CHAPTER 10, SIGNAL MULTIPLEXING BETWEEN TWO OR MORE RTUS

10.A WHAT IS SIGNAL MULTIPLEXING?

Signal multiplexing (Mode-C) operation is used where rapid, cost effective and reliable transfer of measurements and digital signals from one point to another is required. In this mode, two or more RTUs communicate directly and continuously with each other, transferring analog and digital information from the input circuits of one RTU to the output circuits of another RTU. All analog inputs are reflected as analog outputs at the other end and all digital inputs are reflected as digital outputs at the other end in the designated RTU(s). All ScanData RTUs are capable of operating in Mode-C.

MODE-C: SIGNAL MULTIPLEXER SYSTEMS

In Mode-C, back-to-back or signal multiplexer mode, two or more RTUs send and receive analog and digital signals from point to point.

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10.B TYPICAL MODE-C MULTIPLEXING SYSTEMS.

Typical use for Mode-C systems are where signals have to be transferred from remote sites to annunciator panels, to PLCs, to lights and meters and from switches and rheostats out to remote sites.

Many phone companies are now going away from the old metallic cable pairs and using fiber optics instead. These circuits cannot carry 4-20 mA signals. Installing two LMR RTUs at each end of the fiber optic circuit allows you to continue sending your 4-20 mA signal and, in addition, an extra 4-20 mA signal and two

digital signals, going both ways. The savings are obvious.

Many utilities use leased metallic lines to carry Pulse Duration (PDM) signals. One pair is used for each signal, an obvious waste of transmission capability and a waste of money when phone company leased lines are used. Installing RTUs at each end makes it possible to use only one cable circuit to carry virtually any amount of analog and digital signals.

MULTIPLEXING A FEW ANALOG AND DIGITAL SIGNALS

An example of a unique LMR Mode-C installation is with the Philadelphia Energy Company. They had been using leased lines from the phone company, transmitting DC metering signals over these lines. The phone company, in upgrading their cable systems, went to fiber optics which cannot transfer DC signals.

The Philadelphia Energy Company opted to install LMR RTUs in Mode-C over these fiber optics circuits and gained a number of advantages, among them lower cost, far higher reliability with automatic error detection, the ability to transmit and receive several signals over one connection, etc.

Signal multiplexing RTUs are also often used to expand existing SCADA and Telemetry systems. Two back to back signal multiplexing RTUs can be used to bring in the extra analog and digital signals needed into the existing system.

10.C WHAT IS THE UPDATE TIME?

The multiplexing system continuously updates all signals, so that any change of any analog or digital input almost immediately reflects as a similar change in the corresponding analog or digital output. The update time depends on the amount of signals transmitted in the system.

At 1,200 baud, a common transmission rate for older systems, 120 characters per second are transmitted. This means that each character takes about 8 mS. The system transmits four digital signals in each character, which means that each digital signal takes 2 mS to transmit. An analog signal is normally transmitted with three characters so that each analog signal takes 25 mS to transmit. Newer systems transmit at 9,600 baud or higher with correspondingly shorter transmit times.

Adding all the analog signals in the system and multiplying this number by 25, then adding all the digital signals and multiplying that number by 2, gives you the total amount of milliseconds needed to transmit the information in a 1,200 baud system. To this must be added the time it takes to transmit the housekeeping characters such as start of message, checksum and end of message. The total time for most 1,200 baud systems is normally in the order of a few seconds.

10.D WHAT ABOUT ERRORS?

Modern computer error detecting technologies make the signal transfer in Mode-C

virtually error free.

What happens if the radio link is hit by strong interference and the signal is distorted? Will the analog and digital outputs be distorted or in error? No. The system rejects any signal that does not pass a 7 level check for parity, framing error, bit error, checksum error, etc. If the signal does not pass all these checks, the system will not update and the last old valid output remains.

What this means on a noisy radio link is that updating slows down when interference occurs. Erroneous values are not transmitted.

10.E AUTOMATIC COMMUNICATION FAILURE INDICATION

All ScanData RTUs operating in Mode-C mode can be equipped with a communication failure indication. In each RTU an unused digital output is used for comfail. This output will turn on if more than 5 scans occur without receipt of an acceptable message.

10.F RE-DIRECTION OF ANALOG AND DIGITAL SIGNALS

Normally, all analog and digital inputs from the slave RTUs are directed to the master RTU outputs and, vice versa, all analog and digital inputs at the master RTU are directed to one or more of the slave RTUs.

