Mazda MX-5 MK2.5 (NBfl)

Speeduino PnP V3 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 Mk2.5
- Speeduino PnP MK2.5 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, 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 2 MIL / checkengine
  3 Purge2000 4 Purge 5 Purge2500 (3 rules used for fuel vapor purge control)
  7 alt_off
  8 o2_heater

installation and first use in a car

(you can see it on YT)
https://www.youtube.com/watch?v=OD0WwL1L4V0

note: even if your **PnP ECU** 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 1.8vvt):
    a. J1 baro - ext
    b. J2 ignition drive 5V
    c. J4 o2 input – stock
    d. J5 immo – off

02. now **<u>disconnect battery NEGATIVE terminal</u>** in the trunk
03. remove plug from vacuum port near throttle body on intake manifold, connect vacuum line there, 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 VVT

04. remove doorsil trim on passenger side, unwrap carpet, remove styrofoam, remove ECU cover
05. remove ECU plugs (3pcs), remove harness clamps
06. temporarily install carpet
07. connect vacuum line to **PnP ECU** MAPsensor - **essential!**
08. connect 3 plugs to **PnP ECU**
09. connect battery NEGATIVE terminal
10. connect **PnP ECU** with laptop using USB cable, run TunerStudio with project you created earlier, wait for connection with **PnP ECU**
11. 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. termperatures IAT and ECT
12. start engine
13. check battery is charged properly (**BatteryVoltage** should rise from 12V to around 14V)
14. 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 is used. Should work well but if you encounter problems like stalling you can switch to **PWM Open Loop** mode. This one is more stable (no engine stalling for instance) even if fueling and spark advance are not optimal at expense of idle stability versus load. After optimization you can try to re-enable **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 **on next cold start** adjust whole **IAC PWM duty** curve to get desired idle rpm

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**

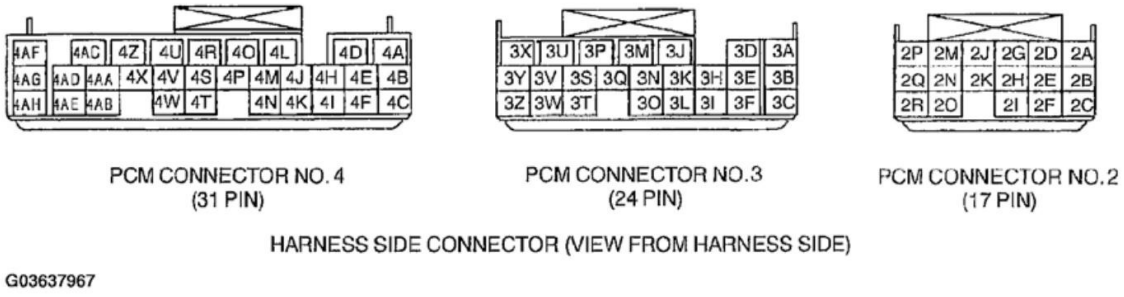
other functionalities:

1. battery warning light. Lights up when battery is outside 12.3V … 15V range. Can be changed if necessary →**programmable outputs→rule 1**
2. MIL (CheckEngine). Lights up when Speeduino status is different than 0 (ok). Can be changed if necessary →**programmable outputs→rule 2**
3. 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 😊
4. variable tumble flaps during warmup (1.8VVT only). →**programmable outputs→rule 6**
5. **alternator off** feature during cranking and battery overcharge protection →**programmable outputs→rule 7**
6. stock o2 sensor heater →**programmable outputs→rule 8**
7. idle up when PSP sensor becomes active →**startup/idle→idle up settings→idle up amount %/steps**
8. engine cooling fan 1 → **accessories→thermo fan**
9. AC control (ac clutch, fan, idle rpm, cutout) → **accessories→Air Conditioning Control**
10. launch control/flat shift → **accessories → launch control/flat shift**
11. tacho settings →**accesories→tacho output**
12. MAIN RELAY control (if necessary). use **new rule** out D42

install inside original 1.8NBfl (BP7P) / 1.8NB (BP5D) 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 ECU** PCB in case, install handles

