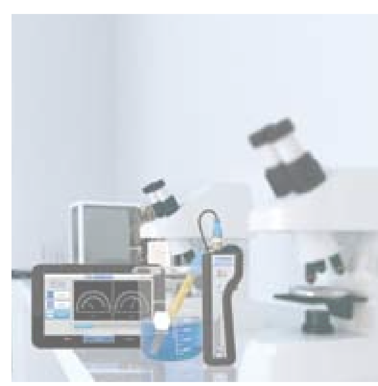
UWBT
Portable Data Acquisition System

Modern Applications of the UWBT Series



Solution pH Measurement Using UWBT-PH

Pharmaceutical, chemical and wastewater treatment labs can use the UWBT-PH model to measure pH of chemical samples for process monitoring and documentation (see figure 1).

Figure 1: UWBT-PH in a chemistry lab

The UWBT-PH allows lab technicians to measure multiple samples using up to four transmitters connected to one Android™ smart device, or up to three transmitters connected to one iOS™ smart device (see figure 2). Lab technicians find this set-up more efficient than using individual pH meters to perform process measurements and retrieve test data. An outstanding feature of the UWBT-PH model is that its front end electronics are designed to accept pH input from any high impedance pH probe with a BNC connection. In this example the technician is sampling pH from four unique chemical solutions, each one having a different type of pH probe. The probes vary by the length, type of liquid junction and type of electrolyte, with the variants tuned to different types of chemicals being measured. If a probe breaks or degrades appreciably, the technician can unplug the BNC connector from the transmitter and substitute a new pH probe.

Figure 2: Four UWBT-PH transmitters connected to one tablet

Just like other UWBT models, pH readings can be selected and displayed in either graphical, digital or analog gauge format, along with the corresponding solution temperature. This temperature may be read from the probe, if such a probe comes with a temperature sensor. Otherwise, it is entered as a fixed solution temperature within the app (see figure 3).

Figure 3: Entering fixed solution temperature

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Screen images of devices are simulated. Actual appearance of devices may vary.

Relative Humidity Measurement Using UWBT-RH

ISO 17025, Section 5.3, requires the control, monitoring and recording of laboratory environmental conditions for an accredited test and calibration lab. This monitoring includes measuring and maintaining air temperature and humidity conditions to a predefined specification. The UWBT-RH ambient temperature/relative humidity transmitter is a highly convenient way to monitor these parameters. In figure 1 the product is shown conveniently hanging on the wall of a calibration lab, near sensitive metrology equipment and directly next to an old circular paper chart recorder. The rear of the UWBT-RH case contains a keyhole that fits a #4 screw (M3 metric). The bottom of the case contains a USB connector for connecting the AC power supply into a wall outlet. The power supply comes standard with a plug configuration for the country in which the transmitter is sold.

Figure 1: Mounting UWBT-RH on a wall for long-term monitoring

In prior years a metrology lab technician would load a new piece of circular chart paper into the chart recorder for a pre-defined sampling period, typically 1 day or 1 week. The completed charts might be locked away in a file cabinet, making it difficult to correlate past lab temperature and humidity conditions with outstanding metrology issues. Incorrectly charting data past one rotation of the chart paper was common. Even if a technician could find the right chart paper in a file cabinet, reading the data would be made difficult by blue or red ink smudges on the chart paper. In addition, the only way a technician would know that current lab conditions were out of normal operating range would be to carefully study the current chart paper, manually comparing the plotted curves to a documented set of standard conditions.

Using the UWBT transmitter, a technician can log up to 20,000 data points internally in the transmitter at fixed rates of 1 sample per second up to 1 sample/minute. This gives the technician a flexible range of 5½ hours to 2 weeks of internal data storage. Humidity data is stored in both %RH and dew point. Data files in .csv or .txt format can be downloaded from the transmitter (see figure 2a), sent to an e-mail address or sent to one of five different cloud storage sites (see figure 2b). The .csv files are conveniently manipulated within a PC spreadsheet program (See figure 2c). The default file name conveniently includes the date and time of logging. Data files can be stored and retrieved by name on a network file server. They can be conveniently accessed long after outstanding metrology issues are uncovered, or any time that an ISO 17025 audit takes place in the lab.

