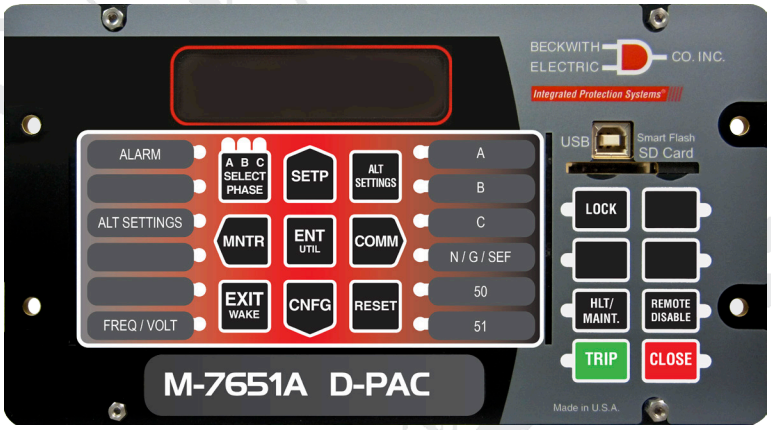
BECKWITH ELECTRIC CO. INC.

PROTECTION



M-7651A D-PAC

Protection, Automation and Control System for Power Distribution Applications

Protection

- Over 30 Protection Elements for optimal protection of Power Distribution Systems
- Ready to use advanced Protection Schemes for applications including Feeder Protection, Bay Control and DG Interconnection Protection
- 8 Setting Profiles
- Comprehensive I/O Matrix provides visual confirmation of enabled functions and selected outputs improving security

Automation/Communications

- Front panel USB and SD Card ports for local programming and data transfer
- One or two optional serial ports (TIA-232, TIA-485 or Serial Fiber)
- Optional single or dual Ethernet ports (copper or fiber) with simultaneous multi-user and multi-protocol support
- Protocols supported include:
  - MODBUS, DNP3.0
  - Optional: IEC61850
- Comprehensive Cyber Security tools for NERC CIP Compliance
- IEEE 1686 Compliant

Control

- Four user programmable Inputs and Outputs, expandable to twelve Inputs and twelve Outputs, plus three Virtual Inputs
- User programmable front-panel LEDs and pushbuttons

Monitoring

- Power Quality Monitoring up to the 63rd Harmonic including THD and TDD
- PQ Viewer (ITIC Curve)
- Sags, Swell and Sub-Synchronous Transient Detection
- Advanced Data Logging and Load Profile Recorder
- 3500 Event Sequence of Events (SOE) Recorder
- 100 DFR quality records of up to 480 cycles each with an adjustable sampling rate up to 128 s/c

IPScom® – *Uncomplicated Software for Complex Power System Applications*

- Integrated Metering, DFR and PQ Visualization Tools
- Search and filtering tools for analysis of SOE, DFR and PQ records
- IPSlogic Programmable Logic

Flexibility

- Fast and easy retrofitting for most popular relays in existing cutouts using Beckwith's Adapter Panel Technology™

Industry Leader Since 1969
Made in the USA

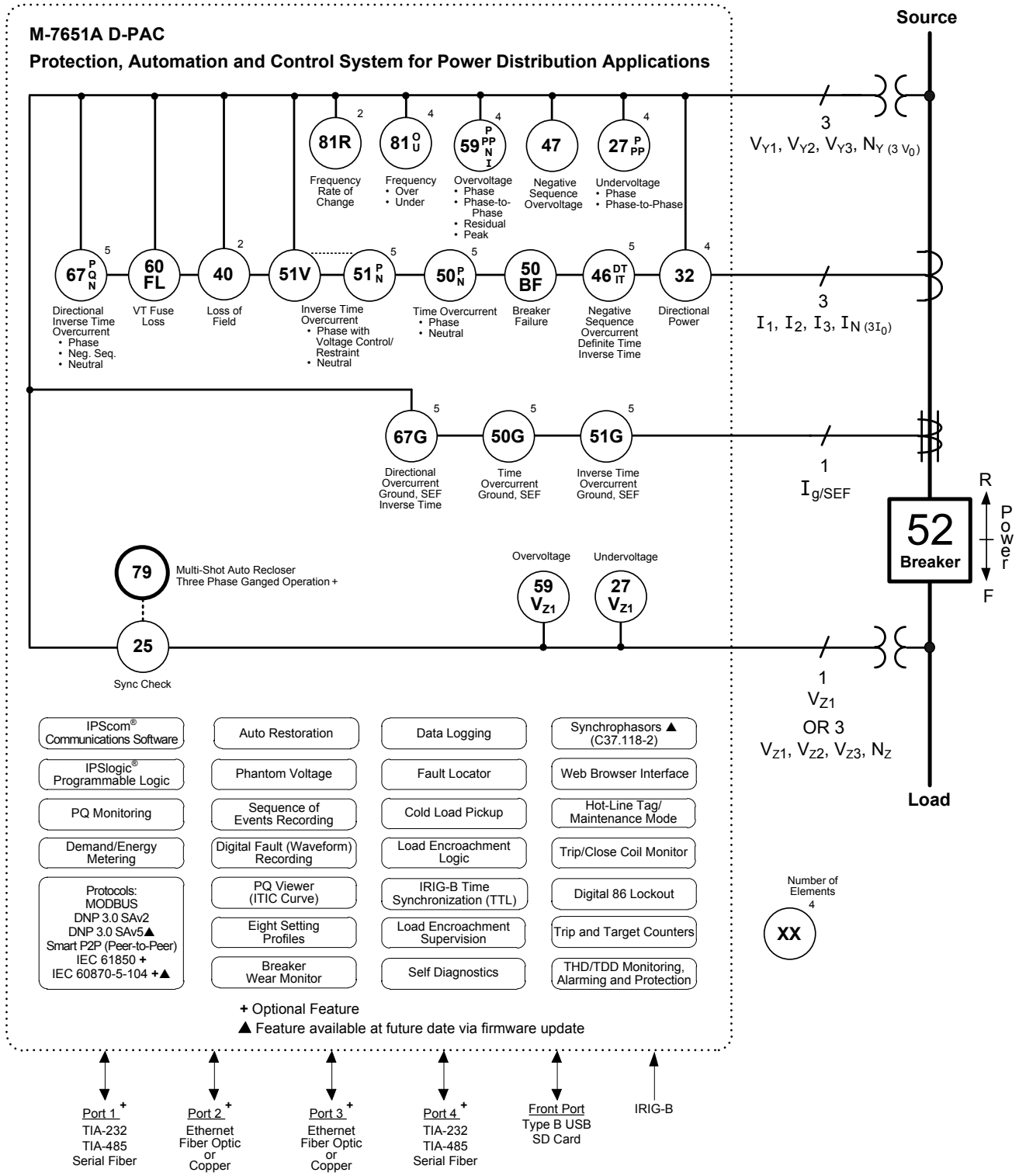


Figure 1 M-7651A D-PAC Typical Connections

Standard Control Features

- Over 30 protection functions
- Horizontal or Vertical Mounting
- 50 Hz or 60 Hz Frequency
- High (90 to 315 Vac/Vdc) or Low (18 to 60 Vdc) Power Supply
- IPScom Communications Software
- IPSlogic Programmable Logic
- Synchrophasors (IEEE C37.118-2)▲
- Load Encroachment Supervision
- Phantom Voltage
- Digital 86 Lockout▲
- I/O Map
- Smart Fuse Coordination▲
- Custom Curve Designer
- Hot-Line Tag/Maintenance Mode
- Fault Locator
- Eight Setting Profiles
- Compare Settings Tool
- Cold Load Pickup
- Auto Restoration
- Breaker Wear Monitor
- Power Quality Monitoring
- THD/TDD Monitoring, Alarming and Protection
- ITIC Curve Violation Counters and Recording
- Demand and Energy Metering
- Power Supply Monitor
- Trip/Close Coil Monitor
- Data Logging
- Sequence of Events Recording
- Trip and Target Counters
- Digital Fault (Waveform) Recording
- Fault Event Records
- Self-Diagnostics
- Three Phase Current Inputs plus one Ground or Sensitive Earth Current Input
- Three Phase Voltage Inputs plus one Sync Check Voltage Input
- IRIG-B Time Synchronization (TTL)
- Front Panel USB and SD Card ports
- Protocols Included:
  - MODBUS®
  - DNP3.0 SAv2
  - Smart P2P (Peer-To-Peer)▲
- Four User Programmable Digital Inputs
- Four User Programmable Digital Outputs
- Conformal coated circuit boards
- Configurable Front HMI LEDs and Pushbuttons
- 12 Vdc Backup Power Input
- SMTP E-mail server▲
- Web Browser Interface
- IEEE 1686 Standard Compliant Cyber Security
- IPsec (Internet Protocol Security)
- RADIUS Client Capability to manage local and remote access to the control
- Wide Variety of Communications Accessories

Optional Features

- Multi-Shot Auto Recloser, Three-Phase Ganged Reclose Operation
- PORT 1: TIA-232, TIA-485, or Fiber Optic
- PORT 2 – Rear Ethernet Fiber Optic or Copper
- PORT 3 – Rear Ethernet Fiber Optic or Copper
- PORT 4 – TIA-232, TIA-485, or Fiber Optic
- Optional Protocols in addition to standard MODBUS and DNP3.0 (requires at least one Ethernet Port):
  - Add IEC 61850
  - Add IEC 60870-5-104/101▲
  - Add Combination IEC 61850 and IEC 60870-05-104/101▲
- Expanded I/O – Additional eight digital Inputs and eight digital Outputs for a total of 12 each
- Low Energy Analog (LEA) Inputs per C37.92. Configurations available: 4 LEA, 3LEA + 1VT, or 6LEA.
- ArcFlash detection▲
- M-2032A Battery Charger/Power Supply – please refer to the M-2032A Specification for additional information and ordering options.

M-7651A Mounting Options

- 19" Rack Mount Adapter Panel
- Adapter Frames to mount the M-7651A into existing cutouts

▲ Feature available at future date via firmware update / IPScom update

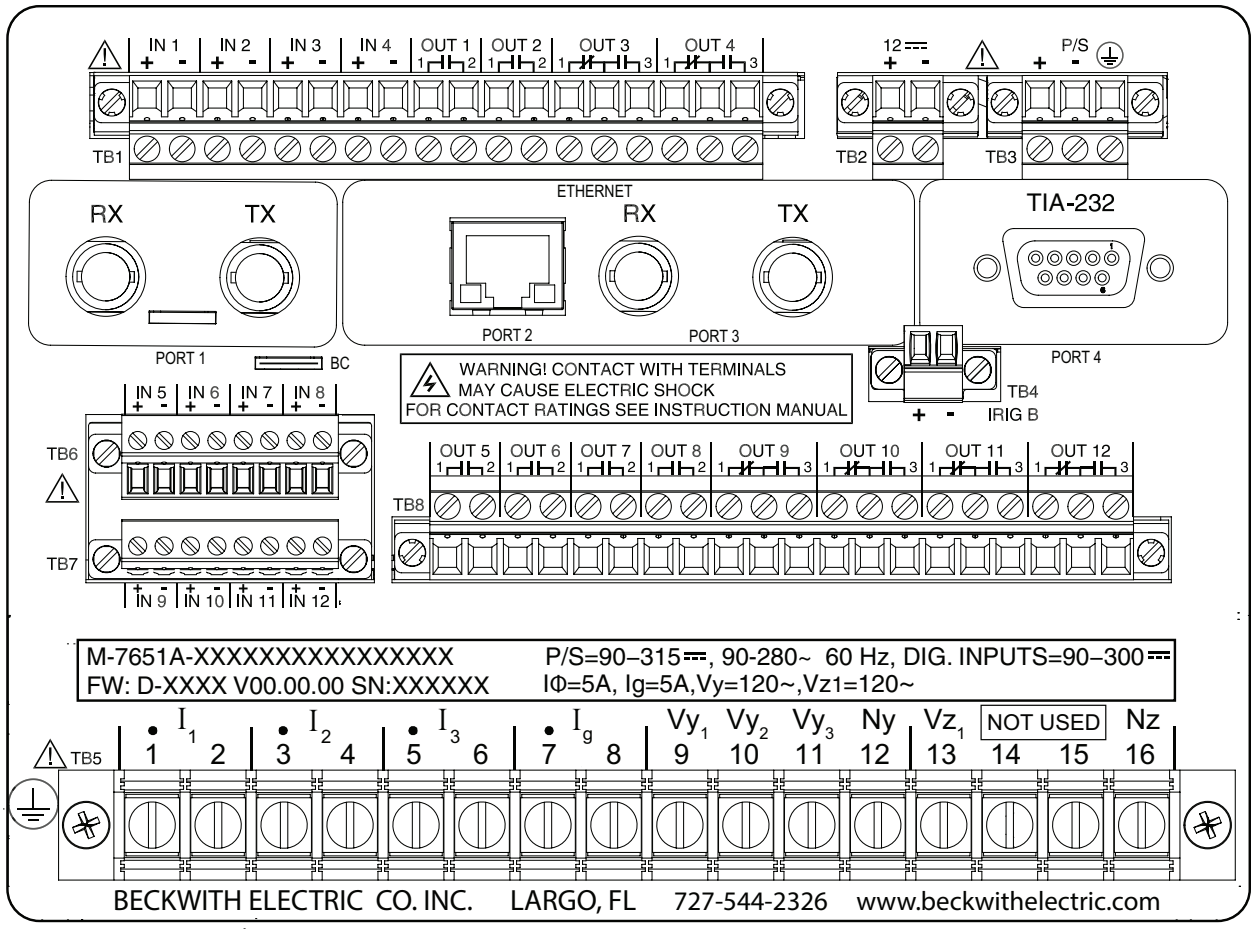


Figure 2 M-7651A External Connections (Typical configuration, other options are available)

PROTECTIVE FUNCTIONS

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	Sync Check			
25	Reference Phase	A/B/C	_	_
	Undervoltage Permission			
	Dead Line/Dead Bus	Yes/No	_	_
	Dead Line/Live Bus	Yes/No	_	_
	Live Line/Dead Bus	Yes/No	_	_
	Live Line Minimum Voltage	0.0 to 200.0 V	0.1 V	± 0.2 V or ± 0.5%
	Live Bus Minimum Voltage	0.0 to 200.0 V	0.1 V	± 0.2 V or ± 0.5%
	Sync Check Permission			
	Max/Minimum Time Delay	0.01 to 600.00 s	0.01 s	± 0.01 s* or ± 1%
	Minimum Voltage	10.0 to 300.0 V	0.01 V	± 0.2 V or ± 0.5%
	Maximum Voltage	10.0 to 300.0 V	0.01 V	± 0.2 V or ± 0.5%
	Angle Difference	0.00° to 90.00°	0.01°	± 0.3°
	Magnitude Difference	0.00 to 300.00 V	0.01 V	± 0.2 V or ± 0.5%
	Frequency Difference	0.00 to 5.00 Hz	0.01 Hz	± 0.02 Hz or ± 2%
	Undervoltage			
27	**Phase Undervoltage (#1 to #4 Steps)**			
	Pickup	10.00 to 300.00 V	0.01 V	± 0.2 V or ± 0.5%
	Definite Time	0.00 to 600.00 s	0.01 s	± 0.01 s* or ± 1%
	Auto Restoration	Enable/Disable		
27 PP	**Phase-to-Phase Undervoltage**			
	Pickup	10.00 to 300.00 V	0.01 V	± 0.2 V or ± 0.5%
	Definite Time	0.00 to 600.00 s	0.01 s	± 0.01 s* or ± 1%
27 Vz1	**Vz1 Undervoltage**			
	Pickup	10.00 to 300.00 V	0.01 V	± 0.2 V or ± 0.5%
	Definite Time	0.00 to 600.00 s	0.01 s	± 0.01 s* or ± 1%
	Bus Side Voltage Supervision			
27B	**Bus Side Voltage Supervision**			
	Minimum Closing Voltage	0.00 to 300.00 V	0.01 V	± 0.2 V or ± 0.5%
	Supervision Time	0.00 to 600.00 s	0.01 s	± 0.01 s* or ± 1%

*An additional measurement time of 1 cycle needs to be added to the measured time delay.

