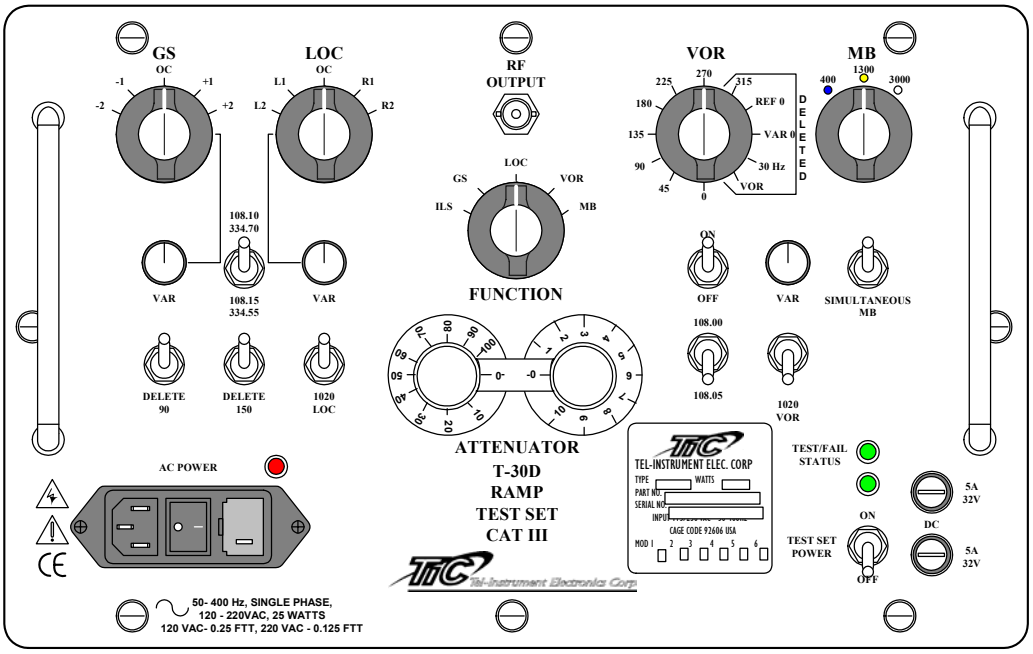
T-30D
VOR/ILS/MB



Ramp Test Set

Operating and Maintenance Manual

S/N Effectivity 597

A	B	C	D	E	F	G	H	I	J	K	L	M
N	O	P	Q	R	S	T	U	V	W	X	Y	Z

T-30D TABLE OF CHANGES

Date	REV	ECO	Page	Description
2-4-97	B		3-3	Correct sensory input keys to 7 – 13
10-1-97	C		4-5, 4-17	Notes Added on Table 4-2, para. 2.3 and Table 4-3, para 5.0 to set modulation bandwidth
6-10-98	D	1461	5-1, 6-8, 6-9	Added Capacitor from E-1 to GND
7-31-98	E	1470	5-1, 6-8, 6-9	Added Resistor, 100 Ω, from E-20 to R3, pin 2
01-26-99	F		4-3	Text Added- Para 1.2, e
			4-5	Text Added- Para 2.3, h, j, l
			4-13	Text Added- Para 1.2, d
			4-17	Text Added- Para 5.2
			4-17	Text Added- Para 5.3, c
			4-23	Text added- Para 5.2, b, d, f
11-30-02	G		All Pages	Complete Overhaul and rewrite of Manual

Table of Contents

Table of Contents (continued)

Table of Contents (continued)

Table of Contents (continued)

List of Illustrations (Figures)

List of Tables

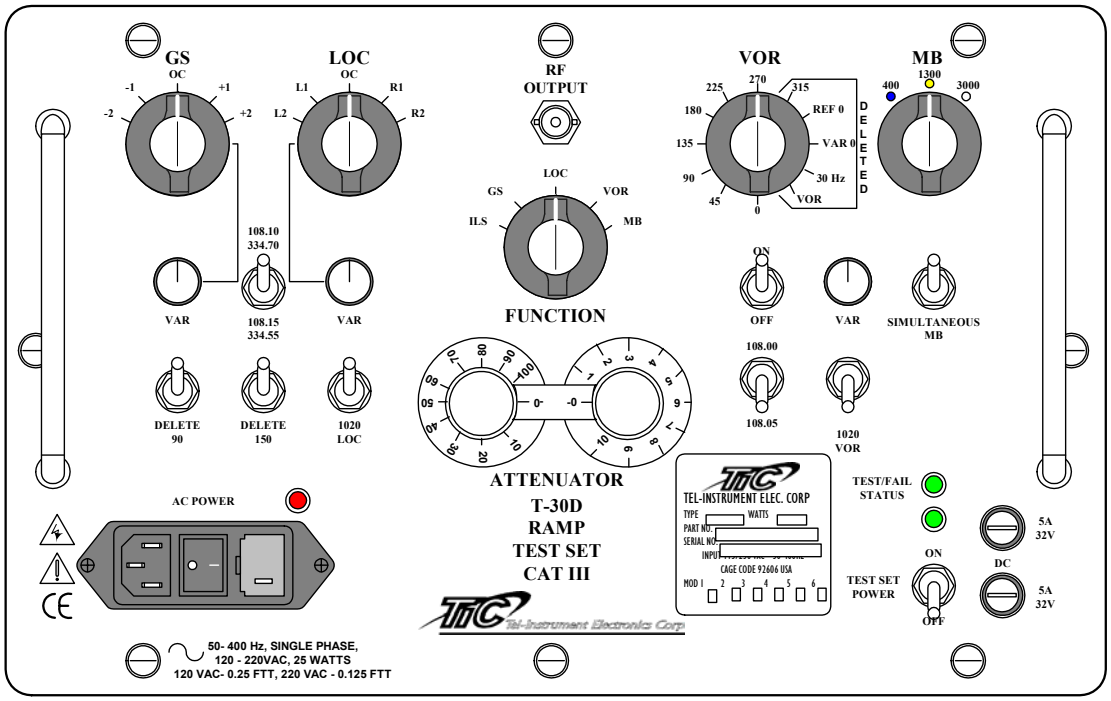
CHAPTER I

INTRODUCTION

SECTION A

1.1 Scope of Manual

This manual is intended to familiarize the operator with the operating and maintenance procedures necessary to utilize and maintain the T-30D Test Set.



T-30D Ramp Test Set

Figure 1-1

1.2 Purpose and Function of Equipment

The T-30D Ramp Test Set is designed for one-man operation of the VOR, MB, GS, LOC, flight director, and autopilot from the cockpit or flight deck. The unit functions by radiating controllable RF signals directly into the aircraft's antennas. The unit will permit compliance with CAT III periodic ramp check certification.

The T-30D is simple and straightforward in operation and functions primarily as a "go-no-go" test set. Instrumentation in all aircraft has certain established operational tolerances. The purpose of the T-30D is to determine that these tolerances are being met.

1.3 Warranty

The Tel-Instrument Electronics Corporation warrants that each product it manufactures is free from defective material and workmanship for a period of two (2) years subject to the following terms and conditions. Tel-Instrument Electronics Corporation will remedy any such warranted defect subject to the following:

This warranty requires the unit to be delivered by the owner to Tel-Instrument intact for examination, with all transportation charges prepaid to the factory, within two (2) years from the date of sale to original purchaser. Tel-Instrument will solely determine when such defect exists.

This warranty does not extend to any of Tel products which have been subject to misuse, neglect, accident, improper installation, or used in violation of operating instructions. This warranty does not extend to units which have been repaired, calibrated, or altered in any way by a facility that is not approved, in writing, by Tel-Instrument Electronics Corp. to perform such work. This warranty does not apply to any product where the seals or serial number thereof has been removed, defaced or changed, nor to accessories not of our own manufacture.

Repair parts will be made available for a minimum period of five (5) years after the manufacture of this equipment has been discontinued.

This warranty is in lieu of all other warranties expressed or implied and all such other warranties are hereby expressly excluded. No representative or person is authorized to assume for us any other liability or warranty in connection with the sale of Tel's products.

This warranty does not cover or include batteries (batteries have a separate 90 day warranty).

Additional information with regard to the applications and maintenance of this equipment will be available from time to time.

SECTION B

EQUIPMENT SPECIFICATIONS/DESCRIPTION

1.4 Specifications[1]

VOR

Frequency	108.05 MHz ± 0.025%
	108.00 MHz ± 0.025%
Power	+17/ ± 2 dB
Attenuation	110 dB in 1 dB steps
Modulation	
Audio Frequency	30/9960 Hz
Audio Frequency Accuracy	± 0.01%
AM Depth	30 ± 2%
FM Deviation	480 ± 30 Hz
Distortion	< 5%
Indicator Deflection/Bearing	0-315° /± 0.1º in 45° Steps/Variable ±10 º- 15°
Tone	1020 Hz ± 2%

LOC

Frequency	108.15 MHz ± 0.025%
	108.10 MHz ± 0.025%
Power	+17 ±2 dB
Attenuation	110 dB in 1 dB steps
Modulation	
Audio Frequency	90/150 Hz
Audio Frequency Accuracy	±0.01%
AM Depth	20 ± 2%
Distortion	< 5%
Phase Accuracy	90 to 1150 Hz ±10º
Indicator Deflection	
On Course	0.0 ± 0.01DDM/0.155 ± .02 DDM
Variable	-0.155 to +0.155 DDM
Step	Left and Right; 1 & 2 Dots
Tone	1020 Hz ± 2%

[1] Tel Instruments Electronics Corporation reserves the right to change and modify specifications without notice.

Glide Slope (GS)

Frequency	334.70 MHz ± 0.0025%
	334.55 MHz ± 0.0025%
Power	+11 ±2 dB
Attenuation	110 dB in 1 dB steps
Modulation	
Audio Frequency	90/150 Hz
Audio Frequency Accuracy	± 0.01%
AM Depth	40 ± 3%
Distortion	< 5%
Phase Accuracy	90 to 1150 Hz ± 10º
Indicator Deflection	
On Course	0.0 ± 0.01DDM/0.175 ± .025 DDM
Variable	-0.175 to + 0.175 DDM
Step	Up and Down; 1 & 2 Dots
Delete	90 and/or 150 Hz

Marker Beacon (MB)

Frequency	75.0 MHZ ± 0.005%
Power	+18 ± 2dB
Attenuation	110 dB in 1 dB steps
Modulation	
Audio Frequency	400/1300/3000 Hz
Audio Frequency Accuracy	± 2%
AM Depth	95 ± 4%
Distortion	< 10%

Physical Characteristics

Size	14.5 x 9.4 x 6.5 in.
Weight	18 lbs.
Power	Internal Battery or external 120/220 VAC 50-400 Hz
Environmental	Storage- -51° to + 71° C Operating -30° to +55ºC

1.5 Safety Considerations

The following are general safety precautions that are not related to a particular test or procedure. These are recommended procedures that all personnel must apply during many phases of operation and maintenance. It is assumed that the operator has general knowledge of electrical theory and the dangers associated with it.

