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# **ST8600 Steering Wheel Display System**

**Users Guide**

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*Part No. ST542072-003*



## Preface

Thank you for choosing the Stack ST8600 Steering Wheel Display System. This system will give you a wealth of information to enable you to obtain the maximum safe performance from your vehicle.

### Registration Form

Please complete and return the Registration Form contained in the package. This will allow us to keep you up to date on the latest developments from Stack.

### Purpose of this manual

This manual will help you install and use the ST8600 Steering Wheel Display System. It explains how to set up and configure the system for your vehicle.

### Edition Notice

This edition is for all versions of the ST8600 Steering Wheel Display System distributed to customers world-wide. The units of measurement used to illustrate the use of the Display System in this edition are for the UK version. Units used in the various versions are shown in the following table.

Parameter Type	UK Version	US Version	EC Version
Speed	MPH	MPH	km/h
Temperature	Degrees C	Degrees F	Degrees C
Wheel Circumference	Millimetres	Inches	Millimetres
Pressure	PSI	PSI	Bar

## Related Products From Stack Limited

If you need information about other Stack motor sport products, these can be obtained from Stack or from your local Stack dealer. Products available from Stack include:

- Intelligent Tachometers
- Action Replay Tachometers
- Performance Analysers
- Speedometers
- Boost Gauges
- Analogue Sensors
- Digital Sensors
- Data Logging Systems
- Display and Logging Systems
- Radio Telemetry Systems
- Display and Analysis Software

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## **Chapter 1. Introducing the Display System**

The ST8600 Steering Wheel Display System monitors and displays a range of values, known as performance parameters, needed for effective car and driver management in most competitive situations.

Two variants of the Display System are available:

- ST8600 – basic system
- ST8600M – full system including Wheel Speed and Predictive Lap Timer

The system comprises a sensor interface module and a digital display built into a steering wheel to show the following performance parameters:

- Engine Speed (RPM)
- Oil Pressure
- Oil Temperature
- Engine (Water) Temperature
- Fuel Pressure
- Battery Voltage
- Gear Position via gearbox sensor or by ratio (requires wheel speed sensor)
- Wheel Speed (optional on ST8600)
- Lap Times (ST8600) Available with the optional lap timing system.
- Predictive Lap Timer (ST8600M)

You can view the peak values (tell-tales) for all the parameters.

The system provides a range of warning messages based on pre-set alarm values for the following performance parameters:

1. Oil pressure
2. Oil temperature
3. Fuel pressure
4. Engine (Water) temperature
5. Battery voltage

You can enable or disable the warning system for each parameter individually.

You can redefine the alarm value for each parameter to a value that is more suitable for your vehicle.

The system provides a nine-way sequential gearshift warning light that is based on RPM values that you define for your vehicle.

## How to use this Manual

Stack recommends that you unpack and connect the components in the system **before** you install it in your vehicle. This will enable you to familiarise yourself with operating the display and configuring it for the vehicle in which you intend to install it.

This manual starts by taking you through the process of setting up the system before installation, operating the digital display, configuring the system and setting the alarm values and installing it in the vehicle. By the end of Chapter 2, you will have set up the system so that you will be assured that it is functioning normally. You can then read Chapter 3 and practice using its functions. Chapter 4 takes you through configuring it for your vehicle. Chapter 5 explains how to install it in the vehicle and Chapter 6 provides a set of trouble-shooting guidelines.

A schematic diagram of the wiring harness is in Appendix A.

Please note that this manual does not attempt to explain how to interpret or use the information from the ST8600 Steering Wheel Display System as that is very specific to the type of vehicle in which it is installed and the type of competition in which the vehicle is engaged.

## Chapter 2. Getting Started

This chapter guides you through the initial unpacking and setting up of the equipment for pre-installation checks and familiarisation with its operation.

### Standard ST8600 Steering Wheel Display System Items

The ST8600 Steering Wheel Display System is supplied with the following standard components:

Quantity	Description
1	Steering Wheel Display (ST21302x)
1	Sensor Interface Module (ST847)
1	Wiring Harness (ST870)
2	Pressure Sensors (ST747-1/8 <sup>th</sup> NPTF ) with M10 adaptors for EC systems
2	M6 Temperature Sensors (ST991) with M10 (EC) or 1/8 <sup>th</sup> NPTF (UK/USA) adaptors

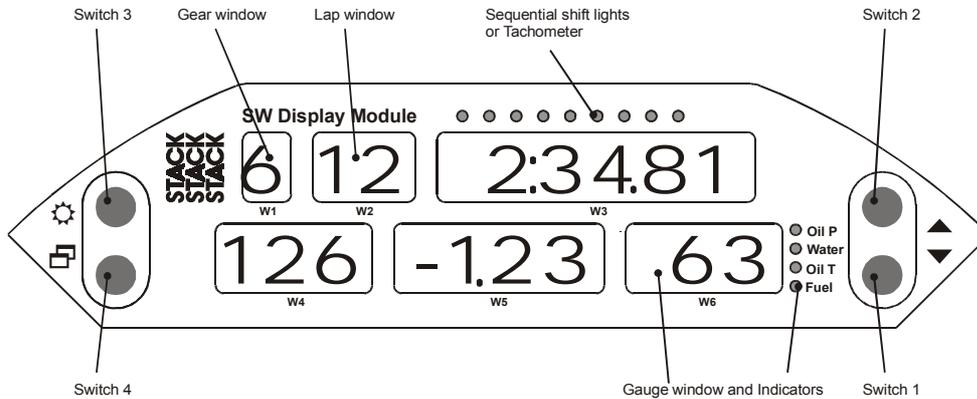
### Optional ST8600 Steering Wheel Display System Items

The ST8600 Steering Wheel Display System can be used with the following optional components:

Quantity	Description
1	RPM Sensor (ST697 H.T. Pick-up)
1	Wheel Speed Sensor (ST670) or ST492 (Pulse Amplifier) (standard with ST8600M)
1	+/- 5g Accelerometer (ST791)
1	Infra-red Lap Timing System (ST546) (standard with ST8600M)
1	Manual Lap Timing Switch (ST5097)
1	External Alarm Warning Lamp (ST533, ST536)
2	External switches (ST510)
1	Mini Sure-Seal Receptacle Kit (ST582)

## The Steering Wheel Display Module

The Display Module consists of a race-style steering wheel integrated with a digital display module. The Display Module is illustrated below:



The Display Module is connected to the Sensor Interface Module using a 5-way Lemo connector.

## The Sensor Interface Module

The Sensor Interface Module consists of a single "black box". It is connected to the Display Module and to a variety of sensors by a wiring harness. The wiring harness has a 19-way Mil-spec connector.

There is also a 4-way Mil-spec connector to allow expansion with a range of Stack Data Acquisition systems. This must be joined to the connector marked "S" on the Network Expansion Harness supplied with those systems.

## Wiring Harness

Each of the wires in the harness is labelled.

