GT86/BRZ/FR-S Plug-in

USER MANUAL

Rev 1.0

GT86/BRZ/FR-S

EMtron Australia

1.0 Introduction

The Toyota/Subaru GT86/BRZ/FR-S features a flat four configuration engine that employs an interesting combination of four (4) direct injectors and four (4) port injectors for fuel. The ECU must be able to control both types of injector along with accurately control the GDI pump pressure to a target. GDI pressures operate significantly higher than a conventional port injection system.

To correctly calculate the fuelling requirements the ECU is able to accept sensor inputs from the MAF Meter and/or MAP sensor depending on the fuel model mode selected.

1.1 Guide

This manual does not cover ECU installation.

2.0 Plugin Features

General

- KV12 ECU based platform.
  - Dual 100MHz Processors
  - 32MB ECU logging Memory
    - Over 1000 channels available
    - 1Hz to 500Hz logging rate
  - Emtune Software for tuning and data analysis
  - Knock Control using digital filtering with Bosch technology

- 6061 Grade Aluminium CNC Billet Enclosure
- Fully compatible with all OEM systems and user programmable. This includes:
  - Vehicle Stability Control (VSC) using throttle torque reduction
- Compatible with all Emtron Proven Motorsport features
- Upgradeable to run the Emtron Fuel model through installation of a Flex Meter, Fuel Temperature and Fuel Pressure Sensor
- Input Expansion Capabilities through DTM connector
  - 4x User Analog Volt Inputs (Fuel Temperature, Inlet Temp and Pressure)
  - 1x User Digital Input (Flex Meter Input)
- Output Expansion Capabilities through the DTM connector
  - 1x Auxiliary Output (Boost Control Solenoid)

Communications

- CAN 2.0B Node 1: User CAN Bus for I/O expansion(Lambda, EGT)
- CAN 2.0B Node 2: 500k Baud Full CAN Bus OEM Integration
- High Speed Ethernet 100Mbps

Operating Temperature

- Operating Temperature Range: -30 to 125°C (-22 to 257°F)

Physical

- Enclosure Size 160 mm x 162 mm x 38 mm
- 890g

3.0 Kit Contents

When purchasing a Toyota/Subaru GT86/BRZ/FR-S plug-in the following items are included:

- GT86/BRZ/FR-s Plug-in ECU
- DTM 12 way Female Connector and pin kit

3.1 Expansion Loom

The ECU's Input capabilities can be expanded using the expansion connection which is a male DTM 12 Way (DT06-12SA) See Table 3.0 and Figure 3.1

These additional inputs can be connected to any sensor, but the recommended sensors are indicated in brackets.

Pin Number	Function
1	Analog Sensor 0V Reference
2	5.0V Aux Supply
3	AN 8 (e.g. Fuel Temp or Inlet Temp)
4	AN 9 (e.g. Fuel Temp or Inlet Temp)
5	AN 10 (e.g. Fuel Pressure)
6	DI 6 (e.g. Ethanol Content Sensor)
7	14V Out Protected (ELC1 Power Supply)
8	Ground (ELC1 Ground)
9	Auxiliary Output 5 (e.g. Boost Control solenoid)
10	NC
11	CAN 1 Hi
12	CAN 1 Lo

Table 3.0 - Expansion Port Pin out

To minimise signal contamination and maximise noise immunity, it is recommended to twist the CAN wire pairs at a minimum one twist per 40mm of cable:

Pair 1		Pair 2
CAN High	<------->	CAN Low

Figure 3.0 - DT06-12SA (ECU Side)

The Mating connector, Part number: DT04-12PA

Figure 3.1 DT04-12PA (Car side)

