COND-USB

Strain Gauge or Load Cell Digitiser Module

1. INTRODUCTION

This chapter provides an introduction to the COND-USB products, describing the product range, main features and application possibilities.

1.1. Overview

The COND-USB products are miniature, high-precision Strain Gauge Converters; converting a strain gauge sensor input to a **digital** USB serial output. They allow high precision measurements to be made and communicated directly to a PC. With the appropriate drivers installed, the COND-USB appears as a virtual communication port to the PC .

1.2. Key Features

1.2.1. Three Form factors:

The product is available in three formats depending on how it is to be integrated:

1.1.1.1. PCB Only:

For OEM integration into the customer's own products. This can include fitting into a load cell body if space allows.

1.1.1.2. OEM Field Connector Module:

The DSJ2 provides field terminals and a USB Type B connector.

1.1.1.3. Cased:

Supplied in a desk mounting case (approx 86 x 57 x 25mm) with 1.4m of USB cable terminating in a type A plug and a 9 way D-Type socket for the strain gauge connections.

1.2.2. High Stability`

25ppm/°C basic accuracy (equates to 16 bit resolution)

1.2.3. Adjustable sensitivity

Supplied pre-configured for standard 2.5mV/V full-scale strain gauges.
A single additional resistor re-configures the input between 0.5 and 100 mV/V full-scale.

1.2.4. Temperature sensing and compensation (optional)

An optional temperature sensor module (DTEMP) is available which will enable an advanced 5-point temperature-compensation of measurements.

1.2.5. Linearity compensation

Advanced 7-point linearity compensation available as standard.

1.2.6. USB

Uses a simple 'Virtual Communications Port' as its connection method to a PC.
Device addressing allows up to 127 devices.
ASCII version allows for continuous output stream.

1.2.7. Low current

Functions as a 'Low Power Device' i.e. draws less than 100mA (one unit load) when connected to a 350 Ohm Bridge.

1.2.8. Digital calibration

Completely drift-free, adjustable in-system and/or in-situ via standard communications link.
Two independent calibration stages for load cell and system-specific adjustments.
Programmable compensation for non-linearity and temperature corrections.
Calibration data is transferable between devices for in-service replacement.

1.2.9. Self-diagnostics

Continuous monitoring for faults such as strain overload, over/under-temperature, broken sensors or unexpected power failure.
All fault warnings are retained on power-fail.

1.2.10. Multiple output options

Choice of three different protocols for ease of integration: ASCII or MODBUS
All variants provide identical features and performance.

1.3. Special Facilities

1.3.1. Output Capture Synchronisation

A single command instructs all devices on a bus to sample their inputs simultaneously, for synchronised data capture.

1.3.2. Output Tare Value

An internal control allows the removal of an arbitrary output offset, enabling independent readings of net and gross measurement values.

1.3.3. Dynamic Filtering

Gives higher accuracy on stable inputs, without increasing settling time.

1.3.4. Programmable Output Modes

Output rate control enables speed/accuracy trade-off.
ASCII output version provides a decimal format control and continuous output mode for 'dumb terminal' output.

1.3.5. Unique Device Identifier

Every unit carries a unique serial-number tag, readable over the communications link.

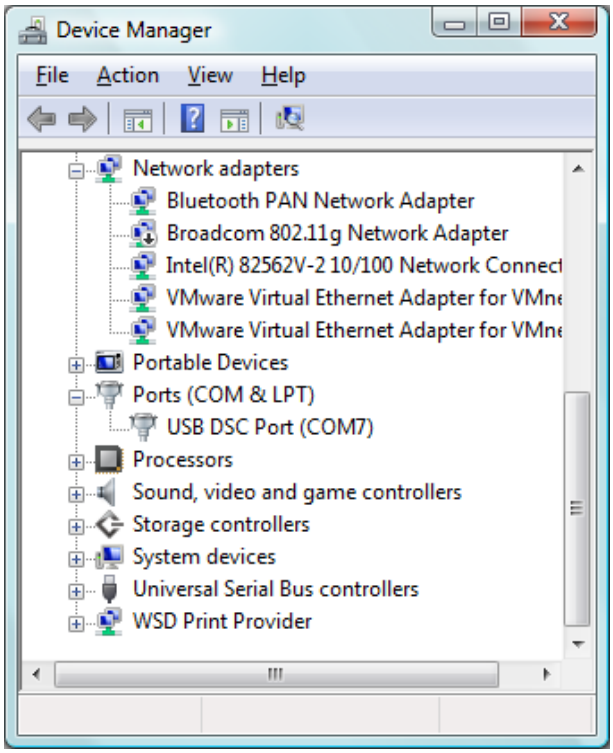
1.3.6. External Temperature Sensing (optional)

An external temperature module is available for improved accuracy (especially tracking changing temperature conditions).

