Remote Facilities Controller

Model RFC-1/B

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Relay Panel

Model RP-8

– Instruction Book –

615 - 228 - 3500
222 - 2367 fax

This documentation is valid for
Remote Facilities Controller hardware version 3.01
Relay Panel hardware version 1.10

Sine Systems, inc
Nashville, Tennessee

Table of Contents

Hardware Book

Software Book

Section 1 — Warranty/Product Registration:

Warranty

Sine Systems, Inc. agrees to repair or replace the RFC-1 Remote Facilities Controller or the RP-8 Relay Panel at no cost, if the unit fails in normal use, during the first year of original ownership. This Warranty does not include damage caused by improper installation or use, nor does it include damage caused by any external means such as lightning or voltage transients. For Factory Service Policy, see "Section 7 — Troubleshooting and Repair."

Suitability For Use

The purchaser and user of the Sine Systems RFC-1 Remote Facilities Controller or the RP-8 Relay Panel bears the sole responsibility for determining suitability of this equipment for their intended use. Because this equipment can, as can any electronic equipment, fail in an unpredictable or unexpected way, even in normal use, Sine Systems, Inc. cannot be held responsible for damages, either direct or indirect, resulting from use of this equipment. Under no circumstances should this equipment be used or relied upon in a situation where a life-threatening condition could result if the equipment were to fail.

Product Registration

To help us know our customers and to keep them informed of future engineering, product, and safety information, please fill out the following form and send a copy to Sine Systems at the address below. It is not necessary to return this form to validate the warranty but it is necessary if you wish to receive engineering bulletins.

If you did not purchase the equipment new, we still encourage you to register as an owner so that you will automatically receive all pertinent safety and product information.

Record the following information and return a copy to Sine Systems:

RFC-1 Serial Number (on front panel): _____

Name of purchaser (company or call sign): _____

Mailing address: _____

Contact Name: _____

Telephone: _____

Purchased from: _____

Date delivered: _____

Section 2 — "About This Manual . . ."

Unfortunately, it seems that the instruction book is sometimes the least well-prepared part of an industrial electronic product. Too often, products are sold with no instruction book and sometimes without even a schematic diagram. In the other extreme, some products are sold with a voluminous instruction book but which contains mostly useless information such as manufacturing drawings or impossible-to-decipher wire lists. The extra information itself is of no harm, but its inclusion often results in the fact that it takes a great deal of time to locate a simple piece of often needed data: the "pin out" of a particular connector for example.

It is the philosophy of Sine Systems to include in our instruction books all information that might be useful to the end user, and nothing else. Any obscure data which is not in the instruction book can easily be obtained by a telephone call to Sine Systems. Our telephone number is shown on the front cover of this manual. Every effort has been made to insure that our documentation is complete, well organized and fully indexed. Each Sine Systems Instruction Book is identified as to the manufacturing version of the units for which it is valid documentation. This eliminates the possibility for confusion if more than one version of a product is in service at a time.

Many manufacturers print their instruction books in fairly high volume to reduce costs and then insert "addendum" or "change" pages in the front or back of the book when changes are required. While this technique is attractive from the standpoint of the manufacturer, it significantly compromises the value of an instruction book to the end user because it disrupts the orderly arrangement of data, and in some cases, results in confusing or contradictory information. Sine Systems' Instruction Books are printed in small quantities shortly before the unit is shipped. This insures that the information contained in each instruction book is completely up-to-date and arranged in a logical order.

The instructions for the RFC-1 Remote Control System are divided into two books. The first, the "hardware" book, deals with the physical details of the system and the second, the "software" book, deals with all the operating characteristics of the system which are determined by the resident firmware. To allow easy access to all information, tables of contents and indexes are included in each book.

We want to be as proud of our Instruction Books as we are of the products they document. To this end, we encourage feedback from our customers on how we can make our instruction books, as well as our products, even better.

John Pate
President, Sine Systems

Section 3 — Safety Information

WARNING!

The RFC-1 Remote Facilities Controller and the RP-8 Relay Panels should be installed only by qualified technical personnel. Incorrect or inappropriate installation could result in a hazardous condition.

The RFC-1 Remote Facilities Controller is registered with the Federal Communications Commission and certified to meet specific safety requirements. It is extremely important that the RFC-1 not be modified in any way. Modification of this equipment will void the FCC certification, void the warranty, and perhaps pose a hazard to the user of this equipment or to maintenance personnel of your local telephone company.

Service of the RFC-1 Remote Facilities Controller should be performed only by qualified technical personnel who are familiar with the implications of FCC Part 68 registration. Extreme caution should be used if the RFC-1 Remote Facilities Controller case is opened without first being disconnected from the telephone line and the RP-8 Relay Panels. High voltages may be present on telephone lines, and although the RFC-1 is powered by 12 volts AC from a "wall plug" transformer, failure of this transformer could cause dangerous and potentially lethal voltages to become present. Only the supplied transformer should be used.

The RFC-1 contains self-resetting "fuses" that protect it from excessive current. If these are replaced, the replacement devices should be of the same type and rating.

Depending on the installation, the RP-8 Relay Panels may be connected to 120 volts AC. If this is the case, use extreme care when working in the vicinity of these panels. Disconnect all sources of high voltage AC before contacting these panels.

The RFC-1 Remote Facilities Controller and the RP-8 Relay Panels are designed for indoor use in a dry location. Installation and operation in other locations could be hazardous.

Section 4 — Specifications

RFC-1 Remote Facilities Controller

General

power requirements:	12 volts AC, 0.55 amps maximum
size:	6.0" wide x 7.0" deep x 1.75" high, maximum
connectors:	
"LINE" (RJ11C)	dial-up telephone line
"TELEPHONE" (RJ11C)	dual purpose, programmable: 1. For use with local telephone set 2. For use as dedicated control port
"RELAY PANELS" (16 pin)	interface relay panels and 12 volt AC power
outward dialing method:	"pulse" dialing; 10 pulses/second or "imprecise" (Note 1) DTMF dialing with software versions 5.07 and later

Telemetry

telemetry/status output:	synthesized voice
maximum number of channels:	64 telemetry/status
telemetry source:	positive or negative DC voltage
minimum voltage required for full scale:	1.0 volt
maximum offset voltage:	sources may offset up to 30 volts from ground
telemetry resolution:	one part in 1020 minimum, software dependent
telemetry accuracy:	0.5% of full scale

Control

control source:	DTMF tones/clock calendar/telemetry conditions
maximum number of channels:	64 OFF/ON control
control duration:	as long as DTMF tone is present or minimum programmed "relay on" time, whichever is greater

Note 1: The RFC-1 does not contain a dedicated DTMF generator. "Imprecise" DTMF tones can be generated by the RFC-1 using tones which are prerecorded in the speech synthesizer. Because of a broad frequency tolerance, these tones are swept slightly in frequency and are sent at a lower amplitude than normal DTMF tones. In the vast majority of uses, these tones are a workable substitute for precise DTMF tones although success can not be guaranteed in all cases.

RP-8 Interface Panel

General

block selection:	user selectable using jumper plug
power requirements:	supplied by RFC-1
size:	3.5" high x 19" wide x 1.75" deep, maximum

Telemetry /Status Inputs

number of telemetry/status inputs:	8
switching method:	hermetically sealed reed relay
input impedance:	50K to 60 K ohms
maximum input voltage:	16 volts DC (across "+" and "-" terminals)

Control Outputs

number of control relay outputs:	8 ON/ 8 OFF
output type:	form "C" contacts, floating
contact ratings:	120 volts AC, 5 amps resistive/2 amps inductive

Section 5 — Installation

WARNING!

Installation of the RFC-1 Remote Facilities Controller and RP-8 Relay Panels should be performed only by a qualified technician. Installation is not difficult; however, an attempted installation by a person who is not technically qualified could result in danger to operating or maintenance personnel, or damage to the unit.

Unpacking

When the RFC-1 and RP-8 panels are unpacked, they should be inspected for obvious signs of mechanical damage or loose parts. Loose parts should be tightened before installation. If damage is found, save the packing material and report it to the shipping company and the dealer from which it was purchased. Do not install the unit.

FCC Information

The RFC-1 complies with Part 68 of the FCC rules. On the front panel of the RFC-1 is a label that contains, among other information, the FCC registration number and ringer equivalence number (REN) for this equipment. If requested, this information must be provided to the telephone company.

The RFC-1 is designed for use with standard modular (RJ11C) telephone jacks.

The REN is used to determine the quantity of devices which may be connected to the telephone line. Excessive REN's on the telephone line may result in the devices not ringing in response to an incoming call. In most, but not all areas, the sum of the REN's should not exceed five (5.0). To be certain of the number of devices that may be connected to the line, as determined by the total REN's contact the telephone company to determine the maximum REN for the calling area.

If the RFC-1 causes harm to the telephone network, the telephone company will notify you in advance of service disconnection. But if advance notice isn't practical, the telephone company will notify the customer as soon as possible. Also, you will be advised of your right to file a complaint with the FCC if you believe it is necessary.

The telephone company may make changes in its facilities, equipment, operations, or procedures that could affect the operation of the RFC-1. If this happens, the telephone company will provide advance notice in order for you to make the necessary modifications in order to maintain uninterrupted service.

If trouble is experienced with the RFC-1, please contact Sine Systems, Inc. (at the telephone number on the cover of this instruction book), for repair and (or) warranty information. Additional information is contained in the "Troubleshooting and Repair" section of this manual. If trouble with the RFC-1 is causing harm to the telephone network, the telephone company may request you remove the equipment from the network until the problem is resolved.

The RFC-1 cannot be used be used on public coin service lines provided by the telephone company. Connection to Party Line Service is subject to state tariffs. Contact your state public utility commission, public service commission, or corporation commission for information.

Mechanical Installation

The RFC-1 generates little heat and can be mounted in just about any convenient location. It can be mounted on a desk top or in the bottom of an equipment rack, it can be wall mounted, or it can be rack mounted with the optional RK-3 rack mount kit. The RP-8 panels should be mounted in a standard 19" equipment rack at a location which is convenient to the necessary control and metering sources which will be connected to it. Eight feet of cable is supplied for interconnection between the RFC-1 and the RP-8 panels but this cable can be replaced with a longer one if necessary. RP-8 panels can be installed in two or more locations if desired.

