Mazda MX-5 NA1.6 / 1.8 94-95

Speeduino PnP ECU installation and use

WARNING! 1. this product is for offroad/closed circuit use only

2. you are responsible fo everything what you do with this product and what will happen to your Miata

Required tools and materials:

- Mazda MX5 Mk1 (NA) 1.6 1989-1996 / 1.8 1994-1995
- Speeduino PnP NA v2 by Alex Engineering ®😊 set with accessories and this manual
- typical tools like 10mm hex wrench, pliers, zip-ties
- laptop with TunerStudio installed, recommended also MegaLogViewer HD, USB type A-B cable. I recommend spending some time and become familiar with TS and MLV if you are not already

recommended sequence of work

(to reduce unnecessary stress)

- first connection on the bench
- installation in a car
- first startup and base spark advance check and adjustment
- first tests, logging, small VE table adjustment (low/mid load/RPM) using stock narrowband sensor

  for instance using my tutorial (eng subtitles)
  https://www.youtube.com/watch?v=bLf0nnnWRD4&t=883s

- additional functionality tests
- further car mods and calibration

first connection on the bench

- install drivers for Arduino Mega 2560

  CH340 Windows drivers: http://www.wch.cn/downloads/file/65.html

- connect Speeduino to laptop using USB A-B cable, there is no need to connect external power supply. In case you have **BT** module switch it **OFF** (BT blocks USB communication)
- create new project in TunerStudio, choose **Detect,** wait till TS detects Speeduino firmware and let TS download ini file

  WARNING: if after connection of Speeduino to laptop you notice assigned COM port number above 4 **TunerStudio** may NOT detect Speeduino board. In that case manually change COM port number to 1 … 4 range in Windows Device Manager and retest

- choose units (Celsius, BAR, others can be default) →**next** , COM port should already be chosen as detected, on the left of **Test Port** button should be **Succesfull!!** →**next** choose **dashboard** (Default is ok) → **Finish**
- verify communication with the board. „Not Connected" should disappear, there will be progress bar instead for a while when settings are being retrieved. Then you should see gauges, Engine MAP parameter should be around 100kPa (this is current air pressure around you)
- Save retrieved settings to file for instance BASE_TUNE
- its worth giving friendly names to additional functionalities settings→programmable outputs:

  3 Purge2000 4 Purge 5 Purge2500 (simple EVAP control)

installation and first use in a car

note: even if your **Speeduino PnP** set came with wideband controller option preinstalled board is configured for stock narrowband sensor use. This is for convenience, less changes at once, less stress at the beginning

0. Open roof! Without this – similarly as other MX5 works – may not be succesfull! 😉 *(joke)*
01. check jumper settings (factory set). For stock Miata (1.6 or 1.8):
    a. J2 ignition drive 5V
    b. J4 o2 input – stock
    c. J3 CKP source: 1.6 115HP or 90HP non-immo **2E**
       1.6 / 90HP with immo **2F**

