CAUTION

- Most COMM receiver antenna connectors are also used for the COMM transmitter connector. Precautions should be taken not to key the transmitter with the COMM antenna connector connected to the NAV-401L/402AP RF Output Connector. Transmitter output signals at this connector may cause damage to the Attenuator and Signal Generator System

- Do not key transmitter into the Modulation Input/External Frequency Counter Input Connector, the RF Output Connector, or the connectors on the Rear Panel. Internal damage may result.

- Do not exceed 100 W max input power.

- Do not exceed Input Power Versus Time Limits of Table 1-1(SECTION I).

NAV-401L

MARKER, G/S, VOR, LOC, COMM, RAMP AND BENCH TEST SET

ifr

Manual Part Number: 1002-0972-600

10200 WEST YORK STREET/WICHITA, KANSAS 67215 U.S.A./(316) 522-4981 TWX 910-741-6952

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SECTION 4 Theory of Operation

GENERAL DESCRIPTION AND SPECIFICATIONS

NAV-401L SECTION 1

1 Description.

1-1 The NAV-401L is an FCC Type-Accepted bench and ramp test set designed to meet the electronic functional test requirements of Category I and Category II ILS Systems, Communication (COMM), Navigation (NAV), and Marker (MKR) Systems.

1-2 The NAV-401L is housed in a compact, portable case. It includes a signal generator with a variable attenuator which can be connected to the equipment under test by a radiated signal from a self-contained antenna or by a coax line. It can be operated under either crystal frequency control or in variable frequency mode in each band.

1-3 The NAV-401L generator can be modulated internally by a 1020Hz Indent tone, Marker, VHF Omnidirectional Range (VOR), Localizer (LOC) or Glide Slope (G/S) tones, or by an external signal.

1-4 The NAV-401L includes a six-digit counter which indicates the RF frequency of the signal generator on any band, the frequency of a COMM transmitter under test, any external signal input from 1 MHz to at least 300 MHz, or the VOR bearing selected by Bearing Select Switches.

1-5 An RF power meter is built-in to measure COMM transmitter power from 0-10W or 0-100W either peak or average power by selecting a switch position located on the Front Panel. A COMM transmitter demodulation output permits viewing or listening to COMM modulation.

1-6 A built-in Modulation Meter measures Signal Generator Percent of Modulation on any frequency band from 0-30% or 0-100%. Front Panel controls permit quick setting of modulation percentages.

1-7 A 90° bearing check monitor allows quick verification of basic VOR bearing from the VOR demod signal.

1-8 A nickel-cadmium battery and built-in charging system permit completely portable operation for up to 2 hours continuous duty with the counter off, one hour continuous duty with the counter on. Any time the set is plugged to an AC line, the battery is being charged. In battery operation, an automatic timer turns the set off after 6 to 10 minutes. The set can be recycled by pressing power switch to BAT position.

NAV-401L (S/N 1500 and On)
NAV-402AP (S/N 101 and On)

2 Specifications.

2-1 RF OUTPUT

Power:	Continuously variable from -7 dBm to -110 dBm (0.1 V to 0.709 μV)
Accuracy:	±2 dB from -30 dBm to -110 dBm (See enclosed -7 to -30 dBm Attenuator Correction Chart)
Frequency Range:	MKR. . . 72 MHz to 78 MHz VOR/LOC. 107 MHz to 120 MHz COMM LO: 118 MHz to 136 MHz HI: 134 MHz to 156 MHz G/S. . . 327 MHz to 337 MHz
Standard Crystal Frequencies:	MKR XTL . . . 75.000 MHz VOR XTL . . . 108.000 MHz LOC XTL . . . 108.100 MHz G/S XTL . . . 334.700 MHz COMM XTL. . . 126.900 MHz NOTE Any channel frequency crystal may be custom installed in any of the bands.
RF Frequency Accuracy:	Variable Frequency Mode with Digital Display indication: . . . . 0.002% Phase Lock Operation: 25 kHz increments in MKR, LOC, VOR, and COMM bands: 50 kHz increments in G/S band: . . . . 0.002% Crystal Control Mode: 0.005%

2-2 MKR SIGNAL

Tones:	1020 Hz (±1%) Ident 400 Hz (±1%) 1300 Hz (±1%) 3000 Hz (±1%)

2-2 MKR SIGNAL (cont'd)		
	Modulation:	Calibrated to 95%(±5%) for each tone. Variable from 3% to 96%.
2-3 VOR SIGNAL		
	Tones:	30 Hz (±0.02%) Reference 30 Hz (±0.02%) Variable Phase 9.96 kHz (±0.02%), 480 (±25) Hz Deviation (S/N 1500 and above) 1020 Hz (±1%) Ident
	Modulation:	Calibrated to 30(±2%) for each tone. Variable from 3% to 55%.
	Bearing:	3599 digitally derived courses in 0.1 degree increments. Course Accuracy: ±0.1 degree
2-4 LOC SIGNAL		
	Tones:	90 Hz (±0.02%) 150 Hz (±0.02%) 1020 Hz (±1%) Ident
	Modulation:	90 Hz and 150 Hz modulation levels calibrated to 20%(±2%). Variable from 3% to 35%. Audio Tone modulation levels calibrated to 30%(±2%). Variable from 3% to 55%.
	DDM:	0.093, 0.155 and 0.200 DDM, and Tone Delete. Accuracy: ±0.0013 DDM (1.3 μA). Variable Control: ±0.4 DDM. (See Table in SECTION 3)

2-4 LOC SIGNAL (cont.) Phase Shift:	90 Hz and 150 Hz phase locked to 5 times VOR BEARING SELECT SWITCH setting. 150 Hz selectable (Ref. to 90 Hz) in five degree increments. Accuracy: ±1° Typical. (See Table in SECTION 3)
2-5 G/S SIGNAL Tones:	90 Hz (±0.02%) 150 Hz (±0.02%)
Modulation:	Calibrated to 40% (±2%) for each tone. Variable from 3% to 75%.
DDM:	0.091, 0.175, and 0.40 DDM, and Tone Delete. Accuracy: ±0.0024 DDM (±2.0 µA) Variable Control: ±0.8 DDM. (See Table in SECTION 3)
Phase Shift:	90 Hz and 150 Hz phase locked to 5 times VOR BEARING SELECT SWITCH setting. 150 Hz selectable (Ref. to 90 Hz) in five degree increments. Accuracy: ±1° Typical. (See Table in SECTION 3)
Auxiliary Localizer Signal:	Simultaneously selected and paired with G/S Crystal Signal. Output typically -18 dBm, independent of OUTPUT ATTENUATOR CONTROL setting. Standard Frequency: 108.100 MHz Frequency Accuracy: ±0.005%
2-6 COMM SIGNAL Tones:	1020 Hz (±1%) Ident 400 Hz (±1%) 1300 Hz (±1%) 3000 Hz (±1%)

2-6 COMM SIGNAL (cont.) Modulation:	Calibrated to 30%(±2%) for each tone. Variable from 3% to 55%.
2-7 EXTERNAL MODULATION:	A 10 Hz to 20 kHz, 5 Volts peak to peak signal will typically produce 30% modulation for VOR, LOC, and COMM Signals, and 95% modulation for MKR Signals. G/S Signals cannot be externally modulated. External modulation of VOR, LOC, COMM, and MKR Signals can be varied over the same ranges as the internal modulations discussed above.
2-8 DISTORTION	At Back Panel Demodulated Outputs with Filter (Figure 1-1): 1020 Hz . . . . 1.00% Max 400 Hz . . . . 1.00% Max 1300 Hz . . . . 1.00% Max 3000 Hz . . . . 1.00% Max 30 Hz . . . . 0.65% Max 90 Hz . . . . 0.65% Max 150 Hz . . . . 0.65% Max At Back Panel Demodulated Outputs without Filter: 1020 Hz . . . . 2.50% Max 400 Hz . . . . 2.50% Max 1300 Hz . . . . 2.50% Max 3000 Hz . . . . 2.50% Max 30 Hz . . . . 2.00% Max 90 Hz . . . . 2.00% Max 150 Hz . . . . 2.00% Max

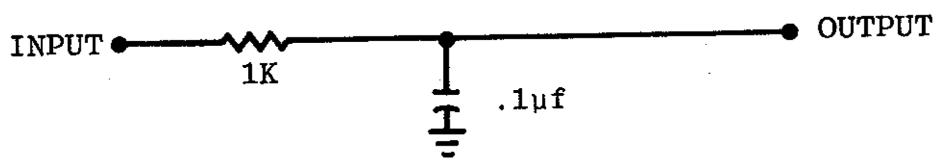


Figure 1-1 Low Pass Filter

2-9 COUNTER CHARACTERISTICS

Functions:	Measures internal signal generator frequencies. Measures frequency of external COMM transmitter. Measures frequency of external signal at Counter Input. Displays internal VOR Bearing as selected on Front Panel.
Clock Oscillator Frequency:	10 MHz
Clock Oscillator Frequency Accuracy:	Accurate within ±0.002% (Typically ±0.0005% over normal temperature and period of use).
Counter Resolution:	Hz . . . . 1 Hz kHz . . . . 10 Hz kHz . . . . 100 Hz MHz . . . . 1 kHz
External Input: Range:	Hz, kHz: 1 MHz to 10 MHz kHz, MHz: 10 MHz to 300 MHz
Impedance:	50Ω a.c. terminated.
Sensitivity:	0.08 V rms (-9 dBm) @ 10 MHz 0.15 V rms (-3 dBm) @ 200 MHz 0.23 V rms (0 dBm) @ 300 MHz
Maximum Counter Input Power:	250 mW RF, or +24 dBm.

CAUTION

DO NOT EXCEED MAXIMUM INPUT POWER LEVEL (250 mW RF, or +24 dBm) TO COUNTER OR DAMAGE TO UNIT MAY RESULT.

2-10 MONITOR METER CHARACTERISTICS

Power Meter:	Function:	Measures COMM transmitter power from 0 to 100 Watts.
	Scales:	0 to 100 Watts 0 to 10 Watts
	Accuracy:	±3% of full scale, plus ±5% of meter indication.
	Maximum Input Power:	20 Watts CW Continuous Duty

TABLE 1-1

INPUT POWER VERSUS TIME LIMITS		
Input Power (Watts)	ON Time Limit (Minutes)	Maximum Duty Cycle
20 to 40	5.0	50%
40 to 80	1.0	20%
80 to 100	0.5	10%

RF Level Monitor:		Center of scale indicates proper transmitter RF level
Battery Level:	Scale:	0 to 30 Volts
	Accuracy:	±5% of reading
2-11 Bearing Monitor Circuit:	Range:	±0.5 degrees (0 degrees at meter center)

2-12 SPECTRAL PURITY Harmonics:	At least 15 dB below carrier level at -30 dBm output level, over entire frequency range,
Broadband Noise:	At least 70 dB below carrier level at -30 dBm output at ±50 kHz. Spectrum Analyzer Set-up: 10 kHz Frequency Span, 300 Hz Bandwidth, 10 Hz Video Filter.
2-13 POWER Battery:	An internal NICAD battery system permits a continuous duty cycle for 1.5 hours. The battery charger continuously charges the battery whenever the test set is connected to AC power.
AC Line:	105 to 120 Vac or 220 to 250 Vac, 50 to 400 Hz, 25 Watts.
2-14 PHYSICAL CHARACTERISTICS Weight:	17 lbs. (7.7 kg.) complete
Width:	11.375 in (28.9 cm)
Height:	5.125 in (13.0 cm)
Depth:	16.125 in (41.0 cm)

Table 1-2 Tone Modulation Levels

BAND	TONE								
	30Hz	9960Hz	90Hz	150Hz	1020Hz	400Hz	1300Hz	3000Hz	Ext*
MKR	XX	XX	XX	XX	95%	95%	95%	95%	95%
VOR	30%	30%	XX	XX	30%	30%	30%	30%	30%
LOC	XX	XX	20%	20%	30%	30%	30%	30%	30%
G/S	XX	XX	40%	40%	XX	XX	XX	XX	XX
COMM	XX	XX	XX	XX	30%	30%	30%	30%	30%

NOTE: 95% Modulation accuracy ±5% except EXT
40% Modulation accuracy ±2% except EXT
30% Modulation accuracy ±2% except EXT
20% Modulation accuracy ±2% except EXT
XX - Tone not available

*External Input approximately 5Vp-p. Input impedance is 20KΩ in series with 33μf.

1 Introduction.

1-1 Each IFR Precision Simulator is carefully inspected for mechanical and electrical quality before shipment from the factory. On receipt, the instrument should be physically free of mars and scratches, and in perfect mechanical and electrical order.

2 Grounding Requirements.

2-1 To protect operating personnel, the National Electrical Manufacturer's Association (NEMA) recommends that the instrument panel and cabinet be grounded. All IFR instruments are equipped with a three-conductor power cord which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cord three-prong connector is the ground pin.

2-2 To preserve this protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green pigtail on the adapter to ground.

3 Installation.

3-1 No special installation procedures are necessary for this equipment.

4 Initial Inspection.

4-1 The instrument should be inspected immediately for possible in-transit physical damage. A check for supplied accessories, and a test of the electrical performance of the instrument (as outlined in SECTION 5 of this manual) should also be made. Any damage or deficiency should be reported immediately to the carrier and a claim filed, if necessary. Refer to the LIMITED WARRANTY AND SERVICE INSTRUCTIONS of this manual for delineation of responsibilities and liabilities. Follow the directions in the LIMITED WARRANTY AND SERVICE INSTRUCTIONS when it becomes necessary to ship the instrument.

5 Cleaning.

5-1 It is wise to clean the dust, cobwebs, and other debris out of the test set prior to periodic inspection, repair or calibration. Some shops clean their test equipment on a regular basis such as biannual or annual proof-of-performance checks.

5-2 Internal chassis parts and frame should be wiped with a lint-free cloth moistened with rubbing alcohol. The Front Panel may also be cleaned with rubbing alcohol. Safety solvent should be used to remove tar and oil from the outside case.

5-3 Dust removal is best done with a hand controlled dry air jet of 25 to 50 psi (1.827 kg/cm^2 to 3.653 kg/cm^2). The Rear Panel should be cleaned with a dry cloth only.

5-4 CARE MUST BE TAKEN TO AVOID BREAKING WIRES OR SHORTING COMPONENT LEADS TOGETHER DURING CLEANING.

6 Inspection Procedures.

6-1 General. Inspection is necessary to determine the general condition of the test set. It has been determined through hard experience that deliberate moving, however slight, of the discrete components on the various PC Boards and other assemblies often causes unnecessary circuit problems and can quickly change simple problems into complex ones. Therefore, IFR recommends ONLY A VISUAL INSPECTION without touching the components. Test set owners and operators should be aware that ANY opening of the instrument casing can result in calibration deviations. Complex modules, such as RF modules, should NOT be opened during Preliminary Inspection.

6-2 Chassis. Inspect the chassis for tightness of subassemblies, damaged chassis-mounted connectors, and corrosion or damage to the metal surface. Surface damage may indicate further damage to parts in the area.

6-3 Capacitors. Inspect all readily available capacitors for loose mounting, deformities or obvious physical damage, and leakage or corrosion around the leads.

6-4 Connectors. Examine all readily accessible coax connectors for loose or broken parts, cracked insulation, and bad contacts. DO NOT disassemble connectors within the test set.

6-5 Potentiometer Controls. Any Front Panel potentiometer control that feels rough when rotated should be checked with an ohmmeter for proper operation.