Electrical Installation

The RFC-1 should be connected to a standard telephone line with the modular (RJ11C) jack on the front panel labeled "LINE." A seven foot cord is supplied with the RFC-1 for this purpose. A telephone may be connected to the front panel jack labeled "TELEPHONE." When the RFC-1 is not being used, this telephone will function normally. Alternately, the TELEPHONE jack may be used as a dedicated control port. This is described in the "Dedicated Control Port" section later in this chapter.

The "TELEPHONE" jack on the front panel of the RFC-1 is connected to an internally generated DC source in the "Local Control" mode. This supplies the power to the local telephone and allows it to generate tones with its keypad. The DC power supplied by the RFC-1 is a lower voltage than would normally appear on a standard telephone line. However, with extensive field use, only one telephone has been found that would not generate tones reliably with the DC power supplied by the RFC-1. This particular telephone was a low cost telephone purchased from a discount retailer. Consequently, if the "Local Control" button is pushed and "OK" is heard on the telephone but the telephone will not generate tones reliably, try a different telephone. The best type of telephone to use is one that has good sidetone suppression of the DTMF tones. This eliminates the annoyance hearing loud tones while calibrating. In the high RF fields near AM transmitters, the simple, "non-electronic" telephones work the best. In particular, the original "2500" series AT&T telephone is virtually "bullet proof" when it comes to RF and its sidetone suppression is very good also.

The RFC-1 should be connected to the RP-8 relay panel(s) by means of 16 conductor ribbon cable. Eight feet of this cable is supplied with the RFC-1. One ribbon cable connector is included with the RFC-1 and one additional connector is included with each RP-8 panel. To terminate these connectors, first slide the connector over the end of the ribbon cable. Be sure to check three things: 1) that the color stripe is on same side as the other connectors on the cable, 2) that the ribbon cable lines up with the little slots in the connector, and 3) that the connector is perpendicular to the cable. If the connector is to be on the end of a cable, the cable can emerge from the top or bottom of the connector, but either way let the cable stick out a quarter of an inch or so. Next, squeeze the connector together with a small vice. A pair of pliers and a couple of small blocks of wood will also work. If the vice has "gripping teeth," sandwich a couple of pieces of cardboard between the jaws and the connector to prevent damage. When the connector is squeezed together sufficiently, the latches on the ends of the connector will click. If this is an end termination, trim off any excess cable flush with the

connector with a pair of diagonal cutters. Connectors terminated at intermediate locations on the cable terminate in the same way but in this case, temporarily remove the latch portion of the connector to get it on the cable. This is done by prying apart the latches on the ends of the connector and then pulling the connector apart.

Plan your interconnection cable before you begin installing connectors. For RP-8 panels mounted adjacent to each other, the connectors should be placed at about six inch intervals on the cable. Don't forget to allow a little extra cable for future expansion. Remember, if you need to add RP-8 panels, simply add connectors to the existing cable. There is no need to replace the cable.

RP-8 Channel Block Assignment

Each RP-8 panel in the system should be assigned to a different "block" of eight channels. These blocks are: 00-07, 08-15, 16-23, 24-31, 32-39, 40-47, 48-55 and 56-63. Assignment to consecutive blocks is usual but not required. Block assignment is accomplished with a small jumper plug located on each RP-8 panel. Simply move this plug to the desired block. This is normally of no consequence, but be aware that the RFC-1 "sits" on channel 63 during idle conditions (in between telephone calls). If the last block of channels are used (56-63), the telemetry relay for channel 63 will be energized during idle periods.

RP-8 Terminal Blocks

All control, telemetry and power connections made to the RP-8 panels are made through the small screw-terminal blocks. These terminal blocks are removable from the PC board which makes installation, modification and testing much easier. To remove them, simply pull them straight out. Note that they are designed in such a way that they can be reinstalled in either of two ways: vertically or horizontally. Vertical installation is usually better if you want to use it more like a plug and horizontal installation is easier if you want to use it more like a barrier strip. Either way is fine but be aware that they can be installed backwards. In the case of a control output, the normally open and the normally closed contacts would be exchanged so you might be unintentionally turning something on if you plugged it in backwards.

RP-8 Panel Identification

The front of the RP-8 Relay Panel includes a place to record data around each telemetry adjustment access hole. Viewed from the front of the panel, the lowest channel number will be on the far right. It is often desirable to write the channel number in the space indicated as well as any other information pertinent to that channel. A "Sharpie" pen is a good method to hand write information and dry-transfer lettering is a way to produce a more professional look. Lettering can be cleaned from the panels using acetone. Acetone is a strong solvent and should be kept away from plastics including the "Local Control" pushbutton. Acetone is also highly flammable.

Power Connection

Power to operate the RFC-1 and up to eight RP-8 panels is supplied by a 12 volt AC "wall-plug" transformer supplied with the RFC-1. This transformer has a U.S.A. standard plug and is designed for 120 volts AC, 50-60 Hz. The leads of this transformer should be stripped and connected to the terminals marked "12 VAC" on any one of the RP-8 panels in the system. If

the supplied transformer is of the type that has a connector on the end of the cord, simply cut the connector off and discard it.

In installations where 120 volts AC is not available, the RFC-1 may be powered by any transformer delivering 12.0 to 14.2 volts AC (50 - 60 Hz) or any DC power supply delivering 15.4 to 17.5 volts DC. The RFC-1 draws a maximum of 0.35 amperes. A 12.6 volt "filament" transformer is an ideal substitute power source. The power source should be "floating." Neither side of the power source should be connected to ground (earth) nor should the power source be connected to any other equipment. Failure to do this will result in inaccurate telemetry indications.

WARNING!

Before power is applied initially, check the "12 VAC" terminals with an ohmmeter for a short circuit. Make this test with the flat cable plugged into both the RFC-1 and the RP-8 panel(s). If a short is detected, it is likely that one of the flat cable connectors has been installed backward. Do not connect the wall-plug transformer until the problem is found and corrected.

Telemetry Connections

Telemetry connections are made on the RP-8 panels through the eight terminal blocks located across the top of the panel marked "Telemetry." The channels on the panel are identified as "00" through "07" but this would be the correct numbering only if it was assigned to the first "block."

The RFC-1 can telemeter either a positive or a negative voltage source. One volt DC is the minimum voltage required for a full scale reading but a lower voltage will be sufficient if less than a full-scale reading is satisfactory.

The telemetry terminal blocks are marked "-", and "+". Connect the positive side of the telemetry source to the "+" terminal and the negative side to the "-" terminal. Either side may be ground referenced, if desired, or the telemetry source may be offset from ground up to 30 volts.

High telemetry voltages (4 volts or greater) will cause the active range of the calibration potentiometers to be limited to the bottom few turns of the 22 turn total range and make calibration "touchy." For this reason it is suggested that high telemetry voltages be attenuated with an external attenuator. The best way to accomplish this is to add a 2.2K resistor shunted across the RP-8 telemetry terminals and a series resistor connected to the telemetry source. The series resistor should be about 2200 ohms per volt in excess of two volts. For example, to attenuate a telemetry voltage of 10 volts, use a 2.2K shunt resistor and a 18K series resistor. The values are not critical.

Shielded wire for telemetry circuits is not normally necessary as a considerable amount of RFI filtering is included in the RFC-1. However, lines from AM sampling loops in some installations may contain a very large amount of RF which can cause telemetry linearity or other problems. RF chokes of about 2.5 millihenrys inductance inserted in each telemetry lead should eliminate this problem.

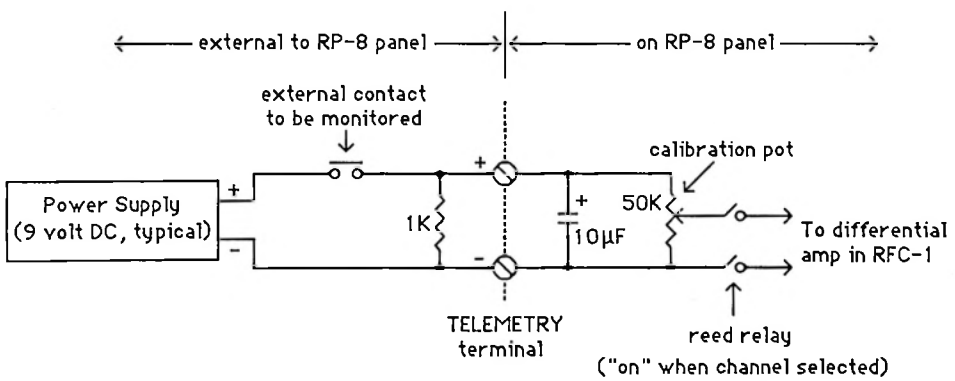
WARNING!

Some older equipment provides telemetry outputs which can be elevated as much as several hundred volts above ground. Do not connect this type of telemetry source to the RP-8 panels!

If the RFC-1 is to be used in "parallel" with another remote control, it is usually quite feasible to simply parallel the corresponding telemetry sources. There are some potential problems to consider, however. First, be sure the telemetry sources fall within the voltage guidelines discussed above. Second, calibration of the original remote control will be necessary after the RFC-1 connections are made since an additional load will have been placed on the telemetry sources. Third, the RFC-1, and all other remote controls for that matter, present a slightly different load impedance depending on whether a particular channel is selected. For this reason, do not calibrate or read one remote control with the other remote control "sitting" on the same channel. Nothing catastrophic will happen, but, depending on the impedance of the telemetry source, inaccurate telemetry readings may result and the Telephone Alarm System may be tripped unnecessarily.

Status Connections

The RFC-1 has the feature that any telemetry channel can also be a status channel. To understand how to accomplish this it is helpful to first understand the telemetry output protocol. The RFC-1 has the capability to read telemetry over a range of 0000 to 2040. If the reading is between 0003 and 2039, the telemetry is spoken as four digits. If the reading is 0002 or lower, the words "Status: Off" are spoken. If the reading is 2040 (or over-range) the words "Status: On" are spoken. The following illustration shows how status indications can be accomplished:



When the external contacts are closed, the telemetry reading for the channel will be "Status: On" and when the contacts are open the telemetry will be "Status: Off." The power supply shown in the illustration can be a simple "wall-plug" battery eliminator which can supply anywhere from 6 to 12 volts DC. An example of this is a Radio Shack 273-1455. A single power supply can furnish power for many status contacts. The external 1K ohms resistor is added to more quickly discharge the 10 µF capacitor on the RP-8 panel. Otherwise about 5

seconds is required before a "Status: Off" reading is reached after the external contacts open. The telemetry calibration potentiometer should be set so that when the external contacts close, a "Status: On" reading is achieved.

