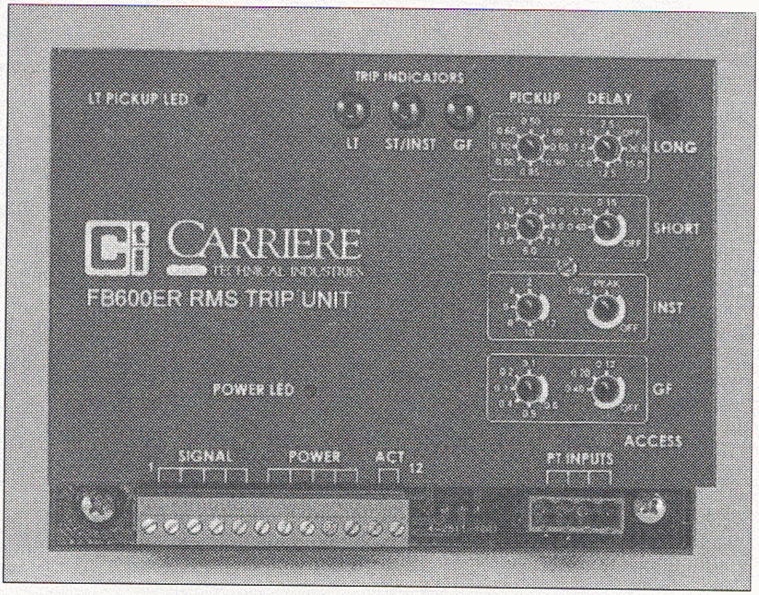
CARRIERE
TECHNICAL INDUSTRIES

FB600ER
RMS TRIP DEVICE

Instruction Manual



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1.1 Scope

The FB600ER RMS Trip Device is a protective relay used to open a low voltage circuit breaker under overcurrent conditions. It is primarily intended for retrofitting power circuit breakers to upgrade existing protection. This model of the FB600ER is completely compatible with previous versions and can be interchanged. The retrofit kit consists of the trip device, the current transformers (CTs), the actuator and all the other associated hardware necessary to upgrade the breaker. This manual describes the function and operation of the FB600ER trip device only. Separate installation manuals, specific to the installation of each breaker type, are supplied by Carriere with the retrofit kit. The FB600ER can also be used to directly replace other trip units without the need to replace the CTs or actuator by using the Carriere CT Conversion Module. Contact Carriere for more information.

The FB600ER is a solid state trip device with a proven design using high-quality components to ensure a long life of reliable operation. All units are extensively tested to meet or exceed applicable ANSI standards, specifically ANSI C37.17 Standard for Trip Devices for AC and General Purpose DC Low-Voltage Power Circuit Breakers. The FB600ER will trip a breaker on overloads with separately adjustable Instantaneous, Short Time, Long Time and Ground Fault pickup levels. Long Time, Short Time and Ground Fault functions exclusively use *True RMS* current sensing. For the Instantaneous function, overload Peak Detection or True RMS Detection can be selected. The Short Time, Long Time and Ground Fault time delays are also separately adjustable, providing a flexible trip device that covers wide areas of operation. Indicators are provided for Instantaneous/Short Time, Long Time and Ground Fault trips which help determine the cause of a trip. The FB600ER requires no control power to operate as it derives power from the current transformers in the breaker. All settings are made using switches located on the FB600ER. This means the retrofit kit is simple to install yet effective in providing various modes of detection, alone or in combination.

The FB600ER RMS Trip Device is also upgradable to support communications. Please contact Carriere for more information about this feature.

1.0 INTRODUCTION

1.2 Features

1.2.1 Long Time Function:

Pickup Level:
0.50, 0.60, 0.70, 0.80, 0.85, 0.90, 0.95, 1.00 times CT rating (Amps rms) or defeat.

Pickup Time:
2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20 seconds at 6X pickup level. Other times vary with current^2. Refer to the Time/Overcurrent curves in **Figure 3.1** for other overload conditions.

1.2.2 Short Time Function:

Pickup Level:
2.5, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 10.0 times CT rating (Amps rms) or defeat.

Pickup Time:
0.15, 0.25, 0.40 seconds at >150% of pickup level.

1.2.3 Instantaneous Function:

Pickup Level:
2.0, 4.0, 6.0, 8.0, 10.0, 12.0 times CT rating (Amps rms) or defeat.

Pickup Time:
50 ms maximum at >150% of pickup setting (peak detection).
75 ms maximum at >150% of pickup setting (RMS detection).

1.2.4 Ground Fault Function:

Modes of Operation:

i) Solidly grounded 3 phase, 3 wire system
Residual Connection

ii) Solidly grounded 3 phase, 3 wire system
Zero Sequence Connection

iii) Solidly grounded 3 phase, 4 wire system
Residual Connection plus CT on Neutral Conductor

iv) Resistance grounded 3 phase, 4 wire system
Zero Sequence Connection

Pickup Level:
0.10, 0.20, 0.30, 0.40, 0.50, 0.60 times G/F CT rating for Zero Sequence Connection and times phase CT primary rating for Residual Connections or defeat.

Pickup Time:
0.12, 0.20, 0.40 seconds at >150% of pickup level.

1.2.5 Indicators:

Long Time pickup LED indicates when Long Time pickup level is exceeded
Power LED indicates when the FB600ER is on
Latched Long Time trip indicator
Latched Instantaneous/Short Time trip indicator
Latched Ground Fault trip indicator

The latched indicators remain set after the breaker trips and there is no power supplied to the FB600ER. The indicators are reset when the breaker is turned on again or power is re-applied to the FB600ER. The minimum power level for the relay to be "on" is approximately 0.25X rated current (or less) and at this point or higher the latch indicators will reset.