4.0 ECU Channel Assignment

ECU Channel - Injection	Function
Injection Channel 1	Port Fuel Injector Cylinder 1
Injection Channel 2	Port Fuel Injector Cylinder 2
Injection Channel 3	Port Fuel Injector Cylinder 3
Injection Channel 4	Port Fuel Injector Cylinder 4
Injection Channel 5	Rear Lambda Heater
Injection Channel 6	Purge
Injection Channel 7	DBW Power Supply Relay
Injection Channel 8	Direct Injection Power Supply Relay
Injection Channel 9	DI Fuel Injector Cylinder 1
Injection Channel 10	DI Fuel Injector Cylinder 2
Injection Channel 11	DI Fuel Injector Cylinder 3
Injection Channel 12	DI Fuel Injector Cylinder 4

ECU Channel - Ignition	Function
Ignition Channel 1	Ignition Cylinder 1
Ignition Channel 2	Ignition Cylinder 2
Ignition Channel 3	Ignition Cylinder 3
Ignition Channel 4	Ignition Cylinder 4
Ignition Channel 5	Alternator Control
Ignition Channel 6	Engine Fan Relay
Ignition Channel 7	AC Clutch Relay
Ignition Channel 8	Starter Relay (Push Start) Start Inhibit (Key Start)
Ignition Channel 9	Not Used
Ignition Channel 10	Not Used
Ignition Channel 11	DI Fuel Pump Control
Injection Channel 12	Not Used

ECU Channel - Analog Inputs	Function
Analog Voltage 1	MAP
Analog Voltage 2	DBW 1 Servo Position Main
Analog Voltage 3	DBW 1 Servo Position Sub
Analog Voltage 4	MAF
Analog Voltage 5	Rear O2 Sensor
Analog Voltage 6	**IO Expansion Loom** (e.g. Fuel Pressure)
Analog Voltage 7 (Pull-up Channel)	Engine Temperature
Analog Voltage 8 (Pull-up Channel)	**IO Expansion Loom** (IAT/FTemp/FPressure
Analog Voltage 9 (Pull-up Channel)	**IO Expansion Loom** (IAT/FTemp/FPressure
Analog Voltage 10 (Pull-up Channel)	**IO Expansion Loom** (IAT/FTemp/FPressure)
Analog Voltage 11 (Pull-up Channel)	Intake Temperature MAF
Analog Voltage 12 (Pull-up Channel)	Engine Oil Temperature
Analog Voltage 13	Pedal Position Sensor (PPS) Main
Analog Voltage 14	Pedal Position Sensor (PPS) Sub

NOTE: Analog Voltage Channels 7-12 have switchable pull-ups which are suitable for temperature measurement.

ECU Channel - Digital Inputs	Function
Digital Input 1	Cam Position - Inlet RH
Digital Input 2	Cam Position - Exhaust LH
Digital Input 3	Cam Position – Exhaust RH
Digital Input 4	Neutral Position Switch
Digital Input 5	Direct Injection 1 Feedback
Digital Input 6	**IO Expansion Loom** (e.g. Ethanol Sensor)
Digital Input 7	Direct Injection 2 Feedback
Digital Input 8	DI Fuel Pump Feedback
Digital Input 9	Clutch Switch
Digital Input 10	Start Signal from Starter Relay (Button Start) NC (Key Start)
Digital Input 11	AC Pressure (some models only)
Digital Input 12	Start/Stop Switch (Button Start) Start Signal from Starter Relay (Key Start)
Digital Input 13	Brake Switch
Digital Input 14	Cruise Control Switch

ECU Channel - Auxiliary Outputs	Function
Auxiliary 1	VVT Solenoid Inlet RH
Auxiliary 2	VVT Solenoid Inlet LH
Auxiliary 3	VVT Solenoid Exhaust RH
Auxiliary 4	VVT Solenoid Exhaust LH
Auxiliary 5	**IO Expansion Loom** (e.g. Boost Control Solenoid)
Auxiliary 6	Engine Speed Output
Auxiliary 7	Fuel Pump Speed Control
Auxiliary 8	AC Fan Relay
Auxiliary 9	DBW +
Auxiliary 10	DBW –
Auxiliary 11	Start Inhibit (Button Start) NC (Key Start
Auxiliary 12	Not Used
Auxiliary 13	Canister Pump Module Relay (PPMP)
Auxiliary 14	Canister Pump Module Relay (VPMP)
Auxiliary 15	Canister Pump Module Relay (MPMP)
Auxiliary 16	Not Used

NOTE: Auxiliary Channels 13-15 have drivers suitable ONLY for relay control with switching currents that must be less than 0.5A.

