Installation and Operating Manual

ActuCOM R8 IOM 8-18

HOERBIGER

altronic

Table of Contents

1 General Information

1.1 Purpose and Scope

This manual provides instructions for installation, calibration and operation of the ActuCOM R8 unit, with respect to its main functionality, see Section 1.4.

This manual gives instructions on how to utilize the hardware features and functions that may be provided. The availability of any feature or function, which is described in this manual, depends on the hardware revision and software version of a specific model. The parameters and values provided in this manual are defined under typical conditions. These values may vary when subject to different conditions, such as software version, application settings and environmental conditions.

1.2 Audience

This manual is intended for engineering personnel who are responsible for the engine installation of the ActuCOM R8.

1.3 Intended Applications

This ActuCOM R8 is intended for operating a valve or equivalent mechanical device, where the rotating motion of the ActuCOM shaft can be translated mechanically to a variable positioning or actuation of the mechanical device. If the valve is the main control of an engine's output torque, the ActuCOM R8 built-in Speed Governor can be used for speed control. The ActuCOM R8 can also be used as a basic positioner, which realizes a position command on the analogue input channel.

1.4 Basic Control Options

The ActuCOM R8 contains the following functionality:

- Engine Speed Control, with
  — Internal or External speed set point (4-20 mA), selectable
  — Configurable controller dynamics
  — Over-speed protection
  — Inc/Dec step bias to the speed set point
- Actuator Position Control
- Configurable Start operation
- Configurable Alarm and Shutdown operation

⚠ WARNING!

EXPLOSION HAZARD!
Do not connect or disconnect this equipment unless power has been removed or the area is known to be nonhazardous.

⚠ AVERTISSEMENT!

RISQUE D'EXPLOSION!
Avant de deconnecter l'equipement, couper le courant ou s'assurer que l'emplacement est designe non dangereux.

⚠ WARNING!

EXPLOSION HAZARD!
**Substitution of components may impair suitability for Class I, Division 2.**

⚠ AVERTISSEMENT!

RISQUE D'EXPLOSION!
La substitutiond e composantsp eutr endre ce materiel inacceptable pour les emplacements de Classe I, Division 2.

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2   Installation

This section contains information on the electrical connections to other units, power supply, injectors and crank and cam sensors.

2.1   This equipment is suitable for installation in Class I, Division 2, Group A, B, C and D hazardous locations only when installation has been performed according to the installation instructions.

2.2   Wiring to or from this device, which enters or leaves the system enclosure, must utilize wiring methods suitable for Class I, Division 2 Hazardous Locations, as appropriate for the installation.

2.3   This device is OPEN type equipment that must be used within a suitable end-use system enclosure, the interior of which is accessible only through the use of a tool. The suitability of the enclosure is subject to investigation by the local Authority Having Jurisdiction at the time of installation.
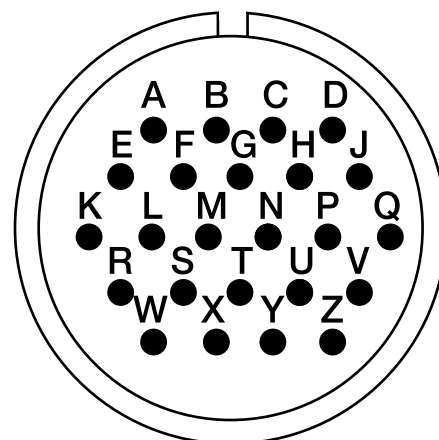
2.4   Electrical Connections
NOTE: all shield wires must be grounded
ActuCOM R8 Harness Part number 693215 details and descriptions:

Pin	Conductor Description	Wire Color	I/O Description	ID Label
Z	Single Conductor	Red	(+) 24 volts	NA
Q	Single Conductor	Black	(-) 24 volts	NA
M	Shielded 2-Conductor Cable	Red	CAN-High	CAN BUS
G		Black	CAN-Low	
C		Shield	CAN-Shield - MUST be grounded	
H	Shielded 2-Conductor Cable	Red	(+) Analog Output	4-20 Output
D		Black	(-) Analog Output	
J		Shield	4-20 Output-Shield - MUST be grounded	
J	Shielded 2-Conductor Cable	Shield	Analog Input-Shield - MUST be grounded	Analog Input
N		Red	Analog Input	
P		Black	Analog Input	
R	Shielded 2-Conductor Cable	Red	(+) Magnetic Pickup (MPU)	MPU
S		Black	(-) Magnetic Pickup (MPU)	
W		Shield	MPU-Shield - MUST be grounded	
W	Shielded 4-Conductor Cable	Shield	RS485-Shield - MUST be grounded	RS485
T		Red	(+) RS485	
Y		Black	(-) RS485	
NOT USED		White	NOT USED	
X		Green	Ground	
U	Unshielded 8-Conductor Cable	Black	(U & V are open for 0-5V or shorted for 4-20mA)	Discrete Inputs
V		White	(U & V are open for 0-5V or shorted for 4-20mA)	
F		Yellow	Discrete Input #1	
B		Red	Discrete Input #2	
A		Brown	Discrete Input #3	
L		Blue	Discrete Input #4	
E		Orange	Discrete Input #5	
K		Green	Discrete Output Low Side Switch	

2.5   Power Supply

- 24VDC Power Supply (must be Class 2)
- 20-28VDC Battery system with an external 5 amp fuse

2.6   Installation

This chapter contains general installation instructions for the ActuCOM R8 control. Power requirements, environmental precautions, and location considerations are included to determine the best location for the control. The control can be ordered as an actuator with speed control or as an actuator with speed control and an Integrated Throttle Body (ITB).

> **⚠ WARNING!**
>
> **EXPLOSION HAZARD!**
> **Do not remove covers, connect or disconnect electrical connectors unless power has been switched off. Do not clean equipment unless power has been switched off. Only use equipment suitable for explosive atmospheres.**
>
> **Deviation from installation instructions and technical guidelines may lead to improper operation of the equicom, damage or destruction of the engine and associated machinery, and/or personal injury or death to operators and nearby personnel.**

> **⚠ CAUTION!**
>
> **This manual is intended for use by qualified and experienced technical personnel with formal training in the operation and maintence of gas engines. This manual was neither designed nor intended as a technical guide to gas engines and assumes a high degree of understanding of gas engine operation and theory by the reader. Only qualified personnel should attempt installation of ActuCOM R8.**

2.7   Mounting Location

The ActuCOM R8 is designed for installation on the engine. The mounting location on the engine has to provide suitable access to the air throttle, fuel gas control valve, or the diesel control shaft. The ActuCOM R8 must be able to change the throttle, valve, or shaft position to control engine speed. Secondary mounting location considerations are temperature, heat sink capability, vibration, and wire length.

2.8   Temperature

The ActuCOM R8 is designed to operate within a temperature range of –40 to +90°C (–40 to +194°F).

2.9   Mounting the ActuCOM R8

The ActuCOM R8 can be base mounted using four tapped bolt holes in the bottom of the actuator. The base mount configuration requires the use of four M8x1.25 screws with a minimum engagement of 16mm.

All exterior and mounting dimensions and exterior fasteners are metric. The brackets and attaching hardware must be designed to hold the weight and to withstand the vibration associated with engine mounting. The user should be aware that in any application, bracket design can significantly change the vibration levels at the actuator. Therefore, every effort should be made to make the bracket as stiff as possible so that engine vibrations are not amplified, creating an even more severe environment at the actuator. Additionally, when possible, orienting the actuator shaft parallel to the crankshaft of the engine will often reduce the vibration load on the actuator's rotor system in reciprocating engine applications.

2.10   Output Shaft

The ActuCOM R8 has 350° of available travel. The max fuel direction of this travel is software configurable in the clockwise or counterclockwise direction via the terminal program.

2.11   Fuel Position Stops

The linkage should be designed to use as much actuator travel as possible, without preventing minimum and maximum fuel positions.

2.12 Linkage

Proper design and installation of the actuator linkage is necessary for the ActuCOM R8 unit to provide the best possible speed control. Certain applications with low inertia may be unstable with high impulse loads and may require additional system inertia. Ensure the actuator has ample work capacity to control the fuel supply under maximum load conditions.

Manually stroke the fuel-control linkage from stop to stop as if the actuator were moving it. The linkage must move freely, without friction and backlash. Lubricate or replace worn linkage or fuel control parts as required.

The Mass Moment of Inertia (MMOI) for the ActuCOM R8 is 5.9 ft/lb (8 N m).

> **⚠ WARNING!**
> **EMERGENCY STOP**
> *The actuator contains no internal return spring; therefore an external positive shutdown is necessary in the event of a loss of power to the actuator.*
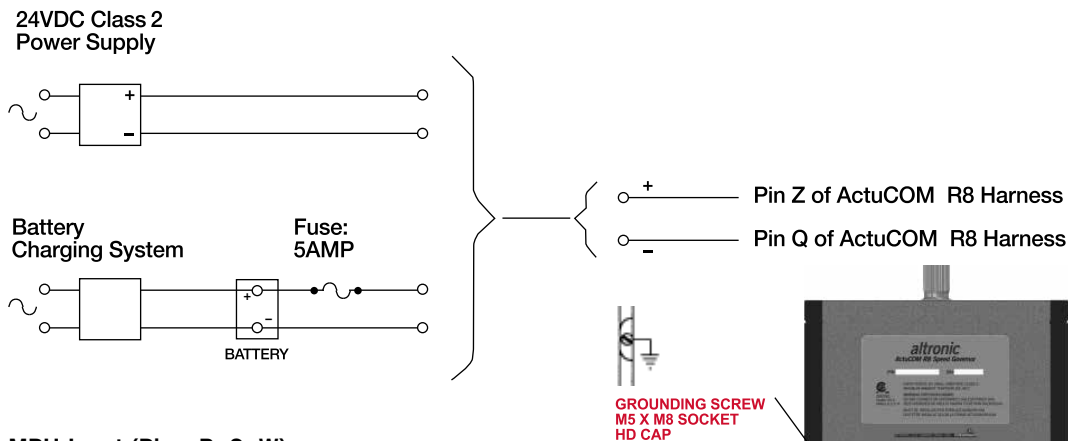
2.13 Supply Power (Pins: Z, Q)

Pin Z = Supply Power Plus

Pin Q = Supply Power Minus

Refer to the DC Power Hookup Diagram below for more details.

2.14 MPU Input (Pins: R, S, W)

Pin R = MPU plus signal

Pin S = MPU min signal

Pin W = Shield

The MPU input detects the frequency of an MPU sensor typically pulsed by the flywheel ring gear or holes in the flywheel. The control calculates the engine speed from this MPU input signal frequency.

Connect the MPU sensor between pins R and S. Pin R is the positive input signal and pin S is for the negative input signal. The conductor shield must be connected to pin W and the other side of the MPU sensor cable is not connected and is isolated.

2.15 RS-485 Service port (Pins: Y, T, X, W)

Pin Y = RS-485 -

Pin T = RS-485 +

Pin X = Ground

Pin W = Shield Chassis

The RS-485 service port is used to monitor, configure, and troubleshoot the ActuCOM R8.
Use a Windows operating system PC to perform these typical functions:

- Monitor operations
- Calibrate the position control
- Tune prime mover dynamics
- Load or retrieve parameter settings from the control or a file
- Change a parameter setting for speed or position control

**The ActuCOM R8 Terminal Program can be downloaded from the Internet at
http://www.altronic-llc.com/catalog-downloads.shtml.**

2.16   Discrete Inputs (Pins: F, B, A, L, E)

Pin F = Discrete Input 1

Pin B = Discrete Input 2

Pin A = Discrete Input 3

Pin L = Discrete Input 4

Pin E = Discrete Input 5

The Discrete inputs are used to control the behavior of the ActuCOM R8 from a control panel or other control system components such as load share modules, temperature controllers, oil temperature sensors, etc. There are five Discrete inputs on the ActuCOM R8 control. The input functions (below) are mapped to discrete inputs using the Terminal Program.
If desired, multiple functions can be mapped to a single input.

The functions available for Discrete input configuration are:

- Run Enable Input
- Idle/Rated Input
- Rated 1/2 Input
- Raise Input
- Lower Input
- Alt Dynamics Input
- Isoch/Droop Input

All five discrete inputs are the same electrical circuits. All five can be configured in the software for high side switch or low side switch and for an active closed contact or an active open contact.

2.17   High Side Switch:

If used as a high side switch, the switch contact must be connected to the discrete input pin and to the supply plus of the ActuCOM R8.

2.18   Low Side Switch:

If used as a low side switch, the contact must be connected to the discrete input pin and to the power supply minus of the ActuCOM R8.

2.19   Active Closed:

Active closed can be used for situations where it is safer to make the function inactive if the wire is broken, or disconnected.

2.20   Active Open :

Active open contact can be used for situations where it is safer to make the function active if the wire is broken, or disconnected.

2.21   Discrete Output (Pin: K)

The discrete output is used to give a signal to a control system or an operator panel. In the software you can determine when this output is turned on or off.

The electrical circuit is a low-side switch with the return current going to supply minus, pin Q. It is possible to drive a relay if more current is needed for the load. If the load is below 0.5 A, the load can be driven directly from the output.

2.22   **Analog Input (Pins: N, P, U, V, J)**

Pin N = Analog Input Plus Signal

Pin P = Analog Input Minus Signal

Pin U = 4 to 20mA Select 1

Pin V = 4 to 20 mA Select 2

Pin J = Shield (shared)

The Analog input can be used for Remote Speed Setpoint, Speed Biasing, or Position control. The signal type is configured by the wiring harness and software.

Connect the Analog Input sensor between pins N and P. Pin N is the positive input signal and pin P is for the negative input signal. The conductor shield must be connected to pin J and the other side of the Analog Input sensor cable is not connected and is isolated. The Analog Input and the Analog Output cables share pin J.

Mode: 0 to 5V
If the input is used for 0 to 5 V, connect a voltage source between pins N and P. Make sure that there is no connection between pins U and V. The signal at pin N must be more positive than the signal at pin P.

Mode: 4 to 20mA
If the input is used for 4 to 20 mA, connect a current source between pins N and P. Make sure that pins U and V are connected as close as possible to the connector. The signal at pin N must be more positive then the signal at pin P.

2.23   **Analog Output (Pins: H, D, J)**

Pin H = Analog Output Plus Signal

Pin D = Analog Output Minus Signal

Pin J = Shield (shared)

The 4 to 20mA analog output drives a 0Ω to 450Ω load. The high side (pin H) drives current from the internal power supply to the load. Connect the return current to pin D. Pin D is internally connected to the power supply ground.

A shielded twisted-pair cable is recommended for the analog output.

2.24   **CAN Port (Pins: M, G, C)**
Pin M = CAN High

Pin G = CAN Low

Pin C = Shield

Can Port used for Factory programming only.

3   TERMINAL PROGRAM — XPERCOM

3.1   Description

The ActuCOM can be accessed by using the XperCOM Terminal Program. Through XperCOM, the ActuCOM is subject to configuration and calibration of its functionality. This section describes how to set up and connect the XperCOM to an ActuCOM unit.
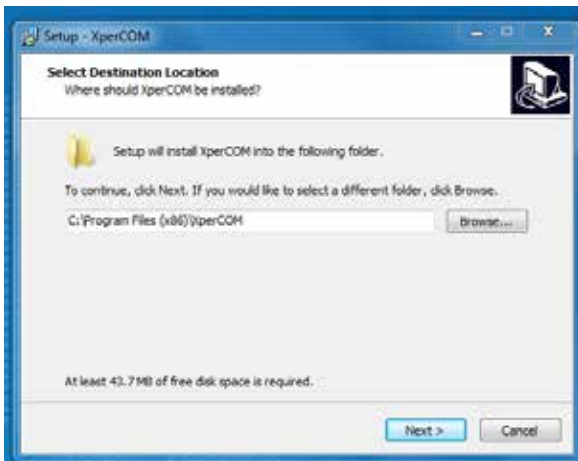
3.2   XperCOM installation

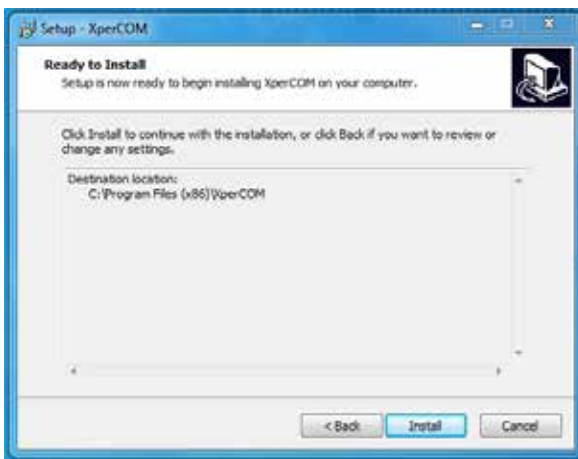XperCOM comes in an installation file, XperCOM-2.x.yy-AC-R8.exe. Run the file.

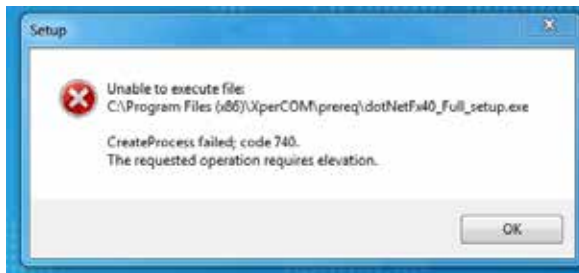1. Run .exe file
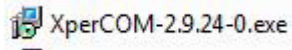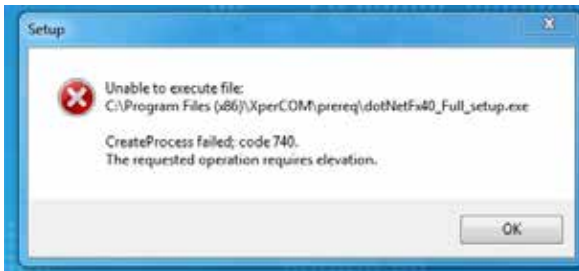

2. Click Next.

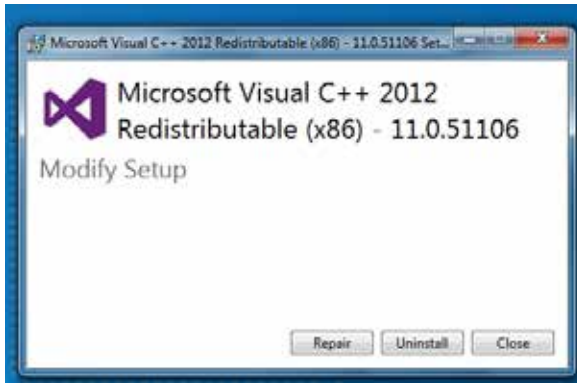3. Click Install

4. Click Finish

5. Click OK

6. Click OK again

7. Click Yes

8. Click Repair

9. Click Close
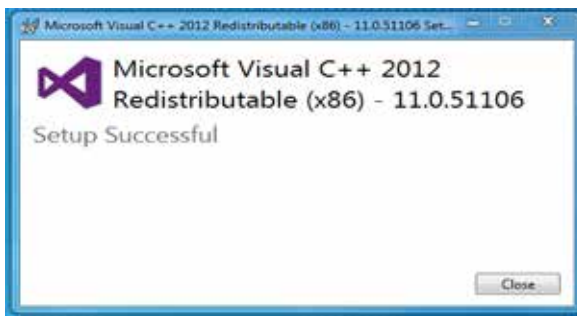
10. Restart your computer to complete the installation

3.3   Connecting XperCOM to ActuCOM

1. Connect your RS485 interface to your laptop and the ActuCOM designated pins. The ActuCOM also needs power supplied.

2. Start XperCOM
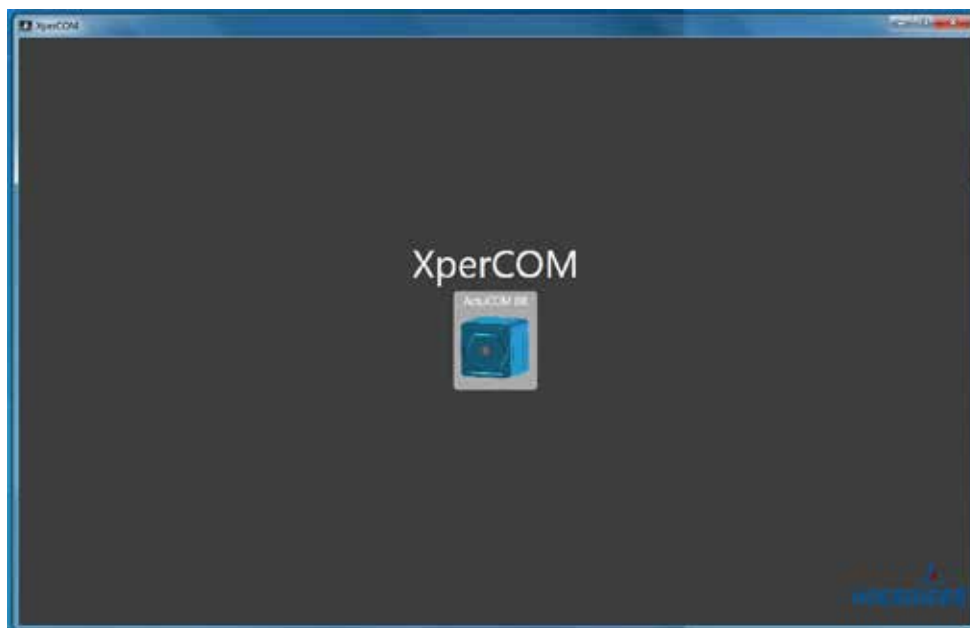
3. Click on the ActuCOM R8 symbol.
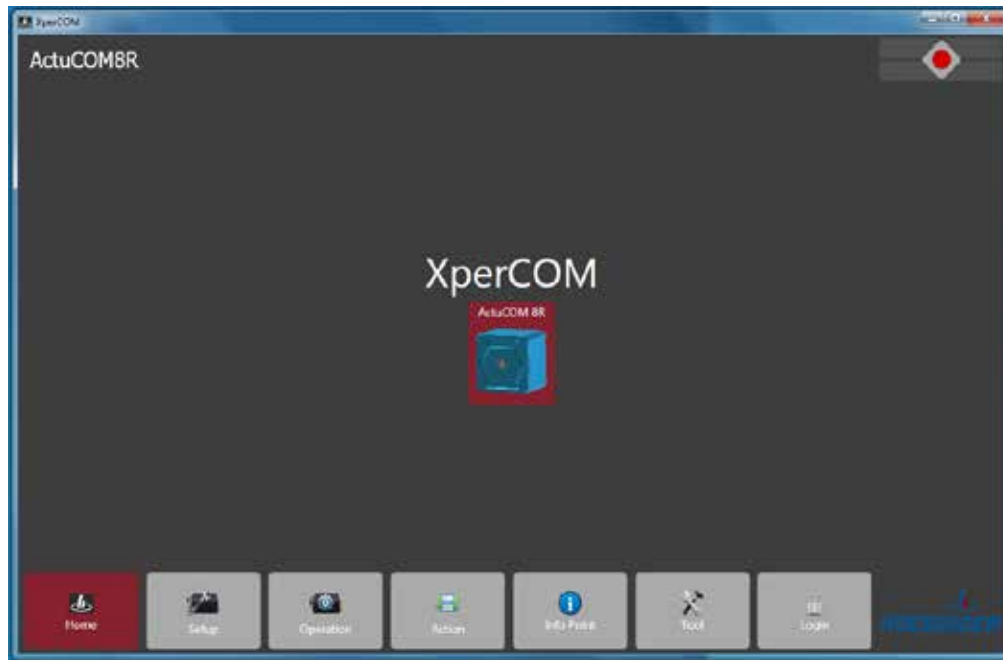
4. Press the communications status diode in the top right, or the "Tool" button in the bottom button bar to enter communications setup:

