



Colour Displays & Data

TRAINING CONFERENCE 2015



INDEX 2015 Training Reference

MoTeC Colour Displays

MoTeC Colour Displays	0
Overview	1

Introduction to Colour Displays

Introduction to Colour Displays	2
Types of Colour Displays	3
D Series Displays	4
C Series Display Loggers	6

Creating a Display Configuration

Creating a Display Configuration	8
Configuration Overview	9
Colour Display Configuration	10
Colour Display Basics	11

Input/Communications Setup

Input/Communications Setup	12
System Overview	13
Input Configuration	14
Channel Configuration	16
Sensor Calibration	17
Communications Setup	19

Output Setup

Output Setup	21
--------------------	----

Functions/Tables/Conditions

Functions/Tables/Conditions	26
Lap Timing Setup	27
Ground Speed	28
Lap Distance	29
Gear Detection	30
Fuel Prediction	31
2D Tables	32
3D Tables	33
User Conditions	34

Logging/Display/Alarms

Logging/Display/Alarms	35
Logging Setup	37
Display Setup	41
Display Setup - Overrides	45
Display Setup - DC	48
Alarm Setup	52
Shift Lights	54

Vehicle Details

Vehicle Details	57
Configuration Details	58

Connecting to the Display

Connecting to the Display	61
Connection Settings	62
Online Options	63
Retrieving Logging	64
Vehicle Details	65
Monitor Channels	66
Simulate	67
Dash Options	69

Display Creator

Display Creator	70
Overview	71
Introduction	72

Creating a New Config/Initial Set Up

Creating a New Config/Initial Set Up	73
Creating a new project	74
Communication Setup	75
Channel Setup	79

Page Layout

Page Layout	82
Dial Gauge - Setup	83
Dial Gauge - Positioning	85
Dial Gauge - Needle	86
Dial Gauge - Surround	87
Import Image	89
Inserting Image	91
Channel Values	92
Adding a Channel	96
Grouping	99
Channel Value	101

Enumerators/Switches

Enumerators/Switches	102
----------------------------	-----

Alarms/Conditions

Alarms/Conditions	112
-------------------------	-----

Sending a Configuration

Sending a Configuration	119
-------------------------------	-----

Preloaded Projects

Preloaded Projects	121
Additional Features	128

i2 Data Analysis

i2 Data Analysis	130
Topics	131
Reasons for Data Logging	132
Logging	133
Sensors	134
Dash Channel Structure	135
Examples of Dash Systems	136

i2 Introduction

i2 Introduction	137
i2 Standard vs i2 Pro	138
Software Download/Installation	139
Getting Started	140
New Workspace Wizard	141
Workbook/Worksheet Setup	142
Open a Log Data File	145
Data Window	146
Adding Components	147
Add Time/Distance Graph	148
Adding Channels	149
Channels Window	150
Time/Distance Graphs	151
Gauges	153
Add Gauges – Steering Wheel	154

Gauges – Numeric Gauge	155
Zoom Functions	156
Resizing and Layout	159
Layout Editor	160
Values Box	161
Graph Properties	162
Channel Properties	165
Channel Options on a Graph	166
Save Workspace Settings	167
Histograms.....	168
Throttle Histogram	169
Zoom Linking.....	170
Introduction to Track Mapping	171
Track Editor	172
Track Mapping Troubleshooting	174
Track Mapping - Position.....	176
Track Mapping - Transparent.....	177
Track Report.....	178
Track Mapping - Report.....	179
Track Mapping - Rainbow	180
Corrected Speed & Distance	181
Data Overlaying.....	182
Comparing Laps - Overlays	183
Where Did I Lose Time?	184
Offset Axis	185
Status Channels	186
Maths	187
Maths Expressions.....	188

Lap Gain/Loss

Lap Gain/Loss.....	190
What is Lap Time Gain/Loss?.....	191
What is a Reference Lap?	192
Generating a Reference Lap in i2.....	193
Set Reference Lap in Dash	195
Gain Loss Displayed in the car	197

Reliability and Safety

Reliability and Safety.....	198
Channel Report.....	199
Using the Channel Reports.....	200
Temperature Sensors	201
Reading Temperatures.....	202
Engine Temperature Problem.....	203
Types of Pressure Sensors	204
Reading Pressures	205
Oil Pressure Problem.....	206
Fuel Pressure Problem.....	207
Reading Battery Voltages	208
Useful Tips	209
Annotations.....	210

Evaluating Driver Performance

Evaluating Driver Performance	211
Reading Engine RPM Trace	212
Wheel Speed Sensors.....	213
Reading a Wheel Speed Trace	214
Logging Rate and Accuracy 1	215
Wheel Lockup	216
Wheel Spin	217
Force and Motion Sensors	219
Reading a G Force Trace	220
Driving Line Analysis.....	221
G-G Diagram	222
Datum Cursor.....	223
Straight Line Acceleration.....	225
Rate of Change Measurement.....	226
Reading Brake Pressure Trace.....	227
Brake Pressures	228
Braking Analysis	229

Scatter Plot	230
Brake Pressure Scatter Plot	231
Steering Sensors.....	232
Calibrating a Steering Sensor.....	233
Reading a Steering Trace	234
Steering Trace Examination.....	235
Oversteer	236
Understeer	237
GPS Mapping	238
Open a Log File	239
Add GPS Track Map.....	241
Auto Inserting Beacons in i2	242
Time Report	244
Section and Split Times	245
Driver Consistency.....	246

Evaluating Chassis Performance

Evaluating Chassis Performance	247
Brake Temp Sensor	248
Brake Temp Analysis.....	249
Brake Temp Data.....	250
Linear/Rotary Potentiometers.....	251
Suspension Analysis	252
Filtering and Screen Resolution.....	254
Talk to the Driver	255
Damper Histogram Analysis.....	256
Add a Damper Histogram.....	258
Tyre Temp Sensors.....	259
More Tyre Temp Sensors	260
i2 Data Overlay for Comparison.....	261
What is an Overlay & What Can You Learn?.....	262
Creating an Overlay.....	263
Variance	264
Multiple Overlays	265

Data Maintenance

Data Maintenance.....	266
Weekend Checklist	267
Organising Log Files.....	268
Organising/Opening Log Files.....	269
View/Edit Details.....	270
Edit Details.....	271
Exporting Data	272
Exporting Channel Report Data.....	273
Creating a Summary Sheet	274
The Final Chapter	275

T2 Telemetry

T2 Telemetry	276
T2 Telemetry Setup	278
T2 Server Setup	279
T2 Server Setup Incoming Data.....	281
T2 Server Setup Outgoing Data.....	282
Connecting T2 Server to i2 Pro.....	283
i2 Pro Telemetry View	284
i2 Pro Maths Using T2 Telemetry Data.....	286
Telemetry Options in i2 Pro	287

Appendix

Appendix.....	288
Drags: Auto Run Insertion 1	289
Drags: Auto Run Insertion 2	290
Drags: Run Display.....	291
Drags: Manual Run Insertion.....	292
Advanced Features	293
Setup Sheets.....	294
Keyboard Shortcuts.....	295
Display Creator Tips.....	299



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MoTeC Colour Displays





Overview

- Introduction to Colour Displays
- Creating a New Configuration
- Input/Communication Setup
- Output Setup
- Functions/Tables/Condition Setup
- Logging/Display/Alarms
- Vehicle Details
- Connecting/Sending Configuration
- Questions



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Introduction to Colour Displays





Types of Colour Displays

D Series (D153/D175)

- Display only
 - No logging hardware
 - Switch and dial inputs
 - CAN communications

C Series (C125/7 and C185/7)

- Display Loggers
 - 120MB to 500MB memory
 - Range of inputs
 - Replaces CDL3/SDL3/ADL3





D Series Displays

D153

- Designed specifically for steering wheel integration
- Flying lead connection
- 8 Analogue and 6 Switch Inputs





D Series Displays

D175

- 22 Pin Autosport connector
- 10 multicolour LED Shift Lights
- CAN connection
- 8 Analogue inputs





C Series Display Loggers

C125/C127

- 120MB logging option
- 10 Multicolour LED Shift Lights
- Full E888/E816 expander compatibility
- Plug in race kit available
- I/O option available



I/O Features

2 expanders max, no limitations on using them (like the CDL3 had)

Race Logging Kit:

- 10Hz GPS
- Two button loom
- Network Cable
- Terminated race loom



C Series Display Loggers

C185/C187

- 500MB logging option
- 10 Multicolour LED Shift Lights
- Full E888/E816 and VIM/SVIM expander compatibility
- 79 Pin Autosport connector
- Advanced functions/maths



Standard 250MB

30 I/O standard 44 optional

T2 Upgrade available



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Creating a Display Configuration





Configuration Overview

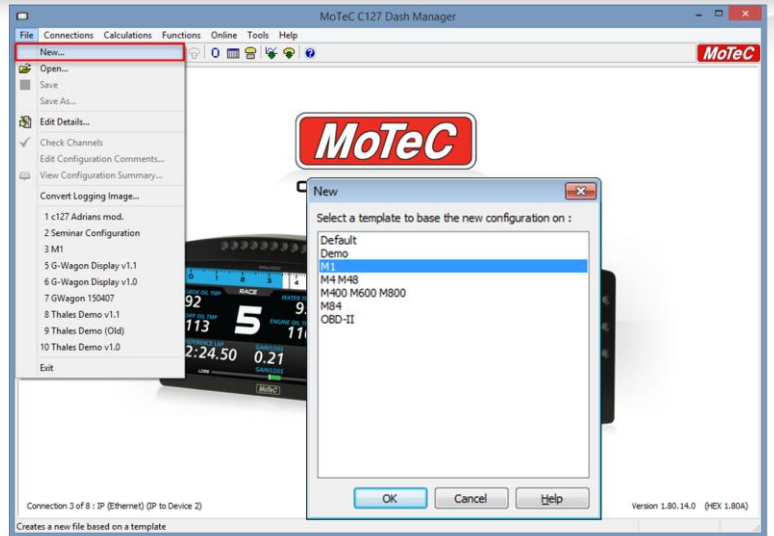
- Create a New File/Open Existing File
- Inputs - Physical & Communications
- Logging Setup
- Display Setup
- Alarms
- Vehicle Details
- Connecting to the Display
- Sending the Configuration



Colour Display Configuration

Creating a new config

- Open Dash Manager
- File>New>M1
- Save
- File locations



Open the correct Dash Manager for the Display you have.

Locale File

After installing Dash Manager software, the first time the software is run a dialogue will appear asking you what 'locale' file you want to use, with a choice of:

- All channels metric
- Common channels in PSI, F, MPH, In
- Common channels in PSI
- Drag Racing

By default all channels in the Dash are treated as Metric. While it is possible to change the units used for any particular channel by using the 'Edit channel' feature, the locale file offers a way to change the units for a large group of commonly used channels and select the one most appropriate to your application. The selection can be changed at a later date by going to 'Tools – Options' and selecting a different locale file.

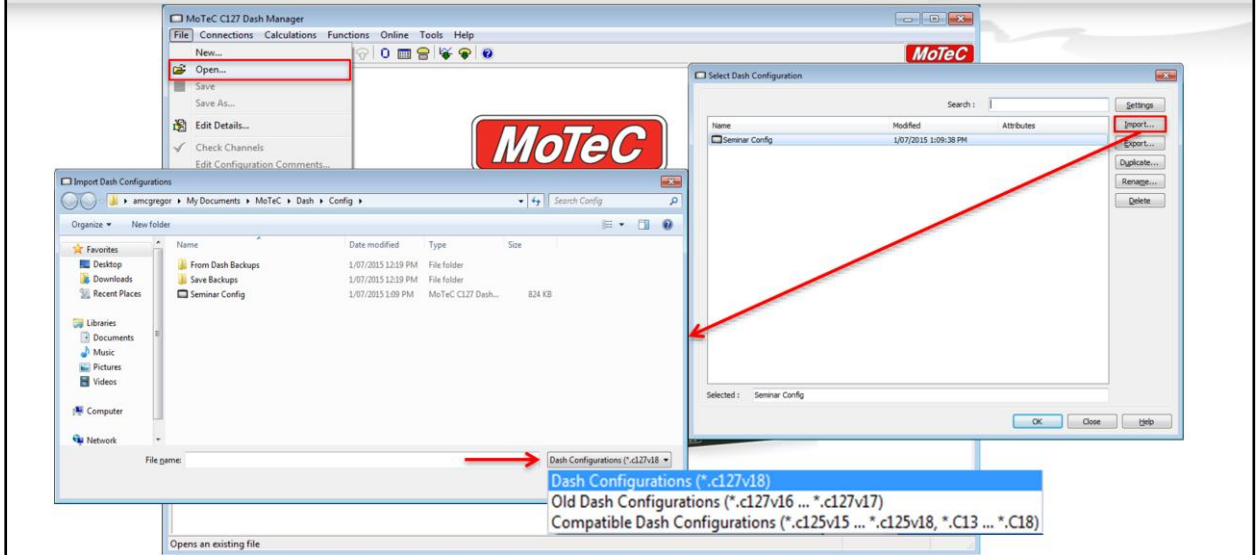
Click on File>New and then either select Blank to start from scratch or select the ECU you are using. In this case I will be connected to an M1.

Click on File>Save and call the config an appropriate name. It's always good to include either dates or version numbers so changes can be easily tracked.

Files are by default saved to 'user\document\MoTeC\Dash\Config



Colour Display Basics



Click on File>Open to display a window listing all previously saved configs.

If you have a config created with an older version of Dash Manager you can import it using the import button.

You can also select compatible Dash configurations, in this case you can import a C125 config to create a C127 config. C185 to C187 is also possible.



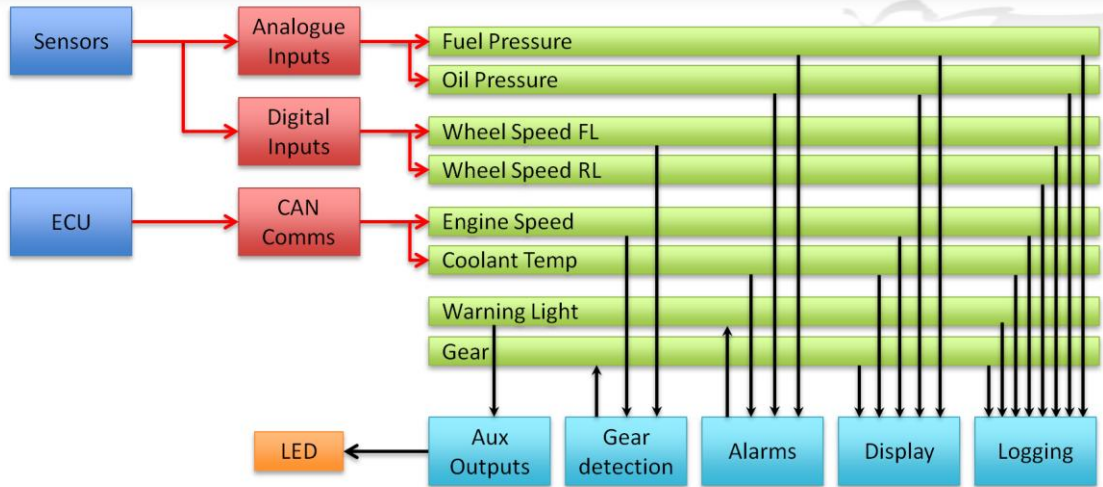
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Input/Communications Setup





System Overview





Input Configuration

MoTeC C127 Dash Manager - Seminar Config

File | Connections | Calculations | Functions | Online | Tools

Devices...
Communications...
CAN Bus Error Counts...

Expansion devices such as E888 and SVIMs are listed here

Connections

Devices: (C127)

Input Pins | Output Pins | Internal Pins

Input Pins: Filter: All pins

Connection	Input	Pin No.	Channel	Calibration	Default
(C127)	AV 1	3			
(C127)	AV 2	4			
(C127)	AV 3	5			
(C127)	AV 4	6			
(C127)	AV 5	12			
(C127)	AV 6	13			
(C127)	AT1	16			
(C127)	AT2	17			
→ (C127)	DIG1	14	Reset Button <input type="checkbox"/>	Low volts = Active	0
→ (C127)	DIG2	15	Next Button <input type="checkbox"/>	Low volts = Active	0
→ (C127)	SPO1	21	Mode Button <input type="checkbox"/>	Low volts = Active	0
(C127)	SPO2	22			
→ (C127)	SPO3	23	Brightness Switch <input type="checkbox"/>	High volts = On	0

0 of 425 duplicates in use

Channel... Clear Duplicate Delete Load Cal... Change Cal... Spd Levels... Settings...

Use anti-aliasing filter on the device

OK Cancel Help

This is where all of the physical inputs and outputs are setup, as well as expanders if available.

When using the M1 setup, a number of inputs are preconfigured for display control such as the mode button/alarm acknowledge and brightness adjustment.



Input Configuration

The screenshot shows the MoTeC software interface. On the left, the 'Connections' window is open, displaying a table of input pins. The 'Channel' column for the first row (AV 1) is highlighted. Below the table, the 'Channel...' button is highlighted with a red box. A red arrow points from this button to the 'Select Channel' dialog box on the right. The dialog box has a search bar containing 'brake pres fr' and a list of channels with 'Brake Pres Front' selected.

Connection	Input	Pin No.	Channel	Calibration	Default
→ (C127)	AV 1	3	Brake Pressure Front [kPa]	Not Calibrated	0 kPa
(C127)	AV 2	4			
(C127)	AV 3	5			
(C127)	AV 4	6			
(C127)	AV 5	12			
(C127)	AV 6	13			
(C127)	AT1	16			
(C127)	AT2	17			
(C127)	DIG1	14	Reset Button []	Low volts = Active	0
→ (C127)	DIG2	15	Next Button []	Low volts = Active	0
→ (C127)	SPD1	21	Mode Button []	Low volts = Active	0
(C127)	SPD2	22			
→ (C127)	SPD3	23	Brightness Switch []	High volts = On	0

0 of 425 duplicates in use

Channel... Clear Duplicate Delete Load Cal... Change Cal... Spd Levels... Settings... OK Cancel Help

Use anti-aliasing filter on the device

Select Channel

Category Search

Search text :
brake pres fr

Channels :

- Brake Pres FR
- Brake Pres Front
- Brake Pressure Front
- Brake Pressure Front Diag
- Max Brake Pres Front

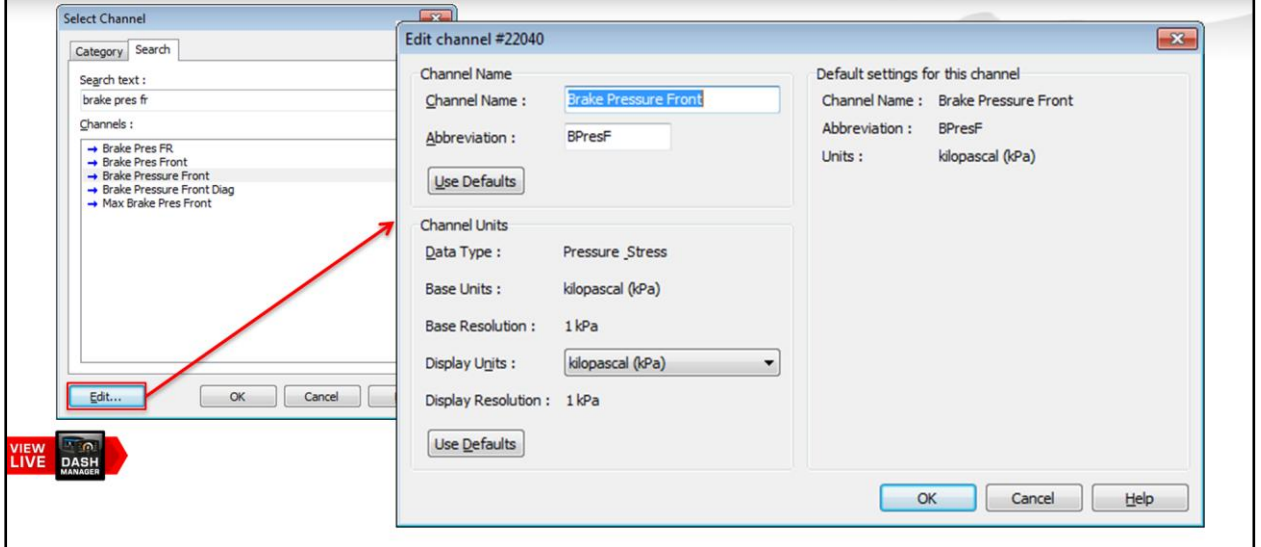
Edit... OK Cancel Help

To select a channel, either double click the input line or highlight it and click channel.

We are going to set up a front brake pressure sensor on AV1. Start typing in the search bar until 'Brake Pressure Front' is displayed. Either double click it or highlight it and press OK.



Channel Configuration



Editing Channel Details

In the channel selection window click Edit. This will allow you to change the name of the channel and its displayed unit.

It is important to note the base resolution of the channel cannot be changed. All calculations within the Dash are done in the base unit of the channel and then are converted afterwards to the display unit. This is especially important when configuring CAN templates or using Advanced Maths.

As an example, let's say you have an M800 that is set to use PSI for Engine Oil Pressure which you want to display on your C127 in PSI. The base resolution of Engine Oil Pressure in the ECU will be 0.1PSI and it will be 0.1kPa in the Dash.

So in the CAN setup you have to convert from 0.1PSI to 0.1kPa.

$$0.1\text{PSI} = 0.6895\text{kPa}$$

The Dash only uses whole numbers in the communications setup so you have to multiply the input channel by 6895 and then divide by 1000

$$0.1 * 6895 / 1000 = 0.6895$$

Now the Dash will have the correct channel value and will convert it to the selected displayed units in the background.



Sensor Calibration

The screenshot shows the MoTeC software interface. On the left, the 'Connections' window displays a table of input pins. At the bottom of this window, the 'Load Cal...' button is highlighted with a red box. A red arrow points from this button to a 'Select Pressure & Stress Calibration' dialog box on the right. The dialog box contains a search bar with the text 'ho' and a table of calibration files.

Name	Modified	Attributes
\\.\HoneyWell MLH 0-100PSIG	23/06/2015 3:31:36 PM	Read-only
\\.\HoneyWell MLH 0-2000PSIG	23/06/2015 3:31:36 PM	Read-only
\\.\HoneyWell MLH 0-250PSIG	23/06/2015 3:31:36 PM	Read-only
\\.\HoneyWell MLH 0-500 PSIG	23/06/2015 3:31:36 PM	Read-only

Selected: HoneyWell MLH 0-2000PSIG

There are two ways to calibrate the input, either with an existing calibration file or manually.

To load an existing calibration click on load Cal:

In the search box begin typing until the file you want is visible.

Either double click it or highlight and click OK.



Sensor Calibration

The screenshot shows the MoTeC software interface. On the left, the 'Connections' window displays a list of input pins. The 'Steering Angle Calibration' dialog box is open on the right, showing calibration settings and a table for manual data entry.

V	deg
0.405	-90.0
2.490	0.0
4.480	90.0

Manual Calibration

There are two ways to insert values. You can either go through each position on the table if you have a data sheet from the sensor manufacturer, or in this case where we are calibrating a steering potentiometer, you can use the read value button.

Point the steering wheel straight ahead, click read value and then enter 0 deg in the adjacent box.

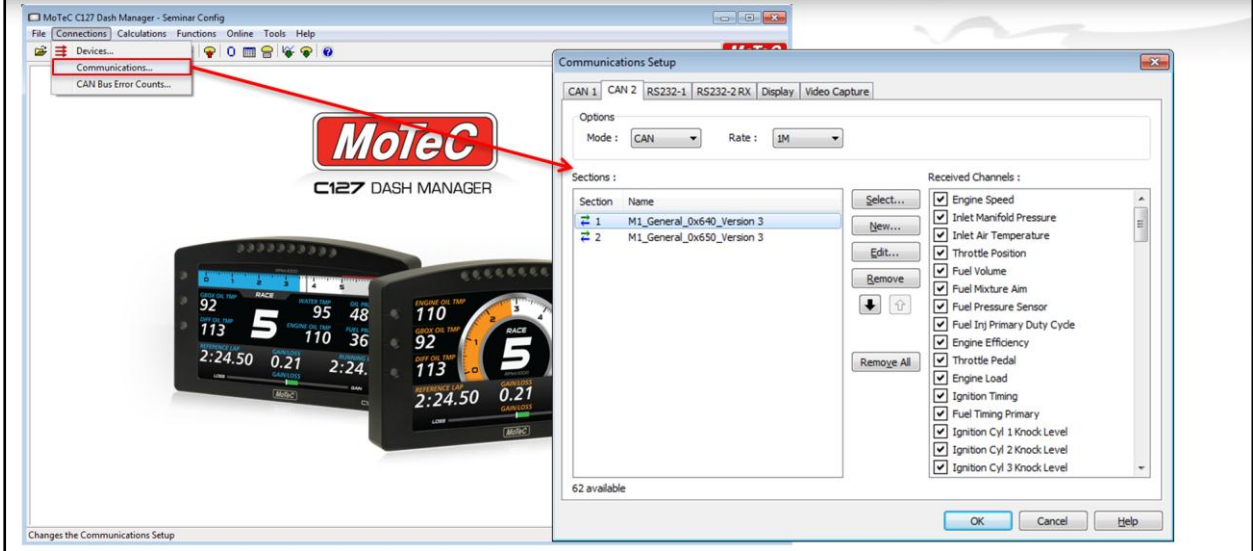
Turn the wheel 90 deg to the left, click read value and enter -90 deg. Repeat for 90 deg to the right from centre.

This sensor is rotary pot with a 5V supply so the method needs to be set to Ratiometric (5V).

Absolute voltage is used when the sensor has its own internal regulation and its output voltage is not proportional to its input voltage.



Communications Setup



Communications Setup

This is where all CAN/Serial communications are set up to communicate with any other device.

As we started an M1 config, the comms templates are already loaded for the channels that are sent out of the M1 with a GPA/GPR Package.

CAN rate can be set to a number of different values, MoTeC devices default to 1M, some can be changed others are fixed. Typically vehicle factory CAN buses will be at 500k, heavy vehicles (J1939) at 250k. All devices on the CAN bus must be at the same rate otherwise they will not work.

Some of the CAN buses can be repurposed as additional serial ports if necessary by changing the mode in the drop down menu.



Communications Setup

Left Screenshot: The 'Select...' button is highlighted. Below it, a search bar contains the text 'hd'. A table below the search bar shows the search results:

Name	Modified	Attributes
HD VCS Transmit	23/06/2015 3:31:38 PM	Read-only

Right Screenshot: The 'Video Synchronisation' section is shown. The checkbox 'Send video synchronisation messages' is checked. The 'CAN Bus' dropdown menu is set to '2'. A red arrow points to the dropdown menu with the following text:

Sends messages on this CAN bus to sync data and video

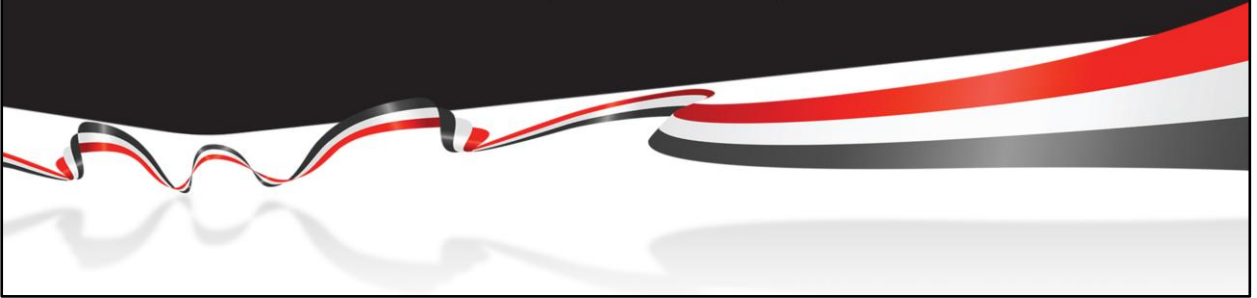
We want to add an HD-VCS camera to our comms setup. To do this, click Select and in the search bar start typing HD-VCS until the template comes up. Click OK and it is set up, ready to go.

The next thing to do is set up the video synchronisation messaging. Click on the Video Capture tab and tick the 'Send Video Synchronisation Messages' box. Select the correct CAN bus from the drop down menu and click OK.



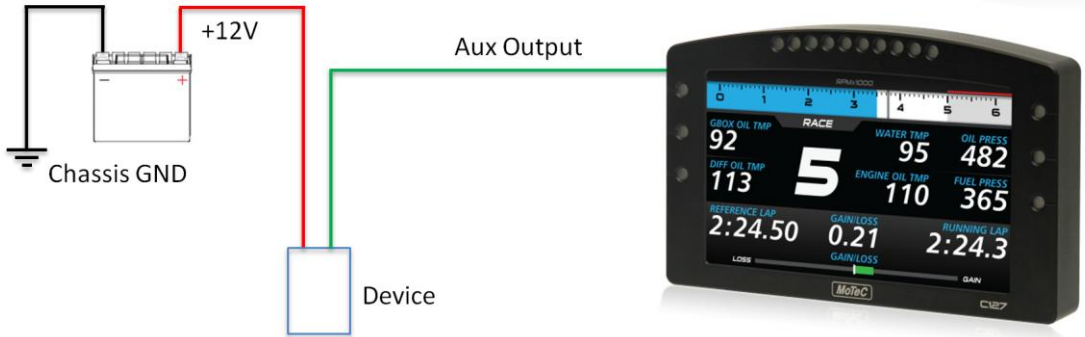
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Output Setup





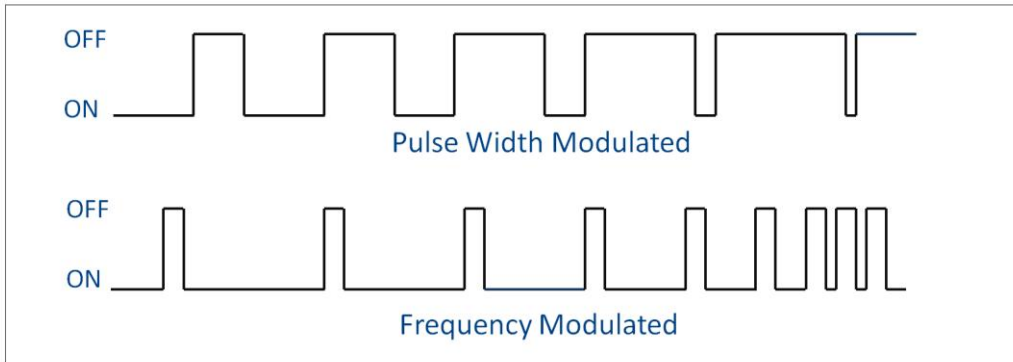
Outputs



The Aux outputs are open collector and driven to ground. They have a max current of 0.5A so are only suitable to directly control small loads. Solid state relays are required when controlling higher current devices.



Outputs



Electrical Specifications

The Auxiliary Outputs switch to ground and may drive up to 0.5 Amps.

On/Off Output:

- Fuel Pump
- Shift Light
- Thermo Fan

Duty Cycle

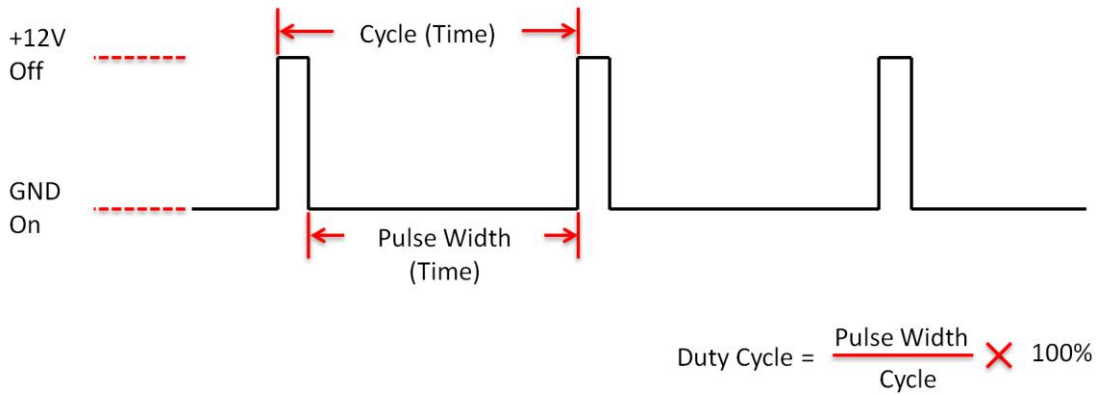
- Boost Control

Frequency

- Tachometer



Outputs



A device is normally continuously powered. The Dash output is switched to ground to turn the device 'on'.

Frequency: Number of complete cycles in one second, measured in Hertz.
 1 Hz = 1 cycle/second.

Cycle: Time from when a device is turned 'on' until the next time it is turned 'on'.

Pulse Width: The time in seconds the device is 'on'.

Duty Cycle: Percentage of time the device is 'on' in one cycle.



Output Setup

Channel that controls the output

Each digital output can be controlled in one of several modes:

On/Off only output available in an older SDL.

Light: If the light is on, it is driven with a programmable duty cycle to vary its intensity

Frequency: the output is driven at a programmable frequency (Note: 22Hz minimum)

Duty Cycle: the output is driven at a programmable duty cycle

Frequency and Duty Cycle: Both the Frequency and Duty Cycle of the output can be varied



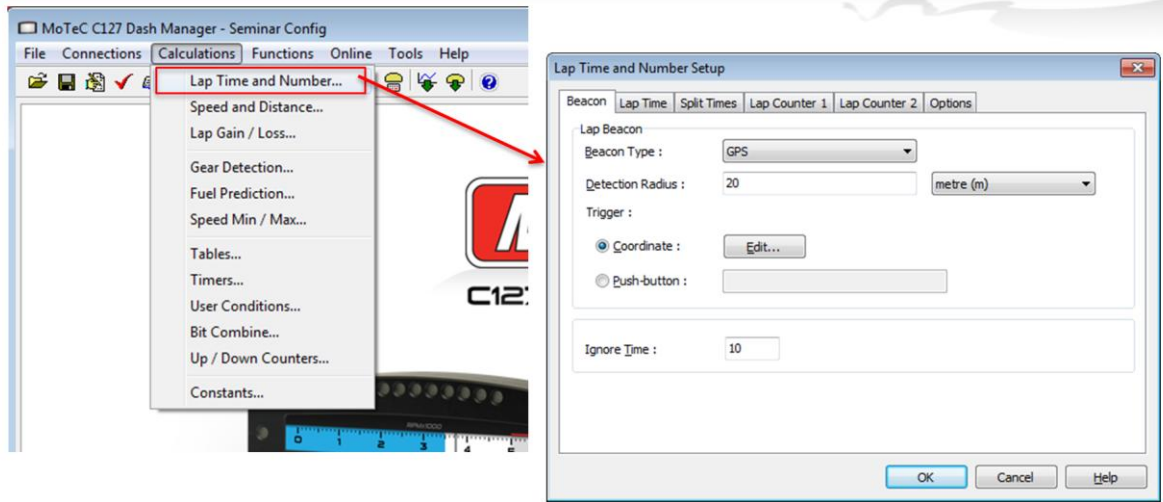
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Functions/Tables/Conditions





Lap Timing Setup



Beacon Types

GPS: Uses a connected GPS unit and GPS coordinates of the start/finish line to trigger the start/end of lap. The detection radius is used to ensure that the lap is triggered whether you are on the far right or far left of the track. Also accounts for drift. The beacon triggers when the vehicle passes at 90 degrees to the start/finish location, so making the detection radius larger should have no effect on the accuracy of the timing. Only the drift will cause inaccuracy. Coordinates set the location of the start finish line. This is tied to the venue file.

Button/Internally Generated: Can set up a switch to trigger the beacon or internal maths calculation on other conditions . Can simply be an on/off signal sent from another device on CAN.

BR2: CAN signal from a MoTeC BR2 module. Need to add CAN template to correct CAN bus and set the Mode and ID to match beacon. Can specify an ignore time; beacon will not be triggered within this time period even if a beacon signal is received.



Ground Speed

Speed and Distance Setup

Ground Speed | Drive Speed | Slip | Lap Distance | Trip Di

Method : Left

Limit for Average : Off

Input Channels

Left : 4 Wheel (ABS)

Speed and Distance Setup

Ground Speed | Drive Speed | Slip | Lap Distance | Trip Distance | Odometer

Method : Left

Limit for Average : 0 %

Input Channels

Left : GPS Speed Select

Right : Select

G Correction Select

Generate

Ground Speed : Ground Speed Select

OK Cancel Help

Ground Speed Tab

Calculates vehicle Ground Speed from either the left or right wheel speed, or from one of a number of methods that help to avoid wheel lockups giving incorrect readings. Correction of wheel lockups is particularly important for the Lap Distance calculation which is derived from the Ground Speed.

Method

Specifies the method for calculating the Ground Speed.

- Left - Uses the Left wheel speed channel.
- Right - Uses the Right wheel speed channel.
- Fastest - Uses the fastest of the two wheel speeds to avoid errors due to wheel lock.
- Average - Uses the average of the two wheel speeds until the difference between the two exceeds a limit value, at which point the fastest of the two wheel speeds is used to avoid errors due to wheel lock.
- 4 Wheel (ABS) - Uses the fastest of up to four wheel speeds, including the wheel speeds defined in the drive speed calculation.

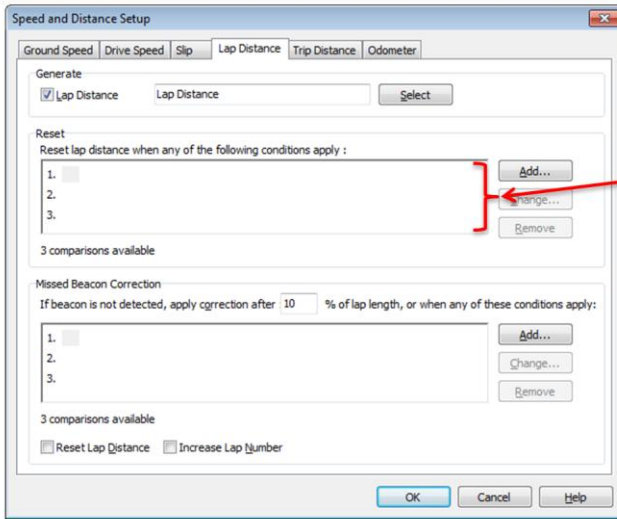
G Correction

G Correction is used to correct for wheel lockups during braking. It predicts the wheel speed during braking using the Longitudinal G Force sensor to detect and correct wheel lockups.

This can be used when only one wheel speed sensor is allowed. It may also be used when measuring more than one wheel speed, which is particularly useful for ABS systems; they tend to have erratic wheel speeds as the wheels partially lock during ABS activation.



Lap Distance



Add conditions to reset lap distance when no beacon is detected

Representative lap distance is important for a number of calculations, so it is useful to set other conditions that will reset lap distance for when the vehicle enters the pits or misses a beacon.

Beacon correction uses the lap length set in the venue file.



Gear Detection

Drive Speed and Engine Speed channels need to be set up

Requires Speed, RPM or Gear sensor

Requires ratios of gearbox in details

MUST be updated each time a different tyre or gear ratio is used.

1. The Output Channel 'Gear' is selected.
2. The acceptance delay applies a filter, otherwise (especially for speed/RPM method) the fluctuations in RPM during the change will cause it to attempt to show more than one gear.
3. The method can be either derived from speed and an RPM signal or purely from a sensor.
4. If the details are entered (as shown on previous page) for the ratios and the correct circumference of the tyre is entered, pressing the Calculate button will update the speed/RPM ranges for the Dash.
5. A dialog appears asking the user to confirm the details – pressing on Calculate (again) then updates the information in the Gear Detection screen.

The Gear Detection often causes the most problems as people forget that each time a tyre is changed and ratios are changed the Dash must be updated and the NEW configuration sent to the Dash – assuming gear is being calculated from speed/RPM and not directly from a voltage sensor.

Gear will only be displayed if:

- The correct tyre size is entered (correct wheel speed calibration)
- The correct Ratios are entered in the details editor [File Menu] [Edit details] Gears Tab
- You have gone to the gear detection page and clicked [Calculate]



Fuel Prediction

3 Types:

- Incrementing Fuel Used for ECU signals
- Fuel Used Pulse
- Fuel Usage Value

The Dash can calculate fuel consumption figures using either a channel from an ECU, or from a fuel level sensor. There are three calculation methods, each slightly different with 'Incrementing Fuel Used Value' being the most common and widely supported by different ECUs.

MoTeC ECUs transmit Fuel Used (RAW) in 10ml units, e.g. a value of 15 on the input channel corresponds to 150ml. As the calculation is done in mls, this means that the RAW Fuel Used value must be multiplied by 10, giving a scaling of $(+0)*10/1$

The Fuel Used value is stored in permanent memory so that if the Dash power is removed, the Fuel Used value is maintained at next power on. If the fuel used figure stops updating for 4 seconds and it has been at least 10 minutes since it was last saved, then it will be saved. RPM is not used in determining when to save the fuel used.

The Fuel Used is only zeroed when the reset condition becomes true.

Check the boxes under the other tabs to select the channels you wish to have calculated, e.g. Fuel Used per Lap, Fuel Remaining.

Fuel Usage is the fuel flow rate.



2D Tables

The screenshot shows the MoTeC software interface. On the left, a menu is open with 'Tables...' selected. In the center, the 'Tables Setup' window shows a table with columns 'Number' and 'Output Channel'. A red box highlights the 'Add...' button. Two red arrows point from this button to two 'Change 2D Table' dialog boxes. The first dialog box shows an input channel of 'Inlet Manifold Pressure' and an output channel of 'Boost Pressure'. The second dialog box shows an input channel of 'Steering Angle' and an output channel of 'Steered Angle'. Both dialog boxes contain a table with 12 rows and 3 columns.

Number	kPa	kPa
1	0.0	0.0
2	100.0	0.0
3	200.0	100.0
4	300.0	200.0
5		
6		
7		
8		
9		
10		
11		
12		

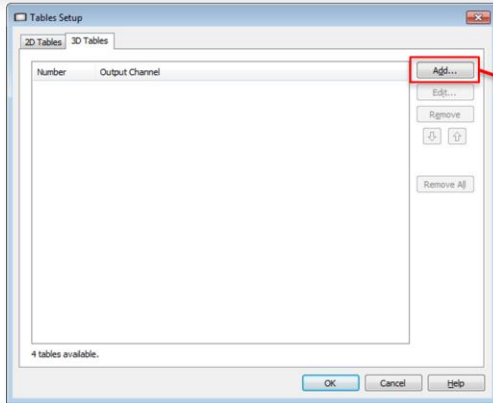
Number	deg	deg
1	-90.0	-13.0
2	0.0	0.0
3	90.0	13.0
4		
5		
6		
7		
8		
9		
10		
11		
12		

The tables are a good way of converting channels. In this case we have Inlet Manifold Pressure but we want to be able to display Boost Pressure. The 2D table allows us to convert from one to the other.

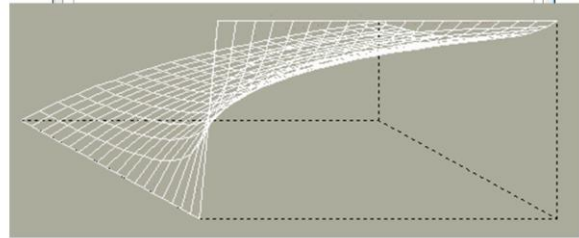
Another example is Steering Position. If you have steering wheel position sensor and want to convert to actual steered angle you can use a 2D table.



3D Tables



X Axis	Y Axis	Output	Table
%	0 kPa	100 kPa	200 kPa
0 kPa	0.0	100.0	100.0
100 kPa	0.0	50.0	66.6
200 kPa	0.0	33.3	50.0



Graphical representation (with additional data points)

Populate Table

In this example, the Brake Bias channel is calculated from Front and Rear Brake Pressure. When front brake has a high pressure value and rear brake pressure has a low value, then the output of the table will indicate more front brake bias.

The tables (both 2D and 3D) linearly extrapolate between points and off both ends. The graph shown used a number of additional data points.



User Conditions

The screenshot displays the MoTeC software configuration interface. The main window is titled 'User Conditions Setup' and contains a table of conditions. A 'Change...' button is highlighted in red. A 'Change User Condition' dialog is open, showing a list of conditions with the first one highlighted in blue. A 'Change Comparison' dialog is also open, showing a comparison setup for 'Coolant Temperature' with a 'Greater than or equal to' operator and a value of 90.0. The 'Output Channel' is set to 'Thermo Fan Ctrl'.

The example above shows the setup for a channel that will be used for controlling a thermo fan.

Conditions are used for many purposes throughout the setup of the Dash. This function allows you to set up a single comparison or combinations of comparisons to generate an On/Off (True/False) output channel. These can then be fed into other parts of the config, for example to control an output, or start a timer. Especially useful if the same condition is used more than once – saves defining it again. They are also useful for setting a smart display.



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Logging/Display/Alarms

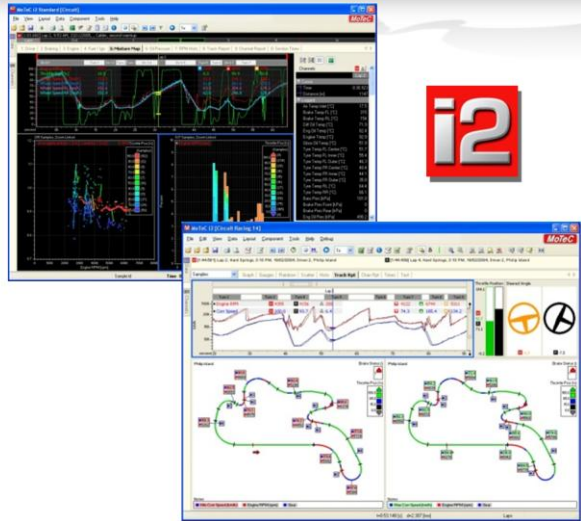




Logging

Why do we log?

- Monitor vehicle reliability
- Tools for vehicle and driver analysis
- Analyse performance
- Periodically sample selected inputs
 - Typically once/sec to 5000 times/sec
- Greater value from test laps
- Store data for retrieval/archiving
- Driving technique
- Comparison against reference lap



- Data Logging is used to record quantitative data (facts) about vehicle performance (drive train and chassis).
- Monitor the drive train in all parts of a lap to look for unusual changes
- Confirm 'gut feel' and driver feedback about what is happening in the vehicle
- Sampling rate is determined by the sensor being logged - must log fast enough to record important data variations
- Maximise information available in a test session. Data logging will record everything that happens.
- Data can be used for future setups and as comparison with other drivers.
- Help diagnose faults and optimise performance, e.g. check fuel and oil pressure are stable during the session - no surges.
- Overlay speeds before and after a chassis change
- Measure oversteer/understeer at individual corners for planning chassis adjustments
- Measure braking ability of vehicle (and driver)
- Compare all elements of a lap against a Reference Lap to understand chassis changes, driver technique, tyre performance etc.



Logging Setup

Must manually select your memory if it is different to standard to give accurate logging time remaining

The available logging time is displayed based on memory size, and as you add channels or change the logging rate for a channel, the logging time is updated automatically.

The Dash Manager software performs an estimation of how long the memory will last based on the actual logging rates you have defined. This calculation is displayed in the logging screen instantaneously as the changes are made.



Logging Setup

Hold Ctrl or Shift to select multiple channels

Channel	Rate	
Airbox Temperature	10 times/second	[F]
Bat Volts Dash	25 times/second	[F]
Bat Volts ECU	20 times/second	[F]
Beacon	once/second	[F]
Boost Pressure	10 times/second	[F]
Brake Bias Setting	once/second	[F]
Brake Pressure Front	25 times/second	[F]
Brake Pressure Rear	25 times/second	[F]
Comms RS232-2 Diag	20 times/second	[F]
Coolant Temperature	10 times/second	[F]
Dash Temp	once/second	[F]
Device Up Time	once/second	[F]
Engine Oil Pressure	10 times/second	[F]
Engine Oil Temperature	10 times/second	[F]
Engine Speed	10 times/second	[F]
Fuel Pressure Sensor	10 times/second	[F]
Fuel Temperature	10 times/second	[F]
Fuel Used M1	10 times/second	[F]
G Force Lat	25 times/second	[F]
G Force Long	25 times/second	[F]
G Force Vert	25 times/second	[F]
Gear	10 times/second	[F]
GPS Altitude	20 times/second	[F]
GPS Date	20 times/second	[F]
GPS Heading	20 times/second	[F]
GPS Latitude	20 times/second	[F]
GPS Longitude	20 times/second	[F]

Logging memory : 120 NB Time available : 0:10:00h56m00s

Channel : (Multiple Channels Selected)

Rate :

- once/second
- twice/second
- 5 times/second
- 10 times/second (default)
- 25 times/second
- 50 times/second
- 100 times/second
- 200 times/second
- 250 times/second
- 500 times/second

Log time available updated when rate changed or channel added

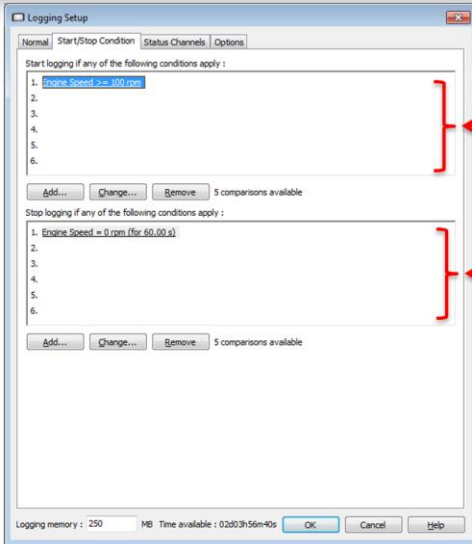
By highlighting a channel and then clicking on the 'Rate' button, the logging rate may be individually set for each channel between 1 to 500 times per second (1000Hz for C185/C127).

Some of the channels are marked with an 'F' to indicate that they are filtered by an anti-aliasing technique.

Channels are sampled at their maximum rate and then averaged to match the chosen logging rate.



Logging Setup



Starts logging when any of these conditions are true

Stops logging when any of these conditions are true

The Start/Stop conditions are used to determine when the display is actually logging data. Any channel and multiple conditions can be used to set when the logging starts and stops.

The stop condition overrides the start condition, so if a stop condition is true then the logging will stop irrespective of the start condition.



Logging Setup

Normal
Start/Stop Condition
Status Channels
Options

Output Channels

<input checked="" type="checkbox"/> Log Time Remaining :	Log Time Remaining	Select...
<input checked="" type="checkbox"/> Log Data Available :	Log Data Available	Select...
<input checked="" type="checkbox"/> Log Data Unloading :	Log Unloading	Select...
<input checked="" type="checkbox"/> Logging Running :	Logging Running	Select...
<input checked="" type="checkbox"/> Logging Memory Busy :	Log Memory Busy	Select...
<input checked="" type="checkbox"/> CPU Usage :	CPU Usage	Select...
<input checked="" type="checkbox"/> Device Uptime :	Device Up Time	Select...

Logging memory : 250 MB
Time available : 0:20:31:56m:40s
OK Cancel Help

Useful for diagnostic purposes.

Using 'Logging Running' in a start logging condition is a good way of starting logging as soon as the Dash is powered up, i.e. 'Logging Running' = False for 0.5sec will start the logging straight away and, as long as you don't have a stop condition, it will continue until the power is turned off.



Display Setup

minar Config

Functions Online Tools H

- Logging...
- Display...**
- Alarms...
- Shift Lights...
- Shift Light Module...
- Telemetry...
- Preserved Channels...

Fixed layout,
3 different
pages

Scroll through
listed Channels
using an input

Display Setup

Display : Internal Display (Fixed Layout) Edit...

RACE PRACTICE WARMUP Channels Backlight

Page Label : RACE

Display Style : Change...

Number 1 : Coolant Temperature (C) <99999>

Number 2 : Engine Oil Pressure (kPa) <99999>

Number 3 : Ground Speed (km/h) <99999>

Number 4 : Session Time (MM:SS) <59.59>

Number 5 : Lap Number <99999>

Number 6 : Bat Volts Dash (V) <9999.9>

Gauge : Engine Speed 0 to 8000, Shift 7000

Gear : <9>

Bar 1 : Lap Gain/Loss Running (s)

Bar 2 : Bat Volts Dash (V)

Bottom: (4/20 used, 1/4 overrides used)

1: Running Lap Time (M:SS.H)	Lap Gain/Loss Running (s)	Lap Time (M:SS.HH)	<59.59_99_9_99_59.99>
2: Min Corner Speed (km/h)	Lap Gain/Loss Running (s)	Max Straight Speed (km/h)	<9999_9_99_9999>
3: Inlet Manifold Pressure (kPa)	Engine Oil Temperature (C)	Airbox Temperature (C)	<999_9_99_9_999_9>
4:	Gear Detect Value		<GEAR_DETECT_VALUE999999>
5:			
1: Reference Lap Time (M:SS.HH)	Lap Gain/Loss Final (s)	Lap Time (M:SS.HH)	<59.99_9_99_59.99>
2:			

Change... Clear Copy From... Options...

OK Cancel Help

Fixed layout, similar setup to previous Dashes. Set positions for channels, channels can be selected.

Three individually configurable pages, with selectable styles.