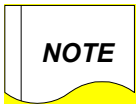
1. When performing any of the tests thoroughly read and understand all procedures before actually performing them.

2. The various front panel connectors, switches, and controls specified can be located by referring to Figure 2-2 on Page 2-3.

3. Take the time to learn the proper operation and function of the Test Set as outlined in Chapters 1, 2, and 3. Through knowledge of the Test Set and its capabilities greatly improves the time it takes to complete the tests.

4. Pay particular attention to **NOTES** and **WARNINGS** that may accompany some test procedures.

WARNINGS
Alerts the operator to potential dangers associated with a particular tests. Thoroughly understand the warning before proceeding to prevent a potentially dangerous situation or damage to the Test Set.



NOTES
Provides supplemental information that enhances the test procedure.

5. Observe all standard safety procedures when working with live voltages. The potential for electric shock exists any time the Test Set is removed from its case.

6. DO-NOT service the unit or make adjustments alone. Always be in the presence of another person when working with live voltages.

7. Be familiar with general first aid procedures and CPR (Cardiopulmonary Resuscitation). Contact your local Red Cross for more information.

8. Ensure the test equipment and the tools you utilize are in good operational condition and not damaged in any way.

1.6 Abbreviations, Acronyms and Glossary of Terms[2]

A/A	Air to Air
A/A B	Air to Air Beacon
ac or AC	Alternating Current
A/D	Analog to Digital
AM	Amplitude Modulation
ATC	Air Traffic Control
AUT	Aircraft Under Test
BIT	Built in Test
CW	Continuous Wave
D/A	Digital to Analog
dB	Decibel
dBm	Decibels relative to 1 milliwatt
dc or DC	Direct Current
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FIFO	First In First Out
FREQ	Frequency
ft.	Feet
G/A	Ground to Air
Hz	Hertz
IF	Intermediate Frequency
KHz	Kilohertz
kts.	Knots
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MHz	Megahertz
nmi.	Nautical mile
ns	Nanosecond
PMCS	Preventative Maintenance Checks and Services
PPM	Pulses per Minute
PRF	Pulse Repetition Frequency
PW	Pulse Width
PWR	Power
RF	Radio Frequency
RMS	Root Mean Square
R/T	Receiver Transmitter
RX	Receiver
TX	Transmitter
VORTAC	VOR and TACAN (co-located)
VOR	VHF Omni-Directional Range
VSWR	Voltage Standing Wave Ratio
WOW	Weight On Wheels
UUT	Unit Under Test

2

Further definitions may be found in the following reference books and documents: Helfrick, A.D. Principles of Avionics. Leesburg: Quality Books, 2000. RTCA/DO-181B. Minimum Operational Performance Standards for Air Traffic Control RADAR Beacon System/Mode Select (ATCRBS/Mode S) Airborne Equipment. Washington D.C.: 1999. United States. Federal Aviation Administration. Federal Register Fed 3, 1987 FAA rules Part 91.

CHAPTER II

PREPARATION FOR USE AND OPERATION

SECTION A

2.1 General

This Chapter contains all necessary information on the initial unpacking, inspection, and set-up of the T-30D Test Set. From this point forward, the T-30D Test Set will be known as the T-30D, Test Set, or T/S.

2.2 Unpacking

When receiving the T-30D for the first time, ensure that there is no damage to the shipping container. Carefully unpack the unit and save the shipping container in a safe location for shipping or extended storage.

Examine the unit for obvious signs of damage. Check all displays, switches, and connectors before utilizing the Test Set.

If any damage is found, DO NOT use the Test Set until a determination of the Test Sets functions can be assessed. Refer to the procedures outlined in Chapter 4, Section B, Test Set Verification and Acceptance Checks. You may also contact Tel-Instrument Electronics Corp. for assistance.

The T-30D batteries were installed and fully charged when shipped from the factory.

2.3 Installation

The T-30D is ready to use from the factory. There are no installation procedures applicable.

2.4 Accessories

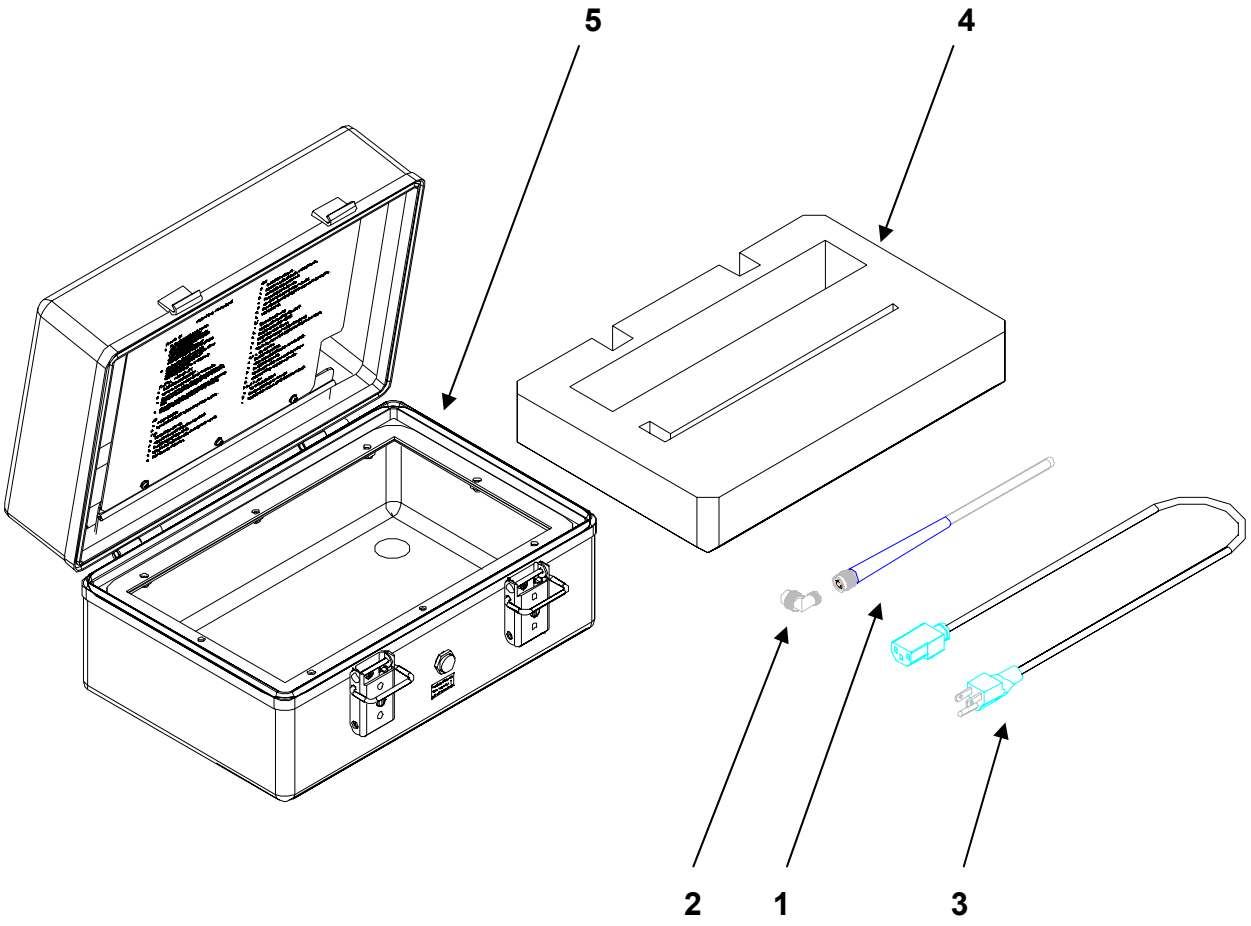
Check that all accessories that you purchased with the Test Set are accounted for. The T-30D comes standard with the following (see Table 2-1 and Figure 2-1):

T-30D Test Set, P/N 90 000 053

#	NOMENCLATURE	P/N	QTY
1	RF Antenna Assembly	40 030 003	1
2	Adapter, TNC, RT Angle	48 000 013	1
3	Power Cable Assembly, AC	75 010 025	1
4	Foam Insert, Case	31 000 009	1
5	Case, Universal	64 030 026	1
6	Manual (not Shown)	90 008 053	1

T-30D Accessories and Part Numbers

Table 2-1



T-30D Accessories

Figure 2-1

SECTION B

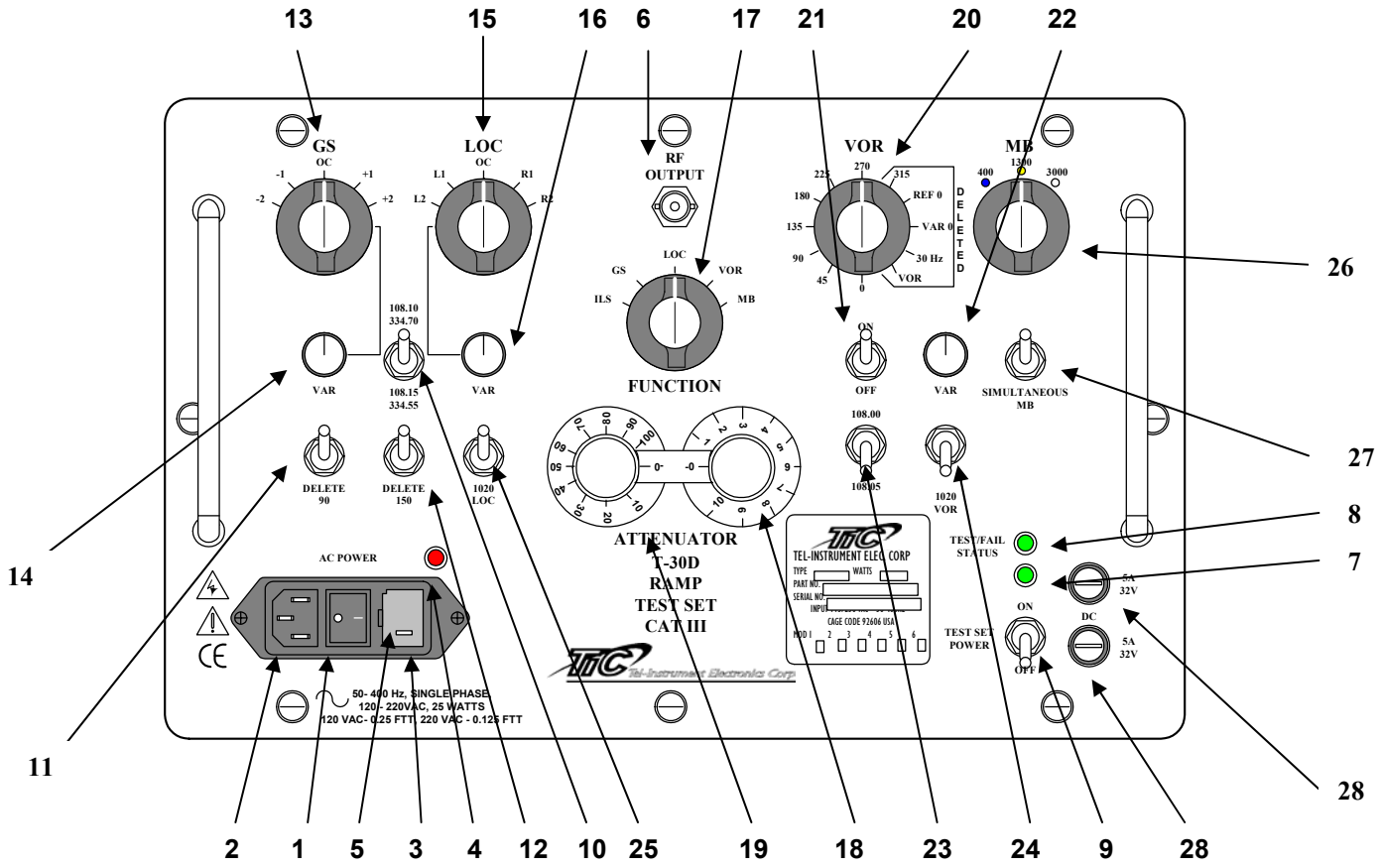
OPERATING CONTROLS, INDICATORS, AND CONNECTORS

2.5 General

This section covers location and function of each control, indicator, or connector. All components are located on the front panel of the Test Set.

