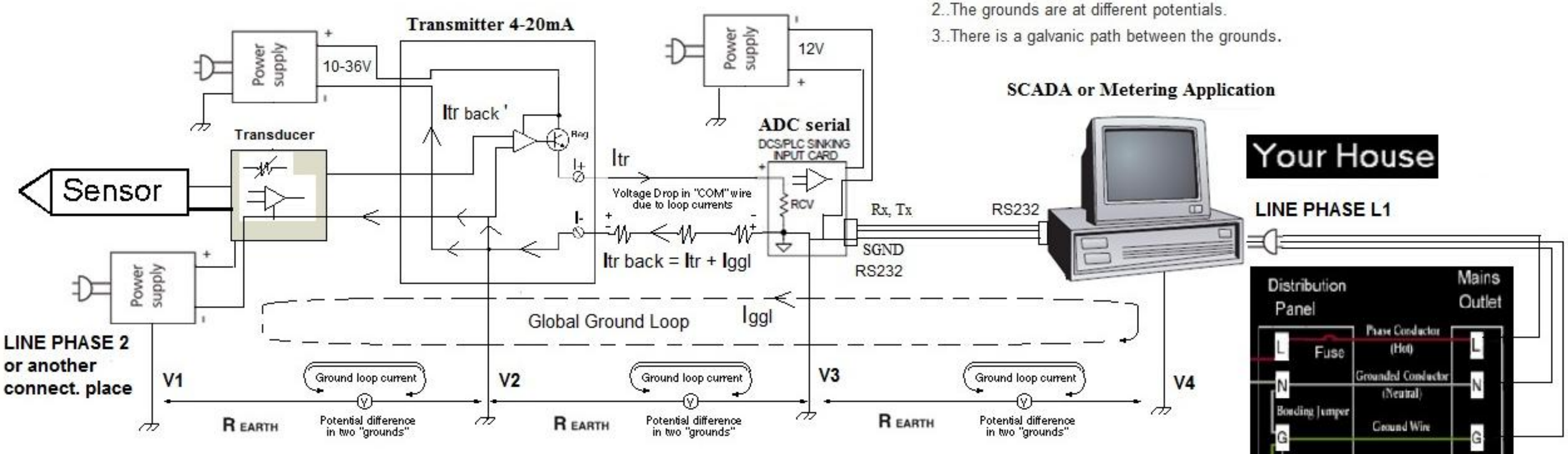
Ground Loops Currents Problem and Solutions

Ground Loop Currents Problem

A ground loop forms when three conditions are present:

1..There are two grounds.
2..The grounds are at different potentials.
3..There is a galvanic path between the grounds.



When ground loop is not a problem

- None of the wires in the loop carry any current
- The loop is not exposed to external changing magnetic fields
- There is no radio frequency interference nearby

Direction of Iggl depends of potential difference of grounds, and so that interfier in summing current for Itr back

Solutions for Avoiding Ground Current Loop

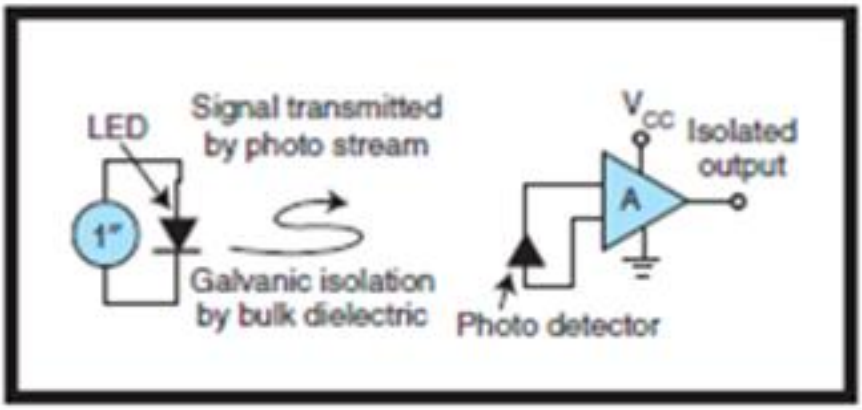
Main point is to break all galvanic paths between devices and take a wire with low resistance if is it possible.