1.3.7. Software Reset

A special communications command forces a device reboot as a failsafe to ensure correct operation.

1.4. Device Manager

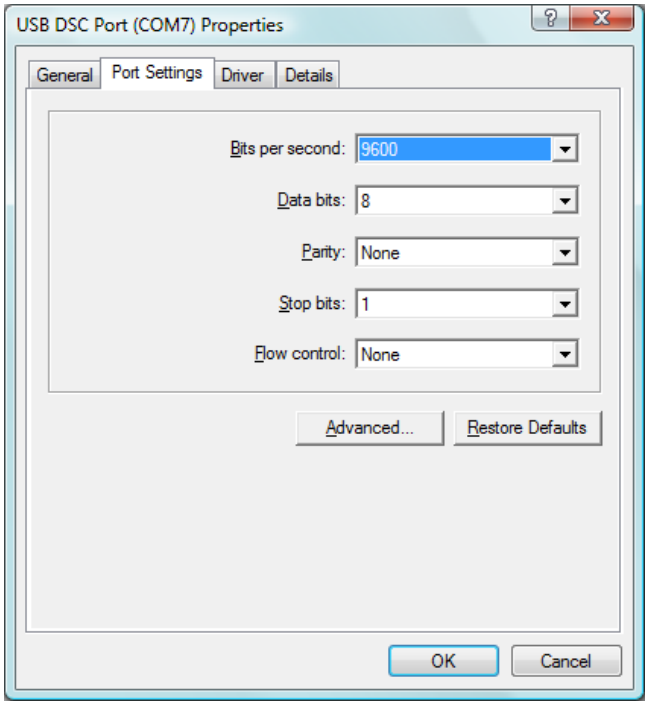


Select the **Ports (COM & LPT)** item and expand it.
If the DSC USB device has been installed correctly you should see an item named **USB DSC Port (COMx)** where the COM port assigned is shown in brackets.

If this COM port is between 1 and 8 then note the number as it will be needed when **Instrument Explorer** is used to connect to the device.

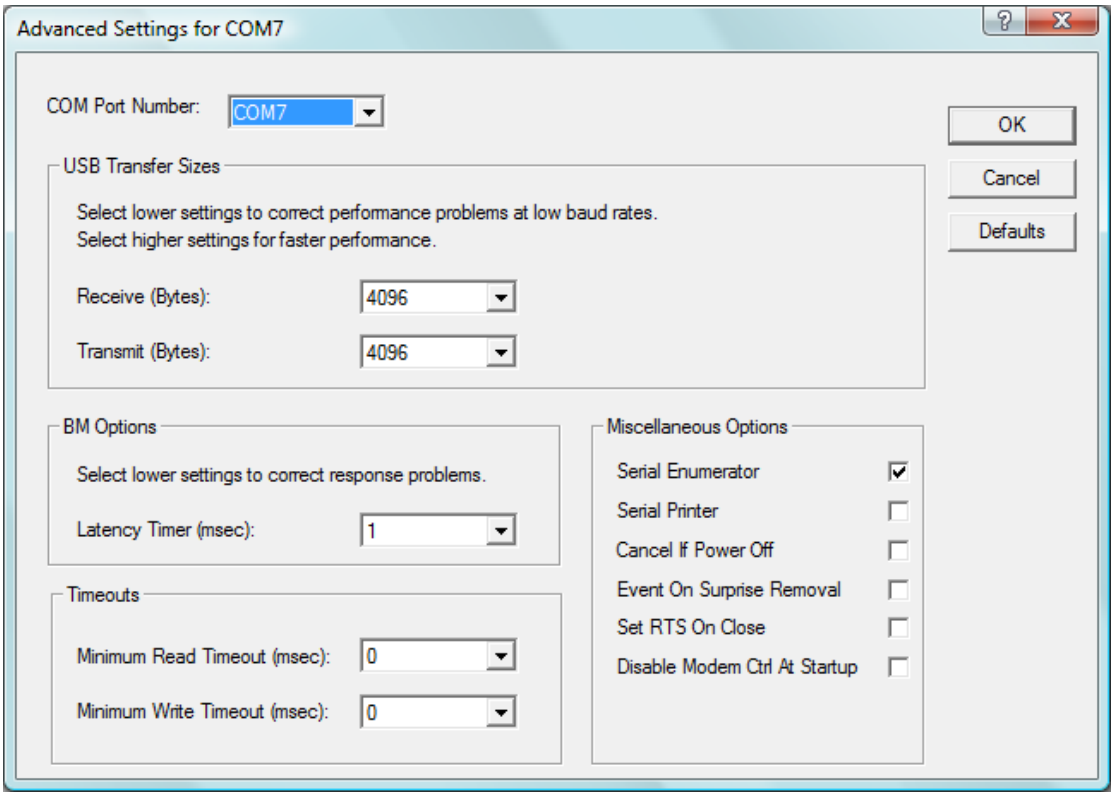
If the COM port is greater than 8 then it must be changed as follows:

Right click the device and select **Properties** from the pop-up menu.