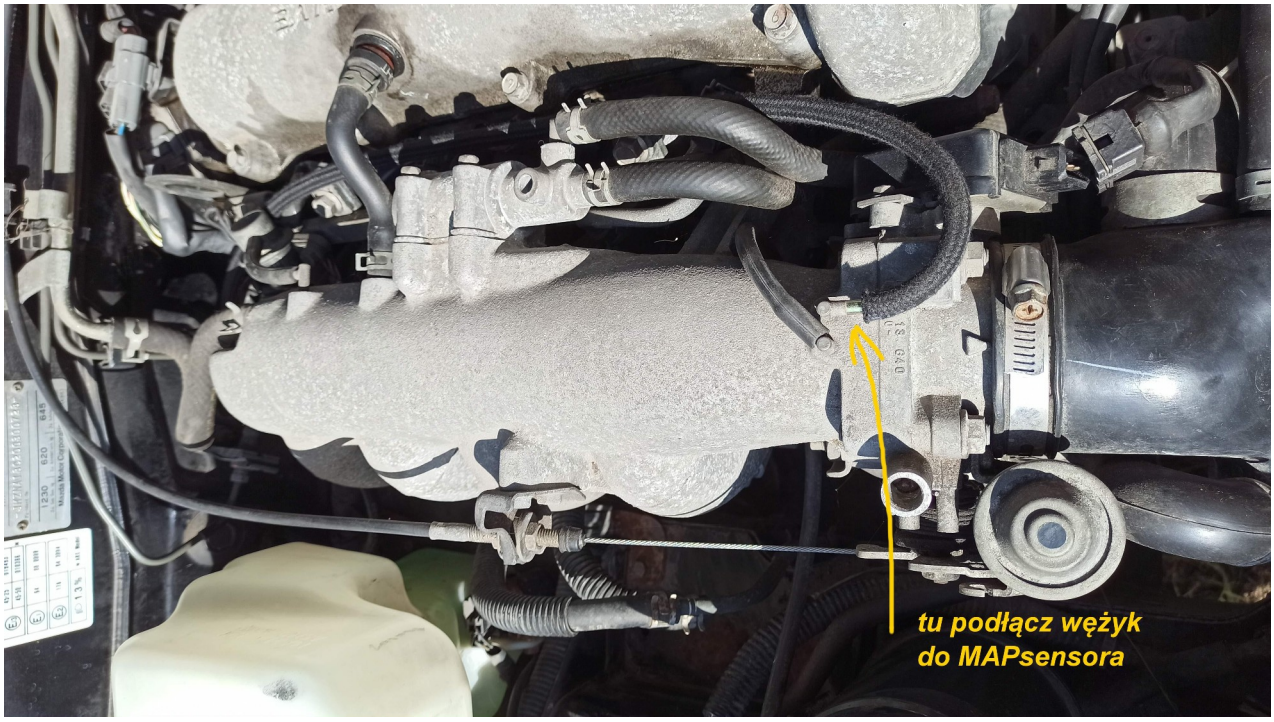
02. now **<u>disconnect battery NEGATIVE terminal</u>** in the trunk

03. **1.6 only – remove ST_SIG fuse** from fuse box under hood

04. **1.6 only – disconnect TPS** sensor

05. connect vacuum line to intake manifold, route to cabin.

    This vacuum line is **not only** for boosted engines, it is **essential** for engine control at all. Speeduino uses Speed-Density control algorithm: MAP/RPM based
    Speeduino does NOT use AFM sensor for engine control



06. remove doorsil trim on passenger side, unwrap carpet, remove styrofoam and ECU cover
07. unplug ECU plugs (2pcs) and harness clamps
08. (applicable if you PCB is revision 2.05 or lower) cut wire „1o” (BPP switch). Used as FLEX input, can interfere with ABS if equipped
09. temporarily install carpet
10. connect vacuum line to Speeduino PnP MAPsensor - **essential!**
11. connect 2 plugs to Speeduino PnP
12. connect battery NEGATIVE terminal
13. connect Speeduino PnP with laptop using USB cable, run TunerStudio with project you created earlier, connect with Speeduino PNP

14. move ignition switch to ON (not cranking yet) position, verify if following sensors show reasonable values in TunerStudio:
    a. pressures MAP and BARO
    b. battery voltage
    c. temperatures IAT and ECT
    d. in case of 1.6 engine TPS will show 0, until you replace it with potentiometer type TPS. Its not necessary at the beginning but improve engine response and enable other functionalities like LC/FS
15. start engine
16. test carefully

WARNING! Settings you got should be treated as start point for testing and careful driving. To ensure proper performance and engine safety proper tuning is mandatory (spark advance, fueling etc.)

during first runs please check:

1. idle RPM versus ECT

On initial maps I provide **PWM open+closed loop** mode. Usually it works pretty well but in case you encounter problem like stalling you can switch it to **PWM open loop**. This mode is more stable even if fueling and spark advance are not optimal but usually cannot maintain constant idle rpm vs different engine load. When fueling is adjusted you can try to re-enable more advanced **PWM Open+Closed loop** mode

