EMC-6
EMC-6L

Hybrid Fan Controller User Manual

www.hctcontrols.com

Revision Record

Rev	Description	Date Released	Last Updated by
Rev A	Initial Revision	9-May-14	WB
Rev A.1	E-fan and hydrualic fan auto reverse curves updated	2-Jun-14	WB
	controller weight is added, format updated	27-Jun-14	WB
Rev A.2	Updated product photo on cover page	4-Oct-14	BC
Rev A.3	Updated error logging information and Appendix B	2-Jul-15	BC
Rev B	Diagnostic inputs increased from 12 to 16. Added inverted waveform functionality. Added Setpoint Control. Increased operating fan duty cycle to 1,000 Hz.	10-Jul-15	BC

Contents

This page is intentionally left blank.

HCT Introduction

Welcome to **High Country Tek** Inc. HCT is North America's foremost independent designer and producer of modular, ruggedized digital and analog electronic controllers for the fluid power industry.

From our factory in California, we manufacture 'specialty' controllers for specific functions and the user programmable 'DVC family' to enable large area networked system solutions.

The modules are used in mobile, industrial and marine applications. They are also applied successfully in other industry segments.

HCT products are encapsulated in solid flame resistant material for maximum durability, electrical integrity and complete environmental security.

HCT is a market leader in many application arenas, including hydraulic generator, *e-Fan* and hydraulic fan system controls. These controllers facilitate significant fuel, emission and operational savings.

HCT's market neutrality offers integration with any hydraulic OEM valves, pumps, sub-systems or systems.

For more information, please visit us at: **www.hctcontrols.com**.

EMC-6 Product Overview

The industry's first hybrid fan controller designed with diverse flexibility enabling the precise control of variable speed hydraulic fan systems and brushless e-fans in addition to engine accessories. The controller provides low current varying PWM signals to six independent e-fan banks based upon the command inputs with each bank capable of driving up to 20 e-fans per bank. The EMC-6 is targeted for more complex Tier IV and Tier V cooling systems due to the thermistor and diagnostic inputs, SAE J1939 communication, and precise temperature control. The CE and E-Mark certified controller is designed with a unique hardened package making it a durable and rugged option for the Mobile and Mass Transit industries. It is ideal for dynamic systems that require a single hydraulic fan with additional precise e-fan bank control for isolated cooling needs like; charge air, engine bay ventilation, transmission or hydraulic oil cooling in order to achieve enhanced engine performance and reduced emissions.

The EMC-6's unique PID Set Point feature automatically adjusts the fan speed based upon the user set temperature while prioritizing multiple thermistor inputs and J1939 messages. For greater performance requirements the OEM can adjust the cooling response by adjusting the PID closed loop settings. The EMC-6 is also unique such that it can be configured through the Graphical User Interface (GUI) to invert the waveform for Active High and Active Low e-Fans making this a single solution for multiple fan types.

The simple and easy-to-use GUI enables the user to perform simple or complex actions based upon configurable inputs. The GUI is password protected for OEM manufacturers in order to prevent tampering of the pre-tested and qualified OEM configurations. The GUI is designed to have a standard diagnostic dashboard for service technicians that enable access to non-critical functions while obtaining necessary functional information and recording data for troubleshooting or performance monitoring.

The EMC-6 provides a great deal of functionality making this an effective solution for the most stringent and complex demands for today's Tier IV and V requirements.

Warranty Information

High Country Tek guarantees this product to be free of defects in materials and workmanship for one year from the date shipped from the factory. Within this time frame, High Country Tek will provide evaluation of warranted items free of charge. Warranty repair or replacement will be at the factory's discretion.

Please have the units full Model / Part Number and Serial Number available when contacting the factory. Do not return products to the factory without a RMA (Return Material Authorization) number.

Product Use Limitations

HCT products may not be suited for any of the following applications:
- Any product which comes under the Federal Highway Safety Act, namely steering or braking systems for passenger-carrying vehicles or on-highway trucks.

- Aircraft or space vehicles.

- Ordinance or military equipment.

- Life support equipment.

- Any end product which, when sold, comes under U.S. Nuclear Regulatory Commission rules and regulations.

HCT does not have any performance assurance programs for testing their products for the above applications.

HCT's products are not designed for these applications and HCT does not warrant, recommend, or specifically approve its products for these applications.

The user shall be solely responsible for any loss or damages occasioned by breach of the provisions of this paragraph and shall carry product liability and liability insurance to insure against such loss or damages.

Cautions

Changing setup values or operating modes while a machine is running may cause unintended machine movement. It could lead to possible **injury** or **death**. Any moving parts should be disabled prior to changing setup values or operating modes. In every case, exercise caution and work should be completed only by qualified personnel.

Product Application Guidelines

ALWAYS do the following

- FULLY read this manual and accompanying data sheets BEFORE starting.

- Isolate this unit from all other equipment BEFORE any form of welding.

- Isolate the controller from ANY form of battery charging or battery boosting.

- Be aware of the electrical & mechanical connections, and the expected reactions of the equipment.

- Operate the units within the temperature range.

- Use the correct tools to do the job (i.e. P.C., software) etc.

- Separate High Voltage AC cables from Low Voltage DC signal and supply cables.

- Make sure power supply is CORRECT, ELECTRICALLY CLEAN, STABLE, and rated for the full load.

- Make sure the controller output voltage & current is compatible with the equipment.

- All unused wires / terminals should be terminated safely.

- Ensure ALL connectors have no unintended SHORT or OPEN circuits.

- Ensure ALL connectors are wired correctly, secure, locked in place and fully connected.

- Disconnect or connect wires to or from this unit only when the power supply is disconnected.

- Use adequate screening in areas of intense Radio Frequency fields.

- Ensure ALL work areas are clear of personnel before operating the controller.

- Follow and abide by local and country health & safety standards.

Controller Specification

Housing Type	HCT encapsulated block, flameproof
Power Supply Voltage	9 to 32VDC *(Absolute Maximum)*
Current Consumption	Load current + 200mA Quiescent *(Max)*
Command Inputs	Programmable SAE J1939 CAN messages
	3x option selection switches *(ON/Off)*
	Up to 16x inputs for fan diagnostics *(ON/Off)*
	Up to 6x inputs for sensors or Potentiometers (Max temp = 50Ω, min temp = 2MΩ)
Outputs	Up to 3x 0-5Vdc @ 10mA analog outputs
	Up to 6x 0-100% PWM *(Sourcing for EMC-6, Sinking for EMC-6L, max 500mA, short circuit protection)*
	1x 3A Proportional PWM current output
	1x 3A on/off output for reverse coil
	1x 0.5A on/off output for alarm indicator
	1x 5V±5% regulated reference voltage
PWM Freq.	Software adjustable - 33 to 1000Hz
Module Connector	48-way Cinch 1.5mm SHS Header, Cinch PN: 581 01 48 011
Communication	Mini USB or 4-way Weatherpak for RS232
Housing Material	Black, Polycarbonate
Encapsulation	Flameproof epoxy resin
Mounting	2x ¼" x20 SAE Grade 2 screws
Temperature Range	-40 to +85ºC *(Operational)*
	-60 to +90ºC *(Storage)*
NEMA/IP Rating	NEMA 6P/IP68
CAN Data Rate	250Kbps, 500Kbps and 1000Kbps

Controller Dimensions / Mounting Information

- Controller weight is approximately 1.26Lbs.

- Mount controller in an easily accessible location.

- Mount controller to a flat surface.

- If mounting to a hydraulic product, allow at least a 2mm air gap underneath the unit.

- Use BOTH mounting holes with correct hardware.

- DO NOT mount controller with connector facing UP if possible.

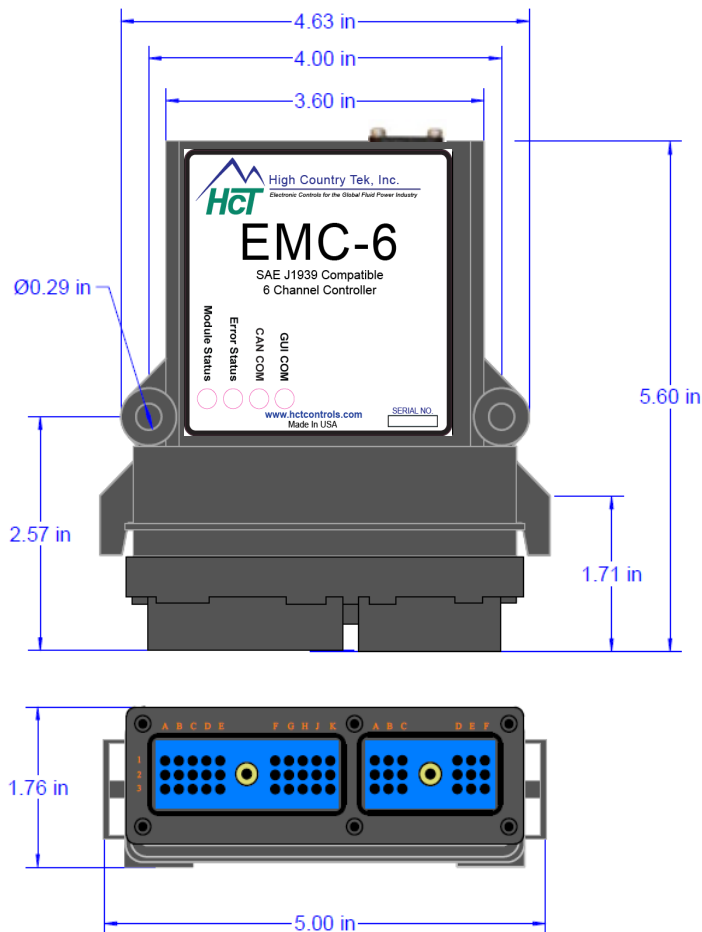- Recommended, ¼-20 SAE Grade 2 screws, Dry Torque – 4 Ft-lbs, Lubricated – 3 Ft-lbs.

Figure 1

Wiring Diagram

9 – 32VDC Power Input

FUSE

C2 - Ana_In 1
D2 - Ana_In 2
E2 - Ana_In 3
C1 - Ana_In 4
D1 - Ana_In 5
E1 - Ana_In 6
C3 - GND
D3 - GND
E3 - GND

A1 - RXD
F3 - GND
A2 - TXD
A3 - Not used

RS232

B1 - CAN_Hi
B2 - CAN_Lo
B3 - GND

J1939 I/O

F1 - Diag_In 1
G1 - Diag_In 2
H1 - Diag_In 3
J1 - Diag_In 4
J2 - Diag_In 5
J3 - Diag_In 6
K2 - Diag_In 7
K3 - Diag_In 8
e2 - Diag_In 9
e3 - Diag_In 10
f2 - Diag_In 11
f3 - Diag_In 12

K1 - Power_In
a1 - Power_In
a2 – Not used
F2 - Reverse_In   momentary
G2 - Fire_In   latched
H2 - Ignition_In   latched

d2 - Alarm_Out   0.5A On/Off (sourcing)
d3 - Reverse_Out 3A On/Off (sourcing)
f1 - GND

a3 - Ref_Out   5V±5% @ 200mA

Bank 1   0-5V @ 5mA (Pin G3)
          0.5A PWM % (Pin b1)

Bank 2   0.5A PWM % (Pin b2)
          0-5V @ 5mA Output (Pin H3)

Bank 3   0.5A PWM % (Pin c1)
          0-5V @ 5mA Output (Pin d1)

Bank 4   0.5A PWM % (Pin c2)
          3A Prop. PWM (sourcing, Pin e1)

Bank 5   0.5A PWM % (Pin b3)
Bank 6   0.5A PWM % (Pin c3)

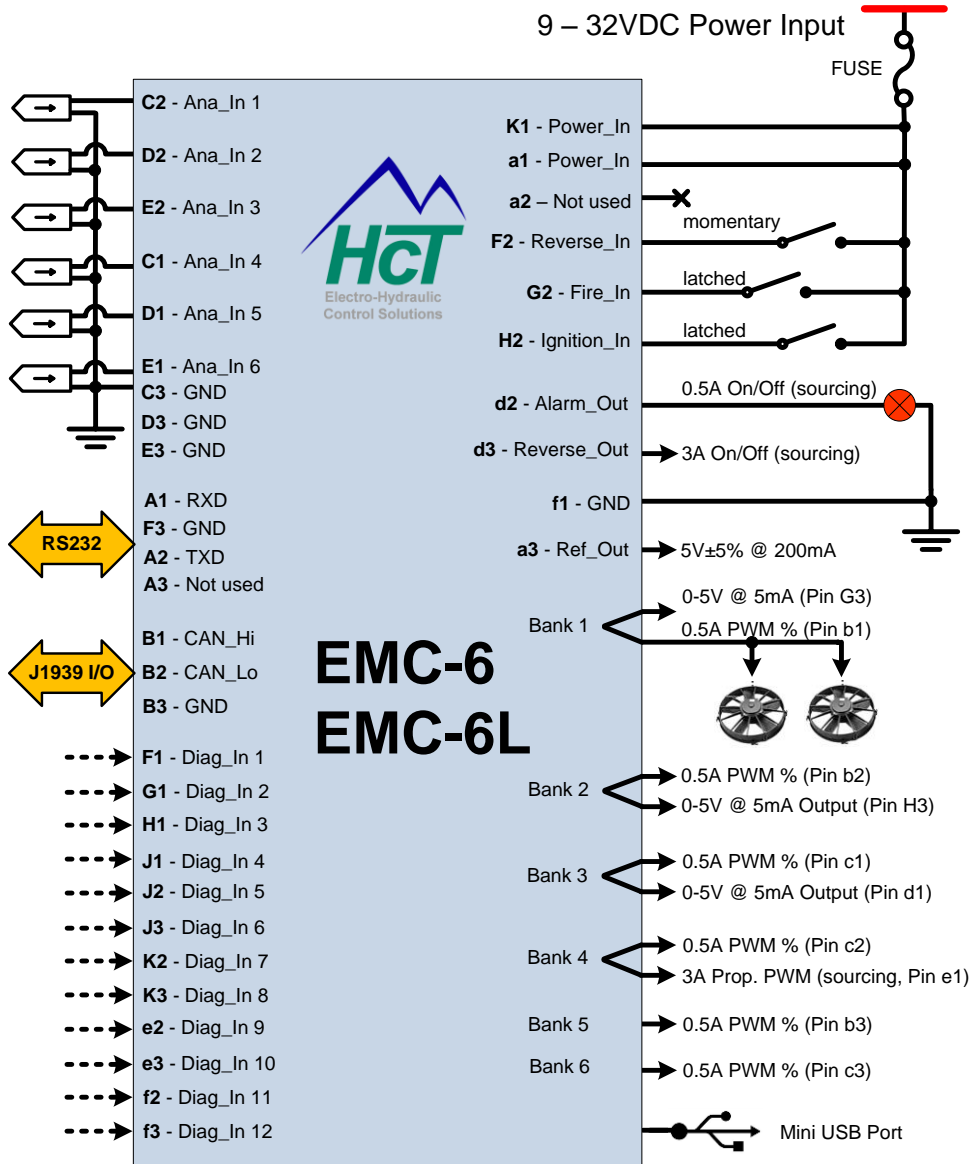Mini USB Port

EMC-6
EMC-6L

Figure 2

PWM% outputs are sourcing for EMC-6. PWM% outputs are sinking for EMC-6L.