PCM TERMINAL VOLTAGE TABLE (REFERENCE)



PCM CONNECTOR NO. 4 (31 PIN)

PCM CONNECTOR NO. 3 (24 PIN)

PCM CONNECTOR NO. 2 (17 PIN)

HARNESS SIDE CONNECTOR (VIEW FROM HARNESS SIDE)

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possible upgrades:

1. different (usually bigger) 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 to NOT ADJUST VE TABLE first but change **required fuel** and other injectors parameters like dead time. Then fine tuning VE table can still be necessary, but do it as second step please

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. Driving signals are on pins:
    1. cyl 1 terminal 3F (stock 1+4 output)
    2. cyl 3 terminal 3I (stock 3+2 output)
    3. cyl 4 terminal 3Z (ign 3 output)
    4. cyl 2 terminal 3W (ign 4 output)
2. Set COP drive voltage and dwell as above
3. change spark mode **spark→spark settings** from Wasted Spark to **Sequential**

note: boards revision 3.10 or lower have by mistake outputs 3 and 4 swapped. So in this situation terminal 3Z will be cyl 2 and 3W - cyl 4. Sorry for inconvenience!

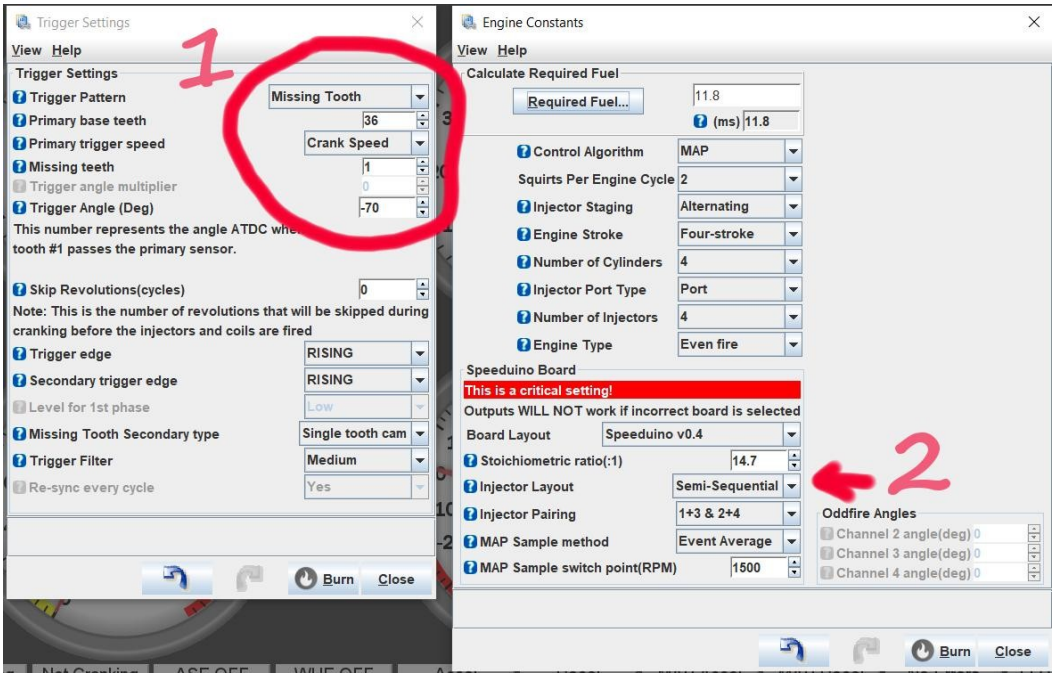
3. wideband o2 sensor **LSU4.9** using internal wideband controller
    1. install LSU4.9 or compatible sensor, connect it to harness provided and harness to J7 connector
    2. switch J4 jumper to WB position (factory setting is **„stock narrowband"** even if you ordered wideband LSU4.9 controller option)
    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 ignition ON 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. MIL light is blinking during heating up phase, then goes off.

