

ME221/ME442 Engine Management System



ME221 / ME442 GEN 2/2B MX5 1996-1998

Plug-In Quick-Start Manual

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1 Introduction

Thank you for using our system in your pursuit of power! The Motorsport Electronics core system stems from over 15 years of electronics design and engineering, from a small, active development team. With tuners all across the world, and an ever expanding network of users, the ME experience is more than just a circuit board - we are here to help and we actively encourage and welcome feedback, both via our normal support system as well as community support via our "ME Users" facebook group. Get involved - if you have an idea for a feature, there's no reason it can't be implemented!

This guide covers the physical installation of the ME221/442 Plug-In Engine Management System for the Mazda MX-5 NA (1996-97, late Mk1 model years). The ME is the core control system as used by many of our Plug'n'Play ECUs - so this guide applies to some of them also.

Visiting a rolling road and an experienced mapper will sometimes be the best option for most users (the ones who just want their car to perform how they want, without much interest in as to how to get it to) - for others, the experience of doing it themselves is what matters, and with the ME ECU being so flexible, and so many rolling roads and tuners supporting the ME product range, as well as a user friendly tuning system, plus a growing support network, both styles of approach are equally accessible.

This guide does not cover the basics of using the MEITE tuning software (i.e the menus, keys etc) - that is covered in the MEITE guide [here](#).

1.1 Safety First!

It must be said first and foremost that tuning an engine can be an exciting experience, as well as a risky one. If you really don't know what you're doing, or even where to start, read all the manuals until you do, and if you're still lost - seek professional advice from one of our world-wide installation agents. **Failure to do so may damage your engine, and even yourself!**

If you have no experience of engine management - follow the manual closely, ask for support if you get stuck, and aim only to get the basic physical install done - leave the rest to a reputable tuner to avoid engine damage or personal injury. NEVER tune your ECU on the public highway!

1.2 Connectivity & Disclaimer

While we develop the connectivity, products and basemaps on REAL cars in house, that doesn't mean to say there isn't some weird and wonderful cross-over that moved a certain connection - we detail any of these "special" cases in the appendix if applicable. It is however always the installers obligation to check the compatibility of the ECU with the OEM harness - Motorsport Electronics Limited cannot be held liable for any costs incurred through incorrect installation or use of the product. DRIVE-BY-WIRE/E-THROTTLE SHOULD NOT BE USED ON PUBLIC HIGHWAYS - DO SO AT YOUR OWN RISK.

1.3 Getting Help & Support

There are various avenues for support - the first being the online manuals and documentation. Almost all support can be answered with a simple "it's on this page" - but in those rare cases, you can either raise a support ticket via our website, or call us Mon-Fri 9am-5pm GMT on +44 (0) 1373 710610 where one of our support engineers will be happy to guide you through any queries. Please bear in mind while we will try and offer some tuning support, in most cases a visit to your nearest ME approved agent will be the best advice for tuning. Our basemaps are provided

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“as-is” and should be used at your own risk. Note they are from real cars, tuned on the rolling road at our headquarters and validated by our agents across the globe - but just like wiring ‘oddities’ this is no guarantee of their suitability for your specific modifications - using a basemap for more than startup testing prior to calibration is not advised!

There is also a vast and vibrant user community online that can offer helpful insight - check Facebook for “ME Users”, and feel free to get involved!

2 Initial Board Setup

Before you install the new Plug-In ECU into your vehicle, various checks must be carried out.

2.1 Board Switch Settings

Please note that some ME Plug-In ECUs require jumper settings to facilitate different models or functionality.

Mazda MX-5 96-97

If you do not have fuel pump operation, you may have a Euro spec ECU. In that case, there is a solder bridge on the underside of the circuit board labelled "FP_EURO". Simply join these two pads with solder.