Alternately, the RFC-1 power supply may be used to furnish a voltage for status indications. However, this should only be done if neither side of the internal power supply will be grounded and if relatively short wiring runs are possible. The power supply for the RFC-1 must remain "floating" and should not be exposed to the possibility of transient high voltage. The negative side of the internal power supply is available on conductor number 15 and the positive side (+10 volts) is available on conductor 14 of the interconnect cable, counting from the right. Generally speaking, is it easier and safer to use a separate external power supply for powering status circuits.

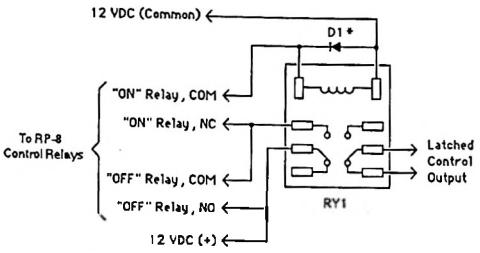
The previous illustration is only one of many possibilities of how status indication can be accomplished. For example, if you wanted a closed contact to read "Status: Off" you could connect the voltage source through a 1K ohm resistor to the positive telemetry terminal and bridge the monitored contacts across the positive and negative telemetry terminals. A closed contact would "short" the voltage and produce a "Status: Off" indication. Also, in many cases it will be convenient to use an externally generated voltage to indicate status. Suppose, for example, that you wanted to monitor a large AC contactor which did not have auxiliary contacts. A small step-down transformer could be placed across the coil of the contactor and the resulting low voltage AC could be routed through a series diode and resistor (about 1K) to the telemetry input. The 10 µF capacitor on the RP-8 panel is sufficient for filtering. Remember that 16 volts DC is maximum voltage that should be applied across the "+" and "-" terminals.

Control Outputs

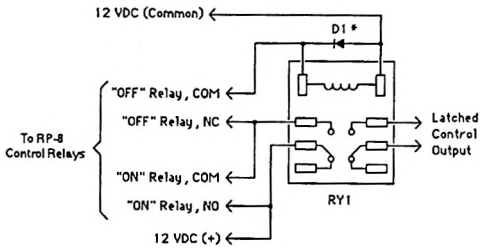
Each RP-8 panel has 8 "ON" relay outputs and 8 "OFF" relay outputs. Each output is form C (SPDT), floating, and rated at 120 volts AC, 5 amperes resistive, 2 amperes inductive.

WARNING! Although the control relay contacts are rated for 120 volts AC, we highly recommend that you bring only low voltage AC or DC to the RP-8 panel. This is because of the large number of exposed terminals that would be hazardous to maintenance or operating personnel if high voltage were present.

The control relays on the RP-8 panels operate "momentarily." In other words, the relay operates as long as the "*" or "#" key is pushed on the telephone keypad. If latched operation is needed, an external latching relay is required. This can be either a mechanically or magnetically latched relay. For many applications, an electrically latched relay can be used. The following diagram illustrates two examples of this:



Note: This circuit "powers up" with the latched output "ON."



Note: This circuit "powers up" with the latched output "OFF."

Parts List:

RY1: DPDT relay; 10A contacts, 12VDC coil (Radio Shack 275-218)
D1: 1N4005 (RadioShack 276-1004)
Power Source: 12 VDC wall plug supply (Radio Shack 273-1652)

* Omit D1 if an AC relay is used.

If a transmitter requires a maintained contact to operate the filaments, for example, the left of the above circuits is recommended. The only disadvantage of an electrically latched relay in this application is that if the power were to fail momentarily when the filaments were off, they would be turned on. For filament supplies, this would not normally be a problem. For plate voltage supplies, a mechanically or electrically latched relay would likely be necessary.

Failsafe Operation

For applications that require it, Sine Systems offers the model AFS-1 Dual Channel Audio Failsafe unit. This device bridges one or two audio sources (a program line, for example) and will open a relay contact when audio is absent from both inputs for 4 minutes. This can be used as an alternate means to turn a broadcast transmitter off in the event of a telephone line failure.

Other possible means of alternate means to turn off a broadcast transmitter are the squelch relay in an STL receiver, the use of the "dedicated control port" described later in this section, and, in applications where an AM station is rebroadcasting an FM station, the "Stereo Pilot" LED in an FM receiver.

Initial Programming

The initial (programmed at the factory) user-programmable settings are contained in the "Software" instruction book.

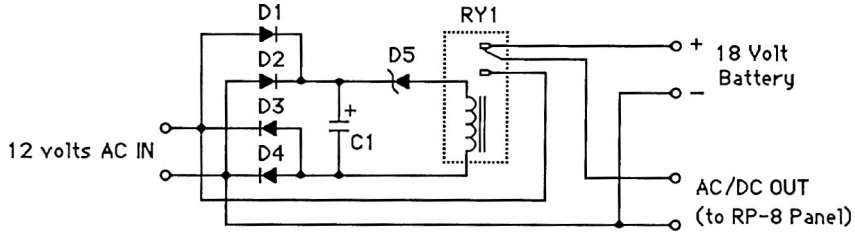
Battery Back-up

The RFC-1 allows up to 80 time/date functions to be programmed by the user. These functions are stored in non-volatile memory and remain intact if power is interrupted to the RFC-1, even for extended periods of time. However, the clock/calendar itself does require continuous power. It is a simple matter to reset the clock/calendar after a power outage but if it were not discovered in time, one or more programmed events could be missed. For non-critical applications, this problem can be lessened by programming the RFC-1 to automatically make a call and report power failures upon power restoration. The operator receiving the call can then reset the clock and calendar. For more critical applications, an uninterruptable power supply is the best solution. This has the secondary advantage of

allowing the RFC-1 to make and receive telephone calls while the power is off. This is often very important where the controlled site is very remote or difficult to reach.

The RFC-1 may be operated on an uninterruptable power supply of the type designed for personal computers. An example of this is the Tripp Lite BC250 which is available from Digi-Key (800-344-4539) for about $129.00. The BC250 will operate the RFC-1 for about 1.5 hours without external power. The BC250 is not an "instant switching" UPS but this is not required since the filter capacitor in the RFC-1 is capable of providing power to the RFC-1 during the switching time.

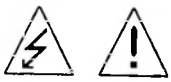
Alternately, the RFC-1 may be operated during power failures by any means that supplies +15.2 to +19.9 volts DC to the "12 VAC" terminals on the relay panels instead of the normal 12 volts AC. The DC source should be "floating" (neither side connected to ground) to allow the telemetry section to work properly. Polarity of the voltage is unimportant as this connection point precedes the bridge rectifier in the the RFC-1 power supply. The RFC-1 may be powered by DC at all times, if desired. The following is a simple circuit that will allow emergency operation on batteries for a cost of less than $20.00:



D1 to D4; 1N4005 (Radio Shack 276-1104)
D5; 6.2 volt, 1 watt zener (Radio Shack276-561)
C1; 47 µF or 50 µF; 16 to 35 volt electrolytic (Radio Shack 272-1027)
RY1; relay, SPDT, 12 VDC, 300 to 500 ohm coil (Radio Shack 275-248)

WARNING! It is very important that this circuit remain floating, i.e. not connected to ground. This is important because the telemetry sampling in the RFC-1 is floating.

The value of C1 should be just large enough to keep RY1 pulled-in during normal power conditions. If its value is too large, the switchover time will be excessive and the RFC-1's clock will reset. The value of C1 shown above is the correct value for the indicated relay.
The 18 volt battery consists of three 6 volt heavy-duty lantern batteries wired in series. These are available from Radio Shack; stock # 23-016. These batteries will power the RFC-1 for about 14 hours. If only a very short term back-up is needed, two alkaline 9 volt batteries may be used. This will operate the RFC-1 for 30 minutes to one hour, depending on use. The batteries will need to be changed at intervals of 12 to 18 months even if they are seldom used because of their limited shelf life.



WARNING! Do not under any conditions apply a DC voltage greater than 19.9 volts (peak, if significant ripple is present) to the RFC-1. Prolonged exposure will cause the over-voltage protection circuitry in the RFC-1 to overheat and be damaged. This maximum voltage rating precludes the use of some rechargable batteries.

If you have the capability for operation from a back-up battery, you may want to have the ability to telemeter power line voltage. This can be done easily with an unregulated wall-plug power supply, a Radio Shack 273-1552 for example, connected to one of the telemetry inputs. After measuring the power line voltage, the telemetry channel can be calibrated directly in volts. For example "1175" would correspond to 117.5 volts.

Operation at Sites Without a Telephone Line

The RFC-1 is designed to be connected to an ordinary telephone line. In some cases, a telephone line is either not available or is prohibitively expensive at the site where the RFC-1 is to be installed. This is usually because the site is very remote or otherwise difficult to access. In these cases, there are several alternatives to a regular telephone line. Here are some suggestions:

The "Rural Radiotelephone" or "Ranch Telephone":

Rural radiotelephone systems, or "ranch phones" as people like to call them out west, are systems that use a full duplex VHF or UHF radio circuit to extend a telephone line. There are two "boxes" in a system. One is installed at a location where there is a telephone line and is connected to a small Yagi antenna. The other box is installed at the remote site and is connected to another Yagi antenna. The second box has a RJ-11 jack that behaves just line a regular telephone line. The RFC-1 and a local telephone can be used with this system just as it would be used with a regular telephone line. The RFC-1 and the local telephone can receive and make telephone calls. Rural telephones have a range of 1 to 10 miles or more depending on terrain. The transmitter power levels are usually in the range of 1 to 10 watts. Because they contain transmitters, rural telephones must be licenced. Channels are scarce in the more populated areas of the country but are usually available in the areas where rural telephones are most often needed.

The big disadvantage of rural radiotelephones is the initial cost; about $5200 for a typical system. This is somewhat mitigated by the fact that, once installed, there is no recurring cost. A company which sells rural radiotelephones is DX Radio Systems, 3370 San Fernando Road, Unit 206, Los Angeles, CA, 90065. Their telephone number is (800) 447-6937 or (213) 257-0800. Another source for such equipment may be your local telephone company.

