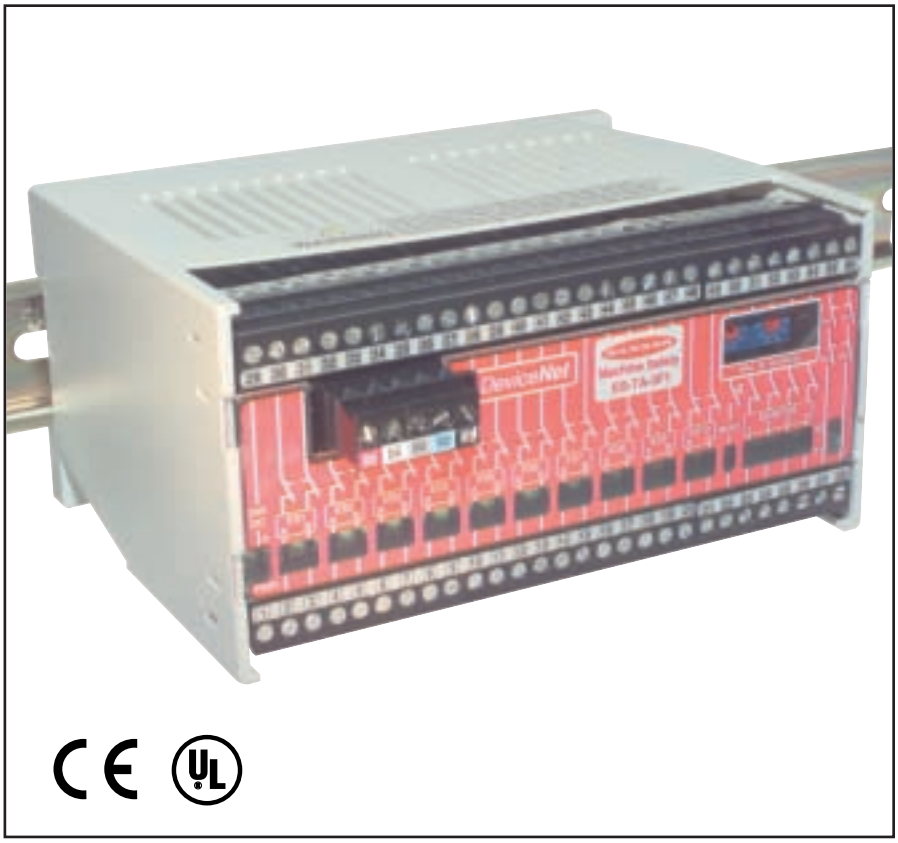
BANNER®

the machine safety specialist

Ten-Input Emergency Stop Safety Module

Model ES-TA-3F1 with DeviceNet™



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Features

- Monitors up to ten normally-closed Emergency Stop switch circuits for a contact failure or wiring fault
- Diverse-redundant input monitoring circuit
- DeviceNet™ monitoring of status and diagnostic information
- Auto reset or monitored manual reset
- Two output switching channels for connection to control-reliable power interrupt circuits
- Designed to comply with standards UL991, EN418, and EN954-1 (Safety Category 4)
- For use in functional stop category 0 applications per NFPA 79 and EN418
- Plug-in terminal blocks and replaceable circuit boards
- LED indicators for status of all inputs and outputs
- Manual MAC ID Address switches and LED
- Autobaud

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Important ... read this page before proceeding!

Banner Engineering Corp. has made every effort to provide complete application, installation, operation, and maintenance instructions. In addition, any questions regarding the use or installation of Banner model **ES-TA-3F1** Emergency Stop Safety Module should be directed to the factory applications department at the telephone numbers or address shown on back cover.

The user must ensure that all machine operators, maintenance personnel, electricians, and supervisors are thoroughly familiar with and understand all instructions regarding the installation, maintenance, and use of the model **ES-TA-3F1** Emergency Stop Safety Module, and with the machinery it controls.

The user and any personnel involved with the installation and use of the model **ES-TA-3F1** Emergency Stop Safety Module must be thoroughly familiar with all applicable ANSI/NFPA standards. The standards, listed below, directly address the use of emergency stop systems. Banner Engineering Corp. makes no claim regarding a specific recommendation of any organization, the accuracy or effectiveness of any information provided, or the appropriateness of the provided information for a specific application.

The user has the responsibility to ensure that all local, state, and national laws, rules, codes, and regulations relating to the use of this Emergency Stop Safety Module in any particular application are satisfied. Extreme care is urged that all legal requirements have been met and that all installation and maintenance instructions contained in this manual are followed.

U. S. Standards Applicable to Use of Emergency Stop Safety Modules

ANSI B11 — Standards for Machine Tools "Safety Requirements for the Construction, Care and Use"
Available from: Safety Director
AMT – The Association for Manufacturing Technology
7901 Westpark Drive
McLean, VA 22101-4269
Phone: 703.827.5266

NFPA79 — "Electrical Standard for Industrial Machinery (1997)"
Available from: National Fire Protection Association
1 Batterymarch Park, P.O. Box 9101
Quincy, MA 02269-9101
Phone: 800.344.3555

ANSI/RIA R15.06 — "Safety Requirements for Industrial Robots and Robot Systems"
Available from: Robotic Industries Association
900 Victors Way, P.O. Box 3724
Ann Arbor, MI 48106
Phone: 734.994.6088

European Standards Applicable to Use of Emergency Stop Safety Modules

EN292-1 — "Safety of Machinery – Basic Concepts, General Principles for Design
Part 1: Basic Terminology, Methodology"

EN292-2 — "Safety of Machinery – Basic Concepts, General Principles for Design
Part 2: Technical Principals and Specifications"

EN60204-1 — "Electrical Equipment of Machines: Part 1: General Requirements"
Also, request a type "C" standard for your specific machinery.

EN418 — "Safety of Machinery – Emergency Stop Equipment Functional Aspects, Principles for Design"
Available from: Global Engineering Documents
15 Inverness Way East
Englewood, CO 80112-5704
Phone: 800.854.7179

Key to Categories

- **A Functional Stop Category (0, 1 or 2), per EN60204-1 and NFPA79,** refers to the type of stopping action required by the guarded machine in question. Some machines may be stopped safely, immediately following a stop command (removal of power); others, due to their high speed, mass or momentum, would run on following an immediate stop command. These machines require power to be provided to the guarded machine's braking system for a specified delay time, to effect a controlled stop.
  Category 0 Stop: immediate removal of power, uncontrolled stop
  Category 1 Stop: controlled stop with a delay before power is removed from guarded machine
  Category 2 Stop: controlled stop with power left available to the guarded machine actuators

- **A Safety Category (B, 1, 2, 3 or 4), per EN954-1,** refers to "the performance of a safety related part of a control system (or circuit) with respect to the occurrence of faults..." Of the many factors involved when selecting an appropriate safety category, hazard analysis, risk assessment and risk reduction are among the most important. The level of risk is based on the severity of a potential harm and its probability of occurring, which is used to determine the appropriate performance of a control system or circuit. Typically, as described in Annex B of EN954-1, in cases where serious injury is possible:

  - **Safety Category 2** would be selected only if exposure to a hazard is infrequent, and of a short duration.

  - **Safety Category 4** would be selected if exposure to a hazard is frequent to continuous, or if exposure is for a long duration.

For more information, refer to standards EN954-1, EN418, NFPA 79, EN60204-1 and British Standard 5304:(1988).