2.6 Controls, Indicators, and Connectors

Table 2-2 and Figure 2-2 describes function and location of each control, indicator, and connector.



T-30D Controls, Indicators, and Connector Locations

Figure 2-2

TABLE 2-2 / OPERATING CONTROLS AND FUNCTION		
Index	**Description**	**Function**
1	**AC POWER**	ON/OFF Switch for AC Input power.
2	AC Input	Connector for AC Line Cord.
3	**AC**	Fuses for AC Line Power/ ¼ A SB Fuses.
4	AC Power "ON" Indicator	Light illuminates with AC Power "ON".
5	AC Input	120V or 220 VAC Select fuse drawer.
6	**RF OUTPUT**	RF Output connector for selected Antenna.
7	Energized Light	Illuminates when Test Set is turned "ON".
8	**TEST/FAIL STATUS**	Indicates Self Test Status and battery condition.
9	**TEST SET POWER**	Selects ON/OFF condition of Test Set.
10	**108.10-334.70 108.15-334.55**	Selector Switch for GS and LOC frequency pairing.
11	**DELETE 90~**	Momentary toggle switch, deletes 90 HZ modulation
12	**DELETE 150~**	Momentary toggle switch, deletes 150Hz modulation
13	**GS**	Allows deviation from Glide slope path. OC = On Course +1 = One Dot Above +2 = Two Dots Above -1 = One Dot Below -2 = Two Dots Below
14	**VAR**	With the **108.10/334-70, 108.15/334.55** switch in the **108.10** position, allows continuous variation above or below the on Course signal.
15	**LOC**	Allows deviation from the LOC path. OC = On Course L1 = One Dot Left L2 = Two Dots Left R1 = One Dot Right R2 = Two Dots Right
16	**VAR**	With the **108.10/334-70, 108.15/334.55** switch in the **108.15** position, allows continuous variation Left or Right of the on Course signal.
17	**FUNCTION**	Selects Test Set Operating Modes: **ILS, GS, LOC, VOR, MB**
18	**ATTENUATOR**	Controls RF output of Test Set in 1 dB steps.
19	**ATTENUATOR**	Controls RF Output in 10 dB steps.
20	**VOR**	With **FUNCTION** switch in **VOR**, selects bearing of aircraft to VOR Station in 45° increments from 0 – 315°. Permits deletion of the **REF 0, VAR 0, 30 Hz**, or **VOR** signals.
21	**VAR ON/OFF**	On/Off switch for the **VOR VAR** control.
22	**VAR**	Provides continuous variation for ±10 left/right of VOR bearing.
23	**108.00/108.05**	VOR Frequency selection.
24	**1020 ~ VOR**	Momentary switch enabling the 1020 Hz VOR tone.
25	**1020 ~ LOC**	Momentary switch enabling the 1020 Hz LOC tone.
26	**MB**	Selects Marker Beacon Signals: 400 Hz (Blue Outer Marker), 1300 Hz (Amber Middle Marker), and 3000 Hz (White Inner Marker)
27	**SIMULTANEOUS MB**	Provides Simultaneous MB and ILS tests.
28	**DC**	Fuses for DC Power (5 A/32 V).

2.7 AC and Battery Power Operation

Review the following procedure to maintain the Test Set battery in a fully charged state. It is recommended that you charge the battery fully to ensure that all tests can be completed without interruption. If the battery drains during extended operation, the operator may continue testing by utilizing AC Power.

2.7.1 AC Operation

1. Disengage the two case latches and open the cover.
2. Remove the supplied AC Power cord that was supplied with the Test Set.
3. Connect one end to the **AC INPUT** connector and the other end into a suitable 120 VAC receptacle.
4. Set the **AC POWER** rocker switch to "ON" (—). The AC Power "ON" LED should illuminate. Verify the **TEST/FAIL STATUS** LED briefly illuminates then extinguish. If the **TEST/FAIL STATUS** LED remains lit, this indicates that the Test Set has failed the Self Test. If the LED blinks, this condition indicates the battery voltage is low.

2.7.2 220 VAC Operation

The T-30D may be operated utilizing either 120 or 220 VAC. Before using 220 VAC, the operator must configure the fuse drawer.

WARNING
Failure to properly configure the Test Set for 220 VAC operations before use may result in severe damage to the Test Set.

1. Remove the **FUSE DRAWER** from the Test Set by releasing the Tab and pulling the cartridge straight out.
2. Pull the bottom fuse holder from the rear of the cartridge, rotate, and reinstall back in the cartridge ensuring that **220** is viewable through the front window.

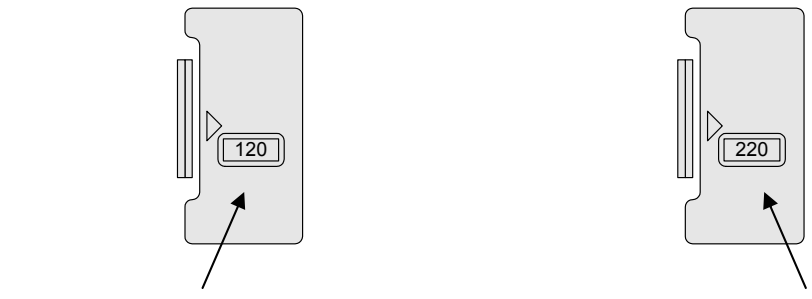


Figure 2-3

2.7.3 Battery Operation

The Battery allows the operator to utilize the Test Set without an AC power cord connected. The Test Set contains a built in charger that will recharge the battery from a 120 or 220 VAC (when properly configured) source. With AC power connected and the Test Set in use, the T-30D will begin to regain its charge.

Several features are built into the Test Set to provide maximum battery life.

1. When the Test Set is turned "ON", the Test/Fail LED indicator will illuminate and at the completion of the *Self-Test*, extinguish.

2. A timing circuit will automatically turn "OFF" the Test Set after 15 minutes of operation (if the test set is being charged, it will not turn "OFF"); the Test Set is also turned "OFF" whenever the cover is closed on the test set.

3. During battery operation, when the **TEST/FAIL STATUS** indicator begins to blink, there are approximately 15 minutes of operating time left. The battery should be recharged or the Test Set plugged in to a suitable AC power source to prevent interruption of tests.

4. The Test Set will continually monitor the battery voltage; if the battery voltage drops to 10 volts, the Test Set will automatically turn OFF.

The Test Set will take approximately 16 hours to fully recharge, once the LED begins to blink. The Test Set may remain plugged in once charging is completed. No adverse effects will occur. Due to the *Memory-Effect* of the batteries, it is not recommended that the T/S battery be fully discharged.

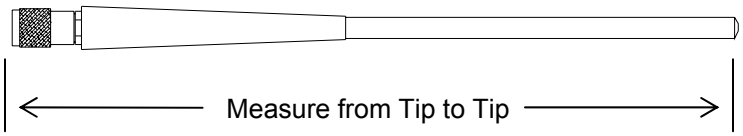
2.8 Omni-Antenna

Most navigation receiver checks will be performed on the ramp utilizing the supplied Omni-Antenna. The Omni-Antenna has been designed in calibrated segments for the correct bandwidth of the frequencies to be used. By extending or collapsing the antenna, dependent on the frequency being tested, the antenna will be properly tuned.

In order to perform ramp testing Antenna to Antenna, perform the following steps:

1. Remove the Omni-Antenna from the Test Set cover. Connect it to the **RF OUTPUT** connector located on the front panel of the Test Set.

2. Use Table 2-3 and Figure 2-4, on the following page, and fully extend, *then* retract the antenna to the correct length for the frequency being tested. The Table and correct lengths are also printed on the inside cover of the Test Set.



Omni Antenna

Figure 2-4

FREQUENCY TESTED	ANTENNA LENGTH
Marker Beacon	Fully Extended
VOR	Top three sections retracted (28½")
LOC	Top three sections retracted (28½")
GS	Top five sections retracted (19½")
ILS	Top three sections retracted (28½")

Antenna Lengths

Table 2-3

3. Most tests can be performed while the operator is in the cockpit. Place the Test Set 10-30 ft. from the Unit Under Test (UUT) antenna. Due to the many types of aircraft and their configuration, the operator may need to move the antenna to a different location for each type. Landing gear doors, external fuel tanks and ground support equipment may interfere with the Test Set signals. For accurate results, Line-of-Sight to the antenna being tested is recommended. Relocate the Test Set at a various positions and re-test if test results are erroneous or inaccurate.

SECTION C

OPERATING INSTRUCTIONS

2.9 General Test Procedures

NOTE

The following tests are not meant to replace the testing criteria required for your particular model of equipment. They are general testing procedures to assist the operator in properly utilizing the T-30D T/S.

All of the following tests are described utilizing the T-30D Test Set. It is assumed the operator has a detailed knowledge of Avionics Systems and the UUT (Unit Under Test) test requirements. Refer to Table 2-3 for correct antenna lengths for each test performed. Figure 2-5 illustrates a typical HSI/CDI indicator for reference when conducting VOR/LOC/ILS and GS Test.