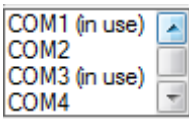


Select **the Port Settings** Tab from the window that appears.

Click the **Advanced** button.



You can now select a new **COM Port Number** from the dropdown list at the top of this dialog.
When you drop the list you may find that next to some of the listed COM ports there is an '**(in use)**' note.



Unless you have physical COM ports at the destination you wish to use then you can ignore this. The '**in use**' note will be shown against any COM port that has, at some time, ever been allocated as a virtual COM port.

Once changed, select **OK** on all dialogs until they are closed.

You have now established which COM port your DSC device is 'connected' to.

NOTE: The selected COM port should now remain with the DSC device regardless of which USB port it is plugged into. However, plugging the device into a different USB port may, depending on operating system, result in a request for drivers again. If this occurs follow the above procedure from the '**Found New Hardware Wizard'** section.
Plugging in a new DSC device will also result in a driver request on Windows XP. Again, follow the above procedure from the '**Found New Hardware Wizard'** section.

1.5. Connecting a Load Cell

You can now connect a strain gauge bridge, load cell or simulator to the COND-USB.

A suitable strain gauge should have an impedance of 350-5000 Ohms and (at least for now) a nominal output of around 2.5mV/V.

2. SOFTWARE COMMAND REFERENCE

This chapter contains tables of all COND-USB commands, with brief details of each.

2.1. Commands in Access Order

ASCII name	description	datatype	access	MD reg
CMVV	Temp Compensated mV/V	float	RO	11
STAT	Status	int	RO	13
MVV	Filtered & factory calibrated mV/V	float	RO	17
SOUT	selected output	float	RO	19
SYS	main output	float	RO	21
TEMP	temperature	float	RO	23
SRAW	raw system output	float	RO	25
CELL	cell output	float	RO	27
FLAG	error flags	int	RW	29
CRAW	raw cell output	float	RO	31
ELEC	electrical output	float	RO	33
SZ	system zero	float	RW	45
SYSN	snapshot result	float	RO	47
PEAK	Peak value	Float	RO	49
TROF	Trough value	Float	RO	51
CFCT	Communications failure count	Float	RW	53
VER	software version	byte	RO	61
SERL	serial number low	int	RO	63
SERH	serial number high	int	RO	65
STN	station number	int	RW	67
BAUD	baud rate select	byte	RW	69
OPCL	Output Control (Value select)	byte	RW	71
RATE	reading rate select	byte	RW	73
DP	digits after point	byte	RW	75
DPB	digits before point	byte	RW	77
NMVV	Nominal mV/V for scaling ELEC	float	RW	79
CGAI	cell gain	float	RW	81
COFS	cell offset	float	RW	83
CMIN	cell range min	float	RW	89
CMAX	cell range max	float	RW	91
CLN	lin n-points	byte	RW	101
CLX1..7	lin raw-values	float	RW	103..115
CLK1..7	lin corrections	float	RW	123..135

SGAI	system gain	float	RW	141
SOFS	system offset	float	RW	143
SMIN	system range min	float	RW	145
SMAX	system range max	float	RW	151
USR1..9	g.p. storage values	float	RW	163..179
FFLV	Dynamic Filter Level	Float	RW	185
FFST	Dynamic filter steps	Float	RW	187
RST	reboot	–	X	201
SNAP	take snapshot	–	X	207
RSPT	Reset peak & trough	–	X	209
SCON	Shunt cal ON	–	X	211
SCOF	Shunt cal OFF	–	X	213
OPON	Digital Output on	-	X	215
OPOF	Digital output off	-	X	217
CTN	tempco n-points	byte	RW	221
CT1..5	tempco Temp points	float	RW	223..231
CTG1..5	tempco gain-adjust	float	RW	233..241
CTO1..5	tempco offset-adjust	float	RW	243..251

Table Key
'..' - Denotes a range (e.g. CLK1..7 means 'CLK1' to 'CLK7')
Access RW/RO/WO/X = read-write / read-only / write-only / execute
Datatype float/int/byte/– = 4-byte real / two-byte integer / 1-byte integer / none
MD reg = start register address (always odd) for MODBUS protocol

3. INSTALLATION

This chapter gives detailed information on integrating the COND-USB into a production system – including mounting, protection, adjustments, wiring and electrical requirements.

