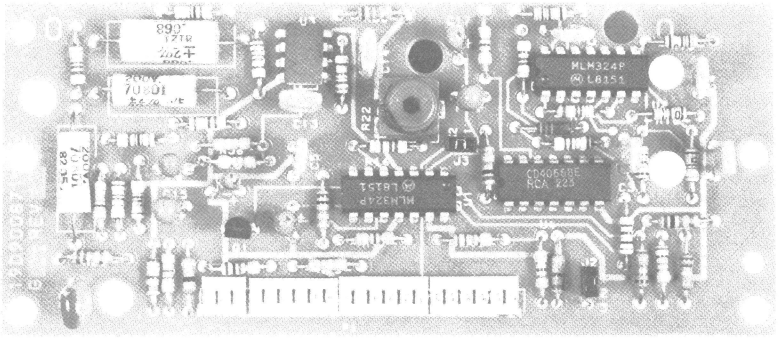
MOBILE RADIO

# DELTA-S, SX MAINTENANCE MANUAL

## PROGRAMMABLE TONE/DIGITAL CHANNEL GUARD & FILTER



Maintenance Manual LBI31201C

PROGRAMMABLE CHANNEL GUARD TONE/DIGITAL DELTA-S, SX

### SPECIFICATIONS *

| | |
|---|---|
| Input Voltage | 9 Volts DC |
| Current Drain | 15 Milliamperes Maximum |
| Programmable Digital Codes | 83 |
| Programmable Tones | 32 (67-210.7 Hz)<br>EIA Standard Tones |
| Rx Mute | Muted $\leq$0.5 VDC |
| | Unmuted $\geq$8.0 VDC |
| Encode Output Level | 0-900 Millivolts P-P |
| Decode Response Time | 250 Millisecond at 100 Hz |
| PTT Delay | 160-190 Milliseconds |
| Walsh Bits | 5 Volt P-P |
| Temperature Range | -30°C (-22°F) to +60°C (140°F) |
| Receiver Response Time W/Tone Channel Guard | $< \frac{2500}{\text{CG Freq.}}$ |
| Channel Guard Bandwidth | At least $\pm$ 1% and less than $\pm$ 2% of marked frequency |

*These specifications are intended primarily for the use of the serviceman. Refer to the appropriate Specification Sheet for the complete specifications.

GENERAL ELECTRIC

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## DESCRIPTION

Channel Guard provides a means of restricting calls to specific radios through the use of a continuous tone or digitally coded squelch system (CTCSS or CDCSS). Tone frequencies range from 67 Hz to 210.7 Hz 33 standard tones and 83 unique digital codes are available. These tones/codes are identified in Tables 1 and 2.

| STANDARD TONE FREQUENCIES | | | | |
|---|---|---|---|---|
| 67.0 | 88.5 | 107.2 | 131.8 | 167.9 |
| 71.9 | 91.5 | 110.9 | 136.5 | 173.8 |
| 74.4 | 94.8 | 114.8 | 141.3 | 179.9 |
| 77.0 | 97.4 | 118.8 | 146.2 | 186.2 |
| 79.7 | 100.0 | 123.0 | 151.4 | 192.8 |
| 82.5 | 103.5 | 127.3 | 156.7 | 203.5 |
| 85.4 | | | 162.2 | 210.7 |

Table 1 - Channel Guard Tone Frequencies

The Channel Guard board may be used with an external Channel Guard encoder. When an external encoder is used jumper P3 in the CG HI line must be removed.

The Channel Guard filter board used in DELTA S,SX radios provides amplification, filtering and limiting for the microcomputer generated Channel Guard signals. It also removes Channel Guard signals from the received audio in the decode mode.

## CIRCUIT ANALYSIS

The Channel Guard board contains a summing amplifier, U1A, 8-pole active voice reject filter, U2A-D and U1B, limiter, U1C and tone/code reject filter U3A,B. A Channel Guard disable circuit Q1 allows the Channel Guard encode to be disabled. The Channel Guard decoder can be disabled at the microcomputer.