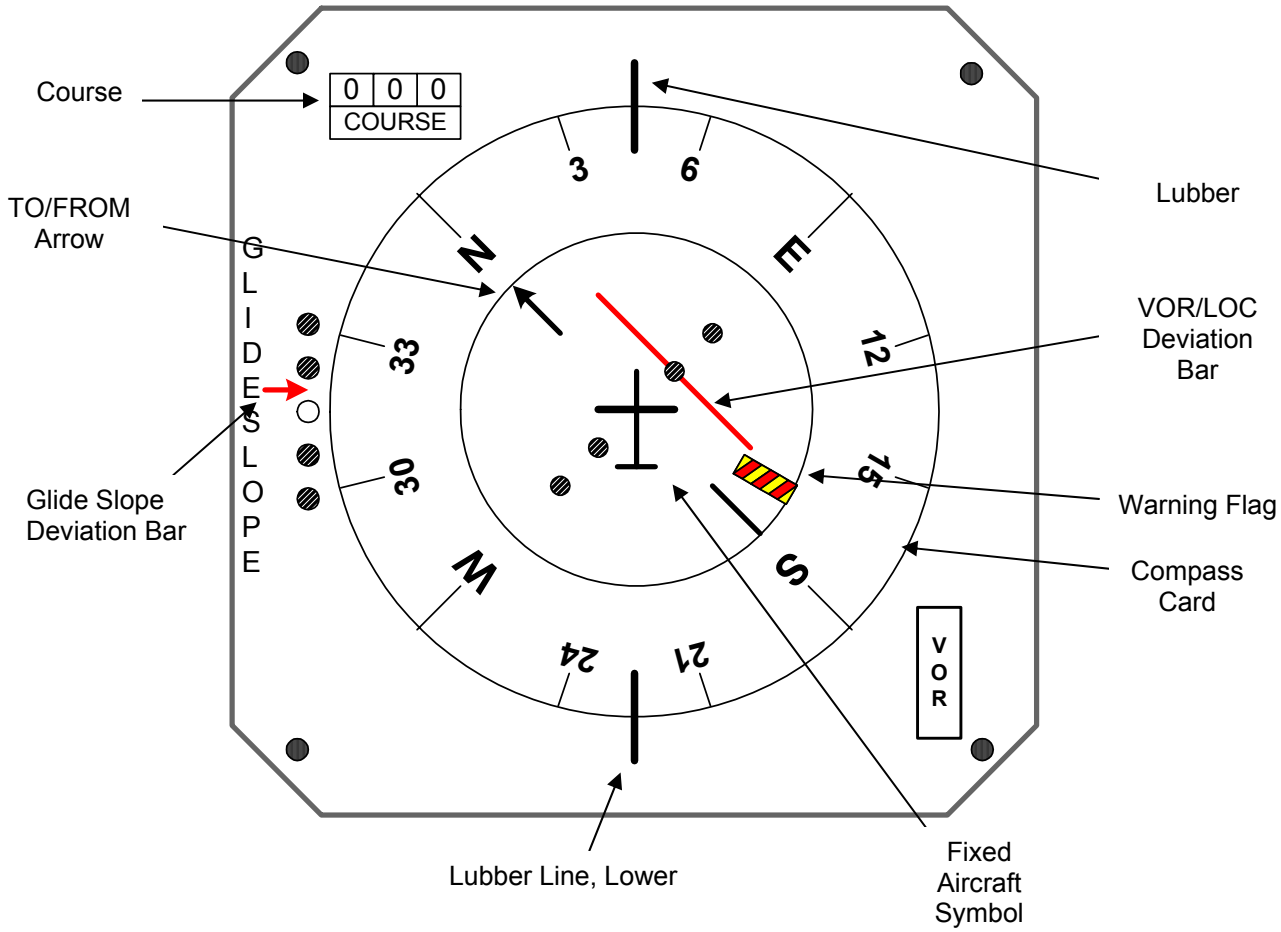


Figure 2-5

Basic HSI/CDI Indicator

2.10 Marker Beacon Tests (MB)

Verify proper operation of an aircraft MB receiver as follows:

1. Connect the Omni-Antenna to the **RF OUTPUT** connector on the Test Set and fully extend the antenna (Table 2-3).

NOTE

It may be necessary to extend the Antenna out of the Cockpit door or window for MB operation.

2. Turn “ON” the MB receiver.

3. Set **FUNCTION** Switch to **MB**, **ATTENUATOR** dials to **0**.

4. Set **MB** Switch to **400**. Blue (outer) marker lamp shall light and a 400 Hz tone shall be audible from the cabin speaker or intercom system.

5. Set **MB** Switch to **1300**. Amber (middle) marker lamp shall light and a 1300 Hz tone shall be audible from the cabin speaker or intercom system.

6. Set **MB** Switch to **3000**. White (inner) marker lamp shall light and a 3000 Hz tone shall be audible from the cabin speaker or intercom system.

7. Gradually increase signal attenuation with the **ATTENUATOR** knobs until the Marker Beacon light extinguishes. This will determine the Marker Beacon receiver sensitivity level.

8. Set both **ATTENUATOR** dials to **0**.

NOTE

When the function switch is in ILS, the MB may be turned “ON” by setting the **SIMULTANEOUS MB** switch "ON."

2.11 VOR Procedures

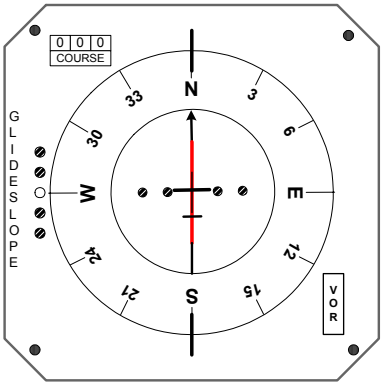
Verify proper operation of an aircrafts VOR receiver as follows:

1. Connect the Omni-Antenna to the **RF OUTPUT** connector on the front panel of the Test Set and extend it fully, then retract it three sections (Table 2-3).

2. Set **VOR** frequency Select Switch to **108.00**.

3. Turn "ON" the VOR receiver and tune it to 108.00 MHz. Set the HSI/BDI to a 0° VOR bearing.

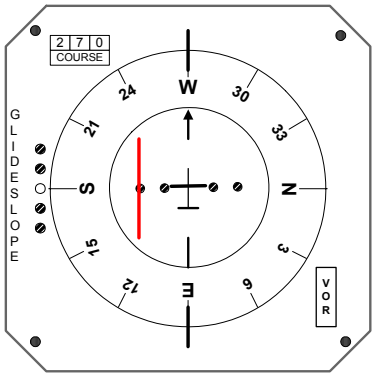
4. Set **FUNCTION** Switch to **VOR** and the **VOR** Switch to **0°**. Vertical pointer shall center and flag shall be retracted.



Indicator shown with Deviation Bar centered and course at 000 degrees.

5. Repeat step 4 at the **45°**, **90°**, **135°**, **180°**, **225°**, **270°**, and **315° VOR** Switch positions. For each position, make sure that the corresponding bearing is shown on the VOR display. The vertical pointer shall center and the flag shall be retracted at each position.

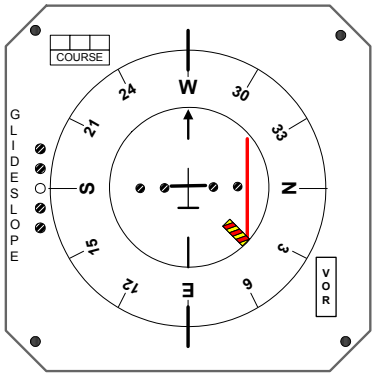
6. With the **VOR** Switch at **270°** and the VOR display or Heading Bug set to 315°, set the **VAR** Switch "ON". Slowly rotate **VAR** knob from the left stop to the right stop. Observe movement of the indicator vertical pointer. Vertical pointer shall move from the two-dot *LEFT* position to the two-dot *RIGHT* position in response to the movement of the **VAR** knob.



Indicator represents **VOR** variable fully CCW (2 Dots Left) and course at 270°

7. Set **VAR** Switch “OFF”.

8. Set **VOR** Switch to **DELETE REF Ø**. Vertical pointer shall move away from center position and the flag shall appear.



Indicator represents VOR flag in view when **VOR** switch set to **DELETED REF Ø.**

9. Set **VOR** Switch to **270°** vertical pointer shall center and flag shall retract.

10. Repeat Steps 8 and 9 for the **DELETE VAR Ø, DELETE 30 Hz**, and **DELETE VOR** positions of the VOR Switch. The same results shall be observed.

11. Momentarily press the **1020 ~ VOR** Switch. A 1020 Hz tone shall be heard from the cabin speaker or intercom.

12. Reduce the T-30D output signal strength with the **ATTENUATOR** knob. Ensure the flag hides and appears at the prescribed limits as provided by the manufacturer of your equipment.

13. Repeat steps 2-12 at the **108.05** position of the **VOR** frequency Select Switch. The same results shall apply.

14. Set both **ATTENUATOR** dials to 0.

2.12 LOCALIZER (LOC) Test Procedures

WARNING
When conducting tests with the aircrafts autopilot engaged, any variation of the aircrafts controls may move the associated control services. Use caution to ensure that all personnel and ground support equipment are clear of the control services.

Verify proper operation of aircrafts LOC receiver equipment as follows:

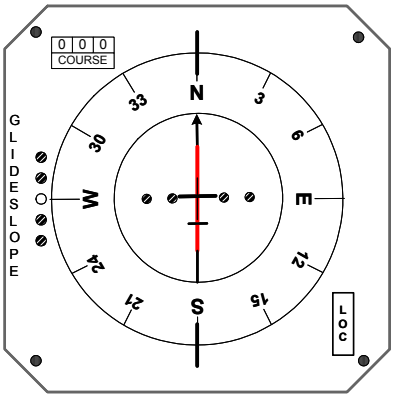
1. Connect the Omni-Antenna to the **RF OUTPUT** connector on the front panel of the Test Set and extend it fully, then retract it three sections (Table 2-3).

2. Set **ILS** Frequency Select Switch to **108.10/334.70**.

3. Turn on the LOC receiver. Tune for an operating frequency of 108.10 MHz.

4. Set the **FUNCTION** Switch to **LOC**.

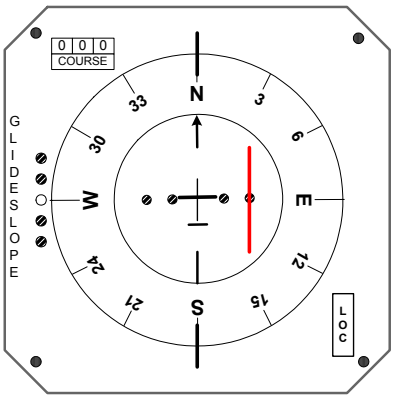
5. Set the **LOC** Switch to **OC** (On Course). Vertical pointer shall center and flag shall be retracted.



Indicator represents LOC, On Course

6. Set **LOC** Switch to **R1**. Vertical pointer shall show an One-Dot *RIGHT* deflection. Turn **LOC** Switch to **R2**. Vertical pointer shall show a Two-Dot *RIGHT* deflection.

7. Set **LOC** Switch to **L1**. Vertical pointer shall show an One-Dot *LEFT* deflection. Turn **LOC** Switch to **L2**. Vertical pointer shall show a Two-Dot *LEFT* deflection.



