The MDP Digital Time Overcurrent Relay is a digital, microprocessor based, nondirectional overcurrent relay that protects against phase-to-phase and phase-to-ground faults. The MDP™ performs the following functions:

- Inverse overcurrent, including four characteristic curves and four values of definite time protection, as well as instantaneous overcurrent protection with programmable delay
- Phase and ground current measurement
- Phase and ground current metering
- Operating time and fault current of the last trip
- Breaker status
- Breaker operation (RS232 and RS485 versions only)

The MDP™ series relays include four measuring units, one for each of the three phase currents and an additional one for ground or residual current. Each of the four measuring units includes a time and an instantaneous overcurrent unit. The phase settings are combined so that all phase units are set the same.

Table 1–1: CURRENT RANGES

NOMINAL CURRENT (In)	INVERSE TIME UNIT (Is)		INSTANTANEOUS UNIT
	PHASE	GROUND	
5 A	1.5 to 13.25 A	1.5 to 13.125 A	1 to 31 × Is (all relays)
		0.5 to 4.375 A	
		0.1 to 0.875 A	
	0.5 to 4.375 A	0.5 to 4.735 A	
1 A	0.3 to 2.625 A	0.3 to 2.625 A	
		0.1 to 0.875 A	
		0.05 to 0.4375 A (½ A CT)	

The pickup value for the instantaneous unit can be adjusted between 1 and 31 times the value selected for the inverse time unit.

The instantaneous unit can be disabled by adjusting the setting to zero times the inverse value. The MDP relay has two trip output relays that can be selected to indicate whether a trip has been produced by

- an instantaneous unit or an inverse unit, or
- by phase or ground.

This selection is made by means of a switch behind the right lower side of the nameplate. An alarm output is provided to signal a critical alarm (such as power supply failure or self check failure). An output contact is provided to close the breaker from a command issued via the communications channel.

A single-line diagram illustrating the functionality of the MDP relay is shown on the following page. A typical wiring diagram is shown in Figure 1–2: TYPICAL WIRING DIAGRAM on page 1–3.

1

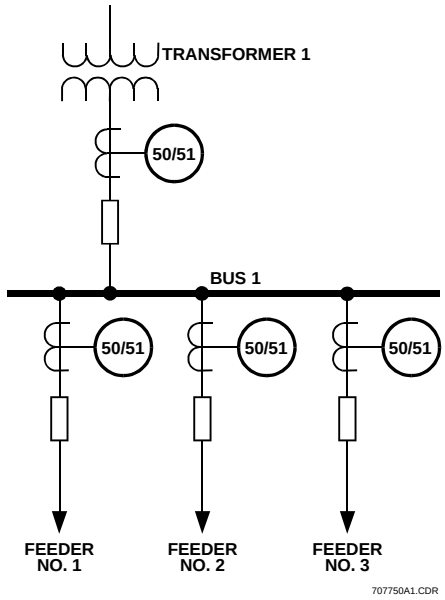

Figure 1–1: SINGLE-LINE DIAGRAM

1.2 ORDER CODES

MDP	✳	✳	✳	✳	✳	
	0					No communications or control inputs (Block Ground, Block Instantaneous, Breaker Status)
	1					Control Inputs and communications upgrade socket
	2					CommNet
	3					Modbus RTU
	4					RS232
	5					RS485
		1				5 A nominal, 0.5 to 4.375 A ground, 1.5 to 13.125 A phase
		2				5 A nominal, 1.5 to 13.125 A ground, 1.5 to 13.125 A phase
		3				5 A nominal, 0.1 to 0.875 A ground, 1.5 to 13.125 A phase
		4				1 A nominal, 0.1 to 0.875 A ground, 0.3 to 2.625 A phase
		5				1 A nominal, 0.3 to 2.625 A ground, 0.3 to 2.625 A phase
		6				1 A nominal, 0.05 to 0.4375 A ground, 0.3 to 2.625 A phase
		7				5 A nominal, 0.5 to 4.375 A ground and phase
			1			24 to 48 V DC
			2			48 to 125 V DC, 35 to 120 V AC
			3			110 to 250 V DC, 85 to 240 V AC
				00000		Reserved
					D	Revision Level

