# Comm operating procedure

General:

1) Apply power to unit
2) Turn unit on with power/volume control switch
3) Acknowledge initialization page by pressing ENT button.

To receive:

1) Apply a modulated RF signal to the comm antenna BNC connector.
2) Tune the input signal to the comm active frequency field on the display.
3) Adjust the volume control knob for the appropriate audio output level on connector J2 pin 7.

To transmit:

1) Connect a load capable of absorbing at least 40W of RF power to the comm antenna BNC connector.
2) Ground pin 4 of connector J2.
3) The transmitter will deliver power to the load at the active channel frequency until ground is removed from J2 pin 4 .

To change active channel frequency:

1) Push the inner knob of the NAV/COMM frequency selector until the comm standby frequency field is highlighted.
2) Change the standby frequency by turning the inner knob of the frequency selector to change the kHz value, and the outer knob to change the MHz value.
3) Press the transfer button to make the standby channel the active channel.

# Theory of Operation

# GNS 400

# VHF Aircraft Communications Transceiver

## 1. PLL Synthesizer

The PLL (phase locked loop) synthesizer serves a dual purpose in the transceiver. This circuit generates the local oscillator (LO) signal that is used to drive the mixer during receive mode, and also generates the transmitter frequency during transmit mode. The PLL circuit consists of a reference oscillator, serial synthesizer prescaler I300, a charge pump, a loop filter, a VCO (voltage-controlled oscillator), and buffer amplifier.

When the transceiver is in aircraft receive mode, the PLL synthesizer output frequency is offset 21.4 kHz above the selected channel frequency to provide high side LO injection for the mixer. During transmit mode, the output frequency is the same as the selected channel frequency.

## 2. Comm Transmitter

### 2.1 Transmit Audio Stages

### 2.2 Mic Amplifier / Compressor

The input audio from the microphone is coupled to the mic amplifier I500-A, which has an adjustable gain of up to 20 dB. Output from the mic amplifier is coupled into the TX audio compressor circuit, comprised of I500-B, I500-D, I502-B, D500, Q502, and associated components. This circuit is intended to maintain modulation at a relatively constant level, and to prevent very loud sounds from over modulating the transmitter.

### 2.3 TX Audio Filter

Due to the narrow bandwidth required by 8.33 kHz channel spacing, the comm transmitter is required to limit the audio bandwidth to voice frequencies only. The transmit audio filter consisting of I503 and associated components performs this function.

### 2.4 RF Amplifier Stages

### 2.5 Predriver

The predriver, Q300, is the first stage of RF amplification in the transmitter. This stage receives a low level RF signal from the PLL synthesizer section at the selected channel frequency. The predriver stage provides approximately 20 dB of gain to the incoming RF signal.

### 2.6 Driver

The signal from the predriver is further amplified by the driver stage Q504. This stage provides an additional 12 dB of gain to the RF signal and is also the modulated stage of the transmitter.. The modulating audio signal and carrier power DC offset are applied to the gate of the transistor producing an amplitude modulated waveform.

2.7 Power Amplifier (PA)

The RF power amplifier stage Q501 operates as a class AB push-pull amplifier with a gain of approximately 14 dB. The PA output is switched to the antenna by PIN diode D507. The RF output from D507 couples into directional coupler T503. This transformer provides a means of sampling both forward power to the antenna and reflected power from the antenna and is used to control the output level of the transmitter. (See Modulator Feedback Loop section)

2.8 Harmonic Filter

The harmonic filter is the final stage in the transmitter. Its function is to reduce transmitter harmonics to an acceptable level. This filter is a ninth order elliptic filter, and is comprised of C537, C538, C539, C540, C541, C542, C543, C544, C545, L506, L507, L508, and L509.

2.9 Modulator Feedback Loop

The modulator feedback loop consists of directional coupler T503, error amplifier I501A/B, and driver/modulator stage Q504. The directional coupler senses the forward power out of the transmitter and compares it to a reference signal. The amplified error signal is used to control the gain of driver stage Q504 to maintain a constant output level from the transmitter. The error amplifier also corrects for modulation non-linearity and AM noise in the transmitter output. The directional coupler also senses the reflected power on the transmitter output and feeds a detected sample to the error amplifier which cuts back the transmitter's power level to protect the PA output stage Q501.

