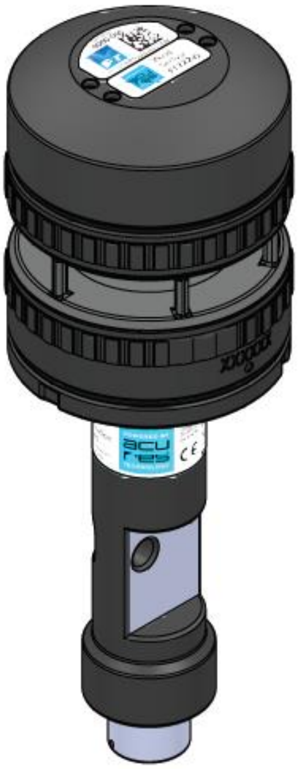
FT722 & FT742 – Digital (RS485) Wind Sensor Manual

Flat-Front & Pipe-Mounted Variants



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Product Symbols

The following symbols may be used upon the product and within the manual.

Meaning / Description	Symbol	Signification / Description
Warning/ Caution An appropriate safety instruction should be followed or caution to a potential hazard exists	⚠	**Avertissement / Attention** Une instruction de sécurité doit être suivie ou attention portée à un danger potentiel qui existe.
DC Current only Equipment operates under Direct Current (DC) supply only.	⎓	**Courant continu uniquement** L'équipement fonctionne sous une alimentation en courant continu (CC) uniquement.
Product Disposal In accordance with European directive 2012/19/EU on Waste Electrical and Electronic Equipment (WEEE), these product components must be recycled. This should be done by returning the product to FT Technologies or by using an appropriate waste disposal company. This product should not be disposed of in general waste of landfill. This product complies with the RoHS2 (2011/65/EU) directive.		**Élimination du produit** Conformément à la directive européenne 2012/19/EU relative aux déchets d'équipements électriques et électroniques (DEEE), ces composants du produit doivent être recyclés. Cela doit être fait par le retour du produit à FT Technologies ou en utilisant une entreprise d'élimination de déchets. Ce produit ne doit pas être éliminé avec les ordures ménagères ou en décharge. Ce produit est conforme à la directive RoHS2 (2011/65/EU).
Recognized Component Sensors marked with the ETL label indicate that the product conforms to UL Standard 61010-1 and is certified to CSA Standard C22.2 No. 61010-1.	RECOGNIZED COMPONENT C ETL US LISTED Intertek 4000105	**Composant Reconnu** Les capteurs marqués avec l’étiquette ETL indiquent que le produit est conforme à la norme UL 61010-01 et est certifié à la norme CSA22.2 61010-01.
CE Mark The EU Declaration of Conformity complies with the essential requirements of the following applicable EMC Directive 2014/30/EU, and carries the CE Marking accordingly.	CE	**Marquage CE** Déclaration de conformité CE de la compatibilité électromagnétique (EMC) et marquage CE conformément à la directive CE 2014/30/EU.

Safety Instructions

English

- To ensure the safe installation and operation of this product the equipment must be installed and integrated:
    - Using suitably qualified and trained personnel
    - In accordance with any regional electrical codes
    - In accordance with the instructions set out in this manual, observing all information, warnings and instructions
    - In accordance with any other instructions or guidance FT Technologies provide
- To ensure that the product remains compliant with the electrical safety requirements of the UL / CSA 61010-1 Standards it must be;
    - Connected to an appropriately approved isolated power supply (for example UL/CSA IEC 60950-1:2005 + A1:2009 + A2:2013) rated 12-30VDC and be current limited (6A Max)
    - Protected by UL 1449 listed surge protection devices
    - Connected with an approved interface cable (for example UL/ CSA recognised AWM style 21198, rated 300V, 80°C)
- The equipment must only be operated within the range of the specified technical data and used for the purposes for which it was designed.
- The equipment should always be transported in packaging which is appropriate, that will prevent any accidental damage from occurring.
- Always ensure that any failures or errors from the product cannot cause any damage to any other equipment or property or cause any other consequential effects.

Consignes de Sécurité

Français

- Pour assurer la sécurité de l'installation et le fonctionnement de ce produit, l'équipement doit être installé et intégré :
    - À l'aide de personnel qualifié et formé
    - Conformément à tous les codes électriques régionaux
    - Conformément aux instructions figurant dans ce manuel et en observant toutes les informations, avertissements et instructions
    - Conformément à d'autres instructions ou directives que FT Technologies fournit

  Pour garantir que le produit reste compatible avec les exigences de sécurité électrique de l'UL/CSA 61010-1 normes, l'équipement doit être;

    - Connecté à une alimentation agrée convenablement isolée (par exemple UL/CSA IEC 60950-1:2005 + A1:2009 + A2:2013) de tension nominale 12-30 VCC et avec courant limité (6 A max)
    - Protégé par des dispositifs de protection UL 1449 contre les surtensions
    - Connecté avec un câble d'interface (par exemple UL/CSA reconnu AWM style 21198, de valeur nominale 300 V, 80°C)
- L'équipement doit être utilisé uniquement dans la plage des données techniques spécifiées et utilisé aux fins pour lesquelles il a été conçu.
- L'équipement doit toujours être transporté dans un emballage qui est approprié, qui permettra d'éviter qu'un quelconque dommage accidentel ne survienne.
- En toutes circonstances, garantir que les défaillances ou les erreurs du produit ne puissent pas causer des dommages à d'autres équipements ou autres biens ou provoquer d'autres effets indirects.

1 INTRODUCTION

1.1 Product Overview

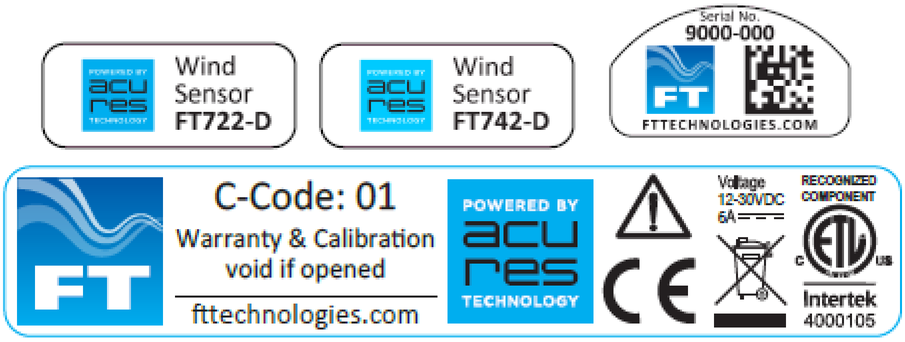
The FT722 and FT742 are solid-state ultrasonic wind sensors using a patented Acoustic Resonance airflow sensing technique to measure accurately both wind speed and direction. The sensors have been specifically designed to operate in harsh environments including offshore, lightning and ice-prone areas. The wind sensor has no moving parts to degrade or wear-out and is designed for applications requiring high reliability. They help reduce costly down-time and unscheduled maintenance visits.

Mounting and aligning the sensor is very simple. A 0° wind datum marking can be used to align the sensor to a reference point. For operation in ice-prone areas, the FT722 and FT742 are fitted with a highly-effective thermostatically controlled all-body heating system. A three element heater is used to ensure heat is evenly distributed over the entire surface area.

1.2 Build Versions and Labelling

The electrical interface is the same as our previous range of FT702LT (RS485) sensors. The same pin-outs and RS485 communication standard is used.

Figure 1 shows how to identify the sensor platform version and individual serial number, depending on the attached main labels:



Additional labels may be attached. Only sensors marked with the Intertek label conform to the UL Standard 61010-1 and are certified to CSA Standard C22.2 No. 61010-1.

Figure 1: Examples of Main Sensor Labels

1.3 Scope of Use

The sensor is designed, manufactured and optimised for high availability.

No promise in part or full can be given to guarantee a sensor's continuous operation, as exceptional circumstances can occur that may result in the failure of the output from a sensor. Exceptional circumstances can include:

- Poor installation
- Inadequate inspection
- Power supply failures
- Poor quality electrical connections
- Lightning exposure
- Problematic environmental conditions or combination of conditions
- Physical Damage

Typically higher levels of wind speed and wind direction data availability are achieved through the use of an additional FT sensor or alternative sensor. Control strategies or algorithms, which compensate in whole or in part, for any temporary interruption of data from individual sensors should also be applied. The choice and implementation of such methods is entirely the Purchaser's responsibility.

1.4 Major Changes Compared to Previous FT702LT Digital Products

- The FT742 has a higher speed range available (0-75m/s)
- New optional Overspeed Warning Scheme introduced (see Section 2.7). By default this feature is disabled to match legacy behaviour
- This product has a faster data output rate (was up to 5Hz, now up to 10Hz)
- By default, the averaging filter now samples over the same time period, but averages twice as many data points
- A new innovative mechanical design incorporating a series of “turbulators” (patent pending) which condition the air flow to deliver improved accuracy
- An optional Selective Filter can be enabled (see Section 2.5), which rejects invalid wind data from entering the averaging filter, thus improving data quality and reducing error flags. This feature is disabled by default to match legacy behaviour
- The Acoustic Temperature and Anemometer Mount features were introduced in software V7.5

It is strongly recommended that customers carry out their own product validation before deployment of the FT wind sensor.

1.5 FT722 and FT742 differences

The FT722 is capable of recording 0-50m/s wind speeds.
The FT742 is capable of recording 0-75m/s wind speeds.

Since the maximum speeds are different, the optional overspeed warning is triggered at different speeds.

1.6 Disclaimer

There are no warranties, representations or conditions, expressed or implied of any kind given in this manual for any particular design application. The Purchaser should independently undertake sufficient testing to confirm validity and suitability of any design. The Purchaser assumes all risks and liability in conjunction with the use of the information given.

Any warranty given by FT Technologies in respect of the Equipment is conditional upon the sensor being handled, installed, integrated and operated in accordance within the guidelines given in this manual.

FT Technologies can take no responsibility for the effectiveness of any sensor lightning protection scheme implemented. The wind sensor has passed a wide range of EMC tests but FT Technologies does not warrant the sensor to survive lightning strikes.

Information supplied by FT Technologies Ltd. shall not be construed as permission to license to operate under, or recommendation to infringe any existing or pending patent, patent applications or trademarks.

2 FUNCTIONAL DESCRIPTION

2.1 Technical Performance

Sensor Performance[1 & 2]

Measurement Principle Acoustic Resonance (compensated against variations in temperature, pressure and humidity)

Wind speed Measurement

	FT722	FT742
Range	0-50m/s	0-75m/s
Resolution	0.1m/s	0.1m/s
Accuracy	±0.3m/s (0-16m/s) ±2% (16m/s-40m/s) ±4% (40m/s-50m/s)	±0.3m/s (0-16m/s) ±2% (16m/s-40m/s) ±4% (40m/s-75m/s)

Knots and km/h options available.

Wind Direction Measurement

Range	0 to 360°	0 to 360°
Accuracy	2° RMS (within ±10° of 0°) 4° RMS (beyond ±10° of 0°)	2° RMS (within ±10° of 0°) 4° RMS (beyond ±10° of 0°)
Resolution	1° (both models)	

Acoustic Temperature Measurement[5]

Units	Celsius, Fahrenheit or Kelvin
Resolution	0.1°
Accuracy	±2°C under the following conditions: Wind speed between 5m/s and 60m/s Temperature Difference < 10°C (Sensor Temp. vs Air Temp.) Operating (air) temperature between -20°C and +60°C

Environment

Temperature Range	-40 to +85°C (operating & storage)
Humidity	0-100%
Altitude	0-4000m

Data I/O

RS485 Interface	Digital RS485 (half duplex), galvanically isolated from power supply lines and case
Format	ASCII data, polled or continuous output modes
Data Update Rate	Up to 10 measurements per second (10Hz)

Power Requirements[3]

Supply Voltage	24VDC nominal (12V to 30VDC)
Supply Current (Heater off)	31mA (typical)
Supply Current (Heater on)	6A (max) – The heater is thermostatically controlled. Heater power consumption will depend on the heater energy required to keep the sensor's temperature at a user determined set point. The heater is limited to 4A and 99W by the default software settings [4].

Physical

Weight	Flat-Front 320g (max). Pipe-Mount 350g (max. excluding adaptor)
Material	Aluminium alloy, hard anodised
I/O Connector	5 way (RS485 option)
Mounting Method	Flat-Front or Pipe-Mount options. Self-aligning, screw fixing

Notes:

1. All specifications subject to change without notice.
2. Specifications calculated with the default settings and filters enabled.
3. See safety instruction requirements (page 5 & 6).
4. The heater set point, current, operational voltage and maximum power limits can be configured at the factory or by programming the sensor's internal parameter settings, see Sections 6.4.15 and 6.4.17, or contact FT technologies for further information
5. Acoustic Temperature accuracy can be affected by the wind sensor heater – user calibration may be required

2.2 Wind Speed Calibration

The wind sensor is calibrated in our wind tunnels before dispatch. As the sensor has no moving parts, there is no need to recalibrate a sensor over its lifetime as no measurement degradation will occur. The sensor's compact strong monolithic shape is designed to prevent accidental transducer movement or damage. FT Technologies' calibration procedure and wind tunnels are designed to give a calibration profile that is within the accuracy limits set in the product technical specification (see Section 2.1). Periodically the accuracy of FT's wind tunnels are compared with the accuracy of an independent wind tunnel to ensure that no drift has occurred.

In exceptional circumstances users may wish to apply additional calibration factors. The sensors have an option to set a User Calibration Table, which can modify the wind sensor's wind speed output (see Section 6.4.24).

The User Calibration Table can be programmed with up to 64 correction factors which are maintained in non-volatile memory. When enabled, the uncorrected wind speed output is adjusted according to the stored User Calibration Table records using linear interpolation. The adjustments are applied to wind speed readings regardless of wind direction.

For further details on user calibration modification using the Acu-Vis 2.0 program please contact FT Technologies.

2.3 Wind Speed and Direction Filtering

It is important that the system does not rely exclusively on a single wind reading for any control decision. A single reading may be inaccurate due to measurement error, turbulence, corruption or interference. It is recommended that an average of wind readings is used. In addition if 100% data availability is required then a second FT sensor or alternative wind sensors should be fitted in addition.

The sensor has optional internal filtering available. This is a digital finite impulse response (FIR) filter, which works by calculating the moving average of a fixed number of previous readings. If filtering is being applied externally, the sensor's output filters can be disabled. If filtering inside the sensor is preferred, the length of the averaging for both wind speed and direction can be independently set (See Sections 6.4.12 & 6.4.13).

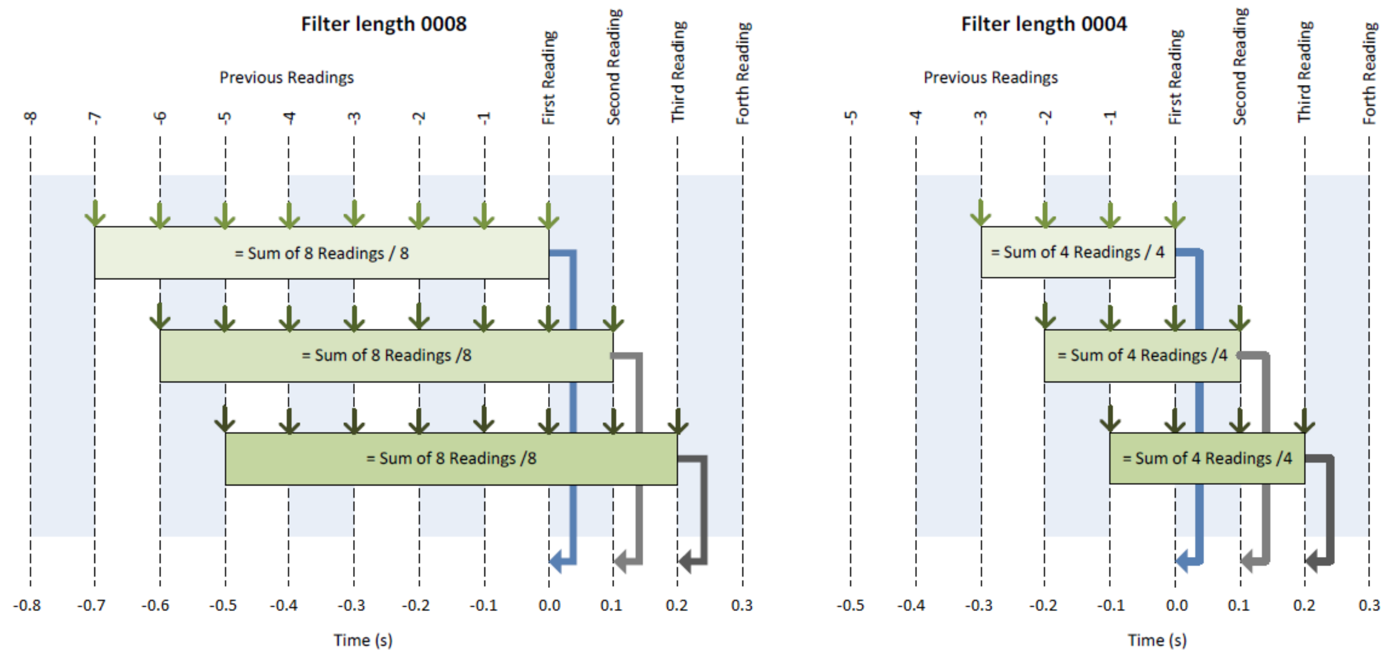


Figure 2: Examples of FIR Filtering

Always use an average of several readings for any calculations or control decisions because single readings can accidentally become corrupted.

2.4 Electronic Rotation of the Datum Direction

The datum direction of the sensor can be offset electronically by using the CF command (Section 6.4.6). This facility can be used to adjust the datum direction in case of any mechanical misalignment within the mounting arrangement. To offset the datum direction, in either the clockwise or anticlockwise direction, use the CF command (Section 6.4.6). Once the offset has been set it will be retained in the sensor Flash memory.

2.5 Selective Filter Scheme

In addition to the averaging filter described in Section 2.3, the sensor has a feature called the Selective Filter. The scheme allows the user to set a "validity period", during which the sensor will exclude invalid readings from entering the averaging filter. The output will freeze on the last previous "good" reading and only raise an error flag once the number of bad readings exceeds the validity period. This scheme can be enabled by factory configuration or by using the FL software command (see Section 6.4.14). The filter is turned off by default to match legacy behaviour.

2.6 Error Detection

The sensor has a self-checking mechanism which can detect if a reading is invalid. On very rare occasions where an invalid reading may have been detected, this is signalled to the computer or data logger by setting an error flag character within the wind velocity output message (see Sections 6.4.30 & 6.4.31).

When an error is detected, the error flag character is set to a value of: 1.

Note: An optional Overspeed Warning Scheme can be enabled (but is disabled by default). See Section 2.7 for further details.

It is important that error flags are not ignored. Data associated with an error flag should **not** be processed as valid wind data. The system should be capable of riding through rare periods when data may be temporarily unavailable. If errors are ongoing (more than several seconds), a reset of the sensor should be applied (see Section 6.4.21 for instructions on sending an RSU command).

It is recommended that errors are monitored and logged. If the frequency of errors has recently increased, then inspection of the sensor for physical blockages may be required (see Section 4.1).

2.7 Overspeed Warning Scheme

During periods where the sensor detects wind speed beyond the rating of the sensor, the sensor will (by default) indicate a general error flag status.

An additional Overspeed Warning Scheme can be enabled: if an overspeed condition is detected (above the highest speed rating), the error flag character will be set to: 2 (see Sections 6.4.30 and 6.4.31) unless a general error condition is also detected. Not all high speeds can be detected and may report as the regular error flag 1 instead.

To comply with legacy behaviour, this scheme is disabled by default.

The Overspeed Warning Scheme can be enabled by software commands (see Section 6.4.20), via the Acu Vis PC software program (see Section 4.4) or enabled in the factory before despatch.

2.8 Heater Setup

The sensor is fitted with an integral three-element distributed heater that can be used to prevent icing-up of the sensor in freezing temperatures. The heater is controlled automatically by the sensor using a user programmable 'set point' temperature. The sensor uses a control scheme which dynamically changes the current supplied to each individual heater element in order to maintain the programmed set point temperature.

It is important to consider the resistive losses in the cable and rate the cable appropriately. In general, power losses in the cable should be minimised in order to maximise the available heating power to the sensor. A heater setpoint temperature of >30°C is recommended for most applications. To change the heater set point or to disable the heater use the Acu-Vis test software or the HT RS485 software command (see Section 6.4.15).

Since the heater circuit is thermostatically controlled, the actual power being drawn from the supply will depend on the programmed set-point and the environmental conditions (i.e. ambient temperature, wind speed, precipitation etc.). The maximum power that the sensor can consume is by default software limited to 99W (with the heater enabled). The power supply must be rated to provide the maximum power that the sensor can consume.

The maximum current limit of the sensor can be adjusted between 0.1 and 6.0 Amps (from the default of 4 Amps and in increments of 100mA). By default the heater requires a minimum of 11VDC for operation. The heater activation voltage and the maximum current limit can be changed at the factory, using the Acu-Vis test software or the HTL software command (see Section 6.4.17).

If the sensor is powered up and there is a possibility it has become iced, it is recommended that the sensor is allowed to heat up for 30 minutes, followed by a User Reset Command (see Section 6.4.21) to permit the sensor to initialise correctly without ice blockage.

2.9 Acoustic Temperature

The Acoustic Temperature feature takes a measurement of the ambient temperature via measurable acoustic properties of the airflow. Sections 6.4.2, 6.4.3 and 6.4.4 describe related software commands.

The averaging system can be performed for 0 to 50 seconds (in increments of 10 seconds), or between 1 to 10 minutes (in increments of 1 minute).

See Section 2.1 for details regarding operating specifications. Operation with high temperature gradients (between sensor body and ambient airflow), extreme humidity levels and low wind conditions (below 5m/s) may result in reduced accuracy.

Caution: The acoustic temperature feature requires calibration at FT Technologies. If the sensor has had a software upgrade to 7.5 (or above) then the data will be uncalibrated and may not comply with the official specification. Testing is recommended to confirm suitability for the application.

3 MECHANICAL INSTALLATION & LIGHTNING PROTECTION

Two mounting options are available and have different mechanical dimensions and properties. The Flat-Front sensor allows for simple mounting against a flat bar using a single screw, nut and washer. The Pipe-Mount sensor offers enhanced cable protection from environmental factors and an improved low-impedance ground path for lightning protection - the pipe mount sensor may be preferred for difficult or lightning-prone areas. See Section 3.1 for Flat-Front sensors, Section 3.2 for the Pipe-Mount sensors.

Ensure the airflow into the sensor is not obstructed or influenced by nearby objects. We recommend a minimum clearance distance of 20cm between the sensor and other objects.

- See safety instruction requirements on pages 5 & 6.
- The wind sensor installation must be properly designed to ensure the correct operation of the sensor. This section is for guidance only. It is the responsibility of the designer and installer to ensure that the installation and its design is fit for purpose. Please see the Disclaimer in Section 1.6.

3.1 Flat-Front Sensors

3.1.1 Mechanical & Electrical Integration

The flat-front model has a flat contact area used to attach the sensor onto a mechanical bracket.

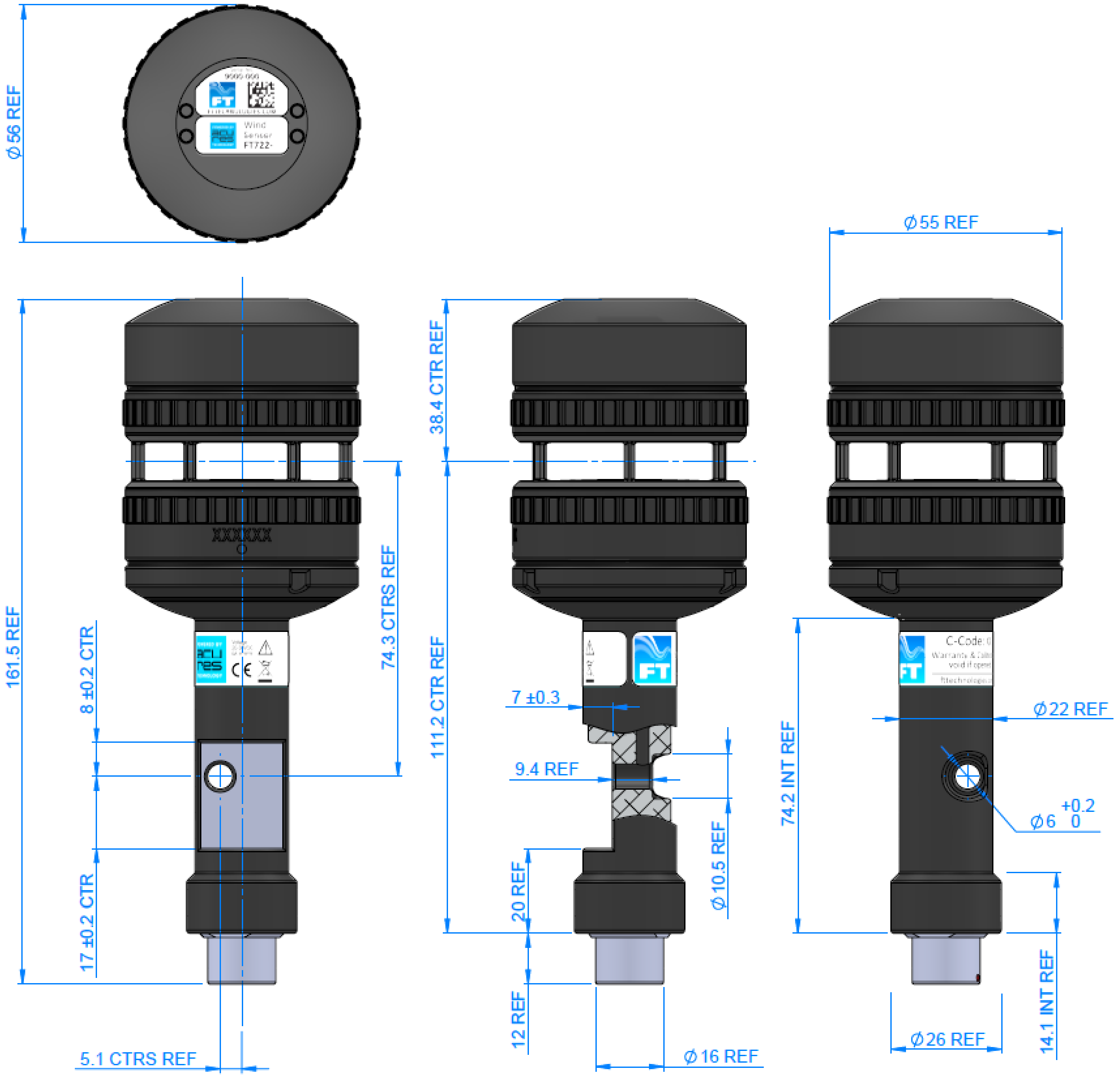


Figure 3: Flat Front Wind Sensor

The sensor measures the wind direction relative to the mounting flat and bar. When the wind sensor is correctly aligned the wind direction measurements will be as shown in Figure 4.

