QT-4500-SERIES AND QT-6500-SERIES 150-MHz TRANSMITTER

OPERATOR'S MANUAL
QPN 915-0003-000
REV E
ECN 3354

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Specifications subject to change or improvement without notice.

Glenayre electronics

ECN Status

ECN No.	**assembly affected**	
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ECN No.	**assembly affected**	**date**

FACTORY CUSTOMER SERVICE

Quintron Corporation provides complete factory service in support of its products. Virtually all of the circuits are on replaceable printed circuit boards. An efficient method of maintaining your equipment is to carry a stock of replacement pc boards and to rely on the Quintron Service Department for pc board repair when needed. Return authorization and shipping instructions can be quickly received by telephone and a warranty replacement pc board will normally be on the way to you within 24 hours. A pc board sent to Quintron for repair will normally be returned within five days of receipt. If repair advice or instructions are required, the Service Department stands ready to help in any way possible.

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We have installed this toll-free number as an added customer convenience. This number is a direct line to our Service Department only and cannot be used to reach any other department. We are pleased to provide this special benefit to our customer. Use it wisely. We want to make it easy for you to solve any technical problems with Quintron equipment.

This toll free number is good for 48 states as well as Puerto Rico and the U.S. Virgin Islands. Alaska and Hawaii are excluded.

IMPORTANT

Changes which occur after a technical manual has been printed are listed on addenda pages placed in the rear of the manual. We recommend that you write this new information on the appropriate pages in the manual for easy future reference.

OSHA SAFETY BULLETIN
GENERAL SAFETY INFORMATION

The United States Department of Labor, through the provisions of the Occupational Safety and Health Act of 1970 (OSHA), has established an electromagnetic energy safety standard which applies to the use of this equipment. Proper use of this radio will result in exposure below the OSHA limit. The following precautions are recommended:

- DO NOT operate the transmitter of a fixed radio (base station, radio paging transmitter RF equipment) when someone is within two feet (0.6 meter) of the antenna.
- DO NOT operate the transmitter of any radio unless all RF connectors are secure and any open connectors are properly terminated.

In addition,

- DO NOT operate this equipment near electrical blasting caps or in an explosive atmosphere.
- All equipment must be properly grounded according to national and local electrical codes.
- All equipment should be serviced only by a qualified technician.

Refer to the appropriate section of the product service manual for additional pertinent safety information.

CSA SAFETY BULLETIN
CAUTION

TO PREVENT ELECTRIC SHOCK DO NOT USE THE (POLARIZED) PLUG WITH AN EXTENSION CORD, RECEPTACLE OR OTHER OUTLET UNLESS THE BLADES CAN BE FULLY INSERTED TO PREVENT BLADE EXPOSURE.

ATTENTION

POUR PREVENIR LES CHOCS ELECTRIQUES NE PAS UTILIZER CETTE FICHE POLARISEE AVEC UN PROLONGATEUR. UNE PRISE DE COURANT OU UNE AUTRIE SORTIE DE COURANT, SAUF SI LES LAMES PEUVENT ETRE INSEREES A FOND SANS EN LAISSEU AUCUNE PARTIE A DECOUVERT.

FOREWORD

This instruction manual contains the information necessary to install, operate, and maintain model QT-4500-series and QT-6500-series transmitters. The manual is arranged into eight sections.

SECTION I. GENERAL INFORMATION - Provides an overall description of the transmitter, identifies the major subassemblies, and lists the electrical and mechanical specifications.

SECTION II. INSTALLATION - Provides information to unpack, inspect and install the transmitter.

SECTION III. OPERATION & ADJUSTMENTS - Provides information needed to make minor transmitter adjustments.

SECTION IV. MAINTENANCE - Provides basic instructions to align, test, troubleshoot, and repair the transmitter.

SECTION V. ALIGNMENT - Provides detailed instructions on procedures needed to set up and verify proper transmitter operation.

SECTION VI. THEORY OF OPERATION - Provides simplified and detailed descriptions of the functions of the assemblies within the transmitter.

SECTION VII. ASSEMBLIES - Bills of material, assembly drawings, and schematic diagrams of transmitter assemblies are included.

SECTION VIII. OPTIONS - Lists and describes options which may be part of the transmitter.

ADDENDUM. Describes changes to the equipment which occur after the printing date of this manual.

The following pages include the table of contents, which lists the main paragraphs and illustrations with their page number, and a listing of engineering change notices affecting this transmitter.

FOREWORD

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SECTION I
GENERAL INFORMATION

1.1 INTRODUCTION

The Quintron QT-4500/QT-6500 Series transmitters consist of a line of high performance, solid state FM communications transmitters for operation in the 132 to 185 MHz band. The QT-4500 series has an adjustable output level of 12 to 25 Watts and the QT-6500 series has an adjustable output level of 50 to 100 Watts.

Six models are currently available in each of the two series of transmitters:

1. The single channel phase modulated QT-4500 or QT-6500.
2. The single channel Digi-Cap II Direct FM QT-4501 or QT-6501.
3. The dual channel phase modulated QT-4520 or QT-6520
4. The dual channel Digi-Cap II Direct FM QT-4521 or QT-6521.
5. The multi-channel phase modulated QT-4502 or QT-6502.
6. The multi-channel Digi-Cap II Direct FM QT-4503 or QT-6503.

The QT-4502, QT-4503, QT-6502 and QT-6503 all offer up to four channel operation.

These modern transmitters are designed for paging and with appropriate options, for base station or repeater service in land-mobile communication systems, and for other applications where voice communication, data transmission, and/or digital paging and signaling capabilities are required. All versions of the QT-4500 and QT-6500 series transmitters connect directly to a variety of data modems, site interface equipment and remote control devices offered by various manufacturers for voice communications, paging, and data transmission systems. All units are designed to fully utilize the high-speed capabilities of these modern, automated systems. The QT-4501, QT-6501, QT-4503, and the QT-6503 are especially suitable for very high speed paging, signaling and data transmissions where the superior fidelity of the Digi-Cap direct frequency modulation process holds both digital data and voice waveform distortion to a minimum, providing full ±5KHz deviation capability from 20Hz to 3000Hz.

Employing solid state active components throughout, these transmitters provide efficient, reliable service in all applications, including installation in remote and unattended locations. All active circuits, except the power supply, are mounted on plug-in p.c. cards.

All models are FCC type accepted for:

Domestic Public Radio Services (Part 21)
Public Safety Radio Services (Part 89)
Industrial Radio Services (Part 91)
Land Transportation Services (Part 93)

The QT-6550 and QT-6551 are FCC type accepted for Land Maritime Service (Part 81) for operation in the 156 to 162 MHz band at a power rating of 50 Watts.

Several unique performance features make these transmitters ideally suitable for service in today's high capacity automated systems:

---Up to two operating channels available on models QT-4520, QT-6520, QT-4521 and QT-6521.

---Up to four operating channels available on models QT-4502, QT-6502, QT-4503 and QT-6503.

---Three separate inputs provide for: (1) Voice Modulation, (2) Tone-digital modulation, and (3) CTCSS Sub-Tone Squelch Control.

---The Direct FM QT-4501, QT-4503, QT-6501 and QT-6503 models transmit digital signal formats with minimum distortion; input signal waveform is preserved in all models by a wideband (20-3000 Hz) input channel having controlled phase response.

---A built-in modulation limiter prevents transmitter overmodulation.

---With the High Stability option, carrier frequency is held to ±.000005% equivalent to ±7.5 Hz at 150 MHz.

---High Speed keying capability; better than 1 millisecond in direct keying mode. Built-in VOX keying is included, 50m sec. maximum. VOX keying can be used only in local or extended local control modes.

---High temperature thermal interlock turns transmitter off if system becomes overheated. On the QT-6500, it turns off the B+ to the 100W PA Bd. and high VSWR causes a fold-back of power.

---A single adjustment sets output power to any desired level between 12 and 25 watts (QT-4500 Series) or 50 to 100 watts (QT-6500 Series). RF output stages are broadband, requiring no tuning or loading adjustments.

---Extremely low harmonic and spurious signal output promotes the use of the transmitter in the typical modern metropolitan area where interference problems must be kept to a minimum. (QT-6500 series)

---Operational status of transmitter is indicated via LED readouts showing (1) that RF output power is reaching a pre-set operating level, (2) audio signal level is sufficient for ±2.5KHz transmitter deviation, and (3) DC voltages on ON and (4) VSWR is excessive (6500 Series Only).

Logic signals are available for driving remote indicators for the above parameters (1) and (2).

1.2 TECHNICAL CHARACTERISTICS

1.2.1 ELECTRICAL

Frequency Range		North America 148 to 174 MHz Export 132 to 185 MHz
Number of Channels	(QT-4500/4501)	Single channel
	(QT-6500/6501)	Single channel
	(QT-4520/6520)	2 channels
	(QT-4521/6521)	2 channels
	(QT-4502/4503)	3 or 4 channels
	(QT-6502/6503)	3 or 4 channels
Output Power	(QT-4500 series)	continuously adjustable, 12 to 25 watts
	(QT-6500 series)	continuously adjustable, 50 to 100 watts
Output Impedance		50 Ohms
Maximum permissible VSWR		1.5 to 1
Output Connector		Female Type N
Frequency Stability, Standard		±0.0002% or ±0.0001%
Optional High Stability	(QT-4500/4501 & QT-6500/6501 Only)	±0.000005%
Emission Designations		16K0F2D, 16K0F3E
Maximum Deviation		±5.0 KHz
Spurious and Harmonic Radiation		1 microwatt maximum
Turn-on Time, External Key		1ms maximum
VOX Key		50ms maximum
Duty Cycle	(QT-4500 series)	continuous operation
	(QT-6500 series)	continuous duty

Primary Power	110, 120, 220, and 240 VAC, ±10%, 50/60 Hz	
Power Input Requirement	QT-4500	QT-6500
Standby	260 ma	500 ma
Full Power	1.0A	3.0A
Audio Harmonic Distortion	2% max at 1 KHz at 2/3 max deviation	

Monitoring Indicators:

Local with Remote Outputs	Modulation, RF output, High VSWR Sinking Current for remote indicators is 16ma maximum
Local only	Power on

Environmental:

Temperature Range	-30° C to $+60^{\circ}$ C
Humidity	0 to 95%
Altitude	10,000 ft.

Audio Input:

Voice Level	-25 to +15dBm
Impedance	600 ohms, unbalanced
Digital Level	0.5V to 5.0V
Impedance	600 ohms, unbalanced

Audio Response:

Input 1 (Voice)	Within +1, -3dB of standard EIA Pre-emphasis curve, 300Hz to 3KHz Note: 600 ohm balanced Voice input may be internally strapped to digital/Tone input for flat, un-preemphasized frequency response.

INPUT 2 (Digital/Tone), Direct FM(QT-4501, QT-4503, QT-4521, QT-6501, QT-6503, QT-6521)....+1dB, -3dB 20Hz to 3KHz. Transmits digital data with pulse widths from 0.25ms to 4.0ms with full ±5KHz deviation.

INPUT 2 (Digital/Tone), PM(QT-4500, QT-4502, QT-4520, QT-6500, QT-6502, QT-6520)...........+1dB, -3dB 300Hz to 3KHz

1.2.2 MECHANICAL

<u>QT-4500 Series</u>

Size.........................7"H X 6 9/16D X 17"W for standard rack mounting Handles protrude 1½" front.
QT-4502, QT-4503 use additional 1 3/4" rack mount assembly 8" deep.
Weight...20 lbs.
Construction.........................Aluminum chassis, painted light beige, Plug-in P.C. cards with 100% front access except for external connections and power supply.

<u>QT-6500 Series</u>

Size 12½"H X 7 5/8D X 17"W for standard rack mounting. (10½"D with CD fan) Handles protrude 1½" front.
QT-6502, QT-6503 use additional 1 3/4" rack mount assembly 8" deep
Weight...55 lbs.
Construction.......................Plated steel chassis, painted light beige, Plug-in P.C. cards with 100% front access except for external connections and power supply.

