

ZETRON

**Models 1708 and 1716
Remote Terminal Units
Installation and Operation Manual**

Part No. 025-9209J

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Zetron, Inc.
12034 134th CT. NE
Redmond, WA 98052, USA

European Union Representative:

Zetron, Inc.
28 Campbell Court,
Campbell Road,
Bramley, Basingstoke,
Hants, RG26, UK

Declares that the Product: **Model 1708 Remote Terminal Unit**

In Application of Council Directives: EU EMC Directive 89/336/EEC
EU Low Voltage Directive 73/23/EEC

Compliance was demonstrated to the following specifications:

Radiated Emissions	CISPR 22: 1994, EN 55022 Class A
Conducted Emissions	CISPR 22: 1994, EN 55022 Class A
Electrostatic Discharge (ESD) Immunity	IEC 1000-4-2:1995, EN 50082-1, 3KV CD, 8KV AD
Radiated RF Immunity	IEC 1000-4-3:1995, EN 50082-1, 3V/m
Electrical Fast Transient/Burst Immunity	IEC 1000-4-4:1995, EN 50082-1, 0.5 kV Signal Lines 1.0 kV Power Lines

Redmond, WA, USA
May, 97

Robert E. Lawrence
Compliance Manager

R. E. Lawrence



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Zetron, Inc.
28 Campbell Court,
Campbell Road,
Bramley, Basingstoke,
Hants, RG26, UK

Declares that the Product: Model 1716 Remote Terminal Unit

In Application of Council Directives: EU EMC Directive 89/336/EEC
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Compliance was demonstrated to the following specifications:

Radiated Emissions	CISPR 22: 1994, EN 55022 Class A
Conducted Emissions	CISPR 22: 1994, EN 55022 Class A
Electrostatic Discharge (ESD) Immunity	IEC 1000-4-2:1995, EN 50082-1, 3KV CD, 8KV AD
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May, 97

Robert E. Lawrence
Compliance Manager

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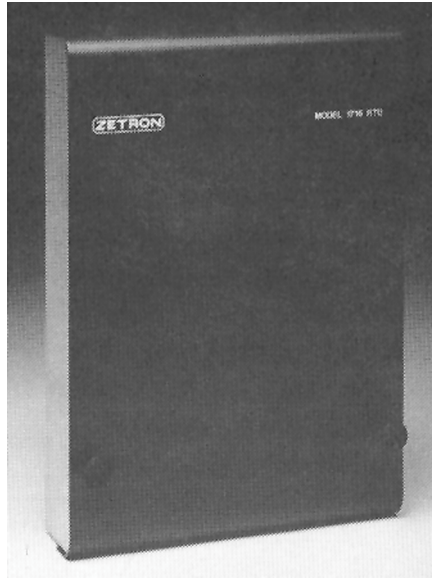
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INTRODUCTION



GENERAL

A Model 1708 or 1716 Remote Terminal Unit (RTU) is one part of a wireless SCADAⁱ telemetry system. A SCADA system typically consists of a PC with software connected to a Controller and one or more RTUs at multiple distant locations. The Controller and RTU are both microprocessor controlled and, along with the user's radio link, make up the communications network necessary for monitoring and controlling equipment at remote sites. The Controller is typically located at a central office and can address up to 65,535 RTUs located at various remote sites. Using the Controller and the RTUs, the user at the central office can control equipment or retrieve information from the remote sites.

The size of a system is dependent on airtime available and the total transmissions required. To determine the maximum number of RTUs your system will support, call Zetron at (425)-820-6363.

The RTU interfaces directly to a wide variety of two-way radios, either conventional or trunking. The RTU is designed to connect to remote sensing devices that can provide dry contact closure to ground, TTL level voltage changes or 0 to 5 volts and 4 to 20 mA for analog measurement.

Table 1 lists the I/O capability of the Models 1708 and 1716 RTUs and the Model 1700 Controller.

ⁱ SCADA = Supervisory Control and Data Acquisition. A general term for an industrial measurement, data gathering, and control system.

Table 1. Digital and Analog I/O Capability

I/O	1708	1716	1700
Digital In	8	16	0
Digital Out	8	16	4
Analog In	4	8	0
Analog Out	0	4	0

The RTU is initialized through the RS-232 port, which allows the user to customize the parameters for each RTU to best fit the application.

SYSTEM DESCRIPTION

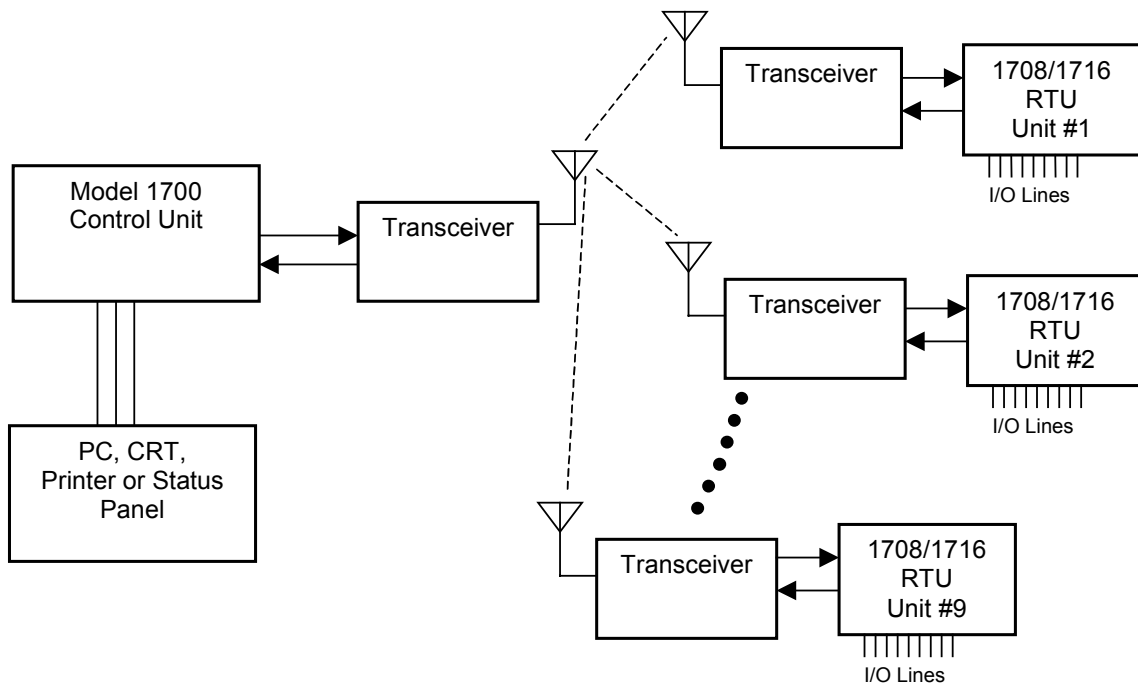


Figure 1. A Typical System with One Controller and Nine RTUs

Figure 1 depicts a model system that might be used to monitor and control pump stations. This system gives the user PC or status panel control of turning pumps on or off and of polling the sites to verify status and to receive alarm reports of pump failures or communications failures.

MODBUS SYSTEM

MODBUS is an industry-standard protocol used to transfer commands and data. An example of a SCADA program that uses the MODBUS protocol is Lookout (by National Instruments). Many PLCs also use the MODBUS protocol. A MODBUS option for the Model 1700 controller allows the controller and Zetron RTUs to be used in a MODBUS system.

A MODBUS SCADA system with a Model 1700 controller is shown in Figure 2.

In a MODBUS system, the PC can communicate with up to 150 Model 1708 or Model 1716 RTUs over radio or wireline through a single Model 1700 controller. A system can be expanded beyond 150 RTUs by adding additional controllers and using additional serial ports on the PC. The total number of RTUs in a system is limited only by the number of serial ports available on the PC, and by the MODBUS slave address limit of 247.

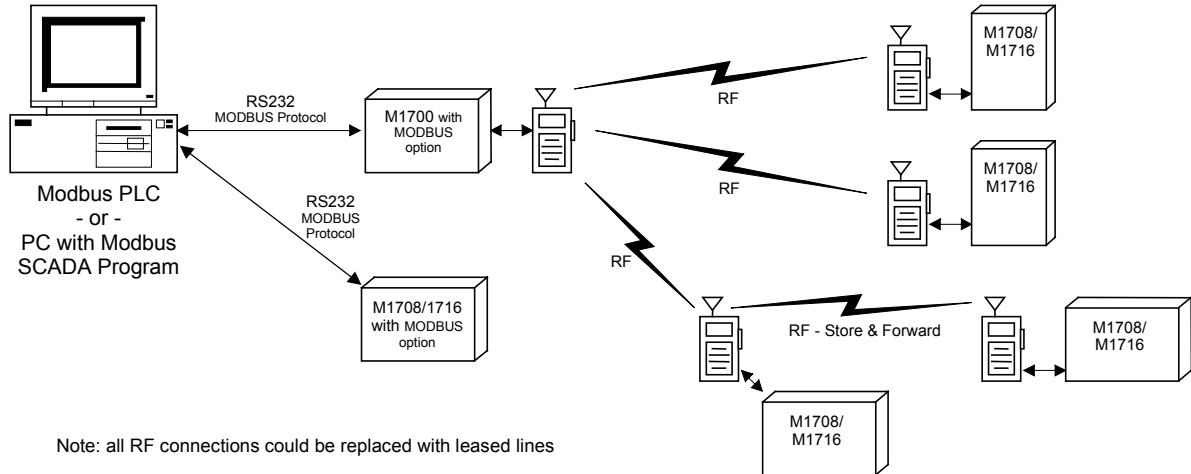


Figure 2. Generalized MODBUS System

CONNECTIONS

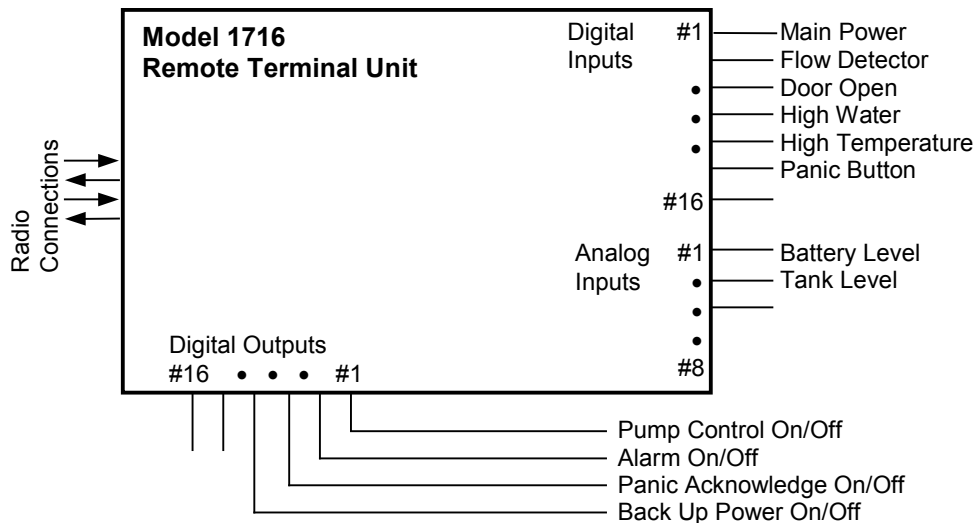


Figure 3. Model 1716 RTU Standard Connections for a Pump Site

A standard application of monitoring and controlling a remote pump site could be accomplished by using output #1 to control the pumps on/off switch and by connecting input #1 to a flow meter to determine if the pump is pumping. If the control relay on the RTU is damaged, the pipe is blocked, or a short or open circuit to the pump control has occurred, then the RTU will report that no liquid is flowing.

There are a variety of other status points that may be monitored: open door or window, high water alarm, high temperature, main power, panic button for man at site, etc.

The RTU analog input range is 0 to 5 V_{dc}, and the levels being monitored should be electrically scaled to fall within this voltage range. Many sensing devices output 0 to 5 V_{dc}. However, some sensor outputs are 4 to 20 mA current loops, or an input may be using a 12-volt power supply. The diagram below shows how to convert these two power sources into 0 to 5 V_{dc} levels for the RTU (4-20 mA Loop would be converted to 1-5 V_{dc}). There is a 249 Ω resistor in the RTU that may be used to convert 4-20 mA to volts.

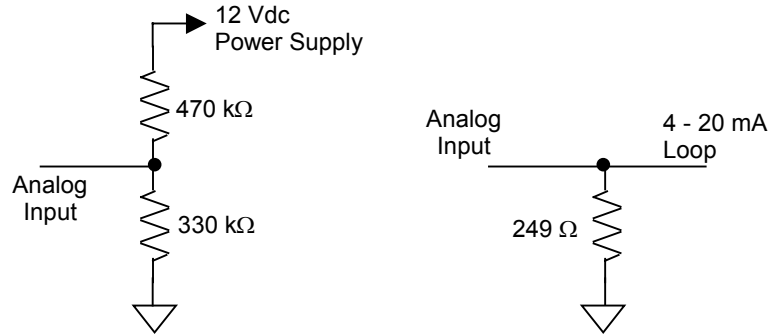


Figure 4. Common Conversion Circuits for 0-5 V_{dc} Scaling

SPECIFICATIONS

PHYSICAL SPECIFICATIONS

Power	10.5-16 V _{dc}
Current	75 mA typical, 150 mA maximum
Temperature	0 to +60 degrees C
Size	7.25"W x 10.5"L x 2.25"H
Weight	2 pounds

RS-232 INTERFACE

Baud Rate	4800
Parity	None
Bits	8
Stop Bits	1

RADIO INTERFACE

Audio Output	20 mV to 2 V p-p (mic level audio), 1 k Ω
Audio Input	100 mV to 4 V p-p, 50 k Ω
Channel Busy Input	Low: 0 to 0.7 V _{dc} , <100 Ω to ground High: 3.5 to 12 V _{dc} , >10 k Ω to ground
PTT output	Relay contact closure, 300 mA max

Radio Modem Specifications

Data Rate	1200 baud
Signaling	Minimum Shift Keying (MSK)

Signal Integrity

Required Signal Strength	95% success at 12 dB SINAD
Probability of False Data	1 in 10^9 (0.0000001%)

I/O SPECIFICATIONS

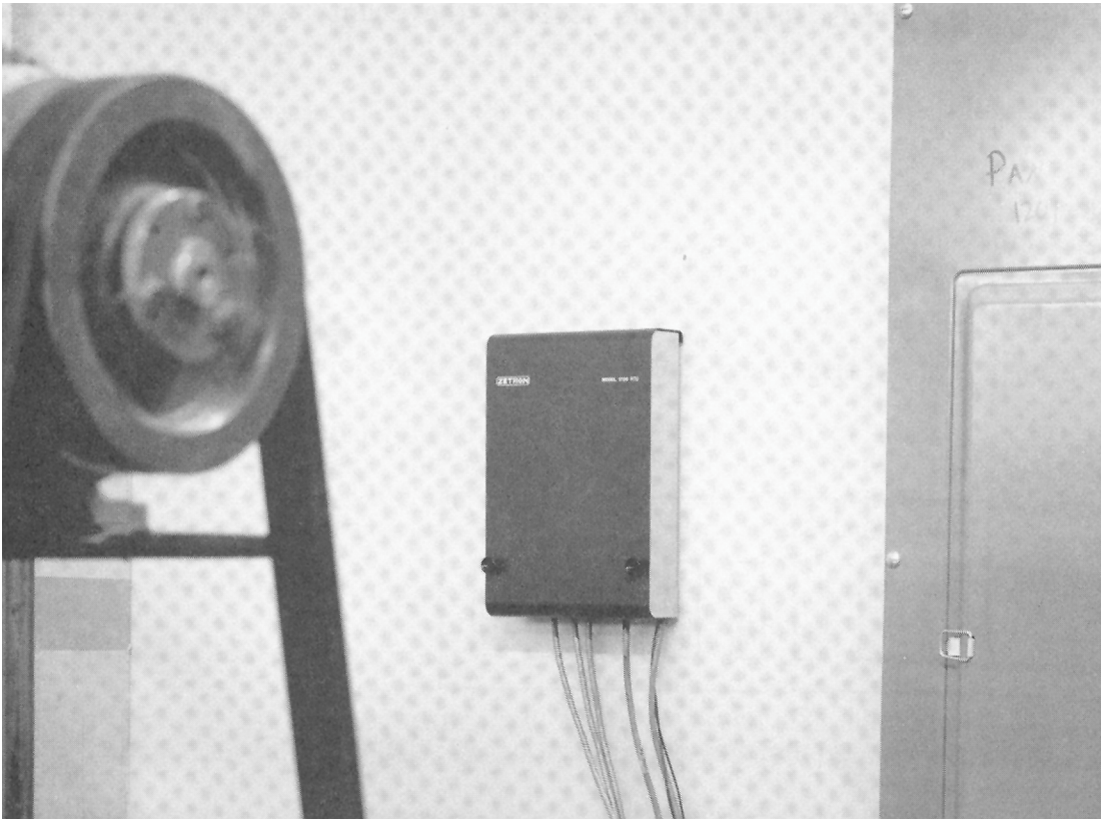
External Inputs

Contact Closure Inputs	Model 1708: 8 inputs Model 1716: 16 inputs Contact closure to ground or 0-5 V or 5-0 V voltage change Logic low: $<500 \Omega$ or $<0.8 V_{dc}$ Logic high: $>2.5 k\Omega$ or $>2.0 V_{dc}$ Protected to +50 VDC
Analog Inputs	Model 1708: 4 inputs Model 1716: 8 inputs 0 to 5 V_{dc} analog sensor with 8-bit A/D input

External Outputs

Open Collector Outputs	Model 1708: 8 outputs Model 1716: 16 outputs 12 V_{dc} , 100 mA max
Analog Outputs	Model 1716: 4 outputs 0 to 5 V_{dc} 8-bit D/A

OPERATION



GENERAL OPERATION

The Model 1708 and Model 1716 Remote Terminal Units (RTUs) perform two basic tasks:

1. RTUs report changes in input/output to the Controller
2. RTUs respond to commands from the Controller.

Analog and digital inputs may be configured to report changes as they occur without being polled by the Controller (report by exception). When the RTU recognizes an alarm condition, it will check to see if the radio channel is busy. If the channel is busy, the RTU will wait for the channel to clear. If the channel is not busy, the RTU will transmit its data and wait for a reply from the Controller indicating that the alarm was received. If the RTU has not received a reply within 15 seconds, it will re-send the packet and wait for a reply. In all cases, the RTU will continue attempting to complete the transmission sequence until it receives the correct response.

