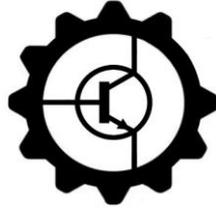
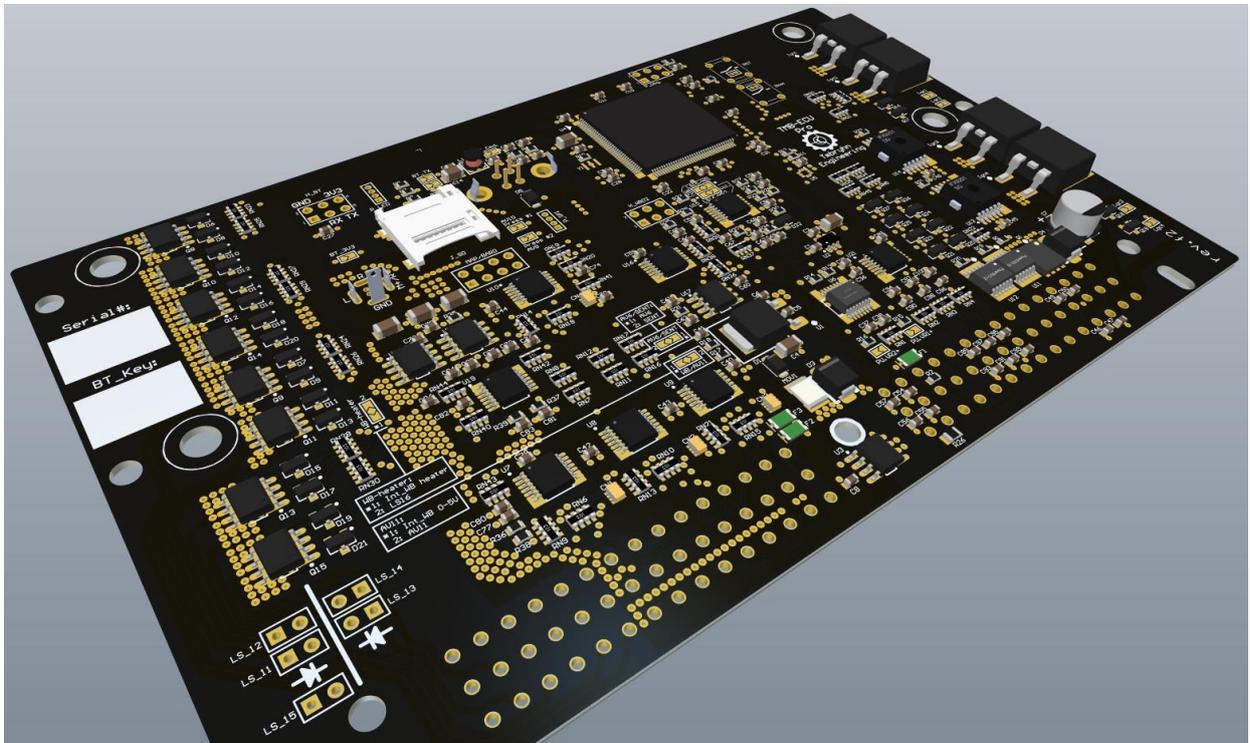


