Lubrigard

Technical Specifications for

Lubrigard Oil Condition Sensor (OS006)

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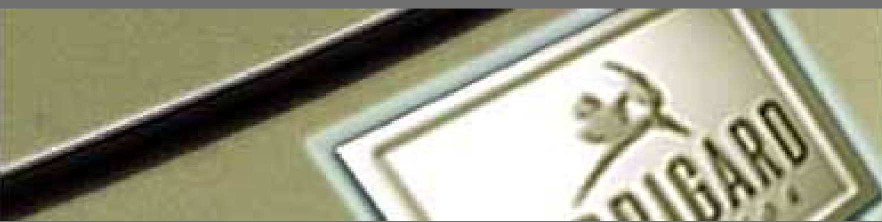

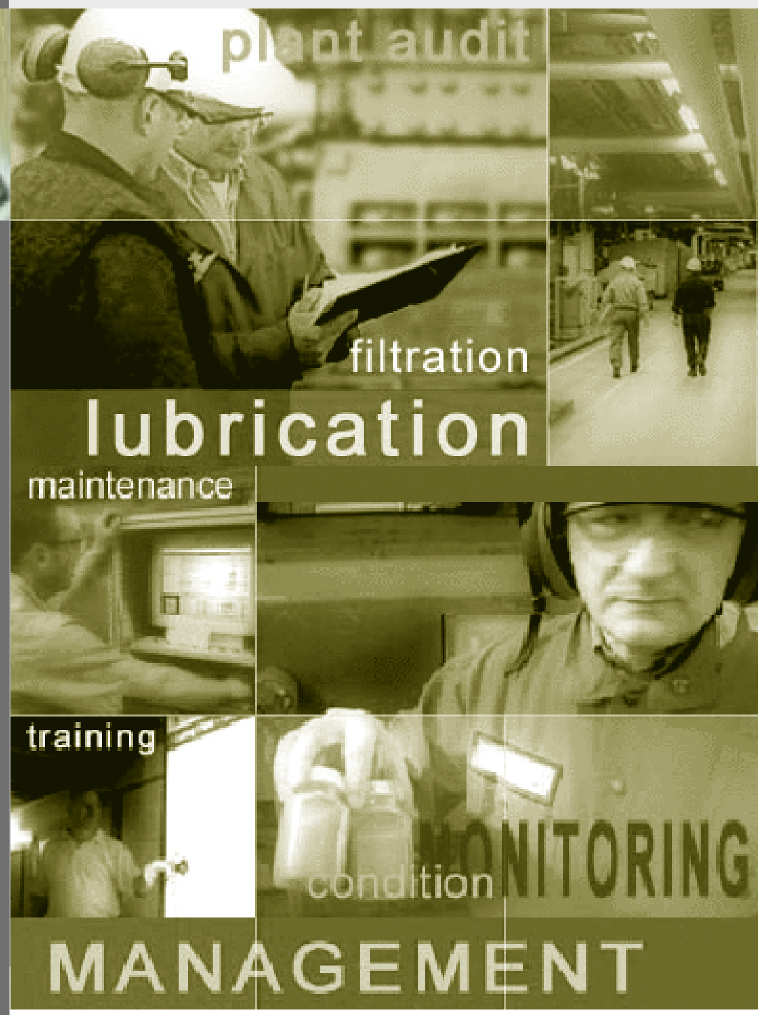

LUBRIGARD

PROACTIVE LUBRICATION MANAGEMENT

Technical Specifications For

Lubrigard Oil Condition Sensor

Lubrigard presently have a limited supply of prototype sensors with digital read-out available and we can ship from stock. We ship sensors complete with a small monitor that includes Yellow (caution) and Red (alarm) lights and a digital readout. The lights are triggered by increases in contamination in oil samples, and a numeric value in the digital read-out increases accordingly.

The sensors Lubrigard have in stock were manufactured in bulk as prototype sensors suitable for extensive testing in the field. The present sensors were designed and manufactured from information gathered from earlier prototypes manufactured in the mid and late1990's and installed in mobile equipment in the field, and on test stands in the lab. The earlier sensors were tested by several large diesel engine manufacturers with excellent results, and we are presently gathering information from limited field testing to incorporate any design changes required for the finished product. We are always looking to broaden our test base to obtain more information correlating the sensor readings to oil analysis results from samples in different types of equipment. We are also exploring new applications for the sensor, and as these sensors are still in the "product specific development stage".

Bill Quesnel Jr.
Vice-President
Lubrigard Ltd.

