NAVAIR 17-20AX-727

AX-727

TECHNICAL MANUAL

INSTRUMENT CALIBRATION PROCEDURE

VOR/ILS TEST SET

IFR INC
NAV 401L

THIS PUBLICATION SUPERSEDES NAVAIR 17-20AX-727
DATED 1 OCTOBER 1996

AX-727

PUBLISHED BY DIRECTION OF COMMANDER NAVAL AIR SYSTEMS COMMAND

1 JANUARY 2001

LIST OF EFFECTIVE PAGES

The purpose of this list is to identify the pages in this document affected by any technical content changes made since the previous release of the document.

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SECTION 1

INTRODUCTION AND DESCRIPTION

1.1 This procedure describes the calibration of the IFR Inc NAV 401L VOR/ILS Test Set. The instrument being calibrated is referred to herein as the TI (Test Instrument).

1.2 All comments concerning this procedure should be directed to Navy Measurement Science Directorate, Naval Warfare Assessment Station, P.O. Box 5000, Corona, CA 92878-5000.

1.3 This procedure includes tests of essential performance parameters only. Any malfunction noticed during calibration, whether specifically tested for or not, should be corrected.

Table 1. Calibration Description

TI Characteristics	Performance Specifications	Test Method
NAV Tones	MKR frequencies: 400 Hz, 1020 Hz, 1300 Hz, and 3000 Hz Tolerance: ±1% VOR frequencies: 30 Hz, 1020 Hz, and 9.96 kHz Tolerance: ±0.02% 30 Hz and 9.96 kHz; ±1%, 1020 Hz LOC frequencies: 90 Hz, 150 Hz, and 1020 Hz Tolerance: ±0.02%, 90 Hz and 150 Hz; ±1%, 1020 Hz G/S frequencies: 90 Hz and 150 Hz Tolerance: ±0.02%	Measured with a frequency counter or calibrated oscilloscope.
DDM centering	AC range: 550 mV rms to 1.1 V rms Tolerance: ±2 mV	Measured with a digital multimeter.
Distortion	Marker signal tones: <1% VOR: <0.5% LOC: <0.5% G/S: <0.5%	Measured with a distortion analyzer.
Amplitude modulation	MKR signal tones: AM range, 0% to 100% Tolerance: ±5% at 95% AM VOR signal tones: AM range, 0% to >50% Tolerance: ±2% at 30% AM LOC signal tones: AM range, 0% to 40% Tolerance: ±2% at 20% AM G/S signal tones: AM range, 0% to 80% Tolerance: ±2% at 40% AM	Measured with a modulation meter.
Attenuator output level	Output range: -7 to -110 dBm Tolerance: -7 to -30 dBm, use correction chart; -30 to -110 dBm, ±2 dB	Measured with a RF millivoltmeter or a power meter.

TI Characteristics	Performance Specifications	Test Method
RF frequency	Variable RF frequency range: MKR - 72 to 78 MHz VOR - 107 to 120 MHz LOC - 107 to 120 MHz COMM LO - 118 to 136 MHz COMM HI - 134 to 156 MHz G/S - 327 to 337 MHz Tolerance: ±0.001% Crystal RF frequencies: MKR XTL - 75.0 MHz; VOR XTL - 108.0 MHz; LOC XTL - 108.1 MHz; G/S XTL - 334.7 MHz; COMM XTL - 126.9 MHz Tolerance: ±0.005%	Measured with a frequency counter.
VOR Bearing	Bearing range: 0 to 360° Tolerance: ≤0.1°	Compared to a standard bearing from a navigational test set.
Frequency counter	Range: 1 MHz to >300 MHz Tolerance: ±0.001%	Compared to a known signal frequency.
Power meter	Range: 0 to 100 W in two ranges Tolerance: ±5% fs	Compared to a known RF power source.
Battery voltage and timer	Range: 0 to 30 V dc Tolerance: ±5% iv	Compared to battery voltage.

SECTION 2

EQUIPMENT REQUIREMENTS

NOTES

Minimum use specifications are the principal parameters required for performance of the calibration, and are included to assist in the selection of alternate equipment, which may be used at the discretion of the using laboratory. Satisfactory performance of alternate items shall be verified prior to use. All applicable equipment must bear evidence of current calibration.

The instruments utilized in this procedure were selected from those known to be available at Navy calibration facilities, and the listing by make or model number carries no implication of preference, recommendation, or approval for use by other agencies. It is recognized that equivalent equipment produced by other manufacturers may be capable of equally satisfactory performance in this procedure.

