CONTINENTAL CONTROLS CORPORATION

Installation and Operating Manual

Catalyst Monitor, CM

Class I, Div 1, 2, Group D: T4

ISO 9001:2015 CERTIFIED

Preface

It is highly recommended that the user read this manual in its entirety before commencing operations. It is the policy of Continental Controls Corporation that it is neither our intention nor obligation to instruct others on how to design or implement engine control systems.

Continental Controls Corporation will not assume responsibility for engine controls which are not designed or installed by our authorized representatives.

This manual is intended to help the end user install and operate the Catalyst Monitor. Do NOT attempt to operate, maintain, or repair the Catalyst Monitore until the contents of this document have been read and are thoroughly understood.

Every attempt has been made to provide sufficient information in this manual for the proper operation and maintenance of the Catalyst Monitor.

All information contained within shall be considered proprietary information and its release to unauthorized personnel is strictly prohibited.

If additional information is required, please contact:

Continental Controls Corporation
San Diego, CA, USA
+1(858) 453-9880

Website: www.ContinentalControls.com

Email: Info@ContinentalControls.com

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Safety Warning!

DO NOT ATTEMPT TO REPAIR THE GV1. THE CATALYST MONITOR MUST BE RETURNED TO CONTINENTAL CONTROLS CORPORATION FOR REPAIR AND SERVICE.

When installing the CM in a Class 1 Division 2 Hazardous location, installation of all electrical equipment MUST be in compliance with the National Electric Code (NEC). The customer is responsible for termination of pigtail wires out of the Cable Harness Assembly on the CM.

The CM cables must be continuously supported and protected against physical damage using mechanical protection such as dedicated struts, angles, or channels. The CM cables MUST be secured at intervals not exceeding 1.8 Meters (6 feet).

Do not connect or disconnect the CM unless power has been switched off. Make sure to disconnect the CM if welding is to be performed on the engine or skid.

Electrostatic Discharge Awareness!
Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts.

- Discharge body static before handling the control unit.
- Avoid all plastic, vinyl, and Styrofoam around printed circuit boards.
- Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.

Glossary of Terms

Term	Definition
Air/Fuel ratio (AFR)	The ratio of mass air rate to mass fuel rate
CO	Carbon Monoxide
CO_2	Carbon Dioxide
EGR	Engine Gas Regulator or Electronic Gas Regulator
EGT	Engine Gas Temperature
Excess Oxygen	> 10% O_2
Lambda	Stoichiometric air/fuel ratio Lambda = 1.0 lean (fuel limited) being > 1.0 rich (O_2 limited) being < 1.0
Lean Combustion	> 4% O_2
LVDT	Linear Variable Differential Transformer
NOx	Oxides of Nitrogen (NO and NO_2)
NSCR	Non-Selective Catalytic Reduction *(see Three-Way Catalyst)*
Rich Combustion	< 1% O_2
SCR	Selective Catalytic Reduction
Sensor: O_2 – Lamda	An exhaust sensing device. Outputs a low signal when lean of lambda and a high signal when rich of lambda.
Sensor: O_2 – Wide band	An exhaust sensing device. Outputs a high signal when lean of lambda and a low signal when rich of lambda.
Stoichiometric	Theoretical air/fuel ratio where all fuel and oxygen are completely consumed leaving no O_2 in the exhaust. Equals Lambda 1.0.
Supply Pressure	The fuel gas supply pressure immediately upstream of the ECV5
THCs	Total Hydrocarbons
Three-Way Catalyst	A device containing both reduction and oxidation materials to convert NO_x, CO, and THC emissions to C, N, CO_2, O_2, and H_2O
UHCs	Unburned Hydrocarbons
VOC	Volatile Organic Compound

Introduction

Our Catalyst Monitor is designed to log data for differential pressure and temperature to notify the user of unacceptable conditions to ensure the engine remains in continuous compliance. This real-time information system will keep our customers fully informed of the origins of emissions control system problems, and keep the downtime spent trouble-shooting the initial problem to a minimum.

Our goal is to provide a monitor for various inputs and outputs to NCSR and Oxidation catalysts to provide some assurance that these devices were working as intended.

The Catalyst Monitor is available in three dif-ferent configurations: The first is solely intended to gather information from the exhaust system and log that data. The second will include dual wide-band O2 sensor controllers.

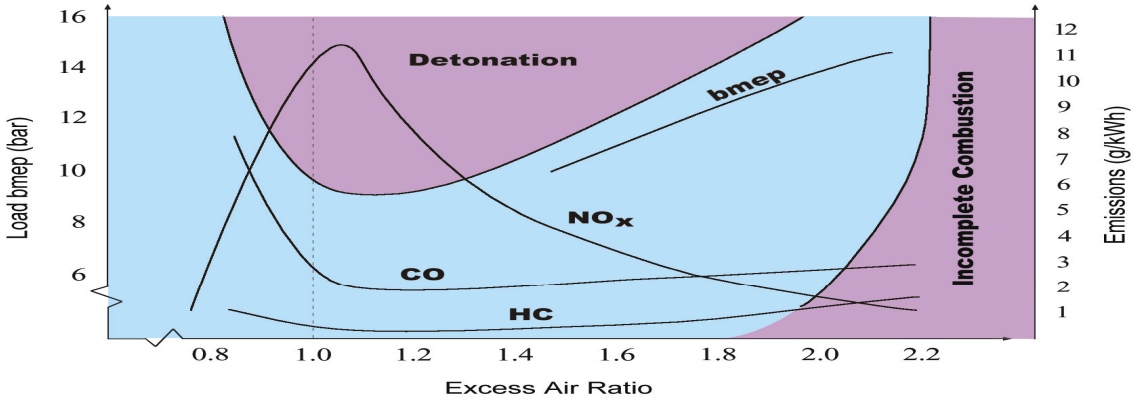
For dynamic adjustment of the AFR set point: The third version will communicate via CAN-Bus with the Air Fuel Ratio Controller to make corrections to the set point to maintain low emissions levels and extend the useful life of the catalyst by using a spe- cial post catalyst NOx sensor, to help establish the correct O2 sensor set point for optimum control.

Various local and federal agencies require monitoring of various engine parameters. Parame-ters often consist of catalyst inlet and outlet temper- ature monitoring. The catalyst monitor will meet this continuous monitoring requirement.

Here are some of the key parameters which the shutdown or alarm will respond to in order to maintain continuous compliance; differential pres-sure readings, pre and post catalyst readings, a thir-ty minute time to reach a minimum catalyst temper- ature, and temperature rolling averages after the four hour interval.

Background

Years ago, before exhaust emissions were a concern; the natural gas engines used mainly by the natural gas industry were designed to run with 2% to 4% excess air. The air-fuel ratio controllers were mechanical devices that were not very accurate. The air fuel ratio would often vary with load and as long as the engine would carry the load and didn't detonate or miss-fire it was considered acceptable. Later when exhaust emissions became important, it was discovered that these engines were running with very high NOx levels, sometimes at the peak of the NOx curve. Two strategies evolved to reduce the NOx while containing the CO and unburned hydrocarbons. Rich-burn operation is Stoichiometric and to the left of the stoichiometric point. Lambda, needs to be much higher than 1.0, to reduce the NOx significantly. Operation in the detonation (or knock region) and the incomplete combustion region, must be avoided. In the graph, it can be seen that the engine can be operated at a higher load or BMEP, without detonating, when operating with a large amount of excess air. The higher BMEP means, more horsepower is available and the engine will be a little more efficient because of the higher cylinder pressure.



Rice NESHAP

In 1970 Congress passed the Clean Air Act (CAA) which created the Environmental Protection Agency (EPA) EPA was tasked with reduc- ing air pollution by regulating and removing air pollutants.

In 1990 Congress passed the revised CAA which gave the EPA broader powers to reduce air borne pollutants. These pollutants includ- ed, amongst others, Oxides of Nitrogen (NOx), Carbon Monoxide (CO), Non-Methane Hydrocarbons, and Particulate Matter (PM10, PM2.5).

On February 17, 2010, the Environmental Protection Agency (EPA) issued a final rule that will reduce emissions of toxic air pollutants from existing diesel powered stationary reciprocating in- ternal combustion engines (RICE). These engines also are known as compression ignition (CI) engines. RICE NESHAP is an acronym for Reciprocating Inter- nal Combustion Engines National Emission Stand- ards for Hazardous Air Pollutants.

The EPA officially made the RICE NESHAP rul- ing in August of 2010. The ruling is intended to re- duce emissions of toxic air pollutants like formalde- hyde, acetaldehyde, acrolein, methanol and other air toxics from several categories of

previously unregu- lated stationary engines. Major sources of air toxins are defined as those that emit or have the > potential to emit 10 short tons per year of a single hazardous air > pollutant (HAP) or 25 short tons per year of any combination of HAPs.

RICE NESHAP consists of two separate rul- ings. Compression ignited stationary engines (diesel) are overseen by the Feb, 2010 ruling with an en- forcement deadline of May, 2013. Natural gas fueled stationary engines need to comply with the Spark Ignited RICE NESHAP (SI RICE NESHAP) ruling. The ruling was passed in August, 2010, with a final com- pliance date of November, 2013.

This final rule applies to stationary diesel en- gines that meet specific siting, age and size

criteria. It will control emissions of formaldehyde, acetaldehyde, acrolein, methanol and other air toxics from diesel engines. To determine the HAP require- ments for your specific engine, you must know the following information: Horsepower, operating hours per year, and if you have an area or major source of emissions.

Affected stationary diesel engines must com- ply with carbon dioxide or formaldehyde emission lim- its or be fitted with emission controls, such as an oxi- dation catalyst.

The rule is applicable to anyone using the follow- ing natural gas engines: Current spark ignited en- gines in use (not new), 4 Stroke Lean Burn (SLB) en- gines, 4 Stroke Rich Burn (SRB) engines, and Landfill or Digester Gas engines, 2 Stroke Lean Burn (SLB) engines. For compliance specifications, please advise the chart below for subsequent categories of the en- gine and their appropriate numerical emission stand- ards.

Oxidation catalysts are widely available and recom- mended by the EPA to meet the emission regulations for rich-burn engine.

Theory of Operation

The Catalyst Monitor comes in three versions and features an optional new component: NOx sen- sor. NOx sensor feedback also will be used to auto- matically trim the pre catalyst O2 set point. Based on the recorded emissions data analysis can be done to determine the optimum pre-catalyst oxygen sensor set-point (or o2 set point schedule) to accommodate for load transitions, changing BTU, etc. This feature can be accommodated to any of the three versions of the catalyst monitor.

Description

Features of the Catalyst Monitor Alarm / Shutdown Temperature / Pressure
The catalyst monitor has one relays that will interface engine controller, that can be programmed as shutdown or warning.

The relays can be programmed to trigger on any of the inputs, or multiple inputs. Instantaneous read- ing or an average. There is a programmable time delay. The relay will open upon triggering. The factory settings will meet the RICE NESHAP requirements.

An input is provided for resetting the alarms and shutdowns.

Data Logging On Board For Periodic Or Contin- uous Data Retrieval

Data logging is available to a 4 gig thumb drive through the on board usb port.

The 4gig drive will hold 3 years of data logging at a rate of once a second. This is written as a comma delimited file easily imported in to any spread sheet or data base.

Component Specifications

Data logged consists of the following:

- Date
- Time
- Pre and Post-cat Temp
- Catalyst Differential Pressure (dP)
- Left Bank Oxygen Sensor (O2)
- Right Bank Oxygen Sensor (O2)
- Hour Meter

Automatic Adjustment to CCC AFR Controllers

When using the Catalyst monitor in conjunction with a CCC AFR product and nox sensor. The Catalyst Monitor can provide a set-point trim the to AFR via the can bus.

Operator Configurable:
The alarms, data collection and rate are pro- grammable.
Variety of I/O Supported:

- 1 Relay output
- 2 0-5vdc analog output.
- Ethernet
- 2.4 gig wireless radio
- CAN bus
- 4-20 mA input
- 2 thermocouples

Non-Resettable Real Time Clock and hour meter
The cat monitor has a real time clock so all the data is time stamped. The factory data logging settings will meet the RICE NESHAP requirements. The data is also available through the cat monitor Ethernet port using modbus/tcpip, a 2.4gh radio serial link is also provided using modbus protocol. **Voltage ****

These numbers for current may change after testing. Voltage specifications for the catalyst moni- tor is 10-30V. Current will be somewhere near the following: CM1 (single connector, no O2 sensors) 1 amp. CM2 (one O2 sensor) – 3 amp. CM3 (two O2 sensors) – 5 amp. The thermocouple inputs are type K. The first version of the NOx sensor requires 12V while the second vision is 24V.

Status Lights
There are two green/yellow bi-color lights.; the top of these buttons is the STATUS light.

The STATUS light has five distinct color pat- terns:

- Solid Green - Engine is not running, there is no alarm or shutdown
- Flashing Green/Off - Engine is running, but no alarm and no shutdown
- Flashing Green/Yellow - Engine is running with alarm enabled, but no shutdown
- Flashing Yellow/Off - Engine is not run- ning, alarm is enabled
- Solid Yellow - Shutdown

The bottom light is the logging light, which has three distinct color patterns:

- Solid Green - USB disk is detected
- Flashing Green - Writing to USB disk, (WARNING: do not remove while it's flash- ing).
- Solid Yellow - No disk or disk error

Thumb Drive

USB data disks are manufactured with the heat capacities of 0-60 degree Celsius. Bearing this parameter in mind it is highly ad- vised that when operating around a catalyst monitor, who's temperature ranges from 40-85 degrees Celsius, one should be wary of not placing it near or on surfaces which reach temperatures capable of damaging the memory device. If a catalyst monitor needs to be placed in a high-temperature lo- cation accommodations must be made to keep the thumb drive safe from overheating or meltdown.

Relays

There are two relay outputs in the Cat- alyst Monitor. With 10amp contacts. They have the ability to be programmed to custom alarm and shutdown thresholds. These re- lays will open if a shutdown is triggered.

Functional Description

The Catalyst Monitor possesses two relays that can be programmed in accord- ance with RICE NESHAP requirements. These requirements are to satisfy 40CFR Part 63 subpart Quad Z.

The Catalyst Inlet temperature must be averaged over an hour. That hourly aver- age must be combined into a four hour roll- ing average. The readings will be rad and av- eraged multiple times over a second to en- sure accuracy of results within real-time feedback. The Catalyst monitor will alarm the system and shut down in the event of:

- The catalyst inlet temperature does not reach a minimum temperature of (750) degrees Fahrenheit 30 minutes after start of ignition. Or as designated by the operator.
- If the unit is not "loaded" 30 minutes after start of ignition.
- If the catalyst temperature 4 hour rolling average falls below the minimum temper- ature of 750 degrees Fahrenheit.
- The four hour rolling average must be rec- orded continuously while the unit is run- ning. No data needs to be collected when the engine is rolling down after the stop of ignition.

The catalyst differential pressure must be recorded once monthly when the unit is operating. In the event of a change of more than two inches of water the alarm will be ac- tivated.

Model CM1:

2 Thermocouples, 1 DP

Application for compliance with RICE — NESHAP emissions standards, basic moni- toring features:
Standard version will be for use in data logging applications, and includes DP trans- ducer, pre and post catalyst thermocouples. It will provide continuous monitoring of pre and post catalyst temperatures along with differential pressure (pressure across the catalyst). Version 1 will offer various types of alarms related to DP, DT, Pre & Post catalyst temperatures. DP measurement helps to de- tect deposits in the catalyst (cat masked). Catalyst temperatures have to meet some limits within a certain time frame for the cat- alyst to operate in efficient and safe manner. There will be minimum, maximum, delay, shutdown settings for each of the key cata- lyst monitor parameters as well as a non-resettable clock (shutdown will be optional).

