ROHDE&SCHWARZ

Test and Measurement
Division

VOR/ILS Generator

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1 Information on Air Navigation

1.1 Determination of Position Using VOR

The VOR (= VHF Omnidirectional Radio Range) is an omnidirectional beacon in the VHF range enabling the pilot of an aircraft to determine its position in the air. This is achieved by VOR ground stations sited at defined co-ordinates, emitting the same RF carrier via two different antennas. One of the antennas radiates in all directions, the second one emits a rotating beam. This antenna rotates at 30 revolutions per second, thus leading to an amplitude modulation of 30 Hz with the transceiver aboard the aircraft. The same RF carrier is transmitted via the omnidirectional antenna, but it is amplitude-modulated with the frequency 9960 Hz. This subcarrier is again frequency-modulated with a 30-Hz reference signal. Since the phasing of the rotating amplitude-modulated signal depends on the direction it can be used for determining the position of the aircraft. The frequency-modulated 30-Hz signal is referred to as reference phase. The reference signal and the rotating beam are synchronized such that a receiving instrument, which is located in magnetic north direction to the transmitter, receives both with a phase offset of 0° (cf. fig. 1). If, e.g., the position of the aircraft is 90° to the VOR transmitter base, the amplitude-modulated 30-Hz signal is received with a phase offset of 90° to the reference signal.

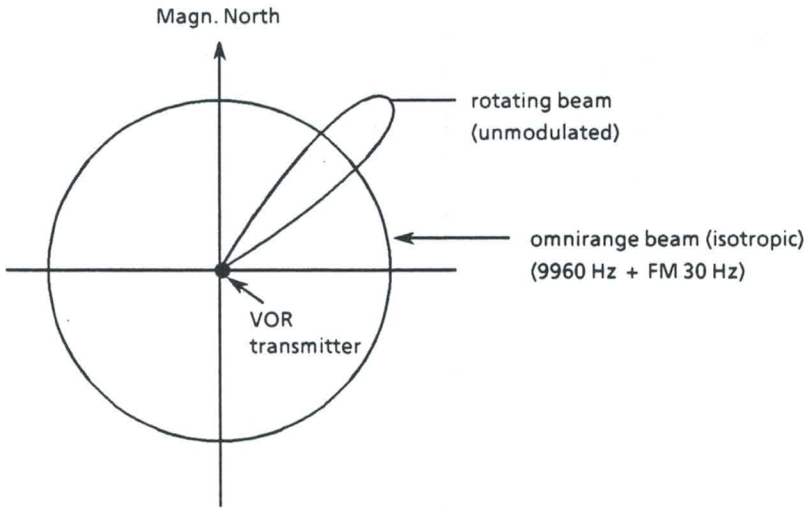


Fig. 1 VOR function principle

1.2 Landing Approach with ILS

The ILS (= Instrument Landing System) is a radio landing system, which allows for an approaching aircraft to be lead in the right angle until touchdown. The ILS consists of two function units. The localizer determines the vertical approach angle whereas the glide slope determines the horizontal angle to the touchdown point. The ILS ground transmitter emits four lobe-shaped beams in the direction of the approach line. The two lobes of the localizer are arranged in parallel, i.e. one on the right and one on the left side, those of the glide slope in vertical order, i.e. as an upper and a lower lobe. The antennas each emit amplitude-modulated RF carriers. The carrier frequencies are different for the glide slope and the localizer (cf. fig. 2).

