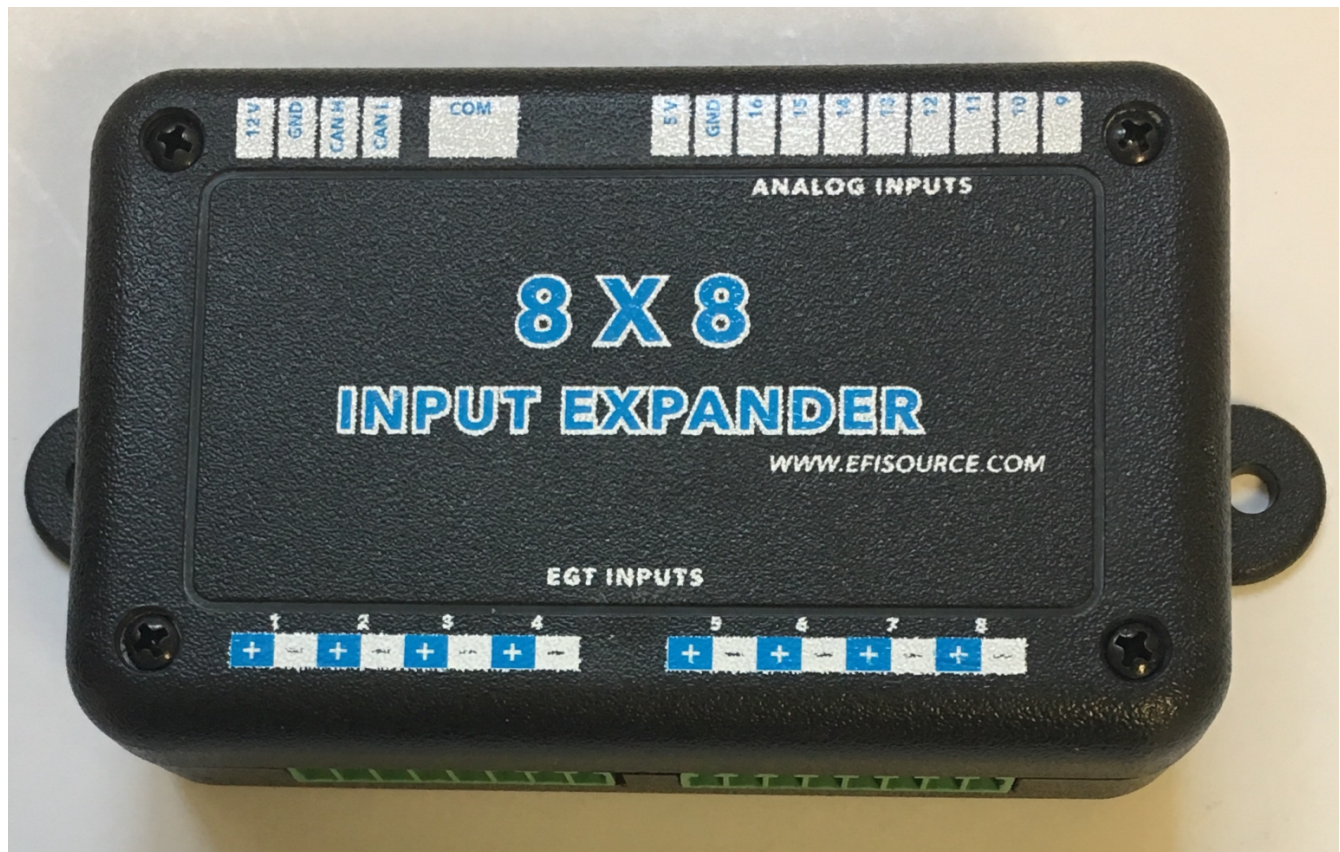


1. Introduction

The 8X8 Input Expander is a flexible data acquisition device that can collect data from up to 8 exhaust gas temperature (EGT) sensors and up to 8 generic sensors (analog inputs) such as wideband O2 sensors (with external controllers), temperature sensors, pressure sensors, etc.

The data collected from those sensors can be sent to an ECU or some display devices using its CAN bus connection. The data can also be read from a PC using the USB port.

The unit can be configured through the CAN bus or the serial port using the Megasquirt protocols and the tuning software TunerStudio.



2. Connections

2.1 Power

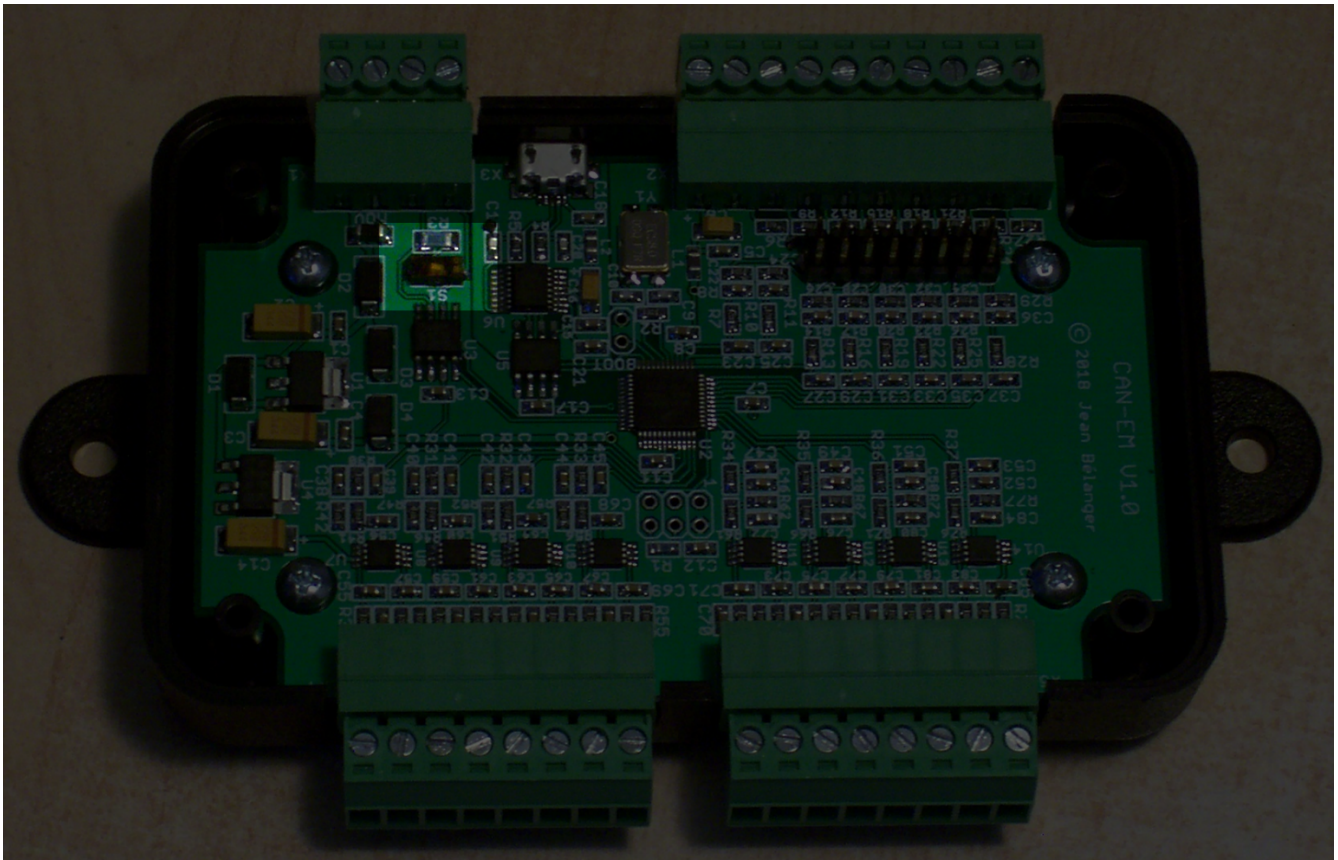
The 8x8 Input Expander requires a 12V and a ground connection to power the unit. These should be a switched power feed and should be shared with the ECU for both wires.