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 if necessary

warning: currently Speeduino works with non-stock triggers only in **semi-sequential** mode. VVT control works only in open loop then. Not recommended

5. additional oil pressure/fuel pressure sensors
    1. connect sensors (0-5V signal) to terminal
        1. AUX1 – terminal 4K (oil pressure)
        2. AUX2 – terminal 3E (fuel pressure / * oil temperature)
    2. enable and calibrate → **accessories** → **pressure transducers**

note 1: possible to connect stock 0/1 pressure sensor. 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.

from PCB rev 3.11 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 – pin 3L – input D2
   2. FLEX2 – pin 3N – input D3
   3. configure what should they do ;-) Can be used for map switching, FleXFuel etc

8. boost control
    1. connect control valve to +12V ignition and to terminal 4U
    2. **enable boost CUT protection** → **tuning→engine protection→boost cut→enable boost limit ON**, **boost limit** set low value at first for example 120kPa
    3. check **VE i Spark maps for values MAP >100**, enhance or modify values if necessary (lots of fuel, low spark advance)
    4. enable boost control →**accessories→boost control→boost control enabled→on**. Set table **boost targets/duty**
    5. test carefully!

9. Internal BARO sesor instead of external
    1. on Speeduino PnP PCB solder **MPXH6115A** sensor -> **S2**
    2. move **J1 Baro Sel** jumper to **INT**
    3. verify sensor calibration

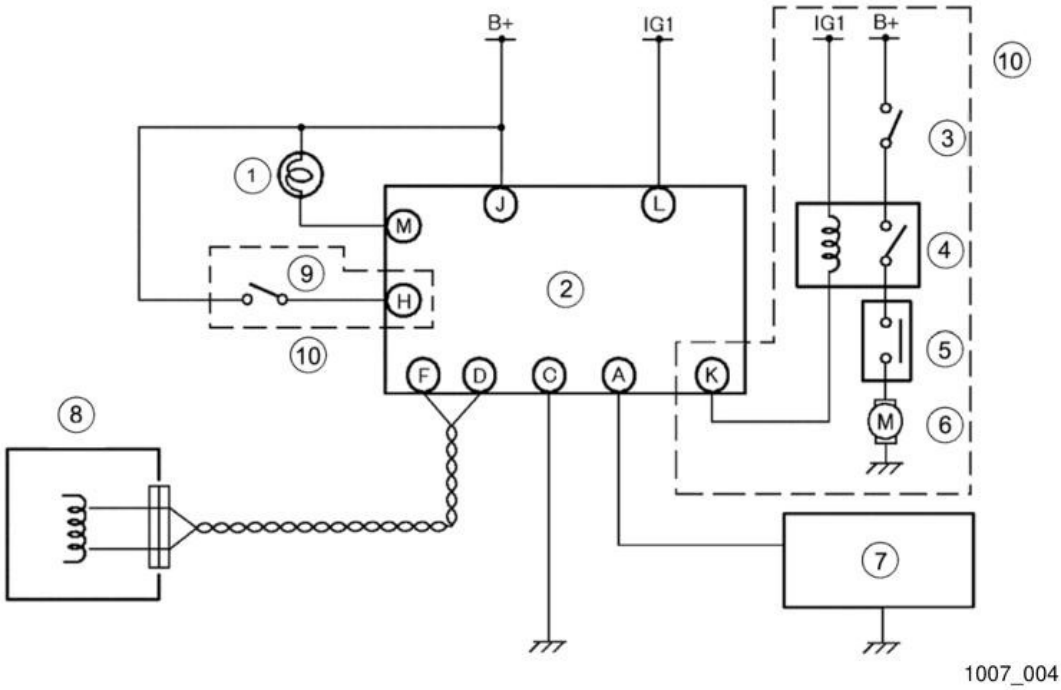
10. external immobiliser (disables fuel pump)
    1. connect signal from external immo (OK state when short to GND) to terminal 3S (stock car has original immo communication there)
    2. solder **J5** jumper to **ON** position