6-6 Printed Circuit (PC) Boards. (Readily accessible PC Boards only). Check the connectors and mating plugs for corrosion and damage. Inspect all mounted components, including crystals and IC's for damage. The PC Boards should be free of all foreign material.

6-7 Resistors. Inspect all readily available resistors for cracked, broken, charred, or blistered bodies and loose or corroded soldering connections.

6-8 Semiconductors. Inspect all readily available diodes, rectifiers, and transistors for cracked, broken, charred, or discolored bodies. Check the ends of the components to see that the seals around the leads are in place and in good condition.

6-9 Switches. Examine all readily available toggle switches for loose levers, terminals, and switch body connections to frame. The line switch contacts should not be bent or the switch action too loose.

6-10 Transformer. Inspect the transformer for signs of excessive heating, broken or charred insulation, and loose mounting hardware.

6-11 Wiring. Inspect all the wiring of the chassis for broken or loose ends and connections and for proper dress relative to other chassis parts. All the laced wiring should be tight with the ends securely tied.

7 Repacking for Shipping.

7-1 The LIMITED WARRANTY AND SERVICE INSTRUCTIONS contain detailed directions for repacking and shipping. Additional questions may be directed to the IFR Shipping Department.

7-2 Any instrument shipped to IFR for any reason MUST be tagged with: (1) its owner's identification, (2) the service or repair required, (3) its model number, and (4) its full serial number. Identify the instrument by prefix, model, and serial number in ALL correspondence.

7-3 IFR Precision Equipment should be shipped ONLY in their original containers. If the original container is not available, contact IFR for shipping instrunctions.

7-4 DO NOT return an instrument or its component parts to IFR without first receiving authorization from the IFR Customer Service Department. Refer to the LIMITED WARRANTY AND SERVICE INSTRUCTIONS for complete directions.

1 Introduction.

1-1 This section contains notes on general usage, tables used in operation of the NAV-401L; illustrations and descriptions of all controls, indicators and connectors; description of signals simulated, and operation procedures.

2 Signals Simulated.

2-1 The NAV-401L is a completely self-contained bench and ramp test instrument for: MARKER, VOR, ILS, and COMM equipment. The NAV-401L simulates MARKER signals with Inner (3000 Hz), Middle (1300 Hz) and Outer (400 Hz) tones. VOR Ground Station signals are simulated by an RF signal modulated by a 30 Hz reference signal, a variable 30 Hz signal, and a 9960 Hz signal. Localizer (LOC) signals are simulated by RF modulated by 90 and 150 Hz tones. Glide Slope (G/S) signals are simulated by modulating RF with 90 and 150 Hz tones. A second localizer frequency paired with G/S frequency is available as an option on the NAV-401L (standard on the NAV-402AP). COMM signals are simulated by RF modulated by the 400, 1300, or 3000 Hz MARKER tones or the 1020 Hz IDENT tone. IDENT may also be applied to MARKER, VOR, or Localizer signals.

3 General Usage of NAV-401L.

3-1 Connection to equipment under test, operation of NAV-401L controls and calibration of LOC and G/S course centering accuracy has been made as simple as possible. Bench and ramp operation of the NAV-401L are very similar. Differences in bench and ramp operation are given in the following two paragraphs.

3-2 The NAV-401L is an FCC Type accepted instrument and cannot be used in VAR (variable) frequency modes during ramp use. Any test signals radiated from the antenna must be crystal controlled. IFR does not authorize the NAV-401L to be externally modulated on any band during ramp use. This includes microphones, audio generators, etc.

3-3 During ramp testing, it is recommended to conserve battery power by operating the counter readout only when necessary. A push-button switch that controls power to the readout assembly is part of Counter Mode Switch.

4 Ramp Operation.

4-1 With the possible exception of Marker Beacon, most NAV COMM systems of a typical avionics package may be checked while NAV-401L is placed in a vertical position in the cockpit. The antenna is extended from two to three feet vertically. With the antenna on the RF Output Jack (10), the VOR, LOC, and G/S modes of NAV COMM Receivers may be checked and indicators operated through their limits. The COMM Receiver may also be operated, if desired, modulating the NAV-401L with either the 400, 1300, or 3000 Hz tones or the 1020 Hz IDENT tone.

4-2 On some installations, the Marker Antenna is located far aft on the fuselage. When this situation occurs, and receiver sensitivity is low (-35 to -45 dBm); the NAV-401L situated in the cockpit does not radiate enough RF to operate the Receiver. Moving the NAV-401L outside the aircraft will normally give more than enough signal strength to completely check Marker audio and lights.

4-3 To check COMM transmitter frequencies from cockpit, connect COMM Transmitter Output to COMM Transmitter Input Connector (11) and select MHz on Counter Mode Switch (3). Test set will read out the COMM Tramsmitter frequency when Transmitter is keyed.

5 Bench Operation.

5-1 Bench testing and alignment procedures usually dictate use of direct coax connections between the NAV-401L and equipment under test. NAV-401L Attenuator Dial readout is the RF level in dBm present at RF Output Connector (10) into 50 Ohms. To make accurate sensitivity measurements, the loss in dBm of the connecting coaxes must be known.

CAUTION

Most COMM Receiver Antenna Connectors are also used for the COMM Transmitter Connector. Precautions should be taken not to key the Transmitter with the COMM Antenna Connector connected to the NAV-401L RF Output Connector (10). Damage to the Attenuator and Signal Generator System may result.

6 General Purpose Counter Operation.

6-1 With Tone Select Switch in the CTR IN position, NAV-401L Counter may be utilized as a general utility counter. Frequencies from 1 MHz to 300 MHz can be measured.

6-1 (Cont.) Counter Mode Switch (3) can be used in any of four time base positions; Hz, kHz, kHz, or MHz.

7 Portable Operation.

7-1 Built-in battery supply permits completely portable ramp operation for up to two hours with Counter Readout off and one hour with Counter Readout on. Timer allows ample time for most ramp equipment checks but protects against battery being drained by set.

7-2 Between periods of ramp use, battery should be charged to maintain long life. Charger operation is automatic and is on whenever NAV-401L is connected to a.c. power. The set does not have to be turned on. The charger automatically causes charging current to be proportional to battery charge condition. Overnight charging is recommended.

NOTE

If the NAV-401L test set is used only for bench operation, the NICAD batteries can lose their storage ability. The test set should be periodically operated on battery power to allow the batteries to partially discharge.

7-3 Battery voltage is measured by placing the Monitor Meter Function Switch (30) in BAT position. The 0 to 30% scale shows battery voltage. Less than 12.5 V indicates a discharged battery. Portable operation should never be attempted at this voltage level. An automatic low voltage cutoff circuit will turn the NAV-401L off just below this level. Normal battery charged condition will be indicated as 15 V or greater.

7-4 To operate the LOC and G/S outputs simultaneously, first adjust all controls for normal G/S operation (G/S XTAL mode, only). The Output Attenuator varies the RF level of the G/S signal; and G/S DDM Controls vary the DDM of G/S signal. Next, select LOC with the AVG/PEAK LOC XMTR ON Switch (12). This activates a separate Localizer generator within the NAV-401L. This generator output is combined with the G/S output at the RF Output Connector (10) at the fixed level of -18 dBm (approx.). The Attenuator does not affect LOC output level in this mode. LOC DDM Controls vary the DDM of Localizer signal.

Table 3-1. Correspondence Chart for Decibels, Volts, and Watts (50Ω load)

Decibels	Volts	Watts
+40dBw	709V	10,000W
+39dBw	633V	7,940W
+38dBw	563V	6,320W
+37dBw	501V	5,000W
+36dBw	447V	3,980W
+35dBw	399V	3,160W
+34dBw	355V	2,510W
+33dBw	317V	2,000W
+32dBw	282V	1,590W
+31dBw	252V	1,260W
+30dBw	224V	1,000W
+29dBw	200V	794W
+28dBw	178V	632W
+27dBw	159V	500W
+26dBw	141V	398W
+25dBw	126V	316W
+24dBw	112V	251W
+23dBw	100V	200W
+22dBw	89.1V	159W
+21dBw	79.5V	126W
+20dBw	70.9V	100W
+19dBw	63.3V	79.4W
+18dBw	56.3V	63.2W
+17dBw	50.1V	50.0W
+16dBw	44.7V	39.8W
+15dBw	39.9V	31.6W
+14dBw	35.5V	25.1W
+13dBw	31.7V	20.0W
+12dBw	28.2V	15.9W
+11dBw	25.2V	12.6W
+10dBw	22.4V	10.0W

Decibels	Volts	Watts
+9dBw	20.0V	7.94W
+8dBw	17.8V	6.32W
+7dBw	15.9V	5.00W
+6dBw	14.1V	3.98W
+5dBw	12.6V	3.16W
+4dBw	11.2V	2.51W
+3dBw	10.0V	2.00W
+2dBw	8.91V	1.59W
+1dBw	7.95V	1.26W
0dBw = +30dBm	7.09V	1.00W = 1000mW
+29dBm	6.33V	794mW
+28dBm	5.63V	632mW
+27dBm	5.01V	500mW
+26dBm	4.47V	298mW
+25dBm	3.99V	316mW
+24dBm	3.55V	251mW
+23dBm	3.17V	200mW
+22dBm	2.82V	159mW
+21dBm	2.52V	126mW
+20dBm	2.24V	100mW
+19dBm	2.00V	79.4mW
+18dBm	1.78V	63.2mV
+17dBm	1.59V	50.0mW
+16dBm	1.41V	39.8mW
+15dBm	1.26V	31.6mW
+14dBm	1.12V	25.1mW
+13dBm	1.00V = 1000mV	20.0mW
+12dBm	891mV	15.9mW
+11dBm	795mV	12.6mW
+10dBm	709mV	10.0mW

Table 3-1 (cont.)

Decibles	Volts	Watts
+9dBm	633mV	7.94mW
+8dBm	563mV	6.32mW
+7dBm	501mV	5.00mW
+6dBm	447mV	3.98mW
+5dBm	399mV	3.16mW
+4dBm	355mV	2.51mW
+3dBm	317mV	2.00mW
+2dBm	282mV	1.59mW
+1dBm	252mV	1.26mW
0dBm	224mV	1.00mW = 1000uW
-1dBm	200mV	794uW
-2dBm	178mV	632uW
-3dBm	159mV	500uW
-4dBm	141mV	398uW
-5dBm	126mV	316uW
-6dBm	122mV	251uW
-7dBm	100mV	200uW
-8dBm	89mV	159uW
-9dBm	79mV	126uW
-10dBm	70.9mV	100uW
-11dBm	63.3mV	79.4uW
-12dBm	56.3mV	63.2uW
-13dBm	50.1mV	50.0uW
-14dBm	44.7mV	39.8uW
-15dBm	39.9mV	31.6uW
-16dBm	35.5mV	25.1uW
-17dBm	31.7mV	20.0uW
-18dBm	28.2mV	15.9uW
-19dBm	25.2mV	12.6uW
-20dBm	22.4mV	10.0uW
-21dBm	20.0mV	7.94uW
-22dBm	17.8mV	6.32uW
-23dBm	15.9mV	5.00uW
-24dBm	14.1mV	3.98uW
-25dBm	12.6mV	3.16uW

Decibels	Volts	Watts
-26dBm	11.2mV	2.51uW
-27dBm	10.0mV	2.00uW
-28dBm	8.9mV	1.59uW
-29dBm	7.95mV	1.26uW
-30dBm	7.09mV	1.00uW = 1000nW
-31dBm	6.33mV	794nW
-32dBm	5.63mV	632nW
-33dBm	5.01mV	500nW
-34dBm	4.47mV	398nW
-35dBm	3.99mV	316nW
-36dBm	3.55mV	251nW
-37dBm	3.17mV	200nW
-38dBm	2.82mV	159nW
-39dBm	2.52mV	126nW
-40dBm	2.24mV	100nW
		79.4nW
-41dBm	2.00mV	63.2nW
-42dBm	1.78mV	50.0nW
-43dBm	1.59mV	39.8nW
-44dBm	1.41mV	31.6nW
-45dBm	1.26mV	
-46dBm	1.12mV	25.1nW
-47dBm	1.00mV = 1,000uV	20.0nW
-48dBm	891uV	15.9nW
-49dBm	795uV	12.6nW
-50dBm	709uV	10.0nW
-51dBm	633uV	7.94nW
-52dBm	563uV	6.32nW
-53dBm	501uV	5.00nW
-54dBm	447uV	3.98nW
-55dBm	399uV	3.16nW
-56dBm	355uV	2.51nW
-57dBm	317uV	2.00nW
-58dBm	282uV	1.59nW
-59dBm	252uV	1.26nW
-60dBm	224uV	1.00nW = 100pW

Table 3-1 (cont.)

Decibles	Volts	Watts
-61dBm	200uV	794pW
-62dBm	178uV	632pW
-63dBm	159uV	500pW
-64dBm	141uV	398pW
-65dBm	126uV	316pW
-66dBm	112uV	251pW
-67dBm	100uV	200pW
-68dBm	89.1uV	159pW
-69dBm	79.5uV	126pW
-70dBm	70.9uV	100pW
-71dBm	63.3uV	79.4pW
-72dBm	56.3uV	63.2pW
-73dBm	50.1uV	50.0pW
-74dBm	44.7uV	39.8pW
-75dBm	39.9uV	31.6pW
-76dBm	35.5uV	25.1pW
-77dBm	31.7uV	20.0pW
-78dBm	28.2uV	15.9pW
-79dBm	25.2uV	12.6pW
-80dBm	22.4uV	10.0pW
-81dBm	20.0uV	7.94pW
-82dBm	17.8uV	6.32pW
-83dBm	15.9uV	5.00pW
-84dBm	14.1uV	3.98pW
-85dBm	12.6uV	3.16pW
-86dBm	11.2uV	2.51pW
-87dBm	10.0uV	2.00pW
-88dBm	89.1uV	1.59pW
-89dBm	7.95uV	1.26pW
-90dBm	7.09uV	1.00pW = 1000fW
-91dBm	6.33uV	794fW
-92dBm	5.63uV	632fW
-93dBm	5.01uV	500fW
-94dBm	4.47uV	398fW
-95dBm	3.99uV	316fW

Decibels	Volts	Watts
-96dBm	3.55uV	251fW
-97dBm	3.17uV	200fW
-98dBm	2.82uV	159fW
-99dBm	2.52uV	126fW
-100dBm	2.24uV	100fW
-101dBm	2.00uV	79.4fW
-102dBm	1.78uV	63.2fW
-103dBm	1.59uV	50.0fW
-104dBm	1.41uV	39.8fW
-105dBm	1.26uV	31.6fW
-106dBm	1.12uV	25.1fW
-107dBm	1.00uV = 1,000nV	20.0fW
-108dBm	891nV	15.9fW
-109dBm	795nV	12.6fW
-110dBm	709nV	10fW
-111dBm	633nV	7.94fW
-112dBm	563nV	6.32fW
-113dBm	501nV	5.00fW
-114dBm	447nV	3.98fW
-115dBm	399nV	3.16fW
-116dBm	355nV	2.51fW
-117dBm	317nV	2.00fW
-118dBm	282nV	1.59fW
-119dBm	252nV	1.26fW
-120dBm	224nV	1.00fW = 1000aW
-121dBm	200nV	794aW
-122dBm	178nV	632aW
-123dBm	159nV	500aW
-124dBm	141nV	398aW
-125dBm	126nV	316aW
-126dBm	112nV	251aW
-127dBm	100nV	200aW
-128dBm	89.1nV	150aW
-129dBm	79.5nV	126aW
-130dBm	70.9nV	100aW

Table 3-1 (cont.)