2.2 CAN bus & serial port

The unit is connected to the CAN bus by connecting CANH and CANL to the bus. If there is no existing bus, connect CANH from the unit to CANH on the ECU and CANL on the unit to CANH on the ECU.

The CAN bus requires one terminating resistor on each end of the bus. If connecting to an existing bus will require disabling the unit terminating resistor as the existing bus already has both needed resistors. This is done by switching off the small switch shown below.



If the installation creates a new bus, leave the switch in its default ON position.

The serial port uses a USB port with a micro B connector. The PC should automatically detect the unit when connected but if you need to install the drivers, you will find them here: <https://www.ftdichip.com/FTDrivers.htm>

2.3 EGT inputs

The EGT inputs are designed to be used with type K thermocouple and will read temperatures from 32°F (0°C) up to 2282°F (1250°C). The inputs can be used to measure the exhaust gas temperature but can also be used for reading the head temperature on air cooled engine as long as type K thermocouples are used.

The thermocouples need to be connected the correct way so make sure to respect the polarity of the probes you use with respect to the polarity indicated on the case. Under the ANSI standard where there is a yellow wire and a red wire, the yellow wire is positive ('+') and the red wire is negative ('-'). With the IEC standard where there is a green and a white wire, the green wire is positive ('+') and the white wire is negative ('-').

The sensors are numbered inside the data stream the same way as shown on the case.



2.4 WBO2

Up to 8 wideband O₂ sensors can be connected to the 8x8 Input Expander. The sensors cannot be directly connected to the unit but need a controller to generate the needed analog signal such as the Zeitronix controllers available from EFISource.

The signal wire coming from the controller is connected to one of the 8 available positions. It is preferable to fill the positions sequentially from the first position (analog input 9).

If the controller being used has a digital ground, it will need to be connected to the ground position. If the controller only has one ground output, do not connect it to the unit as this is a heater ground and will generate a lot of noise and current which could lead to a failure.

If there are many ground wires that need to be connected, it may not be possible to fit them all in the connector. In that case you will need to splice them all in a remote location and run a single wire to the unit. Make sure to isolate this remote location from external grounds to prevent noise and keep the best accuracy.

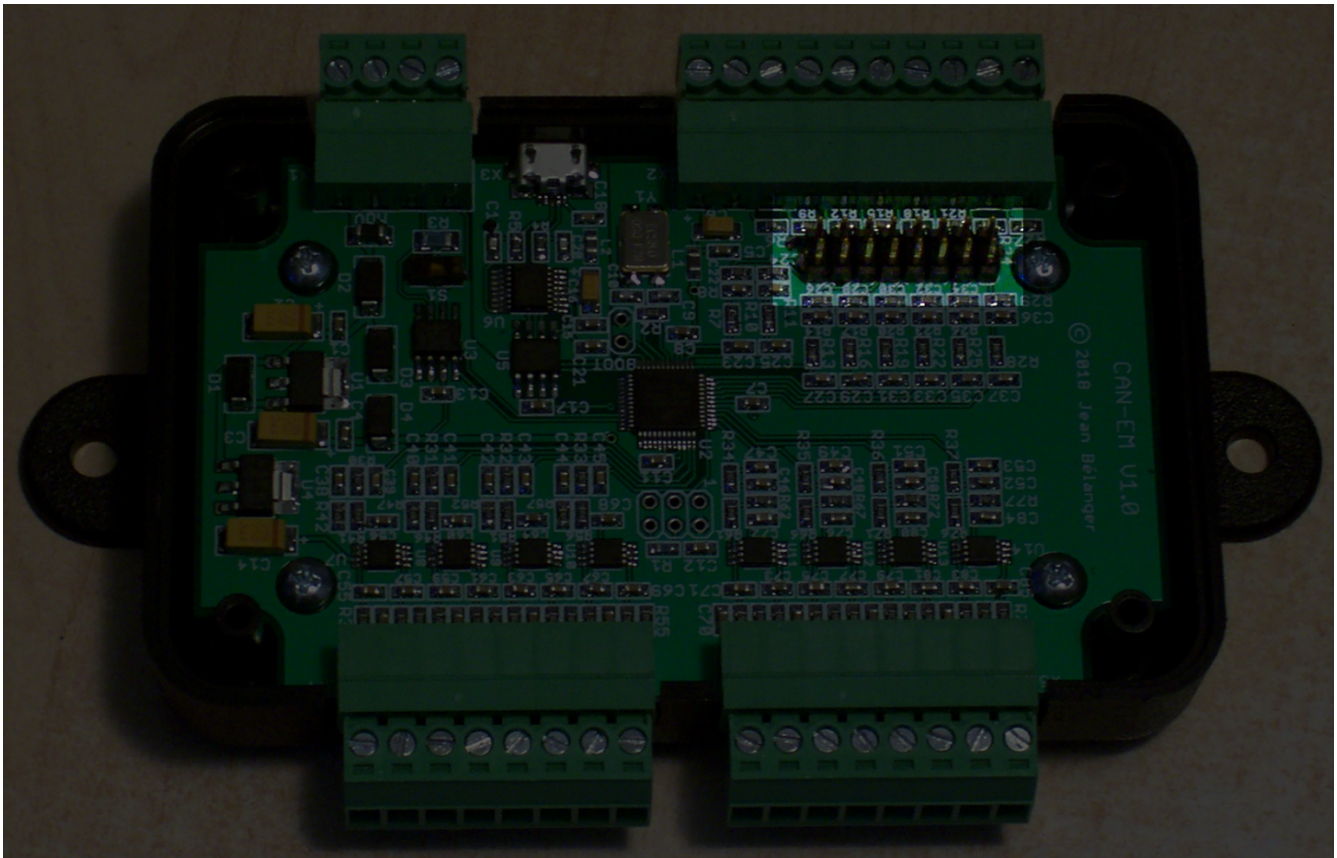


2.5 Analog inputs

Any analog input that is not used by a WBO2 controller can be used by another type of analog sensor. The three major types are: thermistors (temperature sensors), pressure sensors, and potentiometers (TPS, suspension movement sensors,...).

Thermistors

Thermistors have 2 wires: a signal wire and a ground. The signal wire goes to the analog input connector and the ground goes to the ground position on the same connector. In addition to the wiring, there is a need to set bias resistor jumper inside the unit. The picture below shows the header which has 8 pairs of pins corresponding to each of the 8 analog inputs. On each input used for a thermistor needs to have a jumper set such that both pins are connected together.



Single wire temperature sensors are not designed to be used with an ECU or any electronic data logging device. The ground is provided by the body of the sensor which can lead to noise and inaccuracies. Moreover, they generally do not have a resistance range that works well with the analog input circuit leading to poor resolution.