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 jest = 0 and still problems 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 **PnP ECU** install IMMO light blinks
  - cut BLU/BLK cable (going from immo module terminal M to clusters terminal 2N) or
  - remove immo module, then connect K terminal to ground (terminal C) to bypass starter blocking relay

- The immobilizer module of the current MIS is connected to the:
  - Coil antenna / transceiver
  - PCM
  - Security light in the IC
  - Key reminder switch
  - Starter circuit
  - Ignition switch, B+ and ground



MIS wiring diagram of MPV (LW)

1	Security light	6	Starter
2	Immobilizer module	7	PCM
3	Ignition switch (start position)	8	Coil antenna
4	Starter relay	9	Key reminder switch
5	TR switch (ATX)	10	From year 2000 onwards

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

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 3.05 connector is under mega2560 board, from PCB 3.05 on 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 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

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

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 (when using stock narrowband sensor)

choose **narrowband**

when using Bosch **LSU4.9** wideband with M1 controller module

choose Innovate LC-1

Write to Controller

signal	mega2560	car connector		
CKP	D19	3Y		
CMP	D18	3V		
IGN 1+4	D40	3F	Sequential: cyl 1	
IGN 3+2	D38	3I	Sequential: cyl 3	
IGN 3	D52	3Z	Sequential: cyl 4*	stock unused terminal
IGN 4	D50	3W	Sequential: cyl 2*	stock unused terminal
			Boards below rev 3.10 have IGN3 and IGN4 swapped	
INJ1	D8	2A		
INJ2	D9	2D		
INJ3	D10	2G		
INJ4	D11	2J		
IACV	D5	2Q		
VCT	D6	4R*	1.8vvt only	
BOOST	D7	4U*		stock unused terminal
o2 heater / spare	D4	3J		
BATT ref	A4	4AF		
ECT	A1	4P		
IAT	A0	4N		
TPS	A2	4V		
BARO	A5	4AE	stock	
MAP	A3	-		
o2 sensor	A8	4W	stock narrowband	
AC request	D46	4F		
AC relay	A15	2K		
FAN	D47	2B		
FAN2 (AC)	D48	2C		
MAIN relay	D42	3H		
Fuel Pump	D45	2M		
Purge	D39	3C		
Tach	D49	3O		
VTCS	D12	2N	1.8vvt only	
Batt low lamp	D36	3U		
MIL lamp	D26	2R		
PSP / idle up	D27	4C		
FLEX1 in	D2	3L		stock unused terminal
FLEX2 in	D3	3N		stock unused terminal
AUX1 in	A10	4K		stock unused terminal

AUX2 in	A11	3E		stock unused terminal
spare out1	D31	4Z		stock TCM/unused terminal
spare out2	D29	4AC		stock TCM/unused terminal
Clutch (LC/FS)	D41	4I		
VSS	D21	3T		
ALT off	D35	-		
ext immo	-	3S	(gnd = ok)	stock immo communication

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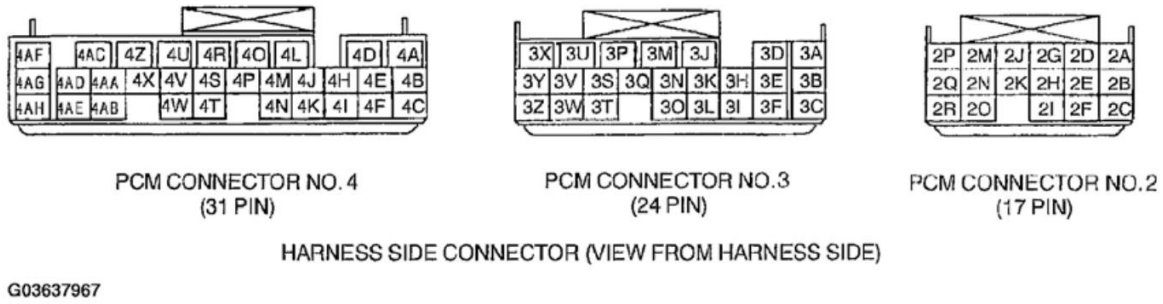

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