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 temperature 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 connects 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 inde-
dependently of the circuit closing (front)
contact.

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 be-
tween the make and break stationary con-
tacts. 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 over-
load. 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 bi-
metallic 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 perme-
ability reactor is provided in shunt with the
heaters. This reactor does not affect the
time curve of the relay up to 100% of setting
but provides protection from very high cur-
rents of short duration.

9. Scale Plate

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

Shipping Weights and Dimensions

<table>
<thead>
<tr>
<th>Case</th>
<th>Units Per Case</th>
<th>Weight, Lbs.</th>
<th>Domestic Shipping Carton Dims, Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>FT-21</td>
<td>1</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>14</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9 x 12 x 12</td>
</tr>
</tbody>
</table>

September, 1990
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

<table>
<thead>
<tr>
<th>Unit</th>
<th>Control Voltage</th>
<th>Contact Capacity in Amperes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Will Break</td>
<td>Will Close</td>
</tr>
<tr>
<td>Heater</td>
<td>125 v dc</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>250 v dc</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>120 v ac</td>
<td>5.0</td>
</tr>
<tr>
<td>Instantaneous</td>
<td>120 v dc</td>
<td>1.5</td>
</tr>
<tr>
<td>Trip</td>
<td>250 v dc</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>120 v ac</td>
<td>15.0</td>
</tr>
</tbody>
</table>

These values apply when a contactor or seal-in switch is not used to seal-in around the heater unit or contacts. For tripping duty, the heater units can close 30 amperes provided the heater contacts are sealed-in by the contactor switch.

Instantaneous trip contacts will carry 30 amperes for one second.

Coil Burden Data at 5 Amps, 60 Hertz

<table>
<thead>
<tr>
<th>One Heater Unit and One Instantaneous Trip Unit in Series</th>
<th>Heater Tap Link</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Open</td>
</tr>
<tr>
<td>Continuous rating, amperes</td>
<td>3.5</td>
</tr>
<tr>
<td>Watts</td>
<td>6.25</td>
</tr>
<tr>
<td>Volt-amps, amperes</td>
<td>6.25</td>
</tr>
<tr>
<td>Power factor</td>
<td>1.0</td>
</tr>
<tr>
<td>Resistance in ohms of heater and trip unit</td>
<td>0.25</td>
</tr>
<tr>
<td>1-second ampere rating of heater unit</td>
<td>70</td>
</tr>
</tbody>
</table>

Internal Wiring (Front View)

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

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

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

Fig. 2

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

Fig. 3

September, 1990
Type BL-1, Continued

Operating Time Curves, 60 Minute®

Setting 2.5 Amps

- % Of 2.5 Amps
  - 0%
  - 70%
  - 100%

Continuous Load Before Overload

Operating Time in Minutes

200 400 600 800 1000
Percent Of Current Setting

Setting 3.75 Amps

- % Of 3.75 Amps
  - 0%
  - 70%
  - 100%

Continuous Load Before Overload

Operating Time in Minutes

200 400 600 800 1000
Percent Of Current Setting

Fig. 4

350066

Fig. 6

350066

Setting 3.5 Amps

- % Of 3.5 Amps
  - 0%
  - 70%
  - 100%

Continuous Load Before Overload

Operating Time in Minutes

200 400 600 800 1000
Percent Of Current Setting

Fig. 5

350066

Fig. 7

350066

Setting 5 Amps

- % Of 5 Amps
  - 0%
  - 70%
  - 100%

Continuous Load Before Overload

Operating Time in Minutes

200 400 600 800 1000
Percent Of Current Setting

0.93 Minutes
At 1000%

Fig. 5

350066

Fig. 7

350066

© 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.