Display Setup

The image shows three overlapping 'Display Setup' windows, each representing a different mode: RACE, PRACTICE, and WARMUP. Each window has a 'Display' dropdown set to 'Internal Display (Fixed Layout)' and a 'Backlight' button. The RACE window shows a large tachometer and various gauges. The PRACTICE window shows a large tachometer and various gauges. The WARMUP window shows a large tachometer and various gauges. Each window has a 'Page Label' field and a 'Display Style' dropdown. The RACE window has a 'Page Label' of 'RACE' and a 'Display Style' of 'RACE'. The PRACTICE window has a 'Page Label' of 'PRACTICE' and a 'Display Style' of 'PRACTICE'. The WARMUP window has a 'Page Label' of 'WARMUP' and a 'Display Style' of 'WARMUP'. Each window has a 'Gauge' section with 'Engine Speed' and 'Gear' settings. The RACE window has 'Engine Speed 0 to 8000, Shift 7000' and 'Gear <9>'. The PRACTICE window has 'Engine Speed 0 to 8000, Shift 7000' and 'Gear <9>'. The WARMUP window has 'Engine Speed 0 to 8000, Shift 7500' and 'Gear <9>'. Each window has a 'Number 1' through 'Number 4' section with various data fields. The RACE window has 'Coolant Temperature (C) <99999>', 'Engine Oil Pressure (kPa) <99999>', 'Lap Gain/Loss Running (s)', and 'Lap Time (M:SS.HH)'. The PRACTICE window has 'Coolant Temperature (C) <99999>', 'Engine Oil Pressure (kPa) <99999>', 'Lap Gain/Loss Running (s)', and 'Lap Time (M:SS.HH)'. The WARMUP window has 'Coolant Temperature (C) <99999>', 'Engine Oil Pressure (kPa) <99999>', 'Lap Gain/Loss Running (s)', and 'Lap Time (M:SS.HH)'. Each window has a 'Bottom' section with a list of data fields. The RACE window has 'Bottom: (4/20 used, 1/4 overrides used)'. The PRACTICE window has 'Bottom: (4/20 used, 1/4 overrides used)'. The WARMUP window has 'Bottom: (6/20 used)'. Each window has a 'Change...' button and a 'Copy From...' button. The RACE window has 'Change...' and 'Copy From...'. The PRACTICE window has 'Change...' and 'Copy From...'. The WARMUP window has 'Change...', 'Copy From...', and 'Options...'. The RACE window has 'OK', 'Cancel', and 'Help' buttons. The PRACTICE window has 'OK', 'Cancel', and 'Help' buttons. The WARMUP window has 'OK', 'Cancel', and 'Help' buttons.

Three pages with different colours/layouts/channels. Switch between them with a button.



Display Setup

Display Style :



Change...

Select a colour set from the drop down menu or customise each colour individually

Select the style you want to use

Colour Set :
Black/Orange

Gauge Pointer : [Color Selection]

Gauge Background : [Color Selection]

Gauge Tick Marks : [Color Selection]

Gauge Shift Point : [Color Selection]

Gauge Peak Hold : [Color Selection]

Main Labels : [Color Selection]

Main Numerics : [Color Selection]

Main Background : [Color Selection]

Main Foreground : [Color Selection]

Panel Labels : [Color Selection]

Panel Numerics : [Color Selection]

Panel Background : [Color Selection]

Panel Foreground : [Color Selection]

OK Cancel Help



Display Setup

Change the displayed units

Changing the displayed units in the Display Setup does not change it in the logging.

Take note of the number of decimal places and the maximum value that can be displayed. If a larger number is required the resolution will need to be reduced.

Filter: Helpful for channels that are updated very quickly, allows you to actually read the value without it jumping up and down by small amounts all the time. 250 milliseconds is usually enough.



Display Setup - Overrides

Channel to be displayed while override is true

Number 6 - Override 1

Show

When the channel updates Hold Time : 2.0 sec

While the following channel is true : Select...

Settings

Channel : Boost Switch Select...

Label : BOOST SELECT

Format : Decimal

Units : kilopascal (kPa)

Decimal Places : 1

Maximum Value : 9999.9

Filter : 250 msec

OK Cancel Help

Length of time displayed

Let's say we have a rotary switch set up in the M1 to set the boost level. Every time the dial is rotated the value boost aim will be displayed.



Display Setup

The input channel used to change pages

Display Setup

Display : Internal Display (Fixed Layout) Edit...

RACE PRACTICE WARMUP Channels Backlight

Button Channels

Mode Button : Display Mode Change Select

Next Line Button : Display Next Line Select

Previous Line Button : Select

Output Channels

Display Mode : Select

Bottom Line Number : Select

OK Cancel Help

The input channel used to change the bottom line

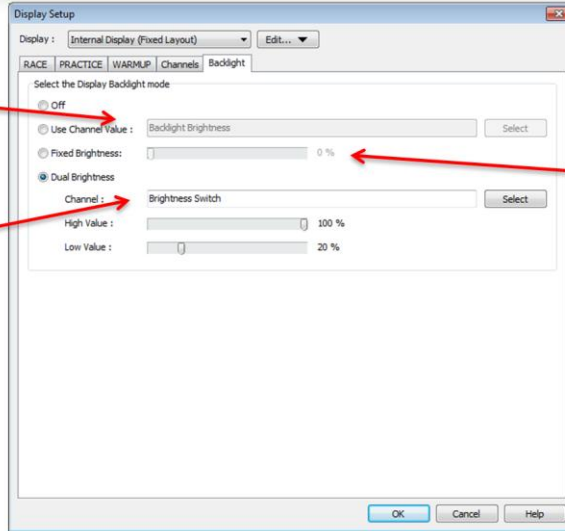
This is where we set up the channels that control the toggling of the pages and which of the bottom lines is displayed. There are also output channels to indicate which page and what bottom line is displayed.



Display Setup

Use a channel to set the brightness

Toggle between two fixed values via a switch channel



Fixed brightness value

The backlight brightness can be controlled in a number of ways, either by a percentage channel, a fixed set brightness or two levels that are switched between via a switch such as a headlight switch.



Display Setup - DC

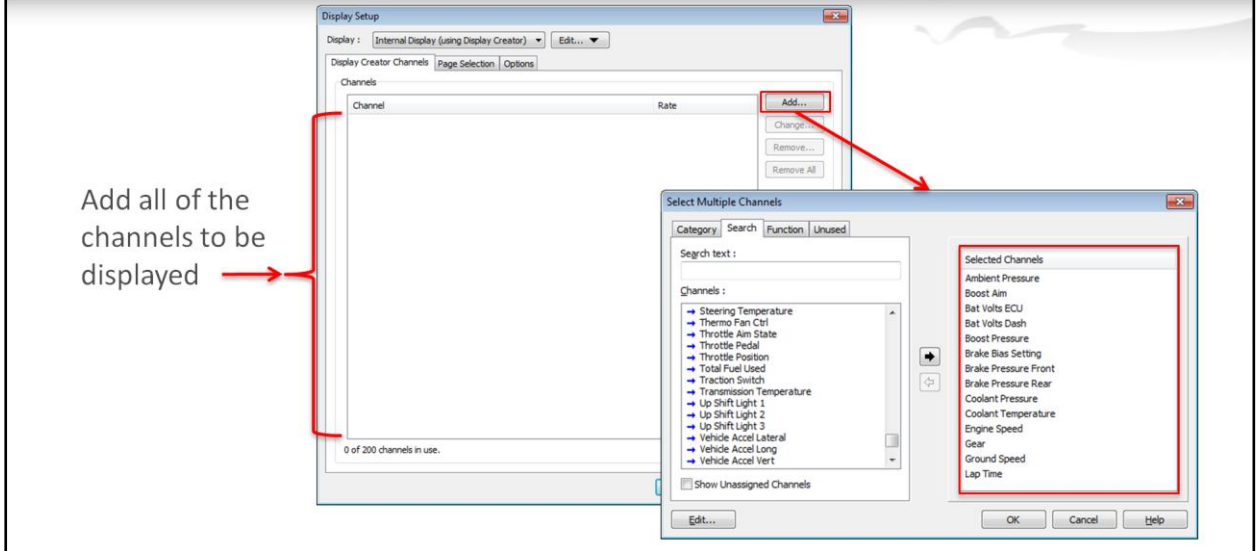
The screenshot shows the 'Display Setup' window with a 'Properties...' menu item highlighted. A red arrow points from this menu item to the 'Display Properties' dialog box. In the dialog box, the 'Type' dropdown menu is open, showing four options. A red arrow points to the third option, 'Internal Display (using Display Creator)', with the text 'Select the type of display setup'.

If Display Creator is being used instead of the fixed layout then we can also configure it from here. Change the display type to an 'Internal Display' (using Display Creator) as shown.

It is also possible to add a setup here if you have an additional D-Series Dash that you want to configure with a fixed layout.



Display Setup - DC



Each of the channels you want to use in your Display Creator project needs to be added here. Think of the Logger and the Display as two separate devices. This sets up the transmit template and creates a DBC file that can then be loaded into Display Creator as the receive template.



Display Setup - DC

Input channel to change pages

Page control channel

Display Page: Number used in conditions to control which page is displayed.

Number of Pages: Number of pages you will be using in your Display Creator project. Note the first number is zero, so for 3 pages Display Page has a range of 0-2.

Page Up Button: Channel used to increment Display Page by one

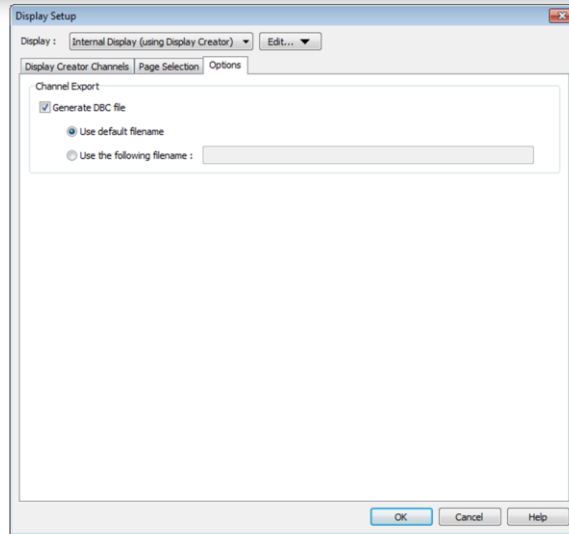
Page Down Button: Channel used to decrement Display Page by one

Page Reset Button: Channel used to reset Display Page to zero

Preserve Page: If ticked will save the value of Display Page when the display is turned off. Whatever page the Display was on before powering off will be displayed on power on.



Display Setup - DC



DBC file name: Generally easiest to leave as the default name.

When a Display is set up to use Display Creator it will create a DBC file to be imported into your DC project. This is all of the communications information required for the channels you select to send to the Display.



Alarm Setup

Minor Config

Functions Online Tools H

- Logging...
- Display...
- Alarms...**
- Shift Lights...
- Shift Light Module...
- Telemetry...
- Preserved Channels...

Alarms Setup

Number	Message	Condition
1	Ref Lap Reset	Reference Lap Time Reset True
2	Session Reset	Session Reset True
3	OVER RPM	Engine Speed >= 8000 rpm
4	ENGINE HOT	Coolant Temperature >= 100.0 C (for 1.00 s, modify by 5.0 C, mod...)
5	BATTERY LOW	Bat Volts Dash <= 10.00 V (for 2.00 s) and Engine Speed >= 1000 ...

5 alarms configured, 43 available.

Input
 Acknowledge Button : Alarm Acknowledge

Output
 Warning Light : Warning Light

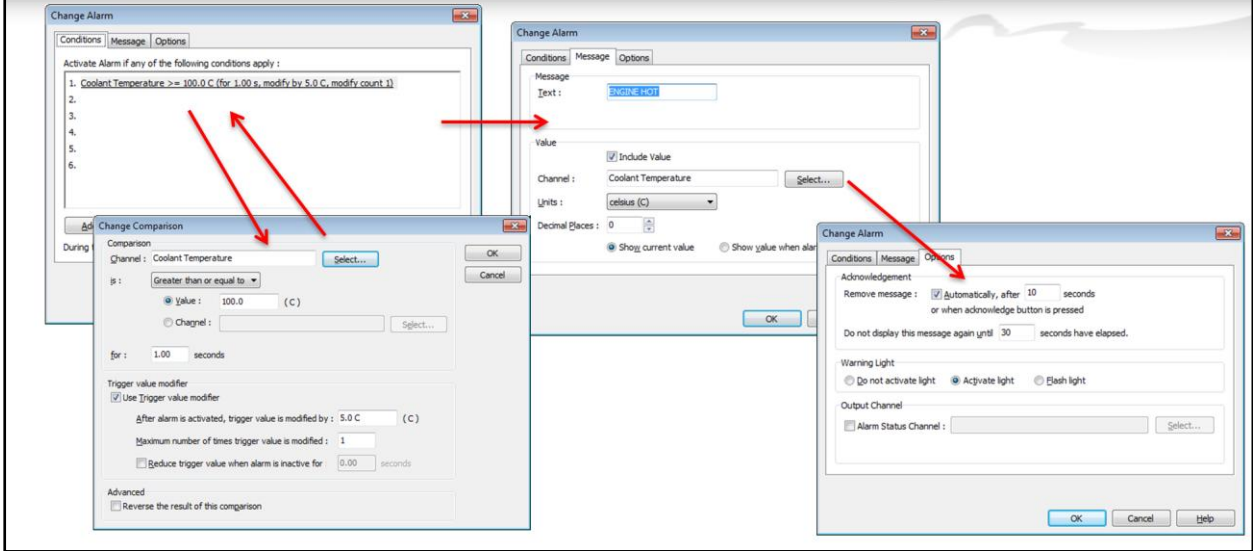
Add additional alarms

Input used to acknowledge alarms

Output channel used to indicate an alarm is active



Alarm Setup



Alarms allows us to create a warning based on certain conditions. In this case we are creating an engine temp alarm. When the coolant temperature exceeds 100 degrees celcius for 1 second the alarm will be triggered.

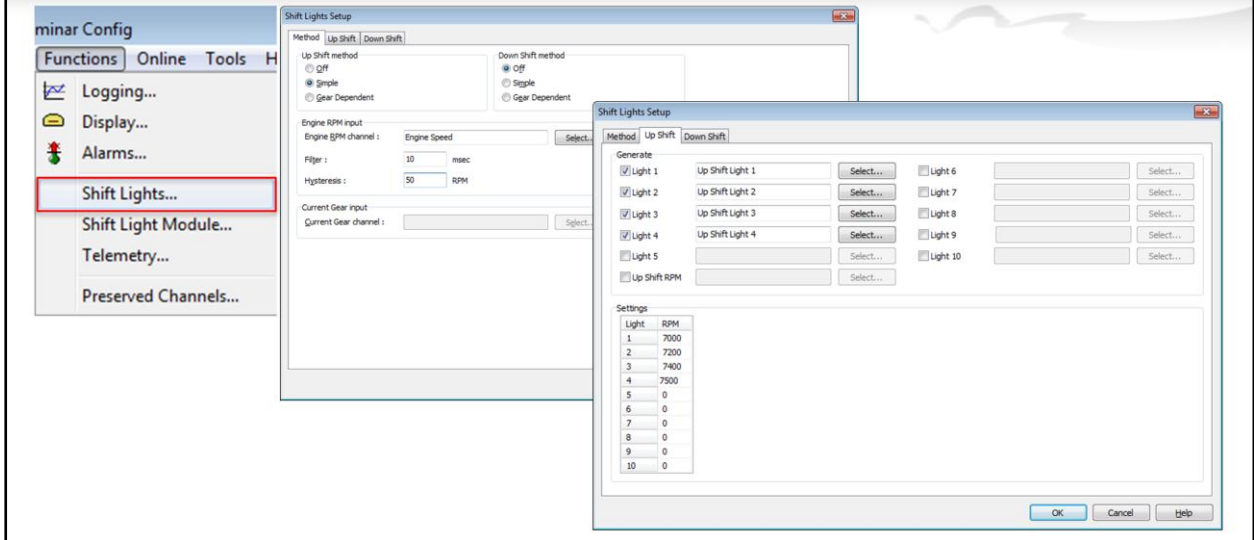
We are also able to modify the value once it has been triggered. In this case, if the coolant temperature exceeds 100 degC the alarm comes on. Once this is cleared it will now have to exceed 105 degC to trigger the alarm.

A message needs to be added and will be displayed at the bottom of the screen when an alarm is active. The current value of the channel can also be set to be displayed.

It can be set to automatically acknowledge the alarm after a set period of time and an on delay can be set. An output channel can be set for each individual alarm to allow display of specific alarms, such as on a SLM.



Shift Lights



Shift Light Setup

The Shift lights are set up by a two stage process. The menu is accessed from Functions then Shift Lights as shown above in the first picture.

Next choose which channel drives the lights. This is most likely to be RPM, however, if you wish to have the lights as a boost gauge for testing a turbo engine or inline G for deceleration, then this channel could also be assigned a channel for a light. (Not in the Shift Light setup, however.)

Try to remember to put the RPM signal lower than the actual RPM you wish to shift at.

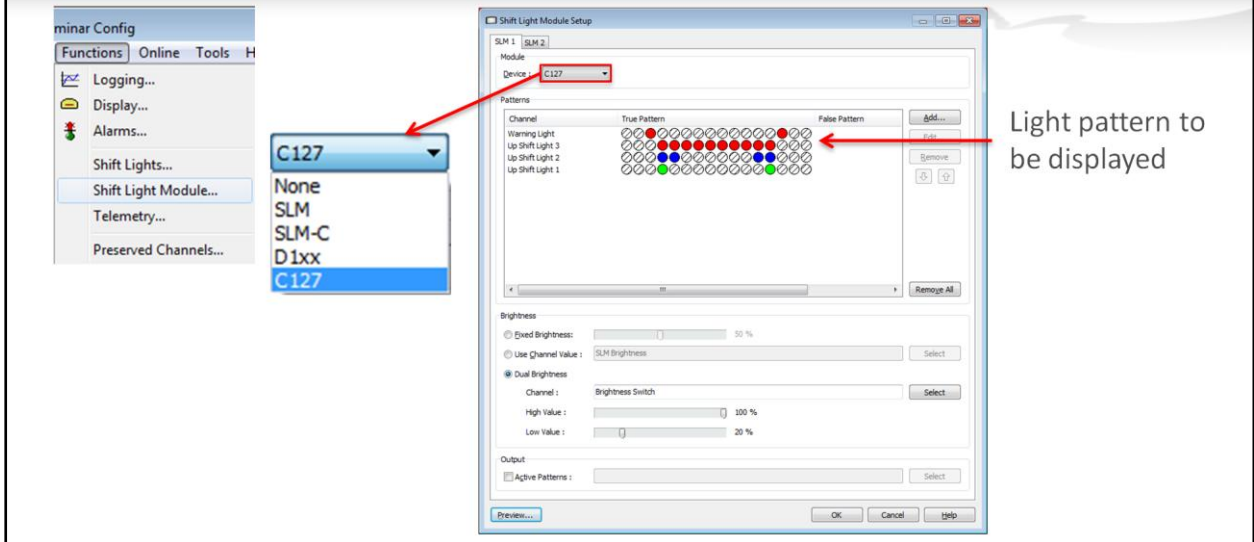
Why? The main reason is the driver will always need to see the light before he knows to change gear. If you want to shift at 6700 RPM for example the light should come on 100 RPM less (more for a new driver)

Hysteresis is to stop potential 'flickering' of the shift light if RPM is around the shift point.

The shift lights can also be set to Gear Dependant. This requires a Gear signal from either the gearbox, or can be calculated by using Speed and RPM. The gear channel must first be set up under 'Calculations – Gear Detection'. Using a Gear channel, the RPM that triggers the shift lights can be modified for the higher gears.



Shift Light Module



SLM is a CAN communications-based shift light with eight individual LEDs that can each emit eight different colours at user defined brightness. The lights can be driven by the Up Shift Light channels, as well as the Warning Light channel or any others.

When used with a Dash, the SLM can be configured as a four stage shift light as well as having patterns based on up to four User Condition channels and a Warning Alarm option. The number of lights, and the colour and brightness for each, can be individually set for each display configuration.

The ability to pick individual items out of status groups and error groups. It is also possible to have a light flash, as well as changing between two colours when active; each colour is up to the user.

The ability to have certain colours displayed when any condition is false is also available as an alternative to simply having the lights 'off' when nothing is triggering them.

Patterns are arranged in priority order, with the top of the list having the highest priority. This means that if a pattern has a high priority, e.g. Warning Lights, it cannot be affected by another pattern condition lower in the list becoming true.

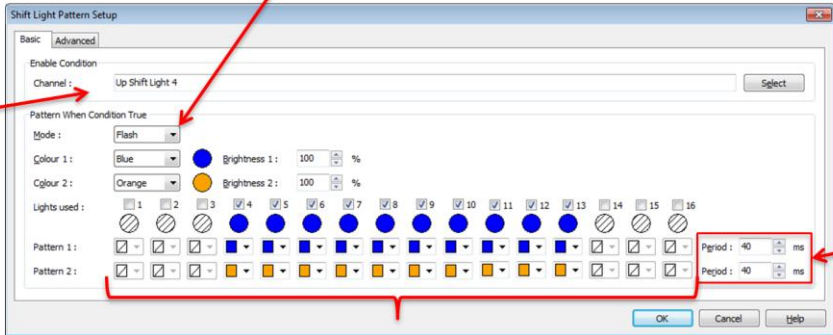
Use of SLM over CAN will free up Aux Outputs to be used for other functions.



Shift Light Module

Select the channel to control the lights

Select Mode - Either Flash/Static



Flash timing

Select which lights will be used



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Vehicle Details





Configuration Details

The screenshot shows the MoTeC C127 Dash Manager interface. On the left, the 'File' menu is open, with 'Edit Details...' highlighted. On the right, the 'Details Editor' dialog box is displayed, containing the following fields and controls:

- Next Event**: Event Name (text field), Clear All (button)
- Session**: (text field)
- Short Comment**: (text field)
- Long Comment**: (text area)
- Venue**: Current Venue (dropdown), Edit... (button), Manage Venues (button)
- Coordinates**: (Not Set)
- Logging Directory**: C:\Users\amcgregor\Documents\MoTeC\Logged Data
- Vehicles**: Manage Vehicles (button)
- Buttons**: OK, Cancel, Help

The details can be filled out either before sending the configuration or when downloading the data. This is often overlooked but is very important when trying to identify data later on.



Configuration Details

Venue

Current Venue : Edit... Manage Venues

Coordinates : (Not Set)

Logging Directory : C:\Users\jmcgregor\Documents\MoTeC\Logged Data

Name	Length	Best Lap Time	Coordinates
Adelaide	3.21900 km	(Not Set)	-34.9303800 138.6204960
Albert Park	5.30300 km	(Not Set)	-37.8499733 144.9688260
Barbagallo	2.41500 km	(Not Set)	-31.6641775 115.7863923
Baskerville	2.01000 km	(Not Set)	-42.7464370 147.2943970
Bathurst	6.21300 km	(Not Set)	-33.4393834 149.5592218
Broadford	2.16000 km	(Not Set)	-37.2159070 145.0823480
Calder Oval	(Not Set)	(Not Set)	-37.6793540 144.7536000
Calder	2.28000 km	(Not Set)	-37.6799228 144.7538686
Darwin	2.87000 km	(Not Set)	-12.4483680 130.9077400
Eastern Creek	4.42000 km	(Not Set)	-33.8037274 150.8708936
Holden Performance	(Not Set)	(Not Set)	-27.7469180 153.2036230
Homebush	3.50000 km	(Not Set)	-33.8437200 151.0708090
Lakeside	2.41100 km	(Not Set)	-27.2284720 152.9649060
Mallala	2.60100 km	(Not Set)	-34.4152070 138.5058660
Morgan Park	2.96700 km	(Not Set)	-28.2620460 152.0363919
Phillip Island	4.44500 km	(Not Set)	-38.5013350 145.2315488
Queensland Raceway	3.12000 km	(Not Set)	-27.6963460 152.6546360
Sandown	3.90000 km	(Not Set)	-37.9490784 145.1643209
Surfers Paradise	2.98000 km	(Not Set)	-27.9861680 153.4272720
Symons Plains	2.41000 km	(Not Set)	-41.6576961 147.2500363
Townsville	2.85000 km	(Not Set)	-19.2720600 146.8109188
Wakefield	2.20000 km	(Not Set)	-34.8401540 149.6851580
Warwick Farm	(Not Set)	(Not Set)	-33.9111700 150.9450860
Winton	3.01000 km	(Not Set)	-36.5188820 146.0871151

Venue Manager

No venues have been set up. Please select one of the following options:

Setup Options

Automatically set up venues

Region : Australia

Add a new venue

Import all venue files from a previous installation

Manually select and import venue files

OK Cancel Help

Clicking on the Manage Venues button for the first time will bring up a window to automatically import venue files.

Additional tracks can be added manually using either the import button to bring in tracks that have already been setup by MoTeC or by clicking Add and filling in all of the details manually.

Every track in the Venue Manager is loaded into the display, meaning that if you have GPS beacons set up you can turn up to any of those tracks and get lap times without having to change the config.

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Page 59



Configuration Details

Every vehicle requires a unique ID and two vehicles cannot have the same ECU or Dash serial numbers

Used for Fuel Remaining calculations, needs to be the amount in the tank not the actual capacity

Used to calculate gear when no sensor is present
Can be entered in decimal (1.6) or teeth (32:20) formats

- **Vehicle Number and Dash Serial Number:** These are the parameters the Dash looks for when sending or retrieving configs or data from the Dash. It will match up this page with the Dash serial number. If you wish to upload and download on multiple computers, this information should match and be on all computers used.
- **Description:** Usually the style of vehicle, e.g. Formula Ford or V8 Superboats
- **Engine ID:** If you are running a sealed engine, log the serial number and the install date. Most people ignore it and when they come to talk with their supplier they have forgotten these details.
- **Weight/Fuel Tank etc:** Useful for when you're back in the office and forgot what run 23 Friday afternoon was. Also note the units can be metric or imperial. 100 gallons will not fit in a 100 litre fuel tank.
- **Driver:** This will be displayed in i2 as the name along with the log file. Leaving it blank may save time but wastes valuable post processing time matching your laps up to the official timing and scoring sheet to work out who was driving.
- **Comments section:** This will be added to the Log file. It's your main hope of remembering which run was with fresh tyres, different springs etc.
- **Track:** Used by i2 for its Vehicle Roll calculation
- **Wheelbase:** Used by i2 for its Oversteer calculation
- **Fuel Tank Capacity** is used for Fuel Remaining calculations
- **Gear Ratios:** For the record and used if calculating Gear from Speed and RPM.

Most of the errors in missed details on laptops etc. come from users not having the details for the car they download on their computer.



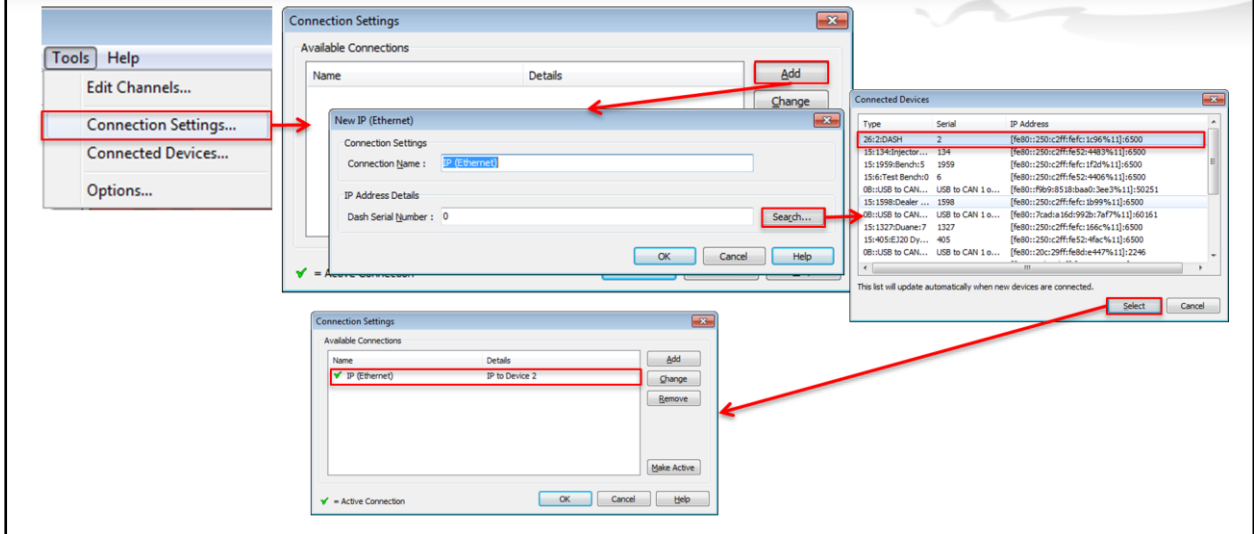
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Connecting to the Display





Connection Settings



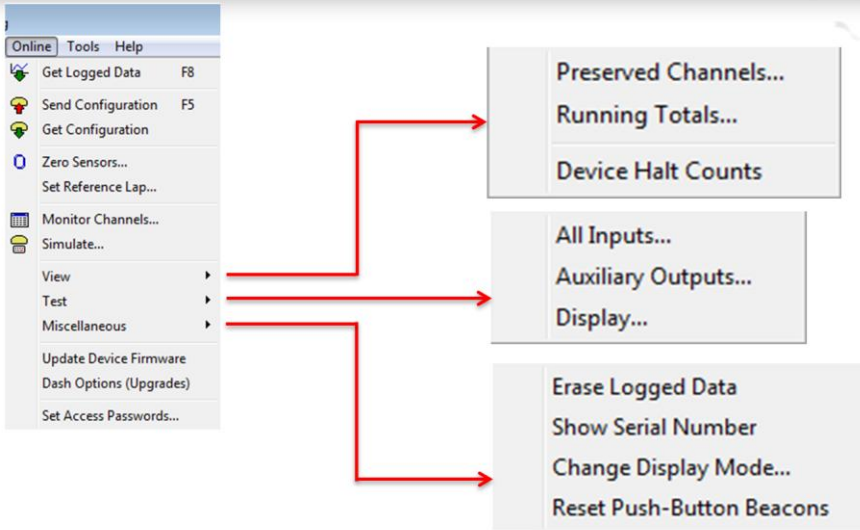
All of the Colour Display Loggers (C-Series) use Ethernet to communicate with the PC.

The Display-only devices (D-Series) require a CAN connection.

- Add a new connection, click Add.
- Either enter the serial number directly or click search. If using search it will list all connected devices.
- Double click or highlight and click Select on the device with which you want to connect.
- If you have more than one device in your available connections, highlight the one you want to connect to and click 'Make Active'. There will be a green tick next to the active one.



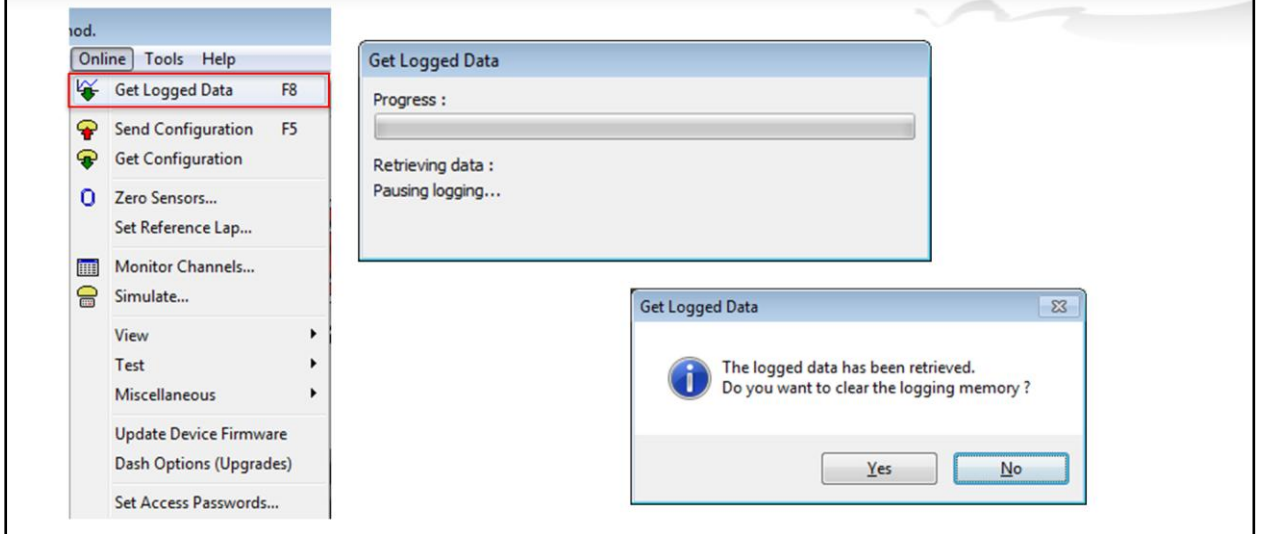
Online Options



- Send/Retrieve Configs
- Get Logged Data
- Real time viewing of sensors
- Zero Sensors
- Simulate conditions with engine/vehicle off
- Enable options in the Dash
- Upgrade the firmware in the field
- Test inputs/outputs, raw voltages/diagnostics
- Send Reference Laps
- View History Logs



Retrieving Logging



Clicking on Get Logged Data or pressing F8 will download the data from the logger (if the upgrade is enabled). Once the data is retrieved it will ask if you want to clear the logging from the device.



Vehicle Details

Current venue can be selected or a new venue created

Driver can be selected

Add as much information as possible

Location of log file

Vehicle details: When the download is complete you will be asked to fill out details about the logged data. It is important to put in as much information as possible to allow easy search at a later date. It is very difficult to find a specific log file months later if these details are not filled in correctly.

Log file location can be edited in the Manage Venues window.



Monitor Channels

Online Tools Help

- Get Logged Data F8
- Send Configuration F5
- Get Configuration
- Zero Sensors...
- Set Reference Lap...
- Monitor Channels...**
- Simulate...
- View
- Test
- Miscellaneous
- Update Device Firmware
- Dash Options (Upgrades)
- Set Access Passwords...

Monitor Channels - Seminar Config

Name	Data Type	Value
SV Aux Supply	Voltage	14.972 V
SV Aux Supply	Voltage	8.029 V
Airbox Mass Flow	Mass Flow	0.0 g/s
Airbox Temperature	Temperature	0.0 C
Alarm Acknowledge	OFF/ON	0
Alternator Current	Current	0.0 A
Ambient Pressure	Pressure & Stress	-0.01 bar
Ambient Temperature	Temperature	
Anti Lag Diagnostic	Enum	
Anti Lag State	Enum	
Anti Lag Switch	OFF/ON	
Bat Volts BR2	Voltage	
Bat Volts Dash	Voltage	
Bat Volts ECU	Voltage	
Beacon	OFF/ON	
Boost Actuator Duty Cycle	Ratio	
Boost Aim	Pressure & Stress	
Boost Aim State	Enum	
Boost Control Diagnostic	Enum	
Boost Pressure	Pressure & Stress	
Boost Switch	Pressure & Stress	
BR2 Beacon Count	Unitless	
BR2 Beacon Number	Unitless	
BR2 CAN Diag	Unitless	
BR2 Diag	Unitless	
BR2 Valid Reception	Unitless	
Brake Bias Setting	Ratio	

Monitor Channels - Test Config

Throttle Pos 0.0 %

Steering Angle 289.1 deg

Engine RPM 0 rpm

Gear 1

Turbo Speed 0 rpm

Oil Level -1.80 l

Engine Temp 0.0 C

Eng Oil Temp 0.0 C

Eng Oil Pres 0.000 bar

Eng Oil Temp 190.1 C

Eng Oil Pres 0.000 bar

Eng Oil Temp 0.000 bar

Eng Oil Pres 0.000 bar

Eng Oil Temp 0.000 bar

Eng Oil Pres 0.000 bar

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Page 66



Simulate

Online Tools Help

- Get Logged Data F8
- Send Configuration F5
- Get Configuration
- Zero Sensors...
- Set Reference Lap...
- Monitor Channels...
- Simulate...
- View
- Test
- Miscellaneous
- Update Device Firmware
- Dash Options (Upgrades)
- Set Access Passwords...

Simulate Test Config

Category	Search	Function	All	test	Units	Type	Value
Search text:							
Channels:							
ACU Temp			ACU Temp		Temperature		125.9 C
Air Pres Post Restrictor			Air Pres Post Restrictor		Pressure & Stress		0.000 bar
Air Temp Inlet			Air Temp Inlet		Temperature		0.0 C
Alarm Ack Button			Alarm Ack Button		OFF/On		0
ALS State			ALS State		Unitless		0
Baro Pres			Baro Pres		Pressure & Stress		0.000 bar
Bat Volts ACU			Bat Volts ACU		Voltage		12.06 V
Bat Volts BR2			Bat Volts BR2		Voltage		0.00 V
Bat Volts EBXX			Bat Volts EBXX		Voltage		0.00 V
Battery Volts			Battery Volts		Voltage		0.00 V
Beacon			Beacon		OFF/On		0
BR2 Beacon Count			BR2 Beacon Count		Unitless		0
BR2 Beacon Number			BR2 Beacon Number		Unitless		0
BR2 CAN Diag			BR2 CAN Diag		Unitless		0
BR2 Temp			BR2 Temp		Temperature		0.0 C
BR2 Valid Receptions			BR2 Valid Receptions		Unitless		0
Brake Bias Setting			Brake Bias Setting		Ratio		100.0 %
Brake Pres Front			Brake Pres Front		Pressure & S...		
Brake Pres FR			Brake Pres FR		Pressure & S...		
Brake Pres Rear			Brake Pres Rear		Pressure & S...		
Brake Temp FL			Brake Temp FL		Temperature		
Brake Temp FR			Brake Temp FR		Temperature		
Brake Temp RL			Brake Temp RL		Temperature		
Calibration			Calibration		Unitless		
Clutch Pressure			Clutch Pressure		Pressure & S...		
Clutch Status			Clutch Status		Temperature		
CRU Mngt			CRU Mngt		Temperature		
Crankcase Pres			Crankcase Pres		Temperature		
Damper Pos FL			Damper Pos FL		Unitless		
Damper Pos FR			Damper Pos FR		Unitless		
Damper Pos RL			Damper Pos RL		Unitless		
Damper Pos RR			Damper Pos RR		Unitless		
Damper Sp Time			Damper Sp Time		Unitless		
Display Mode Button			Display Mode Button		Unitless		
Display Next Line Button			Display Next Line Button		Unitless		
Drive Speed			Drive Speed		Unitless		
EBXX Temp			EBXX Temp		Temperature		

Mode Beacon ID: 0 8000 Engine RPM (rpm) Alarm

Next Line Engine R... Alarm ...

To create an object, drag and drop a channel onto a view.

Hide Channels View Add Libraries

Connection OK

All test

Pit Lim AkRtbn

0 0 8000

Engine RPM (rpm)

Brake Bias (%) 0.0

80.00 80.00

0.00 0.00

0.00 0.00

BP Front (bar) BP Rear (bar)



Questions

- If you need assistance, feel free to drop us a line at support@motec.com.au
- If you have suggestions on possible improvements or feature requests, email us at the same address and we can look into it for you



Dash Options

C125/C127

- Data logging – 120MB
- I/O
- Pro Analysis
- T2 Telemetry
- Display Creator

C185/C187

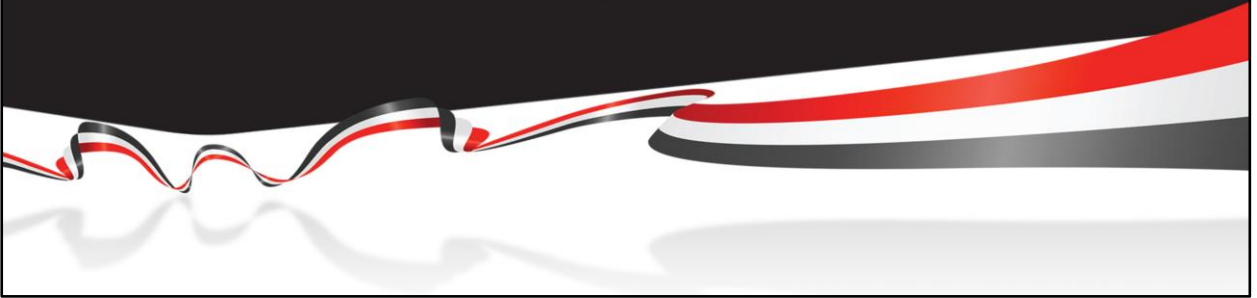
- Data logging – 500MB
- I/O
- Pro Analysis
- T2 Telemetry
- Display Creator
- Advanced Functions

Input Type	C125/C127		C185/C187	
	Standard	I/O Upgrade	Standard	I/O Upgrade
Analog Volt	0	6	10	20
Analog Temp	0	2	4	8
Digital	2	2	4	4
Switch	0	0	2	2
Speed	1	3	4	4
Aux Out	0	4	6	8



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Display Creator





Overview

- Introduction to Display Creator
- Creating a New Project/Initial Setup
- Input/Communication Setup
- Page Layout
- Enumerators/Switches
- Alarms/Conditions
- Sending a Configuration
- Preloaded Projects
- Additional Features
- Questions



Introduction

- Full control of the layout – optimise for your application
- Create custom graphics/icons
- Import images and illustrations
- Incorporate sponsors/team logos
- Number of pages only limited by overall project size
- Custom fonts
- Animation



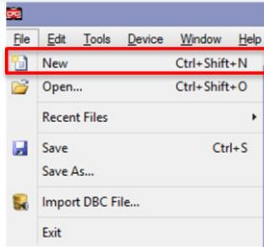
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Creating a New Config/Initial Set Up



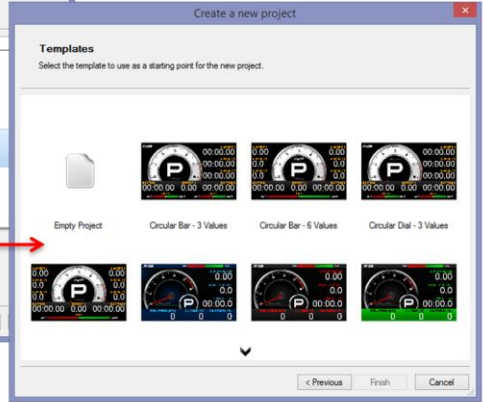
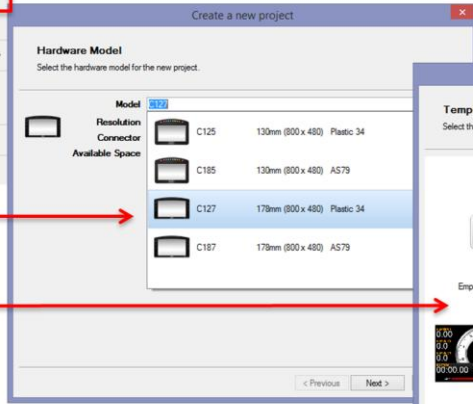


Creating a New Project



Select the device you are designing for

Choose from either a blank page or various pre-made designs





Communication Setup

The screenshot shows the MoTeC software interface with a file selection dialog box open. The dialog box is titled "Select a DBC file" and shows the path "amcgregor > My Documents > MoTeC > Dash > Config". The file list contains the following items:

Name	Date modified	Type	Size
From Dash Backups	8/07/2015 9:51 AM	File folder	
Save Backups	8/07/2015 2:33 PM	File folder	
Seminar Config - Internal Display (using ...)	8/07/2015 2:33 PM	DBC File	4 KB

A red arrow points from the text "Select the DBC file created by Dash Manager" to the "Seminar Config - Internal Display (using ...)" file in the list. The MoTeC software interface in the background has a red box around the "File" menu icon.

Select the DBC file created by Dash Manager

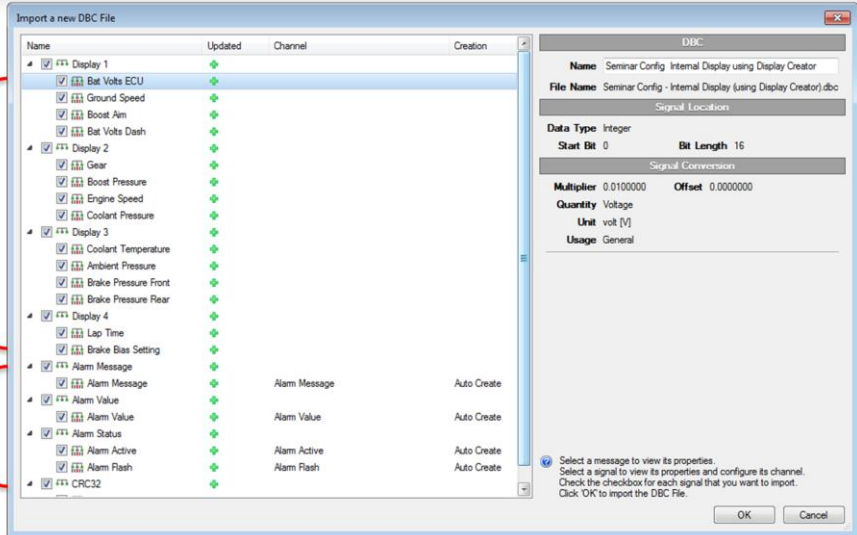
The DBC file must match the Dash Manager Configuration loaded into the Display.



Communication Setup

List of channels added to the display setup in Dash Manager

Channels automatically added by Dash Manager



This is a list of all of the channels in the dbc file created by Dash Manager.

It is possible to untick channels that are not needed in the Display setup, which is usually more useful when importing a dbc file from an external source in which there are a number of channels that you don't require to be displayed.



Communication Setup

The screenshot shows the MoTeC software interface. A window titled "DBC File 'Seminar Config - Internal Display using Display Creator'" is open, showing a table of DBC file entries. The selected entry has the file name "g:\Seminar Config - Internal Display (using Display Creator).dbc". Below the table are buttons for "Unlink", "Select...", and "Update...". A notification dialog titled "DBC file changed" is also visible, with the message: "The DBC file 'Seminar Config - Internal Display (using Display Creator).dbc' has changed. The contents of the DBC file have been modified outside of Display Creator. Do you want to update the DBC file contents in the project now?". The dialog has "Update" and "Ignore" buttons.

Unlinking removes the association with the dbc file, allows editing of individual signals

Select new dbc file

Update DC if dbc file has changed

Notification of change to dbc file

When using a dbc file created by Dash Manager, if the Display setup is modified and the dbc file is changed, DC will automatically notify you that changes have been made to a linked dbc file.



Communication Setup

- ▲ Display 1
 - Bat Volts Dash
 - Bat Volts ECU
 - Boost Aim
 - Ground Speed
 - ▲ Display 2
 - Boost Pressure
 - Coolant Pressure
 - Engine Speed
 - Gear
 - ▲ Display 3
 - Ambient Pressure
 - Brake Pressure Front
 - Brake Pressure Rear
 - Coolant Temperature
 - ▲ Display 4
 - Brake Bias Setting
 - Lap Time
- (Not Used)
 - (Not Used)
 - (Not Used)
 - (Not Used)

 - (Not Used)
 - (Not Used)
 - (Not Used)
 - (Not Used)

 - (Not Used)
 - (Not Used)
 - (Not Used)
 - (Not Used)

 - (Not Used)
 - (Not Used)

The signals now need to be associated with a channel

Each of the input signals need to be assigned to a channel in Display Creator. There are two methods of doing this, the first is create all of the channels and link them to the input signals. The second is to create both the channel and link to the signal when creating the display element.



Channel Setup

Name	Type	Unit	Assigned By	Used By
Alarm Active	Channel	none	Alarm Active in Alarm Status in Seminar Config Internal Display using Displa...	<input type="checkbox"/> (Not Used)
Alarm Flash	Channel	none	Alarm Flash in Alarm Status in Seminar Config Internal Display using Display ...	<input type="checkbox"/> (Not Used)
Alarm Message	Channel	none	Alarm Message in Alarm Message in Seminar Config Internal Display using ...	<input checked="" type="checkbox"/> Alarm 1
Alarm Value	Channel	none	Alarm Value in Alarm Value in Seminar Config Internal Display using Display ...	<input checked="" type="checkbox"/> Alarm 1
CRC32	Channel	none	CRC32 in CRC32 in Seminar Config Internal Display using Display Creator	<input type="checkbox"/> (Not Used)
Channel 6	Channel	none	(Not Assigned)	<input type="checkbox"/> (Not Used)

Add new channel

Click the 'Add New Channel' button to create a new channel.



Channel Setup

Name of the channel

Connect to existing signal from dbc file

Channel 'Channel 1'

Name Channel 1

Value

Data Type Floating Point

Quantity Unitless

Display

Unit none

Minimum 0

Maximum 0

Preview - For 'Pages' view

Value

Tools

Connect to Signal...

Connect to Signal

Match Channel and Signal

Channel Properties

Name Engine Speed

Data Type Floating Point

Quantity Angular Speed [1/s]

Select a signal or bit decode

Name	Channel
Seminar Config Internal Display using Display Creator	
+ Display 4	
+ Display 3	
+ Display 2	
+ Engine Speed	<input checked="" type="checkbox"/> (Not Used)
+ Coolant Pressure	<input type="checkbox"/> (Not Used)
+ Boost Pressure	<input type="checkbox"/> (Not Used)
+ Display 1	
+ CRC32	
+ Alarm Value	
+ Alarm Status	
+ Alarm Message	

OK Cancel

Once you have created a new channel, make sure it is selected and click Connect to Signal.

Select a signal from the DBC file to link it to the new channel. The name, data type, quantity and unit are all updated to match the signal automatically.



Channel Setup

Details are automatically filled out to match signal details

The screenshot shows the 'Channel Setup' dialog for 'Engine Speed'. It is divided into several sections: 'Name' (Engine Speed), 'Value' (Data Type: Floating Point, Quantity: Angular Speed [1/s]), 'Display' (Unit: rev/sec [rps], Minimum: 0 rps, Maximum: 0 rps), 'Preview - For "Pages" view' (Value: [input field] rps), and 'Tools' (Connect to Signal... button).

Min and Max used in simulation mode

Allows you to specify a value to be displayed for the channel when creating the layout

It is important to check the units; this will default to the base units sent by the Dash. In the case of Engine Speed this is Hz, or rev/sec, which is almost of no use so should be changed to RPM.

Minimum and Maximum are useful when using the simulate function but otherwise do not affect the actual functionality of the channel when used in a Display.



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Page Layout





Dial Gauge - Setup

Select New Dial Gauge

Channel to be used in the Dial Gauge

Dial Settings

Displayed values

Tick Value	Tick Text
0.00	0
10.00	10
20.00	20
30.00	30
40.00	40
50.00	50
60.00	60
70.00	70
80.00	80
90.00	90
100.00	100

The first thing we want is a tacho. We create a new dial gauge and select 'Engine Speed' as the channel.

The start/finish angles for the gauge can be set; the number of divisions and the text that is displayed can all be configured from this window.



Dial Gauge - Setup

Making a tacho so add engine speed as the control channel

Set the start and finish angle of the pointer, the min and max values and the number of divisions

Configure Gauge

Ticks

Input Channel: Channel Engine Speed rpm

Values

First Angle: -180.00 Last Angle: 90.00

First Value: 0.00 Last Value: 9000.00

Major Divisions: 9

Minor Divisions: 4

Text

Decimal Places: 0

First Value: 0 Last Value: 9

Tick Value	Tick Text
0.00	0
1000.00	1
2000.00	2
3000.00	3
4000.00	4
5000.00	5
6000.00	6
7000.00	7
8000.00	8
9000.00	9

OK Cancel

What value will be shown for Engine Speed value

Change to the value you want displayed

0 degrees is top centre. Positive is clockwise to bottom centre and negative is anti-clockwise to bottom centre. The Minor and Major divisions set the number of tick marks on the dial.

The text is what is actually displayed on the dial. We want the tacho to show 0-9 rather than 0-9000 so we make the change in this section.



Dial Gauge - Positioning

Adjust the horizontal and vertical diameters to a more suitable size

Click the centre button to centre the dial on the page

We now need to position and size the dial correctly. We want to reduce the size slightly to allow room for additional channels and we want it centred on the page.



Dial Gauge - Needle

Length 168 Width 28
Offset 14

Appearance
Element Built-In Dial Pointer
Image

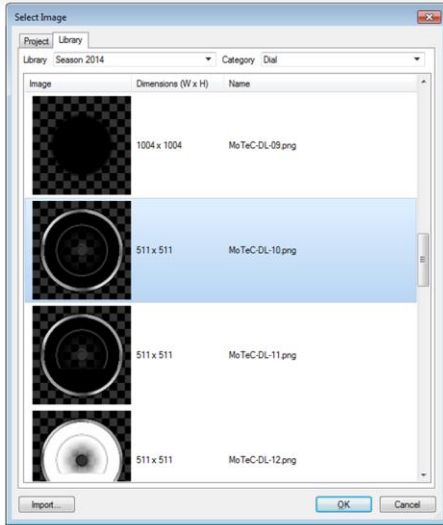
Select Image
Project Library
Library Season 2014 Category Needle
Image Dimensions (W x H) Name
MoTeC-ND-05.png 12 x 201
MoTeC-ND-06.png 18 x 318
MoTeC-ND-07.png 38 x 420
MoTeC-ND-08.png 66 x 328

Library tab contains a selection of images
Select a new needle image
Filter only needle images

The dial can be changed from the default to any custom image. There are a number of preloaded images that can be selected from the library tab or your own image can be loaded by clicking on Import.