1.3 OPTIONS AND ACCESSORIES

1.3.1 HIGH FREQUENCY STABILITY

For installation requiring very high carrier frequency stability, an optional reference oscillator is available for the QT-4500, QT-4501, QT-6500, and the QT-6501 transmitters. This oscillator holds carrier frequency to ±0.000005% over an operating temperature range of -30 C to +60 C, equivalent to ±7.5Hz at 150 MHz. Long term stability is held to ±0.000005% per year, equivalent to ±7.5Hz.

1.3.2 PM-100/PM-100C POWER MONITORING PANELS

The PM-100 Power Monitoring Panel provides a switchable meter for indicating forward power and reflected power at the transmitter output connector, 5% accuracy. The unit is supplied on a standard rack panel 3½" high and includes the necessary fittings (except coaxial cable) for all connections at the rear of the transmitter.

The PM-100C option consists of the PM-100 metering panel plus an alarm circuit that indicates:

1. That transmitter power output is not reaching the required level when the system is keyed.

2. The antenna system VSWR is excessive.

1.3.3 BAT-1 (QT-4500 Series) and BAT-2 (QT-6500 series)

Now standard on QT-4500 Series and QT-6500 Series.

1.3.4 TWO FUNCTION DC CONTROL

This option permits remote control of two functions of a CTCSS equipped base station by sending two corresponding levels of dc current over the telephone line controlling the station. The first function, which occurs when the line current reaches approximately 6ma, is used to disable the receiver CTCSS (tone squelch) for channel monitoring purposes prior to station transmissions. The second function, normally transmitter "Keying", occurs when the line current reaches approximately 11 ma. Input to this card is transformer-coupled, 600 ohms, balanced.

When a station does not employ CTCSS, the 6ma function is not used and the 11ma function is employed for transmitter keying.

The two Function DC Control mounts on the rear of the transmitter chassis and can be used for 4-wire audio base stations or for transmitter-only installations.

1.3.5 TK-110 TONE CONTROL

This unit is a factory installed option which utilizes an auxiliary tone on the voice or data line to key the remote transmitter. The TK-110 is used in lieu of the dc control method when direct metallic continuity is not available between the controlling location and the transmitter site. The option includes all elements needed at the transmitter for this mode of keying; tone encoders and other equipment required at the sending location are not supplied. Tones in the 2000Hz or 3000Hz range are recommended, but any standard EIA tone from 1200Hz to 3000Hz is available.

Triggering current levels are compatible with most existing dc control systems.

1.3.6 CABINET OPTIONS

Desk Height Cabinet.	30" High X 22" Wide X 15" Deep (76.2 cm X 55.9 cm X 38.1 cm) 42" High X 22" Wide X 15" Deep (76.2 cm X 55.9 cm X 38.1 cm)
Indoor rack cabinet.	68" High X 22" Wide X 18" Deep (172.7 X 55.9 X 45.7 cm)
Outdoor Cabinet.	48" High X 26" Wide X 21½" Deep , wall mount or 72" High X 29" Wide X 21" Deep, upright

RFI Cabinets. 72" High X 24" Wide X 21" Deep.

All cabinets except 48" outdoor have locking front and rear doors. An optional lock is available for the transmitter front cover when the system is used as a free-standing unit. The 48" outdoor requires a padlock and has a front door only.

The transmitters are normally supplied in desk height, upright cabinets 30 inches high, 21 3/4 inches wide, 15 inches deep. Both outdoor weatherproof and indoor full-rack cabinets are available as options. Cabinets are constructed of heavy gauge, cold rolled steel with painted interior and exterior surfaces.

The transmitter assembly is housed in a painted aluminum or plated, painted steel, dust resistant, rf shielded enclosure. Lockable transmitter doors are available as an option. All units are type accepted for open-rack mounting and are available without the cabinets for installation in standard 19" racks or cabinets. Single channel models are supplied with rubber feet, permitting the QT-4500, QT-4501, QT-6500 and the QT-6501 to be used as free standing units. The QT-4502, QT-4503, QT-6502 and the QT-6503 employ an external 1 3/4" rack-mounting, multi-channel oscillator assembly and are designed for rack or cabinet mounting only.

1.3.7 FERRITE ISOLATORS

Single or dual band Ferrite Isolators, with or without high temperature interlock on the reject load, are available. The optional second harmonic trap is recommended when isolators are used.

1.3.8 RF AND AC LINE FILTERS

An optional filter assembly containing an AC line filter and telephone line filters for up to three line-pairs is available. This unit is commonly used when RFI cabinets are specified.

1.3.9 POWER OUTPUT INDICATOR RELAY (QT-6500 Series)

This accessory consists of a small pc board which mounts on the rear of the transmitter chassis and provides relay logic for activating an external or remote indication that transmitter output power is reaching a pre-set level.

1.4 QUINTRON NOMENCLATURE

The Quintron system of numbering assemblies, subassemblies, and components is used to uniquely reference and identify components used in the equipment. When several assemblies are provided in a rack cabinet, main assemblies are designated by Unit Numbers according to their position in the rack from top to bottom. For example, if the transmitter is rack mounted with the PM-100 or PM-100C Power Monitor Panel, the Power Monitoring Panel is normally located in the top rack position and designated Unit 1. The transmitter, located below the PM-100, is Unit 2. Progressing downward, other assemblies, if supplied, would be designated Unit 3, Unit 4, etc.

PC boards and other subassemblies are assigned "A" numbers, usually according to their position in the assembly from left to right. These "A" numbers may be prefixed with the Unit number to indicate the main assembly of which the subassembly is a part. Continuing the example above, 2A2 refers to the A2 PC board, the Audio Amplifier in the transmitter, Unit 2, 2A2 R1 designates resistor R1 on this same board, 2A2.

Terminal board connections follow the same basic numbering system. Thus, terminal 2TB1-3 refers to terminal 3 on terminal board 1 of Unit 2, the transmitter.

SECTION II
INSTALLATION

2.1 UNPACKING & INSPECTION

Immediately upon receipt of the transmitter shipment, unpack the equipment, inspect it for damage, and check the items received against the accompanying packing list. Typically, the list will include the items outlined in the sample packing list below, plus any optional accessories that have been ordered. Possible options are listed in Section I of this manual.

Important: Report any shipment damage to the Carrier and to Quintron immediately.

SAMPLE EQUIPMENT LIST

Qty	Description
1	Transmitter assembly, complete with cover, full complement of PC boards, crystal.
1	Service Manual.
1	Line Cord, 3 conductor.
1	Set angle mounting brackets for rack mount.
1	Accessory bag containing: extender board, tuning tools and any test cables required. Spare fuses.

After unpacking, open the transmitter front cover and examine the equipment closely. All required PC boards and other plug-in units must be firmly seated in their sockets. Check all coaxial connectors for tightness.

2.2 INSTALLATION

The transmitter location should be chosen to protect the equipment from dust and extreme environmental conditions. Normally, the transmitter is supplied in the short, desk height cabinet (30" High, 22" Wide, 15" Deep), with locking front and rear doors. Outdoor and full-rack cabinet options are listed in Section I of this manual. The QT-4500, QT-4501, QT-6500 and the QT-6501 may be operated as free-standing units or they may be installed in any standard EIA 19 inch rack. Rubber feet and rack mounting hardware, along with installation hardware, are supplied as standard equipment when the transmitters are ordered without a cabinet. Mounting hardware is 10-32NF (National Fine).

The QT-4502, QT-4503, QT-6502 and the QT-6503 require an external 1 3/4" rack-mounting oscillator assembly which may be installed in any of the cabinet options. This MCS-4 multi-channel oscillator output is routed via 50 ohm coaxial cable to J2, the BNC "External Oscillator" input located on the rear of the transmitter chassis. Plus 26 Volts for the MCS-4 is available from the transmitter chassis at terminal TB-1 on the rear of the unit.

Care should be taken if you order a cabinet or rack from an independent supplier. First, make sure that the cabinet has adequate louvers to allow for heat dissipation up to 200 Watts. Second, if you do not specify EIA hole patterns on the rack or cabinet mounting rails, some suppliers will still send you the older type NEMA or Western Electric (WE) hole pattern. These hole patterns will require you to drill extra holes to properly mount the equipment.

Older style equipment with NEMA or WE hole patterns will mount in EIA-drilled cabinets and racks without modifications.

The installation location should provide several inches of unobstructed space immediately to the rear of the large finned heat sink located on the rear of the chassis. This is necessary for proper cooling of the amplifier power elements. Air flow through the cabinet should not be restricted, and the cabinet should have ample louvered openings for air flow at both top and bottom. Operation in an enclosed rack cabinet may require a cabinet flushing fan or blower.

On the QT-6500 series transmitters, for continuous duty 100 watt operation, the thermostatically controlled fan must be installed on the rear of the heatsink. This fan plugs into J4 on the rear of the chassis and is thermostatically controlled by S3. For continuous duty of the QT-4500 series transmitters no fan is required.

Power transformer T1 is tapped to accommodate input voltages of 110, 120, 220 and 240 volts. Terminal connection for these values of AC line voltages are shown on the power supply cover plate located on the left-hand front section of the chassis.

On the QT-4500 series transmitters, J4 on the rear of the chassis is the battery input connection. On the QT-6500 series transmitter, J5 is the connection used. Four battery terminals are supplied in the accessory kit.

The transmitter RF output connection J3 is a female type N fitting located on the rear of the chassis, upper left-hand corner. J2, the BNC external oscillator input connection is used with the MCS-4 channel oscillator.

System terminal connections are made at TB1 located on the rear of the chassis.

2.3 QT-4500/6500 SERIES TERMINAL CONNECTIONS

Terminal No.	Function
1	+26 Volts. 1A maximum. For powering auxiliary equipment.
2	RF Output Indicator For driving external indication that rf output is above preset level. Threshold adjustable via R7 on final amplifier A6 (A7 on QT-6500 units). Open collector goes low (below 0.4 V) when rf out-put reaches threshold level.
3	VSWR Indicator (Not used on QT-4500 Series) Provides logic for external indication of excessive VSWR. Threshold adjustable via R11 on Master PCB A1. Open collector goes high when VSWR is above threshold level.
4	Modulation Indicator Used for external indication that audio level is sufficient to produce ± 2.5 KHz deviation. Open collector goes low for indication.

Terminal No.	Function
5	Channel Select (QT-4520/4521 and QT-6520/6521) Ground to change channel 1 to channel 2.
6	Key A relay contact closure to ground or a low logic level (from TTL logic) applied to this terminal keys the transmitter ON.
7-8	Input 1, Voice Unbalanced 600 ohm termination for voice audio. Follows standard EIA pre-emphasis curve.* Accepts input level between -25 dBm and +15 dBm. Level adjustable via R2 on A2 PCB. Terminal 7 is ground.
9	Input 2, Digital Unbalanced to ground, 600 ohm termination for tone or digital signal formats. Flat frequency response; 20 to 3000 Hz on Direct FM Versions; 300 to 3000 Hz on PM Units. Accepts levels between 0.5 volts and 5.0 volts level adjustable via R11 on A2 PCB.
10	Subtone Input Unbalanced to ground, 5000 ohm termination for sub-audible tone squelch control. Nominal 0.5 volts required to produce $\pm$0.75 KHz deviation at tone frequency of 100 Hz.
11	Chassis Ground
12 (Not used on QT-4500 Series, Labeled Decoder Key Output)	Fo Input Used for optional Fo Accessory.
J1	AC Power 110 to 120 or 220 to 240 VAC, 50/60 Hz.
J2	Ext. Osc Type N connection for external oscillator input. Used with the QT-4502/4503 and the QT-6502/6503 for connecting the MCS-4 Multi-channel oscillator to the transmitter. Also requires cross connection between E1 and E2 on Master PC Board A1. See MCS description, in Section VIII for channel selection.
J4 (J5 on QT-6500)	Stand-by Battery Connection.