September, 1990
Operating Time Curves, 15 Minute²

<table>
<thead>
<tr>
<th>Setting 2.75 Amps</th>
<th>% Of 2.75 Amps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous Load</td>
<td>Before Overload</td>
</tr>
<tr>
<td>0%</td>
<td>100%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Setting 3.75 Amps</th>
<th>% Of 3.75 Amps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous Load</td>
<td>Before Overload</td>
</tr>
<tr>
<td>0%</td>
<td>100%</td>
</tr>
</tbody>
</table>

0.75 Minutes At 1000%

Fig. 8

<table>
<thead>
<tr>
<th>Setting 4 Amps</th>
<th>% Of 4 Amps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous Load Before Overload</td>
<td></td>
</tr>
<tr>
<td>0%</td>
<td>100%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Setting 5 Amps</th>
<th>% Of 5 Amps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous Load Before Overload</td>
<td></td>
</tr>
<tr>
<td>0%</td>
<td>100%</td>
</tr>
</tbody>
</table>

0.074 Minutes At 1000%

0.095 Minutes At 1000%

Fig. 9

© 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.

September, 1990
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
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 1/6-inch either side of moving contact.

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 counter-balanced 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.

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Open</th>
<th>Close</th>
</tr>
</thead>
<tbody>
<tr>
<td>125 V</td>
<td>0.04</td>
<td>1.0</td>
</tr>
<tr>
<td>250 V</td>
<td>0.02</td>
<td>1.0</td>
</tr>
</tbody>
</table>

@ Infrequent operation only.

September, 1990
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

![Diagram of a circuit with DT-3 relay and SG coil.]

Dc Supply

Pos.

0 Ohms—125 V Dc
1320 Ohms—250 V Dc

68

650 Ohms
125 V Dc

68X

DT-3

Search Coil
In Machine

To Control Or
Trip Circuits

800 Ohms—125 V Dc
5000 Ohms—250 V Dc

With Grounded Search Coil

120 Or 240 Volt, 60 Hertz Supply

Dc Supply

Pos.

![Diagram of a circuit with DT-3 relay and grounded search coil.]

Neg.

Matched Leads
From Search Coil
To Relay

Search Coil
In Machine

3rd Lead
To Switchboard

To Control Or
Trip Circuit

Fig. 16

183A327

Fig. 17

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

September, 1990
Type DT-3, Continued
Internal Wiring (Front View)
Type DT-3 Dc Relay – FT-21 Case

Fig. 18

Type DT-3 Ac Relay – FT-21 Case

Fig. 19

184A451

182A789

September, 1990
Resistor Assembly Supplied With DT-3 260-Volt Dc Relay

Shipping Weights and Carton Dimensions

<table>
<thead>
<tr>
<th>Case Type</th>
<th>Weight, Lbs.</th>
<th>Domestic Carton Dimensions, Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>FT-21</td>
<td>12</td>
<td>16 x 16 x 16</td>
</tr>
</tbody>
</table>

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  
Flexiext Case Dimensions: DB 41-076  
Contactor Switches: DB 41-061  
Other Protective Relays:  
Application Selector Guide, TD 41-016

Fig. 20

September, 1990
# Types BL-1 and DT-3 Temperature Relays

## Temperature

### Thermal Overload (Device Number: 49)

<table>
<thead>
<tr>
<th>Type</th>
<th>Units Per Case</th>
<th>Contacts Per Unit</th>
<th>Contactor Switch (CS)</th>
<th>Operation Indicators:</th>
<th>Amps: Ac/Db</th>
<th>Relay Data</th>
<th>Style Number</th>
<th>Case Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>BL-1</td>
<td>One</td>
<td>Split-cc</td>
<td>20 amp dc</td>
<td>Two 0.2 amp</td>
<td>2.5-5</td>
<td>629A288</td>
<td>290B119A11</td>
<td>FT-21</td>
</tr>
<tr>
<td></td>
<td>Two</td>
<td>Split-cc</td>
<td></td>
<td>1.0 amp</td>
<td>2-6-50</td>
<td></td>
<td>290B119A09</td>
<td></td>
</tr>
<tr>
<td>25 to 60 Hz</td>
<td></td>
<td>and cc</td>
<td></td>
<td>Two 0.2 amp</td>
<td>2.0 amp</td>
<td>629A289</td>
<td>290B119A10</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Split-cc</td>
<td></td>
<td>Three 0.2 amp</td>
<td>2-6-50</td>
<td></td>
<td>290B119A23</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>and cc</td>
<td></td>
<td>Three 1.0 amp</td>
<td>2-6-50</td>
<td></td>
<td>290B119A21</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>and cc</td>
<td></td>
<td>Three 0.2 amp</td>
<td>2-6-50</td>
<td></td>
<td>290B119A24</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>and cc</td>
<td></td>
<td>Three 1.0 amp</td>
<td>2-6-50</td>
<td></td>
<td>290B119A22</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>and cc</td>
<td></td>
<td>Three 2.0 amp</td>
<td>2-6-50</td>
<td></td>
<td>290B119A30</td>
<td></td>
</tr>
</tbody>
</table>

