

20-27B

Tone Panel

Version 1.10

Printings

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SPECIFICATIONS

Input Voltage	10.7 Vdc - 18 Vdc
Standby current @ 13.8 Vdc	75 mA
Temperature range	0 to +70 deg C
Relative humidity	90% at 50 deg C
Line impedance	600 ohms
Line control	2 or 4 wire audio
Receive to line audio output level	50 mVrms - 2.8 Vrms into 600 ohms
Receive to line S/N ratio	> 50 dB (ref. -10 dBm in to +10 dBm out)
Receive to line distortion	< 3%
Receive to line frequency response through de-emphasis	+1, -3 dB (300 to 3000 Hz) +1, -3 dB at 6 dB/octave (300 to 3000 Hz)
Line to TX audio output level	30 mVrms - 1.3 Vrms into 600 ohms
Line to TX S/N ratio	> 40 dB (ref. 0 dBm in to +2 dBm out)
Line to TX distortion	< 3%
Line to TX frequency response	+1, -3 dB (300 to 3000 Hz)
Outputs - open collector	100 mA sink
Outputs - relay contacts	1 A Form C
Weight	1.3 lb.
Dimensions	4.25" x 6.5" x 1.5"

1.0 GENERAL DESCRIPTION

1.1 Description

The Model 20-27B Sequential Tone Panel is designed to operate in conjunction with IDA Models 24-66 and 24-20 tone remote controllers, as well as other sequential tone remotes currently marketed. The 20-27B detects tones from remote controllers to control remotely located repeater and base station radios. At the same time the 20-27B provides a two-way audio path in either the 2 or 4-wire mode.

The characteristics that the 20-27B is to operate under can be selected and changed with a software program that can be run on a standard personal computer. In multi-frequency applications the 20-27B can be configured for a number of frequency control schemes. When setting the 20-27B up for operation, the installer has the choice of which one of the eleven function tones is to be associated with a particular function. The 20-27B can also be set up for dual function tone signalling which allows a pair of function tones to be associated with each function.

Interfaces to a number of different radios have been developed which allow the 20-27B to control the radio's various functions. The installer has the choice of which function tones are to be associated with each radio function (system, group, scan, etc.). Various radio interface cables are available for quick and easy installation.

The 20-27B provides a local microphone jack and related circuitry for applications which require regular operation from the radio/panel. An amplified desk microphone is available from IDA Corporation.

1.2 Capabilities and Features

- ◆ 2 wire or 4 wire operation
- ◆ Remote update
- ◆ 11 function tones 1050 - 2050 Hz
- ◆ Dual function tone capability
- ◆ PC programmable
- ◆ Non-volatile memory
- ◆ 6 programmable open collector outputs
- ◆ 4 programmable open collector/relay outputs
- ◆ Local microphone
- ◆ Interfaces to various different radios

2.0 INSTALLATION AND SETUP

2.1 Inspection

Please refer to the checklist packed with the 20-27B in order to become familiar with the unit and to insure that everything ordered has been received. In the event a part is missing from the checklist, please call the Customer Services Department at 1-701-280-1122.

This unit was thoroughly inspected before leaving the factory. If the outer package appears damaged, please inspect the unit for possible damage immediately. Any dents, scratches, or marks suggest rough handling in shipping. Please notify the shipper if you find any indications of mishandling. If there are any concerns about the condition of the 20-27B when it is received, please don't hesitate to call the Customer Services Department.

2.2 Disassembly and Reassembly

When performing the alignment procedure or making changes to the jumpers on the 20-27B, it is necessary to remove the printed circuit board from the case. This is accomplished by removing the two black screws from the front of the 20-27B and removing the front panel. Remove the top cover by sliding it off the 20-27B. Since the printed circuit board contains sensitive circuitry, be sure to take the necessary precautions against static discharge.

To reassemble the 20-27B, replace the top cover and the front panel making sure the front and back panels are seated properly with the case. Replace the two black screws but do not over-tighten them.

2.3 Installation Procedure

This section provides a basic step-by-step installation procedure for the 20-27B. Refer to sections **2.4 - 2.9** for detailed installation information. Detailed information on adjusting the 20-27B audio levels can be found in section **4.0 Adjustment Procedures**.

1. The system should initially be set up and tested on the bench. Use only one remote at first. Additional remotes can be added later.
2. Connect the 20-27B to the base station radio. Be sure to program the base station radio as required.
3. Set the 20-27B jumpers as required.
4. Program the 20-27B and the remote to allow the remote to control the base station radio as desired.

2.3 Installation Procedure (cont.)

5. Connect the 20-27B to an earth ground and then connect the line from the 20-27B to the remote.
6. Receive audio from the base station radio should now be heard at the remote. Adjust the *RX Audio to Line Level* for the desired level to the line. Adjust the receive audio in the remote as necessary.
7. Press PTT on the remote. If the base station radio does not key, adjust the *Line Input Level* until the base station radio keys when PTT is pressed on the remote. The *2175 Hz Detect Level* may also need to be adjusted.
8. Once the remote is able to key the base station radio reliably, adjust the transmit audio in the remote as necessary. Then adjust the *Line to TX Audio Level* for the desired transmitter deviation from the base station radio.
9. The remote should now be able to change channels or systems and groups on the base station radio. The 20-27B should also be able to update the remote (if enabled with the programming software) when the channel or the system and group is changed from the faceplate of the base station radio. If not, check the *2175 Hz Encode Level*. Also check the tone detect levels in the remote.
10. If a local microphone is to be used, connect the local microphone to the 20-27B and press the PTT button. Adjust the *Local Mic to TX Audio Level* for the desired transmitter deviation from the base station radio.
11. Program any additional remotes as required. Generally, they should be programmed the same as the first remote.
12. Connect additional remotes in parallel to the first remote. Make sure all remotes except for one are set to high impedance.
13. Adjust the transmit and receive levels of the remotes as required. Audio from all remotes should arrive at the 20-27B with the same level. If a 4-wire line is being used, adjust the *4-Wire Intercom Level* for the desired level of intercom audio.
14. Verify that all desired functions of the base station radio can be controlled by all of the remotes. Also verify that all of the remotes are updated by the 20-27B when a change is made from the faceplate of the base station radio.

