

YTMX580 Multi-input Temperature Transmitter

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Yokogawa developed the YTMX580 multi-input temperature transmitter with eight-channel inputs and wireless communication functions conforming to the ISA100.11a standard. YTMX580 can accurately monitor temperatures at multi-points in hazardous areas to obtain the temperature distribution in the process industry, which reduces the number of transmitters and wires to be installed and curbs the total cost. This paper describes YTMX580's high performance in multipoint measurement, electric characteristics that enable long-term operation with batteries, and the enclosure which satisfies the requirements of being intrinsically safe, dust-proof, and waterproof.

INTRODUCTION

Since 2010, Yokogawa has been providing wireless products conforming to the ISA100.11a wireless communication standard for industrial automation (IA) ^{(1),(2)}. As a new addition to the lineup, Yokogawa has developed the YTMX580 multi-input temperature transmitter.

Like the YTA510 temperature transmitter, YTMX580 is driven by batteries, but the number of its inputs has been increased from two to eight. Like Yokogawa's existing wireless products, YTMX580 conforms to explosion proof standards, enabling operation in hazardous areas.

FEATURES

YTMX580 can accept signals from up to eight sensors such as IEC-conforming thermocouples (eight types including Types K, E, J) and resistance temperature detectors (three

types including Pt100), then converts the corresponding measurement values to wireless signals and transmits them.

YTMX580 can also accept signals of DC voltage, resistance, and 4–20 mA DC current.

This model conforms to the ISA100.11a wireless communication standard and uses license-free 2.4 GHz band. In addition, it adopts the 128 bit Advanced Encryption Standard (AES) to ensure high security.

Figure 1 shows the external view of the YTMX580 and Table 1 shows its major specifications.



Figure 1 External view of the YTMX580

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Table 1 Major specifications of YTMX580

| Item | Specifications |
|-------------------------------------|---|
| Wireless standard | ISA100.11a |
| Number of input points | 8 |
| Input signal *1 | Thermocouples, RTD, DC voltage, resistance, 4–20 mA DC current (require an external shunt resistor) |
| Accuracy | Pt100: $\pm 0.3^{\circ}\text{C}$ (lower than 400°C), Type K: $\pm 1.0^{\circ}\text{C}$, etc. |
| Cold junction compensation accuracy | $\pm 0.5^{\circ}\text{C}$ |
| Update period | 1 sec to 3600 sec. |
| Battery life | 6 years under the following conditions Network connection: Jointed Update period: 60 sec Role: I/O only Ambient temperature: 23°C LED indicator: Off |
| Ambient temperature | -40 to 85°C |
| Ambient humidity | 0 to 100% RH |
| Protection class | IP66/IP67, NEMA Type 4X |
| Explosion proof specification | Intrinsic safety: FM, CSA, ATEX, IECEx certified; TIS to be applied Nonincendive protection: FM, CSA certified |
| Mass | 3.2 kg (without mounting brackets) |

*1: DC voltage and DC current are out of scope of the explosion proof certification

1) Multi-channel input

When performing a high-density temperature measurement application such as temperature profiling, multipoint measurement is indispensable. The YTMX580 can receive up to eight signals by using Yokogawa's multi channel measurement technology established in its recorders ⁽³⁾. This multi channel input can help reduce the number of transmitters required for temperature measurement in hazardous areas, curb initial costs for the introduction, and improve the efficiency of maintenance work.

Any of signals of IEC-conforming thermocouples and resistance temperature detectors, DC voltage, resistance, and 4–20 mA DC current can be assigned to respective channels.

2) High-speed measurement

The YTMX580 achieves high-speed measurement at every two seconds at the fastest with eight channels. Using this high speed measurement capability, it can measure every one second at the fastest when the number of channels is decreased to three or less.

The measurement interval is selectable within the range of 1 to 3600 seconds.

3) Powered by batteries for a long period of time

While the YTMX580 is capable of high-speed measurement with up to eight channels, it has extended the battery life to six years under its normal operating conditions. This is the result of a thorough design for reducing power consumption to extend the battery life, regarding maintainability as important.

4) Standardization

The batteries and battery pack are compatible with those for the other transmitters (EJX-L series and YTA510) in Yokogawa's wireless product lineup.

The wireless circuit is designed to be common to these products, so the operability and specifications when using these products, such as settings procedure required for wireless devices and communication distance, are also common.

These standardizations ensure the common maintainability of Yokogawa's wireless products.

5) Enclosure

The enclosure is made through low copper aluminum die casting to achieve compact size, light weight, and corrosion resistance. The degree of protection conforms to IP66/IP67 of the IEC 60529 and NEMA Type 4X. The YTMX580 operates in an ambient temperature range of -40°C to 85°C (in the case of the non-explosion proof type) and withstands harsh environments.