†Select the greater of these accuracy values. For voltage accuracy specified, the range is (20 – 180 V).

PROTECTIVE FUNCTIONS (*cont.*)

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	Directional Power (#1 to #4 Steps)			
32	Pickup	–3.00 to +3.00 PU	0.01 PU	± 0.02 PU or ± 6%
	Definite Time	0.00 to 600.00 s	0.01 s	± 0.01 s* or ± 1%
	Power	Real/Reactive		
	Each directional power element can be set as overpower or underpower.			
	The per unit pickup is based on the nominal secondary VT voltage and CT current settings.			
	Loss of Field - Dual-zone Offset-mho Characteristic (#1 to #2 Steps)			
40	Circle Diameter			
	1 A CT	0.5 to 500.0 Ω	0.1 Ω	± 0.5 Ω or ± 5%
	5 A CT	0.1 to 100.0 Ω	0.1 Ω	± 0.1 Ω or ± 5%
	Offset			
	1 A CT	-250.0 to 250.0 Ω	0.1 Ω	± 0.5 Ω or ± 5%
	5 A CT	-50.0 to 50.0 Ω	0.1 Ω	± 0.1 Ω or ± 5%
	Time Delay	0.01 to 300.00 s	0.01 s	± 1 Cycle or ± 1%
	Time Delay with Volt. Ctrl.	0.01 to 300.00 s	0.01 s	± 1 Cycle or ± 1%
	Time delay with Voltage Control for each zone can be individually enabled.			
	Voltage Control	5 to 180 V	1 V	± 0.5 V or ± 0.5%
	Directional Element	0° to 20°	1°	–

*An additional measurement time of 1 cycle needs to be added to the measured time delay.

†Select the greater of these accuracy values. For voltage accuracy specified, the range is (20 – 180 V).

PROTECTIVE FUNCTIONS (*cont.*)

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	Negative Sequence Overcurrent (#1 to #5 Steps)			
46 DT	**Definite Time**			
	Pickup			
	1 A CT	0.02 to 20.00 A	0.01 A	± 0.02 A or ± 3%
	5 A CT	0.10 to 100.00 A	0.01 A	± 0.1 A or ± 3%
	Definite Time	0.00 to 600.00 s	0.01 s	± 0.01 s* or ± 1%
46 IT	**Inverse Time**			
	Pickup			
	1 A CT	0.02 to 3.20 A	0.01 A	± 0.02 A or ± 3%
	5 A CT	0.10 to 16.00 A	0.01 A	± 0.1 A or ± 3%
	Electromechanical Reset Delay	Yes/No		
	Reset Coefficient	0.001 to 30.000 s	0.001 s	± 0.01 s* or ± 1%
	TCC Modifiers			
	Time Adder	0.00 to 30.00 s	0.01 s	± 0.01 s* or ± 1%
	Minimum Response Time Adder	0.00 to 1.00 s	0.01 s	± 0.01 s* or ± 1%
	IEC Curves Family (IEC 60255-151)	Inverse, Very Inverse Extremely Inverse		
	Time Multiplier	0.05 to 1.00	0.01	± 2 cycles or ± 5%
	IEEE Curves (C37.112)	Moderately Inverse Very Inverse Extremely Inverse		
	Time Multiplier	0.10 to 25.00	0.01	± 2 cycles or ± 5%
	US Curves	Moderately Inverse Standard Inverse Very Inverse Extremely Inverse Short Time Inverse		
	Time Multiplier	0.05 to 15.00	0.01	± 2 cycles or ± 5%
	Traditional Recloser Curves	101; 102; 103; 104; 105; 106; 107; 111; 112; 113; 114; 115; 116; 117; 118; 119; 120; 121; 122; 131; 132; 133; 134; 135; 136; 137; 138; 139; 140; 141; 142; 151; 152; 161; 162; 163; 164; 165; 200; 201; 202		
	Time Multiplier	0.10 to 2.00	0.01	± 2 cycles or ± 5%
	Definite Time			
	Time Multiplier	0.10 to 100.00	0.01	± 2 cycles or ± 5%

*An additional measurement time of 1 cycle needs to be added to the measured time delay.

†Select the greater of these accuracy values. For voltage accuracy specified, the range is (20 – 180 V).

PROTECTIVE FUNCTIONS (*cont.*)

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	Negative Sequence Overvoltage			
47	Pickup	0.00 to 300.00 V	0.01 V	± 0.2 V or ± 0.5%
	Definite Time	0.00 to 600.00 s	0.01 s	± 0.01 s* or ± 1%
	Breaker Failure			
50 BF	Pickup			
	Phase Current			
	1 A CT	0.02 to 2.00 A	0.01 A	± 0.02 A or ± 3%
	5 A CT	0.10 to 10.00 A	0.01 A	± 0.1 A or ± 3%
	Residual/ Ground (Sensitive Ground) Current			
	1 A CT	0.02 to 2.00 A	0.01 A	± 0.02 A or ± 3%
	5 A CT	0.10 to 10.00 A	0.01 A	± 0.1 A or ± 3%
	10 mA CT	0.001 to 0.160 A	0.001 A	TBD
	50 mA CT	0.005 to 0.800 A	0.001 A	TBD
	200 mA CT	0.020 to 3.200 A	0.001 A	TBD
	Time Delay	0.01 to 600.00 s	0.01 s	± 0.01 s* or ± 1%
	Retrip Delay	0.01 to 600.00 s	0.01 s	± 0.01 s* or ± 1%

*An additional measurement time of 1 cycle needs to be added to the measured time delay.

†Select the greater of these accuracy values. For voltage accuracy specified, the range is (20 – 180 V).

PROTECTIVE FUNCTIONS (*cont.*)

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	Instantaneous/Definite Time Overcurrent (#1 to #5 Steps)			
50P	**Phase Instantaneous/Definite Time Overcurrent**			
	Pickup			
	1 A CT	0.02 to 20.00 A	0.01 A	± 0.02 A or ± 3%
	5 A CT	0.10 to 100.00 A	0.01 A	± 0.1 A or ± 3%
	Definite Time	0.00 to 600.00 s	0.01 s	± 0.01 s* or ± 1%
50 HCL	**High Current Lockout (#1 to #5 Steps)**			
	Phase	Enable/Disable		
	Reference Current			
	1 A CT	0.10 to 100.00 A	0.01 A	± 0.02 A or ± 3%
	5 A CT	0.50 to 500.00 A	0.01 A	± 0.1 A or ± 3%
	Definite Time	0.00 to 600.00 s	0.01 s	± 0.01 s* or ± 1%
50N	**Residual Instantaneous/Definite Time Overcurrent**			
	Pickup			
	1 A CT	0.02 to 20.00 A	0.01 A	± 0.02 A or ± 3%
	5 A CT	0.10 to 100.00 A	0.01 A	± 0.1 A or ± 3%
	Definite Time	0.00 to 600.00 s	0.01 s	± 0.01 s* or ± 1%
50 HCL	**High Current Lockout (#1 to #5 Steps) with "$3I_0$" HCL Operating Current Reference**			
	Residual/Ground	Enable/Disable		
	Reference Current			
	1 A CT	0.03 to 100.00 A	0.01 A	± 0.02 A or ± 3%
	5 A CT	0.15 to 500.00 A	0.01 A	± 0.02 A or ± 3%
	Definite Time	0.00 to 600.00 s	0.01 s	± 0.01 s* or ± 1%
50G	**Ground Instantaneous/Definite Time Overcurrent**			
	Pickup			
	1 A Gnd CT	0.02 to 20.00 A	0.01 A	± 0.02 A or ± 3%
	5 A Gnd CT	0.10 to 100.00 A	0.01 A	± 0.1 A or ± 3%
	Definite Time	0.00 to 600.00 s	0.01 s	± 0.01 s* or ± 1%
50 HCL	**High Current Lockout (#1 to #5 Steps) with "G" HCL Operating Current Reference**			
	Residual/Ground	Enable/Disable		
	Reference Current			
	1 A Gnd CT	0.03 to 100.00 A	0.01 A	± 0.02 A or ± 3%
	5 A Gnd CT	0.15 to 500.00 A	0.01 A	± 0.1 A or ± 3%
	Definite Time	0.00 to 600.00 s	0.01 s	± 0.01 s* or ± 1%

*An additional measurement time of 1 cycle needs to be added to the measured time delay.

†Select the greater of these accuracy values. For voltage accuracy specified, the range is (20 – 180 V).

PROTECTIVE FUNCTIONS (*cont.*)

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	Inverse Time Overcurrent (#1 to #5 Steps)			
51P	**Phase Inverse Time Overcurrent with Voltage Control/Restraint**			
	Pickup			
	1 A CT	0.02 to 3.20 A	0.01 A	± 0.02 A or ± 3%
	5 A CT	0.10 to 16.00 A	0.01 A	± 0.1 A or ± 3%
	Load Encroachment Logic	Use/Do Not Use	–	–
	Voltage Control or Voltage Restraint	4.0 to 150.0 %	0.1 %	
51N	**Residual Inverse Time Overcurrent**			
	Pickup			
	1 A CT	0.02 to 3.20 A	0.01 A	± 0.02 A or ± 3%
	5 A CT	0.10 to 16.00 A	0.01 A	± 0.1 A or ± 3%
51G	**Ground Inverse Time Overcurrent**			
	Pickup			
	1 A Gnd CT	0.02 to 3.20 A	0.01 A	± 0.02 A or ± 3%
	5 A Gnd CT	0.10 to 16.00 A	0.01 A	± 0.1 A or ± 3%
	Electromechanical Reset Delay	Yes/No		
	Reset Coefficient	0.001 to 30.000 s	0.001 s	± 0.01 s* or ± 1%
	TCC Modifiers			
	Time Adder	0.00 to 30.00 s	0.01 s	± 0.01 s* or ± 1%
	Minimum Response Time Adder	0.00 to 1.00 s	0.01 s	± 0.01 s* or ± 1%
	IEC Curves Family (IEC 60255-151)	Inverse, Very Inverse Extremely Inverse		
	Time Multiplier	0.05 to 1.00	0.01	± 2 cycles or ± 5%
	IEEE Curves (C37.112)	Moderately Inverse Very Inverse Extremely Inverse		
	Time Multiplier	0.10 to 25.00	0.01	± 2 cycles or ± 5%
	US Curves	Moderately Inverse Standard Inverse Very Inverse Extremely Inverse Short Time Inverse		
	Time Multiplier	0.05 to 15.00	0.01	± 2 cycles or ± 5%
	Traditional Recloser Curves	101; 102; 103; 104; 105; 106; 107; 111; 112; 113; 114; 115; 116; 117; 118; 119; 120; 121; 122; 131; 132; 133; 134; 135; 136; 137; 138; 139; 140; 141; 142; 151; 152; 161; 162; 163; 164; 165; 200; 201; 202		
	Time Multiplier	0.10 to 2.00	0.01	± 2 cycles or ± 5%
	Definite Time			
	Time Multiplier	0.10 to 100.00	0.01	± 2 cycles or ± 5%

*An additional measurement time of 1 cycle needs to be added to the measured time delay.

†Select the greater of these accuracy values. For voltage accuracy specified, the range is (20 – 180 V).

PROTECTIVE FUNCTIONS (*cont.*)

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	Overvoltage			
59	**Phase Overvoltage (#1 to #4 Steps)**			
	Pickup	10.00 to 300.00 V	0.01 V	± 0.2 V or ± 0.5%
	Definite Time	0.00 to 600.00 s	0.01 s	± 0.01 s* or ± 1%
	Auto Restoration	Enable/Disable		
59I	**Peak Overvoltage**			
	Pickup	100 to 150 %	1%	± 3%
	Definite Time	0.01 to 140.00 s	0.01 s	± 0.05 s*
59N	**Residual Overvoltage**			
	Pickup	10.00 to 300.00 V	0.01 V	± 0.2 V or ± 0.5%
	Definite Time	0.00 to 600.00 s	0.01 s	± 0.01 s* or ± 1%
59 PP	**Phase-to-Phase Overvoltage**			
	Pickup	10.00 to 300.00 V	0.01 V	± 0.2 V or ± 0.5%
	Definite Time	0.00 to 600.00 s	0.01 s	± 0.01 s* or ± 1%
59 Vz1	**Vz1 Overvoltage**			
	Pickup	10.00 to 300.00 V	0.01 V	± 0.2 V or ± 0.5%
	Definite Time	0.00 to 600.00 s	0.01 s	± 0.01 s* or ± 1%
	VT Fuse-Loss Detection			
60 FL	**A VT fuse-loss condition is detected by using the positive and negative sequence components of the voltages and currents.**			
	Time Delay	0.03 to 600.00 s	0.01 s	± 0.01 s* or ± 1%
	Three Phase VT Fuse Loss Detection	Enable/Disable		

*An additional measurement time of 1 cycle needs to be added to the measured time delay.

†Select the greater of these accuracy values. For voltage accuracy specified, the range is (20 – 180 V).

PROTECTIVE FUNCTIONS (*cont.*)

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	Directional Overcurrent (#1 to #5 Steps)			
67P	**Phase Directional Overcurrent**			
	Operating Current	Phase Current		
	Phase Polarization Voltage	V_1		
67N	**Residual Directional Overcurrent**			
	Operating Current	$3I_O$		
	Phase Polarization Voltage	Vz_1, V_1, V_2, V_O		
67G	**Ground Directional Overcurrent**			
	Operating Current	I_g		
	Phase Polarization Voltage	Vz_1, V_1, V_2, V_O		
67Q	**Negative Sequence Directional Overcurrent**			
	Operating Current	Negative Sequence Current		
	Phase Polarization Voltage	V_2		
	Enabled Direction	No-Direction/Directional		
	Minimum Polarization Voltage (% of nominal voltage)	2.0 to 10.0 %	0.1%	± 3%
	Action if below	Trip/Block Trip		
	Maximum Sensitivity Angle 1	0° to 359°	1°	± 1°
	Maximum Sensitivity Angle 2	5° to 90°	1°	± 1°
	Time Delay	Definite/Inverse	–	–
	Definite Time: Pickup			
	1 A CT/Gnd CT	0.05 to 20.00 A	0.01 A	± 0.02 A or ± 3%
	5 A CT/Gnd CT	0.25 to 100.00 A	0.01 A	± 0.1 A or ± 3%
	Delay	0.00 to 600.00 s	0.01 s	± 0.01 s* or ± 1%

■ **NOTE:** Function 67 Inverse Time Delay Specifications continued on next page.

