



OEX

OEM ECU Expander

Installation, configuration and strategy reference

Updated edition | October 2026 | Hardware version 4

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Introduction

The Syvecs OEX expands an existing engine-management system with additional inputs, outputs and control strategies. It can read OEM sensor and CAN data, control supplementary injection and wastegates, monitor lambda and knock, and exchange information with the original engine ECU.

Hardware at a glance

Inputs and communication	Outputs and control
20 analogue inputs: 12 flexible AS inputs and eight 0-5V AV inputs	12 low-side outputs and eight half-bridge outputs
Two NTK wideband inputs and two knock inputs	Four DAC channels; DAC1/2 are normally allocated to NTK ion-pump control
Two CAN 2.0B interfaces, a CAN FD interface and K-Line	USB-C calibration and PC / memory-stick logging

Retain the OEM ECU and add the functions required

The software supports internal or external fuel calculations, sequential supplementary injection, closed-loop lambda correction, dual wastegate control, flex-fuel adjustments, knock monitoring, traction control, limp strategies, water injection and nitrous control. An external drive-by-wire strategy is also available for suitable installations. Configure and validate each function for the vehicle before use.

CAN and signal integration

Use a predefined CAN stream, supported OBDII data or Generic CAN Receive to obtain engine and vehicle information. CAN forwarding and byte modification support integration between networks. Analogue signal modifiers can rescale or clamp a signal before passing it to the OEM ECU through an available DAC output.

Installation and calibration are intended for a competent technical audience. Incorrect wiring or configuration can damage equipment. Syvecs and the original author accept no liability for damage caused by incorrect installation or configuration. For assistance, contact support@syvecs.com.

Installation and commissioning overview

Stage	Action
Identify the unit	Confirm hardware version, installed firmware and calibration. Check whether DAC1/2 are allocated to internal lambda control.
Plan the loom	Separate high-current supplies and power grounds from sensor supplies and analogue grounds. Size wiring and protection for the connected loads.
Connect power	Use the required VBAT1, VBAT2, power-ground and ignition connections shown in Connections - Power.
Connect SCal	Connect through USB-C, save the calibration and verify live supply and sensor readings.
Assign inputs	Choose the correct AS or AV input, linearisation and error thresholds. Check CAN source priority and decoding.
Assign outputs	Configure drive type and frequency, program the unit, then perform controlled output testing.
Establish synchronisation	For sequential injection, confirm reliable crank/cam decoding and SyncState 720 before enabling fuel delivery.
Commission strategies	Validate fuel, lambda, boost and protective functions progressively while logging the relevant channels.

Shared hardware resources

DAC1 and DAC2 are configured for NTK ion-pump control as standard; using them as general-purpose DAC outputs requires the appropriate build option. AS inputs support configurable pull-ups; AV inputs do not. Full-bridge motor control uses fixed paired half-bridge outputs.

Using SCal help

Press F1 on a map for its help text. Green maps are live adjustable; blue maps require Device > Program. Save the current calibration before changing configuration and verify the resulting input/output behaviour.

Specifications and maximum ratings

Outputs

8 x Half Bridge Outputs (Support: Full Bridges, Lowside or HighSide Drive) (15Amp Peak (100ms) 8Amp Continuous) 12 x Low Side Outputs (12Amp Peak (100ms) 6Amp Continuous) 4 x DAC Outputs (-5v to 5v) - Max 65mA

Inputs

12 x Flexible Inputs supporting frequency, Sent, thermistor, bipolar 8 x 0-5v Voltage inputs 2 x NTK Lambda Inputs 2 x Knock Inputs

Communication Interfaces

USB For Updates, Configuration and memory stick logging 2 x CAN 2.0B interface for communication with other controllers or logging systems 1 x CANFD interface for communication 1 x Kline Interface

Power Supply

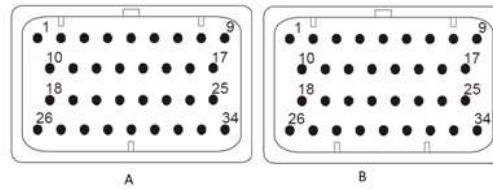
6 to 26V input voltage range

Physical

IP67 Sealed Automotive Spec -40c to 125c. 2 x 34 way Superseal 1.0 connectors 150mm x 150mm

Pinout - Connector A

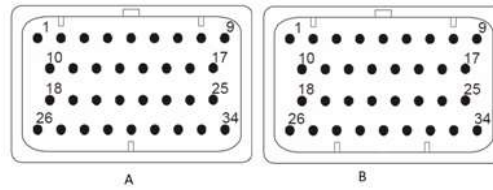
Mating connector: 4-1437290-0 | 34-way, Key 1



Signal	Pin	S-Cal assignment	Description
HBR1	A1	HBRIDGE 01	H-Bridge Output - Can be driven High or Low
PWR ON	A2		Ignition 12V Signal - OEX Wake up (Required)
AS1	A3	AN01	Flexible Input - 3k Pull Up Available in Software
AS3	A4	AN03	Flexible Input - 3k Pull Up Available in Software
AS5	A5	AN05	Flexible Input - 3k Pull Up Available in Software
AV7	A6	AN07	0-5V Input Only
AV09	A7	AN09	0-5V Input Only
VBAT1	A8		12V Supply - High Current (Required)
VBAT1	A9		12V Supply - High Current (Required)
HBR2	A10	HBRIDGE 02	H-Bridge Output - Can be driven High or Low
KLINE	A11		Kline or LinBus
AS2	A12	AN02	Flexible Input - 3k Pull Up Available in Software
AS4	A13	AN04	Flexible Input - 3k Pull Up Available in Software
AS6	A14	AN06	Flexible Input - 3k Pull Up Available in Software
AV8	A15	AN08	0-5V Input Only
AV10	A16	AN10	0-5V Input Only
5V	A17		5v Output for Sensors
HBR3	A18	HBRIDGE 03	H-Bridge Output - Can be driven High or Low
CAN0L	A19		CAN 0 Low
CAN0H	A20		CAN 0 High
DAC1 / NTK1 ION	A21	DAC01	Analogue output / NTK1 Ion Pump (White Wire)
DAC2 / NTK2 ION	A22	DAC02	Analogue output / NTK2 Ion Pump (White Wire)
DAC3	A23	DAC03	Analogue output - Can output -5v to +5v volts
DAC4	A24	DAC04	Analogue output - Can output -5v to +5v volts
ANGND1 / LAM GROUND / KNKGND	A25		Sensor Ground Connection / NTK Ground (Black Wire) / Knock Ground
HBR4	A26	HBRIDGE 04	H-Bridge Output - Can be driven High or Low
LSO1	A27	LOW-SIDE 01	Low Side Output
LSO2	A28	LOW-SIDE 02	Low Side Output
LSO3	A29	LOW-SIDE 03	Low Side Output
LSO4	A30	LOW-SIDE 04	Low Side Output
LSO5	A31	LOW-SIDE 05	Low Side Output
LSO6	A32	LOW-SIDE 06	Low Side Output
PWRGND	A33		Ground Connection - High Current (Required)
PWRGND	A34		Ground Connection - High Current (Required)

Pinout - Connector B

Mating connector: 4-1437290-1 | 34-way, Key 2



Signal	Pin	SCal assignment	Description
VBAT2	B1		12V Supply - High Current (Required)
VBAT2	B2		12V Supply - High Current (Required)
AV17	B3	AN17	0-5V Input Only
AV19	B4	AN19	0-5V Input Only
AS11	B5	AN11	Flexible Input - 3k Pull Up Available in Software
AS13	B6	AN13	Flexible Input - 3k Pull Up Available in Software
AS15	B7	AN15	Flexible Input - 3k Pull Up Available in Software
KNOCK1	B8	KNK1	Knock Sensor 1 Input
HBR5	B9	HBRIDGE 05	H-Bridge Output - Can be driven High or Low
5V	B10		5v Output for Sensors
AV18	B11	AN18	0-5V Input Only
AV20	B12	AN20	0-5V Input Only
AS12	B13	AN12	Flexible Input - 3k Pull Up Available in Software
AS14	B14	AN14	Flexible Input - 3k Pull Up Available in Software
AS16	B15	AN16	Flexible Input - 3k Pull Up Available in Software
KNOCK2	B16	KNK2	Knock Sensor 2 Input
HBR6	B17	HBRIDGE 06	H-Bridge Output - Can be driven High or Low
ANGND2 / LAM GROUNDS / KNKGND	B18		Sensor Ground Connection / NTK Ground (Black Wire) / Knock Grounds
NTK NRNST 1	B19		NTK1 NRST Voltage (Grey Wire)
NTK NRNST 2	B20		NTK2 NRST Voltage (Grey Wire)
CAN1L	B21		CAN 1 Low
CAN1H	B22		CAN 1 High
CANFDL	B23		CANFD Low
CANFDH	B24		CANFD High
HBR7	B25	HBRIDGE 07	H-Bridge Output - Can be driven High or Low
PWRGND	B26		Ground Connection - High Current (Required)
PWRGND	B27		Ground Connection - High Current (Required)
LSO7	B28	LOW-SIDE 07	Low Side Output
LSO8	B29	LOW-SIDE 08	Low Side Output
LSO9	B30	LOW-SIDE 09	Low Side Output
LSO10	B31	LOW-SIDE 10	Low Side Output
LSO11	B32	LOW-SIDE 11	Low Side Output
LSO12	B33	LOW-SIDE 12	Low Side Output
HBR8	B34	HBRIDGE 8	H-Bridge Output - Can be driven High or Low

Connections - Power

The OEX ECU has 5 power connection points, four of these are high current and can be connected to a fused battery power or switched power source. One of them is Ignition to turn the unit on.

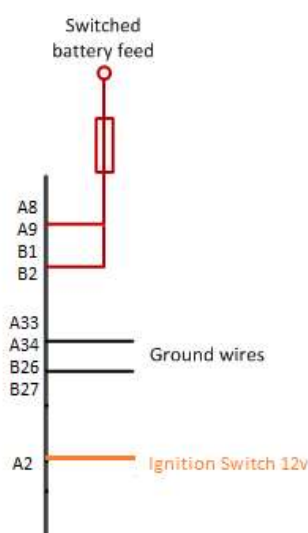
If driving motors or solenoids which pull a lot of current then ensure the correct amount of pins are connected. Each pin on the OEX ECU is able to sink around 14 amps of current. If driving multiple solenoids that pulls 20+ amps total, ensure at least two high current 12v pins and two power ground pins are used.

Internally A8/A9 are linked, as well as B1/B2. These can either be used to provide extra current on a supply, or as a way of providing switched power to additional loads through the loom.

Pin A2 (Ignition Sw) switches the OEX on when supplied with a 12v supply.

Power Grounds are joined internally. The OEX ECU must have A33 and B26 connected to a good ground. If driving lots of Low Side outputs, connect A34 and B27 also share the load.

NOTE! Power Grounds are designed to conduct High Current loads - Do not mix Power Grounds with Analogue (AN) Grounds.



Pin Number	Function	Notes
A8	VBAT1	Use a fused 12v Switched feed. MUST CONNECT
A9	VBAT1	Use a fused 12v Switched feed.
B1	VBAT2	Use a fused 12v Switched feed. MUST CONNECT
B2	VBAT2	Use a fused 12v Switched feed.
A33	Power Ground	Shared Power Ground
A34	Power Ground	Shared Power Ground
B26	Power Ground	Shared Power Ground
B27	Power Ground	Shared Power Ground
A2	Power On	12v Ignition Switch - Logic Power

Connections - Outputs

Low Side Outputs

The low side outputs pull to ground when 'on'. They offer full pulse width modulation control. The outputs can be used to drive up to 12A Peak / 6A Continuous. These are suitable for injectors, solenoids, relays etc

Pin Number	Function	SCal Assignment
A27	LSO1	LOW SIDE 01
A28	LSO2	LOW SIDE 02
A29	LSO3	LOW SIDE 03
A30	LSO4	LOW SIDE 04
A31	LSO5	LOW SIDE 05
A32	LSO6	LOW SIDE 06
B28	LSO7	LOW SIDE 07
B29	LSO8	LOW SIDE 08
B30	LSO9	LOW SIDE 09
B31	LSO10	LOW SIDE 10
B32	LSO11	LOW SIDE 11
B33	LSO12	LOW SIDE 12

Half Bridge Outputs

A H bridge is an electronic circuit that enables a voltage to be applied across a load in either direction. These circuits are often used to drive electronic throttle motor applications to allow DC motors to run forwards and backwards. Half Bridge Outputs also have full pulse width modulation available and can be driven to 12v or Ground depending on the Output drive type selection.

Output Drive Type: Full Bridge = Pairs 2 x H-bridge outputs to offer push/pull drive for motor control, I.E HBR1&2 / HBR3&4 H-Bridge - Drives to 12v Low Side - Drives to Gnd

Full Bridge channel pairing is fixed, and you only need to assign 1 pin, for example HBRIDGE01 in full bridge mode to enable both HBRIDGE01 and HBRIDGE02 operation. You cannot for example use HBRIDGE02 and HBRIDGE03 together.

These outputs can be used to drive up to 15A Peak / 8A Continuous. If you are driving the outputs for high current devices it's extremely important to ensure the 12v and Ground wire gauge is also capable to handle the current demand. The minimum drive frequency that a H-Bridge can support is 20hz.

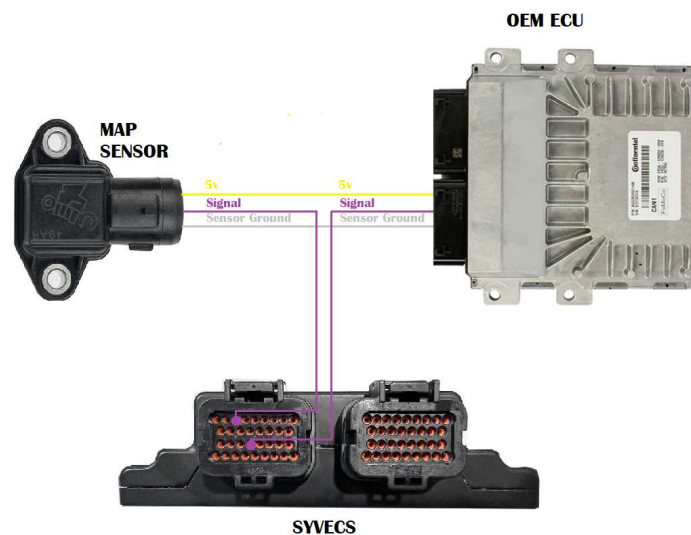
Pin Number	Function	SCal Assignment
A1	H-Bridge1	HBRIDGE01
A10	H-Bridge2	HBRIDGE02
A18	H-Bridge3	HBRIDGE03
A26	H-Bridge4	HBRIDGE04
B9	H-Bridge5	HBRIDGE05
B17	H-Bridge6	HBRIDGE06
B25	H-Bridge7	HBRIDGE07
B34	H-Bridge8	HBRIDGE08

DAC outputs

Four DAC (digital-to-analog) outputs are also present on the OEX ECU that convert a binary input number into an analog voltage output. These outputs are useful for mirroring an OEM Sensor voltage and adjusting it to keep OEM systems happy like a Manifold Pressure voltage clamp. The outputs can be driven from -5v to +5v and not designed to handle much loading. Maximum current is 65ma DAC1 and DAC2 as Default are set to drive the IonPump for NTK lambda control 1 and 2. DAC 3 and 4 are available as standard. DAC1 and DAC2 can be made available to customers but needs to be ordered this way.

Pin Number	Function	SCal Assignment
A21	DAC1/NTK1I	DAC01 Setup for Ion Pump on OEX as Default
A22	DAC2/NTK2I	DAC02 Setup for Ion Pump on OEX as Default
A23	DAC3	DAC03
A24	DAC4	DAC04

Example: Signal INPUT into AS2 and DAC1 is used for Signal OUTPUT for adjustment to Map signal and clamp.



The DAC1 example requires a unit built with DAC1 available as an analogue output. On a standard NTK-equipped unit, use an available DAC3 or DAC4 instead.

