Metallic Wear Debris Sensor (MWDS)

On-Line Metallic Wear Debris Sensor

Communication Protocol Manual

Key to Symbols

 = Caution

 = Note – Helpful Hints and Tips

About This Manual

This manual is divided as follows:

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 Do not discard this manual.

This Communication Protocol Manual comprises a functional part of the Parker Kittiwake Metallic Wear Debris Sensor product (MWDS). This manual must be kept safe for future reference.

The Installation and Operation instruction manual is a separate manual supplied with the product.

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1 Contents

2 Introduction

2.1 Scope of this manual

This manual covers the communication protocols and is supplementary to the Metallic Wear Debris Sensor 'Installation and Operation' Manuals MA-K19523-KW and MA-K19523-EX.

The MWDS is available with Hazardous area (ATEX and IECEx) certification. This protocol manual covers both versions, however the Hazardous area version is digital communications only – it does not have analogue outputs; Alarm line and two 4-20mA loops.

2.2 Abbreviations

Fe	Ferrous
NFe	Non-Ferrous
MPH	Mass per hour
PPM	Particles per Minute
MWDS	Metallic Wear Debris Sensor
U16	Unsigned 16 bit integer
U32	Unsigned 32 bit integer stored in Intel Format with the Least Significant 16 bits first

3 Technical Information

All units are metric unless otherwise stated; millimetres or metres, Bar, °C.

3.1 Particle Size Classification Reporting

The MWDS automatically classes particles into size categories or classes. These are termed ‘Bins’. These bins can be viewed and allow access to high resolution histogram analysis of detected particles. The following table describes these 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

Each Bin size range has the following 3 values available:

- Cumulative count
- Particles per minute
- Mass per Hour (µg)

Therefore, there are a total of 60 bins; 30 per metal type – of which 10 are cumulative totals, 10 are PPM and 10 are MPH.

3.2 Event Seconds per Minute

The Event Seconds per Minute indicate signals that could not be resolved into individual particles but are of sufficient strength and duration to indicate the detection of particulate matter.

If two or more particles are ‘overlapping’, their combined signals will create a distorted signature with magnified and diminished features. Such a signature cannot be properly analysed but are recorded as occurring provided they are of sufficient strength and duration. The Event Seconds per Minute value indicates to the nearest second the duration of such events in the last minute. It is updated every second.

If the Particles per Minute (PPM) totals and Event Seconds per Minute totals are plotted, they can indicate a ‘swarm’ of particles if the Particles per Minute bracket the Event Seconds per minute. The precursors of the swarm are detected individually (PPM), then the density causes the Event Seconds to report combined signals until the swarm passes with PPM reporting the stragglers. The commonest scenario for this to occur is during testing where excessive quantities of particles are introduced into a test rig all at once.

Event Seconds per Minute report unresolvable signals and may also indicate sudden vibrations or temperature changes. They should be of concern if they are associated with individual particle counts or are of sufficient duration. Note that the rounding means a reading of 1 represents up to 1.5 second, 2 of 1.5 to 2.5 seconds and so on.

Note: this value is only available via Modbus and for firmware version 1.14 onwards.

3.3 Interfaces

The MWDS supports the following:

- Status lights (LEDs)
- Engineering Mode over RS485 – a limited facility during sensor start-up
- Modbus RTU over RS485 – offering full functionality
- Modbus over TCP/IP – offering full functionality
- CANopen – Reduced Functionality, please contact Parker Kittiwake for further details
- 4-20mA outputs offering indications of Particles per Minute and Mass per Hour
- Alarm Line

3.4 Modbus

The Modbus protocol is transmitted via RS485 or TCP/IP. The Modbus Register map is common to both Modbus RTU using RS-485 and Modbus TCP/IP. This can be accessed simply through the supplied DebriSCAN PC based program or via a user supplied interface.

3.5 CAN

The sensor is equipped with CANopen, but has reduced functionality compared to Modbus, however CAN may be used for evaluation purposes. Alternative protocols - such as J1939 - can be implemented by special order only, please contact Parker Kittiwake for details.

3.6 Serial RS-485: Engineering Mode

Engineering Mode offers a set of basic operations to assist in setting up and maintaining the sensor. In the event that the operator believes they have set the sensor communications to a non-working configuration, engineering mode allows recovery. A detailed description of the mode is provided in the Appendix.

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

3.7 Analogue Outputs

The 4-20mA and Alarm lines are only available on non-ATEX products (though the Alarm is reported via the Green LED and bits in the Status Word).

Only the Analogue interfaces operate concurrently with any one digital interface at a time; TCP/IP or RS485 or CAN.

3.8 Status Lamps (LED's)

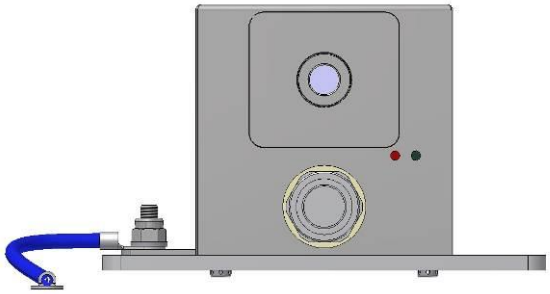
The Status Lamps are useful during commissioning, setup and equipment inspections.

During Start up, both LEDs flash in unison, indicating Engineering mode is available.

Following Start up, both LEDs will be on, with the Green LED flickering whenever data is transmitted or received.

A continuously flickering Red LED indicates a failure or issue.

Following Start up, either of the LEDs flashing indicates the occurrence of a condition (see table).



State of LED	Red LED 1: Hardware	Green LED 2: Communications
Off	No Power, unit halted or failed LED	No Power, unit halted or failed LED
Steady On	Monitoring without Error	Reception without error
Flickering	Not Monitoring (e.g. Balancing)	Data transmission/reception
Flashing	Power Reset has occurred	Alarm Level Triggered

It should be noted that the operator should clear the Status Word Reset Bit in order to acknowledge the Reset condition. The Red LED should then remain on and cease flashing. From that point, if the Reset bit is set and the Red LED is flashing than a power cycle/sensor reset will have occurred.

3.9 Important Initialisation Information

The unit is delivered with the default of Ethernet Communications selected. If the unit is to be connected via RS485 or CAN, the communications method will need to be changed before the MWDS can be connected to a data polling system (connecting over RS485 or CAN before changing the default could accidentally invoke Engineering mode). The user should first use Engineering Mode over RS485 or DebriSCAN over Ethernet to select the required mode. Note that Engineering mode only sets the mode for the following session and the mode will require being reselected within that session to become the new default.