TMB ECU Pro
By
Tmbryhn engineering



Revision: f2



Disclaimer of liability

Introduction

Specifications & Features

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

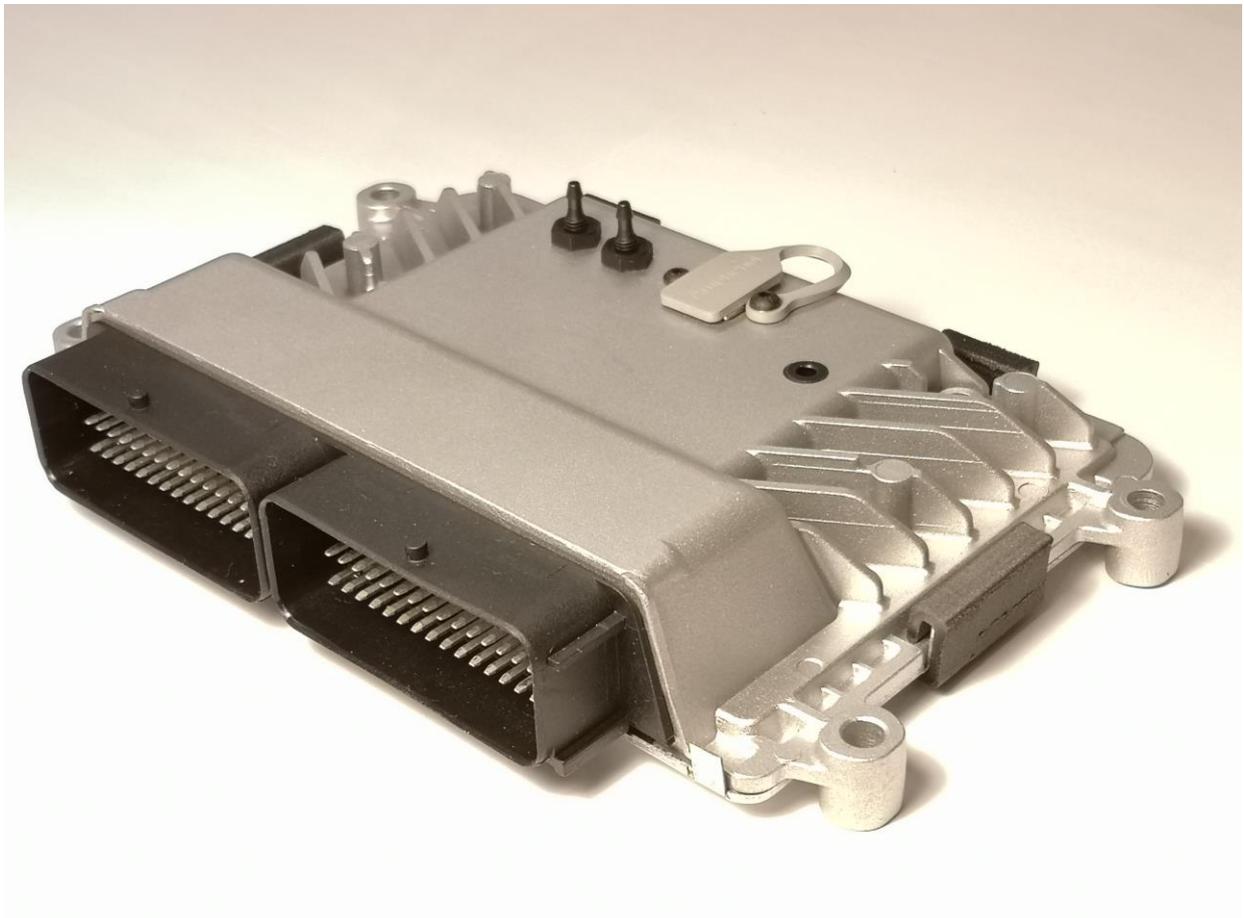
The TMB ECU Pro is a robust and versatile EMS offering a wide range of functionality suitable for most EFi implementations. The ECU connects with TunerStudio and is based on an open source platform (RusEFi) with a steadily growing user and developer community, resulting in continuous improvement and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

Some of the key hardware features includes high speed 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 an 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, flexfuel, dual ETB and advanced knock monitoring.

The ECU package includes the following items:

- TMB ECU Pro
- Shielded USB cable
- Bosch LSU 4.9 Wideband oxygen sensor + connector & weld-in bung
- Pre-terminated flying lead + spare pins (optional)
- Relay holder; main pwr & fuel pump (optional)



Specifications & Features

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

Inputs		
Internal WBO2 controller	1x	Bosch LSU4.9
Trigger, Crank & Cam	2x VR / 6x Hall	https://github.com/rusefi/rusefi/wiki/All-Supported-Triggers#universal
Digital, switched (Active GND)	6x	Hall/Optical trigger, switches, flex fuel etc. Internal 1k Pullup
Analog, 0-5V	10x	Pressure, Position etc.
Analog, "Temp"	4x	Internal 2.7k Pullup. Dedicated to 2-wire temp. sensors
MAP/BARO internal sensor	2x	400kPa (4 bar / 58 PSI) absolute
Knock sensor	2x	OEM "donut" wideband & narrowband sensors