Decibles	Volts	Watts
-131dBm	63.3nV	79.4aW
-132dBm	56.3nV	63.2aW
-133dBm	50.1nV	50.0aW
-134dBm	44.7nV	39.8aW
-135dBm	39.9nV	31.6aW

Decibels	Volts	Watts
-136dBm	35.5nV	25.1aW
-137dBm	31.7nV	20.0aW
-138dBm	28.2nV	15.9aW
-139dBm	25.2nV	12.6aW
-140dBm	22.4nV	10.0aW

dBw - decibels referenced to one watt
dBm - decibels referenced to one milliwatt
V - volts
mV - millivolts (volts x 10^{-3})
uV - microvolts (volts x 10^{-6})
nV - nanovolts (volts x 10^{-9})
W - watts
mW - milliwatts (watts x 10^{-3})
uW - microwatts (watts x 10^{-6})
nW - nanowatts (watts x 10^{-9})
pW - picowatts (watts x 10^{-12})
fW - femtowatts (watts x 10^{-15})
aW - attowatts (watts x 10^{-18})

Table 3-2. Correspondence Charts for 90Hz and 150Hz Tones

LOCALIZER

Tone Difference Values			Course Deviation Indicator	
90Hz and 150Hz % Modulation	DDM	Decibels	Deflection	Microamps
20.00, 20.00	0	0	Centered	0
15.35, 24.65	.093	4.114	Standard	90
12.25, 27.75	.155	7.101	Full Scale	150
10.00, 30.00	.200	9.542	More than full scale	194
0.00, 40.00	.4	Infinity	Full one tone delete other	387

NOTE:
- Standard CDI deflection = 30% of full scale (linear movement).
- Deflections in microamps apply to indicators with full scale deflection current of 150μA.

GLIDE SLOPE

Tone Difference Values			G/S Deviation Indicator	
90Hz and 150Hz % Modulation	DDM	Decibels	Deflection	Microamps
40.00, 40.00	0	0	Centered	0
35.45, 44.55	.091	1.987	Standard	78
31.25, 48.75	.175	3.862	Full Scale	150
20.00, 60.00	.400	9.542	More than full scale	343
0.00, 80.00	.8	Infinity	Full one tone delete other	686

NOTE:
- Standard G/S indicator deflection = 53% of full scale (linear movement).
- Deflections in microamps apply to indicators with full scale deflection current of 150μA.

Table 3-3. 150Hz and 90Hz Tones Variable Phase Relationships

VOR BRG Switch Position	150Hz Phase Relative to 90Hz
000.0	0^0
001.0	$+5^0$
002.0	$+10^0$
003.0	$+15^0$
004.0	$+20^0$
005.0	$+25^0$
006.0	$+30^0$
007.0	$+35^0$
008.0	$+40^0$
009.0	$+45^0$
010.0	$+50^0$
011.0	$+55^0$
012.0	$+60^0$
013.0	$+65^0$
014.0	$+70^0$
015.0	$+75^0$
016.0	$+80^0$
017.0	$+85^0$
018.0	$+90^0$
019.0	$+95^0$
020.0	$+100^0$
021.0	$+105^0$
022.0	$+110^0$
023.0	$+115^0$
024.0	$+120^0$ or 0^0 *

* $+120^0$ will have the same phase relationship as 0^0; therefore, only 1^0 through 12^0 BRG switch positions need be used.

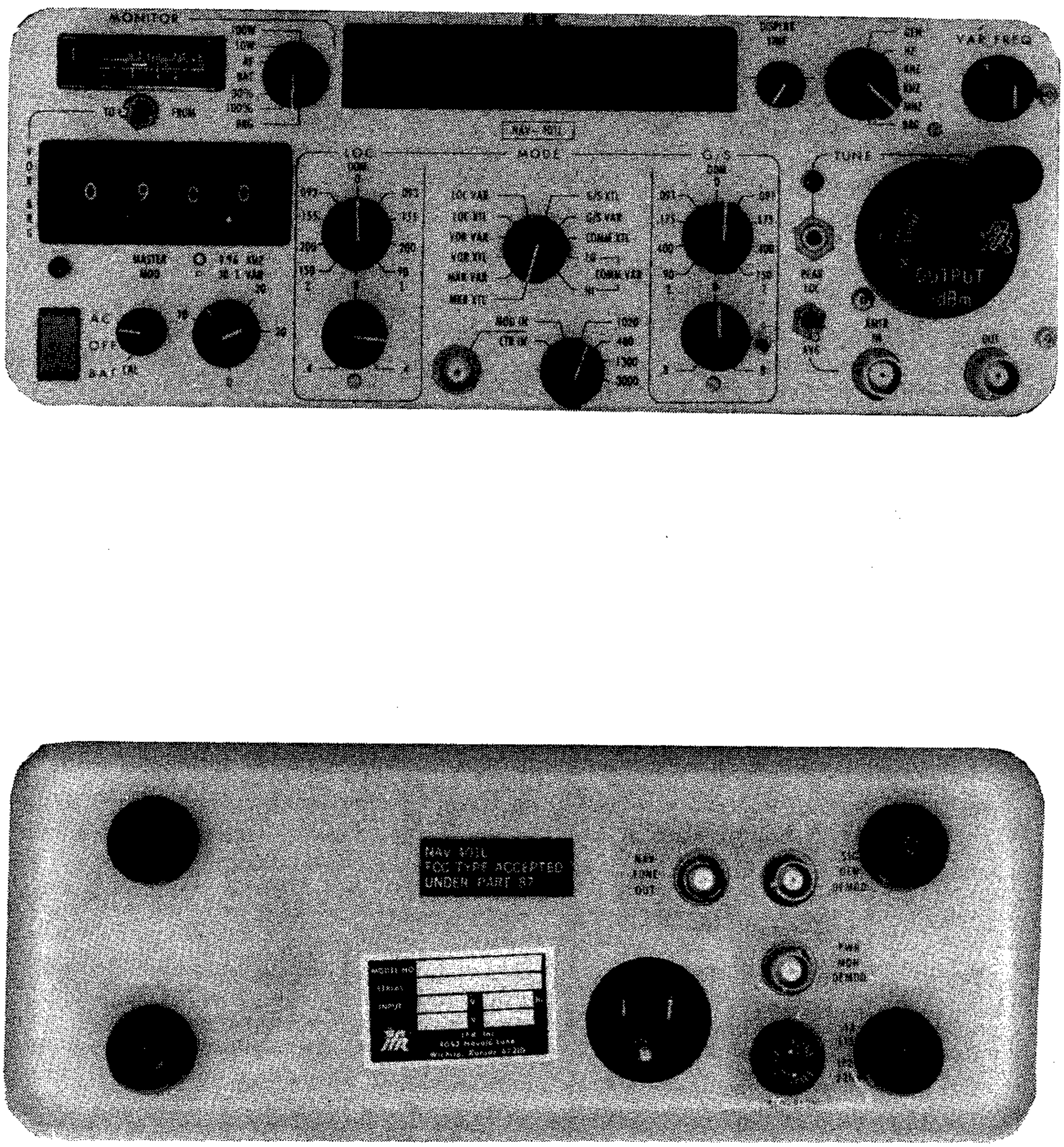


Fig. 3-1 NAV-401L Front and Rear Views

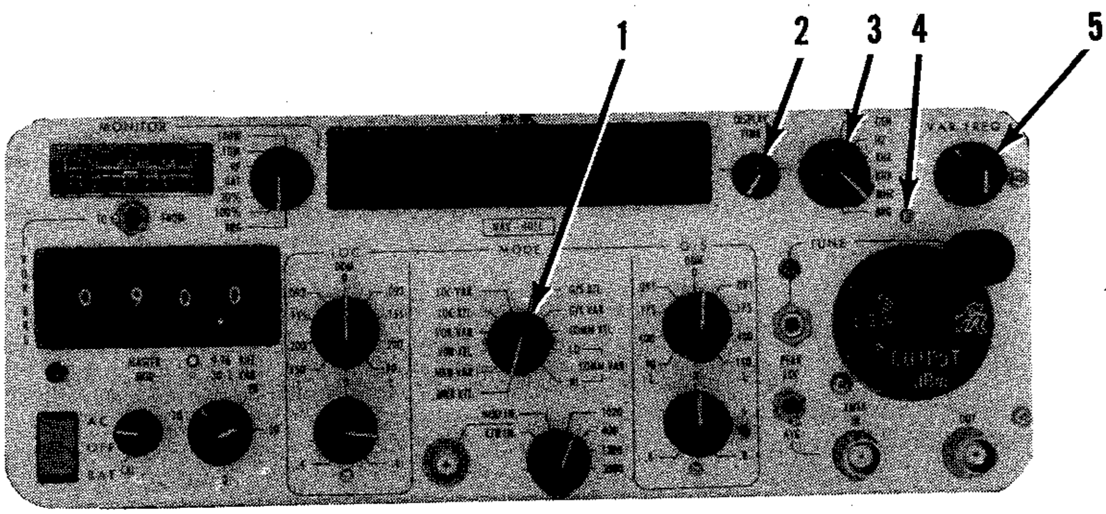


Fig. 3-2

CONTROL/INDICATOR/CONNECTOR	FUNCTION
1. Frequency Mode Switch	Selects frequency band to be used: MARKER (MKR), VOR, Localizer (LOC), Glide Slope (G/S), or COMM. Each band except COMM is divided into two positions: a crystal controlled frequency position, and a variable frequency position, COMM band utilizes three switch positions: a crystal controlled position, and two variable frequency positions.
2. Display Time Control	Varies Counter update time. CCW rotation causes interval between updates to decrease. In full cw position, the count is held indefinitely.
3. Counter Mode Switch	Selects source of signal to be counted. In GEN position, displays frequency of internal signal generator. In Hz, kHz, kHz, or MHz positions, Counter measures frequency of a COMM Transmitter connected to XMTR IN Connector, or external signal source. External signal

Table 3-4 Controls, Indicators & Connectors

CONTROL/INDICATOR/CONNECTOR	FUNCTION
3. (Cont.) Counter Mode Switch	must be applied to MOD IN/CTR IN Connector (18). In BRG (Bearing) position, the input to Counter is the output of digital bearing determining circuitry. Display should equal VOR BRG Switch (27) indication. This provides a check on bearing selection circuits. In BRG position, bearing monitor circuitry also checks VOR modulation for proper operation at 90°. A pushbutton switch is incorporated into Counter Mode Switch which applies power to Counter Readout in either battery or a.c. operation. This switch is activated by depressing Counter Mode Switch Knob. It is highly recommended during portable operation to use Counter Readout only when necessary.
4. Meter Bearing Center Adjust	Used to center Monitor Meter (29) to set a reference level in internal bearing check operation. Monitor Meter Function Switch (30) should be in the BRG position and Counter Mode Switch (3) should be in any position except BRG while the Meter is being centered.
5. Variable Frequency Controls	Coarse and fine controls used to manually sweep the Internal Signal Generator frequency. CW rotation of these controls increases the frequency. Frequency Mode Switch (1) must be in a VAR position for manual sweeping. Coarse Control, larger knob, gives from 1 to 2 MHz deviation per turn. Fine Control, smaller knob, gives approximately 20 to 40 kHz deviation per turn.

Table 3-4 (Cont.)

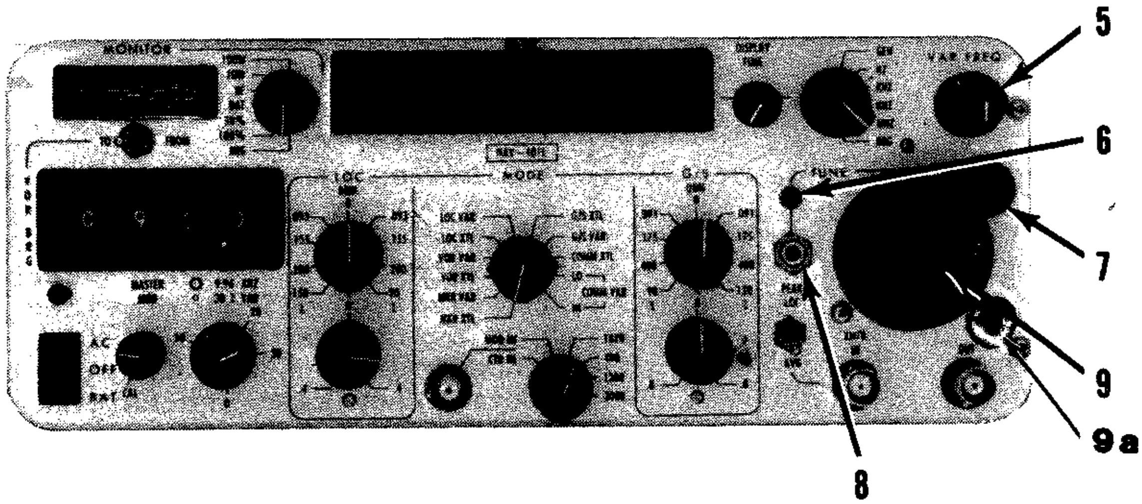


Fig. 3-3

CONTROL/INDICATOR/CONNECTOR	FUNCTION
5. (Cont.) Variable Frequency Controls	Phase Lock Circuit. Phase Lock Circuit is activated by turning the Fine Variable Frequency Control full CCW, into the detent position. Phase lock can be obtained every 25 kHz in variable frequency modes, except for G/S. G/S frequencies are phase locked in 50 kHz increments. Coarse Variable Frequency Control is used to select desired phase locked frequencies. Phase lock is indicated by proper count on the Frequency Counter (31). It is necessary to adjust for phase locked steps since pull-in range of phase lock circuit is less than 25 kHz. A phase lock on any frequency other than 25 or 50 kHz steps is not valid and will have severe frequency modulation (FM). NOTE Variable Frequency Oscillator should not be adjusted to a frequency within ±5 kHz of an XTAL frequency to avoid interaction between oscillator circuits.

CONTROL/INDICATOR/CONNECTOR	FUNCTION
6. Tune Indicator	Indicates proper Signal Generator tuning. Tune Indicator is extinguished when Generator is properly tuned.
7. Tune Control	Adjusts Signal Generator for optimum tuning. It must be readjusted whenever a different frequency band is used or when Variable Frequency Controls (5) change frequency more than a few MHz in any one band. Tune Control should also be adjusted whenever Attenuator (9) is set for an output level from -15 dBm to max output level available, or whenever setting of Attenuator is changed within this range.
8. Fine Tune Switch	Fine tunes the Transmitter when tuning is within fine tune range and the Tune Indicator (7) is extinguished. When Fine Tune Switch is pressed, Tune Control (6) is adjusted for a minimum indication on Monitor Meter (29).
9. Output Attenuator Control	Used to adjust RF level of Signal Generator Output at the RF Output Connector (10) into a 50Ω load. Attenuator Dial is calibrated in -dBm or dB below 1 mW. The dial is accurate for output levels below -30 dBm. An Attenuator Correction Chart is included with each instrument. Also included is a chart converting -dBm to soft microvolts. **NOTE** Soft Microvolts - microvolts as measured with 50Ω loading. Hard Microvolts - microvolts as measured through a 6 dB pad, into 50 Ohms.

Table 3-4 (Cont.)

