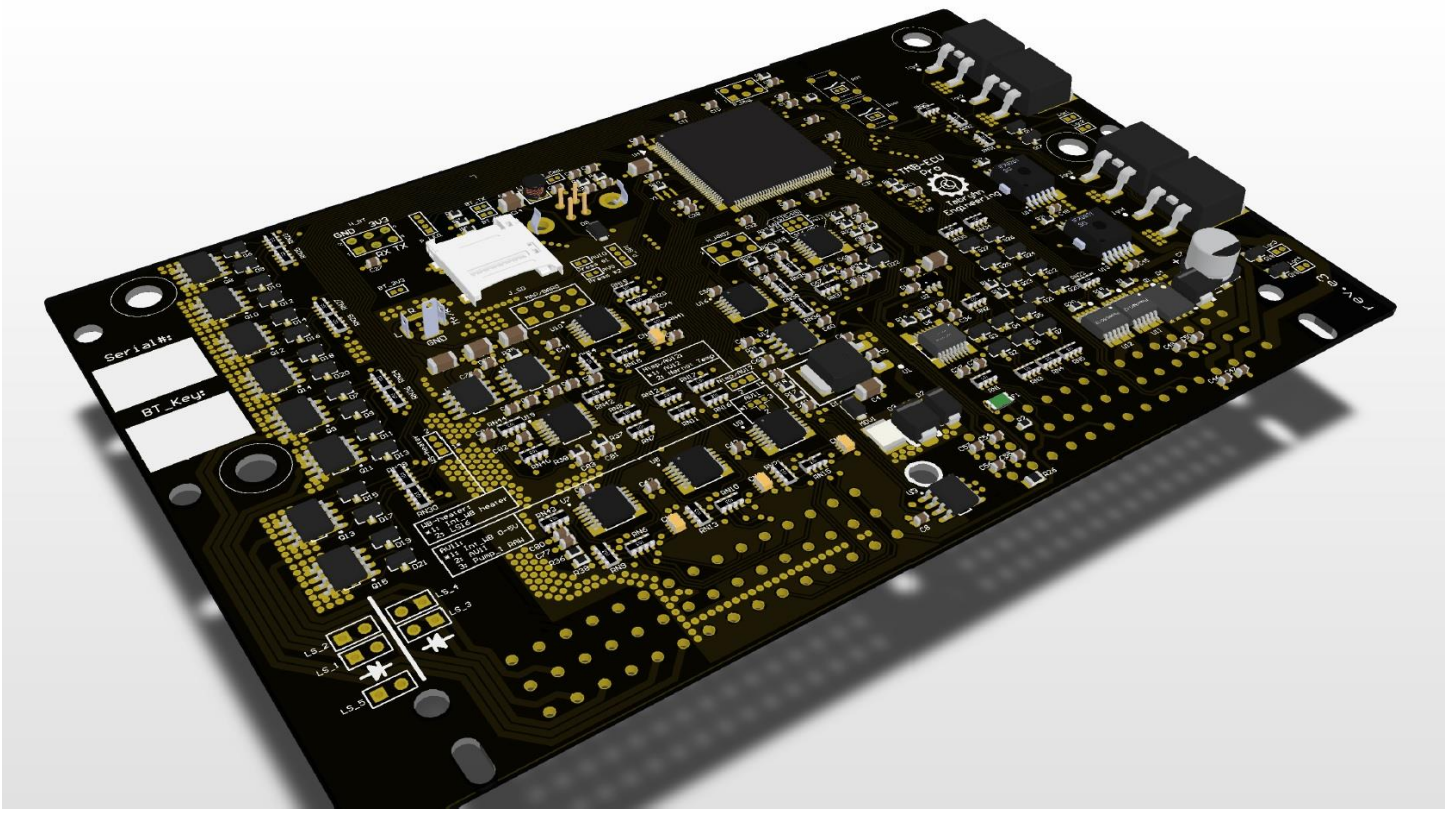
TMB ECU Pro

By

Tmbryhn engineering

Revision: e2 & e3



Disclaimer of liability

Introduction

Hardware specification

Schematics

DISCLAIMER OF LIABILITY:

All parts are sold for OFF ROAD and ground-vehicle use only, or vehicles that pre-date any governmental emissions control requirements. Aftermarket EFI systems are not for use on pollution controlled vehicles. Your country may have specific rules restricting tampering with your vehicle's emissions system and violation of such guidelines or rules can lead to substantial fines or penalties. Race parts are inherently dangerous and may cause injury or damage if improperly modified or altered before use. The publisher of this manual will not be held liable for and will not pay you for any injuries or damage caused by misuse, modification, redesign, or alternation of any of our products. The publisher of this manual will not be held in any way responsible for any incidental or consequential damages including direct or indirect labor, towing, lodging, repair, medical, or legal expense in any way attributable to the use of any item in our catalog or to the delay or inconvenience caused by the necessity of replacing or repairing any such item.