Figure 2a: File download

Figure 2b: File communication

Transmitter Name: Lab A			
Sensor Type: RH			
Logging Sample Rate: 1 minute			
Engineering Units: Celsius(C)			
Time	Temperature	RH	Dewpoint Temperature
12/3/14 9:57	20.8	43	46.2
12/3/14 9:58	20.8	43	46.3
12/3/14 9:59	20.8	43	46.2
12/3/14 10:00	20.8	43	46.2
12/3/14 10:01	20.8	43	46.2
12/3/14 10:02	20.8	43	46.3
12/3/14 10:03	20.8	43	46.2
12/3/14 10:04	20.7	43	46.3
12/3/14 10:05	20.7	43	46.3
12/3/14 10:06	20.7	43	46.4
12/3/14 10:07	20.7	43	46.4
12/3/14 10:07	20.7	43	46.3
12/3/14 10:08	20.7	43	46.4
12/3/14 10:09	20.7	43	46.4
12/3/14 10:09	20.7	43	46.4
12/3/14 10:10	20.8	43	46.4
12/3/14 10:11	20.7	43	46.4
12/3/14 10:12	20.7	43	46.4

Figure 2c: File data structure

The technician can receive alerts when lab temperature or RH conditions go outside preset limits. Alarms are indicated in 3 different formats. The app graphics and smart device sounds are available when the transmitter is paired with a smart device, whether or not it is logging data directly to a smart device (see figure 3a). Sounds are available in one of five standard ringtones that come with smart devices.

Either temperature or humidity high and low alarm limits can be displayed within the app (see figure 3b). In this example the temperature high and low alarm limits are displayed in the gauge screen for Transmitter 1. The green color on the gauge background refers to the nominal operating range of temperature limits. The blue color on the background refers to the range of temperatures that will be colder than the low alarm limit. The red color on the background refers to the range of temperature that will be warmer than the high alarm limit. The green colored battery icon communicates both a 99% charge level, with the internal white icon indicating that the external AC power supply is connected. The blue colored background of the Bluetooth icon indicates that the transmitter is paired with a smart device. If the transmitter were to un-pair from the smart device, the background color would turn to black.

Figure 3a: Alarm settings menu

Figure 3b: Alarm display

The red LED on the transmitter, located under the word "PWR/ALARM" will blink every 2 seconds in either high or low alarm condition (See figure 4). Technicians no longer need to squint at smudged chart papers.

Figure 4: UWBT-RH Transmitter

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Monitoring Air Duct Temperature Using UWBT-RTD

Measuring temperature inside an air duct is a common facilities maintenance task for energy conservation, particularly when office area temperatures are far from defined setpoints. Historically, maintenance staff have stood on a ladder holding an RTD probe inside an air duct with one hand, the connector on the probe plugged into a handheld thermometer held with the other hand. The maintenance tech will then read the duct temperature off an LCD display. A wall-mount data logger cannot be used to record data over long periods of time, as it cannot fit inside the duct. The handheld thermometer cannot be used for logging data because it cannot be attached to the duct. Hence, the maintenance person will be standing on the ladder for a long and uncomfortable time while he tries to obtain data.

With a UWBT temperature transmitter fitted with an M12 probe connector, the maintenance technician has a much less cumbersome way of gathering data (see figure 1). In this application a PR-25AP air temperature RTD probe is screwed in via its M12 connector to a UWBT-RTD transmitter. The technician first pairs the transmitter to a smart device, attached to his person or conveniently located on a nearby bench. He then sets sensor settings, begins the data logging process, climbs on a ladder, and inserts to probe tip into the air duct.

