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CENTURY SERIES
Models 4710, 4715, 4720 and 4725
Record Modules (Parts of Models
4610, 4615, 4620 and 4625 R/P Systems)

TECHNICAL MANUAL

SPARTA
Division of Cetec Corporation

5851 Florin-Perkins Road, Sacramento, Ca. 95828 • (916) 383-5353 • Telex 377-488 • Cable SPARTA

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PROPRIETARY NOTICE

098-4710

$5.00

SPARTA ELECTRONIC CORPORATION
5851 FLORIN-PERKINS ROAD SACRAMENTO, CALIFORNIA 95828
A DIVISION OF COMPUTER EQUIPMENT CORPORATION

CONTENTS

CENTURY SERIES FEATURES

INSTALLATION

ELECTRONIC ADJUSTMENTS (Cont'd)

CIRCUIT DESCRIPTIONS

INTRODUCTION

The Century Series of cartridge record modules are intended for use with Model 4510-4525 cartridge reproducers. The record modules are available in four basic models:

4710 - mono record, with standard 1000 Hz stop tone generator.

4715 - mono record, with added 150 Hz EOM tone generator.

4720 - stereo record, with standard 1000 Hz stop tone generator.

4725 - stereo record, with added 150 Hz EOM tone generator.

These models include a recording head to convert the appropriate reproducer module to a record/playback unit. Refer to the Reproducer Operating Manual for details of installation and alignment of heads.

Century Series cartridge equipment is also supplied in completely assembled and tested record/ playback systems as follows:

4610 - mono record/play with standard 1000Hz generator/detector.

4615 - mono record/play with added 150 Hz EOM generator/detector.

4620 - stereo record/play with standard 1000Hz generator/detector.

4625 - stereo record/play with added 150 Hz EOM generator/detector.

GENERAL DESCRIPTION

The record and reproduce modules are the same size, facilitating a variety of mounting configurations:

- Dual table top with flip top cover
- Triple rack mount (1 R/P plus optional play only)
- Quad custom cabinet (2 R/P or 1 R/P and 2 play only)

All electronics for audio and tone recording are on a single plug-in printed circuit board, as is the power supply regulator. Thus, each model uses the same basic p.c. board, less unneeded circuit components. Program bias level can be adjusted through an access hole in the p.c. board cover.

A combination of discrete and integrated circuits have been used in the record circuits, to provide best possible performance. Record modules have separate regulated power supplies, and utilize a single switched bias oscillator for program and tone recording circuits.

Three pushbutton-selected audio inputs are provided on the front panel of each record module, plus switch positions to check bias and tone record levels. Audio inputs and Remote Control connections are made to the barrier strip at the rear of the module. An Encoder input is also provided, to record AFSK or Touch Tone data on the cue track for use in automatic logging systems.

SPECIFICATIONS

FREQUENCY RESPONSE:	50-15,000 Hz ± 2db
NOISE:	55db or more below saturation recording (mono) 52 db or more below saturation recording (stereo)
DISTORTION:	2% or less, record-reproduce at NAB Standard Reference Level
EQUALIZATION:	NAB (Adjustable)
AUDIO INPUTS:	3 selected by pushbuttons, balanced bridging, -10 to +8 dbm
METERING:	Program record level, cue record level, bias
CUE SIGNALS:	NAB 1 kHz stop standard; 150 Hz E.O.M. optional; Encoder input for AFSK
BIAS OSCILLATOR:	68 KHz, separate switches and level controls for program and tone recording
REMOTE CONTROL:	Program record, EOM record
DIMENSIONS:	Record and playback modules each 6" H x 5 3/4" W x 14" D
POWER:	117 volts, 50/60 Hz (available for 230 VAC on special order)
WEIGHT:	Record module, 8 lbs. Record/playback with dual lid, 27 lbs.

INSTALLATION

UNPACKING:

After removing the equipment from the shipping container, carefully inspect if for shipping damage. If damage is discovered, make a written request to the carrier for inspection, and retain all cartons and fillers. The carrier is responsible for any damage incurred in shipping, but the claim must be promptly filed by the receiver.

ENCLOSURES:

Table top units are shipped with lids installed. However, Triple Rack Mounts and Quad Cabinets are shipped separately from the record and playback modules.

The record and playback modules are fastened together for use with the Dual Lid and Triple Rack Mount. A 10-32 x 1/2" machine screw secures the two modules together at the upper rear inside edges. A chassis tie tab is used at the top front edges. If a record module is ordered separately, the chassis tab will be supplied.

When ordered with the Triple Rack Mount, modules will be supplied with small tabs fastened to the upper rear edge of the p.c. board covers. After the modules are in the rack mount, the screws securing the tabs should be loosened and retightened with the tab extending vertically so as to prevent the modules from accidentally being pulled out of the rack mount. The modules can be secured to the rack adapter by turning the locking latch screws clockwise. These are Phillips head screws located beneath each module cage.

The record and playback modules are not fastened together when used with the Quad Cabinet, due to the ventilation separators at the front of the cabinet. Extended length cables are supplied so as to permit considerable individual movement of the record or playback module.

If desired, the modules can be secured to the cabinet by means of angle brackets which attach to the upper part of the p.c. board covers.

The record module has a short cable terminating in an 8-pin connector which plugs into the reproduce module.

The a-c cord of the record module can be plugged into the accessory outlet of the reproduce module, if desired.

AUDIO & CONTROL CONNECTIONS

BARRIER STRIP PINS:

1. Input #1 Left Channel +
2. Input #1 Left Channel -
3. Common Shield
4. Input #2 Left Channel +
5. Input #2 Left Channel -
6. Common Shield
7. Input #3 Left Channel +
8. Input #3 Left Channel -
9. Common Shield
10. Record Preset
11. Record Preset
12. Record lamp
13. Input #1 Right Channel +
14. Input #1 Right Channel -
15. Common Shield
16. Input #2 Right Channel +
17. Input #2 Right Channel -
18. Common Shield
19. Input #3 Right Channel +
20. Input #3 Right Channel -
21. Common Shield
22. Encoder Common
23. Encoder +
24. Common

RECORD PLUG:

The 8 pin record plug (P3) carries logic circuits that can be used as status indicators and for various remote control applications. The pin numbers below are for the record plug.

1. Record Preset Line (-25 in run mode)
2. -25 VDC from stop switch
3. -25 VDC stop/ready mode
4. -25 VDC run mode
5. Common
6. EOM remote record - normally jumpered to pin 5 - cut jumper and connect n.c. switch across pins 5 & 6
7. Spare (110 VAC if supplied with remote control)
8. Spare (110 VAC if supplied with remote control)

OPERATION

RECORD PRESET: This illuminated pushbutton switch turns on the record circuitry. The tape transport must be stopped and with a cartridge inserted before the record mode can be activated. The switch is lighted when in the record mode. The switch is also used to record E.O.M. tones (see below.)

E.O.M. RECORD: In recorders so equipped, the 150 Hz end-of-message tones are recorded on the cue track of the tape by depressing the Record button while the tape is in motion. E.O.M. tones can be applied in either the record or play modes.