*An additional measurement time of 1 cycle needs to be added to the measured time delay.

†Select the greater of these accuracy values. For voltage accuracy specified, the range is (20 – 180 V).

PROTECTIVE FUNCTIONS (*cont.*)

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	Directional Instantaneous/Definite Time Overcurrent (Cont'd.)			
	Inverse Time:			
	Pickup			
	1 A CT/Gnd CT	0.02 to 3.20 A	0.01 A	± 0.02 A or ± 3%
	5 A CT/Gnd CT	0.10 to 16.00 A	0.01 A	± 0.1 A or ± 3%
	Electromechanical Reset Delay	Yes/No		
	Reset Coefficient	0.001 to 30.000 s	0.001 s	± 0.01 s* or ± 1%
	TCC Modifiers			
	Time Adder	0.00 to 30.00 s	0.01 s	± 0.01 s* or ± 1%
	Minimum Response Time Adder	0.00 to 1.00 s	0.01 s	± 0.01 s* or ± 1%
	IEC Curves Family (IEC 60255-151)	Inverse, Very Inverse Extremely Inverse		
	Time Multiplier	0.05 to 1.00	0.01	± 2 cycles or ± 5%
	IEEE Curves (C37.112)	Moderately Inverse Very Inverse Extremely Inverse		
	Time Multiplier	0.10 to 25.00	0.01	± 2 cycles or ± 5%
	US Curves	Moderately Inverse Standard Inverse Very Inverse Extremely Inverse Short Time Inverse		
	Time Multiplier	0.05 to 15.00	0.01	± 2 cycles or ± 5%
	Traditional Recloser Curves	101; 102; 103; 104; 105; 106; 107; 111; 112; 113; 114; 115; 116; 117; 118; 119; 120; 121; 122; 131; 132; 133; 134; 135; 136; 137; 138; 139; 140; 141; 142; 151; 152; 161; 162; 163; 164; 165; 200; 201; 202		
	Time Multiplier	0.10 to 2.00	0.01	± 2 cycles or ± 5%
	Definite Time			
	Time Multiplier	0.10 to 100.00	0.01	± 2 cycles or ± 5%

*An additional measurement time of 1 cycle needs to be added to the measured time delay.

†Select the greater of these accuracy values. For voltage accuracy specified, the range is (20 – 180 V).

PROTECTIVE FUNCTIONS (*cont.*)

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	Frequency (#1 to #4 Steps)			
81	Pickup	40.00 to 65.00 Hz	0.01 Hz	± 0.02 Hz
	Definite Time	0.00 to 600.00 s	0.01 s	± 0.01 s* or ± 1%
	Hysteresis	0.0 to 1.0 Hz	0.1 Hz	
	Undervoltage Block	Enable/Disable		
	Minimum Voltage	1.00 to 180.00 V	0.01 V	
	Minimum Load	Enable/Disable		
	1 A CT	0.00 to 40.00 A	0.01 A	± 0.02 A or ± 3%
	5 A CT	0.00 to 200.00 A	0.01 A	± 0.1 A or ± 3%
	The pickup accuracy applies at a range of 57 to 63 Hz. Beyond this range the accuracy is ± 0.1 Hz.			
	Auto Restoration	Enable/Disable		
	Rate of Change of Frequency (#1 to #2 Steps)			
81R	Pickup	0.20 to 5.00 Hz/s	0.01 Hz/s	± 0.02 Hz/s
	Definite Time	0.00 to 2.00 s	0.01 s	± 0.01 s* or ± 1%
	Maximum Frequency	40.00 to 70.00 Hz	0.01 Hz	
	Minimum Current			
	1 A CT	0.00 to 20.00 A	0.01 A	± 0.02 A or ± 3%
	5 A CT	0.00 to 100.00 A	0.01 A	± 0.1 A or ± 3%
	Minimum Voltage	0.00 to 300.00 V	0.01 V	
	Pickup Cycle Number	3 to 15	1	
	Breaker Monitor			
BM	Pickup	1 to 60000 kA** Cycles	1 kA** Cycles	± 1 kA** Cycles
	Time Delay	0.00 to 600.00 s	0.01 s	± 0.01 s* or ± 1%
	Breaker Open Arc Current Delay	0 to 2000 ms	1 ms	
	Arc Current Cycle	0 to 20 Cycles	1 Cycle	
	Preset Accumulators	0 to 60000 kA** Cycles	1 kA** Cycle	
	Timing Selection Method**	$I^{1.5}T$, IT or I^2T		
	(**Timing Selection Method determines unit: kA, $kA^{1.5}$ or kA^2)			

The Breaker Monitor feature calculates an estimate of the per-phase wear on the breaker contacts by measuring and integrating the current through the breaker contacts as an arc.

The per-phase values are added to an accumulated total for each phase, and then compared to a user-programmed threshold value. When the threshold is exceeded in any phase, the relay can set a programmable output contact.

The accumulated value for each phase can be displayed.

The Breaker Monitoring feature requires an initiating contact to begin accumulation, and the accumulation begins after the set time delay.

*An additional measurement time of 1 cycle needs to be added to the measured time delay.

†Select the greater of these accuracy values. For voltage accuracy specified, the range is (20 – 180 V).

PROTECTIVE FUNCTIONS (*cont.*)

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	Trip/Close Circuit Monitoring			
TCM	Time Delay	0.01 to 600.00 s	0.01 s	± 0.01 s* or ± 1%
CCM	Time Delay	0.01 to 600.00 s	0.01 s	± 0.01 s* or ± 1%
	Trip Coil and Close Coil input voltages are limited to the specifications in Table 5.			
	Total Harmonic Distortion / Total Demand Distortion			
THD	Operating Quantity	Current/Voltage		
	Limit	3.0 to 10.0 %	0.1%	± 2%
	Time Delay	0.00 to 600.00 s	0.01 s	± 0.01 s* or ± 1%
TDD	Operating Quantity	Current		
	Limit	3.0 to 10.0 %	0.1%	± 2%
	Time Delay	0.00 to 600.00 s	0.01 s	± 0.05 s* or ± 1%

*An additional measurement time of 1 cycle needs to be added to the measured time delay.

†Select the greater of these accuracy values. For voltage accuracy specified, the range is (20 – 180 V).

OPTIONAL PROTECTIVE FUNCTIONS

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	Sensitive Ground Instantaneous/Definite Time Overcurrent (#1 to #5 Steps)			
50 GS	Sensitive Ground Pickup			
	10 mA Gnd CT	0.001 to 0.160 A	0.001 A	(TBD)
	50 mA Gnd CT	0.005 to 0.800 A	0.001 A	0.0015 A or ± 3%
	200 mA Gnd CT	0.020 to 2.500 A	0.001 A	(TBD)
	Definite Time	0.00 to 600.00 s	0.01 s	± 0.01 s* or ± 1%
	Replaces Standard 50G Ground			
50 HCL	**High Current Lockout (#1 to #5 Steps) with "G" HCL Operating Current Reference**			
	Residual/Ground	Enable/Disable		
	Reference Current			
	10 mA Gnd CT	0.001 to 0.160 A	0.001 A	(TBD)
	50 mA Gnd CT	0.005 to 0.800 A	0.001 A	0.0015 A or ± 3%
	200 mA Gnd CT	0.020 to 3.200 A	0.001 A	(TBD)
	Definite Time	0.00 to 600.00 s	0.01 s	± 0.01 s* or ± 1%

*An additional measurement time of 1 cycle needs to be added to the measured time delay.

†Select the greater of these accuracy values. For voltage accuracy specified, the range is (20 – 180 V).

OPTIONAL PROTECTIVE FUNCTIONS (*cont.*)

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	Sensitive Ground Inverse Time Overcurrent (#1 to #5 Steps)			
51 GS	Sensitive Ground Pickup			
	10 mA Gnd CT	0.001 to 0.160 A	0.001 A	(TBD)
	50 mA Gnd CT	0.005 to 0.800 A	0.001 A	0.0015 A or ± 3%
	200 mA Gnd CT	0.020 to 2.500 A	0.001 A	(TBD)
	Electromechanical Reset Delay	Yes/No		
	Reset Coefficient	0.001 to 30.000 s	0.001 s	± 0.01 s* or ± 1%
	TCC Modifiers			
	Time Adder	0.00 to 30.00 s	0.01 s	± 0.01 s* or ± 1%
	Minimum Response Time Adder	0.00 to 1.00 s	0.01 s	± 0.01 s* or ± 1%
	IEC Curves Family (IEC 60255-151)	Inverse, Very Inverse Extremely Inverse		
	Time Multiplier	0.05 to 1.00	0.01	± 2 cycles or ± 5%
	IEEE Curves (C37.112)	Moderately Inverse Very Inverse Extremely Inverse		
	Time Multiplier	0.10 to 25.00	0.01	± 2 cycles or ± 5%
	US Curves	Moderately Inverse Standard Inverse Very Inverse Extremely Inverse Short Time Inverse		
	Time Multiplier	0.05 to 15.00	0.01	± 2 cycles or ± 5%
	Traditional Recloser Curves	101; 102; 103; 104; 105; 106; 107; 111; 112; 113; 114; 115; 116; 117; 118; 119; 120; 121; 122; 131; 132; 133; 134; 135; 136; 137; 138; 139; 140; 141; 142; 151; 152; 161; 162; 163; 164; 165; 200; 201; 202		
	Time Multiplier	0.10 to 2.00	0.01	± 2 cycles or ± 5%
	Definite Time			
	Time Multiplier	0.10 to 100.00	0.01	± 2 cycles or ± 5%

Replaces Standard 51G Ground

*An additional measurement time of 1 cycle needs to be added to the measured time delay.

†Select the greater of these accuracy values. For voltage accuracy specified, the range is (20 – 180 V).

OPTIONAL PROTECTIVE FUNCTIONS (*cont.*)

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	Sensitive Ground Directional Overcurrent (#1 to #5 Steps)			
67 GS	Phase Polarization Voltage	Vz_1, V_1, V_2, V_O	–	–
	Enabled Direction	No-Direction/Directional	–	–
	Minimum Polarization Voltage (% of nominal voltage)	2.0 to 10.0 %	0.1%	± 3%
	Action if below	Trip/Block Trip	–	–
	Maximum Sensitivity Angle 1	0° to 359°	1°	± 4°
	Maximum Sensitivity Angle 2	5° to 90°	1°	± 4°
	Time Delay	Definite/Inverse	–	–
	Definite Time:			
	Pickup 10 mA Gnd CT	0.001 to 0.160 A	0.001 A	(TBD)
	Pickup 50 mA Gnd CT	0.005 to 0.800 A	0.001 A	0.0015 A or ± 3%
	Pickup 200 mA Gnd CT	0.020 to 2.500 A	0.001 A	(TBD)
	Delay	0.00 to 600.00 s	0.01 s	± 0.01 s* or ± 1%
	Inverse Time:			
	Electromechanical Reset Delay	Yes/No		
	Reset Coefficient	0.001 to 30.000 s	0.001 s	± 0.01 s* or ± 1%
	TCC Modifiers Time Adder	0.00 to 30.00 s	0.01 s	± 0.01 s* or ± 1%
	Minimum Response Time Adder	0.00 to 1.00 s	0.01 s	± 0.01 s* or ± 1%
	IEC Curves Family (IEC 60255-151)	Inverse, Very Inverse Extremely Inverse		
	Time Multiplier	0.05 to 1.00	0.01	± 2 cycles or ± 5%
	IEEE Curves (C37.112)	Moderately Inverse Very Inverse Extremely Inverse		
	Time Multiplier	0.10 to 25.00	0.01	± 2 cycles or ± 5%
	US Curves	Moderately Inverse Standard Inverse Very Inverse Extremely Inverse Short Time Inverse		
	Time Multiplier	0.05 to 15.00	0.01	± 2 cycles or ± 5%
	Traditional Recloser Curves	101; 102; 103; 104; 105; 106; 107; 111; 112; 113; 114; 115; 116; 117; 118; 119; 120; 121; 122; 131; 132; 133; 134; 135; 136; 137; 138; 139; 140; 141; 142; 151; 152; 161; 162; 163; 164; 165; 200; 201; 202		
	Time Multiplier	0.10 to 2.00	0.01	± 2 cycles or ± 5%
	Definite Time Time Multiplier	0.10 to 100.00	0.01	± 2 cycles or ± 5%

Replaces Standard 67G Function

*An additional measurement time of 1 cycle needs to be added to the measured time delay.

†Select the greater of these accuracy values. For voltage accuracy specified, the range is (20 – 180 V).

OPTIONAL PROTECTIVE FUNCTIONS (*cont.*)

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	Reclose Relay			
79	**Three-Phase Ganged Operation:**			
	Ground Precedence	Yes/No		
	Sequence Coordination Active For Trips	None/1/2/3	–	–
	Maximum Number of Phase Trips	1/2/3/4/5	1	–
	Maximum Number of Ground/Residual Trips	1/2/3/4/5	1	–
	Reset Time after Auto Reclose	1 to 1800 s	1 s	± 0.01 s* or ± 1%
	Reset Time from Lockout	0 to 1800 s	1 s	± 0.01 s* or ± 1%
	Reclose #1, #2, #3, #4 Time Delay for Phase Fault	0.01 to 600.00 s	0.01 s	± 0.01 s* or ± 1%
	Time Delay for Ground Fault	0.01 to 600.00 s	0.01 s	± 0.01 s* or ± 1%
	79 Trip Reclose Sequence			
	Trip #1, #2, #3, #4, #5			
	Function Element 1, 2, 3, 4, 5	50P, 50N, 50G/GS, 46DT, 51P, 51N, 51G/GS, 46 IT, 67P, 67N, 67G/GS, 67Q	–	–
	79 Drive to Lockout			
	Trip Sequence 1, 2, 3, 4, 5	50P HCL, 50G/GS or 50N HCL	–	–
	Protective Function Elements 1, 2, 3, 4	27, 32, 81U/O	–	–
	Supervision			
	Blocking Functions	27 BSVS, 27Vz1, 25 Sync	–	–
	Supervision Time	0.00 to 600.00 s	0.01 s	± 0.01 s* or ± 1%

*An additional measurement time of 1 cycle needs to be added to the measured time delay.

†Select the greater of these accuracy values. For voltage accuracy specified, the range is (20 – 180 V).

Introduction

The M-7651A D-PAC is a digital, Smart Grid ready, advanced Protection, Automation and Control System for Power Distribution Applications that is compatible with most manufacturer's switchgear and suitable for new installations or as a direct, easy-to-install, replacement for older protection, automation and control systems. It offers a comprehensive protection package with over 30 individual protection functions and up to eight setting groups. The M-7651A D-PAC features a high accuracy metering system with advanced recording and reporting functions as well as continuous data sampling at 128 samples per cycle.