Pressure sensors

Pressure sensors have 3 wires: a signal wire, a 5V (supply) wire and a ground wire. The signal wire goes to the analog input connector and the 5V and ground wires go to the 5V and ground positions on the same connector.

Only sensors that generate a voltage signal and operate between 0 and 5V can be used.

Potentiometers

Potentiometers have 3 wires: a signal wire, a 5V (supply) wire and a ground wire. The signal wire goes to the analog input connector and the 5V and ground wires go to the 5V and ground positions on the same connector.

Only potentiometers of 1000 Ohms (1k Ohms) or more should be used to limit the current drain.

5V and ground connections

If there are many 5V and/or ground wires that need to be connected to the analog inputs connector, it may not be possible to fit them all in the connector. In that case you will need to

splice them all in a remote location and run a single wire to the unit; this will be needed for 5V and for ground with one wire each going to the unit. Make sure to isolate these remote locations from external grounds and other any 12V source to prevent shorts, noise and keep the best accuracy. Shorts between 5V and 12V can lead to failures.

3. MS3 Configuration

At the moment of writing this manual, the MS3 release version is 1.5.1. The latest beta version is pre-1.5.2 beta 6. Both versions are presented here with the latter having a simpler set of configuration settings.

3.1 EGT

MS3 1.5.1 release

With this MS3 release version, there is a need to use the CAN receiving feature (under the CAN-bus/Testmodes menu). The picture below shows the settings needed when using 8 EGT and 8 analog inputs on the 8x8 Input Expander. The EGT inputs are the first eight in the table. If some inputs are not used, simply omit them.

There are 2 CAN messages sent (default are 1680 and 1681 and they are standard (11-bit) CAN messages) and each one contains 4 EGT values at offset 0, 2, 4, and 6. This is what is described below. Use the size, Multiply, Divide and Add shown below.

The local variables used are CAN ADC01 to CAN ADC08.

Local variable / channel	Std/Ext	Identifier (dec.)	Offset	Size	Multiply	Divide	Add
CAN ADC01	Std	1680	0	B2U	1	1	0
CAN ADC02	Std	1680	2	B2U	1	1	0
CAN ADC03	Std	1680	4	B2U	1	1	0
CAN ADC04	Std	1680	6	B2U	1	1	0
CAN ADC05	Std	1681	0	B2U	1	1	0
CAN ADC06	Std	1681	2	B2U	1	1	0
CAN ADC07	Std	1681	4	B2U	1	1	0
CAN ADC08	Std	1681	6	B2U	1	1	0
CAN ADC09	Std	1682	0	B2U	1	1	0
CAN ADC10	Std	1682	2	B2U	1	1	0
CAN ADC11	Std	1682	4	B2U	1	1	0
CAN ADC12	Std	1682	6	B2U	1	1	0
CAN ADC13	Std	1683	0	B2U	1	1	0
CAN ADC14	Std	1683	2	B2U	1	1	0
CAN ADC15	Std	1683	4	B2U	1	1	0
CAN ADC16	Std	1683	6	B2U	1	1	0

Master enable for CAN receiving.

Buttons: Back, Forward, Burn, Close

The picture below shows how to use the CAN ADC variables defined above for the EGT inputs to the MS3 (under the Advanced Engine menu). Set the number of EGT inputs according to the actual number used. Set the calibration values shown below and assign each

EGT channel to the corresponding CAN ADC.

EGT / Thermocouple Inputs

File View Help

EGT / Thermocouple Inputs

Configuration

No. EGT inputs 8

Calibration - see documentation

Temp At 0V(°F) 32

Temp At 5V(°F) 2282

Actions

EGT Actions Off

Warning LED same as AFR safety

Warn Temperature(°F) 1620

Added Fuel(ms) 0.00

Add To Both

Per cylinder Off

Shutdown Engine Off

Time > Warn Temp(s) 0.02

Max Temperature(°F) 1710

See AFR safety for shutdown options

Data capture

EGT 1 Channel CAN ADC01

EGT 2 Channel CAN ADC02

EGT 3 Channel CAN ADC03

EGT 4 Channel CAN ADC04

EGT 5 Channel CAN ADC05

EGT 6 Channel CAN ADC06

EGT 7 Channel CAN ADC07

EGT 8 Channel CAN ADC08

EGT 9 Channel CAN ADC17

EGT 10 Channel CAN ADC18

EGT 11 Channel CAN ADC19

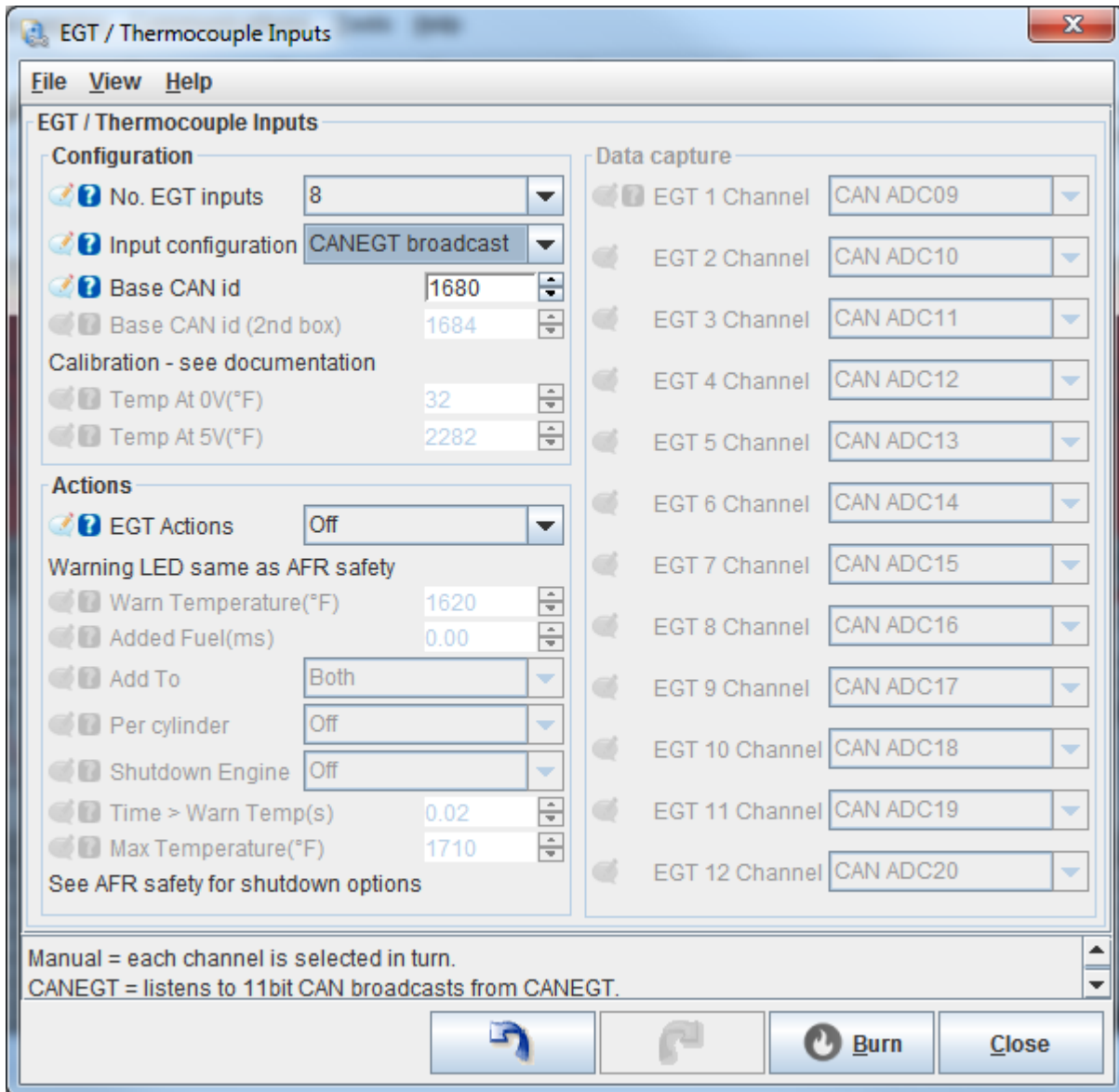
EGT 12 Channel CAN ADC20

Number of EGT channels to enable.