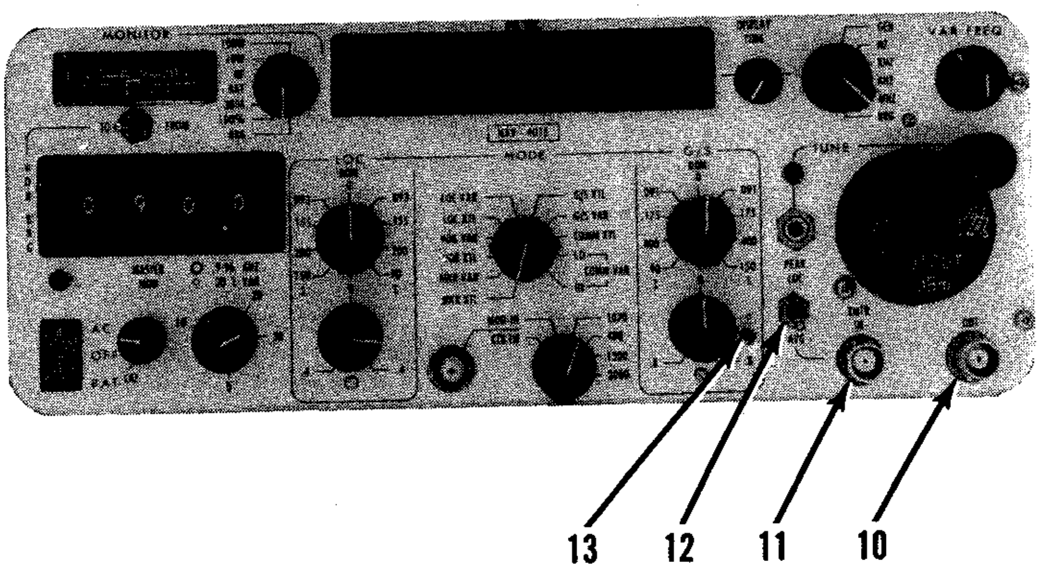


Fig. 3-4

CONTROL/INDICATOR/CONNECTOR	FUNCTION
9a. A-100 Amp Voltage Supply Connector	Provides power supply voltage for A-100 Amp. CAUTION CONNECTOR IS NOT TO BE USED FOR ANY AUXILIARY EQUIPMENT EXCEPT THE A-100 AMP.
10. RF Output Connector	Provides Attenuated Signal Generator Output to equipment under test. This connector is diode protected against a COMM Transmitter being accidently keyed, but steps should be taken to make sure than keying does not occur. Output is source terminated in 50 Ohms.
11. COMM Transmitter Input Connector	Input to Monitor Meter (29). It is connected with a 50Ω cable to a COMM Transmitter for power and frequency measurement purposes. Power indicated is either peak or average power. COMM Transmitter frequency is indicated on Digital Display (31) with Counter

Table 3-4 (Cont.)

CONTROL/INDICATOR/CONNECTOR	FUNCTION
11. (Cont.) COMM Transmitter Input Connector	Mode Switch (3) in Hz, kHz, kHz, or MHz positions. An internal 25 dB pad is used in series with Power Monitor Circuit. NOTE See SECTION 1, Technical Summary for Power Meter input power vs. time requirements.
12. AVG/PEAK LOC XMTR ON Switch	Selects function of Power Meter (29). In PEAK position, the Power Meter indicates peak power amplitude of a COMM Transmitter with modulation applied. Peak Position also provides output from the separate Localizer Transmitter simultaneously with the Glide Slope signal, with Frequency Mode Switch (1) in the G/S XTAL position (for checking Autopilots or Course Computers). In AVG position, Power Meter indicates average RF power of a COMM Transmitter and disregards power changes due to proper modulation.
13. 90/150 Hz Variable Phase (ϕ) Switch	When Variable Phase (ϕ) Switch is depressed, phase of 150 Hz tone can be varied in 5^0 steps by use of VOR Bearing Select Switches (27). Normally, 150 and 90 Hz tones used for LOC and G/S modulation are phase-locked together. If VOR Bearing Select Switches are set to 000.0^0, depressing Variable Phase (ϕ) Switch produces no change of phase. For each 1^0 step of VOR Bearing Select Switch, 150 Hz tone is shifted $+5^0$ relative to the 90 Hz tone. 90 Hz tone always remains constant in phase with respect to 000.0^0 VOR Bearing Select Switch position.

Table 3-4 (Cont.)

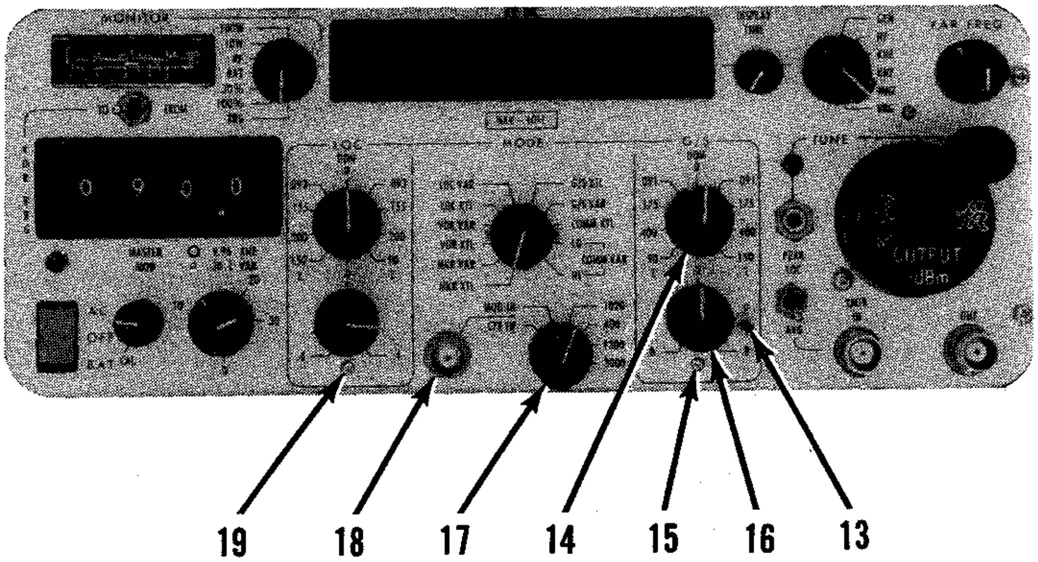


Fig. 3-5

CONTROL/INDICATOR/CONNECTOR	FUNCTION
13. (Cont.) 90/150 Hz Variable Phase (ϕ) Switch	When 24° VOR Bearing is selected, 90 and 150 Hz tones are at their original phase relationships. When a 12° VOR Bearing is selected, amplitude summation of the 90 and 150 Hz tones is at maximum magnitude.
14. Glide Slope DDM Control	Selects amount of G/S pointer deviation on ILS Indicator under test. Calibrations in DDM (Difference in Depth of Modulation) represent standard deflection, full scale, and greater than full scale deflections. CW rotation of control gives upward deflection. In either 90 Hz or 150 Hz positions, the opposite tone is deleted and selected tone is at the same level as the on-course value (40%) so that a flag test can be made. Localizer DDM Control (21) should not be in the 90 or 150 Hz position when using Glide Slope function. This would cause either 90 or 150 Hz tone to be deleted by LOC DDM Control (21).

Table 3-4 (Cont.)

CONTROL/INDICATOR/CONNECTOR	FUNCTION
14. (Cont.) Glide Slope DDM Control	Continuous Wave (CW) operation can be obtained by placing G/S DDM Control (14) on 150 Hz and LOC DDM Control (21) on 90 Hz or vice versa.
15. Glide Slope Centering Adjust Control	Varies the amplitude of 90 Hz tone and is used as an exact course centering control for Glide Slope modulation.
16. Glide Slope Variable DDM Control	Continuously varies G/S pointer deflection from 0.8 DDM, down through 0 DDM to 0.8 DDM up. CW rotation of this control gives upward pointer deflection. G/S DDM Control (14) must be in arrow position (index mark down, directly toward G/S Variable DDM Control).
17. Tone Select Switch	Selects modulation input to internal Signal Generator or input to the Counter. In the MOD IN position, Modulation Input/External Frequency Counter Input Connector (18) is used as input to the Signal Generator. In any of four tone positions, a tone is selected to modulate various frequency bands selected by the Frequency Mode Switch (1). Glide Slope band cannot be externally modulated. When CTR (Counter) IN position is selected, Modulation Input/External Frequency Counter Input Connector (18) is used as input to the Digital Counter.
18. Modulation Input/ External Frequency Counter Input Connector	External input to the Counter or external input to the Signal Generator. See paragraphs on Counter Mode Switch (3) and Tone Select Switch (17) for further information.
19. Localizer Centering Adjust	Varies amplitude of 90 Hz tone and is used as an exact course centering control for Localizer modulation.

Table 3-4 (Cont.)

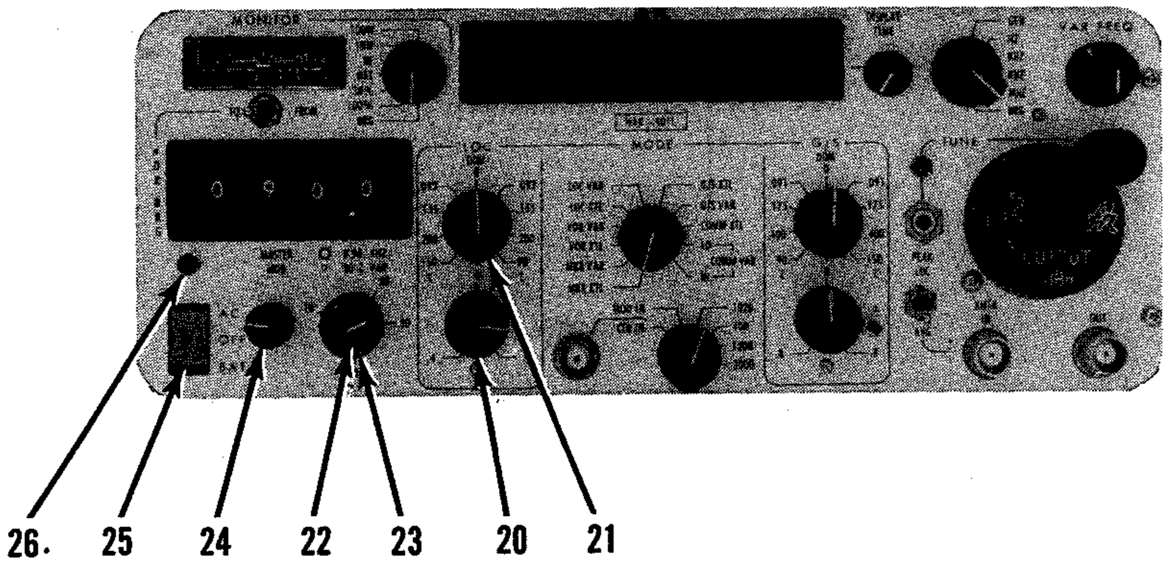


Fig. 3-6

CONTROL/INDICATOR/CONNECTOR	FUNCTION
20. Localizer Variable DDM Control	Continuously varies LOC pointer deflection from 0.4 DDM left through 0 DDM to 0.4 DDM right. CW rotation of 0 control gives right pointer deflection. LOC DDM Control (21) must be in arrow position (index mark down, directly toward LOC Variable DDM Control).
21. Localizer DDM Control	Selects amount of deviation of LOC pointer of an ILS Indicator under test. Calibrated in DDM, switch positions correspond to standard deflection, full scale, and greater than full scale deflections. In either 90 or 150 Hz position, the opposite tone is deleted and selected tone is at the same level as the on course value (20%) so that a flag test can be made. The G/S DDM Control (14) should not be in the 90 or 150 Hz position when using the Localizer function. This would cause the 90 or 150 Hz tone to be deleted by G/S control.

Table 3-4 (Cont.)

CONTROL/INDICATOR/CONNECTOR	FUNCTION
21. (Cont.) Localizer DDM Control	Continuous wave (CW) operation can be obtained by placing G/S DDM Control (14) on 150 Hz and LOC DDM Control (21) in 90 Hz position or vice versa.
22. 30 Hz VAR Level Control	Changes percentage of modulation of 30 Hz VAR tone of VOR Composite Signal from 0 to 30%. It reaches 30% when knob is turned past the 30% line to the stop.
23. 9960 Hz REF Level Control	Changes percentage of modulation of 9.960 kHz tone of VOR Composite Signal from 0 to 30%. It reaches 30% when the knob is turned past 30% line to the stop.
24. Master Modulation Level Control	Controls modulation level of all modulating tones. In CAL (detent) position (full ccw), modulation levels of each type of signal (LOC, G/S, etc.) are fixed at their proper values of 20%, 30%, 40%, 95%, etc. In other than CAL position, control varies level of modulation of any signal from 0 to approximately twice normal level for that signal. For example, VOR IDENT tone is 30% in CAL position, and 0 to 60% in variable operation.
25. AC/Battery Power Switch	Controls power to NAV-401L. It is a three position, center off switch. When AC is selected, test set is powered from a.c. line. When switch is depressed to BATT, which is a momentary position battery timer is activated. Test set will now operate on battery power until timer turns test set off, or until AC/ Battery Power Switch is again depressed to BATT position. Time limit for battery timer is from 6 to 10 minutes.
26. Power On Indicator	Illuminates when ac or battery power is applied to the set.

Table 3-4 (Cont.)

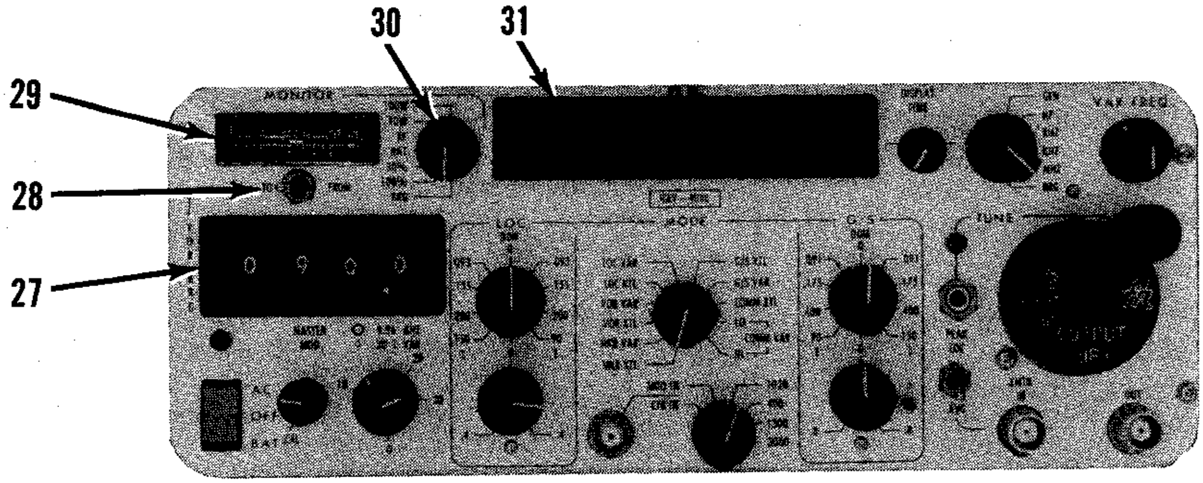
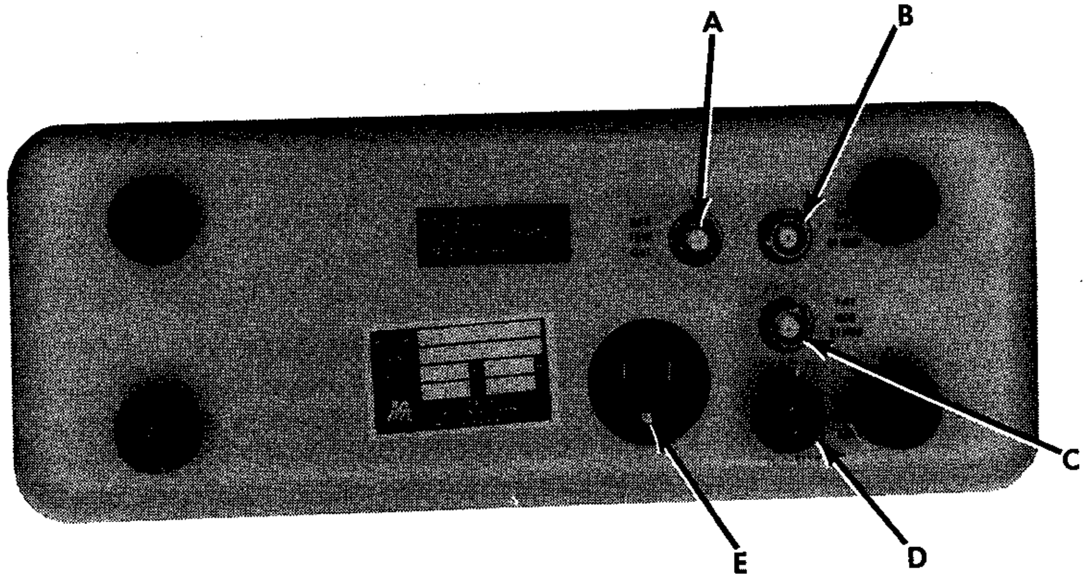


Fig. 3-7

CONTROL/INDICATOR/CONNECTOR	FUNCTION
27. VOR Bearing Select Switches	Four thumbwheel switches select VOR Bearing that is to be simulated by the NAV-401L. The Hundreds Digit Thumbwheel Switch (on left) is stopped at 3. Bearing indications from 360 through 399.9° are not valid.
28. VOR Bearing TO/FROM Switch	Changes selected VOR Bearing to reciprocal bearing for flag tests, etc.
29. Monitor Meter	Provides analogue indication of RF power, Signal Generator RF Output Level, battery voltage, percent modulation of Signal Generator, and indication at 90° that VOR bearing circuitry is functioning properly.