Introduction

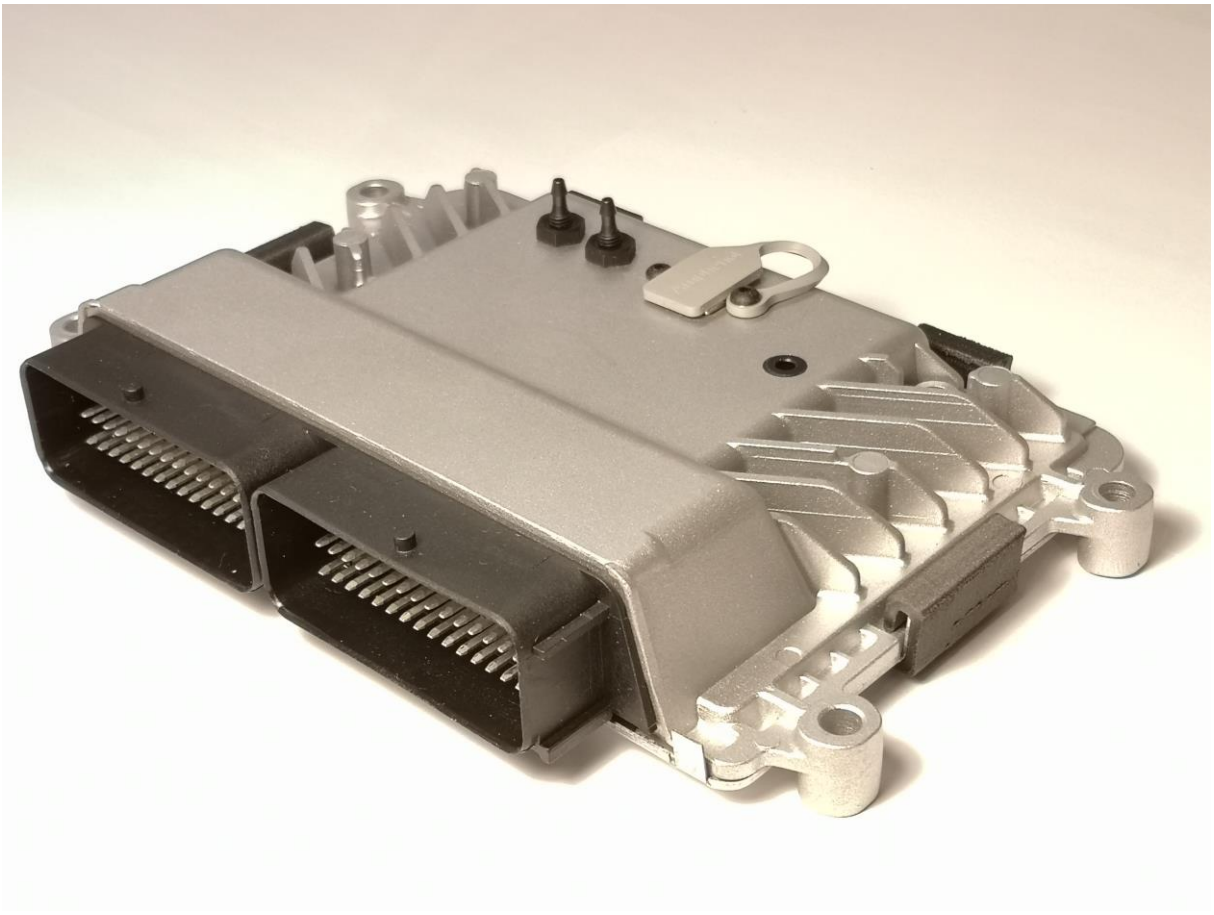
The TMB ECU Pro is a robust platform offering a wide range of functionality suitable for most EFi implementations. The software is based on an open source platform (RusEFi) with a steadily growing user and developer community, resulting in continuous improvement and a growing list of features.

Some of the key hardware features includes direct USB communication, integrated wideband controller, dual DBW capability, dual knock sensor inputs with headset output, internal SD card logging, passive/logic coil drivers, integrated 4 bar MAP/Baro sensors and a substantial amount of analog/digital I/O for expansion beyond basic fuel/ignition control.

The result is a more or less all-inclusive affordable EMS that delivers functionality for a wide variety of engine setups – from a single cylinder to a V12 running features like fully sequential fuel delivery, direct spark, turbo w. boost control, dual ETB and advanced knock control.

The ECU package includes the following items:

1. TMB ECU Pro
2. Shielded USB cable
3. Bosch LSU 4.9 Wideband oxygen sensor + connector & weld-in bung
4. Pre-terminated flying lead + spare pins (optional)



TMB-ECU Pro hardware/software spec.

Specification:

Voltage range	7.0 - 30.0
Min temp. °C	-40
Max temp. °C	85
Injector Pulse Width resolution (ms)	0,01
Spark resolution (crankshaft°)	0,1
Cylinder quantity	1-12

Hardware features:

Inputs		
Internal WBO2 controller	1x	Bosch LSU4.9
Tach / trigger inputs	2x VR / 5x Hall	Supports a wide selection of OEM trigger patterns
Digital input	5x	Active GND, Internal Pullup
Analog input (0-5V)	10x	
Analog input ("Temp")	4x	Internal 2.7k pullup
MAP/BARO internal sensor	2x	4 Bar absolute
Knock sensor	2x	

Outputs		
Ignition	12x	4x Passive / 12x Logic
Low-side/General purpose	16x	High-Z injectors, Idle, Boost, VVT, relays etc.
High-side/General purpose	4x	Relays, tachometer signal, lamps & LEDs etc.
Drive By Wire / Motor control	2x	H-bridge
Tachometer	1x	12V pulse
Headset w. volume control	1x	In-ear Knock monitoring

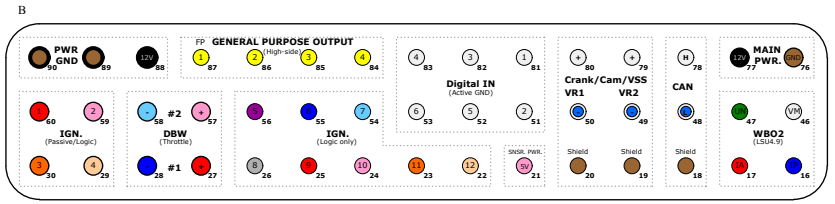
Connection	
USB	Tuner Studio, MSDroid, ShadowDash
CAN-bus	Additonal WBO2, data acquisition modules, race-dash, etc.
Internal SD card	Automatic datalogging

