URC Utility Relay Company

INSTALLATION/MAINTENANCE INSTRUCTIONS
FBK HI-SPEED DC TRIP UNIT
WITH UNIVERSAL INPUT CONTROL VOLTAGE

For Use With
FBK-H Direct Current Circuit Breakers

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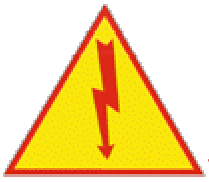
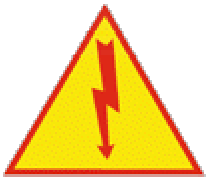
THESE INSTRUCTIONS DO NOT PURPORT TO COVER ALL DETAILS OR VARIATIONS IN EQUIPMENT NOR TO PROVIDE FOR EVERY POSSIBLE CONTINGENCY TO BE MET IN CONNECTION WITH INSTALLATION, OPERATION, OR MAINTENANCE. SHOULD FURTHER INFORMATION BE DESIRED OR SHOULD PARTICULAR PROBLEMS ARISE WHICH ARE NOT COVERED SUFFICIENTLY FOR THE PURCHASER'S PURPOSES, THE MATTER SHOULD BE REFERRED TO UTILITY RELAY COMPANY.

*Optional Features

Utility Relay Company



SAFETY NOTICE



DANGER: TURN OFF POWER SUPPLYING THE EQUIPMENT BEFORE WORKING INSIDE THE BREAKER!!!

Installing, commissioning, maintaining, changing or refitting these units must be carried out only by qualified and suitably trained specialist personnel and under strict observation of national and international safety regulations.

Non-compliance with these warnings can result in death, severe physical injury and extensive damage to the equipment.

The control circuits are partly equipped with capacitors that may be charged with dangerous voltages.
Work on this section must be carried out carefully.

1.0 Introduction

This manual applies to Hi-Speed trip units with Firmware Rev. 4.03 and with the following Catalog numbers:

B-814-U0-8B-XX
B-814-U0-9B-XX
B-819-U0-8B-XX
B-819-U0-9B-XX

The Hi-Speed DC Trip System is a state of the art, microcontroller based trip system intended for use on one and two pole FBK DC circuit breakers. The Hi-Speed DC Trip System provides bi-directional and directional overcurrent protection.

For transit system applications, optional rate-of-rise protection is available.

The Hi-Speed Trip System consists of 3 basic components:

- A bi-directional Hall-effect current transducer
- The trip unit
- An impulse trip coil (not provided by Utility Relay Company)

The trip unit contains the following basic components:

- Logic circuits that include analog and digital electronics and a Motorola microcontroller
- User input/outputs
  16 character liquid crystal display (LCD)
  membrane type input push buttons
  two LED indicators
- High voltage power supply
- High voltage trip capacitor
- A capacitor discharge system

The trip unit provides the following trip functions:

Bi-directional

- Over load* (LT)
- Short Time* (ST)

Uni-directional (forward current only)

- Hi-Speed Instantaneous Forward (FASTFOR)
- Hi-Speed Instantaneous Reverse* (FASTREV)
- Rate-of-Rise* (R/R)

The current transducer provides a signal to the trip unit proportional to the breaker current. The trip unit converts the transducer signal into amps for display on the LCD and also compares the current to the trip unit settings. If the trip unit determines that a trip is required, the trip capacitor that is charged to 2300 volts is discharged into the Impulse coil. The impulse coil unlatches the breaker mechanism causing the breaker to open.

The Hi-Speed DC Trip System has a universal control voltage input that is suitable for operation with the following control voltages:

- 120 volt AC 50/60Hz
- 125 volt DC
- 250 volt DC

2.0 Features

The Hi-Speed DC Trip System offers the following features:

a) Unique current sensing method provides bi-directional current sensing with one transducer.

b) Displays last trip data for the three last trip events including the current at the time of trip (except for FASTFOR and FASTREV).

c) Trip log provides a record of the number of trips for each trip function since last reset.

d) All settings are made directly in amps or in seconds.

e) Ease of coordination is provided with settings that are made in extremely small increments.

f) 16 Character alphanumeric display with backlight.

The trip unit also incorporates several self-test features that continually monitor the trip system status. The green LED on the face of the trip unit provides a visual indication that the trip unit is operating properly.

Self-test features include:

1) Watch-dog timer and check-sum monitoring to ensure the micro-controller is functioning properly.

2) Monitoring of the current transducer to ensure it is properly connected.

3) Monitoring of the high voltage trip capacitor charge.

