Easyshift system, version 3.1.9

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Table of Contents

1. System Description

The Geartronics Easyshift system is a sophisticated full-throttle ‘gear cut’ system for use only with sequential manual transmissions using dog engagement. *Please note that this system is NOT suitable for use with H-pattern gearboxes or any type of road car gearbox using synchromesh engagement.*

The system is designed to provide a closed-loop engine cut function to enable clutchless full-throttle up-shifting in applications where the existing engine control unit cannot provide such a function. In some applications, the Easyshift ECU can also support throttle blipping to allow clutchless downshifting (see page 11 for information relating to the throttle blip function).

The closed-loop control strategy, using feedback from the gear position sensor, ensures that the engine torque reduction is maintained only for as long as is necessary to safely engage the next gear. This is not a timer based system, and every cut will be of a different duration to precisely match the mechanical speed of the shift. This ensures the fastest and smoothest shifts possible with the minimal interruption of torque at the driven wheels.

The cut may be triggered by a variety of methods, including simple switches, analogue load cells, or by detecting the initial movement of the selector barrel. Each of these triggering methods is explained in more detail later in this manual.

For installations where the engine control unit does not provide any gear cut function (OEM ECU’s for example), the Easyshift system can operate in standalone mode by using the internal ‘high-side’ switch to cut the 12v supply to the ignition coils or fuel injectors. However, if the engine ECU supports a compatible gear cut function, we usually recommend that this function is used to perform the actual torque reduction. This is achieved by sending a digital cut request signal from the Easyshift ECU. However, this is only possible if the engine ECU’s internal cut strategy has the option to maintain the cut based on the state of the input signal rather than cut for a fixed time period. If your engine control unit has its own internal closed-loop cut strategy then it’s not usually necessary to use the Easyshift system. Many high-end engine ECU’s now provide an internal closed-loop gear cut function. Please contact Geartronics for advice regarding common aftermarket ECU’s and their gear cut strategies.

2. Triggering methods

In order for the Easyshift ECU to initiate an engine cut (or more accurately a torque reduction), it must first sense that a gear shift is about to commence. This can be achieved in several different ways depending on the specific installation. Some gearboxes have built-in switches specifically for this purpose, but where no switch is fitted, some other means must be used to initiate the cut.

2.1 Load cells and strain gauges

The preferred method of triggering is to use an analogue load cell, either in the form of a replacement gear knob, or an in-line version mounted in the gear linkage. The advantage of using load cells is that they provide a varying ‘analogue’ output which is proportional to the force applied to the gear lever. This allows a very accurate method of adjusting the trigger point in the Easyshift software. The cut can therefore be initiated before there is any movement of the selector barrel or forks, while still maintaining immunity to false triggering. This reduces wear on the selector mechanism and also means that the shift feels ‘lighter’ to the driver.

Gear knob load cell

In-line load cell

2.2 Built-in switches & microswitches

Some sequential gearboxes, most commonly those made by Sadev, are fitted with a simple 2-wire switch that activates immediately after the driver starts to pull the gear lever. When using these switches, it’s very important that they are setup accurately so as to trigger at the correct point. If the trigger point is too sensitive then the system may make an unwanted cut when the car goes over a bump. However, if the switch is not sensitive enough, then the driver will feel that he/she has to apply too much force before the shift can take place. On Sadev gearboxes, the sensitivity is adjusted by ‘trial & error’ by adding or removing shims under the switch body.

Built-in cut switch – Sadev SCL82

Microswitches, proximity sensors, linear sensors or ‘magic eyes’ intended to detect gear lever movement are strongly discouraged. We do not consider such methods consistent or reliable and we can offer no support.

2.3 Barrel triggering

For applications where a built-in switch is not available, and the cost of load cells is prohibitive, the Geartronics Easyshift ECU is able to initiate the engine cut by detecting the initial movement of the selector barrel by constantly monitoring the gear position sensor. This technology was developed by Geartronics many years ago, and has since been copied by others.

Using the 'barrel triggering' method allows the existing gear position sensor to be used both to initiate and terminate the cut, and no other sensors are necessary. The drawback of barrel triggering is that by the time the engine cuts, and more importantly the load comes off the dogs, the selector fork will already be loaded and trying to pull the dog ring off the engaged gear. This slight delay in the engine cut can make the gear lever initially feel reluctant to move. This can be especially evident in the lower gears when transmission 'wind-up' is at its greatest. Although minimal, wear on the barrel and selector forks is possibly slightly increased, although dog wear is not affected.