ECU Channel - Crank/Cam	Function
Crank Index	Crank Sensor
Sync Sensor	Cam Position - Inlet Bank 1 (LH)

5.0 Plug-in Specific Information

5.2 Fuel Model

The ECU can use many combinations of methods to generate the fuel mass output . The ECU base calibration is supplied using simple but common Speed Density (MAP). There are many other fuel modelling methods possible to achieve an excellent result. Commonly modified camshafts, aftermarket air bypass valves, larger turbochargers and modified intake piping will tend to create unstable Mass Flow Sensor readings so MAP based fuel models tend to make the process much simpler.

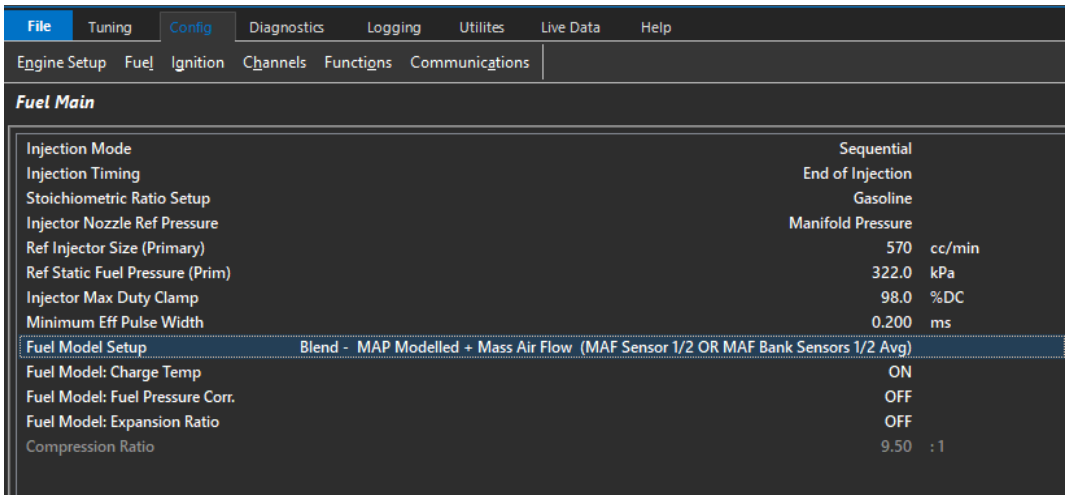

Figure 5.1. Fuel Model Setup

Press F1 when you have this setting selected for more detailed help on each Fuel Model.

When MAF is selected the Secondary Load table can be used to scale the MAF if required. The factory calibration should provide good initial air mass calculations but it will be common to modify the intake and therefore this will require re calibration of the MAF meters. This table will need to be switched ON. To do this select Fuel Menu-> Fuel Table Control -> Secondary Load Table. Set to a value of 12 as shown in Figure 5.2.