Back Forward Burn Close

MS3 pre-1.5.2 beta 6

With the MS3 version pre-1.5.2 beta 6 and later, the EGT settings are simpler as shown below (under the Advanced Engine menu). Simply set the number of EGT inputs used on the 8x8 Input Expander, set the input configuration to CANEGT broadcast and set the base CAN id to 1680 (unless this has explicitly been changed from its default).



3.2 WBO2

MS3 1.5.1 release

With this MS3 release version, there is a need to use the CAN receiving feature (under the CAN-bus/Testmodes menu). The picture below shows the settings needed when using 8 EGT and 8 analog inputs on the 8x8 Input Expander. The WBO2 inputs are the last eight in the table. If some inputs are not used, simply omit them.

There are 2 CAN messages sent (default are 1682 and 1683 and they are standard (11-bit) CAN messages) and each one contains 4 AFR values at offset 0, 2, 4, and 6. This is what is described below. Use the size, Multiply, Divide and Add shown below.

The local variables used are CAN ADC09 to CAN ADC16.

CAN receiving

File View Help

☒ Enable receiving CAN data On

Local variable / channel	Std/Ext	Identifier (dec.)	Offset	Size	Multiply	Divide	Add
CAN ADC01	Std	1680	0	B2U	1	1	0
CAN ADC02	Std	1680	2	B2U	1	1	0
CAN ADC03	Std	1680	4	B2U	1	1	0
CAN ADC04	Std	1680	6	B2U	1	1	0
CAN ADC05	Std	1681	0	B2U	1	1	0
CAN ADC06	Std	1681	2	B2U	1	1	0
CAN ADC07	Std	1681	4	B2U	1	1	0
CAN ADC08	Std	1681	6	B2U	1	1	0
CAN ADC09	Std	1682	0	B2U	1	1	0
CAN ADC10	Std	1682	2	B2U	1	1	0
CAN ADC11	Std	1682	4	B2U	1	1	0
CAN ADC12	Std	1682	6	B2U	1	1	0
CAN ADC13	Std	1683	0	B2U	1	1	0
CAN ADC14	Std	1683	2	B2U	1	1	0
CAN ADC15	Std	1683	4	B2U	1	1	0
CAN ADC16	Std	1683	6	B2U	1	1	0

Master enable for CAN receiving.

Buttons: [Undo] [Redo] [Burn] [Close]

The picture below shows how to use the CAN ADC variables defined above for the EGO inputs to the MS3 (under the Fuel Settings menu). Set the EGO Sensor Type to Wide Band and set the number of sensors according to the actual number used. Assign each EGO port to the corresponding CAN ADC and set the AFR/EGO Sensor Mapping according to your actual setup. For more information on the settings, refer to the manual.

AFR / EGO Control

FileViewHelp

AFR / EGO Control

AlgorithmSimple

Use EGO Delay TableUse IGN events

Ignition Events Per Step16

EGO Sensor Response Time(ms)50

Controller Step Size(%)1

Use Authority TableOff

Controller Auth +/- (%)15

Only Correct Above:(AFR)9.0

And Correct Below:(AFR)20.0

Active Above Coolant(°F)160.0

Active Above RPM1300

Active Below TPS(%)70.0

Active Below Load(%)90.00

Active Above Load(%)20.00

EGO Delay After Start(s)30

PID Proportional Gain(%)100

PID Integral(%)20

PID Derivative(%)0

EGO Sensor TypeWide Band

Number Of Sensors8

Remember to Calibrate and set Project Properties

EGO ports

EGO 1 PortCAN ADC09

EGO 2 PortCAN ADC10

EGO 3 PortCAN ADC11

EGO 4 PortCAN ADC12

EGO 5 PortCAN ADC13

EGO 6 PortCAN ADC14

EGO 7 PortCAN ADC15

EGO 8 PortCAN ADC16

AFR / EGO Sensor Mapping

Injector- Uses Sensor

MS3X Inj AEGO1

MS3X Inj BEGO2

MS3X Inj CEGO3

MS3X Inj DEGO4

MS3X Inj EEGO5

MS3X Inj FEGO6

MS3X Inj GEGO7

MS3X Inj HEGO8

V3 Inj 1EGO1

V3 Inj 2EGO1

None - no fuel changes are made in response to oxygen sensor readings.

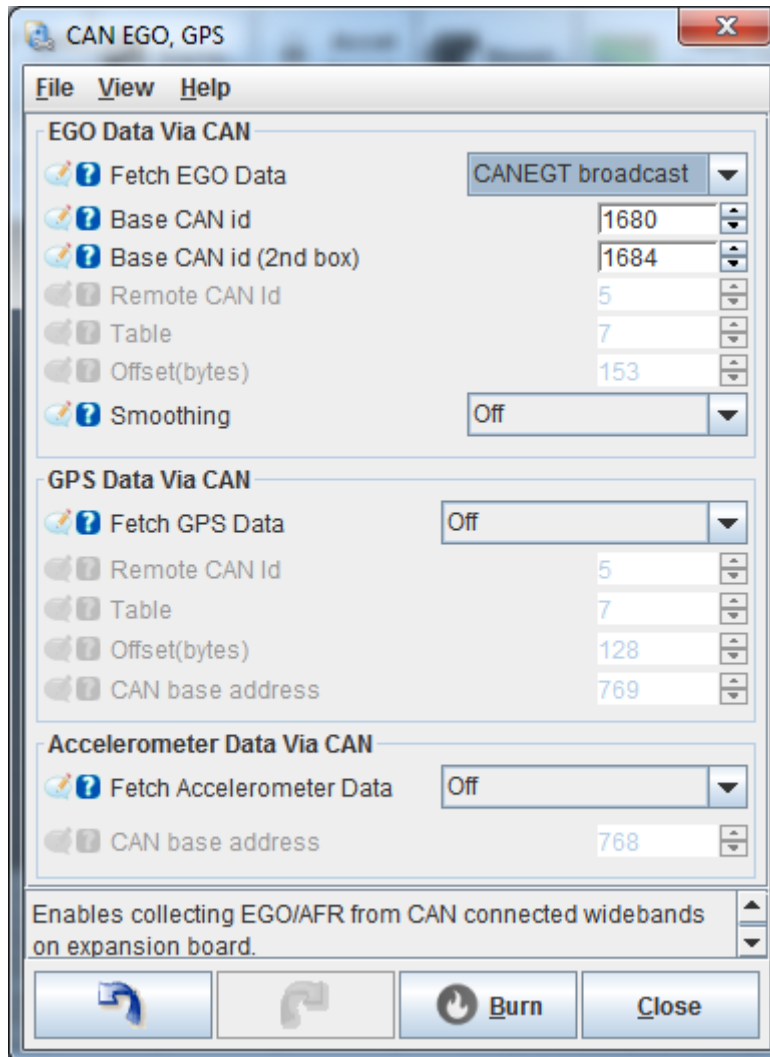
Simple - This method of closed-loop EGO control is well-suited to use with a narrowband O2 sensor.