1.3 Accuracy:

Long Time:	Pickup Level ⇒ +/-10%, Delay ⇒ +/-20%
Short Time:	Pickup Level ⇒ +/-10%, Delay ⇒ See **Figure 3.2** Time/Current curves
Instantaneous:	**Peak Detection**
	Pickup Level ⇒ +/-10%, Delay ⇒ 50 ms max at >150% of Pickup Level
Instantaneous:	**RMS Detection**
	Pickup Level ⇒ +/-10%, Delay ⇒ 75 ms max at >150% of Pickup Level
Ground Fault:	Pickup Level ⇒ +/-10%, Delay ⇒ See **Figure 3.2** Time/Current curves

1.4 Maximum Inputs:

CT:
1.25 Amps rms continuous on secondary windings
4 Amps rms for 1 minute
12 Amps rms for 6 seconds

1.5 Environment:

Operating Temperature Range: 0°C to +65°C (32°F to 149°F)

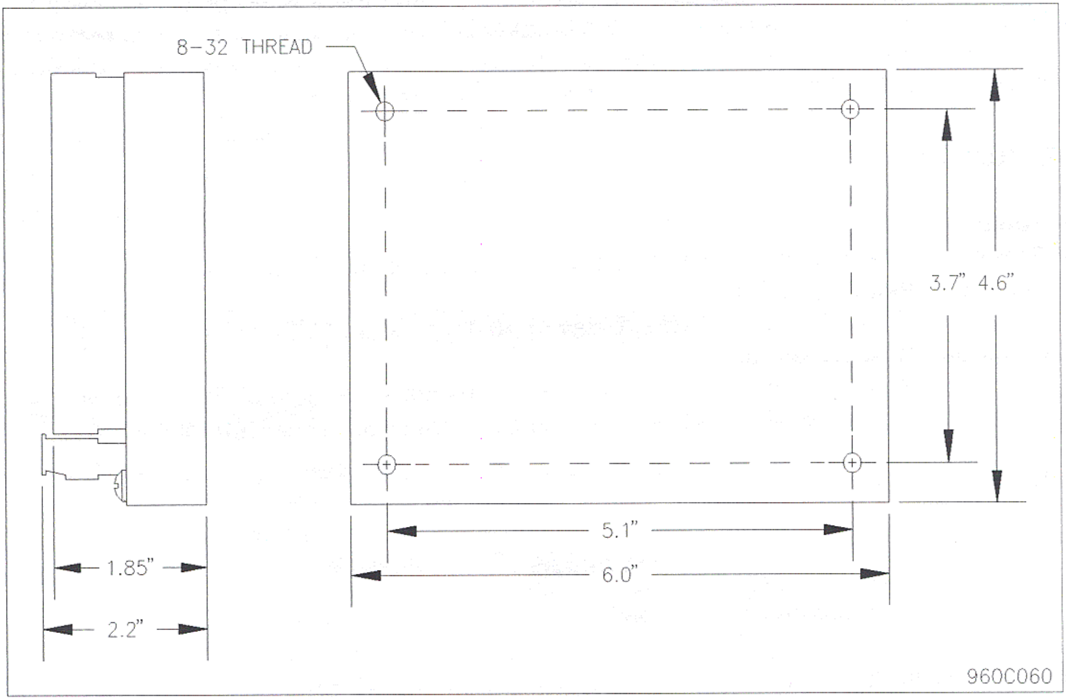
2.0 INSTALLATION

2.1 Physical Dimensions

The FB600ER is housed in a metal chassis with a removable cover to physically protect components, shield the circuit from electromagnetic interference and at the same time provide easy access to the switch settings. **Figure 2.1** shows the dimensions of the FB600ER. Four threaded holes are provided on the base of the trip device for mounting on the breaker chassis using 8-32 X ¼" screws. The retrofit kits provided by Carriere include any hardware necessary to mount the FB600ER in the breaker.

Note that there is a Lexan window that protects the rotary switches by simply turning the screw that is located in the center of the switch layout.