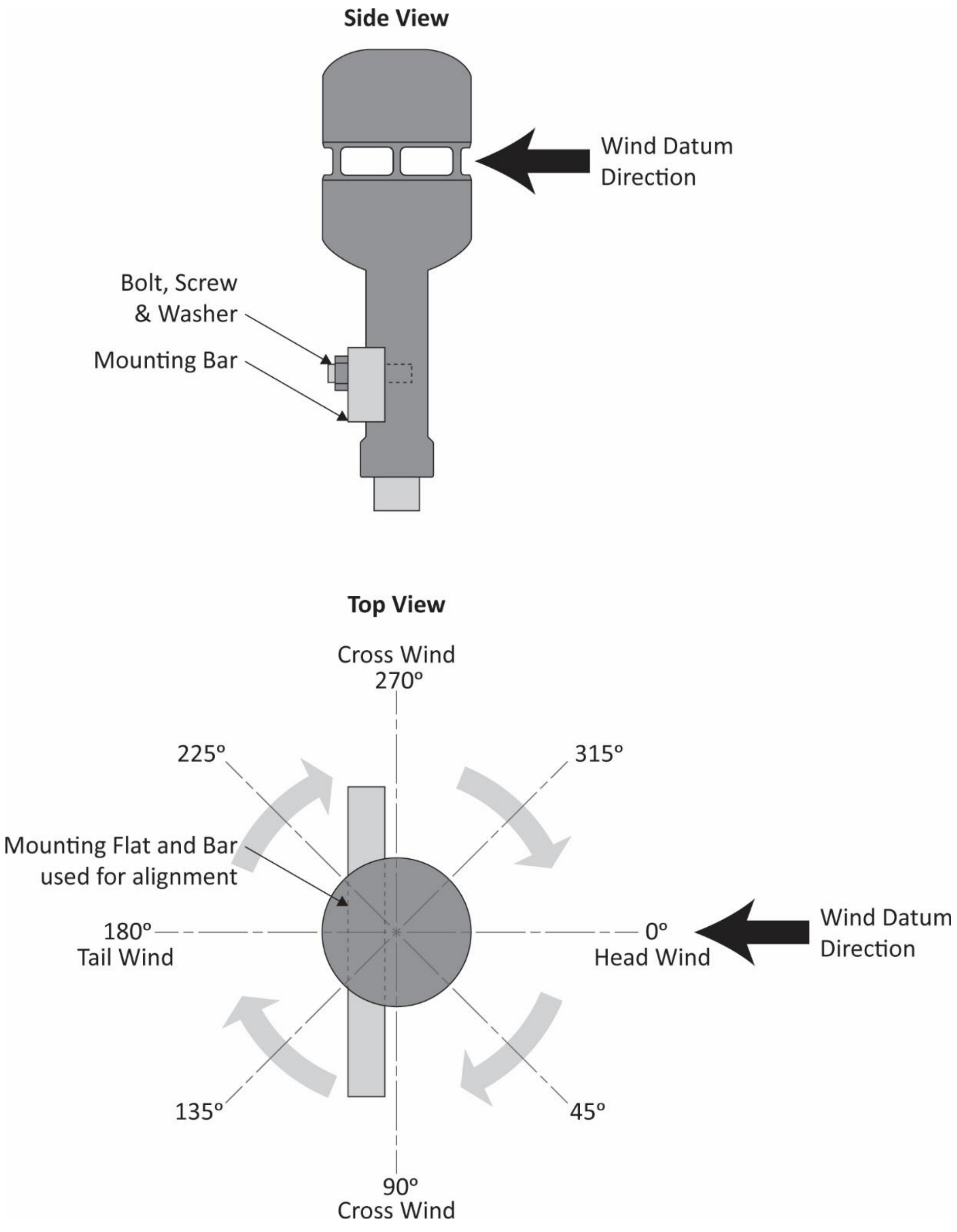


Figure 4: Correct Sensor Alignment

The Flat-front option is designed to be mounted using an M6 socket head cap screw, nut and washer made from galvanised steel.

The mounting flat on the support tube of the sensor (see Figure 5) allows for firm fitting against a flat surface. The preferred material of the mounting bar is an appropriate grade of aluminium. As an alternative hot dipped galvanised steel can be used (aluminium is preferred as it provides superior thermal conduction in icing conditions). If galvanised steel material is selected, the mounting bar should have a minimum galvanising thickness of 50µm to ensure long-term protection against corrosion. The galvanising quality should conform to ASTM A123, Standard Specification for Zinc (Hot-Dip Galvanised) Coatings on Iron & Steel Products.

The mounting flat of the sensor is provided free of coatings to allow for a good electrical connection between the body of the sensor and ground through the mounting bar. In order to protect the mounting surface against corrosion, a very thin layer (<0.2mm) of electrical joint compound should be applied. An example of this could be AFL Global's Electrical Joint Compound # 2. It should be applied directly to the sensor's mounting surface, whilst avoiding the fixing hole. Use of an electrical joint compound will also help to maintain long-term low impedance connection to ground. This connection should be checked as part of a service inspection of the sensor, as detailed in Section 4.

Some electrical joint compounds contain fluoride etchants which may react with certain materials. Material compatibility should therefore be checked prior to application (refer to the electrical joint compound manufacturer's data).

In order to keep the pressure within the sensor equalised with the atmospheric pressure, a small breather hole is located within its support tube. It is therefore important that the airway to this breather hole be kept clear. This can be achievable by cutting a small 3mm channel in the mounting bar as shown (see Figure 5).

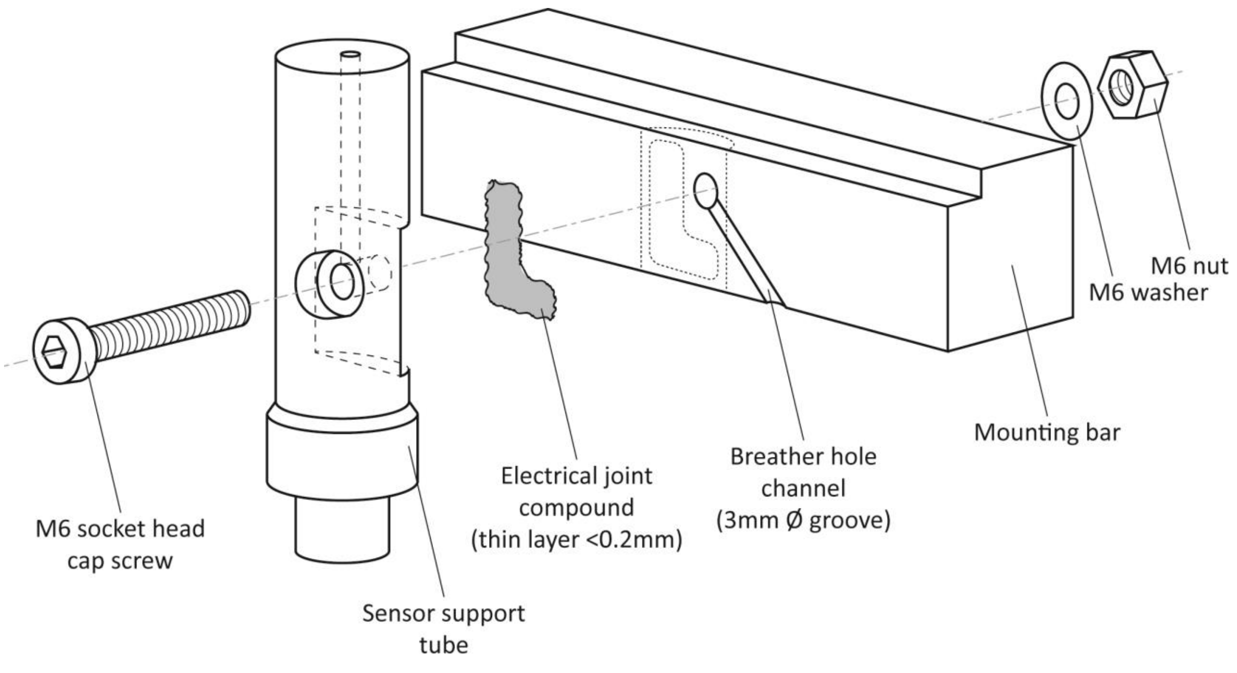


Figure 5: Sensor Installation

It is recommended that a protective sleeve be fitted over the base of the sensor and the connector. This will provide environmental protection as well as stress-relief from vibration. Heat shrink or cold shrink would be suitable for this purpose. FT offers a cold shrink solution which is available on request (part number FT909). The sleeve should cover the lower part of the support tube, the connector itself and at least 25mm of cable (see Figure 6).

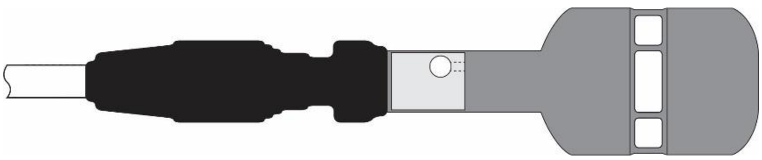


Figure 6: Flat-Front sensor with protective sleeve

3.1.2 Connector Details

All electrical connections are made to the digital sensor via a 5-way multipole connector located in the base of the wind sensor housing. The connector pin designations are shown in Figure 7 and the connector/mating connector manufacturer's part numbers in Figure 8.

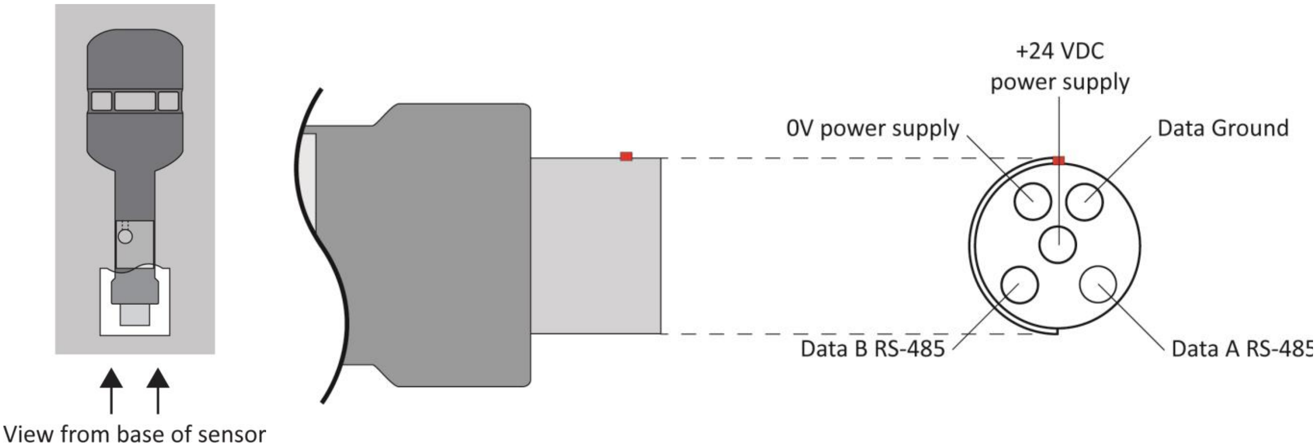


Figure 7: Sensor Connector Pin

Manufacturer	Connector Type	Connector Description	Manufacturers Part Number	Maximum Outer Cable Diameter
W.W.Fischer	RS485 Cable Side Connector	5 way plug	SE104Z053-130/8.7	8.0mm
ODU	RS485 Cable Side Connector	5 way plug	SX2F1C-P05NJH9-0001	9.2mm

Figure 8: Connector Sourcing Options

3.1.3 Cable Details

The mating connectors are suitable for use with cables with overall diameters as per the table above and for individual cores of diameters of up to 1.2mm. Cable such as SD980CPTP 3x2x0.5mm² from SAB Brockskes or similar types may be used. Care must be taken to ensure that the cable is suitable for the environment it will be used in and is adequately approved, for example AWM Style 21198.

In an area with a moderate or severe lightning strike exposure the cable shield may not provide sufficient protection. In this case the cable will require further shielding such as being enclosed in a metal pipe or conduit.

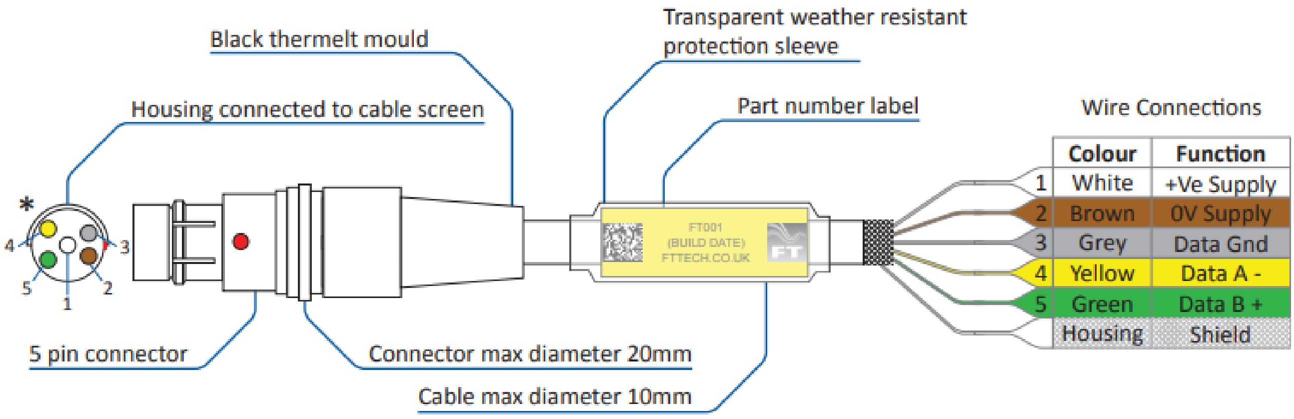
FT can supply cables with a mating connector leading to bare wires at the other end, for connection to user systems. The digital version of the -FF and -PM sensors use either the FT001 (15m) or FT007 (5m) digital cable. Note: 4-20mA sensors use a different (8-way) connector and will require an alternative cable.

Please ensure that when sourcing cables from alternative sources that the cables are suitable for the requirements and the cable wiring is equivalent. The sensor is protected against common miswiring events within the operating range of the sensor.

For further details of cables and accessories please visit the FT website at https://www.fttechnologies.com/Wind-Sensors/Accessories

FT can also provide Acu-Test cables allowing operators to view wind speed and direction data with the Acu Vis software. These cables are intended for short testing periods and are not suitable for long-term datalogging. Please see Section 4.4 for further details.

FT001 and FT007



Specification

Part No.	FT001	FT007
Length	15 m	5 m
Weight	1.3 kg	0.5 kg
Use with	RS485 wind sensors FT702LT, FT722-D & FT742-D	
Temp. Range	-40 to +85°C	
Min. bend radius	57 mm	
Max. Cable Rating	6 A	
Wire thickness	$0.5mm^2$ / AWG21	

Please contact info@fttechnologies.com for further details.

Figure 9: Cable Specifications

3.1.4 Lightning, Surge & EMI Protection

It is important to install the sensor with appropriate protection against lightning and other sources of electromagnetic interference in order to maximise its chance of survival and continued operation during and after exposure.

Protection against direct lightning effects

The sensor installation must be designed in such a way that a protection zone is created around the sensor so that its body can never be subjected to a direct lightning strike.

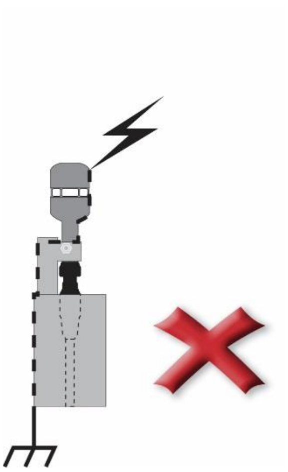


Figure 10: Direct lightning strike

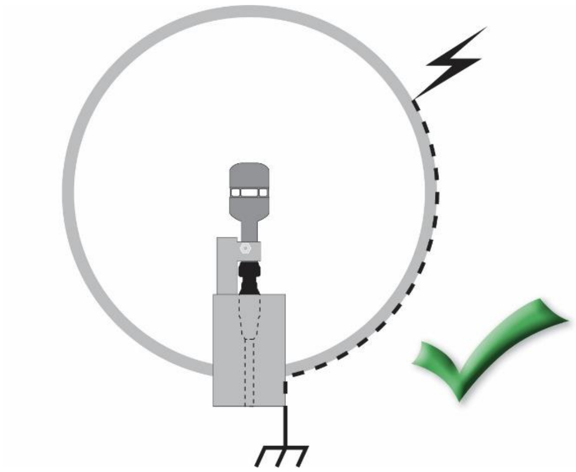


Figure 11: Indirect lightning strike

This level of protection is achievable through the use of conductive structural parts known as “lightning interceptors”. These help to create the protection zone and to divert the majority of the lightning current away to ground.

The lightning interceptor must have a direct connection to ground through metal parts with a minimum cross-sectional area of 50mm^2 (see Figure 13). The length of any grounding wire or strap must be kept to a minimum. This will help to provide the lowest possible impedance path to the ground reference.

The recommended clearance distance between the sensor and the lightning interceptor should be 30x the diameter of the interceptor material, but never less than 20cm (due to aerodynamic factors and an increased risk of lightning flashover).

Figure 12 below shows examples of lightning interceptors and how they can be used to create a protection zone around the sensor. It is recommended that the interceptor is made from an appropriate grade of aluminium or hot-dipped galvanised steel. These materials help to ensure a long-term low impedance connection to ground.

The standards for Lightning Protection of Wind Turbines are described in IEC 61400-24. The installation instructions in this manual should be sufficient to ensure that the lightning protection zone around the sensor will achieve a lightning protection level of LPZ0B as described in the standard.

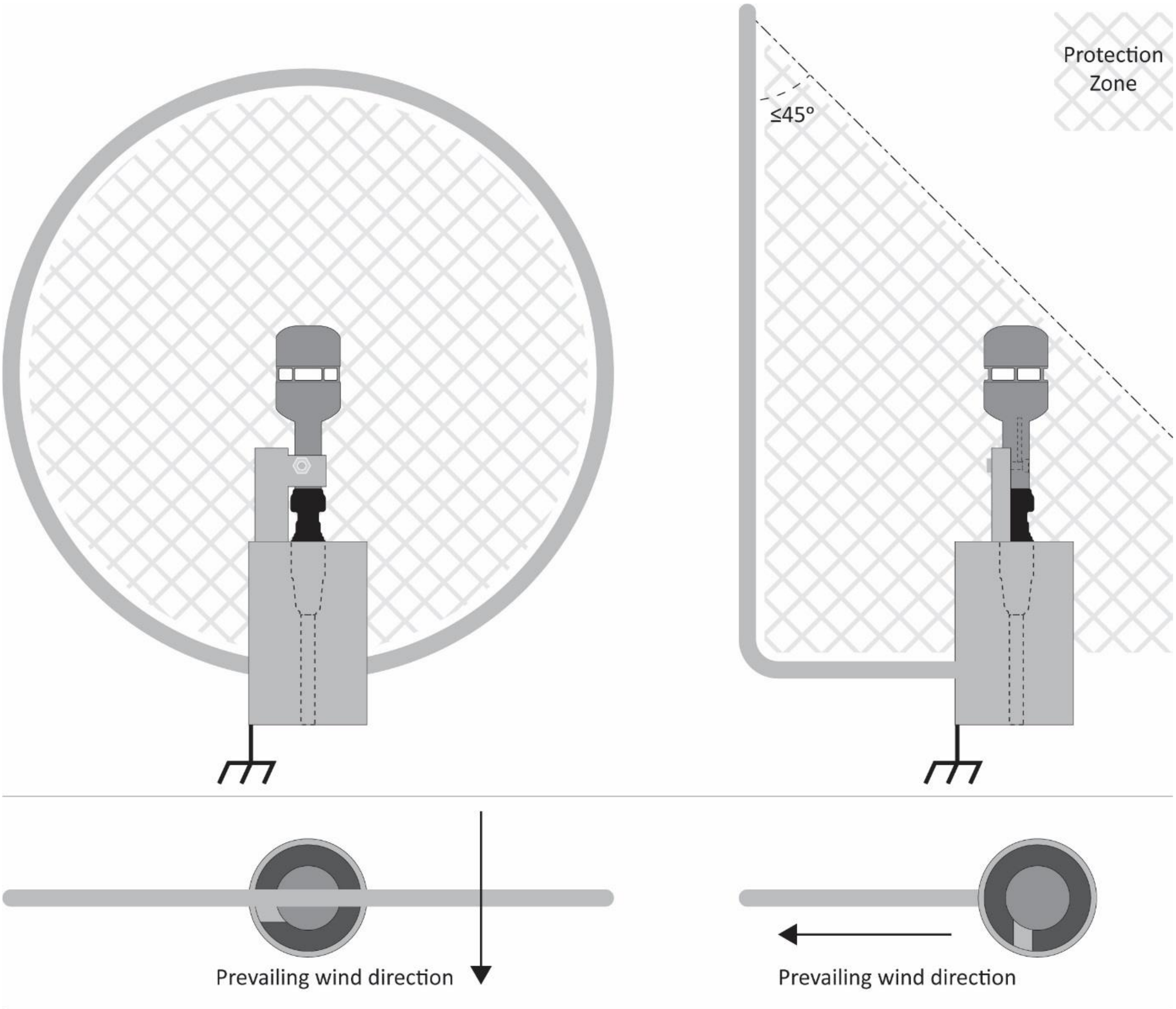


Figure 12: Ring and Rod interceptors

It is recommended that the installation is reviewed by an appropriate lightning design expert. Companies such as GLPS (Global Lightning Protection Systems) can provide design advice.

Protection Against Indirect Lightning Effects & Electromagnetic Interference

Objects within the protection zone described above can still be subject to very high electromagnetic fields and partial lightning surge currents. It is therefore critical that appropriate shielding and termination is used throughout the system to reduce these effects. A shielded signal cable will offer some protection, however it is recommended that double shielding is employed between the sensor and the chassis of the computer and power supply cabinet.

A metal conduit surrounding the shielded cable is a good way of providing this additional protection and will also help to prolong the life of cables and connectors. The impedance of the metal conduit needs to be as low as possible since a substantial proportion of the lightning current will flow in it. An example of metal conduit could be HellermannTyton's HelaGuard steel conduit with plastic coating and steel overbraid.

All cable shielding must be continuous and 360° terminated at both ends using EMC glands or cable clamps with a direct connection to the cabinet chassis. There must also be a direct connection from the cabinet chassis to the grounding reference. Any metal conduit used must also be continuous and terminated at both ends with appropriate fittings. Figure 13 below shows the principle of the protection scheme. The cabinet should be protected with a metallic grounded housing.

① Preferably this connection is established using structural aluminium parts or alternatively by use of a copper cable with a cross section of min. 50mm^2

② Any shielding conduit must be terminated at both ends

③ Shielded cable must either be 360° terminated using a EMC cable gland in the cabinet wall -or alternatively using a cable clamp in direct connection with the cabinet chassis

④ The chassis of the cabinet must have a direct connection to ground

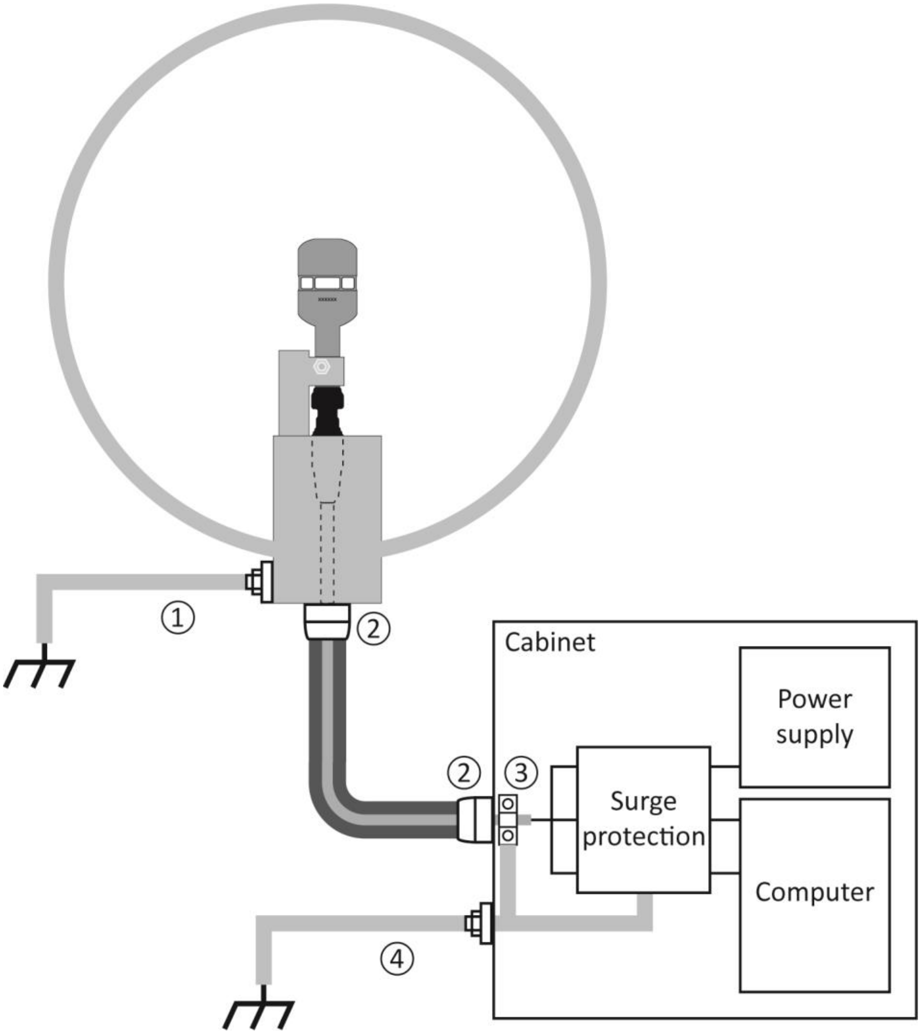


Figure 13: Protection of equipment against indirect effects

Surge Protection

All connections from the wind sensor to any computer equipment and power supply should run through Surge Protection Devices (SPDs). These will suppress any unwanted overvoltage transients present on the signal or power lines. The surge suppression devices should be UL 1449 listed.

