

USER MANUAL

Turbine Blade Tip-to-Casing Cold Clearance Wireless Measurement Kit

Model **CMS-3400**

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INTRODUCTION

With new construction and at overhaul, turbine blade tip-to-casing clearances at room temperature must be properly set. Hand-held feeler gages have long been used to measure the tip clearances and inspect the roundness of the TBC linings at access ports provided for that purpose.

Typically, turbine cases are not perfectly round, having some asymmetry and ovalization developed from many hours of operation. The Philtec CMS-3400 Gap Measurement Kit provides wireless blade-mounted fiber optic sensors and a Windows Tablet preloaded with Philtec's Control Software to digitally capture the full 360° picture of casing roundness and gap data.

This measurement system can be operated in dual or quad channel mode. As a technician slowly jogs a rotor thru 360° of rotation, Gap and Angle data pairs can be simultaneously recorded from four rows of blades and saved for offloading and data analysis.

NOTE: The user must build the necessary fixturing that protects the blades while mounting the sensor hardware securely.

DESCRIPTION

CMS-3400 is a four channel wireless sensor system for the measurement of turbine blade tip-to-casing cold clearances.

The system is comprised of:

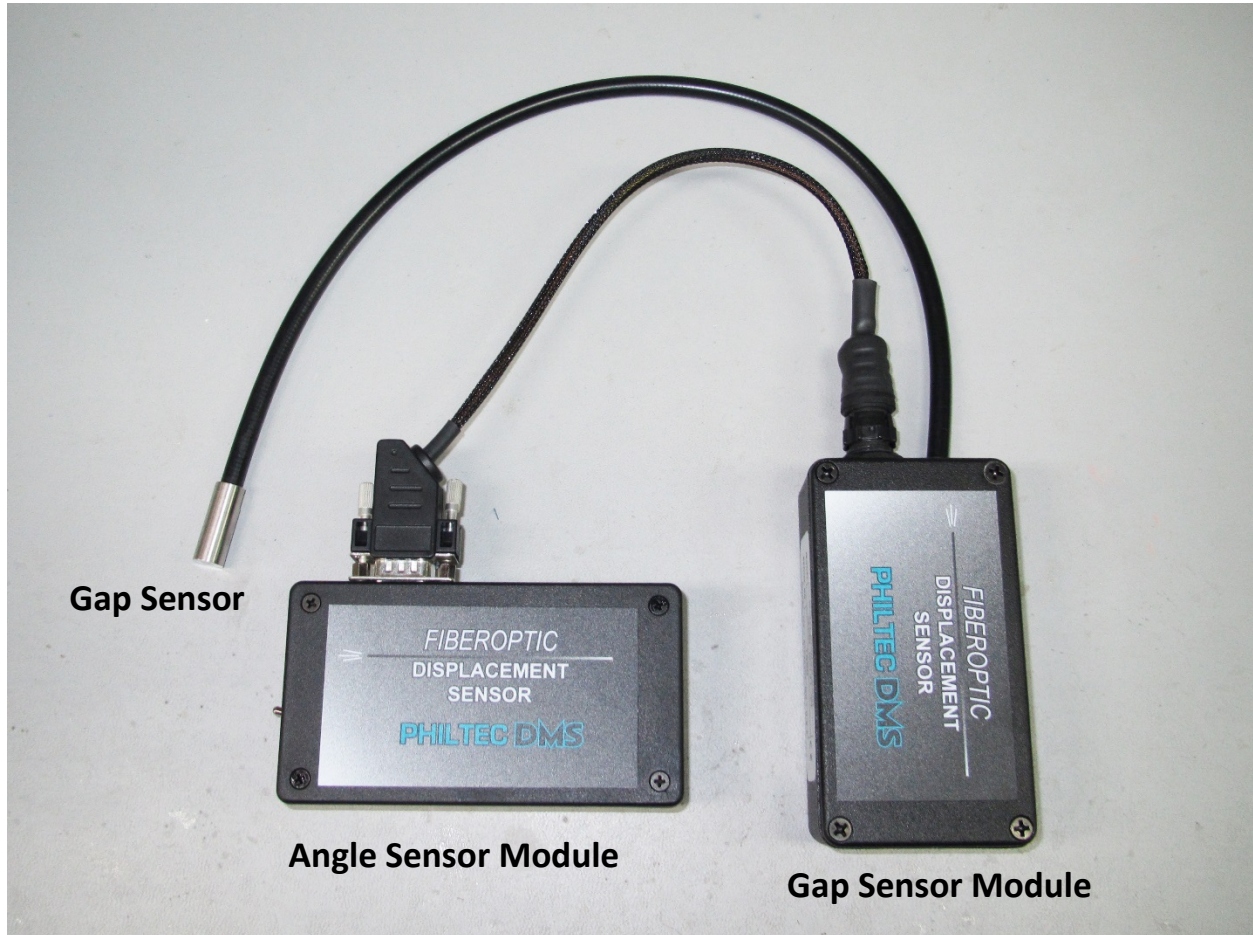
- 4 Gap Sensor Modules with 15 mm Range Gap Probes
- 4 Angle Sensor Wireless Modules
- 4 Data Link Cables
- 4 Mini to Standard USB Cables
- 1 Windows 8" Tablet with Philtec Operating Software Preinstalled
- A 16 GB USB Flash Drive
- A Protective case for Tablet