Table 2. Equipment Requirements

Item	Minimum Use Specifications	Calibration Equipment
2.1 Oscilloscope	Range: 50 MHz dual trace Uncertainty: time base accuracy, ±3%	Tektronix TDS620A, 7904AOPT03, 7904OPT03, 7704AMOD129GOPT03, or 7704AMOD129G with 7A26 and 7B92A plug ins
2.2 Frequency counter	Frequency: 25 Hz to 335 MHz Uncertainty: 1×10^{-7} Resolution: 0.001 Hz	Hewlett-Packard 53132AOPT010, 030
2.3 Digital Multimeter (DMM)	AC range: 0.5 to 1.2 V rms Uncertainty: ±0.5 mV	Hewlett-Packard 3458A
2.4 RF millivoltmeter	Power range: 0 to -35 dBm Uncertainty: ±0.125 dB	Booton Electronic 9200BOPT01A, 92BDOPT09, 92BDOPT01, 09
2.5 Power meter	Power indication range: 0 to -35 dBm Uncertainty: ±0.125 dB, when combined with cal factor uncertainty	Hewlett-Packard 436AOPT022
2.6 Low-level power sensor	Frequency range: 75 to 350 MHz Power range: -28 to -32 dBm	Hewlett-Packard 8484A
2.7 Mid-level power sensor	Frequency range: 100 to 350 MHz Power range: +10 to -25 dBm	Hewlett-Packard 8481A or 8482A
2.8 Modulation meter	Carrier frequency range: 50 to 400 MHz AM range: 15% to 100% Uncertainty: ±0.5% iv	Hewlett-Packard 8901AOPT010 or 8901B
2.9 RF power source*	Power range: 4 to 80 W Uncertainty: NA Frequency range: 118 to 156 MHz	Ailtech (Eaton) 445B with 184 plug in; or Microdot 445B with 184 plug in
2.10 RF amplifier**	Power range: >50 W Gain: >35 dB Frequency range: 118 to 156 MHz	ENI 5100L; or Ailtech (Eaton) 2C52
2.11 Directional coupler	Frequency range: 118 to 156 MHz Coupling factor: 20 dB Accompanied by a Report of Calibration form a Type I NSL	Werlatone C2408
2.12 Coaxial attenuator	Attenuation: 20 dB Accompanied by a Report of Calibration from a Type I NSL	Weinschel 2-20, 44-20; or Hewlett-Packard 8491BOPT020
2.13 Navigational indicator T/S	No known substitute	Collins 478A-3 ZIFOR III***
2.14 Signal generator**	Frequency range: 1 to 30 MHz (118 to 156 MHz, if used with RF amp) Output level: 1 mW min (20 mW min if used with RF amp)	Hewlett-Packard 8642BOPT001, 710, 907, 8642BOPT001, 907, 8640BOP001, 002, 003
2.15 Distortion analyzer	Capable of measuring distortion less than 1% to 0.1% resolution	Sound Technology 1700BOPT003, 005; or Hewlett-Packard 8903BOPT050, 907, 910, 8903BOPT907, 334A, or 332A

Item	Minimum Use Specifications	Calibration Equipment
2.16 Stop watch	Timing range: 0 to minutes Uncertainty: ±30 sec	Fisher Scientific 14-649-5 or 300
2.17 Attenuator correction chart	NA	Supplied with TI
2.18 Low pass filter	Cutoff frequency: 15 kHz Impedance: 50 Ω	Hewlett-Packard 86602-60054

*Not required if RF amplifier and signal generator is used to test the TI power meter accuracy.
**Not required if RF power source is used to test the TI poer meter accuracy.
***Non-NCE equipment.

SECTION 3

PRELIMINARY OPERATIONS

3.1 Ensure that all power switches are set to off, and set all auxiliary equipment controls as necessary to avoid damage to the equipment and so that dangerous voltages will not be present on output terminals when the power switches are turned on.

3.2 Connect the TI to its AC adapter.

3.3 Connect the auxiliary equipment, and the TI, to the appropriate power source.

3.4 Turn all power switches on, and allow a sufficient warm-up time for the equipment (the TI requires no warm-up time).

SECTION 4

CALIBRATION PROCESS

NOTE

Unless otherwise specified, verify the results of each test and take corrective action whenever the test requirement is not met, before proceeding.

4.1 NAV TONE TESTS

4.1.1 Set the TI controls as follows:

MODE switch to	MKR XTL
MASTER MOD control to	CAL

4.1.2 Connect the frequency counter input to the TI NAV TONE OUT connector on the back panel of the TI.

4.1.3 Set the frequency counter for frequency measurements, as applicable.

4.1.4 Set the TI TONE SELECT switch to the following settings. At each setting, verify that the frequency counter indicates within the tolerance limits listed.

TI TONE SELECT Switch	FREQUENCY COUNTER	
	Nominal (Hz)	Tolerance Limits (Hz)
1020	1020	1010 to 1030
400	400	396 to 404
1300	1300	1287 to 1313
3000	3000	2970 to 3030

4.1.5 Set the TI TONE SELECT switch to CTR IN.

4.1.6 Set the TI MODE switch to VOR XTL.

4.1.7 Adjust the TI 9.96 kHz level control fully ccw and the 30 Hz VAR level control fully cw.

4.1.8 Verify that the frequency counter indicates between 29.994 and 30.006 Hz.

4.1.9 Adjust the TI 9.96 kHz level control fully cw and the 30 Hz VAR level control fully ccw.

4.1.10 Verify that the frequency counter indicates between 9958.008 and 9961.992 Hz.

4.1.11 Disconnect the frequency counter from the TI, and then connect the oscilloscope input to the TI NAV TONE OUT connector.

4.1.12 Adjust the oscilloscope controls as follows:

Vertical Amplifier VOLTS/DIV	>200 mV/div -UNCAL
TIME Base SEC/DIV	100 µs/div
Time Base Trigger Slope	+ (Positive Slope)

4.1.13 Adjust the oscilloscope trigger and position controls to vertically center the display, and then position the sweep trigger point at the left edge of the center horizontal graticule line as shown in Figure 1.

