

March 2001

**Multi-Zoned Distance**  
 Device Number: 87L

# Type REL 356 Current Differential Line Protection System



meters. The REL 356 is suitable for any system voltage from subtransmission through UHV.

### REL356 System Operation

The basic operation of the REL 356 relay system performs a true differential comparison of line current flowing through each terminal of the protected line. A pilot channel, either fiber optic or audio tone, is used to bring in the remote terminal signal(s) for comparison to the local signal. The unique methods used to represent the three phase current and securely transmit the remote signal produce the application flexibility and fidelity of the REL 356.

The REL 356 combines the phase currents (IA, IB, and IC) measured at the protective relaying terminal into a single quantity. This quantity is an output of Symmetrical component Filter which is proportional to the weighted sum of the sequence components.

The quantity IT, therefore, is defined as:

$$IT = C_0 I_0 - C_1 I_1 + C_2 I_2$$

The quantity IT is itself a sine wave. The C1 (positive sequence weighting coefficient), C2 (negative sequence weighting coefficient) and C0 (zero sequence weighting coefficient) are system settings that control the sensitivity of the relaying system.

For the comparison process two quantities are generated from the local and remote IT waveforms. The operate quantity is derived by vector addition of the local and remote quantities. The restraint (bias) quantity is obtained by adding the local and remote quantities on a magnitude basis. The resultant output is opposite in polarity to the "operate" quantity. The "operate" and "restraint" quantities are combined and the result fed to a level detector which produces a trip signal.

### Operating Quantity

$$OP = |ITL + ITR|$$

### Restraint Quantity

$$RES = |ITL| + |ITR|$$

### Trip Decision

$$IF [(OP-0.7 RES) > SET] THEN TRIP$$

### Where

ITL = Local Quantity

ITR = Remote Quantity

SET = System Setting

### BASIC SYSTEM

#### Standard Features

- Numerical Processing (Fully Digital)
- Multiple Microprocessor Design
- Current Differential Protection Algorithm
- Current Change (DI) Detectors and Selectable Voltage Change (DV) Detector
- Direct Transfer Trip
- Four High Set Overcurrent Units for Direct Trip
- Fault Locator Function
- Self Checking Function
- Sampling Techniques
  - 7 Incoming Analog Waveforms
  - 12 Samples per Cycle
- High Speed Operation
- Close Into Fault Detection
- 19 Inch wide Rack Mounting; 4-Rack Units High
- Loss of Potential Supervision
- Loss of Current Monitoring
- 50 or 60 Hz Operation
- 1 or 5 Ampere Current Transformer Operation
- RS-232C Communications Port
- Digital Fault Recording

#### Contact Outputs for:

- Breaker Trip
- General Start
- Breaker Failure Initiate
- System Failure Alarm
- Reclose Initiate
- Channel Alarm
- Reclose Block
- Trip Alarm

#### Adaptive Communication Channel Delay Measurement

#### Local Man-Machine Interface

#### Optional Features

- FT-14 Test Switches
- Distance Backup Function
- Power Swing Block or Trip
- Dual Power Supplies
- ITU (CCITT) G.703 Communication Interface
- Extended Contact Output (6 Trip, 6 BFI, 2 RB)
- RS-232C Communications Port with IRIG input port

### APPLICATION

REL 356 provides high speed protection for long and short lines. It is particularly suitable for lines too short to be protected by impedance measuring systems, such as the run from generator to switchyard. The channel flexibility built into the REL 356 allows application on lines up to 400 kilo-

**Direct Transfer Trip**

A feature of the REL 356 system is Direct-Transfer-Trip (DDT) function. The breaker or breakers at the remote terminal of a protected line can be tripped at high speed from the local terminal using elements of the REL 356 and the same communications channel. Transfer tripping is keyed by an external contact from other protective devices.

**REL 356 SPECIFICATIONS****TECHNICAL****Principal of operation**

Current differential using flexible communications channel interface.