2.5 Line Connection (cont.)

If a 4-wire line is being used, the transmit and receive pairs need to be reversed. The inside pair needs to become the outside pair and the outside pair needs to become the inside pair. This is done by cutting the cable and connecting the red wire to the black wire, the black wire to the red wire, the green wire to the yellow wire, and the yellow wire to the green wire. This should be done only to the cable connecting the 20-27B to the first remote. Additional remotes should be wired in parallel. If the line from the 20-27B is plugged into a wall jack, the transmit and receive pairs can be reversed on the back side of the wall jack.

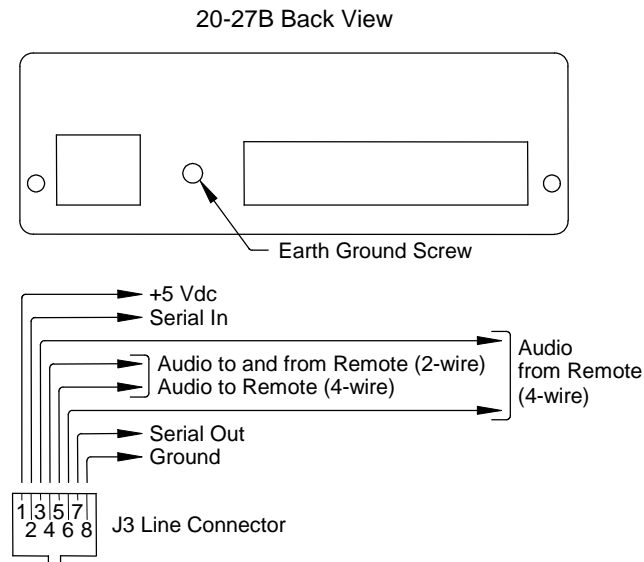


Figure 2

2.6 Earth Ground Connection

A good earth ground should be connected to the earth ground screw on the back of the 20-27B to allow the surge arresters to provide maximum protection from line transients. Without a good earth ground, the ability of the surge arresters to protect the internal circuits of the 20-27B from line transients will be limited. Refer to Figure 2 for the location of the earth ground screw.

2.7 Desk Microphone Connection

The 20-27B provides a local microphone jack and related circuitry for applications which require regular operation from the radio/panel. The local microphone should be connected to the modular jack labeled "LOCAL MIC" on the front of the 20-27B. The connections that the local microphone jack provides are detailed in Figure 3. An amplified desk microphone is available from IDA Corporation.

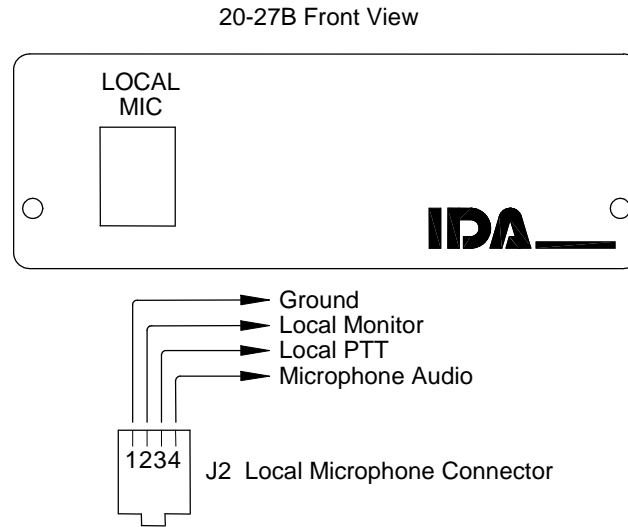


Figure 3

2.8 Computer Connection

A computer must be connected to the 20-27B in order to program setup data into the 20-27B. Figure 2 details the connections that need to be made. To connect the computer to the 20-27B, the modular plug end of the programming cable should be plugged into the modular jack on the back of the 20-27B (the line will need to be unplugged first). The DB-25 end of the programming cable should be plugged into the serial port of the computer. If the computer has a DB-9 serial port, the DB-25 to DB-9 adapter will need to be used.

Note: Before connecting the 20-27B to a computer with the programming cable, be sure to remove jumpers JP15 and JP16.

2.9 Jumper Settings

The 20-27B has a number of jumpers that control the operation of the 20-27B. The functions and settings of these jumpers are described below.

JP1 - This jumper determines the operating mode of the 20-27B. JP1 should be jumpered to A-B for Internal EEPROM mode and to B-C for Programming mode. In the Internal EEPROM mode, the operating characteristics of the 20-27B are stored in an internal EEPROM. This EEPROM is programmed using the programming software.

The Programming mode allows the 20-27B to be programmed by the programming software. Programming of the 20-27B is accomplished by using a PC linked serially to the modular connector on the back of the 20-27B with the programming cable. The programming information is stored by the 20-27B in an internal EEPROM.

Note: Before connecting the 20-27B to a computer with the programming cable, be sure to remove jumpers JP15 and JP16.

JP2 - This jumper should be jumpered to A-B.

JP3 - This jumper determines if the audio received from the base station radio is de-emphasized. If JP3 is shorted, the audio is de-emphasized. If JP3 is not shorted, the audio is not de-emphasized.

JP4 - The setting of this jumper is determined by the type of line being used, either 2-wire or 4-wire. JP5 should be jumpered to A-B for 2-wire operation and to B-C for 4-wire operation.

JP5 - The setting of this jumper determines if the line audio passes through the automatic gain control circuit before being sent to the base station radio to be transmitted. JP5 should be jumpered to A-B to bypass the AGC and to B-C to use the AGC.