3. Gear position sensors

Whichever method of triggering is employed, it's very important that the gearbox is fitted with a high quality hall-effect gear position sensor. This is necessary to provide the required feedback for the Easyshift ECU's closed-loop strategies.

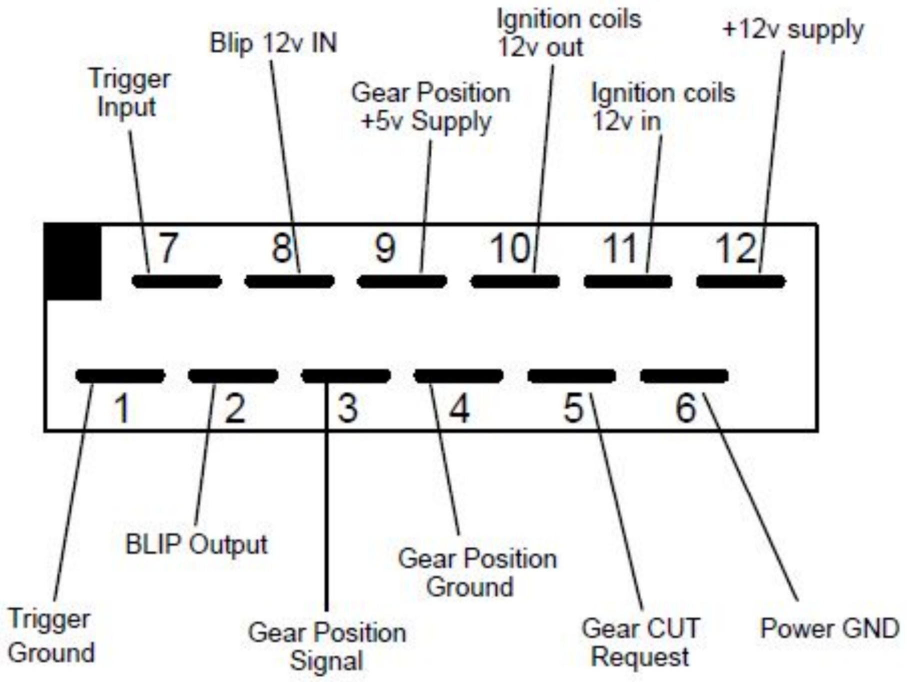
The gear position sensor accurately measures the position of the selector barrel so that the Easyshift ECU can determine the precise point of dog engagement, and therefore the safe point at which to re-instate engine torque. Failure of the gear position sensor will result in erratic operation at best, and can lead to premature dog wear or even catastrophic transmission failure. It's therefore essential that reliable hall-effect (non-contact) sensors are used. Traditional resistive sensors must never be used, especially the gold coloured sensors fitted to older Sadev gearboxes.

All gear position sensors have a mechanical range of 360°, but most have a measurement range slightly less than this. Although the Easyshift ECU can be calibrated for any gear in any position, it's important that the sensor never crosses over the 'dead band'. This is the small indeterminate position between the start and stop point of the electrical range. To aid correct fitting, most sensors have an identification mark on one edge of the sensor shaft. When this identification mark is in alignment with the cable exit on the sensor body, the sensor is mid travel. The sensor should usually be fitted so that this position corresponds with the mid point of the selector barrel movement, usually between 2nd and 3rd gears on a typical 6-speed gearbox. However, the mid travel on most Sadev gearboxes is actually 3rd gear because of the ½ shift to neutral.

Typical hall-effect gear position sensor

4. Wiring information

Most systems are supplied with either a generic wiring harness, or a bespoke harness specifically made for your application. However, we can also supply the Easyshift ECU with a connector kit so that you can make your own harness. The connector pinout and pin function is shown below:



If you choose to make your own wiring harness then we strongly recommend that only the highest quality materials are used, such as Raychem 'Spec-55' wire and Raychem DR25 heat-shrink sleeving. Also, it's very important to use the correct crimp tooling so as to avoid failures during service. DO NOT use solder joints!