PINOUT

The module has a 30-Pin Cinch connector and an 18-Pin Cinch connector. Either the RS232 port from the 30-pin Cinch connector or the mini USB port at the top of the controller can be used for serial communication.

EMC-6/EMC-6L Connector Designation Table
30 Pin Metri-Pak Connector (Male, Plug)

PIN	Name	PIN	Name	PIN	Name
A1	RXD (RS232)	F1	Diag_In 1	J1	Diag_In 4
A2	TXD (RS232)	G1	Diag_In 2	J2	Diag_In 5
A3	Not used	H1	Diag_In 3	J3	Diag_In 6
C1	Therm_In 4	F2	Reverse_In	K1	Power_In
C2	Therm_In 1	G2	Fire_In	K2	Diag_In 7
C3	GND	H2	Ignition_In	K3	Diag_In 8
D1	Therm_In 5	F3	GND	B1	CAN_Hi
D2	Therm_In 2	G3	Bank 1 An_Out	B2	CAN_Lo
D3	GND	H3	Bank 2 An_Out	B3	GND
E1	Therm_In 6	E2	Therm_In 3	E3	GND

Figure 3

EMC-6/EMC-6L Connector Designation Table
18 Pin Metri-Pak Connector (Male, Plug)

PIN	Name	PIN	Name	PIN	Name
a1	Power_In	c1	Bank 3 PWM	e1	Bank 4 3A
a2	Not used	c2	Bank 4 PWM	e2	Diag_In 9
a3	Ref_Out	c3	Bank 6 PWM	e3	Diag_In 10
b1	Bank 1 PWM	d1	Bank 3 An_Out	f1	GND
b2	Bank 2 PWM	d2	Alarm_Out	f2	Diag_In 11
b3	Bank 5 PWM	d3	Reverse_Out	f3	Diag_In 12

Figure 4

NOTE: Thermistors 1-4 (pins C1, C2, D2, E2) can be utilized as Fan Diagnostic inputs and configured within the GUI on the **Analog Settings** tab.

LEDs / Diagnostic Codes

The module has 4 LEDs.

GUI LED blinks GREEN -- Normal communication

GUI LED steady GREEN -- No communication

CAN LED steady RED and Error Status blinks GREEN -------------- CAN message timeout

CAN LED blinks RED -- Intermittent CAN message timeout

CAN LED blinks green fast --- Normal operation

Error Status LED steady GREEN -- Normal operation

Error Status LED blinks RED 1~6 times -------------------------------- Bank #1-6 diagnostic error.

Error Status LED blinks GREEN 1 time --------------------------------- CAN message timeout

Error Status LED blinks GREEN 2 times -------------------------------- Analog value out of range

Error Status LED blinks GREEN 3 times -------------------------------- CAN value out of range

Error Status LED blinks GREEN 4 times -------------------------------- Reference Voltage low

When multiple errors occur, the LED sequences through the error codes.

Module status LED steady GREEN -- Normal operation

Module status LED blinks RED/GREEN --------------------------------- Reverse cycle

Module status LED steady RED --- Fire

Module status LED blinks GREEN -- Low voltage

Alarm indicator blinks RED 1~6 times at 0.5 seconds intervals ----- Bank #1-6 diagnostic error

Alarm indicator sequences through the error codes -------------------- Diagnostic errors on more banks

Alarm indicator steady red --- J1939 times out

Alarm indicator blinks red 1 time at 1.0 seconds intervals ------------ Any fan bank in reverse

Accessories

999-10104

30-pin Harness (3M length)

999-10107

18-pin Harness (3M length)

999-10077

48-pin Mating Connector Kit

CD-EMC-6

PC set-up software
System diagnostics
Data logging feature

108-00134

USB Mini B
(2M length)

999-10075

4-way weatherpak
to RS232

108-00119

RS232 to PC USB

206-00083 (3/8"-18NPT)
206-00083M (M12x1.5)

Liquid thermistor
-40°C to +150°C.

999-10213 (Mating connector)

For both liquid and dry thermistors

206-00084 (3/8"-18NPT)

Dry Thermistor
-40°C to +150°C.

Example Applications
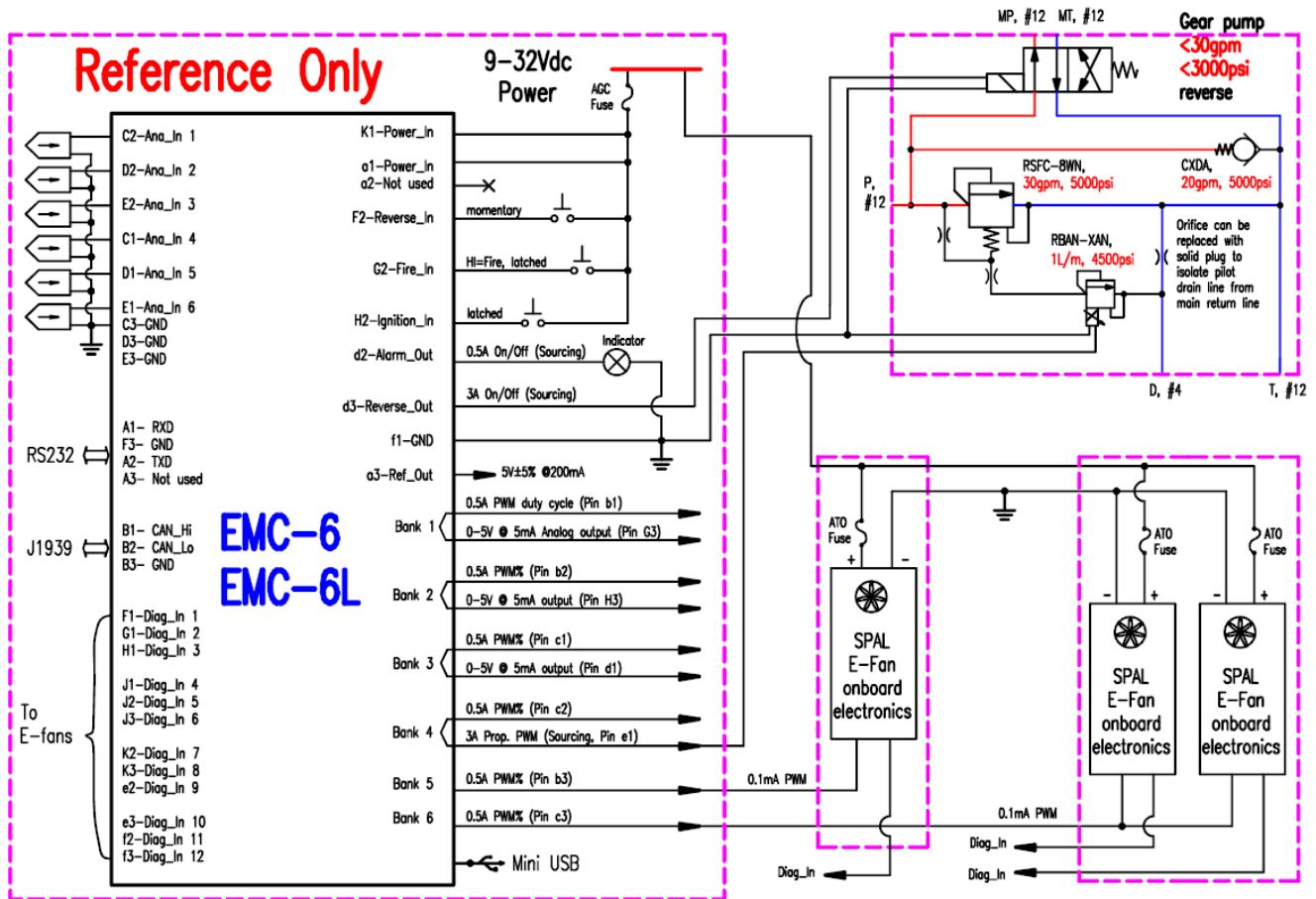
Figure 5

GUI Installation

Use the default file locations for easy future update when installing the Graphical User Interface (GUI). The user has the option to choose file location.

Do NOT run the GUI from a network drive as it needs to access certain files only in the local Windows directories.

System Requirements

- Windows XP, Vista, Windows 7 or 8, 100MB or greater free disk space.

Installation Steps

- Insert the CD and follow the on screen instructions. This will install the GUI, manual and help files.

- Go to Help menu, install the CommFront driver or Mini USB driver.

- To insure a complete install for CommFront, install it twice.

- Install all software and drivers before plugging in the USB dongle or USB cable.

Launch the GUI

Click Start ⇒ HCT Products ⇒ Fan Drives ⇒ EMC-6
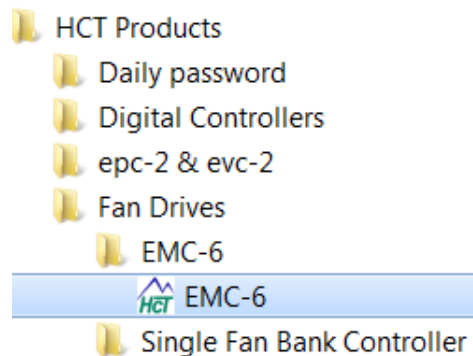
Figure 6

GUI Overview

At start up the GUI searches all the PC communication ports and identifies the controller. The GUI appears once the module is identified.
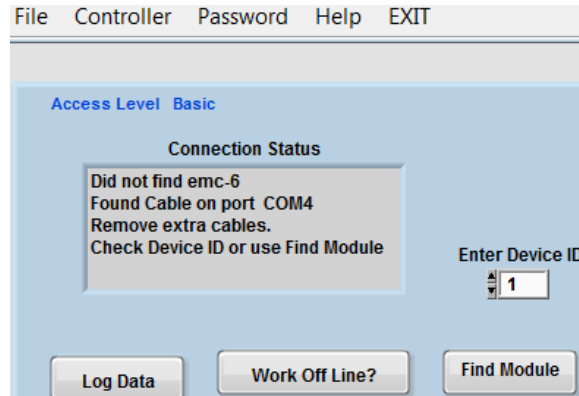
Figure 7

- **Device ID** – When using more than one EMC-6 with the same computer, each EMC-6 will need to have a unique device ID. The default Device ID is 1.

- **Log Data** – logs the operational data in Excel format, see Page 23 for details.

- **Work Off Line** – allows the user to work with GUI offline without the module connected. The user can load any existing data files, modify them or create new data files and save them to the PC without an OEM password.

- **Find Module** – the GUI tries to find the controller and reconnect it.

File

- **Save settings to a file (.txt)** – saves the settings to a data file that may be loaded into any EMC-6 controller.

- **Read settings from a file (.txt)** – loads the data file from the PC to the EMC-6 GUI. At this point the data is not written to the controller yet.
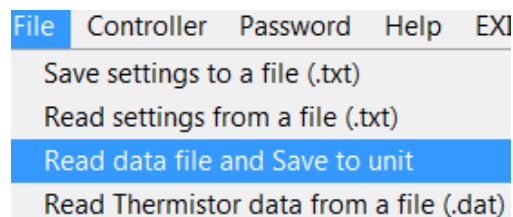
Figure 8

- **Read data file and Save to unit** – loads the data file from the PC, writes to the controller and permanently saves the settings.

- **Read Thermistor data from a file (.dat)** – loads the thermistor data file from the PC to the GUI to match the thermistor in the system. The data are not written to the controller yet.