By configuring various combinations of the slow-, fast-, and time-delay curve elements, the M-7651A D-PAC can allow as many as five Phase-to-Phase or Phase-to-Ground trips and four total reclosing operations. If required, individual phase or ground reclose intervals are user-settable with time-delays of up to 600 seconds. The settings for the different functions can be accomplished by using the IPScom S-7600 Communications Software or the front panel pushbuttons. For convenience and security, the M-7651A D-PAC offers an SD card reader. Programming can be done in the office and settings can be loaded using an SD card thus minimizing the time a user needs to spend in front of the relay.

Overcurrent Protection

Up to five cumulative fast- and delay-curve operations provide phase and ground overcurrent protection. With a recloser CT ratio of 1000:1, for example, the phase overcurrent protection can have primary currents set as sensitive as 20 A for phase overcurrent and 5 A for ground overcurrent protection.

The M-7651A D-PAC offers over 50 different time curves plus four user programmable curves to facilitate coordination with other elements in the network. The phase or ground fast- and delay-curves can be set either with the user-designed curves or with the curve selection choices listed in Table 1.

Use traditional Recloser Control curve modifiers to alter fast- and delay-curves (including US or IEC curves):

- Constant Time Adder – adds time to curve
- Vertical Multiplier (time dial) – shifts entire curve up or down in time
- Minimum Response Time – delays curve tripping for minimum time
- High Current Lockout – high set lockout maximum
- High Current Trip – closes on bolted fault

Custom Overcurrent Protection

IPSlogic includes algorithms that allow user programmable customization of the overcurrent protection.

The M-7651A D-PAC supports the following curve selections:

Curve Category	Curve Selection
IEC Curves (IEC 60255-151)	Inverse, Very Inverse, Extremely Inverse
IEEE Curves (IEEE C37.112)	Moderately Inverse, Very Inverse, Extremely Inverse
Traditional Recloser Curves ■NOTE: (Newer curves are shown with the older curve designations in parentheses)	101 (A); 102 (1); 103 (17); 104 (N); 105 (R); 106 (4); 107 (L); 111 (8*); 112 (15); 113 (8); 114 (5); 115 (P); 116 (D); 117 (B); 118 (M); 119 (14); 120 (Y); 121 (G); 122 (H); 131 (9); 132 (E); 133 (C); 134 (Z); 135 (2); 136 (6); 137 (V); 138 (W); 139 (16); 140 (3); 141 (11); 142 (13); 151 (18); 152 (7); 161 (T); 162 (KP); 163 (F); 164 (J); 165 (KG); 200; 201; 202
US Curves	Moderately Inverse, Standard Inverse, Very Inverse, Extremely Inverse, Short Time Inverse
Definite Time	Definite Time
User-Designed Programmable Curves	Four Programmable Curves

Table 1 M-7651A D-PAC Curve Selection

Reclosing Operation

When there is any breaker open operation due to a fault, the relay will close the breaker automatically without user intervention. The Reclosing Operation is achieved using the 79 function in conjunction with overcurrent functions (i.e. 50P, 50G/50GS, 50N, 46DT, 51P, 51G/51GS, 51N, 46IT, 67P, 67N, 67G/GS, 67Q).

The **Reclosing Sequence** is an extension of the single Reclosing Operation. In this instance, when a breaker opens and closes automatically, it will continue until a specified count is reached. Any overcurrent fault will cause a trip after the trip time expires, at which time the 79 function will start the **Reclose Interval**. Both the trip time and Reclose Interval are user settable.

At the end of the Reclose Interval the control will automatically send a close command to the breaker. This process will continue until the maximum number of trips is reached or until the fault clears, whichever occurs first. Once the maximum number of trips is reached, the control will automatically be placed in Lockout and prevent further operation until the unit is reset. The maximum number of trips is user settable. See the Instruction Book Setpoints Chapter for a detailed explanation of the Reclosing function.

Power Quality Monitoring

Power Quality (PQ) events: sags, swells, voltage and current unbalances; real-time harmonic analysis of current and voltage for each phase, THD, phase voltage loss and variations, and ITIC excursion detection.

Monitoring/Metering

Real-Time Metering – the following measured and calculated values are available in real-time:

- Instantaneous values of the current for three phases, ground or sensitive ground
- Line and phase voltages
- Active, reactive, apparent single- and three-phase power, including directional*
- Active energy received and delivered
- Demand metering on per-phase basis
- Reactive energy in quadrants I and III
- Single-phase and three-phase power factor*
- Frequency and phase sequence
- Sequence current and voltage magnitudes

*When the VT Configuration is set to any Delta Connection, only three phase power metering is displayed in the Primary and Secondary Metering screens. Individual phase power metering is grayed out, and the value displayed is "0".

Settings Groups

The M-7651A D-PAC has eight setting groups. Switch setting groups to properly account for prevailing power system conditions. For example if one breaker is dedicated for maintenance you can store the settings for all the feeders and use the appropriate group when that breaker is out of service for maintenance. All the functions shown in Figure 1 (Single Line diagram) are available in each settings group.

Oscillographic Recording

The Oscillograph Recorder provides comprehensive data recording of voltages, currents, and status input/output signals for all monitored waveforms. The Oscillograph recorder stores 100 records of up to 480 cycles each regardless of the sampling rate (at 16, 32, 64, or 128 samples per cycle). Oscillograph data can be downloaded using any communications ports to any Windows™ compatible computer running the IPScom S-7600 Communications Software. Once downloaded, the waveform data can be examined, printed or used in generating reports. The waveform data is also available in COMTRADE file format.

The recorder may be triggered using either the designated protective function element or logic equations. When triggered, the recorder stores pre-trigger data, and then continues to store data for a user-defined post-trigger delay period. The post-trigger delay will range from 5 to 95% of the total record length.

Live Oscillograph

The Live Oscillograph feature allows the user to view in real time the eight channels of oscillography with Power, Power Quality, Phasors and Harmonics.

Sequence of Events

The M-7651A D-PAC keeps records of the last 3500 Sequence of Events with the following information:

- Pickup, trip, and extinction date and time, and fault duration
- Voltage and current signals for each phase, neutral and sensitive neutral during pre fault, trip and maximum or minimum depending on each case
- Trip cause
- Protection pickup elements that were activated
- Active group
- Fault directionality

Fault Locator

The M-7651A D-PAC Fault Locator feature can reduce the time required to restore service due to a distribution system fault by providing an accurate estimate of the fault's location, even during periods of high customer load. The control integrates line impedance settings, fault type and fault conditions to calculate the fault location estimation. This feature works without requiring special instrument transformers, pre fault data, or communication to other devices.

Fault Event Records

The M-7651A D-PAC can record and store up to 3,500 events related to the operation of protection functions, changes in configuration, states of the digital inputs and outputs, pickup and/or operation of protection functions, automated mechanism, statistics, etc.

Front Panel

- LCD display, 2 rows, 20 characters per row, with configurable contrast
- Twelve programmable tricolor front panel LEDs
- Keyboard – 17 pushbuttons (Two dedicated for Trip and Close):
  - Six programmable pushbuttons with programmable LEDs
  - Nine function pushbuttons

M-7651A D-PAC includes Programmable Alarm LEDs to indicate any general overcurrent trip (TRIP), plus additional LEDs to indicate the type of overcurrent trip. The Fast-Curve LED indicates a Fast-Curve Trip.

Recloser/Breaker Wear Monitor

The M-7651A D-PAC control records the amount of current carried in each phase each time the recloser trips. The control's operational logic employs an algorithm integrating the amount of unfiltered AC current at the time of each trip and the number of operations (close to open) as a method of calculating wear. The control uses this information to establish wear setpoints derived in accordance with IEEE C37.61-1973, and initiates a signal to assert an alarm or modify the breaker operation parameters, such as reducing the total number of breaker operations.

Load Profile Trending (Data Logging Feature)

The M-7651A D-PAC can store up to 25 parameters in nonvolatile memory (instantaneous, maximum, and minimum with date and time stamping). These parameters include the instantaneous values and energy accumulator groups in time intervals between 1 and 3600 seconds, with 1 second steps. The M-7651A D-PAC has a storage capacity of up to 3,500 records.

Synchrophasors▲

Synchrophasors improve system operation and reliability allowing operators to closely monitor the distribution network in real time to detect potential cascading voltage collapses before they occur. The M-7651A D-PAC supports the transmission of synchrophasors acting as a Phasor Measurement Unit (PMU) in compliance with IEEE C37.118-2. Phasor measurements taken at a selectable rate of up to 60 messages or frames per second can be transmitted to a Phasor Data Concentrator for user analysis in a wide-area monitoring and control system.

Phantom Voltage

The M-7651A has the capability to calculate and provide three-phase voltage that is measured without having three voltages physically connected to the terminals of the M-7651A. The following VT configurations are supported:

- Phantom Wye
- Phantom Delta
- Open Delta

Phantom WYE is supported for VT connection ONLY. The M-7651A will measure one analog voltage signal on any of the voltage terminals and will then calculate the two remaining corresponding balanced phase voltages.

Example: A voltage signal is applied to the terminal defined as Phase A. The M-7651A will calculate and provide all three balanced Line to Ground phase voltages.

Phantom Delta is also supported in the VT connection ONLY. The measured signal applied to one of the voltage terminals is assumed to be a Line to Line quantity. The M-7651A will then calculate the remaining two corresponding balanced Line to Line voltages.

Example: Line to Line voltage AB is applied to the Phase A terminal of the unit. The M-7651A will then calculate BC and CA and will provide all voltages.

Open Delta configuration is also supported in the VT connection ONLY. For example, if two voltage signals with a phase differential of 60 degrees are applied to 2 voltage terminals, with the remaining terminal grounded, the M-7651A will calculate and provide balanced Line to Line voltages AB, BC and CA derived from the two measured voltage signals. The M-7651A assumes proper polarity has been observed. The two measured signals come from Open Delta connected PTs.

Example of Open Delta CA:

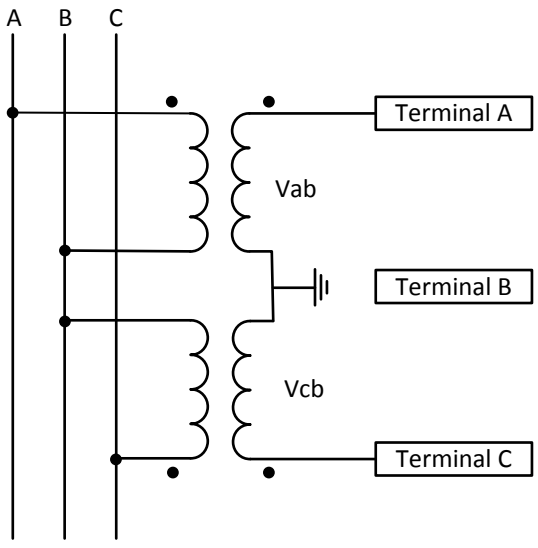


Figure 3 Open Delta CA Example Diagram

Cyber Security

The M-7651A D-PAC was designed from the ground up to help customers be NERC and cyber security compliant. The M-7651A D-PAC meets or exceeds the following standards:

IEEE 1686 Compliant

FIPS180-2, 186-2

IEC 62351-1, -2, -3, -5

ISO/IEC 9798-4

RFC 2104, 3174, 3394

IPsec using Internet Key Exchange (IKE) Version 1 and 2, compliant with: RFC 2367, 2393, 2394, 2401, 2402, 2406, 2407, 2408, 2409, 2411, 2412, 3456, 3706, 3947 and 3948

RADIUS Server Support (optional), compliant with: RFC 2865 and 2866

Smart Peer-to-Peer (P2P) Communications▲

Smart P2P Communications is a peer-to-peer communication feature provided that shares operational status among peer devices within its local network. P2P communication can be done via Ethernet communications including multi mode fiber optic link. The transmission distance for fiber optic is dependent on the type of fiber optic used, "Single Mode" or "Multi Mode", and can transmit up to 2,000 meters. Smart P2P Communication can be used to implement pilot transfer schemes or advanced network reconfiguration algorithms.

S-7600 IPScom Communications Software

The S-7600 IPScom Communications Software enables local or remote communication between a Windows™ based computer and the M-7651A D-PAC. It is a Windows application, which allows the user to interact with software modules in different languages. The S-7600 IPScom Communications Software makes efficient use of object-oriented programming, achieving a smooth and scalable design, and has an open data structure that allows maintenance and the incorporation of new functions.

The S-7600 IPScom Communications Software is a Windows application that provides an easy graphical interface to program and monitor the M-7651A D-PAC. The S-7600 Software interface provides simple, easy function programming.

Smart Flash SD Card Slot

Allows the user to perform the following functions locally without needing a laptop in field.

- Load Setpoints
- Save Setpoints
- Save Data Log
- Save Sequence of Events
- Save Oscillograph Records
- Clone Save
- Clone Load
- Firmware Update
- Save Metering Data
- Save Wake Screen Data
- Physical Security Key
- Bootloader Update

Cold Load Pickup

The M-7651A D-PAC Cold Load Pickup feature provides the user with the ability to automatically adjust the M-7651A D-PAC Overcurrent protection elements to consider the duration of a loss of load and the recloser response to the loss of load. The Cold Load Pickup feature can tailor the recloser settings to allow the return of the load without tripping. The Cold Load Pickup feature continuously monitors recloser parameters to ascertain when the non-Cold Load Pickup settings can be restored.

Selective Load Shedding Provides Improved System Response and Service Reliability

Modernizing existing feeder protection apparatus by retrofitting with the M-7651A D-PAC provides improvements to system response and service reliability. The Protection, Automation and Control System can be set up to recognize critical loads and help stabilize system loading. Including underfrequency elements as components of the recloser feature scheme allows segmenting the feeder to sustain maximum load and respond to system conditions during power transients. Recloser programming allow as much as six levels of frequency and time settings to coordinate with other devices during a power loss.

▲ Feature available at future date via firmware update

General Specifications

Power Supplies

The M-7651A D-PAC provides a choice of two main power supply input ranges; a low voltage range of 18 to 60 Vdc and a high range of 90 to 280 Vac or 90 to 315 Vdc.

The M-7651A D-PAC also features a backup power supply input of 11 to 14 Vdc, that allows continued operation in case of main power supply loss.

▲**CAUTION:** An orange TB3 receptacle indicates that a Low Voltage Power Supply is installed in the unit.

Power Supply	Range	Burden
24/48 Vdc	18-60 Vdc	12 VA
125/220 Vdc/Vac (Optional)	90-280 Vac 90-315 Vdc	15 VA

Table 2 Power Supply Specifications

AC Voltage Inputs

Voltage	Nominal	Maximum Continuous	Max Short Duration	Burden
Line to Neutral	120 Vac	300 Vac	600 Vac for 10 s	1MΩ
Low Energy Analog	4 Vac	12 Vac	300 Vac for 10 s	1MΩ

Table 3 AC Voltage Input Specifications

AC Current Inputs

AC Current	I Nominal	I Continuous	I Short duration	Burden
Phase Current	1 A 5 A	3 A 15 A	100 A for 1 second 500 A for 1 second	< 0.021 VA < 0.20 VA
Ground Current	1 A 5 A	3 A 15 A	100 A for 1 second 500 A for 1 second	< 0.021 VA < 0.20 VA
Sensitive Earth Fault (SEF)	10 mA 50 mA 200 mA	0.3 A 1.5 A 6 A	100 A for 1 second 100 A for 1 second 100 A for 1 second	< 0.001 VA < 0.002 VA < 0.01 VA

Table 4 AC Current Input Specifications

Digital Inputs (Opto-Isolated)

The M-7651A D-PAC includes four programmable inputs with capability for expansion up to twelve. These inputs must be externally wetted. The M-7651A D-PAC offers two voltage ranges.