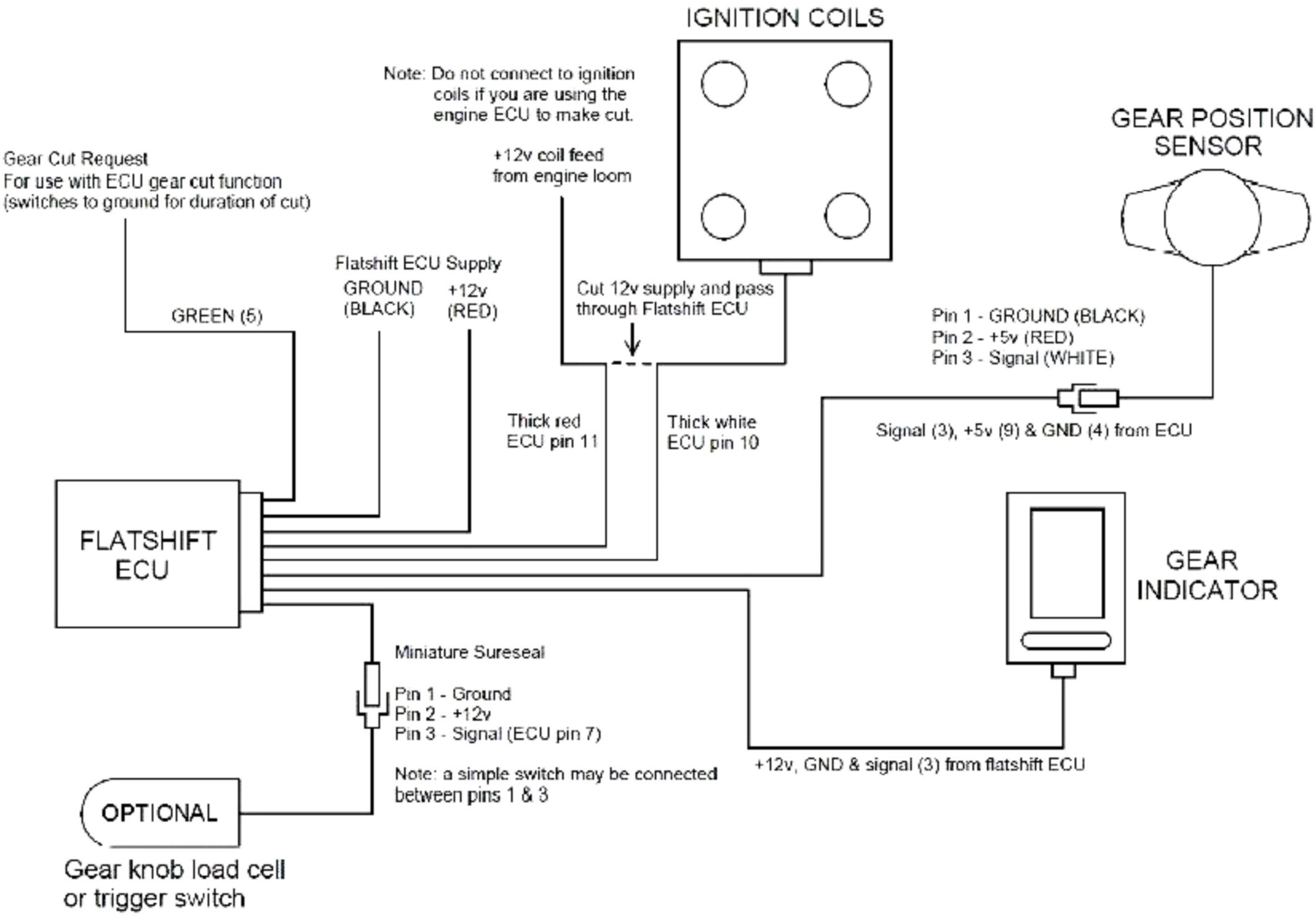
4.1 Detailed pinout description

Pin #	Function	Wire colour
1	Sensor ground for trigger input source	Black
2	12v output for throttle blipper solenoid (15 Amps maximum, 500mS maximum duration)	Pink
3	Gear position signal – analogue 0-5v	White
4	Sensor ground for gear position sensor	Black
5	Cut signal to engine ECU (pulled up to 5v, pulls to ground for duration of cut)	Green
6	Power ground, connect to chassis ground or battery negative terminal	Black (20awg)
7	Trigger input from load cell or switch (not used when barrel triggering is enabled)	Yellow
8	12v supply for throttle blipper solenoid (Sourced separately from pin 12 supply)	Brown
9	+5v supply to gear position sensor (also used for load cells requiring a 5v supply)	Red
10	Controlled 12v output to ignition coils (not used when engine ECU is performing the cut)	White (20awg)
11	12v input from ignition coils (not used when engine ECU is performing the cut)	Red (20awg)
12	+12v power supply (should be connected to same source as engine ECU supply)	Red (20awg)