Model CM2:
2 Thermocouples, 1 DP, 1 O2 sensor (Pre-Catalyst)
New component: pre-catalyst O2 sensor. This has the same functionality as version 1 plus support for two wide-band oxygen sensors.
Model CM3:

2 Thermocouples, 1 DP, 2 O2 sen- sors (Used for dual-bank engines or occasionally pre and post catalyst exhaust monitoring). Plus support for post-cat NOx sensor.

New component: post catalyst O2 sensor:

The configurations 3 can be used in conjunction with ECV5 or EGC for minimizing engine emissions. The system continuously measures the post catalyst O2 sensor feedback and manipulates the pre-cat O2 sensor set point in accordance with the algorithm to control the amount of fuel entering the catalyst. The customer will be empowered by having access to the algorithm settings which will give him control over the emissions managing process. The NOx sen- sor will be an optional addendum which is available for dynamic feedback systems which communicate via CAN systems back to engine control, (whether it is EGC or ECV) in order to configure the O2 set point. There are 2 relays that we can program to be flexible to different shutdown ranges.

Applications

Rich-Burn Combustion

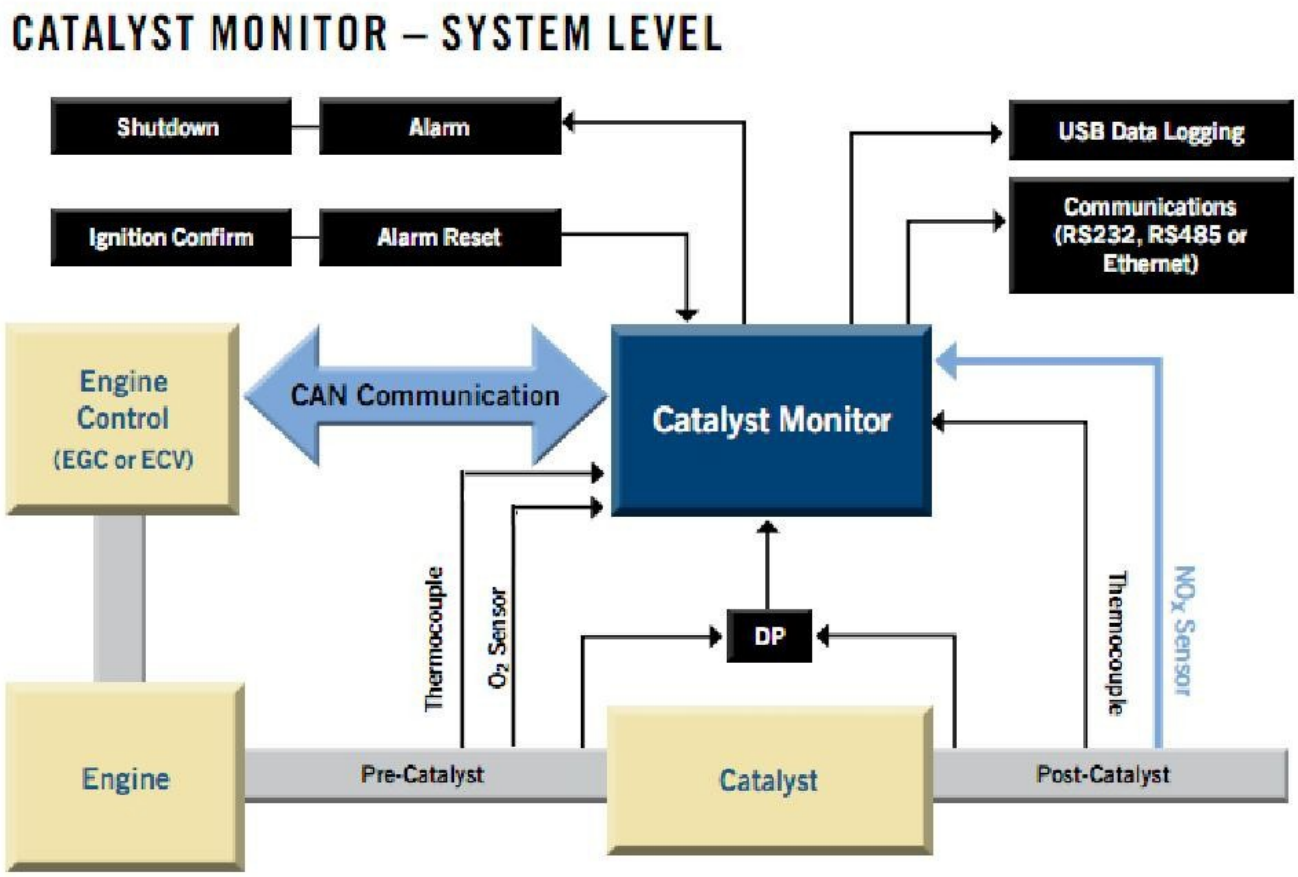
The first method, and the easiest implement is to operate the engines at a Stoichiometric fuel mixture. These is also refered to as "Rich Burn" operation. A stoichiometric mixture is the chemically correct fuel mixture for combustion, with near-zero oxygen left over in the exhaust.

This method of operation is suitable for a three-way catalytic converter. The mixture must be precisely controlled in order for the reaction in a cat- alytic converter to oxidize the CO and COXYGEN and reduce the NO and NOXYGEN to N2 and OXYGEN without having undesirable products left over.

Rich-Burn Oxygen Sensor
In order to achieve the precise mixture re- quired for the catalyst, an OXYGEN sensor is fed back to the control device to close the loops on the amount of oxygen in the exhaust. The mixture is con- trolled to maintain very low oxygen content in the exhaust, and less than 0.02% oxygen. This results in combustion that is consuming nearly all of the oxy- gen. If higher oxygen content is indicated, the engine is running too lean and lower oxygen content indi- cates the mixture is too rich.

Benefits of Rich-Burn
One of the benefits of engines running in Rich Burn Mode, with a catalytic converter, is that they operate with very small quantities of NOx emissions and CO in the exhaust. NOx in the range of a few parts per million is achievable.

Catalyst Monitor: System Level



Service Options & Replacement Parts

- Bosch O2 Sensor: 2000 hours expected life. (Part No. 52040029)
- NOx Sensor: Replace as needed 12V: (Part No. 60202029) 24V: (Part No. 60202039)
- CM Battery: 20+ Years expected life.
- Thermocouples: Type K, replace as necessary.
- Transducer: (Part No. 60202019)
- DP: The 4-20mA 0-5" pressure transducer is: Dwyer, model 631B, Part No. (631B-3)
- Thumb Drive: Three years expected life.

If any other performance issues are requiring customer service or attention the customer must send the Catalyst Monitor back to CCC.

Software Description

The primary function of the catalyst monitor is to provide data logging services and an optional real-time intelligent feedback system which maintains continuous compli- ance with the AFR set point.

Interface to wide-band O2 sensor needs an intelligent controller to interact with the oxygen sensor to control heater, pump current, provides linear 0-5v signal proportional to oxygen content.

Add a level of control to a standard AFR controller, utilizing either a post-catalyst wide-range O2 sensor or NOx sensor.

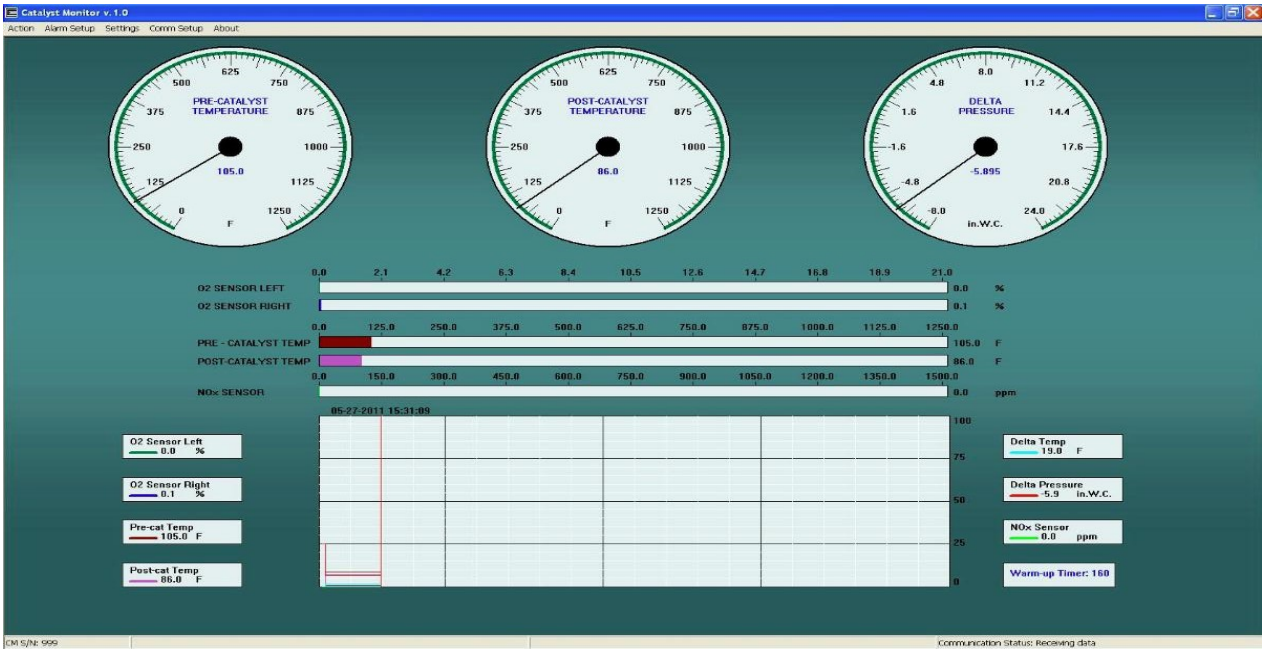
The Catalyst Monitor receives input from the DP the pre and post catalyst ther- mocouple feedback as the primary source of information gathering. Upgraded catalyst monitors are also equipped with NOx sensors with CAN communication which retains com- pliance without the need for human interven- tion by automatically designating a new AFR set point.

The Catalyst Monitor Software Overview

The Catalyst Monitor is a Microsoft Windows-based application used for interfacing the engine control systems.

The Catalyst Monitor application provides real-time monitoring of control functions via data collection and gives the user overall control over the Catalyst functionality, serves as a diagnostic tool to help detect and evaluate problems related to fuel control and emissions reduction on natural gas engines.

The Catalyst Monitor is an intuitive, user-friendly software tool which offers an advanced array of features like easy setup of all user-definable set-points in the Catalyst, monitoring key data points, optional data- logging, playback of history files, settings report, zoom feature, digital inputs control, and other features.



Communications Setup

Communication Port

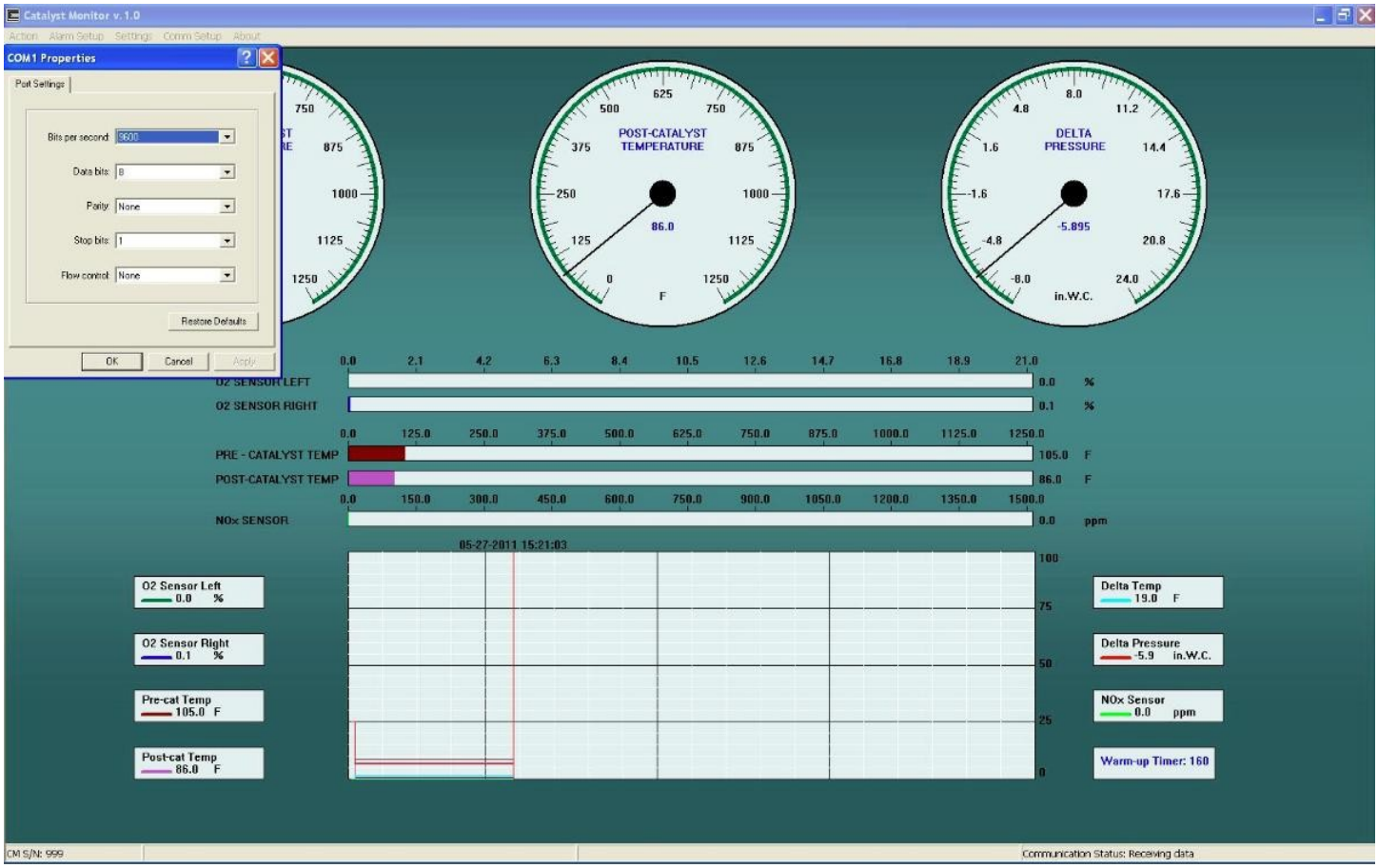
Communication Port Properties

Main Menu –> Comm Setup

The catalyst monitor automatically establishes communications with EGC using default communication port COM 1 and Device ID1. However, it is possible to specify different communication port and/or device ID.

Communication setup guide:

1. Go to Comm Setup –> Comm port
2. Communications Port dialogue box should open up.
3. Enter communication port number and device ID.
4. Press OK to apply changes. Communication Port Properties dialogue box will open up automatically. Do not change any settings! Press OK to close the dialogue box. Catalyst Monitor will apply new settings to establish communications with the engine.



Communication Properties

Default communication port settings:

- Bits per second: 9600
- Data bits: 8
- Parity: None
- Stop bits: 1
- Flow control: None

Playback

Action / Log File

Main Menu –> Action –> Log File

Optional real-time data logging allows storing gthe crucial information on a PC running Windows OS soft-ware. Data Logging is enabled by default.