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LUBRIGARD

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Lubrigard is a division of WearCheck Canada Inc.

Sensor
Introduction

The reliability and longevity of lubricated equipment is crucially dependent upon the quality of its lubricating oil. The Lubrigard oil condition sensor, allows real time reporting of the condition of the oil in a piece of machinery. The sensor utilises internal micro processing to indicate the condition of oil, including the contamination levels, relative to the initial condition of new oil.

Based on the sensor output, the oil drain down intervals may be extended on large industrial gearbox's, engines, compressors etc where the cost of replacing and monitoring the oil is expensive. The sensor triggers an investigation into the quality of the oil, preventing the need for expensive routine maintenance.

The Lubrigard Oil Condition Sensor can reduce the overall operating cost of machinery through the removal of routine inspections, waste oil disposal and subsequent renewal.

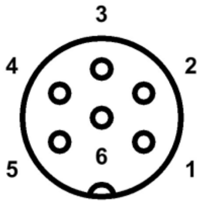
Detection

The Lubrigard Oil Condition Sensor can measure the degradation of oil due to oxidisation, viscosity breakdown, presence of excessive soot, water ingress, glycol, metallic particles or generation of any polar molecules of various sources such as electrical breakdown.

Hydrocarbon and synthetic oils oxidize with use at elevated temperatures and may also become contaminated with soot, metallic particles, water or glycol. These components will all change the electrical conductivity characteristics of lubricating fluid which can be measured consistently and accurately.

Dielectric Constant, or permittivity is a complex parameter involving an "energy storage" portion and an "energy loss" portion also known as "Tan Delta". Unlike some other sensors, which measure dielectric constant directly, the Lubrigard Sensor employs very high frequencies to measure Tan Delta. The measurement is found to be sensitive to changes in contamination, but tolerant of the variations found in most widely available lubricant packages.

Different lubricants will inevitably produce different outputs, and the microcontroller compensate for these small changes by means of a once only calibration insitu.
To compensate for expected variations in operating temperature in the sensor, a high accuracy temperature device communicates with the micro-controller that drives the output display.



Pin 1 - Yellow (4-20mA current sink output)
Pin 2 - White (switch/calibrate output)
Pin 3 - Red (+10 to +30V dc power supply)
Pin 4 - Black (0V and power supply common)
Pin 5 - Blue (RS232 RXD)
Pin 6 – Green (RS232 TXD)

Figure 1 – Pin connections.

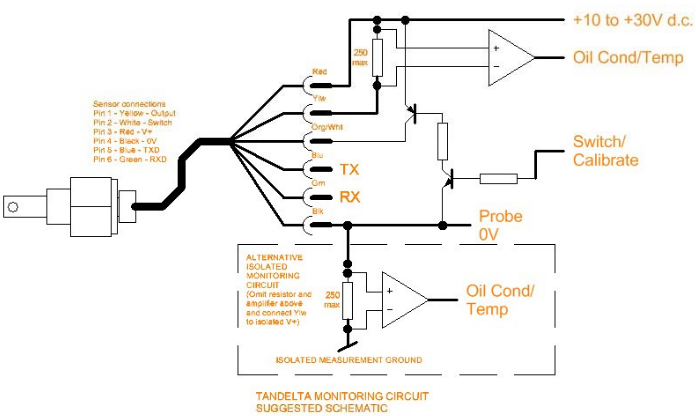


Figure 2 – Connection details for setting up the Lubrigard oil condition sensor. It is important that the connection details are followed closely to ensure proper sensor readings and to prevent damage to the sensor.

The oil condition output represents a measure of the lubricating ability of the oil, with 0% (or slightly negative) representing new, clean oil, and the percentage increasing as the oil deteriorates. We would recommend that an acceptable oil quality is taken as being between 0% (7.2mA) and 30% (11mA), after which the oil should be condemned. A useful warning level is normally set at 25% (10.4mA), above which an oil sample should be taken and analysed and the condition monitored carefully for any further increase.

Sensor

Set-Up & Calibration

The Lubrigard sensor is designed to be easy to use in a variety of configurations depending on the monitoring equipment to which you would like to interface. It uses a simple four wire connection to connect to its power supply, switch/calibrate input and 4-20mA current sink output, with an additional two wires if you would like to use an RS232 or RS485 (optional) interface to connect to a PC or laptop. The connections and recommended wire colours are as shown in figure 1.