■**NOTE:** Hardware prior to Serial Number 500 only supports a low voltage range of 24–48 Vdc with a minimum Turn-on Voltage of 18 Vdc. Please refer to the unit label "DIG. INPUTS" for the applicable range.

Wetting Voltage	
Input	**Pickup Range**
Low	9 – 60 Vdc
High	90 – 300 Vdc

Table 5 Digital Input Specifications

Output Contacts

The M-7651A D-PAC includes four output contacts expandable to twelve. Any of the protective functions can be individually programmed to activate any one or more of the four Programmable Output Contacts (OUT1 through OUT4). Any output contact can also be selected as pulsed or latched. IPSlogic can also be used to activate output relay contact.

The optional expanded I/O includes an additional eight Programmable Output Contacts (OUT5 through OUT12). These contacts are configurable only using IPScom Communications Software.

The output contacts are all rated per IEEE C37.90 (See Tests and Standards section for details).

Operation Frequency and Phase Rotation

Frequency:	60 Hz or 50 Hz
Tracking:	42 to 65 Hz
Phase Rotation:	ABC or ACB

Communications Ports

The unused communications ports can be disabled through software to comply with cyber security requirements.

Front – USB Port – Type B, Version 1.1 (Local Programming), SD Card

Rear – Communication Ports:

- Port 1 (optional) – Serial TIA-232, TIA-485, Fiber, or none
- Port 2/Port 3 (optional) – One or two Ethernet Ports, RJ45 10/100 BASE-T or Fiber 100 BASE-FX
- Port 4 (optional) – Serial TIA-232, TIA-485, Fiber, or none
- Ethernet Ports are auto-detect, auto-negotiable 10/100 Mbps, with support for multi-user rights for up to six concurrent users

Time Synchronization Port:

- IRIG - B (B000)
- Input – Demodulated
- Input level – TTL
- Isolation – 1,500 Vdc

Protocols

Serial Ports – MODBUS®, DNP3.0

Ethernet Ports – MODBUS over TCP/IP and UDP, DNP3.0 over TCP/IP and UDP; IEC 61850, SmartP2P (Peer to Peer)▲, IEC 60870-5-104/101▲ (optional)

Self-Diagnostics

The M-7651A D-PAC includes several self-diagnostic functions and routines that detect possible hardware failures. It also includes a manual test mode that is used to check if the LEDs, Inputs, Outputs, Display, and Keyboard are working properly.

▲ Feature available at future date via firmware update

System Setup

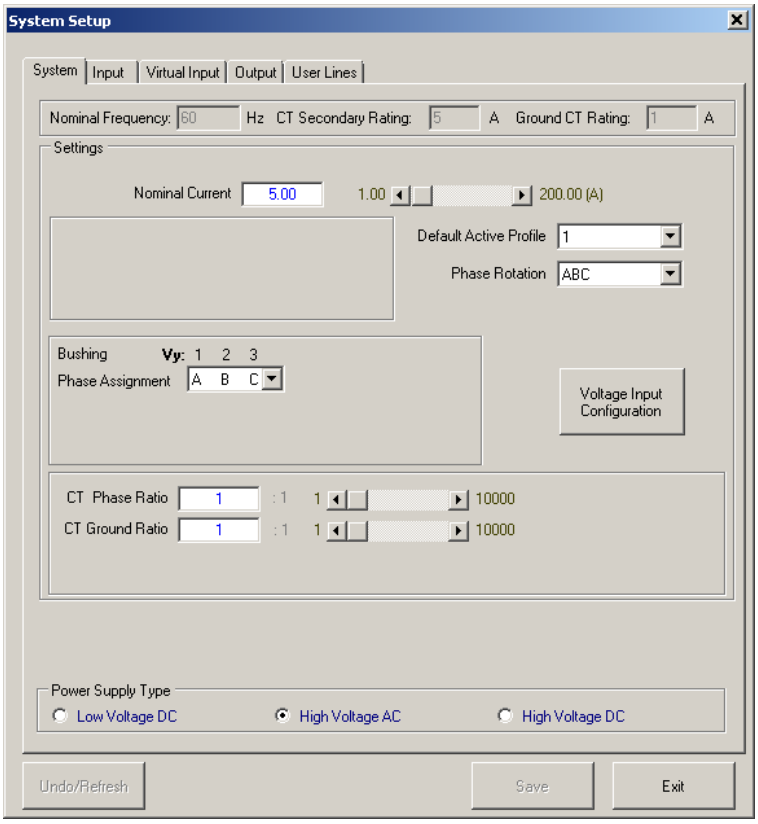


Figure 4 IPScom System Setup Screen (Shown: Voltage Input Option H4)

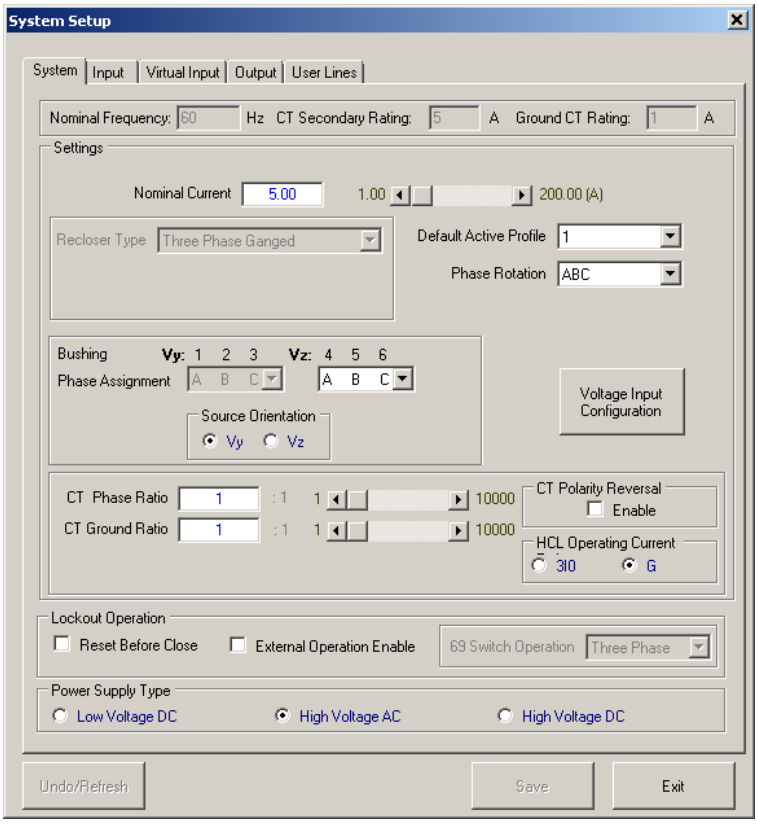


Figure 5 IPScom System Setup Screen (Shown: Voltage Input Option X6 and Optional Autoreclose)

System Setup (Cont'd.)

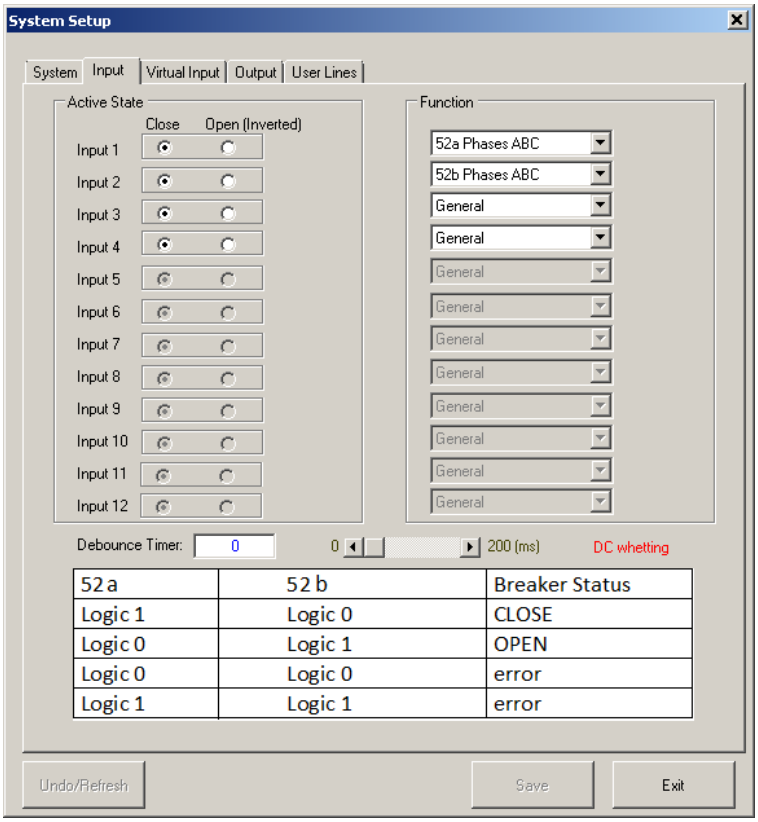


Figure 6 IPScom System Setup – Inputs Dialog Screen (without Extended IO)

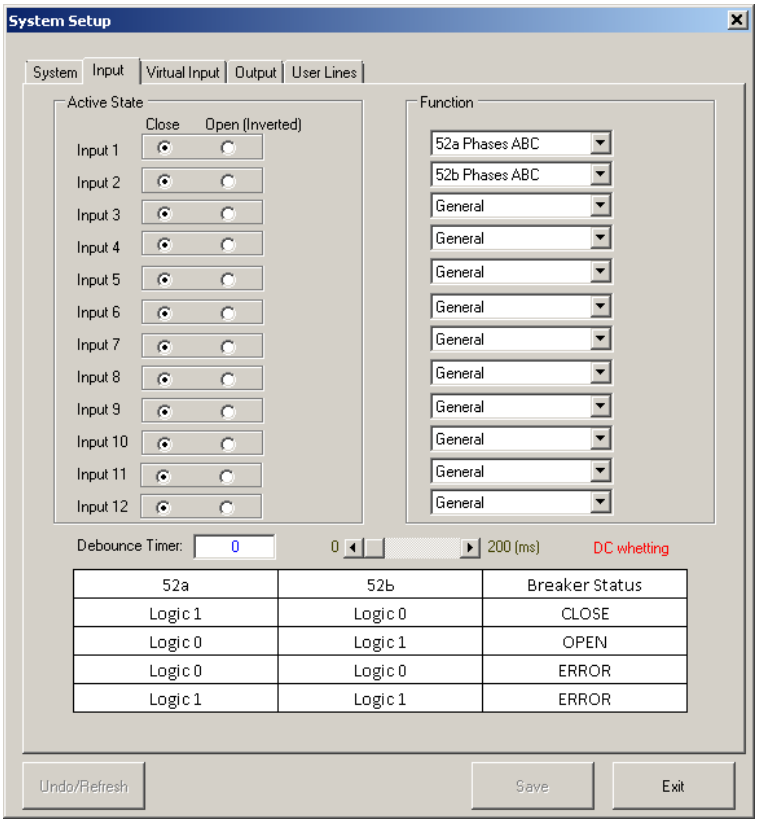


Figure 7 IPScom System Setup – Inputs Dialog Screen (with Extended IO)

System Setup (Cont'd.)

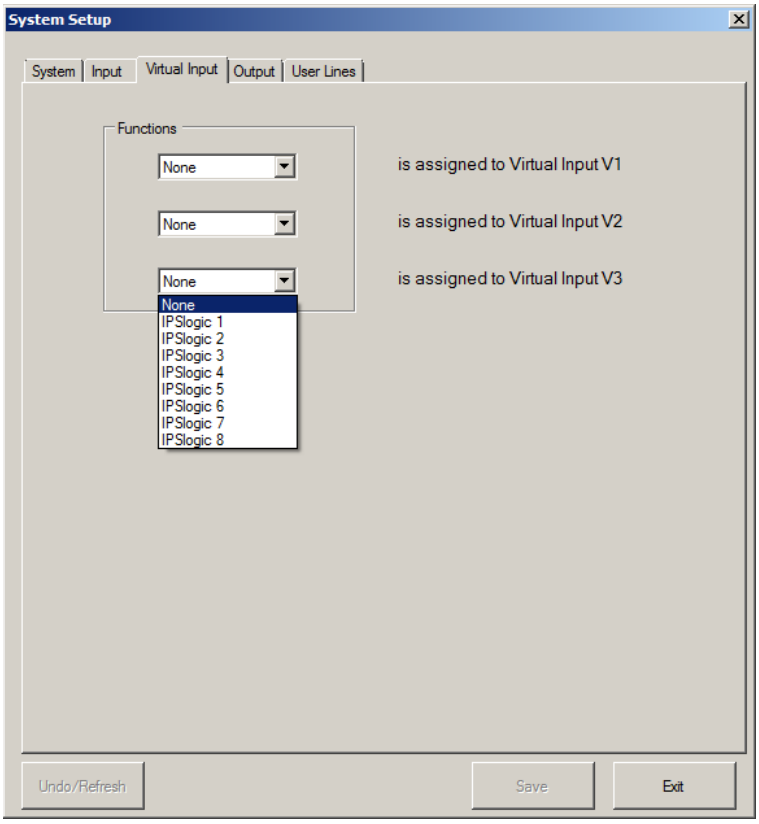


Figure 8 IPScom System Setup – Virtual Inputs Dialog Screen

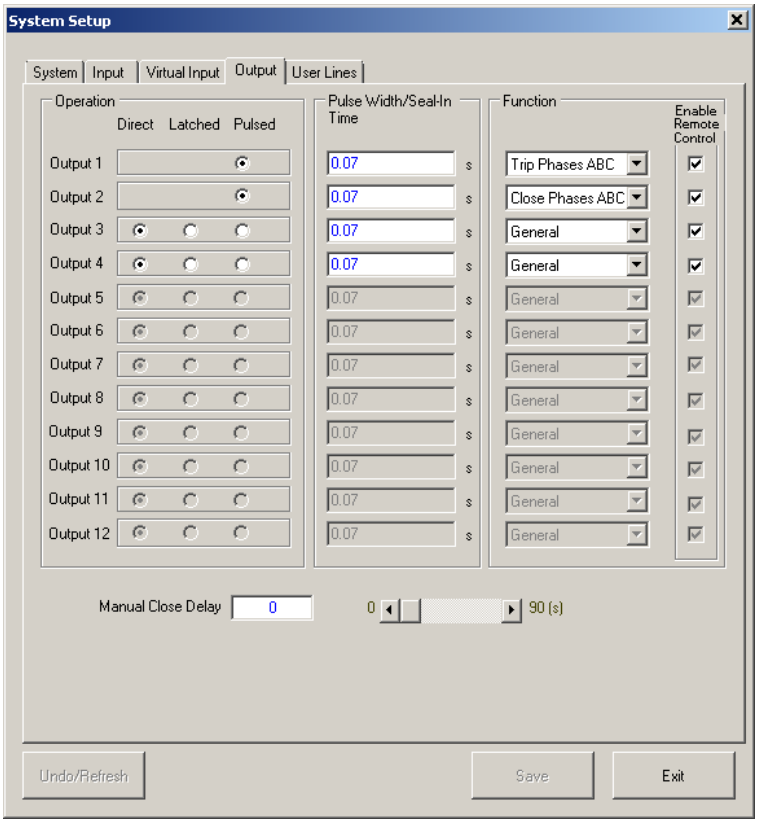


Figure 9 IPScom System Setup – Outputs Dialog Screen (without Extended IO)

System Setup (Cont'd.)