3.1. Before Installation

Carefully remove the COND-USB device from its shipment box. Check that the device is complete and undamaged.
Check the Product Type Code – on the product label is that which you ordered.

The COND-USB can operate in any industrial environment providing the following limits are not exceeded

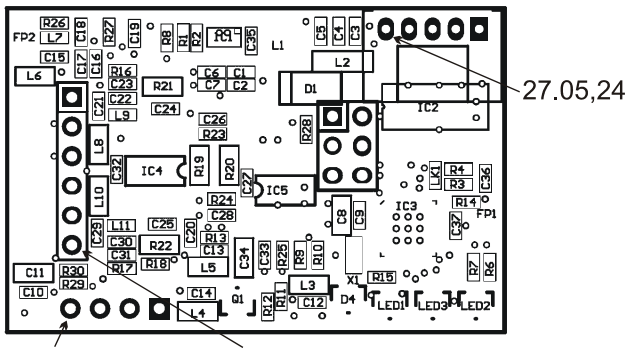
Operating Temperature	-40 ºC to +85 ºC
Humidity	95% non condensing
Storage temperature	-40 ºC to +85 ºC

For precise details of Environmental Approvals, see chapter 5.3.
It is advisable to follow the following installation practices where possible:
- Minimise vibration
- Do not mount next to strong electrical or magnetic fields (transformers, power cables)

- Install electrical protection device as the unit is not internally fused
- Always ensure the package is secure and protected

3.2. Physical Mounting

3.2.1. OEM PCB:



The PCB can be fitted to a motherboard by fitting in-line pins to the 6-way, 4-way and 5-way rows of holes and plugging them into corresponding sockets on the motherboard or directly soldering through holes.
The 6-way and 4-way holes are on a 0.1" pitch, the 5-way holes are on a 2mm pitch.

3.3. Electrical Protection

Electrostatic protection is sufficient for installation purposes only.
No over-current or over-voltage protection is provided in case of faults, the supply arrangements should therefore employ adequate power limiting or fusing.

NOT PROTECTED AGAINST REVERSE POLARITY OF SUPPLY

3.4. Moisture Protection

The COND-USB must only be operated in a dry environment, as moisture can dramatically degrade the measurement performance. Any simple box or enclosure can be used, however, in extreme conditions an enclosure with the appropriate IP rating should be chosen.
If a metal enclosure is used it should be grounded to the 'SH' connection.

3.5. Soldering Methods

Take care when soldering cables to the pads. Use a temperature controlled soldering iron set to a maximum 330ºC, for no longer than 2 seconds per pad. Excessive heat or increased soldering time may result in damage to the PCB.

NOTES: Solder with water-soluble flux should not be used (even low-residue), as this can leave a surface film which attracts atmospheric moisture, degrading measurement performance.

3.6. Power Supply Requirements

The COND-USB is a 'low power' device (<100mA) and normally derives its power from the host machine. It will operate over the worst-case voltage range stated in the USB rev 2.0 specification i.e. 4.35-5.25V.

The OEM-Module version, as supplied with the Evaluation kit, can be operated in 'Self powered' mode i.e. powered by a separate supply (4.25V to 5.5V) connected to pins 1 and 4 of J3 – follow the screen printed legend on the PCB for the polarity. Care should be taken to assure that this supply is not also connected to the host by the USB cable.

A single device consumes typically 70mA with a 350 Ohm gauge connected.

An installation should therefore assume at least 80mA per unit, and allow for extra current being taken at power-on (though supply voltage can safely drop temporarily), and for possible voltage drops in long cables.

The COND-USB can supply enough excitation current to drive up to four 350 Ohm gauges connected in parallel. In this case 'Self powered' mode must be used (see note above for the OEM-Module) as the total supply current will rise to approximately 135mA taking it above the USB specification for 'Bus Powered' devices.

Any power-supply ripple should be below 100mV, and supply arrangements should provide current limiting for fault conditions (see *Electrical Protection,* above).

3.7. Cable Requirements

3.7.1. Strain Gauge Input (COND-USB)

For optimal performance twin twisted pair with individual shields is recommended, this gives good noise immunity. Maximum length should not exceed 20m. Normal 4 core shielded cable can be used in areas of low electromagnetic noise.

3.7.2. Power and Communication

Standard, good quality USB cables should be used.

