



## The SWIS10 and SWIS 20 Steering Wheel Instrument and Data Logging Systems

## Farrington Steering Wheel Displays and Data Loggers

With the introduction of the FL20 Data Logger, Farrington is able to offer a wide range of instrument displays and data loggers. Essentially there are more than five different steering wheels (SW-ddd), although they only differ in size, that can be connected to two types of control box/data loggers to form a range of systems that this document describes.

A complete system comprises a steering wheel display, a control box / data logger, a matching loom and, optionally, some sensors.

Before looking at complete systems in detail, the following paragraphs outline the components in the range.

### Steering Wheel Displays

The standard versions are as follows:

SW-250 MOMO Model 12 Suede 250 mm diameter with flat bottom.



SW-260 MOMO Model 11 Suede 260 mm diameter



SW-270 MOMO Model 29 Suede 270 mm diameter with flat bottom.



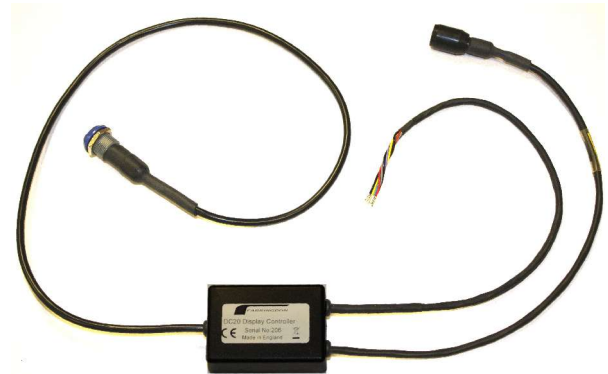
SW-320 Or -340 MOMO Model 32 Suede 320 or 340 mm diameter circular.



Alpha 240 mm flat bottom as used by some Williams F1 cars –not illustrated.

### Control Box / Data Loggers

There are two types of control box, the small, low cost DC20 which performs no data logging but simply interfaces the steering wheel from an engine management unit using either RS232 or CAN. It is available with a direct wheel speed sensor input and with lap timing.



The other, the much more powerful FD20 uses MMC or SD Flash Cards for data logging memory. There is no need for a download lead as the data is transferred by removing the card from behind the sealed door and putting it into your laptop (either directly or through a USB adapter).

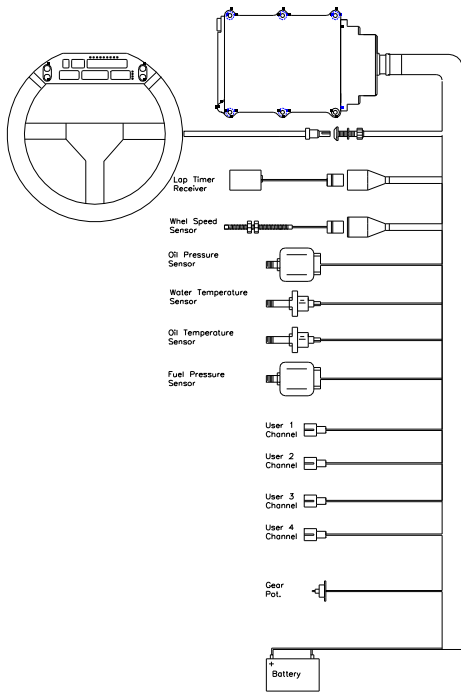


The FD20 has many more channels and therefore needs a connector with more ways and in turn this means that a different loom is required.

### Looms

The Display Controller has flying leads – one with a connector for the steering wheel, another with a connector for the Infra Red Detector (option) and another with free wires for connection to the wheel speed sensor (option) and to the engine management unit.

There are two types of loom for the FD20 Data Logger, the FD20-4 has four separate Mini Sureseal user channel connectors for four user channels and the FD20-8 has eight separate user channel connectors.



## Complete Systems

The four complete standard systems are as follows:

System	Steering Wheel	Control Box/Data Logger	Function
SWIS10-11	any	DC20	Instruments only
SWIS10-12	any	DC20	Adds lap timer
SWIS20-4	Any	FD20	Adds SD card Data Logging with 4 user channels
SWIS20-8	any	FD20	Adds another 4 user channels

These systems are now described in detail. All systems have the same basic functions that allow engine temperatures and pressures, rpm, battery voltage and road speed to be displayed on the steering wheel.