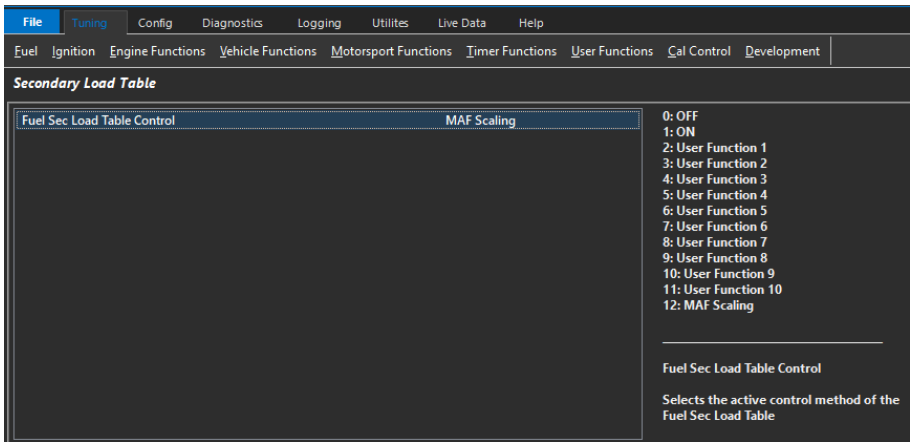

Figure 5.2. Secondary Load Table - MAF Scaling

There is also a runtime in the F3 Menu -> Fuel Tab showing the current Fuel Model the ECU is running in.

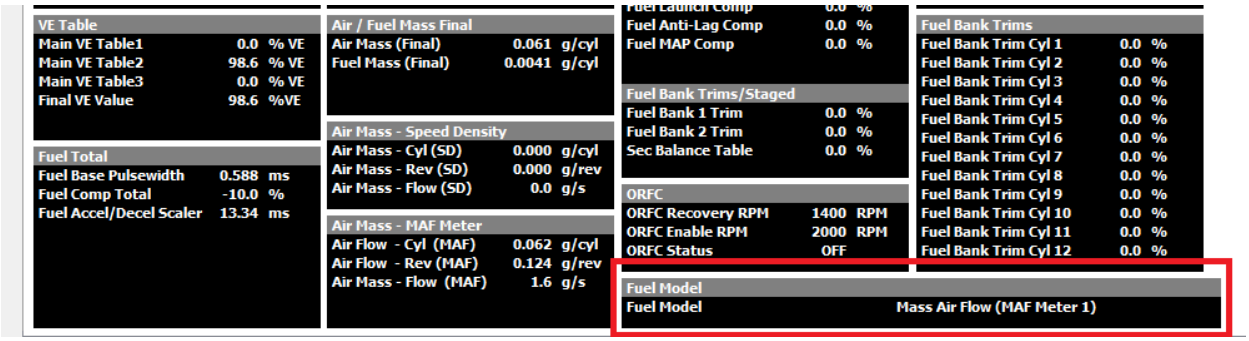

Figure 5.3. Fuel Model Runtime

5.3 Inlet Air Temperature

A factory fitted Inlet Temperature Sensor is fitted. This is available on Analog Input 11 and should already be configured in the base calibration shipped with the ECU.

5.4 Check Engine Light

The control of this light is done through the CAN bus. The base calibration file has the output already configured and selected to “CAN Bus OEM”.

5.5 AirCon Switch

The AirCon Switch status is read through the CAN bus. The base calibration file has the Input Source selected to “CAN Bus OEM”.

6.0 Diagnostic Trouble Codes (DTCs)

On initial installation it is advised to clear all the DTC's if error(s) are reported. To check, connect to Emtune and look at the DTC status in the bottom toolbar. If there are Errors the status box will be Red as shown in Figure 5.0.