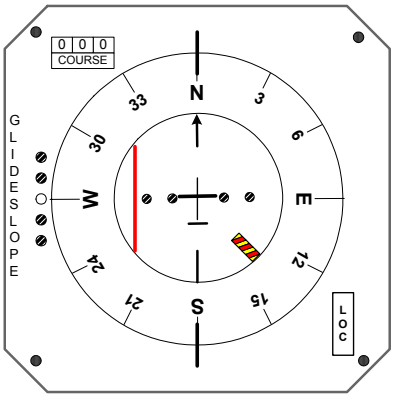
Indicator represents LOC Two Dots right of course

8. Set **LOC** switch to **VAR**. Rotate the **VAR** knob from the *LEFT* to *RIGHT* stop. Vertical pointer shall move from the *LEFT* two-dot position to the *RIGHT* two-dot position in response to the movement of the **VAR** knob.

9. Set **LOC** Switch to **OC**. Reduce the T-30D output signal strength with the **ATTENUATOR** knob. Verify that the flag appears IAW manufacturer's specifications.

10. Set both attenuator dials to **0**. Verify that the **LOC** Switch is at **OC** and that vertical pointer is centered.

11. Momentarily press **DELETE 90 ~** Switch. Vertical pointer shall swing full *LEFT* and the flag shall be visible.



Indicator indicates Full Left Deflection and Flag visible. LOC **DELETE 90 ~** switch pressed.

12. Momentarily press **DELETE 150 ~** Switch. Vertical pointer shall swing full right and the flag shall be visible.

13. Momentarily press **1020 ~ LOC** Switch. A 1020 Hz tone shall be heard from the cabin speaker or intercom.

14. Repeat steps 2-13 with the **ILS** frequency select switch at **108.15/334.55**. The same results shall be observed.

15. Set both **ATTENUATOR** dials to 0.

2.13 Glide Slope (GS) Procedures

WARNING
When conducting tests with the aircrafts autopilot engaged, any variation of the aircrafts controls may move the associated control services. Use caution to ensure that all personnel and ground support equipment are clear of the control services.

Verify proper operation of the aircraft GS receiver equipment as follows:

1. Connect the Omni-Antenna to the **RF OUTPUT** connector on the front panel of the Test Set and extend it fully, then retract it five sections (Table 2-3).

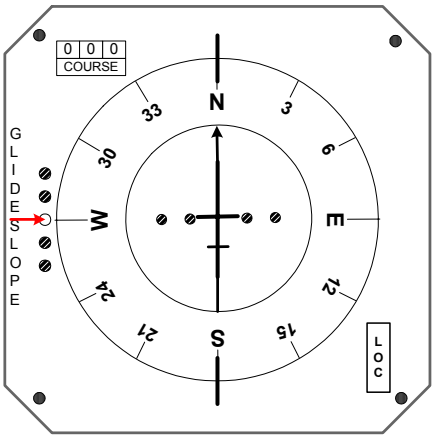
2. Set **ILS** frequency Select Switch to **108.10/334.70**.

3. Turn on the GS receiver. Tune for an operating frequency of 334.70 MHz.

4. Set the **FUNCTION** Switch to **GS**.

5. Set the **GS** Switch to **OC**. Horizontal pointer shall center and flag shall be retracted.

GS Pointer is Centered and On Course (OC).

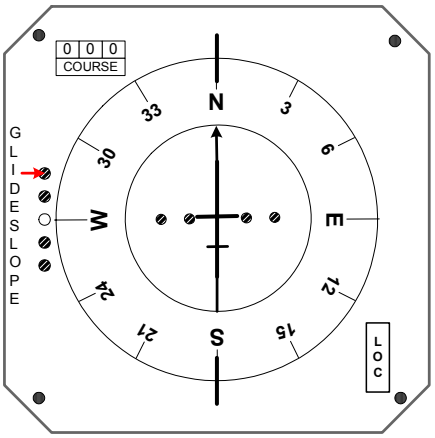


6. Set **GS** Switch to **+1**. Horizontal pointer shall show a One-Dot *UP* deflection. Turn **GS** switch to **+2**. Horizontal pointer shall show a Two-Dot *UP* deflection.

7. Set **GS** Switch to **-1**. Horizontal pointer shall show a One-Dot *DOWN* deflection. Turn **GS** Switch to **-2**. Horizontal pointer shall show a Two-Dot *DOWN* deflection.

8. Set **GS** Switch to **VAR**. Rotate the **VAR** knob from the left to right stop. Horizontal pointer shall move from the *DOWN* Two-Dot position to the *UP* Two-Dot position in response to the movement of the **VAR** knob.

GS Pointer indicates full Two-Dot *UP* Deflection



9. Set GS Switch to OC. Reduce the T-30D output signal strength with the **ATTENUATOR** knob. Verify that the flag appears IAW manufacturer's specifications.

10. Set both attenuator dials to **0**. Verify that the **GS** Switch is at **OC** and that horizontal pointer is centered.

11. Momentarily press **DELETE 90 ~** Switch. Horizontal pointer shall swing full up and the flag shall be visible.

12. Momentarily press **DELETE 150 ~** Switch. Horizontal pointer shall swing full down and the flag shall be visible.

13. Repeat steps 2-13 with the ILS frequency select switch at **108.15/334.55**. The same results shall be observed.

14. Set both **ATTENUATOR** dials to 0.

2.14 Instrument Landing System (ILS) Procedure

WARNING
When conducting tests with the aircrafts autopilot engaged, any variation of the aircrafts controls may move the associated control services. Use caution to ensure that all personnel and ground support equipment are clear of the control services.

Verify proper operation of the aircraft ILS receiver equipment as follows:

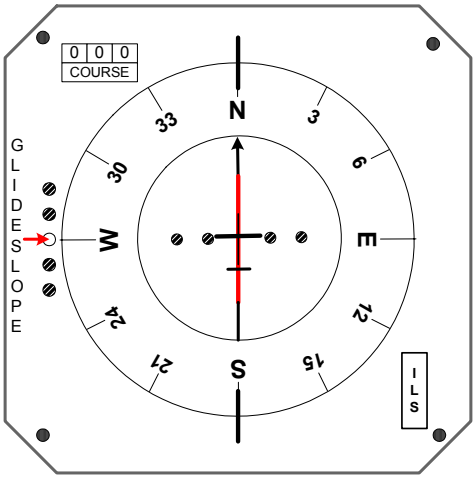
1. Connect the Omni-Antenna to the **RF OUTPUT** connector on the front panel of the Test Set and extend it fully, then retract it three sections (Table 2-3).

2. Set **ILS** frequency select switch to **108.10/334.70**.

3. Turn on the LOC/GS receiver (s). Tune for a LOC operating frequency of 108.10 MHz (GS 334.70 MHz).

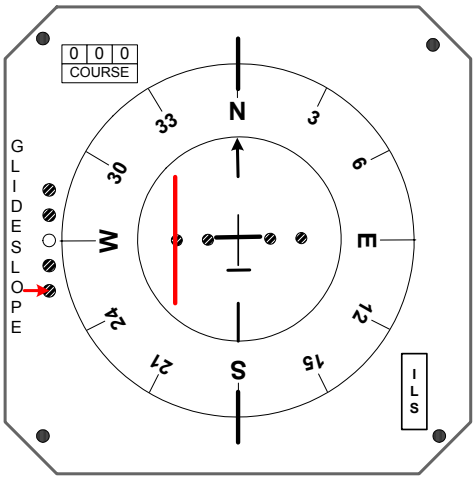
4. Set the **FUNCTION** switch to **ILS**.

5. Set both **LOC** and **GS** switches to **OC**. Vertical and horizontal pointers shall center and both flags shall be retracted.



Glide Slope and Localizer Pointers indicate On Course (OC).

6. Set both **LOC** and **GS** Switches to **VAR**. Rotate the **VAR** knob from the left and right stop. Vertical pointer shall move from *LEFT* Two-Dot position to the *RIGHT* Two-Dot position in response to the movement of the **VAR** knob. Simultaneously, the horizontal pointer shall move from the *DOWN* Two-Dot position to the *UP* Two-Dot position.



Glide Slope and Localizer Pointers indicate Two-Dots *DOWN* and Two-Dots *LEFT* of On Course.

7. Repeat steps 2-6 with the ILS frequency select switch at **108.15/334.55**. The same results shall be observed.

8. Set both ATTENUATOR dials to 0.

9. Simultaneous MB - At any time during ILS operation, the MB may be turned on by setting the **Simultaneous MB** "ON" switch.

2.15 Basic Principles of VOR, LOC, GS, and MB

2.15.1 Basic ILS Principles

ILS (Instrument Landing System) was introduced in the 1930's. The system consists of antennas and transmitters, located at the end of the runway at centerline, providing horizontal, vertical, and distance guidance. The system is broken down into: LOC-horizontal control, GS- vertical control, and MB- distance control.

The localizer transmitter utilizing the VHF navigation band from 108.10 – 111.95 MHz provides horizontal guidance (LOC), using every odd 100 KHz position.

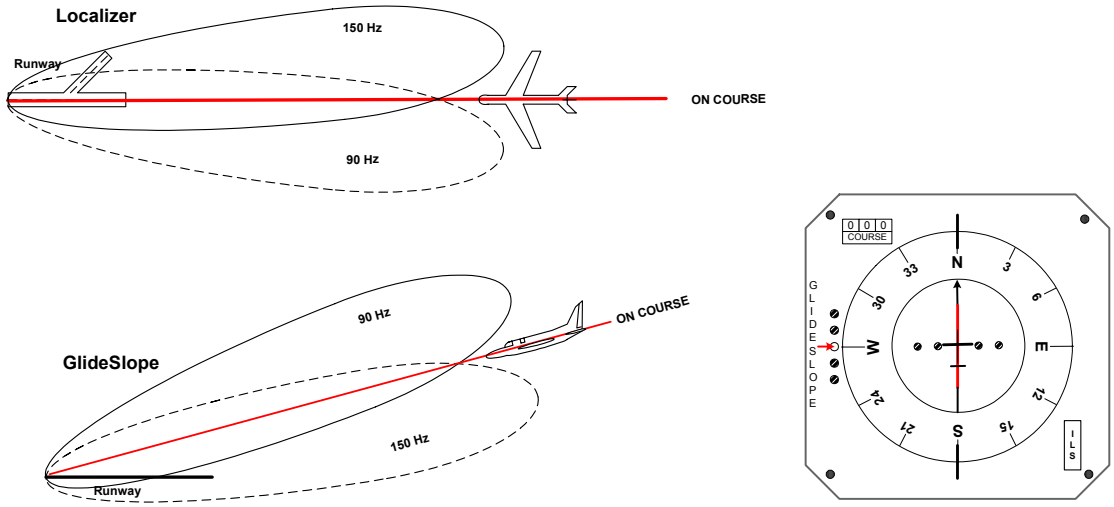
The vertical transmitter utilizing the UHF navigation band from 329.15 – 335.00 MHz provides the vertical guidance (GS).

The LOC and GS Frequencies are typically paired; where as- when you select the appropriate LOC frequency, the ILS receiver will automatically select the paired GS frequency.

Marker Beacon transmitters transmit on a frequency of 75 MHz and is not paired with the ILS receiver.