Sensor supplies and grounds

Sensor/ Analogue Grounds (AN Grounds)

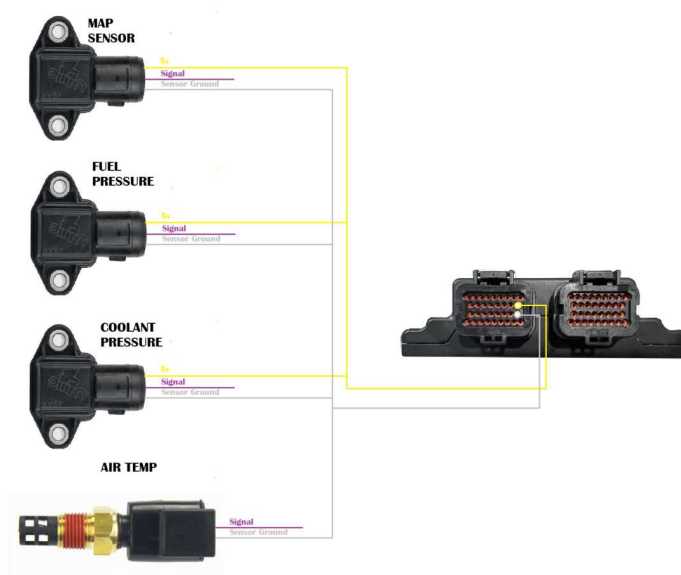
Sensors and miscellaneous analogue inputs have their own Ground pins; these grounds must be kept separate from the Power grounds. The sensor ground pins are able to support multiple sensor connections as shown in the diagram below

Pin Number	Function
A25	ANGND1
B18	ANGND2

5V Regulated Supply

Sensors and miscellaneous analogue inputs have their own power pins which need a stable power supply, the 5v Regulated outputs are protected and provide a stable/clean 5v which can handle 500ma Maximum. The regulated 5V pins are able to support multiple sensor connections as shown in the diagram below

Pin Number	Function
A17	5VOUT1
B10	5VOUT2

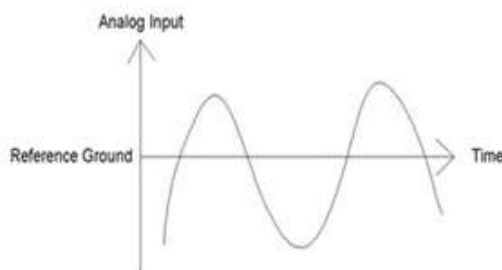


Flexible inputs - AS

The Syvecs OEX ECU has 20 programmable inputs available of two different types.

Flexible Inputs - AS Inputs

These Inputs are able to swing above and below the reference ground meaning they can see Positive Voltage as well as Negative.



AS Input capability:

- Fully adjustable hardware trigger thresholds
- Hardware Frequency measurement
- Digital states
- 0-5v Analogue
- SENT Digital Decoding
- Thermistor (software pullup)
- MagnetoResistive Sensors

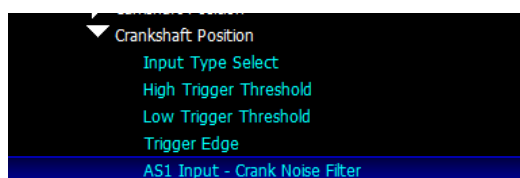
Example of typical sensor application:

- Reluctor Crank and Cam Sensors / ABS Sensors wheel speed
- Hall Sensors
- Map Sensor
- Temperature Sensor
- SENT Sensors

Bipolar inputs are not just limited to the above they can also be used for any sensor that outputs 0-5volts. They are also able to provide a 3k Pull-up through SCA1 when the Input Type is set as Thermistor

Pin Number	Input	SCA1 Assignment
A3	AS1	AN01
A12	AS2	AN02
A4	AS3	AN03
A13	AS4	AN04
A5	AS5	AN05
A14	AS6	AN06
B5	AS11	AN11
B13	AS12	AN12
B6	AS13	AN13
B14	AS14	AN14
B7	AS15	AN15
B15	AS16	AN16

AS1 Recommended for Crank sensor as has option for additional filtering.



Voltage inputs - AV and speed sensors

These Inputs are able to sense a Voltage level but not offer Frequency measurements.

Example of typical sensor application:

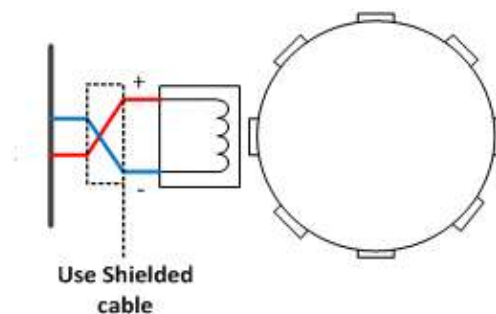
- Manifold Pressure sensors
- Throttle Positions
- Oil Pressures

Voltage Inputs are not just limited to the above they can also be used for any sensor which outputs a 0-5volt signal. They do NOT have an internal 3k software configurable pull up. This needs to be wired externally.

Pin Number	Input	SCal Assignment
A6	AV7	AN7
A15	AV8	AN8
A7	AV9	AN9
A16	AV10	AN10
B3	AV17	AN17
B11	AV18	AN18
B4	AV19	AN19
B12	AV20	AN20

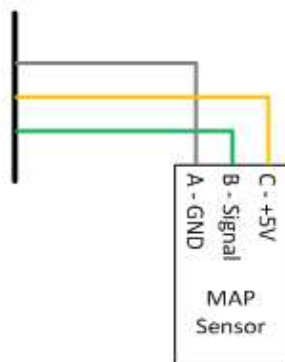
Sensor Schematics - Examples

Speed Sensor - Magnetic Type



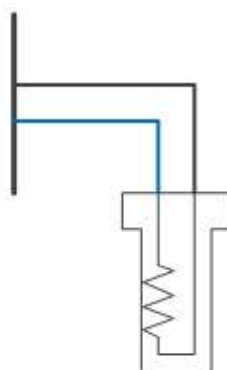
Pin Number	Function	Notes
A25	ANGND1	May be shared with multiple sensors
A4	AS3	Use a flexible AS input: AS1-AS6 or AS11-AS16

MAP and coolant temperature sensors



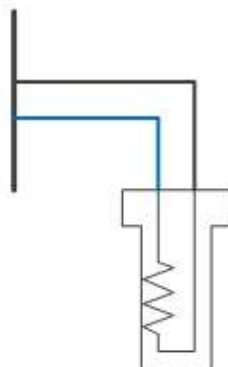
Pin Number	Function	Notes
A25	ANGND1	May be shared with multiple sensors
A17	5VOUT1	Regulated sensor power supply
B12	AV20 Input	Any Input can be used

Coolant Temperature Sensor (CTS)



Pin Number	Function	Notes
A25	ANGND1	May be shared with multiple sensors
A4	AN3	Use AS1-AS6 / AS11-AS16 with the software pull-up, or AV inputs with an external pull-up

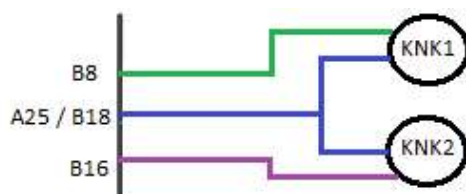
Air temperature and knock sensors



Pin Number	Function	Notes
A25	ANGND1	May be shared with multiple sensors
A4	AN3	Can use Inputs AS or AV with External pullup

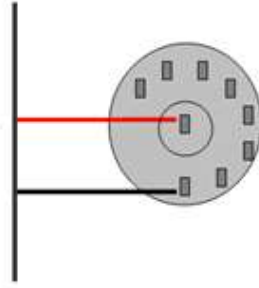
Knock Sensors

The OEX allows sensing of all broadband knock sensors, connection can be done direct or T into the OEM knock sensor signal wires and connect to B8 or B16. See Knock Control section for more information.



Pin Number	Function	Notes
B8	KNK1	Knock Signal 1
B16	KNK2	Knock Signal 2
A25 or B18	KNKGND	Knock Ground

Calibration switches



Pin Number	Function	Notes
A25	ANGND1	May be shared with multiple sensors
A12	AN2	Can use Inputs AS or AV with External pullup

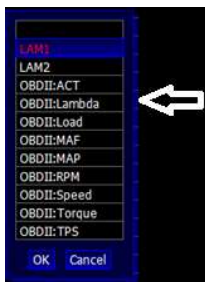
Wideband lambda wiring

The Syvecs OEX Controller has the ability to drive two NTK L2H2 Wideband Lambda sensors without the use of external hardware. We also have the capability to drive two denso AF sensors but this is a build-time option.

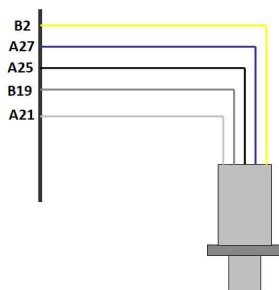
Lambda monitoring allows calibrators to see the Air Fuel Ratios inside the exhaust and also implements Limp strategies.

Please see wiring and fitting information below for an L2H2 NTK

Tip: If the vehicle you have the OEX controller fitted to already has wideband lambda support, you can use the OBDII support to grab the lambda data from the OEM Ecu.



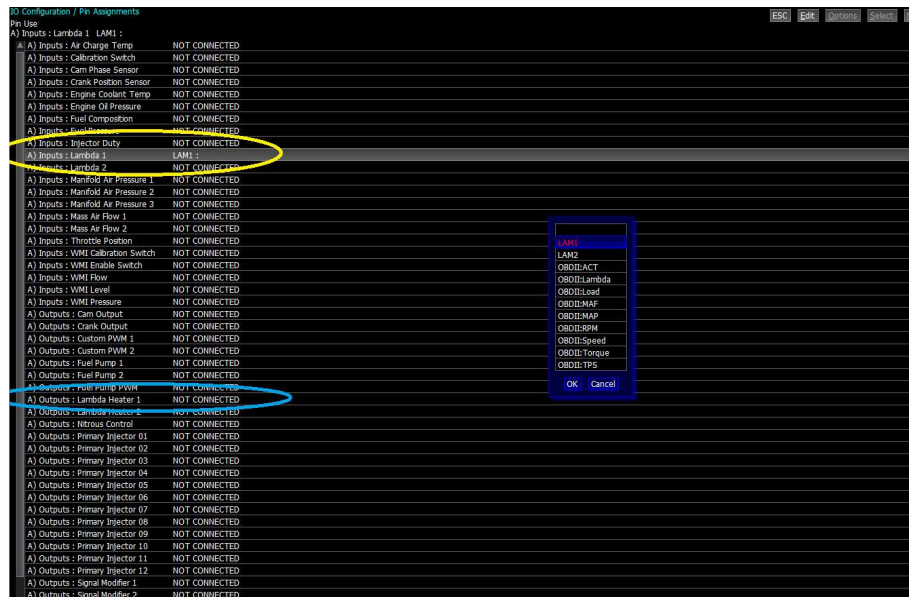
NTK L2H2 Wiring



Lambda Pin	Colour	Name	OEX ECU Pin Lambda 1	OEX ECU Pin Lambda 2
1	Yellow	Heater	12v fused supply	12v fused supply
2	Blue	Heater Drive	Any LSO or HBR Output	Any LSO or HBR Output
6	Grey	Nernst Cell	B19	B20
7	White	Ion Pump	A21	A22
8	Black	Signal Ground	A25 or B18	A25 or B18

NTK L2H2 setup and mounting

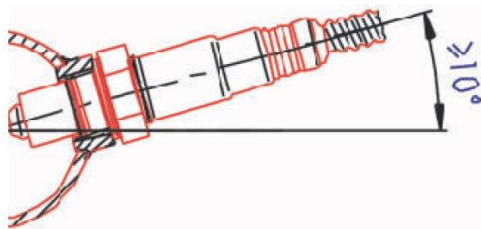
After wiring in the NTK lambda you can assign the Lambda1 or Lambda2 function to the dedicated LAM input used. This is set in IO Configuration - Pin Assignments. Highlighted in Yellow. The input setup and linearization will be as default set for an NTK L2H2 Sensor in the ecu.



The Lambda Heater control also needs to be assigned to the output used, this can be any Low-Side or H- Bridge Output on the OEX ECU. The default values set in the maps for the heater will be correct for the NTK L2H2.

Recommended Lambda Mounting

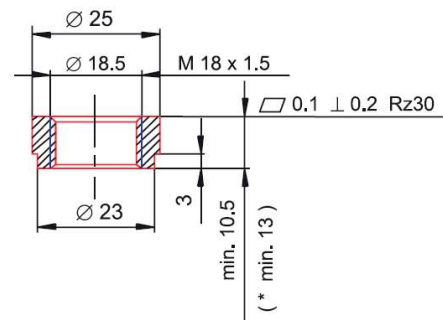
Mounting recommendation



Recommended materials for the mating thread in the exhaust pipe

*: THexagon > 600°C or

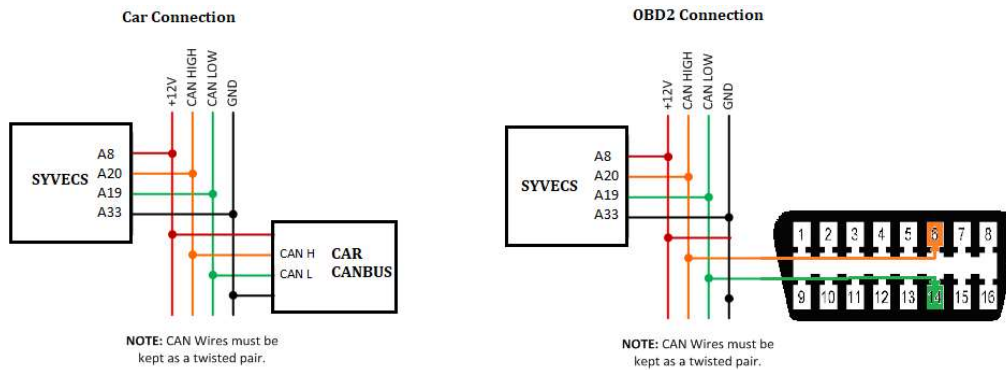
TGas > 930°C



CAN interfaces and wiring

Controller Area Network Bus (CAN Bus) is a widely used data interface commonly used in many cars and aftermarket accessories (such as Data loggers and Dashes). Data is sent using a pair of wires, which are maintained as a twisted pair.

By default, the OEX ECU has 2 x CAN bus interfaces: - CAN0 - CAN1



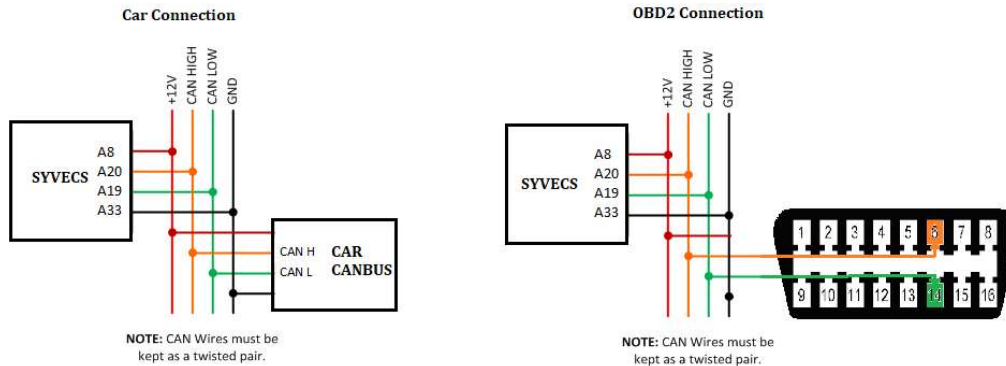
The OBDII CAN wires need to be connected as above and can be wired to either CAN on the OEX Controller

CAN interface	Low	High
CAN0	A19	A20
CAN1	B21	B22
CAN FD	B23	B24

CAN0 and CAN1 are the classical CAN interfaces used by the examples. CAN FD capability is listed separately in the hardware specification. Configure the selected interface for the connected network.

OBDII connections and setup

The OEX controller supports the OBDII Data receive protocol allowing users to retrieve data via the OEM ECU OBDII protocol making installation very straightforward. (please note: Not every manufacturer supports the SAE J1979 protocol we use)



The OBDII CAN wires need to be connected as above and can be wired to either CAN on the OEX Controller.