Labels on short cables	Connection To
B +	Battery Positive
B -	Battery Negative (Earth)
LAP	Lap timing sensor
REG	5 volt regulator
A	Accelerometer

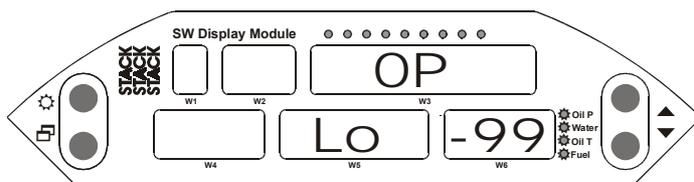
Labels on Medium Cables:	Connection To
D	Steering Wheel Display
ES	Engine Speed (RPM)
WS	Wheel speed sensor
GP	Gear Position sensor
S1 and S2	External Switches 1 and 2
AL	Alarm warning light

Labels on Long Cables:	Connection To
OP	Oil pressure sensor
OT	Oil temperature sensor
ET	Engine (Water) temperature sensor
F	Fuel pressure sensor

## Connecting the Components

1. Connect the wiring harness to the Sensor Input Module.
2. Connect the Steering Wheel Display Module to the harness using the Lemo connector.
3. Connect each sensor to the appropriate wire in the wiring harness, as shown above.
- 4\* Connect the External Alarm Lamp to the cable labelled AL.
- 5\* Connect the two external switches to the cables labelled S1 and S2.
- 6\* Connect the Lap Time Receiver or the Manual Lap Time Switch to the cable labelled LAP.
7. Connect a 12v DC power supply to the Battery B+ and B- wires.
8. Switch on the 12v DC power supply.

The Display Module will start up with an alarm signal indicating low oil pressure.



This is normal in this environment.

You can now proceed to familiarise yourself with operating the Display Module

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\* Optional components; not supplied with all systems.

## Chapter 3. Operating the Display System

This chapter takes you through the operation of the system so that you can familiarise yourself with its use before you install it in the vehicle.

### Switching the Display System on

You will have switched the system on already if you have followed the instructions in the previous chapter and have just set the system up for the first time before installing it.

When installed in the vehicle, the system is switched on when you switch the ignition on.

When the power is first switched on, the digital display will immediately show a "Low Oil P" warning and the alarm light will come on. Press (☐) or (▼) to clear the warning message from the display. Either of the external switches will also perform this function.

The digital display is always lit when the system is switched on.

If none of these actions occurs when you switch on, switch off the power to the system and consult the section on troubleshooting in this manual.

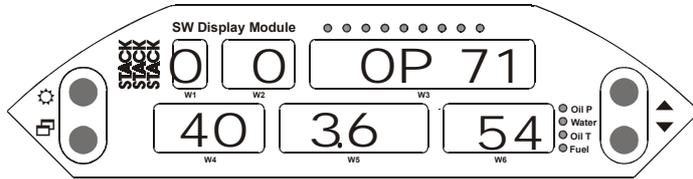
### Changing the display layers

The digital display can show three separate sets of parameters and their values; these are called display layer 1, layer 2 and layer 3.

Each of the display layers can be displayed in turn by pressing (☐) or external Switch 1. Press (☐) when display layer 3 is being displayed in order to return to display layer 1.

- ⇒ **The format of the values in these displays will vary for systems supplied outside the UK, as the parameters are displayed in different units.**

## Display Layer 1 – Warm-up



Display layer 1 shows:

- W1 Gear Number. 0 is Neutral
- W2 Lap Counter
- W3 Oil Pressure
- W4 Oil Temperature
- W5 Engine speed (0.1kRPM)
- W6 Gauge Value (see below)

Press (□) to see display layer 2.

### Gauge Value

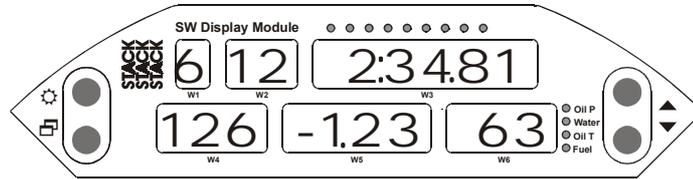
W6 can show the value for one of four parameters:

- Oil Pressure
- Water Temperature
- Oil Temperature
- Fuel Pressure

The LED to the right of the window indicates which parameter is being displayed.

Press (▼) to cycle through each of these parameters. The parameter you select will be shown on all display layers.

## Display Layer 2- Race



Display layer 2 shows:

W1 Gear Number. 6 is 6<sup>th</sup> gear

W2 Lap Counter

W3 Lap Time (ST8600) or Predicted Lap Time (ST8600M)

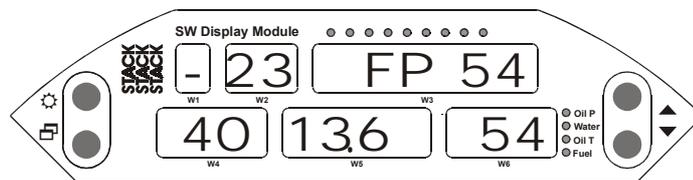
W4 Wheel Speed

W5 Difference from Best Lap Time (ST8600M only)

W6 Gauge Value (see Display Layer 1)

Press (⏏) to change display to layer 3

## Display Layer 3- Miscellaneous



Display layer 3 shows:

W1 Gear Number. – Is Reverse

W2 Lap Counter

W3 Fuel Pressure

W4 Oil Temperature

W5 Battery Voltage

W6 Gauge Value (see Display Layer 1)

Press (⏏) to display layer 1 again.

## Peak Values (Tell-Tales)

The system can display the peak values (sometimes called ‘tell-tales’) that have been recorded during a run for all the monitored parameters.

Peak values are updated only when the engine speed has exceeded its "gate value" for RPM *for at least one-second*. The gate value is a pre-defined RPM value that is used to control when the system updates the peak values. This is to prevent abnormal peak values from being recorded.

The system stores either a maximum or a minimum value as the peak value, depending on the parameter, as follows:

Parameter	Type of Peak Value
Engine Speed (RPM)	Maximum
Wheel Speed	Maximum
Oil Pressure	Minimum
Oil Temperature	Maximum
Engine Temperature	Maximum
Fuel Pressure	Minimum
Battery Voltage	Minimum

## Displaying the Peak Values

Press and hold ( ▲ ). For the first three seconds the display will indicate the names of the parameters, which are being displayed, and, thereafter, it will show the peak values for those parameters. Release the switch to return to the normal display.

## Resetting the Peak Values

You can reset all of the peak values, including the fastest lap time, manually. All peak values are reset at the same time.

To reset the peak values:

- Press and hold (▼)
- While holding (▼), press (⚙)
- Release to see a message confirming that the peak values have been reset.

If the engine is running **at** or **above** its gate value when the peak values are reset, they are set to the current value of each performance parameter. If the engine is running **below** its gate value, the peak values are not reset to the current values but are set to the following values:

Parameter	New Peak Value
Engine RPM	0 RPM
Wheel speed	0 MPH or 0 km/h
Oil Pressure	999 PSI or 99.9 Bar
Fuel Pressure	999 PSI or 99.9 Bar
Oil Temperature	-99C or -99F
Engine Temperature	-99C or -99F
Battery Voltage	26.0V

## Peak Value Memory

The peak values are stored in a memory, which is powered by an internal back-up battery. They remain stored in this memory when the external power source is disconnected from the system. The internal battery needs to be changed every 4-5 years. An alarm is triggered when the power from this battery drops below a safe level and the warning "Lith Lo" is displayed.