Verify that the interface port chosen corresponds to RS-485 interface connected to computer.
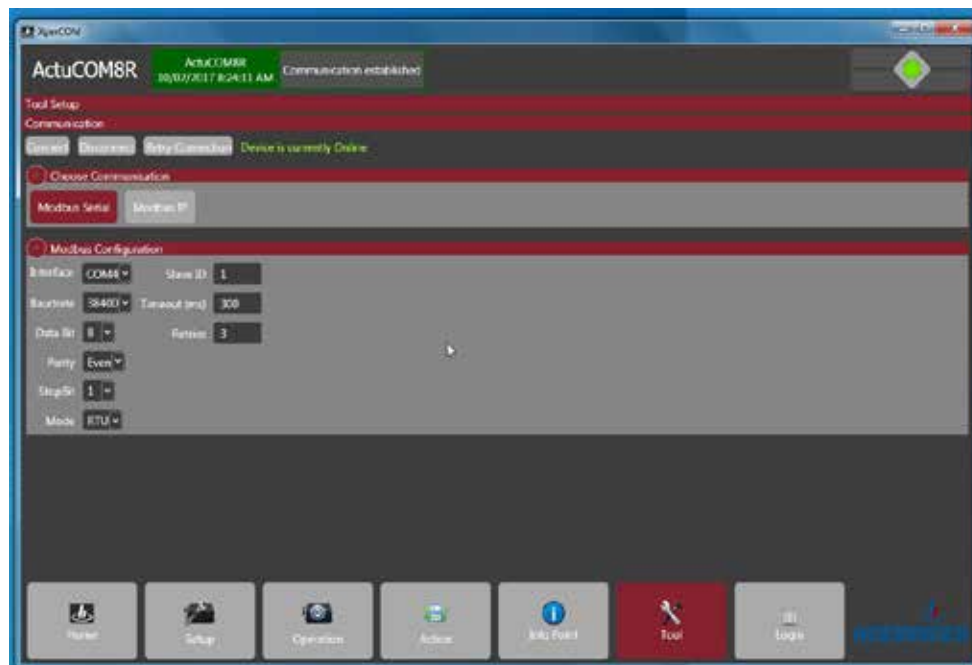
Press "connect" to start communication with ActuCOM
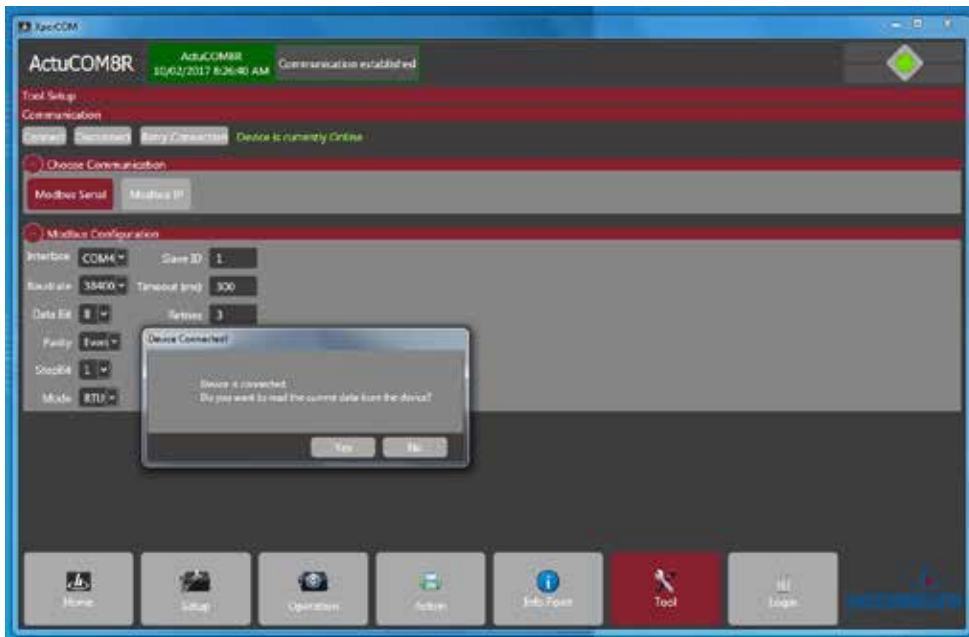
5. When the connection is established, XperCOM offers you to retrieve the current configuration and calibration file from the ActuCOM in a pop-up window. Click Yes.

6. Choose Setup. Now, the current ActuCOM calibration is shown in XperCOM.
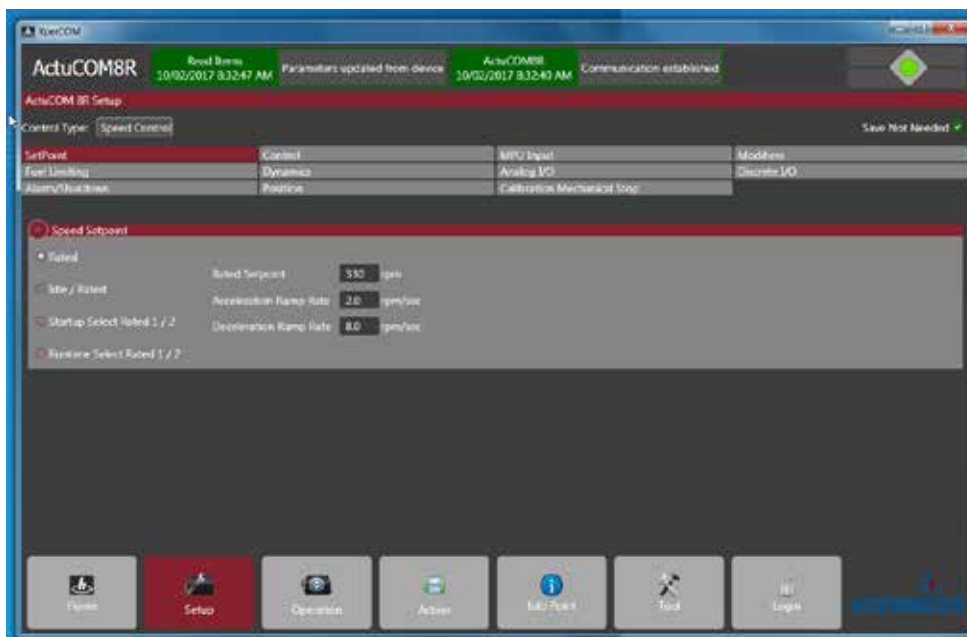
3.4   Changing calibration in ActuCOM

1. Select the Setup view in XperCOM. Here you can access all configuration and calibration parameters in the system.

2. Make all desired changes in the different parameter views in Setup.

3. Click Action button and select Send To Device.

4. Now, in the upper right corner, a lamp turned red saying Save Needed. This means that you have sent new calibration data to the ActuCOM, but the data has not been saved in the NVM. The new calibration is active in the ActuCOM but will be lost in a power cycle. To save the calibration in the NVM, click Action and select Save on target. The lamp in the upper right corner turns green and says Save Not Needed.
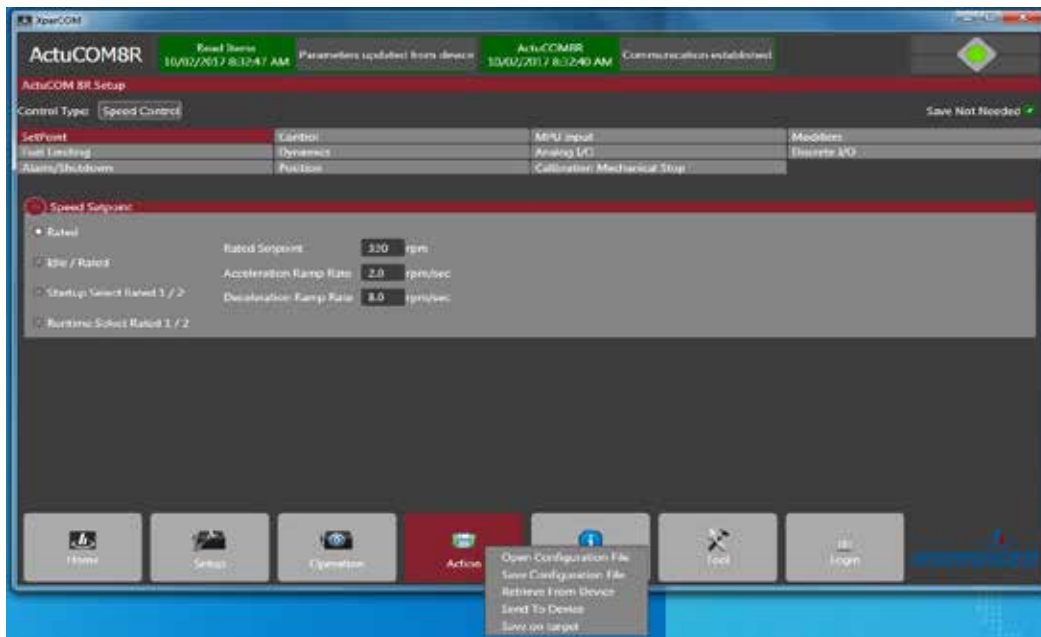
3.5   Viewing ActuCOM operations status

Click the Operations button. The graphics shows an overview of the current operation status of the ActuCOM.

On the far right side there is the position set point and the actual position of the electric motor, going into the Position Controller. The position is given in % of the defined rotational operating range of the motor. The actual position comes from the motor position sensor and is compensated for the calibrated mechanical end stops.

The rest of the graphics shows how the position set point is calculated. In normal operation, the position set point is the output from a Speed Controller PID, with a speed set point and speed measurement as inputs along with the current controller gains. At some times the position set point may be limited by the Fuel Limit settings. During start-up, the position set point is defined by the Start Fuel settings.
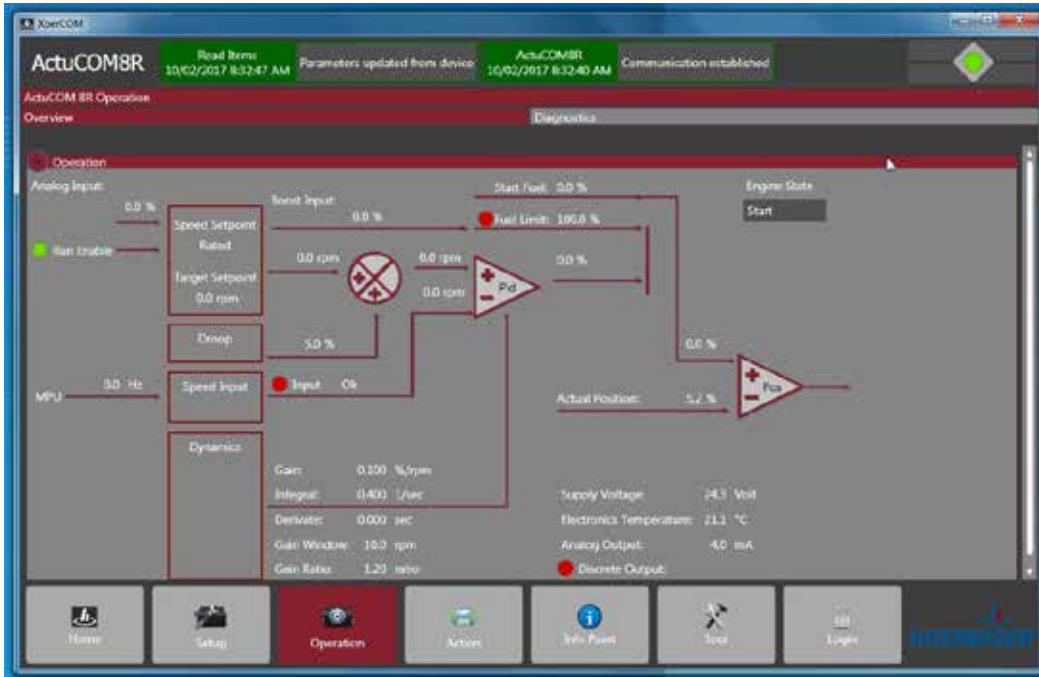
When entering Operations tab it is possible to start a logging window:

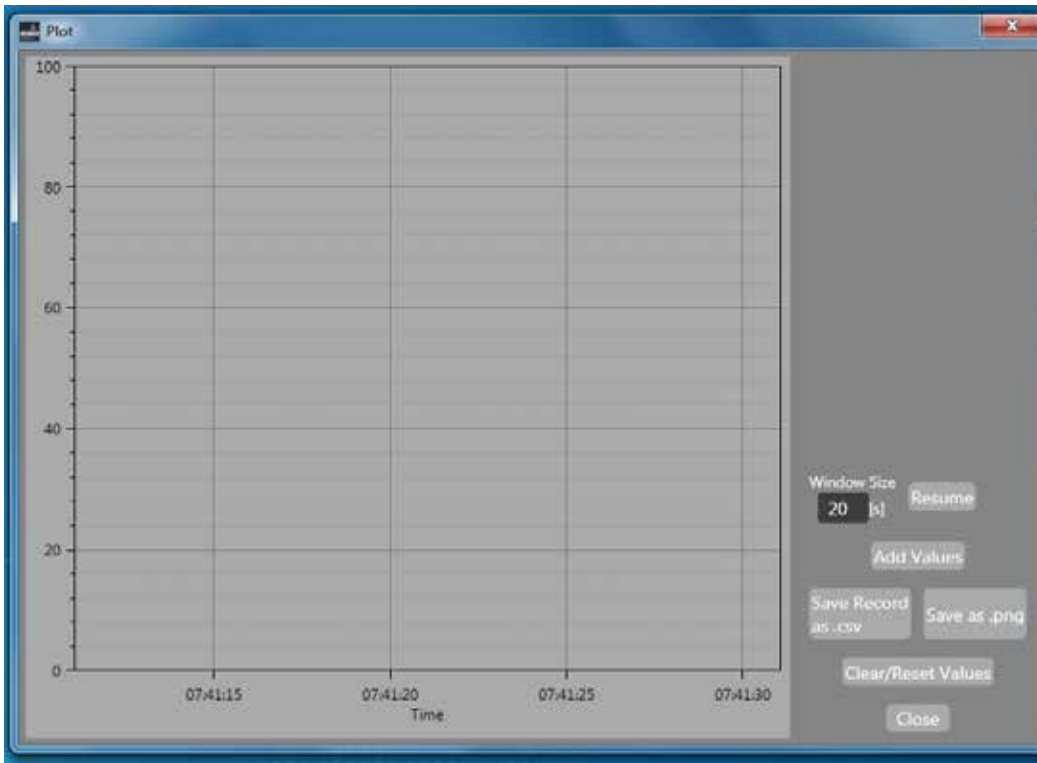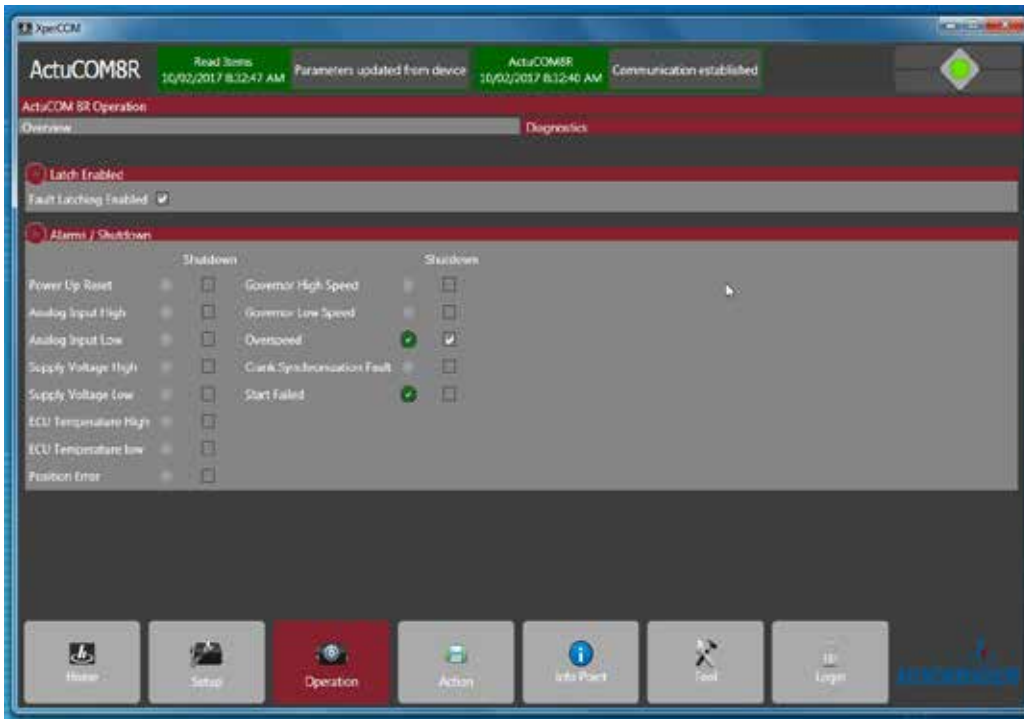Using the log window, behavior can be monitored and saved:

Viewing status for errors can be done using the diagnostics tab in the operations window:

Viewing status for errors can be done using the diagnostics tab in the operations window:

A green checkmark next to an error indicates the error is active at this moment.

3.6 Backup configuration files

The XperCOM offers the option of storing an ActuCOM calibration file on the computer as a back-up. Also, a stored calibration file can be sent to the ActuCOM and saved to be the default start up calibration for the ActuCOM.

For saving a calibration file:

1. In the Setup view, have all the desired setting in place.

2. Click Action and select Save Configuration File.

3. Select a name and place on the hard drive for the configuration file to be stored.

For loading a calibration file and making it the default calibration for the ActuCOM:

1. Click Action and select Open Configuration File.

2. Select a stored configuration file. The Setup view shows the content of the loaded configuration file.

3. Connect XperCOM to the ActuCOM again by clicking Setup or Tool -> Connect. When the pop-up window asks you to retrieve the calibration data from target, click No.

4. Click Action and select Send To Device. The ActuCOM now has the loaded configuration.

5. Click Action and select Save On Target to save the calibration in the NVM and make it the default calibration at start-up.

> **NOTE**
>
> *If transferring configurations between different units, the offset angle which is unique for each motor housing, should be considered.*

4   Description of Operation

The operation of the ActuCOM features two main operation modes:

1. Speed Control

2. Analog Position Control

In Speed Control mode, the ActuCOM controls the engine speed to a desired speed set point, by operating the ActuCOM motor rotational position. The ActuCOM motor axle must in this case operate a device that directly controls the motor torque, e.g., an air throttle (rich burn) or a fuel valve (lean burn).

In Analog Position Control mode the ActuCOM executes a position command coming in via the analog input channel.
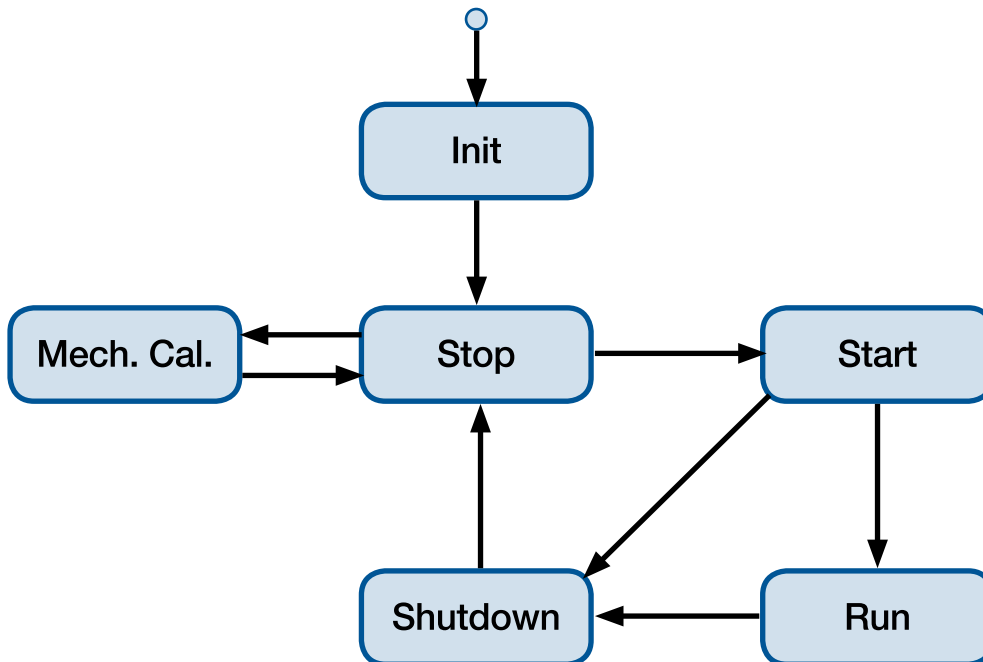
4.1　Speed Control Operation

Figure 1. ActuCOM engine states in Speed Control mode.

