MANUFACTURER DOCUMENT PACKAGE

Manufacturer's Manual

Reference package for procurement and maintenance review

BENTLY NEVADA

3701/55 289761-01

EMERGENCY SHUTDOWN TERMINAL BASE

Used with the applicable 3701/55 ADAPT ESD base configuration.

REFERENCE PACKAGE

OFFICIAL DOCUMENT

Selected official manufacturer pages follow this cover.

Source: Bently Nevada 3701/55 ADAPT ESD, 100M8833 Rev. L.

3701/55 ADAPT (ESD) Emergency Shutdown Device

Datasheet

Cordant™

100M8833 Rev. L



Description

The 3701/55 Emergency Shutdown Device, (ADAPT ESD) is a safety PLC with a graphical logic programming interface and integrated overspeed detection. ADAPT ESD is designed for emergency shutdown of rotating machinery such as steam, gas, and hydro turbines, expanders, and other process equipment.

ADAPT ESD is a compact, standalone, triple-redundant, safety shutdown device that is designed to meet a broad range of user scenarios and applications. The design offers an electrical and mechanical package with attention to reliability and availability as well as extensive self-diagnostics and compliance to industry standards.

Inputs

Inputs to the system are processed using three CPU modules to provide triple modular redundancy (TMR). Each CPU processing module processes two unique speed input channels, for a total of six speed channels for the system. The processing modules also monitor an array of 32 discrete (DI) and process variable (PV) signal inputs. Twelve channels of this input signal array may be configured either as discrete inputs or 4-20 mA analog inputs. Remaining channels in the array are reserved for discrete input signals only.

Outputs

Machinery shutdown functionality of the 3701/55 ADAPT ESD system is actuated by TMR relay output modules. Each relay output module has five relays with a level of configurability that accommodates a variety of applications and requirements. Four of the five relays in each module are used to annunciate system logic. The remaining relay reflects the

Baker Hughes

OK/NOTOK status of the associated protection path. The Bently Nevada Monitor Configuration software provides a graphical interface to configure relay logic. The state of each relay is determined by the system inputs and configured system logic in conjunction with the control state of the relay. Relay control states depend on the application, and may be set as normally energized/de-energized and independent one-out-of-one, (1oo1), voting or TMR two-out-of-three, (2oo3), voting. Each CPU module in the system has two, internally powered, 4-20 mA recorder outputs controlled by the full-scale speed set by the user through the Monitor Configuration software.

Compliance

The 3701/55 ESD complies with most applicable technical regulations and standards.

- North American general safety, CSA certified
- CE, Low Voltage and Electro-Magnetic Compatibility
- Functional Safety certification (SIL)
- CE, Machinery Directive
- North American, Hazardous Area certification, CSA certified
- European ATEX and IECEx Hazardous Area certification pending

3701 ADAPT ESD Overview

Typical (and recommended) applications of the ADAPT ESD will use a triple modular redundant architecture. In this configuration, each processor module physically connects to an array of 32 input channels, 12 of which are configurable as discrete inputs or 4-20 mA analog inputs, as well as two speed inputs. The Bently Nevada Monitor Configuration software allows you to configure large combinations of logic blocks in order to manage the system trip logic. This logic dictates how the trip mechanisms for the system are driven. The ADAPT ESD system can drive 12 independent trip relays. Of the 12 relays, six of these signals can optionally be configured for two-out-of-three, (2oo3), voting. In the 2oo3 arrangement, the system activates a relay only when any two of the three CPU modules drive to trip. In independent mode, or one-out-of-one voting, any single CPU that drives to trip will cause an assigned relay to activate on the corresponding output card. For the highest safety, the system should be configured in “de-energize to trip”, or “normally energized” mode so that loss of power will not result in a machine running unmonitored.

ADAPT ESD Processing Module (CPU)

The ADAPT ESD system has three CPU modules. The CPU (part number 323174-01) is a state-of-the-art, high-performance CPU module. All three CPU modules process all 32 discrete inputs and 12 analog inputs. Each individual CPU module processes two speed inputs, for a total of six speed inputs. The CPU module features redundant Ethernet connections. The CPU receives trip logic configuration from the Bently Nevada Monitor Configuration software. The trip logic can have up to 500 logic steps. The input-to-output decision time is optimized to provide 2ms nominal logic processing time and 8ms relay toggle time in order to minimize the overall duration between detection of an emergency condition and successful shutdown. All embedded code on the CPU is capable of being upgraded without disassembly of the system.

