

RADIO COMMUNICATIONS
FOR PROFESSIONALS

RITRON, INC.

MAINTENANCE AND OPERATING MANUAL TELENEXUS SYSTEM TELEPHONE LINE EXTENDER

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NOTE: This manual has been revised to include all Engineering changes to the Telenexus system. If a parts value shown on the schematic differs from the value given in the parts list, the parts list should be considered correct. The last Engineering Change Notice (ECN) is 1697 for the RTLT-1, and 1561 for the RTSU-1.

RITRON TELENEXUS SYSTEM

GENERAL DESCRIPTION

The RITRON TELENEXUS System provides a means of extending telephone service to areas where phone lines are not economically or physically practical. The base unit consists of a RITRON Repeater Plus, a suitable antenna and a RITRON Telephone Line Terminator (RTL-T-1) that is connected to a telephone line via an RJ11 plug. The remote unit consists of another RITRON Repeater Plus (Desktop or Wall Mount version), an antenna and a RITRON Telephone subscriber unit (RTSU-1) that is connected to a standard telephone instrument by an RJ11 plug. The two-way radio link between the Repeater Plus systems acts as a telephone line; the system is compatible with Touch Tone or rotary-dial telephone lines.

When the remote/ RTSU-1 unit originates a call, the subscriber unit (RTSU-1) senses the "off-hook" condition and activates its repeater transmitter. The base unit Repeater Plus/ RTL-T-1 senses the RF signal from the remote repeater and, in turn, keys the base repeater transmitter and connects the telephone line. At this point, the telephone instrument is effectively connected across the telephone line via the radio link. Since "incoming" and "outgoing" voice signals are carried on a SINGLE pair of telephone lines, a hybrid circuit is required in order to separate the two for the radio link, which uses one radio frequency to carry audio FROM the phone line TO the subscriber unit, and a second radio frequency to carry audio FROM the subscriber unit TO the telephone line.

With the subscriber phone switched across the telephone line, as shown by receipt of a dial tone, the desired number can be dialed. If a Touch Tone phone is used, the resulting tone pulses, generated by the phone, are applied through the radio link directly to the telephone line; however, if a rotary-dial phone is used, additional circuitry is required to simulate the "on-off" dial pulses.

With a rotary-dial phone, dialing is done by a single-pole "pulsing" switch that is located on the back of the dial—which opens and closes to simulate an "on-hook/off-hook" condition as the dial rotates. The number of pulses delivered is equal to the number dialed on the rotary phone.

With the "pulsing" switch OPEN ("on-hook"), the 2805 Hz oscillator in the RTSU-1 turns ON; as the dial rotates, the switch CLOSES ("off-hook"), turning OFF the oscillator. A series of 2805 Hz pulses are produced, equal in number to the desired number dialed. These pulses of 2805 Hz tone are applied to the remote repeater transmitter and sent to the base repeater.

The base unit repeater receiver routes the detected pulses to the RTL-T-1 Line terminator. When a 2805 Hz pulse is received, a relay in the RTL-T-1 OPENS, which disconnects the hybrid from the telephone line. As the 2805 Hz pulse drops out, the relay CLOSES and reconnects the hybrid to the phone line. This simulates an "on-hook/off-hook" pulse-dialing sequence. The number of relay operations agrees with the "dialed number." After the complete phone number has been dialed, the relay connects the hybrid to the telephone line, allowing voice communi-

With the subscriber unit "ON-HOOK," the 2805 Hz tone will be present on the remote REPEATER speaker. For Touch Tone systems, this 2805 Hz tone IS NOT necessary and may be disabled by moving JU202 in the RTSU-1 to its "A" position.

A call TO the remote subscriber phone is placed in the usual manner. After the number is dialed, a "ringing-voltage" is applied to the telephone line. The "ring-detector" in the RTL-T-1 line terminator senses this voltage and keys the base repeater transmitter which, in turn, activates the remote repeater. If the remote telephone is "on-hook," the incoming signal causes the "ringing-voltage" to turn ON in the RTSU-1 subscriber unit, and then applies this voltage to the ringer in the telephone instrument. When the phone is picked up, the "off-hook" detector senses this and turns OFF the "ringing voltage," connects the hybrid to the telephone instrument and keys the remote repeater transmitter. This connects the telephone to the phone line.

USING THE TELENEXUS SYSTEM

There is little difference between using the Telenexus system and using any conventional telephone system. For example, to place a call from the subscriber phone to any other phone, simply pick up the handset and wait for a dial tone—then, dial the desired number. When the called phone is answered, normal conversation can begin. Since the Telenexus system is full-duplex, there is no delay between talking and listening (transmitting and receiving).

When a call is placed from any phone to the subscriber unit phone number, the subscriber phone will ring. Picking up the subscriber handset will establish the two-way communication path. Either party can end the call by hanging up their handset.

IMPORTANT INFORMATION FOR THE CUSTOMER

The RTL-T-1 line terminator, registered under Part 68 of the FCC Rules and Regulations for direct connection to the Public Switched Telephone Network, is subject to the restrictions of FCC RULES AND REGULATIONS Parts 68 and 90.

All subscriber connections to the telephone system are to be made with STANDARD PLUGS and telephone company-supplied jacks (or their equivalent) to facilitate QUICK disconnection in case of a malfunction that could harm the telephone network.

CUSTOMER'S RESPONSIBILITIES

Customers that intend to connect REGISTERED equipment to the telephone network are no longer required to notify the telephone company, unless the telephone company requests notification. A notification must include:

- 1) The particular telephone line or lines to which the connection is to be made.
- 2) The FCC registration number and the ringer equivalence number from the equipment's serial or ID label.
- 3) The universal service order code for the type of jack required, for a new line.

REGISTRATION INFORMATION

Product Model: RLT-1
Trade Name: Telenex
Manufacturer: RITRON, Inc.
FCC Registration Number: AIE9QZ-13714-VP-
DOC Approval Number: 1084 3398 A
Ringer Equivalence: 0.7B
Registration Class: Fully protected voice circuitry
Equipment Description: Radio Repeater Interface
Universal Service Order Code: RJ11C

RIGHTS OF THE TELEPHONE COMPANY

The telephone company has the right to temporarily disconnect service to any device that harms the system; however, prior notice will be given if practicable. If prior notice is NOT given, the telephone company shall:

- 1) Promptly notify the customer after service is discontinued,
- 2) Give the customer the opportunity to correct the situation that caused the discontinuance and,
- 3) Inform the customer that he has the right to file a complaint with the Federal Communications Commission according to the procedures set forth in Part 68 of the FCC RULES AND REGULATIONS.

The telephone company also has the right to make changes in the facilities, equipment, operations and procedures. If it can be foreseen that the changes will cause the customer's equipment to be incompatible, adequate prior notice will be given to allow the customer to make such changes as are necessary to insure uninterrupted service.

PROHIBITED CONNECTIONS

The RITRON Telephone Line Terminator (RTL-T-1) may NOT be connected to:

- 1) A "party-line."
- 2) Any line providing coin service.

WARNING: The RTSU-1 generates, uses and can radiate radio-frequency energy. If not installed and used in accordance with the "Telenex Maintenance and Operating Manual," the RTSU-1 might cause interference to radio communications. The RTSU-1 has been tested and found to comply with the limits for a class A computing device pursuant to subpart J of part 15 of the FCC Rules, which are designed to provide reasonable protection against such interference when the unit is operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference, in which case the user (at his own expense) will be required to take whatever measures may be required to correct the interference.

TELENEXUS SYSTEM INSTALLATION

BASE UNIT EQUIPMENT NEEDED

- 1) One RITRON Repeater Plus (Desktop or Wall Mount) with sub-audible tone.
- 2) One telephone line terminator (RTL-T-1) with captive four-wire cable and modular plug.
- 3) One Yagi directional antenna.
- 4) 100 foot RG-8/U Co-axial Cable, with PL-259 connectors installed.
- 5) One six-conductor interconnecting cable, with a 20-pin connector on one end, and a 10-pin connector on the opposite end. This cable is NOT REQUIRED if you are using a Wall Mount Repeater Plus.

REMOTE UNIT EQUIPMENT NEEDED

- 1) One RITRON Desktop or Wall Mount Repeater Plus (must be configured the same as the base repeater, except that the TX and RX frequencies are reversed) with sub-audible tone.
- 2) One telephone subscriber unit, RTSU-1, with captive four-wire cable and modular jack.
- 3) One Yagi directional antenna.
- 4) 100 foot RG-8/U Co-axial Cable, with PL-259 connectors installed.
- 5) One six-conductor interconnecting cable, with a 20-pin connector on one end, and a 10-pin connector on the opposite end. This cable is NOT REQUIRED for the Wall Mount repeater.

NOTE: A TELEPHONE INSTRUMENT IS REQUIRED FOR USE WITH THE RTSU-1, BUT IS NOT SUPPLIED AS PART OF THE TELENEXUS SYSTEM.

After unpacking the Telenexus equipment, carefully inspect the units for any mechanical damage, such as broken knobs, bent switches, dented cases or "cut" cables. If mechanical damage due to shipping is found, file a claim promptly with the transportation carrier.

NOTE: BE SURE to remove power from the Repeater Plus while making the following connections.

CONNECTIONS TO THE DESKTOP REPEATER PLUS

The RTL-T-1 or RTSU-1 is installed OUTSIDE OF the Desktop repeater. To connect the repeater to the RTL-T-1 or RTSU-1, use the six-conductor cable that is fitted with a 10-pin connector plug on one side and a 20-pin plug on the other. The connectors feature a ramp-type locking mechanism to insure against accidental disconnection. Notice that at the ends of each connector there is a plastic indexing pin to assist in mating the appropriate connectors with the proper polarity. The male section of the 10-pin connector is mounted on the PC board of the RTL-T-1 or RTSU-1, and is accessed through a slotted opening in the repeater housing rear panel. Insert the 10-pin connector plug into the slotted opening with the plastic indexing pins facing toward the BOTTOM of the RTL-T-1 or RTSU-1. When the connector pins and plug are properly mated, apply a moderate amount of pressure to seat the connector and engage the locking mechanism. Interconnection of the 20-pin connector is performed in a like manner, EXCEPT that the indexing pins face the TOP of the REPEATER cabinet.

CONNECTIONS TO THE WALL MOUNT REPEATER PLUS

The RTL-T-1 or RTSU-1 is installed INSIDE OF the Wall Mount repeater case by inserting the ten connector pins located on the bottom-side of the RTL-T-1 or RTSU-1 PC board into the 10-pin socket on the REPEATER main board. Secure the RTL-T-1 or RTSU-1 with four stand-offs. No further connections between the REPEATER and the RTL-T-1 or RTSU-1 are required.

CONNECTING THE RTL-T-1 TO THE TELEPHONE LINE

Connection to the telephone line is made by uncoiling the captive cable in the RTL-T-1 and inserting the modular plug into the jack (RJ11C) provided by the telephone company. If the RTL-T-1 is to be connected to an existing line, which may be terminated in a different type of jack, adapters are available and may be supplied by either the telephone company or the customer. The most common type of adapter is the four-pin square array to the six-position modular plug. This adapter carries the Universal Service Order Code identification "RJA1X." The "T" or "Cube" adapter may be useful for applications in which an existing line with a RJ11C jack and a standard non-key telephone instrument is currently in use. This adapter is identified with the Universal Service Order Code "RJA2X."

CONNECTING THE RTSU-1 TO THE TELEPHONE DEVICE

Uncoil the captive four-wire subscriber unit cable; then, insert the modular plug (RJ11C) into the mating modular jack on the telephone device.

