

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
1200 E. 151st Street
Olathe, KS 66062

005-00051-55 Rev. A

Approvals

Date

Drawn: BAS	6/4/98
Checked:	
Approved:	
Project Mgr.:	

CONFIDENTIAL

This drawing and these specifications contained herein are the property of GARMIN Corporation and may not be reproduced or used in whole or in part as the basis for manufacture or sale of products without the written permission of GARMIN Corporation.

Archive Filename: 00500051.55A

Revisions

Rev.	Date	Description of Change	Apprvd.
A		Production Release	----

ROGERS CONSULTING LABS, INC.
11701 Craig
Overland Park, KS 66210
Phone/Fax: (913) 339-6072

GARMIN INTERNATIONAL, INC.
MODEL: GNS 430 012-00214-() SN: UNIT 43
Test #: 980616 FCC ID#: IPH-0021400
Test to: FCC Parts 2 and 87 Page 33 of 44

WORKING DRAFT TO TYPE 6/2/98

THIS PAGE INTENTIONALLY LEFT BLANK

Setup Procedure	37
COMM TRANSCEIVER ASSEMBLY ALIGNMENT	38
Initial Control Settings	38
Discrete Adjustment	38
Digital Pots	39
Covers	39
Synthesizer Alignment	39
TCXO Alignment	39
VCO Alignment	40
Communication Transmitter Alignment	40
Transmitter Power MOSFET Bias Setting	40
Output Power Calibration	41
Modulator Adjust	41
Sidetone Adjust	41
Communication Receiver Alignment	42
Preselector Alignment	42
IF Alignment - 25 KHz Mode	42
IF Alignment - 8.33 KHz Mode	43
RF AGC Alignment	43
Squelch Calibration - 25 KHz Mode	43
Squelch Calibration - 8.33 kHz Mode	44

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

ROGERS CONSULTING LABS, INC.
11701 Craig
Overland Park, KS 66210
Phone/Fax: (913) 339-6072

GARMIN INTERNATIONAL, INC.
MODEL: GNS 430 012-00214-() SN: UNIT 43
Test #: 980616 FCC ID#: IPH-0021400
Test to: FCC Parts 2 and 87

Page 36 of 44

WORKING DRAFT 5.0 - REV. 6/23/98

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.

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!

ROGERS CONSULTING LABS, INC.
11701 Craig
Overland Park, KS 66210
Phone/Fax: (913) 339-6072

GARMIN INTERNATIONAL, INC.
MODEL: GNS 430 012-00214-() SN: UNIT 43
Test #: 980616 FCC ID#: IPH-0021400
Test to: FCC Parts 2 and 87 Page 39 of 44

- 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 $50 \text{ mA} \pm 10 \text{ mA}$.
- 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 $50 \text{ mA} \pm 10 \text{ mA}$.
- 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 $50 \text{ mA} \pm 10 \text{ mA}$.
- 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

ROGERS CONSULTING LABS, INC.
11701 Craig
Overland Park, KS 66210
Phone/Fax: (913) 339-6072

GARMIN INTERNATIONAL, INC.
MODEL: GNS 430 012-00214-() SN: UNIT 43
Test #: 980616 FCC ID#: IPH-0021400
Test to: FCC Parts 2 and 87 Page 41 of 44

- 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).

ROGERS CONSULTING LABS, INC.
11701 Craig
Overland Park, KS 66210
Phone/Fax: (913) 339-6072

GARMIN INTERNATIONAL, INC.
MODEL: GNS 430 012-00214-() SN: UNIT 43
Test #: 980616 FCC ID#: IPH-0021400
Test to: FCC Parts 2 and 87 Page 44 of 44

WORD\GARMIN110 TYP 6/21/98