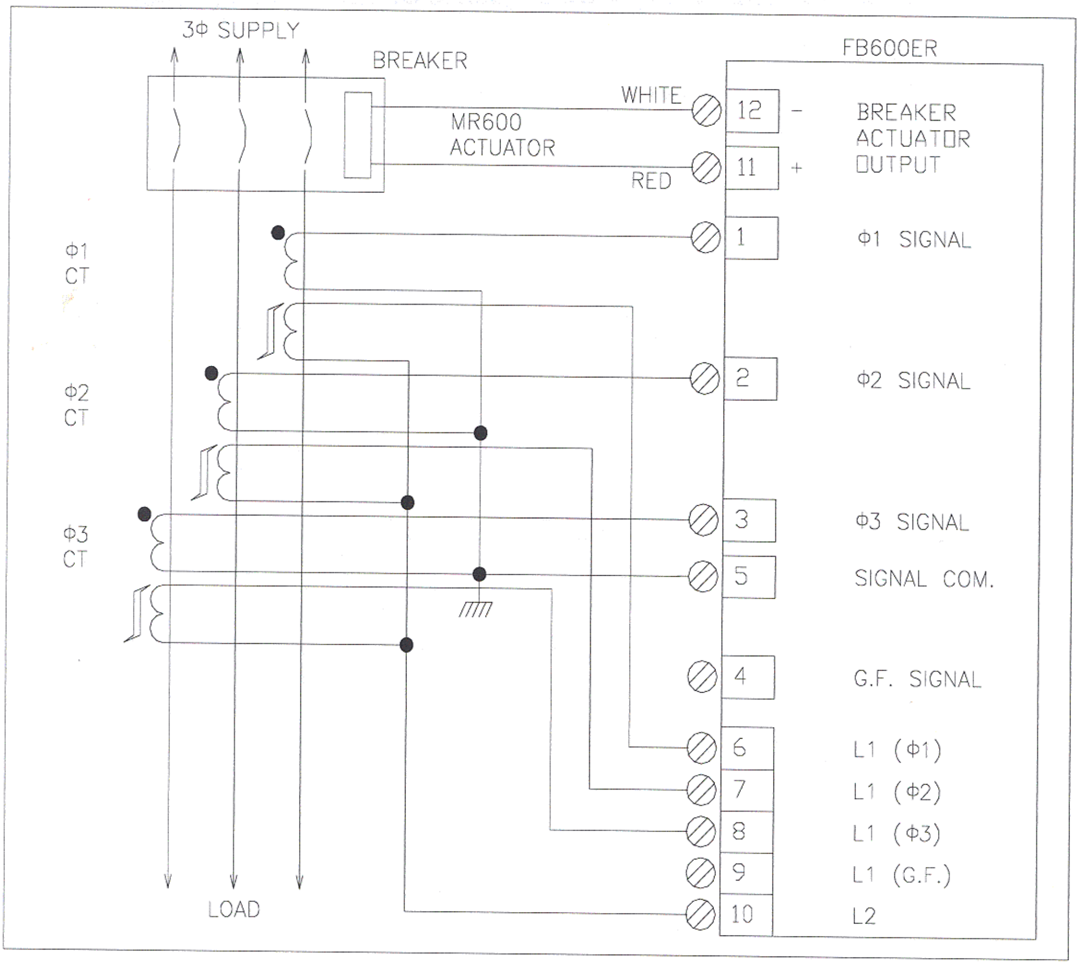
Figure 2.1 FB600ER Physical Dimensions



i) No Ground Fault Sensing

Figure 2.2 is the wiring configuration for a three phase system without a neutral wire or ground fault indication. Each of the specially wound phase CTs has a signal winding and a power winding, therefore eliminating the need for an external control power source. When a trip condition occurs, a pulse is provided by the circuitry of the trip device for the magnetically controlled actuator which triggers the breaker to open.

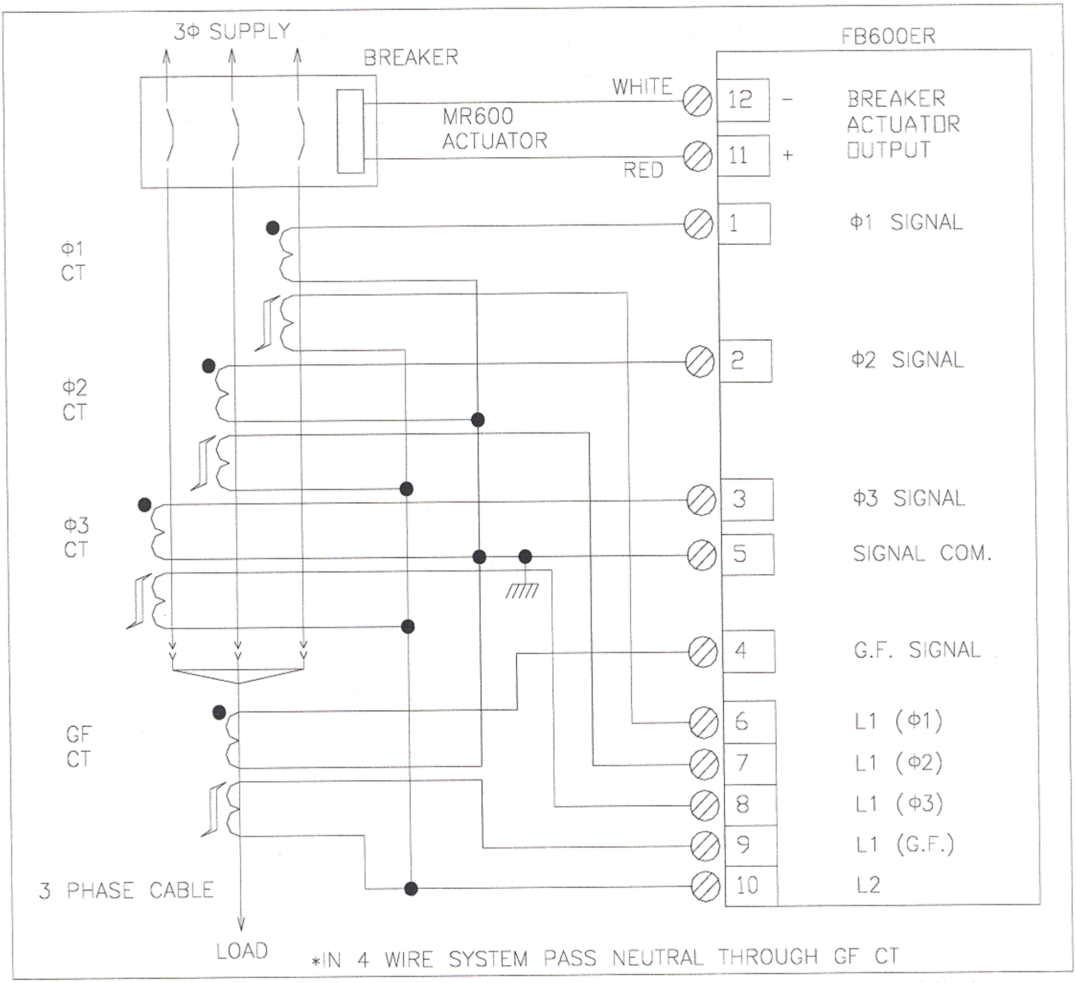
Figure 2.2 External Wiring: No Ground Fault Protection