SECTION 1 – Product Description

The purpose of the model ES-TA-3F1 Emergency Stop (E-stop) Safety Module is to increase the control reliability of a multiple-input Emergency Stop circuit. The ANSI B11.19 standard states:

> "Control reliability of electrical, electronic, or pneumatic systems frequently consists of multiple, independent parallel or series circuitry or components so arranged that any single failure . . . **either sends a stop command to the machine tool or prevents a successive cycle from being initiated."**

As indicated in Figure 3, a typical Emergency Stop switch offers two redundant switching contacts. In a properly designed machine stop circuit, the opening of either of the two Emergency Stop contacts immediately removes electrical power from the machine control elements which react to stop hazardous machine motion and/or any other machine hazard. This redundancy of stopping control offered by a two-pole Emergency Stop switch is the first step towards control reliability. However, failure or defeat of one of the switch contacts to a short-circuit will go undetected, thereby removing the redundancy, and leaving the Emergency Stop circuit prone to eventual failure.

The model ES-TA-3F1 E-Stop Safety Module connects up to ten Emergency Stop switches to the machine Emergency Stop control elements. The Emergency Stop switches become the inputs to the Safety Module, which monitors the condition of both contacts of each E-stop switch connected to it. The output of the E-stop Safety Module consists of two redundant output switching channels, each of which is the series connection of two force-guided relay contacts (K1 and K2 in Figure 3).

As recommended by the Control Reliability section of ANSI B11.19, outputs of the E-Stop Safety Module consist of two contacts (K1 and K2). These contacts are mechanically linked, force-guided contacts, allowing the Safety Module to monitor the outputs for failures. If the Safety Module detects failure of any contact of either the input E-stop switches or the output relays, the Safety Module output is disabled and cannot be reset. The two switching output circuits of the Safety Module are rated for up to 250V ac at up to 4 amps (resistive load).

The model ES-TA-3F1 E-Stop Safety Module also provides a selectable (automatic or manual) reset function.

The Safety Module has indicators for input power, E-Stop inputs, monitor inputs, reset input and output relay status (see Figure 1). A selector for Auto or Manual Reset is located under the control panel cover (see page 8 for instructions). See Sections 6 and 7 for information regarding troubleshooting and repairs.

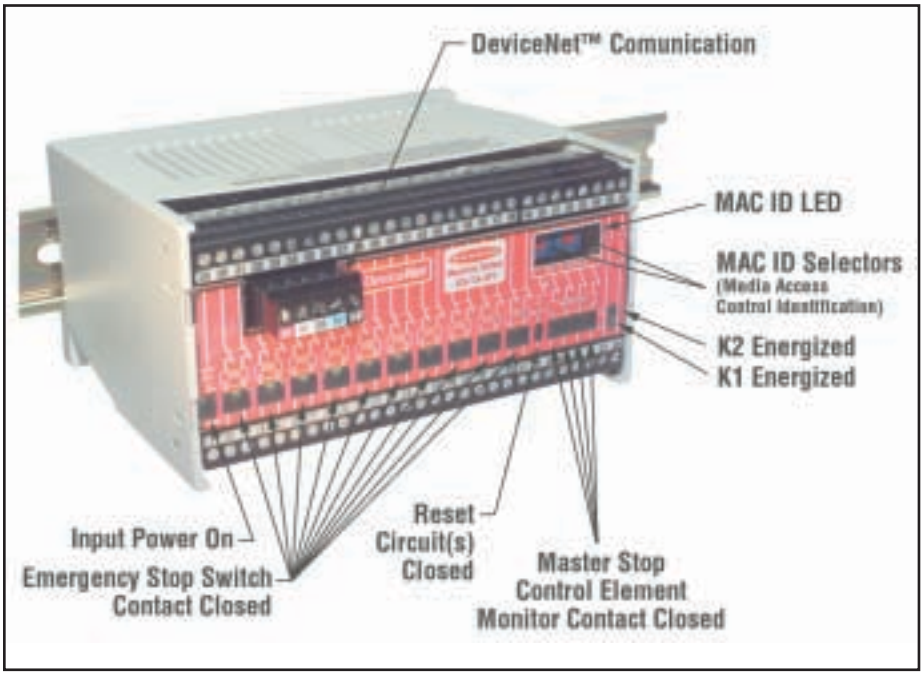

Figure 1. ES-TA-3F1 status indicators

SECTION 2 – Emergency Stop Switch Requirements

As shown in Figure 3, each Emergency Stop switch must provide two contacts which are closed when the switches are in the "ready" position. Once activated, the Emergency Stop switch must open both contacts. The switch may be returned to the closed-contact position only by a deliberate action (such as twisting, pulling or unlocking). Additionally, NFPA79, section 13.2 Emergency Stop Devices specifies the following switch ("stop control") requirements:

- Emergency Stop push buttons must be located at each operator control station and at other operating stations where emergency shutdown is required.
- Stop and Emergency Stop push buttons must be continuously operable from all control and operating stations where located.
- Actuators of Emergency Stop devices must be colored RED. The background immediately around the device actuator must be colored YELLOW. The actuator of a push-button-operated device must be of the palm or mushroom-head type.
- The Emergency Stop actuator must be either a momentary or self-latching type.

NOTE: Some applications may have additional requirements. The user must refer to all relevant regulations.

WARNING. . .

Model ES-TA-3F1 Emergency Stop Safety Module is not a point-of-operation guarding device, as defined by OSHA regulations. It is necessary to install point-of-operation guarding devices, such as safety light screens and/or hard guards, to protect personnel from hazardous machinery. **Failure to install point-of-operation guards on hazardous machinery can result in a dangerous condition which could lead to serious injury or death.**

SECTION 3 – Mounting the E-Stop Safety Module

Mount the ES-TA-3F1 E-Stop Safety Module inside a lockable enclosure which has a minimum rating of NEMA3 (IP54). The model ES-TA-3F1 E-Stop Safety Module is not designed for exposed wiring. **It is the user's responsibility to house the Safety Module in an enclosure with NEMA 3 (IEC IP54).** For security reasons, the key to the lockable enclosure should be in the possession of a Qualified Person (see section 5.1, Security Protocol).

The Safety Module housing may be mounted onto standard 35 mm DIN rail or may be mounted directly to the backplate of the lockable enclosure, using the supplied hardware. Leave a minimum 1 cm (1/4") gap between the Safety Module housing and adjacent housings, to allow room for potential board replacement at a later date.

The ES-TA-3F1 E-Stop Safety Module should be configured before initial checkout and use (see section 4.4 and 4.5).