As an option, thick anti-corrosive coating is available.

6) Explosion proof

As a transmitter intended to be installed and used in hazardous areas, the YTMX580 conforms to explosion proof standards.

While featuring multi channel and high speed measurement performance, the electric energy consumed in the circuits is restricted so that it satisfies the explosion proof standards, specifically Group IIC gases and temperature class T4 (maximum surface temperature of 135°C) of the international intrinsic safety explosion proof standard.

ACHIEVING BOTH HIGH SPEED/MULTI CHANNEL MEASUREMENT AND BATTERY LIFE EXTENSION

When considering the maintainability for users, it is desirable for wireless products to operate as long as possible without replacing batteries. With low-power consumption design and optimal power consumption control, the YTMX580 operates with an average current of $250\ \mu\text{A}$ or less. As a result, it has a long battery life of up to six years at a measurement interval of 60 seconds. It can also perform eight-point measurement at an interval of two seconds as described before.

The following sections explain the technical measures to satisfy both high speed/multi channel measurement and battery life extension.

Reducing the Consumption Current

As shown in Figure 2, the internal structure of the main unit is composed of an input measurement unit, a display unit for indicating the status of the device, a wireless communication unit implementing the ISA100.11a communication function, an infrared communication unit for configuring the device by using the FieldMate⁽⁴⁾ or other tools, a power supply unit, a CPU, a ferroelectric random access memory (FeRAM), and so on. Each unit is designed to lower its power consumption by aggressively reducing the current consumed by it.

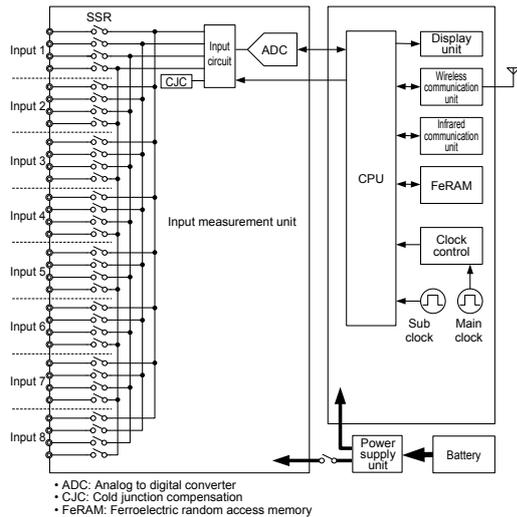


Figure 2 Block diagram of the internal structure

To reduce the consumption current further, the YTMX580 implements the intermittent operation controlled by the firmware shown in Figure 3. With intermittent operation, a sequence of processes is performed on the basis of the measurement cycle. Input measurement processing, communication processing, status checking, and so on are performed, and then the CPU is put in sleep mode to reduce unnecessary power consumption. To reduce the power consumption further, when the CPU is in sleep mode, the power supply to the input measurement unit is cut off, unnecessary built-in functions of the CPU are disabled, and the CPU clock is switched to the lower-speed sub clock. Likewise, low power consumption operation responding to the communication conditions is performed also in the wireless and infrared communication units.

As the result of the power supply control, clock control and others described above, the YTMX580 achieves low consumption current of 50 μ A or less in the sleep mode.

Although the method to cut off the power supply to the not operating circuits by power supply control is effective for reducing power consumption, this may complicate the interface with the other live circuits because of the necessity to clearly define the interface against the sudden cutoff of the power. However, the YTMX580 is designed applying simplified signal interfaces between the units so as not to affect the other circuits at the power cutoff.

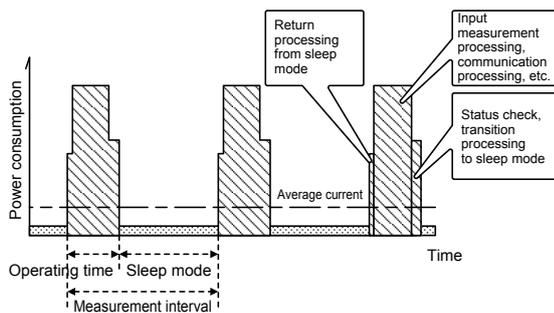


Figure 3 Intermittent Operation

Shortening the Operating Time

To reduce power consumption, it is indispensable to reduce the consumption current in each period of the intermittent operation cycle. As for the operating time in its cycle, the recovery time from the sleep mode needs to be taken into account.