ii) Zero Sequence Ground Fault Sensing

On resistance grounded or solidly grounded 3 wire systems where the phase conductors run outside the breaker, Zero Sequence Ground Fault Detection can be used as in **Figure 2.3**. The three phase cable passes through a fourth ground fault CT external to the breaker which detects the zero sequence component of the 3 currents. If a ground shield is present in the cable, it must pass outside of the ground fault CT window. When there is no ground fault, the sum of 3 phase instantaneous currents is zero and no signal is input to the FB600ER. When a ground fault condition arises, a signal and power is generated.

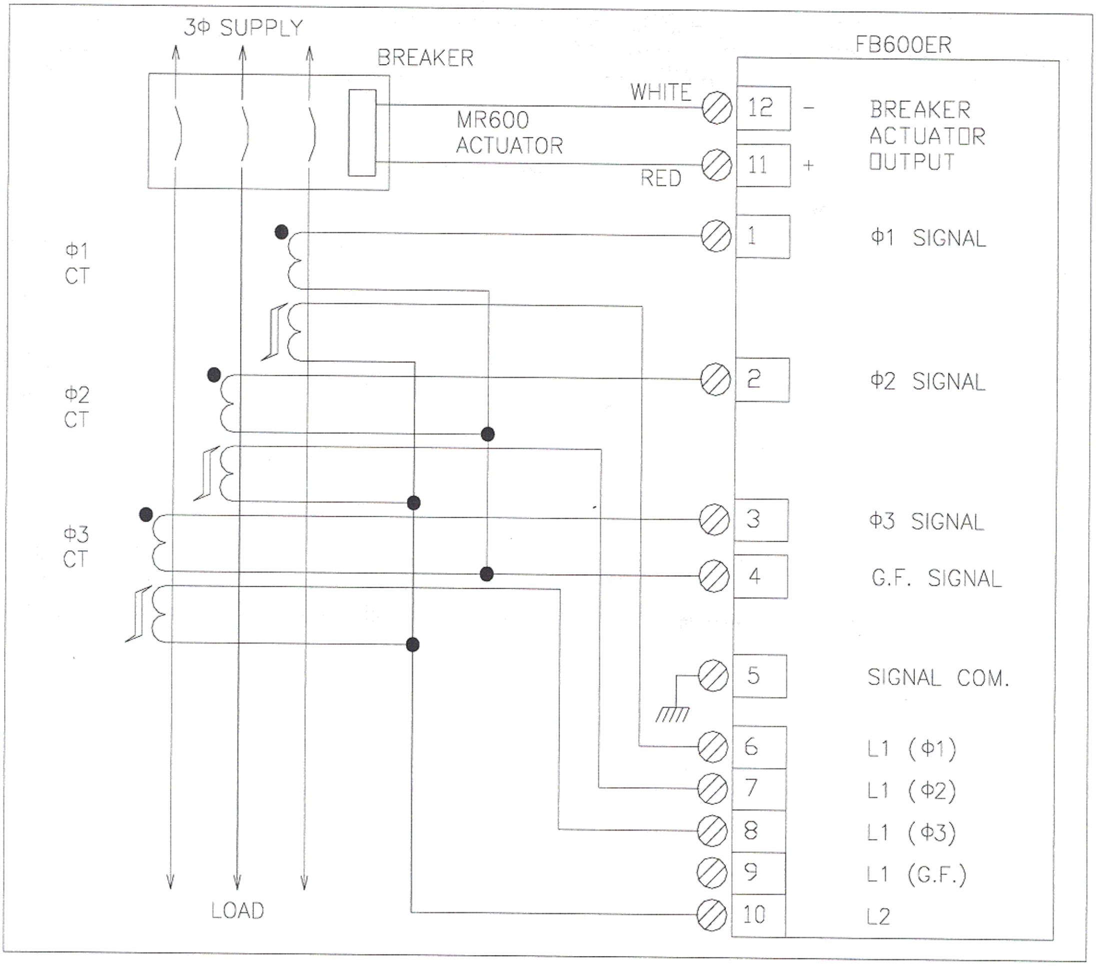
Figure 2.3 External Wiring: Zero Sequence Ground Fault Detection



iii) Solidly Grounded 3 Wire System / Residual Ground Fault Sensing

In a three wire system where it is inconvenient to run the three phases through a separate ground fault CT, the residual or common return of the three phase CTs can be used to detect for ground fault current. **Figure 2.4** is the connection scheme for this method of detection. If there is no ground fault present, the three phase CT instantaneous currents sum to zero. If there is a ground fault, the three currents do not sum to zero and if this sum exceeds the ground fault pickup level for the desired time setting the breaker will trip.