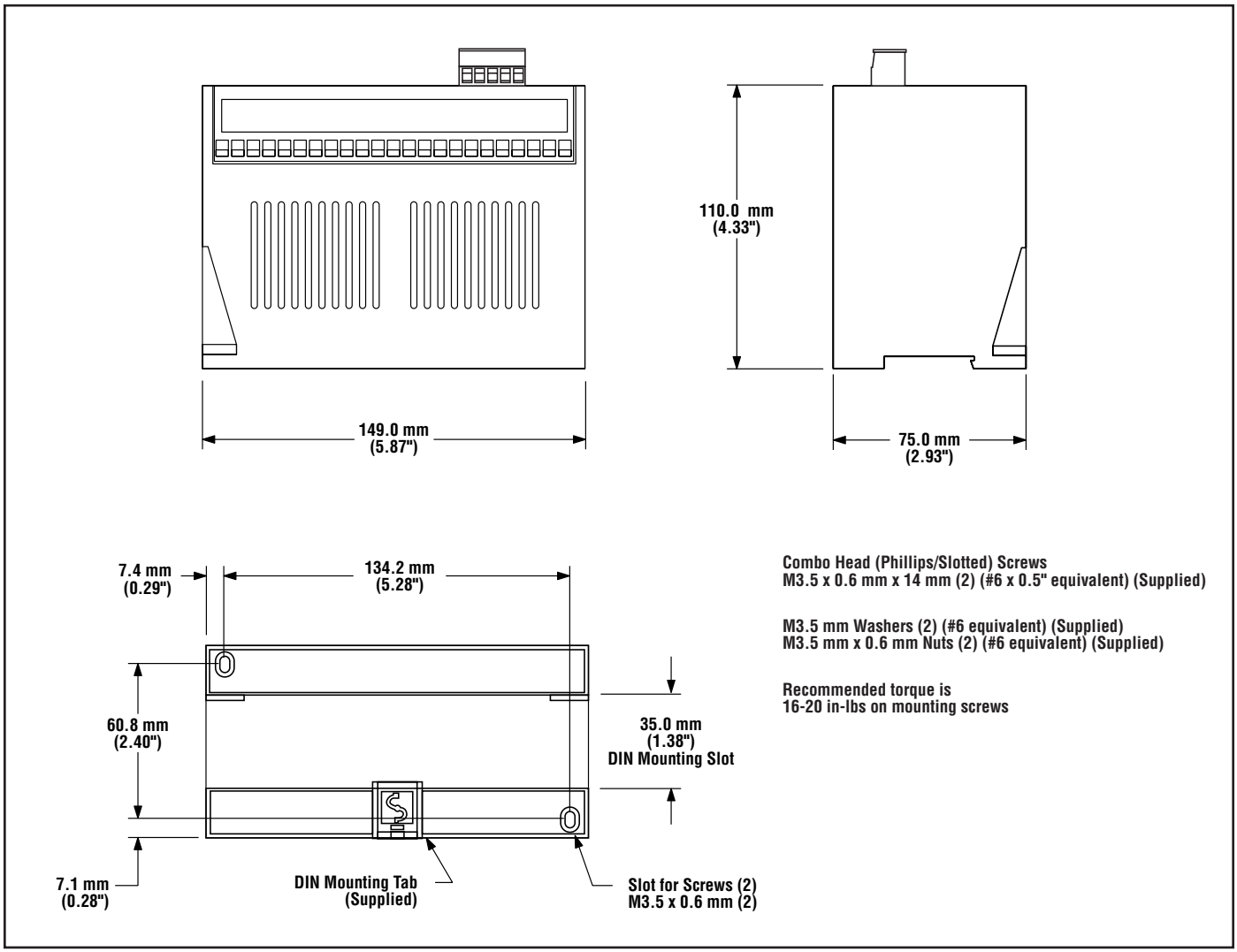

Figure 2. ES-TA-3F1 Safety Module dimensions

SECTION 4 – Electrical Hookup and Initial Checkout

It is not possible to give exact wiring instructions for a device such as the model ES-TA-3F1 E-Stop Safety Module which interfaces to a multitude of machine control configurations. The following guidelines are general in nature.

The E-Stop Safety Module has no delay function. The output relay contacts open within 25 milliseconds from the time that any Emergency Stop switch contact opens. This classifies the E-Stop Safety Module as a functional "Category 0" Emergency Stop control as defined by NFPA 79 (National Fire Protection Association Standard for Industrial Machinery) and EN418 (European Standard: "Safety of Machinery, Emergency Stop Equipment, Functional Aspects – Principles of Design").

4.1 Connection of Emergency Stop Switches

Connect the two poles of each Emergency Stop switch as shown in Figure 3. The switches in Figure 3 are shown in their "ready" position with both contacts closed. See Product Specifications on page 20 for E-stop switch input requirements.

NOTE: Jumper any unused inputs to simulate an emergency stop switch in the closed-contact position.

4.2 Connection of Reset Switch

The circuit Reset switch can be any mechanical switch, such as a normally open momentary switch, or a two-position key switch. The Reset switch must meet the requirements listed in the Product Specifications on page 20. The Reset switch connects between terminals 22 and 50 of the Safety Module.

The Reset switch must be located outside and not accessible from the area of dangerous motion, and must be positioned so that any area of dangerous motion may be observed by the switch operator during the Reset operation. Any areas not in full view must use supplemental guarding to detect personnel.

CAUTION . . .
Electrical Hazard

Always disconnect power from the ES-TA-3F1 E-Stop Safety Module and all power from the machine being controlled before making or removing any wire connections.

Electrical installation and wiring must be made by qualified personnel and must comply with the NEC (National Electrical Code), IEC 60204-1 and -2, and all applicable local standards and codes.

CAUTION . . .
Do Not Use As A Safety Switch (Interlock) Monitor

The ES-TA-3F1 E-Stop Safety Module is not to be used as a gate or interlocking switch monitor. The use of input devices other than emergency stop switches (see section 2) may result in a reduction in the safety category as described by EN 954-1.

WARNING . . .
Do Not Use Jumpers to Bypass an E-stop circuit.

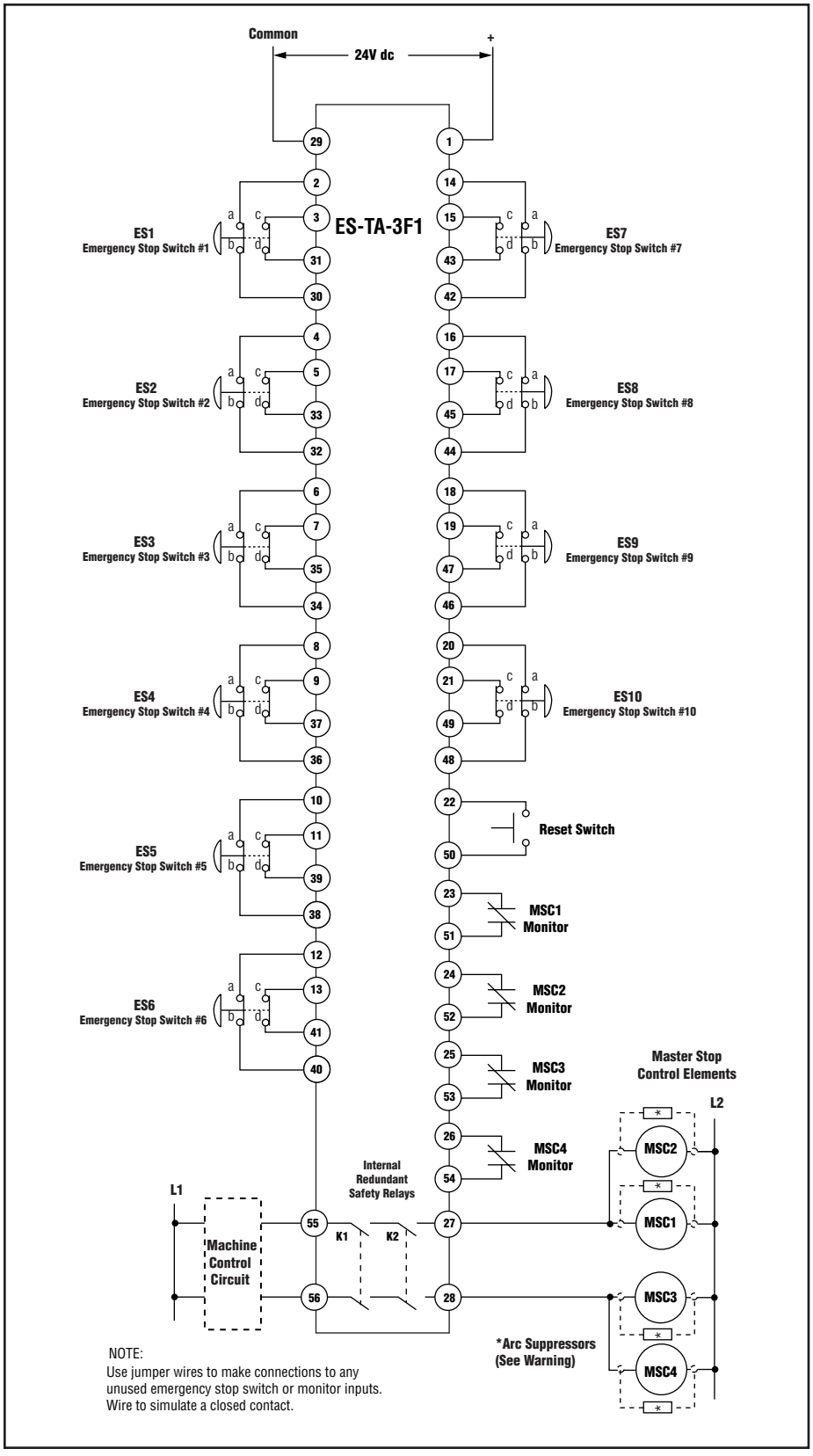

Figure 3. General hookup information for model ES-TA-3F1 Emergency Stop Safety Module

