MoTeC

M1 Launch Control

USER GUIDE

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OVERVIEW

This guide describes the setup and operation of the Launch Control Function in the MoTeC M1 Packages. It has been developed using GPR in an M150, but the same information applies to GP M1 Variants and Packages that have Launch Control enabled.

WHY LAUNCH CONTROL?

Launch Control is used to facilitate consistent acceleration for vehicles using the MoTeC M1 series of ECUs. This system is very useful for all vehicles. It works by limiting the Engine Speed to a pre-determined value controlled by the Vehicle Speed. The vehicle's launch characteristics are defined by the Vehicle Speed versus Engine Speed curves that are configured by the tuner.

Launch Control is also used with turbocharged engines to allow for the building of boost pressure to assist in getting the vehicle off the line without bogging down.

When it is optimised for the conditions and the car, the M1 ECU will be able to maximise the vehicle's acceleration curve off the line, and can do this consistently and repeatedly.

Launch Control operates primarily by using the ignition system to maintain the aim Engine Speed. It can also use a pre-set Aim for the Drive By Wire throttle, if fitted. This helps to reduce the amount of ignition retard and cut that is needed to maintain the Aim Engine Speed, lowering the Exhaust Gas Temperature that may be generated.

The purpose of this document is to assist in the setup and optimisation of Launch Control.

Aims of Launch Control Usage

The aim of a properly tuned Launch Control system is to enable the launching of the vehicle in a manner that maximises its potential.

This is done through an iterative process that shapes the Engine Speed curve used by the M1 so that the amount of slip at the tyre interface is optimised for a stable and consistent drive from the starting position. When the Launch Control system is correctly tuned for the vehicle and conditions, the vehicle should experience a smooth, linear acceleration from the line that has no dips or rises. Looking at the tyre marks left behind (if possible) there should be two consistent and even lines as the tyres slip off the line, and then a progressive transition in to the tyres fully gripping up. If there are skips in the lines left behind, further tuning is required. This will also be felt by the driver as the vehicle will not smoothly launch from stationary, rather it will accelerate in a series of lurches, as the tyres grip and then slip. You will also be able to see this in the datalogging traces for the wheel speeds and longitudinal acceleration, which should have smooth, progressive curves from stationary.

Interaction with Traction Control System

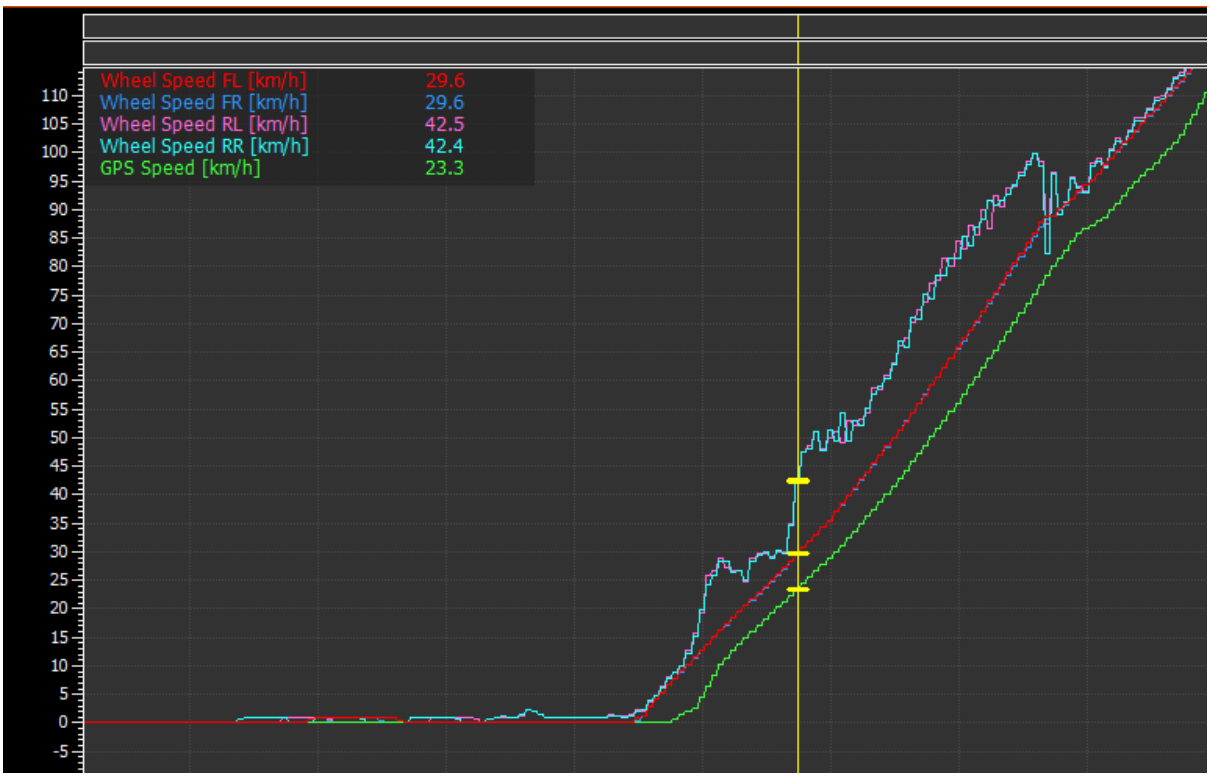
The setting of the Exit **Vehicle Speed** for the various tables in the M1 Launch Control system has a relationship with the operation of the Traction Control system. If the Traction Control system is employed, the minimum value that can be used in the **Traction Activate Vehicle Speed** is 20km/h (or equivalent speed in alternative units). If there is a difference in the deactivate speed for the Launch Control System and the activate speed for the Traction Control system, vehicle operation can be compromised through the transition period.