Burn

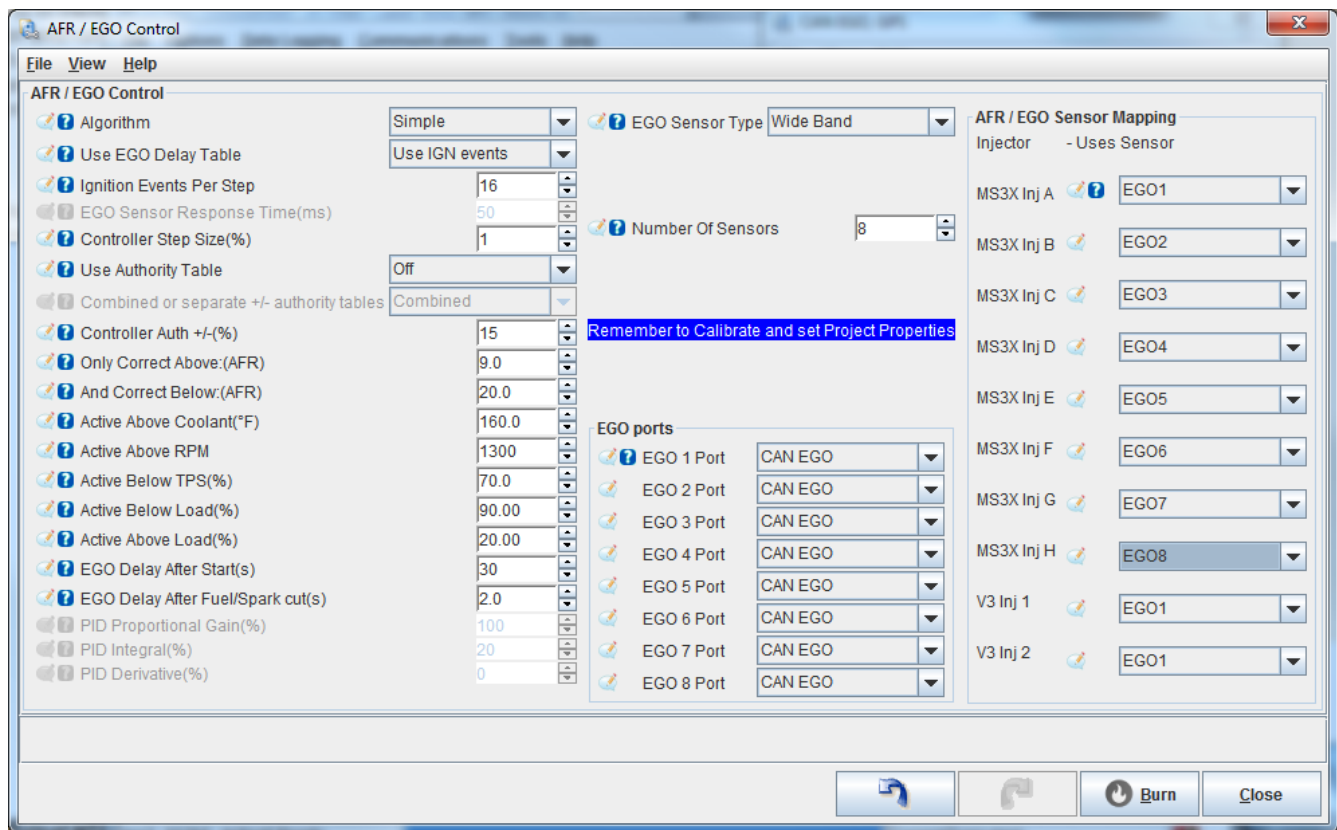
Close

MS3 pre-1.5.2 beta 6

With the MS3 version pre-1.5.2 beta 6 and later, the EGO settings for getting the data over the CAN bus are simpler as shown below (under the CAN-bus/Testmodes menu). Simply set the Fetch EGO Data configuration to CANEGT broadcast and set the base CAN id to 1680 (unless this has explicitly been changed from its default).



The picture below shows how to use the CAN data defined above for the EGO inputs to the MS3 (under the Fuel Settings menu). Set the EGO Sensor Type to Wide Band and set the number of sensors according to the actual number used. Assign each EGO port to CAN EGO and set the AFR/EGO Sensor Mapping according to your actual setup. There is no numbering needed when using CAN EGO as it is done automatically. For more information on the settings, refer to the manual.



3.3 Analog inputs

MS3 1.5.1 release

With this MS3 release version, there is a need to use the CAN receiving feature (under the CAN-bus/Testmodes menu). The picture below shows the settings needed when using 8 EGT and 8 analog inputs on the 8x8 Input Expander. The analog inputs are the last eight in the table. If some inputs are not used, simply omit them.

There are 2 CAN messages sent (default are 1682 and 1683 and they are standard (11-bit) CAN messages) and each one contains 4 analog values at offset 0, 2, 4, and 6. This is what is described below. Use the size, Multiply, Divide and Add shown below.

The local variables used are CAN ADC09 to CAN ADC16.

CAN receiving

File View Help

CAN receiving

Enable receiving CAN data On

Local variable / channel	Std/Ext	Identifier (dec.)	Offset	Size	Multiply	Divide	Add
CAN ADC01	Std	1680	0	B2U	1	1	0
CAN ADC02	Std	1680	2	B2U	1	1	0
CAN ADC03	Std	1680	4	B2U	1	1	0
CAN ADC04	Std	1680	6	B2U	1	1	0
CAN ADC05	Std	1681	0	B2U	1	1	0
CAN ADC06	Std	1681	2	B2U	1	1	0
CAN ADC07	Std	1681	4	B2U	1	1	0
CAN ADC08	Std	1681	6	B2U	1	1	0
CAN ADC09	Std	1682	0	B2U	1	1	0
CAN ADC10	Std	1682	2	B2U	1	1	0
CAN ADC11	Std	1682	4	B2U	1	1	0
CAN ADC12	Std	1682	6	B2U	1	1	0
CAN ADC13	Std	1683	0	B2U	1	1	0
CAN ADC14	Std	1683	2	B2U	1	1	0
CAN ADC15	Std	1683	4	B2U	1	1	0
CAN ADC16	Std	1683	6	B2U	1	1	0

Master enable for CAN receiving.

Back Forward Burn Close

To use the analog inputs for data other than AFR values from WBO2 sensors, the Generic Sensor Inputs feature needs to be used (under Advanced Engine menu). Each sensor is associated with a CAN ADC defined above and a name can be assigned. For calibration of the sensor using the remaining fields in the table below, refer to the manual.