The microcomputer selects the assigned Channel Guard encode code/tone information from the EE PROM memory for each channel, transmit and receive, and generates the Channel Guard signal. This signal is applied as Walsh Bit 1 and 2 to summing amplifier U1A. The Walsh bits are summed together and filtered to provide a smooth sine wave for tone Channel Guard or a digital waveform for digital Channel Guard.

The switched volume/squelch Hi signal to the summing amplifier is controlled by bilateral switches U4A and B. In the encode mode DPTT is high applying A- from U4B to the control input of U4A turning it off and preventing any input from the SW Vol/Sq Hi line from interfering with the encoding signal.

The output of summing amplifier U1A is applied to buffer/amplifier U1B through a two-pole active voice reject filter consisting of U2A through D. The active filter shunts all frequencies above 300 Hz to ground, thereby preventing those frequencies from interfering with the encoded signal. The output of U1B is the assigned CG tone or digital signal. This signal is applied to the audio processor through CG deviation control R22. Channel Guard deviation is set for 0.75 kHz.

### CG Decode

In the decode mode DPTT is low, turning bilateral switch U4B off, allowing the 9 V FLTRD supply to turn U4A on. Audio from the SW Vol/Sq Hi line is then applied to the summing amplifier U1A through bilateral switch U4A. This signal is amplified and filtered by U1A,B and U2A-D, so that only the CG signal (if present) is applied to hard limiter U1C. The CG signal is squared up for comparison by the microcomputer to determine if the CG signal is correct. If the microcomputer determines the CG signal to be correct, RX Mute transistor Q721 (on the TRS board), is turned off applying +9 VDC to the RX MUTE line to open the receiver.

### CHANNEL GUARD (CG) DISABLE

The CG DIS line has a double function. It can disable the encode or the decode CG function. The encode function is disabled by applying +17 V or more to P1-9. This will turn on Q1 and shunt the Channel Guard tone/code to ground while the decode function is disabled within the microcomputer software. To disable the decoder, ground the CG DSBL line at P1-9. The microcomputer will detect that the line is low, turn off Q721 and force the RX MUTE line high. The decode filter/limiter circuit is not affected, it continues to operate. The detection software also does not stop working. This allows the off hook STE to function. When the CG DIS line is pulled high (9.0 VDC) the microcomputer does not sense any changes. It is buffered by protection diode D711. Channel Guard disable transistor Q1 will turn on when the CG DIS line goes above 8.5 V and shorts the output of the filter to ground. This will prevent any signal from going out on CG HI and will also disable the decoder since no limited CG tone will go to the microcomputer. The receiver will be muted since no CG is decoded. Disabling the decoder this way will never allow the audio to open up,

| PRIMARY CODE | EQUIVALENT CODE | PRIMARY CODE | EQUIVALENT CODE | PRIMARY CODE | EQUIVALENT CODE |
|---|---|---|---|---|---|
| 023 | 340, 766 | 205 | 135, 610 | 464 | 237, 642, 772 |
| 025 | | 223 | 350, 475, 750 | 465 | 056, 656 |
| 026 | 566 | 226 | 104, 557 | 466 | 144, 666 |
| 031 | 374, 643 | 243 | 267, 342 | 503 | 157, 312 |
| 032 | | 244 | 176, 417 | 506 | 224, 313, 574 |
| 043 | 355 | 245 | 370, 554 | 516 | 067, 720 |
| 047 | 375, 707 | 251 | 236, 704, 742 | 532 | 161, 345 |
| 051 | 520, 771 | 261 | 227, 567 | 546 | 317, 614, 751 |
| 054 | 405, 675 | 263 | 213, 136 | 565 | 307, 362 |
| 065 | 301 | 265 | 171, 426 | 606 | 153, 630 |
| 071 | 603, 717, 746 | 271 | 427, 510, 762 | 612 | 254, 314, 706 |
| 072 | 470, 701 | 306 | 147, 303, 761 | 624 | 075, 501 |
| 073 | 640 | 311 | 330, 456, 561 | 627 | 037, 560 |
| 074 | 360, 721 | 315 | 321, 673 | 631 | 231, 504, 636 745 |
| 114 | 327, 615 | 331 | 372, 507 | 632 | 123, 657 |
| 115 | 534, 674 | 343 | 324, 570 | 654 | 163, 460, 607 |
| 116 | 060, 737 | 346 | 616, 635, 724 | 662 | 363, 436, 443 444 |
| 125 | 172 | 351 | 353, 435 | 664 | 344, 471, 715 |
| 131 | 572, 702 | 364 | 130, 641 | 703 | 150, 256 |
| 132 | 605, 634, 714 | 365 | 107 | 712 | 136, 502 |
| 134 | 273 | 371 | 217, 453, 530 | 723 | 235, 611, 671 |
| 143 | 333 | 411 | 117, 756 | 731 | 447, 473, 474 744 |
| 152 | 366, 415 | 412 | 127, 441, 711 | 732 | 164, 207 |
| 155 | 233, 660 | 413 | 133, 620 | 734 | 066 |
| 156 | 517, 741 | 423 | 234, 563, 621 713 | 743 | 312, 515, 663 |
| 162 | 416, 553 | 431 | 262, 316, 730 | 754 | 076, 203 |
| 165 | 354 | 432 | 276, 326 | | |
| 172 | 057 | 445 | 222, 457, 575 | | |
| 174 | 142, 270 | | | | |