It is recommended that if Traction Control is used in conjunction with Launch Control, then the activate speed used for the Traction Control, and the highest value used in the Vehicle Speed axis in the Launch Control system should be the same for a smooth transition between the two systems. The actual transition point can be tuned to suit the vehicle's Launch and Traction Control requirements, but care must be taken to ensure a smooth transition between the systems.

WHAT IS NEEDED?

To use the Launch Control Function, wheel speed sensors are a must have, as the exit condition for the Launch Control system is Wheel Speed. A minimum of two sensors (one each of Driven Wheel and Non-Driven Wheel Speed) is recommended, so that the optimum level of wheel slip, and thus the engine speed limit curve, can be calculated, with four wheel speed sensors the preferred option. It is possible to use a single wheel speed sensor on the non-driven wheel in conjunction with the Launch Control system, however, the tuning of the system is made more difficult.

Due to the difficulty of determining the vehicle's actual speed (Ground Speed) with an AWD system, the use of a Vehicle Speed Controlled Launch Control system is not recommended. You can still use Launch Control as a method of building boost pressure to get the vehicle off the line, or to give a consistent Engine Speed at launch, but the vehicle speed may be incorrectly calculated from the wheel speed sensors, leading to the Launch Control disabling prior to the vehicle moving from the line, or after accelerating briefly. This can be minimised by either using a driver-controlled launch button that disables the Launch Control when released, or by having a higher exit speed for the Launch Control, which needs to be carefully configured so that the Launch Control does not stay enabled for too long and slow down the vehicle.



A data logged Speed trace of a 600hp RWD race car launching. As can be seen, there is a small amount of slip with the rear wheels, which can be useful as it stops the engine from bogging down off the line. Also worth noting, and visible in the green trace, is the delay in the GPS Speed signal compared to the Wheel Speed signals.

Wheel Speed Sensors

With the sensors and tone rings, the more teeth on the tone rings the more effectively the launch control system will work, as it can detect changes to the wheel speeds sooner, and react in a shorter period. GPS Speeds are not suitable for use with the Launch Control system, as they are prone to wander when stationary - which can cause the Launch Control system to not engage - and they have a lag in operation when the vehicle speed changes quickly.

