CHAPTER 19, INSTALLING THE SYSTEM

19.A SUMMARY:

The preceding chapters of this Handbook have covered the various aspects of Telemetry and SCADA practices with theoretical examples. These practices will be put to test when it comes to the actual installation of the equipment and putting it into service. This is covered in this chapter. Refer back to earlier chapters if you need more details on what is covered herein.

The importance of good installation practices cannot be over emphasized. The great majority of boards returned to ScanData for repair have failed because of abuse of some kind, either by applying wrong voltage, wrong polarity, applying power to input and output circuits and by lightning strikes. Failures from other causes are rare.

Testing the input and output circuits is covered in this chapter. Testing the communication circuits is covered in the next chapter, Chapter 20. Finding why an equipment or a circuit does not work can be done only by thoroughly testing the installation.

Note that over 70% of all the boards sent back to ScanData for repair have nothing wrong with them. Time and effort can be saved by thoroughly testing the installation and locating the error, which is, as often as not, caused by a faulty installation.

Virtually all modern RTUs and PLCs are microprocessor based. They start operating the moment power is applied.

Installing and servicing these devices involves:

- **Connecting the proper power supply and verifying that the unit is drawing rated current.**
- **Connecting the communication lines and verifying that the unit is communicating.**
- **Connecting the field wiring (sensors and actuators) and verifying that the proper input and output signals are generated and read by the unit.**

19.B HARDWARE INSTALLATION

Mount the equipment on a plate or on a wall if it is supplied in a NEMA or a table top enclosure.

All incoming field wiring should be routed in at ground level and then vertically up to the equipment. The lightning protectors should be installed at ground level at the point were the wiring enters the building. This is important for all wiring, for AC wiring, telephone lines and field instrumentation wiring, and especially important for field instrumentation wiring that may run along a section of metal pipe or parallel to a section of a lightning conductor rod.

The ground level mounted lightning protection should be connected to a good, direct ground.

19.C CONNECTING THE POWER

Make sure that the RTU is designed to accept the power available. Common supply voltages are 12V DC, 24V DC, 120V DC, 110V AC and 220V AC. Measure the power leads with a voltmeter to verify that the output power matches the RTU power input. Turn the power off and attach the power leads to the power input of the device.

It may be a good precaution to measure the current the device draws and see that it matches the current draw stated in the handbook before you finalize the power supply wiring. Open up the positive power supply lead and insert a milliampere meter to check the current draw.

Remember that most RTUs start operating immediately when the power is applied.

What RTU supply voltage should be used? Most RTUs use either 110V/220V AC, 24V DC or 12V DC. Most analog transducers (see Chapter 12) need 24V DC and most radios need 12V DC. The standby battery (if used) can be either 24V or 12V DC.

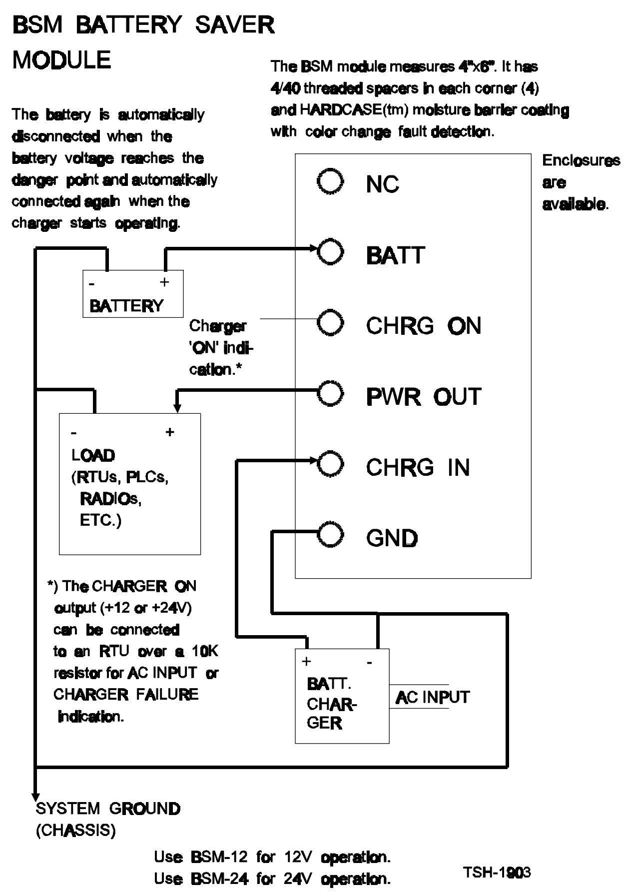
To avoid using dual DC power supplies and dual standby batteries, use the ScanData 12V to 24V DC converter, model C24, or the 24V to 12V DC converter, model C12. These converters operate at about 90% efficiency and are easy to install and use. Using the C24 or C12 allows you to use a single standby battery for all three uses, RTUs, radios and 4-20 mA loop supplies.