The sensor's 4-20mA output is linearly scaled to output between -25% (4mA) and +100% (20mA) oil condition over its range, or similarly between -25C and +100C if outputting temperature. This means that zero oil condition or temperature is represented by 7.2mA current flow. The default output is oil condition, but oil temperature can be selected by taking the switch/calibrate input high (between +5V and +30Vdc) and holding it high. This can be tested by connecting the (white) wire from pin 2 to the +ve supply. The output will revert to oil condition when the input is allowed to return to a low level.

The 4-20mA output sinks the current defined above to its 0V pin, which means that the monitoring circuit must be an active, high-side sensing, or an active, isolated sensing circuit. This means that it must be capable of delivering a current to the sensor from some positive voltage between +5V and +30V, and measuring the current flowing into the sensor. If the sensing resistor is in the 0V side, and the 0V is common to both sensor and measuring circuit, then the resistor will be shorted out by the 0V connection and no measurement will be possible. If the measuring circuit is isolated from the sensor and does not share a 0V connection, then it does not matter where the sensing resistor is located. (Please refer to our drawing which illustrates the recommended monitoring circuit configuration).

The sensor is supplied ready calibrated and zeroed on a sample of typical lubricating oil which may differ from the oil you are using, unless you have pre-arranged for us to use your specific oil type and have supplied us with a sample. If not, for the best accuracy you should zero the sensor on a clean sample of oil before use. If you know that the oil in the application for which you are going to use the sensor is new, clean oil, this can be done in situ; otherwise the sensor should be immersed in a clean container of new oil and tilted to expel any air bubbles which may collect in the sensing gap, and then zeroed using the following procedure. Ideally this should be done while the sensor is fully connected to your measuring circuit.

1) Power up the sensor using a suitable DC supply of between 10 and 30V DC., ensuring the correct polarity on pins 3 and 4.
2) Use the switching device (e.g. relay) in your monitoring circuit to pulse the voltage on the (white) wire from pin 2 as described below. If the sensor is not yet connected to the monitoring circuit, connect a pushbutton switch between the +ve power supply and the switch/calibrate input, or if this is not possible, the sensor can be zeroed by touching the (white) wire from pin 2 to the +ve supply repeatedly; in this case, make sure that the wire is placed firmly on the +ve and held there for the relevant periods, then removed cleanly without multiple connections and disconnections.
3) Note down the current flowing into the sensor using your monitoring circuit, or connect a suitable current meter (e.g. a DMM on 20mA current range) between the +ve supply (+) and the 4-20mA current sink output – the (yellow) wire coming from pin 1. (This is not essential but helps you to track the zeroing process.)
4) Pulse the switch/calibrate input high for between 1 and 2 seconds, then low for the same period, then high, then low, then high, then low to make three full high-low cycles with each level lasting between 1 and 2 seconds. This can be done using your monitoring circuit, the push button or by touching the white wire to the +ve supply. You should see the current on the meter or monitoring circuit drop to 0mA, and then increase in 1mA steps to 6mA as you go through the cycles, and then settle at or near the zero oil condition value of 7.2mA.

Sensor
Communication Protocol

The command protocol and language for the sensor serial communications uses a binary command format communicating over a half duplex RS232 or RS485 interface. The serial configuration must be set to 8 bit with no parity and will initially communicate at 9600 baud. The sensor unit operates in a slave mode, with the serial device which controls the communications (e.g. the monitoring computer) acting as master and issuing commands to which the slave will reply. sensor will not transmit any data except in response to a command from the master, and will expect no further commands until the last command has been replied to.

Commands are multiple sequences of bytes which must be interpreted as a complete data string before the correct action and response can be determined. Any command which is not interpreted and verified will cause the command interpreter to reset back to its initial state, and any interruption of communications of longer than 1s will cause the same result. The master must therefore check for correct response in all cases and re-start any commands which have been corrupted or mis-interpreted. The detailed structure of commands is as detailed below. See Table 1 for the command structure, and Table 2 for the response structure.

Checksum

The checksum is calculated by creating an unsigned 16 bit sum of all preceding data bytes, discarding any overflow and then subtracting the result from 65535. For example the Read Datalog Memory command string required to read 128 records from instrument 2 in cluster 1, starting at record zero, is shown below

“!”,10,01,02,“R”,“d”,00,00,127,<cksm> (ASCII ! = 33D, ASCII R = 82D, ASCII d = 100D)

The checksum here would be 65535 – (33+10+1+2+82+100+0+0+127) = 65180, or FE9CH

Command Overview

(see table 3 for a list of data and response strings)

Commands are divided into two categories:
- Read commands which read data from the Lubrigard unit, beginning “R”
- Write commands which write data to the Lubrigard unit, beginning “W”

1. Read commands allow access to current channel and system settings for confirmation and management of the units’ operation and current measurements (readings) acquired by the units. Note that all commands use exactly the same mechanism as “Read Memory”, accessing system memory but adding the address onto a starting address appropriate to the command; thus “Read Channel Settings” with address 0x03 and length 0x06 reads six bytes, starting from the third byte of the Setup structure within system memory.