Cellular Telephones With "RJ-11 Adaptors":

It is possible, with appropriate adaptation, to use a cellular telephone at the RFC-1 location in place of a regular telephone line. Adapter devices are available which can allow interface a cellular telephone with a standard RJ-11 jack. These devices generate the standard telephone line protocol including "battery," dial tone and ring voltage. In other words, they can make a cellular telephone emulate a regular telephone line. Add to this a 12 volt DC power supply, an external antenna, and you're in business. Because of a patent they own, Spectrum

Technologies is the only company we know of that makes aftermarket adaptors that can completely emulate all characteristics of a telephone line. Spectrum makes adaptors for many types of cellular phones. However, if your RFC-1 has a software version earlier than 5.07 you will need to use their adaptor for Audiovox cellular telephones because it is the only one compatible with pulse dialing. RFC-1s with software version 5.07 and later have DTMF dialing. These adaptors cost about $400.00. The cellular-telephone approach is often attractive for broadcast stations because they can usually "trade out" a cell phone and air time. Spectrum Technologies' phone number is (800) 233-2119.

It is reported that Fujitsu, Motorola, NEC and OKI make cellular-to-RJ11 adaptors for their cell phones. Check with your local dealer for information. Radio Shack makes an inexpensive RJ-11 adapter (part number 17-504 CMC) for one model of their cellular telephones, however, this device does not generate ring voltage and is not suitable for use with the RFC-1.

Fixed-Location Cellular Telephones:

An alternative to using a regular (mobile) cell phone with a cellular-to-RJ11 adaptor is to use a cell phone designed specifically for fixed locations. These phones can be powered directly from 120 volts AC. These phones have a built-in cellular-to-RJ11 adaptor and provide a little "cleaner" solution than the "adaptor" approach. With adaptors and cell phones made by two different companies it is usually the case where one company blames the other if there is a problem. When you get the whole thing in one box, made by the same company, it avoids this problem. One manufacturer is Telular, Inc. (708 256-8000) whose prices start at around $1400. Another is Cellabs (818 700-1300) who makes a similar unit for about $900.

Lightning Protection Tips

In many installations the RFC-1 is connected to both a telephone line and a transmitter which is in turn connected to a tower. Any equipment in this situation is subject to severe abuse from lighting and in some installations this happens on a fairly frequent basis. Lighting can not only come in on the phone line and exit through the device to the station ground system, but it can also hit the station's tower, cause the entire ground system to be elevated above "ground" (up to several kilovolts) for a few microseconds and can partially exit through the device to the telephone line. This is called a "ground surge." In other words, the telephone line can hit the RFC-1 or the RFC-1 can hit the telephone line, depending on the circumstances. The same thing can happen with the power line.

The first step in any protection scheme is to install and maintain a high quality ground system. This will serve two purposes. First, the intensity of the ground surge will be lowered because of the lower resistance to earth ground and second, if everything is "tied together" with low impedance conductors, all equipment will stay closer to the same electrical potential when the system ground takes a hit. All protection devices, equipment racks and transmitters should be tied together with low impedance conductors, preferably copper strap, as short and as free from bends as possible. Do not depend on metal conduit for ground connections. A properly designed and installed ground system will pay for itself many times over in the damage it prevents.

Be sure your local telephone company has installed gas surge protectors on your incoming telephone lines. Old installations may contain carbon protectors which tend to provide less reliable protection. Be sure the ground connection used by the telephone company is an integral part of your station ground system. Sometimes the telephone company will use a

nearby cold-water pipe, metal conduit, or isolated ground rod for their ground and this may be, electrically speaking, quite a distance from your station ground system. Do not disconnect their ground connection, just add a supplemental conductor from their ground point to the station ground.

We highly recommend that you purchase and install your own telephone line surge protector in addition to the one installed by the telephone company. The Radio Shack 43-102 Telephone Spike Protector is inexpensive ($12.95) yet adequate for many installations. Install this between the telephone line and the RFC-1. The 43-102 is designed to pick up a ground connection through the ground prong on a standard AC outlet so be sure this is in fact connected to your station ground by the shortest possible means. For best result, install a "dummy" AC outlet with no AC connections but with a short jumper from the ground terminal on the outlet the metal rack in which the RP-8 relay panel is mounted. The 43-102 has internal, non-replaceable fuses which will blow during a heavy surge. If this happens, replace the protector. Do not attempt to repair it.

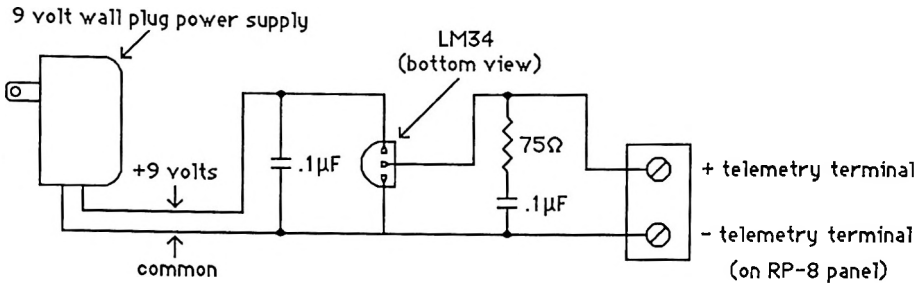
For installations where lighting damage occurs on a regular basis, or for other installations where the absolute maximum in reliability is required, we recommend the Sine Systems SP-8 Surge Protector. Using a combination of ground-plane construction, gas surge-suppressors, metal-oxide varistors, and "sacrificial" carbon film resistors, it provides significant protection against voltage surges from the telephone line, the local telephone, and eight telemetry channels. It is designed to mount directly to an RP-8 Relay Panel with five metal standoffs and therefore provides a very low impedance electrical connection to the RFC-1 and RP-8. One SP-8 Surge Protector consists of an SP-8 Surge Protector PC board assembly, five metal standoffs, two 24" modular telephone cords and installation instructions/engineering documentation. The SP-8/TO is an identical version except for the omission of the telephone line and local telephone surge protection. It is designed to protect additional RP-8 panels in systems having more than one RP-8 panel.

WARNING!

Damage to the RFC-1 and RP-8 by lightning (and any other external means) is not covered under warranty.

Temperature Monitoring

The model TS-1/PS Temperature Sensor with power supply is available as an accessory to the RP-8 Relay Panel to monitor room temperature. Temperatures of 5.0° F to 203.9° F can be monitored with 0.1° F resolution. It's really handy be be able to keep tabs on things like room temperature and transmitter exhaust temperatures. You can purchase our ready-made module or you can put one together yourself and save some money. The heart of such a sensor is the National LM34 which comes in a TO-92 package and provides a linear 10 millivolt per degree Fahrenheit (or Celsius, depending on the version) output. Hooking one up to an RP-8 panel is easy:



The DC power supply can be anywhere from +5 to +20 volts. The LM34 draws only about 70 µA so one small power supply will operate a virtually unlimited number of sensors. The two .1µF caps and 75 ohm resistor help avoid problems with RF at transmitter sites but may not be necessary depending on local conditions. Use shielded wire for long runs in high RF fields. After connecting to your relay panel, use a thermometer to calibrate the telemetry to the correct temperature. The following parts can be obtained from the Digi-Key Corporation (telephone 1-800-344-4539):

Digi-Key part number:	Price:	Description:
T401-ND	$4.82	9 volt wall plug power supply
LM34CZ or LM34DZ	$7.20	temperature sensor (+5°F to 203.9°F)
P4525	$ .19	.1µF capacitor
75Q	$ .26 (for 5)	resistor, carbon film, 75 ohm, 1/4 watt, 5%

Prices shown are from the summer 1991 catalog. A $5.00 service charge is added to orders under $25.00.

It is possible to use the +10 volt unregulated voltage source already present on the RP-8 panels to power temperature sensors but this should be done with great caution. Connecting leads of any significant length to this source could expose the power supply buss in the RFC-1 to damaging transients. Also remember that the RFC-1 has a floating power supply and the circuit common should remain floating (not grounded).

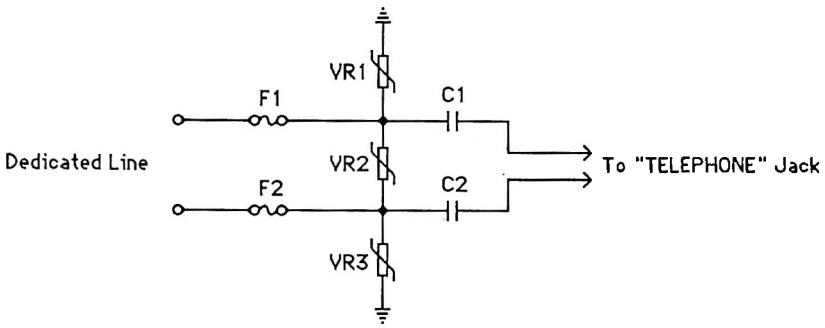
Dedicated Control Port

In addition to being operable from a dial-up telephone line, the RFC-1 may also be operated from a non-dial-up communications link such as a dedicated line, a two way radio, a pager, an STL/SCA link, etc. This additional control method may be used in place of a dial-up line or in addition to a dial-up line for the purposes of an alternate or back-up control and monitoring means. The port used for the dedicated communications link is the modular jack on the front panel of the RFC-1 labeled "TELEPHONE." This is a dual-purpose jack. Depending on user programming, the "TELEPHONE" jack can be connected to a local telephone for ordinary use and for local control and telemetry calibration, or it can become a continuously active "dedicated control port" which can be used in addition to the dial-up port ("LINE" jack) or in place of it. The dedicated control port may be used in a number of different ways and the operational details will be determined by the communications system used and the particulars of the installation.

WARNING!