EARTH GROUND REQUIRED

It is MANDATORY that the repeater be connected to an EARTH ground for proper operation, and for safety. This grounding is normally accomplished through the electrical wiring by means of the three-wire cable and plug supplied with the Repeater Plus. DO NOT use 2-wire extension cords, or 3-pin to 2-pin UNGROUNDED adapters.

YAGI ANTENNA INSTALLATION

Only very general instructions can be given for the antenna installation, as each location will present different mounting problems. However, in all cases the Yagi antenna should be mounted so that its radiating elements are VERTICALLY polarized and directed towards the opposite end of the Telenexus link.

NOTE: Antenna installation procedure is the same for both ends of the Telenexus system.

- 1) Connect one of the PL-259 co-ax connectors, installed on the co-axial cable, to the mating receptacle on the antenna. Be sure that the connector shell is screwed down firmly.
- 2) Starting at a point on the cable about 1/2" from the connector, wrap the cable and connector with one or two layers of vinyl electrical tape to ensure a weather-proof seal at the antenna for the connector and cable.
- 3) Cover the vinyl tape with RTV sealant, or an equivalent.
- 4) Using the metal "saddle" and "u-bolt" supplied with the antenna, fasten the antenna to the mounting mast so that the antenna rods (directors and reflector) are VERTICAL (vertical polarization) with the mast mounted in place.
- 5) Route the cable along the antenna boom, and then down the mounting mast. Secure the cable to the boom and mast with plastic cable-ties or vinyl tape.
- 6) When erecting the antenna mast, BE SURE that no portion of the antenna or its mast can touch any electrical wires. The best precaution is to NOT locate the antenna mast closer to electrical wires than twice the mast length, if possible. If the mast should fall against wires, GET AWAY FROM IT — CALL THE LOCAL POWER COMPANY IMMEDIATELY TO REMOVE IT.
- 7) After the mast is erect, rotate the mast to orient the antenna toward the opposite end of the Telenexus system. Since a Yagi antenna achieves its gain by concentrating the signal in a very narrow beam, it is necessary that each of the two antennas be correctly aimed at each other, i.e., the three short elements (directors) should be toward the desired station. Once the base and remote units are operational, each antenna's aim should be adjusted to obtain MAXIMUM quieting or best quality audio.

POWER CONNECTIONS

The RTL-T-1 line terminator and RTSU-1 subscriber unit obtain their operating power from their associated repeater, which may be connected to either a 120 VAC, 60 Hz source or to a 12 Volt DC power supply, as described in the Repeater Plus manual.

A battery "trickle charger" is incorporated into the repeater (Desktop and Wall Mount units) circuitry to keep an "optional," external EMERGENCY 12VDC battery charged. In the event of a power failure, the unit automatically switches from the previous source to this battery.

NOTE: Refer to the Repeater Plus manual for instructions to connect an external 12 Volt supply or back-up battery.

CAUTION: If operating the repeater from a 120 VAC outlet, be sure the outlet is NOT on a "switched" circuit that may be turned OFF inadvertently during normal operating time. Also note that the repeater MUST BE grounded — refer to the "Earth Ground Required" section above.

WARNING: Do NOT make INTERNAL adjustments to the repeater unless the test equipment specified in the Repeater Plus manual is available. Work on the TRANSMITTER portions of the repeater SHOULD be done by or under the immediate supervision of the holder of an FCC General Radiotelephone Operator License.

WARNING: NEVER attempt to operate a transmitter without either an antenna of the correct impedance, or a dummy load of the proper impedance, connected to the antenna terminals. Do NOT insert a length of wire into the antenna connector and key the transmitter. The resulting high VSWR can destroy the final transistor(s). DO NOT connect the antenna receptacle of one repeater to the antenna receptacle of another repeater.

REPEATER PLUS SET-UP

NOTE: The following instructions pertain ONLY to the DESKTOP repeater (RR-455, RR-155), and NOT to the WALL MOUNT repeater (RR-454).

Repeater Plus Switch, Volume and Squelch Adjustments

After the RTL-T-1 or RTSU-1, power and antenna have been connected to the REPEATER as already described in this manual, adjust the REPEATER front panel controls as follows:

NOTE: For the Wall Mount Repeater Plus, these adjustments are INTERNAL and PRE-SET.

- 1) Rotate the squelch control (SQ) fully COUNTERCLOCKWISE and press the monitor switch.
- 2) Rotate the On-Off/volume control knob (VOL) CLOCKWISE until the PWR light comes ON and noise from the receiver is relatively loud.

- 3) Rotate the squelch control knob CLOCKWISE until the noise disappears.
- 4) Rotate the volume control knob COUNTERCLOCKWISE to minimum, but DO NOT turn the power OFF.
- 5) The TONE A B switch is not used in "standard" Telenex service—disregard its setting.
- 6) Release the monitor switch—it is spring-loaded in the center (OFF) position.

REPEATER PLUS MODIFICATIONS PERFORMED AT THE FACTORY (Not for Wall Mount model)

- 1) Set RR-455 Program Jumper PJ301 to its "K" position. This prevents receiver squelch from activating the transmitter.
- 2) Set RR-455 Program Jumper PJ302 to its "K" position. This disables the repeater 3-minute timer for continuous-data transmission.
- 3) Set RR-455 Program Jumper PJ303 to its "K" position. This opens the audio path from the receiver output to the transmitter input so that the received audio is not re-transmitted.
- 4) Set RR-455 repeater "carrier dropout time" R308, located on the main board, for minimum hang-time (fully clockwise) so that repeater will shut down immediately after transmission ceases.
- 5) For systems using CTCSS tone squelch, the diode installed between "Out" 1 (cathode) and "In" 1 (anode) of the repeater tone matrix MUST BE removed. This prevents re-transmission of tone.

NOTE: All of the above modifications are automatically implemented upon insertion of the RTL-T-1 or RTSU-1 10-pin connector into the 10-pin socket in the Wall Mount Repeater Plus.

REPEATER PLUS OPERATION WITHOUT TONE

If the repeater is NOT equipped with sub-audible tone, the WHITE wire should be positioned in "pin 10" of the 20-pin connector, as opposed to "pin 7" of the 20-pin connector for units equipped WITH tone.

To remove the wire and terminal from its connector shell, place the connector on a flat surface with the guide pins facing DOWN. To release the terminal for removal, press down gently at the wire end of the slot with a pick and pull the wire and terminal from the shell.

INSTALLATION ALIGNMENT PROCEDURE

TEST EQUIPMENT NEEDED

- 1) Oscilloscope or AC milli-voltmeter
- 2) DC voltmeter
- 3) DTMF telephone device

ADJUSTMENTS

The following adjustments are to be performed with the RTL-T-1 base equipment connected to the telephone line that it will ultimately service. The RTSU-1 remote equipment does NOT necessarily have to be at its final location for alignment, although the RF link between the base and remote unit is required. In most cases, it might be desirable to perform the following alignment procedure with the remote RTSU-1 at the base location, terminated at the antenna terminal with a dummy load of the correct impedance. After alignment, the remote RTSU-1 equipment may be moved to its final location.

RTL-T-1 TELEPHONE LINE CURRENT

- 1) Connect the DC voltmeter across R101.
- 2) Pick-up the telephone connected to the RTSU-1 remote unit. This should cause the RTL-T-1 base unit to connect to the telephone line and return a dial tone to the RTSU-1 unit telephone.
- 3) Place JU101 ("shorting plug") to each of the four positions (A, B, C, D) and note the DC voltage across R101 for each setting.
- 4) JU101 should then be placed in the position which allows approximately 2 VDC across R101. This is to set the amount of DC telephone line current through the hybrid circuit. Note that this voltage should be at LEAST 1.8 VDC to guarantee enough telephone line current to "hold" the telephone line.

RTL-T-1 HYBRID

- 5) Connect the oscilloscope or AC milli-voltmeter to pin 9, P101.
- 6) From the DTMF telephone device at the remote RTSU-1 location, place a phone call to a "landline" telephone (preferably NOT a long-distance call).
- 7) After the call has been answered, simultaneously press the "5" and "8" buttons on the DTMF phone at the remote RTSU-1 unit and hold. This will generate a 1336 Hz tone, transmitted TO the base RTL-T-1 for adjustment of the hybrid circuit.

- 8) Place all switches on SW101 to the OFF position.
- 9) Adjust R103 for MINIMUM audio indication on the oscilloscope or AC voltmeter.
- 10) Starting with switch 1 of SW101, place the switches to the ON position, one at a time. This is to determine which individual switch setting, if any, yields the MINIMUM audio on Pin 9, P101, as indicated by the oscilloscope or AC voltmeter.
- 11) Leave this switch ON and, beginning again at switch 1, place the switches ON, one at a time up to the FIRST switch selected. This is to determine which two switches, if required, yield the MINIMUM audio at pin 9.

RTSU-1 HYBRID

- 12) Connect the oscilloscope or AC milli-voltmeter to pin 9, P101 of the remote RTSU-1.
- 13) From the telephone device at the remote RTSU-1 location, place a phone call to a "landline" telephone.
- 14) After the call has been answered, have the individual on the "landline" end simultaneously press the "5" and "8" buttons of a DTMF phone and hold. This will generate a 1336 Hz tone transmitted TO the remote RTSU-1 unit for adjustment of the hybrid circuit.
- 15) Place all switches on SW201 to the OFF position.
- 16) Adjust R219 for MINIMUM audio indication on the oscilloscope or AC voltmeter.
- 17) Starting with switch 1 of SW201, place the switches to the ON position, one at a time. This is to determine which individual switch setting, if any, yields the MINIMUM audio on Pin 9, P101, as indicated by the oscilloscope or AC voltmeter.
- 18) Leave this switch ON and, beginning again at switch 1, place the switches ON, one at a time up to the FIRST switch selected. This is to determine which two switches, if required, yield the MINIMUM audio at pin 9.

THIS COMPLETES THE ALIGNMENT OF THE TELENEXUS SYSTEM.

If not yet done, move the remote RTSU-1 equipment to its final location and place the system into service.

RTL-1 THEORY OF OPERATION

Refer to the RTL-1 schematic while reading the following description.

POWER SUPPLY

The same low-voltage DC supply that powers the REPEATER also provides DC power for operation of the RTL-1 line terminator. Normally, this voltage is supplied by the internal +13.5 VDC regulator in the Desktop Repeater Plus, and by the +12 VDC regulator in the Wall Mount Repeater Plus; however, in case of a power outage, the RTL-1 is also supplied by the emergency battery.

The regulated DC supply voltage enters the RTL-1 PC board through P101 pins 5 and 6, while P101 pins 2 and 3 connect the negative side of the supply to the PC board ground. The regulated DC supply line supplies the line-switching relay, K101, and the 8 Volt regulator, IC105. R139 and R119 form a voltage divider across the 8 Volt supply, with the 4 VDC output providing a mid-point bias for selected op amps.

LINE RELAY, LINE CURRENT LIMITER

The modular plug and 4-wire cable connect the "ring" and "tip" wires of the telephone line to the normally-open contacts of DPDT line-switching relay, K101. With K101 energized, the "ring" and "tip" wires are connected through 1/2 of the split primary winding of hybrid transformer T101, the telephone line current limiter circuit, and 1/2 of the split primary winding of hybrid transformer T102. VR101 is connected across the "ring" and "tip" wires to protect against high differential voltages on the telephone lines.

Relay driver Q101 energizes K101 by pulling one side of the relay's coil to ground when the squelch signal on pin 8 of P101 goes "low" due to an incoming signal from the remote repeater transmitter. CR105 suppresses switching transients when K101 releases.

