TOTALFLOW

Technical Bulletin 159

Using 4-20 ma Transmitters with 12 volt Powered Flow Computer

Totalflow Technical Bulletin

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Purpose

To describe a potential issue when installing and operating traditional 4-20 milliamp current loop transmitters with a 12 volt DC power supply. The Totalflow Flow Computer and RTU operate on a 12 volt power system (battery or 12 VDC).

4-20 milliamp transmitter Description

4-20 milliamp transmitters are essentially variable constant current sources. They need to have sufficient voltage applied to them to ensure that they will be able to drive 20 milliamps into a 250 ohm load. Different transmitter technologies will have different powering requirements.

Many 4-20ma transmitters claim to be operational between 10 and 30VDC. This can be somewhat misleading. If it's a two-wire (line powered) transmitter and it is sourcing its maximum loop current of 20ma, 5VDC is dropped across the 250 ohm resistor.

E = I x R = 20ma x 250 ohm = 5VDC

That only leaves 7 volts to operate the transmitter. This may not be enough to fully operate the transmitter at higher loop currents.

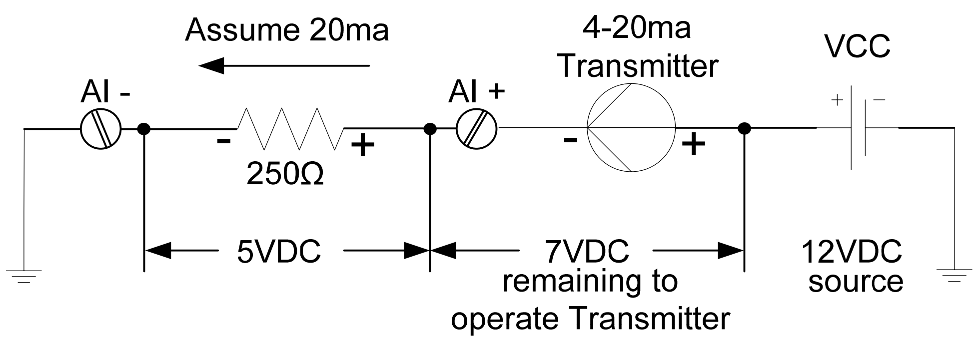


Figure 1–1

NOTE: The following discussion does NOT pertain to 1-5VDC transmitters.

Totalflow flow meters employ a 250 ohm resistor to convert the 4-20 milliamp transmitter current loop to a 1-5VDC signal. In some meters this conversion is made by attaching a 250 ohm resistor across the 4-20ma input pins (see Fig. 1-2A). Some meters use a small three-pin jumper to select an onboard 250 ohm resistor (see Fig. 1-2B), or not. Still other meters employ an electronic switch to select the 250 ohm resistor (see Fig. 1-2C), or not. In the figures, ***VCC*** represents the voltage used to power the transmitter.

With a solar powered system, such as many Totalflow installations, available voltage to power the 4-20 transmitter can become an issue. Batteries in a battery backed solar installation can drop to 12VDC or less. Some transmitters may not be able to drive 20 milliamps into a 250 ohm load with only 12VDC applied to them. Fully charged batteries, connected to an operational battery charger, may be sitting at about 13.5-14VDC.

Again, the 4-20ma transmitter that you choose must be fully operational at voltages as low as 12VDC.

NOTE: Another possible solution would be to reduce the 250 ohm resistor to a smaller value, possibly 125 ohms. An under-powered transmitter could more easily drive 20ma into the lesser resistance. Field calibrating the AI would negate any differences between the 250 ohm and the 125 ohm resistors. However, as you reduce the size of the resistor, you lessen the overall resolution.