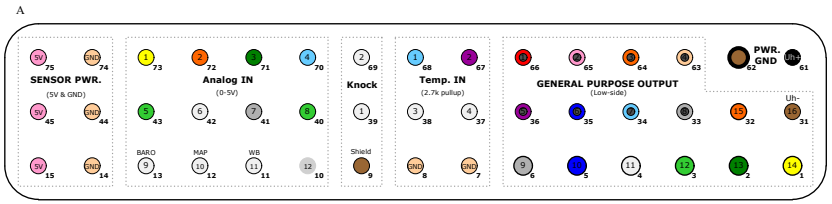
Software features:

RusEFi firmware	https://rusefi.com/
Tuner Studio by EFi Analytics	
Quick tune / VE analyzer Live	Autotune Fuel VE table
Speed density	MAP-based fuel/ignition
Alpha-N	TPS-based fuel/ignition
16x16 VE, Ignition and AFR maps	
Up to 12 cyl. fully sequential fuel/spark	
Time-based & X-Tau accel enichment	
Idle control	DBW or IAC, Closed / Open loop
EGO control	Closed loop
VVT - Variable valve timing	Up to 4x camshafts
Boost control	Closed / Open loop
Drive By Wire	Auto calibration & 3D pedal vs. throttle map
Knock control	Individual cylinder smart DSP knock detection
Fuel pressure	Dynamic injector flow rate compensation
Oil press/temp	
Vehicle speed	
Flex fuel	
Launch control	
Fuel pump and Cooling fan control	
Transmission control	

	Name	Connector Pin #	Size (AWG)	Description		Default / Note
	INPUT					
Power	**12V, ECU**	77	20	ECU Power & GND		Main power relay "87"
	GND, ECU	76	20			Chassis/Batt GND
	GND, PWR	62, 89, 90	18			Chassis/Batt GND
CAN	**CANH**	78	TP	CAN-bus Shielded twisted pair		
	CANL	48	TP			
	Shield	18	22			
Sensor	**GND**	7, 8, 14, 44, 74	22	Sensor GND return		
	5V	21, 15, 45, 75	22	Sensor 5V power		
	Analog Temp 1	68	22	Internal 2.7k pullup		CLT/CHT
	Analog Temp 2	67	22			IAT
	Analog Temp 3	38	22			Oil temp
	Analog Temp 4	37	22			
	Analog Volt 1	73	22	0-5V		PPS-A
	Analog Volt 2	72	22			PPS-B
	Analog Volt 3	71	22			TPS #1A
	Analog Volt 4	70	22			TPS #1B
	Analog Volt 5	43	22			Fuel press
	Analog Volt 6	42	22			Oil press
	Analog Volt 7	41	22			TPS #2A
	Analog Volt 8	40	22			TPS #2B
	Analog Volt 9	13	22	Int. 4 bar #1	0-5V	BARO / AUX
	Analog Volt 10	12	22	Int. 4 bar #2		MAP
WBO2	**IP**	16	22			LSU-Pin 1
	VM	46	22			LSU-Pin 2
	Uh-	31	22	Heater GND (N-FET)		LSU-Pin 3
	Uh+	61	22	Heater 12V		LSU-Pin 4
	IA	17	22			LSU-Pin 5
	UN	47	22			LSU-Pin 6
Crank/Cam/VSS	**VR 1+**	80	TP	VR sensor Shielded twisted pair		Crank
	VR 1-	50	TP			Crank
	VR 2+	79	TP			Cam or VSS
	VR 2-	49	TP			Cam or VSS
	Shield	20, 19	22			
Digital	**Digital 1**	81	22	Active GND		Cam #1 (hall)
	Digital 2	51	22			Cam #2 (hall)
	Digital 3	82	22			
	Digital 4	83	22			
	Digital 5	52	22			
	Digital 6	53	22			
Knock	**Channel 1**	39	22	Sensor "+" input		
	Channel 2	69	22			
	Shield	9	22	Shield / Sensor "-" input		

	OUTPUT					
General Purpose	**Low-side 1**	66	22 Striped	Active GND (N-FET)		Inj #1
	Low-side 2	65	22 Striped			Inj #2
	Low-side 3	64	22 Striped			Inj #3
	Low-side 4	63	22 Striped			Inj #4
	Low-side 5	36	22 Striped			Inj #5
	Low-side 6	35	22 Striped			Inj #6
	Low-side 7	34	22 Striped			Inj #7
	Low-side 8	33	22 Striped			Inj #8
	Low-side 9	6	20			
	Low-side 10	5	20			
	Low-side 11	4	20			Boost
	Low-side 12	3	20			VVT
	Low-side 13	2	20			Idle Open
	Low-side 14	1	20			Idle Close
	Low-side 15	32	20			
	Low-side 16	31	22			Lambda Heater "-", LSU-Pin 3
	High-side 1	87	20	Active 12V (P-FET)		Fuel pump relay +12V (Dedault)
	High-side 2	86	20			
	High-side 3	85	20			
	High-side 4	84	20			
Ignition	**Ign 1**	60	20	Active GND (IGBT)	3.3V logic (PCB Jumper)	Coil, passive #1
	Ign 2	59	20			Coil, passive #2
	Ign 3	30	20			Coil, passive #3
	Ign 4	29	20			Coil, passive #4
	Ign 5	87	22	3.3V logic		Coil, logic #1
	Ign 6	86	22			Coil, logic #2
	Ign 7	56	22			Coil, logic #3
	Ign 8	55	22			Coil, logic #4
	Ign 9	54	22			Coil, logic #5
	Ign 10	26	22			Coil, logic #6
	Ign 11	25	22			Coil, logic #7
	Ign 12	24	22			Coil, logic #8
DBW	**12V, DBW**	88	18	H-bridge		Main power relay "87"
	#1 M+	27	20			
	#1 M-	28	20			
	#2 M+	57	20			
	#2 M-	58	20			





