Eaton HFX Product Family Installation and Operation Manual
For Matlab® Support Package
HFX Product Line

Powering Business Worldwide

HFX 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

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HFX Product Family

1.0 INTRODUCTION

The Eaton HFX product family is a series of advanced, CAN- based controllers for use with mobile and industrial equipment. Using Simulink® programming environment, these controllers enable functional control over electrically operated components within a variety of applications (e.g. agricultural, construction, material handling). It is recommended that an individual have experience with control engineering and programming within the Simulink® environment before using this hardware.

The HFX product family is optimized for reliable operation in severe environments, possessing IP and temperature ratings that exceed existing solutions from competitors. HFX controllers employ several advanced technologies (e.g. I/O with variable configuration 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.

Key Acronyms and Abbreviations

FW	Firmware
HW	Hardware
IDE	Integrated Development Environment
IP	Intellectual Property
MIL	Malfunction Indicator Lamp
POU	Program Organization Unit
PWM	Pulse Width Modulation
RTS	Run Time System
SW	Software
MSP	Matlab® Support Package
I/O	Input/Output
CRC	Cyclic Redundancy Check

2.0 TECHNICAL SPECIFICATIONS

Eaton HFX 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 (USB use is limited to 85°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	48 A @ 85°C (40 A @ 105°C)
Idle Current 12/24 VDC	TBD
Standby Current 12/24 VDC	<3.5mA@12V, <2.5mA@24V
Ignition Pin (K15)	Enable/Disable standby mode
CPU Type	Renesas Super H 72546
Frequency	200 MHz
Bit Width	32 Bit
FPU	Integrated on chip
Data Memory (RAM retain) (additional to cpu)	32 Kbyte (4 Kbyte available to user.)
Flash (ROM program & data combined)	3.75 Mbyte
SRAM	256 Kbyte
EEPROM	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	Partial SAEJ1939 support
Default Node Address	0
Default Baud Rate	250kb/s
USB Specification	N.A.
Baud Rates	N.A.
Default Node Address	N.A.
Default Baud Rate	N.A.
Number of Sensor Supplies	1 for HFX 12/20; 2 for HFX32/48
Sensor Supply Output Voltage	5 VDC or 10 VDC (configurable)
Sensor Supply Maximum Current	200 mA @ 5VDC, 100 mA @ 10V per supply
Analog Input Resolution	12 bits, *10 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
Input Type	Digital Low/High Side (Software configurable)
Maximum Input Frequency	200 Hz
Switch-on Level	Software configurable
Switch-off Level	Software configurable
Input Type	Frequency, Digital Low/High side, (Software configurable)
Maximum Input Frequency Ch 3-8 (FREQ) (0-5 V square wave)	Ch 3-8 0 Hz...50 kHz* in Freq. mode Note: maximum aggregate is 200 kHz, Minimum detectable pulse duration is 20 µsec
Maximum Input Frequency Ch 3-8 (Dig)	
Switch-on Level	Standard switch on at 3.0 V
Switch-off Level	Standard switch off at 2.0 V

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Input Type	Variable reluctance (Software configurable)
Maximum Input Frequency Ch 1-2 (FREQ) (0-5 V square or sine wave) Note: phase and duty cycle are not supported by these inputs	0Hz...25kHz* Note: maximum aggregate is 200 kHz, 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
Output Type	High Side (Software configurable)
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
Type	PWMi, High side (Software configurable)
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
Type	PWMi, 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
Connector Manufacturer	Deutsch Inc.
Model	DRC23-40PA & DRC23-40PB
Contact Surface	Nickel plated
Connector Assembly Parts List	Mating connector DRC26-40SA & DRC26-40SB, size 20 solid contacts P/N 0460-202-20141 intended for 20AWG wire, 460-010-20141 intended for 16-18 AWG wire, size 20 stamped and formed contacts P/N 1060-20-0122(nickel plated), sealing plug P/N 0413-204-2005
Tooling Manufacturer	Deutsch
Hand Tool Part Number	Solid contacts: Service crimper: HST-1561 Production crimper(ratcheting): HDT-48-00 Stamped contacts: DTT-20-00
Die Part Number	N/A
Contact Removal Tool	P/N 0411-240-2005

HFX 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 24 multifunction inputs, depending on model
- Up to 24 multifunction outputs, depending on model
- Diagnostic feedback for short circuit & wire break on all outputs
- Use of proven Deutsch connectors for rigorous IP protection
- Programmable via CAN via E-COM® or Kvaser®
- Three CAN ports
- Sleep input for improved power management
- Regulated supply for sensors
- Three programmable LED status indicators

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.

5.0 APPLICATION

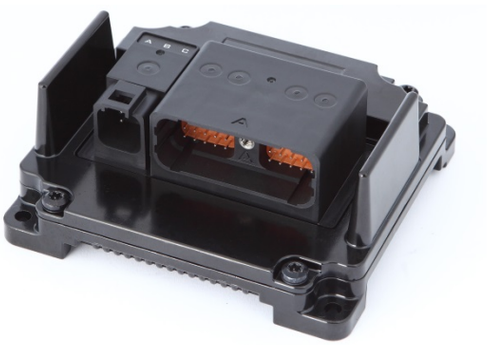
This operating and installation manual should be used in conjunction with the online help provided with the HFX MSP in the Simulink® development environment. Together, this information should form a basis for the simple configuration of the controller and the creation of programs specific to your application 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.

Note: That each controller within the HFX product family requires the installation of the HFX MSP, service tool and CAN adapter drivers before initial use in the application environment. The HFX MSP requires MS Windows® 7 or greater and Mathworks® Matlab® 2014b, 2015b or 2016b with Simulink® and Embedded Coder.

6.0 HARDWARE DESCRIPTION

The Eaton HFX product line consists of four controller models (HFX12m, HFX20m, HFX32m, and HFX48m), each possessing a unique number of I/O. The HFX12m/ HFX20m (pictured below) and HFX32m/HFX48m (pictured below) both share common housings.

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



HFX12m/HFX20m

HFX32m/HFX48m

The three integrated CAN ports on these units support CAN 2.0B, which are configured via Vector *.dbc files.

HFX controllers are programmed via CAN via an E-COM® adapter with either HFX service tool or FXST service tool. Both included in the installation package, see section 8 for service tool installation instructions. A Kvaser® CAN adapter is also compatible with the FXST service tool.

The two regulated outputs (sensor supplies) can be configured individually for either 5 or 10 V operation.

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

Controller Model		HFX48m (24 I/O)	HFX32m (16 I/O)	HFX20m (10 I/O)	HFX12m (6 I/O)
Total Outputs		24	16	10	6
	Total 2 A channels	16	10	6	4
	Number of channels supporting function				
	PWM	16	10	6	4
	PWMi	16	10	6	4
	High Side output	16	10	6	4
	Total 4 A channels	8	6	4	2
	Number of channels supporting function				
	PWM	8	6	4	2
	PWMi	8	6	4	2
	High Side output	8	6	4	2
	Low Side output	8	6	4	2
	H-Bridge pair	4	3	2	1

Controller Model		HFX48m (24 I/O)	HFX32m (16 I/O)	HFX20m (10 I/O)	HFX12m (6 I/O)
Total Inputs		24	16	10	6
	Total frequency channels	8	6	4	2
	Number of channels supporting function				
	High frequency	8	6	4	2
	Variable reluctance	2	2	2	2
	High Side input	8	6	4	2
	Low Side input	8	6	4	2
	Total analog channels	16	10	6	4
	Number of channels supporting function				
	0 - 5 V input	16	10	6	4
	0 - 10 V input	16	10	6	4
	0 - 32 V input	16	10	6	4
	4 - 20 mA input	16	10	6	4
	High Side input	16	10	6	4
	Low Side input	16	10	6	4
	Thermistor	16	10	6	4

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The HFX48m incorporates 24 total outputs, comprised of:

- 8 x 4 A channels
- 16 x 2 A channels

Each channel is capable of:

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

The 8 x 4 A channels are also capable of Low Side output and can be configured in pairs for H-Bridge operation.

The HFX48m also incorporates 24 total inputs, comprised of:

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

The HFX32m incorporates 16 total outputs, comprised of:

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

Each channel is capable of:

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

The 6 x 4 A channels are also capable of Low Side output and can be configured in pairs for H-Bridge operation.

The HFX32m also incorporates 16 total inputs, comprised of:

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

All 16 inputs can also be configured as High Side or Low Side.

The HFX20m 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 HFX20m 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 also be configured as High Side or Low Side.

The HFX12m 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 HFX12m 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 also be configured as High Side or Low Side.

All 4 of the HFX controllers also integrate an internal temperature measurement that can be viewed with the HFX service tool.

7.0 SOFTWARE DESCRIPTION

Software for the HFX family of controllers is provided in the form of the HFX Maltlab® Support Package. This is distributed as a .exe installer file. After running the installer the following files will be added to \Program files (x86)\HFX_MSP\:

- \HFX_Firmware\: Firmware files (MOT files), A separate file is provided for each HFX controller model.
- \Service_Tools\Eaton_HFX_ST_Installer\: Setup.exe in the folder is the installation file for the HFX service tool.
- \Service_Tools\ECom_Drivers\: The Pro-FX Configure HFX Service Tool connects to the HFX over CAN using the ECOM device. This is the driver for that device.
- \Service_Tools\FXST\: NW.exe in the folder is executable for the FXST service tool.
- \simulink\: Contains all the Matlab® Simulink® files.
- \capi\;\Library\;MSP_app_files\: internal files needed for compiling an application.
- readme.txt: text document that contains the revision history of the HFX MSP.

When updating an existing HFX Matlab ®Support Package, it is necessary to un-install the previous version and re-install the new installer executable. In some cases the service tool may also need to be re-installed. The release notes will mention this explicitly

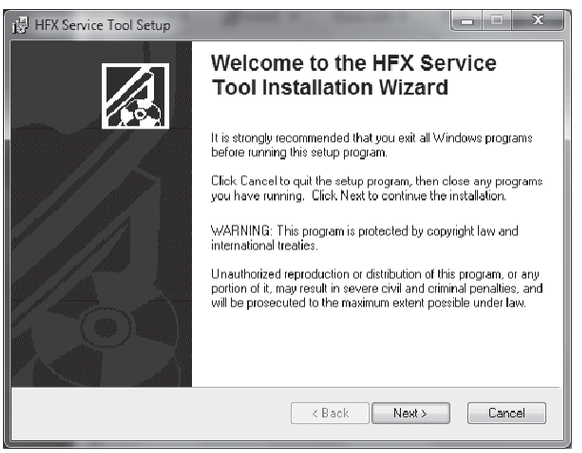
8.0 SERVICE TOOL - INSTALLATION AND GETTING STARTED

8.1 DRIVER INSTALLATION

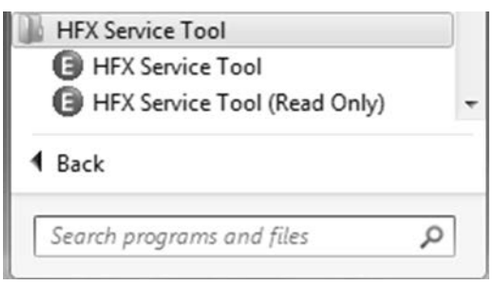
Before using the HFX Service Tool, it is necessary to install the driver for the ECOM USB/CAN interface device. Prior to installing the driver, make sure that all ECOM devices are detached from your computer and that all programs are closed. Run the ECOM driver installation application Driver_Setup_C3.1.0.15.exe, located in \Service_Tools\ECom_Drivers\ folder of the HFX Matlab® Support Package. Proceed with the installation by following the onscreen instructions. Once installation has completed, connect the ECOM device and Windows will complete the installation for the hardware and port.

