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Metallic Wear Debris Sensor

Instruction Manual

Parker

ENGINEERING YOUR SUCCESS.

MWDS - Metallic Wear Debris Sensor

Installation and Operation Manual: EMA-K19578-KW Issue 12

Contents

1. Manufacturer Information

Please see contact details on cover of this manual.

The manufacturer reserves the right to make technical changes without notice. Whilst every care has been taken to ensure the correctness of the information contained in this manual, no liability can be accepted for any errors or omissions.

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Do not discard this manual. This instruction manual comprises a functional part of the Metallic Wear Debris Sensor product. The instruction manual must be kept safe for future reference.

 The digital communication protocols are covered in a separate manual supplied with the product - MA-K19555.

Key to Symbols

 = Caution

 = Note – Helpful Hints and Tips

2. Introduction and Intended Use

The Metallic Wear Debris Sensor [MWDS] is a robust online multi parameter sensor which can be used to monitor the amount of metallic ferrous and non-ferrous wear debris in an oil or other fluid medium.

The MWDS differentiates between discrete metallic particles of ferrous and non-ferrous origin. It simultaneously quantifies the metallurgical composition and the size of particles in a fluid as the fluid flows through the MWDS.

When used as part of a pro-active maintenance programme, the MWDS will help reduce the overall operating cost of machinery, with associated reductions in failure related downtime, removal of routine checks and lab testing.

 The MWDS can communicate via either Modbus RTU (RS-485 or TCP/IP) or CANopen. The protocol manual details how to communicate with the sensor.

2.1 Abbreviations

Fe	Ferrous
NFe	Non-Ferrous
MPH	Mass per hour
PPM	Particles per Minute
MWDS	Metallic Wear Debris Sensor

3. Key changes from previous versions

3.1 General:

- MWDS now has DNV GL approval
- Weight is reduced to 2 kg

3.2 Electrical:

- Maximum operating voltage is increased to 32 Volts
- MWDS no longer provides 4-20 mA outputs

3.3 Communications:

- An additional register for reporting abnormal detection events that cannot be classified as individual particles and counted (typically when multiple particles pass through the sensor together); these events were previously ignored (section 6.3.4)
- The CANopen map has been completely revised with many new registers and features. The details are given in the Protocol Manual and as a machine-readable Electronic Data Sheet (EDS file) supplied with the MWDS.
- Default Modbus & CANopen node is now 21, this can be reconfigured (see Protocol Manual)
- Default CANopen baudrate is now 500 kbps, this can be reconfigured (see Protocol Manual)
- To assist the development of user HMI/PLC/GUI or other interfaces, “test mode” can be used to test and also help identify errors.

4. Safety Summary

4.1 General safety

Please ensure that you thoroughly read and understand this user document before attempting to install or use the MWDS.

Observe local rules and regulations for safe working, including personal protective equipment ‘PPE’ – especially during installation and commissioning.

If the MWDS is used in a manner, or for a purpose, other than that described in this manual, any safety protection may be impaired.

The MWDS and accessories contain no user serviceable parts. Do not dismantle.

This equipment has not been approved for use in an explosive atmosphere. Never use the MWDS near flammable gases or liquids.

A version of the MWDS is available with ATEX and IECEx Zone 1 certification.

4.1.1 Fluid pressure

The MWDS is designed to be connected to pressurised systems. The safety of associated systems, hoses or pipework containing fluid are the responsibility of the end user. This includes isolation of the MWDS during maintenance. The maximum safe operating pressures and installation criteria are detailed in this manual.

Systems can maintain pressure after shutdown and will require depressurisation before working on fluid connections.

4.1.2 Fluid Presence

The MWDS may be coated with a small amount of fluid; this is the residue from the factory acceptance checks. The fluid is a non-toxic paraffin oil compatible with lubricating oils and does not need to be cleaned off.

4.2 EMC

Under the applicable EC Directive 2004/108/EC, the MWDS meets the requirements of BS EN 61326 for RF Immunity in industrial environments. For cable runs exceeding 2 metres, a good quality (braid plus foil) shielded cable should be used.

The cable shield should be earthed. Avoid routing the cable in close proximity to cables for motors and other electrically noisy equipment. The MWDS meets the requirements of BS EN 61326 for immunity to power frequency magnetic fields in industrial environments (30A/m). The cable should not be installed in close proximity to electric motors and other sources of intense magnetic fields.

The MWDS also meets the DNV GL electrical and EMC requirements for location class A, (Machinery Spaces and all areas except Bridge and Open Deck).

The MWDS case must be earthed to ensure that EMC requirements are met.

4.2.1 Customer Responsibility

The user of this equipment or subcontractor must not modify the MWDS or deviate from the recommended installation requirements including EN60079-14.

4.2.2 DNVGL Certification

The MWDS is type approved by DNVGL to CG-0339. The MWDS is type approved for installation in the following classes.

Temperature (B)

Humidity (B)

Vibration (B)

EMC (A)

Enclosure (B)

5. MWDS Technical Specification

5.1 Supplied Equipment

MWDS	Supplied with bare wires for advanced installation
USB stick	Containing manuals and PC software
Anti-vibration fittings	4 off
Earth braid	1 off for earthing MWDS case

5.1.1 Spare Parts

USB stick	Containing manuals and PC software
Anti-Vibration fittings	Spare mounts for MWDS
Earth braid	Spare earth strap

5.1.2 Accessories

Calibrated Particle Standards (Ferrous and Non-Ferrous)	See Section 14.2. Contact Supplier for details

Power Supply and mains cable	Powers one sensor
Cat5 patch lead	To connect the sensor to a PC for communications.
RJ45 connector	Connect bare wires to plug into a PC
USB to RS485 adapter	To connect the sensor to a PC for communications.

5.2 Materials

The MWDS has been designed to monitor a range of working fluids, including mineral and synthetic oils.


To prevent damage and maintain proper function of the MWDS, the end user or system integrator must use the material list below to check the compatibility of the working fluid and any aggressive substances that the MWDS is likely to come into contact with.


Aggressive substances - include but are not limited to: Acidic/corrosive liquids or gases that may attack metals, or hydrocarbons/solvents that may affect polymeric materials.

Powder coated Steel, Epoxy	Main Enclosure
Nickel Plated Brass	Cable Connection
PVC	Cable Sheath
FKM Fluoroelastomer (Viton®)	Internal Fluid Seals

Surfaces wetted by working fluid	Viton® (FKM), Aluminium, PEEK (Glass filled Polymer).

5.3 Environmental

Maximum fluid Pressure:	20 Bar (sustained and transitory)
Permitted Fluid temperatures:	-20 to +85°C
Ambient operating temperature:	-20 to +70°C / (DNVGL Class B)
IP rating:	IP66 / (DNVGL Class B)
Atmospheric pressure	0.90 to 1.10 Bar
Weight:	2 kg


Cables and hoses should be properly supported. Do not use the MWDS to support hoses.

5.4 Communications and Alarm output

Alarm Interface:	Opto-isolated contact closure (0.1A max)
Digital:	Modbus over TCP/IP (10BASE-T Ethernet) Modbus over RS485 - 2 wire Half Duplex CANopen

The default communication standard is Modbus over TCP/IP. If an alternative communication standard is required this should be changed prior to installation. Please see software protocol manual for details.

5.5 System Electrical

Power Input:	18 – 32V DC
Power consumption:	0.16A (160mA)
Fuse Rating:	0.2A (200mA)
Cable specification:	Screened. CSA:0.22mm²,1A, AC:440V max:70°C
Connection method:	Pre-wired cable, length 2m[1]
Cable Specifications	Twisted pair cable, shielded. Min 0.22 mm². EIA/TIA 568A Catergory 5 Min 0.22mm²
Cable Length RS485: CAN: Alarm system:	 1000m maximum (Shielded & Twisted Pair Cable) 1000m maximum (Shielded & Twisted Pair Cable) 50m
Case earthing: MWDS Connection: Conductor:	 M6 x 10mm stud Braid (supplied)
Cable Lengths: [recommended maximums] RS485 or CANopen: TCP/IP 10BASE-T Ethernet:	 1000m @ 9600 bps (RS485) or 50 kbps (CANopen) 100m

MWDS is classified as permanently connected equipment and requires an external isolating switch or circuit breaker and fuse. This must be clearly identifiable, labelled and positioned in a readily accessible location. All electrical wiring must be installed in accordance with the relevant standards and any local codes that may apply. Use conduit to protect cable runs.

The MWDS case is Galvanically isolated from all internal circuitry, including 0V, supply voltage and communications.

[1] Different pre-wired cable lengths available on request.

5.6 System Plumbing

Connection:	Pipe Thread ISO 228 – G ½ inch (BSPP) x 17mm deep Female thread
Sealing method:	Use a self-centring bonded washer, fitting with integrated face seal or proprietary sealing compound such as Loctite 577
Maximum system fluid pressure:	20 bar
Minimum Particle Speed:	0.28m/s (1.3 litres/minute) Constant flow
Maximum Particle Speed:	1.9m/s (9 litres/minute) Constant flow
MWDS bore diameter	10mm
MWDS bore length	120mm
Permitted Fluid temperature:	-20°C to 85°C

Use a 51mm A/F Wrench (spanner) across the flats of the MWDS fluid connection to minimise the turning forces on the MWDS when tightening the fluid connections. Excessive force (torque) may damage the MWDS beyond repair.

5.7 MWDS Performance

The following defines the particle detection performance of the MWDS.

Minimum Fluid Speed:		0.28 m/s (1.3 Litres/minute)[2]
Maximum Fluid Speed:		1.9 m/s (9 Litres/minute)[2]2 above
Lower Detection Limits:	Ferrous	40 micron (0.04mm)[3] [4] [0.00157 inch]
	Non-Ferrous metallic	135 micron (0.135 mm) [4] [0.00531 inch]

5.8 MWDS Dimensions and Installation drawing RS-246

Mounting detail and dimensions are contained in drawing RS-246 – Sheet 1 and 2. Drawings are at the rear of this manual – see 15.

[2] Volumes quoted are for the MWDS bore and minimal Pipe work (10mm diameter and 0.5m long – including MWDS bore).

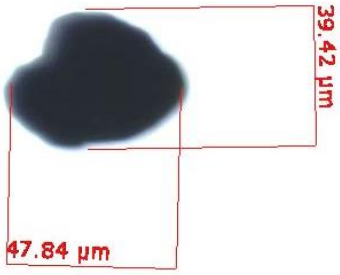
[3] Constant flow rate 0.3m/s, Iron metal (Electrolytic) 99.99% Fe purity - spherical particle. The MWDS will not detect combined Fe in a non-magnetic compound – for example; rust.

[4] Particle size is reported as the diameter of a spherical particle. See section 5.2.2.

6. Wear Debris (Particle) Detection and Reporting Information

6.1 Particle Size – limit of Detection

0.3m/s, Iron metal (Electrolytic) 99.9% Fe purity - spherical particle



6.2 Wear Debris Particle Sizing notes

Bin sizing is affected by the following:

6.2.1 Metallurgy

The reported size of detected particles is affected by the electro-magnetic properties of the particle material, including the electrical conductivity and the magnetic permeability of the material. The particles bins have been structured about typical bearing metals, such as Chrome Steel (for the Ferrous bins) and Brass (for the Non-Ferrous bins).

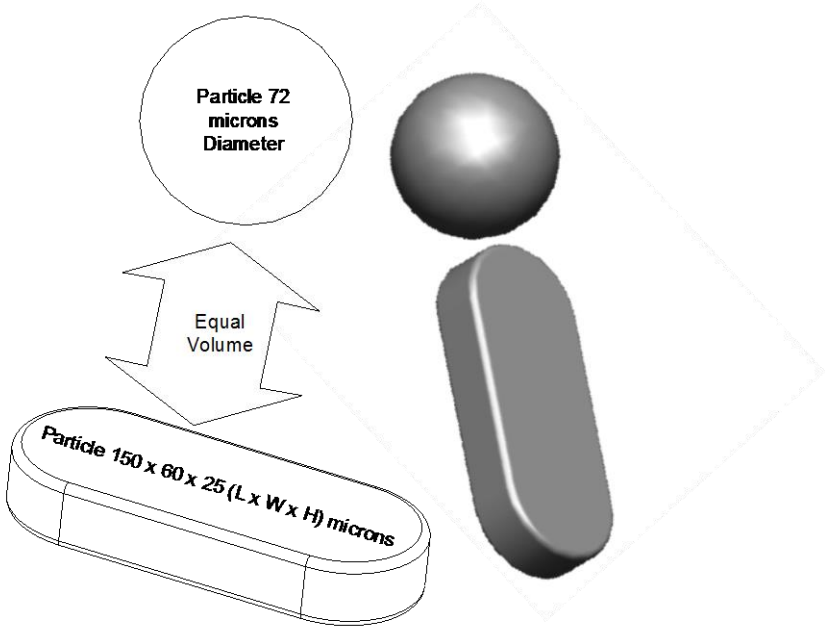
It is important to view the bins as a histogram to understand particle distribution.

6.2.2 Particle Size information

The MWDS detects the volume of the particle and displays this as particle size by assuming the particle is spherical and then calculating the diameter of the sphere.

Wear debris is not spherical – but is random in shape, therefore the equivalent spherical diameter is useful for understanding the comparative volumes of wear debris coming from machinery. It should be noted that the volume of a 70 micron (0.07mm) sphere will contain the same volume as a particle 150 x 60 x 25 microns (L x W x H). When the particles are viewed under a microscope, these flakes may appear larger than the equivalent sphere but their volumes are the same.