2.2 Connected Hardware & Basemaps

The ME Plug-In ECU (and specifically its supplied basemaps) is designed to drive stock hardware & utilise OEM sensors - it is also designed to run only High-Impedance injectors. If you have changed your sensors/coils etc, you will need to configure them using the MEITE tuning studio.

3 ECU Installation

This section provides information on the physical install of the ME Plug-In Engine Management System.

3.1 ECU Handling

You should always handle both the stock ECU (and its internals) as well as the PCB with due care and attention, protecting them from anti-static discharge. Use a grounded wrist-strap where possible as damage can occur. Also be wary of physical damage to the ECUs which can be caused by applying force or subjecting them to contamination from oil/dirt. A workshop environment is NOT a safe environment for working with electronics!



1. Carry out the install on a conductive, and earthed metal workspace.
2. Wear a grounded to earth wrist-strap when working with electronics.
3. Avoid contact with any of the components, contacts or metal work of the PCBs.

3.2 Fitting of the ECU

The ECU is designed to fit into the OEM placement

The below outlines a simple guide for all models of the ME Plug-In range. Specific models are detailed (where available) on our youtube channel.

1. Ensure the ignition is off, and disconnect the negative terminal of the battery. Note saved stereo settings etc may be lost.
2. Locate the factory ECU. It is located in the passenger footwell area under the carpet and kick-plate.
3. Remove any bolts to allow removal and disconnection of the factory ECU.
4. Install the new ME Plug-In ECU into the factory casing. You may also wish to pre-drill the casing to allow access to the USB and Wideband (ME442) ports.
5. Run the provided vacuum hose from the inlet manifold (after the throttle) to the on-board MAP sensor. Drill the case with a 10mm drill to allow the hose to pass through. You can route the hose through the grommets on the OEM bulkhead of the car up being the glove box.
6. See above section if you need to carry out any pin-swaps/jumper settings.
7. Ideally, install a tuning cable, modifying the OEM casing to allow the cable to run through.
8. Reconnect the battery, but do not attempt to start - follow the manual through entirely first.

4 Additional Sensors, Wideband & Inputs/Outputs

The ME Plug-In ECU offers more connectivity than the factory ECU, allowing upgrades such as MAF-Less fuelling (utilising an IAT & MAP sensor), or spare control lines for nitrous, boost control etc.

4.1 MAP Sensor Plumbing / MAF-Less

The ME221/ME442 relies on its on-board 400 kPa MAP sensor. Run the provided 3mm ID silicone hose from the sensor on the ME Plug-In to the inlet manifold AFTER the throttle body. Be sure it is not crimped anywhere when passing through the bulkhead as required etc.

If you are using a forced induction setup, you will also need to add an IAT (Inlet Air Temperature) sensor to the inlet manifold after any intercooling stage. Connect one of the IAT sensor pins to the Red/black wire that would have originally been connected to the MAF (ECU pin 2K). The other pin should be connected to a ground eg the Black/Light Green wire that was originally connected to the MAF. They can be connected to the sensor either way around. Be sure to check in the MEITE software in the later stages that the IAT sensor reads a sensible value to confirm that the wiring is good.

4.2 Additional Inputs/Outputs/CANbus/Drive-by-Wire/etc

The Auxiliary connector inside the ECU allows a host of spare connections. These are detailed in the Appendix. Some spare I/O can only be used when using the ME442 version of the Plug-In. For AEM widebands, see here: [AEM Wideband Install guide](#).

4.2 Bosch Wideband Lambda (ME442 Only)

The 6-way black connection on the core allows you to connect using our WBO2 Kit a Bosch LSU 4.9 Sensor which can be installed in place of the first stock lambda sensor. This allows the ME442 to have accurate AFR measurements useful for either manual or auto-tuning, as well as engine protection. You can order the wideband sensor and cable kit from our website.

4.3 On-Board Logging (ME442 Only)

The ME442 has an SD-Card slot for onboard logging. Install an SDHC card here (4Gb is a good size) and you can configure the ECU to datalog within MEITE. It also features a real-time clock so each log will be date-stamped for easy later review.