## Alarms

The Steering Wheel Display System has built-in warnings to alert the driver when certain parameters either exceed or fall below their alarm values. For example, a warning is signalled if the fuel pressure falls below its alarm value or if the oil temperature rises above its alarm value. You can adjust the pre-set alarm levels when you configure the Display System. See Chapter 4, *Configuring the Display System* in this manual.

Some of the warnings (see the following table) are triggered only while the engine speed exceeds its "gate value" for RPM *for at least one second*. Blipping the engine may not be enough to trigger a warning. The gate value is a predefined RPM value that is used to control when the system is to trigger a warning. This is to prevent abnormal warnings from being triggered when, for example, the engine is either not running, is idling or is being warmed up.

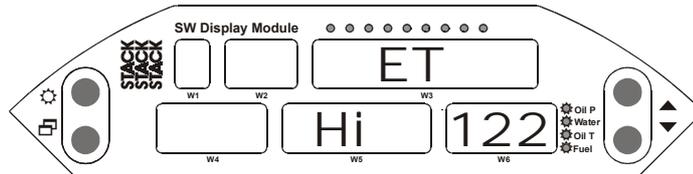
(The oil pressure alarm will come on at power-up until the engine is started and pressure exceeds the threshold set for the alarm.)

The Steering Wheel Display System has the following built-in alarms:

Parameter	Alarm is triggered when the:	Gated to RPM
Oil Pressure	current value drops below the pre-set value	No
Oil Temperature	current value exceeds the pre-set value	Yes
Engine Temperature	current value exceeds the pre-set value	Yes
Fuel Pressure	current value drops below the pre-set value	Yes
Battery Voltage	current value drops below the pre-set value	No

## Displaying an Alarm

When an alarm condition occurs, all four “gauge” LED’s are illuminated and the digital display gives a warning message to show the type of alarm. If an external Alarm Lamp is fitted, that will also be illuminated.

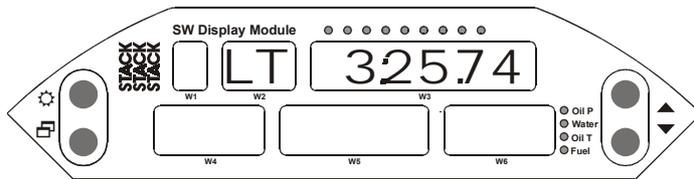


## Clearing an Alarm

Press (▼) or (□) to clear the alarm. Alarms can also be cleared when you press External Switch 1 or External Switch 2.

## Lap times

A lap time pop-up is displayed for eight seconds either when triggered by the infra-red lap time sensor on passing the lap time beacon or when you press the Manual Lap Switch.



You may change the pop-up duration when configuring the display (see Chapter 4).

In the ST8600, the most recent lap time is shown on display layer 2. Press (↵) to move to that display layer to show you the lap number and time of the last recorded lap.

In the ST8600M, the lap time on display layer 2 is replaced by the Predicted Lap Time

## Resetting the Lap Times to Zero

Press and hold (▼) and then press (⚙) to reset the lap count lap time and best lap time to zero. If you have a ST8600M, this action will also reset the Predictive Lap Timer.

Note: this action also clears all the peak values.

## Sequential Gear Shift Lights

The Steering Wheel Display System is equipped with nine sequential gearshift lights. Each lamp can be set to illuminate at a different engine RPM. See "Configuring the Display System" for information about setting these values.

## Chapter 4. Configuring the Display System

### Configuration mode

You put the Steering Wheel Display System into configuration mode by pressing (▼) and, whilst holding that switch, pressing (☐). You then work through the configurable parameters in a pre-set sequence. Press (☐) to display the next configurable parameter. The configurable parameters are displayed in the following order:

Configurable Parameter	Setting Required
Night-time brightness	Select a value between 1 and 10 to be the display and shift-light brightness for night-time use.
Day-time brightness	Select a value between 1 and 10 to be the display and shift-light brightness for day-time use.
Shift light set-points	Sets up the nine sequential shift-light (tachometer) points. See below.
Gear position calibration	Sets up the gear position calibration points. See below.
Wheel circumference	Set the value to the overall circumference of the wheel to which the Wheel Speed Sensor is fitted. Remember that this rolling circumference should be measured around the outside of the tyre.
Wheel sensor pulses per revolution	Set the value to the number of ferrous targets that the Wheel Speed Sensor is to count for each wheel revolution.
Engine speed cylinders	Set the value to the number of cylinders in the engine (for RPM). If fitted to a two-stroke engine set the value to 2x the number of cylinders. (E.g. 2 cylinder 2 stroke = 4cyls)
Gate RPM	Minimum RPM for the Fuel Pressure, Oil Temperature and Pressure and Engine Temperature warnings to operate, and all peak values to be updated.
Logging RPM	RPM at which the optional logging system is started.
High engine temperature	Maximum engine temperature alarm

High oil temperature	Maximum oil temperature alarm
Low fuel pressure	Minimum fuel pressure alarm
Low oil pressure	Minimum oil pressure alarm
Low battery voltage	Minimum battery voltage alarm
Lap-time popup duration	Set the length of time that the lap-time popup will be displayed whenever the vehicle passes a lap beacon.

The following configurable parameters are only available in the ST8600M:

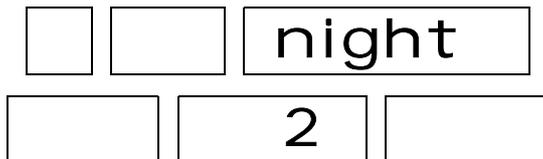
Predictive Lap Timer acceleration limit	In order to reduce the effects of wheel-spin, this setting determines the maximum allowable acceleration of the wheel, in units of G. If fitted to a non-driven wheel this can be left at the default value of 1.0G where it will have minimal effect, otherwise it should be set to a suitable value. In the wet this setting may need to be reduced.
Predictive Lap Timer deceleration limit	In order to reduce the effects of wheel lock-up, this setting determines the maximum allowable braking deceleration of the wheel, in units of G. This should be set to an appropriate value and reduced in wet conditions.

## Setting or resetting configuration values

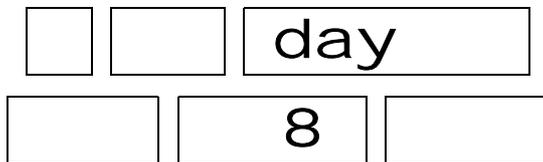
Use (▼) and (▲) to adjust the value. Holding down the switch will cause the value to adjust automatically.

Examples of the displays for each of the configuration items are shown below.

### Night-time brightness



### Day-time brightness



**Shift light set-points**

	S1	+4 to
SEt	SHIF	

“ Hold switch 1 (▼) + press switch 4 (☐) to set **shift** RPM”  
 See description below for details of setting the sequential shift light set points.

**Gear position calibration**

	S1	+4 to
SEt	GEAR	

“ Hold switch 1 (▼) + press switch 4 (☐) to set **gear** ratio speeds“  
 See description below for details about setting the gear position calibration.