INSTALLATION

Three elements are mounted to adjacent blades:

- Blade 1: Gap Probe
- Blade 2: Gap Sensor Module
- Blade 3: Angle Sensor Wireless Module (with Bluetooth Transmitter)



NOTE: The user must build the necessary fixturing that protects the blades while mounting these three elements securely. The rotor will be slowly jogged by a technician to rotate the sensors thru 360° inside the casing.

MODULE DIMENSIONS					
MODULE	LENGTH, mm	WIDTH, mm	HEIGHT, mm	WEIGHT, Oz.	MATERIAL
Gap Sensor	112.5	60.5	31	11	Aluminum
Angle Sensor	113.8	63.2	28.2	5.5	ABS Plastic

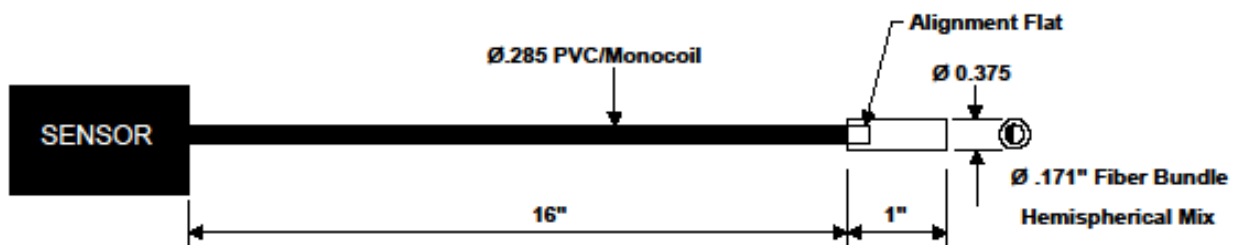
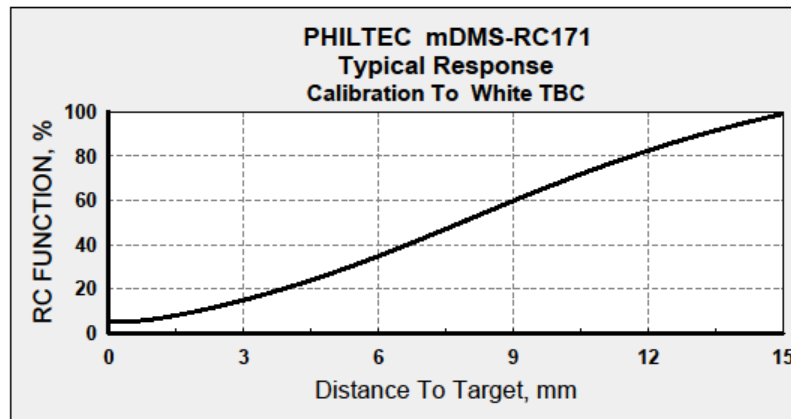
Gap Sensor Detail

Operating Principle

The Gap Sensor is a Reflectance Compensated Fiber Optic Displacement Sensor. These are reflective type transducers based upon detecting the intensity of reflected light. They have a pair of adjacent fiber optic detectors in the sensor tip. Light reflected off the target surface follows two separate paths back to the electronics where a ratiometric calculation provides the distance measurement which is independent of varying surface reflectance; i.e., *reflectance compensated*.

Operating Range

- The Gap Sensor has a 15 mm operating range supplied with calibration to a TBC surface. It can be gapped anywhere within its operating range.
- It must be mounted perpendicular to the target surface $\pm 0.5^\circ$ for best accuracy.
- Use a shim or feeler gage to set the sensor gap to a desired value.



Gap Sensor Detail

Angle Sensor

- Install the Angle Sensor Module into the correct orientation and ensure it is switched on.
- The orientation angle of the Angle Sensor Module is measured with 0.1° resolution, where 0.0° or 360° is at the 12 o'clock position.