# GNS400 COMM TRANSCEIVER
# ALIGNMENT PROCEDURE

GARMIN Corporation
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005-00051-55 Rev. A

**Approvals**

| Approvals | Date |
|---|---|
| Drawn: BAS | 6/4/98 |
| Checked: | |
| Approved: | |
| Project Mgr.: | |



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**Revisions**

| Rev. | Date | Description of Change | Apprvd. |
|---|---|---|---|
| A | | Production Release | ---- |
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## General

The alignment procedures are intended to be performed after board assembly . The alignment procedures are also used after replacing a component or module causing misalignment. The alignment procedures should be followed in the sequence presented. Certain sections of the radio must be aligned using subsections of the alignment procedure before the whole board can be aligned.

This alignment procedure is written for a complete realignment. If only a subsection is required, use only the initial settings required as outlined in the procedure for the subsection. The comm board must be placed into a main chassis before alignment. Unless otherwise specified, alignment should be performed with the input power supply set to 27.5 ± 0.2 VDC.

## Reference Documents

004-00044-03 Min Prfm Spec, GNS 400 Comm
016-00214-00 Assy Dwg, GNS400 Comm PCB
320-00099-06 Ca Assy, (B), GNS400 COMM

### *Test Equipment*

The test equipment needed to perform an alignment of a GNS 400 COMM XCVR assembly is as listed below.

| DESCRIPTION | VENDOR/PART NO. | QTY |
|---|---|---|
| 0-30VDC/0-6A VARIABLE POWER SUPPLY | TOPWARD MODEL 2306 OR EQUIV | 1 |
| 486DX PC W / SERIAL PORT | 486DX PC W / SERIAL PORT | 1 |
| Software - GNS400 Serial interface Program | | |
| MANUAL TEST PANEL | GARMIN GPS/GNS MANUAL TEST PANEL T10-00035-00 | 1 |
| RADIO TEST SET | HP 8920A WITH OPTIONS 003/019/050/102 OR HP8920B WITH OPTIONS 001/102 | 1 |
| DIGITAL MULTIMETER | FLUKE 87 W/TEST PROBE LEADS | 1 |

## *Setup Procedure*

1. Preset variable power supply to +27.5 VDC and set the current limit to 4.0 A.

2. Connect power supply positive output to red 'DC IN +' banana jack on rear panel of Manual Test panel. Connect power supply negative output to black 'DC IN -' banana jack on rear panel of Manual Test panel.

3. Make the following connections for the Manual Test Panel as shown in Figure 1 and described here. Connect an approved 6 ft RG-223 cable between the comm transceiver antenna connector and the HP8920A/B RF IN/OUT connector. Connect the 320-00099-06 Ca Assy, (B), GNS400 COMM to the 26-pin high-density connector on the back of the comm (J2) and to the surface mount connector J26 on the top side of the comm. Connect the other end of the cable to the (B) connector on the manual test panel. Connect COMM AUDIO on Manual Test panel to HP8920A/B AUDIO IN HI. Connect Audio Out on HP8920A/B to Manual Test Panel connector marked AUDIO OUT FROM HP8920A/B. Connect serial port cable from PC to serial port input connector on manual test panel.

4. Connect positive and negative digital multimeter inputs to COMM IF AGC and GND outputs, respectively, on Manual Test panel. Set up DVM to measure DC voltage in autoscale.

5. Plug AC power cord into rear of test panel. Plug AC power cord into 120VAC outlet.

6. Insure that PANEL POWER push-button switch and UNIT POWER push-button switch are not depressed and are not lighted (OFF). Turn on external power supply. Push PANEL POWER switch to turn on. Verify that lighted push-button lights up. Push UNIT POWER switch to turn on. Verify that lighted push-button lights up. Monitor 28V voltage with DVM. Set voltage of external power supply at +27.5 VDC. Push UNIT POWER switch to turn off.