Controller

- **Write all settings to controller** – executes all "**send new settings**" on every Tab and saves settings to Volatile Memory (RAM). It does not save settings permanently, a Power Cycle will restore permanently saved settings.
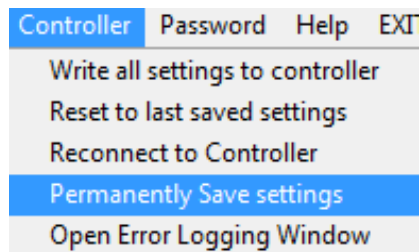

Figure 9

Settings not permanently saved will be lost after a power cycle.

- **Reset to last saved settings** - like a Power Cycle, the module reloads the settings permanently saved in Non-Volatile Memory.

- **Reconnect to Controller** – the GUI resets communication with the module, re-reads and updates all variables.

- **Permanently Save settings** – saves the settings to its Non-Volatile Memory (permanent memory).

- **Open Error Logging Window** – opens the internal data logging windows that display the error situations, such as the count of timeouts, coil open/shorts, fire input ON, the high and low error when bank stimulus and diagnostics occur.

Error Logging Window - Control Messages and Unit Errors

This tab displays the received messages and the number of times the message timed out counting from 1 to 255. The messages displayed are defined in the Control Messages tab of the EMC-6 GUI.
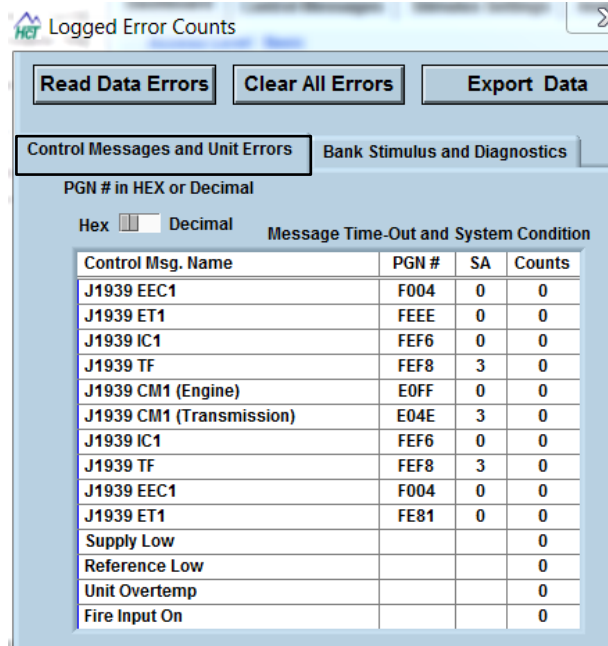
Figure 10

- **Control Msg. Name** – the CAN message defined on the Control Messages tab. Each message shows the PGN#, in Hex or Decimal, and Source Address (SA) as per defined in the Control Messages tab.

  NOTE: The Source Address (SA), in this case, is the address of the device on the J1939 Bus that the EMC-6 is receiving messages from.

- **Counts** – ranging from 1 to 255, this represents the number of times the message timed out per the defined Time-Out value in the Control Messages tab.

- **Supply Low** – supply voltage drops below 8 volts for more than 2 seconds.

- **Reference Low** – reference voltage output (pin a3) drops below 4.00 volts for more than 2 seconds (indicating the output is sourcing more than 250mA).

- **Unit Overtemp** – the controller hardware rises above 85°C for more than 2 seconds.

- **Fire Input On** – Fire Input is switched high greater than 8 volts for more than 2 seconds. (Fire and Reverse are normally low unless inverted on the Global Settings page).

Error Logging Window - Bank Stimulus and Diagnostics

This tab displays the number of faults for each stimulus within each fan bank defined in the Bank Control tab of the EMC-6 GUI.
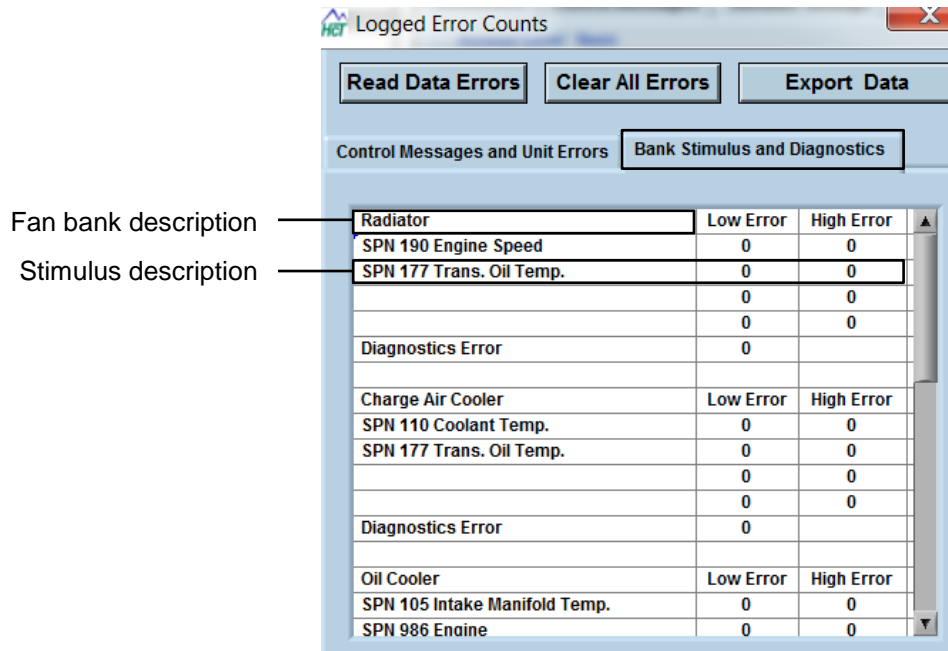
Fan bank description

Stimulus description

Figure 11

- **Low Error** – ranging from 1 to 255, this represents the number of times the stimulus temperature dropped below the Alarm Low temperature defined in the Bank Control tab.

- **High Error** – ranging from 1 to 255, this represents the number of times the stimulus temperature exceeded the Alarm High temperature defined in the Bank Control tab.

Password

- **OEM Password** – allows full access to view settings, setup data files, apply changes or upload data files to controllers and manual control.
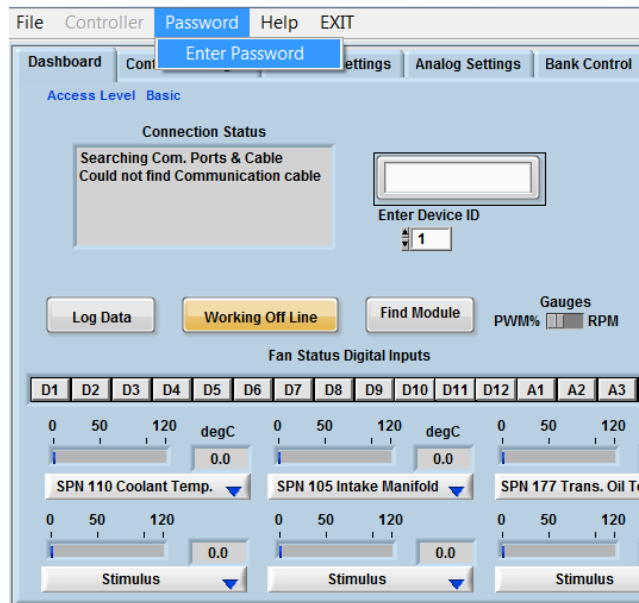
  NOTE: Passwords are *'cAsE SeNsitivE'*

Figure 12

Help

- **About Controller** - displays the controller type, BIOS, Serial No, Activation Date, the GUI revision and Part Number, contact information, etc.

Figure 13

- **Help Files** – opens the folder C:\\HCT products/Fan Drives/EMC-6 where the manual and other related information are located.

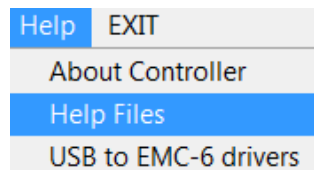- **USB drivers** – opens the folder where USB driver installation instruction is located.

Figure 14

Exit

- **Exit Program** – exits the GUI and frees up the communication port and memory used by the application.
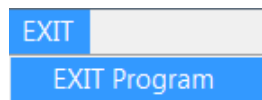

Figure 15

Dashboard

The Dashboard monitors the fan system in real time.

Configure all tabs from left to right so that the subsequent tabs have the correct background settings.
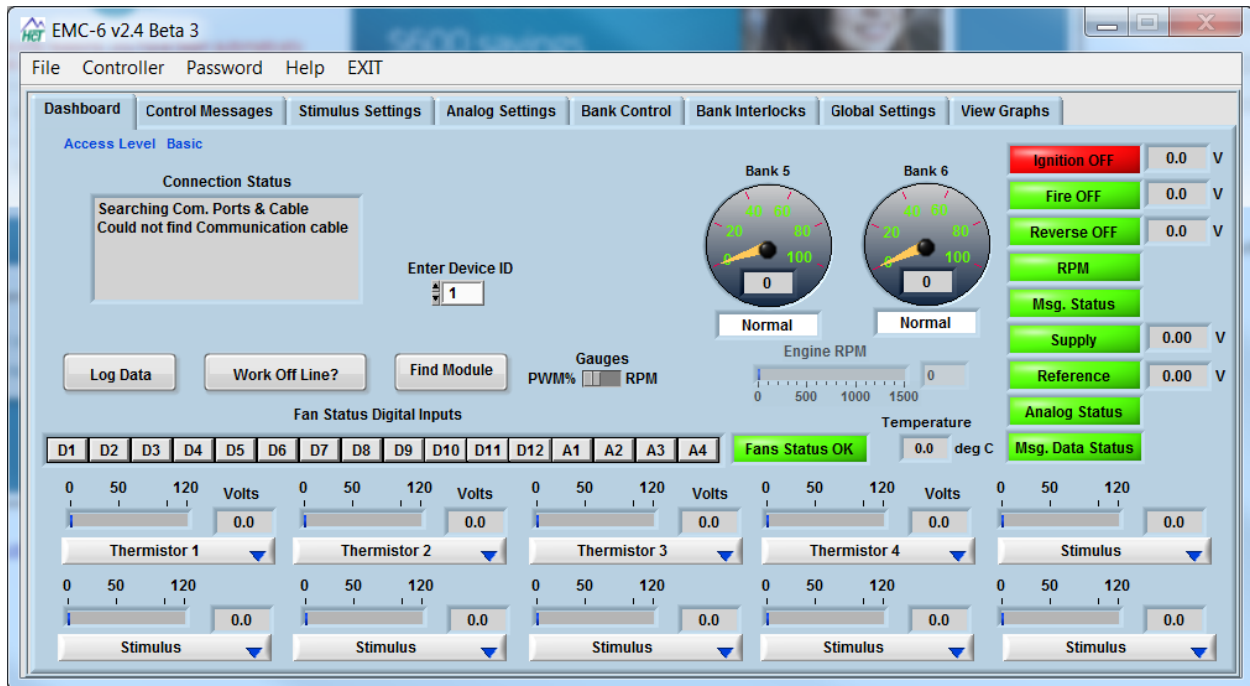

Figure 16

- **Gauges PWM/RPM** – displays either the real time PWM % or the Calculated Fan RPM.

There are six operational states for the fan bank gauges:

Normal – All the fans in this bank are operating normally.

Diag. Error – At least one fan in this bank is reporting an error.

Manual – All the fans in this bank are in manual mode.

Reset – At least one Locked Rotor error was detected. The module is resetting all the fans in this bank.

Dwell – The fans in this bank are freewheeling before entering into reverse direction.

Reverse – The fans in this bank are in Reverse.

- **Fan Operating Status and Fan Error Status** – indicates the fan status.

  Green – indicates that fans are running.

  Gray – indicates that fans are OFF.

  Red – indicates one or more fans have errors. It happens when the respective diagnostic pin does not have voltage when the fan is running; or has voltage when the fan is not running.

  Fan ID numbers are assigned in the "**Bank Interlocks"** tab.

- **State Indicators** – displays the state of the inputs, RPM, J1939 messages, Supply voltage and Reference voltage.

  Green – the input is on or active.

  Yellow – the input is in an intermediate state (i.e. RPM low).

  Red – the input is off or timed out, or in an error state like Ignition OFF.

- **Log Data -** logs the operational data in Excel format. The file size is only limited by the PC's hard-drive capacity.

  Each log begins with a list of settings followed by operational information. The sample rate depends on the workload of the PC and the controller at the recording. A timestamp scales the logs appropriately. Subsequent logs may be saved in a new file or appended to the original file by selecting the original file.

  The log file is saved as a .csv file. Microsoft Excel can be used to open this file.

- **Stimulus Bar Graphs** – displays the real time readings of the stimulus.

  Select the stimulus from the pull down menu. Scale the bar graphs. The units are set in the **"Stimulus Settings"** for CAN values and in the **"Analog Settings"** for the Analog Inputs.

- **Engine RPM** - displays the engine RPM from SPN 190, or the error value in "**Stimulus Settings**" when the engine RPM message times out.

Control Messages

The user may define up to 10 CAN messages as the controlling inputs. Currently the EMC-6 supports the SAE J1939 protocol.