Angle Sensor Module at 0° or 360°

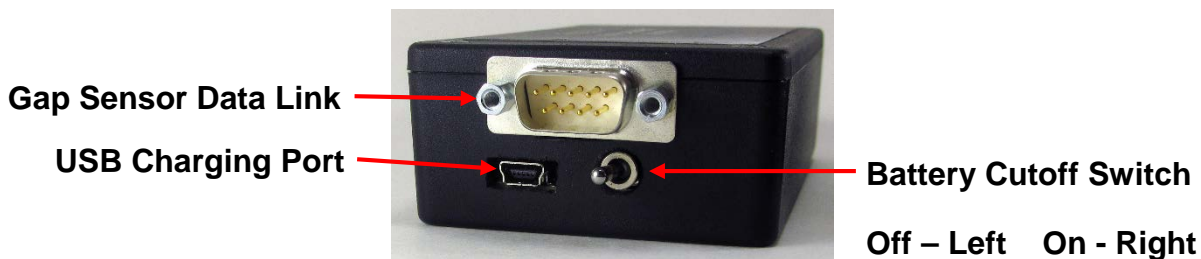


OPERATION

Angle Sensor

The Angle Sensor Module houses a Bluetooth transmitter and battery.

Bluetooth Battery Module



Power Requirements

USB @ 500mA

Specifications

Time To Charge: 4 Hours

Run Time: 10 Hours w/full charge

Standby Mode: 4 Weeks

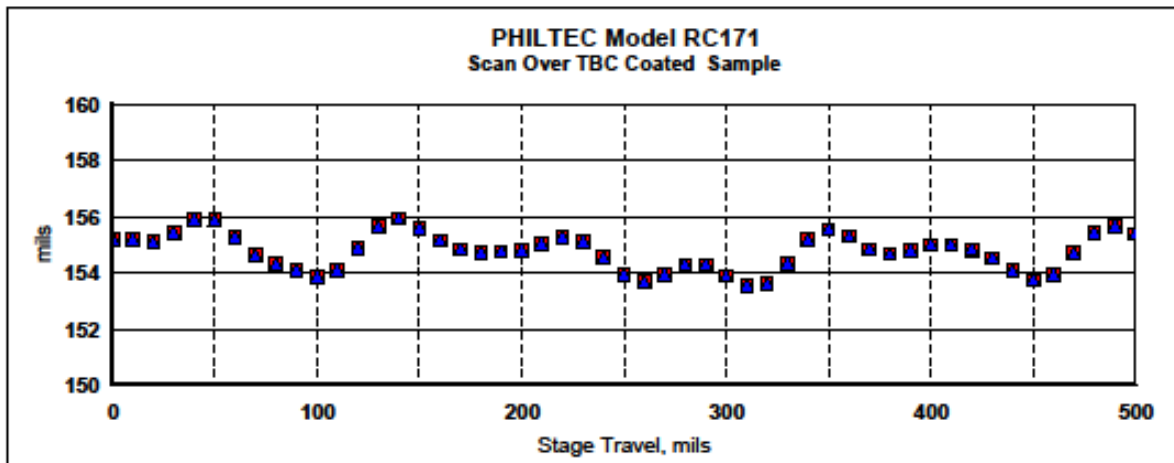
Run Time: 3 Hours After 4 weeks Standby

Radio Range: Up to 50 Meters Line of Sight

Gap Sensor

Gap Sensor Accuracy

Surfaces with Thermal Barrier Coatings are diffuse (dull) reflectors of light. Light rays are scattered as they reflect off the TBC surface, causing variations in the sensor output. The chart here shows the instantaneous accuracy of the sensor when scanned over a flat TBC surface is ± 0.001 " (1.3% of the gap value). Accuracy can be improved via data averaging.