The line current limiter consists of R101, R102, R151, R152, JU101, C126 and C127. With K101 energized, the telephone line current flows through T101, T102 and the line current limiter. JU101 selects the proper series resistance required to limit the DC line current to 20 mA. C126 and C127, in parallel with the series resistors, allow the AC audio signals to pass through the line current limiter unhindered.

LOGIC CIRCUITRY

The logic circuitry consists of IC106A, IC106B, IC106C, IC106D, opto-coupler IC108 and switching transistors Q101 and Q103. The receiver squelch line (P101 pin 8), the ring detector (IC107 pin 4) and the 2805 Hz switch (Q103) supply the inputs to the logic circuits.

The squelch line (P101 pin 8) is "high" with NO input signal to the base repeater receiver. A signal FROM the remote repeater causes P101 pin 8 to pull IC106C pin 9 "low." The subsequent "high" on pin 10 is routed through R136 to the base (pin 6) of IC108. The NPN

transistor in IC108 then turns ON, the collector (pin 5) keying the base repeater transmitter via P101 pin 10. The "high" on IC106C pin 10 is also applied to pin 5 of NAND gate IC106B. Pin 6 is also "high," (assuming Q103 is OFF). The "low" output on pin 4 is applied to inverter IC106A, pins 1 and 2. The "high" output (pin 3) turns ON Q101, which energizes K101 and connects the telephone line. With NO call in progress, the Telenexus system is in standby mode — line relay K101 is NOT energized, and both repeater transmitters are OFF.

RING DETECTOR

A coupling network, C121 and R105, connects the "ring detector," IC107, across the "ring" and "tip" wires ahead of K101, the "line relay." A "ringing signal" on the telephone wires will appear between pins 1 and 8 of ring detector IC107, where the signal is rectified, filtered by C123, and applied to an internal Schmitt trigger. The output on pin 4, which consists of a positive DC voltage at each ring, turns ON the LED in IC108 via R137. The opto-coupler in IC108 is used to totally isolate the telephone line from the system ground. The LED then causes the transistor in IC108 to conduct, keying the base repeater transmitter with each ring. Note that the squelch line at P101 pin 8 is "high" at this time.

With optional components C129, C130 and CR106 installed, the telephone line is connected upon ring detection. With the transistor in IC108 ON due to ring detection, C129 and C130 slowly charge through R104. This slow charge of C129 and C130 pulls IC106C pin 8 "low," with the subsequent "high" at IC106C pin 10 connecting the phone line and keying the base repeater transmitter as described above. When C129 and C130 become fully charged, the "high" now present at IC106C pin 8 will disconnect the telephone line and de-activate the base repeater transmitter. If the squelch line at P101 pin 8 goes "low" during the period of time that C129 and C130 are charging, the phone line is connected and the base repeater transmitter keyed as described above; inverter IC106D will be "high" at pin 11, which instantly charges C129 and C130 through CR106 to reset the circuit.

2805 HZ "DIAL-PULSE" CIRCUIT

The third function of the logic circuitry is the conversion of 2805 Hz tone pulses into "on-hook/off-hook" dialing signals for use with rotary-dial phones. As a number is dialed on a rotary-dial phone at the remote subscriber unit, pulses of 2805 Hz tone are transmitted to the receiver in the base repeater. The 2805 Hz pulses then appear on P101 pin 1 (ACC RX AUDIO). A 2805 Hz pulse simulates an "on-hook" (open) condition; whereas, absence of the 2805 Hz signal creates an "off-hook" (closed) condition. The incoming signal also pulls the squelch line "low" on P101 pin 8.

The ACC RX AUDIO is amplified and filtered by IC103A/IC103B and associated components. The output, which contains the 2805 Hz tone pulses and any stray voice signals, is amplified by op amp IC104B and applied to a voltage-doubling detector, CR103, CR104 and associated components, so that only the tone pulses have sufficient amplitude to turn Q103 ON.

The "low" squelch signal on P101 pin 8 is applied to IC106C pin 9. The inverted output on pin 10 drives NAND gate IC106B pin 5 "high." If NO 2805 Hz tone is applied to CR103/CR104, Q103 does NOT conduct and its collector is "high," causing IC106B pin 6 to be "high." The output (pin 4) of the NAND gate, then, will go "low" and be inverted by IC106A, turning ON Q101 and energizing K101. Connecting T101, T102 and the line current limiter across the telephone lines simulates an "off-hook" condition.

With a 2805 Hz tone applied to CR103/CR104, Q103 turns ON and its collector pulls pin 6 of IC106B "low" (pin 5 is still "high"). The "high" output on pin 4 of IC106B is inverted by IC106A and turns OFF Q101, de-energizing K101. Disconnecting T101, T102 and the line current limiter from the telephone lines simulates an "on-hook" condition.

HYBRID CIRCUIT AND AUDIO LIMITER

The hybrid consists of hybrid transformers T101 and T102, R103, C128, SW101 and its associated capacitors. IC101A directs signals FROM the phone lines TO the base repeater transmitter, whereas IC101B routes signals FROM the base repeater receiver TO the phone lines. The hybrid couples the signals TO and FROM the telephone line.

The secondary winding of hybrid transformer T101 couples the audio FROM the telephone line to the "non-inverting" input of IC101A. C105 couples the output of IC101A to R113, which adjusts the deviation of the base repeater transmitter.

C108 applies the processed receiver audio from the bandpass and notch filters to the limiter circuit, which consists of R117, CR102, R116, CR101 and R115. C107 routes the audio from the limiter to the "inverting" input of IC101B. C103 and R108 connect the amplified audio from IC101B pin 7 to the secondary winding of hybrid transformer T102 for coupling to the telephone lines. Notice that there is NO gain adjustment between the limiter and T102; the gain of IC101B is factory-adjusted to prevent inadvertently placing excessive audio on the telephone lines, which is a violation of Part 68.308 of the FCC Rules.

Note that there is a direct audio path from the output of IC101B through the split primary windings (T102 and T101) to the "non-inverting" input of IC101A. The HYBRID BALANCE network prevents the base receiver audio from feeding back into the base transmitter, a condition that would cause feedback problems. The hybrid balance network is comprised of the 1/2 split primary windings of T101 and T102 not connected to the telephone line, R103, C128, SW101 and its associated capacitors. If the hybrid balance network and the telephone line impedances match each other perfectly, the "receive" audio from IC101B to T102's secondary is divided equally between the hybrid balance network and phone line, with no audio entering the transmitter via T101's secondary. Similarly, if the secondary impedances of T101 and T102 are identical, the audio from the phone line is divided equally so that half of it goes into the secondary of T101 to IC101A for transmit audio. The other half goes into the secondary of T102, where it is dissipated in the output impedance of IC101B. With a received signal present, R103 is adjusted for the MINIMUM "ACC RX AUDIO" at IC101A pin 1. SW101 is used to connect the combination of capacitors necessary to further reduce the amount of "ACC RX AUDIO" present at IC101A pin 1.

BANDPASS AND NOTCH FILTERS

The bandpass and notch filters consist of op amps IC103A, IC103B, IC104A, IC102B and associated components. R126 adjusts the "center-frequency" of the bandpass filter, while R124 adjusts the 2805 Hz "notch."

P101 pin 1 applies the base repeater receiver audio (ACC RX AUDIO) to the "non-inverting" input of IC103A through C113 and R128. R127 and R126 route the output of IC103A to the "inverting" input of IC103B. R125 couples the output of IC103B to the "inverting" input of IC104A. Integrated circuits comprised of C111, C112 and associated components cause a 90 degree phase shift in the 2805 Hz signal at the outputs of IC103B and IC104A. The outputs of IC103A and IC104A are applied to the "inverting" input of summing amplifier IC102A. IC102A's output, bandpass filtered for voice frequencies, is "notched" at 2805 Hz to prevent applying 2805 Hz tones directly onto the telephone lines.

R126 is adjusted for MAXIMUM 2805 Hz tone at IC103B pin 7. R124 is adjusted for MINIMUM 2805 Hz tone at IC102A pin 1.

RTSU-1 THEORY OF OPERATION

Refer to the RTSU-1 schematic while reading the following description.

POWER SUPPLY

The same low-voltage DC supply that powers the Repeater Plus, via an internal +13.5 VDC regulator in the Desktop repeater model or a +12 VDC regulator in the Wall Mount version, powers the RTSU-1 subscriber unit. However, for emergency operation, the RTSU-1 can function using an external +12 volt battery.

Regulated DC voltage enters the RTSU-1 through P101 pins 5 and 6, while P101 pins 2 and 3 connect the negative side of the supply to the PC board ground.

The regulated DC source, via F101, supplies the pulse-width modulated power supply (IC103 and T101), the 8 VDC regulator (IC104), Q206 in the bell-ringing circuit and telephone ringer relay K201. Most of the RTSU-1 Integrated Circuit chips and the switching transistors are supplied by the regulated +8 VDC line.

HYBRID AND PROTECTION BRIDGE

The subscriber telephone connects to the RTSU-1 subscriber unit by means of a modular jack and a 4-wire cable attached to the RTSU-1. A bridge that consists of CR205, CR206, CR207 and CR208 connects directly across the coupling transformers to protect against excessive voltage, while R216 and R217 further isolate the phone "tip" and "ring" wires.

The hybrid circuit, built around T201 and T202, separates the transmitted and received signals for processing in the radio link. Audio signals FROM the repeater receiver are processed through IC202; conversely, audio TO the repeater transmitter is processed through IC203 and IC204. R219 and SW201 minimize the amount of "ACC RX AUDIO" in the transmitter audio at test point Δ20.

The received audio from P101 pin 1 is applied through R223, which sets the amplitude of the signal entering IC202. After amplification, the signal is coupled by the transformers TO the telephone instrument. Signals FROM the telephone are: coupled by the transformers to IC203; amplified by IC203 and IC204A; and applied to P101 pin 9 to modulate the repeater transmitter, with R244 controlling the amplitude (transmitter deviation). Q205 detects the output of IC204A, while IC204B amplifies that voltage and develops a DC control signal that is fed back via R235 to regulate the gain of IC203. This feedback provides an AGC action that "levels out" wide amplitude variations in the signal coming FROM the telephone.

LOGIC CIRCUITRY

The logic circuitry in the RTSU-1 consists of three inverters, IC201A, IC201C, IC201D and NAND gate IC201B. The repeater receiver squelch line, P101 pin 8, and the "Off-Hook" detector, Q201, supply inputs to the logic circuitry. The outputs of the inverters and NAND gate drive transistor switches to key the repeater transmitter, initiate the "ringing" sequence, apply "ringing voltage" to the telephone, and activate the 2805 Hz oscillator used for dialing with rotary phones.

With NO CALL in progress, the Telenexus system is in standby mode—both repeater transmitters are OFF and the line relay in the base terminator is NOT energized.

If the phone is removed from its cradle (off-hook), the phone resistance of approximately 600Ω is connected across the "tip" and "ring" wires. The -24V path is then completed through the phone, T201, R201 and R203. This biases ON Q201, the "off-hook detector," and its collector pulls "low." IC201D inverts this signal, turning ON Q202; the collector goes "low" to ground P101 pin 10, which activates the repeater transmitter. The "high" at the output of IC201D also disables the 2805 Hz oscillator, IC205, by applying +8 volts to pins 2 and 5.