PWM open loop mode setting (if necessary)
1. having engine warmed up (ECT around 90deg C) set **IAC PWM duty** observing **Idle Advance Settings**. With light engine load (lights on + blower, no AC) idle rpm should be a little higher than desired, for instance 850rpm (**RPM delta** and **Advance** slightly below 0). After switching off load mentioned (lights, blower) idle rpm should rise a little and **Advance** should go lower.
2. when idle RPM on warm engine are set and you are familiar with procedure **on next cold start** adjust whole **IAC PWM duty** curve to get desired idle rpm through whole ECT range during warmup

   its also worth cleaning IDLE valve and all air passages around idle valve/throttle body and check if all intake is airtight (no false air suction)

2. in case of problems during cranking or while after cranking → set **IAC PWM cranking duty**

3. real spark advance
   1. **Spark Settings – enable fixed/locked timing ON**, set 10 degrees
   2. verify timing with strobe light
   3. if slightly out of spec adjust **Trigger Settings → Trigger Angle**
      in case of bigger difference check mechanical CAS sensor adjustment
   4. after adjustment set **enable fixed/locked timing OFF**

other functionalities:

1. idle up when PSP sensor becomes active →**startup/idle→idle up settings→idle up amount %/steps**

2. AC control (ac clutch, fan, idle rpm, cutout) → **accessories→Air Conditioning Control**

3. engine cooling fan 1 → **accessories→thermo fan**

4. fuel vapor purge (EVAP). 3 rules are used →**programmable outputs→rule 3,4,5** If you decide not to use EVAP functionality you can use them for other purposes 😊

5. launch control/flat shift → **accessories → launch control/flat shift** (potentiometer type TPS is required for this functionality)

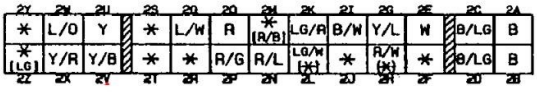
6. tacho settings (if used: 1.8 or 1.6 with COPs) →**accesories→tacho output**

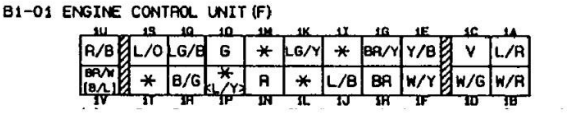
install into original ECU case

1. remove handles from original ECU
2. take out original ECU PCB from case
3. cut holes: rectangular for USB, LSU4.9 and display connectors and round for MAPsensor line
4. remember to remove all metal particles
5. install Speeduino PnP PCB in case, install handles

note: one of mounting points is lower than others. Stock ECU has radiator there. Use washers there to ensure PCB is not warped

NA ECU pinout





possible upgrades:

1. (**1.6 only**) potentiometer type TPS sensor

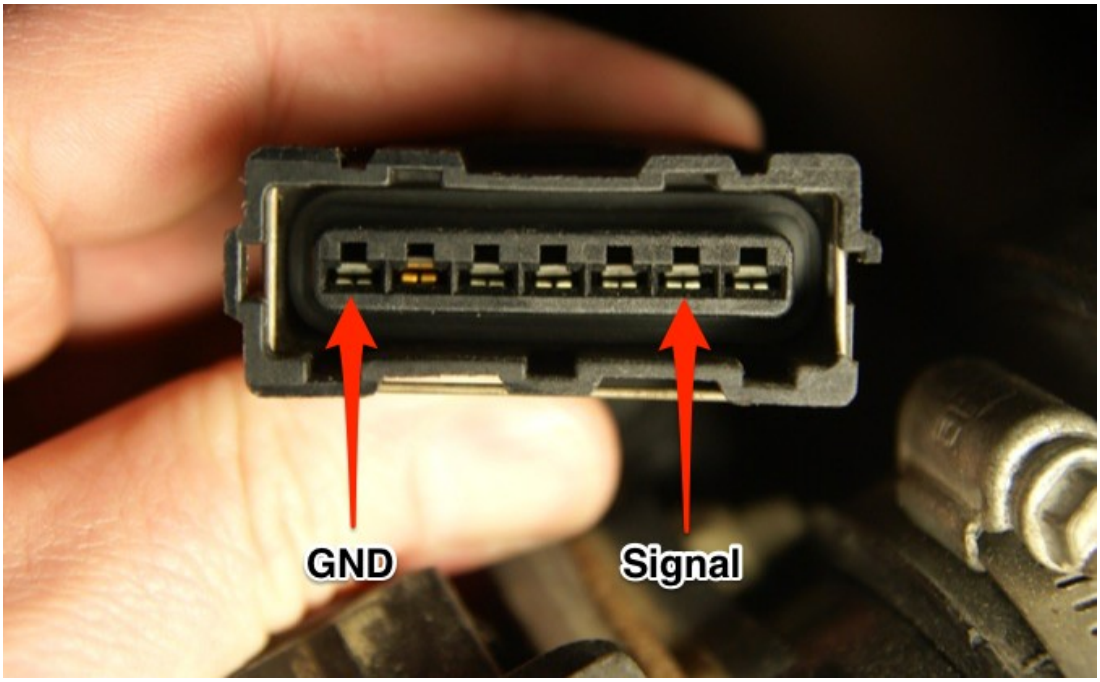
   recommend using following set, includes install manual

   https://alexengineering.pl/product/adapter-tps-mx5-mk1-na/?v=288404204e3d

   having TPS calibrated you can enable following functionalities

   1. Acceleration Enrichment (**Tuning→Acceleration Enrichment**)
   2. deceleration fuel cutoff (**Tuning→Acceleration Enrichment→DFCO)**
   3. lLaunchControl and FlatShift: **accessories→launch control/flat shift**

2. (1.6 only) AFM removal
   1. dosconnect and remove AFM, make intake you like
   2. install new IAT sensor and connect to AFM connector



   3. calibrate your new IAT sensor **tools→calibrate temperature sensors→ air temperaure sensor** set parameters (bias resistor is 2490ohm) or use sensor from list **->write to controller**

3. different injectors
    1. install injectors
    2. change settings→engine constans->**required fuel**
    3. change rest of injector settings settings→injector characteristics

    if you encounter big difference of fueling after injector replacement try at first DONT ADJUST VE TABLE but change **required fuel** and other injectors parameters

4. wasted spark or sequential spark using COPs

    wasted spark

    1. install COPs instead of stock coil
    2. set correct COP drive voltage (5V or 12V) using J2 jumper
    3. set correct dwell: **spark → dwell settings → or use (make!) dwell map**

    sequential mode

    4. install COPs. Driving signals are on pins:
        cyl 1 pin 1G (stock 1+4)
        cyl 3 pin 1H (stock 3+2)
        cyl 4 pin 1E
        cyl 2 pin 1F
    5. Set COP drive voltage and dwell as above
    6. change spark mode **spark→spark settings** from Wasted Spark to **Sequential**

    7. connect tacho input to pin 2 I

5. wideband o2 sensor (using M1 controller module by Marcin Piotrkowski.xyz)
    1. install LSU4.9 controller module if not already installed
    2. connect wideband harness to J1 connector
    3. install LSU4.9 sensor and connect to harness
    4. switch J4 jumper to WB/LSU4.9 position (factory setting is **„stock narrowband"** even if you ordered wideband LSU4.9 controller option)

5. calibrate sensor **tools→calibrate AFR sensor** . Use Innovate LC-1 calibration
6. change **Tuning→AFR/o2→sensor type→wideband**

WARNING: built-in controller module starts sensor heating process immediately with ignition ok. **Please start engine as soon as possible, dont leave on ignition for longer period of time.** Failure to do this can lead to immediate irreversible damage of sensor because cold water/humidity in exhaust will damage hot sensor

use original Bosch 0 258 017 025 sensor or one of many aftermarket/OEM ones like 9687161080, 30751138, 39350-2a410, 39350-4a410 Compatible sensor all have following plug (but often shorter cable):