CONTROL/INDICATOR/CONNECTOR	FUNCTION
30. Monitor Meter Function Switch	Selects Monitor Meter function. COMM Transmitter power is measured on two scales: 0-10 Watts and 0-100 Watts. RF position is used to indicate proper RF leveling of Signal Generator. In BATT position, the 0 to 30% scale is used to read battery voltage. Less than 12.0 V indicates a discharged battery. A fully charged battery should indicate more than 15 V. 30% and 100% switch positions are used to measure modulation level of Signal Generator. BRG switch position allows VOR Generator to be checked at 90°. Center of the band indicates a 0° bearing error. Left and right meter scale limits indicate VOR Bearing errors of ±0.5%.
31. Digital Display	Provides digital readout of: Selected VOR Bearing, Internal Generator frequency, external signal source frequency, or COMM Transmitter frequency. Function displayed is controlled by Counter Mode Switch (3). For details of operation, see paragraphs on Counter Mode Switch (3) and Display Time Control (2).

Table 3-4 (Cont.)



REAR PANEL CONTROL/INDICATOR/CONNECTOR	FUNCTION
A. NAV Tones Demodulated Output Connector	Provides audio output used to test VOR Bearing Circuits or Deviation Circuits of LOC and G/S NAV Receivers. Output level is varied by use of Master Mod Control (24) from approximately 0 to 7 Vp-p into 1000 ohms. The connector also provides access to the audio modulation of MARKER and COMM signals. The connector is internally connected to the NAV-401L Modulator.
B. Signal Generator Demodulated Output Connector	Provides demodulated output of Signal Generator. This output is to be used as a monitoring capability and is not intended to feed VOR and ILS Converters. If output voltage available is adequate and the approximately +4.25 Vdc. component is not objectionable, the output can be used to drive a Converter.

Table 3-4 (Cont.)

REAR PANEL CONTROL/INDICATOR/CONNECTOR	FUNCTION
C. COMM Transmitter Demodulated Output Connector	Provides access to demodulated output of a COMM Transmitter. This may be used to display modulation on an Oscilloscope or to listen to modulation via an External Amplifier
D. Fuseholder	
E. AC Power Connector	

Table 3-4 (Cont.)

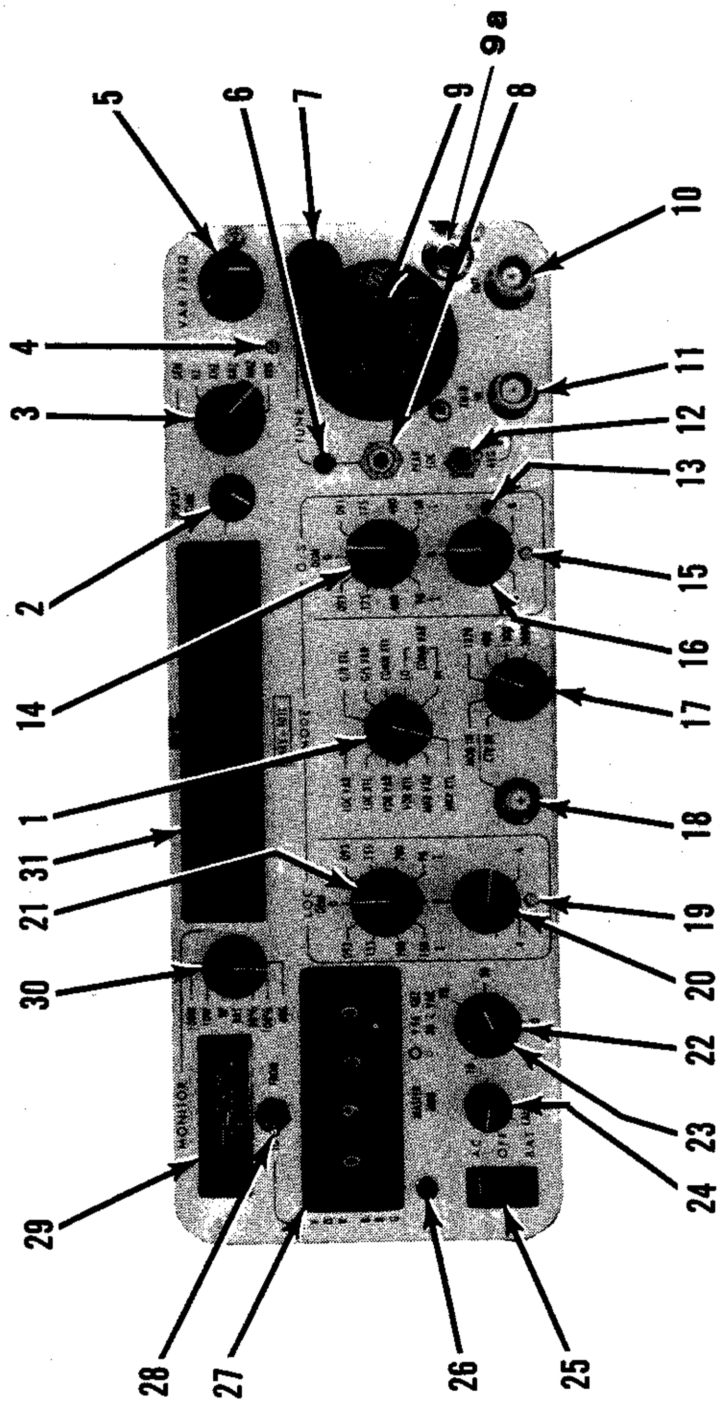


Fig. 3-9 NAV-401L Front Panel Controls, Indicators and Connectors (all)

1. MARKER OPERATION

Monitor Meter & Switch (29) & (30)	RF - To verify proper leveling of Signal Generator. 100% - Use to verify 95% modulation of Signal Generator.
Counter Mode Switch (3)	GEN - To read out frequency of Generator in crystal or Variable modes.
Frequency Mode Switch (1)	MKR XTAL - Mandatory in ramp operation; used on bench for standard Marker center frequency. MKR VAR - Useful to check receiver bandwidths, etc. Can be phase-locked in 25 kHz steps.
VAR Freq Controls (5)	Use as necessary in MKR VAR to check bandwidth of Receiver.
Tune Controls (7) & (8)	Tune Generator output for Tune Indicator (6) off, and dip on Monitor Meter (29).
Output Attenuator (9)	Use as necessary to establish receiver sensitivities.
RF Out Connector (10)	Connect to RECEIVER ANTENNA Connector, or attach Antenna in ramp operation.
Tone Select Switch (17)	Select tone - 1020 (Ident tone) 400, 1300, 3000 Hz as desired.
Master Mod Level Control (24)	Set to CAL for 95% or variable from 0 to 98%.
Power Switch (25)	AC or Battery as desired.

Table 3-5 Typical Test Control Settings

2. VOR OPERATION

Monitor Meter & Switch (29) & (30)	RF - To verify proper leveling of Signal Generator. 30% or 100% - Used to verify or set 30% modulation of each VOR modulating tone. BRG - Use to verify operation of bearing signal at 90° (Internally).
Counter Mode Switch (3)	GEN - To read out frequency of Generator in crystal or variable modes.
Frequency Mode Switch (1)	VOR XTAL - Mandatory in ramp operation; used on bench for a very stable channel center frequency.
	VOR VAR - Can be phase-locked in 25 kHz steps for all channel bench operation or to check receiver bandwidths, etc.
VAR Freq Controls (5)	Use in VOR VAR Mode to change VOR frequency either in 25 kHz steps or to continuously sweep frequency.
Tune Controls (7) & (8)	Tune Generator output for Tune Indicator (6) out and dip on meter (29).
Output Attenuator (9)	Use as necessary to establish receiver sensitivities.
RF Out Connector (10)	To Receiver Antenna Connector, or attach Antenna in ramp operation.
Tone Select Switch (17)	Select IDENT tone - 1020 Hz (or others if desired)
30 Hz VAR Level Control (22)	Use to vary the modulation level of the 30 Hz component from 0 to 30%.
9.96 kHz REF Level Control (23)	Use to vary the modulation level of the 9.96 kHz component from 0 to 30%.

Table 3-5 (Cont.)

Master Mod Level Control (24)	Set to CAL for 30% each VOR tone or variable from 0 to 60% each tone.
Power Switch (25)	AC or Battery as desired.
VOR BRG Select Switches (27)	To bearing desired for radial testing and alignment.
VOR Bearing TO/FROM Switch (28)	Use to achieve exact reciprocals of bearings selected and for flag test of Indicators.

3. LOC OPERATION

Monitor Meter & Switch (29) & (30)	RF - To verify proper leveling of Signal Generator. 30% - Verify or set 20% modulation of each modulating tone and set course centering.
Counter Mode Switch (3)	GEN - To read out frequency of Generator in crystal or variable mode.
Frequency Mode Switch (1)	LOC XTAL - Mandatory in ramp operation: used on bench for a very stable channel center frequency. LOC VAR - Can be phase-locked in 25 kHz steps for all channel bench operation or to check receiver bandwidths, etc.
VAR Freq Controls (5)	Use in LOC VAR mode. Change LOC frequency either in 25 kHz steps or to continuously sweep frequency.
Tune Controls (7) & (8)	Tune Generator output for Tune Indicator (6) out and dip on meter (29).
Output Attenuator (9)	Use as necessary to establish receiver sensitivities.
RF Out Connector (10)	To Receiver Antenna Connector, or attach Antenna in ramp operation.
Tone Select Switch (17)	Select IDENT Tone - 1020 Hz (or others if desired).

Table 3-5 (Cont.)

LOC DDM Control (21) & (20)	Stepped - Used for precise amounts of deflection and flag tests. VAR - Used for checking Auto-Pilot Servos, meter stickiness, etc.
Master Mod Level Control (24)	Set to CAL for 20% each course tone and 30% Ident Tone, or variable 0 to 40% each course tone and 0 to 60% Ident Tone.
Power Switch (25)	AC or Battery as desired.

4. G/S OPERATION

Monitor Meter & Switch (29) & (30)	RF - To verify proper leveling of Signal Generator. 100% - Verify or set 40% modulation of each modulating tone and set course centering.
Counter Mode Switch (3)	GEN - To read out frequency of Generator in crystal or variable mode.
Frequency Mode Switch (1)	G/S XTAL - Mandatory in ramp operation; used on bench for a very stable channel center frequency. G/S VAR - G/S can be phase locked in 50 kHz steps for all channel bench operation or to check receiver bandwidths, etc.
VAR Freq Controls (5)	Use in G/S VAR mode to change G/S frequency either in 50 kHz steps or to continuously sweep frequency.
Tune Controls (7) & (8)	Tune Generator output for Tune Indicator (6) off and dip on meter (29).
Output Attenuator (9)	Use as necessary to establish receiver sensitivities.
RF Out Connector (10)	To Receiver Antenna Connector, or to attach Antenna in ramp operation.

Table 3-5 (Cont.)

G/S DDM Control (14) & (16)	Stepped - Used for precise amount of deflection and flag tests. VAR - Used for checking auto-pilot servos, meter stickiness, etc.
Master Mod Level Control (24)	Set to CAL for 40% each course tone, or variable 0 to 80%.
Power Switch (25)	AC or Battery as desired.
AVG/PEAK LOC XMTR Switch (12)	LOC position if simultaneous G/S and LOC output desired. NOTE: Frequency Mode Switch should be in G/S XTAL position.

5. COMM OPERATION (RECEIVER TESTS)

Monitor Meter and Switch (29) & (30)	RF - To verify proper leveling of signal Generator. 30% or 100% - Verify or set 30% sine-wave modulation tone.
Counter Mode Switch (3)	GEN - To read out frequency of Generator in crystal or variable mode.
Frequency Mode Switch (1)	COMM XTAL - Mandatory in ramp operation; used on bench for a very stable channel center frequency. COMM VAR LO - Use to check COMM Receiver channels 118.0 to 135.95 MHz. COMM VAR HI - Use to check COMM Receiver channels 134.0 to 150 MHz.
VAR Freq Controls (5)	Use in COMM VAR modes to change COMM frequency in 25 kHz steps or to continuously sweep frequency.
Tune Controls (7) & (8)	Tune Generator output for Tune Indicator (6) out and dip on Meter (29).
Output Attenuator (9)	Use as necessary to establish receiver sensitivities.

Table 3-5 (Cont.)

RF Out Connector (10)	To Receiver Antenna Connector, or attach Antenna in ramp operation.
Tone Select Switch (17)	Use to select tone frequency desired or for external modulation input (bench testing only).
MOD IN/EXT FREQ CTR IN Connector (18)	Use to apply external modulation to Signal Generator.
Master Mod Level Control	Set to CAL for 30% each tone selected or variable 0 to 60% modulation each tone.
Power Switch (25)	AC or Battery as desired.

6. COMM OPERATION (TRANSMITTER TESTS)

Monitor Meter & Switch (29) & (30)	10W or 100W - Use to measure transmitter power. CAUTION Observe power versus time limits of power meter (SECTION I).
Counter Mode Switch (3)	Hz, kHz - Use to measure Transmitter frequency - kHz, MHz, HF or VHF bands.
AVG/PEAK LOC XMTR Switch (12)	Peak - Use to indicate increase in power during modulation. Avg - Use to indicate Avg power only disregarding modulation.
MOD IN/EXT FREQ CTR IN Connector (18)	Attach Whip Antenna for COMM frequency measurements in portable operation.
Tone Select Switch (17)	To CTR IN position.
Power Switch (25)	AC or Battery as desired.
COMM XMTR IN Connector (11)	Connect to COMM Transmitter output.