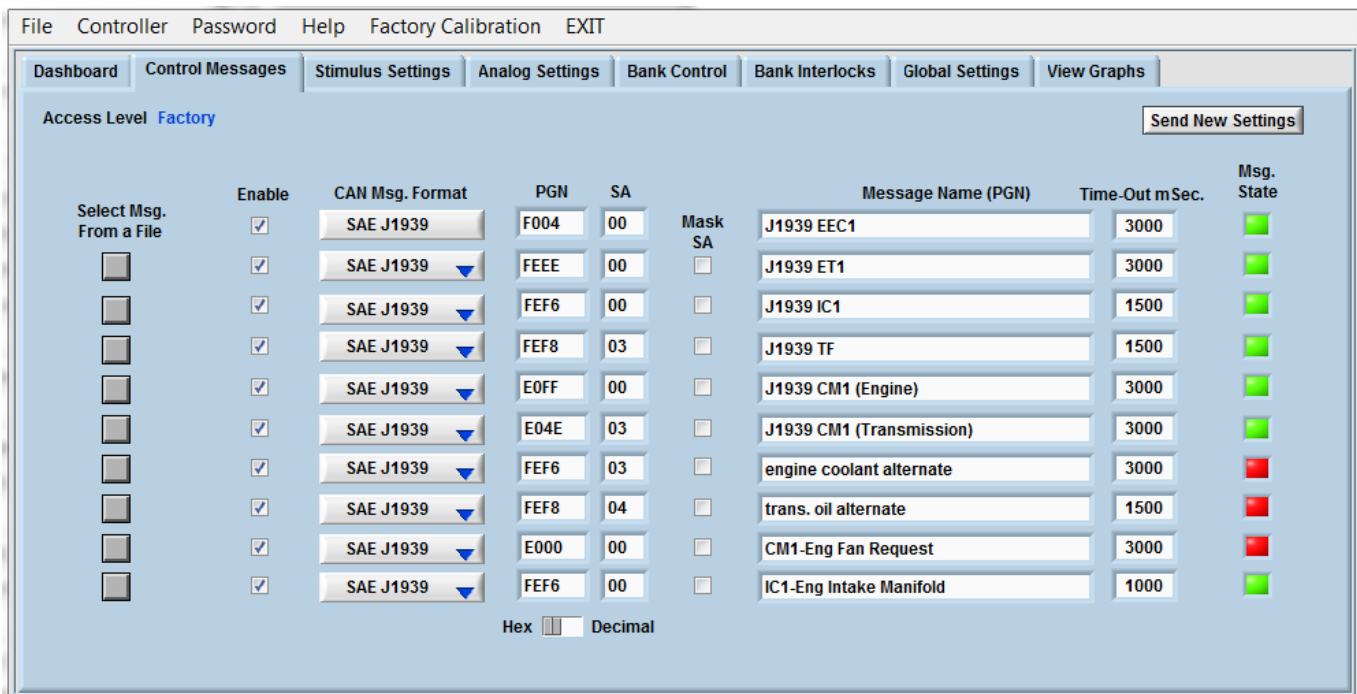NOTE: The first message is always EEC1, Engine RPM (hard coded).

Figure 17

Configure Control Messages

Configure Control Messages from a default file included in the GUI installation.

- **Select Msg From a File** – opens the control message file and displays the Message Window.
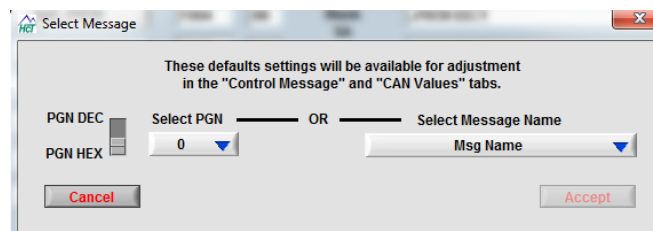

Figure 18

- **Select PGN** or **Select Message Name**, the GUI will match PGN and Message Name.

- **Accept** or **Cancel** the message.

- **Check** to enable the message.

- Select **SAE J1939** as the **CAN Msg. Format.**

- **Mask SA** – if checked, the source address is ignored. The module can receive messages from any source address for the specified PGN number.

Configure Control Messages Manually

- Select **SAE J1939** as the **CAN Msg. Format.**

- Enter the PGN number, Source Address, Message Name and the message time out in milliseconds.

- **Check Box** - enables the message.

- **Mask SA** – if checked, the source address is ignored. The module can receive messages from any source address for the specified PGN number.

- **Send New Settings** – loads the new settings into the unit's RAM memory and activates these messages.

- Control messages are now available on the **Stimulus Settings** Tab.

Message Indicators

- **Msg. State** – indicates if the command message is being received on the J1939 Bus.

  Green – the message is Active.

  Red – the message is Timed Out.

  Grey – the message is Inactive.

- **Hex/Decimal Switch** – switches PGN numbers between Hexadecimal or Decimal format.

Stimulus Settings

The user may define up to 10 CAN messages as the inputs.

> NOTE: The first message is always EEC1, Engine RPM. Only the error value can be changed for this SPN.
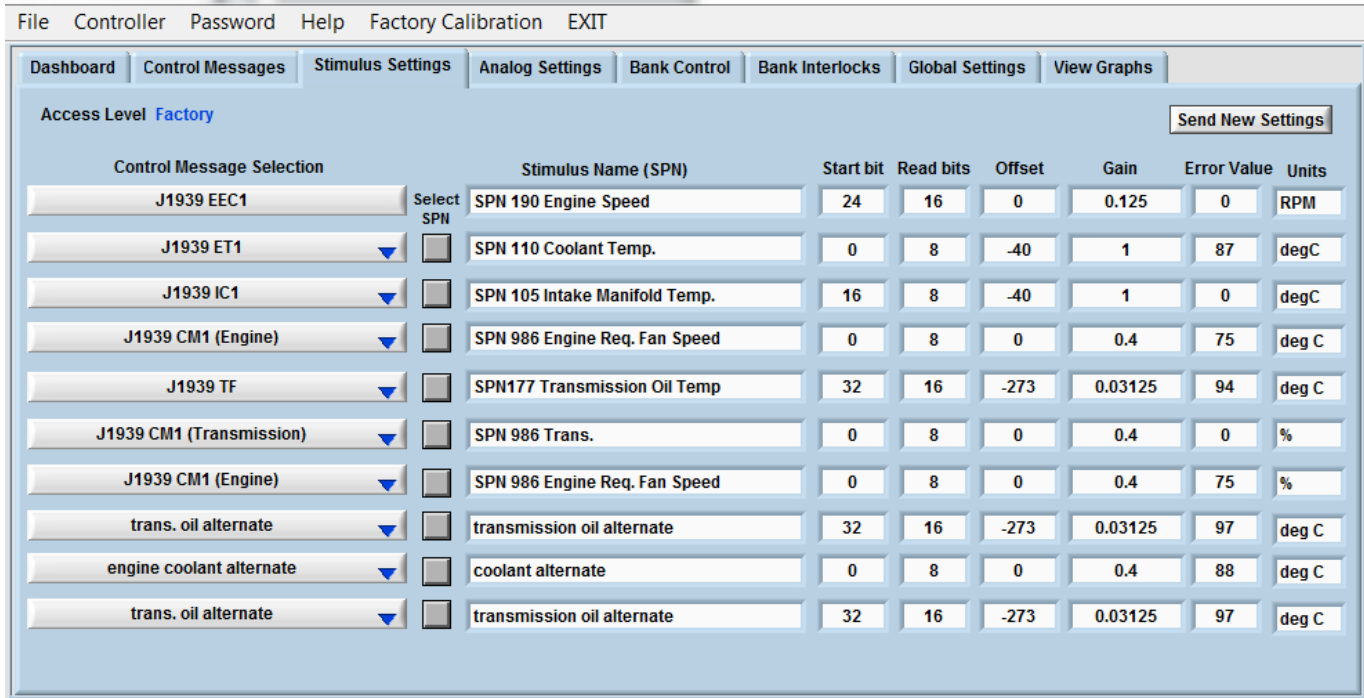
File	Controller	Password	Help	Factory Calibration	EXIT					

Dashboard	Control Messages	Stimulus Settings	Analog Settings	Bank Control	Bank Interlocks	Global Settings	View Graphs

Access Level Factory

Send New Settings

Control Message Selection		Stimulus Name (SPN)	Start bit	Read bits	Offset	Gain	Error Value	Units
J1939 EEC1	Select SPN	SPN 190 Engine Speed	24	16	0	0.125	0	RPM
J1939 ET1		SPN 110 Coolant Temp.	0	8	-40	1	87	degC
J1939 IC1		SPN 105 Intake Manifold Temp.	16	8	-40	1	0	degC
J1939 CM1 (Engine)		SPN 986 Engine Req. Fan Speed	0	8	0	0.4	75	deg C
J1939 TF		SPN177 Transmission Oil Temp	32	16	-273	0.03125	94	deg C
J1939 CM1 (Transmission)		SPN 986 Trans.	0	8	0	0.4	0	%
J1939 CM1 (Engine)		SPN 986 Engine Req. Fan Speed	0	8	0	0.4	75	%
trans. oil alternate		transmission oil alternate	32	16	-273	0.03125	97	deg C
engine coolant alternate		coolant alternate	0	8	0	0.4	88	deg C
trans. oil alternate		transmission oil alternate	32	16	-273	0.03125	97	deg C

Figure 19

Configure Stimulus Settings

Configure Stimulus Settings from a default file included in the GUI installation.

- Select **specific Control Message** from the pull-down menu defined in "**Control Messages**" Tab.

- Select **SPN Selection** text file. A new window will open.

- Select the stimulus from the pull-down menu **Stimulus (SPN)**, the respective values appear automatically.
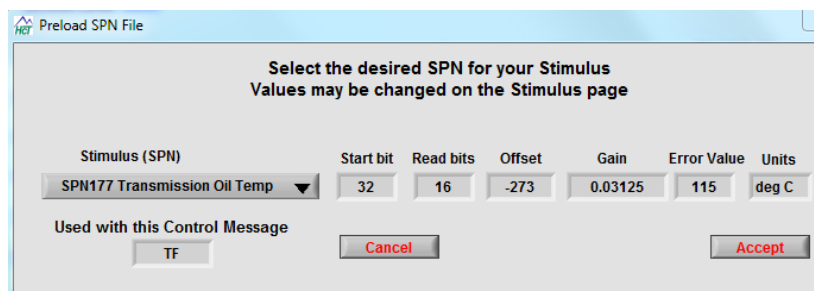
Preload SPN File

**Select the desired SPN for your Stimulus
Values may be changed on the Stimulus page**

Stimulus (SPN)	Start bit	Read bits	Offset	Gain	Error Value	Units
SPN177 Transmission Oil Temp	32	16	-273	0.03125	115	deg C

Used with this Control Message

TF

Cancel   Accept

Figure 20

The stimulus has to match the control message. E.g., SPN177 Transmission Oil Temperature matches J1939 TF.

- If the **Stimulus** does not match the **Control Message**, this window will appear:
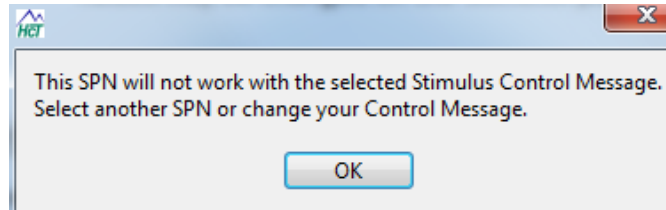
Figure 21

- Match the **Stimulus** to the **Control Message**.

- **Accept** or **Cancel** the selection.

- Enter the **Error Value** on **Stimulus Settings** tab. This will be the stimulus value when this message times out.

- The user can also modify the values on **Stimulus Settings** tab.

Configure Stimulus Settings Manually

- Select **Stimulus** from the list defined in "**Control Messages**" Tab.

- Enter a name in the **Stimulus Name (SPN)**. Use the SPN number and/or a short description.

- Enter values for the following:

  - **Start Bit** – The bit number where the data begins. Bit numbering starts at 0.

  - **Read Bits** – The number of bits in the data package.

  - **Offset** – The offset is applied after the Gain Calculation.

  - **Gain** – The Scale Factor for the Gain Calculation.

  - **Error Value** – the value used for the stimulus when the message times out.

  - **Units** – the unit of the stimulus value.

- **Send New Settings** – loads the new settings into the unit's RAM memory and activates these stimuli.

- **Stimulus Settings** are now available on the **Bank Control** Tab.

Analog Inputs

The user may define up to 6 analog inputs: voltage, thermistor, or diagnostic inputs.

