

Dial-Up Audio Interface Model DAI-1

— Hardware Instruction Book — (concise edition)

**This instruction book contains documentation for the model DAI-1
Dial-Up Audio Interface, Hardware Version 1.03.**

**This version of the product documentation has been edited for
length. It contains only the sections that concern installation and
operation of the product to allow for quicker electronic distribution.**

SINE SYSTEMS
Nashville, TN

Section 3 — Safety Information

3.1



The DAI-1 Dial-Up Audio Interface should be installed only by qualified technical personnel. Incorrect or inappropriate installation could result in a hazardous condition.

The DAI-1 Dial-Up Audio Interface is registered with the Federal Communications Commission and certified to meet specific safety requirements. It is extremely important that the DAI-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 DAI-1 Dial-Up Audio Interface 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 DAI-1 Dial-Up Audio Interface case is opened without first being disconnected from the telephone line. High voltages may be present on telephone lines, and although the DAI-1 is powered by 12 volts DC from an external power supply, failure of this power supply could cause dangerous and potentially lethal voltages to become present.

If the fuses in the DAI-1 are replaced, the replacement fuses should be of the same type and rating as the original fuses. The three fuses used in the DAI-1 are type 2AG fast blow and are rated at 1/2 ampere. Spare fuses are included in the DAI-1 Accessory Kit.

The DAI-1 Dial-Up Audio Interface is designed for indoor use in a dry location. Installation and operation in other locations could be hazardous.

Section 5 — Installation



WARNING!

Installation of the DAI-1 Dial-Up Audio Interface 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.

5.1 Unpacking

When the DAI-1 is unpacked, it 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.

5.2 FCC Information

The DAI-1 complies with Part 68 of the FCC rules. On the front panel of the DAI-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 DAI-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 RENs 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 RENs 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 RENs contact the telephone company to determine the maximum REN for the calling area.

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

If trouble is experienced with the DAI-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 DAI-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 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.

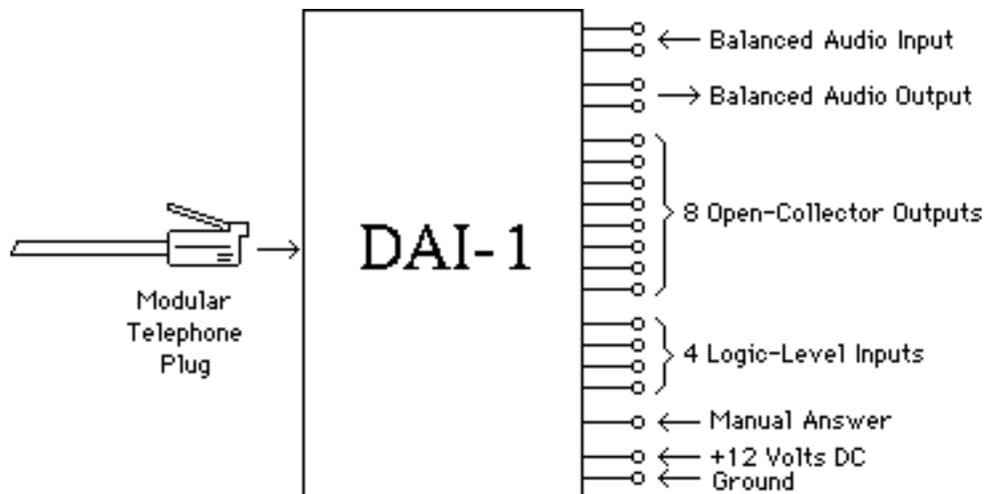
The DAI-1 cannot be used on public coin service lines provided by the telephone company. Connection to Party Line Service is subject to state tariffs. Contact your state public utility commission, public service commission, or corporation commission for information.

5.3 Mechanical Installation

The DAI-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 either the optional RK-3 rack mount kit or the DAI-RP Relay Panel kit.