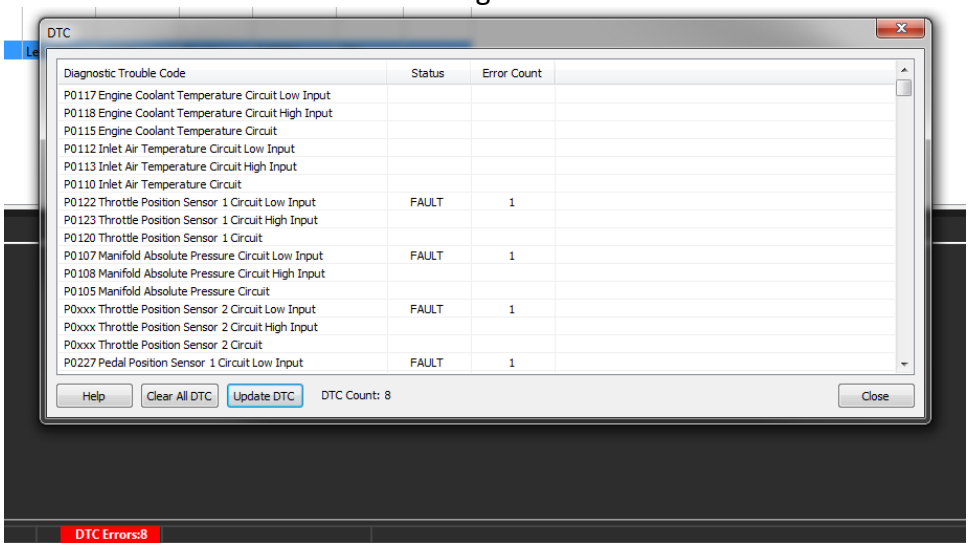

Figure 7.0. DTC example showing 8 errors.

To open the DTC window, click on the DTC Status box in the bottom toolbar OR use the File menu -> Open DTC. Next select "Clear ALL DTCs" and confirm all the Error Codes have been removed; the DTC Status box should go Green indicating this as shown in Figure 7.1. Close the DTC window.

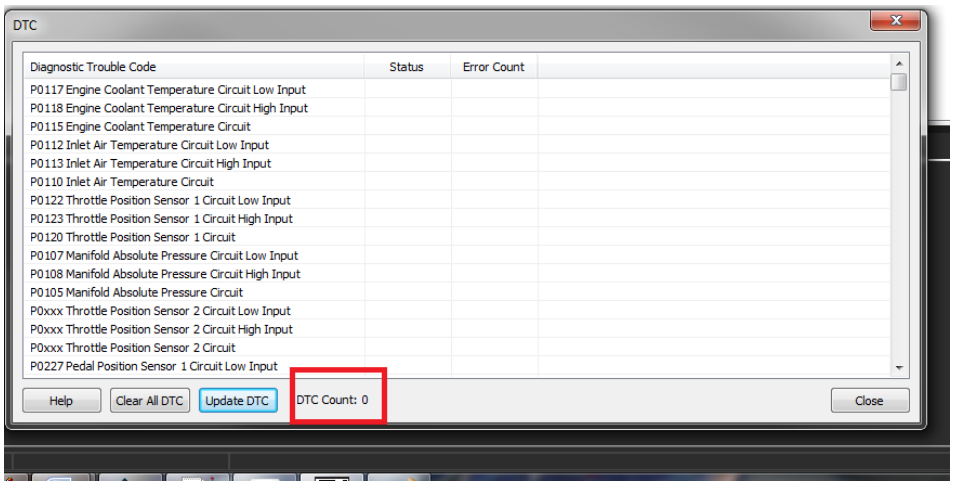

Figure 7.1. DTC example showing no errors.

If the Error Codes have not all been removed, select "Update DTC" then use the DTC window to locate the sensor that is on fault.

7.0 User CAN Bus 1

The ECU CAN Bus 1 is available for Input/Output expansion allowing a wide range of Emtron CAN devices to be connected into the CAN Bus. This includes the following CAN Modules:

- ELC1/2 (Emtron Lambda to CAN 1/2 channel)
- ETC4/ETC8M (Emtron Thermocouple to CAN 4/8 channels)
- EIC10/EIC16M (Emtron Input to CAN 10/16 Channel)

7.1 Emtron Lambda to CAN

The ELC uses Bosch proven integrated circuit technology to precisely control an LSU4.9 Lambda sensor. The Lambda value is transmitted over the CAN Bus and can be used by the ECU for Tuning and Closed Loop control. More information is available by looking at the Emtron ELC User Manual.

The ELC Power, Ground and CAN wires can be directly connected into the IO Expansion Loom as outlined in Table 7.0.