Table 3-5 (Cont.)

1 Introduction.

1-1 This section gives information about the general theory of NAV-401L circuit operation. Descriptions of Glide Slope, Localizer, COMM, Marker, and VOR Ground Station simulation signal generation are followed by theories of various systems and modules.

2 Marker Signal Generation. (ref. Simplified Overall Block Diagram)

2-1 The signal used to simulate the ILS Inner, Middle and Outer Marker Beacons consists of RF modulated by the appropriate audio tone. Typical RF frequency used by the NAV-401L is 75 MHz.

2-2 Three Marker tones (400, 1300, and 3000 Hz) and 1020 Hz IDENT tone are generated on the Regulator-Timer Board (PC-2). Desired tone is selected by the Tone Select Switch (S7B). After passing through the Tone Select Switch, the selected tone is returned to PC-2 where it is converted from a square wave to a low distortion sine wave. This tone output is applied to the 30 Hz Sine Board (PC-4) via Tone Select Switch (S7A). On PC-4, the Marker tone may be combined with VOR, COMM, or Localizer modulation. In Marker mode, only Marker tone is present. Marker tone is passed through Frequency Mode Switch (S701) to Combination Sine Board (PC-3). On PC-3, the Marker tone is processed through a fixed or a variable level buffer amplifier.

2-3 The output of the buffer amp on PC-3 is applied to the Audio Signal Input of the Modulator and Power Amplifier (Assy. 6) and is used to modulate the RF output.

2-4 The Marker (or IDENT) tone output of the Combination Sine Board is also supplied through a separate buffer amp to the NAV Tones Output Connector (J1102). The Modulator and Power Amplifier provides a demodulated tone output which is available at the Signal Generator Demodulated Output Connector (J1104). This signal is 180^0 out of phase with the signal at the NAV Tones Output Connector.

3 COMM Signal Generation. (ref. Simplified Overall Block Diagram)

3-1 COMM signal generation is very similar to Marker signal generation. A different RF frequency is used (126.9 MHz typ.) and percent of RF modulation is different.

4 VOR Signal Generation. (ref. Simplified Overall Block Diagram)

4-1 The 30 Hz Variable and 30Hz Reference signals are generated on Bearing Logic PC Board (PC-5). When a VOR bearing other than 0.0° is selected on Bearing Selector Switches (S2), the 30 Hz VAR signal is phase shifted with respect to the 30 Hz REF signal.

4-2 Two 30 Hz square-wave VAR signals 180° out of phase are routed to 30 Hz Sine Board (PC-4) via TO/FROM Switch (S3). The 30 Hz REF signal is applied to PC-4 directly. On PC-4, 30 Hz VAR and REF signals are processed into low distortion sine waves. The 30 Hz REF signal is applied to the 9960 Hz Oscillator circuit on PC-4 where it is used to phase lock and frequency modulate the 9960 Hz signal. This produces a 30 Hz FM modulated, 9960 Hz signal with a ±480 Hz deviation. The modulated 9960 Hz, and 30 Hz VAR signal are summed on PC-4. This composite VOR modulation signal is applied to Frequency Mode Switch (S701).

4-3 From the MODE Switch, the selected VOR modulation signal is applied to Combination Sine Board (PC-3). On PC-3, the VOR signal is processed through a fixed or a variable level buffer amplifier. The output of this buffer amp is applied to the Audio Signal Input of the Modulator and Power Amplifier (Assy. 6) where it is used to modulate the RF output.

4-4 The VOR modulation signal output of the Combination Sine Board is also supplied through a separate buffer amp to NAV Tones Output Connector (J1102). The Modulator and Power Amplifier provides a demodulated tone output which is available at the Signal Generator Demodulated Output Connector (J1104). This signal is 180° out of phase with the signal at the NAV Tones Output Connector.

5 <u>Localizer and Glide Slope Signal Generation</u>. (ref. Simplified Overall Block Diagram)

5-1 90 and 150 Hz tones for G/S and LOC are generated on Bearing Logic Board (PC-5). Circuitry of PC-5 allows the 150 Hz tone to be phase shifted with respect to the 90 Hz tone when the 90/150 Hz Variable Phase Switch (S9) is depressed and a bearing between 0.0° and 360° is selected on Bearing Select Switches (S2). Amount of phase-shift is controlled by the Bearing Select Switches.

5-2 The 90 and 150 Hz square-wave outputs of PC-5 are applied to Combination Sine Board (PC-3). The 90 and 150 Hz square-waves are converted to low distortion sine waves by sine synthesizing circuits on PC-3. The 90 Hz sine wave is applied to LOC and G/S Centering Controls (R4 & R6), routed back to PC-3 where the signal is buffered, and applied to LOC & G/S DDM Switches (S8 & S5). The 150 Hz sine wave is applied directly to LOC & G/S DDM Switches via a buffer.

5-3 The 90 and 150 Hz tones are summed at LOC and G/S DDM Switches and applied to 30 Hz Sine Board (PC-4). These LOC and G/S deviation signals are buffered on PC-4 and applied to Frequency Mode Switch (S701). The output of the MODE Switch is reapplied to PC-4 where it may be combined with MKR or IDENT tones (Localizer only). The G/S or LOC signal is then processed through a fixed or a variable buffer amplifier on PC-3.

5-4 Output of the buffer amp on PC-3 is applied to the Audio Signal Input of the Modulator and Power Amplifier (Assy. 6) where it is used to modulate the RF output.

5-5 The selected LOC or G/S deviation signal output of the combination Sine Board is also applied through a separate buffer amp to NAV Tones Output Connector (J1102). The Modulator P.A. provides a demodulated tone output which is available at Signal Generator Demodulated Output Connector (J1104). This signal is 180° out of phase with the signal at the NAV Tones Output Connector.

6 Bearing Generator. (ref. Simplified Bearing Generator Block Diagram)

6-1 VOR bearing is generated by a crystal-controlled digital counting system. All of the Circuitry (except the Bearing Select Switches) is located on Bearing Logic Board (PC-5). The 90 and 150 Hz LOC and G/S tones are also generated on the Bearing Logic Board as a side product of the bearing counters.

6-2 The clock signal is generated by crystal oscillator and a divider circuit on PC-5. Each clock pulse is equivalent to 0.1° of bearing. Clock pulses are applied to a counter that counts 3600 clock pulses and then resets to another count cycle. Gates and other logic circuit are used as count control for the counter. The output of the count control circuit is used as the 30 Hz reference square-wave output.

6-3 Four Bearing Select Switches (S2) select counts in the bearing counter corresponding to bearings from 000.1° to 359.9°. Switch outputs are summed together via a common gate and applied as a start pulse to a counter.

6-4 When the start pulse is applied, the counter begins counting clock pulses at a 0.1° rate. After 1800 pulses have been counted, a counter control circuit stops the clock input and resets the counter. Output of the 180° counter system is a 30 Hz square wave. It is delayed from the start of the 30 Hz Reference signal by the number of degrees selected on the VOR BRG SEL Switches. Two outputs are available 180° apart to simulate a TO or FROM signal.

6-5 90 and 50 Hz square waves are generated by picking off counts from the bearing counter and adding further divisions. By this method, the 90 and 150 Hz frequencies are both crystal controlled and phase locked together.

6-6 The phase relationship between 90 and 150 Hz tones can be varied by a special circuit. By using the reset from the 30 Hz VAR output signal, the 150 Hz tone can be stepped in 5^0 increments relative to the 90 Hz tone. VOR BRG SEL Switches are used to vary this phase relationship. Each 1^0 of bearing selected causes 5^0 of 150 Hz phase shift.

7 RF Section. (ref. Simplified RF Block Diagram)

7-1 All RF energy is generated by the Oscillator Assembly (Assy.5). Within the Assembly are five crystal-controlled oscillators and one variable-frequency oscillator. The variable-frequency oscillator is band switched to cover 72-78 MHz and 107-156 MHz bands. Crystal frequencies supplied as standard are those authorized for ramp use by the FAA. Special frequencies can be substituted if required.

7-2 The oscillator output is fed to the Modulator Power Amplifier Assembly (Assy. 6). Within the Modulator P.A. Assembly, the modulator and power amplifier are designed as a servo control system with the RF output controlled by the modulator.

7-3 All RF is amplified and fed through the power amplifier. There is no frequency change, except when operating in G/S mode. In G/S mode, the input carrier frequency is tripled in the output stage. All power amplifier circuits are broadtuned (except for the output stage). The amplifier output stage must be peaked for proper output by Front Panel Tune Control. Output from the final amplifier stage is fed directly to an Attenuator. The output of this attenuator is applied to a Diode Protect Block. This Block guards against damage to the Attenuator if a Transmitter is connected to the RF Output Connector.

7-4 RF at the attenuator input is detected and applied to the modulator input. Proper audio modulation is also applied to the Modulator and Power Amplifier after being buffered by an amplifier on Combination Sine PC Board (PC-3). The modulator-collector modulates the output stage of the power amplifier and requires a certain level of RF output to meet percentage modulation requirements and RF level output of the output stage. Each of five modes of operation requires a different detected voltage. This voltage is determined by five gain switches in the modulator. These switches are driven by Mode Control Lines from Frequency Mode Switch (S701).

7-5 The modulator output to the power amplifier may be routed to the Monitor Meter by the Tune Switch (S11). The power amplifier is in perfect tune when the command voltage from the modulator is minimum. Therefore; when the Tune Switch is depressed, the Tune control is adjusted for a dip on the Monitor Meter.

7-6 The modulator output is also applied to a Tune Indicator (L-2). This indicator is illuminated whenever the modulator requires more detected RF voltage than the power amplifier is tuned for. When the power amplifier is adjusted, Tune Indicator is not illuminated.

7-7 Output of the modulator input amplifier is sampled to give a direct percent of modulation measurement, and a relative indication of the power amplifier's tune condition. This is possible because the percentage of modulation is directly controlled by the modulator. Output of the modulator input amplifier is applied to three places. It is applied to the Combination Sine Board (PC-3) where it is used in the Modulation Monitor circuit and the RF Level Meter circuit. The output is applied to Signal Generator Demodulated Output Connector (J1104). The output is applied to Bearing Check Board (PC-1). During VOR operation, the modulation is demodulated to determine VOR Relative Bearing Error in the RF output (at 90^{0} bearing only).

7-8 A separate Localizer Generator is turned on when AVG/PEAK-LOC XMTR Switch (S10) is in the PEAK-LOC position. The localizer generator frequency is chosen to pair with the 334.7 MHz (typ.) G/S XTL frequency. This frequency is fixed at 108.1 MHz. Audio from the LOC DDM Switch (S5) is applied to the Generator for output modulation . The Generator output level is approximately -15 to -20 dBm. This output is mixed with G/S XTL RF in the Diode Protect Block.

7-9 When Frequency Mode Switch (S701) is set to any Variable Frequency position, the Oscillator can be phase locked in 25 kHz increments, or operated completely free-running. The phase-lock circuit is located on Phase Lock/Power Monitor Assembly (Assy. 4). G/S is phase locked in 50 kHz increments.

7-10 In any mode but G/S, the reference frequency for phase lock is 250 Hz taken from the Counter. The oscillator frequency is taken from the ÷100 prescaler output and compared against the 250 Hz reference. The oscillator output frequency is set by Coarse Variable Frequency Control (R9). When the output frequency closely equals the nearest 25 kHz step, the oscillator frequency is locked to that 25 kHz step.

7-11 In G/S mode, the reference frequency for phase lock is 166 Hz, taken from the Counter. The G/S signal phase locks in 50 kHz steps.

7-12 When phase-lock operation is not desired, Coarse Variable Frequency Control (R9) gives very large frequency changes for any rotation and Fine Variable Frequency Control (R10) gives small frequency changes.

7-13 A COMM Transmitter can be connected to XMTR IN Connector (J2). Signals at this connector are applied to a 25 dB pad. The output of the pad is applied to the power monitor portion of Assembly 4. A monitoring circuit drives the Monitor Meter in one of two ranges, 0 to 10 W, or 0 to 100 W. The output of the Power Monitor is applied to Rear Panel COMM Transmitter Demodulated Output Connector (J1103). This allows the COMM audio to be observed on an Oscilloscope or listened to via an External Amplifier.

7-14 At the XMTR IN Connector (J2), a small sample of the RF is applied to the Counter to measure COMM Transmitter frequencies. The frequency may be displayed in any counter mode except GEN and BRG (Bearing).

8 Counter Section. (ref. Simplified Counter Block Diagram)

8-1 All count inputs to the Counter (except Bearing Check) go through the Prescaler (Assy. 1). There are two inputs to the Prescaler. One from the Buffer Amplifier Assembly is used as the count for the internal generator. This count input is switched to pass through the Prescaler when Counter Mode Switch is in the GEN position.

8-2 The second input to the Counter is from Modulation Input/ External Frequency Counter Input Connector (J1). Also summed at this input is the XMTR IN Connector so that COMM transmitter frequencies may be measured. This count input is switched to pass through the Prescaler when Counter Mode Switch is in any position except GEN or BRG.

8-3 Both inputs to the Prescaler result in a direct count output and a ÷100 prescaled output. Both of these outputs are applied to the Counter (PC-6) where the direct output is counted in the Hz and first kHz positions of the Counter Mode Switch. The ÷100 output is counted in the GEN, second kHz, and MHz Counter Mode Switch positions.

8-4 With Counter Mode Switch in BRG position, duration of the count gate for the Counter is equal to the period of the 30 Hz Reference square wave from the Bearing Logic Board. The count input is from the Bearing Logic Board. This is the output of the 0.1^0 divider gated by VOR Bearing Select Switch output. A number of 0.1^0 clock pulses are applied to the counter that

8-4 (Cont.) correspond to the number of bearing degrees selected. The pulses are counted and displayed by the Counter with a resolution of 0.1^0.

8-5 Counter clock pulses are generated by a 10 MHz XTAL oscillator. This oscillator is located on the Bearing Check Board. The oscillator output frequency is divided to 100 kHz (÷100) and applied to the Counter PC Board where it is further divided to gate times of 0.1 and 1.0 sec.

8-6 In G/S mode, the 0.1 sec. time base is divided by three. This effectively multiplies the input count by three. (In G/S mode, the oscillator frequency is multiplied by three in the output stage of the Power Amplifier.) Since power amplifier input to the Counter is taken from the input of the power amplifier, that count must be tripled so that the Counter displays the G/S frequency output of the power amplifier.

8-7 The minimum recommended operating voltage for the NAV-401L Display is 160 Vdc.

9 Monitoring Section. (ref. Monitoring Section Block Diagram)

9-1 Three monitoring circuits are located on PC-3. Battery voltage is monitored by one of them.

9-2 The signal generator demodulated output from the power amplifier is applied to PC-3. The dc level of this signal is sampled and applied to the Meter for an RF level indication. The demodulated output is also processed to determine the accurate percentage of modulation. Two modulation ranges are available, 0 to 30% and 0 to 100%.

9-3 Two monitor circuits are located on the Bearing Check Board (PC-1). The Power Monitor Assembly (Assy. 4) is applied to PC-1 where it is processed and applied to the Meter in two ranges. The two ranges are, 0 to 10 W and 0 to 100 W.

9-4 The other monitor circuit on PC-1 is the Bearing Check system. The signal generator demodulated output from the power amplifier is further demodulated and broken down to the two 30 Hz signals during VOR operation. The phase relationship of the 30 Hz REF and 30 Hz VAR is compared at 90^0 and an error signal is produced. That error voltage is applied to the Monitor Meter for bearing check information.