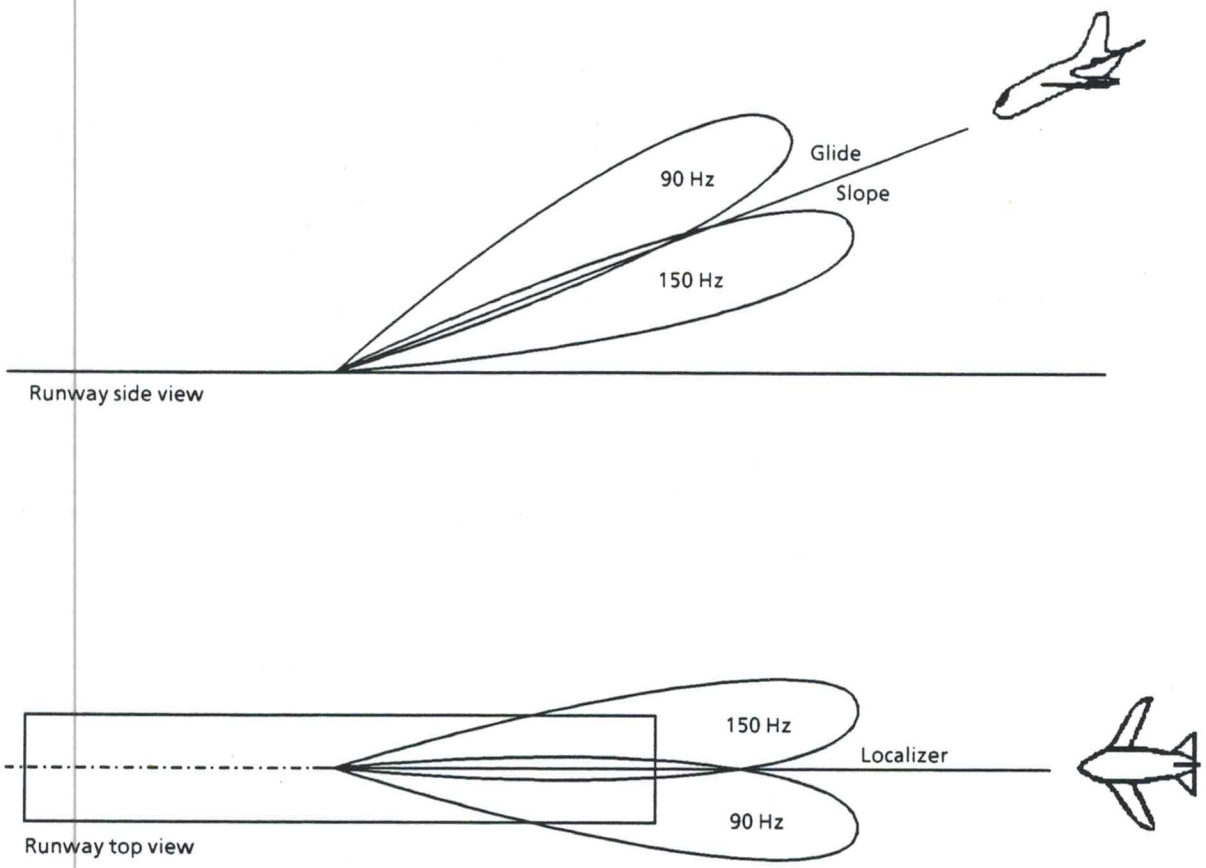


Fig. 2 ILS function principle

1.2.1 Localizer

Looking into approach direction, the left antenna of the localizer emits an RF carrier modulated with 90 Hz, the right one an RF carrier modulated with 150 Hz with a modulation depth of 20 % each. Both radiation fields slightly overlap. The points where both fields can be received with the same strength form a level which corresponds to the correct vertical approach angle. Since the 90-Hz tone and the 150-Hz tone use the same carrier, a different field strength on the receiver causes a different modulation of both tones. The ILS receiver aboard the plane measures and displays the difference of both modulation depths in DDM (= Difference in Depth of Modulation). DDM = 0 thus means that the aircraft is positioned in the right approach angle to the runway.

1.2.2 Glide Slope

The function principle of the glide slope corresponds to that of the localizer. However, the two radiation patterns are arranged in vertical order such that the points of the same field strength form a level which corresponds to the correct glide angle. The lower antenna of the glide slope emits an RF carrier modulated with 150 Hz, the upper one emits an RF carrier modulated with 90 Hz, the modulation depth being 40 % each.

1.3 Marker Beacon

The marker beacon is an RF transmitter within the 75-MHz band located in the approach line to the runway. Its directional antennas radiate the RF power vertically upward. Thus, the receiver aboard the aircraft receives and displays a signal only when flying over the marker beacon. Up to three markers are situated one after the other in the approach lane. The RF carrier of each marker beacon is amplitude-modulated with a different AF frequency.

Outter	Marker	(OM)	=	400 Hz
Middle	Marker	(MM)	=	1300 Hz
Inner	Marker	(IM)	=	3000 Hz

The receiver is enabled to indicate, which marker the aircraft is just passing by means of selection of the individual tones.

2 Application of the Signal Generators

The CMS signal generators for VOR, ILS glide slope, ILS localizer and marker beacon allow for generating the same signals which are transmitted by a VOR/ILS ground station. They are provided at the RF IN/OUT connector and can thus be directly fed to the antenna connector of the VOR/ILS receiver. Optionally, an AF signal can be generated at the MOD GEN output in order to modulate an external RF synthesizer. In addition to the signal generator the CMS provides the measuring functions SCOPE and AF voltmeter.

3 Function Principle of the Signal Generators

3.1 Function Principle of the VOR Signal Generator

The VOR signal generator consists of three AF generators. The first one generates a 30-Hz signal which is varied in phase on the one hand by means of a phase shifter and which is on the other hand frequency-modulated with its fixed phase to the signal of the second generator (9960 Hz), serving as subcarrier. The third generator provides a so-called auxiliary tone of 1020 Hz. All frequencies of the AF generators are default values, which can be varied for test purposes. The amplitudes of the subcarrier, the auxiliary tone and the 30-Hz signal with the variable phase can now be individually attenuated. The three signals are then added up via an adder and either applied to the AF connector MOD GEN via a variable amplifier or modulated to a variable RF carrier by means of an amplitude modulator. The RF signal which can be varied in level over a wide range is output at the RF IN/OUT connector.

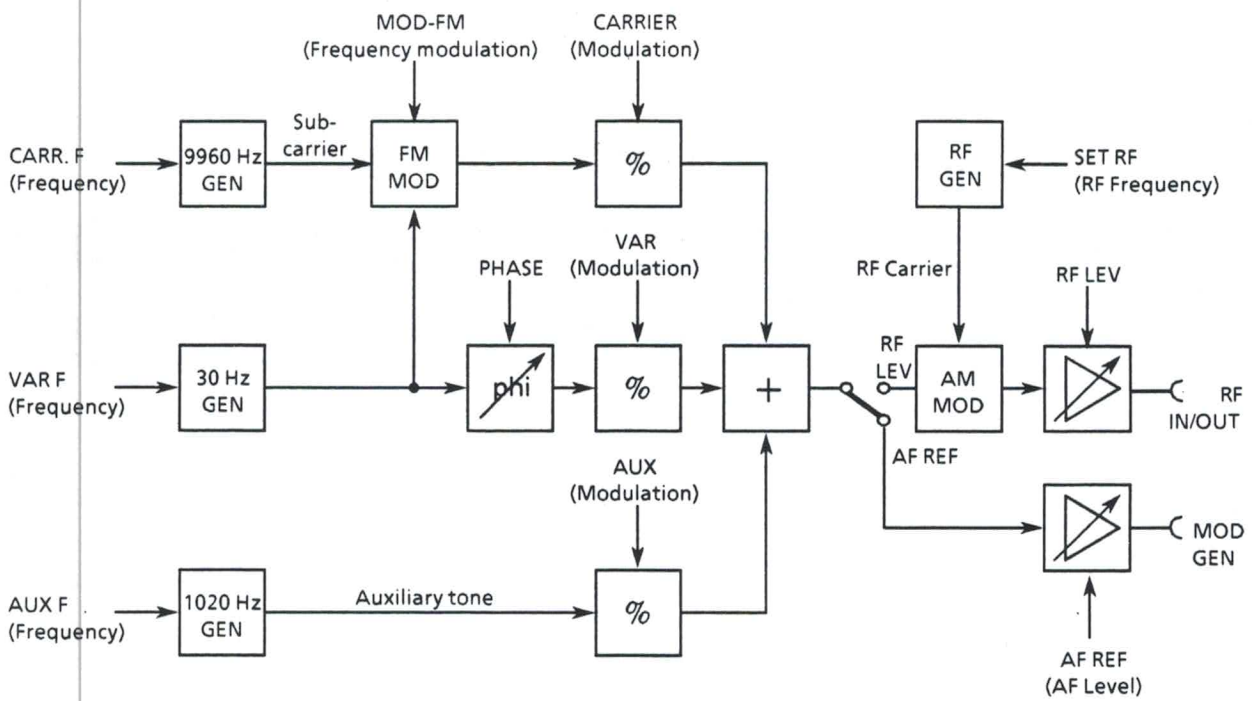


Fig. 3 Block Diagram "VOR Signal Generator"