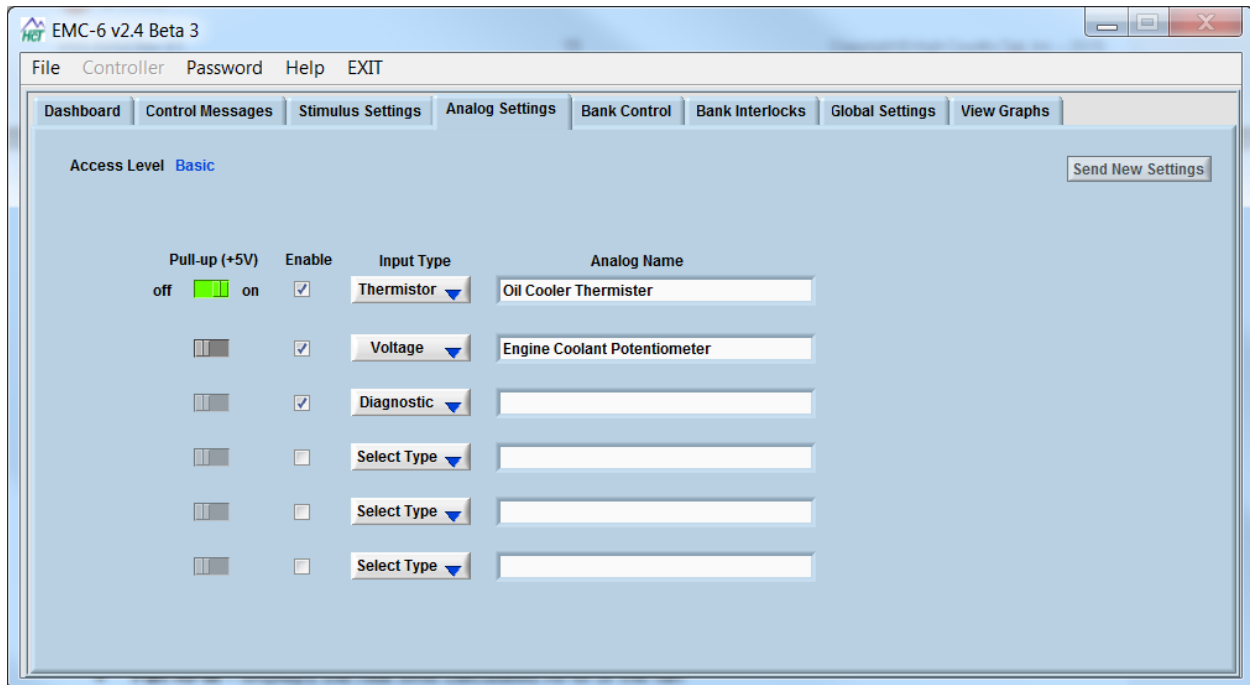NOTE: Additional diagnostic inputs are reserved for analog inputs 1 through 4.

Figure 22

Configure Analog Inputs

- **Pull-Up (+5V)** – Select **On** for thermistors. When on, the module sources current for use with resistive thermal devices. Select **Off** for potentiometer or analog inputs.

- **Enable** – **check** to enable the input.

- **Input Type** – Select Thermistor or Voltage type.

- **Analog Name** – name the input.

- **Low Value** & **High Value** – the minimum and maximum values the sensor can report.

- **Send New Settings** – loads the new settings into the unit's RAM memory and activates these stimuli.

- **Permanently save settings**

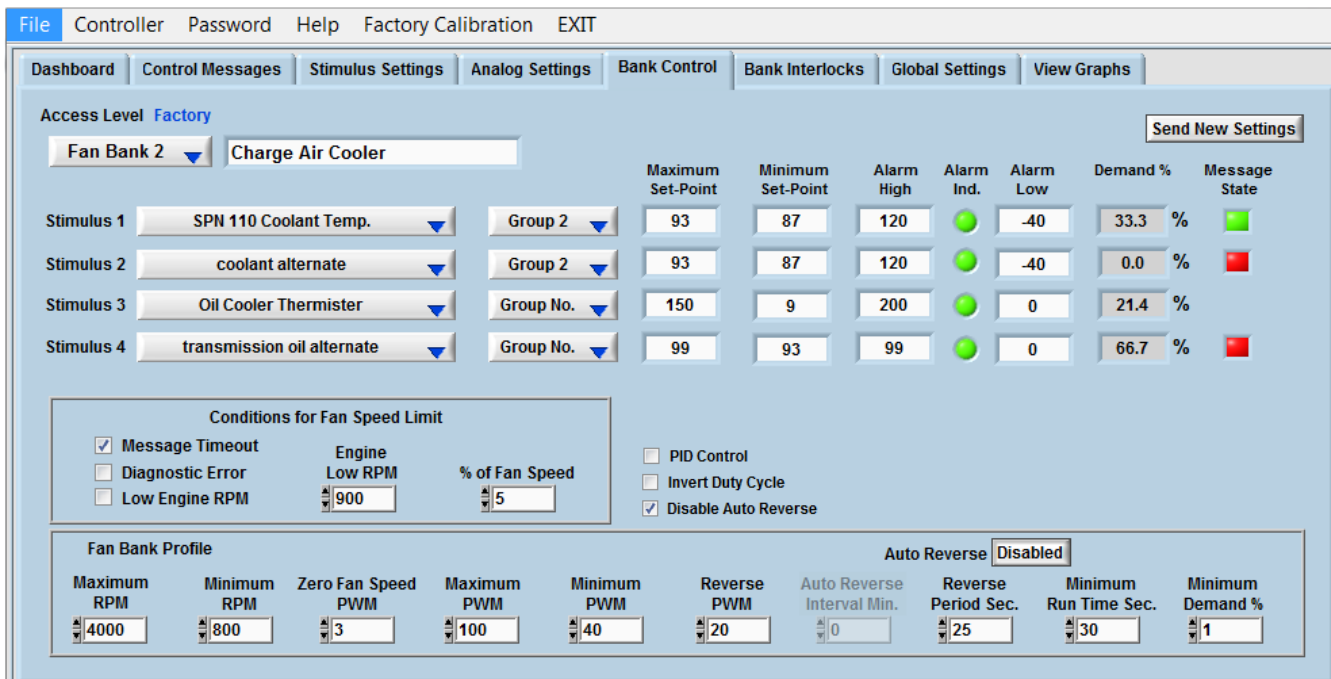- **Analog Settings** are now available on the **Bank Control** Tab.

Bank Control

Figure 23

Setup Fan Bank Parameters

The user may define independently up to 6 banks of electric fans and up to 1 bank of hydraulic fan. For each bank, the user may define up to four stimulus inputs.

- **Fan Bank *n*** – selects the fan bank to be configured.

- **Name the Fan Bank n** – names the bank to identify it on the GUI.

- **Stimulus** – selects stimuli for this bank. All previously configured stimuli are in the pull down menu. Multiple fan banks may use the same stimuli.

- **Stimulus Grouping** – in each fan bank, the inputs can be grouped.

  Group No. – When a stimulus reaches a value that is out of range, as defined by the Alarm High and Alarm Low settings and is not grouped (left as Group No.), then the fan bank will default to the % of Fan Speed condition.

  Group 1 – The fan bank does not default to the % of Fan Speed condition if a stimulus value becomes out of range while grouped with more than one stimulus and the additional stimulus is the operational set points.

  Example: Stimulus 1 and 2 are both grouped as Group 1. Stimulus 1 reaches an alarm set point but Stimulus 2   is still within the operation limits: the fan bank ignores Stimulus 1 and continues to operate with Stimulus 2 as priority.

Group 2 – Like Group 1, the fan bank does not default to the % of Fan Speed condition if a stimulus reaches an Alarm High set point while grouped with more than one stimulus and the additional stimulus is within an operational set points.

Example: Stimulus 3 and 4 are both grouped as Group 2. Stimulus 3 reaches an alarm set point but Stimulus 4 is still within the operation limits: the fan bank ignores Stimulus 3 and continues to operate with Stimulus 4 as priority.

- **Maximum Set-Point** – the stimulus value that makes the fan bank run at full speed.

- **Minimum Set-Point** – the stimulus value that makes the fan bank run at minimum speed.

- **Alarm High** – the stimulus value that trips the High Alarm condition.

- **Alarm Low** – the stimulus value that trips the Low Alarm condition.

- **Demand %** – displays the normalized percentage of demand.

- **Message State** – displays green when normal, red when timed out. A timeout occurs when the message has not been received for a period greater than the **Time Out** setting in the **Control Messages** tab..

Conditions for Fan Speed Limit

- **Message Timeout** – when checked, the fan speed defaults to the % of Fan Speed specified by the user if there is a message timeout. If stimulus is grouped and there is a message timeout indicated on the Message State, the fan bank does not default to the % of Fan Speed as long as there is an additional valid stimulus within the same Group 1 or 2.

- **Diagnostic Error** – when checked, the fan bank speed defaults to the % of Fan Speed if there is diagnostic error.

- **Low Engine RPM** – when checked, the fan bank speed defaults to the % of Fan Speed if the engine RPM is lower than the RPM defined, but it must also be higher than the Minimum Engine RPM in Global Settings tab if Engine RPM interlock is used.

NOTE: The **Dashboard** will display **Analog Error** or **Msg. Data Limit** when the value meets or exceeds the **Alarm High** or **Alarm Low** setting.

Fan Bank Profile

This defines the operational properties of the e-fan used for the specific bank.

- **Maximum RPM** – the rated fan Maximum RPM.

- **Minimum RPM** – the rated fan Minimum RPM.

- **Zero Fan Speed PWM** – the PWM % that causes the fan(s) to stop, see Figure 24.

- **Maximum PWM** – the PWM % that causes the fan(s) to run at maximum RPM, see Figure 24.

- **Minimum PWM** – the PWM % that causes the fan(s) to run at minimum RPM, see Figure 24.

- **Reverse PWM** – the PWM % that causes the fan(s) to run in Reverse, see Figure 24.

- **Auto Reverse Enable/Disable** – enables or disables the Auto Reverse feature.

- **Auto Reverse Interval** (minutes) – see the EMC-6 reverse cycle definition, see Figure 25. It is the time between the 1st reverse signal and the 2nd auto reverse signal.

- **Reverse Period** (seconds) – see the EMC-6 reverse cycle definition, see Figure 25. It is the total time of ramp up in reverse direction, full fan reverse time and ramp down time in reverse direction. Ramp up and down time equal to the dwell time set on the "Global Settings".

- **Minimum Run Time Seconds** – the minimum run time. It prevents the fans from repeatedly starting and stopping when there is low demand and helps reduce thermal cycling in the equipment.

- **Minimum Demand %** – determines the fan minimum speed % until the controlling input demands a higher speed. This eliminates the fans start up delay and quickly responds to fast changing heat loads such as Charge Air Coolers etc.

- **Send New Settings** – loads the new settings into the unit's RAM memory and activates these stimuli.
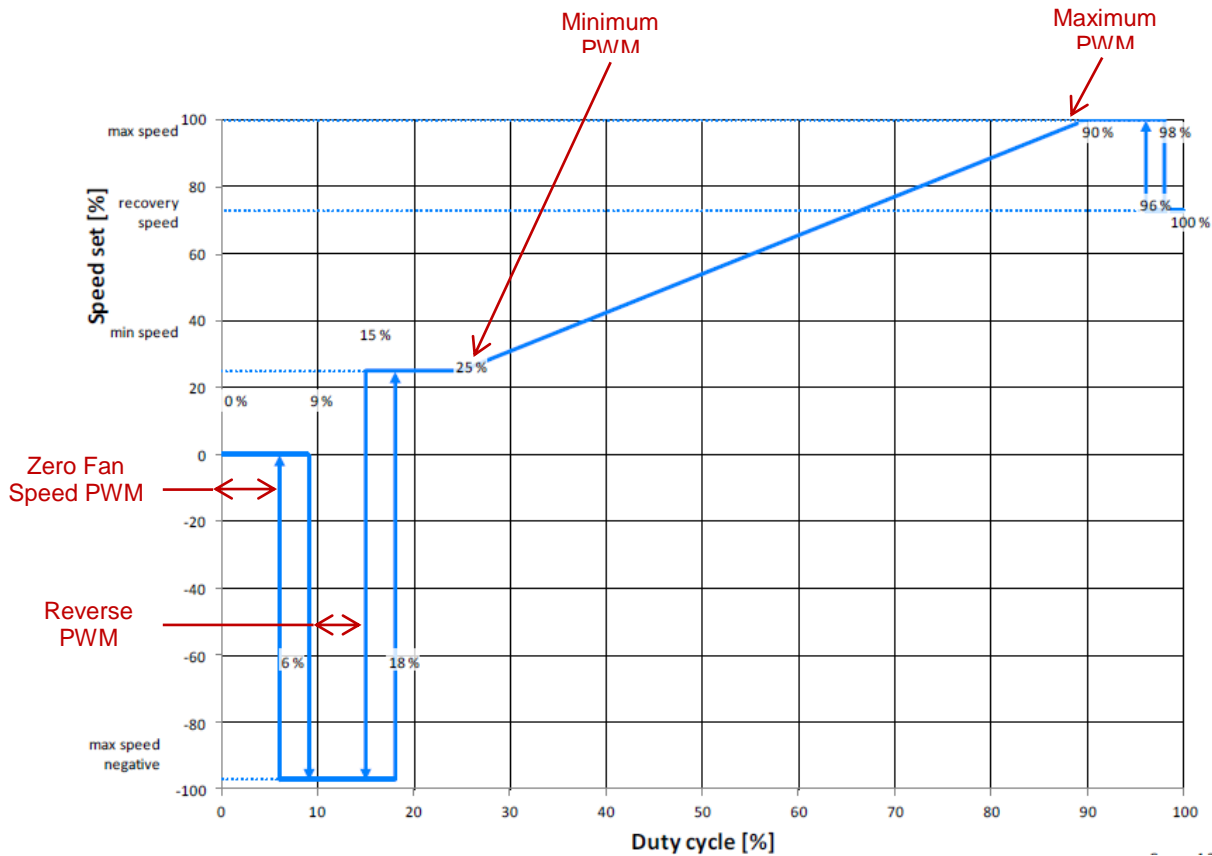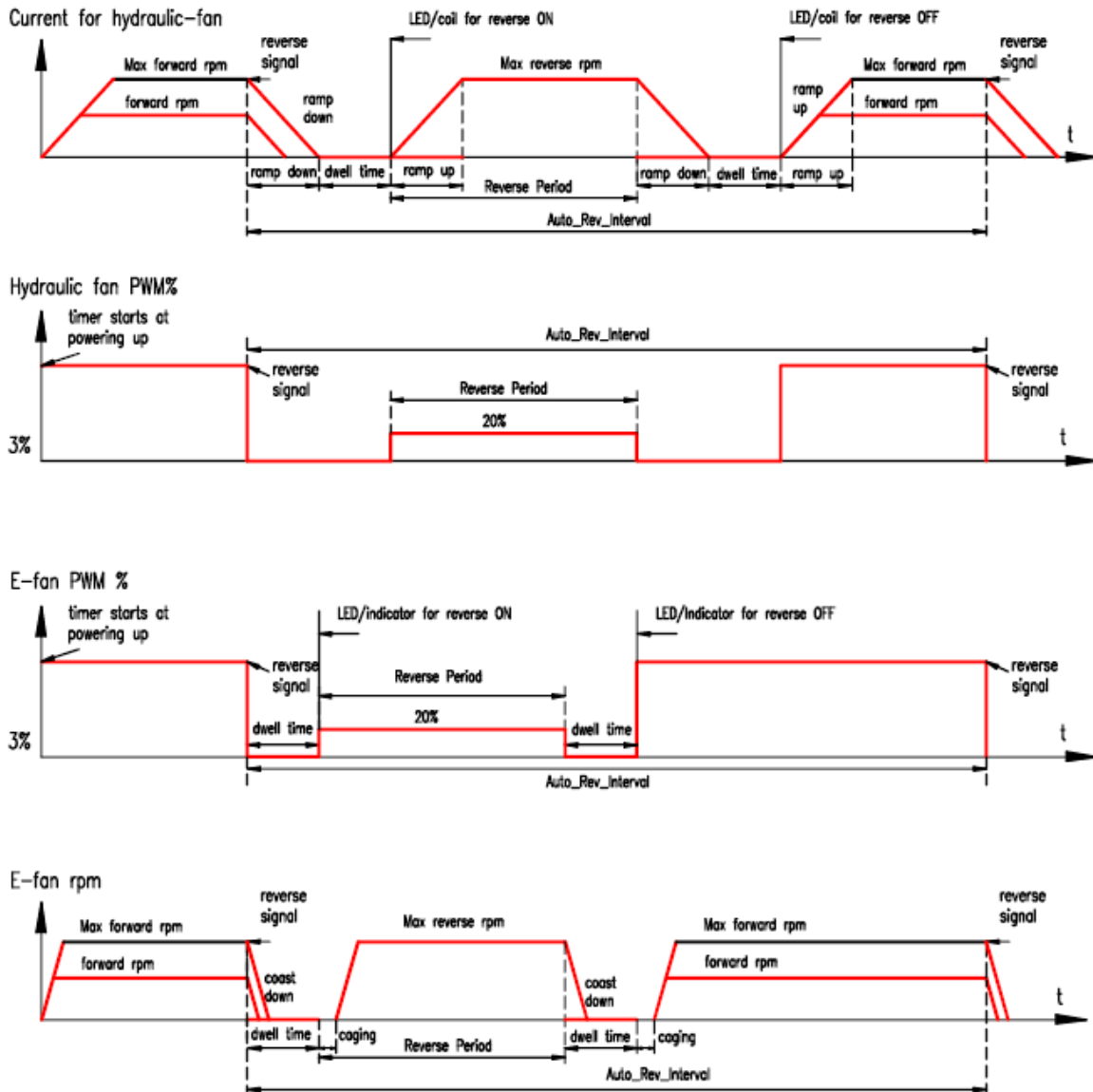