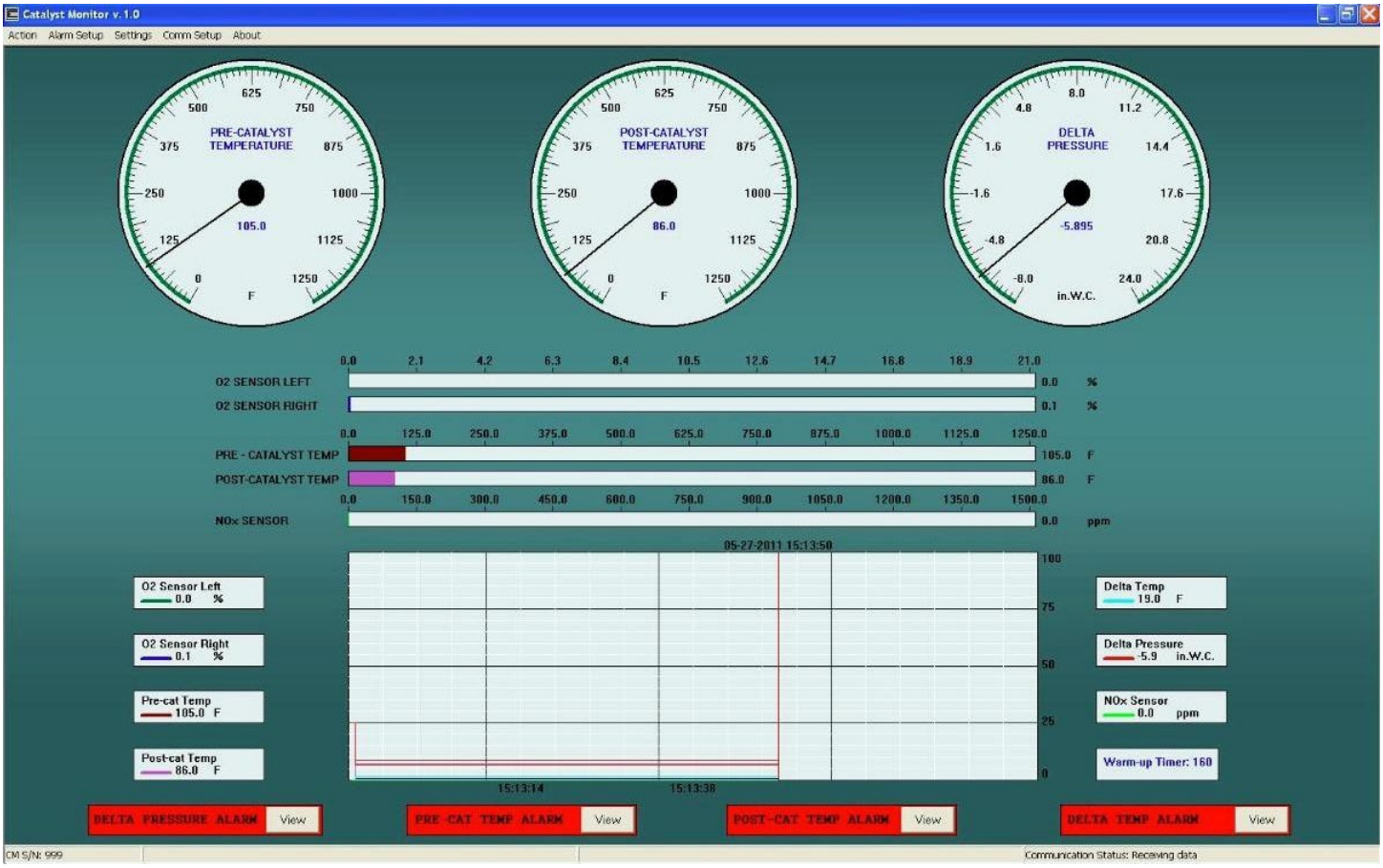
Playback

Main menu –> Action –> Playback

This feature enables the user to play back all the history files in order to detect and evaluate problems relat-ed to fuel control and emissions reduction on natural gas engines.

Playback guide:

1. Select a date from the drop down calendar menu.
2. Click "Open File" to select a log file, created on a specific date.
3. Playback Setup dialogue box should open up.
4. Select a date from the drop-down menu to display available log files.
5. Press "Open File" button to select a log file.
6. Playback track bar is ready to navigate.
7. For easy navigation use Play, Stop, Rewind, Pause, Fast Forward Buttons.

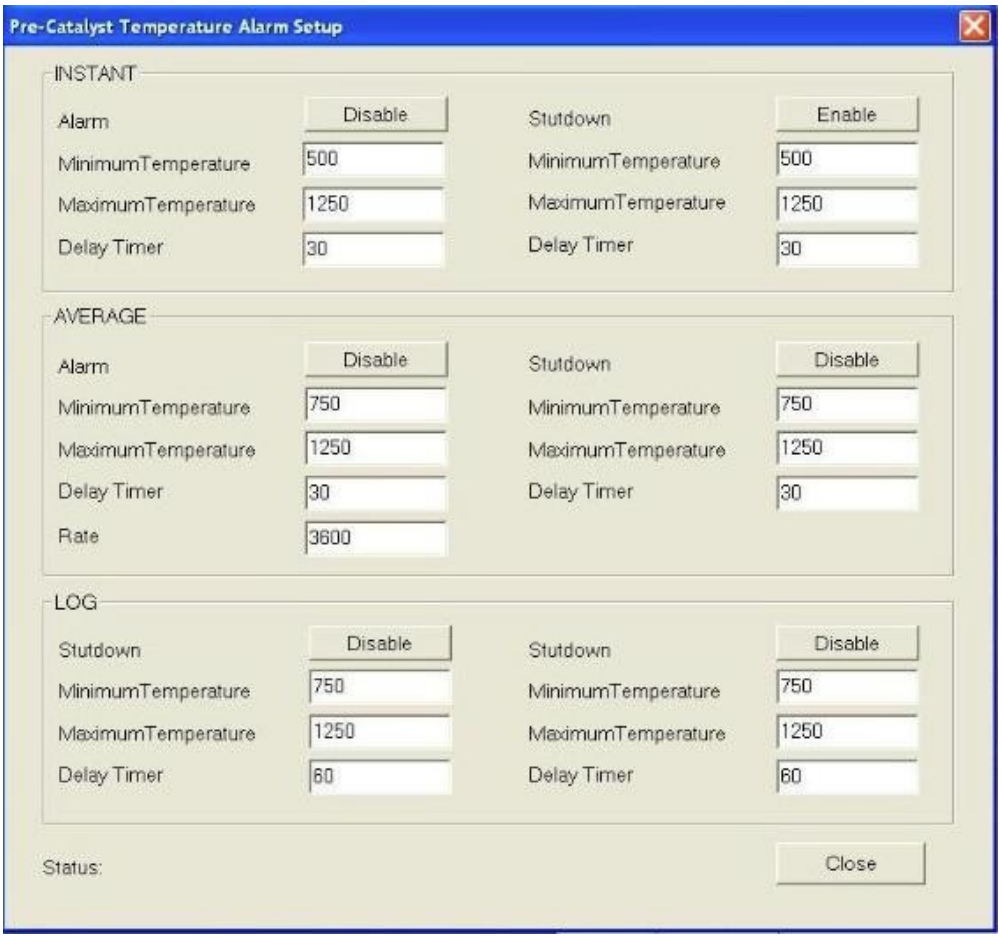


Alarms and Shutdown

There are a total of 24 alarms which are to trigger if the catalyst is not behaving normally.

The alarm can be brought into greater detail when the user presses the "View" button on the right of the alarm signal. There, the user can identify the cause of the alarm and take preventative measures to stop a shutdown.

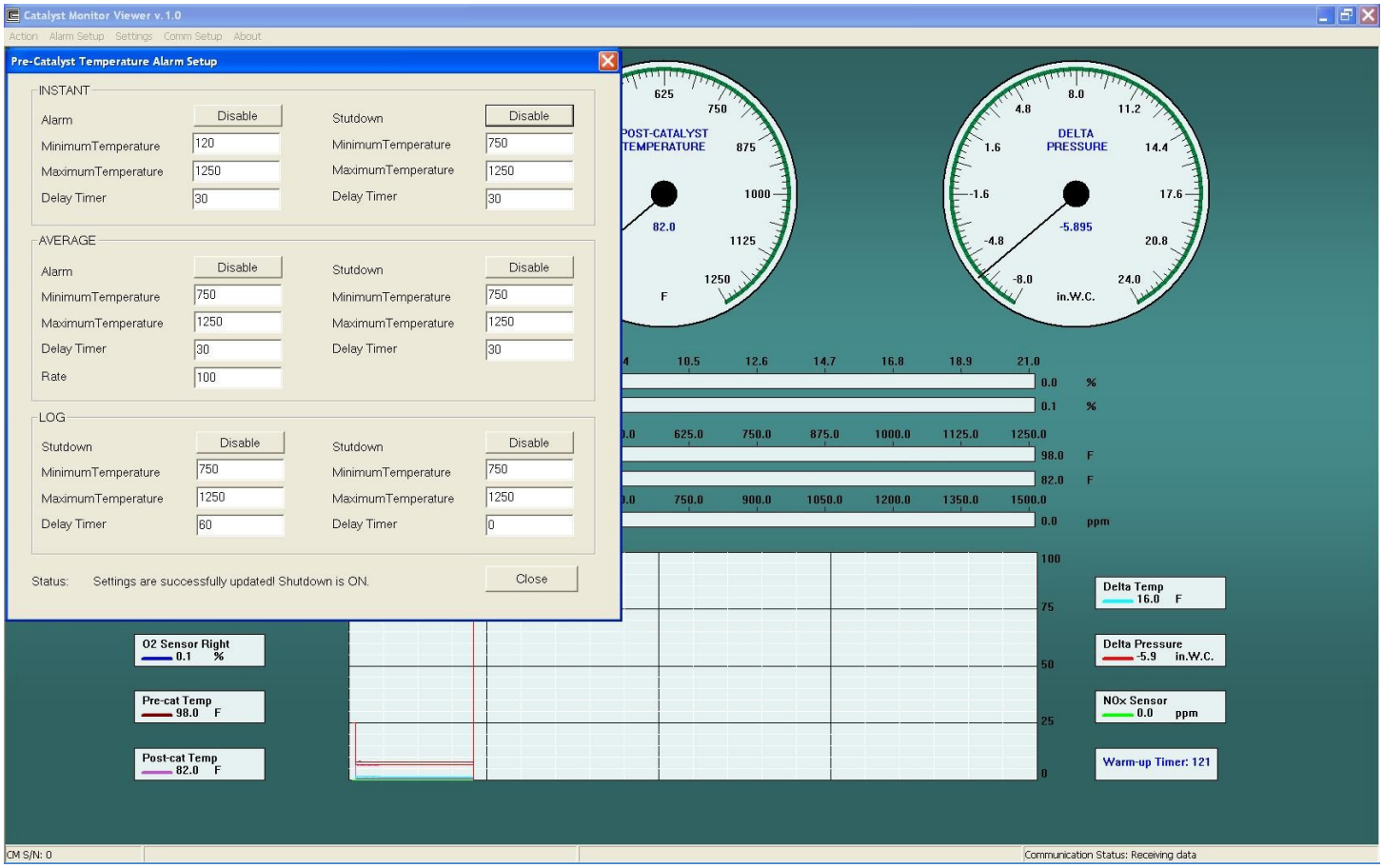
Multiple alarms can trigger simultaneously but only one will lead to a shutdown. The Catalyst Monitor will cite the source of the shutdown. The shutdown details will be clearly defined for the user when the window is displayed.



Pre-Catalyst Alarm Setup

Go to Main Menu:

- –> Action
  - –> Connect
  - –> Disconnect
  - –> Playback
  - –> Exit
- –> Alarm Setup
  - –> Pre-Cat Temp Alarm
  - –> Post-Catalyst
  - –> Differential Temperature Alarm
  - –> Differential Pressure Alarm
- –> Settings
  - –>Log & Filter
  - –> Calibrate Catalyst Monitor
- –> Comm Setup
  - –>Comm Port
  - –>Comm Port Properties
- –> About



Alarm Interface

The alarm interface which governs the alarm and shutdown ranges can be categorized into three measurement over differing spans of time.

The first of the measurements is an "Instant", or real-time feedback data collecting programs which are meant to provide instantaneous information regarding the minimum and maximum temperatures of the catalyst, and the delay (usually set to 30 minutes after ignition confirm). This delay can be adjusted accord- ing to user discretion.

The second measurement is what is referred to as the "Average" which is taken as between hour intervals of the Catalyst Monitor. The average can be adjusted the any customer interval, based upon user need, with a one hour default setting.

The third measurement is what is referred to as the "Log" which is taken from a four hour rolling average of the Catalyst Monitor. This is the "average of the average" value which can be user definable, with a four hour default setting.