If the vehicle originally came with wheel speed sensors and tone rings, then it is recommended that these be used for the sensing of wheel speeds, or retro fitted from another vehicle from the same range that has them. If the vehicle did not have wheel speed sensors standard and needs to have them made to suit, then the recommendation is to have a minimum of 24 teeth, with 48 or more preferred if possible. The number of teeth that can be used will be restricted by the sensor type and the recommended tooth size and spacing for that sensor, as well as the physical space available to mount the sensors and tone rings.

If wheel speed sensors are being added, typically a “Hall Effect” style sensor would be used, as these will give a consistent signal that does not vary in amplitude based on wheel speed.

Warning

If an existing Antilock Braking System is in the vehicle, ***the wheel speeds MUST BE generated by the ABS module****, not by splicing into the wheel speed sensors directly. Doing so can give false readings to the ABS control module and may result in the ABS failing to operate in a braking situation.*

Driver Switches

A single or multi position switch is also recommended. This allows for the Launch Control system to be disabled if needed, or in the case of a multi position switch, provides the ability to have a selectable range of Launch Engine Speed Aims to suit a variety of conditions, i.e. wet, greasy, dry.

See the end of the document for more detail on setting up Driver Switches.

OPERATION

The following conditions must all be met for launch to activate:

- **Launch Mode** must be Enabled.
- **Exhaust Temperature** must be less than **Activate Exhaust Temperature**. If **Activate Exhaust Temperature** is set to 0 this setting is ignored.
- **Coolant Temperature** must be less than **Activate Coolant Temperature**. If **Activate Coolant Temperature** is set to 0 this setting is ignored.
- **Vehicle Speed**, the X axis of the **Engine Speed** table, must be less than or equal to the minimum X axis site value.
- **Throttle Pedal** must be greater than **Entry Throttle Pedal**.
- **Vehicle Speed** must be less than the minimum speed set in any of the tables.

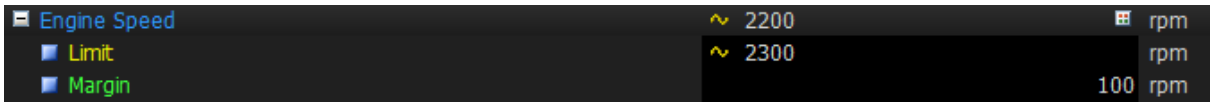
Launch will exit if any of the following conditions are met:

- The engine is stopped.
- **Vehicle Speed**, the X axis of the **Engine Speed** table, exceeds the maximum X axis site.
- **Throttle Pedal** is less than **Exit Throttle Pedal**.
- **Exhaust Temperature** exceeds **Activate Exhaust Temperature**. If **Activate Exhaust Temperature** is set to 0 this setting is ignored.
- **Coolant Temperature** exceeds **Activate Coolant Temperature**. If **Activate Coolant Temperature** is set to 0 this setting is ignored.
- **Vehicle Speed** exceeds the X Axis Value set in **Launch Engine Speed**.

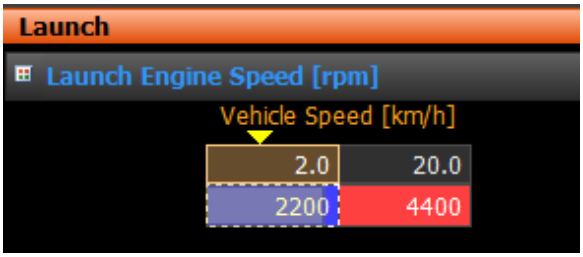
LAUNCH CONTROL CONFIGURATION

Launch Engine Speed

Sets the **Launch Engine Speed**



The **Launch Engine Speed** is configured through this section. This can either be a single axis of **Vehicle Speed**, or it can be linked to a 9-position switch, so that different Launch Engine speeds are available to suit the conditions at the time. The minimum configuration that can be used in the **Launch Engine Speed** table if a **Driver Launch Switch** is not configured, is as follows, where an entry and exit speed is specified.

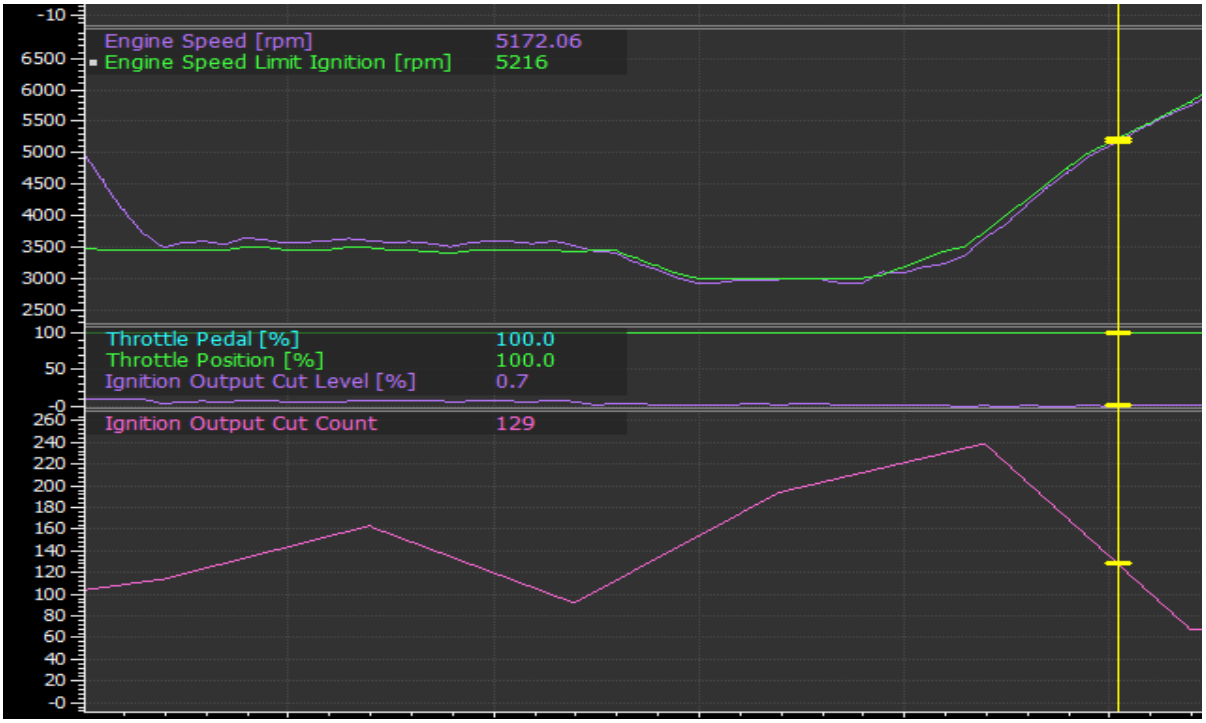


If a physical **Driver Launch Switch** is configured so that the driver must hold the switch in an active position to enable the Launch Control function, then a single value can be used for the **Launch Engine Speed** as the Launch Control system will disable when the button is released.

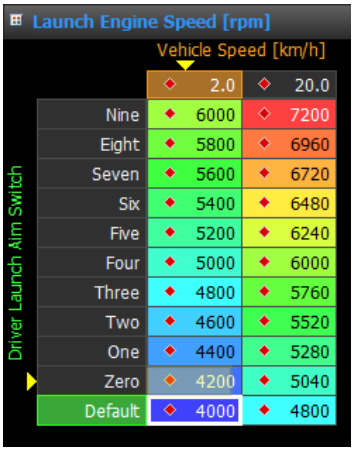
Limit is the **Launch Engine Speed** plus **Launch Engine Speed Margin**. **Launch Engine Speed Limit Margin** is the amount the Engine speed can vary around the Aim value whilst using the **Launch Ignition Timing Limit Advance**, before the Ignition Timing Cut is applied.

A smaller number in the **Launch Engine Speed Limit Margin** results in a harsher limiter function, whereas a larger number softens the cut that is being applied, but also allows for the engine speed to rise further above the **Launch Engine Speed** before the full cut is applied to the Ignition. The primary means of Engine Speed control is ignition retard and cut, fuel cut will also be used if the ignition cut is not maintaining the requested Engine Speed.

While engine speed is above launch **Engine Speed**, the **Ignition Timing Limit Advance** system attempts to control engine speed using closed loop control of ignition timing. If **Engine Speed** exceeds (launch **Engine Speed + Engine Speed Margin**), a hard limit (ignition cut or/and potentially fuel cut) is applied. This allows turbocharged engines to develop boost pressure prior to launch.



Data logging capture showing the Engine Speed being limited by the Engine Speed Limit Ignition during a launch. As can be seen in the magenta trace, the Ignition Output Cut Count is also increasing at the same time.

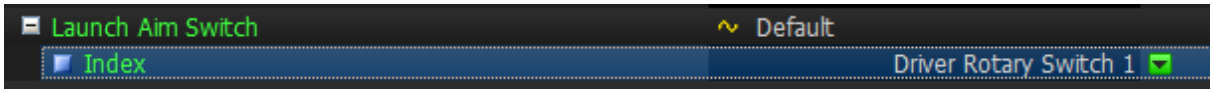


With **Vehicle Speed** in the **Launch Engine Speed** axis, it is a good practice to have the minimum value used as a number greater than 0.0. This is so that if the vehicle moves pre-launch from engaging gear, or there is noise on the speed trace, the M1 will still engage the Launch Control function.

*A recommended minimum starting value for the **Launch Engine Speed** is 2.0 km/h*

To have the Launch Control deactivate automatically once **Vehicle Speed** has exceeded the desired Deactivation point, it is necessary to add **Vehicle Speed** as the X Axis into the Table. When this is done, once Vehicle Speed exceeds the set speed, Launch Control will deactivate and the Vehicle is free to accelerate normally. The changeover point should then be matched into the **Traction Control** activation point, for a seamless transition into **Traction Control** if it is being used. If **Traction Control** is not being used, raise the exit speed to a value that is high enough that the vehicle will have gained traction, but not too high that the Launch control system is interfering with the acceleration of the vehicle, or that gear shifts are affected.

The **Driver Launch Aim Switch** assigns the Y axis values of the **Launch Engine Speed** table.



Launch Activate

The temperature that the **Exhaust Gas Temperature** and **Coolant Temperature** must be below for the Launch Control function to enable.

These are the maximum limits that the **Exhaust Temperature** and **Coolant Temperature** can be for the Launch function to enable, and have no hysteresis values. This means that if you have 850°C set as the maximum, 849.9°C is OK, and 850°C will deactivate the Launch Control function. If the temperature of either of these settings starts below the set value, and then rises above the value, Launch Control will be disabled until they drop back below. If they are set to 0, they are disabled and not used in the Activation process.

Recommended start values: This will vary on the vehicle being used, a small margin (5% - 10%) above the standard operating maximums for the engine would be a starting point.

Launch Entry

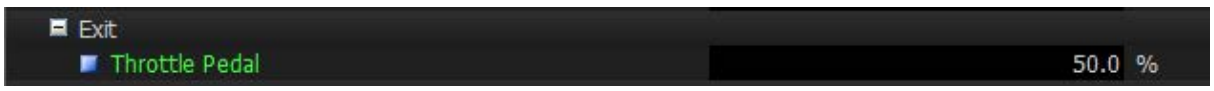
The **Throttle Pedal** position must exceed this value to activate Launch Control.

The **Throttle Pedal** must be over this value to enable Launch Control. Launch Control will remain active once the **Entry Throttle Pedal** value has been exceeded, even if the value drops below the set value, as long as the **Exit Throttle Pedal** value is not exceeded and all other Parameters remain valid.

Recommended start value: 80%

Launch Exit

Launch Control will disable if the **Throttle Pedal** drops below this value.



If the **Throttle Pedal** drops below this position, and presuming that all other enables remain valid, then reopening the **Throttle Pedal** will not re-enable Launch Control until the **Entry Throttle Pedal** value is exceeded again.

Recommended start value: 50%

Launch Ignition Timing Limit Advance

Controls the **Ignition Timing** used by the Launch Control function to maintain **Launch Engine Speed.**

This sets the Minimum limit of **Ignition Timing** retard that will be applied by the M1 to control the Engine Speed to the Aim; the upper limit is set by the timing value set in the **Ignition Timing Main** table. The Error value reports the amount of variance from the **Launch Engine Speed Aim** at that point in time.

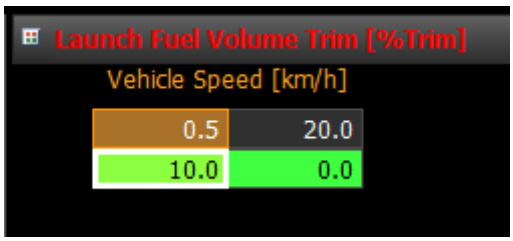
Recommended Start value: -10°BTDC

The **Proportional** and **Integral** Gains work in the same manner that other **P** and **I** functions work in the M1. The tuning of these will be dependent on the operation of the engine itself, with turbocharged engines requiring more control to be applied to maintain the **Launch Engine Speed** that is being targeted.

Recommended start values: Start with 0° and only use if needed.

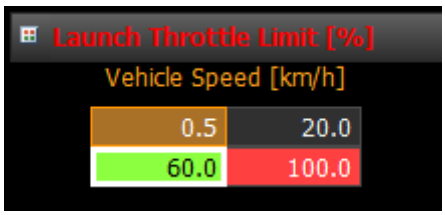
Launch Fuel Volume Trim

Fuel Volume trim is the setting to Add/Remove fuel during the Launch process. This table has an axis based on Vehicle speed, so the trim can be removed as the Vehicle launches.



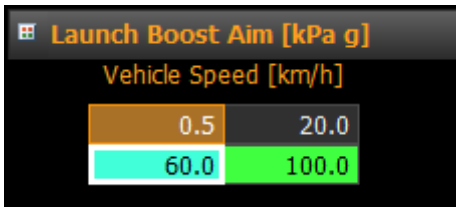
Launch Throttle Limit

Used with a DBW system, this sets the Throttle Servo Aim for the launch. This table has a Vehicle Speed axis to blend the Throttle Servo position back to match the Throttle Pedal Translation table. Set to 100% if not required.



Launch Boost Aim

Sets the Boost aim for Launch; blends back to the Boost Aim Main table with Vehicle Speed on the axis.



These three functions enable as soon as the **Launch State** goes to **Enabled**, irrespective of **Vehicle Speed.**

When configuring the exit point for these trims, it is prudent to ensure that when the trim ends, there is not a step from the trim end value to the normal value that may cause instability in the operation of the vehicle.

DIAGNOSTIC CHANNELS

- ***Launch State***
  This indicates that the Launch Control function is enabled, and that all required conditions have been met. The M1 is in Launch Mode if this State is Enabled.

Launch State

Enumerations		
Disabled	*0*	The subsystem is disabled.
Enabled	*1*	The subsystem is enabled.

Current state of the launch system.

- ***Launch Diagnostic***
  Defines any issues, if present, that are stopping the Launch Control system from enabling. These are **Exhaust Temperature High** and **Coolant Temperature High** values exceeding their Activate Temperatures.

Launch Diagnostic

Enumerations		
Not in Use	*0*	The launch system is not enabled.
OK	*1*	The launch system is functional.
Exhaust Temperature High	*2*	The launch system is disabled because the current exhaust temperature exceeds the activate exhaust temperature.
Coolant Temperature High	*3*	The launch system is disabled because the current coolant temperature exceeds the activate coolant temperature.

Reports the source of any problems with launch.

- ***Launch Enable***
  Overall state of the system, indicates if the system is switched on through the **Driver Switch** settings.

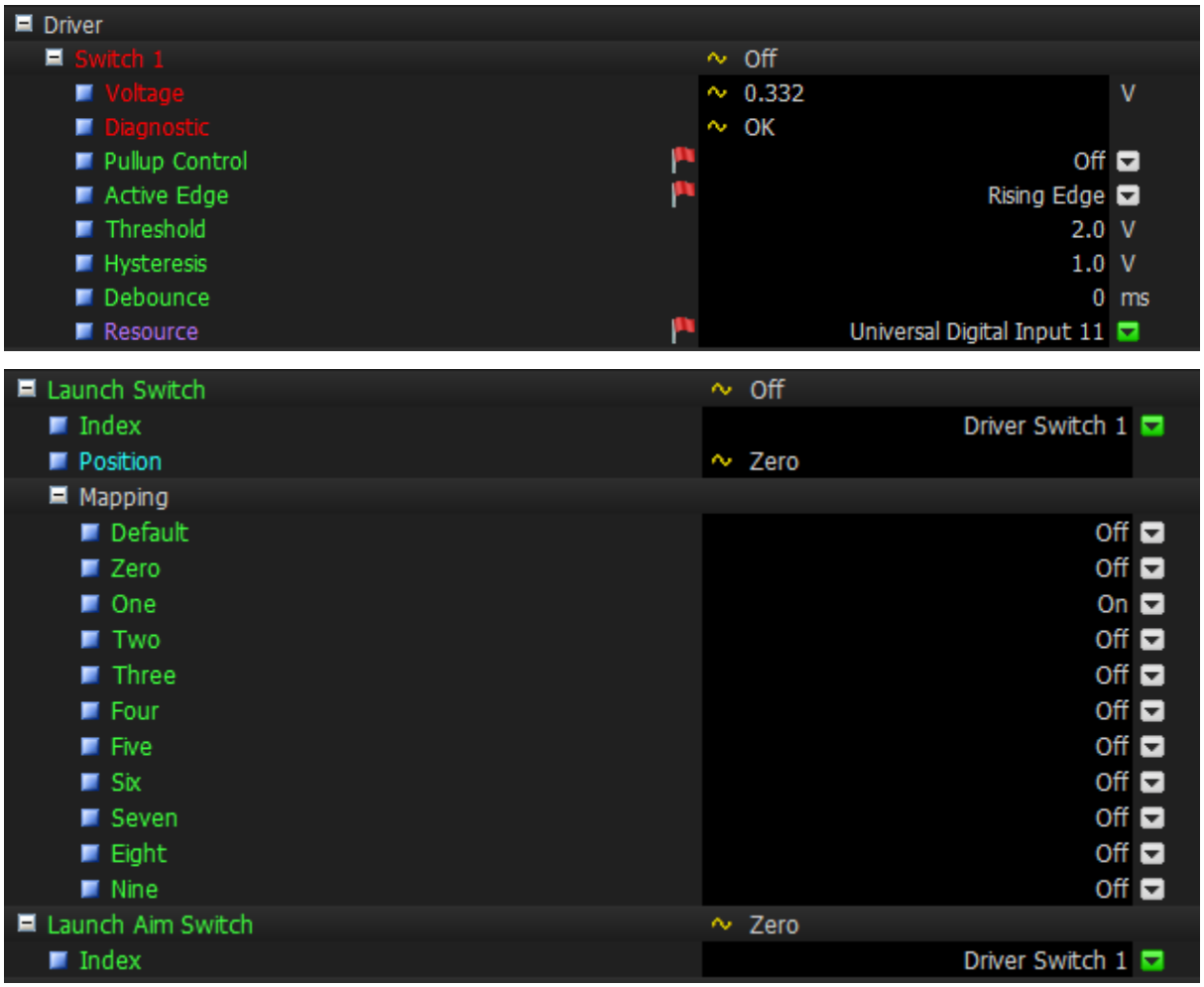
Launch Enable

Enumerations		
Disabled	*0*	The subsystem is disabled.
Enabled	*1*	The subsystem is enabled.

Controls the overall operation of launch.

DRIVER SWITCHES

The **Driver Switch, Launch Switch** and **Launch Aim Switch** must be configured to enable the Launch Control system to work. This can be done without having a physical switch wired into the vehicle. If no switches are used, the Default values set to **On** are used to permanently enable the function. For the ability to vary the Launch Engine Speed, a Multi Position switch needs to be used.



Example Driver Switch setup