PROFESSIONAL TESTING
EUT DESCRIPTION AND OPERATION
TRIMBLE NAVIGATION TC100 TRANSCEIVER

1.0 EUT DESCRIPTION

The **Trimble Navigation (Limited) TC100 Transceiver** is a VHF Airborne Communications Transceiver. The **TC100** is a 7 watt, 2 way radio intended for use in general aviation aircraft. This radio tunes over the frequency range of 118.000 to 136.975 MHz. The radio has a memory and display functions to allow frequently used channels to be stored in memory and then quickly recalled. This equipment is not marketed with an antenna or associated wiring or adapters.

2.0 MODE(S) OF OPERATION

The transceiver was tested in the normal mode of operation. An audio tone was injected into the EUT in accordance with Part 2 of the Rules for intended transmit tests. Most tests were performed at 3 frequencies (lowest, middle and highest) over the range of operation. A one meter cable with a 50 ohm load was placed on the end of the EUT to simulate a wiring load. For antenna conducted emissions, occupied bandwidth, modulation characteristics, and frequency stability tests, the antenna port was connected directly to the spectrum analyzer input.

3.0 Theory of Operation

The theory of operation for this device is described in the following pages. These pages were extracted from the Maintenance Manual for the **TC100**. It should be noted that some references may appear for the TX 760D. The TX 760D was the initial reference designator for the **TC100**.

The EUT does not possess any operator adjustable components which would affect the output power level of the device. The operator may change the transmit/receive frequency turn the device off and on, adjust the squelch, but cannot change the overall power output or maximum modulation bandwidth.

SECTION V

5. THEORY OF OPERATION

The TERRA TX 760D is divided into four functional subassemblies. The subassemblies are; 1) Controller, 2) Display, 3) Audio/synthesizer, 4) Receiver/transmitter.

5.1 CONTROLLER BOARD ASSEMBLY

Use Schematic #9-1100-0093-04 and Component Locator #7050-0027-03 to aid in understanding the following circuit description.

The Controller Subassembly consists of the following components; the Microcontroller, the EErom memory device, the Tuning Encoder/Memory Switch, the On/Off/Volume/Auto/Manual Squelch Switch and the High Voltage Power Supply.

The microcontroller (U701) controls and defines the following functions of the TX 760D: maintains the display; monitors the tuning encoder/memory switch for input; maintains the 12 memory registers in the EErom (U702); computes and transmits the data bit stream for the PLL IC in the synthesizer; and, senses input on numerous lines from other assemblies. These functions will be discussed in further detail in the paragraphs dealing with the individual items.

Pins 1-6 and 62-64 control the multi-plexing of the nine anodes for the display. The pulses generated from U701 are 5 volts in amplitude and approximately 1 KHz in frequency. The duty cycles of the pulses are varied by the dimmer control circuit. The anodes are swept in the following sequence to prevent arcing between anodes; 1,3,5,7,9,2,4,6,8.

Pins 10-17 and Pin 61 control the pulses for the cathodes of the display. The cathodes that are desired to be turned on, are pulsed at the same time the desired anode is pulsed on the display.

The DC voltage on pin 31 of U701 determines the duty cycle of the anode pulse. This level is set by the voltage divider consisting of R701 and the photocell (LDR901) on the display board. In strong light the voltage is low, which makes the duty cycle longer and in turn, brightens the display intensity. Conversely, when the ambient light is low, the voltage on pin 31 goes high and the duty cycle is shortened and the display intensity dims.

5.1 CONTROLLER BOARD ASSEMBLY (Continued)

Pins 22 and 23 are used to tell the software what radio it has been installed in. For the TX 760D, both pins 22 and 23 are held low.

Pins 27 and 29 along with 28 and 30 of U701, are used for reading the tuning inputs from SW701. Using the pull up resistors on pins 1 and 2 of RP701, and depending on the switch position, a high or a low is placed on the two control lines, A and B, of SW701. When SW701 is rotated, the voltage on each control line changes at every other detent. When the knob is turned clockwise, the voltage sequence is as follows; A is high when B goes low, A is low when B goes high, B is high when A goes high and B is low when A goes low. This sequence triggers the software to increment the standby frequency with each clockwise detent. Conversely, a counterclockwise rotation of SW701 generates a pulse pattern exactly opposite of that described above. This triggers the software to decrement the standby frequency with each counterclockwise detent.

