Mazda MX-5 NB

Speeduino PnP v2 ECU installation and use

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

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

Required tools and materials:

- Mazda MX5 Mk2 (NB)
- Speeduino PnP MK2 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
- change one of gauges for instance **PulseWidth** to **BatteryVoltage** (move cursor above gauge, right mouse button→sensor inputs→**Battery Voltage**). Will be useful later
- its worth giving friendly names to additional functionalities settings→programmable outputs:

  1 BATT LAMP

  3 Purge2000 4 Purge 5 Purge2500 (3 rules used for EVAP control)

  6 VICS 7 alt_off 8 o2_heater

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

2. Open roof! Without this – similarly as other MX5 works – may not be succesfull! 😉
3. check jumper settings (factory set). For stock Miata (1.6 or 1.8):
    a. J2 ignition drive 5V
    b. J4 o2 input – stock
4. now **disconnect battery NEGATIVE terminal** in the trunk
5. (applicable if you PCB is revision 2.05 or lower) disconnect EGR valve plug. Its terminals are used as Ignition 3 and 4 outputs for sequential ignition option. Neglecting to do this step may damage Ign 3 and 4 drivers
6. connect vacuum line to intake manifold (1.6 using t-split provided, 1.8 using existing free port plugged), route to cabin. Secure with zip-ties etc

    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 MAF sensor for engine control

1.6

1.8

7. remove doorsil trim on passenger side, unwrap carpet, remove styrofoam and ECU cover
8. unplug ECU plugs (3pcs) and harness clamps
9. temporarily install carpet
10. connect vacuum line to Speeduino PnP MAPsensor - **essential**
11. connect 3 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. throttle position TPS
    b. pressures MAP and BARO
    c. battery voltage
    d. temperatures IAT and ECT
15. start engine
16. check battery is charged properly (**BatteryVoltage** should rise from 12V to around 14V)
17. 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 adjustment (if used)

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

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**

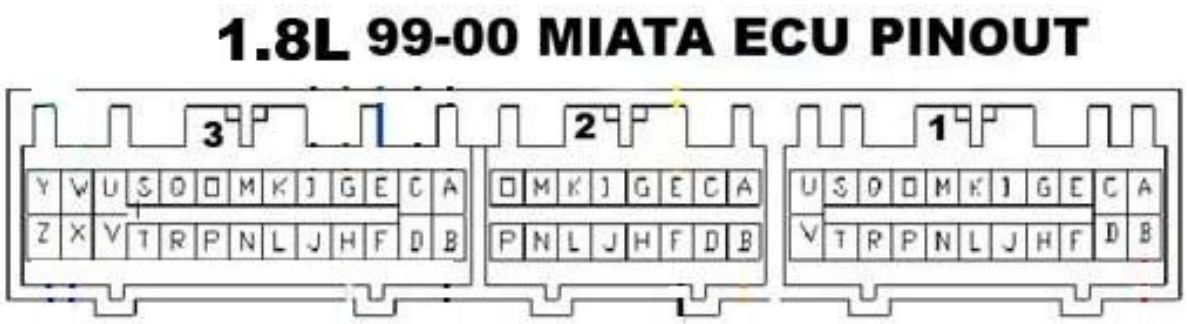
3. real spark advance. **Strobe light necessary**
    1. **Spark Settings – enable fixed/locked timing ON**, set 10 degrees
    2. verify timing with strobe light
    3. if out of spec adjust **Trigger Settings → Trigger Angle**
    4. **after adjustment** set **enable fixed/locked timing OFF**

other functionalities:

1. battery warning light. Lights up when battery is outside 12.3V … 15V range. Can be changed if necessary →**programmable outputs→rule 1**
2. 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 😊
3. variable intake control VICS (1.8 only). →**programmable outputs→rule 6**
4. alternator off feature during cranking and battery overcharge protection →**programmable outputs→rule 7**
5. stock o2 sensor heater →**programmable outputs→rule 8**
6. idle up when PSP sensor becomes active →**startup/idle→idle up settings→idle up amount %/steps**
7. engine cooling fan 1 → **accessories→thermo fan**
8. AC control (ac clutch, fan, idle rpm, cutout) → **accessories→Air Conditioning Control**
9. launch control/flat shift → **accessories → launch control/flat shift**
10. tacho settings (if used tacho output) →**accesories→tacho output**

install into original 1.8NB (BP5D) 1.6 NB (B6MM) 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



possible upgrades:

1. 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 NOT ADJUST VE TABLE but change **required fuel** and other injectors parameters

2. 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

    1. install COPs. Drive signals are on terminals:
        cyl 1 terminal 3G (stock 1+4)
        cyl 3 terminal 3H (stock 3+2)
        cyl 4 terminal 2O (ign 3 output)
        cyl 2 terminal 2P (ign 4 output)
    2. Set COP drive voltage and dwell as above
    3. from PCB rev 2.06 on – connect (solder) IG3 with IG31 and IG4 with IG41 to enable ignition 3 and 4 outputs. From PCB rev 2.09 on there are „jumpers” on board for enabling spark3 and spark 4 outputs
        Remember that EGR valve has to be disconnected or cables going from 2O and 2P terminals to OEM harness cut off
    4. change spark mode **spark→spark settings** from Wasted Spark to **Sequential**