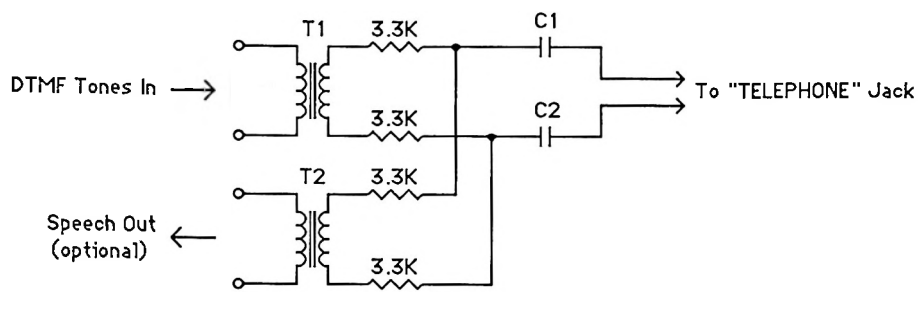
The dedicated control port, when enabled, is a two way audio port with a superimposed source of 12 volts DC for applications requiring "battery," such as telephone sets. However, when the RFC-1 is being used in the "dial-up" mode, this port is connected in parallel with whatever is attached to the "LINE" jack, normally a dial-up telephone line. If this is the case, whatever is connected to the "TELEPHONE" jack will also be connected to the telephone line and should be FCC Part 68 registered.

The following is an example of the dedicated control port used with a dedicated line:



The line can be any length from a few feet to thousands of feet depending on the application and tolerable series resistance. F1 and F2 should be 1/4 ampere fast blow fuses. VR1 through VR3 are 150 volt metal-oxide varistors (MOV's). C1 and C2 are 2 μF, 200 volt film capacitors and are used to block the 12 volt DC "battery" source. If the dedicated line is connected to a telephone set and the DC voltage source is desired to operate the DTMF keypad, the capacitors may be eliminated. If the DC blocking capacitors are not used, however, two conditions must be satisfied: first, no more than about 50 milliamperes DC should be drawn from this port. This is an equivalent DC load resistance of about 240 ohms. Second, no DC load, and only a high impedance AC load, should be present across this port when the RFC-1 is being operated from a dial-up line. Both of these conditions will be satisfied if an ordinary telephone is connected to this port and the telephone is left "on hook" when not in use.

To interface the dedicated port to a radio or other "4 wire" communications link, the following circuit is suggested:

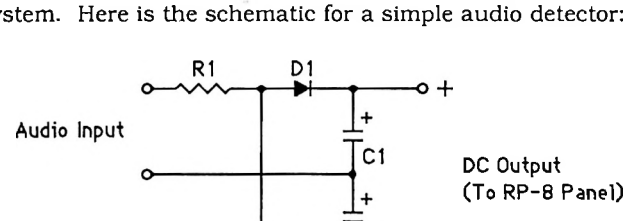


C1 and C2 are 2 µF, 200 volt film capacitors and T1 and T2 are 600 ohm to 600 ohm transformers, such as a Prem SPT-124. This circuit could be used with a two-way radio, a voice pager, an SCA/STL subchannel, or just about any communications link capable of passing voice-grade audio. It is important to remember that operation of the RFC-1 from this port does not require the entry of the security code so the communications link itself should be reasonably secure. Also keep in mind that the dedicated control mode will be entered with the detection of any DTMF tones at the dedicated control port, so spurious DTMF tones, or DTMF tones used for other purposes should not appear at this port. The RFC-1's speech synthesizer is active on the dedicated control port at all times and telemetry readings will be spoken as the RFC-1 makes the initial measurements for the Telephone Alarm System, if activated, as well as for subsequent check-scans.

The proper audio level needed at the dedicated control port can be determined by experimentation and should be adjusted to the minimum level required for reliable operation. In the above circuit, higher value resistors may be substituted but do not use series resistors less than 3.3K ohms if two transformers are used, or less than 1.5K ohms if one transformer is used.

Audio Detection

In some cases it may be desirable to be able to monitor the presence of an audio signal. For example, absence of audio at the output of a modulation monitor could be made to trigger the telephone alarm system. Here is the schematic for a simple audio detector:



R1 is 470 ohms (Radio Shack 271-1317), D1 and D2 are 1N4001 (Radio Shack 276-1101), and C1 and C2 are 470 µF/16V (Radio Shack 272-957). Any audio level of -6 dBv or greater will maintain at least 0.5 volts DC at the output. This covers most "line level" audio sources.

The easiest way to set this up as a "loss of audio" alarm is to turn the telemetry pot wide open (keep turning the calibration control clockwise until you hear a soft clicking sound; the override clutch). Then set the upper limit for this channel to 2040 and the lower limit to around 0150. With audio present, the reading will be "Status: On" almost all the time meaning that the telemetry is pegged against the upper end of the scale (2040). During long pauses the reading will change to numerical values. When the value drops to 0150 or below, the RFC-1 will catch it on the next scan.

Section 6 — Circuit Description

RFC-1

The heart of the RFC-1 is a Motorola MC68HC711E9 microcontroller. This is a complete computer containing a CPU, program ROM, RAM, a timer, a fault monitor, parallel I/O and an A-D converter. The CD22202 (or 75T202) (U2) DTMF decoder and the UDN2981A (U6) relay buss driver connect directly to it and communicate in "parallel." The ISD2590P (U4) speech synthesizer is connected to a parallel port on the microcontroller and to a serial-to-parallel shift register (U10) which is used to assist in the transfer of data.

U8 and U9 are standard voltage regulators and provide the three DC voltages needed by the RFC-1. D6 is used to shift the ground reference point of the power supply. D5 and D7 are used only to absorb transient voltage spikes on the +10 and +6.9 volt busses, respectively.

The relay buss protocol in the RFC-1 is simple. J3 pins 6 through 11 form a six bit parallel binary, positive true, word which identifies the currently selected channel. Pin 6 is the least significant bit. Pin 12 is normally low but goes high when an "ON" command is activated. Pin 13 is normally low but goes high when an "OFF" command is activated. Pins 12 and 13 drive the control relays directly. The voltage level on this buss is somewhat higher than the standard +5 volt logic level to allow for the voltage drop of the telemetry relay driver and isolation diodes on the RP-8 relay panels.

In the idle condition (on hook) the RFC-1 selects channel "63" which makes J3 pins 6 through 11 all high. The "Local Control" pushbutton on the RP-8 relay panels is normally open and is bridged across J3 pin 11 and ground. The microprocessor checks the logic level on pin 11 and if it goes low it assumes that a "Local Control" pushbutton has been pressed and it configures the RFC-1 for the local control mode. This connects the local telephone to the unit through a source of DC so the telephone's keypad will work.

U-3 is a "low voltage interrupt" (LVI) device which resets the microprocessor if the power supply voltage falls below a specific value.

RP-8

Each RP-8 panel contains two "three bit binary to one-of-eight" decoders. One (U1) is connected to the most significant three bits of the channel selection buss and the other (U2) is connected to the least significant three bits of the buss. U1 and U2 are similar in operation but U1 has "active low" outputs and U2 has "active high" outputs. The output of U1 feeds the "Block Selection" jumper. The upper three bits contain the information that determines in which block of channels the selected channel falls. If this matches the jumper for the particular panel, a "low" logic level is applied to U2 pin 11 enabling it to decode the first three bits of the address and route the decoded result (active high) to the relay driver, U3. U3 has 8 inputs and 8 open-collector outputs. A high logic level from the selected output of U2 causes the corresponding open-collector output of U3 to "pull down." This turns on one of the eight reed relays and allows the telemetry to be read for that channel. It also pulls down the low side of the control relays for that channel. The high side of the control relays are connected to the "ON" and "OFF" lines coming from the RFC-1 which can then cause the selected control relays to operate.

The telemetry relay for a particular channel is energized as long as that channel is selected. Only one telemetry relay can be energized at a time. Control relays are energized only when one of the control tones ("*" or "#") is being received.

The power supplied to the RP-8 panels by the RFC-1 is approximately +10 volts, unregulated.

Section 7 — Troubleshooting and Repair

Factory Repair

Factory Service Policy
as of January 1997

Factory service policy is subject to change without prior notice.

Sine Systems is proud to offer same day repair service on all of our products. When we receive your damaged equipment, we will repair it and ship it back out the same day it arrived. Because we offer immediate service, we do not send loaner equipment. If we cannot immediately repair your equipment and return it to you, we may ship you a loaner unit at our discretion.

While we do not require prior authorization on repairs, you may call before returning equipment for repair if you prefer to do so. Emergency service can be made available on Saturdays, weekends and holidays if arrangements are made with us in advance.

Instructions

Please include a note with any specific information available about the equipment failure as an aid to our technicians. Pack equipment carefully to avoid further damage in shipping. We are not responsible for mechanical damage during transport.

When returning a system with multiple components (such as an RFC-1/B), return the entire system (RP-8's, SP-8's, ribbon cable, and power supply) if you want if fixed right the first time. Lightning is rarely selective enough to damage only a single part of a system.

Be sure to include a street address for return shipping by UPS. If you prefer a carrier other than UPS or wish us to bill to your shipping account, we can usually accommodate these requests, however, many carriers do not accept COD shipments so credit card billing may be required for carriers other than UPS. Otherwise, return shipments will be made by the UPS equivalent of the received shipping method unless otherwise specified (i.e. Ground shipment, 2nd Day, Overnight).

Please call us at the telephone number on the cover of this instruction book for the shipping address for repairs.

Same day service does not apply if you ship to an incorrect address and/or the carrier delivers the equipment too late in the day for repairs to be completed. (Sorry but we have to draw the line somewhere.)

Warranty

There is no charge for repair service on items covered under warranty. Additionally, Sine Systems will pay shipping costs to return the repaired equipment to you. You are responsible for shipping charges to return damaged equipment to us for repair.

Repair Rates

For repairs not covered under warranty, we charge a flat rate repair fee plus shipping fees. Flat rate repairs cover only components that fail electrically. Mechanical damage will be assessed on a per repair basis. Repair charges fall into one of three categories.

Minor to moderate repairs are $100 plus shipping fees

We must replace 5 or fewer defective components in a minor to moderate repair. This accounts for roughly 90% of all of our repairs. Sometimes these repairs cost less than $100 depending on the components replaced and the amount of time required to complete repairs.

Major repairs are $200 plus shipping fees

We must replace 6 or more defective components in a major repair. This covers up to 12 components but, again, we may charge less depending on the components replaced and the amount of time required to complete repairs.

Repairs that make us say, "Wow!" cost more than $200 plus shipping

This occurs so rarely that we really do say, "Wow!" when it happens. We also say, "Whew" when we're done fixing it. If the damage is this bad, we strongly suggest that you use our SP-8 Heavy Duty Surge Protector and that you check the integrity of your ground system.