7. Test Fixture is now ready for GNS400 COMM XCVR assembly alignment.

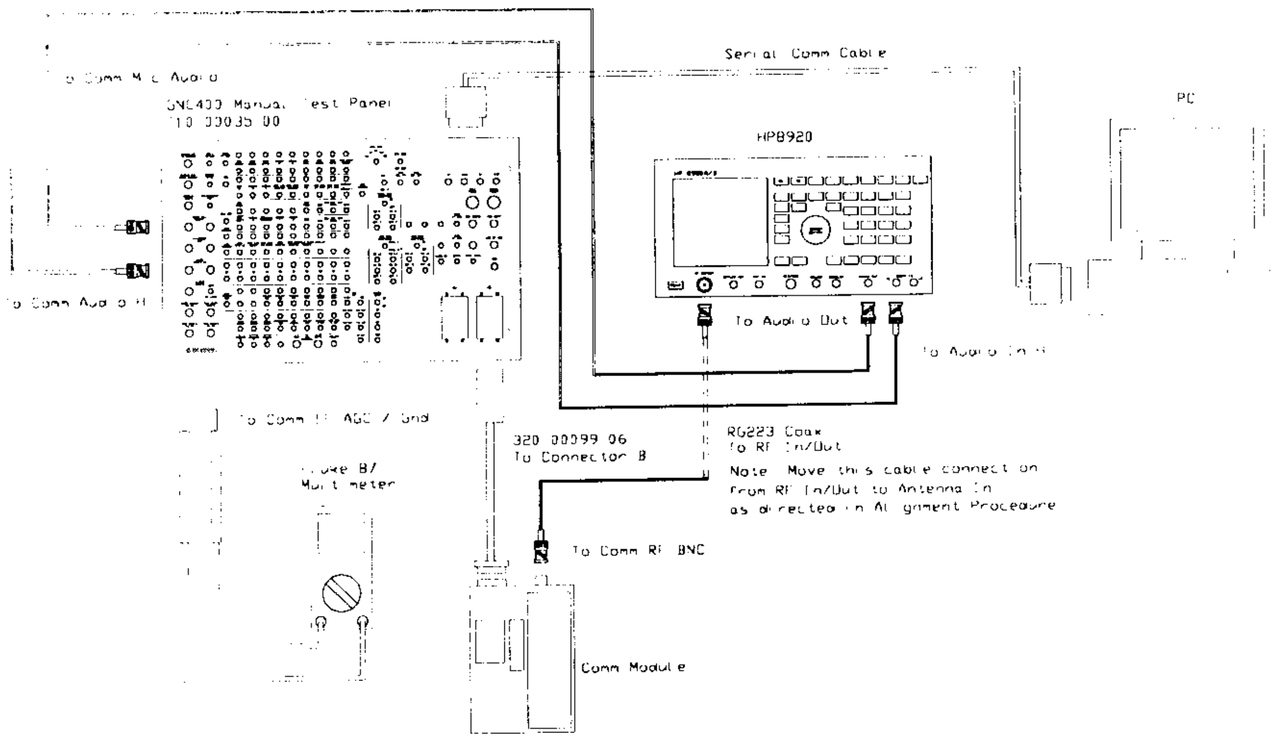


**Figure 1**

## COMM Transceiver Assembly Alignment

This section describes the step-by-step procedure used to perform a GNS400 COMM transceiver assembly alignment. Refer to the GNS 400 COMM XCVR MINIMUM PERFORMANCE SPECIFICATION (MPS) Garmin P/N 004-00044-03 for specifications.

The unit should be connected as outlined in section 0.

### *Initial Control Settings*

#### Discrete Adjustment

L104 Pre-selector Pole 1 coil        Mid - range as Factory preset

L106 Pre-selector Pole 2 coil        Mid - range as Factory preset

L109 Pre-selector Pole 3 coil Mid - range as Factory preset
L111 Pre-selector Pole 4 coil Mid - range as Factory preset
L200 8.33 kHz Xtal filter Input Mid - range as Factory preset
L201 25 kHz Xtal filter Input Mid - range as Factory preset
L202 8.33 kHz Xtal filter Output Mid - range as Factory preset
L203 25 kHz Xtal filter Output Mid - range as Factory preset
T200 IF AMP Input Match Mid - range as Factory preset
T201 IF AMP Output Match Mid - range as Factory preset
C300 Synthesizer Ref. Osc. Mid - range as Factory preset
L302 VCO Coil Mid - range as Factory preset
R558 MIC GAIN Fully CW
R530 TX Driver Bias Fully CCW
R563 TX PA-A Fully CCW
R532 TX PA-B Fully CCW

