Smart Wireless THUM™ Adapter Effect on the 4-20 mA Loop

The Smart Wireless THUM™ adapter is used to wirelessly communicate HART® data acquired from a wired HART device using a self-organizing WirelessHART™ network. The THUM adapter works with any wired HART revision 5.0 device. This technical paper will describe how the THUM adapter maintains the integrity of the 4-20 mA loop, while collecting data and scavenging power for operation from the loop.

Criteria for WirelessHART™ adapters

Field instruments, such as pressure transmitters or valve controllers, are often used in critical process control loops. Any WirelessHART adapter added to this loop must be carefully designed so as to not compromise any aspect of the 4-20 mA loop. Most importantly, the 4-20 mA current signal must not be affected in any way. If the adapter fails, it must still allow the 4-20 mA current signal to continue to flow unaffected. The adapter must not affect startup characteristics or time response, of the connected wired device or control loop. The Emerson Smart Wireless THUM Adapter meets ALL of these criteria.

THUM adapter operation

The THUM adapter connects to a HART wired device, collects the Hart data and then transmits that data over a Smart Wireless network. The THUM adapter is connected to the wired device both in series and in parallel on the 4-20 mA loop. Through the series connection the THUM adapter scavenges and stores energy to perform its basic functions. The parallel connection provides the THUM adapter with HART data communication.

The THUM adapter has five wires colored red, yellow, white, black and green. The red and yellow wires are the power wires connected in series with a wired device in the 4-20 mA loop. It is through this series connection that the THUM adapter draws its operating power from the loop. The 4-20 mA loop current flows through the THUM adapter's two power wires with a voltage drop, but no change in the signal current. The black and white wires, which are common, are the HART communications

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wires and are connected in parallel across the wired device to collect wired HART communications. No power is drawn from the HART communications wires. Finally, the green wire is for the chassis or housing ground connection. Figure 1 depicts the wiring diagram of a normal two wire device. Figure 2 depicts a THUM adapter connected to that wired device, and labels the colors of the THUM adapter's wires.

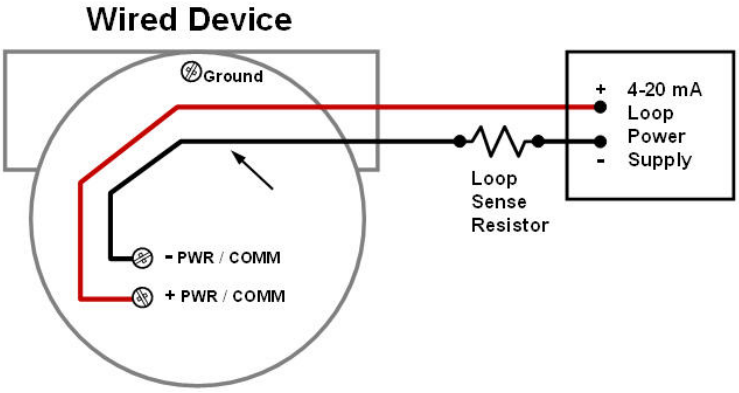

Figure 1. Wiring Diagram for Two Wire Device

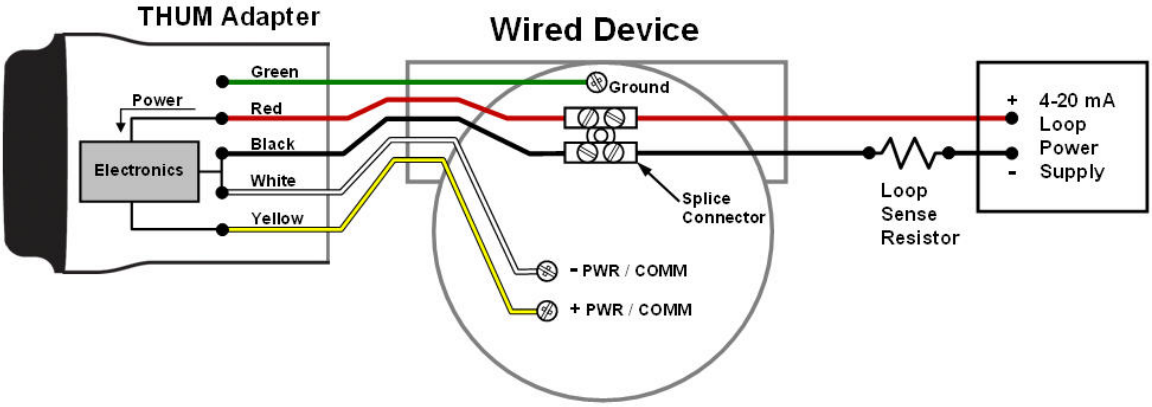

Figure 2. Wiring Diagram for THUM Adapter on a Two Wire Device

THUM adapter effect on the 4-20 mA loop

The THUM adapter is designed to protect the 4-20 MA loop from adverse effects of voltage drop, current draw, open circuit, short circuit, and AC noise.