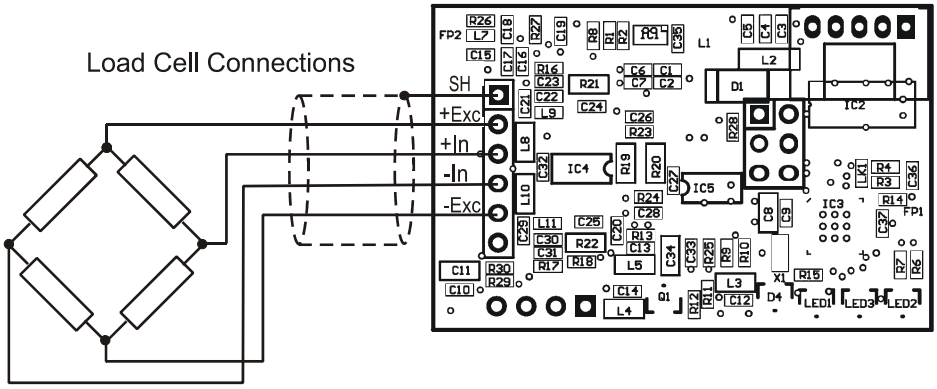
In the case of the 'self-powered' OEM Module described above, use a 'USB type A' to wire tails cable or cut off the 'B type' connector of a standard cable and strip back the outer sheath and connect the 'GND', 'USBDP' and 'USBDM' cores to the 4-way screw connector J3. Leave the Vcc core unconnected. Connect the external 5V supply to 'GND' and 'VCC'. Ensure that the 5V supply stays within the limits 4.25V to 5.5V.

3.7.3. Temperature Sensor

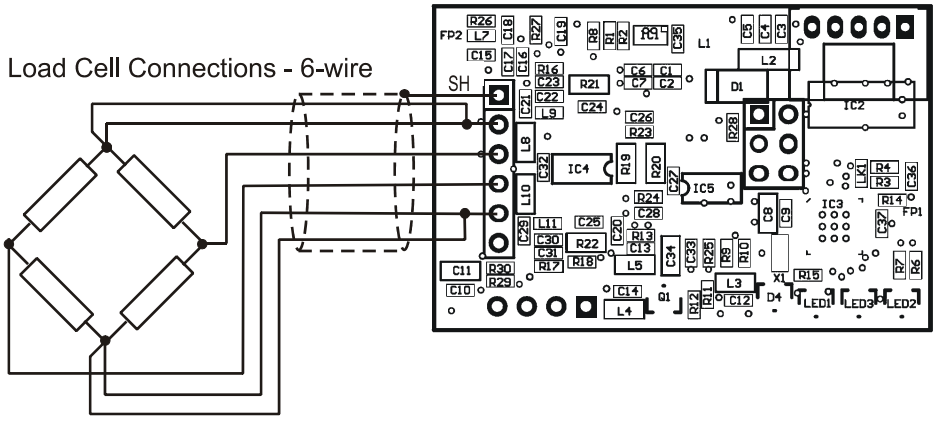
A shielded twisted pair is recommended, with a maximum length of 10m the shield being connected to the load cell body or (SH if DSC). For short lengths (< 2m) in a low noise environment (inside load cell body for example) then normal cable can be used.