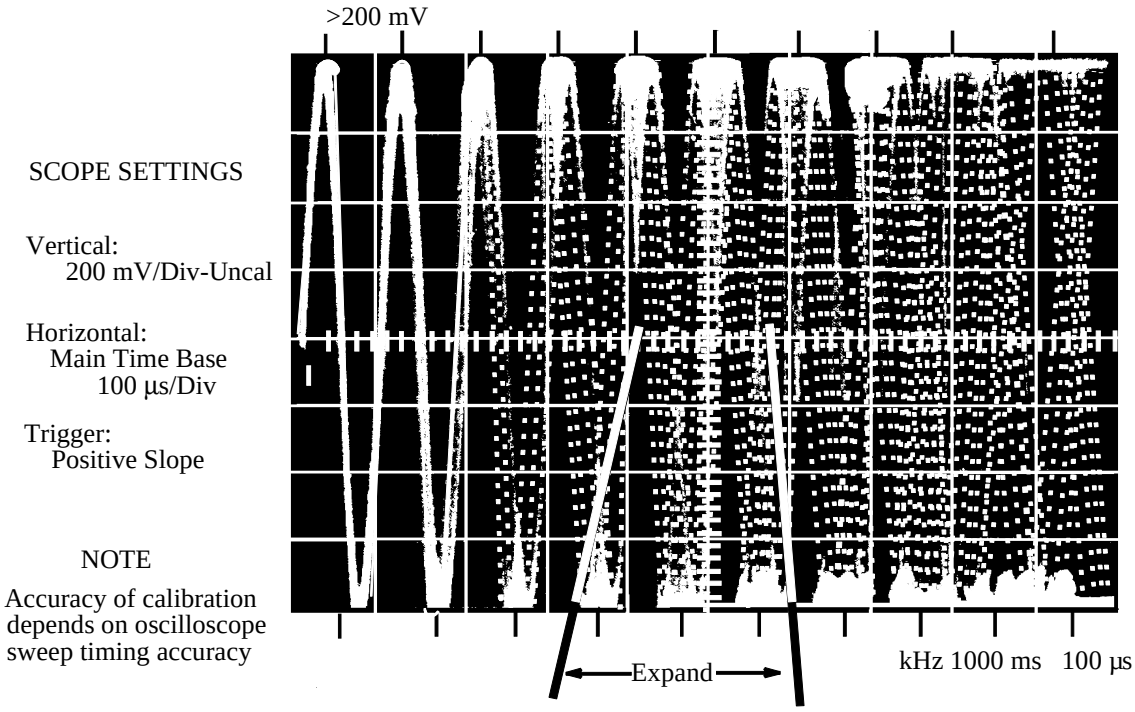

Figure 1. FM Deviation Display

4.1.14 Use the oscilloscope delayed sweep function to expand the portion of the TI signal indicated in Figure 1, with the oscilloscope delayed time base is set for 10 µs/div, such that the display is similar to Figure 2. Verify that the deviation of the expanded display corresponds to delta time (▲t) = 48.5 µs ±2.4 µs (see Figure 2).

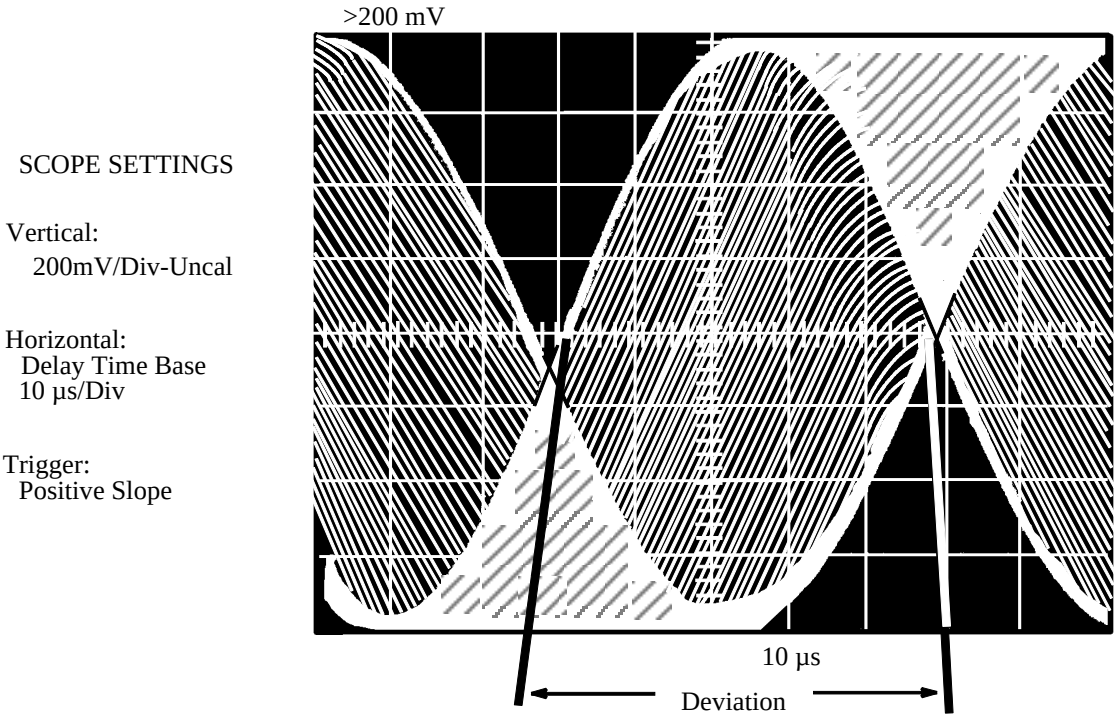

Figure 2. 9960 Hz Deviation Adjustment

4.1.15 Disconnect the oscilloscope from the TI, and then connect the frequency counter input to the TI NAV TONE OUT connector.

4.1.16 Set the TI controls as follows:

MODE switch to	LOC XTL
G/S DDM control to	l0
LOC DDM control to	90 Hz

4.1.17 Verify that the frequency counter indicates between 89.982 to 90.018 Hz.

4.1.18 Set the TI LOC DDM control to 150 Hz.

4.1.19 Verify that the frequency counter indicates between 149.97 to 150.03 Hz.

4.1.20 Disconnect the frequency counter from the TI, and then connect the oscilloscope input to the TI NAV TONE OUT connector.

4.1.21 Set the TI LOC DDM control to 0, and the VOR BRG switches to 004.0.

NOTE

Set the oscilloscope controls as necessary to view the TI waveform.