4.2 Typical wiring schematic

Below is a schematic of our generic wiring harness using miniature Sureseal connectors. This harness is designed for use with the Geartronics gear indicator and Geartronics supplied sensors. Please note that harnesses supplied for Sadev or Tractive applications use the standard Sadev or Tractive connectors respectively.

The generic harness includes provision for a 'cut request' wire to the engine ECU, or direct connection to the ignition coils. Only one of these options should be used.



5. Software installation & setup

The Geartronics Easyshift ECU is a fully programmable device that requires careful setting up prior to use. This is not a 'plug & play' system, and any attempt to operate the system before configuration is complete could result in serious gearbox damage or catastrophic failure!

Every system is supplied with a CD containing the Geartronics 'control panel' application. The software is compatible with all versions of Microsoft Windows from WinXP through to Windows10. Compatibility with macOS is not provided. The current version of the PC application (released November 2016) is 3.1.10.1

5.1 PC communication

Communication with a laptop PC is by means of an RS232 serial port. Unless you have an older laptop with a built-in serial port (9-way D-type connector) then you will need to use a USB to serial converter cable. Suitable cables are available from Geartronics, but if you prefer to source your own then we recommend that you only use cables having either the Prolific PL2303 or FTDI RL232 chipsets. Please refer to the manufacturers instructions regarding installation of Windows device drivers.

5.2 Software installation

Upon inserting the Geartronics CD into your drive, the installation wizard should automatically launch. If it does not run automatically then open 'My Computer' or 'Windows Explorer', browse the CD and run the Setup.exe program. On Windows 8 and Windows 10 systems, you may need to right-click the Setup.exe file and select "Run as administrator". Follow the on-screen instructions to install the software, after which a "Geartronics Flatshift" shortcut icon will be placed on your desktop. See below…