An incoming signal from the base repeater causes the squelch line on P101 pin 8 to go "low." This signal is inverted by IC201C and the resulting "high" on pin 10 is applied to pin 5 of NAND gate IC201B through JU201 (if the jumper is in the "A" position). If the subscriber phone is "on-hook," the collector of Q201 is "high" and pin 6 of IC201B is also "high." The "low" output of IC201B is applied to the input of inverter IC201A (pins 1 and 2) via C203 and R208 during the time it takes C203 to charge through R207. The subsequent "high" at IC201A pin 3 turns ON Q203 and Q204. Q204 energizes K201 to connect the "ring-voltage" to the telephone, while Q203 applies +8 volts to the ringer circuitry (IC101, IC102 and Q101). R213 and CR203 hold the emitter of Q201 "high" with +8 VDC on the ringer circuitry to prevent false "off-hook" detection under heavy ringer load.

With the incoming signal still holding P101 pin 8 "low," IC201C inverts the signal, with the resulting "high" establishing a "high" on pin 5 of IC201B when JU201 is in position "A."

Placing JU201 in position "B" disables "carrier-operated" squelch and enables tone squelch; a RITRON RPQC-1 tone module must be installed for tone squelch to operate.

Taking the subscriber phone "off-hook" turns ON Q201, and its collector goes "low." This "low" is applied to pin 6 of IC201B, which causes the output on pin 4 to go "high." IC201A inverts this signal, switching pin 3 "low," which turns OFF Q204 and de-energizes K201 to remove the "ring-voltage" from the phone. Q203 also turns OFF and removes +8 volts from the ringer circuitry. Q101 turns OFF, so that the power supply again supplies -24 volts for the telephone instrument.

DIALING FROM THE SUBSCRIBER PHONE

With the phone "off-hook," and NO incoming signal present (as described earlier), dialing can now proceed. If the phone is a Touch Tone unit, no additional subscriber circuitry is needed for the dialing sequence—the tones produced by the phone during dialing are coupled by T201 and T202 through R228, C220 and R229 to IC203. The amplified output of IC203 and IC204A, attenuated by R244, is applied through P101 pin 9 to the audio input of the repeater transmitter. The base unit then receives the dialing information tones, and couples them to the telephone lines.

However, if the subscriber phone is a rotary-dial unit, additional circuitry in the RTSU-1 is used since dialing with a rotary phone is NOT accomplished using tones, but by connecting and disconnecting the telephone lines from the system. This is the purpose of the 2805-Hz oscillator. When a digit is dialed and the phone dial is returning to its resting position, a "pulsing" switch located on the back of the dial opens and closes to simulate an "on-hook/off-hook" condition. The number of switch openings equals the digit dialed. When the switch is open ("on-hook"), Q201 is OFF; therefore, its collector is "high." IC201D inverts this signal and the resulting "low" on pin 11 grounds one side of R210. R210 and R245 form a voltage divider across the +8 Volt supply, with the center-tap (+4 VDC) connected to pins 2 and 5 of IC205. This allows the triangular-wave oscillator IC205 to oscillate at 2805 Hz, as determined by the setting of R248. When the "pulsing" switch is closed (off-hook), Q201 is ON and its collector goes "low." IC201D inverts this signal, and the resulting "high" on pin 11 allows pins 2 and 5 of IC205 to raise to +8V, stopping the oscillation. C204 holds the base of Q202 "high," and keeps the repeater transmitter keyed while the dialing sequence is completed.

With JU202 in the "B" position, the 2805 Hz tone pulses are applied through P101 pin 9 to the modulator in the remote (subscriber) repeater transmitter.

The 2805 Hz tone pulses are received by the base repeater and RTL-T-1 where they cause the line relay to open and close, thereby connecting and disconnecting the telephone line. Note that the number of tone pulses transmitted for each digit dialed equals the digit dialed on the phone.

When operating a TOUCH TONE phone, the 2805 Hz dial pulses are not required, and may be disabled by placing JU202 in the "A" position.

POWER SUPPLY - OFF HOOK (-24VDC)

The RTSU-1 subscriber unit must supply both "off-hook" voltage (-24VDC) for the phone instrument, and 240 VAC, 20 Hz voltage for the ringer in the telephone. The heart of the power supply is IC103, a pulse-width modulator, which drives switching transistors Q103 and Q104 in a push-pull configuration. The pulses of collector current are developed across the primary of T101 and stepped up by transformer action for application to the full-wave bridge rectifier that consists of CR101, CR102, CR103 and CR104. The positive end of the bridge is connected to ground through L101 and the parallel-resistor combination of R131 and R132. The negative output of the bridge is filtered by C112, C113, C114 and C115. A feedback loop, comprised of R117 and R118, stabilizes and adjusts the output to the desired level by feeding a portion of the negative-output voltage back to pin 2 of IC103.

Relay K201, in its de-energized position, supplies the -24 VDC output of the bridge to the phone as follows: K201 applies -24V through R218, T202, R217, the phone "tip and ring," R216, T201, R203, and R201. C231 provides additional filtering of the -24V supply when K201 is NOT energized. CR211 aids in the quick recovery of the power supply to -24 VDC when switching between -240 VAC "ring voltage" and -24 VDC operating voltage.

POWER SUPPLY - RINGING VOLTAGE

K201 is energized and rings the phone ONLY when the following condition occurs—the repeater receiver picks up a signal FROM the base transmitter AND the subscriber telephone is "on-hook." The output of the bridge is then no longer - 24 VDC, but approximately -120V. The output of IC103 is driven up and down at a 20 Hz rate by a 20 Hz oscillator and filter (described below), causing the bridge output to swing 120 volts above and below the -120 Volt level to generate the 0 to -240 VAC, 20 Hz ringing signal. When Q204 is turned ON, as described in the "Logic Circuitry" section above, it energizes K201 by pulling the coil to ground. K201 then applies the 20 Hz signal through CR210, the "tip and ring" wires, R216, T201, R203 and R201. The ringing voltage easily swings from 0 V to -240 V, but must be aided in the climb from -240 V to 0 V. This is the purpose of the circuit formed by Q206, CR210 and R251.

As the voltage drops toward -240 V, CR210 is forward-biased and allows current to flow through the phone circuit. As the voltage tries to return to 0 V, positive voltage applied through R251 reverse-biases CR210 and turns ON Q206. The parameters of IC103 are changed to raise the pulse-width modulated power supply output via R117, R118 and pin 2 of IC103.

20 HZ OSCILLATOR AND FILTER

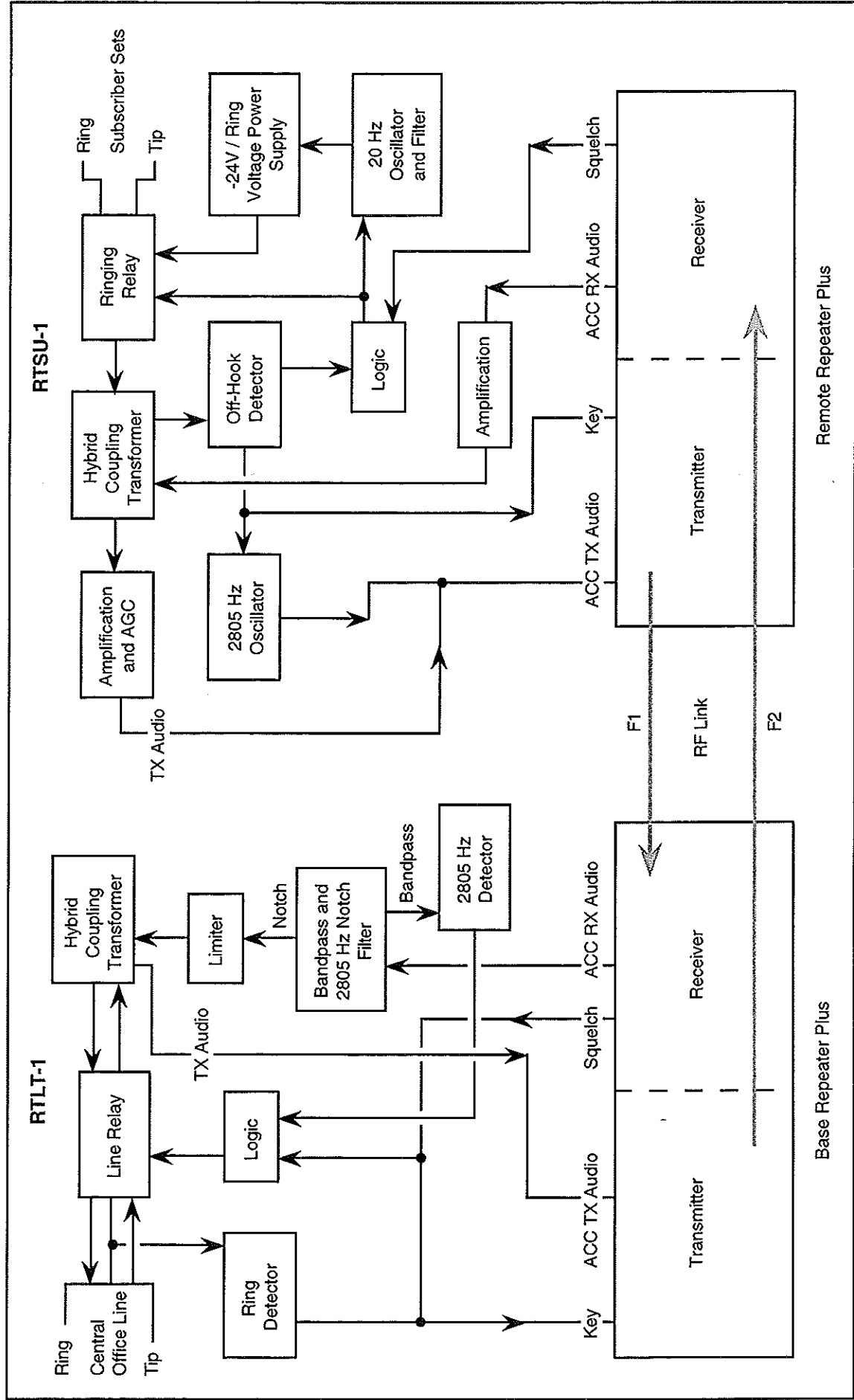
With an incoming signal from the base unit present and the subscriber phone "on-hook," Q203 switches ON and applies +8V to: the 20 Hz oscillator, IC102; the sine-wave filter, IC101; Q102, which applies the 20 Hz signal to IC103 and; Q101, which changes the parameters of IC103 to raise the voltage applied across T101 to approximately 120 volts, causing the output of the rectifying bridge to swing 120 volts above and below the -120 VDC average output and produce the -240 VAC, 20 Hz ringing voltage.

The 20 Hz triangular-wave oscillator is composed of IC102 and associated components. R116 adjusts the frequency to 20 Hz for input to the sine-wave filter, IC101.

IC101 and associated components smooth the 20 Hz triangular wave output of IC102 into a sine wave. R104 is adjusted to give an average voltage of -120 VDC at the output of the rectifying bridge. R105 is adjusted for a sine wave output of 0 to -240 Vp-p at the bridge output.

With Q101 conducting, the series circuit consisting of R103 and R104 is paralleled across R124 and R125. This "lengthens" the output pulses that drive Q103 and Q104, resulting in higher voltage across T101. The 20 Hz sine wave output of IC101 is developed across R105 through Q102, and applied via C101 and C102 to the resistor combination of R103, R104, R124 and R125. The output of IC103 swings up and down at a 20 Hz rate. When the telephone is taken "off-hook," supply to the ringer circuit is removed and Q101 and Q102 turn OFF, creating a discharge path for C101 and C102 through R103, R104 and R105. This aids in the quick recovery of the power supply to -24 VDC.