LSU4.9 controller modules produced 05.2025 or later can show sensor/controller status. LED100 on PCB is blinking during heating up phase, then goes off. You can connect „MIL lamp” OpenDrain (0.5A max) output to external LED to have status on dashboard

6. additional oil pressure/fuel pressure sensors
    1. connect sensors (0-5V signal) to pins
        1. AUX1 – pin 1L (oil pressure)
        2. AUX2 – pin 1J (fuel pressure / * oil temperature)
    2. enable and calibrate → **accessories** → **pressure transducers**

note 1: possible to connect stock 0/1 pressure sensor. In this case enable input pullup by connecting P1 with P11 using solder

note 2: if using AUX2 for temperature measurement enable pullup by soldering testpoints P2 with P22

note 3: there is no native oil temperature measurement support in Speeduino, but display can calculate this. No calibration in Speeduino in this case. In TS you can only read scaled input voltage.

7. display option
    1. connect display to J1 connector
    2. make sure Secondary Serial is enabled
       →**accessories→Canbus/Secondary serial interface → ENABLE**
    3. for oil pressure reading its necessary to enable sensor:
       → **accessories → pressure transducers**
    4. for oil temperature reading its necessary to enable sensor:
       → **accessories→ local auxlinary channel configuration**

       then configuring as follows
       OIL TEMP **aux input 0** analog local, **local analog source 0** pin A11

8. additional digital inputs (active when short to GND)
    1. FLEX1 – pin 1O
    2. FLEX2 – pin 1U
    3. configure what should they do ;-)

9. **boost control**
    1. check MAPsensor line, protect from disconnection
    2. connect boost control valve to +12V ignition and pin 1D (Open-Drain output)
    3. **enable boost CUT protection** → **tuning→engine protection→boost cut→enable boost limit ON**, **boost limit** set low value at first for example 120kPa
    4. check **VE i Spark maps for values MAP >100**, enhance or modify values if necessary (general rule: lots of fuel, low spark advance)
    5. enable boost control →**accessories→boost control→boost control enabled→on**. Set table **boost targets/duty**
    6. test carefully!

In case of problems:

- irregular car jerks especially on high rpm, visible RPM spikes few thousand RPM up in TunerStudio