Name	ELC 4-Way DTM	ECU IO Expansion 12-Way DTM
Ground	Pin 1	Pin 8
CAN Lo	Pin 2	Pin 12
CAN Hi	Pin 3	Pin 11
Power	Pin 4	Pin 7

Table 7.0 – ELC1 to IO Expansion Port wiring

8.0 OEM CAN Bus 2

The ECU Communicates on CAN Bus 2 which is reserved for the GT86/BRZ/FR-S. The ECU maintains full compatibility with all other CAN devices within the vehicle.

The ECU transmits a wide range a raw and calibrated data over the Bus, communicating with other devices but it is also receiving data.

9.0 Emtron Torque Management

The ECU performs extremely accurate torque calculations provided the engine model configuration is accurate. This section allows the user to calibrate any errors in the torque model whilst also influencing the engine torque delivery characteristics.

9.1 Torque Reduction Ign Retard Clamp

This limits the maximum torque reduction the ECU can perform based on ignition timing retard

9.2 Torque Nitrous Gain

In applications where Nitrous is used to increase torque. The ECU calculates this torque increase however if required the gain of this torque increase can be used to trim the output.

9.3 BSFC

Brake Specific Fuel Consumption torque calculation is not used by the ECU however it can be useful when calibrated correctly to cross check the ECU calculated torque levels.

Figure 8.0 Engine Torque Setup

9.4 Engine Torque Correction Table

The ECU accurately calculates the Engine Torque however if any calibration errors lead to incorrect readings this table allows the user to adjust the gain based on any parameter listed in the axis setup form.

Figure 8.1 Engine Torque Correction Table

9.5 Torque Demand Correction Table

Torque Demand is calculated based on various parameters in the ECU along with driver controlled pedal inputs. The GT86/BRZ/FR-S requests accurate information on the torque demanded by the driver so decisions can be made in the many systems in the vehicle. The ECU needs to be reporting this correctly. If there is correlation issues between the torque reported and the Torque Demanded the vehicle will not function as intended and can also lead to drivetrain operation issues. This table allows for gain control of this channel however it should not require modification unless there are engine model or calibration problems.

Figure 8.2 Torque Demand Correction Table

9.6 Frictional Loss Table

The engine torque produced by combustion is calculated by the ECU and commonly referred to as “Torque Ideal”. The moving parts inside the engine assembly create drag and therefore limit the torque available. This table allows for entry of the frictional loss and is represented in Nm. Figure 8.3 shows the default setting provided with the base calibration.

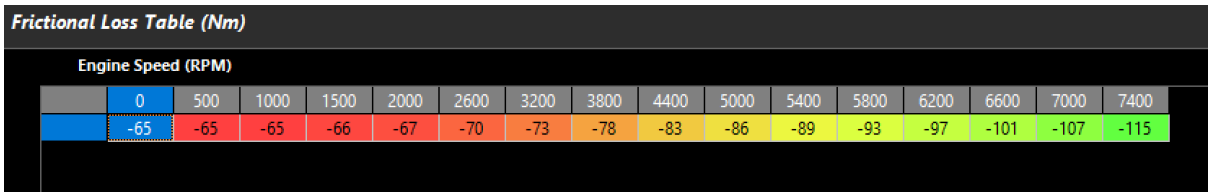

Figure 8.3 Frictional Loss Table

9.7 Frictional Loss Offset 1 Table

There are two (2) tables that allow offsetting of the frictional loss. Figure 8.4 shows a common offset table setting spanned against Engine Oil Temperature.