Generic Sensor Inputs

File View Help

Generic Sensor Inputs

Sensors 1-8

Sensor - Source	Field Name	Transformation	0V value	5V value	Lag Factor
01 CAN ADC09	Sensor 01	Linear	0.0	102.3	100
02 Off	Sensor 02	Raw	0.0	102.3	100
03 Off	Sensor 03	Raw	0.0	102.3	100
04 Off	Sensor 04	Raw	0.0	102.3	100
05 Off	Sensor 05	Raw	0.0	102.3	100
06 Off	Sensor 06	Raw	0.0	102.3	100
07 Off	Sensor 07	Raw	0.0	102.3	100
08 Off	Sensor 08	Raw	0.0	102.3	100

Sensors 9-16

Sensor - Source	Field Name	Transformation	0V value	5V value	Lag Factor
09 Off	Sensor 09	Raw	0.0	102.3	100
10 Off	Sensor 10	Raw	0.0	102.3	100
11 Off	Sensor 11	Raw	0.0	102.3	100
12 Off	Sensor 12	Raw	0.0	102.3	100
13 Off	Sensor 13	Raw	0.0	102.3	100
14 Off	Sensor 14	Raw	0.0	102.3	100
15 Off	Sensor 15	Raw	0.0	102.3	100
16 Off	Sensor 16	Raw	0.0	102.3	100

Allow Input Sharing
Off
CLT/MAT Units
degF

Type of transformation from raw input to useful numbers.
Raw = raw 0-1023 ADC count

Burn Close

MS3 pre-1.5.2 beta 6

With the MS3 version pre-1.5.2 beta 6 and later, the CAN receiving feature can be used for all the analog inputs that are not used for CAN EGO (under the CAN-bus/Testmodes menu).

There are 2 CAN messages sent (default are 1682 and 1683 and they are standard (11-bit) CAN messages) and each one contains 4 analog values at offset 0, 2, 4, and 6. This is what is described below. Use the size, Multiply, Divide and Add shown below.

If used, it is recommended to use the lower numbered analog inputs for WBO2 sensors. The other sensors are then used with the remaining inputs. Analog inputs 1-4 correspond to offset 0,2,4,6 of identifier 1682 and analog inputs 5-8 correspond to offset 0,2,4,6 of identifier 1683.

The example below shows a single analog input on input 1 that is assigned to e CAN ADC09. All the CAN ADC variables are available for this purpose.

Make sure to only define entries for analog sensors actually connected to the 8x8 Input expander. And if CAN EGO is used, make sure to enable the sharing of CAN data (top right of the window).

CAN receiving

File View Help

CAN receiving

Enable receiving CAN data On Enable sharing CAN data On

Local variable / channel	Std/Ext	Identifier (dec.)	Offset	Size	Multiply	Divide	Add
CAN ADC09	Std	1682	0	B2U	1	1	0
Off	Std	0	0	1U	1	1	0
Off	Std	0	0	1U	1	1	0
Off	Std	0	0	1U	1	1	0
Off	Std	0	0	1U	1	1	0
Off	Std	0	0	1U	1	1	0
Off	Std	0	0	1U	1	1	0
Off	Std	0	0	1U	1	1	0

Local variable / channel	Std/Ext	Identifier (dec.)	Offset	Size	Multiply	Divide	Add
Off	Std	0	0	1U	1	1	0
Off	Std	0	0	1U	1	1	0
Off	Std	0	0	1U	1	1	0
Off	Std	0	0	1U	1	1	0
Off	Std	0	0	1U	1	1	0
Off	Std	0	0	1U	1	1	0
Off	Std	0	0	1U	1	1	0
Off	Std	0	0	1U	1	1	0

Master enable for CAN receiving.

Burn Close

To use the analog inputs for data other than AFR values from WBO2 sensors, the Generic Sensor Inputs feature needs to be used (under Advanced Engine menu). Each sensor is associated with a CAN ADC defined above and a name can be assigned. For calibration of the sensor using the remaining fields in the table below, refer to the manual.

Generic Sensor Inputs

File View Help

Generic Sensor Inputs

Sensors 1-8

Sensor - Source	Field Name	Transformation	0V value	5V value	Lag Factor
01 CAN ADC09	Sensor 01	Linear	0.0	102.3	100
02 Off	Sensor 02	Raw	0.0	102.3	100
03 Off	Sensor 03	Raw	0.0	102.3	100
04 Off	Sensor 04	Raw	0.0	102.3	100
05 Off	Sensor 05	Raw	0.0	102.3	100
06 Off	Sensor 06	Raw	0.0	102.3	100
07 Off	Sensor 07	Raw	0.0	102.3	100
08 Off	Sensor 08	Raw	0.0	102.3	100

Sensors 9-16

Sensor - Source	Field Name	Transformation	0V value	5V value	Lag Factor
09 Off	Sensor 09	Raw	0.0	102.3	100
10 Off	Sensor 10	Raw	0.0	102.3	100
11 Off	Sensor 11	Raw	0.0	102.3	100
12 Off	Sensor 12	Raw	0.0	102.3	100
13 Off	Sensor 13	Raw	0.0	102.3	100
14 Off	Sensor 14	Raw	0.0	102.3	100
15 Off	Sensor 15	Raw	0.0	102.3	100
16 Off	Sensor 16	Raw	0.0	102.3	100

Allow Input Sharing Off CLT/MAT Units degF

Type of transformation from raw input to useful numbers.
Raw = raw 0-1023 ADC count

Buttons: [Undo] [Redo] [Burn] [Close]

4. Input Expander Configuration

If only the EGT inputs are used (with EGT and/or CHT probes) and the analog inputs only have Zeitronix WBO2 controllers connected to them (or no analog input) then there is no need to change anything on the default configuration on the 8x8 Input Expander.

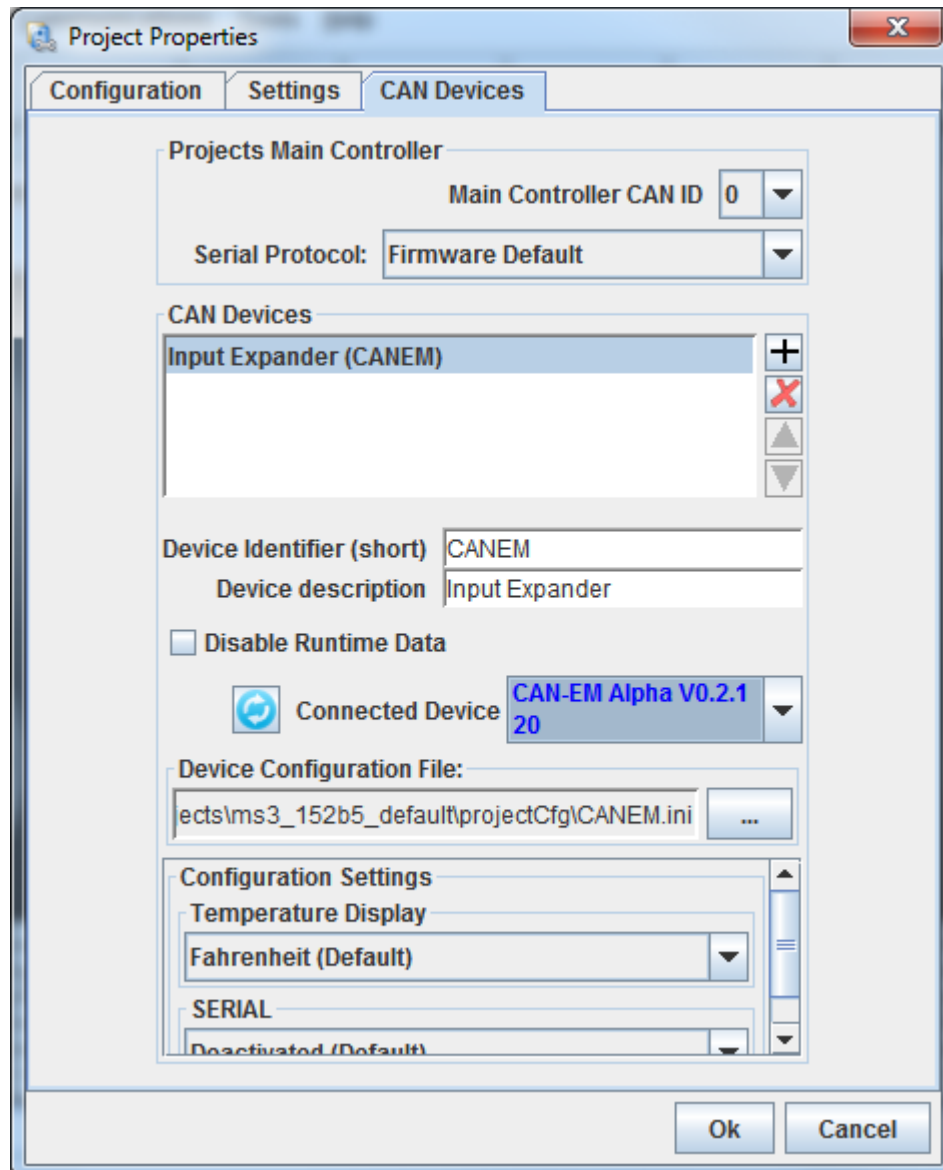
If there is a need to change the default configuration, the following sections give the needed information on how to proceed.