3.0 Trip Unit

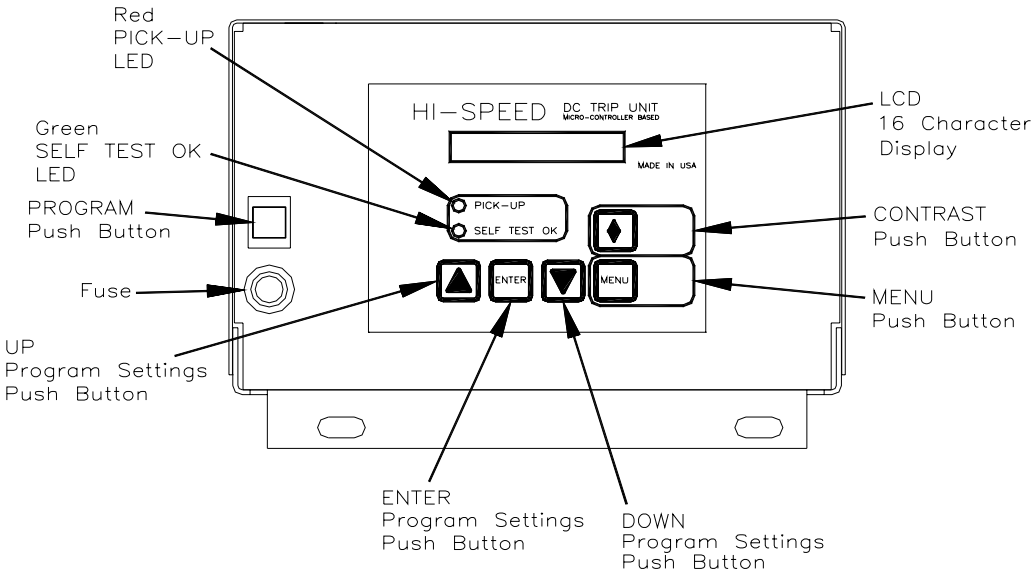
3.1 Current Measurement Algorithms

The trip unit uses an advanced Motorola microcontroller to perform the DC current calculations and to implement the protection and logic functions.

For the **non-hi-speed trip functions**, the trip unit determines the DC current by averaging four A/D (analog to digital) samples of the current transducer signal at a 0.521 milli-second rate. The average value obtained is then multiplied by the current transducer rating to arrive at the breaker current in amps. This is the current used for the non-hi-speed trip functions and the current saved in the last trip data.

For the **FASTFOR trip function**, the microcontroller looks at each individual A/D sample of the current transducer signal in the forward direction and ignores current signals in the reverse direction. For the **FASTREV trip function***, the microcontroller looks at each individual A/D sample of the current transducer signal in the reverse direction and ignores current signals in the forward direction. If two samples in a row for these functions are above the FASTFOR or FASTREV pick-up setting, the microcontroller initiates a trip. This entire procedure will take less than 1.5 milli-seconds. On the FBK breaker, the total time from fault inception to contact parting is less than 8 milli-seconds.

FIGURE 1



3.2 User Input/Outputs

The user inputs/outputs consists of several push buttons, an LCD 16 character display and two LEDs.

The **LCD display** is a 16-character dot matrix liquid crystal display. The LCD is used to display the settings as well as the last trip data and the trip log.

The LCD has a low level backlight to make it easier to read in low ambient light conditions.

The contrast level of the LCD can be adjusted by pushing and holding in the **contrast push button**. Release the contrast push button when the desired contrast level is reached.

The red **pick-up LED** is on whenever the breaker current is above long time* (LT) pick-up setting (if on).

The green **self-test OK LED** is on whenever the microcontroller determines that the trip unit is operating properly and the high voltage capacitor is charged to greater than 1800 volts.

The **menu** push button is mainly used to view the last trip data, trip log and the settings.

The **up, down** and **enter** push buttons are used when making changes to the settings. These push buttons are not operable until the trip unit "settings routine" is entered using the **program button**.

3.3 Normal Display

Whenever the green self-test OK LED is on, the LCD display will show the following...

HI-SPEED

3.4 Impulse Trip Coil Output

As shown in Figure 5, the major components used to operate the impulse trip coil are a high voltage power supply, a high voltage capacitor and the trip circuit.

The **high voltage capacitor** is designed to handle the very high discharge currents into the impulse coil. The capacitor is made with a solid dielectric to eliminate problems associated with liquid dielectric capacitors. The capacitor is charged to 2300 volts but is rated at 3000 volts. A bleed resistor slowly discharges the capacitor when the high voltage power supply is turned off.

The capacitor discharges to 50 volts in less than seven minutes after the control voltage is removed.

The **high voltage power supply** charges the capacitor to 2300 volts from the trip unit control voltage. It takes less than 4 seconds to charge the capacitor. The power supply is under the control of the microcontroller so that it only charges the capacitor when all conditions are proper.

The **trip circuit** discharges the high voltage capacitor into the impulse coil with a small signal from the microcontroller.

3.5 Auxiliary Contacts

The auxiliary contacts are shown in Figure 5. The auxiliary contacts marked with an asterisk are optional.

Reed relays with hermetically sealed contacts are used for all the auxiliary contacts.

The contacts are rated:

Carry:	6.0A, 400VDC
Switching:	100 Watts
DC (Peak AC Resistive):	3.0A Max

Permissive Contacts - The permissive relay has three normally open contacts. The permissive relay is closed only when all of the following are true:

- The trip unit has control power
- The current transducer is connected
- The trip capacitor voltage is greater than 1800 volts
- There are no self test errors detected by the trip unit

The first contact is wired in series with the breaker X-Coil. This contact prevents the breaker from being electrically closed if the Hi-Speed DC Trip System is not functional. This contact is wired to pins E & F on the trip unit control cable connector.

The other two contacts are available for customer uses. They are wired to pins J & K and C & D on the trip unit control cable connector.

Momentary Alarm - The momentary alarm relay has one normally open contact. This relay is normally not energized except for a 500 milli-second period immediately after a trip unit initiated trip. This contact is normally wired to pins S & V on the trip unit control cable connector. **A test trip will not operate the momentary alarm.**

Lockout Contact* - The lockout relay has one normally open contact. This relay is normally not energized except for a 500 milli-second period immediately after a trip unit initiated trip. This contact is normally wired to pins L & P on the trip unit control cable connector. **A test trip will not operate the momentary alarm.**

The lockout contact should be wired to an external lockout relay. The external lockout relay should be wired so that the lockout relay coil circuit is interrupted by a contact in the lockout relay and not by the lockout contact in the trip unit.

An under voltage trip* (UV) and a test trip will not operate the lockout contact.