Outputs		
Ignition	12x	4x Passive / 8+(4)x Logic
General purpose "Low-side" (Active GND)	16x	High-Z injectors, Idle, Boost, VVT, relays etc.
General purpose "High-side" (Active 12V)	4x	Relays, tachometer signal, lamps & LEDs etc.
Drive By Wire / Motor control	2x	H-bridge
Headset w. software volume control	1x	In-ear Knock monitoring

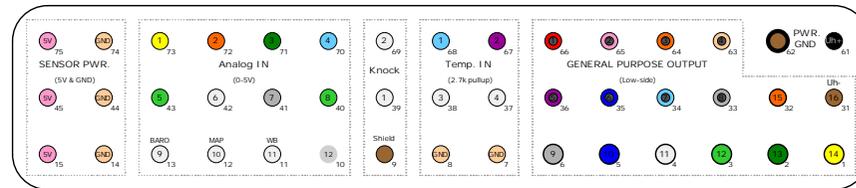
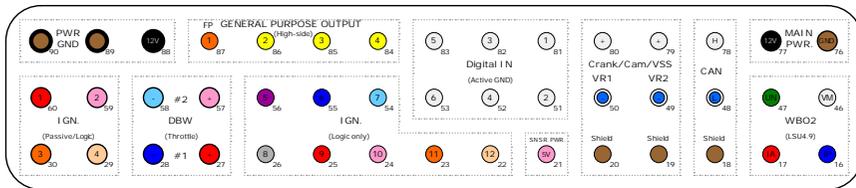
Connection	
USB	Tuner Studio, MSDroid, ShadowDash
CAN-bus	OEM Protocols (BMW, VAG, Mazda etc.), data acquisition modules, race-dash, etc.
Internal SD card	Automatic datalogging, Megalogviewer format (.mlg)

Software

RusEFI firmware	https://rusefi.com/
TunerStudio by EFi Analytics	https://www.tunerstudio.com/index.php
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	2D & 3D
Batch/fully sequential fuel. Wasted/Direct spark (COP)	Up to 12 cylinders
Acceleration enrichment	Simple/Advanced "X-Tau" strategies
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	Pedal & TB Auto calibration. Pedal vs. Throttle vs. RPM map
Knock detection & control	Individual cylinder smart DSP knock detection & ign. timing strategies
Fuel pressure monitoring	Dynamic injector flow rate compensation
Generic Press & Temp monitoring	Oil, fuel etc.
Vehicle & generic shaft speed	CAN or Digital input based. Gear detection strategy
Turbo speed	Digital input, Turbine speed monitoring.
Flex fuel	Continental/GM, 50-150Hz type
Launch control & Anti-lag	Switched or Conditional. Fuel & spark (retard & skip) tables. Adjustable ETB air bypass.
Fuel pump and Cooling fan control	Fuel priming delay, 2x conditional fan control w. hysteresis
Transmission control	Table/Logic based Transmission solenoid control strategies