RECORD LEVEL: This control adjusts the level of audio to the record amplifier. The material to be recorded should be auditioned before recording, and the level control set so that the VU meter(s) deflect to the edge of the red area, but not into it. If an audio console is used to feed the cartridge recorder, the level control can be set using a tone or test record so that 0VU on the console meter produces 0VU on the cartridge meter. The control can then be marked and left at the correct setting.

SOURCE SELECT: There are 3 audio inputs to the Century Series record amplifier, selected by the pushbuttons on the front panel. Two buttons can be depressed simultaneously, allowing both audio sources to be mixed into the record amplifier.

TEST FUNCTIONS: There are 2 test buttons, marked Tone and Bias. The Tone button is used to verify the operation of the 1000Hz stop tone and the optional 150 Hz E.O.M. tone generators. When a cartridge is started in the record mode, the meter pointer should swing to approximately 100 on the scale for about 1/2 second as the stop tone is recorded on the cue track of the tape. Likewise, depressing the Record button while the cartridge is running should produce a meter deflection to 100 as long as the button is held. Readings between 80 and 120 on the meter scale should be considered normal. On stereo recorders only the left channel meter displays the tone test function.

The presence and level of bias to the program record head can be checked by depressing the Bias button with the system in the record mode. The meter should read approximately 100. The correct bias level assures lowest noise, distortion, and best high frequency response. If necessary, the bias can be adjusted by moving the bias control, which is reached through an access hole in the p.c. board cover. On stereo recorders there are separate bias controls for each channel. The bias reading has been factory calibrated for use with Scotch brand 156 tape.

RECORDING PROCEDURE:

Good recordings begin with properly erased cartridges. Slowly pass both sides of the cartridge across the eraser, then slowly pull the cartridge away to a distance of 2 feet or more before turning off the eraser power. This will prevent gliches from being "recorded" on the tape due to the collapsing magnetic field around the eraser.

Check to see that the tape heads are clean. If not, wipe them clean, using alcohol or a prepared head cleaning solution applied with a soft, clean cloth or cotton swab.

Insert the cartridge into the tape transport, then start and stop the cartridge once or twice before pushing the Record button. This will insure that the tape loop is properly tensioned and is guiding correctly across the heads. This procedure helps to avoid the "swishing" sound that is often present when a tape cartridge is first started, as a result of the tape not having been correctly aligned across the heads when the recording was started.

Depress the Record button to turn on the record circuitry. The switch will light indicating a "ready" condition. The transport can now be started by depressing the right side of the Touchbar switch. It is important not to apply audio until the tape is actually moving, otherwise the cartridge will cue out with recorded audio in contact with the reproduce head. This will cause a momentary burst of sound just as the tape stops. It can also cause a wow at the time of starting the cartridge. In an automation system using 25 Hz tone sensing for music tapes, the momentary burst of very low frequency audio (as the tape speed accelerates from zero to 7 1/2 inches per second) can trigger the tone sensor and advance the system before the cartridge has played.

It is good operating practice to select cartridges that are only slightly longer than the announcement to be recorded. This minimizes the cue out time which means more efficient utilization of time during recording and playback. If an optimum length cartridge is not available at the time of recording, it is usually preferable to record the announcement 2 or more times on the same cartridge to minimize cue out time when the cartridge is used on the air. It takes only a minute or two at the time of recording, but can save many minutes for harried operators during the life of the announcement.

If the recorder is equipped with the optional end-of-message tone, the E.O.M tone must end 1 or 2 seconds before the stop tone begins.

If the E.O.M. tone is applied in the play mode and overlaps the stop tone, it will partially erase the stop tone due to the presence of the cue record bias. In an automation system using a "maintained start" type of control, erratic stop cueing can occur unless the E.O.M. and stop cues are separated, since the stop circuit in the cartridge transport will not function until after the E.O.M. tone has ended.

The E.O.M. tone can be any desired length, determined by how long the Record button is depressed. However, the circuit is designed to produce a minimum tone length of .5 second, even if the button is only tapped. In most automation systems the beginning of the E.O.M. signal starts the next audio source, while continuing audio from the first (overlap audio switching). The end of the signal turns off audio from the first source. Therefore, it is important to release the Record button after the announcement has ended. The point at which the tone begins will determine the amount of overlap or tightness of the program.

ELECTRONIC ADJUSTMENTS (See dwg. P-42)

GENERAL:

The entire record electronics is contained on a single plug in printed circuit board. Program bias can be adjusted through an access hole in the p.c. board cover. To make other adjustments it is necessary to remove the cover.

PROGRAM BIAS:

Requires a high impedance a-c voltmeter and a signal generator or test record.

1. Insert erased cartridge into transport.
2. Connect meter to ground and blue test point.
3. Depress Record button momentarily.
4. Adjust R80 for a reading of 64 millivolts.
5. Connect meter across reproducer barrier strip terminals 1 & 2 (audio output) or observe playback level on audio console meter.
6. Record a 1000 Hz tone, using an indicated record level of 0 VU.
7. Adjust R80 for maximum playback level. Make adjustment slowly due to delay between record and reproduce heads.

8. The blue test point reading should fall between 40 - 60 millivolts.

9. Repeat using R100, orange test point, and barrier strip terminals 4 & 5 (stereo only).

Program bias level can also be determined by alternately recording 1000 Hz and 12,000 Hz tones at -10 dbm and adjusting the bias control for the same playback level at both frequencies. Use a 620 ohm resistor across the audio output, unless it is already feeding a terminated input of an audio console.

PROGRAM BIAS TRAP:

Requires oscilloscope or high impedance a-c voltmeter.

1. Insert erased cartridge into transport.
2. Connect meter between ground and junction of C48 & L2.
3. Momentarily depress Record button.
4. Adjust C49 for minimum indication of 68 KHz bias signal.
5. Connect meter between ground and junction of C62 and L3 (stereo only).
6. Adjust C63 for minimum indication of 100KHz bias signal (stereo only).

PROGRAM BIAS TEST CALIBRATION: Potentiometer R78 and R118 (stereo only) have been factory set to give a reading of 100 on the recorder VU meter, when the program bias level is correct.

PROGRAM RECORD EQUALIZATION: Requires a-c voltmeter and a signal generator or test record. Tape heads should be correctly aligned, and bias traps and record bias set. Playback equalization should be adjusted for flattest response.

1. Insert erased cartridge into transport.
2. Connect meter across reproducer barrier strip terminals 1 & 2 (audio output) or observe playback level on audio console VU meter. Put a 620 ohm resistor across the audio output unless it is already feeding a terminated input of an audio console.
3. Depress Record button momentarily.
4. Record a 1000 Hz tone, using an indicated record level of 0 VU
5. Note the playback level on the meter and turn down the Record Level control until the playback level reads 10 db lower.
6. Record a 12,000 Hz tone, without changing the record level setting. Adjust C41 to produce the same playback level as step 5.

7. Verify results by repeating above steps with 2 or 3 different cartridges.

8. Repeat using C56 and barrier strip terminals 4 & 5 (stereo only).

It is not good practice to compromise record and playback equalization controls to achieve a flat record/play response since tapes played on other reproducers will not be correctly equalized for those units.

PROGRAM VU METER CALIBRATION: Requires signal generator or test record, a-c voltmeter or oscilloscope, or connection to audio console.