4.4 Exhaust Gas Temperature Measurement (ME442 Only)

The ME442 has the ability to have an EGT (K-Type thermocouple) directly connected to it for safety and control purposes. Check the Appendix to see where to wire it as some models use the Aux. port, and others use unused pins of the factory connector. K-Type thermocouple kits are available from our website.

4.5 Electronic Boost Control

You can either use a low-side output on the Auxiliary connector (power it from a switched ignition source) or wire the boost control solenoid to the purge solenoids wiring and set LS10 to boost control.

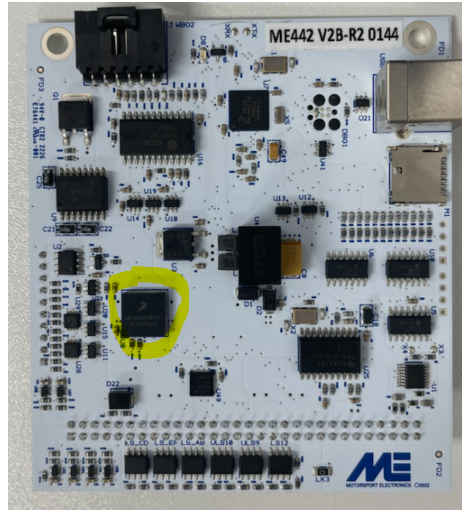
4.6 Knock Sensing

If you choose to fit an aftermarket Bosch Knock Sensor, wire its signal to pin 2H of the main connector, and solder link the “KNOCK” jumper on the back of the ECU board to enable the signal to enter the system.

4.8 Drive-By-Wire [ME442 Only with Optional DBW Upgrade]

Some variants of the ME442 model support the control of drive-by-wire throttles.

If you have a DBW Variant you can tell by looking for the following chip circled in yellow being fitted:



You can then use the following sensor wiring table below: Refer to the appendix for the OEM Pinout as to which pin does what function.

Pin	Software Pin Name in IO	Function to Set Pin To / Wire To
DBW Motor +	HBA Out +	DBW A +
DBW Motor -	HBA Out -	DBW A -
OEM TPS Signal	ANA V2	DBW A Throttle Pos Raw 1 [25]
AUX ANA-V5	ANA V5	DBW A Throttle Pos Raw 2 [26]
AUX ANA-V6	ANA V6	DBW A Pedal Pos Raw 1 [23]
AUX ANA-V7	ANA V7	DBW A Pedal Pos Raw 2 [24]
AUX 5V REF	n/a	5V Supply to sensors
AUX GND	n/a	GND reference to sensors

5 Connecting for Tuning

5.1 MEITE Tuning Software

ME Plug-In ECUs utilise the Motorsport Electronics Integrated Tuning Environment (MEITE for short) for carrying out diagnostics, calibration and setup. You can download the latest copy of MEITE from the www.motorsport-electronics.co.uk website. After downloading, install, and if prompted to auto-update, be sure to, to bring the PC tuning software to the most current version. MEITE supports Windows x32 and x64 versions 7/8/10 and above.

5.2 USB Connectivity

MEITE will automatically install the correct USB drivers when it is first installed. Simply connect the unit with the provided USB cable to a spare port on your laptop. The ECU must be powered by the car for the connection to be established - i.e ignition on.

5.3 Initial Connection

Once you have installed MEITE, and the drivers, connect the ECU to the laptop, and turn the ignition to position 2 - also, be sure to disable any immobiliser so the dashboard Check Engine Light is illuminated.

Open MEITE. If MEITE is already running, press 'Connect' under the 'File' menu. A green bar will progress across the screen as the ECU data is downloaded to the laptop. If this does not happen, check that the correct comm-port is selected in the lower right section of the MEITE window. Refer to the [MEITE guide](#) for further help with getting connected.