10 Power Section. (ref. Power Section Block Diagram)

10-1 The NAV-401L is powered by either an external a c source (115 or 240 Vac.), or an internal 13.75 V NICAD battery pack.

10-2 The Power Supply Assembly (Assy. 2) is located on the Rear Panel. A C power is converted to a lower voltage by a transformer. This a c is rectified to +20 Vdc whenever the NAV-401L is connected to an a c source. The +20 Vdc is applied continuously to the Battery Charging Circuit on Regulator-Timer PC Board (PC-2). Whenever the test set is connected to ac power, the NICAD battery pack is being charged. The battery charger is self-limiting. This causes a discharged battery to be charged at a high rate, and a fully-charged battery to be trickle charged. This self-limiting feature allows the set to be left on continuously when connected to ac.

10-3 During ac power operation, the +20 V is applied through AC/Battery Power Switch (S2) to PC-2 and the +5 Vdc Power Supply (Assy. 3). On PC-2, the +20 V is regulated to +11 V. This +11 V is used throughout the NAV-401L. Negative voltage developed by the +5 V Switching Regulator is applied to PC-2 and dropped to -6.2 V.

10-4 The +5 V Switching Regulator provides two sources of +5 V. One is used by the test set as a whole and the other (switched) is supplied to the counter circuitry.

10-5 When using battery power, a 6-10 minute timer does the actual power switching. The AC/Battery Power Switch turns the timer on, when the switch is depressed to BATT position. This applies battery voltage to the remainder of the power system in place of the +20 V used in ac operation. After approximately 6 to 10 minutes, the timer turns the set off. Pressing the AC/Battery Power Switch a second time to BATT position will turn off the timer and the test set.

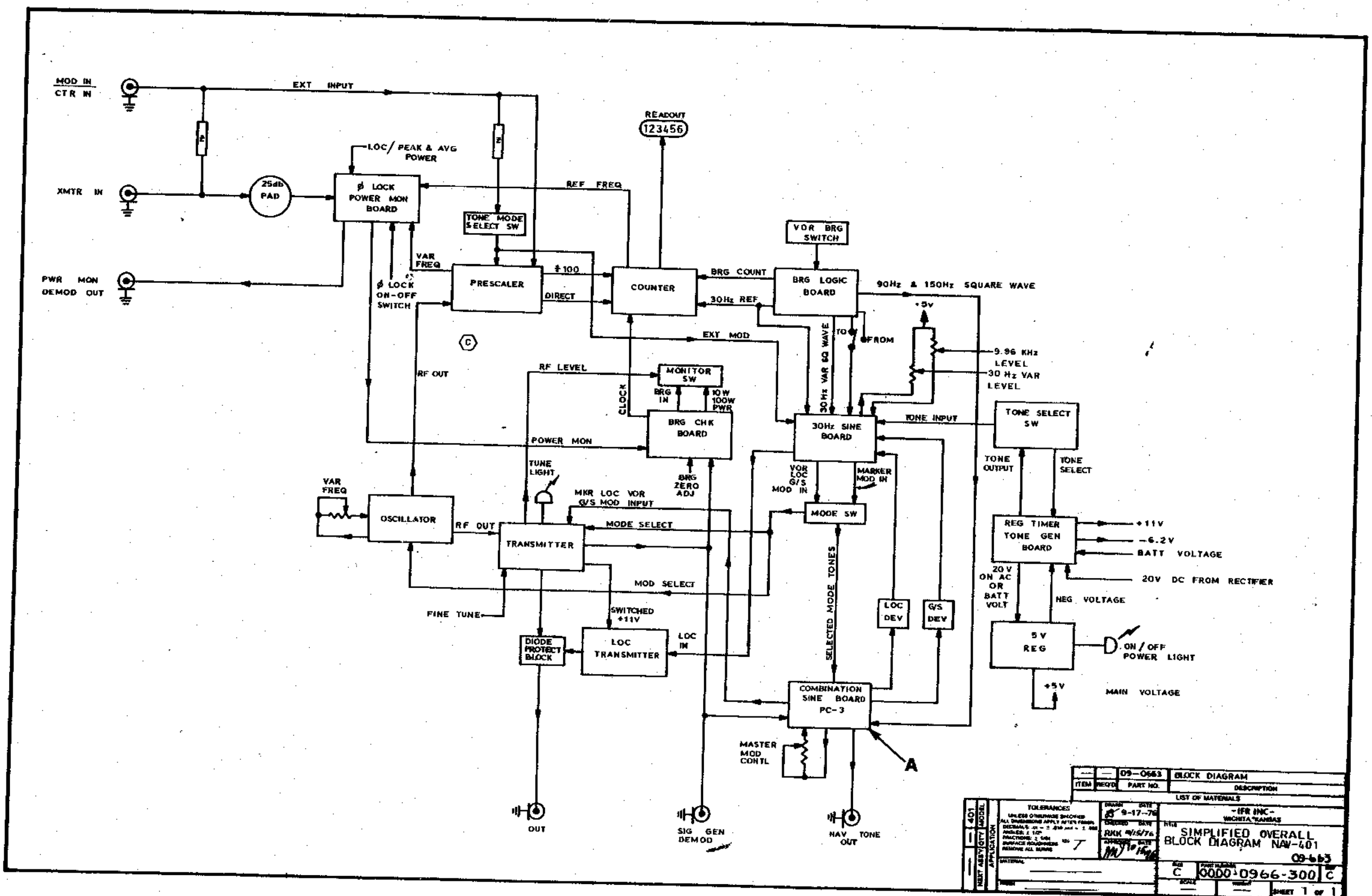

MOD IN
CTR IN
XMTR IN
PWR MON
DEMOD OUT
EXT INPUT
25db PAD
LOC/ PEAK & AVG POWER
ϕ LOCK POWER MON BOARD
TONE MODE SELECT SW
REF FREQ
READOUT
123456
VAR FREQ
ϕ LOCK ON-OFF SWITCH
PRESCALER
÷100
DIRECT
COUNTER
BRG COUNT
30Hz REF
VOR BRG SWITCH
BRG LOGIC BOARD
90Hz & 150Hz SQUARE WAVE
+5V
TO
FROM
EXT MOD
9.96 KHz LEVEL
30 Hz VAR LEVEL
RF OUT
RF LEVEL
MONITOR SW
BRG IN
10W 100W PWR
CLOCK
BRG CHK BOARD
BRG ZERO ADJ
POWER MON
30 Hz VAR SQ WAVE
30Hz SINE BOARD
TONE INPUT
TONE SELECT SW
TONE OUTPUT
TONE SELECT
VOR LOC G/S MOD IN
MARKER MOD IN
MODE SW
VAR FREQ
OSCILLATOR
RF OUT
TRANSMITTER
TUNE LIGHT
MKR LOC VOR G/S MOD INPUT
MODE SELECT
MOD SELECT
FINE TUNE
SWITCHED +11V
LOC IN
DIODE PROTECT BLOCK
LOC TRANSMITTER
SELECTED MODE TONES
LOC DEV
G/S DEV
REG TIMER TONE GEN BOARD
+11V
-6.2V
BATT VOLTAGE
20V DC FROM RECTIFIER
20 V ON AC OR BATT VOLT
NEG VOLTAGE
5 V REG
ON / OFF POWER LIGHT
+5V
MAIN VOLTAGE
COMBINATION SINE BOARD PC-3
MASTER MOD CONTL
A
OUT
SIG GEN DEMOD
NAV TONE OUT
09-0663
BLOCK DIAGRAM
ITEM
PART NO.
DESCRIPTION
LIST OF MATERIALS
TOLERANCES
-IFR INC-
WICHITA, KANSAS
9-17-76
RKK 9/15/76
SIMPLIFIED OVERALL BLOCK DIAGRAM NAV-401
09-663
C
0000-0966-300
C
SHEET 1 of 1
401
NEXT ASSY
QTY
MODEL
APPLICATION
MATERIAL
FINISH