INDOOR CABINETS

DESK SIDE AND UPRIGHT MODELS

PERFORMANCE SPECIFICATIONS

STANDARD UPRIGHT

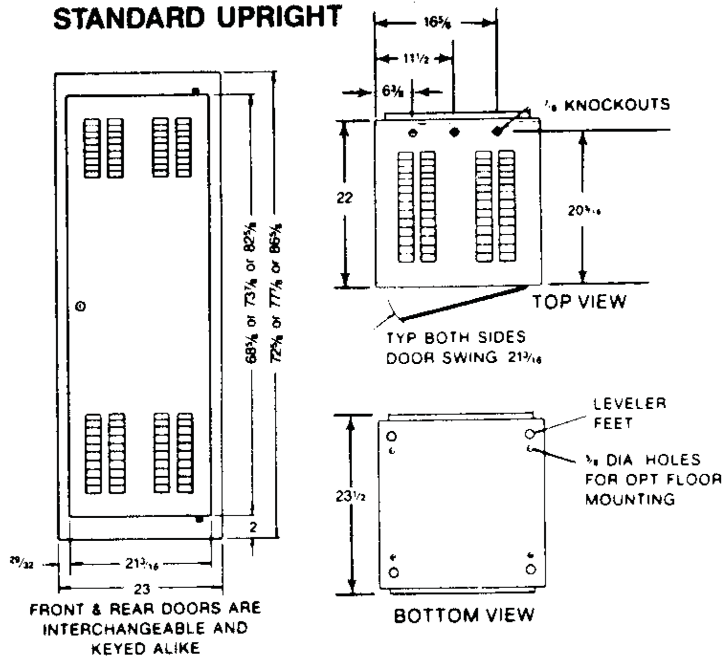
Panel space	19" W (48.26 cm)
72" cabinet	66.50"H (168.91 cm) 38 rack units
78" cabinet	71.75"H (182.24 cm) 41 rack units
87" cabinet	80.50"H (204.47 cm) 46 rack units
Construction	16 gauge cold rolled steel, painted dark gray
Dimensions	
72" cabinet	72.62"H x 23"W x 23.50"D (184.46 cm x 58.42 cm x 59.69 cm)
78" cabinet	77.87"H x 23"W x 23.50"D (200.02 cm x 58.42 cm x 59.69 cm)
87" cabinet	86.62"H x 23"W x 23.50"D (220.02 cm x 58.42 cm x 59.69 cm)
Weight	
72" cabinet	195 lb (87.75 kg)
78" cabinet	215 lb (96.75 kg)
87" cabinet	260 lb (117.00 kg)

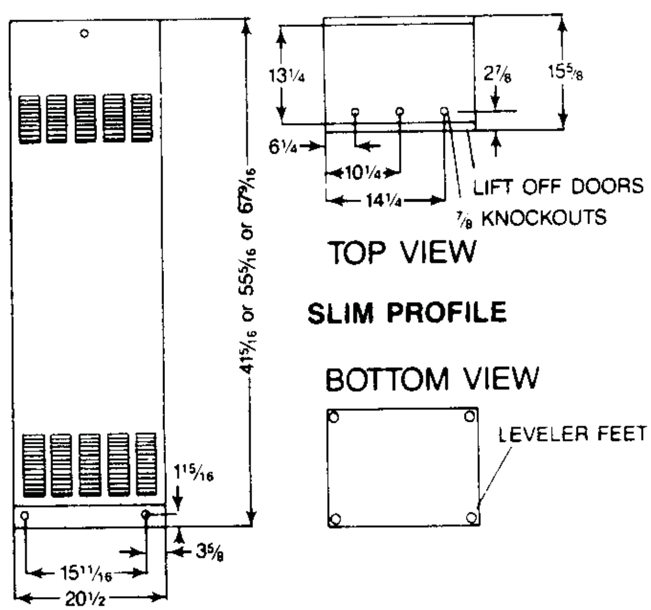
SLIM PROFILE UPRIGHT

Panel space	19" W (48.26 cm)
41" cabinet	35"H (88.90 cm) 20 rack units
55" cabinet	49"H (124.46 cm) 28 rack units
68" cabinet	61.25" H (155.57 cm) 35 rack units
Construction	14 and 16 gauge cold rolled steel, painted dark gray
Dimensions	
41" cabinet	41.28"H x 20.50"W x 15.62"D (104.85 cm x 52.07 cm x 39.67 cm)
55" cabinet	55.28"H x 20.50"W x 15.62"D (140.41 cm x 52.07 cm x 39.67 cm)
68" cabinet	67.56"H x 20.50"W x 15.62"D (171.60 cm x 52.07 cm x 39.67 cm)
Weight	
41" cabinet	76 lb (41.04 kg)
55" cabinet	96 lb (51.84 kg)
68" cabinet	115 lb (62.10 kg)

NOTE: RFI shielded cabinets also available

STANDARD UPRIGHT





Specifications subject to change without notice

FIGURE 2-1 INDOOR CABINETS INSTALLATION DRAWING

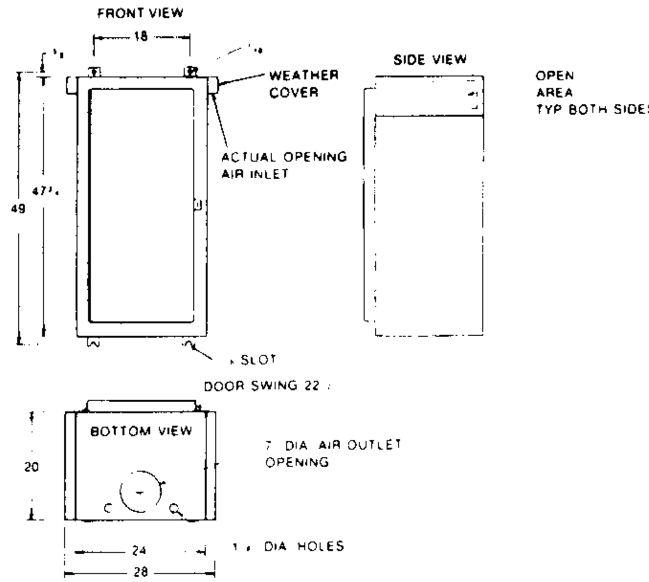
OUTDOOR CABINETS

WALL MOUNT AND UPRIGHT MODELS

PERFORMANCE SPECIFICATIONS

WALL MOUNT SPECIFICATIONS

Panel space	19" W (48.26 cm) 40.25" H (102.23 cm)
Construction	14 gauge cold rolled steel, painted gray
Dimensions	47.75"H x 24"W x 20"D (121.28cm x 60.96cm x 50.80cm)
Weight	180 lb (81.0 kg)



UPRIGHT SPECIFICATIONS

Panel space	19" W (48.26 cm)
72" cabinet	61.25"H (155.57cm)
80" cabinet	68.25"H (173.35cm)
Construction	12 gauge cold rolled steel, painted gray
Dimensions	
72" cabinet	72.06"H x 24.06"W x 24.06"D (183.03cm x 61.11cm x 61.11cm)
80" cabinet	80"H x 24.06"W x 24.06"D (203.20cm x 61.11cm x 61.11cm)
Weight	
72" cabinet	350 lb (157.50 kg)
80" cabinet	400 lb (180.00 kg)

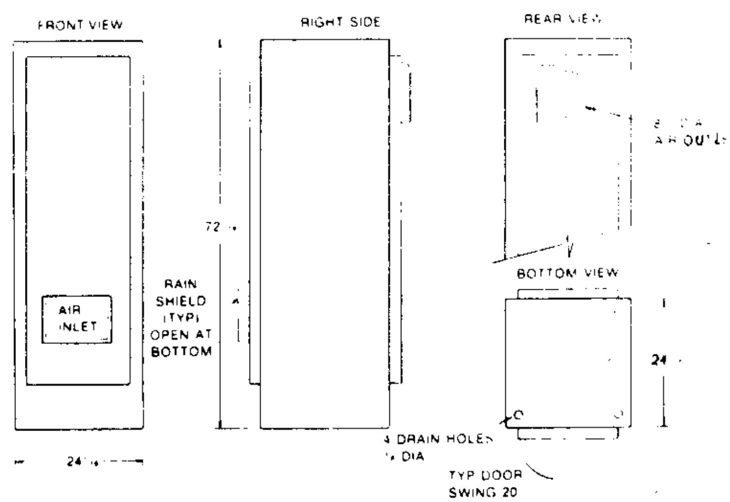


FIGURE 2-2 OUTDOOR CABINET DRAWING

SECTION III
OPERATION & ADJUSTMENTS

3.1 OPERATING & SERVICE HAZARDS

Operating or handling any radio frequency power device, large or small, involves the following hazards:

3.1.1 VOLTAGES

Operating voltages ranging from a few volts to 115 and possibly 240 volts AC are present in this equipment. Care has been taken in the design of the equipment to insure personnel safety. Always remove primary AC power before servicing the equipment.

3.1.2 RADIO FREQUENCY RADIATION

Avoid exposure to strong rf fields, even at relatively low frequency.

Transmitters are specifically designed to generate and amplify radio frequency power. Relatively strong rf fields exist near the output stages of this equipment. The transmitter enclosure is designed to contain this rf energy. Efficient coupling of the rf energy to the antenna and keeping the front cover closed at all times when the equipment is in operation will keep the rf field in the vicinity of the transmitter at a minimum.

3.2 OPERATION & ADJUSTMENTS

3.2.1 TEST EQUIPMENT REQUIRED

Table 5-1 lists required test equipment.

Your transmitter was completely checked out and performing within operating specifications when it left the factory. Since signal levels, control voltages, and possibly AC line voltage may vary from those used in factory testing, the following system checks and adjustments should be made when the equipment is initially placed into service. You can refer to the factory test data sheet included with your equipment for test point levels and performance data.

3.2.2 AC LINE VOLTAGE

Before connecting AC Power to the transmitter, measure the plant AC line voltage under normal load. If the transmitter site is at a remote or isolated point and the transmitter system is a major portion of the total power requirements, the transmitter load should be simulated for this voltage measurement. If necessary, change the primary connection of power transformer T1 to the voltage tap nearest the measured value of AC line voltage. The primary of this transformer is normally wired at the factory for a supply voltage of 120 volts. This information is shown on the equipment AC Power cable.

If the MCS-4 Multichannel oscillator is used, +26 volts for this unit is supplied from TB1-1 on the transmitter chassis.

3.2.3 OUTPUT CONNECTIONS

After all terminal connections are made and before applying power to the system, connect a 50 ohm dummy load and wattmeter to the transmitter output terminal. If the optional PM-100 or PM-100C Power Monitoring Panel is supplied, the wattmeter will not be required. Both output power level and reflected power will be indicated on the Power Monitoring Panel.

Couple a sample of the transmitter rf output to the Service Monitor input.

3.2.4 INPUT LEVELS

Check the level of incoming Voice audio signal at terminals 7 and 8 (Unbalanced Input) of TB1 on the rear of the chassis. This level should fall within the range of -25 dBm to +15 dBm. If Digital Data modulation is to be used, check the level of this signal at terminals 9 and ground of the same terminal board. The level should fall within the range of 0.5 volts to 5.0 volts.

The 50 Ohm dummy load should be connected to the Antenna terminal on the rear of the transmitter before primary power is applied. When primary power is applied, the oscillator and a portion of the exciter circuit are turned on. No RF output will appear until a ground is placed on the keyline (TB1-6). Alternatively, the output can be turned on by application of an input audio signal if the VOX keying circuit is operative. Normally, the VOX keying circuit is disabled prior to shipment. Connect by re-installing the jumper on the Audio PC board.

3.2.5 D.C. VOLTAGES

Turn the equipment on and check the DC voltages at the following Test Points:

	+12 V	TP2 Audio Board A2
	+ 5 V	TP1 Audio Board A2
	+26 V	TP2 25 Watt Driver A6
(QT-6500 series only)	+25 to +29 (unreg)	TP3 100 Watt Final Amp A7 *

*Loaded at 100W output. +34 to +39VC unloaded at 0 Power Output.