In Speed Control mode, the AcutCOM is primarily operating its motor position to control the rotating speed of the engine. However, before the actual speed control can take place, the ActuCOM walks through a series of states, as illustrated by Figure 1.

At power up, the ActuCOM always enters the Init state, in which the configuration stored in the non-volatile memory (NVM) is loaded. On the completion of Init, the ActuCOM resides in Stop state until further action is promoted.

In Stop state the ActuCOM motor is de-energized and the motor axle can be moved by hand. In Stop state it is possible to do a calibration of mechanical stops for the ActucOM motor. This action is initiated via the XperCOM. After re-programming, the ActuCOM requires a calibration of mechanical stops to take place before it can be used.

The Run Enable digital input signal is the main action source for the ActuCOM. When enabled in Stop state, the system moves to Start state to enact the start sequence, if a calibration of mechanical stops has occurred since the last re-programming of the unit. The ActuCOM motor position is here defined by the Start Fuel settings.

As the start sequence finishes, the system is in Run state where the speed control function is active and defines the ActucOM motor position. Several settings are available for speed set point and controller dynamics definition in Run state.

If the Run Enable digital input is disabled, or a shutdown fault occurs, the system transits to Shutdown state, where the motor position is at 0%. To leave the Shutdown state and enter Stop state, the Run Enable signal must be disabled and the engine speed shall be zero. Once in Shutdown state, the system must pass through Stop state before it can start again. If a shutdown fault caused the system shutdown, that fault will be indicated in XperCOM while the system is in Shutdown state. The transit to Stop state clears any faults in the system.

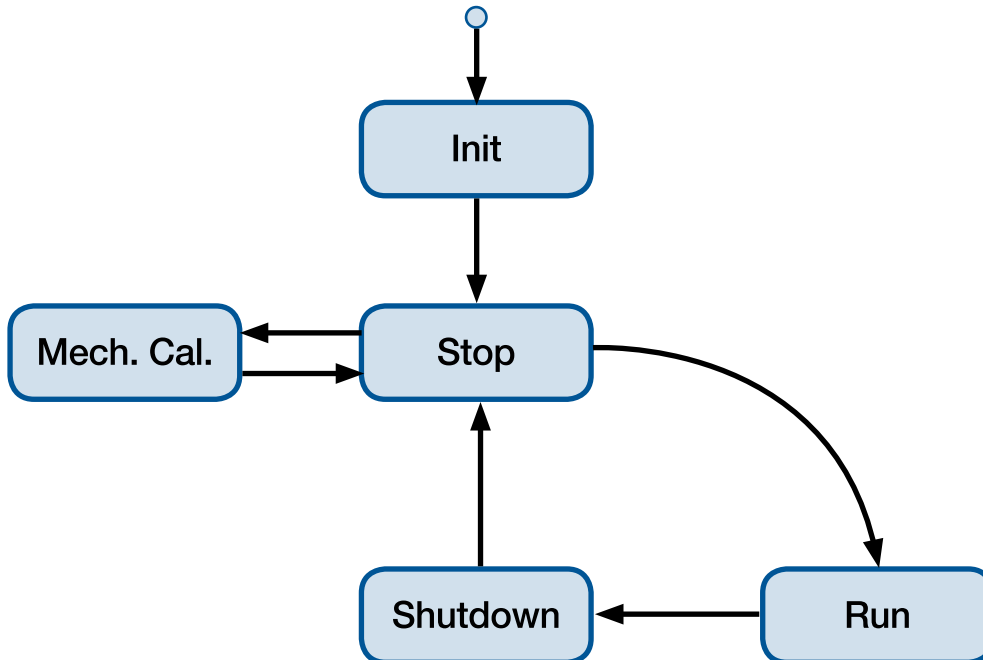**4.2   Analog Position Control operation**

Figure 2. ActuCOM engine states in Analog Position Control

In Analog Position Control mode, the AcutCOM is primarily operating its motor position to meet a position set point defined by the analog input channel. Here too, the ActuCOM walks through a series of states before the actual position control is active, as illustrated by Figure 2.

At power up, the ActuCOM always enters the Init state, in which the configuration stored in the non-volatile memory (NVM) is loaded. On the completion of Init, the ActuCOM resides in Stop state until further action is promoted.

In Stop state the ActuCOM motor is de-energized and the motor axle can be moved by hand. In Stop state it is possible to do a calibration of mechanical stops for the ActucOM motor. This action is initiated via the XperCOM. After re-programming, the ActuCOM requires a calibration of mechanical stops to take place before it can be used.

The Run Enable digital input signal is the main action source for the ActuCOM. When enabled in Stop state, the system moves to Run state to enable position control, if a calibration of mechanical stops has occurred since the last re-programming of the unit. The ActuCOM motor position is here defined by the analog intput signal.

If the Run Enable digital input is disabled, or a shutdown fault occurs, the system transits to Shutdown state, where the motor position is held at 0%. To leave the Shutdown state and enter Stop state, the Run Enable signal must be disabled. Once in Shutdown state, the system must pass through Stop state before it can start again. If a shutdown fault caused the system shutdown, that fault will be indicated in XperCOM while the system is in Shutdown state. The transit to Stop state clears any faults in the system.

5   Configuration and Calibration of Control Functionality

5.1   Mechanical calibration of end stops

A position sensor measures a raw position of the axle rotation between 0 – 350 deg. The calibration of mechanical stops defines a start and a stop point on the measurement range 0 – 350, and the operation range can include the 0 point on the raw position.

Mechanical calibration can be done in two ways, by Automatic or Manual calibration.

5.1.1   Clock-wise (CW) and Counter-clock-wise (CCW) direction

The ActuCOM motor can operate in both CW and CCW directions. The CW direction is defined as in Figure 3 and refers to the opening direction (operating towards 100% position). The CCW direction is
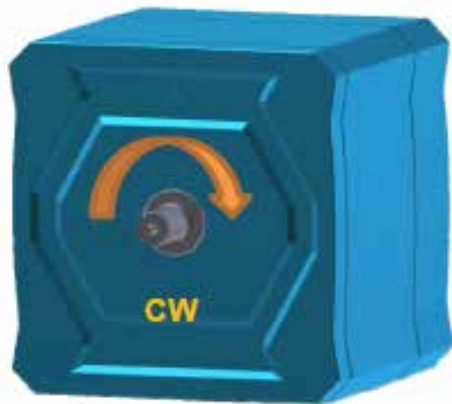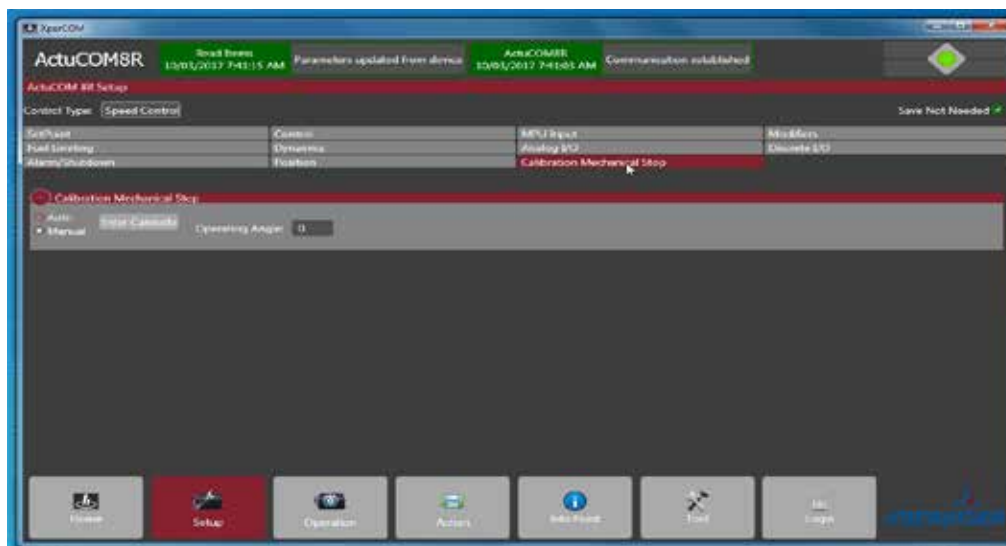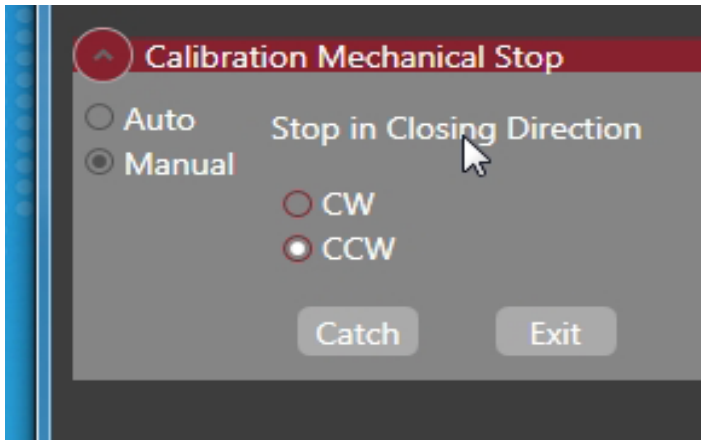

Figure 3. Definition of CW direction of operation.

5.1.2   Manual calibration procedure

1. Connect power to the ActuCOM. Start XperCOM and make sure the communication is running to the ActuCOM by clicking Setup.

2. Click Setup and select the Calibration Mechanical Stop view.

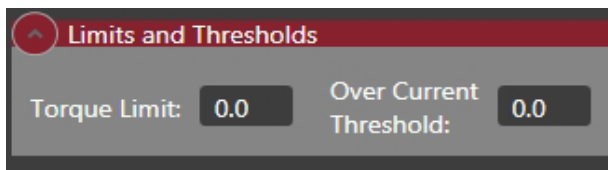3. Check the box Manual and click Enter Calmode.

4. First, select the proper direction of operation by clicking CCW or CW.
5. Position the motor axle by manually moving the axle to its stop position in the closing direction (min position).
   Click Catch to store the first end stop position.
6. Position the motor axle by manually moving the axle to its stop position in the opening direction (max position).
   Click Catch to store the second end stop position.
7. The calibration is done.

5.1.3 Automatic calibration procedure, one stop

In this procedure, it is necessary for the motor to have a mechanical stop present in the closing direction of the motor.

1. Click Setup and select the Position view.
2. Check that the Torque Limit is adequate for the procedure. The Torque Limit is the maximum torque in Nm applied to the motor during the automatic search procedure.

3. Select the Calibration Mechanical Stop view.
4. Check the box Auto and click Enter Calmode. If you regret your choice to enter the automatic calibration mode, click Exit and XperCOM will abort the calibration procedure.

5. Check the box One stop and enter the Operating angle field properly. This angle defines the operating range together with the closing direction stop point that this procedure automatically finds. Click Send To Device to use the altered Operating Angle. Also choose the desired operating direction (CW/CCW).

6. Click Start. The motor now searches for a mechanical stop in the closing direction of the motor.
7. If a mechanical stop is found, the procedure is successful. If not, an error is reported and no calibration is stored.
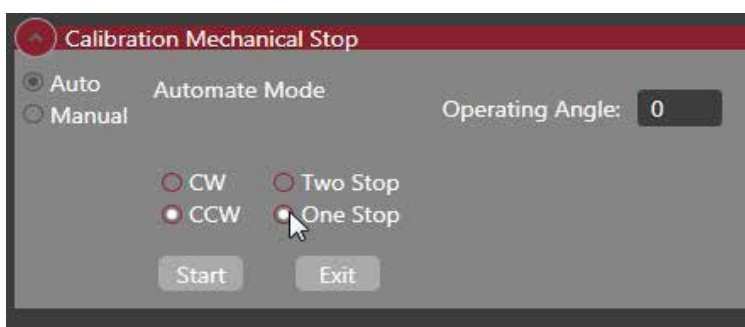
5.1.4   Automatic calibration procedure, two stops

In this procedure, it is necessary for the motor to have mechanical stops present in both the closing and opening directions of the motor.

1. Click Setup and select the Position view.
2. Check that the Torque Limit is adequate for the procedure. The Torque Limit is the maximum torque in Nm applied to the motor during the automatic search procedure.

3. Select the Calibration Mechanical Stop view.
4. Check the box Auto and click Enter Calmode. If you regret your choice to enter the automatic calibration mode, click Exit and XperCOM will abort the calibration procedure.
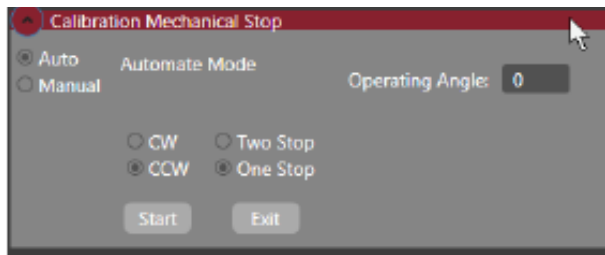
5. Check the box Two stop and choose the desired operating direction (CW/CCW).
6. Click Start. The motor now searches for two mechanical stops, first in the closing direction of the motor and then in the opening direction. When the calibration finishes, the motor stays at the second stop, de-energized.
7. If mechanical stops are found, the procedure is successful. If not, an error is reported and no calibration is stored.

5.2   Soft Stop configuration
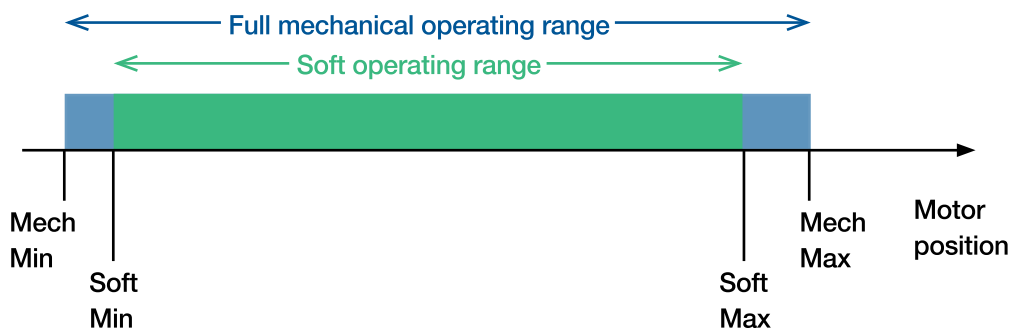
The Soft Stops are defined as end positions with a little margin to the mechanical stops. The purpose is to reduce the wear on the mechanical stops in operation. The Soft Stops will re-define the operating range of the motor. A position command 0–100% (in Analog Position Control mode or Speed Control mode) is translated to match the Soft operating range. However, note that the position measurement in the Operations view always shows the motor position in the full mechanical range reference.

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The Soft Stop Min and Max positions are given relative to the full mechanical operating range in %.

The limits are:

- Soft Stop Min: 0 – 5%
- Soft Stop Max: 95 – 100%

5.3 Control type configuration

Click Setup. In the top left corner there is a label Control Type with a roll-down selection list.

It is possible to select:

- Speed Control, or
- Analog Position Control

This selection can only be made when the ActuCOM is in state Stop.
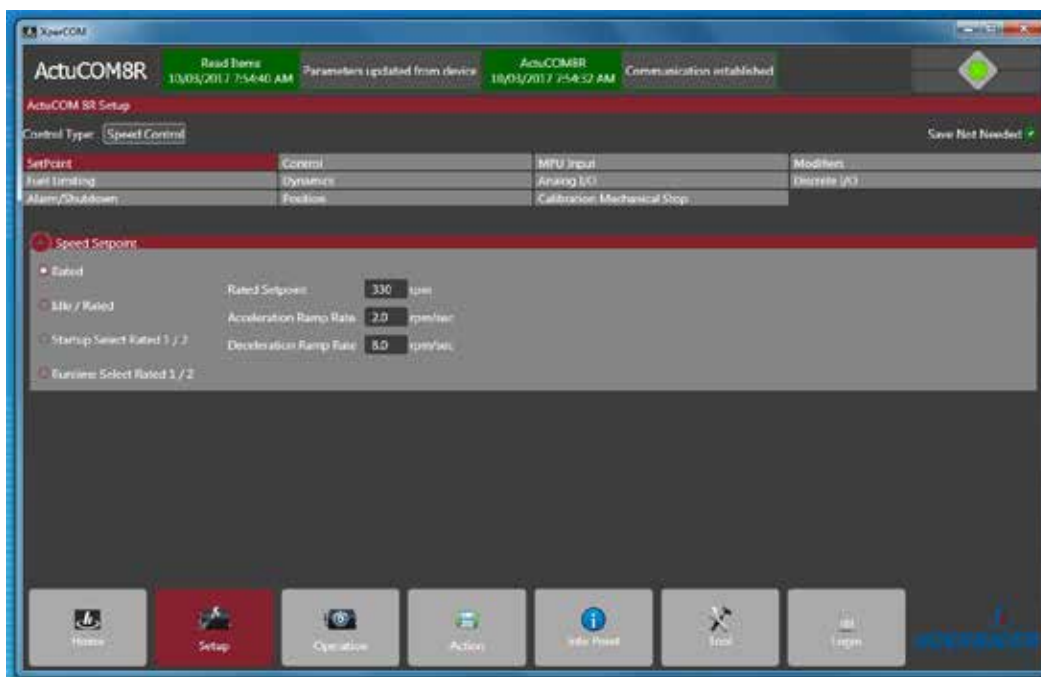
5.4 Speed set point settings

Click Setup and select the SetPoint view.

There are four different modes for the speed set point selection:

1. Rated
2. Idle/Rated
3. Startup Select Rated 1/2
4. RunTime Select Rated 1/2

Different sets of calibration parameters are available for each mode.

5.4.1 Rated

In Rated mode, the system operates on one pre-defined speed set point, Rated Setpoint. When the start sequence is finished, the system enters Run state and the current entry speed is stored. The speed controller is activated on the entry to Run state and the speed set point is ramped from the entry speed to the Rated Setpoint using the ramp rates defined by Acceleration Ramp Rate and Deceleration Ramp Rate.

The Rated Setpoint is subject to set point modifiers, see Section xx.

5.4.2 Idle/Rated

In Idle/Rated mode, two speed set points are defined, Rated Setpoint and Idle Setpoint. The Rated Setpoint and its ramp rates function as in the Rated mode. The digital input signal Idle/Rated Input defines which set point is active.

Switching between idle and rated set points activates the ramping function. When switching from Rated Setpoint to Idle Setpoit the ramping function need to be enabled by the check box Ramp To Idle.

The IdleSetpoint is not subject to set point modifiers.

5.4.3   Startup Select Rated 1/2

In mode Startup Select 1/2, two rated speed set points are defined. The digital input signal Rated 1/2 Select defines which of the two speed set point to use. This selection is only done when the Run Enable is activated. Ramp rates operate as for Rated mode.
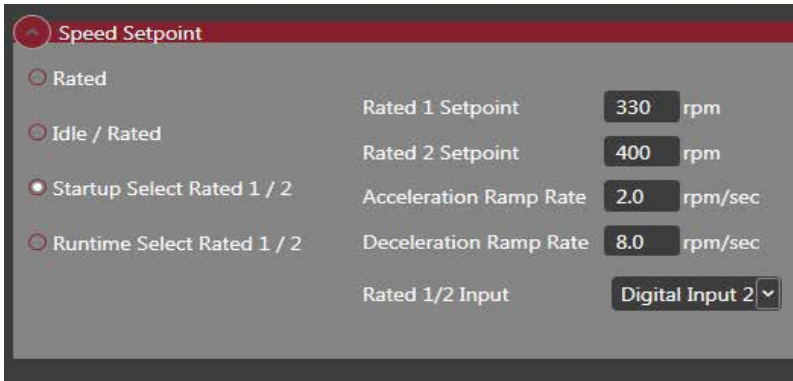
5.4.4   Runtime Select Rated 1/2

Runtime Select Rated 1/2 functions in the same way as Startup Select Rated 1/2 with the difference that the switch between speed set points can be done while the speed controller is active in Run state.

Both speed set points are subject to modifiers.
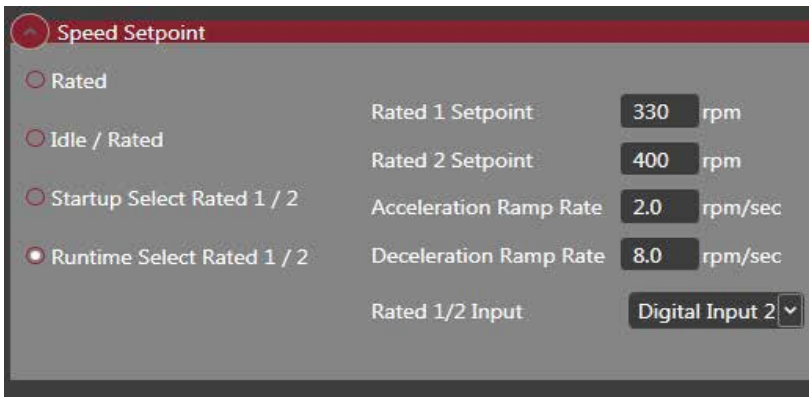
5.5 Fuel Limiting

Fuel limiting is a limit on the ActuCOM opening position during runtime speed control.