Calibrate Catalyst Monitor

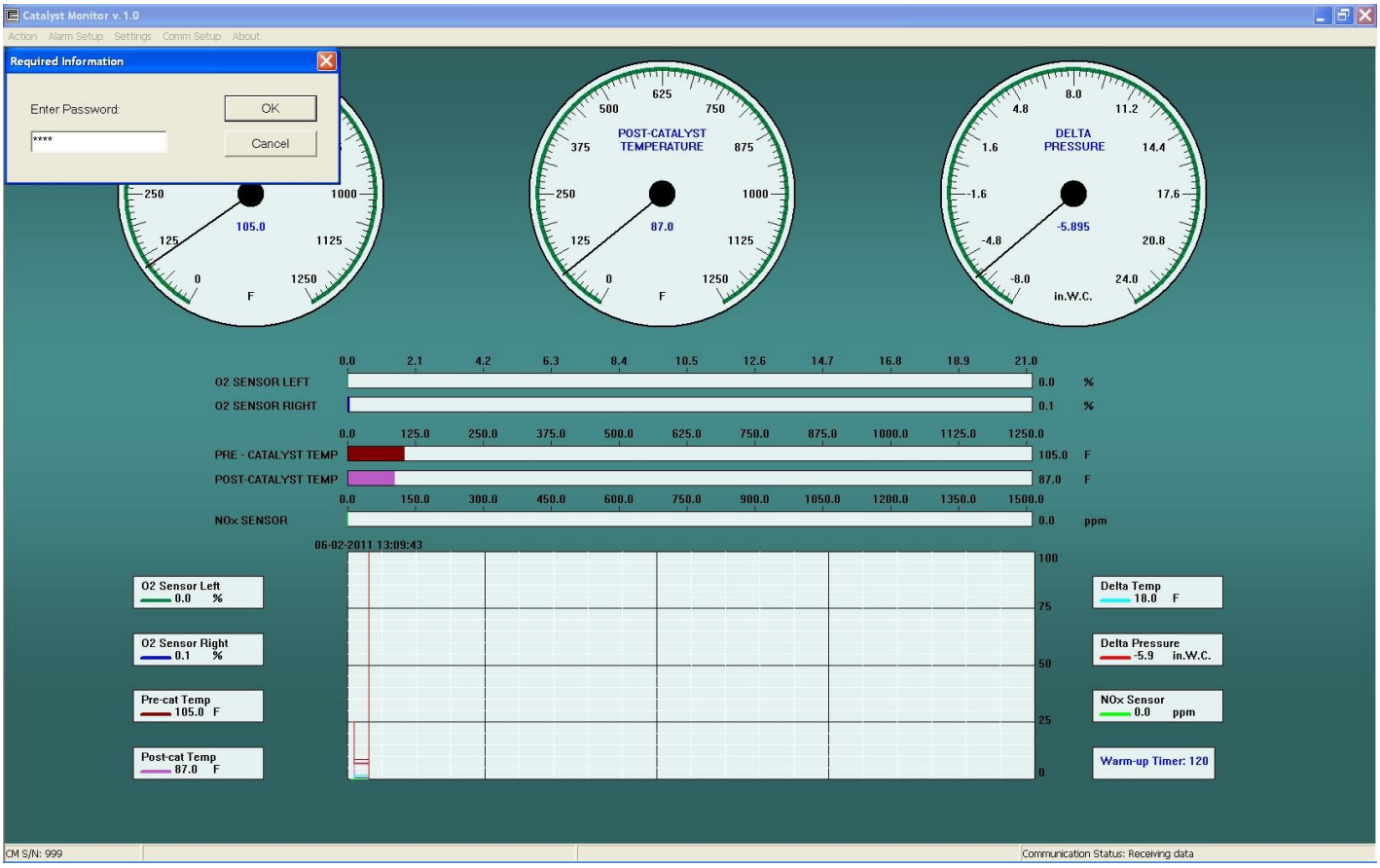
Main Menu –> Settings –> Calibrate CM

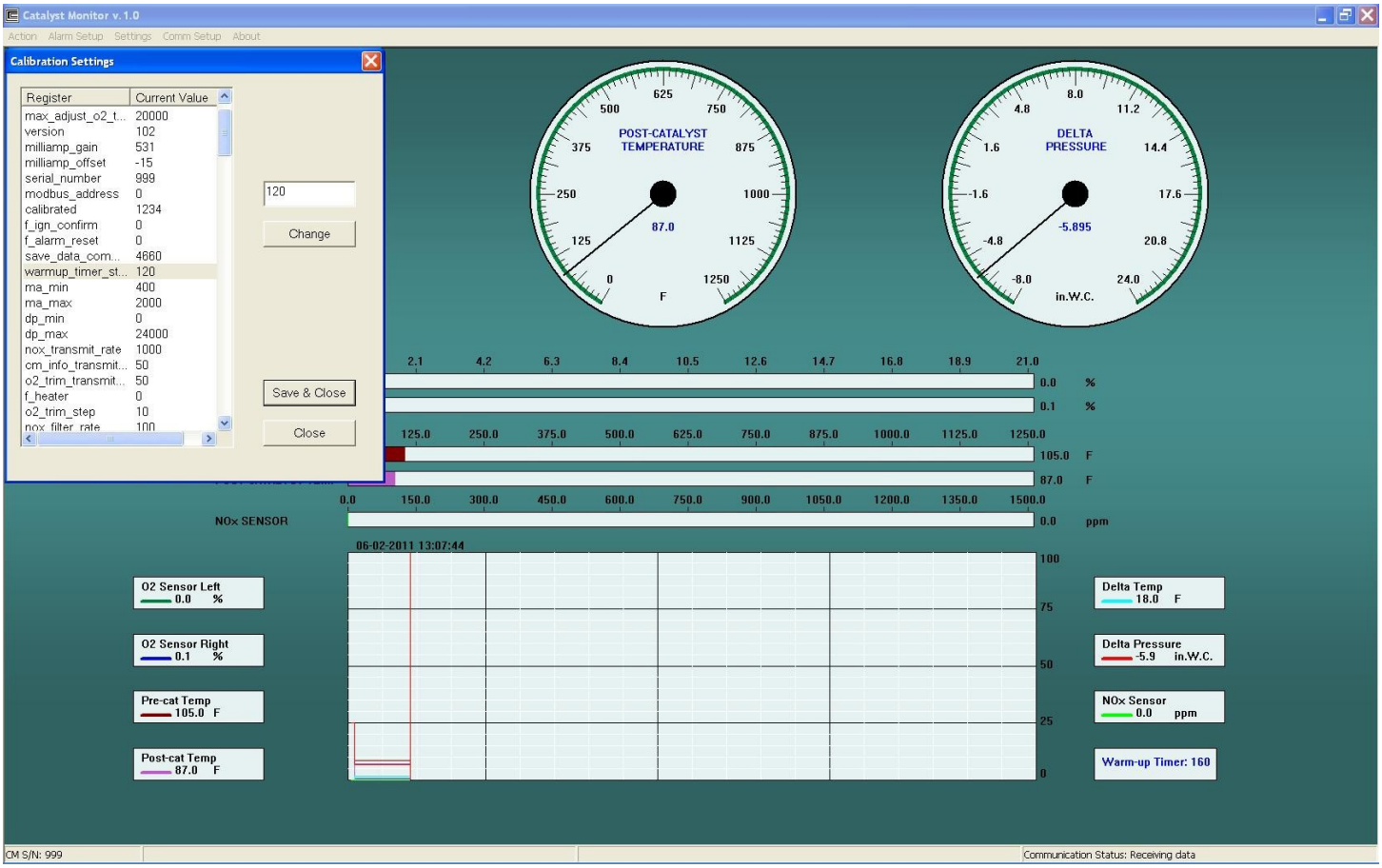
Password protected feature gives the user complete access to all the settings within the Catalyst Monitor. Should you need to use this feature, please contact CCC Engineering Department to obtain the password.

Telephone: (858) 453-9880

Calibration guide:

- Locate and select the setting that needs to be changed.
- Its current value will be displayed in the edit box.
- Type in the value, click change button.
- Press "Save" button to save the new settings, otherwise press "Close" button.





Changing Calibration Settings

After entering the password to access the interface, the user is brought into the calibration menu. There they would be able to access all of the parameters open for augmentation, and the default settings with the Catalyst Monitor.

The user must hit "Save & Close" in order to keep the new settings after making changes to original calibration. If they exit before this is done, the changes will not be saved and the Catalyst Monitor will revert back to previous settings.

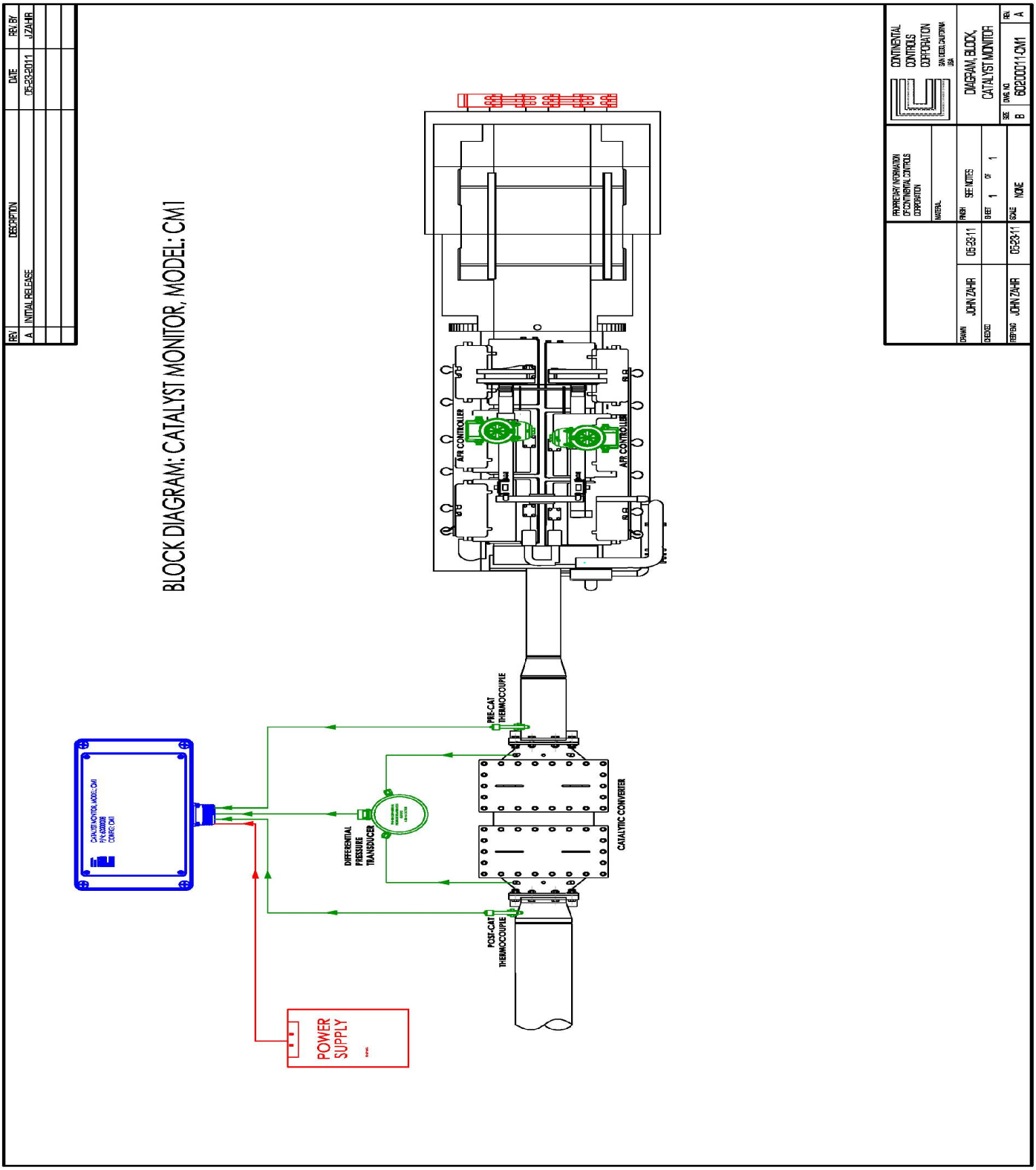
Product Warranty

Continental Controls Corporation warrants that all goods furnished by CCC are free from defects in workmanship and material as of the time and place of delivery.

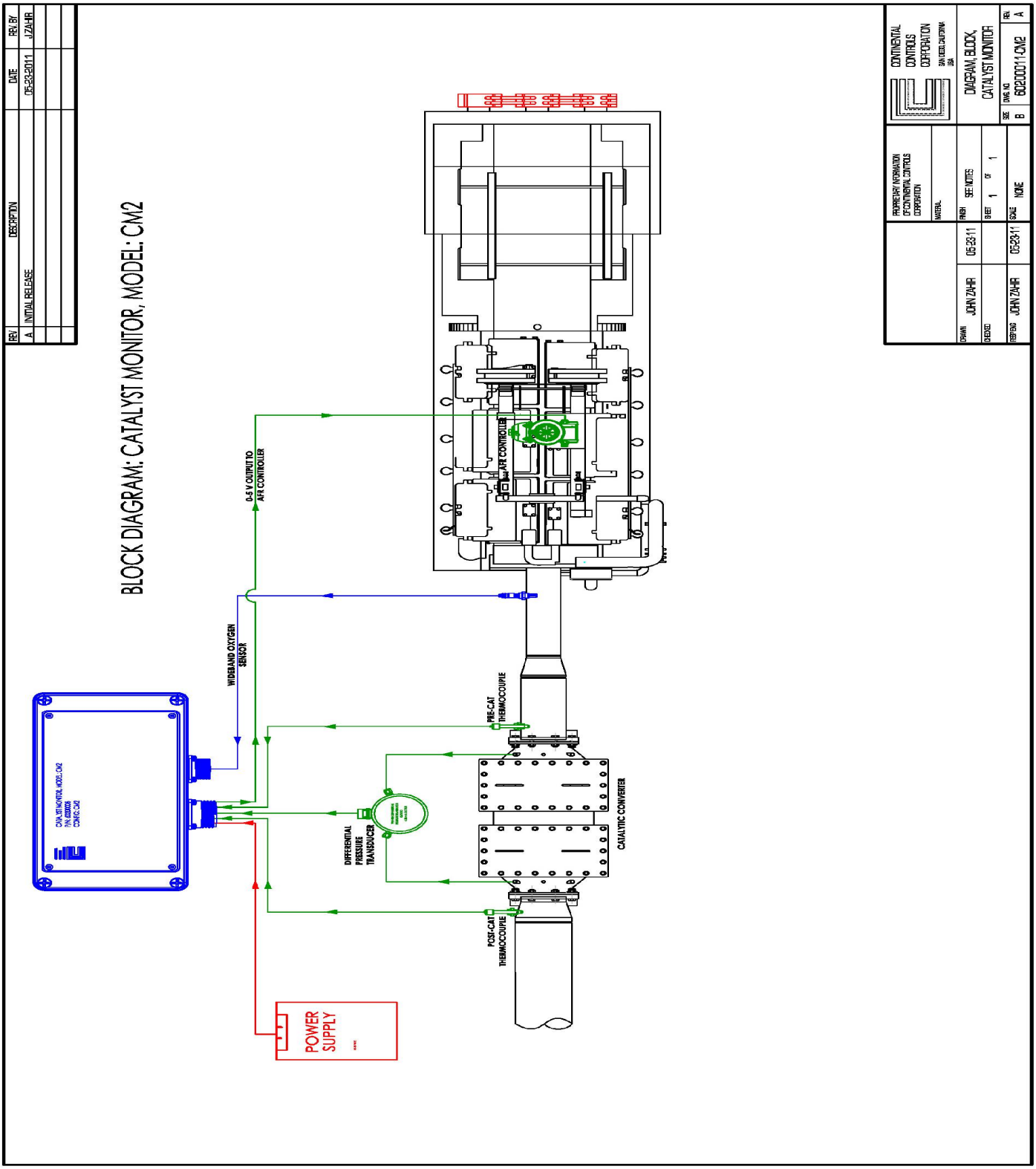
As a matter of general warranty policy, CCC honors an original buyer's warranty claim in the event of failure within 12 months of shipment to the end-user, when the equipment has been installed and operated under normal conditions and in accordance with installation instructions contained in the operating manual and generally accepted operating practices.

All warranty work must be performed and CCC's manufacturing facility in San Diego. The customer is responsible for shipment or delivery of the product to the CCC facility. CCC will pay return ground freight. The customer will pay any expedited freight fees.