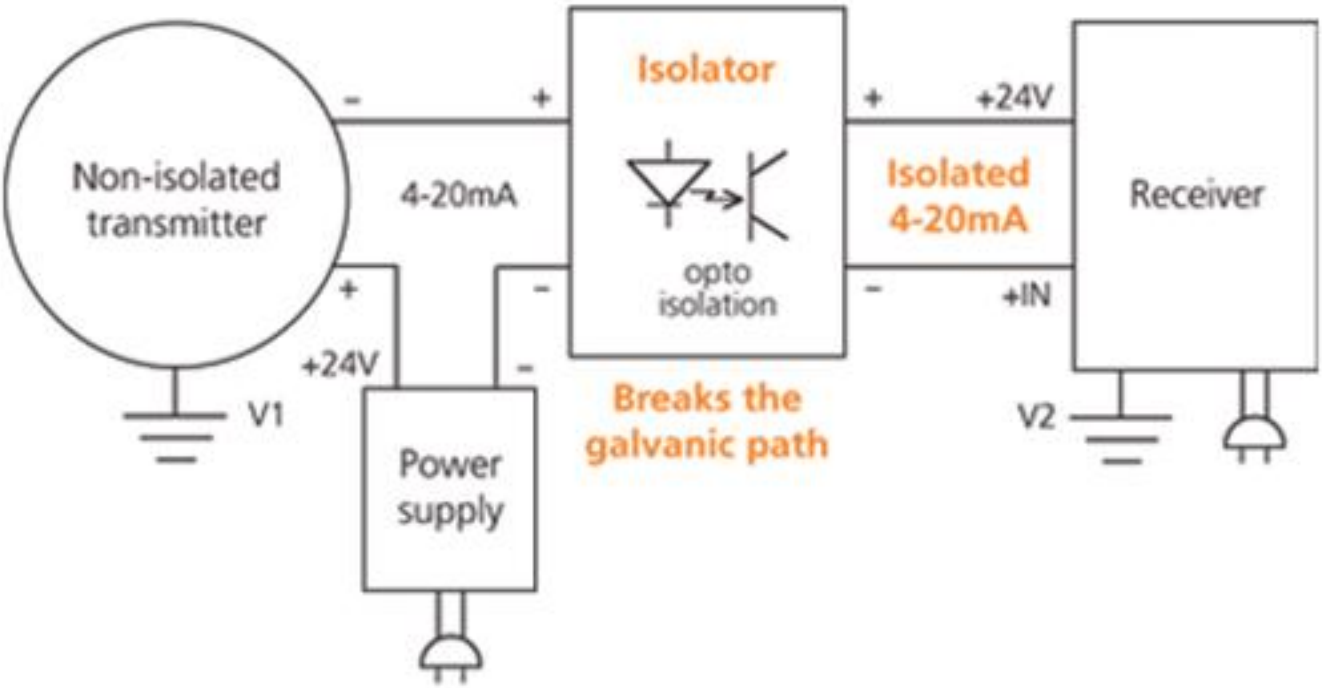
Here is a proposiotion how to do that :

1. **A) (Non) Isolated current transmitter / Receiver path with (non) isolated power supply**