Table 2 - Primary and Equivalent Digital Codes (Octal)

while taking the radio off hook (pulling CG DIS low) will always make the radio open up. Turning CG Disable transistor Q1 on causes the DC bias to change. It will take 2 or 3 seconds for the bias to restore itself after the encoder is disabled.

SQUELCH TAIL ELIMINATION (STE)

STE eliminates squelch tails when the radio is on hook or off hook. When Channel Guard is disabled (off hook) the decoder is still looking at the received signal. The RX MUTE line is high, as would be normally expected. The Channel Guard decoder is looking for the STE burst (phase reversal in tone Channel Guard, STE tone in Digital Channel Guard). If an STE burst is detected, the RX MUTE line will go low for about 200 ms. This will prevent the squelch tail from being heard. After 200 ms, the RX MUTE line will go high again; by now the transmission has ended and the squelch will hold the audio closed. The off hook STE does not affect the operation of the Channel Guard while on hook. Another way of looking at it: the radio will go quiet for 200 ms any time STE is detected. If it was on hook it will stay quiet after the 200 ms, if it was off hook it will revert to noise squelch operation.

Data Polarity Inversion

In some instances it is necessary to invert the polarity of the digital Channel Guard signal to enhance system compatability. Inverted polarity normally results in a wrong code or one that cannot be used. When this occurs, restrap P2 connected between J2-1,2 and connect between J2-2,3. The encode DCG codes may be inverted by reprogramming the EE PROM.

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WORLD HEADQUARTERS • LYNCHBURG, VIRGINIA 24502 U.S.A.

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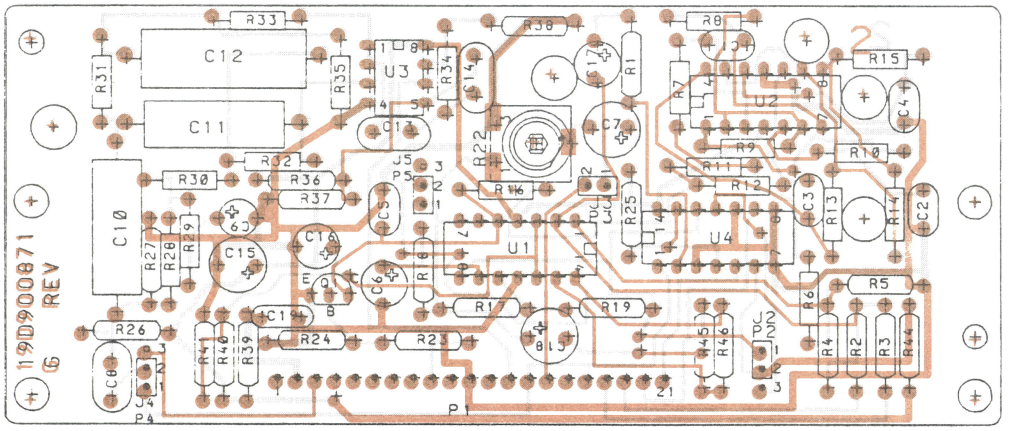
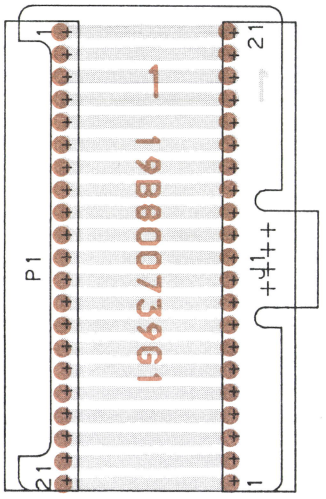
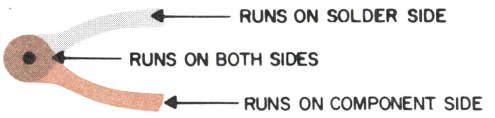
# CHANNEL GUARD BOARD