Lamp Contact* - The lamp relay has one normally open contact. This relay is energized when the breaker current goes above 22% of the current transducer rating. The relay is de-energized when the breaker current goes below 20% of the current transducer rating. This contact is normally wired to pins G & M on the trip unit control cable connector.

3.6 Remote Trip*

With the remote trip feature, the loss of an external signal initiates a hi-speed trip.

The remote trip feature is described in Section 5.4.

3.7 Battery

A 9-volt, 1200 mAh, long life, lithium/manganese dioxide battery is incorporated in the trip unit. This battery has less than 2 grams of lithium. There are no restrictions on transport and no special methods of disposal required with this battery.

The battery is not involved in the protective functions and it does not maintain any of the microcontroller memory.

The battery performs the following two functions:

- Allows the settings to be made and the last trip data to be reviewed without control power.
- Allows the trip unit to save the last trip data with a UV* trip.

Lithium battery ratings:

- Rated shelf life of ten-years
- 1200 mAh Capacity
  (Allows the review of last trip data and settings over 1500 times on battery power only)

If it is necessary to replace the battery, use the following procedure.

- Remove the breaker from service
- Remove the trip unit from the breaker
- Wait at least 15 minutes to allow the high voltage capacitor to discharge
- Remove the top cover of the trip unit and verify that capacitor has discharged to a safe voltage using a high voltage probe
- Remove the four screws securing the top cover of the electronic housing
- Replace the battery
- Reassemble the trip unit and reinstall on the breaker

For best performance, replace the battery with an Ultralife Model U9VL-FP, 9-volt lithium battery. An alkaline type 9-volt battery may also be used with much shorter life.

4.0 Current Transducer

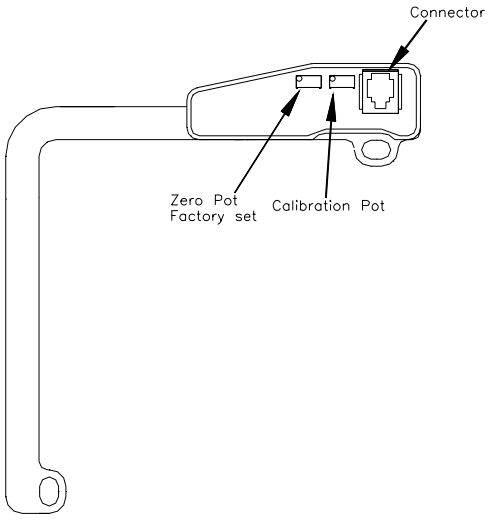


FIGURE 2

The current transducer (FIG. 2) is mounted on the lower stab of the FBK breaker and measures the current through the stab.

The current transducer is based on a Hall-effect devise and contains an electronic circuit that transforms the small Hall-effect voltage into a milli-Amp output for the trip unit. The current transducer output is proportional to the magnetic field strength at the Hall-effect devise that is proportional to the current through the stab.

Two models of transducers are available:

- The low range transducer can be calibrated for transducer ratings from 500A to 1600A.
- The high range transducer can be calibrated for transducer ratings above 1600A.

The current transducer has two multi-turn potentiometers. One is used to zero the current transducer output and is factory set and sealed.

The other potentiometer is used to calibrate the transducer to the transducer rating entered into the trip unit. See Section 9.2 for calibration information.

The current transducer is bi-directional and produces a plus or minus output depending on the direction of the breaker current.

A shielded cable connects the current transducer to the trip unit.

The electronic circuit in the current transducer includes a low pass filter to reduce the effect of high frequency noise and harmonics.

The frequency response of the current transducer is shown in Figure 3.

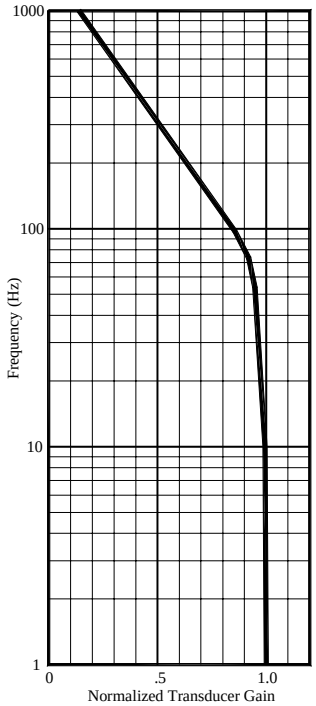


FIGURE 3

5.0 Hi-Speed Trip Functions

5.1 Hi-Speed Forward (FASTFOR)

The FASTFOR pick-up setting ranges from 100% to 500% of the transducer rating in steps that depend on the rating of the transducer entered.

An OFF setting is available if FASTREV* and/or R/R* is available and not OFF.

The FASTFOR pick-up setting steps are 0.05 times the transducer rating. The steps for several typical transducer ratings are:

Transducer Rating (amps)	FASTFOR Pick-Up Steps (amps)
500	25
800	40
1000	50
1200	60
1600	80
2000	100
3000	150
4000	200
6000	300
8000	400
10000	500

TABLE 1

When setting the FASTFOR trip function, the following is displayed…

FASTFOR PU XXXXXA

...where "XXXXX" represents the FASTFOR pick-up setting in amps.

Press and hold the **up** or **down** push button as required until the desired FASTFOR pick-up is displayed.

5.2 Hi-Speed Reverse* (FASTREV)

The FASTREV pick-up setting ranges from 100% to 500% of the transducer rating in steps that depend on the rating of the transducer being used. The FASTREV pick-up setting steps are 0.05 times the transducer rating.

An OFF setting is available if FASTFOR and/or R/R* is available and not OFF.

The steps for several typical transducer ratings are given in Table 1.