6 Pre-Start Setup

Be sure to follow this section carefully. Firmware updates, basic sensor checks and calibrations need to be carried out, as well as loading of a default calibration to allow successful operation of the ECU.

6.1 Firmware Update

Because we offer free feature updates and additions through firmware updates, it is always best to check the current firmware version and the version available from the www.motorsport-electronics.co.uk website. You can check which version you have currently by going to Help>About when connected to the ECU. The ECU FW Version is the number to take note of. If you have a version that is older than the current latest firmware, then follow the firmware update procedure in the [MEITE Guide](#) to update your ECU to the latest version. Note if your car has been tuned, major FW changes can make the map unusable - only update if you are aware of changes that could happen.

6.2 Basemaps and Startup

We provide a number of basemaps on our calibrations server which can be accessed from the ME website (Under support). We offer various startup files, one of which will be always provided based on (and calibrated on) an OEM, low mileage car utilizing OEM sensors and hardware. This should only be used as a guide - professional tuning/advice should still be sought.

Ensure you're connected to the ECU, then go to **Calibrations>Load Calibration** to load on a chosen calibration. Try to use a calibration that closely matches your specification. If none are available, or not yet released, start with the OEM basemap for your model. Be sure to load "Tuning data only". A green bar will progress to show the calibration being loaded. Power cycle the ignition after downloading an entire calibration.

6.3 Sensors and Sense Check

Using the 'Sensor Cals' tab of MEITE, check all sensors read sane values. IAT, Coolant, MAP (which should be around 100 KPa at sea level, with the engine not running), Throttle (moving from 0-100% with throttle actuation). If they do not, refer ME Software guide to tune the HRT tables to suit your sensors.

If you have changed any sensors, such as MAP, or IAT sensors, then you will need to calibrate them using the MEITE. Refer to ME Software guide - which details the specifics of the ECUs functions, for details on this.

6.4 Injectors

If you have changed your injectors to ones that have a different flow rate, be sure to enter their cc/min into the **System>Injection Driver** settings window available on the 'START' tab in MEITE.

6.5 Calibrating Base-Offset/Trigger Offset

If all of the above has been carried out successfully, and everything is reading correctly, it is time to attempt a first-start. The base-maps contain trigger offset numbers for the crank/cam sensors that relate to OEM cars. You should still confirm that the ECU's commanded advance (shown under **Ignition>Ignition Advance**) matches the actual advance angle seen when using a timing light (while cranking).

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If it does not, adjust it by modifying the Trigger Offset number under the ***System>Engine Driver*** window.

You can turn the fuel supply off to stop wetting of plugs during this stage by going to the ***System>Injection Driver*** and turning Fuelling Mode to “OFF”. Remember to reset this to its original setting (usually ‘Fully Seq’) when trying to finally run the engine.

Once you have the engine running and idling, reconfirm the offset as low RPMs can prove difficult to time truly accurately.

7 First Time Startup

If you have made it this far, a base-map suitable for your engine has been loaded, the engine ignition is timed and all sensors are reading sane values. You're now ready to start the engine!

Follow the below process as a final checklist and startup procedure:

1. With the ignition on, and MEITE connected, check the following from the "MAPPING" tab:
 - a. MAP sensor reads around 98-100KPa (at sea level).
 - b. Battery voltage reads around 12+ volts.
 - c. Engine Coolant and Intake Air Temp values read sanely.
 - d. The TPS/Throttle percent number moves from 0-100% as you sweep the throttle.
2. Rectify any issues with the above checklist - there is no point progressing further if the basics above are incorrect!
3. Turn the ignition OFF then back ON - listen for the fuel pump priming for around 2 seconds (if ECU controlled)
4. Crank the engine - you may need some throttle to help it. While cranking you should see an RPM reading of around 200-300rpm on most engines with charged batteries. The engine may be running excessively rich/lean - adjust the "Engine Size" under the System>Engine Driver to richen/en-lean the mixture - note this is a "get you running" hack and it should only need to be changed by around 20% maximum either way - the Engine Size should be reset to the actual size when starting tuning.
5. If you do not get a stable RPM, use the diagnostics tab in MEITE to confirm CRANK and CAM IRQs (pulses from the sensors) - also check for "Lost Sync Count" increasing while cranking as this can indicate failing sensors or electrical noise. Resolve these issues before continuing. If you have attempted multiple starts, check to ensure spark plugs are not wet - ideally replace as opposed to attempt drying them.
6. Once the engine is running, allow it to warm, and then adjust the engine size number to get as good a running as possible.
7. Adjust the idle control in "Manual Mode" under the IDLE tab to help maintain a steady idle without throttle use. (Refer to the [Tuning Manual](#) for more on idle tuning).