19.C.1 STANDBY BATTERIES

Connect the standby battery (batteries) to the charger. Many ScanData RTUs are supplied with a built in charger and automatic standby battery power connection to the RTU. The ScanData ACP power supply is configured to power an RTU and to charge a standby battery at the same time.

Measure the charging current. For a discharged battery, a charge current of a few hundred milliamperes is normal. A fully charged battery should stabilize at around 14.5V and the charging current draw should be minimal, unless the battery is supplying current to the RTU. In that case the charging current should be slightly above the rated RTU current. The voltage across a fully charged battery should be about 14.5V.

19.C.1.a INSTALLING THE BSM BATTERY SAVER MODULE



Installing a Battery Saver Module (BSM) is a good practice in remote installations where the standby battery may be ruined by long power outages. The BSM continuously checks the standby battery voltage and disconnects the battery when the voltage approaches the danger level, below which the battery would be ruined. In this manner the battery will be ready to accept a charge when the primary current is restored.

If you don't use the BSM module you will have to send a man out to replace the standby batteries each time you have a long power outage.

The BSM uses solid state switches and sensors and is very reliable and maintenance free. Follow the BSM wiring instructions and keep the wiring short.

19.C.2 SOLAR CELLS & THERMO ELECTRIC CONVERTERS

Solar cells can be used in locations with adequate sunlight. The ScanData SPG-20 technical manual gives details on how to calculate solar cell sizes. Installing under sized solar cells is a common error. The installation will work fine until there is a long string of sunless days.

It is important to orient the solar cell array to true south and with an angle which corresponds to the latitude of the site plus the correction factor as stated in the manual.

In northern climes the use of solar cells may not be practical as the solar cell arrays would have to be extremely large and the standby batteries equally large to compensate for dark winter months.

In remote sites where natural gas is available, such as at gas wells and gas gathering, transmission and distribution pipe lines, the use of gas fired thermo electric generators is very practical. These devices are now manufactured by different manufacturers.

Whether the station uses solar cells or thermo electric generators, always make sure that there is a sufficient charging current to keep the stand by batteries alive and enough current to operate the RTU.

19.D CONNECTING TO THE COMMUNICATION LINE

The majority of RTUs and PLCs will not transmit any messages unless they are polled by a central station or by another RTU or PLC. This means that you have no way of telling if the RTU is working until the central polls the RTU or until you poll it locally with a laptop and modem or with some other device.

CHANGING FROM 4-WIRE TO 2-WIRE OPERATION

There is sometimes a need to operate 4-wire devices such as modems and RTUs over 2-wire lines. This can be done, using the ScanData 4W2-A and 4W2-P 4-wire to 2-wire converters.

The 4W2-A is operates on 12V DC with built in amplifiers and has 0 db loss in each direction and 20 db loss across the hybrid. The 4W2-P needs no power supply and has 5 db loss from any terminal to any other terminal.

Normally, it is sufficient to connect the RTU to the line to verify that it is operating properly (provided the central is on line and polling). Use the ScanData Telemetry Test Set (TTS) to quickly check the operation. The TTS will tell you if the central is polling the RTU (connect the TTS across the incoming 202 line pair) and if the RTU is answering (connect the TTS across the outgoing 202 pair).

If the RTU does not answer, or if the central is not on line, you can check the RTU by polling it with a lap top connected to a modem such as the ScanData MDM-202A. Chapter 20 describes the methods used when polling the RTU locally.

19.D.1 CONNECTING TO DIALING PHONE LINES

ASCII Mode-A RTUs (SLR, LMR, SMR and M-system RTUs) connect to the dialing telephone lines. Correct operation can be checked very easily by simply dialing the RTU. You will hear the RTU answer by going off hook and by and transmitting an answer tone (about 2,000 Hz). Normally this is sufficient to verify that the RTU is on line and working.