8.2 INSTALL THE HFX SERVICE TOOL SOFTWARE

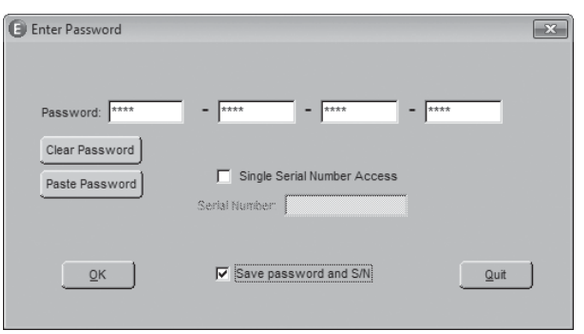
Run the HFX Service Tool installation file setup.exe in \Service_Tools\Eaton_HFX_ST_Installer\.



8.3 LAUNCH THE HFX SERVICE TOOL



You may be prompted for a password. Use the C-API Read/Write password password can be found in the file 'Eaton Display Passwords.txt', located in the Service_Tools\Eaton_HFX_ST_Installer\ folder of the HFX MSP. You have the option to select 'Save password and S/N', which stores the password for the next time the software is used.



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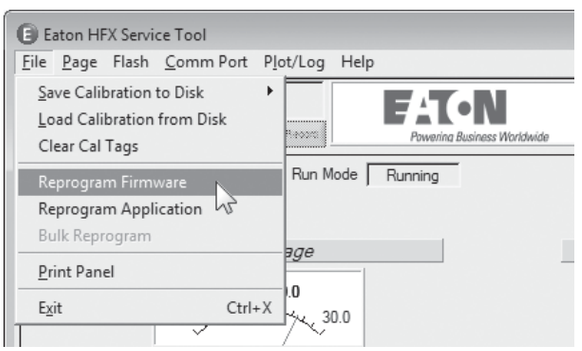
9.0 GETTING STARTED

9.1 FIRMWARE

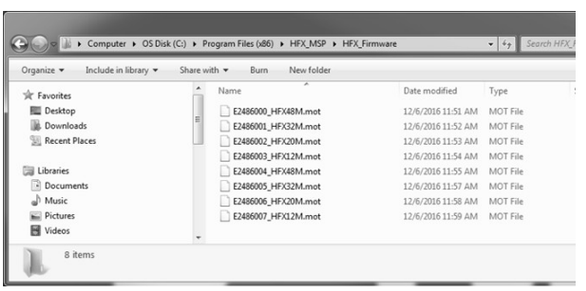
Install the Firmware

HFX units are shipped blank, with no firmware loaded. Prior to first use, it is necessary to load firmware to the HFX.

Launch the HFX Service Tool if it is not already open. On the main page of the service tool select File->Reprogram Firmware.



Select the appropriate firmware to load based on the model of the controller intended for use.



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. There are two controller types, CODESYS and C-API. The CODESYS firmware versions are the files with names ending in 0_HFXMxx through 3_HFXMxx. The C-API versions go from 4_HFXMxx through 7_HFXMxx. The software should then load on the controller and complete installation. You should now be ready to proceed with the application software installation

9.2 CREATE YOUR FIRST PROJECT

Open Matlab®

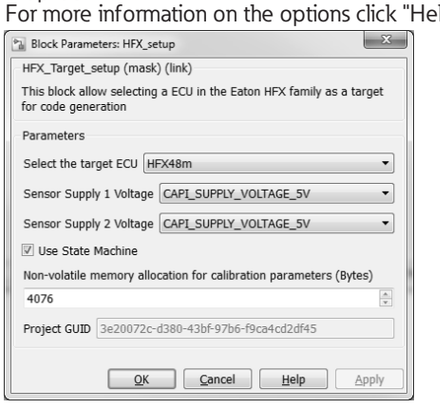
If this is the first time creating a project, execute the following in Matlab® command line: run('C:\Program Files (x86)\HFX_MSP\simulink\HFX_setup_toolchain.p') otherwise skip to the next step.

In the desired location, create a sub folder for the new project. Note: Project paths **cannot contain spaces**.

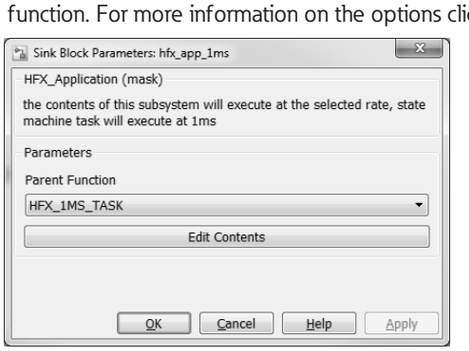
In the shortcut tab, click HFX New Project.
Do not re-use projects, always create a new project. A globally unique identifier is created every time the project is created.

In the Pop-up window type the new projects name and click OK. After a few seconds a new Simulink® project should show on the screen.

Double click the HFX_Setup block and select the appropriate HFX controller from the "Select the target ECU" drop-down.
For more information on the options click "Help".



Open the Library Browser at HFX/Tasks and drag into the top level of the model the hfx_app_1ms HFX Application block. Double click on it and select the appropriate parent function. For more information on the options click "Help".

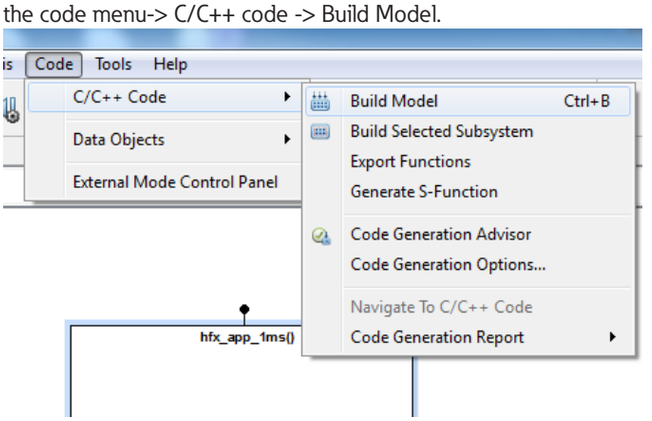


Save and close the model. To edit further re-open the file. Place all developed code in the Application blocks.

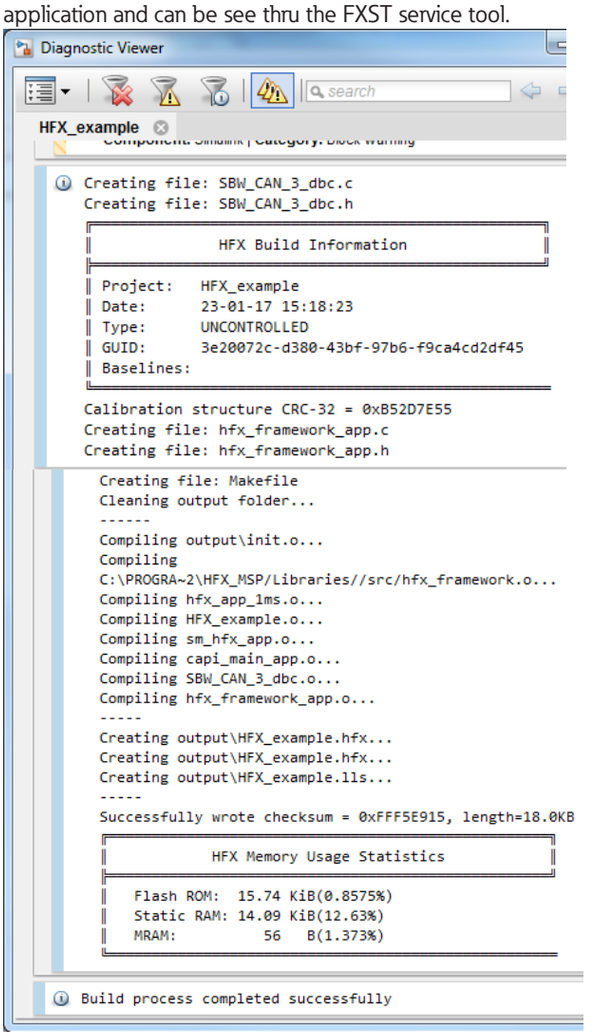
9.3 BUILD APPLICATION

When development is complete, the project can be built to generate the *.HFX file that can be downloaded into the HFX controller via the service tool.

To build the application form the Simulink window click on the code menu-> C/C++ code -> Build Model.



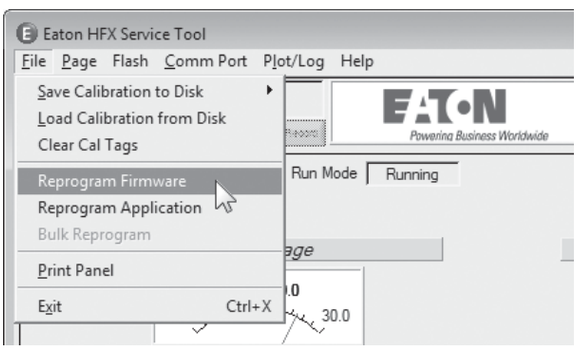
The Diagnostics Viewer will provide build information as shown below, the build information is embedded into the application and can be see thru the FXST service tool.



9.4 INSTALL APPLICATION

Option 1: Install application (HFX service tool)

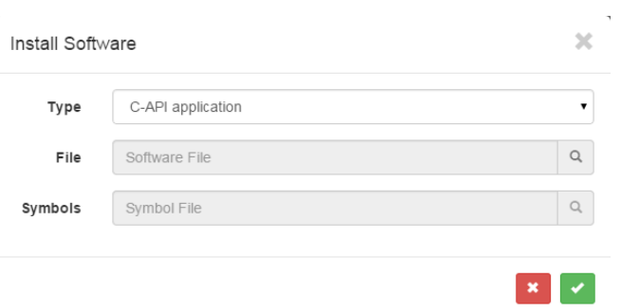
Launch the HFX Service Tool if it is not already open. On the main page of the service tool select File>Reprogram Application.



Select the *.HFX file from the project folder. The *.hfx file is located in the Build_<project_name>\output directory of the project folder.