JP6, JP7 - These jumpers determine if output 1 is an open collector output or a relay output. If JP6 is shorted, output 1 will be a relay output. If JP7 is shorted, output 1 will be an open collector output. Only one of JP6 and JP7 should be shorted at any time.

JP8 - This jumper determines the transmit audio output impedance. When JP8 is shorted, the impedance is 600 ohms. When JP8 is not shorted, the impedance is approximately 10k ohm.

JP9, JP10 - These jumpers determine if output 9 is an open collector output or a relay output. If JP9 is shorted, output 9 will be a relay output. If JP10 is shorted, output 9 will be an open collector output. Only one of JP9 and JP10 should be shorted at any time.

2.9 Jumper Settings (cont.)

JP11, JP12 - These jumpers determine if output 2 is an open collector output or a relay output. If JP11 is shorted, output 2 will be a relay output. If JP12 is shorted, output 2 will be an open collector output. Only one of JP11 and JP12 should be shorted at any time.

JP13, JP14 - These jumpers determine if output 10 is an open collector output or a relay output. If JP13 is shorted, output 10 will be a relay output. If JP14 is shorted, output 10 will be an open collector output. Only one of JP13 and JP14 should be shorted at any time.

JP15 - This jumper is used to enable serial data out to the base station radio. JP15 should be removed when the 20-27B is being programmed. If the 20-27B is not being programmed, JP15 should be shorted.

JP16 - This jumper is used to enable serial data in from the base station radio. JP16 should be removed when the 20-27B is being programmed. If the 20-27B is not being programmed, JP16 should be shorted.

3.0 OPERATION

3.1 Update Sequences

Update sequences are sent from the remote to the 20-27B and can also be sent from the 20-27B to the remote. These update sequences allow the remote to control the different base station radio functions, such as current channel and scan status, and to keep the remote (and any paralleled remotes) updated to the current base station radio status. Figure 4 shows the different components of the update sequence. It is important to note that the update sequence is defined by levels as well as tone frequencies. Line loss needs to be taken into consideration and will probably be a factor at installation. The levels shown in Figure 4 will most likely be less when they arrive at either the 20-27B or the remote, but in the same proportion. The 20-27B is setup for the correct tones and levels from a 600 ohm source with no line loss. However, due to loading of paralleled remotes on the same line, as well as line loss, some audio levels may need to be increased. In paralleled remote installations, all remotes should arrive at the 20-27B with the same levels.

3.1 Update Sequences (cont.)

The guard tone is defined as 2175 Hz at +10 dBm and is the first tone in an update sequence. The guard tone is used to signal the start of an update sequence. If the guard tone is not detected properly, the rest of the update sequence will be ignored. Following the guard tone in the update sequence is the function tone (or tones) at a level of 0 dBm. (Updates sent by the 20-27B to the remote do not include function tones.) The function tone is decoded to determine the action required by the update sequence. When the update sequence is sent by a remote, the function tone may be followed by the hold tone. The hold tone is defined as 2175 Hz at -20 dBm and indicates that the remote's PTT is being pressed. When the 20-27B detects the hold tone, it will key the base station radio and pass audio from the remote to the base station radio. The audio from the remote rides on top of the hold tone. The 20-27B will keep the base station radio keyed until the hold tone is no longer detected.

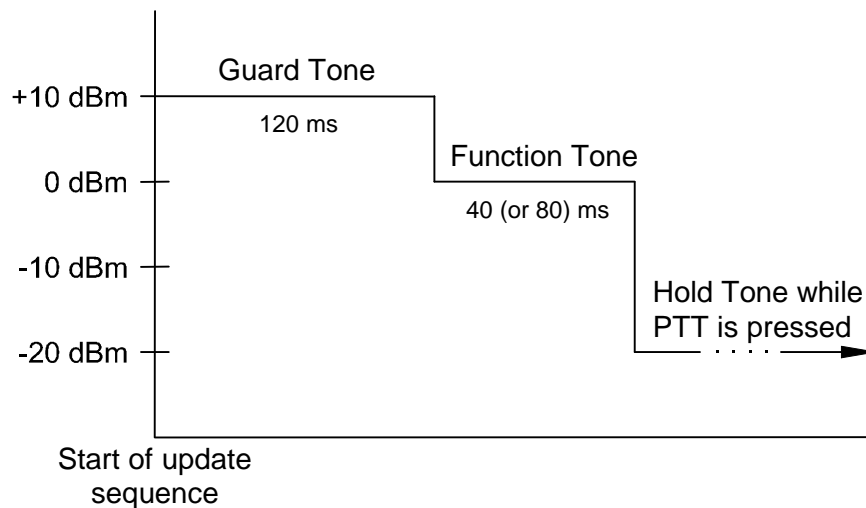


Figure 4

3.2 Outputs

The 20-27B contains 10 open collector outputs. Four of these outputs, outputs 1, 2, 9, and 10, can also be switched to relay outputs. The outputs are available as general purpose outputs and can be programmed as active high or active low and also as timed outputs. The outputs are controlled by the remote which can enable or disable any number of outputs with a single update sequence.

3.3 Local Microphone Control

A desk microphone can be used to allow local control of the base station radio. When PTT is pressed on the desk microphone, the 20-27B will key the base station radio. Audio from the desk microphone will be passed to the base station radio for transmission. The local user can hear transmissions from other radios through the speaker of the base station radio. The monitor switch on the desk microphone can be used to control output 10.