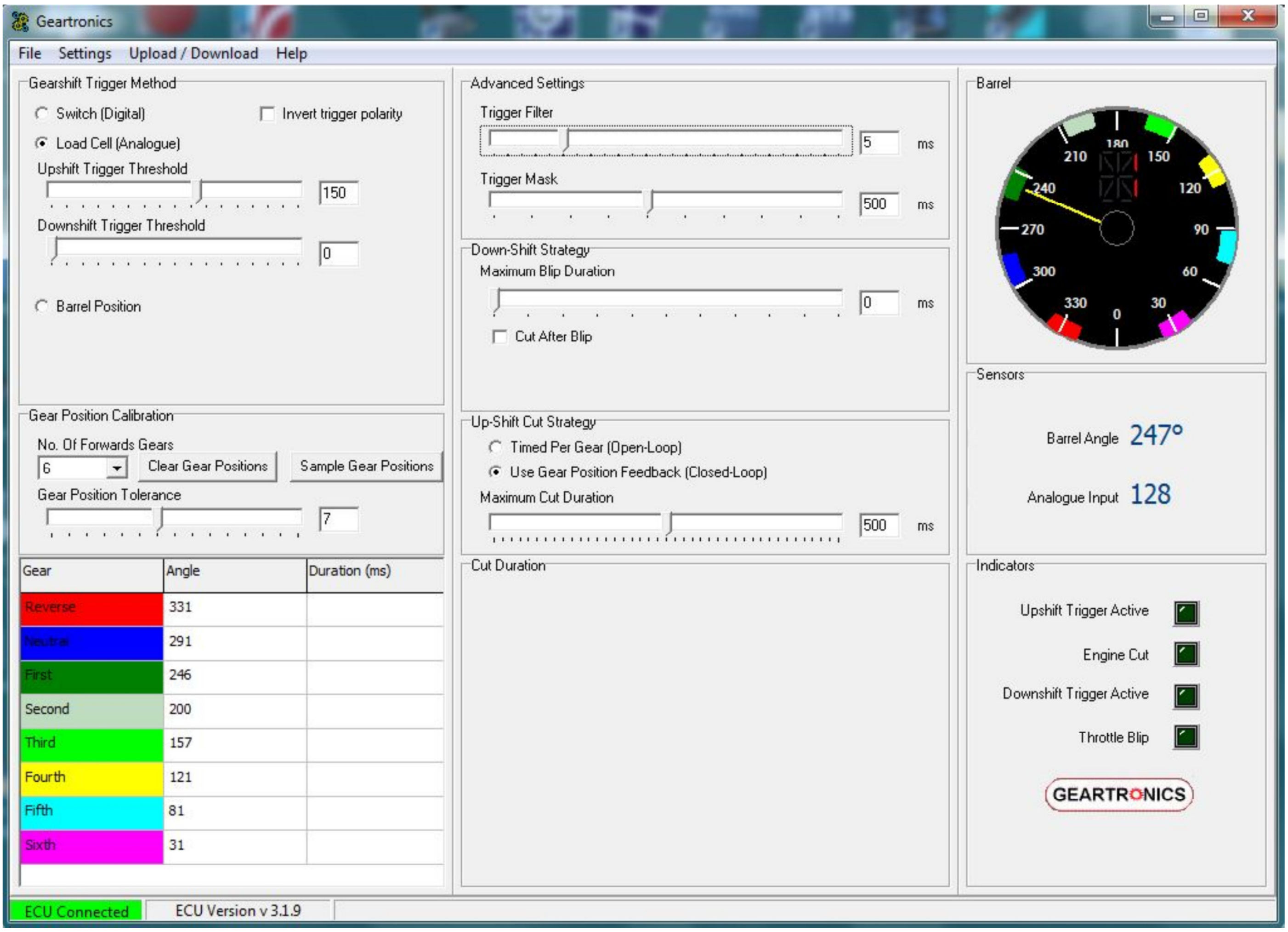
5.3 Initial PC connection

Plug the USB to serial converter cable into any available USB port on your laptop and connect the other end to the Easyshift ECU serial port (9-way D-type connector). Turn on the ignition and verify that the ECU is powered up by observing a single rapid flash of the red LED. Please note that after initial power on, neither the red or yellow LED's should be illuminated unless a gear shift is in progress. Start the Geartronics application by double-clicking the desktop icon. When the application launches, select "Settings" from the menu bar at the top of the screen, then select "Communication". Select the appropriate serial port from the drop-down list. Port selection should only be necessary the first time you connect to the ECU unless you use a different USB cable which will create a new virtual COM port number. If no serial ports are available in the drop-down list then you must re-install the device drivers for your USB to serial converter cable. This can usually be done through Windows "Device Manager".

After the appropriate serial port has been selected, click OK. At which point you will be presented with a dialogue box confirming that the ECU is connected, and inviting you to read the current ECU configuration. The red box at the bottom left of the screen will also turn green to confirm that the ECU is connected. Under normal circumstances, you should answer "YES" to read the current configuration from the ECU. If you receive an error message stating that the PC software and ECU firmware do not match, check the ECU version reported at the bottom of the screen by the side of the green box. The ECU version should be 3.1.9. If either no number or 0.0.0 is reported then this suggests a problem with the USB communication. In the first instance, try pressing F12 on your keyboard, or click "Settings" then "Reset ECU". If the version number is still not reported correctly then you have a problem with the USB to serial port configuration within Windows, and you should refer to the installation instructions that were supplied with the converter cable.

6. Control Panel configuration

Below is a screenshot showing ECU on-line and configured for a load cell input (upshift cut only, no downshift blip)



6.1 Gear position sampling

The first step of the configuration is to select the number of gears (not including neutral or reverse) and calibrate the gear positions. Click the box entitled “Sample Gear Positions” and follow the on-screen instructions. It’s important to ensure that each gear is fully engaged before confirming its position, otherwise you will need to repeat the calibration from the beginning. Note: If your gearbox does not have a reverse gear, then leave the gearbox in the neutral position when the sampling routine asks you to select reverse.

After all the gears have been sampled, the coloured ‘gear acknowledgement windows’ around the barrel position dial will be re-drawn. The gears should be equally spaced around the dial, with the exception of gearboxes that have a ½ shift to neutral or reverse (typically Sadev, Tractive, or motorcycles boxes). With all gearboxes, all forward gears should be equally spaced ±1°.