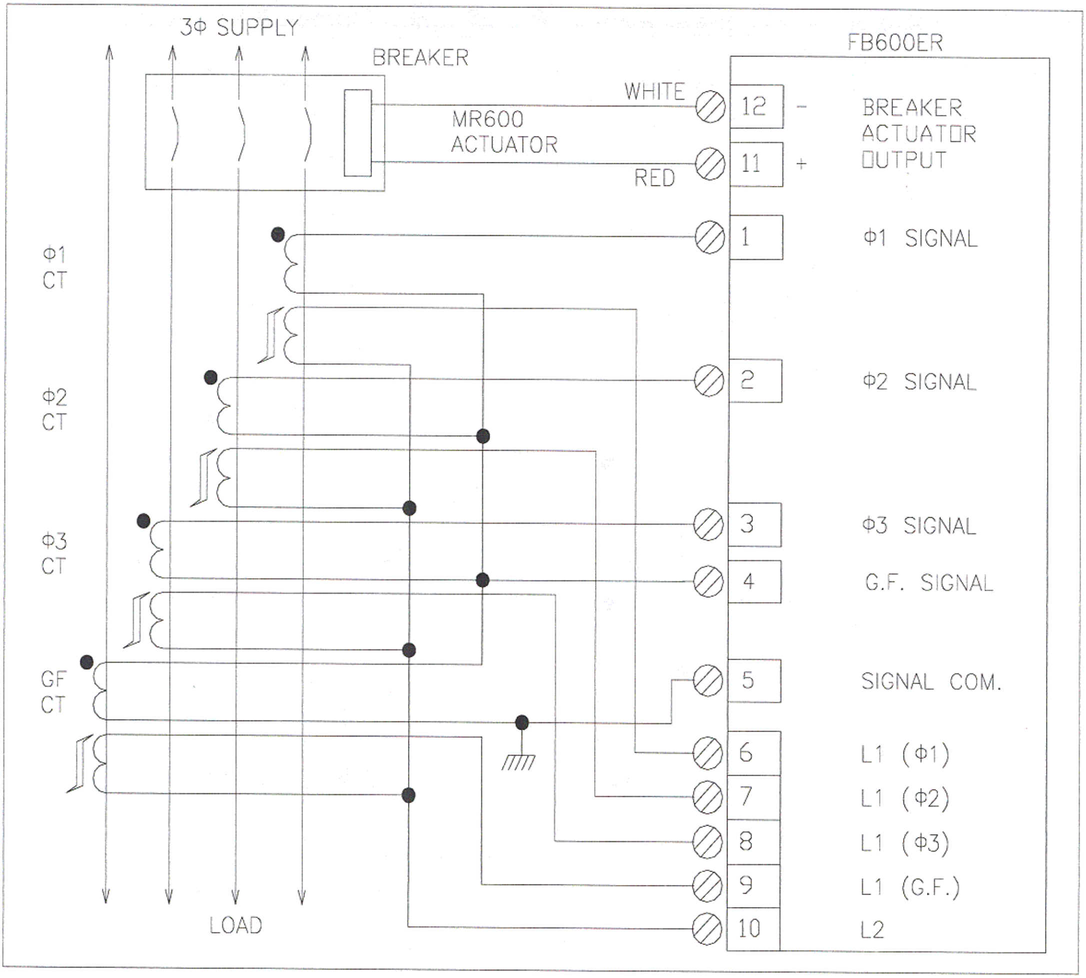
Figure 2.4 External Wiring: 3 Wire Residual Ground Fault Detection



iv) Solidly Grounded 4 Wire System / Residual Ground Fault Sensing

In a four wire system where it is inconvenient to run the three phases and neutral wire through a separate ground fault CT, the wiring scheme in **Figure 2.5** can be used. The fourth CT is connected to the common of the three phase CTs to cancel any residual current sensed in the neutral conductor that is not caused by a ground fault. (Note that the neutral current is flowing in the same direction as the phase currents in this schematic)

Figure 2.5 External Wiring: 4 Wire Residual Ground Fault Detection



2.3 Current Transformers

i) The signal winding must have an output of 1 Amp rms when rated primary current is flowing through the phase conductor. This current flows into a nominal resistive burden of 0.1Ω which is internal to the FB600ER.

ii) The power winding should saturate below the rated CT current and it should supply a maximum of 10VA of power. To operate all of the functions of the FB600ER, the power windings must provide a total of 4.5VA of power. This turn-on point is at approximately 25% of the rated CT current, which is well below all of the pickup levels that can be set on the FB600ER. If little or no current is flowing in the phase conductor, the FB600ER will remain dormant until a current increase occurs. The FB600ER will then quickly turn on and provide protection if there is an overload within the specified time delay for any of the functions.

iii) The ground fault CT is electrically the same as the 3 phase CTs.

2.4 Actuator

When a trip condition is detected by the trip device, an output pulse is sent to the actuator. The magnetic field created by this pulse activates the spring loaded actuator which then trips the breaker. The actuator linkage mechanism varies with the type of breaker that the trip device is installed in.

2.5 System Grounding

The CT signal windings, power windings and the actuator are connected to different points in the circuitry of the FB600ER. The trip device may not operate correctly if the winding common (terminal 5), power winding common (terminal 10) and either of the actuator wires (terminals 11 and 12) are connected together to an external ground. Only the signal winding common should be connected to an external ground.

3.0 SETUP AND OPERATION

3.1 Long Time Function Settings

To provide protection to system components such as transformers, motors and conductors from failure due to resistive heating, Long Time Overload Detection is provided. Long Time detection follows a set of current^2 overcurrent curves that are related to heating effects. **Table 3.1** shows trip times for various levels of current and time delay settings for the Long Time Function. These curves are shown in **Figure 3.1** for coordination purposes.