4.0 ADJUSTMENT PROCEDURES

4.1 Audio Measurements

The common term that is used to express audio power levels in a communications system is the decibel referenced to 1 mW of power (dBm). Another term, which is often misused, is the decibel (dB). It is important the correct term, or unit of measurement, be used as determined by its application.

dB - Power or Voltage Ratio

The decibel or dB is a ratio and is defined as a measure such that:

$$\begin{aligned} \text{dB (power)} &= 10 \log (P_a/P_b) \\ \text{or} \\ \text{dB (voltage)} &= 20 \log (E_1/E_2) \end{aligned}$$

where P_a and P_b are two values of power, E_1 and E_2 are two values of voltage. Note that since dB is a ratio, it has no unit value such volts, amps, or watts.

dBm - Decibel referenced to 1 mW

The symbol dBm indicates a power level with respect to 1 mW of power (0 dBm is equal to 1 mW). Although this definition does not imply a 600 ohm impedance, most AC voltmeters are calibrated in terms of dBm across 600 ohms. In this case using the formula:

$$\begin{aligned} E^2 &= PR \\ \text{gives} \\ E &= 0.77 V_{\text{rms}} \text{ or } 2.2 V_{\text{p-p}} \end{aligned}$$

with $P = 1 \text{ mW}$ and $R = 600 \text{ ohms}$. Therefore, 0 dBm is equal to 0.77 Vrms. It can also be shown that +10 dBm is equal to 2.45 Vrms and -20 dBm is equal to .08 Vrms.

4.2 Adjustment Potentiometers

The functions of the adjustment potentiometers are described below. Refer to section **4.3 Audio Adjustments** for detailed instructions on adjusting these pots. Refer to the adjustment locator diagram in the back of this manual for the location of the adjustment potentiometers. An asterisk (*) indicates the potentiometer has been factory set and should not need adjusting. Potentiometers without an asterisk may need to be adjusted for the best audio quality and performance on a particular system.

R11*	2175 Hz Encode Level
R25	Local Mic to TX Audio Level
R32*	2175 Hz Detect Level
R34*	2175 Hz Bandpass Adjust
R50*, R51*	RX 2175 Hz Notch Filter Adjust
R52*, R53*	TX 2175 Hz Notch Filter Adjust
R90	Line to TX Audio Level
R91	4-Wire Intercom Level
R92	RX Audio to Line Level
R93*	Line Input Level

4.3 Audio Adjustments

2175 Hz Encode Level - This is level of the 2175 Hz tone sent to the line by the 20-27B. Potentiometer R11 has been factory adjusted to provide +10 dBm of encoded 2175 Hz tone into a 600 ohm load across pins 4 and 5 of the line connector J3. R11 can be adjusted if a level other than +10 dBm is desired.

Local Mic to TX Audio Level - This is the level of local microphone audio that is sent by the 20-27B to the base station radio for transmission. Potentiometer R25 should be adjusted to provide the desired transmitter deviation when transmitting from the local microphone. Do not turn R25 up too high since this will cause distortion and clipping.

2175 Hz Detect Level - This is the level of audio sent into the guard and hold tone detectors. Potentiometer R32 has been factory adjusted so that U9 pin 1 just goes high with a 2175 Hz tone at 8 dBm applied across pins 4 and 5 (2-wire) or pins 3 and 6 (4-wire) of the line connector J3. Adjust R32 only if the guard and hold tones are not being detected reliably and only after the *2175 Hz Bandpass Adjust* and the *Line Input Level* have been set.

2175 Hz Bandpass Adjust - This adjustment sets the center frequency of the 2175 Hz bandpass filter. Potentiometer R34 has been factory adjusted for a maximum level at U10 pin 1 with a 2175 Hz tone applied across pins 4 and 5 (2-wire) or pins 3 and 6 (4-wire) of the line connector J3. Adjust R34 only if the guard and hold tones are not being detected reliably.

4.3 Audio Adjustments (cont.)

RX 2175 Hz Notch Filter Adjust - This adjustment sets the notch frequency of the RX audio 2175 Hz notch filter. Potentiometers R50 and R51 have been factory adjusted for a minimum level at U13 pin 1 with a 2175 Hz tone applied to pin 1 of the radio connector P2. Adjust R50 and R51 only if 2175 Hz tones from the base station radio are not being filtered out. For best results, alternate between R50 and R51 while adjusting.

TX 2175 Hz Notch Filter Adjust - This adjustment sets the notch frequency of the TX audio 2175 Hz notch filter. Potentiometers R52 and R53 have been factory adjusted for a minimum level at U11 pin 1 with a 2175 Hz tone applied across pins 4 and 5 (2-wire) or pins 3 and 6 (4-wire) of the line connector J3. Adjust R52 and R53 only if 2175 Hz tones from the line are not being filtered out. For best results, alternate between R52 and R53 while adjusting.

Line to TX Audio Level - This is the level of the audio received from the line that is sent by the 20-27B to the base station radio for transmission. Potentiometer R90 should be adjusted to provide the desired transmitter deviation when transmitting from a remote. Do not turn R90 up too high since this will cause distortion and clipping. Adjust R90 only after the *Line Input Level* has been set.

4-Wire Intercom Level - This is the level of the audio sent from one remote to the other paralleled remotes when using a 4-wire line. Potentiometer R91 should be adjusted to provide the desired level of audio to the paralleled remotes when one of the remotes is transmitting. Do not turn R91 up too high since this will cause distortion and clipping.

RX Audio to Line Level - This is the level of the audio from the base station radio that is sent by the 20-27B to the line. While the base station radio is receiving a transmission from another radio, adjust potentiometer R92 to provide the desired level of audio to the remote through the line taking into account any line loss. Do not turn R92 up too high since this will cause distortion and clipping.

Line Input Level - This is the level of audio received from the remote through the line by the 20-27B. Potentiometer R93 has been factory adjusted to provide +10 dBm at U14 pin 1 with a 2175 Hz tone at +10 dBm applied across pins 4 and 5 (2-wire) or pins 3 and 6 (4-wire) of the line connector J3. The guard tone from the remote may arrive at the 20-27B with a level less than +10 dBm due to line loss between the remote and the 20-27B. If this is the case, adjust R93 to provide +10 dBm at U14 pin 1 when guard tone is being received from the remote.