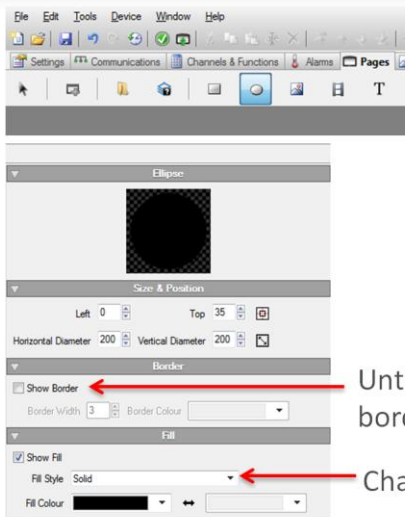
Dial Gauge - Surround



To give the dial gauge a more defined edge we will add some images. Again we can select from a number of preloaded images or import our own. In this case we will use a preload image. The sizing and positioning need to be adjusted to fit our gauge; this is done in the same way as positioning the dial gauge.

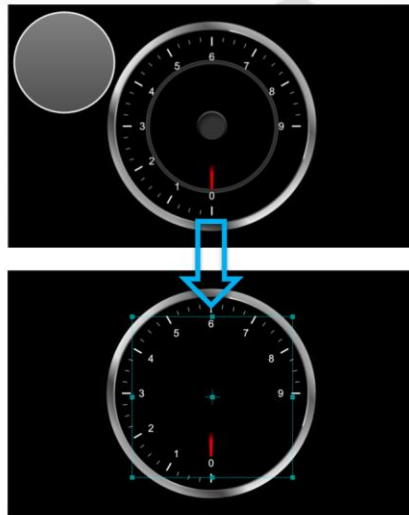


Dial Gauge - Surround



Untick to remove border

Change to solid

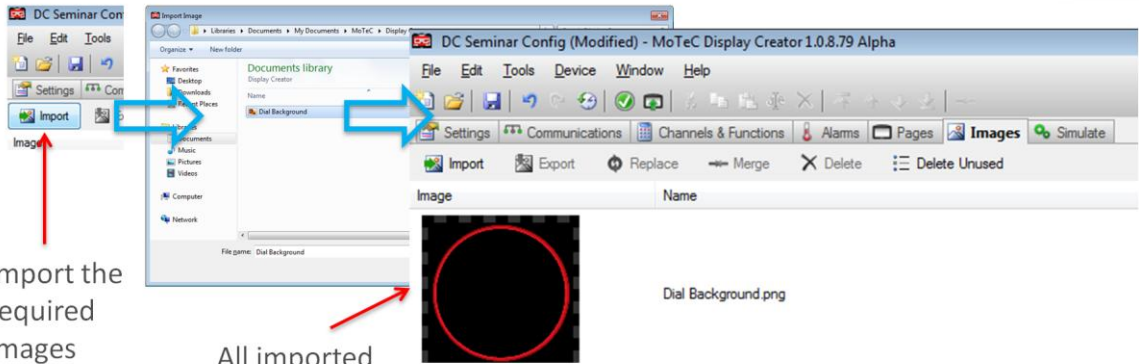


The preloaded image isn't quite what we wanted ; we want to hide the inner rings and insert our own. To do this we create an oval that will cover the rings, allowing us to put our own over the top.

Remove the border, change the fill to solid and the colour to black. We now centre the oval and resize it to cover the rings. The Z-Order needs to be correct so that the inner rings are covered but the dial numbers are not.



Import Image



Import the required images

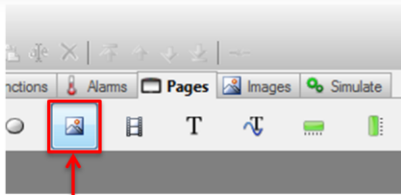
All imported images will be listed here

We can import our own images in two ways, the first is in the 'Images' tab. Click on the 'Import' button, browse to the location of the image you want to import and click ok.

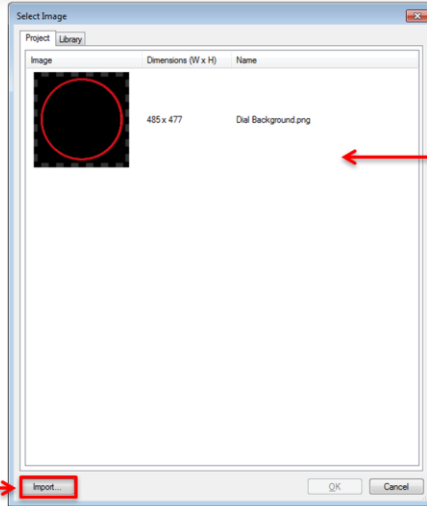
The image will now be selectable from the image insertion window.



Import Image



Click to insert image



Double click to insert image

Can also import from here

The second method is to click the 'Import' button from the Insert image window.



Inserting Image

Adjust the opacity

Centre the image on screen

Adjust the Width and Height

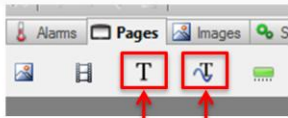
Put the image behind the gauge

Positioning and sizing the image is done in the same way as all other elements. In this case we want to decrease the opacity so that you get more of a glowing effect.

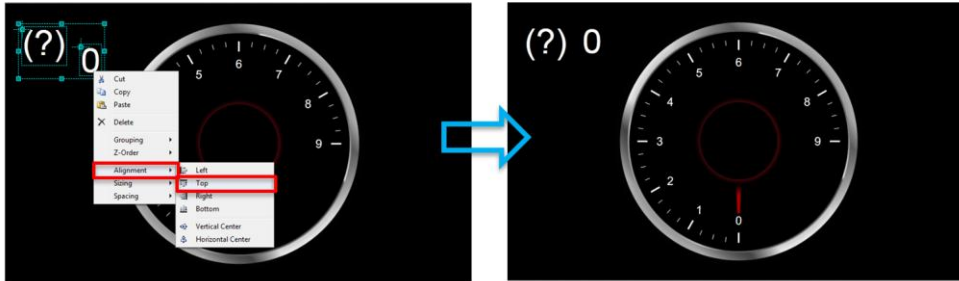
It is also important to ensure the images are in the right order. You can click and drag the image above or below the dial gauge. The higher up the list, the further 'forward' the element is.



Channel Values



Text box Channel Value



We now want to add a number of numerical channels and text labels to display the rest of our channels. Once we have a text element and a channel value we want to align them correctly.

To align two objects, select the them both either by left clicking and dragging the selection window over both of them, or by holding control and clicking on them individually.

Once selected, right click on one of the objects, highlight 'alignment' and then select Top. The two objects will now be aligned at the top.

Note: the object that is selected first becomes the reference, all other objects will move to align with it.



Channel Values

Channel Value 'Coolant Temperature'

X 140 Y 55

Channel

Format Numeric DPS 0

Channel Coolant Temperature °C

Refresh Rate

Refresh Rate 20 Hz

Appearance

Font Default Font [Arial] 50

Style **B** *I*

Colour

Preview

Value

Channel position

Number of decimal places displayed

Linked channel

Update Rate for the channel

Set the font, text size and alignment

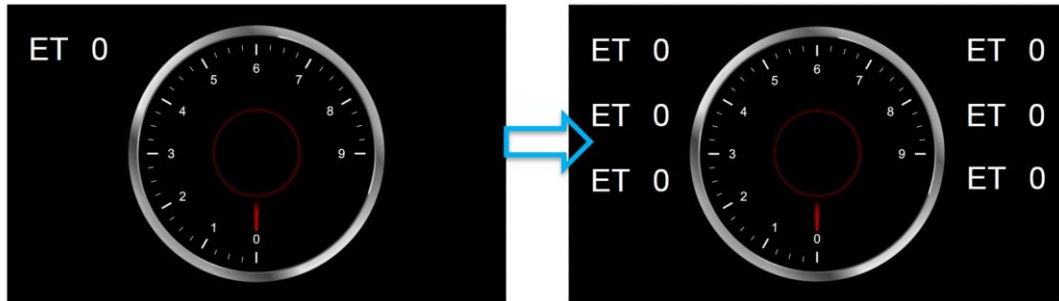
Preview value displayed when editing pages

We want this channel to be 'Coolant Temperature' so we select it from the drop down box.

It is often useful to reduce the refresh rate for channels that update very quickly to make it easier for the driver to read. This is not usually the case for temperature channels so we will leave this as the default.



Channel Values



The easiest way to replicate a number of channels is to copy the text and channel value multiple times to quickly set out where you want your channels displayed. Then go through each of them, change the text and link to the correct channels.



Channel Values

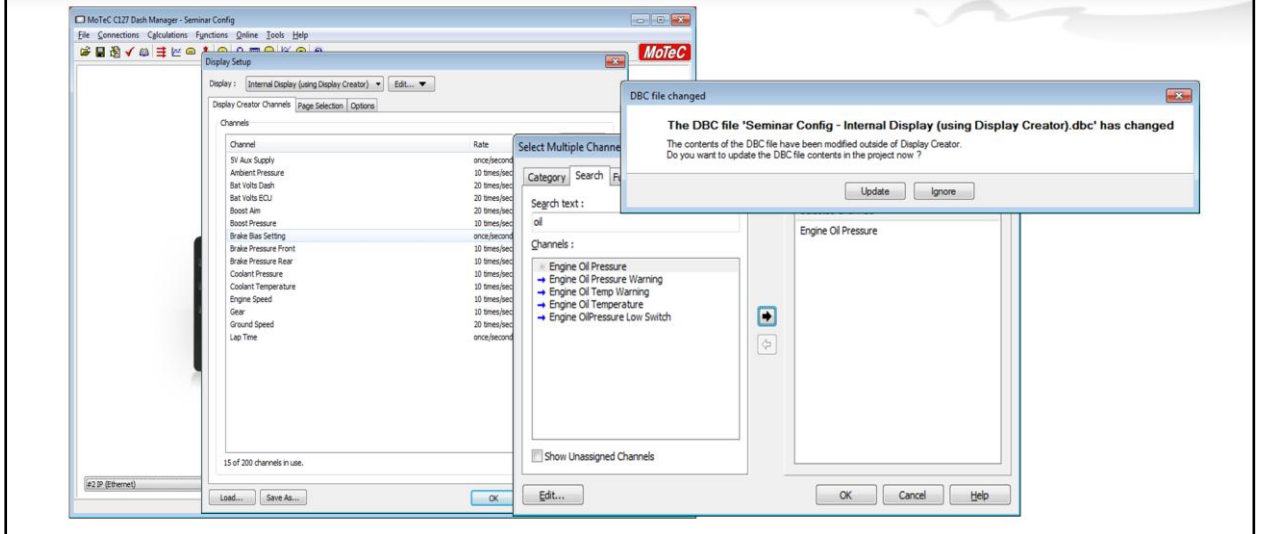
We want to display Oil Pressure but it isn't sent by the Dash yet



We have decided that we want to display 'Oil Pressure', so we will need to add it to the Dash configuration as it is not currently configured.



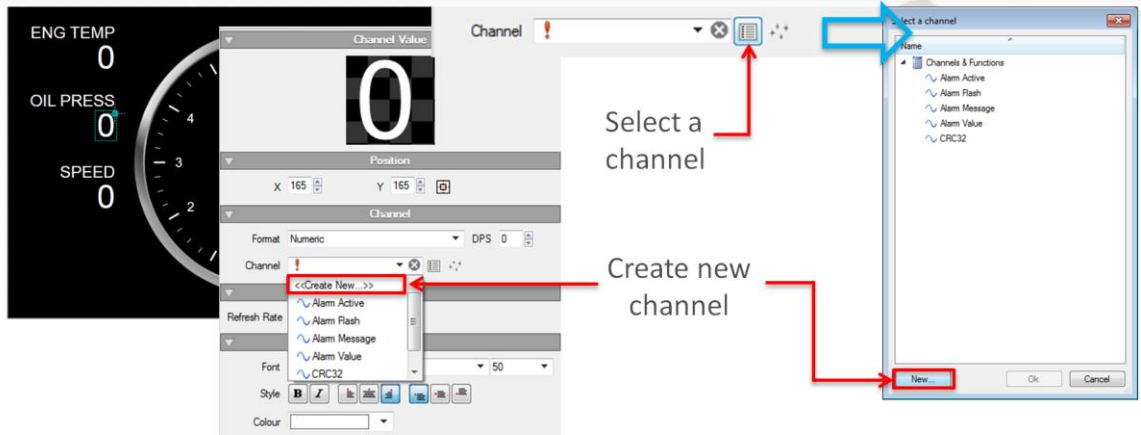
Adding a Channel



In Dash Manager we add 'Engine Oil Pressure' to the Display setup. Once the configuration is saved, we get the DBC file update message in Display Creator.

Click update to add the new channel.

Adding a New Channel



The second method of adding a channel is to do it in the 'Pages' tab. To do this, either select 'Create New' in the channel selection drop down or click the icon next to the drop down and then select 'New'.



Adding a New Channel

Channel properties automatically assigned when signal is selected

Connect to a signal or bit decode

Select the signal with which you want your channel to be linked

To create a new channel simply tick the 'Connect to a signal or bit decode' check button and select the signal. The name and channel properties will be populated automatically.



Grouping

File Edit Tools Device Window Help

Settings Communications Channels & Functions Alarms Pages Images Simulate

Create new group

Name the group

Use grouping to organise the channels

Select the items to be grouped and drag them into the group folder

Page 'Page 1'

- Text 'LAP TIME'
- Channel Value 'Bat Volts Dash'
- Dial Gauge 'Engine Speed'
- Image 'Dial Background.png'
- Image 'Dial Background.png'
- Text 'OIL PRESS'
- Ellipse
- Text 'ENG TEMP'
- Text 'BOOST'
- Text 'BATT'
- Image 'MoTeC-DL-10.png'
- Text 'SPEED'
- Channel Value 'Engine Oil Pressure'
- Channel Value 'Boost Pressure'
- Channel Value 'Bat Volts Dash'
- Channel Value 'Ground Speed'
- Channel Value 'Coolant Temperature'

Group

Page Properties

Name Eng Temp

Page 'Page 1'

- Group
- Text 'ENG TEMP'
- Channel Value 'Coolant Temperature'

It is often a good idea to use groups to collect together parts of the project. For instance all of the images and the dial gauge can be grouped together making it easier to find/edit individual parts.



Grouping

- ▶ Page 'Page 1'
- ▶ Group 'Gear'
- ▶ Group 'Eng Temp'
- ▶ Group 'Oil Pressure'
- ▶ Group 'Speed'
- ▶ Group 'Boost'
- ▶ Group 'Battery'
- ▶ Group 'Lap Time'
- ▶ Group 'Tacho'

Channels now grouped,
making it easier to sort

With everything grouped you can open a group and only see the individual parts for a particular element. It also allows you to hide a group and all of the elements within for testing purposes.



Channel Value

The screenshot displays the MoTeC software interface. On the left, a dashboard features several gauges: a large central tachometer showing '0', and smaller digital displays for 'ENG TEMP', 'OIL PRESS', 'SPEED', 'BOOST', 'BATT', and 'LAP TIME', all showing '0'. On the right, a configuration window titled 'Channel Value: Gear' is open. It shows a tree view on the left with 'Channel Value Gear' selected. The main configuration area includes: Position (X: 400, Y: 240), Channel (Format: Numeric, Channel: Gear), Refresh Rate (20 Hz), Appearance (Font: Default Font [Arial], Style: Bold, Colour: [dropdown]), and a Preview section showing the value '0'.

We also want to add a 'Gear' channel. The same method is used as the other channel values.



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Enumerators/Switches

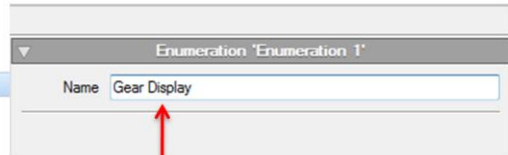




Enumerators



Enumeration 1 Enumeration

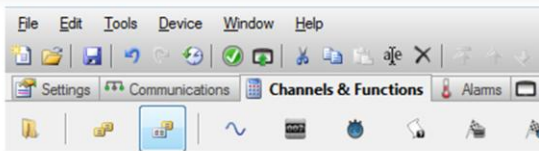


Rename the enumerator to Gear Display

Enumerators are a way of giving a text value to a state channel. For instance, in this case when we receive 0 and -1 from the Dash for gear position we actually want N and R to be displayed.



Enumerators



Gear Display	Enumeration
Enumeration Value 1	Enumeration Value

Text to be displayed when the channel value is 0

Enumeration Value "Enumeration Value 1"	
Name	N
Enumeration Value	
Value	0

Value of the enumeration

Any value that doesn't have an enumerator specified will be displayed as the raw value. In this case, with gear, we only need to specify -1 and 0 as we want forward gears to be displayed as they come from the Dash, i.e. 1, 2, 3 etc.



Enumerators

The screenshot shows the MoTeC software interface. On the left, a tree view shows a channel named 'Gear' under 'Gear Display'. A red arrow points to this channel with the text 'Highlight the gear channel'. In the center, text says 'Now select the enumerator as the data type' with a red arrow pointing to the 'Gear Display' option in a dropdown menu. The dropdown menu is open, showing options: Boolean, Floating Point, Integer, Unsigned Integer, and Text. Below the dropdown, the 'Data Type' is set to 'Integer'. At the bottom, a channel list shows 'Gear' with 'Channel' set to 'none'.

Changing the data type to Gear Display will now display the text specified in your gear display enumerator.

Can be used for any state channel that you want to display text. For instance, if you wanted to display the 'Engine Reference Speed State' channel, each of the values 0-11 can have a text description allocated to them. So instead of displaying the integer value you get a meaningful tag such as 'Cycle Lock'.



Switches

Copy and paste the gear channel into the same group

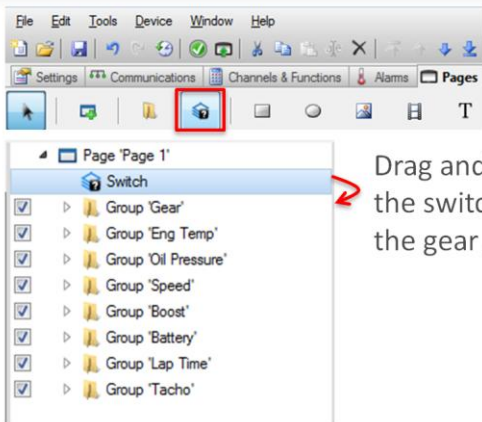
Change the colour of one gear channel to red

Switches allow you to switch between multiple objects with the use of conditions.

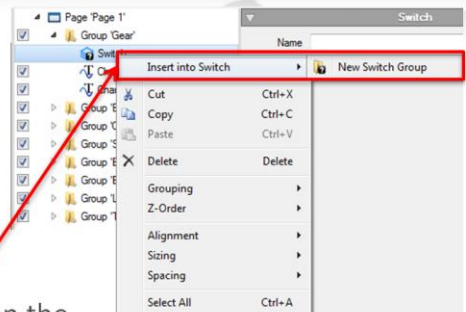
For example, we want the gear indicator to be red when it is in Neutral or Reverse and white when in any of the forward gears.



Switches



Drag and drop
the switch into
the gear group



Right click on the
switch and create
'New Switch
Group'

Put the new switch into the 'Gear' group to keep things tidy. Now create two new switch groups by right clicking on the switch.



Switches

Drag the two gear channels into their own Switch Group

Add conditions for the switch group

This switch group will be displayed only while it's condition is true.

Each of the switch groups can have a number of conditions based on any channel in the configuration. Any number of groups can be added to a switch.

The switch group will only be displayed if the condition is true, otherwise it will be blank. The easiest way is to have one of the groups with no condition, that way it will always be displayed if the other switch conditions aren't true.



Switches

The screenshot shows the 'Add Condition' dialog box with the following settings:

- Channel: Gear
- Condition operator: == Equal To
- Value: Constant
- Result Delay: 0.00 seconds for both 'is true' and 'is false'.

Annotations with red arrows and a bracket:

- 'Condition operator' points to the '== Equal To' dropdown.
- 'Channel used in condition' points to the 'Gear' dropdown.
- 'Value of condition' points to the 'Constant' dropdown.
- 'Add in time delays' points to the 'Result Delay' section with a bracket.



Switches

The logic operator can be changed if needed

Add additional conditions and then edit the logic operators. In this case we want an 'or' operator but if we wanted an 'and', you simply double click on the logic operator and then change it from the drop down menu.

The conditions can be nested to allow for multiple and/or operators.



Switches

The first switch group has no condition so becomes the default

The screenshot shows a software interface for configuring switches. On the left is a tree view under 'Page 'Page 1''. It contains several groups: 'Group 'Gear'', 'Switch', 'Group 'Eng Temp'', 'Group 'Oil Pressure'', 'Group 'Speed'', 'Group 'Boost'', 'Group 'Battery'', 'Group 'Lap Time'', and 'Group 'Tacho''. The 'Switch' group is expanded, showing two 'Switch Group' entries, each with a 'Channel Value' sub-entry. A red arrow points to the first 'Switch Group' entry. On the right, a 'Switch Group' configuration window is open, showing a large 'N' on a checkered background. Below this is a 'Condition' field which is currently empty. To the right of the condition field are several control buttons: 'Add...', 'Remove', 'Edit...', 'Indent', 'Outdent', and 'Remove All'.

A switch group with no condition becomes the default. This group will be displayed when none of the other group conditions are true.



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Alarms/Conditions





Alarms

Name	Priority	Critical	Condition
Alarm 1	1	Yes	(Alarm Active == True)

Standard alarm from Dash Manager

Alarm condition

Alarm message

Channel value

Alarm 1 is automatically added and is controlled by the alarm setup in Dash Manager. It will also display the text and value of channels that are defined in the alarm setup of Dash Manager.

Any number of additional alarms can be added for various conditions.



Alarms

The screenshot illustrates the MoTeC software interface for setting up an alarm. On the left, a sidebar shows a list of alarms, with 'Alarm 2' selected. A red arrow points to the 'Add' button, labeled 'Create new alarm'. The main window shows two 'Add Condition' dialog boxes. The top one is for 'Engine Oil Pressure' with a value of 200 kPa and a 'Less Than' comparison. The bottom one is for 'Engine Speed' with a value of 4000 rpm and a 'Greater Than' comparison. A red arrow labeled 'Rename the alarm' points to the 'Name' field of the 'Alarm: Oil Pressure Low' window, which is currently set to 'Oil Pressure Low'. Another red arrow points to the 'AND' operator between the two conditions in the main window. A third red arrow points to the 'Edit' dialog box, where the 'Type' dropdown is set to 'AND'.

An alarm can be set up with multiple conditions. In this case we have an 'Oil Pressure Low' alarm that is active when the oil pressure is below 200 kPa and the engine speed is above 4000 RPM.

On and off delays can be set for each condition to stop transient behaviour triggering an alarm or the alarm turning off before the driver notices.



Alarms

Default display location of the alarm

Select the overlay page

Alarms that will be displayed

Page 'Overlay Page'

- Alarm Display
 - Alarm Channel Value
 - Alarm Message
 - Alarm Icon

Alarm Display

Page Properties

Name

Size & Position

Left 0 Top 400

Width 800 Height 80

Selected Alarms

Alarms

- Alarm 1
- Oil Pressure Low

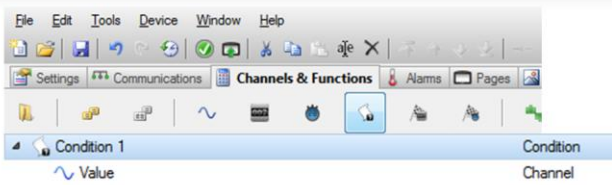
Select All

The new alarm 'Oil Pressure Low' is automatically added to alarm display list.

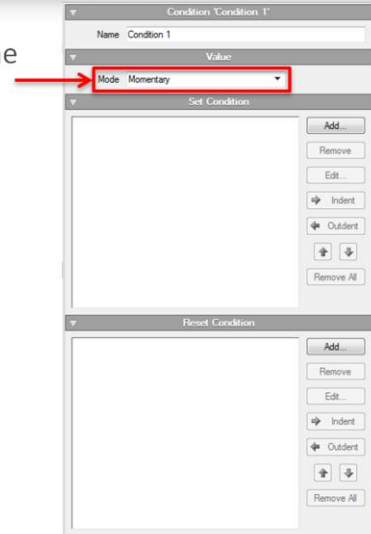
What is displayed when the alarm is active can be modified just like any other object on the other pages.



Conditions



Select the mode



Conditions are useful when we want to use the same conditions multiple times. This way if anything changes you only have to update one condition.

Can be set as Momentary, Toggle or Set/Reset depending on how you want it to function.



Conditions

Condition
Condition

- Orange Glow
- Red Glow

Condition 'Orange Glow'

Name Orange Glow

Value

Mode Momentary

Set Condition

(Engine Speed [rpm] > 6000 [rpm])

Add...
Remove

Condition 'Red Glow'

Name Red Glow

Value

Mode Momentary

Set Condition

(Engine Speed [rpm] > 7000 [rpm])

Add...
Remove

These two conditions will be used in a switch based on Engine Speed.



Conditions

The image shows two digital dashboards side-by-side. The left dashboard features a tachometer with a yellow glow ring. A label above it reads "Orange Glow Value == True". The right dashboard features a tachometer with a red glow ring. A label above it reads "Red Glow Value == True". Both dashboards display various engine metrics: ENG TEMP, OIL PRESS, SPEED, and BOOST (on the left) or BATT and LAP TIME (on the right). The tachometers are in Neutral (N) gear.

The condition functions are used in the switch groups rather than directly putting in the logic functions. This means that if we have a number of pages with the same conditions and you want to modify them you only have to do it in one location rather than every page.

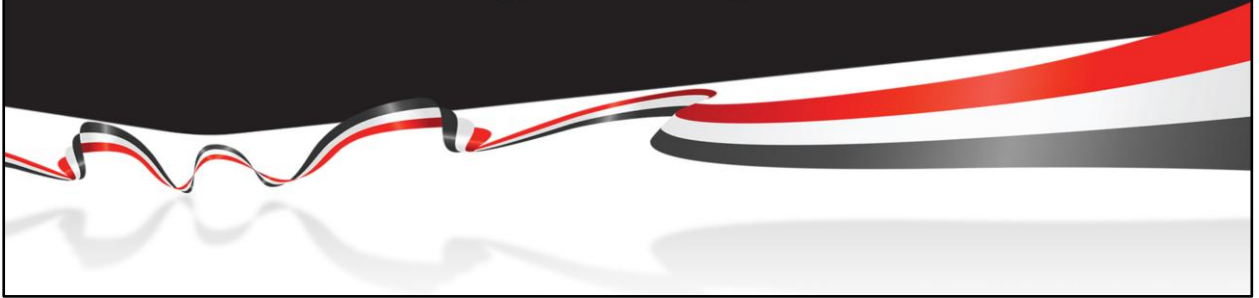
Take note of the order of the switches groups. The red ring needs to be higher up the order because when it is active, i.e. greater than 7000 RPM, the yellow ring is also active (greater than 6000). If the orange switch is higher up, the red one will never be displayed.

Only the first switch group can have no condition.



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Sending a Configuration





Sending Configuration

Send configuration button (or press F5)

Select your display from the drop down

Allows you to store a copy of the project on the display

Build and send project to display

Set a password

Configure Device

Selected Device: Serial 2

Model: C127

Firmware Version: 1.107

The firmware is up to date

Project: DC Seminar Config.dproj

Project Model: C127

Available Space: 16.00 MB

Store a copy of the project on the device

Buttons: Check, Check & Send, Get Project, Upgrade Firmware, Set Passwords...

Close

Select a device from the combo box or use the search button. Press Send Configuration to configure the device.

Sending a DC config is a similar process to sending a Dash config. You select the device from the drop down menu and then click 'Check & Send'.

It is possible to store a copy of the project on the device so it can be retrieved later.

The device can be set up to require a password to send a configuration to stop unwanted changes.



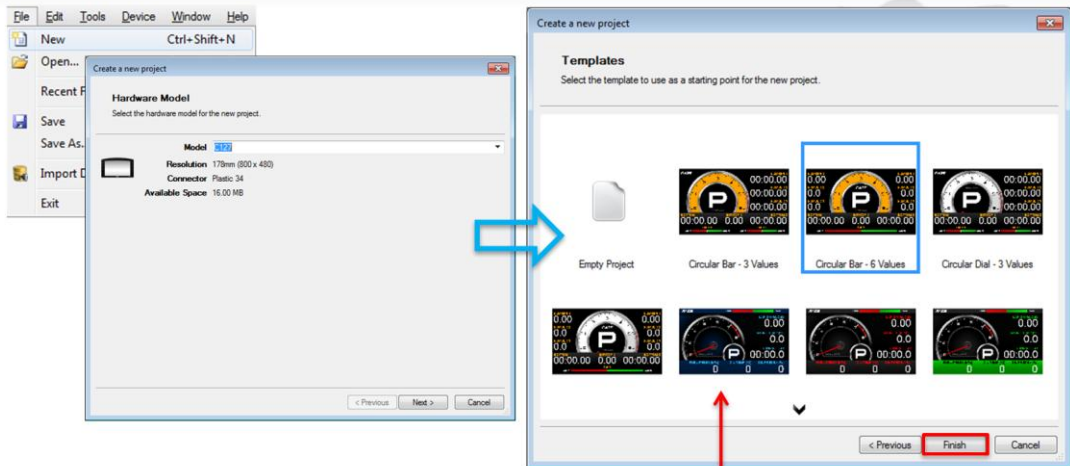
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Preloaded Projects





Preloaded Projects



Select from a number of pre-configured pages

Display Creator has a number of pre-configured display pages that can be selected. These include the default display pages that come with the Colour Displays, allowing customisation without having to build an entire Display from scratch.

Elements or entire pages can be copied from any of the pre-configured projects into your own custom project.



Preloaded Projects

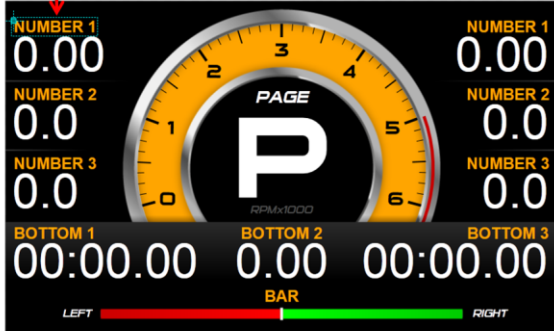


Now that we have a base to start from we add the dbc file from our Dash config in the same way as previously discussed.



Preloaded Projects

Select the channel label



X 12 Y 29

Text

Text OIL PRESSURE

Appearance

Font Arial 23

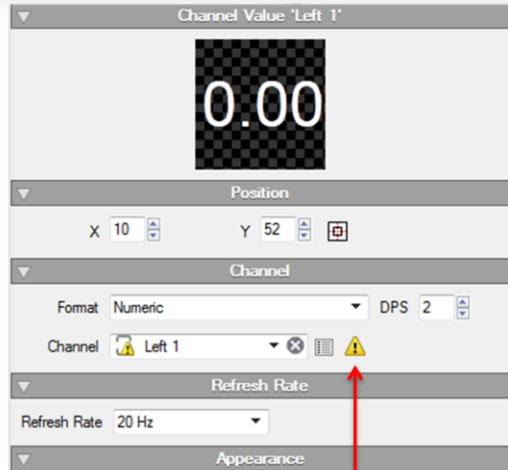
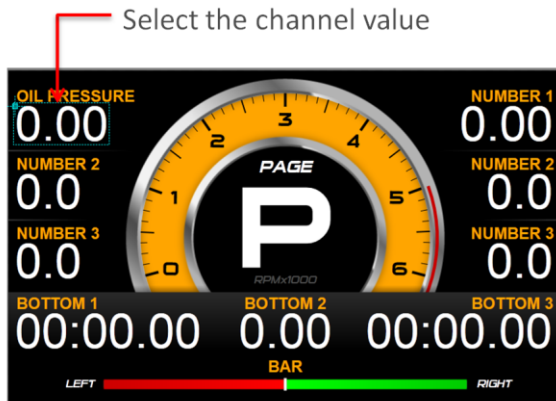
Style **B** *I*

Colour

We now start by selecting the text label and renaming it to the channel we want to display in that position.



Preloaded Projects



Channel place holder not connected

Select the channel you want to allocate, the yellow warning symbol lets you know the allocated channel can't be found. The preconfigured projects all contain channel place holders that need to be reallocated with the channels you actually want displayed.



Preloaded Projects

Select the desired channel

Channel Properties

Name: Engine Oil Pressure

Data Type: Floating Point

Quantity: Pressure & Stress [Pa]

Connect to a signal or bit decode

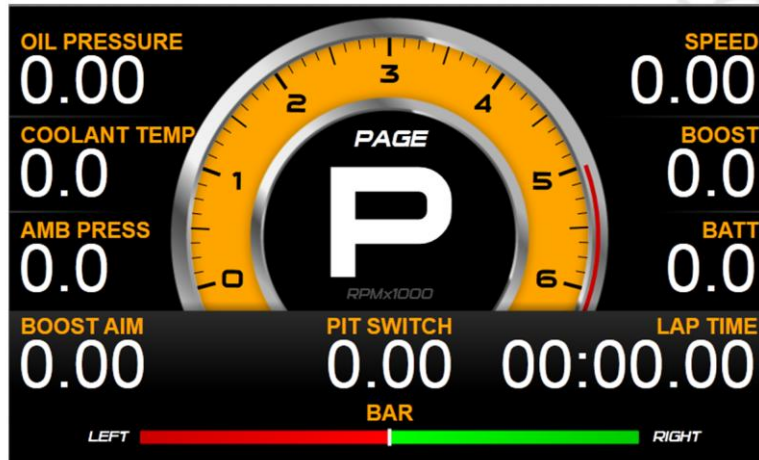
Name	Channel
▶ Seminar Config Internal Display using Display ...	
▶ Display 5	
▶ Display 4	
Engine Oil Pressure	(Not Used)
▶ Display 3	
▶ Display 2	
▶ Display 1	
▶ CRC32	
▶ Alarm Value	
▶ Alarm Status	
▶ Alarm Message	

OK Cancel

Select the signal you actually want to be displayed and click OK. It will automatically create the channel and fill out the parameters.



Preloaded Projects



Continue through and allocate each of the channels you want displayed.

It is important to note that only one channel can be allocated to each signal. If you wish to use a channel in another location don't reconnect to a signal, simple select the channel from the drop down menu.



Additional Features

- Timers/Counters
- Animation
- Simulation
- Bit Decode
- Backlight Control
- Splash Screen

D-Series Only

- Input Signals
- Beacons/Lap timing
- M800 CAN Input

Timers/Counters: Functions similar to Dash functions. Can be used to create time based conditions.

Animation: Create animations from a number of images.

Simulation: Simulate the Display to check layouts/functions/conditions etc. before sending to a Display.

Bit Decode: Decodes a bit stream allowing you to send multiple state channels in one CAN message

Backlight Control: A channel to control the backlight brightness, can be set as a constant value or varied depending on a particular input or conditions.

Splash Screen: Set an image to be displayed when the device powers up instead of the default MoTeC screen.

Input Signals: When using a D-Series Dash this allows you to configure the analogue and switch inputs to be used in configuration

Beacons/Lap Timing: Setup a BR2 for lap timing to be shown on the display

M800 CAN Input: Sets up standard M800 CAN messaging so it doesn't have to be done manually. (Note: If using an M1 ECU a DBC file can be provided by MoTeC on request)



Questions

- If you need assistance, feel free to drop us a line at support@motec.com.au
- If you have suggestions on possible improvements, or feature requests, email us at the same address and we can look into it for you



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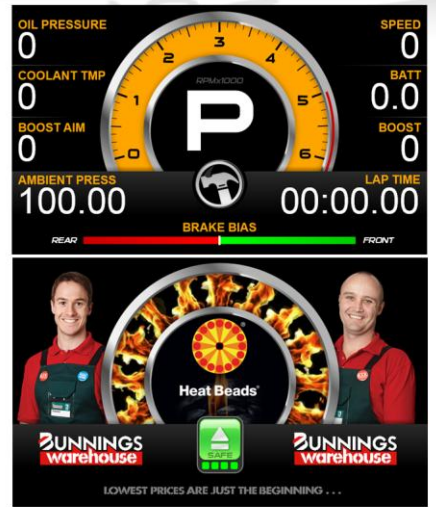
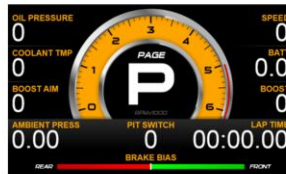
Display Creator Tips





Topics

- Reset Window Layout
- Adjusting templates to introduce sponsors
 - Using 'Global' Conditions
 - Using Timers
 - Incorporating Animation
 - Transitioning
- Simulation





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i2 Data Analysis





Topics

- About Data Logging
- Introduction to Using i2
- Track Mapping
- Displaying Data
- Reliability and Safety
- Evaluating Driver Performance
- Evaluating Chassis Performance
- Data Maintenance
- T2 Telemetry
- Any Questions?

The above program is an outline of the topics covered in today's seminar. If you have a question at any stage, feel free to ask.



Reasons for Data Logging

Why do we use it?

- Monitor vehicle reliability
- Tool for vehicle and driver analysis
- Analyse performance
- Periodically sample selected inputs
 - Typically once/sec to 5000 times/sec
- Greater value from test laps
- Store data for retrieval/archiving
- Driving technique
- Comparison against reference lap



One of the main features of the Dash is its data logging functionality, which gives us the ability to record all sensor values.

This allows decisions to be made on engine, driving and chassis setup. Data Logging is used to record quantitative data (facts) about performance of these areas.

- Monitor the drive train in all parts of a lap to look for unusual changes.
- Confirm driver feedback about what is happening in the vehicle, and its handling.
- Sampling rate is determined by the sensor being logged - must log fast enough to record important data variations.
- Maximise information available in a test session. Data logging will record everything that happens if it is correctly setup, defined and calibrated.
- Data can be used for planning future setups, driver coaching, comparison run to run or with other drivers.
- Help diagnose faults and optimise performance, e.g. check fuel and oil pressure are stable during the session (no surges), brakes/tyres up to temp.
- Overlay data before and after a chassis change to analyse its effect on the chassis.
- Measure oversteer/understeer at individual corners for planning chassis adjustments.
- Measure braking ability of vehicle (and driver).
- Compare all elements of a lap against a Reference Lap to understand chassis changes, driver technique, tyre performance etc.



Logging

- Accepts signals from Analogue or Digital sensors
- Record channels from Sensor Inputs or derived maths calculations
- Data logging stored in Flash Memory
- PC Communications via Ethernet



Sensors

Engine/Driveline

- Engine RPM
- Oil & Water Temps
- Oil Pressure
- Oil Level
- Fuel Pressure
- Throttle Position
- Lambda (Air/Fuel)
- Fuel Used
- Gear Position
- Gearbox Temperature
- Battery Voltage

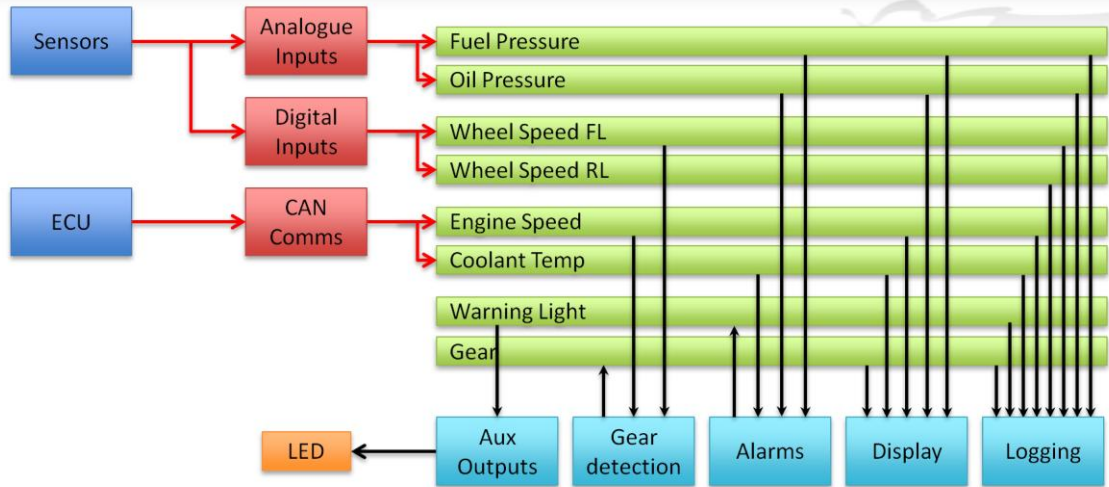
Chassis

- Wheel Speeds
- G-Lat and G-Long
- Steering Angle
- Brake Pressures
- Damper Position
- Ride Heights
- Brake Temperature
- Tyre Temp/Pressure
- Suspension Loads
- Air Speed

A list of sensors available for comprehensive measurement of vehicle and driver performance.



Dash Channel Structure



Channel Overview

Channels are used to convey information between the various systems of the Dash. For example, an input sensor may feed a channel called 'Engine Temperature'. This channel may then be used by any other system, such as the Display or Data Logging systems.

Channel Usage

The Dash channel scheme allows complete flexibility in channel usage, as any available channel can be used by any other function, i.e. any channel can be logged, displayed, used in conditions and/or used in alarms.



Examples of Dash Systems

Basic System

In a typical setup for a Formula Ford you might want to log the following:

- 1 x Ground Speed at 20 Hz
- 2 x Pressures (fuel and oil) at 20 Hz
- 1 x Engine Temperature at 1 Hz
- 1 x Beacon at 1 Hz
- 2 x G-Forces at 20 Hz
- 1 x Engine RPM at 20 Hz
- 1 x Throttle Position at 20 Hz
- Total 9 inputs required

A typical race lasting 30 minutes would require a memory capacity of approx 0.5 MB.

Advanced System

A typical logging setup for a V8 Supercar might be:

- 4 x Suspension position at 500 Hz
- 4 x Brake temperatures at 20 Hz
- 4 x Tyre temperatures at 20 Hz
- 1 x Oil temperature at 1 Hz
- 4 x Tyre pressures at 20 Hz
- 4 x Tyre temperatures at 20 Hz
- Plus all the basic logging setup of diagnostic channels, user conditions, onboard maths channels
- Total 26 inputs required

With this setup an C185 with 250MB memory would allow a logging time of approx 3.5 hours, while the 1 GB ACL would be sufficient for an endurance race.

The onboard data recorded into the logging device is downloaded to a PC, either each time the vehicle comes into the pits or at the end of a race, rally, drag run or test session.

The available memory varies greatly from system to system and more recent logging devices use Ethernet communication for fast download.



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i2 Introduction





i2 Standard vs i2 Pro



i2 Standard

- Single overlay lap
- Simple maths functions
 - Corrected speed/distance
 - Filter, scale and offset
 - + - * /
- 15 Worksheets
- 5 time/distance graphs
- 10 Channels per graph
- 5 Outing graphs
- 2 Histograms
- 1 Scatter plot
- 1 Mixture map
- 1 Track Report
- Section Times



i2 Pro

- Multiple overlay laps
- Advanced mathematics
 - user maths
 - global maths
 - Flexible expressions
- Unlimited display components
- Unlimited Workbooks
- Unlimited Worksheets
- User definable track sections/sectors
- Lap Reports
- Statistics zoom
- Suspension Analysis
- Video
- Multiple projects

i2 Standard is included, while i2 Pro requires the optional Pro Analysis upgrade or a Feature Licence.

There are two levels of analysis functionality: **i2 Standard** and **i2 Pro**. This list shows some of the major differences between the two software versions.

i2 Standard is available to all customers with logging from a MoTeC Data Logger or ECU. It has been designed with the intention of being suitable for teams up to around mid-level motorsport.

i2 Pro provides all the features of Standard but on top of that are extra features that have been requested by professional race teams worldwide, like advanced mathematics, multiple overlay laps, and unlimited components, Workbooks and Worksheets, and viewing Live Telemetry data via T2. It is expected to be used by those in middle to upper levels of motorsport.

There are two ways to make log files compatible with **i2 Pro**:

1. The first option is a Pro Analysis upgrade on your ECU or logging system. This is a password enabled upgrade, which saves all log files from the device as '**Pro**' files. The Pro Analysis upgrade can be purchased at any time, allowing you to use the more powerful software when the need arises. This can even be done at the race track, you need only contact your dealer and they can supply the password to upgrade your specific device.
2. The second method is via the Feature Licences, which allow data in different formats to be used with **i2 Pro**.



Software Download/Installation

- MoTeC software is available for download from the website at:
<http://www.motec.com.au/software/latestreleases>

The screenshot shows the MoTeC website interface. At the top, there's a navigation menu with links for Home, News, Products, Sales, Support, Forums, Downloads, and Corporate. Below this is a search bar and a 'Software' dropdown menu. The main content area is titled 'Downloads' and includes a 'Latest Releases' section. This section contains a table listing various software files with columns for File, Size, and Last Updated. Below the table, there are sections for 'Data Acquisition and Displays' and 'Data Analysis', each with their own tables of files. The website also features promotional banners for seminars and product updates.

File	Size	Last Updated
ACL Manager V1.7027	18 MB	Jun 10th 2015 05:24
ACL Dash Manager V1.2062	5 MB	Apr 16th 2008 12:39
ACL2 Dash Manager V1.5114	9 MB	Dec 12th 2012 16:23
ACL3 EDL3 Dash Manager V5.6030	12 MB	Jun 10th 2015 05:20
ACL Manager V1.1.0.0002	5 MB	Feb 12th 2014 12:11
C125 Dash Manager V1.6003	17 MB	Oct 13th 2014 16:12
C127 Dash Manager V1.7902	17 MB	Nov 26th 2014 17:18
C185 Dash Manager V5.6003	17 MB	Oct 13th 2014 16:13
C187 Dash Manager V5.7009	17 MB	Nov 26th 2014 17:19
CDL3 Dash Manager V1.6009	11 MB	Jun 10th 2015 05:23
Display Creator V1.0.7.0024	90 MB	May 12th 2015 23:51
SD1 Sports Dash Manager V1.6114	7 MB	Dec 12th 2012 16:24
SD1-3 Dash Manager V26009	11 MB	Jun 10th 2015 05:21

While a software and resource USB is included with MoTeC products, the software is regularly updated so it will become necessary to download the latest versions from the MoTeC website.

Installing Software

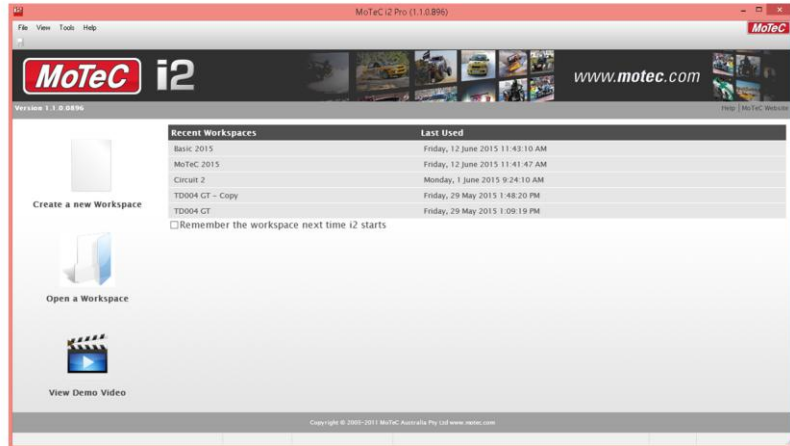
- Go to the MoTeC website at <http://www.motec.com.au/software/latestreleases>
OR
Locate the Dash Manager software on the MoTeC Resource USB
- Save the selected file in your preferred location (for example Desktop)
- When downloading is finished, double click on the file and select run.
Note: the time taken to download the file can vary widely and will depend on the speed of the connection to the internet.
- Follow the instructions on the Install Shield Wizard

To be informed of the latest software releases you can join the MoTeC software announce mailing list by sending an email to <mailto:announce-subscribe@motec.com.au>



Getting Started

- Double left click on the MoTeC i2 Pro Icon on your desktop to start the software



To start the program after installation, click the icon on the desktop or click **Start > All Programs > MoTeC > i2 Pro**

A Workspace stores the **i2** program settings, screen layouts, math calculations etc. used for analysis. Workspaces can be defined per vehicle, by type of racing etc. A user can create as many Workspaces as they wish, each with different settings. New Workspaces can be created or existing older projects opened from the File | Workspaces menu or from the **i2** start up page. Any log file can be opened from within a Workspace, so a Workspace doesn't restrict what information can be analysed.

The first time that **i2** is run, the user is prompted to create a New Workspace. Follow the prompts of the wizard to create the first Workspace.

If upgrading **i2 Pro** to version 1.1, the name changes from Project to Workspace. The older projects can be imported from the File | Workspaces | Open Workspace menu. Click Import, at the bottom of the import window, you will need to change the 'Files of type' to be i2 1.0.Project.

When opening **i2 Standard** for the first time you will be presented with the choice of 4 projects: Circuit, Drag, Rally and Engine. If you click on the box 'load previous project', on subsequent program starts it will take you straight into your graph screens, ready for you to open your data.



New Workspace Wizard

4 Types of Basic Start Profiles depending on type of data to be analysed

Creating a New Workspace:

Workspace Type: There are 4 types of project available: Circuit, Drag, Rally and Engine. The project type determines the default math settings and initial Workbook and Worksheet setups and optimised for that particular data analysis .

Workspace Location: Enter a descriptive project name. This will be used as the folder name under which the project is stored. By default, projects are created in the current user's 'My Documents' folder under 'My Documents\MoTeC \i2\Workspaces\Workspace_Name\' This can be changed by clicking on the button next to the Workspace Location and browsing to the destination folder. Renaming the folder will rename the Workspace.

Profile Worksheets and Maths are included if the box is checked, otherwise the project is blank with no predefined maths or screen layouts.

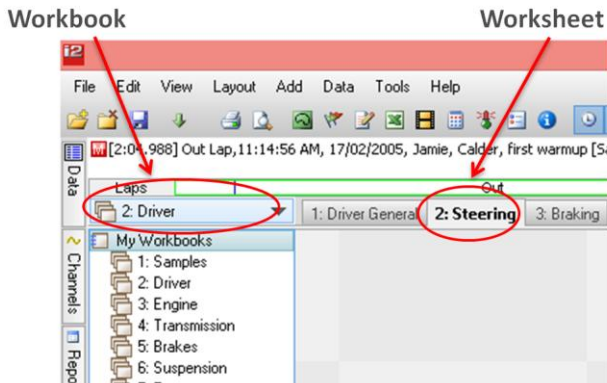
Workspace Summary: After checking the project summary, click on Finish to close the wizard and begin using *i2*.

The entire project folder can be copied from one PC to another and some of the components can also be copied. The project folder and its directory structure contains individual files for channel maths, setup sheets, track maps etc.



Workbook/Worksheet Setup

- Worksheets should be grouped into Workbooks by their type, such as Engine, Driver, Chassis, Suspension, Power or they can be grouped for different people such as Engineer, Driver A, Driver B.



Circuit Racing Project:

The 'Samples' Workbook contains 10 sample Worksheets

Drag Racing Project:

The 'Samples' Workbook contains 8 sample Worksheets

Workbooks and Worksheets

Worksheets are used to contain the screen layouts, i.e. where the data is actually displayed. Each Worksheet is completely configurable and may contain a number of different components such as Graphs, Histograms, Gauges etc. These can all be mixed together in any one Worksheet.

Workbooks are used to group a number of Worksheets. This allows a large number of Worksheets to be defined and organised into categories to suit the user's requirements. A Workspace can contain any number of Workbooks which in turn can contain any number of Worksheets.

Selecting a Worksheet

To select a Worksheet use the mouse or press F7 to activate the Select Worksheet dialog or press the corresponding number key that is shown on the Worksheet tab.

Keyboard shortcuts

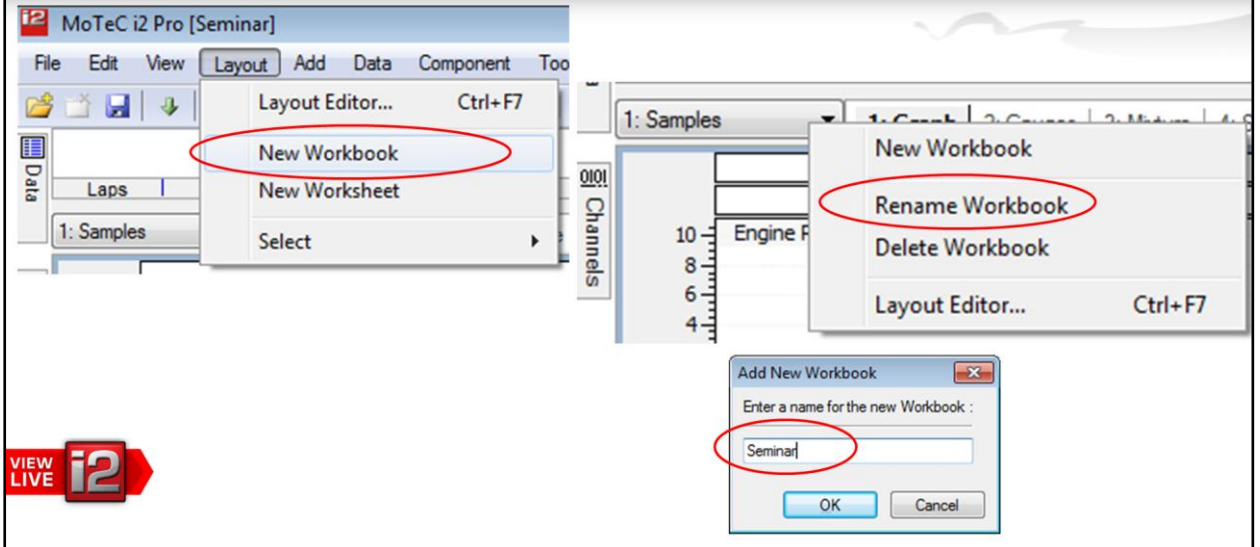
Worksheets may be selected by pressing the corresponding number key (0...9)

Workbooks may be selected by pressing the Ctrl key plus the corresponding number key (Ctrl+0...9)

A Circuit Racing project comes with 8 pre-defined Workbooks, each with a number of pre-defined Worksheets, i.e. there are 10 pre-defined Worksheets in the 'Sample' Workbook, several others such as 'Driver', 'Engine', 'suspension, etc. and one blank Worksheet in the 'User' Workbook. A Drag Racing project currently comes with 8 pre-defined Worksheets in the 'Sample' Workbook and one blank Worksheet in the 'User' Workbook.