Each RTU can be configured differently so that the user can customize operation to match the requirements of the application.

Operation

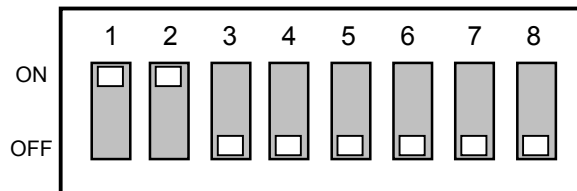
ADDRESSING THE RTU

The RTU is DIP switch addressable from 1 to 255. This is done by using the 8-position DIP switch labeled SW1. Position #1 is the LSB and position #8 is the MSB. All switches off corresponds to 0, and all switches on is 255. The count is binary:

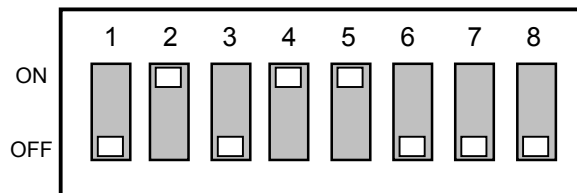
#1	→	1
#2	→	2
#3	→	4
#4	→	8
#5	→	16
#6	→	32
#7	→	64
#8	→	128

Each unit on a system must have a different ID in order to respond.

Examples:



The configuration above would define this unit as #3: $1 + 2 = 3$



The configuration above would define this unit as #26: $2 + 8 + 16 = 26$

Note

The RTU may be given an address greater than 255 by changing the address extension through the configuration menus. See “Address Extension” on page 11.

CONFIGURATION

Each RTU will need to be configured prior to its use unless the factory default initialization values are satisfactory for the application.

To configure an RTU, you will need:

1. A “dumb terminal” or a PC running in the dumb terminal mode. Software programs such as CrossTalk, Kermit, ZCU, Procomm, and others will provide terminal emulation on a PC.
2. A cable with a male 9-pin, D-style connector on one end to interface with the RTU and a connector on the other end to interface with the serial port of your PC or dumb terminal.

Note

The pins on the RTU are different from those of other serial ports found on printers and modems. You will need to use the cable provided with the Model 1700 Controller, make up your own cable, or purchase an additional cable from Zetron for programming the RTUs.

Accessing the RTU Program Mode

1. Connect the serial cable between J2, the 9-pin “D” style connector on the RTU, and the serial port of the PC or dumb terminal.
2. Connect a 12-volt power supply with power off to the RTU pin 1 of P3 and ground to pin 2 of P3.
3. Make sure your dumb terminal or PC is set at 4800 baud, 8 bit, no parity, 1 stop bit.
4. Turn the 12-volt power supply on. You should see the RTU model number and the software version displayed on the CRT.
5. Press the space bar three times to enter the Main Menu.

MAIN MENU

Table 2. RTU Main Menu

Menu Selections	Range	Factory Settings
{P}rekey time	0-40 (x0.1 second)	5 (0.5 second)
{C}hannel busy detect	Low or High	Low (inhibit on logic low)
Channel {B}usy Timeout	0-40 (x0.1 second)	0.5 second
{T}ransceiver type	Conventional or Trunking	Conventional
Add{r}ess extension	0-65280	0
Co{N}troller Address	0-65535	0
{G}roup Call Address	0-65535	65535
Fai{L} safe setup		
{S}tore and Forward		
{O}utput Definition		
{D}igital Input Definition		
{A}nalog Input Definition		
{F}actory defaults		
E{x}it		

To select a menu item, press any key that is within braces {}. Simply pressing ENTER will redisplay the current menu. If you do not press a key for 30 seconds, the RTU will automatically exit the menus. You must press the space bar three times to re-access.

Prekey Time

This menu selection allows the user to change the delay between the time PTT is activated and the time the MSK signaling begins. The default is 500 milliseconds and can range from 0 to 4 seconds in 100 millisecond increments.

For trunked operation, this is the delay from the time a channel-acquired signal is received on the COR input until the data is sent. If there is no delay required (as should be with trunked radio), set this to zero.

CAUTION

THE RTU CONTAINS A DATA COLLISION ALGORITHM. TO AVOID MULTIPLE DATA COLLISIONS, SET THE PREKEY TIME OF EACH RTU TO THE SAME VALUE!

Channel Busy Detect

To identify when the channel is in use, the carrier must be set to inhibit transmission on either **High** (+5 or open) or **Low** (0 V). The level entered here will PREVENT transmission.

For trunked operation, this is used the same way to inhibit transmission. The proper name for this parameter should be “channel-acquired indication” when a trunked system is being used.

Channel Busy Timeout

Enter the amount of time (in tenths of seconds) that the channel has to be available before the RTU can seize the channel. This can prevent the RTU from interrupting a conversation.

For trunked operation, this is used to determine that the TX indicator has stopped flashing (requesting a channel) and is on long enough to verify that the channel has been acquired. (This is only if you are using the TX indicator to provide the channel-acquired signal.)

Transceiver Type

This lets the user select whether the RTU is to be used on a conventional or trunking radio system. The difference being that in trunking, you request a channel by giving PTT and in conventional, you first look to see if the channel is available before giving PTT.

For trunked operation timing, PTT is pressed for 15 seconds while looking for a channel. If a channel is acquired prior to the 15 seconds (this is based on the logic indication on the COR input), the RTU will wait the Prekey delay, send the data, and release PTT. After 15 seconds, if no channel is available, the RTU will release PTT, wait 30 seconds, and retry.

Address Extension

If you have more than 255 RTUs, enter the number to be added to the dip switch address for this RTU. It is suggested that you enter a multiple of 256 (256, 512, 768, 1024 etc.) and use this same number for the rest of the extended address RTUs (up to 255). Record this number on the sheet provided on the inside top cover of the RTU.

Controller Address

Enter the address of the unit that is to receive alarms from this RTU. The default is the Controller address 0.

Group Call Address

The Group Call Address allows outputs on several RTUs to be controlled in a single transmission from the Model 1700 Controller. When the controller sends an output control command to a group call address, all RTUs in the group will execute the command, but will not send back a response (in the case of momentary outputs, each RTU makes an exception report when the output returns to its idle state). Since the RTUs do not send response messages, the group call address cannot be used to poll inputs or outputs.

Operation

All RTUs in a system can have the same group call address, or you can achieve a zoning effect by assigning one address to one group of RTUs and another address to a different group. The group call address should not be the same as the RTUs DIP switch address.

Factory Defaults

This menu selection will allow the user to reset all configurable parameters to the defaults set at the factory including input/output definitions. The user is prompted again to make sure all definitions really should be cleared.

Exit

This menu selection will take the user out of the configuration mode and reset the RTU to its “online” mode.

FAIL SAFE SETUP

The fail-safe menu contains several items that determine how the RTUs behave under abnormal conditions. In many installations, these features will not be needed, so they are disabled by default.

Table 3. RTU Fail Safe Setup Menu

Menu Selections	Range	Factory Settings
{C}ommunication failure enable	0-10	0 (disabled)
Channel {U}se limits		
Time period	0 to 30 minutes	0 (disabled)
# of reports	1 to 999	100
Time out interval	1 to 10 minutes	5 minutes
{E}nable exception reports		enabled
{D}isable exception reports		
E{X}it		

Communication Failure Enable

Selecting this menu item allows you to set the number of times an exception report (power up alarm, input change alarm, or output change alarm) is sent without acknowledgement from its controller before the RTU enters the communications fail state.

The range is 1 to 10 times. Entering a “0” (the default value) disables communications failure detection.

In the failed state, all outputs on the RTU will be turned off - digital outputs go in to the high impedance state and analog outputs go to 0 volts. The outputs remain off even after communications are restored; they remain off until turned on again by a command from the controller.

WARNING

Do **NOT** enable the Communication Failure feature if you are using a Model 17 or Model 1700 Controller with a software version lower than 3.10. Doing so can cause permanent loss of communications between the RTU and the Controller and require a trip into the field to cycle power on the RTU.

Channel Use Limits

Failure of a transducer or other device attached to the inputs of an RTU may cause random alarm transmissions that tie up the radio channel. The RTU allows you to limit the number of exception reports (alarms) the RTU transmits within a specified period. If this number is exceeded, the RTU stays off the channel for a while before resuming alarm transmission.

The period to monitor can be set in the range 1 to 30 minutes. The default value is zero, which disables this feature. The number of reports allowed during the period can range from 1 to 999 (100 is the default), and the time out interval can be from 1 to 10 minutes (5 minutes is the default).

During the time out interval, any new alarms that may be detected are buffered (until the buffer gets full) and are sent when the interval ends.

Enable/Disable Exception Reports

The RTU can be set to poll-only mode by disabling exception reporting (alarms). This is a global setting that overrides the alarm enables on the individual inputs. This function is useful for temporarily disabling alarms while debugging an installation.

STORE AND FORWARD

Store and forward (also called “digi-peat” and “packet”) lets an RTU decode the information from another RTU and retransmit that information. This solves the problem of an RTU out of radio range of the controller. The RTU can pass its data through one or more RTUs to get to the Controller. Remember that this will increase the amount of time required for the transmission.

Table 4. RTU Store and Forward Menu

Menu Selections	Range	Factory Settings
{S}ource Address	0-65535	0
{D}estination Address	0-65535	0
Replacement S{o}urce Address	0-65535	0
Replacement D{e}stination Address	0-65535	0
{N}ext Slot		
E{x}it		

Operation

Slot No.

There are up to 16 slots to configure.

Source Address

Input the address of the transmitting unit.

Destination Address

Input the address of the unit that the transmitting unit is trying to reach.

Replacement Source Address

Input the new address of the transmitting unit.

Replacement Destination Address

Input the new destination address of the transmitting unit.

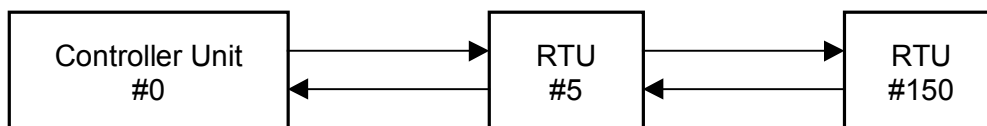
Next slot

Go to the next slot.

Exit

This selection will take the user back to the main menu.

Example



If RTU #150 is out of range of Controller Unit #0, but RTU #5 is in range of both Controller Unit #0 and RTU #150, we would configure RTU #5 as the store and forward unit with the values shown in Table 5.

Table 5. Store and Forward Address Assignments

Parameter	Value	Parameter	Value
SLOT # 1 Source Address	0	SLOT # 2 Source Address	150
Destination Address	10	Destination Address	5
Replacement Source Address	5	Replacement Source Address	10
Replacement Destination Address	150	Replacement Destination Address	0

We have configured RTU #5 to act as the store and forward unit between Controller Unit #0 and RTU #150. If Controller Unit #0 tries to poll RTU #10 (a fake address for RTU #150), the transmissions listed in Table 6 will occur.

Table 6. Store and Forward Traffic Flow

Transmission	From	To	Description
No. 1	#0	#10	Controller Unit #0 polls RTU #10.
No. 2	#5	#150	RTU #5 has been configured in Slot #1 to recognize and re-send all transmissions of 0-to-10 as 5-to-150.
No. 3	#150	#5	RTU #150 receives the poll from RTU #5 and sends its response back to RTU #5.
No. 4	#10	#0	RTU has been configured in Slot #2 to recognize and re-send all transmissions of 150-to-5 as 10-to-0. This completes the cycle.

Note

Enter the ID of the out-of-range RTU higher than the largest ID of the in-range RTUs. Set the Controller address in the out-of-range RTU to its store and forward unit. This is done in the Co{N}troller Address section of the main menu.

DIGITAL INPUT DEFINITION

Table 7. RTU Digital Input Definition Menu

Menu Selections	Range	Factory Settings
{E}nable Input		Enabled
{D}isable Input		
N/{O} Input		
N/{C} Input		
{S}tatus Input		Status
De{b}ounce time	0-65535 (x0.1 s)	0 seconds
{N}ext Input		
E{x}it		

These menu selections control the performance of each input.

Enable Input

To allow the RTU to report an alarm from this input without being polled, the input must be enabled.

Operation

Disable Input

If the input is disabled, its status will still be sent during a poll response, but any change in the state of the input will not cause the RTU to transmit an alarm.

N/O Input

In the normally open mode, the input will cause an alarm transmission whenever it detects a change from high to low or open to closed (closure to ground).

N/C Input

In the normally closed mode, the input will cause an alarm transmission whenever it detects a change from low to high or closed to open.

Status Input

A status input will send an alarm message every time the input changes state. When the input changes, the alarm message will indicate the new state, high or low.

Debounce Time

Each input has a “debounce” time. Debounce is the amount of time the input must reside in the alarm condition in order to trigger the alarm. If this time is set to 3 seconds, the input must stay in the alarm condition for more than 3 seconds before the input will transpond an alarm message. The default setting is for no debounce time. The debounce time can be set from 0 to 6553.5 seconds in 0.1 second increments.

Next Input

This menu selection will increment the current input number for modification. If this is the last input on the RTU, the menu will wrap back to input #1.

Exit

This selection will take the user back to the main menu.

DIGITAL OUTPUT DEFINITION
Table 8. RTU Digital Output Definition Menu

Menu Selections	Range	Factory Settings
{L}atched mode		Latched
{M}omentary mode	0-255 seconds	0 seconds
{O}utput ON		
{F}orce output OFF		
{N}ext output		
E{x}it		

Latched Mode

When latched mode is selected, if the output is commanded on, it will remain in that position until it is commanded off (or power is removed).

Momentary Mode

When momentary mode is selected, the user will be prompted for a time in seconds that the output is to remain in the on position after the output is commanded on. This value, 0-255, will cause the output to automatically return to the off position after the time has expired.

Output On

This menu selection allows the user to locally control the outputs. This is used to check operation and setting of the momentary time.

Force Output Off

This menu selection allows the user to locally control the outputs. This is used to check operation and setting of the momentary time.

Next Output

This menu selection allows the user to increment the current output number. Once incremented, the parameters for the new current output will be displayed along with the menu. Once the user reaches the last output for the RTU, this item will change the current output back to output number 1.

Exit

This selection takes the user back to the main menu.

ANALOG INPUT DEFINITION

Table 9. RTU Analog Input Definition Menu

Menu Selections	Range	Factory Settings
{E}nable Input		Enabled
{D}isable Input		
{H}igh Threshold Value	0-5.00 volts	5.00 volts
{L}ow Threshold Value	0-5.00 volts	0.00 volts
High {R}eset Value	0-5.00 volts	5.00 volts
Lo{w} Reset Value	0-5.00 volts	0.00 volts
Accumulator {S}ampling Rate	1 to 65535 (x0.1 second)	10 (1 sample per second)
% {C}hange alert	0 to 100%	1.9%
% Change de{B}ounce	0 to 250 (x0.1 second)	0.5 second
{N}ext Input		
E{x}it		

Enable Input

To allow the RTU to report an alarm from this input without being polled, the input must be enabled.

Disable Input

If the input is disabled, its status will still be sent during a poll response, but any change in state of the input will not cause the RTU to transmit an alarm.

High Threshold

If the voltage being measured **exceeds** this threshold and the input is enabled, the RTU will automatically report an alarm. The threshold value is 0-255, 0 corresponding to 0 volts and 255 corresponding to 5 volts.

Low Threshold

If the voltage being measured **drops below** this threshold and the input is enabled, the RTU will automatically report an alarm. The threshold value is 0-255, 0 corresponding to 0 volts and 255 corresponding to 5 volts.