All repairs must be billed to a credit card or shipped COD. Specify which you prefer with your request for service. If you request, we will be happy to call with the total amount of the repair (including applicable shipping charges) so that suitable payment can be arranged before a COD shipment. If you need a COD total, do not forget to include a telephone number where you can be reached so that we may contact you in a timely manner.

Field Repair

RFC-1/B Remote Facilities Controller

WARNING!

Repair of the RFC-1 or the RP-8 relay panels should be attempted only by a qualified technician who is familiar with this type of equipment. Incorrect repair could result in a condition which could cause damage to equipment or be hazardous to personnel. Be absolutely sure to disconnect any sources of high voltage which might be connected to the RFC-1 or RP-8 relay panels before testing or repair.

WARNING!

Because the RFC-1 is an FCC registered device, it must not be modified in any way. Any components which are replaced must be replaced with ones of exactly the same type and rating. This is particularly critical in the circuitry involving connection to the telephone line. Unless repair is performed by a properly qualified technician, it is strongly recommended that the RFC-1 be returned to Sine Systems for repair if a failure has occurred in this area. Your safety and the safety of others could depend on it!

Additional useful information concerning the technical operation of the RFC-1 is located in the "Circuit Description" chapter of this manual. A summary of troubleshooting hints is included after the following general service information on the RFC-1 and RP-8.

Fuse Replacement

Later versions of the RFC-1 contain no conventional fuses. In place of the four fuses used in earlier versions, self-resetting fuses called "Polyswitches" are used instead. They protect the RFC-1 from over-current just like fuses, but, in normal use, they never have to be replaced. In some cases, in order to reset the Polyswitches, it will be necessary to disconnect the 12 volt AC power supply for a few seconds. Polyswitches have current ratings just like fuses and if they are ever replaced, be sure and replace them with the same type and rating.

RF Problems

There have been very few reported RF problems with the RFC-1 associated with FM transmitters. The RFC-1 has been tested and found to operate satisfactorily in AM RF fields of 632 volts/meter (the ANSI limit for human exposure) with no additional external filtering. However, extreme conditions have been documented that required additional external filtering to obtain reliable operation. In one such case, touching an exposed conductor of the telephone line produced a painful shock and RF burn. Such extreme conditions are rare but even these problems can be overcome by a combination of one or more of the following remedies:

1) Install an RF filter preceding the "LINE" jack near the RFC-1
2) Install an RF filter preceding the "TELEPHONE" jack near the RFC-1
3) Loop the ribbon cable several times through a ferrite core near the RFC-1 and another near the relay panels.

A typical telephone line RF filter is made by Suttle Apparatus, P.O. Box 28, Lawrence, IL, 62429. Their telephone number is (618) 943-5721. These can be be obtained through a wholesale distributor of telephone products. Be sure you get an RF filter and not simply a telephone 'spike' protector. Ferrite cores suitable for ribbon cable are available from Radio Shack (part number 273-104).

Power Supply

The first step in troubleshooting should be to look for signs of burned or otherwise damaged parts. It is normal for U8, U9 and D6 to run fairly warm but they should not be hot enough to burn or discolor the PC board. Next, check the incoming AC voltage and the four power supply voltages. Note that the "+10 volt" supply is unregulated and may be anywhere from 9 to 11.5 volts DC.

Telemetry

U7 is a differential DC amplifier with a gain of 5. The voltage at U7 pin 6 should be five times the DC voltage between pins 4 and 5 of J3. The A-D converter is contained in U5 which must be replaced if defective.

Relay Panel Output

U6 is an octal source driver. Pins 1 through 8 are the inputs and pins 18 through 11 are the outputs. J3 pins 6 through 11 should contain the address of the currently selected channel in positive logic binary form with pin 11 being the most significant bit. J3 pins 12 and 13 should go high when the appropriate control function is initiated.
Telephone Line Interface:

When the RFC-1 is not in use, both RY1 and RY2 are "off." When the RFC-1 is in use from a remote telephone, RY1 is "on" and RY2 is "off." When the RFC-1 is in use from the local telephone, RY1 is "off" and RY2 is "on." U1 provides gain and isolation for the audio signals going to and from the telephone line. OC1 detects ring voltage and hang-up pulses.

Local Telephone

The "Telephone" jack on the front panel of the RFC-1 is connected to an internally generated DC source in the "Local Control" mode. This supplies the power to the local telephone and allows it to generate tones with its keypad. The DC power supplied by the RFC-1 is at a lower voltage than would normally appear on a standard telephone line. However, with extensive field use, only one telephone has been found that would not generate tones reliably with the DC power supplied by the RFC-1. This particular telephone was a low cost telephone purchased as a discount retailer. Consequently, if the "Local Control" button is pushed and "OK" is heard on the telephone but the telephone will not generate tones reliably, try a different telephone. The best type of telephone to use is one that has good sidetone suppression of the DTMF tones. This eliminates the annoyance hearing loud tones while calibrating. In the high RF fields near AM transmitters, the simple, "non-electronic" telephones work the best. In particular, the original "2500" series AT&T telephone is virtually "bullet proof" when it comes to RF and its sidetone suppression is very good also.

DTMF Decoder

U2 decodes the DTMF signals. Pins 16, 17, 18 and 1 are the "8, 4, 2, 1" weighted binary outputs corresponding to the detected DTMF signal. Pin 14 goes high when the data is valid. The binary output number corresponds directly to the entered key numbers except that the "0" key outputs a "10" output (1010), the "*" key produces an "11" output (1011) and the "#" key produces a "12" output (1100).

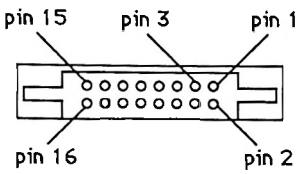
Low Voltage Interrupt

U3 is a low voltage interrupt (LVI) device which resets the microprocessor and prevents it from operating if the supply voltage drops below about 4.5 volts. Pin 1 should normally be high.

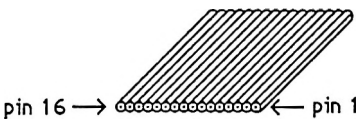
Speech Synthesizer

U4 is the speech synthesizer. The word-address-bits are presented to U4 on pins 1 through 10. The load command is active low and appears on pin 23 of U4. The audio output is on pin 14. U10 is a serial input/parallel output shift register and is used to load the address bits appearing on pins 3 through 10 of U4. U10 is serially loaded by the microprocessor, U5.

Connector Pin Locations



Ribbon Cable Connector
Front View



Ribbon Cable

RP-8 Relay Panels

Additional useful information concerning the technical operation of the RFC-1 is located in the "Circuit Description" chapter of this manual.

The RP-8 relay panels receive operating power from the RFC-1 control unit. There should be approximately 10 volts DC between pins 14 and 15 of J1 (or between pins 16 and 8 of U1). With a telemetry relay selected, the current consumed by the RP-8 panel will be about 33 milliamperes and this may be checked by temporarily removing one end of resettable fuse F2 and inserting a milliammeter.

The binary value of the selected channel should appear on J1 of the relay panel, pins 11, 10, 9, 8, 7 and 6, with pin 11 being the most significant bit. When a panel is "selected" by the RFC-1, U2 pin 11 should go low. The least significant three bits determine which of the eight channels on the selected panel will operate. U2 should generate this information and pass it along to the relay driver U3. The telemetry relay for the selected channel will remain on as long as the channel is selected. Control relays operate only as long as the control tone is received .

A jumper plug should always be plugged into one of the "Block Select" jumper locations or erratic operation will result.

If it is suspected that a malfunction of one of the RP-8 panels is disrupting system operation, remember that it is easy to "lift" the RP-8 panels off the buss one at a time by simply disconnecting the cable from the panel. Remember to move the 12 VAC connection from the wall plug transformer to another panel when necessary.

Troubleshooting Hints and Shortcuts

Trouble at Installation

The following are the most common problems experienced during installation, listed in order of descending frequency of occurrence.

Problem: Everything works but telemetry can not be calibrated.

Possible Solution: Adjustment of the wrong pot. The telemetry connections are counted from left to right from the rear of the RP-8 panel, but the pots are counted from right to left as viewed from the front of the panel. In other words, channel 00 will be adjusted with far right pot.

Problem: Nothing works. The wall plug transformer is not putting out 12 volts AC.

Possible Solution: A ribbon cable connector was incorrectly installed (usually one connector installed backward) and shorted the wall plug transformer. This connects pins 1 and 2 to pins 15 and 16; a dead short. The transformer itself has an internal non-replaceable fuse. If you're in a bind, there is a suitable replacement available at Radio Shack (part number 273-1610).

Problem: Telemetry works OK but control functions don't work. RFC-1 speaks "Error."

Possible Solution: Finish reading Chapter 11. The digits "66" (operate mode) need to be entered before control functions are enabled.

Problem: The telemetry channels read "Status: Off."

Possible Solution: Either the telemetry polarity is backward (+ to - and - to +) or the calibration pot is turned all the way down.

Problem: The telemetry channels read "Status: On."

Possible Solution: The telemetry calibration pot is turned up too high.

Trouble after Installation

Virtually every known failure of an RFC-1 has been due to lightning damage. The most common scenario is lightning entering on the telephone line, flashing across the contacts of RY1 and entering the power supply via R21 and/or R22. The following steps are suggested as the quickest way to repair an RFC-1 in the field with minimal test equipment. If a bench power supply is available, testing can be speeded up quite a bit by setting the supply voltage to 17 volts (DC), setting the current limiting to about 400 milliamperes, and connecting it to the 12 VAC terminals on the RP-8 panel in place of the wall plug transformer. Normal supply current for the RFC-1 is in the range of 250 to 450 milliamperes.

Disconnect the telephone line and all control and telemetry connections from the RP-8 panel. Remove all ICs, except U5, U8 and U9 from the RFC-1 board and all ICs from the RP-8 panel. Remove them by inserting a small screwdriver under alternate ends of each IC and gradually pry them up until they are free. Measure the in-circuit values of R21 and R22 and replace if out-of-tolerance or burned. Connect power to the system by means of the connector on the RP-8 panel. If resettable fuse F1 opens, disconnect the left (input) lead (nearest the resettable fuse) of U9, and one lead of D5 and D7. Reconnect these leads one at a time, replacing anything that opens the resettable fuse. Measure all power supply voltages. Using the heat sink (1/4" spacer) connected to U8 as a reference, there should be about +10 volts on the left lead of U9, -5.1 volts on the center lead of U9, +6.9 volts on the right lead of U9 and +5 volts on the right lead of U8.

