Alnico permanent magnet with two iron pole pieces separated by two brass blocks.

(6) Malleable Iron Frame Casting

(7) Temperature Scale

Calibrated from 60° to 120°C.

(8) Moving Contact

Attached to bottom shaft of moving element. Connected to a third current carrying restraining spring.

(9) Stationary Contacts

Independently adjustable. Minimum contact gap is 1/32-inch either side of moving contact.

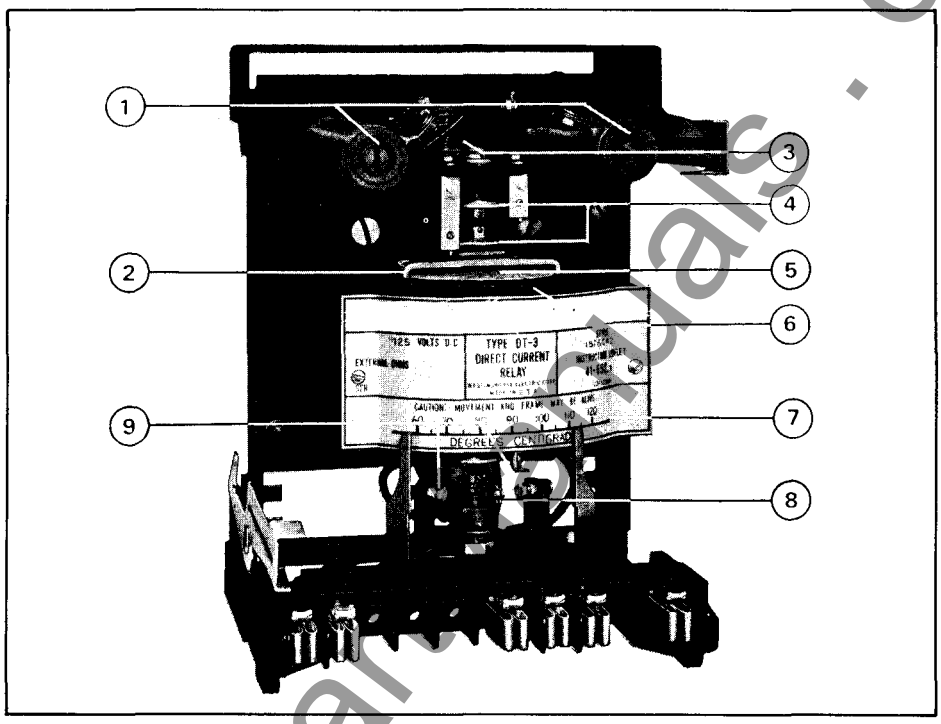


Fig. 15

Characteristics, Settings

The right hand stationary contact can be adjusted so that it will make contact with the moving contact for any search coil temperature within the calibrated range of the relay. The lefthand stationary contact can be set to energize another circuit (see figure 18 at a temperature less than the setting of the righthand contact.

The relay can be supplied for ac or dc operation.

The standard DT-3 relay is designed to operate in conjunction with a 10-ohm search coil, and is calibrated for a range of 60° to 120°C. The moving contact remains at the 90°C center position when no current flows in the moving coil. Center adjustment of the moving contact can be made by loosening the upper plate bearing screw and rotating the restraining spring guide posts to the right or left as required. The three bridge resistors in the bridge circuit (figures 18 and 19) are adjusted to a value of 12.5 ohms to balance out with the search coil, which also has 12.5 ohms resistance at 90°C or 10 ohms at 25°C.

The search coil temperatures determine the direction of current flow through the DT-3 moving coil, and thus determine the direction of moving contact rotation. The electrical torque of the moving coil is counterbalanced by the mechanical torque of the two upper restraining springs, thus determining the position of the moving contact.

Moving Coil and Contact Data

Moving coil resistance: 15 ohms at 25°C.

Dc Control Voltage	Amperes Contacts Will (Non-Inductive Load)	
	Open	Close
125 Volts	0.04①	1.0
250 Volts	0.02①	1.0

① Infrequent operation only.

Typical Applications With Auxiliary Relay

The DT-3 relay contacts will close 1 ampere but should not be used to open any appreciable current (see Contact Data, page 8). Therefore, it is often used to supervise the action of an auxiliary SG relay as shown in figure 16. The SG contact does the actual opening and closing of the master control or trip circuit. The DT-3 righthand contact closes at the higher temperature value to energize the SG coil. The SG relay seals itself in through one of its own contacts and remains sealed in until the low temperature or back contact of the DT-3 closes to short out the SG, which then opens.