4.1.22 Press the TI Φ switch and verify that the relative amplitude of the peaks of the waveform, as displayed on the oscilloscope, changes when the switch is pressed.

4.1.23 Disconnect the oscilloscope from the TI.

4.2 DDM CENTERING TESTS

4.2.1 Connect the DMM to the TI SIG GEN DEMOD connector on the back panel of the TI.

4.2.2 Set the TI controls as follows:

TONE SELECT switch to	CTR IN
LOC DDM control to	0
MODE switch to	LOC XTL
G/S DDM control to	150 Hz
MASTER MOD control to	CAL
9.96 kHz control to	Fully ccw

4.2.3 Set the DMM for autoranging ac voltage measurements, as applicable.

4.2.4 Verify that the DMM AC voltage indication is between 520 and 580 mV rms. Note the exact DMM indication.

4.2.5 Set the TI G/S DDM control to 90 Hz, and then verify that the DMM ac voltage indication is within ±2 mV of the indication noted in step 4.2.4.

4.2.6 Set the TI controls as follows:

G/S DDM control to	0
MODE switch to	G/S XTL
LOC DDM control to	150 Hz

4.2.7 Verify that the DMM AC voltage indication is between 1.040 and 1.160 V. Note the exact DMM indication.

4.2.8 Set the TI LOC DDM control to 90 Hz, and then verify that the DMM AC voltage indication is within +2 mV of the indication noted in step 4.2.7.

4.2.9 Disconnect the DMM from the TI.

4.3 DISTORTION TESTS

4.3.1 Connect the distortion analyzer through the low pass filter to the TI NAV TONE OUT connector on the back panel of the TI.

4.3.2 Set the TI controls as follows:

MASTER MOD control to	CAL
MODE switch to	MKR XTL
TONE SELECT switch to	1020

4.3.3 Verify that the distortion analyzer indicates <1% harmonic distortion.

4.3.4 Set the TI TONE SELECT switch to 400, 1300, and 3000, and verify that the distortion analyzer indicates <1% harmonic distortion for each TI TONE SELECT switch setting.

4.3.5 Set the TI MODE switch VOR XTL.

4.3.6 Adjust the TI 9.96 kHz level control fully ccw and the 30 Hz VAR level control fully cw.

4.3.7 Set the TI TONE SELECT switch to CTR IN, and verify that the distortion analyzer indicates <0.5% harmonic distortion.

4.3.8 Set the TI controls as follows:

MODE switch to	LOC XTL
G/S DDM control to	0
LOC DDM control to	90

4.3.9 Verify that the distortion analyzer indicates <0.5% harmonic distortion.

4.3.10 Set the TI LOC DDM control to 150, and verify that the distortion analyzer indicates <|<>0.5% harmonic distortion.

4.3.11 Disconnect the distortion analyzer from the TI.

4.4 PERCENT MODULATION OF TONES TESTS

4.4.1 Set the TI controls as follows:

MASTER MOD control to	CAL
MODE switch to	MKR XTL
MONITOR switch to	100%
TONE SELECT switch to	1020

4.4.2 Connect the modulation meter input to the TI RF OUT connector.

4.4.3 Set the modulation meter for AM modulation measurements, as applicable

4.4.4 Verify that the modulation meter indicates between 90% and 100% AM, and that the TI MONITOR meter indicates approximately 95% modulation.

4.4.5 Set the TI MODE switch to VOR XTL.

4.4.6 Adjust the TI 30 Hz VAR and 9.96 kHz level controls fully ccw.

4.4.7 Verify that the modulation meter indicates between 28% and 32% AM, and that the TI MONITOR meter indicates approximately 30% modulation.

4.4.8 Set the TI TONE SELECT switch to MOD IN.

4.4.9 Adjust the TI 30 Hz VAR level control fully cw, and verify that the modulation meter indicates between 28% and 32% AM.

4.4.10 Adjust the TI 30 Hz VAR level control fully ccw, and the 9.96 kHz level control fully cw.

4.4.11 Verify that the modulation meter indicates between 28% and 32% AM.

4.4.12 Set the TI control as follows:

MODE switch to	LOC XTL
LOC DDM control to	0
MONITOR switch to	30%
G/S DDM control	90

4.4.13 Verify that the modulation meter indicates between 18% and 22% AM, and that the TI MONITOR meter indicates approximately 20%.

4.4.14 Set the TI G/S DDM control to 150, and verify that the modulation meter indicates between 18% and 22% AM.

4.4.15 Set the TI LOC DDM control to 90, and the TONE SELECT switch to 1020.

4.4.16 Verify that the modulation meter indicates between 28% and 32% AM.

4.4.17 Set the TI G/S DDM control to 0, MODE switch to G/S XTL, and the MONITOR meter function switch to 100%.

4.4.18 Verify that the modulation meter indicates between 38% and 42% AM, and that the TI MONITOR meter indicates approximately 40% modulation.

4.4.19 Set the TI LOC DDM control to 150, and verify that the modulation meter indicates between 38% and 42% AM.

4.4.20 Set the TI MODE switch to COM XTL, and tune the TI RF output. Verify that the modulation meter indicates between 28% and 32% AM.

4.4.21 Disconnect the modulation meter from the TI.

4.5 ATTENUATOR OUTPUT LEVEL TESTS

NOTE

If the RF millivoltmeter is to be used for the TI Attenuator Output Level Tests, then proceed with step 4.5.1; otherwise, if a power meter/power sensor is to be used, skip to step 4.5.2.

4.5.1 Using the RF Millivoltmeter

4.5.1.1 Connect the RF millivoltmeter input to the TI RF OUT connector, and set the RF millivoltmeter for dBm (50 Ω) operation.