Option 2: Install application (FXST service tool)

Launch the FXST service tool (NW.exe) and connect to the controller by pressing the button, then select the button and then select the C-API application option.



Then select the appropriate *.hfx file to download. The *.hfx file is located in the Build_<project_name>\output directory of the project folder.

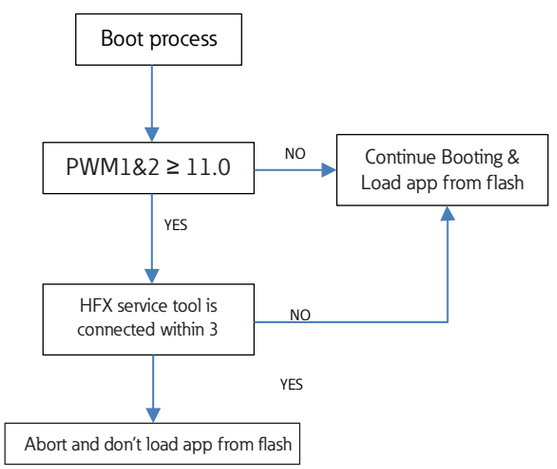
10.0 FUNCTIONALITY AND BASIC OPERATION

At initial startup, the controller enters the bootloader. A bootloader is simply a small program that loads the rest of the firmware when the controller is initially powered up. This firmware resides in the flash memory and provides the necessary memory mapping and instructions for the controller, allowing the application program to be processed. The bootstrap mechanism provides the means to enter the bootloader. The bootstrap mechanism is as follows:

1. Check for PWM1&2 ≥ 11.0 V
2. Delay 3 seconds
3. If the HFX service tool is connected, abort and don't load app from flash
4. Otherwise, load and run the app in flash like normal.

This provides a mechanism to remove a frozen application.

1. Load a new application, or
2. Reset origin will clear entire application memory.



10.1 SLEEP MODE (TIME DELAY OPERATION)

Sleep Mode provides a mechanism to have a controlled shutdown of the vehicle control system. This is a benefit because the unit can be put into an idle state where less current is required thus extending battery life. It is also useful with applications where, prior to shut down, the controller needs to return key functional outputs to a predefined or home position. this function is only enabled if the state machine is enabled in the HFX_setup block. The state machine is enabled by default.

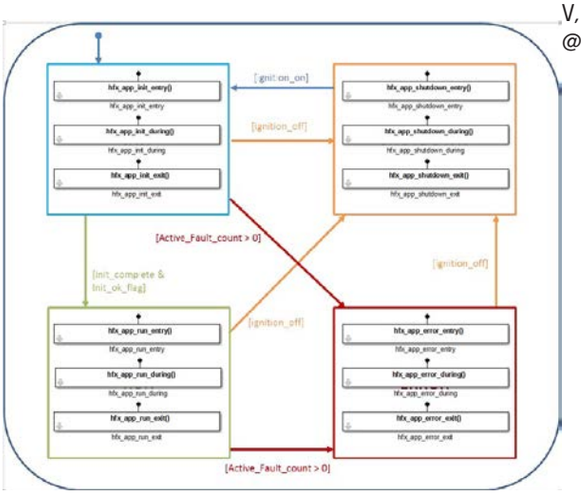
10.2 CONTROLLER STARTUP

Operating Mode	Enter Sleep bit State	Sleep Allowed State
Sleep	True	Ignition Pin < approximately 6.6 V)
Awaken	False	Ignition Pin > approximately 6.6 V)

The controller will transition to the shutdown state and then enter sleep mode after 5 seconds of the ignition pin being low.

The controller will awaken from sleep if {Sleep is low or not connected} and {IGN is high}

Sleep current 2.4 mA, @ 10 V, 1.9 mA @ 15 V, 1.6 mA@ 20 V, 1.2 mA @ 25 V



10.3 TASK CONFIGURATION

The controller supports the following tasks:

- Cyclic: Task processed in a predefined time.

  There are 3 pre-defined task: 1 ms, 5 ms, 50 ms

- Freewheeling: Task processed as soon as the program is started. When complete, it will automatically restart in a continuous loop. "Background" is the only freewheeling task available.

- State Machine Tasks: Task processed in the 1 ms loop time, only one task is active at a time and depends on the state machine transitions.

Note: There are no external events available to trigger task execution. for more information on the tasks, open the help for the HFX Application block.

10.4 WATCHDOG OPERATION

Watchdogs are present to provide an indication that something has gone wrong. Systems that are programmable can hang for a number of different reasons. One of the most common is the execution of an infinite loop due to a programming logic error. This type of failure prevents any of the other code from executing. Also, if an unusual number of interrupts arrives during a single cycle of the loop this can prevent the main loop from having sufficient time to execute. Another possibility is a failure in hardware that causes a constant reset.

Each controller has an internal hardware watchdog that is continuously running in the background to monitor for a system malfunction. This watchdog is not user serviceable and is not visible to the user. It will trigger in the event of a task timeout and can only be reset through a hard reset of the controller, which means that the user must connect the service tool to the controller, tie PWM 1 & 2 to supply voltage, and then power up the unit. This will prevent the application code from loading

10.5 CONTROLLER MEMORY

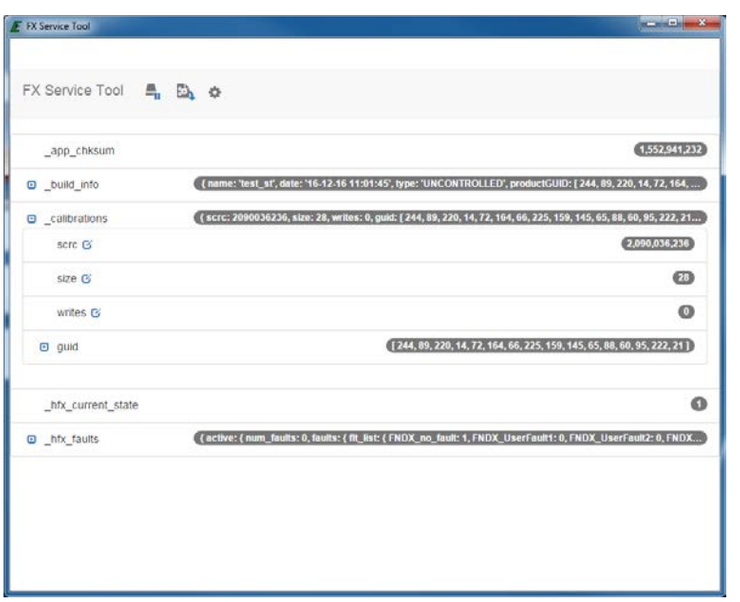
The controller utilizes an advanced superscalar
32 Bit processor operating at 200 MHz. The memory is arranged into the following areas:
ROM Flash 3.75 Mbyte
EEPROM128 kbyte reserved for internal use i.e. firmware/bootloader
RAM 256 kbyte
MRAM 32 kbyte (4 kbyte user accessible calibration parameters)

10.6 CALIBRATION VARIABLES

These are variables that can retain their value throughout the usual program run period. And are user modifiable via FXST service tool or application modifiable via the Calibration blocks in r/w mode. for more information open the help for the HFX Calibration Block.

These variables are going to retain their value in case of sleep mode, power cycle, reset or application download.

Note: In the application download use case, all values will be maintained if the memory structure is compatible with the new application, if there is an incompatibility the ROM default values will be loaded instead. Incompatibilities include changes to the variable names, adding or removing calibration parameters or changing the size of the calibrations structure.



10.7 LED OPERATION

LED A (left-most) - Green power LED

- Off ==> Not powered up
- Solid on ==> Powered up and Application not running
- Fast flash (100ms on, 100ms off) ==> Application running

LED B (middle) - Red MIL

- Application running
  - Flashing (200ms on, 200ms off) ==> critical fault is active
  - Solid on ==> standard fault is active
  - Off ==> no fault
- Application not running
  - Fast Flashing (200ms on, 200ms off) ==> critical fault is active
  - Slow pulse (100ms on, 1500ms off) ==> historic fault is set - must be manually cleared
  - Solid on ==> standard fault is active
  - Off ==> no fault

LED C (right-most) - CAN TX is ok LED, blinks periodically if there are CAN messages being transmitted and there are no errors.

Miscellaneous states

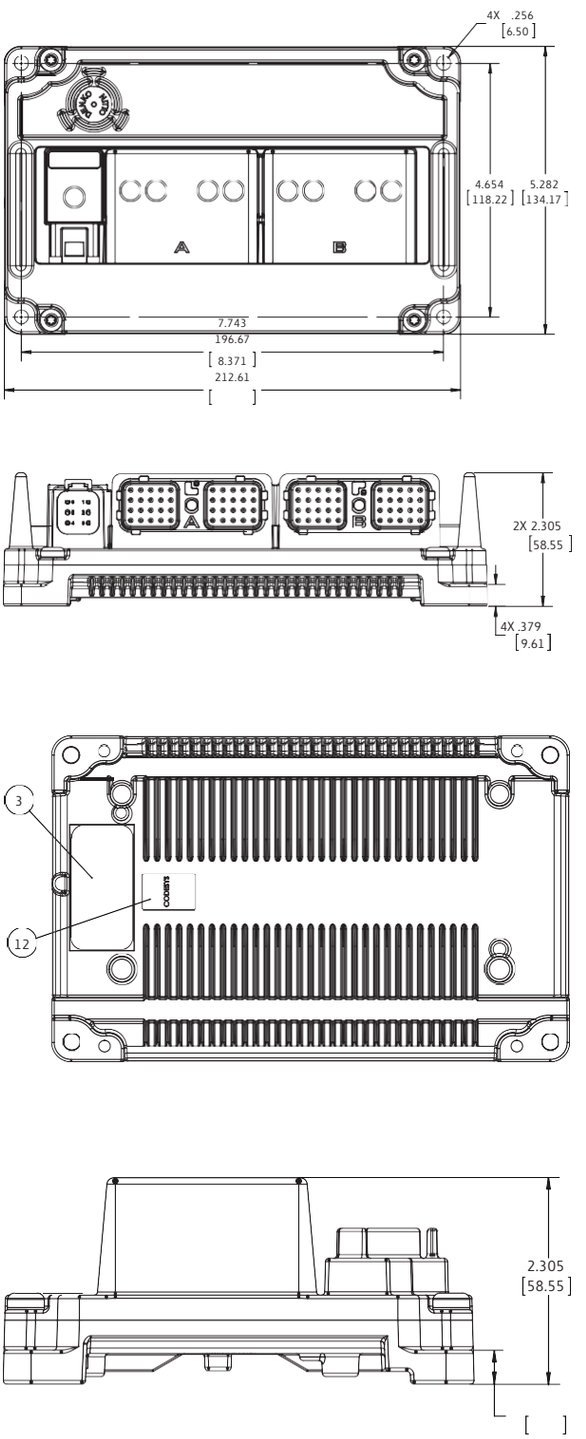
- LED A Off and MIL light solid on ==> No firmware present
- MIL light will pulse briefly for a bulb check on every powerup
- MIL light will retain its state for 3 seconds after an active fault goes inactive