The threshold values set the limit. A low threshold of 0 and a high threshold of 255 effectively disable the alarm since these values cannot be surpassed.

High Reset

To provide for hysteresis, set this value slightly below the high threshold value. The voltage being measured must drop below the High Reset value before another alarm can be initiated. This prevents chattering when a voltage hovers right at the threshold value.

Low Reset

To provide for hysteresis, set this value slightly above the low threshold value. The voltage being measured must rise above the Low Reset value before another alarm can be initiated.

Accumulator Sampling Rate

Set the time between samples in 10th seconds. For example, “1” is 10 samples per second, “2” is 5 samples per second, “100” is one sample every 10 seconds, and “1000” is one sample every 100 seconds. The valid range is 1 to 65535, which represents from 0.1 to 6553.5 seconds between samples.

% Change Alert

% Change alert is the percent change of full scale from the last reported value that will cause another report. For example, if we are measuring feet of water in a 100-foot tank and we wish to know a minimum of every 4-ft change, we would set the % Change alert to 4/100 or 4.0%. If our starting value is 30 ft and the tank is rising, we should get an update at 34 ft, 38 ft, 42 ft, etc.

% Change Debounce

% Change de{B}ounce is the amount of time in seconds that the change must exist before the update can be sent. If, in the example in the previous paragraph, we have the debounce set to 5 seconds and the level rises from 30 to 34 feet for 3 seconds and then drops to 33 feet, no report would be sent. This programming option helps filter out noise spikes and reduce airtime usage.

Next Input

This will increment the current input number for modification. If the current input number is the last input for the RTU, the menu will wrap back to input #1.

Exit

This selection will take the user back to the main menu.

SYSTEM OPERATIONAL LIMITS

Inputs

Chatter	Chattering occurs when a status being monitored changes rapidly, that is, more than once every few seconds. Chattering can cause the RTU to send multiple reports using excessive airtime. The debounce time and hog time in the RTU should be used to prevent excessive transmissions.
Broken Connection	<p>Analog Input - The voltage read by the analog input would float, following the voltage of the previous analog input. More than 5 kΩ source impedance will increase susceptibility to noise.</p> <p>Digital Input - The digital inputs have a +12 V_{dc} pull up and will read a logic high with nothing connected.</p>

Outputs

Power Up State	The analog inputs power up in a 0 volt state. The digital outputs power up in a high impedance, open collector state.
Power Off State	The analog inputs power off in a 0 volt state. The digital outputs power off in a high impedance.
Unit Over Voltage	Over voltage damage to any of the I/O, power supply, or RF inputs caused by lightning, improper connection, etc. can cause unpredictable behavior in any of the electronic components. The RTU provides safeguards against this type of damage, but damage is still possible. Full testing of suspect hardware should be performed.
RS-232	Currently the RTU only uses the serial port for programming. If the RTU is left in programming mode, the unit times out after 30 seconds and normal operation resume. While in programming mode, transmission and reception of data via FFSK is suspended.

Power

Brown Power	There is a low power reset circuit in the RTU which will disconnect power when supply voltage drops below 9.35 volts $\pm 5\%$.
Power Up Conditions	The RTU performs a self-test on power up. If there are errors detected during the self-test, operation is suspended. The digital and analog output states are designed to be in a high impedance and 0 V _{dc} state respectively. If the self-test fails, these default values may not be valid.

Radio Connections and Associated Problems

Loss of transmit or receive audio anywhere along the communications path (repeater, radio, connector or RTU) will cause a communications failure at both the RTU and Controller.

Carrier Detect	Failed Connection - If the carrier detect fails, the RTU will transmit at will or be inhibited from transmitting. Transmitting at will increases the risk of collisions. Never transmitting causes a communications failure alarm at the Controller and a communications failure state at the RTU.
Push to Talk	If Push to Talk fails, the radio will either transmit no data or be locked in transmit and block all other transmissions on the channel. There are jumper settings to provide proper default open or closed conditions for power off and standby for most radios.
Transmit Request	Failed Connection - If the transmit request line is disconnected, collisions with the RTUs sharing the same radio may increase. If the transmit request line is shorted, this will cause a communications fail alarm at the Controller and a communications fail state at the RTU.
Addressing	DIP Switch Failure - If an RTU has a DIP switch failure causing a change in address, there is no provision for the Controller to recognize the error other than to show a communications failure for the old address. Data sent by the new address has the potential to false the data of another RTU at the same address. If there is a DIP switch failure causing a change in address, the Controller will not be able to communicate with the RTUs and possibly the PC.

Operation

Radio System	A radio stuck in transmit for any reason (PTT held in, electronic failure, chattering PTT, etc.) will prevent or interfere with other transmissions. Radios should provide a PTT timer that prevents continuous transmission for extended periods, usually three minutes. This only helps if the radios are functioning properly. It will not prevent all cases of transmit lock-out.
RS-232	Transmit or receive data failure will cause loss of communications between the PC and the Controller. This will cause communications failure states at all RTUs and the Controller.
Buffering	If communications fail, the Controller will buffer 200 bytes, a minimum of 10 messages. After the buffer is full, the controller will stop acknowledging the RTUs and a critical system communications fail status will occur.
Ground	Poor grounding or no common signal ground can cause intermittent communications. A power cycle may appear to cure this situation for short periods of time.

Critical System Failures Summary

Critical system failures can be caused by any of the following conditions:

- Chattering input causing repeated transmissions
- Radio stuck in transmit due to:
 - PTT held on by RTU, user, or radio failure with no timeout
 - Radio locked in transmit due to radio failure
 - Carrier from another radio system causing interference
 - Hardware/firmware failure causing chattering PTT
- Repeater down
- Controller radio down with no standby or backup
- Controller is down due to:
 - COR stuck active
 - Power failure
 - Equipment failure
 - Hardware/firmware failure causing chattering PTT
- RS-232 connection to Controller is down
- PC or software failure

MODBUS SYSTEM SET UP

This section describes the functioning of the Model 1700 controller and Model 1708/1716 RTUs in a MODBUS system.

MODBUS OPTION

The Model 1700 controller has an optional implementation of the industry standard MODBUS protocol. This option is provided by means of a replacement EPROM containing code to support the MODBUS protocol when communicating with the PC running the MODBUS application. The Model 1708 and Model 1716 RTUs do not require any modification to support the MODBUS protocol if they are communicating only with the Model 1700. There are optional EPROMs for both of the RTU models that will allow them to be interfaced directly to the PC, by-passing the Model 1700 controller. The MODBUS implementation makes the devices compatible with nearly all SCADA programs as well as with many PLCs.

The Model 1700 is compatible with most MODBUS programs that use five-digit MODBUS addresses and limit themselves to the functions listed in Table 10.

Table 10. Compatible MODBUS Functions

MODBUS Function	Function Code	Used for...
Read Coil Status	01	Digital Outputs
Read Input Status	02	Digital Inputs
Read Holding Registers	03	Analog Outputs, Counters, Accumulators
Read Input Registers	04	Analog Inputs
Force Single Coil	05	Digital Outputs
Preset Single Register	06	Analog Outputs, Counters, Accumulators
Force Multiple Coils	0F	Digital Outputs
Preset Multiple Registers	10	Analog Outputs, Counters, Accumulators

The correspondence between Zetron and MODBUS I/O terminology is listed in Table 11.

Table 11. Zetron and MODBUS I/O Terminology

Zetron I/O Type	MODBUS I/O Type
Digital/Relay Output	Coil
Digital Input	Input Status
Analog Input	Input Register
Analog Output	Holding Register
Accumulator	Holding Register
Counter	Holding Register
Run-time	Holding Register

COMMUNICATIONS

In a MODBUS system using radio or wireline communications, only the controller speaks MODBUS. For queries addressed to RTUs, the controller translates back and forth between the MODBUS protocol and the RTU radio protocol.

There are two ways to set up a MODBUS system using the Model 1700 controller with the MODBUS option: Polled-only and report-by-exception.

Polled-Only System

In a polled-only system, the “master” PC or PLC controls all communication in the system. When a MODBUS query is sent to an RTU through the Model 1700 controller, the controller always translates the query to the RTU FFSK protocol and sends it out over the radio. When the RTU responds, the response is translated from RTU FFSK protocol to MODBUS protocol and sent back to the master through the serial port of the Model 1700 controller.

Configuring a system as polled-only gives the master complete control over communications, particularly use of the radio channel, which can be a bottleneck. Radio communications occur only when the master polls an RTU. The RTUs never transmit except in response to a poll. There is no possibility of data collisions, which completely eliminates one cause of communication failures.

On the other hand, there is one major disadvantage to a polled-only system. The master will not be able to see changes in RTU input status that occur between polls. It only sees the current input status at the time each poll response is sent. Any RTU input changes that occur between polls are lost.

Report-By-Exception System

In a report-by-exception system, RTUs report changes in I/O status as they occur without waiting to be polled by the master. The Model 1700 controller stores this status within its own memory. When the master polls for status from an RTU, the Model 1700 controller builds the poll response from this stored status, and sends it back to the master immediately. A radio transmission occurs only if the master tries to control an RTU output or asks for RTU status that the Model 1700 controller does not have. In this case, the Model 1700 must try to obtain the RTU status over the radio before it can build the response to send back to the master.

A report-by-exception system should also use the Model 1700 controller autopoll feature. This causes the Model 1700 to periodically poll the input status for all RTUs in the system. If an RTU or its radio fails, the Model 1700 will not get a response to the poll and it will invalidate the status of the RTU. The next time the master tries to poll that RTU, a communications failure will occur unless the RTU has been fixed.

The advantage to a report-by-exception system is that the master sees changes in RTU I/O status almost immediately. The main disadvantage is that data collisions can occur between polls from the master and exceptions from RTUs or between exceptions from different

RTUs. In a large system with lots of I/O activity, this can result in frequent communications failures.

Which Is Better - Polled-Only or Report-By-Exception?

A polled-only system is easier to configure. Problems in a polled-only system can be much easier to diagnose. For example, if a communications failure occurs, it can not be due to data collisions, but is probably a true indication of a problem with the RTU, radio or communications path. Therefore, a polled-only system should be favored over a report-by-exception system.

A report-by-exception configuration may be needed if the system is very large so that the polling loop takes a long time, or if some signal changes are short duration and need to be reported automatically by the RTU. For a small system where a radio channel is also used for voice communications, report-by-exception can reduce the amount of airtime used for data transmission.

MODBUS MASTER REQUIREMENTS

In a MODBUS system, the “master” will typically be a PC running a software application that is compatible with the MODBUS protocol. The following list contains some of the major requirements for this “master” to be compatible with the Model 1700 controller and the Model 1708/1716 RTUs.

- The serial port(s) on the PC must be capable of supporting a three-wire version of RS-232 communications (Tx, Rx, ground). The communication parameters used are: 4800 baud, 8 data bits, no parity, and 2 stop bits.
- The application must have a configurable polling timeout period. The range must allow enough time for a radio transmission to be sent to an RTU and for the response to be sent back (3 to 5 seconds minimum).
- The application must limit itself to the command codes listed in Table 10.
- The application must support the MODBUS RTU protocol (as opposed to the MODBUS ASCII or MODBUS Plus protocols).

Fortunately, most PC software packages that support MODBUS protocol follow these rules. In some software packages, MODBUS protocol support is a standard feature. For others, the MODBUS protocol must be purchased separately as an option. As long as the software meets the above requirements, it will work with the Model 1700 controller.

Some of the software packages that work with the Model 1700 MODBUS option are listed on page 36.

CONFIGURING THE 1700 CONTROLLER

When using the MODBUS option, the Model 1700 controller address is usually set to “1” (DIP switch 1 ON, DIP switches 2 through 6 OFF). Any address in the range of “1” to “63” could be used. It should *never* be set to “0”.ⁱⁱ

The Model 1700 controller has built-in configuration menus that can be accessed through a PC with a terminal program. For more information on the general configuration of a controller, please see the “PROGRAMMABLE FEATURES” subsection of the “Model 1700 Controller Installation and Operation” manual, part number 025-9209. Only the menu items that apply to the MODBUS option are discussed here.

MODBUS Menu

When the MODBUS option is installed in the controller, the main menu displayed contains an additional item right after the RS232 {W}atchdog item, {M}odbus. Typing an “m” will open the menu listed in Table 12.

Table 12. 1700 Controller MODBUS Menu

Menu Selections	Range	Factory Settings
{R}TU status storage	Enable, Disable	Enabled
{A}utopoll...	Autopoll interval (0 to 65535 minutes) First autopoll RTU (1 to 255) Number of RTUs (1 to 255)	Autopoll interval = 0 First RTU = 1 Number of RTUs = 1
E{x}it		

The following two subsections make reference to the items on the MODBUS menu.

Polled-Only Configuration

For a MODBUS, polled-only system, you must configure the following items. This is in addition to any other parameters you configure on the controller.

1. From the controller main menu, type “M” to open the MODBUS menu.
2. From the MODBUS menu, type “R” to open the RTU Status Storage item.
3. At the RTU Status Storage prompt, type “D” to disable the status storage feature. This should return you to the MODBUS menu.

ⁱⁱ The address “0” is a reserved address in the MODBUS protocol. If you give a controller or RTU an address of “0”, the PC or PLC will not be able to communicate with it.

4. From the MODBUS menu, type “A” to open the Autopoll menu.
5. From the Autopoll menu, type “I” to open the Interval item.
6. At the Autopoll Interval prompt, type in zero (0) and then press ENTER to disable the autopoll feature.
7. At the Autopoll menu, type “X” to return to the MODBUS menu. At the MODBUS menu, type “X” to return to the controller main menu.

You may now exit the programming mode or continue with any other configuration programming you need to perform on this controller.

Report-By-Exception Configuration

For a MODBUS, report-by-exception system, you must configure the following items. This is in addition to any other parameters you configure on the controller.

1. From the controller main menu, type “M” to open the MODBUS menu.
2. From the MODBUS menu, type “R” to open the RTU Status Storage item. At the RTU Status Storage prompt, type “E” to enable the status storage feature. This should return you to the MODBUS menu.
3. From the MODBUS menu, type “A” to open the Autopoll menu.
4. From the Autopoll menu, type “I” to open the Interval item. At the Autopoll Interval prompt, type in the time in minutes that the 1700 controller must wait in between polls of all the RTUs in the system. Press ENTER to return to the Autopoll menu.
5. From the Autopoll menu, type “F” to open the First RTU item. At the First RTU prompt, type in the address of the lowest numbered RTU in the system. Press ENTER to return to the Autopoll menu.
6. From the Autopoll menu, type “N” to open the Number of RTUs item. At the Number of RTUs prompt, type in the total number of RTUs in the system. (It is highly recommended that the RTUs be consecutively numbered in any system that is automatically polled.) Press ENTER to return to the Autopoll menu.
7. At the Autopoll menu, type “X” to return to the MODBUS menu. At the MODBUS menu, type “X” to return to the controller main menu.
8. At the main controller menu, type “R” to open the Radio menu. At the Radio menu, type “R” to open the RTU response timeout item. At the RTU response timeout prompt, type in the number of seconds the controller should wait for an individual RTU to respond and press ENTER. This will return you to the Radio menu.
9. From the Radio menu, type in “X” to return to the controller main menu.

You may now exit the programming mode or continue with any other configuration programming that you need to perform on this controller.

Note

The RTU Response Timeout sets the period for which the controller will wait for a response whenever it polls an individual RTU. A period of 5 to 10 seconds will normally be adequate; however, if the store-and-forward method is being used, the timeout period might have to be set to a larger value. This value needs to be the smallest number of seconds that produces reliable results because it can affect the total amount of time required to poll all of the RTUs in the system.

RS-232 Watchdog Configuration

The Model 1700 controller has the ability to monitor the RS-232 serial connection for MODBUS protocol queries. If the master fails to send a MODBUS query for a specific amount of time, the Model 1700 controller will turn on its output number “1”. This output could be connected to some kind of alarm that would notify the system operator that either the master itself has failed or the RS-232 connection between the master and the Model 1700 controller has failed.

This feature can be enabled or disabled, and the timeout period set through the Model 1700 controller RS-232 watchdog menu. The default setting is disabled. The range for the timeout period is 10 to 65535 in seconds (just over 18 hours maximum).

CONFIGURING THE RTUs

Unless an RTU is interfaced directly to the master PC that is running the MODBUS program, there is no special configuration necessary. The RTU communicates with the Model 1700 and the controller takes care of translating the information received into the MODBUS protocol format. The same applies to any commands sent from the master PC out to the RTUs by means of the controller.

If the RTU is to be interfaced directly to a serial port on the master PC, then it must have the optional MODBUS version of the firmware installed. This version of the RTU firmware does not show any radio configuration options since the RTU communicates directly with the master PC.

Assign Addresses

The default setting for the RTU address is zero. This should be set to a number between one and 255 (not the same address as the Model 1700 controller). Each RTU must have a unique address. See “ADDRESSING THE RTU” on page 8 for more information on setting the RTU address.

MODBUS Version of the RTU Menu

When you access the program mode for a Model 1708/1716 that has been equipped with the MODBUS version of the RTU firmware, a shortened version of the main menu appears. Table 13 lists this modified menu. Basically, all the menu items dealing with radio communication or the controller addressing have been removed.