Fuel limiting operates based on two sources:

1. Engine speed (Runtime Fuel Limiting)
2. Boost pressure (Boost Fuel Limiting)

Boost pressure is retrieved through the Analog Input signal, which needs to be configured accordingly to enable Boost Fuel Limiting.

Both Runtime Fuel Limiting and Boost Fuel Limiting can be disabled
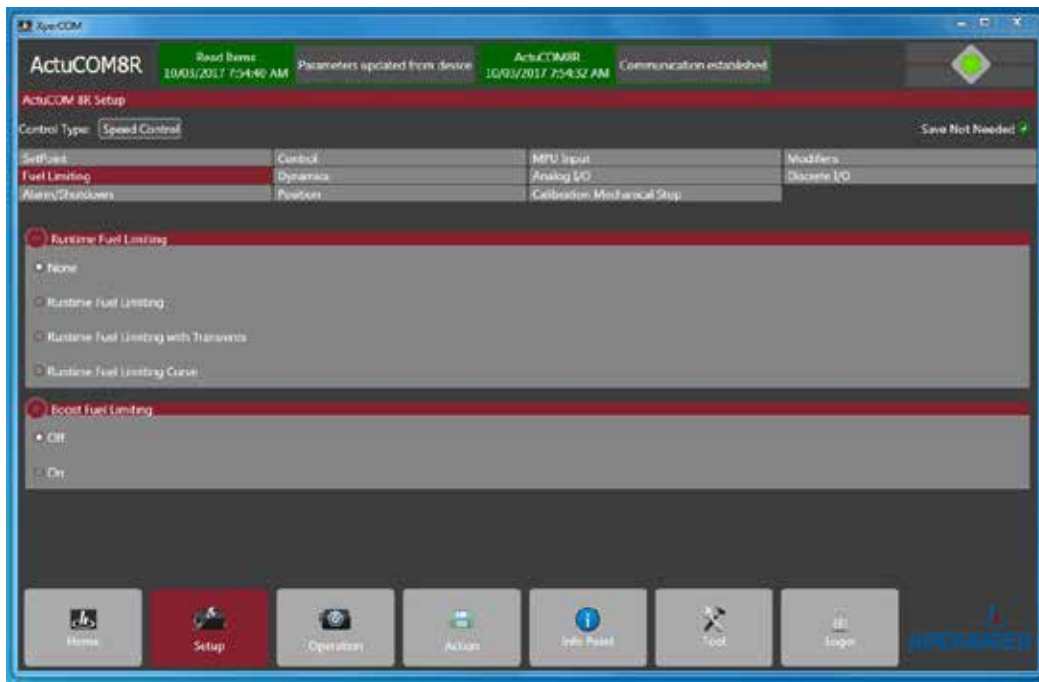
5.5.1 Runtime Fuel Limiting

The Runtime Fuel Limiting has four options:
1. None
2. Runtime Fuel Limiting
3. Runtime Fuel Limiting with Transients
4. Runtime Fuel Limiting Curve

None means that the Runtime fuel Limiting is disabled.

5.5.1.1 Runtime Fuel Limiting

A single value, Maximum Fuel Limit, limits the motor opening position to this value at all times in Run state.
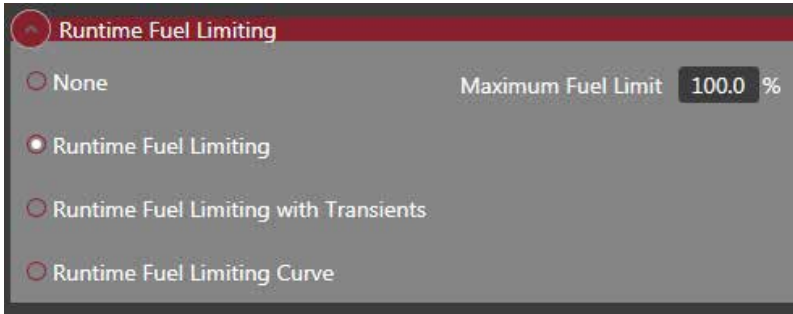
5.5.1.2 Runtime Fuel Limiting with Transients

In this mode, the Fuel Limit has two levels, Transient Fuel Limit and SteadyState Fuel Limit. The system allows the motor position to reach Transient Fuel Limit for the time Transient Fuel Limit Time. If the fuel limit is active for the duration of that time, the fuel limit is switched to the Steady State Fuel Limit for as long as this fuel limit is active. Once the motor position required by the Speed Controller has decreased below the Steady State Fuel Limit, the system will accept a new transient fuel limit.
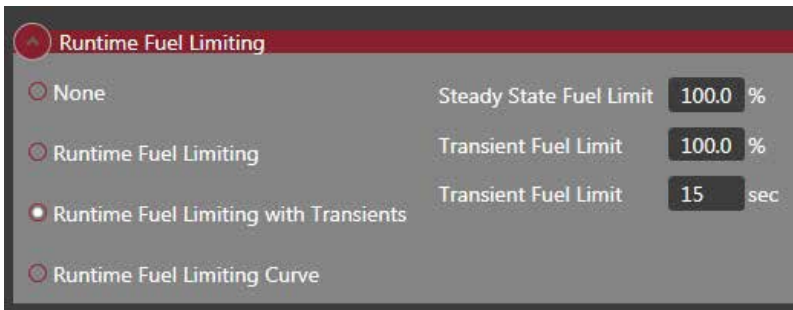
5.5.1.3 Runtime Fuel Limiting Curve

In this mode, the system accepts a speed dependent fuel limit. The system can handle five support points in this curve. The actual fuel limit is interpolated between the support points, and the end points are extrapolated if necessary.
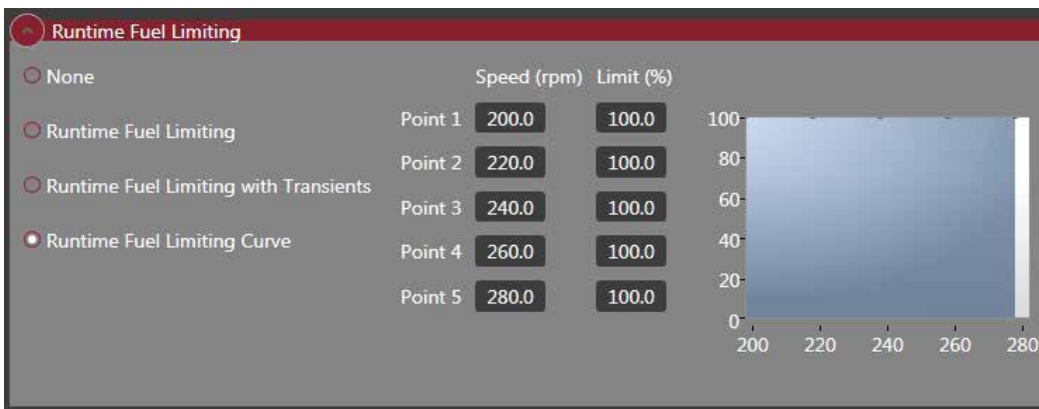
5.6   Start and shutdown settings

Go to Setup -> Control.
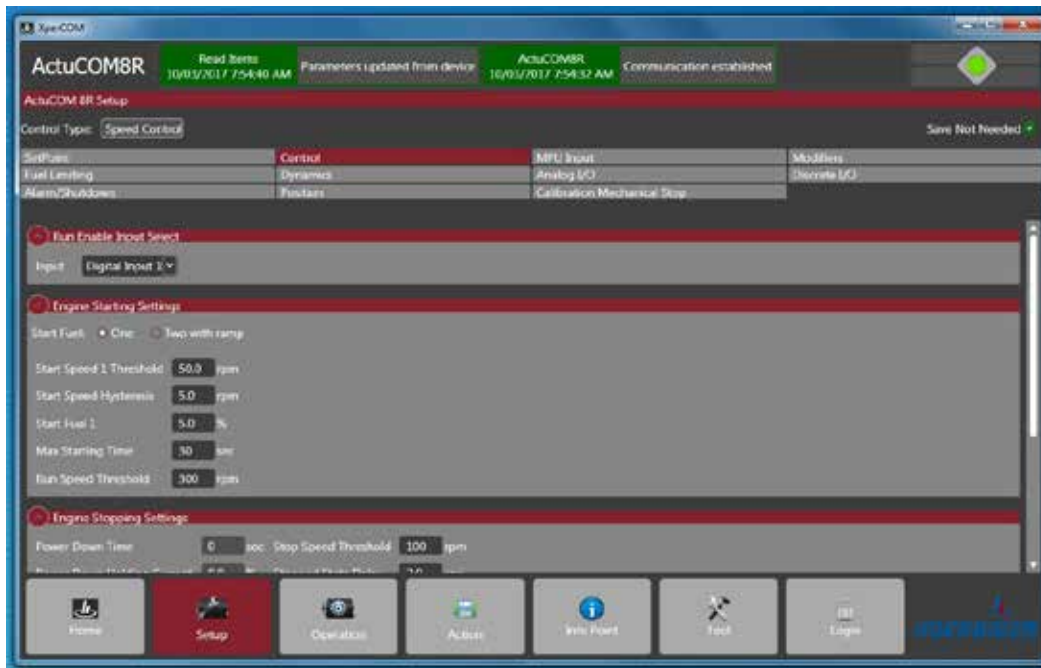
The expander Run Enable Input Select defines which digital input that is interpreted as the Run Enable signal in the system. This signal is the primary control signal for the system to start and stop.

The expander Engine Starting Settings contains all parameters for the start sequence. The start sequence starts when

1. the system comes from the Stop state

2. the Run Enable signal is activated

When the engine speed exceeds the Start Speed 1 Threshold, the Start Fuel 1 actuator position is commanded. When the engine speed exceeds the Run Speed Threshold, the start sequence is over and the ActuCOM enters Run state, in which the speed controller is active. If the system has not entered Run state within the Max Starting Time from when the Start Speed 1 Threshold was exceeded, a Start Fault is generated and the system goes to Shutdown.
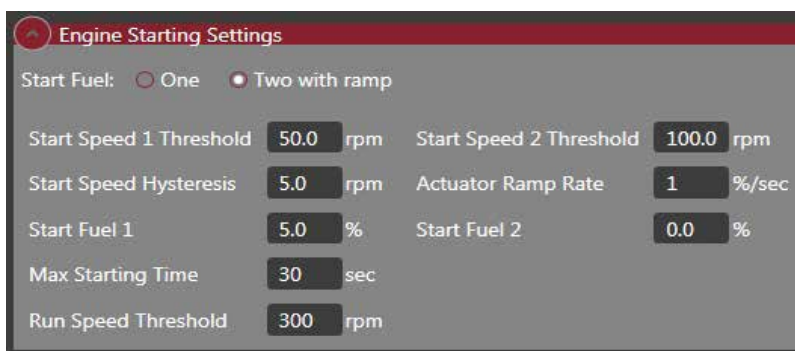
The start sequence can use one or two Start Fuel settings, selected by the radio buttons One or Two with ramp. In the case Two with ramp is selected, the Start Fuel 2 level is commanded when the engine speed exceeds the Start Speed 2 Threshold. The switch from Start Fuel 1 to Start Fuel 2 follows a ramp rate, Actuator Ramp Rate.

5.6.1   Engine Stopping Settings

The Shutdown state features two parameters.

The Stop Speed Threshold defines a speed threshold for detecting engine stall. When the engine speed falls below this level, the system transits to Shutdown state.

The Stopped State Delay defines a waiting time for the transition from Shutdown to Stop when the conditions for such transition otherwise are met.
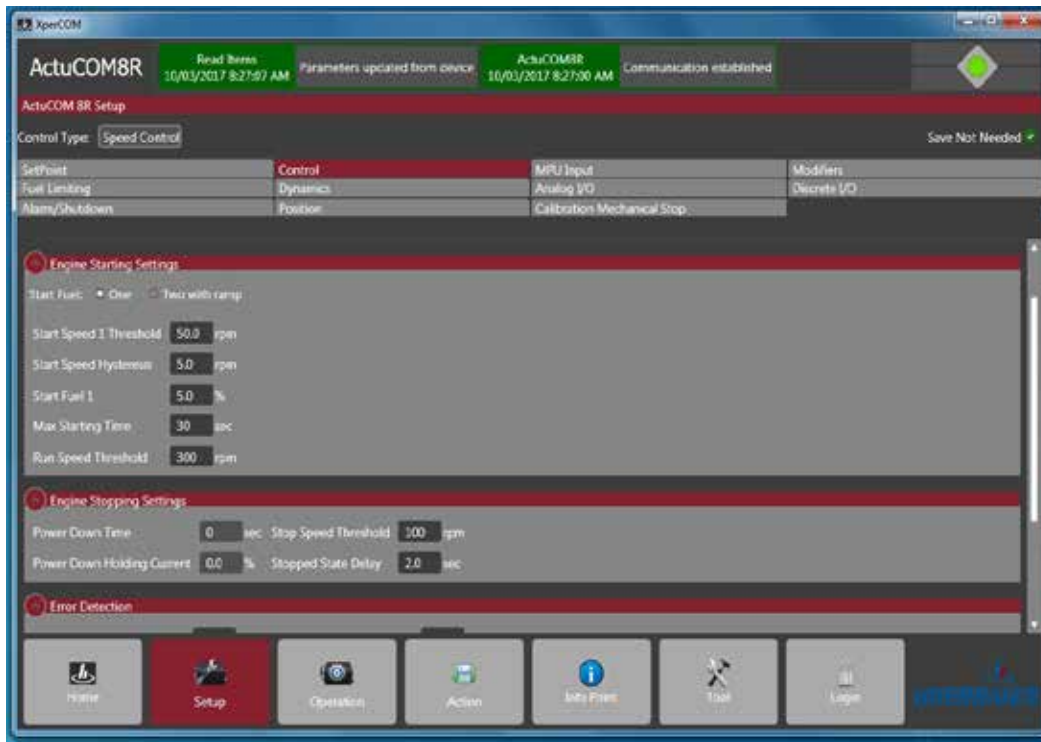
5.7 Over-speed Protection

Go to Setup -> Control. Under the expander Error Detection the parameter Overspeed Threshold can be set to any speed level. Once the speed crosses this threshold, the ActuCOM will shut down.
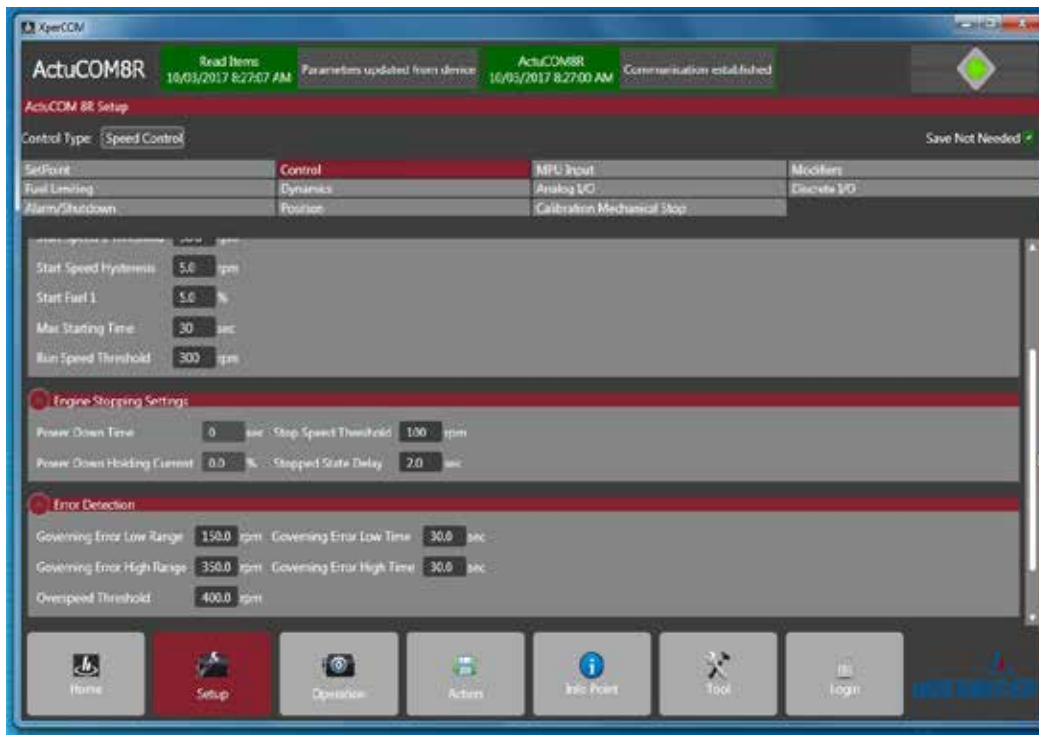
5.8 Controller Dynamics settings

Click Setup and select the Dynamics view.
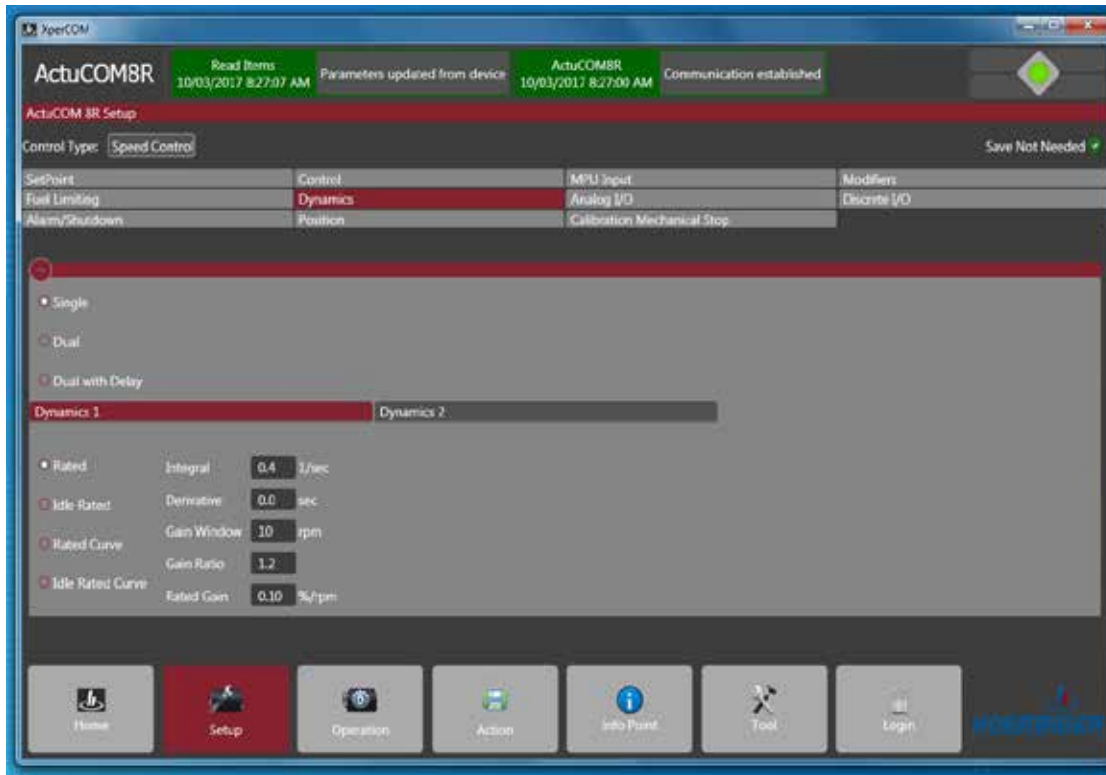
The controller dynamics refer to the dynamic properties of the speed controller. The dynamic properties are defined by the PID controller gain parameters.

The system can define one (Single) or two (Dual / Dual with Delay) sets of gain parameters. If Single is selected, only the parameters in Dynamics 1 are used. If Dual or Dual with Delay is selected, the system can switch between Dynamics 1 and Dynamics 2 settings.

When Dual is selected, the user shall select a digital input channel for the Alt Dynamics Input signal. This signal is used for switching between the two sets of gain parameters in Dynamics 1 and Dynamics 2.
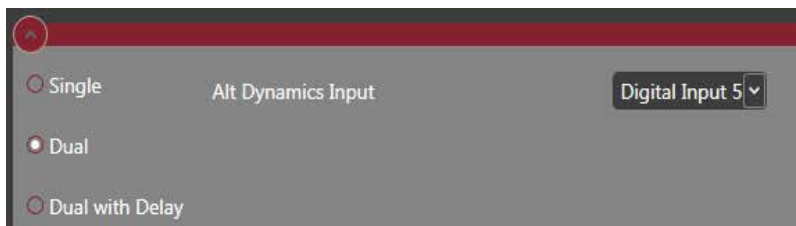
If Dual with Delay is selected, two more parameters appear. They define a delay time for switching between the two gain sets, one in each direction.
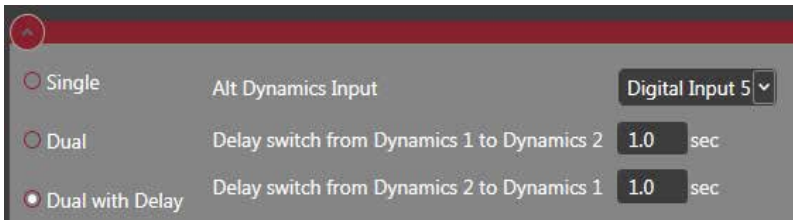
The dynamics can be selected to four different modes:

1. Rated
2. Idle Rated
3. Rated Curve
4. Idle Rated Curve

For Rated, five parameters are defined. The Rated Gain is the general proportional gain for the PID controller. The Integral and the Derivative gain parameters shall be multiplied to the Rated Gain to yield the actual PID gains for the I and D parts respectively.

