

# Calibrating Voltage Input Signal Conditioners Using the Fluke 787 ProcessMeter

## Introduction

Many manufacturing and processing plants carry a wide variety of signal conditioning devices. The Fluke 787 ProcessMeter is an ideal tool for calibrating many 4-20 mA signal conditioners using its precision current sourcing and simulation capabilities. However, there are many signal conditioners that require a precision voltage source for proper calibration. Using a simple precision resistor and standard connector, the Fluke 787 can field calibrate many standard and non-standard voltage input signal conditioners. Voltage input signal conditioners come in many varieties. The most common are 0-10V and 0-5V input levels. Typical outputs of these devices are an isolated or non-isolated 0-10V or 4-20 mA. Signal conditioners with inputs of 1-5V or 2-10V are also prevalent in many applications and usually derive their inputs from a resistor in series with a 4-20 mA loop. Resistors with values of 250 ohms to 500 ohms are common loop load resistors and provide voltage input levels as a function of the loop current. (See Figure 1.)

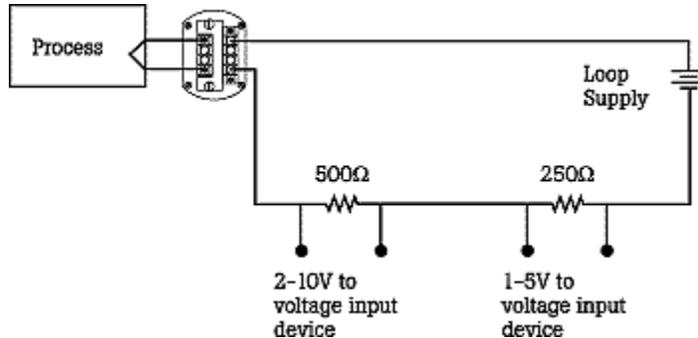


Figure 1.

## Using the Fluke 787 ProcessMeter as a voltage source

A hand-selected, precision shunt resistor may be used to derive voltages for calibration using the Fluke 787's current source mode. Using this system, the Fluke 787 is capable of generating voltages for devices with input spans as low as 10 mV to as high as 12V. Table 1 gives values of precision resistors to accommodate a variety of voltage calibrations.

# Constructing a precision load resistor assembly

A simple precision current shunt can be constructed using a precision 1000 ohm, RN60, 1W resistor, a dual banana jack connector and some test leads with alligator clips (see Figure 2). The RN60 class resistor is available from many commercial sources. This resistor can be obtained in a 50 ppm/° C, 0.1% value which provides the stability and accuracy sufficient for most field calibrations. The resistor should be hand selected using a precision DMM for a value of 1000 ohms. Construct the assembly as shown in Figure 2. This precision resistor assembly, coupled with the precision current sourcing capabilities of the Fluke 787, will provide precision voltages up to 12V. This assembly will allow a direct one-to-one display correlation to voltage when sourcing current from the Fluke 787 during calibration.

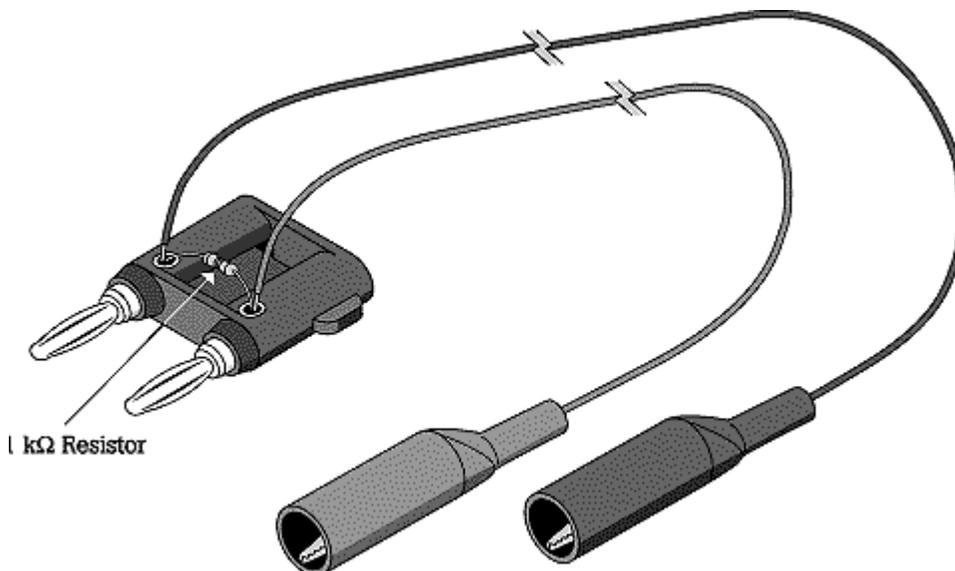


Figure 2.

## Calibrating the signal conditioner

The following is a procedure for calibrating a 0-10V input, 4-20 mA output signal conditioner using the precision resistor assembly constructed in Figure 2.