TELENEXUS SYSTEM BLOCK DIAGRAM



RTL-1 ALIGNMENT PROCEDURE

EQUIPMENT NEEDED

- 1) RITRON Repeater Plus (Desktop or Wall Mount version) modified for use with the TELENEXUS SYSTEM (as given in this manual in the section, "Repeater Plus MODIFICATIONS PERFORMED AT THE FACTORY")
- 2) 50 Ω dummy load— power rating sufficient to handle full output of either the repeater Desktop or Wall Mount model
- 3) 450 MHz FM-signal generator
- 4) Dual-trace oscilloscope
- 5) FM deviation meter
- 6) Audio Frequency tone signal generator
- 7) DC voltmeter

SET-UP

- 1) Connect the RTL-1 to the Repeater Plus (Desktop version) via the 10-pin/20-pin interconnect cable or, to the Repeater Plus (Wall Mount model) by fully mating the RTL-1 10-pin connector to the 10-pin socket on the repeater (Wall Mount) main PC board.
- 2) Connect a 50 Ω dummy load to repeater antenna receptacle.
- 3) Connect the RTL-1 modular telephone plug to the 4-pin modular telephone jack on a telephone line.
- 4) Connect a small antenna to the output of the FM signal generator, or lay the generator output cable adjacent to the repeater. **DO NOT CONNECT THE SIGNAL GENERATOR RF CABLE DIRECTLY TO THE REPEATER ANTENNA CONNECTOR; THE GENERATOR OUTPUT ATTENUATOR WILL BE DESTROYED IMMEDIATELY!**
- 5) Turn ON power to the repeater and the test equipment.
- 6) Set the FM signal generator to the INPUT (receive) frequency of the repeater. Use the AF tone generator to modulate the FM signal generator as needed.

ADJUSTMENTS

Test points referred to in the steps below are indicated on the attached RTL-1 schematic with a triangle "Δ" symbol.

All components that require adjustment are identified in FIG-1 on the next page.

2805 HZ DIAL PULSE:

- 1) Modulate the signal generator with a 2805 Hz tone at 3 KHz deviation (simultaneously modulate with sub-audible tone, if applicable).
- 2) Increase the signal generator output level until it "keys" the repeater.
- 3) Adjust R126 in the RTL-1 for the MAXIMUM 2805 Hz signal as shown on the scope connected to pin 7 of IC104 (test point Δ 4).
- 4) Adjust R124 in the RTL-1 for the MINIMUM 2805 Hz signal on the scope connected to pin 1 of IC102 (test point Δ 3).

TELEPHONE LINE CURRENT:

- 5) Change the modulating signal from 2805 Hz to 1000 Hz at 3 KHz deviation. The telephone line should now be connected.
- 6) Connect a DC voltmeter across R101 (100 Ω resistor).
- 7) Place "shorting plug" JU101 to each of the four positions (A, B, C, D) and note the DC voltage across R101 for each position.
- 8) Place JU101 in the position that allows approximately 2 VDC across R101. Note that the voltage across R101 MUST be greater than 1.8 VDC to ensure enough telephone line current to "hold" the telephone line.

AUDIO HYBRID NULL:

- 9) Place all switches on SW101 to the OFF position and adjust R103 for the MINIMUM 1000 Hz signal on the scope connected to pin 1 of IC101.
- 10) Beginning with SW101 switch 1, sequentially turn ON each switch, one at a time, to determine which single switch will yield the MINIMUM 1000 Hz signal on the scope connected to pin 1 of IC101.
- 11) Beginning again with SW101 switch 1, sequentially turn ON each switch, one at a time, up to the first switch selected in step 16. This is to determine which additional switch, if any, will yield the MINIMUM 1000 Hz signal on the scope connected to pin 1 of IC101.

TELEPHONE AUDIO TO TRANSMITTER:

- 12) Reduce the signal generator output and adjust the FM deviation meter to the output (transmit) frequency of the repeater.
- 13) From a second telephone line, call into the telephone line connected to the RTL-1 (the transmitter LED will light with each "ring").

- 14) Connect the telephone line by increasing the signal generator output until it "keys" the repeater.
- 15) Simultaneously press the DTMF phone "5" and "8" keys at the second phone line.
- 16) Adjust R113 for 3 KHz deviation at the repeater output frequency when modulated by the tone generated by the DTMF phone.

NOTE: When the RTL T-1 is connected to another telephone line, the HYBRID NULL CIRCUIT and TELEPHONE LINE CURRENT LIMIT CIRCUIT may require re-adjustment. Refer to the "Installation Alignment Procedure" section of this manual.

THIS COMPLETES THE RTL T-1 ALIGNMENT PROCEDURE.

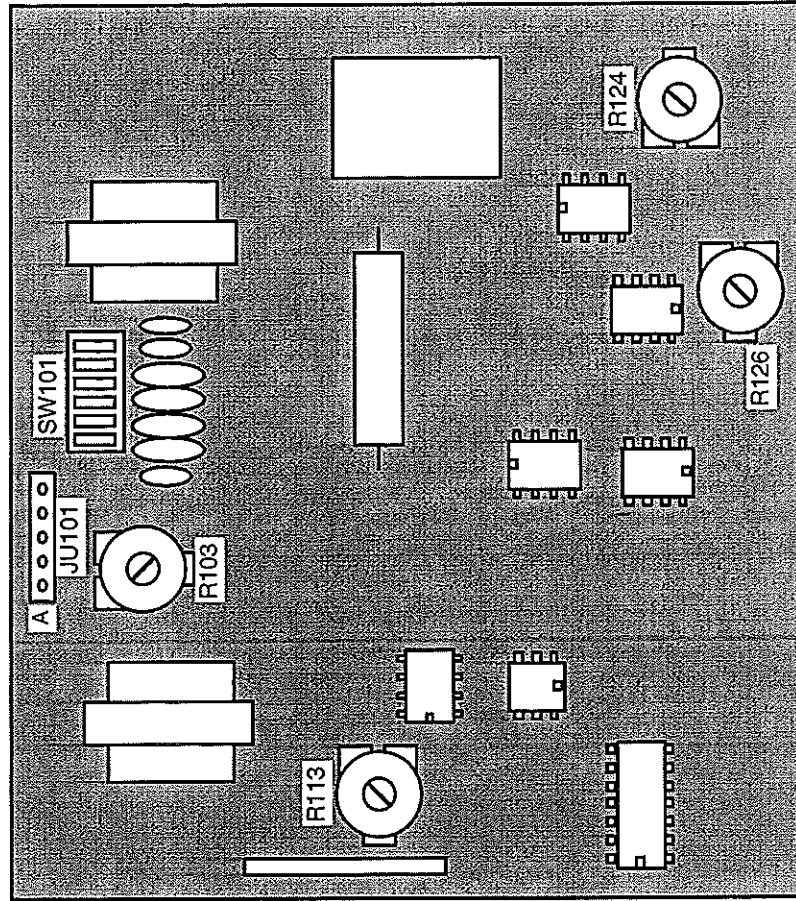


FIG-1: RTL T-1 (Top-view)

SUMMARY OF ADJUSTMENTS (REFER TO FIG-1 AT LOWER LEFT)

R126	Maximum 2805 Hz signal
R124	Minimum 2805 Hz signal
JU101	Telephone line current
SW101	Audio hybrid null
R103	Audio hybrid null
R113	Telephone audio level to transmitter

RTSU-1 ALIGNMENT PROCEDURE

NOTE: IF THE RTSU-1 IS TO BE INSTALLED IN A TELENEXUS SYSTEM, THE FOLLOWING PROCEDURE IS COMPLETED AT THE FACTORY. IN THIS CASE, ONLY RE-ADJUSTMENT OF THE TELEPHONE HYBRID CIRCUIT MIGHT BE REQUIRED.

EQUIPMENT NEEDED

- 1) RITRON Repeater Plus (Desktop or Wall-mounted version) modified for use with the Telenexus system (refer to the Telenexus manual under "Repeater Plus Modifications Performed At The Factory")
- 2) 50Ω dummy load with power rating sufficient to handle full output of either the Repeater Plus Desktop or Wall-mounted model
- 3) Voltmeter
- 4) Oscilloscope
- 5) Multifunction communications monitor OR, a 450 MHz FM signal generator, FM deviation meter and Audio Frequency tone signal generator

SET-UP

- 1) Connect the 50Ω dummy load to the repeater antenna receptacle.
- 2) Connect the RTSU-1 to the repeater (Desktop model) via the 10-pin/20-pin interconnect cable or, to the repeater (Wall-mounted version) by fully inserting the RTSU-1 10-pin plug (on the bottom of the PC board) into the 10-pin socket on the repeater main board.
- 3) Connect the RTSU-1 modular telephone plug to the 4-pin modular telephone jack on a standard telephone device.
- 4) Apply power to the repeater and the test equipment.
- 5) Connect a small antenna to the FM signal generator, or place a generator output cable near the repeater, to provide an input signal. If a multifunction communications monitor is used, select duplex mode and connect directly to the RF input port.

- 6) Adjust the FM signal generator to the input (receive) frequency of the repeater. Use the AF tone generator to modulate the FM signal generator with a 1KHz tone at 3 KHz deviation (simultaneously modulate with sub-audible, if applicable).

CAUTION: If the telephone is "off-hook" and is connected to the tip and ring lines as in step 3 of the set-up procedure, the transmitter will key immediately upon application of power. When keyed, full RF power is available at the antenna port. CONFIRM THAT THE REPEATER PLUS ANTENNA RECEPTACLE IS CONNECTED TO THE 50 Ω LOAD, NOT THE SIGNAL GENERATOR OUTPUT CABLE.

ADJUSTMENTS

TEST POINTS REFERRED TO IN THE STEPS BELOW ARE INDICATED ON THE ATTACHED RTSU-1 SCHEMATIC WITH A TRIANGLE "Δ" SYMBOL. ALL COMPONENTS THAT REQUIRE ADJUSTMENT ARE IDENTIFIED IN FIG-2 ON THE NEXT PAGE.

STEPS 1 THROUGH 11 ARE PERFORMED WITH THE TELEPHONE DEVICE "OFF-HOOK."

-24 VDC TELEPHONE OPERATING VOLTAGE

- 1) Adjust R117 for -24 VDC at test point Δ17.

RECEIVED AUDIO TO THE TELEPHONE INSTRUMENT:

- 2) Connect the oscilloscope across the 600 Ω telephone device (use test points Δ18 and Δ19). Do not measure to ground; this is a differential voltage measurement.
- 3) Adjust R223 for -9 dBm (0.8 Vp-p or 0.275 VRMS) of the 1000 Hz signal across the 600 Ω telephone device.

HYBRID NULL:

- 4) Place all switches on SW201 to the off position and adjust R219 for minimum 1000 Hz signal on the oscilloscope connected to test point Δ20.
- 5) Beginning with SW201 switch 1, turn each switch on to determine which single switch yields the minimum 1000 Hz signal on the scope connected to test point Δ20.
- 6) Beginning again with SW201 switch 1, sequentially turn each switch on, up to the first switch selected in step 5. This determines which additional switch, if any, yields the minimum 1000 Hz signal on the scope connected to test point Δ20. **NOTE:** If the RTSU-1 is connected to a different telephone device, the hybrid null procedure might have to be repeated.

AGC AND TELEPHONE AUDIO TO TRANSMITTER:

- 7) With the 1000 Hz signal applied to test point Δ22, adjust IC203's nulling potentiometer, R233, for a minimum signal at test point Δ23.
- 8) Set R244, the 10 K Ω output potentiometer of the AGC/amplifier stage, to produce the maximum signal level at test point Δ10.
- 9) With the oscilloscope set for 2 volts per division, connect a DC coupled probe to test point Δ21. Adjust R228, the AGC/amplifier stage input pot, for a maximum of 1/2 volt negative deflection with strong voice audio applied from the telephone set.
- 10) Apply the oscilloscope probe to the wiper of the repeater transmitter deviation potentiometer. Press and hold the telephone Touch Tone "#" symbol and adjust R244, the AGC/amplifier stage output potentiometer, until the waveform is slightly (less than 10%) limited.
- 11) Adjust the repeater deviation potentiometer for 5 KHz total voice and CTCSS deviation.