3.2 Function Principle of the ILS Signal Generator

The ILS signal generator consists of three AF generators. The first two generators supply the 90-Hz signal and the 150-Hz signal. The frequency ratio is 3/5 with the generators being phase-locked. The user can set a phase offset of 0° to 100° relating to the 150-Hz signal. The third generator generates a auxiliary tone of 1020 Hz. All frequencies of the AF generators are default values which can be varied for test purposes. The amplitudes of the 90-Hz tone and the 150-Hz tone as well as that of the auxiliary tone can now be individually attenuated. The three signals are then added and either applied to the AF connector MOD GEN via a variable amplifier or modulated to a variable RF carrier by means of an amplitude modulator. The RF signal which can be varied in level over a wide range is output at the RF IN/OUT connector (cf. fig. 4). This generator is used for glide slope and localizer operation.

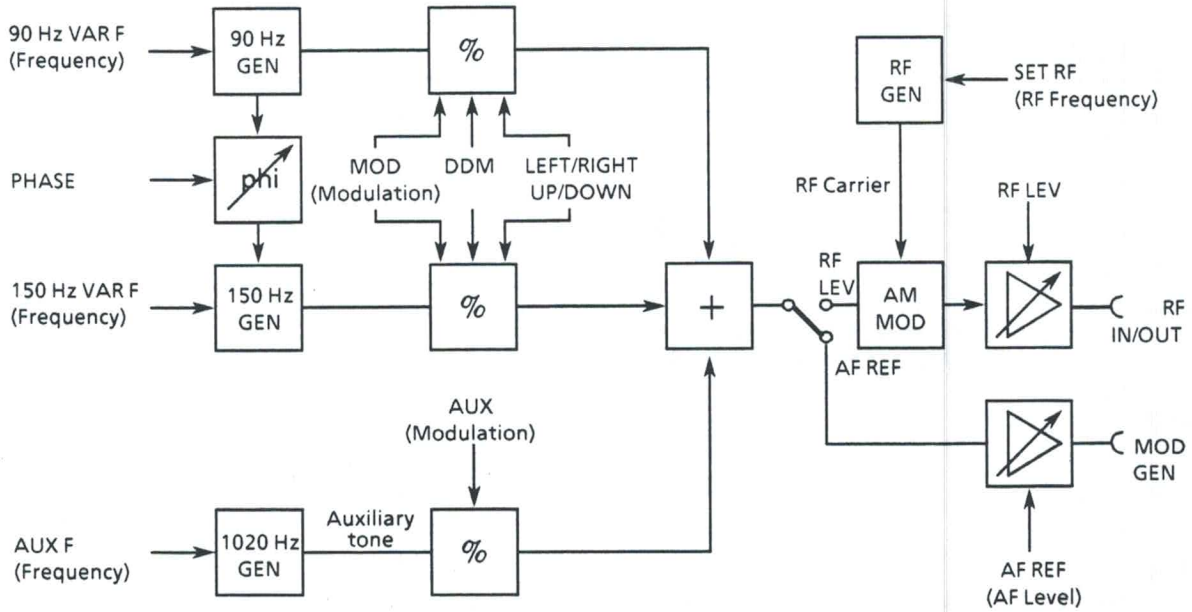


Fig. 4 Block Diagram "ILS Signal Generator"

3.3 Function Principle of the Marker Beacon Signal Generator

The marker beacon signal generator consists of two AF generators. The first one generates a sinewave signal with one of the three specified frequencies (300 Hz, 1300 Hz, 3000 Hz). The second generator provides a auxiliary tone of 1020 Hz with the frequency, however, being variable over a wide range. The amplitudes of both tones can be attenuated individually. They are then added by means of an adder and output to the AF connector MOD GEN via a variable amplifier or modulated to an RF carrier by means of the amplitude modulator. The RF signal which can be varied in level over a wide range is output at the RF IN/OUT connector.

4 Operation of the VOR/ILS Signal Generator

4.1 Menu Structure

Four menus are reserved for the VOR/ILS generator:

- VOR
- ILS-GS (ILS glide slope)
- ILS-LOC (ILS localizer)
- MB (marker beacon)

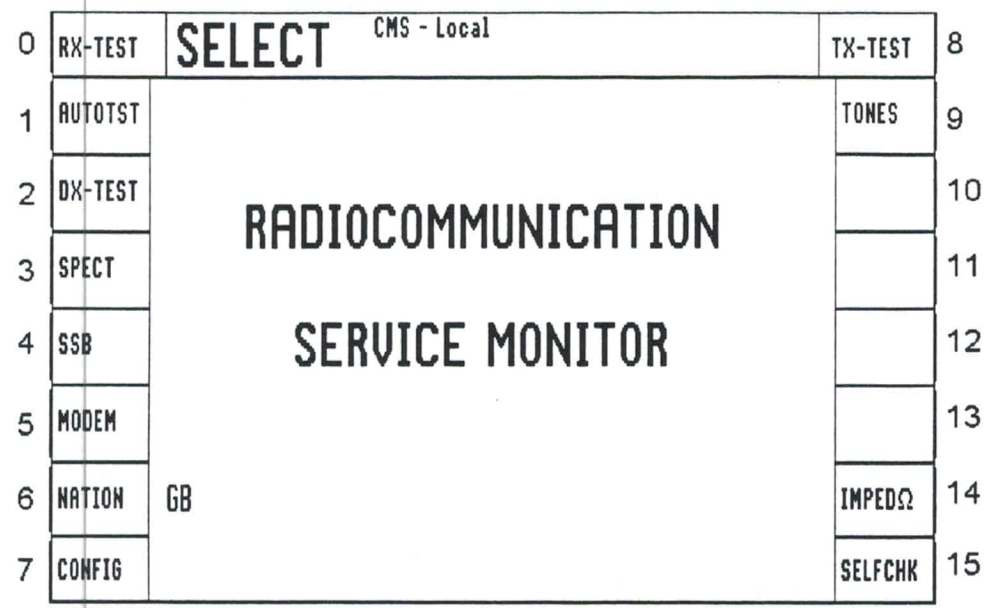


Fig. 5 SELECT menu

The SELECT menu allows for selecting the VOR menu by pressing softkey 11 or for selection of the ILS-LOC menu by pressing softkey 12. The ILS-GS menu can be entered by pressing softkey 0 in the ILS-LOC menu, the MB menu is reached by pressing softkey 8. The softkey MENU UP is used for returning to the SELECT menu from each of the four above-mentioned menus.

