



SFX Product Family

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SFX Product Family

General Information

Warning

Before beginning installation of this product:
Read and follow all installation instructions.
Please contact Eaton immediately if you have any questions.

Note: This manual was written with great care and precision. However, since the potential for error exists, we can provide no assurance of the absolute accuracy of its contents.

Warranty

In order to consistently bring you the highest quality, full featured products, we reserve the right to change our specifications and designs at any time.

A limited warranty is given with these Eaton products. Please see our website for details.
http://www.eaton.com/Eaton/ProductsServices/Hydraulics/WarrantyTermsConditions/PCT_612027

Safety Considerations

Definitions and Symbols



This symbol is the "Safety Alert Symbol".
It occurs with either of two signal words:
CAUTION or WARNING, as described below.

WARNING

Indicates a potentially hazardous situation which, if not avoided, can result in serious injury or death.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, can result in minor to moderate injury, or serious damage to the product. The situation described in the CAUTION may, if not avoided, lead to serious results. Important safety measures are described in CAUTION (as well as WARNING).

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SFX Product Family

1.0 INTRODUCTION

The Eaton SFX product family is a series of advanced, functional safety-rated controllers for use with mobile and industrial equipment. Designed and evaluated in line with IEC 61508 SIL 2 these controllers enable functional safety to be incorporated into a variety of applications (e.g. agricultural, construction, material handling). It is recommended that an individual have experience with functional safety system development and programming within the MATLAB/Simulink & C software environments before using this hardware.

The SFX product family is optimized for reliable operation in severe environments, possessing IP and temperature ratings that exceed existing solutions from competitors. SFX controllers employ several advanced technologies (e.g. I/O with variable configuration architecture, dual processor architecture), enabling simple management and enhancing both ease of use and functionality. These controllers are intended as both a standalone solution, or as the centerpiece to a complete control system that can include other CAN-based devices such as displays and keypads, in applications that require a functional safety solution.

Key Acronyms and Abbreviations

CODESYS	Controller Development System
FW	Firmware
HW	Hardware
IDE	Integrated Development Environment
IP	Ingress Protection
MIL	Malfunction Indicator Lamp
POU	Program Organization Unit
PWM	Pulse Width Modulation
RTS	Run Time System
SIL	Safety Integrity Level
SW	Software

SFX Product Family

2.0 TECHNICAL SPECIFICATIONS

Eaton SFX Controllers

Dimensions	212.61mm L x 134.17mm W x 58.55mm H
Weight	43.2 ounces (1225 grams)
Storage Temperature Range	-40 - +125 °C
Operating Temperature Range	-40 - +105°C
IP Rating	IP67/IP69K
Operating Altitude	0-4000 m
Supply Voltage	6-32 VDC, Nominal operation @ 12 /24 VDC
Reverse Polarity Protection	Integrated
Peak Supply Voltage	36 VDC
Maximum Current	24 A @ 85°C (20 A @ 105°C)
Idle Current 12/24 VDC	<300mA
Standby Current 12/24 VDC	<3.5mA@12V, <2.5mA@24V
Ignition Pin (K15)	Enable/Disable standby mode
Main CPU	Renesas Super H 72546
Frequency	200 MHz
Bit Width	32 Bit
FPU	Integrated on chip
Main CPU Data Memory (RAM retain) (addition to main cpu)	32 Kbyte
Main CPU Flash (ROM program & data combined)	3.75 Mbyte
Main CPU SRAM	256 Kbyte
Main CPU EEPROM	128 Kbyte
Safety CPU	Renesas RH850/P1M
Frequency	160 MHz
Bit Width	32 Bit
FPU	Integrated on chip
Safety CPU Flash (ROM program & data combined)	2 Mbyte
Safety CPU SRAM	128 Kbyte
CAN Specification	2.0A, 2.0B
Baud Rates	50 kb/s, 100 kb/s, 125 kb/s, 250 kb/s, 500 kb/s, 800 kb/s, 1Mb/s
Protocol	SAE J1939
Default Node Address	0 (main processor)/2 (safety processor)
Default Baud Rate	250kb/s
Number of Sensor Supplies	1
Sensor Supply Output Voltage	5 VDC or 10 VDC (configurable)
Sensor Supply Maximum Current	200 mA @ 5VDC, 100 mA @ 10V
Input Type	Analog, Digital, Pull-up or Pull-down resistor (Software configurable)
Analog Input Resolution	12 bits
Accuracy	+/- 1 % FS
Measuring Ranges	0...5 V, 0...10 V, 0...32 V, 0...20 mA (Ratiometric)
Short Circuit Protection	Integrated
Open Circuit Detection	Dependent upon selectable termination
Input Sampling Frequency	1 kHz
Maximum Input Frequency	200 Hz
Switch-on Level	Software configurable
Switch-off Level	Software configurable
Input Type	Frequency Ch 3-4, Digital, Pull-up or Pull-down resistor (Software configurable)
Maximum Input Frequency (FREQ) (0-5 V square wave)	0 Hz...50 kHz* in Freq. mode Note: maximum aggregate is 200 kHz, minimum detectable pulse duration is 20 µsec