4.1 Creating project

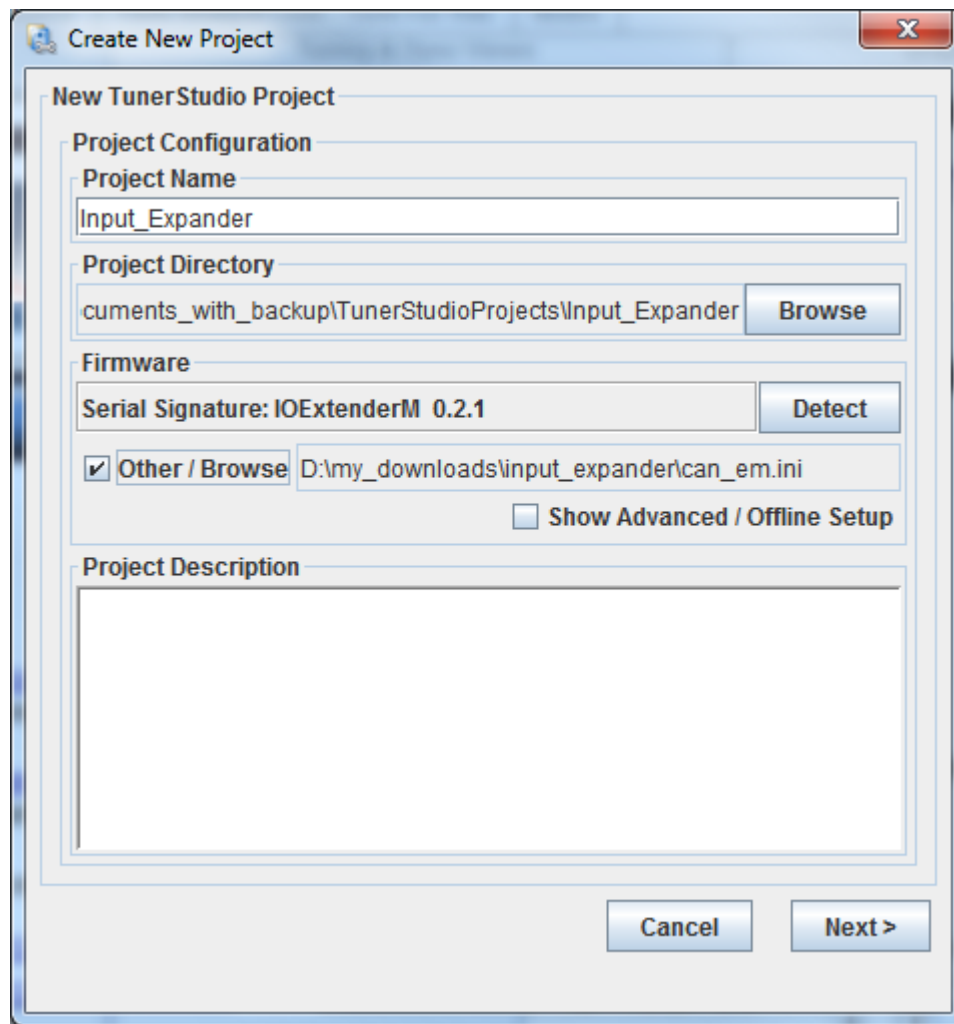
To change the settings on the 8x8 Input Expander, a project needs to be created for it in TunerStudio. There are 2 ways to do so. The first one is to add a CAN device to an existing MS3 project. This is done in the Project Properties using the CAN Devices tab (under the File/Vehicle Projects menu).

As shown below, the '+' button needs to be pressed, a device identifier and a device description are entered. The Connected Device is selected from the pull-down menu if the unit is actually connected to the MS3 CAN bus and the MS3 is powered up. Otherwise select CAN ID: 8. Press on the '...' button and navigate to the location where the CANEM.ini file has been saved on your computer.

Then press Ok.

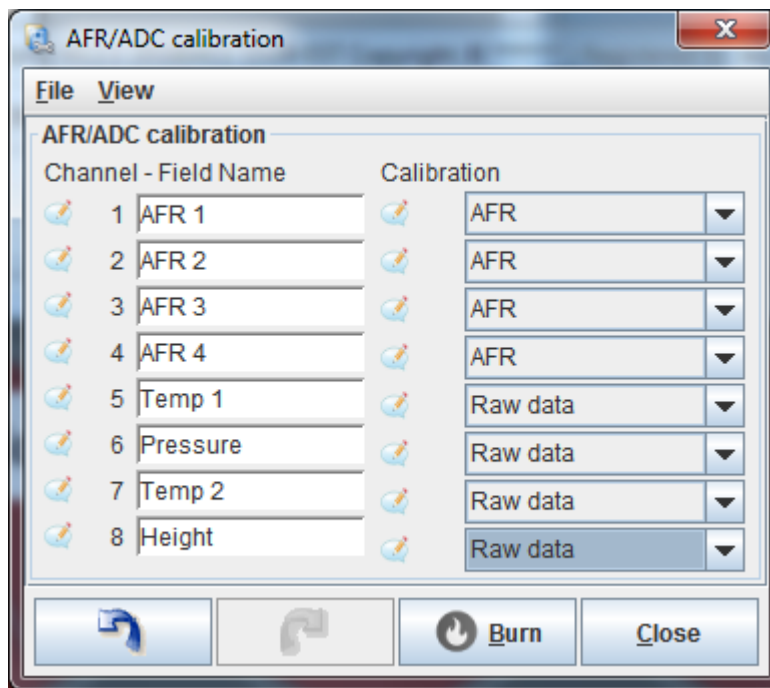


The second method consist of creating a TunerStudio project uniquely for the 8x8 Input Expander. This can be done by connecting the unit to the PC using the USB port. The project is created like any other TunerStudio project except that TunerStudio cannot detect the unit automaitcally. So instead of using the 'Detect' button use the 'Other/Browse' box and navigate to the location where the CANEM.ini file has be saved on your computer. Then proceed as for any other project creation.