0.33mm² / 22 AWG

0.5mm² / 20 AWG

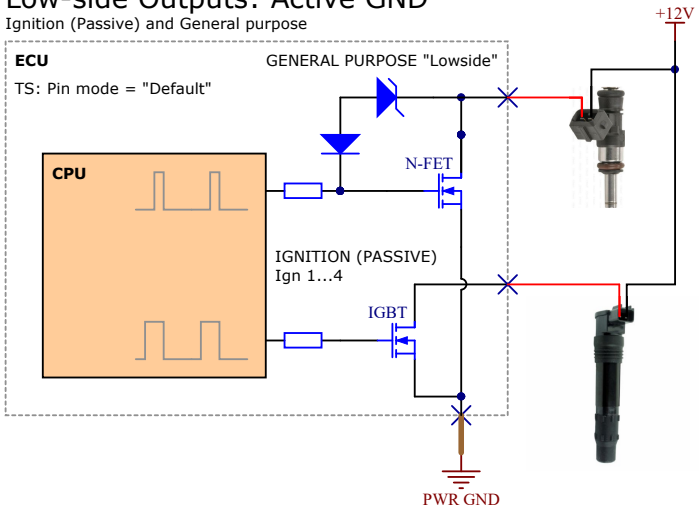
0.75mm² / 18 AWG

TMB ECU Pro wiring guide:

Input/Output general guideline

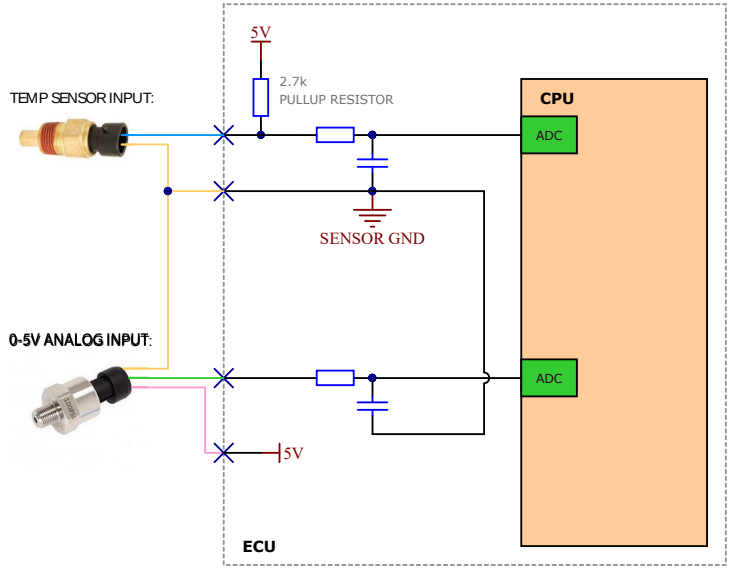
Low-side Outputs: Active GND

Ignition (Passive) and General purpose



Analog sensor inputs:

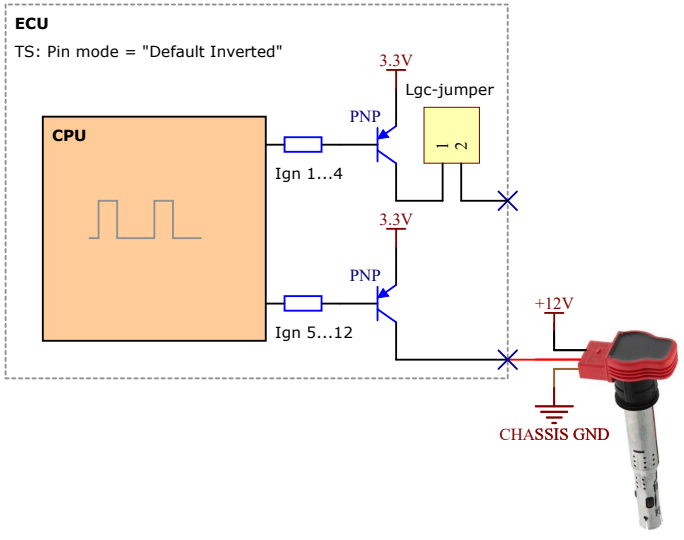
2-wire temp and 0-5V sensors



*ADC: ANALOG TO DIGITAL CONVERTER

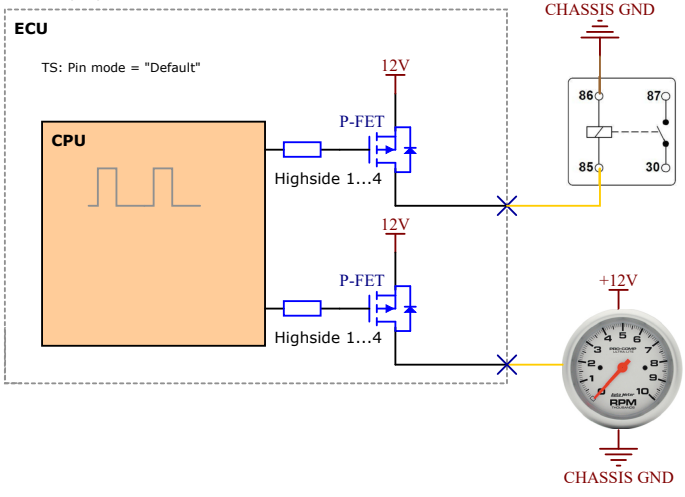
High-side Outputs: Active 3.3V

Ignition (Logic) outputs



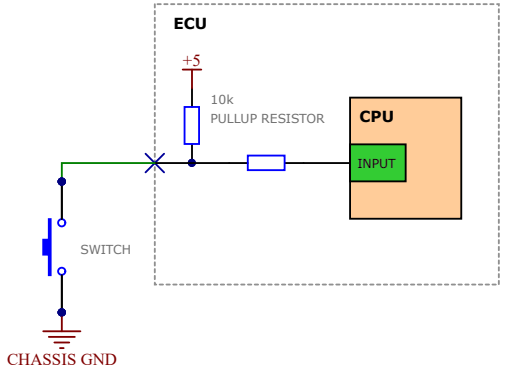
High-side Outputs: Active 12V

General purpose



Digital inputs:

Active GND: Switch, open-collector Hall sensor etc.



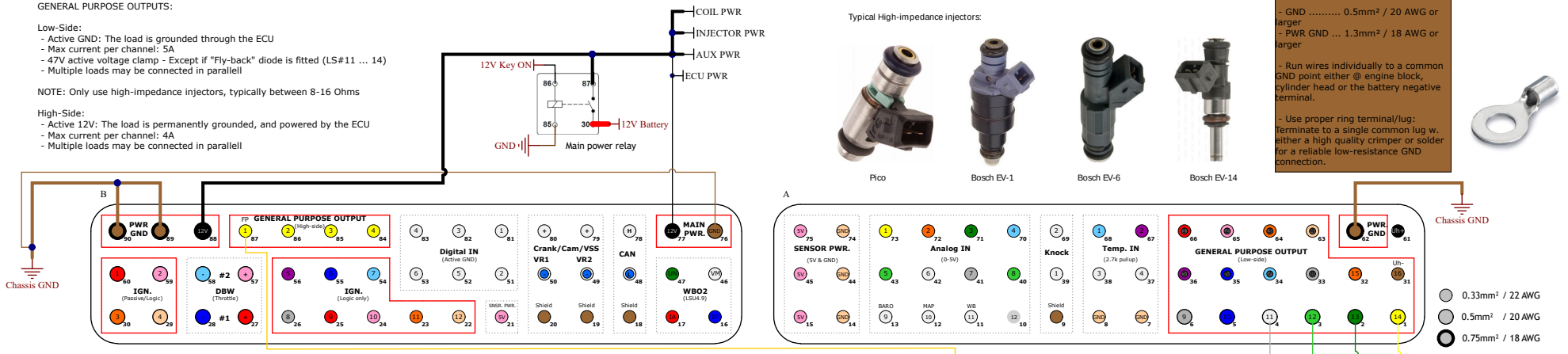
TMB ECU Pro wiring guide:
Power, Ignition/Injection & Misc.

GENERAL PURPOSE OUTPUTS:

Low-Side:
- Active GND: The load is grounded through the ECU
- Max current per channel: 5A
- 47V active voltage clamp - Except if "Fly-back" diode is fitted (LS#11 ... 14)
- Multiple loads may be connected in parallell

NOTE: Only use high-impedance injectors, typically between 8-16 Ohms

High-Side:
- Active 12V: The load is permanently grounded, and powered by the ECU
- Max current per channel: 4A
- Multiple loads may be connected in parallell



Typical High-impedance injectors:

Pico | Bosch EV-1 | Bosch EV-6 | Bosch EV-14

GROUNDING GUIDELINES:

- GND ..... 0.5mm² / 20 AWG or larger
- PWR GND ... 1.3mm² / 18 AWG or larger

- Run wires individually to a common GND point either @ engine block, cylinder head or the battery negative terminal.

- Use proper ring terminal/lug: Terminate to a single common lug w. either a high quality crimper or solder for a reliable low-resistance GND connection.

0.33mm² / 22 AWG
0.5mm² / 20 AWG
0.75mm² / 18 AWG

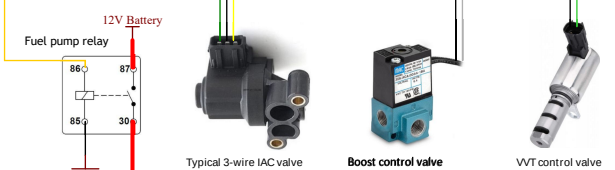
PASSIVE COILS
- Positive: Constant 12V through relay
- Negative: Passive ignition output (1 ... 4)

LOGIC COILS
- Constant 12V through relay
- Constant GND connection
- Input signal: Logic ignition output (1* ... 4* or 5 ... 12)

COP | Dual Channel - "Wasted spark" | Single | COP | Dual Channel - "Wasted spark" | Quad Channel | Single

"Fly-back" clamping diodes:

For inductive loads with high inductance ratings such as relays, idle- and VVT valves, the following GP-pins may be equipped internally with diodes between 12V and the following outputs:
#11, 12, 13 & 14



Typical 3-wire IAC valve | **Boost control valve** | VVT control valve

2/3 wire IAC:
Tuner Studio: "Idle" -> "Idle Hardware":
- 3-wire = "Double Solenoid Mode"
- Inverted output: See "Idle Solenoid output(s) Mode"

Boost and VVT control valves:
Polarity is not critical for either type.