The softkey AF MOE (9) can be actuated in the VOR, ILS-GS and ILS-LOC menus for calling a submenu enabling the measuring functions Scope, AF voltmeter and DC voltmeter (only with built-in option CMS-B20). These measuring functions are implemented as a standard in the marker beacon menu MB. Operation of the oscilloscope corresponds to the operating modes transmitter test or receiver test. The submenus of these functions, however, cannot be entered in this application.

The oscilloscope can be set to FREEZE/ CONTINUOUS modes by activating softkey 11 and pressing the CLEAR/ ENTER key.

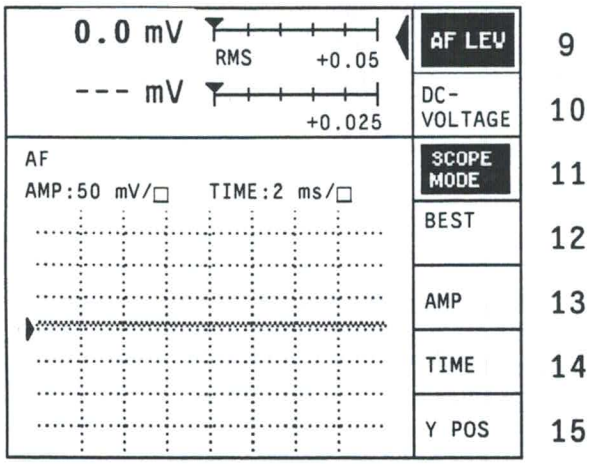


Fig. 6 Submenu AF MODE

4.2 General Operation Features of the Operating Modes VOR, ILS-LOC, ILS-GS and MB

4.2.1 Switchover AF Output or Modulation to RF Carrier

The softkey RF LEV/AF REF (2) is assigned two functions. First, it is used for selecting, whether the AF signals are output at the MOD GEN connector or amplitude-modulated to an RF carrier and output at the RF IN/OUT connector. The second function is the setting of the AF or RF output level. If the RF LEV field is inverted (bright characters on a dark background), the measuring signal is output in modulated form and the value displayed is the RF level. If the active cursor is located at this position, a new RF level can now be entered with the units dBm or µV. If the AF REF field is inverted, the AF signal is directly output. The displayed value then means the reference output level, the proportional modulation values of the individual signals refer to. This level can either be output in V, mV or µV.

4.2.2 RF Frequencies

The SET RF function is used for setting the frequency of the RF carrier. Each of the 4 menus contains an individual table listing the standard frequencies for VOR, ILS and MB (cf. table 1, page 19). The values are called by rotating the VAR spinwheel. The two frequencies for ILS-LOC and ILS-GS are always paired, i.e., in case of a switchover from one menu to the other, the corresponding frequency value is loaded respectively. This does not affect VOR and MB.

4.2.3 VAR Function

The relevant parameters can be varied using the VAR spinwheel. The parameters are preset to the smallest possible step size or, if present, to a table of values (RF, DDM) which are loaded one after the other. If the parameters are varied via the keypad, rotating the VAR spinwheel causes the next values from the table to be loaded. If a new step size is entered, the table cannot be accessed. The table can be activated again by entering a step size of zero. The AF modulations and AF frequencies displayed in each of the four menus are specified standard values which can, however, be varied for simulation of deviations and faults.

4.2.4 Presettings

Varied parameters in the VOR, ILS and MB menus can be reset to their standard values using the key combination SHIFT / RESET (cf. table 2, page 20); however, this effects entering the SELECT menu again.

4.3 VOR Menu

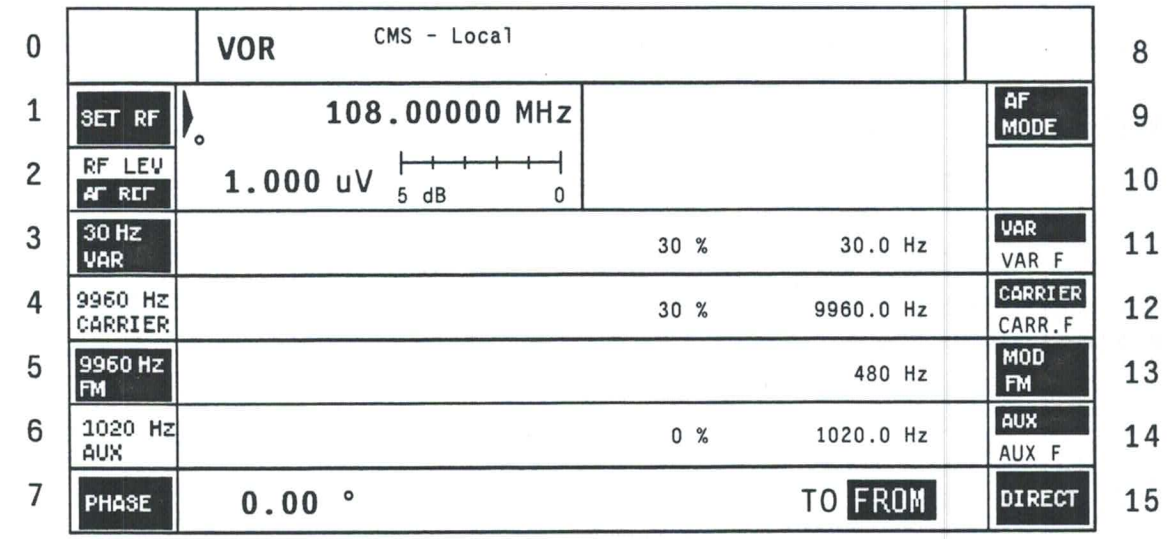


Fig. 7 VOR menu

Softkey 3: 30 Hz VAR

This softkey activates the phase-variable 30-Hz tone. It is active when the field is inverted.