SFX Product Family

Maximum Input Frequency (Dig)	
Switch-on Level	Standard switch on at 3.0 V (Software Configurable)
Switch-off Level	Standard switch off at 2.0 V (Software Configurable)
Input Type	Frequency, Ch 3-4, Analog, Pull-up or Pull-down Resistor (Software Configurable)
Analog Input Resolution	9 bits
Accuracy	+/- 2% FS
Measuring Range	0...5 V
Input Type	Variable reluctance Ch 1-2 (Software configurable)
Maximum Input Frequency (FREQ) (0-5 V square or sine wave)	0Hz...25kHz* Note: maximum aggregate is 200 kHz,
Note: phase and duty cycle are not supported by these inputs	minimum detectable pulse duration is 20 µsec
Switch-on Level	Selectable as 2.2 V or self adaptive (input device changes voltage with frequency)
Switch-off Level	Selectable as 0.0 V or 1.0 V
Input Type	Variable Reluctance, Ch 1-2, Analog (Software Configurable)
Analog Input Resolution	9 bits
Accuracy	+/- 15% FS
Measuring Range	0...5 V
Output Type	High Side
Max Amperage	2A
Diagnostics	Open/Short circuit protection
Output Type	Low/High side, H-Bridge (Software configurable)
Max Amperage	4A
Diagnostics	Open/Short circuit protection
Output Type	PWM, High side
Max Amperage	2A
Diagnostics	Open/Short Circuit Protection
PWM Frequency	50 – 2 kHz
Dither Frequency	Configurable
Dither Amplitude	Configurable
Control Range	0.05 - 2 A
Control Resolution	1 mA
Fly Back Protection	Integrated
Duty Cycle Resolution	.01% @ 250 Hz
Output Type	PWM, High Side (Software configurable)
Max Amperage	4A
Diagnostics	Open/Short circuit protection
PWM Frequency	50 – 500 Hz
Dither Frequency	Configurable
Dither Amplitude	Configurable
Control Range	0.05 - 4 A
Control Resolution	1.5 mA
Fly Back Protection	Integrated
Duty Cycle Resolution	.01% @ 250H
Suggested Connector Manufacturer	Deutsch Inc.
Model	DRC23-40PA
Contact Surface	Nickel plated
A Connector Assembly Parts List	Mating connector DRC26-40SA, size 20 solid contacts P/N 0462-201-20141 intended for 20AWG wire, 0462-005-20141 intended for 16-18 AWG wire, size 20 stamped and formed contacts P/N 1062-20-0122 (nickel plated), sealing plug P/N 0413-204-2005
A Connector Tooling Manufacturer	Deutsch
A Connector Hand Tool Part Number	Solid contacts: Service crimper: HST-1561 Production crimper(ratcheting): HDT-48-00 Stamped contacts: DTT-20-00
A Connector Contact Removal Tool	P/N 0411-240-2005
P Connector Assembly Parts List	Mating connector DT06-6S-EP06, size 16 solid contacts P/N 0462-201-16141 intended for 16-20AWG wire, size 16 stamped and formed contacts P/N 1062-16-0122(nickel plated), wedge W6S-P012, sealing plug P/N 0413-217-1605
P Connector Tooling Manufacturer	Deutsch
P Connector Hand Tool Part Number	Solid contacts: Service crimper: HST-1561 Production crimper(ratcheting): HDT-48-00 Stamped contacts: DTT-16-00

SFX Product Family

3.0 KEY FEATURES

- Robust, compact, fully sealed & potted cast aluminum construction
- Completely protected outputs (thermal and overcurrent)
- Reverse polarity protection
- Up to 10 multifunction inputs, depending on model
- Up to 10 multifunction outputs, depending on model
- Diagnostic feedback for short circuit & wire break on all outputs
- Use of proven Deutsch connectors for rigorous IP protection
- Three CAN ports
- Sleep input for improved power management
- Regulated supply for sensors
- One programmable LED status indicator

4.0 SAFETY CONSIDERATIONS

Note: This operating and installation manual is intended for use by a competent programmer, electrician, technician, or engineer. The instructions included in this manual should be read and kept as a reference document prior to initial controller installation and use. Incorrect operation of these controllers can present a significant threat to both individuals and equipment. In the event of an equipment break down, do not attempt to repair the controller as there are no user serviceable parts inside the enclosure. Any evidence of tampering will invalidate the warranty.

The SFX Installation and Operations Manual is intended to be used in conjunction with the SFX Safety Manual

5.0 APPLICATION

This operating and installation manual should be used in conjunction with other SFX manuals in references. Together, this information should form a basis for the simple configuration of the controller and the creation of programs specific to your application needs. Proper operation of the controller is dependent on the program that is created and ultimately downloaded to the hardware, therefore extensive testing is required. Customers programming the controller possess the responsibility of ensuring that both the hardware and software performs as intended with their applications. Applications may need to undergo functional safety life cycle assessment as per guidelines available in safety manual.