Consult OEM manufacturer datasheet for correct PWM frequency or adjust till you attain a stable and responsive cam position.

MAC valves works fine with 15-30 Hz PWM frequency

WARNING!

Never connect the pump directly to the output - This will damage the driver circuit.
Always use a relay rated for at least 16 amps.

IGNITION OUTPUTS:

Passive:
- Output 1 ... 4: Internal ignition amplifiers (Active GND)
- Max current per channel: 17A
- TunerStudio setting: "Ignition Pin Mode" = "Default"

Logic:
- Output 1 ... 12: 3.3V pulse (1* ... 4* internal solder jumper)
- For coils w. built-in ignitor or external ignition amplifier.
- Max continuous current: 100mA
- TunerStudio setting: "Ignition Pin Mode" = "Default Inverted"

WARNING: Setting the "Ignition Pin Mode" incorrectly will destroy the coils and/or the ignition outputs! Always disconnect the 12V power supplying injectors, coils and miscalaneous loads whenever loading firmware or setting up your project for the first time.

Tuner Studio CONFIG:

1. Set firing order: "Base Engine Settings" -> "Firing Order".

2. Set "Trigger" -> "Trigger type":
NOTE: "Sequential" injection & "Individual Coils" may only be enabled if Crank+Cam trigger or Camshaft primary trigger is implemented.

Spark:
-> "Single Coil": Traditional distributor setup
-> "Individual Coils": One coil per cylinder running direct spark
-> "Wasted Spark": Each channel is wired to a pair of cylinders @ TDC simultaneously
(Individual coil setups running wasted spark: Activate "Individually wired Wasted Spark")
-> "Two Distributors": Traditional distributor setup w. two spark plugs per cylinder

Fuel:
-> "Simultaneous": All injectors fire simultaneously
-> "Batched": Injectors are wiried in pairs between cylinders at TDC simultaneously.
-> "Sequential": Individually wired injectors fire on a per-cylinder basis in firing order

3. Define which outputs are wired to the respecive coils & injectors:
- "Fuel" -> "Injection hardware"
- "Ignition" -> "Ignition settings"

NOTE: Injection and Ignition output pins are driven according to the defined firing order.
Thus, the list of pins (1 ... n) are sequenced in the firing order.

	Wasted Spark / Batch Inj.			Direct Spark / Sequential Inj.			
No. of cyl.	4	6	8	4	5	6	8
Ign/Inj Pin # (720°)	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
	1	3	3	3	3	3	3
	2	1	4	4	4	4	4
		2	1		5	5	5
		3	2			6	6
			3				7
			4				8

TMB ECU Pro wiring guide:

Sensor input: Crank/Cam, knock, digital & analog

Similar to most electronic control systems, an Engine Management System acquires key information by reading a set of sensors in order to perform accurate calculations essential for eg. fuel delivery, spark timing and idle control.

The sensor inputs can be divided into two fundamental categories with a set of typical sub-categories:

Digital:
- Crankshaft/Camshaft speed & position
- Switched/Pulsed, timed or triggered events

Analog:
- Temperature
- Pressure
- Relative position
- Knock sensing

Crank/Cam sensors:
The ECU processor tracks the pulses generated by the crank & cam sensors to calculate engine speed, position and phase. For a basic wasted spark & semi-sequential/batch injection configuration, a crank trigger system such as a 36-1 or 60-2 is sufficient for crankshaft speed and position tracking.
To run direct spark or fully sequential fuel delivery, a cam sensor for engine phase detection is needed in addition to the above mentioned crank trigger setup.

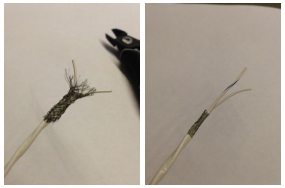
Tuner Studio CONFIG:
The trigger setup for the crank and cam sensor inputs is found under "Base Engine" -> "Trigger".
VR sensors: Configure "Only rising edge" = "True"
Use the "Composite" and "Tooth" logger to verify correct funtion of the speed/position sensor inputs.

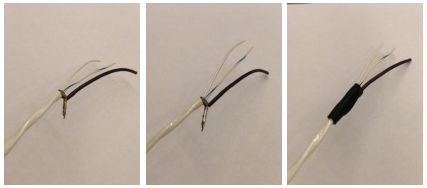
VR & Hall sensors explained:
https://www.linkedin.com/pulse/inductive-hall-effect-rpm-sensors-explained-kiril-mucevski

Supported trigger patterns:
https://github.com/rusefi/rusefi/wiki/All-Supported-Triggers#universal

HOW TO terminate shielded twisted pair signal cable used with eg. crank and cam sensors:

The braid connects to a "Shield GND" pin and limits electromagnetic interference (EMI) from affecting the signal.