(19D900872, Rev. 3)
(19A703002, Sh. 1, Rev. 2)
(19A703002, Sh. 2, Rev. 2)

# EXTENDER BOARD

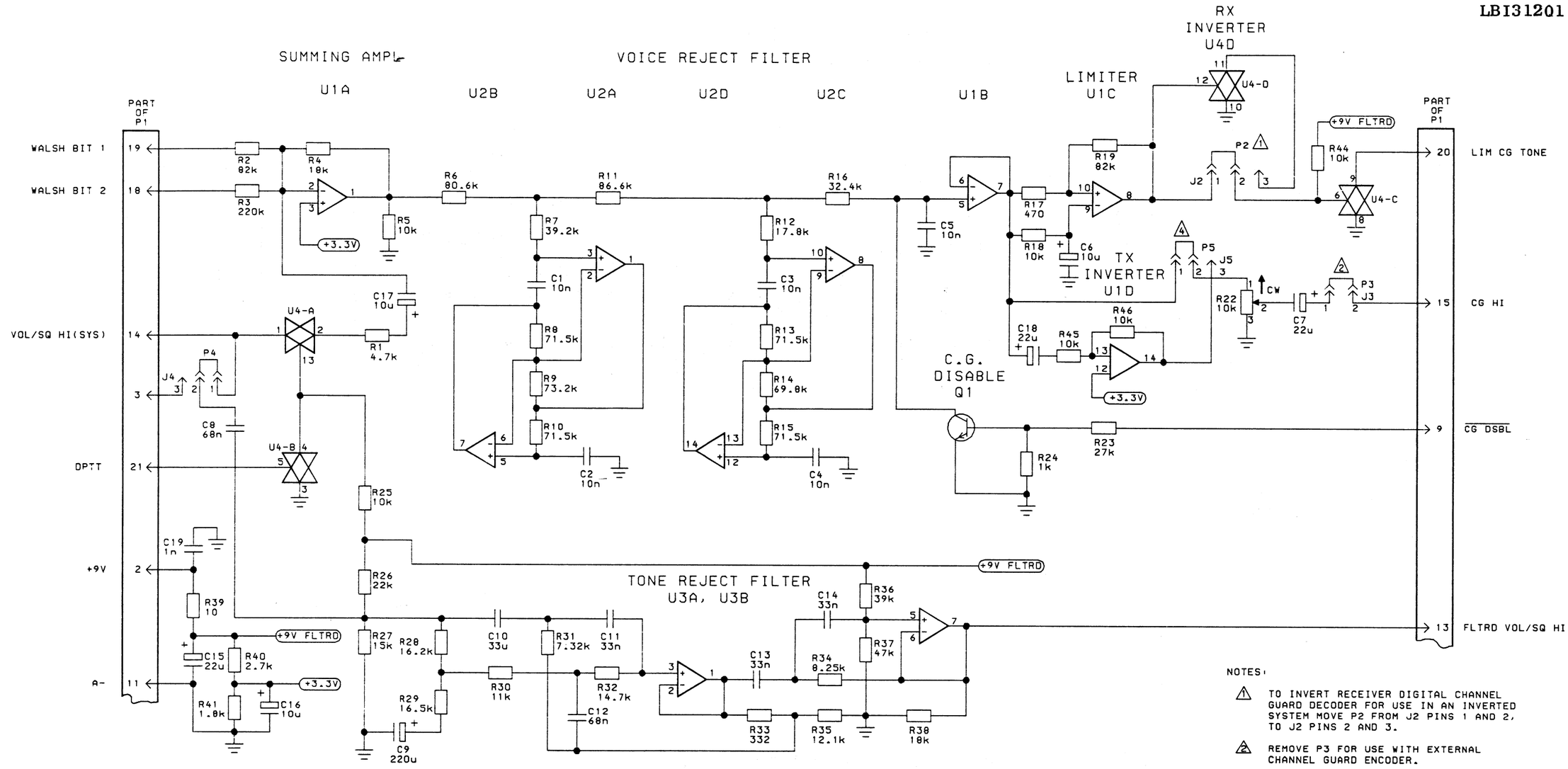



(19B800740, Rev. 2)
(19A701971, Sh. 1, Rev. 1)
(19A701971, Sh. 2, Rev. 1)

# OUTLINE DIAGRAM

TONE/DIGITAL CHANNEL GUARD




| POWER AND GND CONNECTIONS | | |
|---|---|---|
| DEVICES | V+(9V) PIN NO. | GND |
| U1 | 4 | 11 |
| U2 | 4 | 11 |
| U3 | 8 | 4 |
| U4 | 14 | 7 |

| MODEL NO. | REV. LETTER |
|---|---|
| 19D900871G1 | C |

NOTES:

1. TO INVERT RECEIVER DIGITAL CHANNEL GUARD DECODER FOR USE IN AN INVERTED SYSTEM MOVE P2 FROM J2 PINS 1 AND 2, TO J2 PINS 2 AND 3.