Figure 1: Measuring air duct temperature with UWBT-RTD-M12

The left screenshot of figure 2 displays the UWBT app running on the technician's smart phone. The app displays 82.4°F (28.0°C), a very warm temperature for an office environment, indicating that something is wrong with the building temperature control system. When the technician clicks the light green colored icon for "Start Logging", the app screen changes to the screenshot of the right side of figure 2. The red icon showing "Rec" indicates that data logging is in process.

Figure 2: Display mode, start and stop logging screens

The PR-25AP air temperature RTD probe is well designed for this application (see figure 3a). It combines the high accuracy RTD sensor found in the OMEGA ultra-precise RTD probes with the convenience and reliability of an M12 connection. The PR-25AP comes standard with a Pt100 Wire Wound RTD calibrated to Class A Accuracy standard of IEC 60751. The probe tip is designed to provide a barrier to airflow between the air stream and the ambient conditions. It has been tested to 400 psi with no leakage. The probe is constructed with a 316L stainless steel housing and sheath for strength and corrosion resistance.

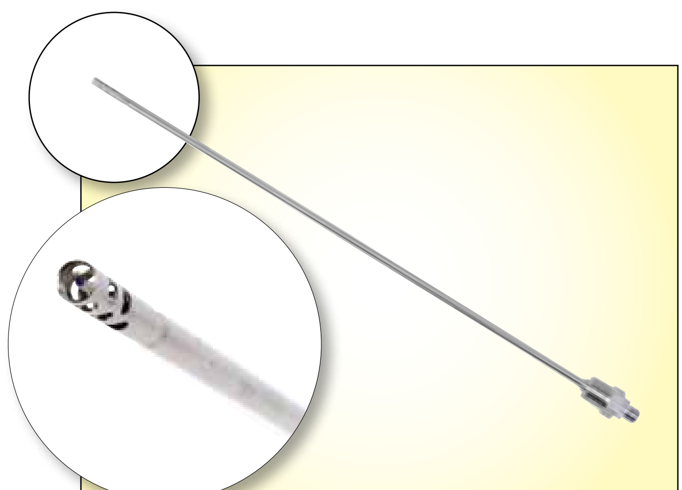

Figure 3a: PR-25AP air temperature RTD probe with specially designed probe tip

In certain situations, the technician may want to leave an RTD probe inserted into the duct for an extended time, walk away to accomplish another task, and log temperature data internally. The RTD-805 air temperature RTD sensor is well suited for this situation (see figure 3b). The technician would use transmitter model UWBT-RTD-TB with this sensor, as this model comes standard with a 3 position terminal block for connecting the loose wires of the sensor.

Figure 3b: RTD-805 air temperature RTD sensor with exposed element

The RTD-805 sensor is available with either a stainless steel or plastic housing. Similar to the PR-25AP probe, it comes standard with a 3-wire Pt100 wire wound RTD calibrated to Class A Accuracy standard of IEC 60751. The technician would connect the three wires of the sensor to the terminal block located on the front face of the transmitter (see figure 3c). The tip of the sensor would be inserted into the air duct. The technician can loosely place the transmitter inside a ceiling tile, as it weighs only 0.13 kg (0.38 lbs). The technician would pair with the transmitter and start the internal data logging process. He could record log duct temperature data at 1 sample/minute for up to 150 hours of battery life, and come back at a later time to download the data to his smart phone. The data could be conveniently emailed to other maintenance staff, with subsequent analysis made of the air temperature control system in the building.

Figure 3c: RTD cable connected to UWBT-RTD-TB

Occasionally, a technician may lose track of which ceiling tile a transmitter is placed inside, while still recalling the general location of the office area (see figure 4). In this case the technician could still pair with the transmitter without disturbing the ceiling tiles, as long as he is in Bluetooth® signal range. He can download sensor data to his smart device, review the data, and choose whether or not to continue the data logging process.