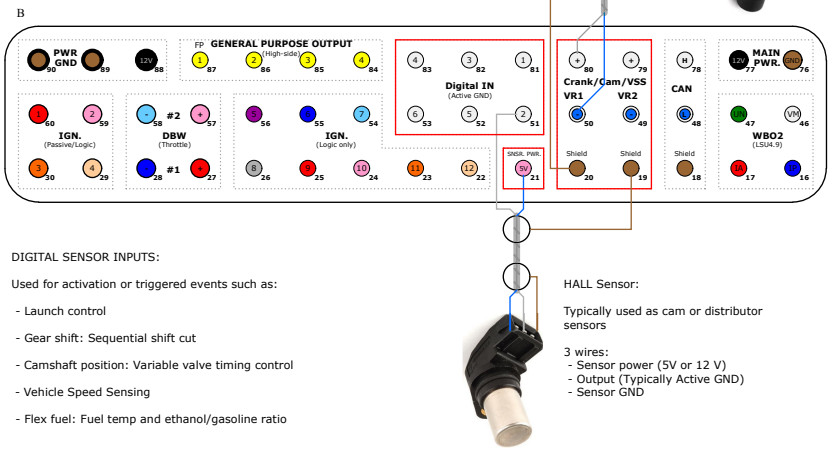




VR Sensor:

Typically used as crank position sensors.
Passive & inductive; no power supply required

2 or 3 wires:
- VR+
- VR-
- Cable shield (optional)



DIGITAL SENSOR INPUTS:

Used for activation or triggered events such as:

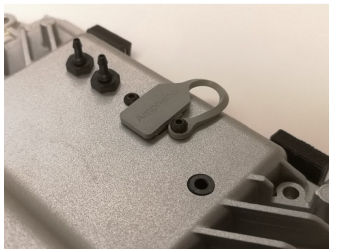
- Launch control
- Gear shift: Sequential shift cut
- Camshaft position: Variable valve timing control
- Vehicle Speed Sensing
- Flex fuel: Fuel temp and ethanol/gasoline ratio

All digital inputs are generic, have internal 5V 10k pullup-resistors and are of the "Active GND" type, eg. active state when switched to GND.
The digital inputs may be wired to eg. a switch or an open-collector device such as a Hall or optical sensor.

HALL Sensor:

Typically used as cam or distributor sensors

3 wires:
- Sensor power (5V or 12 V)
- Output (Typically Active GND)
- Sensor GND



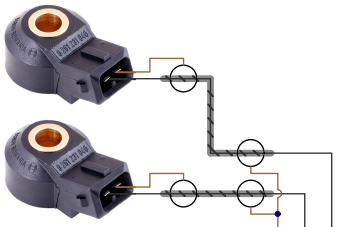
2x Internal 4 bar pressure sensor ports: Analog 9 & 10
Knock monitoring: 3.5mm headset output

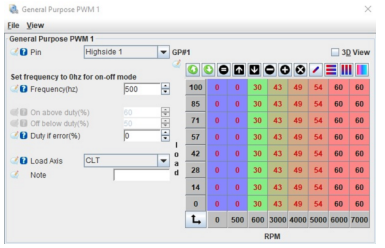
KNOCK:

The ECU has two dedicated Digital Signal Processed knock sensor input used for smart engine knock detection through "doughnut" style wideband sensors typically found on most modern OEM implementations.

Tuner Studio: "Controller" -> "Software Knock"

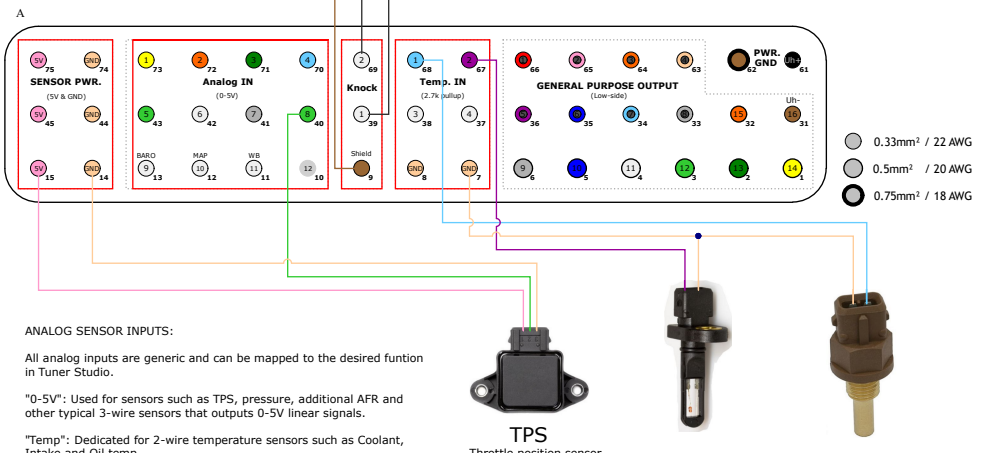
Knock setup guide:
https://github.com/rusefi/rusefi/wiki/knock-sensing





Headset OUTPUT Volume control:
Using PWM through "Lowside 16" (default) or "Highside 2" (alternative solder jumper) pin, the headset volume can be adjusted as a function of RPM and/or a secondary variable of choise. 30-60% is generally regarded a suitable volume range.

Tuner Studio: "Advanced" -> "General Purpose PWM x"



ANALOG SENSOR INPUTS:

All analog inputs are generic and can be mapped to the desired funtion in Tuner Studio.

"0-5V": Used for sensors such as TPS, pressure, additional AFR and other typical 3-wire sensors that outputs 0-5V linear signals.

"Temp": Dedicated for 2-wire temperature sensors such as Coolant, Intake and Oil temp.
All "Temp" inputs have internal 2.7k pullup resistors.

2x integrated 4 Bar pressure sensors (calibration - "MPXH6400"):
Analog 9 & 10.
Used to monitor manifold absolute pressure, real-time barometric correction, exhaust back pressure or crank case pressure monitoring/logging.

TPS
Throttle position sensor

NOTE: TPS polarity is not critical.

Config: "Sensors" -> "TPS"
- Analog input
- Min/Max

IAT
Intake air temp.

