

3701/55 ADAPT Emergency Shutdown System

Bently Nevada* Asset Condition Monitoring

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 a robust electrical and mechanical package with careful 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 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.



imagination at work

Specifications and Ordering Information
Part Number 100M8833-01
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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 4-20mA 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.

System 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

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

Power Requirements

18 – 36 Vdc Voltage Input Range
24 W Typical/35 W Max. Power Consumption

Notes:

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 on 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
57 kOhm Max. Closed State Impedance
1.2Vdc Maximum Low Voltage Input for externally wetted signals.
187 kOhm Min. Open State Impedance

2.9Vdc Minimum High Voltage Input for externally wetted signals.

Internal Wetting Voltage 10-15 Vdc

Input Resistance (TMR): 150KΩ Typical

±40V Faulted Input Tolerance

Analog Inputs

4-20mA Full Scale Range

Pos 'B'/Neg 'A' Polarized Terminals

0-159 Hz Operating Frequency Typical

±1% of Full Scale Range

±32V Common Mode Input Range

0-25mA Differential Input Range

±40V Faulted Input Tolerance

Proximity Speed Inputs

Auto Threshold and Hysteresis

0 to -24 Vdc Input voltage Range

-24Vdc Transducer Power Supply Typical (-23.5 Vdc to -24.75 Vdc over operating range)

30mA Max Transducer Current with Current Fold-back Protection

3Hz – 10kHz Operating Frequency

1.0 Vpp Min Pulse Amplitude

24Vpp Max Pulse Amplitude

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

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Notes:

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

Magnetic Pickup Speed Inputs

Auto Threshold/Hysteresis
1.0 Vpp Min Pulse Amplitude
80Vrms Max Amplitude
2Hz – 20kHz Operating Frequency

Error:

+/-0.1 RPM Below 100RPM
+/-1.0 RPM Below 10kRPM
+/-0.01% FSR >10kRPM

OK Checking:

0 to 30k Ohms OK
Above 30k Ohms Not OK

System Control Contacts

Lock Config/Test Modes
Reset Alarms
Reset Password and IP Address

Relay Output Specifications**CH 1/2 Relay Contacts**

Configurable, Independent 1oo1 Voting or TMR 2oo3 Voting
SPDT, Single Pole-Double Throw
5A/250 Vac/1500 VA Max.
5A/250 Vdc/150 VA Max.
Available Normally Open or Normally Closed Contacts
Configurable Energize or De-Energize to Trip
8 ms Nominal Transition Time

CH 3/4 Relay Contacts

Min Switch Current: 12Vdc/100mA

Independent 1oo1 Voting Only
SPDT, Single Pole-Double Throw
5A/250 Vac/1500 VA Max.
5A/250 Vdc/150 VA Max.

Available Normally Open or Normally Closed Contacts

Configurable Energize or De-Energize to Trip

8 ms Nominal Transition Time

Min Switch Current: 12Vdc/100mA

OK Relay Contact

Normally Open/

De-Energize to Trip

8 ms Nominal Transition Time

5A/250 Vac/1500 VA Max.

5A/250 Vdc/150 VA Max.

Min Switch Current: 12Vdc/100mA

Notes:

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

4-20mA Recorder Output Specifications

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

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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 Alarm 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 -> Un-configured

Relay Channel LED

Red -> Active (tripped)
Off -> Inactive
2 Hz -> Voltage Check Failure

Logic Configuration Specification

500 Maximum Logic Blocks
2ms Max In to Out Decision Time (500 blocks w/o timer delays)
30ms Max Contact Closure Delay (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)

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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 61010-1,
3 g @ 3-57 Hz
5 g @ 57-500 Hz

Shock

Per IEC 61010-1,
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

General Safety and LVD

LV Directive 2014/35/EU
CAN/CSA-C22.2 No. 61010-1-12
UL 61010-1 3rd Ed.

Electro-Magnetic Compatibility

EMC Directive 2014/30/EU
EN 61326-1:2006
EN 61000-6-2:2005
EN 61000-6-4:2007+A1:2011

Safety of Machinery

EU Directive 2006/42/EC,
Machinery Directive
IEC 61508:2010, Parts 1-7
IEC 62061:2005+A1

For further certification and approvals information, please visit the following website:

<http://www.GEmeasurement.com>

Notes:

Power supplies must be IEC 60950-1 compliant for EU installations.

Hazardous Area Approvals

For a detailed listing of country and product specific approvals, refer to the *Approvals Quick Reference Guide* (document 108M1756) located at the following website:

<http://www.GEmeasurement.com>

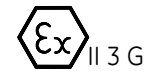
The 3701/55 ADAPT ESD system is not certified for installation in Class I Division 1, or Class I Zone 0/1 locations, but it will support transducers installed in these locations via the use of galvanically isolated safety

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.