5.4 Electrical Installation

The following illustration shows the various connections that can be made to the DAI-1:

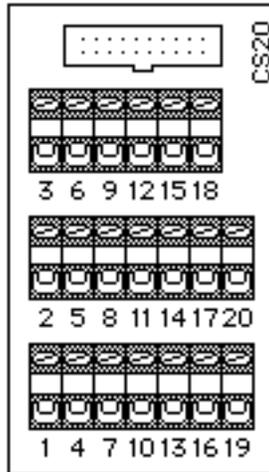


The front panel of the DAI-1 contains two jacks. The first is an RJ11 (modular) jack labeled "LINE" and is for connection to the telephone line. The other is a 20 pin connector designed for "flat cable" interconnection labeled "POWER; INPUT; OUTPUT" and provides for all other connections to the DAI-1.

Provided with the DAI-1 are a 6.5 foot telephone cord with modular plugs and four feet of 20 conductor flat cable with a flat cable connector on one end.

5.4.1 Interface Modules

The individual conductors in the flat cable can be easily peeled apart for stripping and termination. However, terminating these wires individually by soldering is tedious and time consuming. An alternative is to terminate the flat cable with a connector and then plug this into a screw-terminal "interface module":



This speeds up installation considerably. Such a module is included in the DAI-RP kit or it can be ordered separately as Sine Systems part number IM-20 pictured above. Interface modules are made by several manufacturers and are available through many distributors.

Flat cable connectors are easy to install without special tools. 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. Let the cable stick out at least a quarter of an inch or so beyond the connector. Next, squeeze the connector together with a small vice. A pair of slip-lock 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. Trim off the excess cable flush with the connector using a pair of diagonal cutters.



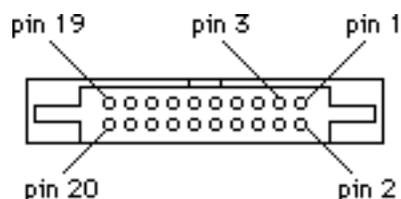
WARNING!

Pin number 1 of the connector on the flat-cable Interface Module (located on the DAI-RP) is on the left side while pin 1 of the connector on the DAI-1 itself is on the right side. To make the pin numbering on the Interface Module come out right, the stripe on the ribbon cable should be on the right side on the DAI-1 connector and on the left side on the flat-cable Interface Module.

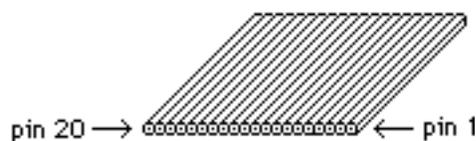
5.4.2 Flat Cable Connections

Pin#:	Connection:
1	audio output (high)
2	audio output (low)
3	audio input (high)
4	audio input (low)
5	+12 volts DC (power)
6	ground (and power negative)
7	ground (and power negative)

- 8 open-collector output #1
- 9 open-collector output #2
- 10 open-collector output #3
- 11 open-collector output #4
- 12 open-collector output #5
- 13 open-collector output #6
- 14 open-collector output #7
- 15 open-collector output #8
- 16 logic-level input #1
- 17 logic-level input #2
- 18 logic-level input #3
- 19 logic-level input #4
- 20 logic-level input #5 (manual off-hook control)



Ribbon Cable Connector
Front View



Ribbon Cable

5.4.2.1 Ground Connection



WARNING!

The DAI-1 contains an internal protection circuit that diverts an abnormally high voltage on the telephone line to the DAI-1 ground connection. Such a voltage might be present during a thunderstorm, for example. For safety considerations, it is very important that the DAI-1 ground connection be connected to a good quality earth-ground. Failure to do this could result in a painful or lethal shock to anyone in electrical contact with the DAI-1 when a high voltage is present on the telephone line.