4.5.1.2 Set the TI controls as follow:

MASTER MOD control to	fully ccw (out of CAL detent)
LOC-PEAK/AVG switch to	AVG
MODE switch to	VOR XTL

4.5.1.3 Adjust the TI OUTPUT attenuator to the following settings. At each setting, verify that the RF millivoltmeter indication is within the tolerance limits listed.

TI OUTPUT Attenuator (dBm)	RF Millivoltmeter Volt Nominal (dBm)	RF Millivoltmeter Tolerance Limits (dBm)
-30	-30	-29.5 to -30.5
-25	-25	*
-20	-20	*
-15	-15	*

*±0.5 dB of attenuator correction chart for actual RF output.

NOTE

If an attenuator correction chart is not supplied with the TI or the attenuator exceeds the tolerance limits listed, a new chart should be completed using Appendix A.

4.5.1.4 Adjust the TI OUTPUT attenuator for -30 dBm.

4.5.1.5 Set the TI MODE switch to the following settings. At each setting, verify that the RF millivoltmeter indication is within the tolerance limits listed.

TI MODE Switch	RF Millimeter Nominal (dBm)	RF Millivoltmeter Tolerance Limits (dBm)
MKR CTL	-30	-28.0 to -32.0
LOC XTL	-30	”
COMM XTL	-30	”

4.5.1.6 Set the TI MODE switch to COMM VAR HI.

4.5.1.7 Adjust the TI VAR FREQ control to 144.0 MHz, and tune the TI RF output. Verify that the RF millivoltmeter indicates between -28 and -32 dBm.

4.5.1.8 Set the TI MODE switch to G/S XTL. Verify that the RF millivoltmeter indicates between -28 and -32 dBm.

4.5.1.9 Adjust the TI TUNE control until the TUNE indicator comes on.

4.5.1.10 Set the TI LOC-PEAK/AVG switch to LOC-PEAK. Verify that the RF millivoltmeter indicates between -15 and -20 dBm.

4.5.1.11 Set the TI MONITOR switch to RF and tune the TI RF output. Verify that the MONITOR needle is approximately centered when the TI RF output is tuned.

4.5.1.12 Disconnect the RF millivoltmeter from the TI. Skip to section 4.6.

4.5.2 Using the Power Meter/Power Sensor

4.5.2.1 Set the TI controls as follows:

MASTER MOD control to	fully ccw (out of CAL detent)
LOC-PEAK/AVG switch to	AVG
MODE switch to	VOR XTL
OUTPUT Attenuator control to	-30 dBm

4.5.2.2 Connect the low-level power sensor to the power meter, zero and reference calibrate the power meter and power sensor, and set the power meter for log (dBm) readings.

4.5.2.3 Connect the low-level power sensor input to the TI RF OUT connector.

4.5.2.4 Set the TI MODE switch to the following settings. At each setting, set the power meter cal factor switch to the appropriate setting for the TI nominal frequency listed according the power sensor cal factor chart, and then verify that the power meter indication is within the tolerance limits listed.

TI		Power Meter Nominal (dBm)	Power Meter Tolerance Limits (dBm)
MODE Switch	Nominal Frequency		
VOR XTL	108 MHz	-30	-29.5 to -30.5
MKR XTL	75 ”	-30	-28.0 to -32.0
LOC XTL	108.1 ”	-30	-28.0 to -32.0
COMM XTL	126.9 ”	-30	-28.0 to -32.0

4.5.2.5 Set the TI MODE switch to COMM VAR HI.

4.5.2.6 Adjust the TI VAR FREQ control to 144.0 MHz, and tune the TI RF output. Set the power meter cal factor switch to the appropriate setting for 144 MHz according the power sensor cal factor chart, and then verify that the power meter indicates between -28 and -32 dBm.

4.5.2.7 Set the TI MODE switch to G/S XTL. Set the power meter cal factor switch to the appropriate setting for 334.7 MHz according the power sensor cal factor chart, and then verify that the power meter indicates between -28 and -32 dBm.

4.5.2.8 Disconnect the low-level power sensor from the TI.

4.5.2.9 Replace the low-level power sensor with the mid-level power sensor, zero and reference calibrate the power meter and power sensor, set the power meter for log (dBm) readings, and then set the power meter cal factor switch to the appropriate setting for 334.7 MHz according the power sensor cal factor chart.

4.5.2.10 Connect the mid-level power sensor input to the TI RF OUT connector.

4.5.2.11 Adjust the TI TUNE control until the TUNE indicator comes on.

4.5.2.12 Set the TI LOC-PEAK/AVG switch to LOC-PEAK. Verify that the RF millivoltmeter indicates between -15 and -20 dBm.

4.5.2.13 Set the TI MONITOR switch to RF and tune the TI RF output. Verify that the MONITOR needle is approximately centered with the TI RF output is tuned.

4.5.2.14 Set the TI controls as follows:

MASTER MOD control to	fully ccw (out of CAL detent)
LOC-PEAK/AVG switch to	AVG MODE switch
VOR XTL OUTPUT attenuator control to	-25 dBm

4.5.2.15 Set the power meter cal factor switch to the appropriate setting for 108 MHz according the power sensor cal factor chart.

4.5.2.16 Adjust the TI OUTPUT attenuator to the following settings. At each setting, verify that the power meter indication is within the tolerance limits listed.

TI OUTPUT Attenuator (dBm)	Power Meter Nominal (dBm)	Power Meter Tolerance Limits (dBm)
-25	-25	±0.5 dB of attenuator correction chart for actual RF output
-20	-20	
-15	-15	

NOTE

If an attenuator correction chart is not supplied with the TI or the attenuator exceeds the tolerance limits listed, a new chart should be completed using Appendix A.