The ratings of the SPDs must be suitable for the surge conditions. Assuming that appropriate shielding and termination has been used throughout, then the SPDs used with the sensor should have a minimum surge current rating of 20kA (8/20µs) and be capable of clamping the output below the maximum input voltage accepted by the electronic systems they are connected to. This will prevent any surges or large voltage differences being present at the inputs to the wind sensor, data acquisition electronics or power supply.

The SPDs should be installed as close as possible to the point where the signals enter the cabinet in order to prevent noise propagating to other electronics. The SPDs should also be grounded appropriately. Figure 14 shows how the SPDs should be installed.

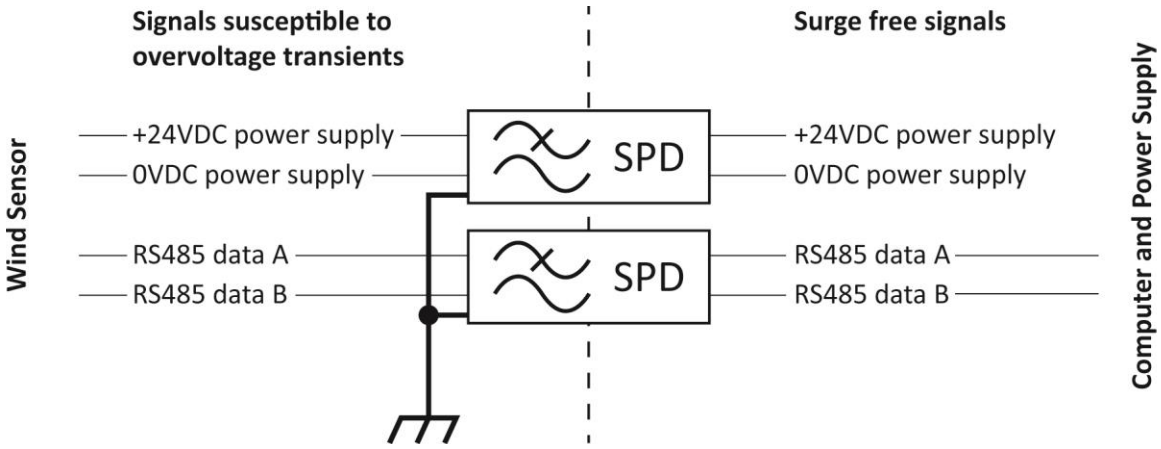


Figure 14: Digital sensor - Interface Surge Protection

The supply pair [24VDC / 0VDC] is electrically isolated from the other lines and the chassis. The triple RS-485 signal wires [Data ground, Data A, Data B] are isolated from the other lines and the chassis. The data ground can be directly connected to the chassis of the data acquisition cabinet.

Some examples of SPDs suitable for this protection are given in Figure 15 below from manufacturers, DEHN & Söhne GmbH. (www.dehn.de) and Phoenix Contact (www.phoenixcontact.com). Users are responsible for ensuring the suitability of these components for their application.

Manufacturer	Type	Manufacturers part number
PSU lines		
Phoenix Contact	Module (x1)	PT 2PE/S 24 AC
RS485 lines		
Dehn	Module (x1) - BCT MOD BE 5 & BCT BAS	919 620 & 919 506
Phoenix Contact	Module (x1)	PT 3-HF-12 DC

Figure 15: Typical SPD configuration used to protect sensor

Figure 16 shows an example of how the wires are up the SPD's inside a Phoenix Contact control cabinet. The termination of the cable shield at the wall of the control cabinet using a cable gland is not shown.

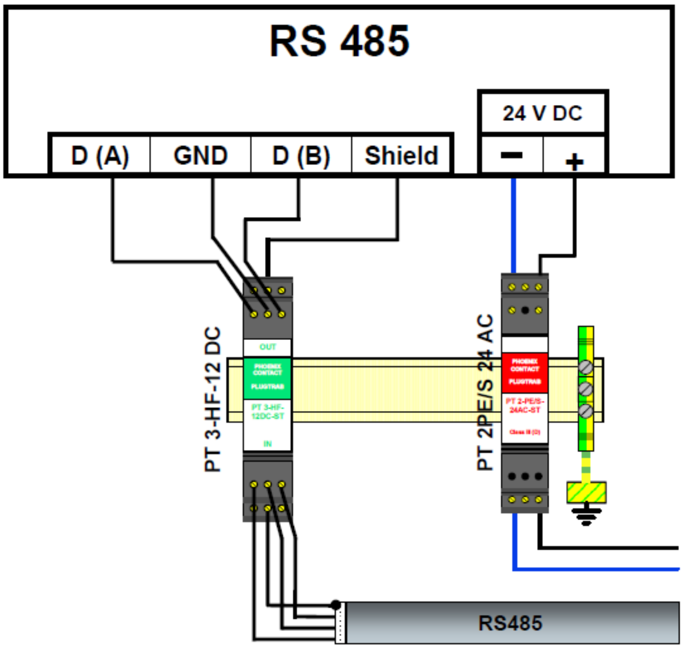
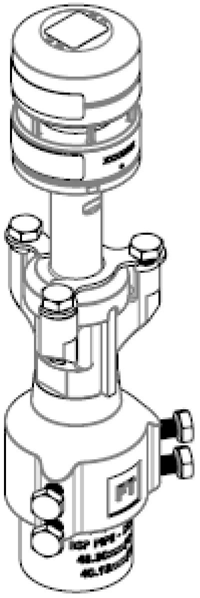


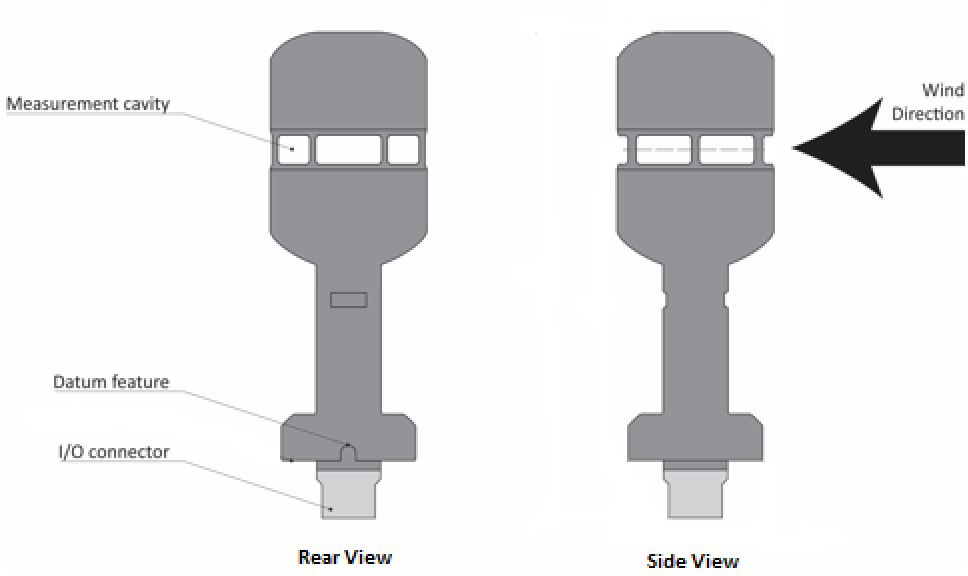
Figure 16: Example of wiring inside a Phoenix Contact control cabinet

3.2 Pipe-Mount Sensors

3.2.1 Mechanical & Electrical Integration

The pipe mount sensor is designed to fit onto the FT Pipe Mount Adaptor (part number FT090). The adapter assembly can then be fitted on top of a variety of pipe sizes (OD 40-51mm).





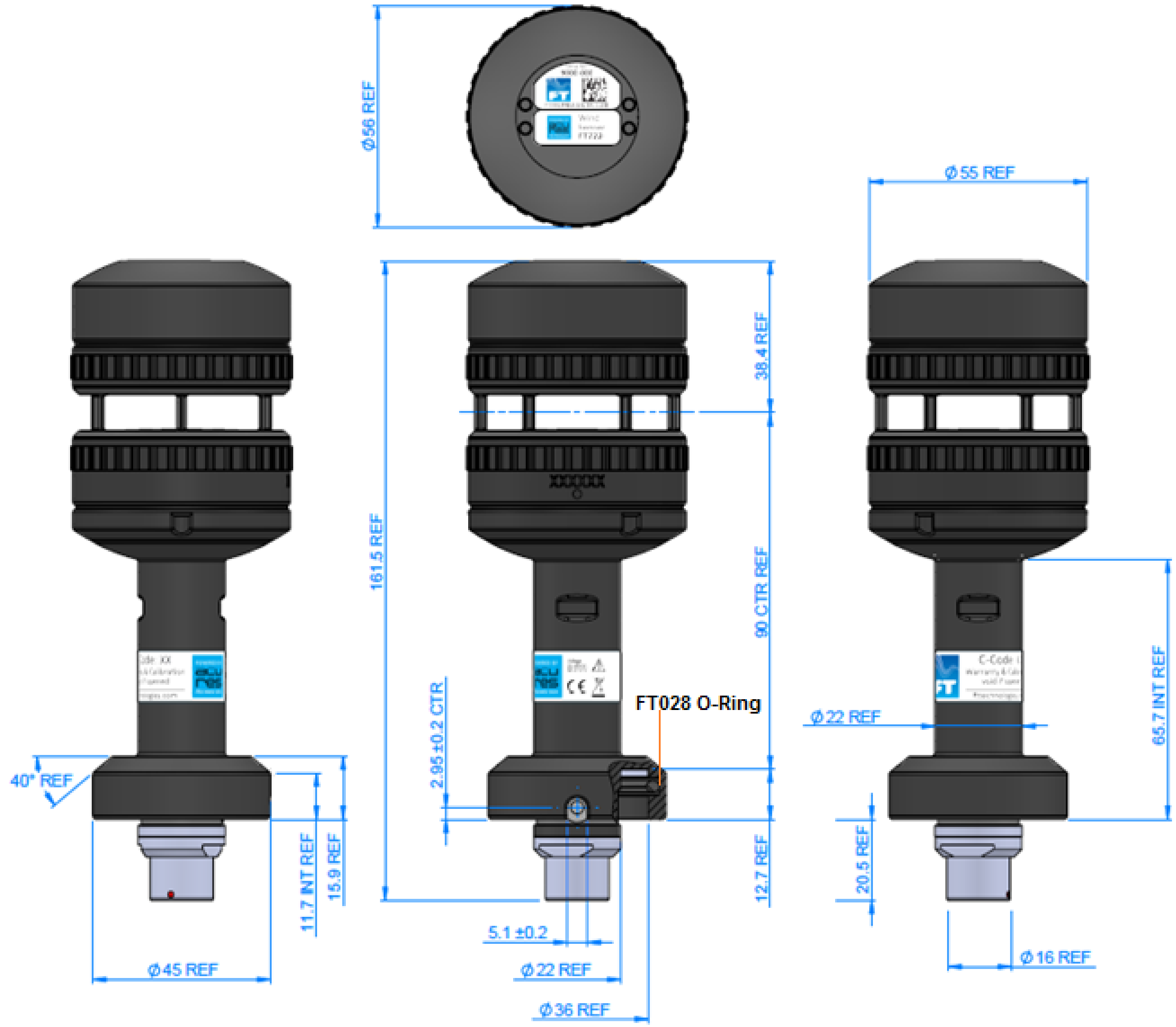


Figure 17: Pipe Mount Sensor

The system ensures that the base of the sensor and connector/cable are sealed inside the pipe and adaptor. This helps to protect against environmental degradation, as well as against the effects of indirect lightning strikes. The FT028 O-ring (see location in Figure 17) is fitted to provide protection to the grounding surface and additional protection for the connector.

The adapter can be secured tightly to the pipe using 4x M8 bolts. The sensor is secured to the adapter using a spring clip and 3 more M8 bolts (supplied with the pipe mount adaptor, part number FT090). The adaptor includes an alignment notch that allows repeatable and accurate orientation. The adapter and spring clip are made from LM25/LM5 series aluminium-magnesium alloy and 5052/5454 grade 'A' aluminium respectively. The M8 bolts have a hot-dip galvanised steel finish.

The vertical pipe should be made of an appropriate grade aluminium (aluminium is preferred as it provides superior thermal conduction in icing conditions), or alternatively hot-dip galvanised steel. If galvanised steel is selected, a minimum galvanising thickness of 50µm should be used to ensure the pipe has adequate long term corrosion protection. The galvanising quality should conform to ASTM A123, Standard Specification for Zinc (Hot-Dip Galvanised) Coatings on Iron & Steel Products.

The pipe should have a direct connection to ground and its top surface should be flat. A liberal amount of electrical joint compound should be applied to this surface before the adaptor is fitted so that a long term low impedance connection to ground is maintained. An example of this could be AFL Global's Electrical Joint Compound # 2.

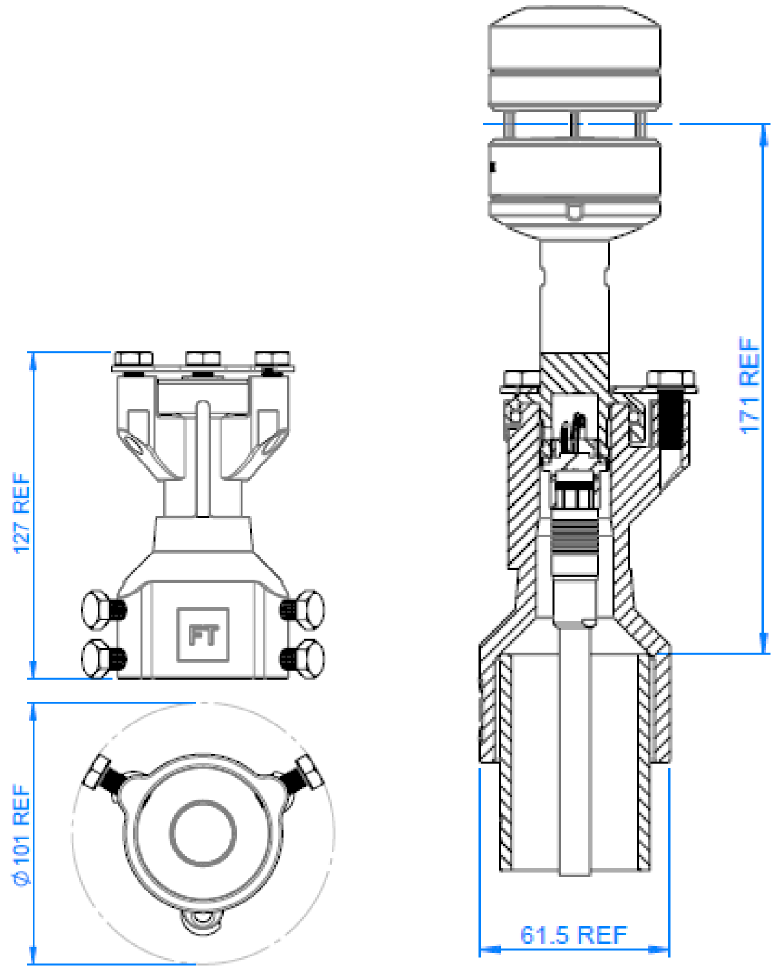


Figure 18: Pipe Mount Sensor and Adapter (all dimensions in mm)

Alignment

The sensor measures the wind direction relative to the 180° rear datum feature (see Figure 19). The pipe mount system is designed for fitting to a vertical pipe. The datum feature can be used in combination with a laser tool to ensure correct alignment and spirit level to ensure that the top of the adapter is flat. The position of the adapter can be adjusted to remove any misalignment if the pipe is constructed slightly off vertical. Once the adapter is aligned correctly the 4 bolts at the bottom of the adapter are used to lock it securely to the pipe, preventing further movement.

The sensor can only fit on top of the adapter in one orientation. If the sensor needs replacing, this can be done without having to realign the adapter.

When the wind sensor is correctly aligned the wind direction measurements will be as shown in Figure 19.

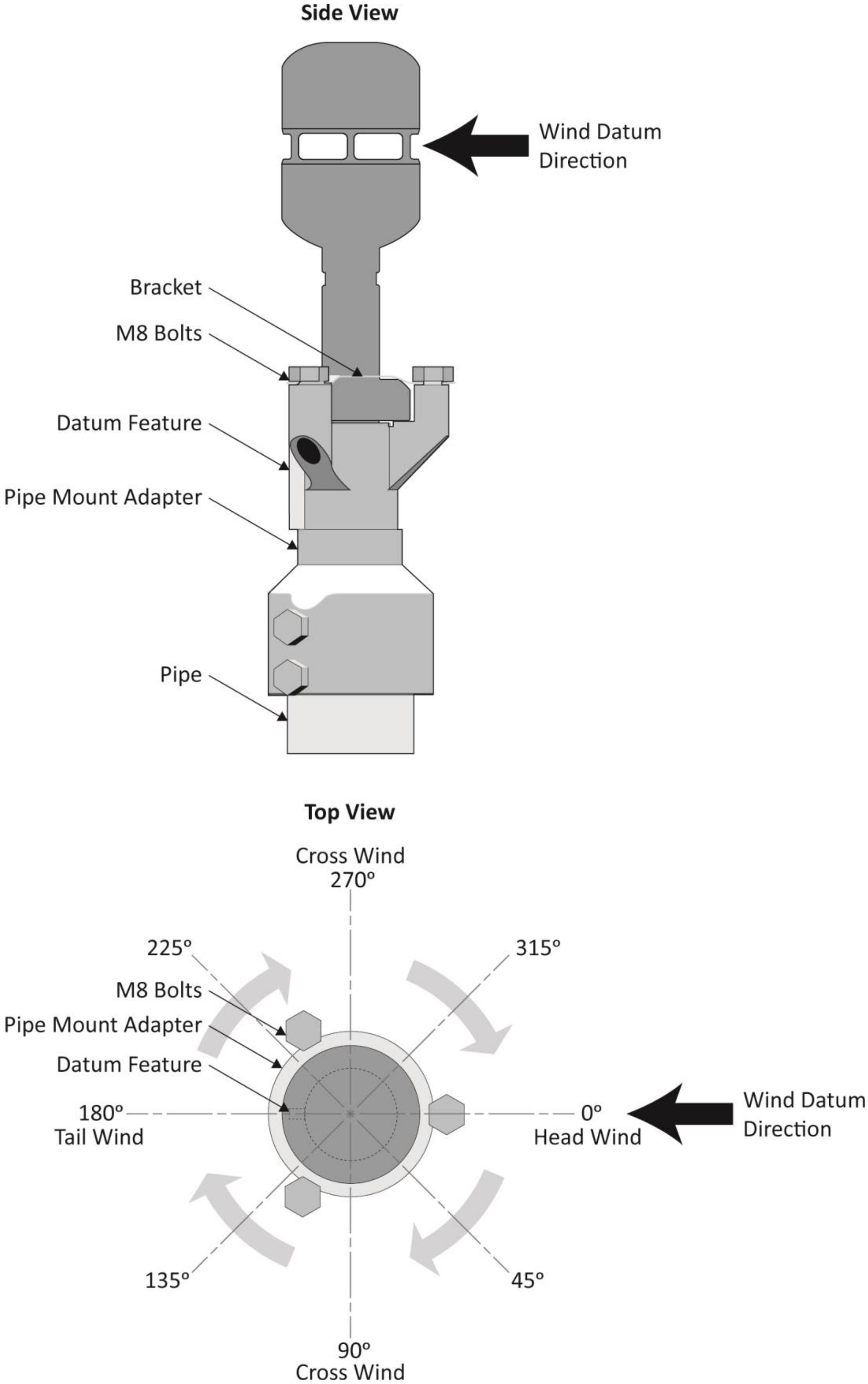


Figure 19: Correct Sensor Alignment

3.2.2 Assembling the Pipe Mount Adapter

Figure 20: Preparing the Adapter

a) The adapter should be fitted onto a pipe with an outer diameter of 40-51mm.
b) The pipe end is to be 172 mm below the desired measuring point; the mid-point of the sensor's measurement cavity.
c) Run the sensor cable up through the pipe and through the adapter (which should not be fitted to the pipe yet) and secure it so that it cannot fall back down inside.

d) Apply a liberal amount of electrical joint compound to the top surface of the pipe
e) Place the adapter on top of the pipe. A spirit bubble can be used to ensure the installation is flat.
f) Rotate the adapter to align the datum feature as required. The datum feature should be at the back of the wind sensor, with respect to the wind direction. A laser alignment tool could be used to ensure accuracy of alignment.
g) Tighten the 4x M8 bolts to fix the adapter securely in position
h) If a gap exists between the side of the pipe and the bottom edge of the adaptor, sealing can be further improved by applying silicone sealant. Suitable sealants could be either Dow Corning 790 Silicone Building or Pecora 864 Silicone Sealant.

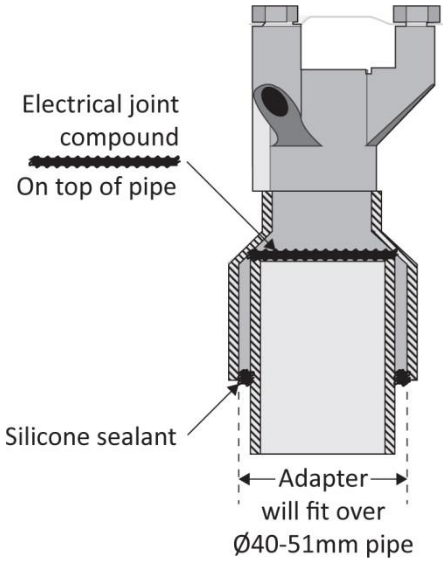


Figure 21: Installing the Adapter

Securing the Sensor

i)

Remove any connector protection caps and mate the cable and sensor connectors.

j)
Place the sensor on top of the adapter, orientated on the datum feature

k)

Slide the bracket over the notch on the wind sensor.

l)

Slide the bracket down to the base and rotate it so that it lines up under the M8 bolts.

m)

Tighten the 3 M8 bolts to secure the sensor to the adapter, preventing any movement.

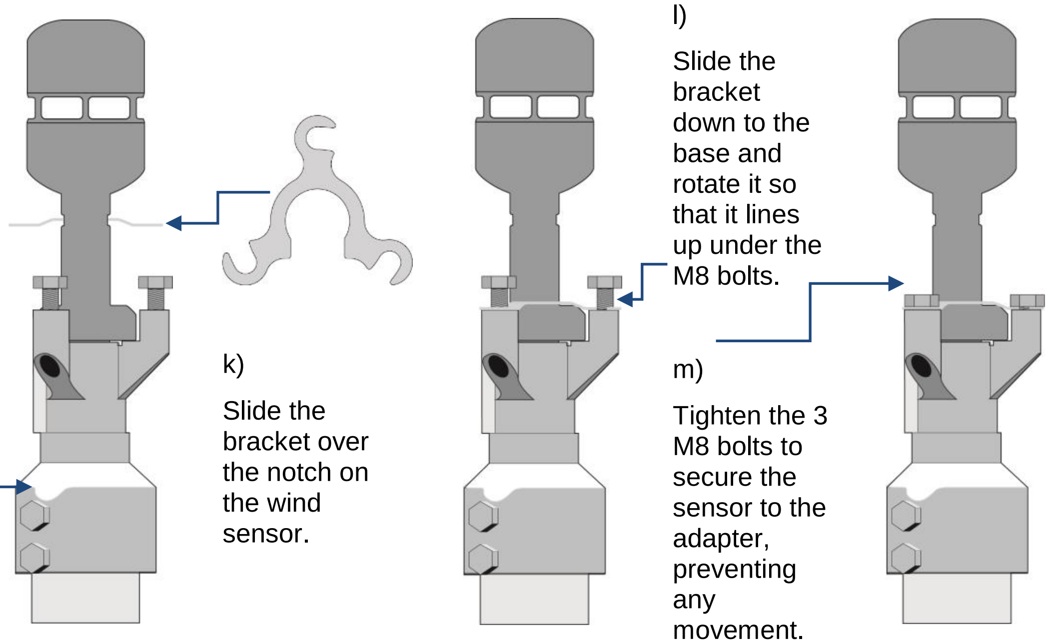


Figure 22: Sensor Installation Instructions

3.2.3 Connector Details

All electrical connections are made to the sensor via a 5-way multipole connector located in the base of the wind sensor housing. The connector pin designations are shown in Figure 23 and the connector/mating connector manufacturer's part numbers in Figure 24.

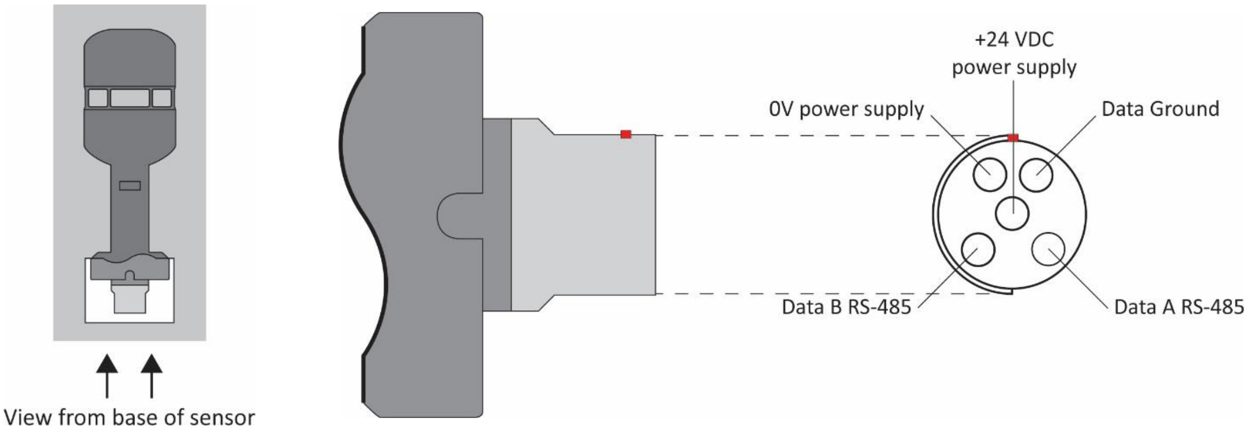


Figure 23: Sensor Connector Pins

Manufacturer	Connector Type	Connector Description	Manufacturers Part Number	Maximum Outer Cable Diameter
W.W.Fischer	Cable Side Connector	5 way plug	SE104Z053-130/8.7	8.0mm
ODU	Cable Side Connector	5 way plug	SX2F1C-P05NJH9-0001	9.2mm

Figure 24: Connector Sourcing Options

3.2.4 Cable Details

The mating connectors for the sensor are suitable for use with cables with overall diameters as described in the table above and for individual cores of diameters of up to 1.2mm. Cable such as SD980CPTP 3x2x0.5mm2 from SAB Brockskes or similar types may be used. Care must be taken to ensure that the cable is suitable for the environment it will be used in and is adequately approved, for example AWM Style 21198.