The system also features an extra gain factor, Gain Ratio, which is multiplied to all P, I and D gains when the speed error is outside the Gain Window.

For Idle Rated, the system offers an alternative P gain for the Idle mode, Idle Gain. To use the Idle Rated mode, the Set Point setting must use Idle/Rated to define the Idle/Rated Input switch.
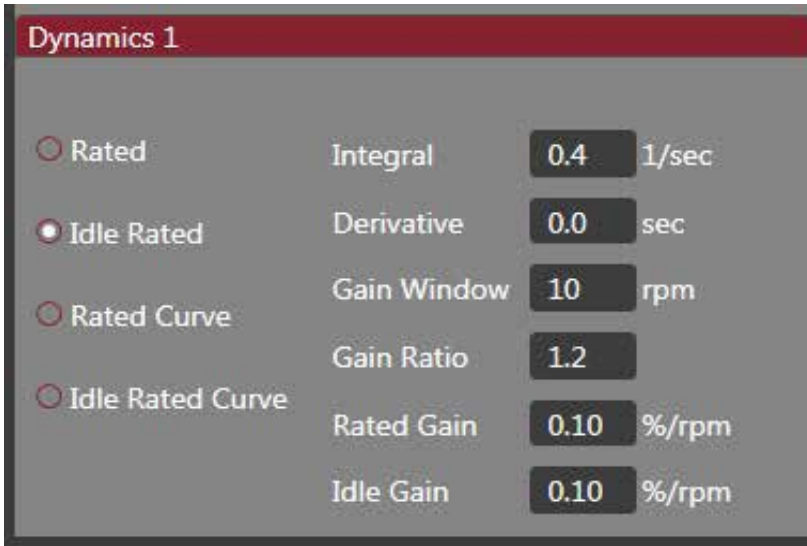
For Rated Curve, we define the P gain (Rated Gain) as a function of the ActuCOM motor position. The gain curve has five support points and the actual P gain is interpolated between the support points. This P gain has the same function as the Rated Gain above. On top of the gain curve, a Common Gain is available that is multiplied to the interpolated P gain to yield the total P gain. Using this parameter, it is possible to change all points in the curve equally.
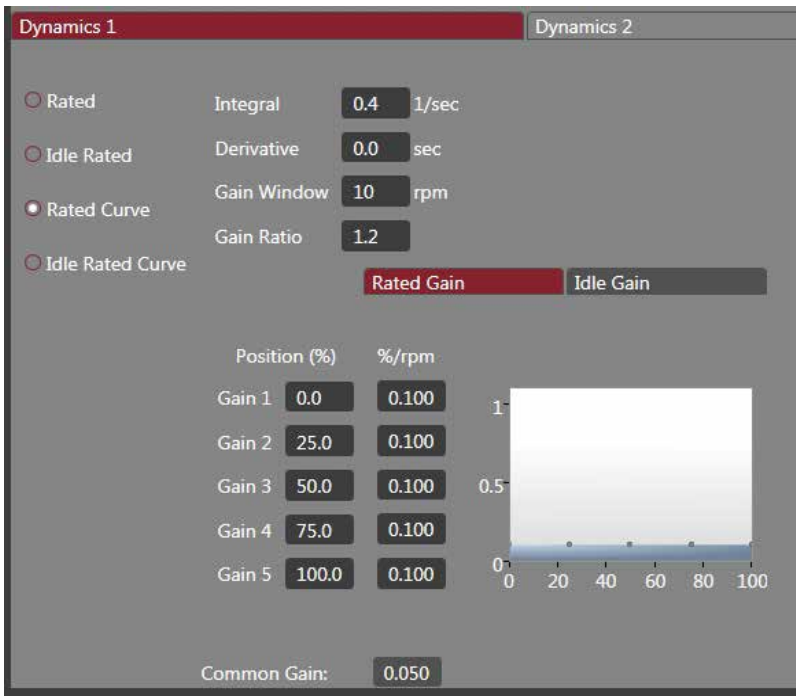
For Idle Rated Curve, an equivalent curve is defined for the Idle Gain.

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5.9   Analog input configuration

Click Setup and select Analog I/O. The expander Input contains the calibration parameters for the analog input channel.
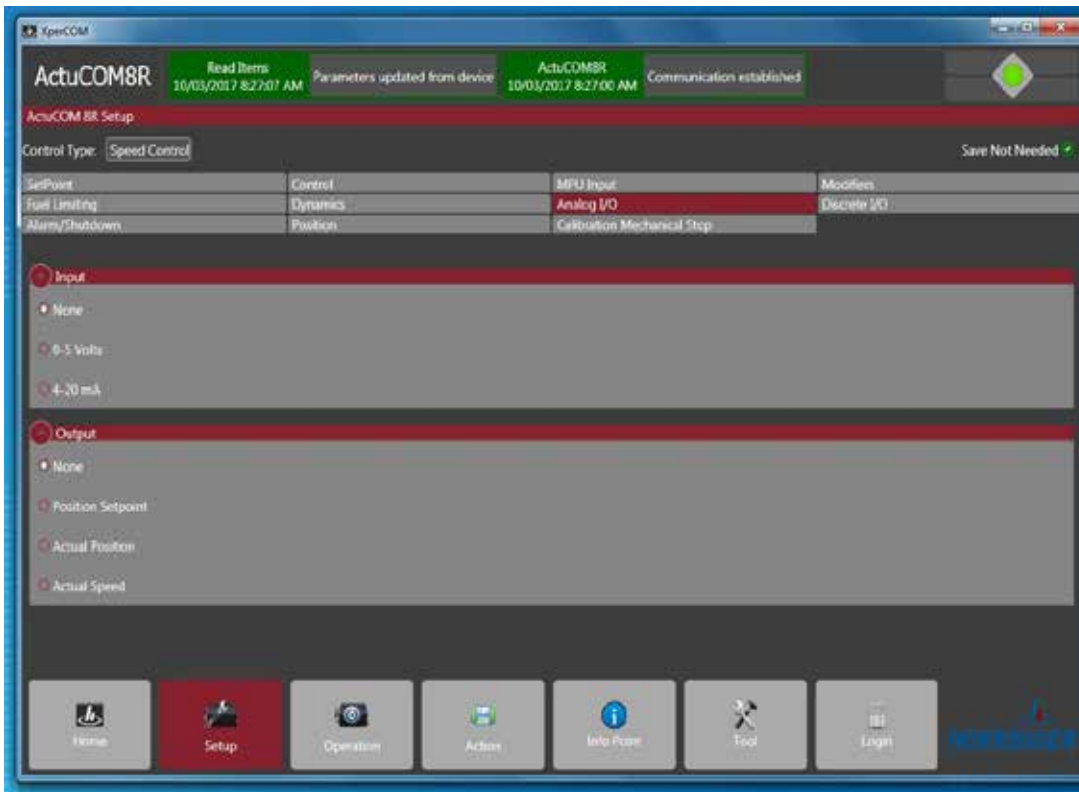
If None is selected, the analog input is not used.

If 0-5V is selected, the analog input shall be connected to a 0-5V source. Observe that the jumper in the connector shall not be used. The Voltage Minimum and Voltage Maximum are translated into the ActuCOM internal scale between Output Minimum and Output Maximum. A diagnostic fault range is also defined in Diagnostic Minimum and Diagnostic Maximum which will trigger an Analog Input Low or Analog Input High fault.

If 4-20mA is selected, the same calibration is given in mA instead. Observe that the jumper needs to be in place fro the 4-20mA input to function.

5.10 Analog output configuration

Click Setup and select Analog I/O. The expander Output contains the calibration parameters for the analog output channel.
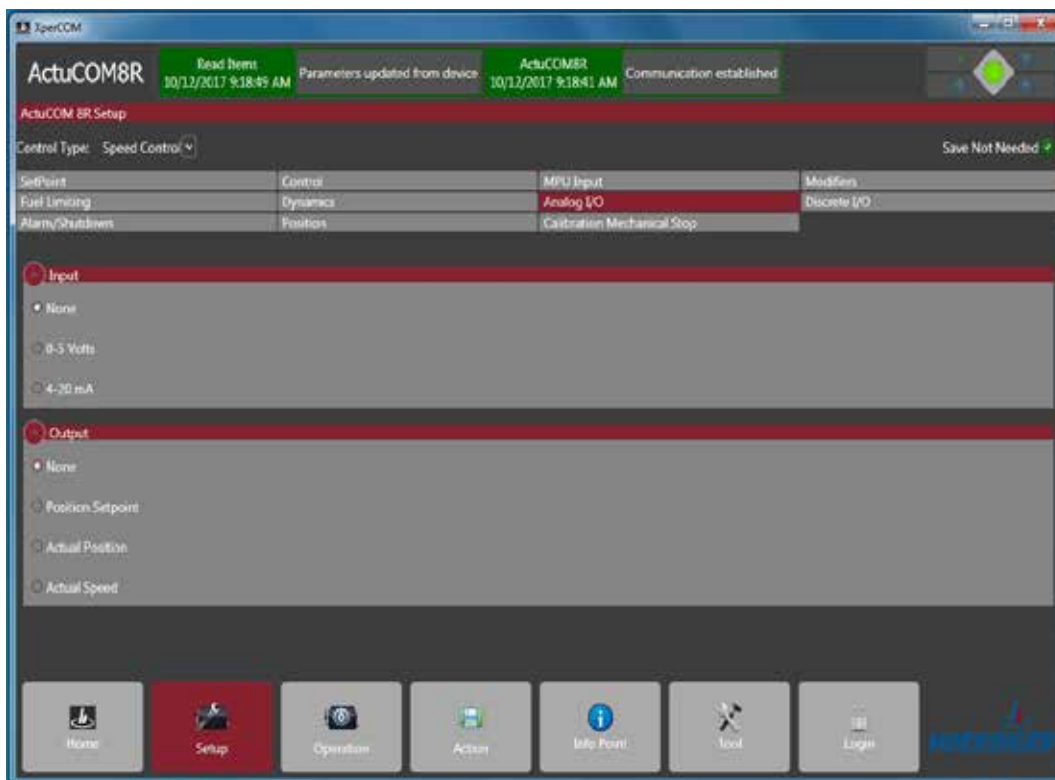
The analog output can be switched off by selecting None.

When activated, the analog output can be configured to represent one of the following:

- Position Set Point
- Actual Position
- Actual Speed

If Position Set Point is selected, the analog output will represent the current position set point in the system. The parameters define how to scale the position set point into the 4-20mA range.

Position Minimum and Maximum parameters are mirrored settings of Soft stop parameters in Angle Configuration in Position Tab.

If Actual Position is selected, the same parameters apply to the current measured position in the system.

If Actual Speed is selected, the 4-20mA range represents the current measured speed.
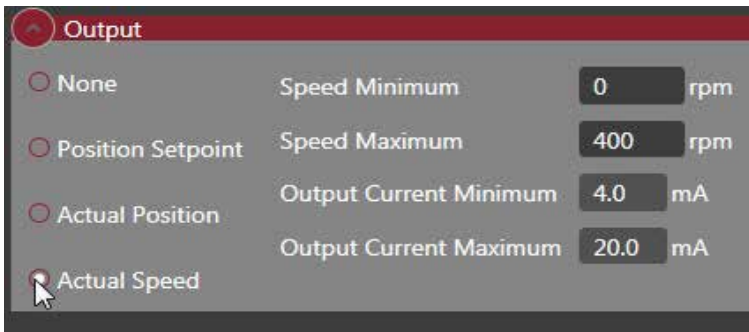
5.11   Digital Input configuration

Click Setup and select Discrete I/O. The part Input Configuration defines how the digital inputs shall operate. For each input the Switch type and Active type can be defined. Switch type High means that the digital input pin is fed by +24V, and Low means ground. Active Open means that the input is considered active when the input pin is left unconnected and Active Closed means that the input is considered active when the input pin is connected to its feed source.

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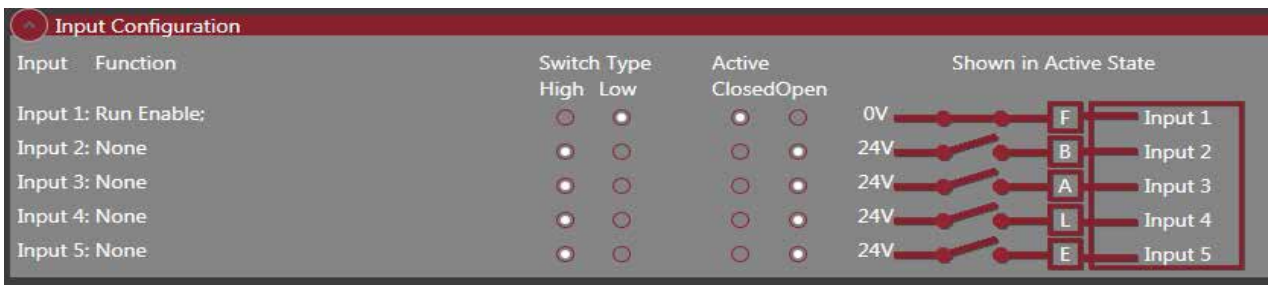
5.12   Digital Output configuration

Digital output configuration defines in which circumstances the digital output should turn on and off. It is possible to have the digital output state depend on error states or speed.
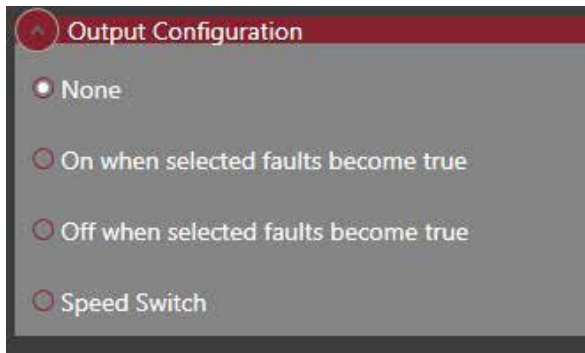
Available modes:

None – Digital output is inactive regardless of actuator state.

On when selected faults become true - Normally inactive. Output becomes active when selected errors occur.

Off when selected faults become true - Normally active. Output becomes inactive when selected errors occur.

Speed Switch – Output state depends on speed.
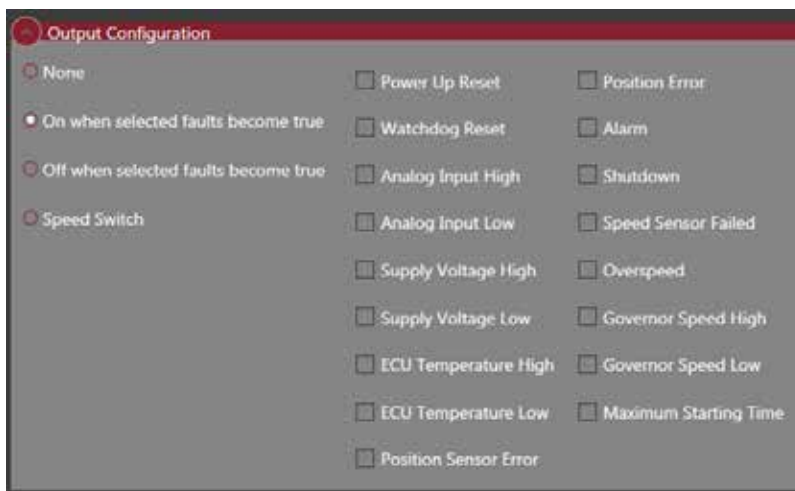
Choose the faults intended to affect digital output with the checkboxes.
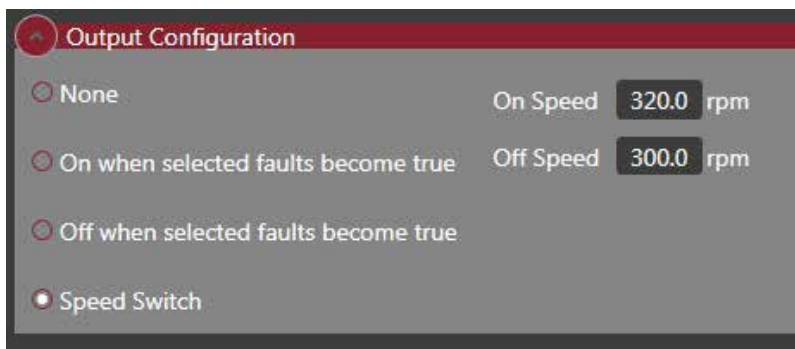
If speed-dependent output is chosen two speeds are chosen with hysteresis between them. In the above example output is off on start until speed reaches 320 rpm. Output remains active until speed goes below 300 rpm.

5.13 Alarms and shutdown configuration
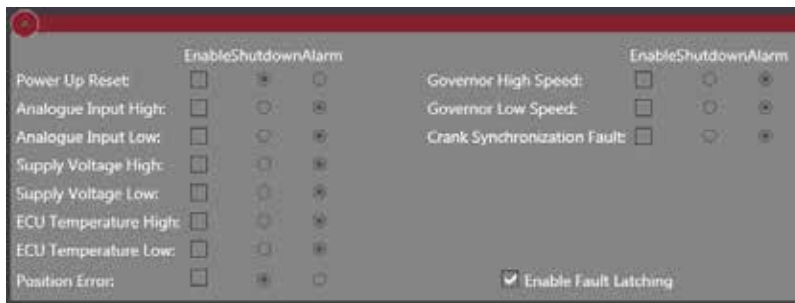
Actions for fault conditions are defined in the Alarm/Shutdown view. If digital output has been configured as an Alarm output, conditions selected as Alarm will affect the output. If fault latching is enabled, fault indications are kept after the fault conditions disappear.

5.14 MPU Input configuration
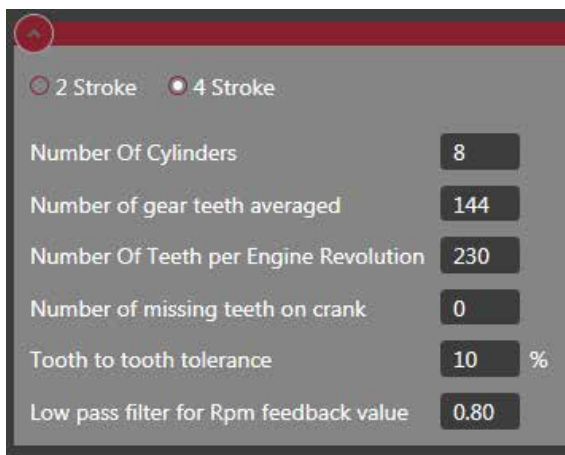
Select the MPU Input view in Setup. Select whether the engine application is a 2 stroke or a 4 stroke and enter total number of cylinders.

The most important parameter is the **Number Of Teeth per Engine Revolution**. It must match the tooth count of the flywheel's ring gear. The engine must be stopped before changes to the **Number Of Teeth per Engine Revolution** can be made.

The **Number of gear teeth averaged** setting is used to define the number of teeth used to calculate the average speed, a higher value will provide better stability, but also will result in a slower response to changes.

A good starting value for the **Number of gear teeth averaged** can be calculated as shown in the following example:

Example: 4 stroke, 8-cylinder engine with 230 teeth

Step 1. (Number Of Teeth per Engine Revolution ÷ Number of Cylinders) = Step 1 Value
(230 ÷ 8) = Step 1 Value = 28.75

Step 2. (Total engine cylinders ÷ 2) + 1 = Step 2 Value
(8 ÷ 2) + 1 = Step 2 Value = 5

Step 3. Step 1 Value X Step 2 Value = Number of gear teeth averaged
28.75 X 5 = 143.75 ≈ 144 (rounded up) = Number of gear teeth averaged
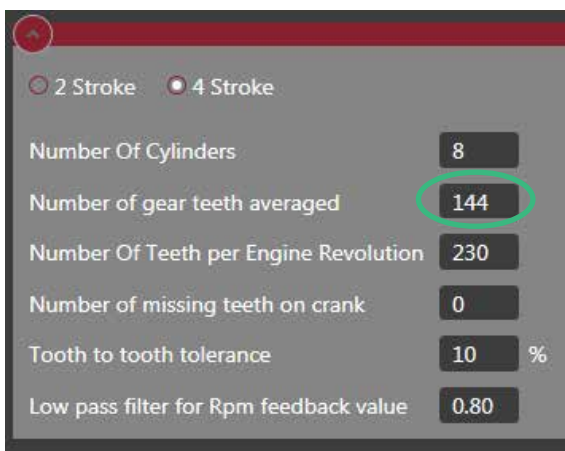
If the ring gear has missing teeth, the number of missing teeth must be specified. **Tooth to tooth tolerance** sets the limit for how a much tooth to tooth measurements can differ from previous tooth to tooth measurement before considering the MPU input to be faulty.

Low pass filter sets how much of previous speed samples are kept (and the rest of effect from the last sample) when calculating the speed value to be used by the speed governor. A typical installation could have a value of 0.7. Lower values are less stable and respond faster to changing inputs whereas higher values will have the opposite effect.