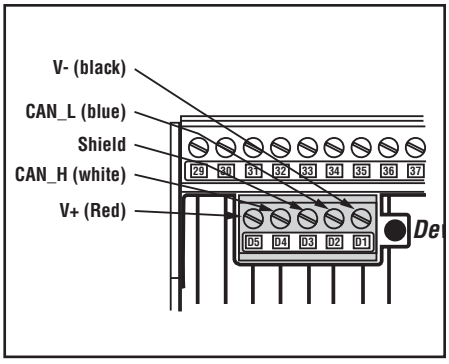

Figure 4. DeviceNet connections

WARNING . . .
Intermediate Devices

NEVER wire an intermediate device (for example, a programmable logic controller - PLC), **other than a captive contact (force-guided) relay, between E-Stop Safety Module outputs and the Master Stop Control element it switches. To do so sacrifices the control reliability of the control-to-machine interface, and creates an unsafe condition which could result in serious injury or death.** Whenever a force-guided relay is added as an intermediate switching device, a normally closed, force-guided monitor contact of that relay must be connected in series with the monitor contact of the Master Stop Control element it is switching. (Reference ANSI B11.1 – 1988, Appendix B4)

WARNING . . .
Arc Suppressors

If arc suppressors are used, they MUST be installed as shown across the load of the Master Stop Control elements (MSC1, MSC2, MSC3 and MSC4). **NEVER install suppressors directly across the output contacts of the E-Stop Safety Module.** It is possible for suppressors to fail as a short circuit. If installed directly across the output contacts of the Safety Module, **a short-circuited suppressor will create an unsafe condition which could result in serious injury or death.**

4.3 Setting the MAC ID Address

In order for the DeviceNet controller to process information from its individual inputs, each input must have a unique 2-digit address. (For example, two devices on the same bus network may not both have 26 as their address; however, two devices within the same factory may have addresses of 26, if they are on separate bus networks.)

The E-Stop Safety Module's address may be assigned in two ways: locally, using the two rotary selectors on the front of the Module (see Figure 5), or remotely, using the rotary selectors and the DeviceNet controller. To set the address locally, set the rotary selectors to a number between 00 and 63 and cycle power to the DeviceNet connection. To allow the DeviceNet controller to set the address, set the rotary selectors to a number higher than 63; the address can then be set using the controller.

The MAC ID LED will be OFF when the MAC ID address rotary switches match the current address of the E-Stop Safety Module (as recognized by the DeviceNet controller). If the addresses do not agree, the LED will flash. (To correct this problem, see DeviceNet Troubleshooting.) The MAC ID LED will be ON steadily when the MAC ID address rotary switches are above 63 and the current address of the E-Stop Safety Module (as recognized by the DeviceNet controller) was set with the MAC ID address rotary switches above 63.

Figure 5. MAC ID address rotary selectors and LED

4.4 Selecting Auto or Manual Reset Mode

The E-Stop Safety Module is switchable between Auto and Manual reset (the factory setting is Manual). When Manual reset is selected, the E-Stop Safety Module may be reset only by a manual Reset switch. When Auto reset is selected, the Safety Module automatically resets whenever power is applied to the device, or at the moment when all E-stop and Monitor inputs become closed. (The manual Reset switch is ignored when Auto reset is selected.) Regardless of which reset method is selected, the E-stop cannot be started unless all starting prerequisites have been met (power to the system, and all E-stop and monitor inputs closed).

To select reset mode, open the Module cover and remove the green Reset Mode selector from the black socket. Reinsert the Reset Mode selector so that the mode you select (either AUTO or MANUAL, one printed on each side of the Reset Mode selector) is facing up. (See Figure 6.)

In all cases, the user must ensure that closing the Emergency Stop switch (in Auto reset) or manually resetting the E-Stop Safety Module does not initiate a restart (per NFPA 79 Section 9.6.3).

Figure 6. Selecting Auto or Manual Reset

4.5 Selecting the Autobaud Feature

The model ES-TA-3F1 E-Stop Safety Module has an autobaud feature which allows for automatic recognition of the baud rate on the network into which the Safety Module is installed. This convenient feature automatically matches the Safety Module baud rate to the network without requiring a baud rate configuration step. The autobaud feature is set to ON at the factory. When the autobaud parameter is set to ON, the baud rate parameter may not be set via the DeviceNet network. The autobaud parameter may be turned off by setting the DeviceNet autobaud parameter to OFF (see the EDS file for path information). When the autobaud parameter is set to OFF, the baud rate parameter may be set via the DeviceNet network to the desired baud rate.

To determine if autobaud is set to ON, power (at the DeviceNet power inputs) the E-Stop Safety Module while it is not connected to the DeviceNet network; the Bus Status Indicator will flash green, then red, then OFF in a repetitive sequence. If autobaud is set to OFF, then the Bus Status Indicator will flash green (or red) after the initial green/red sequence at power up.

IMPORTANT . . .
Check Each Switch Individually

Check ALL Emergency Stop switches, individually, during each checkout procedure. When two or more Emergency Stop switches are used, each switch must be individually actuated (engaged), then re-armed and the E-Stop Safety Module reset. This allows the E-Stop Safety Module to check each switch and its wiring to detect faults.

4.6 Initial Checkout Procedure

1) IMPORTANT: Ensure that there are no connections at terminals 55/27 and 56/28.

2) Close all E-stop inputs. Ensure all monitoring inputs are closed and that the Reset input is open. (Refer to Figure 3.)

3) Apply input power to the E-Stop Safety Module at terminals 1 and 29. Verify that K1, K2 and Reset indicators are OFF. Verify that all E-stop and monitor indicators are ON. (If Auto/Manual Reset selector is set to Auto mode, verify that K1, K2 and all E-stop indicators are ON; Reset and all monitor indicators are OFF.)

4) Close the Reset input (if Auto/Manual Reset selector is set to AUTO mode, go to step 5). Verify that the Reset and K1 LED indicators go ON. K2 indicator should remain OFF. Open the Reset switch and verify that the Reset indicator is OFF. The K1 and K2 indicators should both be ON at this time. If the K2 indicator comes ON before the Reset switch is opened, disconnect the input power and check all wiring. Return to step 2 after the cause of any problem has been corrected.

5) Activate one Emergency Stop switch (open its contacts). The K1 and K2 indicators should turn OFF, simultaneously. If either indicator does not go OFF, check the E-stop indicators. (The indicators for the activated Emergency Stop switch should be OFF, as well as indicators for E-stops with higher numbers. For example, if E-stop #6 is activated, the indicators for #6, #7, #8, #9 and #10 should all go OFF simultaneously.) If all E-stop indicators are OK but either or both K1 and K2 indicators are ON, disconnect the input power and check all wiring. Return to step 2 after the cause of the problem has been corrected.

6) Repeat the above checkout procedure for each E-stop switch, individually (ES1 through ES10).