Figure 4: Which ceiling tile holds the UWBT transmitter?

Once the data collection exercise is over, the technician will want to retrieve the UWBT transmitter. He can more closely locate the tile location by using the Bluetooth signal strength feature of the app. (see figure 5). The signal strength icon is located at the top of the Sensor Settings menu. The left side of figure 5 shows two of five bars in blue font, indicating that the user's smart device is located near the outer edge limits of the pairing distance from the transmitter. As the user walks closer to the transmitter, the number of bars in blue font will increase until five bars are shown in blue font. At that point the technician will want to pop ceiling tiles until he finds which one contains the transmitter.

Figure 5: Bluetooth signal strength indication

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Prototype Probe Temperature Measurement using UWBT-RTD-TB

UWBT-RTD-TB

The OMEGA Engineering R&D group used a UWBT-RTD-TB transmitter to take response time measurements on the PR-31 RTD probe, while it was still in product development (see figure 1). The purpose of the experiment was to make sure this new probe had a speed response consistent with similar probes that OMEGA had sold in the past. The experimental PR-31 probe was inserted into an insulated beaker of hot water, the water temperature controlled by a model CSI32-K-C24 controller. The water inside the beaker was heated by a 6 x 18" 540 Watt silicone rubber heater, and agitated by a magnetic stirrer. This was done to show the difference in response time of the sensors at different flow rates in a test regime where 0.9 meter/sec (3 feet/sec) is the norm. The probe was inserted into the beaker with the temperature of the water as a function of time communicated by the UWBT transmitter to a tablet. The sensor response time for the probe to sense the 90°C (194°F) water temperature was determined from this data stream. The response time to achieve 50%, 63%, and 90% of the final reading was graphed as a function of five different stirrer speeds.

Figure 1: UWBT-RTD-TB shown recording temperature data from a PR-31 RTD probe

The UWBT transmitter was well suited for real time temperature measurement. No power supplies, signal conditioners, plotters, or measurement equipment were needed, just a tablet. When the UWBT transmitter is paired with a smart device, the app automatically recognizes the metrology type of the transmitter (thermocouple, RTD, humidity, pH, etc.). The app displays only the screens relevant for that metrology. The configuration details in figures 2 are automatically customized for the metrology. The app provides convenient pull-down menus for a user to select from one of several pre-defined options. Once sensor settings are defined, the app provides the user with the ability to log data at different frequencies internally on the transmitter or directly to a smart device.

Figure 2: RTD sensor settings

Data entry for complex data (transmitter names, etc.) is achieved by bringing up the standard keyboard for a smart device, the same one used in text messaging and writing email (see figure 3).

Figure 3: Smart device keyboard used for data entry

Figure 4 shows a close-up view of sensor tip inserted into the beaker while half of the lid was removed. The sensor position is located 13 mm (½") from the side wall of the beaker, intended to maximize the flow rate of the water past the sensor.

Figure 4: Close-up of sensor tip inside beaker

Figures 5 show the response times of 3 mm (⅛") and 6 mm (¼") diameter PR-31 probes. The speed settings to 2, 4, 6, and 8 correspond to 170 RPM, 560 RPM, 900 RPM, 1100 RPM and 1120 RPM respectively. The speed of response results were in line with expectations. The 3 mm (⅛") probes respond much faster than the 6 mm (¼") probes to a step change in temperature input. This is due solely to the smaller thermal mass inherent in a smaller probe.