The ScanData redirection software allows any analog or digital input in the system to be directed to any analog or digital output point. This software also allows any input to be directed to two or more output points.

10.G MULTIPLEXING PULSE SIGNALS

MULTIPLEXING A LARGE AMOUNT OF ANALOG, DIGITAL AND PULSE COUNT SIGNALS

An example of a large Mode-C installation is with Shell Oil in Bakersfield, California, where Shell needed to transmit analog, digital and pulse control signals both ways some 20 miles over cable from their power generating plant to the PG&E power delivery point in Bakersfield, California.

One ScanData M-system was installed at each end of the cable. These RTUs continuously and automatically transfer 40 analog signals and 60 digital signals. In addition, five power metering pulse counts are continuously transferred from one end to the other, using proprietary ScanData software to input the pulses at one end and outputting the same pulses at the other end, without loosing a single metering pulse.

ScanData has a proprietary pulse transmission software that allows pulse trains of up to 5 Hz to be multiplexed from any RTU to the master RTU in Mode-C signal multiplexing systems. Each pulse train is transmitted as a pulse count to prevent missing pulses. This pulse count is received at the master and added to the

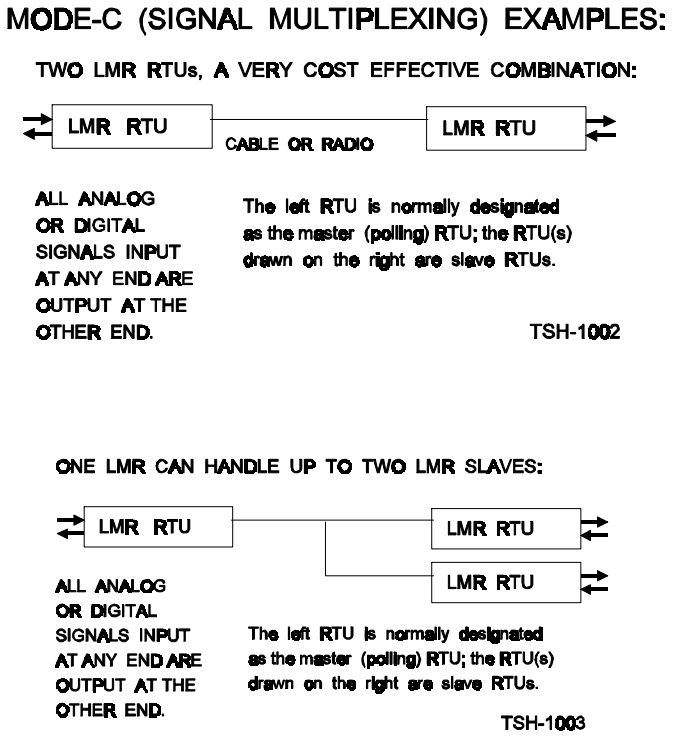
previous pulse count. The total pulse count is bled out over a special bleed out software that is interrupt driven (transparent to the main program) and bleeds out the pulse count at a 5 Hz rate over a digital output circuit.

A metering pulse transmission system was first installed with Getty Oil Company near Bakersfield, California, where it was used to transmit custody transfer flow pulses over splinter frequency radio which had severe interference. Three out of four transmissions were judged unusable. In spite of this, the system worked for several years without the loss of a single flow pulse count.

Shell Oil Company (see sidebar) and others have since used the same system with excellent results.

10.H WHICH RTU TO USE?

The ScanData LMR and LMX series RTUs are designed for, among other things, to operate very cost effectively in Mode-C.

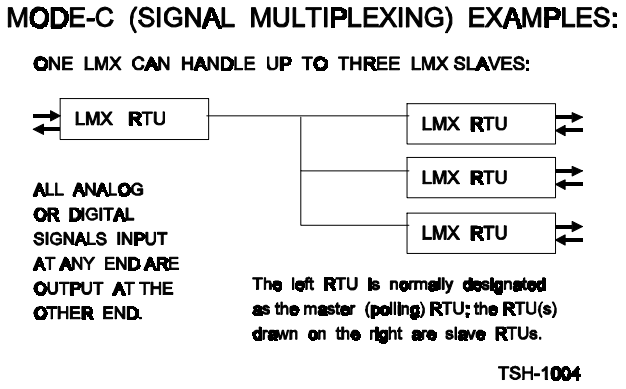


One LMR-I RTU at one end of a cable or radio circuit and an LMR-O at the other end of the circuit will transfer one analog signal one way and two digital signals both ways.