**Wheel circumference**

		1000
SP	Circ	

“**S**peed, tyre **C**ircumference, value = mm (EC, UK) & 0.1ins (US) “

**Wheel sensor pulses per revolution**

		10
SP	PUI S	

“**S**peed, **P**ulses per 1 revolution of the wheel, value “

**Engine speed cylinders**

		4
ES	CyLS	

“Engine Speed, number of Cylinders, value “

**Gate RPM**

		3000
ES	gAtE	on

**Logging RPM**

		3000
ES	LOg	on

**High engine temperature**

	Hi	105
Et	tESt	on

**High oil temperature**

	Hi	130
Ot	tESt	on

**Low fuel pressure**

	Lo	10
FP	tEst	on

**Low oil pressure**

	Lo	35
OP	tEst	on

**Low battery voltage**

	Lo	10.0
bat	tEst	on

**Lap-time popup duration**

		40.0
LaP	PoP	on

**Predictive Lap Timer acceleration limit**

		1.0
PI t	aCC	

**Predictive Lap Timer deceleration limit**

		1.5
PI t	dEC	

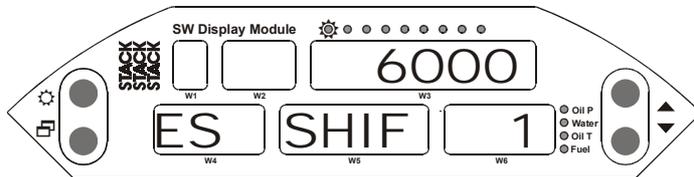
## Switching Alarms on or off

You can enable (switch on) or disable (switch off) each of the alarm warnings by pressing and holding (▼) and then pressing (☐).

Note that you might change the preset value of the parameter slightly while pressing both switches. This does not matter if you are switching the alarm warning off and, if necessary, you can correct the value after you switch it on again.

## Sequential Shift Light Set-points

Hold (▼) and then press (☐) to enter the Shift Light Setting menu.



W3 shows the Engine Speed (RPM) above which the Shift Light shown in W6 will illuminate. The appropriate Shift Light pattern for each set point is shown above.

Use (▼) and (▲) to adjust the RPM value.

Press (☐) to display the next set-point in sequence. When all nine set-points have been configured, the display will return to showing the Shift Light entry screen.

You may leave the Shift Light setting menu at any time by pressing (⚙️). All the modified set-points will be remembered.

## Gear Position Calibration

The ST8600 system generates a Gear number in one of two ways:

1. Calculating the **Ratio** of RPM to vehicle Speed.
2. Fitting a Position **Sensor** to the gear box

If the Sensor is **not fitted**, the Gear **Ratio** Calibration screens will be shown.

If the Sensor **is fitted**, the Gear **Sensor** Calibration screens will be shown.

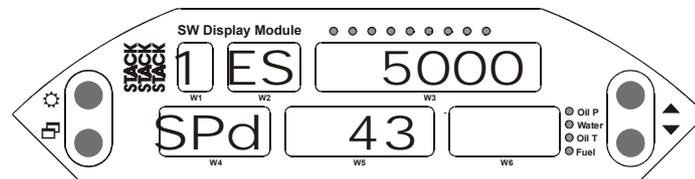
Hold (▼) and then press (☐) to enter the Gear Position Calibration menu.

## Gear Ratio Calibration

This calibration requires the speed of the vehicle @ 5000RPM for each gear:

Gear	1	2	3	4	5	6	7
Speed							

Before starting this calibration measure the speed in MPH for UK, US systems & km/h for EC systems.



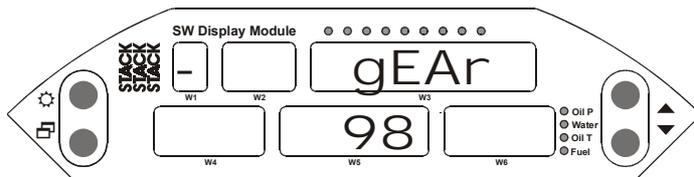
W1 shows the forward gear number for which this calibration is being made and W5 shows the Wheel Speed which the vehicle will reach when the Engine Speed is 5000RPM. Up to nine forward gears may be calibrated.

Use (▼) and (▲) to adjust the Wheel Speed value.

Press (☐) to display the next gear in sequence.

To end the calibration, press (⚙️). Then either press (📁) to Save, or (⚙️) to Cancel the calibration (all the new gear positions will be ignored and the previous calibration will be reinstated).

## Gear Sensor Calibration



W1 shows the gear number for which this calibration is being made – is Reverse, 0 is Neutral, 1 is First Gear etc. Up to seven forwards gears may be calibrated.

W5 shows the raw value being read from the Gear Position Sensor.

Put the gear lever in the appropriate position for the gear number being displayed and then press (📁) to display the next gear in sequence.

To end the calibration, press (⚙️). Then either press (📁) to Save or (⚙️) to Cancel the calibration (all the new gear positions will be ignored and the previous calibration will be reinstated).

## Leaving configuration mode

When you wish to return to the normal display, press (⚙️). All the modified parameters will be remembered.

## **Chapter 5. Installing the Display System**

### **Who can install the Display System?**

The Steering Wheel Display System can be installed by anyone competent in fitting electrical and mechanical accessories to cars.

### **Tools needed to install the Display System**

No special tools other than normal workshop tools are needed.

### **Pre-configured Display Systems**

Use the instructions in the previous chapters to set up, operate and configure the ST8600 before installing it in the vehicle.

### **Custom Configured Display Systems**

If you have purchased a Steering Wheel Display System that has been custom configured for you, the system may include components not described in this book. Refer to the additional instructions supplied with the system for such components.

This manual may refer to components not included in the custom system; you should ignore these.

### **Fitting the Display Module**

The Steering Wheel Display Module is supplied undrilled so that you can drill it to suit your vehicle's steering column boss.

Ensure that the interconnecting cable cannot become entangled with the steering column and other controls by tying the Lemo connector to the dashboard close behind the steering wheel. Remember that you may need to disconnect this cable quickly to remove the steering wheel when stepping out of the vehicle.

## **Fitting the Sensor Interface Module**

The Sensor Interface Module consists of a single “black box” which should be fixed in a suitable position on a rigid panel using the strips of Dual-Lock provided for this purpose.

Ensure there is enough clearance for the wiring harness to exit the module without being bent through an acute angle. See “Fitting the wiring harness” below.

## **Switches**

The four built-in switches and the two optional external switches are used to control the functions of the Steering Wheel Display System.

The normal switch functions are described in Appendix B.

You can install the external switches in any convenient location taking account of the following considerations:

- The cable for each switch is approximately 1200mm in length from the 19-way military connector.
- It is important that the driver is able to reach the switches easily when seated in the car. This is particularly true for the optional Manual Lap Switch.

## External Warning light

Whenever an alarm message pops up, all four gauge indicator lamps are illuminated.

As an option, you can install an additional External Warning Light for that function. The External Warning Light should be installed in a position that is in the driver's direct line of vision because it needs to be visible at all times.

Stack can supply a suitable warning light for installation in the dashboard as well as a shrouded version that can be mounted on top of the dashboard.

- ⇒ **Important: If you are using your own warning light, ensure that the bulb rating does not exceed 2 watts; otherwise the Display System will be damaged.**

## Engine Speed (RPM) Measurement

The engine speed (RPM) is measured by connecting the engine speed wire directly to the ignition system. A single wire from the connector labelled ES connects the Display System to the ignition system or low-tension side of the coil.