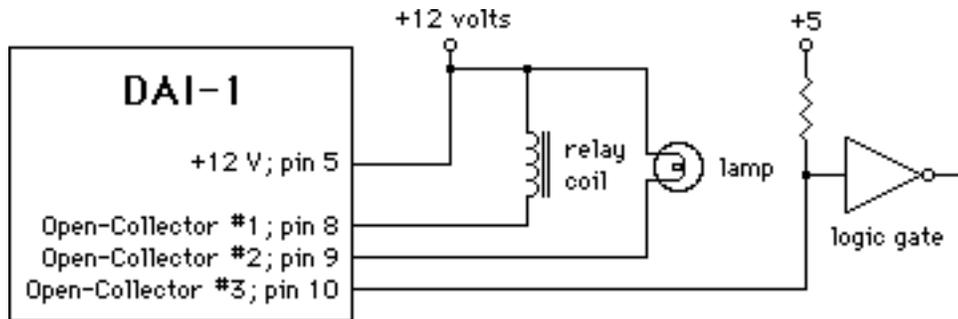
The DAI-1 ground connections appear on two pins: 6 and 7. Both of these pins should be connected to the station ground or other good quality earth-ground.

5.4.2.2 Power Connection

The DAI-1 requires 12 to 14 volts DC at about 80 milliamperes. Any devices operated by the open-collector outputs will require additional current. For optimum operation, the peak-to-peak ripple voltage should be under 0.5 volts. For most applications, a 12 volt DC (unregulated), 500 milliampere "wall plug" power supply is entirely adequate. Radio Shack has one (273-1652) for about \$11.00. The "+" power supply connection should go to pin 5 and the "-" connection should go to pins 6 and 7 (also the ground connection). In wall-plug power supplies we have used, the lead with the stripe on it is the positive lead. However, be sure about your power supply because a polarity reversal will blow the power fuse in the DAI-1.

5.4.2.3 Open-Collector Connections

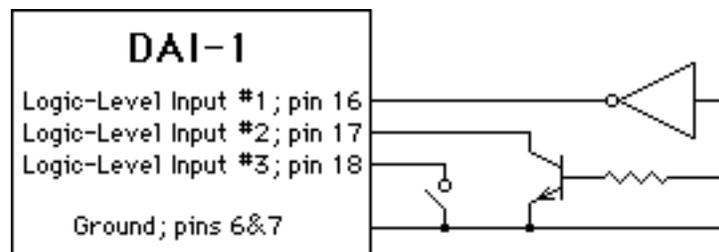
The DAI-1 has 8 open-collector outputs. These can be used to turn on relays, lamps, LEDs, buzzers, and so on. It is most practical to use the open-collector outputs to operate devices that operate on 12 volts DC. Alternately, an intermediate 12 DC relay can be used to control other devices. Each open-collector output can "sink" 350 milliamperes but the total of all outputs should not exceed 1.0 amperes. Here is how devices are connected to the open-collector outputs:



The power supply voltage for the "high" side of the open-collector loads can be any voltage up to the voltage used to operate the DAI-1. Diodes across the relay coils are not necessary. Protection from inductive loads is already provided in the DAI-1. External logic gates should have the same ground reference as the DAI-1.

5.4.2.4 Logic-Level Input Connections

The DAI-1 has a total of five Logic-Level Inputs. Four are user-programmable in function and one is a dedicated purpose "off hook" control. All Logic-Level Inputs can be driven by a five-volt logic level, a contact closure, or a ground referenced open-collector. Logic is arranged "active low" and internal pull-up resistors are present. In other words, when using an open-collector or contact closure, a "pull down" to ground activates the appropriate function. Logic-Level Inputs 1 through 4 may be held at ground indefinitely but Logic-Level Input 5 (the manual off-hook control) should not be held down more than 2.56 seconds or a microprocessor reset will occur. The following illustration shows examples of Logic-Level Input connections:



External logic gates should have the same ground reference as the DAI-1. Unused Logic-Level Inputs should be left unconnected. The time required for a Logic-Level Input change to activate a function is controlled by user-programming and is discussed in the Software Book.

