Engine Conversions

Electrical Information, Hints, Tips and FAQ for BRZ/GT86/FRS

Contents

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1 Overview

This guide is put together to help those who are thinking of, in the process of, or have completed an engine conversion in the BRZ/GT86/FRS platform.

Aimed primarily for the more thorough conversions where full integration between the new engine and the platform is required, such as the gen4 LS with features such as cruise control, pushbutton start, A/C and traction control. It is these extra features that can complicate the conversion, and if just one component is not quite right, the system may not function as desired.

This guide is generally referenced towards our AGT plug and play translator system and using the OEM GM engine management (E38 hardware), however a lot of the information is also valid for our wire in translator and other branded translator/wiring systems as well as non GM engine conversions.

Stand alone, or aftermarket engine management systems can be controlled a little differently and is beyond the scope of this guide.

2 Vehicle Selection

The main difference between the chassis wiring stems from whether the original had a manual or automatic transmission.

Both manual and automatic vehicles can be used (can be converted to the GM manual), however there are some electrical complications added if the vehicle was an automatic, especially on the pushbutton start automatic models.

If an automatic vehicle is used, you must alter some of the vehicles wiring to make it work correctly. The best way to do this is download the wiring diagrams and look at the STARTING wiring diagrams. The diagrams show the wiring for both automatic and manual versions, with (MT) labels on wiring on the manual models, and (AT) on wiring for the Automatic models. The best way to describe the modifications required is to remove the (A/T) wiring and add the (MT) wiring. Summarised below:

- **KEY START**
    - Remove the Inhibiter Switch
    - Add clutch switch wiring (both TOP and BOTTOM travel switches)
    - Add 2pin reverse lamp plug & wiring (If reverse lamps are required)

- **PUSHBUTTON START**
    - Remove the Inhibiter Switch
    - Add clutch switch wiring (both TOP and BOTTOM travel switches)
    - Remove BRAKE signal to Certification ECU
    - Add clutch bottom of travel switch to Certification ECU
    - Add 2pin Reverse lamp plug & wiring (If reverse lamps are required)

If a manual vehicle is used, there are no electrical modifications required, however make sure you keep the clutch switches working correctly. Some customers have had issues with the clutch switches after modifications to the clutch pedal (such as different master cylinder installation. An inoperable clutch "bottom of travel" switch will cause issues starting, unless the wiring is bypassed. An inoperable "top travel" clutch switch will prevent cruise control from operating.

Electrical wiring diagrams can be readily sourced and downloaded online from forums such as the "Subaru Legacy International" forums. We have also extracted the engine related diagrams and available to download on the agtengineering.com.au website

3 Engine (+ Management) Selection

To get full system integration, a gen4 GM E38 ECU must be used with an appropriate calibration (tune installed). The E38 ECU was used in various GM models throughout a range of years on a number of different engine types. In most cases the engine will run fine whatever calibration is used. However, as an example, if you want pushbutton start to work, and the E38 calibration you are using came from a vehicle without the pushbutton start technology, the E38 may not engage the starter motor with a start request (via Canbus).

At AGT Engineering, we have a tune available on our website from a late model VF model SS Commodore (LS3). This model has pushbutton start, cruise control and traction control, and has been proven to work well with our translator. We recommend using this tune file to prevent issues arising from features that may be missing or other abnormalities from your calibration file.

Symptoms of an incompatible calibration can be very minor, such as incorrect gauge/warning lamp indication, to pushbutton start not functioning, to an inoperable throttle pedal.

If you have an older GM engine (such as the LS1), or a different type of engine (such as a 2JZ), there is no current way to get full integration unless the engine is compatible with an aftermarket ECU that has BRZ/GT86/FRS Canbus support.

A standard GM E38 ECU will need to be flash tuned prior to starting the engine to remove the VATS anti-theft and a few other tweaks to suit a stand alone installation. We recommend you get a local tuner to do this for you. Every time a different person alters the tune, it costs "tune credits". If you get someone to remove the VATS, then someone else to tune the vehicle, it will cost you two lots of tuning credits. If you local tuner has previously edited your tune, they do not need to purchase extra credits and can re-tune the vehicle unlimited amount of times.

4 Canbus Translator / Engine Harness Selection

There are a few different translator / harness options available to suit your budget, wiring experience and any existing components you may already have (such as the engine harness). These are summarised below:

- Plug and Play Translator and pre-modified LS3 harness
    - This package requires very little work to install, plug the translator in place of the FA20 ECU, plug the modified LS harness into the FA20 engine receptacle, and plug the engine wiring onto all the engine components. Only wiring modifications needed is the alternator power wire extended and possibly the starter trigger wire (depending on the starter model used). The modified harnesses are obtained brand new from GM to suit LS3/L98 with the TR6060 gearbox. Some minor modifications may be needed if you are using a different gearbox, different o2 sensors etc.
- Plug and Play Translator (no harness)
    - This package does not include the LS engine loom. Instead, it includes a new FA20 engine plug and allows you to save a few $$ and re-use your existing harness if it is appropriate. It requires some re-wiring of the LS harness and crimping about 35 harness wires into the FA20 engine plug. This can take a few hours for someone experienced with the correct tooling (crimpers etc). This is ideal if you have a already have the harness with your engine.
- Wire in Translator
    - This package includes a wire in translator and is ideal if you already have a stand alone LS harness in the vehicle. It provides just about all the integrated functions like the plug and play model including throttle pedal conversion. It is also considerably cheaper. The amount of wiring can vary from just 6 wires to around 20 depending on how many functions are to be used.