Softkey 4: 9960 Hz CARRIER

This softkey activates the unmodulated subcarrier. It is active when the field is inverted.

Softkey 5: 9960 Hz FM

This softkey activates the FM-modulated subcarrier. Softkeys 4 and 5 cannot be active simultaneously, i.e. switching on the modulated subcarrier automatically disables the unmodulated carrier. Softkey 5 is active when the field is inverted.

Softkey 6: 1020 Hz AUX

This softkey switches on the auxiliary tone. It is active when the field is inverted.

Softkey 7: PHASE

This function sets the phase of the 30-Hz signal. The entry is made using `Softkey 7/number/ENTER`. The phase value is indicated in degrees. The step size of the VAR spinwheel is preset to 10°.

The softkeys 11 to 14 are used for entering the frequency using `Softkey/number/dimension or ENTER` and for entering the modulation using `Softkey/number/% or ENTER`. The modulation is displayed in percent.

Softkey 11: VAR/VAR F

Dual function for entering the frequency and modulation of the phase-variable 30-Hz signal.

Softkey 12: CARRIER/CARR. F

Dual function for entering the frequency and modulation of the subcarrier.

Softkey 13: MOD FM

Entry of the frequency deviation for the FM modulation of the subcarrier.

Softkey 14: AUX/AUX F

Dual function for entering the frequency and modulation of the auxiliary tone.

Softkey 15: DIRECT.

Softkey with toggle function for switching over the direction TO/FROM. If TO is inverted the internal phase is additionally shifted by 180°. This does not affect display of the phase.

4.4 ILS Menu

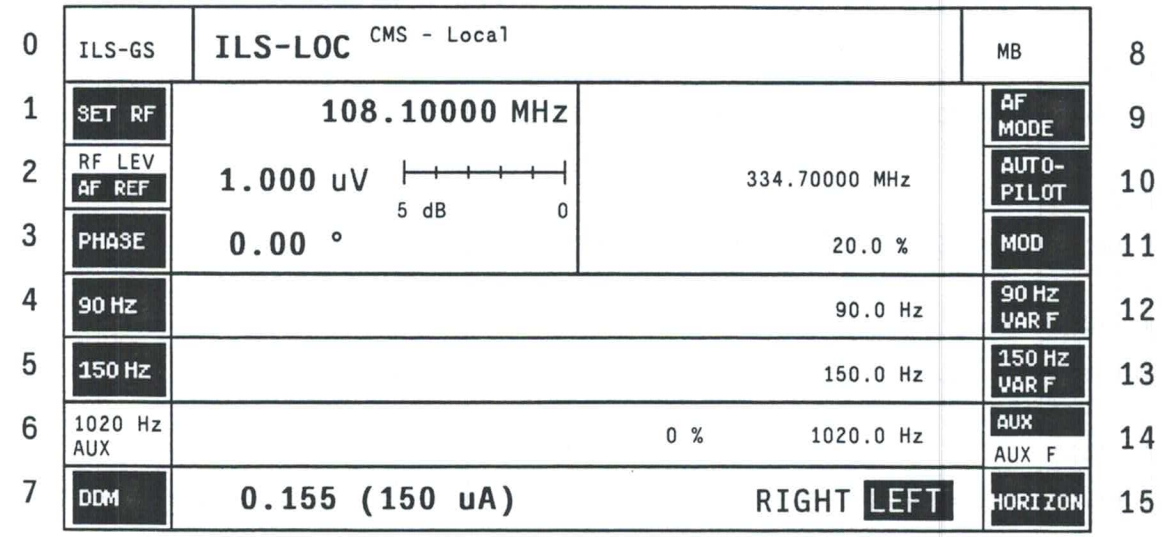


Fig. 8 ILS-LOC menu

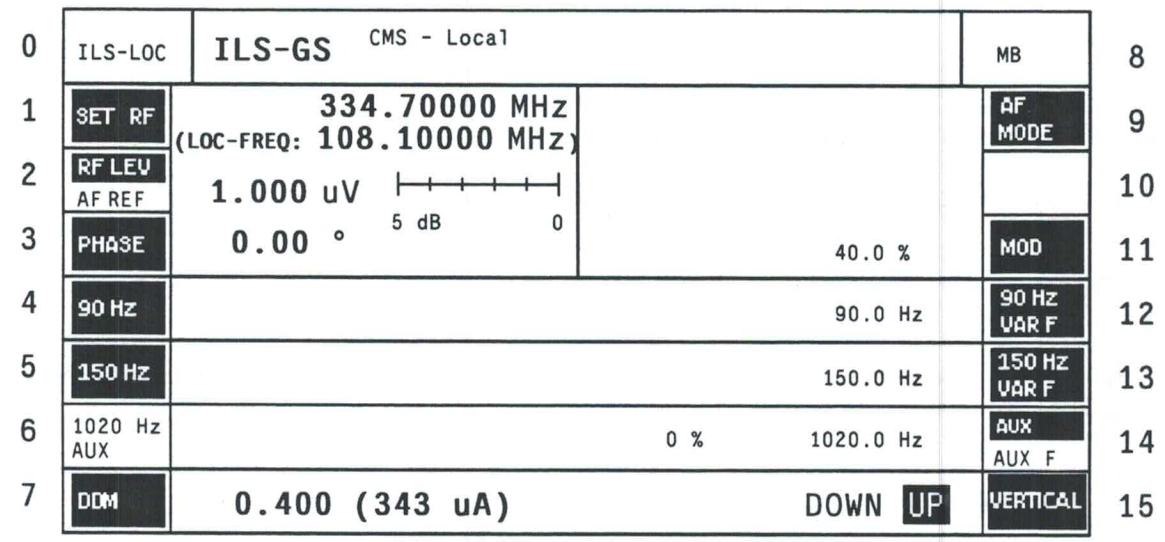


Fig. 9 ILS-GS menu

The two menus ILS-LOC and ILS-GS are identical concerning arrangement and function, except for softkeys 0 and 15 which are labelled differently. The default parameters are, however, different.