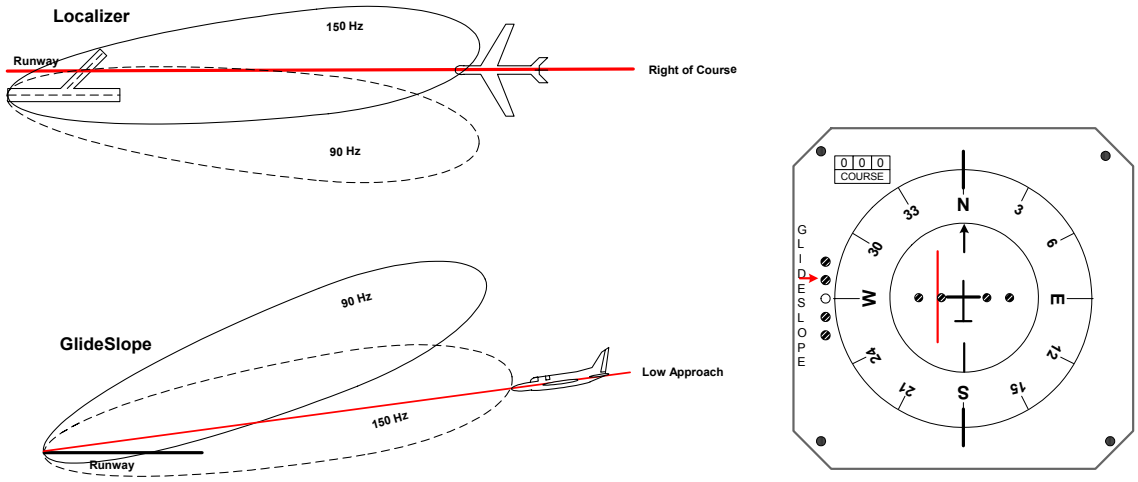
Both the LOC and GS Transmitters transmit a carrier modulated RF with 90 and 150 Hz signals. When an aircraft is receiving the signals and is receiving equal amounts of the 90 and 150 Hz modulation, the aircraft is "On Course", as depicted in Figure 2-6.

If the aircraft is receiving a percentage of modulation greater than the other, the receiver will display an offset either Left/Right or Above/Below "On Course", as shown in Figure 2-7.



Illustrates an "On Course" aircraft, receiving equal amounts of 90 and 150 Hz modulation.

Figure 2-6

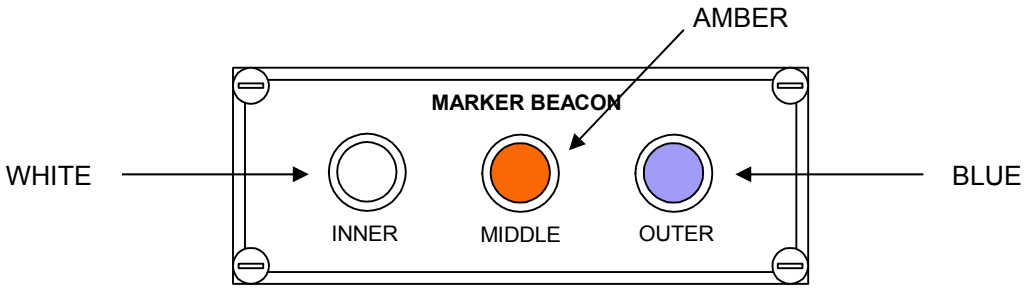


Illustrates an aircraft receiving a higher percentage of LOC 150 Hz modulation, and GS 90 Hz modulation. The Indicator will reflect left and above “On Course” when flying “TO” the VOR station.

Figure 2-7

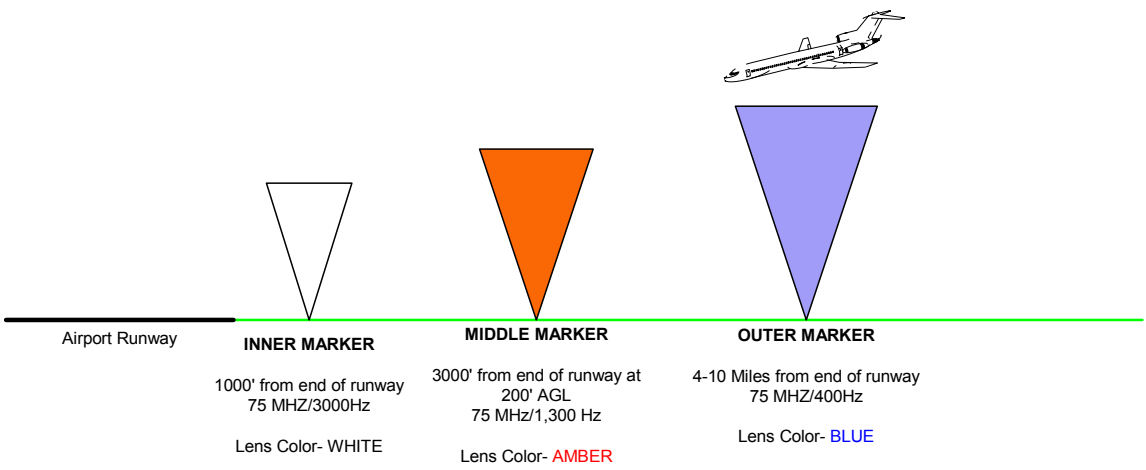
2.15.2 Marker Beacon

The Marker Beacon provides distance to the airport runway. There are normally three transmitters, Outer Marker, Middle Marker and Inner Marker. All three transmit at 75 MHz, modulated at different frequencies for identification. The Inner marker is modulated at 3000 Hz, Middle at 1300 Hz, and the Outer at 400 Hz. As the aircraft flies over the transmitters, located at the approach end of the runway, the MB receiver will receive the signal and dependent on the modulation (Figure 2-9), illuminate the appropriate light on the panel (Figure 2-8).



Typical MB Display

Figure 2-8



Typical MB Approach Parameters

Figure 2-9

2.15.3 Basic VOR Principles

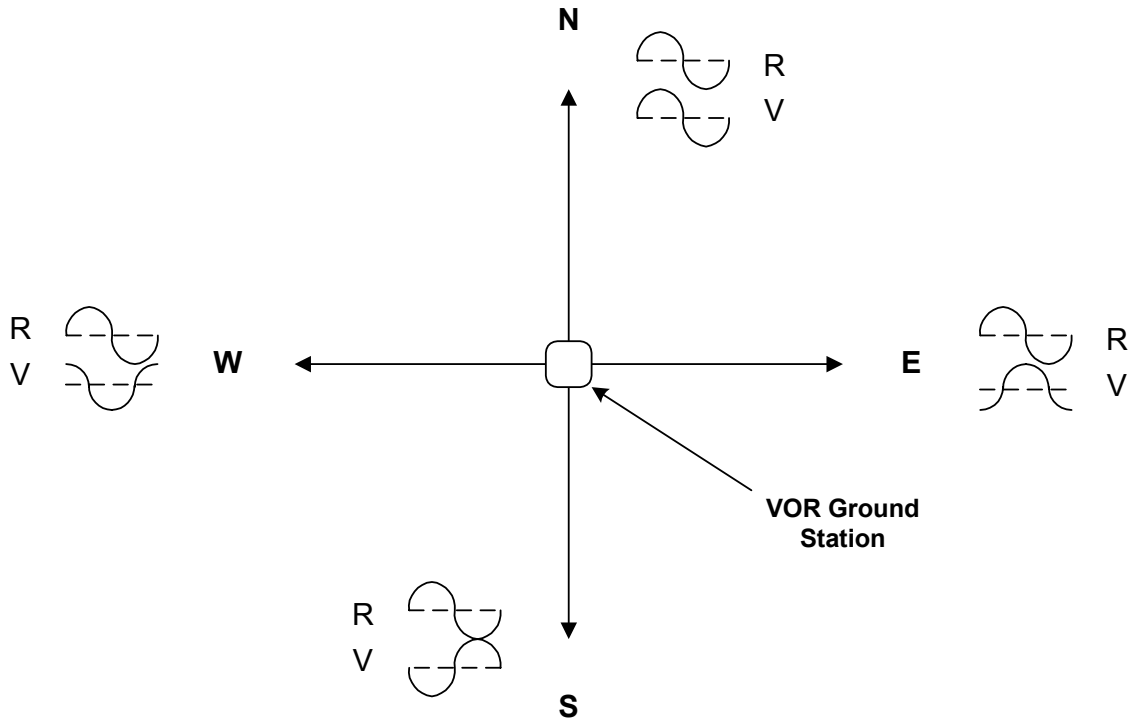
VOR (Variable Omni Range) is a VHF navigational aid utilized to determine the bearing of an aircraft to a designated point. The system comprises of a fixed ground station and the airborne receiver. The ground station transmits two signals, a reference and a variable signal. Within line of sight of a VOR ground station, the aircraft receiver will detect, then compare the phase relationship between the *reference* and *variable signals* and translate it to a bearing from the ground station.

The basic principle of VOR is the measurement of time (phase) difference between the two signals.

The *reference signal* is a 30 Hz signal which frequency modulates (FM) a 9960 Hz subcarrier. The frequency modulated signal is then used to amplitude modulate (AM) a RF carrier.

The *variable signal* uses the same carrier frequency but no modulation from the transmitter. The signal is modulated at 30 Hz by the rotation of the antenna.

The *variable* 30 Hz AM signal and the 30 Hz FM *reference* signal are timed (by the rotation of the antenna) to be in phase at a relative position of due north of the VOR station (see figure 2-10).



Phase Relationship between Variable and Reference Signals

Figure 2-10

Using Figure 2-10, Note at due North, the signals are *IN* phase. At due East - the signals are 90° out of phase, due South - 180° out of phase, due West – 270° out of phase. The VOR receiver in the aircraft, measures this phase difference and displays the information as the correct bearing TO or FROM the ground station.

CHAPTER III

THEORY OF OPERATION

3.1 Overall Theory of Operation

The T-30D provides VOR, LOC, GS, MB signal generation, as shown in Fig. 3-1. The VOR and LOC RF carriers are generated using a phase locked loop synthesizer, which is capable of generating frequencies within the entire VHF navigation band. The GS RF carrier is generated with a similar phase locked loop and is capable of generating all GS frequencies. The MB RF carrier is generated with a crystal oscillator.