5.0 CIRCUIT DESCRIPTION

5.1 Power Supply

The 20-27B is powered from a 13.8 Vdc supply connected across pin 20 (13.8 Vdc) and pin 7 (ground) of P2. The 13.8 Vdc supply is fed into the voltage regulators U16 and U17 through D8 and F1. D8 prevents a reverse voltage from harming the 20-27B and F1 is a 1 amp fuse that provides protection from excessive current draw. U16 is a 5 Vdc regulator that provides power for the digital circuits of the 20-27B. U17 is a 10 Vdc regulator that provides power for the analog circuits of the 20-27B. C60, C61, and C62 provide filtering for the power supplies. In addition, U13D is used to provide a 5 Vdc reference for the analog circuits of the 20-27B.

5.2 Transmit Audio

Audio appearing on the line enters the 20-27B on pins 4 and 5 of J3 when using a 2-wire line and on pins 3 and 6 of J3 when using a 4-wire line. SG1 - SG4 are surge arresters that protect the 20-27B from line transients. Line audio is coupled into the 20-27B by T1 (2-wire) or T2 (4-wire). R86 (2-wire) and R99 (4-wire) are used to provide a 600 ohm impedance to the line. Audio from T1 and T2 goes to JP4 which determines if a 2-wire or a 4-wire line is being used. The audio then passes to U14A which is an amplifier stage that is used to compensate for line loss. Potentiometer R93 controls the gain of this amplifier stage.

The audio then enters the automatic gain control (AGC) circuit which compensates for varying input levels by providing a constant output over an input range of 30 dB. The AGC circuit is comprised of U12B and U11C and their associated components. The audio signal on pin 13 of U12 is rectified internally and is used to control the gain of the internal gain cell connected between pins 9 and 11 of U12. The attack time of the AGC is determined by C33 and the recovery time is determined by C32. The AGC output is at pin 8 of U11.

The audio then enters the TX 2175 Hz notch filter through jumper JP5. JP5 determines if the transmit audio comes from the AGC output or if it bypasses the AGC through R78 and R88. The notch filter is comprised of U11A and U11B and their associated components. Potentiometers R52 and R53 are used to tune the notch filter to 2175 Hz. The notch filter removes the 2175 Hz hold tone from the transmit audio to prevent it from being heard.

The audio will then pass through the bilateral switch U8A when this switch is enabled by the control section. The audio passes to U11D which is a summing amplifier stage that is used to provide the proper level of audio to the base station radio. Potentiometer R90 controls the gain of the transmit audio through this stage. The audio then passes to pin 21 of P2 which is the transmit audio output. Jumper JP8 determines if the transmit audio output is a high or a low impedance.

5.3 Receive Audio

Receive audio from the base station radio enters the 20-27B on pin 1 of P2. The audio passes to U13C which is a buffer stage for the receive audio. Jumper JP3 determines if the receive audio is de-emphasized or not.

The audio then enters the RX 2175 Hz notch filter. The notch filter is comprised of U13A and U13B and their associated components. Potentiometers R50 and R51 are used to tune the notch filter to 2175 Hz. The notch filter removes any 2175 Hz component present in the receive audio to prevent falsing any 2175 Hz detectors in the remote.

The audio will then pass through the bilateral switch U8B when this switch is enabled by the control section. The audio then passes to line driver U15 which drives the line coupling transformer T1 when enabled by the control section. Potentiometer R92 controls the gain of the receive audio through the line driver. Audio coupled to the line by T1 appears across pins 4 and 5 of J3. Resistor R98 is used to provide a 600 ohm impedance to the line when U15 is enabled.

5.4 Guard and Hold Tone Detect

Line audio from U14A is passed into the 2175 Hz bandpass filter through potentiometer R32. R32 adjusts the level of audio into the bandpass filter and therefore into the guard and hold tone detect circuits. The bandpass filter is comprised of U10A, U10B, and U10C and their associated components. Potentiometer R34 is used to tune the bandpass filter to 2175 Hz.

The 2175 Hz tones that come out of the bandpass filter are passed into the guard and hold tone detect circuits. The guard tone detect circuit is comprised of U9A and its associated components. Diodes D3 and D4 pass only the positive transitions of the 2175 Hz tones to capacitor C16 which causes C16 to charge up. During negative transitions, C16 is discharged by resistor R27. The charge on C16 is passed to U9A which is a comparator that compares the charge on C16 to a reference level. U9A outputs a high to the control section when the charge on C16 exceeds the reference level which indicates that guard tone is being detected.

The hold tone detect circuit is comprised of U10D and U9B and their associated components. U10D is an amplifier stage that provides approximately 30 dB of gain. Diodes D5 and D6 pass only the positive transitions of the 2175 Hz tones to capacitor C24 which causes C24 to charge up. During negative transitions, C24 is discharged by resistor R46. The charge on C24 is passed to U9B which is a comparator that compares the charge on C24 to a reference level. U9B outputs a high to the control section when the charge on C24 exceeds the reference level which indicates that hold tone is being detected.

5.5 4-Wire Intercom

Line audio from U14A passes through the bilateral switch U8D when this switch is enabled by the control section. The audio passes back to the line through the line driver U15. Potentiometer R91 controls the gain of the 4-wire intercom audio through the summing amplifier. The 4-wire intercom circuit allows audio from a remote that is transmitting to be received by paralleled remotes when using a 4-wire line.

5.6 Outputs

The 20-27B provides 10 outputs on connector P2. Pins 11 - 16 of P2 are outputs 3 - 8 and are passed directly to the control board. Pins 4 - 6, 8 - 10, 17 - 19, and 22 - 24 of P2 are the common, normally closed, and normally open relay outputs for outputs 1, 2, 9, and 10 when jumpers JP6, JP11, JP9, and JP13 (respectively) are installed. If jumpers JP7, JP12, JP10, and JP14 are installed, pins 6, 10, 19, and 24 of P2 are outputs 1, 2, 9, and 10 (respectively) and are passed directly to the control board.