These voltages should measure within ±5% of their nominal value.

3.2.6 FREQUENCY TRIM (A3C8)

Trimmer capacitor C8 (Standard Stability) is located behind the small hole in the oscillator oven assembly on the Oscillator PC board A3. The total trim range is approximately 8 KHz at 150 MHz. This adjustment should be made only after the transmitter has been in continuous operation (primary power applied, but not necessarily keyed) for at least three hours. Use a frequency counter capable of resolving to at least 10 Hz. On the Dual Channel and Universal Oscillator PC boards the frequency trim control is on the oscillator assembly housing.

The Frequency trimming adjustments for the MCS-4 Multi-channel oscillator are located and designated on the individual OE-30 oscillator assemblies.

3.2.7 VOICE INPUT LEVEL (A2R2)

A potentiometer adjustment available on the front edge of the Audio card (A2) when the front panel is removed is used to set the desired deviation for a given input signal level at the Voice Input terminals, TB1-7 and 8, at the rear of the unit. For a typical speech input, adjust A2R2 for occasional 5 KHz deviation peaks, as observed on a service monitor.

3.2.8 DIGITAL INPUT LEVEL (A2R12)

Potentiometer adjustment R12 is used to set for desired deviation on a given tone or digital input signal at the Digital Input terminals, TB1-9 and ground, at the rear of the unit. For a continuous tone or digital input, adjust for a frequency deviation of 4.5 KHz, as observed on a service monitor.

3.2.9 DEVIATION LIMITER THRESHOLD (A2R28)

The deviation limiter sets the incoming audio and data signals at a constant level to prevent transmitter over-modulation. This control has been set at the factory and should not require readjustment with initial equipment installation.

3.2.10 VCO ADJUST (A4L1)

This adjustment applies only to the direct FM modulator. L1 controls the free-running frequency of the modulated voltage-controlled oscillator, and is adjusted to set the phase-locked loop control voltage, as measured at TP2, to the center of the allowable voltage range. Measure the DC voltage at TP2 (Brown) with a 20,000 Ohms/Volt multimeter, and adjust L1 for a voltage of +6 Volts. The loop will be locked with the transmitter on the correct frequency, when the voltage at TP2 is between +1 and 11 Volts.

3.2.11 POWER OUTPUT ADJUSTMENT AND INDICATOR THRESHOLD ADJUSTMENT (A5R13 and A6R7 or A7R7)

Slowly increase the transmitter output power with A5R13 until you reach the desired level of minimum power required. Adjust A6R7 (4500 series) or A7R7 (6500 series) until the RF output indicator LED on the Audio PCB lights. The factory setting for this adjustment is 20 watts on the QT-4500 series and 80 watts on the QT-6500 series.

3.2.12 ANTENNA CONNECTION

When the initial adjustments outlined above are completed, remove all power to the transmitter, disconnect the rf dummy load, and connect the antenna system to the transmitter rf output connector. If the PM-100 or PM-100C Power Monitoring Panel is supplied, check output power level to the antenna and reflected power level to determine that these parameters are within operating limits. The System VSWR should not exceed 1.5 to 1 (less than 4% of reflected power). If the Power Monitoring Panel is not supplied, both output power and forward power should be measured on a wattmeter such as the Bird Model 43, or equivalent, to determine that these parameters are within operating limits when the antenna is connected to the system.

Simplified Power/VSWR Conversion Chart

Reflected Power in Watts / Forward Power in Watts = POWER RATIO	VSWR
0.000	1.0
0.002	1.1
0.008	1.2
0.017	1.3
0.028	1.4
0.040	1.5
0.053	1.6
0.074	1.75
0.111	2.0
0.183	2.5
0.250	3.0
0.360	4.0

* * * * * * * * * * * * * * CAUTION * * * * * * * * * * * * * *

If tests reveal a VSWR greater than 1.5, your antenna, coax line, or filter network is defective or improperly tuned. Even a VSWR over 1.2 should not be accepted as normal. You are wasting power and getting less system coverage than you should for your investment.

* *

4. MAINTENANCE

4.1 INTRODUCTION

This section contains fault isolation and general maintenance information and general care of semiconductors, the proper use of test equipment, and general good practice.

4.2 TECHNICAL ASSISTANCE

A toll-free telephone number is available for customers with equipment problems. This number is a direct line to our service department and cannot be used to reach any other department. In most of the United States, Puerto Rico, and the U.S. Virgin Islands, call 800/637-9181. In Alaska, Hawaii, and outside the U.S.A. call 217/223-3211. Business hours are between 8:00 a.m. and 5:00 p.m. Central time.

4.3 SEMICONDUCTOR MAINTENANCE

4.3.1 GENERAL

Due to the wide utilization of semiconductors in this electronic equipment, somewhat different techniques are necessary in maintenance procedures. In solid-state circuits the impedances encountered are often of much lower values than those encountered in vacuum-tube circuits. Therefore, a few ohms discrepancy can greatly affect the performance of the equipment. Also, coupling and filter capacitors are of larger values and usually are tantalum. Hence, when measuring values of capacitors, an instrument accurate in the high ranges must be employed. Capacitor polarity must be observed when measuring resistance. Usually, more accurate measurements can be obtained if the semiconductors are removed from the circuits.

4.3.2 SEMICONDUCTOR TEST EQUIPMENT

Damage to semiconductors by test equipment is usually the result of accidentally applying to much voltage to the elements. Common causes of damage from test equipment are discussed in the following paragraph.

4.3.3 TRANSFORMERLESS POWER SUPPLIES

Test equipment with transformerless power supplies are one source of high current. However, this type of test equipment can be used by employing an isolation transformer in the ac power line.

4.3.4 LINE FILTER

It is possible to damage semiconductors from line current, even though test equipment has a power transformer in the power supply, if the test equipment is provided with a line filter. This filter may function as a voltage divider and apply half voltage to the semiconductor. To eliminate this condition, connect a ground wire from the chassis of the test equipment to the chassis of the equipment under test before making any other connections.

4.3.5 LOW-SENSITIVITY MULTIMETERS

Another cause of semiconductor damage is a multimeter that requires excessive current to provide adequate indication. Multimeters with sensitivities of less than 20,000 ohms per volt should not be used on them. When in doubt as to the amount of current supplied by a multimeter, check the multimeter circuits on all scales with an external, low-resistance multimeter connected in series with the multimeter leads. If more than one milliampere is drawn on any range, this range cannot be safely used on small semiconductors.

4.3.6 POWER SUPPLIES

When using a battery-type power supply, always use fully charged batteries of the proper value. Make certain that the polarity of the power supply is correct for the equipment under test. Do not use power supplies having poor voltage regulation, (voltage regulation within 5%, ripple 1%).

4.3.7 SEMICONDUCTOR VOLTAGE AND RESISTANCE MEASUREMENTS

When measuring voltage or resistance in circuits containing semiconductor devices, remember that these components are polarity and voltage conscious. Since the values of capacitors used in semiconductor circuits are usually large, time is required to charge these capacitors. Thus, any reading obtained is subject to error if sufficient time is not allowed for the capacitor to fully charge. When in doubt, it may be best to isolate the components in question and measure then individually.

4.3.8 TESTING OF TRANSISTORS

A transistor checker should be used to properly evaluate transistors. If a transistor tester is not available, a good multimeter may be used. Make sure the multimeter meets the requirements outlined in paragraph 4.3.5.

- PNP TRANSISTOR To check a PNP transistor, connect the positive lead of the multimeter to the base of the transistor and the negative

lead to the emitter or collector. Generally, a resistance reading of 50,000 ohms or more should be obtained.
Reconnect the multimeter with the negative lead connected to the base. With the positive lead connected to the emitter or collector a resistance value of 500 ohms or less should be obtained.

- NPN TRANSISTOR With the negative lead of the multimeter connected to the base of the transistor, the value of resistance between the base and emitter or collector should be high. With the positive lead of the multimeter connected to the base, the value of resistance between the base and emitter or collector should be low. If these results are not obtained, the transistor is probably defective and should be replaced.

CAUTION

If a transistor is found to be defective, make certain that the circuit is in good operating order before installing a replacement transistor. If a short circuit exists in the circuit, putting in a new transistor will most likely result in burning out the new component and causing further damage. Do not depend on fuses to protect transistors. Always check the value of the bias resistors on the various elements. A transistor is sensitive to improper bias voltage; therefore, a defective bias resistor may damage the transistor.

4.3.9 REPLACING SEMICONDUCTORS

Never remove or replace a semiconductor with the power supply turned on. Transients produced may damage the semiconductor or others remaining in the circuit. If a semiconductor is evaluated in a in an external test circuit, be sure that no more voltage is applied to the semiconductor than normally is used in the circuit from which it came. The following paragraphs outline special considerations when replacing semiconductors.

1. Grasp the lead to which heat is applied between solder joint and the semiconductor with long nosed pliers. This will dissipate some of the heat that would otherwise be conducted into the semiconductor from the soldering iron. Make certain that all wires soldered to the semiconductor terminals have first been properly tinned so that the necessary connection can be made quickly. Excessive heat will permanently damage a semiconductor.
2. In some cases, power transistors are mounted on heat sinks that are designed to dissipate heat away from then. In some circuits, the transistor must also be insulated from ground. The insulating is accomplished by means of a mica insulating washer. When replacing transistors so mounted, be sure that the insulating washers are replaced properly. After the transistor is mounted and before making any connections, check the case of the transistor to ground with a multimeter to check the insulation.
3. It is important to remember to always remove all thermal compound and clean all matter (filings, etc.) from the transistor, heat coupler, heat sink, etc. Apply a thin layer of thermal compound to the transistor and carefully mount it, making sure not to get any particles on the compound. A small piece of matter can hold the transistor above the heat coupler or heat sink and cause rapid failure. A thermal compound such as Wakefield part No. 120-8 or equivalent is recommended.

4.3.10 REPLACING RF STRIPLINE POWER TRANSISTORS

It is strongly recommended that when a power transistor fails, the pc board be returned to the factory for repair because of the special procedures required to replace that item.

4.4 INTEGRATED CIRCUIT MAINTENANCE

4.4.1 GENERAL

A knowledge of integrated circuit fundamentals is as necessary in testing digital logic circuits involving ICs as a knowledge of rectification fundamentals is needed to test a power supply.

4.4.2 TERMINOLOGY

Several terms are used whenever logic circuits are discussed:

1. A logic state is a high or low level voltage applied to the input or seen at the output of a device. A high level voltage is called a HI. A low level voltage is called a LO. Logic threshold voltage of a device is the input voltage required at the input to change the output state.
2. A truth table is a list of logic states that will yield certain output logic states. A digital logic element should be thought of as a circuit element with its input level being either HI or LO as programmed by the levels present on its inputs.
3. Logic elements which have multiple inputs and single outputs are known as gates. The OR gate produces a high output when one or more of the inputs are high. With all the inputs LO, the output is LO. The AND gate produces a HI only when all inputs are HI. When any input is LO, the output is LO. A small circle at the output of a gate on the schematic indicates "negation", which means that the sense of the gate is reversed. An OR gate with negation is called a NOR gate and an AND gate with negation is called a NAND gate. A NOR gate produces a LO output when one or more inputs are HI and a NAND gate produces a LO output when all inputs are HI.
4. The flip-flop logic element is the basic data storage element of digital logic. It has two outputs that are always at opposite logic levels. That is, when one particular output is HI the other is LO. The flip-flop will remain in a particular state until the state is changed by an input signal. The operation of these flip-flops is controlled by the signals on their inputs, and is best understood by a careful study of their truth tables. It should be kept in mind that a small circle at either the input or the output indicates negation. Also, a circle on a clock input indicates that a HI to LO transition causes the flip-flop to function.
5. Besides the gates and flip-flops, two other commonly used logic elements are inverters and expanders. Inverters are merely switching transistors such that if a HI is the input to a device, a LO is the output and visa- versa. An expander is a set of parallel switching transistors that depends upon another transistor to provide their supply voltage. Generally, these devices are used to expand the number of inputs available to a standard gate.