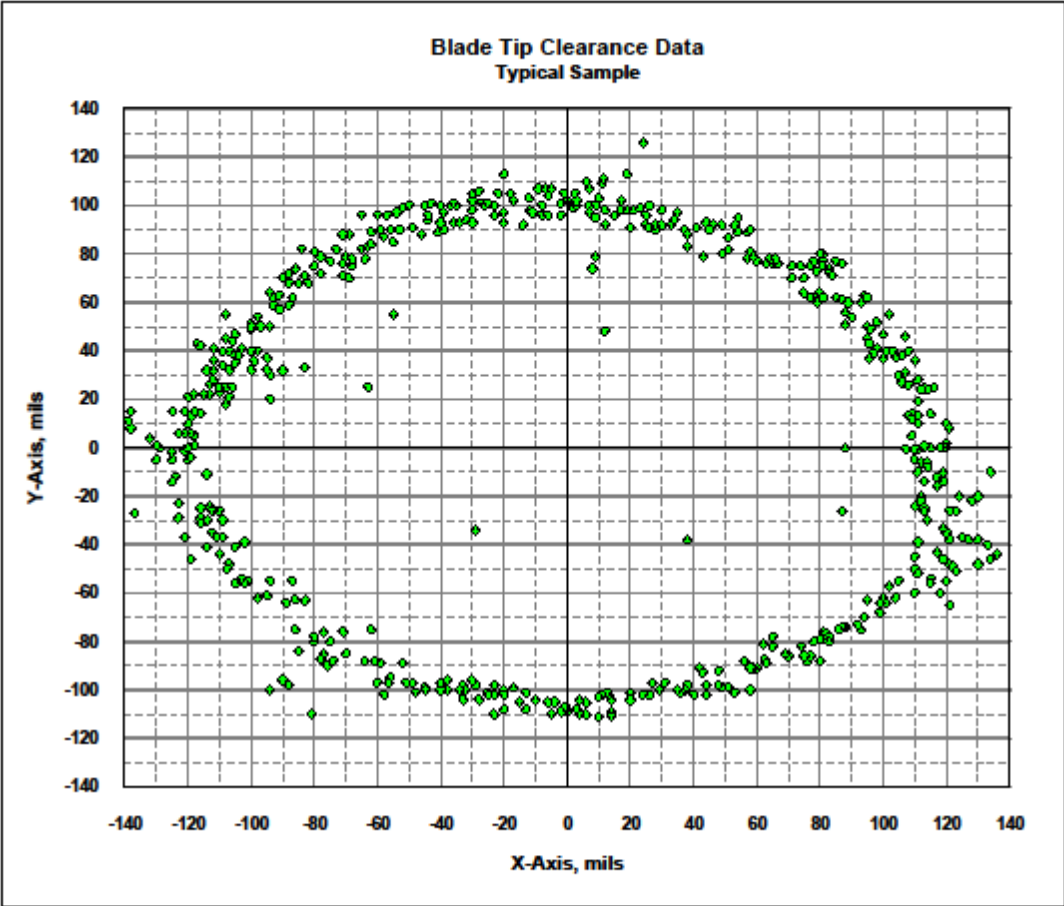


Data Sample Rate

The CMS-3400 Tablet records gap and angle data pairs at a typical rate of 10 samples/second. The maximum available data rate is 1,000 samples /second.

TYPICAL DATA

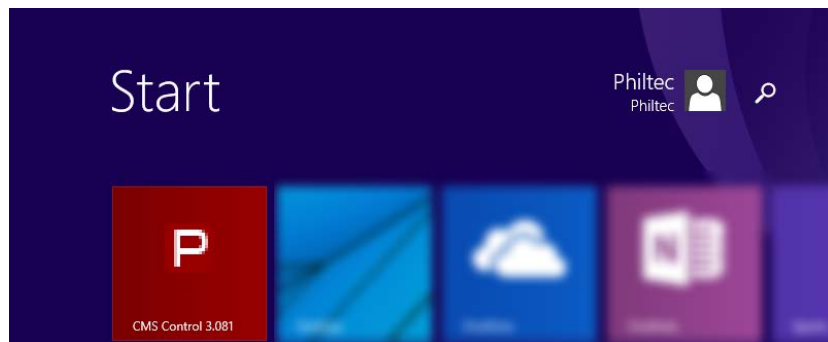
Ovalization of turbine casings can range from 0.010 – 0.040” or more as shown here.



CMS Control

CMS Control can be installed on any Windows PC and will work with any bDMS wireless module once paired. The Windows 8 tablet in the CMS-3400 kits have CMS Control preinstalled and are paired with the bDMS units included.

The program can be started by pressing (or clicking if using a mouse) the CMS Control tile on the Windows Start Screen.



This application is designed for the tablet screen in horizontal orientation (vertical will be supported in future versions). The default configuration will automatically open the wireless modules that were packaged with the tablet and display the 4 channel screen. Data will be saved to a text file while the program is connected to the modules. Pressing "Exit" will disconnect from the modules and close the program.

All default values and sensor connections can be modified in the Admin screen.