The speed at which SW701 is rotated determines how much the frequency is changed with each detent. A software-configured, microprocessor timer measures the elapsed time between detents. If the time is greater than 150 mSec; the standby frequency is changed by 25 KHz. If the time is less than 150 mSec, the standby frequency is changed by 200 KHz.

When the shaft of SW701 is pressed, the high, from pin 7 of RP701, on pin 21 of U701 is taken low. The software then lights the memory digit on the display. The digit will be "0" if the memory has not been used since power up. If memory has been used it will be the last used memory register. Holding the shaft in while rotating the switch will cause the number to increment or decrement. The voltage pattern described in the frequency tuning description will determine the increment or decrement. This causes the recall of the memories stored in each of the EErom registers and displays them in the standby window.

Pin 25 of U701 monitors the transfer (<-->) switch control line. This control line is held high by pin 3 of RP701 until a low is generated in the display assembly. When the low occurs, the standby and active frequencies in the display and EErom are swapped and a new data bit stream is sent to the synthesizer.

5.1 CONTROLLER BOARD ASSEMBLY (Continued)

Pin 24 of U701 is used to monitor the store (STO) control line. This control line is held high by pin 12 of RP701 until a low is generated in the display assembly. If a memory register has been called up on the display, a low on this line will place the standby frequency currently in the window into that register of the EErom.

Pin 33 of U701 is the lock detect line from the PLL IC in the synthesizer. If this line is low, the software in U701 inhibits all transmit capabilities and causes an error code (01) on the display to flash repeatedly.

Pin 34 of U701 is used to monitor the receive indicator line. This line is held high, with pin 8 of RP701, until the squelch opens on the receiver board assembly. When the squelch opens a low is placed on the cathode of CR702, causing pin 34 to go low and the "R" on the display will light up. This will not happen if the transmitter is on. CR702 is used to block the 5 volts (on RP701) from affecting the squelch circuit of the receiver.

Pin 44 of U701 is the PTT monitor line. This line is normally held high by pin 13 of RP701. When the PTT switch is depressed and a low is placed on pin 2 of P8, a "T" is illuminated on the display. An internal timer is also started within U701, if the PTT line is held low for more than approximately three minutes (stuck microphone condition), the TX inhibit line is enabled, and a flashing error message (02) appears in the standby window of the display. CR701 blocks the voltage normally on the PTT line on the TX/RX board assembly. Pin 45 of U701 is the TX inhibit line mentioned above. This line is normally held low by the software, allowing the first L.O. amplifier within the transmitter section to function. If the software senses a low on pin 33 (synthesizer unlock) or a stuck microphone condition, it allows pin 45 to go open, pulling the line high through R708. This disables the first L.O. amplifier.

Pins 38, 40, 41, 42 and 43 of U701 control the serial bit stream used for the PLL IC and the EErom (U702). Pin 38 is an enable line for the PLL IC, this is high only when a new frequency is shifted to the active window of the display. Pin 40 is the chip select line for the EErom (U702). This line will go high whenever a frequency is stored or recalled from the memory. Pin 42 is the serial output line from U701.

5.1 CONTROLLER BOARD ASSEMBLY (Continued)

The software calculates a nineteen bit serial data stream corresponding to the frequency shown in the active window of the display. This bit stream is used in the PLL IC. The data stream is calculated and arranged in the manner described in Section 5.3.

Pin 41 of U701 is the serial data in line. The EErom (U702) sends the data from its registers, upon start up or when a memory channel is recalled, on this line. Pin 43 of U701 is the serial clock line which the EErom (U702) and the PLL IC (U607) use to clock the data bit stream into their respective registers.

C703 and the resistor on pin 12 of RP701 provide a RC time constant for a soft start of the reset voltage. A low to high transition on pin 7 of U701 will cause a reset within the software of the microprocessor.