The ILS-LOC and ILS-GS RF frequencies are allocated in pairs (cf. table 1, page 19). When changing these frequencies via softkey 1, the new allocated frequency is used when entering the respective other menu. The allocated LOC frequency is additionally displayed in the ILS-GS menu.

The frequency ratio of the ILS signals "90 Hz" and "150 Hz" is always 3/5. Thus, changing the frequency of one signal automatically changes the frequency of the other signal proportionally. Both signals are phase-locked. The phasing is set using the PHASE parameter.

Softkey 3: PHASE

This function is used for setting the phase between the 90-Hz and the 150-Hz signals. The entry is made using `Softkey 3/number/ENTER`.

Softkey 4: 90 Hz

This softkey enables the 90-Hz tone. It is active, when the field is inverted.

Softkey 5: 150 Hz

This softkey enables the 150-Hz tone. It is active, when the field is inverted.

Softkey 6: 1020 Hz AUX

This softkey enables the auxiliary tone. It is active, when the field is inverted.

Softkey 7: DDM

This function is used for entering the modulation difference between the 90-Hz signal and the 150-Hz signal.

DDM = (90-Hz modulation - 150-Hz modulation) / 100% with RIGHT or DOWN

DDM = (150-Hz modulation - 90-Hz modulation) / 100% with LEFT or UP

Calculation of the modulation of individual tones:

90-Hz modulation = MOD + / (-) DDM/2 * 100 % with RIGHT or DOWN (with LEFT or UP)

150-Hz modulation = MOD - / (+) DDM/2 * 100 %

Rotating the VAR spinwheel calls the subsequent table of values for the localizer and the glide slope, respectively. DDM can be varied in positive and negative direction.

ILS-LOC		ILS-GS	
0.000	(Course Line)	0.000	(Glide Path)
± 0.046		± 0.045	
± 0.093		± 0.091	
± 0.155	(Course Sector)	± 0.175	(Glide Sector)
± 0.200		± 0.400	

The current corresponding to the DDM value (in µA), which is used for calibration of conventional moving-coil instruments, is indicated in brackets after the DDM value. Being useful for servicing purposes (adjustment works) only, the current is output exclusively on the display and not via IEC bus or in the autorun report.

Softkey 10: AUTOPILOT (with option CMS-B38 only)

This softkey appears only when the CMS is fitted with a second RF output. On pressing this softkey a modulated glide-slope signal is made available provided option CMS-B38 is built in. In this case, the frequency setting appears next to softkey 10 as shown in Fig. 8. A glide-slope signal is output and displayed only if the localizer frequency to be entered by means of softkey 1 corresponds to a standard value in Table 1. If a new standard frequency is selected with softkey 1 via the rollkey or directly entered, the glide slope frequency varies in line with the standard (Table 1). If a frequency is selected out of the standard range, the glide-slope signal is switched off. This state is indicated on the display by the symbol "----".

The modulation of the glide slope synthesizer is carried out together with the localizer frequency using softkeys 11 to 13. The specifications of the GS synthesizer (as shown on Fig. 9) do not apply to option CMS-B38.

The softkeys 11 to 14 are used for entering the frequency using `Softkey/number/dimension or ENTER` and for entering the modulation using `Softkey/number/% or ENTER`. The modulation is displayed in percent.

Softkey 11: MOD

This function is used for setting the modulations of the 90-Hz signal and the 150-Hz signal. MOD indicates the arithmetic average of the modulation of the two signals.

MOD = (90-Hz modulation + 150-Hz modulation) / 2

Softkey 12: 90 Hz VAR F and Softkey 13: 150 Hz VAR F

These functions are used for setting the frequencies of the 90-Hz signal and the 150-Hz signal.

Softkey 14: AUX/AUX F

Dual function for entering the frequency and the modulation of the auxiliary tone.

Softkey 15: L/R (ILS-LOC) or U/D (ILS-GS)

Softkey with toggle function for converting the modulation of the 90-Hz and the 150-Hz tones.

Menu / Tone	ILS-LOC	ILS-GS
90 Hz	RIGHT	DOWN
150 Hz	LEFT	UP

Assigning the higher modulation to one of the two tones.

4.5 Marker Beacon Menu (MB)

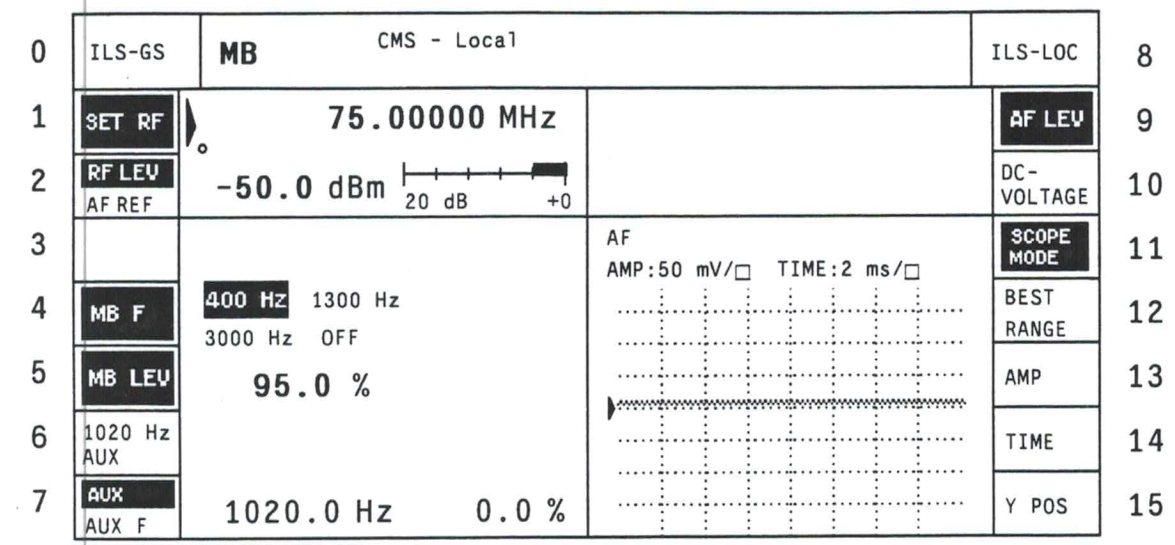


Fig. 10 MB menu

Softkey 4: MB F

This toggle function is used for selecting one of the three AF frequencies for the marker beacon. The tone is switched off in the OFF position.