2. Write commands allow the remote configuration of current channel and system settings for management of the units’ operation, and modification of the units’ system memory, for use in monitoring and debugging operations only.

Table 1 – The command structure.

Byte 0	“!”	Wake-up code
Byte 1	<count>	Number of bytes to follow, including checksum but excluding <count>
Byte 2	<iaddr>	Single byte instrument address
Byte 3 & 4	<cmd>	Two byte command
Byte n to n+1	<data>	Optional, depending on the command
Byte n, n+1	<cksm>	16 bit inverse checksum of all preceding bytes including acknowledge

Table 2 – The response structure

Byte 0	“A” or “E”	Acknowledge character: acknowledgment or Error
Byte 1	<count>	Number of bytes to follow, including checksum but excluding <count>
Byte 2 to n-1	<response>	Optional, depending on the command
Byte n ,n+1	<cksm>	16 bit inverse checksum of all preceding bytes including acknowledge

Table 3 – Command strings.

<cmd>	Description	<data>	<response>
“Rc”	Read config settings	2 byte address plus 1 byte <length>	<length> bytes
“Rm”	Read system memory	2 byte address plus 1 byte <length>	<length> bytes
“Rr”	Read current readings	Byte address plus 1 byte <length>	<length> bytes
“Rv”	Read version and serial no.	2 byte address plus 1 byte <length>	<length> bytes
“Wc”	Write channel settings	2 byte address plus 1 byte <length>	<length> bytes
“Wm”	Write system memory	2 byte address plus 1 byte <length>	<length> bytes

Bytes 0-2	24 bit floating point representation of Oil Temp value, in C (unless otherwise scaled)
Bytes 3-5	24 bit floating point representation of Ambient Temp value, in C (unless otherwise scaled)
Bytes 6-8	24 bit floating point representation of Oil Condition

Figure 3 – Response string for command “Rr”

Sensor

Communication Protocol (con’t)

Read Current Readings Command “Rr”

This command has two items of data, a two byte <starting address> and a single byte <length>. It commands the sensorunit addressed by <iaddr> to transmit <length> bytes from <starting address> relative to the start of the current readings array for each of the five channels within the unit. Each reading comprises three bytes of data in 24 bit floating point format and must be interpreted as such by the receiving system. If the command is correctly interpreted, the sensor unit addressed will acknowledge the command with the Ack code, echo the number of bytes it will transmit, and send a response containing the data requested, followed by a checksum. If the command is not correctly interpreted, the sensor unit addressed will acknowledge with the Error code and a checksum. If the unit addressed cannot be found, there will be no reply.

The command string is 10 bytes long (no. of bytes in each field as subscript):

“!”,<081>,<iaddr1>,“R”,“r”,<start address2>,<length1>,<cksm2>

The response string comprises the acknowledge character, the <count> of bytes to follow and then <length> bytes of data, followed by a 16 bit checksum. In its most common usage as used to download all five channel readings, this will comprise 15 bytes of data, as show in Fig. 3.

Thus the response string is <length> + 4 bytes long (no. of bytes in each field as subscript):

“A”,<length+21>,<length bytes of data>,<cksm2>

Or, in case of error:

“E”,<021>,<FFA92>

Read Memory Command “Rm”

This command has two items of data, a two byte starting <address> and a single byte <length>, allowing a read of up to 256 addresses from system memory. It commands the sensor unit addressed by <iaddr> to transmit <length> memory bytes starting at <address>. If the command is correctly interpreted, the sensor unit addressed will acknowledge the command with the Ack code, echo the number of bytes it will transmit, and send a response containing all the data requested, followed by a
checksum. If the command is not correctly interpreted, or the starting <address> is outside the range of system memory, the sensor unit addressed will acknowledge with the Error code and a checksum. If the unit addressed cannot be found, there will be no reply.