CLT
Coolant temp.

Sensor GND & 5V:

- All "Sensor GND" and "5V" pins are internally connected in the ECU.
- All sensors should be grounded at a dedicated "Sensor GND" return point.

NOTE: Do not ground any sensors in engine block or chassis as this may result in erratic signal behaviour or ground offsets.

TMB ECU Pro wiring guide:
WBO2 & DBW

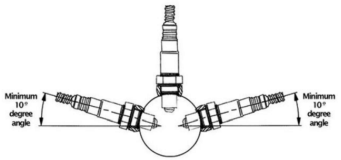
TMB ECU Pro is equipped with an internal wideband controller for use with the Bosch LSU 4.9 wideband sensor. All Genuine Bosch sensors are calibrated individually during production - hence the controller does not require free-air calibration.

In order to maximize sensor lifespan and reliability in accordance with Boschs recommended guidelines, the control logic features a smart heater strategy applying a gentle heater ramp-up whenever the ECU detects a cold sensor, and assures that the sensor is never heated unless the engine is running (Active by Fuel Pump logic state).

WBO2 sensor INSTALLATION GUIDELINE:

Accumulation of condensation combined with rappid changes in temperature may lead to cracks in the ceramic sensor element and permanent damage.

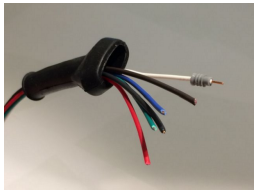
Please follow these guidelines when fitting the sensor to limit accumulated moisture whenever the vehicle is parked:



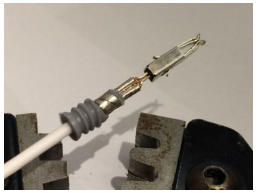
Bosch LSU4.9 wideband sensor

1. Typical termination equipment

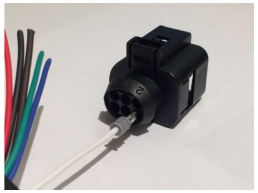
2: Connector, terminals, wire seals and grommet.



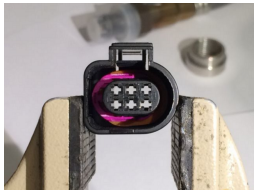
3: Feed wires through grommet and strip 3.5 - 4mm of insulation.



4: Proper crimp. Make sure the terminal retains the seal as hown.

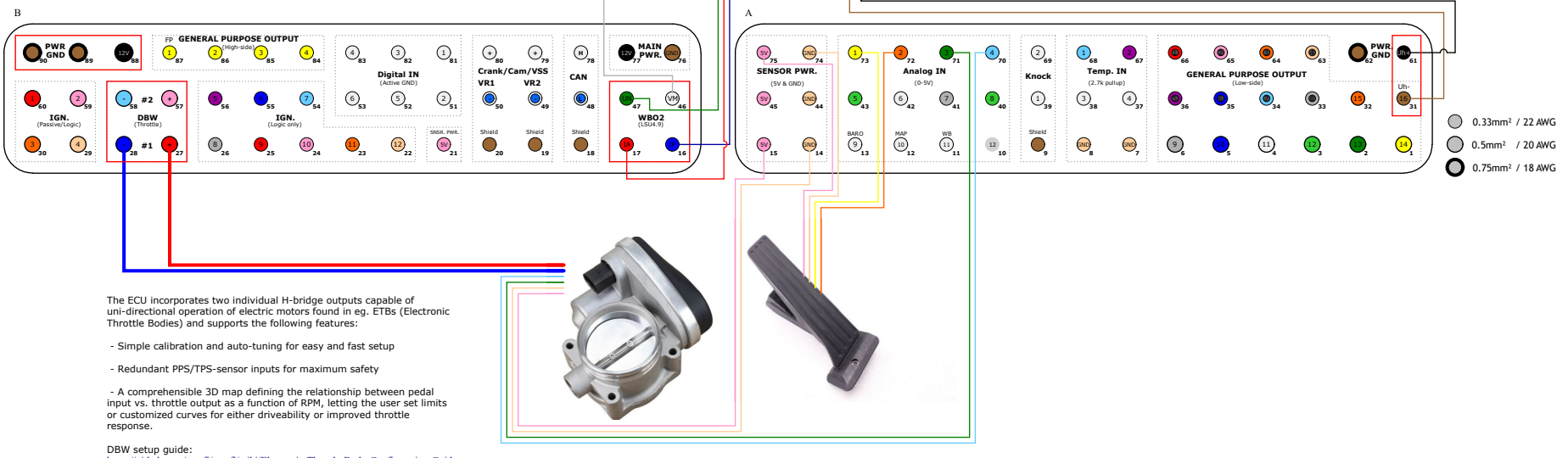


5: Insert the pin from the rear. A "click" is heard when the primary lock is engaged.



6: After all terminals are inserted and locked, push the pink secondary lock into place from the left side.

7: Finish the termination job by fixing the grommet into place.



The ECU incorporates two individual H-bridge outputs capable of uni-directional operation of electric motors found in eg. ETBs (Electronic Throttle Bodies) and supports the following features:

- Simple calibration and auto-tuning for easy and fast setup

- Redundant PPS/TPS-sensor inputs for maximum safety

- A comprehensible 3D map defining the relationship between pedal input vs. throttle output as a function of RPM, letting the user set limits or customized curves for either driveability or improved throttle response.

DBW setup guide:
https://github.com/rusefi/rusefi/wiki/Electronic-Throttle-Body-Configuration-Guide