ADAPT ESD Relay Module

There are three relay modules in each ESD system. Each Relay Module (part number 323073-01) has five relay contacts. Two of the relays are independent relays, driven by a corresponding CPU module. The remaining two relays are configurable as either independent or 2oo3 voted. When using a 2oo3 mechanical trip assembly, a typical installation would involve a series connection of one independent relay from each of the three relay modules. Each of the three CPUs would independently drive relays on each of the three relay cards. When two of the three CPUs drive for trip, the trip assembly would have the inputs it needs to

actuate the safety mechanism. Alternately, 2oo3 relays can be implemented directly on the ESD system. The remaining fifth relay is a protection fault relay used to convey the overall health/status of the system. The ADAPT ESD system drives the protection fault relay to broadcast a condition has compromised the integrity of the system.

Networking Overview

The 3701/55 ADAPT ESD system supports fixed (static) IP addressing as well as DHCP. You can easily use the Bently Nevada Monitor Configuration software to set the system to any static IP address or set for DHCP. The system has 6 physical network interfaces in order to provide 2 interfaces per CPU module. The system should be configured so that each CPU module is connected to a single subnet through one of the available interfaces. For redundant communications, the second set of three interfaces can be utilized, and should be configured for a separate subnet.

Computer Requirements

Bently Nevada Monitor Configuration software will run on most Windows desktop or notebook computer systems. Bently Nevada Monitor Configuration software is designed to run and fully tested on Microsoft Windows 7. Software operation is also verified for operation in 32-bit or 64-bit environments.

Networking Requirements

Bently Nevada Monitor Configuration software requires Ethernet ports with TCP/IP protocol support to communicate with the 3701/55 ADAPT ESD. The dual ports on each CPU module should be configured for separate subnets to successfully implement redundant data pathways when this feature is available. Bandwidth sharing on any network, depending on traffic, is always a consideration and will affect network performance. Ensure that you have installed all networking hardware and configured the hardware according to your network administrator's specifications.

Specifications

Typical specifications are provided for a temperature of +25 °C ± 3°C (+77°F ± 5.4°F). All other specifications are over the operating temperature range of -30°C to +65°C (-22°F to +149°F).

Communication

Ethernet - 6 Ports	10/100 Mbps
Protocol	TCP/IP
Addressing	DHCP and Static IP
Compatible	LAN/WAN
Configuration Modification	Password Protected
Time Synchronization	NTP

Power Requirements

Input Range	18 - 36 Vdc Voltage
Power Consumption	24 W Typical/ 35 W Maximum

For Hazardous Area installations, the supply must be appropriately certified to the local national standards. Refer to Hazardous Area Directives section for power supply requirements in hazardous area applications.

Refer to Bently Nevada Application Note 013 for instruction about connecting the system and power supply to earth ground.

Signal Input Specifications

Discrete Inputs	
Two-Terminal, Dry Contact	Polarity Independent A/B Terminals for dry contacts
Closed State Impedance	57 KΩ Maximum
Open State Impedance	187 KΩ Minimum
Low Voltage Input	1.2 Vdc Maximum for externally wetted signals
High Voltage Input	2.9 Vdc Minimum for externally wetted signals
Internal Wetting Voltage	10 - 15 Vdc
Input Resistance	150 KΩ Typical
Faulted Input Tolerance	±40 V
Analog Inputs	
Full Scale Range	4-20 mA ±1%
Polarized Terminals	Pos 'B'/Neg 'A'
Typical Operating Frequency	0-159 Hz
Common Mode Input Range	±32 V
Differential Input Range	0-25 mA
Faulted Input Tolerance	±40 V

The 3701/55 Overspeed Protection Module will support from 1 to 999 events per revolution with a maximum full-scale range of 1,20,000 rpm and a maximum input frequency of 20 kHz (1EPR).