11.0 INSTALLING THE CONTROLLER

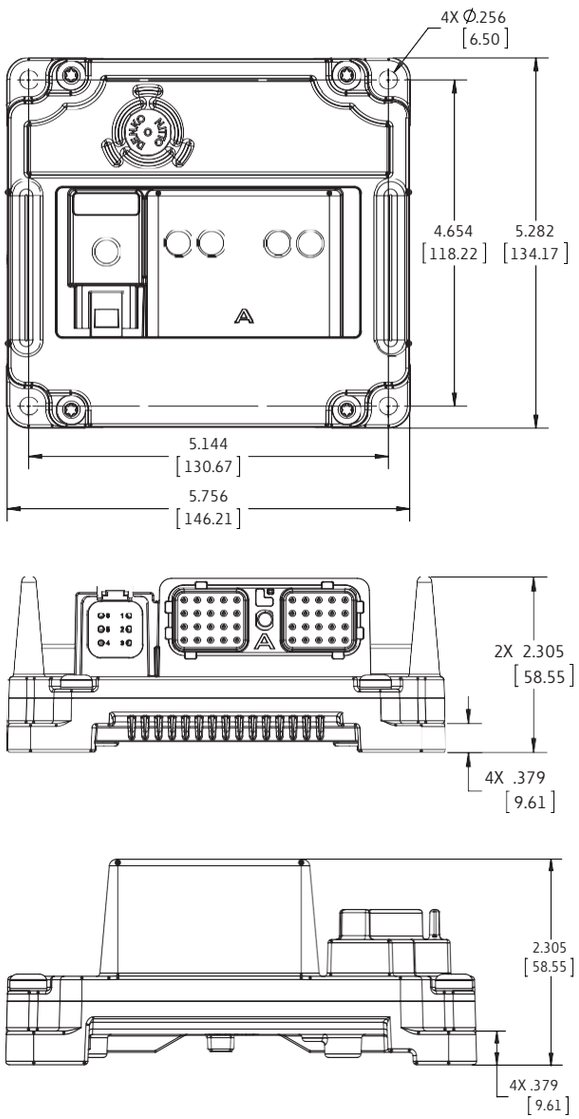
11.1 PRODUCT DIMENSIONS

Ideally the controller should be mounted on a vertical flat surface with connector facing down. Use four standard threaded fasteners to secure the controller to the surface (either 6 mm or ¼" diameter are acceptable).

HFX32m & HFX48m Dimensional Data



HFX12m & HF20m Dimensional Data



11.2 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.
- 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

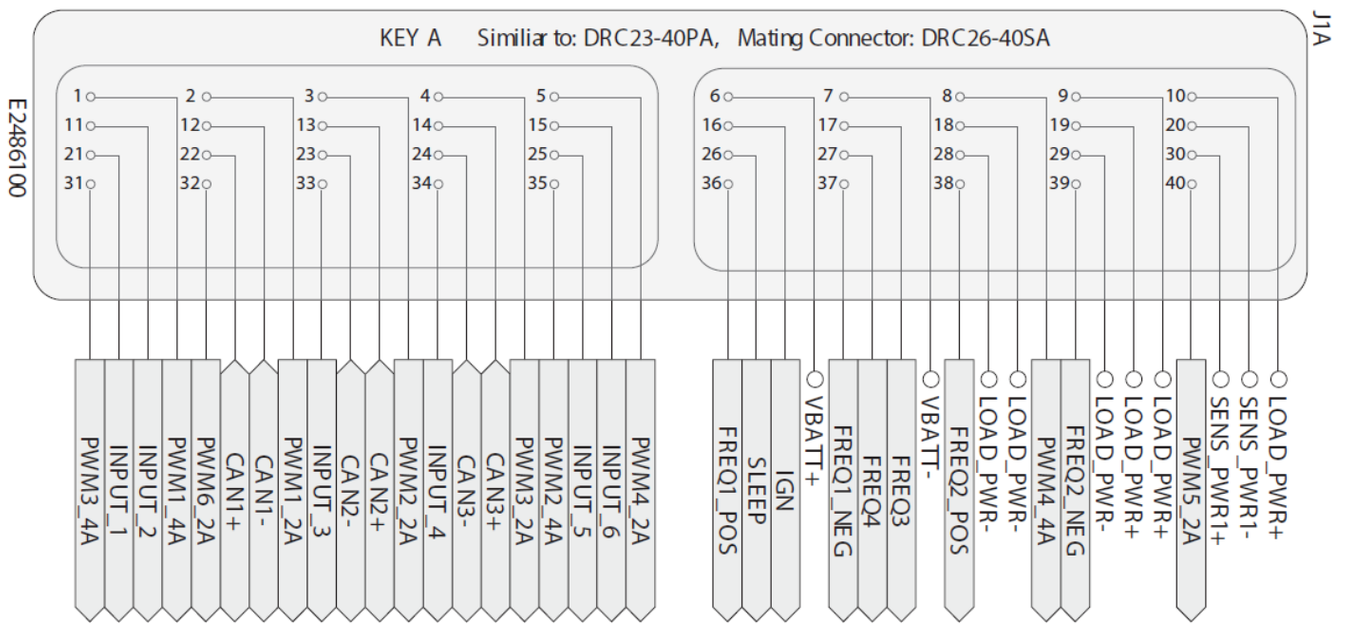
- Make sure that voltage drops are kept within reasonable levels under maximum continuous load conditions e.g. 1 volt on 12-volt systems and 2 volts on 24-volt systems.
- Verify that the harness is constructed to meet the needs of the application environment
  (e.g. shock, vibration, moisture, temperature, 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 use 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.
- 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. Note the following guideline for maximum fuse recommendations:
  - All Units: +VBat = 2 A
  - HFX48 :+Load total < 50 A depending upon anticipated load requirements.
  - HFX32: +Load total < 42 A depending upon anticipated load requirements.
  - HFX20: +Load total < 34 A depending upon anticipated load requirements.
  - HFX12: +Load total < 26 A depending upon anticipated load requirements.

⚠Warning: Prior to Welding

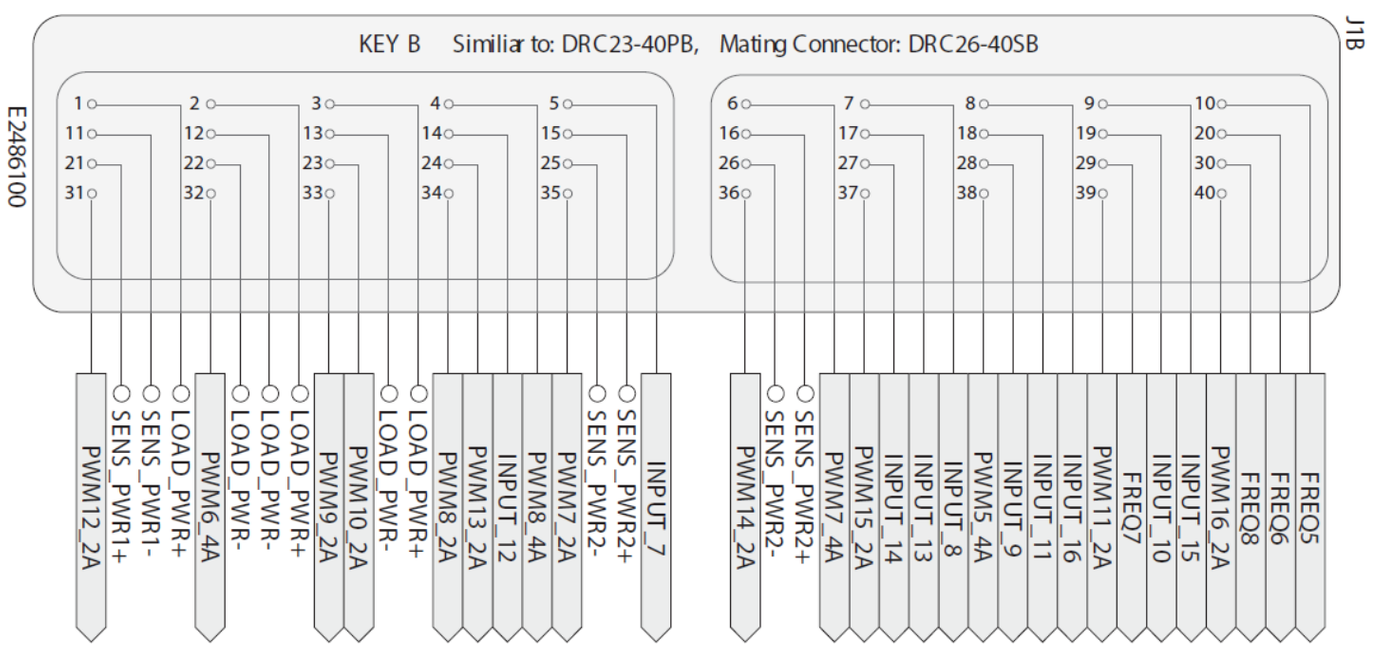
In order to avoid damaging the HFX controller ensure that all electrical connectors are fully disconnected from the HFX controller prior to welding on the machine.

12.0 ELECTRICAL CONNECTION INFORMATION

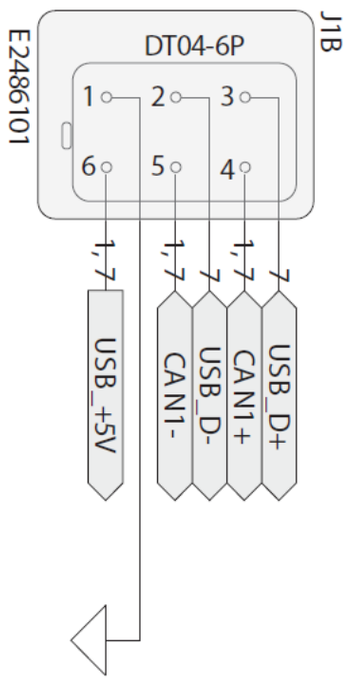
Wiring Pin Out



Note: All 4 of the HFX units share a common pin-out. The HFX12 does not utilize the following pins: 8, 15, 17, 25, 27, 31, 32, and 40.



Note: Although all 4 of the HFX units share a common pin-out, both the HFX12 and the HFX20 do not have connector B. The HFX32 does not utilize the following pins: 4, 6, 8, 14, 17, 18, 24, 27, 29, 30, 31, 36, 37, 39, and 40.