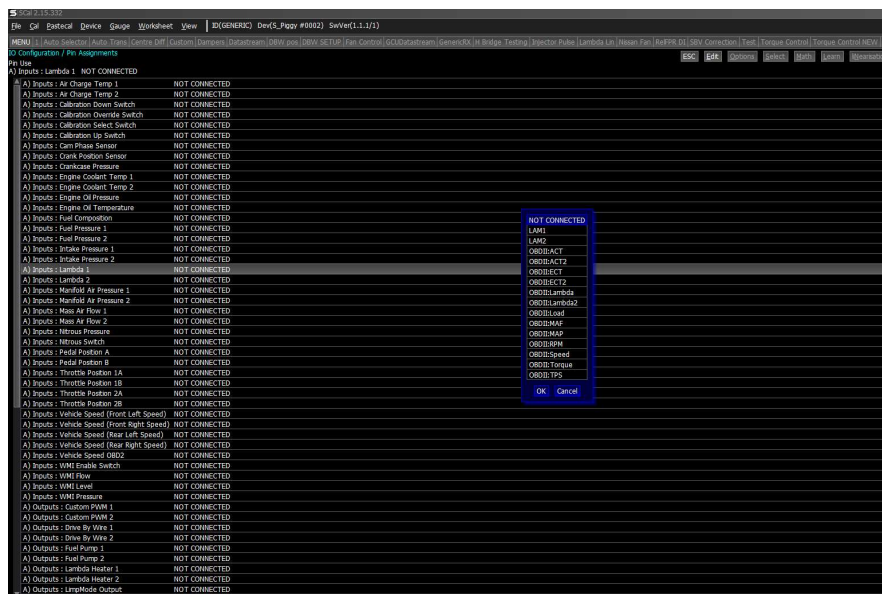
OBDII Setup

OBDII Supports: Rpm, Tps, Torque Actual, Torque Demand, Ignition Timing, Short Term Fuel bank1/2, Maf1, Map1, ACT , ECT, Lam1, Speed

Select the input you wish to assign OBDII data on and then select the OBDII: Item best suited.

Example: Lambda - OBDII Lambda

Users need to Device - Program the controller after for the setting to be applied.



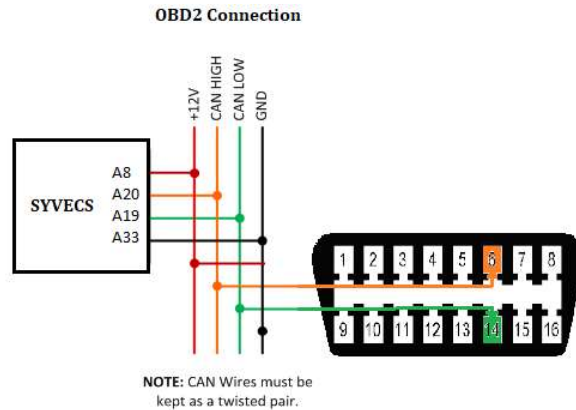
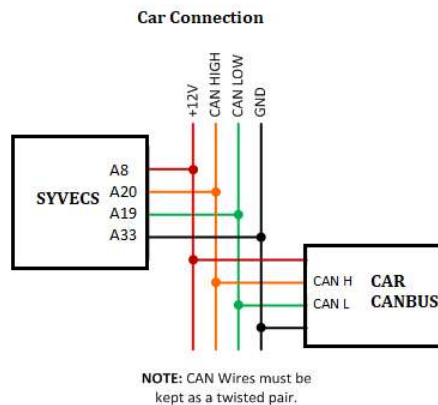
Direct CAN connection

The OEX controller supports direct CAN connection to the vehicle or ECU data bus. This is a very powerful way of getting very fast real time vehicle running data.

At the end of this manual is the list of supported OEM vehicles / Aftermarket Ecu's which Syvecs support and it's expanding all the time. Please Note: OEM Vehicle don't all have the power-train CAN available at the OBDII connector, users may need to connect on the CAN at the ECU location.

If the vehicle/Ecu you wish to connect to is not present in the Datastream - Predefined CAN list then Syvecs also have a generic receive section for allowing calibrators to set a custom CAN receive setup.

Connecting the CAN network on your car needs to be done at the ECU location to ensure the powertrain CAN messages are present. T into the CAN wires and run them to the OEX controller.



Generic CAN Receive

The generic CAN receive section allows for calibrators to setup the items they wish to receive on the OEX by setting the Identifier, Start Bit, Length, and scaling.

The easier way to setup the Generic CAN is to create a worksheet and add in all the maps like below to make each CANRX* maps line up.



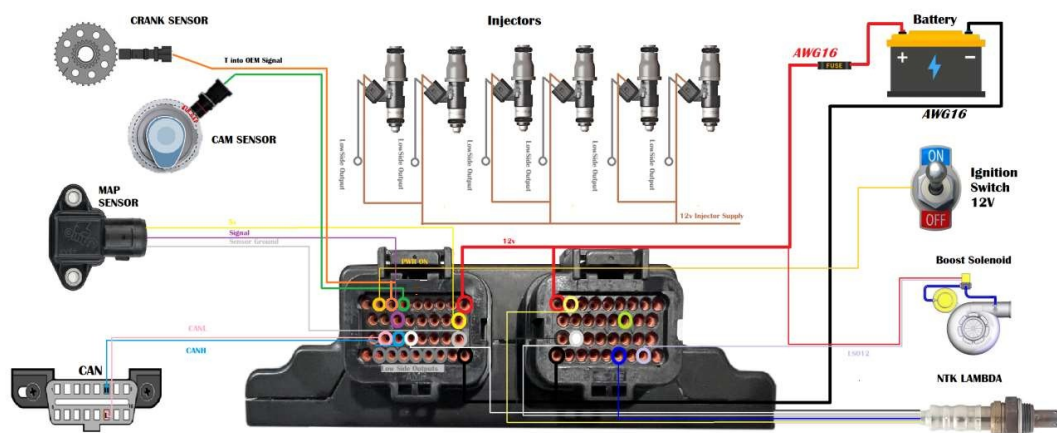
Above you can see the RPM is setup to be received from CAN ID 0x600, data is not Little Endian, value is signed, scaling is 1.00 and is being picked up from start bit 0 with a length of 16 bits.

More info can be found on www.youtube.com/SyvecsHelp. Search for Generic Can Receive.

Please note: Any Item which is assigned in Pin Assignments will take its data from the Pin assignment and ignore the Generic CAN Rx data.

Example six-cylinder wiring

Example supplementary six-cylinder injection, lambda and boost wiring. Connector references below match the illustrated loom.



Connector A

Pin	Connection
A2	Ignition-switched 12V / wake-up
A3 / A4	Crank signal / cam signal
A9	High-current 12V supply in illustrated loom
A12	MAP sensor signal
A17	5V sensor supply
A19 / A20	CAN Low / CAN High
A21	NTK ion pump - white wire
A25	Sensor grounds; reference shared with OEM ECU
A27 / A28 / A29	Injector 1 / Injector 2 / Injector 3
A30 / A31 / A32	Injector 4 / Injector 5 / Injector 6
A34	High-current ground in illustrated loom

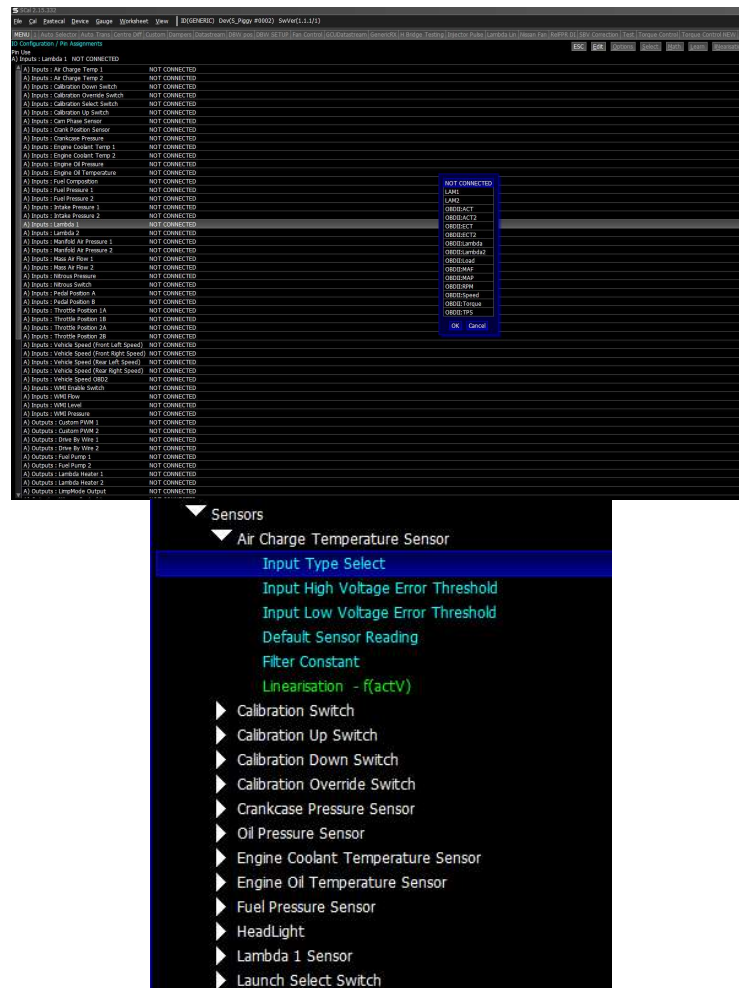
Connector B

Pin	Connection
B1	High-current 12V supply
B2	NTK heater supply - yellow wire; fused supply branch
B18	NTK signal ground - black wire
B19	NTK Nernst cell - grey wire
B26	High-current power ground
B31	NTK heater drive - blue wire
B33	LSO12 - boost solenoid

Follow Connections - Power for required pins A8/A33 and B1/B26. The illustration uses A9/A34; add the required connections and parallel high-current pins to suit the load. B2 is internally linked to B1 and its heater-supply branch must be correctly fused.

Sensor setup

Assign the sensor in I/O Configuration > Pin Assignments, then configure its input type, error limits and calibration in the Sensors area.



Input Type Select

Select 5V or Thermistor as appropriate. Thermistor mode enables a 3K pull-up on AS inputs; AV inputs require an external pull-up.

Input High Voltage Error Threshold

The voltage above which the OEX marks the input as being in error.

Input Low Voltage Error Threshold

The voltage below which the OEX marks the input as being in error.

Default Sensor Reading

The substitute sensor value applied while the input is in error.

Filter Constant

Controls recursive filtering of the signal. A higher value applies more filtering.

Linearisation

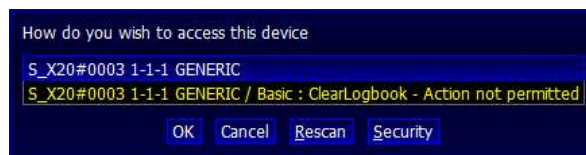
Converts the measured input voltage into the required sensor units.

PC connection and SCal

The OEX ECU has a calibration stored onboard to maintain settings of the OEX ECU hardware. In order for the OEX ECU to work it must have a valid calibration present in the device and when shipping from the factory a default cal is loaded to ensure it works out of the box. Calibrators who wish to enable an Input to work in SENT decoding or setup custom CAN transmit will need to connect live to the OEX ECU. A USB-C port is found at the back of the OEX ECU which is IP67 sealed. Use a USB-C to USB-A male/male cable to connect the OEX ECU to the computer. The S-Suite software can be downloaded from below.

<https://www.syvecs.com/software/>

After running the SSuite installer, open SCal and click Device - Connect A OEX ECU device will be found as shown below, press Ok to proceed The connected green icon should now be present in the top right and all the voltages/temps from onboard



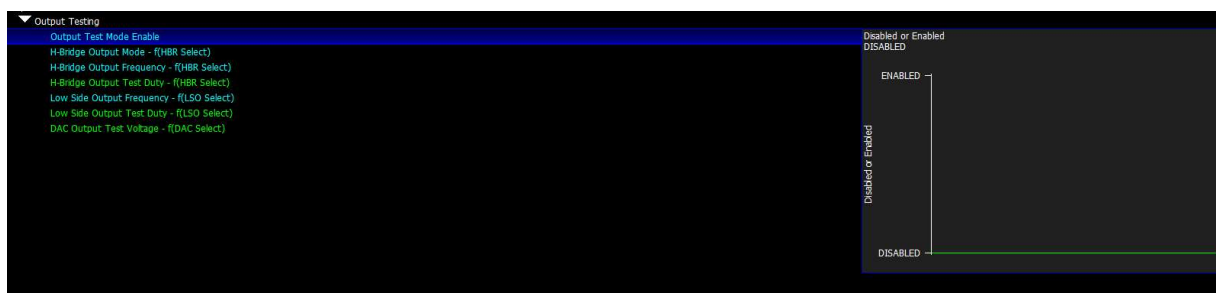
the OEX ECU are listed on the right hand side. Calibrators now have the ability to change the Input setup for each AN Input, setup custom DataStream CAN options or use the output testing (see Output Testing). Press F1 for help on a map and remember that: Green maps - Live Adjustable, changes have immediate effect Blue maps - Require programming to take effect.



Press F1 on a selected map to display the strategy help. The map help belongs to the installed firmware and should be used when a screen differs from the source screenshot.

Output testing

The OEX ECU outputs can be tested live with our Syvecs - SCal program and information on connecting to the unit can be found in the PC Connection section of the manual. After connecting to the expander via USB, users will see an area at the bottom of the calibration tree called output testing.



Here users are able to test the functions of each output by itself without the need for any master/slave CAN communication.

NOTE: H-Bridge Output Mode / H-Bridge Output Frequency / Low Side Output Frequency maps must be set and programmed onto the device for the output testing logic of these outputs to apply. You cannot change these maps when Output Test Mode Enable is enabled.

Set a frequency you wish the outputs to be driven at in H-Bridge Output Frequency and Low Side Output Frequency. Next set the H-Bridge Output Mode and Device - program the OEX ECU.

Output Test Mode Enable can then be enabled.

Now you can then set a duty for each output to be driven in H-Bridge Output Test Duty and Low Side Output Test Duty. These maps can be adjusted live.

If H-Bridge Output Mode map is set on Full Bridge, the paired outputs used in the full bridge individually set the drive direction.

For example: Motor is wired to HBR1 and HBR2, Output Mode is set to Full Bridge on HBR1 and 2. Increasing Duty on HBR1 output duty cell will cause the full bridge to drive the HBR1 output positive and the HBR2 output negative.

DAC Output Test Voltage is a live map which you can set the voltage that DAC1 -4 are driven at in Output test mode.

Limp mode and lean trip

Limp Mode

The OEX limp mode allows users to define working limits of all sensors. If these are exceeded the OEX will enable a limp strategy. Before the strategy will function it must be enabled in the Calibration Switch > Limp Modes Menu to select which Limp Mode you wish to enable.

When active Limp Mode functions in the following way:

- Send CAN messages over the OEM CAN bus (on supported vehicles) and illuminate the engine check light.
- Enable an output on when in limp mode. Useful in cases where the OEM CAN does not support this, or its not implemented.

You can manually define these limits in the Sensors menu within SCal. Limp mode will also disable features such as Wastegate and Nitrous Control.

Lean Trip

Lean trip warnings act in the same way as Limp Mode and activates the same output functions. It is however a stand-alone configurable strategy.

There are three sources for the lean trip value:

- CllTarget (Closed Loop Lambda Target) from fuel base map CllTarget (also possible to receive CAN target from OEM ECU)
- Manifold Pressure
- FuelDutyPri (Final Injector Duty)

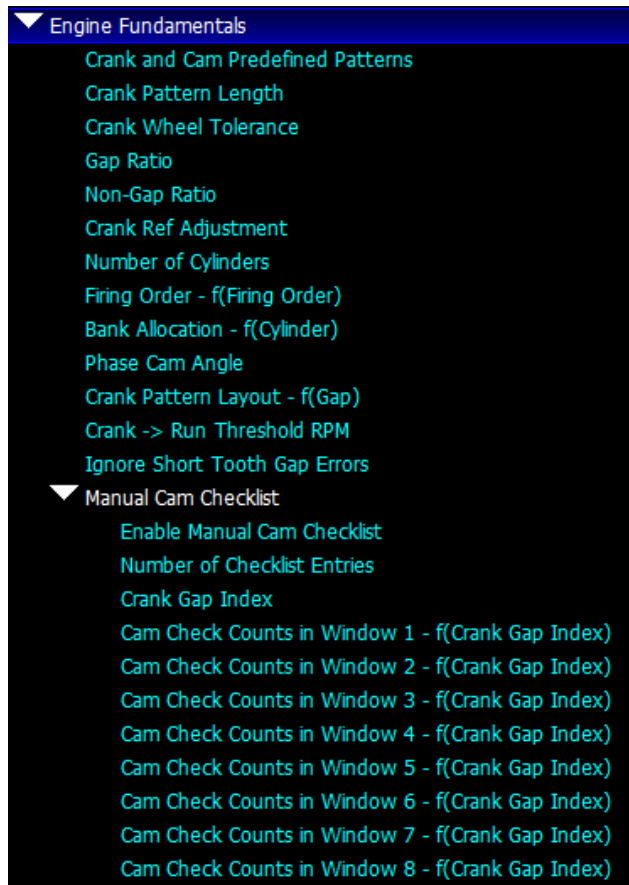


The Enable Engine Speed and Enable Manifold Pressure maps activate the Lean Lambda Strategy. From here a calibrator can set the allowed Lambda for the given Y Axis. If the Actual Lambda passes the value set in the map for time longer than set in Lambda Limp Time. Then a Lean Lambda Limp will become Active.

