Build Your Own AutoCal/Automatic Loop Calibrator

This project will give you an in-depth look at industrial automation and the standards for current loop transmission. We will cover the conventions used, the applications and how to build your own industrial grade current loop calibrator. The device is battery operated by three 9 VDC batteries and will source current in a 5 step sequence from 4-20 ma. It will increment to the next step automatically every 10 seconds, and will either ramp up and repeat or will ramp up and back down again, depending on a single switch setting. Sound interesting…and perhaps even versatile? Let's get started…

WHY USE CURRENT LOOPS ?

I'm sure that's your first question. Let me explain. Automation is the practice of engineering automatically controlled events based on some 'real world' information. This information is typically brought into PLC's (Programmable Logic Controllers) which make control decisions based on the information inputted into the system. This information can be either discrete (on-off) or analog (varies between two extremes).

For example, a switch is a discrete input device. In it's simplest state, it has 2 states-on or off. It can tell you only two things. An analog input, however, can tell you 'where' a value is in relationship to 2 extremes. I say two extremes because it may not vary all the way from 'ON' to 'OFF'. Let's say a switch is hooked up in series between your headlights on your car and the battery. When the switch is 'ON' 12 VDC goes across lights and when the switch is 'OFF'…and 0 VDC is across the lights. Analog values aren't necessarily limited to these two extremes.

In process control, analog loops typically indicate a process variable as 0-100 % range with a 4-20 ma. current loop. In other words, 4 ma. represents 0 % of the range and 20 ma. represents 100 % of the range. The range may be in pressure, temperature, flow, level…or any other parameter for measurement of a physical phenomenon. The 4 ma. lower end gives you enough current to operate the electronics of the device which 'transmits' or sends a corresponding current. These current loops are typically powered by 24 VDC power supplies.

The idea of a current loop is to compensate for voltage drops across connections or long lengths of wire between the field device and the PLC input. It is not uncommon for these devices to be located hundreds of feet away. So the standard for the interfacing of field instrumentation is the 4-20 ma. current loop.

RESOLUTION AND SPEED

Analog input modules for industrial PLC's have 3 parameters: number of channels, ranges, and resolution. Typically, current loops are terminated at the module with a precision 250 Ohm resistor. This converts the current loop of 4-20 ma. to a 1-5 VDC signal which is fed into the PLC memory registers. This signal is 'resolved' or broken down into so many different states…dependent of the resolution of the device.
Most Analog modules are 12-bit…which means they can discern 1 part in 4096. The actual registers are ranged from 0-4095. This means you can 'resolve' or see a difference of 1/4096 or .024 % of the range.

Our loop calibrator has a 16-bit resolution which 0-65536. The resolution of this is .0015 % of the range. Analog Devices manufactures a digitally programmable 16-bit current loop chip as device # AD420. The actual 28 pin PDIP part # is AD420AN-32 and is available from Avnet for $ 16.00 apiece in single lot quantities. That's a spectacular price considering what this chip will do!

INTRODUCING THE AUTOCAL

The purpose of the AutoCal is to generate the necessary timing functions and control logic to enable this chip to be used as an inexpensive accurate FIELD LOOP CALIBRATOR. When the device is turned on…it defaults to 4 ma. After 10 seconds it increments to 8 ma…10 second delay…12 ma…10 second delay…16 ma…10 second delay…20 ma. At this point in the sequence…the output will either sequence directly back to 4 ma. OR sequence back down to 16 ma…10 second delay…12 ma…10 second delay…8 ma…10 second delay…4 ma…and start all over AGAIN.

The timing was selected to give time for screens monitoring system parameters to update and for control valves and other devices to react to these changes. The two modes of operation allow you to check for 'hysteresis'. This seldom used word defines whether a setpoint was reached from an increased value or a decreased value and the effect it has. For example, mechanical wear in a control valve might have a different position and flow rate if the valve was set at 50 % and had been moved from 25 % instead of 75 % open. Anyway…I think you get the idea.

Keep in mind that this system will directly source current and therefore doesn't require power from a control system itself. This makes it ideal for checking valves out of service or checking wiring and registers to make sure they show up in the right places in a program or display screen. Take it from me…a lot of mistakes of this type go unnoticed for years in new plants. An auto sequencing signal from the AutoCal will certainly verify everything throughout the system.

CALIBRATION

The OFFSET pot is used to calibrate the unit. I've found that the best linearity is when this control is adjusted to 12 ma. when the calibrator is stepped to that position. If you set S1 closed the steps will Increase/Decrease and you'll be able to adjust the offsset twice as often till you get it dialed in. Typical errors is 0.02 ma. for any setting which is pretty good. Although there are already industrial calibrators with programmable functions available…we didn't think you needed to pay $ 3,000.00 or more to get this feature. Once again…we used a few inexpensive parts to bring you an accurate cost-effective device that you couldn't find elsewhere. And that's what were really all about anyway…

A preprogrammed PIC 16C54 chip and 4 Mhz. Ceramic resonator are available for only $ 15.00 postpaid anywhere in the United States. Other orders must add the appropriate postage and we'll ship anywhere in the world. If you're interested in manufacturing or distributing this or any one of our other devices…please email us at your earliest convenience. We look forward to working with you in a mutually profitable atmosphere…

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