In an area with a moderate or severe lightning strike exposure the cable shield may not provide sufficient protection. In this case the cable will require further shielding such as being enclosed in a metal pipe or conduit.

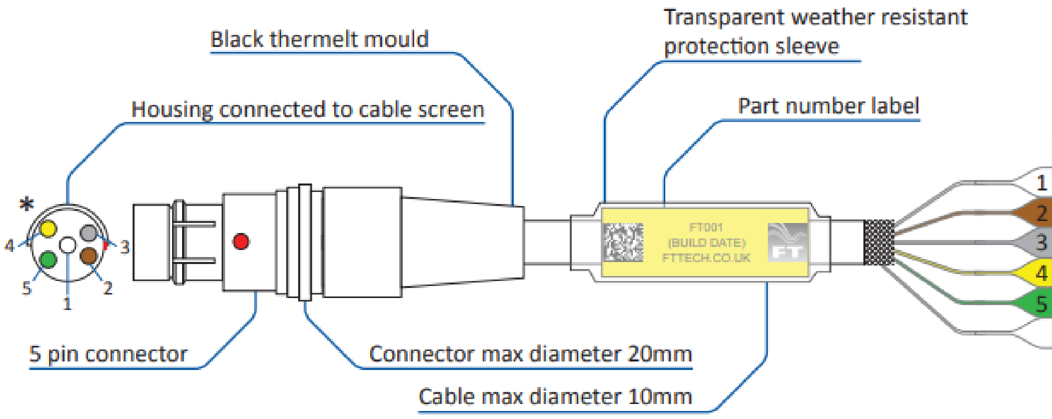
FT can supply cables with a mating connector leading to bare wires at the other end, for connection to user systems. The digital version of the -FF and -PM sensors use either the FT001 (15m) or FT007 (5m) digital cable. Note: 4-20mA sensors use a different (8-way) connector and will require an alternative cable.

Please ensure that when sourcing cables from alternative sources that the cables are suitable for the requirements and the cable wiring is equivalent. The sensor is protected against common miswiring events within the operating range of the sensor.

For further details of cables and accessories please visit the FT website at https://www.fttechnologies.com/Wind-Sensors/Accessories

FT can also provide Acu-Test cables allowing operators to view wind speed and direction data with the Acu Vis software. These cables are intended for short testing periods and are not suitable for long-term datalogging. Please see Section 4.4 for further details.

FT001 and FT007



Wire Connections

	Colour	Function
1	White	+Ve Supply
2	Brown	0V Supply
3	Grey	Data Gnd
4	Yellow	Data A -
5	Green	Data B +
	Housing	Shield

Specification

Part No.	FT001	FT007
Length	15 m	5 m
Weight	1.3 kg	0.5 kg
Use with	RS485 wind sensors FT702LT, FT722-D & FT742-D	
Temp. Range	-40 to +85°C	
Min. bend radius	57 mm	
Max. Cable Rating	6 A	
Wire thickness	0.5mm² / AWG21	

Please contact info@fttechnologies.com for further details.

Figure 25: Cable Specifications

3.2.5 Lightning, Surge & EMI protection

It is important to install the sensor with appropriate protection against lightning and other sources of electromagnetic interference in order to maximise its chance of survival and continued operation during and after exposure.

Protection against direct lightning effects

The sensor installation must be designed in such a way that a protection zone is created around the sensor so that its body can never be subjected to a direct lightning strike.

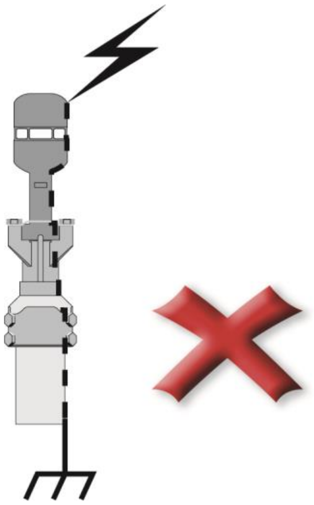


Figure 26: Direct lightning strike

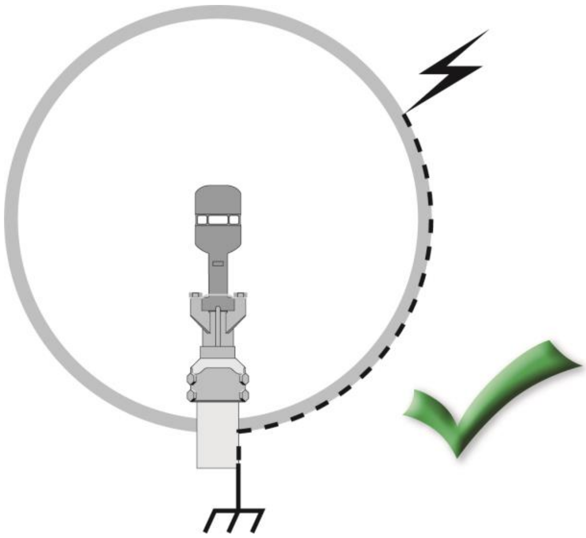


Figure 27: Indirect lightning strike

This level of protection is achievable through the use of conductive structural parts known as "lightning interceptors". These help to create the protection zone and to divert the majority of the lightning current away to ground.

The pipe which the Pipe Mount Adapter is fixed to must have a direct connection to ground and the lightning interceptor must have a direct connection to the pipe. All connections should be through metal parts with minimum cross-sectional area of $50mm^2$. The length of any grounding wire or strap used must be kept to a minimum. This will help to provide the lowest possible impedance path to the ground reference.

The recommended clearance distance between the sensor and the lightning interceptor should be 30x the diameter of the interceptor material, but never less than 20cm (due to aerodynamic factors and an increased risk of lightning flashover).

Figure 28 below shows examples of lightning interceptors and how they can be used to create a protection zone around the sensor. It is recommended that the interceptor is made from an appropriate grade of aluminium or hot-dipped galvanised steel. These materials help to ensure a long-term low impedance connection to ground.

The standards for Lightning Protection of Wind Turbines are described in IEC 61400-24. The installation instructions in this manual should be sufficient to ensure that the lightning protection zone around the sensor will achieve a lightning protection level of LPZ0B as described in the standard.

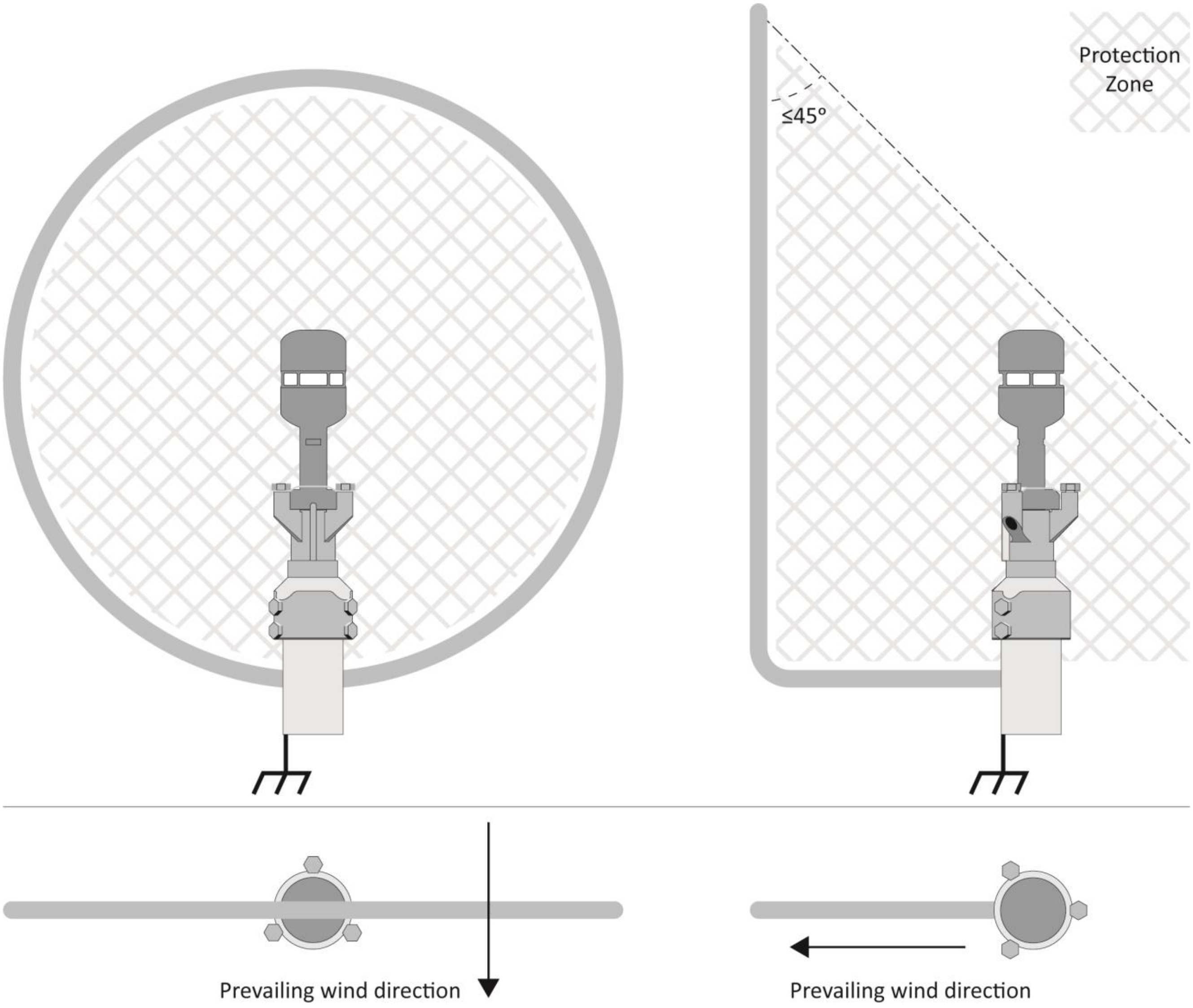


Figure 28: Ring and Rod interceptors

It is recommended that the installation is reviewed by an appropriate lightning design expert. Companies such as GLPS (Global Lightning Protection Systems) can provide design advice.

Protection against Indirect Lightning Effects & Electromagnetic Interference

Objects within the protection zone described above can still be subject to very high electromagnetic field and partial lightning surge currents. It is therefore critical that appropriate shielding and termination is used throughout the system to reduce these effects. A shielded signal cable will offer some protection however it is recommended that double shielding is employed between the sensor and the chassis of the data acquisition and power supply cabinet.

This can be in the form of continuous pipe between the Pipe Mount Adapter and the data acquisition and power supply cabinet. If the pipe is not continuous, then metal conduit surrounding any exposed sections of the shielded cable is a good way of providing this additional protection and will also help to prolong the life of the cable. The impedance of this metal conduit needs to be as low as possible since a substantial proportion of the lightning current will flow in it. An example of metal conduit could be HellermannTyton's HelaGuard steel conduit with plastic coating and steel overbraid.

All cable shielding must be continuous and 360° terminated at both ends using EMC glands or cable clamps with a direct connection to the metallic cabinet chassis. There must also be a direct connection from the cabinet chassis to the grounding reference. Any metal conduit used must also be continuous and terminated at both ends with appropriate fittings. Figure 29 below shows the principle of the protection scheme.

① Preferably this connection is established using aluminium parts or alternatively by use of a copper cable with a cross section of min. 50mm^2

② Any pipe or shielding conduit must be terminated at both ends

③ Shielded cable must either be 360° terminated using an EMC cable gland in the cabinet wall -or alternatively using a cable clamp in direct connection with the cabinet chassis

④ The chassis of the cabinet must have a direct connection to ground

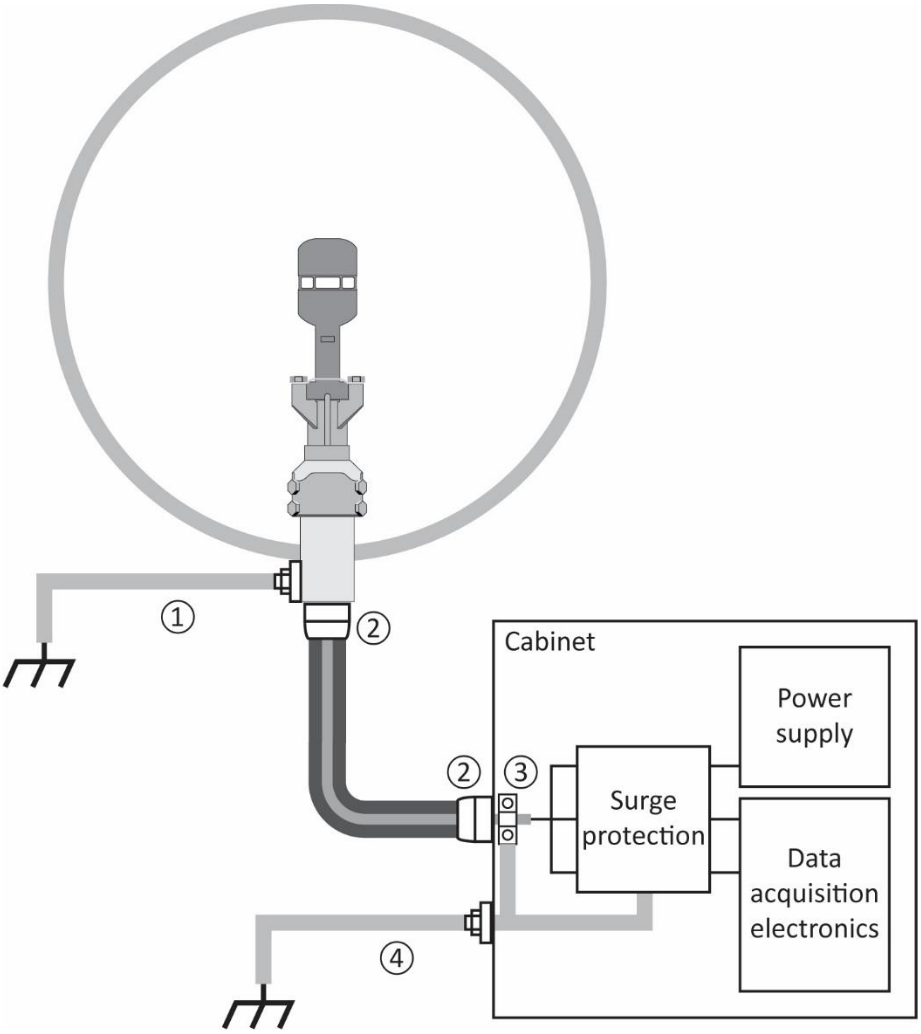


Figure 29: Protection of equipment against indirect effects

Surge Protection

All connections from the wind sensor to any computer equipment and power supply should run through Surge Protection Devices (SPDs). These will suppress any unwanted overvoltage transients present on the signal or power lines. The surge suppression devices should be UL 1449 listed.

The ratings of the SPDs must be suitable for the surge conditions. Assuming that appropriate shielding and termination has been used throughout, then the SPDs used with the sensor should have a minimum surge current rating of 20kA (8/20µs) and be capable of clamping the output below the maximum input voltage accepted by the electronic systems they are connected to. This will prevent any surges or large voltage differences being present at the inputs to the wind sensor, data acquisition electronics or power supply.

The SPDs should be installed as close as possible to the point where the signals enter the cabinet in order to prevent noise propagating to other electronics. The SPDs should also be grounded appropriately. Figure 30 shows how the SPDs should be installed.

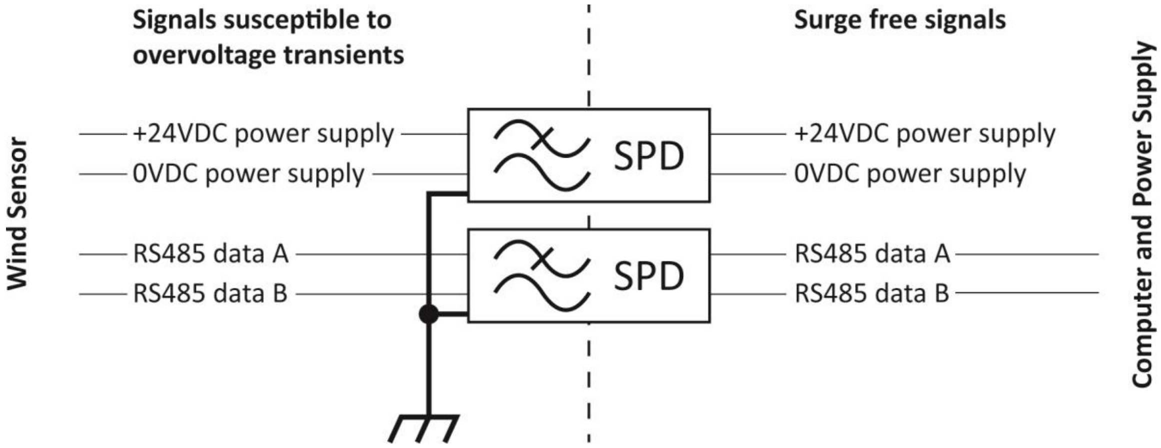


Figure 30: Digital interface surge protection

The supply pair [24VDC / 0VDC] is electrically isolated from the other lines and the chassis. The triple RS-485 signal wires [Data ground, Data A, Data B] are isolated from the other lines and the chassis. The data ground can be directly connected to the chassis on the control cabinet.

Some examples of SPDs suitable for this protection are given below in Figure 31, from manufacturers DEHN & Söhne GmbH (www.dehn.de) and Phoenix Contact (www.phoenixcontact.com). Users are responsible for ensuring the suitability of these components for their application.

Manufacturer	Type	Manufacturers part number
	PSU lines	
Phoenix Contact	Module (x1)	PT 2PE/S 24 AC
	RS485 lines	
Dehn	Module (x1) - BCT MOD BE 5 & BCT BAS	919 620 & 919 506
Phoenix Contact	Module (x1)	PT 3-HF-12 DC

Figure 31: Typical SPD configuration used to protect sensor

Figure 32 shows an example of how the wires are up the SPD’s inside a Phoenix Contact controller cabinet. The 360° termination of the cable shield at the wall of the controller cabinet using a cable gland is not shown.

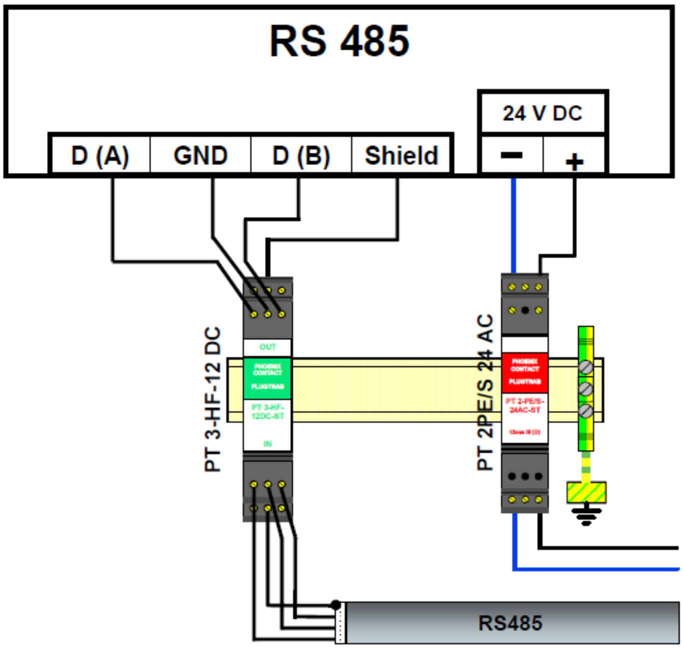


Figure 32: Example of wiring inside a Phoenix Contact controller

4 SERVICE, CONFIGURATION & TESTING

4.1 Inspection

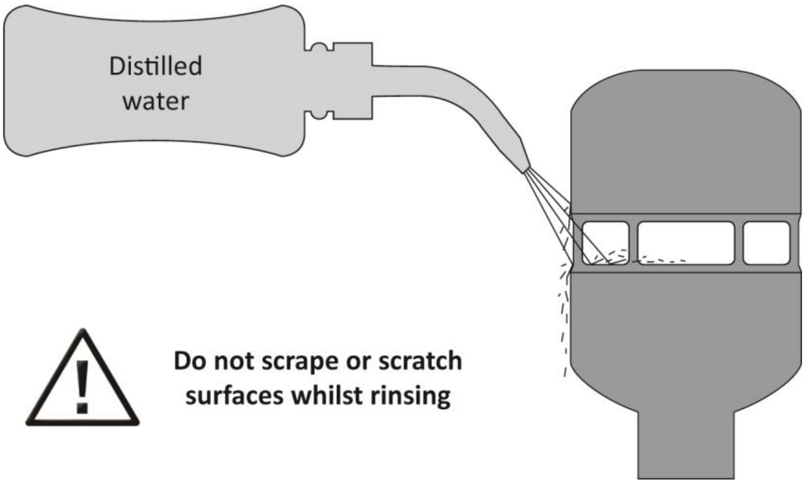
The following checks are required to identify any signs of corrosion or damage on the sensor which may hinder its performance. It is recommended that these checks be carried out annually.

Mechanical Damage: Check the sensor body for signs of damage, paying particular attention to the seals. Also inspect for signs of lightning damage which may appear as burns or scorch marks (or burnt smells). If damage has occurred replace the sensor immediately. Inspect the hydrophobic cavity coating for wear, corrosion and damage.

Corrosion: Inspect the mounting surface of the sensor and the surfaces of other mounting parts for signs of corrosion. If corrosion is present on the mounting interface, it should be removed using an abrasive cloth. Before reinstalling the sensor, electrical joint compound should be applied to the sensor's uncoated mounting surfaces (see Section 3). Check that any mounting screws, nuts and washers are in good condition with no signs of corrosion and tighten as necessary. If corrosion is present replace with parts of the appropriate finish (see Section 3).

Interconnection Cable: Inspect the condition of the cable. If any part has become frayed or damaged in any way, it should be replaced immediately. Intermittent cable faults may not be visible, but may show up as errors in data. Confirm the intended network component values.

Connector Protective Sleeve ('Cold-Shrink': Check for any signs of damage or degradation to the connector protection. If the sleeve is damaged it should be replaced (FT offer a protective sleeve 'cold shrink boot' on part number FT909).



Cleaning: The measurement cavity has a special hydrophobic coating (water repelling) which helps to prevent water building up. When water enters the measurement cavity the surface helps to wash away dust and debris which may have settled. If any debris is present this can be removed by gently rinsing the measurement cavity surface with distilled water using a laboratory wash bottle or similar. Please note excess water droplets can be removed by lightly blowing or shaking the sensor.

Do not scrape or scratch the surfaces whilst rinsing. **Under no circumstances** should objects be inserted inside the measurement cavity, as this can cause irreparable damage. If the coating has been damaged then it may need to be reapplied. The body of the sensor can be washed if required using the same method as described above. Whilst washing the sensor care must be taken not to get water in the breather hole or into the connector at the base of the sensor.

Do not use cleaning chemicals to clean the sensor. If washing a nearby item protect the sensor with a suitable cover. Ensure the cover is removed before re-enabling the wind data survey.

4.2 Fault Finding & Troubleshooting

To determine whether a sensor has a fault carry out the following steps:

- Follow the inspection procedure above to identify signs of physical damage.
- Remove any objects or insects lining the cavity or blocking the airflow.
- Reset the sensor (RSU command or power-cycle).
- Test that the sensor is communicating properly using the Acu-Test Evaluation Pack (see Section 4.4)

If there are signs of physical damage and/or the sensor is failing to communicate properly, it should be replaced. Sensors may be returned to FT Technologies for further analysis if required (see Section 4.3).

⚠ **Warning – The sensor contains no user serviceable components. Do not attempt disassembly as damage may result and product warranties will be invalidated.**

During extreme weather conditions there may be periods where data is temporarily unavailable. However there are ways to mitigate against these affects. The following steps should be taken to ensure the highest levels of data availability from the sensor:

- Using the Acu-Test Evaluation Pack:

- Check that the sensor has the latest version of software (please contact FT Technologies for more information on latest software releases)

- Check that the heater set point is at least 30˚C

- Ensure that the internal filtering in the sensor is enabled (see Section 6.4.12)

* Check that the wind sensor data and status flag errors are being processed as per the advice in Sections 6.4.30 & 6.4.31.

* Ensure the sensor has been installed with adequate lightning and EMI protection (see Section 3) and the cable shielding is terminated at both ends. All mating surfaces must be free of paint and corrosion so that impedances between the sensor and ground are kept as low as possible.

* Check that the measurement cavity's special coating is in a satisfactory condition and no debris is present. Debris can be blown out or washed out with distilled water spray.

Please contact FT Technologies for further information and advice if required.

4.3 Returns

If a sensor appears to be faulty, compile a detailed fault description for each sensor, then contact FT Technologies to request a Returns Materials Authorisation (RMA) form. Please complete the form and return as instructed. Returns cannot be accepted without prior approval via this authorisation form.

Units damaged by lightning or disassembled by the customer cannot typically be repaired, however an inspection fee may still apply.

4.4 The Acu-Test Evaluation Kit

FT can provide Acu-Test Evaluation Kits and power supplies to assist users with connection, development and test of the FT sensors. The kit connects the sensor to a power supply and a Windows PC using virtual COM ports. The USB test cables converts RS485HD to USB.

The models described in this user manual use the FT054 Acu-Test cable:

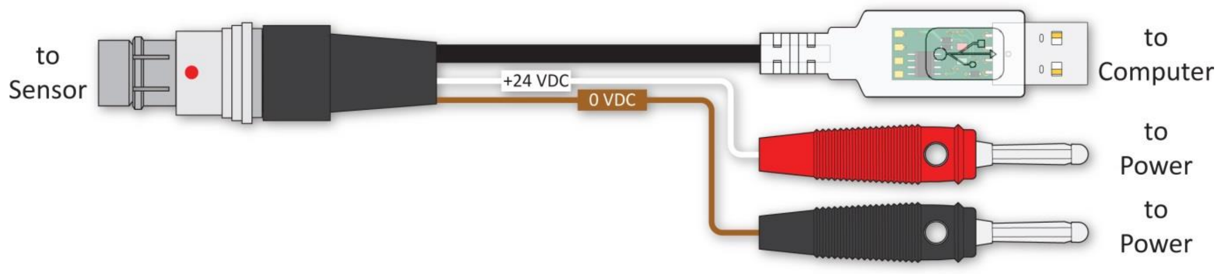


Figure 33: FT054 Acu-Test Evaluation Cable

The Acu-Test Evaluation Kit includes a USB test cable and a CD containing the Acu-Vis software installation files and user manuals. An external power supply capable of 6-30VDC and 4A is necessary, the FT062 power supply may be used where the use of a benchtop electronics power supply is unsuitable.