You can now have the central office computer dial the RTU with its software. You will be able to obtain reports and send commands to and from the RTU from the computer screen.

Voice telemetry and alarm dialing RTUs such as the ScanData VBX-7 also connect to dialing telephone lines. These RTUs can be checked the same way. Dial the VBX-7 and it will go off hook and answer you with your pre-programmed greeting message. You can now proceed to request reports and send commands to the VBX-7, provided you use the secret guard numbers programmed into the VBX-7's rotary switches.

The proper operation of a telephone dialing link is very easily verified. Simply plug in a regular telephone instead of the RTU into the RJ-11 jack and dial a number that you know. If this works, the telephone line is fine and the RTU will work properly when plugged in.

19.D.2 CONNECTING TO CONTINUOUS CABLE LINES

In continuous communication cable systems (Mode-B and Mode-C) you can hear the polling messages arrive on the incoming pair over a pair of high impedance earphones or over the TTS tester.

IMPEDANCE MATCHING

All transmission lines, modems, RTUs and other devices have internal impedances, normally 600 ohm. To get correct level readings and to avoid instability, it is important that each device be properly terminated with its own impedance.

Connecting a modem (600 ohms) to a 600 ohm leased line terminates the line properly. Connecting an RTU with an internal modem to the line does the same thing.

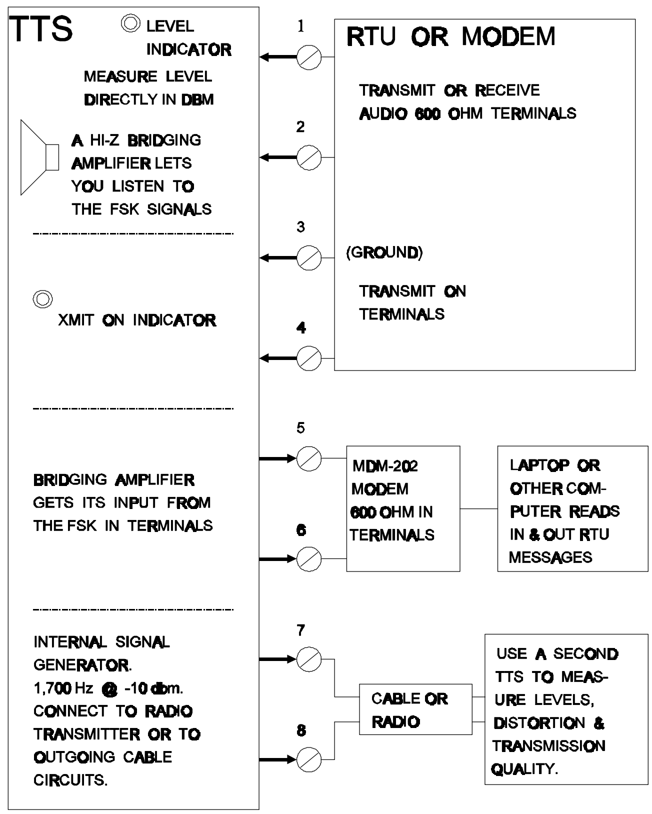
You cannot connect two modems or two RTUs to the same line. You would have two 600 ohm devices in parallel (300 ohms) terminating the 600 ohm line, resulting in an impedance mismatch and a large loss in signal transfer.

If you have to connect two or more RTUs in this manner, use a ScanData FSD-202A multidrop amplifier and line combiner. It has built in 600 ohm transformers in all three branches and equalizing amplifiers for zero signal loss.

The ScanData TTS Telemetry Test Set has a high impedance input which can safely be connected across a 600 ohm line without signal loss. The built in signal generator in the TTS (1,700 Hz at -7 dbm) on the other hand has a 600 ohm impedance which makes it suitable to inject a test signal into any 600 ohm line.

Connect the incoming pair to the RTU 600 ohm incoming or receive terminals (often marked 202 IN). The RTU should now start to answer and you can hear its answer on the transmit or 600 ohm out (often marked 202 OUT) RTU terminals. The RTU will only answer its own polling message, so in large systems polling many RTUs the particular RTU you are looking at will answer less often.