4.4.3 VOLTAGE MEASUREMENTS

Precise voltage measurements are not needed in testing digital ICs other than to see that the voltage is a HI or LO level. An oscilloscope is needed where the input levels are of short duration, either HI or LO. For instance, if a ten-microsecond pulse going from LO to HI was applied to one input of a NOR gate, while the other stayed LO, the output would go LO after ten microseconds and then return HI. This, of course, could not be seen without an oscilloscope.

4.4.4 TESTING INTEGRATED CIRCUITS

LOGIC LEVELS

The fully loaded guaranteed minimum HI and maximum LO for the digital logic output levels are:					
TTL (Vcc = 5 V)		ECL (Vcc = 5.2 V)		CMOS (Vcc = 13 V)	
HI	LO	HI	LO	HI	LO
2.4	0.5	4.25	3.48	12.5	0.5
The minimum HI and maximum LO input levels which are guaranteed to be correctly interpreted are:					
TTL (Vcc = 5 V)		ECL (Vcc = 5.2 V)		CMOS (Vcc = 13 V)	
HI	LO	HI	LO	HI	LO
2.0	0.8	4.06	3.75	9.5	4.0

When checking the input and output levels of a logic element under question it should be remembered that an input or output may not agree with its truth table not because it has malfunctioned, but because some other component connected to the same point has shorted to ground or to the supply voltage (Vcc). This is not uncommon when an output on one element is connected to an input of another. A majority of digital IC failures can be grouped into three categories: 1. input(s) or output shorted to ground pin of IC 2. input(s) or output shorted to Vcc pin of IC 3. open input(s) or output. An input or output shorted to ground would be a constant LO and input or output shorted to Vcc would be a constant HI. Other failures common to digital ICs are ground pin open, Vcc pin open, and inputs shorted. An open ground pin does not allow a LO on the output. An open Vcc pin does not allow a HI on the output. (Remember to isolate the device from other components.). Two or more inputs shorted together can be checked by grounding one of the inputs under question. If the other input also goes to ground, they are probably shorted.

CAUTION

If an IC is found to be defective, verify that proper power supply voltages are present before installing a replacement IC.

4.4.5 REPLACING INTEGRATED CIRCUITS

If an IC is known to be defective and is not used with a socket, the easiest way to remove it is to cut off each of its pins, remove the case, and then unsolder the remaining pins from the integrated circuit card one by one. This is preferable to removing the IC intact because such attempts may result in damage to the pc board.

4.4.6 HANDLING CMOS OR MOS INTEGRATED CIRCUITS

All MOS or CMOS devices are subject to damage by large electrostatic charges. The following precautions should be observed:

- Devices should be transported in conductive carriers. Leads may be shorted by antistatic tubes, conductive foam, or foil. Do not remove devices from protective carriers until ready to use.
- Individuals and tools should be grounded before coming in contact with devices. Avoid touching device input/output pins.
- Work stations should have conductive tops on work benches connected to ground to reduce static build-up.
- Remove power from printed circuit boards before removing or installing devices in sockets.
- After installation of devices on pc boards, board connectors should be shorted to prevent static charges until ready to install boards in system. Conductive foam may be used.

4.5 REPAIR HINTS

The appropriate sections contain detailed functional theory, bills of material, assembly drawings, and schematics of equipment. The chassis and printed circuit board parts lists are divided into referenced and nonreferenced parts. Referenced parts are referred to on assembly drawings or schematics in this manual. Nonreferenced parts are the other parts which make up the individual assemblies. To quickly locate a desired bill of material, use the illustration list in the table of contents to locate the corresponding illustration. The bill of material normally directly precedes the assembly drawing.

SECTION V

ALIGNMENT

5-1 GENERAL

Check transmitters periodically to determine that they are performing within operating limits and adhering to regulating-authority requirements. Perform the following basic performance checks. Parameters falling outside the limits indicated may generally be corrected by performing the system adjustments in section 3.

5-2 TEST EQUIPMENT REQUIRED

Table 5-1 lists the test equipment required.

5-3 INITIAL CONDITIONS

The transmitter should be turned on, but not necessarily keyed, for at least one hour before performing the following checks. Check ac line voltage and dc supply voltages. The transmitter output should be working into a dummy load and a sample of the RF output should be coupled to the service monitor.

5-3.1 MODULATION CHARACTERISTICS

5-3.1.1 INPUT 1 (VOICE) (TB1-7&8)

Connect the audio oscillator to the voice input terminals TB1-7 and -8 on the rear of the chassis. Input impedance is 600 ohms, unbalanced, (balanced when dc or tone option is used), and input level should be reasonably close the normal voice level used in operation. The transmitter accommodates input levels in the range of -25 dBm to +15 dBm.

Table 5-1, Test Equipment Required

item	description
service monitor	IFR model 1200S or equivalent, capable of measuring channel operating frequency and frequency deviation to simulcast standards. Monitor should preferably include a dc-coupled oscilloscope.
audio oscillator	Hewlett-Packard model 204C or equivalent
wattmeter	Bird model 43 or equivalent
dummy load	Bird model 8135 or equivalent, 50 ohm
multimeter	Beckman model 330 or equivalent

The audio response follows a standard EIA preemphasis curve from 300 to 3000 Hz. To check this response, apply a 1000-Hz tone to the input and adjust the audio oscillator output until the frequency deviation, as observed on the service monitor, is 2.0 kHz. The response at other frequencies should be within the range given in the table below for equal audio input levels.

audio freq		minimum deviation	maximum deviation
300 Hz		210 Hz	340 Hz
600 Hz		420 Hz	670 Hz
1000 Hz	(ref)	1000 Hz	1000 Hz
2000 Hz		1400 Hz	2200 Hz
2500 Hz		1700 Hz	2800 Hz
3000 Hz		2100 Hz	3300 Hz

5-3.1.2 INPUT 2 (DIGITAL) (TB1-9)

Connect the audio oscillator to the digital input terminal, TB1-9, and ground, TB1-11. Input impedance is 600 ohms, unbalanced. Input level range is 0.5 to 5.0 volts ac. Use a level approximately equal to that applied in normal operations.

The digital channel is essentially flat over the frequency range of 20 to 3000 Hz for fm models and over the range of 300 to 3000 Hz for pm models. Set the oscillator frequency to 1000 Hz and adjust output level to produce ±2.0 kHz deviation at the transmitter output. Deviation should fall within the limits of ±1.4 kHz and ±2.2 kHz over the full frequency range of 20 to 3000 Hz.

5-3.1.3 AUDIO WAVEFORM DISTORTION

The audio distortion specification is two percent maximum total harmonic distortion at 1000 Hz and 3.3-kHz deviation. This small amount of distortion is not noticeable when the demodulated sine wave is observed on the service monitor display.

No visible distortion shall be evident at any test frequency from 20 to 3000 Hz at and deviation up to 3.3 kHz for the digital input on the QT-4501, QT-4503, QT-6501, or QT-6503 direct fm transmitters. The same is true for any frequency from 300 to 3000 Hz when using the voice input of these two systems.

On the phase modulated QT-4500, QT-4502, QT-6500, and QT-6502, moderate sine wave peak flattening will be observed at 300 Hz for deviation levels above 2.0 kHz.

5-3.2 FREQUENCY STABILITY

Make a check of transmitter frequency stability by periodically recording carrier frequency at maximum output operation. Start the test after several hours of warm up with primary power applied, but with the system unkeyed. Key the transmitter by grounding TB1-6 and adjust output power to 25 watts on QT-4500 series units or 100 watts of QT-6500 series units. Make frequency measurements at short intervals over a period of several hours.

5-3.3 POWER OUTPUT (QT-4500 SERIES)

The power output should be smoothly adjustable between the limits of 12 and 25 watts by means of potentiometer A5R13.

5-3.4 POWER OUTPUT (QT-6500 SERIES)

The power output should be smoothly adjustable between the limits of 50 and 100 watts by means of potentiometer A5R13. The absolute maximum power that can be delivered is typically 110 to 120 watts. Transmitter power output adjustments should include a check of antenna system reflected power to determine that the VSWR is within specifications.

With the exception of R7, none of the adjustments of elements in the final amplifier A7 should be changed. Capacitors C21 and C23 are factory-set and should not be adjusted. Capacitors C1, C9, and C10 require resetting, along with other elements in the system, only if operating frequency is changed over a span of 10 MHz or more. If such a change is required, adjust C1, C9, and C10 as follows:

1. Adjust C1, C9, and C10 for max power output.

2. Connect voltmeter between TP1 and TP2 and adjust either (not both) C9 or C10 for zero voltage difference between TP1 and TP2. This adjustment balances driving levels to Q1 and Q2.

5-4 DETAILED ALIGNMENT

5-4.1 FREQUENCY TRIM

See section 3 for this adjustment.

5-4.2 AUDIO BOARD A2

Refer to Figure 7-3.

1. Apply power to transmitter and check dc voltages as follows:

test point	indication (Vdc)
TP1	5
TP2	12
TP3	n/a
TP4	5-7
TP5	5-7
TP6	5-7

2. Connect audio tone generator to voice input, TB1-7 and 8, and service monitor to RF sample of transmitter output.

3. Connect oscilloscope to TP5 and chassis ground.

4. Apply 1000-Hz tone at -20 dBm.

5. Adjust R2, voice input adjust, until clipping is just noted on scope.

6. If clipping is not symmetrical, adjust R50, limiter symmetry, for symmetrical clipping. Audio level on oscilloscope should be 9 Vp-p.

7. Increase audio generator level 20 dB to 0 dBm.

8. TP4 should be about 3-4 Vp-p.

9. TP6 should be about 6-7 Vp-p.

10. Adjust transmitter deviation to 4.5 kHz on service monitor using R28, deviation limit adjust.

5-4.3 DIRECT FM MODULATOR A4 VCO ADJUST

Refer to Figure 7-11. This adjustment applies only to the direct-fm modulator. L1 controls the free-running frequency of the modulated voltage-controlled oscillator, and is adjusted to set the phase-locked loop control voltage, as measured at TP2, to the center of the allowable voltage range. Measure the dc voltage at TP2 (brown) with a multimeter, and adjust L1 for a voltage of 6 volts. The loop will be locked with the transmitter on the correct frequency, when the voltage at TP2 is between 1 and 11 volts.

5-4.4 PHASE MODULATOR ADJUSTMENTS (A4L1, L2, L3, L4)

Refer to Figure 7-9. These adjustments apply only to the phase modulated transmitter, models QT-6500/4500/4502, and -6502. Adjust each of the four coils for maximum voltage at A4TP2 (yellow), using a multimeter. A typical maximum reading is 4 volts. This adjustment should be done very carefully to ensure minimum distortion of the modulated waveform.

5-4.5 PHASE MODULATOR OUTPUT TUNING (A4L5)

Measure the voltage at A5TP1 (red) on the multiplier board. Adjust A4L5 for mimimum dc voltage. A typical reading is 11 volts.

5-4.6 MULTIPLIER ADJUSTMENTS (A5L2, L4, C11, C13, C15, L7, C17, C19, C22, C24)

The 25- or 100-watt board power plug removed and the transmitter keyed, perform the following steps using a multimeter. Terminate multiplier with 50 ohms. If 25-watt board is hooked up and 100-watt board is unplugged, terminate the 25-watt board with 50 ohms.

for minor tuning:

step	adjustment	test point	tune for	typical voltage
1.	L2	TP2	min V	9-10 V
2.	L4,C11,C13,C15	TP3	min V	9-10 V (note 1)
3.	R13	TP4	set at 9-10 V	(note 2)
4.	C17, C19	TP4	min V	(note 2)
5.	R13	TP4	max V	(note 2)
6.	C22, C24	TP5	max V	4.5 V (note 2)

For a major change of frequency tuning only: Preset the following components:

L2	3 turns in from end of form
L4	2 turns out from max
C11,C13	3/4 mesh
C15	1 turn in from min
R13	maximum cw
C17,C19	1/2 mesh
C22,C24	1/2 mesh

Proceed to step 1 above.