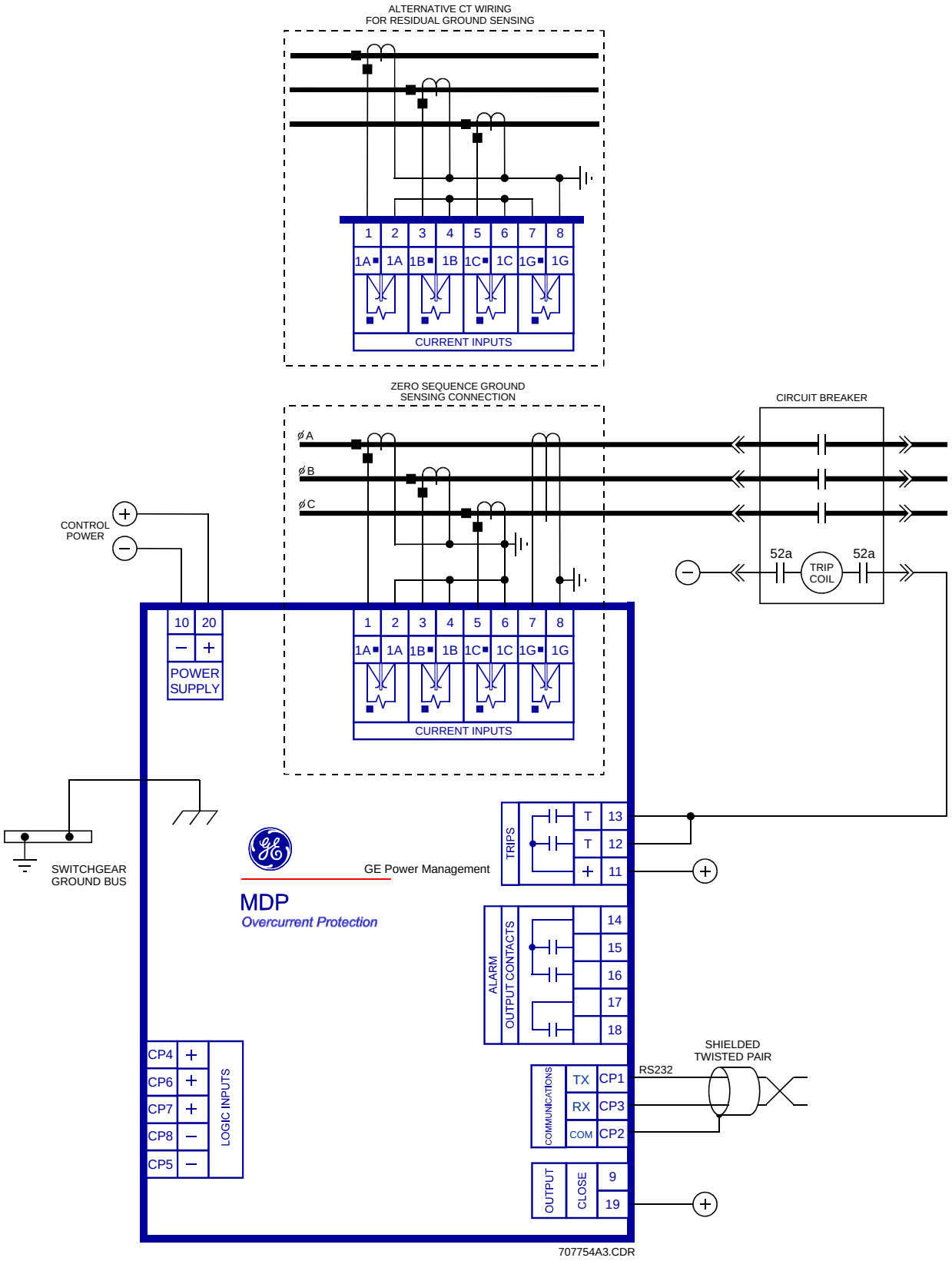

Figure 1–2: TYPICAL WIRING DIAGRAM

1.3 APPLICATION

Time-overcurrent relays are used for the protection of feeders, transmission lines, alternating-current machines and transformers, and numerous other applications where accurate measurement of current and timing is necessary. To ensure proper coordination with a minimum of circuit isolation, the operating time of associated protective devices should be considered when selecting a time-current characteristic for a particular application. Four basic time-current characteristics are available for the MDP relay:

1. **INVERSE / BS142 INVERSE**: The inverse time current characteristic curves are shown in the following diagrams:
   - Figure 2–4: INVERSE TIME CURVE on page 2–5.
   - Figure 2–5: LONG INVERSE TIME CURVE on page 2–6.
   - Figure 2–8: BS142 INVERSE TIME CURVE (1 A MODELS ONLY) on page 2–9.

   The BS142 inverse curve applies to the 1 A model relays only. These relays are generally applied where the short circuit current magnitude is dependent largely upon the system generating capacity at the time of the fault.
2. **VERY INVERSE**: The very inverse time-current characteristic shown in Figure 2–6: VERY INVERSE TIME CURVE on page 2–7 is generally applied where the magnitude of short circuit current flowing through any given relay is more dependent upon the location of the fault relative to the relay than on the system generation setup at the time of the fault.
3. **EXTREMELY INVERSE**: The extremely inverse time-current characteristic shown in Figure 2–7: EXTREMELY INVERSE TIME CURVE on page 2–8 is preferred for applications where sufficient time delay must be provided to allow a re-energized circuit to pick up an accumulated cold load without unnecessary tripping on inrush currents. Distribution feeder circuits are a good example of such applications, and the extremely-inverse characteristic is best suited to such applications because it more nearly approximates typical power fuse and fuse cutout characteristics.