2. REMOVE P3 FOR USE WITH EXTERNAL CHANNEL GUARD ENCODER.
3. CHANGES TO THIS DRAWING MAY AFFECT 19C851036.
4. TO INVERT TRANSMITTER DIGITAL CHANNEL GUARD ENCODER FOR USE IN AN INVERTED SYSTEM MOVE P5 FROM J5 PINS 1 AND 2 TO J5 PINS 2 AND 3.

ALL RESISTORS ARE 1/4 WATT UNLESS OTHERWISE SPECIFIED.
RESISTOR VALUES IN Ω UNLESS FOLLOWED BY MULTIPLIER k OR M.
CAPACITOR VALUES IN F UNLESS FOLLOWED BY MULTIPLIER μ,n OR p.
INDUCTANCE VALUES IN H UNLESS FOLLOWED BY MULTIPLIER m OR μ.

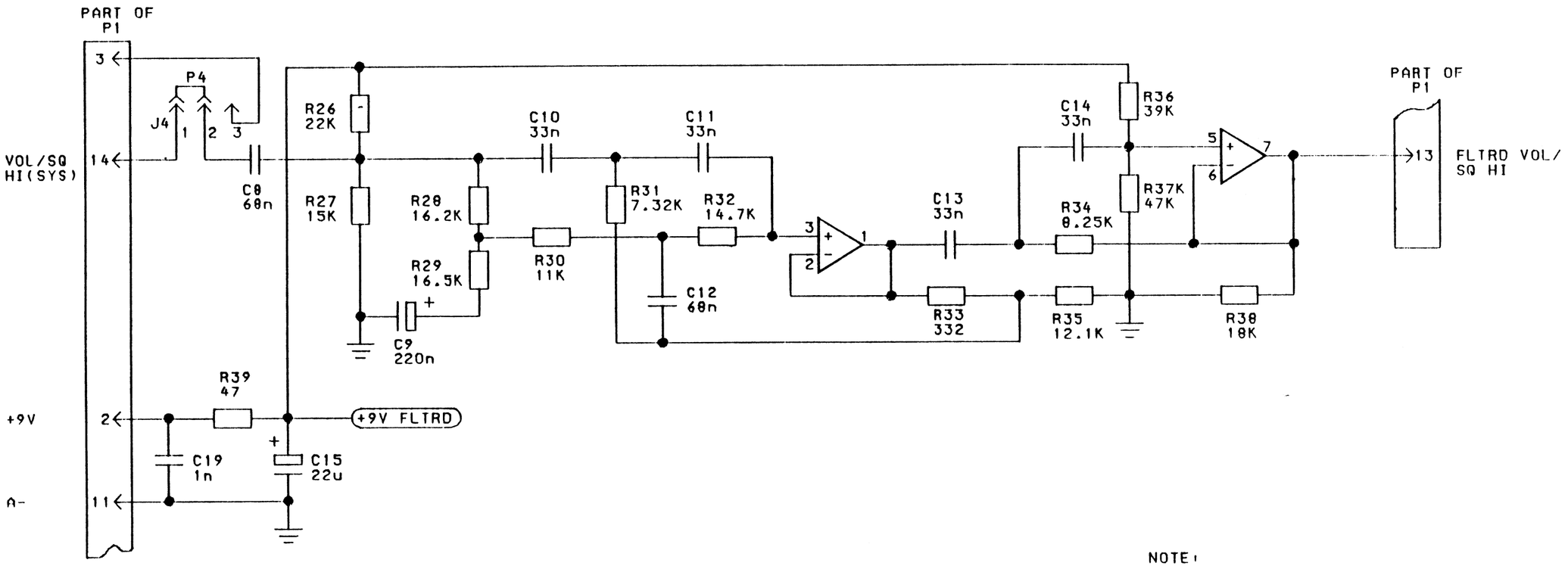
(19D900935, Rev. 4)