Engine Fundamentals - setup overview

Open **Calibration > Engine Fundamentals** after assigning and configuring the physical crank and cam inputs. These maps define the tooth pattern, engine phase, cylinder order and bank allocation used by the OEX.

Sequential injection requires reliable physical crank/cam synchronisation and **syncState 720**. An RPM value received over CAN or OBDII does not supply crank angle or cam phase.



Recommended setup order

1. Save and assign

Save the current calibration. Assign Crank Position Sensor and Cam Position Sensor under IO Configuration > Pin Assignments.

2. Condition the signals

Under Sensors, set input type, high/low trigger thresholds and trigger edge for each signal. Confirm clean, repeatable edges while cranking.

3. Define the engine

Select the decoder, enter pattern length and gap angles, then set cylinder count, firing order and bank allocation.

4. Establish phase

Set Crank Ref Adjustment and, for a single cam event, Phase Cam Angle. Use the Manual Cam Checklist for a suitable multi-tooth cam pattern.

5. Program and verify

These configuration maps require Device > Program. Recheck RPM, synchronisation and cylinder phase before enabling OEX fuel delivery.

Screenshot: Engine Fundamentals and the expanded Manual Cam Checklist. The displayed maps depend on the selected decoder and software version.

Physical inputs and RPM source

With a physical crank input assigned, leave the separate **Engine Speed** pin assignment unassigned. Assigning both prevents startup with **RPM: CRANK already assigned!!** The physical crank decoder controls RPM and synchronisation in this configuration.

When sharing an OEM 5 V crank/cam signal, select the 5 V input type without adding an OEX pull-up. Confirm the actual signal type and voltage first; a reductor signal needs suitable input conditioning. Support can provide suitable base calibrations: support@syvecs.com.

Engine Fundamentals - map reference

Use these descriptions with a measured trigger waveform or a known-good calibration for the engine. All angles below are crankshaft degrees. Screenshot and default values are examples, not universal settings.

Map in SCal	Purpose and setup
Crank and Cam Predefined Patterns	Select the decoder that matches the signal arrangement. The current profile offers Single Gap , Single Cam and Arbitrary Gap , Single Cam . Check the associated tables; selecting a decoder alone does not describe the wheel.
Crank Pattern Length	Number of actual tooth-to-tooth intervals in one repeating crank pattern (1-64). A 36-1 wheel has 35 intervals; a 60-2 wheel has 58. Missing tooth positions are part of the wide interval.
Crank Wheel Tolerance	Angular allowance used when checking expected tooth spacing. Higher values permit more deviation before losing sync. Set from the signal quality and wheel behaviour; excessive tolerance can conceal a problem.
Gap Ratio	For Single Gap mode, the new interval time divided by the previous interval time must exceed this threshold to recognise the long gap. The following interval must give a ratio below its reciprocal.
Non-Gap Ratio	Defines the ordinary-gap acceptance band in Single Gap mode: between 1 / Non-Gap Ratio and Non-Gap Ratio. Allow normal cranking-speed variation while keeping ordinary gaps distinct from the missing-tooth gap.
Crank Ref Adjustment	Aligns the decoder reference with the engine crank-angle reference. Establish from the measured wheel-to-TDC relationship and verify against the OEM timing reference. It must lie within the repeating pattern window.
Number of Cylinders	Set the actual engine cylinder count, then check the active firing-order and cylinder-bank table entries.
Firing Order - f(Firing Order)	Enter cylinder numbers in firing sequence, using the engine manufacturer's cylinder numbering. This axis is firing position, not an injector-output pin number.
Bank Allocation - f(Cylinder)	Assign each physical cylinder to its engine bank. This table is indexed by cylinder number, not firing position. Match the bank-specific fuel and lambda setup; see Engine bank allocation.
Phase Cam Angle	For single-cam-event decoding, identifies which repeating crank window contains the selected cam edge within the 720° cycle. This establishes phase; it is not a variable-cam timing target.
Crank Pattern Layout - f(Gap)	Enter the angular size of each interval in the repeating pattern, including the wide missing-tooth interval. Check the total angle and reverse index order; see the worked examples on the next page.
Crank -> Run Threshold RPM	With physical decoding, Run mode is entered when RPM exceeds this threshold and syncState is 720. Choose a threshold above normal cranking speed and below stable idle.
Ignore Short Tooth Gap Errors	When enabled, early edges below the minimum accepted gap time are discarded instead of causing a short-gap sync error. Start disabled; diagnose wiring, thresholds and noise before using this option.

Engine Fundamentals - crank pattern layout

A pattern is one complete repeating sequence of crank intervals. Its sum defines one **window**. A 360° pattern repeats twice per four-stroke engine cycle; a 120° pattern repeats six times. Windows per cycle = 720° / pattern sum.

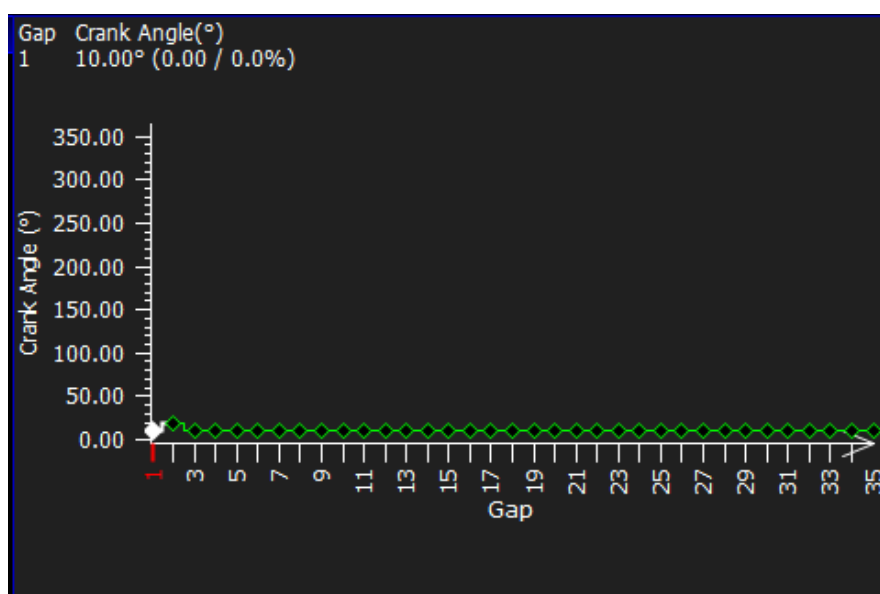
Missing-tooth wheel examples

Wheel	Pattern length	Ordinary interval	Wide interval	Pattern sum
36-1	35	34 × 10°	1 × 20°	360°
60-2	58	57 × 6°	1 × 18°	360°

For a nominal wheel with N equally spaced positions and M consecutive missing teeth: ordinary spacing = 360° / N; the wide interval = (M + 1) × ordinary spacing; actual intervals = N - M. These examples describe wheel geometry, not a complete engine calibration.

How to read the layout

The layout stores interval widths, not cumulative crank angles. The supplied example has 35 entries: 34 × 10° ordinary intervals and one 20° wide interval, totalling 360°. SCal labels the displayed cells **1-35**; the decoder/checklist indices are **0-34**. The wide interval is therefore displayed Gap 2, corresponding to decoder index 1.



Detail from the supplied Crank Pattern Layout screenshot. The vertical scale can make the wide interval look small; check the numeric cells and their sum.

Index order and valid window sizes

The decoder traverses indices in descending order: **N - 1, ... 2, 1, 0**, then wraps to N - 1. Around a single missing-tooth gap, the SCal help identifies index 2 before the gap, index 1 at the wide gap and index 0 immediately after it. Use these decoder indices when creating cam checkpoints.

The current decoder accepts pattern sums of **90°, 120°, 144°, 180°, 240°, 360° or 720°**. Crank Ref Adjustment must be below the selected window size. An invalid sum or out-of-window reference produces a startup message.

Ratio settings and decoder choice

At steady speed a 36-1 wheel gives approximately 2.0 entering the long gap and 0.5 leaving it; a 60-2 wheel gives approximately 3.0 and 0.333. These are measured ratios, not values to copy directly into the threshold maps. Cranking acceleration changes the observed ratios.

Arbitrary Gap mode uses a different matching sequence and exposes additional start-index and Gap Ratio Tolerance maps. Use a proven calibration for that decoder; the Single Gap ratio settings and manual-checklist procedure are not interchangeable with it.

Engine Fundamentals - Manual Cam Checklist

Use **Engine Fundamentals > Manual Cam Checklist** when a multi-tooth cam waveform must identify engine phase. In this firmware the checklist is implemented for **Single Gap, Single Cam**. Establish reliable crank synchronisation before configuring it.

What the checklist checks

At each configured crank-gap checkpoint, the decoder compares the number of selected cam edges seen since the previous checkpoint with the expected count, then resets the count to zero. It works through the successive crank windows and enters syncState 720 when the required sequence matches.

Map	How to set it
Enable Manual Cam Checklist	Enable only when using a defined checklist. With it disabled, the single-cam-event method uses Phase Cam Angle.
Number of Checklist Entries	Number of checkpoints in each crank window: 1-8. This is not the number of cam teeth or the number of windows.
Crank Gap Index	Enter checkpoint indices in descending order, within 0 to Crank Pattern Length - 1. The same checkpoint positions apply to every window.
Cam Check Counts in Window 1-8 - f(Crank Gap Index)	For each used window, enter the number of cam edges between successive checkpoints. A 360° crank pattern uses two windows; a 120° pattern uses six. Only the windows required by the pattern sum participate.

Build the counts from the waveform

1. Capture crank and cam together over a full 720° cycle. Identify the selected trigger edges and the cylinder-1 phase reference.
2. Choose repeatable crank checkpoints away from cam edges. Allow for any cam movement that could shift an edge across a checkpoint.
3. Count cam edges in each interval, including the interval crossing from the last checkpoint in one window to the first in the next. Enter zero where no edge occurs.
4. Enter the window tables in the correct engine-cycle order. The count sequence must distinguish phase; identical counts in every window cannot resolve a 360° ambiguity.
5. Program the calibration and compare the reported counts while cranking. With the checklist enabled, the SCal Messages pane shows counts at checkpoints while acquiring sync. Recheck physical cylinder phase after achieving 720.

Illustrative two-window checklist

For a 360° pattern, suppose a measured cam waveform has two edges in the interval ending at index 10 in Window 1, and one in that interval in Window 2, with no edges in the intervals ending at index 0. Use two checkpoints in descending order:

Crank Gap Index	Window 1 count	Window 2 count
10	2	1
0	0	0

Example only: derive both counts and window order from the actual engine. A count match alone does not prove that cylinder 1 has been assigned to the correct stroke.

Engine Fundamentals - validation and diagnostics

Before enabling sequential injection

Confirm the saved setup. Check pin assignments, sensor input types and edges, decoder selection, gap table, reference angle, cylinder count, firing order and bank allocation. Apply configuration changes with Device > Program.

Crank with OEX fuel delivery disabled. Confirm plausible RPM and repeatable acquisition of syncState 720. Check several starts from different stopped positions, including hot and cold cranking where practical.

Verify physical phase. Compare the crank/cam waveform and reference with the actual cylinder-1 TDC/stroke relationship and OEM timing reference. A stable 720 state can still be incorrectly phased by one crank revolution.

Check cylinder and bank identity. Injector output allocation follows cylinder identity; Firing Order specifies the sequence. Bank Allocation follows cylinder number. Verify each against the engine and loom before using bank-specific corrections.

Validate under changing speed. After cranking checks, enable fuel delivery in a controlled commissioning step. Log RPM, syncState, syncDiag and Run mode during idle, speed changes and restart. Confirm synchronisation remains stable before increasing load.

Useful diagnostic channels

Monitor **rpm**, **syncState**, **syncDiag**, **gapRatio**, **gapRatioMin**, **gapRatioMax**, **gapIdx**, **camTeethSeen** and **crankTeethSeen** as needed. The ratio channels help with initial gap recognition; cam counts and checklist messages help with phase acquisition. They are not a substitute for inspecting the waveform.

If synchronisation is not reliable

Observation	Check next
RPM: CRANK already assigned!!	Remove the separate Engine Speed assignment when a physical Crank Position Sensor is assigned.
No RPM while cranking	Crank input assignment, actual waveform, input type, trigger thresholds and selected edge.
Crank sync acquired, but not 720	Cam signal and edge; Phase Cam Angle for single-event mode; or checklist enable, checkpoint indices, counts and window order for manual mode.
Sync Window ... not ... degrees!!	Sum every active Crank Pattern Layout interval. It must equal one of the supported window sizes listed on page 30.
Crank reference angle MUST be within Sync Window!!	Set Crank Ref Adjustment inside the repeating pattern window and recheck the physical reference.
Short/long gap errors or intermittent sync loss	Check noise, wiring, thresholds, edge selection, wheel pattern and tolerance. Inspect the waveform before increasing tolerance or enabling Ignore Short Tooth Gap Errors.
720 achieved, but wrong cylinder timing	Recheck crank reference, 720° cam phase/window order, manufacturer cylinder numbering, firing order and injector output assignment.

Save the validated calibration and a representative log. For an unfamiliar trigger pattern, ask support@syvecs.com for an appropriate base setup and supply a crank/cam capture plus the wheel and cylinder details.

Fuel control - configuration

The OEX has 2 modes of fuel operation which dictate how the injectors are controlled.

Internal Calculations - The Fuel flow and Injector opening calculations are worked out internally using the Fuel calibrations, corrections and flex fuel models.

External Calculations - The Injector opening time and fuel mass is controlled from an External controller and the OEX acts as a slave based on the fuelFinalExtTarg items values. Cylinder Corrections is done internally.

Calibrators first need to define the injector outputs in the I/O Configuration - Pin Assignments

B) Outputs : WMI Pump B	NOT CONNECTED
B) Outputs : WMI Solenoid A	NOT CONNECTED
B) Outputs : WMI Solenoid B	NOT CONNECTED
B) Outputs : Wastegate 1 Anti-Phase	NOT CONNECTED
B) Outputs : Wastegate 1 Phase	NOT CONNECTED
B) Outputs : Wastegate 2 Anti-Phase	NOT CONNECTED
B) Outputs : Wastegate 2 Phase	NOT CONNECTED
C) Injection : Cylinder 01 Primary Injector	LOW SIDE 01 : A27
C) Injection : Cylinder 02 Primary Injector	LOW SIDE 02 : A28
C) Injection : Cylinder 03 Primary Injector	LOW SIDE 03 : A29
C) Injection : Cylinder 04 Primary Injector	LOW SIDE 04 : A30
C) Injection : Cylinder 05 Primary Injector	LOW SIDE 05 : A31
C) Injection : Cylinder 06 Primary Injector	LOW SIDE 06 : A32
C) Injection : Cylinder 07 Primary Injector	NOT CONNECTED
C) Injection : Cylinder 08 Primary Injector	NOT CONNECTED
C) Injection : Cylinder 09 Primary Injector	NOT CONNECTED
C) Injection : Cylinder 10 Primary Injector	NOT CONNECTED
C) Injection : Cylinder 11 Primary Injector	NOT CONNECTED
C) Injection : Cylinder 12 Primary Injector	NOT CONNECTED
E) Knock : Cylinder 01 Knock	NOT CONNECTED
E) Knock : Cylinder 02 Knock	NOT CONNECTED
E) Knock : Cylinder 03 Knock	NOT CONNECTED

Then ensure the Firing order and Bank allocations are setup correctly in Engine Fundamentals Area

▶ Global Breakpoints
▼ Engine Fundamentals
Crank and Cam Predefined Patterns
Crank Pattern Length
Gap Ratio
Non-Gap Ratio
Crank Ref Adjustment
Number of Cylinders
Firing Order - f(Firing Order)
Bank Allocation - f(Cylinder)
Phase Cam Angle
Crank Pattern Layout - f(Gap)
Crank -> Run Threshold RPM
▶ Manual Cam Checklist
▶ IO Configuration
▶ Output Testing

Select the Fuel Calculation source, either Internal or External

▼ Fuel Control
Fuel Calculation Source
Load Select
Fuel Map 1 - f(rpm,map1)
Fuel Map 2 - f(rpm,map1)
Fuel Map 3 - f(rpm,map1)
Fuel Map 4 - f(rpm,map1)
Injection Angle (ATDC) - f(rpm,map1)
Injection Angle Control
Injection Angle Advance Rate Limit
Injection Angle Retard Rate Limit
▶ Corrections
▶ Wastegate Control
▶ Starting
▶ Flex Fuel

Fuel control - internal and external modes

If internal mode is selected, calibrators can setup the Load select to be how they wish and then populate the fuel maps, corrections and injection angles as they wish.