Table 13. RTU Main Menu with MODBUS Option Installed

Menu Selections
{O}utput Definition
{D}igital Input Definition
{A}nalog Input Definition
RS232 {W}atchdog...
{F}actory defaults
E{x}it

With the exception of the last two menu items ({F}actory defaults and E{x}it), typing in the letter for a menu item opens a submenu. The I/O menu items work just as they would for a regular RTU. The item that is new to the MODBUS version is the RS232 {W}atchdog item. This is the same watchdog feature offered in the Model 1700 controller menu. Since the RTU is connected to the master PC in this configuration, it has the same need to alert the system operator if the serial communication link to the master PC is lost.

CONFIGURING THE MASTER PC (OR PLC)

Each MODBUS software package or PLC is configured differently, so we can only give general guidelines for configuring them here. The areas we will touch on include: serial communications, polling intervals, timeout periods, and retries.

Serial Communications The serial communication parameters used by the master never vary. They must always be set to 4800 baud, 8 data bits, no parity, and 2 stop bits.

Polling Intervals Report-by-Exception
 In a report-by-exception system, the polling interval used by the master can be set to a short period (on the order of 1 second). Much of the time the Model 1700 will be responding to the polls using the last known RTU status stored in its memory.

Polled-Only
 In poll-only systems, the polling interval is generally set to a value that allows the master enough time to have polled all the RTUs in the system. Example: if it takes five seconds for each RTU, and the system has 10 RTUs, the polling interval would be 50 seconds minimum (it could be longer). Some software packages allow different polling intervals for each RTU, so more important or

rapidly changing signals could be polled more often than less important or slowly changing signals.

Timeout Periods The timeout period should be the same for both poll-only and report-by-exception systems. The period should be set to minimum time that it takes for a poll to go out over the radio to an RTU and for the response to return to the master. A typical value is five seconds. However, if the RTUs are doing store-and-forward, or there is a lot of traffic on the radio channel, a longer timeout may be needed.

Retries The master can usually be configured to retry a poll for a specified number of times before giving up and signaling a communications failure for that RTU. The appropriate setting for retries is really system dependent, but a value of 2 or 3 is usually a good starting place.

BASIC MODBUS I/O ADDRESSING

The basic I/O capability of the Model 1700 controller consists of four digital outputs. These are open-collector outputs capable of sinking up to 100 mA and dealing with voltages up to 50 V_{dc}.

In the MODBUS protocol, each I/O point is given a unique address. This address not only identifies a unique point within the system, it also tells the master what type of I/O point the address identifies.

The MODBUS protocol also has its own nomenclature for the various I/O types. It also has its own set of ranges for data. Table 14 shows the relationship between MODBUS nomenclature for I/O addressing and the Zetron nomenclature used in the Model 1700, Model 1708, and the Model 1716.

Table 14. MODBUS versus Zetron I/O Addressing

Zetron Values			MODBUS Values		
I/O Type	Address Range	Value Range	I/O Type	Address Range	Value Range (Raw)
Digital Outputs	1 to 16	OFF, ON	Coils	1 to 16	0 (off), 1 (on)
Digital Inputs	1 to 16	Open Circuit, Grounded	Input Status	10001 to 10016	0 (open circuit) 1 (grounded)
Analog Inputs	1 to 8	0 to 5 V or 0 to 20 mA	Input Registers	30001 to 30008	0 to 32767
Analog Outputs	1 to 4	0 to 5 V	Holding Registers	40001 to 40004	0 to 32767

Within the MODBUS protocol, the Input Status and Input Register signal types (digital and analog inputs) are read-only. The Coil and Holding Register signal types (digital and analog outputs) may be both read from and written to.

When configuring the MODBUS master, the MODBUS addresses and value ranges must be used. Table 15 lists the allowable range values in relation to the signal types.

Table 15. MODBUS Values versus Signal Types

I/O Type ↓ MODBUS Value ⇒	0		1
Coil (digital output)	OFF (open circuit)	N/A	ON (grounded)
Input Status	OFF (open circuit or high voltage)	N/A	ON (ground or low voltage)
I/O Type ↓ MODBUS Value ⇒	0	6553	32767
Input Register (analog input)	0 V or 0 mA	1 V or 4 mA	5 V or 20 mA
Holding Register (analog output)	0 V	1 V	5 V

The most common usage for analog inputs and outputs is with transducers that convert some real world value either into a voltage (in the range 0 to 5V or 0 to 10V) or a current (in the range 4 to 20mA). Most MODBUS master software packages provide a way to configure input registers and holding registers so that the conversion from raw units used in the MODBUS protocol to real world units is done automatically.

Here is an example. A sensor that measures water flow and outputs a current of 4mA for a flow of 0 gal/min and a current of 20mA for a flow of 100 gal/min. This sensor is connected to analog input number 5 of a Model 1716 RTU. In the MODBUS master software, input register 30005 would be configured with a raw range of 6553 (4mA) to 32767 (20mA) and a real world range of 0 gal/min to 100 gal/min.

USING ACCUMULATORS AND COUNTERS

Configuring the master to be able to access accumulators and counters is more difficult than for basic RTU I/O, and requires a good working knowledge of the MODBUS master software package.

Analog input accumulators keep a running total of the analog input value over a period of time. There is one accumulator for each analog input on the Model 1708 or Model 1716 RTU. Each accumulator consists of three values: the accumulated total (sum of samples from the analog input), the total number of samples taken, and the sample rate (how often the analog input is read).

Accumulators are usually used to keep a running total of some flow through a system. For example, if a sensor measuring flow in gal/min is connected to a Model 1708 RTU, the total flow in gallons can be tracked through the use of an accumulator. Accumulators can also be used to calculate the average value of an analog input.

There is one digital input counter for each input of the Model 1708 or Model 1716 RTU. Each counter consists of two values: the count and the time period since the counter was last cleared.

The count value increments each time the input activates. When the input is set up as status mode, the count increments every time the input changes state. If the input is set up as normally open or normally closed, the count increments when the input is grounded or disconnected respectively.

The accumulators and counters are accessed through MODBUS holding registers. Each accumulator or counter value (except for the accumulator sample rate) is spread across three separate holding registers. The lower four decimal digits are in the first register, the middle four decimal digits in the middle register, and the upper four decimal digits in the third register. The example in Table 16 shows accumulator 1 with a current accumulated value of 2,156,349,078, number of samples of 634,127,890, and sample rate of 2,354:

Table 16. How Accumulator 1 Stores Data

Register	Value	Description
41011	9078	Accumulated Value lower four decimal digits
41012	5634	Accumulated Value middle four decimal digits
41013	0021	Accumulated Value upper four decimal digits
41014	7890	Number of Samples lower four decimal digits
41015	3412	Number of Samples middle four decimal digits
41016	0006	Number of Samples upper four decimal digits
41017	2354	Sample rate (the sample rate uses one register)

Some MODBUS software packages (e.g. WonderWare’s Intouch) can automatically combine these registers into a single value. Others, (e.g. National Instrument’s Lookout) require the user to combine the registers into a single value in a “script”. For example, in Lookout, the “script” for the accumulated value might look like the following equation,

$$(((\mathbf{Rtu1.41013} \times \mathbf{10000}) + \mathbf{Rtu1.41012}) \times \mathbf{10000}) + \mathbf{Rtu1.41011}$$

Queries to read an accumulator or counter must request all associated registers or an illegal data address exception will be returned. An illegal data address exception will also be returned to queries that overlap accumulator or counter address boundaries by requesting more than nine registers.

Writing to the first holding register address used by particular accumulator or counter will cause it to be cleared. The value written does not matter; the act of writing to the register causes the clearing. It is not possible to clear just part of an accumulator or counter. For example, you cannot clear the accumulator total without also clearing the number of samples.

An illegal data address exception will be returned to queries beginning at unused addresses, 40005 - 41010, 41088 - 42010, and 42167 - 99999.

Only one accumulator or counter can be polled at a time.

Table 17. Analog Accumulator Holding Register Addresses

Accumulator	Value	# Samples	Sample Rate
1	41011 - 41013	41014 - 41016	41017
2	41021 - 41023	41024 - 41026	41027
3	41031 - 41033	41034 - 41036	41037
4	41041 - 41043	41044 - 41046	41047
5	41051 - 41053	41054 - 41056	41057
6	41061 - 41063	41064 - 41066	41067
7	41071 - 41073	41074 - 41076	41077
8	41081 - 41083	41084 - 41086	41087

Table 17 shows the MODBUS holding register addresses used for analog input accumulators.

The average value of the accumulator and the total accumulated value - scaled to real world units - can be calculated with the formulas presented below. An example will follow to help clarify things, but first, some definitions.

Values to be calculated are:

- A** = Average analog input value scaled to real world units.
- T** = Total accumulated value, scaled to real world units.
- P** = The time period, in seconds, that the accumulator has been running.

Values returned when the accumulator is read are:

- V** = Accumulator value, unscaled.
- N** = Accumulator number of samples.
- R** = Sample rate

Values that are dependent on the sensor being used are:

- M_L** = lowest real world value measured by the sensor.
- M_H** = highest real world value measured by the sensor.
- S_L** = sensor output corresponding to M_L - in Volts or mA.
- S_H** = sensor output corresponding to M_H - in Volts or mA.
- I** = analog input range - 5 Volts or 20mA depending on the type of sensor.

The formula for calculating the average analog input value in real world units is:

$$A = \left(\frac{V \times I}{N \times 256} - S_L \right) \times \left(\frac{M_H - M_L}{S_H - S_L} \right) + M_L$$

The sample rate is returned in 10ths of a second. The default sample rate is 10, or 1 sample per second. The time period (in seconds) over which the accumulation took place can be calculated as:

$$P = N \times R \div 10$$

Once the scaled average value and time period are known, the total can be calculated by multiplying the average value by the time period. If the time units for the sensor are something other than seconds, a conversion factor will also have to be included.

$$T = \frac{A \times P}{\text{SecondsPerSensorTimeUnits}}$$

Here is an example. We will use the same sensor that we used in our discussion of analog input configuration. It measures water flow and outputs a current of 4mA for a flow of 0 gal/min and a current of 20mA for a flow of 100 gal/min. When the accumulator is read, we get a value of 12345678, number of samples of 66666 and sample rate of 20. Therefore, we know the following:

$V = 12345678$	$M_H = 100 \text{ gal/min}$
$N = 66666 \text{ samples}$	$S_L = 4 \text{ mA}$
$R = 20$	$S_H = 20 \text{ mA}$
$M_L = 0 \text{ gal/min}$	$I = 20 \text{ mA}$

Plugging these into the equation for the scaled average value results in the following equation.

$$A = \left(\frac{12345678 \times 20\text{mA}}{65432 \times 256} - 4\text{mA} \right) \times \left(\frac{100\text{gal / min} - 0\text{gal / min}}{20\text{mA} - 4\text{mA}} \right) + 0\text{gal / min}$$

$$A = (14.74\text{mA} - 4\text{mA}) \times \left(\frac{6.25\text{gal / min}}{1\text{mA}} \right) + 0\text{gal / min}$$

$$A = 67.13\text{gal / min}$$

The time period over which the value was accumulated is:

$$P = 65432 \times 20 \div 10$$

$$P = 130864\text{Sec}$$

Finally, the total scaled accumulated value is:

$$T = \frac{67.13\text{gal / min} \times 130864\text{Sec}}{60\text{Sec / min}}$$

$$T = 146415\text{gal}$$

Table 18 shows the MODBUS holding register addresses used for digital input counters.

Table 18. Digital Input Counter Holding Register Addresses

Counter	Value	Period		Counter	Value	Period
1	42011 – 42013	42014 - 42016		9	42091 - 42093	42094 – 42096
2	42021 – 42023	42024 - 42026		10	42101 - 42103	42104 – 42106
3	42031 – 42033	42034 - 42036		11	42111 - 42113	42114 – 42116
4	42041 – 42043	42044 - 42046		12	42121 - 42123	42124 – 42126
5	42051 – 42053	42054 - 42056		13	42131 - 42133	42134 – 42136
6	42061 – 42063	42064 - 42066		14	42141 - 42143	42144 – 42146
7	42071 – 42073	42074 - 42076		15	42151 - 42153	42154 – 42166
8	42081 – 42083	42084 - 42086		16	42161 - 42163	42164 – 42166

The counter value, as mentioned previously, is a count of the number of times the corresponding digital input has activated. This can be converted to engineering units simply by multiplying the count by a conversion factor. For example, if a flow sensor outputs one pulse for every 100 gallons of flow through a pipe. The count can be multiplied by 100 to get the total flow in gallons.

The counter period is returned in 10ths of a second, so the period in seconds is:

$$\text{Counter period in seconds} = \text{Period} \div 10$$

SOFTWARE PRODUCTS FOR THE MODBUS PROTOCOL

The following list contains some of the software packages known to work with the Model 1700 Controller MODBUS option. Please note that Zetron does not sell or support these packages. For sales and support, please contact the manufacturer directly.

FIX®

Intellution
One Edgewater Drive
Norwood, MA 02062

Tel: 781-769-8878
Fax: 781-769-1990
www.intellution.com

Lookout

National Instruments Corporation
11500 North Mopac Expressway
Austin, TX 78759

Tel: 512-794-0100
Fax: 512-683-8411
www.NI.com/lookout

Genesis

Iconics
100 Foxborough Boulevard
Foxborough, MA 02035

Tel: 508-543-8600
Fax: 508-543-1503
www.iconics.com

RealFlex

RealFlex Systems Inc.
12000 Aerospace Avenue, Suite 300
Houston, TX 77034

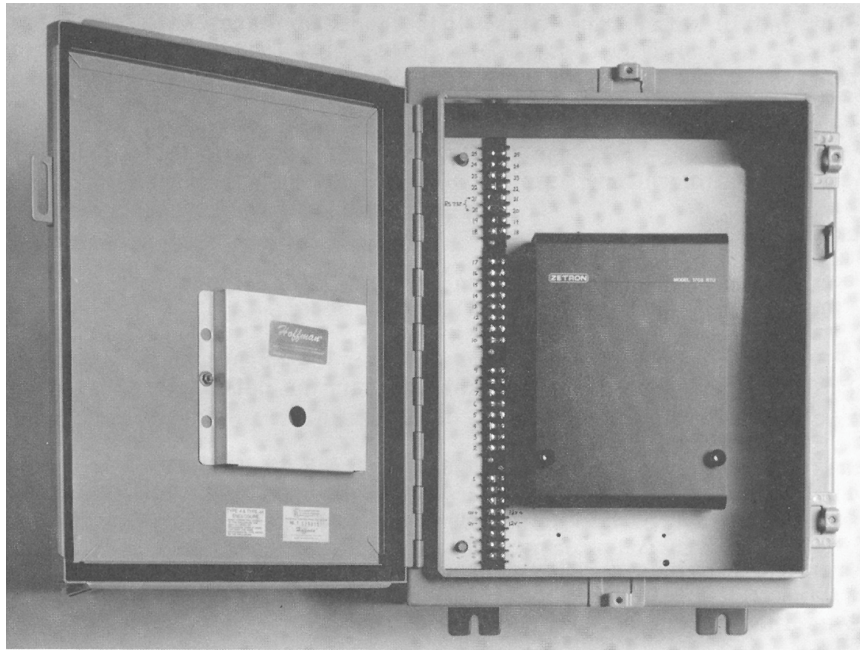
Tel: 281-922-4357
Fax: 281-922-5109
www.realflex.com

InTouch

Wonderware
100 Technology Drive
Irvine, CA 92618

Tel: 949-727-3200
Fax: 949-727-3270
www.wonderware.com

SET UP AND INSTALLATION



INSTALLATION

The Model 1708/1716 may be wall-mounted or mounted within a standard industrial enclosure. See the Model 1700 series enclosure outline (024-0057, page 52) and instructions (024-0056, page 53) for details on mounting the unit.

Power Connection

The power connection is made on the same connector as the radio connections. The RTU operates from 10.5-16 V_{dc}. Since it requires less than 150 mA, the radio power supply (if it provides 10.5-16 V_{dc}) is often used to power the RTU. A 12-volt sealed lead acid battery (Gel Cell) can be used with a 12-volt power supply to power the radio and RTU and to provide back-up operating power in case of a main power failure.

System Grounding

To prevent static discharge from affecting the system, the chassis ground *must* be connected to the earth ground. See the instructions (024-0056) on page 53 for the location of the chassis ground post provided.

CAUTION

The chassis ground *must* be connected to the earth ground using the field wiring.

Radio Connection

The Radio Connector P3 on the RTU requires a minimum of six connections to interface with the radio. The shaded rows in Table 19 indicate that those connections are optional.

Table 19. RTU Radio Connector (P3) Pinout

Pin #	Connection	Schematic Label
1	Power	+12V _{dc}
2	Ground	GND
3	Push to Talk	PTT OUT
4	Push to Talk Common	PTT COM
5	N/A	
6	Carrier Detect	COR
7	Ground	GND
8	Transmit Request ⁱⁱⁱ	TXREQ
9	Transmit Audio	TXAUD
10	Receive Audio	RXAUD

Step 1. Cable Connection

You should find a small clear plastic bag containing a plastic 10-pin connector and 10 metal crimp pins. This connector mates with the Radio Connector P3 on the RTU. Construct a cable using this connector to provide an interface to the radio that provides the six connections listed above.