FIGURE #	DIAGRAM
5-1	System Interconnect
5-2 to 5-5	RF and Digital

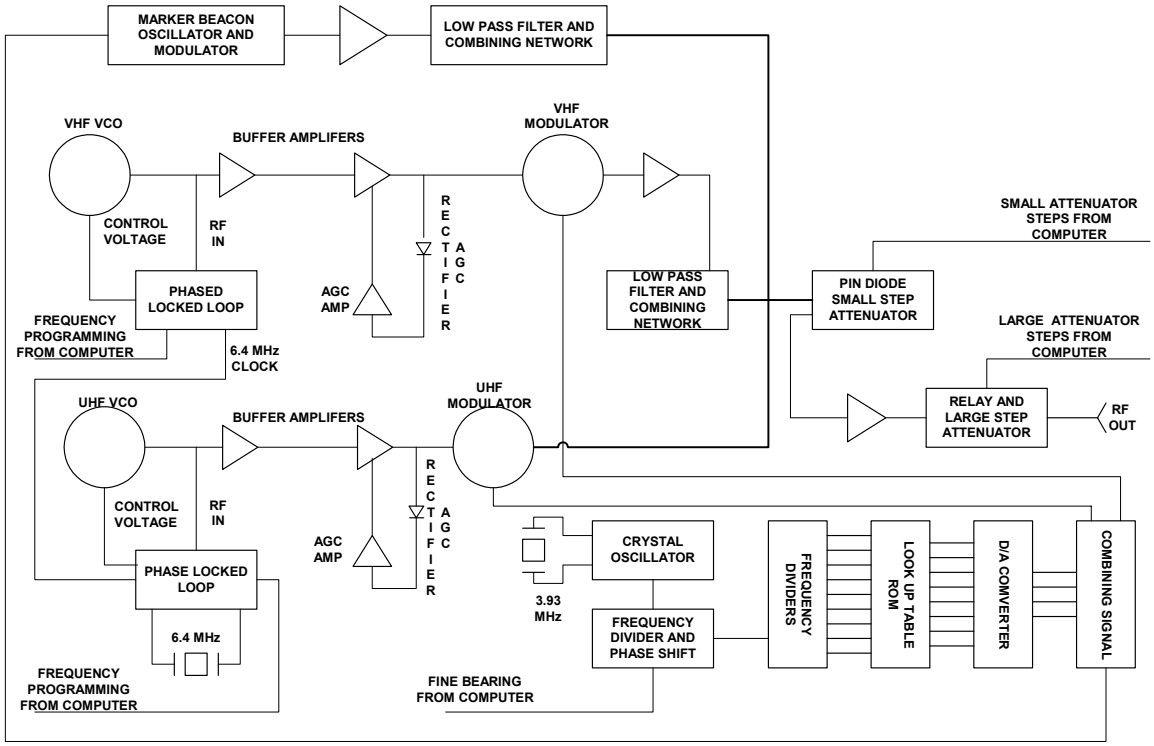
3.2 AC and Battery Power

As shown in Fig. 3-2, AC power is supplied thru the panel connector and thru fuses to the full wave bridge rectifier. The AC power is controlled by the AC Power switch and AC Input voltage select. When the Test Set Power switch is “OFF”, the output from the bridge rectifier is supplied thru fuses to charge the battery pack. When the Test Set Power switch is “ON”, the unit becomes operational. To preserve battery power, if no controls are activated, the unit will turn off after 15 minutes. To signal low battery voltage, the **TEST/FAIL STATUS** LED will begin to blink with approx. 15 minutes of operating time remaining. After this time, the test set will automatically be disabled until the battery is recharged.

The T-30D has a 10-cell series battery pack that provides 12 volts of DC. The capacity of the battery pack is 4 amp hours. The built in charger recharges the battery from the AC source. The battery will be charged with only the AC switch “ON”. The Test Set can be operated when the battery is being charged.

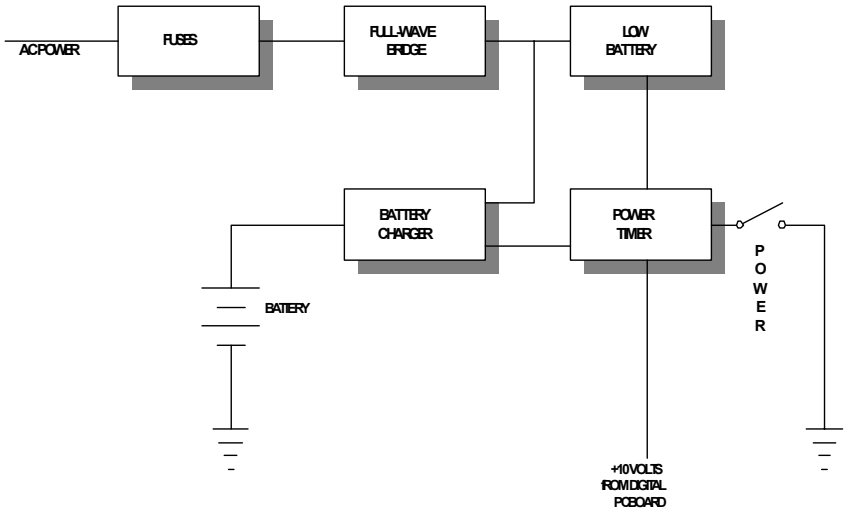
Because the recharge process is not a 100% efficient process, some energy delivered to the cells will generate oxygen and heat. If charging is done at less than 10% of the battery capacity (400ma), the oxygen will recombine in the cell. If the charge rate is greater than 400ma, the oxygen will accumulate and result in a capacity limitation known as *Memory Effect*. The *Memory Effect* is reversible by discharging the battery to a level of 10 volts and then recharging. The battery should never be discharged lower than 9.5 volts or the number a charge cycles (total useful life) will be greatly reduced.

The internal battery charger provides 400ma of current to the battery that, after 16 hours, will completely charge a fully discharged battery pack. The charger can be left on indefinitely without generating the memory effect. Therefore, it is recommended to keep the test set on charge when not in use.



System Block Diagram

Figure 3-1



Power Supply Block Diagram

Figure 3-2

3.3 Microprocessor Operation

The T-30D microcomputer uses an 80C31 processor, U3, operating at 12MHz. The processor RAM is U2 while the PROM is U5. U1 is used for address expansion. The computer monitors the front panel controls, determines the mode of operation, and thus controls the RF frequencies and levels, the modulation tones to be generated and the necessary phase angles when used. The computer also interfaces with an IEEE-488 bus in units fitted with this option.

The front panel switches are scanned using the input and output ports from the microprocessor. There are 6 driver lines, key1 through key6, which are latched into U10. These outputs drive the function switches on the front panel and the switch closures are sensed through the 6 inputs key 7 through key 13.

The microprocessor programs the basic mode of operation of the unit by providing analog switching and the partitions of the look-up PROM used to generate the modulation voltages. The processor also programs the frequency of the synthesizers and the output RF levels. The computer also programs the VOR bearing, both fine and coarse, the percentage of modulation for the LOC and the GS.

The necessary mathematics to convert the front panel controls from the DDM to percentage modulation or the omni bearing to coarse and fine bearing is performed by the microprocessor.

3.4 RF Generation

The RF signal generation involves two phase locked loop synthesizers for the VOR, LOC and GS signal carriers. For the marker carrier a single-frequency, crystal controlled generator is used.

As shown in Fig. 3-3, for the VHF navigation frequencies required of the VOR and localizer, Q3 is the VCO, which is followed by an attenuator to provide isolation from the first buffer amplifier, U66, followed by a second buffer amplifier, U67. The output of the second buffer amplifier is rectified using the Schottky diode CR18 and compared to a reference voltage generated with another Schottky diode, CR19. The output of the feedback amplifier U70 is fed to the base of the transistor, Q4. This transistor adjusts the current to the amplifier, U67, thus changing the gain of this amplifier. The amplitude of the rectified signal from CR18 is adjusted to be equal to and of opposite sign as the current through R185, which sets the RF level at the output of U67.

Having a constant RF voltage input to the modulator permits accurate amplitude modulation from the balanced mixer, U68. The output of the modulator is passed through a low pass filter to eliminate the higher order harmonics created in the balanced modulator, to amplifier U21 and an isolation resistor, R178.

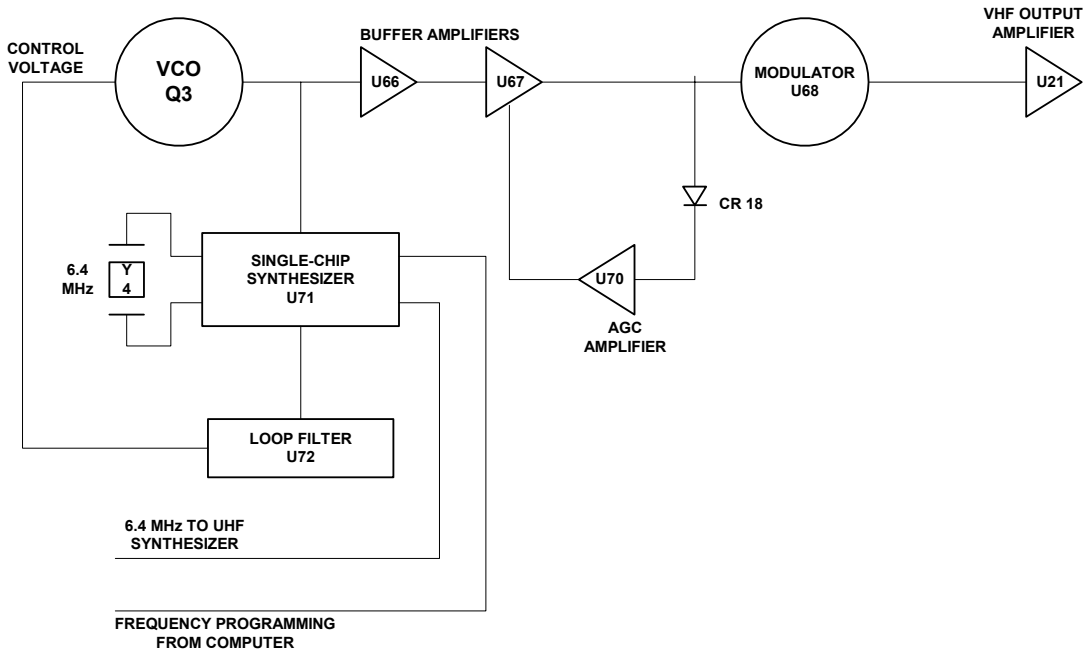
The UHF synthesizer, Fig. 3-4 is very similar; the main difference being the glide slope frequency range is small compared to the VHF NAV band of frequencies. This is evident as the main difference between the VHF and UHF synthesizers, is the VCO.

The VCO for the UHF synthesizer is negative resistance oscillator using Q1. An attenuator follows the VCO, two buffer amplifiers and a feedback level control adjust as the VHF synthesizer. The output of the second buffer amplifier feeds the modulator.

The marker beacon RF signal is generated with a crystal controlled oscillator and modulator, U49. This IC provides a 5th overtone crystal oscillator and a Gilbert cell balanced modulator which is used as an AM modulator. The output of the modulator is amplified and passed through a simple low-pass filter and a 220-ohm isolation resistor.

