SBMX1027 - VIRTUAL BIOINSTRUMENTATION

UNIT IV
INSTRUMENT INTERFACES

4–20mA Current Loop

Current-mode data transmission is the preferred technique in many environments, particularly in industrial applications. Most systems employ the familiar 2-wire, 4–20mA current loop, in which a single twisted-pair cable supplies power to the module and carries the output signal as well.
The 3-wire interface is less common but allows the delivery of more power to the module electronics. A 2-wire system provides only 4mA at the line voltage (the remaining 16mA carries the signal). Current loops offer several advantages over voltage-mode output transducers:
– They do not require a precise or stable supply voltage.
– Their insensitivity to IR drops makes them suitable for long distances.
– A 2-wire twisted-pair cable offers very good noise immunity.
– The 4mA of current required for information transfer serves two purposes:
it can furnish power to a remote module, and it provides a distinctionbetween zero (4 mA) and no information (no current flow).In a 2-wire, 4–20mA current loop, supply current for the sensor electronicsmust not exceed the maximum available, which is 4mA (the remaining 16mAcarries the signal). Because a 3-wire current loop is easily derived from the2-wire version, the following discussion focuses on the 2-wire version.

Need for a Current Loop

The 4–20mA current loop shown in Fig. 1 is a common method of transmittingsensor information in many industrial process-monitoring applications. A sensor is a device used to measure physical parameters such as temperature, pressure, speed, liquid flow rates, etc. Transmitting sensory information through a current loop is particularly useful when theinformationhas to be sent to a remote location over long distances (1,000 ft, ormore). The loop's operation is straightforward: a sensor's output voltage is first converted to a proportional current, with 4mA normally representing the sensor's zero-level output, and 20mA representing the sensor's full-scale output. Then, a receiver at the remote end converts the 4–20mA current back into a voltage which in turn can be further processed by a computer or display module. However, transmitting a sensor's output as a voltage over long
distances has several drawbacks. Unless very high input-impedance devices are used, transmitting voltages over long distances produces correspondingly lower voltages at the receiving end due wiring and interconnect resistances.However, high-impedance instruments can be sensitive to noise pickup since the lengthy signal-carrying wires often run in close proximity to other electrically noisy system wiring. Shielded wires can be used to minimize noise pickup, but their high cost may be prohibitive when long distances areinvolved. Sending a current over long distances produces voltage losses proportionalto the wiring's length. However, these voltage losses also known as loop drops" do not reduce the 4–20mA current as long as the transmitter anloop supply can compensate for these drops. The magnitude of the current inthe loop is not affected by voltage drops in the system wiring since all of thecurrent (i.e., electrons) originating at the negative (−) terminal of the loop power supply has to return back to its positive (+) terminal

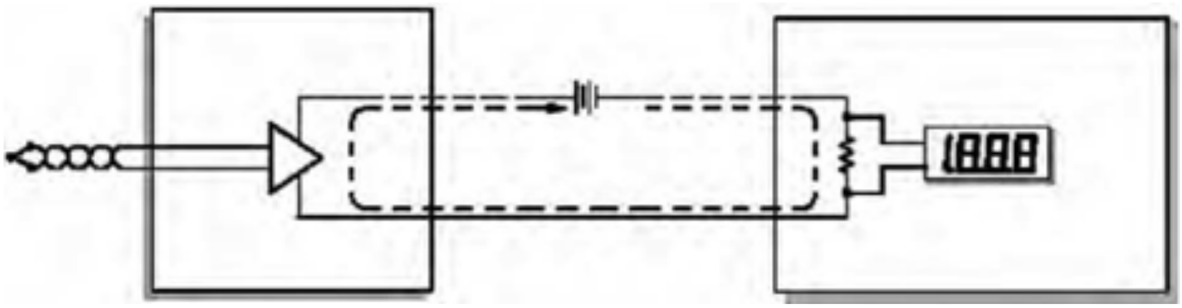

Fig1: Typical components in a loop

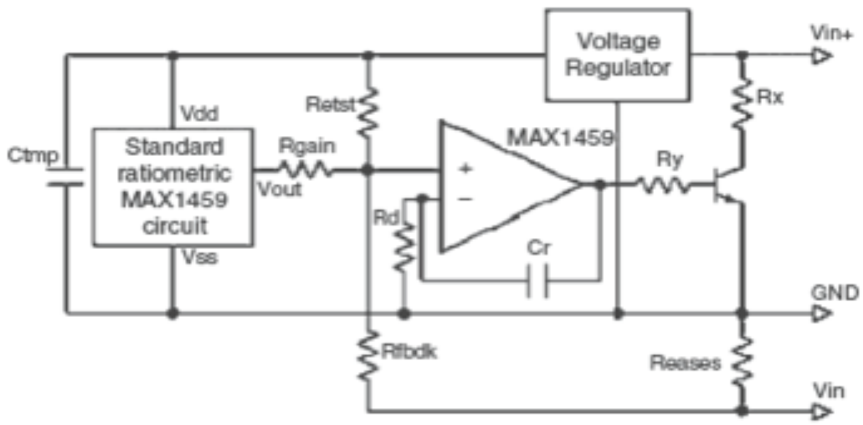

Fig2: 4-20 mA transmitter

Basic 2-wire Circuit

A voltage output should be converted to current when configuring a ratio metric 4–20mA circuit, because current-mode applications require a 4mA offset and 16mA span. This section presents the circuit details and results obtained from a current-loop configuration based on the MAX1459 sensorsignal conditioner. In principle, a voltage regulator is to be added, which converts the 10–32V loop voltage to a fixed 5V for operating the MAX1459. Figure shows the circuitry required for implementing a standard ratio metric version of the MAX1459 circuit. The voltage regulator can be any low-cost device whose quiescent current is sufficiently low for the 4mA budget.