Note: That each controller within the SFX product family requires the installation of hardware-specific firmware, description files and libraries before initial use in the application environment.

6.0 HARDWARE DESCRIPTION

The Eaton SFX product line consists of two controller models (SFX12m, SFX20m), each possessing a unique number of I/O. The SFX12m/SFX20m (pictured below) share a common housing.

Each of these units is designed to function over an extended operating range of supply voltage, from 6 – 32 VDC.



SFX12m/SFX20m

The three integrated CAN ports on these units support CAN 2.0B, the first of which also possesses a software configurable termination. An SAE J1939 stack is available. Additionally, the CANLayer2 software library is available for use with CAN bus.

SFX controllers are programmed via CAN using Eaton's Universal Service Tool (UST.)

SFX Product Family

The table below represents an I/O overview of the various SFX controller models.

Controller Model	SFX20m (10 I/O)	SFX12m (6 I/O)
Total Outputs	10	6
Total 2 A channels	6	4
Number of channels supporting function		
PWM	6	4
High Side output	6	4
Total 4 A channels	4	2
Number of channels supporting function		
PWM	4	2
High Side output	4	2
Low Side output	4	2
H-Bridge pair	2	1

Controller Model	SFX20m (10 I/O)	SFX12m (6 I/O)
Total Outputs	10	6
Total frequency channels	4	2
Number of channels supporting function		
High frequency	4	2
Variable reluctance	2	2
Pull-up resistor	4	2
Pull-down resistor	4	2
Total analog channels	6	4
Number of channels supporting function		
0 - 5 V input	6	4
0 - 10 V input	6	4
0 - 32 V input	6	4
4 - 20 mA input	6	4
Pull-up resistor	6	4
Pull-down resistor	6	4
Thermistor	6	4

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The SFX20m incorporates 10 total outputs, comprised of:

- 4 x 4 A channels
- 6 x 2 A channels

Each channel is capable of:

- High Side output
- Open loop PWM
- Closed loop PWM with current control

The 4 x 4 A channels are also capable of Low Side output and can be configured in pairs for H-Bridge operation.

The SFX20m also incorporates 10 total inputs, comprised of:

- 4 x Frequency (2 of which are capable of handling variable reluctance sensors)
- 6 x Analog (0-5 V, 0-10 V, 0-32 V, 4-20 mA, and Thermistor)

All 10 inputs can be configured to add either an internal pull-up or pull-down resistor.

The SFX12m incorporates 6 total outputs, comprised of:

- 2 x 4 A channels
- 4 x 2 A channels

Each channel is capable of:

- High Side output
- Open loop PWM
- Closed loop PWM with current control

The 2 x 4 A channels are also capable of Low Side output and can be configured as a pair for H-Bridge operation.

The SFX12m also incorporates 6 total inputs, comprised of:

- 2 x Frequency (2 of which are capable of handling variable reluctance sensors)
- 4 x Analog (0-5 V, 0-10 V, 0-32 V, 4-20 mA, and Thermistor)

All 6 inputs can be configured to add either an internal pull-up or pull-down resistor.

Both SFX controllers also integrate an internal temperature measurement that can be used with the IEC application environment.

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7.0 SOFTWARE DESCRIPTION

Software for the SFX family of controllers is provided in the form of the SFX Platform Support Package. This is distributed as a .zip file and contains the following elements:

- Firmware files (MOT files): A separate file is provided for each SFX controller model.
- Universal Service Tool(UST): Setup.exe in the Service Tool folder is the installation file.
- ECOM USB Driver: The Service Tool (UST) connects to the SFX over CAN using the ECOM device. This is the driver for that device.

When updating an existing SFX Support Package, it is necessary to update each of the above elements.

8.0 SERVICE TOOL - INSTALLATION AND GETTING STARTED

Refer UST Manual for installation and usage of Universal service tool.

9.0 FIRMWARE

9.1 Install the Firmware

- 9.1.1 The SFX Safety Controller unit is delivered along with pre-certified safety firmware and an application development environment that must be properly used to create executable, embedded software per the SFX User Manual/Programmer Guide. Mis-use and/or alterations to Eaton supplied software and hardware will invalidate the pre-certification of the SFX Safety Controller.
- 9.1.2 Launch the Universal Service Tool if it is not already open. On the main page of the service tool select File->Reprogram Firmware.
- 9.1.3 Select the appropriate firmware to load based on the model of the controller intended for use.

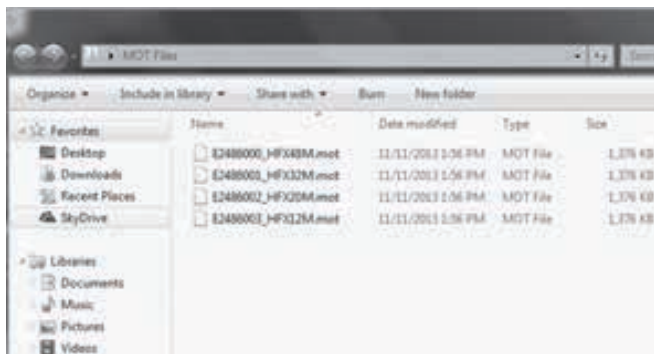
- 9.1.4 The firmware should complete the installation process. If the wrong firmware has been selected, the software will provide a prompt which indicates that the firmware does not match the controller hardware. If this occurs, verify that the correct firmware was selected. The software should then load on the controller and complete installation. You should now be ready to proceed with the application software installation.

