Remote Facilities Controller

Model RFC-1/B

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Relay Panel

Model RP-8

– Hardware Instruction Book –

Concise Edition for Electronic Distribution

This documentation is valid for
Remote Facilities Controller hardware version 2.xx

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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.

If the fuses in the RFC-1 are replaced, the replacement fuses should be of the same type and rating as the original fuses. The four fuses used in the RFC-1 are type 2AG and are rated at 1/8 ampere, 1/4 ampere and 3/4 ampere. Spare fuses are included in the RFC-1/B Accessory Kit.

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, .55 amps maximum
size	6" wide x 7" 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

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

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	18K ohms minimum, 20K ohms maximum
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. 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. DO NOT cut off the connector with the wall-plug transformer plugged in to an AC outlet.

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.

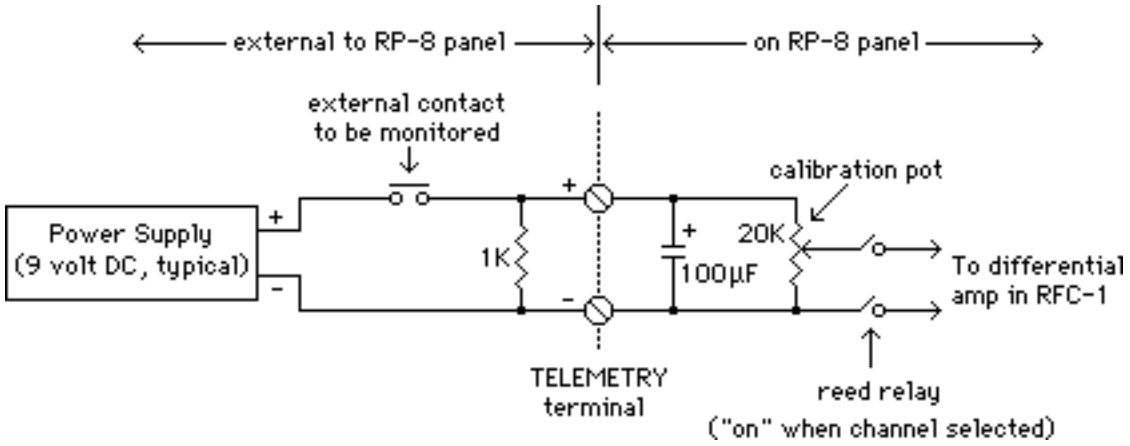
WARNING! Some older equipment provides telemetry outputs which can be elevated as much as several hundred volts above ground. Do not connect this type of telemetry source to the RP-8 panels!

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 100 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.

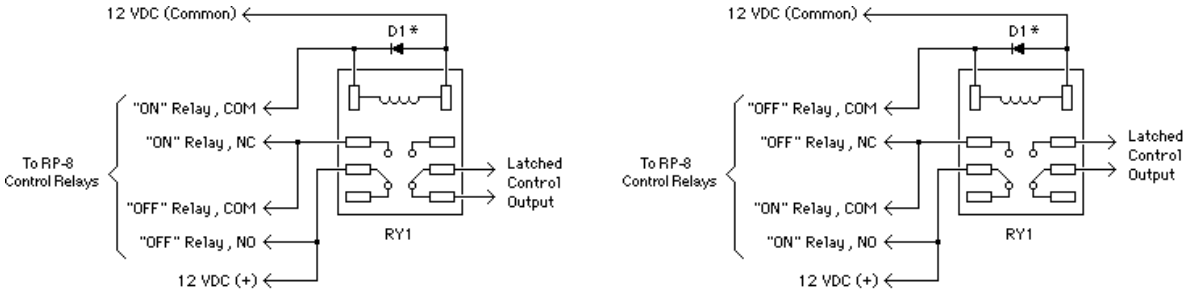
The previous illustration is only one of many possibilities of how status indication can be accomplished. For example, if you wanted a closed contact to read "Status: Off" you could connect the voltage source through a 1K ohm resistor to the positive telemetry terminal and bridge the monitored contacts 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 100 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