3.8. Identifying Strain Gauge Connections

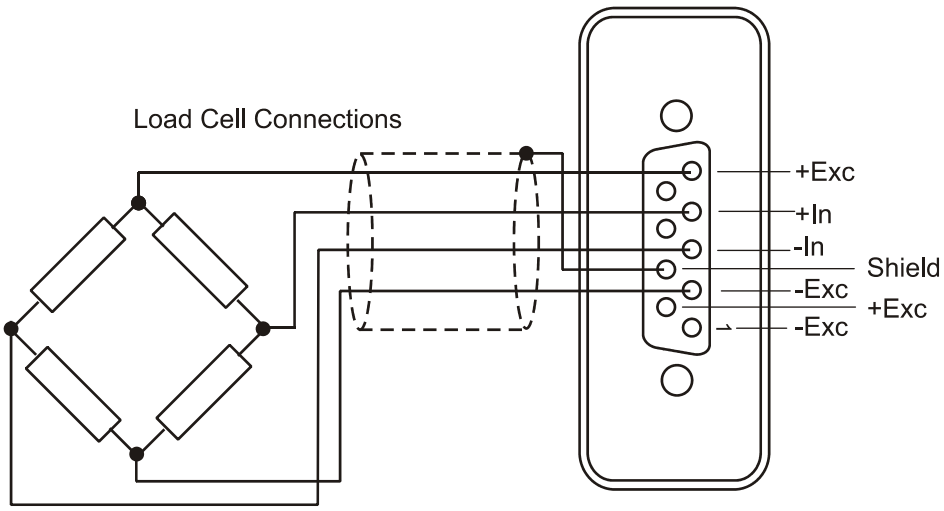
3.8.1. OEM PCB – 4-wire load cell



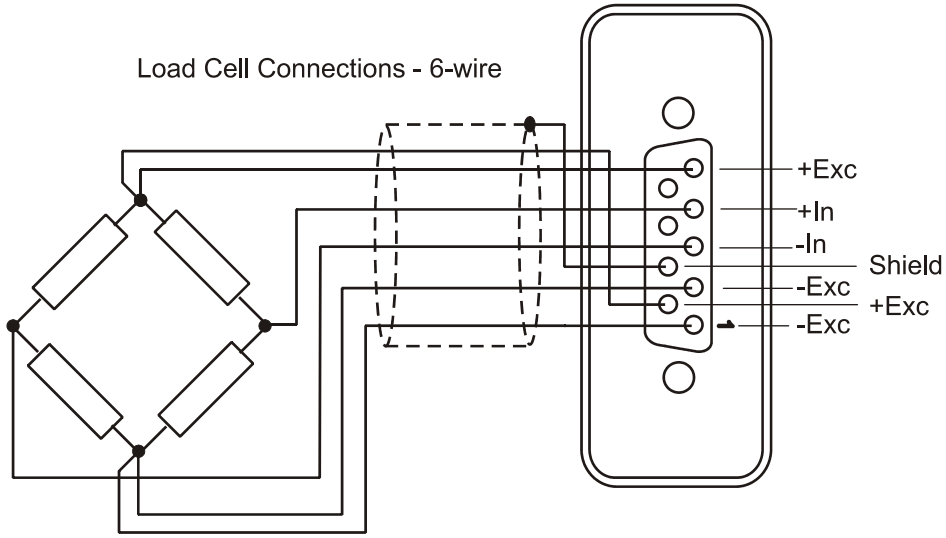
3.8.2. OEM PCB – 6-wire load cell



3.8.3. Cased Version – 4-wire load cell



3.8.4. Cased Version – 6-wire load cell



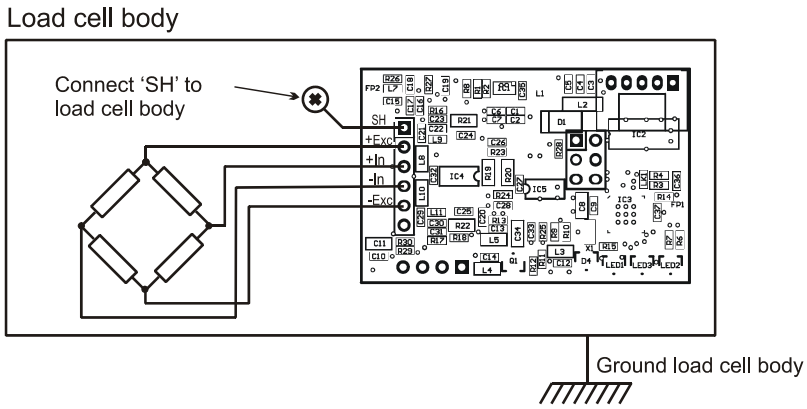
3.9. Strain Gauge Cabling and Grounding Requirements

To achieve full performance specifications and conform to environmental approvals, it is important to follow the wiring procedures outlined in this section.

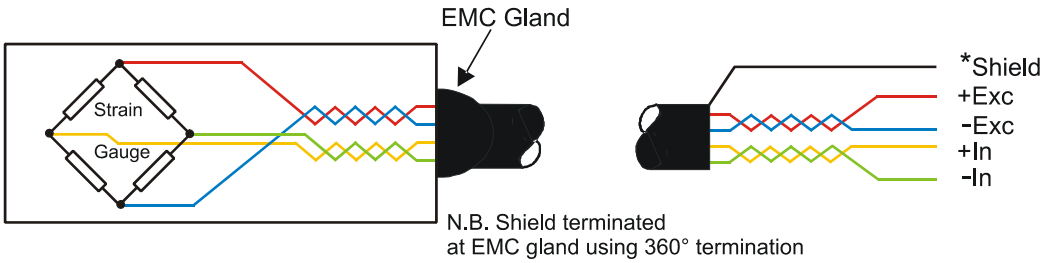
3.9.1. DSC Strain Gauge Cabling Arrangement

1.1.1.4. Key Requirements

If the OEM PCB is fitted within the body of a load cell, the strain gauge wires should be kept as short as possible, at most 20cm. The EXC+/– wires should be twisted together, also the SIG+/– pair, and the two pairs kept apart. It is also recommended to secure the wires from moving due to shock or vibration.
The shield connection 'SH' should be connected to the body of the load cell via a very short length of wire (20mm max).



If the DCell is mounted outside the body of the load cell then, for optimal performance, twin twisted cable should be used, although standard 4 core shielded cable can be used in **low** noise environments.