4.7 Connection to the Machine to be Controlled

The hookup diagram (Figure 3) shows a generic connection of the ES-TA-3F1 E-Stop Safety Module's two redundant output circuits to Master Stop Control elements MSC1, MSC2, MSC3 and MSC4. A Master Stop Control element is an electrically powered device, external to the Safety Module, which stops the machinery being controlled by immediate removal of electrical power to the machine and (when necessary) by applying braking to dangerous motion (reference ANSI B11.19, section 5.2: "Stop Control"). This stopping action must be accomplished by removing power to either Master Stop Control element.

To satisfy the requirements of Safety Category 4 of prEN 954-1, the Master Stop Control elements must offer a normally closed, force-guided monitor contact. One normally closed monitor contact from each Master Stop Control element is wired to the appropriate terminals on the module (see Figure 3). In operation, if any of the Master Stop Control elements fails to de-energize, the associated monitor contact will remain open. As a result, it will not be possible to reset the E-Stop Safety Module.

NOTE: If less than four MSC elements are controlled by the E-Stop Safety Module, jumper the unused monitor inputs to simulate a closed contact. See NOTICE Regarding MSC Monitor Hookup, at right.

Apply power to the machine control elements and perform the Periodic Checkout Procedure (see section 5.2).

CAUTION . . .
Dangerous Voltage

Before performing the initial checkout procedure, make certain all power is disconnected from the machine to be controlled. Dangerous voltages may be present along the E-Stop Safety Module wiring barriers whenever power to the machine control elements is "ON". **Exercise extreme caution whenever machine control power is or may be present. Always disconnect power to the machine control elements before opening the enclosure housing of the E-Stop Safety Module.**

NOTICE Regarding MSC Monitor Hookup

It is strongly recommended that one normally closed auxiliary contact of each Master Stop Control element (MSC) be wired as an MSC monitor contact, as shown in Figure 3. If this is done, any inconsistency of action between the MSCs will create a fault condition, which will prevent the E-Stop Module from resetting.

SECTION 5 – Operating Instructions

5.1 Security Protocol

The model ES-TA-3F1 E-Stop Safety Module should be mounted inside a lockable enclosure. For security reasons, the key to the lockable enclosure must be in the possession of a Qualified Person or Persons. A Qualified Person is a person who, by possession of a recognized degree or certificate of professional training, or who, by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve problems relating to the subject matter and work (ANSI B30.2-1983).

The key to the Reset switch (if the Reset switch, as installed, requires a key) should be available to a Designated Person or Persons. A Designated Person is one who is identified and designated in writing, by the employer, as being appropriately trained and qualified to perform a specified checkout procedure. A machine operator who meets these requirements may be a Designated Person.

5.2 Periodic Checkout Requirements

The functioning of the Emergency Stop system (including the E-Stop Safety Module and the guarded machine) must be verified on a regular periodic basis to ensure proper operation (see also the machine manufacturer's recommendations).

Procedure:

1) With the machine running, activate one Emergency Stop switch (open its contacts). Verify that the machine stops. (The K1 and K2 indicators should turn OFF simultaneously. If either indicator does not go OFF, check the E-stop indicators. The indicators for the activated Emergency Stop switch should be OFF, as well as indicators for E-stops with higher numbers. For example, if E-stop #6 is activated, the indicators for #6, #7, #8, #9 and #10 should all go OFF simultaneously.) If all E-stop indicators are OK but either or both K1 and K2 indicators are ON, disconnect the input power and check all wiring. Repeat this step after the cause of any problem has been corrected.

2) Return the Emergency Stop switch to its closed-contact position. Close and open the Reset switch (if the controller is in Auto Reset mode, this action is not necessary). The machine must not start at this point. Initiate the machine startup procedure (per manufacturer's instructions). Verify that the machine restarts in correct sequence.

3) Repeat the above checkout procedure for each E-stop switch, individually (ES1 through ES10).

5.3 Normal Operation

Following are examples of LED status indication and DeviceNet information for typical E-Stop Safety Module RUN, STOP, and FAULT conditions.

5.3.1 RUN Condition

The following LED status represents a normal run condition, where all E-stop switches are closed, and the E-Stop Module has been reset so that K1 and K2 output contacts are closed:

A normal RUN condition is reported to DeviceNet as follows:

Operating mode:	OK (Go)
E-stop Inputs:	All Closed
Monitor Inputs:	Mon 1 Open (NOTE: unused, jumpered monitor contacts will not be listed as open)
Reset Mode:	Manual Reset (or Auto Reset, depending on selection)
Reset Input:	- - - - - - (or Disabled if in Auto Reset mode)
K1 Relay:	Energized
K2 Relay:	Energized
Autobaud:	On (or Off, depending on selection)
Fault Type:	No Fault
Action 1:	- - - - - -
Action 2:	- - - - - -
Action 3:	- - - - - -

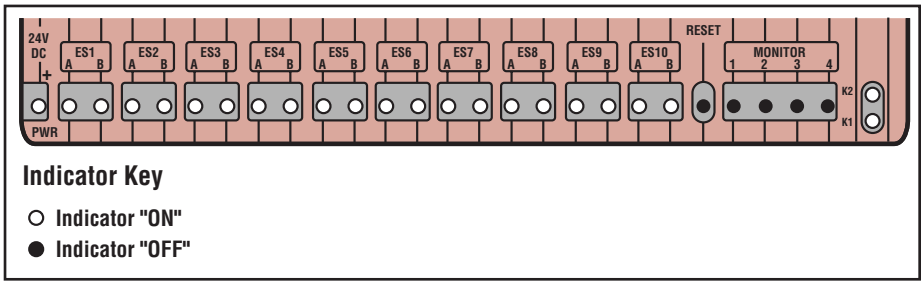

Figure 7. Indicator status for normal RUN condition

5.3.2 STOP Condition

If any E-stop switch is actuated during a normal run condition, the output contacts of K1 and K2 will open. The following LED status illustrates a situation where E-stop switch ES3 has been actuated:

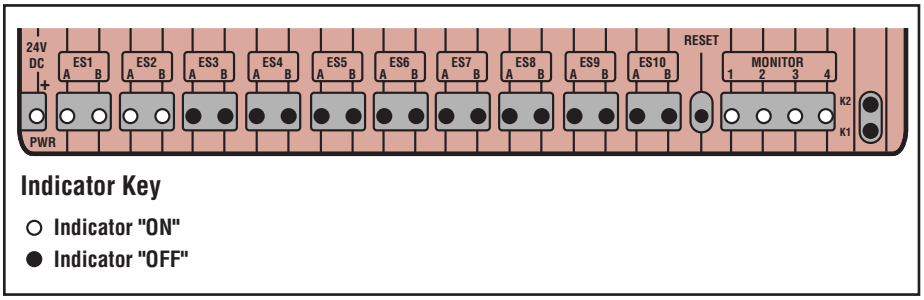

Figure 8. Indicator status for STOP condition (E-stop switch ES3 is actuated)

When the E-stop switch is reset, (ES3 in this example), the indicator lights for ES3, ES4, ES5, ES6 ,ES7, ES8, ES9 and ES10 will come back ON.

K1 and K2 will close and their LED indicators will come ON:

1) After the Reset switch is closed and then opened (Manual Reset mode) or,

2) Immediately upon resetting ES3 (Auto Reset mode).