Step 2. Carrier Detect and Push to Talk Settings

Verify correct jumper settings for Carrier Detect and Push To Talk (PTT) based on the radio you are using.

Carrier Detect

JP1 A = 10 kΩ pull-down to ground on Carrier Detect input
 B = 10 kΩ pull-up to +12 V_{dc} on Carrier Detect input

If your radio provides a logic change of 0-5 V_{dc} when channel is busy, install JP1 in the A position and set the Carrier detect level as high in the RTU.

ⁱⁱⁱ Transmit Request — This line will allow up to 15 RTUs to connect to a single Radio Transceiver. Transmit Request prevents multiple units from transmitting simultaneously. To use, just connect a single wire to this pin between all the RTUs on the same Radio Transceiver. The RTU with the lowest ID will have priority in using the Radio.

If your radio provides a logic change of 5-0 V_{dc} when channel is busy, install JP1 in the A position and leave the RTU setting for Carrier detect as the factory default setting of low.

If your radio provides a relay contact closure to ground or open collector output, install JP1 in the B position and leave the RTU setting for Carrier detect as the factory default setting of low.

You may wish to refer to “Channel Busy Detect” (on page 11) which discusses the carrier detect setting. There is a software controlled LED that will be lit when carrier is detected (based on what was set during configuration).

PTT

- JP3 A = PTT completes the connection between P3 Pin 3 and Pin 4.
 B = PTT provides a ground on P3 Pin 3. (Pin 4 not used)
- JP4 IN = PTT provides a +5 V_{dc} pull-up on P3 Pin 3 when not engaged.
 OUT = PTT goes to an open circuit on P3 Pin 3 when not engaged.

Step 3. Transmit and Receive Audio Adjustment

Connect two RTUs to their radios and power supply, and turn power on.

There are two jumpers located on the PCB next to the large square IC. These jumpers are labeled Test A and Test B. With power on, putting a jumper on Test A and/or Test B will cause the unit to enable Push to Talk and send the tones listed in Table 20.

Table 20. RTU Audio Adjustment Test Tones

Test A	Test B	Tone
out	out	None
out	in	1200 Hz
in	out	1800 Hz
in	in	Alternating 1200 and 1800 Hz

In RTU #1, put test A and test B jumpers in place. This will cause the radio to key up and transmit an alternating 1200 Hz and 1800 Hz tone.

On RTU #1, adjust the **TX AUD** pot to provide an audio output level that meets the radio manufacturer’s specification.

Look at TP1 on RTU #2 with an oscilloscope or voltmeter with an AC setting. Use any ground point, such as the metal enclosure, as a reference. Adjust the **RX AUD** pot and JP7 on RTU #2 until TP1 measures 1 V_{pp} .

- JP7 A = Low 1x gain on Receive Audio
 B = High 10x gain on Receive Audio

TP1 (Audio in) Set to 1V P-P using **RXAUD** pot. Repeat Step 3 but for transmit audio on RTU #2 and receive audio on RTU #1.

CAUTION

Remove the jumpers when finished testing. Do not to leave the radios transmitting continuously as this can harm some radios.

MODEL 1708 JUMPERS AND I/O

The jumper and I/O connector information in this subsection applies to the Model 1708 (Part No. 901-9260). For similar information applying to the 1716, see page 42.

Model 1708 Jumper Settings

Jumper	Name/Signal	Description
JP1	Carrier Detect	A = 47k Ω pull down to ground B = 47k Ω pull-up to +12 V _{dc}
JP2	Serial Port Power	Connects +12 V _{dc} (fused) to J2 Pin 6 of RS-232 Connector (DB9)
JP3	Push-To-Talk	A = PTT completes the connection between P3 Pin 3 and Pin 4. B = PTT provides a ground indication on P3 Pin 3.
JP4	Push-To-Talk	IN = Push to Talk provides a +5 V _{dc} pull up on release. OUT = Push to Talk goes to open upon release.
JP5	Test A	1800 Hz Test Tone — See Table 20 for instructions
JP6	Test B	1200 Hz Test Tone — See Table 20 for instructions
JP7	Receive Audio Gain	A = Low 1x gain on Receive Audio B = High 10x gain on Receive Audio
JP8	External Audio	A = External Audio Source Input B = No External Audio
JP9	Transmit Audio	A = 50 Ω impedance B = 600 Ω impedance
JP10	Carrier Detect Adjust	A = Adjustable Carrier Detect threshold, 0 to 10 V _{dc} B = 0-0.7 V _{dc} Logic low, 3.5-5.0 V _{dc} Logic high
JP11	Analog Input #1	Adds 249 Ω load resistor
JP12	Analog Input #2	Adds 249 Ω load resistor
JP13	Analog Input #3	Adds 249 Ω load resistor
JP14	Analog Input #4	Adds 249 Ω load resistor
JP19	+5 V _{dc} Output	IN = +5 V _{dc} enabled on J1 pin 16 OUT = +5 V _{dc} disconnected on J1 pin 16

Model 1708 I/O Connections**J2 DB9-S(9-pin RS-232 Port)**

Pin #	Connection
1	N/C
2	N/C
3	Transmit from RTU (TXD)
4	Receive from external device (RXD)
5	Ground
6	+12V _{dc} (fused) - JP2 enable jumper
7	N/C
8	N/C
9	DTR

J1

Pin #	Connection	Pin #	Connection
1	Ground	10	Ground
2	Digital Input #1	11	Analog Input #1
3	Digital Input #2	12	Analog Input #2
4	Digital Input #3	13	Analog Input #3
5	Digital Input #4	14	Analog Input #4
6	Digital Input #5	15	External Audio In
7	Digital Input #6	16	+5 V _{dc} (regulated) - JP19 enable jumper
8	Digital Input #7	17	Ground
9	Digital Input #8	18	+12 V _{dc} (fused)

J4

Pin #	Connection
1	Ground
2	Digital Output #1
3	Digital Output #2
4	Digital Output #3
5	Digital Output #4
6	Digital Output #5
7	Digital Output #6
8	Digital Output #7
9	Digital Output #8

MODEL 1716 JUMPERS AND I/O

The jumper and I/O connector information in this subsection applies to the Model 1716 (Part No. 901-9261). For similar information applying to the 1708, see page 40.

Model 1716 Jumper Settings

Jumper	Name/Signal	Description
JP1	Carrier Detect	A = 47k Ω pull-down to ground B = 47k Ω pull-up to +12 V _{dc}
JP2	Serial Port Power	Connects +12 VDC (fused) to J2 Pin 6 of RS-232 Connector (DB9)
JP3	Push-To-Talk	A = PTT completes the connection between P3 Pin 3 and Pin 4. B = PTT provides a ground indication on P3 Pin 3.
JP4	Push-To-Talk	IN = Push to Talk provides a +5 V _{dc} pull up on release. OUT = Push to Talk goes to open upon release.
JP5	Test A	1800 Hz Test Tone — See Table 20 for instructions
JP6	Test B	1200 Hz Test Tone — See Table 20 for instructions
JP7	Receive Audio Gain	A = Low 1x gain on Receive Audio B = High 10x gain on Receive Audio
JP8	External Audio	A = External Audio Source Input B = No External Audio
JP9	Transmit Audio	IN = 50 Ω impedance OUT = 600 Ω impedance
JP10	Carrier Detect Adjust	A = Adjustable Carrier Detect threshold, 0 to 18 V _{dc} B = 0-0.7 V _{dc} Logic low, 3.5-5.0 V _{dc} Logic high
JP11	Analog Input #1	Adds 249 Ω load resistor
JP12	Analog Input #2	Adds 249 Ω load resistor
JP13	Analog Input #3	Adds 249 Ω load resistor
JP14	Analog Input #4	Adds 249 Ω load resistor
JP15	Analog Input #5	Adds 249 Ω load resistor
JP16	Analog Input #6	Adds 249 Ω load resistor
JP17	Analog Input #7	Adds 249 Ω load resistor
JP18	Analog Input #8	Adds 249 Ω load resistor
JP19	+5 V _{dc} Output	IN = +5 V _{dc} enabled on J1 pin 16 OUT = +5 V _{dc} disconnected on J1 pin 16
JP21 to JP37	Optional I/O board configuration jumpers	See "50-PIN INDUSTRIAL I/O BOARD CONNECTOR" on page 45 for more information.

Model 1716 I/O CONNECTIONS

The I/O connector information in this subsection applies *ONLY* to the Model 1716 (Part No. 901-9261). For similar information applying to the 1708, see page 40.

J2 DB9-S(9-pin RS-232 Port)

Pin #	Connection
1	N/C
2	N/C
3	Transmit from RTU (TXD)
4	Receive from external device (RXD)
5	Ground
6	+12 V _{dc} (fused) - JP2 enable jumper
7	N/C
8	N/C
9	DTR (Data Terminal Ready)

J1

Pin #	Connection	Pin #	Connection
1	Ground	10	Ground
2	Analog Input #1	11	Analog Output #1
3	Analog Input #2	12	Analog Output #2
4	Analog Input #3	13	Analog Output #3
5	Analog Input #4	14	Analog Output #4
6	Analog Input #5	15	External Audio In
7	Analog Input #6	16	+5 V _{dc} (regulated) - JP19 enable jumper
8	Analog Input #7	17	Ground
9	Analog Input #8	18	+12 V _{dc} (fused)

J4

Pin #	Connection	Pin #	Connection
1	Ground	10	Ground
2	Digital Input #1	11	Digital Input #9
3	Digital Input #2	12	Digital Input #10
4	Digital Input #3	13	Digital Input #11
5	Digital Input #4	14	Digital Input #12
6	Digital Input #5	15	Digital Input #13
7	Digital Input #6	16	Digital Input #14
8	Digital Input #7	17	Digital Input #15
9	Digital Input #8	18	Digital Input #16

J5

Pin #	Connection	Pin #	Connection
1	Ground	10	Ground
2	Digital Output #1	11	Digital Output #9
3	Digital Output #2	12	Digital Output #10
4	Digital Output #3	13	Digital Output #11
5	Digital Output #4	14	Digital Output #12
6	Digital Output #5	15	Digital Output #13
7	Digital Output #6	16	Digital Output #14
8	Digital Output #7	17	Digital Output #15
9	Digital Output #8	18	Digital Output #16

CONNECTION OF LOCAL RTU TO MODEL 1700 CONTROLLER

When a local RTU (Model 1708 or Model 1716) is connected to the Model 1700, the sense of the RX and TX lines are swapped. The COR, and TxREQ remain the same. The local RTU does not use the radio but uses the radio interface to communicate with the Model 1700. See Figure 5.

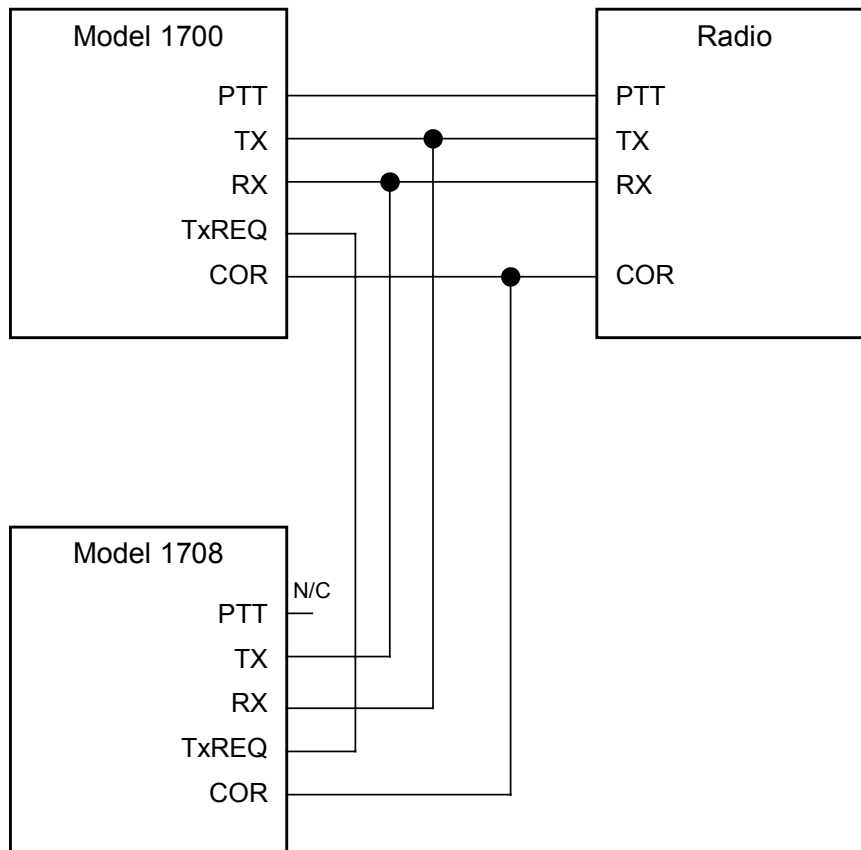


Figure 5. Local RTU Connections

50-PIN INDUSTRIAL I/O BOARD CONNECTOR

The 50-Pin Industrial I/O Board Connector P6 is designed for connection to many industrial I/O and signal conditioning boards available from a variety of manufacturers. This allows connection to these boards using a standard 50-conductor ribbon cable. The jumpers JP21 to JP36 allow the modular I/O connections to be configured as inputs or outputs.

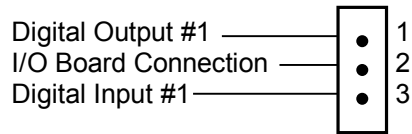


Figure 6. Functional Pinout for Model 1716 Jumpers 21 to 37

A jumper connecting Pin #1 and Pin #2 will connect digital output #1 to module 1 of the I/O board.

A jumper connecting Pin #2 and Pin #3 will connect digital input #1 to module 1 of the I/O board.

This connector, P6, supports 4, 8, and 16 module optically isolated I/O boards. The 50-pin connectors provide common ground on the even numbered pins, +5 V_{dc} on pin 49 and channels 1 to 24 on the odd numbered pins starting with pin 47 and counting backwards from there.

A 24 I/O board is also supported, but channels 17-24 are not equipped with the jumper in the diagram above. For channels 17-24, a single stake pin is exposed for each channel on the Control Link and must be connected to the appropriate input or output.

A total of 16 inputs and 16 outputs are available to be routed to a standard I/O board by means of jumpers or wire wrap and a 50-pin ribbon cable. The 16 I/O points are also available on the J4 and J5 screw terminal block.

Note

Pin 1 and Pin 49 may be connected by a jumper on the I/O board. Remove this jumper if you are installing a 24-module I/O board.

P6

Pin #	Connection	Pin #	Connection
1	Module I/O 24	26	Ground
2	Ground	27	Module I/O 11
3	Module I/O 23	28	Ground
4	Ground	29	Module I/O 10
5	Module I/O 22	30	Ground
6	Ground	31	Module I/O 9
7	Module I/O 21	32	Ground
8	Ground	33	Module I/O 8
9	Module I/O 20	34	Ground
10	Ground	35	Module I/O 7
11	Module I/O 19	36	Ground
12	Ground	37	Module I/O 6
13	Module I/O 18	38	Ground
14	Ground	39	Module I/O 5
15	Module I/O 17	40	Ground
16	Ground	41	Module I/O 4
17	Module I/O 16	42	Ground
18	Ground	43	Module I/O 3
19	Module I/O 15	44	Ground
20	Ground	45	Module I/O 2
21	Module I/O 14	46	Ground
22	Ground	47	Module I/O 1
23	Module I/O 13	48	Ground
24	Ground	49	+ 5 Volts DC
25	Module I/O 12	50	Ground

THEORY OF OPERATION

BASIC FUNCTIONAL DESCRIPTION

The Models 1708 and 1716 Remote Terminal Units are microprocessor-based systems with a software intensive architecture that greatly enhances the versatility of the RTUs and allows them to be quickly adapted to varied tasks.

The microprocessor controls all internal operations, radio audio path control, RS-232 serial port and external input/output interface operations.