The general practice for grounded distribution system protection is to use three-phase overcurrent functions for protection against interphase faults and a ground/residual overcurrent function for single phase-to-ground faults. The use of a separate ground-overcurrent function is advantageous because it can generally be adjusted to provide faster and more sensitive protection for single phase-to-ground faults than the phase overcurrent functions. Typical connections for such an application are shown in Figure 4–2: TYPICAL EXTERNAL CONNECTIONS, GROUND CURRENTS and Figure 4–3: TYPICAL EXTERNAL CONNECTIONS, RESIDUAL CURRENTS on pages 4–2 and 4–3.

The pickup setting of the MDP time unit should be chosen so that it operates for all short circuits in the protected zone and, when possible, also provides backup protection for short circuits in the immediately adjacent system element. The time unit pickup should be set low enough to ensure that the minimum fault current is at least 1.5 times the setting.

The time delay adjustment of the time unit should be chosen to assure selectivity with the protection on the adjacent system elements. This adjustment should be made for the condition that yields maximum fault current at the relay location. The time delay is determined by the adjacent relay operating time for this condition, plus a coordinating time allowance that includes the adjacent circuit breaker maximum operating time and a safety factor to accommodate any uncertainties. Since the MDP time unit has insignificant overtravel, the only relay variation that needs consideration in the safety factor is the tolerance on the time curves. A 0.17 second safety factor is generally used if the relay time is determined by selecting a time dial setting from the time curves. This safety factor can be reduced to 0.07 second if the time unit is instead set to the desired time by accurate tests.

The instantaneous overcurrent unit can be applied in many instances to reduce the fault clearing time for high fault currents. This unit is normally set to pick up only on internal faults in the protected zone. Significant transient overreach can be experienced under certain conditions, and this must be taken into account by selecting a pickup setting that is higher than that which would be dictated by the maximum steady state external fault current.

NOTE

IMPORTANT: If one unit (instantaneous or inverse) operates, the other unit (inverse or instantaneous) *will also* operate. The MDP fault report will record the first fault that occurred. When the fault is cleared, the fault LEDs will display Phase-Phase, Phase-Ground, Instantaneous, and Inverse Time faults. See display section on how to interpret the display for various fault conditions. The MDP generates a new fault report when the fault current drops below the pickup value and a new fault occurs.

Contact converter input CC1 and the output select switch of the MDP allow a zone selective interlocking of the MDP relays. This scheme provides instantaneous operation (with a minimum time delay) of the upstream relay for faults between the upstream and downstream relays. Refer to Figure 4–4: TYPICAL EXTERNAL CONNECTIONS, ZONE SELECTIVE INTERLOCK on page 4–4 for a typical scheme and settings considerations. Note that all the feeders must be radial, with no (or very weak) source.

1.4 INTERFERENCE SUPPRESSION GROUND CONNECTION

The MDP relay contains high frequency interference protection consisting of a series of capacitors connected between the input terminals and the case.

The case stud of the relay should be connected to ground, so these interference suppression circuits can perform their protective function. This connection should be as short as possible, to assure maximum protection. Braided #12 AWG conductors are recommended.

ELECTRICAL RATINGS

Nominal frequency: 25/50/60 Hz

Nominal current: 1 or 5 A

Auxiliary Power Supply: 24 to 48 V DC, 48 to 125 V DC / 38.5 to 150 V AC, 110 to 250 V DC, 85 to 240 V AC

BURDEN RATINGS

GROUND CT	MDP MODEL[1]	PHASE INPUT	BURDEN		POWER SUPPLY AC/DC
			50 Hz AC	60 Hz AC	
1 A	6	0.05 to 0.4375 A			< 3 W at all voltages, quiescent < 4.5 W at maximum voltages
	4	0.1 to 0.875 A	0.09 Ω ∠2.4°	0.09 Ω ∠2.8°	
	5	0.3 to 2.625 A			
5 A	3	0.1 to 0.875 A			
	1, 7	0.5 to 4.375	0.01 Ω ∠9.7°	0.01 Ω ∠11.5°	
	2	1.5 to 13.125 A			

1. Refers to the MDP*X model, see Section 1.2: ORDER CODES on page 1–2

OVERCURRENT RATINGS

Continuous: 2 x In

Three Second: 50 x In

One Second: 100 x In

CT RATINGS

1 A 34500

5 A 87500

1 A special 13600 (models MDPx6 have a sensitive ground CT)

ENVIRONMENTAL RATINGS

Temperature: Operating: –20°C to +65°C (–40°C available upon request)
Storage: –40°C to +65°C