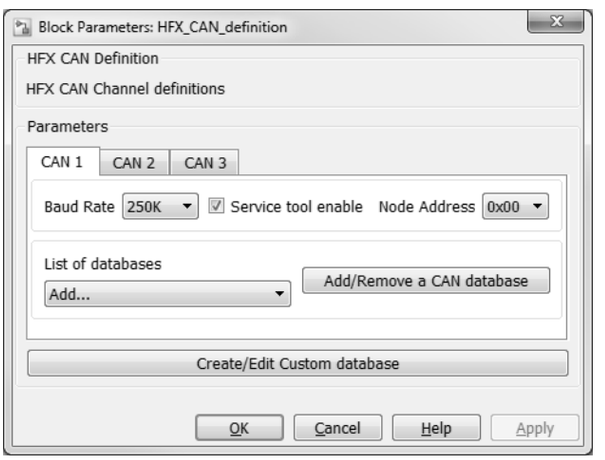


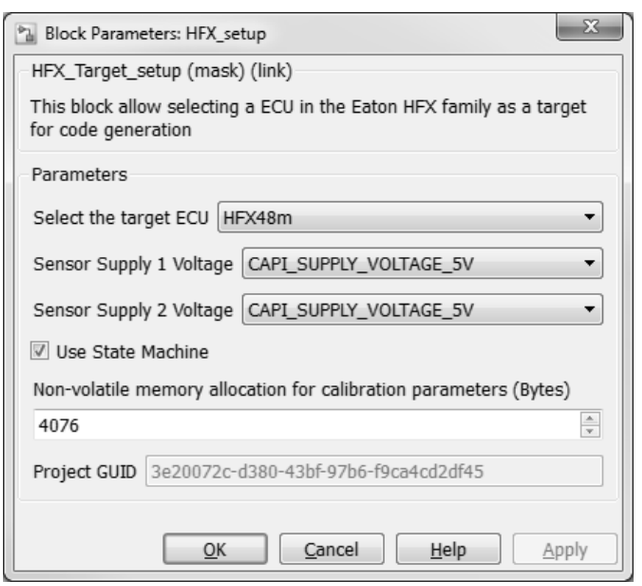
The above connector is used for programming and is common to all 4 models of the HFX controller.

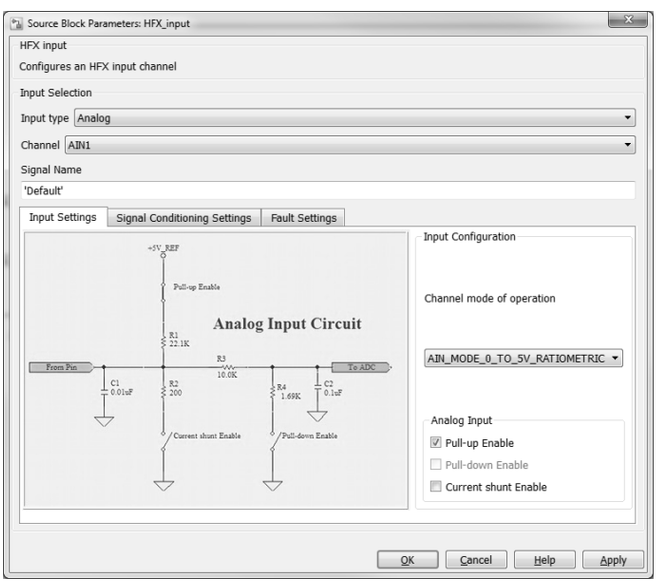
13.0 CONFIGURATION

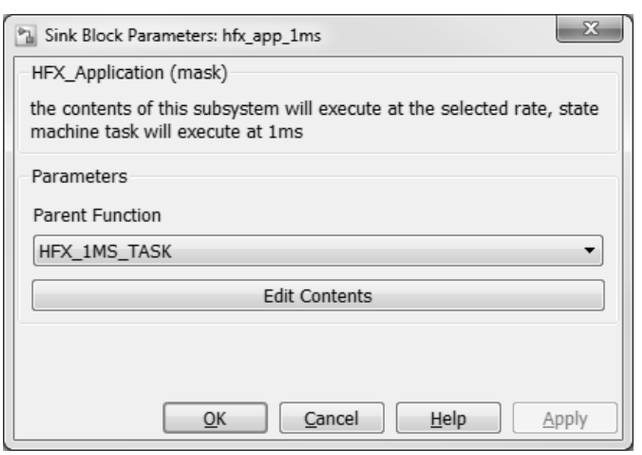
System Configuration

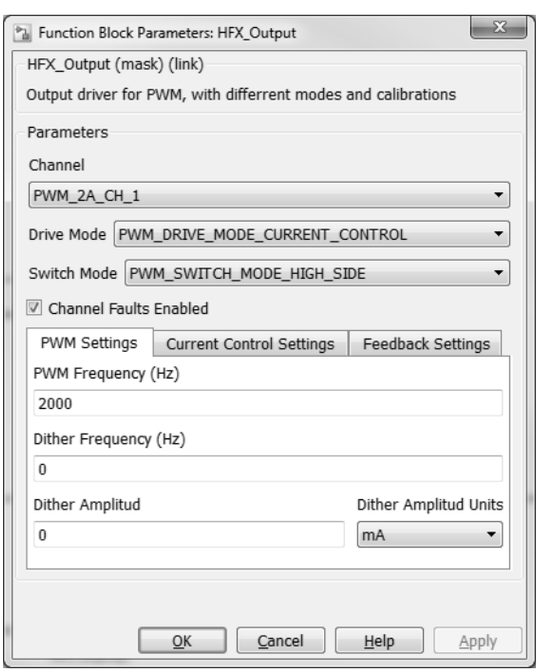
The controller features an advanced configuration capabilities. The target configuration is located in the HFX Target Setup block. The I/O and CAN configuration is centered around the input, output and CAN definition blocks, for more information access the help function for each of the blocks.
Task execution configuration is located in the HFX Application blocks, consult the Help documentation for the blocks for more information