    4. connect tacho input to pin 2K

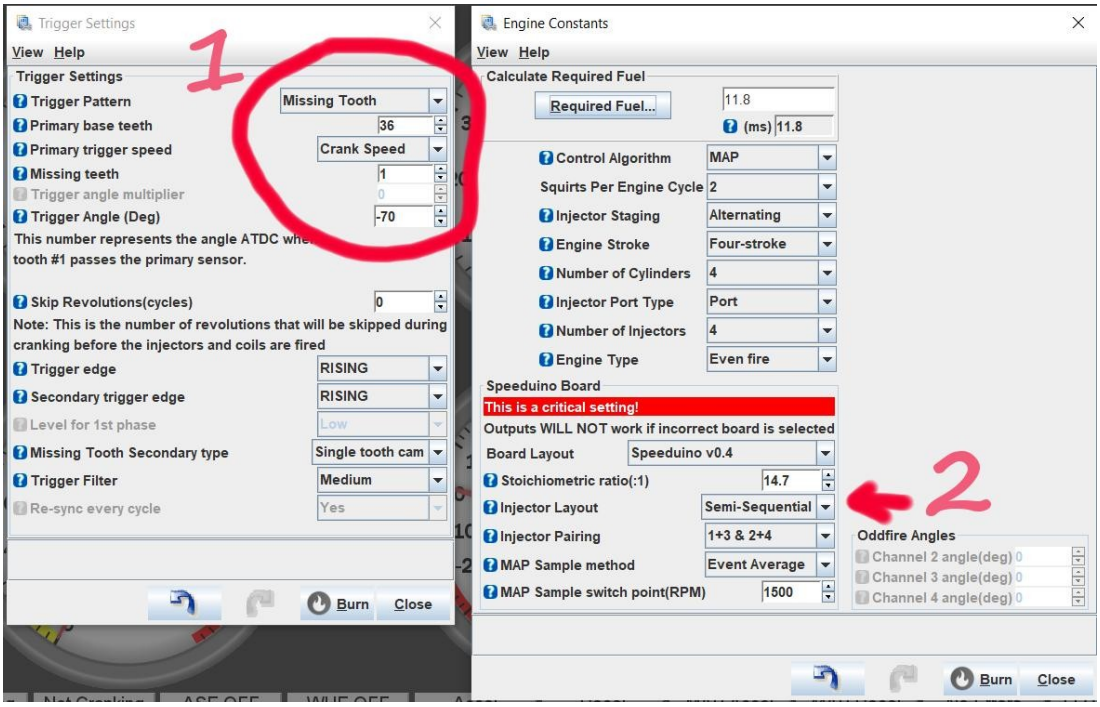
3. wideband o2 sensor (assuming you have LSU4.9 controller module installed)
    1. connect LSU4.9 sensor to J7 connector using harness provided
    2. switch J4 jumper to WB position (factory setting is **„stock narrowband”** even if you ordered wideband LSU4.9 controller option)
    3. calibrate sensor **tools→calibrate AFR sensor**. Use **Innovate LC-1** calibration
    4. change **Tuning→AFR/o2→sensor** type to **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 All compatible sensor have following 6-pin 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

4. trigger wheel change
    1. change trigger wheel on engine crankshaft
    2. change trigger settings (**settings → trigger setup**)
    3. change **engine constans→injector layout** to **semi-sequential**



4. start engine, check spark advance with timing light and adjust

warning: currently Speeduino works with non-stock triggers only in semi-sequential mode

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

note 1: its possible to connect stock 0/1 pressure sensor. In this case enable input pullup by soldering testpoints P1 with P11

note 2: if using AUX2 for temperature measurement enable input 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.

from PCB rev 2.09 on there are „jumpers” for P1_11 and P2_22, no need for soldering

6. 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

7. additional digital inputs (active when short to GND)
    1. FLEX1 – terminal 3J
    2. FLEX2 – terminal 3R
    3. configure what should they do ;-) Can be used for map switching, FleXFuel etc

8. **boost control**
    1. check MAPsensor line, protect from disconnection
    2. connect **boost control valve** to +12V ignition and terminal 1C (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