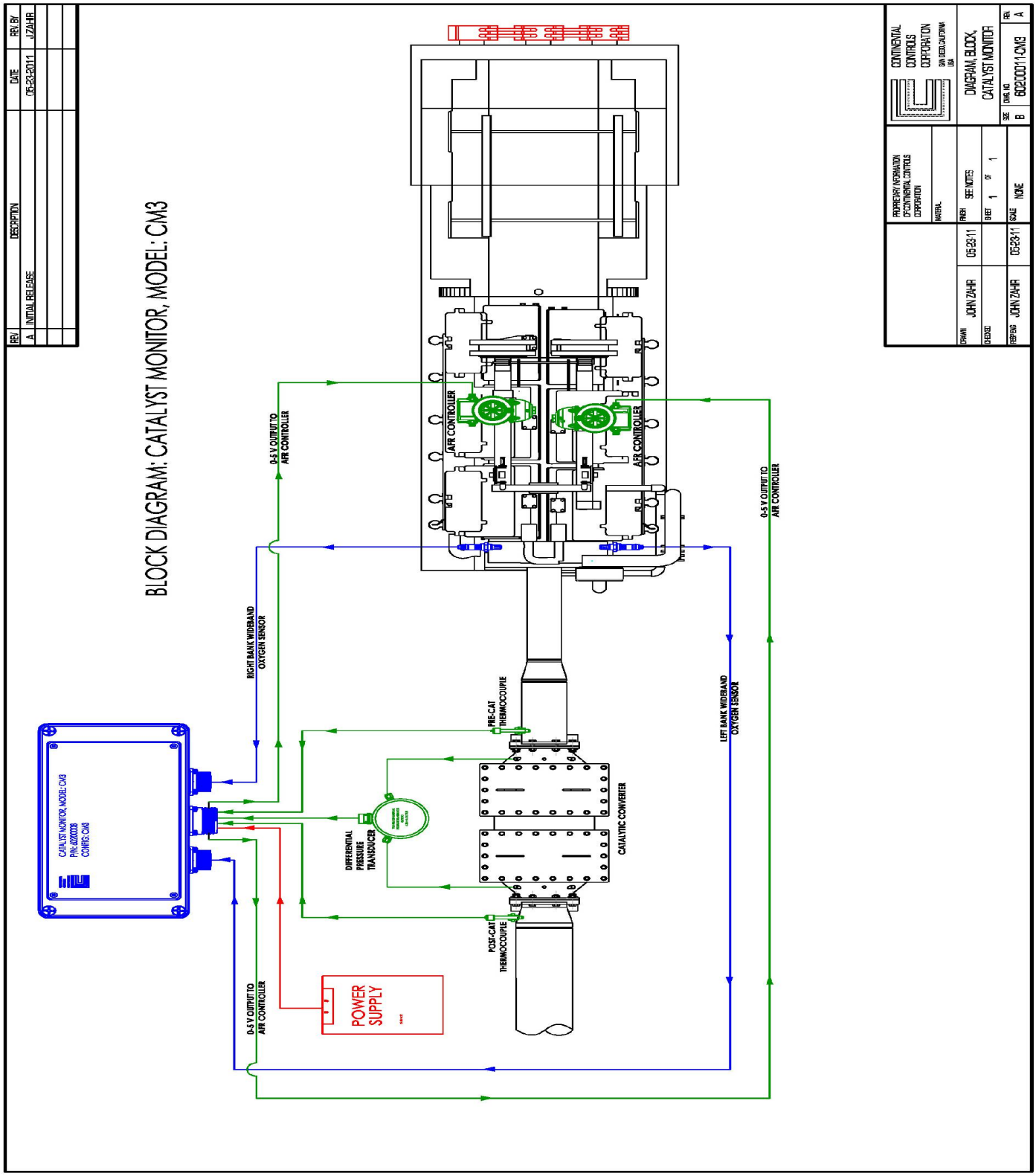
Block Diagram: CM1



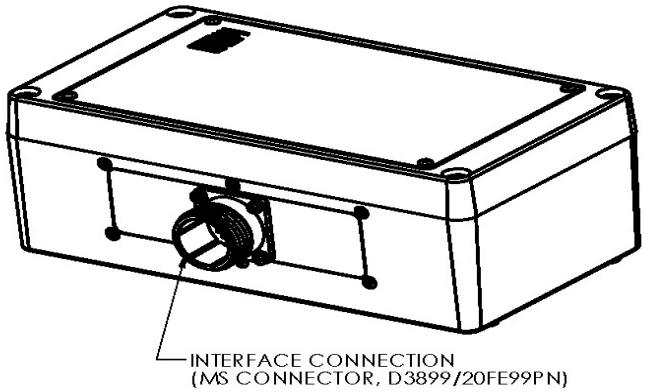
Block Diagram: CM2

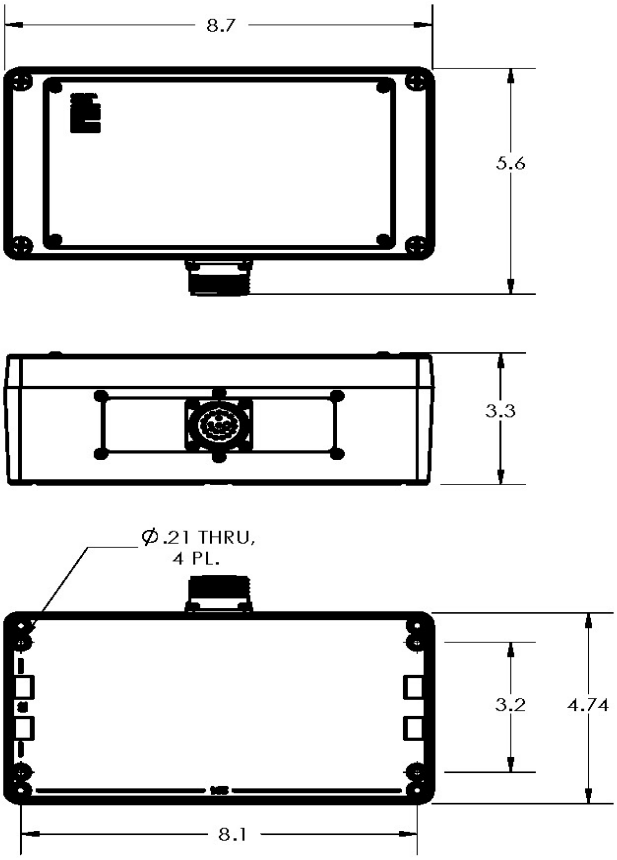


Block Diagram: CM3



Envelope Drawing: CM1





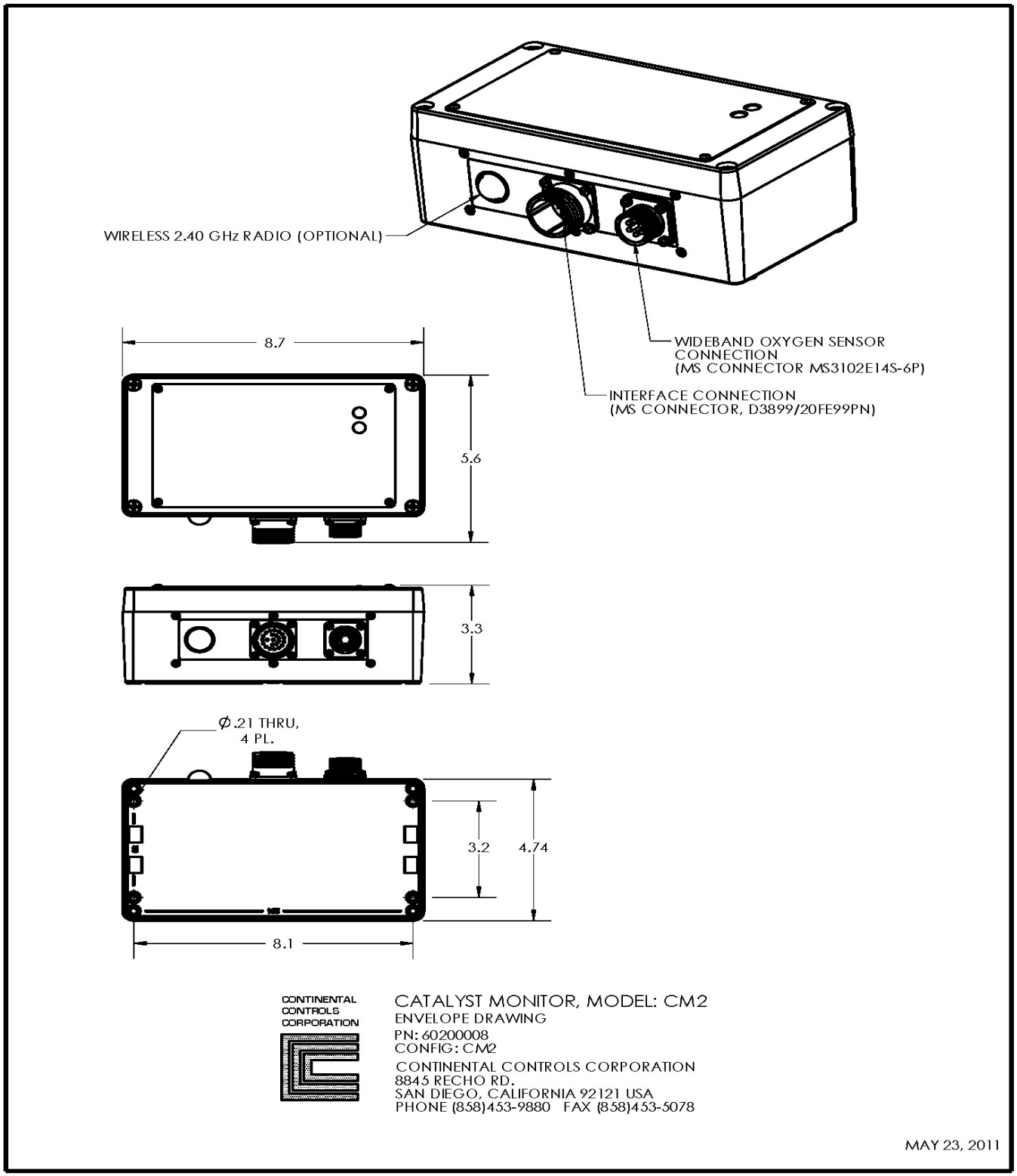
CONTINENTAL CONTROLS CORPORATION

CATALYST MONITOR, MODEL: CM1
ENVELOPE DRAWING
PN: 60200008
CONFIG: CM1

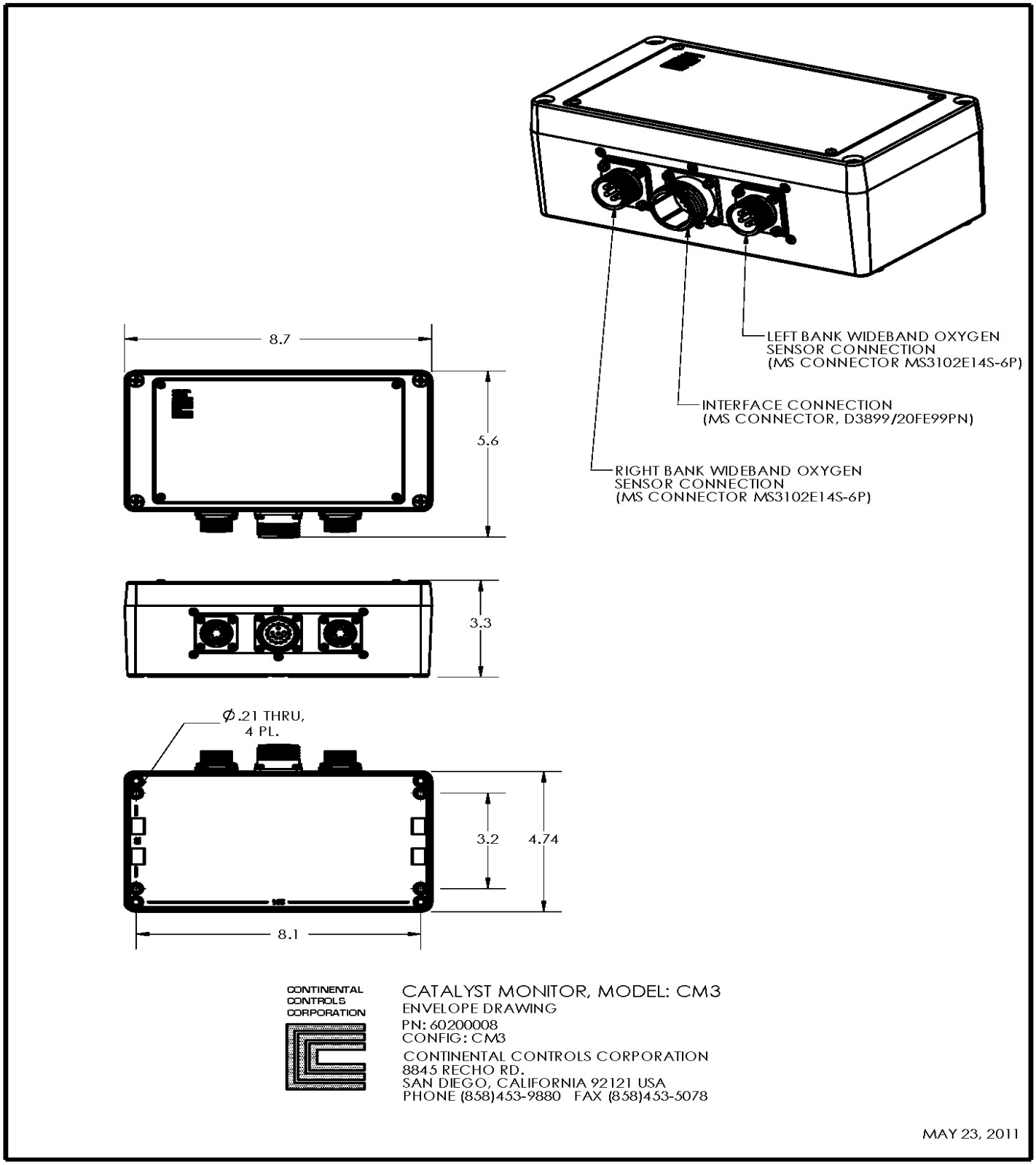
CONTINENTAL CONTROLS CORPORATION
8845 RECHO RD.
SAN DIEGO, CALIFORNIA 92121 USA
PHONE (858)453-9880 FAX (858)453-5078