Y701 is a 4.19 MHz ceramic resonator used as a time base for the microprocessor (pins 8 and 9). C701 and C702 provide the loading for the resonator.
U704 supplies a regulated 5 volts from the switched 13.75 volts. The 5 volts is used to power the microprocessor (U701) and the EErom (U702). It is also used for various pull-up resistors (RP701 and R708) and in the automatic dimming circuit (R701) for the display. The 5 volts is also exported to the synthesizer portion of the Audio/Synthesizer board assembly. C709 is used for additional filtering of the 13.75 volt input line while C708 improves the transient response on the 5 volt line.

U703, a DC to DC converter chip, is the heart of the high voltage power supply for the planar gas discharge display. C704 is a timing capacitor that governs the frequency of an oscillator internal to U703. C705, C711 and R711 form a low pass filter that reduces noise, generated by the high voltage power supply, on the switched 13.75 volt line. Current through R702 creates a sense voltage on pin 7 of U703. When this voltage reaches 330 mVolts below Vcc, the internal circuitry acts to reduce the output current.

The output across the primary of T701 is a rectangular waveform whose duty cycle is controlled by a feedback loop as described below. R710 reduces noise in the system by reducing the Q of the primary. The secondary is coupled to half wave rectifiers, CR703/C706 and CR704/C707 to produce both positive and negative DC voltages.

5.1 CONTROLLER BOARD ASSEMBLY (Continued)

The duty cycle of the waveform applied to the transformer determines the magnitude of these voltages. The transformer is being driven at approximately 40KHz.

Feedback is generated from the positive DC voltage at the cathode of CR703. Because pin 5 of U703 is the inverting input of an internal comparator with a 1.25 volt reference voltage, the voltage at the cathode of CR703 tends to fluctuate around 1.25V + V^z where V^z is the zener voltage of CR705 V^z is nominally 91 volts. R703 provides a path for current through CR705 while R709 is used to provide an equal load current on the negative side. R704 is used to set the total drop across the +90/-90 volt lines to 180 volts.

The feedback loop works as follows: When the voltage at the cathode of CR703 gets above approximately 1.37 volts + V^z, the internal comparator in U702 produces a low output. This tends to reduce the duty cycle of U703's output. This in turn reduces the magnitude of the +90/-90 volt lines. When the voltage at the cathode of CR703 drops below approximately 1.13 volts + V^z the comparator has a positive output and tends to increase the duty cycle and thus brings the voltages up. The total ripple across the +90/-90 volt lines is approximately 0.24 Vp-p.

SW702 is a double shafted switch used for On/Off/Volume and Manual/Auto squelch. Turning the small knob clockwise past the detent places a ground to a relay, K601, on the synthesizer/audio board assembly, enabling the aircraft power to be applied to the radio. Turning the knob further clockwise increases the amount of low level audio returned to the audio amplifier circuitry on the RX/TX board assembly. Turning the large knob clockwise past the detent will take the radio out of auto squelch. The auto squelch level is set by resistors on the RX/TX board. When out of auto squelch the pot in SW702 determines the squelch point along with R707.

5.2 DISPLAY ASSEMBLY

Use Schematic #9-1100-0089-03, Component Locators #7050-0024-02, 7050-0025-02 and Display Schematic #9-1100-0107-02 to aid in understanding the following circuit description.

5.2 DISPLAY ASSEMBLY (Continued)

When the transfer (<-->) switch, SW902, is pressed, it places a ground on pin 25 of the microprocessor, U701, which initiates the transfer sequence described in Paragraph 5.1. When the store (STO) switch, SW901, is pressed, it places a ground on pin 24 of the microprocessor, U701. This initiates the store function described in Paragraph 5.1.

Ambient light on the photo-resistor, LDR901, determines the brightness of the gas discharge display. The photo-resistor varies from approximately 11 kΩ (strong light) to 1 MΩ (dark) and forms a voltage divider with R701 on the controller board assembly. The microprocessor uses this voltage to determine the pulse width of the anode sweeps and thus the brightness of the display. C801 helps to control brief fluctuations of light intensity.