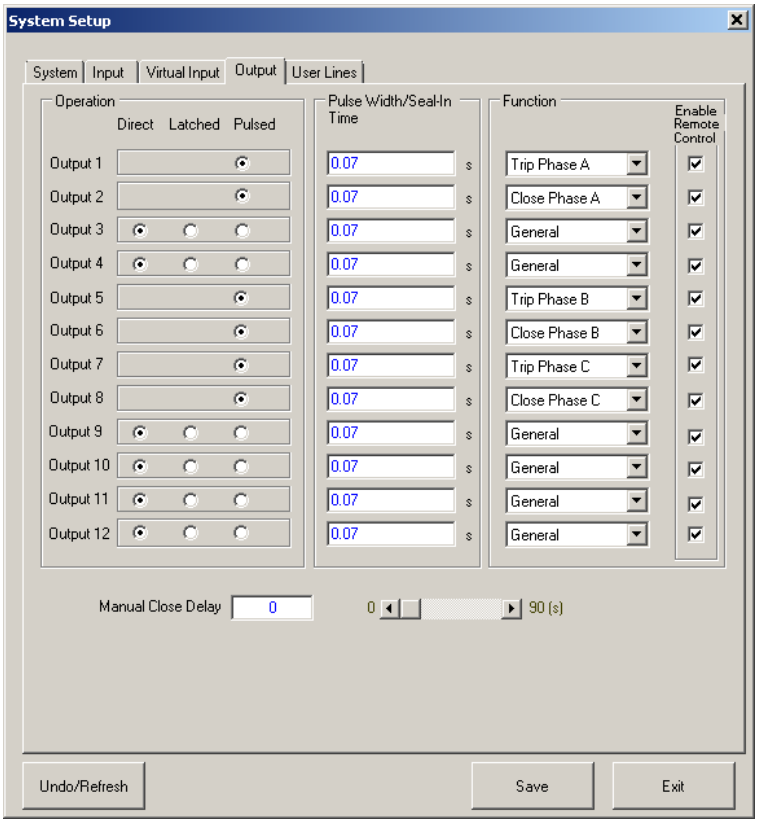


Figure 10 IPScom System Setup – Outputs Dialog Screen (with Optional Autoreclose)

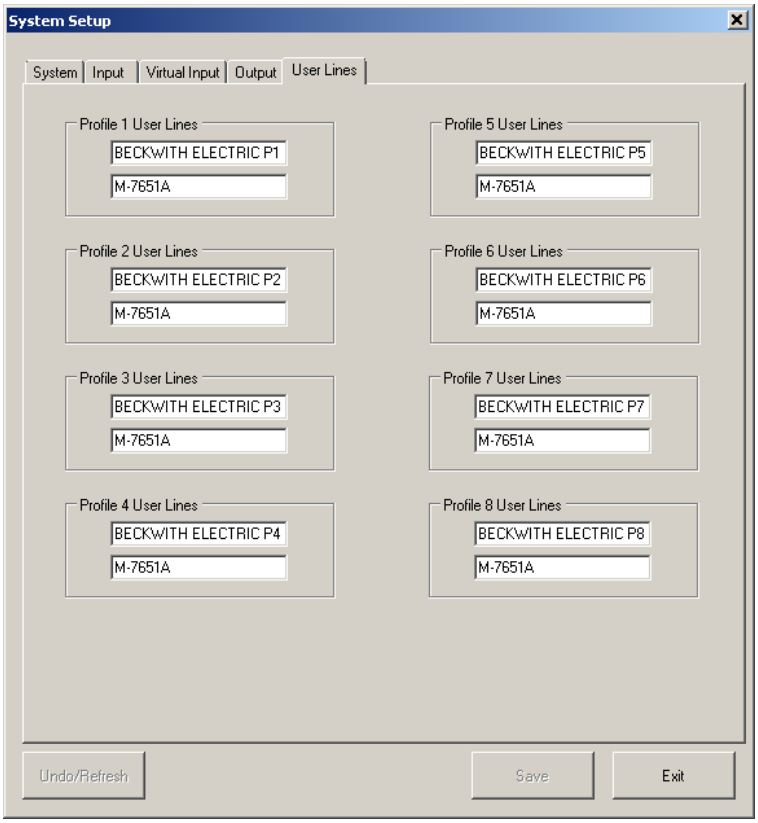
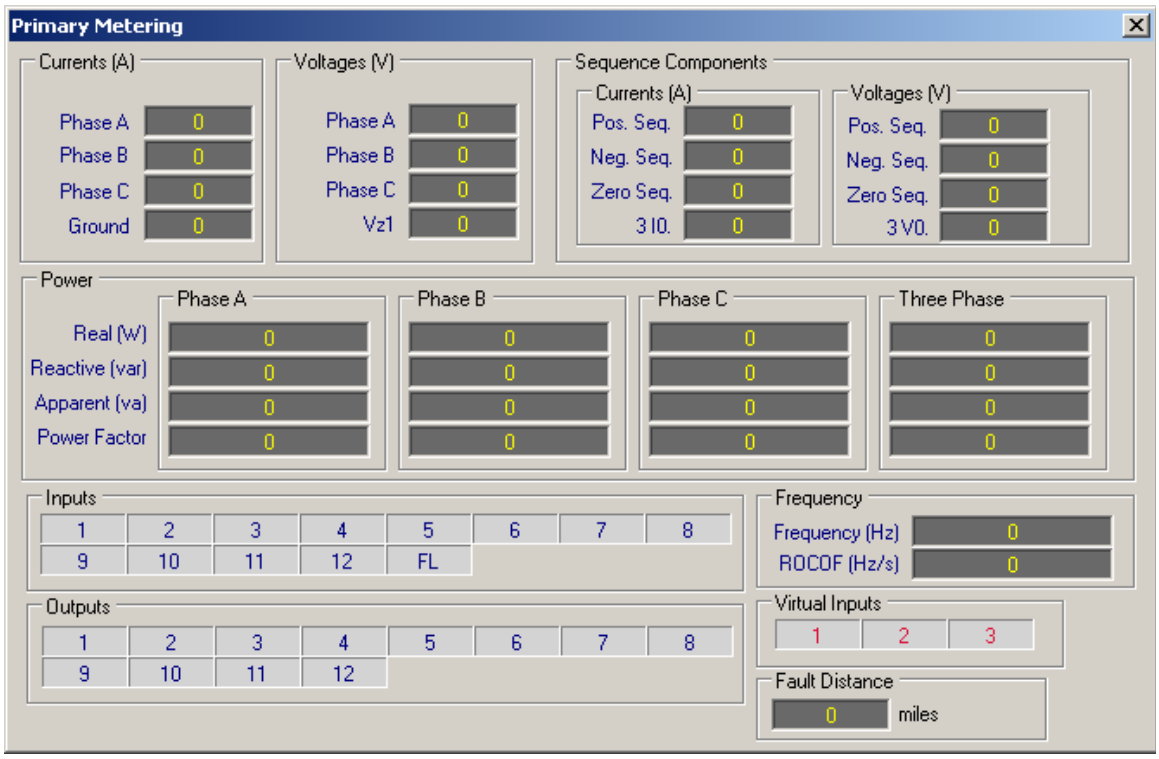
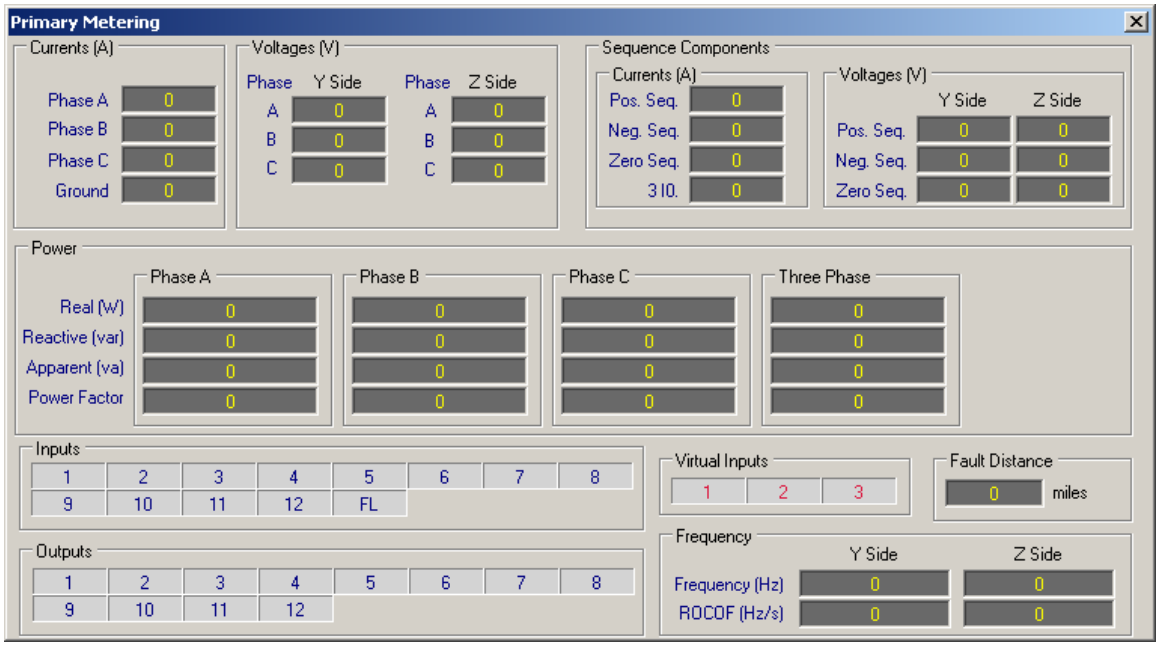


Figure 11 IPScom System Setup – User Lines Dialog Screen



■**NOTE:** Secondary Metering Screen is identical.

Figure 12 IPScom Primary Metering Screen (Voltage Input Option X4, L4, H4 or VT)



■**NOTE:** Secondary Metering Screen is identical.

Figure 13 IPScom Primary Metering Screen (Voltage Input Option X6, L6 or H6)

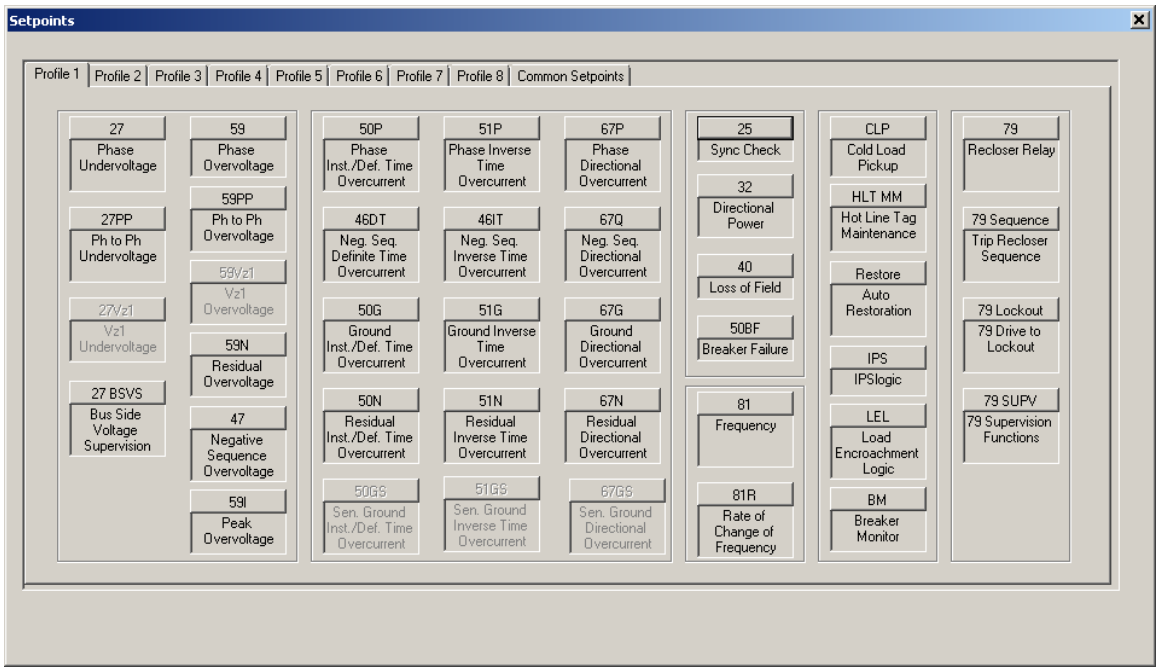


Figure 14 IPScom Becoview Setpoints Dialog Screen (with Autoreclose Option)