5.4.2.5 Audio Connections

The DAI-1 has two balanced, high level, audio connections (ports): one input and one output. The DAI-1 audio input is used to feed audio to the telephone line. The DAI-1 audio output is the audio from the telephone line. The DAI-1 contains internal logic which allows only one audio port to be active at a time. In other words, a tape recorder's playback output can be connected to the DAI-1 audio input, and the recorder's audio input can be connected to the DAI-1 audio output, without generating feedback.

The DAI-1 audio output can drive a balanced high impedance or 600 ohm load at up to about +4dBm. If the DAI-1 audio output is required to drive an unbalanced load, use one output lead (either one) and ground (pins 6&7). Do not connect either side of the DAI-1 audio output to ground for an extended period of time or damage to the DAI-1 could result.

The audio output level of the DAI-1 can be adjusted by programming the internal microprocessor. Instructions on how to do this are contained in the Software Instruction Book. The DAI-1 is factory programmed to an output level setting of "7" which results in a program level of about +2 to +4 dBm and a slight amount of peak clipping. Higher output level settings will result in higher output level and more clipping while lower settings will result in lower output levels and little or no clipping. Also settable by user-programming is the speed-of-operation of the automatic level control (ALC) in both the input and output modes. Depending on the need, the ALC can be enabled or disabled on a key-by-key basis.

When the ALC is enabled and the DAI-1 is feeding audio to the telephone line, a "virtual level preset" capability is created when the DAI-1 switches between two or more audio sources. This feature happens automatically and assures that the audio heard on the telephone line is equal-in-level when sources are switched, even if the audio level of the sources is different. For this reason, if the DAI-1 selects from two or more audio sources to be fed to the telephone line, it is not necessary that they be matched in level. As long as they are in the range of -10 dBm to +4 dBm, the DAI-1 will store the last-used level setting for a given source and recall it when the source is reselected.

The DAI-1 audio input is actively balanced and is a high impedance (>100k). It can be driven by either a balanced or unbalanced source. For unbalanced sources, connect the source "hot" connection to one input pin and the source ground connection to the other input pin. Unlike the DAI-1 audio output circuit, there are no restrictions on grounding the audio input connections. The DAI-1 is designed to automatically adjust for input levels within the range of -10 dBv to +4 dBv.

5.5 Accessories for the DAI-1

5.5.1 DAI-RP Relay Panel

The DAI-RP is an optional kit which includes a 3.5 inch by 19 inch rack panel with space to mount the DAI-1, a screw-terminal interface module with an extra flat cable connector, one 4PDT relay, four 2PDT relays, and a 12 volt DC/500 milliampere wall-plug power supply. Here is a rear view of the DAI-RP with the components installed:

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 generally needed.

The big disadvantage of rural radiotelephones is the cost. The cost of a typical system is about \$5200. 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.

The Cellular Telephone:

It is possible, with appropriate adaptation, to use a cellular telephone at the DAI-1 location in place of a regular telephone line. Adapter devices are available which can convert a cellular telephone to a standard RJ11 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. The adapters are made by Spectrum Technologies (800 233-2119) and cost about \$400.00. When calling, ask about a "cellular-to-RJ11" adapter and be prepared to give them the make and model number of the cellular telephone you plan to use it with. Adapters are available for most popular cellular telephones. When ordering a cellular-to-RJ11 adapter be sure the one you are getting will generate ring voltage, and, if you want the DAI-1 to be able to originate a telephone call, be sure it is compatible with pulse dialing. The cellular-telephone approach is often attractive for broadcast stations because they can usually "trade out" a cell phone and air time.