If the measurement can be performed immediately after recovery from sleep mode, operating time can be shortened and the consumption current can be reduced. In fact, however, on-off control for the power supply circuit is performed, so measurement before the power becomes stable is affected in its input accuracy and stability. To shorten recovery time without affecting input accuracy and stability, the power supply circuit is rigorously verified and major circuit constants are adjusted, thus optimizing processing after the power up.

To achieve quick and stable measurement in as short a time period as possible at an interval of two seconds with eight inputs, the proven scanner method using solid state relays (SSR) is adopted as an input circuit. This scanner method, with the optimization of the input measurement sequence, can shorten the measurement time. Actually, it can perform three input measurement at an interval of one second.

Moreover, this scanner method can consolidate multiple AD converters to one, and lower power consumption in the input circuits.

STANDARDIZED DESIGN

Although the YTMX580 differs from other products in shape, structure and so on, considering the maintainability for users, it is designed to use the same accessories as those for Yokogawa's other wireless transmitters. Those accessories include the battery pack shown in Figure 4 and a remote antenna.

The YTMX580 also uses the same parameter structure as that of the existing YTA510 for user convenience, so that users can perform settings and operations for it via infrared communication using the FieldMate in the same way as for the other wireless transmitters.

For wireless communication, the YTMX580 conforms to the ISA100.11a standard to ensure its interoperability.



Figure 4 Battery pack

STRUCTURE OF ENCLOSURE

(1) Dust-proof and waterproof capability

The degree of protection achieved by the enclosure conforms to IP66/IP67 of the IEC 60529 and NEMA Type 4X, allowing its installation even in harsh environments. Yokogawa owns facilities for waterproof and dust-proof tests. The evaluation tests according to the corresponding standards are performed as shown in Figure 5.

The enclosure is made through low-copper aluminum die casting to achieve compact size, light weight, and corrosion resistance.

The front door is fixed with the main part of the enclosure using bolts at its four corners of symmetrical positions, and their mechanical structure allows them to be tightly fastened keeping their joining surface parallel. This ensures that even pressure is applied to the waterproof gasket between them, thus this structure is suitable for ensuring dustproof and waterproof performance.

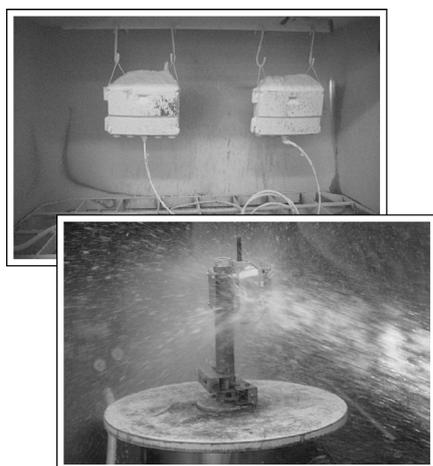


Figure 5 Dust-proof test (above) and waterproof test (below)

(2) Size and mass

The YTMX580 is an eight-channel transmitter, so it has respective wiring holes on the bottom of the enclosure. Although this restricts the size of the enclosure, the holes are arranged in staggered rows to downsize it while not affecting the wiring work efficiency. This downsizing helps reduce the mass of the main unit to 3.2 kg.

(3) Installation environment

The YTMX580 is a field device which is supposed to be installed in harsh environment, so the model with a built in antenna and the remote antenna itself were evaluated by wind tunnel tests at wind speeds exceeding 50 m/s. Although the multi-channel type YTMX580 has many holes for wiring and is susceptible to wind because of its horizontally long rectangular solid shape, no abnormality caused by wind was confirmed.

The YTMX580 is configured via infrared communication, so an infrared communication test exposing the infrared

detector to direct sunlight was performed supposing its outdoor installation. Again no abnormality was found.

(4) Other mechanical structures

The position of the built in antenna is decided in consideration of the wavelength of the used band so as not to cause radio wave interference even if the YTMX580 is mounted on a vertical metal pipe.

For anticorrosive measures, a partial area of the top surface of the enclosure on which the antenna is mounted is slightly tilted, and a drain is formed on the mounting base of the antenna as shown in Figure 6. This can easily drain rain water from the base of the antenna.



Figure 6 Drain

The glass window for infrared communication is placed at the hollow of the enclosure surface to protect it from extraneous shocks and so on, thus ensuring its safety.

CONCLUSION

This paper has described the features of the YTMX580 along with hardware, firmware, mechanical structures, and standardized designs for wireless products which implement those features. This model, with eight-channel multiple inputs, high-speed measurement performance, long battery life, explosion proof capability and other features, is best suited for temperature measurement in hazardous areas.

As a product constituting Yokogawa's wireless product lineup, the YTMX580 will continue evolving so as to respond to various customers' requests and market trends.

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