Remember that ultimately an engine is a simple mechanical system - it needs, air, fuel, compression and a spark (at the right time, usually around 10° BTDC at idle for most common engines). Check for these basics and you can narrow down the issue. If still in doubt, give us call or email and we will help you out - if you can have an internet connection available we can remote connect and check things are enabled correctly.

Congratulations!

You now have a running engine that is ready for full calibration under load. Please visit our website for a list of approved tuning agents, or, contact us about your tuner of choice and we can get in touch to offer training or assistance where needed. That being said, the ME221/ME442, although advanced in areas of knock and boost control etc, is similar to most modern performance ECUs in that it is a VE based engine management system and any competent tuning professional should find it very easy to use.

Appendix A | OEM Header Connectivity

Pinout below is shown looking into the ECU connector - Wire Side of the plugs. Ignore colour indications - use for position reference only.

Pin	Wire	Pin	Wire	Pin	Wire
3Y	Y/R	20	P/B	1U	V/Y
3W	Y/B	21	V	1S	L/B
3U	L/O	22	G/O	1Q	B/R
3S	G/Y	23	L/G	1O	G/Y
3Q	W/L	24	*	1M	*
3O	V/R	25	R/L	1K	L/W
3M	O	26	L	1I	B/R
3K	B/R	27	R/G	1G	W/L
3J	B/W	28	P/L	1E	*
3I	B/Y			1C	L/R
3G	G/B			1A	
3E	B/L				
3C	B/Y				
3A					

Pin #	Function/Mapping	Pin #	Function/Mapping
1A	Cooling Fan (Primary Fan) Relay / LS15	3A/C/D	Grounds
1B	AC/ Secondary Fan Relay / LS16	3B	12V Ignition
1E	Check Engine Light / LS13	3F	Crank Sensor Signal / VR_CRANK
1G	AC Clutch Relay / LS14	3G	Cam Sensor Signal / VR_CAMA
1i	LS4	3L	Tachometer
1K	Air Con Switch / DIGIN 5	3N	Ignition 1&4 / COIL 1
1L	Clutch Switch** / DIGIN 6	3Q	PWM Idle Valve / LS10
1M	VSS Speed / DIGIN 4	3R	Ignition 2&3 / COIL 2
1O	Sensor Ground	3T	Purge Solenoid / Boost LS5
1U/1V	Fuel Pump Relay / LS11 (1V by FP_EURO)	3U	Injector 1
		3V	Injector 2
2B	MAF Signal / ANA V4	3W	Injector 3
2C	O2 Sensor Signal / ANA V3	3X	Injector 4
2F	Throttle Signal / ANA V2		
2G	Coolant Sensor Signal / ANA T2	3Y	DBW A- (ME442 DBW Version Only)*
2H	Knock Sensor + / KNOCK 1 (jumper)	3Z	DBW A+ (ME442 DBW Version Only)*
2i	TPS 5V REF		
2K	Inlet Air Temp Sensor (MAF) / ANA T1	MAP	On-Board MAP / ANA V1