1. Connect meter across reproducer barrier strip terminals 1 & 2 (audio output) or observe playback level on audio console VU meter.

2. Play a "standard reference level" test cartridge, such as SPARTA CL-1, and note the meter reading.

3. Remove the test cartridge and insert an erased cartridge.

4. Record a 1000 Hz tone, setting the Record Level control to produce the same meter reading from the playback as in step 2.

5. Adjust R109 to produce a reading of 0 VU on the record VU meter (left channel, if stereo).

6. Repeat, using R105 and barrier strip terminals 4 & 5 (right channel, stereo systems).

STOP TONE LEVEL:

Requires high impedance a-c voltmeter, and d-c voltmeter.

1. Remove transistors Q11, Q21 & Q22 from their sockets.
2. Insert erased cartridge into transport.
3. Connect d-c meter across coil of relay K2.
4. Momentarily depress Record button.
5. Adjust R41 to turn on relay K2 (-25 vdc across coil).
6. Connect a-c meter to ground and purple test point.
7. Reading at test point should be 3-8 millivolts. Adjust R41 if necessary, making sure that K2 remains on.
8. Replace transistors Q11, Q21 & Q22.

CUE TONE BIAS:

Requires high impedance a-c voltmeter.

1. Insert erased cartridge into transport.
2. Connect meter between ground and purple tiepoint.
3. Remove transistor switch Q11 from its socket.
4. Momentarily depress Record button.
5. Adjust R102 for a reading of 60 millivolts.
6. Reinsert transistor Q11 in its socket.

CUE BIAS TRAP: Requires oscilloscope or high impedance a-c voltmeter.

1. Insert erased cartridge into transport.
2. Connect meter between ground and junction of C34 & L1.
3. Momentarily depress Record button.
4. Remove transistor switch Q11 from its socket
5. Rotate R41, the 1000 Hz gain control, until the cue bias relay turns on, normally at mid-position of the control.
6. Adjust C35 for minimum indication of 68 KHz bias.

E.O.M. TONE LEVEL: Requires high impedance a-c voltmeter, and d-c voltmeter.

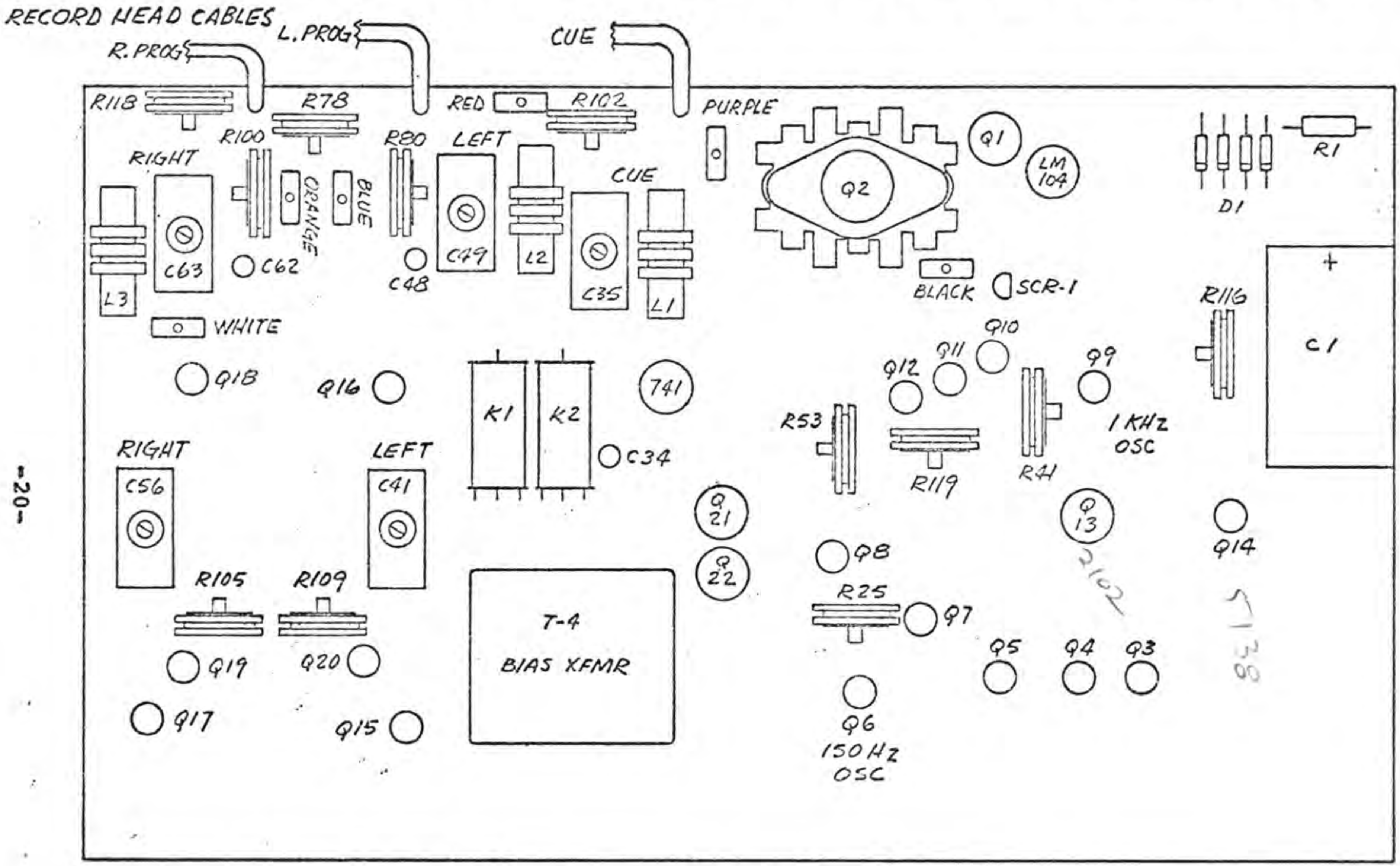
1. Insert erased cartridge into transport.
2. Connect d-c meter across coil of K2.
3. Remove transistor switch Q8.
4. Adjust R25 to turn on relay K2 (-25 vdc across coil).
5. Remove transistors Q21 & Q22 from their sockets.
6. Connect a-c meter to ground and purple test point.
7. Reading at test point should be 5-10 millivolts.
8. Replace transistors Q8, Q21 & Q22.
9. Momentarily depress Record button.

10. Start the cartridge and depress the Record button. Red side of touchbar should light, confirming recording and detection of E.O.M. tone. Adjust E.O.M. detector sensitivity if necessary.

TONE TEST CALIBRATION: Potentiometer R116 has been factory selected to give a reading of 100 on the recorder VU meter when the stop tone record level is correct.

ENCODER LEVEL: Requires high impedance a-c voltmeter and d-c voltmeter.

1. Insert erased cartridge into transport.
2. Connect d-c meter across coil of K2.
3. Apply signal tone to Encoder Input, pins 22 & 23 on the recorder barrier strip.
4. Adjust R53 to turn on relay K2 (-25 vdc across coil).
5. Connect a-c meter to ground and purple test point.
6. Reading at test point should be 5-10 millivolts.
7. Start cartridge and monitor Tone Output, pins 6 & 7 on reproducer barrier strip using headphones or amplifier to verify recording and reproduction of signal tone.