When the power supply checks out OK, set up a test meter to measure the total AC current drawn by the RFC-1. The purpose of this is to weed out any ICs which are shorted or drawing excessive current. With nothing but U5 and the regulators installed, the RFC-1 should draw less than 250 milliamperes AC (rms) if the 12 volt AC wall plug transformer is used, or less than 150 milliamperes DC if a 17 volt DC supply is being used. Disconnect power, install U6, reconnect power and note current flow. Repeat this step with each IC on the RFC-1 board, one at a time, and replace anything that causes the total AC current to exceed 450 milliamperes AC if the 12 volt AC wall plug transformer is used, or 275 milliamperes DC if a 17 volt DC supply is being used. Then replace each IC on the RP-8 panel one at a time using the same technique. The current supplied to the RP-8 panel can be checked by temporarily removing one end of resettable fuse F2 and connecting a milliammeter. The current should be somewhere in the vicinity of 30 milliamperes DC with a telemetry relay selected. The supply voltage delivered to the RP-8 panel should be around 9.5 to 10.5 volts, unregulated.

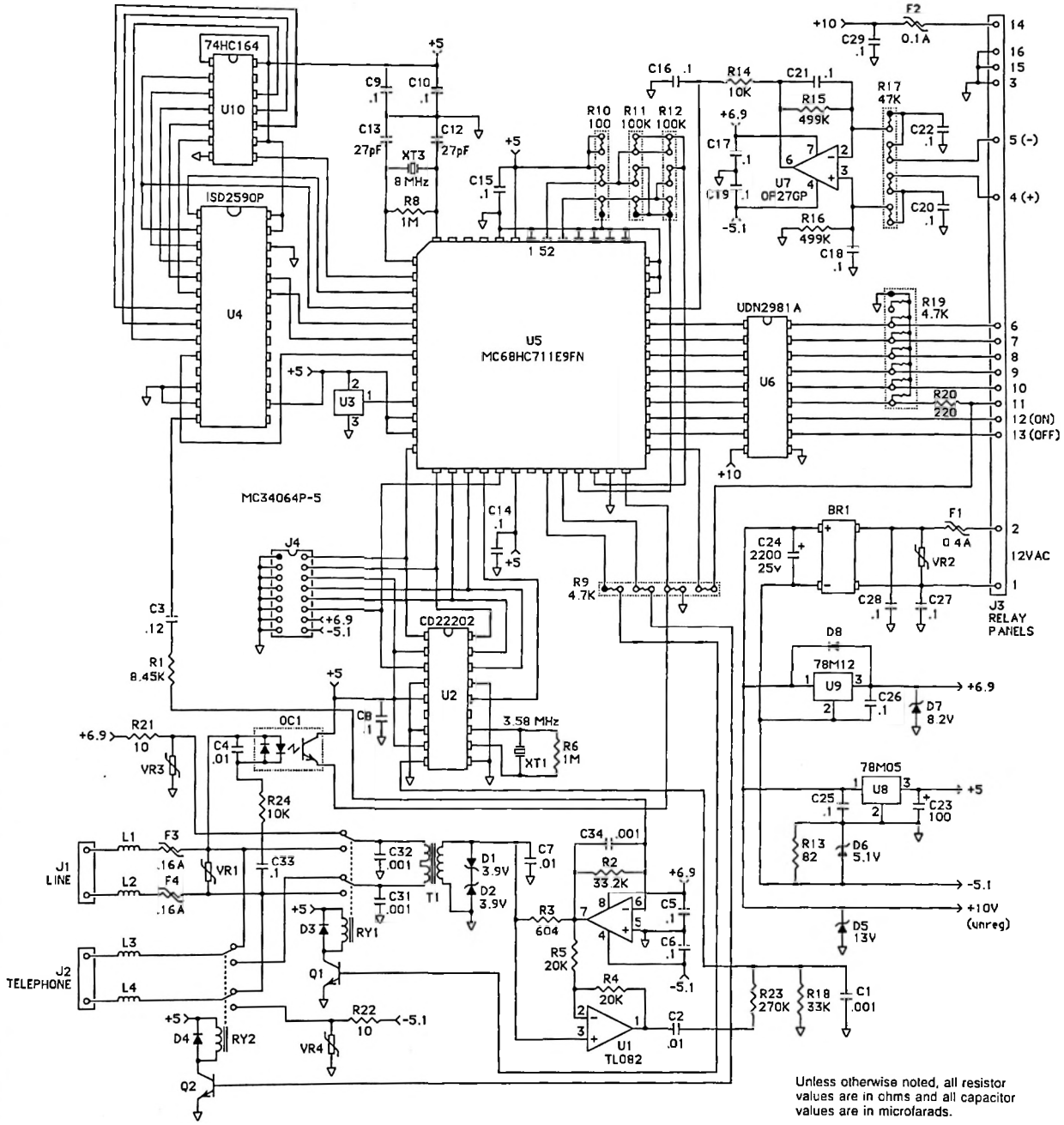
With all ICs installed, carefully feel each component to determine its operating temperature. A malfunction could cause a component to be hot enough to cause a burn so use appropriate caution. U8, U9 and D6 are normally quite warm. However, no other component should be significantly warm. Replace any component which is hot or significantly warm with the exception of U8, U9, or D6. Once all components are checked for normal temperature, begin a functional test of the unit. Test for proper operation of the system using the local telephone first. If "OK" is not heard when the "Local Control" button is pushed, replace U1. If the unit does not respond to DTMF tones, replace U2. Command and telemetry functions are affected by U6 in the RFC-1 and U1, U2 and U3 on the RP-8 panel. If the telemetry relays are working and are feeding a telemetry sample to the RFC-1 but all readings are either "Status: On" or "Status: Off", replace U7.

As a last test, reinstall the RFC-1 board in its case, connect the telephone line and have someone call to be sure the RFC-1 will operate from a remote telephone. Also check to see that the RFC-1 does not cause a hum on the telephone line. This would be an indication that one side of the telephone line was shorted to ground somewhere.

The above procedure will result in a successful repair more than 90% of the time. A typical lightning-damage case will consist of R21 or R22 open or damaged with U9 shorted and U1, U2 and U7 damaged or shorted. This failure mode accounts for virtually all the field failures which have thus far occurred. More rarely, there have been a couple of cases where the contacts were welded shut on one or more of the telemetry selection relays on an RP-8 panel.

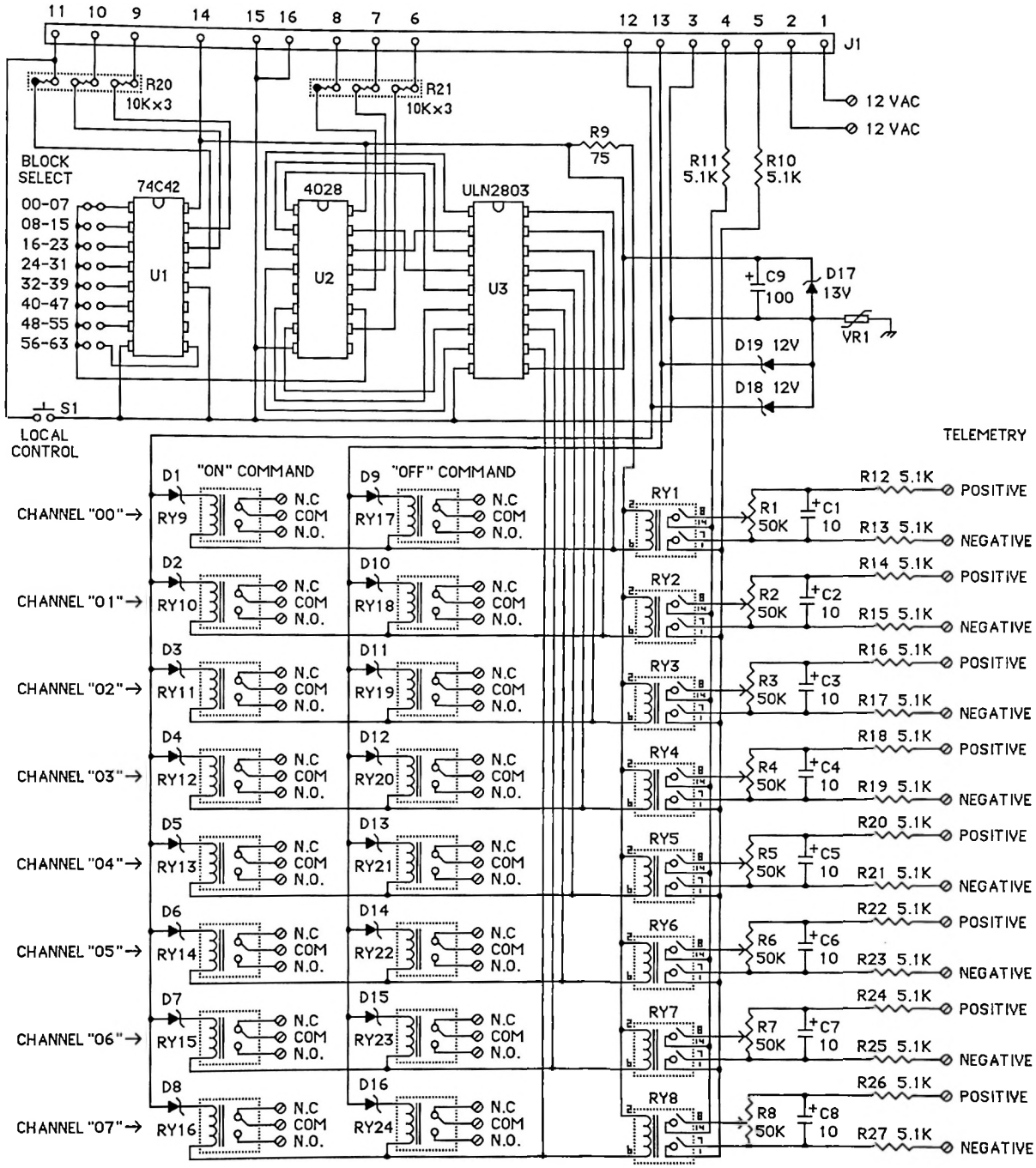
Lightning Protection Tips: See "Section 5—Installation"