**INPUT RATINGS****Nominal ac Voltage**

(VLN) at 60 Hz 69.3 V rms

Nominal ac Current (In) 1 or 5 A rms

Rated Frequency 50 or 60 Hz

**Maximum Permissible ac Voltage**

Continuous 160 Vrms  
(limited by maximum input to A/D converter)

10 Seconds 240 Vrms  
(limited by input transformer flux density)

**Maximum Permissible ac Current**

Continuous 15 A rms  
(limited by thermal characteristics)

1 Second Operational 160 A rms  
5 A nominal  
  
32 A rms - 1 A nominal  
(limited by maximum input to the A/D converter)

**Dc Battery Voltages**

Nominal	Input Range
60/48 Vdc	38 - 70 Vdc
110/125 Vdc	88 - 150 Vdc
220/250 Vdc	176 - 280 Vdc

**Dc Burdens**

Battery 15 W Normal  
40 W Tripping

**Ac Burdens**

Volts per Phase 0.02 VA at 70 Vac  
Current per Phase 0.45 VA at 5A

**External Connections**

Terminal blocks located on the rear of the chassis suitable for #14 square tongue lugs. Wiring to FT-14 switches suitable for #12 wire lugs.

**CONTACT DATA**

Trip Contacts - make and carry 30 A for 1 second, 10 A continuous capability, break 50 watts resistive or 25 watts with L/R = 0.045 seconds

Non-Trip Contacts - 1A dc make and continuous, break 25 watts resistive or 10 watts with L/R = 0.045 from 38 to 280 V dc

Contacts also meet IEC-225-6A, IEC-255-12, IEC-255-16, BS142-1982

**COMMUNICATION CHANNEL OPTIONS****9600 bps Audio Tone**

Operating Speed 9600 bits per sec

Standard Compliance ITU V.29

Carrier Frequency 1,700 Hz

Modulation QAM - Quadrature Amplitude Modulation

Transmit Level -1 dBm to -15 dBm  
Adjustable in 2 dBm steps

Channel Requirements 4 wire, AT&T 3002, C2 Conditioning or better

**56/64 kbs Digital Communication**

Operating Speed 56 or 64 kbits/sec

Direct Digital Option RS422/RS485 (electrical) Asynchronous Operation  
RS530 (mechanical)

**Fiber Optic Options**

a) Wave Length 850 nm

Fiber Optic Connector ST

Cable Multi-Mode

Transmitter Output 18 dBm minimum  
(into 50/125  $\mu$ m cable)

Receiver Input -28 dBm minimum

b) Wave Length 1300 nm

Fiber Optic Connector ST

Cable Single Mode

Transmitter Output (9/125  $\mu$ m cable)

Short Reach Option -20 dBm minimum

Medium Reach Option -10 dBm minimum

Long Reach Option 0 dBm minimum

Receiver Input -32 dBm minimum  
-20 dBm minimum

(Maximum power not to be exceeded)

**Optional G703 Interface**

The external G.703 interface adapter complies with CCITT (ITU) G.703, co-directional, 64 kbps specification

For details refer to IL 40-201.7

**CHASSIS DIMENSIONS AND WEIGHT**

Height 7" (177.8 mm) 4 Rack Units (See Figure 1)

Width 19" (482.6 mm)

Depth 14" (356 mm) including terminal blocks

Weight 38 lb (17.5 kg)

**ENVIRONMENTAL DATA**

Ambient Temperature Range

For Operation -20°C to + 60°C

For Storage -40°C to + 80°C

Insulation Test Voltage 2.8 kVdc, 1 minute; 3.2 kVdc, 1 sec (ANSI C37.90 IEC-255-5)

Open contacts 1400 Vdc continuous

Impulse Voltage Withstand 5 kV Peak, 1.2/50 microseconds 0.5 Joule, (IEC-255-5)

Surge Withstand Voltage 3 kV, 1 MHz (ANSI C37.90.1 IEC-255-22-1)

Fast Transient Voltage 4 kV, 10/100 ns Withstand (ANSI C37.90.1, IEC 255-22-4)

EMI Field Strength Withstand 25 MHz-1GHz, 10 V/m Withstand (ANSI C37.90.2)

Electrostatic Discharge Tests (IEC 255-22-2, IEC, 801-Y) 8/12 kV test voltage

Emission Tests (EN 55022, Class A)