Advantages of 4–20mA Current Loop

Current loops offer four major advantages such as:

– Long-distance transmission without amplitude loss
– Detection of offline sensors, broken transmission lines, and other failures
– Inexpensive 2-wire cables
– Lower EMI sensitivity

RS 232C/RS 485

The RS-232/485 port sequentially sends and receives bytes of information onebit at a time. Although this method is slower than parallel communication,which allows the transmission of an entire byte at once, it is simpler and canbe used over longer distances because of lower power consumption.For example, the IEEE 488 standard for parallel communication states thatthe cable length between the equipments should not exceed 20m total, witha maximum distance of 2m

between any two devices. RS-232/485 cabling,however, can extend 1,200m or greater. Typically, RS-232/485 is used totransmit American Standard Code for Information Interchange (ASCII) data.Although National Instruments serial hardware can transmit 7-bit as wellas 8-bit data, most applications use only 7-bit data. Seven-bit ASCII canrepresent the English alphabet, decimal numbers, and common punctuationmarks. It is a standard protocol that virtually all hardware and software understand.Serial communication is mainly using the three transmission lines:
(1) ground, (2) transmit, and (3) receive. Because RS-232/485 communicationis asynchronous, the serial port can transmit data on one line while receivingdata on another. Other lines such as the handshaking lines are not required.The important serial characteristics are baud rate, data bits, stop bits, andparity. To communicate between a serial instrument and a serial port on computer,these parameters must match.The RS-232 port, or ANSI/EIA-232 port, is the serial connection foundon IBM-compatible PCs. It is used for many purposes, such as connecting amouse, printer, or modem, as well as industrial instrumentation. The RS-232protocol can have only one device connected to each port. The RS-485 (EIA-485 Standard) protocol can have 32 devices connected to each port. Withthis enhanced multidrop capability the user can create networks of devicesconnected to a single RS-485 serial port. Noise immunity and multi dropcapability make RS-485, the choice in industrial applications requiring manydistributed devices networked to a PC or other controller for data collection.USB was designed primarily to connect peripheral devices to PCs, includingkeyboards, scanners, and disk drives.RS-232 (Recommended standard-232) is a standard interface approved bythe Electronic Industries Association (EIA) for connecting serial devices. Inother words, RS-232 is a long established standard that describes the physicalinterface and protocol for relatively low-speed serial data

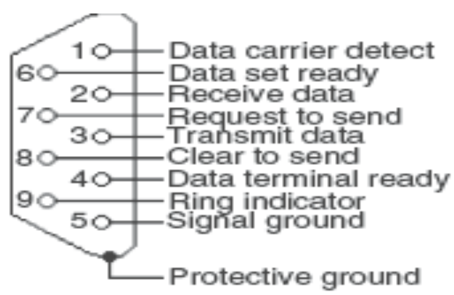

Fig 3: Pin diagram

Table: pin description

Pin Number	Signal	Description
1	DCD	Data carrier detect
2	RxD	Receive data
3	TxD	Transmit data
4	DTR	Data terminal ready
5	GND	Signal ground
6	DSR	Data set ready
7	RTS	Ready to send
8	CTS	Clear to send
9	RI	Ring indicator

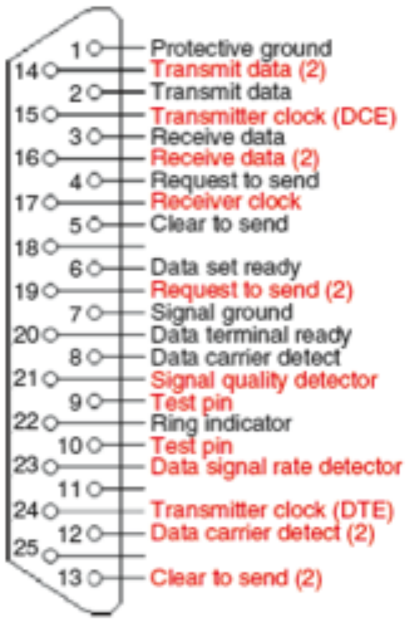

Fig 4: RS232c DB 25 pinout

Signal Descriptions

– TxD – This pin carries data from the computer to the serial device

– RXD – This pin carries data from the serial device to the computer

– DTR signals – DTR is used by the computer to signal that it is readyto communicate with the serial device like modem. In other words, DTRindicates the modem that the DTE (computer) is ON.

– DSR – Similarly to DTR, Data set ready (DSR) is an indication from themodem that it is ON.

– DCD – Data carrier detect (DCD) indicates that carrier for the transmitdata is ON.

– RTS – This pin is used to request clearance to send data to a modem.

– CTS – This pin is used by the serial device to acknowledge the computersRTS signal. In most situations, RTS and CTS are constantly onthroughout the communication session.

– Clock signals (TC, RC, and XTC) – The clock signals are only used forsynchronous communications. The modem or DSU extracts the clock fromthe data stream and provides a steady clock signal to the DTE. Thetransmit and receive clock signals need not have to be the same, or evenat the same baud rate.

– *CD – CD stands for Carrier detect*. Carrier detect is used by a modemto signal that it has a made a connection with another modem, or hasdetected a carrier tone. In other words, this is used by the modem tosignal that a carrier signal has been received from a remote modem.

RI – RI stands for ring indicator. A modem toggles (keystroke) the stateof this line when an incoming call rings in the phone. In other words,this is used by an autoanswer modem to signal the