5.15 Speed set point modifiers

The speed set point can be modified by different methods:

1. Droop
2. Raise/Lower
3. Analog input (external set point)
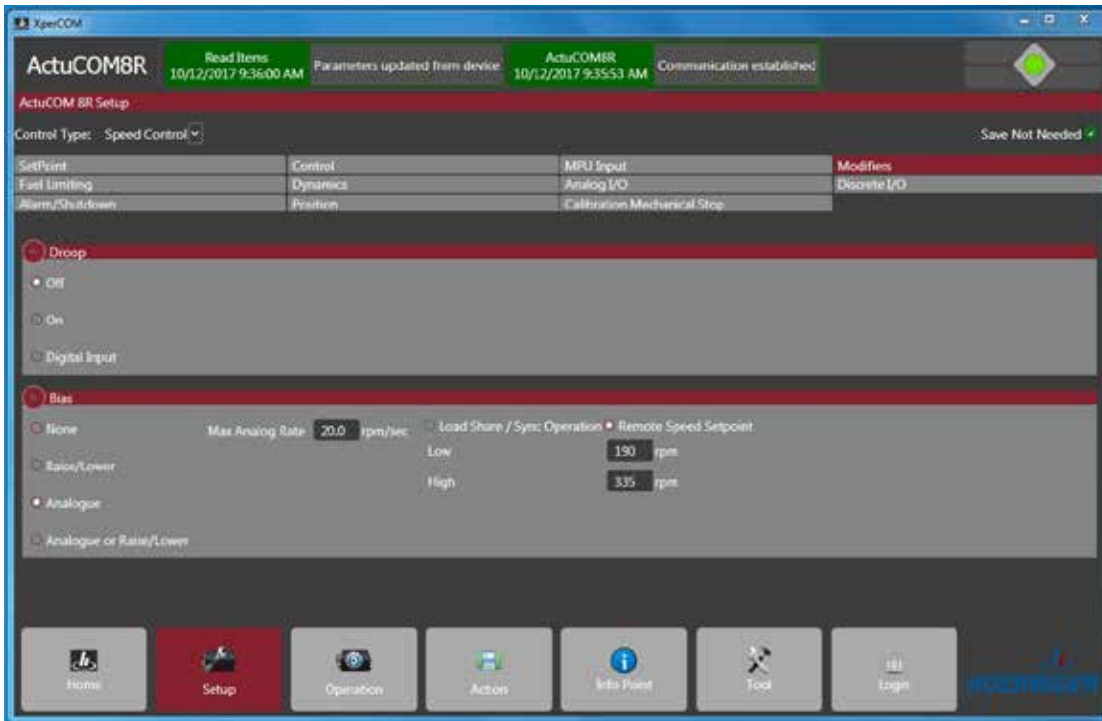
Select Modifiers in Setup.

5.15.1 Droop Modifier

The Droop Modifier can be Off, On or activated by a Digital Input. Droop adds a bias to the basic speed set point. The bias depends on the current actuator position, which is an indication of the engine load. At Full Load the droop bias is zero, and at No Load the droop bias is defined by the Droop parameter. The Full Load and No Load need to be defined as positions of the actuator.
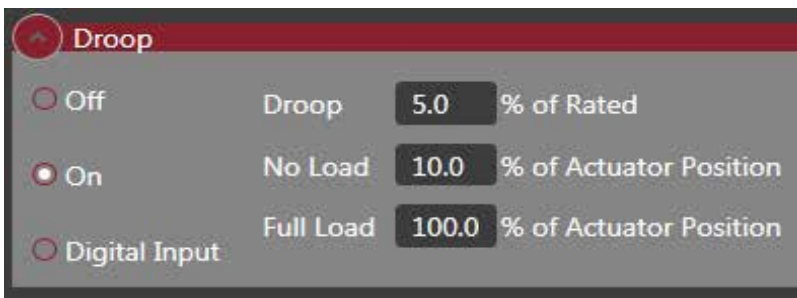
The effect of the settings are illustrated in the following figure:
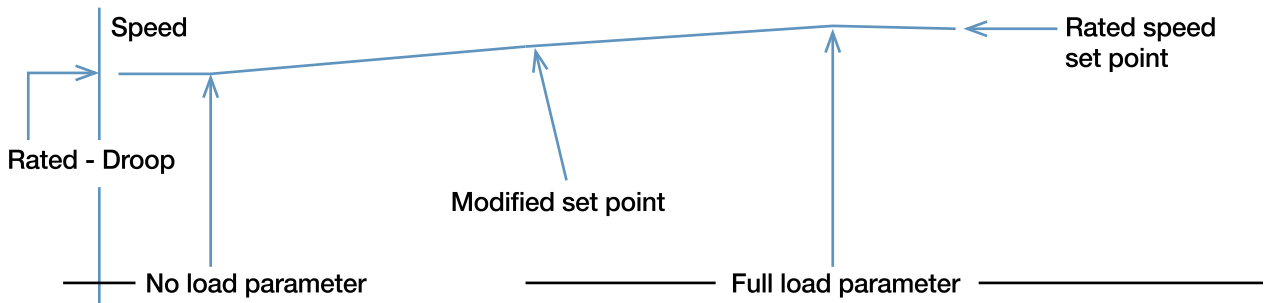
If the Digital Input option is selected, the Isoch/Droop Input must be specified.
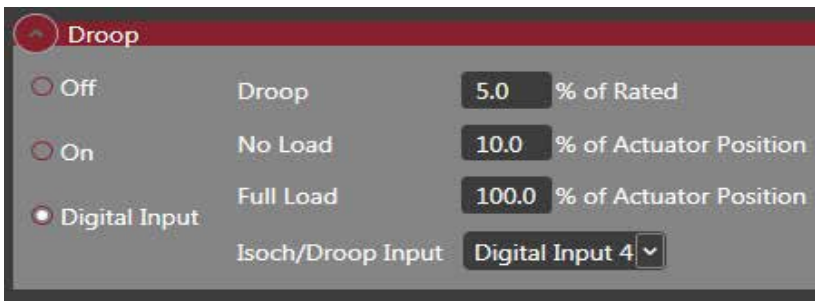
5.15.2 Bias modifier
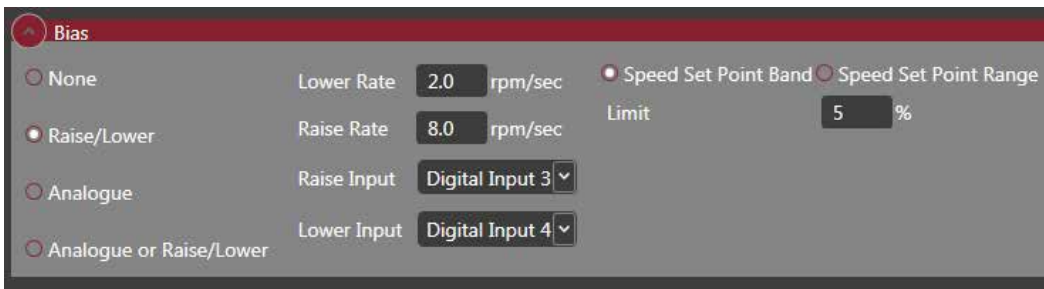
The modifiers (treated as an offset to the set point that otherwise would be active) will be affected by the inputs configured. The limits to the bias are set either as a band around basic set point (percentage difference) or with upper/lower total speed limits (Set point range).
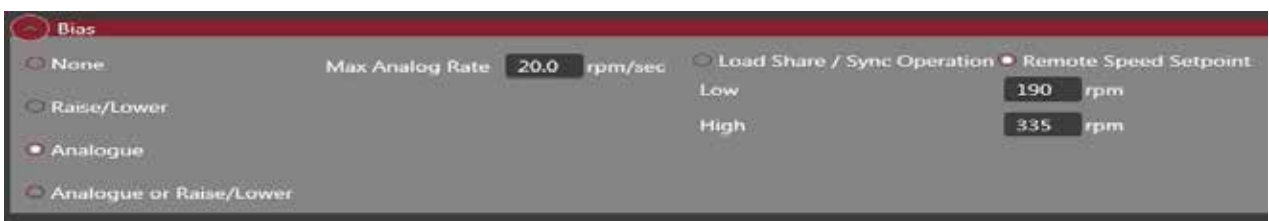
In analog bias mode the basic set point is entirely replaced by a set point derived from analog input. Analog or Raise/Lower uses both analog input to act as the basic set point, and raise / lower inputs to provide an offset modifying it.

6   Tuning Guide

6.1   Getting started – Position Control Mode

This section is a quick-start guide to set up the ActuCOM by some basic calibration through Xper-COM, and using the most basic features of the ActuCOM in position control mode.

1. Connect Power Supply, ground and the RS485 link to XperCOM. Do not connect the Digital Input 1 yet.

2. Start XperCOM and connect to the ActuCOM. Accept to load the current configuration and calibration file from the ActuCOM to the XperCOM. Verify that the electric motor is de-energized and the motor axle can be moved by hand.

3. Choose the Setup view in XperCOM. At this point we will do a calibration of the mechanical stops to define the rotational operating range of the electric motor. The full range is 360 deg, a full turn. Select the Calibration Mechanical Stops view.

4. Mechanical Calibration can be done in two ways, Manual or Automatic. Automatic calibration requires physical mechanical stops to be in place, at least in the closing direction of the rotation. For now, choose the Manual calibration by checking the Manual box and clicking the Enter Calmode button.

5. Select the rotational direction of the motor, clock-wise (CW) or counter clock-wise (CCW). The rotational direction defines the opening direction for the rotational movement of the motor. The opposite direction is the closing direction. Clock-wise rotation is defined as clock-wise in the opening direction when you face the axle end.

6. By hand, set the motor axle to the end point in the closing direction. Click Catch.

7. By hand, set the motor axle to the end point in the opening direction. Click Catch.

8. The calibration of the mechanical stops is now finished.

9. Go to Setup and Position. Check the settings for Soft Stops.

10. Go to Setup and Analog I/O. Check the settings of the Input expander. Have an external analog signal source that matches either a 0-5V or a 4-20mA input, and configure the input accordingly.

11. Connect the external signal source to the analog input and set its signal to match the 0% position.

12. Select Control type to be Analog Position Control.
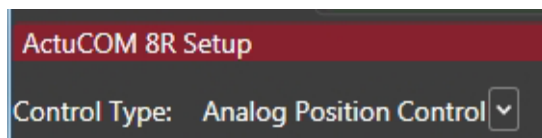
13. Connect the Digital Input 1 to ground. The motor goes to the 0% position and holds steady.

14. Vary the analog input signal between min and max and verify that the motor axle takes positions between its min and max.

6.2 Getting started – speed control mode

This section is a quick-start guide to set up the ActuCOM by some basic calibration through Xper-COM, and using the most basic features of the ActuCOM in speed control mode.

1. Do steps 1-8 in Section 6.1 to do the mechanical calibration of the end stops.

2. Select Control Type to Speed Control.
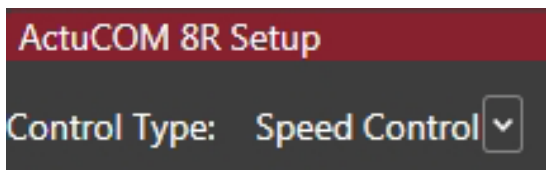
3. Select the SetPoint view. Select Rated mode for Speed Setpoint and set the Rated Setpoint to a suitable value.
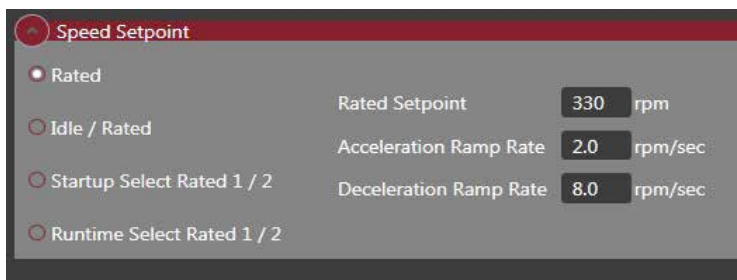
4. Select the Control view. In Engine Starting Settings, set the Start Speed 1 Threshold to a value where the ActuCOM valve will open when the engine starts cranking. The lowest allowed value is 20 rpm. Set the Start Fuel 1 to a value 0-100% for the valve position during cranking. Set the Run Speed Threshold to a value where the engine has started and speed control is possible.

Engine Starting Settings

Start Fuel: ● One   ○ Two with ramp

Start Speed 1 Threshold	50.0	rpm
Start Speed Hysteresis	5.0	rpm
Start Fuel 1	5.0	%
Max Starting Time	30	sec
Run Speed Threshold	300	rpm
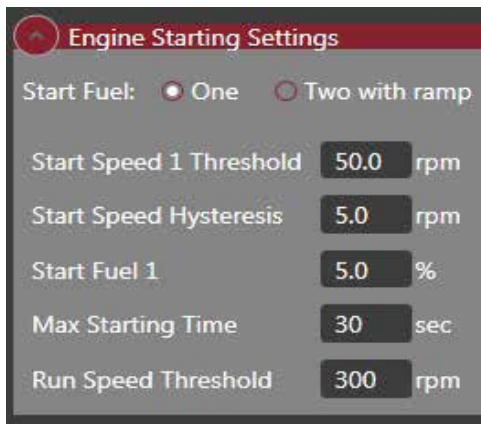
In the Error Detection part, set the Overspeed Threshold to a value that will protect the engine.

Error Detection

Governing Error Low Range	150.0	rpm	Governing Error Low Time	30.0	sec
Governing Error High Range	350.0	rpm	Governing Error High Time	30.0	sec
Overspeed Threshold	400.0	rpm			

5. Select the MPU Input view and check that the settings for Number of Teeth Per Engine Revolution matches your tooth wheel.

○ 2 Stroke   ● 4 Stroke

Number Of Cylinders	8
Number of gear teeth averaged	32
Number Of Teeth per Engine Revolution	100
Number of missing teeth on crank	0
Tooth to tooth tolerance	10 %
Low pass filter for Rpm feedback value	0.10

○ 2 Stroke   ● 4 Stroke

Number Of Cylinders	8
Number of gear teeth averaged	32
Number Of Teeth per Engine Revolution	100
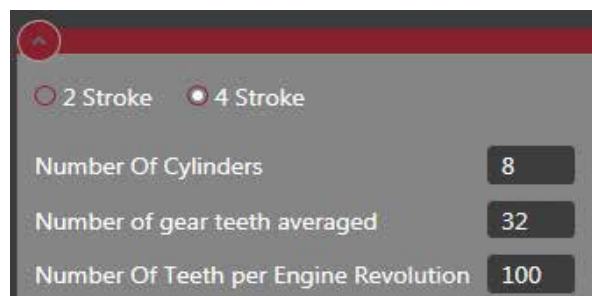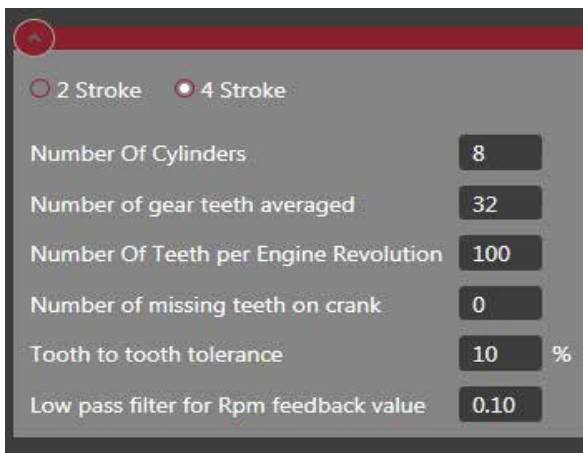
6. Click Action and select Send To Device. The system is now ready for start.

7. When starting the engine, activate Digital Input 1 (Run Enable) by connecting the pin to ground.

8. If a start attempt is unsuccessful or the engine stalls, deactivate Digital Input 1 to enter Stop state. From there you can change the calibration and start over from point 6.

6.3   **Speed Controller Dynamics Tuning**

This section describes how to do a basic tuning of the speed controller dynamics. It is assumed that the system can run the engine at a stable engine speed.

Select the Dynamics view under Setup. As a start, set the Derivative parameter to 0. The default values of Integral and Rated Gain are supposed to yield a slow but stable speed controller.
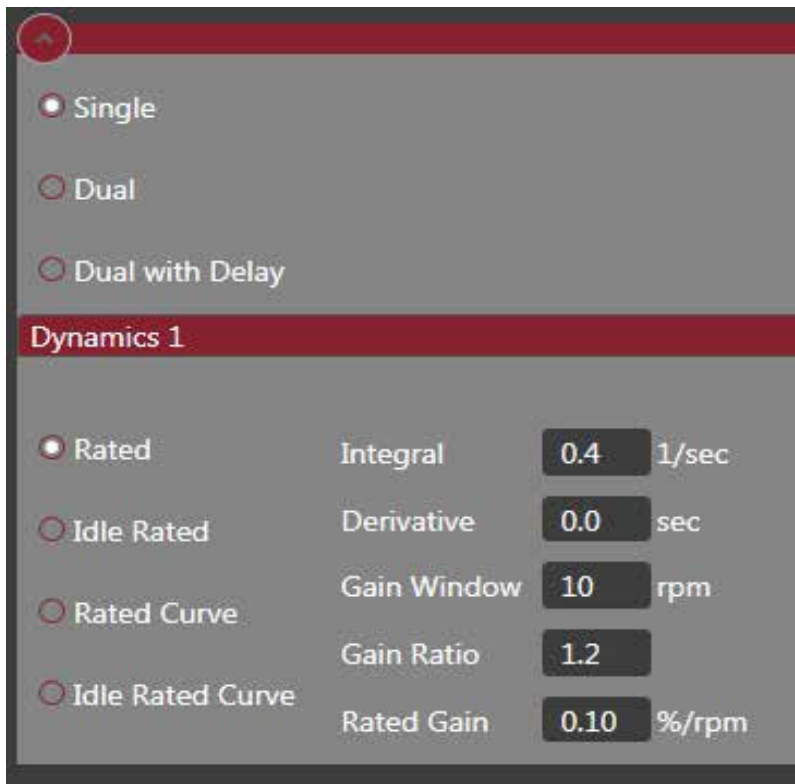
To tune a speed controller, it is useful if steps in speed set point can be performed. Introduce steps in speed set point by changing the Rated Setpoint in the Setpoint view. Observe the response in the actual speed. Adjust the Acceleration Ramp Rate and Deceleration Ramp Rate so that proper steepness of the speed set point step is achieved.
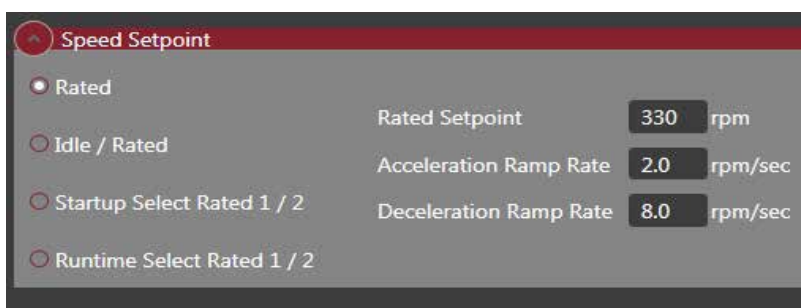
If the speed controller is too slow, primarily increase the Rated Gain until an overshoot appears in the step response.

If the speed controller is too fast, reduce the Rated Gain until a stable behavior appears.

If the speed controller appears uneasy at steady state, decrease the Integral value and compensate by increasing the Rated Gain.

6.4 Inertia Compensation

If the positioning of the motor appears slow due to a big inertia in the mechanical linkage and end actuator, there are parameters to adjust in the ActuCOM.

Click Setup and select the Position view. The PID parameters denote changes in % from their default values. If a more rapid positioning response is desired due to a big inertia, increase the gains by pulling the slider to the right. In the example below, the PGain is increased by 20%, the I Gain by 10% and the D Gain is decreased by 11%.
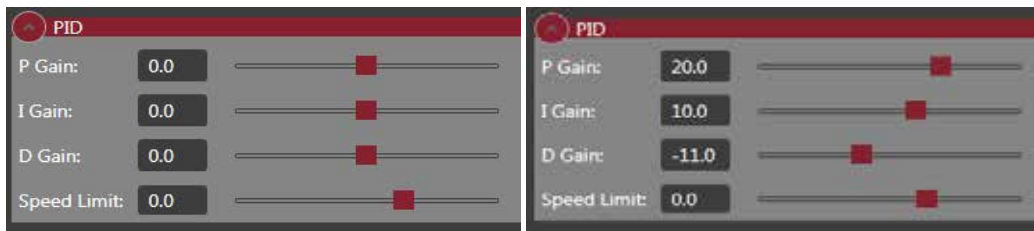
6.5 More on Dynamics tuning

Interpreting Dynamics parameters

The picture contains the parameters defining the PID-parameter for a speed controller. In this case it is taken from an engine running on natural gas, with ACR8 controlling the throttle. For this engine very small throttle changes have a large effect. At rated speed throttle level is typically somewhere between 3-8% (out of 65 degrees of operating angle) depending on load.

The Proportional (P) part of the PID is determined by the setting Rated Gain. This part acts on the regulation error. In the above case an error of 1 RPM (for example if we are at 999rpm, but the setpoint is 1000 rpm) would affect the throttle position by 0.01%.

The Integral (I) part of the PID is determined by the multiplication of Rated Gain with Integral. This part acts on the accumulated error (integrating the difference). In this case a 1 RPM difference for one second would affect the throttle by 0.02% (2.0 * 0.01).

The Differential (D) part of the PID is determined by the multiplication of Rated Gain with Derivative. This part acts on the direction of movement of error (whether regulation error is getting larger or smaller). In this case this parameter is zeroed out. It is generally suggested to treat this parameter as a finetuning, only used after a basic PI-regulator has been achieved. Should the Derivative in this example be changed to 1.0, the effect would be that if speed governing error was increasing with 1 rpm/second, this would affect the throttle by 0.01% (1.0 * 0.01).

The Gain window and Gain ratio will multiply the regulation parameters with Gain Ratio if the governing error is larger than Gain window. Essentially this gives the ability to have a stronger (or weaker) regulator depending on if the governing error is large. In this case the gain ratio of 1.0 means that parameters will be unchanged once error goes above/below 10 rpm.

Changes to the regulator

If you want the regulator to have the same internal dynamics, but be in general faster/slower, you only need to change the Rated Gain parameter. Since the Integral and Derivative parameters are premultiplied with the Rated Gain, the relative strength of the P, I and D parts will be kept the same.

If the regulator has the right strength of the Proportional error handling, but with bad dynamic behavior, the Integral and Derivative fields can be changed. This changes the relationship between the P and the (ID).