Proximity Speed Inputs	
Auto Threshold and Hysteresis	
Input Voltage Range	0 to -24Vdc
Transducer Power Supply Typical	-24Vdc (-23.5Vdc to -24.75Vdc over operating range)
Max Transducer Current	30mA with current fold-back protection
Operating Frequency	3Hz – 10kHz
Minimum Pulse Amplitude	1.0 Vpp
Maximum Pulse Amplitude	24 Vpp
Error	+/-0.1 RPM Below 100RPM +/-1.0 RPM Below 10kRPM +/-0.01% FSR >10kRPM
OK Checking	-17Vdc to –1.5Vdc OK Typical Above -1.5Vdc NOT OK Typical Below -17Vdc NOT OK Typical

Minimum input frequency for proximity transducers is 3Hz (180 rpm for 1 event/revolution & 0.18 rpm for 999 event/revolution). The minimum peak to peak signal amplitude for proximitor speed input of the 3701/55 is 1V. Refer to the table in Appendix on speed signal requirements for minimum (pk to pk) amplitude of signal for different speeds and duty cycles.

Refer to Bently Nevada Application Note 085 for instruction on proximity probe installation.

Magnetic Pickup Speed Inputs	
Auto Threshold and Hysteresis	
Minimum Pulse Amplitude	1.0 Vpp
Maximum Amplitude	80 Vrms
Operating Frequency	2 Hz – 20 kHz
Error	+/-0.1 RPM Below 100 RPM +/-1.0 RPM Below 10k RPM +/-0.01% FSR >10k RPM
OK Checking	0 to 30k Ohms OK Above 30k Ohms Not OK

Minimum input frequency for magnetic is 3Hz (180 rpm for 1 event/revolution & 0.18 rpm for 999 event/revolution). The minimum peak to peak signal amplitude for magnetic speed input of the 3701/55 is 1.5V.

System Control Contacts
Lock Config/Test Modes
Reset Alarms
Reset Password and IP Address

Relay Output Specifications

CH 1/2 Relay Contacts	
Configurable Voting Logic	Independent 1oo1 Voting or TMR 2oo3 Voting
SPDT	Single Pole-Double Throw
5A/250 Vac/1500 VA Maximum	
5A/250 Vdc/150 VA Maximum	
Available Contacts	Normally Open or Normally Closed

Configurable Trip	Energize or De-energize
Nominal Transition Time	8ms
Minimum Switch Current	12Vdc/100mA
CH 3/4 Relay Contacts	
Voting Logic	Independent 1oo1 Voting Only
SPDT	Single Pole-Double Throw
5A/250 Vac/1500 VA Maximum	
5A/250 Vdc/150 VA Maximum	
Available Contacts	Normally Open or Normally Closed
Configurable Trip	Energize or De-energize
Nominal Transition Time	8ms
Minimum Switch Current	12Vdc/100mA
Okay Relay Contact	
Normally Open	
De-Energize to Trip	
5A/250 Vac/1500 VA Maximum	
5A/250 Vdc/150 VA Maximum	
SPDT	Single Pole-Double Throw
Maximum	5A/250 Vdc/150 VA
Nominal Transition Time	8ms
Minimum Switch Current	12Vdc/100mA

Refer to Hazardous Area Directives section for relay requirements in hazardous area applications.

4-20 mA Recorder Output Specifications

Internally Powered	
Full Scale Range	4-20 mA
Maximum Error	0.1 mA
Maximum Loop Impedance	750 Ohm

LED Indicators

Module OK LED	
Green	OK
Off	NOTOK (self-test failure, or input signal out of OK range)
2 Hz	Un-configured
Protection Fault LED	
Red	Protection Fault Present
Off	Run Mode
CPU Test LED	
Off	Run Mode (test mode inactive)
2 Hz	Test Mode Active
CPU Attention LED	
Green	New Event List Entry Requires Attention
Off	No Entries Present in Event List
CPU Alarm LED	
Off	No Channel Alarms Activated
2 Hz	Single Channel Alarms Activated
5 Hz	Multiple Channel Alarms Activated
CPU Speed LEDs	
Green	Speed Signal Present
Off	No Speed Signal Present
2 Hz	Speed Signal Out of OK Range
CPU Net LEDs	
Green	Link Present
Off	Link Not Present
CPU TX/RX LEDs	
Blinking	Active Link
Off	Inactive Link
CPU PWR LEDs	
Green	Power Present
Off	Power Off
Relay OK LED	
Green	OK
Off	NOTOK
2 Hz	Unconfigured
Relay Channel LED	
Red	Active (tripped)
Off	Inactive
2 Hz	Voltage Check Failure