New Workbook



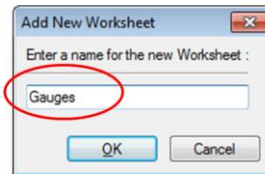
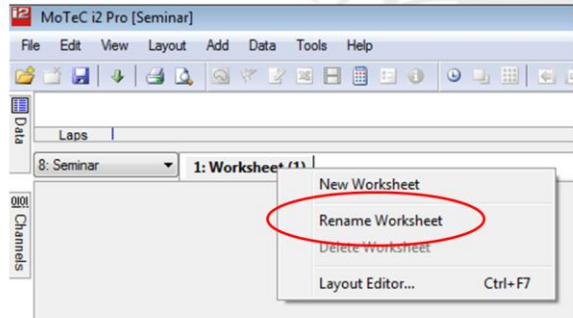
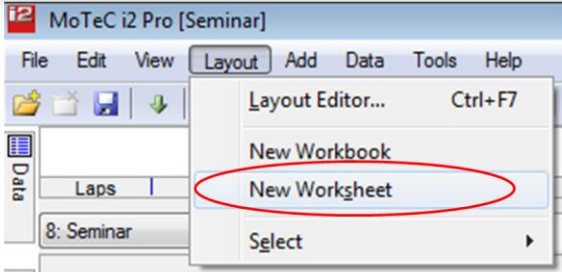
Creating a new Workbook

To add a new Workbook, go to the 'Layout' menu and select 'New Workbook'. Or this can be done from the Layout Editor (menu 'Layout – Layout Editor', shortcut key 'Ctrl+F7' then 'Add Workbook') or right-click on the Workbook list and select 'New Workbook'.

You will be prompted to enter a name. To rename a Workbook, right click on the drop down list and choose 'Rename' or use the Layout Manager.



New Worksheet



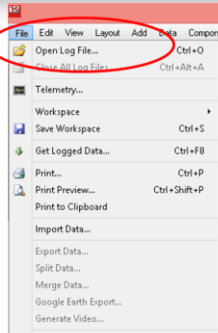
Creating a new Worksheet

To add a new Worksheet, go to the 'Layout' menu and select 'New Worksheet'. Or this can be done from the Layout Editor (menu 'Layout – Layout Editor', shortcut key 'Ctrl+F7' then 'Add Worksheet') or right-click anywhere on the Worksheet tabs area and select 'New Worksheet'.

You will be prompted to enter a name. To rename a Worksheet, right click on the tab and choose 'Rename' or use the Layout Manager.

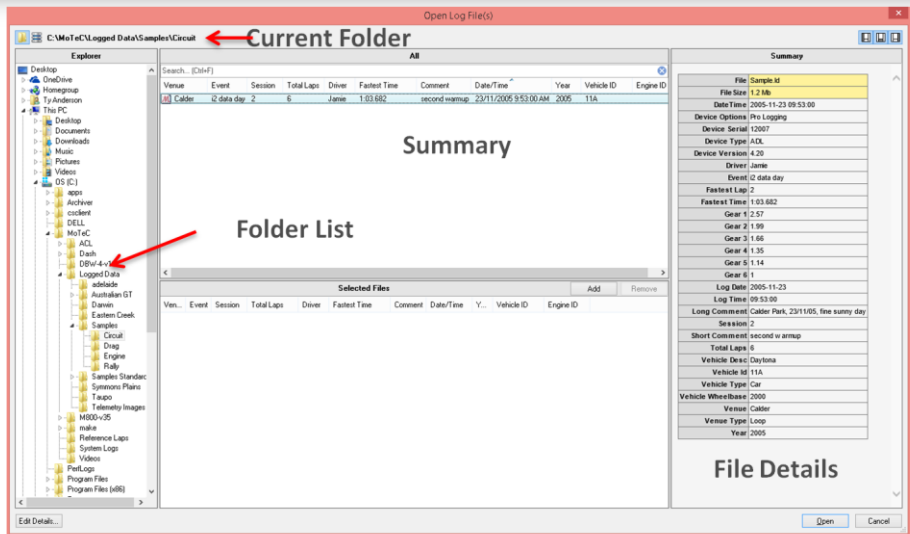


Open a Log Data File



5 Ways to Open Files:

- Pull-down menu 'File/Open Log File'
- Ctrl+O
- Icon on toolbar
- F8, then Icon
- F8, then right-click



Open Log File dialogue

A log file can be opened by going to the 'File' menu and selecting 'Open Log File', by using the keyboard shortcut 'Ctrl+O' or by clicking on the Open Log File icon on the toolbar.

On the left is a folder view with the currently open folder highlighted in grey, the folder name is also shown at the top of the window. Full details of the currently selected file are shown in the pane on the right.

Files shown can be filtered by the Venue, Driver name or Vehicle details by selecting one or more of these from the drop down lists.

Files can be sorted by the columns shown at the top of the centre pane by clicking the heading once – and again to reverse the order.

Columns shown and their order can be selected from a list by clicking on the 'Options' button or by right-clicking on the row of headings to a list of selectable headings.

Select the required file and click on 'Open'.

Multiple files can be opened at once allowing data to be selected from a number of sources - when a file is opened, previously opened files remain 'open'. Files can be closed individually or as a group.



Data Window

Lap Selection

- Main
- Overlay
- Other overlay laps

Open file dialog and icons

Laps	Time			Time Offset	Distance
Calder, i2 data day					
Jamie, 11A					
23/11/2005, 2					
9:53:00 AM, second warmup, Sample.Id					
Out Lap	1:34.136	<input type="checkbox"/>	<input type="checkbox"/>	0:30.454	0:00.000 0:00
Lap 1	1:05.163	<input type="checkbox"/>	<input type="checkbox"/>	0:01.481	0:00.000 0:00
Lap 2	1:03.682	<input checked="" type="checkbox"/>	<input type="checkbox"/>	0:00.000	0:00.000 0:00
Lap 3	1:05.192	<input type="checkbox"/>	<input type="checkbox"/>	0:01.510	0:00.000 0:00
Lap 4	1:03.759	<input type="checkbox"/>	<input checked="" type="checkbox"/>	0:00.077	0:00.000 0:00
In Lap	1:42.068	<input type="checkbox"/>	<input type="checkbox"/>	0:38.386	0:00.000 0:00

File Selection

- Venue, Event
- Driver, Vehicle
- Date, Session
- Time, Comment and Filename
- Other overlay laps
- Main
- Overlay 1
- Lap List

Data Window

Press F8 to go into the data window.

This window lists files that are currently 'open' that you may choose to view. You can open as many files as you like from any folder on your computer. Once one or more files have been opened they will appear listed down vertically along with some file details as shown above.

Use 'R' to select the first overlay lap, and 'O' for an additional overlay. Otherwise press 'M' or 'enter' to select the Main lap. The fastest lap in a session is highlighted in orange. The F4 key toggles the overlay lap on and off. F3 toggles variance.

One lap is chosen as the 'Main' lap, this is indicated by a red dot in the circle next to the lap time. The next column across is for the 'Overlay 0' lap. This is actually the first overlay lap (displayed on those components that only support a single overlay) and is also used for the variance calculation. The third column is for additional 'Overlay' laps that are displayed on graphs and in channel reports. The Main, Overlay 0 and Overlay laps can all be from different files or sessions. The trace colour of an overlay lap can be changed by clicking on its label in the title bar above the main display.



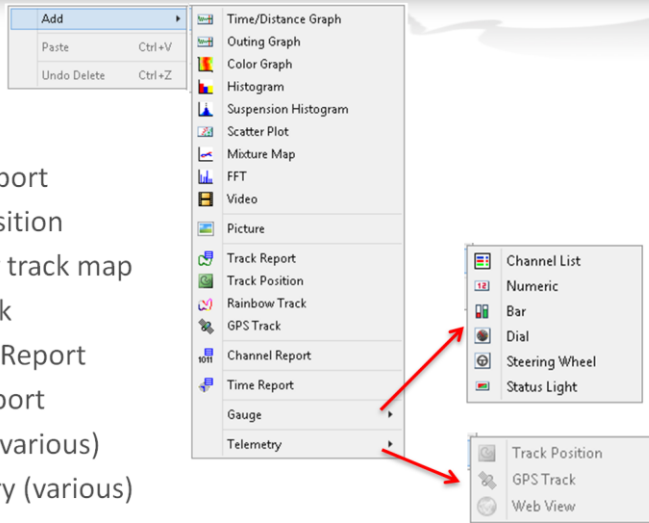
Adding Components

'Layout – Add' menu

Right click on blank area of

Worksheet Available Components:

- Time/Distance Graph
- Outing Graph
- Histogram
- Suspension Histogram
- Scatter Plot
- Mixture Map
- FFT
- Video
- Picture
- Track Report
- Track Position
- Rainbow track map
- GPS Track
- Channel Report
- Time Report
- Gauges (various)
- Telemetry (various)



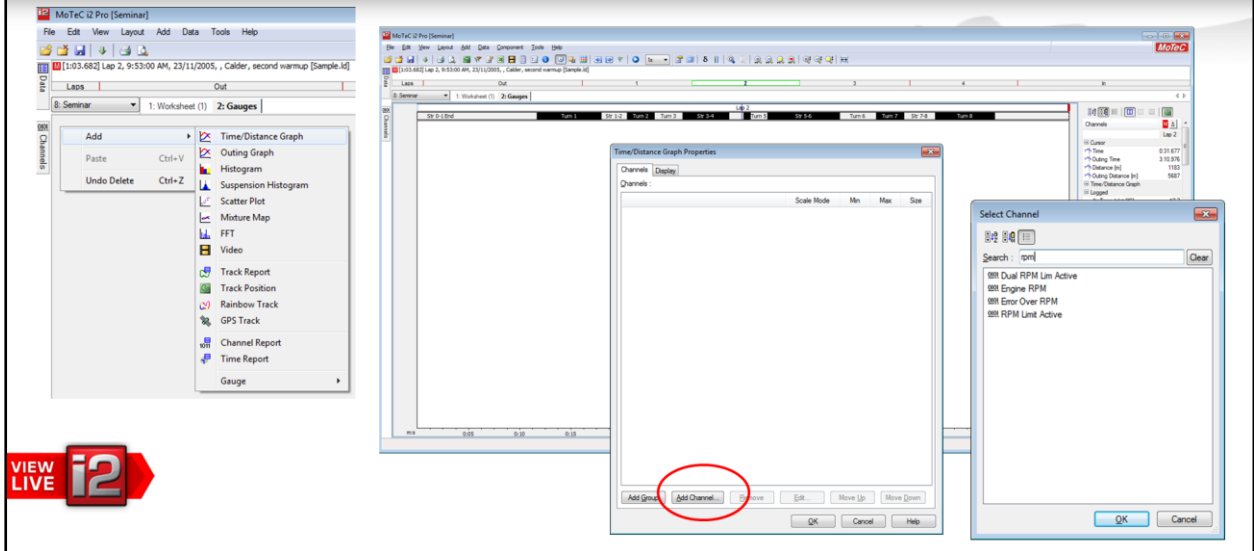
Adding Components

With a new Worksheet now open you are still unable to view any data until a component has been added. Right click anywhere within the blank new Worksheet and a list of available components will appear. Or use the 'Layout' menu to select a new display component.

To add a Telemetry Component you will need to add a telemetry stream to the Workspace.



Add Time/Distance Graph



Time / Distance Graph

Select 'Add – Time Distance Graph' from the menu bar.

When adding any new component, initially the software presents the relevant component's Properties dialog box. This allows the user to organise the component with the desired channels to view and the format they are to appear. The user can access the Properties menu for the currently active component at any time by pressing the 'F5' key.

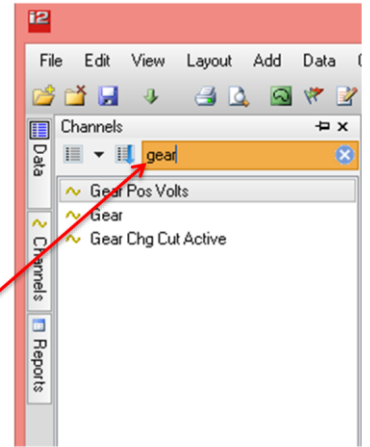


Adding Channels



Available logged and calculated maths channels

Filter the channel list for required channel



Press 'C' to open the Channel list fly out. Double click on a channel to add it to the display component that currently has focus.

Or, press 'Tab' to go into the channel list, arrow up and down then press 'Enter' to add a channel. The list of channels displayed can be narrowed down by typing the first few letters of one or more words of the channel name into the search box to make finding the required channel easier.

You will find that some channels are grouped together, while others remain on their own. The time/distance graph that we have added is being divided into 'Groups'. Each Group can have one or more channels on it. If we add channels that have the same units they will be placed on the same group, channels with different units are given a new group.

It is possible to change the default behaviour and arranged channels according to how you want them in each case. This is done by accessing the Properties for the time/distance graph. Or hold down the 'Ctrl' key when clicking on a channel in the list to force the channel into a new Group (i.e. a separate graph).

Click on the group containing corrected speed to set the focus to that panel

Press the C button to bring up the channel fly out

Type 'Gear' into the search bar

Double click on Gear



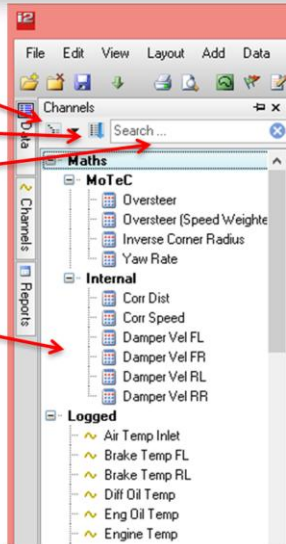
Channels Window

Toggle View List or Tree

Sort Alphabetically

Search Box

Categories

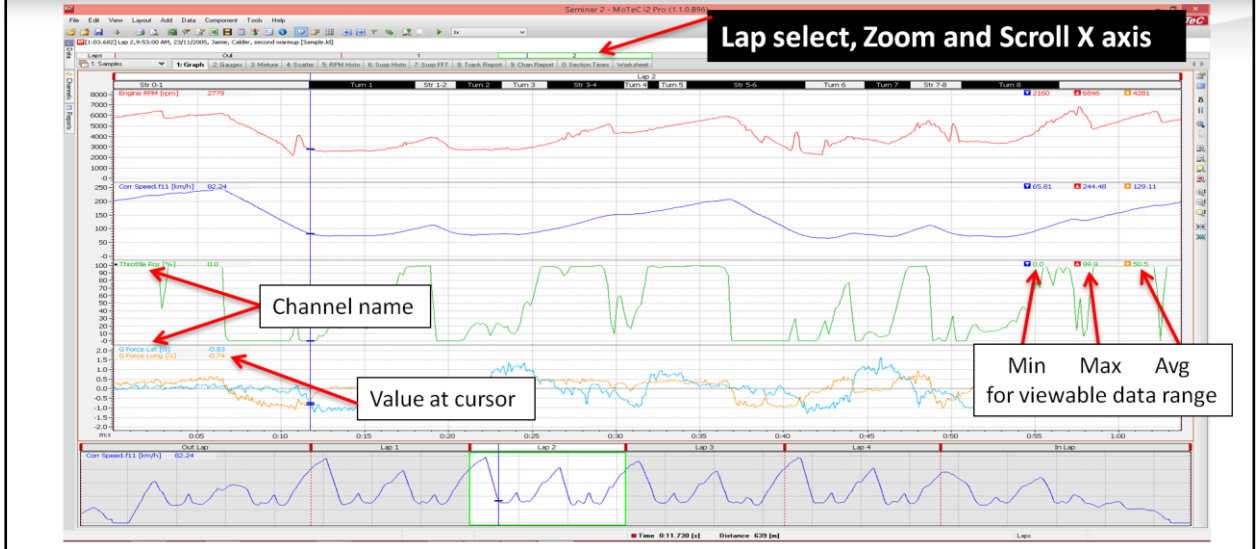


The Channels window is used to add channels to the display component for the currently selected 'Main' logged data, and the selected component display on the Worksheet. This component is the one with the highlight box around it.

The list can be displayed in categories: logged channels, status channels and various maths. Or they can be displayed as a combined (alphabetic) list.



Time/Distance Graphs



The first sample Worksheet includes two graphs. The top graph displays a single lap of data of 5 channels in four groups. The lower graph shows the Corrected Speed channel over the entire session. The cursors on the 2 graphs are linked, and the currently selected lap is highlighted in a green rectangle on the second outing graph.

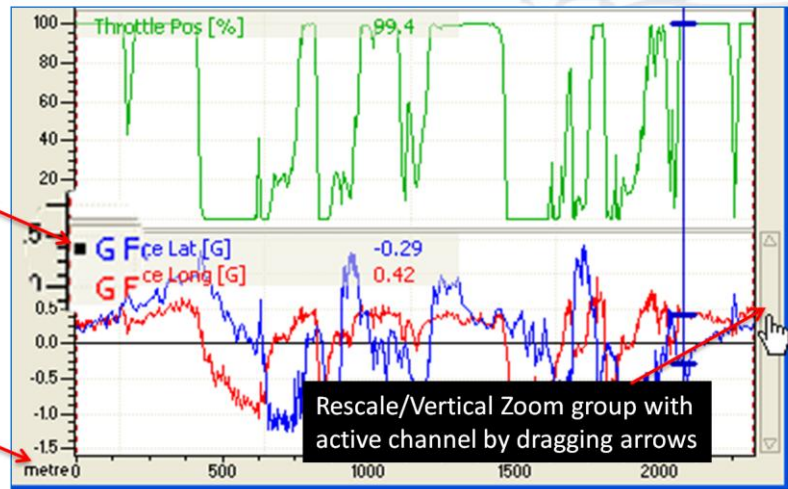
Lap selection bar: grab to scroll through laps, double click to select a lap, grab edges to zoom in/out.



Time/Distance Graphs

Active Channel is defined by the square next to the channel name

F9 toggles between Time/Distance axes



Time / Distance Axis

The graph may operate in time or distance mode – the F9 key toggles the horizontal axis between time and distance. The mode is remembered for each Worksheet and all components on the Worksheet use the same mode.

The graph uses the corrected distance (Corr Dist) channel to determine the distance for the axis when in distance mode. If the Corrected Distance channel cannot be calculated then the graph will not display data in distance mode. Note that the Corrected Distance calculation normally requires that the Corrected Speed calculation is working.

Active Channel

Each graph has an active channel. A square next to the channel name indicates which is the active channel. The active channel can be selected by clicking on the channel label or by using the PgUp & PgDn keys.

This is required for operations that are initiated via keyboard shortcuts. For example the shortcuts from the active channel menu will operate on the active channel. (e.g. Ctrl+Shift+F to filter the channel).

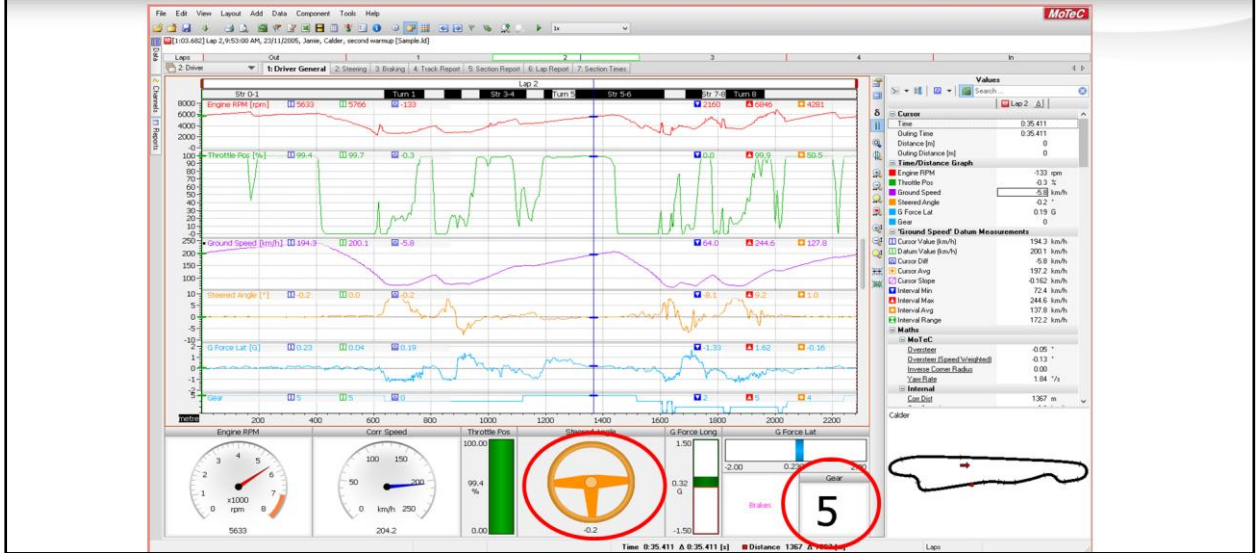
Also when vertical zoom or vertical pan are used via the keyboard they apply to the panel containing the active channel.

The active channel is also used when showing information on a particular channel – for example the datum cursor measurements that are shown in the values window are for the active channel.

- Press Page Up and Down to change channel selection.
- Use the rescale/vertical zoom to horizontally zoom the data.
- Press F9 to change from time mode to distance mode and back again.



Gauges



This Worksheet includes a graph as well as a selection of gauges. Gauges are most commonly used when playing back log data.

The shortcut key 'A' is used to toggle the animation on/off. The playback rate can be selected from the drop down list in the middle of the toolbar.

The gauges are linked to show the channel value at the current cursor position. This can be moved using the shortcut keys, or by clicking and dragging the cursor along the graph. In its function as a gauge the graph acts as a 'chart recorder' with the cursor moving rather than the graph scrolling across the page.

To reorganise the layout in **i2 Standard**, the 'unlock layout' box must be unchecked under the Layout Menu.

It is also possible to copy and paste components when you are setting up screen layouts.



Add Gauges – Steering Wheel

The screenshot shows the MoTeC software interface. On the left, there's a menu with options like 'Add', 'Gauge', 'Steering Wheel', and 'Status Light'. The 'Steering Wheel' option is circled in red. In the center, a 'Wheel Properties' dialog box is open, showing 'Channel: Steered Angle [°]' and 'Scale: Channel/Auto Scale'. The 'Polarity' section has 'Clockwise' selected. At the bottom, a dashboard displays several gauges, with a steering wheel icon highlighted in red.

Right click in the spare space and choose 'Add', 'Gauge' and 'Steering Wheel'.

Select the channel to display by selecting the button to the right off the channel box

Type in 'steer' and double click on "Steered Angle' then select OK.



Gauges – Numeric Gauge

Right click in the spare space and choose 'Add', 'Gauge' and 'Numeric Gauge'.

Select the channel to display by selecting the button to the right off the channel box

Type in 'Gear' and double click on 'Gear' then select OK.



Zoom Functions

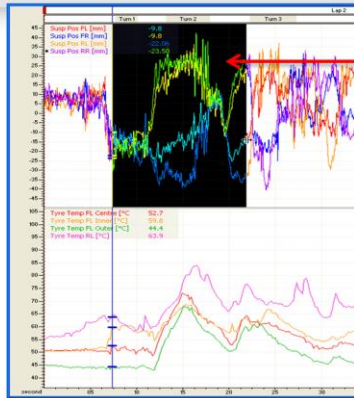
Mouse scroll

Keyboard shortcuts

Scroll bars

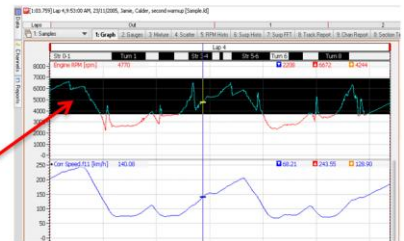
Zoom Icons

- Zoom Window
- Zoom to Cursors
- Zoom In Horizontal
- Zoom Out Horizontal
- Horizontal Zoom Out Full - F2
- Horizontal Zoom Default - W
- Vert Zoom In
- Vert Zoom Out
- Vert Zoom Out Full



Double click and drag to zoom for Horizontal selection

Press Alt & double click, drag to zoom for Vertical Selection



Horizontal Zoom

Zoom In and Out is normally performed using the Up and Down arrow keys to zoom around the cursor, or by dragging the ends of the horizontal scroll bar. The wheel on a mouse will also scroll in/out around the cursor. Place the pointer, double click and drag, then click again to zoom to the selected level.

The W key is used to return to the default zoom level, which in the case of lap mode is a single lap. Note that if the cursor is placed on a lap other than the current main lap then the main lap will be changed to the lap that the cursor is in when W is pressed.

The F2 key is used to zoom Full Out' and show the entire file.

Horizontal Pan

Horizontal pan is performed by dragging the horizontal axis or by dragging the horizontal scroll bar or using the Shift+Left or Shift+Right Arrow keys or the F and B keys (Forward & Back)

Vertical Zoom

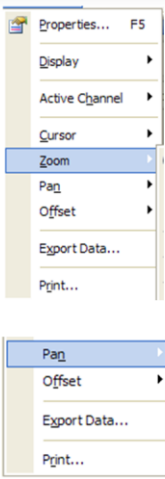
Vertical zoom is performed on the panel for the active channel and can be performed using the Alt+Up or Alt+Down Arrow keys, or by dragging the ends of the vertical scroll bar.

Vertical Pan

Vertical pan is performed using the Shift+Up or Shift +Down Arrow keys, or by dragging the vertical scroll bar.

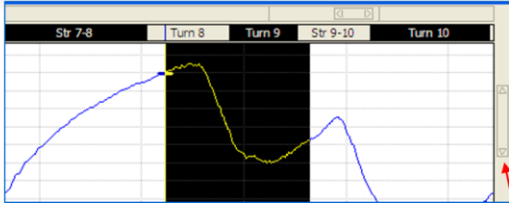


Zoom & Pan



Icon	Shortcut keys
	Zoom Window
	Zoom to Cursors Z
	Horizontal Zoom In Up
	Horizontal Zoom Out Down
	Horizontal Zoom Full Out F2
	Horizontal Zoom Default W
	Vertical Zoom In Alt+Up
	Vertical Zoom Out Alt+Down
	Vertical Zoom Full Out Alt+F2

Pan Left	Shift+Left
Pan Right	Shift+Right
Pan Up	Shift+Up
Pan Down	Shift+Down
Center On Cursor	H



If you accidentally Double Click, Drag & Click double click, hit 'Esc' key

To Zoom: use scroll wheel



To Pan: slide bottom x-axis

Double click to zoom out vertically



Zoom Out to Entire Run



By pressing 'F2' you will be able to zoom out to the entire run of your chosen log file. It is useful sometimes to zoom out to see any trends in temperatures or pressures over a complete outing. In the example above Gearbox Oil temperature is increasing throughout the session and may not have reached its peak before the race was ended.



Resizing and Layout

The screenshot shows a MoTeC data display interface. At the top, there is a speedometer labeled 'Corr Speed' with a needle pointing to 110.1. Below the speedometer is a data plot with multiple colored lines representing different data series. A vertical line labeled 'Turn 3' is visible on the plot. A horizontal splitter is located between the plot and the speedometer. Three red arrows point to specific areas: one to the top-left corner of the speedometer, one to the right edge of the plot area, and one to the horizontal splitter. Three black text boxes with white text provide instructions: 'Click and drag edges to resize' (pointing to the plot edge), 'Click left corner to move' (pointing to the speedometer corner), and 'Click and drag Splitter to resize Groups' (pointing to the splitter).

When modifying your layout, you can examine active component properties.

Resize components by dragging edges.

To move component, hover mouse over the top left corner – the mouse cursor will change to a symbol of 4 arrows.



Layout Editor

Layout Editor Shows the Workbook and the Worksheets contained within it

Here you can change the order or duplicate, import or export to another user

Layout Editor

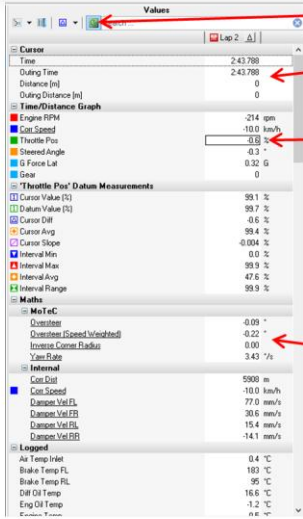
Press Ctrl+F7 to activate the 'Layout Editor'. The Layout Editor can also be used to rearrange the order of Worksheets and Workbooks as well as rename, delete etc. To rearrange the order of Worksheets, highlight one and click on 'Move Up' and 'Move Down' to change its position.

Workbooks and Worksheets can be 'Exported', to be saved as individual files, so they can be imported into other Workspaces or copied to another PC.

The 'Copy To' function is used to make a copy of a Worksheet in another Workbook.



Values Box



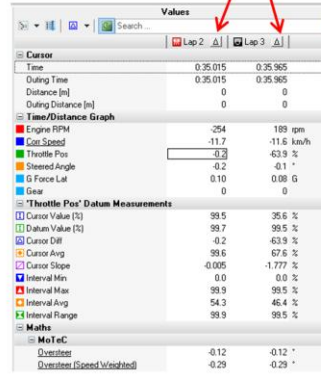
Hide/Show Track Map

Time and Distance at Cursor

Channels on the graph box = active channel

Values of all channels at location of cursor on the screen.

Show difference between Main and Ref laps



The Values box shows channel values at the cursor for all channels, with those on the focused graph listed at the top. When Reference and Overlay laps are shown, their values are shown in additional columns.

The Values box can be toggled On/Off using the 'V' key.

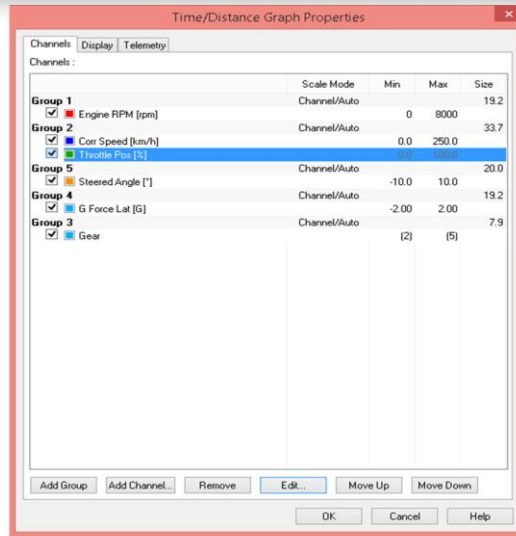
It is also possible to show the difference between the Main and Reference laps by clicking on the 'delta' symbol at the top of the column. Whichever column is selected is used as a base, with the other columns showing the difference.

In the above example the Main Lap column shows channel values, while the Ref Lap column shows the difference to the Ref Lap.



Graph Properties

- Channels
- Groups



Channels are divided into 'Groups' according to channel units. Use the Graph Properties page to add groups – which can contain one or more channels, and then add channels to those groups. The 'move up' and 'move down' functions apply to groups and channels.

The Remove function will remove either a single channel or a group, depending on which is selected.

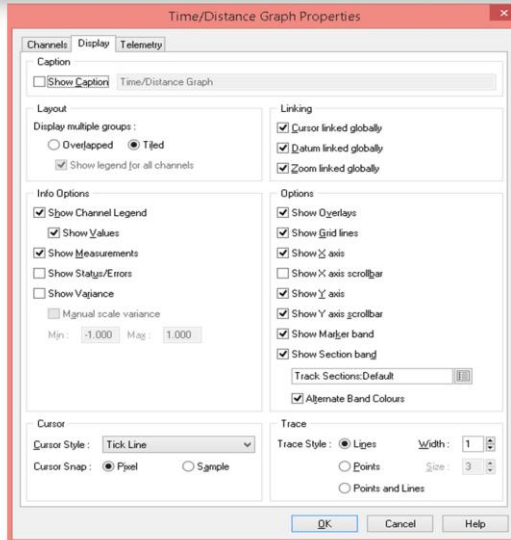
Channel properties such as scaling and colour can be accessed from this screen by double clicking on a channel, or by selecting a channel then hitting 'Edit'. Note that these are global properties and will be applied wherever this channel appears.



Graph Properties

Display

- Title
- Layout
- Info Options
- Options
- Cursor
- Trace



Display

Sets various options for the appearance of the graph. By default the X axis scrollbar is turned off. Check the box to turn this back on. This adds a scrollbar at the top of the graph window that can be used to move the graph through the data at the current zoom level. Measurements, Variance and Status/Errors can be toggled with the 'M', 'F3' and 'E' keys respectively. The graph properties can be used for default settings.

Overlapped

Shortcut key 'G' toggles between Overlapped and Tiled mode. When overlapped, all groups are displayed together as though on one graph. Each group still has separate Y axis scaling that can be set by making a channel in that group active then using the scrollbar.

Cursor & Trace

Select the cursor type, this is selectable for each graph. The traces can be lines or individual data points, line width can also be specified. Showing individual samples allows you to quickly determine if a channel such as damper position is being oversampled.

Linking

By default the cursor is linked across all Worksheets and books. This means that a cursor position set on one Worksheet will be in the same position on another Worksheet. To change this, go to the particular display element properties (F5) and under 'Mode - Link Options' uncheck the box 'Cursor Linked'. The cursor will now be 'local'.

Similarly for the Datum cursor – it can be Datum linked to be in the same position on multiple graphs. More on the Datum cursor later.

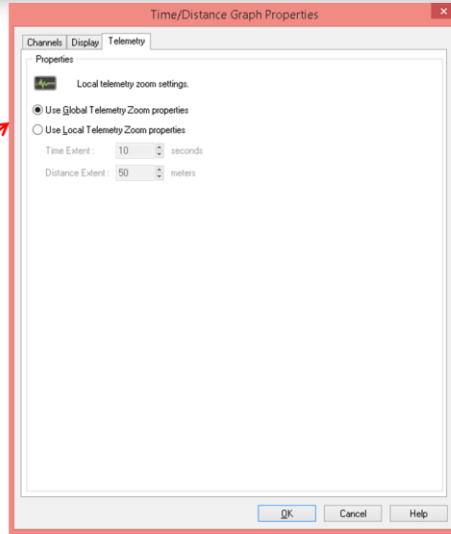
By default all components are also 'Zoom Linked', when the zoom level changes on a graph, linked components will display data based on the selected zoom level. It is possible to uncheck this option so that a graph can be zoomed independently from other display components.



Graph Properties

- Telemetry
 - Zoom Settings

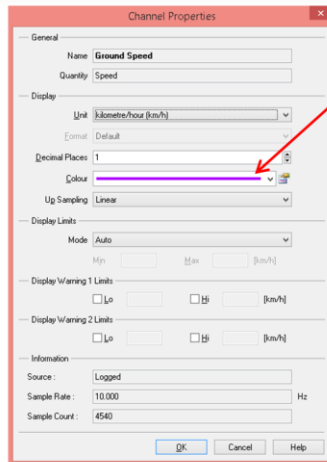
Global Zoom settings are defined under Tools/Options. All graphs use these settings unless local settings are defined, then these only apply to this graph.





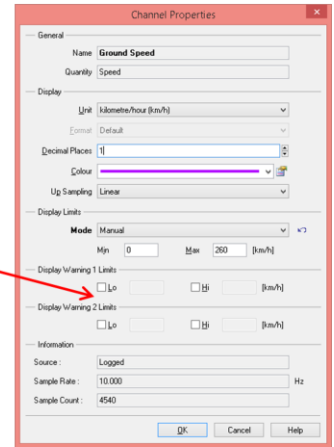
Channel Properties

- Unit
- Decimal Places
- Colour
- Up Sampling
- Scaling
- Info



Edit Channel Colour Scheme

Manual Setting Max and Min Display values



Channel properties such as scaling and colour can be accessed from this screen by double clicking on a channel, or by selecting a channel then hitting 'Edit'. Note that these are global properties and will be applied wherever this channel appears.

Channel Name and Quantity (unit type) are shown at the top, these cannot be edited.

Unit: Display units on all components

Decimal Places : Displayed on all components

Colour: The channel will be the same colour in all graphs and gauges. 8 colours are available in a colour scheme, these can be changed by clicking on the icon next to the channel colour selection. There are also complete colour schemes that can be loaded, e.g. black backgrounds. See 'Tools – Options – Colours' and then 'Select Scheme'. You can also add colours to your channel colour selection in the same place.

Up Sampling: How lines are drawn on a graph between sample points. By default this is linear, meaning that a straight line is drawn to join data points. This is generally what you would use, except for on/off channels such as Brake Status.

Scaling: Manual: A min and max value may be set for each channel. This allows the components to use common scaling avoiding the need to set the min and max for every component. Auto: the various components will auto scale the min and max scale unless they are specifically set to manual scale. Auto scaling can be bad for noisy data as it often expands the trace out beyond the area that you would like to see anyway.

Information: General information about the channel - Source Type, the sample (log) rate and number of samples in the file.

A complete list of channels can be found under 'Tools – Channel Editor', the properties for any channel can then be edited from this screen.



Channel Options on a Graph

- Hide
- Blink
- Remove
- Edit Maths
- Channel Status
- Filter
- Scale / Offset
- Zero at Cursor
- Previous
- Next
- Channel Properties

Ground Speed [km/h] (10.000 Hz)	
Hide Channel	Ctrl+H
Blink Channel	Ctrl+B
Remove Channel	Ctrl+Delete
Edit Maths...	Ctrl+Shift+M
Channel Status...	Ctrl+Shift+S
Filter...	Ctrl+Shift+F
Scale/Offset...	Ctrl+Shift+O
Zero at cursor...	Ctrl+Shift+Z
Previous Channel	Page Up
Next Channel	Page Down
Channel Properties...	Ctrl+N

Right click on a channel name to see the above menu. At the top is shown the channel name along with the logging rate.

Hide channel: removes the trace from the graph, but leaves the label and channel value.

Remove channel: removes the channel from the graph. If there are no other channels in the group, the group will be removed and others automatically expanded to fill the available space.

Edit Maths: is greyed out unless there is a filter or Scale/Offset applied to the channel

Filter: a channel can be filtered by time or number of samples. This filter is temporary while i2 is open and will be lost the next time i2 is loaded.

Scale and Offset : Correct or adjust data. Changes are stored as local file maths.

Zero at Cursor: Correct sensors that have not been zeroed. Changes are stored as local file maths.

Previous Channel: Make previous channel on graph the active channel

Next Channel : Make the next channel on the graph the active channel

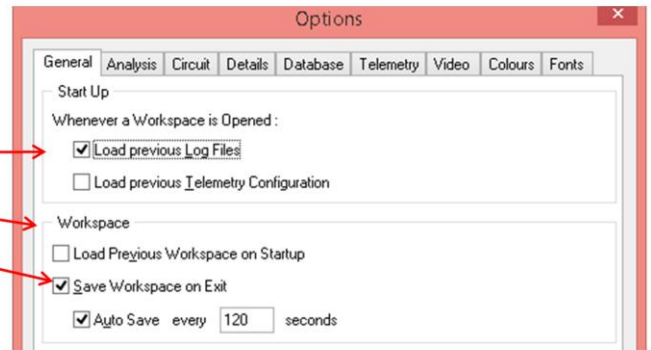
Channel Properties : display the channel properties window



Save Workspace Settings

Selecting Options from the Tools menu

- Start where you left off
- Start with same Workspace
- Auto Saving Workspace settings



At any time go to 'File – Save All Settings'.

Under 'Tools – Options', there is an option to enable 'auto-save' of settings at a specified time interval. Additionally, all changes are saved automatically when exiting the program

General Tab Save Options

The project settings can be Saved on Exit of i2 and at regular intervals. If the Save on Exit feature is tuned off, i2 will ask if the changes should be saved or not.

Analysis

Load data after device unload – data can be downloaded directly from i2 by going to 'File – Get Logged Data'. When this option is checked, that data will be loaded into i2 automatically.

Autoscale options

In general for circuit racing untrusted data is from in/out laps. This data is not used in auto scale as it often contains values outside that seen during a race.

Telemetry Tab

Video Tab

Codec Preference

When you play a video in **i2 Pro** the codec used will determine the visual quality and playback performance.

There are many codecs available and their performance varies widely. To achieve consistency in playback quality within **i2 Pro**, MoTeC recommends the MainConcept codec.

The [Download Codec](#) link will connect you to the MoTeC website where you can download the MainConcept codec. (Internet connection required).

Colour Tab

Change individual colours or select an overall colour scheme.



Histograms

Used to interpret data in other formats



This function provides a Histogram of any channel(s) from the current file.

For example: If RPM is selected, it can be useful in determining where the engine is spending most of its time and therefore identifying where the development effort should be targeted, as well as identifying maximum revs and the duration of time spent there.

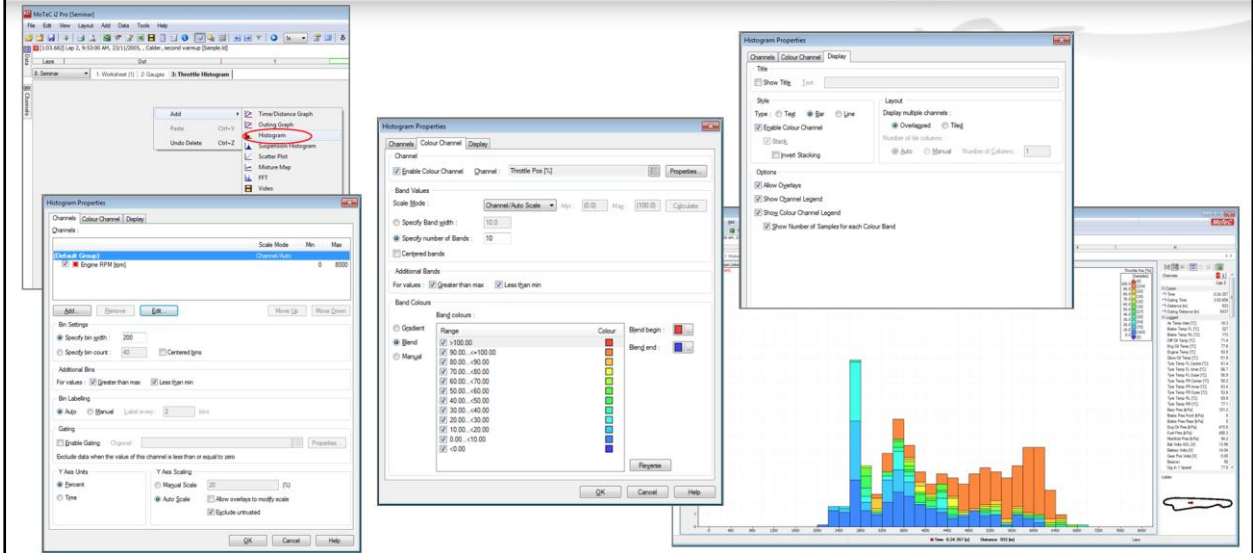
The Histogram can be viewed as a chart, individual bar graph and a stacked bar graph. The values shown can be a percentage of the time shown or actual time in seconds. This can be selected in the Properties section (press F5).

The duration of the Histogram can be for a single lap or the entire logged session. Use zoom functions on a graph to select the time period you wish to view, i.e. the outing graph above is used to control which part of the outing the histogram is being calculated from. This can be changed using the normal zoom keys, up/down or the mouse thumbwheel.

For example: A histogram of the gear channel to show how much use each gear is getting – determine when to replace parts.



Throttle Histogram



The Histogram consists of a user definable number of bins that the logged data is placed into which shows how often a certain channel values have occurred.

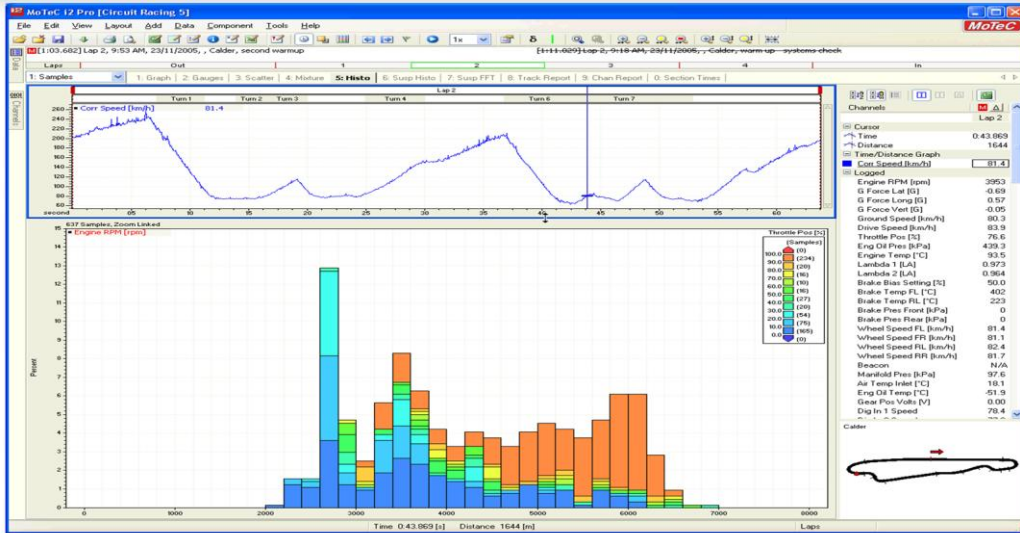
The histogram may be displayed in various styles: bar, line and text and may be optionally colour coded against another channel. For example: If RPM is selected, it can be useful in determining where the engine is spending most of its time and therefore identifying where the development effort should be targeted, as well as identifying maximum revs and the duration of time spent there.

Colour Channel

The histogram may be colour coded against another channel. The bar chart 'stacks' are divided according to the value of another channel, e.g. throttle position on top of engine RPM as above. In the Histogram Properties, select the 'Colour' tab, then select the secondary channel. The rest of the page gives options for the colour channel range and the number of colour bands.



Zoom Linking



Zoom Linking

The data that is displayed is normally for the currently selected range (normally a run or a lap). All graphs, histograms, track reports, FFTs, Scatter Plots and Mixture Maps are 'Zoom Linked'. This means that changing the zoom level on one graph will change the zoom level on all graphs. This changes the amount of data shown on the other linked display elements. This allows you to zoom in on one corner, for example, and view the suspension data just for that area.

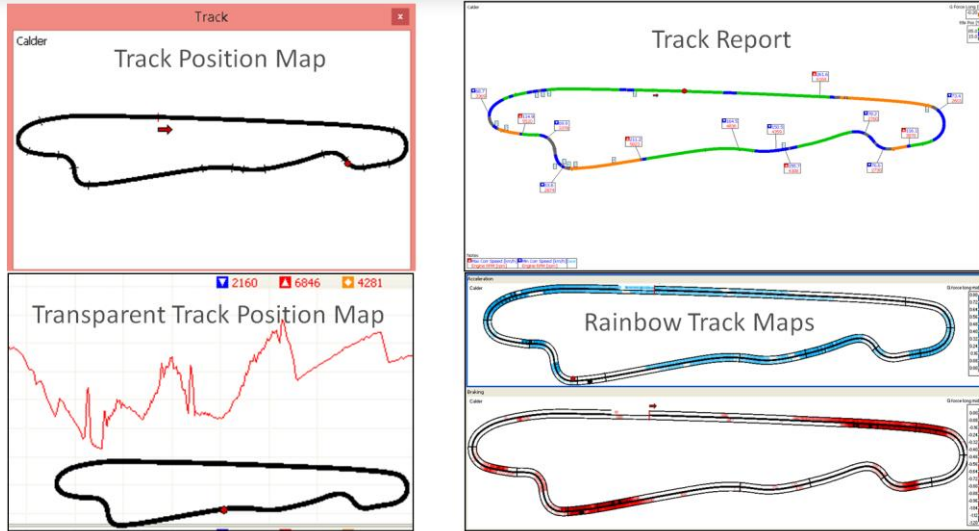
Display elements are also 'zoom linked' across Workbooks/sheets. This way you can change the zoom level on one sheet and then see the same data section on another sheet.

For display components such as Scatter Plots and Histograms, the shortcut keys 'F2' and 'W' still apply. To zoom within a lap or across multiple laps use a graph to select the zoom level.

It is possible to disable zoom linking for a specific component by going into the Properties page and un-ticking the box for 'Zoom Linking'.



Introduction to Track Mapping



A track map provides a graphical representation of the venue at which the logged data was acquired. For this function to be available it is necessary for the following inputs to be logged: lateral G force, vehicle speed and a lap beacon. Or GPS data and a beacon. The software will then derive a map based upon the driving line of the fastest lap in the log file. The map allows the user to relate the data to the specific track position where an event has occurred.

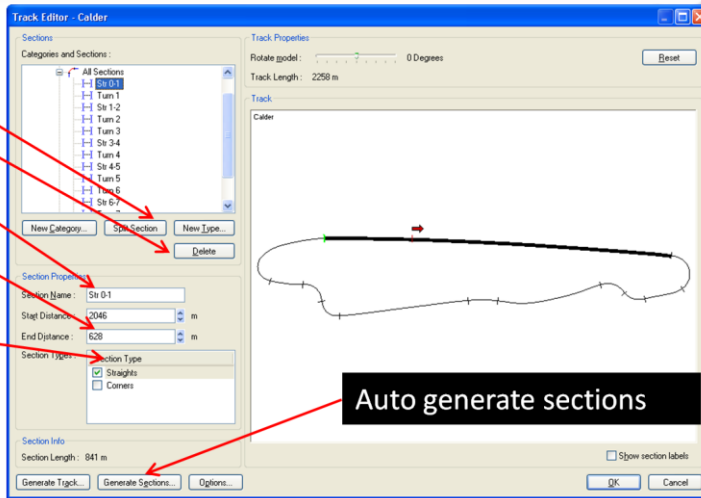
In i2, track maps can be used to show a graphical representation of data logged in the log file. It can of course show the channels Throttle position, Brake Active and Gear, but can also be used to show oil pressure across a lap, or braking pressures for instance, as shown in the rainbow track map examples above.



Track Editor 1

Sections

- Split
- Delete
- Section Name
- Enter Distances
- Section Type



5 Ways to Edit Track:

- Right-click map, select 'Edit Track...'
- Right-click map, press 'T'
- Pull down menu 'Tools' select 'Edit Track...'
- Press 'Alt-T' then 'K'
- Select icon

The Track Editor is used to generate/regenerate a track map, create/modify sections and add new section categories. These can then be used to generate a time report or channel report, e.g. divide the track into 3 sectors for a time report.

The Track Editor can be accessed from the menu 'Tools – Track Editor', by right-clicking on a track report and selecting 'track editor', or by right-clicking on any track map and selecting 'track editor'.

A track map will automatically be generated from data from the fastest lap that is selected on a venue for which no track map currently exists.



Track Editor 2

Generate Track

- Track Length
- Distance Channel
- Lateral G Channel
- Track Type

Generate Track [X]

Source

Range : Lap 2, 9:53:00 AM, 23/11/2005, Calder, secur

Length : 2168 m

Method

GPS Lateral G & Speed

Settings

Distance Channel : Corr Dist (Unstretched) [Properties...]

Lateral G Channel : G Force Lat [G] [Properties...]

Inverse Lateral G Channel

Track Generation Settings

Track Type :

Closed circuit

Crossover circuit

Open circuit

Curvature : 0.0 %

[OK] [Cancel]

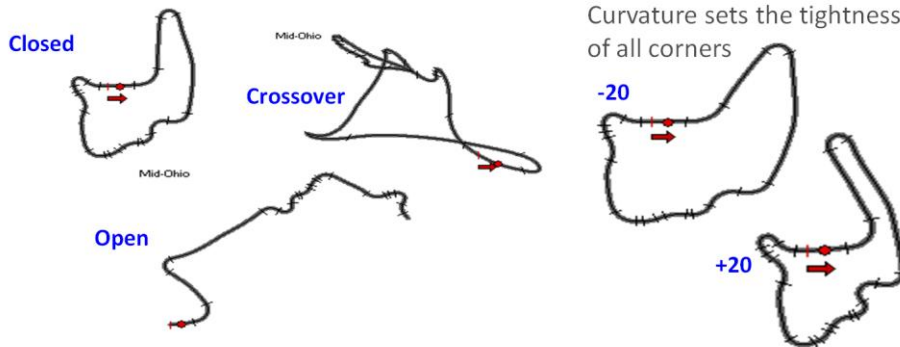
Distance Channel is 'Corr Dist' by default and lateral G is 'G Force Lat'; other channels can be selected using the button next to the channel name. There is an option to use an invert of the lateral G channel if the sensor calibration had been reversed. The track length can be entered manually or use the calculated length of the current lap. If the length is changed, the shape will remain the same, but the map is rescaled to the new distance.

Note that after regenerating a track map, the sections may need to be recalculated. This is done from the main Track Editor page. Again the distance and lateral G channels can be selected, along with a 'lateral G threshold'. This determines the changeover value between straights and corners.



Track Mapping Troubleshooting

My map is close to the actual track, but there are still details that need to be changed.



It is not the right type of track: When the track map is displayed, right click on the track. Select 'Track Editor' and then click 'Generate Track' button, choose between Closed, Crossover Circuit or Open Circuit.