TABLE 3.1: LT TRIP TIMES (SEC) vs CURRENT IN MULTIPLES OF LT PICKUP

Delay	ERROR	10X	8X	7X	6X	5X	4X	3X	2X	1.5X	1.25X	1.1X	1X
	-20%	0.72	1.13	1.47	2.00	2.88	4.50	8.00	18.00	32.00	46.08	59.50	72.00
2.5	0	**0.90**	**1.41**	**1.84**	**2.50**	**3.60**	**5.63**	**10.00**	**22.50**	**40.00**	**57.60**	**74.38**	**90.00**
	+20%	1.08	1.69	2.21	3.00	4.32	6.76	12.00	27.00	48.00	69.12	89.26	108.00
	-20%	1.44	2.26	2.94	4.00	5.76	9.01	16.00	36.00	64.00	92.16	119.01	144.00
5.0	0	**1.80**	**2.82**	**3.68**	**5.00**	**7.20**	**11.26**	**20.00**	**45.00**	**80.00**	**115.20**	**148.76**	**180.00**
	+20%	2.16	3.38	4.42	6.00	8.64	13.51	24.00	54.00	96.00	138.24	178.51	216.00
	-20%	2.16	3.38	4.42	6.00	8.64	13.51	24.00	54.00	96.00	138.24	178.51	216.00
7.5	0	**2.70**	**4.23**	**5.52**	**7.50**	**10.80**	**16.89**	**30.00**	**67.50**	**120.00**	**172.80**	**223.14**	**270.00**
	+20%	3.24	5.08	6.62	9.00	12.96	20.27	36.00	81.00	144.00	207.36	267.77	324.00
	-20%	2.88	4.51	5.89	8.00	11.52	18.02	32.00	72.00	128.00	184.32	238.02	288.00
10.0	0	**3.60**	**5.64**	**7.36**	**10.00**	**14.40**	**22.52**	**40.00**	**90.00**	**160.00**	**230.40**	**297.52**	**360.00**
	+20%	4.32	6.77	8.83	12.00	17.28	27.02	48.00	108.00	192.00	276.48	357.02	432.00
	-20%	3.60	5.64	7.36	10.00	14.40	22.52	40.00	90.00	160.00	230.40	297.52	360.00
12.5	0	**4.50**	**7.05**	**9.20**	**12.50**	**18.00**	**28.15**	**50.00**	**112.50**	**200.00**	**288.00**	**371.90**	**450.00**
	+20%	5.40	8.46	11.04	15.00	21.60	33.78	60.00	135.00	240.00	345.60	446.28	540.00
	-20%	4.32	6.77	8.83	12.00	17.28	27.02	48.00	108.00	192.00	276.48	357.02	432.00
15.0	0	**5.40**	**8.46**	**11.04**	**15.00**	**21.60**	**33.78**	**60.00**	**135.00**	**240.00**	**345.60**	**446.28**	**540.00**
	+20%	6.48	10.15	13.25	18.00	25.92	40.54	72.00	162.00	288.00	414.72	535.54	648.00
	-20%	5.76	9.02	11.78	16.00	23.04	36.03	64.00	144.00	256.00	386.64	476.03	576.00
20.0	0	**7.20**	**11.28**	**14.27**	**20.00**	**28.80**	**45.04**	**80.00**	**180.00**	**320.00**	**460.80**	**595.04**	**720.00**
	+20%	8.64	13.54	17.66	24.00	34.56	54.05	96.00	216.00	384.00	552.96	714.05	864.00

3.2 Short Time Function Settings

Short time delay tripping is used for coordinating protection for power systems to shut down at pickup levels of 2.5 to 10 times the CT rating at time delays of 0.15 to 0.4 seconds.