   B) Isolated sensor / transmitter connection

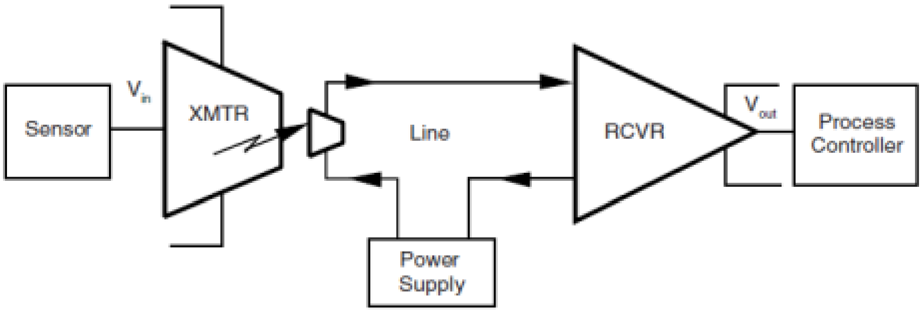
Princips



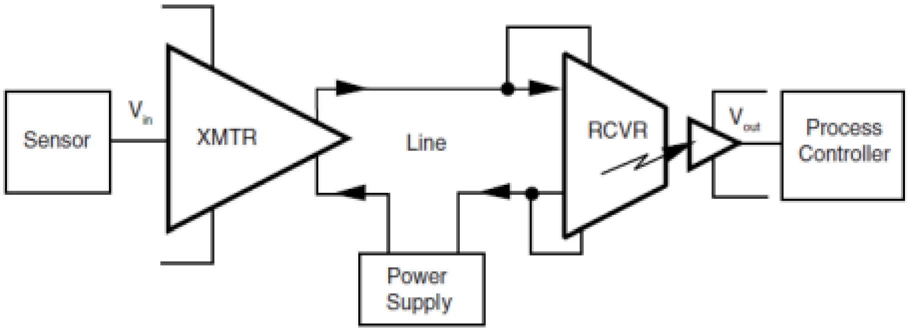


A signal isolator "breaks" the galvanic path between two grounds.