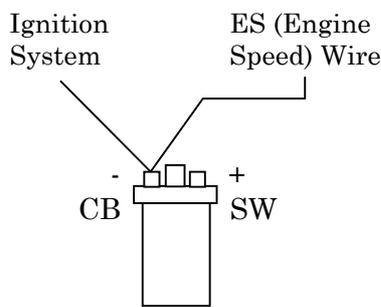
## Connecting the Display System to the Ignition System

The Display System can be connected to a variety of ignition systems as shown:

- Standard contact breaker system
- Series Resistor Connection
- ECU Connection (+ Pull-up resistor)

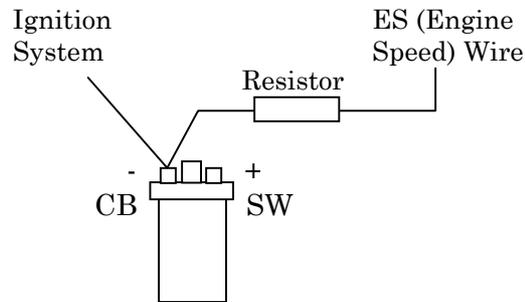
### Standard contact breaker system

Connect the ES (Engine Speed) wire to the negative terminal of the coil.



### Series Resistor Connection

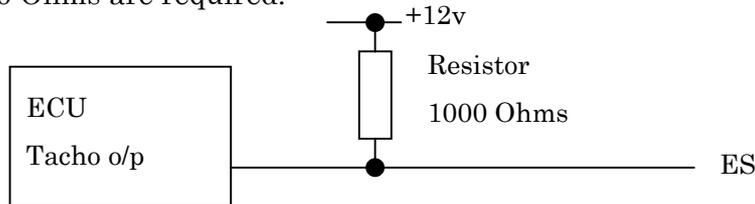
The Series Resistor Connection requires a resistor on the ES (Engine Speed Wire).



### Electronic Ignition or ECU Connection

Connect the ES (Engine Speed) wire directly to the “Tacho” output of the electronic ignition or ECU. If this results in a Zero RPM reading then...

Some ECU’s (MoTeC M800) require a Pull-up resistor connected between the ES wire & +12v (battery positive). Resistor values between 470 & 4700 Ohms are required.



## Pressure sensors (ST747)

The Steering Wheel Display System is supplied with two ST747 0-10 Bar (0-150psi) “solid-state” pressure sensors for monitoring oil pressure and fuel pressure:



The ST747 pressure sensors have a 1/8" NPTF tapered thread.

Adapters are supplied with EC systems = M10 x 1mm (ST154003)  
Optional Adapter available = 1/8 BSP (ST154006)

### Installing the pressure sensor

- Position the sensor and its cable as far as possible (at least 75mm or 3 inches) from sources of intense heat and from the ignition HT leads.
- **It is recommended that the sensors are mounted indirectly, using a suitable pressure hose to connect them to the monitoring point.**
- Do not over-tighten the sensor.

## Temperature sensors (ST991)

The Steering Wheel Display System is supplied with two ST991 temperature sensors for monitoring oil temperature and water temperature.



ST991 has an M6 x 1mm thread.

A sealing washer & an adapter is supplied to allow the sensor to be fitted:

Adapter for EC systems = M10 x 1mm

Adapter for UK,US systems = 1/8 NPTF

### Installing the temperature sensors

- Mount each temperature sensor directly in the appropriate fluid line. Screw the sensor into a suitable mounting boss so that its end lies in the middle of the flow of fluid.
- Position the sensors and their cables as far as possible (at least 75mm or 3 inches) from sources of intense heat and from the ignition HT leads.

## Wheel speed sensor (optional on ST8600)

The ST8600M Display System is supplied with one Stack ST670 proximity sensor (optional on the ST8600). This sensor is used to measure wheel speed in order to display the vehicle's speed in MPH or km/h. The sensor provides an electrical pulse to the system each time a ferrous object, such as a wheel bolt, passes near to the end of the sensor. When you configure the system, you will need to supply the circumference of the wheel and the number of ferrous objects that will be counted for each revolution of the wheel.

### Fitting the wheel speed sensor

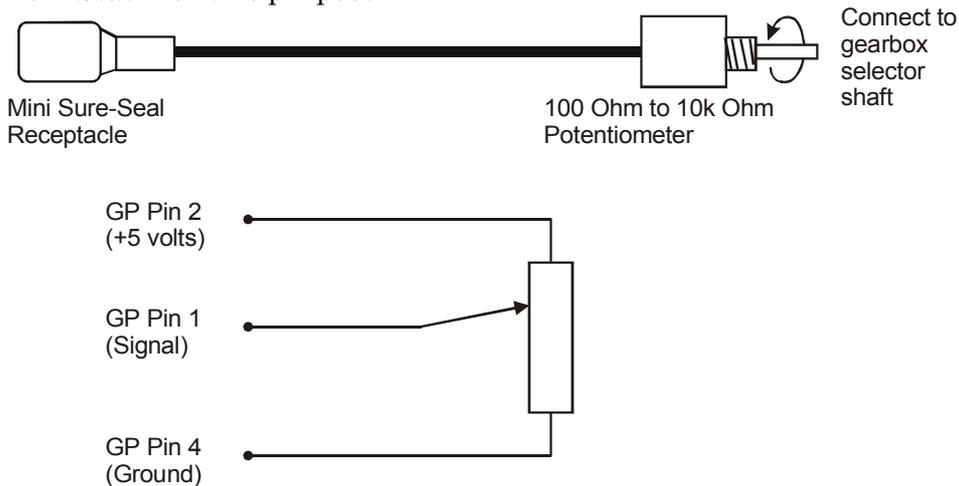
- Locate a suitable position for the wheel speed sensor so that one or more ferrous objects (such as bolt heads) will pass the end of the sensor as the wheel turns.
- If possible, choose the wheel that incurs the least amount of wheel-spin, wheel-lift or lock-up, as these will affect the speed reading.
- Avoid mounting the sensor too close to the brake disc to avoid excessive heating.
- Make a suitably rigid bracket for the sensor and fit it onto the vehicle. Fit the sensor to the bracket.
- Do not over-tighten the sensor.
- Adjust the distance between the end of the sensor and the target ferrous object(s), so that the gap is nominally  $1.5 \pm 0.5\text{mm}$  ( $60 \pm 20\text{thou}$ ). Make sure that no other objects pass within 4mm ( $3/16''$ ) of the end of the sensor while the wheel rotates.
- Once the system is powered up, a small LED built into the back of the sensor will light up each time a ferrous object passes within the defined distance from the end of the sensor.
- Position the sensor and its cable as far as possible from sources of intense heat and from the ignition HT leads.

## Gear Position Sensor (user supplied)

The Gear Position can be calculated as a ratio of Wheel Speed against Engine Speed. However that calculation can lead to errors and also cannot generate values for neutral and reverse gears or when the clutch is disengaged. For this reason the Steering Wheel Display System can obtain a more accurate indication of the gear by installing a Gear Position sensor in the vehicle's gearbox. Most competition sequential gearboxes can be fitted with a potentiometer (variable resistor) which rotates whenever a new gear is selected thus generating a different resistance for each individual gear.