When setting the FASTREV trip function, the following is displayed…

FASTREV PU XXXXXA

...where "XXXXX" represents the FASTREV pick-up setting in amps.

Press and hold the **up** or **down** push button as required until the desired FASTREV pick-up is displayed.

5.3 Normal Current Direction

The direction of normal current flow must be set to match the switchgear configuration.

When the direction of “normal” current flow is from the ***top stab to the bottom stab***, set the current direction to...

DIRECTION TOP+

With this setting, current flow from the top stab to the bottom stab is “forward” and current flow from the bottom stab to the top stab is "reverse".

When the direction of “normal” current flow is from the ***bottom stab to the top stab***, set the current direction to...

DIRECTION TOP-

With this setting, current flow from the top stab to the bottom stab is “reverse” and current flow from the bottom stab to the top stab is "forward".

5.4 Remote Trip*

The remote trip feature initiates a hi-speed trip with the loss of a 14 to 20 milli-amp external signal.

The user normally produces this signal with a 28 Vdc source in series with a 1000 Ohm current limiting resistor or with a 24 Vdc source and a 820 Ohm current limiting resistor.

The remote trip feature is independent of the micro-controller. The micro-controller monitors the external remote trip signal and will save "remote trip" as the last trip data. If the breaker failed to trip on the loss of the external signal because the high voltage capacitor was not charged, the micro-controller will initiate a remote trip as soon as the capacitor is sufficiently charged.

If this optional feature is provided, it **cannot** be turned off in the settings routine.

6.0 Non-Hi-Speed Trip Functions

6.1 Long Time Trip*

The Long Time (LT) trip function provides "thermal" type overload protection.

The LT trip function has a pick-up setting and a time delay setting.

When setting the LT trip pick-up, the following is displayed...

LT PICK-UP OFF

or…

LT PICK-UP XXXXA

...where "XXXX" represents the LT pick-up setting in amps. The LT pick-up setting ranges from OFF and 40% to 100% of the transducer rating. This setting is adjustable in 5 amp steps (50 amp steps for transducers greater than 5000 amp).

Press and hold the **up** or **down** push button as required until OFF or the correct LT pick-up setting is displayed.

Press the **enter** push button to continue.

6.2 Long Time Delay*

The following will be displayed if LT is on…

LT DELAY XX.XSEC

...where "XX.X" represents the LT Delay band. The LT Delay band is labeled by the number of seconds to trip at **6 times** the LT pick-up setting.

The LT Delay setting ranges from 2.5 to 30 seconds in steps of 0.5 seconds. This provides 56 LT Delay bands.

Press and hold the **up** or **down** push button as required until the correct LT Delay setting is displayed.

Please note that the LT trip time is not a constant value, but is a function of the breaker current. For low currents the trip time is longer, and for higher currents the trip time is shorter. The trip time is only equal to the LT Delay setting when a current 6 times the LT pick-up setting is applied. See the time-current curves in Figure 7.

Press the **enter** push button to continue and the following will be displayed…

LT THERMAL ON

If the LT thermal function is desired, press the **enter** push button to move to the next setting.

If the LT thermal function is not desired, press the **down** button to display…

LT THERMAL OFF

The LT trip function is designed to represent thermal heating. The LT thermal function is designed to mimic thermal cooling.

If an overload current momentarily drops below the LT pick-up value...

With LT thermal OFF, the LT trip register is cleared and any new overload starts with zero in the trip timer register.

With LT thermal ON, the LT trip register is slowly decremented when the current is below the LT pick-up and any new overload may start with a non-zero number in the trip timer register.

As shown in Figure 6, the LT trip curve is based on a square function. If the overload goes up by a factor of 2, the trip time goes down by a factor of 1/4.

The LT trip curve can be restated as follows:

$$\mathbf{T} = \frac{\mathbf{TBC_{LT}}}{\mathbf{X^2}}$$

Where: **T** = time to trip in seconds (center of the band)
X = current in multiples of the LT pick-up setting
$\mathbf{TBC_{LT}}$ = the LT Time Band Constant = 36 X LT time band setting

**** NOTE ****
The LT Time Band Constant (TBC_{LT}) is by definition 36 times the LT Time Band Setting in seconds.

EXAMPLE:

Transducer Rating	4000A
LT pick-up	3000A
LT time band	20.0S
Overload Current	9000A

TBC_{LT} = 36 X LT Time Band Setting
= 36 X 20.0
= 720

and $X = \frac{\text{overload current}}{\text{LT Pick-Up}} = \frac{9000A}{3000A} = 3$

therefore:
trip time = $T = \frac{TBC_{LT}}{X^2}$ or $\frac{720}{3^2} = \frac{720}{9}$
= 80 seconds

**** IN SUMMARY ****

To calculate the LT trip time:
1) Calculate the LT Time Band Constant (TBC_{LT})
2) Calculate "X" where $X = \frac{\text{overload current}}{\text{LT Pick-Up Setting}}$
3) Solve the equation: trip time(sec) = $\frac{TBC_{LT}}{X^2}$

6.3 Short Time Trip*

The Short Time (ST) trip function provides a short delay in the trip time to coordinate with a downstream protective device.

The ST trip function has a pick-up setting and a time delay setting.

When setting the ST trip function, the following is displayed...

ST PICK-UP OFF

or…

ST PICK-UP XXXXA

...where "XXXX" represents the ST pick-up in amps.

The ST pick-up setting ranges from OFF or 150% to 500% of the LT pick-up setting in 100 amp steps (1000 amp steps for transducers greater than 5000 amps). If the LT pick-up setting is OFF, then the ST pick-up range is based on the transducer rating.

Press and hold the **up** or **down** push button as required until the correct ST pick-up setting is displayed.