The gas discharge display, DS901, is driven by two different signals, one for the anodes and one for the cathodes. The software controls the synchronization of the anode and cathode pulses. For a segment (cathode), at a particular anode location, to be illuminated it must receive a -90 volt pulse at the same time the anode receives a +90 volt pulse.

The 5 volt anode pulses for anodes 1 through 8 are applied to the high voltage anode driver, U901. The anode 9 pulse is applied to the base of transistor, Q903. The arrangement of Q903, Q901, R912, R913, R914 and R915 works in the same way as the driver IC, U901 to put the +90 volt pulses on the gas discharge display.

The 5 volt cathode pulse for segments a through h and the R and M buss are applied to the high voltage cathode driver, U801. The i segment and T buss pulse is applied to the emitter of transistor Q904. The arrangement of Q902, Q904, R911, R916, R917 and R918 work together in the same way as U801 to place the -90 volt pulses on the gas discharge display.

R801-R805 and R904-R910 are used for current regulation of the display. R901 controls the current for the cathode "keep alive" while R902 and R903 provide current regulation for the left and right anode "keep alive" respectively.

5.3 AUDIO/SYNTHESIZER ASSEMBLY

Use Schematic #9-1100-0097-04 and Component Locator #7050-0033-03, if the unit is a Mod 6 or lower, and Schematic #9-1100-0122-04 and Component Locator #7050-0042-04, if the unit is a Mod 7 or above, to aid in the understanding of the following circuit descriptions.

Relay K601 is used to switch the incoming aircraft A+ for the entire radio. A+ enters the relay on pin 4 and when pin 1 is pulled low the A+ is applied to pin 2. R653 provides current limiting for the coil on the relay. C659 and C660 bypass any stray RF while inductive kickback is controlled with CR603.

Operating power for the board is supplied through R652 and filtered by C657. The circuitry that is operated directly by this voltage is U602, the loop filter operational amplifier, which requires the full supply voltage to achieve the necessary voltage swing, U604, the 600 Ω audio amplifier to achieve the audio power output, and the intercom VOX circuit. The intercom VOX circuit requires this voltage to provide adequate microphone bias current, along with enough voltage swing on the comparator and amplifier circuitry. +5 volts is imported from the controller board for use by U601, the phase lock loop chip and U603, the divide by 40/41 chip. A TX A+ voltage is imported from the receiver/transmitter board, via J7, to power the final RF amplifier during transmit. The remaining voltages on the board are derived from U606, an adjustable voltage regulator set to +8.5 volts by adjusting R648.

The data, clock and enable lines, (J6, Pin 4, 3 and 2) are control signals from the microprocessor to the synthesizer. They are 5V CMOS logic input level compatible. The lock line (J6, Pin 5) is a 5V CMOS logic level output to the microprocessor indicating the lock condition of the synthesizer.

Analog input lines consist of audio sum (J7), sidetone (J7), VOX key (J7), Push To Talk (PTT)(J7), microphone audio (J7), and VOX squelch adjust (J7). Analog output lines include V-Tune (J7) headphone audio (J7) and VOX squelch A+ (J7). On Mod units and above an output line of Vox audio and an input line of Vox audio adjust are added to J7. Signal RF output line (P11) drives the transmitter amplifier on the receiver/transmitter board.

5.3 AUDIO/SYNTHESIZER ASSEMBLY (Continued)

Q601 is the voltage controlled oscillator (VCO) stage. By changing the reverse bias voltage of the varactor, CR601, the frequency of the oscillator changes from 118.000 MHz through 147.675 MHz. An adjustable inductor (L601) allows tuning of the frequency based on a predetermined voltage. This allows a complete range of frequencies for the available voltage.

Q602 serves as a buffer for the VCO while Q603 and Q604 amplify the VCO signal for use as the local oscillator signal or transmitter drive signal. Q603 amplifies both in receive and transmit while Q604 only amplifies in the transmit mode. Q605 is a digital circuit buffer that isolates the digital noise of U603 from the oscillator chain.