Voltage Drop

The THUM adapter induces a voltage drop in order to scavenge power from the loop. This voltage drop marginally reduces the voltage margin available to operate the wired device. To minimize the impact of this voltage drop, the THUM adapter consumes a smaller amount of loop voltage at higher loop currents than it consumes at lower loop currents. The THUM adapter acts with an inverse effect compared with the loop sense resistor, which consumes more loop voltage as the loop current increases. The THUM adapter drops about 2.12 volts when the loop current is at 4 mA, and about 1.35 volts when the loop current is at 20 mA. In a fault state, the THUM adapter drops voltage by 2.5 volts. All 4-20 mA loops must have a minimum of 2.5 volts of excess voltage in order to operate the THUM adapter properly.

Current Draw

The THUM adapter is a passive element with respect to the 4-20 mA loop current. The amount of current flowing in the loop is determined only by the wired device. The THUM adapter uses the current available on the loop to power its electronics, but has no mechanism to effect the loop current.

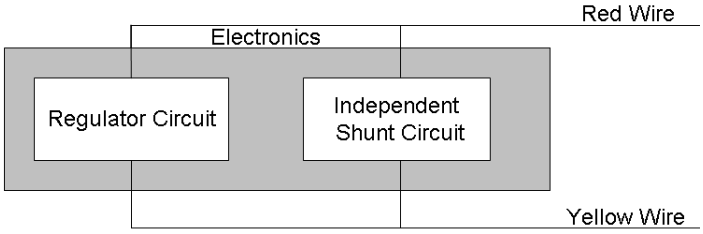

Figure 3. How Loop Current Flows Through a THUM Adapter

Open Circuit Protection

Shown in Figure 3, the loop current flows through the THUM adapter on the Red and Yellow wires. To ensure an open circuit does not occur, the THUM adapter use redundant current loop paths. In the unlikely event the primary loop path fails, there is another path for the loop current to flow and the THUM adapter will not affect the wired device. This ensures that measurement and control using the 4-20 mA loop current continues even if the primary current path in the THUM adapter fails.

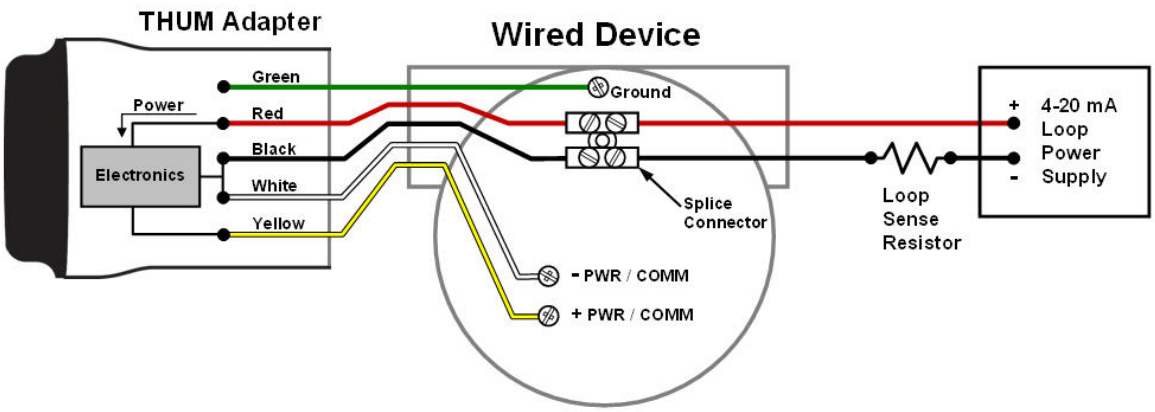

Figure 4. Wiring Diagram for THUM Adapter on a Two Wire Device

Short Circuit Protection

Figure 4 depicts the THUM adapter connected in parallel with the wired device from the Yellow wire to the Black and White wires. To prevent a short circuit condition the THUM adapter is designed so that no single component failure can create this fault. Only simultaneous failures of multiple passive components within the THUM adapter can cause a short circuit.

AC Noise

The THUM adapter is a passive load on the 4-20 mA loop, so the THUM adapter has no impact on, and is unaffected by, small, large, fast or slow changes in the loop current. In this way, the THUM adapter has no adverse effect on the startup characteristics and time response of the wired device. Lastly, the THUM adapter does not add alternating current (ac) noise onto the 4-20 mA loop current. The THUM adapter meets all relevant requirements of the ElecroMagnetic Compatibility (EMC) standard EN 6136-1 (2006). This ensures that the THUM adapter will not be affected by ac noise on the loop that could result in degradation of the digital communications occurring on the loop.

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Summary

The Smart Wireless THUM Adapter was designed for use in critical process control loops where affecting the output of the loop is not acceptable. The THUM adapter is a passive load on the loop, so that the 4-20 mA current signal is preserved. Redundant loop paths and components within the THUM adapter electronics protect the 4-20 mA loop against short circuits and open circuits. No single component failure can disrupt the loop current. Zero impact to loop current changes and no added ac noise preserves the startup characteristics and response time of the wired device. By meeting these strict criteria for performance on a 4-20 mA loop, the THUM Adapter opens up a wide variety of applications to gain the full benefit of intelligent devices through wireless communication.

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