Figure 4-23

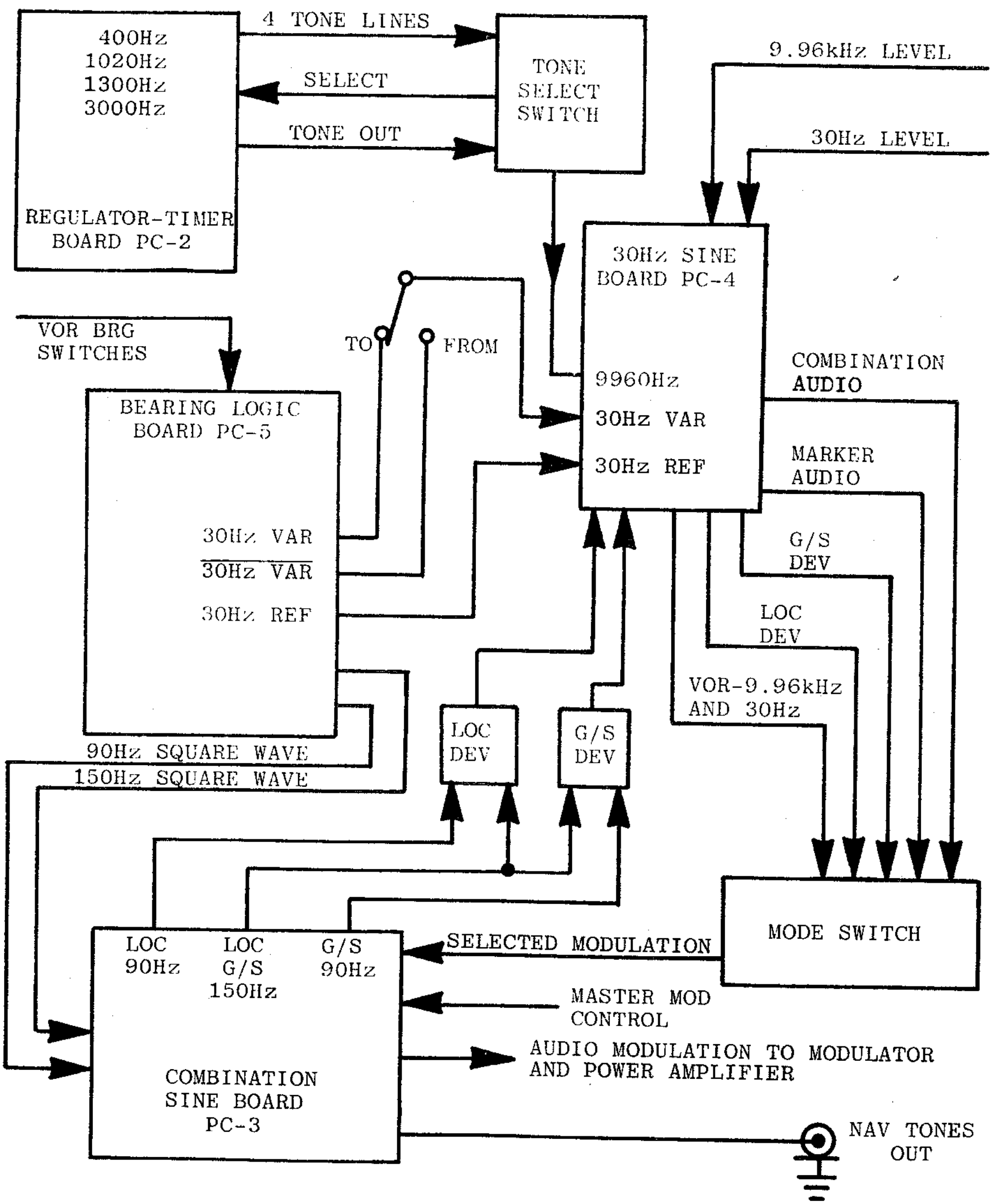


Fig. 4-2 Simplified Tone Generator Block Diagram

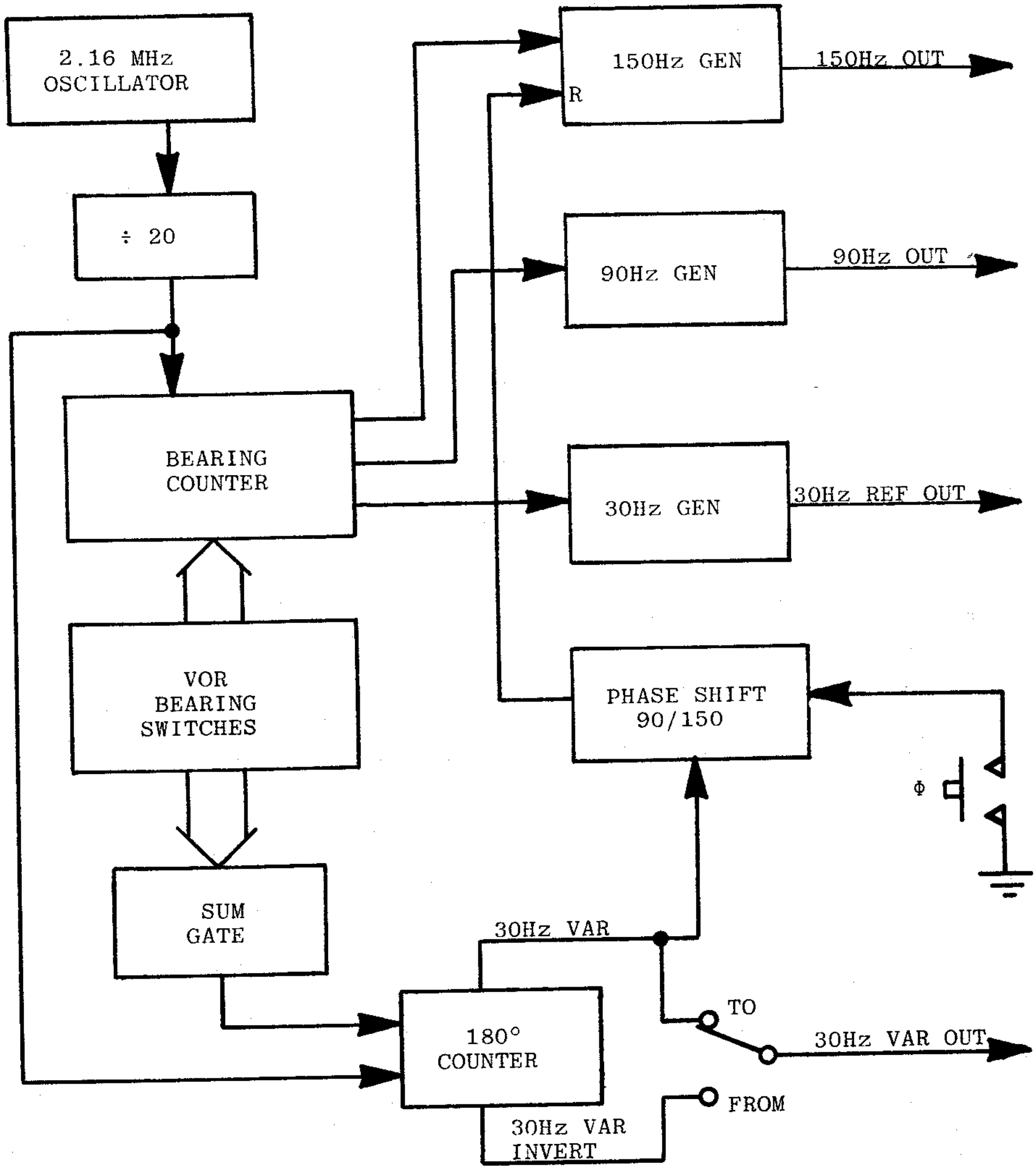


Fig. 4-3 Simplified Bearing Generator Block Diagram

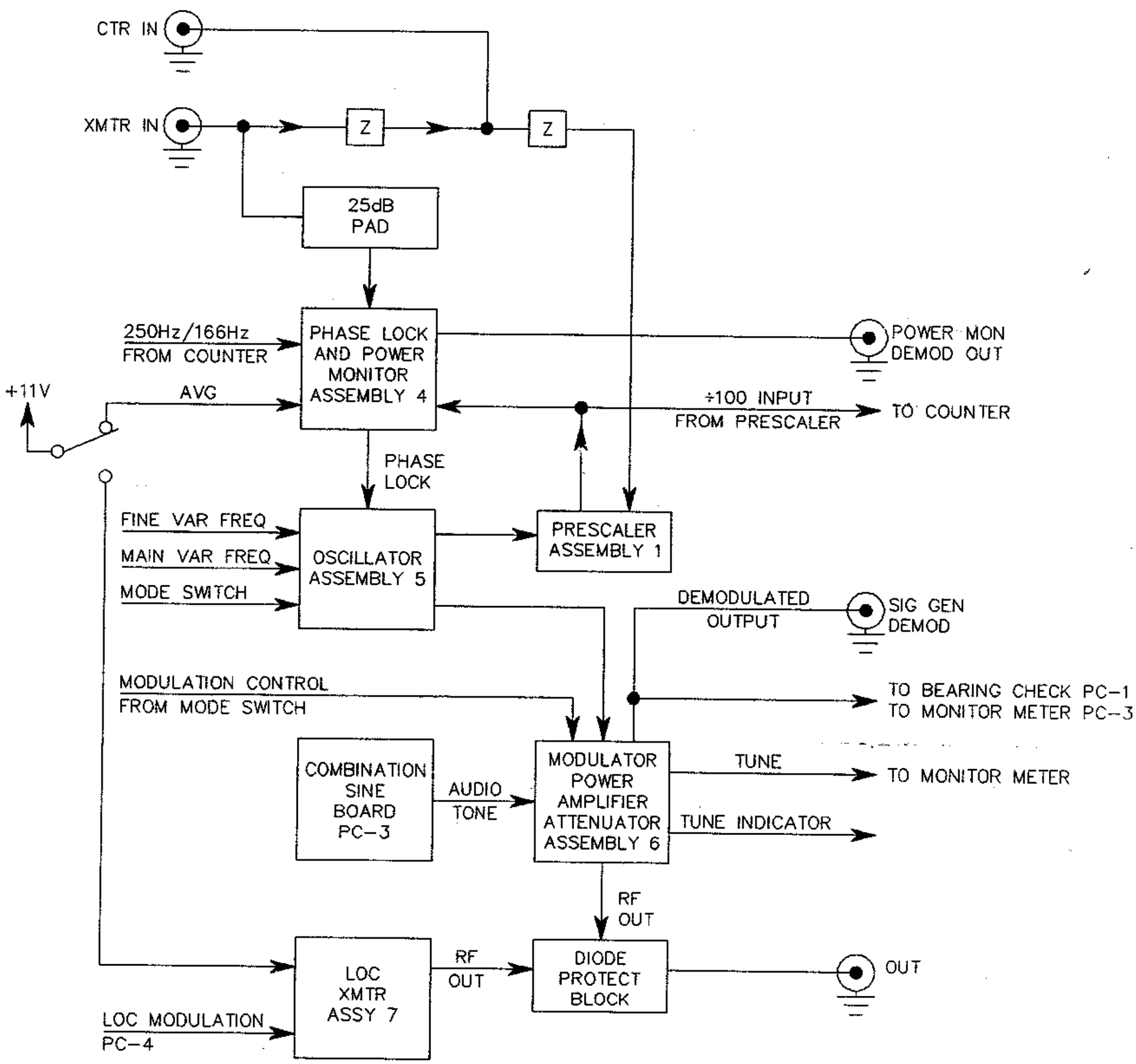


Figure 4-4 Simplified RF Generator Block Diagram

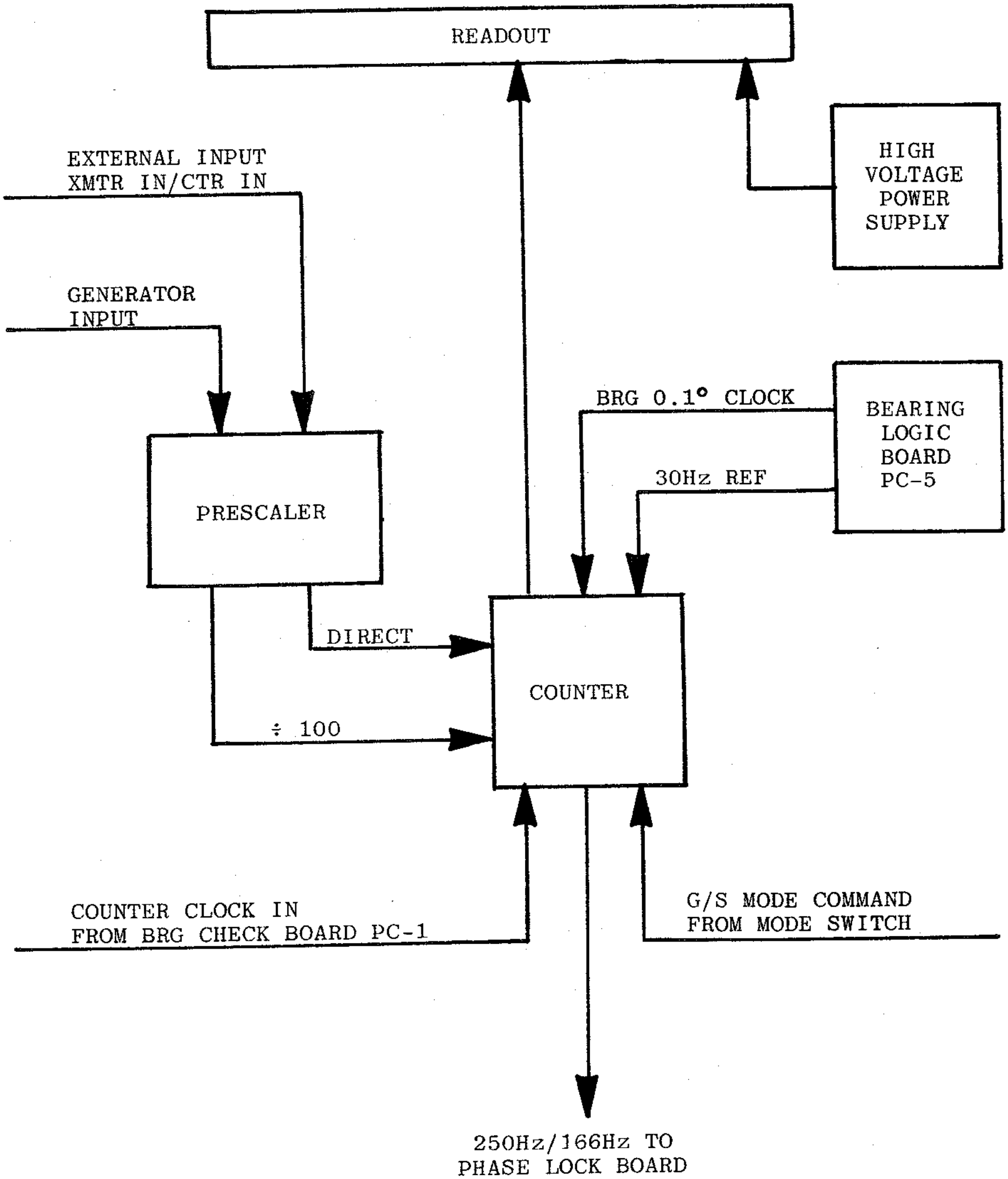


Fig. 4-5 Simplified Counter Block Diagram

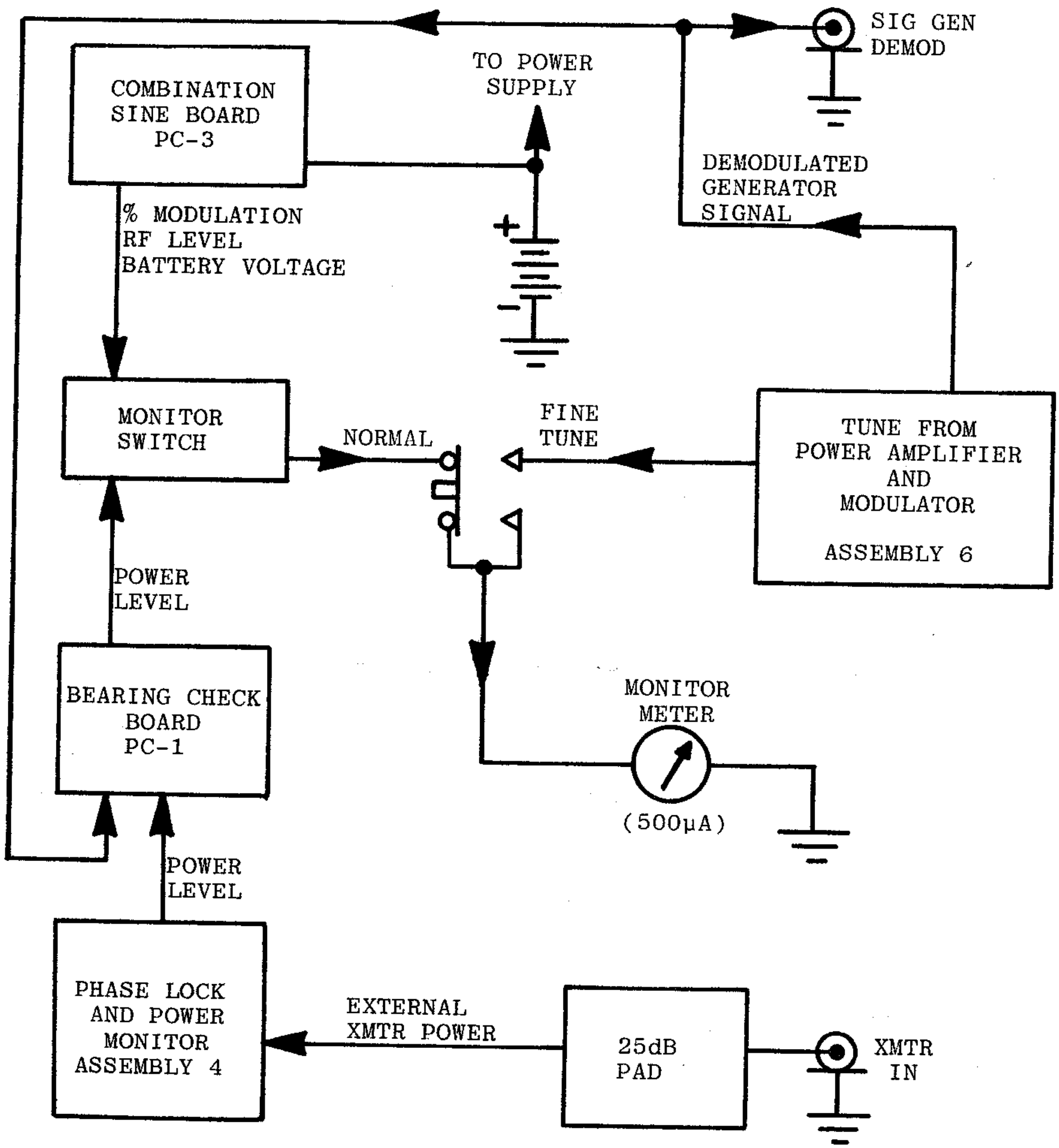


Fig. 4-6 Monitoring Section Block Diagram

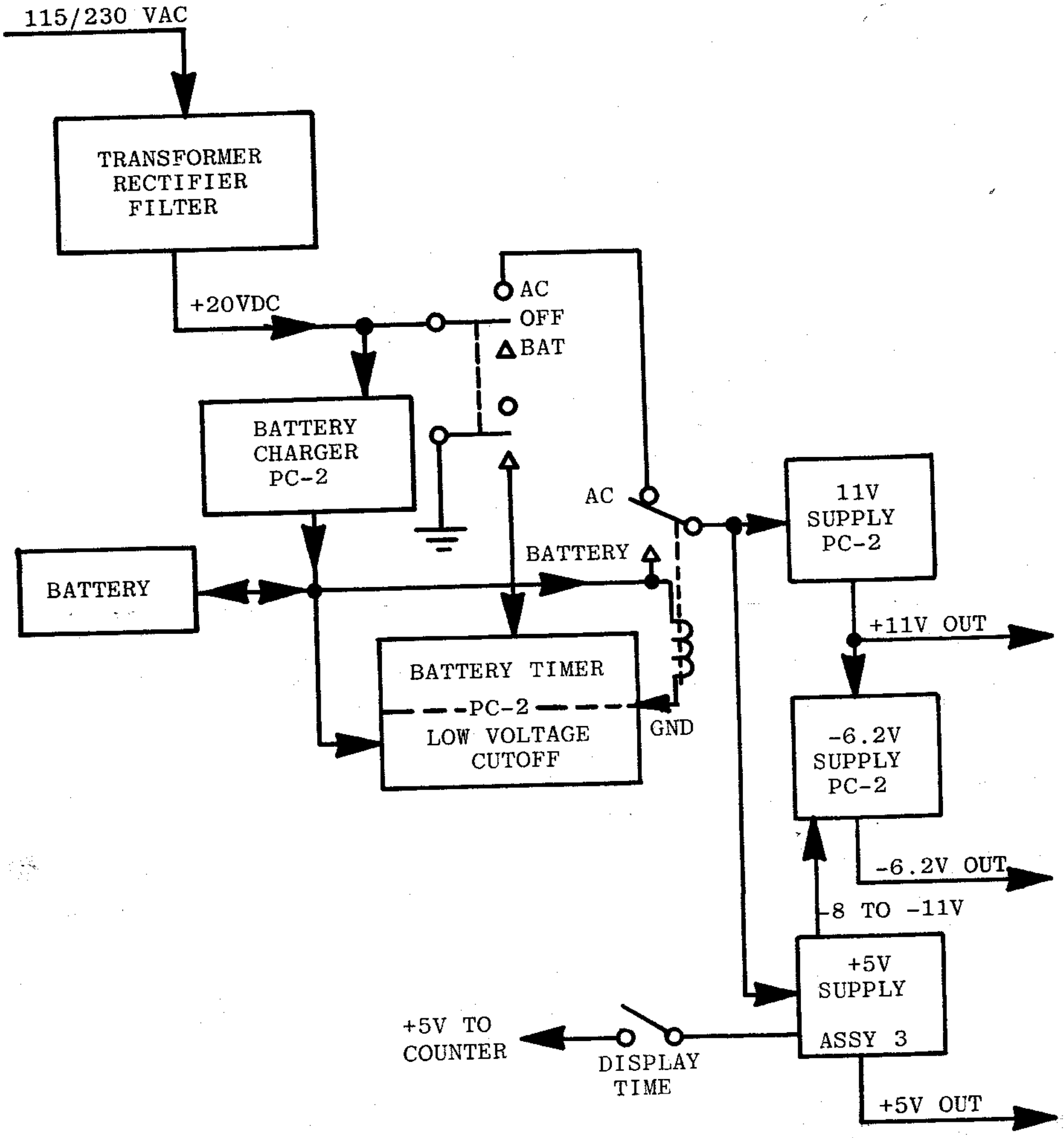


Fig. 4-7 Power Supply Block Diagram