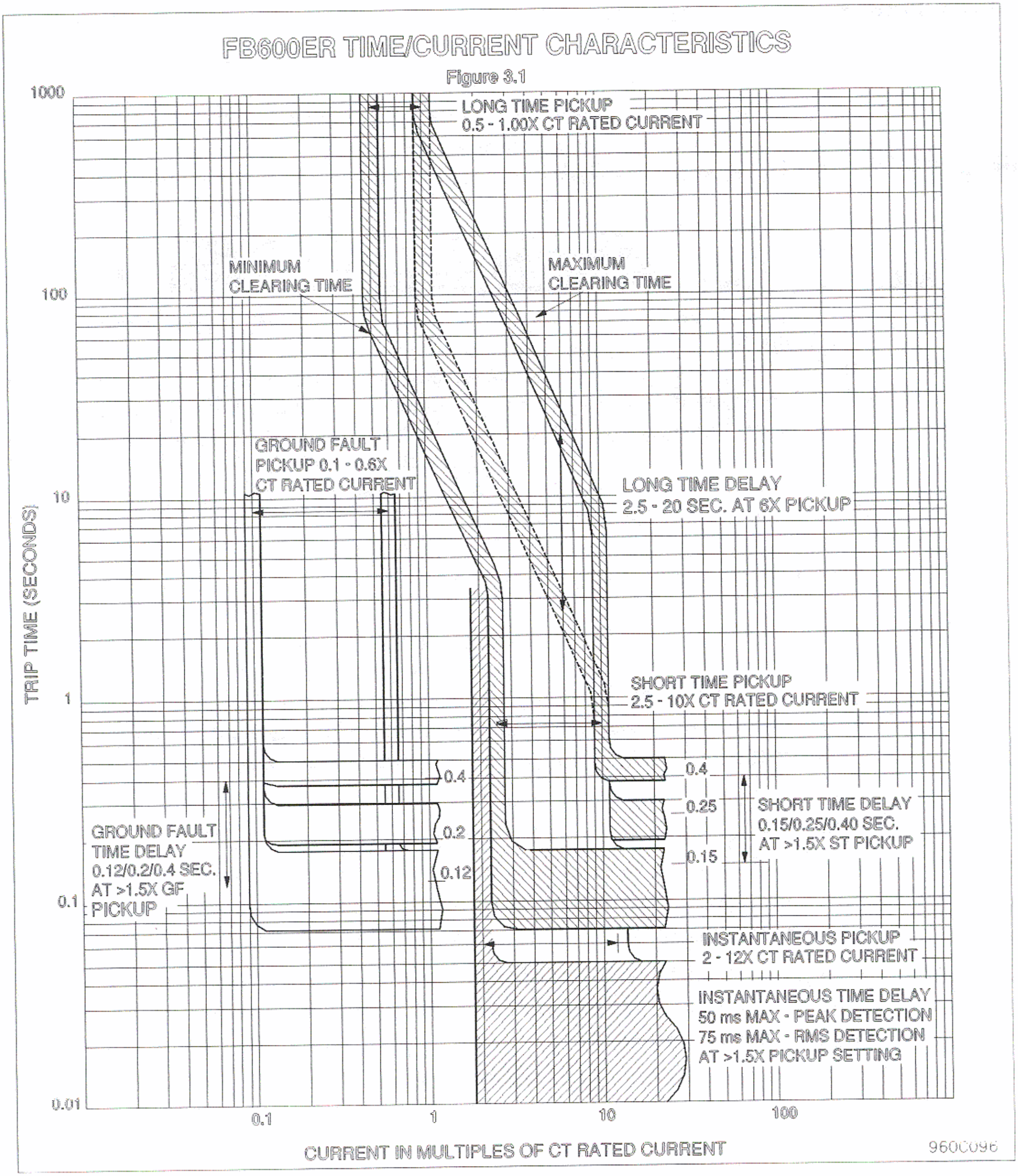
3.3 Instantaneous Function Settings

Instantaneous tripping with minimal delay is used to provided protection against short circuits. There is an option to select between Peak Detection and True RMS Detection. The maximum delay for peak detection is 50ms and for rms detection it is 75ms.

When using RMS Detection, the FB600ER first calculates the rms level of the current with a time constant of less than 30ms (Approximately 2 cycles at 60Hz). If the rms level during this time period is above the Instantaneous Pickup Level, the FB600ER will send a trip signal. With Peak Detection, the rms value of the current is not used. Instead, if the level is above the pickup setting with a time constant of approximately 1/4 of a cycle (60Hz), the FB600ER will send a trip signal. It is important to note that Peak Detection settings are at rms levels, so no calculations are necessary to convert between rms and peak values.

3.4 Ground Fault Function Settings

Ground faults occur when there is a breakdown of insulation or a mechanical short between a phase conductor(s) and ground. The pickup level should be set low enough to provide adequate protection under ground fault conditions, and high enough to prevent nuisance tripping under normal conditions. Delay times are provided for system coordination. Solidly grounded systems generally require shorter delays while resistance grounded systems can have longer delays.


FB600ER TIME/CURRENT CHARACTERISTICS
Figure 3.1
LONG TIME PICKUP
0.5 - 1.00X CT RATED CURRENT
MINIMUM
CLEARING TIME
MAXIMUM
CLEARING TIME
GROUND FAULT
PICKUP 0.1 - 0.6X
CT RATED CURRENT
LONG TIME DELAY
2.5 - 20 SEC. AT 6X PICKUP
SHORT TIME PICKUP
2.5 - 10X CT RATED CURRENT
0.4
0.25
0.15
SHORT TIME DELAY
0.15/0.25/0.40 SEC.
AT >1.5X ST PICKUP
0.4
0.2
0.12
GROUND FAULT
TIME DELAY
0.12/0.2/0.4 SEC.
AT >1.5X GF
PICKUP
INSTANTANEOUS PICKUP
2 - 12X CT RATED CURRENT
INSTANTANEOUS TIME DELAY
50 ms MAX - PEAK DETECTION
75 ms MAX - RMS DETECTION
AT >1.5X PICKUP SETTING
TRIP TIME (SECONDS)
1000
100
10
1
0.1
0.01
0.1
1
10
100
CURRENT IN MULTIPLES OF CT RATED CURRENT
960C096

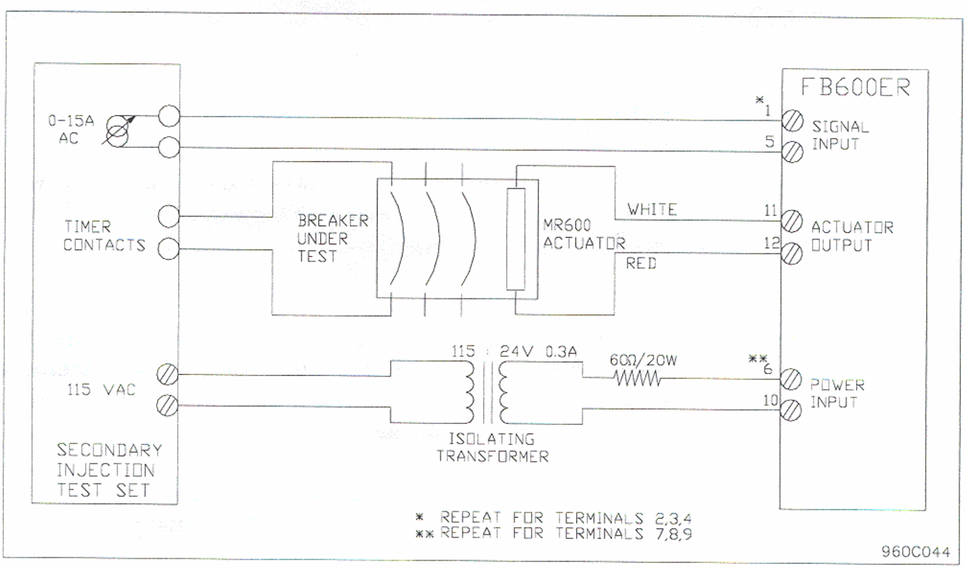
4.1 Secondary Injection Testing

Secondary injection testing involves the direct application of current to the FB600ER, simulating a signal that would be produced by a primary phase conductor. It provides an excellent method for testing the calibration of a trip device. The Carriere STS100 is a portable secondary test set that provides a simple and effective method to test all of the functions of the FB600ER.