Note

For applications where the search coils supplied on generators or motors are permanently grounded on one end, the dc station control circuits cannot be used as a dc supply for the DT-3.

In these applications, a suitable rectifier (internal to the relay) is used as a source of dc. Refer to figure 17.

Legend

68 – Temperature Relay, Type DT-3
68X – Auxiliary Relay, Type SG

With Ungrounded Search Coil

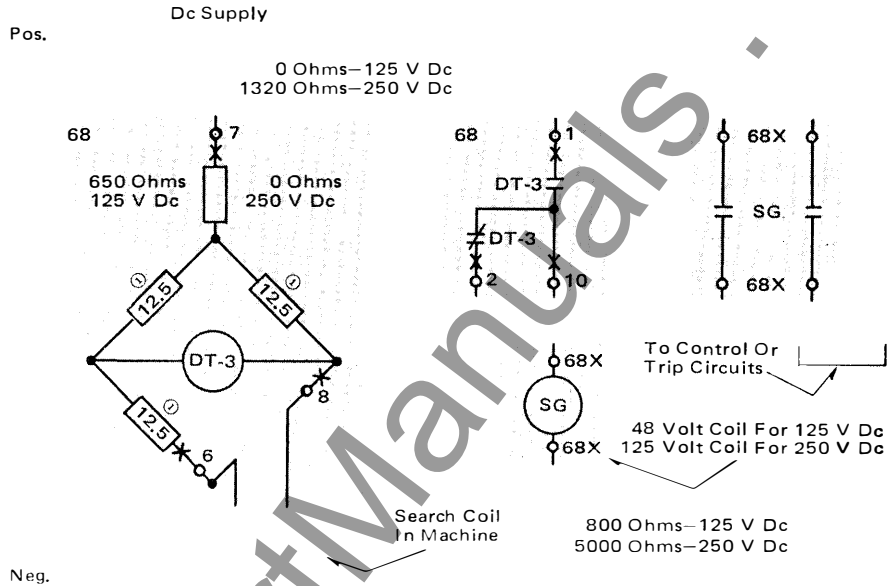


Fig. 16 183A327

With Grounded Search Coil

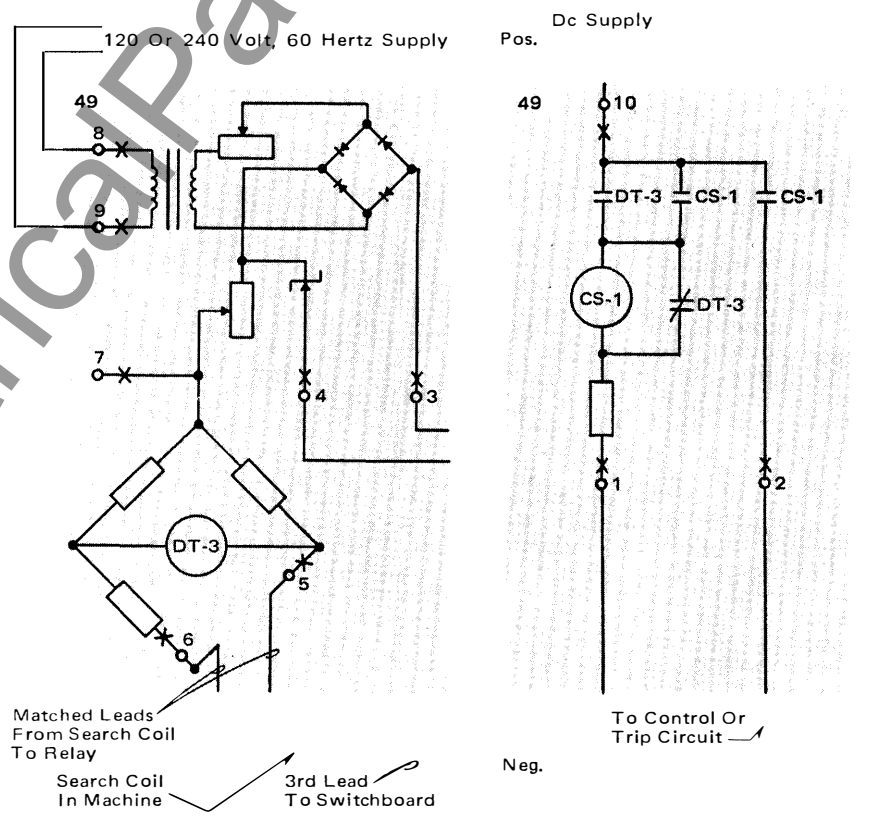


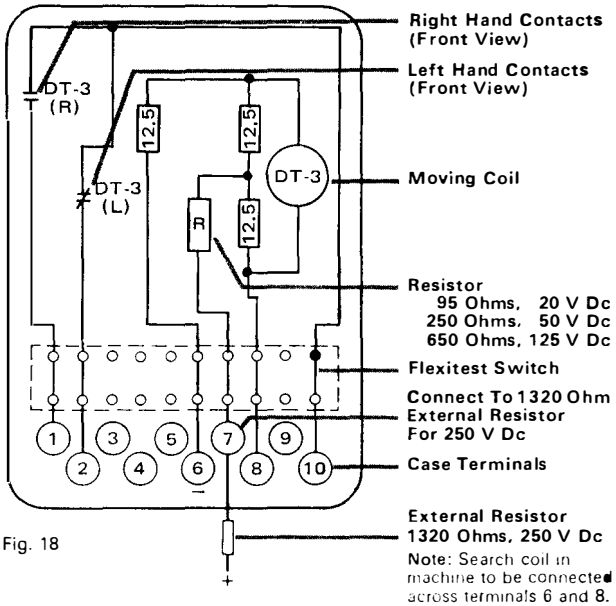
Fig. 17 184A511