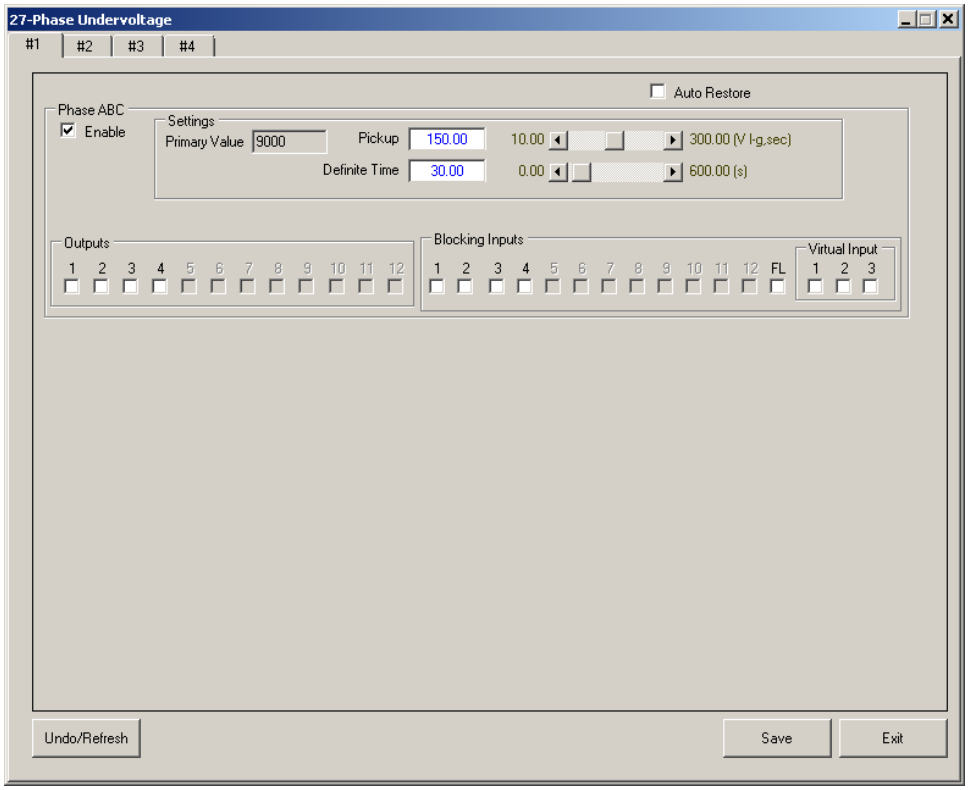


Figure 15 IPScom 27 Undervoltage Setpoint Dialog Screen

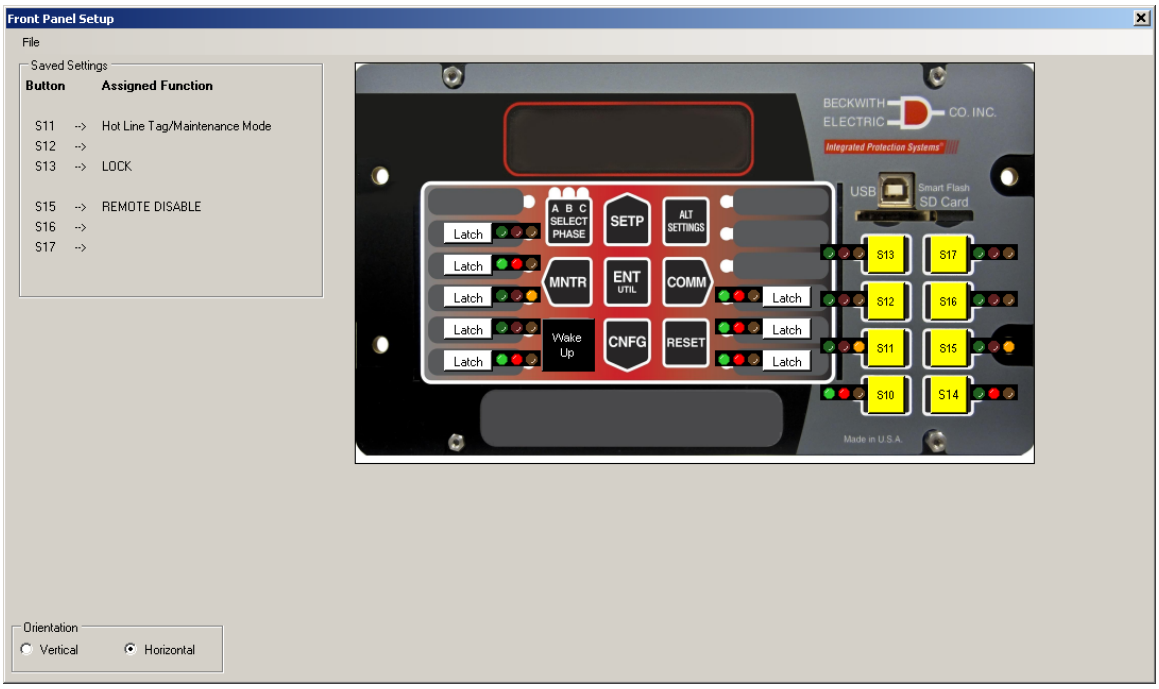


Figure 16 IPScom Smart Button Programming Dialog Screen

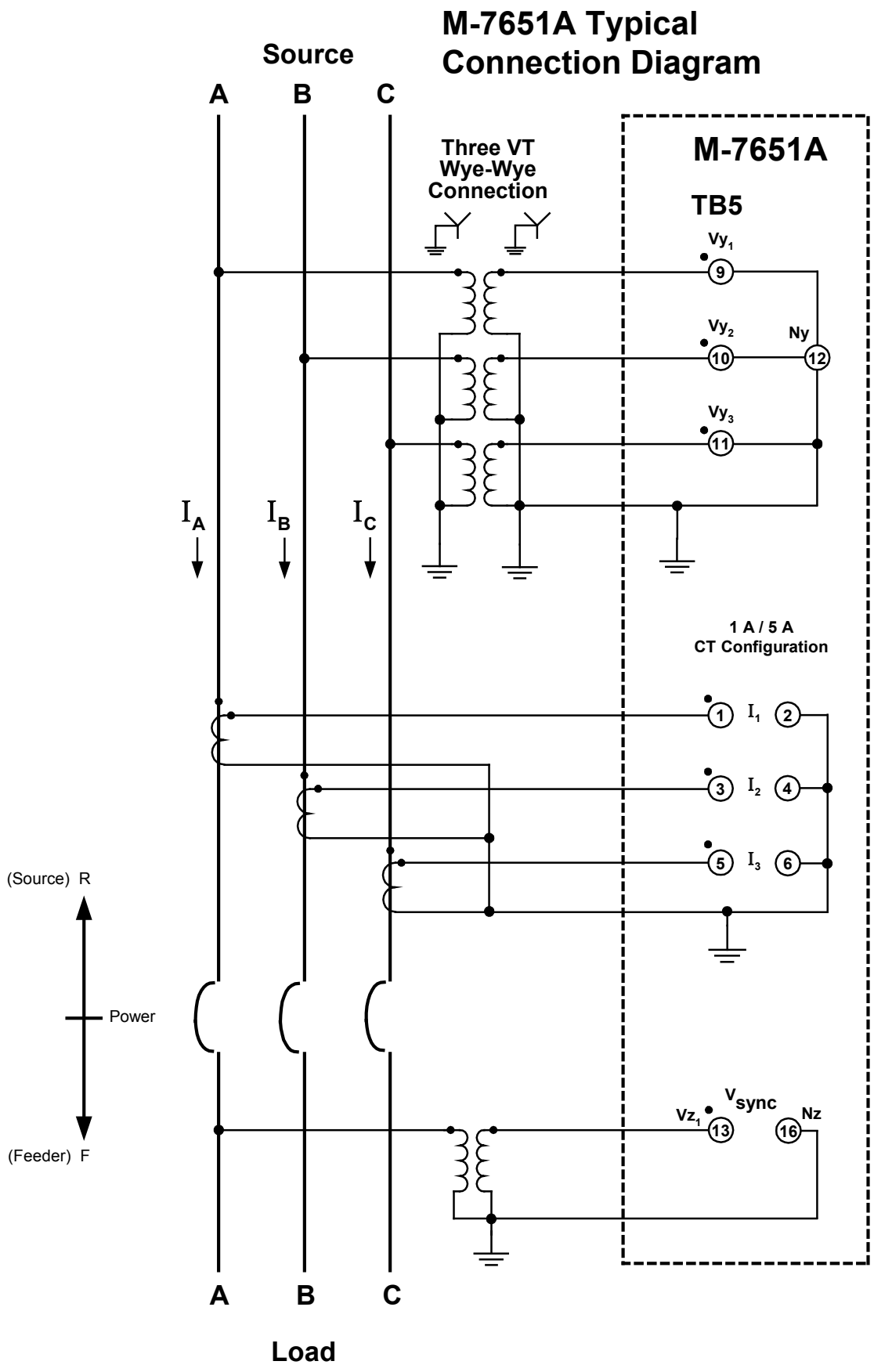


Figure 17 M-7651A D-PAC Three-Line Connection Diagram

Tests and Standards

The M-7651A D-PAC Protection, Automation and Control System for Power Distribution Applications complies with the following tests and standards:

Voltage Withstand

Dielectric Withstand

IEC 60255-27	2,000 Vac

Impulse Voltage

IEC 60255-27	+/- 5,000 V-pk

Insulation Resistance

IEC 60255-27	> 5 G Ω

Electrical Environment

Surge Withstand Capability

IEEE C37.90.1	+/- 2.5 kV Oscillatory
IEEE C37.90.1	+/- 4 kV Fast Transient Burst

1 MHz Oscillatory Immunity

IEC 61000-4-18	+/- 2.5 kV Common Mode
IEC 61000-4-18	+/- 2.5 kV Differential Mode

Electrostatic Discharge Test

IEEE C37.90.3	(+/- 8 kV) - Point Contact Discharge
IEEE C37.90.3	(+/- 15 kV) - Air Discharge
IEC 61000-4-2	(+/- 8 kV) - Point Contact Discharge
IEC 61000-4-2	(+/- 15 kV) - Air Discharge

Radiated Field Immunity

IEEE C37.90.2	35 V/m - 80 to 1000 MHz
IEC 61000-4-3	35 V/m - 80 to 1000 MHz

Fast Transient Disturbance Test

IEC 61000-4-4	+/-4 kV, 5 kHz

Surge Immunity

IEC 61000-4-5	+/- 4 kV Common Mode
IEC 61000-4-5	+/- 1 kV Differential Mode

Voltage Interruption Immunity

IEC 61000-4-11	(5 cycles AC / 50 ms DC)

Output Contacts

IEEE C37.90	30 A make for 0.2 seconds at 250 Vdc Resistive
	8 A carry at 120 Vac, 50/60 Hz
	6 A break at 120 Vac, 50/60 Hz
	0.5 A break at 48 Vdc, 24 VA
	0.3 A break at 125 Vdc, 37.5 VA
	0.2 A break at 250 Vdc, 50 VA

Atmospheric Environment

Temperature

■ **NOTE**: The LCD display's visible temperature range is –20° C to +70° C.

IEC 60068-2-1	Cold, -40° C (-40° F) (operating)
IEC 60068-2-2	Dry Heat, +85° C (+185° F) (operating)
IEC 60068-2-78	Damp Heat, +40° C (+104° F) @ 95% rh (operating)
IEC 60068-2-30	Damp Heat condensation cycle, +25° C, +55° C (+131° F) @ 95% rh (operating)

Mechanical Environment

IEC 60255-21-1	Vibration response Class 1 (0.5 g)
	Vibration endurance Class 1 (1 g)
IEC 60255-21-2	Shock response Class 1 (5 g)
	Shock Withstand Class 1 (15 g)
	Bump Endurance Class 1 (10 g)

IP Protection Degree

IEC 60529	IP 50, Dust Protected

External Connections

The possible connections for the M-7651A D-PAC are shown in Figure 2.

Physical

Mounting: The unit is a semi flush, 3 unit high design that can be panel mounted or mounted in a standard 19" rack mount with the optional Rack Mount Adapter Frame (Figure 20). Vertical mount units are also available.

Size: Horizontal: 9.47" wide x 5.20" high x 6.22" deep (24.1 cm x 13.21 cm x 15.8 cm)
Vertical: 6.0" wide x 8.0" high x 6.22" deep (15.2 cm x 20.3 cm x 15.8 cm)

Approximate Weight: 3.5 lbs (1.6 kg)

Approximate Shipping Weight: 5 lbs (2.27 kg)

Recommended Storage Parameters

Temperature: 5° C to 40° C

Humidity: Maximum relative humidity 80% for temperatures up to 31° C, decreasing to 31° C linearly to 50% relative humidity at 40°C.

Environment: Storage area to be free of dust, corrosive gases, flammable materials, dew, percolating water, rain and solar radiation.

Warranty

The M-7651A D-PAC Protection, Automation and Control System for Power Distribution Applications is covered by a ten-year warranty from date of shipment.

Trademarks

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Specification subject to change without notice. Beckwith Electric Co., Inc. has approved only the English version of this document.