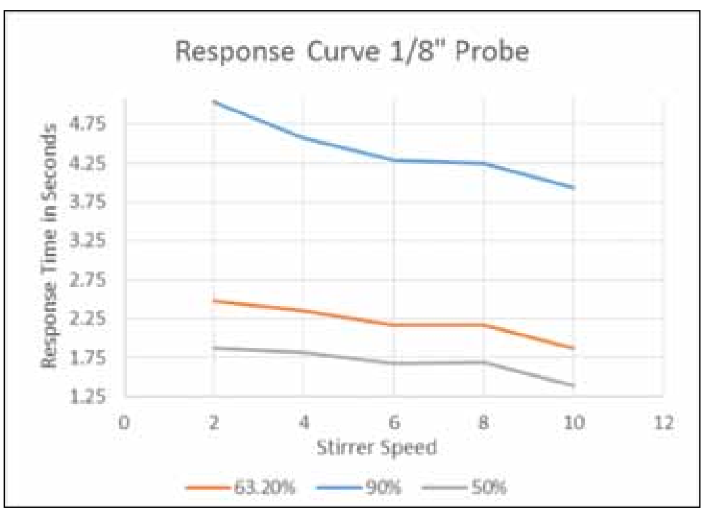

Figure 5a: Temperature response of 3 mm (⅛") probe

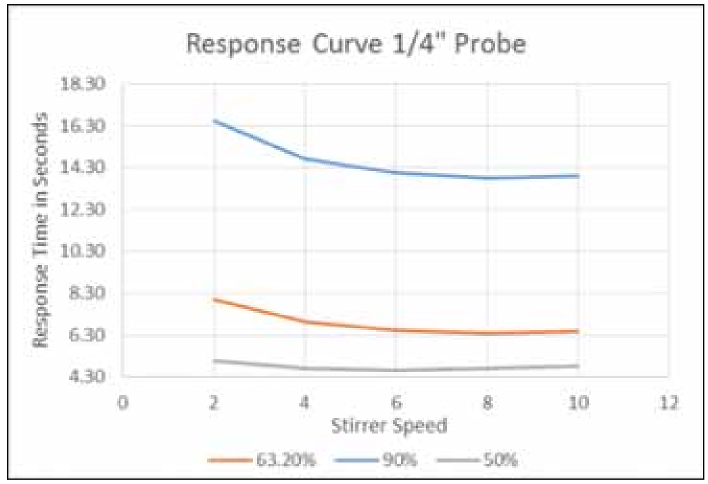

Figure 5b: Temperature response of 6 mm (¼") probe

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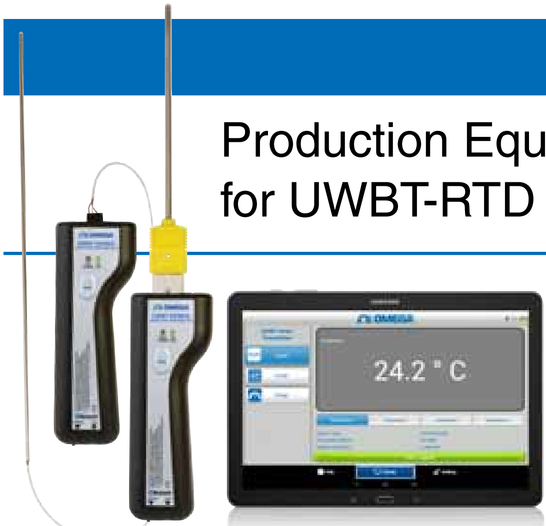
Production Equipment Applications for UWBT-RTD and UWBT-TC



The UWBT transmitter has a host of features that make it very convenient for troubleshooting production equipment. The transmitters are portable, they accept thermocouple or RTD input from the full line of OMEGA® temperature probes, and all data is sent from the transmitter to a smart phone or tablet. The app runs in 9 languages on smart devices using iOS™, Android™ and Fire OS™ operating systems. Data can also be logged locally on the UWBT transmitter for long-term troubleshooting, downloaded to a smart device, and sent from that smart device to an e-mail address or to the Cloud. A maintenance technician can record data at the equipment location, and quickly get guidance from a manufacturing engineer or supervisor on how to proceed to fix the equipment. The photos below show the UWBT transmitter at work troubleshooting production machinery.