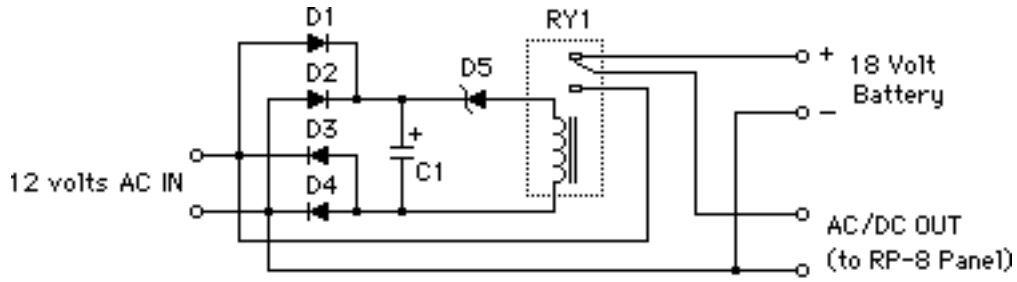
The initial (programmed at the factory) user-programmable settings are contained in the "Software" instruction book.

Battery Back-up

Software version 4 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 +16 to +18 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 back-up power source 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 8 to 10 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.

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 "1170" would correspond to 117.0 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 but only their adaptor for Audiovox cellular telephones is compatible with pulse dialing. This is important because the RFC-1 uses pulse dialing when it originates alarm calls. 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.

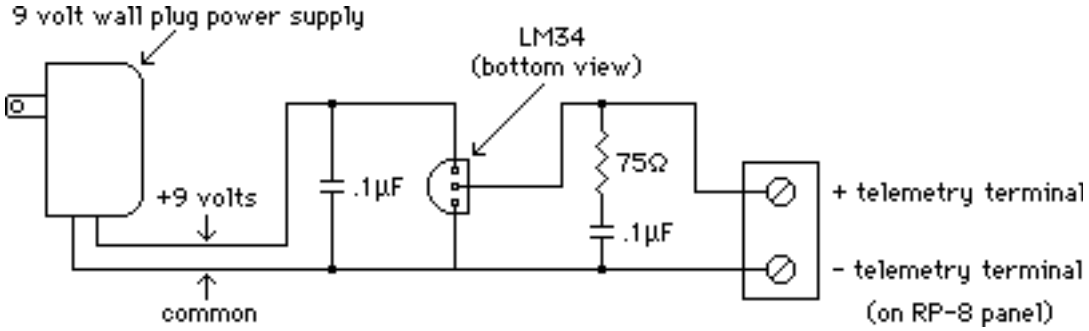
For installations where lighting damage occurs on a regular basis, or for other installations where the absolute maximum in reliability is required, we recommend the Sine Systems SP-8 Surge Protector. Using a combination of ground-plane construction, gas surge-suppressors, metal-oxide varistors, and "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 normally not covered under the Sine Systems one year warranty. However, if the RFC-1 and RP-8 is protected by the SP-8 surge protection system, Sine Systems will repair damage to the RFC-1 and RP-8 at no cost (except shipping) during the warranty period. To be eligible for warranty repair of lightning damage, the user should return the RFC-1/B Remote Facilities Controller and all RP-8 Relay Panels with the SP-8 and SP-8/TO Surge Protectors attached, to Sine Systems. The equipment will be repaired or replaced, and returned to the user at no cost. This applies only to equipment used in the United States.

Temperature Monitoring

The model TM-1 Temperature Monitor module 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).