4.2 Analog inputs

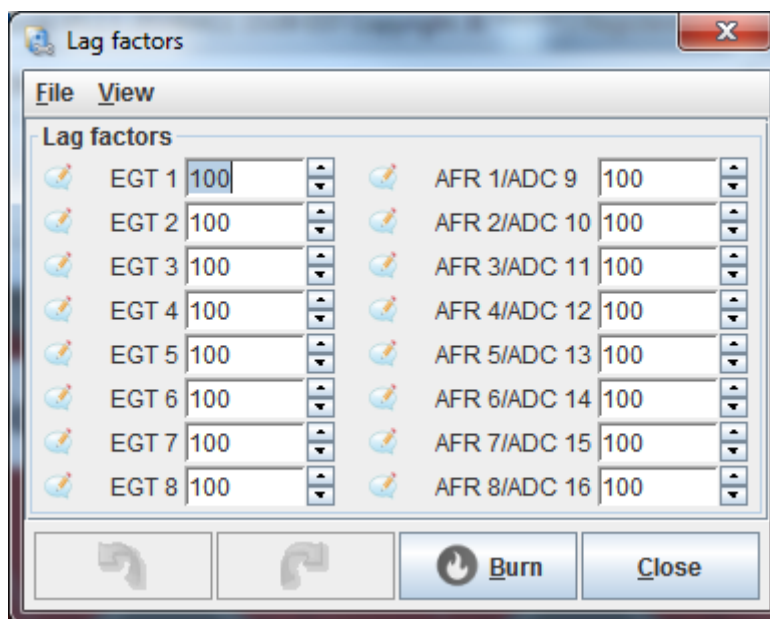
When using analog sensors other than Zeitronix WBO2 controllers, you will need to set the calibration to 'Raw data'. The other calibration options are out of scope for the present document.



5. Advanced Settings

Some advanced settings can be changed under certain circumstances. It is not recommended to change these unless you have a good reason to do so and understand why these changes are made and what consequences these will have

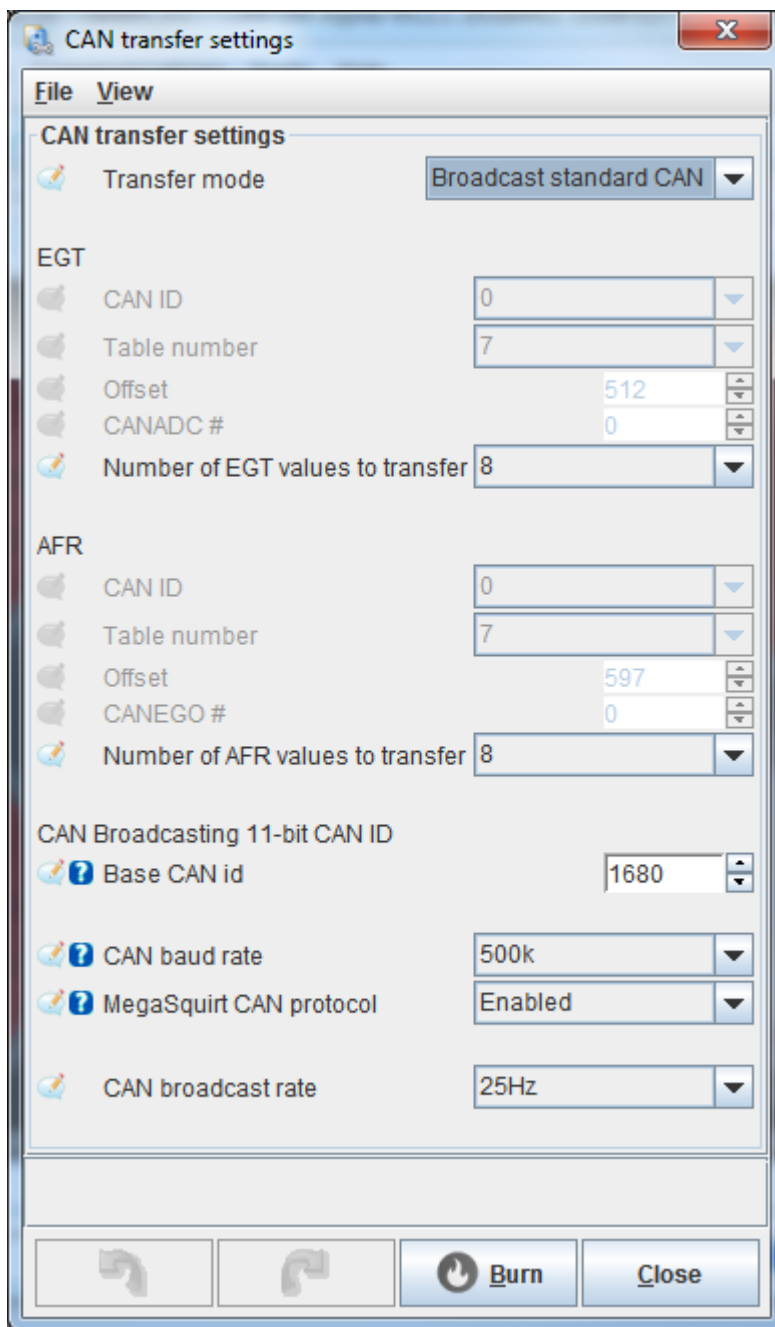
The lag factor can be changed for all the inputs. Note that there are lag factors on the MS3 and it is preferable in most cases to use those.



The CAN transfer settings can be used to change the default settings. It is possible to change the number of EGT and AFR (analog input) values to send fewer CAN messages and less data over the CAN bus. The base CAN id can also be changed from the default 1680 (the EGTs use id base and base+1 and the AFR/analog use base+2 and base+3).

If the MS3 has its CAN bus changed from the default settings, then it is possible to change the baud rate and protocol to match.

And the broadcast rate can be changed from the default 25Hz. Rates of 1, 2, 5, 10, 25, and 50 Hz are available.



The screenshot shows a software window titled "CAN transfer settings" with a standard Windows-style title bar (minimize, maximize, close buttons). The window has a menu bar with "File" and "View". The main content area is divided into several sections:

- CAN transfer settings**: A sub-header with a pencil icon.
- Transfer mode**: A dropdown menu currently set to "Broadcast standard CAN".
- EGT**: A section for Exhaust Gas Temperature settings, containing:
 - CAN ID: A dropdown menu set to "0".
 - Table number: A dropdown menu set to "7".
 - Offset: A numeric input field set to "512".
 - CANADC #: A numeric input field set to "0".
 - Number of EGT values to transfer: A dropdown menu set to "8".
- AFR**: A section for Air/Fuel Ratio settings, containing:
 - CAN ID: A dropdown menu set to "0".
 - Table number: A dropdown menu set to "7".
 - Offset: A numeric input field set to "597".
 - CANEGO #: A numeric input field set to "0".
 - Number of AFR values to transfer: A dropdown menu set to "8".
- CAN Broadcasting 11-bit CAN ID**: A sub-header.
- Base CAN id**: A numeric input field set to "1680".
- CAN baud rate**: A dropdown menu set to "500k".
- MegaSquirt CAN protocol**: A dropdown menu set to "Enabled".
- CAN broadcast rate**: A dropdown menu set to "25Hz".

At the bottom of the window, there are four buttons: a left-pointing arrow, a right-pointing arrow, a "Burn" button with a flame icon, and a "Close" button.