Verifying molding temperature is a critical test during production set-up for injection molded plastic parts (see figure 1). In this application, a horizontal shuttle mold is used to mold electrical connectors via the process of insert molding. A 88401K magnetic thermocouple probe (see figure 2) is attached to the outside of the mold frame. The other end of the probe is plugged into a UWBT-TC-UST transmitter (see figure 1).

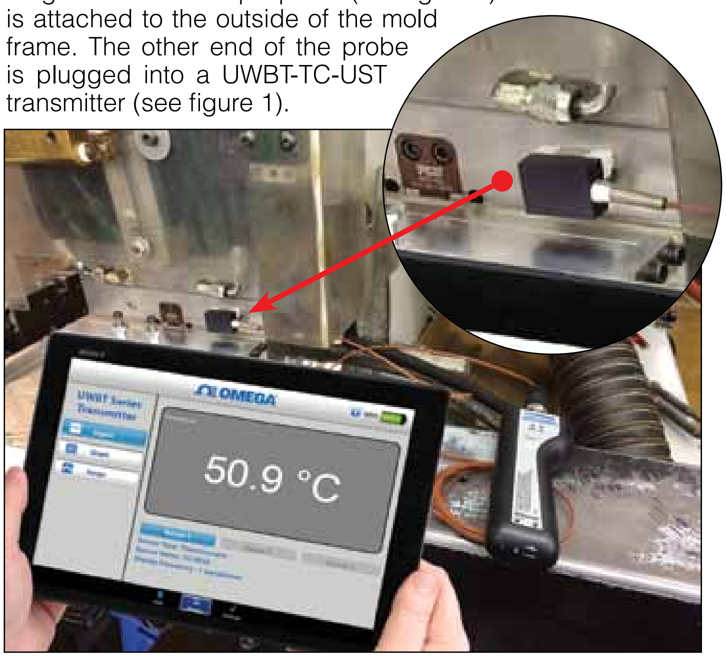


Figure 1: UWBT-TC-UST transmitter monitoring mold temperature

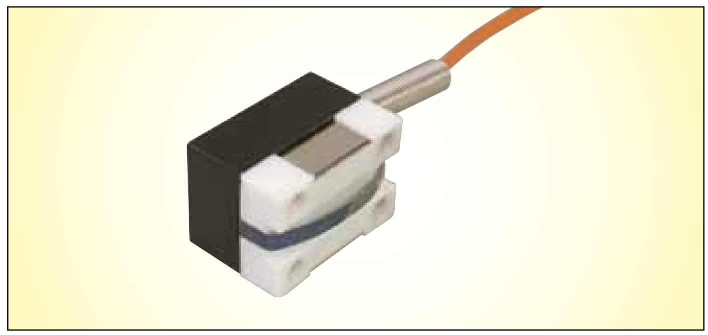


Figure 2: 88401K magnetic probe

Clean room production equipment and processes require special monitoring and maintenance care. In figure 3 SA1-RTD sensor mounted to the outer surface of a gas exhaust shroud is connected to a UWBT-RTD-TB transmitter. The specs for the sensor are shown in figure 4. In figure 5 the 88401K thermocouple probe is mounted to the outer surface of the vacuum exhaust system of a photoresist deposition tool. In figure 6 the SA1-RTD sensor is mounted to the pipe for wafer cleaning fluid. In all cases the transmitter may be left behind in the clean room to monitor temperatures long term. The maintenance technician need not suit up again to enter the clean room to gather data. He can go to a non-cleanroom location within pairing range of the transmitter, and download logged data from the transmitter to his smart device.