N.B. White core shown as yellow in above diagram

* Shield tail length must be kept to a minimum

4. TROUBLESHOOTING

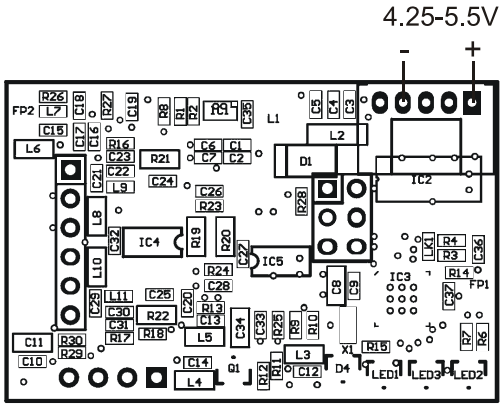
This chapter gives a quick guide to problem solving for COND-USB devices.
Bear in mind that the quickest way to pin down problems is to usually replace items with 'known good' alternatives. This also applies to cables, power supplies, devices etc.

4.1. LED Indicator

The LED is used to indicate the protocol selection, the device is powered and the Device is operating. During correct operation the LED should Flash ON for 100mS then repeat at a rate depending on the protocol as shown in the following table. If this is not the case then follow the instructions below.

Protocol	LED Flash Period
ASCII	0.5 seconds
MODBUS	1 second

If the LED is OFF check the power supply polarity & voltage:



If the LED is permanently ON then contact the factory.

If The LED is ON for the majority of time then Flashes OFF for 100mS then a fault exists. This fault can be read back using the communications. Likely causes of this are Strain Gauge Integrity Error or Limits reached for MVV, CRAW, SRAW or TEMP. First check the connections to the strain gauge are correct. Next check the input is not over-range or the limits set for CMIN, CMAX, SMIN or SMAX have not been exceeded.

4.2. No Communications

The majority of problems involve a failure to communicate, as there are a number of optional settings that must be set to the same value at both ends of the link.
For this reason, any communications application should always check command responses, and flag a problem when these responses are not activated.

Possible problems can be categorised according to where in the 'chain' of communication the problem may be. The typical chain runs as follows:

- PC software (port connection, baud rate, station number, protocol)
- PC serial port (working)
- USB lead to COND-USB
- Bus wiring
- COND-USB device (wiring, station number, baud rate, protocol, working)

A quick checklist elaborates on these areas, if you are using the Instrument Explorer evaluation software (other software may have different requirements at the PC end): Check as follows:

PC End

1. PC software settings: correct serial port, baud rate and protocol
   (standard data setup is 1 start bit + 1 stop bit, no flow control).
2. PC serial port okay: check with another serial device, e.g. wire two PCs together with Hyper Terminal running on both.

Evaluation Board or Device

1. Power reaches the device with correct polarity.
2. USB Connections correct.
3. Device settings: correct station-number, baud rate
   (How do you know these are correct? A substitute device is very useful here!)
4. Device protocol: double-check product label
5. Device running okay: LED is flashing.
6. Devices take 45-55mA supply current without sensor attached, 65-75mA with 350 Ohm gauge.

4.3. Bad Readings

The cause can be either hardware or software related.

4.3.1. Software

1. Check the MVV reading first and ensure it is correct. This figure is the RAW input and is not affected by the user configurable calibration settings.
2. If MVV looks correct, check the calibration settings step by step.
   Consider resetting all the calibration controls to default values – see ***Erreur ! Source du renvoi introuvable.***. This should make SOUT=MVV at all times.

4.3.2. Hardware

1. Load Cell problem should be indicated by flags in STAT, LCINTEG
2. Genuine hardware problems usually show up as **total** failure – i.e. unchanging fixed readings, usually either near zero or permanently at full-scale.
   Check wiring, take voltage level readings and again if possible use a known good device and set up.
3. Check the sensor is connected properly, and has some resistance across the excitation leads, output leads and across each arm of the bridge. For a 350 Ohm gauge these readings should be approximately 350 Ohms, 350 Ohms and 262 Ohms respectively (when disconnected from the device).
4. Check for a damaged COND-USB device by replacement.

4.4. Unexpected Warning Flags

Remember that all warning flags in **FLAG** must be explicitly reset –they do not clear themselves when a problem is resolved.
If a flag cannot be cleared, the cause must be persistent –i.e. it keeps occurring. This can be immediate, regular (every few seconds) or irregular (occasional).
See the 'Flags' section chapter *3* for precise details of how the individual warnings operate.

Bear in mind the following possible problems

1. REBOOT or an increasing CFCT may indicate intermittent connections.
2. Where ECOMUR/OR or EXCUR/EXCOR are triggered, suspect input wiring.
3. Various 'range' errors (CRAWUR/OR, SRAWUR/OR) are also likely to be set if the excitation was interrupted (EXCUR/OR).
4. For range errors, check the associated limit parameters (CMIN/MAX, SMIN/MAX).
5. Problems are likely if any calibration MIN/MAX parameters are set the wrong side of zero (i.e. MIN>0 or MAX<0).