Figure 24

Figure 25

Setpoint Control (PID)

This is a precise closed loop control feature that automatically compensates to changing Stimulus inputs. The PID gains can be adjusted to increase or reduce the response characteristics due to changing Stimulus inputs. This feature uses a single Stimulus input instead of 4. For an overview of PID control and simplified tuning procedure, refer to Appendix C.
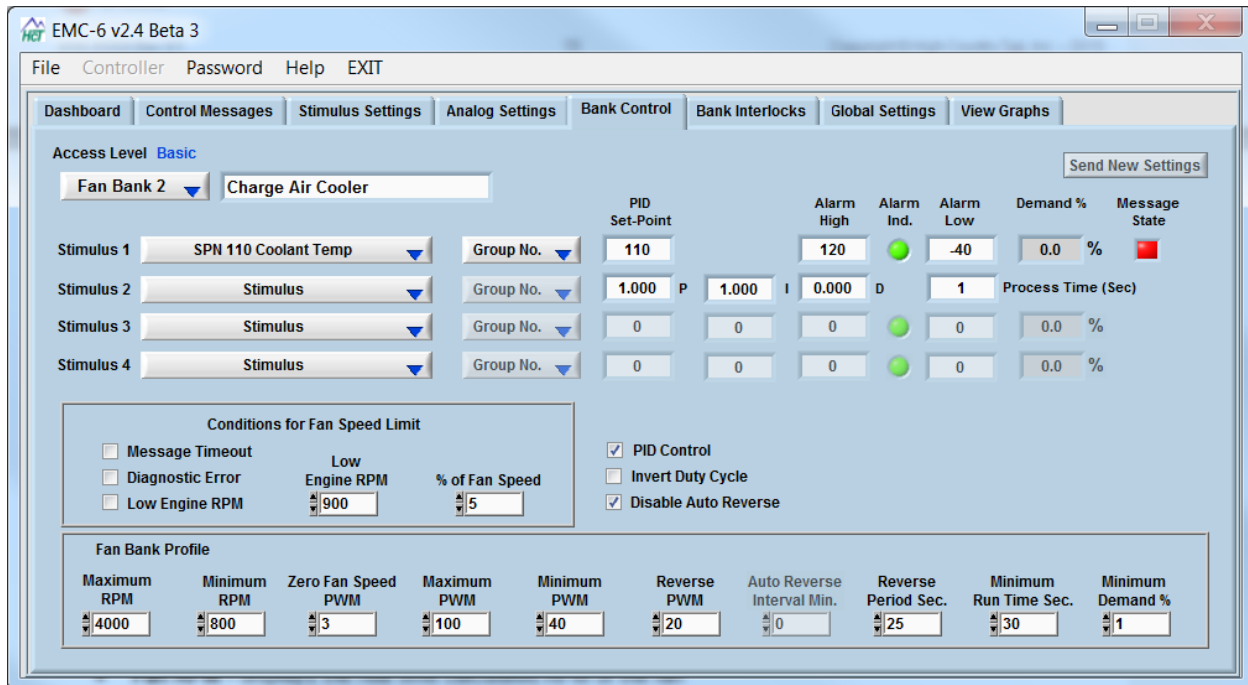

Figure 26

- **PID Control** – enables the Setpoint Control feature. When this is selected Stimuli 2 through 4 become nonfunctional and the PID terms become available.

- **Invert Duty Cycle** – enables the negative logic duty cycle when the checkbox is selected. The EMC-6 default (unchecked) is positive logic duty cycle. Reference the e-fan spec sheet in order to determine which definition the fan uses.

    Example: This is an example of "positive logic duty cycle", see Figure 27.

    - Continuous low voltage is 0% duty cycle
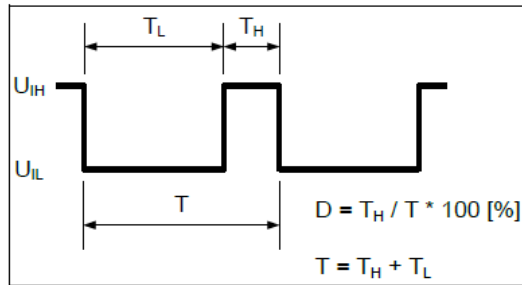   - Continuous high voltage is 100% duty cycle

Figure 27

Using the same waveform diagram, Figure 27, negative logic duty cycle would be: $D = \dfrac{T_L}{T*100[\%]}$

Disable Auto Reverse – When checked, the automatic fan reverse cycle occurring after a time interval period is disabled. Fans will reverse only if the reverse input is toggled with the **Reverse Switch**.

> NOTE: The Module Status LED blinks alternately RED and GREEN when any fan bank is in reverse (including E-Fans and/or Hydraulic).

Bank Interlocks

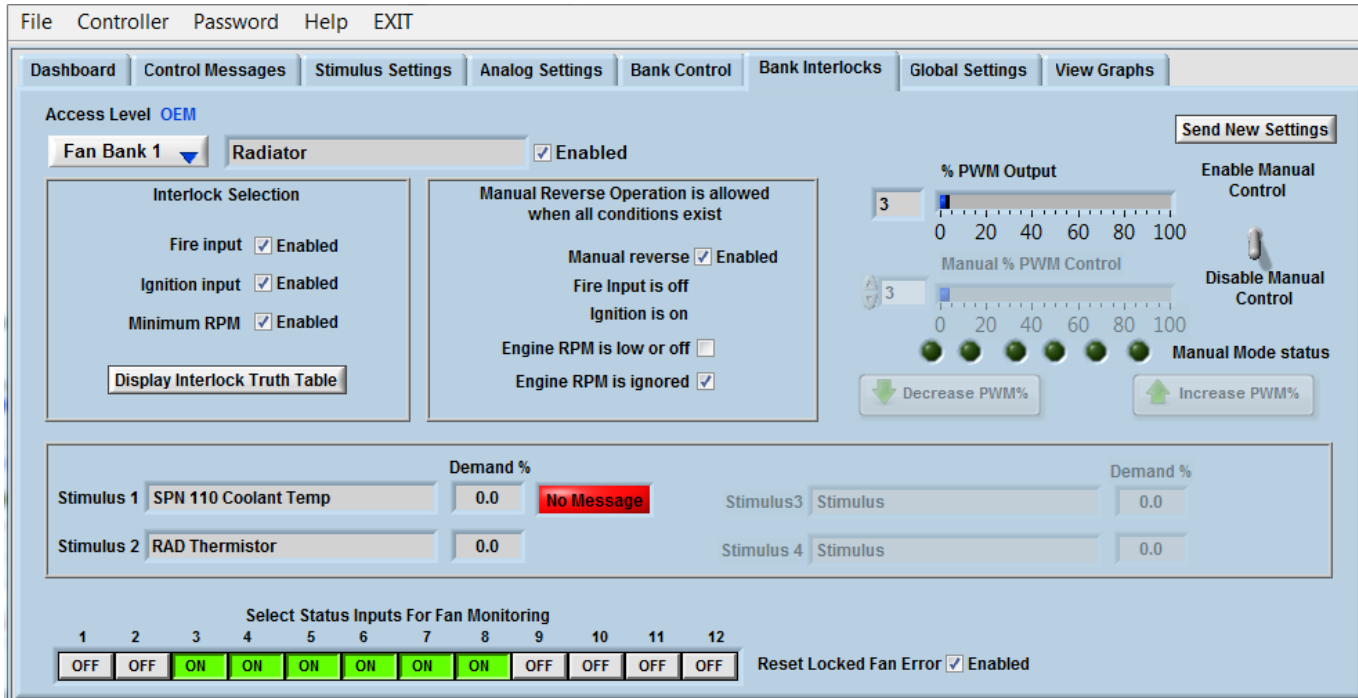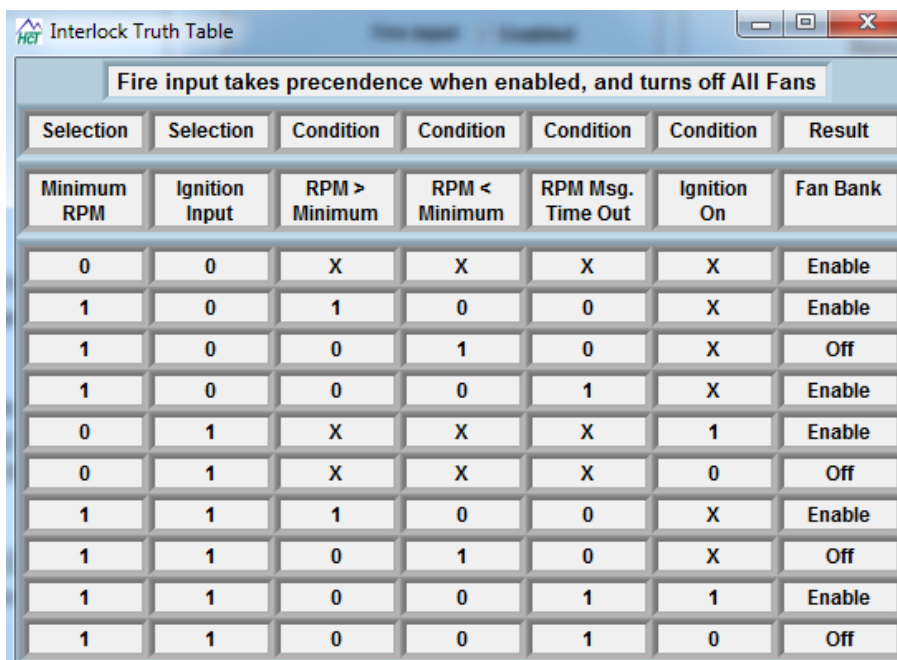The user may define interlock logic for each bank.

Figure 28

- **Fan Bank *n*** – selects the fan bank to be configured.

- **Fan Bank *n* Text Box** – displays the fan bank name defined in the **Bank Control** tab.

- **Enabled** – **check** to enable the fan bank.

Interlock Selection

- **Fire Input** – check to enable the input. The fire input will override all controlling inputs. When the Fire Input switch is activated, this fan bank stops. Manual mode overrides the fire input.