The command string is 10 bytes long (no. of bytes in each field as subscript):

“!”,<081>,<iaddr1>,“R”,“m”,<record no2>,<length1>,<cksm2>

The response string comprises the acknowledge character, the <count> of bytes to follow and then <length> bytes, followed by a 16 bit checksum. The structure of each record is: Thus the response string is (4 + <length>) bytes long (no. of bytes in each field as subscript):

“A”,<count1>,<byte 1>,<byte 2>,...,<byte n>,<cksm2>

or, in case of error:

“E”,<021>,<FFA92>

Read Config Data Command “Rc”

This command has two items of data, a two byte <starting address> and a single byte <length>. It commands the sensor unit addressed by <iaddr> to transmit <length> bytes from <starting address> relative to the start of the channel settings and alarm array for each of the five channels within the unit, and the two relays and eight alarm definitions. Config settings are as defined below and must be correctly interpreted by the receiving system. If the command is correctly interpreted, the sensor unit addressed will acknowledge the command with the Ack code, echo the number of bytes it will transmit, and send a response containing the data requested, followed by a checksum. If the command is not correctly interpreted, the sensor unit addressed will acknowledge with the Error code and a checksum. If the unit addressed cannot be found, there will be no reply.

The command string is 10 bytes long (no. of bytes in each field as subscript):

“!”,<081>,<iaddr1>,“R”,“c”,<start address2>,<length1>,<cksm2>

The response string comprises the acknowledge character, the <count> of bytes to follow and then <length> bytes of data, followed by a 16 bit checksum. The data returned will be dependent on the particular parameters addressed, as shown in Fig. 4.

Thus the response string is <length> + 4 bytes long (no. of bytes in each field as subscript):-

“A”,<length+21>,<length bytes of data>,<cksm2>

or, in case of error:-

“E”,<021>,<FFA92>

Addresses 0 to 2 incl:	Calibration Zero Point: 3 byte floating point numbers in volts
Addresses 3 to 14 incl:	Temperature Coefficients: 4 * 3 byte floating point numbers
Addresses 15 to 23 incl:	Channel Max Ranges: 5 * 3 byte floating point numbers in EU
Addresses 24 to 32 incl:	Channel Min Ranges: 5 * 3 byte floating point numbers in EU
Address 33:	Instrument Address: 1 byte address
Address 34:	Serial Type: 1 byte: 0 = RS232; 1 = RS485
Addresses 35 to 37 incl:	Max Temperature (Ambient): 3 byte floating point number in C
Addresses 93 to 101 incl:	Channel Readings: 3 * 3 byte floating point numbers in EU
Address 256:	Software Version Number: 3 byte floating point number

Figure 4 – Response string for command “Rc”

Read Version and Serial Number Command “Rv”

This command has two items of data, a two byte <starting address> and a single byte <length>. It commands the sensor unit addressed by <iaddr> to transmit <length> bytes from <starting address> relative to the software Version No. variable. Version and Serial No. information is as defined below and must be correctly interpreted by the receiving system.

If the command is correctly interpreted, the sensor unit addressed will acknowledge the command with the Ack code, echo the number of bytes it will transmit, and send a response containing the data requested, followed by a checksum.

If the command is not correctly interpreted, the sensor unit addressed will acknowledge with the Error code and a checksum. If the unit addressed cannot be found, there will be no reply. The command string is 10 bytes long (no. of bytes in each field as subscript):

“!”,<081>,<iaddr1>,“R”,“v”,<start address2>,<length1>,<cksm2>

The response string comprises the acknowledge character, the <count> of bytes to follow and then <length> bytes of data, followed by a 16 bit checksum. The data returned will be dependent on the particular parameters addressed, as follows:

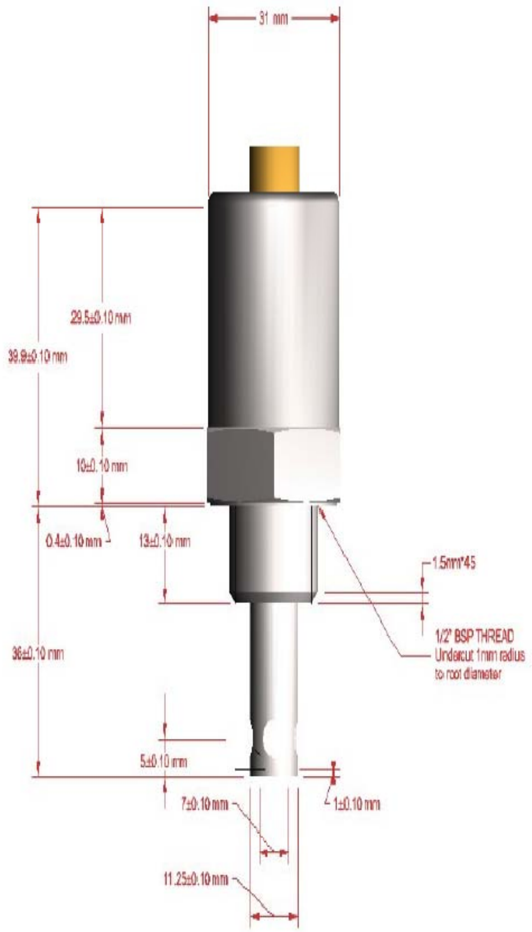
Addresses 0 to 2 incl:	Software Version No: 3 byte floating point version no.