Press the **enter** push button to continue.

6.4 Short Time Delay*

The ST delay curve is either a definite time or a combination of an I^2T ramp and a definite time as shown in Figure 6.

When setting the ST delay, the following is displayed...

ST DELAY .XXSEC

Where ".XX" represents the ST Delay.

The ST delay settings are .07, .10, .15, .20 and .35 seconds.

Press and hold the **up** or **down** push button as required until the correct ST delay setting is displayed.

Press the **enter** push button to display…

ST I SQ T OFF

If the I^2T ramp is not desired, press the **enter** push button to move to the next setting.

If the ST I^2T ramp is desired, press the **up** push button. The following will be displayed:

ST I SQ T ON

With I^2T <u>off</u> the ST trip time is a constant equal to the ST Time Band setting.

With I^2T <u>on</u> and for currents less than 10 X LT pick-up Setting, the ST trip time is determined by the following equation:

$$\mathbf{T} = \frac{\mathbf{TBC_{ST}}}{\mathbf{X^2}}$$

Where: **T** = time to trip in seconds (center of the band)
X = current in multiples of the LT pick-up
TBC_{ST} = the ST Time Band Constant

**** NOTE ****
The ST Time Band Constant (TBC_{LT}) =
12.6 for the .35S Time Band
7.2 for the .20S Time Band
5.4 for the .15S Time Band
3.6 for the .10S Time Band
2.52 for the .07S Time Band

EXAMPLE:

Transducer Rating	6000A
LT pick-up	5000A
ST pick-up	10,000A
ST time band	.20S I^2T ON
Overload Current	15,000A

$TBC_{ST} = 7.2$

and $X = \frac{\text{overload current}}{\text{LT Pick-Up}} = \frac{15{,}000A}{5000A} = 3$

therefore:
trip time = $T = \frac{TBC_{ST}}{X^2}$ or $\frac{7.2}{3^2} = \frac{7.2}{9}$
= .80 seconds

**** IN SUMMARY ****

To calculate the ST I^2T trip time:
1) Determine the ST Time Band Constant (TBC_{ST})
2) Calculate "X" where $X = \frac{\text{overload current}}{\text{LT Pick-Up}}$
3) Solve the equation: trip time(sec) = $\frac{TBC_{ST}}{X^2}$

6.5 Rate-of-Rise Trip*

For transportation use, a rate-of-rise (R/R) trip function is available as an option.

The R/R trip function is uni-directional and operates only for current in the forward direction.

The R/R trip function provides a method to discriminate between a normal load and a distant fault of lower magnitude. This is accomplished because the R/R for a normal load current is much lower than that of a fault current.

The R/R trip function has three settings:
- Delta I
- dI/dT
- Time Delay

The R/R Delta I setting ranges from 30% to 100% of the transducer rating in 50 Amp steps (500 Amp steps for transducer ratings > 5,000 Amp).

An OFF setting is available if FASTFOR and/or FASTREV* is available and not turned off.

When setting the R/R Delta I, the following is displayed...

R/R Delta XXXXA

...where "XXXX" represents the R/R Delta I in amps.

The dI/dT setting ranges from:
Minimum… 1/Sec times the transducer rating rounded up to the next 1,000 Amp/Sec value
Maximum… 16/Sec times the transducer rating rounded up to the next 1,000 Amp/Sec value with an upper limit of 200,000 Amp/Sec
Setting Steps… 1,000 Amp/Sec steps

Currents that are increasing at a lower rate than this setting when the current magnitude crosses the pick-up setting are ignored by the rate-of-rise trip function.

When setting dI/dT, the following is displayed...

dI/dT XXXKA/S

...where "XXX" represents the dI/dT setting in thousand amps per second.

The time delay setting ranges from 48 milli-seconds to 300 milli-seconds in 12 milli-second steps.

When setting the R/R time delay, the following is displayed...

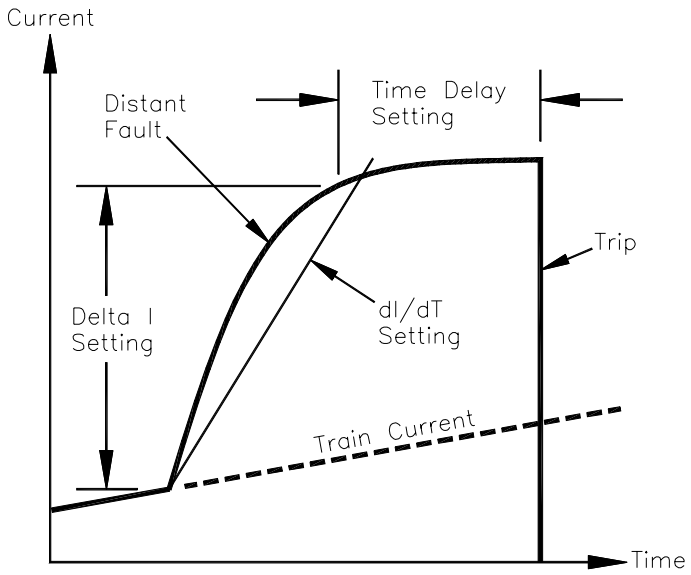
R/R DELAY .XXXS

...where "XXX" represents the R/R delay setting in seconds.

To generate a R/R trip, the load current must satisfy all of the following criteria:
- Be in the forward direction
- Go above the Delta I setting
- Have a dI/dT greater than the dI/dT setting for the total Delta I
- Remain above the Delta I setting for a time greater than the time delay setting

Figure 4 illustrates the rate-of-rise trip function.