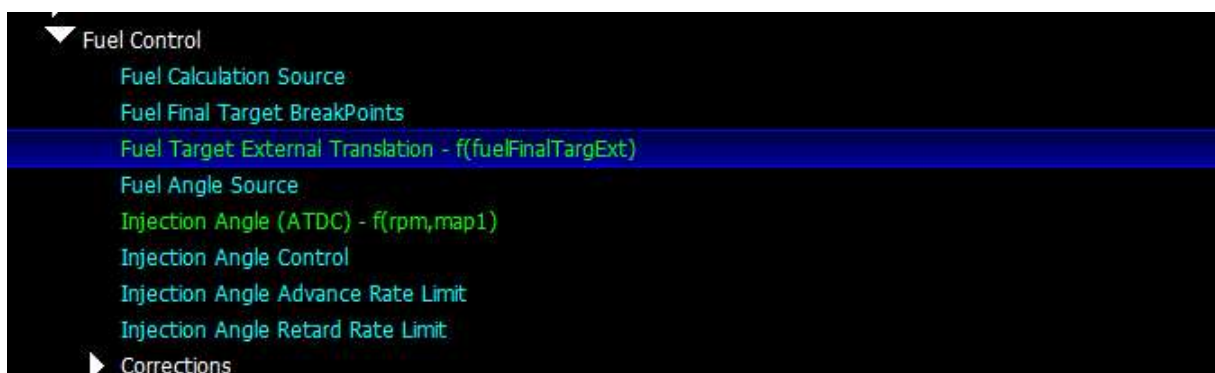


Closed Loop Lambda fuel adjustment is available which can have the lambda target set from an internal source or from an external CAN source which will need to be setup in the GenericRx Datastream area.

As two NTK lambda circuits are available on the OEX, calibrators can wire in 2 NTK lambda sensors direct or pickup the OEM ECU lambda readings using the OBD2 protocol or GenericRX CAN Setup. The Closed loop control is useful if you have the OEM Target from CAN as it keep the OEM ECU Short term trims in check which can also be monitored via OBD2.

External Mode

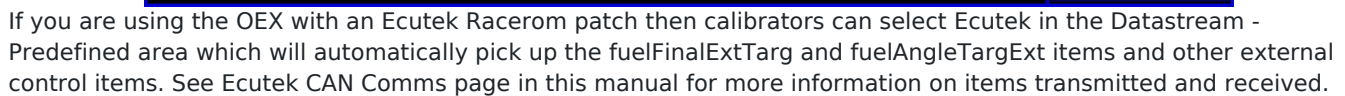
If External mode is selected, the OEX will control the Injector opening times and fuel mass from an external controllers target millisecond value and the OEX acts as purely a slave based on the fuelFinalExtTarg item data.



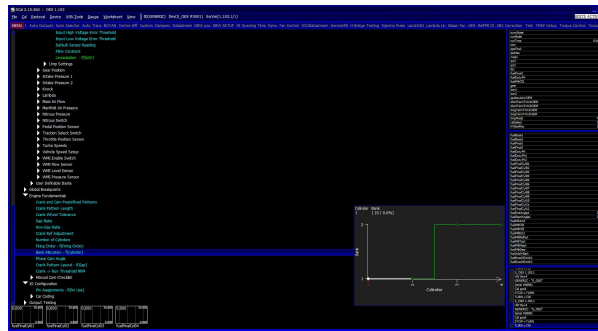
Cylinder Corrections are still controlled via the OEX internally and the fuel target linearisation can be adjusted if calibrators want to adjust the demanded fuel amounts. As Default this calibration is setup 1:1

Fuel injection angle can also be control externally with the OEX by changing the Fuel Angle Source map to External. When set to External the Fuel Angle is setup from the item - fuelAngleTargExt. Make sure the source which is sending the target Is matching Injection Angle Control setup in the OEX. Either Start or End.

The fuelFinalExtTarg and fuelAngleTargExt items which is used for the external calculations can be setup to be received in the Datastream - Generic RX area where calibrations can setup a unique CAN identifier, bit selections, scaling and offsets to match incoming CAN data.



Engine bank allocation



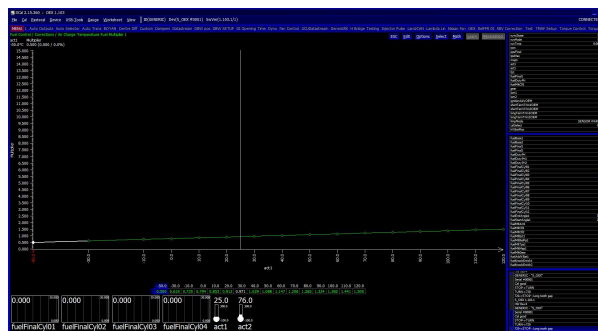
V Engines which fundamentally split the engine into banks need to be setup carefully on the OEX to ensure that the correct fuelling and wastegate control is applied for each section of the engine.

The bank allocation map under the fundamentals section of the calibration tree allows users to input the cylinders which are on each bank.

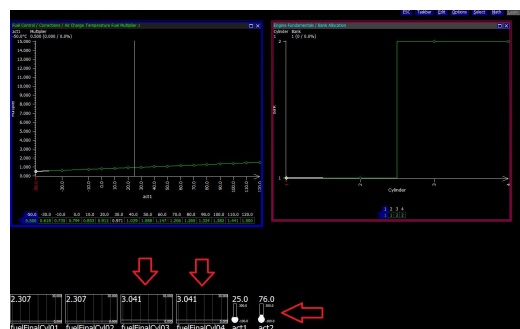
The following strategies are affected by the bank allocation:

*Internal Fuel Control *External Fuel Control *Internal Wastegate Control - Manifold Pressure 2 is used for DT and Err calculations *External Wastegate Target - Manifold Pressure 2 is used for DT and Err calculations

The above strategies are implementing bank corrections when the following sensors are assigned:



*Air Charge Temp 2 - Effects Fuel Control - Air Charge Temp 1 Multiplier - fuelMltAct2 *Engine Coolant Temp 2 Effects Fuel Control - Engine Coolant Temp 1 Multiplier - fuelMltEct2 *Fuel Pressure 2 - Effects Fuel Control - Relative Fuel Pressure 1 Multiplier - fuelMltRelFp2 *Lambda 2 - Effects Fuel Control - Corrections - Closed Loop Lambda - FuelMltClI2 *Manifold Pressure 2 - Effects Fuel Control - Manifold Pressure 1 Multiplier - fuelMltMap2 *Throttle Position 2 - Effects Fuel Control - Throttle Position 1 Multiplier - fuelMltTps2



If a 2nd Air Charge Temperature sensor is assigned and a 2nd bank is setup then the correction for Air Charge Temp under Fuel Control will apply based on the readings from Act2.

FuelFinalCyl03 and 04 are higher due to the increased temperature on ACT2 and fuelMltAct2 being higher

Wastegate control - internal strategy

The OEX can support internal strategy logic where calculations are done inside the OEX, or external strategy logic where the OEX responds to external wastegate duty targets or manifold pressure targets.

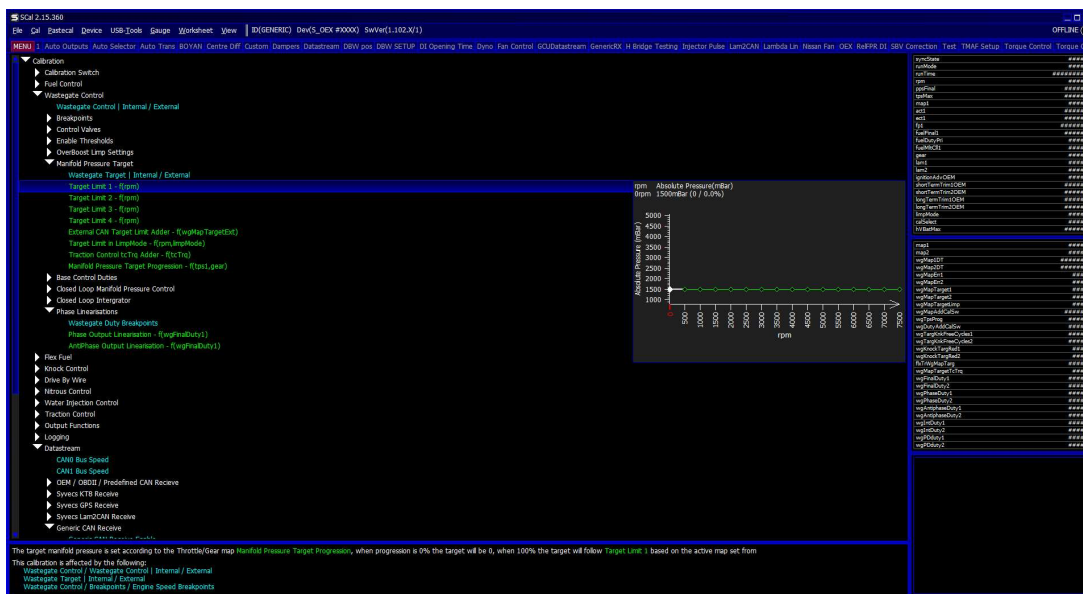
Internal Strategy Control

The Wastegate Control function is a powerful open and closed-loop capable system for controlling manifold pressure. Key features:

- Target boost vs Throttle/RPM/Gear or CAN Target
- Closed loop control or External CAN Duty Control
- Boost reduction (system disables) if OEX detects LIMP condition.

The following explains the process in configuring the Wastegate Strategy, and assumes the boost solenoid is correctly fitted and configured in IO Configuration > Pin Assignments (Usually Wastegate 1 Phase)

1. Set the PWM Frequency for the solenoid used and Output drive type, most solenoid are best control low side drive
2. Set the Enable Engine Speed and Engine Throttle Position
3. Set the desired boost level in Wastegate Control > Manifold Pressure Target > Target Limit 1 This is an absolute value, taking into account atmospheric pressure. For example, 2 bar gauge boost at 1 bar atmospheric pressure corresponds to 3000 mbar absolute.



4. Other target adders and multipliers can effect the wgMapTarget which can be found under the target limits and calibration switches section. This can be useful to limit the manifold pressure in the event of a LimpMode, lower gears or traction control tcTrq adjustments

5. Populate the Wastegate Base duty table for the different wgMapTarget values as a function of engine speed. These can be approximate as the closed loop system can be enabled on top of the base. Note that the table is boost target (wgMapTarget) VS rpm. You would expect the map to show more duty as the wgMapTarget increases. Most wastegates start to open around 20-30% Duty. It makes sense to start low and add more if required.

Wastegate control - closed loop and external targets

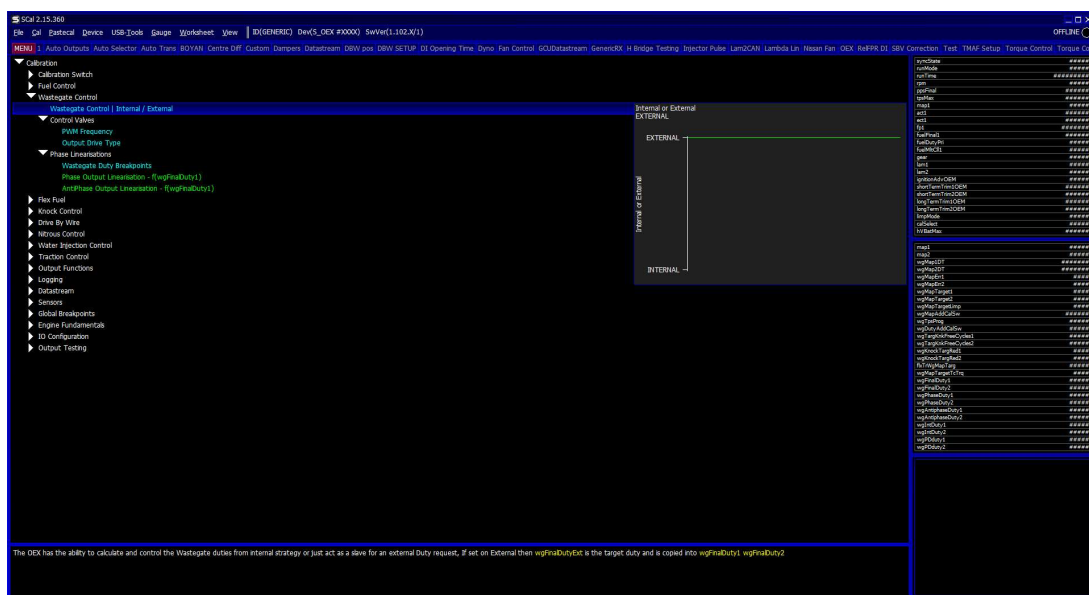
6. Ensure Wastegate Control > Closed Loop Manifold Pressure Control > Enable Closed Loop Control is enabled and setup the PD Duty table and Integrator gains to adjust the wastegate duty based on error in the system compared to the target. 7. Choose the desired Wastegate Target Select from within Calibration Switch > Wastegate Control > Wastegate Target Select. In this example this must be set to 1.

Tips: 1. Calibration Switch > Wastegate Control > Wastegate Control Map Target Adjustment can be configured to allow an external calibration switch to select different boost levels via means of an external configured CAL switch. 2. To monitor boost controller functions from within SCal from the top menu: Gauge > Add add the following: wgMapTarget, wgBaseDuty, wgFinalDuty. Using these values you can adjust Wastegate Control > Manifold Pressure Target > Target Limit 1 map until the values wgBaseDuty, wgFinalDuty closely match during a run. These can also be configured in logging, and reviewed after. 3. Note that Wastegate Control > Manifold Pressure Target > Manifold Pressure Target Progression alters boost target vs TPS vs Gear. This can be tuned to match a particular application, on a per gear basis. It's a key setting to getting a turbo car to be predictable and drivable without the traditional on/off effect of almost all external boost controllers. In order for this to work, TPS will need to be configured in IO Configuration > Pin Assignments. 4. OverBoost Limp is useful to trigger a LimpMode in the OEX in the event the manifold pressure exceeds the Over-Boost Manifold Pressure Limit and Over-Boost Allowed Time.

External Strategy Control

The Wastegate Control logic can also be done externally by an OEM ECU or another module which feeds in a wgMapTargetExt and wgFinalDutyExt target via CAN. This can be setup in the DataStream - Generic CAN Receive or via a preselect CAN stream.

Calibrators can select the Internal or External option for the overall control at the top of the wastegate tree. External selection here just allows users to set a PWM Frequency, Output Drive Type and Phase Output Linearisation for driving the solenoid based on the requested wgFinalDutyExt.



If calibrators wish for the control strategy to still be done via the OEX but have an external system setting the target they can do this via selecting External targetting option in the Manifold Pressure target area. The OEX will then set wgMapTarget based on the value from wgMapTargetExt.