Figure 3: UWBT-RTD-TB monitoring exhaust gas temperature

Figure 4: SA1-RTD sensor specs

Figure 5: 88401K magnetic probe mounted to a vacuum exhaust system

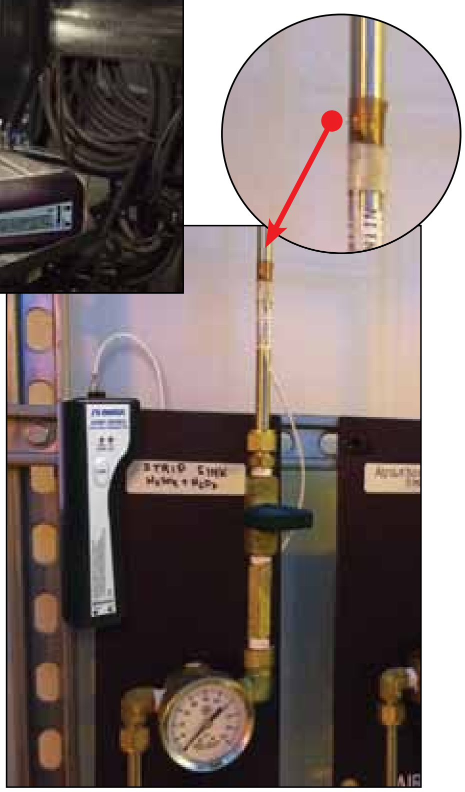


Figure 6: SA1-RTD sensor mounted to the pipe for wafer cleaning fluid

The UWBT transmitter is a useful tool for troubleshooting plant facilities equipment. In figure 7 the SA1-RTD sensor monitors pump motor temperature in a system that treats deionized water used in the wafer production process. The sensor is connected to a UWBT-RTD-TB transmitter, with the app on a smart device configured with a high temperature alarm. If the pump motor temperature goes above a certain value, a sign of imminent failure, the app can sound both visual and audio alarms on a smart device. In figure 8 the 88401K magnetic thermocouple probe measures the temperature on the outlet pipe of the plant boiler system. The 88401K probe is outfitted with a Type K M12 connector, which is screwed into the M12 fitting of the UWBT-TC-RTD transmitter. The M12 connection is so secure that Type K wire can suspend the UWBT transmitter from a knob on the boiler.

Figure 7: SA1-RTD sensor mounted to pump motor

Figure 8: 88401K probe measuring pipe temperature

Chemical Processing Measurements Using UWBT-TC-UST

The Tiarco Chemical division of Textile, Rubber, and Chemical Co. Inc. develops specialty chemicals for producing latex, polyurethane, carpet, grease, and lubricants. Their plant engineering department was interested in using a set of wireless temperature instruments for monitoring chemical batch reactor tanks in the plant. OMEGA® thermocouples measure cooling water inlet and outlet temperatures, as well as the batch reactor temperature. The engineering team then uses the test data for BTU energy calculations. The team put together a portable carrying kit consisting of:

- Three UWBT transmitters
- A Google® Nexus 7 tablet
- USB hub
- HH509 temperature meter for NEMA 4X applications
- Various thermocouple and surface temperature probes

Figure 1: Portable temperature measurement kit

In this application Tiarco Chemical took advantage of the ability of one tablet to pair with three transmitters at once. This set-up is more efficient than using three temperature meters to perform process measurements and retrieve test data from three meters, rather than from one.

UWBT-TC-UST

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Prototype Instrument Temperature Measurement Using UWBT-TC-UST

Verifying the operating ambient temperature range of an instrument is a critical design engineering test during the product development process. This is done by exposing the device to elevated ambient temperatures, and documenting how the device functions under these conditions. In this example four UWBT-TC Type K transmitters are recording temperatures at four critical locations inside the OMEGA® OM-DAQ-USB-2401 data acquisition module (see figure 1). The purpose of the experiment is to make sure that critical components on the circuit boards inside the data module do not overheat when the ambient temperature is 50°C, the maximum rated temperature for the module. The data module is placed in the oven set to 50°C to simulate this environment.

Figure 1: UWBT-TC measuring temperature inside OM-DAQ-USB-2401

Figure 2 shows a close-up view of the four UWBT-TC transmitters. The green LED above the word TX/LOG on the front label blinks twice every 3 seconds to indicate internal logging.