# SCHEMATIC DIAGRAM

## TONE/DIGITAL CHANNEL GUARD

Issue 4

# TONE REJECT FILTER
## U3A, U3B




NOTE:
1. CHANGES TO THIS DRAWING MAY AFFECT 19D900935

ALL RESISTORS ARE 1/4 WATT UNLESS OTHERWISE SPECIFIED.
RESISTOR VALUES IN Ω UNLESS FOLLOWED BY MULTIPLIER k OR M.
CAPACITOR VALUES IN F UNLESS FOLLOWED BY MULTIPLIER μ, n OR p.
INDUCTANCE VALUES IN H UNLESS FOLLOWED BY MULTIPLIER m OR μ.

POWER & GND CONNECTIONS

| DEVICE | V+(9V) PIN NO | GND PIN NO |
|---|---|---|
| U3 | 8 | 4 |

| MODEL NO. | REV. LETTER |
|---|---|
| 19D90087162 | A |

## SCHEMATIC DIAGRAM

TONE REJECT FILTER

(19C851036, Rev. 3)

# PRODUCTION CHANGES

Changes in the equipment to improve performance or to simplify circuits are identified by a "Revision Letter," which is stamped after the model number of the unit. The revision stamped on the unit includes all previous revisions. Refer to the Parts List for descriptions of parts affected by these revisions.

REV. A - TONE/DIGITAL CHANNEL GUARD BOARD 19D900871G1

To improve operation of Digital Channel Guard phase inverter circuit. Deleted R20, R21, added R42, R43, and incorporated U1-D. Old part numbers were:
R20 - 19A700019P45 Deposited carbon: 4.7K ohms ±5%, 1/4w.
R21 - 19A700019P47 Deposited carbon: 6.8K ohms ±5% 1/4w.

REV. B - To allow DCG inversion for field applications. Replaced R42 and R43 with R45 and R46. Added U1D, R44, C18, C19, J4, J5 and jumpers P4 and P5. Changed J2 and J3.

R42 was: 19A700019P49 - Deposited carbon: 10K ohms ±5%, 1/4 w.

R43 was: 19A700019P56 - Deposited carbon: 39K ohms ±5%, 1/4 w.

J2 and J3 was: 19A703248P2 - Contact, electrical.

REV. A - FILTER BOARD 19D900871G2

To add inversion jumper for field applications. Added C19, J4 and P4.

REV. C - CHANNEL GUARD BOARD 19D900871G1
REV. B - CHANNEL GUARD BOARD 19D900871G2

To prevent regulated 9 volts from being clamped to 2.5 volts when power is applied with full audio input present. Changed R39.

R39 was: H212CRP047C - Deposited carbon: 47 ohms ±5%, 1/4 w.