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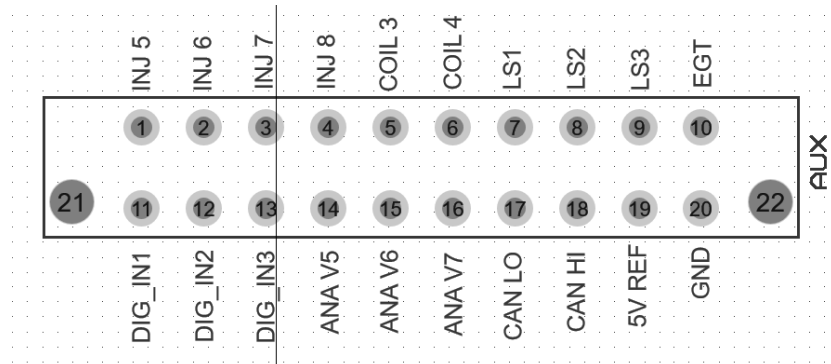
*Auxiliary - not used by OEM, and only on ME442 Variant.

**Not all models - may need to run a wire in some cases.

Appendix B | Auxiliary Connector

The Auxiliary Connector allows a host of other functionality. This is the image of the connection, and they are detailed in the table.

The connector body is MOLEX 39-01-2205 and the pins are MOLEX Mini Fit Jr. All available from mouser.co.uk



Pin #	Function	Pin #	Function
1	Injector 5 (3.5A FB protected)	11	DI 1 (Digital Input 1, 1K, 5V Pull-up)
2	Injector 6 (3.5A FB protected)	12	DI 2 (Digital Input 2, 1K, 5V Pull-up)
3	Injector 7 (3.5A FB protected)	13	DI 3 (Digital Input 2, 1K, 5V Pull-up)
4	Injector 8 (3.5A FB protected)	14	Analogue Volt 5 (0-5V Input)
5	Coil 3 (50mA TTL Output)	15	Analogue Volt 6 (0-5V Input)
6	Coil 4 (50mA TTL Output)	16	Analogue Volt 7 (0-5V Input)
7	LS1 (2A PWM-Able)	17	CANBus 1 Low
8	LS2 (2A PWM-Able)	18	CANBus 1 High
9	LS3 (2A PWM-Able)	19	5V Reference (100mA Max Load)
10	EGT K-Type Signal*	20	EGT/Sensor Ground

*ME442 Versions Only.

Appendix C | Known Issues / Model Specifics

No Known Issues

Appendix D | VVT Swap / 36-2 Triggers

This only applies to baseboard (larger circuit board) versions prior to v1.8. If you plan to run a 36-2 Trigger Wheel change the R2 Resistor on the baseboard to 22K Ohms. To access this resistor, remove the smaller 'core' circuit board by removing the two bolts and separating it from the baseboard.

If you plan to run stock NB triggers (such as doing a VVT swap) then both R1 and R2 need to be changed to 82K.

You can then use a chosen AUX OUT LOW SIDE (PWM) to drive the VVT Solenoid. The other pin of the VVT Solenoid needs to go to 12V switched ignition.

A technical article can be found on our website also.

<https://motorsport-electronics.co.uk/mazda-mx-5-vvt-swap/>

Appendix E | 36-2 and 36-1 Trigger Wheel

If you fit a 36-2 or 36-1 trigger wheel, set the trigger pattern (in Engine Driver -> Trigger options) to the relevant pattern. To obtain sync, you will likely have to reduce the "Sync Start Mult." and "Sync Loss Mult" to a lower value eg 1.1.

Appendix F | Mk2 to Mk1 Engine Swap

If you are planning to install an NB or NB2 engine into the NAs engine bay, and keeping the NA wiring (and the 8995 ECU), there are a couple of mods you will need to do - the 8995 ECU fully supports the NB and VVT engine -

In the Engine bay:

1. Firstly you will need to wire the Crank and Cam sensors from the NB/NB2 engine into the NA's CAS sensor connector - this allows you to remove the CAS. Use shielded cable for this.
2. You will need to link up the Injectors, TPS and Idle harness to the NA loom - there are plenty of guides on this and the wiring is straightforward.
3. It is recommended to change the alternator to the 89-98 NA (self regulated) type, as that is usually easier than wiring the smart alternator to the ECU - change the alternator pulleys if required, but otherwise, they should bolt in.