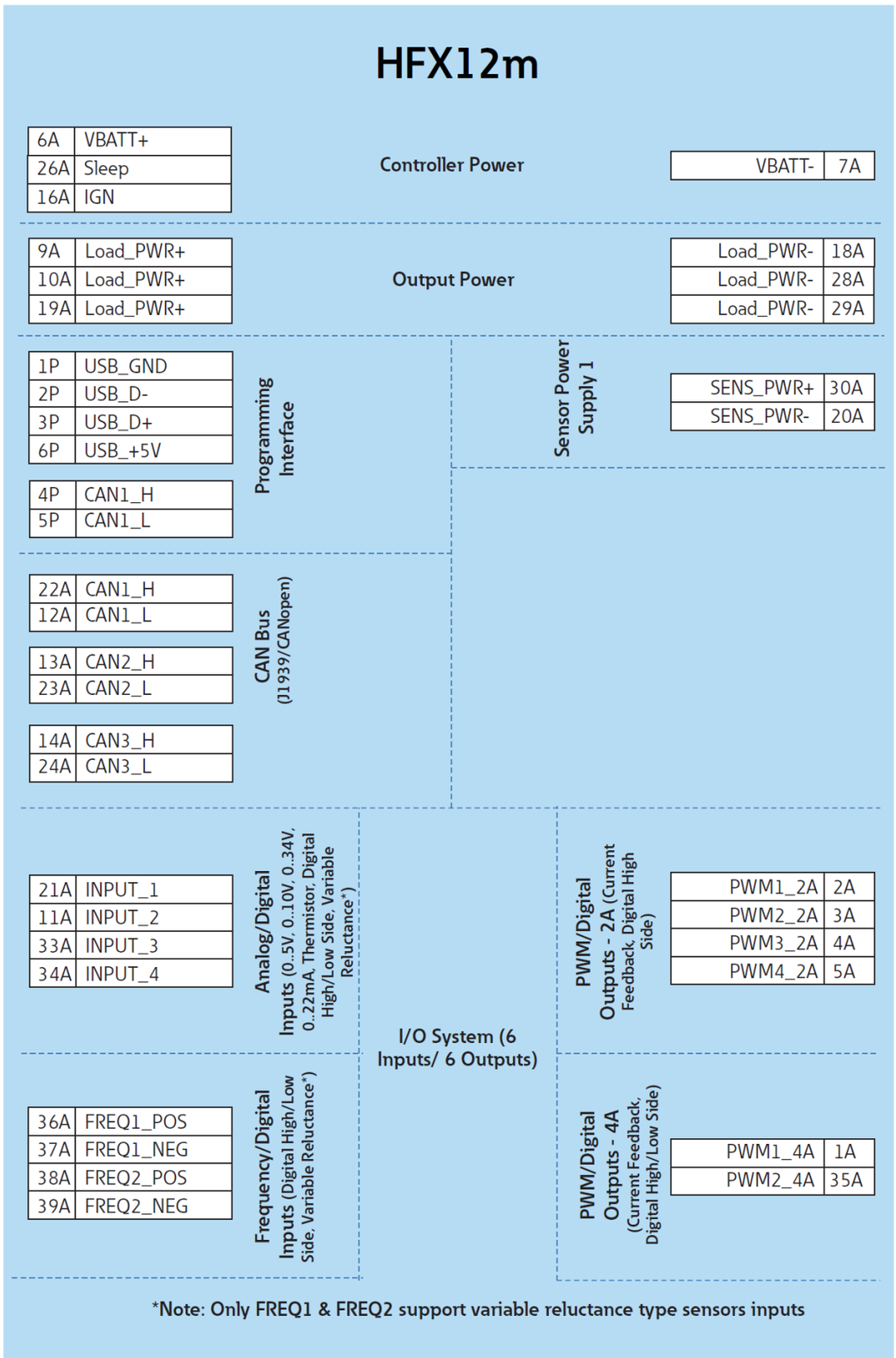




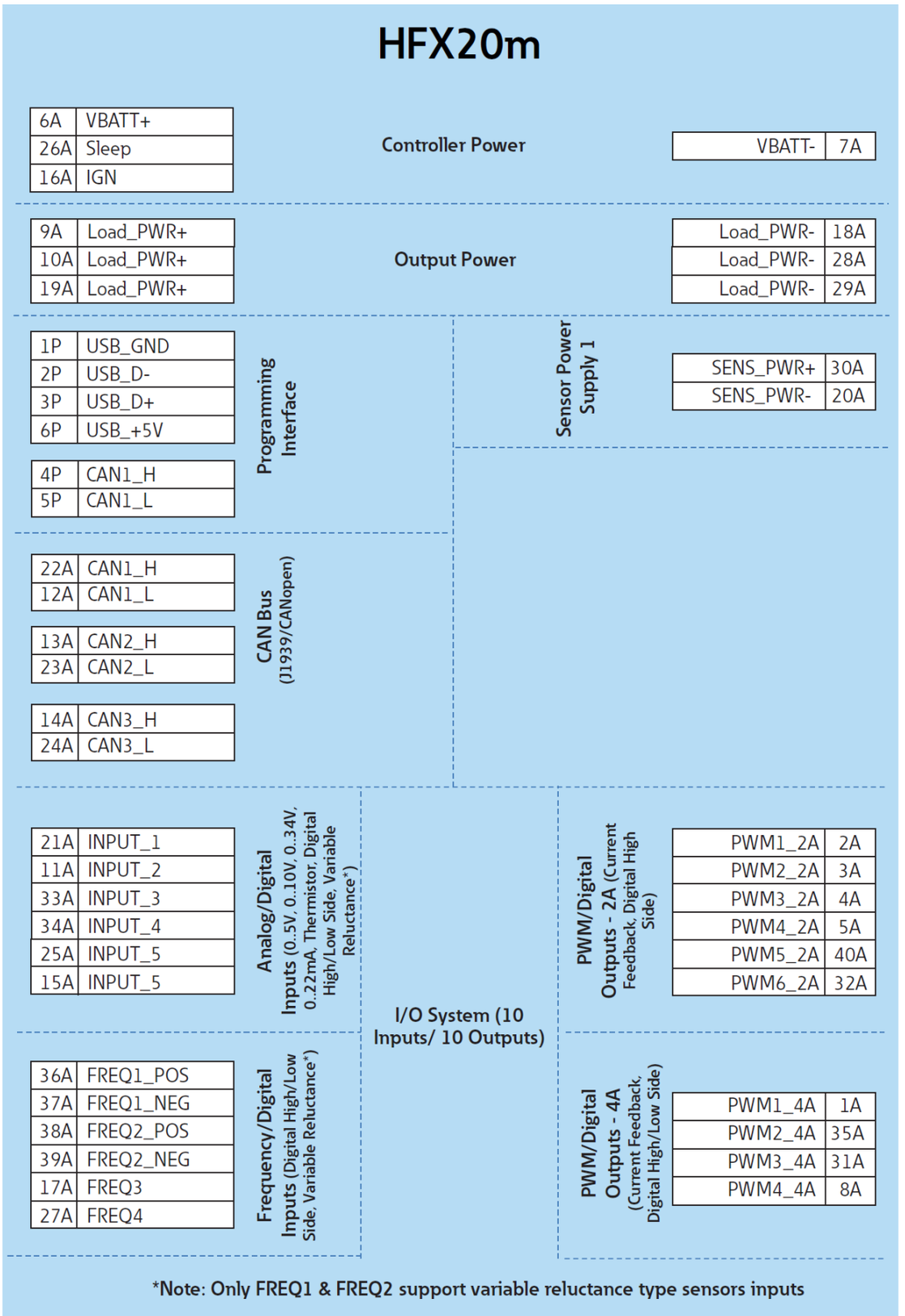




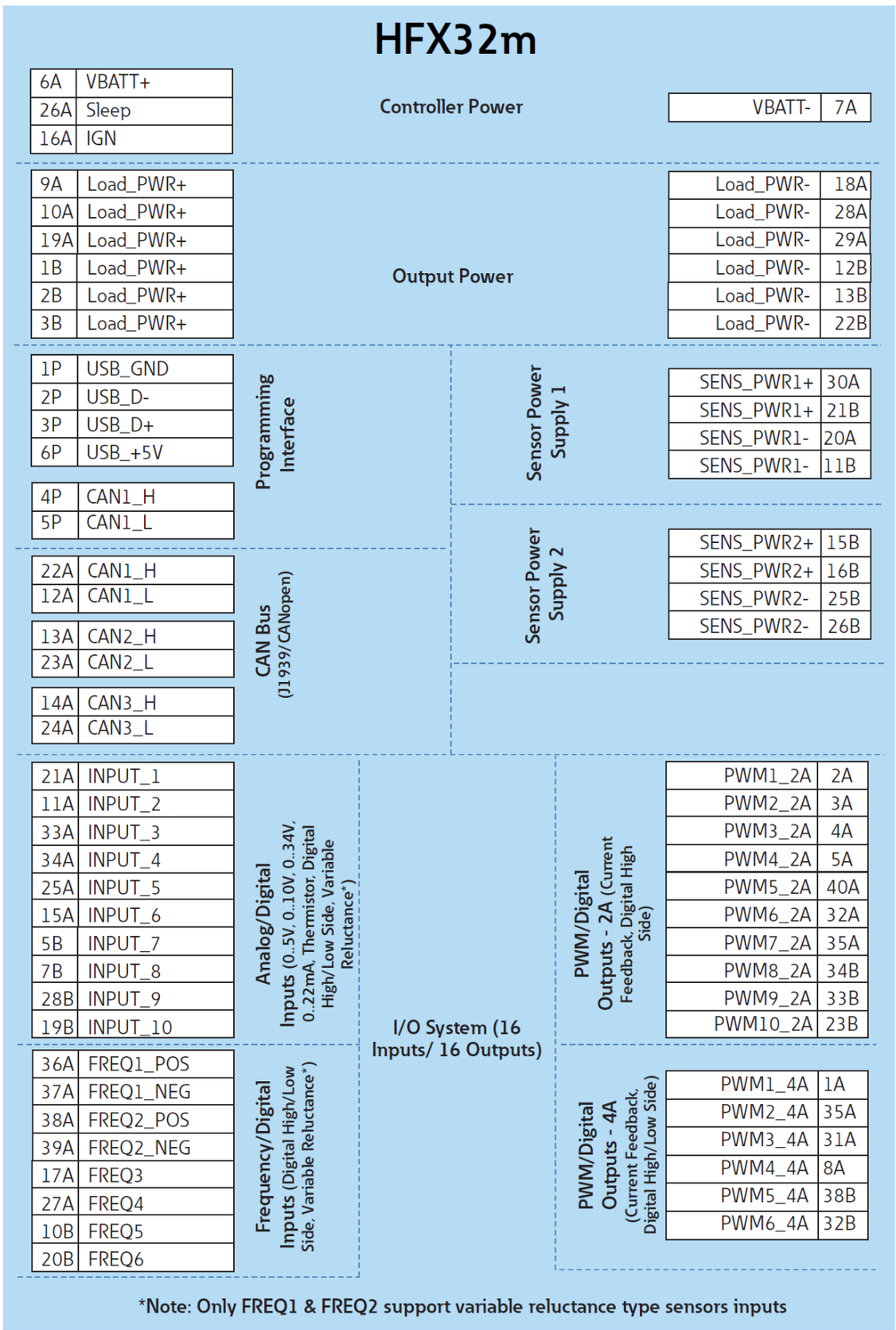
14.0 BLOCK DIAGRAM



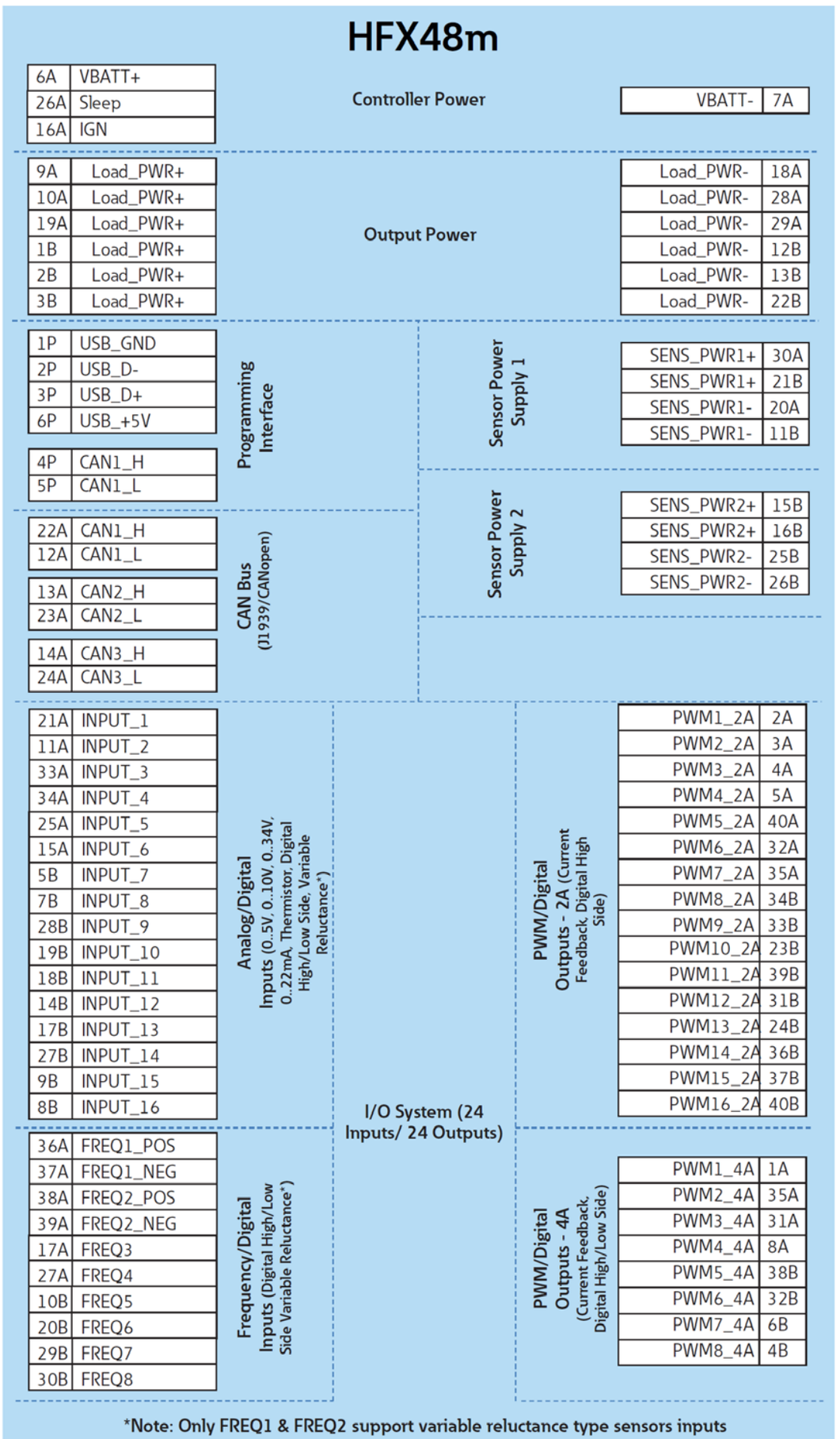
HFX Product Family



HFX Product Family



HFX Product Family



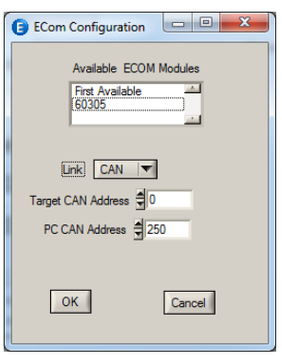
15.0 TESTING AND VALIDATION

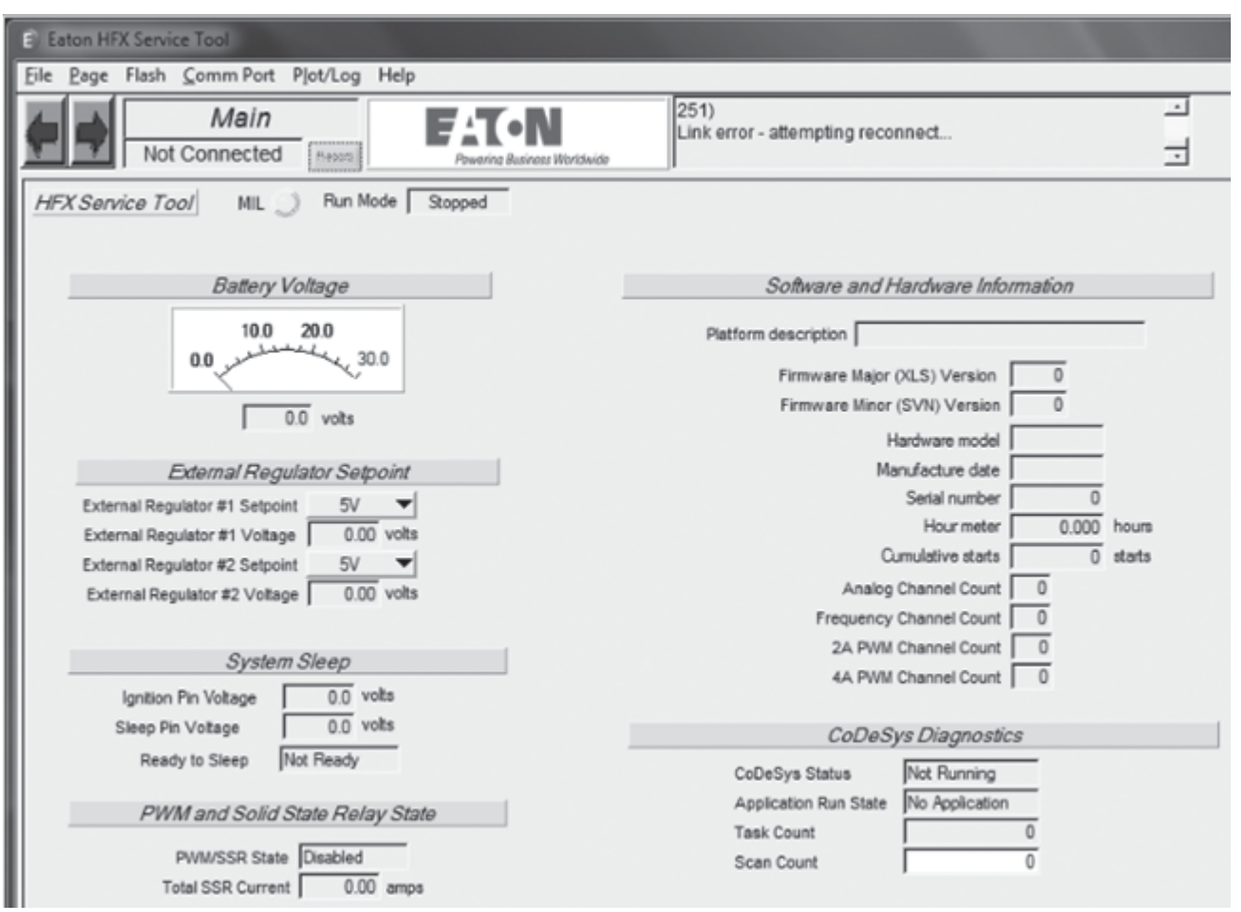
Requirement	Specifications
Electrical/EMI/EMC	
EU (2004/104/)	EU automotive EMC directive
CISPR 25	Conducted emissions (EU broadband & narowband limits)
CISPR 25	Radiated emissions (EU broadband & narowband limits)
ISO 11452-4	Immunity to narrowband conducted electormagnetic energy via bulk current injection
ISO 11452-2	Immunity to narrowband radiated electormagnetic 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 (USB use is limited to 85°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 I minute max supply voltage 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	1000 cycles from -40°C to 105°C powered, test full load every 200 cycles