The orientation of the track is wrong: When the track map is displayed, right click on the track. Select 'Track Editor'. Use 'Rotate Model' slider.

The 'Curvature' parameter will alter how 'sharp' the corners are, a positive number will make the turns tighter, a negative number will do the opposite. This number can be set between -100 and $+100$.

This is sometimes required due to low sampling rates that distort the shape of the circuit slightly and hence this feature enables us to either 'fatten' or 'thin' the circuit down as required

The radiuses of the turns are either too small or too large: When the track map is displayed, right click on the track. Select 'Track Editor' and then click 'Generate Track' button, the curvature can be adjusted.

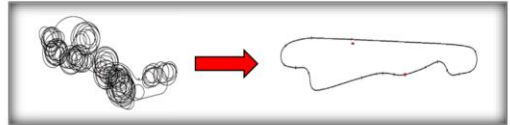


Track Mapping Troubleshooting

My map is totally wrong. I cannot recognise anything.

- **Check the Lateral G trace**

- Is there any offset in the straight line? Create a math channel to correct this offset.
- Is the maximum G Force value in the corner realistic? Create a math channel to adjust the scaling by the maximum value in the corner
- Is there excessive noise in the Lateral G trace? If so check the mounting is secure, check the wiring and connections for potential interference. A noisy trace can sometimes be improved by filtering the Lateral G channel using i2 Channel Maths.



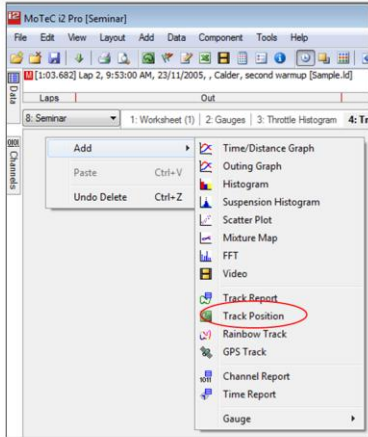
- **Check the Speed**

- Is the maximum speed value realistic?
Check the Speed + Distance or create a math channel to scale or offset your data.
- Check the calibration of your wheel speed sensor.

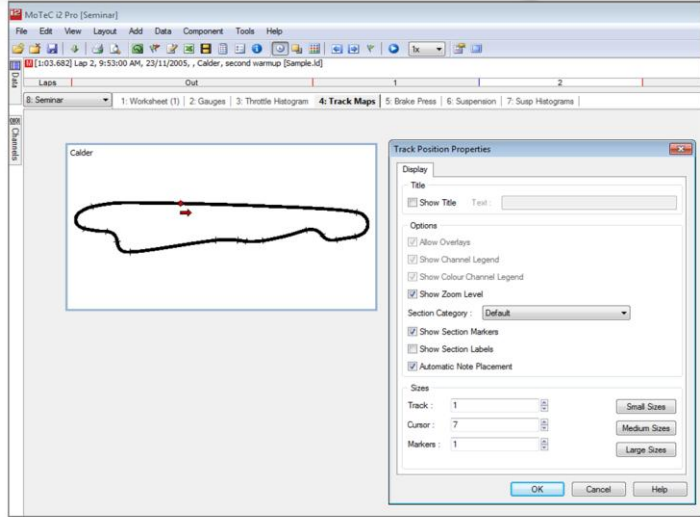
Open the logging and display the Lateral G, Longitudinal G (if fitted) and Wheel Speed. If either of these will not display then they are probably not being logged and the map will not be drawn, check your Dash Manager setup and your sensor wiring.



Track Mapping - Position



Track Position Map



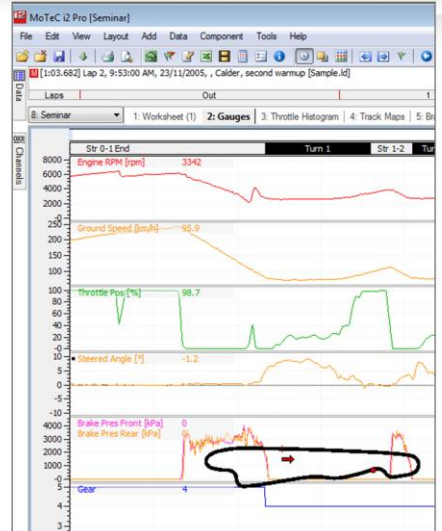
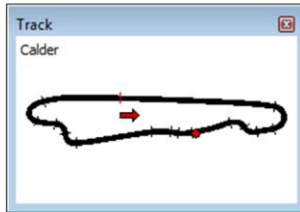
Select the Workbook 'Samples', then add a new Worksheet by right clicking on the Worksheet name area.

Call this sheet 'Track Maps', then right click on the page, then select 'Add', 'Track Position'.



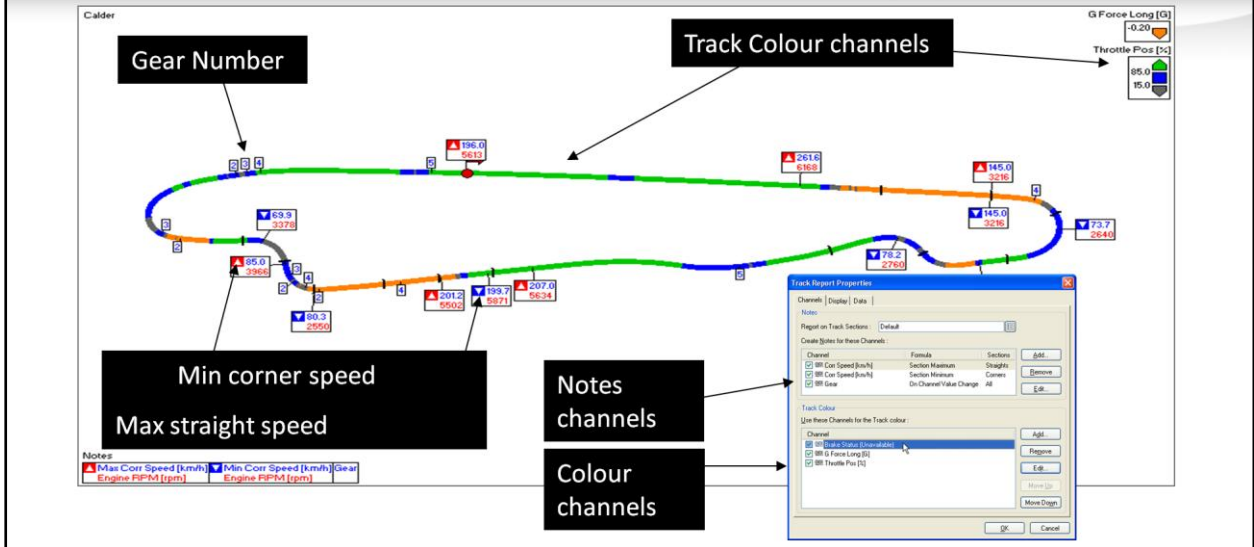
Track Mapping - Transparent

- Pressing 'T' will bring up the Track Display Box
- Dragging the box you can move it on the screen to a position that suits your data layout.
- Now Press 'Ctrl + Shift + T' to make the map transparent





Track Report



The Track Report shows channel statistics on a Track Map based on track sections. The channels shown are fully configurable with a statistical calculation performed over the section in question.

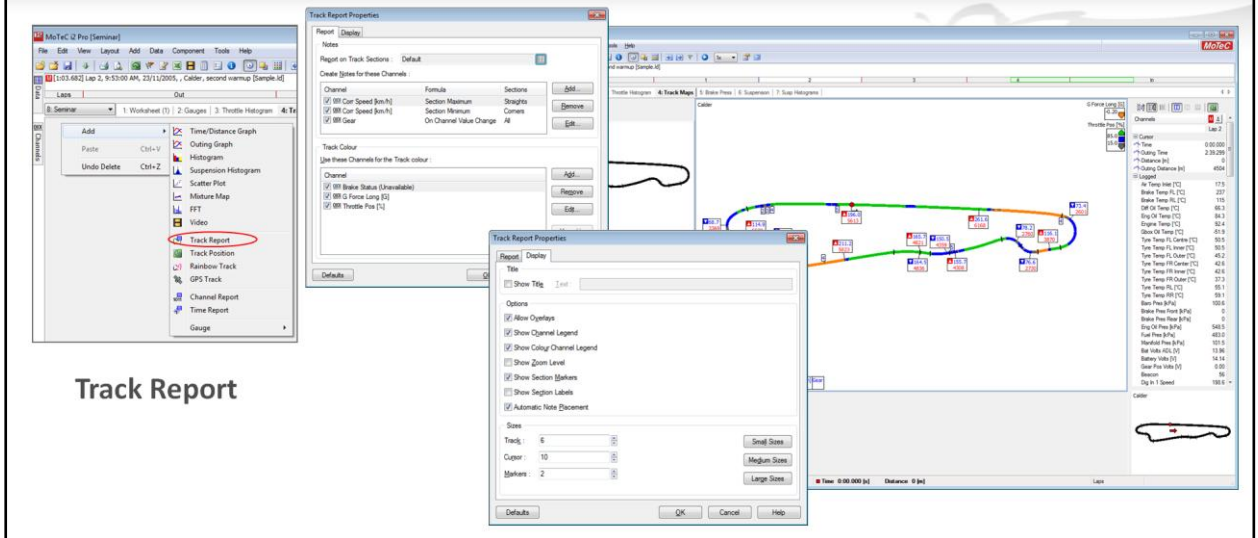
Press 'F5' to see report properties and select the channels shown. They can also be displayed for a particular section type only, e.g. Max Speed on the straights, Min Speed on the corners.

The report may use the default sections or user defined sections. The notes point to the position on the track at which the event occurred. This means that engine RPM is shown at the point of maximum speed, for example.

The notes may be moved by dragging them if their positioning is not suitable. It is worth remembering that once a note is dragged, all others will maintain their positions until 'Automatic Note Placement' is reselected under Properties - Display.

Additional channels can be used to 'colour' the track. These are added in layers with a channel lower in the list only being visible if the channels above it are not being displayed at that point.

Track Mapping - Report



Track Report

Right click on the page, then select 'Add', 'Track Report'.

The Notes: The Notes (value boxes) can be shown for each section of the track or at the point that the channel changes. The section notes may show various channel statistics for each section such as min max or average. The Note may also show the value of other channels at the same point in time where the statistic occurred, for example a Note may be configured to show maximum speed for the section, in this case it may be useful to show the Engine RPM at the same point in time.

Report On Track Sections: The sections used for the report may be selected to base the report on the default sections or on user defined sections.

Report Formulas: The following formulas are available:

- Section Average
- Average channel value for the 'Report on' range
- Minimum
- Minimum channel value for the 'Report on' range
- Maximum
- Maximum channel value for the 'Report on' range
- Absolute Maximum

Maximum 'absolute' (maximum positive or negative) channel value for the 'Report on' range

Value at Start: Channel Value at the start of the 'Report on' range

Value at End: Channel Value at the end of the 'Report on' range

Value Change: The change in value between the start and end of the 'Report on' range.

Standard Deviation: The standard deviation of the channel value for the 'Report on' range.

On Channel Value Change: Shows a note every time the value changes. This is useful for channels that change infrequently such as gear. This formula ignores the report on range.

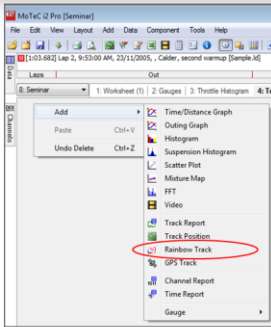
Filter by Section Type: Each note can be filtered by section type. For example if the Report On range is set the default sections then the notes can be filtered by Corner or Straight, this means that notes will only be placed for the section types specified in the filter.

Moving the Notes: The notes may be moved by dragging if their positioning is not suitable. Once a note is dragged, all notes will maintain their positions until **Automatic Note** placement is re-selected from the component menu.

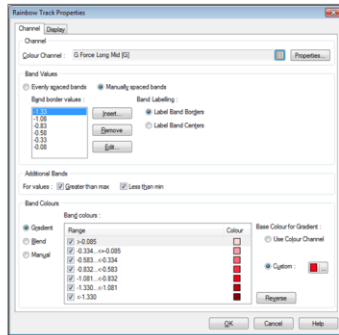
Track Colour Channels: The track can be rendered in a colour gradient according to one or more channels. When using more than one channel, the colours are layered. In this case the channel on top must include gaps so that the channel below can be seen. For example the brake status can be setup such that it only shows colour when the brake is applied allowing the channel beneath to be seen during the non-braking periods. The default configuration for the track report shows how to do this. The channel that is first in the list is the channel that is rendered on top.



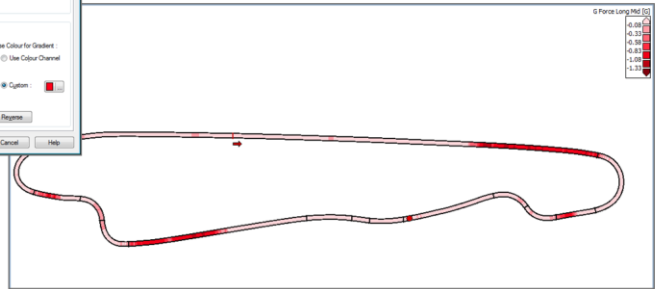
Track Mapping - Rainbow



Rainbow Track Map



Rainbow Track Maps are good indicators for value change on items like Accelerations and Brake Temps



Select the Workbook 'User', then add a new Worksheet by right clicking on the Worksheet name area

Call this sheet 'Rainbow Track Map', then right click on the page, then select 'Add', 'Rainbow Track Map'.

Click on the button to the right of the 'Colour Channel' box, and choose 'G Force Long'

Click on the number of bands, and change it to 5, click the 'Reverse' button, then finish with 'OK'.

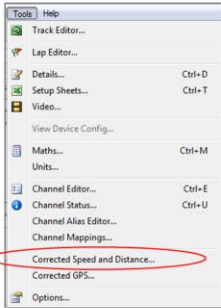
Right click on the page, then select 'Add', 'Rainbow Track'.



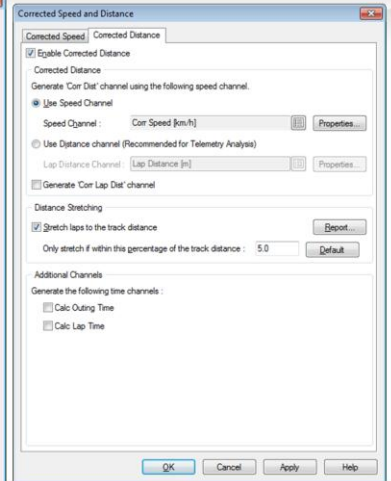
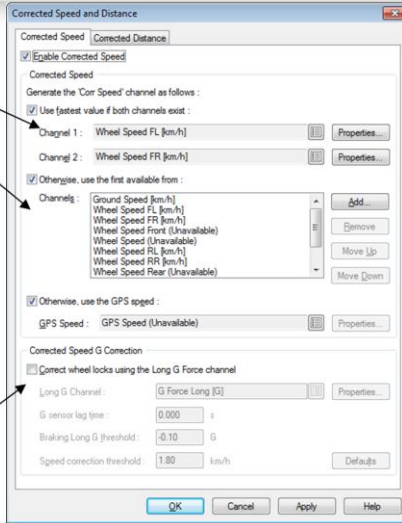
Corrected Speed & Distance

Use fastest of 2 channels

or use first available from this list



Apply Long G correction



Although distance is generally calculated in the Dash Logger, i2 also performs a distance calculation to give what is known as 'Corrected Distance'. Corrected Distance must be calculated so that the graphs can be plotted against distance rather than time. This allows laps to be compared at the same distance point on the track – the only way to make a meaningful comparison. To ensure that the distance is as accurate as possible, there is an option to calculate a 'Corrected Speed' channel from one or 2 input channels, along with Longitudinal G correction to account for wheel lifts or lock ups.

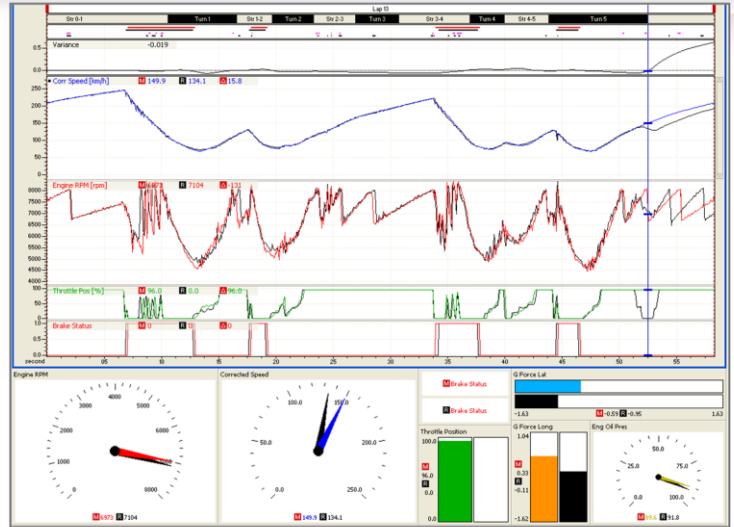
Setup for Corrected Speed is under the 'Tools' menu. By default Corrected Distance is calculated from Corrected Speed, however another speed channel can be selected as the input to this calculation. To account for variations in the measured speed and resulting distance from one lap to another, lap lengths are stretched to match the track length. This allows for consistent comparisons across different laps and sessions.

On the 'Corrected Distance' tab there is a button labeled "Report". Click this button to show the distance report of all laps. This report shows lap stretch or shrink to allow for slight lap length variations. You can turn this on or off in the previous screen, as well as set the maximum stretch/shrink percentage.



Data Overlaying

- Show the effect of vehicle changes
- Show differences between test sessions to highlight where track conditions have changed
- Evaluate differences between drivers



Overlaying allows the differences between two laps to be accurately determined. i2 can display the variance - the cumulative time difference or delta time - between two laps. This shows where time was gained or lost between the two laps being compared to indicate which sections of the lap need further investigation.

Analysis of vehicle speed, throttle position, and lateral G force allows differences in braking points, use of throttle and the line through the corner to be evaluated to provide direct information on how the vehicle and driver have changed between the laps being compared.

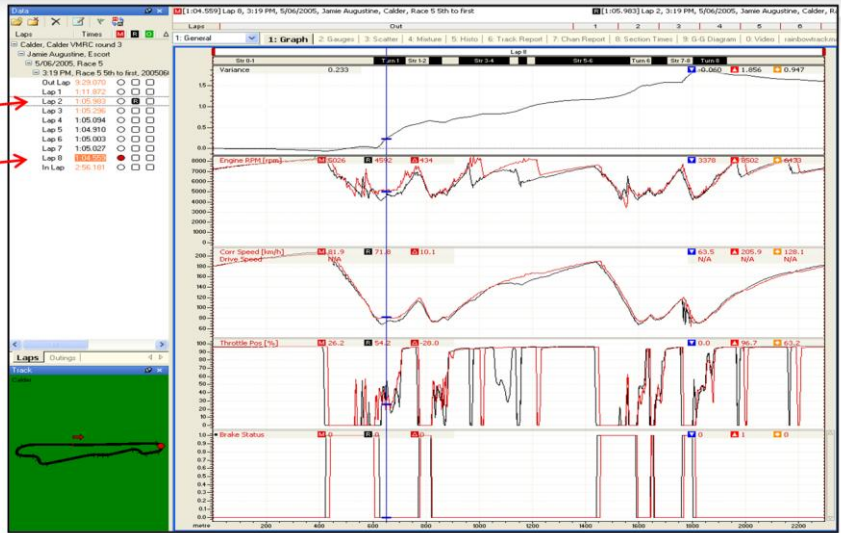
Comparing two laps is one of the best ways to find places where your car or driver can improve. Using two laps of data, select one as the Main lap, and the other as the reference lap. When you do this, it puts the overlaid data in black (colour can be changed) alongside the Main data. One thing to remember when overlaying laps is to always do it in distance mode, not time. The reason for this is that if you are comparing two laps, the track distance will be the same lap to lap, so your speed, throttle, pressure and other readings are compared at the same points on the track. If you try to compare the data using time, as you lose time over the lap, the traces become no longer aligned, offset by the amount that one lap is slower than the other.



Comparing Laps - Overlays

Reference Lap
(Black)

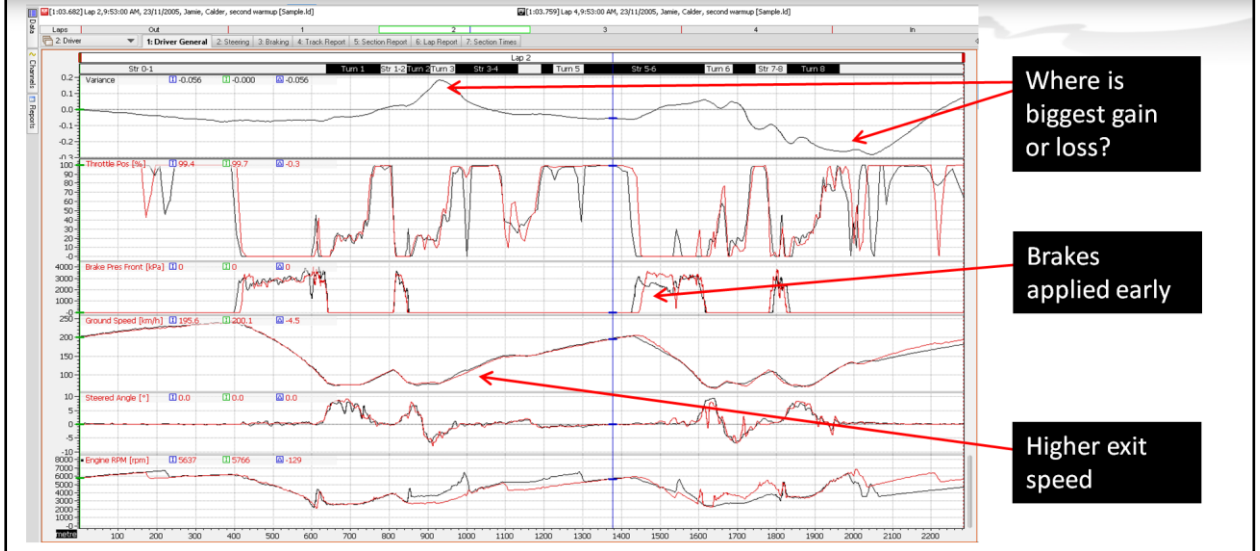
Main Lap (Red)



By pressing F3, you can insert a variance trace at the top of the Worksheet as shown above. As you can see, the variance line shows where one lap has gained or lost time over the other lap. This is a useful trace to find the points on the track where the most time has been gained or lost, showing the driver what part of the track to focus on to make gains in time. As a starting point look for the steepest slope or biggest jump in the variance line, then zoom in on that area of data.



Where Did I Lose Time?



Overlaying data from different drivers allows for quick identification for where one driver may be quicker than the other, by means of different line being driver, braking/turning/ on throttle at different times.

Overlaying the same car but run to run can help in identify where a chassis change has had effect on the car balance and handling.



Offset Axis

The screenshot shows a MoTeC software interface with two main plots. The top plot displays 'G Force Lat [G]' and 'G Force Long [g]' over a distance of 0 to 1200 metres. Below the main plot is an 'Offset Axis' with two rows: 'M' (Main) and 'R' (Reference), each with a numerical value (+6 and +0 respectively). A 'Set Offset for 'Lap 4'' dialog box is open on the right, showing options for 'Offset Type' (Absolute or Relative to start of 'Lap 4'), 'Offset amount' (Specify Time or Specify Distance), and input fields for 'Time' (00.000 s) and 'Distance' (0.00 m). Callout boxes point to a 'Shortcut icon' in the toolbar, the 'Enter Offset value' field in the dialog, and the 'Offset in Distance or Time' values in the main plot.

In some instances you may be comparing data from different sessions where the beacon has been moved. In this case it becomes necessary to offset one lap relative to another. This can be achieved using the 'Offset Axis' feature of i2.

To allow precise alignment of main and reference, each may be offset in time or distance. This is done by turning on the offset axis by selecting Show Offset Axis from the graph component menu or by pressing the 'O' key.

This shows an axis for the main and reference below the nominal axis, which allows either one to be dragged relative to the nominal axis. Dragging can be performed using the mouse or by using the keyboard shortcuts: Ctrl+Shift+Arrows to move the main lap or Alt+Shift+Arrows to move the Reference Lap.

Offsetting may be turned off by pressing the O key again, this will also zero the offsets for the main and reference laps. Normally offsetting is used to make small corrections to allow for slight difference in the distance calculation from lap to lap. The best way to align laps is to look at bumps in the track surface using either the vertical G channel or a suspension position channel.

An offset can also be entered in seconds or meters by right clicking on an offset axis and selecting 'Set Offset'.

Press 'O' to show the offset axis

Click and hold on either the 'M' or 'R' axis, and drag it around to line up the data.

Remember to be in distance mode for overlays (F9)



Status Channels



Status conditions shown in channels list

Status conditions shown on graph

Status conditions shown as gauges

Status channels are used within data logging to indicate when an on/off condition has occurred. Examples of this include a brake switch, shift lights, alarm/warning light, alarm acknowledge button, full throttle switch, clutch switch, nitrous activate and more. It is useful to see this information in the context of the rest of the data, knowing just where on the straight the nitrous is being activated, and what that is doing to your ignition timing, air fuel ratio and ground speed.

By pressing 'E' you can turn the status conditions on and off viewing them only as required.

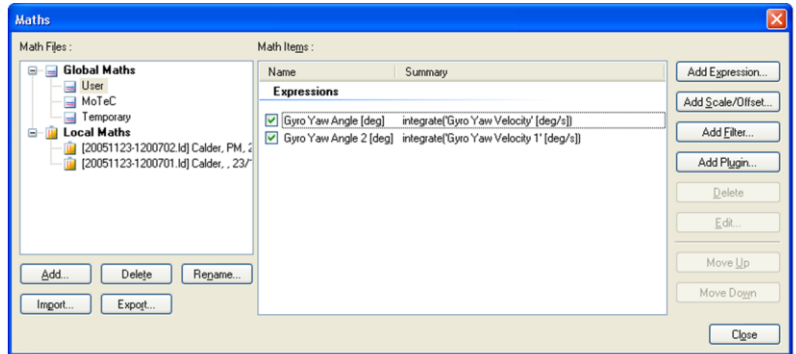


Maths

Simple Maths Functions (Filter, Scale & Offset)

- A number of simplified maths functions are provided to avoid the use of Expression Editor for simple operations like Filtering and Scale & Offset.

- All other functions must be performed using the Expression Editor. Note that these functions modify the original channel – they do not create a new channel. To create a new channel use the corresponding functions in the Expression Editor.



Global Maths

Global maths is calculated for all log files that are loaded. Global maths is stored in maths files within the project. Multiple maths files can be used, which allows the maths to be separated into functional areas such as Engine, Chassis, Aero etc. The global maths files may be copied to other projects by clicking on the Import and Export buttons in the Maths Editor. An example of maths that may be useful as global is a Lateral G filter that you always apply to your car to give your data a comparable trace.

Local Maths (Maths per log file)

Maths may also be created per log file. The local maths is stored alongside the log file in the companion (.idx) file, the original file is never modified. This would normally be used for things such as setting the steering trace to 0 if you had forgotten to do so before the session.

Order of Calculation

The order of the maths equations in the list does not matter. Any dependencies are determined at calculation time so that if a maths equation requires other maths channels then the required maths channels will be calculated first.

On Demand Processing

The maths equations are processed on demand, i.e. as different Worksheets are displayed the required maths channels will be calculated as the Worksheet is displayed (unless they have already been calculated).

Maths Status

The status of the maths calculations is available in the Tools | Channel Status dialog. Note that any maths channels that have not been displayed or otherwise required will be tagged as Pending due to the "on demand" processing scheme.

Constants

Constants are used to represent common factors such as Pi. Maths Constants are stored in the maths files and can only be accessed by maths within that file.

Maths File constants are specified in the Maths Expression Editor.



Maths Expressions 1

Example

An expression that creates vehicle acceleration can be described as follows:
 Vehicle Acceleration = Derivative (Wheel Speed)

The resultant value of this equation depends on the units specified for Wheel Speed, which must be specified in the equation. In this example it is easiest to use units that have a corresponding speed and accel. equivalent as this avoids the need for conversion factors, e.g. m/s for speed, m/s/s for acceleration.

- So the equation could be entered as follows:
 - Channel Quantity: Acceleration
 - Display Units: G (or any other valid unit)
 - Expression Result Units: m/s/s
 - Expression: derivative ('Wheel Speed Front Left'[m/s])

Expression :

```
derivative('Wheel Speed FL'[m/s])
```

This will work irrespective of the units that the Wheel Speed was logged in and units the result is to be displayed in. For example, Wheel Speed may have been logged in mph so the maths will convert mph to m/s before differentiating, which will give a resultant value in m/s/s.

By telling the system the units of the resultant value is m/s/s, the resultant channel can be displayed in any units we like, which in this case would typically be G.

Maths Expressions are powerful maths formulas that are entered in plain text format.

Channel Names Used in Expressions

When entering channel names into an expression, all channel names must be enclosed in single quotes, for example: 'Engine RPM'. The quotes are added automatically if selecting a channel from the embedded channel list. Channel names are not case sensitive so 'Engine RPM' could also be entered as 'engine RPM'

Units of Channels Used in Expressions

When entering an expression, every channel should be followed by units in square brackets. For example: 'Wheel Speed Front Left' [km/h]

The units specified are the units that the channel value is converted to before the calculation is performed and thus affects the resultant number and the appropriate result units (see below).

Note that when a channel is selected from the channel list, the default units will be automatically appended to the channel name. If the units are not the desired units then they may be edited as necessary. When typing the units a help window will show the valid units for the particular channel.

Maths Functions

An extensive set of maths functions is provided for use in the expressions.

For details on the available maths functions and associated parameters see: Maths Functions

Result Units

The result units of the expression must match the numeric result of the expression.

Note that the result units need not be the same as the display units. It is very important to understand this difference.

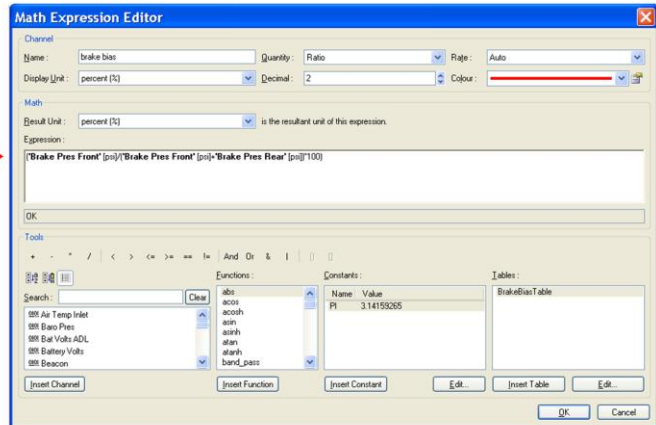


Maths Expressions 2

Calculating Brake Bias %

(‘Brake Pres front’ [psi] / (‘Brake Pres front’ [psi] + ‘Brake Pres Rear’ [psi])*100)

Type Maths Expression



Maths Channel Name

The name of the resulting maths channel is specified in the expression editor.

The maths channel name may contain any character except single quote (').

Sample Rate

The sample rate specifies the sample rate of the resultant maths channel.

If the channels used in the expression do not have the same sample rate then they will be re-sampled to the result sample rate before the maths expression is run. The re-sampling function uses linear interpolation to determine the values at the new sample rate. It is normally best to use a sample rate that is equal to the highest sample rate of the maths input channel(s).

Auto Sample Rate: The Auto sample rate selects the highest sample rate of the input channels and is therefore suitable for most maths processing.

Quantity: The quantity must be set so that valid display and result units can be set.

Display Units, Decimal Places, Colour: Sets the default values for these channel properties.

Enter this expression for Brake Bias Calculated:

(‘Brake Pres front’ [psi] / (‘Brake Pres front’ [psi] + ‘Brake Pres Rear’ [psi])*100)



TRAINING CONFERENCE 2015

Lap Gain/Loss





What is Lap Time Gain/Loss?

- Running time gain or loss compared to a reference lap.
- Continuously updated as the vehicle proceeds around the track.
- Gain/Loss is zeroed each time the vehicle passes the beacon.
- Lap distance and running lap time channels are required.

When driving in the car with Lap Gain/Loss displayed, the driver can get instantaneous feedback on the car, the driving and the current lap. A driver can determine the following easily with Gain/Loss:

- Which specific corner or straight is most of the lap time being gained or lost on?
- Which part of the corner is the time gained/lost?
- Is this lap going to be a fast one?
- Should I pit this lap for a change, or complete the lap?



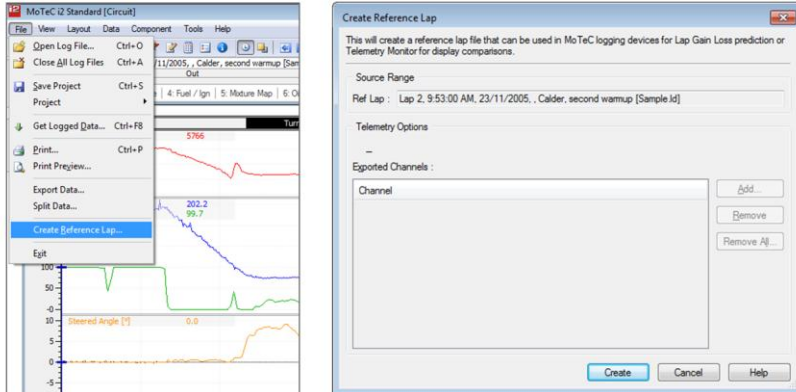
What is a Reference Lap?

- A Reference Lap contains time and distance pairs, indicating what time to expect at a certain distance around the track from a known logged data lap
- The Reference Lap file must be created with i2, then loaded into the Dash using the Dash Manager configuration software



Generating a Reference Lap in i2

- Click on File on the Main menu then click Create Reference Lap make sure that Lap Distance Channel is logged in the data
- i2 will create a reference lap file for the current main lap

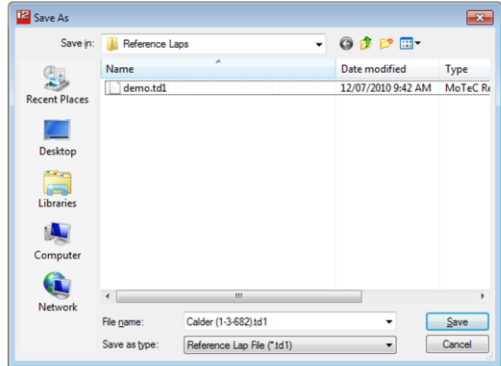
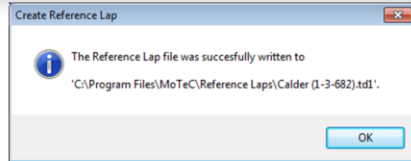




Generating a Reference Lap in i2

Click **Save** button to create Reference Lap

- The default file name is created as follows:
- Venue (Lap-time)
- For example: Calder (1-3-682)
- In this case the venue was Calder and the Lap-time was 1:03:682





Set Reference Lap in Dash

The screenshot shows the MoTeC C185 Dash Manager software interface. The 'Online' menu is open, and 'Set Reference Lap...' is highlighted with a red circle. Below the menu, the 'Set Reference Lap' dialog box is open, showing the file name 'Calder (1-3-682)' and a 'Browse...' button. To the right, the 'Open Reference Lap' dialog box is open, showing a list of files in the 'Reference Laps' folder. The file 'Calder (1-3-682).td1' is selected. Below the file list, the 'File name' field contains 'Calder (1-3-682).td1' and the 'Files of type' is set to 'Reference Lap Files'. The 'Open' button is visible.

Name	Date modified	Type
Calder (1-3-682).td1	6/10/2010 2:46 PM	M
demo.td1	12/07/2010 9:42 AM	M

File name: Calder (1-3-682).td1 Open

Files of type: Reference Lap Files Cancel

Venue: Calder Date / Time: 23/11/2005 9:53:0

Driver: Car: 11A

Session: 2 Ouling: 0 Lap: 2

Lap Time: 63.68 s Distance: 2.2650 km

Comments: second warmup

When connected to the Dash, go to the Online Menu and find 'Set Reference Lap' to send your lap.

Click on Browse button and select Reference Lap then click Open.



Set Reference Lap in Dash

- Click on the Send button to load a Reference Lap into C185
- If you want to make a correction to the Lap Distance or Lap Beacon Position you can change it here
- Click OK and your Reference Lap is set

Set Reference Lap


Reference Lap file

File name : Calder (1-3-682)

Correction : 0.0 % (%)

Beacon Offset : 0 m (m)

Set Reference Lap

 The new reference lap has been sent to the Dash.



Gain Loss Displayed in the car

- Lap time Gain/Loss can be displayed in any position on the driver's display.
- In this example, it is shown on the bottom row as a Gain/Loss bar.
- When the driver is slower than the loaded Reference Lap it colours the bar red
- If the driver is faster than the Reference Lap it colours green in the direction of Gain
- The Predicted Lap Time is also being displayed to the driver (right hand side middle value)





TRAINING CONFERENCE 2015

Reliability and Safety





Channel Report

1: Samples | 2: Graph | 3: Gauges | 4: Mixture | 5: Histo | 6: Susp Histo | 7: Susp FFT | 8: Track Report | **9: Chan Report** | 0: Section Times

Time Report - Selected Laps

		Lap 2
Eng Oil Pres [kPa]	Min	396.5
	Avg	4281
Engine RPM [rpm]	Min	2160
	Max	6846
Engine Temp [°C]	Max	94.4

Time Report - All Laps

		Lap 1	Lap 2	Lap 3	Lap 4
Eng Oil Pres [kPa]	Min	399.7	396.5	383.7	364.4
	Avg	4005	4281	4021	4244
Engine RPM [rpm]	Min	2286	2160	2346	2208
	Max	6420	6846	6648	6672
Engine Temp [°C]	Max	92.4	94.4	95.4	95.0

Time Report - Track Sections (Selected Laps)

		Lap 2													
		Str 0-1 (End)	Turn 1	Str 1-2	Turn 2	Str 2-3	Turn 3	Str 3-4	Turn 4	Str 4-5	Turn 5	Str 5-6	Turn 6	Str 0-1 (Start)	
Corr Speed [km/h]	Min	201.8	145.0	73.4	73.7	76.6	78.2	113.1	199.7	159.7	80.3	63.6	69.9	68.7	
	Max	261.6	221.5	145.0	100.2	116.1	113.8	207.0	211.2	201.2	159.7	85.0	88.4	196.0	
Engine RPM [rpm]	Avg	5980	4243	2852	2809	3178	3082	4854	5794	4529	3406	3084	3654	4884	
	Min	5199	3119	2160	2604	2682	2664	3918	5404	3473	2502	2262	3294	3336	
	Max	6420	5232	4128	3444	3912	4332	5858	5934	5404	4422	4002	4242	6846	

Stats for a single lap
with Reference Lap

Stats for multiple laps
Stats for sections of a single lap

Time Report - Selected Laps

		Lap 2	Lap 4	Δ
Eng Oil Pres [kPa]	Min	396.5	364.4	32.1
	Avg	4281	4244	37
Engine RPM [rpm]	Min	2160	2208	-48
	Max	6846	6672	174
Engine Temp [°C]	Max	94.4	95.0	-0.6

The Channel Report shows channel statistics in a tabular form.

The report may be configured to report on various ranges including:

Report on Laps for All Laps

Report on Laps for the Selected Laps

Report On Sections for Selected laps (either the default sections or user defined sections may be used)

The statistics available are:

Average, Minimum, Maximum, Absolute Maximum, Start Value, End Value, Value Change & Standard Deviation.

Reports for selected laps (not all laps) can also display data from the Reference and Overlay laps when these are selected. Also shown is the difference between the Main and Reference laps.

Press '9' or select 'Chan Report' from the 'Samples' Workbook

Click on the top channel report to give it focus and press 'F5'

Select 'Add' then search for fuel pressure and double click on it.

Turn on the tick box for minimum and click 'OK'.



Using the Channel Reports

Main and Reference Lap details

All laps channel report

Selected laps (main and overlay) channel report

Selected laps channel report by sectors

	Lap 2	Lap 3	Δ
Eng Oil Pres [psi]	Min 57.5	55.7	1.9
Engine RPM [rpm]	Max 6846	6648	198
Engine Temp [°C]	Max 94.4	95.4	-1.0
Fuel Pres [psi]	Min 68.7	68.8	-0.1
Battery Volts [V]	Avg 14.07	13.99	0.07
Diff Oil Temp [°C]	Max 75.7	79.1	-3.4
Air Temp [°C]	Avg 18.1	18.1	0.0
Air Temp Inlet [°C]	Min 17.2	17.3	-0.1
Baro Pres [hPa]	Max 101.0	101.0	0.0
Brake Pres Front [psi]	Max 581.60	484.72	96.89
Brake Pres Rear [psi]	Max 594.65	522.43	62.22
Brake Temp FL [°C]	Max 525	557	-32
Brake Temp RL [°C]	Max 277	287	-10

	Lap 1	Lap 2	Lap 3	Lap 4
Eng Oil Pres [psi]	Min 58.0	57.5	55.7	52.9
Engine RPM [rpm]	Max 6420	6846	6648	6672
Engine Temp [°C]	Max 92.4	94.4	95.4	95.0
Fuel Pres [psi]	Min 68.6	68.7	68.8	69.5
Battery Volts [V]	Min 13.96	13.94	13.89	13.83
Diff Oil Temp [°C]	Max 66.3	75.7	79.1	84.8
Air Temp [°C]	Avg 18.0	18.1	18.1	18.2
Air Temp Inlet [°C]	Max 18.9	18.9	19.0	18.9
Baro Pres [hPa]	Avg 101.6	101.6	101.6	101.6
Brake Pres Front [psi]	Max 597.99	581.60	484.72	579.72
Brake Pres Rear [psi]	Max 630.48	584.65	522.43	586.53
Brake Temp FL [°C]	Max 365	525	557	594
Brake Temp RL [°C]	Max 220	277	287	342

	Str 0-1 (End)			Turn 1			Str 1-2			Turn 2			Str 2-3			Turn 3		
	Lap 2	Lap 3	Δ	Lap 2	Lap 3	Δ	Lap 2	Lap 3	Δ	Lap 2	Lap 3	Δ	Lap 2	Lap 3	Δ	Lap 2	Lap 3	Δ
Corr Speed [km/h]	Min 142.0	138.0	4.0	73.4	71.9	1.5	73.8	70.6	3.2	76.6	74.6	2.0	78.2	76.2	2.0	141.9	140.0	1.9
Max 261.6	239.4	22.2	142.0	138.4	3.7	103.2	100.5	2.6	116.1	112.4	3.7	141.9	140.0	1.9	167.6	163.8	3.8	
Engine RPM [rpm]	Min 3633	3132	501	2160	2580	-420	2618	2562	56	2682	2619	63	2664	2616	48	4278	3996	282
Max 6420	6270	150	4128	5088	-960	3533	3437	96	3912	3834	78	4839	4794	45	5172	5076	96	
Engine Temp [°C]	Max 93.7	95.4	-1.7	93.7	95.3	-1.6	93.6	94.6	-1.0	93.4	94.1	-0.7	93.0	93.0	0.0	93.0	92.0	1.0
Diff Oil Temp [°C]	Max 69.2	77.1	-8.0	70.3	77.5	-7.2	70.8	77.5	-6.7	71.2	77.3	-6.1	71.7	77.3	-5.6	72.2	77.4	-5.2

The i2 Channel report is the best way to get summary data about your outing. This data is often under utilised but can be a very powerful tool for trying to maintain the reliability of your vehicle. By checking this information at the end of each session you may notice trends in the temps, pressures, speeds or voltages of your vehicle.

This screen can show you the data in a lap by lap arrangement, useful to make sure that the data is from a lap where the car is at racing speeds. This is important to consider as there is no use looking at the minimum oil pressure on a lap when the engine was not running, or taking engine temp from a lap where the vehicle is stationary and heat soak is affecting temperature readings.

The data can also be shown in an outings mode where it just shows the min/max readings for an outing. You can even choose to exclude 'untrusted laps' which means that it doesn't include data from your in or out laps in the calculations of your statistics, a problem that often skews statistics of an outing.



Temperature Sensors

- Three major types of sensors:

- Thermistor
- Thermocouple
- Infrared



Exhaust Gas Temps come in either ‘open tip’ or ‘closed tip’ versions.

The closed tip type are more robust and will last longer, but they have a slower response than the open tip sensors.

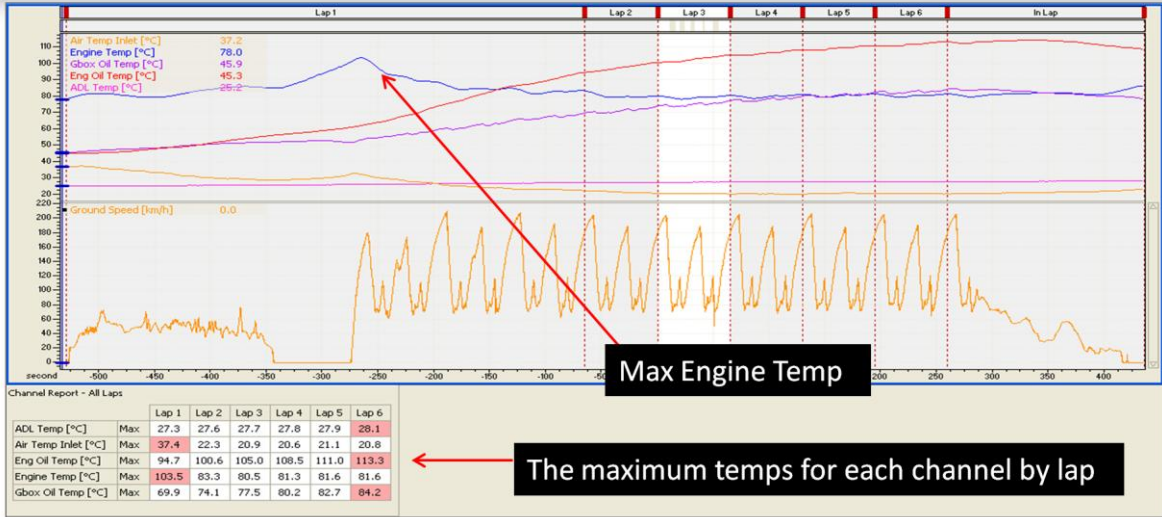
Sensors

Top Row: Infrared tyre temp, infrared brake temp, infrared tyre temp

Bottom Row: Delco Air temp, EGT, installed Bosch water temp



Reading Temperatures



If we look at the engine temperature trace, we can see that it started at around 80 degrees, and fluctuated up and down for a while. At around -250 seconds (from the start of the selected lap) we can see that the temperature peaks at over 100 degrees.

It is important to consider for what reason are you looking at the temperature. Are you looking for peak temperature to decide if a thermo fan is required for times on the grid or as the car cools down at the end? Perhaps you are looking at racing laps only, so that you can see if there is sufficient cooling during a race situation. The answer to this determines where and how you should be looking at the data.

If you are keeping a log of maximum temperatures that an engine has reached, it is usually best to look at peak racing temperature rather than a stationary temperature.

Press F2 to look at the temperatures across the whole session.



Engine Temperature Problem



You can see that at speed the temperature is still climbing. There is a cooling problem and it would be a good idea to stop driving and investigate the situation.



Types of Pressure Sensors

- Different sensors available in Absolute or Gauge
- Standard sensors range from 0 – 3000 PSI
- Can measure Air, Fuel and Oil Pressure

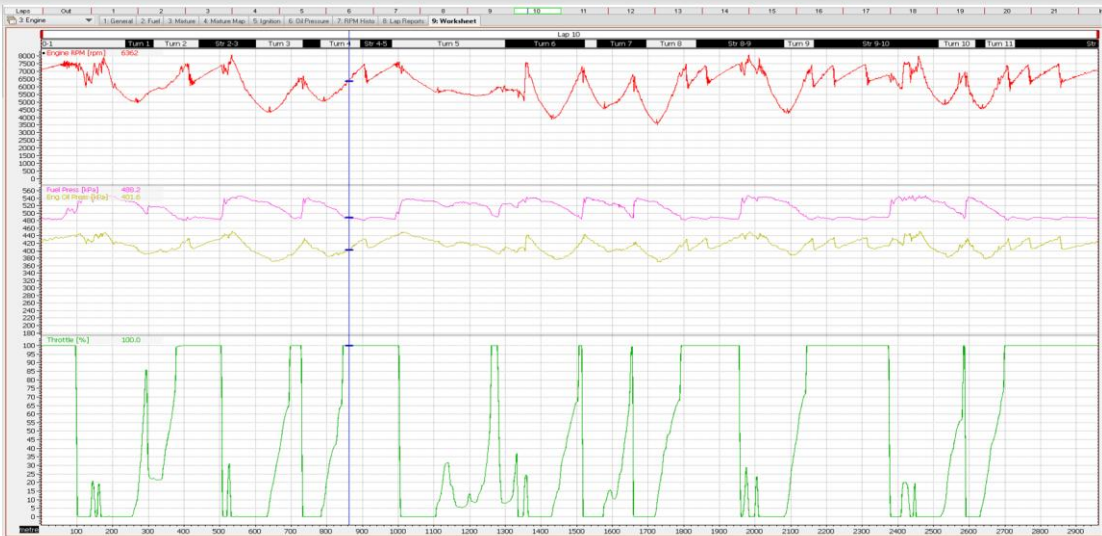


Typical pressure sensors used in motorsport applications. Some sensors shown here can be used to measure brake, crankcase, fuel, oil and water pressure. MoTeC sells a wide range of sensors with varying measurement ranges. The most accurate measurements are made with sensors that are correctly sized for the application.

Response and accuracy vary between different types of sensors.



Reading Pressures



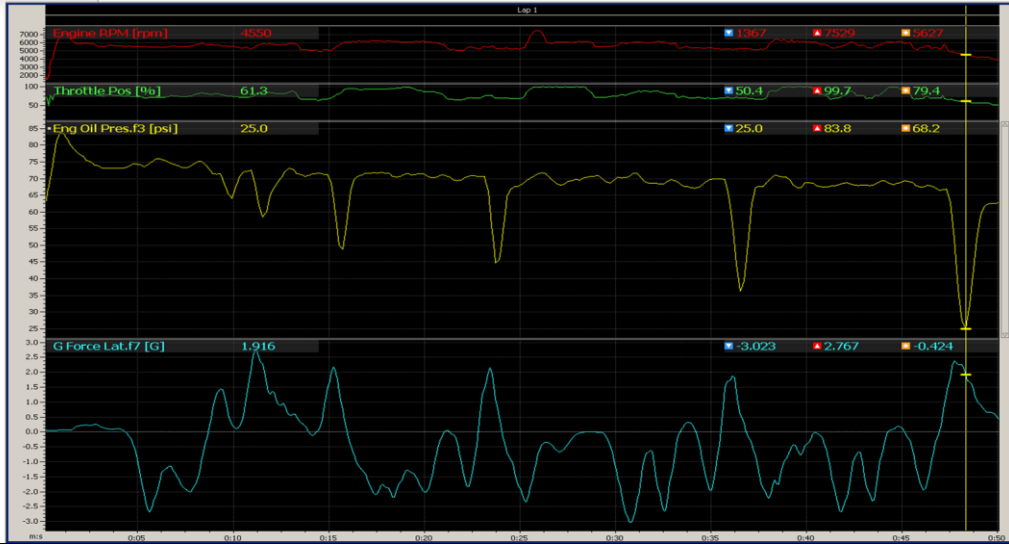
Pressure traces are often vital in examining the health of your vehicle. Whether it be fuel, oil, brake, manifold or other pressure, checking these values after each outing is an important part of ensuring that the engine is running safely.

It is common to see very noisy fuel pressure readings, although sometimes it is believed that the noise is the logger or the sensor.

Looking at fuel pressure data from even highly developed race engines, it is common to see fluctuations of 10-15psi when a good sensor is used. Don't assume that the noise isn't a genuine indication of the pressure that is happening in the fuel rail, it is more likely to be the actual fuel pressure pulse waves than sensor noise. These pressure waves are often dependant on injector duty cycle.



Oil Pressure Problem



To read the traces, again from the left, you can note that the oil pressure trace has some alarming dips.

The first thing to look at is the RPM going up and down to match this, a quick glance we can see that's not the case.

In this example, a check of the lateral G trace clearly shows the engine losing oil pressure each time the vehicle travels around a left hand corner.