Observe that this means that if you want to change only the P – part, and keep I and D with the same effective value as before, you need to change both the Rated Gain and compensate for this change with the Integral and Differential settings. Eg. To double P and keep effective I and D the same: Double Rated Gain, halve Integral and Differential.

Analyzing the behavior

Parts of the PID regulator behavior can be plotted using the XperCOM tool. The terms Esg_PidPropTerm, Esg_PidIntTerm and Esg_PidDiffTerm contain the value for how much each of these terms are changing the throttle position.

When speed and regulation is in a stable state, and no throttle changes are needed, it is expected that these terms will be close to zero. On changes that will cause regulation (for example change of speed setpoint, change in load etc.) these three can be monitored.

To Enter the plotting mode, when you press "Operation" in the main menu, choose "Show operation and open a plot window" in the popup menu.
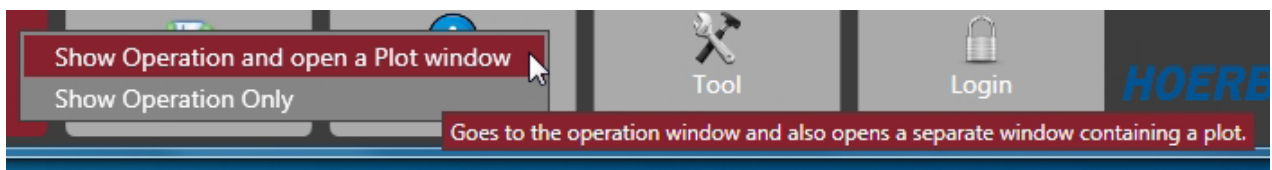
Press "Add Values" to choose parameters :
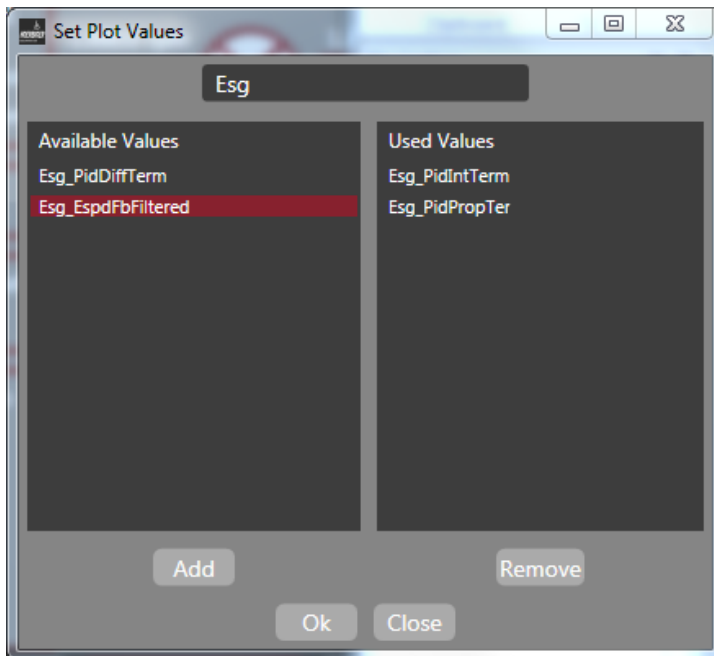
The main data of interest are Esg_PidPropTerm (P), Esg_PidIntTerm (I), Esg_EspdFbFiltered (Engine speed). Choose the ones to plot, press "Add", and the "Ok", and then "Close".

To start logging you can press "Resume". Logging can be paused as well as saved to image or data file.

Note that the values in Esg_PidPropTerm, Esg_PidIntTerm and Esg_PidDiffTerm work on a 10ms basis. For example, if Esg_PidIntTerm has the value 0.01 constantly for 1 second, it means the 0.01 value has been applied 100 times during that second, and changed actuation a total of 1%.

A few examples are provided of logged curves of the Integral term of the regulator, these were made using the Save as .png feature of the XperCOM plot:
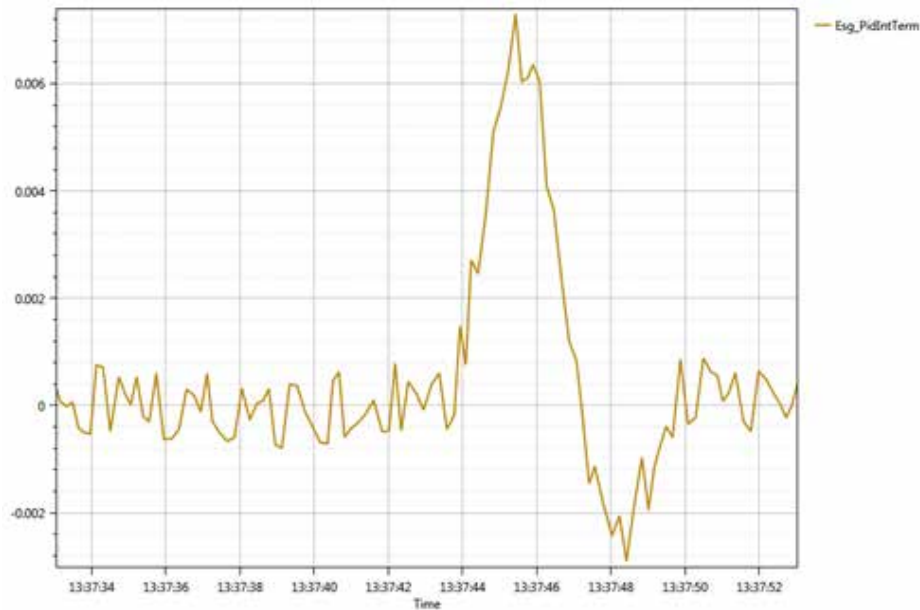
In this example the engine was running stable with only small regulations taking place (correction values close to zero). At 13:37:44 a sudden increase in load occurs. The integral part of the regulator can be seen to work to increase the actuator position until 13:37:47. At that point a small overshoot has occurred and the integral part works to decrease actuator position between 13:37:47 and 13:37:50. After this point operation is stable and correction values are close to zero again.
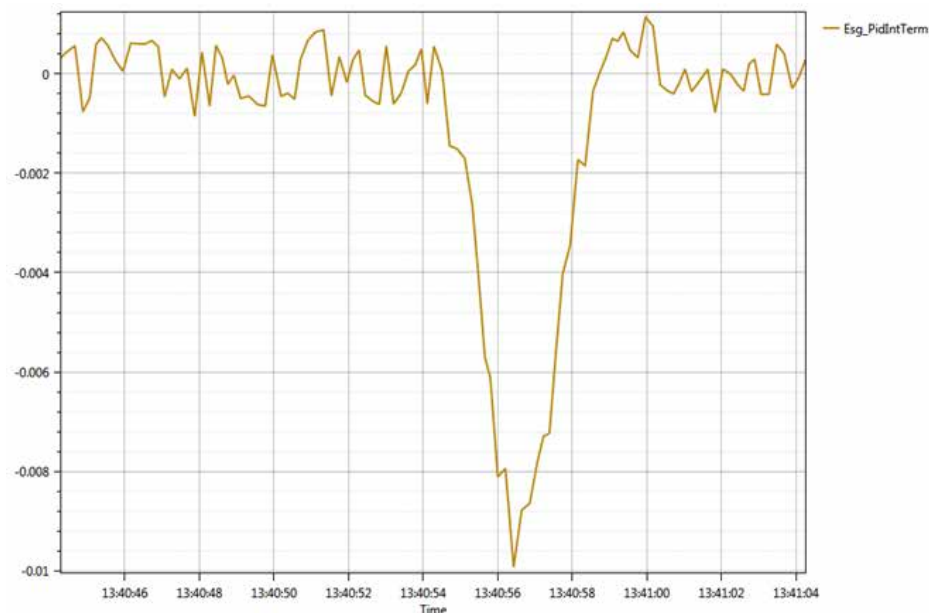
In this example, the engine was running stable until 13:40:54. Then a sudden decrease in load occurred. The integral part of regulator works to lessen the actuation between 13:40:54 and 13:40:59. For cases where load is removed the subsequent overshoot is typically smaller than when load is added.
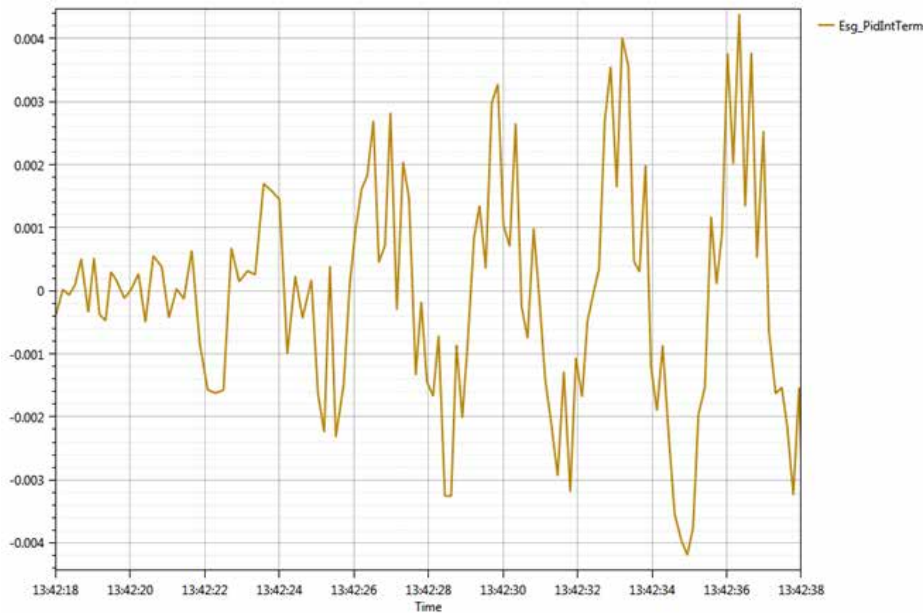
In this example the engine was running stable, and then at 13:42:22 the Integral part of the calibration was increased from 2.0 to 5.0. As can be seen this causes the regulator to become unstable with larger and larger "corrections" being applied in opposite directions. If this is seen it often means the Integral part is too large. As soon as Integral was returned to 2.0 behaviour stabilized. The specific values causing unstable behavior are engine and installation dependent. Note that in this example there was no change in load.

Other settings to consider to get a well behaved regulation

Speed input
To obtain good behavior the incoming speed signal should be properly averaged and have a lot of its jitter filtered out. A number of settings will affect this:

In MPU Input, for number of gear teeth averaged we suggest a value equal to or larger than half the number teeth in one revolution, (depending on response time needed). The value used on the natural gas engine test setup is 96 teeth averaged out of a total of 158 teeth. On some engines it may be advantageous to pick a number corresponding to a set number of cylinders out of the total. (On the test engine 96 teeth out of 158 roughly corresponds to 3 out of 5 cylinders)

Depending on if the incoming speed signal has a lot of jitter the "Low pass filter for Rpm feedback value" can be increased. 0.7 is a reasonable value for incoming readings of good quality. This can be raised to for example 0.8 on moderately noisy speed readings. For speed input with excessive noise levels a value of 0.9, or higher values close to (but below) 1.0 may be tried. The output speed after the low pass filter can be plotted using Esg_EspdFbFiltered.

Another test to see if speed input is smooth enough is to plot Esg_PidIntTerm during load changes. The correction curve should ideally be smooth. The above curves in this document are jagged and point to a jittery input. They were captured at averaged gear teeth of 32 and a feedback filter of 0.10. After raising gear teeth averaged to 96 and feedback filter to 0.80 Integral curve became smooth.

See following picture:
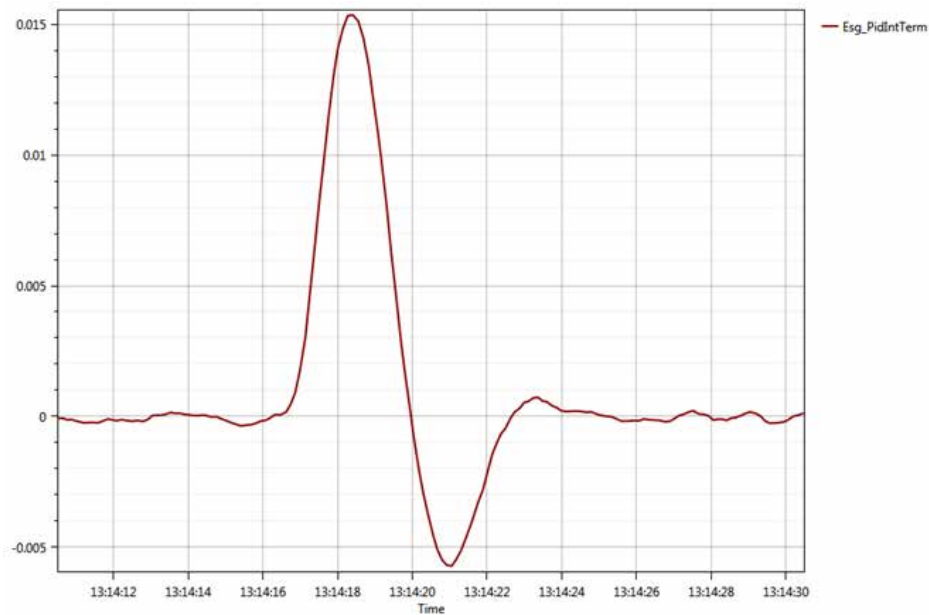
Regulator Integral behavior on step increase in load after tuning speed input.
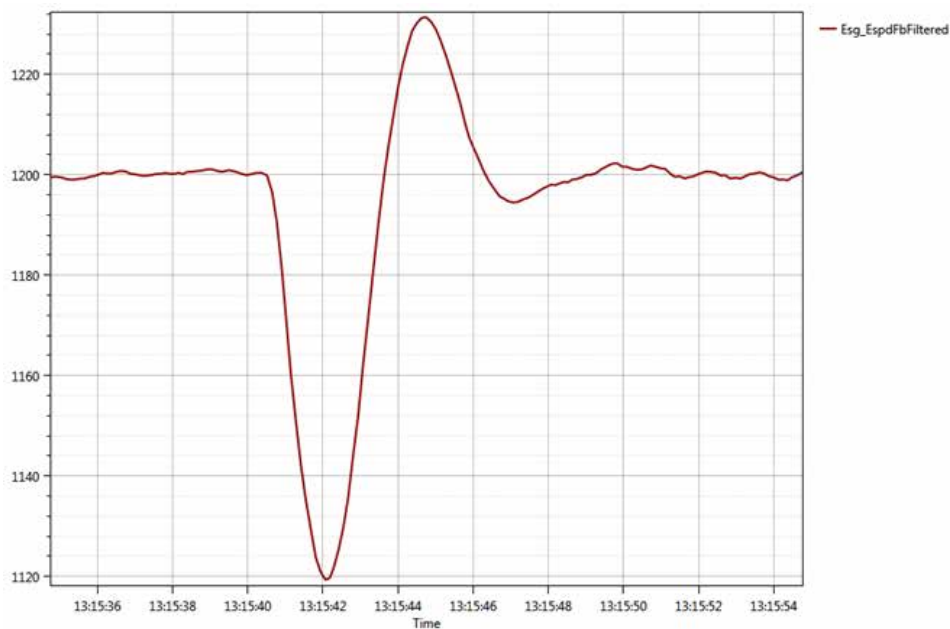
Look of speedcurve after tuning speed input on step increase of load.

Speed ramping
A regulator optimized to respond quickly to changes should not be exposed to large setpoint step changes, as this would lead to overly large response. In config area "SetPoint", Acceleration Ramp Rate and Deceleration Ramp Rate should be chosen to some reasonable values, which will be used for transitions Run -> Idle -> Rated etc. For the natural gas engine used in previous examples the ramp rates used are 10.0 rpm/s, with a start to run state transition at 600rpm, Idle speed 1000rpm and rated speed 1200rpm.

ActuCOM R8 Dimensions and Specifications

**GROUNDING SCREW
M5 X M8 SOCKET
HD CAP**

.98
[25]

5.31
[135]

6.98
[177.4]

.73
[18.5]

.97
[24.6]

.69
[17.4]

3.15
[79.9]

6.34
[161]

4.50
[114.3]

MOUNTING: USE M8-1.25 SCREW,
NOM. TORQUE: 11-13 FT LBS
HOLE DEPTH: .485[12.3]

℄ OF MOUNTING HOLES

2.500
.625
[63.5]
[15.9]

2.08
[52.8]

4.53
[115]
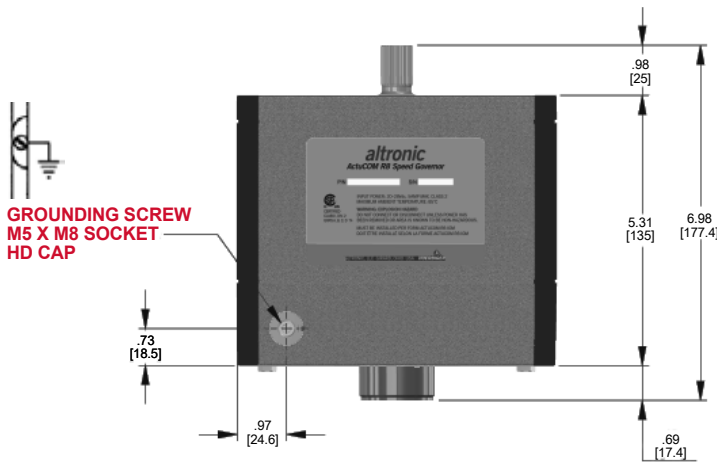
Power Requirement
20-28VDC, 3.6 AMP

Ambient Operating Temperature Range:
–40 to +90°C (–40 to +194°F)

Torque Output: ....5.9 ft/lbs. / 8 Nm

Module Weight: ....16.0 lbs. / 7.3 kg.

Module Mounting: ....Universal (T-Slots)

Actuator Shaft: ....0.625-36 Splined Serration

Communication Protocol:.....Modbus RS-485

Actuator Position Range:
350° of Available Travel, CW or CCW

Operational Modes:
Speed Control or Analog Position Control

Magnetic Pickup Frequency Range:
1Hz to 24 kHz

5 Discrete Inputs:
2 Configurable settings (High-side vs Low-side and
Normally Open vsNormally Closed)

1 Discrete Output: ....Low-side

1 Analog Input:..................Configurable (0-5V or 4-20mA)

1 Analog Output: 4-20mA

Hazardous Area Classification:
Class I, Div. 2, Groups A, B, C & D,Temp Code T4
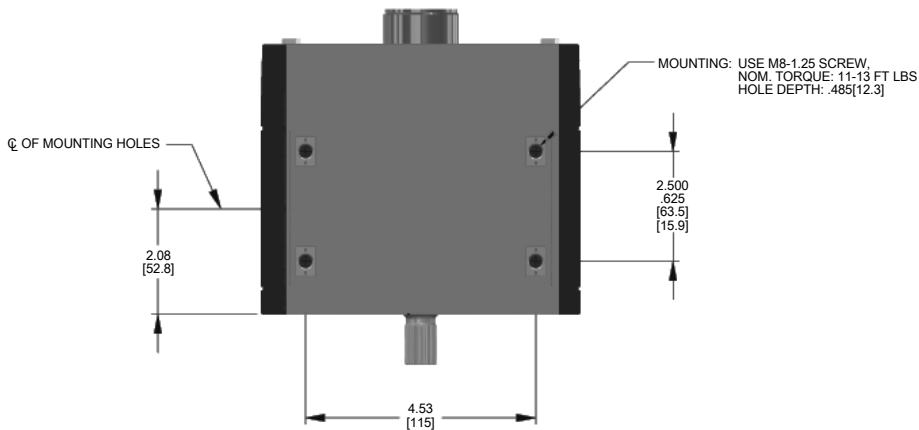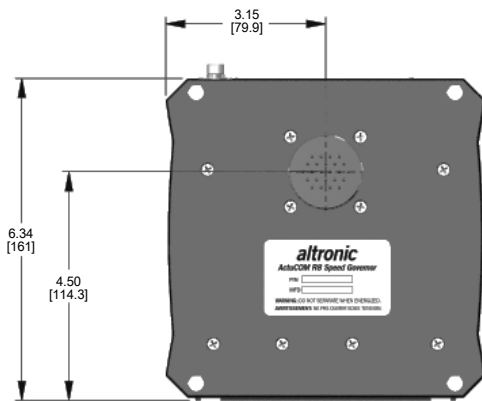
ActuCOM R8 System Wiring Diagram

Magnetic Pickup

.106 DIA

5/8-18 UNF-2A

GS02 HERMETICALLY
SEALED CONNECTOR
OR EQUIVALENT

tronic in

.750 - .800 DIA
19.05mm - 20.3mm

A   B

T +.016
   -.031

1.55
39,4mm

L ±.05

1.75
44,5mm

(APPROXIMATE
CONNECTOR CLEARANCE)

A

1N5237
8.2V ±5%
(TYP 4)