## PARTS LIST

TONE/DIGITAL CHANNEL GUARD BOARD
19D900871G1 FILTER/LIMITER - REV A
19D900871G2 FILTER
ISSUE 3

| SYMBOL | GE PART NO. | DESCRIPTION |
|---|---|---|
| | | - - - - - - - - - - CAPACITORS - - - - - - - - - - |
| C1 thru C5 | T644ACP310J | Polyester: .010 uF ±5%, 50 VDCW. |
| C6 | 315A6047P106N | Tantalum: 10 uF ±20%, 16 VDCW. |
| C7 | 315A6047P226N | Tantalum: 0.47 uF ±20%, 35 VDCW. |
| C8 | T644ACP368J | Polyester: 0.068 uF ±5%, 50 VDCW. |
| C9 | 315A6047P224U | Tantalum: 0.22 uF ±20%, 35 VDCW. |
| C10 and C11 | 19A701594P1 | Polyester: 0.033 uF ±2%, 100 VDCW. |
| C12 | 19A701594P2 | Polyester: 0.068 uF ±2%, 100 VDCW. |
| C13 and C14 | T644ACP333J | Polyester: 0.033 uF ±5%, 50 VDCW. |
| C15 | 315A6047P226N | Tantalum: 0.47 uF ±20%, 35 VDCW. |
| C16 and C17 | 315A6047P106N | Tantalum: 10 uF ±20%, 16 VDCW. |
| C18 | 315A6047P226N | Tantalum: 0.47 uF ±20%, 35 VDCW. |
| C19 | 19A700233P7 | Ceramic: 1000 pF ±20%, 50 VDCW. |
| | | - - - - - - - - - - - JACKS - - - - - - - - - - - |
| J2 | 19A703248P3 | Contact, electrical. (Quantity 3). |
| J3 | 19A703248P3 | Contact, electrical. (Quantity 2). |
| J4 | 19A703248P3 | Contact, electrical. (Quantity 3). |
| J5 | 19A703248P3 | Contact, electrical. (Quantity 4). |
| | | - - - - - - - - - - - PLUGS - - - - - - - - - - - |
| P1 | 19A703248P3 | Contact, electrical. |
| P2 and P5 | 19A702104P1 | Receptacle: 2 position, shorting, rated at 3 amps; sim to Berg 65474-002. |
| | | - - - - - - - - - - TRANSISTORS - - - - - - - - - - |
| Q1 | 19A700023P2 | Silicon, NPN; sim to Type 2N3904. |
| | | - - - - - - - - - - RESISTORS - - - - - - - - - - |
| R1 | H212CRP287C | Deposited carbon: 4.7K ohms ±5%, 1/4 w. |
| R2 | H212CRP382C | Deposited carbon: 82K ohms ±5%, 1/4 w. |
| R3 | H212CRP422C | Deposited carbon: 0.22M ohms ±5%, 1/4 w. |
| R4 | H212CRP318C | Deposited carbon: 18K ohms ±5%, 1/4 w. |
| R5 | H212CRP310C | Deposited carbon: 10K ohms ±5%, 1/4 w. |
| R6 | 19A701250P388 | Metal film: 80.6K ohms ±1%, 250 VDCW, 1/4 w. |
| R7 | 19A701250P358 | Composition: 2.7 ohms ±5%, 1/4 w. |
| R8 | 19A701250P383 | Metal film: 71.5K ohms ±1%, 1/4 w. |
| R9 | 19A701250P384 | Metal film: 73.2K ohms ±1%, 1/4 w. |
| R10 | 19A701250P383 | Metal film: 71.5K ohms ±1%, 1/4 w. |
| R11 | 19A701250P391 | Metal film: 86.6K ohms ±1%, 1/4 w. |
| R12 | 19A701250P325 | Metal film: 17.8K ohms ±1%, 1/4 w. |
| R13 | 19A701250P383 | Metal film: 71.5K ohms ±1%, 1/4 w. |
| R14 | 19A701250P382 | Metal film: 69.8K ohms ±1%, 1/4 w. |
| R15 | 19A701250P383 | Metal film: 71.5K ohms ±1%, 1/4 w. |
| R16 | 19A701250P350 | Metal film: 32.4K ohms ±1%, 1/4 w. |
| R17 | H212CRP147C | Deposited carbon: 470 ohms ±5%, 1/4 w. |