If the system uses a continuously polling central station (a computer or an RTU), you can listen to the received polling message with a ScanData Telemetry Test Set (TTS). Connect the TTS across the incoming cable or radio pair and listen to the polling message. The TTS has a high impedance input so there is no loading on the pair. You should hear a clear 'chirp' (1,200 - 2,200 Hz FSK) each time the central polls an RTU.



TTS Telemetry Test Set

The TTS test set also has a built in level meter. Turn the **'LEVEL'** knob until the **'SET'** led indicator just starts to flicker, then read the level from the graduations by the **'LEVEL'** knob. The out level from the central or from the RTU can both be checked with the TTS. They should normally be about -10 dbm.

The high input impedance of the TTS causes no impedance mismatch when connected across the incoming or outgoing 600 ohm terminals.

To check a continuous communication channel where there is no continuously polling computer or RTU, simply use the test oscillator in the TTS. It continuously transmit a 1,700 Hz tone at a level of -10 dbm. It has a 600 ohm output so that it can be connected directly to any 600 ohm cable or radio pair.

A second TTS unit at the other end can be used to read the level and to listen to the quality of the tone. Remember to terminate the line (if it is not already connected to a 600 ohm device) with a 600 ohm resistor for a correct reading.

Once the communication lines are verified, the RTU should respond to the far end signals by generating FSK answer signals of its own. Connect the TTS across the transmit terminals and check the level and the quality of the outgoing messages. You quickly learn to recognize the sound of a good FSK (1,200 to 2,200 Hz) signal. You can also connect the **'XMIT ON'** terminals on the TTS to the same terminals on the RTU or modem (observe polarity) and see the transmit led light each time the RTU or modem transmits.

WHAT LEVELS ARE USED?

There is no reason to have loss in modern leased line or radio communication circuits. The choice of incoming and outgoing levels is therefore a matter of choice.

A large western electric utility, for instance, has elected to use -15 dbm on all their incoming and outgoing levels.

ScanData RTUs and modems are shipped with output levels of -10 dbm.

The input level into certain radio transmitters can be critical. Too high a level will make the transmitter overmodulate. ScanData radios, RTUs and modems are always shipped with matching levels.

The ScanData RTUs and modems can operate down to a very low level, -40 dbm in some cases. This low level is impractical as the noise on many circuits can be -30 dbm or higher.

19.D.3 CONNECTING TO DATA RADIOS

The operation of continuous data radio systems is similar to continuous cable operation with two differences, the transmit turn on function and the wait times for the radio link to stabilize.

19.D.3.a THE TRANSMIT TURN ON FUNCTION

The RTU needs to turn the radio transmitter **'ON'** each time it wishes to transmit. This is handled, in most RTUs and PLCs, over an open collector transistor. This transistor conducts when the RTU wishes to transmit. All ScanData data radios and most other data radios are designed to handle this method.

Most data radios are adapted from voice communication designs. The transmit turn on circuit is designed to work over a shorting contact on the microphone. Internally, the turn on line is connected to +5V. Shorting it with a switch or with an open collector transistor works equally well.

If you want a quick and easy check on when the RTU is transmitting, connect an LED diode in series with a 2K resistor from the transmit **'ON'** output of the RTU to the +12V terminal on the RTU. Observe correct polarity on the LED. If you have it backwards, it will not light. This LED will blink **'ON'** every time the RTU transmits.

You can use a radio receiver scanner to check that the far end polling station is transmitting and that the RTU is answering. You will hear a chirp from the polling station and a longer chirp when the RTU answers. You may also hear other RTUs but you can tell when your RTU is answering by the blinking LED.

19.D.3.b THE RADIO TURN ON AND TURN OFF DELAYS

Radio circuits are different from cable circuits also in that time delays are applied. Time has to be allowed for the radio link to stabilize after the transmitter is turned on. This is called the front porch or warm up time. There is also a delay after the last character transmitted and before the radio link is turned off. This is to separate the message from the garbage character which is generated when the carrier drops. This delay is called the warm down time or the back porch.

Insufficient front and back porch times will invariably cause problems, especially with some central station software programs and certain PLCs. Check the specifications if you have problems. In general, too long front and back porch times are seldom a problem. Too short times will cause transmission errors.

19.D.3.c CONNECTING TO SPREAD SPECTRUM RADIOS

Spread Spectrum Radios such as the ScanData LDR-S units differ from other data radios in several aspects.

One is that you cannot use a scanner to hear the transmissions, as the radios continuously switch from frequency to frequency.