4.5. Problems with bus Baud rate

There are a number of special difficulties to be considered here:

- Systems with very long cabling may not work with higher baud rates
- Always remember, devices need to be rebooted before certain changes take effect

4.6. Recovering a 'lost' COND-USB

For baud rate problems, see previous section.

If the protocol is unknown e.g. the label has been removed or the diagnostic LED is not visible then try all three protocols (ASCII or MODBUS) until a response is obtained.

If a station number is unknown, it can be reset via *broadcast* command (STN = 0).

Always remember that a reboot (power-off or RST command) is needed to change STN and BAUD settings!

5. SPECIFICATIONS

5.1. Technical Specifications COND-USB

The COND-USB is factory set for 2.5mV/V sensitivity.

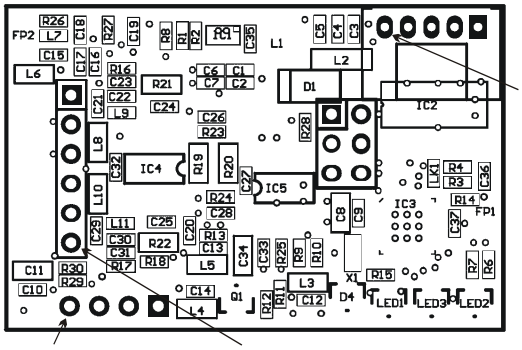
Parameter	Min	Typical	Max	Units
Strain Gauge Excitation System	4 Wire			
Strain Gauge Excitation Voltage	4. 5	5	5.25	VDC
Strain Gauge Drive Capability	80	-	5000	Ohms
Strain Gauge Sensitivity	-3	2.5	3	mV/V
Offset Temperature Stability		5	10	ppm/C
Gain Temperature Stability		30	50	ppm/C
Offset Stability with Time		35	160	ppm of FR (1)
Gain Stability with Time			300	ppm of FR (2)
Non Linearity before Linearization		5	25	ppm of FR
Internal Resolution		16 Million		Counts/divs
Resolution @ 1Hz readings (Noise stable) over 100s		66,000		Counts/divs
Resolution @ 10Hz readings (Noise stable) over 100s		40,000		Counts/divs
Resolution @ 100Hz readings (Noise stable) over 100s		10,000		Counts/divs
Resolution @ 500Hz readings (Noise stable) over 100s		5,000		Counts/divs
Signal Filter	Dynamic recursive type user programmable			
Optional Temperature Resolution (DTEMP)				
Temperature Measurement Resolution		0.0625		Deg C
Temperature Measurement Accuracy (-10 to 85)		0.5		Deg C
Temperature Measurement Accuracy (-55 to 125)		2.0		Deg C
Temperature update Speed		5		Seconds
Electrical				
Power Supply voltage	4.25	5	5.5	V dc
Power Supply current (350 Ohm Bridge)		68	75	mA
Data transmission				
Data transmission rate	2.4	-	460.8	kbps
Output cable length (speed dependant)			5	m
Environmental				
Operating temperature range	-40		+85	C
Storage temperature	-40		+85	C
Humidity	0		95	%RH
Dimensions				
PCB Dimensions COND-USB OEM PCB	43 x 28 x 4mm (1.6929 x 1.1024 x 0.472")			
Cased version	86 x 57 x 26.5mm (3.3465 x 2.2492 x 1.087") excluding connector (95mm 3.740") including 9-way 'D' type connector) with 136 cm 94.462 feet USB cable.			

Notes.

1. From original offset at any time
2. 1st Year

5.2. Mechanical Specification for COND-USB

5.2.1. OEM PCB:



The PCB can be fitted to a motherboard by fitting in-line pins to the 6-way, 4-way and 5-way rows of holes and plugging them into corresponding sockets on the motherboard or directly soldering through holes.
The 6-way and 4-way holes are on a 0.1" pitch, the 5-way holes are on a 2mm pitch. The diagram shows the x,y coordinates of one hole of each connector.

Ideally, the COND-USB should be installed in a protective enclosure, such as a metal box.

5.3. Environmental Approvals

Emissions	BS EN 55011:2007
Immunity	BS EN 61000-4-2:1995 / IEC 6100-4-2:1995 BS EN 61000-4-3:2002 BS EN 61000-4-4:2004 BS EN 61000-4-11:2004

Output shall not exceed the sum of uncertainties when subjected to an electric field of 10V/m over the frequency range 80 to 600MHz

Safety/Low voltage Directive	73/23/EEC as amended by 93/68/EEC BS EN 61010-1:2001 IEC 61010-1:2001