**Digital Pots**

| | |
|---|---|
| PRESELECTOR POLE 1 | Software Default |
| PRESELECTOR POLE 2 | Software Default |
| PRESELECTOR POLE 3 | Software Default |
| PRESELECTOR POLE 4 | Software Default |
| RF AGC THRESHOLD | Software Default |
| SQUELCH 25 kHz | Software Default |
| SQUELCH 8.33 kHz | Software Default |
| TRANSMITTER POWER | Software Default |
| MODULATION DEPTH | Software Default |
| SIDETONE ADJ | Software Default |

**Covers**

Remove the covers from the synthesizer and RF sections.

## *Synthesizer Alignment*

### TCXO Alignment

**NOTE: This adjustment should be done within 60 seconds of a cold start.**

AT NO TIME DURING THE TCXO ADJUSTMENT PROCEDURE SHOULD THE TRANSMITTER BE KEYED. DOING SO COULD DAMAGE THE 8920!

I. Connect comm transceiver module BNC connector to HP8920A/B ANT IN.
II. Recall saved State 1 on HP8920A/B.
III. State 1 on Radio Test Set:
   A. TX mode
   B. Manual Tuning
   C. Tune Frequency of 158.375 MHz
   D. Input Port - Ant.
IV. Start the serial interface program on the PC.
V. Select the serial port which connects the PC to the manual test panel.
VI. Power up the comm unit.
VII. The serial interface program should recognize the comm and highlight the COMM button on the display screen. Press the comm button to activate the control screen.
VIII. Set the Channel Spacing switch for 25 kHz channel spacing.
IX. Set the Set Mode switch to TEST.
X. Set the frequency to 136.975 MHz.
XI. Monitor the TX frequency error on the 8920 and adjust C300 until the frequency error is less than ±50 Hz.
XII. Remove the BNC cable from the ANT IN port on the 8920 and re-connect it to the RF IN/OUT port. It is now OK to transmit without damaging the 8920.

### VCO Alignment

a. With the comm tuned to 136.975 MHz, monitor TP303 voltage with a DMM.
b. Adjust VCO coil L302 until the voltage reads 10.0 ± 0.1 VDC.
c. Replace the synthesizer cover back on the unit.

## *Communication Transmitter Alignment*

### Transmitter Power MOSFET Bias Setting

I. Turn off the 28V power supply.
II. Place a DMM configured to read current in line with the 28V supply to the comm. Use the 10A current input and not the 400mA input on the DMM.
III. Turn on the 28V power supply.
IV. Zero out the current reading on the display using the REL Δ function on the DMM.
V. Make sure the potentiometers R530, R563, and R562 have been turned fully CCW as outlined in section 0.
VI. On the serial interface program, set the Xmit Cal switch to Xmit Cal.
VII. ***SLOWLY*** Adjust R563 until 28V current is 50 mA ± 10 mA.
VIII. Zero out the current reading on the display using the REL Δ function on the DMM.
IX. ***SLOWLY*** Adjust R532 until 28V current is 50 mA ± 10 mA.
X. Zero out the current reading on the display using the REL Δ function on the DMM.
XI. ***SLOWLY*** Adjust R530 until 28V current is 50 mA ± 10 mA.
XII. Place the Xmit Cal switch on the SI program back to normal mode.
XIII. Turn off the 28V power supply.
XIV. Remove the DMM from in-line with the 28V supply and reconnect the 28V supply.
XV. Turn on the 28V power supply.

## Output Power Calibration

I. Recall saved state 2 on HP8920A/B.
II. State 2 on Radio Test Set:
 A. Automatic Tuning
 B. TX mode
 C. AF GEN 1 OFF
 D. RF Level Offset ON - configuration page
 E. RF In/Out = -0.3 dB - configuration page
III. Tune the comm to 118.000 MHz
IV. Key the transmitter.
V. Monitor the TX Power on the HP8920A/B.
VI. Adjust the TRANSMITTER POWER setting on the SI program until the TX carrier power reaches the first level above 12.0 Watts on the 8920A/B. The power should not exceed 13.0 Watts.
VII. Unkey the transmitter.
VIII. Press the Store Cal Values button on the SI program.
IX. Repeat steps c. through h. at 127.000 and 136.975 MHz.