Notes:

1. C15 may require adjustment after L4 to allow min with C13 and C15.

2. Actual voltage varies due to frequency and use of direct fm or pm.

3. Reading of 4.5 Vdc is typical when multiplier board is terminated into 50-ohm load. When reconnected to 25-W driver board, this voltage may range from 3.5 to 8 Vdc due to possible change in load impedance.

5-4.7 25-WATT BOARD TUNING (A6C2, C8, C25, C23, C21, A5R13)

Tune as follows:

Capacitors C2, C8 are both tuned for maximum power output. Then detune C2 to the lower-capacity side for a power decrease of about 2 watts. This allows a smooth variance of power output.

5-4.8 100-WATT POWER AMPLIFIER TUNING (A5R13, A7C9, C10, C23, C1, C21)

This circuit is precisely tuned at the factory. No adjustment should be made unless a repair or frequency change is being made.

If retuning is necessary, follow this procedure carefully:

ALIGNMENT

1. Preset following components:

adjustment	pc board	position
A5R13	mult	fully ccw
A7C1	100-W PA	1/2 turn from fully cw
A7C9, A7C10	100-W PA	1 turn from fully cw
A7C21, A7C23	100-W PA	min (decoupled)

2. Using voltmeter and wattmeter, monitor PA collector current and transmitter power output as follows:

   Connect meter positive (+) lead to A7TP3 and negative (-) lead alternately to A7TP1 and A7TP2 to measure voltage drop across appropriate metering resistors for PA collector circuits. Switching leads from TP1 to TP2 allows careful balancing of collector voltage during following adjustments:

adjustments	reading
R13	Increase drive not to exceed 0.4 Vdc at TP1 and TP2.
C9	Increase to 0.2 Vdc at TP1.
C10	Increase to 0.2 Vdc at TP2.
C23	Tune to min Vdc with max power output.
C1	Tune to max (sharp peak) with max power output.
C9, C10	Increase both in small increments maintaining close voltage balance on Q1 and Q2 collectors. Continue until peak power is obtained. Do not exceed 0.4 Vdc at TP1 or TP2.
C21	Adjust for min voltage balance at TP1 and TP2 with max power output. This allows max efficiency of transmitter. Typical readings of 0.28 to 0.33 Vdc are obtained with 100 W output power. Repeat adjustments several times to ensure proper loading.

3. Vary A5R2 for smooth power adjustment. If not smooth, detune C2 on 25-W board for slightly less capacity. Recheck power adjustment. Couple sample of transmitter output to spectrum analyzer to check for spurious output.

5-4.9 OUTPUT INDICATOR THRESHOLD ADJUSTMENT (A6R67OR A7R7)

Slowly increase transmitter output power with A5R13 until desired min level of power required is reached. Adjust R7 until RF OUTPUT LED on front panel is lit. Factory setting for adjustment is 80 W on QT-6500 and 20 W on QT-4500.

SECTION VI

THEORY OF OPERATION

6-1 SIMPLIFIED CIRCUIT THEORY

6-1.1 GENERAL

The Quintron QT-4500 and QT-6500 Series of solid state transmitters includes the single channel phase modulated Model QT-4500 and QT-6500, the single channel Digi Cap II direct FM Model QT-4501 and QT-6501, the dual channel Phase Modulated QT-4520 and QT-6520, the dual channel Digi-Cap II direct FM QT-4521 and QT-6521, the multi-channel Phase Modulated QT-4502 and QT-6502, and the multi-channel Direct FM QT-4503 and QT-6503. The QT-4500, QT-4501, QT-6500 and QT-6501 accept plug-in printed circuit oscillators to provide either standard frequency stability (±0.0002%) or high stability (±0.000005%) operation. The QT-4502, QT-4503, QT-6502 and QT-6503 provide multi-channel capability of ±0.0005 Standard, ±0.0002 Optional. The QT-4520/4521 and QT-6520/6521 are ±0.0002%.

These units are also available as QT-4500/6500PMX or QT-4501/6501PMX when used with the optional PMX-16 Programmable Master Oscillator. The PMX-16 has its own manual.

The basic transmitter chassis, power supply, rf amplifiers, and all PC boards except Card A4 (the modulator) are common to the QT-4500, QT-4501, QT-6500 and the QT-6501. The QT-4502, QT-4503, QT-6502 and QT-6503 employ an external multi-channel oscillator in lieu of the A3 oscillator PC board. Except for some of the power supply components and for the external multi-channel chassis, the entire transmitter circuitry is contained on six printed circuit boards, A1 through A6, on QT-4500 series units and on eight printed circuit boards, A1 through A8, on QT-6500 series units.

6-1.2 MASTER BOARD A1

This is a back plane board containing the +26 V regulator, power supply overload protection circuitry, the VSWR Sensor signal amplifiers and sensitivity adjustment (QT-6500 series only), plug-in connectors for PC Board A2 through A6, and PC Board interconnect circuitry.

6-1.3 AUDIO BOARD A2

All audio and digital processing circuitry, the VOX keying circuit, and Modulation, RF output, and VSWR status indicators are mounted on the Audio Board.

6-1.4 OSCILLATOR BOARD A3

Two types of A3 oscillator PC boards are available: (1) a Universal Oscillator board which has either a high stability (± 0.000005%) oscillator, a TCXO (±0.0002%) oscillator or a Model 83-12 (±0.0001%) oscillator, and (2) the Standard Stability (±0.0002%) ovenized oscillator. Both oscillator boards operate at 1/36th of the channel carrier frequency.

The QT-4520, QT-4521, QT-6520 and the QT-6521 uses the Dual Channel Oscillator board, see section VIII for information. The QT-4502, QT-4503, QT-6502 and the QT-6503 uses the multichannel oscillator assembly which mounts in 1 3/4" of rack space, see section VIII for information.

6-1.5 PM MODULATOR BOARD A4

This PC board is used in the QT-4500, QT-4502, QT-6500 and the QT-6502 only and phase modulates the transmitter carrier in accordance with the audio, digital, or subtone signal from the A2 board. The input frequency is multiplied by 2 prior to modulation and by 2 after modulation.

6-1.6 FM MODULATOR BOARD A4

Used in the QT-4501, QT-4503, QT-6501 and QT-6503, this PC board modulates the transmitter carrier frequency directly in accordance with the audio, digital, or bustone signal from board A2. Output frequency from this board is 1/9th channel frequency.

6-1.7 MULTIPLIER BOARD A5

The output signal from modulator board A4 is multiplied by 9 in this PC board to arrive at the operating channel frequency. A series of tuned amplifiers reject spurious, harmonic and unwanted sideband signals. R13 in the output stage provides transmitter output power level control. In QT-6500 series units, Q5 (in this same stage) limits output power if an excessive VSWR condition exists at the transmitter system output terminal.

6-1.8 25-WATT AMPLIFER A6 (QT-4500 SERIES)

The 25 watt amplifier accepts the rf output of the Multiplier board, A5, and amplifies it to the transmitter output power level of 25 watts. This board also contains a low pass filter and the Power Output Indication threshold adjust.

6-1.9 25-WATT DRIVER A6 (QT-6500 SERIES)

This rf amplifier provides approximately 21 dB of gain for driving the 100 Watt final amplifier stage, A7.

6-1.10 FINAL AMPLIFIER A7 (QT-6500 SERIES)

Parallel power transistors provide 6 dB of power gain for a system output of up to 100 watts. A power output level sensor and threshold control for local and remote Power Output indicators is included on this PC Board.

The VSWR Sensor at the output of the final amplifier senses the presence of an excessive VSWR condition and uses this information to limit output power to a safe operating level until the VSWR condition has been corrected. This circuit also lights the VSWR indicator located on the Audio board.

6-1.11 HARMONIC FILTER A8 (QT-6500 SERIES)

This passive filter rejects harmonics of the transmitter output signal.

6-2 DETAILED CIRCUIT THEORY

6-2.1 CHASSIS A0 AND MASTER BOARD A1 (QT-4500 SERIES)

Primary power transformer T1 and its associated dc rectifier circuitry is located in the left hand section of the system main chassis. T1 is tapped to accommodate AC line voltages of 110, 120, 220 and 240 volts. Transformer connections for these values of line voltages are shown on Drawing No. 286-0007-000. Thermal switch S2, voltage regulator VR1 and transistor Q1 are mounted under the master PC board, A1. This arrangement brings these elements into contact with the large heat sink mounted on the rear of the chassis for temperature sensing and for heat dissipation.

Transformer T1 and full wave bridge rectifier CR1 supply +37 volts to the foldback dc regulator consisting of U1 (LM305A), dc amplifier Q1 (on the master board), and series pass Darlington transistor Q1 located on the chassis assembly. The output of this circuit is +26 volts, regulated.

The dc voltage developed across current sensing resistor R3 is coupled to current limiting pin 1 of U1. This arrangement automatically prevents regulator overload by reducing output voltage if current drain becomes excessive.

VR1 is a monolithic regulator supplying +12V for all transistor circuit in the chassis except the power amplifier stage. This regulator is short-circuit protected.

6-2.2 CHASSIS A0 AND MASTER BOARD A1 (QT-6500 SERIES)

Primary power transformer T1 and associated dc rectifier circuitry is located in the left hand section of the system main chassis. T1 is tapped to accommodate AC line voltages of 110, 120, 220 and 240 volts. Transformer connections for these values of line voltages are shown on the power supply cover plate. Thermal switches S2 and S3 are located under the 100 watt final amplifier PC board, and voltage regulator A10 as well as transistor Q1 are mounted under the master PC board. This arrangement brings these elements into contact with the large heat sink mounted on the rear of this chassis for heat dissipation.

Dual secondaries of transformer T1 supply full wave bridge rectifiers CR1 and CR2. CR2 furnishes unregulated +30 volts at 7.0 amperes to the 100 watt final amplifier stage A7. CR1 supplies +37 volts to the foldback dc regulator consisting of U1 (LM305A), dc amplifier Q1 on the master board, and series pass Darlington transistor Q1 located on the chassis assembly. The output of this circuit is +27 volts regulated.

The dc voltage developed across current sensing resistor R3 is coupled to current limiting pin 1 of U1. This arrangement automatically prevents regulator overload by reducing output voltage if current drain becomes excessive.

VR1 is a monolithic regulator supplying +12V for all transistor circuits in the chassis except the two power amplifier stages. This regulator is short-circuit protected.

The VSWR sensing Amplifiers, Q2 and Q3, are described under the 100 Watt amplifier section of this manual.

6-2.3 AUDIO BOARD A2

The Audio PC Board contains circuitry for performing the following functions:

1. Amplification, gain control, modulation limiting, and frequency response shaping for both the Voice/Tone and the Digital Data channels.

2. VOX Keying

3. LED status indications showing (a) the presence of sufficient modulating signal to provide at least 1.5 KHz transmitter deviation, (b) the transmitter output power is reaching a required preset level, and (c) the existence of an excessive VSWR condition at the transmitter output terminal. Driving circuits for remote indications of these three parameters are also provided. Maximum permissible sinking current for these circuits is 16 ma.

Schematic 286-0016-000 shows the audio PC board. Voice and/or tone signals are applied to input terminals 7 and 8, which drive operational amplifier U6 via Voice Input Adjust control potentiometer R2. U6 has a gain of about 15 and drives the pre-emphasis circuit consisting of C3 and the input R of U1A. This provides standard EIA 6dB per octave pre-emphasis from 300 to 3000 Hz on the voice input. U1B acts as the deviation limiter to prevent overmodulation. U2 A and B make up the 5 pole low pass filter to limit the response of the audio signal to about 3 KHz.

The Digital Data input is applied at terminal 6 of connector P1 and routed via Digital Input Adjust control R12 to the flat input of U1A. Connecting links AB and CD may be removed and a direct connection made between terminals B and C to provide a flat voice channel with a 600 ohm input impedance.