Relative Humidity: Up to 95% without condensing

ACCURACY

Operating Value: 5%

Operating Time: 5% or 0.025 seconds, whichever is greater

REPEATABILITY

Operating Value: 1%

Operating Time: 2% or 0.025 seconds, whichever is greater

DIGITAL INPUT

Voltage Range: 38.5 to 250 V AC, 24 to 250 V DC

Frequency Range: 40 to 70 Hz

OUTPUT AND TRIP CONTACTS

Closing: Contact will close and conduct up to a maximum of 30 A for tripping duty at control voltages up to 300 V DC. The output contact is also rated for Capacitive trip devices.

Interrupting: 50 W resistive with a maximum of 2 A and 300 V DC

Continuous: 5 A, with 300 V DC maximum

Frequency range: 25 to 70 Hz (note: the MDP responds to RMS values of harmonics to 600 Hz)

The following indicates the ranges of standard models.

NOMINAL CURRENT

5 A Phase Unit Models (models 1 to 3):

Phase Unit:	1.5 to 13.125 A in cumulative increments of 0.375, 0.750, 1.50, 3.0, and 6.0 A
Ground Unit model 1:	0.5 to 4.375 A in cumulative increments of 0.125, 0.250,0.50,1.0, and 2.0 A
Ground Unit model 2:	1.5 to 13.125 Amps in cumulative increments of 0.375, 0.750, 1.50, 3.0, and 6.0 A
Ground Unit model 3:	0.1 to 0.875 Amp in cumulative increments of 0.025, 0.050, 0.10, 0.2, and 0.4 A

5 A Phase Unit Model (model 7):

Phase Unit:	0.5 to 4.375 A in cumulative increments of 0.125, 0.25, 0.50, 1.0, and 2.0 A
Ground Unit:	0.5 to 4.375 A in cumulative increments of 0.125, 0.250, 0.50, 1.0, and 2.0 A

1 A Phase Unit (models 4 to 6):

Phase Unit:	0.3 to 2.625 A in cumulative increments of 0.075, 0.150, 0.30, 0.60, and 1.20 A
Ground Unit model 4:	0.1 to 0.875 A in cumulative increments of 0.025, 0.050, 0.10, 0.2, and 0.4 A
Ground Unit model 5:	0.3 to 2.625 A in cumulative increments of 0.075, 0.150, 0.30, 0.6, and 1.2 A
Ground Unit model 6:	0.05 to 0.4375 A in cumulative increments of 0.0125, 0.0250,0.050,0.1, and 0.2 A

TIME DELAY (TOC)

Independent for phase and ground.

Depends on the curve selected. Five Inverse Time curves are available (see Section 2.5: INVERSE TIME UNIT on page 2–3), as well as four definite times (maximum time 2, 4, 6, and 8 seconds), all in the same relay.

INSTANTANEOUS UNIT PICKUP

Independent for phase and ground.

1 to 31 times the pickup of the TOC setting.

A setting of zero (0) disables instantaneous unit. (X) no multiples selected.

INSTANTANEOUS UNIT TIME DELAY

Independent for phase and ground.

0 to 1.55 seconds in 50 millisecond steps.

PHASE OPERATING CURVES CURVE SELECTION

Available Curves: Inverse/BS142* (for 1 A models), Long Time Inverse, Very Inverse, Extremely Inverse, Four families of definite time characteristics with maximum values of 2, 4, 6, and 8 seconds

Between each family of curves, a specific curve can be selected between 0.5 and 10 in cumulative steps of 0.5, 1, 2, 2 and 4 for 5 a relays. The 1 A model range is from 0.05 to 1.0 in cumulative steps of 0.05, 0.1, 0.2, 0.2, and 0.4.

GROUND OPERATING CURVES CURVE SELECTION

Available Curves: Inverse/BS142* (for 1 A models), Long Time Inverse, Very Inverse, Extremely Inverse, Four families of definite time characteristics with maximum values of 2, 4, 6, and 8 seconds

Between each family of curves, a specific curve can be selected between 0.5 and 10 in cumulative steps of 0.5, 1, 2, 2, and 4 for 5 amp relays. A 1 amp model's range is from 0.05 to 1.0 in cumulative steps of 0.05, 0.1, 0.2, 0.2, and 0.4.

NOTE **BS142 is the INVERSE curve of the 1 A model.**

COMMUNICATIONS ADDRESS

Range: 002 to 998.

A setting of 000 indicates no communications and sets the default display to phase A Current.

NOTE **For RS232 and RS485 all relays will respond to address 001.**

NOTE **All values are adjusted with DIP switches located at the front of the relay, except the communications address, which is located on the rear of the cradle.**

1