The MWDS has been developed using research conducted by independent technical institutes for Tribotechnology. The MWDS is calibrated and defined using spherical particles of laboratory verified composition and dimensions



Example Wear Debris

6.3 Particle Size Classification Reporting

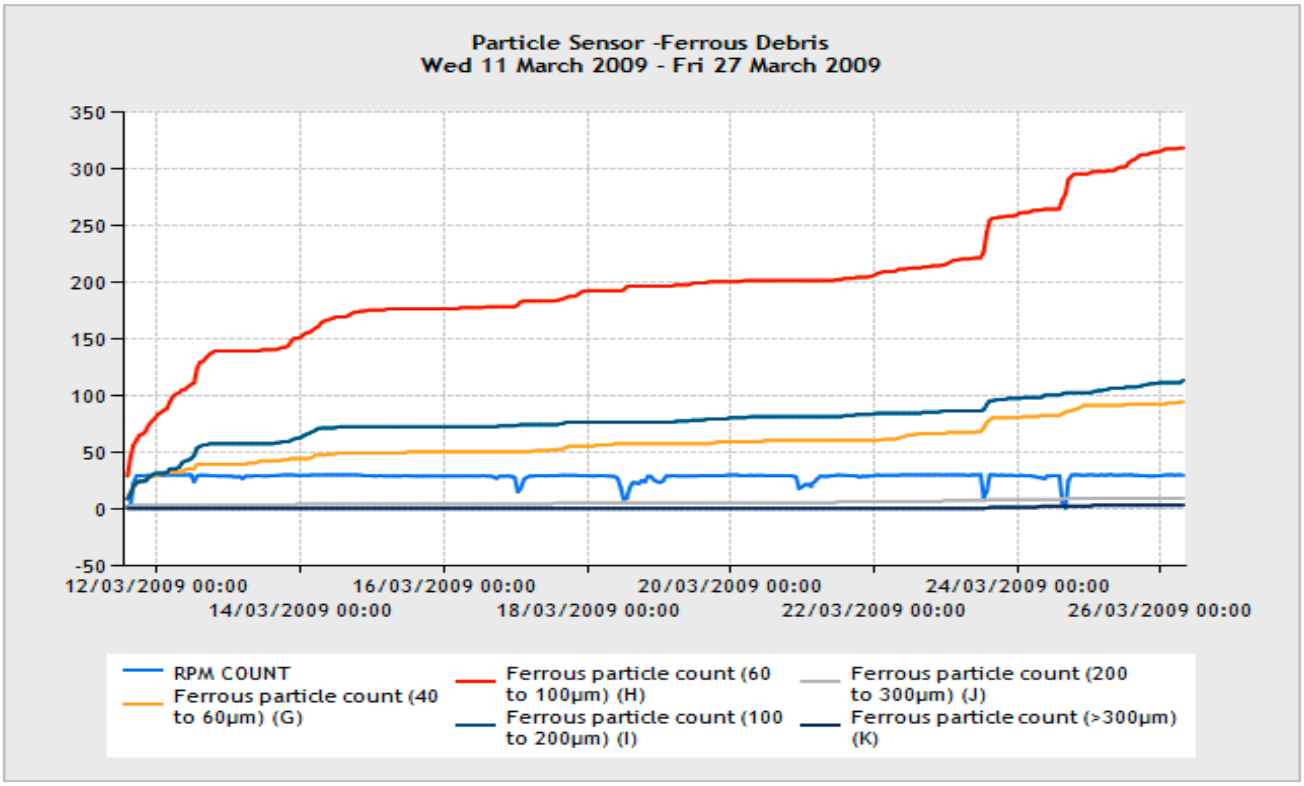
The MWDS classifies particles as ferrous (ferromagnetic materials, typically irons and steels) or non-ferrous (other electrically conductive materials such as copper and aluminium). For each of these material types it assigns each detected particle to a size range for counting purposes. There are 10 size ranges, known as bins, for each material type and the MWDS maintains a particle count for each bin. The size ranges are different for the ferrous and non-ferrous bins since the ferromagnetic properties of irons and steels make it possible to detect much smaller particles.

6.3.1 Ferrous and Non-Ferrous Bins

Bin	Ferrous Ranges	Non-Ferrous Ranges
	Minimum value (µm)	Minimum value (µm)
A	40	135
B	70	200
C	100	300
D	150	400
E	200	500
F	300	600
G	400	700
H	600	800
I	800	900
J	>1000	>1000

6.3.2 Example Analysis of Output

Below is a chart showing an example of how wear evolves with time. Trending the particle bins gives a clear picture of the severity of particle evolution together with the change, and rate-of-change allowing maintenance decisions to be made.



6.3.3 Particle Rate, Mass and Total Bins

In addition to maintaining a count bin for each material type and size range, the MWDS also provides calculated bins giving the rate of detection expressed in two different forms - as the number of particles per minute (PPM) and as the estimated particle mass per hour (MPH) based on typical material density. Thus, there are a total of 60 size-specific bins organised as 6 sets of 10: 3 (Count, PPM, MPH) x 2 (Fe, NFe) x 10 (A - J).

A total is calculated for each set of 10 (A-J) bins, i.e. Total Fe Count, Total NFe Count, Total Fe PPM, Total NFe PPM, Total Fe MPH, Total NFe MPH.

The three totals independent of material type are also calculated (Fe+NFe Count, Fe+NFe PPM, Fe+NFe MPH).

6.3.4 Abnormal Events

The MWDS can only distinguish and count separate particles, and correctly estimate particle material type and size, if no more than one particle passes through the sensor at a time. The particle speed must also be within the specified range. If additional particles enter the sensor before the last particle has left then the MWDS is able to detect that an event has occurred but it cannot determine how many particles were involved or how big they were.

Two or more particles passing through the sensor at exactly the same time will produce a normal signal and simply be detected as a single, larger particle but if they are spread out slightly in time the MWDS is able to detect this as an abnormal event. In this case it is not counted in any of the particle bins. Instead, the MWDS measures the duration of the event and reports it in a separate register in seconds per minute, rounded to the nearest second. If more than one such event occurs in a minute then the total duration is reported. Particles travelling slower or faster than the specified speed range can also trigger an abnormal event.

Events like this are very rare in normal applications but can be easily produced when testing the MWDS by deliberately adding metal particles to fluid unless a great deal of care is taken to dilute them to a realistic level and disperse them evenly - in most fluids metal particles will very quickly settle to the bottom of a container.

6.3.5 Refresh Rates

The particle count bins are updated whenever a particle is detected. The other reported parameters are recalculated at regular intervals as shown in the table below.

Parameter:	Refresh rate:
Particles Per Minute	10 seconds
Mass Per Hour	5 minutes
Unclassified Event Duration	1 second

6.4 MWDS Memory

Every minute, the MWDS automatically saves particle measurement data in its non-volatile memory – so that only the last few seconds of data are lost if the power is interrupted.

6.5 Alarm

The MWDS can be programmed to give warning and alarm indications. The alarm contact can be used to signal alarms.

Default values are set low to assist commissioning:

Particles per minute alarm = 10

Particles per minute warning = 5

Particles mass per hour alarm = 10

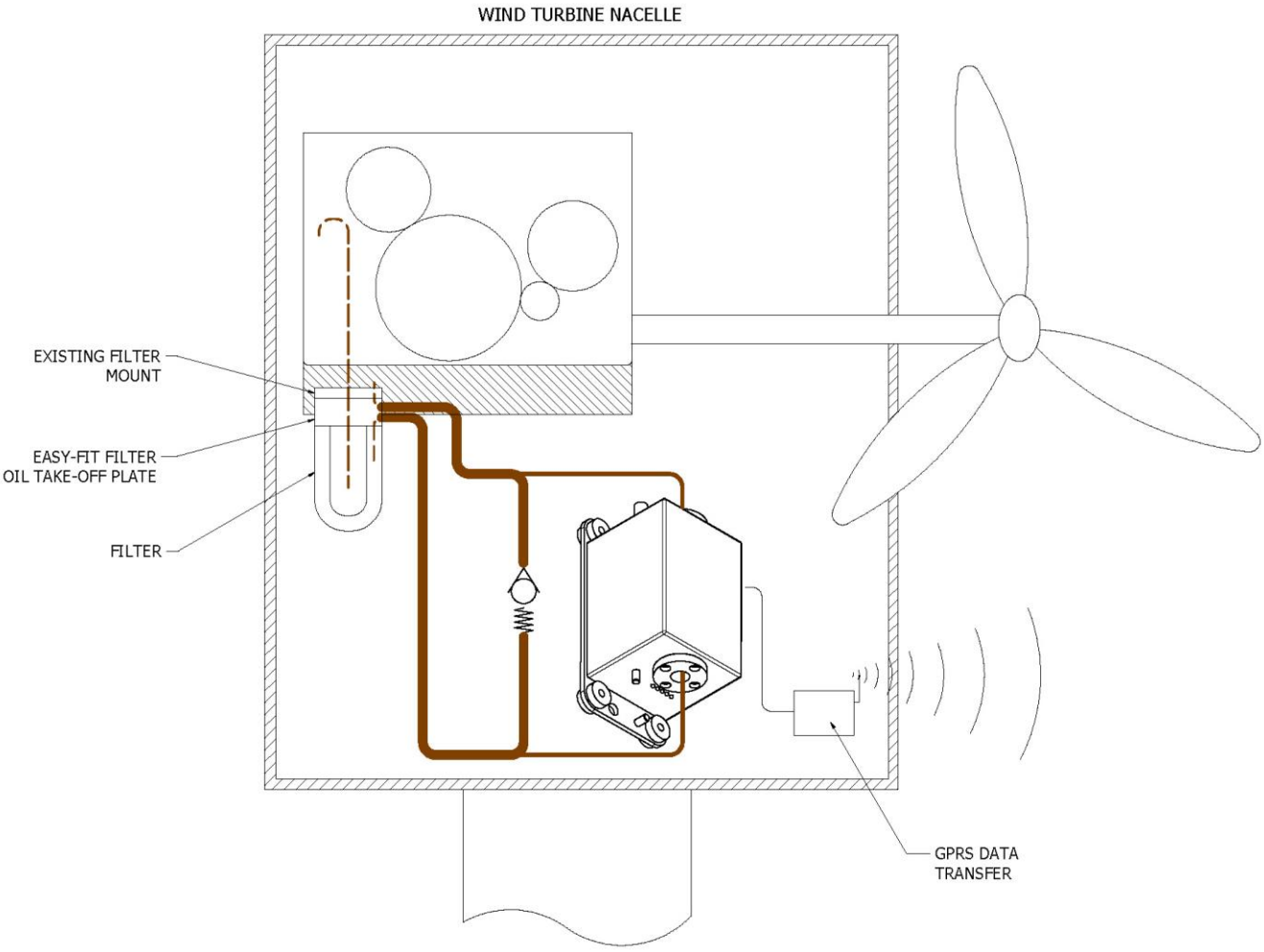
Particles mass per hour warning = 5

7. Application Information

This section of the manual describes two application scenarios. The first is remote monitoring and the second local monitoring. This is not a definitive application list, but demonstrates monitoring potential of the MWDS.

7.1 Application 1 – Wind Turbine

This example shows the MWDS monitoring the condition of a wind-turbine gearbox. A known proportion of oil flows through the MWDS and particles are counted and categorised by size and metallurgical composition.



When combined with other data from the turbine, such as wind speed, power output and gearbox shaft speed, the MWDS gives an insight into wear patterns and shows the conditions where wear is greatest.

7.1.1 Check Valve

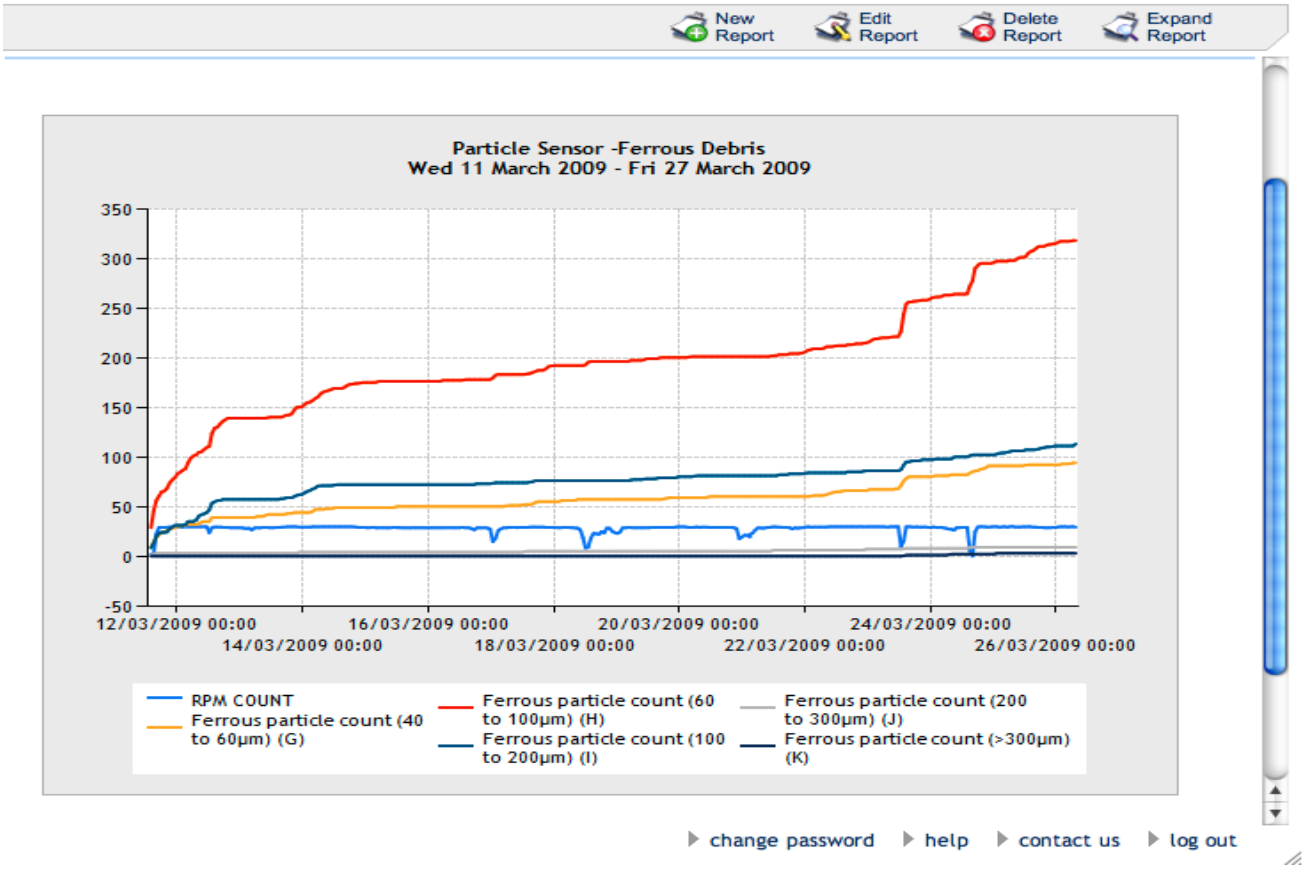
In this particular example, the oil pump is driven from an auxiliary shaft in the gearbox. This means oil is pumped only when the turbine blades (hence gearbox) are turning. This is also variable in speed. Consequently ‘fluid flow management’ is used; a check valve with a ‘cracking’ pressure just higher than the MWDS’ flow restriction. Thus, oil flows through the MWDS at all speeds of the gearbox.