To confirm that the sensor has been mounted in the correct position, check that the pointer on the dial does not cross over the zero degree position as you shift from lowest to highest gear. If this happens, you must take steps to correct it before proceeding. If the sensor requires moving, or if the sensor is replaced for any reason, you must re-sample the gear positions. This is extremely important!

After gear sampling is complete you should adjust the “Gear Position Tolerance”. The tolerance sets the point at which a gear is considered to be engaged, and is the point at which the ECU resumes engine torque. Initially, this should be set to approximately 15% of the total angle between each gear. Therefore a typical gearbox with 45° between gears will require a 7° tolerance. A larger tolerance will have the effect of resuming engine torque earlier, possibly before the gear is safely engaged. Caution should therefore be exercised when adjusting this parameter.

6.2 Trigger method selection

As detailed in section 2, the Easyshift ECU can accept a variety of trigger methods. When using a switch or an analogue load cell, the signal wire should be connected to pin 7 of the 12-way connector. This pin can accept any input ranging for 0-5v. Do not apply a 12v signal to this input or the ECU may be damaged.

Select the trigger method by clicking the appropriate option. Each of the 3 options has its own sub options which are fully explained in the following section.

6.3 Parameter detailed description

“Upshift Trigger Threshold” - By default, the system triggers an upshift event when the “Analogue Input” rises above this value. This parameter is only available when the load cell trigger option is enabled.

“Downshift Trigger threshold” - By default, the system triggers a downshift event when the “Analogue Input” falls below this value. If a throttle blipper is not used, this value should be set to zero (or 255 if the trigger polarity is inverted). This parameter is only available when the load cell trigger option is enabled.

“Invert Trigger Polarity” – When checked, enables triggering when the input falls below the “Upshift Trigger Threshold” or rises above the “Downshift Trigger Threshold”. This option is mainly used with in-line load cells that output a reducing voltage during upshifts.

“Trigger Threshold (Degrees)” – Specifies the initial angle through which the barrel must move in order to trigger a shift event. This parameter is only available when the barrel trigger option is enabled.

“Gear Position Tolerance” – Sets the size of the ‘window’ in which a gear is considered to be engaged. During an upshift event, the engine cut is maintained until the pointer on the barrel position dial first enters the next higher coloured window. During a downshift event, the throttle blipper remains active until the pointer enters the next lower coloured window.

“Trigger Filter” – Specifies the minimum time that a trigger signal must constantly be beyond the threshold before the shift is validated. This parameter should be set to the lowest value that is consistent with reliable triggering without the system ‘false’ triggering. Increased values introduce a delay between the driver operating the shift lever and the system initiating a cut or blip.

“Trigger Mask” – specifies the minimum time between 2 successive shift events. If the system is only being used for upshifts, this parameter can usually be set to approximately 500mS, but this may need reducing if the system is also controlling a downshift throttle blipper.

“Maximum Blip Duration” – Specifies the maximum duration that the throttle blip output remains active in the event that the barrel position does not reach the next gear. If the barrel achieves the next gear position within this time then the throttle blip turns off anyway. Typical values are 100-150mS.

“Cut After Blip” – When enabled, an engine cut is applied as the next gear engages in order to prevent the car from pushing before the throttle has closed. The time setting should be sufficiently long enough to allow the throttle to close below 10%.

Upshift cut strategy, “Timed Per Gear” – Under normal circumstances this option should not be used, and is only provided for diagnostic purposes to validate the duration of the engine ‘cut’ when the engine ECU is performing the actual torque reduction.

Upshift cut strategy, “Use Gear Position Feedback” – this option should always be enabled when the car is running on track. It enables the Easyshift ECU to calculate the precise duration of the ‘cut’ based on the feedback from the gear position sensor.

“Maximum Cut Duration” – specifies the maximum time (not the actual time) that the engine will remain cut in the event that the next gear does not engage. Under normal circumstances the cut will terminate long before this value is reached. However, this parameter is necessary in the event of a gear position sensor failure so that the engine does not stall.

After making changes to any on-screen parameters it is necessary to save the changes to the ECU by pressing F8

7. Throttle blipping & clutchless downshifting

Unless you have an extremely responsive low-inertia engine, such as a motorcycle engine, we generally discourage the use of throttle blippers when manually shifting the gearbox. The reasoning is because the timing relationship between the blip and the shift is the wrong way around.