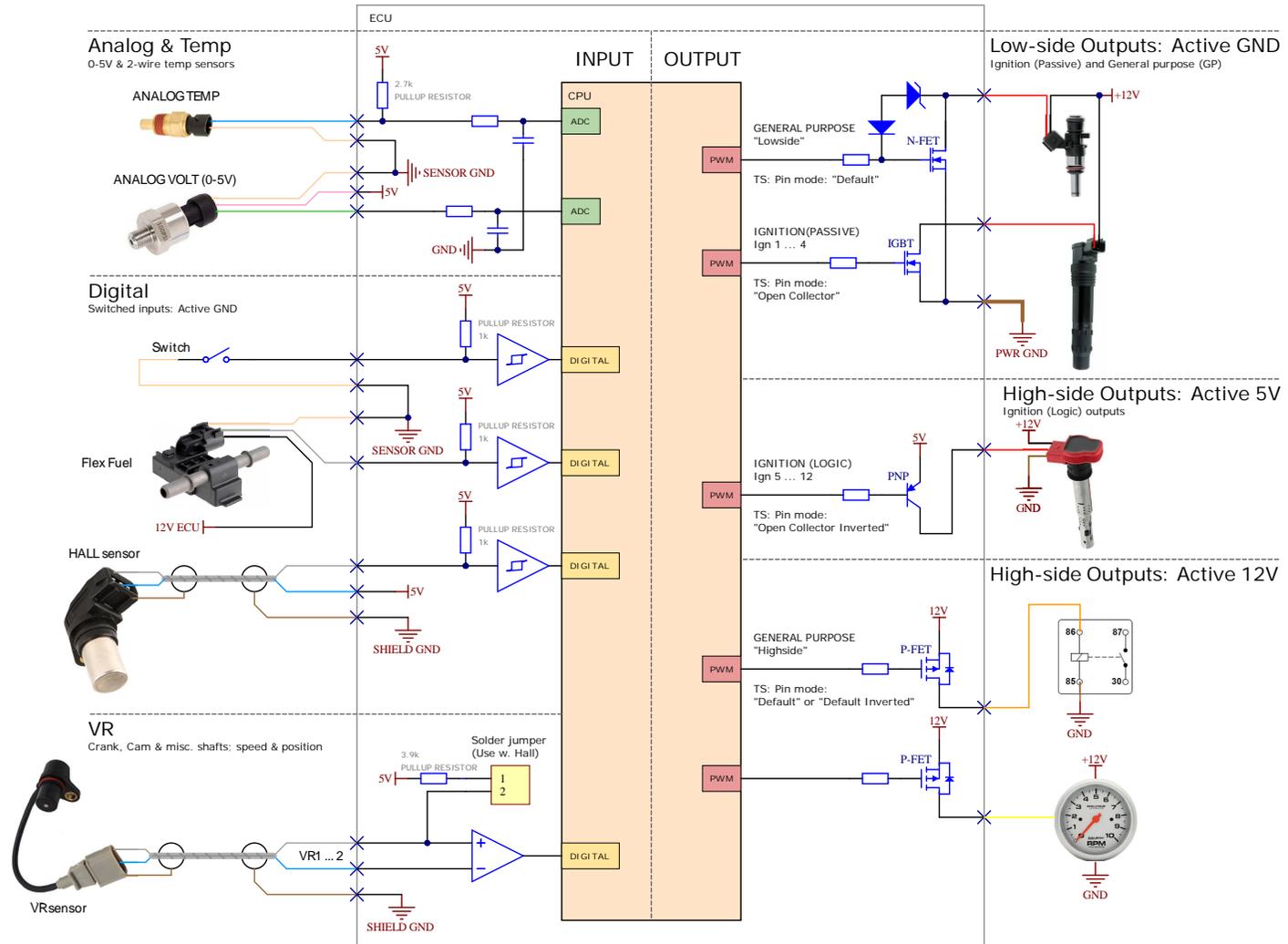
	Name	Connector Pin #	Size (AWG)	Description		Default / Note
INPUT						
Power	12V, ECU	77	20	ECU Power & GND		Main power relay "87"
	GND, ECU	76	20			Chassis/Batt GND
	GND, PWR	62, 89, 90	16			Chassis/Batt GND
CAN	CANH	78	TP	CAN-bus Shielded twisted pair		
	CANL	48	TP			
	Shield	18	22			
Sensor	GND	7, 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 / TPS-SENT			
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	Heater GND (N-FET) Heater 12V		LSU-Pin 1
	VM	46	22			LSU-Pin 2
	Uh-	31	22			LSU-Pin 3
	Uh+	61	22			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	52	22			
	Digital 5	83	22			
	Digital 6	53	22			
Knock	Channel 1	39	22	Sensor "+" input		
	Channel 2	69	22	Shield / Sensor "-" input		
	Shield	9	22			

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	High-side 1	87	22	Active 12V (P-FET)		Fuel pump relay +12V (Default)
	High-side 2	86	22			Tachometer signal (Default)
	High-side 3	85	22			
	High-side 4	84	22			
Ignition	Ign 1	60	20	Active GND (IGBT)	5V 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	56	22	5V logic		Coil, logic #1
	Ign 6	55	22			Coil, logic #2
	Ign 7	54	22			Coil, logic #3
	Ign 8	26	22			Coil, logic #4
	Ign 9	25	22			Coil, logic #5
	Ign 10	24	22			Coil, logic #6
	Ign 11	23	22			Coil, logic #7
	Ign 12	22	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 example