Four Channel Display

The screenshot displays a control panel with the following elements:

- Top right: **Sensors OFF** (red button) and **EXIT** (grey button).
- Four rows of data:

Channel	Device	Clearance	Angle (deg)	Tare Distance	BAT%
ON	Row 1 BT: Philtec bDMS-1799	0.240	88.7	0.240	72
ON	Row 2 BT: Philtec bDMS-179A	0.180	86.3	0.180	73
ON	Row 3 BT: Philtec bDMS-179E	0.162	94.4	0.162	79
ON	Row 4 BT: Philtec bDMS-17A0	0.190	94.1	0.190	76
- Bottom left: **Save Data ON** (green button).
- Bottom center: **UOM: Inch** (dropdown menu).
- Bottom right: **Open Sensors** (grey button) and **Admin Settings** (grey button).
- Status indicators: **Current Process** (0) and **Error s/s** (5.8).

Display data from up to 4 channels. Tare value can be reset by pressing “Tare Distance” readout. First press will display “RESET” button allowing distance reset. “RESET” button will be disappear after 2 seconds if not pressed.

This close-up shows the **Tare Distance** field for Row 1. The value is **0.240**. A **RESET** button is overlaid on the right side of the field. The **Angle (deg)** is **88.7** and **BAT%** is **72**.

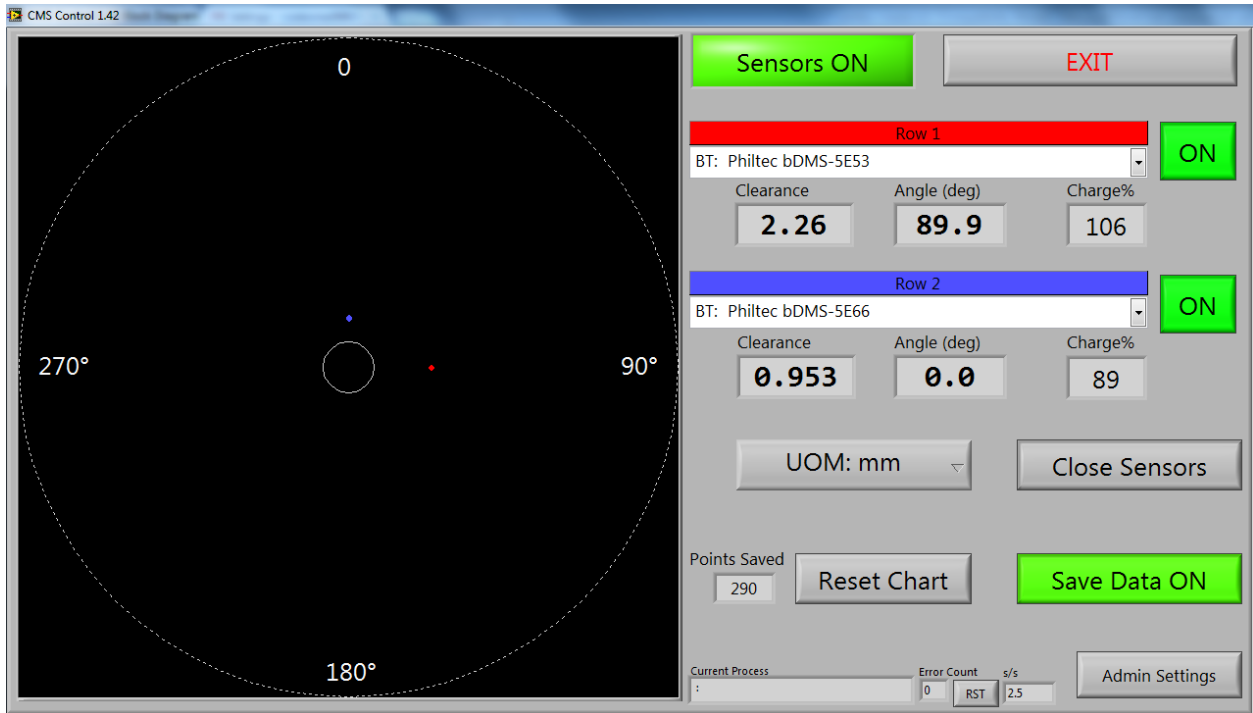
Dual Channel (Text) display

The screenshot displays a dual-channel interface with the following elements:

- Top Bar:** A green "Sensors ON" button and a grey "EXIT" button.
- Channel 3 (Left):** A green "ON" indicator, a red header "Row 3", and a dropdown menu showing "BT: Philtec bDMS-5D58".
- Channel 4 (Right):** A green "ON" indicator, a blue header "Row 4", and a dropdown menu showing "BT: Philtec bDMS-F540".
- Channel 3 Data:** Clearance: 3.22; Angle (deg): 80.0; Charge%: 50; Tare Distance: 0.11.
- Channel 4 Data:** Clearance: 8.12; Angle (deg): 81.2; Charge%: 55; Tare Distance: 0.44.
- Buttons:** "Tare Reset" for each channel, "Save Data ON" (green), "UOM: micron" (dropdown), "Open Sensors", and "Admin Settings".
- Status Bar:** "Current Process" (0), "Error Count" (0), and "RST" (0).