North America

AEX/Ex nA nC IIC T4 Gc:
Class 1, Zone 2
Class I, Division 2, Groups A,B,C,D
T4 @ -30°C ≤ +65°C
Per drawing: 100M1872

ATEX/IECEx (pending)



Ex nA nC IIC T4 Gc
T4 @ -30°C ≤ +65°C
Sira 16ATEX4092X
IECEx SIR 16.0029X

Notes:

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

Power Supplies must be SELV2 compliant.

Hazardous area installations require relay contact voltages below 30 Vac rms, or 30 Vdc to minimize hazard.

Hazardous area installations require relay contact amperages below 5 Amps DC, or AC to minimize hazard.

Hazardous area installations require relay contact power below 100 Watts DC, or 100 VA AC to minimize hazard.

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Hazardous area installations require inter-terminal base connectors to remain unused, thus not available on product from 2016 on.

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 safety standard.

Notes:

SIL installations require relay contact voltages below 250 Vac, or 250 Vdc.

SIL installations require relay contact amperages below 1A AC or DC.

SIL installations require relay contact power below 250VA AC, or 150W DC.

SIL system installations require inter-terminal base connectors to remain unused.

Ordering Information

For a detailed listing of country and product specific approvals, refer to the *Approvals Quick Reference Guide* (document 108M1756) located at the following website: <http://www.GEmeasurement.com>

(All accessories are ordered as separate line)

Product Description

3701/55 ADAPT ESD Monitor

3701/55 -AXX

A: Agency Approval Option

- 00 None
- 01 CSA/NRTL/C
CLASS 1, DIV 2, ZONE 2
- 02 ATEX/IECEX

Accessories

289761-01	ADAPT ESD Terminal Base Assembly
323174-01	ADAPT ESD CPU Module
323073-01	ADAPT ESD 4Ch. Relay Output Module
289036-01	Spare ADAPT ESD Terminal Block
178487/178490	Spare ADAPT ESD Relay Connectors
324343	ADAPT ESD Weatherproof Enclosure
100M8433-01	3701/55 ADAPT ESD Product Datasheet
114M7576	3701/55 ADAPT ESD Product Manual
100M8834-01	3701/55 ADAPT SIL Safety Manual
103M1345-01	3701/55 ADAPT ESD Configuration Software DVD
Bently_Manuals	Customer DVD containing all Bently Manuals, FWD, App Notes, and Install Guides in all available languages

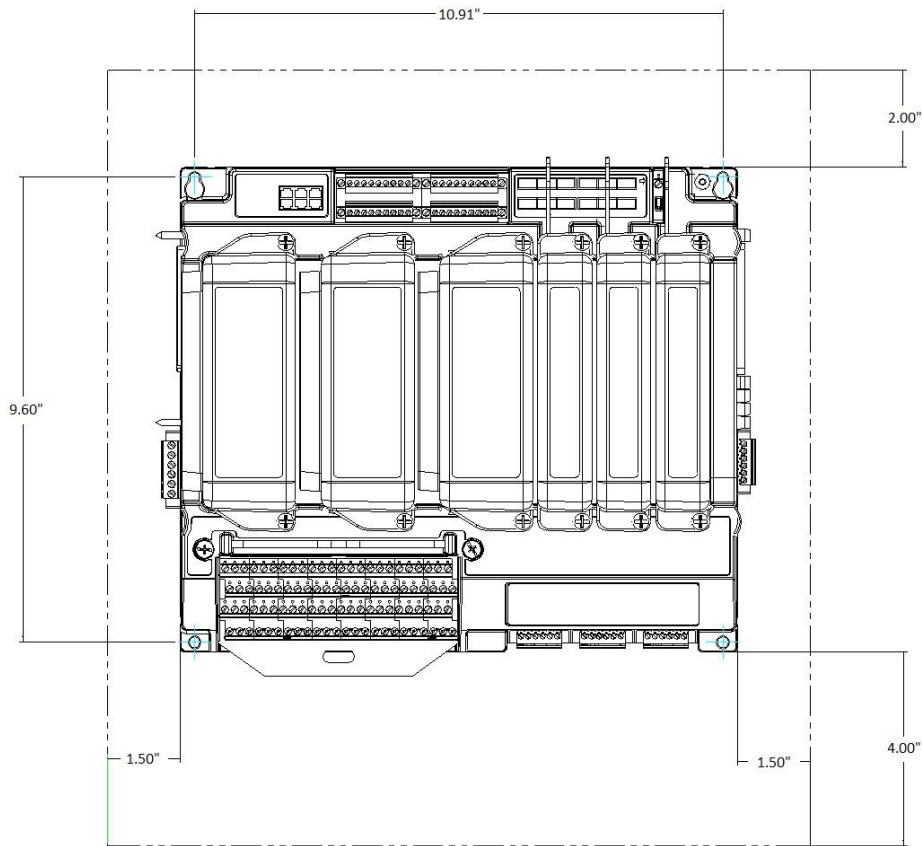


Figure A1: Dimensional Drawing and Enclosure Clearances.

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").

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 1631 Bently Parkway South, Minden, Nevada USA 89423
 Phone: 775.782.3611 Fax: 775.215.2873

www.GEmeasurement.com

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