Fuel Pressure Problem



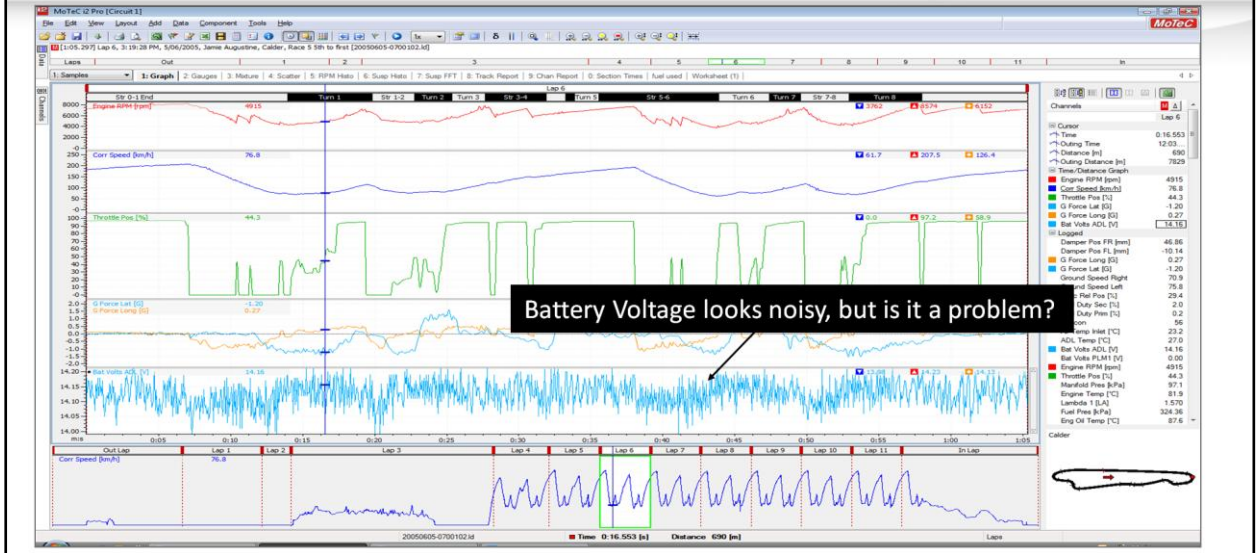
Here you can see a fuel pressure drop. This could be caused by a number of reasons.

Items to check :

- Are the Fuel pumps are staying on?
- Possible blockage in the fuel system?



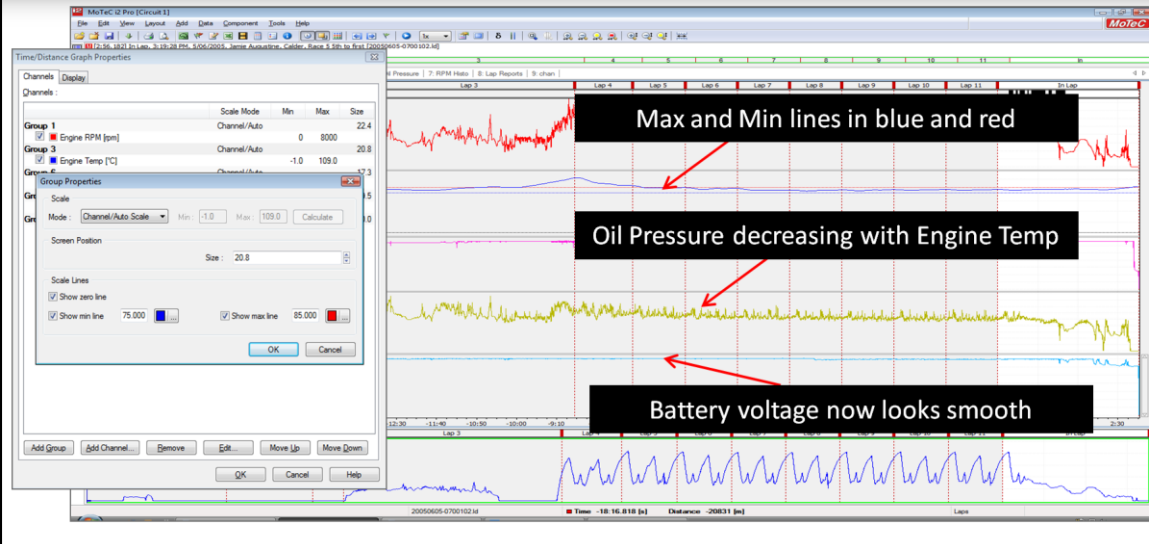
Reading Battery Voltages



Voltage should be logged at 10 Hz as a minimum. They can appear noisy in their trace; this could be interference from the alternator/regulator on the vehicle, or possibly the display scale is too close.



Useful Tips



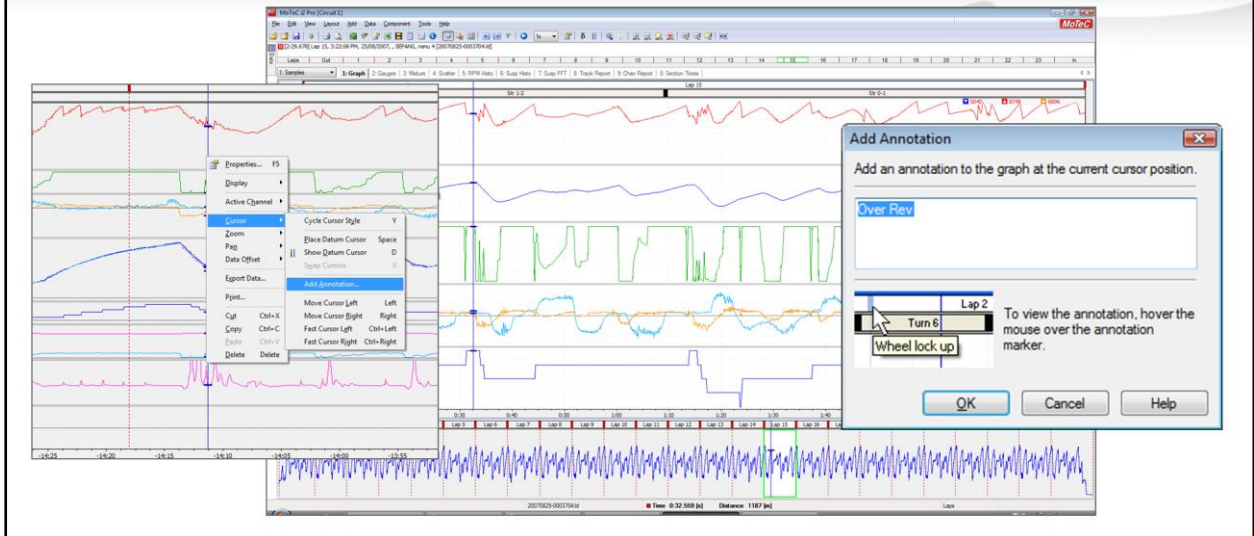
By right clicking on the graph properties, you can rescale channels to a range they work in.

Above we have scaled the battery voltage. This has smoothed out the trace compared to the previous slide .

You can also add a line to the graph at a Max value and a Min value.



Annotations



An annotation or note can be placed at any point in the data. A line will be placed in the data which you can see in all the Worksheets. So, for example, if you have a 'Wheel Lockup' event, you could also look at the oil pressure on a different Worksheet.

How to add an annotation:

- Place the cursor at the required position in a graph
- On the Component menu, click Cursor
- Click Add Annotation.

How to display an annotation:

- The annotation is indicated by a dotted line on the graph. Place the mouse over the dotted line on the graph as shown below

How to edit or remove the annotation:

- Place the mouse over the dotted line
- Right-click and select the appropriate item from the menu



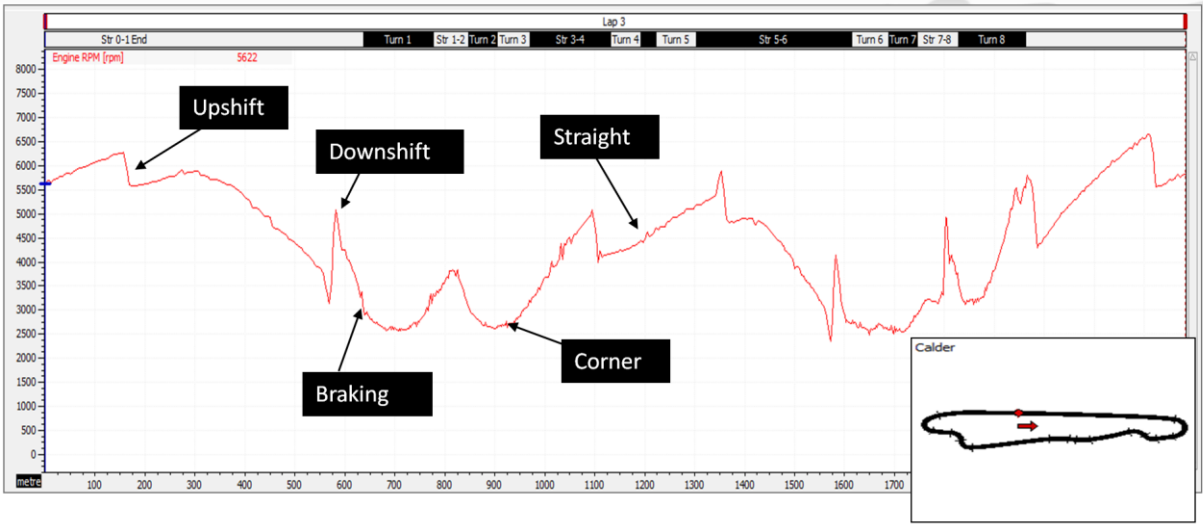
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Evaluating Driver Performance





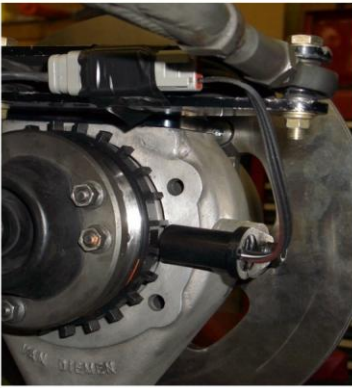
Reading Engine RPM Trace





Wheel Speed Sensors

- Toothed wheel and sensor arrangement
- Accurate calibration in Dash/ECU software is required



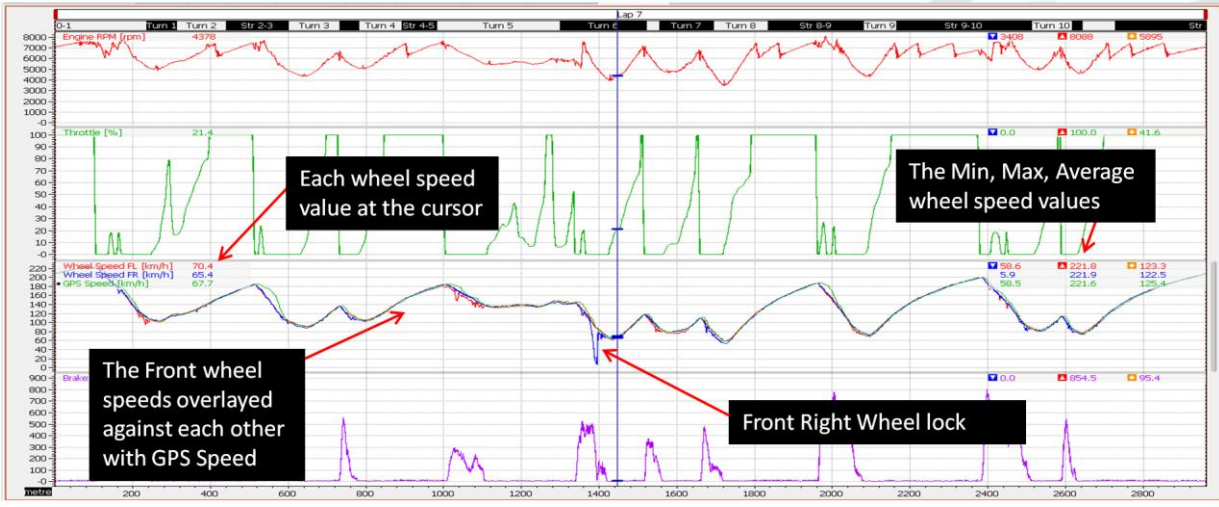
Measurement	Sensors Required	Outcome
Vehicle speed	Wheel speed	Top speed, min corner speeds, corrected ground speed, corner
Lap by lap speed comparisons	Wheel speed, lap beacon	Compare each lap for speed, overlay to find driver mistakes or faster race lines
Wheel lockups under braking	Wheel speeds, front and rear	Brake locking into corners, help determine incorrect setup
Driven wheels slip	Wheel speeds, front and rear	Diagnose traction problems, evaluate driver performance, find the slip ratio of the driving wheels
Gear selection trace	Wheel speed, RPM, throttle position	Create accurate gearing charts to see whether gear selection is correct, driver analysis
Track Mapping	Wheel speed, Accelerometer, Beacon	Create visual representations of the track for reference when examining data, virtual segment time.
Driver analysis	Wheel speed, G sensor	Extensive driver analysis through lap overlays, minimum and maximum speed comparisons, and accelerating/braking efficiency.

The wheel speed sensor is one of the sensors that you get with a data acquisition system. Beside speed and distance computation, this sensor will allow you to:

- Compare the speed of drivers or of cars, lap after lap.
- Detect the wheel locking under braking.
- Detect wheel spin.
- Draw a track map on your screen.
- To detect the gear you are using without having a defined gearbox sensor.



Reading a Wheel Speed Trace



Above you can see all wheel speeds directly determined by sensors on the front wheels, overlayed against each other. The green trace shows a GPS speed trace sampled at 10hz.



Logging Rate and Accuracy 1

Precision of measurement in metres, as result of logging rates at different speeds								
Speed Km/h	Logging Rate in Hz							
	1	2	5	10	20	50	100	200
20	5.56	2.78	1.11	0.56	0.28	0.11	0.06	0.03
60	16.67	8.33	3.33	1.67	0.83	0.33	0.17	0.08
100	27.78	13.89	5.56	2.78	1.39	0.56	0.28	0.14
140	38.89	19.44	7.78	3.89	1.94	0.78	0.39	0.19
180	50.00	25.00	10.00	5.00	2.50	1.00	0.50	0.25
220	61.11	30.56	12.22	6.11	3.06	1.22	0.61	0.31
260	72.22	36.11	14.44	7.22	3.61	1.44	0.72	0.36
300	83.33	41.67	16.67	8.33	4.17	1.67	0.83	0.42

During the study of the various curves, there are two points that are important to remember. Firstly, it is important to understand the influence of the logging rate on the measurement precision. Then, it is useful to have an idea of the consequences of the driver's mistakes at high speed.

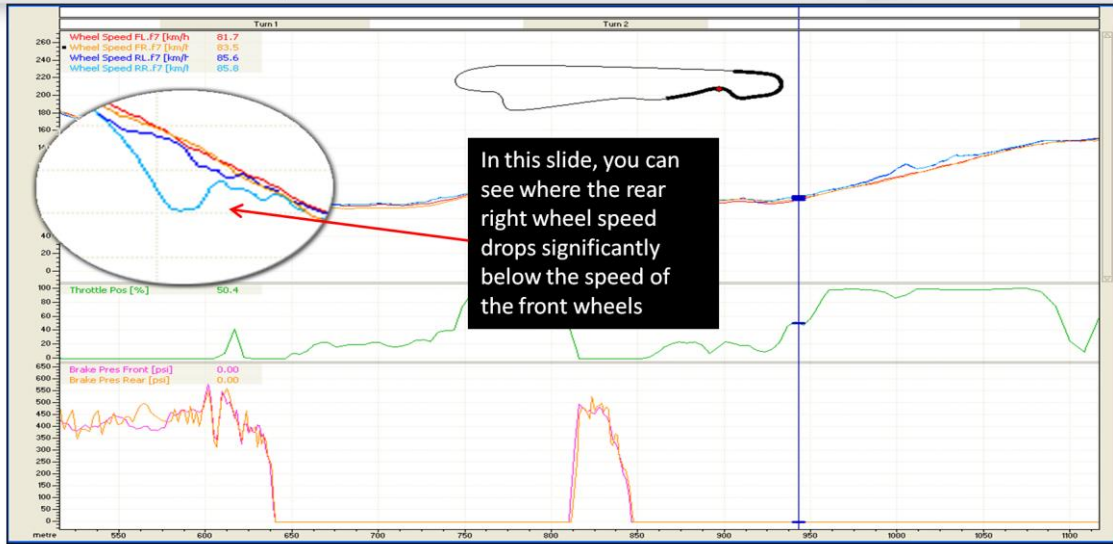
This table shows the distance in meters between two measurements for different combinations of logging rates and vehicle speed. As an example, let's consider a car travelling at 220km/h with a Lateral accelerometer logged at 20Hz:

Distance travelled per sample at 220km/h is:
 $220 \times 1000 / 3600 \times 20 = 3.06\text{m}$

In an average data logging configuration gear changes are recorded at 10 Hz. At 220 km/h, if two drivers are changing gear at exactly the same time, on the data acquisition system it can appear with a difference of up to 6.11 m.



Wheel Lockup



In this slide, you can see where the rear right wheel speed drops significantly below the speed of the front wheels

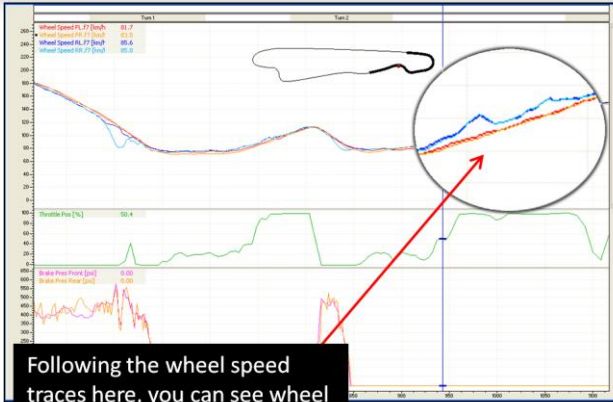
Another very useful tool of the wheel speed comparison graph is to determine wheel lockup. To make this comparison, at least two front (or rear) wheel speed sensors are needed. The screenshot above shows all four wheel speeds together. It can be seen that the rear right wheel speed (light blue trace) has a notable deviation from the other wheels.

If a trace like this is encountered, it means that there is an imbalance in the car setup – whether it is caused by the driver, car setup or track conditions. It is worth looking at setup parameters other than just brake bias. Uneven corner weights, damper problems, brake pad compounds and temperatures and even oil on the track can cause such a lockup.

As you would do every time you analyse data, be sure that what you think you have detected is really happening on the car. Use other sensors such as tyre temps, G sensors, brake pressure sensors and brake temp sensors to confirm your hypothesis. Especially here with an imbalance under brakes, you may be able to determine the cause of the issue, whether it be bias of line pressure or lack of braking friction to the front by looking at the braking pressures versus G force and brake temperatures. You may have the same brake pressures front to rear, but have less retardation at one end to the other depending on calliper piston sizes, pad compounds, rotor types and brake temperatures.



Wheel Spin



Following the wheel speed traces here, you can see wheel spin where the two blue lines rise above the red and orange lines, peaking at 12km/h front to rear speed difference

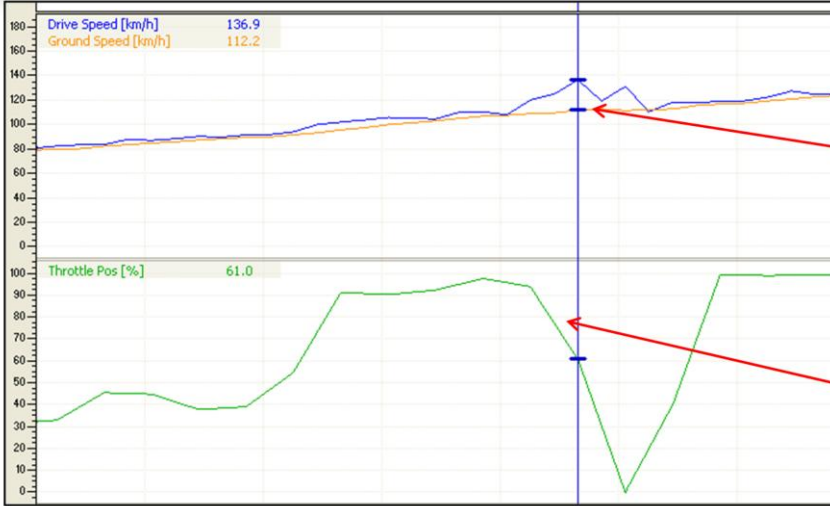


When access to rear wheel speed sensors is limited, it can also be identified from Engine RPM

Wheel spin is an important thing to be able to monitor in data logging. At the end of a session, the driver will reflect upon the performance of the vehicle, and determine what it is that is stopping the car from going any faster. Understeer and oversteer are common problems that a vehicle encounters at the limit and you want to determine what is causing the vehicle to behave in this way. With oversteer, sometimes it is due to the suspension settings in the vehicle, whilst other times driving style is more to blame. Determining this is an important part of deciding how to go about tackling the problem.



Wheel Spin Analysis



This is where the rear wheels have lost traction

Here you can see the driver lifting the throttle to stop the wheel spin



Force and Motion Sensors

- Can be used to measure Acceleration, Deceleration, Cornering and Vertical Forces
- Important to mount the accelerometer as close as possible to the centre of gravity.



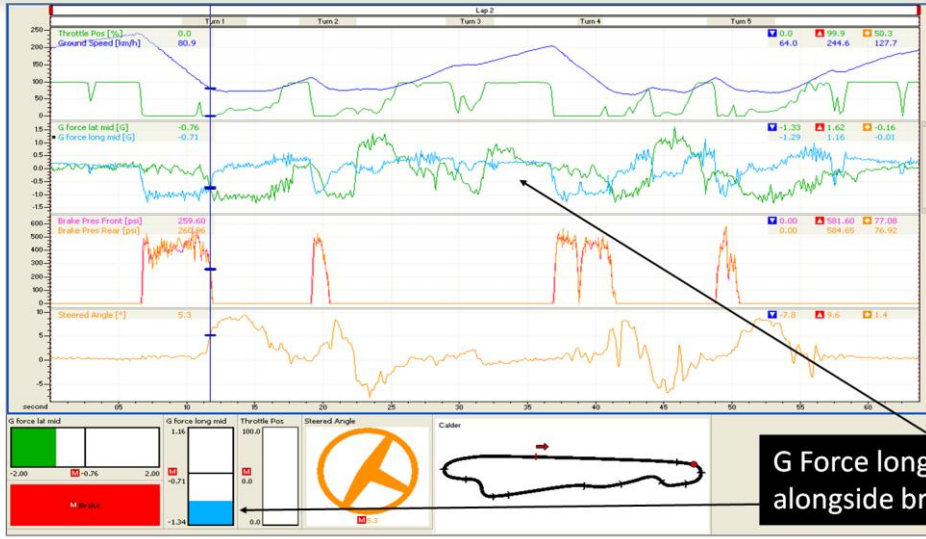
What is an accelerometer?

An accelerometer or G force sensor measures the forces being applied to the car. These forces include acceleration, braking, cornering in both directions, up and down. To understand what they are measuring, imagine a bob weight being hung from the roof of a race car, as you accelerate it swings backwards, as you brake it swings forward. The distance of the bob swing represents how much force there is in that direction. A G sensor measures this force, and the data logger gives a value proportional to the force of gravity, hence 'G' sensor.

- Can be used to measure Acceleration, Deceleration, Cornering, Yaw, Forces etc.
- Strain Gauges can be used in many ways, damper/suspension forces, steering force, pedal forces .



Reading a G Force Trace



What can I get from a 3 axis accelerometer?

3 axis accelerometers allow the user to measure and record the acceleration of a vehicle in three dimensions. By combining the information from all three accelerometer axes it is possible to calculate the resultant overall acceleration in three dimensions.

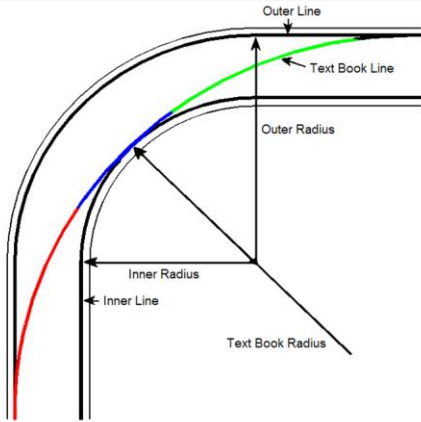
Accelerometers allow the user to perform fundamental operations, for example obtaining a track map or studying the balance of the car in terms of understeer and oversteer. They also permit more complex calculations, for example computation of the weight transfer the car experiences during braking, acceleration or turning phases.

It is extremely useful to use the G sensor to compare braking forces and technique in overlay mode. You can see how hard the initial deceleration is, and verify that the braking is hard, right into the corner, not tapering off at the end. You can also see how consistent the pads are, you could compare a brake fluid line pressure to a deceleration force to look for fade in the braking system.

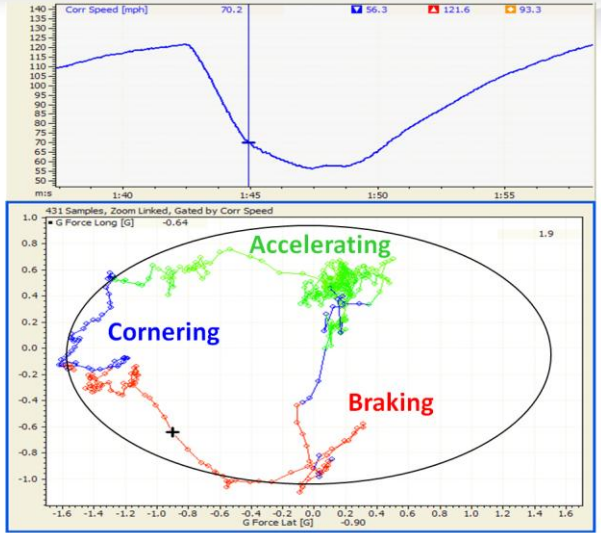
They can also be used to compare how much lateral traction a given tyre/track/suspension setting is able to obtain, then compare to another lap to see how your changes have affected vehicle cornering grip.



Driving Line Analysis



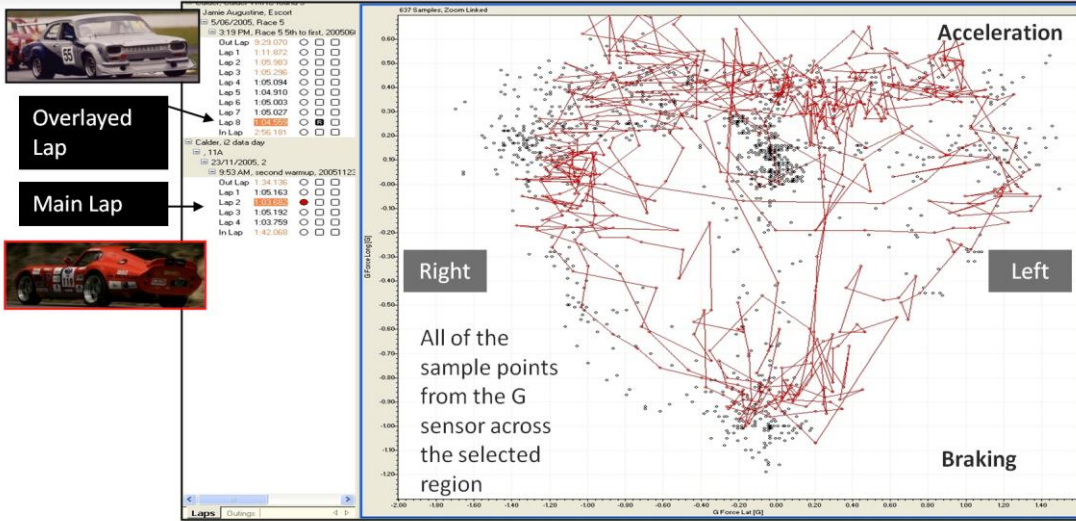
This method maintains the highest 'minimum corner speed' possible through a corner. Driving the *Traction Circle* is the fastest way through this corner.



Above we can see racing line through a corner. There is also a G-G diagram which is a scatter plot of longitudinal and lateral G zoomed on a specific corner.



G-G Diagram



The G-G diagram is a conceptual way of showing the performance of a driver, vehicle and circuit together. This method of measuring performance has been around since the late '50s with the first methods of creating these diagrams using a two axis pen recorder.

In theory, the driver should try to operate as close to the boundary of the G-G circle as possible at all times. In reality, physical limitations prevent a vehicle reaching the theoretical boundary (e.g. changes in suspension geometry, brake balance, tyre grip, etc). The more the driver can push out the envelope of the plot to the ideal circle, the better use he/she is making of the available grip of the tyres and the available grip of the track.

But what is the limit of the vehicle, or the limit with a perfect driver? A G-G diagram is useful as a comparison tool.

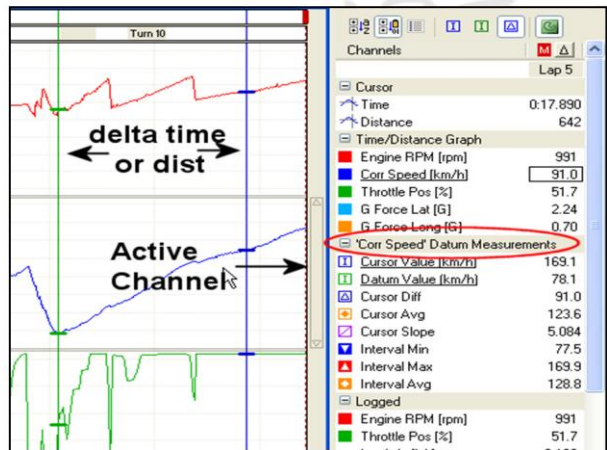
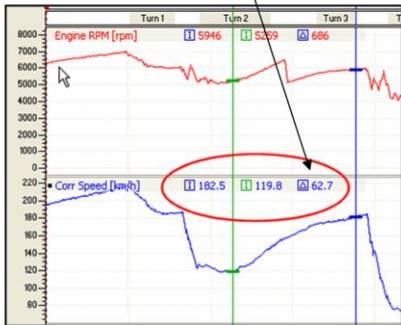
Take the example above, the red data is fastest lap from the Daytona sample file, the overlaid lap is the fastest lap of the Escort sample file. From this example we can see that although the lap times are less than 1 second different, the plots show very different characteristics of the two cars. The black data is out further to the left and the right, showing more cornering forces from the Escort compared to the Daytona. The Escort also shows more samples in the braking area, up to 1.2G deceleration, with the Daytona reaching only just over 1g from a far heavier vehicle. The obvious place where the Daytona is better is up the top of the G-G diagram, showing consistently greater acceleration. Now this example is comparing two different types of car, but it shows how you can overlay different drivers, in the same car and learn how, and why one driver is different than another in the way they extract speed from a car.

The best way to obtain high quality data is to use a 3-axis accelerometer mounted at or below the centre of gravity. We recommend mounting the sensor on Velcro or alike to isolate the vibration in the car from the forces applied to the vehicle itself that we really want to measure.



Datum Cursor

Show differences between 2 points on a graph



The datum cursor is a second cursor that allows measurements to be made between two points. To place the datum cursor, position the main cursor to the point of interest then press the 'Space Bar' key, then move the main cursor as normal. The graph labels now show the values of each channel at the datum cursor, main cursor and the difference between the 2 values.

In addition to this, there are Datum Measurements in the cursor window for the currently active channel. The active channel is denoted by the vertical scroll bar next to that trace, by the channel value having a box around it, and the channel name is given in the 'Datum Measurements' area.

Measurements:

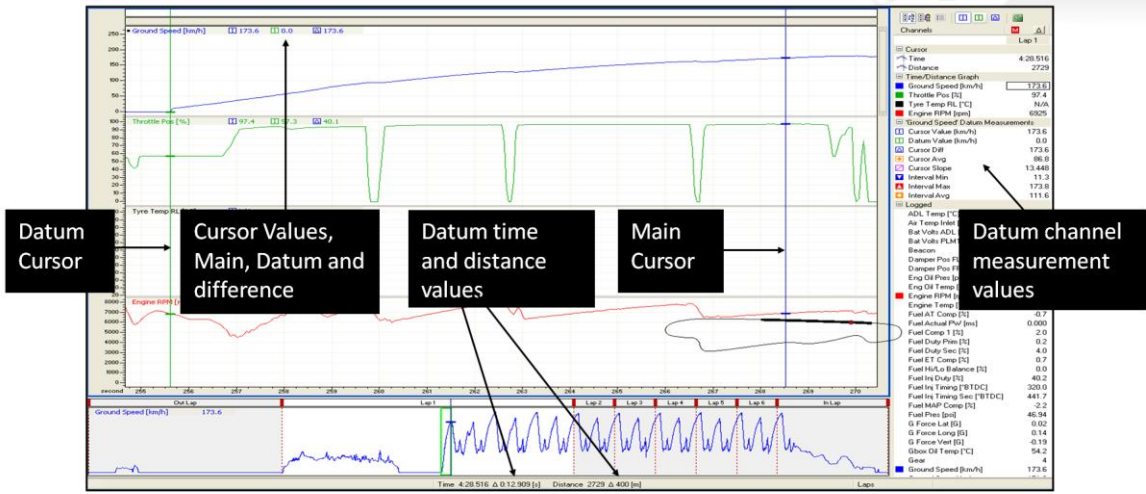
Δ Time	Time difference between the cursors
Δ Distance	Distance difference between the cursors
Cursor Value	Channel value at main cursor
Datum Value	Channel value at datum cursor
Cursor Diff	Channel difference between 2 cursors
Cursor Avg	Average of the 2 cursor positions
Cursor Slope	Rate of change between the 2 cursor positions (gradient)
Interval Min	Min channel value b/w cursors
Interval Max	Max channel value b/w cursors
Interval Avg	Average of all points between the cursors

Keyboard shortcuts:

'D'	Toggle datum mode (& cursor) on/off
'X'	Swap positions of main and datum cursors



Datum Cursor Usage

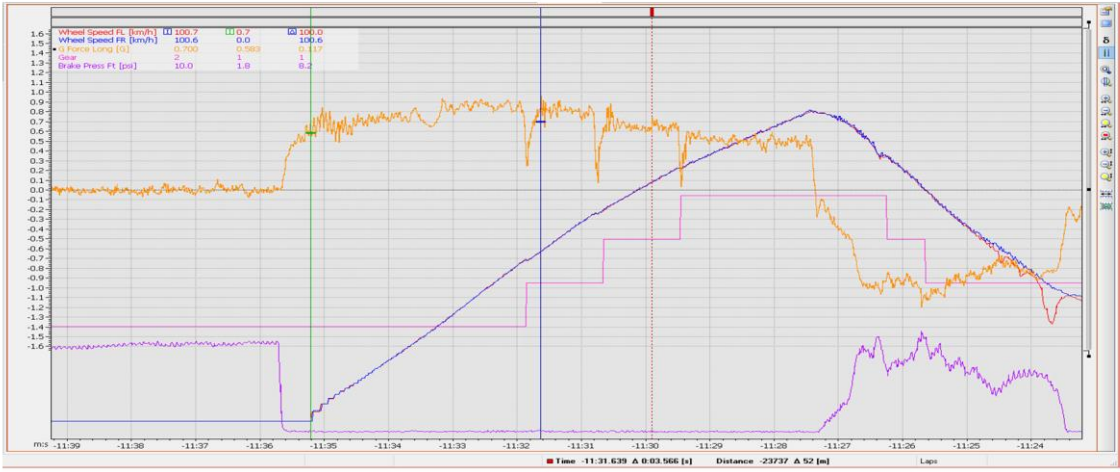


Datum Cursors are an efficient way to measure the change in a channel across a period of either time or distance. Common uses of this include measuring the starting performance of a car (0-100km/h), measuring temperature change across a period, RPM rate of change in each gear and much more.



Straight Line Acceleration

- Race Starts, 0-100 kmh times use Datum Cursor

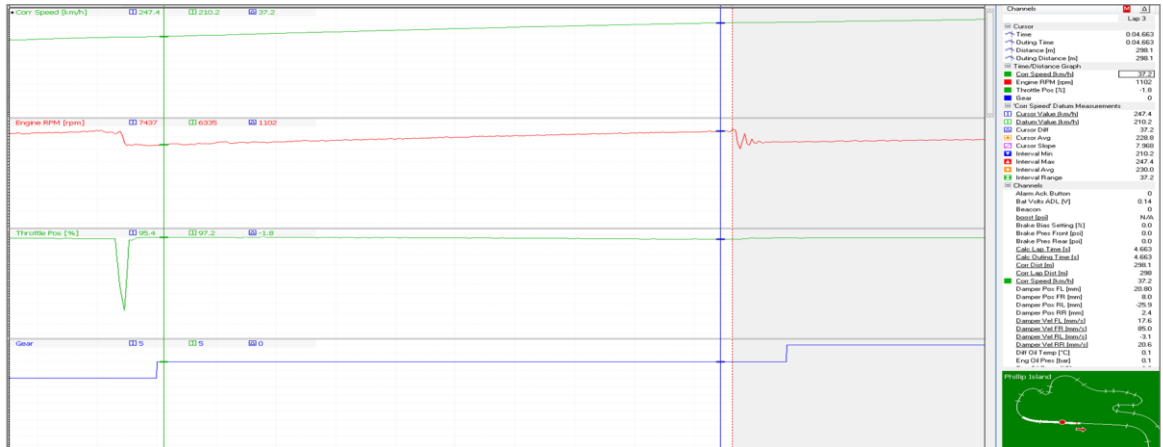


The above example shows the car leaving the line where the green Datum cursor has been placed. The Main cursor has been placed when the car has reached 100km/h.



Rate of Change Measurement

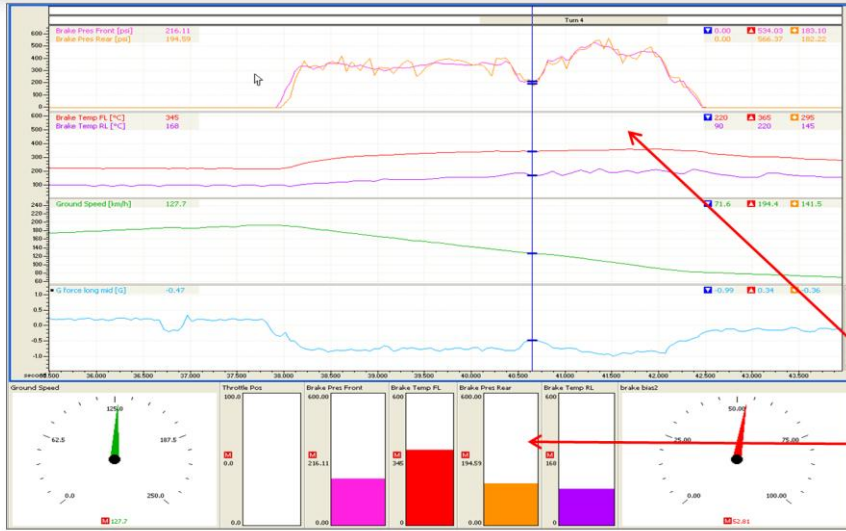
- Easily measure rate of change using Datum Cursor. See acceleration (km/h/Sec) of a V8 Supercar at Phillip Island in 5th gear. Keep this number in mind when dyno tuning your car next time.



Rate of change measurement is very useful in looking at real world accelerations. You can look at gear accelerations to compare to other cars. Just place your datum cursor at the start of the measured area, then put your cursor at the end of the area, and select the channel you wish to measure. Cursor Slope from the values box will tell you your rate of change.



Reading Brake Pressure Trace



Brake pressures and temps shown both on graph and as gauges for clarity.

When it comes to fine-tuning a racecar to improve its performance around the track, many people focus on the horsepower delivered by the engine and the handling characteristics in corners. In fact, the brakes are going to have a significant effect on lap time, as well as lap-to-lap consistency and driving ease. Fine tuning the brakes allows us to exploit more efficiently the grip available under each wheel to minimize the braking distance and facilitate overtaking maneuvers during the race. The right brake bias setting will also reduce the risk of flat spotting the tyres, and make the car easier to drive. One of the most effective tools to monitor the brakes is two brake hydraulic pressure sensors – front and rear. This type of measurement will allow you to understand how your brake system is being used and help the driver to evaluate its performance after a session.

Often, a better braking system can make the little difference at the end of the straight that allows overtaking another car. As in any other hydraulic system, knowing the pressure of the fluid circulating is going to help you to monitor the different forces applied in each of the devices connected. Moreover, the driver can make progress in his driving style: comparing his braking point lap after lap, the intensity of his braking and his speed on the pedal.



Brake Pressures



Rear brakes locking up

Driver releasing pedal to unlock rear wheels

It may seem obvious, but looking at the brake pressure traces gives you the time at which the driver started to brake. This information is very important, as a few meters difference in braking are very important for the speed you carry through the corner, and the time you gain or lose. Once again, looking at these traces with an overlay between two laps will permit you to perform a quick and efficient analysis of driver style and consistency.

Be careful with the logging rate used for those channels. If it's 10Hz for example, the system will record one value each tenth of a second. And at the end of the straight, at 250 km/h, the car is traveling 7 meters in one tenth of a second. So before concluding that driver A brakes 21 meters later than driver B at the end of the straight, check if your logging rate needs to be increased.

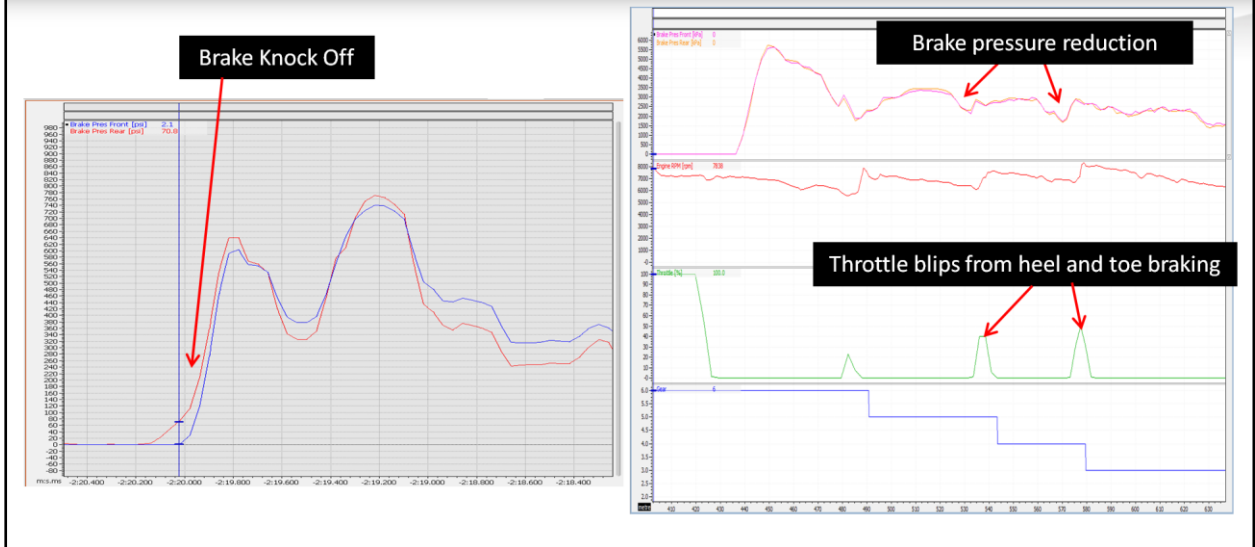
Directly measuring the pressures in the Front and Rear brake systems allows you to know how the driver is braking. In effect, both the shape and the amplitude of the brake pressure traces are very important for optimum braking. Most of the time, you want the maximum deceleration (indicative of late braking) to reach the maximum speed in the corner without losing speed in corner entry and being able to carry the maximum speed in corner exit.

The shape of the optimum trace can be explained by:

- Having the maximum deceleration in corner entry
- Losing the minimum time and speed in corner entry
- Releasing the pedal progressively and gently while turning
- Braking hard at the beginning (by literally jumping on the pedal) will be shown as bigger pitch acceleration.



Braking Analysis



How much does he lose in heel-toe braking?

In a braking zone where the driver downshifts gears, it is always interesting to look at what happens to the brake pressure during that time.

We can clearly see that each time the driver downshifts, he is adding a small amount of throttle, and because he is doing that the brake pressure diminishes slightly. As this ends up being time lost under brakes, the goal here is to lose the minimum of braking pressure while downshifting. It is possible to monitor the driver's progress on this issue using brake pressure sensors.

Brake knock off can be identified when the pressure in the rear builds before the front measures. This is due to the front pads needing to be pushed out further before making connect with the brake rotor.



Scatter Plot

- Engine RPM vs Speed



Scatter Plot Properties

Channels | Colour Channel | Display | Data

Y Axis

Channel : Properties...

Scale Mode : Manual Scale | Min : Max :

Channel/Auto Scale
Manual Scale

X Axis

Channel : Properties...

Scale Mode : Channel/Auto Scale | Min : Max :

The scatter plot shows points for two channels where one channel is on the x axis and the other on the y axis, allowing for relationships and dependencies between them to be identified.

By default the Scatter Plot will scale according to the minimum and maximum channel values of the X and Y axis channels. This can be changed by selecting 'Manual Scale' for either channel and entering min and max values. It is zoom linked to other Worksheets and will display data based on the current zoom level. To see an entire session worth of data press F2. Select a different lap using the Data window or the lap select bar above the Worksheets.

Colour Channel

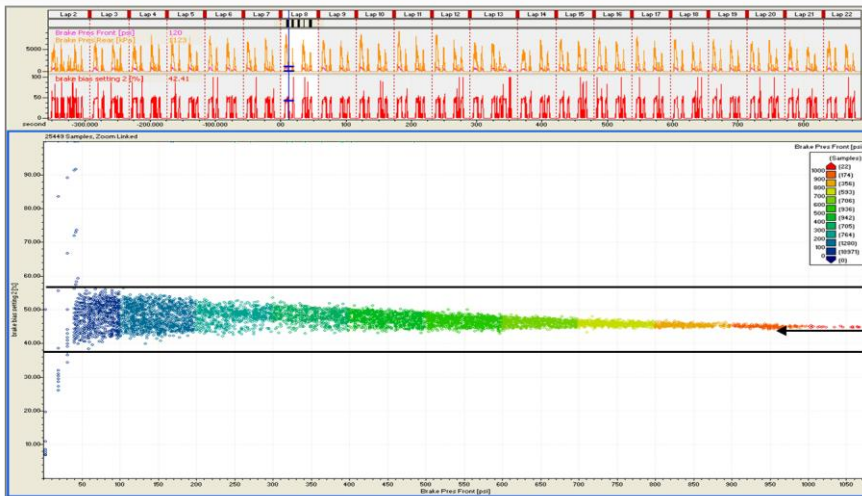
The scatter plot allows a 3rd channel to be used to colour each of the data points, the above example uses throttle position as the colour channel. The channel selected is divided in the number of bands specified and colours assigned accordingly. Data can be removed from the plot by unchecking the box next to the range values.

It is also useful to know that the number of samples logged in the particular band areas is shown on the right of the colour.

Press the up and down arrow to increase and decrease the selected data used to create the scatter plot.



Brake Pressure Scatter Plot



Front/Rear brake pressures zoom linked to histogram
Calculated brake bias channel

Of the 25,500 samples, most pressures above 180psi exist between 43% and 55% bias

An XY graph, or Scatter Plot is a graph that shows the relationship between 2 channels. They can be used to represent many things, such as gearing, G-G diagrams, Brake bias, oil temp vs Pressure and much more. In this instance, we are looking at a Brake Bias Scatter Plot. The graph shows brake bias on the Y axis and Front brake pressure on the X axis. What you are being shown above is one dot on the graph per sample of combined brake pressure and brake bias across the selected session. In the example above, there are 25,449 samples across the 24 laps around Calder Park Raceway.

In a good brake setup, each time that you press the brake pedal to a given pressure, you should get a consistent amount of pressure going to the front brake lines, and a consistent pressure going to the rear brake lines. The last thing that a driver wants is to press the brakes one time and get mostly front brakes, then do the same thing again and get mostly rear brakes. The integrity of the brake system is the critical element you must minimize. In practice, there is nothing worse than an inconsistent brake system. You can always change your brake pads, rotors or calipers, but if your system does not react the same way each time you use it, you cannot rely on it.

What the brake bias knob on the dashboard tells you is one thing, and what really happens inside the system may be different, sometimes very different, all because of compliance in the pedal box and master cylinder. That's why it is so interesting to look at changes in the hydraulic brake bias.

This graph is colored to indicate the front brake pressure. We can see that for small pressures (i.e. for light braking) the brake bias is very inconsistent, but fortunately, it is better when the pressure increases. By plotting this kind of graph, you can either see how consistent your braking system is, or compare two different systems.

- Select Workbook 'Seminar, Create a New Worksheet, choose 'ADD', then 'Scatter Plot'.
- Ensure that you still have out lap (1:34.136) from the Calder, i2 data day file from 9:53am selected.
- Click Add type in brake and choose 'Brake Pressure Front'.
- Select the button next to the channel box listed under X axis, and choose 'Brake Bias Setting'.
- Select scale mode, and change it to manual, setting min value to 0, and max value to 100
- Select the 'colour channel' tab, tick the 'enable colour channel' box, then select brake pressure front as the colour channel. Click OK.



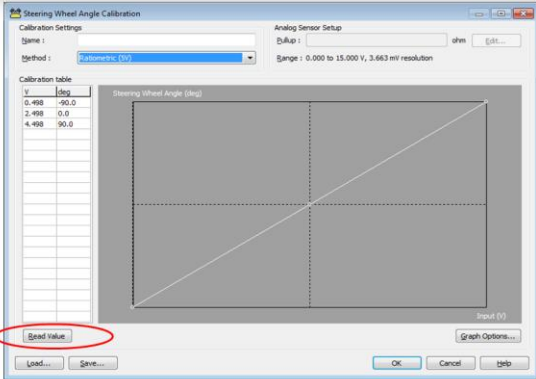
Steering Sensors

- Rotary Sensors
- Interlocking geared teeth
- Can measure steering wheel rotation





Calibrating a Steering Sensor



1. Plug into car
2. Change calibration
3. Enter degrees
4. Read value
5. Repeat 3 & 4
6. Repeat 3 & 4

Minimum of three readings are taken for the calibration. The more the better, depending on how linear the geometry is.

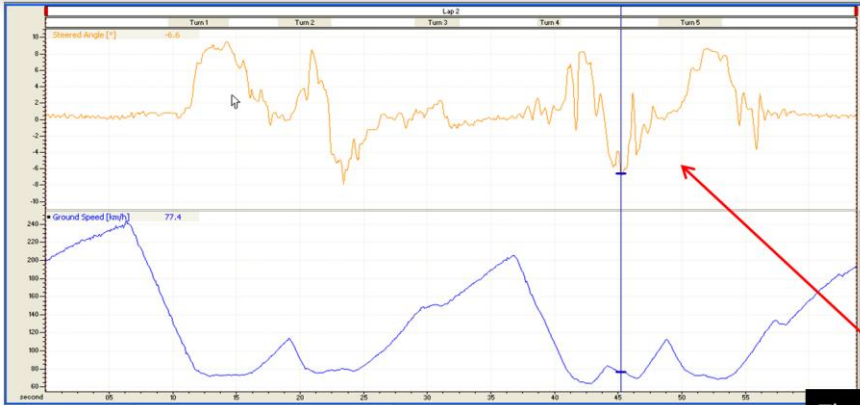
Steered Angle: angle of the tyres
Steering Wheel Angle: angle of the steering wheel



1. Generally for calibration of linear sensors a max/min measurement is taken and the points are interpolated. The above example shows a simple way to calibrate such a sensor for Steering Wheel Angle.
2. We know that at maximum lock the steering wheel angle is 90 degrees. By turning the wheel to full lock we enter the number in the right hand column for degrees.
3. By pressing the READ VALUE button the voltage from the signal wire is read into the Dash and displayed in the left column.
4. This procedure is repeated for straight ahead and the opposite lock.



Reading a Steering Trace

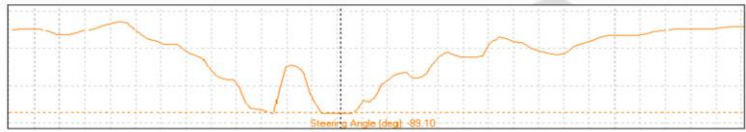


The steering trace can be visualised by displaying it as a gauge.

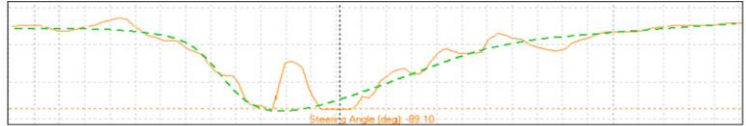


Steering Trace Examination

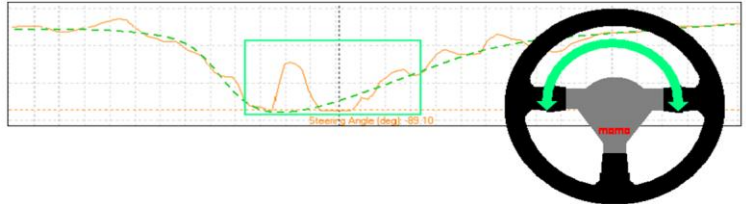
Finally, let's have a look at the steering trace:



The optimal steering angle trace should have been something like the this one:



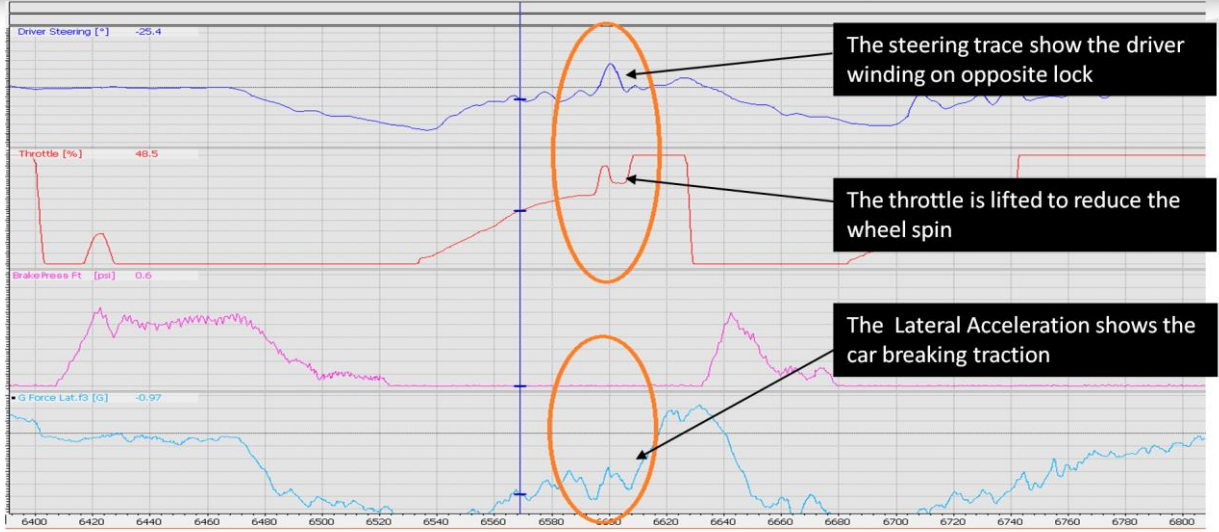
It is clear that the driver is making a correction on the steering wheel:



The actual steering trace is shown in orange, an ideal trace is shown as a dashed green line. Note that a right handed turn has a positive steering wheel angle, while a left turn has a negative angle. Some users will use the reverse. This is ok as long as you are consistent and preferably use the same convention for lateral G force.