U601 is a digital frequency divider. It divides the oscillator frequency by the ratio of 40 or 41 and feeds this forward to the phase lock loop chip (U603). Pin 1 is the control input, it selects divide by 41 when active low.

U603 is the phase lock loop chip. It consists of a reference counter, a phase detector and two additional counters named the "A Counter" and the "N Counter". The modulus control line going to U601 will be low at the beginning of the count cycle. When the "A Counter" counts down from its programmed value, the signal goes high. The signal then stays high until the remaining value in the "N Counter" is counted down. (Both counters start counting down simultaneously.) This divides the VCO signal down to 25 KHz. At the same time the reference oscillator, Y601, a 6.4 MHz crystal oscillator, is being divided by the reference counter. The "divide by" number is determined by the code on RA2, RA1 and RA0, Pin 2, 1 and 20, respectively. In this configuration the 6.4 MHz is divided by 256 to get a 25 Khz reference frequency. The phase detector compares these two 25 KHz signals and generates output pulses proportional to the frequency and phase difference of the two 25 KHz signals.

U602A, connected as an integrator, integrates the error pulses into an error or V-tune voltage. U602B, connected as a low pass filter, further smoothes out the V-tune voltage and applies it to the varactor, CR601, in the VCO. The loop is, therefore, closed to "servo" any error out of the voltage controlled oscillator. The V-tune voltage is also used in the receiver front end on the receiver/transmitter board.

5.3 AUDIO/SYNTHESIZER ASSEMBLY (Continued)

Fine tuning of the oscillator frequency is achieved by adjusting C605 to alter the 6.4 MHz reference frequency, as this frequency is divided by a set number. The reference 25 KHz signal can then adjust the oscillator's 25 KHz signal.

The frequency of the voltage controlled oscillator is therefore a function of the division ratio of the "A Counter" and the "N Counter". This division ratio is input digitally, from the microprocessor, through a shift register and a latch internal to U601.

The corresponding input format is listed as follows:

<----A Counter Bits----><----N Counter Bits----><----SW 1&2---->

divide by A LSB	divide by A MSB	divide by N LSB	divide by N MSB	SW 1	SW 2

__ Last data bit in (Bit 19) First data bit in (Bit 1) ___

The corresponding equation for programming the "A Counter" and the "N Counter" is:

N Counter = The binary equivalent of the MHz portion of the desired synthesizer frequency.

A Counter = The binary equivalent of the KHz portion of the desired synthesizer frequency after dividing by 25.

SW 1&2 are always logic 0 in this application.

For Example: A desired synthesizer frequency of 147.675 MHz. (136.975 MHz plus the 10.7 MHz local oscillator frequency)

N Counter = 147 = 0010010011

A Counter = 675/25 = 27 = 0011011

SW 1 & 2 = 00

Therefore the data bit stream is:

(Last Bit) (First Bit)
1 1 0 1 1 0 0 1 1 0 0 1 0 0 1 0 0 0 0
(A Counter) (N Counter) (SW)

5.3 AUDIO/SYNTHESIZER ASSEMBLY (Continued)

The headphone (600 Ω) audio output stage consists of an audio power amplifier (U604) and an output transformer T602. The gain of U604 is internally fixed at 20. The auxiliary audio signals, sidetone, microphone audio when in VOX mode, and low level audio from the receiver are all introduced into the output amplifier stage.

Supply de-coupling is provided for the audio amplifier by R650 and C633. The audio signal is stepped up by the transformer and passes to the receiver/transmitter board via J7, Pin 9. The load can be either an audio panel, one or two high impedance headsets or a single low impedance headset. The circuit will deliver a minimum of 250mW of audio output power.