Figure 2: Close-up of four UWBT-TC transmitters

The Type K thermocouple connectors plugged into the transmitters are labelled with the name of the electronic component inside the data module whose temperature is being measured. An internal view of the data module is shown in figure 3. Each transmitter puts a date and time stamp on the data stored in its internal memory. Once downloaded to the tablet shown in figure 1, the four .csv files from the transmitters were emailed to the test engineer and stored on a network server. The four .csv files were then combined inside one spreadsheet, with the resulting data shown in figure 4. The maximum operating temperature for the electronic component is 75°C, significantly higher than any of the temperature data collected. Hence, the test engineer concluded that the USB module could operate reliably in an ambient temperature of 50°C.

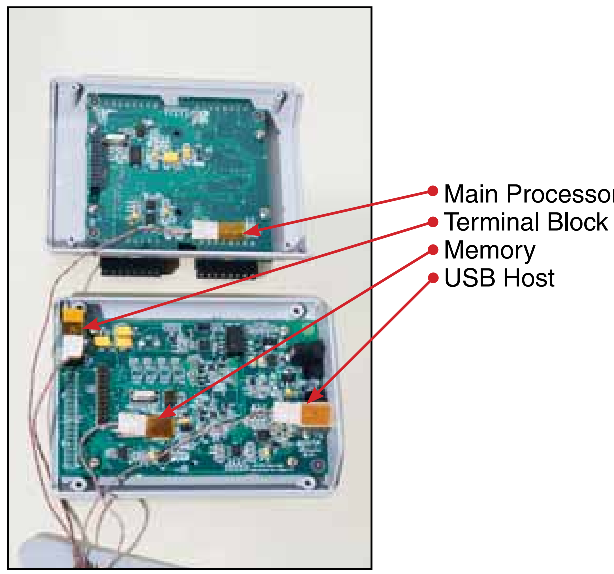

Figure 3: Temperature test points on OM-DAQ-USB-2401 data acquisition module

Transmitter Name : TC-MEMORY		Transmitter Name : TC-TERMINAL BLOCK	Transmitter Name : TC-MAIN PROCESS	Transmitter Name : TC-USB HOST
Sensor Type : Thermocouple		Sensor Type : Thermocouple	Sensor Type : Thermocouple	Sensor Type : Thermocouple
Logging Sample Rate : 1 /second		Logging Sample Rate : 1 /second	Logging Sample Rate : 1 /second	Logging Sample Rate : 1 /second
Engineering Units : Celsius(C)		Engineering Units : Celsius(C)	Engineering Units : Celsius(C)	Engineering Units : Celsius(C)
Time	Temperature C	Temperature C	Temperature C	Temperature C
1/21/15 15:29	53.9	50.4	61.6	54.1
1/21/15 15:30	54.3	50.6	62.1	54.4
1/21/15 15:31	54.6	50.8	62.6	54.7
1/21/15 15:32	54.9	50.9	63.0	55.2
1/21/15 15:33	55.2	50.1	63.4	55.7
1/21/15 15:34	55.4	50.2	63.8	56.1
1/21/15 15:35	55.6	50.4	64.1	56.4
1/21/15 15:36	55.9	50.6	64.4	56.6
1/21/15 15:37	56.1	50.7	64.6	56.7
1/21/15 15:38	56.2	50.8	64.8	57.1
1/21/15 15:39	56.3	51.0	65.0	57.2
1/21/15 15:40	56.2	50.2	65.0	56.8
1/21/15 15:41	55.9	50.8	64.9	56.9
1/21/15 15:42	55.8	50.1	64.8	56.8
1/21/15 15:43	55.6	50.6	64.7	56.8
1/21/15 15:44	55.5	50.7	64.7	56.7
1/21/15 15:45	55.4	50.4	64.7	56.9

Figure 4: Temperature test data for OM-DAQ-USB-2401 data acquisition module

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