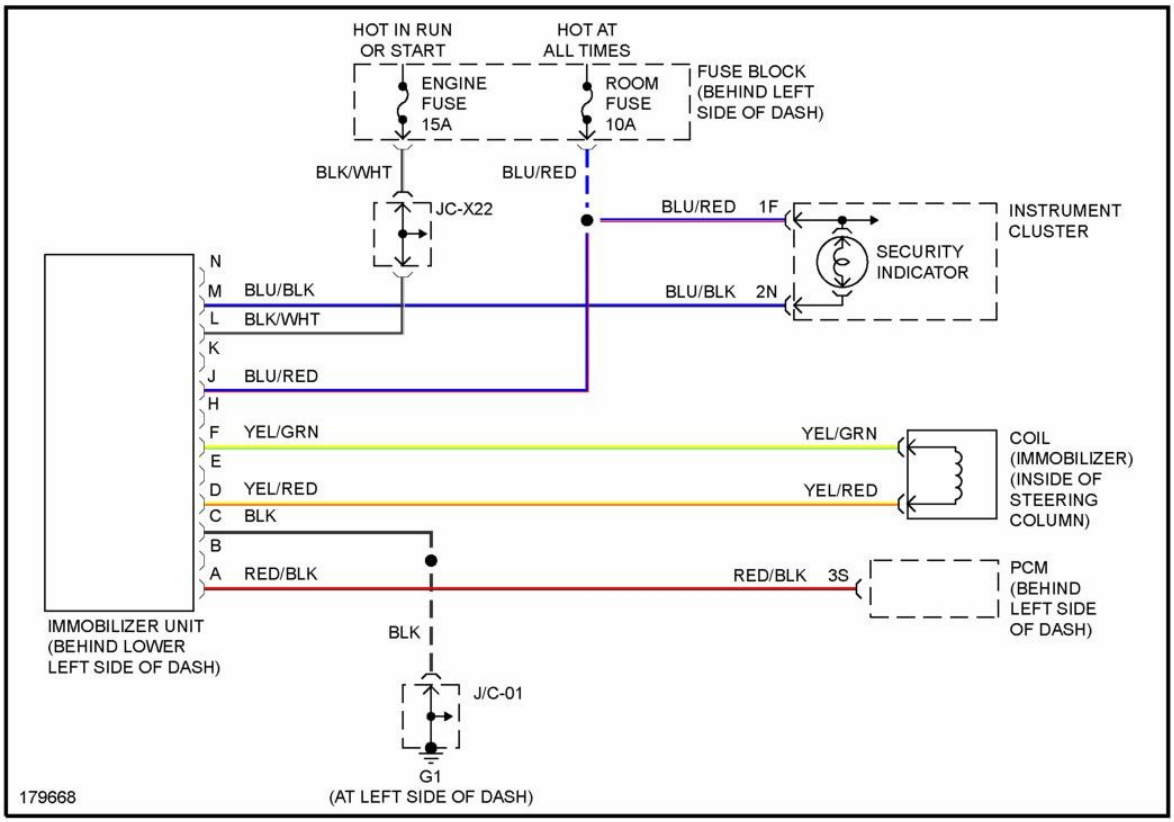
    - Check Sync Losses parameter. Should be 0.
    - If SynCLosses is higher than 0 and rises everytime you notice problem **check grounds in you car**. Unscrew, clean, connect back
    - Check trigger sensor mechanical settings (gap). Set according to manual
    - check trigger plate, should rotate without wobble
    - if you have Sync Losses = 0 and still problems are present switch from fully sequential to semi-sequential **settings→engine constans→injector layout→semi_sequential**

- wideband controller and sensor test:

    - after power on TunerStudio should show AFR around 14.7
    - after around 20 sec if engine is not working AFR should rise to 22 and stay there
    - (if you have access to sensor). When sensor is hot use lighter (gas only, NO FLAME) close to sensor. AFR should fall to 9.5. If you remove gas lighter and blow gently to sensor AFC should rise to 22 again

(applicable to late models equipped with immo) after Speeduino install IMMO light blinks

- cut BLU/BLK cable (going from immo module terminal M to clusters terminal 2N)
  or
- remove immo module



wireless **Bluetooth** connection in TunerStudio

1. Bluetooth module is on the same **serial0** bus as USB communication so you will not be able to use USB and BT at the same time. If you want to use USB connection switch BT module OFF using switch.

2. plug BT module into serial0 connector. Up to PCB rev PCB 2.06 connector is under mega2560 board, from PCB 2.06on it is J14 connector near mega2560 board and J5 serial3 connector. Observe polarity (VCC is +5V power supply, red wire on my modules)

3. For convenience BT switch cord has 2-pin inline connector. Polarity does not matter here as its just a switch

4. add new Bluetooth device in Windows OS (default password: 1234)

5. Open TS project, choose connection type: **Bluetooth Direct** → choose **your Bluetooth device** → Accept

   Before establishing connection with TS blue LED on BT module will flash. When connection is established LED will lit or switch off (depends on BT module version), after while TS should connect to Speeduino and download settings

   When BT connection is active blue LED blinks from time to time

6. In case of using OEM ECU case it may be necessary to move out BT module outside ECU case because of screening efect of metal case

Speeduino - firmware update

1. firmware update Speeduino IS NOT DONE via TunerStudio.
2. Procedure can only be done using USB cable connection, via Bluetooth its not possible
3. connect Speeduino board to laptop, backup settings in your **TunerStudio** project. Close **TunerStudio**

   remember **BACKUP OF YOUR SPEEDUINO SETTINGS** is crucial. Firmware update zeroes them completely. There is no way to recover if you dont have backup