FIGURE 4



7.0 Loss of Control Voltage* (UV)

If the loss of control voltage (UV) function is on, a trip will be initiated with a drop in control voltage.

When setting the UV trip, the following is displayed...

UV TRIP ON

or…

UV TRIP OFF

Use the **up** or **down** push buttons to change the setting if desired.

If the lockout contact option is also provided along with the UV trip option, the lockout relay contact will not operate with an UV trip.

8.0 Settings

8.1 Reviewing Last Trip Data

The trip unit last trip data and settings can be easily reviewed at any time.

Push the **menu** button to enter the last trip data/settings review program. **Protection will still be provided while in the last trip data/settings review program**. Continue to push the **menu** button to step through the last trip data, the trip log and the settings.

The trip unit saves the data for only the last 3 trip events, new trip data is written over the last 3 trip events if necessary. The latest trip is identified as “LAST TRIP”. The second latest trip is identified as “LAST TRIP-1”. The third latest trip is identified as “LAST TRIP-2”.

If no trip events have occurred since the last trip data/trip log was cleared, “NO LAST TRIP” is displayed.

The last trip data consists of the type of trip (i.e., LT, ST, FASTFOR, FASTREV, R/R, REMOTE, TEST or UV as applicable) and the associated DC current.

For a FASTFOR or FASTREV trip, the DC current at the time of trip is not displayed because the trip occurred while the current was ramping up to some higher value not known to the trip unit.

If the **menu** button is not pushed for 30 seconds, the LCD will resume its normal display.

8.2 Reviewing Settings

Continue to push the **menu** button to step thru the last trip data and the trip log and to enter the settings review program.

Continued pushing of the **menu** button will step through the settings.

If the **menu** button is not pushed for 30 seconds, the LCD will resume its normal display.

8.3 Changing Settings

The settings can be changed as follows:

Push and hold the "**Program Push Button**" then push the **menu** button. The following is displayed...

ENTER DATA

SERIAL # XXXXXXX

Press the **enter** button to begin the settings routine. The **Program Push Button** can now be released.

Enter the appropriate pick-up and delay settings using the **up** and **down** push buttons. Push the **enter** button to step to the next setting.

At the last setting the following will be displayed...

ENTER IF DONE

MENU TO REVIEW

To review the settings, push the **menu** button. Make any changes necessary using the **up** and **down** push buttons. As before, use the **enter** push button to move to each new setting.

If the settings are as desired, push the **enter** button and the settings will be saved in the non-volatile EEPROM memory.

Transducer Rating Security Feature

The Hi-Speed trip unit has a security feature to help prevent accidentally changing the programmed transducer rating.

The transducer rating programmed in the trip unit must match the actual calibrated transducer rating.

The transducer rating setting must be changed in the trip unit if:

- The current transducer will be recalibrated to a different value.

or…

- A current transducer with a different calibrated value will be installed on the breaker.

To defeat the security feature…

- With the transducer setting displayed while in the settings routine.

XDUCER XXXXA

- Push and hold the **menu** button and then also push the **enter** button.
- Release both push buttons.
- Use the **up** and **down** push buttons to enter the desired transducer rating.
- Push the **enter** button to step to the next setting.
- After all the settings are made, calibrate the transducer as outlined in Section 9.2.

The current transducer rating can range from 500 amps to 5,000 amps in 100 amp steps, and from 5,000 amps to 12,000 amps in 1000 amp steps.

8.4 Clearing Last Trip Data

After a breaker trip, the trip unit will save the trip data in its non-volatile EEPROM memory. The last trip data for the last 3 trip events can be recalled later.

To clear the last trip data and the trip log:

1) Push the **menu** button and the last trip data will be displayed...

LAST TRIP: XX

2) Push and ***hold*** both the **up** and **down** buttons and then push the **enter** button. The following will be displayed...

NO LAST TRIP

The last trip data and trip log was erased.

9.0 Testing & Calibration

9.1 Enter Desired Settings

With control power applied to the trip unit, enter the desired settings as previously described.

9.2 Calibrate Transducer

The transducer as shipped from the factory is not calibrated. The transducer must be calibrated in-place on the breaker by the customer or a third party.

A high current DC test set with very low ripple is required to program the transducer. The preferred DC current source is ether a DC generator or DC current derived from a 12-pulse AC rectifier.

Once calibrated, the transducer calibrated rating must be recorded on the calibration sticker on the transducer and the calibration potentiometer on the transducer must be sealed.

It is very important that the transducer rating entered in the Hi-Speed trip unit is the same as the rating the transducer on the breaker is calibrated for.

**** IMPORTANT ****
The current transducer rating must NOT be greater than the breaker current rating.

If the current transducer rating is changed in the trip unit, the transducer
MUST BE RE-CALIBRATED

The basic calibration procedure is as follows:

1. Install the transducer and Hi-Speed trip unit on the breaker.

   If the Hi-Speed trip unit has the remote trip option, it must be defeated for calibration. Temporarily disconnecting a wire to the remote trip permissive “b” contact. See Figure 5.

2. Enter the desired current direction (Top+ or Top-) and also enter the desired transducer rating in the Hi-Speed trip unit. See Section 8.3.

3. Connect the breaker to a hi-current DC test set capable of providing current at least 4 times the desired transducer rating in both the forward and reverse direction.

   Start out with current in the forward current direction.

4. Enable the ammeter display on the Hi-Speed trip unit by:
   a) Remove control power from the Hi-Speed trip unit.
   b) Push and hold the **up** push button.
   c) Apply control power to the Hi-Speed trip unit.
   d) Release the push buttons.
   e) Breaker current will now be displayed on the Hi-Speed trip unit until the trip unit control power is removed.