Q606 is a switch for the VOX circuitry. When a low is applied to J7, Pin 3, current flow through R635 causes Q606 to turn on. This applies +13.75 to the VOX circuitry. The +13.75 is also applied to the microphone audio line to excite the microphone element through R633. When in the VOX mode, microphone audio is applied to Pin 2 of U604, the audio amplifier, through R630. The audio signal is also supplied to Pin 2 of amplifier U605A. The signal is then rectified, filtered, and applied to Pin 6 of U605B, which is configured as a comparator. The voltage on Pin 5 of U605B is set by either R642 or an external pot. This voltage then sets the squelch or break point of the VOX intercom feature. Q608 is a squelch mute switch. Whenever a DC voltage is applied to either Pin 7 of U605B or the collector of Q607, Q608 turns on and places a ground on the mic audio input to the audio amplifier. Q607 will only turn on when the PTT line is taken low, thus muting the VOX mode and using sidetone audio.

5.4 RECEIVER/TRANSMITTER ASSEMBLY

Use Schematic #9-1100-0096-04 and Component Locator #7050-0032-03 to aid in the understanding the following circuit descriptions.

The primary power supply voltage is applied to the system at P9, Pin 1. This voltage is filtered by L407, C499, C502 and C503 before being exported on J5, Pin 2 to the controller and audio/synthesizer boards. The switched voltage then comes back on J5, Pin 1. The +13.75 volt switched voltage is used to generate the +9 volts that is used in the receiver section.

5.4 RECEIVER/TRANSMITTER ASSEMBLY (Continued)

The RF signal from the antenna enters the radio on J12 and then passes through the low pass filter consisting of C494, C496, C510 and L406.

The RF signal then passes through C498 and C401 to the input coil T401. CR421 limits the RF input going to the receiver from the transmitter, any nearby transmitters or static discharges. T401 is tuned by C402, the tuning slug within T401, and CR402, a varactor which is tuned by the V-tune voltage, to the desired receive frequency.

The signal in T401 is coupled to T402, by means of stray inductance and capacitance, through slots in each coil's shield can. The coils are mounted close together with slots adjacent to one another. T402, like T401, is tuned with C403, the slug and CR403.

The signal from T402 is coupled to the gate of the first RF amplifier, Q401, through R403. R403 provides some deterrent to spurious oscillations.

Amplified automatic gain control (AGC) is applied to the source of Q401 to prevent overload on strong signals and to maintain a fairly constant audio level. The AGC is also applied to the base of Q416. Q416 is configured to attenuate the RF signal under very high signal strengths, before it appears to the front end of the receiver.

Q401 is coupled to Q402 by T403 and T404. These transformers are tuned in the same manner as T401 and T402. T403 and T404 are also slot-coupled in the same way as T401 and T402.

Q402 is the first mixer. The local oscillator signal from the synthesizer is coupled to the base of Q402 to be mixed with the signal being received. The difference frequency, 10.7 MHz, is selected at the collector of Q402 by T405 and coupled into the dual 10.7 MHz crystal filters (FL401 and FL402). The two filters are cascaded to produce greater selectivity. CR420 and R441 are used to couple the TX A+ voltage into the base of Q402. This shuts off the receiver signal during transmit.

The output of FL402 is connected to T406 which couples the signal into the second mixer and IF amplifier, internal to U401. The crystal oscillator, Y401, generates an 11.155 MHz signal that mixes with the 10.7

5.4 RECEIVER/TRANSMITTER ASSEMBLY (Continued)

MHz signal to produce a second IF of 455 KHz. The mix of the two frequencies leaves U401 on Pin 15 and the 455 KHz signal is filtered with FL403 and returned to U402, via Pin 12. The signal is then amplified and has AGC applied to it. The signal then leaves U402 on Pin 7 to be applied to T407 and detected by CR408. The modulation from the signal is then developed across the load resistor R418.

From the detector the audio proceeds to the series automatic noise limiter (ANL). The ANL circuit consists of forward biased CR409, C423, C424, R419, R420, R422 and R423. Audio from the ANL is coupled to an operational amplifier, U402B that is configured as an audio pre-amplifier. The output of the pre-amplifier is then exported to the controller assembly on J5, Pin 6 for use in the volume pot of SW702.

The wiper contact of the volume control connects back through J5, Pin 7 to the input of U403, the speaker output audio amplifier, and to the Audio Sum Line that is taken through P7, Pin 6 to the headphone output audio amplifier. The gain of U403 is set to 40dB for sufficient amplification to drive a speaker to full volume.

AGC voltage is taken from the cathode of CR407, filtered, and applied to the 455KHz amplifier internal to U401. The AGC is also applied to the AGC amplifier U404B. This amplifier takes the AGC voltage and amplifies it by a factor of 1000 and applies it to the source of Q401 and the base of Q416.

U404A serves as an amplifier for the squelch circuits. When in the automatic squelch mode, R439 sets the squelch level. When in the manual squelch mode, the potentiometer within SW702 sets the squelch level. U404B serves as the controller for the squelch gate, Q403. When Q403 conducts, it connects the input signal of U402B to ground and prevents receiver noise from reaching the speaker. When a signal, strong enough to break squelch, is received, Q403 becomes non-conductive and the audio circuitry functions normally. The output of U402B also controls the receive indicator on the display of the radio.

The RF signal from the synthesizer is capacitively coupled to the base of Q412. Q412 is class "A" biased and functions as a buffer amplifier.

5.4 RECEIVER/TRANSMITTER ASSEMBLY (Continued)

T408 is a broad band toroid transformer and forms the collector load for Q412. The signal is capacitively coupled from the top of T408 to the base of Q413. Q413 is class "AB" biased with both a fixed bias and additional bias being developed proportional to the signal level. This additional bias is developed by rectifying part of the signal with CR418. The resulting voltage created across R492 is added to the existing fixed bias voltage across R492.

The broad band toroid T409, is the collector load for Q413. The output signal of T409 is capacitively coupled to the driver stage, Q414.
Q414 is class "B" biased with its collector load being T410, another broad band toroid. The signal is taken from the top of T410 and capacitively coupled to the base of Q415, the final amplifier. Q415 is also class "B" biased, its collector load is T411. T411 also serves as the inductor for the first section of the low pass output filter.

The low pass filter serves two purposes. It is used to transform the low collector impedance of Q415 to the 50 Ω impedance of the antenna system. It also reduces the high order harmonics and spurious frequencies above 137 MHz. The filter consists of a Pi-section (T411, C489 and C490), an L-section (L404, C492), another L-section (L405, C493) and a final Pi-section (L406, C510, C494 and C496). The output of the filter is connected to the antenna connector.

Q411 is used as a transmit inhibit gate. If the microprocessor on the controller board senses a synthesizer that is unlocked or a three minute time-out on the PTT line, it sends a voltage to the base of Q411. This saturates Q411, grounding the base of Q413 and the transmit signal, thus inhibiting transmission of signal.

When the transmitter is keyed, a microphone bias voltage is obtaining from the collector of Q409. The audio obtained from the microphone is developed across the microphone gain control potentiometer R477. The wiper of R477 couples a portion of the audio to the inverting input of U405B. The non-inverting input is connected to a voltage divider across the supply at a point equal to one half of the TX A+ voltage. R457 and R458 set the gain of this stage to 100 for the lower audio frequencies. Some of the audio out of U905B is routed to the gate of Q408, the compressor.

5.4 RECEIVER/TRANSMITTER ASSEMBLY (Continued)

A large positive pulse at the gate will pull the drain down and reduce the audio signal at the input to U405B. The amount of the reduction is set by the compression adjustment potentiometer R474.

The output signal from U405B is also connected to the inverting output of U405A. The non-inverting input, like U405B is connected to one-half of the TX A+ voltage. This permits an audio signal swing of nearly ±1/2 of the TX A+ voltage. The supply voltage for the modulator comes through Q409 direct from the aircraft battery. It is not regulated, only switched when the PTT line goes low.

U405A is configured as an ordinary audio amplifier, whose gain is set to 10 by R460 and R462. The output of U405A is coupled to the base of Q405, which is configured as an emitter follower. Q405 drives Q406, another emitter follower, which drives Q407 another emitter follower. Q407, being in series with the supply to the RF driver and final amplifier, functions as the modulator.

The output power of the transmitter is set with R465. With no audio applied, it adjusts the quiescent voltage available to the RF driver and final amplifier (Q414 and Q415 respectively).