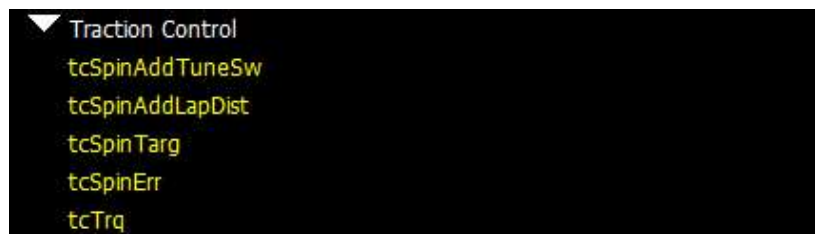
Traction control - strategy

The Syvecs Traction control strategy is derived to provide a solution for variety of motorsports racing series, as well as road or track use. It is a multidimensional approach to dealing with varying conditions of adhesion. Traction control is active when Overall Enable is ENABLED and vehicleSpeed exceeds Minimum Vehicle Speed and Minimum Pedal Position is exceeded.

First wheelSpin is calculated as $(\text{drivenSpeed} - \text{vehicleSpeed}) / \text{vehicleSpeed}$ in %. Its important to make sure the Vehicle Speed and Driven Speed has been setup in Sensors - Vehicle Speed Setup - Veh / Driven Select.

The wheel spin target, tcSpinTarg is calculated by modifying the base values (Spin Target 1/2/3/4) by a calibration switch, lap distance and tune switch settings (Calibration Switches / Traction Control / Traction Control Spin Target Adder, Calibration Switches / Traction Control / Traction Spin Target Multiplier) and limiting the result (Minimum Spin Target, Maximum Spin Target). tcSpinErr is then calculated as $\text{wheelSpin} - \text{tcSpinTarg}$. The overall torque reduction demand (tcTrq) is then calculated as tcSpinErr multiplied by Base Gain and Calibration Swtiches / Traction Control / Traction Control Gain Tuning and clamped by Torque Reduction Clamp. The tcTrq is then linked into the wastegate control strategies and also can be sent very fast on CAN to OEM Controllers to do Torque limiting.

Helpful items to log at a minimum of 100Hz:



If Overall Enable is set to other than DISABLED is selected, then ensure that Vehicle Speed Breakpoints, Steering Wheel Angle Breakpoints, Lateral G Breakpoints, and Yaw Breakpoints are set accordingly. If the data highlighted in blue has been changed, remember to “program” the calibration into the ECU before moving on. With Traction Control ENABLED, maximum wheel spin can be precisely controlled. There are three strategies to choose from.

Yaw Based Traction

Use when the rotational rate of the car around its centre of mass can be monitored. This is the best control strategy for road racing, as it compensates for rotational instability.

Traction control - tables and tuning

Lateral G Based Traction

Utilizes lateral acceleration sensor to limit the front to rear tire slip as the lateral G increases. It could sometimes be insufficient in Road Race scenario because the lateral G could decrease as tire slip increases and cause the targets to allow additional available torque from the engine thereby increasing slip further and causing the car to become unstable. This strategy is preferred for Drag Racing applications where the car is not pushed to its traction limits laterally.

Table Descriptions:

Minimum Vehicle Speed

The minimum speed for Traction control to be active

Minimum Pedal Positon

The minimum ppsFinal for Traction control to be active (ppsFinal will follow TpsMax if not assigned)

Spin Targets 1,2,3,4 - f(vehicleSpeed, latGAbs)

3D Wheel speed targets with axis based on Traction Control Overall Enable strategy and vehicle speed.

Minimum Spin Target

This prevents strategy activation if the slip is lower than the absolute minimum desired. In theory, the drive wheels will always have a slight amount of slip over the Un-Driven wheels. It is up to the user to determine the realistic and allowable minimum amount.

Maximum Spin Target

This is the absolute maximum allowed slip regardless of the calibration and multipliers.

Base Gain - f(vehicleSpeed)

The overall torque reduction demand tcTrq is calculated as tcSpinErr multiplied by Base Gain. This table is used for overall sensitivity by vehicleSpeed, when tcTrq is active. Higher numbers produce a larger TcTrq value.

Torque Reduction Clamp - f(rpm)

This sets the maximum allowed tcTrq.

Tuning Tips:

The Traction control area of the Syvecs can be extremely effective when setup correctly, the first thing to remember is that the Target Slip tables are based on a % and the Torque reduction is only applied when the WheelSpin parameter (which is wise to log fast) is greater than the TcSpinTarg. WheelSpin is calculated as (drivenSpeed-vehicleSpeed) / vehicleSpeed in % so its important to remember that at slow speeds the difference in Speed between driven and Vehicle although small has a much larger % value and the slip target table needs to be set a lot higher to ensure the traction control does not apply TcTrq adjustments when difference is small.

Traction control - worked slip example

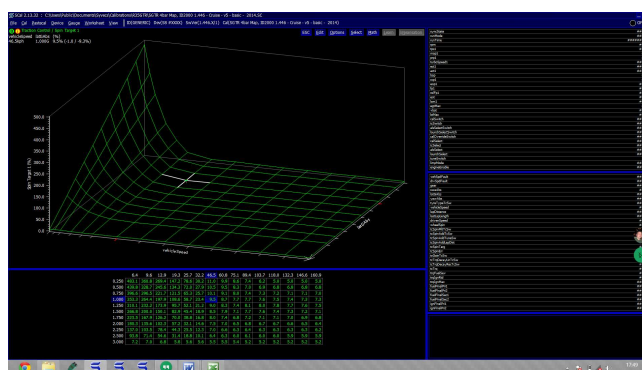
Wheel spin (%) = 100 x (drivenSpeed - vehicleSpeed) / vehicleSpeed. The following values are recalculated from the speeds printed in the source example; both speeds use mph.

Vehicle speed	Driven speed	Calculated wheel spin (%)
4	24	500
6	24	300
8	24	200
12	24	100
16	24	50
20	24	20
25	26	4
30	24	-20
40	40	0
50	50	0

The raw calculation is negative when driven speed is below vehicle speed. Zero vehicle speed is undefined in this formula; the strategy uses its configured minimum-speed conditions.

Traction control - calibration examples

Example Traction slip table



Once Torque is under control you can tweak the gain to adjust the levels of TcTrq calculated based on vehicle speed to make the system more or less sensitive. Generally its set more sensitive at high speeds where loss of traction can carry a lot more energy in the movement of the car. A valuable parameter when setting up traction control is Longitudinal G which is available from a Syvecs GPS/IMU Module, you can use this to monitor how the vehicle is accelerating to maximise accel. On certain tyres, allowing the tyre to slip 5% gains more accel where friction energy from slip is added to the tyres compound to add adhesion.



Data logging - configuration

The OEX supports logging direct to a laptop internal memory or to an external memory stick allowing data rates up to 4000 times a second to ensure nothing is missed.

Logging start and stop trigger points can be setup in SCal which both OEX logging systems will follow.

Details on setting up the items that are logged and the frequency they are logged at can be found by pressing F1 in the logging section or following instructions below.

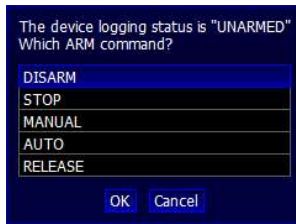
Data is logged in blocks of 6 monitoring items. Each block will be logged at the frequency selected in DataloggingFreq. If a speed above 100Hz is required, log the same item in more than one block, with each block set to 100Hz, but with a separation of $4000/(\text{rate})$ blocks, so for example for 400Hz, put the same item in Block 1, 11, 21, and 31.

Overall, Enable or Disable status is found under the calibration switch area and is based on the CalSelect position



If enabled, datalogging must be Armed in SCal via USB-Tools - ARM Logging - AUTO.

Data logging - triggers and recording



If a Memory Stick is connected then logging will be automatically Armed and arming via SCal is not necessary

Once Auto is selected the USB-Tools will flash yellow to signal the logging system is ARMED but not logging



Logging will then begin when:

-Rpm is at or above DataloggingRpmStart and -TpsMax is at or above DataloggingTpsStart and -VehicleSpeed is at or above DataloggingSpeedStart and - Datalogging Enable Cal Select (Enable)

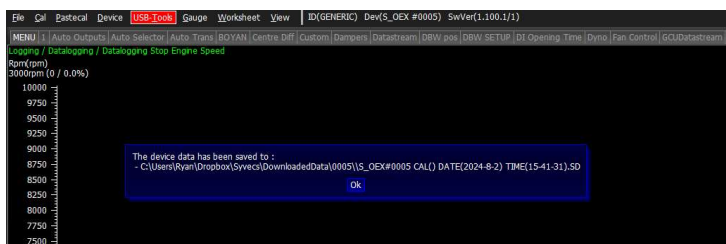
The USB-Tools will turn Green when the logging has started



Once logging, it will cease under any of these conditions :

-Commanded to Stop by SCal - USB Tools - ArmLogging - STOP -Change in CalSelect datalogging switch disables logging -Rpm remains below DataloggingRpmStop and -TpsMax remains below DataloggingTpsStop and -VehicleSpeed remains below DataloggingSpeedStop for DataloggingTimeOut milliseconds. -USB Stick removed

When logging stops it causes USB-Tools to change to RED and will automatically save the file into the working directory for the Serial number of the device. As shown below.



USB memory-stick logging

The Syvecs OEX allows for external memory stick logging with speeds up to 4000hz per item. In order to achieve this a good quality USB Stick with low latency and fast read/write speeds is required, we suggest the Kingston DataTraveler Max with a Male USBC to Female USB Adaptor.

<https://www.kingston.com/unitedkingdom/en/usb-flash-drives/datatraveler-max>

The Drive must be programmed in FAT32 format, as standard FAT32 is only supported to 32gb in windows but a program called FAT32 Formatter can do larger. This can be downloaded here www.syvecs.com/downloads/FAT32_Format.zip

The USB Memory stick can then be plugged into the USB port on the OEX to allow easy logging for end users.

Logging will then begin when:

-Rpm is at or above DataloggingRpmStart and -TpsMax is at or above DataloggingTpsStart and -VehicleSpeed is at or above DataloggingSpeedStart and -Datalogging Enable Cal Select (Enable)



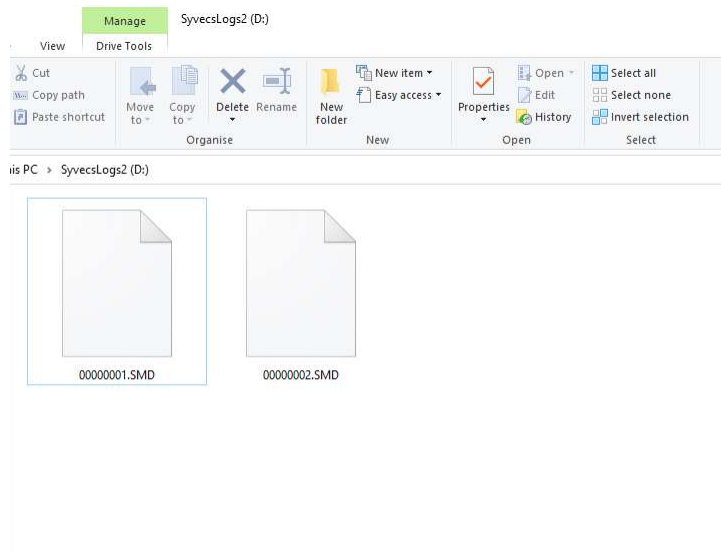
Users are then able to remove the USB Stick when logging has been disabled or the power is turned off to the OEX.

Logging will cease under any of these conditions :

-Change in CalSelect datalogging switch disables logging -Rpm remains below DataloggingRpmStop and -TpsMax remains below DataloggingTpsStop and -VehicleSpeed remains below DataloggingSpeedStop for DataloggingTimeOut milliseconds. -USB Stick removed

Log conversion for SView

The log files saved on the USB Memory stick will be in .SMD format, these can be zipped up to a much smaller size to transfer to your dealer or support.



To convert the .SMD files to .SD files which are used with Syvecs logging program Sview, users need to open SCal and click USB-Tools - Demux Logging File

Select the USB Drive or location of the .SMD files and click OK

The files will then be converted and saved under the working directory of the OEX Serial number.



The device data has been saved to :
- C:\Users\Ryan\Dropbox\Syvecs\DownloadedData\0005\S_OEX#0005 CAL() DATE(2024-8-2) TIME(15-41-31).SD

Ok

Analogue and pulsed signal outputs

A Key feature of the OEX is the ability to manipulate an incoming 0-5v analogue sensor value and pass it back out modified as required.

The process works like this:

1. Connect a signal to be modified to an available AN input (AN01-AN20). Note: It is not necessary to assign this input from within IO Configuration > Pin Assignments unless you require a pull up for a temperature sensor for example.
2. Connect the output of the signal to a spare DAC channel (pins A21-A24).
3. Select the desired input AN channel (as used in step 1) to Output Functions > Signal Modifier (1/2/3/4)> Input Select
4. Assign the above output to a Signal Modifier DAC channel from within IO Configuration > Pin Assignments (pins A21-A24).
5. The signal will now be passed through the relevant signal modifier and is configurable from within Output Functions > Signal Modifier (1-4).

Configuration of Signal Modifiers

Each of the four Signal Modifiers has a 3D map with adjustable breakpoints, a second multiplier map based on Cal switch position and finally an output voltage clamp. The load axis of the map can be changed from the top menu by using View > Customising Options. It is also possible to rename each Signal Modifier from this menu. This will then switch the calibration screen to show all the available customising options available within the calibration. In this case are all shown under Output Functions Once you have selected the Axis you want, selecting View > Customising options again will take you back to the main map. You will need to save this and Device > Program the unit for the changes to take effect

After this configuration is complete, the signal will enter the selected AN input, be modified by the signal modifiers and passed back out of the chosen DAC output. Examples of this are OEM MAP sensors where intercepting and clamping this signal will allow you to run more boost with the additional fuelling requirements taken care with by the Fuel control options available within the OEX.

Custom Signal Outputs

In addition to the above. The OEX also allows you to create output voltages based on various conditions. For example: Output Function > Signal output(1/2/3) > Output value shows a map that will output a voltage VS RPM/Manifold pressure. Should you want to change the axis of these to another sensor that can be achieved through View > Customising options from the top menu. This will then switch the calibration screen to show all the available customising options available within the calibration. In this case are all shown under Output Functions Once you have selected the Axis you want, selecting View > Customising options again will take you back to the main map. You will need to save this and Device > Program the unit for the changes to take effect

Custom Pulsed Outputs

In exactly the same way above, you can create custom PWM outputs from within Output Function > Custom PWM Control (1 2). Again you are also able to select the Axis that these outputs relate as already described.

Resource check: only assign a general-purpose signal output to a DAC channel available on the supplied hardware. DAC1/2 remain reserved when their NTK lambda circuits are in use.

CAN forwarding and frame filtering

CAN bus is a communication bus used in most vehicles today. When adjusting engine control in sync with the OEM Engine Control Units (ECUs), there may be instances where CAN frames need to be modified to achieve tasks like stopping torque limits from external modules, such as a gearbox ECU, or removing a CAN message/byte that is causing a warning light to appear on the dashboard.

The OEX is highly beneficial in these situations, as it allows CAN0 and CAN1 to act as a bridge or gateway with the CAN connection you want to modify. This enables calibrators to adjust the CAN data coming out of the OEM ECU before it is transmitted to the rest of the vehicle.



Calibrators can first select the option to forward the CAN frames in a specific direction. Since a CAN network typically has many TX and RX frames, it is advisable to enable forwarding in both directions: from CAN0 to CAN1 and from CAN1 to CAN0.

When forwarding is enabled, options are available to drop a CAN frame/identifier as well as to make byte adjustments in a specified CAN frame/identifier.

Dropping CAN frame/identifiers

Dropping a CAN frame/ID is done by entering the hex ID value in the "CAN Identifiers to Drop" map. To drop the 0x105 frame, you would enter 105H in the first map cell. Please note that if you want to drop multiple CAN frames/IDs, the values in the map need to increase from left to right, such as 105H, 230H, etc.

CAN byte modification

It can be very useful to modify a single byte of data in a CAN frame/ID to remove warnings and errors on a dashboard. This is possible with the OEX by first selecting the CAN frames/IDs that the calibrator would like to adjust. A value of 0x1FFFFFFF is void, and hence no adjustment will occur.

The option is available for 8 frames to be adjusted. Enter the hex value for the frame with an "H" at the end. For example, 0x660 would be entered as 660H.

The byte adjustment table allows users to enter a new byte of data into the frame that was set above. Values of 100H mean no adjustment, and the OEX will simply forward the byte being received. If a value less than 100H is entered, it will be transmitted in the modified CAN transmission on the bridged CAN bus.