5. Close the breaker.

6. Coarsely calibrate the transducer by injecting a DC current through the breaker approximately equal to 50% of the programmed transducer rating. Turn the calibration potentiometer (this is a multi turn potentiometer) until the current displayed on the Hi-Speed trip unit matches the injected current.

   Use a Nylon or ceramic screwdriver.

7. Finish the calibration by increasing the breaker current to about 100% of the programmed transducer rating. Fine-tune the calibration potentiometer until the displayed current matches the injected current.

The transducer is now calibrated.

8. Seal the calibration potentiometer.

9. Check the calibration at other values of forward current and reverse current as outlined in Section 9.3.

9.3 Verify Pick-Up & Trip Times

A DC high current test set can be used to primary injection test the pick-up and time delays of the various trip functions. A DC test set with very low ripple is recommended as described in Section 9.2.

1. Verify proper calibration in the forward direction by testing at several other values of current. The minimum suggested test values are at 50%, 100% and 400% of the transducer rating.

2. Reverse the current direction and verify proper calibration in the reverse direction by testing at several values of current. The minimum suggested test values are 50%, 100% and 400% of the transducer rating.

The R/R* function cannot be completely tested with a normal high current DC test set. A rough test can be performed as follows:

No Trip Test...Slowly increase the test current above the R/R Delta I setting. A R/R trip should not occur.

Trip Test...Adjust the test set controls for a test current greater than the R/R Delta I setting. Start the test current so that a "step" function is created. A R/R trip should occur.

9.4 Test Trip

A test trip can be initiated from the front of the trip unit.

Whenever “HI-SPEED” is displayed on the LCD, simultaneously push both the **up** and **down** buttons and the trip unit will initiate a test trip. The last trip data will indicate that a test trip occurred.

9.5 Erase Last Trip Data

After completing the primary injection test, it is important to erase the last trip data from the memory of the trip unit.

**** IMPORTANT ****
Erase the last trip data from the memory of the trip unit after completing the primary injection tests.

See section 8.5 for clearing the last trip data.

10.0 Ratings

Ambient Temperature:
Trip Unit: -4°F (-20°C) to 150°F (65°C)
LCD Display:
Standard Temp, Supper Twist
32°F (0°C) to 122°F (50°C)

Humidity:
95% non-condensing

Conformal Coating on Circuit Boards:
Acrylic conformal coating
HumiSeal type 1B15H
or Konform type AR2000

Current Transducer:
1 milli-Amp secondary at rated current.
Linear to ±6 milli-Amp

Control Voltage Tolerance:
70-280Vdc
75-145Vac, 50/60Hz

Pick-Up Accuracy:
+/- 10% for FASTFOR, FASTREV*, LT*, ST* and R/R*

Auxiliary Contacts:
See Section 3.5.

11.0 Warranty

Utility Relay Company provides a conditional twenty-four (24) month warranty. Contact Utility Relay Company for full details.

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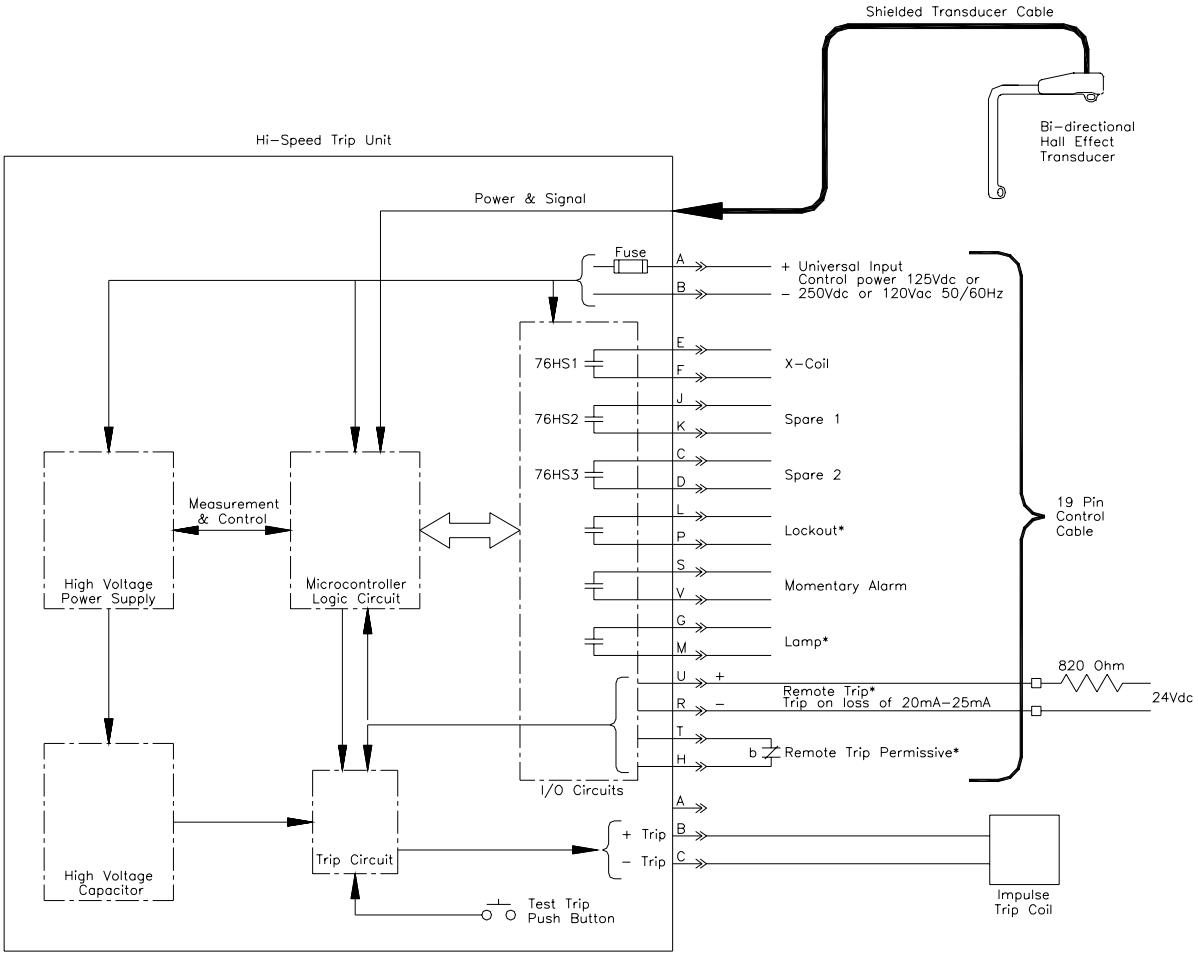