### DT-3

<table>
<thead>
<tr>
<th>Type</th>
<th>Contacts</th>
<th>Contactor Switch (CS-1)</th>
<th>Operation Indicator</th>
<th>Temperature Range</th>
<th>Rating</th>
<th>Relay Data</th>
<th>Style Number</th>
<th>Case Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>DT-3</td>
<td>Split-co</td>
<td>None</td>
<td>50°-190°C</td>
<td>120 ac</td>
<td>1844451</td>
<td>2988851A29</td>
<td></td>
<td>FT-21</td>
</tr>
<tr>
<td></td>
<td>and cc</td>
<td>120 volts dc</td>
<td></td>
<td>120 ac</td>
<td>29013419</td>
<td>2988851A29</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>125 volts dc</td>
<td></td>
<td>120 ac</td>
<td>1844451</td>
<td>2988851A29</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>125 volts dc</td>
<td></td>
<td>240 ac</td>
<td>1844451</td>
<td>2988851A29</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>125 volts dc</td>
<td></td>
<td>250 dc</td>
<td>1844451</td>
<td>2988851A29</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>250 volts dc</td>
<td></td>
<td>250 dc</td>
<td>1844451</td>
<td>2988851A29</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>60°-120°C</td>
<td></td>
<td>20 dc</td>
<td>1824789</td>
<td>2988851A29</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>60°-140°C</td>
<td></td>
<td>20 dc</td>
<td>1844257</td>
<td>2988851A29</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>100°-160°C</td>
<td></td>
<td>48 dc</td>
<td>8964566</td>
<td>2988851A13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0°-100°C</td>
<td></td>
<td>125 dc</td>
<td>3504146</td>
<td>2988851A13</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>60°-120°C</td>
<td></td>
<td>125 dc</td>
<td>1824789</td>
<td>2988851A29</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>60°-120°C</td>
<td></td>
<td>250 dc</td>
<td>1844851</td>
<td>2988851A29</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>50°-190°C</td>
<td></td>
<td>240 ac</td>
<td>1844851</td>
<td>2988851A29</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>50°-190°C</td>
<td></td>
<td>120 ac</td>
<td>34942A13</td>
<td>7740048A09</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>125 Vdc</td>
<td></td>
<td>50°-190°C</td>
<td>120 Vac</td>
<td>7740048A25</td>
<td></td>
<td>FT-21</td>
</tr>
<tr>
<td></td>
<td></td>
<td>120 Vac</td>
<td></td>
<td>0.2 amp dc</td>
<td>3521A42</td>
<td>7740048A25</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(120 ohm 0°C nickel sensor)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>125 Vdc</td>
<td></td>
<td>120 Vac</td>
<td>7740048A25</td>
<td></td>
<td></td>
<td>FT-21</td>
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<td></td>
<td></td>
<td>120 Vac</td>
<td></td>
<td>0.2 amp dc</td>
<td>7740048A25</td>
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<td>(100 ohm 0°C platinum sensor)</td>
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</table>

© 50-Hertz relays and auxiliaries can be supplied at same price. Order “Similar to Style Number . . . . . . . . , except 50 Hertz.”
© Style number includes external series resistor.
* Ac ratings are 60 Hz.
© BL-1 relay not recommended for dc machine applications.
© 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.