4.5.2.17 Disconnect the power meter/power sensor setup from the TI.

4.6 RF FREQUENCY TESTS

4.6.1 Adjust the TI VAR FREQ fine tune control fully ccw into the detent, phase lock, position.

4.6.2 Adjust the TI MASTER MOD control fully ccw but not into CAL (detent) position.

4.6.3 Connect the frequency counter input to the TI RF OUT connector.

4.6.4 Set the TI MODE switch to VOR VAR.

4.6.5 Adjust the TI VAR FREQ control to phase-lock the output frequency at 110.000 MHz. Verify that the frequency counter indicates between 109.9989 and 110.0011 MHz. Disconnect the frequency counter from the TI.

4.6.6 Set the TI COUNTER MODE switch to GEN, and the MODE switch to the following settings. At each setting, verify that the TI counter indicates within the tolerance limits listed.

TI MODE Switch	TI Counter	
	Nominal (MHz)	Tolerance Limits (MHz)
MKR XTL	75.000	74.997 to 75.003
VOR XTL	108.000	107.995 to 108.005
LOC XTL	108.000	108.095 to 108.105
G/S XTL	344.700	334.695 to 334.705
COMM XTL	126.900	126.894 to 126.906

4.7 BEARING TESTS

4.7.1 Set the TI control as follows:

MODE switch to	VOR XTL
MASTER MOD control to	CAL
TONE SELECT switch to	CTR IN

4.7.2 Adjust the TI 9.96 kHz and 30 Hz VAR level controls fully cw.

4.7.3 Connect the TI NAV TONE OUT connector to the navigational indicator test set VOR COMP input connector.

4.7.4 Set the TI VOR BRG switches to 090.0, and the TO/FROM switch to TO. Verify that the navigational indicator test set indicates a bearing between 89.9° and 90.1°.

4.7.5 Set the TI TO/FROM switch to FROM. Verify that the navigational indicator test set indicates a bearing between 269.9° and 270.1°.

4.7.6 Set the TI MONITOR switch and COUNTER MODE switch to BRG. Ensure that the TI MONITOR meter needle deflects approximately midscale.

4.7.7 Set the TI VOR BRG switches to 000.0. Verify that the navigational indicator test set indicates a bearing between 179.9° and 180.1°.

4.7.8 Set the TI TO/FROM switch to TO. Verify that the navigational indicator test set indicates a bearing between 359.9° and 000.1°

4.7.9 Disconnect the navigational indicator test set from the TI.

4.8 FREQUENCY COUNTER TESTS

4.8.1 Set the TI controls as follows:

TONE SELECT switch to	CTR IN
COUNTER MODE switch to	Hz

4.8.2 Connect the signal generator output to the TI MOD IN/CTR IN connector, and set the signal generator output for 0 dBm.

4.8.3 Set the signal generator frequency to 1 MHz, 5 MHz, and 10 MHz. At each frequency setting, verify that the TI frequency counter displays the signal generator frequency within ±0.001%.

4.8.4 Set the TI COUNTER MODE switch to MHz.

4.8.5 Set the signal generator frequency to 10 MHz, 50 MHz, 100 MHz, and 300 MHz. At each frequency setting, verify that the TI frequency counter displays the signal generator frequency within ±0.001%.

4.8.6 Disconnect the signal generator from the TI.

4.9 POWER METER TESTS

4.9.1 Set the TI MONITOR switch to 100 W.

4.9.2 Zero and reference calibrate the power meter and mid-level power sensor, and then set the power meter for linear (mW) display. Set the power meter cal factor switch to the appropriate setting for 125 MHz according the power sensor cal factor chart.

4.9.3 Connect the equipment as shown in Figure 3. Ensure that the RF power source or signal generator output level is set to minimum.