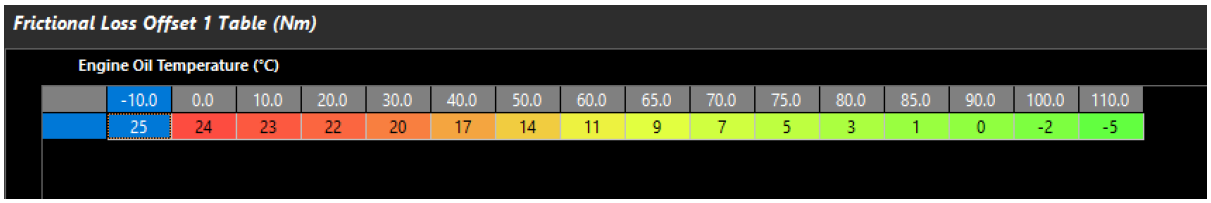

Figure 8.4 Frictional Loss Offset 1 Table

9.8 Torque Reduction Ignition Retard Gain Table

This table calibrates the torque reduction % per degree. When a torque request is applied the ECU will calculate how much retard is required to achieve this torque request. Figure 8.5 shows the default table settings.

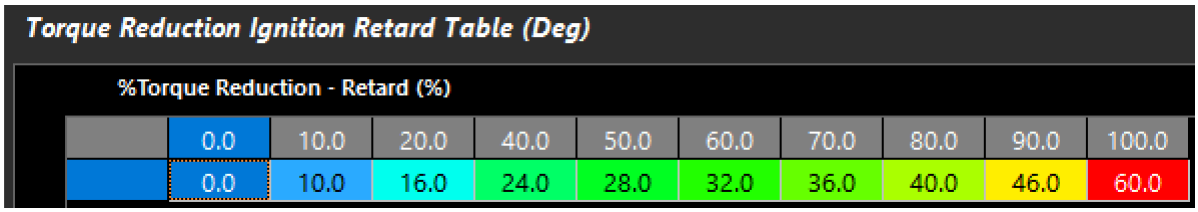

Figure 8.5 Torque Reduction Ignition Retard Gain Table

9.9 Torque Reduction Gain Table

This table calibrates the torque reduction % per %cut. When a torque request is applied the ECU will calculate how much cut is required to achieve this torque request. Figure 8.5 shows the default table settings.

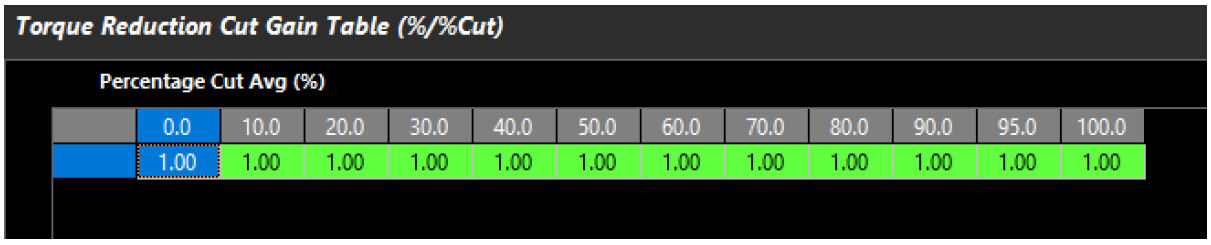

Figure 8.6 Torque Reduction Cut Gain Table

10.0 Ordering Information

Product	Part Number
Emtron GT86/BRZ/FR-S Plugin	1609-72086

Appendix A - ECU Pinout

OEM Pin Number	Function	
A1	Throttle Servo Motor -	AUX10
A2	Throttle Servo Motor +	AUX9
A3	Power Ground	GND
A4	Power Ground	GND
A5	Cam Solenoid Exhaust RH	Aux 4
A6	O2 NarrowBand Heater	
A7	Cam Solenoid Exhaust LH	Aux 3
A8	Ignition 4	Ign 4
A9		
A10	Ignition 2	Ign 2
A11	Purge	Inj 6
A12	Injector 1 (Port)	Inj 1
A13	Injector 4 (Port)	Inj 2
A14	Injector 1 (Direct)	Inj 1 Direct
A15		
A16	Cam Solenoid Inlet RH	Aux 2
A17	Cam Solenoid Inlet LH	Aux 1
A18	TPS (Main)	An 2
A19	5V Engine (TP and VSV)	Eng 5V
A20	Oil Temperature	An 10
A21	Ignition 1	Ign 1
A22	Injector 2 (Port)	Inj 2
A23	Injector 4 (Direct)	Inj 4 Direct
A24	Injector 3 (Direct)	Inj 3 Direct
A25	Injector 2 (Direct)	Inj 2 Direct
A26		
A27		
A28	TPS (Sub)	An 3
A29	Sensor Ground (Knk,MAF,Oil Temp,Eng Temp)	Sensor 0v Ref
A30	ECT	An 7
A31	Ignition 3	Ign 3
A32	Injector 3 (Port)	Inj 3
A33		
A34		
B1	Canister Pump Module (VPMP)	
B2		
B3		