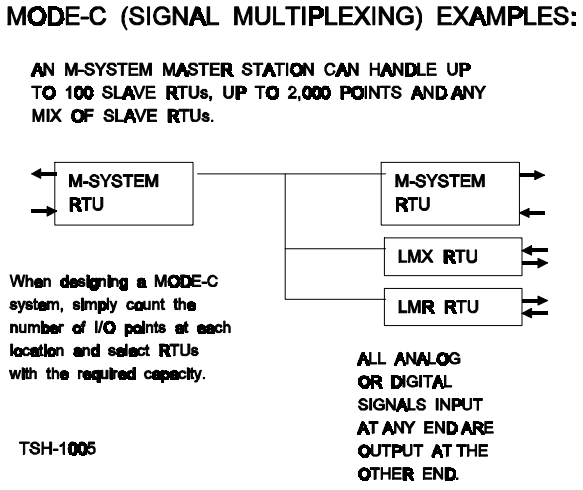
This is a very popular installation for controlling water pumps, where the pump is

some distance away from the tank. LMR installations of this type have been done all over the world.

RTUs with a higher I/O capacity will operate in the same manner over the same circuits. The LMX RTU, for instance, will transmit eight digital signals and two analog signals both ways.



The M-system RTU will transmit and receive up to 4,000 points. To specify your M-system, simply add the I/O boards you need. All ScanData RTUs operate equally well over cable or radio, with their built in Bell-202 modems.



10.I BRANCHING CABLE LINES

Use the FSD-202A multi-drop amplifier and combiner when you have to branch a 4-wire line out to two RTUs. The FSD-202A is transformer isolated and is normally set to 0 db loss. There is no limit to how many FSD-202A units you can use in a system.

10.J USING 2-WIRE CABLE LINES

When only a 2-wire cable is available, use the 4W2-A four wire to two wire converter. When using this converter, be aware that all the information you transmit is immediately reflected back to your receiver. The ScanData RTUs can handle this without difficulty but some cable circuits may not be able to handle the instability that can occur.

10.K USING DATA RADIO LINKS

All ScanData RTUs work equally well over radio links and interface directly to most radios and all ScanData radios over their built in modems. The only difference is that radios need a longer time to stabilize after the transmitter is turned on. This time is often referred to as warm up time or front porch. The radios also need some time after the message is finished before turning the transmitter off. One of the reasons for this is that turning the transmitter off invariably results in a garbage character being created in the modem or in the computer serial interface. This delay is referred to as warm down time or back porch.

These two delays make multiplexing over radio slightly slower than multiplexing over cable.

The exception is using the ScanData Spread Spectrum Data Radio which is interfaced to the RTUs over RS-232 connectors. Here no front porch or back porch delay times are needed.

10.L MULTIPLEXING OVER DIAL UP LINES

Signal multiplexing by dialing works very well, in spite of dialing not being a continuous transmission media.

The Scan-Data CDS system transmits up to eight 4-20mA analog and up to 8 digital signals from one remote site to another by dialing.

The CDS system consists of two units, the Commander at one end and the Responder at the other end. Each connects to a regular or cellphone RJ-11 jack. The Commander dials the Responder when any of its inputs change or when an external timer, such as the Scan-Data RLT closes its contact.

After the Responder answers and handshakes with a password, the Commander transfers all its 4-20mA and digital information to the Responder.

This manner of signal multiplexing has proven very reliable in numerous installations.

WHERE CAN I GET MORE INFORMATION?

Reference literature:

pri-0901.pdf Design Guide and Price List.

app-1104.pdf How to send multiple analog and digital signals by radio or cable.

muxc1073.pdf MUX signal multiplexer

cds-1368.pdf Multiplexing analog and digital signals over phones or cellphones.

An easy way to get the latest and most recently updated versions of these descriptions is to go on our WEB site:

www.scan-data.com

When you are there, click on the blue button near the bottom of the WEB page that says **Technical Information.** Then click on the description # you need.

Another good source for information onn 4-20mA and digital signal multiplexing is:

www.4-20mamux.com