B
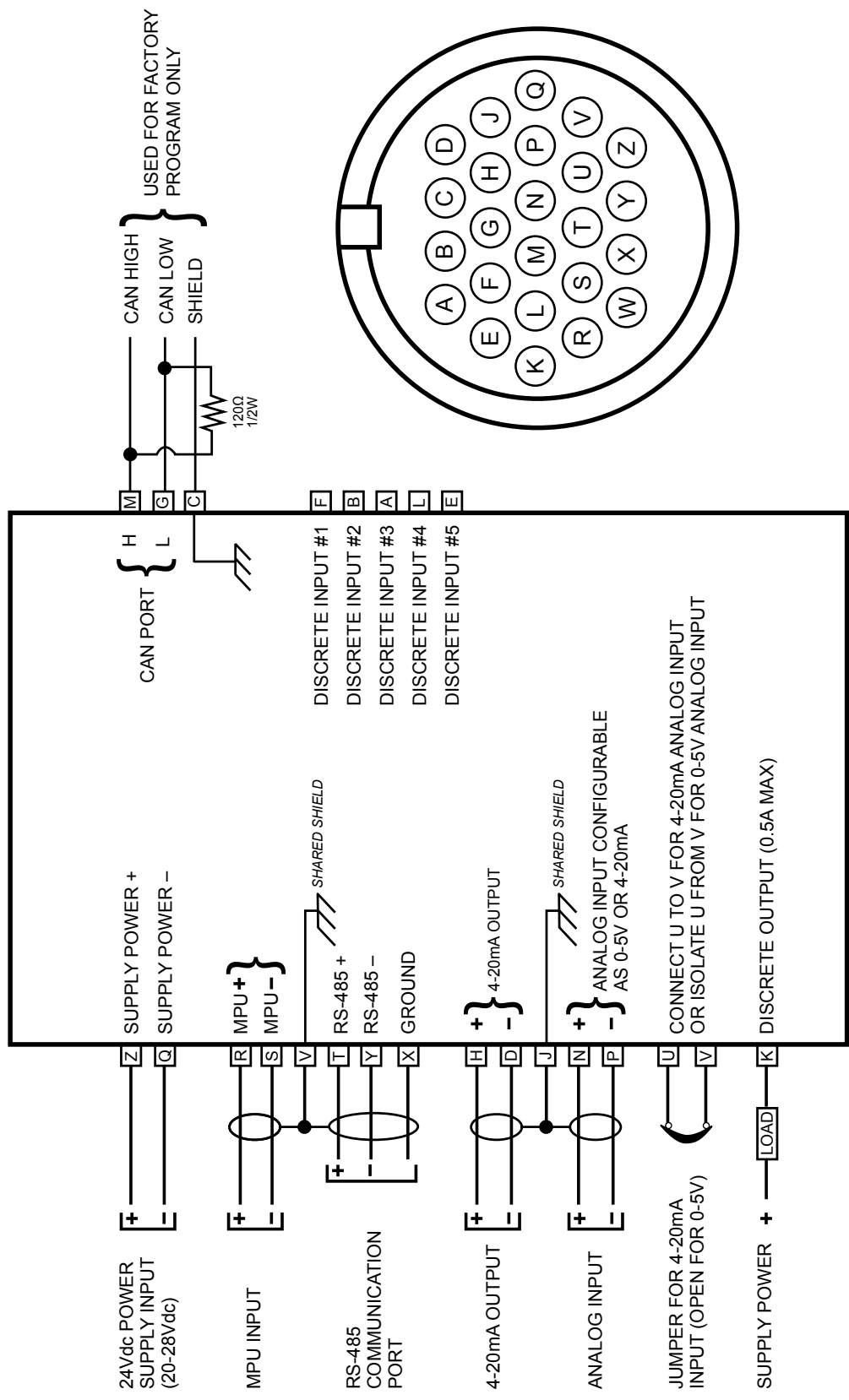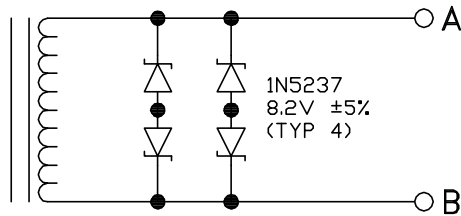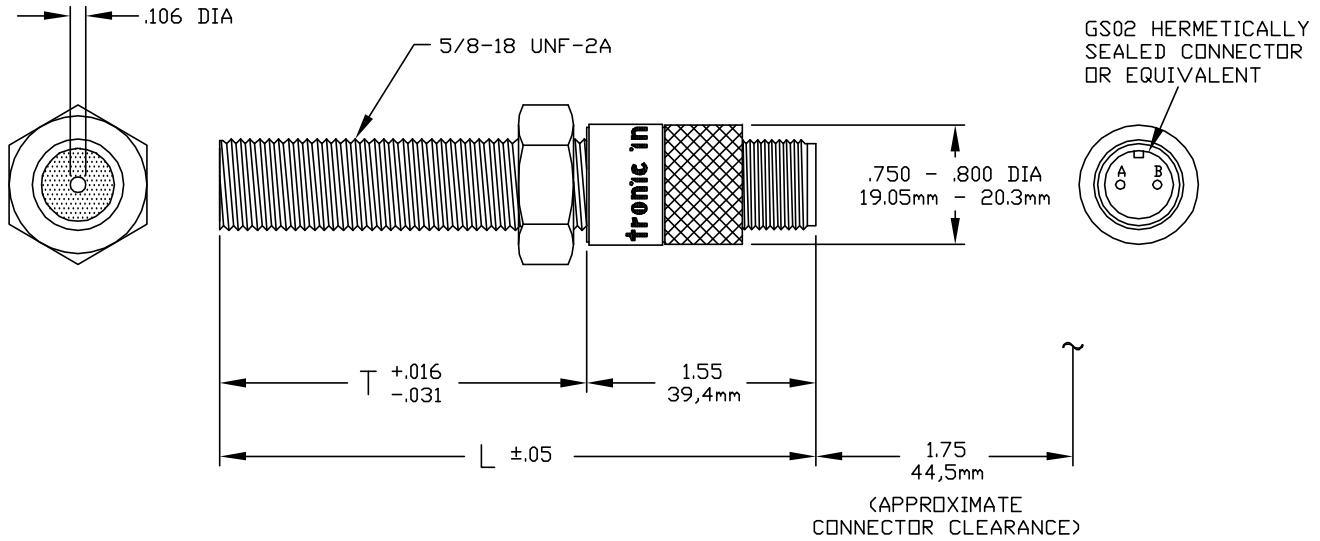
*NOTE:

ELECTRICAL VALUES GIVEN ARE ABSOLUTE
RATINGS ASSURED 100% BY TEST.

POLARITY: PIN "B" POSITIVE WITH RESPECT
TO PIN "A" WITH THE APPROACH OF A
FERROUS TARGET.

ELECTRICAL DATA *	
MAX. COIL INDUCTANCE	420 mH
MIN. COIL RESISTANCE	800-1200 Ω

ALTRONIC P/N	T	L
691118-1	1.75"/44,5mm	3.30"/83.3mm
691118-2	2.50"/63,5mm	4.05"/102.8mm
691118-3	3.0"/76.2mm	4.55"/115.6mm
691118-4	4.5"/114.3mm	6.05"/153.7mm
691118-6	6.0"/152.4mm	7.55"/191.8mm

Shielded Harness Conduit Length Adjustment

TO SHORTEN HARNESS

1. LOOSEN AND DISENGAGE NUT (2) AND REMOVE CONDUIT (1).
   COMPLETELY FROM CONNECTOR AND HARNESS ASSEMBLY (3).

2. REMOVE ITEMS (5), (4), AND (2) IN THAT ORDER FROM CONDUIT (1).
   NOTE THREADS ON (5).

3. CUT CONDUIT TO LENGTH WITH HACKSAW AND DRESS WITH FILE TO
   INSURE A CLEAN, SQUARE END. REMOVE FILINGS FROM INSIDE CONDUIT.

4. REINSTALL ITEMS (2), (4), AND (5) IN THAT ORDER.

5. INSTALL REASSEMBLED CONDUIT INTO (3) AND TIGHTEN (2).

ALTRONIC INC.
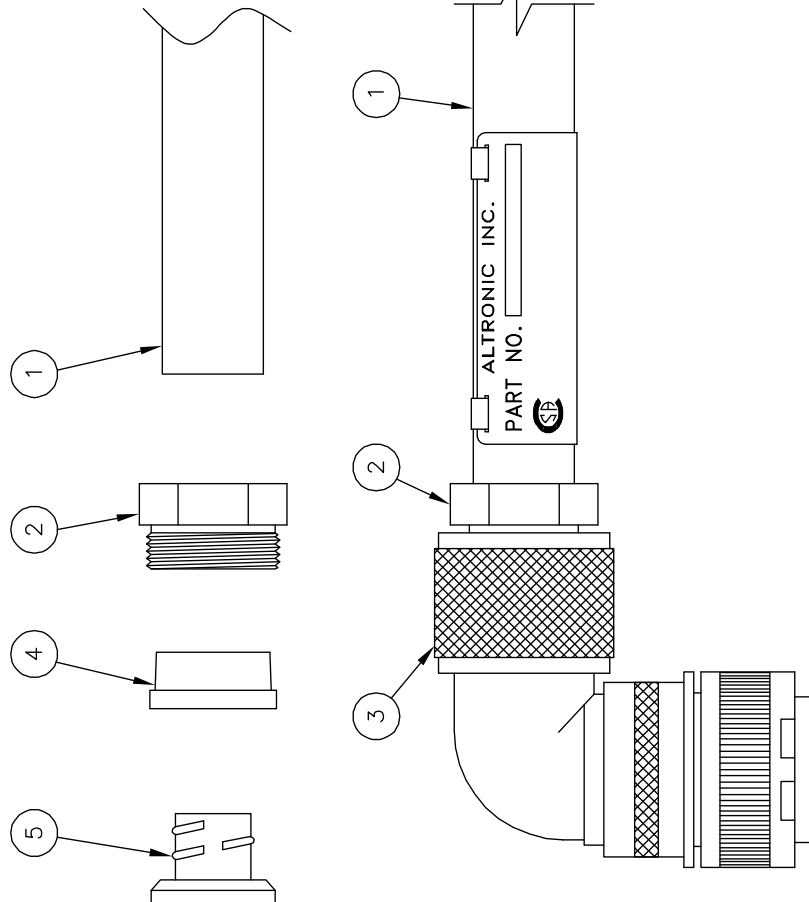
PART NO.

ActuCOM R8 Harness

693 215
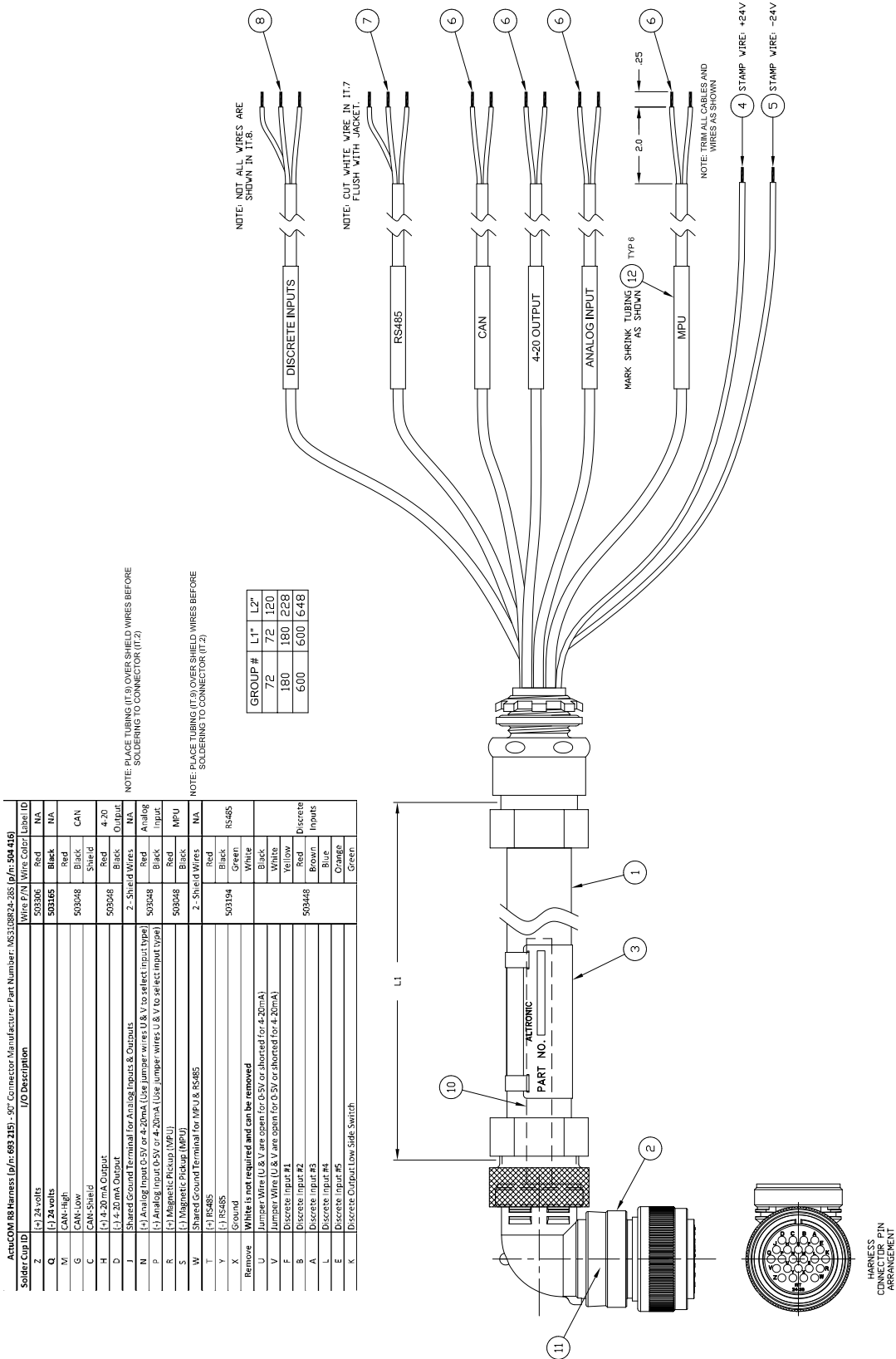
ActuCOM R8 Harness (p/n: 693 215) - 90° Connector Manufacturer Part Number: MS31G8R24-28S (p/n: 504 416)

Solder Cup ID	I/O Description	Wire P/N	Wire Color	Label ID
Z	(+) 24 volts	503306	Red	NA
Q	(-) 24 volts	503165	Black	NA
M	CAN-High		Red	
G	CAN-Low	503048	Black	CAN
C	CAN-Shield		Shield	
H	(+) 4-20 mA Output	503048	Red	4-20
D	(-) 4-20 mA Output		Black	Output
J	Shared Ground Terminal for Analog Inputs & Outputs	2 - Shield Wires		NA
N	(+) Analog Input 0-5V or 4-20mA (Use jumper wires U & V to select input type)	503048	Red	Analog
P	(-) Analog Input 0-5V or 4-20mA (Use jumper wires U & V to select input type)		Black	Input
R	(+) Magnetic Pickup (MPU)	503048	Red	MPU
S	(-) Magnetic Pickup (MPU)		Black	
W	Shared Ground Terminal for MPU & RS485	2 - Shield Wires		NA
T	(+) RS485		Red	
Y	(-) RS485	503194	Black	RS485
X	Ground		Green	
Remove	White is not required and can be removed		White	
U	Jumper Wire (U & V are open for 0-5V or shorted for 4-20mA)		Black	
V	Jumper Wire (U & V are open for 0-5V or shorted for 4-20mA)		White	
F	Discrete Input #1		Yellow	
B	Discrete Input #2	503448	Red	Discrete
A	Discrete Input #3		Brown	Inputs
L	Discrete Input #4		Blue	
E	Discrete Input #5		Orange	
K	Discrete Output Low Side Switch		Green	

GROUP #	L1"	L2"
72	72	120
180	180	228
600	600	648

DISCRETE INPUTS

RS485

CAN

4-20 OUTPUT

ANALOG INPUT

MPU

NOTE: NOT ALL WIRES ARE SHOWN IN IT.8.

NOTE: CUT WHITE WIRE IN IT.7 FLUSH WITH JACKET.

NOTE: PLACE TUBING (IT.9) OVER SHIELD WIRES BEFORE SOLDERING TO CONNECTOR (IT.2)

NOTE: TRIM ALL CABLES AND WIRES AS SHOWN

MARK SHRINK TUBING AS SHOWN   TYP 6

STAMP WIRE +24V

STAMP WIRE -24V

ALTRONIC PART NO.

HARNESS CONNECTOR PIN ARRANGEMENT

altronic

MIL-DTL-5015 Connector Specifications

Both ITT Cannon and Amphenol offer MIL-DTL-5015 Connectors and both brands are compatible with the ActuCOM R8

FEATURES

SEALED RECEPTACLES

All CT solder receptacles have inserts and contacts bonded in place in accordance to the MIL-DTL-5015 specifications. These receptacles are sealed and their air leakage rate is not greater than one atmospheric cubic inch per hour (4.55 x 10·3 cubic centimeters per second) through the interface. Gaskets and seal screws are used to seal the panel and protect from leaks around the connectors.

HIGH PERFORMANCE, LOW COST

Originally designed to the first military specification—Tri-Service connector for the Army, Air Force and Navy—these connectors are now widely used in industrial applications. These threaded connectors are easy to specify, purchase and assemble, providing long service life for applications needing minimum maintenance. PEI-Genesis assembles these in days to reduce the user's total cost of ownership.

AGENCY APPROVALS
• MIL-DTL-5015

TECH SPECS

MATERIALS & FINISHES	
Shell	Aluminum alloy (shells can be grounded)
Shell Plating	Olive drab chromate coating over cadmium plating, black zinc cobalt, electroless nickel
Contacts	Copper alloy
Contact Platings	Hard silver plating or gold plating
Insulator*	Resilient polychloroprene (Neoprene)
Seals	Silicone or Neoprene

' Optional zero halogen and high-temperature insulators are available.

ELECTRICAL DATA

Operating Voltage/Test Voltage According to MIL-DTL-5015

SERVICE RATING	OPERATING VOLTAGE		TEST VOLTAGE AC VRMS	AIR SPACING NOM. (INCHES)	CREEPAGE DISTANCE NOM. (INCHES)
	DC V	AC VRMS			
I	250	200	1,000	–	1/16
A	700	500	2,000	1/16	1/8
D	1,250	900	2,800	1/8	3/16
E	1,750	1,250	3,500	3/16	1/4
B	2,450	1,750	4,500	1/4	5/16

The indicated values for the Operating Voltage are limits concerning the electrical function. In any case when the working voltage exceeds 50V, safety precautions must be in accordance with the following standards: VDE 0100, IEC 309-1 or applicable national standards.

NOTE: High Voltage Cartridge Contacts are available. These cartridges are used in either size 8 or 4 contact cavities using 20 AWG contact rated 7.5 amps max and working voltages up to 5000 Vdc - 3500 Vac.

CONTACT SIZE	(C1) TEST CURRENT (AMPS)	CONTACT RESISTANCE MILLIOHM MAX .	POTENTIAL DROP (MILLIVOLTS)
16/16S	13	16	49
12	23	3	42
8	46	1	26
4	80	0.5	23
0	150	0.2	21

" Maximum total current to be carried per connector in wire bundles as specified in MIL-W-5088. Contact resistance, when tested to MIL-C-39029, will not exceed voltage drops listed in above table.

NOTE: CB & CT current rating are tested differently.

Wire Range Sizes 26 AWG to O AWG

Insulation Resistance CT/CNMS: >5000 megaohms at 77°F (25°C) per MIL-DTL-5015, 3.18

MIL-DTL-5015 Connector Specifications

Both ITT Cannon and Amphenol offer MIL-DTL-5015 Connectors and both brands are compatible with the ActuCOM R8

MECHANICAL

Operating Temperature	-55° to + 125°C (-67° to +257°F) Neoprene
Sealing	48 hours in 6 feet of water per MIL-DTL-5015, 4.6.19. Meets 20-day extreme humidity testing per
Wire Sealing Range	The connector is designed for individual wire sealing. Sealing of an outer cable jacket on multiconductor cables must be accomplished with an appropriate endbell. Sealing is only guaranteed if wires comply to MIL-W-5086 or within the listed ranges are used.

CONTACT SIZE	WIRE SIZE (MIL-W-5086)	INSULATION O.D. LIMIT			
		MIN. (INCHES)	MIN.(MM)	MAX. (INCHES)	MAX.(MM)
16	16	.064	1.63	.130	3.30
12	12	.114	2.90	.170	4.32
8	8	.164	4.17	.255	6.48
4	4	.275	6.98	.370	9.40
0	0	.415	10.54	.550	13.97

Mating Life	100 cycles minimum. To MIL-DTL-5015, 3.16
Salt Spray	CAD OD: MIL-STD-1344 Method 1001 Condition B. minimum.A206 : 48 hours
Heat	+ 125°C (+257°F) for 60 hours, +85°C (+ 185°F) for 1000 hours per MIL-DTL-5015, 4.6.14, minimum.
Chemical Resistance	20-hour full immersion unmated in hydraulic fluid and lubricating oil per MIL-DTL-5015 minimum.
Vibration	10 to 2,000Hz (15g's) 10 microseconds maximum discontinuity. To MIL-STD-1344 Method 2005 per MIL-DTL-5015.
Shock	50g 11ms duration, three major axes. 10 microseconds maximum discontinuity. To MIL-DTL-5015, 3.13.
Contact Type	Solder, crimp, PC or thermocouple. Hard silver or gold plating.
Number of Circuits	1 to 55
Contact Insertion	Solder contacts are bonded into insulator
Contact Retention	Pin and socket contacts are designed to resist severe vibration and repeated connection and disconnection.

CONTACT SIZE	RETENTION FORCE NEWTONS (LBS.)		SEPARATION FORCE MIN. NEWTONS (LBS.)		GAUGE	AXIAL LOAD NEWTONS (LBS.)		SEPARATION FORCE MIN. NEWTONS (LBS.)	
16	35	(7.9)	1	(.22)	G 1.56	44	(10)	1	(0.29)
12	55	(12.4)	1.5	(.34)	G 2.36	67	(15)	2	(0.5)
8	80	(18.0)	3	(.67)	G 3.58	89	(20)	3	(0.75)
4	90	(20.2)	4	(.90)	G 5.69	89	(20)	4	(1)
0	95	(21.4)	8.5	(1.9)	G 9.04	111	(25)	9	(2)

NOTE: CT/CNMS receptacle contacts are bonded into the insulator.
Polarization Key and keyway with optional rotational polarization
Approvals/Specifications MIL-DTL-5015