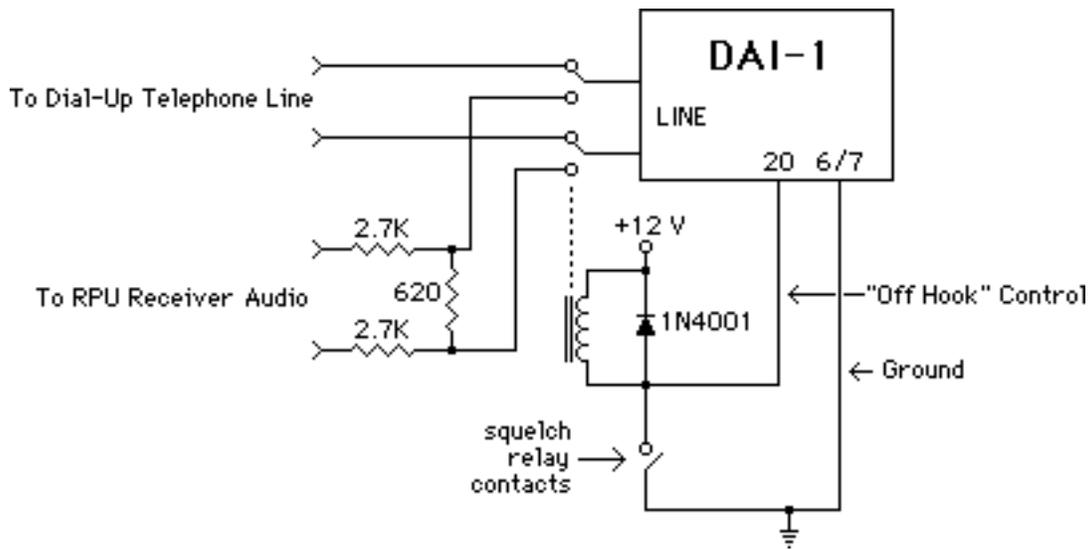
It is reported that Fujitsu, Motorola, NEC and OKI make cellular-to-RJ11 adaptors for their cell phones. Check with your local dealer for information. Radio Shack makes an inexpensive RJ11 adapter (part number 17-504 CMC) for one model of their cellular telephones, however, this device does not generate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

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. One manufacturer is Telular, Inc. (708 256-8000). Their phones have a built-in cellular-to-RJ11 adaptor and start at around \$1400. Another is Cellabs (818 700-1300) who makes a similar unit for about \$900.

5.7 Use With RPU Equipment

It is quite feasible to use the DAI-1 with communications links other than telephone lines. For example, the control and switching capabilities of the DAI-1 often can be useful during remotes using a UHF Remote Pickup Unit (RPU). The audio output of the RPU receiver should be adjusted to a level of -30 dBm to 0 dBm and then fed to the LINE jack on the DAI-1. The "manual off-hook" control, using either the front panel pushbutton or the logic-level input, should be activated .

It is easy to construct an extremely versatile system that allows either of two communications links to be used with the DAI-1. Using the squelch relay in an RPU receiver to control a 2PDT relay, either a telephone line or the output of the RPU receiver can be connected to the DAI-1.



The DAI-1 contains an internal 4.5 kHz low-pass filter. This will not limit the bandwidth of audio coming from the telephone line but it will restrict bandwidth of the audio coming from the RPU. This is usually not a problem for voice broadcasts, but if music is being broadcast it may be a point to consider.

When broadcasting using an RPU, DTMF tones may be used to control the DAI-1 just like when using a telephone line. DTMF tones can be generated by simple tone-dialers of the type available from Radio Shack. Modification of these devices may be necessary to obtain the necessary audio connection.

5.8 Lightning Protection Tips

The DAI-1 contains surge protection on both the telephone line and power connections. In applications where the DAI-1 is installed in an office or studio environment this will be sufficient to prevent damage to the DAI-1 from lightning-induced transients. If the DAI-1 is installed at a transmitter or any facility near a tall metal tower, additional protection is suggested.