Worked example: change one payload byte

Illustrative CAN identifier 660H, forwarded from CAN0 to CAN1. Replace the third payload byte with 2AH; leave all other byte-adjustment cells at 100H to pass their received values through. This is a format example, not a vehicle-specific CAN message.

CAN0 receives	OEX byte modifier	CAN1 transmits
ID 660H	Third byte = 2AH	ID 660H

Payload	1	2	3	4	5	6	7	8
Received	10	20	30	40	50	60	70	80
Adjustment	100H	100H	2AH	100H	100H	100H	100H	100H
Forwarded	10	20	2A	40	50	60	70	80

Payload values are hexadecimal. Byte positions here are counted from 1; use the corresponding cell in the installed calibration. 100H is a pass-through setting, not a byte transmitted on the bus.

Setup and verification

Enable forwarding in the required direction, enter the identifier in the frame-selection map, and change only the intended byte. Leave unused frame entries at 1FFFFFFH and unchanged byte cells at 100H. Capture CAN traffic on both sides and compare the identifier, payload length and each byte.

A byte replacement affects all eight bits in that byte. Where the message contains a checksum or rolling counter, the replacement must remain valid for the receiving module. Verify the result against the actual message definition and receiver response.

Knock detection and control

Knock Detection

The OEX has 2 on-board Knock inputs which can be connected into existing knock circuits on OEM ecu applications. This is generally done by a T connection into the Knock signals but you can also fit external knock sensors on the Engine if required and wire direct to the OEX.

The Knock sensors need assigning in the IO Configuration - Pin Assignments, here assign which Knock input is assigned to which cylinders. This is best done based on the bank allocation of your engine in which one sensor is used on each bank.

The Sensors - Knock area is the next section to go over to edit the calibrations that suit your engine and cylinder configuration. Press F1 on each map to see the help comments

Knock control - wastegate and fuel corrections

After a per-cylinder knock event is detected, control becomes active when the engine-speed, throttle-position and manifold-pressure enable conditions are satisfied. The OEX can apply wastegate target reduction and fuel enrichment.

Map / function	Action
First Event	Applies the initial correction when a knock event is detected and no event is already active.
Step	Adds a correction for each further event while knock control is active.
Severe Event	Applies the severe-event correction when a severe event is detected with no event already active.
Non-Knocking Cycles	Sets how many engine cycles without knock are required to remove an event from the active list.
Reinstate Step	Removes the applied correction progressively when no knock events are detected.

Set Maximum Target Reduction and Maximum Fuel Enrichment so the corresponding limp thresholds can be reached before the correction limits. This allows excessive correction to trigger the configured LimpMode warning to the OEM ECU and driver.

Knock detection - thresholds

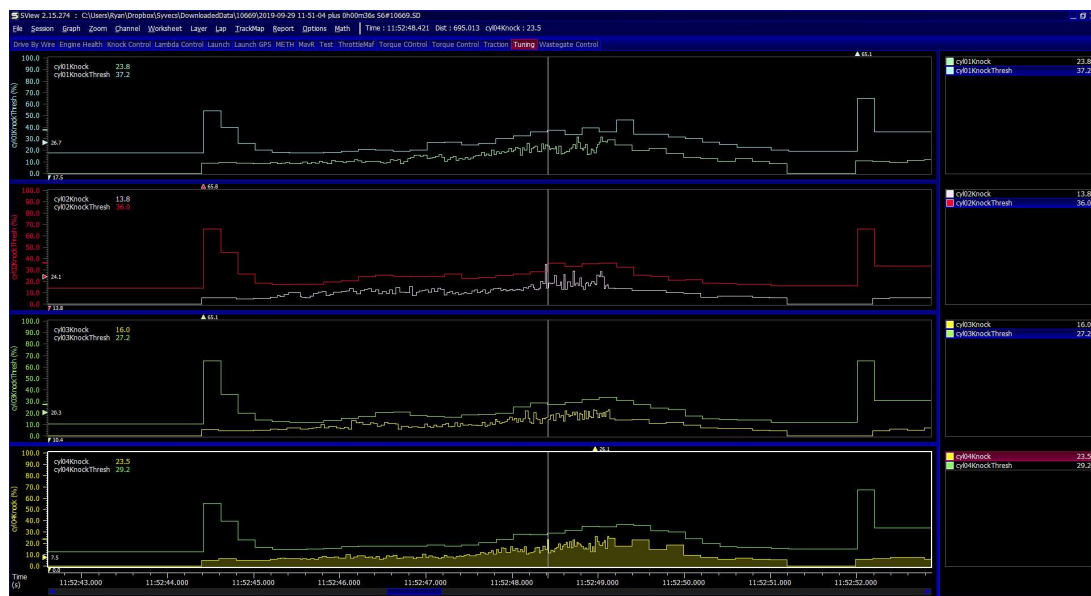
The Knock detection will start when the RunMode is in RUN and the Rpm is greater than set in Knock Detect Enable Engine Speed. The Detection strategy will first check the Knock Bandpass Filter Centre Frequency and Knock Integrator Time Constant values to base the raw knock levels on, this will then be sampled during the window set in Window Start to Window End.

An overall Knock Gain is further applied to all the cylinder values computed but the option to adjust the gain per cylinder can be done in Knock Gain Tuning.

Calibrators can datalog the sampled cylinder knock values in items Cyl1Knock to Cyl12Knock which aids in spotting visually spike in knock or pre-Ignition.

The Cylinder knock values are then further processed and sampled into a knockbase level which calibrators can then adjust threshold maps against per cylinder to trigger a knock event.

The Event Detection Level is used for setting a standard knock event and Severe Event Detection Level is used for detecting a severe event. The Values in Severe Event Detection Level should be higher than in Event Detection Level.



Cyl01Knock to Cyl04Knock logged with thresholds

If the cylinder knock values go past the level set in Pre-Ignition Detection Level then the cylinder will be marked in error and a limp activated.

Predefined CAN streams

The original manual entries are supplemented by profiles decoded in the supplied carmodels.c. Code presence is not confirmation of support in every released OEX firmware or vehicle variant. Confirm the installed firmware selection and CAN interface before use. Blank cells indicate no channel marked in the manual or decoded by the added profile.

Engine channels

ECU / vehicle	RPM	MAP	TPS	PPS	Mode	Trq A	Trq D
Audi Mk2 TTRS / RS3	Y		Y	Y		Y	Y
Audi Mk3 TTRS / RS3 / S3	Y	Y	Y	Y	Y	Y	Y
Audi R8 Gen1	Y		Y	Y		Y	Y
Audi R8 Gen2	Y	Y	Y	Y	Y	Y	Y
BMW E46	Y		Y	Y		Y	Y
BMW E92	Y		Y	Y		Y	Y
BMW 2020	Y		D	Y	Y	Y	Y
BMW G8x	Y		D	Y	Y	Y	Y
Canam 2010+	Y	Y	Y	Y	Y	Y	Y
Canam 2022+	Y	Y	Y	Y	Y	Y	Y
Corve(cid:425)e Z06	Y		Y	Y		Y	Y
ECUMASTER	Y	Y	Y	Y			
Evo X	Y	Y	Y	Y	Y	Y	Y
Ford Focus Mk2	Y		Y	Y	Y	Y	Y
Ford Mustang	Y		Y	Y	Y	Y	Y
FuelTech (aftermarket)	Y	Y	Y				
Honda FD2/FN2	Y	Y	Y	Y		Y	Y
Honda FK2/FK8	Y		Y	Y		Y	Y
Infini(cid:415) Q60	Y		Y	Y	Y	Y	Y
Jeep 2022	Y		Y	Y	Y	Y	Y
Lamborghini LP520	Y		Y	Y		Y	Y
Lamborghini LP560	Y		Y	Y		Y	Y
Lamborghini Huracan	Y	Y	Y	Y	Y	Y	Y
Lamborghini Aventador	Y	Y	Y	Y	Y	Y	Y
LandRover Defender 90 110	Y		Y	Y		Y	Y
Lexus 2024 profile	Y	Y	Y	Y	Y	Y	Y
LINKECU	Y	Y	Y	Y			
McLaren 12c,650,675,570,600, 720,765,P1	Y	Y	Y	Y	Y	Y	Y

Y = marked in the manual or decoded in supplied code; D = derived; C = scaling requires validation; Q = diagnostic response required.
Trq A/D = torque actual/demand; Mode = drive mode; ACT/ECT/EOT = air/coolant/oil temperature.

Predefined CAN streams - engine channels (continued)

Engine channels

ECU / vehicle	RPM	MAP	TPS	PPS	Mode	Trq A	Trq D
Mercedes Gen1 E55 C63	Y	Y	Y	Y		Y	Y
Mercedes Gen2 C63 SLS	Y	Y	Y	Y	Y	Y	Y
Mitsubishi Evo X	Y		Y	Y	Y	Y	Y
MoTeC M1	Y	Y	Y	Y	Y	Y	Y
Nissan 370Z	Y	Y	Y	Y	Y	Y	Y
Nissan Patrol Y61	Y		Y	Y		Y	Y
Nissan Patrol Y62	Y	Y	Y	Y		Y	Y
Nissan R35GTR	Y	Y	Y	Y	Y	Y	Y
Nissan Y63	Y			Y	Y		
Porsche 991 / 981 / GTS / GT2RS / GT3	Y	Y	Y	Y	Y	Y	Y
Porsche 996	Y	Y	Y	Y	Y	Y	Y
Porsche 997/987	Y	Y	Y	Y	Y	Y	Y
Porsche 992	Y		Y	D	Y		
Simos 18	Y	Y	Y	Y	Y	Y	Y
Subura Impreza My15+	Y	Y	Y	Y	Y	Y	Y
Suzuki 2013+	Y	Y	Y	Y		Y	Y
Syvecs Ecu's	Y	Y	Y	Y	Y	Y	Y
Toyota Yaris Gr	Y	Y	Y	Y	Y	Y	Y
Toyota LandCruiser/Lexus LX570	Y	Y	Y	Y		Y	Y
Toyota GT86 /BRZ	Y			Y		Y	Y
Toyota Supra 2020	Y		D	Y	Y	Y	Y
Toyota Land Cruiser 2024	Y	Y	Y	Y	Y	Y	Y
VAG Me7	Y		Y	Y		Y	Y
VAG MED9	Y		Y	Y		Y	Y
VAG MED17	Y	Y	Y	Y	Y	Y	Y
VW Golf Mk5/6 Seat TFSI/TSI, Audi TSI/TFSI	Y		Y	Y		Y	Y
VW Golf Mk7 MQB Seat MQB Audi MQB	Y	Y	Y	Y	Y	Y	Y
Yamaha YXZ	Y		Y	Y		Y	Y

Y = marked in the manual or decoded in supplied code; D = derived; C = scaling requires validation; Q = diagnostic response required.
Trq A/D = torque actual/demand; Mode = drive mode; ACT/ECT/EOT = air/coolant/oil temperature.

Predefined CAN streams - vehicle channels

Temperature, gear and vehicle channels

ECU / vehicle	ACT	ECT	EOT	Gear	Brake	Speed	LatG	LongG
Audi Mk2 TTRS / RS3		Y	Y	Y	Y	Y	Y	Y
Audi Mk3 TTRS / RS3 / S3	Y	Y	Y	Y	Y	Y	Y	Y
Audi R8 Gen1		Y	Y	Y	Y	Y	Y	Y
Audi R8 Gen2	Y	Y	Y	Y	Y	Y	Y	Y
BMW E46		Y	Y		Y	Y		
BMW E92		Y	Y	Y	Y	Y		
BMW 2020		Y	Y	Y	D	Y		
BMW G8x		Y	Y	Y	D	Y		
Canam 2010+	Y	Y		Y		Y		
Canam 2022+	Y	Y		Y		Y		
Corve(cid:425)e Z06		Y			Y	Y		
ECUMASTER	Y							
Evo X	Y	Y	Y	Y	Y	Y	Y	
Ford Focus Mk2	Y	Y		Y		Y		
Ford Mustang	Y			Y		Y		
FuelTech (aftermarket)	Y	Y	Y	Y		Y		
Honda FD2/FN2		Y			Y	Y		
Honda FK2/FK8		Y	Y		Y	Y	Y	Y
Infini(cid:415) Q60		Y		Y	Y	Y	Y	Y
Jeep 2022				Y	Y	Y		
Lamborghini LP520		Y	Y	Y	Y	Y	Y	Y
Lamborghini LP560		Y	Y	Y	Y	Y	Y	Y
Lamborghini Huracan	Y	Y	Y	Y	Y	Y	Y	Y
Lamborghini Aventador	Y	Y	Y	Y	Y	Y	Y	Y
LandRover Defender 90 110		Y				Y		
Lexus 2024 profile		Y	Y		C	Y	C	C
LINKECU	Y	Y	Y			Y		
McLaren 12c,650,675,570,600, 720,765,P1		Y		Y	Y	Y		

Y = marked in the manual or decoded in supplied code; D = derived; C = scaling requires validation; Q = diagnostic response required.
Trq A/D = torque actual/demand; Mode = drive mode; ACT/ECT/EOT = air/coolant/oil temperature.

Predefined CAN streams - vehicle channels (continued)

Temperature, gear and vehicle channels

ECU / vehicle	ACT	ECT	EOT	Gear	Brake	Speed	LatG	LongG
Mercedes Gen1 E55 C63		Y		Y	Y	Y		
Mercedes Gen2 C63 SLS	Y	Y		Y	Y	Y		
Mitsubishi Evo X	Y	Y	Y	Y	Y	Y		
MoTeC M1	Y	Y	Y			Y		
Nissan 370Z		Y	Y	Y	Y	Y	Y	Y
Nissan Patrol Y61		Y		Y	Y	Y	Y	Y
Nissan Patrol Y62		Y	Y	Y	Y	Y	Y	Y
Nissan R35GTR		Y	Y	Y	Y	Y	Y	Y
Nissan Y63	Q	Q				Y		
Porsche 991 / 981 / GTS / GT2RS / GT3	Y	Y	Y	Y	Y	Y	Y	Y
Porsche 996		Y	Y	Y	Y	Y		
Porsche 997/987		Y	Y	Y	Y	Y	Y	Y
Porsche 992				Y	Y	D		
Simos 18	Y	Y	Y	Y	Y	Y	Y	Y
Subura Impreza My15+		Y			Y	Y		
Suzuki 2013+		Y			Y	Y		
Syvecs Ecu's	Y	Y	Y	Y	Y	Y	Y	Y
Toyota Yaris Gr		Y	Y		Y	Y	Y	Y
Toyota LandCruiser/Lexus LX570	Y	Y			Y	Y		
Toyota GT86 /BRZ		Y	Y		Y	Y		
Toyota Supra 2020		Y	Y	Y	D	Y		
Toyota Land Cruiser 2024		Y	Y		C	Y	C	C
VAG Me7		Y	Y	Y	Y	Y	Y	Y
VAG MED9		Y	Y	Y	Y	Y	Y	Y
VAG MED17	Y	Y	Y	Y	Y	Y	Y	Y
VW Golf Mk5/6 Seat TFSI/TSI, Audi TSI/TFSI		Y	Y	Y	Y	Y	Y	Y
VW Golf Mk7 MQB Seat MQB Audi MQB	Y	Y	Y	Y	Y	Y	Y	Y
Yamaha YXZ		Y		Y		Y		

Y = marked in the manual or decoded in supplied code; D = derived; C = scaling requires validation; Q = diagnostic response required.
Trq A/D = torque actual/demand; Mode = drive mode; ACT/ECT/EOT = air/coolant/oil temperature.