P.C. BOARD NO. 065-7050
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SPARTA ELECTRONIC CORPORATION SACRAMENTO, CALIFORNIA 95828 A DIVISION OF COMPUTER EQUIPMENT CORPORATION			TITLE ADJUSTMENTS & TEST POINTS CENTURY SERIES RECORD/ PLAYBACK		
DWN SMC	DATE [illegible]	SCALE FULL	SHT 1 OF 1	DWG NO. P-42	
APPD	DATE				

POWER SUPPLY

The record power supply utilizes an integrated circuit precision negative voltage regulator. The regulated voltage is determined by the value of R3, A change of 1000 ohms varies the output by 2 volts. Transistors Q1 & Q2 are current amplifiers. The current limit is set by R4 which provides protection for the power supply components in the event of a short circuit elsewhere in the system.

It should be noted that the power supply is on and power is applied to some of the control circuit whenever the line cord is plugged in.

CONTROL CIRCUIT

Supply voltage for the program record circuitry is switched by an SCR which can be turned on only when the tape transport is stopped. The Record button connects to the collector of relay driver Q7 in the transport control circuit. When the control relay is not on, the Record button is near ground potential and can latch the SCR, which conducts -25 vdc to the record circuits. This voltage also closes relay K1 providing bias current through the program head(s).

If the transport is started while the SCR is latched -24 vdc from the transport control relay is applied to the base of transistor switch Q12, turning it on. This discharges C23 and turns Q11 off until C23 recharges through R44. When Q11 is conducting it acts as a shunt across the 1000 Hz oscillator output. When Q11 is off, the 1000 Hz signal passes to the Cue Amplifier which in turn connects to the cue tape head. The oscillator output from Q10 is also coupled through C28 to D9 which rectifies the signal and charges C27 until switch Q13/14 turns on, supplying the voltage to close K2 which provides bias current through the cue head. The value of R44 is selected to require approximately 1/2 second to charge C23 sufficiently so that Q12 and Q11 turn on again, shunting the 1000 Hz signal to ground.

The SCR is turned off when (a) the stop switch is depressed, or (b) the transport control relay returns to its "off" position when a 1000 Hz stop tone is sensed. Turnoff is accomplished by applying a negative potential to the anode of the SCR through a "Non Polarized" capacitor.

RECORD CIRCUITS

Record Amplifier: A balanced bridging input is employed to accommodate a wide variation in possible source impedances. The record gain control is across the secondary of the input transformer T2. Q15 and Q16 are common emitter amplifiers. The preamplifier, Q15, is coupled to the head current amplifier Q16, through a pre-emphasis network composed of C41-44 and R70-71. The output of Q16 connects to the record head through a bias trap composed of C2 & C49. This trap prevents the record bias current from entering the record amplifier. The circuit is duplicated in stereo systems.

Meter Amplifier: The VU meter is driven by Q20 which derives its signal from the output at preamplifier Q15 through R69 & C40. The meter is calibrated by the adjustment of R105. The circuit is duplicated in stereo systems.

Bias Oscillator: This is a conventional 68Khz push-pull oscillator with transformer coupled output. Two reed relays, K1 & K2, switch the bias current to the program and cue heads. Thus, bias is applied to the cue track only during the actual recording of 1000 Hz stop tones and 150 Hz end-of-message tones. The reed switches also make it possible to record E.O.M. tones in the playback mode, without putting bias through the program head. Program bias levels are controlled by R80 and R100 (stereo only). Cue bias levels are set by R102. Program bias current is sampled by R78 and fed by C47 to the Bias position of the meter switch.

Stop Tone Oscillator: The 1000 Hz stop tone is generated by transistor phase shift oscillator Q9, coupled through level control R41 to buffer amplifier Q10. The output of Q10 is normally shunted to ground by transistor switch Q11.

Each time a cartridge is started in the record mode, Q11 is turned off for approximately 1/2 second, allowing the 1000 Hz signal to pass to an integrated circuit summing amplifier which drives the cue tape head.

150 Hz GENERATOR

The optional 150 Hz end-of-message tone is generated by transistor phase shift oscillator Q6, coupled through level control R25 to buffer amplifier Q7. The output of Q7 is normally shunted to ground by transistor switch Q8. However, each time the Record button is operated Q8 is turned off, allowing the 150Hz signal to pass to the integrated circuit summing amplifier which drives the cue tape head. Q8 remains off as long as the Record button is depressed, but a minimum tone duration is provided by the pulse stretching circuit consisting of Q4, Q5, and C7. When the normally closed section of the Record switch is opened Q3 turns on, taking the base of Q4 to near ground potential which turns Q4 off and Q5 on. When Q5 turns on, the transistor switch Q8 gates on the 150 Hz signal. When Q5 turns on C7 is effectively placed between the base of Q4 and ground. Until C7 charges sufficiently, Q4 cannot turn on even if the button is released after a few milliseconds. This insures a minimum length of 1/2 second for all E.O.M. tones which should be a sufficient length to operate any external circuits.

The oscillator output from Q7 and from the Encoder Input are coupled through diodes D10 & D12 which rectify the signals and charge C27 until switch Q13/14 turns on, supplying the voltage to close K2 which provides bias current through the cue head.

PARTS LIST

Century Decks

Part #	Description	Price (As of 1/1/76)
001-4310	HM-2P Head Mounting Assy	21.60
001-4320	HM-2RP " " "	27.00
002-7040-03	4520 Stereo Record w/aux PCB	90.00
002-7040-04	4525 Stereo Playback w/aux Pcb	102.00
002-7051-04	4725 Stereo Record w/aux PCB	141.00
003-0003	Belt kit	2.25
003-0005	Pinch Roller kit	4.90
012-0562	Stop Switch - Cntry PB	1.04
012-0585	Pivot Pin	.65
012-0608	Motor (Papst)	57.68
012-0609	Motor Cap 6mfd @ 230V	9.76
012-0623	Cart Guide	11.50
180-0001	Relay Control (K1) 2.5K AZ428-70-4H	7.42
180-0012	Datacel 2P Sigma 301R2-24 (4520)	6.85
182-0680	Play Solenoid	10.04
244-0004	Lamp Holder	1.45
244-0005	Lamp Start/Stop (CM# 1819)	1.38
244-0010	Lamp 28V (4610)	1.73
261-0007	Fuse .5A Slo-Blo	1.45
296-0009-02	White Lens (4610)	2.68
296-0012	Illuminated Push Switch (4610)	12.89
296-0021	Switch Body 5 Pos (4610)	6.26
296-0422	Switch Stack On/Off #253460	1.36
302-0020	Micro Switch (underside)Crt Snsg	2.72
318-0003	Xfmr Audio 10K CT 23-W-7 (4610)	6.67
318-0015-02	Xfmr Audio 23-W-12	7.19
326-0010	Xfmr Pwr 23-K-19C	6.99
368-0007-02	Meter VU 2.5" Modutec	28.07
368-0007-04	Bezel 2.5" Modutec	5.05
895-0010	Head Mono Record	31.00
895-0020	Head Mono Play	31.00
895-0040	Head Stereo Record	82.70
895-0042	Head Stereo Play	82.70
012-0591	Contact Arm Assembly	3.95
012-0589	Spring - Contact Arm	.75
550-0607	Push/Release Knob	.60

Rotary Lift Mechanism:

012-0583	Arm (pivot bar)	1 ea	15.37
012-0584	Bracket	2 ea	1.19
540-0206	Screw	4 ea	.15

Minimum Order: $10.00

SPARTA
Division of Cetec Corporation

WARRANTY

SPARTA ELECTRONIC CORPORATION (SPARTA") expressly warrants products manufactured by it and bearing SPARTA model numbers to be free from defective material and factory workmanship.