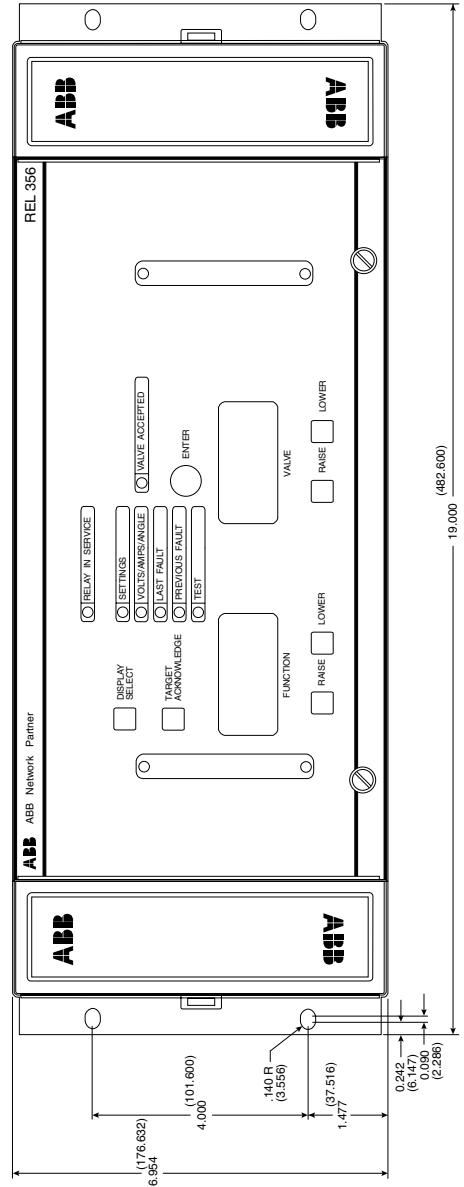
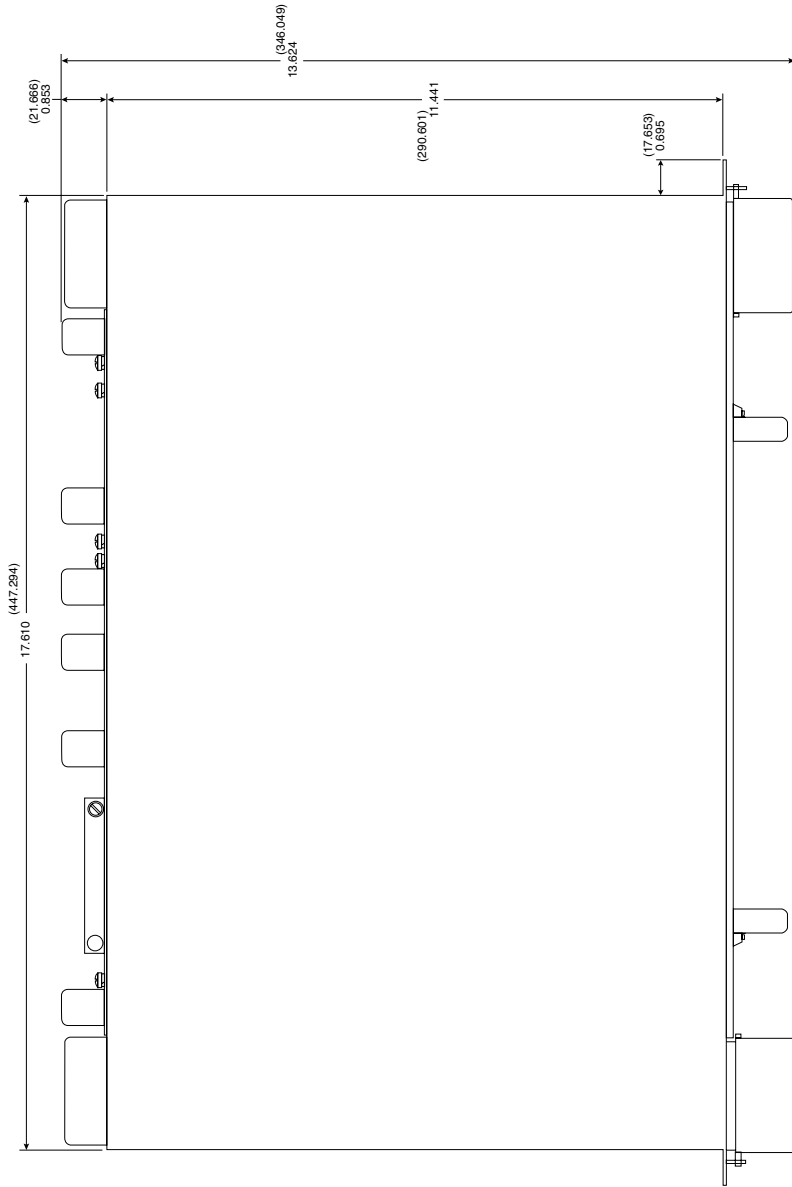