Logic Configuration Specification

Maximum Logic Blocks	500
Maximum In to Out Decision Time	2 ms (500 blocks w/o timer delays)

Maximum Contact Closure Delay	30 ms (detection to new relay state)
Input Blocks	
Discrete Input Channels	Configurable inverting logic
Speed Inputs	6 high/low setpoints plus Not OK
Analog Input 4-20 mA Recorders	6 high/low setpoints plus Not OK
Logic Blocks	
Multiple-input AND	
Multiple-input OR	
Multiple-input XOR	
Inverter	
8-input M-out-of-N	
RS Flip-Flop	
Timer	Triggered on high/low transition, or pulse
Output Blocks	
Relay Output	Configurable 1oo1 or 2oo3

Physical

Dimensions	
ADAPT ESD System (LxWxH)	25.4 x 30.48 x 18.0 cm (10.0 x 12.0 x 7.1 in)
Processing Module (LxWxH)	15.8 x 6.1 x 15.8 cm (6.2 x 2.4 x 6.2 in)
Relay Output Module (LxWxH)	15.8 x 2.8 x 15.8 cm (6.2 x 1 .1 x 6.2 in)
Weight	
ADAPT ESD System	8.8 kg (19.4 lb)
Processing Module	1.2 kg (2.6 lb)
Relay Output Module	0.6 kg (1.3 lb)
ADAPT ESD System Construction	
Aluminum Chassis	
Cast Aluminum Module Cases	
Black Powder Coat Finish (indoor/outdoor use)	

Environmental

Operating Temperature	-30°C to +65°C (-22°F to +149°F)
Storage Temperature	-45°C to +85°C (-49°F to +185°F)
Relative Humidity	0% to 95% Non-condensing
Vibration	Per IEC 60068-1, 3 g @ 3-57 Hz 5 g @ 57-500 Hz
Shock	Per IEC 60068-2, 15 g for 11 mS Operational & Non-operational

Environmental Considerations

The ADAPT ESD is designed to meet a broad range of use cases and environments. The design incorporates significant measures to provide a robust electrical and mechanical package with careful attention to system reliability, including extensive shock, vibration, and temperature exposure.

That being said, the ADAPT ESD system should be treated with the appropriate care, as exposure to extreme environments will shorten the life expectancy of the system. Exposing the ADAPT ESD to condensing liquids, rain, sand, or situations that impair ventilation can cause excessive internal heating and performance loss. For installations that may exceed environmental specifications we can create custom solutions to meet specific needs. For example, although the ADAPT ESD has hazardous area approvals, it must be in a NEMA grade enclosure. If you have any questions regarding an application, please contact your local sales and service representative.

Compliance and Certifications

FCC

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

- This device may not cause harmful interference.
- This device must accept any interference received, including interference that may cause undesired operation.

EMC

EU Directive 2014/30/EU

EU 61326-3-1

EN 61000-6-2

EN 61000-6-4

Electrical Safety

CAN/CSA-C22.2 No. 61010-1-12

UL 61010-1

EU Directive 2014/35/EU Low Voltage Directive

EN 61010-1

RoHS

RoHS Directive 2011/65/EU

India - Battery EPR Marking

GE Oil & Gas India Private Limited

EPR Certificate No.: 1.1595372902047E+20

Maritime

ABS 2009 Steel Vessels Rules

1-1-4/7.7,4-8-3/1.11.1,4-9-7/13

Safety of Machinery

EU Directive 2006/42/EC, Machinery Directive

Safety Related Electronic Control Systems,

IEC 62061-1

IEC 61508

For further certification and approvals information, please visit Bently.com.

Power supplies must be 2006/95/EC and 60950-1 compliant for CE installations.

CE compliant installations require relay contact voltages below 120 Vac, or 50 Vdc to minimize shock hazard.

Hazardous Area Approvals

For the detailed listing of country and product-specific approvals, refer to the *Approvals Quick Reference Guide (108M1756)*.