### Fitting the gear position sensor

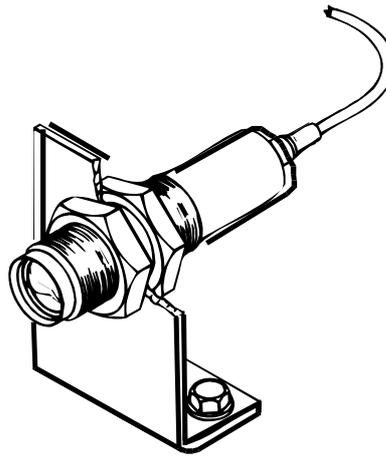
- The overall resistance of the potentiometer (not supplied by Stack) must be between 100 Ohms and 10k Ohms.
- Connect the sensor to the GP connector on the wiring harness as in the diagram below. Mini Sure-Seal receptacles (ST582) are available from Stack for this purpose.



- Position the cable as far as possible from sources of intense heat and from the ignition HT leads.
- Check its operation by looking at the raw value shown in the Gear Position Calibration menu. Values between 3 and 254 are valid. Check that each gear position generates a different value; rotate the sensor to achieve this.

## Lap Timing Sensor (optional on ST8600)

The ST543 lap-timing sensor is actuated by an infrared beacon (ST544) positioned at the side of the circuit. The sensor is fixed to a rigid bracket mounted at a convenient position on the outside of the vehicle where it is able to detect the signals from the beacon.



It is secured by two nuts with an M18 x 1mm thread.

This sensor must be positioned horizontally and square to the axis of the vehicle. In order to detect the signals from the beacon, it must be sited outside the vehicle, ie; it must not be located inside a window. It should, if possible, be positioned so that other vehicles that are being overtaken (or are overtaking) at the moment your vehicle passes the beacon do not block the signal.

Note that after detecting a signal, the system does not recognise any further signals from beacons for a period of ten seconds.

## Trackside Infra-Red Lap Beacon (optional)

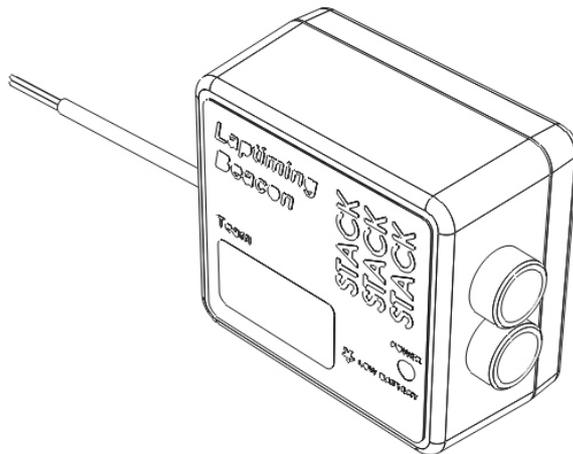
The ST544 trackside infrared lap beacon should be located as follows:

- As near to the start/finish line as possible
- At the same height as the on-vehicle lap timing sensor
- Level, so that it emits a horizontal beam
- It must be between 2 and 30 meters (6 to 95ft) from the vehicle when the vehicle passes it.

Avoid positioning it so that the sun is directly behind it when it is being used.

Where the unit is to be used for lengthy periods in very hot, sunny conditions, it should be protected by shading it from direct sunlight.

Do not allow water to be sprayed onto the transmitter lenses. During wet conditions, fit a protective shroud over the beacon; take special care not to obscure the infrared emitters.



## **Power supply to Trackside beacon**

The beacon operates from a 12v DC supply. A sealed lead-acid battery with a minimum rating of 2.5 amhours is recommended. When fully charged, this will provides about 15 hours of operation.

The condition of the battery is indicated by the colour of the LED indicator on the front panel of the unit:

1. Green:               The voltage is, at present, adequate for use
2. Red:                 The voltage is too low (replace the battery).
3. No Colour:         The battery is exhausted or disconnected.

## **Wiring harness**

The Display Module, Sensor Interface Module and the sensors, external switches and warning light for your Steering Wheel Display System are connected together by means of the wiring harness supplied with the system.

The wiring harness can be fitted after the modules and all the sensors and switches have been installed.

This harness has been designed so that the various branches are long enough for most single seater and saloon cars. Occasionally, an individual branch may need to be extended or significantly shortened. If the standard harness is totally unsuitable for your vehicle, contact Stack for details of custom harnesses. Provided that you have chosen suitable locations for the switches, sensors and any external warning light that you are installing, you should not need to extend any of the individual wires in the harness.

## Fitting the wiring harness

When fitting the harness on the vehicle, you should observe the following:

- Start by attaching the harness to the Sensor Interface Module by connecting the 19-way Mil-spec. connector.
- First position the ends of all the wires at the locations of the sensors, lamps and switches to which each is to be connected, but do not connect them yet.
- All wires should be as far as possible and not less than 75mm from ignition HT leads and distributor caps, etc.
- When you pass any wire through a bulkhead or dashboard, fit a cable gland into the hole so that the edge of the hole cannot chafe the wire.
- Particular care is needed when passing wires through holes in carbon fibre because the carbon can cut through cables very easily.
- The heatshrink sleeving around the sensor cables can be cut back, if necessary, to enable the sensor cables to go in different directions. It is recommended that you always leave at least 150mm of heatshrink sleeving to provide additional strain relief for the cable where it enters the 19-way connector.
- Connect the wires once all the sensors are in position and you have secured the wiring harness.
- Ensure that the cable from the Steering Wheel Display Module cannot become entangled with the steering column and other vehicle controls. If necessary, tie the Lemo connector to the dashboard close behind the steering wheel. Remember that you may need to disconnect this cable regularly to step into or out of the vehicle.

## Wiring labels

See Chapter 2 if you need to check the labels used to identify the individual cables in the wiring harness.

## **Data Acquisition Expansion**

Stack Data Acquisition systems are supplied complete with their own wiring harness. It is very important that the Network Expansion Harness is only joined to the 4-way Mil-spec. socket on the Sensor Interface Module using its connector marked "S".

## **Checks and Alarms**

You should check the system to ensure that all the sensors are detecting the correct values. You should also run the engine up to its operational levels to check that the values displayed by the Display System are accurate. You should then check out the alarm systems to ensure that they are functioning correctly before going on to the circuit.

## Chapter 6. Troubleshooting

No.	Symptom	Possible Cause	Remedy	Notes
1.	Display is dead	Ignition is switched off	Switch ignition on	The power leads are labelled <b>B+</b> & <b>B-</b> . The battery positive lead <b>B+</b> is 19w connector pin <b>G</b> . <b>B-</b> is 19w connector pin <b>H</b> .
		Battery is dead	Recharge or replace battery	
		Power connection to <b>B+</b> or <b>B-</b> is faulty	Check if battery is connected correctly. Check power lead continuity	
		Display Module interface lead disconnected	Reconnect Display Module interface lead	
2.	Low Battery warning on display	Battery voltage is low	Recharge or replace battery	
		Power connection to <b>B+</b> or <b>B-</b> is faulty	Check power lead continuity	
3.	Display Freezes	Battery is almost dead	Recharge or replace battery	Display Controller will not operate below 8 volts
		Power connection to <b>B-</b> or <b>B+</b> is faulty	Check power lead continuity	
		Display Module interface lead shorted	Check the interface cable for short circuits	Pin B to pin 1 of the Lemo (D) connector
		Display Module interface lead open-circuit	Check the interface cable for open circuits	Pin C to pin 5 of the Lemo connector
4.	Display values and messages unclear or unreadable	Display too hot	Ensure that the display is operated within the specified temperature range	Operating temperature is -20°C (+5°F) to +70°C (+158°F)