*ADC = ANALOG TO DIGITAL CONVERTER

*PWM = PULSE WIDTH MODULATION

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 parallel

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

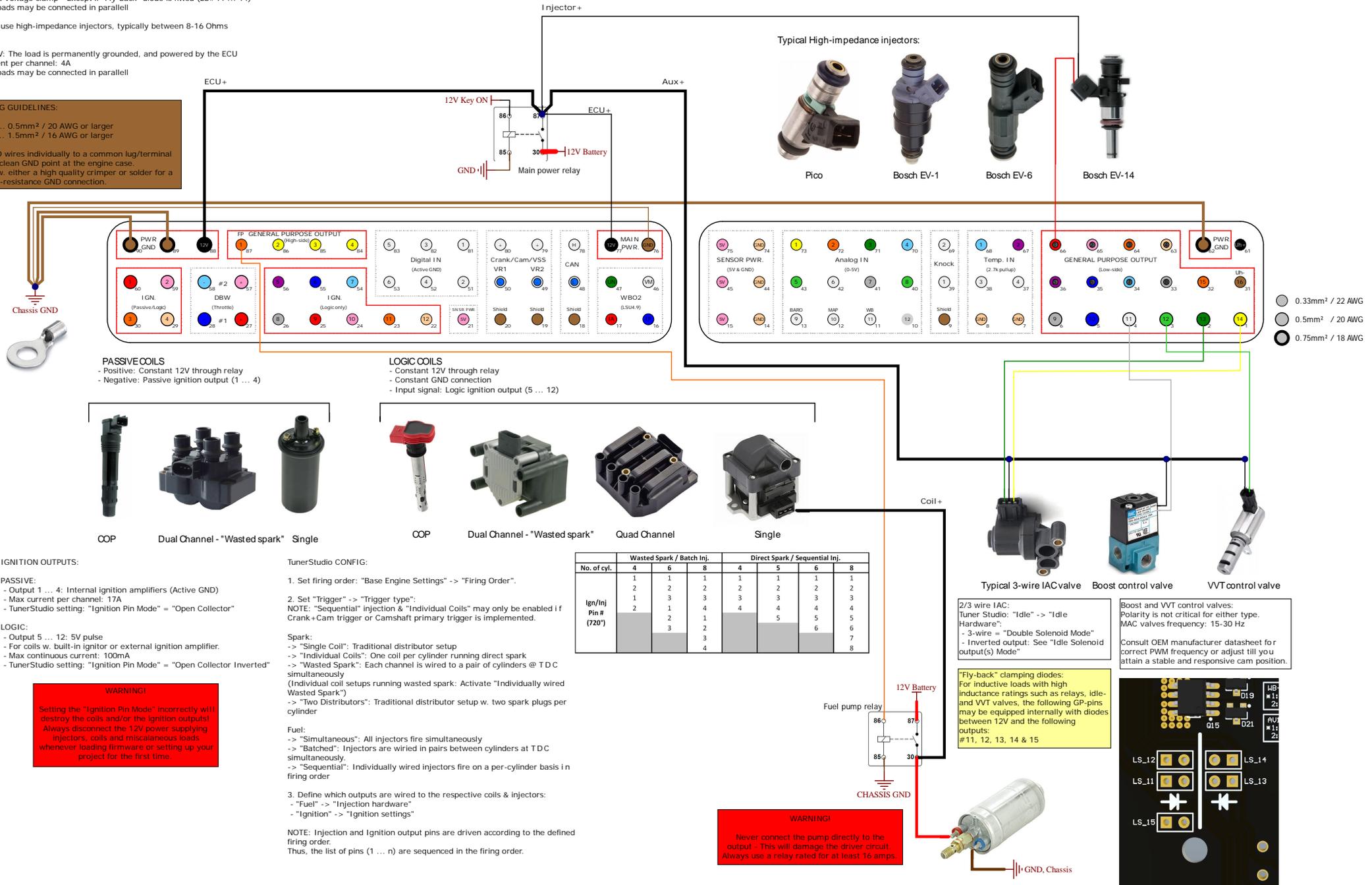
High-Side:

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

GROUNDING GUIDELINES:

GND 0.5mm² / 20 AWG or larger
 PWR GND ... 1.5mm² / 16 AWG or larger

Run all GND wires individually to a common lug/terminal bolted to a clean GND point at the engine case.
 Terminate w. either a high quality crimp or solder for a reliable low-resistance GND connection.