In order to make smooth clutchless (and non-damaging) downshifts, we need to increase the engine RPM to match the next lower gear. To do this successfully we need the RPM to rise at *exactly* the same point as the selector barrel starts to rotate. Obviously, with a manual shift, the gear lever movement must come first because it's only the action of pushing the gear lever that can trigger the blip. Now, because the gearbox is usually only very lightly loaded during a downshift (especially under heavy braking), the selector barrel will move easily from one gear to the next, even without the unloading effect of the throttle blip. This means that by the time the throttle has opened, and more importantly the RPM has begun to rise, the next gear will already have been engaged, therefore rendering the throttle blip pointless. The engine speed will obviously increase as the next gear engages, but this is purely a mechanical function, and has the effect of imposing an instant engine braking effect on the driven wheels, which can cause a loss of control.

The only way around this timing problem is for the driver to initially push the gear lever gently enough to trigger the blip, but not hard enough to shift quickly. Then, immediately after the blip has triggered, push the lever harder to shift to the next gear. Unfortunately this requires a lot of skill, especially when the driver is under pressure trying to defend the corner. Arguably, this requires an equal level of skill to that required for 'heel & toe' downshifting. For that reason, we don't recommend using the downshift blipping function unless you fully understand the limitations.

Please note that the above limitations only apply to manual shifting and *not* to the Geartronics semi-automatic paddleshift system. This is because the strategy used in our paddleshift GCU reverses the blip/shift timing so as to open the throttle *before* the gear lever movement. The engine speed can then be controlled by a series of carefully timed engine cuts so that the RPM increase corresponds exactly with the selector barrel movement, leading to smooth rev-matched shifts.

For users wishing to use the Easyshift downshift strategy, the system will support either pneumatic actuators (controlled by a suitable solenoid valve and suitable compressed air supply) or a high powered 12v solenoid up to a maximum current requirement of 15 Amps. The ECU can also support electronic DBW throttle blipping in conjunction with a suitable aftermarket engine ECU. However, this DBW option requires a small internal modification to the PCB.

8. Troubleshooting

Symptom	Reason/resolution
Unable to communicate with laptop PC	1. Ensure ECU is powered up – red LED should flash briefly during power-up 2. Verify correct COM port selection (Settings > Communications) 3. Verify communication cable is plugged in securely 4. Verify USB driver installation in windows
Engine will not start	1. Ensure ECU is powered up – red LED should flash briefly during power-up 2. Check red LED not permanently illuminated or flashing during engine cranking 3. Check gear cut input polarity in engine ECU (where applicable) 4. Check integrity of ignition coil wiring to pins 10 & 11 (where applicable)
Engine does not cut	1. Check 1st gear or above is selected – cut is not enabled in R, N or top gear. 2. Check “Upshift Trigger Active” status indicator in software 3. Check selection of trigger method 4. Check analogue input and trigger threshold settings 5. Check gear cut setup in engine ECU (where applicable) 6. Check polarity of coil cut wires, pins 10 & 11 (where applicable)
Engine only cuts on downshifts	1. Gear position calibration crosses zero! (only applies to barrel triggering) 2. Check trigger polarity (only applies switch or load cell input)
Excessive force required to disengage current gear	1. Engine not cutting at all (see above) 2. Trigger switch faulty or not adjusted correctly (Example: Sadev gearbox) 3. Trigger threshold set to high (load cell and barrel triggering only) 4. Insufficient cut severity in engine ECU (where applicable)
Engine cuts randomly, especially over bumps	1. Trigger switch faulty or not adjusted correctly (Example: Sadev gearbox) 2. Trigger threshold set to low (load cell and barrel triggering only) 3. Insufficient trigger filtering 4. Failing gear position sensor (barrel triggering only) 5. Resting hand on gear lever!
Missing upshifts	1. Using insufficient force on gear lever 2. Excessive wheelspin! 3. Incorrect gear position calibration 4. Insufficient maximum cut time 5. Gear position tolerance too big 6. Incorrect gear cut setup in engine ECU (where applicable)
Engine cut too long	1. Gear position tolerance too small (barrel does not achieve target position) 2. Incorrect gear position calibration or failing gear position sensor 3. Incorrect gear cut setup in engine ECU (where applicable)
Dashboard gear indicator displays wrong gear number	1. The gear indicator is programmed independently of the Easyshift ECU! Refer to separate programming instructions.