THE FOREGOING EXPRESS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, IT BEING EXPRESSLY UNDERSTOOD AND AGREED THAT SPARTA DOES NOT WARRANTY EITHER THE MERCHANTABILITY OF ITS PRODUCTS OR THEIR FITNESS FOR A PARTICULAR PURPOSE.

The obligation of SPARTA under the foregoing express warranty is limited to repairing any warranted product which upon SPARTA's examination proves to be subject to defective material and/or factory workmanship, when such product is returned to our factory, transportation prepaid by the purchaser, within one year from the date of original purchase from SPARTA. Under no circumstances shall a breach of any warranty by SPARTA subject SPARTA to any claim for consequential damages, the purchaser expressly assuming all risk of such consequential damages. In the case of any breach of any warranty, the liability of SPARTA shall not under any circumstances exceed the cost of repair or replacement of the defective product.

High voltage transformers, modulation transformers, reactors and filter chokes carry an extended warranty of 50% of the replacement cost being allowed should failure occur during the second year.

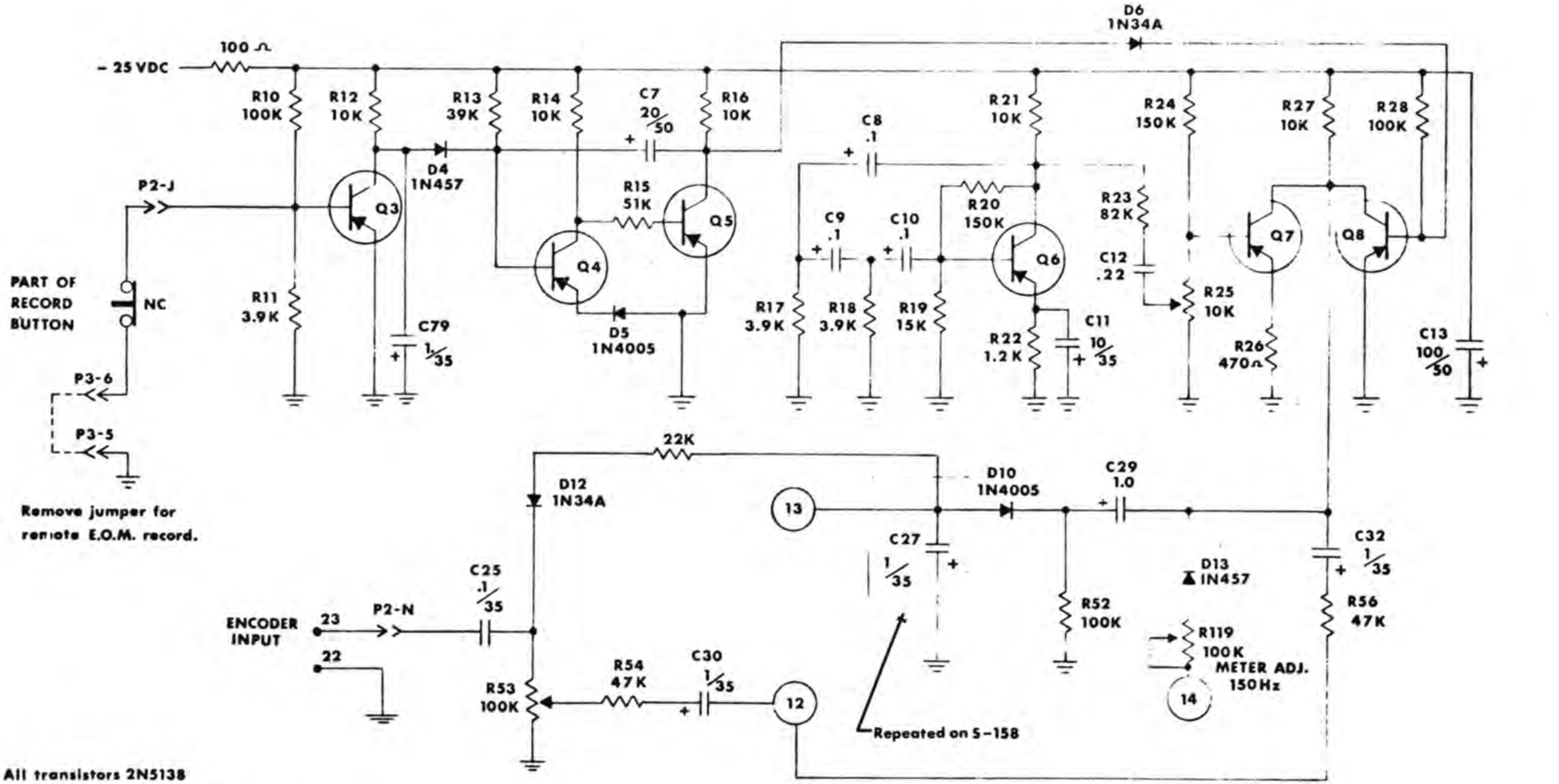
The foregoing express warranty does not apply to any products manufactured by SPARTA that have been repaired, worked upon or altered by persons not authorized by SPARTA, or that have been subject to misuse, negligence or accident, or the serial number of which has been altered, effaced or removed; neither does the foregoing express warranty apply to any products of SPARTA that have been connected, installed, used or adjusted otherwise than in accordance with the instructions furnished by SPARTA. Accessories, allied equipment, and components supplied, but not manufactured by SPARTA are not warranted, either expressly or impliedly, by SPARTA, and shall carry only such warranty, if any, as is made by the manufacturer of such product.

The foregoing warranty shall be void if SPARTA shall inspect any product and find it to have been modified, improperly installed or misused.

NO PERSON, INCLUDING ANY DEALER, AGENT OR REPRESENTATIVE OF SPARTA IS AUTHORIZED TO MAKE ANY WARRANTY, WRITTEN OR ORAL, OR TO ASSUME FOR SPARTA ANY LIABILITY, EXCEPT TO REFER PURCHASER TO THE FOREGOING EXPRESS WARRANTY.

SPARTA reserves the right to make changes in design and improvements upon its products without assuming any obligation to install the same upon any of its products theretofore manufactured.