Isolated Transmitter / Receiver path examples

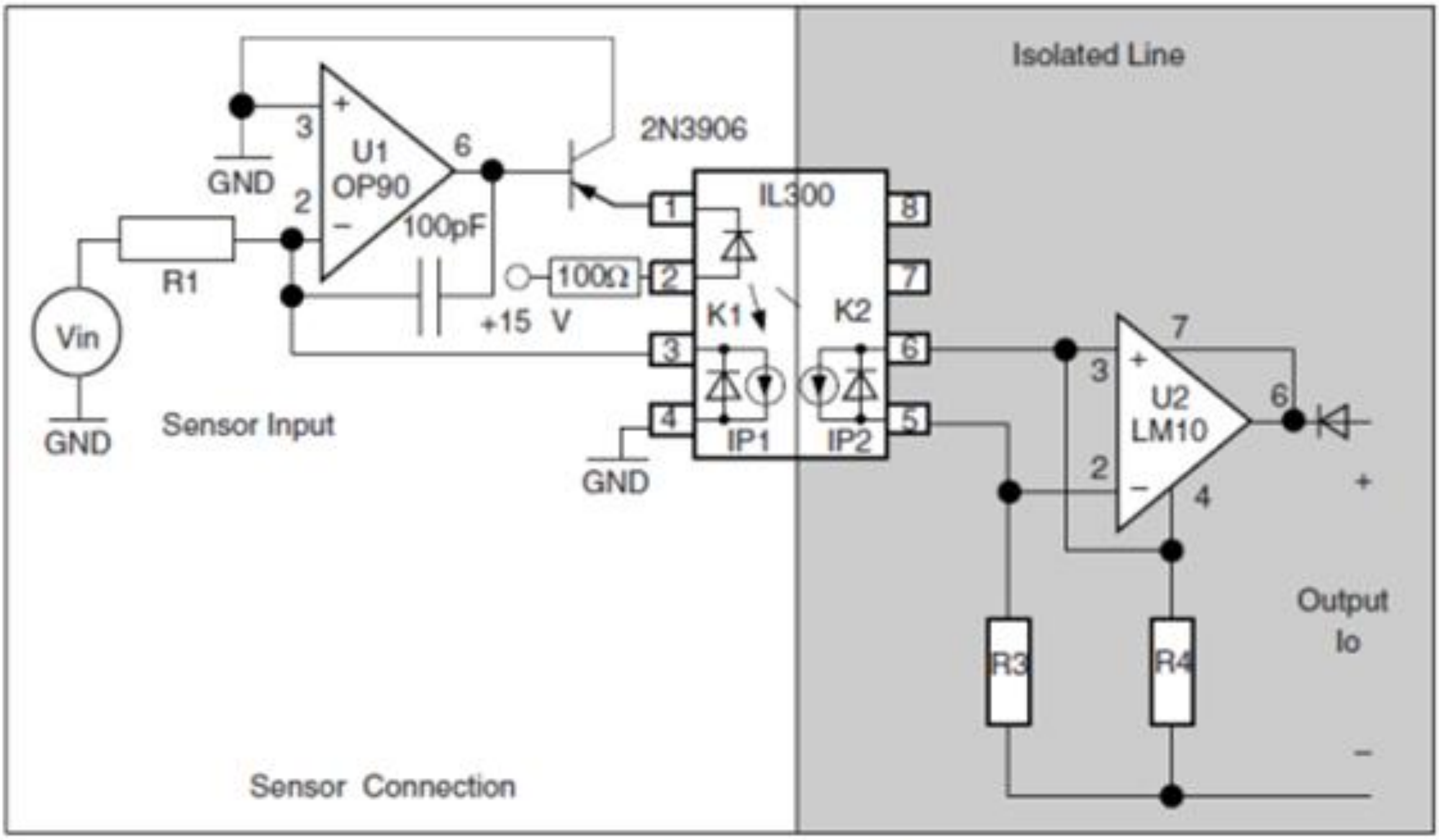


Isolated Transmitter and non-Isolated Receiver Current Loop



Non-Isolated Transmitter and Isolated Receiver

Detail (for Isolated Transmitter)



Isolated 1 V to 5 V, 4 mA to 20 mA Transmitter

2. No ground connection between devices (transmitter and on the other side receiver or serial ADC ...) and small resitance of wire.

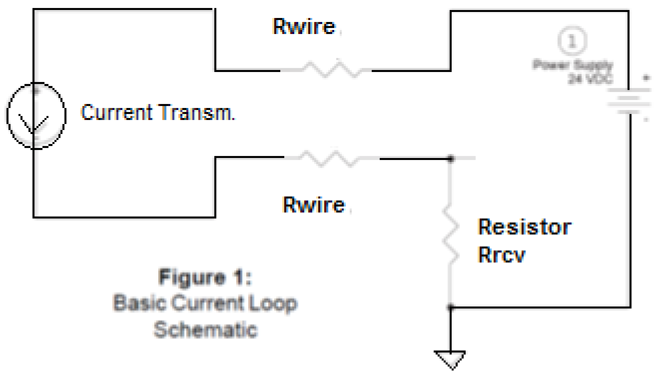


Figure 1: Basic Current Loop Schematic

In Figure 1, current supplied from the power supply flows through the wire to the transmitter and the transmitter regulates the current flow within the loop. The current allowed by the transmitter is called the loop current and it is proportional to the parameter that is being measured. The loop current flows back to the controller through the wire, and then flows through the Rreceiver resistor to ground and returns to the power supply. The current flowing through Rreceiver produces a voltage that is easily measured by an analog input of a controller. For a 250Ω resistor, the voltage will be 1 VDC at 4 mA and 5 VDC at 20 mA.

ANSI/ISA : **Three different loop connection types**

ANSI/ISA standard 50.00.01 actually describes three different current loop connection types. The two-wire transmitter described here is a Type 2 connection type, in which the transmitter has a "floating" connection relative to ground. The standard also describes a Type 3 connection type, or 3-wire transmitter loop, where the Transmitter and Receiver share a ground connection with power, and the transmitter uses a third wire to connect to power outside of the current loop. Type 4 refers to a 4-wire transmitter where the Transmitter and Receiver float, and separate power leads power the transmitter outside of the current loop. Four-wire transmitters can be AC or DC powered. In fact, 24VAC is a common power voltage for AC powered 4-wire transmitters. The following figures show the three basic transmitter connection types:

ANSI/ISA CURRENT TRANSMITTER CONNECTION TYPES

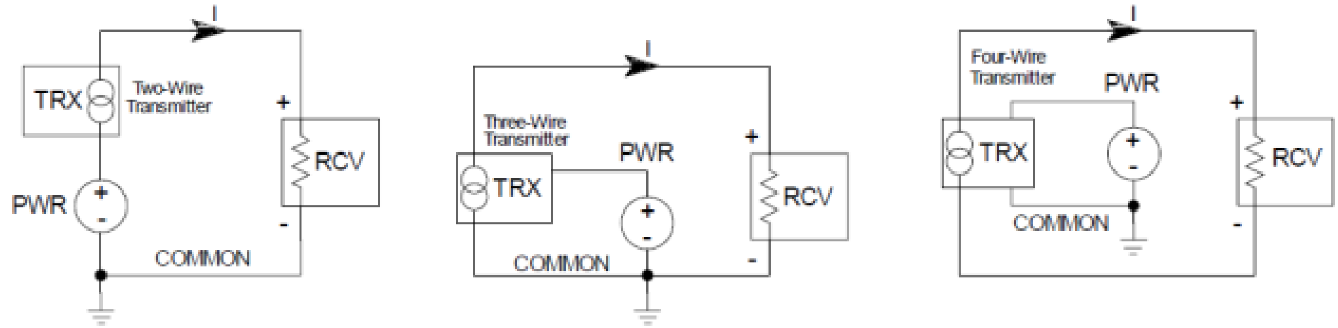


Figure 3A: Type II 2-Wire Circuit
Transmitter Floats Relative to Ground
DC Power in Series in Loop

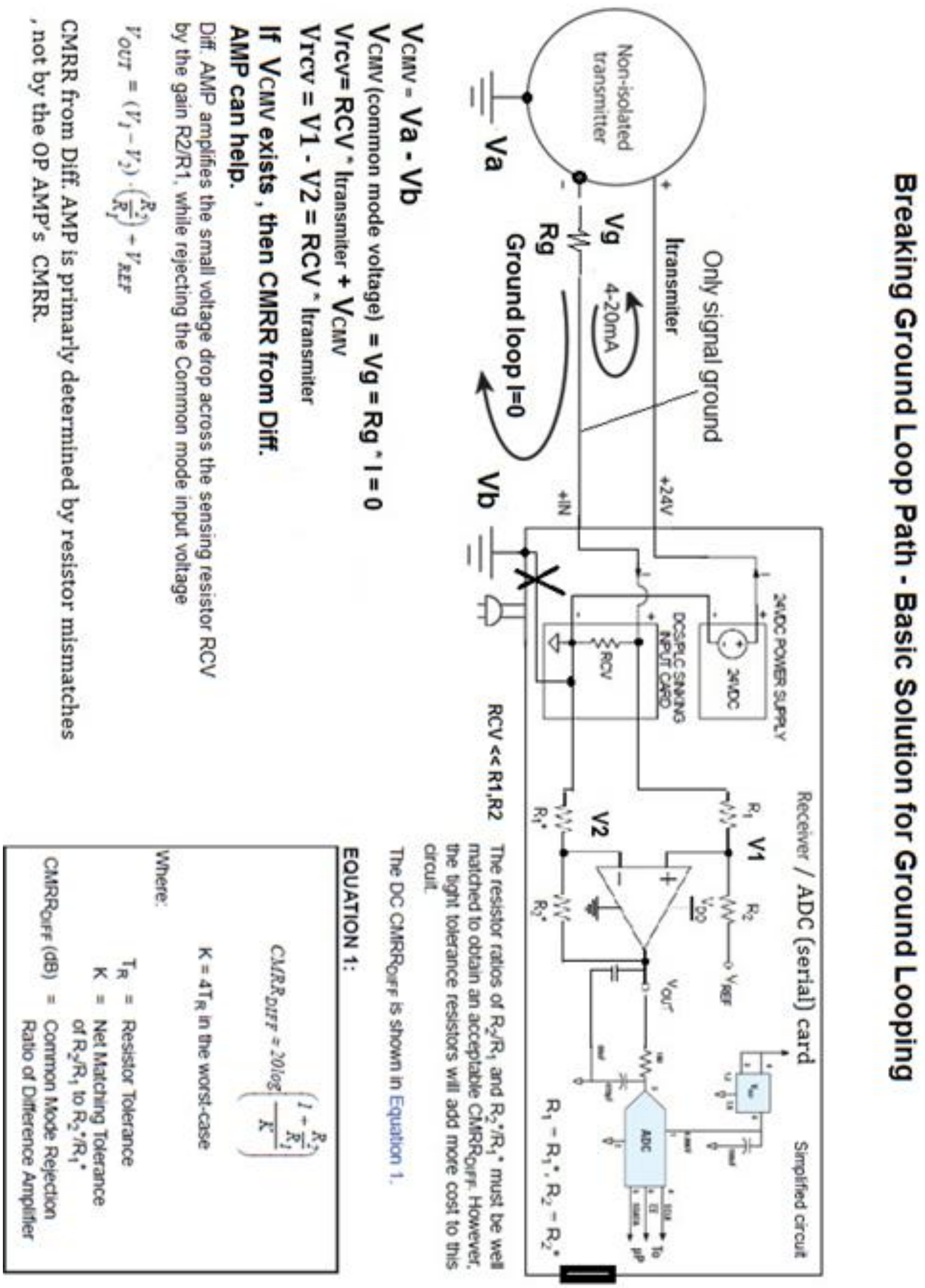
Figure 3B: Type III
Transmitter & Receiver Share Common w/ Power
Separate DC Power Connection to Transmitter