7.1.2 Gate Valve

Independently driven pumps (for example electronically motor driven) will require a gate valve to regulate flow due to constant flow and pressure.

7.1.3 Data Capture

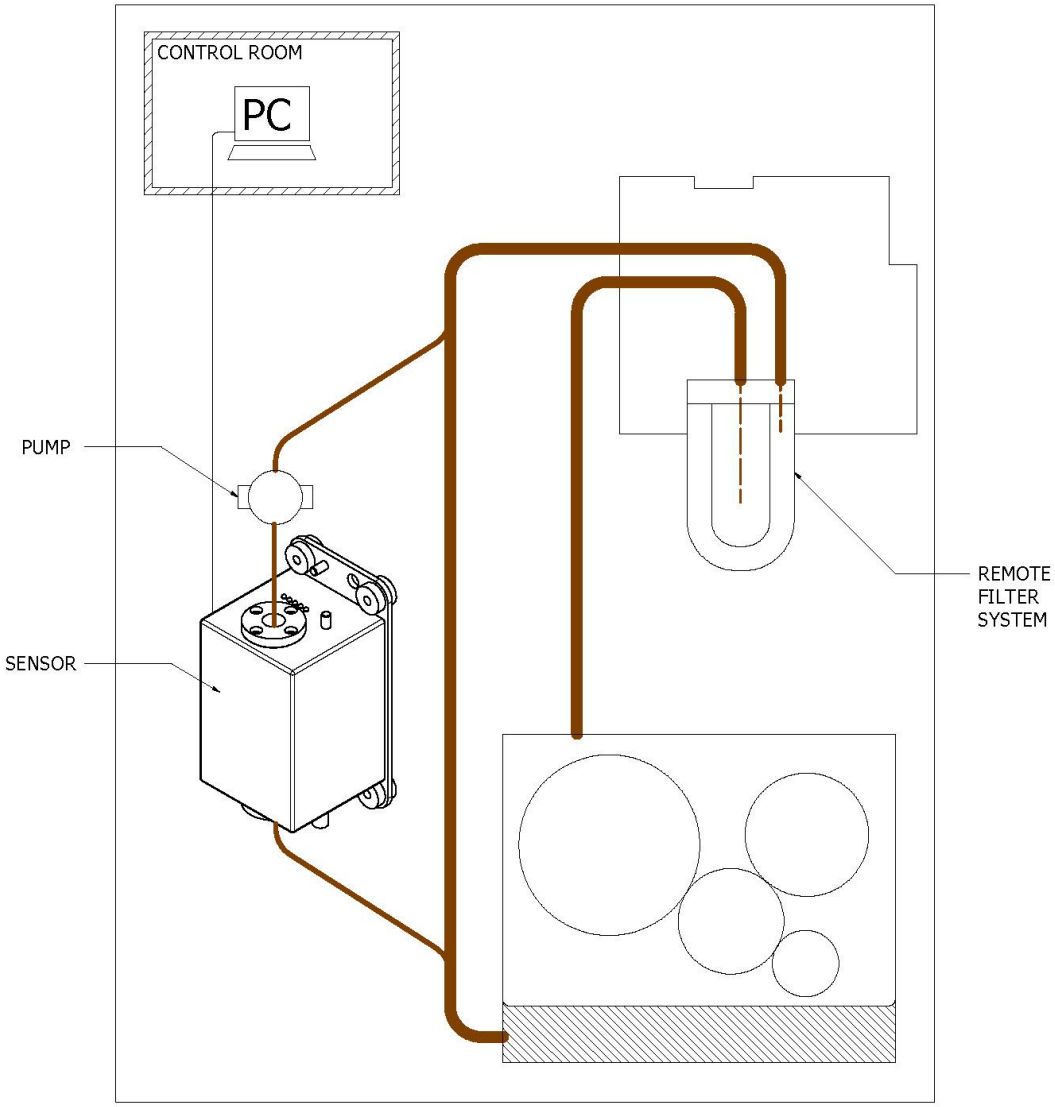
Data is transmitted via GPRS for off-site monitoring, below is a typical screen shot:



7.2 Application Information 2 – Gearbox (Monitoring Loop)

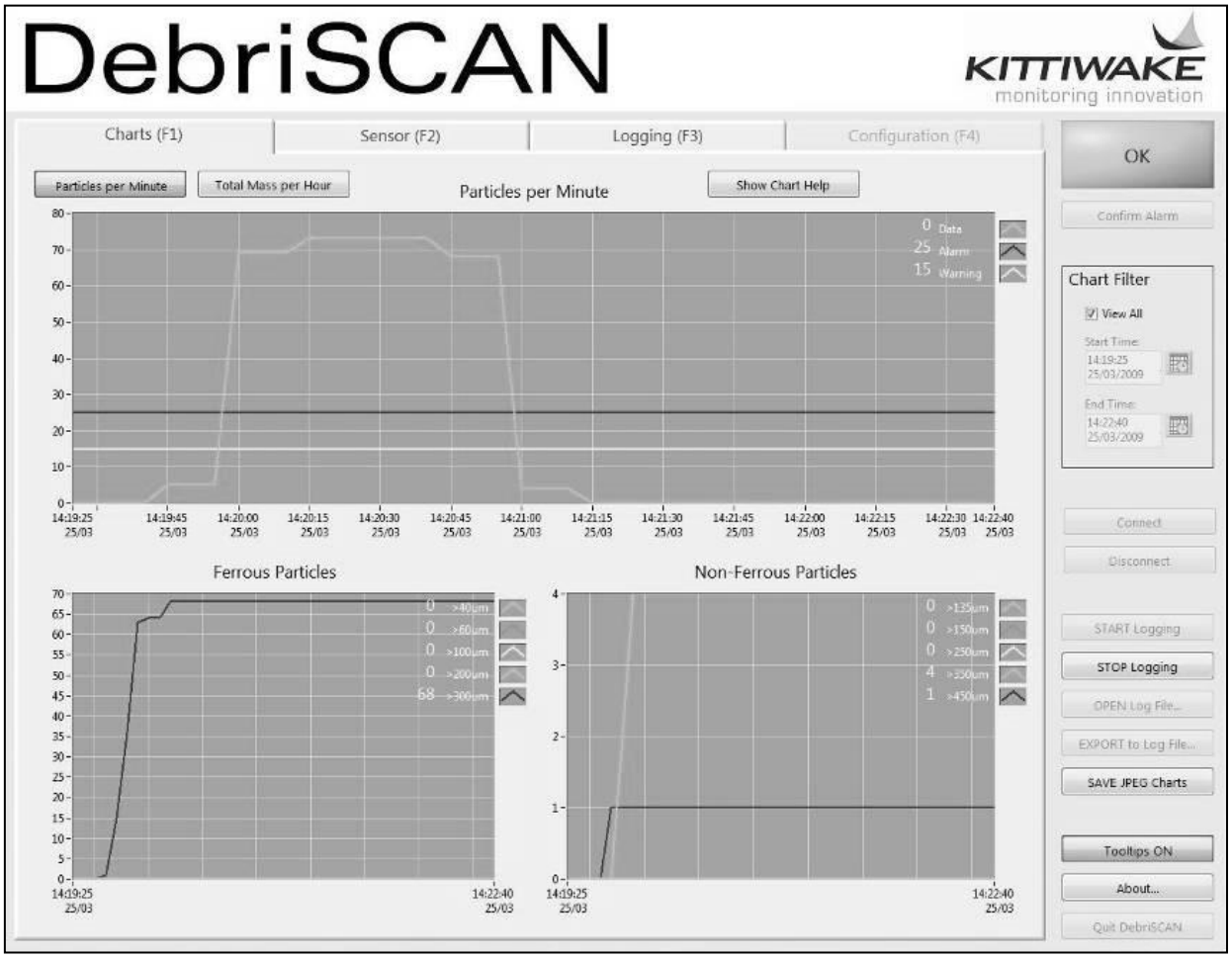
This example shows the MWDS monitoring the condition of a gearbox. The gearbox may be those used in ship propulsion thrusters or a land-based industry. Oil flows through the MWDS and particles are counted and categorised by size and metallurgical composition. Early warning of failure can be detected allowing proactive maintenance to be carried out.

When combined with other data from the gearbox, such as power transmission and gearbox shaft speed, the MWDS gives an insight into wear patterns and shows the conditions where wear is greatest.



7.2.1 Data Capture

Data is transmitted locally to a computer for on-site monitoring, below is a typical screen shot:



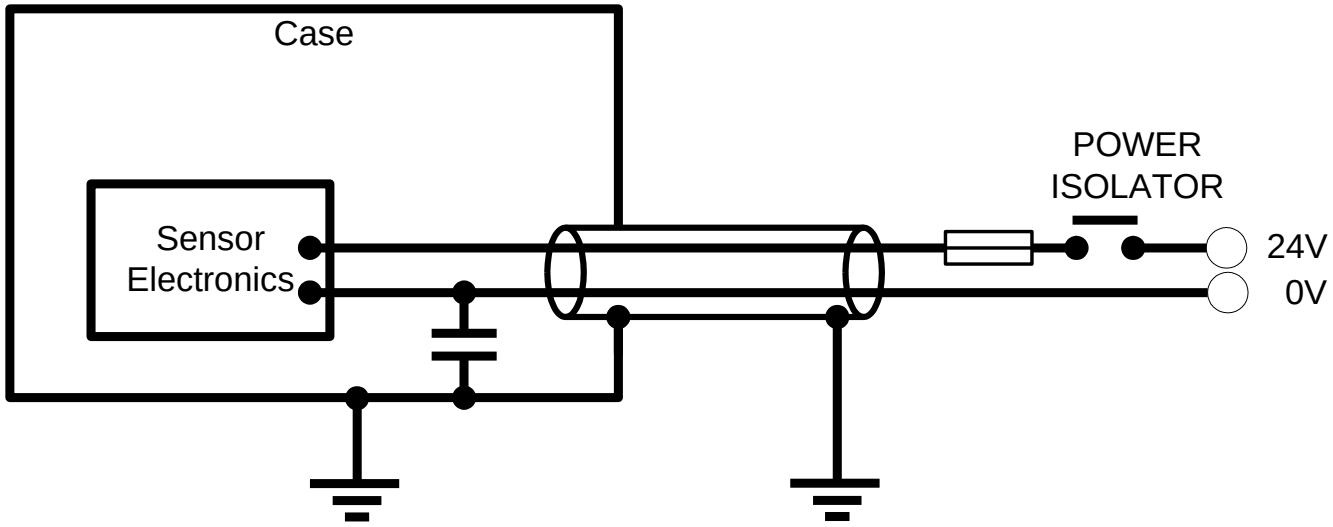
8. Electrical Connections and Communications

Colour (twisted pairs)	Description	Wire
White (with blue ring)	Power +18-32V dc	1
Blue (with white ring)	Power 0V dc (and 0V reference for RS485 & CAN)	2
Red (with blue ring)	Not connected	3
Blue (with red ring)	Not connected	4
Red (with orange ring)	Not connected	5
Orange (with red ring)	Not connected	6
White (with grey ring)	Alarm In	7
Grey (with white ring)	Alarm Out	8
White (with green ring)	TCP/IP Tx+ (From Sensor point of view)	9
Green (with white ring)	TCP/IP Tx- (From Sensor point of view	10
Orange (with white ring)	TCP/IP Rx- (From Sensor point of view)	11
White (with orange ring)	TCP/IP Rx+ (From Sensor point of view)	12
Brown (with white ring)	RS485– or CAN low[5]	13
White (with brown ring)	RS 485+ or CAN high[5]	14
	(RS485 & CAN 0V reference)	(2)

[5] The MWDS can communicate via RS485 or CAN, but not both at the same time.

8.1 Grounding Requirements

The case and cable ground is decoupled from the 0V to avoid Ground loop return issues as the diagram below. The 0V can be connected to the ground if deemed necessary.



The MWDS must have a low inductance earth connection to meet EMC requirements. There is an M6 stud on the MWDS enclosure for this purpose and this should be earthed using a short length of braid. A suitable earth strap is supplied already attached.

8.2 TCP/IP (Ethernet) Cabling and Connections

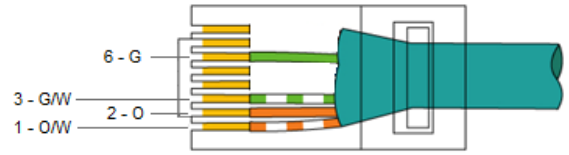
The default communication output for the MWDS is Modbus over TCP/IP for ease of connection to a PC and use of DebriSCAN to configure the sensor. This can be changed to RS485 or CANopen. Consult the software protocol manual for details.

Ethernet Wiring has 2 different standards. T568A is generally used for one end of a crossover cable, and T568B is the standard for a straight through cables at both ends. The reason for the 2 types is because the Tx (Orange) and Rx (Green) sometimes need to be switched to allow some devices to communicate.