5.7 Local Microphone

The monitor signal from the local microphone enters the 20-27B on pin 2 of J2 and is connected to the control line for output 10. This allows output 10 to be controlled using the monitor button on the local microphone. The PTT signal from the local microphone enters the 20-27B on pin 3 of J2 and is passed to the control board. The audio from the local microphone enters the 20-27B on pin 4 of J2. Resistors R23 and R24 provide power to the local microphone and R23 also provides a 600 ohm impedance to the local microphone. The microphone audio passes through the bilateral switch U8C when this switch is enabled by the control section. The audio then passes to the base station radio through the summing amplifier U11D. Potentiometer R25 controls the gain of the microphone audio through the summing amplifier U11D.

5.8 Control Board

The 20-27B is controlled by U2 which is an 8-bit microcontroller. The microcontroller continuously executes instructions from the program code that is stored internally. Crystal X2 provides a 11.0592 MHz clock to the microcontroller. U7 is a voltage monitor that will reset the microcontroller on power-up and under low voltage conditions. The programmable operating characteristics of the 20-27B are stored in U6 which is a serial EEPROM. The microcontroller reads data out of U6 as required.

Port 0 on the microcontroller (pins 36 - 43) is used for controlling outputs 1 - 8. Resistor network R1 provides pull-up resistors for the port 0 pins which are connected to the driver inputs of U1 which contains 8 open collector drivers. The driver outputs of U1 are passed to the base board through connector J1. Port 2 on the microcontroller (pins 24 - 31) is used for controlling outputs 9 and 10, the bilateral switches, and the line driver. Resistor network R3 provides pull-up resistors for the port 2 pins which are connected to the driver inputs of U4 which contains 8 open collector drivers. The driver outputs of U4 are passed to the base board through connector J1.

Port 1 on the microcontroller (pins 2 - 9) is used for reading the state of various inputs and for communicating with U3. The microcontroller will take specific actions based upon the state the inputs. U3 is an audio signal processor that is used for decoding the tones in the update sequences that are received from the remote and for generating the tones in the update sequences that are sent to the remote. The microcontroller reads data from U3 to determine which tones are being decoded and writes data to U3 to cause U3 to generate the tones required for each update sequence sent. Potentiometer R11 is used to adjust the level of the update sequence tones sent to the line.

Pins 11 and 13 on the microcontroller are used to send and receive serial data. Pins 18 and 19 on the microcontroller are used to read the settings of jumpers JP1 and JP2.

APPENDIX A - RADIO INTERFACES

This appendix contains instructions for interfacing the 20-27B to various radio models.

Relm GMH Interface

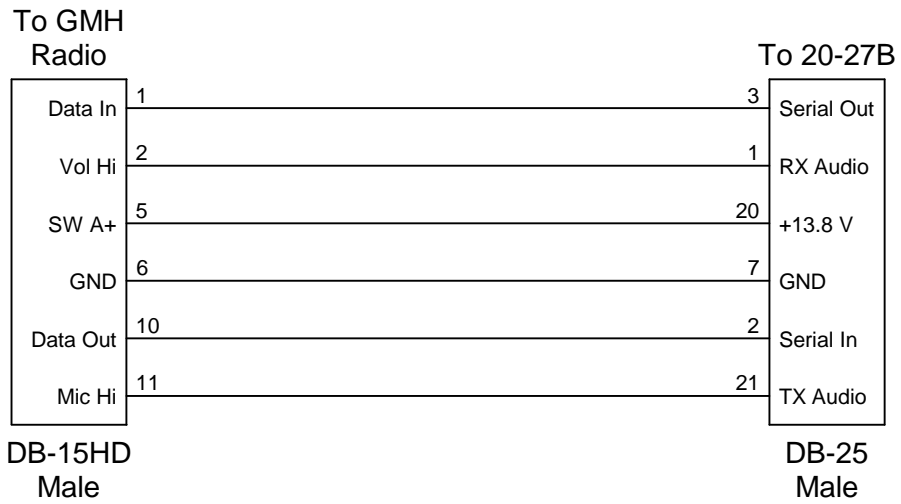
These instructions are for interfacing the 20-27B to the Relm GMH radio. The following items are included in the Relm GMH interface kit:

1. Relm GMH to 20-27B interface cable assembly.
2. Instruction sheet.

The following steps outline the procedure for interfacing the Relm GMH radio to the 20-27B:

1. Connect the DB-25 end of the GMH interface cable to the DB-25 connector on the back of the 20-27B.
2. Connect the DB-15HD end of the GMH interface cable to the DB-15HD connector on the back of the GMH radio.
3. Configure the following jumpers in the 20-27B as indicated:
 - JP3: Not shorted
 - JP8: Not shorted
4. Configure the remaining jumpers based upon system requirements. The audio level adjustments will also need to be checked.

Relm GMH Interface Cable



Relm GMH Interface Cable Kit 106-27RLMGMH

Item	Description	Part No.	Qty.
1	4-40 X 1/2 SCREW	199-4035	2
2	DB25 CONNECTOR MALE	231-0005	1
3	SCREW/CLIP KIT	231-0014	2
4	DB25 COVER ASSEMBLY	231-0015	1
5	DB15HD COVER ASSEMBLY	231-0073	1
6	DB15HD CONNECTOR MALE	231-0081	1
7	6 CONDUCTOR CABLE	800-1112	1.3'

Kenwood TK-880 Interface

These instructions are for interfacing the 20-27B to the Kenwood TK880 radio. The following items are included in the Kenwood TK880 interface kit:

1. Kenwood TK880 to 20-27B interface cable assembly.
2. Instruction sheet.

The following steps outline the procedure for interfacing the Kenwood TK880 radio to the 20-27B:

1. The Kenwood TK880 radio firmware must have the checksum [1DAF]. Consult the radio manual to determine the installed firmware version.
2. The following modifications must be made to the radio:
 - Resistor R94 (0 ohm) removed
 - Resistor R24 (0 ohm) installed
3. The radio must be programmed with the COM 1 (Internal Port) set to REM in the optional features menu in the Kenwood radio programmer.
4. Connect the DB-25 end of the Kenwood TK880 interface cable to the DB-25 connector on the back of the 20-27B.
5. Connect the molex end of the Kenwood TK880 interface cable to the molex connector on the radio's accessory pigtail cable.
6. Configure the jumpers on the 20-27B based upon the system requirements. The audio level adjustments will also need to be checked.