Softkey 5: MB LEV

This funtion sets the modulation of the marker beacon tones. The entry is made using `Softkey/number/% or ENTER.`

Softkey 6: 1020 Hz AUX

This softkey switches on the auxiliary tone. It is active when the field is inverted.

Softkey 7: AUX/AUX F

This function is used for setting the modulation and frequency of the auxiliary tone. The frequency is entered using `Softkey 7/number/dimension or ENTER.` Entry of modulation is made using `Softkey 7/number/% or ENTER.`

Softkey 10: DC-Voltage

This function is not includet in the CMS 33.

Table 1 Standard frequencies of the RF carriers

VOR frequencies [MHz]			ILS frequencies paired		Marker beacon frequencies [MHz]
			LOCALIZER [MHz]	GLIDESLOPE [MHz]	
108.00	112.70	115.40	108.10	334.70	74.600
108.05	112.75	115.45	108.15	334.55	74.625
108.20	112.80	115.50	108.30	334.10	74.650
108.25	112.85	115.55	108.35	333.95	74.675
108.40	112.90	115.60	108.50	329.90	74.700
108.45	112.95	115.65	108.55	329.75	74.725
108.60	113.00	115.70	108.70	330.50	74.750
108.65	113.05	115.75	108.75	330.35	74.775
108.80	113.10	115.80	108.90	329.30	74.800
108.85	113.15	115.85	108.95	329.15	74.825
109.00	113.20	115.90	109.10	331.40	74.850
109.05	113.25	115.95	109.15	331.25	74.875
109.20	113.30	116.00	109.30	332.00	74.900
109.25	113.35	116.05	109.35	331.85	74.925
109.40	113.40	116.10	109.50	332.60	74.950
109.45	113.45	116.15	109.55	332.45	74.975
109.60	113.50	116.20	109.70	333.20	75.000
109.65	113.55	116.25	109.75	333.05	75.025
109.80	113.60	116.30	109.90	333.80	75.050
109.85	113.65	116.35	109.95	333.65	75.075
110.00	113.70	116.40	110.10	334.40	75.100
110.05	113.75	116.45	110.15	334.25	75.125
110.20	113.80	116.50	110.30	335.00	75.150
110.25	113.85	116.55	110.35	334.85	75.175
110.40	113.90	116.60	110.50	329.60	75.200
110.45	113.95	116.65	110.55	329.45	75.225
110.60	114.00	116.70	110.70	330.20	75.250
110.65	114.05	116.75	110.75	330.05	75.275
110.80	114.10	116.80	110.90	330.80	75.300
110.85	114.15	116.85	110.95	330.65	75.325
111.00	114.20	116.90	111.10	331.70	75.350
111.05	114.25	116.95	111.15	331.55	75.375
111.20	114.30	117.00	111.30	332.30	75.400
111.25	114.35	117.05	111.35	332.15	
111.40	114.40	117.10	111.50	332.90	
111.45	114.45	117.15	111.55	332.75	
111.60	114.50	117.20	111.70	333.50	
111.65	114.55	117.25	111.75	333.35	
111.80	114.60	117.30	111.90	331.10	
111.85	114.65	117.35	111.95	330.95	
112.00	114.70	117.40			
112.05	114.75	117.45			
112.10	114.80	117.50			
112.15	114.85	117.55			
112.20	114.90	117.60			
112.25	114.95	117.65			
112.30	115.00	117.70			
112.35	115.05	117.75			
112.40	115.10	117.80			
112.45	115.15	117.85			
112.50	115.20	117.90			
112.55	115.25	117.95			
112.60	115.30				
112.65	115.35				
VOR menu			ILS-LOC menu	ILS-GS menu	MB menu

Table 2 Presetting standard values

Parameter	Value displayed	Presetting Δ VAR
VOR, ILS-LOC, ILS-GS and MB menu:		
RF LEV	1 uV	0,1 dBm
AF REF	1 mV	0,1 mV
VOR menu:		
30 Hz VAR	ON	--
9960 Hz CARRIER	OFF	--
9960 Hz FM	ON	--
1020 Hz AUX	OFF	--
PHASE	0,00 °	10 °
VAR	30 %	0,1 %
VAR F	30 Hz	0,1 Hz
CARRIER	30 %	0,1 %
CARR. F	9960 Hz	1 Hz
MOD FM	480 Hz	1 Hz
AUX	20 %	0,1 %
AUX F	1020 Hz	1 Hz
DIRECT.	FROM	--
SET RF	108.0 MHz	cf. table 1
ILS-LOC and ILS-GS menu:		
PHASE	0 °	1 °
90 Hz VAR F	90 Hz	0,1 Hz
150 Hz VAR F	150 Hz	0,1 Hz
ILS-LOC menu:		
SET RF	108,10 MHz	cf. table 1
AUTOPILOT	334,70 MHz	with SET RF
90 Hz	ON	--
150 Hz	ON	--
1020 Hz AUX	OFF	--
DDM	0,000	cf. ILS menu, softkey 7 (DDM)
MOD	20 %	0,1 %
AUX	20 %	0,1 %
AUX F	1020 Hz	0,1 Hz
L/R	LEFT	--
ILS-GS menu:		
SET RF	334,70 MHz	cf. table 1
90 Hz	ON	--
150 Hz	ON	--
1020 Hz AUX	OFF	--
DDM	0,000	cf. ILS menu, softkey 7 (DDM)
MOD	40 %	0,1 %
AUX	5 %	0,1 %
AUX F	1020 Hz	0,1 Hz
U/D	UP	--
MB menu:		
SET RF	74,6 MHz	cf. table 1
MB F	400 Hz	--
MB LEV	95,0 %	0,1 %
1020 Hz AUX	OFF	--
AUX	5 %	0,1 %
AUX F	1020 Hz	1Hz