Display data from 1 or 2 channels.

Graph Display



Display data from 1 or 2 channels with polar plot.
0 degree position for module is switch/cable side of enclosure facing up.

Admin Com-Row Config

The wireless module and sensor settings can be changed with the Admin display. Press “Save Defaults” to store current configuration to the tablet.

Com and Row selection: select which modules to read and in which order. Row selection is stored in the text log file but does not impact how data is read. Com channels can be turned off (press ON/OFF to the right of Com dropdown selector) if channel is not needed or unavailable.

UOM: Unit of measure used for tablet display and text log file.

Start Screen: screen displayed at program start.

Startup Scan: scan for wireless modules at program start. Should be OFF except for troubleshooting.

Auto Start: ON will open sensors immediately when CMS Control starts. OFF will start CMS Control in standby mode and user presses “Open Sensors” to begin data acquisition.

Save Defaults: Saves Com-Row Config data, UOM, Start Screen, Startup Scan, Auto Start, and File Name Prefix

Re-scan BT Ports: scans for available Bluetooth connections

Open Sensors: Open sensors and modules listed in Com-Row Config (Com must be ON)

Save Data: Save data to text log file

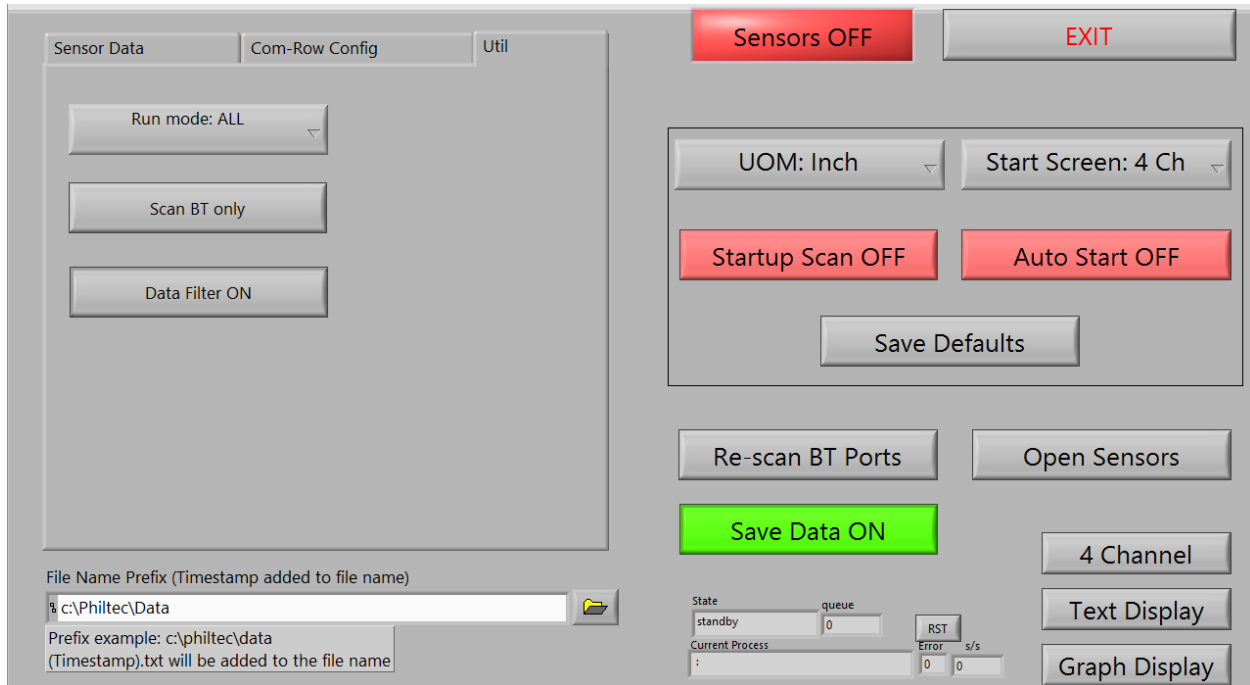
File Name Prefix: File name prefix and location of text log file. Time stamp (YYYY_MM_DD_HH_MM) and “.txt” will be appended for file name.