MAY 23, 2011

Envelope Drawing: CM2



Envelope Drawing: CM3



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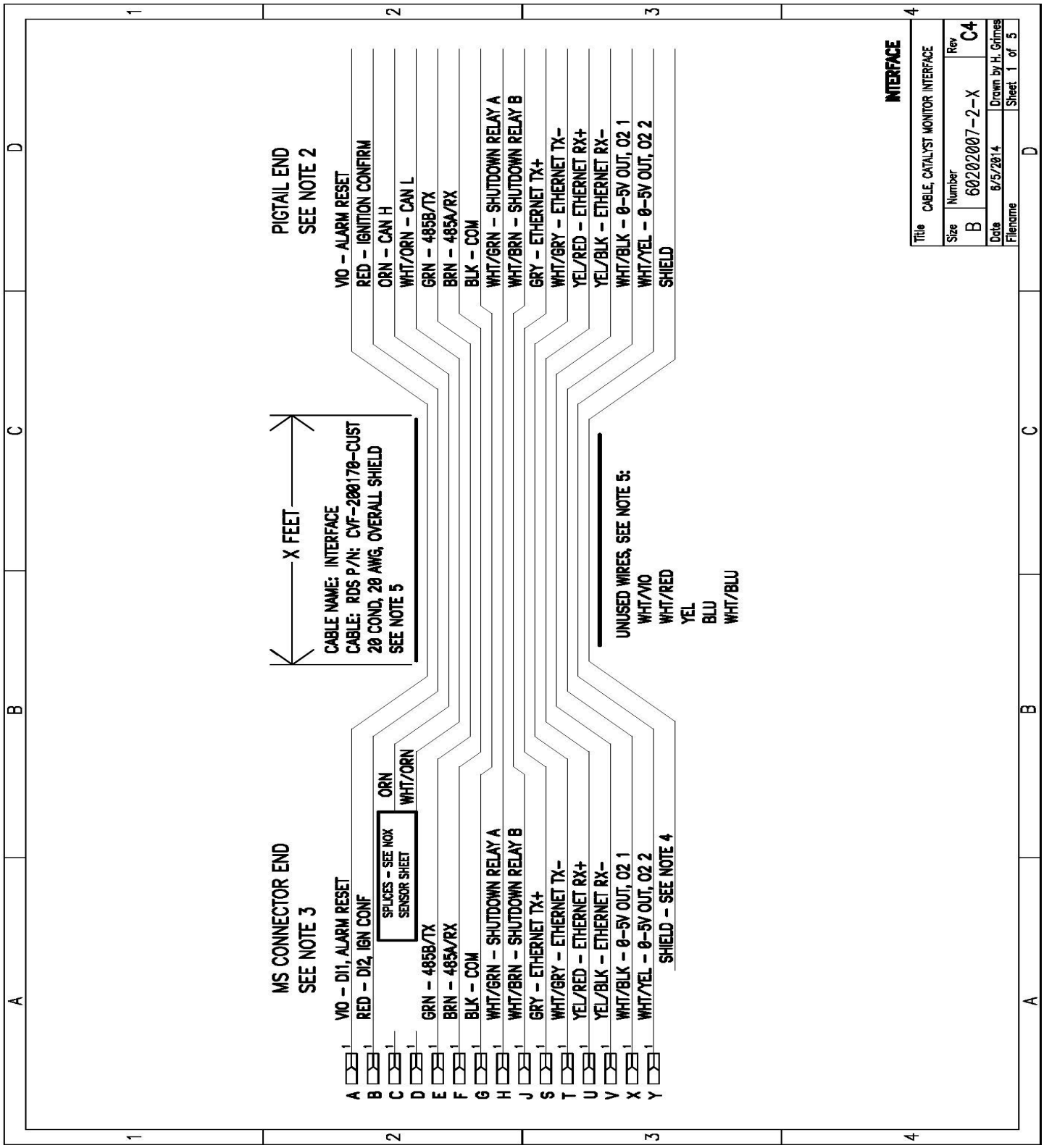
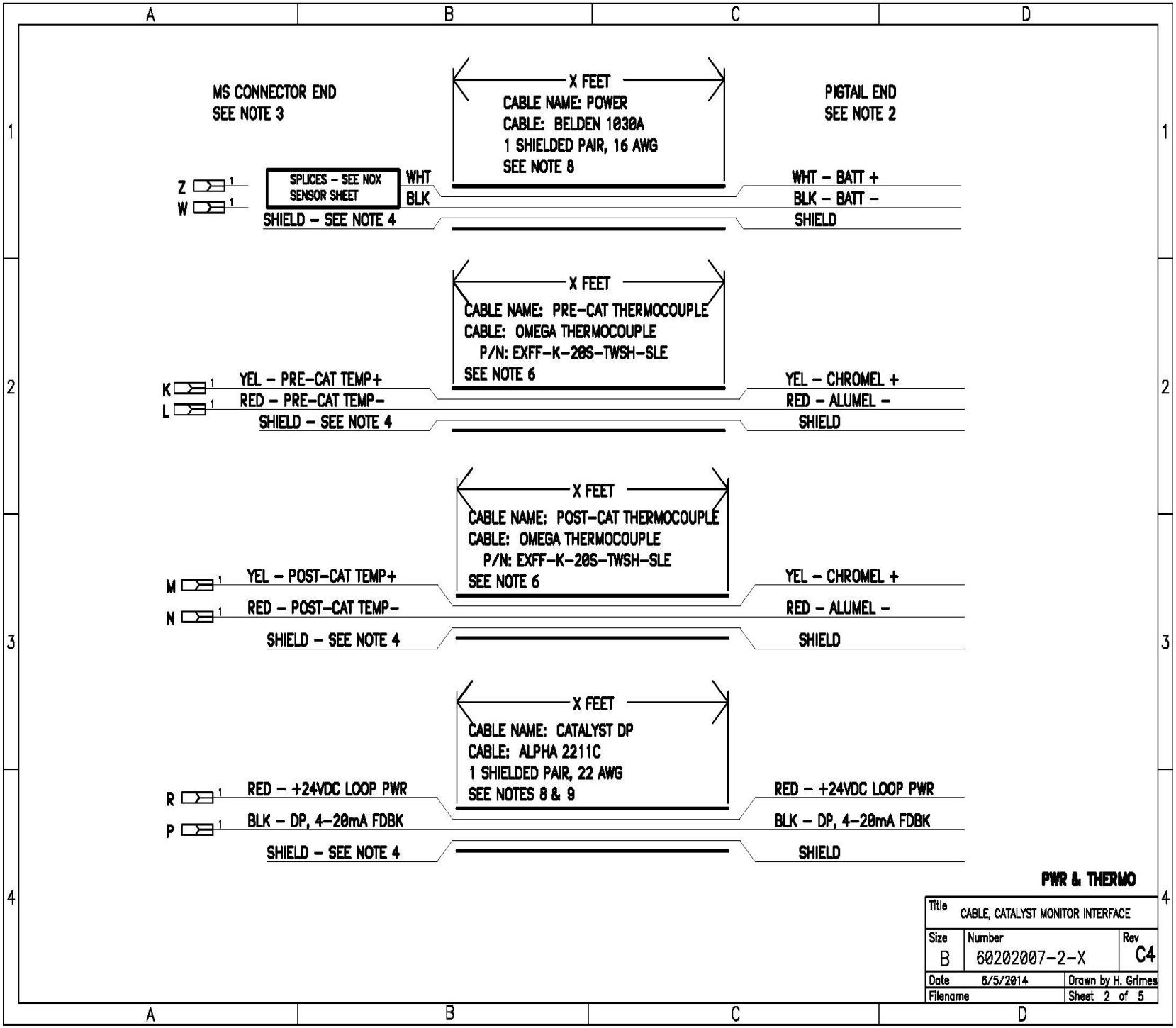
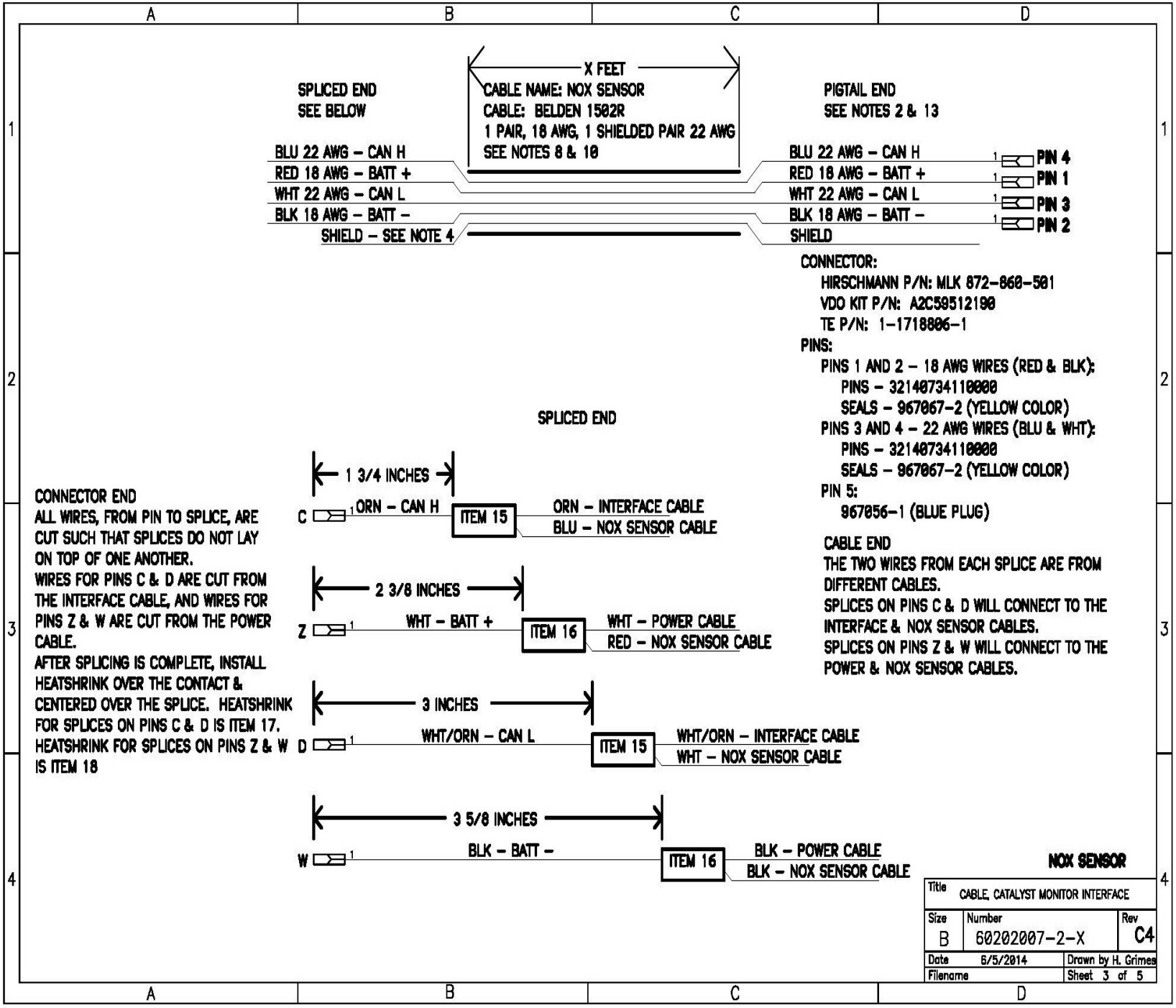
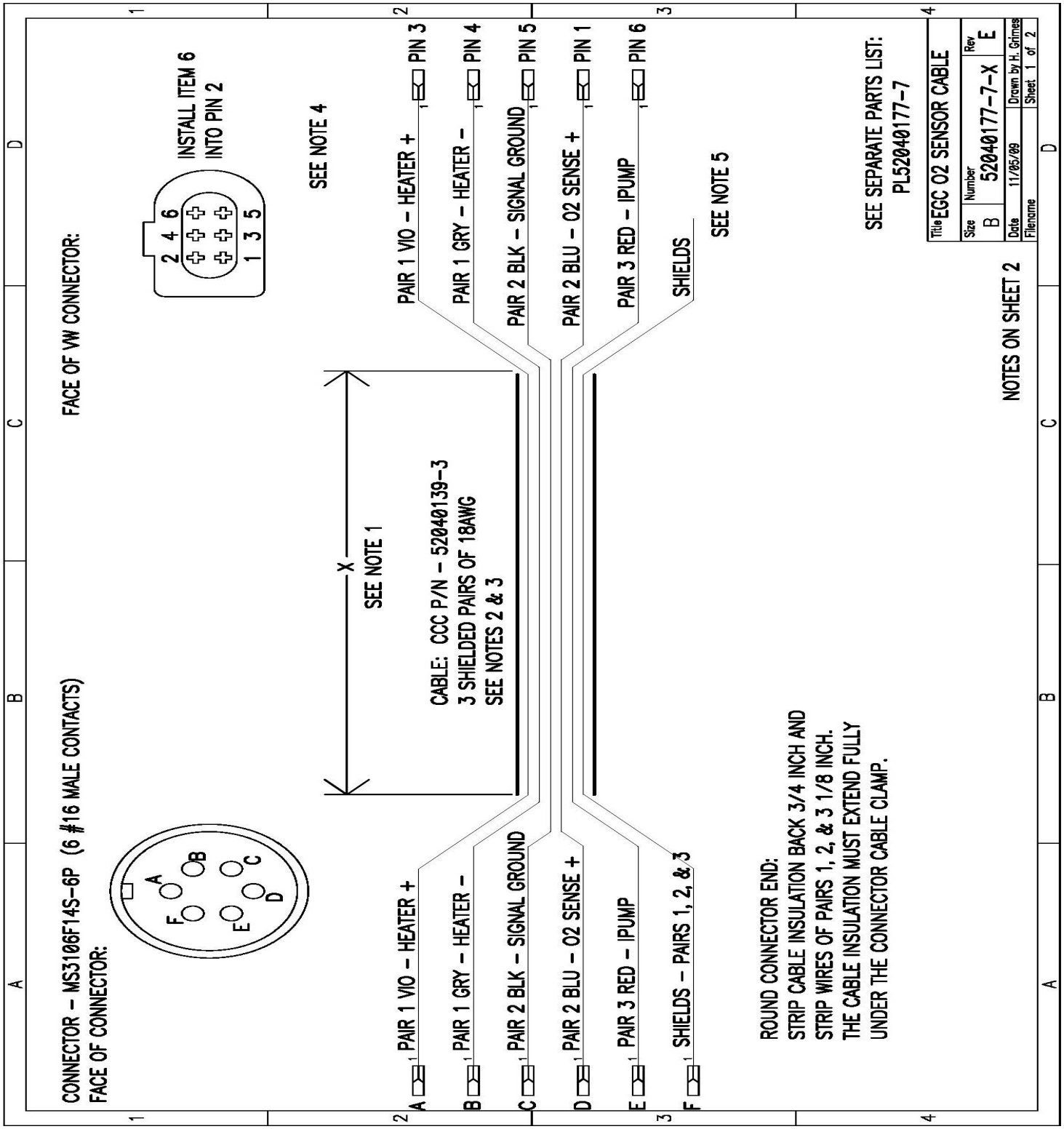
Interface Cable, 60202007-X



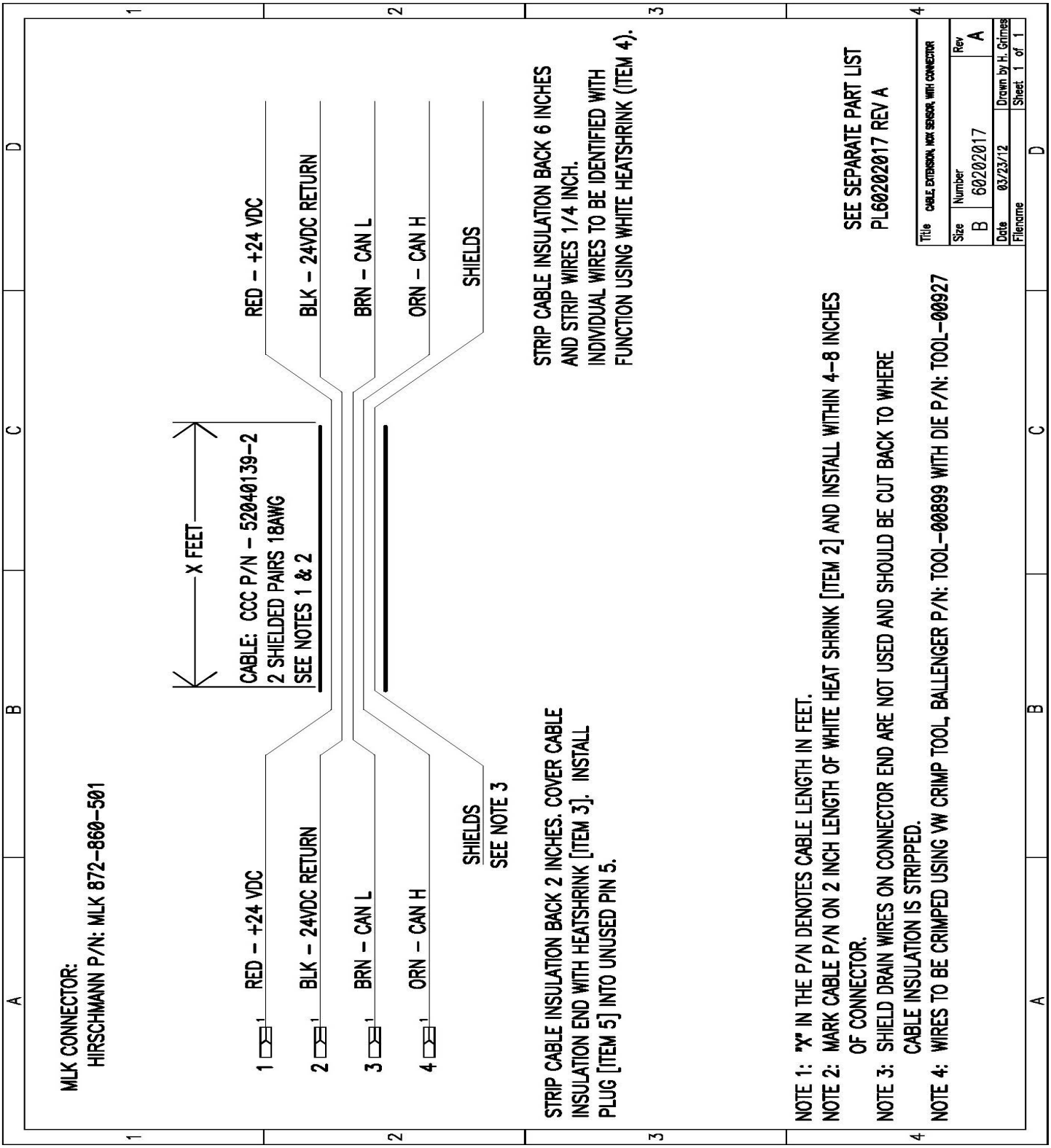

MS CONNECTOR END
SEE NOTE 3
PIGTAIL END
SEE NOTE 2
X FEET
CABLE NAME: POWER
CABLE: BELDEN 1030A
1 SHIELDED PAIR, 16 AWG
SEE NOTE 8
Z
W
SPLICES - SEE NOX SENSOR SHEET
WHT
BLK
SHIELD - SEE NOTE 4
WHT - BATT +
BLK - BATT -
SHIELD
X FEET
CABLE NAME: PRE-CAT THERMOCOUPLE
CABLE: OMEGA THERMOCOUPLE
P/N: EXFF-K-20S-TWSH-SLE
SEE NOTE 6
K
L
YEL - PRE-CAT TEMP+
RED - PRE-CAT TEMP-
SHIELD - SEE NOTE 4
YEL - CHROMEL +
RED - ALUMEL -
SHIELD
X FEET
CABLE NAME: POST-CAT THERMOCOUPLE
CABLE: OMEGA THERMOCOUPLE
P/N: EXFF-K-20S-TWSH-SLE
SEE NOTE 6
M
N
YEL - POST-CAT TEMP+
RED - POST-CAT TEMP-
SHIELD - SEE NOTE 4
YEL - CHROMEL +
RED - ALUMEL -
SHIELD
X FEET
CABLE NAME: CATALYST DP
CABLE: ALPHA 2211C
1 SHIELDED PAIR, 22 AWG
SEE NOTES 8 & 9
R
P
RED - +24VDC LOOP PWR
BLK - DP, 4-20mA FDBK
SHIELD - SEE NOTE 4
RED - +24VDC LOOP PWR
BLK - DP, 4-20mA FDBK
SHIELD
PWR & THERMO
Title CABLE, CATALYST MONITOR INTERFACE
Size B
Number 60202007-2-X
Rev C4
Date 6/5/2014
Drawn by H. Grimes
Filename
Sheet 2 of 5