P1, terminal 3, accepts low frequency (CTCSS) coded digital tone signals which are used in some receiver systems for squelch control.

Modulating Voice or Data signals are combined with subtone signals, when used, at the input of U2A, the low pass filter stage. The output of U2B is routed to (a) the Modulator PC board A4 (for transmitter modulation) via deviation limiter control R28 and (b) the VOX keying and modulation indicating circuits consisting of U3 and associated components.

Modulating audio is applied to terminal 3 of VOX keyer U3 and the trigger threshold for this unit is established by the setting of potentiometer R39. When the input audio level is sufficient to trigger U3, terminal 2 is driven to low logic level. This action drives U3-4 high, transistor Q2 into conduction, and keying output terminal 4 to the low logic level required to key the transmitter.

The operation of the modulation indicator is identical to that of the VOX keyer except that the trigger threshold of this circuit is fixed by voltage divider R47 and R48.

LED3 and LED4, when lit, indicate respectively adequate rf output level from the system and excessive VSWR at the transmitter output connection when these conditions exist. Multiple inverter elements in U4 drive these LED indicators into conduction as determined by the RF Indicator Input and VSWR Indicator Input logic signals from the system final amplifier PC board. Q6 and Q7 collector output at P2 terminals 5 and 8 may be used to drive remote indicators showing the status of these two parameters.

6-2.4 REFERENCE OSCILLATOR A3

As shown in Dwg. No. 285-0038-001, most elements of this PC board are enclosed in a temperature controlled oven assembly for maximum frequency stability. In addition, crystal Y1, Darlington amplifiers Q1 and Q4, temperature sensitive resistor R8, and the 3 watt heating resistor R7 are mounted on a common aluminum plate for effective thermal intercoupling between these elements. Oven temperature is maintained at +75°C by the general dissipating of heat from transistors and other components within the oven and primarily by the heat dissipation of resistor R7.

Oven temperature is set by adjustment of potentiometer R2 and the associated amplifier Q4, which in turn drives amplifier Q1. Q1 controls the current flowing through heating resistor R7. Variations in oven temperature are sensed by high gain Darlington Q4 and amplified by Q1 which changes the current through R7 to compensate for the original tendency toward temperature change.

Thermal sensitive resistor R8 senses oven temperature and converts this to a temperature indicating Voltage at TP2. An oven temperature of +75°C corresponds to a potential of 7.5 Volts at TP-2. Each 0.1 Volt increment of deviation from this nominal 7.5V sensor voltage represents a temperature deviation of 1°C within the oven.

6-2.5 UNIVERSAL OSCILLATOR BOARD A3

This oscillator board uses either a high stability (74-14), TCXO (OE-30), or Std. stability (83-12) Oscillator assembly, which operates at 1/108th of the carrier frequency at UHF or 1/36th at VHF. The board contains an oscillator assembly Y1, an amplifier Q1, two threshold amplifiers U1A and U1B, and two LEDs for alignment.

Allow the oscillator board to operate for 15 minutes before tuning. Turn the level control R4 clockwise until the green "OK" LED 2 comes on or until the control is maximum clockwise. Tune L1 for maximum brightness of the green "OK" LED 2. As L1 is tuned the level control R4 must be reduced (CCW) to keep the red "HI" LED 1 from coming on. When L1 has peaked, adjust R4 so that the green LED is on and the red LED is off.

6-2.6 FM MODULATOR BOARD A4

The FM Modulator consists of voltage controlled oscillator (VCO) Q2 which is phase locked to a sub-harmonic of the crystal reference signal and is frequency modulated directly by the transmitted audio signal. TCXO reference frequency is 1/36th of the assigned channel frequency. The VCO is locked to 1/9th of the channel frequency for an effective multiplication factor of four on this PC board.

VCO frequency is determined by a number of parameters, including inductor L1, by the audio modulating voltage applied to varicap CR3, and by the phase detector control voltage driving varicap CR2. The crystal reference signal entering the FM board via terminal 3 on P1 is divided by 128 in U1 , and applied to one input of (Pin 14) phase detector U2. The second input to the phase detector (Pin 3) is a sub-harmonic of the TCXO output, which has been amplified in U6, divided by 8 in counter U4, and divided again by 64 in counter U5. The phase detector output signal is essentially a dc voltage proportional to the phase difference between the VCO input and the reference input, is applied to varicap CR2 and holds the VCO locked in a precise phase relationship to the crystal reference. RC network R11/C5 reduces the phase detector loop response at audio modulating frequencies, preventing the loop from tracking out audio information. R12 and C6 remove residual input frequency components from the phase detector output signal. L1 sets Q2 oscillator frequency in the center of its lock-in range as established by varicap C2.

VCO output in amplified by IC U6, providing two low impedance outputs; one routed to the phase detector as discussed above, and the second to the VHF Multiplier, to subsequent rf power amplifier and finally to the transmitter output terminal.

The 4 to 1 ratio between the reference signal counter U1 (counting by 128) and the combined effect of VCO counters U4 and U5 (4X 128) establishes VCO output frequency at 4 times TCXO reference input frequency, 1/9th of channel carrier frequency.

Transistor Q3 amplifies the VCO signal and, subject to the control of transistors Q5 and Q4, provides an FM Modulator output which is routed to the VHF multiplier. Q5 keys this output "ON" when the transmitter is keyed. Q4 inhibits rf output in the VCO is out of lock with the crystal reference (off frequency).

6-2.7 PM MODULATOR BOARD A4

The PM Modulator accepts the crystal reference standard output, multiplies this by a factor of 2, phase modulates this result in accordance with the Voice, Subtone, or Data information from PC Board A2, amplifies this signal, and again multiplies by 2 in the final stage of P.C. Board A4. The output of this board is a modulated IF signal at 1/9 of carrier frequency.

The reference oscillator signal is applied to frequency doubler Q1 where it is filtered by double tuned circuit, L1-C4 and L2-C6. This signal drives the phase modulator network consisting of L3-C9, dual varicap modulator CR2, and output components L4, C14 and C15. Q1 is keyed "ON" via either the transmitter VOX Keying signal or via an external keying signal applied to P1, Pin 1.

The transmitter may be either positive (2.5 to 30VDC) keyed or ground keyed. The transmitter is factory set for ground keying with the "A" jumper in place. The operating voltage of the keying circuit is shown on schematic 285-0157-000.

The modulating voice, tone or data signal from the Audio PC board is applied to dual voltage variable capacitor CR2. The capacity of this element changes as a function of the Audio signal, producing a phase shift of the applied rf signal which is proportional to the level of the modulating audio voltage. R5 and R6 provide the required bias voltage for varicap CR2. CR3, R9 and C11, etc. form a detector and filter for adjustment indications of L1, L2 and L3. These coils are adjusted for maximum dc voltage at TP2. R8, C22 and C23 provide high frequency deemphasis of the modulating signal.

The phase modulated IF signal is amplified and frequency doubled in stage Q2. IF output frequency is at 1/9 transmitter channel frequency and is of the order of approximately 17 MHz. This signal is applied to multiplier p.c. board A5.

Frequency determined components on the PM Modulator PC Board, A4 are: (Dipped mica capacitors, values in pF)

	C4,6	C9	C14	C15	C24
132-148 MHz	390	68	91	360	560
148-175 MHz	300	56	75	300	430
175-185 MHz	270	50	68	250	330

6-2.8 MULTIPLIER BOARD A5

Tuned Amplifier Q1 filters and amplifies the modulated IF signal arriving from Modulator A4, rejecting any extraneous noise or spurious signals falling outside the passband of this stage, and drives frequency tripler Q2. Unwanted harmonics of the IF signal and its associated sidebands are further rejected by four tuned filters, L4-C8, L5-C11, L6-C13, and L7-C15 in the collector circuit of tripler Q2. Q3 is a second tripler, bringing multiplier board output frequency to 9 times input, the on-channel operating frequency. Additional rejecting of subharmonics and unwanted sidebands is provided by tuned circuits L9-C17 and L10-C19. Amplifier Q4 boosts power output level to approximately 150 milliwatts for driving subsequent rf power amplifiers.

Power Adjust potentiometer R13 sets the transmitter output power level. Q5 serves to limit transmitter output power to a preset level if the antenna-feeder VSWR is excessive. (See 100 Watt final amplifier description for an explanation of the operation of this circuit) CR4 and C28 provide a rectified sample of multiplier signal output at TP5 (yellow) for alignment indications. Test points TP1, 2, 3 and 4 provide convenient locations for checking collector voltage and determining collector currents of transistors Q1, Q2, Q3 and Q4. The Multipler PC board output is routed to the 25 Watt Driver, board A6.

Frequency determined components on the Multiplier PC Board, A5, are: (Dipped mica capacitors, values in pF)

	C4	C8
132-144 MHz	510	250
144-162 MHz	510	200
162-180 MHz	430	150
180-185 MHz	360	120

6-2.9 25-WATT AMPLIFIER A6 (QT-4500 SERIES)

A two stage class C rf amplifier provides a power gain of 21 dB over a frequency range of 132 to 185 MHz. Collector current of each stage may be checked by measuring the voltage drop across metering resistors R2 and R4. A typical voltage drop across R2 would be 0.5 volts (Ic = 250 ma), and across R4 would be 0.33V (Ic = 1.25 Amps). The output of Q2 is routed through a four section harmonic filter to P5 and then via a short length of coax to transmitter output terminal J3.

A small sample of the system rf output is routed via a 0.7 pf capacitive probe to CR1 and its associated filtering circuit. This rectified signal is amplified by transistor Q3 and routed to the audio board for transmitter rf output indications (see audio amplifier P.C. board description). R7 is used to set the threshold level at which the rf output indication is triggered.

6-2.10 25-WATT DRIVER A6 (QT-6500 SERIES)

A two stage class C rf amplifier provides a power gain of 21 dB over a frequency range of 132 to 185 MHz. Collector current of each stage may be checked by measuring the voltage drop across metering resistors R2 and R4. A typical voltage drop across R2 would be 0.5 volts (Ic = 250 ma), and across R4 would be 0.33V (IC - 1.25 Amps). The output level of Driver A6 is approximately 25 Watts, which is routed to the 100 Watt final amplifier.

6-2.11 FINAL AMPLIFIER A7 (QT-6500 SERIES)

A7, the 100 Watt Final Amplifier, is a single stage class C rf power amplifier which delivers an output level of up to 100 Watts. The circuit is broadband and does not require tuning. Active elements of the amplifier consist of two type power transistors operating in parallel. Collector current of each transistor may be checked by measuring the voltage drop across metering resistors R3 and R4, utilizing test points TP1, 2 and 3. These measurements must be made with a high impedance meter such as one equivalent to 20,000 ohms per volt or higher. Typically, this voltage drop will measure about 0.3 Volts, corresponding to a collector current of 3 amperes. Collector current balance between transistors is not critical and an unbalance of the order of under 10% is not excessive.

The rf level sensing circuit formed by CR1, Q3 and associated components drives the RF indicator logic located on the Audio P.C. Board, A2. CR1 rectifies a sample of the amplifier rf output and emitter-follower Q3 provides a low impedance output stage for feeding this signal to the Audio P.C. Board. R7 permits adjustment of the threshold level at which LED3 (located on the audio board) and the Remote RF Indicator logic trigger to show low rf output.

C21 and C23 are factory set and should not be adjusted in the field. C1, C9, and C10 require adjustment only with major frequency changes. (See alignment section).

6-2.12 VSWR SENSOR (QT-6500 SERIES)

A VSWR sensing circuit consisting of a directional coupler, a hot carrier diode rectifier, and associated circuitry is included on the 100 Watt output amplifier PC board. This circuit detects any reflected rf energy appearing at the transmitter output terminal and automatically reduces transmitter output power if the VSWR exceeds a preset level. This signal also triggers logic circuitry in the audio p.c. board which 1) turns on a LED indicator if the VSWR is excessive, and 2) generates a logic signal which may be used for remote indication of an excessive VSWR condition.