Kenwood TK880 Interface Cable



Kenwood TK880 Interface Cable Kit 106-28KEN880

Item	Description	Part No.	Qty.
1	DB25 CONNECTOR MALE	231-0005	1
2	SCREW/CLIP KIT	231-0014	1
3	4-40 X 1/2 SCREW	199-4035	2
4	DB25 COVER ASSEMBLY	231-0015	1
5	MOLEX MALE PIN	231-0034	6
6	15 POS MOLEX CONNECTOR	231-0054	1
7	CBL 6 COND/22 AWG	800-1112	1'

Kenwood TK-790 Interface

These instructions are for interfacing the 20-27B to the Kenwood TK790 radio. The following items are included in the Kenwood TK790 interface kit:

1. Kenwood TK790 to 20-27B interface cable assembly.
2. Instruction sheet.

The following steps outline the procedure for interfacing the Kenwood TK790 radio to the 20-27B:

1. The Kenwood TK790 radio firmware must have the checksum [353E]. Consult the radio manual to determine the installed firmware version.
2. The following modifications must be made to the radio:
 - Short the 'SB' pads for switched battery on the DB-25
 - Resistor R641 (0 ohm) removed
 - Resistor R640 (0 ohm) installed
3. Connect the DB-25 end of the Kenwood TK790 interface cable labeled 'Panel' to the DB-25 connector on the back of the 20-27B panel.
4. Connect the DB-25 end of the Kenwood TK790 interface cable labeled 'Radio' to the DB-25 connector on the back of the radio.
5. Configure the jumpers on the 20-27B based upon the system requirements. The audio level adjustments will also need to be checked.

Kenwood TK790 Interface Cable



Kenwood TK790 Interface Cable Kit 106-28KEN790

Item	Description	Part No.	Qty.
8	DB25 CONNECTOR MALE	231-0005	2
9	SCREW/CLIP KIT	231-0014	2
10	4-40 X 1/2 SCREW	199-4035	4
11	DB25 COVER ASSEMBLY	231-0015	2
12	CBL 6 COND/22 AWG	800-1112	1'

PARTS LIST

20-27B PC Board 101-0242

Item	Reference	Description	Part No.	Qty.
1	C1,2,5,6	18pF 100V MONO CAP	362-0007	4
2	C3,4,10,13,15,16,18, 20,21,25,33,40,44,48, 52,54,55,59	.1uF MONO CAP	362-0001	18
3	C7,26,42	100pF MONO CAP	362-0016	3
4	C8,41	2.2uF 35V TANT CAP	390-0005	2
5	C9,43,45,58	1uF 35V TANT CAP	390-0003	4
6	C11,12,14,57,60	10uF 16V TANT CAP	390-0010	5
7	C17,22,27,28,29,30, 31,34,35,36	.01uF ULTRA MONO CAP	362-0019	10
8	C19,23,49	.22uF 50V MONO CAP	362-5224	3
9	C24,37,38,46,47,50	.47uF MONO CAP	362-0002	6
10	C32	33uF 16V TANT CAP	390-2336	1
11	C39	330pF MONO CAP	362-0004	1
12	C51	2.2uF NP ELEC CAP	361-0002	1
13	C53	.01uF MONO CAP	362-0003	1
14	C56	4.7uF 35V TANT CAP	390-0004	1
15	C61	10uF/50V ELEC CAP	360-5106	1
16	C62	220uF/16V ELEC CAP	360-0007	1
17	D1,2	ZENER 6.8V 1N5235	111-0012	2
18	D3,4,5,6	DIODE 1N914/1N4148	110-0001	4
19	D7	ZENER 3.3V 1N5226/4728	111-0015	1
20	D8	DIODE 1N4003	110-0002	1
21	F1	1 AMP FUSE PCB MOUNT	290-0008	1
22	J1	13 PIN POST .1"	234-0032	2
23	J2	JACK 4 POS MODULAR	231-0021	1
24	J3	JACK 8 IN 6 MODULAR	231-0007	1
25	JP1,2,4,5	JUMPER POST 3 PIN	231-1003	4
26	JP3,6,7,8,9,10,11,12, 13,14,15,16	JUMPER POST 2 PIN	231-1002	12
27	JP1,2,4,5,6,8,9,11,13, 15,16	SHORTING PLUG	234-0046	11
28	K1,2,3,4	RELAY SPDT MINI	700-0005	4
29	P1	26 POS POST .1 X .1	231-1071	1
30	P2	DB25 RIGHT ANGLE	231-0004	1
31	P2	4-40 X 3/8 SCREW	199-3056	2
32	P2	4-40 HEX NUT	199-0010	2
33	P3	BRACKET GROUNDING	200-0012	1
34	P3	4-40 X 1/4 SCREW	199-3055	1
35	P3	#4 STAR WASHER	199-2001	1
36	R1,3	3.3K 9 EL RES NETWORK	316-0008	2
37	R2,4	1M 5% 1/4 W RES	312-0047	2