FUNCTIONAL BLOCK DIAGRAM

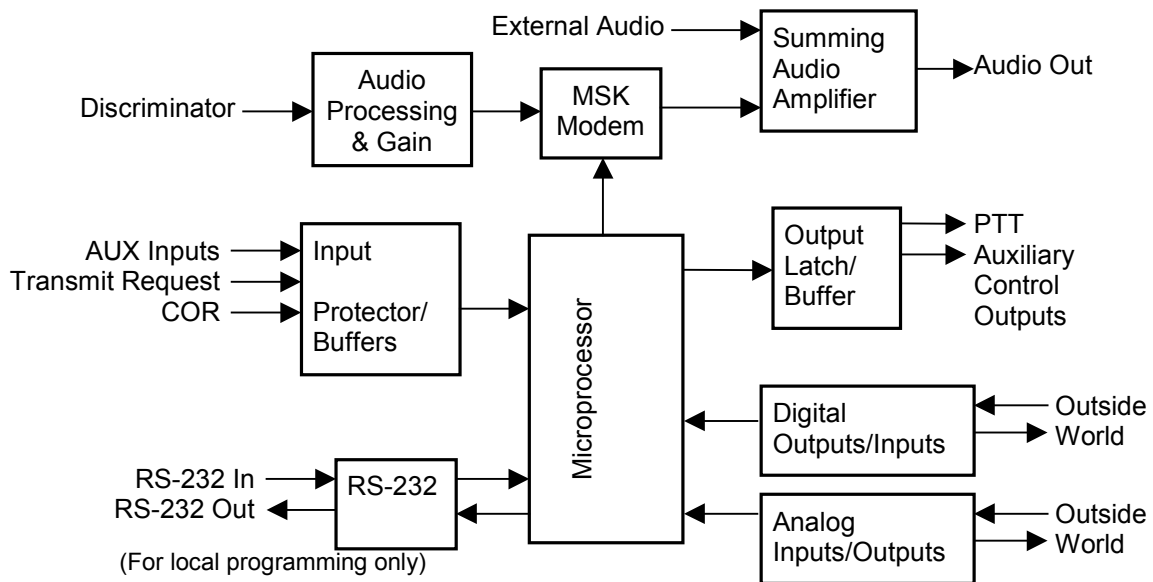


Figure 7. RTU Functional Block Diagram

TROUBLESHOOTING GUIDE

OVERVIEW

In case of installation or operational difficulty, call Zetron at (425) 820-6363. Please have the serial number of the unit and/or the Zetron order number. If the call is made from the installation site by the installer or radio technician, the problem can usually be solved over the telephone.

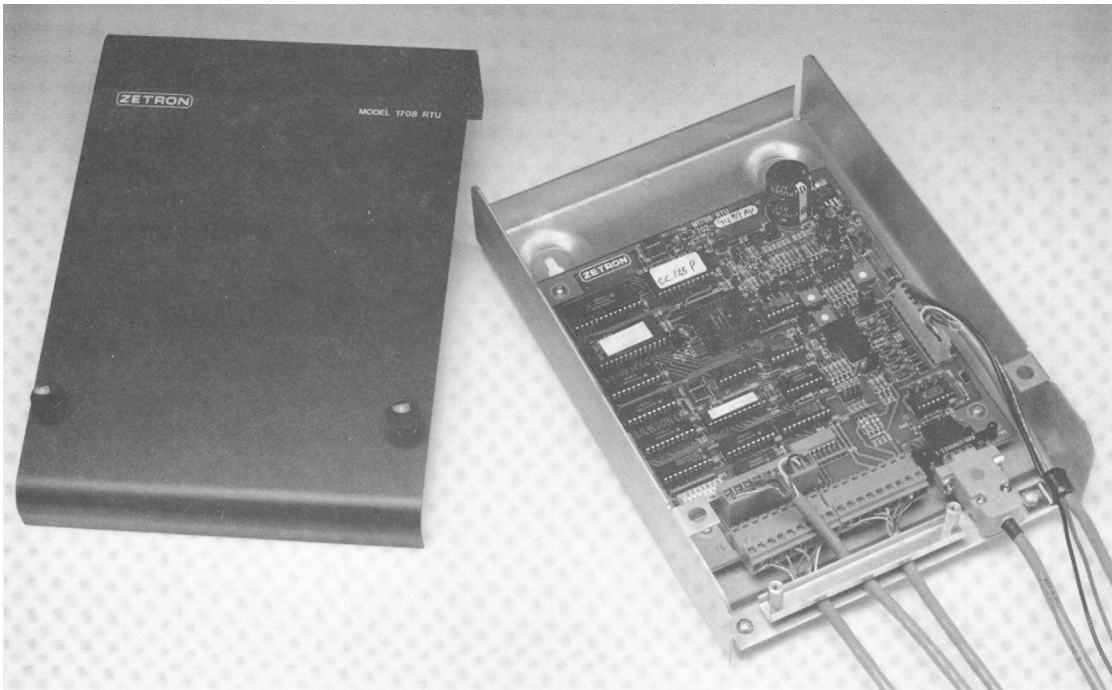
Some commonly encountered problems can be solved by following the recommendations below.

- Problem:** Unit will not communicate with PC or dumb terminal.
- Recommendations:** Make sure you are using some communications software such as Cross-Talk, Pro-Comm, Kermit, or ZCU or you are using a dumb terminal. You cannot access the programming mode directly from DOS.
- Verify the baud rate at 4800, 8 bit, no parity, 1 stop bit with echo off.
- Verify that you have specified the correct communications port.
- You should see between -6 and -12 V_{dc} on pins 3 and 4 (Ref. to ground) of J1, the black 9-pin connector, when the RTU is connected to the PC and both the PC and RTU have power. If you do not see these voltages, check the connections; most often they are reversed.
- There should be a common ground reference for the RTU and the PC or terminal.
- Press the space bar three times to access the menu.
-
- Problem:** Unit will not key the radio.
- Recommendations:** Check jumpers JP6 and JP7.
- Make sure Channel Busy Detect is set correctly.

Problem: Units will not communicate.

Recommendations: Check address on RTU and Controller.
Verify setting of DIP switch 7 and 8 on Controller.

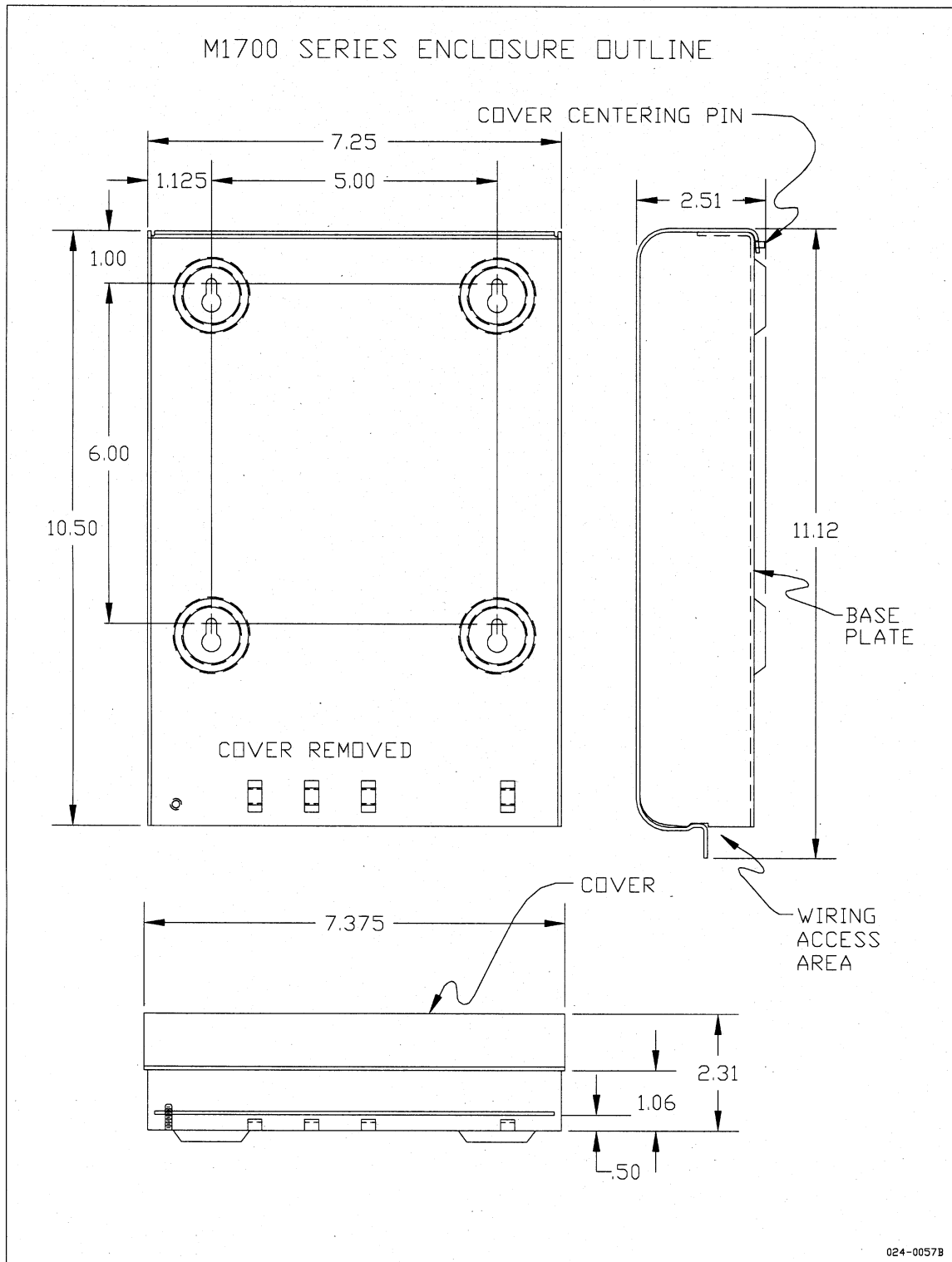
REPAIR



MODEL 1708/1716 COVER REMOVAL AND REPLACEMENT

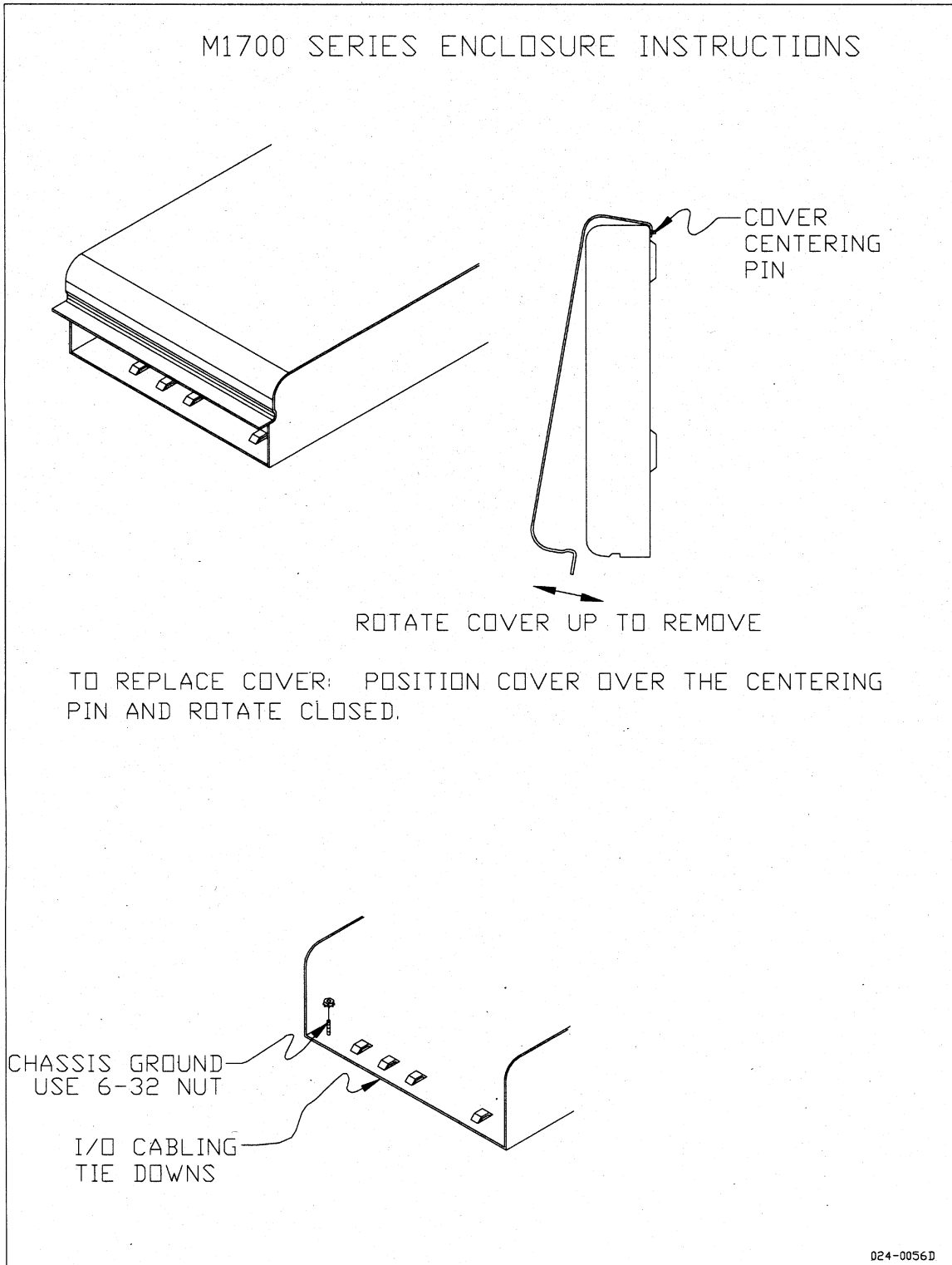
To remove the cover of the unit, rotate the cover up and off the cover centering-pin at the top. To replace the cover, position the cover over the centering pin and rotate the cover down to cover the unit. See the following diagrams for details.

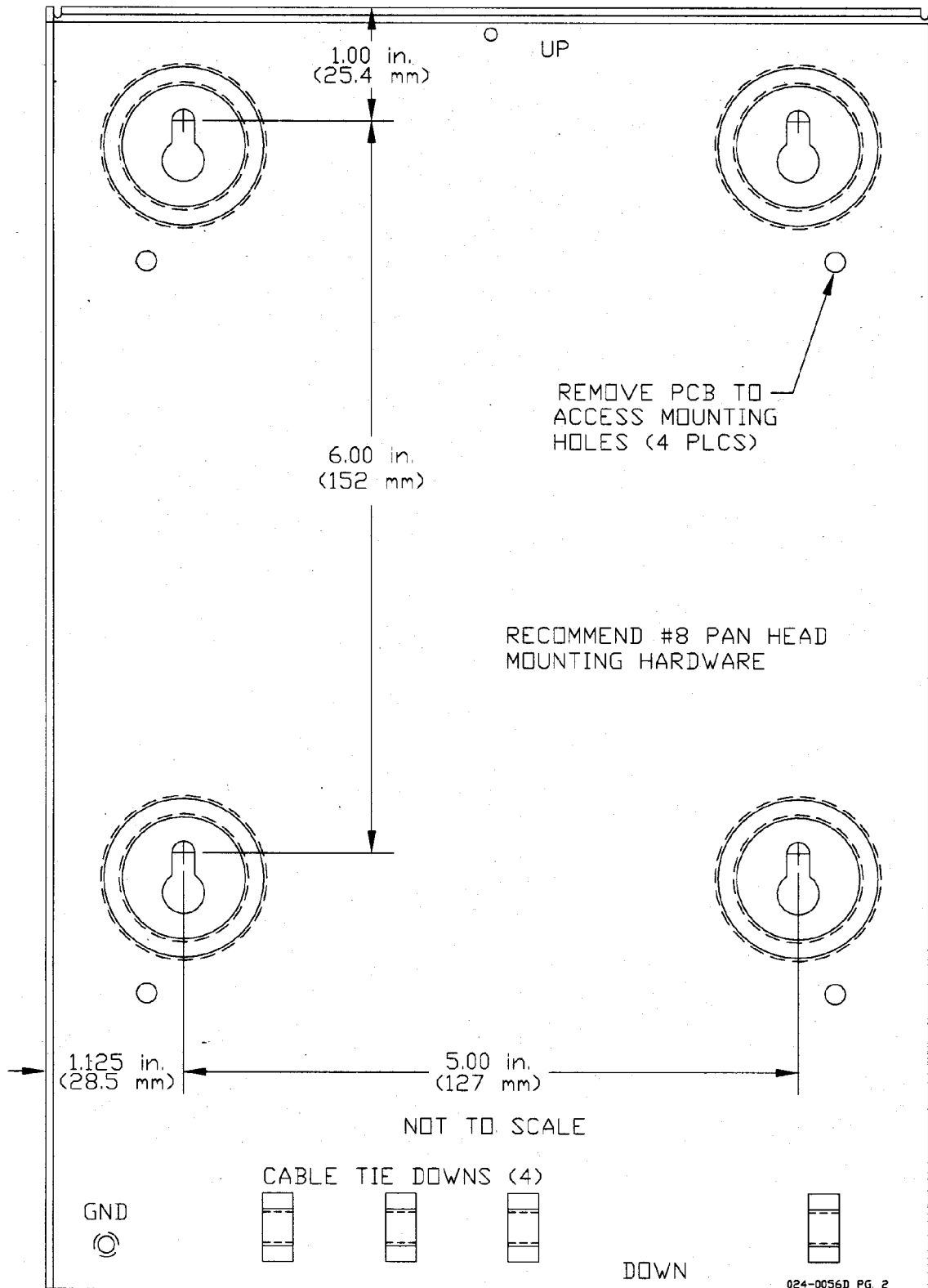
MODEL 1700 SERIES ENCLOSURE OUTLINE (024-0057B)