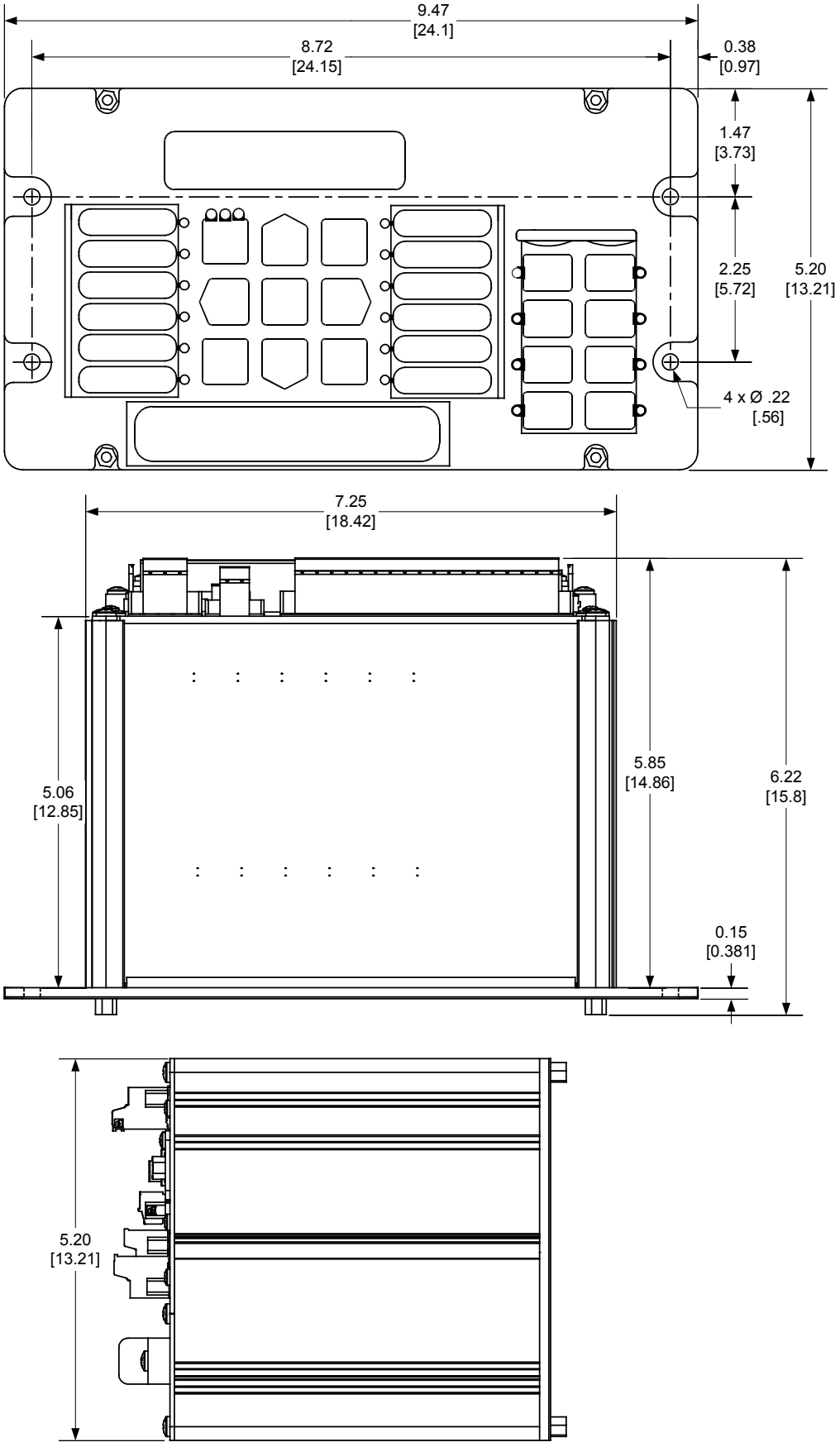

Figure 18 M-7651A D-PAC Horizontal Model Mounting Dimensions

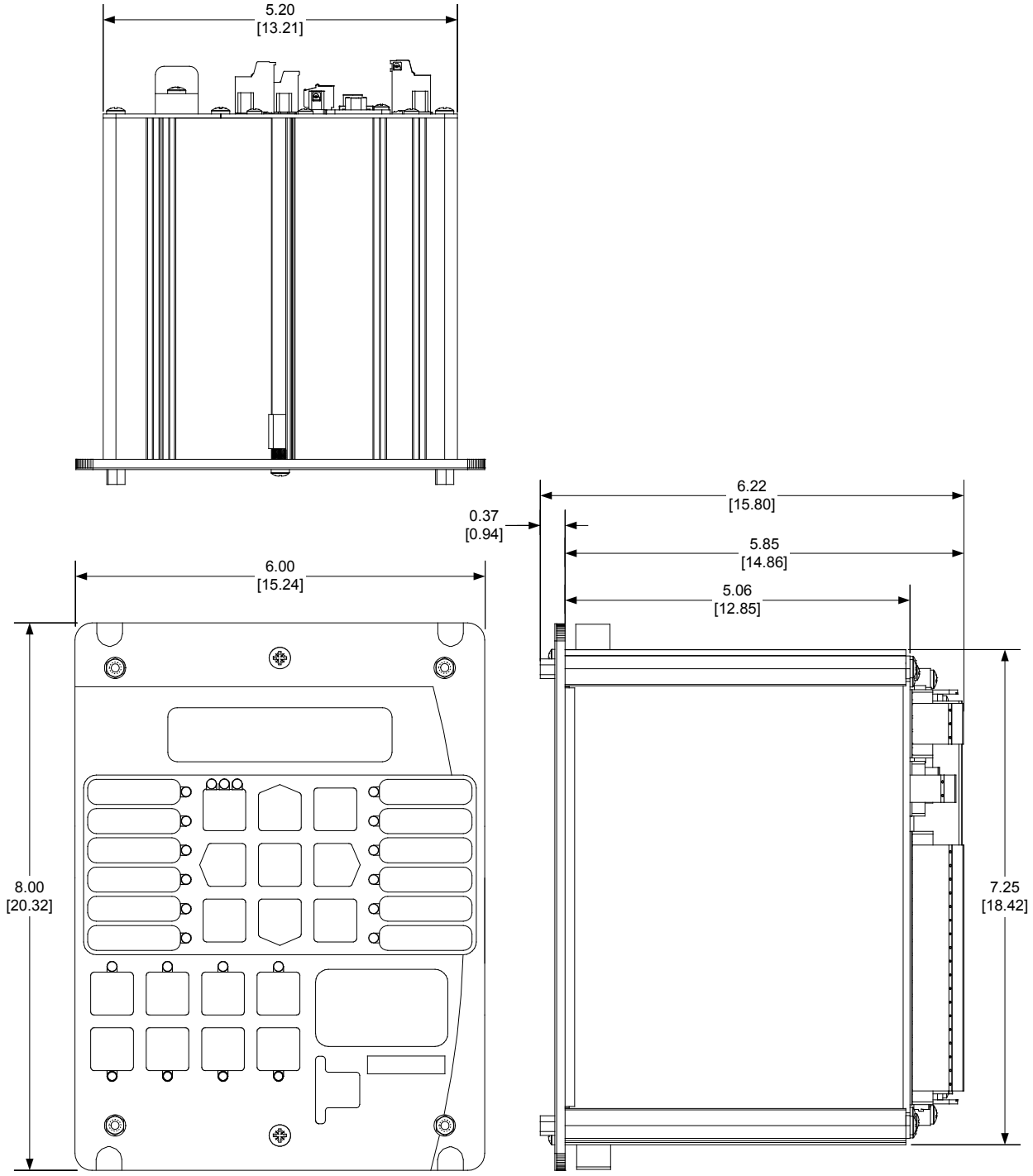

Figure 19 M-7651A D-PAC Vertical Model Mounting Dimensions

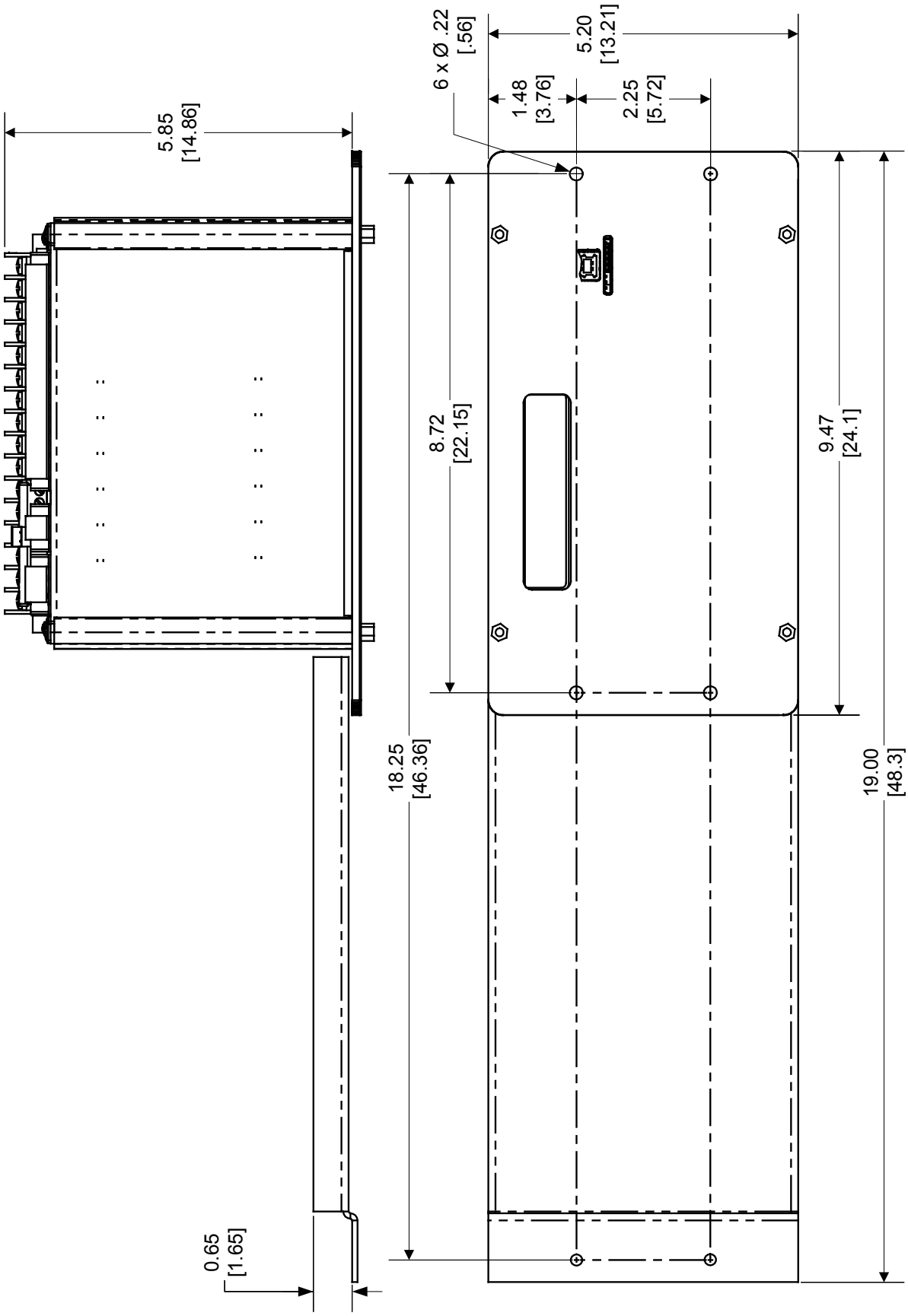

Figure 20 M-7651A D-PAC 19 Inch Rack Mount Adapter Frame Dimensions

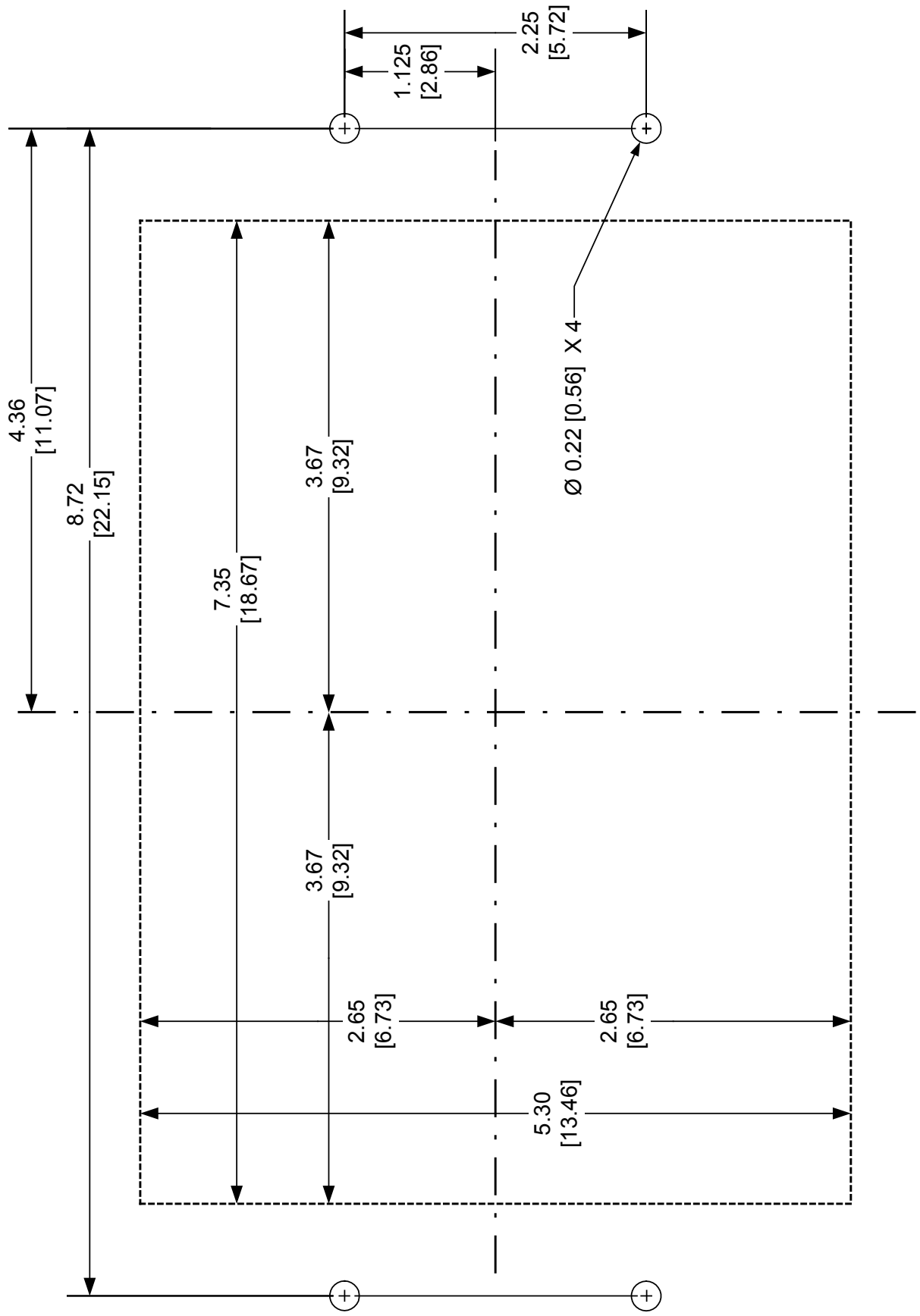

Figure 21 Horizontal Panel Mount Cutout Dimensions

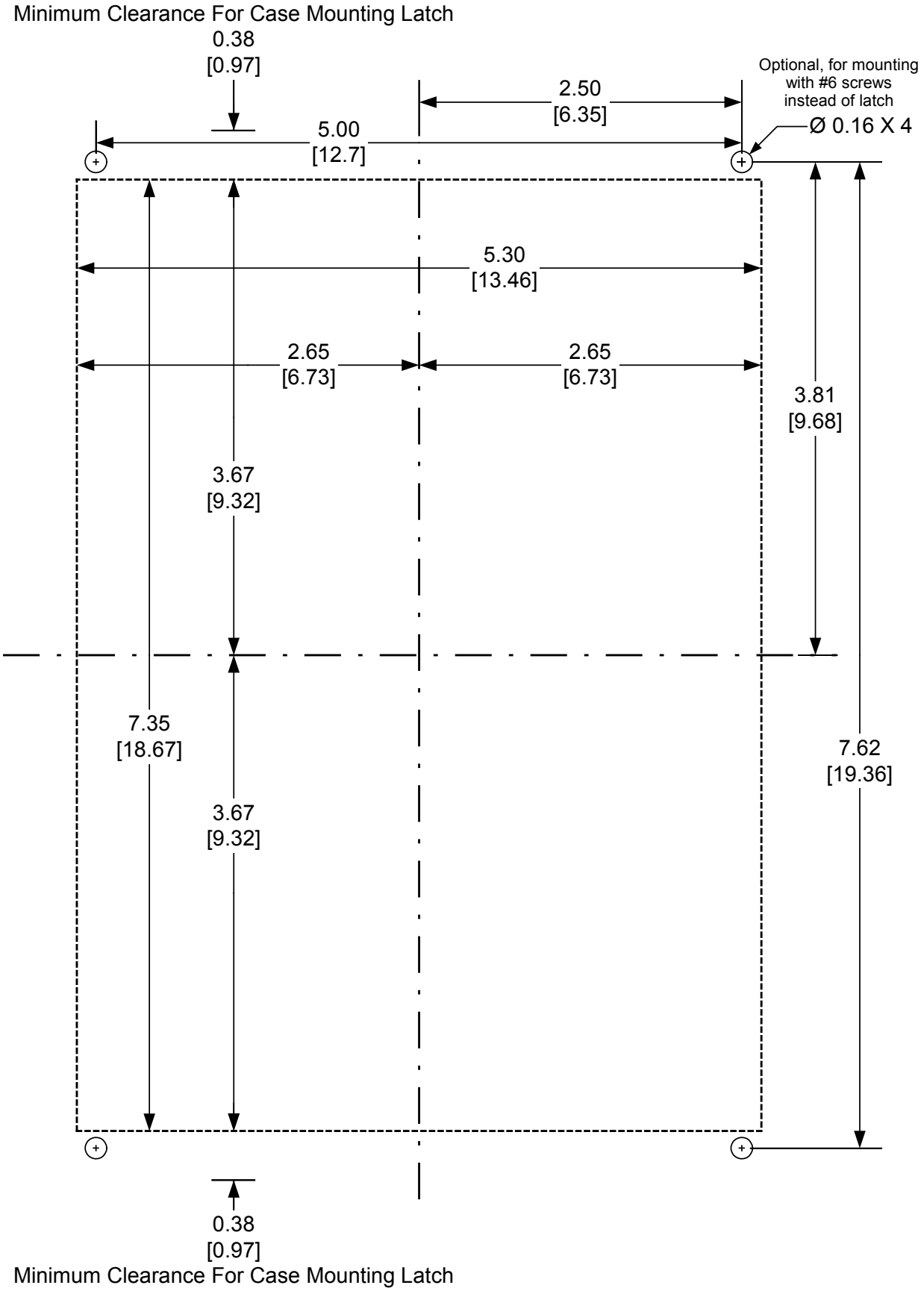

Figure 22 Vertical Panel Mount Cutout Dimensions

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