## Modulator Adjust

I. Recall saved State 3 on the HP8920A/B.
II. State 3 on Radio Test Set:
 A. TX Mode
 B. Manual Tuning
 C. Manual Tune Freq = 118.000 MHz
 D. AF ANL IN to AM DEMOD
 E. DE-EMPHASIS to OFF
 F. DETECTOR to RMS*SQRT2
 G. AFGEN1 FREQ = 1 KHz
 H. AFGEN1 LEVEL = 275 mV
III. Set the COMM frequency to 118.000 MHz.
IV. Key the transmitter and adjust R558 for 85% - 95% modulation depth.
V. Unkey the transmitter.
VI. Key the transmitter and adjust the MODULATION DEPTH setting on the SI program until the 8920A/B modulation depth reading just falls below 80%. Back the MODULATION DEPTH setting off one step to put the modulation reading above 80%. The modulation depth should not exceed 82%
VII. Unkey the transmitter.
VIII. Press the Store Cal Values button on the SI program.
IX. Repeat steps f. through h. at 127.000 and 136.975 MHz. Remember to set the Manual tune Freq on the 8920A/B to the appropriate channel frequency you are transmitting on.

## Sidetone Adjust

I. Recall saved State 4 on the HP8920A/B.
II. State 4 on Radio Test Set:
 A. TX Mode
 B. Automatic Tuning
 C. DE-EMPHASIS to OFF
 D. AF GEN 1 FREQ to 1 KHz
 E. AF GEN 1 Level to 275 mV
 F. AF ANL IN to AUDIO IN
 G. DETECTOR to RMS
 H. AF IN LO to 600 TO HI

III. Set the COMM frequency to 118.000 MHz.
IV. Key the transmitter and adjust the SIDETONE ADJ setting on the SI program until the audio level on the 8920A/B just exceeds 1.4 Vrms. The level should not exceed 1.5 Vrms.
V. Unkey the transmitter.
VI. Press the Store Cal Values button on the SI program.
VII. Repeat steps c. through f. at 127.000 and 136.975 MHz.

## *Communication Receiver Alignment*

### Preselector Alignment

I. Recall saved State 5 on the HP8920A/B.
II. State 5 on Radio Test Set:
   A. RX mode
   B. RF GEN FREQ = 118.000 MHz
   C. AF GEN1 OFF
   D. ohm/emf = emf on config page
   E. RF Level Offset ON - configuration page
   F. RF In/Out = -0.3 dB - configuration page
III. Set the COMM frequency to 118.000 MHz.
IV. While monitoring the IF AGC voltage on the test panel with a DMM, adjust the HP8920A/B RF GEN amplitude until the DMM reads 5.0 VDC.
V. Adjust PRESELECTOR POLE 1 on the SI program until maximum IF AGC voltage is achieved.
VI. While monitoring the IF AGC voltage on the test panel with a DMM, re-adjust the HP8920A/B RF GEN amplitude until the DMM reads 5.0 VDC.
VII. Adjust PRESELECTOR POLE 2 on the SI program until maximum IF AGC voltage is achieved.
VIII. While monitoring the IF AGC voltage on the test panel with a DMM, re-adjust the HP8920A/B RF GEN amplitude until the DMM reads 5.0 VDC.
IX. Adjust PRESELECTOR POLE 3 on the SI program until maximum IF AGC voltage is achieved.
X. While monitoring the IF AGC voltage on the test panel with a DMM, re-adjust the HP8920A/B RF GEN amplitude until the DMM reads 5.0 VDC.
XI. Adjust PRESELECTOR POLE 4 on the SI program until maximum IF AGC voltage is achieved.
XII. Repeat steps e, g, i, and k to fine tune the preselector poles - it is not necessary to re-adjust the RF input level each time.
XIII. Press the Store Cal Values button on the SI program.
XIV. Repeat steps c. through m. at 127.000, 136.975, and 162.500 MHz. Remember to set the RF GEN Freq on the 8920A/B to the appropriate channel frequency you are receiving on.