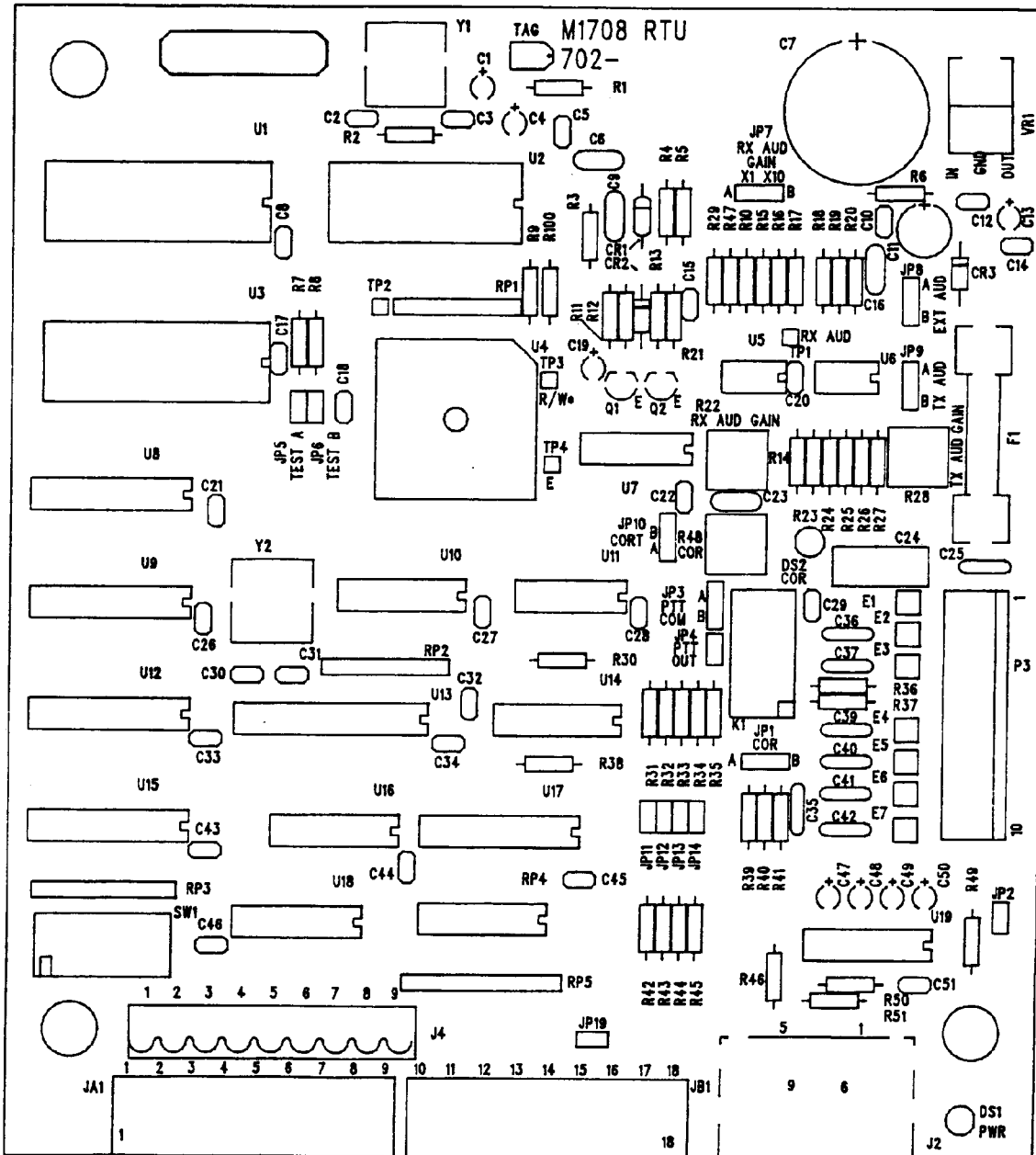
MODEL 1700 SERIES ENCLOSURE INSTRUCTIONS (024-0056D)

(Sheet 1 of 2)

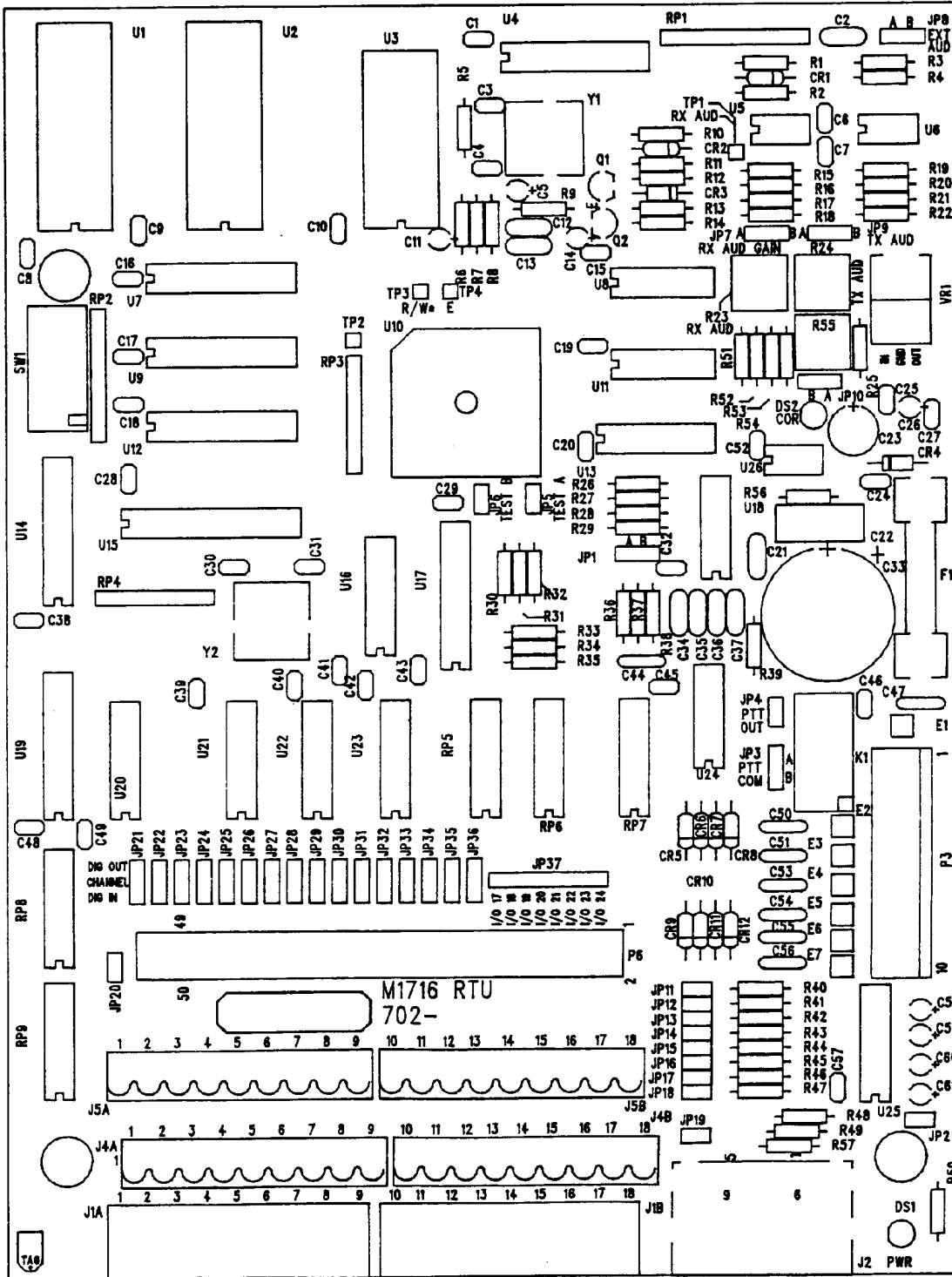




MODEL 1708 REMOTE TERMINAL UNIT SILKSCREEN (702-9439F)



MODEL 1716 REMOTE TERMINAL UNIT SILKSCREEN (702-9440F)



APPENDIX A

COMMUNICATING OVER TWO-WIRE BALANCED LINE (600Ω)

Zetron's Model 1700, 1708, and 1716 RTUs all have similar data transmission circuitry. That circuitry is designed to operate with most makes and models of two-way radios. This applications note is designed to assist in connecting the Model 17xx units over wireline for data transmission over long distances.

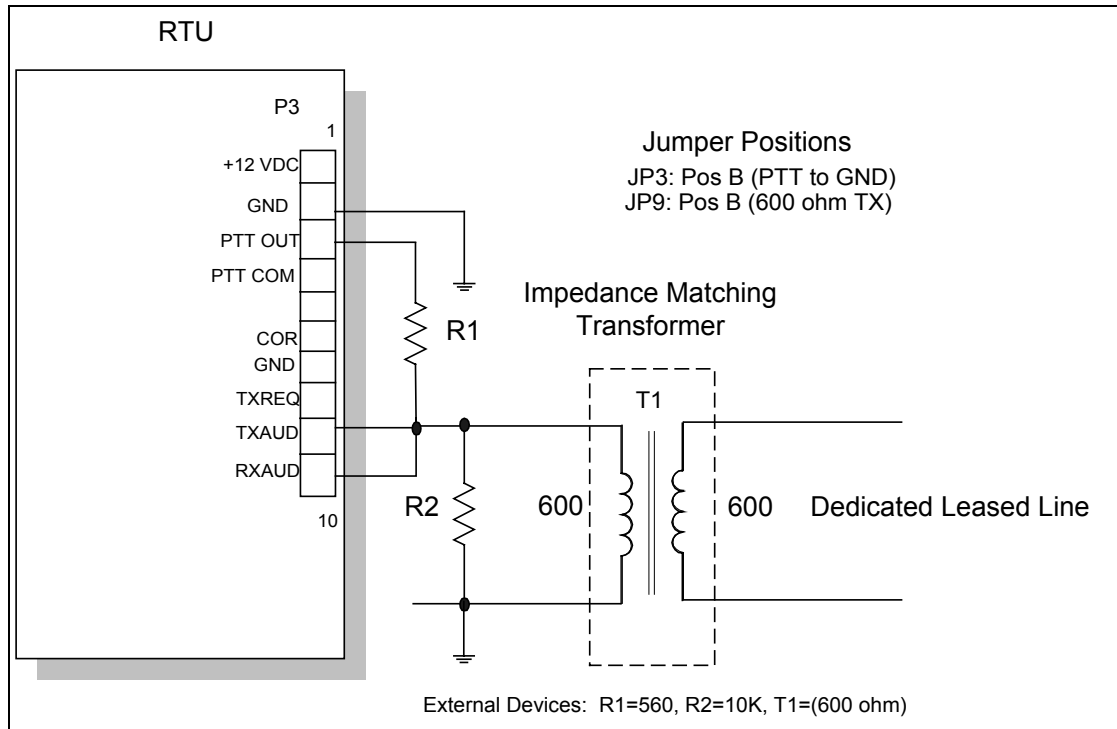


Figure 8. Leased Line Interface Circuit

Notes

Loss of signal will result from lack of proper grounding. Transformer will have to be a balanced 600Ω transformer for this to work properly, otherwise there will be additional signal loss. Transformers can be purchased through Zetron, part # 305-0022, or through a vendor. Resistor values should be observed.

Leased Lines

This application is for a dedicated leased line. Normal dial-up lines will not work. RTUs do not have the capability of dialing and waiting for a response. In this situation, when the unit reports a change of state, it will simply send the information.

Simple copper-pair wire will require line drivers over long distances since attenuation is high. Leased lines from the phone company should not require external amplification devices.

Collisions

There is no data flow control provided in the transformer coupling. If a busy indication is available, it can be connected to the COR input P3-6 of the unit.

If no busy indication is available, make sure the COR input is left at factory defaults, channel busy on logic low, and that jumper JP10 is in the "B" position. This will enable the units to transmit at all times.

APPENDIX B

MODEL 1730/1732 COMMUNICATIONS AND I/O TEST PROGRAM

The Model 1730 - Model 1732 Communications And I/O Test program is a troubleshooting tool for the Model 1730 Controller and Model 1732, Model 1716 and Model 1708 RTUs. With it you can:

- verify or debug radio communications between the M1730 Controller and RTUs
- verify proper wiring of Controller and RTU i/o points to equipment
- verify that i/o points on the Controller and RTUs are configured properly
- monitor the operation of an RTUBASIC program running in a M1732 RTU by watching changes in the RTUs inputs and outputs

STARTING THE PROGRAM

The setup process adds the program “M1730-M1732 Comm And I/O Test” to your Windows Start menu in the “Programs\Zetron\M1730-M1732 Comm And I/O Test” group. Select this menu item to start the test program. If the setup process created a shortcut on your desktop, you may also double click on this icon to start the program. The main window is shown in Figure 9.

To use the test program, you must connect one of your PC's RS232 ports to connector J2 on the Model 1730 controller or Model 1732 RTU. Use the same cable that you use to configure the Model 1730 or Model 1732.

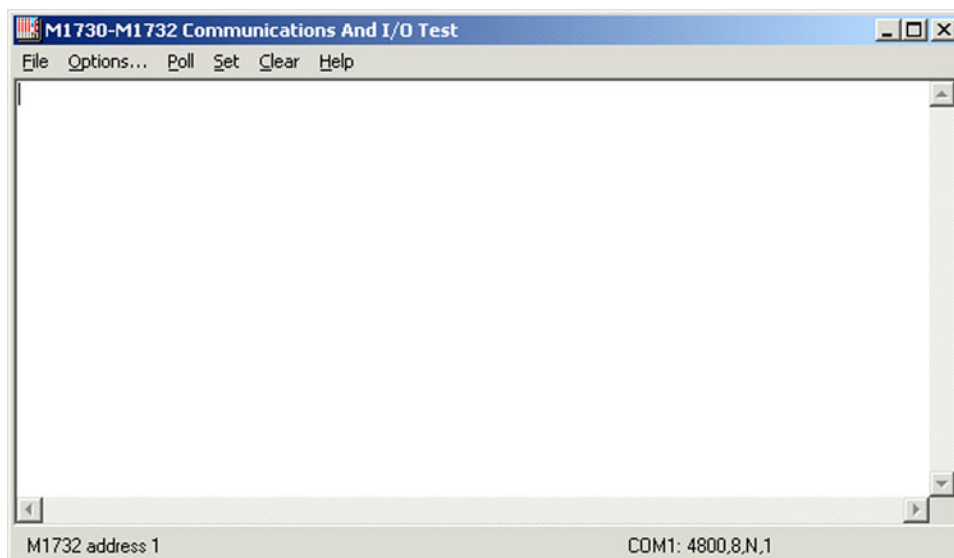


Figure 9. Communications and I/O Test Main Window

When connected to the Model 1730 controller, you will be able to test not only the controller but any RTU that communicates with that controller over the radio as well. If the Model

Appendix B

1730 has the MODBUS option, it must be configured to use the ULTRAc protocol so that it will pass all messages received from RTUs through to the Communications And I/O Test program.

When connected to the Model 1732 RTU, you will be able to test only the I/O points on that particular RTU.

All functions of the program are accessed through the menus. The center of the main window is where messages received from the controller and/or RTUs are displayed. The bottom of the window shows the currently selected device type and address, and the communications port settings.

SETTING OPTIONS

Selecting Options from the main menu brings up the dialog shown in Figure 10.

In the Address field, put the address of the Controller or RTU that you want to test.

The Device field should specify the type of device you are testing. The choices include: 1730, 1732, 1708, and 1716.

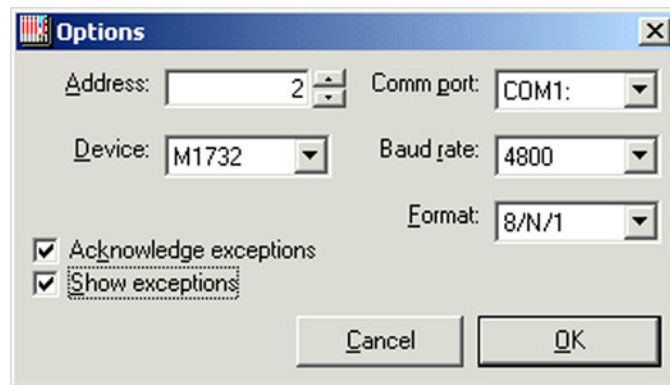


Figure 10. The Options Dialog Box

The Comm port, Baud rate and Format fields select and configure the RS232 communications port used to communicate with the device under test. You must select a port that is not in use by any other program.

The Acknowledge exceptions field should be checked if you want the test program to acknowledge exceptions reports received from the Model 1730 Controller and/or RTUs. If not acknowledged, the sender of the exception will keep sending the report, and eventually go into its communications fail state.

The Show exceptions field controls whether or not exception reports are shown on the screen. When this box is checked, exceptions reports received from any device will be displayed.

THE POLL MENU

The Poll selection in the main menu is used to poll the Controller or RTU for current I/O status, logic register values (Model 1732 RTU only) or hardware information.