Note: The FT062 power supply requires a regional C13-style adaptor for mains connection. See Figure 34.

Figure 34: The FT062 Power Supply (left) & Benchtop Electronic PSU Example (right)

The Acu-Test kit allows the user to view and modify configuration settings. The Acu-Test cable is not intended for long-term datalogging use.

Acu-Vis 2.0 software will work on a PC running Microsoft Windows 7, 8, 8.1 and 10.

Note: RS485 half-duplex sensors running in Continuous Update (CU) mode can be difficult to communicate with due to the limitations of half-duplex topology. Contact FT Technologies for assistance or disable CU mode using Acu-Vis 2.0

Caution: Live connection/disconnection of the power and/or sensors during live operation, or miswiring of the power leads could damage the Acu-Test cable and is not covered by FT's standard warranty terms

Warning: Modifying settings may alter the performance of FT wind sensors, ensure the user understands the potential risks

Warning: Users should perform a risk assessment and be suitably trained before attempting to use any electrical equipment. Personal injury may result from unsuitable working practices

4.4.1 Software Installation

1. Insert the Acu-Vis 2.0 CD into the PC. Begin the installation by running the setup.exe file, it may be necessary to contact an IT administrator. Follow the on-screen instructions.

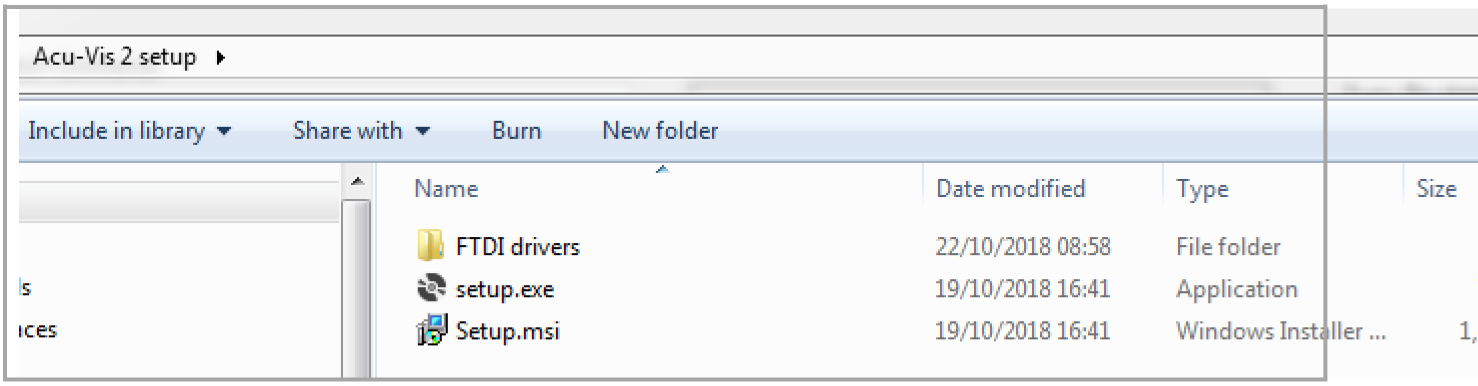


Figure 35: Acu-Vis Install Files

2. Remove the FT742 sensor and USB test cable from their packaging

3. Ensure the power supply is disabled

4. Connect the test cable to the relevant parts: Connect the +24VDC terminal of the power supply to the white wire (red test plug) and 0V terminal to the brown wire (black test plug). Connect the USB to a spare USB PC socket and remove any unnecessary USB devices

Figure 36: Acu-Test Cable Power Connections

5. Windows will automatically detect the USB cable and attempt to update the FTDI drivers

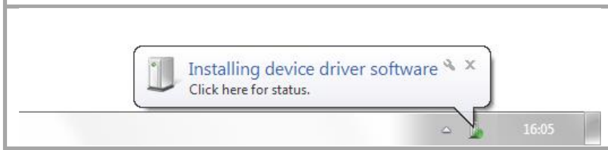
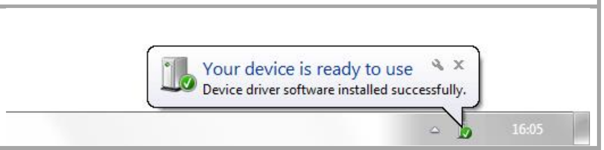
Please wait for Windows to install the hardware	Ready for use
	

Figure 37: Windows driver installation sequence

6. When the user is ready to operate the sensor - enable the power. When using a benchtop PSU ensure the required voltage is supplied (6-30VDC) and the current output is enabled

7. Once the above sequence is complete, wait approximately 5 seconds and then run Acu-Vis 2.0 by selecting the shortcut icon on the desktop or from the start menu in the FT Technologies folder.

Figure 38: Acu-Vis Windows Launch Icon

8. If you need to change the Acu-Test cable it is recommended to press the 'Disconnect' button and follow the exit process, close the Acu-Vis program and then disable the power. Remove the USB cable and replace with the required cable

In case of technical issues please contact the technical support team at FT Technologies.

4.4.2 Acu-Vis 2.0 Software Operation

Acu-Vis 2.0 opens on the Connect display window - press the green 'CONNECT' button to begin a user session, the program will detect the wind sensor as long as it is powered up and operating normally. If the sensor is in Continuous Update mode Acu-Vis 2.0 will disable it (and provide an option at the end of the session to re-enable it).

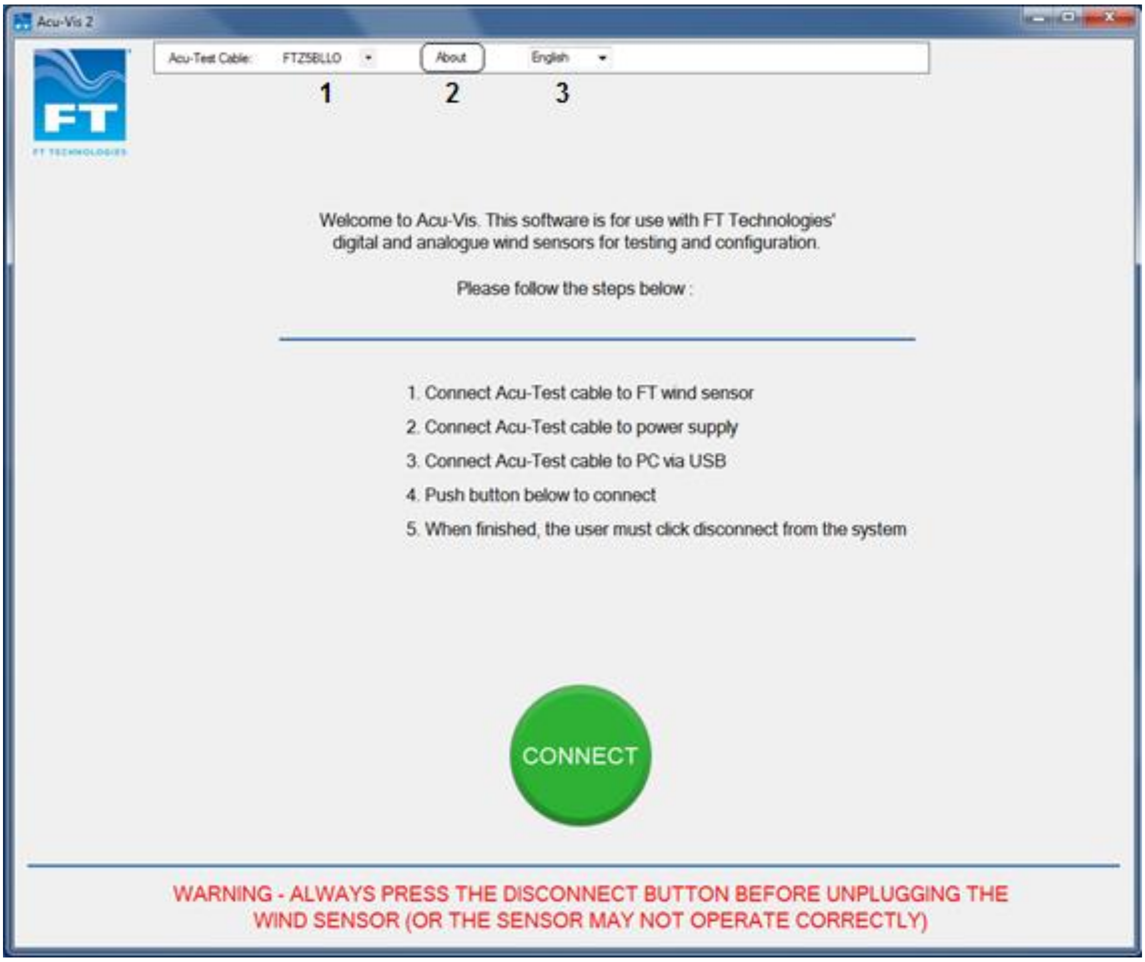


Figure 39: The Acu-Vis Home Screen

1. The Acu-Test cable serial number
2. About Window: FT Technologies contact information and software build versions
3. Language selection options: English, French, Chinese, Spanish, Japanese and Korean

Wind Readings Tab

The Wind Readings display includes sensor settings, real-time wind speed and direction data.

The temperature gauge on the right-hand side shows the Heater Setpoint, Internal Temperature and the 'Acoustic Temperature' ambient air reading.

Note: Acoustic Temperature data requires software V7.5+ and an FT temperature calibration

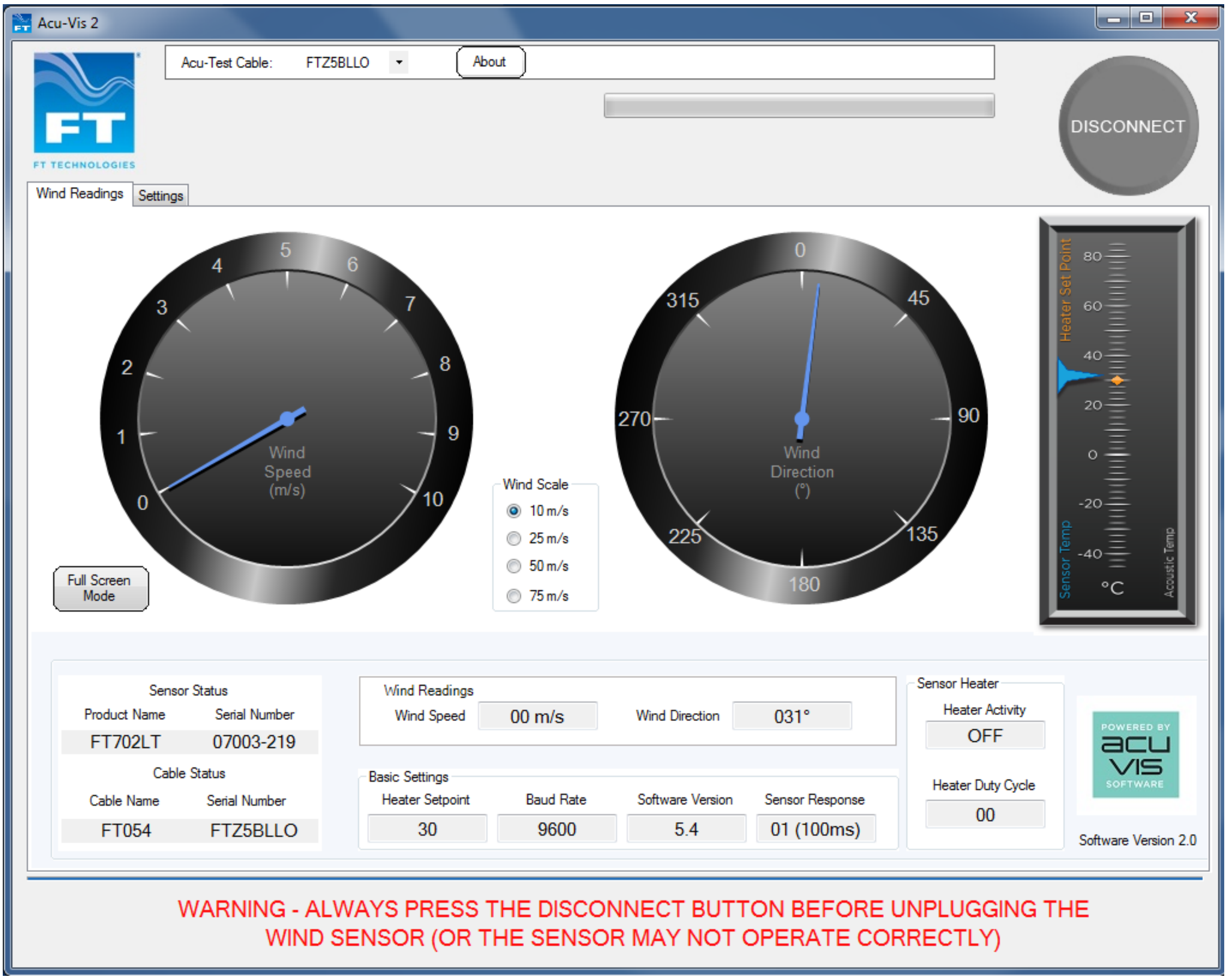


Figure 40: Acu-Vis 2.0 Live Display

Settings Tab

The Settings tab provides an interactive user interface for changing basic sensor settings with point and click operation. Consult the user manual for full software command details.

- Heater Settings: On/Off and Heater Setpoint
- Wind Speed & Direction Filter: On/Off and the averaging time period
- Heater Current Limit: Change the maximum current limit used by the sensor
- Wind Direction Datum Offset: Apply a directional offset to the sensor

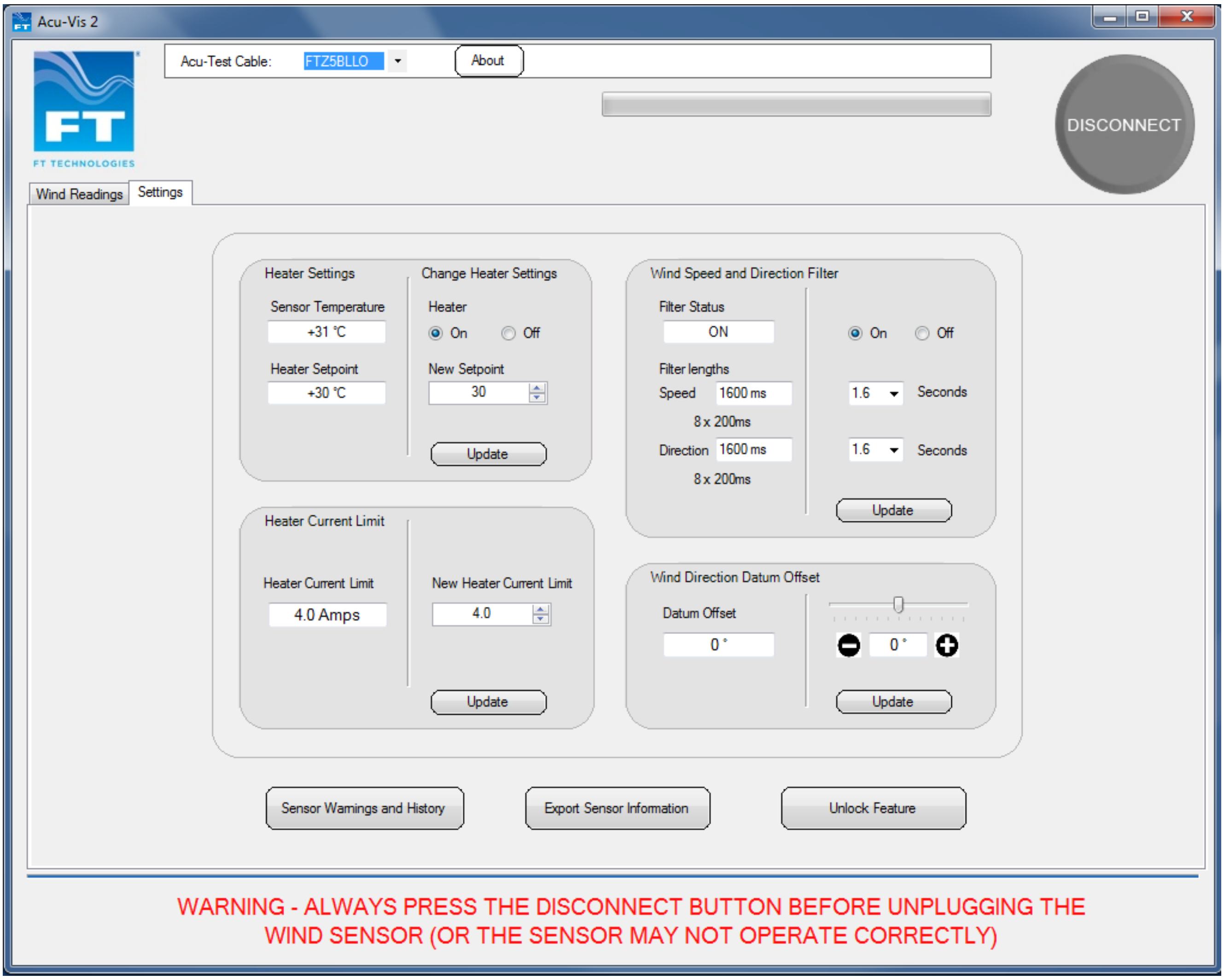


Figure 41: Acu-Vis 2.0 Settings Display

- The 'Sensor Warnings and History' button will provide a history of the connected sensor settings where it has been connected to the PC

- The 'Export Sensor Information' button creates an encrypted file containing current user settings and diagnostic information. This feature will export a file in .fff format that can be forwarded to the FT Technologies support teams

- The 'Unlock Feature' button is used to unlock advanced features in Acu-Vis 2.0, including the 'Commands' and the 'User Calibration Table' tabs. Contact FT Technologies for further details

Commands Tab

The Command tab allows the user to view and send various software commands:

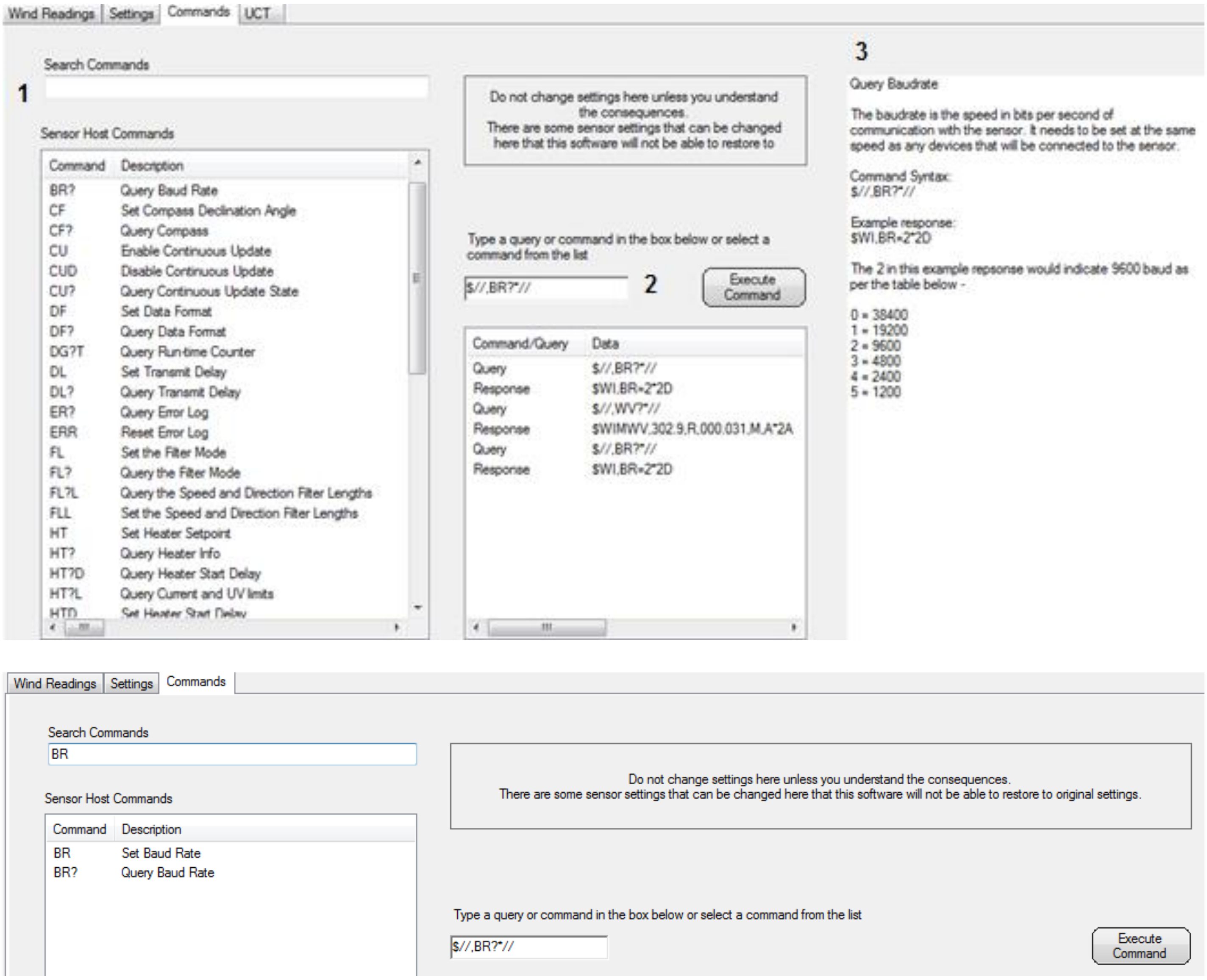


Figure 42: Command Line Terminal Display

- Search for commands (for example: BR) or select them from the ‘Sensor Host Command’ menu. Selecting a query will add the command to the ‘Execute Command’ window, a technical description will be displayed

- This window shows the command structure and allows the user to transmit commands using the ‘Execute Command’ button. If the command has a response it will be shown below

  Some SET commands require the user to add values into the command (for example: $//,DFP*//). The user will be prompted to enter the missing settings

  Note: The command console hides the <cr><lf> end-of-line terminal message and uses a default sensor ID of $// to communicate with all sensor ID numbers (// is a wildcard value)

- This window provides a description of the selected software command. Please refer to the user manual software command section for full descriptions

UCT ('User Calibration Table') Tab

The UCT window provides the user with a simple method of changing the calibration performance of the sensor. Refer to the UCT commands detailed in the user manual for further information.

Acu-Vis 2.0 will download any existing UCT settings and display them on the table and graph.

The easiest method of changing the UCT is to use the 'Standard % Offset" buttons to establish a calibration change.

When the calibration change has been selected press the orange 'Save UCT to Sensor' button and ensure the 'UCT Status' is set to Enabled.

Caution: This feature will change the calibration profile of the sensor and may compromise survey data and/or system performance

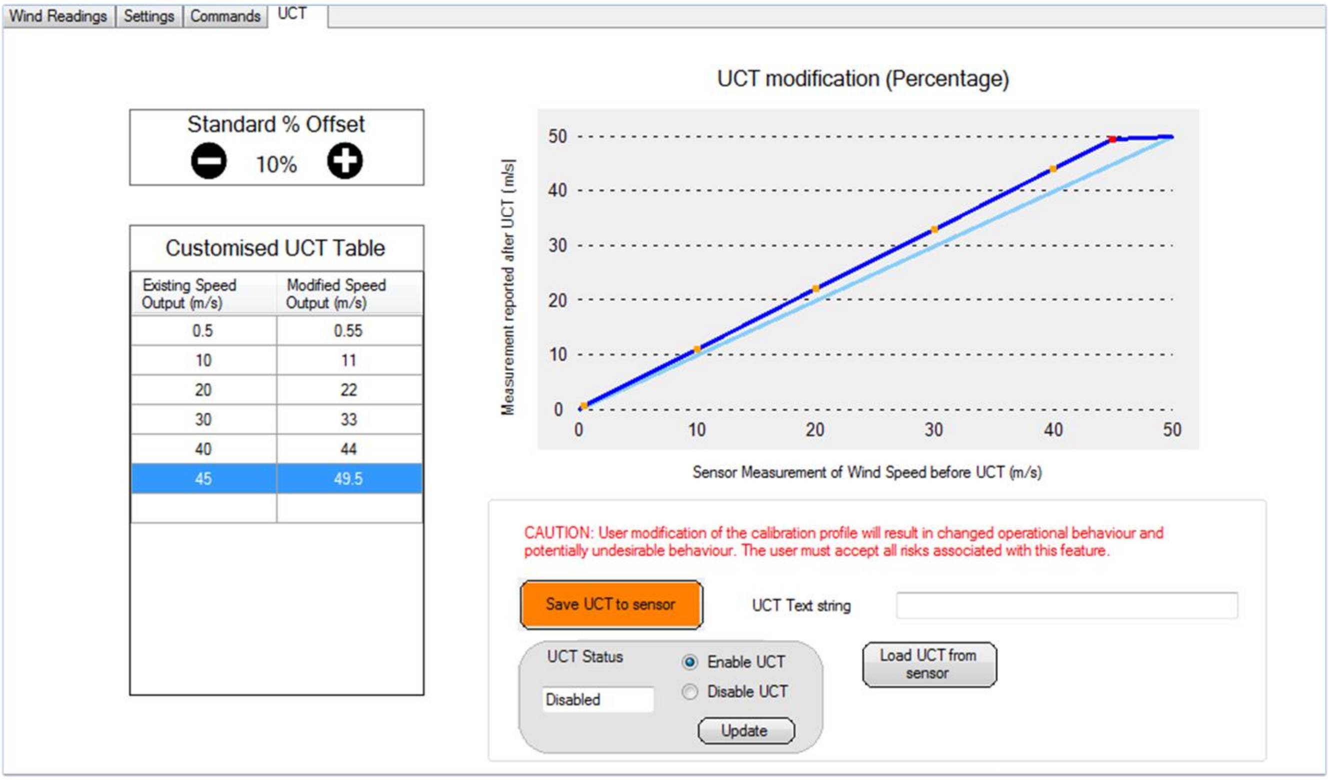
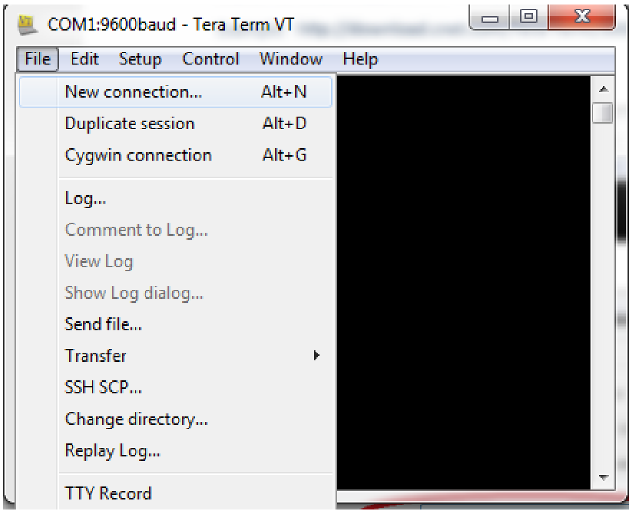


Figure 43: UCT Modification Window

4.4.3 Command Line Terminal Programs (Including Tera Term)

The FT054 Acu-Test cable can also be used to communicate via command line terminal programs, including Hyperterminal and Tera Term. This provides the user with a visible method of communication with digital wind sensors without building an RS485HD network.