Any commercial tester can also be used to test the functions of the FB600ER provided it has a signal output from 0 to 12 Amps AC, an electronic timer, and a source to power the FB600ER. The 0 to 12 Amp output represents 0 to 1200% of rated current in the phase CT secondary winding. The timer is required to measure timing delays for the different overload functions of the FB600ER. The power source common must be isolated from the signal common in the secondary test set. Some test sets do not have this isolation and require an isolation transformer (the STS100 does have it), as shown in **Figure 4.1**. The breaker poles can be used as the trip contact to stop the test, adding the trip time of the breaker to the total trip time. Carriere can also provide the FT1 Interface Module which isolates the power and signal commons for most commercial secondary test sets as well as supplying a power signal for the FB600ER (see **Figure 4.2**).

See **Sections 4.3-4.6** for the testing procedures for the particular functions.

Figure 4.1 Secondary Injection Testing: Using Breaker Contact



4.2 Primary Injection Testing

To test a retrofit kit installed on a breaker as a complete system, primary injection testing is essential. This will ensure that the FB600ER, the CTs, the actuator, the mechanical hardware associated with the retrofit kit, and the breaker itself will work properly together. Refer to ANSI C37.59 Standard Requirements for Conversion of Power Switchgear Equipment for the testing procedure for retrofit kits.

Ground Fault overload works on the principle of detecting phase imbalances. Therefore, if a 3 phase tester is not used, the Ground Fault function should be disabled to avoid nuisance tripping during all testing except for Ground Fault. When using single phase primary injection to test the Ground Fault function, it is important to remember that the FB600ER turns on at approximately 0.25X rated current, and some of the ground fault settings are lower than this. For these lower settings secondary injection testing should be used since the power supply is constant. During normal three phase operation of the breaker, all phases will be supplying power (in parallel) to the FB600ER.

It is important to remember that when testing the trip timing, the values stated in this manual do not include the mechanical trip time of the breaker itself.

Ensure that the breaker frame is directly connected to ground during testing. If the breaker frame is floating, inaccurate test results may occur!

4.3 Long Time Function Testing

Defeat the other trip functions to isolate the Long Time overload circuitry. Increase the current until the long time LED (located directly below the dip switches) begins to flash. This indicates that the Long Time overload circuitry has started to time out and this point should be ± 10% of the pickup setting.

To test the time delay for Long Time overload detection, apply 6X the pickup level and record the trip delay. For example, if the pickup level is set to 0.8X the rated current and the time delay to 2.5 seconds, applying 0.8 X 6 = 4.8 Amps will cause a trip in 2.5 seconds (± 20%). For primary testing this means applying a current equal to 4.8 X CT Ratio.

If other current levels other than 6X are applied, **Table 3.1** has been included in this manual which lists various pickup times vs. applied current . This should assist in performing tests to check the Time/Current relationship for the Long Time function.

4.4 Short Time Function Testing

Defeat the other trip functions to isolate the Short Time overload circuitry. To test the pickup level, select the shortest time delay and increase the current until the actuator trips or an output pulse is obtained. The pickup level should be ± 10% of the stated pickup setting.

Adjust the Short Time delay to the desired setting and apply current at 150% or more of the set pickup level. The delays should follow the Time/Current characteristics from **Figure 3.1**.

4.5 Instantaneous Function Testing

Defeat the other trip functions to isolate the Instantaneous circuitry. To test the pickup level increase the current level until a trip signal (or actuator trip) occurs: The level should be ±10% of the stated pickup settings.

To test the timing of the Instantaneous overload detection circuitry, apply current at 150% or more of the set pick-up level. If Peak Detection is used, there should be a trip signal in less than 50ms and if RMS sensing is used, the trip signal should occur in less than 75ms.

4.6 Ground Fault Function Testing

For pickup level tests, use the shortest delay. Defeat the other trip functions to isolate the Ground Fault detection circuitry and make sure that the input signal is connected to the ground fault terminals 4 and 5 as shown in **Figures 2.3**, **2.4** and **2.5**.

Increase the current in one phase until the actuator trips or an output pulse is obtained. By applying current to only one phase, it mimics a phase imbalance in a three phase system caused by a ground fault. The pickup level should be within ± 10% of stated pickup settings. To test the time delay, apply current at 150% of the set pickup level. The delays should follow the Time/Current characteristics from **Figure 3.1**. When primary injection testing the Ground Fault function, be aware of the current levels for power input. This is described in greater detail in **4.2 Primary Injection testing**.

4.7 Final Settings

Once all of the calibration tests have been completed, adjust all of the switches to their final settings.

5.0 COMMUNICATION OPTION

5.1 Upgradability

The FB600ER RMS Trip Device can be purchased with or upgraded to include a communication module so a network of trip devices can be monitored from a central location. There is a separate manual concerning this option. Contact Carriere for more information.

WARRANTY

Products are warranted to be free of defects in material and workmanship for 24 months. Notification of defects must be received within 30 days after installation. Warranty is limited to repair or replacement of parts. The warranty does not apply to equipment damaged during installation. We make no other warranty than that described above. *Schneider Canada Services* assumes no liability for installation labour or ensuing damages.

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