Thus the response string is <length> + 4 bytes long (no. of bytes in each field as subscript):-

“A”,<length+21>,<length bytes of data>,<cksm2>

or, in case of error:

“E”,<021>,<FFA92>



Sensor
Installation

Sensor Head Installation

Precautions

Please read these instruction before installing the oil condition sensor. The sensor has been designed as robust as possible, however it is liable to damage through mistreatment. The following must be noted:

- Install the sensor head before attempting electrical/wiring connections.
- Do not attemp to screw or tighten the sensor using the body. Always use the “Hex” head with the correct size spanner.
- Do not twist the cable relative to the sensor head. Keep away from sharp edges which may cut into the cable.
- Do not bend the cable, minimum bend radius = 50mm (2 inches).

Choosing Sensor Mounting Location

The performance of the sensor will be enhanced through careful consideration of the mounting location. The following guidlines should be followed:

- The sensor should not be mounted in the bottom of a sump since the sensor head may become restricted preventing correct operation.
- Dynamic oil flow is necessary; do not mount in places where the oil is likely to stagnate or be static, since the oil in the sensor needs to be
- representative of the whole system.
- When the oil condition sensor is mounted in a pipeline, please ensure that the sensor will not restrict flow
- When mounting the oil condition sensor in a lubrication system, for maximum performance, please ensure the sensor is located prior to the oil filters, oil coolers etc to ensure oil is representative of the whole system.

Mechanical Installation

The standard thread is ½ inch BSP. Please take a note of following guidlines:

- To avoid thread damage do not use with taper fittings
- Tighten with a adjusted size spanner and do not over tighten.

Cable

Do not twist the cable relative to the sensor head as irreparable damage may result. Do not excessively bend or fold the cable (the minimum bend radius is 50mm (2 inches).

Routing of cable

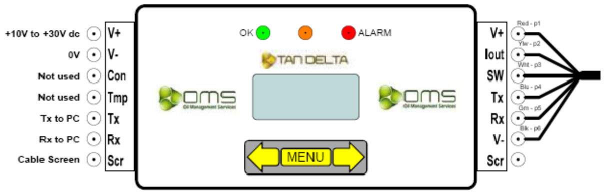
- Keep the cable away from sharp edges which may cut into the cable.
- Do not fold the cable, minimum bend raduius = 50mm (2inches).
- Where possible, keep the cable away from sources of heat, (such as an engine block), and electrical interfaces.

Sensor
Communication Options

Telemetry
The Lubrigard Oil Condition Sensor supports telemetry with the use of transmitting and receiving modems connected to a PC running trending software.

GPRS
The Lubrigard Oil Condition Sensor supports GPRS with the use of GPRS converter connected directly to the Internet controlled by a PC running trending software.

Additional Options
The Lubrigard Oil Condition Sensor supports direct connection to an oil indicator control unit, direct connection to a PLC and/or HMI.



LUBRIGARD

Technical Specifications for
Lubrigard Oil Condition Sensor

Specifications

Analogue Output	4-20 mA
Communications	CAN, RS232 & RS485
Connections	Standard ½" BSP male thread (alternate thread size available on request)
Detection	Oil condition (0-100 oil quality units)
Fluid Compatibility	Mineral & synthetic oils (or any lubricating oil)
Fluid Temperature	-10 to 110°C (-14 to 230°F)
Inputs	Calibration by push button or contact closure
Max Fluid Pressure	10 Bar (145 PSI)
Options	Various cable lengths can be accommodated with mating connector. Alternative connection options and standalone display unit available by request
Power Supply	9-30 VDC
Protection	IP67
Range	0-100 Oil Q unit
Repeatability	3%
Weight	160g
Output Connection	Industry standard 6 pin connector