To begin a Tera Term connection click ‘New Connection…’ in the File Menu:



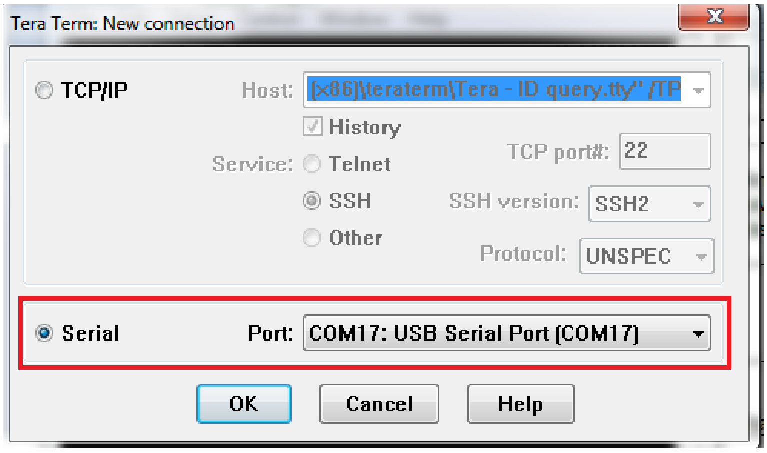


Figure 44: Creating a Connection in Tera Term

Create a new Serial connection, the COMx channel will be dynamically assigned by the user’s computer, but should typically be recognised as a ‘USB Serial Port’.

It is necessary to modify several settings to view the data and simplify the end-of-line character requirements of software commands (i.e. remove the requirement to type <cr><lf> at the end of all commands).

- Navigate to the ‘Terminal Setup’ window from the top menu: Setup > Terminal
  a. Set the ‘New-Line Transmit’ setting to: “CR+LF”
  b. Enable ‘Local Echo’ by ticking the box (Local Echo makes typed characters visible on the display)

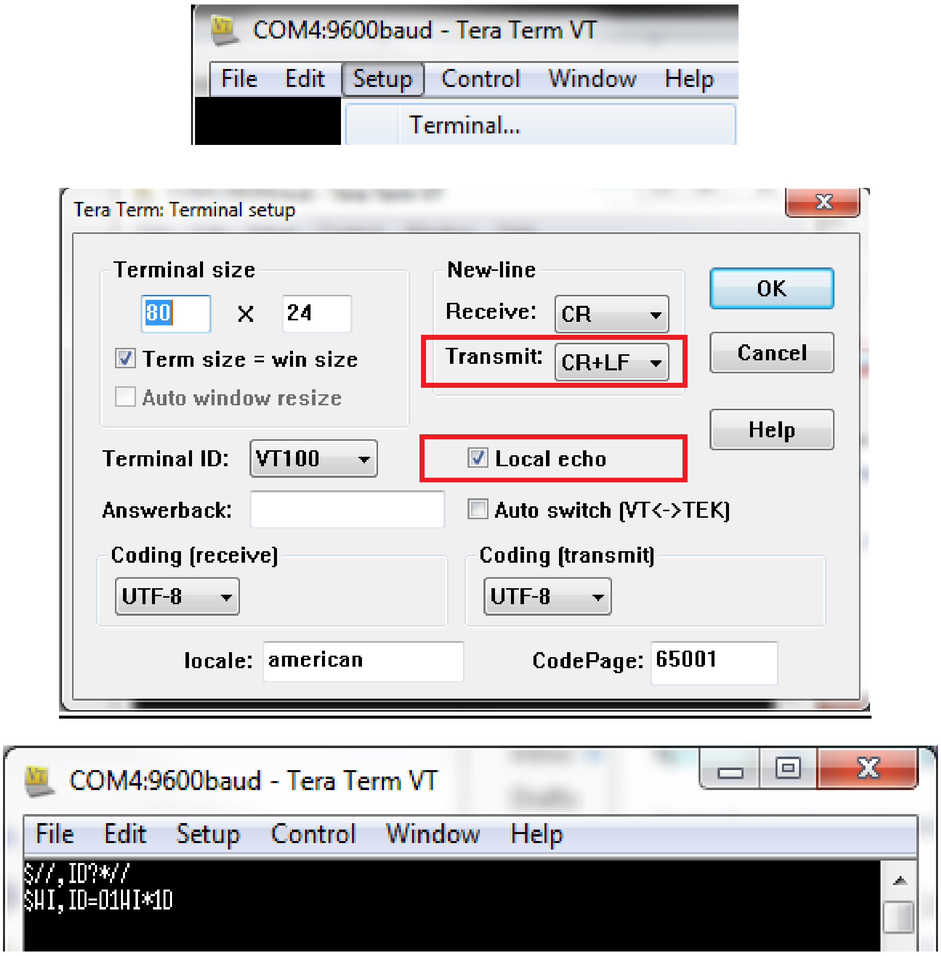


Figure 45: Modifying Terminal Settings in Tera Term

Tera Term defaults to a baud rate of 9600, it may be necessary to configure this setting via the Setup menu → Serial Port… settings window.

With connection enabled with the settings configured as described above, send commands to the sensor to confirm successful connection. Please note that in half-duplex communication protocols the sensor cannot receive commands while simultaneously transmitting information, therefore it may be necessary to repeat the command and confirm it was accepted using a QUERY command. This can be an issue when using CU mode at high frequencies.

Below are some useful commands:

$01,ID?*//	Query the sensor ID setting
$01,CU?*//	Query the CU mode setting
$01,CUD*//	Disable CU mode
$01,CUE00010*//	Enable CU mode at 1 second intervals (1Hz). Note: Command is for FT742 sensors only.

The // line bypasses the checksum validation. Checksum validation is recommended for production datalogging to improve data integrity. See Section 5 and 6 for further details regarding command structures and replies.

Note: If a sensor is set to an ID setting other than 01, replace $01 with the alternative ID. Starting a command with $// will perform the relevant command on all connected sensors.

5 SENSOR COMMUNICATION

5.1 Introduction

The sensor features an easy to use ASCII-based communication protocol transmitted over an RS485 serial link. The protocol incorporates checksum validation to ensure the integrity of all data transmissions. In addition to the FT Technologies proprietary protocol the sensor can output the common NMEA 0183 MWV (Wind Speed and Angle) sentence.

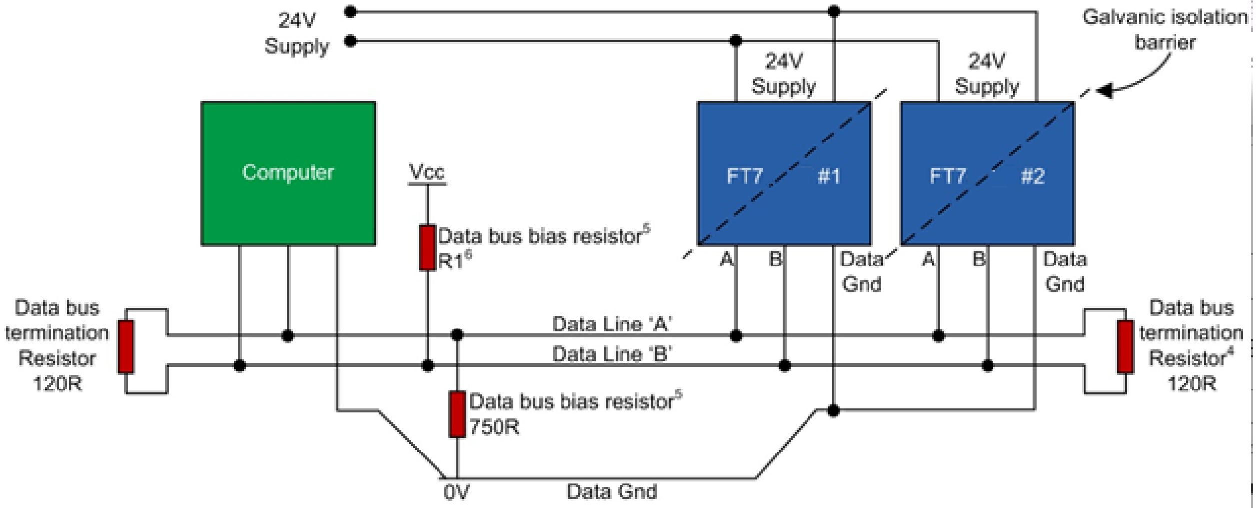
5.2 RS485 Protocol

The sensor is fitted with an RS485 half-duplex serial interface. Slew-rate limited drivers are used to reduce EMI, and minimize reflections from improperly terminated transmission lines and stubs. The signal state definitions for the serial interface data lines are as follows:

- The idle, marking, logical “1”, OFF or stop bit state is defined by a negative voltage on line A with respect to line B.
- The active, spacing, logical “0”, ON or start bit state is defined by a positive voltage on line A with respect to line B.

The circuit below (Figure 46) shows the recommended wiring diagram for connecting the sensor to the PC.
If two or more wind sensors are to be installed it is possible to use the same 2-wire data link to connect all the sensor units to the computer.

Before using a sensor in a multi-device system, the Listener identifier of each sensor must be set to a unique value. Use the ID command (Section 6.4.18) to set the Listener identifier for each sensor. If the Listener identifiers are being set in the final host system, then it is important that only one sensor be connected at a time to the RS485 bus until all devices have been assigned a unique Listener ID. Great care should be exercised when using the ‘//’ characters for addressing. The ‘//’ address characters can be used to send a SET command simultaneously to all sensor units (for example, to enable or disable filtering). Under no circumstances should the ‘//’ characters be used with any QUERY commands since this will cause all sensor units to transmit data resulting in bus contention.



Notes:
1. Data lines A & B should be twisted pair type. Cable should incorporate overall screening braid which should be connected to chassis at each circuit node.
2. All resistors should be anti-surge type, such as Tyco CCR resistors rated at 1W or similar.
3. Surge protection not shown.
4. Subject to testing, one or both termination resistors may be omitted, if computer makes use of slew-rate limited RS485 drivers.
5. Subject to testing, the bias resistors may be omitted, if computer makes use of fail-safe RS485 receivers.
6. For Vcc = 5V use 750R for R1, For Vcc = 24V use 6800R for R1.

Figure 46: RS-485 Connection Diagram for 2 Wind Sensors

5.3 Configuring the Sensor

All user parameter settings are stored in non-volatile memory and are retained when the sensor is switched off. When the sensor is next switched on (or a user reset command is sent) the sensor will revert to these settings. The sensor can therefore be configured prior to final installation if required.

The sensor settings can be returned to the factory values (see Figure 51 for factory default settings) at any time by sending the factory reset command.

5.4 Communication

5.4.1 Conventions used in this manual

All examples of sensor transmitted and received messages are printed in italic courier monospace font, e.g.

$<listenerID>,DFP<checksum><cr><lf>*

Angle brackets are used as placeholders for data (e.g. <wind speed>) or for non-printable ASCII characters (e.g. <cr> for carriage return).

Figure 47 lists the various special characters and symbols which are used in the examples given in this Handbook.

Symbol	Valid Characters	HEX Values	Definition
a	{A to Z} {0 to 9} {/}	41-5A, 30-39, 2F	talker/listener address field characters
c	{A to Z} {0 to 9}	41-5A, 30-39	fixed length field of alpha (upper case only) and numeric characters
h	{A to F} {0 to 9} {/}	30-39, 41-46, 2F	checksum field validation characters
s	{ }	20	space
x	0 to 9	30-39	fixed length field of numeric characters
x.x	{0 to 9} {.}	30-39, 2E	fixed point numeric field (i.e. always with leading and trailing zeros)
±	{+ -}	2B, 2D	polarity indicator. Where a value can take on both positive and negative values a polarity indicator (either + or -) is always sent as the first character in the field. The field length therefore remains fixed for both positive and negative values.
	{$}	24	start of message delimiter
	{*}	2A	checksum field delimiter
	{,}	2C	field delimiter
-	{-}	2D	dash
<cr>		0D	Carriage return — End of message delimiter
<lf>		0A	Line feed — End of message delimiter
<name>			placeholder for data

Figure 47: Symbols used in this Handbook

5.4.2 Data Transmission

Data is transmitted and received via an asynchronous serial communication interface using ASCII characters. The interface operates with the following parameters:

Parameter	Setting
Baud Rate	1200, 2400, 4800, 9600 (factory default), 19200, 38400
Data Bits	8
Start Bits	1
Stop Bits	1
Parity	None

Figure 48: Data Transmission Parameters

To set the sensor baud rate use the BR command (Section 6.4.1)

The sensor does not use handshaking (either hardware or software) to control the flow of data to and from the host computer. It is important, therefore, that the serial interface of the host computer is set with handshaking/flow control disabled.

5.4.3 Message Format

Data communication between the sensor and the host computer is performed by the transmission of ASCII messages. Figure 49 shows the composition of the message. The same message format is used for both received and transmitted messages.

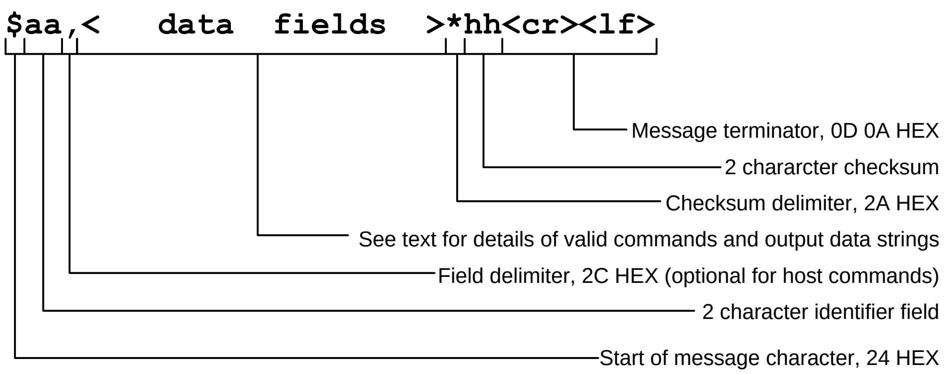


Figure 49: Message Format

All messages start with the '$' start of message character, followed by the 2 character talker/listener identifier (Section 5.4.4) field.

Following the first delimiter is the main body of the message which comprises a variable number of data fields (dependent on the message being transmitted), each separated by the field delimiter character (','). Data fields may contain alpha, numeric, or alphanumeric data depending on the information content of the field.

Messages sent to the sensor will contain a command in <data fields> and messages transmitted from the sensor will contain output data in <data fields>.

The data field section of the message is terminated by the checksum delimiter character '*'. Following the checksum delimiter is the two-character checksum field. See Section 5.4.5 for information on how to compute the checksum and Section 5.4.6 if checksum message validation is not required.

All messages are terminated with a carriage return <cr> and line feed <lf>.

5.4.4 Listener and Talker Identifiers

The sensor is assigned with both a Listener and Talker identifier address that allows an individual sensor to be uniquely identified in a system comprising more than one sensor.

Whenever a message is sent to the sensor, the identifier field of the message (the 2 characters immediately following the '$' start of message character) must correspond to the sensor Listener identifier address, otherwise the sensor will ignore the message. In applications where more than one sensor is connected to the RS485 bus, you should assign each sensor in the system a unique Listener ID. The host computer will then be able to address individually each sensor. If you do not wish to use the Listener ID in messages sent from the host computer, you can replace the Listener ID with '//'. Sending '//' in place of the Listener ID will allow any sensor, irrespective of its Listener ID setting, to respond to the message.

Whenever a message is transmitted from the sensor, the identifier field of the message (the 2 characters immediately following the '$' start of message character) will contain the Talker ID. The Talker ID is used as a message tag to identify which sensor has transmitted the message.

The factory default value for the Listener ID is 01 and for the Talker ID it is WI (Weather Instrument). To change the Listener and/or Talker ID use the ID Command, Section 6.4.18.

Note: It is important to use the correct listener IDs for the system. Incorrect serial IDs will fail to communicate with the controller. For example, repair technicians may incorrectly believe the sensor is faulty.

5.4.5 Calculating the Message Checksum

All messages sent to, or received from, the sensor include a checksum field. Messages that are transmitted from the sensor always include a checksum value in the checksum field. Messages sent to the sensor by the host computer can either contain a checksum value or an 'ignore checksum identifier' in the checksum field.

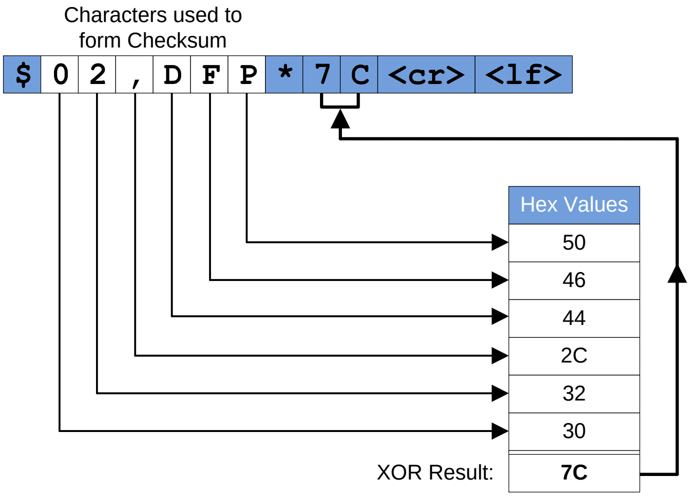


Figure 50: Checksum Example

The checksum value is calculated by Exclusive OR'ing (XOR'ing) all the bytes between (but not including) the '$' and the '*' characters of the message. The resulting single byte value is then represented by 2 HEX characters in the message string. The most significant character is transmitted first.

Note: Since a message only contains ASCII characters (which have values in the range 0-7F) the checksum value will always be between 0 and 7F.

5.4.6 Disabling the Checksum

All messages which are sent to the sensor must contain a valid checksum value in the checksum field, otherwise the sensor will not process the incoming message. Although it is recommended that a checksum value be computed for all messages which are sent to the sensor, in some cases this may not be convenient (i.e. when communicating with the sensor with a terminal). To prevent the sensor from performing checksum validation of incoming messages, send the ASCII characters '//' in place of the checksum value.

Example:

Send a message to set the data output format to Polar using the DFP command (the sensor Listener ID in this example is set to 02)

With a checksum (sensor checksum validation automatically enabled):

*$02DFP*50<cr><lf>*

Without a checksum (sensor checksum validation automatically disabled):

$02DFP//<cr><lf>*

A checksum value is always transmitted by the sensor with every outgoing message. However the checksum field can be ignored by the host computer if checksum validation for received messages is not required.

6 PARAMETER SETTINGS

6.1 Command Types

6.1.1 Set Commands

Figure 51 lists the commands that may be sent to the sensor from the host computer that are used to SET configuration options for the wind sensor.

Command	Mnemonic	Configuration Options	Factory Default	Section
Anemometer Mount	AM	Normal Inverted	Normal	6.4.1
Acoustic Temperature Units	AT	C (Celsius) F (Fahrenheit) K (Kelvin) Filter Length	C (Celsius) 1 minute	6.4.3 6.4.4
Serial interface baud rate	BR	1200, 2400, 4800, 9600, 19200, 38400	9600	6.4.5
Datum offset	CF	000.0° to 359.9°	0.000°	6.4.6
Continuous Update	CU	Enable or Disable Update interval, 0.1-6000 seconds	Disabled	6.4.7
Wind velocity data format	DF	Polar or NMEA	Polar	6.4.8
Command delay interval	DL	00 to 20	01	6.4.10
Clear Error Report	ER	Reset	000000000000	6.4.11
Wind velocity filter	FL	Enable or Disable, Speed filter length Direction filter length	Enabled 0016 0016	6.4.12 6.4.13
Selective Filter	FL	Enable or Disable Selective filter length	Disabled 010	6.4.14
Heater settings	HT	Setpoint Temperature Heater Start Delay Time Current Limit Undervoltage Limit	Heater Disabled 4 seconds delay 4 Amps	6.4.15 6.4.16 6.4.17
Listener and talker identifiers	ID	Listener ID = xx Talker ID = xx	Listener ID = 01 Talker ID = WI	6.4.18
Min/Max wind speed	MM	Reset	999.9,000.0	6.4.19
Overspeed Warning Scheme	OS	Enabled or disable	Disabled	6.4.20
Reset	RS	Load Factory Default, Load Current Settings, Load Saved Parameters	NA	6.4.21
User Calibration Table	UC	Enable or Disable Clear Wind speed table record Save wind speed table Table label	Disabled N/A N/A N/A	6.4.24 6.4.25 6.4.26 6.4.27 6.4.28
Save User Parameters	US	Copies current Parameters	NA	6.4.29

Figure 51: Set Commands

When a valid message is recognised by the sensor, the sensor will carry out the command contained in the message. To verify that the command has been successfully carried out, an associated QUERY command can be sent after most SET commands (see Section 6.1.2 for the list of parameters which may be queried).

6.1.2 Query Commands

Figure 52 lists the commands that may be sent to the sensor from the host computer that are used to QUERY the wind sensor's latest readings or configuration.

Command	Mnemonic	Sensor Data Returned	Section
Anemometer Mount	AM	Normal Inverted	6.4.1
Acoustic Temperature	AT	Temperature Temperature Units (°C, °F, K) Filter time period	6.4.2 6.4.3 6.4.4
Serial interface baud rate	BR	1200, 2400, 4800, 9600, 19200, 38400	6.4.5
Datum offset	CF	000.0° to 359.9°	6.4.6
Continuous update	CU	Enabled or Disabled Update interval (0.1 - 6000 seconds)	6.4.7
Wind velocity data format	DF	Polar or NMEA	6.4.8
Runtime Counter	DG	Number of hours of runtime	6.4.9
Command delay interval	DL	00 to 20	6.4.10
Error report	ER	Factory Report	6.4.11
Wind velocity filter	FL	Enabled or Disabled Speed filter length, 1-64 Direction filter length, 1-64	6.4.12 6.4.13
Selective Filter	FL	Enabled or Disabled Validity period	6.4.14
Heater settings	HT	Setpoint Temperature, 0°C to 55°C. Percentage of heater current, 0% to 100% Internal sensor temperature, 00°C to ±99°C, Heater Delay Time, 4s to 999s Current Limit, 0.1A to 6.0A Undervoltage Limit, 11V to 17V	6.4.15 6.4.16 6.4.17
Listener and talker identifiers	ID	Listener ID = xx Talker ID = xx	6.4.18
Min/Max wind speed	MM	Min & Max Speeds Recorded	6.4.19
Overspeed Warning Status	OS	Enabled or Disabled	6.4.20
Serial Number	SN	Serial Number	6.4.22
Software Version	SV	Software Version	6.4.23
User Calibration Table	UC	Enabled or Disabled Wind speed table record Table label	6.4.24 6.4.25 6.4.26 6.4.27 6.4.28
Saved User Parameters	US	Matches Saved to Current User Parameters	6.4.29
Wind velocity reading	WV	Wind Speed, Direction and Sensor Status	6.4.30 6.4.31

Figure 52: Query Commands

6.2 User Calibration Table

The User Calibration Table includes up to 64 user programmable records. Each record comprises a pair of values representing the corrected speed (wind tunnel speed) and the corresponding uncorrected wind sensor speed. In addition to the calibration table, there is provision for a user-defined text string of up to 32 characters which is stored together with the table.

The User Calibration Table records must be entered in ascending order of wind sensor speed. The minimum allowable difference between wind sensor speed values in consecutive records is 0.5m/s.

To load the User Calibration Table with data, the following steps need to be taken:

1. The Table must first be cleared (See Section 6.4.25).
2. Each pair of table row values is entered into a RAM copy of the User Calibration Table (See Section 6.4.26)
3. A text string linked to the table may be entered if desired. This can be entered at any point after the table is cleared and before the RAM copy of the table is saved into Flash memory. (See section 6.4.28)
4. The RAM copy of the User Calibration Table is saved into Flash memory (See Section 6.4.27

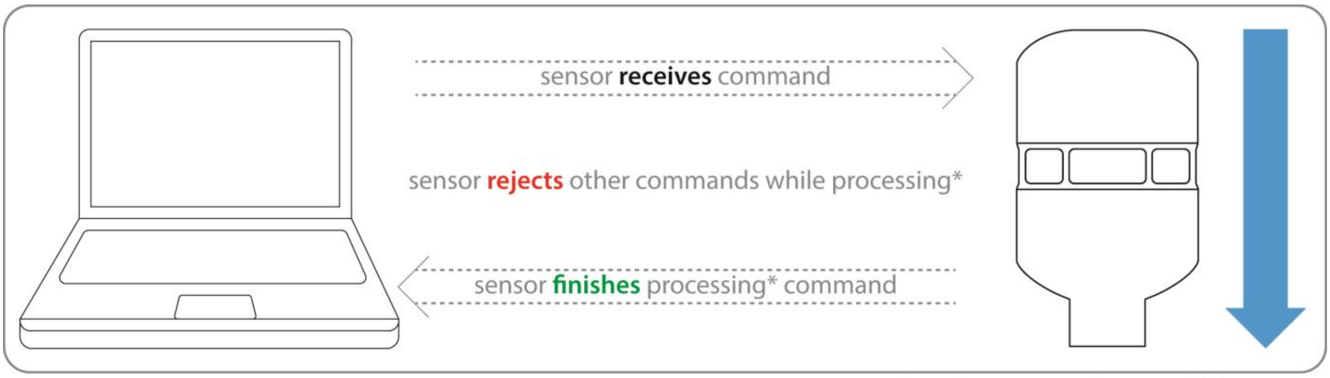
At any point in the above procedure (or at any other time) commands can be sent to the wind sensor to:

- Verify that the table has been cleared;
- Verify the last row of data written to the table;
- Read the number of table entries and the table checksum;
- Read out a selected row of table data,
- Read out the User Calibration Table label.