Another is that Spread Spectrum Radios have internal modems so that you connect to them over an RS-232 9-pin connector.

A third is that these radios work in a shared frequency band. You may have to shift bands once or twice to find an unused band.

A fourth is that there is no carrier turn on procedure. Any character or bit is immediately transmitted the moment it appears at an input. All receivers (that are tuned to the same band) immediately receive this character or bit. There is no delay and no need for any wait periods to stabilize the link.

19.D.3.e RADIO REPEATERS

There are basically two kind of (non Spread Spectrum Radio) repeaters. One is the single frequency store and transmit, where the incoming message is stored and re-transmitted on the same frequency after some delay. The other is the dual frequency repeater.

The store and transmit repeater has the advantage of using a single frequency. One of the disadvantages with this approach is that every RTU in the system will have to delay its answer to allow for the store and re-transmit time.

The dual frequency repeater has no time delay but it uses two frequencies. It can also lock up if each receiver locks on the other transmitters frequency. The ScanData RDC Repeater Direction Controller is often used to prevent this phenomenon. It makes each receiver lock on the far end voice frequency FSK carrier. Check the manual on how it works.

Spread Spectrum Radio repeaters can use two units, connected back to back, each unit using a different band. Use this method with caution as there may be inter unit interference, depending on the frequency hopping pattern of each band.

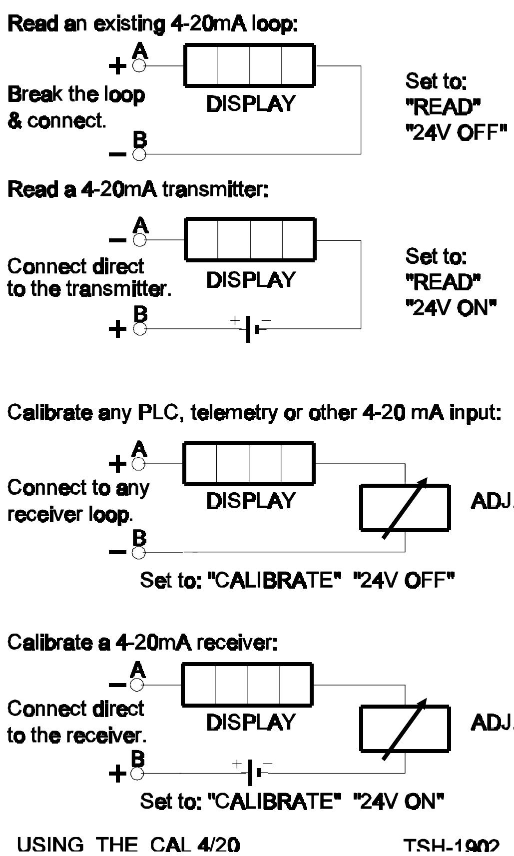
19.E CONNECTING THE RTU ANALOG INPUTS

The most common analog input interface is the 4-20 mA loop input. It has become virtually universal. It has many advantages. The resistance of the connecting wires (the field wiring) has no influence on the accuracy of the loop. Nor do variations in the power supply voltage.

The second most common analog interface is the 1-5V voltage input.

The installation drawings should tell you which of the two is used. You can check this by measuring across the input terminals with an ohm meter. The 4-20 mA loop input will normally read 125 or 250 ohms. The 1-5V input will read very high, one megohm or higher.

The 4-20 mA loop input needs loop power. Sometimes this power (12V or 24V DC) is supplied by the RTU or PLC input terminals. At other times you have to connect an external loop power supply.



The installation drawings should tell you if the RTU or PLC supplies loop power. You can always check this by looking for voltage on the analog input terminals with your tester. If you find 12V or 24V between one of the analog input terminals and ground, you need no external loop power.

Use the ScanData CAL 4/20 loop calibrator to thoroughly test the analog inputs. This instrument checks all aspects of the 4-20 mA loop. It delivers a 4-20 mA current. It will deliver 1-5V if you connect a 250 ohm resistor across its output.

The RTU or PLC will work whether or not there is any input at the analog input terminals.

19.F CONNECTING THE RTU DIGITAL INPUTS

Most RTU and PLC digital inputs are designed for a 'dry' contact input. 'Dry' meaning that nothing else is tied to the contacts or the contact wires.