① Resistor values are shown for 60°-120°C scale and 10 ohm search coil.

Type DT-3, Continued

Internal Wiring (Front View)

Type DT-3 Dc Relay – FT-21 Case



Note: Search coil in machine to be connected across terminals 6 and 8.

Fig. 18

182A789

Type DT-3 Ac Relay – FT-21 Case

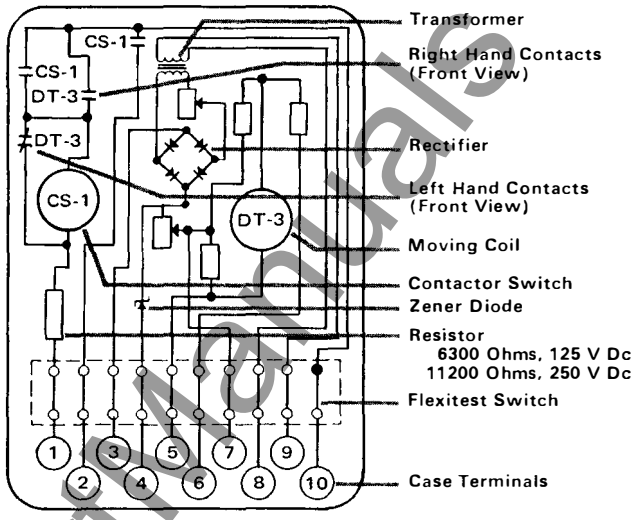


Fig. 19

184A451

Resistor Assembly Supplied With DT-3 250-Volt Dc Relay

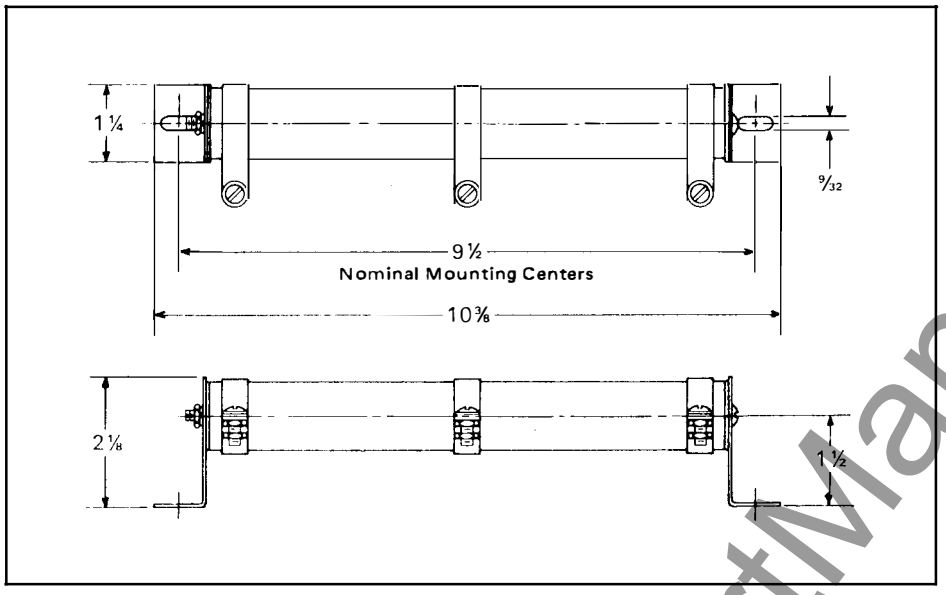


Fig. 20

Shipping Weights and Carton Dimensions

Case Type	Weight, Lbs.		Domestic Carton Dimensions, Inches
	Net	Shipping	
FT-21	12	16	9 x 12 x 12