## Steering Wheel Display

The display is divided into six “windows” coloured alternately red and green. Each window contains high brightness red or green 7-segment LED displays mounted behind special filters that minimise glare and increase contrast. The different colours break up the display and help the driver locate a particular window. The table below shows how the windows are used.

### The Display Windows and LEDs

Window Title	No. Digits	Colour	Other Information
Gear	1	Red	Derived from gear ratios, rpm and speed or from a special output from the gearbox.
Laps	2	Green	When fitted with a lap timer, this window shows the number of laps completed. Displays recalled lap number in recall mode.
Lap Time	6	Red	When fitted with a lap timer this window displays the lap time at the end of each lap. When fitted with the performance monitor, this window shows the time difference between the best and current laps. Also used to display recalled lap times, extra gauge readings and alarms. Displays RPM as an option.
Speed	3	Red	Displays speed or any gauge reading.
Elapsed Time	4	Green	Displays elapsed time. Very useful for qualifying and for endurance races. If the Lap Time window is used to display RPM, then this window displays lap time and performance. (SWIS10-2 or 3).
Gauge	3	Red	Displays the four main gauge readings: Oil Pressure, Water Temperature, Oil Temperature and Fuel (pressure or level). The four LEDs next to this window show which gauge is being displayed. Other gauges such as battery voltage are shown in the lap time window and labelled by text in this window – e.g. bat

There are nine shift lights – two yellow, four red and three extra bright blue. These can be set to light at any RPM. You can set more than one light to light at the same RPM, so for example you may choose to make the top three red lights come on together. You can also ask for different coloured lights – for example all red so that you can arrange the shift lights to light first the both outside lights then the outside two and so on.

### SWIS10 Models

The SWIS10 Models derive most of its data from a CAN or RS232 interface to the engine management unit. There are two models of the SWIS10 system the SWIS10-11 and the SWIS10-12. The dash 11 model provides instruments only and the dash 12 model includes a sophisticated Lap Timer.

### SWIS10-11

The dash 11 model provides the main instrument set for a race or track day car.

The parameters displayed are as follows:

#### Gear

The Gear Window displays your current gear. The system can deduce the gear from the RPM and the wheel speed if the ratios are known. Of course this does not prevent you from selecting the wrong gear as it only works when the clutch is

engaged. An analogue input is available for cars with a gear position sensor.

#### RPM

As there is no lap timer, the Lap Time Window displays RPM as a number e.g. 10500 or 6500. The nine shift lights can be set to light at any RPM. When the engine is turned off, the maximum RPM (tell-tale) is displayed.

#### Speed

The optional wheel sensor provides the signal for speed if it is not available from the EMU. It is displayed a 3 digit number in MPH or KPH.

#### Elapsed Time

The centre bottom window displays elapsed time in minutes and seconds or hours and minutes. It can be reset to 00:00 at any time by pressing both bottom buttons.

#### Odometer

The system keeps track of the miles (or kilometres) travelled and this is displayed in the Lap Time Window at power up - very useful for tracking the engine mileage. The completed full miles or kilometres are accumulated while the power is on. Fractions of miles covered are lost when the power is switched off.



#### Oil Pressure

Oil pressure is displayed in the Gauge Window when selected with the right hand buttons. The pressure in pounds per square inch (psi) is shown as a number. An alarm limit can be set so that when the oil pressure drops below this limit the word Oil appears flashing in the Lap Time Window and the Gauge Window shows the actual pressure.



#### Water Temperature

When selected with the right hand buttons, the water temperature is displayed in degrees centigrade in the Gauge Window. Again alarm limits can be set which when exceeded cause the alarm "Hot" to be displayed flashing in the Lap Time Window. Unlike the Oil Pressure warning, this can be overridden by pressing either of the right hand buttons.

#### Oil Temperature

Oil temperature and its alarm are displayed in the same way as Water Temperature.

#### Fuel

Fuel Pressure and its alarm is displayed in the same manner as Water temperature. If fuel level is to be displayed, please contact Farringdon with details of the sensor. The alarm limit for the Fuel reading causes the word "Fuel" to be displayed in the Lap Time Window. An alarm delay function can be switched on that ignores the minimum limit until it has been seen for 5 seconds.

#### Battery

By pressing the top right hand button when it is showing oil pressure, the Lap Time window display changes to show first RPM or speed and after another press, the battery voltage.