No.	Symptom	Possible Cause	Remedy	Notes	
5.	The Low Oil Pressure message does NOT appear on power up. The warning light is not turned on	Pressure sensor has failed	Replace sensor	Swap with the fuel pressure sensor to confirm fault	
		Sensor connections are faulty	Check for continuity on sensor lead	A reading of 999 or -99 on the display indicates an open circuit connection	
		Pin D of the 19-way connector to pin 1 of the OP connector Pin H of the 19-way connector to pin 4 of the OP connector Pin 1 of the REG connector to pin 2 of the OP connector			
		Oil pressure alarm disabled	Check that the oil pressure alarm is set on		
6.	Display gives a fixed temperature reading of 999 C or 999 F	Temperature sensor has failed	Replace sensor	Check harness for short or open circuit	
		Faulty sensor connections	Check continuity of sensor leads		
7.	Display gives a fixed temperature reading of -99° C or -99° F	A temperature sensor has failed	Replace sensor	Swap with the other temperature sensor to confirm fault	
		Faulty sensor connections	Check continuity of sensor leads for open circuits.	Check wiring harness for open circuits	
		Pin E of the 19-way connector to pin 1 of the OT connector Pin P of the 19-way connector to pin 1 of the ET connector Pin H of the 19-way connector to pin 4 of the OT and WT conns Pin 1 of the REG connector to pin 2 of both sensor conns			

No.	Symptom	Possible Cause	Remedy	Notes
8.	Fixed pressure reading of 999 PSI or 99.9 Bar	Pressure sensor has failed	Replace sensor	Swap with the other pressure sensor to confirm fault
		Faulty sensor connections	Check continuity of sensor leads for open circuits	Check wiring harness for open circuits
		Pin D of the 19-way connector to pin 1 of the OP connector Pin R of the 19-way connector to pin 1 of the F connector Pin H of the 19-way conn to pin 4 of the OP and F conns Pin 1 of the REG connector to pin 2 of both sensor conns		
9.	Fixed pressure reading of -99 PSI or -9.9 Bar	Pressure sensor has failed	Replace sensor	Swap with the other pressure sensor to confirm fault
		Faulty sensor connections	Check continuity of sensor leads for short circuits	Check the wiring harness for short circuit
10.	Fixed pressure reading of 0 PSI or 0.0 Bar or suspected low or slow reading	Pressure sensor has failed	Replace sensor	Swap with the other pressure sensor to confirm fault
		Faulty sensor connections	Check pressure connections	Check plumbing for a blockage, e.g., kinks in flexible hoses
11.	Displays pressure values too low and temperature values too high	Low Battery voltage	Recharge battery	The system does not give accurate readings when voltage is below 8.0V
12.	Sensor reading incorrect	Another gauge connected to sensor	Disconnect other gauge	It is not permissible to connect a second gauge

No.	Symptom	Possible Cause	Remedy	Notes
13.	Peak values not updated	Gate RPM value set too high	Change Gate RPM in the display configuration menu	Peak values only updated while the engine RPM is greater than the Gate value
14.	Peak values not retained on power-down	Internal memory battery dead	Contact a Stack service agent for a new battery service	Display shows "Lith Lo" warning on power up
15.	Steering wheel switch(es) do(es) not work	Switch(es) faulty	Contact a Stack service agent	No user serviceable parts
16.	External Switch 1: Change gauge parameter function does not work	Switch 1 faulty	Replace switch	Disconnect switch and short its leads. If display changes, replace Switch 1. Otherwise check wiring.
		Faulty switch wiring	Check switch wiring for correct continuity	Pin K to blue S1 wire less than 1.0 Ohm and Pin K to Pin H (earth) greater than 1M Ohms
17.	External Switch 2: Change display layer function does not work	Switch 2 faulty	Replace switch	Disconnect switch and short its leads. If display changes, replace Switch 2. Otherwise check wiring.
		Faulty switch wiring	Check switch wiring for correct continuity	Pin L to red S2 wire less than 1.0 Ohm and Pin L to Pin H (earth) greater than 1M Ohms

No.	Symptom	Possible Cause	Remedy	Notes
18.	Manual Lap Time Switch: does not set or display pop-up lap times when no automatic receiver in use	Manual Lap Time Switch faulty	Replace switch	Disconnect the switch and short its leads together. If a lap pops up, replace the switch. Otherwise check wiring.
		Faulty switch wiring	Check switch wiring for correct continuity	Pin T to pin 1 of the LAP connector greater than 1.0 Ohm and Pin T to Pin H (earth) greater than 1M Ohms
19.	Lap time is not displayed automatically (Automatic receiver is fitted)	Lap marker receiver lead faulty	Check lap marker wiring	Disconnect receiver and short pins 1 and 4 of the LAP connector. If display changes, replace receiver after checking its wiring.
		Lap marker receiver faulty	Replace lap marker receiver	
20.	External warning light dead when the display warning lights are illuminated	Bulb has burnt out	Replace bulb	Bulbs must not be more than 2 watts
		Faulty wiring to light	Check continuity of wiring.	Pin G to red AL wire less than 1.0 Ohm and Pin U to yellow AL wire greater than 1.0 Ohm