3.10 Selecting Communications Protocol

During sensor start up, Engineering Mode over RS485 is available. This allows a different communications mode to be selected for the following session only. This allows a mode to be tested with the knowledge that on rebooting the sensor will revert to the previous mode. Within that session the communications mode can be confirmed/changed to be used in subsequent sessions.

It should be noted that CAN does not offer the facility to change communications mode. CAN can be selected from either of the Modbus modes and the MWDS then rebooted. To change back from CAN, the MWDS will need rebooting, and a Modbus method selected using Engineering mode. The new selection will require being confirmed from that mode. If CAN is selected from Engineering mode, it will only be active during the following session and the sensor will revert to the previous mode following a reboot.

 On delivery, the MWDS defaults to Modbus over TCP/IP. The MWDS only supports one protocol at a time and does not allow hot-swapping. After start up, the communications method cannot be changed without rebooting the sensor.

3.11 Factory Default Configuration

The Factory Default Configuration is shown in the following table.

IP Address	169.254.1.32
Modbus Node Id	32
Modbus Baud Rate	19200
CAN Node Id	1
MPH Alarm Level	0 (Off)
MPH Value equivalent to 20mA	1000000
PPM Alarm Level	0 (Off)
PPM Value equivalent to 20mA	2000
Communications Mode	Modbus TCP/IP
Status Word	Reset Condition plus any other condition(s) detected
Termination	Disabled (note: will not be restored if Factory Default Condition is requested).

3.12 Interfaces and Data Polling

3.12.1 Sensor Start-up

On power up both the LEDs will flash in unison for approximately 10 seconds indicating that the Engineering Communication Interface is active. During this period, the operator may carry out recovery actions such as restoring the unit to its factory defaults.

If present, the 4-20mA output and the Alarm output are exercised during this period to enable the circuits to be tested. Note: that in the event of a power cycle the outputs will temporarily be at each limit and may therefore signal alarm conditions to any monitoring equipment.

Alarm	4-20mA PPM	4-20mA MPH
ON (Open Circuit)	20mA	20mA

3.13 Data Polling

3.13.1 Minimum Polling Frequency

The MWDS operates as a Slave Device and will not instigate communications. Due to the limit of information that can be transmitted per message, multiple message requests are required to obtain a full set of information.

Communications will not interfere with the sensors functionality of particle detection. It should be noted that the response to a request may be delayed whilst sensor functionality takes place. There should be a minimum of 2 milliseconds between the reception of the last byte of a received message and the transmission of the next message request by the Master.

 Polling for a full set of information should be a minimum of 1 second. (Do not poll <1 second speeds. Note that this time should be increased for slower baud rates on RS485).

3.13.2 Register Update Timings

The unit updates at the following parameters at the timings below:-

Particle counts and count totals	As particles detected
PPM counts and totals	10 Seconds
MPH values and totals	5 Minutes
Status	As changes are detected.

The PPM data will read zero after approximately 1 minute and MPH 1 hour - unless another particle is detected in the meantime.

 When requesting data, it should be noted that the data can be updated during a polling sequence. When a block of Modbus Registers is requested, they are first copied to an intermediate buffer and it is ensured that the block is internally consistent. (This method cannot be employed with CAN as CAN operates on individual fields.) However no check is made to ensure they are consistent with a following block in the series.

Example:

- A request is made for the Particle Counts for 10 Fe Bins
- The data is transmitted, during which an Fe particle is detected
- A request is made for the total number of Fe Particles

- The data is transmitted and will include the new Fe Particle in the total count. This will not match the total of the values transmitted earlier.

As the count of particles per minute is updated every 10 seconds and the mass per hour values every 5 minutes, the chance of these being out of synchronisation is low but not impossible.

Example:

- A request is made for the Particle Counts for 10 Fe Bins – no particles have been detected
- The data is transmitted, during which an Fe particle is detected
- The Particles per minute counts are updated
- A request is made for the Particles per minute Counts for 10 Fe Bins
- The data is transmitted and will include the new Fe Particle. The particle counts will be zero whilst the number of particles per minute for 1 bin will be 1

There are various combinations of circumstances that can result in data being out of synchronisation for short periods. Though the probability is low, eventually one of the situations will occur.

3.13.3 Effective Polling Strategies

There may be a wish to minimise the amount of traffic to any one slave device, and thus strategies to retrieve the minimum amount of data each time may be required.

Lean Data retrieval

Many data recording devices have the ability to manipulate and post process the data. Therefore the additional calculated values – such as particles per minute, can be derived from the count totals. It is possible to retrieve only the totals and calculate ‘particles per minute’ and set alarm levels. Mass per hour is calculated by the sensor based on actual particle sizes rather than nominal values of the particle bins. It would be possible to approximate the mass per hour based on count and nominal bin values; whilst still providing useful trending, this calculated value would differ slightly from the more precise values calculated by the sensor.

Data retrieval based on status word

The Status word can be examined to see if the “Particle Count change”, bit is set.

Once this status word has been read, the status word has to be cleared. If, at the next polling interval, the status word has not been set, the sensor has not detected any particles and the full set of data does not require being read; it has not changed.

Note that the PPH and MPH will continue to update until they read zero. Should the PPM or MPH be a logged parameter, the sensor should be polled until the both PPM and MPH reach zero. The polling of data would then revert to changes to Particle count change. The PPM data will read zero after approximately 1 minute and MPH 1 hour - unless another particle is detected in the meantime.

Synchronisation and heartbeat

The PPM and MPH bits update at their respective refresh intervals, this can allow the user to achieve synchronisation with the sensor functionality if the user polls at longer intervals. The PPM interval can be used as a heartbeat signal.

In the event that the user polls for data infrequently (e.g. hourly or daily), polling the Status Word and clearing activity bits becomes a useful 'Idle' activity to confirm that the unit is functioning correctly.

Status is used to indicate a number of conditions that occur as and when. It is up to the user to determine how often this should be polled. Conditions requiring to be cleared by the operator can be ignored unless the operator wants to utilise the functionality.

Data retrieval based on count totals

Poll the totals at intervals and compare them with the previous values. If a total has changed, then the associated data (i.e. counts, PPM and/or MPH) can be polled. The totals can then be polled again to see whether they have changed.

However it is not anticipated that users will require to poll the data at less than 10 second intervals and thus the recommended simple Modbus strategy is to poll as follows:

- Read the totals
- Read the bin counts, PPM and MPH values
- Reread the totals
- If the totals have changed, repeat from the second step until either the totals are consistent or it is clear the numbers are changing rapidly.

3.14 Data Accumulation

Consideration should be given to the amount of data being accumulated. For each of the 20 bins, the combined count, PPM and MPH counts will require 10 bytes so depending on what additional information is stored, storing all the data could require 1Kb for every 4 polls. At 5 second intervals, the file accumulated over 24 hours will be just over 3.1Mbytes. Whilst disc space will probably not be a consideration, speedily accessing the data might be.

Consideration should be given to storing periodic (e.g. daily, weekly) files depending on the polling interval selected. Additional thought should be given to reducing the resolution of historical data for example: 5 minute interval backups for the past 24 hours, hourly backups for the past month, and daily backups for older data.

3.15 Bin Counts

These bins hold the counts of Ferrous and Non-Ferrous Particles for each bin size. 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 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).

For this reason it is recommended that the particle per minute should be monitored to give an indication of change in rate of particle numbers and total mass per hour to give an indication of the size of any change.

4 Interface Settings

4.1 RS485 (Modbus)

Default settings:

Modbus Node ID:	32
Modbus Baud rate:	19200
Parity:	Even
Data bits:	8
Stop bits:	2

 Note that due to the half-duplex RS485, the Master-Slave protocol should be strictly adhered to. The MWDS operates as a Slave Device and will not instigate communications.

The following options can be configured with DebriSCAN PC software:

- Modbus Node Identifier.
- Baud rate. The following standard values are supported by DebriSCAN; 1200, 2400, 4800, 9600, 19200, 38400 and 57600. The number of data bits, parity and the number of stop bits are fixed. Note, at 1200 baud data transfer can take several seconds.
- Terminating resistor enabling/disabling

4.2 TCP/IP (Modbus)

Hardware Connection:	10 Base-T Ethernet

Default settings:

Modbus Node ID:	32
IP Address:	169.254.1.32
Speed:	10Mbps

The TCP/IP implementation also supports Discovery messages. This provides the IP address, default host name, MAC address as well as the firmware build date and time. The default host name includes the firmware version number.

The IP Address can be modified. The TCP/IP implementation also supports DHCP address allocation which will override the default or user set IP address. A DHCP change should occur seamlessly whilst a user requested change requires the unit to be rebooted. In the event that communications are lost as a result of a change, the unit should be rebooted and a Discovery message made to obtain the current IP address once any DHCP activity has ceased.

4.3 CAN

CAN Node ID:	1 (Default)
CAN Baud rate:	50kb (fixed)

4.4 Current Loop 4-20 mA outputs

Outputs for standard sensor only (Not fitted to Hazardous area sensor).

4-20mA output 1 follows digital Particles-per-Minute, 4-20mA output 2 follows the digital Mass-per-Hour output.

The scale may be adjusted using the Modbus or DebriSCAN PC application, as follows:

Current (mA)	Scale	Digital Equivalent	
		Particles Per Minute	Mass Per Hour (µ
4	Not changeable	0	0
20	Factory Setting	200	999,999
	User adjust min	1	1
	User adjust max	1,000	9,999,999
Update Frequency		10 Seconds	5 minutes

4.5 Alarm

Alarms can be activated via all digital protocols including the DebriSCAN PC application. The Alarm is reported through the Green Status LED, the Status Word (bit set) and the alarm circuit on the standard sensor. Note, the Hazardous area sensor does not have this alarm circuit.

Parameter	Update Frequency	Alarm value
PPM	10 seconds	16 Bit (0 … 65535), 0 = Off
MPH	5 minutes	32 Bit (0 … 4.2E+9), 0 = Off

5 Modbus

5.1 Overview

The Modbus Register map described below is common to both Modbus RTU using RS-485 and Modbus TCP/IP. Parts of the map have been allocated functionality for future enhancement, contain diagnostics for maintenance purposes or are currently unused. For support purposes, U16 write access to Holding Registers 327 - 336 and read access to the reserved areas of the Input Registers are recommended. Users should not write to these or other reserved Holding Register locations.

The base register address is set to 256. The Modbus frame limit is 256 bytes, which includes the header, CRC and data. The maximum amount of data is 125 Words.

5.2 Modbus Holding Registers - Control

5.2.1 Overview

The unit is supplied with a default configuration, some aspects of which may be altered via the Holding Registers. These contain data of various types, listed in the tables in the following sections with more detailed descriptions.

- Holding Register Data Type 1 refers to registers used during unit configuration. These are used to set required values and test the interface. Changes either take effect immediately or after a reboot.
- Holding Register Data Type 2 refers to registers used during operation allowing the counts to be zeroed and the status to be reset.
- Holding Register Data Type 3 is used for Firmware updates and should not be accessed without explicit instructions from the supplier.
- Holding Register Data Type 4 is currently not in use and dedicated to future enhancements.

 It should be noted that some configuration data listed in tables below will only come into effect after the unit is rebooted. As the data is required to be saved to EEPROM, 10 seconds should be left between the last change made and the request to reboot.

In the event of rebooting and being unable to restore the settings, see Engineering Communication Interface.

5.2.2 Holding Register Table

Data Type	Register Address(es)	Description	Data Type
U32	257	CAN Node ID	1 (after Reboot)
U32	259	Reserved	4
U32	261	Modbus Node ID	1 (after Reboot)
U32	263	Modbus Baud rate	1 (after Reboot)
U16	265	Sensor Number	1
U16	266	Alarm Level for Total particles per minute	1
U16	267	Total particles per minute Value for 20mA	1 (-KW Version)
U32	268	Alarm Level for Total Particles Mass per Hour	1
U32	270	Total particle mass per hour Value for 20mA	1 (-KW Version)
U16	272	Communications Mode	1 (after Reboot)
U32	273	Status Word	2
U16	275-278	IP Address octets	1 (after Reboot)
U16	284	Termination	1 (after Reboot)
Commands			
U16	279	Zero All Particle Counts	2
U16	280	Reset unit to Factory Default Configuration	1 (after Reboot)
U16	281	Reboot unit	1
U16	282	Enter Ethernet boot loader mode	3
U16	283	Enter Test Mode	1

Data Type	Register Address(es)	Description	Data Type
Reserved			
U16	285 - 416	Reserved	4

5.2.3 Reserved Words

These are areas of the map that may have been allocated functionality for future enhancement, contain diagnostics for maintenance purposes or are currently unused. For support purposes, U16 write access to Holding Registers 327 - 336 is recommended. Users should not write to these or other reserved Holding Register locations.

5.2.4 CAN Node ID (U32 257)

A change to this value will only take effect following a reboot of the unit.

This identifies the unit within the users system so that several units each uniquely identified by their Node Id can coexist on a network. Note that the ID is held in the bottom 8 bits of the U16 value at address 258 and all other bits should be zero.

5.2.5 Modbus Node ID (U32 261)

A change to this value will only take effect following a reboot of the unit.

This identifies the unit within the users system so that several units each uniquely identified by their Node Id can coexist on a single RS485 network. The range is 1 to 247. Note that the ID is held in the bottom 8 bits of the U16 value at address 262 and all other bits should be zero.

5.2.6 Modbus Baud Rate (U32 263)

A change to this value will only take effect following a reboot of the unit. The following standard values are supported by DebriSCAN; 1200, 2400, 4800, 9600, 19200, 38400 and 57600. The number of data bits, parity and the number of stop bits are fixed.

Be aware that other baud rates may be requested and, depending on the interface, may also result in good communications. Slower baud rates (e.g. 300) may necessitate less frequent polling.

The time taken to transfer data should be taken into account when determining polling times. The total amount of data to be transferred could be 240 bytes which is then formed into packets. At 1200 baud this will take several seconds. It is up to the user to ensure that they are not requesting a subsequent set of data before the previous data transfer is complete.

5.2.7 Sensor Number (U16 265)

This identifies the unit within the system for customer use. The range is 0 to 65535.

5.2.8 Alarm Level for Total particles per minute (U16 266)

If the number of particles per minute exceeds this level, the PPM alarm is set. If the level is zero the alarm is switched off. The range is 0 – 65535.

5.2.9 Total particles per minute Value for 20mA (U16 267)

The 4-20mA outputs are scaled by identifying the value represented by an output of 20mA. The default is 2000. The range is 0 – 65535. Though the output has 1024 ‘steps‘, the sensitivity of the circuitry is such that working to the nearest 0.1mA is recommended.

5.2.10 Alarm Level for Total Particles Mass per Hour (U32 268)

If the total particle mass per hour exceeds this level, the MPH alarm is set. If the level is zero the alarm is switched off. The range is 0 – 4294967295.

5.2.11 Total particle mass per hour Value for 20mA (U32 270)

The 4-20mA outputs are scaled by identifying the value represented by an output of 20mA. The default is 1000000. The 4-20mA output is scaled accordingly. The range is 0 – 4294967295. Though the output has 1024 ‘steps‘, the sensitivity of the circuitry is such that working to the nearest 0.1mA is recommended.

5.2.12 Communications Mode (U16 272)

A change to this value will only take effect following a reboot of the unit.

This sets which mode is to be used the next time the unit is powered up. The valid modes are:

Value	Communication Mode
1	Modbus RTU on RS485
2	CANOpen on CAN
3	Modbus TCP/IP on Ethernet

Invalid values will be ignored. In the event the unit boots up with an invalid value, it will be reset to use Ethernet (3).

5.2.13 Status Word (U32 273)

This value is used to reset the Status Word temporarily as Status conditions will be retested during the appropriate time in the execution cycle and the bits set accordingly. In the intervening time, the Status Word will reflect the value that has been set and not the actual status of the system.

This allows the user to verify their system in respect of setting and clearing alarms and other status reporting. Note that unused bits will not normally be set or cleared by the MWDS.

On power up the reset bit of the Status Word is set causing the Red LED to flash. Clearing the bit in the Status Word clears the condition and causes the Red LED to stop flashing. Any future power cycles/reboots will then be brought to the attention of the operator through this bit.

0=LSB	Function	Notes
Bits 0 & 1	Reserved.	
Bit 2	Particles per Minute Alarm	Set/Clear if the PPM alarm is set or clear. This flag is updated every 10 seconds.
Bit 3	Mass per Hour Alarm	Set/Clear if the MPH alarm is set or clear. This flag is updated every 5 minutes.
Bit 4	Unit Balancing	Set whilst the unit is balancing and clear otherwise. Whilst the unit is balancing, particles are not being detected. Under normal operation, balancing will take approximately 100 milliseconds and will occur not more than once a day. Balancing will occur more frequently if the temperature is changing rapidly.
Bit 5	Unit has Reset	Set on power up. This bit should be cleared by the user on installation or when the power has been interrupted. This flag does not affect the logging capability of the sensor; it is for information purposes only.
Bit 6	Unit is in Test Mode	Set when unit is outputting Test Data and clear otherwise. Test mode lasts 10 minutes and can be toggled on and off.
Bit 7	Reserved	
Bit 8	Particle Counts Changed	Set when the Particle Counts have changed. This bit should be cleared by the user if knowledge of when the Particle Counts have Changed is required. Note: this does not reflect changes to the PPM and MPH counts.
Bit 9	PPM Update	Set when the PPM values are recalculated. This bit should be cleared by the user if knowledge of when the PPM values have been updated is required.
Bit 10	MPH Updated	Set when the MPH values are recalculated. This bit should be cleared by the user if knowledge of when the PPM values have been updated is required.
Bit 11	Data To Write	Set when configuration data is waiting to be written to EEPROM. Cleared when the EEPROM has completed the write
Bits 12-31	Unused.	

5.2.14 IP Address (U16 275 - 278)

A change to these values will only take effect following a reboot of the unit.

 Note: these values may be automatically changed if the unit is connected to a DHCP server. A discovery request may be used to obtain the current settings.

5.2.15 Termination (Internal Terminating Resistor) (U16 284)

A change to this value will only take effect following a reboot of the unit.

Set the value to zero to enable the internal termination. If external termination for the RS485 or CAN is fitted the internal termination should be disabled.

5.2.16 Command: Zero All Particle Counts (U16 279)

By setting the 16 bit holding register 279 to a non-zero value, all the particle values (i.e. counts, PPM and MPH bins and totals) will be zeroed. The non-volatile memory counts will also be cleared immediately. On completion the value is cleared.

5.2.17 Command: Reset to Factory Defaults (U16 280)

Changes as a result of this command will only take effect following a reboot of the unit.

By setting the 16 bit holding register 280 to a non-zero value, the configuration stored in non-volatile memory is restored to the Factory Defaults. Note: this will not zero the particle counts. When the unit is next rebooted, the runtime configuration will be reset with the factory defaults. Until then the current configuration will still be operating. On completion the value is cleared.

The Sensor Number and Termination value will be preserved.

5.2.18 Command: Reboot Unit (U16 281)

By setting the 16 bit holding register 281 to a non-zero value, the unit will be rebooted. Changes to the configuration which require a reboot will come into effect, once the unit has fully booted. The unit will be unable to communicate to the Modbus interface for approximately 30 seconds. The Particle Counts will be preserved but the Particle Per Minute and Mass Per Hour values will be zeroed. On completion the value is cleared.

5.2.19 Command: Enter Firmware Update Mode (U16 282)

By setting the 16 bit holding register 282 to a non-zero value, the unit will enter the Firmware Update Mode. No further communication will be possible via the Modbus interface. On completion the unit will require to be rebooted. The configuration (i.e. user settings) and previous particle counts should be preserved.

The user should not enter Firmware Update Mode unless following explicit instructions from the supplier. Should this mode be entered then the only method of exiting is to reboot the unit by power cycling it.

5.2.20 Command: Factory Acceptance Test Mode (U16 283)

By setting the 16 bit holding register 283 to a non-zero value, this causes the unit to enter/exit Test Mode. The particle counts are zeroed and a test sequence is invoked for 10 minutes or until the command is set again. On exit the particle counts are zeroed to clear the test data. On completion the value is cleared.

The test sequence adds large values to the bins and totals for particle counts, particles per minute and mass per hours. This allows the operators configuration and data handling methods to be verified. It should be noted that the Mass Per Hour totals will overflow and return to zero one or more times during the test.

During test mode a value is added to all the bins at 10 second intervals. The values are as follows (where Bin is in the range 1-10 equivalent to a-j):

Particle Counts – Bin * 20000

Particles Per Minute – Bin * 20

Mass Per Hour – Bin * 2000000

The totals represent the sum of 10 Fe and 10 NFe bins being treated as above.

The 4-20mA and Alarm outputs will reflect the test values. The 20mA and Alarm levels should be set to appropriate values if the outputs are to be checked.

5.3 Modbus Input Registers - Monitoring

5.3.1 Overview

The Input Registers contain data of various types listed in the 2.3.3 with detailed descriptions in section 2.3.4

- Input Data Type 1 registers consist of data that is likely to only be downloaded once to identify the unit and its configuration. They may be re-read following changes or merely to confirm that the unit is operating correctly.

- Input Data Type 2 registers are those that provide the optimal monitoring performance. These consist of the particles per minute (PPM) for each bin, the total number of particles per minute (PPM) over all bins, total particle mass per hour (MPH) over all bins, an indication of non-particle events per minute, an indication of particle speed, system runtime in seconds, and the status word. The PPM values are updated at 10 second intervals and the MPH value at 5 minute intervals. The PPM values give an indication of the quantity of particles whilst the MPH values give an overall indication of the particle size. (i.e. a large increase in small particles may not cause as large a rise in MPH as a small increase of large particles). The Event Seconds per Minute indicate signals that could not be resolved into individual particles but are of sufficient strength and duration to indicate the detection of particulate matter.

- Input Data Type 3 registers provide supporting information for the above. Note that the particle count may not be beneficial over an extended time period as the numbers accumulate to large

quantities. In an unfiltered system, the same particles will be counted over and over again as the oil circulates.

- Input Data Type 4 registers exist merely to verify that the Modbus configuration is correct (e.g. registers 257 and 691 are fixed values).

- Input Data Type 5 registers are areas of the map that may have been allocated functionality for future enhancement, contain diagnostics for maintenance purposes or are currently unused. For support purposes, read access to these areas is recommended.

5.3.2 Input Register Table

Data	Register Address(es)	Description	Type
U32	257	Identifier	4
U32	259	Product Code	1
U32	261	Software Revision	1
U32	263	Sensor Serial Number	1
U32	265	Modbus Node ID	1
U32	267	Modbus Baud Rate	1
U32	269	CANOpen Node ID	1
U16	271 - 294	Reserved	5
U32	295	Sensor Runtime	2
U16	297 - 338	Reserved	5
U32	339	Status Word	2
U32	341-359	Ferrous (Fe) Bin Counts for 10 bins	3 (10 Values)
U32	361-379	Non-Ferrous (NFe) Bin Counts for 10 bins	3 (10 Values)
U16	381 - 382	Reserved	5
U32	383	Alarm Level for Total Particles Mass per Hour	1
U32	385	Total particle mass per hour	1(-KW version)

		Value for 20mA	
U16	387 - 390	Reserved	5
U16	391	Alarm Level for Total particles per minute	1
U16	392	Total particles per minute Value for 20mA	1(-KW version)
U16	393	Reserved	1
U16	394	Sensor Number	1
U16	395	Reserved	1
U16	396-405	Ferrous (Fe) Bin Sizes (Lower Limits) for 10 bins	1 (10 Values)
U16	406-415	Non-Ferrous (NFe) Bin Sizes (Lower Limits) for 10 bins	1 (10 Values)
U16	416-419	IP Address as 4 values	1
U16	420-424	Reserved	5
U32	425-437	Reserved	5
U16	438-448	Reserved	5
U16	449	Termination	1
U16	450-511	Reserved	5
U16	512	Event Seconds per Minute	2
U16	513-522	Ferrous (Fe) Bin Particles Per Minute for 10 bins	2 (10 Values)
U16	523-532	Non-Ferrous (NFe) Bin Particles Per Minute for 10 bins	2 (10 Values)
U16	533-623	Reserved	5
U16	624	Sensor Particle Speed	2
U16	625-632	Reserved	5
U32	633-651	Ferrous (Fe) Bin Mass Per Hour for 10 bins. Values are in	3 (10 Values)

		micrograms.	
U32	653-671	Non-Ferrous (NFe) Bin Mass Per Hour for 10 bins. Values are in micrograms.	3 (10 Values)
U32	673	Total Fe particles per minute	3
U32	675	Total NFe particles per minute	3
U32	677	Total All particles per minute	2
U32	679	Total Fe particles	3
U32	681	Total NFe particles	3
U32	683	Total All particles	3
U32	685	Total Fe mass per hour(µg)	3
U32	687	Total NFe mass per hour (µg)	3
U32	689	Total All particle mass per hour (µg)	2
U16	691	Top of Input Registers = 0xAAAA	4

5.3.3 Reserved Words

These are areas of the map that may have been allocated functionality for future enhancement, contain diagnostics for maintenance purposes or are currently unused. For support purposes, read access to these areas is recommended.

5.3.4 Identifier (U32 257)

This word has a fixed value (0x000001AD) which allows the Modbus communications configuration to be checked.

5.3.5 Product Code (U32 259)

This word holds the MWDS firmware part number.

5.3.6 Software Revision (U32 261)

This word holds the MWDS software revision as an integer (i.e. v1.07 is held as 107).

5.3.7 Sensor Serial Number (U32 263)

This word holds the unit specific MWDS Serial Number.

5.3.8 Modbus Slave Node ID and Baud Rate (U32 265, 267)

These words hold the Modbus Baud Rate as bits per second (bps) and the Modbus Slave ID. The defaults are 19200 and 32 respectively.

5.3.9 Sensor Runtime (U32 295)

This word holds the time since power-up/reset in seconds. This parameter is provided for indication purposes only since there may be drift that can amount to 90 seconds per week.

5.3.10 Status Word (U32 339)

This value is used to report various sensor conditions (see table below). Some bits are cleared automatically depending on the condition whilst other bits indicate that a condition has been set. These latter bits will require clearing by the operator.

On power up the reset bit of the Status Word is set and the Red LED will flash. Clearing the reset bit clears the condition and causes the Red LED to stop flashing. Any future power cycles/reboots will then be brought to the attention of the operator through this bit. Other conditions requiring to be cleared by the operator can be ignored unless the operator wants to utilise the functionality.

0=LSB	Function	Notes
Bits 0 & 1	Reserved.	
Bit 2	Particles per Minute Alarm	Set/Clear if the PPM alarm is set or clear. This flag is updated every 10 seconds.
Bit 3	Mass per Hour Alarm	Set/Clear if the MPH alarm is set or clear. This flag is updated every 5 minutes.
Bit 4	Unit Balancing	Set whilst the unit is balancing and clear otherwise. Whilst the unit is balancing, particles are not being detected. Under normal operation, balancing will take approximately 100 milliseconds and will occur not more than once a day. Balancing will occur more frequently if the temperature is changing rapidly.
Bit 5	Unit has Reset	Set on power up.
Bit 6	Unit is in Test Mode	Set when unit is outputting Test Data and clear otherwise.
Bit 7	Reserved	
Bit 8	Particle Counts Changed	Set when the Particle Counts have changed.
Bit 9	PPM Updated	Set when the PPM values are recalculated.
Bit 10	MPH Updated	Set when the MPH values are recalculated.

Bit 11	Data To Write	Set when configuration data is waiting to be written to EEPROM. Cleared when the EEPROM has completed the write
Bits 12-31	Unused.	

5.3.11 Bin Counts (U32 341-371)

These sets, each of ten 32 bit words, hold the counts of Ferrous and Non-Ferrous Particles for each bin. 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 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).

For this reason it is recommended that the particle per minute should be monitored to give an indication of change in rate of particle numbers and total mass per hour to give an indication of the size of any change.

5.3.12 Alarm Level for Total Particles Mass per Hour (U32 383)

This word holds the Alarm Level for Total Particles Mass per Hour, The default is 0 (i.e. alarm off). See the description under Holding Registers.

5.3.13 Total particle mass per hour Value for 20mA (U32 385)

This word holds the Total particle mass per hour Value for 20mA. The default is 1000000. The 4-20mA output is scaled accordingly. See the description under Holding Registers .

5.3.14 Alarm Level for Total Particles Per Minute (U32 391)

This 16 bit word holds the Alarm Level for Total Particles Per Minute, The default is 0 (i.e. alarm off). See the description under Holding Registers.

5.3.15 Total particles per minute Value for 20Ma (U32 392)

This 16 bit word holds the Total particle particles per minute Value for 20mA. The default is 1000000. The 4-20mA output is scaled accordingly. See the description under Holding Registers.

5.3.16 Sensor Number (U32 394)

This 16 bit word holds the user supplied Sensor Number.

5.3.17 Bin Sizes (Lower Limits) (U32 396-415)

These sets, each of ten 16 bit words, hold the nominal lower limit particle sizes relating to each Ferrous and Non Ferrous Bin.

5.3.18 Event Seconds per Minute (U16 512)

This value identifies the time that the signal indicated that a signal was detected that could not be resolved into individual particles but indicate that particulate matter was present. It is reported to the nearest second as a value between 0 and 60. Note that the rounding means a reading of 1 represents up to 1.5 second, 2 of 1.5 to 2.5 seconds and so on.

Event Seconds per Minute report unresolvable signals and may indicate sudden vibrations or temperature changes. They should be of concern if they are associated with individual particle counts or are of sufficient duration.

Note: this value is only available via Modbus and for firmware version 1.14 onwards.

5.3.19 Bin Particles per Minute (U32 513-532)

This set of ten 16 bit words hold the Particles per Minute count for each Ferrous and Non-Ferrous Bin.

5.3.20 Sensor Particle Speed (U32 624)

This 16 bit word gives an indication of the speed of the last particle in millimetres per seconds. It should not be used as a measurement of fluid speed or flow.

5.3.21 Mass Per Hour (U32 633-671)

These sets, each of ten 32 bit words, hold the Mass per Hour values for each Ferrous and Non-Ferrous Bin.

5.3.22 Totals (U32 673-689)

This set of values contains the totals of Ferrous, Non-Ferrous and All particles.

5.3.23 Top of Input Registers (U16 691)

This 16 bit word has a fixed value (0xAAAA) which allows the Modbus communications configuration to be checked.

6 CAN Register Map

6.1 Overview

The sensor is equipped with CANopen, but has reduced functionality compared to Modbus, however CAN can be used for evaluation purposes. Alternative protocols - such as CAN J1939 - can be implemented by special order only, please contact Parker Kittiwake for details.


The following data and functionality is not available via this simplified CANopen protocol:

- Mass per hour per bin
- Bin, mass per hour and particles per minute subtotals and totals
- Alarm and 4-20mA settings

6.2 0x6404 Read/Write Registers

Sub-Index	Description	Bytes	R-Read, W-Write, C–Command
1	Identifier	4	R
2	Product Code	4	R
3	Firmware Revision	4	RC
4	Serial Number	4	R
5	Can Node Id	4	RW
6-19	Reserved	4	RW
20	Sensor Runtime	4	R
21	Status Word	4	RC
22	Toggle Test	4	RC
23	Reboot	4	RC
24	Zero Count	4	RC
25	Modbus Node Id	1	RW
26	Modbus Baud Rate	4	RW

6.2.1 Reserved Words

These are areas of the map that may have been allocated functionality for future enhancement, contain diagnostics for maintenance purposes or are currently unused. For the avoidance of doubt, users should not write to these locations.

6.2.2 Identifier – Read Only (U32 1)

This word has a fixed value (0x000001AD) which allows the communications configuration to be checked.

6.2.3 Product Code – Read Only (U32 2)

This word holds the MWDS firmware part number.

6.2.4 Firmware Revision – Read and Command (U32 3)

This word holds the MWDS software revision as an integer (i.e. v1.07 is held as 107).

By writing to change this value, the unit will enter the Ethernet Firmware Update Mode. No further communication will be possible via the CAN interface. On completion the unit will require to be rebooted.

The user should not enter Firmware Update Mode unless following explicit instructions from the supplier. Should this mode be entered then it may be cleared by power cycling the unit in order to cause a reboot.

6.2.5 Sensor Serial Number – Read Only (U32 4)

This word holds the unit specific MWDS Serial Number.

6.2.6 CAN Node ID (U32 5)

This identifies the unit within the users system so that several units each uniquely identified by their Node Id can coexist on a single CAN network.

6.2.7 Sensor Runtime – Read Only (U32 20)

This word holds the time since power-up/reset in seconds. This parameter is provided for indication purposes only since there may be drift that can amount to 90 seconds per week.

6.2.8 Status Word (U32 21)

This value is used to reset the Status Word temporarily as Status conditions will be retested during the appropriate time in the execution cycle and the bits set accordingly. In the intervening time, the Status Word will reflect the value that has been set and not the actual status of the system.

This allows the user to verify their system in respect of setting and clearing alarms and other status reporting. Note that unused bits will not normally be set or cleared by the MWDS.

On power up the reset bit of the Status Word is set causing the Red LED to flash. Clearing the bit in the Status Word clears the condition and causes the Red LED to stop flashing. Any future power cycles/reboots will then be brought to the attention of the operator through this bit.

0=LSB	Function	Notes
Bits 0 & 1	Reserved	
Bit 2	Particles per Minute Alarm	Set/Clear if the PPM alarm is set or clear. This flag is updated every 10 seconds.
Bit 3	Mass per Hour Alarm	Set/Clear if the MPH alarm is set or clear. This flag is updated every 5 minutes.
Bit 4	Unit Balancing	Set whilst the unit is balancing and clear otherwise. Whilst the unit is balancing, particles are not being detected. Under normal operation, balancing will take approximately 100 milliseconds and will occur not more than once a day. Balancing will occur more frequently if the temperature is changing rapidly.
Bit 5	Unit has Reset	Set on power up. This bit should be cleared by the user on installation or when the power has been interrupted. This flag does not affect the logging capability of the sensor; it is for information purposes only.
Bit 6	Unit is in Test Mode.	Set when unit is outputting Test Data and clear otherwise. Test mode lasts 10 minutes and can be toggled on and off.
Bit 7	Reserved.	
Bit 8	Particle Counts Changed	Set when the Particle Counts have changed. This bit should be cleared by the user if knowledge of when the Particle Counts have Changed is required. Note: this does not reflect changes to the PPM and MPH counts.
Bit 9	PPM Update	Set when the PPM values are recalculated. This bit should be cleared by the user if knowledge of when the PPM values have been updated is required.
Bit 10	MPH Updated	Set when the MPH values are recalculated. This bit should be cleared by the user if knowledge of when the PPM values have been updated is required.
Bit 11	Data To Write	Set when configuration data is waiting to be written to EEPROM. Cleared when the EEPROM has completed the write
Bits 12-31	Unused	

6.2.9 Operator Command Enter/Exit Test Mode (U32 22)

This word holds the time since power-up/reset in seconds.

By writing to change this value, this causes the unit to enter/exit Test Mode. The particle counts are zeroed and a test sequence is invoked for 10 minutes or until the command is set again. On exit the particle counts are zeroed to clear the test data.

The test sequence adds large values to the bins and totals for particle counts, particles per minute and mass per hours. This allows the operators configuration and data handling methods to be verified. It should be noted that the Mass Per Hour totals will overflow and return to zero one or more times during the test.

During test mode a value is added to all the bins at 10 second intervals. The values are as follows:

Particle Counts – Bin Number * 20000

Particles Per Minute – Bin Number * 20

Mass Per Hour – Bin Number * 2000000

The totals represent the sum of 10 Fe and 10 NFe bins being treated as above.

6.2.10 Operator Command: Reboot Unit (U32 23)

This word holds the time since power-up/reset in seconds.

By writing to change this value, the unit will be rebooted. Changes to the configuration which require a reboot will come into effect, once the unit has fully booted. The unit will be unable to communicate to the CAN interface for approximately 30 seconds. The Particle Counts will be preserved but the Particle Per Minute and Mass Per Hour values will be zeroed.

6.2.11 Operator Command: Zero All Particle Counts (U32 24)

This word holds the time since power-up/reset in seconds.

By writing to change this value, all the particle counts (i.e. counts, PPM and MPH bins and totals) will be zeroed. The non-volatile memory counts will also be cleared immediately.

6.2.12 Modbus Node ID – Read and Write (U32 25)

This identifies the unit within the users system so that several units each uniquely identified by their Node Id can coexist on a single RS485 network. The range is 1 to 247.

6.2.13 Modbus Baud Rate – Read and Write (U32 26)

This identifies the baud rate. The following values are supported 1200, 2400, 4800, 9600, 19200, 38400 and 57600. Note the number of data bits, the parity and the number of stop bits are fixed (8, even and 2, respectively).

Be aware that other baud rates may be requested and, depending on the interface, may also result in good communications. Slower baud rates (e.g. 300) may necessitate less frequent polling.

The time taken to transfer data should be taken into account when determining polling times. The total amount of data to be transferred could be 240 bytes which is then formed into packets. At 1200 baud this will take several seconds. It is up to the user to ensure that they are not requesting a subsequent set of data before the previous data transfer is complete.

6.3 0X6420 Read Only Registers

Sub-Index	Description	Bytes per sub-index
1-10	Ferrous (Fe) Bin Counts for 10 bins	4
11-20	Reserved	4
21-30	Non-Ferrous (NFe) Bin Counts for 10 bins	4
31-40	Reserved	4
41-51	Reserved	2
52	Reserved	1
53-54	Reserved	2
55	Reserved	1
56	Reserved	4
57-65	Reserved	2
66	Reserved	4
67	Reserved	2
68-77	Ferrous (Fe) Bin Particles Per Minute for 10 bins	2
78-87	Non-Ferrous (NFe) Bin Particles Per Minute for 10 bins	2
88-97	Reserved	2

6.3.1 Reserved Words

These are areas of the map that may have been allocated functionality for future enhancement, contain diagnostics for maintenance purposes or are currently unused. For the avoidance of doubt, users should not write to these locations.

6.3.2 Bin Counts (U32 1-10/21-30)

These sets, each of ten 32 bit words, hold the counts of Ferrous and Non-Ferrous Particles for each bin. 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 increase and thus a change may not be immediately noticeable (e.g. after months of running and counts of 20,000+ an increase in the number of particles of 200 may not be obvious).

For this reason it is recommended that the particle per minute should be monitored to give an indication of change in rate of particle numbers and total mass per hour to give an indication of the size of any change.

6.3.3 Bin Particles Per Minute (U16 68-77,78-87)

These sets, each of ten 16 bit words hold the Particles per Minute count for each Ferrous and Non-Ferrous Bin

6.4 Reserved Registers

These are areas of the map that may have been allocated functionality for future enhancement, contain diagnostics for maintenance purposes or are currently unused. For the avoidance of doubt, users should not write to these locations.

0x6000 SubIndices 1-4

0x6001 SubIndices 1-2

0x6408 SubIndices 1-26

0x7F40 SubIndex 1

7 Appendix

7.1 Engineering Communication Interface

During the first 10 seconds from power on, the WDS performs self diagnostics and checking routines. During this period both the Green and Red LEDs flash on and off in unison. The Engineering Communication Interface is active during this phase.

Hardware Connection:	RS485
Baud rate:	57600
Parity:	Even
Data bits:	8
Stop bits:	2
Hardware Control	None

The baud rate chosen differs from the default Modbus baud rate in order to prevent accidental invocations of this mode.

The Engineering Communications Interface exists to allow the operator to carry out some basic functionality. The operator should only have to invoke this mode if they have set the unit to a communications configuration that the controlling software is unable to handle (e.g. increasing the baud rate to a point where noise interferes with communication and then being unable to set the baud rate to the correct value). It can be useful when disconnecting a system employing one means of communication in order to set up another method for diagnosis.

- Connect to Hyperterminal or a similar utility before powering the unit up. The mode operates with the PC being the Master and the unit as the Slave. Hence the unit will not instigate communications.

7.1.1 Unlocking Engineering Communications

It is necessary to distinguish between genuine attempts to connect to engineering mode and default connections within the customer set-up (i.e. if a set-up system is rebooted, then a remote system might start polling the sensor over RS485 whilst the Engineering Communication Interface is active).

The operator is required to type 123456789 (i.e. the digits 1 to 9). The typed digit will be echoed to the screen. In the event of an error, the correct digit is output following the one typed and the index reset (i.e. the operator must start again from 1). There should be a slight pause between each key of 2 milliseconds as having read a character, the 8 character input buffer is flushed.

On rebooting, in order to synchronise with the start of the period, the operator is advised to press 1 until a 1 is echoed and then proceed with the following digits. When successful the following message will be output:

Engineering Mode Active - Press 0 for Menu

On Pressing 0, the following will be displayed:

0,?,/) This Menu

1) Display Banner and Status

2) Display Diagnostics

3) Use RS485 Modbus Node (<settings>)

4) Use CAN Communications (<settings>)

5) Use Ethernet (<IP address>)

6) Zero Particle Counts

7) Clear Diagnostics and ReBoot

8) Goto Firmware Update via Ethernet

9) Set Factory Defaults and Start

A or No Activity for 30 seconds) Exit Engineering Mode and Start Program

A non-menu character is ignored.

>

Note that options 3, 4 and 5 display the current settings for the particular communications mode.

Each received character resets the Engineering Mode timeout to 30 seconds. If Engineering Mode has been unlocked and then ends or times out, then the following message is displayed:

>Engineering Interface Terminated, Starting Program

On selecting a command, the command line is echoed and the appropriate action taken.

7.1.2 Display Banner and Status

This prints a display identifying the firmware and some status information in the form:

*** Wear Debris Sensor FW-19339 <version>, <Date> <Time> ***

(A,B,C,D,E,F - < Reason for Last Reboot>). Using <Communications Mode Information>

Where A is the Reboot Count and B to F are Factory Diagnostics

Example:

*** Wear Debris Sensor FW-19339 v01.00, Jul 31 2013 11:52:07 ***

(7,0,0,0,0,129 - Master Clear). Using Ethernet 10Mbs, (169.254.1.32)

7.1.3 Display Diagnostics

This displays up to 25 lines of diagnostic data for factory use.

7.1.4 Use RS485 Modbus

This sets the communications mode for the following session to be RS485. The settings to be used are displayed. On rebooting, the sensor will revert to the method stored unless during the following session, a new communications method is written.

7.1.5 Use CAN Communications

The sensor is equipped with CANopen has a reduced functionality which can be used for evaluation purposes. Alternative protocols - such as J1939 - can be implemented by special order only, please contact Parker Kittiwake for details.

This sets the communications mode for this session to be CAN. The settings to be used are displayed. On rebooting, the sensor will revert to the method stored unless during the following session, a new communications method is written.

7.1.6 Use Ethernet

This sets the communications mode for this session to be Ethernet. The settings to be used are displayed. On rebooting, the sensor will revert to the method stored unless during the following session, a new communications method is written.

7.1.7 Zero Particle Counts

This zeros the particle counts.

7.1.8 Clear Diagnostics and ReBoot

This is used to clear the Diagnostic and particle count records. This command is for factory use only.

7.1.9 Goto Firmware Update via Ethernet

This sets the unit into the bootloader mode so that new firmware can be uploaded.

The user should not enter Firmware Update Mode unless following explicit instructions from the supplier. Should this mode be entered then the only method of exiting is to reboot the unit by power cycling it.

7.1.10 Set Factory Defaults and Start

This overwrites all customer changes made, setting the unit to a known state. The Sensor number and termination state will be preserved.

8 Notes