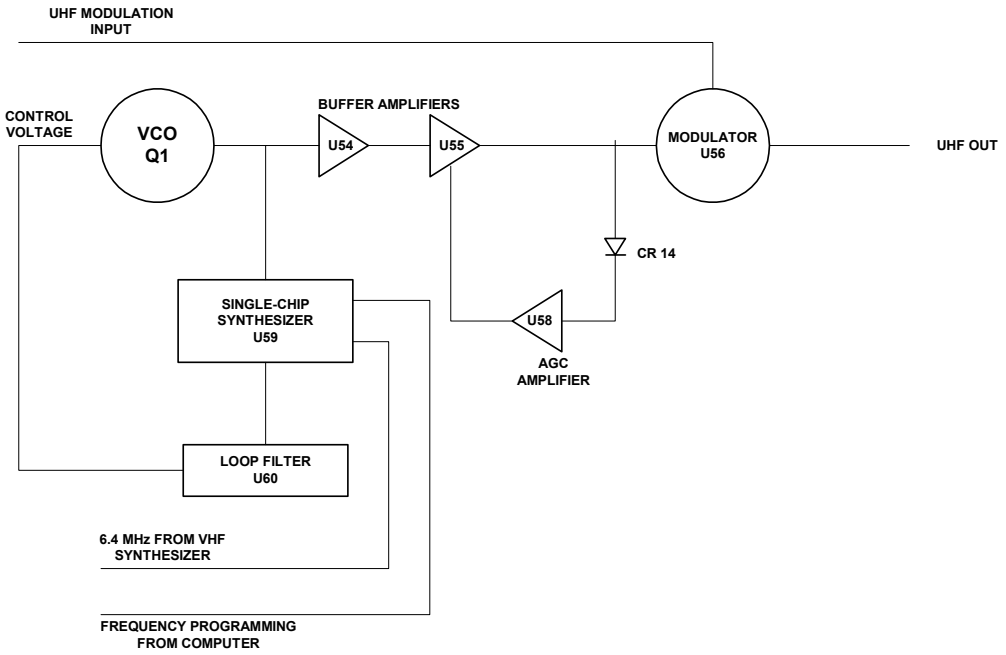
The output signal from the VHF, UHF, and MB are combined and attenuated in 1dB steps with two PIN diode attenuators providing 1, 2, 4, 5, 10, and 20dB steps, for a total of 42dB of attenuation. The output of PIN diode attenuators is amplified by the power amplifier U73. Relay attenuators provide two additional 34dB steps after the power amplifier, bringing the total attenuation to 110dB.

The PIN diode and relay attenuators are controlled by the computer and are set by the front panel attenuation switches.



VHF Block Diagram

Figure 3-3



UHF Block Diagram

Figure 3-4

3.5 Modulation

The modulation waveforms are generated using digital sampling techniques and a look-up table, U35, which is sequentially addressed. The output of the look-up table ROM feeds several D/A converters that create the analog output to feed the modulators. The basic cycle time of the look-up table is 1/30th of a second. There are 2048 samples per cycle, which implies that the addresses change at a 61.44 kHz rate.

The SINE PROM has look-up tables to generate all of the required sine frequencies. In the VOR mode of operation, the PROM provides one cycle (1/30 sec) of 30Hz variable phase, 9960Hz IDENT tone, and a 9960Hz un-modulated frequency for VOR delete modes test.

In the ILS mode of operation, the PROM provides 3 cycles of 90Hz, 5 cycles of 150Hz tones for GS and LOC. It also provides 1020Hz IDENT tone for the LOC when selected by the operator. The 90 and 150Hz tones are loaded to separate LOC and GS D/A converters. The D/A converters and amplifiers set the amplitude of these tones

In the MB mode of operation, the PROM provides 13.5 cycles of 400Hz, 43.5 cycles of 1300Hz, or 100 cycles of 3000Hz, as selected by the operator. The MB tone generation is accomplished differently from the VOR and ILS tones. Because two of the three MB frequencies are not exact multiples of 30Hz, as the VOR, LOC, and GS tones are, the look-up table is read twice for each MB tone and the polarity of the output is reversed between the two readings. This effectively reduces the sample rate from 30 to 15 times per second.

For the 3000Hz MB tone, 100 complete cycles are stored and retrieved 30 times per second which produces an exact 3 kHz output. For the 1300Hz tone, 43.5 cycles are stored and retrieved

at a 30Hz rate. Since the polarity is changed every other sequence, the one-half cycle at the end of one sequence is followed by a reverse polarity cycle at the beginning of the next cycle and results in a continuous sine wave. Sampling 43.5 cycles at 30 times a second, results in a frequency of 1305Hz; and sampling 13.5 cycles at 30 times a second results in a frequency of 405Hz. Both of these tones are within ICAO spec.

U28, U29 and U30 form a 12-bit binary counter. Eleven bits of the counter feed a binary adder consisting of U31, U32 and U33. The output of the adder feeds the address input of the look-up PROM, U35. The adder allows the VOR coarse bearing to be added to the address of the PROM when reading the 30Hz variable signal from the look-up PROM. When operating in the VOR mode, the VOR coarse bearing is added to the PROM address only when the output control of U15 and U16 is low. When the output control is at logic 1, the pull down resistors cause the B input to the adder, U31, U32 and U33, to be all zero and thus the address is the same as the state of the address counters U28, U29 and U30.

On all other modes, the VOR coarse bearing, VCBO through VCB10, is zero, and the address of the EPROM is the same as the address counter, regardless of the state of the output control.

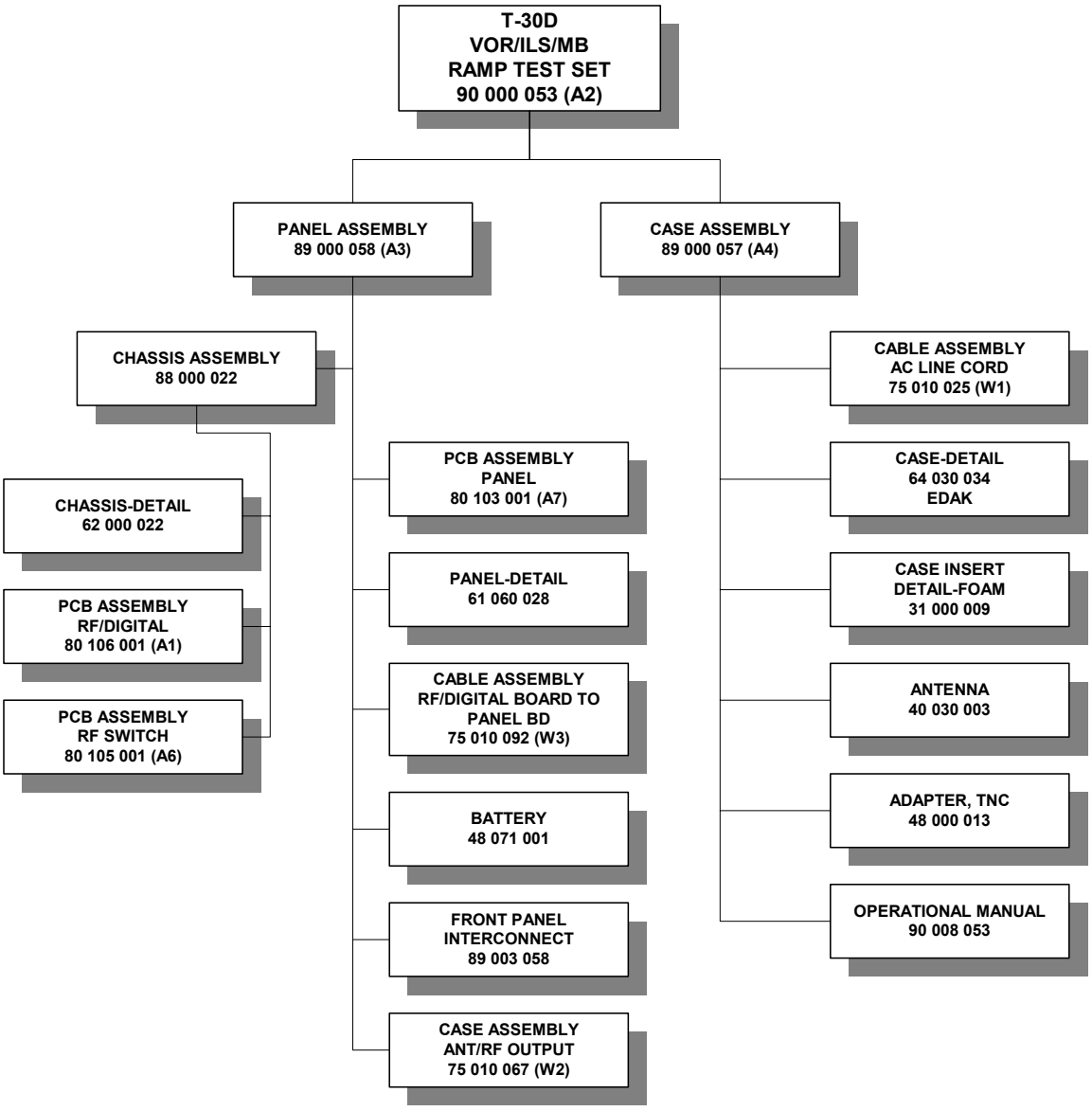
The D/A converters have storage latches and the output of the look-up PROM, that represents the digital amplitude of the waveform, is latched into five D/A converters. The 61.44 kHz address clock is further divided into 4 periods. U40 contains four of the five D/A converters and receives the data for the LOC 90Hz in section A, LOC 150Hz in section C, GS 90Hz in section B and GS 150Hz in section D. There are five D/A converters and only 4 sub-periods for each address. In the ILS modes of operation, where all 5 D/A converters are used, the 90 and 150Hz waveforms are latched into two D/A converters each of the first two sub-periods while the 1020Hz IDENT or one of the marker tones are latched during the remaining two periods.

In the VOR mode, a 30Hz sine function is latched into the D/A converter U39-A, while a 9960 Hz frequency modulated reference waveform is latched into U40 section B and the 1020Hz IDENT is latched into sections A.

In the ILS modes, the 90Hz sine function is latched into U40 A and B while the 150Hz tone is latched into U40C and D. The 1020Hz IDENT tone or the MB tone, depending on whether the MB or IDENT tone is selected, is stored in U39-A. When the MB is not activated, U39-A receives the 1020Hz IDENT tone that is routed to the VHF modulation for the localizer through U42 and R43.

The VOR fine bearing is created by using the second latch available in U39. In U40, the second latch is effectively disabled by permitting the latch to remain transparent. The 61.44 kHz address clock is divided into 16 sub clocks. By delaying, the strobe pulse to the second latch by multiples of 1/16th of the 61.44 kHz period the address clock the phase angle between the reference and variable can be adjusted. Since each 30 Hz cycle is divided into 2048 samples, each sample represents 0.176 degrees, using the 1/16th clock period, the fine adjustment can be made with 0.011-degree resolution.

The reference voltage for all four D/A converters in U40 can be controlled by the D/A converter, U8. U40 receives the samples for localizer and glide slope 90Hz and 150Hz tones. Therefore, the DDM's of the GS and LOC may be set under control of the computer.



T-30D Ramp Test Set Configuration Chart

Figure 3-5