10.0 INSTALLING THE CONTROLLER

10.1 Mounting Considerations

The following procedure is recommended when mounting the SFX series controllers.

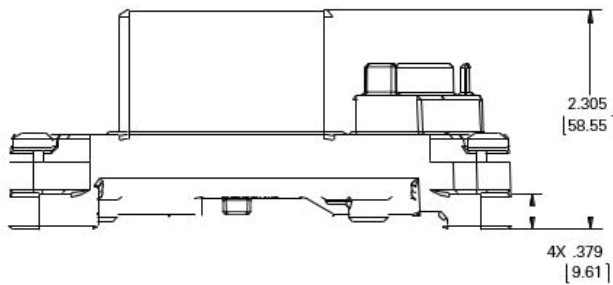
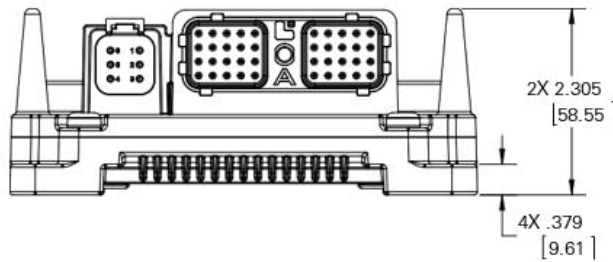
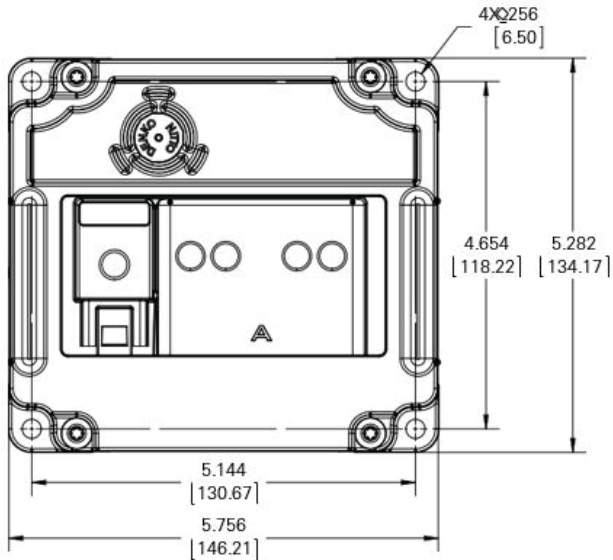
- The controller should be mounted on a vertical flat surface with the open end of the connector facing down.
- Use four standard threaded fasteners to securely mount the controller to the surface (either 6mm or ¼" diameter are acceptable).
- The SFX series is designed for ambient operating temperatures up to 105°C maximum. The housing is constructed of cast aluminum and allows for effective heat dissipation when mounted to metal surfaces and/or when adequate ventilation is available.
- When mounting multiple controllers inside a vented enclosure allow for a minimum of 2" between adjacent controller surfaces so that adequate air flow is present to aid in cooling.
- When mounting a controller(s) inside a sealed unvented enclosure, the temperature rise above ambient is determined by the size of the enclosure (surface area) and the expected power dissipation of the controller(s). A conservative guideline to use for the maximum power dissipation expected from one SFX controller is 50 watts.
- Please check with your enclosure manufacturer for appropriate guidelines concerning the necessary enclosure volume to adequately limit thermal rise below the maximum operating temperature of 105°C



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10.2 Product Dimensions

SFX12m & SFX20m Dimensional Data



11.0 WIRING THE CONTROLLER

11.1 Recommended Wiring Practices

This section contains information about the controller connectors and pin outs. Please use the following recommended wiring practices when installing and using the controller:

- Ensure correct and adequate single point ground to prevent ground loops.
- Use twisted or twisted shielded pair cable for CAN per the applicable standard ISO11899-2.
- Confirm that the CAN network is properly terminated using 120Ω resistors.
- Ensure the appropriate sized conductor cross section is specified for the intended load current in the harness design.