- 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 (5 ... 12)



IGNITION OUTPUTS:

PASSIVE:

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

LOGIC:

- Output 5 ... 12: 5V pulse
- For coils w. built-in ignitor or external ignition amplifier.
- Max continuous current: 100mA
- TunerStudio setting: "Ignition Pin Mode" = "Open Collector Inverted"

WARNING!

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

TunerStudio 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 wired 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 respective 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.

No. of cyl.	Wasted Spark / Batch Inj.			Direct Spark / Sequential Inj.			
	4	6	8	4	5	6	8
1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2
3	1	3	3	3	3	3	3
4	2	1	4	4	4	4	4
5		2	1		5	5	5
6		3	2			6	6
7			3			7	7
8			4			8	8

WARNING!

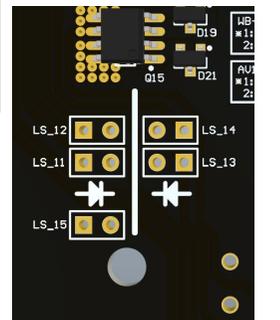
Never connect the pump directly to the output - This will damage the driver circuit. Always use a relay rated for at least 16 amps.

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

"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 & 15

Boost and VVT control valves:
 Polarity is not critical for either type. MAC valves frequency: 15-30 Hz

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



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

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:

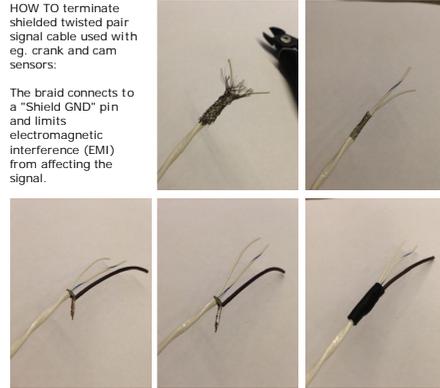
- Crankshaft/Camshaft speed & position
- Switched/Pulsed, timed or triggered events

Analog:

- Temperature
- Pressure
- Relative position
- Knock sensing

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.



CRANK / CAM SENSOR INPUTS - "VR":

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 or utilize VVT control, a dedicated cam sensor for engine phase and camshaft position tracking is required.

TunerStudio CONFIG:

"Base Engine" -> "Trigger".

VR sensors: Configure "Only rising edge" = "True"

Use the "Composite logger" to verify correct function of the speed/position sensor inputs.

VR & Hall sensors explained:

<https://www.linkedin.com/pulse/inductive-hall-effect-rpm-sensors-explained-kiril-mncevski>

Supported trigger patterns:

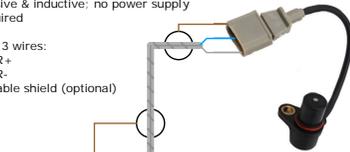
<https://github.com/rusefi/rusefi/wiki/All-Supported-Triggers#universal>

VR Sensor:

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

2 or 3 wires:

- VR+
- VR-
- Cable shield (optional)



KNOCK:

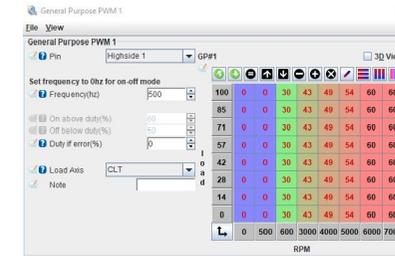
The ECU has two Digital Signal Processed knock sensor input channels used for smart engine knock detection through a wide variety of "donut" style wideband or smallband sensors typically found on most factory EFI equipped vehicles.

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

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



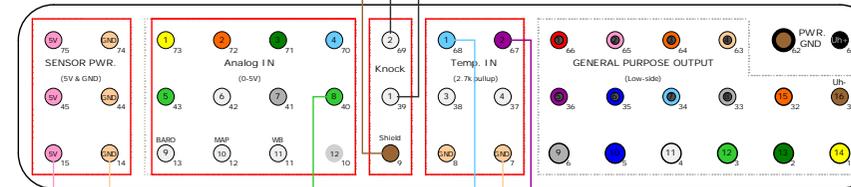
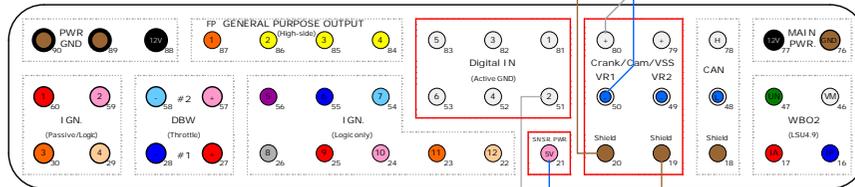
2x Internal 4 bar pressure sensor ports: Analog 9 & 10
Knock monitoring: 3.5mm headset output



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 choice. 30-60% is generally regarded a suitable volume range.