Example:

- If your 4-20ma transmitter can drive full range (20ma through the 250 ohm resistor) you have essentially converted a 4-20ma current range into a 1-5VDC voltage range. The analog to digital (A/D) converter used in Totalflow equipment expects a 1-5VDC signal. During field calibration we might have the 4ma of loop current represent 10bbls of fluid per hour and 20ma represent 100bbls. The conversion to voltage (using the 250 ohm resistor) would be as follows:

  1VDC = 10bbls/hour
  5VDC = 100bbls/hour

  Assuming that the A/D converter is ranged between 0 and 5VDC, and that the converter is resolving 15 bits; you would expect to resolve about 150µVDC (or .0006ma). These numbers translate to about .003bbl (3 thousandths of a barrel, or about one half fluid ounce).

- If your 4-20ma transmitter can NOT drive full range (20ma through the 250 ohm resistor) you may want to reduce the value of the resistor. For the example we will drop it to 125 ohm (or half). A 4-20ma current would now be converted to a .5 - 2.5VDC voltage range. Again, during field calibration, we would have the 4ma current represent 10bbls per hour and the 20ma signal represent 100bbls per hour. The voltage conversion (using the 125 ohm resistor) would be as follows:

  .5VDC = 10bbls/hour
  2.5VDC = 1000bbls/hour

  The A/D's full range is still 0-5VDC. However, we are only using about half of its range capability. Just like the resistor value, our ability to resolve barrels of fluid per hour has been cut in half. Our overall accuracy remains unchanged, but we can only resolve about .006bbl (6 thousandths of a barrel, or about one fluid ounce).