4. note down VSS sensor and gearbox data → **accessories→vss and gear detection**

5. run **SpeedyLoader** Active internet connection necessary

   https://github.com/speeduino/SpeedyLoader/releases

6. choose firmware from list
7. choose COM port Speeduino is connected to
8. choose upload, wait few minutes to finish and OK message
9. close **SpeedyLoader**, run **TunerStudio** and make new project

   choose **Detect,** wait till TS detects Speeduino board and let TS download ini file

   choose project parameters (units, dashboard itd)

10. load Speeduino settings from file you saved in 3rd step

11. before you start engine **calibrate**
    1. ECT i IAT sensors
    2. AFR sensor
    3. VSS sensor and gear data

12. Check calibration (should be correct after loading backup) of
    1. TPS sensor
    2. MAP i BARO sensors
    3. BATT voltage reading

13. backup settings to new file in your newly created TS project

    from now you will be using this new TS project

14. start engine and carefully check if everything works correctly

Sensor calibration (if necessary)

Coolant Temperature Sensor

choose **RX-7_CLT** or

bias 2490 ohm
-20 oC 16000 ohm
20 oC 2500 ohm
80 oC 300 ohm

Write to Controller

Air Temperature Sensor

choose **RX7_AFM** or

bias 2490 ohm
-20 oC 16000 ohm
20 oC 2500 ohm
80 oC 300 ohm

Write to Controller

AFR sensor

if using stock narrowband sensor

choose **narrowband**

if using wideband with LSU4.9 controller by Marcin Piotrowski.xyz

choose **Innovate LC-1** calibration

Write to Controller

TPS

release throttle, press button **GetCurrent** (closed throttle)

fully press and hold throttle, press button **GetCurrent** (full throttle)

Accept

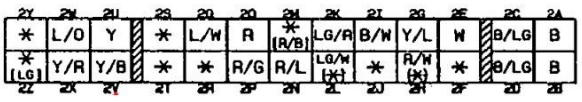
VSS sensor (if equipped)

→ accessories → VSS and gear detection → 60kmh auto calibrate

then Set gear 1, 2,3,4,5 (6)

signal	mega2560	car connector			
CKP	D19	2E	90hp immo 2F		
CMP	D18	2G			
IGN 1+4	D40	1G			Sequential: cyl 1
IGN 3+2	D38	1H			Sequential: cyl 3
IGN 3	D52	1E	stock DLC FEN		Sequential: cyl 4
IGN 4	D50	1F	stock unused pin		Sequential: cyl 2
INJ1	D8	2U			115HP 1+3
INJ2	D9	2V			115HP 2+4
INJ3	D10	2Y			1.6 90HP / 1.8
INJ4	D11	2Z			1.6 90HP / 1.8
IACV	D5	2W			
VCT/WMI/ NITRO	D6	1K			stock DLC TEN
BOOST	D7	1D			Stock DLC MEN
BATT ref	A4	1B			
ECT	A1	2Q			
IAT	A0	2P			
					NEEDS REWIRING!!! - stock
TPS	A2	2L		1,6	**WOT switch**
		2M		1,8	TPS AT/1.8
BARO	A5				internal
MAP	A3				internal
			stock		
o2 sensor	A8	2N	narrowband		
FAN	D47	1R		1,6	
		1L		1,8	
Fuel Pump	D45	1C		1,6	**remove ST SIG fuse**
		2T		1,8	
Purge	D39	2X			
Tach	D49	2I			
VICS	D12	2H			stock unused pin
PSP / idle up	D27	1P			
FLEX1	D2	10			BPP switch
FLEX2	D3	1U			headlight switch
AUX1	A10	2J			stock unused pin
AUX2	A11	2O			stock VAF/MAF input
Clutch	D41	1V			
VSS	D21	1M			1.6 90HP / 1.8 130HP

AC input	D46	1Q	
AC solenoid	A15	1J	
AC fan	A48	2S	1.8 only



B1-01 ENGINE CONTROL UNIT (F)