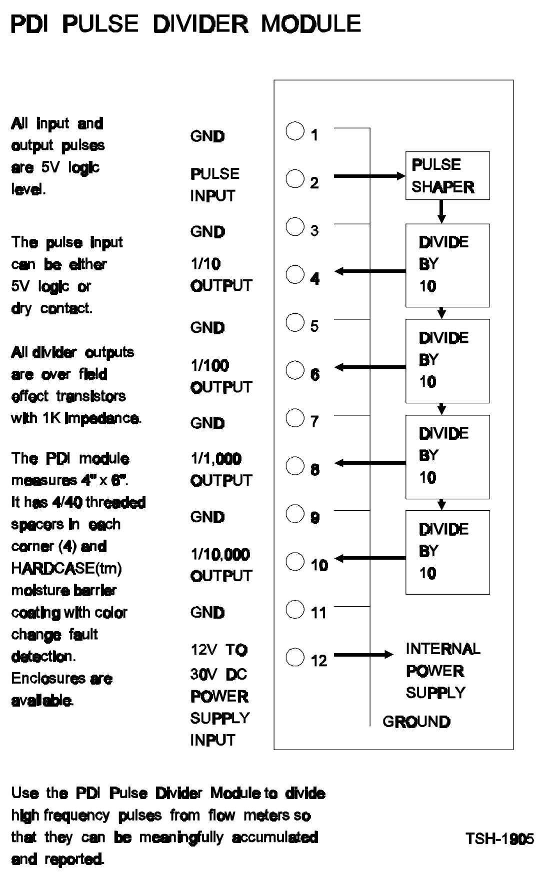
Normally, the minus side of the digital input is tied to system ground. The plus side is tied to +5V over a 10K resistor (the value varies). Shorting these two terminals drops the plus side of the input to ground. This arrangement also allows you to connect a 5V logic output to the digital input.

The digital input is often supplied with an RC delay filter to prevent contact bounce from tripping the input.

The VBX-7 RTU has a software digital input delay of several seconds to prevent contact bounce from tripping the input and the alarm. This is to prevent false alarms coming from water tank level gauges where pump action causes the float to bob up and down.

19.G CONNECTING THE RTU PULSE INPUTS

The pulse input circuit in an RTU or PLC is identical to the digital input circuits.



A PDI pulse divider is often used if the pulse rate from the pulsing device (the flow meter or other) is too rapid to be meaningfully counted. Check the PDI manual for installation instructions.

19.H CONNECTING THE RTU ANALOG OUTPUTS

The analog outputs from the RTU or PLC are almost always 4-20 mA. The most common arrangement is to have an open collector output transistor with the emitter tied to ground. You apply the load (the 4-20 mA receiver) between the output transistor collector and the (external) loop supply.

The ScanData CAL 4/20 loop calibrator instrument is an excellent instrument for checking all aspects of the 4-20 mA loop, both the input and the output circuits.

19.I CONNECTING THE RTU DIGITAL OUTPUTS

The digital outputs from the RTU or PLC are almost always a relay driver transistor which can be part of an opto-isolator circuit. The driver transistor in the ScanData RTUs can supply up to 100 mA and can be used in circuits up to 48V DC.