### IF Alignment - 25 KHz Mode

I. Recall saved State 5 on the HP8920A/B as in section 0
II. Set the COMM frequency to 118.000 MHz, 25 kHz mode.
III. While monitoring the IF AGC voltage on the test panel with a DMM, adjust the HP8920A/B RF GEN amplitude until the DMM reads 5.0 VDC.
IV. Adjust L201 until maximum IF AGC voltage is achieved.
V. While monitoring the IF AGC voltage on the test panel with a DMM, adjust the HP8920A/B RF GEN amplitude until the DMM reads 5.0 VDC.
VI. Adjust L203 until maximum IF AGC voltage is achieved.
VII. While monitoring the IF AGC voltage on the test panel with a DMM, adjust the HP8920A/B RF GEN amplitude until the DMM reads 5.0 VDC.
VIII. Adjust T200 until maximum IF AGC voltage is achieved.
IX. While monitoring the IF AGC voltage on the test panel with a DMM, adjust the HP8920A/B RF GEN amplitude until the DMM reads 5.0 VDC.
X. Adjust T201 until maximum IF AGC voltage is achieved.

## IF Alignment - 8.33 KHz Mode

I. Set the Channel Spacing switch on the SI program for 8.33 KHz channel spacing.
II. Set the COMM frequency to 118.005 MHz, and the HP8920A/B RF GEN Freq to 118.000 MHz.
III. While monitoring the IF AGC voltage on the test panel with a DMM, adjust the HP8920A/B RF GEN amplitude until the DMM reads 5.0 VDC.
IV. Adjust L200 until maximum IF AGC voltage is achieved.
V. While monitoring the IF AGC voltage on the test panel with a DMM, adjust the HP8920A/B RF GEN amplitude until the DMM reads 5.0 VDC.
VI. Adjust L202 until maximum IF AGC voltage is achieved.

## RF AGC Alignment

a. Set the Channel Spacing to 25 kHz.
b. Set the COMM frequency to 118.000 MHz and the HP8920A/B RF GEN Freq to 118.000 MHz.
c. Set the HP8920A/B RF GEN amplitude to 12.5 uV.
d. While monitoring the RF AGC voltage at TP202, adjust RF AGC THRESHOLD for a voltage of approximately 7.9 VDC.
e. Decrease RF AGC THRESHOLD until the RF AGC voltage just begins to decrease.
f. Press the Store Cal Values button on the SI Program.
g. Repeat steps d. through f. at 127.000 and 136.975 MHz. Remember to set the RF GEN Freq on the 8920A/B to the appropriate channel frequency you are receiving on.

## Squelch Calibration - 25 KHz Mode

I. Recall saved State 6 on the HP8920A/B.
II. State 6 on Radio Test Set:
    A. RX Mode
    B. RF GEN Freq = 118.000 MHz
    C. RF GEN amplitude = 2.0 uV
    D. AF GEN1 to AM
    E. AM DEPTH = 30%
    F. AF GEN1 FREQ = 1 KHz
    G. AF IN LO to 600 TO HI
    H. ohm/emf = emf on config page
    I. RF Level Offset ON - configuration page
    J. RF In/Out = -0.3 dB - configuration page
III. Set the Channel Spacing switch on the SI program for 25 KHz channel spacing.
IV. Set the COMM frequency to 118.000 MHz.
V. Enable compressor and squelch.
VI. Adjust SQUELCH 25 KHz on the SI program until the squelch just opens (audio turns on).
VII. Press the Store Cal Values button on the SI program.
VIII. Repeat step d. through g. at 127.000 and 136.975 MHz. Remember to set the RF GEN Freq on the 8920A/B to the appropriate channel frequency you are receiving on.

## Squelch Calibration - 8.33 kHz Mode

I. Recall saved State 6 on the HP8920A/B as in section 0.
II. Set the Channel Spacing switch on the SI program for 8.33 kHz channel spacing.
III. Set the COMM frequency to 118.005 MHz.
IV. Enable compressor and squelch.
V. Adjust SQUELCH 8.33 kHz on the SI program until the squelch just opens (audio turns on).
VI. Press the Store Cal Values button on the SI program.
VII. Repeat step c. through f. at 127.005 and 136.980 MHz. Remember to set the RF GEN Freq on the 8920A/B to the appropriate channel frequency you are receiving on (127.000 and 136.975 MHz, respectively).