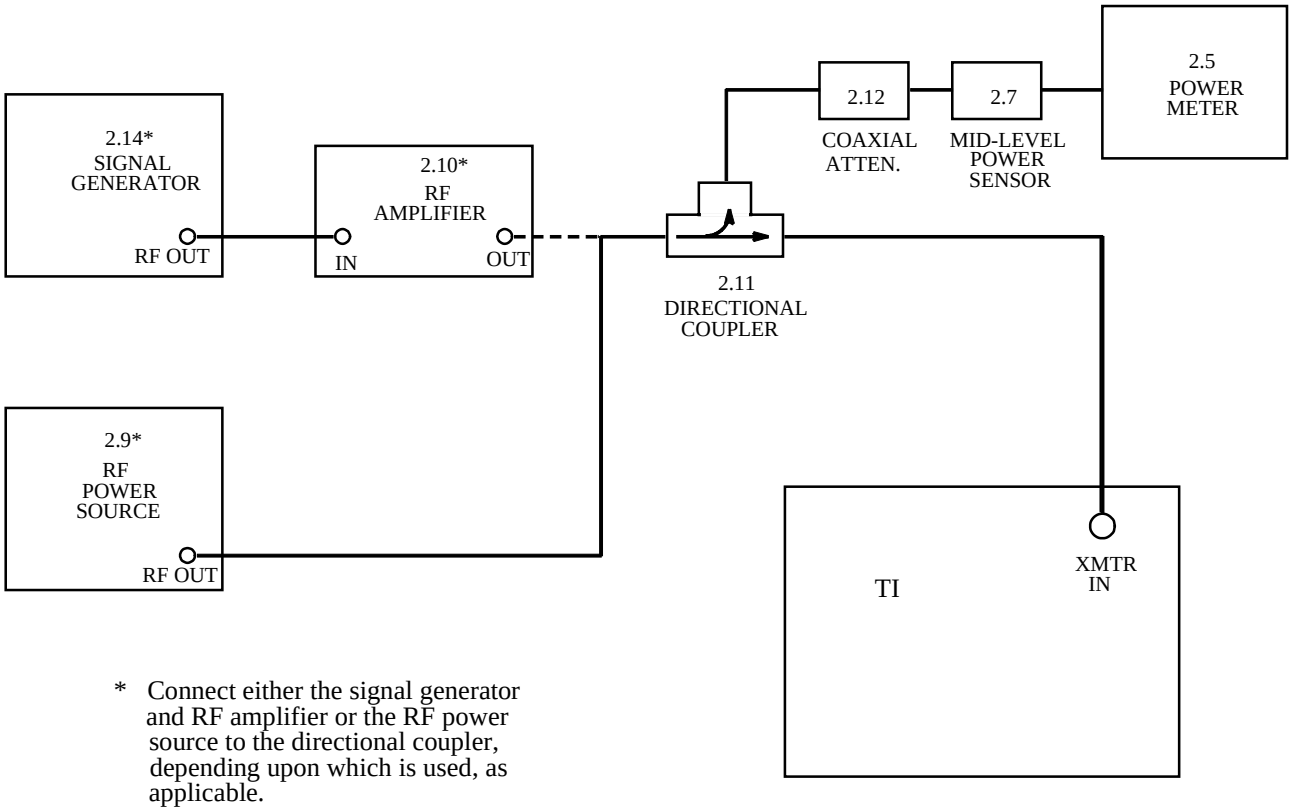

Figure 3. Power Meter Test Configuration.

4.9.4 Set the RF power source (or signal generator) frequency for 125 MHz, and adjust the output level for an approximate 50 watt unmodulated output.

4.9.5 Calculate and note the actual input power level to the TI as follows:

Input Power to TI	=	Power Meter Indication x 20 dB coupler value x 20 dB attenuator value
Power Meter Indication	=	Indication (in Watts) (Ex. = 4.51 mW or 0.00451 W)
20 dB coupler value	=	Report of Calibration value (linear) (Ex. = 101.5 or 20.065 dB)
20 dB attenuator value	=	Report of Calibration value (linear) (Ex. = 105 or 20.21 dB)
Then Input Power to TI	=	0.00451 x 101.5 x 105 = 48.06 W

4.9.6 Verify that the TI MONITOR meter indication corresponds to the actual RF power source value noted in step 4.9.5 within ±5 watts.

4.9.7 Set the RF power source (or signal generator) frequency for 125 MHz, and adjust the output level for an approximate 5 watt unmodulated output.

4.9.8 Set the TI MONITOR switch to 10 W.

4.9.9 Using the equation given in step 4.9.5, calculate and note the actual input power level to the TI.

4.9.10 Verify that the TI MONITOR meter indication corresponds to the actual RF power source value noted in step 4.9.9 within ±0.5 watts.

4.9.11 Set the RF power source output level to minimum, and disconnect the test setup.

4.10 BATTERY VOLTAGE AND TIMER TESTS

4.10.1 Disconnect the TI from its AC adapter.

4.10.2 Set the TI MONITOR switch to BAT. Verify that the TI MONITOR meter indicates the battery voltage on the 0 to 30% scale (corresponds to a 0 to 30 V scale). Verify that the TI MONITOR meter indicates greater than 12 V, (for fully charged batteries, the meter should indicate 15 V; and for discharged batteries, the meter should indicate 12 V; or below). If the TI MONITOR meter indicates below 12 V, take appropriate action to replace or recharge the TI batteries.

4.10.3 Press the TI POWER switch to BAT position and start a stopwatch to verify that the battery timer turns the TI off after 6 to 10 minutes.

4.10.4 Unless other measurements are to be performed, set all power switches to off or standby and disconnect from the TI.

CALIBRATION CHECKLIST

TEST INST(S) IFR Inc NAV 401L VOR/ILS Test Set

PROC. NO. NA 17-20AX-727		MFG.	MODEL			SER. NO.
PROCEDURE STEP NO (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL (6)	CALIBRATION TOLERANCES (7)
4.1	NAV Tone Tests					
4.1.4	TI Tone Select	(Hz)				(Hz)
”	1020 Hz MKR	1020				1010 to 1030
”	400 Hz MKR	400				396 to 404
”	1300 Hz MKR	1300				1287 to 1313
”	3000 Hz MKR	3000				2970 to 3030
4.1.8	30 Hz VAR	30				29.994 to 30.006
4.1.10	9.96 kHz level	9960				9958.008 to 9961.992
		(µs)				(µs)
4.1.14	480 Hz VOR dev	48.5				46.1 to 50.9
		(Hz)				(Hz)
4.1.17	90 Hz LOC-G/S	90				89.982 to 90.018
4.1.19	150 Hz LOC-G/S	150				149.97 to 150.03
4.1.22	90/150 Hz Phase Shift	--	ck ( )			Ampl Dif
4.2	DDM Centering Tests	(mV)				(mV)
4.2.4	150 Hz G/S	550				520 to 580
4.2.5	90 Hz G/S	500				±2 step 4.2.4
		(V)				(V)
4.2.7	150 Hz LOC	1.100				1.040 to 1.160
4.2.8	90 Hz G/S	1.100				±2 step 4.2.7
4.3	Distortion Tests					
4.3.3	1020 Hz	--	ck ( )			Distortion <1%
4.3.4	400 Hz	--	ck ( )			” <1%
”	1300 Hz	--	ck ( )			” <1%
”	3000 Hz	--	ck ( )			” <1%
4.3.7	30 Hz VAR	--	ck ( )			” <0.5%
4.3.9	90 Hz	--	ck ( )			” <0.5%
4.3.10	150 Hz	--	ck ( )			” <0.5%