August 1, 1973



All transistors 2N5138

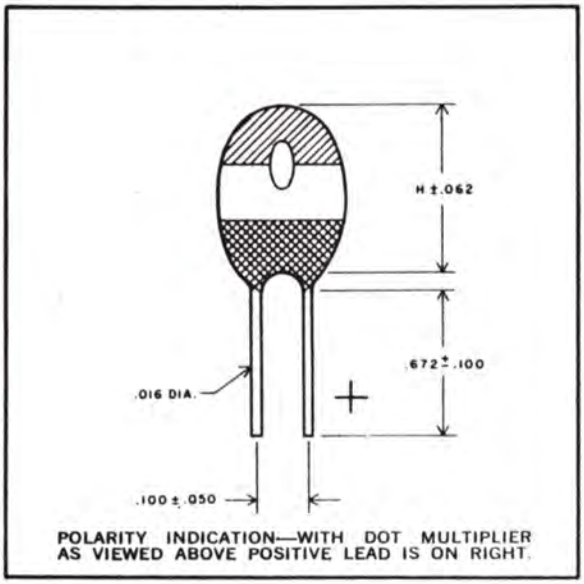
(12) To S-158 (12) 150Hz to cue amp (record)
(13) Aux tone bias enable
(14) To 150Hz metering circuit

SPARTA ELECTRONIC CORPORATION
SACRAMENTO, CALIFORNIA 95828

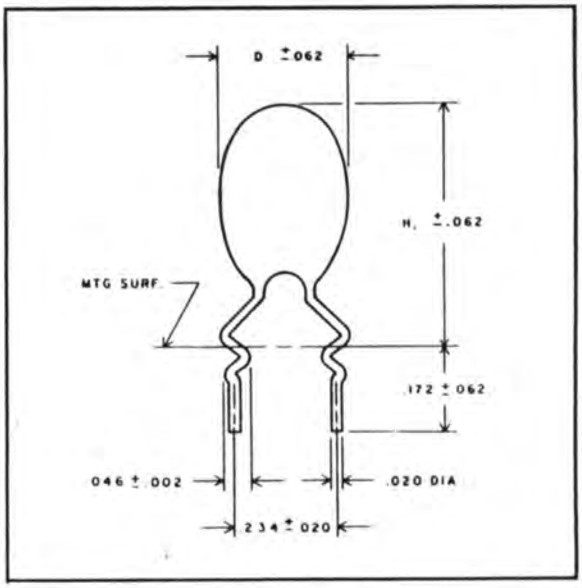
TITLE: 150Hz GENERATOR CENTURY RECORD

DWN	DATE	SCALE	SHT	DWG NO.
SMK	30 OCT 72		1 OF 1	S-163 F
APP: RMC	DATE: 30 Oct 72			

Solid Tantalum Electrolytic Capacitors



TAG—STRAIGHT LEADS

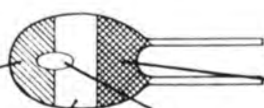


TAG—CRIMPED LEADS
(SPECIAL ORDER ONLY)

CASE DIMENSIONS—TYPE TAG **TABLE 3**

CASE	DIA. (D)	LENGTH (H)	*(H_1)
1	.138	.238	.378
2	.159	.258	.397
3	.159	.278	.421
4	.178	.278	.421
5	.178	.298	.437
6	.219	.338	.457
7	.238	.338	.457

*CRIMPED LEAD VERSION ONLY



MARKING CODE **TABLE 4**

CAPACITANCE (MFDS)				WORKING VOLTAGE	
COLOR	CAP 1ST SIGNIFICANT NUMBER	RING 2ND SIGNIFICANT NUMBER	DOT MULTIPLIER	COLOR	VOLTAGE
BLACK	—	0	x1	WHITE	3
BROWN	1	1	x10	YELLOW	6.3
RED	2	2	—	BLACK	10
ORANGE	3	3	—	GREEN	16
YELLOW	4	4	—	BLUE	20
GREEN	5	5	—	GREY	25
BLUE	6	6	—	PINK	35
VIOLET	7	7	—		
GREY	8	8	x0.01		
WHITE	9	9	x0.1		

Eliminate that RFI in your Audio Circuits

Once the symptoms are understood, RF in your audio circuits can be eliminated. Here is your guide to symptoms and cures.*

**Written by the engineering staff of Sparta Electronics and edited by Paul Gregg.*

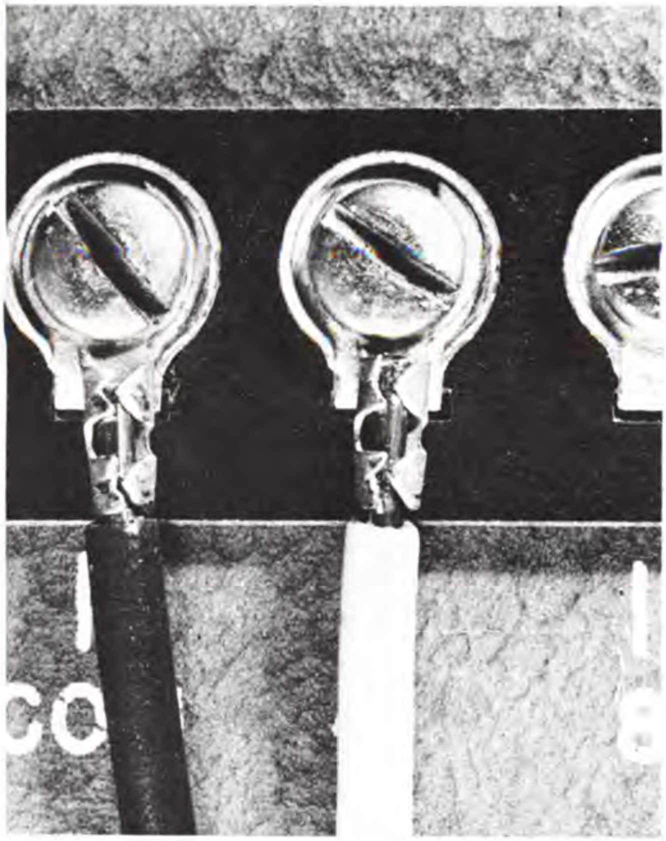


Fig. 1 The terminal connectors shown here are crimped to the wires. This is an especially hazardous practice if the wires are copper. Creeping corrosion inside the clamp is possible.

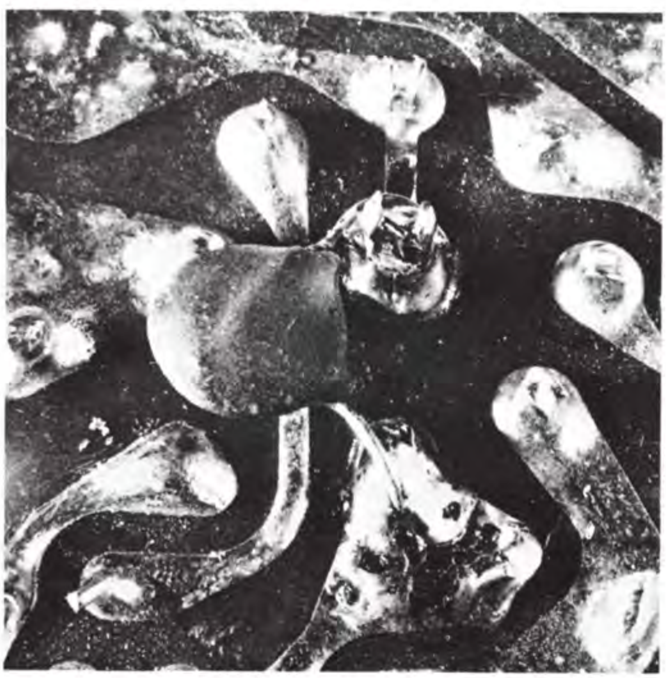


Fig. 2 A disc capacitor is shown here with minimum possible leads. It is a good practice to keep all leads short and to trim excessive wire protruding through connectors after soldering.