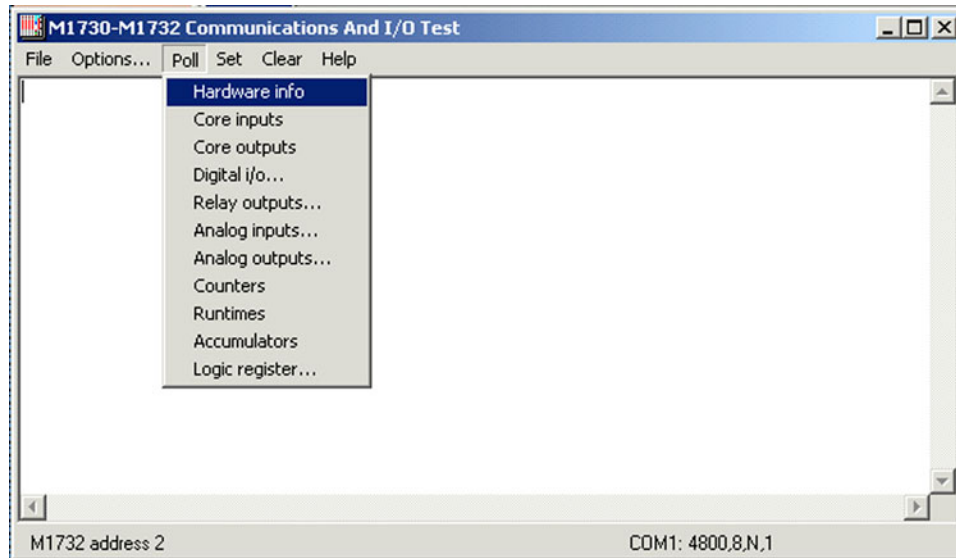


Figure 11. The Poll Menu

For menu items that end in an ellipsis (...), additional information such as the module or register number must be entered the before poll is sent. Examples of the dialogs for this are shown in Figure 12.

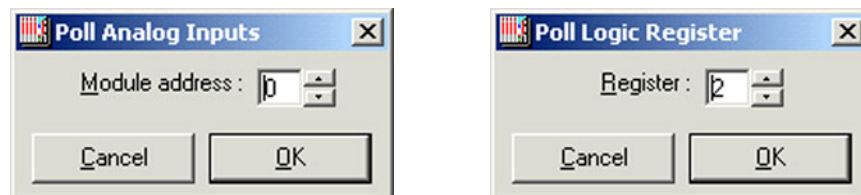


Figure 12. Entering Additional Polling Information

THE SET MENU

The Set option in the main menu is used to control outputs and change logic registers.

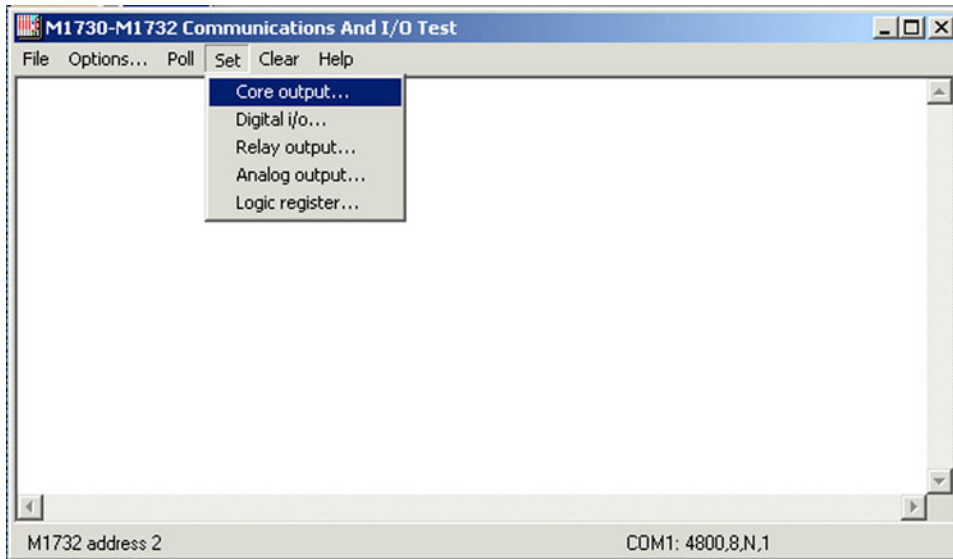


Figure 13. The Set Menu

When one of the Set menu items is selected, a dialog box always pops up requesting additional information such as the module number, output number and output value.

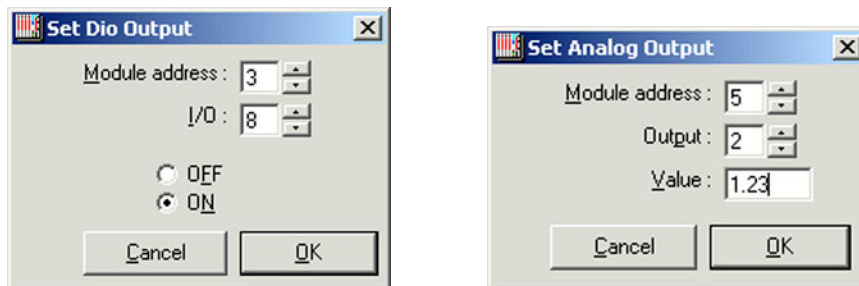


Figure 14. Entering Output Control Information

For setting logic registers, the register number, register type and new value are requested as shown in Figure 15.

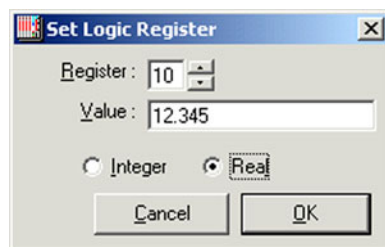


Figure 15. Setting a Logic Register

THE CLEAR MENU

The Clear menu provides options for clearing the message window and for clearing counters, runtimes and accumulators.

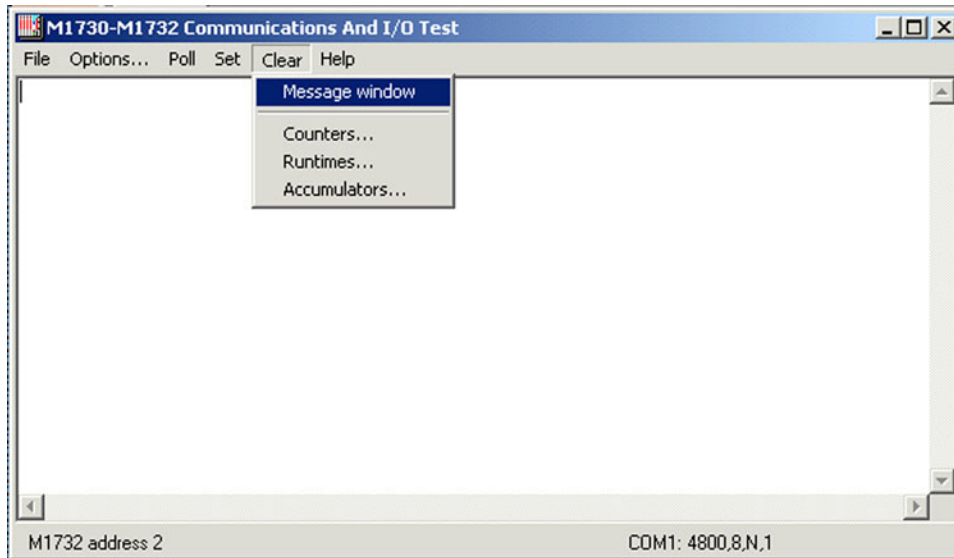


Figure 16. The Clear Menu

On the Model 1730 Controller and Model 1732 RTU, you can select one or more counters, runtimes or accumulators to clear at the same time. Figure 17 shows how this is done for counters.

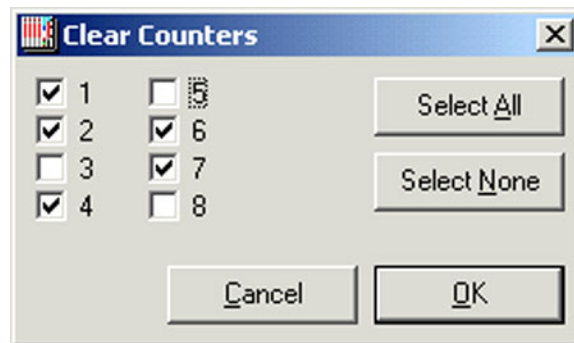


Figure 17. Specifying Which Counters to Clear

GLOSSARY

AC power module	The module that connects a device to an AC power source.
Accumulator	See analog input accumulator.
Acquisition timeout	The timeout for the first two steps of radio transmission: radio contention via the TXREQ signal and channel busy detect via the COR signal.
Address	See module address.
Analog input accumulator	Analog input accumulators keep a running total of the analog input value over time. They are often used to keep a running total of some flow through a system.
Autopolling	Data communications strategy where the SCADA master automatically sends queries for status to the RTUs.
Baud Rate	The rate of signal transitions for a given unit of time.
Binary format	A format to transfer information, generally consisting of ones and zeros. This is not intended to be a human-readable form.
Channel Busy Delay	The amount of time the radio channel must be available before the device will key up and transmit data.
Coil	From relay coil, now indicates a digital or relay output.
COM port	RS-232 serial communications port on a PC or Controller/RTU Core module.
Communications	See direct serial, phone modem, radio interface, or dedicated leased lines.
Communications failure	A breakdown in system communications. See exception reporting communications failure, polling communications failure, or RS-232 watchdog.
Compile	To translate a computer program expressed in a high-order language into its machine language equivalent.

Controller	In this manual, the word “controller” refers to the device that interfaces between the computer controlling the SCADA system and a radio transceiver.
Controller Address	The device address of a Controller.
Counter	The counter value is a count of the number of times the digital input on the core module activates.
Data address exception	An error indication in the MODBUS protocol that occurs when a query is sent to an illegal data address. It can also occur if the query addresses too many addresses at once.
Data value exception	An error indication in the MODBUS protocol that occurs when an attempt is made to write an illegal data value to a location. For example, attempting to set an output with a maximum value of 5 to 10 volts.
Dedicated leased line	See leased line.
Device	In this manual, the word “device” refers to the Model 1700 Controller, the Model 1708/1716 RTU, or other similar units.
Device address	The address used by the SCADA program to contact a specific device.
Digital I/O module	I/O module that connects its device to equipment to be monitored or controlled by the SCADA system. The module inputs and outputs digital signals.
DIP switch	A small enclosure containing a row of on/off switches that are used in a manner similar to jumpers for configuring electronic hardware. The switch takes its name from the fact that it fits into the same hole pattern used for DIP-style integrated circuits. DIP switch packages typically come with either four or eight switches.
Direct serial communications	A method of communication where computers and devices are connected without a modem and use serial communication.
Enclosure	The general term used in this manual for the structure that the modules sit in. See NEMA enclosure or Z-Box.

Exception Report Channel	The communications method used by a device for exception reports to a Controller. The choices are Radio, Phone, and Direct Serial.
Exception reporting	The ability of an RTU or Controller to report changes in I/O status to the master without being polled.
Form C relay	Relay with both normally open and normally closed contacts.
Group Call Address	An additional address assigned to an RTU (besides its own device address) to which the RTU responds. All RTUs with the same Group Call Address respond to messages with this address.
High Threshold	A value used with analog inputs or outputs to determine when to report an exception or log data.
Holding register	MODBUS term for transferring special data, such as analog outputs or accumulators.
Hysteresis	For analog inputs, outputs, and accumulators, a method of preventing multiple exception reports or data log entries as the signal crosses the threshold value. The value represents fluctuations above or below the threshold that will not cause an exception report or data logging.
Inbound Address Offset	Parameter used for store and forward radio communications.
Inbound Address Range High	Parameter used for store and forward radio communications.
Inbound Address Range Low	Parameter used for store and forward radio communications.
Initial Retry Interval	The time interval to wait before attempting to establish communications through the Exception Report Channel after the first failure.
Input register	MODBUS term for transferring analog input data.
Inter-Packet Delay	The minimum delay between the time the radio is keyed down at the end of a transmission and the beginning of a key up sequence for the next transmission.

Interpreter	A method of computer programming where an intermediate language is used.
Key Down Delay	Delay between the end of a radio transmission and the time the radio is unkeyed.
Key Up Delay	Delay between the time the radio is keyed up and the start of data transmission.
Leased line	Permanent wireline connection between Controller and an RTU. Also called “private line.”
Low Threshold	A value used with analog inputs or outputs to determine when to report an exception or log data.
Master	General SCADA term for the central control (hardware and software) of the system. See Slave.
MODBUS	MODBUS is an industry-standard process-control protocol used to transfer commands and data.
Modem Detect Command	Command sent to the modem on power up or reset to try to detect the presence of the phone modem. The modem is expected to answer “OK”.
Modem Initialization String	This string is used to initialize the modem before a telephone number is dialed.
Modem line	See phone line.
Modulo-10000 format	A method used in the MODBUS protocol to spread large data values across several registers. Each register holds a value between 0 and 9999. For example, the value 1234567890 would be spread across three separate registers containing the values 12, 3456, and 7890.
Multiplier	For the Counter, this factor is used in converting the counter totals into the units selected by the user.
NEMA enclosure	An enclosure that meets National Electrical Manufacturers Association (NEMA) standards.
Offset	For the Counter, this offset is used in converting the counter totals into the units selected by the user.
Outbound Address Offset	Parameter used for store and forward radio communications.

Outbound Address Range High	Parameter used for store and forward radio communications.
Outbound Address Range Low	Parameter used for store and forward radio communications.
Percent Change Delay	A value used with analog inputs or outputs to determine when to report an exception or log data.
Percent Change Threshold	A value used with analog inputs or outputs to determine when to report an exception or log data.
Phone line	A dial-up telephone line.
Phone modem module	A module that provides the interface between the RTU and a dial-up telephone line.
PLC	Programmable logic controller. A small industrial device that originally replaced relay logic. Usually uses the MODBUS protocol for communications.
Poll Cycle Interval	For autopolling, this is the time between successive polling cycles, defined as the time between the end of one autopoll cycle and the start of the next.
Polled-only system	A SCADA system in which the master controls all communication. The RTUs only transmit in response to a poll (query) from the master.
Polling	Refers to the communications from the master to query the status of inputs on RTUs.
Polling communications failure	A polling communications failure occurs when an RTU does not receive a poll for a programmed period. A local logic program uses a built-in variable, LastPollTime, to detect this type of communications failure.
Power-Up Message	A message (e.g., product name, version number, etc.) sent by the device to its Port1 serial port on power-up.
Protocol	A set of conventions governing the format and timing of message exchange between two communications terminals.
Radio interface module	A module that provides the interface between the device's core module and the radio transceiver. Also called "radio modem."

Radio modem	See radio interface module.
Relay Output Module	The module that connects a device to equipment to be controlled by the SCADA system. The equipment must have on/off controls.
Report by exception	See exception reporting.
Retry	For autopolling and exception reporting, an additional attempt to communicate with a device that fails to respond.
Retry Timeout	For autopolling, the timeout period begins at the end of the polling transmission from the Controller and determines when an RTU is considered to have failed to respond.
Rings to Answer	The number of rings to wait before letting the modem answer incoming calls.
RS-232	Standard for asynchronous serial data communications defining connectors and signal levels.
RS-232 Watchdog	Function in a Controller that looks for messages from the PC.
RS-232 Watchdog Timeout	A Controller monitors its RS-232 communications with the PC running the SCADA program. If the Controller does not see any messages in the set period, the SCADA program has failed.
RTU	Remote Terminal Unit. — Usually a small stand-alone data acquisition and control device in the field that allows the central SCADA master to communicate with field instruments. It provides the interface between a radio transceiver, or other communications link, and the equipment being monitored and controlled. Its function is to control process equipment at the remote site, acquire data from the equipment, and transfer the data back to the central SCADA master. The Models 1708 and 1716 are RTUs.
RTU Address	Device address of an RTU.
RTU Poll Interval	For autopolling, this represents the interval between receiving a response from the last RTU polled, and sending a poll to the next RTU in the sequence.

RTU Type	A configuration setting. An RTU can be a Model 1708 or a Model 1716.
SCADA	Supervisory Control And Data Acquisition. General term for an industrial measurement, data gathering, and control system. The system usually consists of a central host or master, one or more field data gathering and control devices, called remote terminal units, and software used to monitor and control the remotely located field data gathering and control devices.
SCADA program	Software used to monitor and control remotely located field data gathering and control devices, e.g., LOOKOUT.
Scaling Factor	For accumulators, the numeric value associated with the time factor.
Serial communications	Communication method where data is transferred one bit at a time.
Slave	General SCADA term for the remote site data collection and control device (RTU). The slave reports to the master, the central control of the SCADA system.
Slot #	For Store and Forward radio transmissions, 10 slots or blocks of addresses can be assigned to the store and forward lookup table.
Source file	The human readable form of a computer program.
Store and forward	The ability of an RTU to receive messages from the Controller and resend the message to another RTU and vice versa.
Stored status	RTU status stored in a Controller and used to build responses to MODBUS protocol queries.
Time Factor	For accumulators, the time factor is used to adjust the samples-per-second accumulation to the custom values.

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