For additional technical documentation, please log in to bntechsupport.com and access the Bently Nevada Media Library.

cNRTLus

Class I, Zone 2: AEx nA nC IIC T4 Gc;
Class I, Zone 2: AEx ec nC IIC T4 Gc;
Class I, Division 2, Groups A, B, C, and D;

T4 @ Ta= -30˚C to +65˚C
When installed per drawing 100M1872

ATEX/IECEx

II 3 G
Ex nA nC IIC T4 Gc
Ex ec nC IIC T4/T5 Gc

T4 @ Ta= -30˚C to +65˚C

The 3701/55 ADAPT ESD system is not certified for installation in Class I Division 1, or Class I Zone 0/1 locations, but it will support transducers installed in these locations via the use of galvanically isolated safety barriers or zener barriers. If galvanic isolators are used, no change is necessary to the installation. A removable ground jumper allows the monitor to support zener barrier installations. Removing the jumper will disconnect circuit common from chassis at the monitor so that chassis can be connected at the barrier.

Power supplies must be Class I, Div 2 or Class I, Zone 2 compliant for hazardous area installations.

Hazardous area installations require:

- Relay contact voltages below 30 Vac rms, or 30 Vdc to minimize hazard.
- Relay contact amperages below 5 Amps DC, or AC to minimize hazard.
- Relay contact power below 100 Watts DC, or 100 VA AC to minimize hazard.
- Inter-terminal base connectors to remain unused.

Certified Functional Safety (SIL) Systems

The 3701/55 ADAPT ESD system is certified as a SIL 3 device. The SIL 3 safety category is verified by methods outlined by IEC 61508, Part 1-7 safety standard.

SIL installations require:

- Relay contact voltages below 250 Vac, or 250 Vdc.
- Relay contact amperages below 1A AC or DC.
- Relay contact power below 250VA AC, or 150W DC.
- Inter-terminal base connectors to remain unused.

Ordering Information

For the detailed listing of country and product-specific approvals, refer to the *Approvals Quick Reference Guide (108M1756)*.

For additional technical documentation, please log in to bntechsupport.com and access the Bently Nevada Media Library.

3701/55 ADAPT ESD Monitor

A: Agency Approval	
00	None
01	CSA/NRTL/C CLASS 1, DIV 2, ZONE 2
02	ATEX/IECEx
B: Relay Option	
01	Standard Relay Module
02 *	Gold-plated Relay Module

* This relay option **does not** have Hazardous Area Certifications

Accessories

289761-01	ADAPT ESD Terminal Base Assembly
323174-01	ADAPT ESD CPU Module
323073-01	ADAPT ESD 4 Ch. Relay Output Module
323073-02	ADAPT ESD 4 Ch. Gold-plated Relay Output Module
289036-01	Spare ADAPT ESD Terminal Block
324343	ADAPT ESD Weatherproof Enclosure
103M1345-01	3701/55 ADAPT ESD Configuration Software DVD Please download this software at bnTechSupport.com
Bently_ Manuals	Customer Documentation DVD

Reference Materials

Please refer to the Bently_Manuals Customer DVD to access all documentation noted below.

100M8433	3701/55 ADAPT ESD Product Datasheet
100M8834	3701/55 ADAPT ESD SIL Safety Manual
114M7576	3701/55 ADAPT ESD User Guide