Modifying the ECU:

YOU DO NOT NEED TO DO THIS ON REV R1.2 BASEBOARDS AND ABOVE! PLEASE CONTACT US IF YOU ARE UNSURE!

The ECU requires its pullup resistors removed, and changed/added externally to support the OEM Cam/Crank sensors:

1. Remove the ME221/442 8995 ECU from the car.
2. Carefully unbolt the core from the baseboard. There are 2 nuts that need to be undone, then carefully prise the core up being sure not to bend any pins.
3. Replace the now visible R1 and R2 resistors with 82Kohm. ([These](#))
 - a. **NOTE IF YOU PLAN TO RUN a 36-2 CRANK TRIGGER, CHANGE R2 to 22K.**
4. Refit the core back into the ECU, and tighten the retaining nuts.

MEITE Settings:

Now ensure you change the settings in the MEITE for the Crank/Cam in the System>Engine Driver to MX5 NB, and cycle power. You should then get a steady RPM when cranking, you may need to change your trigger offset angle to approx 642 (or confirm with timing light/load an NB basemap onto your ECU).

If you don't get a steady RPM, check the Diagnostics tab - both Crank & Cam IRQs should count up when cranking - if one (or both) doesn't, then the signal is not making it to the ECU correctly - check wiring for the one which isn't working.

Enabling VVT Control:

If you have an NB2 VVT engine, you will also need to run some additional wires to make full use of the VVT system:

1. The connector for the VVT solenoid is a standard 2-pin mini-timer type.
2. Run a 12v, ignition switched supply to the VVT solenoid Pin 1 (from the Purge Valve or injector harness is a safe bet), and then run a wire from the VVT solenoid Pin 2 to where the ECU is in the passenger footwell - connect using the MAC/AUX Port guide above to a spare LS (LS1, LS2 or LS3 are preferred for VVT.)
3. Fit an SB340 Diode across the power and signal wires running to the VVT solenoid, A diagram is shown below.
4. In the I/O Settings in MEITE, be sure to set your chosen LS to 'VVT' in the output settings. You can then tune the VVT control using the settings under the VVT tree item, or simply import the VVT settings and tables from an 0105 VVT basemap.