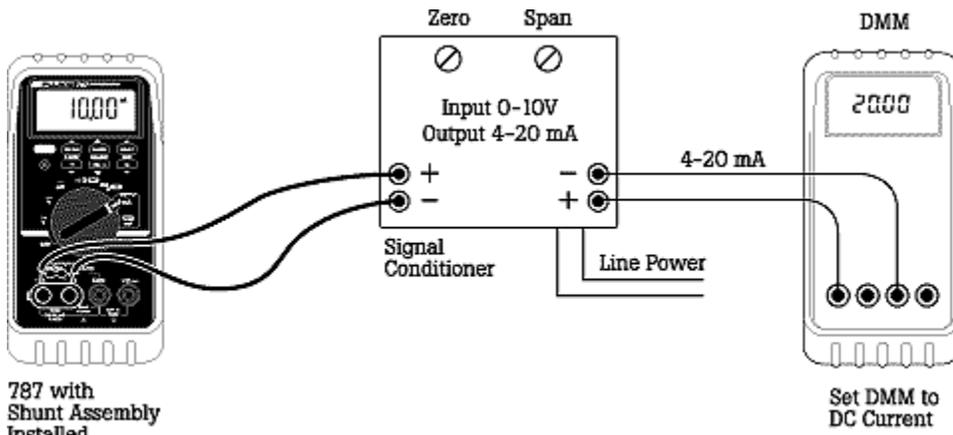
**Step one** - Setting the Fluke 787 to source 0-20 mA

1. With the shunt assembly in the "source" jacks, turn the meter to  $\overline{\text{mA}}$  <sup>OUTPUT</sup>.
2. Check the display. If the display does not read 0 mA, turn the meter off and on again while holding the **RANGE** button for at least two seconds. The display should now read 0.000 mA.

**Step two** - Calibrating

1. Place a precision multimeter such as the Fluke 87, set to dc current mode, in series with the output of the signal conditioner as shown in Figure 3.

2. Connect the test leads from the precision shunt assembly to the signal conditioner input terminals, observing proper polarity.
3. Turn the Fluke 787 to the mA source setting. The display should read 0.00 mA (0.00V to the shunt).
4. Adjust the "Zero" control on the signal conditioner to display 4.00 mA on the multi-meter connected to the signal conditioner's output.
5. Press the **MIN MAX** button on the Fluke 787 twice until the 787 display reads 10.00 mA. Then adjust the span adjustment on the signal conditioner until the display on the output meter reads 20.00 mA.
6. Push the **100** button twice until the display on the Fluke 787 reads 0.00. Verify the meter connected to the output signal conditioner reads 4.00 mA.
7. Calibration is now complete.



787 with Shunt Assembly Installed  
Figure 3.

### Step three - Checking linearity

Once zero and span controls have been properly set, signal conditioner linearity may be verified using the following procedure. This procedure will check Zero, 50% and Span settings for signal conditioner linearity.

1. With the precision resistor assembly in place, adjust the source current of the Fluke 787 to 0 mA (0.0V) using the "min-max" or "Sound" button. Note the output meter value displays 4 mA.
2. Using the min-max button, step the source current to 25% and 50% and note the corresponding values. Table 2 shows the correct values of output for a linear signal conditioner.  
(If values differ from that shown in Table 2 by more than the linearity specification of the signal conditioner, contact the signal conditioner manufacturer.) The Fluke 787 ProcessMeter™ is the first integrated multimeter and loop calibrator designed with the needs of the process professional in mind.

Resistor Value	Sourced Current	Fluke 787 Display	Sourced Voltage
10 ohms	0-20 mA	0-20.000	0-200.00 mV
100 ohms	0-20 mA	0-20.000	0-2.000V

1000 ohms	0-12 mA	0-12.000 mA	0-12.000V
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**Table 1.** Values of precision resistors to accommodate a variety of voltage calibrations  
 Note: Input impedance of the device under test should be  $\geq 1$  Mohms

## Constructing a precision current shunt for the Fluke 787

Parts required:

Resistor: 1000 ohms

1. Type: RN60 (50 ppm@70° C) 1W
2. 36" test leads with alligator clips
3. Connector: Dual Banana Plug w/screw terminals

Fluke 787 Display Reading	Signal Conditioner % Input	Signal Conditioner Input Voltage	Output Current
0.000 (0%)	0	0V	4.00 mA
5.000 (25%)	50	5.000V	12.000 mA
10.000 (50%)	100	10.000V	20.000 mA

**Table 2.** Correct values of output for a linear signal conditioner.

## Making Fine Adjustments (dealing with interactive control adjustments)

Many signal conditioners with 0-20 mA and 4-20 mA outputs are notorious for zero and span control interaction. If, when performing step 6 in the calibrating section on page 2, your output meter displayed a value higher or lower than 4 mA, perform the following steps to effect the required 4 and 20 mA display on the output meter.

1. Note the value above or below 4 mA that was displayed on the output meter when you returned to a source value of 0.00 on the Fluke 787. Adjust the Zero control on the signal conditioner so the value of the output meter shows one-half the difference of the remaining mA value to 4 mA.  
 Example: If your display reading at zero input in step 7 was 3.50 mA. Adjust the output (with 0.00 source current) to display a reading of 3.75 which is one-half the delta toward the desired value of 4 mA. (eg.  $4.00 - 3.50 = 0.50$ ;  $0.05 / 2 + 3.50 = 3.75$ , or one-half the difference between the reading and the desired value.)
2. Set the source current of the Fluke 787 to 10.00 mA using the (min-max) button. Note the "output" meter display reading. Adjust the "Span" control of the signal conditioner one-half the delta from 20 mA. Example: If the output display reads 21 mA. Adjust the "Span" control to 20.5 mA. (One-half the delta to the required value of 20 mA.)

3. Repeat this "one-half step" process until the required output is obtained. (The interactions of Zero and Span controls on signal conditioners that exhibit this trait diminishes as the deltas become less.) There are signal conditioners that have non-inter-active controls which do not require this procedure.

Note: Many manufacturers specify a warm-up time prior to beginning calibration.