Further Information

List Prices: PL 41-020
Technical Data: TD 41-025
Instructions:
Type BL-1, IL 41-553.1
Type DT-3, IL 41-552.1
Renewal Parts:
Type BL-1, RPD 41-904
Type DT-3, RPD 41-930
Flexitest Case Dimensions: DB 41-076
Contactor Switches: DB 41-081
Other Protective Relays:
Application Selector Guide, TD 41-016

December, 1990
Supersedes TD 41-020, Types BL-1 and DT-3 on page 83, dated November, 1987
Mailed to: E, D, C/41-500A

For Protection of Ac Motors, Ac Generators, and Transformers

Types BL-1 and DT-3 Temperature Relays

Temperature
Thermal Overload (Device Number: 49)

Type	Units Per Case	Contacts Per Unit	Contactor Switch (CS)	Operation Indicators: Amp Dc	Amps: Ac/Dc Heater Unit	Amps: Ac/Dc Instantaneous Trip Unit	Relay Data: Internal Schematic	Relay Data: Style Number	Case Size
BL-1	One	Spst-cc	2.0 amp dc	Two 0.2 amp Two 1.0 amp	2.5-5	One 6-50	629A288	293B119A11 293B119A09	**FT-21**
25 to 60 Hertz ⑨		Spdt-co and cc		Two 1.0 amp			629A289	293B119A10	
	Two	Spst-cc		Three 0.2 amp Three 1.0 amp		Two 6-50	629A280	293B119A23 293B119A21	
		Spdt-cc and co		Three 0.2 amp Three 1.0 amp Three 2.0 amp			629A290 3508A12	293B119A24 293B119A22 293B119A30	

Type	Contacts	Contactor Switch (CS-1)	Operation Indicator	Temperature Range	Rating: Volts ⑧	Relay Data: Internal Schematic	Relay Data: Style Number	Case Size
DT-3	Spdt-co and cc	48 volts dc	None	50°-190°C	120 ac	184A451	1962 384	**FT-21**
		125 volts dc	None		120 ac	184A451	1961 834	
		125 volts dc	0.2 amp dc		120 ac	836A573	288B881A32	
(10 ohm search coils only 25°C copper)		125 volts dc	None		240 ac	184A451	288B881A26	
		125 volts dc	None		125 dc	762A503	1963 345⑩	
		250 volts dc	None		250 dc	762A503	288B881A28⑦⑩	
		None	None	60°-120°C	20 dc	182A789	1876 041⑩	
				60°-140°C	20 dc	184A287	1961 560⑩	
				100°-160°C	48 dc	836A556	288B881A13⑩	
				0°-100°C	125 dc	3503A64	288B881A15⑩	
				60°-120°C	125 dc	182A789	1876 042⑩	
				60°-120°C	250 dc	182A789	1876 043⑦⑩	
				50°-190°C	240 ac	184A851	1962 311	
DT-3 ①	Spdt-co and cc	125 Vdc	0.2 amp dc	50°-190°C 100°-160°C	120 ac	3496A13	774B048A09 774B048A10	**FT-21**
(120 ohm 0°C nickel sensor)								
DT-3 ①	Spdt-co and cc	125 Vdc 120 Vac	0.2 amp dc	50°-190°C	120 Vac 120 Vac	3521A42	774B048A25 774B048A26	**FT-21**
(100 ohm 0°C platinum sensor)								

① 50-Hertz relays and auxiliaries can be supplied at same price. Order "Similar to Style Number . . . . . , except 50 Hertz".
⑦ Style number includes external series resistor.
⑧ Ac ratings are 60 Hertz.
⑨ BL-1 relay not recommended for dc machine applications.
⑩ For applications where the search coils supplied on generators or motors are permanently grounded on one end, the dc circuits cannot be used as a dc supply for the DT-3. Use ac relays which have internal rectifiers as a source of dc.