A STOP condition created by actuation of E-stop switch ES3 is reported to DeviceNet as follows:

Operating mode:	Stop Condition
E-stop Inputs:	E-Stop 3 Open
Monitor Inputs:	All Closed
Reset Mode:	Manual Reset (or Auto Reset, depending on selection)
Reset Input:	Open (or Disabled if in Auto Reset mode)
K1 Relay:	De-energized
K2 Relay:	De-energized
Autobaud:	On (or Off, depending on selection)
Fault Type:	No Fault
Action 1:	- - - - - -
Action 2:	- - - - - -
Action 3:	- - - - - -

5.3.3 FAULT Condition

The following status indication illustrates a typical fault condition in which one switch contact remains closed when an E-stop switch is actuated. This example illustrates the situation where contact “B” of switch ES4 fails, closed:

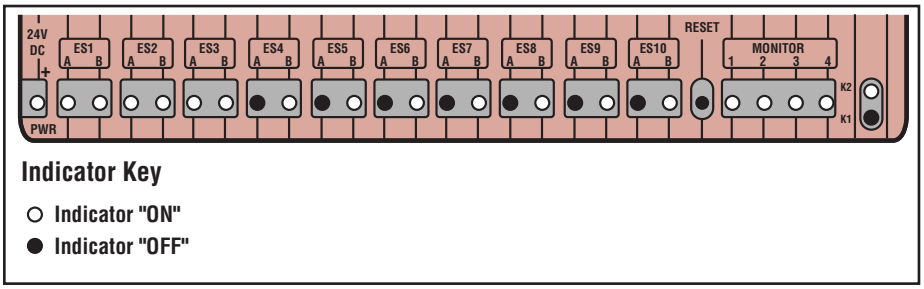

Figure 9. Typical indicator status for FAULT condition (contact “B” of E-stop switch ES4 remains closed upon actuation)

A FAULT condition created by failure of contact “B” of E-stop switch ES4 is reported to DeviceNet as follows:

Operating mode:	Fault Condition
E-stop Inputs:	4A Open 4B Short
Monitor Inputs:	All Closed
Reset Mode:	Manual Reset (or Auto Reset, depending on selection)
Reset Input:	Open (or Disabled if in Auto Reset mode)
K1 Relay:	De-energized
K2 Relay:	Energized
Autobaud:	On (or Off, depending on selection)
Fault Type:	E-Stop 4 Fault
Action 1:	Check E-Stop 4
Action 2:	New Relay Board
Action 3:	New Comm. Board

SECTION 6 — Troubleshooting

Use the indicator LEDs on the E-Stop Safety Module to diagnose fault type (see Section 5.3). Use your DeviceNet Manager as a troubleshooting aid. Also, see the most current Electronic Data Sheet (EDS) file; it assigns a number to a specific text string that will be helpful in troubleshooting problems.

6.1 General E-Stop Module Faults

Fault Type	Cause	Recommended Action
E-stop input fault	1 input shorted, 1 input open	Check E-stop inputs Replace Power Supply PC board Replace Communication PC board Replace Interconnection PC board
Reset input fault	Shorted input on power up	Check Reset input Replace Power Supply PC board Replace Communication PC board
Monitor input fault	Open input on power-up or after stop	Check for open Monitor inputs Replace Power Supply PC board Replace Communication PC board
Output relay fault	Internal circuit failure	Replace Relay PC board Replace Communication PC board
Power fault	No power or power supply failure	Check power, LED working? Replace Relay PC board Replace Communication PC board
Auto Reset fault	Missing selector card or Internal circuit failure	Check missing Auto Reset selector card Replace Power Supply PC board Replace Communication PC board

The ES-TA-3F1 E-Stop Safety Module also features a self-contained provision for troubleshooting; indicator LEDs on the front cover provide clues to possible faults. If the circuit is working properly, the Power LED should be ON, and the individual indicator lights for each Emergency Stop switch input should remain ON.

If one of the Emergency Stop switches connected to the circuit has been activated, its indicator on the front panel of the module will go OFF; in addition, each indicator to the right of it on the panel will also go OFF. (For example, if switch #4 has been activated, the indicators for switches 4, 5, 6, 7, 8, 9 and 10 will be OFF.)

To reset, begin by verifying that the problem prompting the E-stop procedure has been corrected. The E-stop switch indicator, and all those to the right of it on the control module front panel, should go ON. Then activate the Reset switch connected to the E-Stop Safety Module, and reset the E-stop switch indicated by the first LED to be OFF, reading from left to right on the control panel. (For example, if switch #4 has been activated, the indicators for switches 4, 5, 6, 7, 8, 9 and 10 will be OFF; start by resetting switch #4.) Verify that all monitor indicators are ON. (If one of the monitor inputs is open, its indicator will go OFF; in addition, each monitor indicator to the right of it will also go OFF. For example, if monitor 2 is open, the indicators for monitor 2, 3 and 4 will be OFF.)

If any of the E-stop switch indicators remain OFF, repeat this step with the next E-stop switch indicator (again, the first/left-most unlit LED on the front of the module control panel).

NOTE: After a successful reset, both of the K1/K2 indicators should be ON. If not, the E-Stop Module has an internal fault and should be returned to the factory for repair.

6.2 E-Stop Module Faults Specific to DeviceNet

ES-TA-3F1 Network Status Indicator	Description	Recommended Action
Green ON Steady	On line, connected/allocated to master	No action required.
Green Flashing	On line, not connected/allocated to master; If autobaud is ON, address and baud rate ok	1) Connect/allocate the device to the master. 2) Check that all connectors and wiring are correct and tightly connected. 3) Check that the overall network is functional by connecting to some other device on the same DeviceNet network. 4) If autobaud is turned OFF, set the autobaud parameter (offline) to ON or set the MAC ID switches to a value known not to be in use and offline try to connect at 125K (factory default), then 250K, then 500K baud until successful. If unsuccessful, repeat step 2.
Red ON Steady	Critical network fault or duplicate node address detected	1) Check to ensure that no other device on the network has the same MAC ID (network address). Each DeviceNet device must have a unique MAC ID. Use the MAC ID address switches (set at 00 to 63) or set the MAC ID over the network by setting MAC ID parameter to the desired value (the MAC ID switches must be set to 64 or higher to allow setting of the MAC ID via the network.) 2) If autobaud is turned OFF, check that the configured baud rate matches the baud rate of the network. 3) Ensure that the DeviceNet network is properly terminated and grounded per DeviceNet specifications. 4) Check for insufficient network power supply.
Red Flashing	Connection timeout or no power to E-Stop Safety Module	1) Check input power to the E-Stop Safety Module. 2) Check DeviceNet I/O connection time out expected packet rate (EPR) parameter setting and/or problem with DeviceNet master.
OFF	No network power or off line	1) Check the DeviceNet connector(s) for proper supply voltage and wiring for loose or incorrect connections.
Green/Red/OFF	Autobaud detecting network baud rate.	1) Check that all connectors and wiring are correct and tightly connected. 2) Check that the overall network is functional by connecting/allocating to some other device on the same DeviceNet network. 3) Create repetitive network communication to some other device on the same DeviceNet network. This will allow detection of the baud rate.

ES-TA-3F1 MAC ID Indicator	Description	Recommended Action
ON Steady	MAC ID address is controlled by the master.	No action required.
Flashing	The address indicated by the MAC ID switches does not match the current address. This indicates that the switch setting has been changed with the device on. This is normal if the user is in the process of changing the address.	1) If switches have been changed, return the switches to the correct address (the indicator will stop flashing). 2) If trying to change the address, complete the address change procedure.
OFF	MAC ID address is controlled by the MAC ID switches.	No action required.

Figure 10. Gently pry up each of the five wiring barriers.

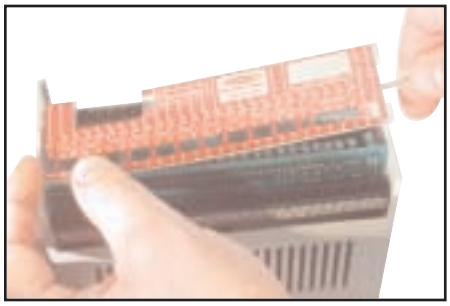

Figure 11. Remove the cover.

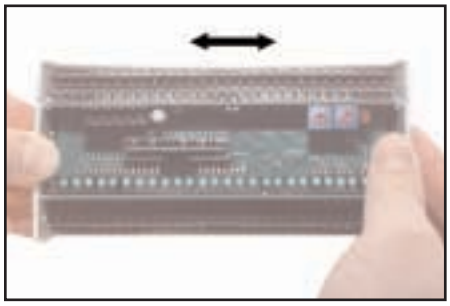

Figure 12. Gently push the sides of the module outward.