Figure 3C: Type IV
Transmitter and Receiver Float
Separate Supply Powers Transmitter

Continuing ..

2. No ground connection between devices (transmitter and on the other side receiver or serial ADC ...) and small resitance of wire.

Detail (If we do not break groun loop , ther is COMMON MODE VOLTAGE)



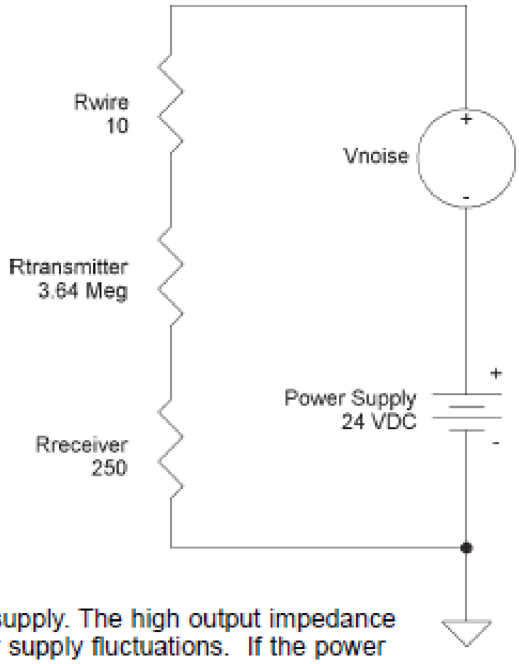
Noise Reduction Example:
If the noise source in Figure 2 has an amplitude of 20 Volts, then the noise voltage seen across the Rreceiver is only 0.0014 volts.

This is because the noise voltage measured across any resistor is equal to the Ohms of that resistor divided by the total Ohms in the circuit multiplied by the noise voltage.

Voltage Noise at Rreceiver =
Vnoise × Rreceiver/(Rwire+Rtransmitter+Rreceiver)

Vnoise = 20 × 250/3,640,260 = 0.0014 volts

The voltage across Rreceiver at 20 mA of loop current is five volts. Adding 0.0014 volts of noise is only 0.028% of five volts, which is an insignificant error.