TELEPHONE RINGING VOLTAGE:

STEPS 12 THROUGH 19 ARE PERFORMED WITH THE TELEPHONE DEVICE "ON-HOOK."

- 12) Install JU201 in the "A" position unless the RPQC-1 "Paging Quiet-Call" module is used.
- 13) Short IC201 pin 2 to ground to activate the "ringing circuitry."
- 14) Adjust R104 for -120 VDC at test point Δ17. R105 must be set fully counter-clockwise while R104 is adjusted.
- 15) Adjust frequency control potentiometer R116 for a 50 ms (20 Hz) triangle wave at -120 VDC (at test point Δ14).
- 16) Adjust R105 for a 20 Hz, 240 Vp-p sine wave, centered at -120 VDC (at test point Δ17).
- 17) Remove the short from IC201 pin 2.

2805 HZ BREAK FREQUENCY

18) With the telephone device "on-hook," adjust R248 for a 356.5 microsecond (2805 Hz) triangle wave at IC205 pin 7 (test point Δ24).

19) Place JU202 in position "B" to enable access to the 2805 Hz "break" tone.

THIS COMPLETES THE RTSU-1 ALIGNMENT PROCEDURE.

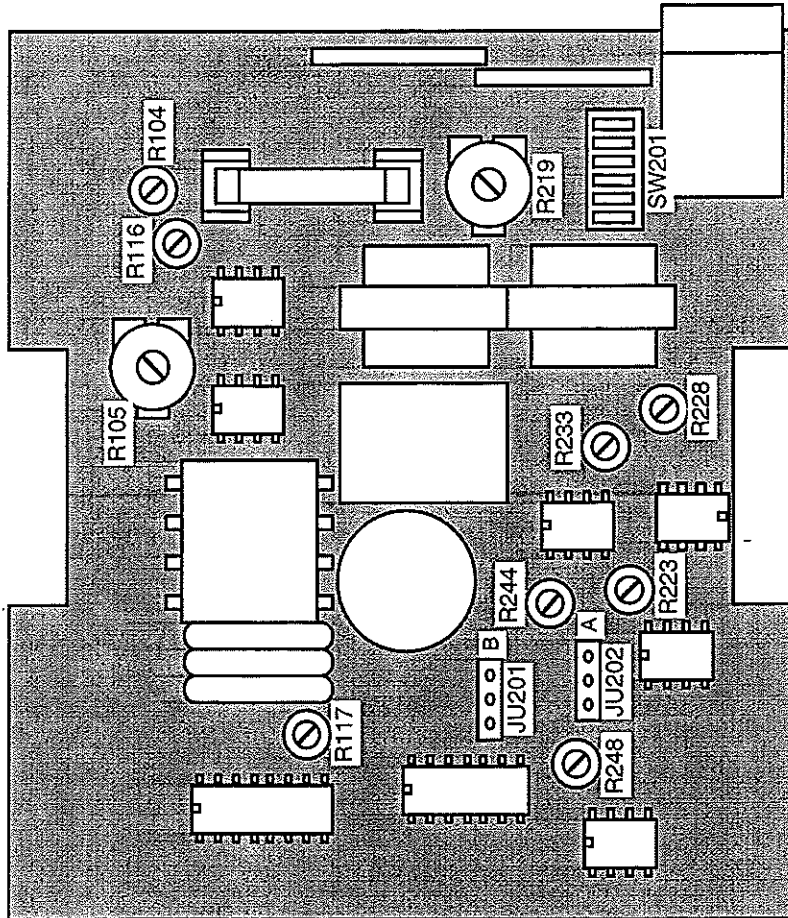


FIG-2: RTSU-1 (Top-view)

SUMMARY OF ADJUSTMENTS (REFER TO FIG-2 AT LOWER LEFT)

R117	Telephone line voltage (-24 VDC)
R223	Audio level to telephone instrument
R219	Telephone hybrid null adjustment 1
SW201	Telephone hybrid null adjustment 2
R233	AGC amp balance
R244	Telephone audio level to transmitter
R228	AGC threshold
R104	Telephone ringing voltage bias
R116	Telephone ringing voltage frequency
R105	Telephone ringing voltage amplitude
R248	2805 Hz break frequency
JU201	RPQC-1 selective calling enable jumper (in position "A," unless the RPQC-1 is used)
JU202	2805 Hz break frequency enable jumper (in position "B" to enable the 2805 Hz "break" tone)

RTLT-1 SCHEMATIC REFERENCE PARTS LIST

NOTE: This parts list reflects component values current through ECN 1697. If a component value in the schematic differs from that in the parts list, the parts list is to be considered more current.

REF #	DESCRIPTION	RITRON #	REF #	DESCRIPTION	RITRON #
CAPACITORS, UNLESS STATED OTHERWISE					
C 103	10 µF 16V ELECTROLYTIC CAP	01503006	IC101	CA3260E DUAL BI-MOS OP AMP	03131017
C 104	.0022 µF MYLAR CAP 10% 50VDC	01501041	IC102	CA3260E DUAL BI-MOS OP AMP	03131017
C 105	1 µF 50V ELT RADIAL	01503002	IC103	CA3260E DUAL BI-MOS OP AMP	03131017
C 106	.001 µF/5P 10% .1"LS RADIAL 50V	01516239	IC104	CA3260E DUAL BI-MOS OP AMP	03131017
C 107	1 µF 50V ELT RADIAL	01503002	IC105	MC78L08CP; 8 VOLT REG	03131013
C 108	1 µF 50V ELT RADIAL	01503002	IC106	IC NAND GATE CD4011	03134011
C 109	.01 µF/5V 20% .2"LS RADIAL 25 V.	01516451	IC107	RING DETECTOR; TI #TCM1520A	03131024
C 110	10 µF 16V ELECTROLYTIC CAP	01503006	IC108	DARLINGTON OPTO COUPLER	03131020
C 111	.001 µF MYLAR .12"C 5% 100V CAP	01501040	HEADERS		
C 112	.001 µF MYLAR .12"C 5% 100V CAP	01501040	JU101	5 PIN METHODE HEADER .1"C	02100027
C 113	1 µF 50V ELT RADIAL	01503002	JU101	2 PIN SHORTING PLUG	02100075
C 114	.001 µF/5P 10% .1"LS RADIAL 50V	01516239	RELAY		
C 115	.1 µF/X7R 20% .1"LS RADIAL 50 V.	01515463	K 101	RELAY; DPDT 12VDC 3A SMALL	04500006
C 116	.1 µF/X7R 20% .1"LS RADIAL 50 V.	01515463	CONNECTOR		
C 117	.1 µF/X7R 20% .1"LS RADIAL 50 V.	01515463	P 101	CONNECTOR 10 PIN (MALE)	02100041
C 118	.001 µF/5P 10% .1"LS RADIAL 50V	01516239	TRANSISTORS		
C 119	10 µF 16V ELECTROLYTIC CAP	01503006	Q 101	MPS-A13 NPN DARLINGTON	04800007
C 120	10 µF 16V ELECTROLYTIC CAP	01503006	Q 103	MPS-4124 NPN LOW NOISE AUD.	04800006
C 121	.47µF 800V 10% CAP/AXIAL	01517004	RESISTORS, 5% 1/4W CF, UNLESS STATED OTHERWISE		
C 123	10 µF 50V ELECT CAP 10%	01503021	R 101	100 Ω	04700121
C 124	100 pF/N750 5% .1"LS RADIAL 50 V.	01510727	R 102	470 Ω	04700129
C 125	27 pF/NP0 5% .1"LS RADIAL 50 V.	01510020	R 103	2 KΩ TRIM POT; LINEAR	04750005
C 126	10 µF 50V ELECT CAP 10%	01503021	R 104	1 MΩ	04700169
C 127	10 µF 50V ELECT CAP 10%	01503021	R 105	2.2 KΩ	04700137
C 128	.0022 µF MYLAR CAP 10% 50VDC	01501041	R 106	560 Ω	04700130
C 131	.0047 µF MYLAR .12"LS 10%	01501045	R 107	10 KΩ	04700145
C 132	.01 µF MYLAR 100V 10%	01501050	R 108	560 Ω	04700130
C 133	.022 µFD MYLAR TOOTH-PICK	01501051	R 111	100 KΩ	04700157
C 134	.033 µFD; MYLAR CAP	01501053	R 111	100 KΩ	04700157
C 135	.022 µFD MYLAR TOOTH-PICK	01501051	R 112	270 KΩ	04700162
C 136	.033 µFD; MYLAR CAP	01501053	R 113	10 KΩ TRIM POT/HORZ MOUNT	04750008
C 137	.1 µF/X7R 20% .1"LS RADIAL 50 V.	01515463	R 114	15 KΩ	04700147
			R 115	3.3 KΩ	04700139
DIODES, GENERAL PURPOSE, UNLESS STATED OTHERWISE					
CR101	1N4148; DIODE/GENERAL PURPOSE	04810001	SWITCH		
CR102	1N4148; DIODE/GENERAL PURPOSE	04810001	SW101	6 POSITION DIP SWITCH	05100023
CR103	1N4148; DIODE/GENERAL PURPOSE	04810001	TRANSFORMERS		
CR104	1N4148; DIODE/GENERAL PURPOSE	04810001	T 101	HYBRID TRFOR.600 OHM SPLIT PRIM.	05600023
CR105	1N4001 DIODE 50 VOLT/1AMP	04810003	T 102	HYBRID TRFOR.600 OHM SPLIT PRIM.	05600023
R 116	22 KΩ		R 116	22 KΩ	04700149
R 117	3.3 KΩ		R 117	3.3 KΩ	04700139
R 118	470 KΩ		R 118	470 KΩ	04700165
R 119	10 KΩ		R 119	10 KΩ	04700145
R 120	10 KΩ		R 120	10 KΩ	04700145
R 121	10 KΩ		R 121	10 KΩ	04700145
R 122	100 KΩ		R 122	100 KΩ	04700157
R 122	100 KΩ		R 122	100 KΩ	04700157
R 123	47 KΩ		R 123	47 KΩ	04700153
R 124	100 KΩ MINI POT HORZ		R 124	100 KΩ MINI POT HORZ	04750028
R 125	18 KΩ		R 125	18 KΩ	04700148
R 126	10 KΩ TRIM POT/HORZ MOUNT		R 126	10 KΩ TRIM POT/HORZ MOUNT	04750008
R 127	12 KΩ		R 127	12 KΩ	04700146
R 128	100 KΩ		R 128	100 KΩ	04700157
R 128	100 KΩ		R 128	100 KΩ	04700157
R 129	1 KΩ		R 129	1 KΩ	04700133
R 130	100 KΩ		R 130	100 KΩ	04700157
R 130	100 KΩ		R 130	100 KΩ	04700157
R 131	10 KΩ		R 131	10 KΩ	04700145
R 132	100 KΩ		R 132	100 KΩ	04700157
R 133	47 KΩ		R 133	47 KΩ	04700153
R 134	10 KΩ		R 134	10 KΩ	04700145
R 135	100 KΩ		R 135	100 KΩ	04700157
R 135	100 KΩ		R 135	100 KΩ	04700157
R 136	1 MΩ		R 136	1 MΩ	04700169
R 137	2.2 KΩ		R 137	2.2 KΩ	04700137
R 138	100 KΩ		R 138	100 KΩ	04700157
R 138	100 KΩ		R 138	100 KΩ	04700157
R 139	10 KΩ		R 139	10 KΩ	04700145
R 140	560 Ω		R 140	560 Ω	04700130
R 148	15 KΩ		R 148	15 KΩ	04700147
R 150	1 MΩ		R 150	1 MΩ	04700169
R 151	470 Ω		R 151	470 Ω	04700129
R 152	470 Ω		R 152	470 Ω	04700129