- **Ignition Input** – check to enable the input. When the Ignition switch is de-activated, this fan bank stops.

- **Minimum RPM** – check to enable the input. When enabled, the fan bank will not run until the Engine RPM meets or exceeds the Minimum Engine RPM set point on **Global Settings**.

- **Display Interlock Truth Table** – opens a window that displays a table of the interlock logic.

Selection	Selection	Condition	Condition	Condition	Condition	Result
Minimum RPM	Ignition Input	RPM > Minimum	RPM < Minimum	RPM Msg. Time Out	Ignition On	Fan Bank
0	0	X	X	X	X	Enable
1	0	1	0	0	X	Enable
1	0	0	1	0	X	Off
1	0	0	0	1	X	Enable
0	1	X	X	X	1	Enable
0	1	X	X	X	0	Off
1	1	1	0	0	X	Enable
1	1	0	1	0	X	Off
1	1	0	0	1	1	Enable
1	1	0	0	1	0	Off

Fire input takes precedence when enabled, and turns off All Fans

Figure 29

Manual Reverse Configuration

Manual Reverse Operation is allowed only when the fire input is off and the ignition is on unless the inputs are disabled in the Interlock Selection Box.

- **Manual Reverse** – check to enable the input. When disabled, this fan bank has no Manual Reverse.

- **Engine RPM is Off/low** – if checked, this fan bank has Manual Reverse when the Engine RPM is lower than the Minimum Engine RPM setting on **Global Settings** or 0rpm. Engine J1939 message timeout does not qualify as 0rpm.

- **Engine RPM is ignored** – when checked, the user can operate a reverse cycle by enabling the Reverse Switch while the engine is running.

When ignition input is disabled, make sure nobody is working on the fans when switching on manual reverse with ignition OFF.

Manual Control

The user may manually verify that the E-fans are working properly and determine the maximum, minimum and reverse PWM duty cycles.

- **Enable / Disable Manual Control** – turns On/Off manual control.

- **% PWM Output** – displays the PWM duty cycle output for this fan bank.

- **Manual % PWM Output** – displays the command input for this fan bank. To change the input, the user can drag the bar or type the value or increase/decrease arrow.

- **Manual Mode Status** – The indicators are dark when the banks are in normal mode and Red when the banks are in manual mode.
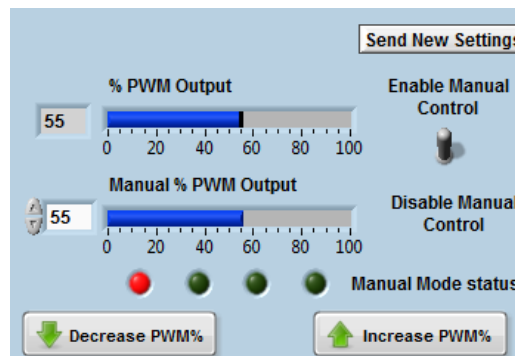

Figure 30

Caution

- *Only allowed with the OEM password.*

- *All settings on this tab will immediately affect the output.*

- *All limits and controls are bypassed.*

- *The controller goes back to normal operation when disabling the manual mode.*

- *Cycling power on the unit will exit the manual model.*

- *Disconnecting the communication cable will exit manual mode.*

Select Digital Inputs for Fan Status

The EMC-6 has 12 discrete Fan Diagnostic inputs (DG) with four additional configurable Fan Diagnostic inputs providing the potential for 16 total DG inputs. Analog inputs 1 through 4 can be configured as diagnostic inputs and are displayed as A1, A2, A3, and A4 on the Dashboard and Bank Interlock tabs. Turn the buttons to ON if DG inputs are connected to this fan bank. Ensure all the others are OFF.
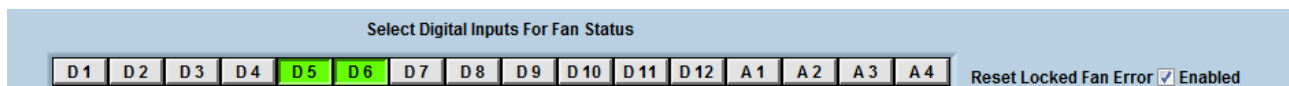

Figure 31

- **Reset locked fan error** – when selected, the controller will set the fan bank PWM % to 0 to restart the failed fans after the fans give up restarting by themselves. The period for resetting the fans is set on **Global Settings**.

Global Settings

The parameters on this page apply to all of the fan banks.
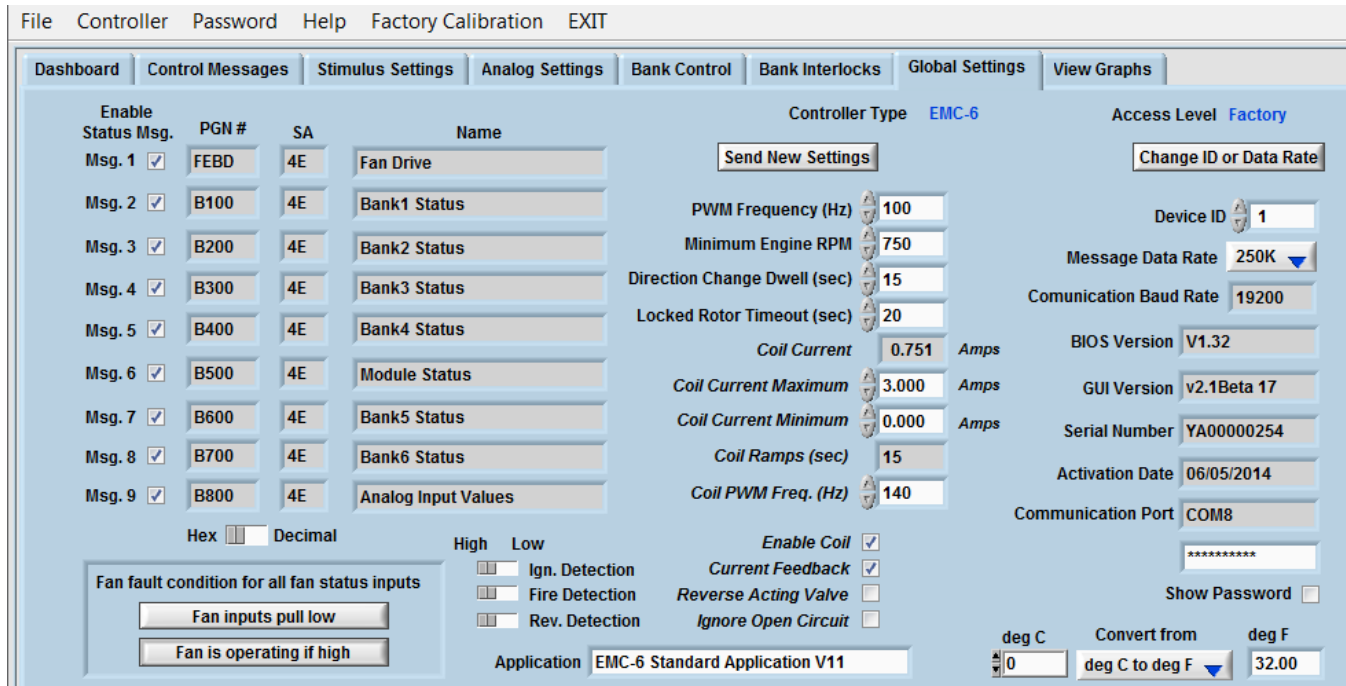

Figure 32

The EMC-6 can transmit the module status messages via SAE J1939. Check to enable the messages. The Source Address (SA) for the EMC-6 module is 78 (0x4E). See the **Appendix A** for more details.

• **PWM Frequency (Hz)** – is the PWM frequency for all E-fan banks.

• **Minimum Engine RPM** – is the minimum engine RPM defined by the user which affects the operational status of the fan bank outputs.

• **Direction Change Dwell (Seconds)** – see the EMC-6 reverse cycle definition, see Figure 25. For hydraulic fan, dwell time equals the ramp down and ramp up time (fan changes from max rpm to 0 or vice versa). For E-fan, dwell time is the coast down time plus 0rpm time before entering reverse cycle and getting out of reverse cycle.

• **Locked Rotor Timeout (Seconds)** – sets the period that the EMC-6 will reset the failed fans after fans give up restarting by themselves. This only works if **Reset locked fan error** is enabled on the **Bank Interlocks** section.

• **Coil current** – displays the valve current to the hydraulic fan in real time.

• **Coil Current Maximum** – is the maximum current for the proportional hydraulic valve (up to 3A).

• **Coil Current Minimum** – is the minimum current for the proportional hydraulic valve.

• **Coil PWM Freq. (Hz)** – is the PWM frequency (dither) for the hydraulic valve.

• **Enable Coil** – check to enable 3A output.

- **Current Feedback** – check to have constant current control. Uncheck to have PWM duty cycle control for the hydraulic valve.

- **Reverse Acting Valve** – check for a reverse acting hydraulic valve, uncheck for normal acting hydraulic valve.

- **Ignore Open Circuit** – when checked, the controller will not detect an open circuit.

  When coil max current is set high and PWM output is 100%, controller will not declare coil open as long as some current is flowing. It does not matter whether "**Ignore open circuit**" is checked or not.

Fan Fault Conditions

This sets how the module interprets the DG inputs for all fans.

- **Fan Inputs Pull Low/High** – Pull High is used when the fan provides a DG signal that drives the voltage low when active. Pull low is used when the fan provides a DG signal that drives the voltage high when active.

- **Fan Is/Is Not Operating if High** – Determines the polarity state of the DG input, refer to the fan datasheet for more information.

Detection Switches

- **Ignition Detection, Fire Detection, Reverse Detection** – when set high, the inputs are ON when the input voltage is higher than 8V. When set low, the inputs are OFF when the input voltage is higher than 8V. The inputs are pulled low (0V) if left unconnected.

Device Settings

- **Device ID** – Determines the module's PGN addresses on the SAE J1939 bus. The user may install multiple EMC-6 modules on a single SAE J1939 bus. The default **Device ID** is 1.

- **Message Data Rate** - is the CAN data rate. EMC-6 supports 250K, 500K or 1000Kbps. It must match the J1939 bus to ensure the communication.

- **Communication Baud Rate** – displays the baud rate for the serial port.

- **GUI Version** – displays the version of the GUI.

- **Serial Number** – displays the serial number of the specific unit, referenced to the factory record.

- **Activation Date** – is the date when the module is configured first time at the factory.

- **OEM Password** - the **OEM Password** is included in the GUI CD. Users may reset the OEM password. Just don't forget it.

- **Communication Port** – displays the PC Communication Port that the GUI is connected to.

- **Temperature Conversion Tool** - converts temperature from Celsius to Fahrenheit or vice versa.

- **Change ID or Data Rate** – loads the new settings into the unit's RAM memory and activates these values.

View Graphs

Any input and/or output can be graphed in the two windows. Each window displays up to two parameters simultaneously selected from the pull-down menus.

Each graph can be scaled individually. The graph will display the **Calculated Fan RPM** if the Gauges are toggled to **RPM** on **"Dashboard"**.
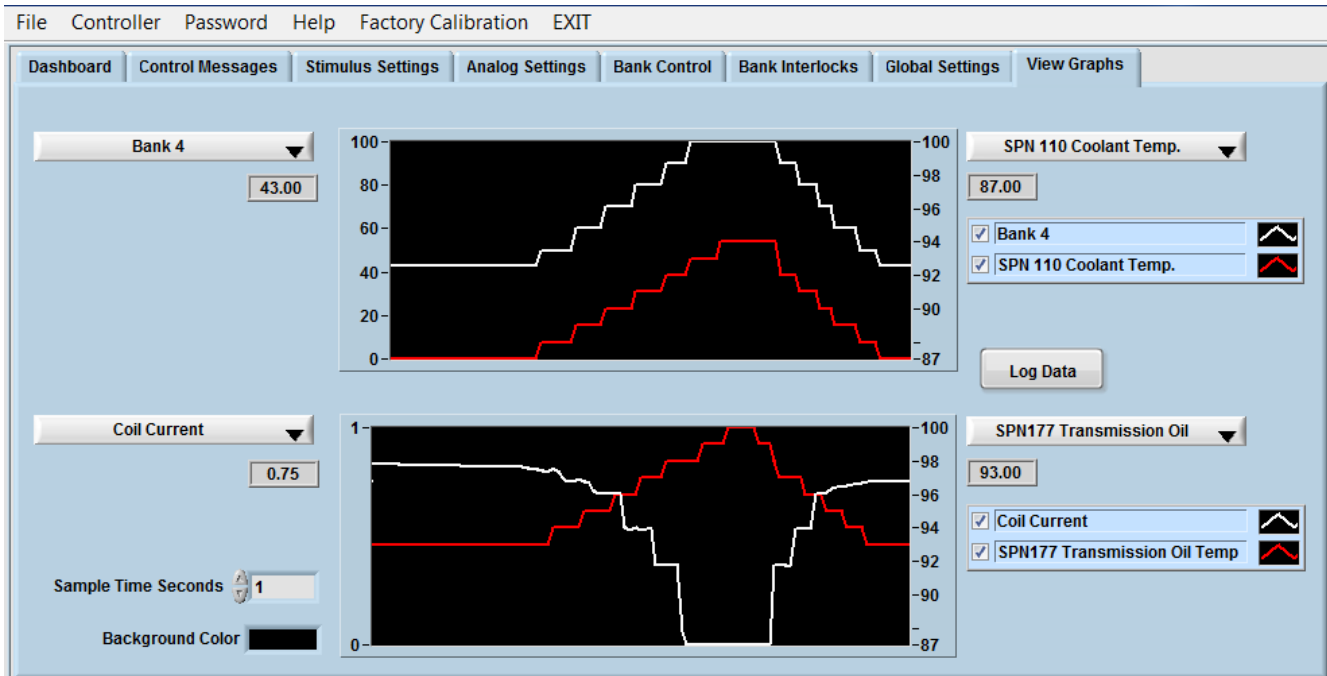

Figure 33

- **Sample Time Seconds** – bigger number slows down the speed that the graphs move along X axis.