### SWIS10-12

The dash 12 model includes all the instruments described above together with a Lap Timer. Based upon the Farringdon RCA60, the Lap Timer integrated into the SWIS10-12 provides many of the same features. The infra red components use the same low power technology and the dual IR detector is supplied which detects the permanent high power beacons installed at most UK car racing tracks. The unique "IN" feature is included so that the Lap Time Window flashes "Pits" when the beacon is switched to the "IN" position. A maximum lap time of 19:59.99 allows for longer circuits such as the Nordschliefe in Germany. (An optional push button switch input is available for timing where beacons are not available.)



#### Lap Time

When the system is powered on, the Lap Time Window displays a running time. When the car passes the beacon for the first time, the running time is frozen and the lap number changed from 0 to 1. This is the first out lap and of no real interest. At the second pass of the beacon the lap time is frozen in the Lap Time Window for the "Hold Time". The Hold Time should be set so that the driver can reach a good place on the track to glance down and read the lap time. This will differ from circuit to circuit. Once the Hold Time has expired, the Lap Time Window changes to show the time into the current lap. This allows the driver to monitor the progress of the lap by noting the time into the lap when passing under a bridge or some other landmark.

The number in the Laps Window can be cleared by pressing both top buttons. Usually the car will pass the beacon on the parade and warm-up laps. This feature allows the driver to clear the lap count on the grid before the start. (An easily accessible set up option switches the Lap Timer Window to RPM and the Elapsed Time window to lap time when a permanent display of RPM is required.)

#### RPM

If the Lap Time Window is used for the Lap Timer, RPM has to be selected with the right hand buttons. "Scrolling" beyond Oil Pressure causes RPM (or the tell-tale if the engine is not running) to be displayed. The letters tac (tachometer) or tt (tell-tale) are displayed in the Gauge Window. As a set up option, RPM can be displayed in the Lap Time window and the above procedure will show speed in the Lap Time window.

#### Fastest Lap

The system keeps track of the fastest lap. It can be displayed in the Laps and Lap Time Windows by "scrolling" past Oil Pressure and RPM or Speed with the right hand top button. The letters Ftd (Fastest Time of the Day) are displayed in the Gauge Window. The fastest lap can be cleared when the system is powered up by pressing any button when prompted.

#### Battery

Pressing the top right hand button again causes the battery voltage to be displayed.

### Recall Mode

Pressing both right hand buttons makes the system enter Recall Mode. The letters rcl are displayed in the Gauge Window and the left hand buttons allow the stored lap times to be scrolled through. The memory will hold up to 750 laps before it is overwritten.



Here we see that the time for lap 21 was 1 minute 5.02 seconds.

### The SWIS20 Systems

The SWIS20 systems use the FD20 control/data logging box which offers much larger memory, much faster logging rates and more user channels. However, the SWIS20 also drives the steering wheel with the same instrument display, warnings, lap timing and performance monitor as the SWIS10-12

There are two SWIS20 Systems that differ only in the number of user channels available in the loom. The SWIS20-4 which includes the FL20-4 Loom which has a four user connectors for 4 user channels and the SWIS20-8 has eight user connectors for 8 user channels.

### Memory and Sampling Method

Both SWIS20 Systems use physically small SD flash memory cards as data logging storage. This has the advantage of much larger memory without the problem of long download times. The SWIS20 Systems have all the lap timing and display features of the SWIS10 but in addition, data is logged against time - that is all channels are sampled a certain number of times per second. This *sampling rate* is the same for all channels and adjustable as part of the set up facility from 4 to 500 samples per second.

The systems are provided with a 1 Gbyte card as standard giving recording capacities of more than 20 million samples. So at 10 samples per second, this card can hold more than 20 DAYS of continuous data - enough for a whole seasons racing. At the other extreme, with a sampling rate of 500 samples per second and with a 1 Gbyte card, a total recording time of about 17 hours is possible.

### Real Time Clock and Calendar

An important feature of the SWIS20 systems is the real time clock and calendar. This clock is maintained by a small, dedicated battery that will last for more than a season without replacement. Data is logged as files, each sequentially numbered in the same way as pictures in a digital camera. The creation time and date is when data logging started and the last modified time and date is the time when data logging stopped. These times and dates help to locate files of logged data from previous meetings.

### Set Up

The system can be set up from the steering wheel or from the computer in the same way as SWIS10 systems. A setup file is written on the flash card which is updated, either from the steering wheel itself or when setup is selected in the Data Analysis software, Podium *Flash*.

### Data Channels

There are, in effect 20 direct data channels. All 20 channels are sampled at the same rate and substantially at the same time.