If the DAI-1 is installed at a transmitter, first 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.

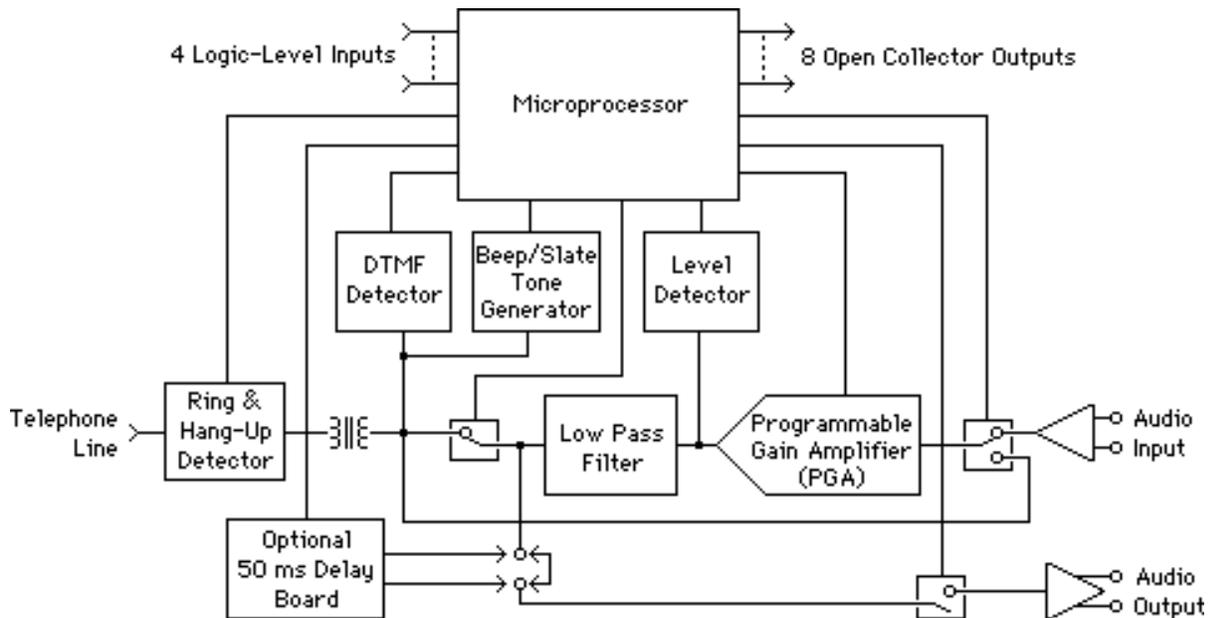
We highly recommend that you purchase and install your own telephone line surge protector in addition to the one installed by the telephone company. The Radio Shack 43-102 Telephone Spike Protector is inexpensive (\$12.95) yet adequate for many installations. Install this between the telephone line and the DAI-1. The 43-102 is designed to pick up a ground connection through the ground prong on a standard AC outlet. However, for best results,

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 DAI-1 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.

Section 6 — Troubleshooting and Repair

6.1 Circuit Description

The following block diagram and the schematic diagram located on page 7.2 will aid in the description of the DAI-1:



The heart of the DAI-1 is a Motorola MC68HC711 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 (U7) DTMF decoder, the ULN2803 (U8) octal open-collector driver, the MAX7624 multiplying converter, and the status inputs connect directly to it and communicate in "parallel." The microprocessor operates off a 3.579 MHz crystal oscillator and a portion of this signal is used to drive the DTMF decoder as well.

D5 is a 15 volt, 5 watt zener which protects the DAI-1 from over-voltage and reverse-polarity on the power supply input. U9 is a standard 5 volt regulator. U-1 is a "low voltage interrupt" (LVI) device which resets the microprocessor if its supply voltage falls below 4.5 volts.