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)

16.0 SERVICE TOOL

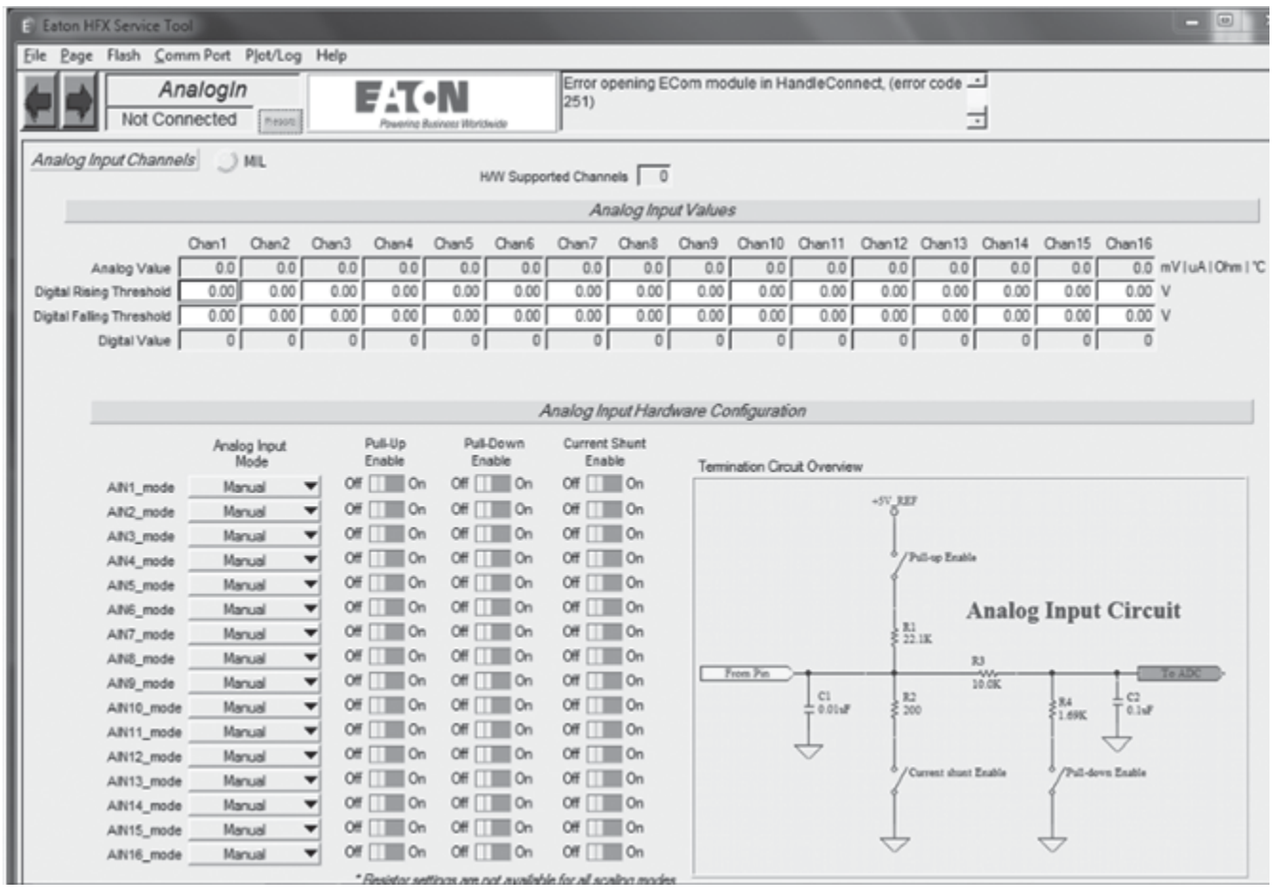
16.1 HFX SERVICE TOOL

The HFX service tool allows the user to download firmware or application programs and provides an aid for troubleshooting. There are five pages that display and/or allow configuration of various I/O types. Please see section 9 for details covering firmware and application installation. The tool has to be configured to the target node address to be able to connect. The configuration option is in the "Comm Port" menu under "ECOM Configuration"



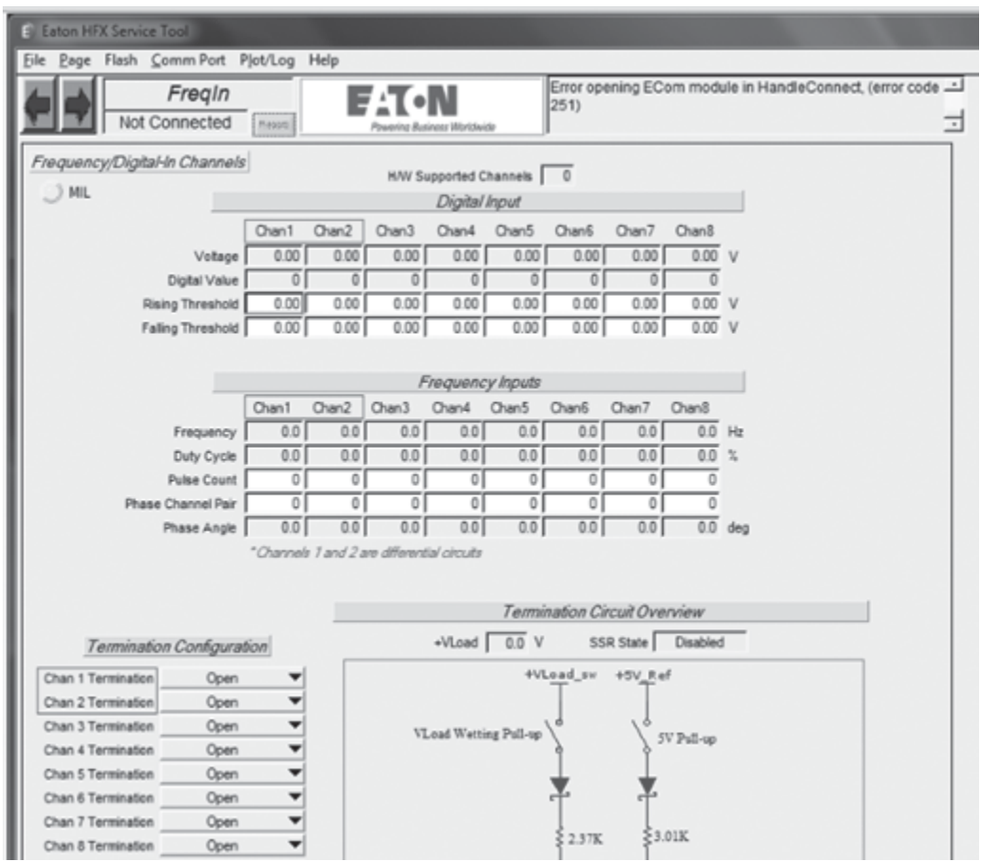


The above page is the Main page. This page allow the user to check the status of the MIL, supply voltage, ignition pin voltage, solid state relay, hours of use, and application. It also provides the total output current and several additional details about the software and hardware setup. Additionally, the output voltage on the regulated sensor supply can be adjusted temporarily.