Section 8 — Illustrations and Diagrams



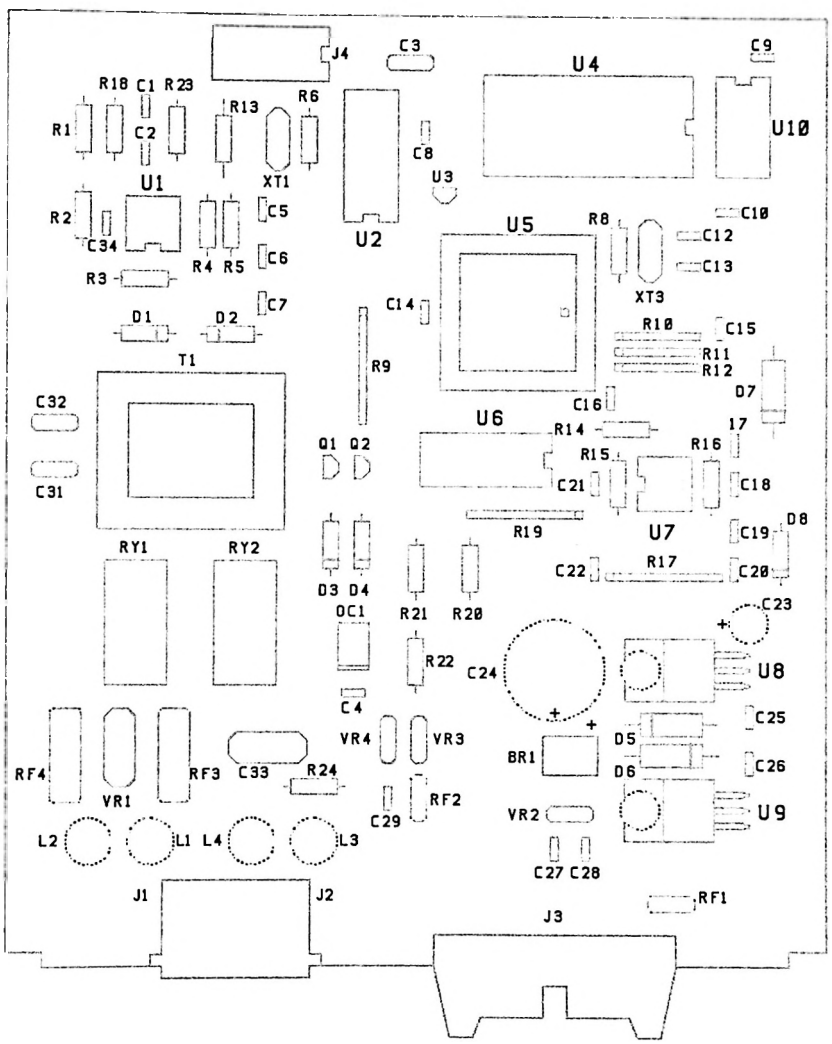
Unless otherwise noted, all resistor values are in ohms and all capacitor values are in microfarads.

RFC-1/B Remote Facilities Controller
Schematic Diagram
Hardware Version 3.01



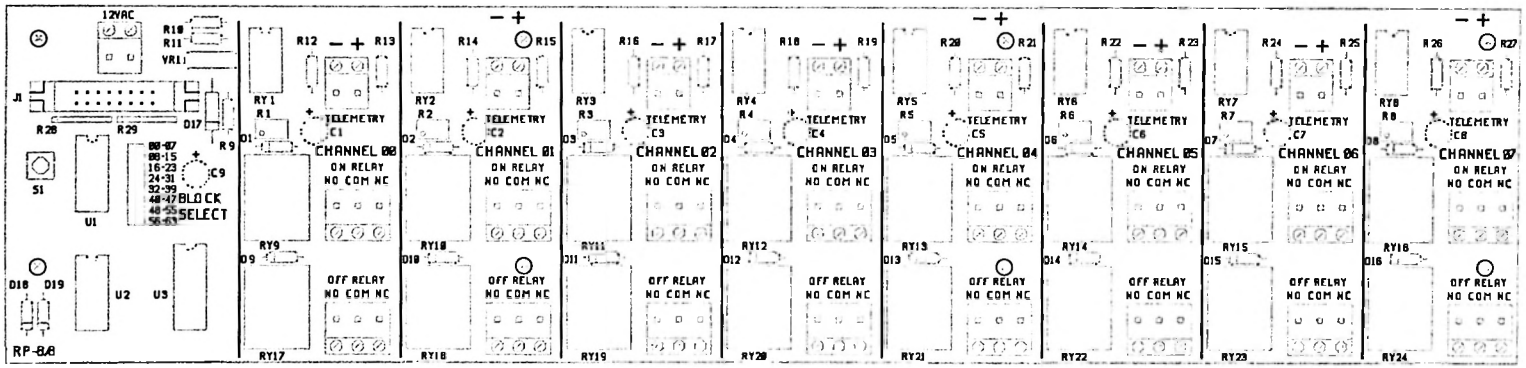
Unless otherwise noted, all resistor values are in ohms and all capacitor values are in microfarads.

RP-8 Relay Panel
Version 1.10
Schematic Diagram



RFC-1/B

Hardware Version 3.01



RP-8 Relay Panel
Hardware Version 1.10

Component Locations

Section 9 — Parts List

Parts List for RFC-1/B Remote Facilities Controller
Hardware Version 3.01

R21, 22	resistor, carbon film, 1/4W, 5%, 10 ohms
R20	resistor, carbon film, 1/4W, 5%, 220 ohms
R14, 24	resistor, carbon film, 1/4W, 5%, 10K
R6, 8	resistor, carbon film, 1/4W, 5%, 1M
R13	resistor, carbon film, 1/2W, 5%, 82 ohms
R3	resistor, metal film, 1/4W, 1%, 604 ohms
R1	resistor, metal film, 1/4W, 1%, 8.45K
R4, 5	resistor, metal film, 1/4W, 1%, 20.0K
R2	resistor, metal film, 1/4W, 1%, 33.2K
R15, 16	resistor, metal film, 1/4W, 1%, 499K
R19	resistor network, SIP, common terminal, 7 x 4.7K
R10	resistor network, SIP, isolated, 3 x 100
R11, 12	resistor network, SIP, isolated, 3 x 100K
R9	resistor network, SIP, isolated, 4 x 4.7K
R17	resistor network, SIP, isolated, 4 x 47K
C31, 32	capacitor, disc, .001 µF, 1KV
C10, 11, 12, 13	capacitor, monolythic ceramic, 50V, 27 pF
C1, 34	capacitor, monolythic ceramic, 50V, .001 µF
C2, 4, 7	capacitor, monolythic ceramic, 50V, .01 µF
C5, 6, 8, 9, 10, 14, 15, 16,	capacitor, monolythic ceramic, 50V, .1 µF
17,18, 19, 20, 21, 22, 25, 26,	"
27, 28, 29	"
C3	capacitor, polyester, 50V, 5%, .12 µF
C33	capacitor, polyester, 400V, 5%, .1 µF
C23	capacitor, aluminum electrolytic, radial, 100 µF, 16V
C24	capacitor, aluminum electrolytic, radial, 2200 µF, 25V
L1, 2, 3, 4	inductor, 1.0 mH
D1, 2	diode, zener, 3.9V, 1W, 1N4730A
D3, 4, 8	diode, 1N4005
D6	diode, zener, 5.1V, 5W, 1N5338B
D7	diode, zener, 8.2V, 5W, 1N5344B
D5	diode, zener, 13V, 5W, 1N5350B
BR1	diode bridge, 200V, 1A
VR1	varistor, 230VAC
VR2	varistor, 14VAC
VR3, 4	varistor, 11 VAC
XT1	crystal, 3.579 MHz
XT3	crystal, 8.000 MHz

RY1, 2	relay, 2C, 5V, 1500V isolation
T1	transformer, 600:600; Prem SPT-124
OC1	optocoupler, darlington, bipolar, 5 kV breakdown; NEC 2506-1
Q1, 2	transistor, PN2222A
U4	IC, ISD2590P audio storage device
U5	IC, MC68HC711E9CFN2 microprocessor
U6	IC, UDN2981A octal source driver
U7	IC, OP-27GP precision op-amp
U1	IC, TL082CP dual op-amp
U2	IC, CD22202E or 75T202-IP DTMF decoder
U3	IC, MN1381-S (Panasonic) low voltage detector
U8	regulator, 5V, 500 mA, TO-220, MC78M05CT
U9	regulator, 12V, 500 mA, TO-220, MC78M12CT
U10	74HC164
RF1	resettable fuse, 0.4A (Raychem Polyswitch)
RF2	resettable fuse, 0.1A (Raychem Polyswitch)
RF3, 4	resettable fuse, 0.16A/600V (Raychem Polyswitch)
	transformer, wall plug, 12VAC, 1A

Parts List for RP-8 Relay Panel
Version 1.10

R9	resistor, carbon film, 1/4W, 5%, 75 ohms
R10, 11, 12, 13, 14, 15, 16,	resistor, carbon film, 1/4W, 5%, 5.1K
17, 18, 19, 20, 21, 22, 23,	"
24, 25, 26, 27	"
R20, 21	resistor, SIP, isolated, 3 x 10K
R1, 2, 3, 4, 5, 6, 7, 8	resistor, trimmer, 50K, vertical, 22 turn
C1	capacitor, aluminum, radial, 100µF, 16V
C2, 3, 4, 5,6, 7, 8, 9	capacitor, aluminum, radial, 10µF, 16V
S1	switch, pushbutton, momentary contact, normally open, PC
D1, 2, 3, 4, 5, 6, 7, 8, 9,10	diode, zener, 8.2V, 0.5W, 1N5237B
D17	diode, zener, 13V, 5W, 1N5350B
D18, 19	diode, zener, 12V, 1W, 1N4742A
VR1	varistor, 85 volts DC
U1	IC, 74C42
U2	IC, CD4028
U3	IC, ULN2803
RY1, 2, 3, 4, 5, 6, 7, 8	relay, reed, 2A, 5V, DIP
RY9, 10, 11, 12, 13, 14, 15,	relay, 1C, 5V, 5A
16, 17, 18, 19, 20, 21, 22,	"
23, 24	"