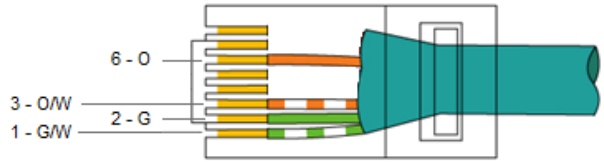
The choice of which type of wiring is necessary depends on what is connecting to what. Essentially there are 2 options for wiring the MWDS, depending on what it will be connected to:

8P8C (RJ45) Pin	Connection to Ethernet switch or hub (T568B)	Connection to PC (T568B)
1	White/Green	White/Orange
2	Green/White	Orange/White
3	White/Orange	White/Green
6	Orange/White	Green/White

If the sensor is connected to a PC the wiring should be as per T658B:



If the sensor is connected to a Switch/Hub, the wiring should be as per T568A:



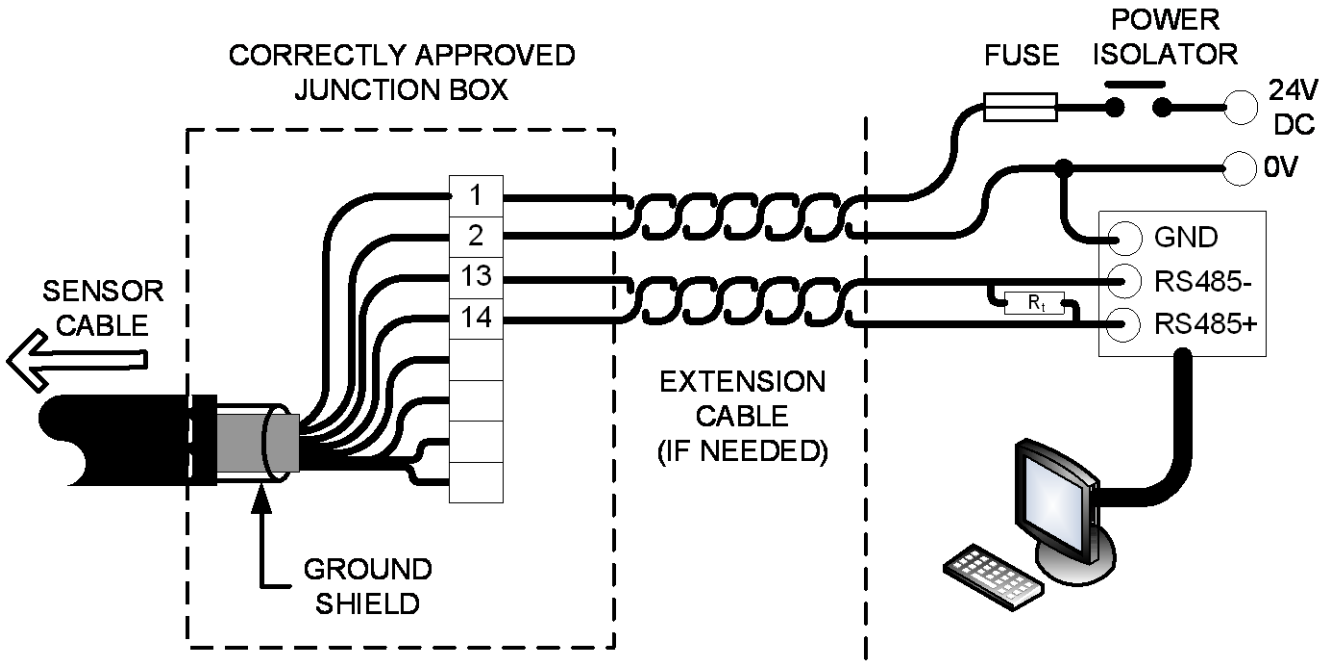
It may be preferable to wire the sensor through an existing Ethernet cable. This can be achieved by opening up one end of the Ethernet cable and connecting the sensor through some

terminal connectors. If a standard patch cable (usually T658B, with white/orange on pin 1) is used then the connections' colours will simply be straight through.

It may be the case that the device that the MWDS is plugged into will be able to detect the device type, and, if necessary, automatically crossover the connection.

8.3 RS485 – to PC

This wiring diagram shows the MWDS configured to communicate via RS485 to a PC, display panel or data acquisition module. An RS485 to USB adapter can be used when connecting to a PC. The MWDS communication is half duplex.



8.4 RS485 - Modbus Wiring

Detailed instructions on how to implement Modbus over 2 wire RS485 bus are available from the Modbus organisation – see 8.4.1. Some points to note that are often overlooked are:

- It is vital to make sure that all communicating equipment has a common 0V connection (shown as "common" in the Modbus Over Serial Line guide) - so "two wire" RS485 actually uses three wires!

- Bus termination resistors are required at each end of the bus - a total of 2 resistors.

  The MWDS has an internal resistor that can be enabled or disabled as a firmware setting. This is intended for use when the MWDS is at one end of the bus and it is inconvenient to install an external resistor.

- Bias resistors are also required somewhere on the bus to maintain a defined voltage when no transmissions are taking place – see below. These are often provided in RS485 adapters. In the USB to RS485 adapter sold as an accessory for the MWDS they can be enabled by internal links.

- The two RS485 wires are commonly designated as A and B but manufacturers of RS485 products are inconsistent as to which of these is which. When Modbus is correctly biased, and no transmission is taking place, one wire sits at a slightly more positive voltage than the other. This can be checked by measuring the voltage between the wires (or with respect to 0V) using a voltmeter. In this manual the more positive wire is designated as RS485+ and the other as RS485-.

   If a voltmeter is unavailable and Modbus communications fail to work try swapping these wires - no damage will be caused by connecting them the wrong way round.

8.4.1 Modbus Implementation Guide

Further reading can be found from the Modbus Organisation:

Modbus Organization
PO Box 628
Hopkinton, MA 01748

Telephone: +1 508-435-7170
Fax: +1 508-435-7172

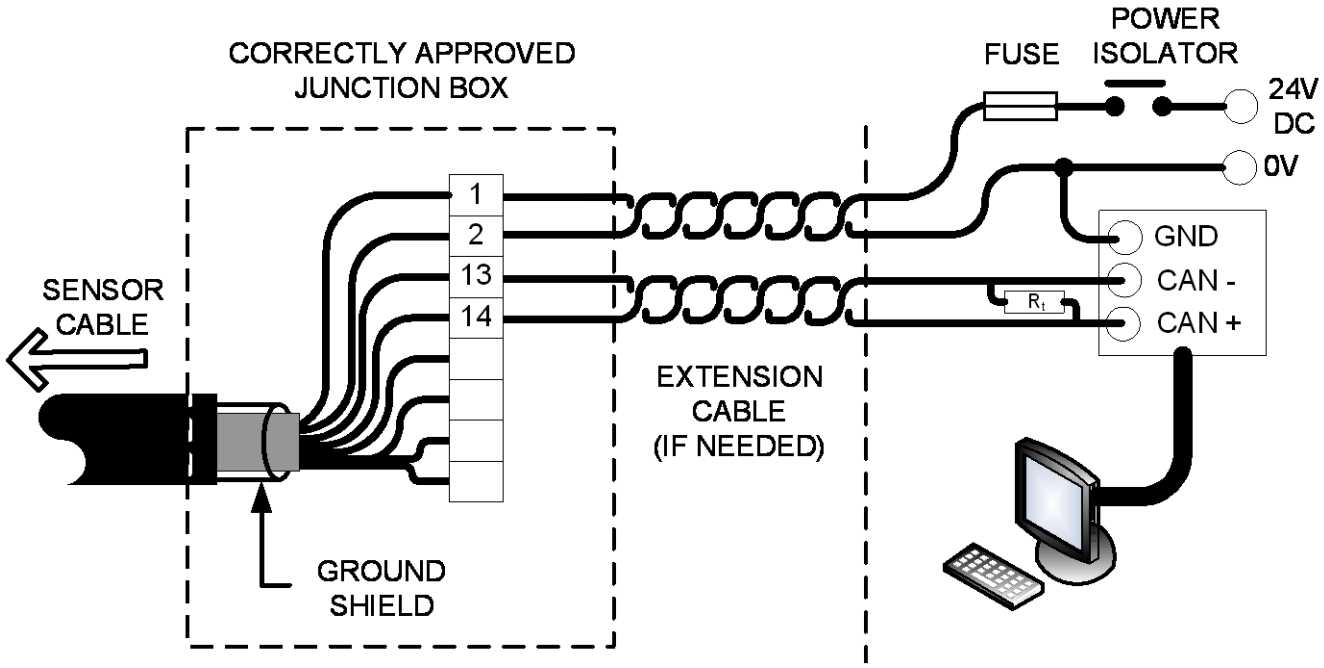
www.modbus.org

A detailed specification and Implementation guide should be found here:

http://www.modbus.org/docs/Modbus_over_serial_line_V1_02.pdf

8.5 CANopen

This wiring diagram shows the MWDS configured to communicate via CAN to a PC, display panel or data acquisition module.



The bus will require a 120Ω terminating resistor at each end of the bus. For sensors communicating directly (not multiple sensors on the bus) a 120Ω resistor is fitted at the terminal for HMI/PC – this is typically done via a jumper or DIP switch. The MWDS will require its on-board 120Ω resistor enabling. To do this, please refer to the protocol manual supplied. For multiple sensors on a bus, there needs to be a 120Ω resistor at either end – not 1 per MWDS.

The MWDS can use RS485 or CAN, but not both at the same time. This reduces the twisted pair count in the cable as only one interface is required.

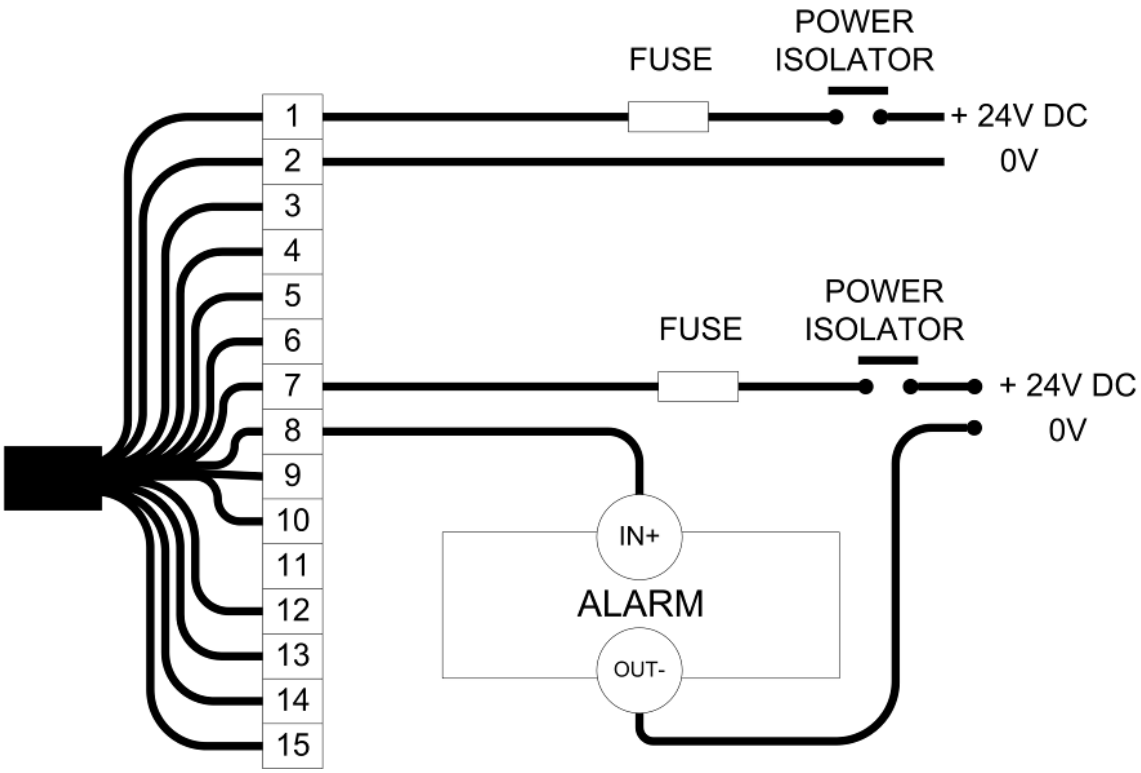
The sensor will need to be configured to use CAN using DebriSCAN (via the default TCP/IP communication) or by serial (RS485) communications. Refer to the software protocol manual.

8.6 Alarm Contacts

This wiring diagram shows the MWDS configured using a separate source for a simple alarm signalling unit. During normal operation the alarm is closed providing continuity between wires 7 and 8. If an alarm is raised the MWDS creates an open circuit between wires 7 and 8. This open circuit alarm status enables the wiring of several MWDS alarms together in series. The total

circuit will have continuity during normal operation but will have the continuity broken by any MWDS that enters an alarm state. The alarm circuit is opto-isolated and so can interface with systems on different power rails.

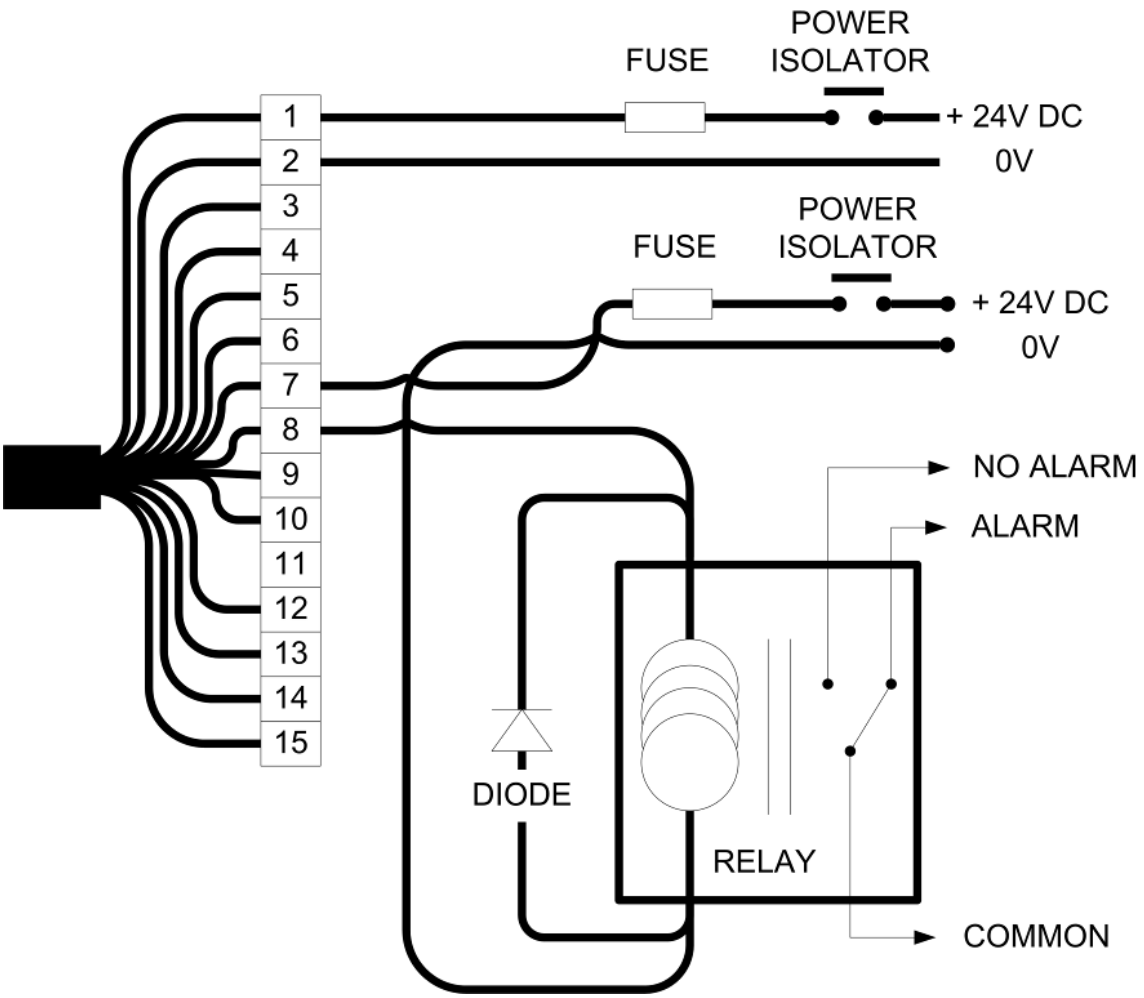
The current flow through the alarm must not exceed 100mA and the potential across the alarm circuit must not exceed 24V.