REF #	DESCRIPTION	RITRON #
VARISTORS		
VR101	VARISTOR; 82 VOLT .4 WATTS	05111001
HARDWARE		
HD1	FRONT NAMEPLATE "RITRON INC."	01400016
HD2	GRAY PLASTIC CASE; PAC-TEC	01400022
HD3	MADE IN USA BY RITRON LABEL(PERM)	01400054
HD4	BLANK BLACK PANEL; UNMODIFIED	01400060
HD5	FCC LABEL; RTL-T-1	01400561
HD10	BUSHING; LINE CORD	02800002
HD11	ROUND RUB FEET (SELF ADHESIVE)	02800028
HD12	4 X 1/4" PPHMS SELF-TAP/TYPE 25	02801009
HD13	CABLE; TELEPHONE W/PLUG	06001016
HD15	BACK PANEL MOD; RTSU-1; RTL-T-1	06102001

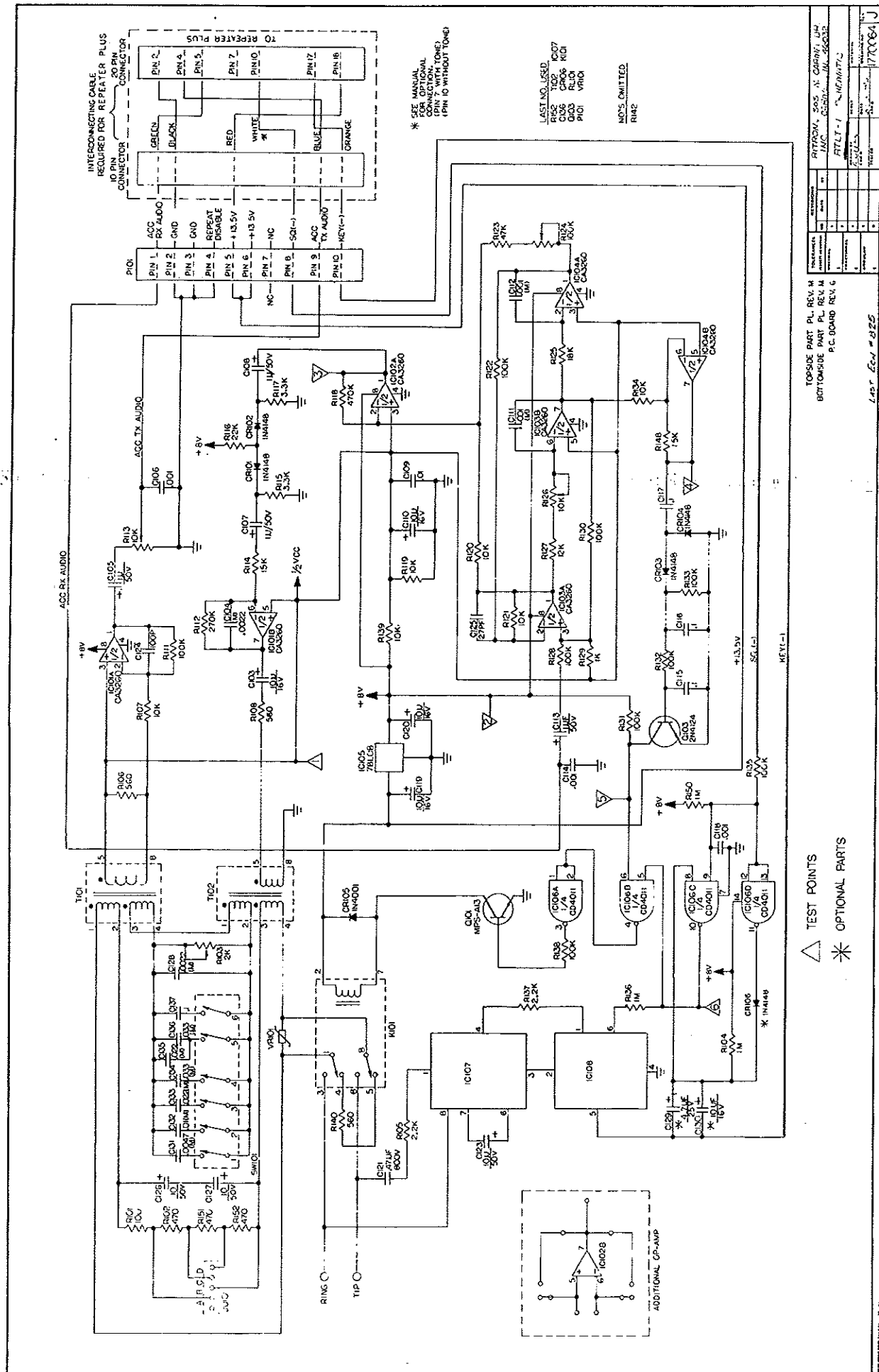
RTSU-1 SCHEMATIC REFERENCE PARTS LIST

NOTE: This parts list reflects component values current through ECN 1561. If a component value in the schematic differs from that in the parts list, the parts list is to be considered more current.

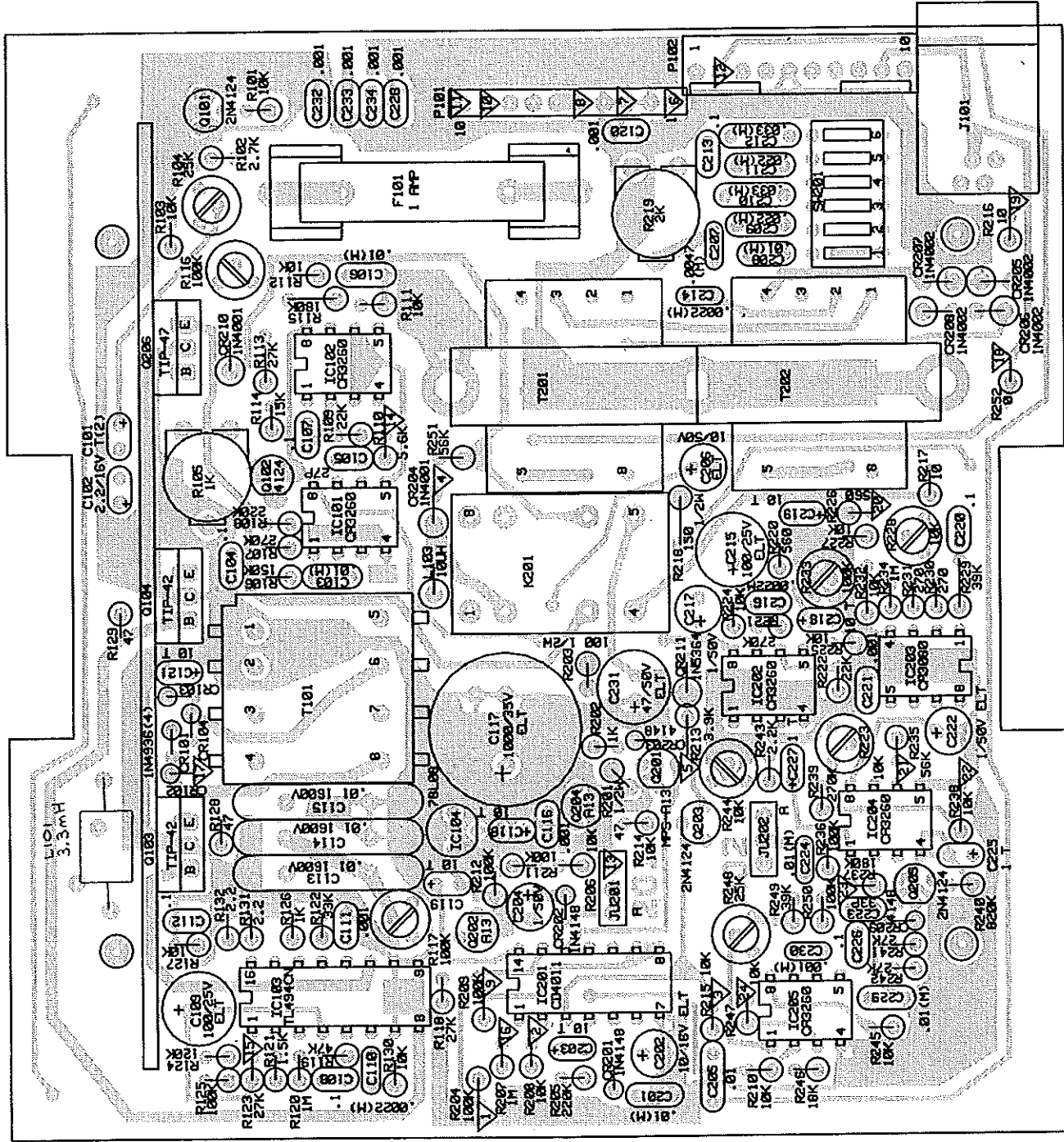
REF #	DESCRIPTION	RITRON #	REF #	DESCRIPTION	RITRON #
CAPACITORS					
C101	2.2 µFD; 35 VDC; TANT	01502009	C222	1 µF 50V ELT RADIAL	01503002
C102	2.2 µFD; 35 VDC; TANT	01502009	C223	33 pF/NP0 5%. 1"LS RADIAL 50 V.	01510021
C103	.01 µF MYLAR 100V 10%	01502009	C224	.01 µF MYLAR 100V 10%	01501050
C104	.1 µF/X7R 20%. 1"LS RADIAL 50 V.	01501050	C225	1 µF 35V TANTALUM CAP	01502007
C105	27 pF/NP0 5%. 1"LS RADIAL 50 V.	01515463	C226	.1 µF/X7R 20%. 1"LS RADIAL 50 V.	01515463
C106	.01 µF MYLAR 100V 10%	01510020	C227	1 µF 35V TANTALUM CAP	01502007
C107	.1 µF/X7R 20%. 1"LS RADIAL 50 V.	01501050	C228	.001 µF/Y5P 10%. 1"LS RADIAL 50V	01516239
C108	.1 µF/X7R 20%. 1"LS RADIAL 50 V.	01515463	C229	.01 µF MYLAR 100V 10%	01501050
C109	100µFD; 25VDC ELECT CAP	01503010	C230	.001 µF MYLAR .12"C 5% 100V CAP	01501040
C110	.0022 µF MYLAR CAP 10% 50VDC	01501041	C231	47µF 50VDC ELECTROLYTIC RDL LEAD	01503025
C111	.001 µF/Y5P 10%. 1"LS RADIAL 50V	01516239	C232	.001 µF/Y5P 10%. 1"LS RADIAL 50V	01516239
C112	.1 µF/X7R 20%. 1"LS RADIAL 50 V.	01515463	C233	.001 µF/Y5P 10%. 1"LS RADIAL 50V	01516239
C113	.01 µFD 1600V Z5U CER.CAP 20%	01517000	C234	.001 µF/Y5P 10%. 1"LS RADIAL 50V	01516239
C114	.01 µFD 1600V Z5U CER.CAP 20%	01517000	DIODES, 1N4148 GENERAL PURPOSE, UNLESS STATED OTHERWISE		
C115	.01 µFD 1600V Z5U CER.CAP 20%	01517000	CR101	1N4936 400V 1AMP DIODE	04810022
C116	.001 µF/Y5P 10%. 1"LS RADIAL 50V	01516239	CR102	1N4936 400V 1AMP DIODE	04810022
C117	1000µFD; 35DC	01503030	CR103	1N4936 400V 1AMP DIODE	04810022
C118	10µFD 16V TANT CAP 20%	01502013	CR104	1N4936 400V 1AMP DIODE	04810022
C119	10µFD 16V TANT CAP 20%	01502013	CR201	1N4148; DIODE/GENERAL PURPOSE	04810001
C120	.001 µF/Y5P 10%. 1"LS RADIAL 50V	01516239	CR202	1N4148; DIODE/GENERAL PURPOSE	04810001
C121	10µFD 16V TANT CAP 20%	01502013	CR203	1N4148; DIODE/GENERAL PURPOSE	04810001
C201	.01 µF MYLAR 100V 10%	01501050	CR204	1N4001 DIODE 50 VOLT/1AMP	04810003
C202	10 µF 16V ELECTROLYTIC CAP	01503006	CR205	DIODE; GP PWR 1N4002	04810004
C203	10µFD 16V TANT CAP 20%	01502013	CR206	DIODE; GP PWR 1N4002	04810004
C204	1 µF 50V ELT RADIAL	01503002	CR207	DIODE; GP PWR 1N4002	04810004
C205	.01 µF/Y5V 20%. 2"LS RADIAL 25 V.	01516451	CR208	DIODE; GP PWR 1N4002	04810004
C206	10 µF 50V ELECT CAP 10%	01503021	CR209	1N4148; DIODE/GENERAL PURPOSE	04810001
C207	.0047 µF MYLAR .12"LS 10%	01501045	CR210	1N4001 DIODE 50 VOLT/1AMP	04810003
C208	.01 µF MYLAR 100V 10%	01501050	CR211	1N5364 ZENER DIODE 33V 5W	04820118
C209	.022 µFD MYLAR TOOTHPICK	01501051	FUSES		
C210	.033 µFD; MYLAR CAP	01501053	F101	FUSE COVER; RUBBER	03100013
C211	.022 µFD MYLAR TOOTHPICK	01501051	F101	1 AMP 250V FUSE	05110006
C212	.033 µFD; MYLAR CAP	01501053	F101	FUSE HOLDER; PC BOARD MOUNT	05120002
C213	.1 µF/X7R 20%. 1"LS RADIAL 50 V.	01515463	CASE		
C214	.0022 µF MYLAR CAP 10% 50VDC	01501041	H104A	BLANK BLACK PANEL; UNMODIFIED	01400060
C215	100µFD; 25VDC ELECT CAP	01503010	H104B	BLANK BLACK PANEL; UNMODIFIED	01400060
C216	.0022 µF MYLAR CAP 10% 50VDC	01501041	INTEGRATED CIRCUITS		
C217	1 µF 50V ELT RADIAL	01503002	HW101	GRAY PLASTIC CASE; PAC-TEC	01400022
C218	10µFD 16V TANT CAP 20%	01502013	HW102	FLAT ALUMINUM HEAT SINK	26200100
C219	10µFD 16V TANT CAP 20%	01502013	HW103	CABLE; TELEPHONE W/PLUG	06001016
C220	.1 µF/X7R 20%. 1"LS RADIAL 50 V.	01515463	HW104	CABLE #22AWG/6-CONDUCTOR	06001017
C221	.001 µF/Y5P 10%. 1"LS RADIAL 50V	01516239	HW105	20-PIN TERM HOUSING/FEMALE	02100031
			HW106	BACK PANEL MOD; RTSU-1; RTL-1	06102001
			HW107	CONNECTOR 10 PIN (FEM)	02100042
			HW108	CONNECTOR 10 PIN (FEM)	02100042
			HW109	TERMINAL; 2100031/2100042	02100046
			HW110	ROUND RUB FEET (SELF ADHESIVE)	02800028
			HW111	4 X 1/4" PPHMS SELF-TAP/TYPE 25	02801009
			HW112	BUSHING; LINE CORD	02800002
			HW115	3/8 INCH DIAM. HEAT SHRINK	06002015
			IC101	CA3260E DUAL BI-MOS OP AMP	03131017
			IC102	CA3260E DUAL BI-MOS OP AMP	03131017
			IC103	SWITCHING REG. CONTROL TL494CN	03131025
			IC104	MC78L08CP; 8 VOLT REG	03131013
			IC201	IC NAND GATE CD4011	03134011
			IC202	CA3260E DUAL BI-MOS OP AMP	03131017
			IC203	OP AMP TRANSCONDUCTANCE	03131049
			IC204	CA3260E DUAL BI-MOS OP AMP	03131017
			IC205	CA3260E DUAL BI-MOS OP AMP	03131017
			JACK		
			J101	RJ11 4 WIRE PC MOUNT JACK	02100083
			HEADER		
			JU201	METHODE 1100-1-103-02	02100024
			JU201	2 PIN SHORTING PLUG	02100075
			JU202	METHODE 1100-1-103-02	02100024
			JU202	2 PIN SHORTING PLUG	02100075
			RELAY		
			K201	RELAY; DPDT 12VDC 3A SMALL	04500006