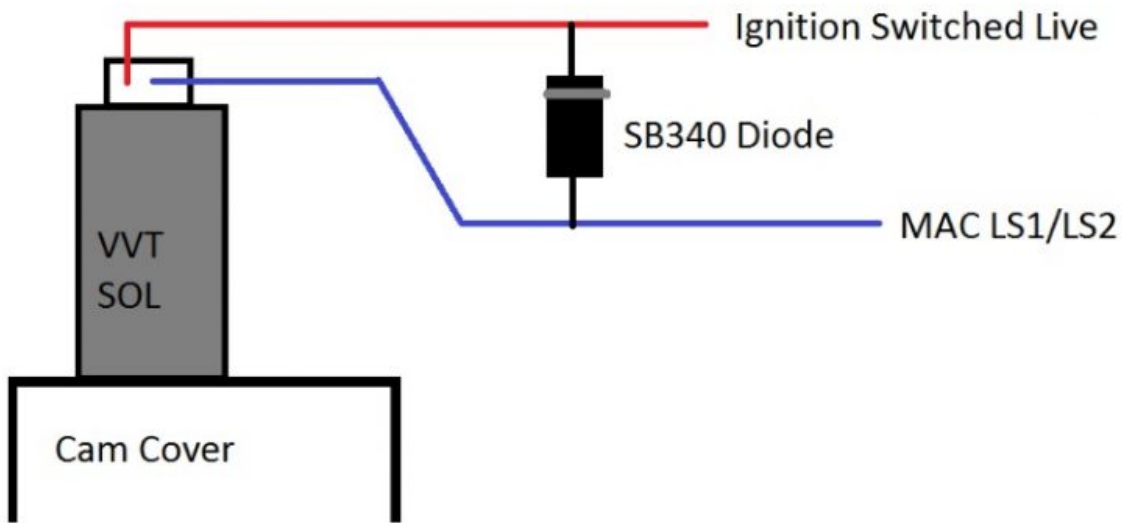


Fig: Wiring of the VVT Solenoid

Appendix G | USB Intermittent communication loss

USB while usually stable, can be subjected to electrical noise from ignition systems and cause intermittent communications dropouts while tuning.

Please follow the below steps to remedy this.

1. Ensure you are using resistive plugs and leads. Even race plugs that claim to be resistant are some times not. Use modern resistive plugs and leads, and swap back after tuning if required.
2. Ensure the ECU is fully cased and grounded to the chassis.
3. Use a premium quality shielded USB cable.
4. Ground the car to the dyno (using a jump lead), and also check with an electrician that the dyno is suitably earthed.
5. Coils packs and ignitors should be properly earthed to the engine block.
6. All electrical grounds on the engine must be in good state of repair.
7. If using coil-on-plug ignition, it is common practice to install a noise suppressing capacitor. Check for information with the supplier and also in our online manual.

The final solution is to use a USB->RS232 adapter module and run directly with serial .

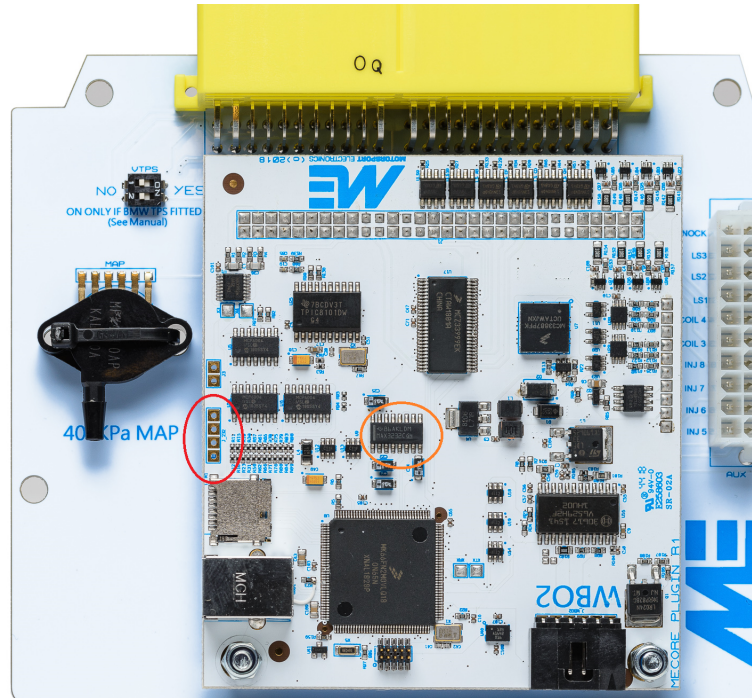
Connecting Direct RS232 to a GEN2 ME221/442 Core

The previously mentioned points should solve any issue but at a last fallback option, you could connect to the RS232 connector.

The ME core circuit board (the smaller one at the top) has a four pin header near the SD card slot - circled in red.

Check whether the RS232 chip circled in orange is fitted with your revision of ECU.

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Use an RS232 Extension cable like the ones that we supply on our website to connect directly to an RS232 Port equipped laptop (or more commonly use an FTDI cable if you do not have such a port but note this can reintroduce USB noise issues!)

Using a meter to work out which wire goes where in your cable connect as per the below diagram:

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