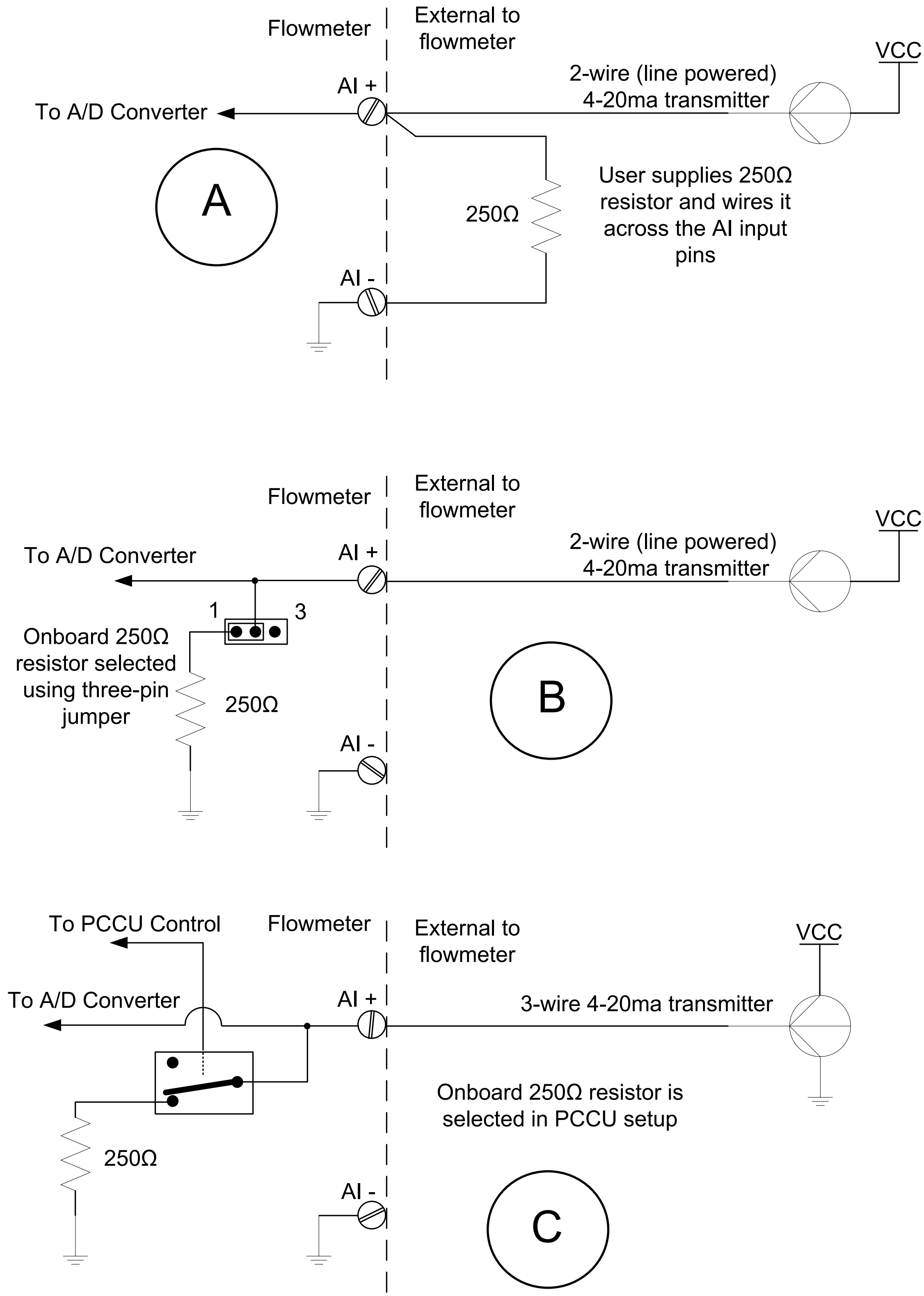
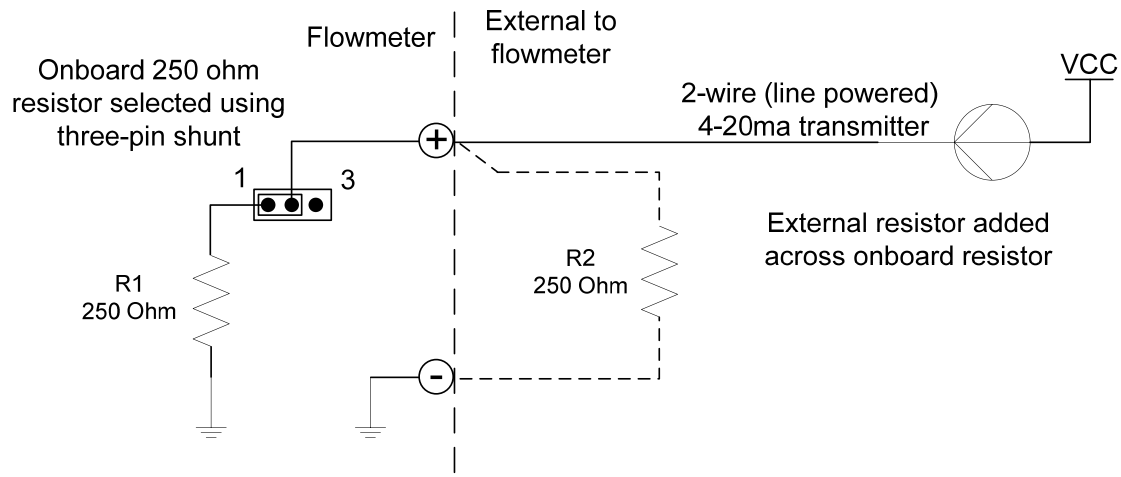


Figure 1–2

Conclusion:

If the 4-20ma transmitter you are using cannot drive a full 20ma through the 250 ohm resistor, you can reduce the resistive value. However, as the resistive value is reduced, resolution (not overall accuracy) will be reduced proportionately. If you drop the resistive value by half (250 ohms to 125 ohms), the resolution will also be reduced by half.

To reduce the resistive value of an onboard resistor you can add an external resistor across the analog input pins. This places the two resistors in "parallel" with one another. The parallel combination produces an equivalent resistance that is less than either of the two resistors alone. The value of this equivalent resistance is calculated as shown in the figure.



$$\text{Equivalent Resistance} = \frac{R1 \times R2}{R1 + R2} = \frac{250 \times 250}{250 + 250} = \frac{62500}{500} = 125 \text{ Ohms}$$

Figure 1–3