4 Channel: 4 channel screen with tare function

Text Display: 2 channel screen with tare function

Graph Display: 2 channel screen with polar plot

Admin
Util tab



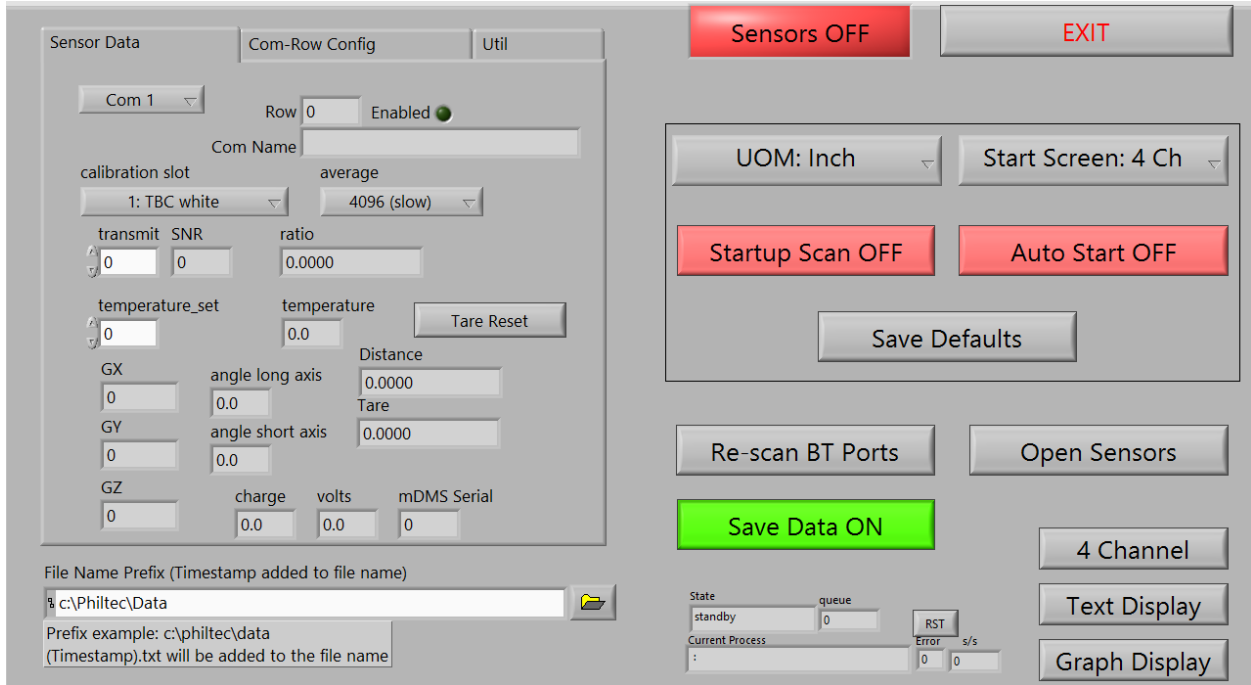
Run mode: set to ALL. Other settings used for diagnostic testing.

Scan: set to "BT only". Other settings used for diagnostic testing.

Data Filter: ON will remove "out of range" distance readings from text log file.

Admin

Sensor Data tab



Sensor Data tab is used for sensor diagnostic. Consult factory before changing sensor settings on this tab.

CMS Control Install

The latest version of CMS Control can be downloaded from the Philtec website.
<http://philtec.com/downloadssupport/firmware.html>

New version will not replace previous installation and both should function properly.

CMS Control install / upgrade procedure (Windows 8):

Download zip file from website
(CMS_Control_X_XXX.zip)
Extract zip to a folder.
Run setup.exe

CMS Control Application (Windows 8 or greater):

note: For wireless modules only
Optimised for tablet display

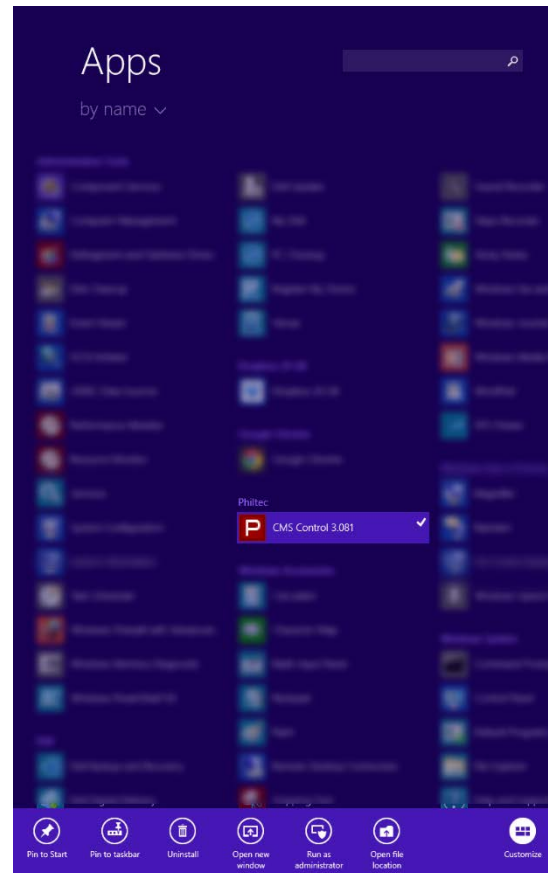
[CMS Control Version 3.081](#)