Note: Please review individual overcurrent shutdown values in the configuration and use the correct wire gauge conductor to accommodate maximum load current configured

- Make sure that voltage drops are kept within reasonable levels under maximum continuous load conditions e.g. 1 volt on 12-volt systems and 2 volts on 24-volt systems.
- Verify that the harness is constructed to meet the needs of the application environment (e.g. shock, vibration, moisture, temperature, chemicals, and impact).
- Make certain that the harness is designed and constructed to minimize induced interference resulting from EMI coupling between signal wires.
- Separate power circuits from low-level signals.
- All splices (soldered or crimped) should be covered with adhesive lined heat shrink tubing.
- Make provisions for drip loops to attach devices in exposed locations and prevent moisture entry and formation.
- Provide sufficient clearance from moving parts.
- Wires routed through holes in the vehicle body/chassis should use grommets.
- Avoid sharp metal edges, fasteners, and other abrasive surfaces or use protective shielding when routing harness assembly.
- Route wires to avoid exhaust system components or other high temperature areas, use appropriate heat shielding or other insulation where routing is a problem.
- Avoid routing near wheel wells or provide adequate mechanical protection to the assembly.

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- Use a protective fuse sized appropriately for the controller supply current.

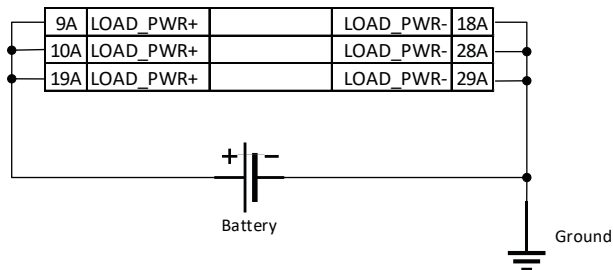
Note: typical maximum load current is 60% - 80% of fuse rating. Verify that wiring can handle more current than the fuse rating. Fuse speed (fast blow / slow blow) depends on the rating of the power supply.

Note the following guideline for maximum fuse recommendations:

- All Units: +VBat = 2 A
- SFX20m: +Load total < 34 A depending upon anticipated load requirements.
- SFX12m: +Load total < 26 A depending upon anticipated load requirements.

WARNING

All SFX Load PWR+ pins (9, 10, and 19) must be connected to the same supply voltage source. All SFX LOAD_PWR- pins (18, 28, and 29) must be connected to the same supply voltage return point. Failure to connect all the pins to their respective sources or returns or to use them to power or ground other devices may cause internal failures of the SFX controller, damage to the controller connector, or damage to the wiring harness, and is not covered by warranty.



WARNING

Prior to Welding

In order to avoid damaging the SFX controller ensure that all electrical connectors are fully disconnected from the SFX controller prior to welding on the machine.

WARNING

Prior to Electrostatic Painting

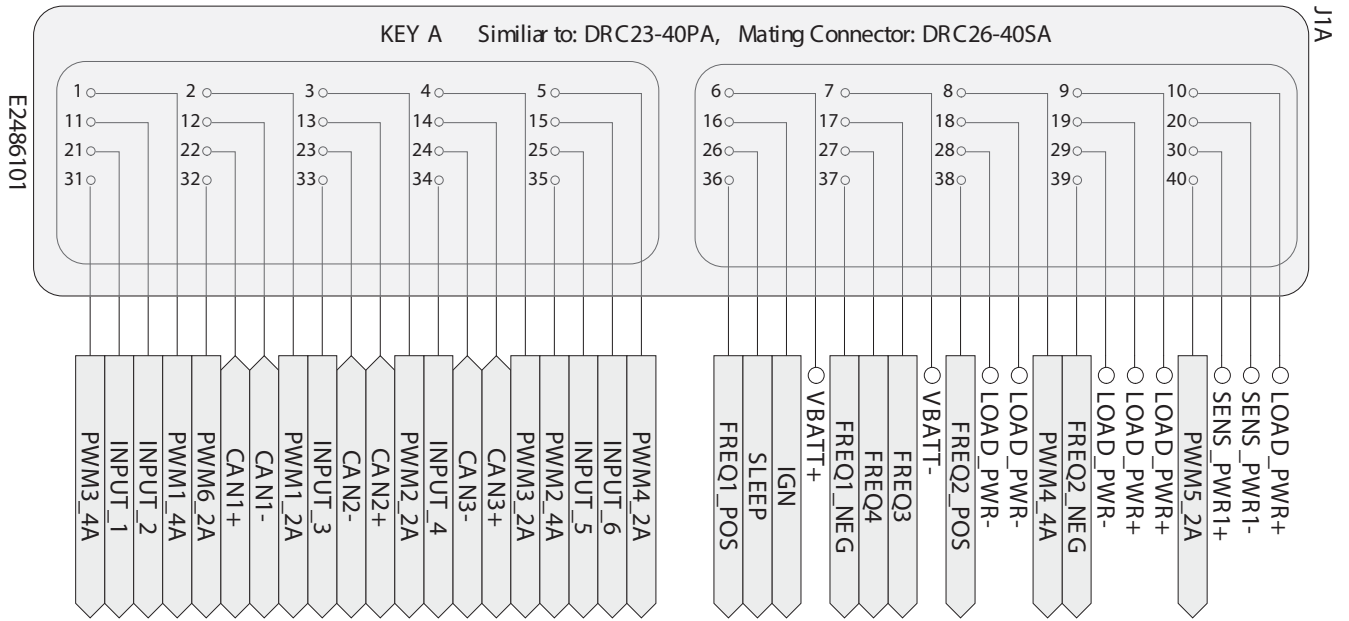
In order to avoid damaging the SFX controller ensure that all electrical connectors are fully disconnected from the SFX controller and sealed mating connectors without wires are installed in the SFX connector ports prior to electrostatic painting on the machine.