U5b and U5c comprise the balanced audio output section. U5a serves in the balanced audio input section. U4 is a multiplying D-A converter which is configured as a programmable gain amplifier (PGA). U5d buffers the output of the PGA. This drives the level detection circuit and a third order low pass filter using U2c. The DC output of the level detection circuit is fed to the analog-to-digital (A-D) converter in the microprocessor. U3 is a CMOS switch with four single-pole-single-throw sections and is used to route audio. U2a and U2d comprise a hybrid circuit that lowers the amount of "send" audio arriving at the DTMF detector.

OC1 detects ring and hang-up signals. A hang-up is detected by a step voltage change on the telephone line caused by a momentary "battery" interruption (loop break). Capacitors C2 and C3, and inductors L1 and L2 form a low pass filter to attenuate radio frequency interference (RFI). SP1 is a three terminal gas surge protector.

6.2 Field Repair



WARNING!

Repair of the DAI-1 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. Disconnect the telephone line before testing or repair.



WARNING!

Because the DAI-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 DAI-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!

6.2.1 Fuse Replacement

The DAI-1 contains three internal, replaceable fuses. The fuses are type 2AG rated at 0.5 ampere, fast blow. Spare fuses are included with the DAI-1 accessory kit. The DAI-1 fuses should be replaced only with fuses of the same type and rating.

6.2.2 RF Problems

The DAI-1 contains internal protection against RF energy. In extreme cases, such as operation very near broadcast transmitters, additional protection may be necessary. The following steps are recommended:

- 1) Install an RF filter preceding the "LINE" jack near the DAI-1
- 2) Loop the ribbon cable several times through a ferrite core near the DAI-1

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

6.2.3 Power Supply

The first step in troubleshooting should be to look for signs of burned or otherwise damaged parts. U9 may run a little warm but should not be hot enough to burn or discolor the PC board. Check the incoming DC voltage and fuse F3. Check for +5 volts DC at the output of the regulator (U9). The bottom two resistors in the SIP network R10 form a voltage divider which generates a "midpoint" reference voltage for the analog circuits. Check to see that this is one-half the main power supply voltage. If it is not, something is pulling it up or down. The current consumption of the DAI-1 at 12 volts DC should be about 80 milliamperes. If it is significantly more than this, remove the ICs one at a time until the current drops.

6.2.4 Telephone Line Interface

When the RFC-1 is not in use, RY1, the hook relay, is off. U2a and U2d provide gain and isolation for the audio signals going to and from the telephone line. OC1 detects ring voltage and hang-up pulses.

6.2.5 DTMF Decoder

U7 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).

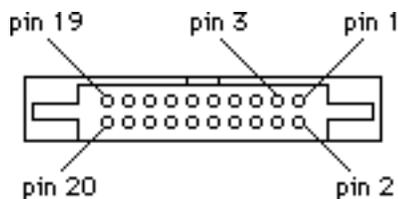
6.2.6 Low Voltage Interrupt (LVI)

U1 is a "low voltage interrupt" 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 (+5 volts).

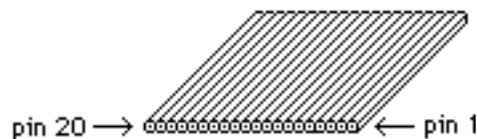
6.2.7 CMOS Switch

Each section of the DG211 CMOS switch (U3) is independently controllable. When the control pin is at +5 volts, the switch is open. When the control pin is at ground, the switch is closed.

6.2.8 Connector Pin Locations



Ribbon Cable Connector
Front View



Ribbon Cable

6.3 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 it 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. Damage due to negligence, lightning or acts of god and nature are not covered under warranty.

There is on exception to this and it is: we will repair lightning damage during the warranty period on an RFC-1/B if you have our SP-8 Heavy Duty Surge Protector properly installed in a well grounded system. The SP-8 and the RFC-1/B must be purchased at the same time for this warranty to apply; and the SP-8 must be returned to us with the system 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.