- 1) Time from beacon
- 2) Speed
- 3) RPM
- 4) Oil Pressure
- 5) Water Temperature
- 6) Oil Temperature
- 7) Fuel Pressure or Level
- 8) Battery Voltage
- 9) Lateral G
- 10) Longitudinal G
- 11) Gear
- 12) Control Box temperature
- 13) User Channel 1
- 14) User Channel 2
- 15) User Channel 3
- 16) User Channel 4
- 17) User Channel 5
- 18) User Channel 6
- 19) User Channel 7
- 20) User Channel 8

The user channels are sampled with 10 bits resolution while dedicated temperatures and pressures are read to 8 bit resolution.

### Thermocouple Input

A dedicated thermocouple input is supplied that overrides User Channel 8 to provide a cold junction compensated K Type Thermocouple from 0 to 1023 degrees C.

### Data Logging Trigger

Data logging can start when power is applied, when the engine is started or when the car reaches a minimum speed. Setting logging to start when the engine runs allows data logging during rolling road testing, but more importantly, it will catch any engine problems while warming up.

### Engine Management Interface

The FD20 Data Logger has a dedicated serial interface for connection to the car engine management system (ECU). As modern engine management units require most of the engine temperatures and pressures to ensure that the engine runs safely, these measurements are transmitted from the ECU for display or other purposes. The FD20 can read this ECU output and use this data instead of directly connected separate sensors. On setting up the system, the user can decide whether to take the standard temperatures and pressures from dedicated sensors or from the ECU data stream.

Although the input to the FD20 is RS232 only, CAN to RS232 interface modules are available. Various CAN protocols are available and others being added all the time.

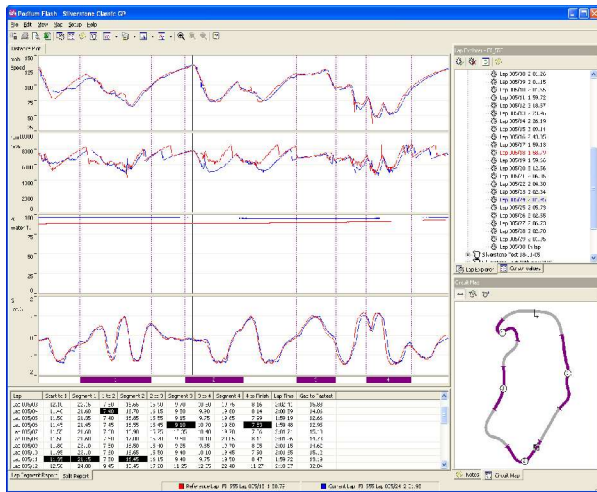
### ECU Data Interleaving

Some ECUs provide much more data than just the main four engine temperature and pressures. This other data, such as throttle opening, lambda, manifold pressure and fuel consumed, can be logged every other sample time. Although the maximum sampling rate is halved, many of these other channels from the ECU can be logged. This interleaving of the standard data and the ECU data is enabled during set up, so that the full sampling rate can be used when data is required on high frequency user inputs such as suspension movement.

The data logged is as follows:

## Data Analysis Software

A copy of Podium *Flash* is supplied with each SWIS20 System. Derived from Podium Plus, it matches the facilities of the FD20 Data Logger. The lap explorer displays laps found in the data files, annotating out-laps and in-laps and marks files logged while the car is stationary at "static".



Non-linear sensors may be attached to the user channels and displayed in "engineering units" by inserting the third order polynomial coefficients for the transfer function of the sensor.

A powerful zoom facility is provided allowing detailed inspection of small portions of a lap – essential if data is being sampled at a high rate.

The usual graphs, histograms, x-y plots, split reports, time lines, track maps etc can be produced from the data.

In addition, specific support for the memory card such as formatting, time setting and generating setup files is included.

Podium *Flash* is video enabled so that video files can be synchronised with data graphs and reports. Further in order to handle the very large amounts of data that can be recorded, a database export feature is available that allows the data to be explored with queries such as:

"...display the number of times oil pressure has dropped below 10 psi when lateral g has been less than 1.5G..."

## The Performance Monitor Option

The Performance Monitor displays the difference between the performance in the current lap and that of the best lap. After the "Hold" time has expired, the Lap Time Window shows the



difference between the time into the current lap and the corresponding time in the best lap. Positive or negative signs indicate whether the current lap is faster or slower than the previous best. The Performance Monitor can produce staggering improvement to lap times.

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