CAUTION

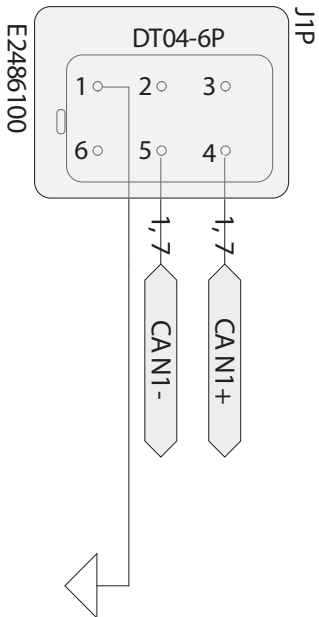
To maintain the environmental ratings of the SFX controller all connector locations must have a weather sealed connector as specified in the technical specifications installed. All connector cavities in each connector must have either an appropriate sized wire or the correct sealing plug installed. Torque the A connector to 25-28 in-lbs (2.82 – 3.16 Nm) A dust plug may be shipped in the C connector of the controller. This is not an environmental seal.

SFX Product Family

11.2 Wiring Pin Out



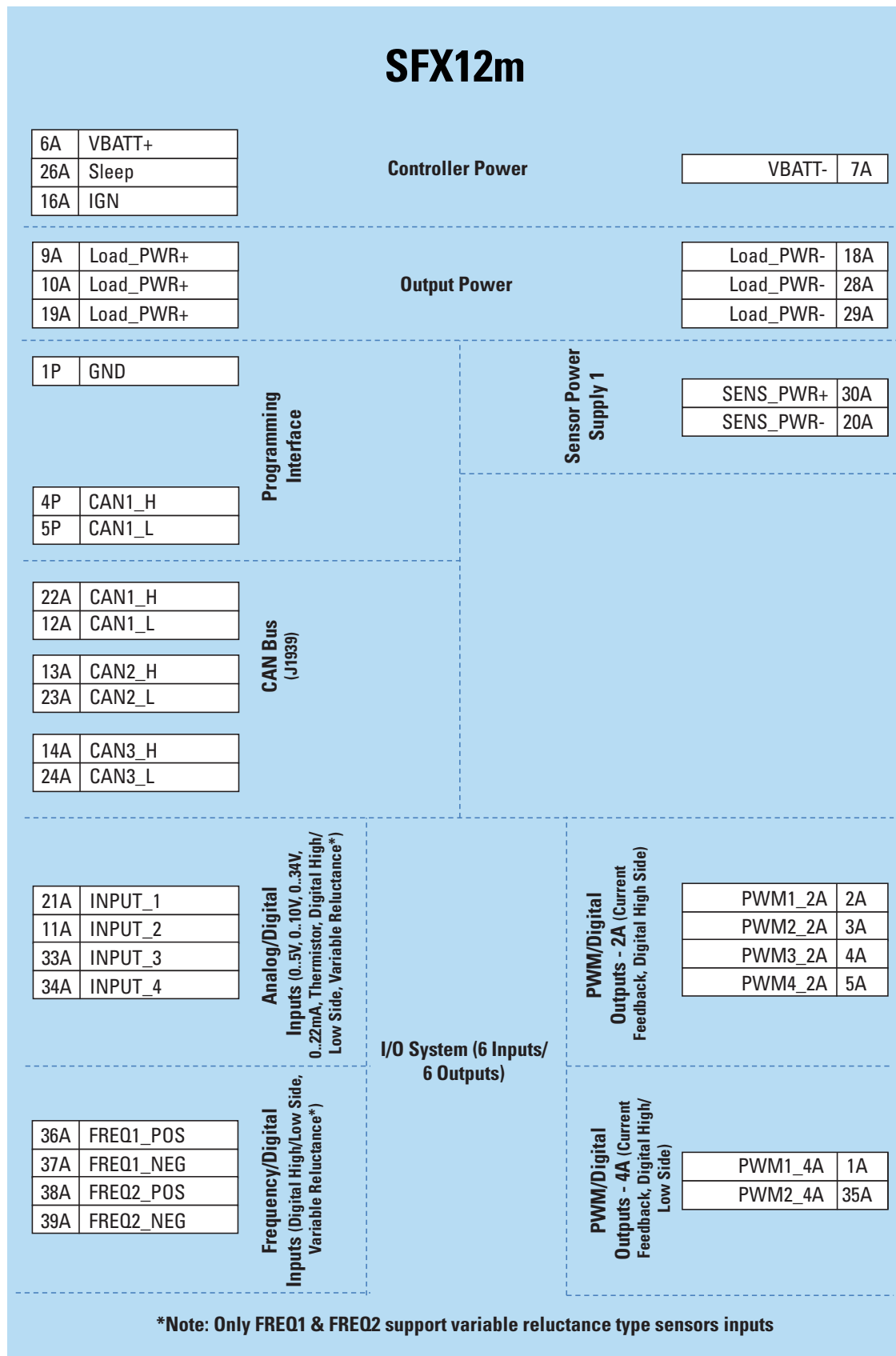
Note: Both SFX units share a common pin-out. The SFX12m does not utilize the following pins: 8, 15, 17, 25, 27, 31, 32, and 40.



