# Application note: 4 – 20mA Inputs

This application note describes how to read 4-20mA signals using the VM-1.

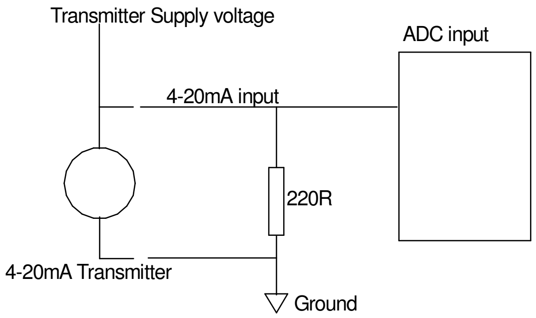
## Introduction

4-20mA signals are used to transmit signals in industrial environments. They have several useful features:

- Noise immunity: a current signal is not so susceptible to noise and ground potential differences as a voltage.
- Fault detection: a disconnected sensor is easy to spot, as the signal current will be zero – a fault condition.

## Converting the signal

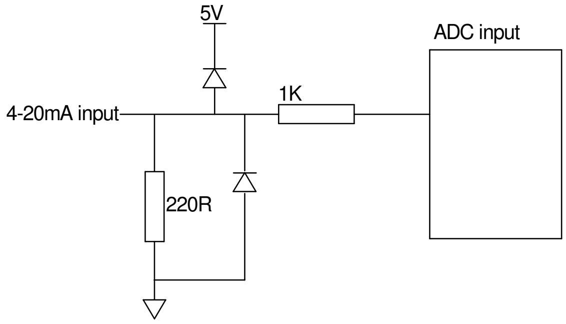
To convert a 4-20mA signal to a 0-5Volt signal suitable to feed into an Analogue to Digital Converter (ADC) you should use a 220R resistor. This gives 4.4 Volts at 20mA and 0.88 Volts at 4mA – a span of 3.52 volts. The 4-20mA transmitter should be connected between the top of this resistor and ground.




The 4-20mA transmitter should only be grounded at the VM-1 end.

## Input Protection

In some applications you might wish to protect the inputs of the ADC. You can use a pair of diodes and a series resistor to do this. 1K is often a good value – but check the ADC for the maximum source resistance it can tolerate.

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Any over-voltage at the input (caused by over current) will turn on the diodes limiting the voltage excursion. The series resistor will limit the current flow into the ADC input protection diodes, which can usually only handle small currents.

## Code

If the converter has 10-bit resolution then a bit of venom code to read the signal might be.

```
MAKE an_in Analogue (40)
volts := an_in . Value * 5.0 / 1024.0
Current := volts / 220.0
```

You can then check the signal for faults:

```
IF current > 20.0E-3 OR current < 4.0E-3
  Print “fault”
```

Depending on your application, and the overall accuracy of your system, you may want to define the fault conditions a little less strictly than above.

You can scale the measured current to whatever range you need:

```
Signal := ( current – 4.0E-3 ) * (100.0/16.0)
```

This will make the variable signal range from 0.0 to 100.0 when the current ranges from 4mA to 20mA.

*Note that this code uses floating-point arithmetic. It is quite acceptable to use integer arithmetic, but you need to be a little more careful about calculating the final value you need. For example you would not calculate the voltage as an integer as it would limit the precision of the measurement to worse than 20% (1 volt in 5). You might instead calculate a value in millivolts.*

## Accuracy

The overall accuracy of your measurement will depend on these factors:

- The accuracy of the sensor and it’s 4-20mA transmitter
- The accuracy of your 220R sense resistor
- The accuracy/precision of the analogue to digital converter (ADC).

Usually you can just add up the percentage accuracies from all these sources to arrive at an overall accuracy. If you need to be very sure of the overall accuracy figure then your analysis will need to be more sophisticated.

## Noise

If the cable run from the sensor to the VM-1 application is very long, you may want to make sure the cable is shielded from electromagnetic interference in some way to minimise noise on the signal. A common way to do this is to use a twisted pair cable.

## Opto-Isolation

Opto-isolation is sometimes required so that the current loop signal can be read by more than one instrument by connecting them in series.

The circuits described here don’t use any opto isolation as it is much more difficult to design circuits with it. Therefore if you need to include other instruments in the current loop, they will need to be isolated.