MoTeC	Technical Note	
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Introduction

This document describes the use of a MoTeC ECU for the purpose of Traction Control of a vehicle. Given suitable sensor inputs, an ECU can determine if wheel slip is occurring, The ECU can then be configured to reduce engine power by a fuel cut, ignition cut or a combination of both as specified by the user.

Wheel Speed Measurement

At least two wheel speeds – one driven, and one rolling – are required by the ECU. If possible it is preferable for all four wheel speeds to be measured so that wheel slip can be calculated more accurately.

M4/48 ECU

The M4/48 ECU can directly measure 2 wheel speeds.

Locked Diff

- 1 sensor on rolling wheel (use wheel least likely to lift)
- 1 sensor on driven wheel

Open Diff

- 1 sensor on rolling wheel (use wheel least likely to lift)
- 1 sensor on tail shaft

M8/800 ECU

The M800 and M8 ECU's can directly measure 3 or 4 wheel speeds[1].

Locked Diff

- 2 sensors on the rolling wheels (preferred) or 1 sensor on a rolling wheel (use wheel least likely to lift).
- 1 sensor on a driven wheel or the tail shaft.

Open Diff

- 2 sensors on the rolling wheels (preferred) or 1 sensor on a rolling wheel (use wheel least likely to lift)
- 2 sensors on the driven wheels (preferred) or 1 sensor on tail shaft

Traction Control Multiplexer (TCM)

The Motec Traction Control Multiplexer (TCM) may be used to convert 4 wheel speeds to a signal that feeds into one input digital input. This leaves the other digital inputs available for other functions. The TCM may be used on all MoTeC ECU's.

Wheel Speed Sensor Types

Open collector (Hall) type sensor must be used when measuring the wheel speeds.

[1] **M8 Note:** Using the 4th input requires that the ignition drive signal is taken from a PWM Auxiliary output - this requires special wiring.

Note: It is important that the sensor system be engineered properly because a bad signal could cause inadvertent traction control (engine cut), so the traction control sensors are just as important as the engine sensors.

Disable Switch

It is advisable to have a switch to disable traction control in case of bad operation or the loss of a wheel speed sensor. This may be implemented by connecting a switch to a Switched/Digital Input and assigning the Traction Control Enable function. The TCM also has an input is available for a disable switch.

Sensor Disk

A toothed disk must be fitted to the sensing wheels. The teeth must be evenly spaced. The edge variation (distance from leading edge to leading edge for Hall sensors or tooth centre to centre for magnetic sensors) must be less than 0.5% to give an accuracy of 1kph in 200kph. Therefore if the tooth spacing is 20mm then the variation between edges must be less than 0.1 mm.

Different numbers of teeth may be used between the front and back wheels if desired.
The number of teeth will depend mainly on the size of the toothed disk and the requirements of the sensor, however the following minimums and maximums must be observed.

12 teeth minimum
120 teeth maximum

Note: If measuring the tail shaft speed, reduce these numbers by the diff ratio.

Sensor Setup

The ECU must be told how many teeth each sensor has and the calibration for each sensor.
The Function for each Digital Input must be set for Speed Measurement or TCM.
The parameters for each Digital Input must also be set as follows (see the Input / Output Functions menu).
Note: For the TCM only the calibration parameter is required.

Digital Input Parameters

Units

Set to 1 (Speed)

Calibration

The calibration for each sensor must be entered as pulses per 1/10th speed unit, i.e. pulses per 1/10th km (100m) or 1/10th mile.

To calculate the calibration factor follow the procedure below:

Measure the Rolling Circumference

Measure how many times the wheel rotates over a measured distance (eg 100m) then divide the distance by the number of rotations then convert the answer to the desired speed units (ie. km or miles)

Eg: 52.5 rotations over 100m and the speed is to be displayed in km/h

Rolling circumference = 100 / 52.5 = 1.905 metres = 0.001905 km

Calculate the Rolling Circumference

Multiply the rolling diameter of the wheel by 3.141 (π) then convert the answer to the desired speed units (ie. km or miles)

Eg: Rolling diameter is 0.62 metres and the speed is to be displayed in km/h

Rolling Circumference = 0.62 x 3.141 = 1.947 metres = 0.001947 km

Calculate the Calibration factor

$$\text{Calibration} = \frac{\text{Number of Teeth}}{10 \times \text{Rolling Circumference in Speed Units}}$$

eg: For rolling circumference of 0.001947 km, 24 teeth and km/h

$$\text{Calibration} = \frac{24}{10 \times 0.001947} = 1232$$

Note: If measuring the tail shaft speed then the calibration number should be multiplied by the diff ratio. Eg: if the diff ratio is 3.12:1 then multiply the calibration number by 3.12.

Note: If the front and back wheels have different circumferences or a different number of teeth then separate calculations must be done for the front and back wheels.

Sample Teeth

The sample teeth parameter ensures that sufficient resolution is maintained on wheels with a large numbers of teeth.

Note that using 48 teeth is no better than using 24 teeth, because sampling is performed over two teeth on the 48 tooth wheel.

Use the following table to determine this factor.

Number of Teeth	Sample Teeth
12 to 24	1
25 to 48	2
49 to 96	4
97 to 120	6

Note: If measuring the tail shaft speed reduce the number of teeth in this table by the diff ratio.

Check Sensor Setup

Check that the sensor setup is correct by logging the Speed Sensor readings and the Wheel Slip. The speed reading for all sensors should be the same when the vehicle is under light power and Wheel Slip should be zero.

RPM Limit Type

Traction Control uses the same type of RPM limiting as specified in the RPM Limit parameters. This is set under the RPM Limit menu item, and is not part of the Traction Control parameters.

For most applications using traction control the RPM Limit Type should be set to Type 2 - Primary Ignition Cut with Fuel cut 100 RPM above the ctrl range.

Data Logging

Data logging of the Traction Control performance is essential, particularly for Launch Control.

For the M4/48 Data Set 0 is suggested, while for the M800 logging of the following channels is suggested: RPM, TP, Wheel Speeds, Ground Speed, Drive Speed, Wheel Slip, Traction Control Cut Level, Slip Target, Launch Target.

Traction Control Setup

Before enabling Traction Control, ensure that the speed sensors are reading correctly and slip is reading zero when there is no slip. See 'Check Sensor Setup' above.

The Traction Control function should be set to the desired method of traction control (this is under the 'Miscellaneous Functions' menu in the M4/48, and the 'Functions' menu in the M800). The various parameters for the selected method of traction control must be set and adjusted to suit the vehicle, see below.

Function

0 - Slip Measurement

Measure Slip, but do not perform any Traction Control.
This method can be used to calculate and log slip values to improve wheel speed calibration.

1 - Slip Control

Performs both Traction Control, and Launch Control if required.

Traction Control

Controls traction by measuring the speed difference between the driven wheels and the rolling wheels to calculate the slip, then cuts the Ignition by an increasing amount if the slip exceeds the Aim Slip.

The Aim Slip may be set for various throttle positions in the Traction Control Table.
The cut method is the same as the RPM Limit cut method. Ignition Cut is recommended for most applications.

2 - Launch Control (only)

Limits the Engine RPM during the launch phase to stop excessive wheel spin. The Traction Control Table sets the Desired Launch RPM Limit at various ground speeds. Launch mode is entered when the speed is less than the "End Speed" parameter. The cut method is the same as the RPM Limit cut method.

Only a single - undriven - wheel speed input is needed for this function.

Parameters - Function 1 (Slip Control)

SLIP SOURCE

Sensor source for the slip calculation. The source may be derived from:

- The Digital Inputs using 2, 3 or 4 sensors
- The Traction Control Multiplexer (TCM)
- One rolling wheel speed and the current engine RPM and Gear Position.

See the Help in the EMP software for more details.

SLIP FILTER

Provides filtering of Slip Value to remove undesired fluctuations in case of noise.

1 - No Filtering
10 - Maximum Filtering

Typical: 4

SLIP CTRL RANGE

Additional Slip above the Aim Slip at which full cut will be used. If the actual measured slip is above the current Slip Table value by this amount, then a cut of 100% is used.

The Aim Slip is dictated by the Traction Control Table.

Typical: 10 km/hr

See Figure 2 for details.

CUT LIMIT

Maximum amount of cut allowed.

Avoids excessive cut.

Typical: 75 %

NO CUT RPM

RPM below which cut is not allowed. This is to prevent engine stall on launch.

Highly dependant on engine torque.

Typical: 3000 to 5000

See Figure 1 for details.

FULL CUT RPM

RPM above which full cut is allowed. Maximum amount of cut is given by the 'Cut Limit' parameter.

Must be greater than the No Cut RPM.

Between No Cut RPM and Full Cut RPM a progressive amount of cut is allowed.

Typical: 750 above NO CUT RPM

See Figure 1 for details.

NO CUT THROTTLE

Throttle Position below which cut is not allowed. Regardless of other settings, if the TP is below this value, then the ECU will not cut the engine.

Typical: 10%

See Figure 2 for details.

FULL CUT THROTTLE

Throttle Position above which full cut, as set in the 'Cut Limit' parameter, is allowed.

Must be greater than the No Cut Throttle.

Typical: 50%

See Figure 2 for details.

LAUNCH RPM

RPM Limit used for Launch.

Activated if the Wheel speed is zero.

Typical: 1000 above NO CUT RPM

0: Disable Launch Control (Provides Traction Control only)

See Figure 1 for details.

LAUNCH CTRL RANGE

Control Range for LAUNCH RPM.

Additional RPM above the LAUNCH RPM at which maximum cut (to cut limit) will be used.

Typical: 500 RPM

See Figure 1 for details.

LAUNCH CHANGE SPEED

Speed at which Launch RPM Limiting stops and Traction Control starts.

Between speed = 0 and the LAUNCH CHANGE SPEED the RPM Limit is ramped down between the LAUNCH RPM and the LAUNCH AIM RPM.

Must be above the speed at which the clutch is fully released.

Must be below the LAUNCH AIM RPM no slip ground speed otherwise the engine will become RPM limit bound. For example: if the launch aim rpm is intended to give 30km/h, then the launch change speed needs to be less than 30.

Typical: 25 km/hr

See Figure 1 for details.

LAUNCH AIM RPM

Should be set to give smooth transition between Launch Control and Traction Control.

Typical: Slightly above the NO CUT RPM.

Can be calculated as: Total Speed = Launch Change Speed + Slip. Enter the rpm value that would give this speed.

See Figure 1 for details.

DRIVEN WHEEL BALANCE

Sets the balance ratio between the driven wheels if two driven wheel sensors are used.

0% - Use slowest wheel only
100% - Use fastest wheel only

Typical for LSD	30%
Typical for Non LSD	80%

Traction Control Table - Function 1

The Traction Control Table sets the Aim Slip for various throttle positions. The Aim Slip is the speed difference between the driven wheels and the rolling wheels, measured in speed units (ie. km/h or mph).

Note: If percentage slip is desired rather than speed difference, then a negative Slip Source number should be used. Typically 2 km/h is desirable at lower throttle positions (up to 20% say) increasing to about 10 km/h at full throttle.

Parameters – Function 2 (Launch Control)

SPEED SOURCE

The Digital Input used to measure wheel speed

END SPEED

Speed at which to end Launch Control. It is suggested that this is set to be slightly above the change speed for first gear.

Note that Launch Control reactivates when speed drops below the End Speed.

RPM CONTROL RANGE

Additional RPM above the table RPM value at which all cylinders will be cut.

Typical: 500 rpm

Traction Control Table – Function 2 (Launch Control)

The Traction Control Table sets the Desired Launch RPM Limit at various ground speeds.

The Launch RPM Limit is only in effect while Launch Mode is active.

Adjusting Traction Control Parameters

If starting from scratch, begin with the suggested values for the above parameters, then do some testing and log the channels suggested above. Make some changes, do more testing, and so on, until the required performance is reached.

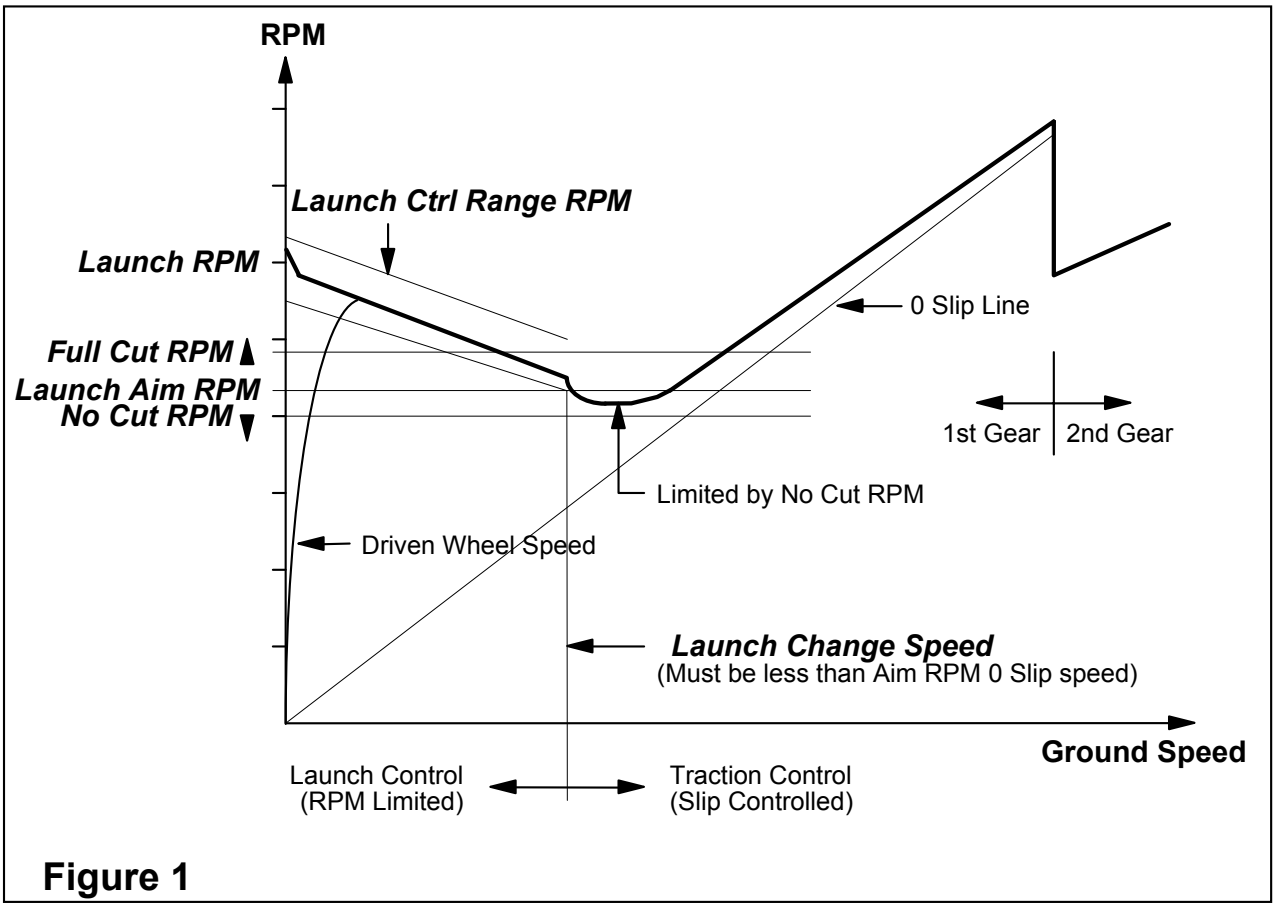

Figure 1

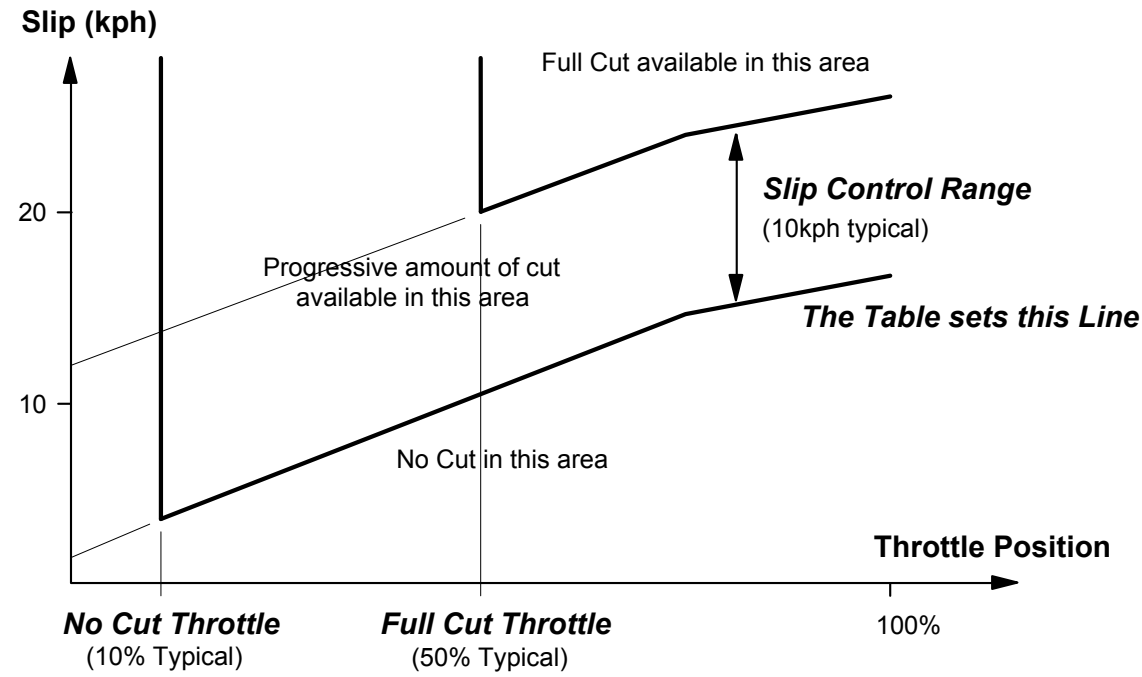
Slip (kph)
Full Cut available in this area
Slip Control Range
(10kph typical)
20
Progressive amount of cut
available in this area
The Table sets this Line
10
No Cut in this area
Throttle Position
No Cut Throttle
(10% Typical)
Full Cut Throttle
(50% Typical)
100%

Figure 2