SECTION 7 – Repairs

Board Replacement

In some cases, it may be possible to repair your Module by replacing one or more of its boards. See the chart below for the proper replacements and the installation instructions that follow.

Replacement Circuit Boards	Model No.	Part No.
Replacement Power Supply and Relay board	**ESD-PST-2**	55706
Replacement Communication board with DeviceNet	**ESD-AB-2D**	55705
Replacement Interconnection board	**ESD-IB-2**	55704
Replacement Reset Mode Selector	**ESD-JB-1**	54994

Removing the Circuit Boards

1) Remove the five wiring barriers (leaving the wires connected to them, if possible) by gently prying each barrier up and off, using a flat-blade screwdriver (Figure 10).
2) Remove the cover by placing your thumb and index fingers opposite each other at the center of the cover. Place your index (first) finger on the edge of the cover. Pull upward on the cover center, while your index finger holds the cover edge down. Pull until the cover edge clears the slots in the housing.
3) Gently push the sides of the module housing outward (at the top corners) to dislodge the four locking tabs (on the two circuit boards) from the slots on the sides of the housing (Figure 12). Pull the assembly of the three circuit boards straight out of the module housing.
4) Disconnect the circuit boards from one another (Figure 15).

Installing the Replacement Circuit Boards

1) The boards install in reverse order: first connect all three circuit boards together.

2) Align the board edges with the slots on the Module walls (use the slots which are closest to the vented Module walls). Slide the three-board assembly into the Module. Apply pressure on the top edge of the boards until the locking tabs on the boards engage the slots on the housing. Squeeze the sides of the housing to fully engage the tabs into their slots (Figure 13).

3) Replace the Module cover by holding the center of the cover between your thumb and fingers. Place your index (first) finger on the edge of the cover. Insert the tabs of the cover opposite your index finger into the slots on the housing. While holding the center of the cover in an arc, insert the tabs of the other edge into the slots; press the center of the cover into place until it is flat.

4) Remount the Module and replace the wiring barriers by pushing them down into their receptacles. Take care to match the terminal labels on the wiring barriers with the terminal labels on the board headers.

If it ever becomes necessary to return an E-Stop Safety Module to the factory, please do the following:

1) Contact the Banner Factory Application Engineering Group at the address or at the numbers listed at the bottom of the back page. They will attempt to troubleshoot the system from your description of the problem. If they conclude that a component is defective, they will issue an RMA (Return Merchandise Authorization) number for your paperwork, and give you the proper shipping address.

2) Pack the E-Stop Safety Module carefully. Damage which occurs in return shipping is not covered by warranty.

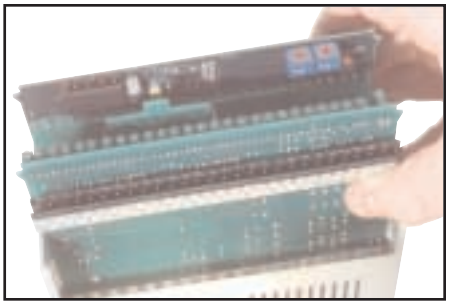

Figure 13. Pull the three-circuit board assembly from the housing.

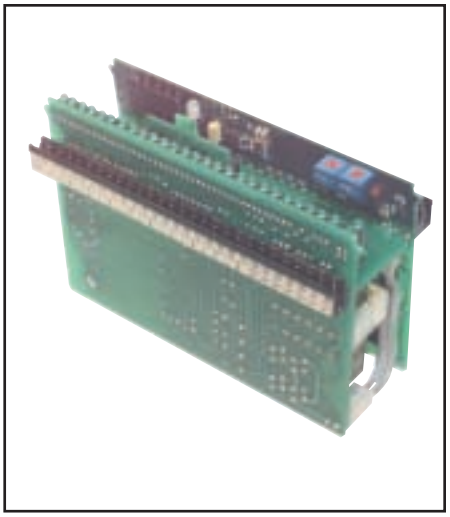

Figure 14. Three-circuit board assembly.

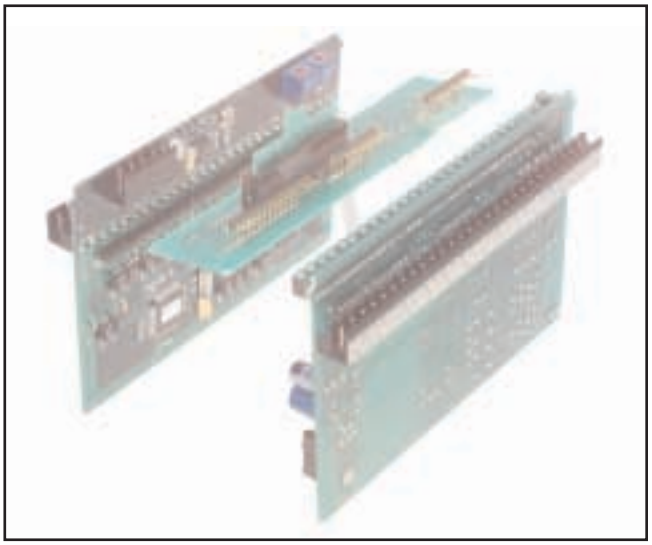

Figure 15. Disconnect the circuit boards from one another.

WARNING . . .
For Information Monitoring Only

NEVER use the DeviceNet™ data to control a safety-related function. DeviceNet™ information must be used for non-safety monitoring purposes, only. **To do so creates an unsafe condition which could lead to serious injury or death.**

SECTION 8 – DeviceNet

8.1 Information Communicated to DeviceNet

Module Status	OK (GO) Power-Up Stop Condition Fault
E-Stop Inputs Status	All Closed E-Stop X Open (Where X is 1, 2, 3, 4, 5, 6, 7, 8, 9 or 10. Only one open input is reported at a time.) Fault (Input number and status of both circuits for that input; i.e., 1A Open, 1B short)
Monitor Inputs Status	All Closed Monitor X Open (Where X is 1, 2, 3, or 4. Only one open input is reported at a time.)
Reset Mode	Auto Reset or Manual Reset*
Reset Input Status	Open, Closed or Disabled (Reset Input is disabled in Auto Reset mode)
Output Module Status	K1 Energized or De-energized K2 Energized or De-energized
Diagnostic Information	Fault Type Troubleshooting Suggestions
Autobaud	ON* or OFF

* Factory setting

8.2 DeviceNet Specifications

Power Requirements	11 to 25V dc; 80 mA (supplied by DeviceNet network)		
Bus Status Indicator	**A bi-colored (red/green) LED visible on the control module indicates network status:**		
	Green	Steady	On line, connected/allocated to master
		Flashing	On line, not connected/allocated to master; if Autobaud is ON, address and baud rate ok
	Red	Steady	Critical network fault or duplicate node address detected
		Flashing	Connection timeout or no power to light screen
	Green/Red	OFF	No network power or off line
	Green/Red/OFF	Flashing Sequentially	Autobaud detecting network baud rate
Vendor Code	12 (Banner Engineering Corp.)		
Device Type	131 (E-Stop Safety Module)		
Connection Types Supported	Explicit Message, Poll, COS (Change of State)		
Product Code	1 (10-Input E-Stop Module)		
Network Address	0-63 (Manual switches or Network configured)		
Baud Rate Supported	Autobaud or Network configured (125K, 250K, 500K) Factory setting is Autobaud ON.		
EDS File Part Number	52243	NOTE: EDS and Bitmap files on 3.5" floppy disk supplied with controller (part number 52243). For custom EDS files or Bitmap files contact Banner Applications Department	
EDS File Name	131_1_1.eds		
Bit Map Icon File Name	131.bmp		

8.3 POLL & COS I/O Assembly Instances

Device I/O assemblies consist of:

- **Poll:** One product specific input assembly containing operating mode, status of E-stop inputs, status of Monitor inputs, status of Reset Mode, status of Reset input, status of output relays (K1 and K2), Autobaud setting and Fault type.
- **COS:** One product-specific input assembly containing the operating mode only.