CALIBRATION CHECKLIST

TEST INST(S) IFR Inc NAV 401L VOR/ILS Test Set

PROC. NO. NA 17-20AX-727		MFG.	MODEL			SER. NO.
PROCEDURE STEP NO (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL (6)	CALIBRATION TOLERANCES (7)
4.4	Percent Modulation of Tones Tests					
4.4.4	1020 Hz MKR	95%				90% to 100%
4.4.7	1020 Hz VOR	30%				28% to 32%
4.4.9	30 Hz VAR VOR	30%				28% to 32%
4.4.11	9.96 kHz VOR	30%				28% to 32%
4.4.13	90 Hz LOC	20%				18% to 22%
4.4.14	150 Hz LOC	20%				18% to 22%
4.4.16	1020 Hz LOC	30%				28% to 32%
4.4.18	150 Hz G/S	40%				38% to 42%
4.4.19	90 Hz G/S	40%				38% to 42%
4.4.20	1020 Hz COMM	30%				28% to 32%
4.5	Attenuator Output Level Tests					
4.5.1	Using the RF Millivoltmeter					
4.5.1.3	TI Indication (dBm)	(dBm)				(dBm)
”	-30	-30				-29.5 to -30.5
”	-25	--				±0. 5 dB of chart
”	-20	--				”
”	-15	--				”
		(dBm)				(dBm)
4.5.1.5	MKR CTL	-30				-28.0 to -32.0
”	LOC XTL	-30				-28.0 to -32.0
”	COMM XTL	-30				-28.0 to -32.0
4.5.1.7	VAR FREQ 144.0 MHz	-30				-28.0 to -32.0
4.5.1.8	G/S XTL	-30				-28.0 to -32.0
4.5.1.10	LOC-PEAK	-17.5				-15.0 to -20.0
4.5.1.11	RF MONITOR	--	ck ( )			Needle centered

CALIBRATION CHECKLIST

TEST INST(S) IFR Inc NAV 401L VOR/ILS TEST SET

PROC. NO. NA 17-20AX-727		MFG.	MODEL			SER. NO.
PROCEDURE STEP NO (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL (6)	CALIBRATION TOLERANCES (7)
4.5.2	Using the Power Meter/Power Sensor					
4.5.2.4	TI Indication (dBm)	(dBm)				(dBm)
”	VOR XTL -30	-30				-29.5 to -30.5
”	MKR XTL -30	-30				-28.0 to -32.0
”	LOC XTL -30	-30				-28.0 to -32.0
”	COMM XTL -30	-30				-28.0 to -32.0
		(dBm)				(dBm)
4.5.2.6	VAR FREQ. 144.0 MHz	-30				-28.0 to -32.0
4.5.2.7	G/S XTL	-30				-28.0 to -32.0
4.5.2.12	LOC-PEAK	-17.5				-15.0 to -20.0
4.5.2.13	RF MONITOR	--	ck ( )			Needle centered
4.5.2.16	TI Indication (dBm)					
”	-25	--				±0.5 dB of chart
”	-20	--				”
”	-15	--				”
4.6	RF Frequency Tests					
4.6.5	Output Frequency	(MHz)				(MHz)
”	VOR VAR	110.000				109.9989 to 110.0011
4.6.6	MKR XTL	75.000				74.997 to 75.003
”	VOR XTL	108.000				107.995 to 108.005
”	LOC XTL	108.100				108.095 to 108.105
”	G/S XTL	334.700				334.695 to 334.705
”	COMM XTL	126.900				126.894 to 126.906
4.7	Bearing Tests					
4.7.4	90° TO	90.0°				89.9 to 90.1°
4.7.5	270° FROM	270.0°				269.9 to 270.1°
4.7.5	180° FROM	180.0°				179.9 to 180.1°
4.7.8	0° TO	0.0°				359.9 to 000.1°

CALIBRATION CHECKLIST

TEST INST(S) IFR Inc NAV 401L VOR/ILS Test Set

PROC. NO. NA 17-20AX-727		MFG.	MODEL			SER. NO.
PROCEDURE STEP NO (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL (6)	CALIBRATION TOLERANCES (7)
4.8	Frequency Counter Tests					
		(MHz)				w/in ±0.001%
4.8.3	1 MHz	1				”
”	5 ”	5				”
”	10 ”	10				”
4.8.5	10 ”	10				”
”	50 ”	50				”
”	100 ”	100				”
”	300 ”	300				”
4.9	Power Meter Tests					
4.9.6	50 Watts	--	ck ( )			w/in ±5 watts
4.9.10	5 Watts	--	ck ( )			w/in ±0.5 watts
4.10	Battery Voltage and Timer Tests					
4.10.2	15 V fully charged	15 V				12 to 15 volts
4.10.3	Shut off	--	ck ( )			6 to 10 minutes

APPENDIX A

ATTENUATOR CORRECTION CHART
NAV-401L SERIAL NO: _____
1-34-0011

Dial Reading (dBm)	Actual RF Output 108.0 MHz (No mod)
-11.0	_____
-12.0	_____
-13.0	_____
-14.0	_____
-15.0	_____
-16.0	_____
-17.0	_____
-18.0	_____
-19.0	_____
-20.0	_____
-21.0	_____
-22.0	_____
-23.0	_____
-24.0	_____
-25.0	_____
-26.0	_____
-27.0	_____
-28.0	_____
-29.0	_____
-30.0	_____

Frequency		Actual RF output at -30 dBm
75.0	MHz	_____
108.1	MHz	_____
117.0	MHz	_____
126.9	MHz	_____
136.0	MHz	_____
144.0	MHz	_____
334.7	MHz	_____