Figure 1. REL 356 Outline Drawing

## REL 356 Current Differential Protection System

Typical catalog number

Options	Cat. #	MC	2	B	2	N	A	N	R	G
TRIP/BFI/RI/RB/CONTACTS		.	.	.	.	.	.	.	.	.
2 Trip, 2 BFI, 4 RI, 2 RB contacts		2	.	.	.	.	.	.	.	.
6 Trip, 6 BFI, 4 RI, 2 RB contacts		6	.	.	.	.	.	.	.	.
CURRENT RATING			.	.	.	.	.	.	.	.
1 Amp CT		A	.	.	.	.	.	.	.	.
5 Amp CT		B	B	.	.	.	.	.	.	.
BATTERY SUPPLY VOLTAGE			.	.	.	.	.	.	.	.
48/60 Vdc Single Supply		1	.	.	.	.	.	.	.	.
110/125 Vdc Single Supply		2	2	.	.	.	.	.	.	.
220/250 Vdc Single Supply		3	.	.	.	.	.	.	.	.
48/60 Vdc Dual Supply		4	.	.	.	.	.	.	.	.
110/125 Vdc Dual Supply		5	.	.	.	.	.	.	.	.
220/250 Vdc Dual Supply		6	.	.	.	.	.	.	.	.
DISTANCE BACKUP RELAYING			.	.	.	.	.	.	.	.
Backup Distance Protection		P	.	.	.	.	.	.	.	.
No Backup Protection		N	N	.	.	.	.	.	.	.
COMMUNICATION CHANNEL INTERFACE			.	.	.	.	.	.	.	.
(Refer to "Communication Channel Options" in Specifications for more details)			.	.	.	.	.	.	.	.
9600 bps Audio Tone Channel		A	A	.	.	.	.	.	.	.
9600 bps Audio Tone Channel (British TELCOM)		B	.	.	.	.	.	.	.	.
56/64 kbs Direct Digital Channel		D	.	.	.	.	.	.	.	.
56/64 kbs Fiber Optic, 850 nm, Multimode, ST Connector		H	.	.	.	.	.	.	.	.
56/64 kbs 1300 nm, Single Mode Fiber, ST Connector Short Reach		E	.	.	.	.	.	.	.	.
56/64 kbs 1300 nm, Single Mode Fiber, ST Connector Medium Reach		M	.	.	.	.	.	.	.	.
56/64 kbs 1300 nm, Single Mode Fiber, ST Connector Long Reach		L	.	.	.	.	.	.	.	.
TEST SWITCHES			.	.	.	.	.	.	.	.
FT-14 Switches		F	.	.	.	.	.	.	.	.
No FT-14 Switches		N	N	.	.	.	.	.	.	.
REMOTE COMMUNICATION DEVICE			.	.	.	.	.	.	.	.
RS-232C PONI		R	.	.	.	.	.	R	.	.
INCOM® PONI		C	.	.	.	.	.	.	.	.
RS-232C with IRIG Port		B	.	.	.	.	.	.	.	.
Modbus PONI		M	.	.	.	.	.	.	.	.
ADDITIONAL FEATURES		G	.	.	.	.	.	.	.	G
Oscillographic Data Storage			.	.	.	.	.	.	.	.



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