38	R5,44	4.7K 5% 1/4 W RES	312-0040	2
39	R6,7,16,18,19,22,47, 67,77,79,84,95,97	10K 5% 1/4 W RES	312-0011	13
40	R8,38,39,40,41,82,89	47K 5% 1/4 W RES	312-0020	7
41	R9	40.2K 1% 1/4 W RES	311-4022	1
42	R10	374K 1% 1/4 W RES	311-3743	1
43	R11,32,91	25K 1 TURN MINI POT	351-1253	3
44	R12	11.8K 1% 1/4 W RES	311-1182	1
45	R13,30,85,87	220K 5% 1/4 W RES	312-0012	4
46	R14,15,26,86	100 OHM 5% 1/4 W RES	312-0010	4
47	R17	17.8K 1% 1/4 W RES	311-1782	1
48	R20	232K 1% 1/4 W RES	311-2323	1
49	R21	93.1K 1% 1/4 W RES	311-9312	1
50	R23	620 OHM 5% 1/4 W RES	312-0045	1
51	R24,74	1K 5% 1/4 W RES	312-0019	2
52	R25,90,92,93	100K 1 TURN MINI POT	351-1104	4
53	R27,35	3.9K 5% 1/4 W RES	312-0070	2
54	R28,29,33	7.15K 1% 1/1 W RES	311-7151	3
55	R31	22K 5% 1/4 W RES	312-0015	1
56	R34,50,51,52,53	2K 22T SIDE ADJ POT	352-0050	5
57	R36,61,66	6.8K 5% 1/4 W RES	312-0018	3
58	R37	750K 1% 1/4 W RES	311-7503	1
59	R42,43,70,71,81,83,94	100K 5% 1/4 W RES	312-0003	7
60	R45	3K 5% 1/4 W RES	312-0023	1
61	R46	2.2K 5% 1/4 W RES	312-0007	1
62	R48,76	470K 5% 1/4 W RES	312-0046	2
63	R49,55,59,63	46.4K 1% 1/4 W RES	311-4642	4
64	R54,62	2.67K 1% 1/4 W RES	311-0017	2
65	R56,88	13.7K 1% 1/4 W RES	311-1372	2
66	R57	28.7K 1% 1/4 W RES	311-2872	1
67	R58,64	1.78K 1% 1/4 W RES	311-1781	2
68	R60,65	7.32K 1% 1/4 W RES	311-7321	2
69	R68	3.3K 5% 1/4 W RES	312-0035	1
70	R69	430K 5% 1/4 W RES	312-0026	1
71	R72,73	12K 1% 1/4 W RES	312-0021	2
72	R75	5.1K 5% 1/4 W RES	312-0024	1
73	R78	51.1K 1% 1/4 W RES	311-5112	1
74	R80	24K 5% 1/4 W RES	312-0064	1
75	R96	560 OHM 5% 1/4 W RES	312-0069	1
76	R98	470 OHM 5% 1/4 W RES	312-0028	1
77	R99	680 OHM 5% 1/4 W RES	312-0017	1
78	SG1,2,3,4	VARISTOR 150V UL	300-0001	4
79	T1	2-COIL TRANSFORMER	410-0006	1
80	T2	AUDIO TRANSFORMER	410-0005	1
81	U1,4	ULN2803 IC	130-0302	2
82	U2	N83C51 IC	130-3002	1
83	U3	MX803J IC	130-0304	1
84	U5	CD4048 IC	130-0111	1
85	U6	24LC16 IC	130-0359	1
86	U7	7665 IC	130-0242	1

87	U8	4066 IC	130-0067	1
88	U9	LM393 IC	130-0139	1
89	U10,11,13	TLO64 IC	130-0251	3
90	U12	NE572 IC	130-0240	1
91	U14	TLO62CP IC	130-0120	1
92	U15	MC34119 IC	130-0352	1
93	U16	UA7805 TO-220 IC	130-0022	1
94	U17	LM2940-10 TO-220 IC	130-0277	1
95	U1,4	18 PIN DIP SOCKET	220-0004	2
96	U2	44 PIN PLCC SOCKET	220-0011	1
97	U3	24 PIN DIP SOCKET	220-0005	1
98	U5,12	16 PIN DIP SOCKET	220-0001	2
99	U6,7,9,14,15	8 PIN DIP SOCKET	220-0003	5
100	U8,10,11,13	14 PIN DIP SOCKET	220-0002	4
101	U16,17	HEAT SINK, TO-220	210-0002	2
102	U16,17	INSULATOR, TO-220	210-0103	2
103	X1	4 MHZ CRYSTAL	305-0007	1
104	X2	11.0592 MHZ CRYSTAL	305-0012	1
105	X1,2	1/8" PORON	201-2013	2
106		4-40 X 1/4 SCREW	199-3055	2
107		4-40 X 1/2 SPACER	200-0304	2
108		S/N LABEL	200-0801	1
109		20-27B PC BOARD	900-0242	1

**20-27B Cabinet
103-0242**

Item	Description	Part No.	Qty.
1	4-40 X 1/4 SCREW	199-3055	1
2	IDA PRODUCT S/N LABEL	199-6135	1
3	20-27B CABINET	900-5060	1
4	20-27B FACEPLATE	900-5060S	1
5	20-27B BACKPLATE	900-5061A	1

**Option 371 Installation Kit
102-OPT371**

Item	Description	Part No.	Qty.
8	4-40 X 1/2, SCREW	199-4035	2
9	DB25 CONNECTOR MALE	231-0005	1
10	4 PIN MODULAR PLUG	231-0006	2
11	SCREW/CLIP KIT	231-0014	1
12	DB25 COVER ASSEMBLY	231-0015	1
13	4 COND. TELEPHONE WIRE	800-1002	6'
14	9 CONDUCTOR CABLE	800-1105	4'

**10 Foot Telephone Cable Assembly Option
800-2016**

Item	Description	Part No.	Qty.
1	6 POS 6 COND MOD PLUG	231-0008	2
2	6 COND. TELEPHONE WIRE	800-1003	10'

ADJUSTMENT LOCATOR DIAGRAM

Insert
Adjustment Locator Diagram
here.

SCHEMATICS

Insert
Schematics
here.