| R18 | H212CRP310C | Deposited carbon: 10K ohms ±5%, 1/4 w. |
| R19 | H212CRP382C | Deposited carbon: 82K ohms ±5%, 1/4 w. |
| R22 | 19B800874P208 | Variable: 10K ohms ±20%, 1/3 w. |
| R23 | H212CRP327C | Deposited carbon: 27K ohms ±5%, 1/4 w. |
| R24 | H212CRP210C | Deposited carbon: 1K ohms ±5%, 1/4 w. |
| R25 | H212CRP310C | Deposited carbon: 10K ohms ±5%, 1/4 w. |
| R26 | H212CRP322C | Deposited carbon: 22K ohms ±5%, 1/4 w. |
| R27 | H212CRP315C | Deposited carbon: 15K ohms ±5%, 1/4 w. |
| R28 | 19A701250P321 | Metal film: 16.2K ohms ±1%, 250 VDCW, 1/4 w. |
| R29 | 19A701250P322 | Metal film: 16.5K ohms ±1%, 250 VDCW, 1/4 w. |
| R30 | 19A701250P305 | Metal film: 11K ohms ±1%, 250 VDCW, 1/4 w. |
| R31 | 19A701250P284 | Metal film: 7.32K ohms ±1%, 250 VDCW, 1/4 w. |
| R32 | 19A701250P317 | Metal film: 14.7K ohms ±1%, 250 VDCW, 1/4 w. |
| R33 | 19A701250P151 | Metal film: 332 ohms ±1%, 250 VDCW, 1/4 w. |
| R34 | 19A701250P289 | Metal film: 8.25K ohms ±1%, 250 VDCW, 1/4 w. |
| R35 | 19A701250P309 | Metal film: 12.1K ohms ±1%, 250 VDCW, 1/4 w. |
| R36 | H212CRP339C | Deposited carbon: 39K ohms ±5%, 1/4 w. |
| R37 | H212CRP347C | Deposited carbon: 47K ohms ±5%, 1/4 w. |
| R38 | H212CRP318C | Deposited carbon: 18K ohms ±5%, 1/4 w. |
| R39 | H212CRP047C | Deposited carbon: 47 ohms ±5%, 1/4 w. |
| R40 | H212CRP227C | Deposited carbon: 2.7K ohms ±5%, 1/4 w. |
| R41 | H212CRP218C | Deposited carbon: 1.8K ohms ±5%, 1/4 w. |
| R45 and R46 | H212CRP310C | Deposited carbon: 10K ohms ±5%, 1/4 w. |
| | | - - - - - - - - INTEGRATED CIRCUITS - - - - - - - |
| U1 and U2 | 19A701789P1 | Linear, Low Power OP AMP; sim to LM324N. |
| U3 | 19A701789P2 | DUAL OP AMP; sim to LM358. |
| U4 | 19A700029P44 | Digital: BILATERAL SWITCH. |
| | | - - - - - - - - - MISCELLANEOUS - - - - - - - - - |
| | 19A700036P510 | Screw, thd. forming: M3.5-.6 x 10. (Secures Tone/Digital Channel Guard Board). |
| | 19A701979P1 | Flatwasher. M3.5. (Secures Tone/Digital Channel Guard Board). |
| | | ASSOCIATED PARTS |
| | | EXTENDER BOARD 19B800930G1 |
| | | - - - - - - - - - - - JACKS - - - - - - - - - - - |
| J1 | 19A702517P2 | Contact, electrical: rated 4.5 amps; sim to Berg 4820S. (Quantity 21). |
| | | - - - - - - - - - - - PLUGS - - - - - - - - - - - |
| P1 | 19A702517P2 | Contact, electrical: rated 4.5 amps; sim to Berg 4820S. (Quantity 21). |
| | | OPTION INTERCONNECT CABLE 19B850936G1 |
| | | - - - - - - - - - - - PLUGS - - - - - - - - - - - |
| P1 and P2 | | Connector. Includes: |
| | 19A700041P47 | Shell. |
| | 19A700041P26 | Contact: sim to Molex 08-50-0113. (Quantity 21 each connector). |

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES