THEORY OF OPERATION

NAT Part #: **NTX403**

Description: **Remote Mount UHF FM Transceiver**

Document #: **NTX403\615-0**

Rev: **0.99**

Prepared By:	Checked By:	Approved By:
NAT 249	NAT 220 NAT 117	FROZEN

1. Introduction

Information in this section consists of a description of the theory of operation.

The NTX403 is a complete, remote controlled UHF FM transceiver capable of receiving and transmitting from 403.000 to 511.99375 MHz.

The NTX403 consists of the following subassemblies:

1.1 NTX138-7U Controller Subassembly

The Controller subassembly provides all of the control functions that are necessary for the transceiver to function. These include synthesizer programming, power supply generation and control, audio system management, sub-audible tone encoding and decoding and communication interfaces to other ancillary equipment, such as control heads.

1.2 NTX403-2 Transmitter Subassembly

The Transmitter subassembly generates the 1W or 10W FM signal that is transmitted from the radio. It contains the circuitry necessary for the generation and modulation of the synthesized, low level signal that drives the power amplifier stages. Modulation format is FM, and the circuitry is designed to provide low distortion levels over the operational frequency range.

1.3 NTX403-5 Main Receiver Subassembly

The Main Receiver subassembly provides the demodulation capability for the transceiver. It is capable of receiving all valid channels in the 403.000 MHz to 511.99375 MHz UHF range. The NTX403 uses a triple conversion super-heterodyne architecture.

2. Overview

This theory of operation applies to the latest version of all drawings. Reference the drawing NTX403\302.

3. Transmit Functions

The NTX transmitter subassembly is designed to provide either 1 or 10 W of RF power output into a 50 ohm antenna system. The subassembly incorporates state of the art RF gain blocks and power MOSFET technology in order to ensure a reliable, efficient and repeatable transmitter operation.

3.1 Transmitter

When the aircraft microphone is keyed, signal $\overline{\text{MIC KEYLINE}}$ is applied to the system microcontroller U704 on the Controller subassembly. This signal selects the correct transmit frequency from the frequencies programmed into the radio at power-up (as set by the Control head front panel switches).

The system microcontroller U704 sends programming information to TX PLL Frequency synthesizer (U207) as **SERIAL DATA** to set the frequency of the voltage controlled oscillator (VCO). Separate control lines originating at the microprocessor select and enable the transmit VCO. The transmit VCO output signal is separated in two paths by RF splitter U204. The first path consists of the transmit signal filtered to remove harmonics, applied to the buffer amplifier U200, sent to driver amplifier U201 and power amplifier Q210. The second path provides the PLL frequency synthesizer with feedback for conventional loop control.

The RF power from the final transmit stage is sent to the RF relay which switches the antenna between the transmit and receive paths. The TX signal is filtered to remove harmonics then sampled by the forward and reverse power detectors to provide RF power level control. A separate control line feed from the controller subassembly provides transmit high and low power selection.

Aircraft microphone audio enters the Controller subassembly as **MIC AUDIO HI.** It is amplified, buffered, and then split to provide both the transmit audio and the radio sidetone, which is present on the receive audio line. The MIC audio signal is fed to mic processing amplifier, for pre-emphasis and then to deviation level control U714 and through an audio Low pass filter at U716A before passing to the Transmitter subassembly as **TX AUDIO MOD**.

The signal **TX AUDIO MOD** from the Controller subassembly modulates the frequency of the transmit VCO at the charge pump/loop filter.

A CTCSS tone is added to the transmit signal by CTCSS encoder/decoder U732. The tone is fed to the Transmitter subassembly where it is summed with the transmit audio for frequency modulating the transmit VCO

4. Receive Functions

The NTX Receiver is designed to be a complete, modular receiver subsystem, requiring only power, antenna connections and CPU programming in order to function correctly. On power-up or when changes are made, information contained in the Control Head causes volume control information, receive frequency information and CTCSS tone data stored in memory to be sent as serial data to the system microcontroller on the Controller subassembly.

4.1 Main Receiver

When the aircraft microphone is un-keyed, $\overline{\text{MIC KEYLINE}}$ is deactivated and the microcontroller will send serial data to the Receiver PLL Frequency synthesizer to set the frequency of the voltage controlled oscillator U516. Control signals are sent to MOSFET switch U727 on the Controller subassembly and to the RF relay on the Transmitter subassembly. When receiving control signal TX/RX ENABLE disables the MOSFET switch U727 and switches off the filtered +24 Vdc which feeds the driver amplifier and power stages on the Transmitter subassembly. The system microcontroller switches the state of the TX PTT signal to RF relay on the Transmit subassembly enabling the flow of the receive signal from the antenna.

The receive RF signal enters the Transmitter subassembly through the external antenna passing through the TX low pass filter, RF relay and RX Low pass filter before being fed to the Main Receiver subassembly.

On the Main Receiver subassembly, the receive RF signal is passed through a high pass filter and amplified by LNA U504. The signal is filtered, amplified then applied to 1st mixer U509. This signal mixes with the local oscillator signal from the RX VCO, resulting in a 90 MHz 1^{ST} IF signal. This signal is buffered by Q502, amplified and fed thru a 90 MHz 1^{ST} IF filter to 2^{nd} Mixer U502 and through 2^{nd} IF filter FL502. The 2^{nd} IF signal at 21.4 MHz is applied to receiver U503, where the signal is converted to a 455 kHz IF, demodulated and the receive audio recovered.

The recovered audio is passed through a low pass filter for de-emphasis and fed to the RX audio gate U507. The recovered audio is also fed to a bandpass filter, noise squelch detector and squelch comparator U506 that responds to the amount of high frequency noise that is present in the recovered audio signal to determine if an RF carrier is present on the channel.

When an RF carrier is present on the receive channel squelch comparator U506 outputs a squelch detect signal, **MAIN RX ACTIVE,** to the RX Audio GATE U507. Gated audio is filtered, buffered by audio amplifier U508 and passed to the controller subassembly as **MAIN RX AUDIO.**

On the controller subassembly the main receive audio is filtered, passed through the Main RX mute gate U721 and fed to the digital volume control U723. Digital volume control receives volume information from the system microcontroller, which corresponds to the setting of the potentiometer located on the control head front panel. The volume controlled receive audio is applied to mixer amplifier U719, fed through the Sidetone/RX audio switch U720 to the audio power amplifier U722, and through the output transformer T702 as receive audio.

End of theory of operation