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



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

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

ANALOG SENSOR INPUTS:

All Analog Volt inputs are generic and can each be mapped to the desired function in TunerStudio.

Analog Volt (AV), "0-5V":

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

*AV9 & 10: Allocated by default to the two internal MAP/BARO sensors through pre-soldered jumpers.

*AV11: Hardwired to the internal WBO2 controller

*AV6: Optionally used as dedicated digital TPS input signal for SENT based ETBs. Note solder jumper below.

Integrated 4 Bar absolute pressure sensors (calibration - "MPXH6400"), AV9 & AV10:

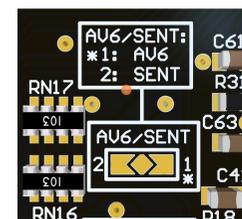
Usually used to monitor manifold pressure, but may also be used to monitor/log values such as eg. barometric pressure, exhaust back pressure or crank case pressure.

Analog Temp (AT):

Dedicated for 2-wire temperature sensors such as Coolant, Intake and Oil temp.

All "Temp" inputs have internal 2.7k pullup resistors.

All temp inputs can be used as "Active GND" digital inputs.



Throttle position sensor
NOTE: TPS polarity is not critical.

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

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

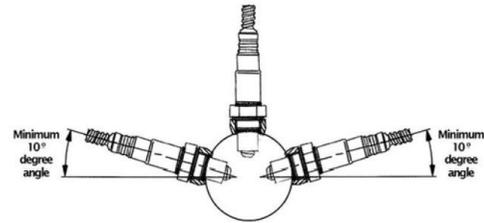
TMB ECU Pro is equipped with an internal wideband controller for use with the Bosch LSU 4.9 wideband sensor. All Genuine Bosch sensors are calibrated individually during production - hence the controller does not require free-air calibration.

In order to maximize sensor lifespan and reliability in accordance with Bosch's 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 rapid 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 O2 sensor



1. Typical termination equipment



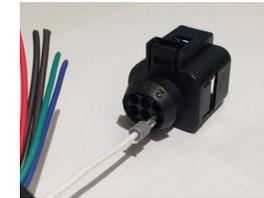
2. Connector, terminals, wire seals and grommet.



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



4. Proper crimp. Make sure the terminal retains the seal as shown.



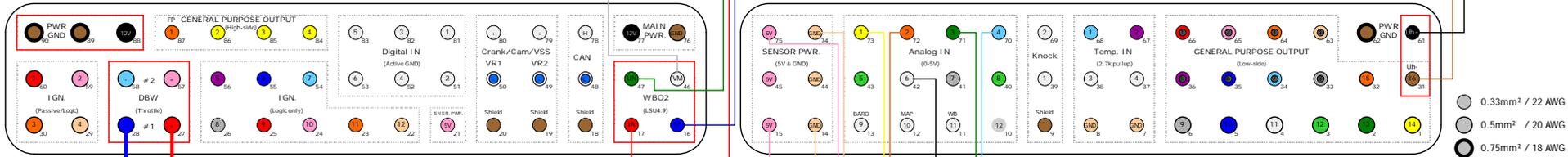
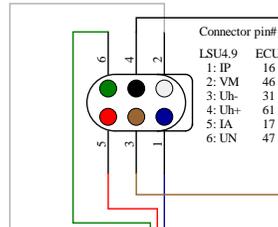
5. Insert the pin from the rear. A "click" is heard when the primary lock is engaged.



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.



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

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

- Simple calibration of pedal & TPS along with TB PID auto-tuning for easy and quick setup
- Redundant PPS/TPS-sensor implementation for OEM safety standard.
- Comprehensive 3D map defining the relationship between pedal input vs. throttle output as a function of RPM, allowing the user to either set limits or customized curves for increased driveability or improved throttle response.

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