76HS1 to 3	Permissive Contacts: Closed when all of the following are true Control voltage is applied Transducer is connected No errors detected in logic circuit Capacitor voltage > 1800Vdc
Lockout Contact*	Closed for 500mSec after a trip (except UV* and Test Trip Push Button)
Momentary Alarm Contact	Closed for 500mSec after a trip (except Test Trip Push Button)
Lamp*	Closed when current > 22% of transducer rating Open when current < 20% of transducer current
Remote Trip*	Trip on loss of customer supplied 20mA–25mA signal
Remote Trip Permissive*	Prevents Remote Trip output if breaker is open

FIGURE 5
Block Diagram

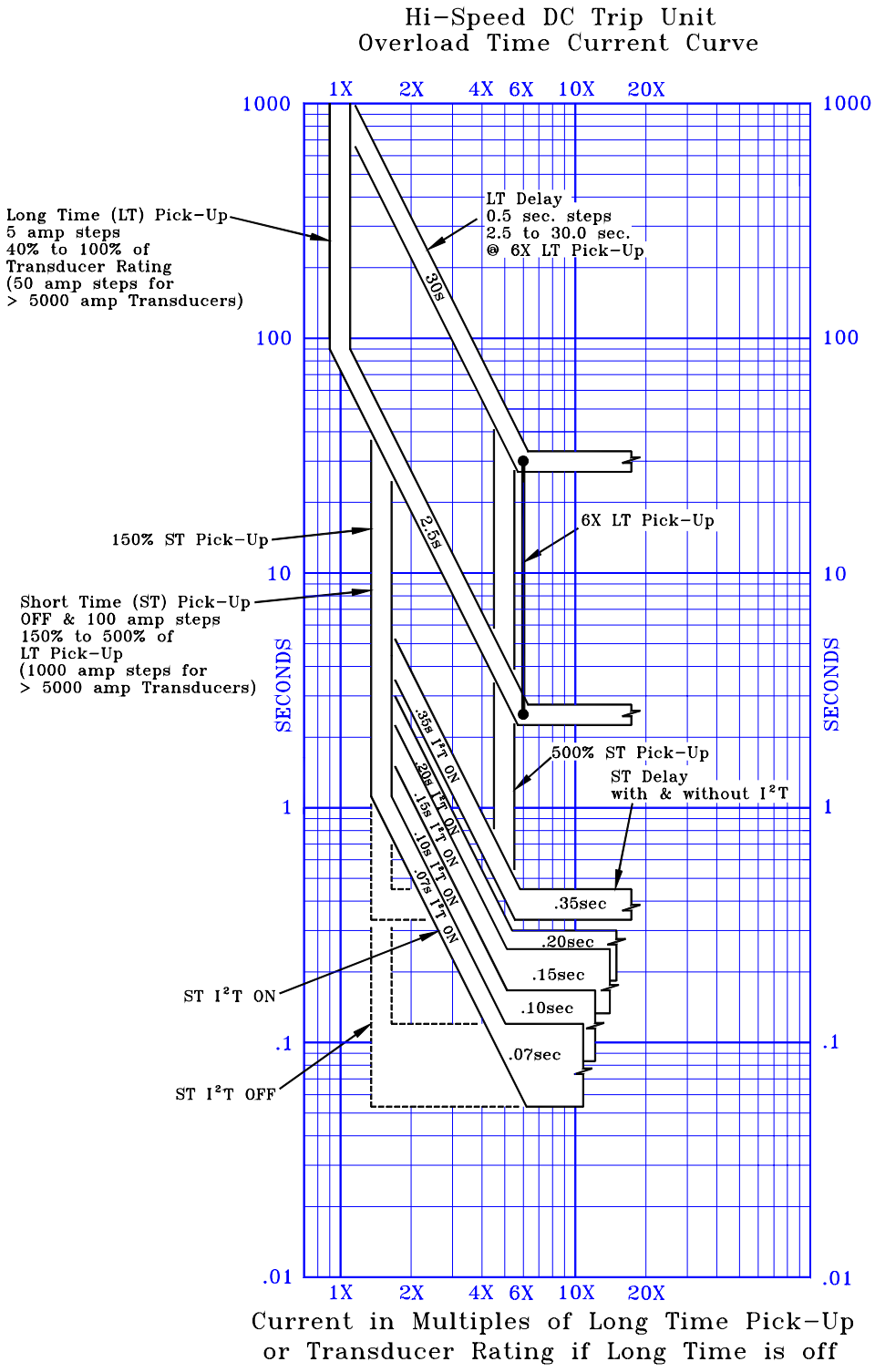

FIGURE 6
Non-Hi-Speed Trip Functions TCC