Graphs and Figures

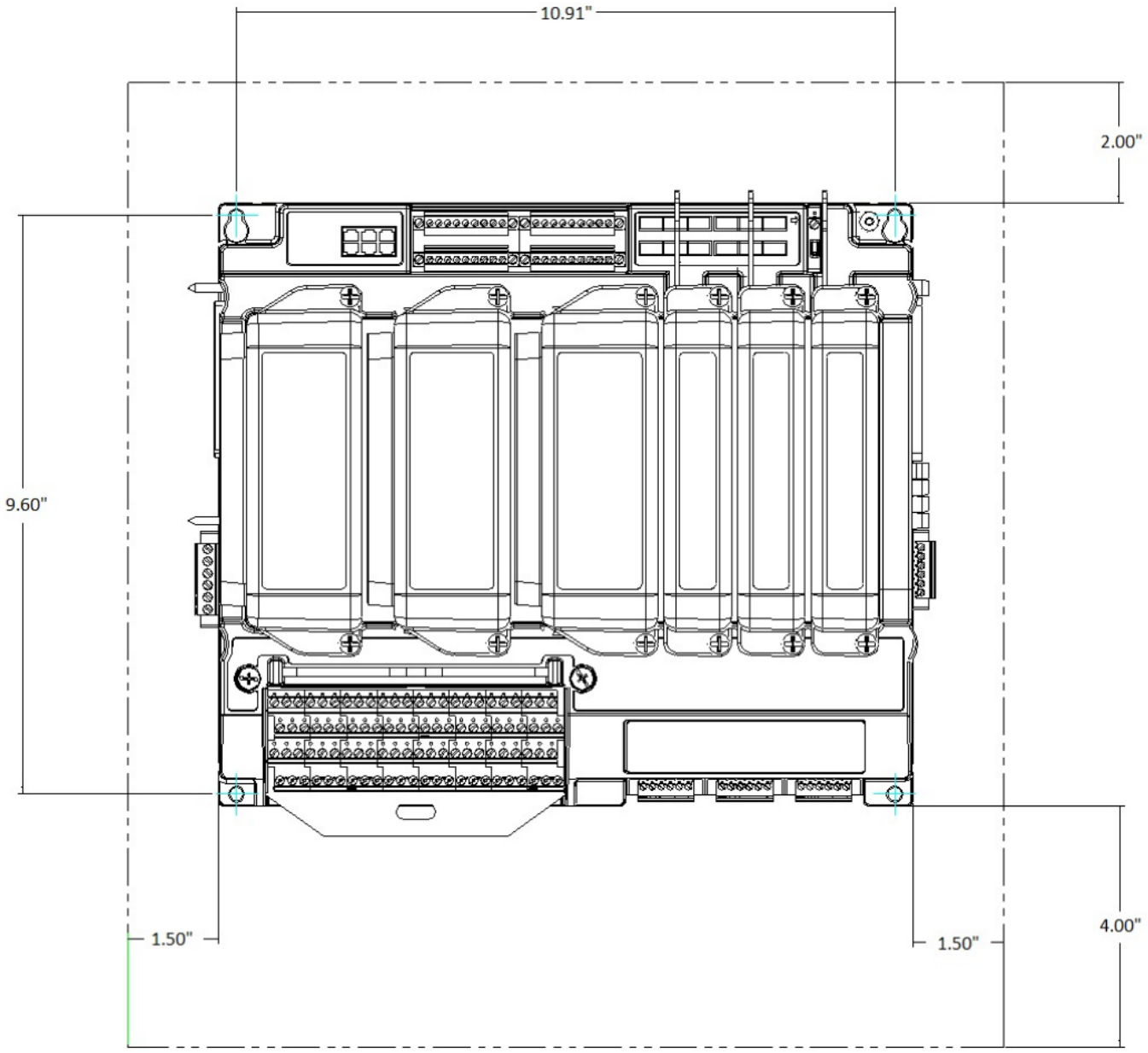


Figure 1: Dimensional Drawing and Enclosure Clearances.

Terminal base of the 13701/55 ESD system must be mounted vertically with power supply terminal exiting horizontally for proper heat dissipation. Required enclosure depth minimum nine inches, (9″).

Appendix

Table 1: Speed Signal Requirements

Period (s)	Frequency (Hz)	RPM	Duty Cycle (%)							
			50	25	10	5	1	0.5	0.1	0.05
			Minimum Amplitude V(p-p)							
5	0.2	12	1	1	1	1	1	1.06	1.9	3.1
2	0.5	30	1	1	1	1	1	1.17	2.82	4.98
1	1	60	1	1	1	1	1	1.19	3.05	5.09
0.1	10	600	1	1	1	1	1.06	1.31	3.2	5.42
0.01	100	6000	1	1	1	1	1.08	1.34	3.48	5.8
0.001	1000	60000	1	1	1	1	1.31	1.86	6.11	Greater than 8V
0.0005	2000	120000	1	1	1	1	1.57	2.45	Greater than 8V	Greater than 8V

This table is applicable for Proximitor-based speed measurements.