Radio frequency interference, or RFI, is always a possibility when audio equipment is operated in the presence of RF fields. It can be particularly troublesome in solid-state systems containing low-level program lines and high-gain preamplifiers because less RF voltage or current is needed in such systems to cause interference.

With properly-designed audio equipment, particularly that intended for use by radio broadcasters, the incidence of RFI is relatively low when proper installation practices have been followed. But RFI does occur in even the best of installations because of its virtually unpredictable nature. It does not necessarily require a strong field for RFI to result, and it is not uncommon for an audio system to be unaffected by a nearby high-power transmitter, yet be ridden with RFI from a distant source at a different frequency.

The obvious question, of course, is "Why can't audio equipment be made RFI-proof?" The answer, unfortunately, cannot be so obvious. Although normal gain and frequency response of an amplifier can be limited to the audio range, this is not the case for individual components and conductors. Capacitors, resistors, inductors, wires and transistors continue to function as such at frequencies far beyond the bounds of the audio spectrum: the wire that is a simple conductor at audio frequencies may become a highly efficient antenna or inductor at radio frequencies; the insignificant stray capacitance at audio frequencies can become a very effective coupling or tuning capacitor at radio frequencies; the semiconductor junction that is a linear control element at audio levels will become an excellent diode detector or modulator if sufficient RF energy reaches it.

The task of RFI suppression, then, is just that—suppression rather than elimination. No matter what pains are taken at the design and manufacturing levels to minimize susceptibility to RF, the possibility will still exist simply because there is no way to force a component (such as a semiconductor) to recognize the difference between a change of voltage or current at audio frequencies and a similar or greater change at some higher frequency.

Fortunately, there are many effective preventive measures that can be taken, and the ultimate solution to RFI becomes that of providing reasonable suppression during initial design and manufacture followed by additional effort during subsequent installation if required by an unusually severe environment. It is well to note that the best of built-in suppression can be undone by improper or careless installation.

RFI Symptoms

The symptoms of RFI are varied, depending upon the strength of the field, how it is entering the system, where and how it is being detected, and what kind of modulation it carries. An AM carrier may enter a system, be partially or completely detected by a non-linear element (more on this later) and produce the modulation superimposed over the normal program. If the two programs are different, the intruder is usually recognized as such quite readily. If they are the same, the symptoms may appear as hum, noise, raspiness or similar distortion. Also, if the RFI is strong enough, the result may be a completely blocked amplifier stage with only noise or perhaps silence as a symptom.

An audio system normally does not contain the necessary elements for FM detection, so when the intruding carrier is frequency modulated the symptom is usually that of an un-modulated carrier: hum, noise, distortion of the normal program, or again the silence of a blocked amplifier stage. If the offender is a VHF FM carrier, however, it will often enter the audio system via a conductor or cable that is resonant or "tuned" at or near the frequency of the interfering carrier, quite literally a tuned antenna. In such a case the FM can be converted to AM by riding the slope of the tuned element and subsequently be detected by a non-linear element so as to exhibit the symptoms of AM RFI.

When RFI is caused by a TV transmitter, the symptoms will most often, though not always, be characterized by a raucous 60 Hz buzz due to the AM frame-rate sync-pulse. Since two carriers may be involved, one AM and one FM, the symptoms may also become involved, even to the extent of including those of a completely separate carrier from another source.

No matter how complex the symptoms, however, there are two factors common to all forms of RFI. First, RF energy is entering the system by a path or paths that can be located and interrupted. Second, the RF is being detected by a non-linear element or rectifier that can be located and suppressed.

The process of eliminating or suppressing RFI, then, involves two basic steps; preventing or minimizing the transfer of RF into the system, and preventing detection of the RF. The first step is simplified considerably by identifying the source and particularly the frequency of the interfering carrier, and the second requires locating the point at which it is being detected.

Suppressing Entering RFI

When considering the means whereby RF energy can enter an audio system, one must be constantly aware that stray capacitances may be excellent conductors for RF and that any wire or metal structure will be resonant at many different frequencies. The most prevalent example, of course, is the twisted pair shielded audio cable feeding a console which may act as a quarter-wave stub antenna at one frequency and as a multi-wavelength long-wire antenna at a much higher frequency. Of nearly equal importance are instances where turntable tone-arm leads act as VHF antennas—particularly troublesome because of their locations in very low-level, high impedance circuits—and AC powerlines, which can be very efficient longwire antennas at the lower radio frequencies.

Problem Cables

The search for the route of RFI is generally a process of eliminating, one by one, the connecting cables by which RF may be entering the system. At the same time, judicious use of operating switches and potentiometers will provide positive clues as to the source. For example, if reducing a turntable mixer control to zero will stop the interference it is a near certain indicator that both injection and detection are taking place in that channel and prior to the mixer control, perhaps in another part of the system.

If a connecting cable is found to be an offender, the first step is to examine the connections at both ends and particularly the way the shield is connected. In most instances best operation will be obtained when the shield is connected at the load or console end and left open at the source end. This is because the equipment at each end of the connecting cable will always have some sort of return to a common ground, and connecting the shield at both ends completes a loop which quite often will respond to magnetic fields. There is no hard and fast rule, however, and it is wise to try various combinations.

When the interference is in the VHF range, it will often be found that shortening *or* lengthening a cable will eliminate RFI by "detuning" it. Also, it may be found that simply moving or re-routing will accomplish the same effect. In such cases it is often true that touching cables or connections will result in a change of level or symptoms of the RFI. Obviously, con-