8.6.1 Alarm Relay

This wiring diagram shows the MWDS wired to drive a relay. This may be used where alarm load conditions would exceed the maximum permissible voltage or current. In the diagram, normal conditions would result in the relay coil driven via the alarm wires. The relay would be energized and the relay common terminal would be shorted to the 'no alarm' terminal. If an alarm is raised wires 7 and 8 become open circuit and the relay coil is no longer energized. In this case the common terminal of the relay would be shorted to the 'alarm' terminal.

The diode fitted across the relay coil terminals is to prevent back-emf voltage spikes during switching, which could exceed the alarm maximum voltage. Care must be taken when selecting a suitable relay that the coil voltage and current requirements do not exceed the alarm output specifications.



8.7 Communications

8.7.1 DebriSCAN

The MWDS is supplied with PC based software which can be used to record data from the MWDS and also configure the MWDS communication – choosing TCP/IP or RS485 or CANopen.

8.7.2 Communication Protocol

The MWDS is supplied with a manual which details the software protocol. The software manual also prescribes the hardware interface which must be connected in accordance with the specifications in this manual.

9. Installation Considerations

9.1 Pipework Design – RS-247 and RS-248

Refer to drawings RS-247 and RS-248 at the end of this manual – see 15

Fluid (Oil) in the MWDS needs to be representative of the whole system. Where possible, avoid 90° bends, bore diameters less than 13mm (1/2”) and long pipe runs.

9.1.1 Full Flow

Where possible, the entire fluid flow should be diverted through the MWDS [full flow]. Care must be taken to ensure the flow rate does not exceed the specified upper particle speed limit.

9.1.2 Bypass

Due to the limited bore size and flow rate for the MWDS, the MWDS is typically installed on a manifold allowing part of the fluid to flow through the MWDS. This is referred to as bypass mode.

Representative sample flow is very important: ensure that a known proportion of fluid flows through the MWDS, use a factor to calculate the particles present in the total flow – this could be achieved by measuring the volumetric flow rate of the fluid through the MWDS and main pipe. Consistency is key to interpreting results from the MWDS – if the flow through the MWDS is variable, a flow meter should be used to derive a concentration factor, for example; double the flow will double the detected particles, even if the particle evolution rate is consistently the same.

In many cases a gate valve is fitted to divert flow into the MWDS, in some cases a pump is used to draw fluid through the MWDS. The pump has the advantage of automatically sampling a known amount of fluid from a main line in a non-invasive manner.

9.2 Mounting the MWDS – RS-246 and RS-252

Please refer to Sheets 1 and 2 of drawing RS-246 at the end of this manual – see 15. Anti-vibration mounts are provided with the MWDS – use of these should be decided on prior to installation by evaluation of the mounting location. Ensure that the mechanical couplings to the fluid system do not allow excess vibration through to the MWDS and are properly supported, do not use the MWDS to support pipework or cable runs, this may damage the MWDS. If it is not practical to use the supplied mounts, alternative bolts sized to fit 11.8mm bore (M10) should be used.

Use flexible hose and anti-vibration mounts to minimise the effects of vibration. All external fasteners have provision for wire-locking. Cables and hoses should be properly supported. Do not use the MWDS to support hoses.

9.3 Communications

The choice of communication and power is dependent on installation. CANopen is suited to many applications due to its robust nature and wide compatibility with HMI and peripherals. How data is recorded is a consideration and how it is accessed.

9.3.1 Test Mode

To assist the development of user HMI/PLC/GUI or other interfaces, “test mode” can be used to test and also help identify errors.

During Test Mode, the MWDS readings are replaced by generated values. These start at the minimum possible value and ramp up to the maximum value over a 5-minute period and are then reset to zero. These cycles continue for 10 minutes. Test Mode then ceases. This allows the user HMI/PLC or other interface to be tested over the full range of possible values. Once started, Test Mode can be halted at any time.

 There is no LED indication that the unit is in Test Mode.

 Test Mode can be enabled via the Toggle Test Mode Command, this is detailed in the protocol manual.

9.4 Installation Best Practice

The MWDS is extremely sensitive and can detect ferrous particles as small as 40 microns, for optimum operation, observe the following:

- The MWDS is mounted before any fluid (oil) filtration
- The fluid (oil) sample is representative of the main fluid (oil) flow
- The installation does not divert fluid from work (starve lubrication)
- System pressure is within the MWDS pressure range
- Bypass flow rate is both constant and within MWDS flow limits
- Use flexible hose to minimise vibration
- Use supplied anti-vibration mounts to minimise vibration effects if required
- Hoses/Cable are clamped rigid at regular intervals
- Use valves on the bypass lines to allow easy removal of the MWDS

10. Installation of MWDS

This section is arranged in order of suggested installation task. Please read through the entire section prior to commencing work.

DO NOT CONNECT POWER TO MWDS NETWORK UNTIL DIRECTED.

10.1 Installation Procedure

10.1.1 Unpack the MWDS

Unpack all equipment and check delivery for all parts. Notify the manufacturer or reseller immediately of missing or damaged parts. Ensure that all additional (not supplied by MWDS manufacturer) equipment and accessories necessary for installation are present and appropriately rated before proceeding.

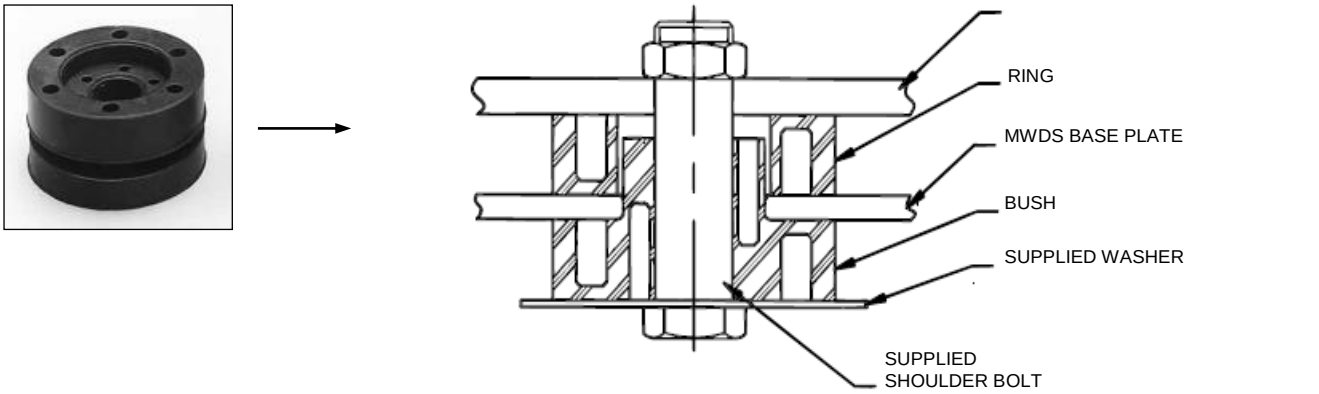
10.1.2 Set Communications

The default communication output for the MWDS is Modbus over TCP/IP for ease of connection to a PC and use of DebriSCAN to configure the sensor. This can be changed to RS485 or CANopen. Consult the software protocol manual for details.

10.1.3 Mount the MWDS using Anti-vibration Mounts

Follow the drawings at the end of this manual – see 15.

The supplied vibration mounts, shoulder bolts and large washer must be fitted correctly in order to provide the intended isolation - as shown below. Use suitable locking nuts and/or locking washers.



10.1.4 Make the Fluid Connections

Make connections in accordance with the Technical Specification, Application Information and Installation Considerations section 5, 7 and 8. Ensure all power is 'OFF'.

Use a 51mm A/F Wrench (spanner) across the flats of the MWDS fluid connection to minimise the turning forces on the MWDS when tightening the fluid connections. Excessive force (torque) may damage the MWDS beyond repair.

Ensure that all fluid connections are leak tight and there are no fine leaks that could produce a mist. Use a proprietary sealing compound such as Loctite 577, which is compatible with the system fluid (oil).

Isolation valves may be fitted at a planned maintenance interval – allowing fitment of the MWDS at a later date. Fluid may need draining from the system to ensure Pipework can be fitted.

10.1.5 Re-fill Fluid

Ensure the system is fully refilled per machinery manufactures instructions.

10.1.6 Make Electrical Connections

The cable should be clamped rigidly at regular intervals along it length. It is recommended that the first clamp is within 15cm (6") of the MWDS. The remaining clamps should be located at 15-30cm (6-12") intervals along its length.

Avoid routing the cable in close proximity to cables for motors, electrically noisy equipment and other sources of intense magnetic fields.

10.1.7 Install PC, HMI or Data Transmitter/Logging Device

Ensure the PC, HMI or data transmitter is securely mounted and that connections to and from the PC/transmitter are secure and will not easily pull out.

If a PC is to be used with the supplied PC software, install the software as dedicated instructions.

11. Commissioning and Use

 Before opening isolation valves, connecting power or attempting to use the MWDS, re-check the suitability of the following:

- Oil inlet and outlet connections
- Oil inlet and outlet hose runs
- Types and connections of cables
- Tightness of all oil and electrical connections.

11.1.1 Power On

Turn on the power supply. The status lights on the unit will illuminate after approximately 5 seconds to indicate power and function.

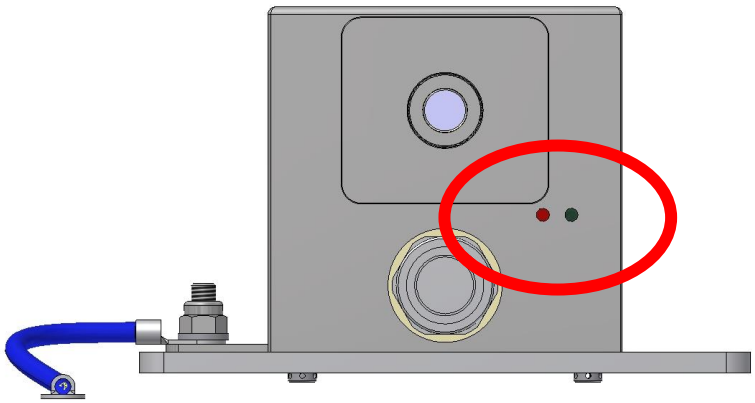
11.1.2 Check that MWDS Data is Being Received

If an HMI or computer is being used to display or monitor MWDS data make sure that all desired registers (particle counts, particles per minute etc.) are being received by this equipment.

 It is not possible to communicate with the MWDS during the first 20 seconds from power 'On'. Wait for the sensor to boot and retry.

11.2 Status Lights

The MWDS has 2 LEDs which can be used to verify operation. The status lights are configured as follows:



State of LED	Red LED 1 Hardware	Green LED 2 Communications
Off	No Power or software frozen.	No Power No reception
Steady On	Monitoring without Error	Reception without error
Flickering (<0.1 Hz)	Hardware issue (Not Monitoring – e.g. Balancing)	Data transmission; the MWDS will only transmit on receipt of a message
Flashing (0.5Hz)	Power Reset has occurred	Alarm Level Triggered

On boot up both LEDs will flash on and off in unison for approximately 10 seconds. The Green LED should then emit a steady light whilst the RED LED continues to flash reporting the power up/reset.

The flashing RED LED is useful to determine if the power has been off and indicates the need to check data recording. The flashing RED LED is then acknowledged in software and goes to a steady state. Refer to the software protocol manual.

11.2.1 Start Fluid Flowing Through the MWDS

Open the isolation valves (where fitted) and start the machine so that fluid can flow through the MWDS.

Adjust the oil flow rate (if necessary)

Using the techniques described in the 'installation information' and 'technical information' sections ensure the oil flow is within the limits specified.

The flow rate through the MWDS must be constant and within MWDS flow limits.

12. Data Recording and Result Interpretation

12.1 Data Logging and Zeroing

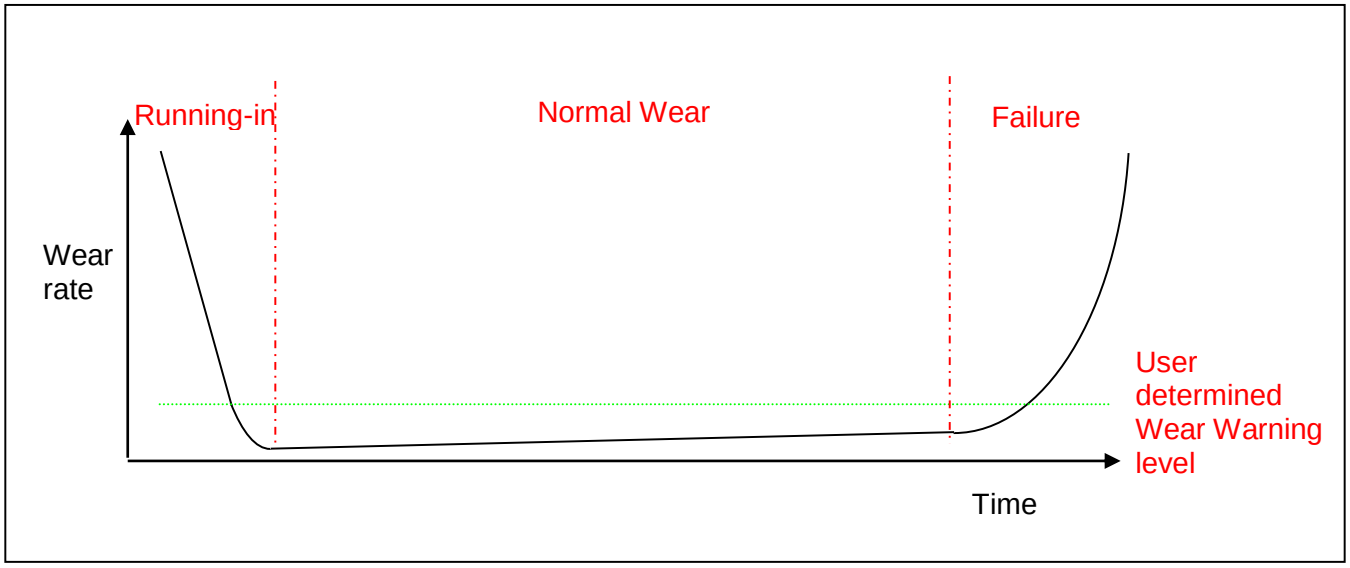
The MWDS will detect individual metallic particles and classify them by their size and metallurgical composition. The cumulative particle count is maintained by the MWDS when the MWDS is 'on'. It is not possible to 'pause' recording of data.

Therefore, after an overhaul or oil change on the machinery – and especially after failure, cumulative particle counters should be zeroed.

The MWDS has no internal clock and data is not time stamped – this should be performed by the interface equipment; data logger; HMI, PLC or PC. Particle per minute data is live and is not recorded.

12.2 Interpreting Results

The clearest indication of the onset of failure is a rapid rise in the wear rate. Although no two pieces of equipment are the same, generally, most metallic components in a system will have high wear when initially installed (due to bedding in processes), low wear in normal operation (when there is adequate lubrication), and high wear again as the component eventually fails. This is often called a classic bathtub curve. With this knowledge specific warning limits for each piece of equipment can set. If a rapid increase in wear is spotted early enough, proactive and preventative maintenance can be conducted before critical breakdown.



12.3 Setting the Record Interval

Longer intervals between reading the MWDS data will only affect the resolution of any charts or review of data. Short intervals will result in large file sizes and could lead to expensive data transfer costs if the data is transmitted remotely

12.4 Monitoring Strategy

When data is being accumulated, it becomes important to be able to monitor the most important aspects to determine whether a more detailed examination of the accumulated data is necessary. How the strategy is determined depends on the application.

It should be noted that the counts of particles are not a good indicator in themselves and the lubrication system layout should be referred to. For instance, on an unfiltered system the same particles will be counted over and over again. The count numbers constantly increase and thus a change may not be immediately noticeable (e.g. after months of running with counts above 20,000 an increase in the number of particles of 200 may not be obvious).

One suggested strategy is to monitor both the particles per minute (PPM) for each bin and the total particle mass per hour (MPH) over all bins. The PPM values give an indication of the quantity of particles whilst the MPH values give an overall indication of the particle mass. A significant change in either would then lead to an investigation of the accumulated data to determine what is occurring. A large increase in small particles may not cause as large a rise in MPH as a small increase of large particles. Linked to this strategy is the ability to set the Alarm conditions to trigger at predetermined levels of PPM and/or MPH. A triggered Alarm will set the Alarm line and the Alarm bits in the Status Word. Hence only the Status Word needs monitoring.

Alternate strategies are to vary the polling speed or the choice of data polled in response to detected changes (e.g. Alarm bit set in Status Word).

In addition to implementing one of these strategies, it is recommended that the user regularly reviews the MWDS data. The MWDS is intended as a trending tool and observing the changes in the system over longer periods (e.g. per day) can allow for early detection of a developing issue – even before Alarm levels of PPM or MPH have been reached.

12.5 Review Wear Rates

It is advisable to review the wear limits regularly and to keep historical data for reference and trending.

12.6 Self-Diagnostics

The MWDS is equipped with internal self-diagnostics for monitoring correct operation and continued performance. The diagnostics also provides the ability for the MWDS to report issues to the user.

12.7 Fault Finding

Refer to the fault finding and troubleshooting section at the back of this manual.

13. Cleaning, Maintenance and Calibration

Please retain all original packaging for shipping purposes. All fluids must be removed from the equipment and the MWDS cleaned appropriately before return. The manufacturer will not be liable for damage to returned goods resulting from inadequate packaging.

13.1 Cleaning

The outer case does not require cleaning during normal use. If required, the case can be cleaned with a soft, clean water-damp cloth or tissue.


Do not use aggressive chemicals which are not compatible with the materials detailed in the specification section to clear or flush a blockage in the MWDS bore. Do not use wire brushes or scrapers to clear a blockage as this may scratch and damage the bore.

13.2 Calibration and Service

The MWDS uses proven magnetometry; combined with internal micro-processing to indicate metallic particle contamination. Due to the lack of moving parts and sophisticated production methods, the factory calibrated MWDS posses' high reliability with long term stability.


For continued performance, it is recommended that the MWDS system is serviced, checked and calibrated regularly by authorised installation and service personnel. The recommended re-calibration period is two years.


The manufacturer can provide check standards allowing the user to verify performance.

14. Troubleshooting and Fault Finding

14.1 Troubleshooting

Symptom	Possible Causes	Solution
MWDS is not powered (both LEDs are unlit).	Wiring/MWDS Failure	Check wiring
		Check fuse
Communications not responding, both LEDs flashing in unison	MWDS is still initialising	Wait 30 seconds until both LEDs stop flashing in unison. Check connections
	MWDS communications set up incorrectly	Check using Engineering Mode on RS485 (refer to Software Manual)
No communication after both LEDs stopped flashing in unison	Wire Connections	Check wiring
	MWDS communications set up incorrectly	Check using Engineering Mode on RS485 (refer to Software Manual)
Red Light Flashes at approximately 1 second intervals.	The unit has been reset. Stops flashing when Status Word is cleared	Clear the status word. Determine the reason for the reset (i.e. was the system powered off, was a reboot requested). If the problem persists (i.e. the unit has been found to reset for no obvious reason) then contact the supplier.
Green Light Flashes at approximately 1 second intervals.	Parts per Minute or Mass per Hour Alarm Activated. Stops flashing when condition clears.	Acknowledge alarm by clearing status word. Determine the reason for the Alarm.
Red Light flickers	Unit is balancing. This should not occur very often and normally lasts less than a second.	If the problem persists (i.e. the flickering is constant or is noticeable) then contact the supplier.
No particles detected.	MWDS not filling with oil	Check the speed of the oil through the MWDS is within specification
	MWDS or pipe blocked	Sludge build-up or pipe bend too tight. Un-block. If reoccurs, re-position the MWDS.
	Very low wear (No particles to detect)	Confirm presence of debris in the oil (e.g. Laboratory test a sample)
	Flow rate not in specification	Check the speed of the oil through the MWDS is within specification
	MWDS firmware fault	Re-Boot MWDS - turn power to MWDS off and on again

Wear rates increasing at greater rate than normal but the oil has been tested as OK	Recent Environmental changes	Check that no new cables have been installed in the near vicinity of the MWDS cable
		Check levels of vibration
MWDS not filling with oil	Oil inlet valve closed	Open inlet valve
	MWDS or inlet pipe blocked	Sludge build-up or pipe bend too tight. Un-block. If reoccurs, re-position the MWDS.
MWDS or pipe blocked	Pipe bend too tight	Refer to installation manual and re-run pipe if necessary.
	Sludge build up	Consider sampling from higher in a sump.
	Incorrect position in the system to 'catch' particles: Poor sample point	Re-position MWDS

14.2 Checking the Readings – MWDS Confidence Test

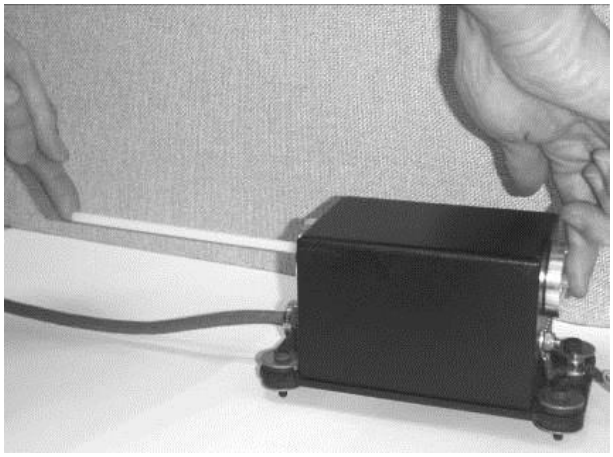
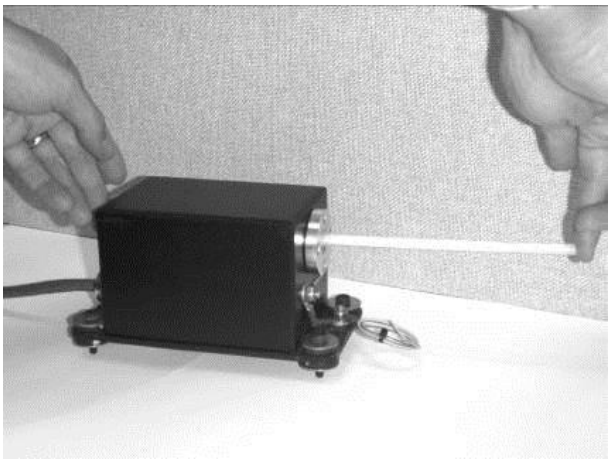
The manufacturer or reseller offers a range of check standards consisting different particle sizes allowing the user to verify performance. This method is recommended for field use. However, for expedience, a confidence check can be made by dropping small metallic debris into the MWDS. In the example below a small paperclip is chosen. Do not use a paperclip which is too large for the sensor bore.

Connect communications to the MWDS and Zero Bins.

Stand the MWDS on a flat surface so that the metallic object can be dropped down the centre of the MWDS bore. The object should fall right through the MWDS and clear the bottom of the sensor. The particle count can be inspected to verify operation.

14.2.1 Checking Particle Detection Calibration

The calibrated particle standards – available from the manufacturer – should be used for checking the calibration of the sensor. The particle is mid-way along the rod, each rod contains 1 particle. Move the rod to-and-fro so that the debris sensor detects the particle. The size of the particle within the rod should also cause the same size particle bin range to count.

Start	Finish
Insert the rod completely into the sensor so that one end is flush with the side of the sensor. Note the particle in the middle of the rod is approx ½" outside of the sensor. This is the 'start' position.	In one clean movement taking about 0.5 sec, slide the rod through the sensor – do not remove the rod; it needs to finish flush with the side of the sensor.
	

14.2.2 Communication Testing

The sensor is equipped with a self-test feature to assist in testing/debug of communications. When in test mode, each bin will increment every second. Details of how to perform the communication test is in the protocol manual.

15. Drawings

This section contains the following:

RS-246 – Sheets 1 and 2.

General Arrangement and installation detail, including dimensions for the MWDS.

RS-247 Pipework detail; how to prepare MWDS Pipework

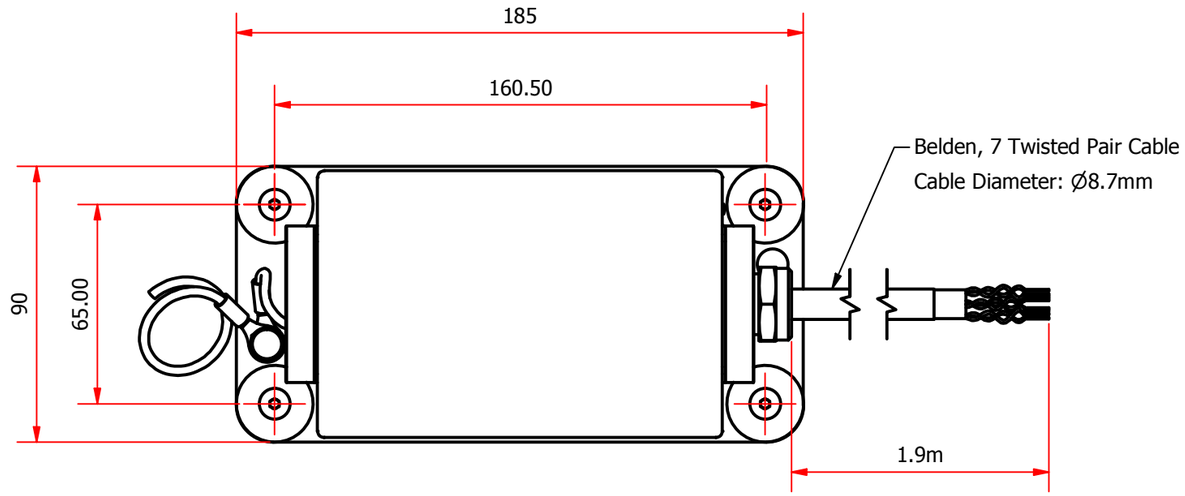
The diagrams show how to get fluid flow to and from the MWDS at the correct rates.

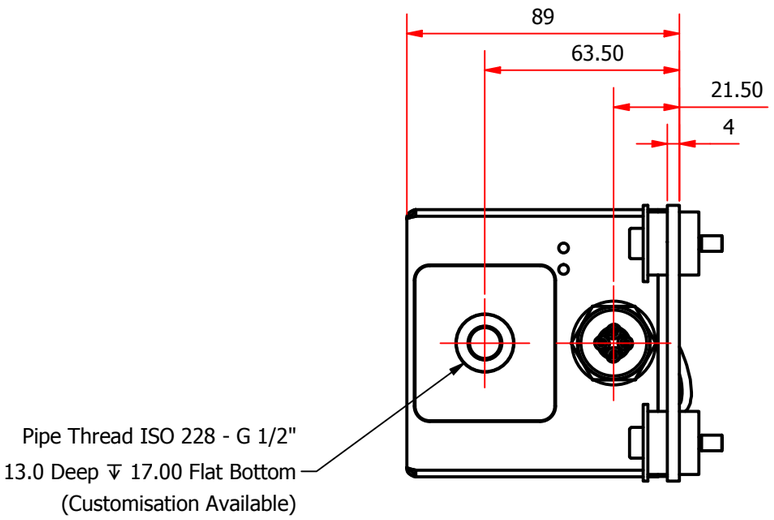
RS-248 Sandwich plate installation

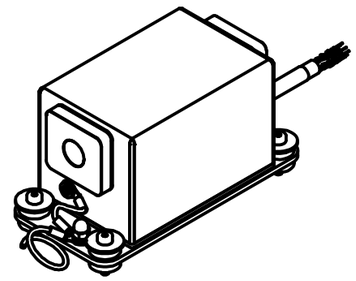
A possible solution for machinery where there no exposed pipework, but a canister type filter which will facilitate fitment.

RS-252 Installation guidelines

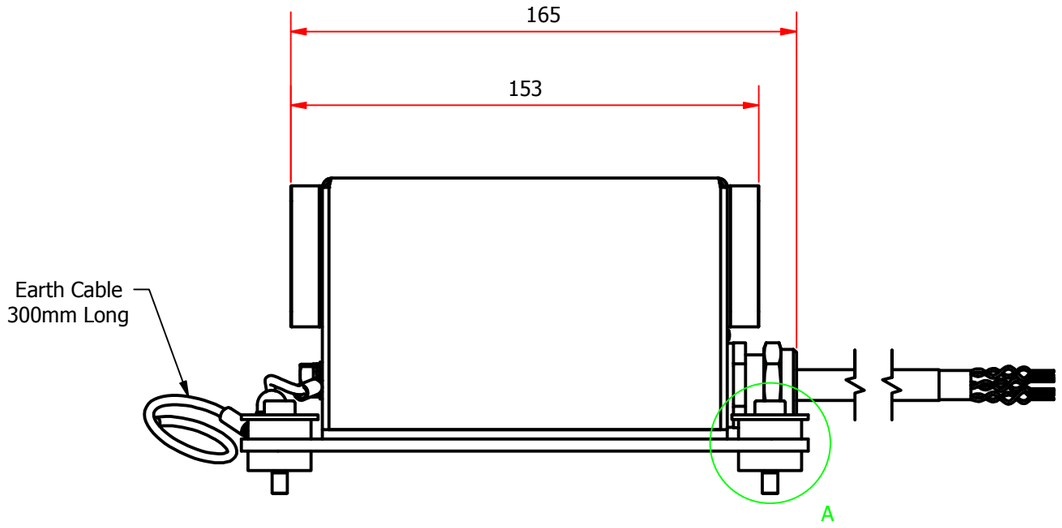
Mounting detail including orientation, pipe work design and clamping.

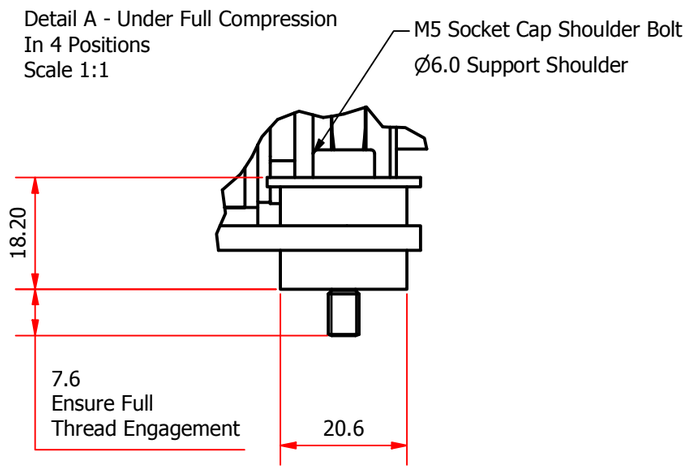


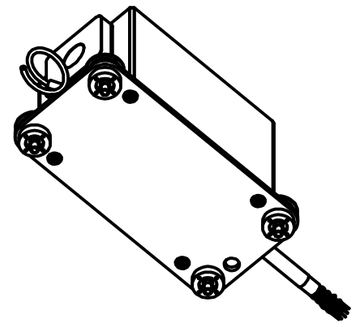




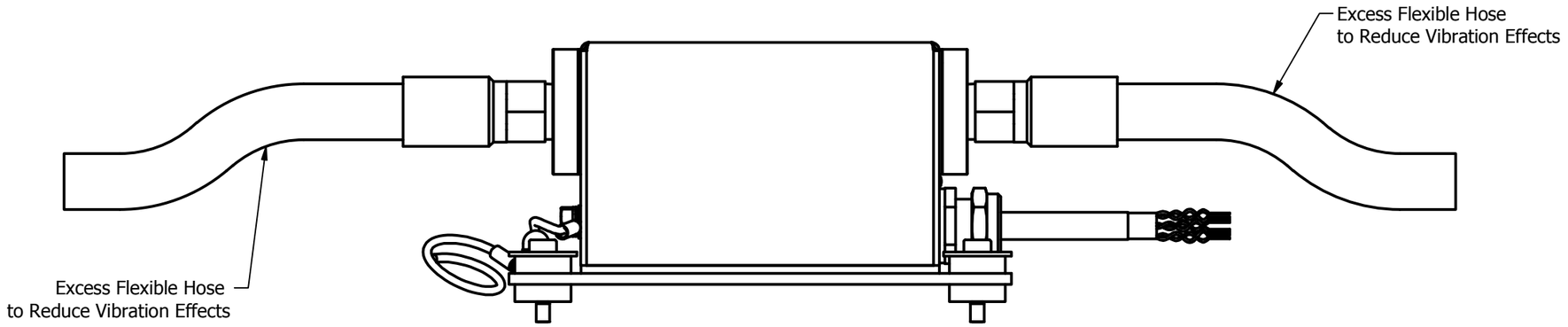
Isometric Views
Scale 1:4

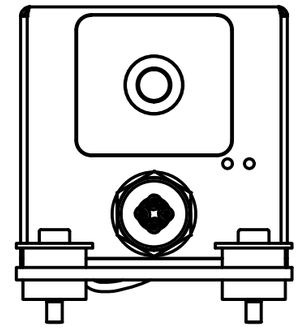


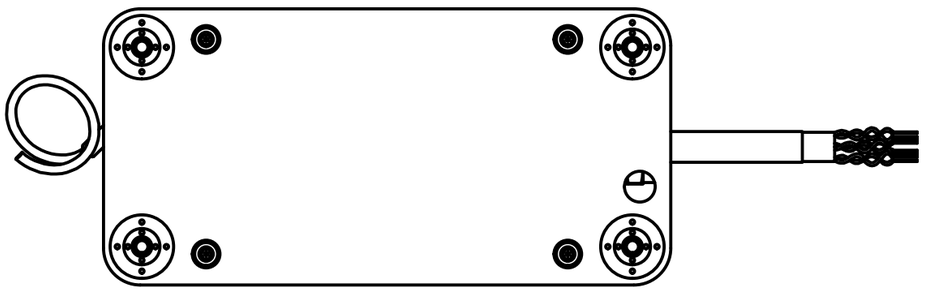


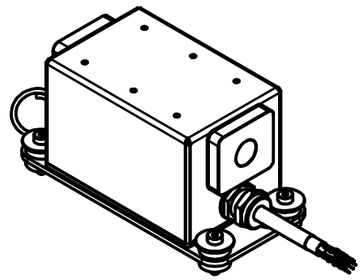


UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN mm. TOLERANCES ARE: DECIMALS x ± 0.5, x.x ± 0.2, x.xx ± 0.1; ANGLES ± 1 DEG. DO NOT SCALE DRAWING	PART NUMBER: FG-K19567	USED ON: -	SURFACE FINISH √ N/A U.O.S
	DRN. OGI: 26/02/2013	TITLE: MWDS MkII GA	
	CHK. :		
	APP. :	THIRD ANGLE	DWG NUMBER: RS-246 Rev: 1
	STATUS: RELEASE		SCALE: 1:2 Size: A3 SHEET 1 OF 2







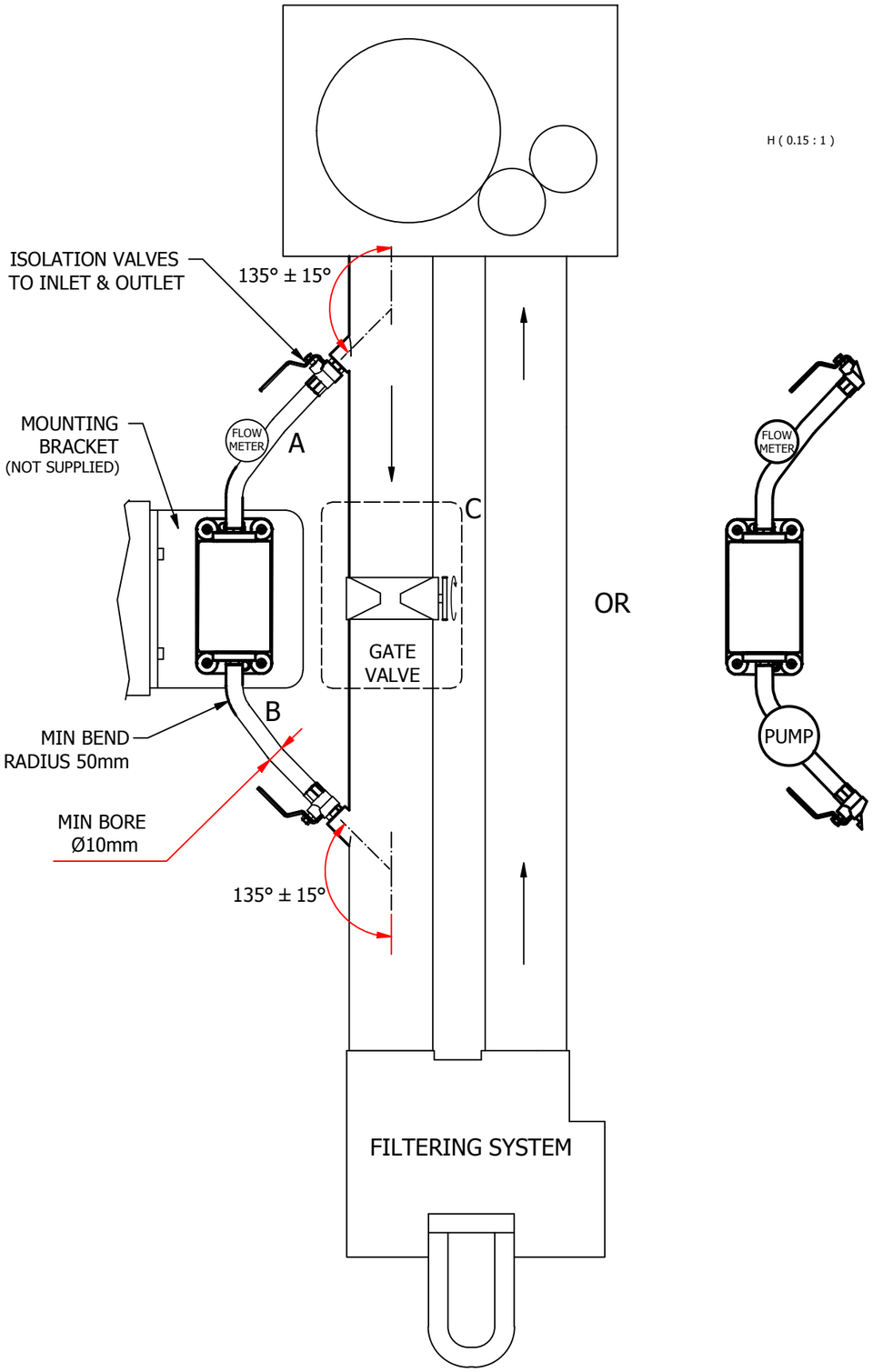


Isometric View
Scale 1:4

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN mm.	PART NUMBER: FG-K19567	USED ON: -	SURFACE FINISH √N/A U.O.S
TOLERANCES ARE: DECIMALS: x ± 0.5, x.x ± 0.2, x.xx ± 0.1; ANGLES: ± 1 DEG	DRN. OGI: 26/02/2013	TITLE: MWDS MkII GA	
	CHK. :		
	APP. :	THIRD ANGLE	DWG NUMBER: RS-246 Rev: 1
DO NOT SCALE DRAWING	STATUS: RELEASE		SCALE: 1:2 Size: A3 SHEET 2 OF 2

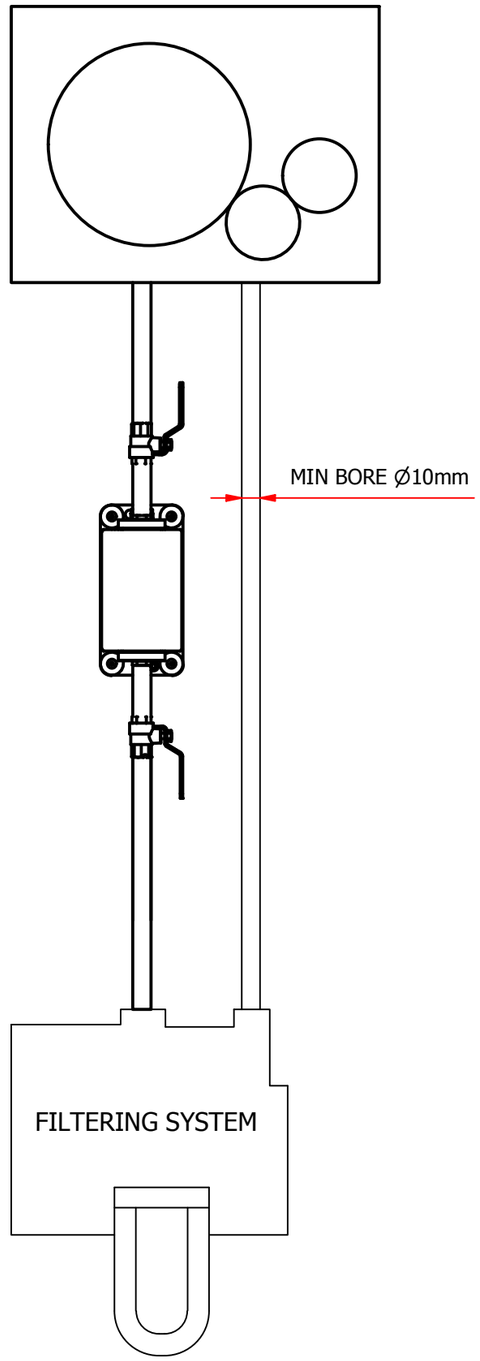
BYPASS LOOP OPTION

USED WHEN FLOW RATE IS TOO HIGH FOR SENSOR



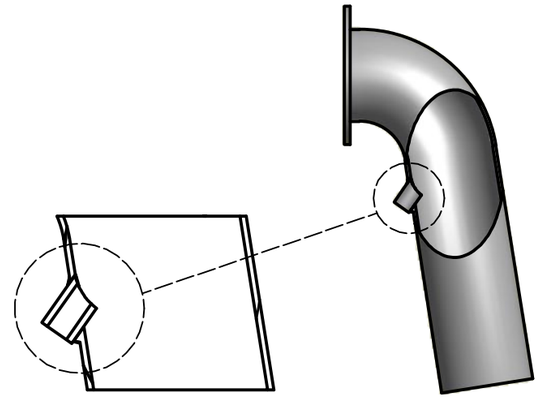
FULL FLOW LOOP OPTION

USED WHEN FLOW RATE IS SUITABLE FOR SENSOR



PIPE WORK DESIGN

1. AVOID 90° FITTINGS.
2. LENGTH OF PIPES 'A' AND 'B' TO BE MAX 1m. IDEAL LENGTH <0.5m.
3. WHEN USING 'BYPASS LOOP OPTION' WITH CONSTANT FLOW, USE METHOD 'C' AND A GATE VALVE TO ENSURE A SUITABLE FLOW RATE THROUGH THE SENSOR.
4. INLET POSITIONING. NOTE FITTING MUST BE POSITIONED AND SHAPED TO ENCOURAGE OIL FLOW INTO SENSOR PIPE.



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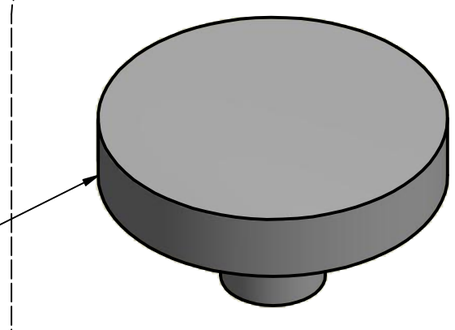
	CHK. :		
	APP. :	THIRD ANGLE	DWG NUMBER: RS-247 Rev: 1
DO NOT SCALE DRAWING	STATUS: RELEASED		SCALE: NTS Size: A3 SHEET 1 OF 1

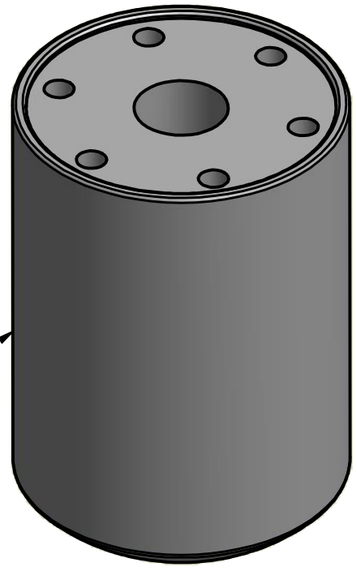
OPTION WHEN THERE IS NO EXPOSED PIPEWORK



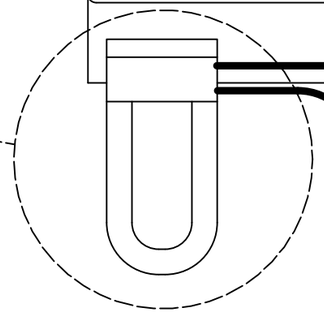
EXISTING FILTER MOUNT

CUSTOM SANDWICH PLATE
(CONTACT PARKER KITTIWAKE FOR DETAILS)

CUSTOM SANDWICH PLATE BOLT
(CONTACT PARKER KITTIWAKE FOR DETAILS)

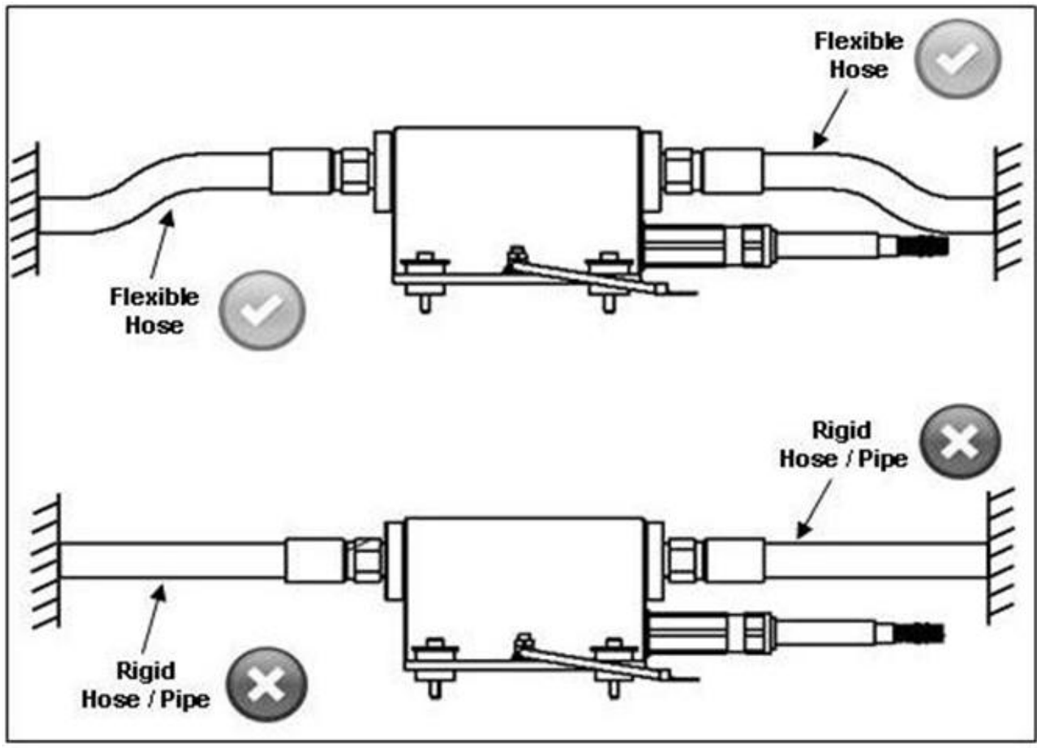


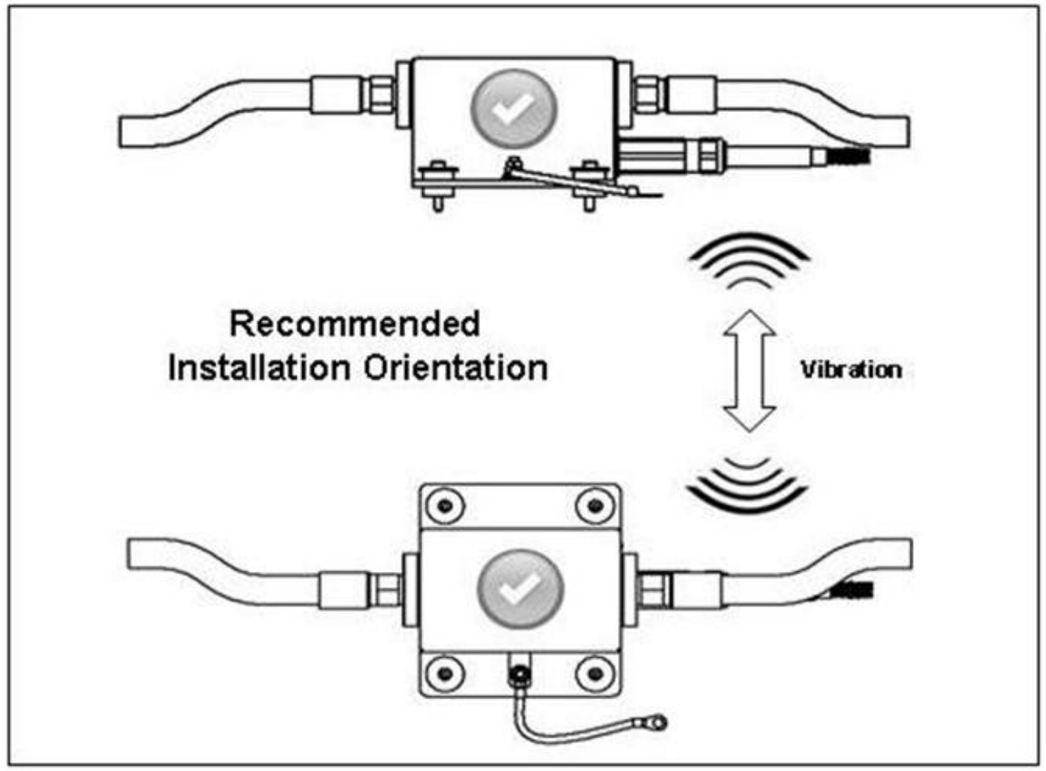
EXISTING OIL FILTER

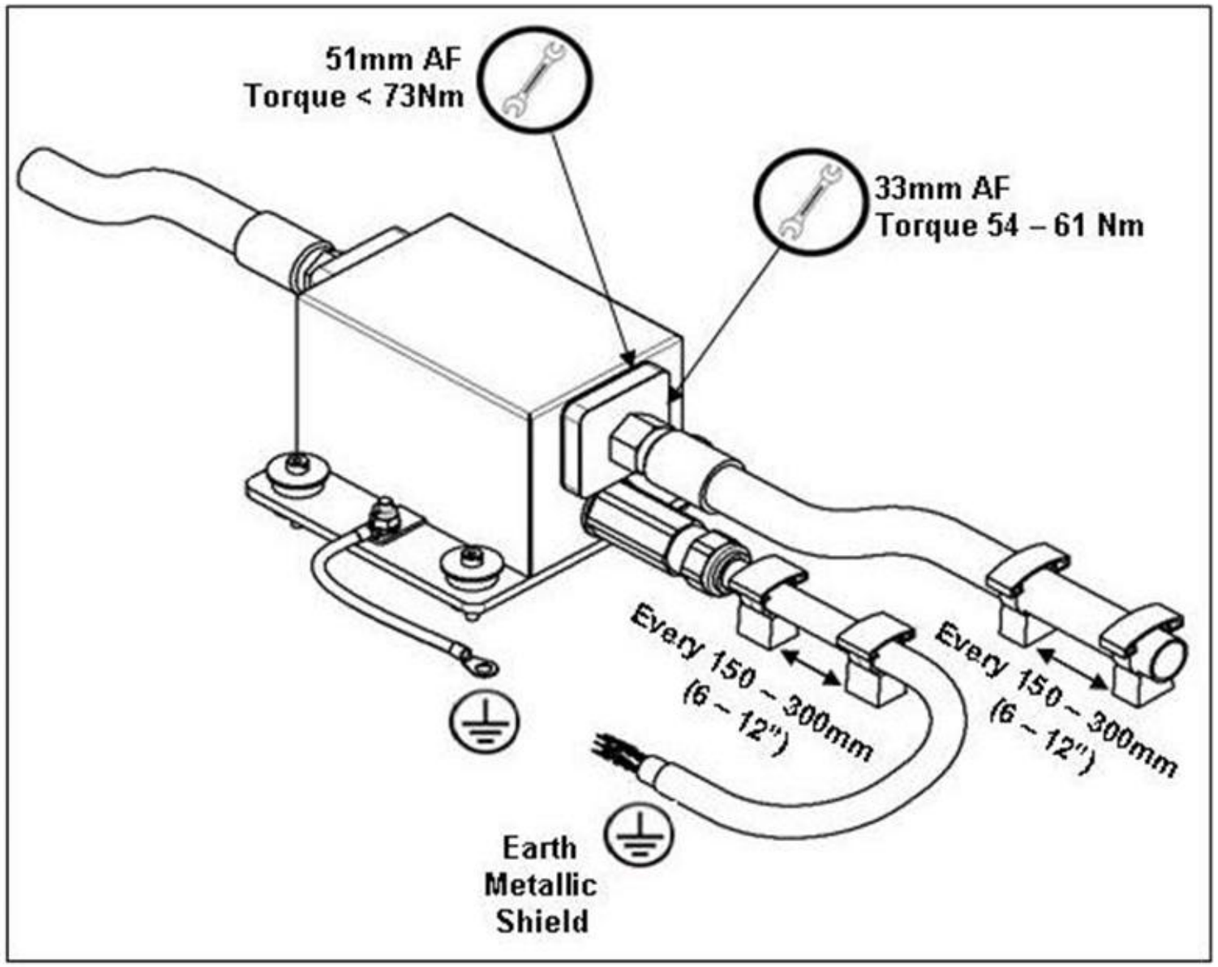


DO NOT RESTRICT FLOW RATE. MATCH PIPE BORE AND LENGTH TO SUIT FLOW RATE OF FILTER. A BYPASS MAY BE NEEDED TO MEET DIFFERING FLOW REQUIREMENTS OF FILTER AND SENSOR. ENSURE PIPE LOOP LENGTH <2m

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN mm. TOLERANCES ARE: DECIMALS: x ± 0.5; x.x ± 0.2; x.xx ± 0.1 — ANGLES: ± 1 DEG. DO NOT SCALE DRAWING	PART NUMBER:	USED ON:	SURFACE FINISH √N/A U.O.S
	DRN. OGI: 24/04/2013	TITLE: SENSOR INSTALLATION - NO EXPOSED PIPEWORK	
	CHK. :		
	APP. AJB:	THIRD ANGLE	DWG NUMBER: RS-248 Rev: 1
	STATUS: RELEASED		SCALE: NTS Size: A3 SHEET 1 OF 1







UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN mm. TOLERANCES ARE: DECIMALS x ± 0.5, x.x ± 0.2, x.xx ± 0.1; ANGLES ± 1 DEG. DO NOT SCALE DRAWING	PART NUMBER: -	USED ON: -	SURFACE FINISH √N/A U.O.S
	DRN. oliveri: 12/11/2013	TITLE: MWDS MkII - INSTALLATION GUIDELINES	
	CHK. :		
	APP. :	THIRD ANGLE	DWG NUMBER: RS-252 ISSUE 1
	STATUS: RELEASED		SCALE: NTS Size: A3 SHEET 1 OF 1

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