CR2 rectifies the reflected energy sensed by the directional coupler. L15, L16, C32, and C33 filter this rectified voltage which is then routed to the master p.c. board via J2, to the base of transistor amplifier Q2 via threshold adjusting potentiometer R7. The positive signal appearing on the base of Q2 (when the VSWR is high) pulls Q2 into conduction, driving its collector in the negative direction. This signal is applied to the base of Q3 which controls PNP transistor Q5 located on the Multiplier p.c. board A5. Q5 is in series with the positive voltage supply for rf output amplifier stage Q4 and with the power adjust control R13. An excessive VSWR condition drives the collector of Q3 (on Master PC Board A1) positive which increase the effective resistance of Q5, thus reducing the Multiplier P.C. Board rf signal level and decreasing transmitter output power.

Q3 (Master board) output is also routed to Audio P.C. board A2 via pin 6 of XA2, P2. This signal is 1) inverted by one element of the hex inverter U3, located on the audio board, providing output logic for driving a remote "Excessive VSWR" indicator via terminal 5 of XA2P2, and 2) is applied to two additional inverting stages of U3. This double inverted signal drives terminal 8 of U3 negative, thus turning VSWR indicator LED 4 on.

6-2.13 HARMONIC FILTER A8 (QT-6500 SERIES)

The output from the 100 Watt Final Amplifier is routed to a four section filter A8 which reduces harmonics of the transmitter output signal to more than 80dB below the modulated carrier.

6-2.14 BATTERY BACKUP KIT BAT-1

Battery Back-up Kits provide a means of automatically switching a Quintron transmitter to stand-by battery power in the event of AC line voltage failures. The BAT-1 is used with low power transmitters (up to and including 35 watts of output power) such as the Quintron QT-4500 series.

Drawing No. 283-0076-000 is a schematic of the BAT-1. All items shown, with the exception of the battery, are supplied with the kit. Typical batteries for this application would include high quality lead-acid deep discharge batteries such as those used for trolling motors.

The QT-4500 series transmitters require a nominal battery voltage of +28 volts for full output power. Since all DC supplies in this transmitter are fully regulated, battery voltages up to +30 volts are acceptable to the system. Two series connected, heavy duty 12V deep discharge batteries will supply sufficient energy to operate the transmitter at slightly reduced power output for a period of several hours. Operation at voltages below 22 volts is not recommended.

Installation: Installation of the battery should be in accordance with the manufacturers recommendations, maintaining the necessary precautions against possible dangerous and damaging effects of acid or alkali electrolytes, metallic corrosion, combustible battery fumes, etc. Except for the battery, all parts shown on the appropriate schematic diagrams are supplied with the kit. F1 is an in-line fuse contained within the battery connection cable. The P4 end of this cable mates with J4, the quick-disconnect jack located on the rear of the transmitter chassis. The free end of this cable connects to the positive battery terminal. Battery ground (negative terminal) connects to the binding-post type terminal located immediately below J4. All other components are factory installed within the transmitter chassis.

Circuit Description: During the charging cycle 37VDC from C13 drives the regulator U1 thru current limiting resistor R1. The voltage to the battery will be about 28VDC limited to 1/2 amp.

When AC fails, the voltage at C13 drops until it goes below the battery voltage. CR1 then conducts and the battery takes over the transmitter supply voltage.

6-2.15 BATTERY BACKUP KIT BAT-2

General Information: The BAT-2 Battery Back-up Kit provides a means of automatically switching a Quintron transmitter to stand-by battery power in the event of AC line voltage failures. The BAT-2 is available for medium power units (above 35 Watts and up to and including 100 Watts).

The BAT-2 is shown in schematic No. 283-0077-000. All items shown on the schematic, with the exception of the battery, are supplied with the kit.

Automotive type batteries can be used, however, they will not give long-life service. Automotive batteries are designed to provide larger amounts of currents for relatively short, 1 to 3 minute, periods.

For standby use, you need a battery designed to provide moderate amounts of current for long periods. Batteries in this category are referred to as deep discharge batteries. This type of battery should give you 3 to 4 years of standby service. Batteries of this type are used for such applications as electric trolling motors, golf carts and tow-motors.

Most battery manufacturers make deep discharge batteries. A typical example is the Gould "Action Pack" deep cycle. Sears and Roebuck also markets a special deep discharge version of their "Die-Hard" battery line which would also be good for this type of service. It is available through a Sears Catalog Center.

There are also special types of batteries, such as gelled electrolyte, wet cell and nickel-cadmium as used in telephone central offices. The chargers in your Quintron transmitter are not suitable for these types of batteries. These types require special charging characteristics. Also, while nickel-cadmium batteries have extremely long life (10 to 20 years), they are very expensive.

This series of Quintron transmitters places limitations on the battery supply voltage because the dc supply for the final amplifier is unregulated. At full charge, a 28 volt battery will deliver the full 100 watts of transmitter RF output power. If this full power operation is desired during the initial period of battery operation, a battery voltage of 28 volts is required. This 28 volt maximum should not be exceeded, however. After the initial period, the power output will fall-off at an approximately linear rate of 4.3 watts per volt as battery voltage decreases. At a battery voltage of 20 volts, output power will be about 40 watts.

Battery current drain under the above conditions varies approximately linearly with battery voltage from an initial maximum of 7.2 amps to approximately 4.5 amps at 20 volts.

Alternately, two series connected "12 volt" automotive batteries may be used for stand-by if reduced power output is acceptable. At full charge, this combination will actually deliver 27 to 28 volts to the transmitter, which corresponds to an output power of 95 to 100 watts during the initial period of battery operation. Current drain at this initial point will be approximately 6 amps.

Installation: Installation of the battery should be in accordance with the manufacturers recommendations, maintaining the necessary precautions against possible dangerous and damaging effects of acid or alkali electrolytes, metallic corrosion, combustible battery fumes, etc. Except for the battery, all parts shown on the appropriate schematic diagrams are supplied with the kit.

F1 is an in-line fuse contained within the battery connection cable. The P4 end of this cable mates with J5, the quick-disconnect jack located on the rear of the transmitter chassis. The free end of this cable connects to the positive battery terminal. Battery ground (negative terminal) connects to the binding-post type terminal located immediately below J5. All other components are factory installed within the transmitter chassis.

Circuit Description: During the charging cycle 37VDC from C13 drives the regulator U1 thru current limiting resistor R1. The voltage to the battery will be about 28VDC limited to 1/2 amp.

When AC fails, the voltage at C13 and C14 drops until it goes below the battery voltage. CR1 and CR3 then conducts and the battery takes over the transmitter supply voltage.

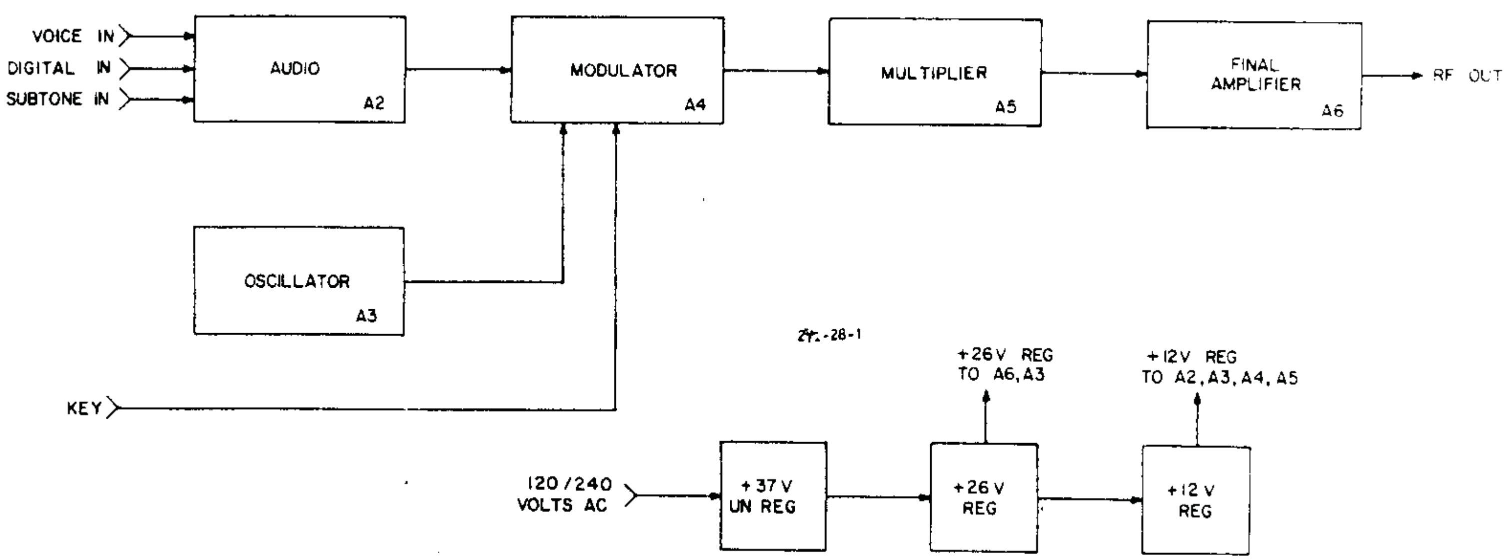


Figure 6-1, QT-4500 Transmitter Block Diagram

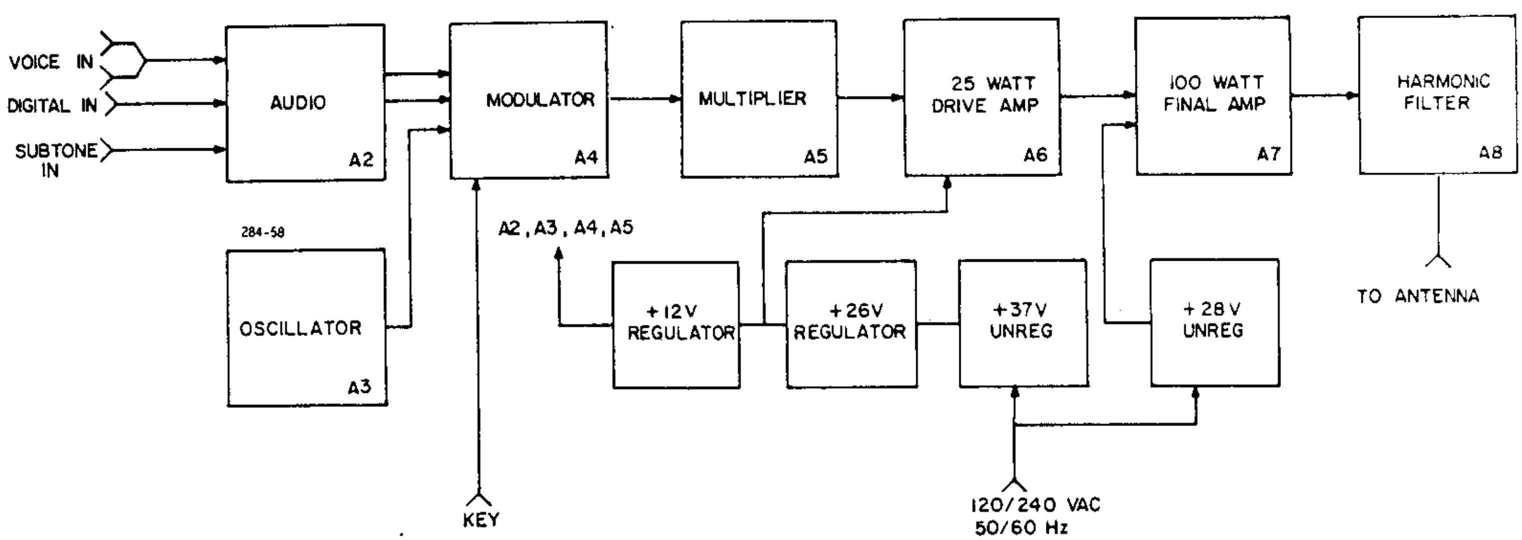


Figure 6-2, QT-6500 Transmitter Block Diagram