[CMS Control Version 2.10](#)

Windows will place CMS Control into Philtec section of Apps screen. This can be found by pressing the down arrow on the lower left corner of the Start screen.

To move the shortcut to the Start screen, press shortcut for 1 second (or right click if using mouse) to display option menu then press "Pin to start". CMS Control tile will be added to the Start screen.

CMS tile can now be dragged to desired location on Start screen.



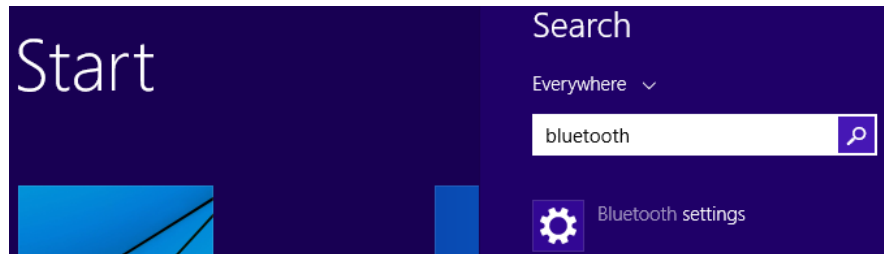
bDMS Pairing

The bDMS module must be paired with the PC or tablet before it can be used by CMS Control.

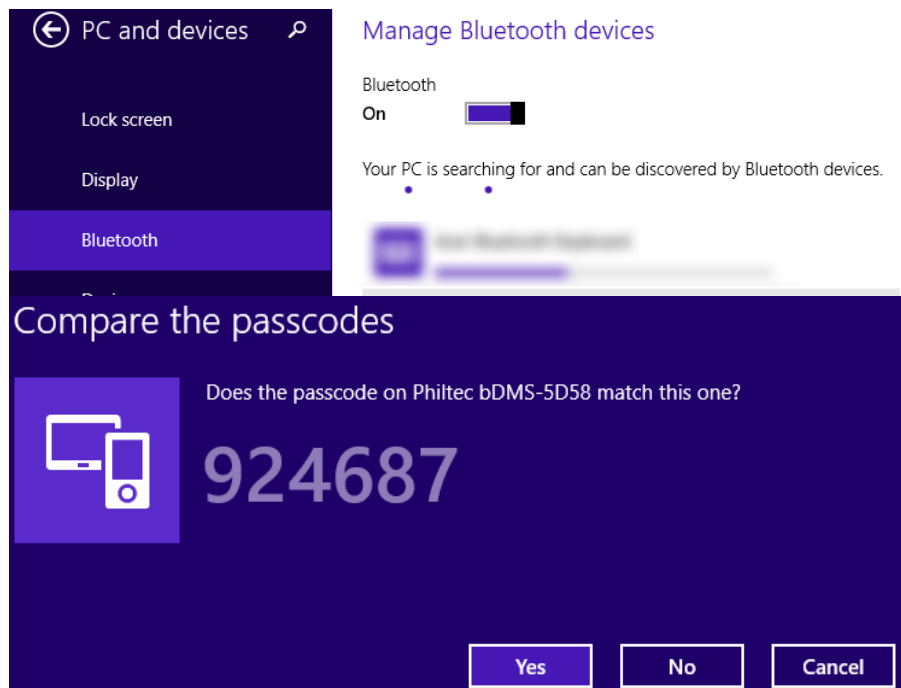
Note: modules shipped with the tablet are already paired.

To pair a bDMS module to a PC or tablet (Windows 8):

From the Start screen, enter “Bluetooth” into search bar and press “Bluetooth settings”.



The bDMS module should be found by Windows. Press “Pair”



Windows might display a passcode confirmation. Current modules do not have a display. Press “Yes”.

Module should now be paired and ready for use by CMS Control.