REF #	DESCRIPTION	RITRON #	REF #	DESCRIPTION	RITRON #	REF #	DESCRIPTION	RITRON #
INDUCTORS								
L101	3.3 MH CHOKE/MF-332	01801023	R120	1 M Ω	04700169	R236	100 K Ω	04700157
L103	10UH WILCO ML100	01800119	R121	1.5 K Ω	04700135	R237	180 K Ω	04700160
CONNECTORS								
P101	CONNECTOR 10 PIN (MALE)	02100041	R122	33 K Ω	04700151	R238	10 K Ω	04700145
P101	CONNECTOR 10 PIN (MALE)	02100041	R123	27 K Ω	04700150	R239	270 K Ω	04700162
P101	10 PIN 0.1" CENTER HEADER	02100084	R124	120 K Ω	04700158	R240	820 K Ω	04700168
P102	10 PIN POLARIZED PC MNT CONN	02100313	R125	100 K Ω	04700157	R241	27 K Ω	04700150
TRANSISTORS								
Q101	MPS-4124 NPN LOW NOISE AUD.	04800006	R126	1 K Ω	04700133	R242	27 K Ω	04700150
Q102	MPS-4124 NPN LOW NOISE AUD.	04800006	R127	10 K Ω	04700145	R243	2.2 K Ω	04700137
Q103	TIP-42, 40V 6A PNP POWER TRANS	04800019	R128	47 Ω	04700117	R244	10 K Ω MINI POT	04750035
Q104	TIP-42, 40V 6A PNP POWER TRANS	04800019	R129	47 Ω	04700117	R245	10 K Ω	04700145
Q201	MPS-A13 NPN DARLINGTON	04800007	R130	10 K Ω	04700145	R246	18 K Ω	04700148
Q202	MPS-A13 NPN DARLINGTON	04800007	R131	2.2 Ω	04700100	R247	10 K Ω	04700145
Q203	MPS-4124 NPN LOW NOISE AUD.	04800006	R132	2.2 Ω	04700100	R248	25 K Ω MULTI-TURN POT	04750046
Q204	MPS-A13 NPN DARLINGTON	04800007	R201	47 Ω 1/2W 5% CF RESISTOR	04710000	R249	39 K Ω	04700152
Q205	MPS-4124 NPN LOW NOISE AUD.	04800006	R202	1 K Ω	04700133	R250	100 K Ω	04700157
Q206	TIP-47 NPN POWER TRANSISTOR	04800026	R203	100 Ω 5% 1/2W CC RESISTOR	04710020	R251	56 K Ω	04700154
RESISTORS, 5% 1/4W CF, UNLESS STATED OTHERWISE								
R101	10 K Ω	04700145	R204	100 K Ω	04700157	SWITCH		
R102	2.7 K Ω	04700138	R205	220 K Ω	04700161	SW201	6 POSITION DIP SWITCH	05100023
R103	33 K Ω	04700151	R206	10 K Ω	04700145	TRANSFORMERS		
R104	25 K Ω TRIM POT/MINI (HOR)	04750014	R207	1M Ω	04700169	T101	RTSU-1 PWR SUPPLY TRANSFORMER	05600022
R105	1 K Ω HORIZ MINI-POT	04750002	R208	10 K Ω	04700145	T201	HYBRID TRFOR.600 OHM SPLIT PRIM.	05600023
R106	150 K Ω	04700159	R209	100 K Ω	04700157	T202	HYBRID TRFOR.600 OHM SPLIT PRIM.	05600023
R107	270 K Ω	04700162	R210	10 K Ω	04700145	HARDWARE		
R108	220 K Ω	04700161	R211	100 K Ω	04700157	HW101	GRAY PLASTIC CASE	01400022
R109	22 K Ω	04700149	R212	100 K Ω	04700157	HW102	FLAT ALUMINUM HEAT SINK	26200100
R110	5.6 K Ω	04700142	R213	3.9 K Ω	04700140	HW103	CABLE TELEPHONE W/ PLUG	06001016
R111	10 K Ω	04700145	R214	10 K Ω	04700145	HW104	CABLE #22 AWG/ 6 CONDUCTOR	06001017
R112	10 K Ω	04700145	R215	10 K Ω	04700145	HW105	20-PIN TERM HOUSING FEMALE	02100031
R113	27 K Ω	04700150	R216	10 Ω	04700108	HW106	BACK PANEL MOD RTSU-1 RTL T-1	06102001
R114	15 K Ω	04700147	R217	10 Ω	04700108	HW107	CONNECTOR 10-PIN FEMALE	02100042
R115	180 K Ω	04700160	R218	150 Ω ; 1/2W; 5% CF RESISTOR	04700108	HW108	CONNECTOR 10-PIN FEMALE	02100042
R116	100 K Ω MINI POT	04750034	R219	2 K Ω TRIM POT; LINEAR	04710022	HW109	TERMINAL 2100031/2100042	02100046
R117	100 K Ω MINI POT	04750034	R220	560 Ω	04700130	HW110	ROUND RUBBER FEET SELF-ADHESIVE	02800028
R118	27 K Ω	04700150	R221	270 K Ω	04700162	HW111	4 x 1/4" PPHMS SELF-TAP/TYPE 25	02801009
R119	47 K Ω	04700153	R222	10 K Ω MINI POT	04750035	HW112	BUSHING LINE CORD	02800002
			R223	10 K Ω MINI POT	04700145	HW115	3/8" DIA HEAT SINK	06002015
			R224	10 K Ω	04700145			
			R225	10 K Ω	04700145			
			R226	560 Ω	04700130			
			R227	10 K Ω	04700145			
			R228	10 K Ω MINI POT	04700145			
			R229	39 K Ω	04750035			
			R230	270 Ω ; 1/4W; 5%	04700152			
			R231	270 Ω ; 1/4W; 5%	04700126			
			R232	10 K Ω	04700126			
			R233	100 K Ω MINI POT	04700145			
			R234	1M Ω	04750034			
			R235	56 K Ω	04700169			

RTL T-1 DIAGRAMS



RTSU-1 DIAGRAMS



SCHEMATIC 17711001 REV D
 BOTTOMSIDE PARTS PLACEMENT 17611001 REV D
 PC BOARD 17011001 REV C

RISU-1
 TOPSIDE PARTS PLACEMENT
 17511001
 REV D

RITRON INC
 CARMEL IN