- **Back ground Color** – click to change the background color.

- **Graphing Title** - Uncheck to remove the graph. Click or right click to format the graphing curves.

- **Log Data** – logs the operational data in .csv format.

Appendix A Fan Status Messages

The Fan Drive Message, PGN 65213, FEBD

SPN	Start bit	# bits	Parameter Name
975	1	8	Estimated Percent Fan Speed (0-100%)
977	9	4	Fan Drive State

The Bank 1 Status Message, PGN 45312, B100

SPN	Start bit	# bits	Parameter Name
975	1	8	Bank Estimated % Fan Speed (0-100%)
	9	16	DG State Input 1 – 16, 0 = Fan failure, 1 = Fan is Operational
1639	25	16	Estimated Fan RPM

The Bank 2 Status Message, PGN 45568, B200

SPN	Start bit	# bits	Parameter Name
975	1	8	Bank Estimated % Fan Speed (0-100%)
	9	16	DG State Input 1 – 16, 0 = Fan failure, 1 = Fan is Operational
1639	25	16	Estimated Fan RPM

The Bank 3 Status Message, PGN 45824, B300

SPN	Start bit	# bits	Parameter Name
975	1	8	Bank Estimated % Fan Speed (0-100%)
	9	16	DG State Input 1 – 16, 0 = Fan failure, 1 = Fan is Operational
1639	25	16	Estimated Fan RPM

The Module Status Message, PGN 46068, B400 (Note 1)

SPN	Start bit	# bits	Parameter Name
	1	16	Ignition Input Volts
	17	16	Reverse Input Volts
	33	16	Fire Input Volts
	49	16	Supply Volts

The Bank 4 Status Message, PGN 46336, B500

SPN	Start bit	# bits	Parameter Name
975	1	8	Bank Estimated % Fan Speed (0-100%)
	9	16	DG State Input 1 – 16, 0 = Fan failure, 1 = Fan is Operational
1639	25	16	Estimated Fan RPM

The Bank 5 Status Message, PGN 46592, B600

SPN	Start bit	# bits	Parameter Name
975	1	8	Bank Estimated % Fan Speed (0-100%)
	9	16	DG State Input 1 – 16, 0 = Fan failure, 1 = Fan is Operational
1639	25	16	Estimated Fan RPM

The Bank 6 Status Message, PGN 46848, B700

SPN	Start bit	# bits	Parameter Name
975	1	8	Bank Estimated % Fan Speed (0-100%)
	9	16	DG State Input 1 – 16, 0 = Fan failure, 1 = Fan is Operational
1639	25	16	Estimated Fan RPM

Analog Inputs, PGN 47104, B800 (Note 2)

SPN	Start bit	# bits	Parameter Name
	1	8	Analog Input 1
	9	8	Analog Input 2
	17	8	Analog Input 3
	25	8	Analog Input 4
	33	8	Analog Input 5
	41	8	Analog Input 6

- **Estimated Percent Fan Speed** – an average percent fan speed (0-100%) of all active fan banks.

    NOTE: Range is 0-250, each bit = 0.4%

    Example: 0x00 = 0%
                0xFA = 100%
                0xA7 = 66.8%

- **Fan Drive State** – assigns a 0 or E.

    0 = Error if any DG bit within any active bank shows a fan failure

    E = Normal fan operation

- **Bank Estimated % Fan Speed** – calculated percent fan speed (0-100%) of selected bank.

    NOTE: Range is 0-250, each bit = 0.4%

    Example: 0x00 = 0%
                       0xFA = 100%
                       0xA7 = 66.8%

- **DG State Input 1 - 16** – assigns a 0 or 1 for up to 16 fan diagnostic inputs for selected fan bank.

    0 = Fan failure

    1 = Fan is operating or not selected for this bank

    NOTE: This is true for all cases regardless if the fan is configured with an inverted waveform.

- **Estimated Fan RPM** – calculates the fan speed based upon user configurations in the Bank Control tab of the GUI (multiply by 0.125 RPM/bit for RPM value).

    Example: Byte 3   Fan RPM Low Side Byte

                       Byte 4   Fan RPM High Side Byte

                       Byte 3 = 4A
                       Byte 4 = 39
                       0 x 394A = 14666 (decimal)
                       14666 x 0.125 = 1833.25 RPM

NOTES:

1. The scale factor for Voltage Inputs (Supply, Fire, Ignition, and Reverse, is 0.01 V/bit with an offset of 0.

    Example: 0x04B0 = 1200 (decimal)

                           1200 x 0.01 = 12 Volts

2. The scale factor for Analog Inputs depends on how the input is set up.

    a.   If set up as a voltage input:

        i.   Scale Factor – 0.02 V/bit with an offset of 0 (range is 0-5 Volts).

    b.   If set up as a thermistor input:

        i.   Scale Factor – 1° C/bit with an offset of -40 (range is -40° – 215° C).

    Voltage Example: 0x7D = 125 (decimal), 125 x 0.02 = 2.5 Volts
    Thermistor Example: 0x7D = 125 (decimal), 125 - 40 = 85°C

3. For more information on Suspect Parameter Numbers (SPN) refer to SAE J1939-71

Appendix B Troubleshooting Communication Port Adapters

Overview

Windows does not like Com ports with the same name, and some devices might hang onto a com port when not in use. Here is how to clean and remove problem ports.

Option 1

Devices that have been installed but are not currently available are "phantom devices". These devices are not usually displayed in the device manager, but can be made to be displayed.

This allows device properties to be changed or devices to be uninstalled even though the device is not physically connected to the PC.

Control Panel $\Rightarrow$ System Properties $\Rightarrow$ "Advanced" option and click "Environment Variables"

$\Rightarrow$ In the System Variables sections, click "New"
$\Rightarrow$ "DevMgr_Show_NonPresent_Devices" and set the value to 1 $\Rightarrow$ OK $\Rightarrow$ Close the System Properties panel.
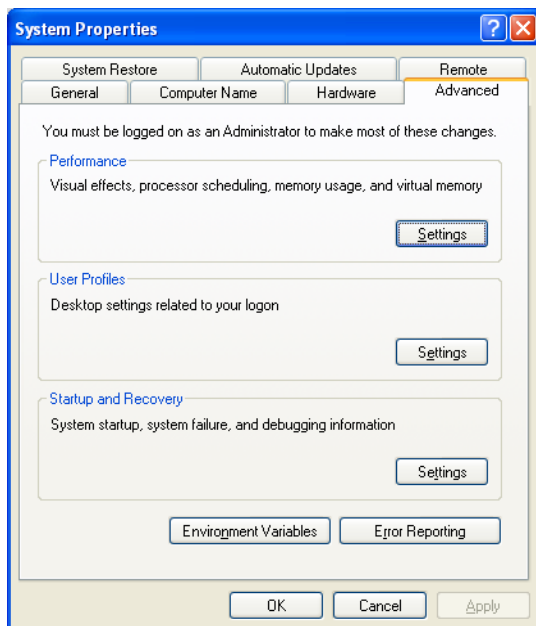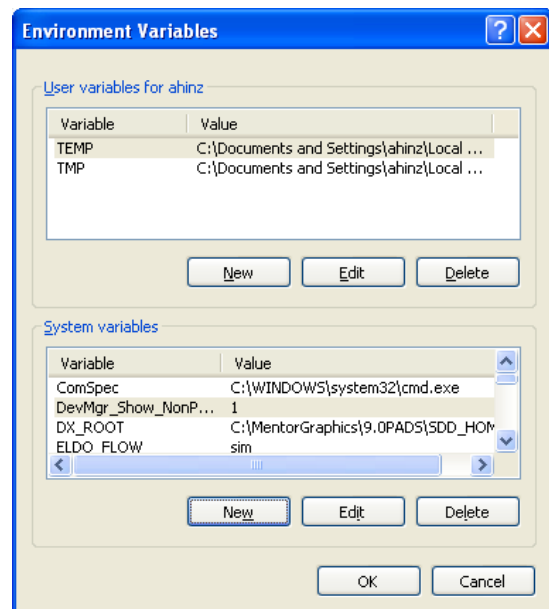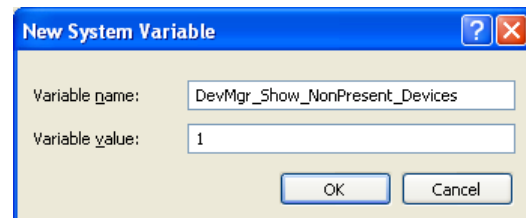
Figure 34

Figure 35

Figure 36

⇒ Open the Device Manager
⇒ "View" ⇒ Show Hidden Devices".

Device Manager will show all hidden and phantom devices.

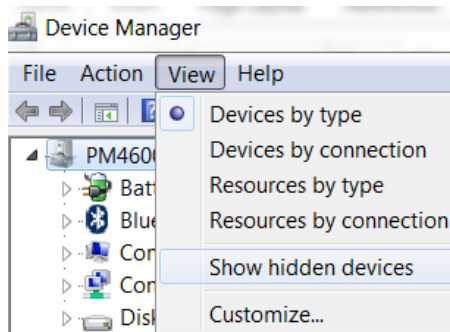⇒ Uninstall the phantom devices by right clicking on them, and 'delete'.
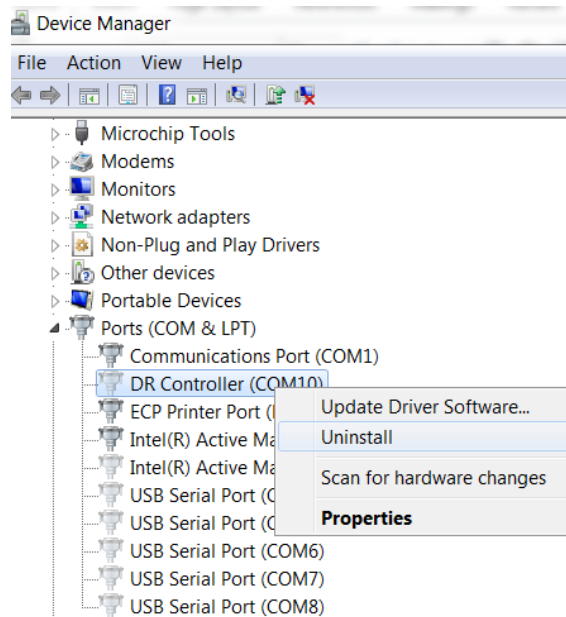⇒ Reboot the PC.

Figure 37

Figure 38

Option 2

Open the Control Panel: Add or Remove Programs

Remove old versions of FTDI drivers Windows Driver Package – FTDI CDM Driver Package

Reinstall the FTDI Drivers as explained in Software Installation above.

The current driver package for your operating system may be obtained directly from the vendor at http://www.ftdichip.com/FTDrivers.htm

Appendix C PID Tuning for Setpoint Control

Overview

The process of setting the optimal gains for P, I and D to get an ideal response from a closed loop control system is called tuning.

Tuning Procedure
This is a trial and error method.

1) Set the I and D terms are set to zero first
2) Increase the proportional term (P) until the output oscillates after a step change to the set point.
3) As the proportional gain is increased, the system response becomes faster (don't increase P too much otherwise the system could become unstable).
4) Increase the integral term (I) to reduce the steady state error (difference between the set point and the actual feedback value at steady state). The integral term reduces the steady state error, but increases overshoot. Some amount of overshoot is always necessary for a fast system so that it can respond to changes quickly.
5) If needed, increase the derivative term (D) until the system response is acceptably quick to a step change with minimal overshoot. Increasing the derivative term decreases overshoot and yields higher gain with stability.

- ❖ **Mining & Exploration**
- ❖ **Agriculture**
- ❖ **Cranes & lifts**
- ❖ **Refuse & Re-cycling**
- ❖ **Construction**
- ❖ **Off-Road vehicles**
- ❖ **Forestry, Wood & Pulp**
- ❖ **Reclamation & Salvage**
- ❖ **Oil Field & Sands**
- ❖ **Demolition Equipment**
- ❖ **Cooling Solutions**
- ❖ **Military Apparatus**
- ❖ **Specialty Use**
- ❖ **Remote Control**
- ❖ **Power Generation**
- ❖ **Emission Controls**
- ❖ **Integrated Drivers**
- ❖ **Valve & Pump Controls**

HCT Product Sales and Support:

For a full list of authorized distributors worldwide, please visit:

www.hctcontrols.com/distributors/index.htm

Need More Information ?

For customer service, pricing, order placement
and application support, contact us through E-mail at:
info@hctcontrols.com

www.hctcontrols.com

SUN hydraulics
CORPORATION

A SUN Hydraulics Company

HcT
Electro-Hydraulic
Control Solutions

High Country Tek, Inc.
208 Gold Flat Court
Nevada City, CA, 95959
Tel: (1) 530 265 3236
Fax:(1) 530 265 3275