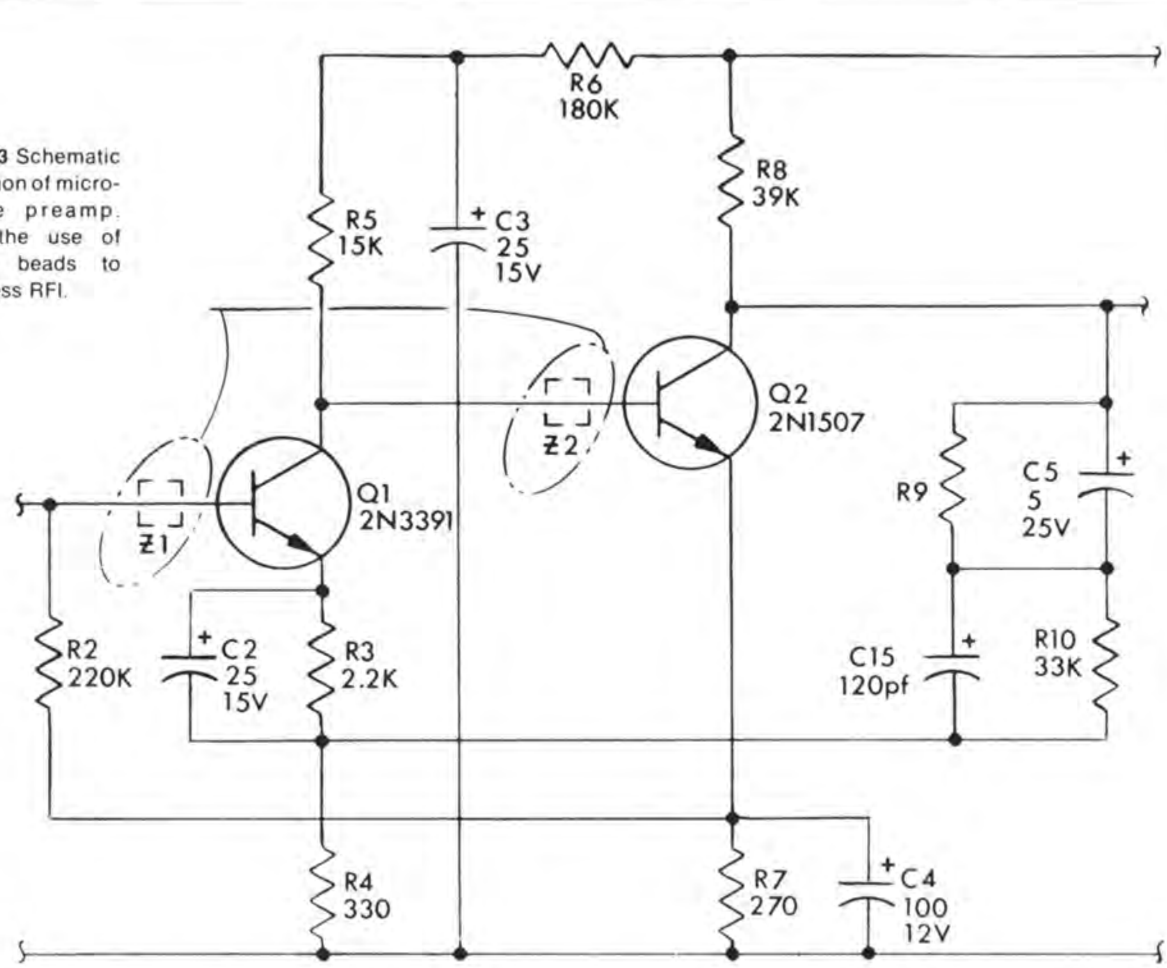


Fig. 3 Schematic of portion of microphone preamp. Note the use of ferrite beads to suppress RFI.

necting cables should never be coiled and tied in loops. If one must be shortened but not cut, fold it back and forth upon itself and tie it securely.

Using Capacitors

If cable-dress and shielding techniques are insufficient, bypass program-carrying conductors to ground or shield terminals with suitable capacitors. Since the reactance of a capacitor decreases as frequency increases, the procedure is to choose a capacitor value which will have no significant effect at program line impedances and frequencies, yet form a low reactance shunt path to ground for the radio frequencies. For the typical 600 Ohm system, a value of C.001 mfd to 0.002 mfd is nearly ideal since the reactance is about 5K Ohms at the higher audio frequencies, falls to 100 Ohms at the middle of the AM broadcast band, and is close to 1 Ohm at the middle of the FM-TV bands.

The capacitors used should be low-inductance types, such as disc ceramics. Lead-lengths should be kept short, otherwise, the capacitor and leads could become resonant at a frequency which could add rather than cure RFI. The preceding given values can be extrapolated to other impedance levels simply by following the reciprocal relationship: if the audio line impedance is higher, the capacitor should be proportionally smaller, and vice versa.

RF Chokes

In severe circumstances, RF chokes may be inserted in series with the audio lines, and with bypass capacitors to ground at each end a very effective filter section will result, if lead lengths are kept short. The Ohmite Z-50 and Z-144 chokes are typical and quite popular for suppression at the higher frequencies. Alternately, passing audio leads through ferrite beads is very effective and space-saving at VHF frequencies. Chokes are generally not too practical at AM broadcast frequencies, however, since those with high enough reactance usually have enough DC resistance to affect audio levels in low-impedance lines. When filtering AC power lines, 0.01 to 0.1 mfd, 600 Volt capacitors may be used, although it may be simpler and more effective to employ a commercial filter designed for the purpose.

RF Detection

The suggestions so far have dealt with means of preventing RF from entering the audio system. Of equal importance and often the most effective approach is to isolate and suppress the point of detection. Even though it may require going into the circuitry of equipment in the audio system, it often requires less effort than adding multiple filters to prevent the RF from entering in the first place. As an aid in locating points at which RF can be detected, it will help to consider some circumstances that can result in a non-linear junction, or rectifier.

Considering one of the earliest known forms of an RF detector, the galena crystal and cat's whisker, we can see the effects of RF detection resulting from point-contact of two dissimilar metals. The significant factor is that a junction of any two dissimilar metals or metal compounds is a potential detector. Now, we cannot prevent such junctions in an audio system because they exist virtually every time a connection is made. What we can do, however, is assure that every connection is secure and tight so there is no possibility of introducing a voltage-drop—audio *or* RF.

Turntable RFI

In this context we must also consider a very common cause of RFI in turntable systems. Connections to the tone-arm cartridge are made with small push-on clips because soldering to the cartridge pins directly would likely destroy the cartridge. The combination of a loose clip, particularly if oxidized, plus the tone arm lead (an excellent VHF antenna) and the following high-gain amplifiers is an excellent invitation to RFI. Also, the usual tone arm with plug-in cartridge-shell and plug-in connecting cable provides two additional sets of contacts at which RFI detection can take place.

Transistor RFI

Within the circuitry of individual equipments of an audio system, the most common offender is the emitter-to-base junction of a transistor. This junction is a forward-biased diode, with bias set so that a change of base current with signal will produce a linear but amplified change of collector current. Should RF energy reach such a junction, the bias could shift to a non-linear area and result in distortion of the normal program material. If the RF is amplitude modulated, it is likely that partial or full detection would take place, resulting in audible recognition of the AM component along with normal program. A sufficiently high level of RF, however, could completely block a transistor, causing complete loss of any audible symptom. It becomes quite necessary to allow for varying symptoms with varying levels of interference when attempting to locate an offending junction.

Once the point of detection is determined, the solution is much the same as earlier described; shunt capacitors with short leads, and series inductors in severe instances. It is usually easiest and most effective to add a capacitor directly across the emitter-to-base junction. The most effective capacitor value will vary with particular circuit parameters, but a value of 100 pf is a good starting-point. As a general guide, the capacitor should be as large as practical without causing a loss at the highest audio frequencies.

The input impedance at the base of a transistor is usually measured in thousands of Ohms, and the signal current is generally quite small. If it is found that a capacitor reduces but does not adequately suppress the RFI, it will often suffice to then add a series resistor of perhaps 100 to 1 K Ohms in series with the signal path immediately preceding the shunt capacitor, and substitute an inductor for the resistor in particularly severe instances. These latter extremes are rarely necessary, since most audio equipment designs include equivalent suppression at the most-likely points of RFI detection.

Exit RFI, Stage Left

We can conclude that RFI is always a possibility in an audio system and can appear unexpectedly when a change or addition is made to the system or when another transmitter goes on the air. We can also conclude that RFI suppression is a logical process of eliminating or minimizing RF paths into the audio system, or locating and suppressing the points at which detection is taking place, or both. ▲

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