Oversteer



Oversteer

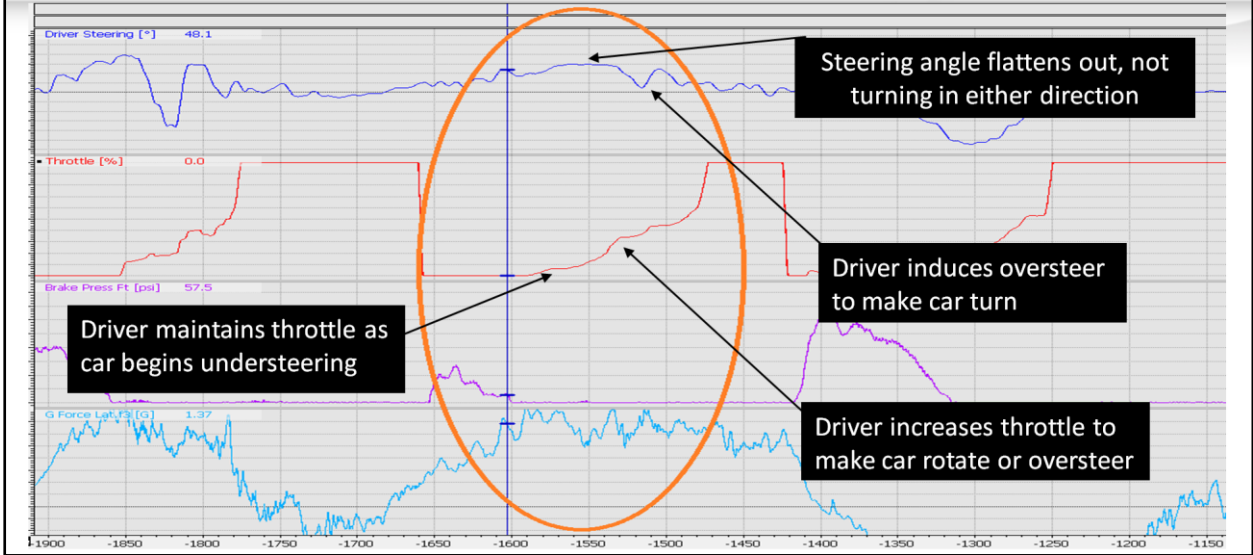
Oversteer can also be recognised by a loss in lateral G force along with a steering correction by the driver and a reduction in throttle. The G force trace is one in which we can see a balance problem with the car. The driver is unable to drive the car hard out of the corner for fear of spinning the car around, hence the decrease in lateral Gs at the exit of the corner.

If we examine the steering trace we will be able to see how the driver is reacting as the car exits the corner. It is useful to be able to see this, as you can use it to measure the reaction time of the driver to the oversteer, and perhaps be able to better quantify just how severe the oversteer is. This is an important measurement to make when trying to solve a handling issue; yes the car may still oversteer, but have we made an improvement or not?

After observing the steering trace it is clear that the driver has quickly reacted to correct the situation by opposing the direction of the corner to prevent the car from swapping ends. A throttle lift often accompanies this trace, as it does in this case, but sometimes the driver decides to power through the oversteer to compensate for the loss of cornering grip with pure forward acceleration.



Understeer

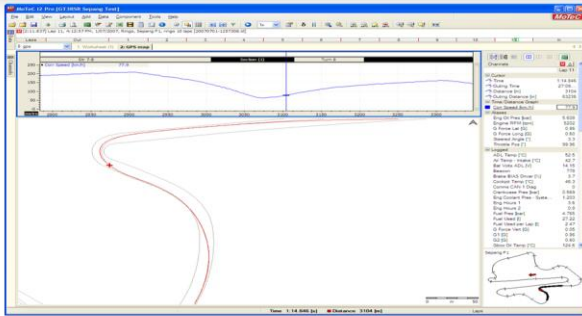


In this example the driver has turned into the corner and stopped moving the steering wheel, this is evident by the flat trace, at this point the driver has begun to introduce some throttle, this further adds to his understeer.

The driver of this vehicle has then induced a rapid change in throttle position to help induce some oversteer to make the car rotate as the front wheels are no longer turning the car.



GPS Mapping

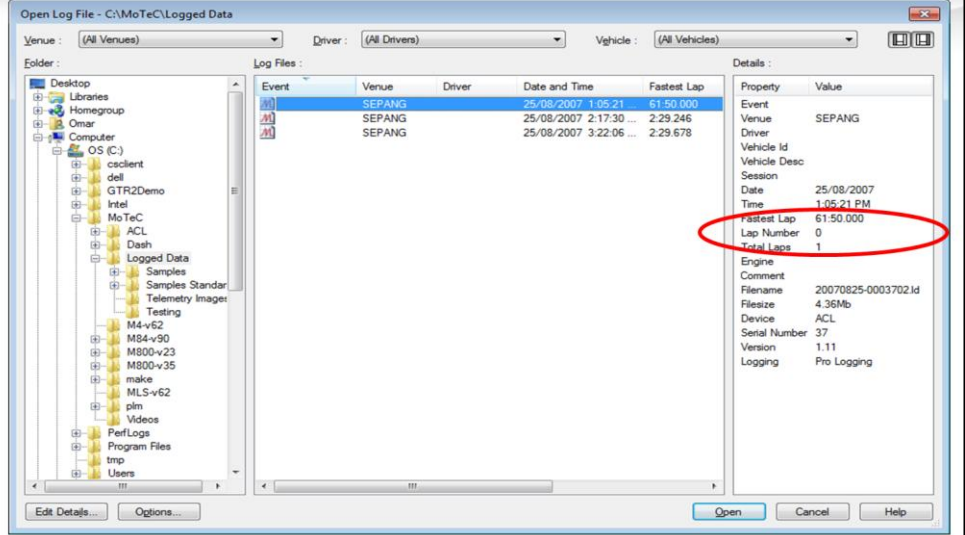


Track maps in i2 can now be created purely from the GPS data with no other sensors needed. See example above. i2 will allow also you to use an export function to place your driver's line into Google Earth. The function is under the 'File' menu and creates a kml file that is compatible with Google Earth from the position data that is currently visible on the graph. Note the red trace in the image above right.



Open a Log File

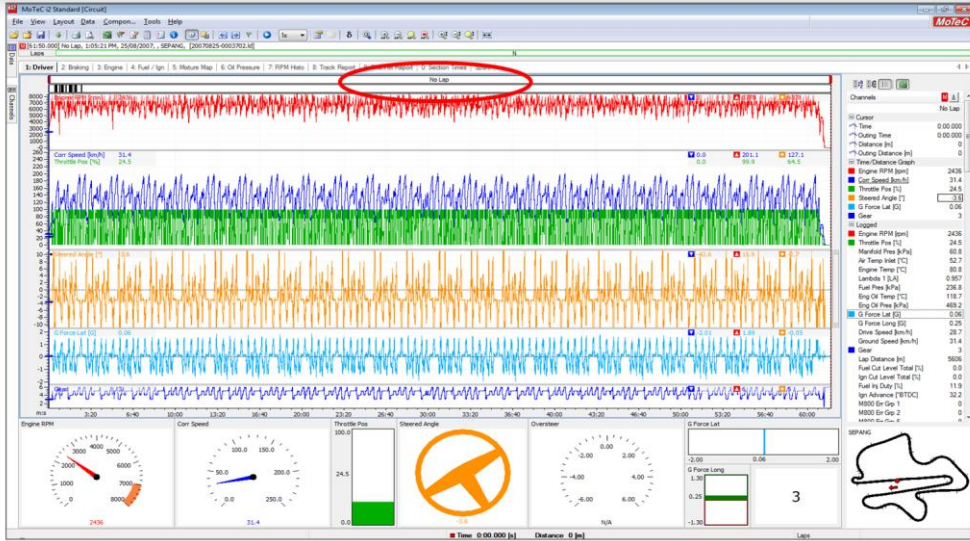
- Navigate to log file and click Open



Open the log file that is missing laps but has GPS Latitude and Longitude logged.



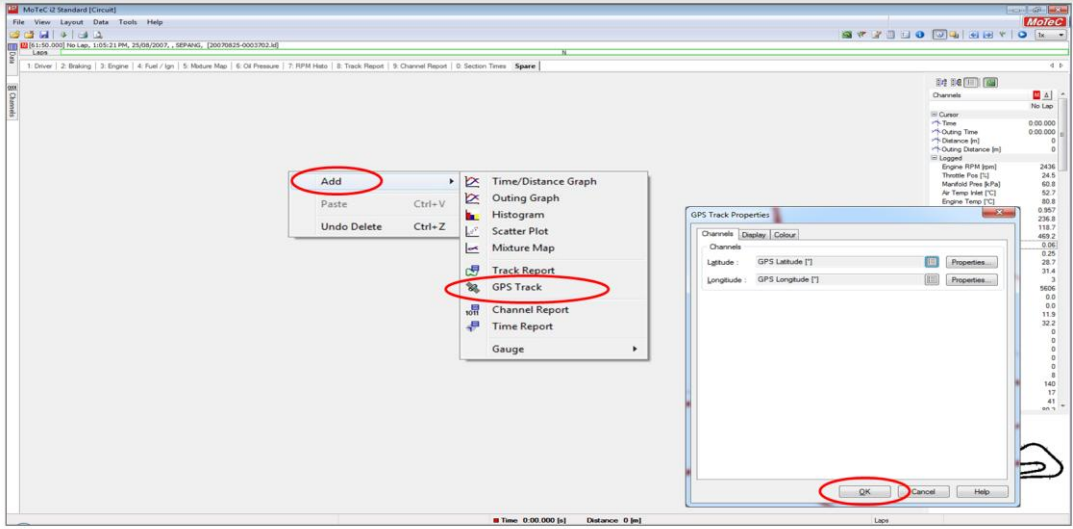
Open a Log File



You can see that there are no laps in this data.



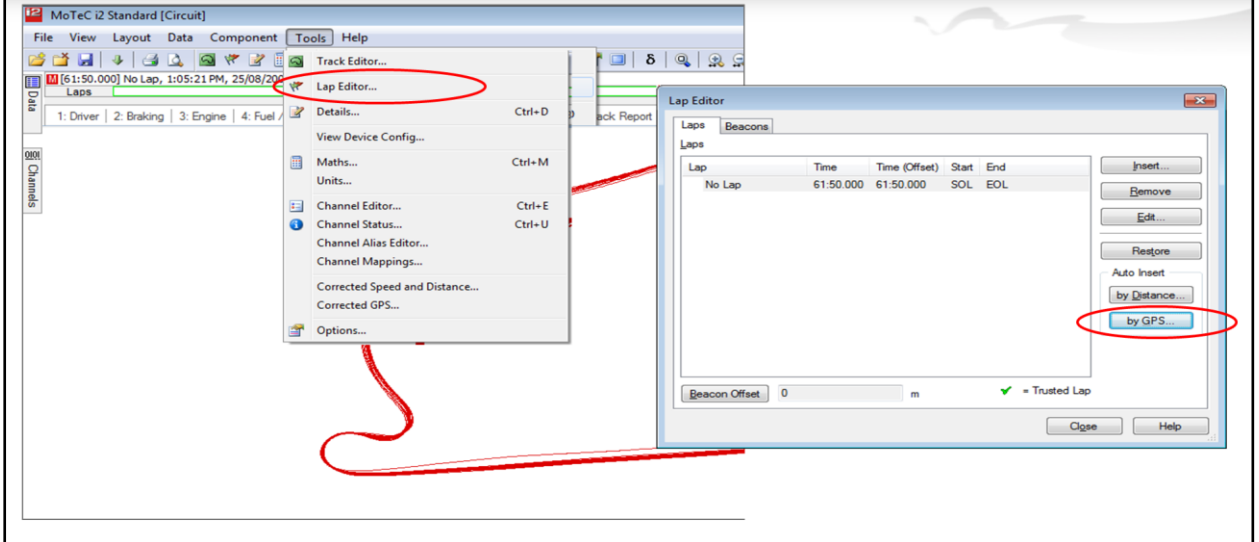
Add GPS Track Map



Add a 'GPS Track'.



Auto Inserting Beacons in i2



Go into 'Lap Editor' and click 'By GPS'.



Auto Inserting Beacons in i2

Auto Insert Beacons by GPS

Options

Latitude: degree

Longitude: degree

Tolerance: m

Lap Editor

Laps Beacons

Lap	Time	Time (Offset)	Start	End
Out Lap	0:00.691	0:00.691	SOL	BCN
✓ Lap 1	2:47.444	2:47.444	BCN[Auto GPS 1]	BCN
✓ Lap 2	2:32.859	2:32.859	BCN[Auto GPS 2]	BCN
✓ Lap 3	2:31.419	2:31.419	BCN[Auto GPS 3]	BCN
✓ Lap 4	2:32.632	2:32.632	BCN[Auto GPS 4]	BCN
✓ Lap 5	2:34.136	2:34.136	BCN[Auto GPS 5]	BCN
✓ Lap 6	2:30.294	2:30.294	BCN[Auto GPS 6]	BCN
✓ Lap 7	2:31.441	2:31.441	BCN[Auto GPS 7]	BCN
✓ Lap 8	2:29.618	2:29.618	BCN[Auto GPS 8]	BCN
✓ Lap 9	2:32.344	2:32.344	BCN[Auto GPS 9]	BCN
✓ Lap 10	2:32.451	2:32.451	BCN[Auto GPS 10]	BCN
✓ Lap 11	2:33.722	2:33.722	BCN[Auto GPS 11]	BCN
✓ Lap 12	2:33.945	2:33.945	BCN[Auto GPS 12]	BCN

Auto Insert

Beacon Offset: m ✓ = Trusted Lap

Enter the GPS Co-ordinates and click Execute, then click Close.



Time Report

Section Times

	Lap 1	Lap 2	Lap 3	Lap 4	Eclectic	Rolling Minimum
Main Str (End)	0:07.275	0:07.151	0:07.462	0:07.079	0:07.079	0:07.079
Turn 1	0:04.158	0:04.141	0:04.467	0:04.139	0:04.139	0:04.139
Str 2-3	0:02.710	0:02.609	0:02.574	0:02.638	0:02.574	0:02.638
Turn 2	0:02.787	0:02.649	0:02.688	0:02.661	0:02.649	0:02.661
Turn 3	0:03.616	0:03.500	0:03.573	0:03.557	0:03.500	0:03.557
Str 3-4	0:05.155	0:04.900	0:04.965	0:05.044	0:04.900	0:05.044
Turn 4	0:05.336	0:05.098	0:05.140	0:04.899	0:04.899	0:04.899
Back Straight	0:07.050	0:06.726	0:06.955	0:06.701	0:06.701	0:06.701
Turn 5	0:01.829	0:01.681	0:01.897	0:01.763	0:01.681	0:01.763
Turn 6	0:02.770	0:02.693	0:02.978	0:02.725	0:02.693	0:02.725
Turn 7	0:11.749	0:11.730	0:12.028	0:11.491	0:11.491	0:11.491
Main Str (Start)	0:10.723	0:10.800	0:10.459	0:11.055	0:10.459	0:10.459
Totals	1:05.163	1:03.682	1:05.192	1:03.759	1:02.770	1:03.162

Split Times

Time Report - Track Sections (All Laps)

	Lap 1	Lap 2	Lap 3	Lap 4	Eclectic	Rolling Minimum
Split 1	0:18.894	0:18.301	0:19.027	0:18.331	0:18.301	0:18.331
Split 2	0:32.856	0:31.888	0:32.806	0:31.666	0:31.666	0:31.666
Split 3	0:13.413	0:13.493	0:13.359	0:13.762	0:13.359	0:13.359
Totals	1:05.163	1:03.682	1:05.192	1:03.759	1:03.326	1:03.356

The Time Report shows split times in a tabular form. The sections that are used may be the default sections or user defined sections.

Eclectic

The Eclectic column shows the minimum times for each section and totals them to show the best possible time if all sections could be completed in the minimum times. This can be a bit unrealistic as driving line etc. can affect the times from one section to the next so the minimum times can't be joined up in practice.

Rolling Minimum

The rolling minimum shows the set of consecutive section times that form the minimum overall time for a complete lap. These times are highlighted in bold to easily determine where this starts, i.e. it will typically be spread across 2 laps.

Sections

To change the sections used, go to the Time Report properties (F5) then 'Data – Ranges – Report on:' and select the section type – Defaults, User Defined or Splits (if available).

Press the '0' key, or choose section times to select the section times report.



Section and Split Times

The screenshot displays several data tables and a track diagram. On the right side, four callout boxes with arrows point to specific data areas:

- Corner section times for all laps.** Points to the 'Time Report - Track Sections (All Laps)' table for corners.
- All section times for all laps** Points to the 'Time Report - Track Sections (All Laps)' table for straights.
- Straight section times for all laps** Points to the 'Track Sections (All Laps)' table for straights.
- Times from the split beacons from all laps** Points to the 'Split 1', 'Split 2', and 'Split 3' rows in the 'Track Sections (All Laps)' table.
- Split times and section markers for selected lap** Points to the track diagram showing split beacons (Str 1-1 to Str 1-4) and section markers (Turn 1 to Turn 7).

Similar to channel statistics, **i2** can create reports based on time around the track, called a 'Time Report'. These time reports are used to further examine the detail about where you were fast and where you were slow, section by section across the whole lap.

You can report on:

- All sections
- Corner sections only
- Straights sections only
- Custom sections only
- Split beacon sections

You can create a report such as the one in the top right corner which shows times for the 4 lap outing, only when the car was going around corners as shown by the section markers on the track. The red line indicates the rolling minimum lap time. The rolling minimum is the fastest lap that the car did for that outing regardless of where the Start/Finish line is. It may start and finish on the back straight, instead of at the start finish line. It is good indication of a lap that the car is capable of doing, as it was actually driven, but can be affected by an artificially fast section, such as forgetting to brake at all for a corner. Check adjacent section times to see if it is a realistic time.



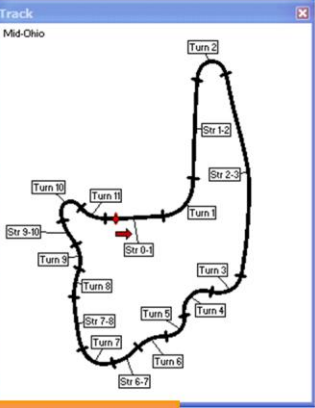
Driver Consistency

- Use Time Report

Eclectic is the theoretical best lap time if you add up all of the fastest sections.

Blue = fastest section times

Time Report - Track Sections (All Laps)									
	Lap 1	Lap 2	Lap 3	Lap 4	Lap 5	Lap 6	Eclectic	Rolling Minimum	
Str 0-1 (End)	0:04.297	0:04.298	0:04.236	0:04.211	0:04.228	0:04.288	0:04.211	0:04.288	0:04.288
Turn 1	0:05.352	0:05.289	0:05.177	0:05.216	0:05.273	0:05.374	0:05.177	0:05.374	0:05.374
Str 1-2	0:08.258	0:08.051	0:08.117	0:08.007	0:08.181	0:08.213	0:08.007	0:08.213	0:08.213
Turn 2	0:06.711	0:06.415	0:06.567	0:06.653	0:06.780	0:06.403	0:06.403	0:06.403	0:06.403
Str 2-3	0:16.615	0:16.561	0:16.765	0:16.550	0:16.511	0:16.566	0:16.511	0:16.566	0:16.566
Turn 3	0:04.067	0:04.146	0:04.043	0:04.162	0:03.946	0:03.911	0:03.911	0:03.911	0:03.911
Turn 4	0:05.829	0:05.855	0:05.785	0:05.867	0:05.808	0:05.669	0:05.669	0:05.669	0:05.669
Turn 5	0:03.734	0:03.817	0:03.818	0:03.797	0:03.811	0:03.811	0:03.811	0:03.811	0:03.811
Turn 6	0:03.039	0:03.041	0:03.027	0:03.018	0:03.061	0:03.061	0:03.018	0:03.018	0:03.018
Str 6-7	0:02.599	0:02.610	0:02.597	0:02.615	0:02.636	0:02.636	0:02.597	0:02.636	0:02.636
Turn 7	0:03.899	0:03.904	0:03.925	0:03.865	0:03.828	0:03.822	0:03.822	0:03.822	0:03.822
Str 7-8	0:04.933	0:04.934	0:04.937	0:04.916	0:04.871	0:05.013	0:04.871	0:04.871	0:04.871
Turn 8	0:02.537	0:02.558	0:02.592	0:02.495	0:02.539	0:02.502	0:02.495	0:02.539	0:02.539
Turn 9	0:02.479	0:02.581	0:02.576	0:02.497	0:02.551	0:02.541	0:02.479	0:02.551	0:02.551
Str 9-10	0:02.575	0:02.592	0:02.602	0:02.608	0:02.567	0:02.602	0:02.567	0:02.567	0:02.567
Turn 10	0:05.601	0:05.616	0:05.660	0:05.739	0:05.616	0:05.721	0:05.601	0:05.616	0:05.616
Turn 11	0:03.275	0:03.237	0:03.199	0:03.186	0:03.181	0:03.205	0:03.181	0:03.181	0:03.181
Str 0-1 (Start)	0:01.134	0:01.125	0:01.117	0:01.114	0:01.114	0:01.113	0:01.114	0:01.114	0:01.114
Totals	1:26.944	1:26.636	1:26.749	1:26.523	1:26.511	1:26.460	1:25.376	1:26.208	1:26.208



Fastest Rolling Lap

Different shades of colour can be used to indicate how close the driver is to the minimum time in terms of percentage. The lower the percentage, the closer the time is to their minimum and therefore the more consistent the driver is in those track sections.



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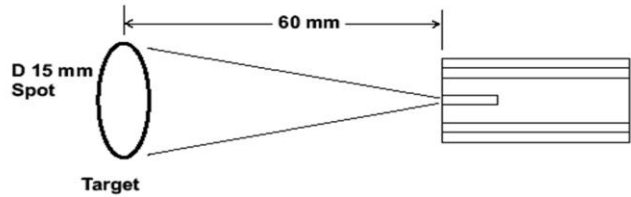
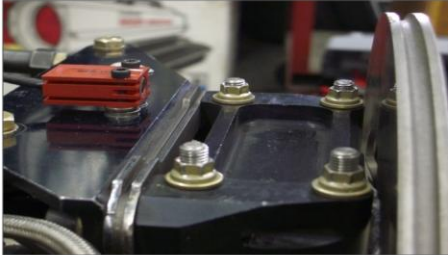
Evaluating Chassis Performance





Brake Temp Sensor

- Working temperature of your brake
- Are your ducts cooling efficiently?

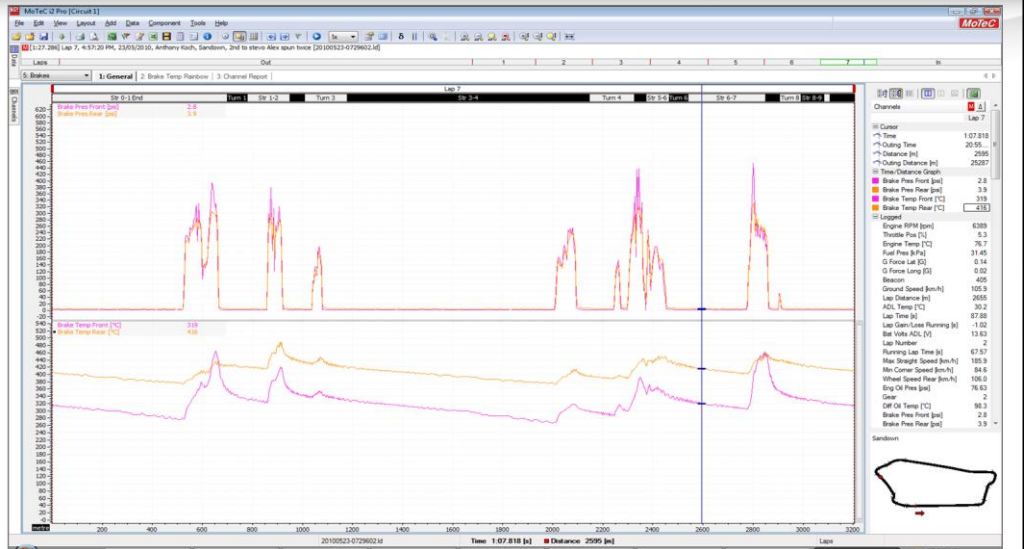


Under braking the kinetic energy is turned into heat and light in the brake rotor. This energy can be detected using an Infrared sensor. These type of sensors are also used to measure tyre temperature.



Brake Temp Analysis

- Single Lap



From the brake pad manufacturer – know the temperature range within the braking system when it is operating at its peak performance. From the data we can see if we are achieving the desired temperatures. Then decide what we need to do with brake ducts.



Brake Temp Data

- Entire race

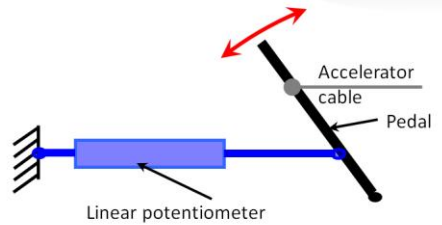


Notice the increasing brake temperatures over a race distance and the stabilization of temperatures over a number of laps.



Linear/Rotary Potentiometers

- Standard lengths from 50mm to 200mm
- Uses include position measurement of suspension and pedals etc.
- The most common installation configuration for linear potentiometers is on the shock absorber



Linear potentiometer (resistive sensing element) or a linear pot. There is a slider that moves along a track and the resistance changes. Useful sensors but fragile and need to be maintained.



Suspension Analysis



Click on Workbook list, and select 'Seminar', select new Worksheet, calling it 'Suspension'.

Right click on Worksheet space, and select 'Add' then 'Time Distance Graph'.

From the next panel, select 'Add channel', then add the channels shown above.



Suspension Analysis

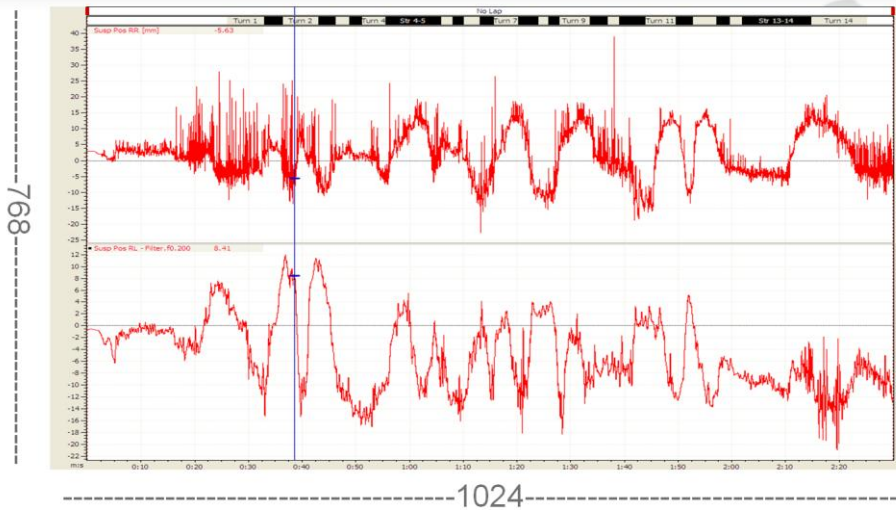
- In this example, the front suspension goes negative under braking. Therefore, for suspension position, bump or compression is negative. This is the easiest convention for people to follow.



Observe what is happening on the straights and corners. Convention is to have negative suspension travel as compression.



Filtering and Screen Resolution



Firstly, it is important to observe the raw data because this could already highlight some car setup problems, or sensor installation/wiring problems.

Moreover, you may see differences between vibrations in compression and in rebound. Raw data from shocks or strain gauges could be difficult to understand in terms of noticeable car attitude change, especially without zooming in. A filtered signal allows overall trends to be seen without any zoom needed. However, it is important to have a look at them first without applying any filter to be sure that you do not miss a part of the behaviour.

In the same way, it's important to also consider that the size of your screen also acts like a filter.

For example, say that your computer resolution is 1024 x 768 and you are looking at data logged at 20Hz. At the best you will see only $1024 / 20 = 51.2$ seconds of the data without any filtering. So if you look at an entire lap that is longer than this you are necessarily 'filtering' – not all of the data points will fit onto the screen. If you want to see the each point, you need to zoom onto a segment equal to or smaller than 51.2 seconds.

Changing the display to show 'Points' rather than lines will quickly tell you if you are seeing all of the data or not.



Talk to the Driver

- The experience of your driver, the comments they give and the way they feel the car will all affect the analysis of the data.
- Is there a balance problem in just one corner?
 - Or is it in all 'right handers'?
- Zoom into the corner(s) and look the damper position at each corner of the car with relation to the G trace and other channels



Damper Histogram Analysis

To spend more time in a region, stiffen that region.
To spend less time in a region, soften that region.

Graph of 'AMOUNT OF TIME' spent at different 'DAMPER SPEEDS'



Tips about the damper speed histogram:

- It can really only be used for a whole lap (the linear potentiometers must be in the same position at the beginning and the end of the damper analysis)
- Always use the same number of bins
- Use a Min and Max such that the whole shock speed histogram covers 95% of the measured shock speeds
- Always use the same numbers for the Max and Min shock speed (for later comparison)
- The shape of the histogram should be symmetrical
- Always use the same scale on the Y axis (for later comparison)

Damper settings represent an interesting part of fine tuning a racecar. Even if the basic principles are simple, without any tools it is almost impossible for the engineer to know if the dampers are really working at their best.

With four linear potentiometers on the car you can record where, when, and how each damper applies forces to the car.

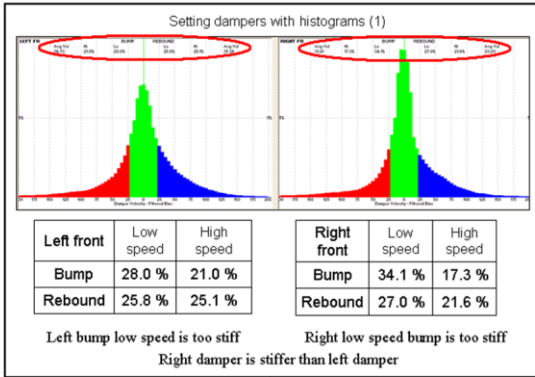
The damper speed histogram is a simple tool allowing us to check how the dampers are working. It refines the ratio between low and high speed, as well as bump and rebound, front and rear, left and right. It is also very useful for checking that your dampers have been set up correctly.

The damper speed histogram shows the percentage of time (out of the lap time) that the shock is spending at certain speeds.

The damper histogram is made up of four parts. Low speed bump, Low speed rebound, High speed bump and High speed rebound. A damper should always spend more of its time around the change of direction (0mm/s) than any other point on the histogram. It should spend progressively less and less as the graph goes from low speed to high speed. The change over point from low to high speed is vehicle and damper dependant but on a circuit racing vehicle often around 25mm per second. A balanced histogram should show a symmetrical curve. If you want a damper to spend more time in one point on the histogram, you need to stiffen up the damper in that region. To spend less time there, you need to soften the damper in that area.



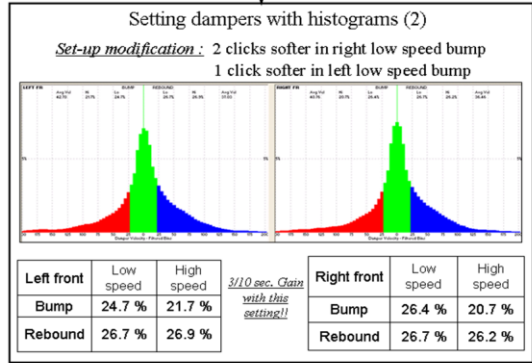
Damper Histogram Analysis



Damper histogram with initial bump/rebound settings

Example of gain made using Damper Histogram analysis

Damper Histogram with modified damper settings



By simple observation we can see that the 2 front dampers shown in the top left histogram do not seem evenly balanced. A good shock histogram should show a symmetrical curve. If we take the values displayed at the top of the histogram we can observe the percentage of time spent in low or high speed bump or rebound.

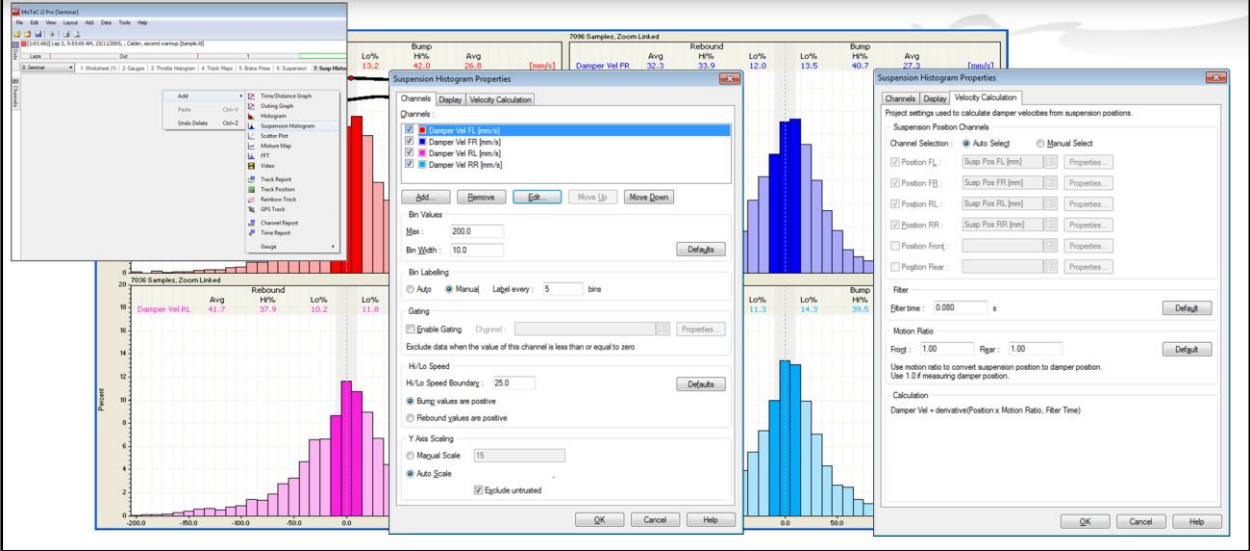
When the histograms are compared to each other, we look at Low speed bump to Low speed rebound, then High speed bump versus High speed rebound. We can deduce from the above histogram of the front left damper that the low speed bump setting is too stiff, as it is spending too much time there compared to the low speed rebound. So to fix this we would soften the left low speed bump settings, and in this example we softened it just one click.

Looking at the front right damper, we can see that it is far more uneven. It is spending 34% of time in low speed bump, with only 27% in low speed rebound. To even this out, we would soften the right front low speed bump settings. That would increase the time spent in high speed bump, giving a far more even damper histogram distribution.

In this actual example, the car gained 3/10ths of a second after making this change to the damper settings.



Add a Damper Histogram



The suspension histogram component displays histograms for a number of suspension velocity channels. The velocity channels are normally calculated from suspension or damper position channels. i2 includes built in velocity calculations. The calculations can be configured from the 'Velocity Calculation' page in the 'Suspension Histogram' properties. If needed these calculations can be turned off and the user can create their own maths functions to generate the velocity channels.

Filter

The velocity calculation includes filtering of the position channels to ensure good results when plotting the histogram. Without an appropriate amount of filtering the histograms may look "notchy". Note that too much filtering will reduce the high frequency content of the signal so too much filtering is also undesirable.

Style

The histogram can be displayed as either a line graph or a bar graph. The channels can also be overlapped or displayed in a grid of panels. The bar style looks more like a conventional histogram however the line style is much more useful when comparing one channel to another or when the channels are overlapped.

High Speed/ Low Speed Boundary

A velocity can be nominated as the Hi Speed/ Lo Speed boundary. This is normally set to match the high speed, low speed transition of the damper. This value is used in the various calculated info and is shown visually as band on the histogram.

Calculated Info

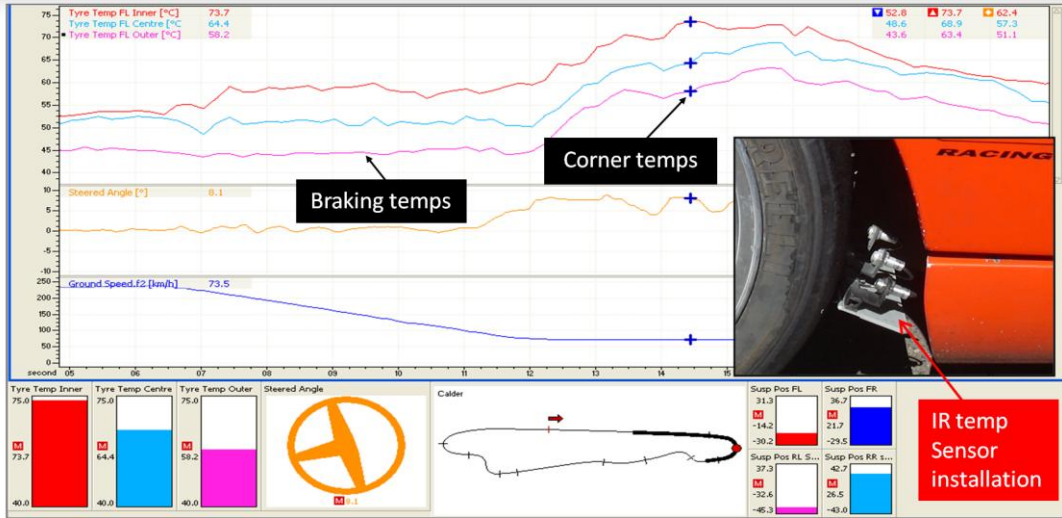
The suspension histograms calculate the following data:

- Rebound Avg: The average velocity of all values of rebound
- Rebound Hi %: Percentage of velocities falling in the rebound Hi speed area.
- Rebound Lo %: Percentage of velocities falling in the rebound Lo speed area.
- Bump Avg: The average velocity of all values of bump
- Bump Hi %: Percentage of velocities falling in the bump Hi speed area.
- Bump Lo %: Percentage of velocities falling in the bump Lo speed area.

Note that 'bump' velocities can be selected as either positive velocities or negative velocities (rebound will be the opposite).



Tyre Temp Sensors



Have you ever wondered how valuable the data is that comes from measurements made with a tyre temperature probe? Do you want to make critical setup decisions from data that is strongly influenced by the length of the pit lane, your position on the pit lane, and the position of the pit entry on the track? What happens if the pit entry is just after a heavy lateral G corner? And what would the temperature measure if this corner was oriented in another direction?

Your tyre temperatures, by the time that you get to measure them, are heavily skewed by the last thing that happened to the car. If the pitlane entry is long, the tyres would have cooled down considerably, and the temperatures may have equalised whilst driving down the lane. Perhaps due to static camber, you may see very high temperatures on the inside of a tyre in a straight line, but the same car may be very good under brakes and through cornering due to the caster and camber curves in the suspension design. So you may end up pulling off camber due to the high inner temperatures read by a pyrometer in pit lane, where the car may in fact be well set up for where it matters, under brakes and through the corners.

Making setup adjustments based upon data coming from a tyre temperature probe is unlikely to work because it is way too imprecise. The solution, as shown above, is to mount 3 infrared tyre temp sensors by the wheel, continuously monitoring the evolution, turn after turn, of the tyre temperature surface in the middle, the outer and the inner edge of the tire.

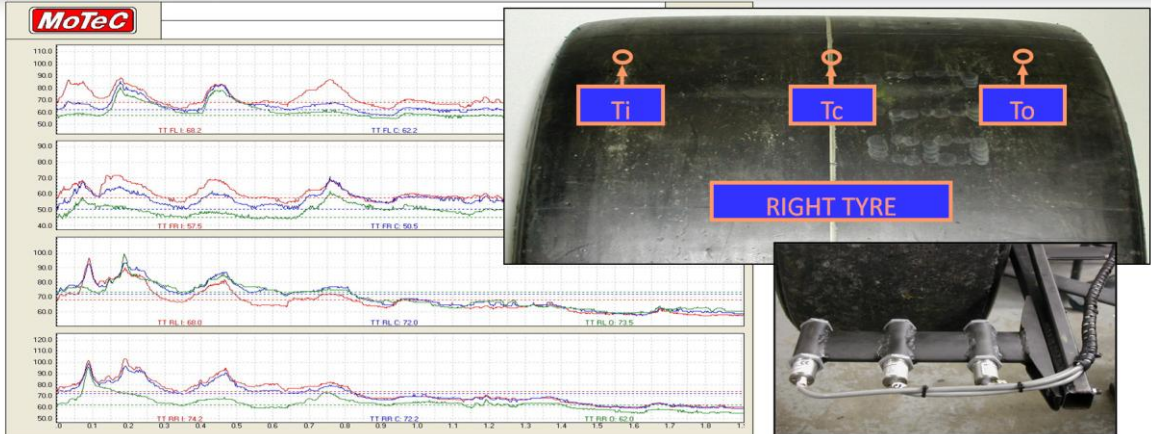
Even if these tyre temperature sensors are only taking the surface temperature of the rubber and not the core temperature like the probe, it can be easily demonstrated that the temperatures of the tyres measured in the pits are only giving a vague indication of what is really happening on the track.

The measured pyrometer readings in pit lane from the car represented by the data above were:
 Inside 56 Centre 45 Outside 38

Pyrometers don't show you where the tyre temperature is coming from, whether it is down the straights (too much static camber), in corners (not enough roll on camber or caster), or under brakes (too much camber change under bump). Only data logged tyre temperature sensors can do that.



More Tyre Temp Sensors



On the right part of the graph, the temperatures are as seen in the pits when the car stops. On the left part of the graph, you get an idea of what is really happening on the track.

Example of Tyre Temp installation

What Can I Learn From One or Three Tyre Temperature Sensors per Wheel?

Depending on the budget of the team, it is possible to install either one or three tyre temperature sensors per tyre. While it is possible to establish a clearer picture of how one tyre is working with three sensors installed across the face of the tyre, a large amount of information can be established by installing just one tyre temperature sensor. The following information can be obtained if one tyre temperature sensor is installed at the centre of each tyre:

- Load distribution
- Brake distribution and balance
- Wheel lock-up
- Wheel lift
- Traction loss/ wheel spin
- Cornering temperatures
- General dynamic operating temperature
- Oversteer and understeer indications

It is also possible to install three tyre temperature sensors across the face of the tyre to establish a clearer picture of how the tyre is working, as shown above.

The ability to understand temperature information across the face of a tyre will allow the race engineer to tune the car more effectively, as well as monitoring the results of each change. As well as obtaining the information mentioned above for one tyre temperature sensor, three tyre temperature sensors could also acquire the following data:

- Temperature distribution
- Tyre inflation (over/under)
- Camber adjustment (too much/little)
- Toe (too much/little)

Therefore, it is possible to conclude that one tyre temperature sensor on each wheel will provide us with general information about the chassis and tyre performance. Three temperature sensors will allow us to establish a greater understanding of how each tyre on the car is performing, and permit individual changes to be made to each wheel allowing for maximum performance.



i2 Data Overlay for Comparison

- What is an overlay?
- What can you learn from them?
- Creating a single overlay
- Realigning laps
- Explaining the delta
- Distance and beacon accuracy
- Variance
- Creating multiple overlays



What is an Overlay & What Can You Learn?

- Viewing two pieces of similar data recorded at different times or from different vehicles.
- Accurate differences between the two data log files can then be identified.
- Driver, vehicle, engine performances, gains and losses

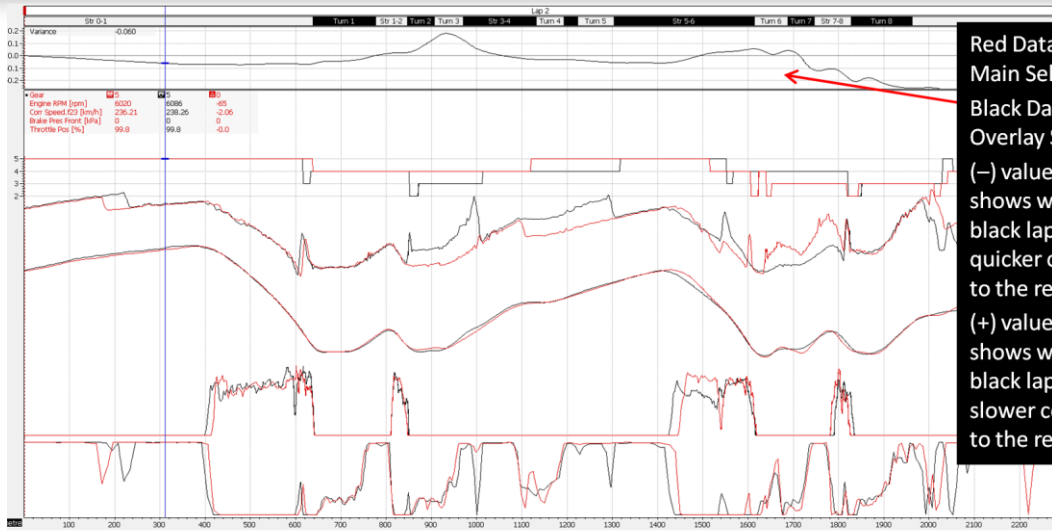


Creating an Overlay

- Open a file with multiple laps or two files with laps
- Open the Data Window (F8)
- Click on the main and overlay lap



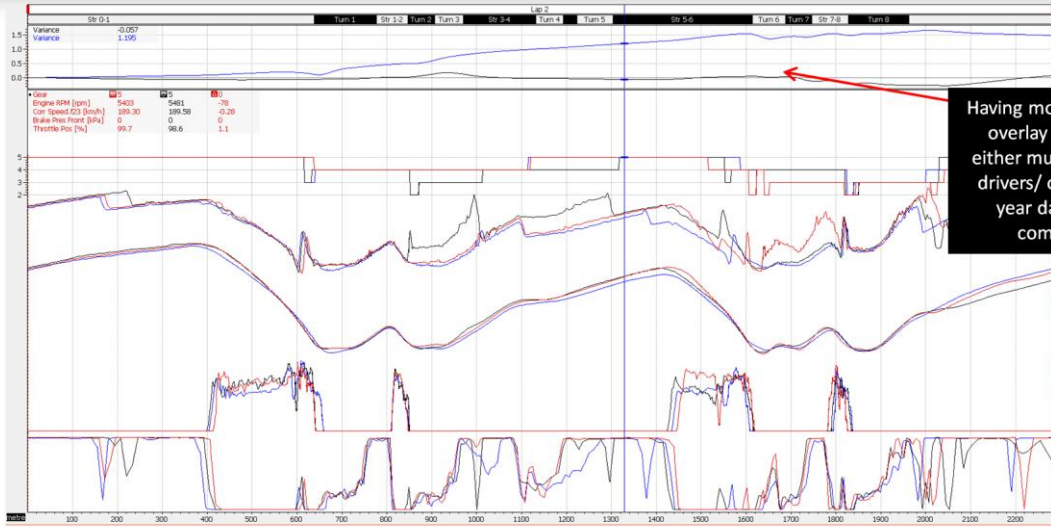
Variance



Red Data is the Main Selection, Black Data is the Overlay Selection
(-) value variance shows where the black lap was quicker compared to the red lap
(+) value variance shows where the black lap was slower compared to the red lap



Multiple Overlays



Having more than one overlay can allow either multiple laps / drivers/ or previous year data to be compared



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Data Maintenance





Weekend Checklist

Start of Weekend

- Update Details Editor
 - Event: General comments about meeting/test
 - Venue: Track name and the directory to which log files will be placed (very important).
 - Vehicle: Update any changes since the vehicle last ran, including gear ratios.
- Check Sensors
 - Use Monitor Active Channels or scrolling through the Warm-up page on the Dash to check that all sensor values are appropriate for that sensor and fix any that are wrong.
- Zero Sensors
 - If required, zero G Sensors, Suspension Sensors, Steering etc.

- Logging
 - Check that logging templates are appropriate. A race logging template (slower rates and fewer channels than practice logging) might be loaded.
- Venue Dependant Variables
 - New Reference Laps for Lap Gain/Loss change.
- Beacons and Lap Times
 - Make sure Beacon Receiver is on correct side of car, or GPS coordinates are correct.

Before/After Each Session

- Details Editor: Update changes made to car, enter session details (practice, qualifying, race, etc).

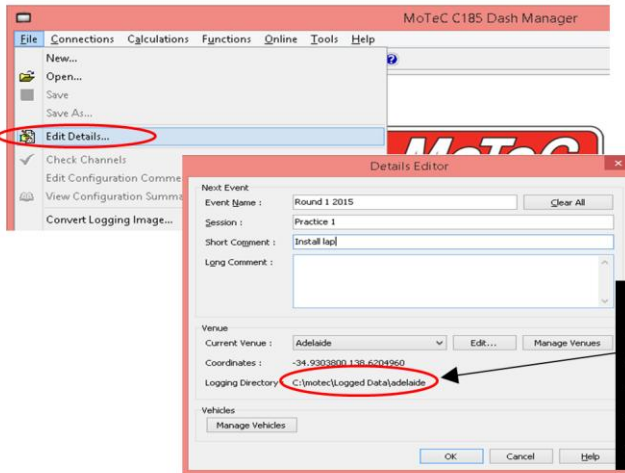
End of the Day

- Be sure to collect your Beacon Transmitter.

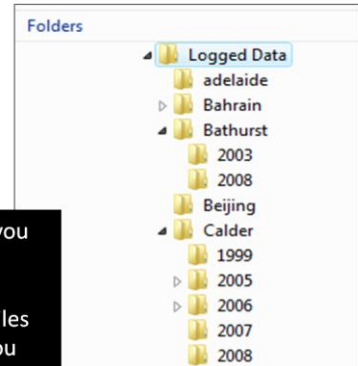


Organising Log Files

- Organise your logged data into specific folders for events so you can access them quickly



Organise by Venue and Year



In Dash Manager you can set up the directory that you want all your log files to go into when you download the data

In Dash Manager you can go to file then details editor to setup where the log files should be stored when you download the data. Make sure you have folders organised by year and venue as well as session if you can, then you will quickly be able to find older data when you need to do comparisons.



Organising/Opening Log Files

Folder View

Database View
Allows user to search via details saved in the configurations

Click on Year will bring up all the year with available data for selection

Open Log File(s)

Year	Driver	Failed Time	Date
2004	Driver 1	0:06:136	10/1
2004	Driver 1	0:06:136	10/1
2005		2:49:000	23/1
2005		2:49:000	23/1
2005	Jarvis	1:03:662	23/1
2			
2005		1:03:662	23/1
Man Pin	2015	0:14:731	2/02
Man Pin	2015	4:03:000	2/02
Man Pin	2015	5:05:743	2/02

Summary

File: C:\MotoC\CL\logged Data\Sample M
File Size: 0.4 Mb
Data Time: 2004-10-10 16:06:31
Device: Optima Pro Logging
Device Serial: 4095
Device Type: ACL
Device Version: 1.10
Driver: Driver 1
Engine: v10
Event: Nationals
Fastest Lap: 0
Fastest Time: 0:06:136
Folder: C:\MotoC\CL\logged Data
Log Date: 2004-10-10
Log Time: 16:06:31
Sheet Comment: First Qualifier
Total Laps: 1
Vehicle Desc: Car 01
Vehicle Id: v10
Version: V050
Year: 2004



View/Edit Details

Details

Name	File 1	File 2
Event	Session	i2 data day
Venue	Calder	Calder
Venue Length		
Driver	Jamie	Jamie
Vehicle Id	11A	11A
Vehicle Desc	Daytona	Daytona
Vehicle Number	65	65
Engine Id		
Session	1	2
Start Lap		
Short Comment	first warmup	second warmup
Long Comment		Calder Park, 23/11/05, fine sunny day
Log Date	17/02/2005	23/11/2005
Log Time	11:14:56 AM	9:53:00 AM
Statistics		
Fastest Time	2:04.988	1:03.682
Fastest Lap	0	2
Total Laps	2	6
File		
File Name	Sample55.id	Sample Id
File Path	C:\Users\Manderson\Do...	C:\MoTeC\Logged Data\Samples\...
File Size	3.80Mb	1.15Mb
Weather		
Sky	Cloudy	Sunny
Track Temp	48 [C]	43 [C]
Air Temp	29 [C]	36 [C]
Baro Pressure		1097 [Bar]
Rel Humidity		75 [%]
Wind Direction		Northly
Wind Speed		23 [km/h]
Weather Comment		
Device		
Vehicle		

Details Editor

Summary | Weather | Vehicle | Custom | General

Data Source: 11:14:56 AM, 17/02/2005, Jamie, Calder, first warmup [Sample55.id]

Event: Session

Venue: Calder Length: (metre (m))

Driver: Jamie

Vehicle ID: 11A Vehicle Number: 65

Vehicle Desc: Daytona

Engine ID:

Session: 1 Start Lap:

Short Comment: first warmup

Long Comment:

Log Date: 17/02/2005

Log Time: 11:14:56 AM

Buttons: Edit..., Options..., Close, Help

4 Ways to Edit Details:

- Pull-down menu - 'Tools/Details'
- In the open file window
- Icon on toolbar
- Shortcut key 'Ctrl-D'

If you forget to update the details in your Dash Manager before a session then you can amend the details in i2 to each of your log files.