See Sections 6.4.24 - 6.4.28 for further details.

6.3 Timing Constraints

When a valid command is received by the sensor input buffer, there will be a time delay whist the command is being processed. The actual command latency depends on exactly when the last character of the command is received within the sensor internal processing cycle. The sensor can process only one SET or QUERY command at a time.



*Time processing depends on command type and delay settings.

Figure 53: Command Processing

Once a SET command has been received by the sensor, it can take approximately 400ms for the command to be processed and any setting change implemented. If other commands are sent during this period, they may be ignored by the wind sensor. Therefore all SET commands must be separated by a period of at least 500ms before further commands are sent. (Or longer in the case of a Reset command being sent See Section 6.4.21).

Once a QUERY command has been received by the sensor, it takes up to 50ms for the command to be processed. The sensor will then wait for a predefined delay before sending a response. This delay time is programmable in increments of 50ms.

See Section 6.4.10 for details of how the delay between the sensor receiving a command and transmitting a reply can be adjusted. An additional latency is recommended depending on the time taken for the computer to switch between transmit and receive modes.

If the delay time has been extended using the DL command, then the next QUERY command sent to the wind sensor must be separated by the maximum QUERY command processing time (50ms) and at least the DL interval (50ms default.) It is therefore recommended that the frequency of any QUERY command does not exceed 10Hz, i.e. 10 commands per second.

Message Example:

For example, to set the wind velocity output to Polar format and verify that the command has been accepted, send the following commands:

Set the wind reading format to polar:

$//DFP//<cr><lf>*

Then wait 500ms for the SET command to be implemented by the sensor.

A QUERY can then be sent to confirm command has been carried out:

$//DF?//<cr><lf>*

Then wait 50-100ms for the sensor to send a response:

*$WI,DF=P*5D<cr><lf>*

Please note the above example assumes the sensor has a factory default time delay of 50-100ms (DL01).

6.4 Command Parameters

Each command, and its usage, is described in the following Sections. All examples, other than where stated, assume that the sensor Listener ID is set to 01, and the sensor TalkerID is set to WI, (Weather Instrument).

6.4.1 AM: Set or Query the Anemometer Mount Orientation

Command Parameter	AM

Command Syntax	SET Sensor:	*$<listenerID>,AM<orientation>*<checksum><cr><lf>* *$aa,AMx*hh<cr><lf>*
	QUERY Sensor:	*$<listenerID>,AM?*<checksum><cr><lf>* *$aa,AM?*hh<cr><lf>*
	Sensor output:	*$<talkerID>,AM=<orientation>*<checksum><cr><lf>* *$aa,AM=x*hh<cr><lf>*

Parameters	<orientation>	
	N	Set Normal orientation for mounting the sensor in ‘regular’ orientation
	I	Set Inverted orientation for mounting the sensor ‘upside down’

Examples	Example 1 Set the anemometer mount orientation to inverted and verify the new setting:	
	Message	Comment
	$01,AMI//<cr><lf>*	Set Inverted orientation
	$01,AM?//<cr><lf>*	Query orientation setting
	*$WI,AM=I*4A<cr><lf>*	Inverted orientation setting

Description	Use the AM command if changing the mounting of the anemometer between right way up and upside down. In inverted orientation the sensor’s compass and wind direction readings will be reversed to provide correct direction and heading output. Note: This feature was introduced in software version V7.5.

6.4.2 AT.1: Query the Acoustic Temperature

Command Parameter	AT

Command Syntax	SET Sensor:	*N/A*
	QUERY Sensor:	*$<listenerID>,AT?*<checksum><cr><lf>* *$aa,AT?*hh<cr><lf>*
	Sensor output:	*$<talkerID>,AT=<temp>,<units>,<status>*<checksum><cr><lf>* *$aa,AT=±xxx.x,c,c*hh<cr><lf>*

Parameters	<temp>	
	-077.8 to +368.3	Read only parameter that returns the current acoustic temperature reading in the range: -61.0°C to +95.1°C -77.8°F to +203.2°F 212.2K to 368.3K
	<units>	
	C	The acoustic temperature is output in degrees Celsius
	F	The acoustic temperature is output.in degrees Fahrenheit
	K	The acoustic temperature is output in Kelvin
	<status>	
	V	The acoustic temperature reading is valid.
	A	An acoustic temperature reading is being acquired. The output may not be valid during this time.

Examples	<u>Example 1</u> Query the latest acoustic temperature reading – a valid reading in degrees Celsius.	
	<u>Message</u>	<u>Comment</u>
	$01,AT?//<cr><lf>*	Query acoustic temperature
	*$WI,AT=+023.9,C,A*15<cr><lf>*	Sensor response (being acquired)
	<u>Example 2</u> Query the latest acoustic temperature reading. A valid reading in Kelvin is being acquired.	
	<u>Message</u>	<u>Comment</u>
	$01,AT?//<cr><lf>*	Query acoustic temperature
	*$WI,AT=+297.2,K,V*0C<cr><lf>*	Sensor response

Description	The AT query command returns the current acoustic temperature reading in the selected units. An acoustic temperature reading will be returned even if the sensor is in the process of trying to acquire a valid reading. The acoustic temperature reading is filtered with a one minute time constant by default. The accuracy of the acoustic temperature reading may be affected by the relative humidity of the air surrounding the sensor. See Section 2.9 for further details. Caution: The acoustic temperature feature requires calibration at FT Technologies. If the sensor has had a software upgrade to 7.5 (or above) then the data will be uncalibrated and may not comply with the official specification.

6.4.3 AT.2: Set or Query the Acoustic Temperature Units

Command Parameter	AT (units)

Command Syntax		
	SET Sensor:	*$<listenerID>,ATU<units>*<checksum><cr><lf>* *$aa,ATUc*hh<cr><lf>*
	QUERY Sensor:	*$aa,AT?U*hh<cr><lf>*
	Sensor output:	*$<talkerID>,AT=<units>*<checksum><cr><lf>* *$aa,AT=c*hh<cr><lf>*

Parameters	<units>	
	C	The acoustic temperature is to be output in degrees Celsius
	F	The acoustic temperature is to be output.in degrees Fahrenheit
	K	The acoustic temperature is to be output in Kelvin

Examples	Example 1 Set the Acoustic Temperature reading output units to degrees Fahrenheit.	
	Message	Comment
	$01,ATUF//<cr><lf>*	Set units to Fahrenheit
	$01,AT?U//<cr><lf>*	Query temperature units
	*$WI,AT=F*5C<cr><lf>*	Sensor response

Description	Use this command to change the measurement units of the acoustic temperature output readings. The available measurement units are degrees Celsius, Fahrenheit and Kelvin.

6.4.4 AT.3 Set or Query the Acoustic Temperature Filter Length

Command Parameter	AT (filter length)

Command Syntax	SET Sensor:	*$<listenerID>,ATF<filter length>*<checksum><cr><lf>* *$aa,ATFxxc*hh<cr><lf>*
	QUERY Sensor:	*$<listenerID>,AT?F*<checksum><cr><lf>* *$aa,AT?F*hh<cr><lf>*
	Sensor output:	*$<talkerID>,AT=<filter length>*<checksum><cr><lf>* *$aa,AT=xxc*hh<cr><lf>*

Parameters	<filter length> *00S to 50S,* *01M to 10M*	Time constant of the acoustic temperature filter in seconds (S) or minutes (M). Supported settings are 00S (to disable the filter), then ten second increments from 10S up to 50S, then one minute increments from 01M to 10M. (Factory Default Setting = 01M)

Examples	Example 1 Set the filter time constant to 40 seconds. Verify that the command has been accepted.	
	Message	Comment
	$01,ATF40S//<cr><lf>*	Set 40s time constant
	$01,AT?F//<cr><lf>*	Query filter time constant
	*$WI,AT=40S*4D<cr><lf>*	Sensor response
	Example 2 Set the filter time constant to 2 minutes. Verify that the command has been accepted.	
	Message	Comment
	$01,ATF02M//<cr><lf>*	Set 2 minute time constant
	$01,AT?F//<cr><lf>*	Query filter time constant
	*$WI,AT=02M*55<cr><lf>*	Sensor response

Description	Use this command to alter the time constant of the acoustic temperature filter. The filter can be disabled by setting the time constant to zero (00S). Valid time constants are ten second steps from 10S to 50S and then one minute steps from 01M to 10M.

6.4.5 BR: Set or Query the Serial Interface Baud Rate

Command Parameter	BR

Command Syntax	SET Sensor:	*$<listenerID>,BR<baudrate>*<checksum><cr><lf>* *$aa,BRx*hh<cr><lf>*
	QUERY Sensor:	*$<listenerID>,BR?*<checksum><cr><lf>* *$aa,BR?*hh<cr><lf>*
	Sensor Output:	*$<talkerID>,BR=<baudrate>*<checksum><cr><lf>* *$aa,BR=x*hh<cr><lf>*

Parameters	<baudrate>	
	0	Set the baud rate to 38400 baud
	1	Set the baud rate to 19200 baud
	2	Set the baud rate to 9600 baud (Factory Default Setting)
	3	Set the baud rate to 4800 baud
	4	Set the baud rate to 2400 baud
	5	Set the baud rate to 1200 baud

Examples	<u>Example 1</u> Set the baud rate to 19200 baud, verify the new setting and send a user reset command to activate the new baud rate	
	<u>Message</u>	<u>Comment</u>
	$01,BR1//<cr><lf>*	Set baud rate to 19200
	$01,BR?//<cr><lf>*	Query baud rate setting
	*$WI,BR=1*2E<cr><lf>*	Sensor Output
	$01,RSU//<cr><lf>*	Send user reset

Description	Use the BR command to change the sensor serial interface baud rate. The new baud rate setting will only come into effect when the sensor is next powered-up or after a Reset command (RSU) has been received. If the baud rate is changed, you will only be able to communicate with the sensor if the host computer's baud rate is set to the same baud rate. If you do not know what the current setting of the sensor baud rate is you will need to try each baud rate in turn until you establish communication.

6.4.6 CF: Set or Query the Wind Datum Offset Angle

Command Parameter	CF

Command Syntax	SET Sensor:	*$<listenerID>,CF<offset>*<checksum><cr><lf>* *$aa,CFxxx.x*hh<cr><lf>*
	QUERY Sensor:	*$<listenerID>,CF?*<checksum><cr><lf>* *$aa,CF?*hh<cr><lf>*
	Sensor Output:	*$<talkerID>,CF=<mode>,<status>,<offset>,<offset>* <checksum><cr><lf>* *$aa,CF=c,c,xxx.x,xxx.x*hh<cr><lf>*

Parameters	<offset> *000.0 to 359.9*	Applying an offset electronically rotates the datum direction of the sensor in a counter clockwise direction (when looking down from above). (000.00 is Factory Default Setting)
	<mode> *D*	Always returns D
	<status> *D*	Always returns D

Examples	Example 1 The datum direction of the sensor is rotated by 5° to the left with respect to the sensor's mounting surface (as per Section 3).	
	Message	Comment
	$01,CF355.0//<cr><lf>*	Set offset angle to 5°
	$01,CF?//<cr><lf>*	Query parameters
	*$WI,CF=D,D,355.0,355.0*26<cr><lf>*	Sensor output
	Example 2 The datum direction of the sensor is rotated 5° to the right with respect to the sensor's mounting surface (as per Section 3).	
	Message	Comment
	$01,CF005.0//<cr><lf>*	Set offset angle to 5°
	$01,CF?//<cr><lf>*	Query parameters
	*$WI,CF=D,D,005.0,005.0*26<cr><lf>*	Sensor output

Description	Use the CF command to set the sensor wind datum direction offset.

WARNING: Once set, the offset value is retained within the non-volatile memory. If the sensor's location is changed then the offset value must be changed to suit the new installation or set to zero otherwise incorrect wind direction readings will be obtained.

6.4.7 CU: Set or Query the Continuous Update Setting

Command Parameter	CU	

Command Syntax	SET Sensor:	*$<listenerID>,CU<cont.update>,<interval>*<checksum><cr> <lf>* *$aa,CUcxxxxx*hh<cr><lf>*
	QUERY Sensor:	*$<listenerID>,CU?*<checksum><cr><lf>* *$aa,CU?*hh<cr><lf>*
	Sensor Output:	*$<talkerID>,CU=<cont.update>,<interval>*<checksum><cr> <lf>* *$aa,CU=c,xxxxx*hh<cr><lf>*

Parameters	<continuous update>	
	E	Enabled
	D	Disabled (Factory Default Setting)
	<interval>	
	1 to 59999	interval, in 0.1s increments, between outputs in continuous mode

Examples	<u>Example 1</u> Set the sensor to output readings automatically every 10 seconds. Verify that the command has been accepted.	
	<u>Message</u>	<u>Comment</u>
	$01,CUE00100//<cr><lf>*	Enable CU mode, rate = 0.1Hz
	<u>Example 2</u> Disable the continuous updating. Verify that the command has been accepted. (Note: This command must only be sent during the first four seconds after power-up – for more information see below).	
	<u>Message</u>	<u>Comment</u>
	$01,CUD//<cr><lf>*	Disable CU mode
	$01,CU?//<cr><lf>*	Query CU mode setting
	*$WI,CU=D,00100*40<cr><lf>*	Sensor response

Description	Use the CU command to enable or disable the continuous update mode of operation. When continuous update is enabled, the sensor will output wind velocity readings at a rate determined by the <interval> setting. Each time the continuous update mode is enabled, the required <interval> setting must be sent (even if this has been sent to the sensor previously). When the continuous update mode is enabled, if the sensor is switched-off, when power is reapplied the sensor will automatically resume outputting readings. Once the sensor has been put into continuous update mode then it becomes a talker only and will not respond to any further commands. To be able to send commands again the continuous mode must be disabled. To achieve this, the CUD (disable continuous update mode) command must be sent within the first four seconds of the power being applied to the sensor.

WARNING: Do not use the continuous update mode if there are other talkers connected to the data bus. Only one active talker is allowed on the data bus at any one time otherwise bus contention will occur

6.4.8 DF: Set or Query the Wind Velocity Data Format

Command Parameter	DF

Command Syntax	SET Sensor:	*$<listenerID>,DF<format>*<checksum><cr><lf>* *$aa,DFc*hh<cr><lf>* or *$aa,DFcc*hh<cr><lf>*
	QUERY Sensor:	*$<listenerID>,DF?*<checksum><cr><lf>* *$aa,DF?*hh<cr><lf>*
	Sensor output:	*$<talkerID>,DF=<format>*<checksum><cr><lf>* *$aa,DF=c*hh<cr><lf>*

Parameters	<format>	
	P	Set the data format to Polar (wind speed and direction) (Factory Default Setting)
	N	Set the data format to NMEA 0183 with wind speed in m/s
	NN	Set the data format to NMEA 0183 with wind speed in knots
	NK	Set the data format to NMEA 0183 with wind speed in km/h

Examples	Example 1 Set the wind velocity output data format to NMEA with wind speed in m/s and verify the new setting.	
	Message	Comment
	$01,DFN//<cr><lf>*	Set format to NMEA (m/s)
	$01,DF?//<cr><lf>*	Query format setting
	*$WI,DF=N*43<cr><lf>*	Sensor response
	Example 2 Set the wind velocity output data format to NMEA with wind speed in knots and verify the new setting.	
	Message	Comment
	$01,DFNN//<cr><lf>*	Set format to NMEA (knots)
	$01,DF?//<cr><lf>*	Query format setting
	*$WI,DF=NN*0D<cr><lf>*	Sensor response

Description	Use the DF command to set the required format of the wind velocity readings. See command WV (Sections 6.4.30 & 6.4.31) for a description of the sensor output for each of the format types. When a DF Set command is sent to the sensor, a reset of the minimum and maximum readings to their default values is automatically performed. Polar Format: The sensor returns the magnitude of the wind speed (m/s only) and the wind direction (0-359 degrees). NMEA 0183 Format: The sensor returns the wind angle (0-359 degrees, Relative) and wind speed (m/s, knots or km/h). The sensor TalkerID is always set to WI when NMEA format is selected irrespective of any value that may have been set with the ID command.

6.4.9 DG: Query the Run-time Counter

Command Parameter	DG	

Command Syntax		
	SET Sensor:	*N/A*
	QUERY Sensor:	*$<listenerID>,DG?T*<checksum><cr><lf>* *$aa,DG?T*hh<cr><lf>*
	Sensor output:	*$<talkerID>,DG=<counter>*<checksum><cr><lf>* *$aa,DG=xxxxxx*hh<cr><lf>*

Parameters	<counter>	
	000000 to 999999	Holds the number of hours that the anemometer has been in operation during its lifetime.

Examples	Example 1 Query the Run-Time Counter.	
	Message	Comment
	$01,DG?T//<cr><lf>*	Query Run-Time Counter
	*$WI,DG=012897*CF<cr><lf>*	Sensor response (12897 hours = 1 year, 5 months, 21 days and 9 hours)

Description	Use the DG command to query the number of operational hours that the anemometer has been in use. The Run-Time Counter is incremented on completion of each full hour that the anemometer has been in use.

6.4.10 DL: Set or Query the Command Delay Interval

Command Parameter	DL	

Command Syntax	SET Sensor:	*$<listenerID>,DL<delay>*<checksum><cr><lf>* *$aa,DLxx*hh<cr><lf>*
	QUERY Sensor:	*$<listenerID>,DL?*<checksum><cr><lf>* *$aa,DL?*hh<cr><lf>*
	Sensor output:	*$<talkerID>,DL=<delay>*<checksum><cr><lf>* *$aa,DL=xx*hh<cr><lf>*

Parameters	<delay> *00 to 20*	(delay interval, in 50ms increments) (Factory Default Setting = 01)

Examples	Example 1 Set the command delay interval to 250ms and verify the new setting.	
	Message	Comment
	$01,DL05//<cr><lf>*	Set delay to 250ms
	$01,DL?//<cr><lf>*	Query delay setting
	*$WI,DL=05*02<cr><lf>*	Sensor response

Description	Use the DL command to set the delay interval from when the sensor receives a command to when the command is executed. The DL command is primarily intended for use where a time delay may be required to allow the RS485 interface to switch from transmit to receive mode. For example, if the delay interval is set to 250ms then the sensor will commence outputting the wind velocity data between 250-300ms after receiving a WV query command. If any further commands are sent to the sensor before the delay interval has elapsed they will be discarded.

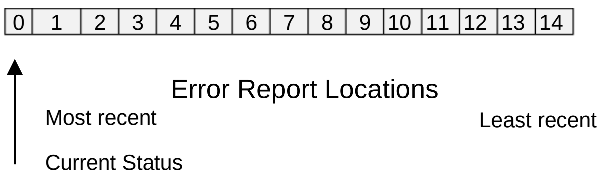
6.4.11 ER: Query or Reset the Error Report

Command Parameter	ER

Command Syntax		
	SET Sensor:	*$<listenerID>,ER<reset>*<checksum><cr><lf>* *$aa,ERc*hh<cr><lf>*
	QUERY Sensor:	*$<listenerID>,ER?*<checksum><cr><lf>* *$aa,ER?*hh<cr><lf>*
	Sensor output:	*$<talkerID>,ER=<error report>*<checksum><cr><lf>* *$aa,ER=xxxxxxxxxxxxxxx*hh<cr><lf>*

Parameters		
	<reset> *R*	 Resets the historical log section of the error report to all 0's
	<error report> *<error report>*	 Sensor error report string

Examples		
	Example 1 Query the error report Message *$01,ER?*//<cr><lf>* *$WI,ER=000000000000000*28<cr><lf>*	 Comment Query error report Sensor response

Description	
	The error report contains information on errors that have occurred during the operation of the sensor. The output string is always comprised of 15 ASCII characters (all shown as '0', ASCII 30(HEX) in the above example).
	
	The first character in the data field represents the current operational status of the sensor. '0' (ASCII 30(HEX)) indicates that the sensor is functioning correctly any other character indicates that an error condition exists. The status is cleared once the ER command is executed.
	The next 14 locations contain an historical log of the last 14 errors with the most recent error being recorded in the leftmost position. Each error condition is assigned an ASCII character. The historical log is stored in Flash and is retained when the power is switched off or the sensor software reset.
	This report can be sent back to the FT factory for analysis if there are problems with the sensor.

Currently the historical error log is only used for factory diagnostic purposes.

6.4.12 FL.1: Set or Query General Filter Settings

Command Parameter	FL (enable/ disable)

Command Syntax		
	SET Sensor:	*$<listenerID>,FL<filter>*<checksum><cr><lf>* *$aa,FLc*hh<cr><lf>*
	QUERY Sensor:	*$<listenerID>,FL?*<checksum><cr><lf>* *$aa,FL?*hh<cr><lf>*
	Sensor output:	*$<talkerID>,FL=<filter>*<checksum><cr><lf>* *$aa,FL=c*hh<cr><lf>*

Parameters	<filter>	
	E	Filter enabled (Factory Default Setting)
	D	Filter disabled

Examples		
	Example 1 Enable the filter. Verify that the command has been accepted.	
	Message	Comment
	$01,FLE//<cr><lf>*	Enable filtering
	$01,FL?//<cr><lf>*	Query filter setting
	*$WI,FL=E*40<cr><lf>*	Sensor response
	Example 2 Disable the filter. Verify that the command has been accepted.	
	Message	Comment
	$01,FLD//<cr><lf>*	Disable filtering
	$01,FL?//<cr><lf>*	Query filter setting
	*$WI,FL=D*41<cr><lf>*	Sensor response

Description	Use the FL command to enable or disable moving average filtering of the wind speed and wind direction readings (see Section 2.3).

6.4.13 FL.2: Set or Query Filter Lengths

Command Parameter	FL (lengths)

Command Syntax		
	SET Sensor:	*$<listenerID>,FLL<speedLen>,<dirLen>*<checksum><cr><lf>* *$aa,FLLxxxx,xxxx*hh<cr><lf>*
	QUERY Sensor:	*$<listenerID>,FL?L*<checksum><cr><lf>* *$aa,FL?L*hh<cr><lf>*
	Sensor output:	*$<talkerID>,FL=<speedLen>,<dirLen>*<checksum><cr><lf>* *$aa,FL=xxxx,xxxx*hh<cr><lf>*

Parameters		
	<speedLen> *0001 to 0064*	Sample size of the wind speed filter. Number of previous readings# used to calculate the latest wind speed reading, 0001 is equivalent to disabling the filter (Factory Default Setting = 0016)
	<dirLen> *0001 to 0064*	Sample size of the wind direction filter. Number of previous readings# used to calculate the latest wind direction reading, 0001 is equivalent to disabling the filter; (Factory Default Setting = 0016)

Examples		
	Example 3 Modify the filter's dimensions. Verify that the command has been accepted.	
	Message	Comment
	$01,FLL0001,0032//<cr><lf>*	Set speed filter length to 1 and direction filter length to 32.
	$01,FL?L//<cr><lf>*	Query filter's length settings.
	*$WI,FL=0001,0032*29<cr><lf>*	Sensor response.

Description	
	Use this command to modify the speed and direction filter lengths. When the filter is enabled, speed and direction readings are independently averaged by calculating the mean of the previous number of readings# set by the filter lengths <speedLen> and <dirLen>. Please note the previous readings filter length by definition includes the most up to date wind reading at position 1. So setting a filter to a length of 0001 gives just the current reading (see Section 2.3). The sensor's internal memory is large enough to retain 64 previous speed and direction readings, allowing for maximum filter length of 6.4 seconds.

6.4.14 FL.3: Set or Query the Selective Filter

Command Parameter	FL (selective filter)

Command Syntax	SET Sensor:	*$<listenerID>,FLS<FilterStatus><period>*<checksum><cr><lf>* *$aa,FLScxxx*hh<cr><lf>*
	QUERY Sensor:	*$<listenerID>,FL?S*<checksum><cr><lf>* *$aa,FL?S*hh<cr><lf>*
	Sensor output:	*$<talkerID>,FL=<FilterStatus>,<period>*<checksum><cr><lf>* *$aa,FL=c,xxx*hh<cr><lf>*

Parameters	<FilterStatus>	
	E	Enabled
	D	Disabled
	<Period>	
	000 to 255	Length of validity period (in increments of 0.1 seconds): 000 A single error will trigger the error flag 001 2 consecutive errors will trigger the error flag (0.2 seconds)

Examples	<u>Example 1</u> Query the Selective Filter Status.	
	<u>Message</u>	<u>Comment</u>
	$01,FL?S//<cr><lf>*	Query the Selective Filter status.
	*$WI,FL=E,005*hh<cr><lf>*	Sensor reports it is enabled with a 5 reading (0.5 second) filter.
	<u>Example 2</u> Enable or Disable the Selective Filter Status.	
	$01,FLSE010//<cr><lf>*	Enable the Selective Filter for up to 10 readings (1 second).
	$01,FL?S//<cr><lf>*	Query the Selective Filter status.
	*$WI,FL=E,010*hh<cr><lf>*	Sensor reports it is enabled with a 10 reading (1 second) filter.
	$01,FLSD//<cr><lf>*	Disable the Selective Filter.

Description	In addition to the averaging filter described in Section 2.5, the sensor has a feature called the Selective Filter. The scheme allows the user to set a “validity period”, during which the sensor will exclude invalid readings from entering the averaging filter. The output will freeze on the last previous “good” reading and only raise an error flag once the number of bad readings exceeds the validity period. This scheme can be enabled by factory configuration. The filter is turned off by default to match legacy behaviour. Depending on the control system used, this may improve data quality.

6.4.15 HT.1: Set or Query General Heater Settings

Command Parameter	HT (enable/ disable)

Command Syntax		
	SET Sensor:	$<listenerID>,HT<tsp>*<checksum><cr><lf> $aa,HTxx*hh<cr><lf>
	QUERY Sensor:	$<listenerID>,HT?*<checksum><cr><lf> $aa,HT?*hh<cr><lf>
	Sensor output:	$<talkerID>,HT=<tsp>,<%>,<temp>*<checksum><cr><lf> $aa,HT=xx,xx,±xx*hh<cr><lf>

Parameters		
	<tsp> 00-55 99	 Heater control circuit set point temperature (degrees Celsius) Disables the heater (factory default setting)
	<%> 00-99	Read only parameter that returns the % of full scale heater current limit 0% (heater off) to 99% (heater fully on)
	<temp> -99 to +99	Read only parameter that returns the current internal temperature of the sensor, In ºC, in range 00 to ±99ºC

Examples		
	Example 1 Set the sensor set point temperature to 5°C. Verify that the command has been accepted. Message $01,HT05*//<cr><lf> $01,HT?*//<cr><lf> $WI,HT=05,00,+24*3B<cr><lf>	 Comment Set heater set point temp Query heater setting Sensor response
	Example 2 Turn off the sensor heater. Verify that the command has been accepted. Message $01,HT99*//<cr><lf> $01,HT?*//<cr><lf> $WI,HT=99,00,+24*3E<cr><lf>	 Comment Disable heater Query heater setting Sensor response

Description	
	Use the HT command to set the sensor heater parameters, including switching the heater on or off and configuring the heater set point. It is possible to query the sensor's internal temperature. It is also possible to query the duty cycle of the heater, which specifies the percentage of the current being drawn by the heaters. By default the sensor requires a minimum of 11VDC for heater operation. This setting can be modified on request by the factory or via the command detailed in Section 6.4.17.