The above connector is used for programming and is common to both models of the SFX controller.

SFX Product Family

11.3 Block Diagram



SFX20m

6A	VBATT+
26A	Sleep
16A	IGN

Controller Power

VBATT-	7A
--------	----

9A	Load_PWR+
10A	Load_PWR+
19A	Load_PWR+

Output Power

Load_PWR-	18A
Load_PWR-	28A
Load_PWR-	29A

1P	GND
----	-----

Programming Interface

4P	CAN1_H
5P	CAN1_L

Sensor Power Supply 1

SENS_PWR+	30A
SENS_PWR-	20A

22A	CAN1_H
12A	CAN1_L

CAN Bus (J1939)

13A	CAN2_H
23A	CAN2_L

14A	CAN3_H
24A	CAN3_L

21A	INPUT_1
11A	INPUT_2
33A	INPUT_3
34A	INPUT_4
25A	INPUT_5
15A	INPUT_5

Analog/Digital Inputs

(0..5V, 0..10V, 0..34V, 0..22mA, Thermistor, Digital High/Low Side, Variable Reluctance*)

I/O System (10 Inputs/10 Outputs)

PWM/Digital Outputs - 2A

(Current Feedback, Digital High Side)

PWM1_2A	2A
PWM2_2A	3A
PWM3_2A	4A
PWM4_2A	5A
PWM5_2A	40A
PWM6_2A	32A

36A	FREQ1_POS
37A	FREQ1_NEG
38A	FREQ2_POS
39A	FREQ2_NEG
17A	FREQ3
27A	FREQ4

Frequency/Digital Inputs

(Digital High/Low Side, Variable Reluctance*)

PWM/Digital Outputs - 4A

(Current Feedback, Digital High/Low Side)

PWM1_4A	1A
PWM2_4A	35A
PWM3_4A	31A
PWM4_4A	8A

*Note: Only FREQ1 & FREQ2 support variable reluctance type sensors inputs

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12.0 TESTING AND VALIDATION

Requirement	Specifications
Electrical/EMI/EMC	
2004/104/EU	EU automotive EMC directive
2014/30/EU	E-Mark
EN 61326-1 2013	Industrial CE-Mark
EN ISO 14982 2009	Ag Forestry
EN 13766-2 2016	Earth Moving Machines
EM 50581 2012	ROHS
CISPR 25	Conducted emissions (EU broadband & narrowband limits)
CISPR 25	Radiated emissions (EU broadband & narrowband limits)
ISO 11452-4	Immunity to narrowband conducted elector magnetic energy via bulk current injection
ISO 11452-2	Immunity to narrowband radiated elector magnetic energy via absorption lined chamber
SAE J1113-2:2004	Audio frequency noise immunity
ISO7637-2:2004	Automotive test pulse 1 reference level IV
ISO7637-2:2004	Automotive test pulse 2a, 2b reference level IV
ISO7637-2:2004	Automotive test pulse 3a, 3b reference level IV
ISO7637-2:2004	Automotive test pulse 4 reference level IV
ISO7637-2:2004	Automotive test pulse 5 reference level IV
SAE J1113-12	Chattering relay test
SAE J1113-12	Mutual coupling
ISO 10605:2001 Sect 5.2.2	ESD powered up test - direct contact discharge test level IV
ISO 10605:2001 Sect 5.2.3	ESD powered up test - air discharge test level IV
ISO 10605:2001 Sect 7	ESD unpowered handling - direct contact discharge testlevel IV
ISO 10605:2001 Sect 7	ESD unpowered handling - air discharge test level IV
EN61000-4-2:1995 Sect 8.3.2.1&2	ESD indirect discharge with horizontal and vertical coupling plane method test level IV
SAE J1113-26	Immuniy to A.C. power line electric fields reference +/- 15 kV
SAE J1113-26	Immuniy to A.C. power line magnetic fields reference 40 uT
Mechanical/Environmental	
Storage Temperature Range	-40°C - 125°C
Operating Temperature Range	-40°C - 105°C
Initial Conditioning	-40°C for 24 hours, 105°C for 24 hours
High Temperature endurance	125°C for 200 hours unpowered. After test unit must be functional
Voltage Range	6 V - 32 V
Ignition Cycling	10,000 cycles of 1 minute max supply volt age alternating with 1 minute no voltage at power supply connection.
Thermal Shock	J1455 Section 4.1.3.2; 2 hour -40°C two hour soak, 5 four hour cycles, two hours @ -40°C & two hours @ 105°C
Humidity/Temp Cycling	J1455 Section 4.2.3 Six 48 hour cycle at 20°C to 60°C, 90 - 98% RH