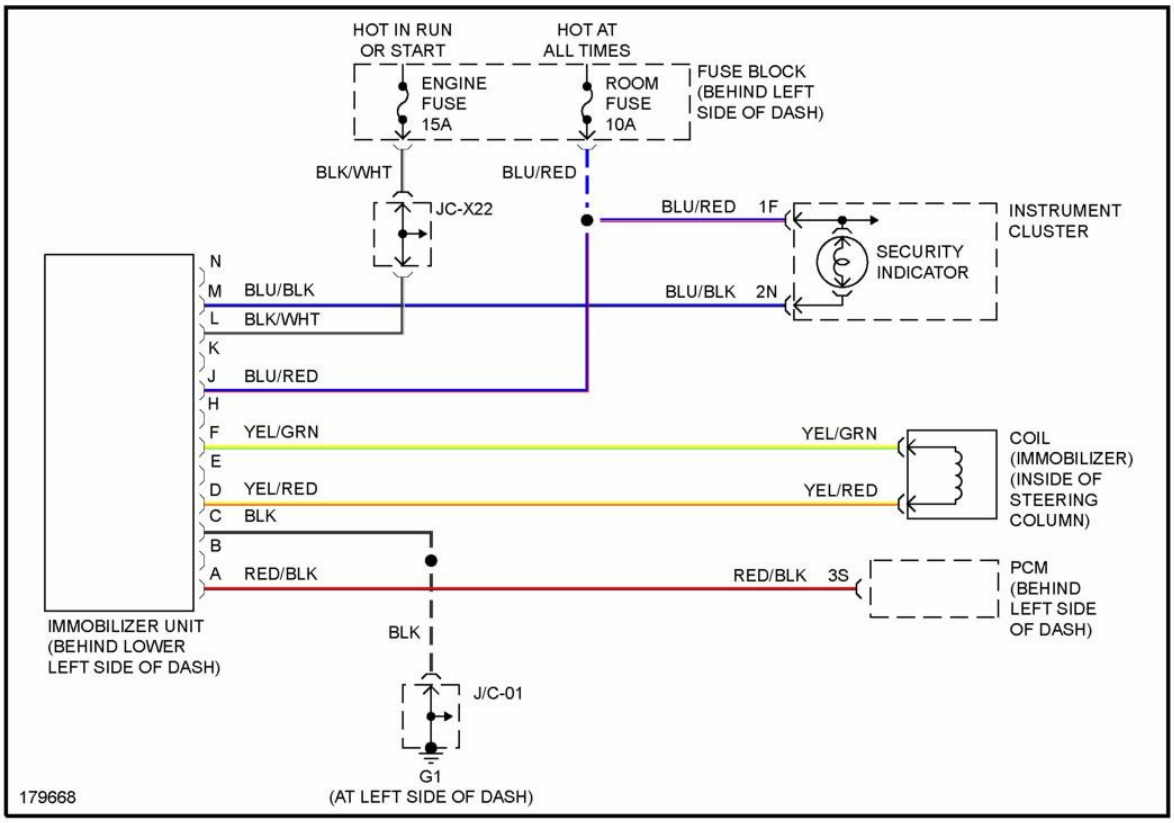
    - Check Sync Losses parameter. Should be 0.
    - If SynCLosses is higher than 0 and rises everytime you notice problem **check grounds in you car**. Unscrew, clean, connect back
    - Check trigger sensor mechanical settings (gap). Set according to manual
    - check trigger plate, should rotate without 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

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

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

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

   Before establishing connection with TS ble LED on BT module will flash. When connection will be establishet 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

5. 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

TPS

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

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

Accept

Coolant Temperature Sensor

bias 2500 ohm

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

Write to Controller

Air Temperature Sensor

bias 2500 ohm

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

Write to Controller

AFR

using stock narrowband sensor: choose **narrowband**

using built-in wideband LSU4.9 controller: choose **Innovate LC-1**

Write to Controller

signal	mega2560	car connector	
CKP	D19	2J	
CMP	D18	2H	
IGN 1+4	D40	3G	Sequential: cyl1
IGN 3+2	D38	3H	Sequential: cyl 3
IGN 3	D52	2O	stock EGR (sequential: cyl 4)
IGN 4	D50	2P	stock EGR (sequential: cyl 2)
INJ1	D8	3W	
INJ2	D9	3X	
INJ3	D10	3Y	
INJ4	D11	3Z	
IACV	D5	3M	
VCT/ WMI/ NITRO	D6	3D	stock unused pin
BOOST	D7	1C	stock unused pin
o2 heater / spare	D4	1U	
BATT ref	A4	1B	
ECT	A1	2E	
IAT	A0	2B	
TPS	A2	3E	
BARO	A5	-	
MAP	A3	-	
o2 sensor	A8	2C	
FAN	D47	1R	
FAN2 (AC)	D48	1I	
Fuel Pump	D45	3P/3N	
EVAP Purge	D39	3L	
Tach	D49	2K	stock unused pin
VICS	D12	3Q	
Batt low lamp	D36	1Q	
MIL lamp	D26	1E	
PSP / idle up	D27	1G	
FLEX1	D2	3J	o2 2nd sensor US
FLEX2	D3	3R	stock unused pin
AUX1	A10	1K	stock unused pin
AUX2	A11	1J	stock unused pin

Clutch	D41	3I 1.8
VSS	D21	2D
ALT off	D35	-
AC input	D46	1P
AC solenoid	A15	1S