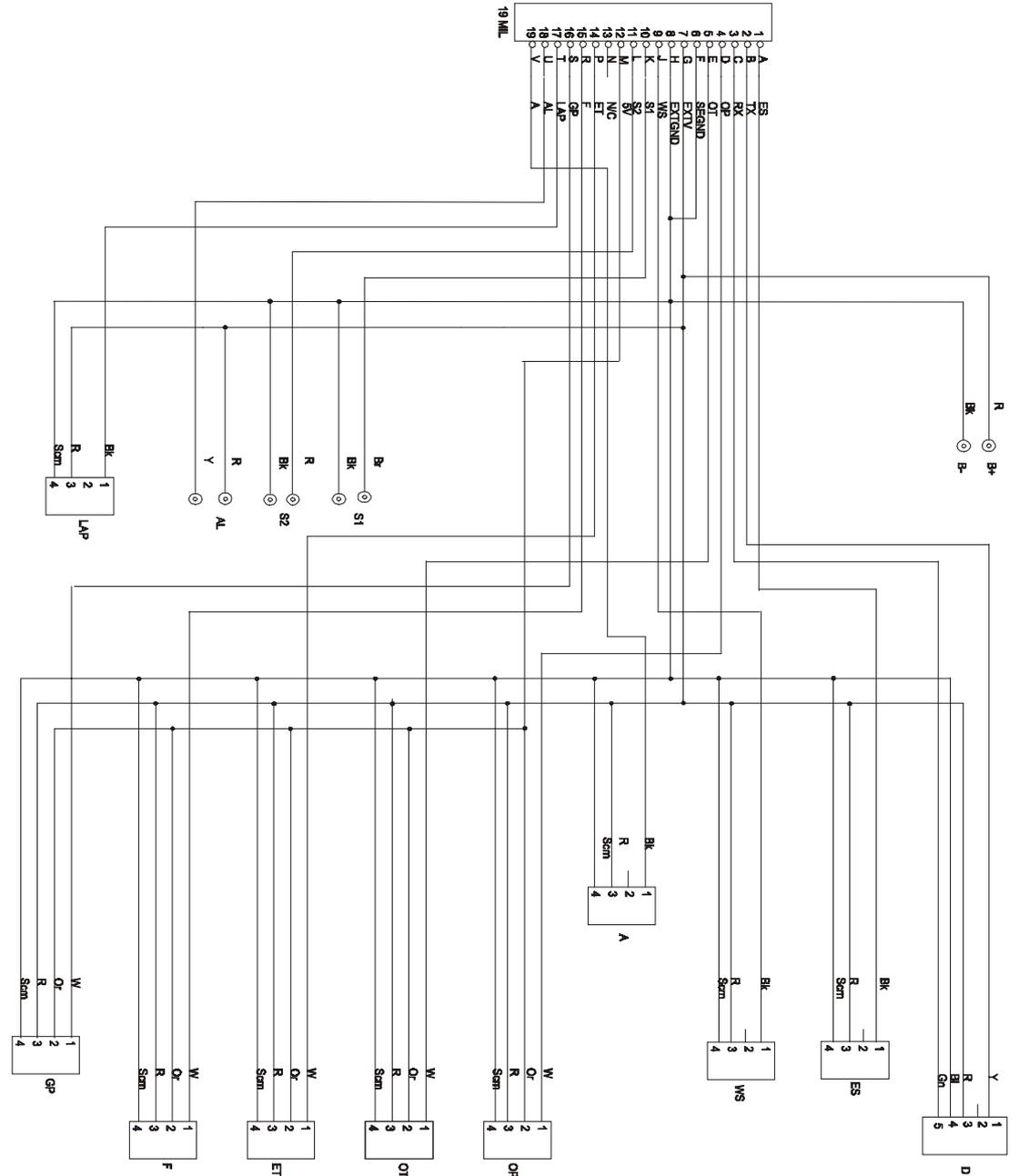
No.	Symptom	Possible Cause	Remedy	Notes
21.	No RPM speed reading	Incorrect wiring	Check the connection of the engine speed wire to the ignition system (or ST697 sensor if used)	See instructions supplied in this manual. If connected directly to the coil, check that it is to the switched low-tension side (usually the negative side).
22.	Displayed RPM value too high or too low by a constant %-age amount	<p>System configured with wrong number of engine cylinders.</p> <p>Ignition system pulses per revolution not same as number of cylinders</p>	<p>Reconfigure system to correct number of cylinders.</p> <p>Reconfigure system to correct number of pulses per revolution.</p>	<p>Ignition systems may either:</p> <p>a) produce "waste" sparks giving double the number of cylinders per revolution</p> <p>b) use multiple coils where each additional coil gives proportionately fewer pulses per revolution</p>

No.	Symptom	Possible Cause	Remedy	Notes
23.	Engine speed (RPM) reading erratic; value jumps high or low	Incorrect wiring	Reconnect the ES wire as specified in this manual	
		Signal from ignition system or coil is noisy	Condition the ES signal by placing a resistor in line with the ES wire	Typical resistor values: 10K ohms for dedicated Tacho output 47K Ohms for coil connection (not CDI) 100K Ohms for coil connection (CDI). Resistors are: ½W 5% 350v
		Points bounce or weak spring	Fit new points	
		Faulty points condenser	Fit new condenser	
24.	Displayed speed value too high or too low by a constant %-age amount.	System configured with wrong number of targets per wheel revolution	Reconfigure the system with correct values	
		System configured with wrong wheel circumference.	Reconfigure the system with correct circumference	Typical wheel circumference for a car is 1800mm / 70"
25.	No speed reading Speed reading erratic, value jumps high or low	Faulty sensor and/or wiring	Check sensor indicator for correct operation	Rotate the wheel by hand and check that the sensor indicator lights up as each target passes the sensor
		Incorrect sensor gap (too far or too close)	Check that the gap is approximately 1mm	
		Sensor and targets moving apart	Fabricate a more rigid sensor bracket	

No.	Symptom	Possible Cause	Remedy	Notes
26.	Speed reading dies after a short time	Wheel speed sensor temperature too high	Shield the sensor from radiated heat from brakes and bearings. Insulate sensor from conducted heat with fibre washers. Duct cooling air around the sensor	Maximum temperature for correct operation of the wheel speed sensor is +80°C (175°F)
27.	No alarms for engine, oil or fuel (temperatures and pressures) being displayed	All the alarms have been switched off	Switch on the required alarms	Most alarms only operate when the engine is running at or above the RPM gate value
		The engine RPM gate value is set too high	Reset the RPM gate to a lower value	
28.	Display and alarm light flash when the engine is running	Intermittent alarm caused by a parameter with its alarm level set too close to the normal operating value	Either change the value for the alarm or turn the alarm off	

No.	Symptom	Possible Cause	Remedy	Notes
29.	Display works OK until engine starts then Display freezes or resets continuously. Display recovers once engine is stopped.	Interference from ignition system and/or HT Leads	Fit suppressed (Silicone) HT leads. Fit a suppression capacitor (2.2uF) between the coil (battery connection) & chassis	Use 'Helical' suppressed leads in extreme cases
		Wiring too close to HT leads and/or injector leads or HT leads tied to isolated metal work to which ST8600 wiring is also tied.	Run ST8600 wiring away from HT leads & injector leads	Recommended Minimum spacing is 75mm (3.0")
		ES signal from ignition system or coil is very noisy	Condition the ES signal by placing a resistor in line with the ES wire	Typical resistor values: 10K ohms for dedicated Tacho output 47K Ohms for coil connection (not CDI) 100K Ohms for coil connection (CDI). Resistors are: ½W 5% 350v

# Appendix A. Wiring Harness Schematic Diagram



## Appendix B. Summary of Switch Functions

### Normal Operation

Functions	Switch or Switches
Show next Gauge Value	(▼) or External Switch 1
Show Peak Values	(▲)
Toggle Day and Night Brightness	(⚙)
Change Display Layer	(☞) or External Switch 2
Clear Alarm	(▼) or (☞) or Ext. Switch 1 or 2
Reset Peak Values, Lap Count and Lap Time	(▼) & (⚙) together
Put system into Configuration Mode	(▼) & (☞) together

### System Configuration Mode

Functions	Switch or Switches
Decrease the value of the parameter being displayed	(▼)
Increase the value of the parameter being displayed	(▲)
Enable or disable an alarm for the parameter being displayed	(▼) & (☞) together
Display the next configurable parameter	(☞)
Quit configuration mode and return to normal mode	(⚙)
Enter Shift Light or Gear Position calibration mode	(▼) & (☞) together
Exit Shift Light or Gear Position calibration mode	(⚙)

## Returned Goods Procedure

In the unlikely event of a Stack part developing a fault and requiring repairs, you are kindly requested to contact your distributor or Stack Ltd for a **Returns Authorisation Number (RAN)**.

A returns goods form and RAN will be supplied by email/Fax/Post to fill in. Please return the faulty part back to Stack Ltd either direct or via the distributor with this completed form.

*Please Note: Returning a part **without** this form and **RAN** will lengthen the repair times and possibly increase the cost of the repair.*

For a current list of distributors log onto the Stack websites at [www.stackltd.com](http://www.stackltd.com) click on the “Where to buy” tab at the top of the home page and select Distributors.



To Contact Stack Ltd:

Email: [sales@stackltd.com](mailto:sales@stackltd.com)

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