B4		
B5	Direct Injector Power Supply Relay	Inj 8
B6		
B7	DBW (ETCS) Power	Inj 7
B8	Canister Pump Module (MPMP)	
B9		
B10	Fuel Pump Feedback	DI 5
B11	Cooling Fan Relay 3	Ign 5
B12	Cooling Fan Relay 1 2	Ign 6
B13	EFI Relay (Gnd)	
B14		
B15	Tacho	Aux 6
B16		
B17	DBW Relay (Gnd)	Inj 7
B18	Alternator Control	Aux 8
B19	FPC	Aux 7
B20	Canister Pump Module	
B21	5V Eng (FPS Main)	5V Eng
B22	5V Eng (FPS Sub)	5V Eng
B23	FPS Main Signal	An 13
B24		
B25		
B26	Starter Relay	Ign 8
B27		
B28		
B29	Sensor Ground (PP)	Sensor 0V Ref
B30	Sensor Ground (PP)	Sensor 0V Ref
B31	FPS Sub Signal	An 14
B32		
B33		
B34	Start Cut Relay	Aux 11
B35	AC Clutch	Ign 7
C1	Power Ground	
C2	Power Ground	
C3	Power Ground	
C4		
C5	02 Wideband Heater	
C6	14V ECU Power	
C7		
C8		
C9	Fuel Pressure Signal	An 6
C10		

C11	DF1	DI 5
C12		
C13	Fuel Pump Feedback	DI 8
C14	Exhaust Cam Position (LH)	DI 2
C15	Intake Cam Position (RH)	DI 1
C16	Crank Signal +	
C17	Knock Signal (RH)	
C18	02 Wideband Sensor Signal 1 -	
C19	02 Wideband Sensor Signal 1 +	
C20	Manifold Pressure Sensor	An 1
C21	02 NarrowBand Sensor Signal 2	
C22		
C23		
C24		
C25	Exhaust Cam Position (RH)	DI 3
C26	Inlet Cam Position (LH)	Sync Index
C27	Crank Signal -	
C28	Knock Signal LH +	
C29	Shield (Knock)	
C30	Shield (O2)	
C31	DF2	DI 7
C32	Fuel Pump Driver	Aux 12
C33		
C34	5V for CAM Sensors	5V Eng
C35	Shield (Crank)	
D1	14V ECU Power	
D2	Battery	
D3	Brake Switch (NO)	
D4	Signal Ground/Shielding	
D5		
D6		
D7	Brake Switch (NC)	DI 13
D8	AC Pressure Sensor	DI 11
D9		
D10		
D11		
D12	Intake Temp (MAF)	AN 11
D13		
D14	Starter Signal from Start Relay	DI 10
D15	Clutch Switch	DI 9
D16	Neutral Switch	DI 4
D17	Start Request	DI 12

D18	CAN Lo	CAN Lo
D19	CAN Hi	CAN Hi
D20		
D21		
D22	MAF Signal	AN 4
D23		
D24	Battery Current Sensor	
D25		
D26		
D27	Ignition Switch	
D28	Shield (MAF)	
D29	Ground (MAF)	
D30	Cruise Switch (Main)	DI 14
D31		

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