OBDII data and triggered messages

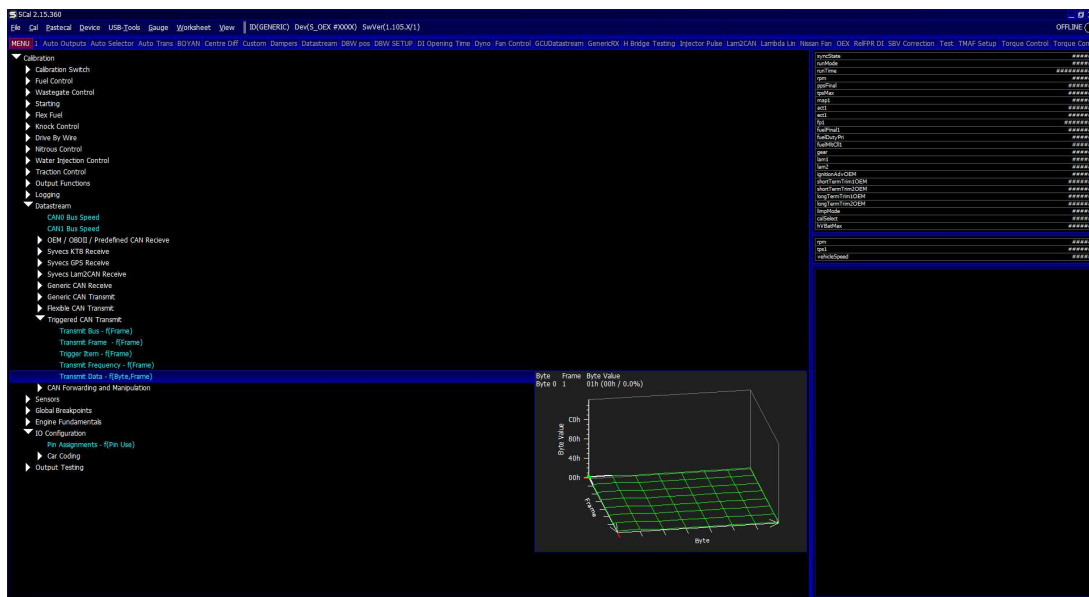
The Syvecs OEX supports CAN-based OBDII data acquisition on compatible OEM ECUs. However different data/PIDs are available between cars models so not all the OBD2 pin assignments show in the OBDII Setup section of this manual will be supported.

The OEX will prompt you after device programming if the PID is not supported.

The following data/PIDs are supported in the OEX and more can be added upon request.

OBDII:ACT OBDII:ACT2 OBDII:ACT3 OBDII:ECT OBDII:ECT2 OBDII:EOT OBDII:FP OBDII:IgnitionAdv OBDII:Lambda
 OBDII:Lambda2 OBDII:Load OBDII:LongTermFuel1 OBDII:LongTermFuel2 OBDII:MAF OBDII:MAP OBDII:MAP2 OBDII:RPM
 OBDII:ShortTermFuel1 OBDII:ShortTermFuel2 OBDII:Speed OBDII:Torque OBDII:TPS

Calibrators can also use the triggered CAN section of the OEX to send OBD2 0x7DF frames to clear DTC's and also enable custom features of the car like Dyno mode. As default the values are setup to clear DTC's



OBDII support and PID availability vary by ECU and vehicle. Select supported items and check the response after programming; CAN connectivity alone does not guarantee access to every listed value or vehicle-specific function.

EcuTek RaceROM CAN communication

The OEX CAN link supports compatible OEM ECUs with an EcuTek RaceROM patch. Select Datastreams > OEM/OBDII/Predefined CAN Receive > ECUTEK to activate the communication.

Received from EcuTek RaceROM

Item	Function
fuelFinalExtTarg	External injector opening-time target
fuelAngleTargExt	Start or end injection-angle target
wgMapTargetExt	Manifold-pressure target
wgFinalDutyExt	Wastegate duty target
wmiSwitch / wmiDuty	Water/methanol activation and duty
n20Switch / n20Duty	Nitrous activation and duty
aux1 / aux2	Auxiliary custom-function channels

Transmitted to EcuTek RaceROM

Item	Function
fuelFinal1	Final injection time
fuelAngle1	Injection angle
wgFinalDuty1	Wastegate duty
tcTrq	Traction-control torque reduction
fp1	Fuel pressure
fuelComp	Ethanol content (%)
ecp1	Engine coolant pressure
calSelect	Calibration selection
aux1	Custom input
limpMode	Limp and OEX states

The screenshot shows the Syvecs software interface with the 'Predefined CAN Receive' section expanded. The 'VAG MED17' section is highlighted, showing a list of vehicles and their corresponding CAN IDs. The 'NOT USED' section is also visible.

Vehicle	CAN ID
Toyota GT86 / Subaru BRZ / Impreza 2015+	0x2C
Subaru MY15	0x2D
Porsche 991 / 981 / GT5 / GT3RS / GT3	0x2E
Nissan 370Z	0x2F
McLaren 570 / 720 / 740	0x30
Lamborghini UTM	0x31
Lexus 570 2024	0x32
Honda Type R FK	0x33
Ford 2019 Mustang / F150	0x34
Corvette Z06	0x35
BMW E46	0x36
Audi MQ TTRS / R3	0x37
NOT USED	

EcuTek CX29 - overview and setup

CX29 provides two-way CAN communication between an EcuTek-equipped OEM ECU and the Syvecs OEX. The OEM ECU can send operating data and control targets to the OEX; the OEX can return additional sensor data, injection information, mode selections and torque-limit requests. This allows supplementary hardware and OEX strategies to work with the original engine management.

Requirements

Use OEX firmware with CX29 support and an EcuTek calibration / RaceROM version that supports CX29 on the target ECU. Enable and configure the required functions on both devices. A vehicle being listed in the predefined CAN table does not by itself establish EcuTek CX29 compatibility.

OEM ECU to OEX	OEX to OEM ECU
Sensor data, torque values and mode information	Additional pressure, temperature, lambda and fuel-composition data
Supplementary injection pulse-width and angle targets	Supplementary injection information and diagnostic status
Boost target, auxiliary values and trigger states	Torque-limit request, mode selection and custom auxiliary values

Connection and configuration sequence

Step	Setup action
1. Connect CAN	Connect the OEX to the appropriate OEM network using the CAN wiring guidance in this manual. CAN0: A19 Low / A20 High. CAN1: B21 Low / B22 High.
2. Set bus speed	Match the connected network. The training example uses 500 kbit/s; confirm the actual vehicle requirement. Program the OEX after changing blue configuration maps.
3. Configure OEM data	Select the correct predefined OEM CAN stream and its bus where required for vehicle data such as wheel speeds.
4. Select the CX29 bus	Under the EcuTek CX29 datastream settings, select the bus connected to the OEM ECU. The example uses CAN0 for both OEM data and CX29.
5. Configure receive	Enable CX29 receive, then enable only the items needed by the OEX. Configure the OEM ECU to transmit those items and flash its calibration.
6. Configure transmit	Enable CX29 transmit, allocate slots and select auxiliary sources. Configure the OEM ECU to receive and use the corresponding information.
7. Validate	Check live values, units, source ownership and timeout behaviour before enabling dependent outputs or torque requests.

Use F1 on the selected SCal map for help matching the installed firmware. Green maps are live adjustable; blue maps require Device > Program. Save both calibrations before making changes.

EcuTek CX29 - receive channels

Receiving an item is optional: the OEM ECU may transmit more items than the OEX needs. Enable only the required channels. An enabled receive item must actually be sent, otherwise its timeout can expire. Standard channels are converted into OEX internal units; auxiliary channels have configurable scaling and offset.

16-bit receive items

CX29 item	OEX destination / purpose
Triggers	Mapped status inputs such as failsafe, launch, sport and traction-disable states
Mass airflow	maf1
Actual torque / target torque	trqActual / trqDemand
Manifold pressure	map1
Actual boost / target boost	ptp1 / wgMapTargetExt
Vehicle speed	vehicleSpeed
Secondary injection pulse-width target	fuelFinalTargExt - external supplementary injection request
Secondary injection angle	fuelAngleTargExt - external injection-angle target
Auxiliary A1 / A2 / A3	cx29AuxA1 / cx29AuxA2 / cx29AuxA3; configurable scaling and offset

8-bit receive items

CX29 item	OEX destination / purpose
Triggers	Mapped auxiliary trigger inputs
Pedal position / throttle position	ppsA / tps1A
Coolant / intake-air temperature	ect1 / act1
Target lambda / actual lambda	cllTarg1 / lam1
Calibration selection / gear	calSelect / gear; verify the displayed mode and gear against the OEM ECU
Slip	wheelSpin; verify the received units and source before strategy use
Auxiliary B1 / B2 / B3	cx29AuxB1 / cx29AuxB2 / cx29AuxB3; configurable scaling and offset

Source selection and triggers

A channel already owned by a physical input or Generic CAN Receive can prevent CX29 from updating it. Check the active source if CAN traffic is present but the value does not change. Do not assume that enabling a CX29 channel overrides every other source.

Use one trigger format for a given control function and avoid conflicting assignments between 8-bit and 16-bit receive. Trigger packets contain state bits and validity bits: a trigger is updated only when its corresponding validity bit is set.

RPM and load identifiers exist in the supplied code but are not enabled receive destinations. For supplementary injection, use the required crank/cam signals and verify SyncState 720. Use the appropriate OEM RPM source for applications that do not require local engine synchronisation.

EcuTek CX29 - strategy integration

External supplementary injection

Step	Configuration and verification
Assign and synchronise	Assign injector outputs and crank/cam inputs; configure engine fundamentals and trigger decoding. Confirm correct RPM and SyncState 720 before injection is enabled.
Receive the request	Enable Secondary Injection Pulse Width Target in CX29 receive. Confirm fuelFinalTargExt responds to the OEM ECU request.
Use external calculation	Select the external fuel calculation source. The training example uses a 1:1 external translation table; verify units and the intended request-to-output relationship for the installation.
Set injection timing	For OEM-controlled timing, enable the CX29 injection-angle item, select the external angle source and enable the required injection end-angle option. Check fuelAngleTargExt.
Check operation	Verify actual injection behaviour and logs against the request. Test loss of the target message under controlled conditions before running under load.

Lambda and boost targets

Target lambda can feed the CAN lambda-target selection when using the applicable internal fuel-control strategy. Receiving cllTarg1 alone does not select that strategy. Similarly, receiving wgMapTargetExt makes the target available; configure the wastegate strategy to use its external target and validate pressure units and limits.

Auxiliary outputs

Assign a received trigger or auxiliary value to an external controlled output, custom map or supported strategy. This can support an on/off output, PWM control, water injection or nitrous functions where the corresponding OEX strategy and hardware are configured. Receiving a value does not automatically assign an output pin.

Traction-control feedback to the OEM ECU

Stage	Signal path
Measure	Receive valid wheel speeds through the selected OEM CAN stream. Configure vehicle speed; a suitable GPS source can be used where appropriate.
Calculate	Configure and validate the OEX traction strategy, speed sources, slip targets and tcTrq response.
Transmit	Send tcTrq through a selected CX29 auxiliary source, or transmit the dedicated torque-limit value from the external torque-limit table.
Apply	Configure the EcuTek ECU to interpret the received value and act on it. Confirm requested and actual torque behaviour in logs.

A traction torque-reduction value and an absolute torque-limit request have different meanings. Match the selected channel, scale and OEM strategy. The dedicated torque-limit transmitter uses trqLimExt; it is not automatically the same as tcTrq.

Mode selection

A wired OEX calibration switch can select the mode sent to the OEM ECU through the CX29 mode-selection mapping. Allocate the mode item in the transmit table, configure the matching OEM mode logic and verify every switch position.

EcuTek CX29 - transmit configuration

Enable transmit, then populate the frame table with the items the OEM ECU is configured to receive. The supplied implementation cycles through eight frames in round-robin order. Repeating an important item in multiple frame rows increases its update frequency; confirm the actual interval with a CAN log rather than assuming a fixed rate from the video example.

Slot layout and conflict rules

Slot	Permitted use	Rule
A	One 16-bit item	Always 16-bit
B + C	One 16-bit BC item OR two 8-bit items	Leave 8-bit B and C unused when BC is allocated
D + E	One 16-bit DE item OR two 8-bit items	Leave 8-bit D and E unused when DE is allocated
F	One 8-bit item	Available alongside 16-bit A, BC and DE

The configuration validator rejects overlapping BC/B/C or DE/D/E assignments. It also requires the 16-bit switch selection, if present, to use slot A. For a predominantly 16-bit layout, use A, BC and DE, then add small values in F.

Available transmit data

Width	Items implemented in the supplied code
16-bit	Secondary injection pulse-width information; torque limit; boost target maximum; manifold pressure; fuel, oil and coolant pressure; error status; auxiliary A1-A4
8-bit	Fuel composition; oil, intake-air and exhaust temperature; lambda; selected mode; auxiliary B1-B4

Auxiliary sources, scaling and offset

Each transmit auxiliary can select an OEX monitoring item. Set its scaling and offset to match the OEM receiver, then compare values at several operating points. Use 16-bit channels where resolution or range requires them and keep values within the selected representation. The default source choices are calibration-dependent.

Example allocation - illustrative only

Frame rows	16-bit A	16-bit BC	16-bit DE	8-bit F
1-4	Injection PW	Torque limit	Aux A4 (tcTrq)	Fuel composition
5-8	Injection PW	Error status	Fuel pressure	Selected mode

This repeats the injection item in all eight rows, while sharing the other channels. Leave 8-bit B-E unused in these rows. This is a slot-planning example, not a ready-to-run calibration; set auxiliary sources and OEM interpretation explicitly.

Implementation details that affect setup

The dedicated injection feedback item is sourced from fuelBase1 in the supplied implementation, so it must not be treated as a measurement of final injector on-time. The supplied transmit functions return zero for the switch-packet selections and fuel temperature; do not rely on these selections for live switch states or temperature data. Use a validated auxiliary mapping where the OEM receiver supports it.

EcuTek CX29 - validation and diagnostics

Receive timeout behaviour

Timeouts are configured per enabled receive item in the 8-bit and 16-bit timeout maps. A successfully accepted item reloads its counter; the timeout service decrements the counter and calls the item-specific default handler when it expires. Use the installed map units and help when setting the duration. Do not assume a universal one-second timeout from the demonstration.

The code issues a message in the form "Cx29: [item] timed out". Several channels use configured sensor defaults; external pulse-width and angle targets, external boost target, vehicle speed and torque values are set to zero by their respective default handlers. Trigger defaults clear mapped states. Validate each required channel and dependent strategy separately, particularly auxiliaries and mode selection; not all defaults act on the same destination as their receive path.

Troubleshooting

Symptom	Checks
No CX29 data	Check bus selection, wiring, bit rate, OEX receive enable and the OEM CX29 transmit configuration. Confirm the OEM calibration has been flashed.
One item times out	Check its individual receive enable, the OEM item selection and transmit interval. Look for the named item in SCal messages.
Traffic present, value unchanged	Check physical-input and Generic CAN Receive ownership of that item, then confirm the transmitted tag and the enabled CX29 destination.
Wrong value or range	Check source selection, standard channel units, auxiliary scaling/offset, and receiver interpretation. Validate gear and mode numbering explicitly.
Configuration clash	Remove overlapping 16-bit BC/DE and 8-bit B-E assignments. If selecting 16-bit switches, place that selection in A only.
OEM ECU does not respond	Check that the required transmit item is allocated and the OEM ECU is configured to use it. Compare requested values with received values and resulting OEM strategy behaviour.
Injection does not operate	Check local RPM, SyncState 720, injector output assignments, external fuel source and a valid pulse-width target.
Switch transmit remains zero	The supplied switch-packet transmit cases return zero. Do not depend on them without verified firmware support.

Error-status feedback

The status word contains one limp code, not a bit per fault. Bit 15 (0x8000) is the warning flag: 1 = warning; 0 = fatal for a non-zero limp code. A zero status means no reported error. Decode the limp code with status & 0x7FFF; the enum definitions are needed for its numeric values.

Bit 15	Status / flag names in cx29.c
1 - Warning	LEVEL, PRESSURE, FLOW, ACT, EOT, OVERBOOST, KNOCKFUEL, KNOCKWG, KNOCKIGN
0 - Fatal	SENSORWARN, LEANLAM, ECT, EOP, FUELP, DBW, ECP
0 - No error	NONE
Special: 0x0064	Debounced synchronisation loss. Reported when supply is above 8 V, a crank input is assigned, OEM RPM is above 500 and SyncState is not 720 for the qualifying count.

Names above omit the OEXLIMP_ prefix. ACT/ECT/EOT = air/coolant/oil temperature; EOP/ECP = oil/coolant pressure; FUELP = fuel pressure; DBW = drive-by-wire. The code classifies SENSORWARN as fatal despite its name. Error transmission is gated by supply voltage and crank-input assignment; zero alone is not proof that every system is healthy.

Commissioning sign-off

Log requested and received values at idle and under controlled operating conditions. Confirm mode changes, torque-request direction, message intervals and signal-loss response. Verify that the OEM ECU reacts as intended before using CX29 to control supplementary fuel, boost or traction-related torque limits.



Watch the CX29 setup video on YouTube