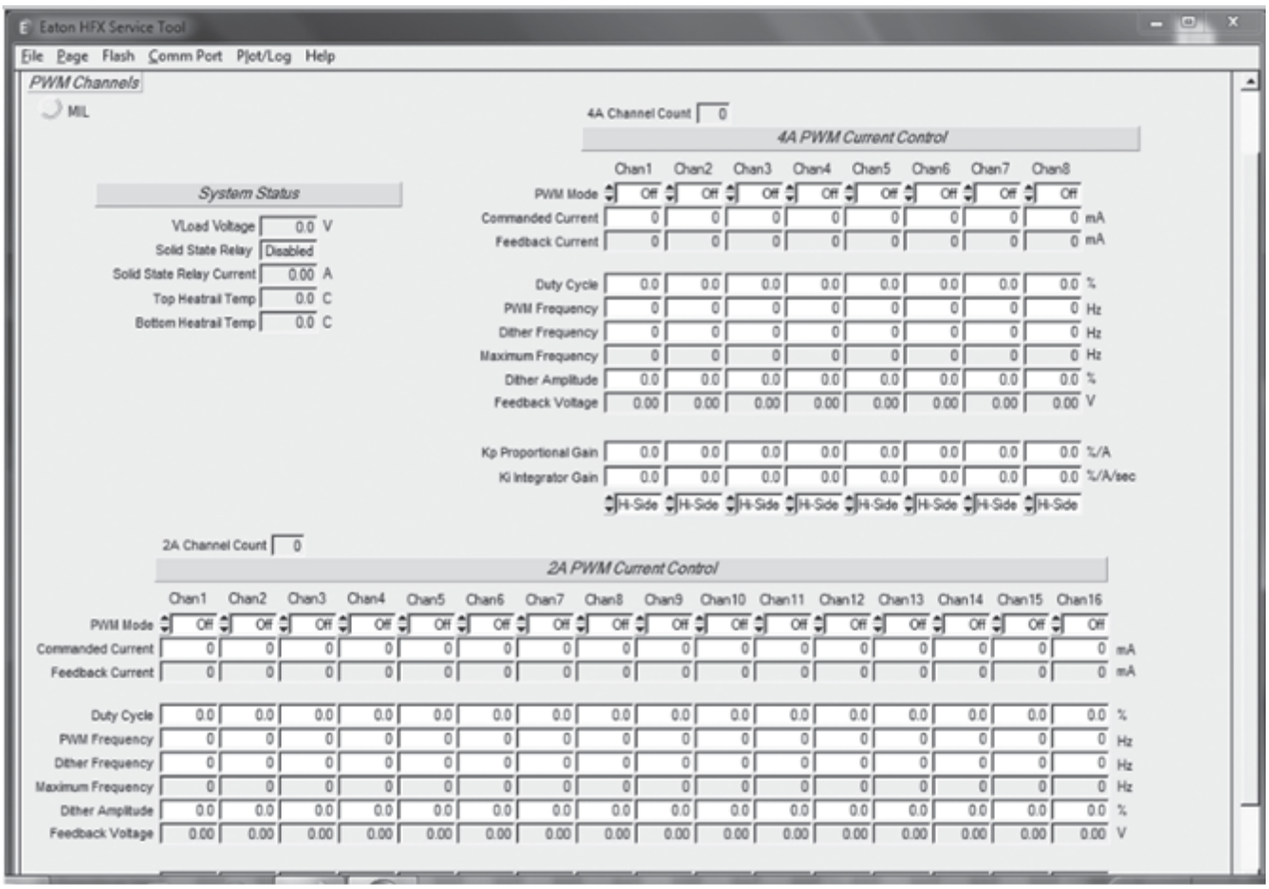


The above page is the Analog In page. This page enables the user to view input values associated with the analog channels and configure each channel for a specific type of input. It also offers the ability to individually select filters for each channel.

HFX Product Family

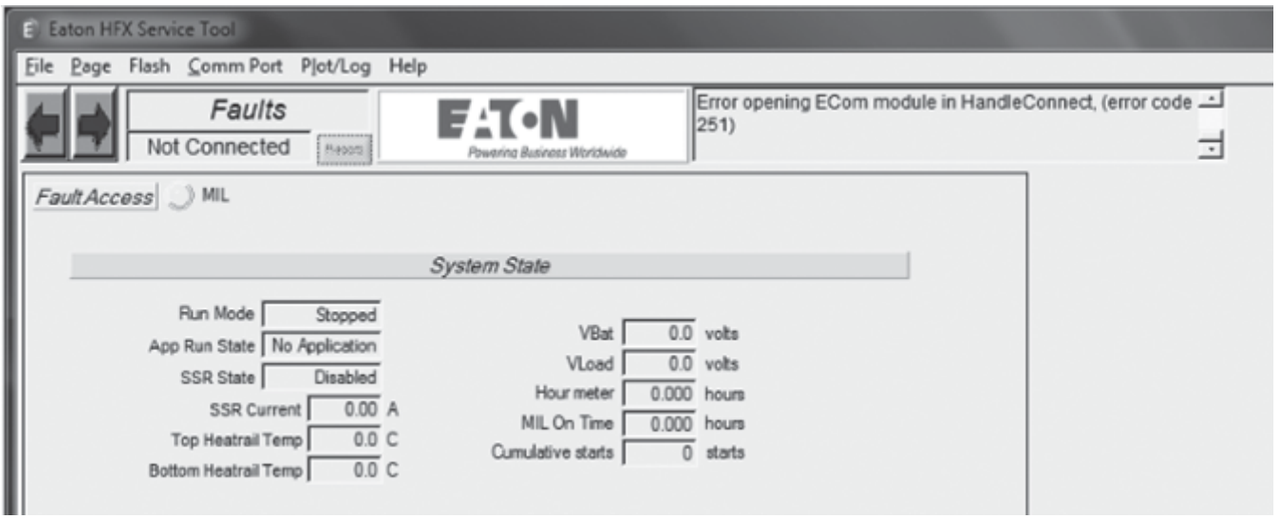


The above page is the Freq In page. This page enables the user to view input values associated with the frequency channels and configure each channel for a specific type of input to temporarily deviate from the application defined configuration..



The above page is the Output page. This page enables the user to view controller temperature, individual channel feedback current/voltage, dither, duty cycle, frequency and current control gain specific to each output channel. Each channel can also be configured as current control, or PWM to temporarily deviate from the application configuration. Additionally, the 4 A channels can be configured temporarily as Low-Side outputs.

HFX Product Family



The above page is the fault page and it displays warnings, system status, and any faults that are active. To see the full list of faults consult the help documentation for the Fault block in the HFX MSP.

16.2 FXST SERVICE TOOL

The purpose of this tool is to allow access to the application level build information calibrations, probes and overrides and allow reprograming of the target application and view faults and certain configurations. For uploading a new application see section 9.

Any Value shown in the tool with a  icon, indicates that this is a read/write value and can be changed . Changes to Overrides are only temporary and return to the original after a power-cycle. Changes to calibration parameter are persistent and will be maintained thru power-cycles, the exceptions are the calibration header information. Any changes to this region will cause the ROM defaults to be loaded on the next power-cycle. For more information on Overrides and Calibrations consult the help documentation of the respective blocks in Simulink®.

All projects will include the following information plus any Probes and Overrides added to the application:

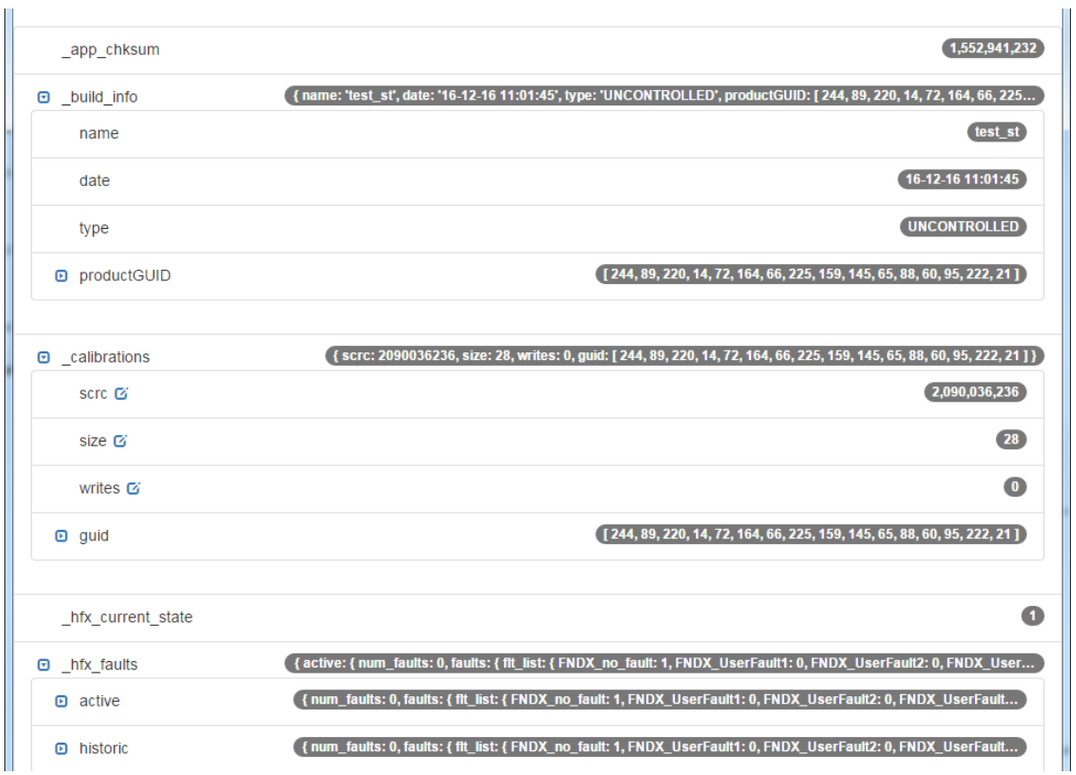
_app_checksum: Application CRC32 value. The 32 bit Cyclic Redundancy Check is an error detection code that validates the integrity of the application.

_build_info: including project filename, build date and time, a type parameter for future use and a globally unique identifier (GUID).

_calibrations: contains a calibration header with a CRC32 value for the calibrations, a parameter storing the size of the calibration section, a counter indication how many times the values in the calibration has been changed and the GUID of the application for compatibility check. After the header all the calibration parameter will be included starting from the pwm gains, followed by the input signal conditioning tables and then the user defined calibrations.

_hfx_current_state: the state machine current state; 0 for INIT, 1 for RUN, 2 for Shutdown and 3 for ERROR.

_hfx_faults: a list of active and historic firmware faults, for more information on the faults see the help function in the Fault block.



HFX Product Family

For both tools the default node address of an HFX unit is 0, this can be configured in the application and it has to match the configured value in the service tool. To configure the FXST service too select the icon.

To support more than 1 HFX unit in the CAN 1 channel the units must be programmed to have different node addresses so that the tool can differentiate between the units.

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