This same principle applies to voltage fluctations in the power supply. The high output impedance of the T1K Temperature Transmitter rejects errors due to power supply fluctuations. If the power supply of Figure 1 is varied such that the voltage dropped across the transmitter varies from 7 to 24 VDC, the output current only changes by 0.000005 amps, or 5 micro-amps. This equals only 0.00125 volts across the 250Ω Receiver resistor, which is an insignificant fluctation.

3. Serial communication isolation between serial ADC card / receiver and HOST PC (Isolatet RS232 or similar)

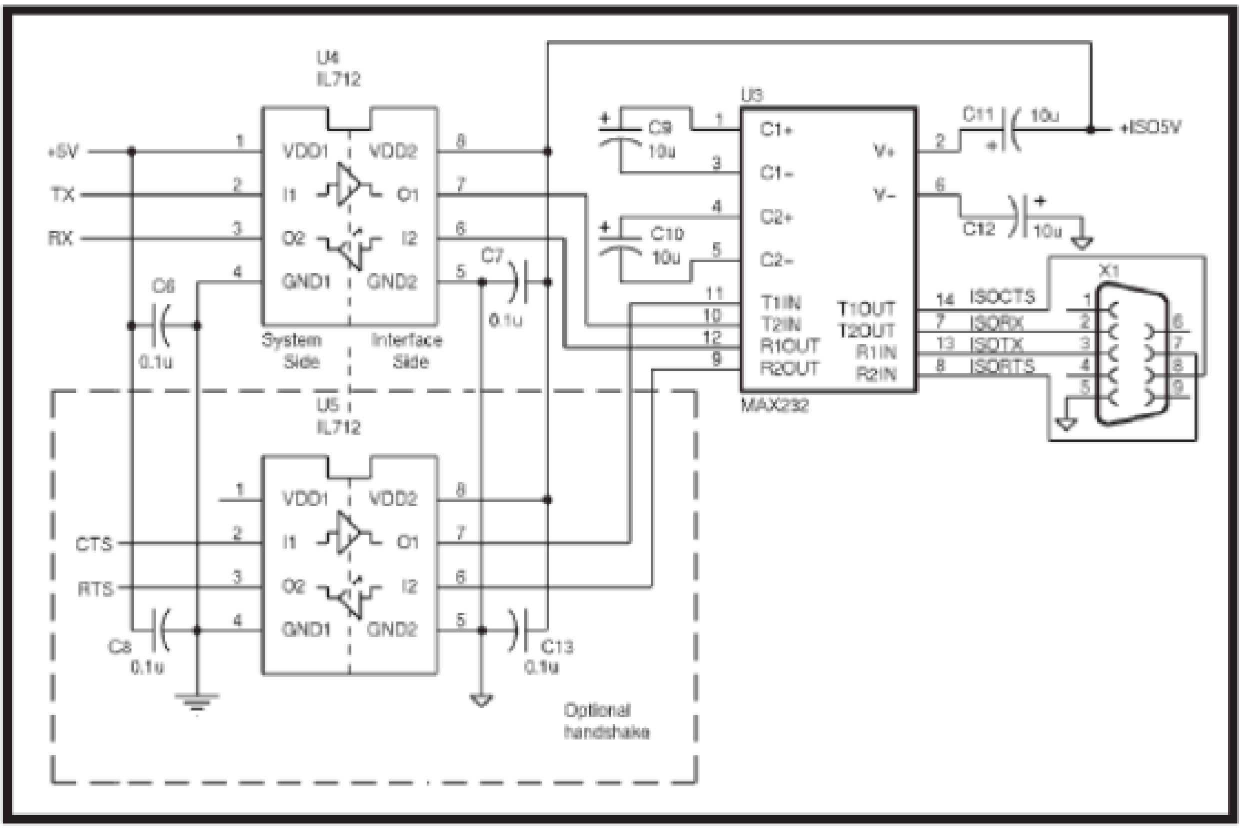


Figure 5—*The IL-712 contains 2 isolators, which can easily be used with a MAX-232 for serial isolation. An additional IL-712 will add isolation for hardware handshaking.*