X FEET
CABLE NAME: NOX SENSOR
CABLE: BELDEN 1502R
1 PAIR, 18 AWG, 1 SHIELDED PAIR 22 AWG
SEE NOTES 8 & 10
SPLICED END
SEE BELOW
PIGTAIL END
SEE NOTES 2 & 13
BLU 22 AWG – CAN H
RED 18 AWG – BATT +
WHT 22 AWG – CAN L
BLK 18 AWG – BATT –
SHIELD – SEE NOTE 4
BLU 22 AWG – CAN H
RED 18 AWG – BATT +
WHT 22 AWG – CAN L
BLK 18 AWG – BATT –
SHIELD
PIN 4
PIN 1
PIN 3
PIN 2
CONNECTOR:
HIRSCHMANN P/N: MLK 872-860-501
VDO KIT P/N: A2C59512190
TE P/N: 1-1718806-1
PINS:
PINS 1 AND 2 – 18 AWG WIRES (RED & BLK):
PINS – 32140734110000
SEALS – 967067-2 (YELLOW COLOR)
PINS 3 AND 4 – 22 AWG WIRES (BLU & WHT):
PINS – 32140734110000
SEALS – 967067-2 (YELLOW COLOR)
PIN 5:
967056-1 (BLUE PLUG)
SPLICED END
1 3/4 INCHES
C
ORN – CAN H
ITEM 15
ORN – INTERFACE CABLE
BLU – NOX SENSOR CABLE
2 3/8 INCHES
Z
WHT – BATT +
ITEM 16
WHT – POWER CABLE
RED – NOX SENSOR CABLE
3 INCHES
D
WHT/ORN – CAN L
ITEM 15
WHT/ORN – INTERFACE CABLE
WHT – NOX SENSOR CABLE
3 5/8 INCHES
W
BLK – BATT –
ITEM 16
BLK – POWER CABLE
BLK – NOX SENSOR CABLE
CONNECTOR END
ALL WIRES, FROM PIN TO SPLICE, ARE CUT SUCH THAT SPLICES DO NOT LAY ON TOP OF ONE ANOTHER.
WIRES FOR PINS C & D ARE CUT FROM THE INTERFACE CABLE, AND WIRES FOR PINS Z & W ARE CUT FROM THE POWER CABLE.
AFTER SPLICING IS COMPLETE, INSTALL HEATSHRINK OVER THE CONTACT & CENTERED OVER THE SPLICE. HEATSHRINK FOR SPLICES ON PINS C & D IS ITEM 17. HEATSHRINK FOR SPLICES ON PINS Z & W IS ITEM 18
CABLE END
THE TWO WIRES FROM EACH SPLICE ARE FROM DIFFERENT CABLES.
SPLICES ON PINS C & D WILL CONNECT TO THE INTERFACE & NOX SENSOR CABLES.
SPLICES ON PINS Z & W WILL CONNECT TO THE POWER & NOX SENSOR CABLES.
NOX SENSOR
Title
CABLE, CATALYST MONITOR INTERFACE
Size
B
Number
60202007-2-X
Rev
C4
Date
6/5/2014
Drawn by H. Grimes
Filename
Sheet 3 of 5

Oxygen Sensor Cable, 52040177-1



NOX Cable, 60202017



Modbus Register Map

30x Input regsiters

Register	Name (CM manual)	Description	Scaling Factor	Units
30001	pre_cat_nox	Ignore	1	
30002	post_cat_nox	NOx reading from post-cat Nox sensor	1.0E-01	ppm
30003	pre_cat_o2	Ignore	1	
30004	post_cat_o2	Ignore	1	
30005	pre_cat_temp	Pre-catalyst temperetaure	1	F
30006	post_cat_temp	Post-catalyst temperature	1	F
30007	pre_status_supply	Ignore	1	
30008	pre_status_sensor_heater	Ignore	1	
30009	pre_status_nox_signal	Ignore	1	
30010	pre_status_o2_signal	Ignore	1	
30011	post_status_supply	NOx sensor supply status	1	
30012	post_status_sensor_heater	Nox sensor heater status	1	
30013	post_status_nox_signal	Nox sensor NOx signal status	1	
30014	post_status_o2_signal	Nox sensor O2 signal status	1	
30015	pre_status_nox_error	Ignore	1	
30016	pre_status_o2_error	Ignore	1	
30017	post_status_nox_error	Error Code	1	
30018	post_status_o2_error	Error Code	1	
30019	rtc_sec	Real time clock: second	1	
30020	rtc_min	Real time clock: minute	1	
30021	rtc_hour	Real time clock: hour	1	
30022	rtc_wday	Real time clock: week day	1	
30023	rtc_mdate	Real time clock: date	1	
30024	rtc_month	Real time clock: month	1	
30025	rtc_year	Real time clock: year	1	
30026	ecu_lb_can_off	Left bank valve CANbus not detected/turned off	1	
30027	ecu_rb_can_off	Right bank valve CANbus not detected/turned off	1	
30028	pre_nox_can_off	Ignore	1	
30029	post_nox_can_off	NOx sensor CANbus not detected/turned off	1	
30030	battery_voltage	Catalyst Monitor supply voltage	1.0E-01	V

Register	Name (CM manual)	Description	Scaling Factor	Units
30031	milliamp_input	mA reading from DP	1.0E-02	mA
30032	catalyst_dp	Differential pressure across catalyst	1.0E-02	in.W.C.
30033	nox_heater	NOx heater ON/OFF flag	1	
30034	nox_warmup_timer	Nox/O2 heater warmup timer	1	seconds
30035	left_bank_o2_setpoint	Left bank valve - O2 sensor setpoint	1.0E-03	V
30036	left_bank_o2_feedback	Left bank valve - O2 sensor feedback	1.0E-03	V
30037	left_bank_press_setpoint	Left bank valve - pressure setpoint	1.0E-03	in.W.C.
30038	left_bank_press_feedback	Left bank valve - pressure feedback	1.0E-03	in.W.C.
30039	left_bank_manifold_press	Left bank valve - manifold pressure	NA	NA
30040	left_bank_actuator_output	Left bank valve - actuator output	1	
30041	left_bank_speed	Left bank valve - speed (if applicable)	NA	RPM
30042	left_bank_sequence	Left bank valve - sequence*	1	
30043	right_bank_o2_setpoint	Right bank valve - O2 sensor setpoint	1.0E-03	V
30044	right_bank_o2_feedback	Right bank valve - O2 sensor feedback	1.0E-03	V
30045	right_bank_press_setpoint	Right bank valve - pressure setpoint	1.0E-03	in.W.C.
30046	right_bank_press_feedback	Right bank valve - pressure feedback	1.0E-03	in.W.C.
30047	right_bank_manifold_press	Right bank valve - manifold pressure	NA	NA
30048	right_bank_actuator_output	Right bank valve - actuator output	1	
30049	right_bank_speed	Right bank valve - speed (if applicable)	NA	
30050	right_bank_sequence	Right bank valve - sequence*	1	
30051	o2_sp_trim	O2 sensor setpoint trim	1.0E-04	Lambda
30052	post_cat_nox_avg	Average post-cat Nox signal	1.0E-01	ppm
30053	ign_confirm	Ignition confirm flag	1	
30054	alarm_reset	Alarm reset flag	1	
30055	pre_temp_avg	Average pre-catalyst temperature	1	F
30056	post_temp_avg	Average post-catalyst temperature	1	F

Register	Name (CM manual)	Description	Scaling Factor	Units
30057	dp_avg	Average catalyst differential pressure	1.0E-02	in.W.C.
30058	o2_1_avg	Average left bank O2 reading	1.0E-03	% O2
30059	o2_2_avg	Average right bank O2 reading	1.0E-03	% O2
30060	pre_temp_log	Long average/Log pre-catalyst temeperature	1	F
30061	post_temp_log	Long average/Log post-catalyst temeperature	1	F
30062	dp_log	Long average/Log catalyst differential pressure	1.0E-02	in.W.C.
30063	o2_1_log	Long average/Log left bank O2 reading	1.0E-03	% O2
30064	o2_2_log	Long average/Log right bank O2 reading	1.0E-03	% O2
30065	alarm_status_high	Over range alarm status	1	
30066	alarm_status_low	Under range alarm status	1	
30067	shutdown_status_high	Over range shutdowns status	1	
30068	shutdown_status_low	Under range shutdown status	1	
30069	filesize	Current log file size	1	
30070	freespace	USB disk free space	1	
30071	dac1_output	Left bank O2 DAC output	1	
30072	dac2_output	Right Bank O2 DAC output	1	
30073	o2_heater	O2 heater ON/OFF flag	1	
30074	percent_o2_1	Left bank O2 percent	1.0E-03	% O2
30075	o2_1_heater_pv	Left bank O2 heater feedback	Ignore	
30076	o2_1_heater_avg	Left bank O2 heater average feedback	Ignore	
30077	o2_1_heater_out	Left bank O2 heater output	Ignore	
30078	percent_o2_2	Right bank O2 percent	1.0E-03	% O2
30079	o2_2_heater_pv	Right bank O2 heater feedback	Ignore	
30080	o2_2_heater_avg	Right bank O2 heater average feedback	Ignore	
30081	o2_2_heater_out	Right bank O2 heater output	Ignore	
30082	o2_1_status	Left bank O2 status	1	
30083	o2_2_status	Right bank O2 status	1	
30084	o2_warmup_timer	O2 warmup timer	1	

Register	Name (CM manual)	Description	Scaling Factor	Units
30085	o2_trim_direction	O2 trim direction	1	
30086	adc1	ADC reading channel1	Ignore	
30087	adc2	ADC reading channel2	Ignore	
30088	adc3	ADC reading channel3	Ignore	
30089	adc4	ADC reading channel4	Ignore	
30090	adc5	ADC reading channel5	Ignore	
30091	adc6	ADC reading channel6	Ignore	
30092	adc7	ADC reading channel7	Ignore	
30093	adc8	ADC reading channel8	Ignore	
30094	pre_status_o2_error	Not used	Ignore	
30095	o2_1_working	O2 sensor at operating temperature	1	
30096	o2_2_working	O2 sensor at operating temperature	1	
30097	eth_status	Diagnostics	1	
30098	eth_txabrt	Diagnostics	1	
30099	eth_reset	Diagnostics	1	
30100	eth_tx	Diagnostics	1	
30101	eth_rx	Diagnostics	1	
30102	eth_packets_avail	Diagnostics	1	
30103	eth_state	Diagnostics	1	
30104	eth_rtc_sec	Diagnostics	1	
30105	eth_rtc_min	Diagnostics	1	
30106	eth_rtc_hour	Diagnostics	1	
30107	eth_rtc_wday	Diagnostics	1	
30108	eth_rtc_mdate	Diagnostics	1	
30109	eth_rtc_month	Diagnostics	1	
30110	eth_rtc_year	Diagnostics	1	
30111	eth_ip_1	Diagnostics	1	
30112	eth_ip_2	Diagnostics	1	
30113	eth_ip_3	Diagnostics	1	
30114	eth_ip_4	Diagnostics	1	
30115	eth_use_static_ip	Diagnostics	1	
30116	trimming_active	Diagnostics	1	
30117	n3x_regs	Number of input(3x) registers	1	

Register	Name (CM manual)	Description	Scaling Factor	Units
30057	dp_avg	Average catalyst differential pressure	1.0E-02	in.W.C.
30058	o2_1_avg	Average left bank O2 reading	1.0E-03	% O2
30059	o2_2_avg	Average right bank O2 reading	1.0E-03	% O2
30060	pre_temp_log	Long average/Log pre-catalyst temeperature	1	F
30061	post_temp_log	Long average/Log post-catalyst temeperature	1	F
30062	dp_log	Long average/Log catalyst differential pressure	1.0E-02	in.W.C.
30063	o2_1_log	Long average/Log left bank O2 reading	1.0E-03	% O2
30064	o2_2_log	Long average/Log right bank O2 reading	1.0E-03	% O2
30065	alarm_status_high	Over range alarm status	1	
30066	alarm_status_low	Under range alarm status	1	
30067	shutdown_status_high	Over range shutdowns status	1	
30068	shutdown_status_low	Under range shutdown status	1	
30069	filesize	Current log file size	1	
30070	freespace	USB disk free space	1	
30071	dac1_output	Left bank O2 DAC output	1	
30072	dac2_output	Right Bank O2 DAC output	1	
30073	o2_heater	O2 heater ON/OFF flag	1	
30074	percent_o2_1	Left bank O2 percent	1.0E-03	% O2
30075	o2_1_heater_pv	Left bank O2 heater feedback	Ignore	
30076	o2_1_heater_avg	Left bank O2 heater average feedback	Ignore	
30077	o2_1_heater_out	Left bank O2 heater output	Ignore	
30078	percent_o2_2	Right bank O2 percent	1.0E-03	% O2
30079	o2_2_heater_pv	Right bank O2 heater feedback	Ignore	
30080	o2_2_heater_avg	Right bank O2 heater average feedback	Ignore	
30081	o2_2_heater_out	Right bank O2 heater output	Ignore	
30082	o2_1_status	Left bank O2 status	1	
30083	o2_2_status	Right bank O2 status	1	