6.4.16 HT.2: Set or Query Delay Heater Settings

Command Parameter	HT (delay)

Command Syntax		
	SET Sensor:	$<listenerID>,HTD<delay>*<checksum><cr><lf> $aa,HTDxxx*hh<cr><lf>
	QUERY Sensor:	$<listenerID>,HT?D*<checksum><cr><lf> $aa,HT?D*hh<cr><lf>
	Sensor output:	$<talkerID>,HT=<delay>*<checksum><cr><lf> $aa,HT=xxx*hh<cr><lf>

Parameters	<delay>	
	004 to 999	Heater Delay in seconds. This is the period after sensor power on before the heater will be enabled. (Factory Default is 004 = 4 seconds)

Examples	Example 3 Set the sensor heater delay to 010. Verify that the command has been accepted.	
	Message	Comment
	$01,HTD010*//<cr><lf>	Set heater delay to 010
	$01,HT?D*//<cr><lf>	Query heater delay setting
	$WI,HT=010*22<cr><lf>	Sensor response

Description	Use the HT command to set the sensor heater parameters, including setting a delay time which specifies how many seconds will elapse after powering on the sensor before the heater is enabled.

6.4.17 HT.3: Set or Query Limit Heater Settings

Command Parameter	HT (current and under-voltage limit)

Command Syntax		
	SET Sensor:	*$<listenerID>,HTL<CurrentLimit>,<UVoltLimit>*<checksum><cr><lf>* *$aa,HTLxx,xx*hh<cr><lf>*
	QUERY Sensor:	*$<listenerID>,HT?L*<checksum><cr><lf>* *$aa,HT?L*hh<cr><lf>*
	Sensor output:	*$<talkerID>,HT=<CurrentLimit>,<UVoltLimit>*<checksum> <cr><lf>* *$aa,HT=x.x,xx*hh<cr><lf>*

Parameters		
	<CurrentLimit> *01 to 60*	Heater Current Limit in steps of 100mA. Valid values of the current limit are in the range 01 to 60. That is, 100mA to 6.0A. (Factory default is 40 = 4.0 Amps.)
	<UVoltLimit> *11 to 17*	Heater Under Voltage Limit in Volts. If the supply voltage falls below the under voltage limit, the heater will be turned off, until the supply returns above the limit. The factory default setting is 11VDC.

Examples		
	<u>Example 4</u> Set the sensor heater current limit to 3.3A and set the under voltage limit to 12VDC. Verify that the command has been accepted.	
	<u>Message</u>	<u>Comment</u>
	$01,HTL33,12//<cr><lf>*	Set current and voltage Limit
	$01,HT?L//<cr><lf>*	Query heater settings
	*$WI,HT=3.3,12*12<cr><lf>*	Sensor response

Description	The HT command may be used to set the sensor heater parameters such as the maximum current and under voltage limit of the heaters.

6.4.18 ID: Set or Query the Listener & Talker Identifiers

Command Parameter	ID

Command Syntax	SET Sensor:	$<listenerID>,ID<RxID><TxID>*<checksum><cr><lf> $aa,ID=cccc*hh<cr><lf>
	QUERY Sensor:	$<listenerID>,ID?*<checksum><cr><lf> $aa,ID?*hh<cr><lf>
	Sensor output:	$<talkerID>,ID=<RxID><TxID>*<checksum><cr><lf> $aa,ID=cccc*hh<cr><lf>

Parameters	<RxID> *00 to ZZ*	The sensor 2 digit listener address identifier (Factory Default RxID = 01)
	<TxID> *00 to ZZ*	The sensor 2 digit talker address identifier (Factory Default TxID = WI)

Examples

Example 1

Set the sensor listener address identifier to A1 and the talker address identifier to B1. Verify that the command has been accepted.

Message	Comment
$01,IDA1B1//<cr><lf>*	Set address ID's
$A1,ID?//<cr><lf>*	Query ID settings
*$B1,ID=A1B1*6C<cr><lf>*	Sensor response

Note: the ID? command must use the new listener ID otherwise the command will not be recognised.

Description

Use the ID command to set the listener and talker address identifiers. See Section 5.4.4 for information on listener and talker address identifiers.

The use of incorrect ID numbers may result in communication failure, for example during technician replacement.

6.4.19 MM: Reset or Query the Min/Max Recorded Wind Speed

Command Parameter	MM

Command Syntax		
	SET Sensor:	*$<listenerID>,MM<setting>*<checksum><cr><lf>* *$aa,MMc*hh<cr><lf>*
	QUERY Sensor:	*$<listenerID>,MM?*<checksum><cr><lf>* *$aa,MM?*hh<cr><lf>*
	Sensor output:	*$<talkerID>,MM=<MinSpeed>,<MaxSpeed>*<checksum><cr><lf>* *$aa,MM=xxx.x,xxx.x*hh<cr><lf>*

Parameters		
	<setting> *R*	Resets the min/max readings to their default (<MinSpeed> to 999.9 and <MaxSpeed> to 000.0) until the first reading
	<MinSpeed> *000.0 to 999.9*	Minimum detected wind speed in current unit (m/s, knots or km/h)
	<MaxSpeed> *000.0 to 999.9*	Maximum detected wind speed in current unit (m/s, knots or km/h)

Examples		
	Example 1 Query the min/max wind speed readings	
	Message	Comment
	$01,MM?//<cr><lf>*	Query the min/max readings
	*$WI,MM=005.1,034.2*22<cr><lf>*	Sensor response

Description	
	Use the MM command to query the minimum and maximum wind speed readings that the sensor has recorded since it was last switched on. The minimum and maximum readings are set to their default values when an MMR, an RS or a DF set command is executed.

6.4.20 OS: Set or Query Overspeed Warning Scheme

Command Parameter	OS

Command Syntax		
	SET Sensor:	*$<listenderID>,OS<mode>*<checksum><cr><lf>* *$aa,OSm*hh<cr><lf>*
	QUERY Sensor:	*$<listenerID>,OS?*<checksum><cr><lf>* *$aa,OS?*hh<cr><lf>*
	Sensor output:	*$<talkerID>,OS=<mode>*<checksum><cr><lf>* *$aa,OS=m*hh*

Parameters	<Mode>	
	D	Overspeed Warning Disabled
	E	Overspeed Warning Enabled

Examples		
	Example 1	
	Enable the Overspeed Warning scheme. Verify that the command has been accepted.	
	Message	Comment
	$01,OSE//<cr><lf>*	Enable the scheme
	$01,OS?//<cr><lf>*	Query Overspeed Warning scheme
	*$WI,OS=E*56<cr><lf>*	Sensor response
	Example 2	
	Disable the Overspeed Warning scheme. Verify that the command has been accepted.	
	Message	Comment
	$01,OSD//<cr><lf>*	Disable the scheme
	$01,OS?//<cr><lf>*	Query Overspeed Warning scheme
	*$WI,OS=D*57<cr><lf>*	Sensor response

Description	Use this command to query, enable or disable the Overspeed Warning Scheme (See Section 2.7).

6.4.21 RS: Reset the Sensor

Command Parameter	RS	

Command Syntax	SET Sensor:	*$<listenerID>,RS<mode>*<checksum><cr><lf>* *$aa,RSc*hh<cr><lf>*
	QUERY Sensor:	*NA*
	Sensor output:	*None*

Parameters	<mode>	
	F	Reset the sensor, loading the factory default settings
	S	Reset the sensor, loading saved parameters settings
	U	Reset the sensor, reloading the user parameter settings

Examples	Example 1 Reset the sensor, reloading the last parameter settings	
	Message	Comment
	$01,RSU//<cr><lf>*	Reset sensor, reloading last settings

Description	Use the RS command to reset the sensor software. The sensor will be ready to receive new commands or take readings from a maximum of 2 seconds after any reset command is sent. To restart the software, but continue to use the previous user parameter settings use the RSU command To restart the software, but load the saved parameter settings use the RSS command. To restart the software, but load the factory default parameter settings use the RSF command See command US (Section 6.4.29) for a description for setting or querying these Saved Parameters.

6.4.22 SN: Query the Serial Number and Platform Version

Command Parameter	SN

Command Syntax	SET Sensor:	N/A
	QUERY Sensor:	*$<listenerID>,SN?*<checksum><cr><lf>* *$aa,SN?*hh<cr><lf>*
	Sensor Output:	*$<talkerID>,SN=<SerialNumber>,<PlatformVersion>*<checksum><cr><lf>* *$aa,SN=xxxxx-xxx,xxsss*hh<cr><lf>*

Parameters	<SerialNumber> *00000-000 to 99999-999*	Unique serial number of the sensor
	<PlatformVersion> *00-99*	Platform version (issue) of the sensor design. The 3 spaces after the 2 digit number are reserved for future use.

Examples	Example 1 Read the sensor serial number and platform version	
	Message	Comment
	$01,SN?//<cr><lf>*	Query serial number
	*$WI,SN=09000-130,24 *3E<cr><lf>*	Sensor response

Description	The SN command returns the serial number of the sensor and also the platform version of the sensor. The serial number format starts with a 5 digit batch code, followed by a 3 digit number which identifies a sensor within a particular batch. The overall number is the unique serial number identifier for the sensor.

6.4.23 SV: Query the Software Version

Command Parameter	SV

Command Syntax	SET Sensor:	*NA*
	QUERY Sensor:	*$<listenerID>,SV?*<checksum><cr><lf>* *$aa,SV?*hh<cr><lf>*
	Sensor Output:	*$<talkerID>,SV=<SoftwareVersion>*<checksum><cr><lf>* *$aa,SV=sssx.xss*hh<cr><lf>*

Parameters	<SoftwareVersion>	
	1.0 to 9.9	Software version of the sensor. The spaces are reserved for future use.

Examples	Example 1 Read the software version number	
	Message	Comment
	$01,SV?//<cr><lf>*	Query software version
	*$WI,SV= 7.5 *16<cr><lf>*	Sensor response

Description	The SV command returns the software version of the sensor.

6.4.24 UC.1: Set or Query General User Calibration Settings

Command Parameter	UC (enable/ disable)	
Command Syntax	SET Sensor:	$<listenerID>,UC<table>*<checksum><cr><lf> $aa,UCx*hh<cr><lf>
	QUERY Sensor:	$<listenerID>,UC?*<checksum><cr><lf> $aa,UC?*hh<cr><lf>
	Sensor output:	$<talkerID>,UC=<entries>,<table>,<UCRAMChecksum>, <UCFlashChecksum>*<checksum><cr><lf> $aa,UC=nn,x,yyyy,zzzz*hh<cr><lf>

Parameters		
	<table>	
	E	User Calibration Table enabled
	D	User Calibration Table disabled (Factory Default Setting)
	<entries>	
	nn	Number of calibrated table entries
	<UCRAMChecksum>	
	yyyy	User calibration table RAM copy checksum
	<UCFlashChecksum>	
	zzzz	Saved user calibration table Flash copy checksum

Examples		
	Example 1 Enable the user calibration table and verify new setting	
	Message	Comment
	*$01,UCE*7E<cr><lf>*	Enable calibration table
	*$01,UC?*04<cr><lf>*	Query user calibration table status
	*$WI,UC=55,E,5174,5174*70<cr><lf>*	Typical sensor response

Description	
	Use the UC command to enable or disable the implementation of the user calibration table for calibrating wind speed readings. The four-digit user calibration table checksum is calculated by summing all table entries over the number of table rows present. The least significant 4 digits of the resulting sum are retained as the table checksum. The user-defined text string is not included in the checksum. Each xx.xx speed value is treated as an integer by ignoring the decimal point. For example, the table row: 15.00, 14.97 is summed as 1500 + 1497 = 2997. A table sum of 55174 results in the checksum 5174. If the user calibration table has not been loaded, the number of calibrated table entries (nn) will be 00 and the saved user calibration table Flash copy checksum (zzzz) will be 5535. Contact FT technologies for details on simplified methods to change User Calibration Table settings.

When the User Calibration facility is enabled, the uncorrected wind speed indication of the sensor is calibrated according to the stored calibration records, using linear interpolation.

6.4.25 UC.2: Clear User Calibration Table Record

Command Parameter	UC (Erase table)

Command Syntax	SET Sensor:	*$<listenerID>,UC<erase>*<checksum><cr><lf>* *$aa,UCCLEAR*hh<cr><lf>*

Parameters	<erase> *CLEAR*	 Erases both Flash and RAM copies of user calibration table

Examples	Example 1 Erase the user calibration tables and verify	
	Message	Comment
	*$01,UCCLEAR*62<cr><lf>*	Erase calibration tables
	*$01,UC?*04<cr><lf>*	Query user calibration table status
	*$WI,UC=00,D,0000,0000*71<cr><lf>*	Sensor response

Description	Use the UCCLEAR command to erase the RAM and saved FLASH copies of the user calibration table. A UCCLEAR is performed before a new user calibration table is loaded (see Section 6.4.26). The user calibration table label is also cleared to 32 ASCII spaces when the UCCLEAR command is sent (see Section 6.4.28).

6.4.26 UC.3: Set User Calibration Table Record

Command Parameter	UC (set & verify record)

Command Syntax	SET Sensor Calibration Record:	*$<listenerID>,UCW<Cspeed>,<Uspeed>*<checksum><cr><lf>* *$aa,UCWxx.xx,yy.yy*hh<cr><lf>*
	Verify Last Record:	*$<listenerID>,UC?W*<checksum><cr><lf>* $aa,UC?W*hh<cr><lf>
	Sensor output:	*$<talkerID>,UC=<error code>*<checksum><cr><lf>* *$aa,UC=n*hh<cr><lf>*

Parameters	*<Cspeed>* *xx.xx*	Corrected speed
	<Uspeed> *yy.yy*	Uncorrected speed
	<error code> *0* *1* *2* *3* *4* *5*	Table entry accepted Error: Sensor speed out of order (latest row speed <previous row speed) Error: Sensor speed increment less than 0.5ms than previous record Error: Data entry not allowed (table has not been cleared first) Error: Bad argument (data format not valid) Error: User calibration table is full (all 64 rows have been entered)

Examples	Example 1 Enter user calibration table record and verify	
	Message	Comment
	*$01,UCW00.90,01.11*48<cr><lf>*	Set a wind speed correction
	*$01,UC?W*53<cr><lf>*	Query if table entry was accepted
	*$WI,UC=0*29<cr><lf>*	Sensor response

Description	Use the UCW command to set and verify individual user calibration table records. New records can only be entered if the Calibration table is cleared first (see Section 6.4.25) Up to 64 records can be entered sequentially into the sensor's RAM and verified. Once sufficient records have been loaded, these can be saved to the Flash using the user calibration save command (see Section 6.4.27).

6.4.27 UC.4: Save and Read User Calibration Table

Command Parameter	UC (save and read)

Command Syntax	Save Sensor Calibration Record:	*$<listenerID>,UCS*<checksum><cr><lf>* *$aa,UCS*hh<cr><lf>*
	QUERY Saved Sensor Calibration Record:	*$<listenerID>,UC?R<row>*<checksum><cr><lf>* $aa,UC?Rnn*hh<cr><lf>
	Sensor output:	*$<talkerID>,UC=<row>,<Cspeed>,<Uspeed>*<checksum><cr><lf>* *$aa,UC=nn,xx.xx,yy.yy*<cr><lf>*

Parameters	*<row>* *01 – 64*	Calibration table row number
	<Cspeed> *xx.xx*	Corrected speed
	<Uspeed> *yy.yy*	Uncorrected speed

Examples	<u>Example 1</u> Save a new user calibration table from RAM into Flash memory and verify	
	<u>Message</u>	<u>Comment</u>
	*$01,UCS*68<cr><lf>*	Save calibration table
	*$01,UC?*04<cr><lf>*	Query user calibration table status
	*$WI,UC=55,E,5174,5174*70<cr><lf>*	Typical sensor response
	<u>Example 2</u> Read calibration data stored in row 5 of the Flash calibration table	
	<u>Message</u>	<u>Comment</u>
	*$01,UC?R05*53<cr><lf>*	Query Flash user calibration record
	*$WI,UC=05,06.00,06.03*1F<cr><lf>*	Typical sensor response

Description	Use the UCS command to save a new user calibration table into Flash memory. A user calibration query (see Section 6.4.24) command can then be used to verify that the checksum of the RAM and Flash copies are equal. This demonstrates that the table has been saved without error. Use the UC?R command to verify the data stored in an individual Flash calibration record.

Once the table has been saved into Flash memory, new data and the text string can only be written to it by first clearing the table.

6.4.28 UC.5: Set & Query User Calibration Table Label

Command Parameter	UC (label)

Command Syntax		
	SET Sensor label:	$<listenerID>,UCT<text string>*<checksum><cr><lf> $aa,UCTxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx*hh<cr><lf>
	QUERY Sensor label:	$<listenerID>,UC?T*<checksum><cr><lf> $aa,UC?T*hh<cr><lf>
	Sensor output:	$<talkerID>,UC=<label32>*<checksum><cr><lf> $aa,UC=xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx*hh<cr><lf>

Parameters		
	<text string> xxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxx	Up to 32 upper or lower case alphanumeric ASCII characters (can also include ASCII space, underscore and hyphen characters). Factory default is 32 ASCII spaces.
	<label32> xxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxx	32 ASCII characters, Note: ASCII spaces will be added to entered ASCII string if it is less than 32 characters to form a string of 32 characters.

Examples	
	<u>Example 1</u> Set the User Calibration label to "speed offset V03" and verify

Message	Comment
$01,UCTspeed offset V03*50<cr><lf>	Set Calibration table label
$01,UC?T*0C<cr><lf>	Query Calibration table label
$WI,UC=speed offset V03 *26<cr><lf>	Sensor response

Description	
	Use the UCT command to set a User calibration table label. The label can be up to 32 ASCII characters long and include ASCII space, underscore and hyphen characters. The user calibration table label can be cleared by using the UCCLEAR command. (see Section 6.4.25) This resets the label to 32 ASCII spaces. UC?T query command will only return a response after the user calibration table has been initialised.

6.4.29 US: Set or Query Saved Parameters

Command Parameter	US	
Command Syntax	SET Sensor:	*$<listenerID>,US<setting>*<checksum><cr><lf>* *$aa,USS*hh<cr><lf>*
	QUERY Sensor:	*$<listenerID>,US?*<checksum><cr><lf>* *$aa,US?*hh<cr><lf>*
	Sensor output:	*$<talkerID>,US=<match>*<checksum><cr><lf>* *$aa,US=c*hh<cr><lf>*

Parameters		
	<setting>	
	S	Copies the User Parameters and saves them as the Saved Parameters.
	<match>	
	P	indicates the User Parameters are the same as the Saved Parameters
	F	indicates the User Parameters are not the same as the Saved Parameters

Examples		
	Example 1 Set and Verify new user saved parameters	
	Message	Comment
	$01,USS//<cr><lf>*	Set saved parameters
	$01,US?//<cr><lf>*	Query the saved parameters
	*$WI,US=F*4F<cr><lf>*	Sensor response

Description

There are three copies of Parameters stored in Flash memory namely, User Parameters, Factory Parameters, Saved Parameters respectively. All three copies are initially loaded with the same default settings.

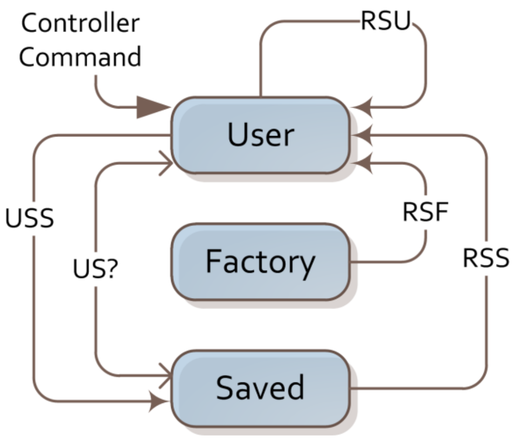


Figure 54: Relationship between the 3 flash copies of Parameter Settings

The User Parameters is the copy that the sensor operates from, at all times. When sending a command to the sensor, it is the User Parameter copy which is updated. The user parameters copy is non volatile so the sensor will keep the last settings when it is powered up again.

The Factory Parameters retain the original default settings and cannot be modified, but can be used to replace the User Parameter, by using the RSF command (see Section 6.4.21)

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Description continued	The Saved Parameters are created by means of the USS command. This command copies the User Parameters and saves them into a separate area in Flash reserved for the Saved Parameters. The query US command compares item by item the Saved Parameters against the User Parameters and reports any discrepancy; this command could be used after USS to confirm that all of User Parameters have been copied correctly in Saved Parameters. A reset command can be used to load the Saved Parameters back to the User Parameters. See command RSS (Section 6.4.21) for the details of the RSS command. After RSF and RSS commands are executed the restored parameters are loaded into RAM, so it is imperative to execute any one of the Set Commands described in Section 6.1.1; executing any one of these commands instructs the sensor to make a non-volatile copy of the newly created User Parameters.

The Command USS should never be done outside of a laboratory or controlled environment. This then ensures that the Saved Parameters copy is not corrupted. Then in the field when changing a User parameter, if a lightning strike occurs exactly at the same time as an attempted change and the User version becomes corrupt there is always a 'clean' back up Saved copy of the parameters that can be used to recover the sensor.

6.4.30 WV Polar: Query the Wind Velocity Reading

Command Parameter	WV (Polar)

Command Syntax		
	SET Sensor:	N/A
	QUERY Sensor:	*$<listenerID>,WV?*<checksum><cr><lf>* *$aa,WV?*hh<cr><lf>*
	Sensor output:	*$<talkerID>,WVP=<speed>,<angle>,<status>*<checksum><cr><lf>* *$aa,WVP=xxx.x,xxx,x*hh<cr><lf>*

Parameters		
	<speed> *000.0 to 075.0*	Measured wind speed in metres per second (the FT722 is limited to 050.0)
	<angle> *000 to 359*	Measured wind direction in degrees relative to sensor datum
	< status > *0 to Z*	Indicates whether an error condition was detected by the sensor operating system. A status value of 0 indicates no issues have been detected (ASCII 30(HEX)). If the sensor detects an error condition, the status character will be set to 1. If the Overspeed Warning Scheme (see Section 2.7) is enabled and if the sensor detects wind speed above the maximum range, the status flag will be set to 2.

Examples		
	<u>Example 1</u> The following example illustrates the polar wind velocity data format. The example shows the sensor output with a wind speed of 20m/s and a wind angle of 45°.	
	<u>Message</u>	<u>Comment</u>
	$01,WV?//<cr><lf>*	Query the wind velocity
	*$WI,WVP=020.0,045,0*73<cr><lf>*	Sensor polar response

Description	
	The WV command returns the wind velocity value in the currently selected format. Polar or NMEA formats are available. Use the DF command, Section 6.4.8, to select the required output format. Polar Format: The sensor returns the magnitude of the wind speed (m/s) and the wind direction (0-359°). NMEA 0183 Format: The sensor returns the NMEA 0183 Wind Speed and Angle sentence MWV (see WV NMEA, Section 6.4.31).

It is important that the status is always monitored. Readings associated with errors should not be treated as valid. It is important that the host computer is able to cope with occasional periods when valid data may be temporarily unavailable.

The status is cleared once the WV command is executed, provided that the error condition does not persist.

6.4.31 WV NMEA: Query the Wind Velocity Reading

Command Parameter	WV (NMEA)

Command Syntax	SET Sensor:	N/A
	QUERY Sensor:	*$<listenerID>,WV?*<checksum><cr><lf>* *$aa,WV?*hh<cr><lf>*
	Sensor output:	*$WIMWV,<angle>,R,<speed>,<units>,<status>*<checksum><cr><lf>* *$WIMWV,xxx,R,xxx.x,c,A*hh<cr><lf>*

Parameters	<angle> *000 to 359*	Measured wind direction in degrees relative to sensor datum
	<speed> *000.0 to 075.0* *000.0 to 145.8* *000.0 to 270.0*	 Measured wind speed (in metres per second). FT722 limited to 050.0. Measured wind speed (in knots). FT722 limited to 097.2. Measured wind speed (in km per hour). FT722 limited to 180.0.
	<units> *M* *N* *K*	 Indicates the wind speed is presented in metres/second Indicates the wind speed is presented in knots Indicates the wind speed is presented in kilometres/hour
	< status > *0 to Z*	 Indicates whether an error condition was detected by the operating system, such as out of range wind speed or incorrect signal level. Any character other than 'A' (ASCII 41(HEX)) = error.
Examples	<u>Example 1</u> The following example illustrates the NMEA wind velocity data format. The example shows the sensor output in m/s with a wind speed of 20m/s and a wind angle of 45°. <u>Message</u> *$01,WV?*//<cr><lf>* *$WIMWV,045,R,020.0,M,A*3D<cr><lf>* <u>Example 2</u> The following example illustrates the NMEA wind velocity data format. The example shows the sensor output in knots with a wind speed of 30.6 knots and a wind angle of 9°. <u>Message</u> *$01,WV?*//<cr><lf>* *$WIMWV,009,R,030.6,N,A*31<cr><lf>*	 <u>Comment</u> Query the wind velocity Sensor NMEA response <u>Comment</u> Query the wind velocity Sensor NMEA response

Description	The WV command returns the wind velocity value in the currently selected format and units. Polar or NMEA formats are available. Use the DF command, Section 6.4.8, to select the required output format and units. Polar Format: The sensor returns the magnitude of the wind speed (m/s) and the wind direction (0-359°) (see WV Polar, Section 6.4.30). NMEA 0183 Format: The sensor returns the NMEA 0183 Wind Speed and Angle sentence MWV. The sensor returns the wind direction (0-359°) and wind speed (m/s, knots or km/h) using the MWV Wind Speed and Angle sentence. The sensor Talker ID is always set to WI when NMEA format is selected, irrespective of any setting that may have been set with the ID command.

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