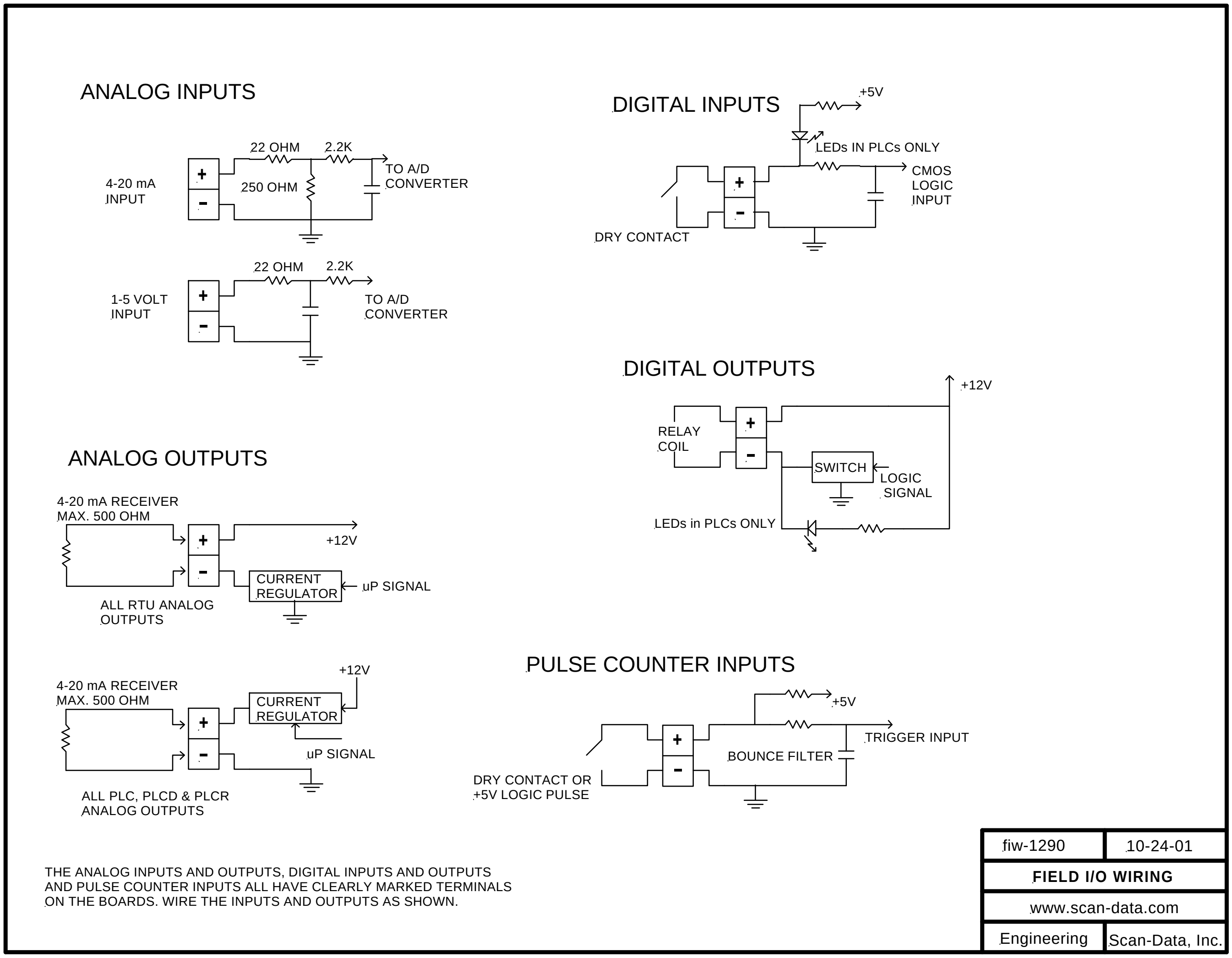
The output driver transistor collector connects to the minus end of the relay coil. The plus end of the relay coil connects to the plus side of a power supply matched to the relay coil rating (12V, 24V and 48V are common DC voltages). The RTU or PLC can supply relay power. Check the manual or check the output terminals for voltage. Normally, with ScanData RTUs, the plus side of the digital output terminal pair is tied to 12V over an on board fuse.

It is a good practice to use relays with protective diodes installed across the relay coil. You have to observe polarity when you connect these relay coils to the RTU or PLC.

19.J CONNECTING THE RTU PULSE OUTPUTS

ScanData has a special pulse transmission software design that allows you to reliably send pulses from one RTU to another, without loosing pulse counts during periods of missed or garbled transmissions.

The RTU pulse output side of this design uses one of the digital output circuits of the RTU. The output circuit is internally wired to +5V over a 1K resistor so that the output is a 5V pulse.



DWG FLW-1290 shows typical PLC and RTU I/O interface circuits.

WHERE CAN I GET MORE INFORMATION?

The following descriptions, pertinent to this chapter, are included in the DESCRIPT directory on the SCADATech(TM) CD:

pri-0901.pdf Design Guide and Price List.

gui-0980.pdf How to design SCADA and Telemetry systems.

acp-1045.pdf 110/220V to 12V DC regulated power supply.

bsm-0892.pdf Battery saver module.

app-1239.pdf	How to connect 4-wire modems to 2-wire cables.
ttsc1033.pdf	Telemetry test set.
din-1470.pdf	LSA snap-in DIN rail bases & lightning protection.
lsp-1476.pdf	DIN rail mounted lightning protectors.
imc-1471.pdf	ISA identifier support adapter covers, custom made.

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.