5 Air Conditioning

There are a number of ways to to get air conditioning working in your conversions. We recommend getting an experienced refrigeration company to adapt the lines from the GM AC Compressor, to the BRZ/GT86 system.

The Australian VE/VF Commodores use a hard double pipe for the compressor connection which runs underneath the front of the engine under the crank pulley. We found re-using this pipe to be advantageous as it allowed industry standard AN fittings to be welded on just past the front pulley to allow connection to the flexible hoses.

The double pipe also had provision for the AC Pressure sensor. This pressure sensor is recommended as this allows the GM ECU to control the A/C system as it was designed. The A/C pressure determines the speed and operation of the radiator fans and shuts the compressor off if the pressure is too low or too high. The BRZ/GT86 AC pressure switch should also be left intact, as this

switch is also wired to cut the compressor relay if the pressure is too high/low. It can however be bypasses as the pressure function is also performed by the GM system as described above.

Some people have bypassed the GM sensor by adding two 5kohm resistors in series between 0V and 5V with the middle going to the Signal wire to the E38. This fools the GM ECU that the AC is normal and allows compressor relay control. If you bypass the GM sensor we recommend keeping the BRZ/GT86 switch operational.

6 Common Issues

AGT Engineering have been involved in converting BRZ/86/FRS's since 2015 and have helped customers worldwide with their conversions. With any modern engine conversions, there can be a multitude of issues, some minor, some major. Electrical and mechanical.

Common electrical issues can be caused by the engine conversion itself, however interestingly a lot of issues are totally non-engine related, such as errors from the ABS system, given away by the ABS and TRACTION lamps staying on after the conversion.

With the engine conversion, a lot of customers do other modifications, and/or remove/alter components to aid the engine conversion. The main issues to date have been the following:

- Steering angle sensor calibration error – caused by wheel alignment change, disconnecting the steering shaft and not aligning it back up correctly.
- Wheel Speed sensor errors – Damaged, or hubs changed (e.g. upgrade to 5x114.3) or even been disconnected.
- Brake Light Switch (BLS) error – Common issue with these vehicles (even when unmodified).
- A/T M/T Discrepancy error - Ensure the Canbus translator is in the correct mode.
- Broken Clockspring – This will prevent the cruise control from working (and also the steering wheel airbag and horn). Caused by rotating the steering wheel with the column disconnected from the steering rack.

When the ABS and TRACTION lights fail to go out, most people think it is an issue with the translator, however in most cases it is one of the issues above. Unfortunately, the only way to properly diagnose an ABS fault is with a high end OBDII scanner, or the Subaru Select/Toyota TechStream diagnostic tools.

Of course, there are also a lot of issues that can arise from the engine/translator system with such a modern complex conversion. The main issues that seem to be experienced are usually wiring issues and incompatibility of the hardware/tune as discussed previously and summarised below:

- **GROUNDS** – This seems trivial; however, lots of conversions seem to have issues starting caused by unconnected grounds. Check and double check all grounds are in place before powering anything up!

- Incorrect, mismatched hardware – This happens everywhere, even our Subaru conversions where engine parts, wiring, ecu's etc are sourced from different models. This is fine if you know what is and what is not compatible or know how to fault find. However, if you want a better chance of a faultless first start, make sure it is all compatible. Preferably all from the one vehicle.
- Mismatched options – This is more prevalent for fully featured conversions with cruise control and pushbutton start. If you want pushbutton start to work for example, you will need to use an LS tune (calibration) that also has pushbutton start functionality. The LS3 E38 tune file on the AGT website has a tune file you can use that has all the functions such as cruise control and pushbutton start operational.
- Wiring issues – An engine harness with connection issues, or wires pulling out of the 54pin plug are the main issues here. Ensure your harness is sourced from a quality supplier (why we use GM OEM), and make sure you use correct crimpers on the 54pin plug pins if you are adding the 54pin plug yourself. Pull test each wire before you install the harness.
- Clutch switch issues – If the clutch pedal assembly is modified or even removed and replaced, sometimes there can be issues with the operation of the two clutch switches. There are two switches. The clutch "top of travel" switch is activated on any movement of the pedal. This is primarily used by the engine system to disengage cruise control and can prevent cruise control from activating.
  The clutch "bottom of travel" switch is activated when the clutch pedal is pressed to the floor. It is hard wired in series with the starter relay to prevent the engine from starting unless the clutch is pressed all the way in.
- Throttle Pedal issues – These issues generally pop up if an incompatible calibration is used or a wiring issue.

The Canbus translators with the Bluetooth option provide a good tool for system diagnosis, with indication of all the major inputs and outputs on a phone or tablet device. The plug and play translators also have a TEST MODE to allow you to test various inputs and outputs without having to run the engine. The test mode is a particularly handy function to undertake before the "first start".