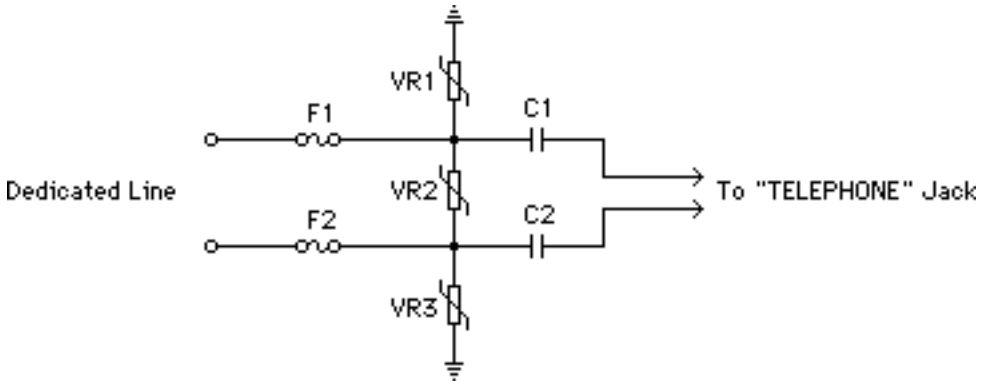
Dedicated Control Port

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!

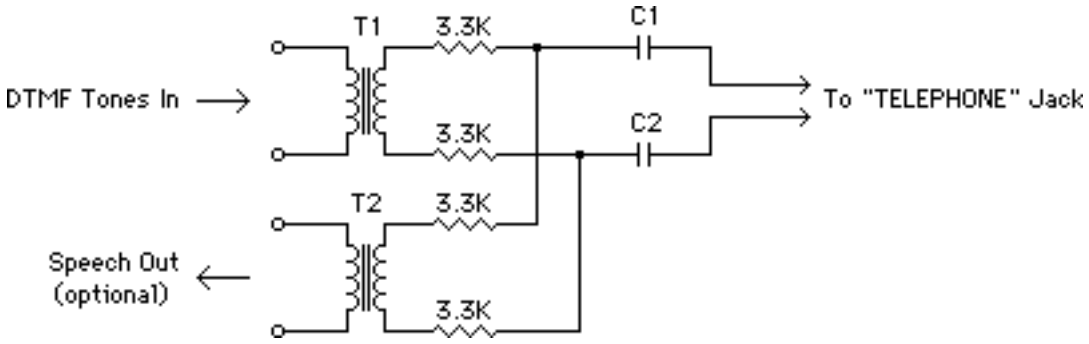
The dedicated control port, when enabled, is a two way audio port with a superimposed source of 12 volts DC for applications requiring "battery," such as telephone sets. However, when the RFC-1 is being used in the "dial-up" mode, this port is connected in parallel with whatever is attached to the "LINE" 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:



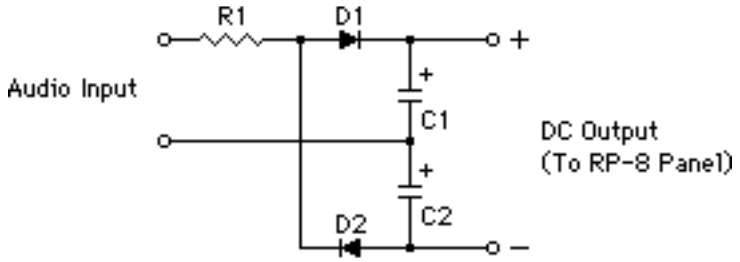
C1 and C2 are 2 µF, 200 volt film capacitors and T1 and T2 are 600 ohm to 600 ohm transformers, such as a Prem SPT-124. This circuit could be used with a two-way radio, a voice pager, an SCA/STL subchannel, or just about any communications link capable of passing voice-grade audio. It is important to 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 MC68HC811E2FN 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 SP0256AL2/P (U4) speech synthesizer, the 75T202-IP (U2) DTMF decoder and the UDN2981A (U6) relay buss driver connect directly to it and communicate in "parallel."

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.