Rain Cycle	100 cycles 1 hour tap water spray, 1 hour 71°C
Thermal Cycling	187 cycles from -40°C to 105°C powered and operating, fully tested afterwards
Brine Ingestion	8 cycles of 1 hour at 105°C followed by 1 hour in brine solution @ 13°C
Hot Plugging	5 cycles connect/disconnect while active
Ingress Potection	IP67/IP69K
Tansit Shock	J1455 Section 4.11.3.2
Vibration	J1455 Section 4.10.4.1/5.82Grms, 8 hours per axis
Shock	J1455 Section 4.10.4/6+/-pulses, 50 G's, 6 ms
Fluid Compatibility	J1455 Section 4.4.3
Dust	J1455 Section 4.7.3/IEC529
Thermal Shock	J1455 Section 4.1.3.2
Handling Drop Test	J1455 Section 4.11.3.1/ 1 meter drop on concrete on each of 6 box faces
Salt Spray	J1455 Section 4.3.3
Wash Down	J1455 Section 4.5.3/4.83MPa, 11.4 l/min, 10.2 cm away, 2 minutes duration
Ice	3 cycles (stabilize -20°C then submerge in 0°C water, then -20°C)
Maximum Voltage	168 hours at 105°C with 16 VDC
Salt Fog	ASTM-B117/96 hours at 35°C 5% NaCl
Short Circit	Short each pin to supply and ground in powered state
Steam Clean	5.7 l/min 2.41 Mpa 20 -30 cm distance for 375 cycles
Tri-Temperature Functional	1, 24 hour cycle form -40°C to +105°C
Chemical Compatibility	See list below
Temperature Destruct Test	Increase temperature until unit is destroyed (dwell at max for 10 minutes, bring down to room temp and repeat cyclically)

SFX Product Family

13.0 DEVICE COMMUNICATION TROUBLESHOOTING

The following is a list of things to check, in order of priority, if you are having problems connecting to your controller using the Universal service tool.

Make sure the device is powered up. You should see a green light on LED A of the device. It is okay if this is flashing (this just means the controller is currently in run mode).

If the green light on LED A is not on:

1. Verify power is connected to VBATT+ on the SFX.
2. Verify power return is connected to VBATT- on the SFX.
3. If the application is using the ignition pin, verify the ignition pin is connected to power.
4. If the application is using the sleep pin, verify the sleep pin is connected to VBATT-.

If communication issues persist:

1. Verify all devices are connected.
2. Verify all devices are communicating at the same baud rate.
3. Verify the correct node IDs are being used.
4. Verify the correct CAN network termination.
With power off a properly terminated CAN network should measure 60Ω between CAN_H and CAN_L. This is usually implemented with two 120Ω terminating resistors, one at each end of the CAN network backbone.
 - a. If resistance $<50\Omega$ is measured more than two 120Ω terminating resistors are likely present on the CANbus. Find and remove one terminating resistor.
 - b. If resistance $>70\Omega$ is measured only one 120Ω terminating resistor is likely present on the CAN network. Add a second terminating resistor in an appropriate location.

Note: CAN1 on the SFX has a switchable internal 120Ω terminating resistor. If this is being used CAN1 should measure 120Ω when properly terminated.

5. Verify the CAN_H and CAN_L lines have not been crossed.
6. With the CAN network active measure from CANH to VBATT- and CANL to VBATT-.

- a. If < 2 volts, the respective CANH or CANL conductor may be shorted to VBATT- or chassis ground. Find and fix the short, then retest the CAN communication;
- b. 2.0-3.0 volts is normal;
- c. If >3.0 volts the respective CANH or CANL conductor may be shorted to VBATT+. Find and fix the short, then retest the CAN communication

Note: voltage between CANH and CANL will vary between 0.45 and 0.95 volts when operating correctly.

14.0 DEVICE RECOVERY

If the SFX becomes non-responsive due to an application issue or incorrect CAN configuration, the SFX may need to be recovered. To recover the SFX, first power off the SFX. Attach the service tool, and short PWM1_2A AND PWM2_2A to VBAT (must be > 11 V). Then power on the system with the service tool running and attempt to connect within 3 seconds after power-on. Connecting PWM1_2A and PWM2_2A at power on will prevent the application from running and provides an opportunity to load a different application.

Eaton
Hydraulics Group USA
14615 Lone Oak Road
Eden Prairie, MN 55344
USA
Tel: 952-937-9800
Fax: 952-294-7722
www.eaton.com/hydraulics

Eaton
Hydraulics Group Europe
Route de la Longeraie 7
1110 Morges
Switzerland
Tel: +41 (0) 21 811 4600
Fax: +41 (0) 21 811 4601

Eaton
Hydraulics Group Asia Pacific
Eaton Building
No.7 Lane 280 Linhong Road
Changning District,
Shanghai 200335
China
Tel: (+86 21) 5200 0099
Fax: (+86 21) 2230 7240

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