8.4 I/O Assemblies Data Attribute Format

Assembly instance 1 is used as the response data for the **Poll** command. Produced connection size of 4 bytes. Consumed connection size of 0 bytes.

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	E-Stop Inputs					Operating Mode		
1	Reset Mode Invalid	Reset Mode	Reset Input Invalid	Reset Input	K1 Relay Invalid	K1 Relay State	K2 Relay Invalid	K2 Relay State
2	Reserved	Autobaud	Reserved	Monitor Input Invalid	Monitor Input 4	Monitor Input 3	Monitor Input 2	Monitor Input 1
3	Reserved	Reserved	Reserved	Fault Type				

Assembly instance 2 is used as the response data for the **COS** command. A COS command is issued in response to a change in the E-Stop Module operating mode. Produced connection size of 1 byte. Consumed connection size of 0 bytes.

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	E-Stop Inputs					Operating Mode		

E-Stop Inputs
0: All E-Stops are closed.
1: E-Stop 1 is open.
2: E-Stop 2 is open.
3: E-Stop 3 is open.
4: E-Stop 4 is open.
5: E-Stop 5 is open.
6: E-Stop 6 is open.
7: E-Stop 7 is open.
8: E-Stop 8 is open.
9: E-Stop 9 is open.
10: E-Stop 10 is open.
11: E-Stop 1A is open, 1B is short.
12: E-Stop 1A is short, 1B is open.
13: E-Stop 2A is open, 2B is short.
14: E-Stop 2A is short, 2B is open.
15: E-Stop 3A is open, 3B is short.
16: E-Stop 3A is short, 3B is open.
17: E-Stop 4A is open, 4B is short.
18: E-Stop 4A is short, 4B is open.
19: E-Stop 5A is open, 5B is short.
20: E-Stop 5A is short, 5B is open.
21: E-Stop 6A is open, 6B is short.
22: E-Stop 6A is short, 6B is open.
23: E-Stop 7A is open, 7B is short.
24: E-Stop 7A is short, 7B is open.
25: E-Stop 8A is open, 8B is short.
26: E-Stop 8A is short, 8B is open.
27: E-Stop 9A is open, 9B is short.
28: E-Stop 9A is short, 9B is open.
29: E-Stop 10A is open, 10B is short.
30: E-Stop 10A is short, 10B is open.
31: E-Stop status is unknown.

Operating Mode
0: Power-Up
1: OK (Go)
2: Stop Condition
3: Fault
4: Operating mode is unknown.

Reset Mode Invalid
0: The reset mode is known.
1: The reset mode is unknown.

Reset Mode
0: The reset mode is manual.
1: The reset mode is automatic.

Reset Input Invalid
0: The status of the reset input is known.
1: The status of the reset input is unknown/disabled.

Reset Input
0: The reset input is open.
1: The reset input is closed.

K1 Relay Invalid
0: The state of the K1 relay is known.
1: The state of the K1 relay is unknown.

K1 Relay State
0: The K1 relay is OFF.
1: The K1 relay is ON.

K2 Relay Invalid
0: The state of the K2 relay is known.
1: The state of the K2 relay is unknown.

K2 Relay State
0: The K1 relay is OFF.
1: The K1 relay is ON.

Autobaud
0: Autobaud is OFF.
1: Autobaud is ON.

Monitor Input Invalid
0: The Monitor input status is known.
1: The Monitor input status is unknown.

Monitor Input 1
0: Monitor input 1 is open.
1: Monitor input 1 is closed.

Monitor Input 2
0: Monitor input 2 is open.
1: Monitor input 2 is closed.

Monitor Input 3
0: Monitor input 3 is open.
1: Monitor input 3 is closed.

Monitor Input 4
0: Monitor input 4 is open.
1: Monitor input 4 is closed.

Fault Type
0: No Fault
1: E-Stop 1 Fault
2: E-Stop 2 Fault
3: E-Stop 3 Fault
4: E-Stop 4 Fault
5: E-Stop 5 Fault
6: E-Stop 6 Fault
7: E-Stop 7 Fault
8: E-Stop 8 Fault
9: E-Stop 9 Fault
10: E-Stop 10 Fault
11: Reset Input Fault
12: Monitor 1 Fault
13: Monitor 2 Fault
14: Reserved
15: Monitor 3 Fault
16: Reserved
17: Reserved
18: Reserved
19: Monitor 4 Fault
20: Reserved
21: Reserved
22: Reserved
23: Reserved
24: Reserved
25: Reserved
26: Reserved
27: Output Fault
28: Power Fault
29: Auto Reset Fault
30: The Fault type is unknown

8.5 Additional Information Available through Explicit Messaging

Autobaud Setting:
1 byte message, 0 = OFF, 1 = ON. See EDS file for path information.
Factory setting is ON.

Diagnostic Information:
See EDS file for details regarding Fault Type and Troubleshooting suggestion information.

E-Stop Safety Module – Model ES-TA-3F1

SECTION 9 – Product Specifications

Supply Voltage and Current	24V dc ±15% at 450mA maximum; 10% maximum ripple
Supply Protection Circuitry	Protected against transient voltages and reverse polarity
Output Configuration	**Outputs (K1 and K2):** two redundant (i. e. total of four) safety relay (forced-guided) contacts Contact ratings: Maximum voltage: 250V ac or 250V dc Maximum current: 4A ac or dc (resistive load) Maximum power: 1000VA, 20 watts Mechanical life: 10,000,000 operations Electrical life: 100,000 at full resistive load NOTE: Transient suppression is recommended when switching inductive loads. Install suppressors across load. Never install suppressors across output contacts (see Warning on page 5).
Output Response Time	25 milliseconds maximum
Input Requirements	Emergency stop switch must have two normally closed contacts each capable of switching 20 to 150mA @ 12 to 18V dc. Reset switch must have one normally open contact capable of switching 20 to 150mA @ 12 to 18V dc. Master Stop Control (MSC) Element monitor contacts must be capable of switching 20 to 250 mA @ 12 to 18V dc
Status Indicators	**28 green LED indicators:** Power ON ES1-A ES3-A ES5-A ES7-A ES9-A Monitor-1 Reset K1 energized ES1-B ES3-B ES5-B ES7-B ES9-B Monitor-2 K2 energized ES2-A ES4-A ES6-A ES8-A ES10-A Monitor-3 ES2-B ES4-B ES6-B ES8-B ES10-B Monitor-4 1 Bi-color red/green LED indicator for Bus Status 1 Amber LED Indicator for MAC ID
Enclosure	**Size:** See Figure 2, page 5 **Material:** polycarbonate. Rated NEMA 1, IEC IP20
Mounting	Mounts to standard 35 mm DIN rail track. Safety Module must be installed inside an enclosure rated NEMA 3, IEC IP54, or better.
Vibration Resistance	10 to 55Hz @ .35mm displacement per IEC 68-2-6
Operating Temperature	0° to 50°C (+32° to 122°F)
Dimensions	See diagram, page 10
Certifications	CE UL

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the machine safety specialist

WARRANTY: Banner Engineering Corp. warrants its products to be free from defects for one year. Banner Engineering Corp. will repair or replace, free of charge, any product of its manufacture found to be defective at the time it is returned to the factory during the warranty period. This warranty does not cover damage or liability for the improper application of Banner products. This warranty is in lieu of any other warranty either expressed or implied.