40x Holding Registers

Register	Name	Description	Scaling Factor	Units
40001	rtc_update	Update real time clock flag	1	
40002	min_adjust_o2_trim	Minimum O2 trim adjustment	1	
40003	max_adjust_o2_trim	Maximum O2 trim adjustment	1	
40004	version	Software version	1	
40005	milliamp_gain	mA input gain	1	
40006	milliamp_offset	mA input offset	1	
40007	serial_number	Serial number	1	
40008	modbus_address	Modbus address	1	
40009	calibrated	Original calibration flag	1	
40010	f_ign_confirm	Force ignition confirm flag	1	
40011	f_alarm_reset	Force Alarm reset flag	1	
40012	save_data_command	Save holding registers to flash	1	
40013	warmup_timer_start	Warmup timer duration	1	
40014	ma_min	Minimum mA input	1.0E-02	mA
40015	ma_max	Maximum mA Input	1.0E-02	mA
40016	dp_min	Minimum catalyst differential pressure	1.0E-02	in. W.C
40017	dp_max	Maximum catalyst differential pressure	1.0E-02	in. W.C
40018	nox_transmit_rate	CAN transmit rate - Nox	1	millisec
40019	cm_info_transmit_rate	CAN transmit rate - Catalyst Monitor info	1	millisec
40020	o2_trim_transmit_rate	CAN transmit rate - O2 setpoint trim	1	millisec
40021	f_heater	Force Nox/O2 heater flag	1	
40022	o2_trim_step	O2 setpoint trim increment	1	
40023	nox_filter_rate	Nox averaging filter rate	1	
40024	min_meter	Minute meter - Read Only	1	
40025	hour_meter	Hour meter - Read Only	1	
40026	data_log_enable	USB data logger enable flag	1	
40027	log_rate	USB data logger rate	1	
40028	sample_rate	O2 averaging rate	1	
40029	overall_rate	Not used	Ignore	
40030	log_time_after_shutdown	Time in seconds to continue logging data after shutdown	1	
40031	pre_temp_shutdown	Pre-catalyst temperature /Shutdown/Ala Shutdown/Alarm enable flag	1	
40032	pre_temp_avg_shutdown	Average pre-catalyst temperature Shutdown/Alarm enable flag	1	

Register	Name	Description	Scaling Factor	Units
40033	pre_temp_log_shutdown	Long average/Log pre-catalyst temperature Shutdown/Alarm enable flag	1	
40034	pre_temp_avg_rate	Pre-catalyst temperature averaging rate	1	
40035	pre_temp_alarm_min	Pre-catalyst temperature alarm minimum	1	F
40036	pre_temp_alarm_max	Pre-catalyst temperature alarm maximum	1	F
40037	pre_temp_alarm_delay	Pre-catalyst temperature alarm delay	1	seconds
40038	pre_temp_avg_alarm_min	Average pre-catalyst temperature alarm minimum	1	F
40039	pre_temp_avg_alarm_max	Average pre-catalyst temperature alarm maximum	1	F
40040	pre_temp_avg_alarm_delay	Average pre-catalyst temperature alarm delay	1	seconds
40041	pre_temp_log_alarm_min	Long average/Log pre-catalyst temperature alarm minimum	1	F
40042	pre_temp_log_alarm_max	Long average/Log pre-catalyst temperature alarm maximum	1	F
40043	pre_temp_log_alarm_delay	Long average/Log pre-catalyst temperature alarm delay	1	seconds
40044	pre_temp_shutdown_min	Pre-catalyst temperature shutdown minimum	1	F
40045	pre_temp_shutdown_max	Pre-catalyst temperature shutdown maximum	1	F
40046	pre_temp_shutdown_delay	Pre-catalyst temperature shutdown delay	1	seconds
40047	pre_temp_avg_shutdown_min	Average pre-catalyst temperature shutdown minimum	1	F
40048	pre_temp_avg_shutdown_max	Average pre-catalyst temperature shutdown maximum	1	F
40049	pre_temp_avg_shutdown_delay	Average pre-catalyst temperature shutdown delay	1	seconds
40050	pre_temp_log_shutdown_min	Long average/Log pre-catalyst temperature shutdown minimum	1	F
40051	pre_temp_log_shutdown_max	Long average/Log pre-catalyst temperature shutdown maximum	1	F
40052	pre_temp_log_shutdown_delay	Long average/Log pre-catalyst temperature shutdown delay	1	seconds
40053	post_temp_shutdown	Post-catalyst temperature Shutdown/Alarm enable flag	1	
40054	post_temp_avg_shutdown	Average post-catalyst temperature Shutdown/Alarm enable flag	1	
40055	post_temp_log_shutdown	Long average/Log post-catalyst temperature Shutdown/Alarm enable flag	1	
40056	post_temp_avg_rate	Post-catalyst temperature averaging rate	1	

Register	Name (CM manual)	Description	Scaling Factor	Units
40057	post_temp_alarm_min	Post-catalyst temperature alarm minimum	1	F
40058	post_temp_alarm_max	Post-catalyst temperature alarm maximum	1	F
40059	post_temp_alarm_delay	Post-catalyst temperature alarm delay	1	seconds
40060	post_temp_avg_alarm_min	Average post-catalyst temperature alarm minimum	1	F
40061	post_temp_avg_alarm_max	Average post-catalyst temperature alarm maximum	1	F
40062	post_temp_avg_alarm_delay	Average post-catalyst temperature alarm delay	1	seconds
40063	post_temp_log_alarm_min	Long average/Log post-catalyst temperature alarm minimum	1	F
40064	post_temp_log_alarm_max	Long average/Log post-catalyst temperature alarm maximum	1	F
40065	post_temp_log_alarm_delay	Long average/Log post-catalyst temperature alarm delay	1	seconds
40066	post_temp_shutdown_min	Post-catalyst temperature shutdown minimum	1	F
40067	post_temp_shutdown_max	Post-catalyst temperature shutdown maximum	1	F
40068	post_temp_shutdown_delay	Post-catalyst temperature shutdown delay	1	seconds
40069	post_temp_avg_shutdown_min	Average post-catalyst temperature shutdown minimum	1	F
40070	post_temp_avg_shutdown_max	Average post-catalyst temperature shutdown maximum	1	F
40071	post_temp_avg_shutdown_delay	Average post-catalyst temperature shutdown delay	1	seconds
40072	post_temp_log_shutdown_min	Long average/Log post-catalyst temperature shutdown minimum	1	F
40073	post_temp_log_shutdown_max	Long average/Log post-catalyst temperature shutdown maximum	1	F
40074	post_temp_log_shutdown_delay	Long average/Log post-catalyst temperature shutdown delay	1	seconds
40075	catalyst_dp_shutdown	Catalyst differential pressure Shutdown/Alarm enable flag	1	
40076	catalyst_dp_avg_shutdown	Average catalyst differential pressure Shutdown/Alarm enable flag	1	
40077	catalyst_dp_log_shutdown	Long average/Log catalyst differential pressure Shutdown/Alarm enable flag	1	
40078	catalyst_dp_avg_rate	Catalyst differential pressure averaging rate	1	seconds
40079	catalyst_dp_alarm_min	Catalyst differential pressure alarm minimum	1	F
40080	catalyst_dp_alarm_max	Catalyst differential pressure alarm maximum	1	F
40081	catalyst_dp_alarm_delay	Catalyst differential pressure alarm delay	1	seconds

Register	Name (CM manual)	Description	Scaling Factor	Units
40082	catalyst_dp_avg_alarm_min	Average catalyst differential pressure alarm minimum	1	F
40083	catalyst_dp_avg_alarm_max	Average catalyst differential pressure alarm maximum	1	F
40084	catalyst_dp_avg_alarm_delay	Average catalyst differential pressure alarm delay	1	seconds
40085	catalyst_dp_log_alarm_min	Long average/Log catalyst differential pressure alarm minimum	1	F
40086	catalyst_dp_log_alarm_max	Long average/Log catalyst differential pressure alarm maximum	1	F
40087	catalyst_dp_log_alarm_delay	Long average/Log catalyst differential pressure alarm delay	1	seconds
40088	catalyst_dp_shutdown_min	Catalyst differential pressure shutdown minimum	1	F
40089	catalyst_dp_shutdown_max	Catalyst differential pressure shutdown maximum	1	F
40090	catalyst_dp_shutdown_delay	Catalyst differential pressure shutdown delay	1	seconds
40091	catalyst_dp_avg_shutdown_min	Average catalyst differential pressure shutdown minimum	1	F
40092	catalyst_dp_avg_shutdown_max	Average catalyst differential pressure shutdown maximum	1	F
40093	catalyst_dp_avg_shutdown_delay	Average catalyst differential pressure shutdown delay	1	seconds
40094	catalyst_dp_log_shutdown_min	Long average/Log catalyst differential pressure shutdown minimum	1	F
40095	catalyst_dp_log_shutdown_max	Long average/Log catalyst differential pressure shutdown maximum	1	F
40096	catalyst_dp_log_shutdown_delay	Long average/Log catalyst differential pressure shutdown delay	1	seconds
40097	delta_temp_shutdown	Catalyst differential temperature Shutdown/Alarm enable flag	1	
40098	delta_temp_avg_shutdown	Average catalyst differential temperature Shutdown/Alarm enable flag	1	
40099	delta_temp_log_shutdown	Long average/Log catalyst differential temperature Shutdown/Alarm enable flag	1	
40100	delta_temp_avg_rate	Catalyst differential temperature averaging rate	1	seconds
40101	delta_temp_alarm_min	Catalyst differential temperature alarm minimum	1	F
40102	delta_temp_alarm_max	Catalyst differential temperature alarm maximum	1	F
40103	delta_temp_alarm_delay	Catalyst differential temperature alarm delay	1	seconds
40104	delta_temp_avg_alarm_min	Average catalyst differential temperature alarm minimum	1	F

Register	Name (CM manual)	Description	Scaling Factor	Units
40105	delta_temp_avg_alarm_max	Average catalyst differential temperature alarm maximum	1	F
40106	delta_temp_avg_alarm_delay	Average catalyst differential temperature alarm delay	1	seconds
40107	delta_temp_log_alarm_min	Long average/Log catalyst differential temperature alarm minimum	1	F
40108	delta_temp_log_alarm_max	Long average/Log catalyst differential temperature alarm maximum	1	F
40109	delta_temp_log_alarm_delay	Long average/Log catalyst differential temperature alarm delay	1	seconds
40110	delta_temp_shutdown_min	Catalyst differential temperature shutdown minimum	1	F
40111	delta_temp_shutdown_max	Catalyst differential temperature shutdown maximum	1	F
40112	delta_temp_shutdown_delay	Catalyst differential temperature shutdown delay	1	seconds
40113	delta_temp_avg_shutdown_min	Average catalyst differential temperature shutdown minimum	1	F
40114	delta_temp_avg_shutdown_max	Average catalyst differential temperature shutdown maximum	1	F
40115	delta_temp_avg_shutdown_delay	Average catalyst differential temperature shutdown delay	1	seconds
40116	delta_temp_log_shutdown_min	Long average/Log catalyst differential temperature shutdown minimum	1	F
40117	delta_temp_log_shutdown_max	Long average/Log catalyst differential temperature shutdown maximum	1	F
40118	delta_temp_log_shutdown_delay	Long average/Log catalyst differential temperature shutdown delay	1	seconds
40119	dac1_offset	Left bank O2 voltage output offset	Ignore	
40120	dac1_gain	Left bank O2 voltage output gain	Ignore	
40121	dac2_offset	Right bank O2 voltage output offset	Ignore	
40122	dac2_gain	Right bank O2 voltage output gain	Ignore	
40123	o2_1_offset	Left bank O2 offset	Ignore	

Register	Name (CM manual)	Description	Scaling Factor	Units
40135	o2_2_enable	Right bank O2 sensor enable	1	
40136	alarm_relay_active_closed	Alarm relay polarity	1	
40137	shutdown_relay_active_closed	Shutdown relay polarity	1	
40138	config	Catalyst Monitor configuration	1	
40139	do_cal	Initiate O2 sensor free air calibration	1	
40140	o2_cal_complete	O2 calibration complete	1	
40141	nox_setpoint	NOx sensor setpoint	1.0E-01	ppm
40142	nox_integral_gain	NOx integral gain	1	
40143	nox_offset	NOx offset	1	
40144	f_dac	Force DAC flag	1	
40145	mac_1	MAC address octet1	1	
40146	mac_2	MAC address octet2	1	
40147	mac_3	MAC address octet3	1	
40148	mac_4	MAC address octet4	1	
40149	mac_5	MAC address octet5	1	
40124	o2_1_gain	Left bank O2 gain	Ignore	
40125	o2_2_offset	Right bank O2 offset	Ignore	
40126	o2_2_gain	Right bank O2 gain	Ignore	
40127	o2_heater_i	O2 heater integral gain	Ignore	
40128	o2_heater_p	O2 heater proportional gain	Ignore	
40129	o2_heater_sp	O2 heater setpoint	Ignore	
40130	o2_heater_ramp_rate	O2 heater warmup ramp rate	Ignore	
40131	o2_cal_timer_start	O2 calibration warmup timer duration	1	seconds
40132	o2_percent_max	O2 percent maximum	1.0E-03	% O2
40133	o2_percent_min	O2 percent minimum	1.0E-03	% O2
40134	o2_1_enable	Left bank O2 sensor enable	1	
40150	mac_6	MAC address octet6	1	
40151	ip_1	IP address octe1	1	
40152	ip_2	IP address octe2	1	
40153	ip_3	IP address octe3	1	
40154	ip_4	IP address octe4	1	
40155	use_static_ip	Static address enable flag	1	
40156	set_sec	Set real time clock: second	1	
40157	set_min	Set real time clock: minute	1	
40158	set_hour	Set real time clock: hour	1	
40159	set_wday	Set real time clock: week day	1	
40160	set_mdate	Set real time clock: date	1	

Register	Name (CM manual)	Description	Scaling Factor	Units
40161	set_month	Set real time clock: month	1	
40162	set_year	Set real time clock: year	1	
40163	modbus_address_2	Modbus address 2	1	
40164	narrowband_output_en	Narrow band O2 output enable flag	1	
40165	new_nox_alg_en	NOx algorithm enable flag	1	
40166	lean_multiplier	Lean multiplier (algorithm)	1	
40167	rich_multiplier	Rich multiplier (algorithm)	1	
40168	adaptive_inc_table_0	Table setting0 (algorithm)	1	
40169	adaptive_inc_table_1	Table setting0 (algorithm)	1	
40170	adaptive_inc_table_2	Table setting0 (algorithm)	1	
40171	adaptive_inc_table_3	Table setting0 (algorithm)	1	
40172	adaptive_inc_table_4	Table setting0 (algorithm)	1	
40173	adaptive_inc_table_5	Table setting0 (algorithm)	1	
40174	adaptive_inc_table_6	Table setting0 (algorithm)	1	
40175	spare0	Not used	NA	
40176	spare1	Not used		
40177	spare2	Not used	NA	
40178	spare3	Not used	NA	
40179	n0regs	Not used	NA	
40180	nregs	Number of holding(4x) registers	1	

Scaling:

To send data to Catalyst Monitor, first multiply the actual setting by the scaling factor , then write data to the Modbus register.

Example:

1. You want to set Maximum Catalyst Differential Pressure(register 40017) to 10 in. W.C.

   10 * 100 = 1000

   Write 1000 to Modbus register 40017

2. You read 850 from register 40017

   850 * 0.01 = 8.5

   Maximum Catalyst Differential Pressure = 8.5 in W.C.

Register 40012: Value 0x1234(Hex,) written to this register, directs the valve's computer to save all other

Value 0x1234(Hex,) written to this register, directs the valve's computer to save all other 4x holding registers into static memory for the next power cycle.

Notes: * ECV5 Sequence - Operating mode: 0 - Stopped, 1 - Default control mode, 2 -Air/Fuel Ratio control mode