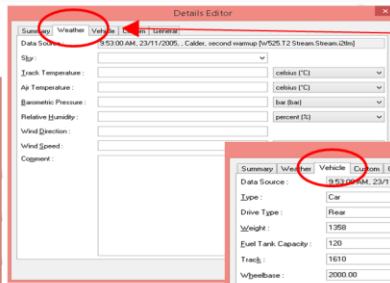
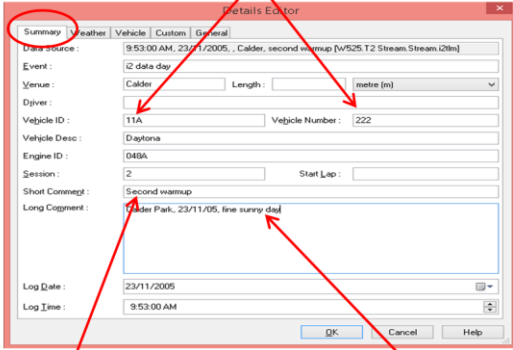
The menu item 'Tool – Details', or 'Ctrl + D' keyboard shortcut will bring up a window with details for all the files that are currently open. Groups of detailed information can be expanded and collapsed using the +/- symbols on the left of the window.

Click on the 'Edit' button to bring up a 'Details Editor' window. Most of the details listed can be edited or added if they had been left empty. Details with numerical values such as gear and diff ratios can be used in maths expressions.

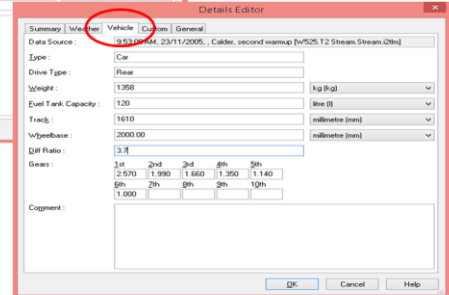


Edit Details

Chassis # and Car #, used for the name of the Excel setup sheet.



Weather Data can be added and saved with the log file



Short Comment shows in open window when loading log files

Long Comments don't show in open window when loading log files

If you fill in the vehicle details you can use these for your maths calculations.

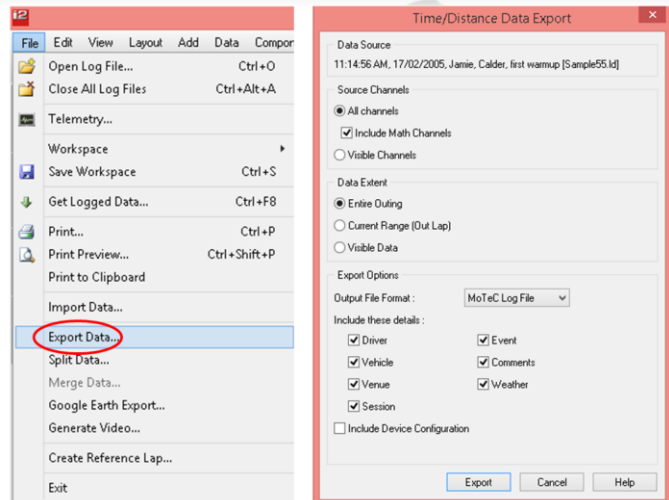
The short comment shows up when you 'open' window for logging files but long comment is not shown.



Exporting Data

- Export to Matlab, .csv file or to the clipboard for use in Excel etc.
- For 'Component' export, only the channels shown get exported.
- For 'File' export, all channels get exported.
- All data is exported at the same rate it is logged at.

Exporting to .ld file allows you to share your data with another competitor but only the channels you have graphed.



If you want to process your data using methods not available in i2, or perhaps you want to send someone part, but not all of your data, there is an export facility in i2. Export allows you to save your data in one of three formats: either CSV (Comma delimited text file) suitable for Microsoft Excel or other non MoTeC applications, the Matlab data format (i2 Pro), or the MoTeC log file format, which will let you open the new file in i2 again.

The File menu has an item called 'Export'. This will always export all of the channels in your file to another log file or a CSV file. Often people wish to export a subset of data, this is done by creating a graph with just those channels that you wish to export shown. Then right-click on the graph and select 'Export Data', only those channels on this graph will be exported.

Both functions allow you to select the timeframe over which to export data: Entire outing (the whole log file), Current Range (e.g. a lap), Visible Data - just the time/distance range shown on screen, e.g. after zooming in.

Data Export: All data or a portion (e.g. lap) may be exported. To export data to a MoTeC (.ld) file, CSV format file or .MAT Matlab file, on the Graph **Component** menu, click **Export Data**.

NOTE: Only the channels in the graph will be exported.

CSV Files: CSV stands for Comma Separated Value file. This is a common format that can be imported by many applications including spread sheet programs such as MS Excel.

MoTeC Log Files: Exporting to a MoTeC log file allows a small number of channels to be exported. This can be useful when you need to give someone some of your data but not all of it.

The device configuration can be included or excluded from the exported data.

The various details can also be included or excluded.

NOTE: When exporting the Current Range (Lap), we export slightly more data than the lap, to ensure the beacons are correctly positioned. This will result in a very small in and out lap.

MATLAB Files: All channels may be exported to a .MAT file. The .MAT file can be loaded into MATLAB and used in the usual way. The output sample rate may be specified as follows:

- Default: each channel is exported at its own rate.
- Fastest: All channels are up-sampled to the fastest channel rate.
- Custom: All channels are re-sampled to the specified rate.



Exporting Channel Report Data

Channel Report - Laps

		SEPANG, Sepang														
		, DC5														
		22/07/2009, DC5														
		5:07:43 PM, Run5-hot														
		Lap 1 [2:31.889]	Lap 2 [2:30.205]	Lap 3 [2:28.740]	Lap 4 [2:29.848]	Lap 5 [2:29.377]	Lap 6 [2:28.101]	Lap 7 [2:28.698]	Lap 8 [2:28.499]	Lap 9 [2:28.087]	Lap 10 [2:27.860]	Lap 11 [2:27.876]	Lap 12 [2:27.537]	Lap 13 [2:28.345]	Lap 14 [2:27.842]	Lap 15 [2:29.773]
Brake Pres Front [kPa]	Max	4784	4820	5212	4879	4683				4980	5180	4884	5053	5276	4984	4747
Brake Pres Rear [kPa]	Max	3938	4266	4226	4294	3970				4686	4978	4403	4472	4239	4444	4111

It is also useful to then store the outing stats using the 'export to clipboard' function to create an ongoing spreadsheet of races and sessions. Right clicking in the Channel Report area will give you two options. Left click on To File if you want a .csv file or Left Click on To Clipboard if you want to paste the data into a spreadsheet.



Creating a Summary Sheet

- Export the channel reports and paste in Excel.

RACE REPORTS2002.xls [Read-Only]									
AGP 2002									
			PRACTICE 1	QUALIFYING	RACE 1	RACE 2	RACE 3		
			CAR 55	CAR 55	CAR 55	CAR 55	CAR 55		
Laps Completed	Laps		12	11	12	14	3		
Start Position					12	15	17		
Finish Position			6	12	15	17	DNF		
Fastest Lap	min		2:00.601	2:00.054	2:02.032	2:12.667	n/a		
Fastest Session Lap	min		1:59.809	1:58.671	1:59.477	2:05.766	2:03.1		
Start 0-100km/h	sec				4.02	5.62	5.3		
Start T.P.	%				87.9	55	44.6		
Start RPM	RPM				7392	5004	3156		
Fuel Used per Lap	litres	Avg.	3.04	2.95	3.25	3.18	0		
Fuel Used for Session	litres	Max.		39	39	44.5			
Speed	km/h	Max.	247	245.3	247.9	294	232.5		
RPM	RPM	Max.	8070	7914	8268	8352	7614		
Lateral G-Force	G	Max.	1.85	1.97	1.82	1.5	-4.7(1.2)		
Ambient Temp	°C	Avg.	20.8		19.6	18.9	18.1		
Track Temp	°C	Avg.	23.3		22.3	20.4	19.5		
Engine Oil Temp	°C	Max.	92	90.1	103	89.6	86.2		
Engine Water Temp	°C	Max.	70	70	81	70	70		
Diff Oil Temp	°C	Max.	82.4	89.5	90.4	87.6	56.3		
Gearbox Oil Temp	°C	Max.	75.6	80.8	85.2	82.5	55.5		
Oil Pressure	psi	Min.	62.32	58.51	50.75	60.41	64.1		
Fuel Pressure	psi	Min.	50.39	50.31	50.39	52.03	50.39		
Cock Pit Temp	°C	Max.							
Battery Voltage	V	Min.	13.68	13.72	13.43	14.2	13.73		

Here is a sample of a race summary sheet. You can see that it lists summary information of selected channels from each session of an event, and the tabs at the bottom show the other events of the year. The file is created by exporting out information from the Channel Report screen and pasting it into a spreadsheet. This gives you a useful, ongoing record of important pieces of information about your vehicle. It can be used to bring attention to trends in your data of changes in oil pressure, battery voltage, diff temps, gearbox temps, whatever is useful to measure for your particular vehicle. With this data, when you ask, "Is it normal for the gearbox to run at that temperature? At this track?", you can quickly go over previous sessions, races, and years to see what you should expect from your vehicle. Using the i2 channel reports to create these summary sheets can help increase the reliability of your racing.

Note that it is very helpful to record information such as ambient air temperature and track temperature with your details and then include them with the summary spreadsheet.



The Final Chapter

- If you need assistance, feel free to drop us a line at support@motec.com.au
- If you have suggestions on possible improvements, or feature requests, email us at the same address, and we can look into it for you
- Can be found wandering the paddock
- Eager to hear new applications
- In the extremely unlikely event that you have a Dash hardware or software crash, we would like to hear from you with the information so that we can continue to improve the product.
- Any Questions?



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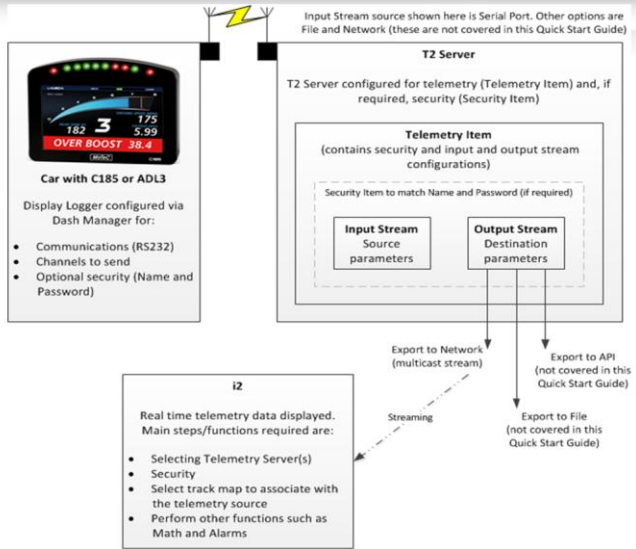
T2 Telemetry





Overview of T2 Telemetry

- This is a simplified overview of T2 Telemetry requirements and function.



With the aid of a radio device the Dash/Logger can send back live telemetry data to a computer back in the pits where a T2 Server application can decrypt the stream and rebroadcast on a network for multiple i2 Pro versions of software to receive.

T2 Server is capable of recording the incoming telemetry stream, for replay at a later time.



T2 Telemetry Setup

- RS232 Telemetry output defined in communications.
- Telemetry Server type, MoTeC T2, or MoTeC Telemetry for Telemetry monitor
- Setup channels to be transmitted and rates at which to be sent
- Setup Alias Name if a different naming convention is required

In Dash Manager Telemetry Setup, you will need to select the Type of Telemetry Sever you will be using

Telemetry channels setup to send with Alias Names

Channel	Rate	Filter	Alias Name	Alias Unit
(No Group)				
G Force Lat	100 times/second			
G Force Long	100 times/second			
G Force Vert	100 times/second			

Channel	Rate	Filter	Alias Name	Alias Unit
(No Group)				
OH_Throttle	5 times/second		Throttle Position	%
OH Steering_Angle	5 times/second		Steered Angle	deg
OH_Ground_Speed	5 times/second		Ground Speed	kph
OH_RPM	5 times/second		Engine RPM	rpm
OH_Brake_Press_Front	20 times/second		Brake Pressure Front	psi
Lap_TrialTime	10 times/second			

Channel Properties

Channel: OH_Ground_Speed

Name: OH_Ground_Speed

Rate: 5 times/second

Group: (No Group)

Filter: None
 Filtermap
 Average

Alias: Ground Speed

Unit: MilesPerHour (mph)



Dash Manager Setup

Communications Setup

Note: The T2 function upgrade must be enabled for the Data Logger to send telemetry data.

Current RS232 communication templates Telemetry Only or GPS & Telemetry can be used with T2.

Setup communications:

Go to the Connections > Communications menu.

In the Communicators Setup window, select an RS232 tab.

Set the applicable baud rate for the selected RS232 port.

Once the communications are set up, click on and open the telemetry setup. Here is where you define the T2 Telemetry option, what channels and at what rates they will be sent.

If receiving telemetry from multiple cars with different names, alias names can be used to make all incoming channels appear with the same name. This is more so used in category wide applications.



T2 Server Setup

MoTeC T2 Server (1.1.0.814)

Server @ W525

There are no Telemetry Items configured. Please add a new item.

Add Item...

T2 Stream

Input: Sample Onig
MetaData ID: 3072465C286a9a9b6a7a20a20af
Event/Phase: 0 data stop Cable
Driver
Vehicle ID: 11A
Session: 2

T2 Server @ W525

T2 Stream

Input	Output
Sample Onig	CAN
Sample Onig	Serial
Sample Onig	Network

VIEW LIVE T2

Adding inputs to receive the data telemetry source and defining outputs for where to send the data.



T2 Server Setup

Options

General | Theme | Folders

Application

- Automatically load most recent configuration on startup
- Automatically delete managed Meta Data Files on exit

Server

Control Port: 8888

API

- Use alternate names & units (when available)

Network Diagnostics

Ping Response Timeout: 1500 ms

OK Cancel

Options

Folders

The following paths will be searched when Meta Data cannot be found.

You only need to specify remote computers that use Dash Manager to configure you ADL's. You can add remote paths using the \machinename\folder convention.

- C:\Users\anderson\Documents\MoTeC\T2\MetaData
- C:\ProgramData\MoTeC\T2\MetaData
- C:\ProgramData\MoTeC\T2\MetaData\Erebus
- C:\Users\Public\Documents
- C:\ProgramData\MoTeC\T2\MetaData\Tekno
- C:\ProgramData\MoTeC\T2\MetaData\T8
- C:\ProgramData\MoTeC\T2\MetaData\Nissan
- C:\ProgramData\MoTeC\T2\MetaData\LDM
- C:\ProgramData\MoTeC\T2\MetaData\HDT

Telemetry Image Location

Path: C:\ProgramData\MoTeC\T2\Image

OK Cancel

Meta Data File

When a Data Manager Logger configuration file including T2 Telemetry setup is sent to the Data Logger, a Metadata file is created. This file is essential for T2 to operate it defines the channel names, and units.

Note: When Dash Manger and T2 Server are running on the same PC, and using the default location for the Metadata file, no intervention is required and access to the file is automatic.

Meta Data Location

Dash Manager

By default, the Metadata file is saved in the **C:\ProgramData\MoTeC\T2\Meta Data** folder of the Dash Manager PC.

To specify a different location: in Dash Manager **Tools > Options** menu **Telemetry** tab, specify the required location.

T2 Server

To receive and transmit telemetry data, the T2 server requires the Metadata file to be located in the **C:\ProgramData\MoTeC\T2\Meta Data** folder on the PC that runs T2 Server.

T2 Server can be set up to automatically pull and copy the file to this location as follows:

In T2 Server, go to the **Tools > Options** menu **Folders** tab and specify the remote location for T2 Server to search.

Select the **Add** button to specify other locations.

As each Metadata file has a unique identifier, T2 server monitors all specified locations and pulls the Metadata file once it is available.



T2 Server Setup Incoming Data

Multiple types of inputs can be set up to receive the incoming telemetry data



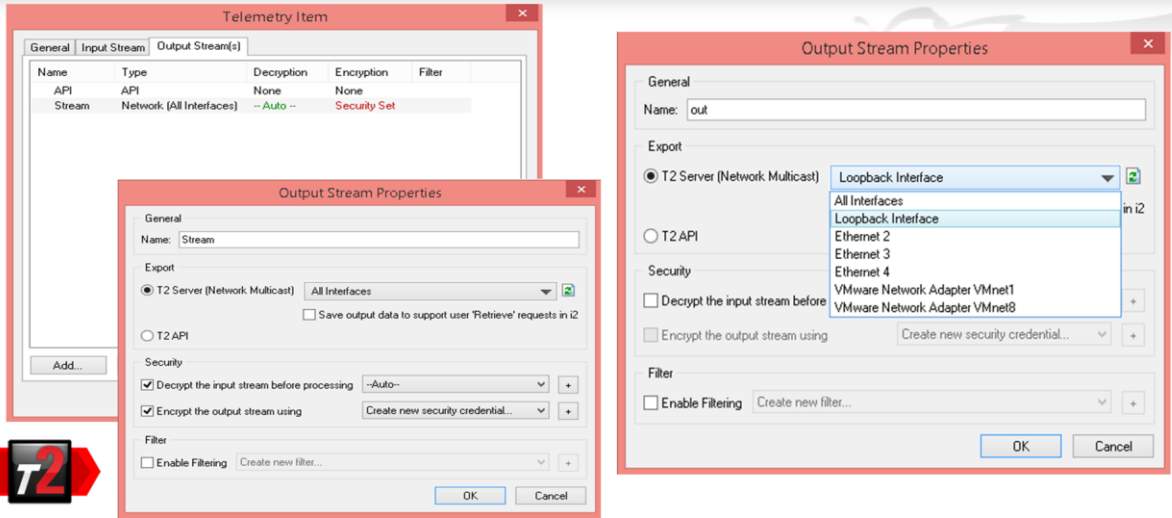
To record the incoming data stream the tick box 'Save input data' needs to be ticked.

A Network or Serial port allows for a physical port to be configured to receive the stream, A MoTeC LD or MoTeC Image file allow pre-recorded or logged files to be replayed.

A T2 Server allows for a connection from another T2 server distributing the stream.



T2 Server Setup Outgoing Data



T2 Server can have multiple outputs for the single incoming stream.

These outputs can be setup with different encryption, filters and or sent to different networks.

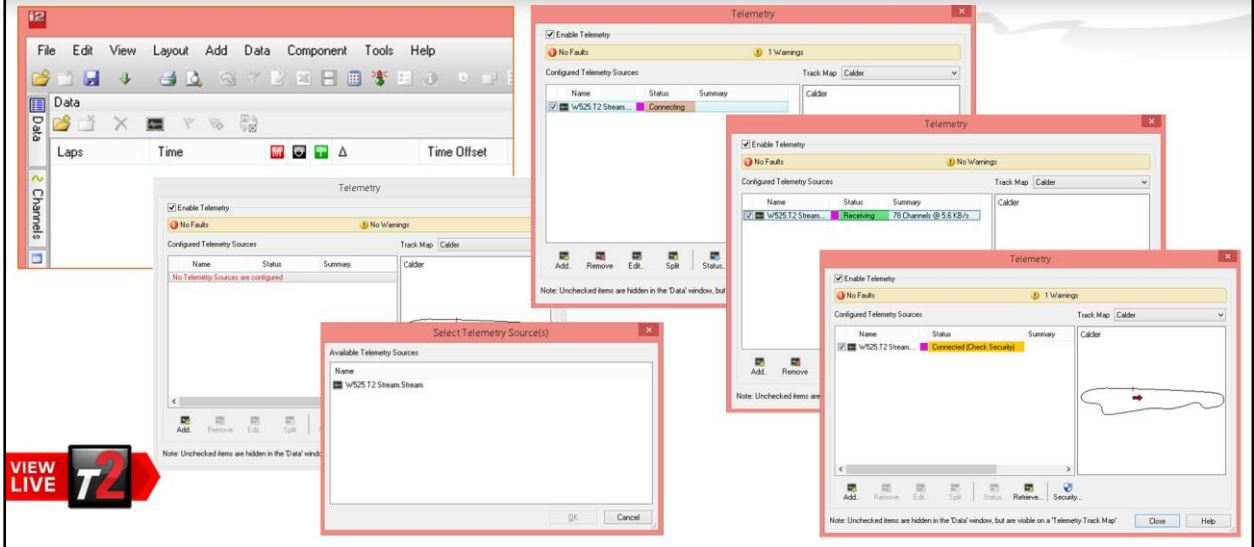
Data can be sent to 'All interfaces' this will send data to all network connections.

'Loopback Interface' will only distribute on the local machine.

Otherwise you can select a specific network to send the data.



Connecting T2 Server to i2 Pro



Telemetry: The Telemetry window is used to add, edit and manage telemetry sources.

Add: Displays the Select Telemetry Sources window, from where available telemetry sources can be selected and added to the Telemetry window.

Remove: Removes the highlighted telemetry source from the Telemetry window.

Edit: Displays the Edit Telemetry Source window, from where the source details can be adjusted.

Split: Split data into a logged source and telemetry source.

Status: Display the status of the telemetry source.

Retrieve: Retrieve logged data for the telemetry source from the telemetry server.

Security: Manage telemetry source passwords.



i2 Pro Telemetry View

- An incoming Telemetry stream will appear at the top of the i2 data window in a collapsed position
- The Telemetry stream can be exploded by hitting the + symbol, this will expose laps completed with the live at the bottom
- Logged data will appear at the bottom

Laps	Time	Time Offset	Distance
Telemetry			
Car # 222 [Ty Anderson]			
w525 T2 Stream Stream 3			
Bathurst, Bathurst 12 hour			
Jamie and Ben, White Daytona			
6/02/2015, P4			
5:38:20 PM, 20150206-0014406.lid			
Out Lap	4:06.944	1:51.500	0.00.000
Lap 1	2:24.414	0:09.070	0.00.000
Lap 2	2:18.910	0:03.566	0.00.000
Lap 3	2:16.759	0:01.411	0.00.000
Lap 4	2:15.746	0:00.402	0.00.000
Lap 5	2:23.028	0:07.684	0.00.000
Lap 6	2:23.422	0:08.078	0.00.000
Lap 7	4:08.046	1:52.702	0.00.000
Lap 8	2:17.346	0:02.002	0.00.000
Lap 9	2:36.043	0:20.699	0.00.000
Lap 10	2:43.333	0:27.989	0.00.000
Lap 11	2:15.344	0:00.000	0.00.000
Lap 12	2:41.998	0:26.654	0.00.000

Normal Collapsed view, Highlighted green to show its connected to live data

Exploded view showing completed laps in this live outing, Highlighted orange to show there is no live data is coming in

Laps	Time	Time Offset	Distance
Telemetry			
Car # 222 [Ty Anderson]			
w525 T2 Stream Stream 3			
Out Lap	0:13.932	-0:49.750	0.00.000
Partial Lap 3	10:59.204	9:55.522	0.00.000
Lap 4	1:05.163	0:01.481	0.00.000
Lap 5	1:03.526	0:00.000	0.00.000
Lap 6	1:05.192	0:01.510	0.00.000
Lap 7	1:03.759	0:00.077	0.00.000
Lap 8	1:03.759	-0:28.714	0.00.000
Bathurst, Bathurst 12 hour			
Jamie and Ben, White Daytona			
6/02/2015, P4			
5:38:20 PM, 20150206-0014406.lid			
Out Lap	4:06.944	1:51.500	0.00.000
Lap 1	2:24.414	0:09.070	0.00.000
Lap 2	2:18.910	0:03.566	0.00.000
Lap 3	2:16.755	0:01.411	0.00.000
Lap 4	2:15.746	0:00.402	0.00.000
Lap 5	2:23.028	0:07.684	0.00.000
Lap 6	2:23.422	0:08.078	0.00.000
Lap 7	4:08.046	1:52.702	0.00.000
Lap 8	2:17.346	0:02.002	0.00.000
Lap 9	2:36.043	0:20.699	0.00.000
Lap 10	2:43.333	0:27.989	0.00.000
Lap 11	2:15.344	0:00.000	0.00.000
Lap 12	2:41.998	0:26.654	0.00.000



i2 Pro Telemetry View

- Multiple cars can be added and viewed live

Adding multiple cars in i2 Telemetry window

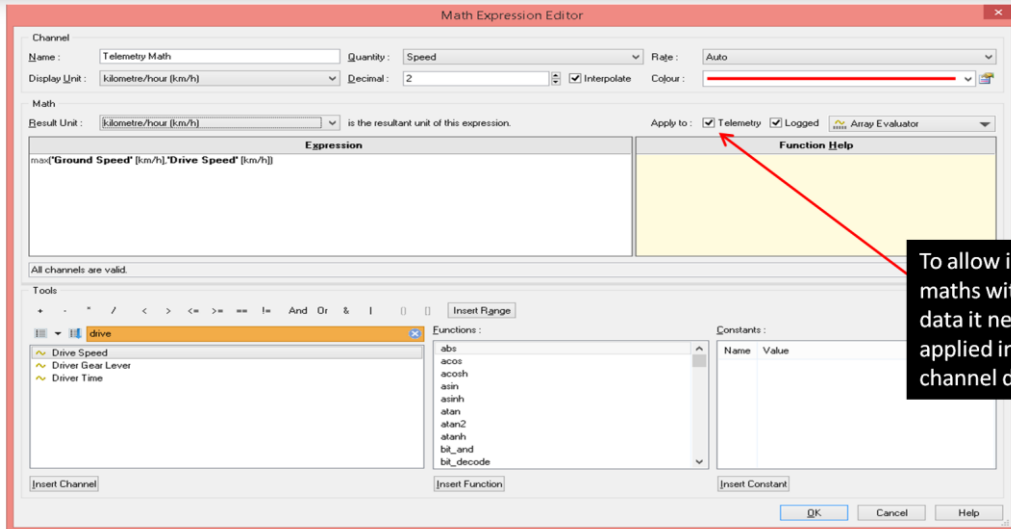
Name	Status	Summary
✓ VSCC 1.888 Team	Receiving	84 Channels @ 16.3 KB/s
✓ VSCC 1.222 Team	Receiving	84 Channels @ 16.3 KB/s
✓ VSCC 1.111 Team	Receiving	84 Channels @ 16.3 KB/s
✓ VSCC 1.585 Team	Receiving	84 Channels @ 16.3 KB/s
✓ VSCC 1.97 Team	Receiving	84 Channels @ 16.3 KB/s
✓ VSCC 1.95 Team	Receiving	84 Channels @ 16.3 KB/s
✓ VSCC 1.47 Team	Receiving	84 Channels @ 16.3 KB/s
✓ VSCC 1.34 Team	Receiving	84 Channels @ 16.3 KB/s
✓ VSCC 1.23 Team	Receiving	84 Channels @ 16.3 KB/s
✓ VSCC 1.23 Team	Receiving	84 Channels @ 16.3 KB/s
✓ VSCC 1.22 Team	Receiving	84 Channels @ 16.3 KB/s
✓ VSCC 1.21 Team	Receiving	84 Channels @ 16.3 KB/s
✓ VSCC 1.18 Team	Receiving	84 Channels @ 16.3 KB/s
✓ VSCC 1.17 Team	Receiving	84 Channels @ 16.3 KB/s
✓ VSCC 1.15 Team	Receiving	84 Channels @ 16.3 KB/s
✓ VSCC 1.14 Team	Receiving	84 Channels @ 16.3 KB/s
✓ VSCC 1.8 Team	Receiving	84 Channels @ 16.3 KB/s
✓ VSCC 1.7 Team	Receiving	84 Channels @ 16.3 KB/s
✓ VSCC 1.8 Team	Receiving	84 Channels @ 16.3 KB/s
✓ VSCC 1.5 Team	Receiving	84 Channels @ 16.3 KB/s
✓ VSCC 1.4 Team	Receiving	84 Channels @ 16.3 KB/s
✓ VSCC 1.3 Team	Receiving	84 Channels @ 16.3 KB/s
✓ VSCC 1.2 Team	Receiving	84 Channels @ 16.3 KB/s
✓ VSCC 1.1 Team	Receiving	84 Channels @ 16.3 KB/s

i2 data window showing multiple cars with car number and driver name visible

Time	Time Offset	Distance C
Car # 1 [Ty Anderson]		VSCC 1.1 Team 5
Car # 24 [Ty Anderson]		VSCC 1.11 Team 27
Car # 11 [Mark McCoy]		VSCC 1.14 Team 14
Car # 12 [Ty Anderson]		VSCC 1.15 Team 15
Car # 13 [Mark McCoy]		VSCC 1.17 Team 16
Car # 14 [Ty Anderson]		VSCC 1.18 Team 17
Car # 2 [Mark McCoy]		VSCC 1.2 Team 6
Car # 15 [Mark McCoy]		VSCC 1.23 Team 18
Car # 16 [Ty Anderson]		VSCC 1.23 Team 19
Car # 9 [Mark McCoy]		VSCC 1.22 Team 28
Car # 17 [Mark McCoy]		VSCC 1.3 Team 7
Car # 3 [Ty Anderson]		VSCC 1.33 Team 21
Car # 18 [Ty Anderson]		VSCC 1.34 Team 22
Car # 19 [Mark McCoy]		VSCC 1.4 Team 9
Car # 4 [Mark McCoy]		VSCC 1.47 Team 23
Car # 20 [Ty Anderson]		VSCC 1.5 Team 3
Car # 5 [Ty Anderson]		VSCC 1.5 Team 24
Car # 21 [Mark McCoy]		VSCC 1.6 Team 10
Car # 6 [Mark McCoy]		VSCC 1.7 Team 11
Car # 7 [Ty Anderson]		VSCC 1.8 Team 12
Car # 8 [Mark McCoy]		VSCC 1.888 Team 25
Car # 25 [Ty Anderson]		VSCC 1.9 Team 13
Car # 10 [Ty Anderson]		VSCC 1.95 Team 26
Car # 22 [Ty Anderson]		VSCC 1.95 Team 26
Car # 23 [Mark McCoy]		VSCC 1.95 Team 26



i2 Pro Maths Using T2 Telemetry Data



To allow i2 to calculate maths with telemetry data it needs to be applied in the maths channel definition.

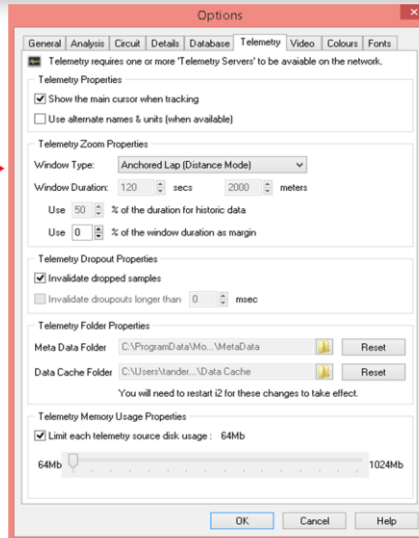
Math Channels

In telemetry mode, Math Channels can calculate their values live. To do this, in the Math Expressions Editor, select the Apply to: Telemetry checkbox.



Telemetry Options in i2 Pro

Clicking on Tools/Options and moving to the Telemetry Tab will bring up the options to define how the telemetry data is handled within i2



If a channel has been sent over telemetry with an Allais name configured, to use this name in the i2 as the name of the channel Click on Tools | Options from the i2 menu, In the Options box, Click on the Telemetry Tab and Tick on the option 'Use alternative names & units'. If the Use alternative names and units boxes are not ticked in either T2 or i2Pro the standard channel name will be used.

Telemetry Tab

Zoom Properties Window Types

Sliding: The cursor stays at the right edge of the graph and as the data comes in the window is continuously slides to the right . The size of the window is defined by Window Duration in seconds for time mode and in metres for distance mode.

Anchored: When anchored mode is selected the window is static and for the defined duration time/distance. The window is divided into two parts: historic data (with user definable duration) and live data. When live data is received, the cursor moves inside the live data part until it reaches right edge of the window, at which point the window jumps to the left and the live data becomes the new historic data. The new live data continues to be drawn in the new live data part.

Anchored Lap (Distance Mode) - Anchored Lap Type is valid only for distance mode and uses lap distance as the Window Duration and margin to show historic data.

Invalidate dropped samples: When this check box is unchecked, channels hold the last valid value when samples are dropped.

Invalidate dropouts longer than: When this check box is checked, channel values are invalidated if the samples were dropped for longer than the user defined duration.

Meta Data Folder: The folder where telemetry MetaData file is saved.

Data Cache Folder: The folder where telemetry data is cached.

Limit each telemetry source disk usage.

When this check box is checked, the cache will grow until it reaches the user defined size. After that the cache memory is overwritten from the start of the data.



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Appendix





Drags: Auto Run Insertion 1



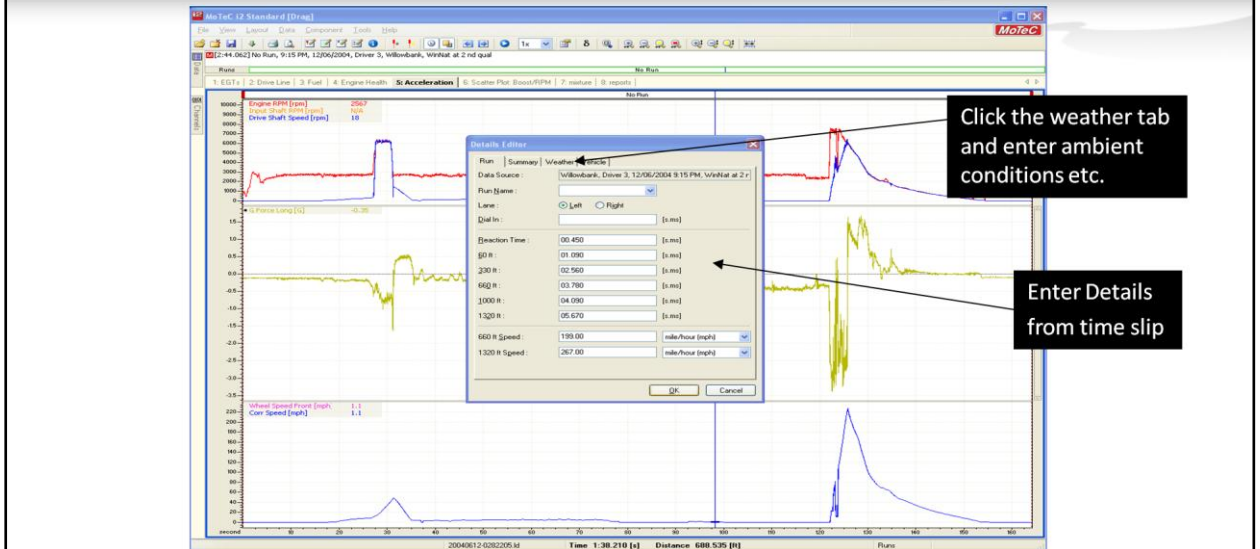
i2 features an all new auto run insert function. With a few clicks of the mouse button the software can automatically insert the pass into the data with all relevant incremental times shown.

Once set up, all your runs will start from exactly the same moment in each file, triggered from an event that occurs on the vehicle. This can be the first pulse from the drive shaft speed sensor or a signal from an on off switch such as a Wide Open Throttle switch. It is best to choose an event that indicates the actual forward movement of the vehicle. Testing suggests this is around the point where data shows a Longitudinal G force greater than 0.2g

The default method is to use the point where 'Drive Shaft Speed' starts to move. Though this can be changed to another channel.



Drags: Auto Run Insertion 2



Once the start point of the run has been determined, we can enter information from the timeslip into i2, that will also be shown on the graph.

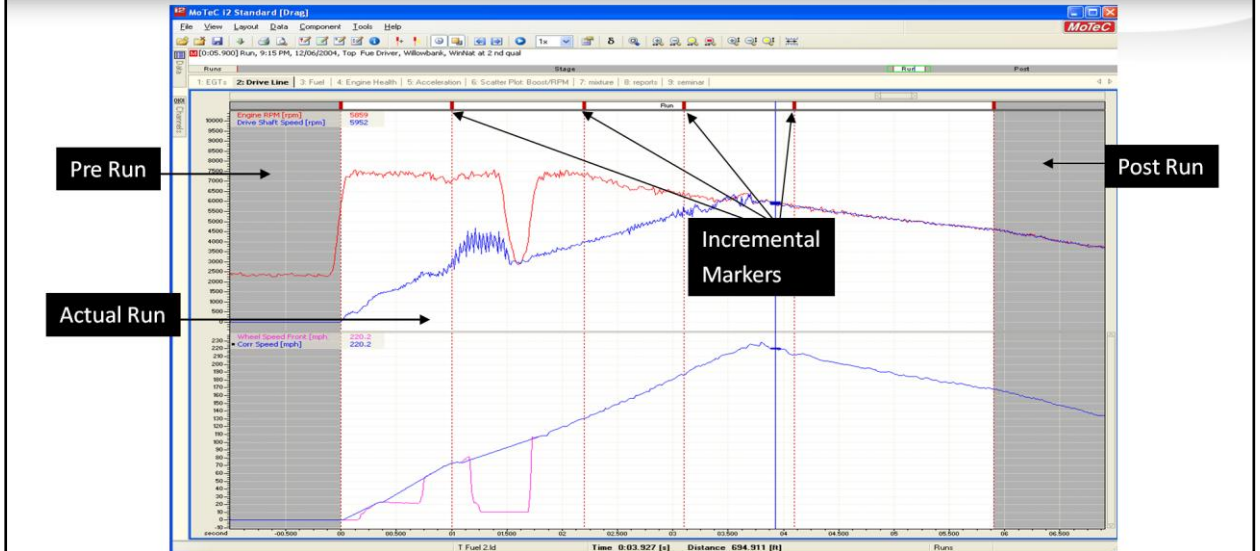
Go into the 'Tools' menu and choose the 'Run Editor'. From here choose 'Edit Details', and enter the time slip information into the cells. At the completion of entering the time slip information press OK.

In here you can also store other important details about the run, such as the weather at the time of the run, tyre temps, pressures, gearing etc. so that later you can go back and see what contributed to a better or worse run that time.

This will return you to the 'create run' screen where all that remains is to click 'create' and the run will be highlighted in the data. To select the run press W for 'whole run'.



Drags: Run Display

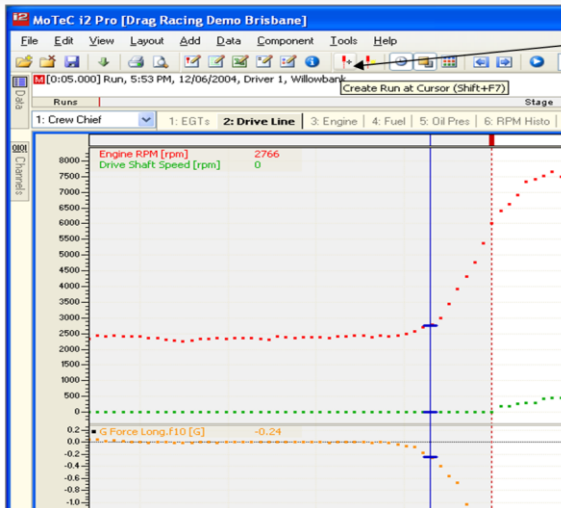


Back in the data, the exact run is then displayed along with 1 second of data pre and post run with a grey background. Also displayed is the entered time sheet information, i.e. 60/330/1000 ft times.

In the example above, the blue corrected speed line on the bottom group shows the corrected speed and therefore distance travelled. This becomes particularly important for overlaying other files and reading Time and Distance reports.



Drags: Manual Run Insertion



Click Create Run at Cursor

If 60ft times etc. are the same Click Create

Run Details	
Run Name	:
Reaction Time	:
Time 60 ft	: 01.000
Time 330 ft	: 02.000
Time 660 ft	: 03.000
Time 1000 ft	: 04.000
Time 1320 ft	: 05.000

If there is already a run on screen and it is not in the right place you can easily shift it by using the Create Run at Cursor feature.

In the above example the run has been previously auto created using the first drive shaft speed data point. Depending on the number of teeth on the drive shaft this point can be a long time after the car has actually started to move.

In the above picture we have changed the properties of the time/distance graph to show data points rather than lines. After some limited testing we have made a rough conclusion that most cars actually start to cross the beam somewhere around 0.25 G Longitudinal. The cursor (blue line) has been placed at this point and now by clicking the 'Create Run at Cursor' icon (Hot Key: Shift + F7) the run start point will be corrected. Assuming all increments are the same, click the create button and the run will shift to this point.



Advanced Features

- Gating
- User Sections
- Alias Editor
- Channel Mapping

Gating : The gating channel allows data to be rejected based on the value of a channel. Data is rejected if the channel value is less than or equal to zero. The gating channel is normally generated by a maths expression. For example a maths channel defined as $\text{abs}(\text{'G Force Lat'}) > 0.5$ would result in a value of 1 during corners and 0 during straights and would therefore reject any data in straights. Gating can be used with Scatter Plots, Mixture Maps, Histograms and Suspension Histograms, with the same or a different gating expression for each. This is similar to how you can turn on and off trace colors in a histogram.

User Sections: In addition to modifying the auto created sections, users can define a new section category and define sections from scratch, e.g. track sectors. These can then be used in channel reports, track reports and time reports.

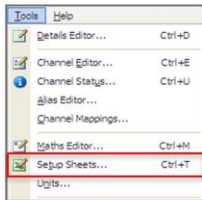
Alias Editor: allows a channel to be created that will use the data from the first available channel in the corresponding alias list. This can be useful if the name of a channel varies between log files. For example an alias channel could be created called Vehicle Speed that uses either Ground Speed, Wheel Speed FL or Wheel Speed FR. Note that the first available channel is used so the order of the list can be important.

Channel Mapping: allows a channel to be renamed and/or the units of a channel to be overridden. This can be useful if a channel is named differently in some log files. It is also useful for channels that were logged without units (for example a Wheel Speed from an ECU).

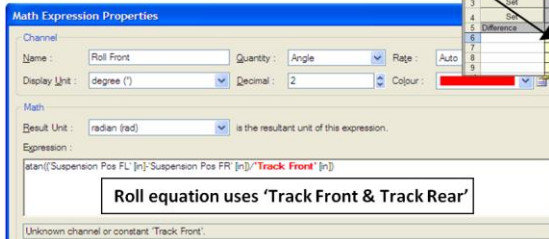
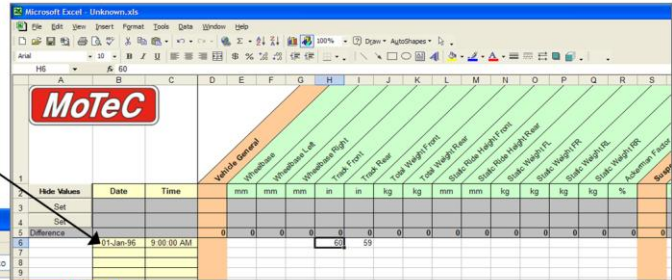


Setup Sheets

- Excel sheet for importing constants to be used in math equations, which can vary by session.
- File can be located anywhere, be sure to enable macros. Exit Excel once changes are complete.



You must enter the Date and Time of your download



- You can delete columns which aren't in use.
- You can create columns, names and select units.
- You can leave blanks where the value doesn't change from session to session.

Setup Sheets

Allows the user to import a list of values relevant to a particular session, e.g. Corner weights, Spring Rates, Tyre pressures. As well as being linked to the relevant log file, the data can be used in maths expressions.

Setup Sheets are a method by which users are able to track changes to their car, along with making these changes available to be used as a constants within i2 for Maths calculations. It can be thought of as a flexible extension to the details editor area per car and session. The sheet is built and pre formatted by i2, and there is one created per car id. In your log file details, you specify an ID for your vehicle. This id must be unique to that vehicle, as this is used for the name of the setup sheet. To start a setup sheet, click on the "Create" button, which then becomes the "Edit" button. This creates the setup sheet named {Vehicleid}.xls, and opens it for editing.

The sheet, once created, is relatively free format, you can change or add any channel name, it just needs to start in column A. You can choose from any of the available channel units that i2 recognises for your channel, if there are no suitable units, leave it blank and it will come across as unitless. Next, add the time/date stamp for your data. To decide which constant is suitable for the currently selected log file, i2 looks at the download time of the log file, and finds the last column that the log file was created after. If there is a value in that row, it takes that value. If it is blank, then it goes back one column at a time until it finds a value, which it uses as the value for that channel. So you can see in the above example, that the file date of 23/11/2005 would make it use the column 'E'. Here it chooses the 'Wheelbase' of 2010, 'Wheelbase Left' of 2010, but has to go back to column 'D' to find a value for 'Wheelbase Right'[, at 2005mm.

There are a few more things to note about setup sheets. If two blank cells are seen in a row in column A (after row 10), it is deemed that there are no more channels to process.

There is one sheet per vehicle ID per project, so be sure to use the same project each time. You can use formulas to create values in the cells; only the final result is used within i2.

If you have further calculations to do for your formula, do them on another sheet, as it only looks at the first sheet of the Workbook when looking for the setup sheet.

To view the setup sheet, click on the 'Tools' menu, then 'Setup Sheets', or Control+T

If there is a button called create, click that to create a sheet, or use Edit if it already exists

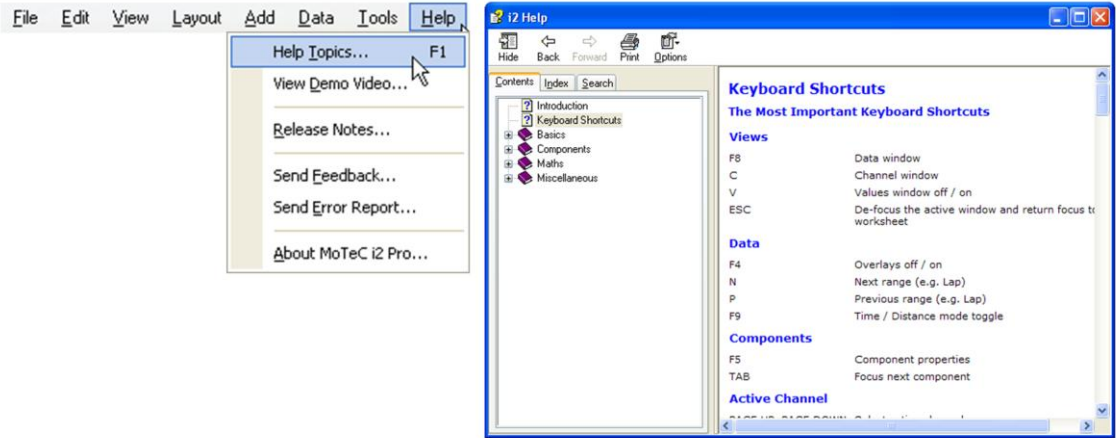
Add some numbers into cells C11, C12, C13 and C14

Save and close the spreadsheet.



Keyboard Shortcuts

- See the Help File for a complete list of Keyboard Shortcuts





Keyboard Shortcuts

Views

F8	Data window
C	Channel window
V	Values window off / on
ESC	De-focus the active window and return focus to the worksheet

Data

F4	Overlays off / on
N	Next range (e.g. Lap)
P	Previous range (e.g. Lap)
F9	Time / Distance mode toggle

Components

F5	Component properties
TAB	Focus next component

Active Channel

PAGE UP, PAGE DOWN	Select active channel
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Graph

LEFT / RIGHT ARROW	Cursor movement
CTRL + LEFT / RIGHT ARROW	Fast cursor movement
UP / DOWN ARROW	Horizontal zoom in / out
F2	Horizontal zoom full out
W	Horizontal zoom to default (e.g. 1 Lap)
SHIFT + LEFT / RIGHT ARROW	Pan left / right
F3	Variance off / on
E	Status and Errors off / on
G	Overlapped / Tiled

Windows

ALT+Letter	Activate a main menu item that has the letter underlined. Or, if a dialog window is active, focus an item or activate a button with a label that has the letter underlined.
TAB	Move to the next item
SHIFT+TAB	Move to the previous item
ENTER	Activate the default button
ESC	Close or cancel an open window
ARROW Keys	Move up and down in a list, select a dropdown item, select an option button
SPACEBAR	Activate a button or toggle a check box select / clear
CTRL+TAB	Next page on a tabbed window
SHIFT+CTRL+TAB	Previous page on a tabbed window

File

CTRL+O	Open log file
CTRL+A	Close all log files
CTRL+S	Save project
CTRL+F8	Unload logged data

General

CTRL+P	Print worksheet
F1	Help

Edit

CTRL+X	Cut component
CTRL+C	Copy component
CTRL+V	Paste component
DELETE	Delete component



Keyboard Shortcuts

Views

F8	Data window
C	Channel window
V	Values window off / on
ESC	De-focus the active window and return focus to the worksheet

Data

F8	Select Lap / Outing / Run (shows Data window)
F9	Time / Distance mode toggle
F4	Overlays off / on
J	Single colour for main (shows all channels in the same colour for the main data)
P	Previous range (e.g. Lap)
N	Next range (e.g. Lap)
CTRL+F	Select fastest lap in current file
Q	Swap Main and Overlay 0
F2	Horizontal zoom full out
W	Horizontal zoom to default (e.g. 1 Lap)
A	Animate Start / Stop

Data Window

ENTER	Make the selected item Main
CTRL+ENTER	Make the selected item Overlay 0
ALT+ENTER	Make the selected item an Overlay

Layout

F7	Select worksheet
CTRL+F7	Activate Layout Manager
0..9	Select corresponding worksheet
CTRL+0..9	Select corresponding workbook
F11	Previous worksheet
F12	Next worksheet
CTRL+F11	Previous workbook
CTRL+F12	Next workbook

Tools

CTRL+D	Details editor
CTRL+E	Channel editor
CTRL+U	Channel status
CTRL+M	Maths editor
CTRL+T	Setup sheets

Active Channel

PgUP, PgDn	Select active channel
CTRL+H	Hide active channel
CTRL+Delete	Remove active channel
CTRL+SHIFT+M	Edit active channel maths (if maths channel)
CTRL+SHIFT+S	View active channel status (if maths channel)
CTRL+SHIFT+F	Filter active channel
CTRL+SHIFT+O	Scale and offset active channel
CTRL+SHIFT+Z	Zero at cursor active channel
CTRL+N	Properties of active channel



Keyboard Shortcuts

Components General

F5	Component properties
Tab	Focus next component
SHIFT+Tab	Focus previous component
L	Channel legend off / on
K	Colour channel legend off / on
G	Cycle layout (Overlap / Tiled)
S	Cycle display style
ALT+0..9	Corresponding colour band off / on
Delete	Delete selected component

GRAPH

Graph Display

E	Status and Errors off / on
F3	Variance off / on
L	Show channel legend off / on
M	Show measurements off / on
G	Overlapped groups off / on
S	Toggle trace style

Graph Zoom

Keyboard	
UP / DOWN ARROW	Zoom in / out
F2	Zoom full out
W	Zoom to default (e.g. 1 Lap)
Z	Zoom to datum and main cursors
ALT+UP / DOWN ARROW	Vertical zoom in / out
ALT+F2	Vertical zoom full out

Mouse

Double-click, move, click	Horizontal zoom
ALT + Double-click, move, click	Vertical zoom
CTRL + Double-click, move, click	Window zoom
Double-click on the horizontal scroll bar	Horizontal zoom full
Double-click on the vertical scroll bar	Vertical zoom full

Graph Pan

Keyboard	
SHIFT + LEFT / RIGHT ARROW	Pan left / right
SHIFT + UP / DOWN ARROW	Pan up / down (if vertically zoomed)
F	Pan forward
B	Pan back
H	Centre on cursor

Mouse

Click + drag on the horizontal axis	Horizontal pan
Click + drag on the vertical axis	Vertical pan
Click + drag on the horizontal scroll bar	Horizontal pan
Click + drag on the vertical scroll bar	Vertical pan

Graph Cursor

Keyboard	
LEFT / RIGHT ARROW	Cursor movement
CTRL + LEFT / RIGHT ARROW	Fast cursor movement
SHIFT+F7	Place beacon at cursor (if Circuit Project)
	Place run at cursor (if Drag Project)
	Place stage at cursor (if Rally Project)
Y	Cursor style
HOME	Cursor to left of screen
END	Cursor to right of screen

Graph Datum Cursor

Keyboard	
D	Datum cursor off / on
SPACEBAR	Place datum cursor
X	Swap datum and main cursor

Graph Alignment Offsetting

Keyboard	
O	Offsetting axis off / on
CTRL+SHIFT+ARROW	Offset the main lap (offset axis must be on)
ALT+SHIFT+ARROW	Offset the ref lap (offset axis must be on)
Mouse	
	Drag the main or ref offsetting axis