5 IEC-Bus Commands for VOR/ILS Signal Generator

VOR

Command	Data	Units	Function
VOR:AF	number	MV UV V	AF reference level
VOR:AF:VARIATION	number ON OFF	MV UV V	
VOR:AUX:FREQUENCY	number	KHz Hz MHz	Frequency setting of the
VOR:AUX:FREQUENCY:VARIATION	number ON OFF	KHz Hz MHz	auxiliary tone
VOR:AUX:LEVEL	number	PCT	Modulation of the
VOR:AUX:LEVEL:VARIATION	number ON OFF	PCT	auxiliary tone
VOR:AUX:TOGGLE	ON OFF		Auxiliary tone on/off
VOR:MOD:FM	number	KHz Hz MHz	Frequency deviation of subcarrier
VOR:MOD:FM:VARIATION	number ON OFF	KHz Hz MHz	
VOR:CARRIER:FREQUENCY	number	KHz Hz MHz	Frequency of subcarrier
VOR:CARRIER:FREQUENCY:VARIATION	number ON OFF	KHz Hz MHz	
VOR:CARRIER:TOGGLE	ON OFF		Unmodulated subcarrier on/off
VOR:CARRIER:LEVEL	number	PCT	Modulation of subcarrier
VOR:CARRIER:LEVEL:VARIATION	number ON OFF	PCT	
VOR:VAR:LEVEL	number	PCT	Modulation of the phase-variable signal
VOR:VAR:LEVEL:VARIATION	number ON OFF	PCT	
VOR:VAR:FREQUENCY	number	KHz Hz MHz	Frequency of the phase-variable signal
VOR:VAR:FREQUENCY:VARIATION	number ON OFF	KHz Hz MHz	
VOR:VAR:TOGGLE	ON OFF		Phase-variable signal on/off
VOR:MODFM:TOGGLE	ON OFF		Modulated subcarrier on/off
VOR:PHASE	number		Phase shift
VOR:PHASE:VARIATION	number ON OFF		
VOR:DIRECTION	TO FROM		Switchover TO/FROM

ILS Localizer

Command	Data	Units	Function
ILS:LOC:AF	number	MV UV V	AF reference level
ILS:LOC:AF:VARIATION	number ON OFF	MV UV V	
ILS:LOC:PHASE	number		Phase shift
ILS:LOC:PHASE:VARIATION	number ON OFF		
ILS:LOC:F90HZ:TOGGLE	ON OFF		90-Hz tone on/off
ILS:LOC:F90HZ:FREQUENCY	number	KHZ HZ MHZ	Frequency setting for the 90-Hz tone
ILS:LOC:F90HZ:FREQUENCY:VARIATION	number ON OFF	KHZ HZ MHZ	
ILS:LOC:DDM	number		DDM setting
ILS:LOC:DDM:VARIATION	number ON OFF		
ILS:LOC:MODULATION	number	PCT	Modulation of the 90-Hz-/150-Hz tone
ILS:LOC:MODULATION:VARIATION	number ON OFF	PCT	
ILS:LOC:AUTOPILOT	ON OFF		GS synth. on/off
ILS:LOC:F150 HZ:TOGGLE	ON OFF		150-Hz tone on/off
ILS:LOC:F150 HZ:FREQUENCY	number	KHZ HZ MHZ	Frequency setting for the 150-Hz tone
ILS:LOC:F150 HZ:FREQUENCY: VARIATION	number ON OFF	KHZ HZ MHZ	
ILS:LOC:AUX:TOGGLE	ON OFF		Auxiliary tone on/off
ILS:LOC:AUX:FREQUENCY	number ON OFF	KHZ HZ MHZ	Frequency setting for the
ILS:LOC:AUX:FREQUENCY:VARIATION		KHZ HZ MHZ	auxiliary tone
ILS:LOC:AUX:LEVEL	number	PCT	Modulation of the
ILS:LOC:AUX:LEVEL:VARIATION	number ON OFF	PCT	auxiliary tone
ILS:LOC:LEFTRIGHT	LEFT RIGHT		Higher modulation with DDM referred to 150-Hz tone (right) or 90-Hz tone (left)

ILS Glide Slope

Command	Data	Units	Function
ILS:GS:AF	number	MV UV V	AF reference level
ILS:GS:AF:VARIATION	number ON OFF	MV UV V	
ILS:GS:PHASE	number		Phase shift
ILS:GS:PHASE:VARIATION	number ON OFF		
ILS:GS:F90HZ:TOGGLE	ON OFF		90-Hz tone on/off
ILS:GS:F90HZ:FREQUENCY	number	KHZ HZ MHZ	Frequency setting for the 90-Hz tone
ILS:GS:F90HZ:FREQUENCY:VARIATION	number ON OFF	KHZ HZ MHZ	
ILS:GS:DDM	number		DDM setting
ILS:GS:DDM:VARIATION	number ON OFF		
ILS:GS:MODULATION	number	PCT	Modulation of the 90-Hz-/150-Hz tone
ILS:GS:MODULATION:VARIATION	number ON OFF	PCT	
ILS:GS:F150 HZ:TOGGLE	ON OFF		150-Hz tone on/off
ILS:GS:F150 HZ:FREQUENCY	number	KHZ HZ MHZ	Frequency setting for the 150-Hz tone
ILS:GS:F150 HZ:FREQUENCY: VARIATION	number ON OFF	KHZ HZ MHZ	
ILS:GS:AUX:TOGGLE	ON OFF		Auxiliary tone on/off
ILS:GS:AUX:FREQUENCY	number	KHZ HZ MHZ	Frequency setting for the
ILS:GS:AUX:FREQUENCY:VARIATION	number ON OFF	KHZ HZ MHZ	auxiliary tone
ILS:GS:AUX:LEVEL	number	PCT	Modulation of the
ILS:GS:AUX:LEVEL:VARIATION	number ON OFF	PCT	auxiliary tone
ILS:GS:UPDOWN	UP DOWN		Higher modulation with DDM referred to 150-Hz tone (down) or 90-Hz tone (up)

Marker Beacon

Command	Data	Units	Function
MB:AF	number	MV UV V	AF reference level
MB:AF:VARIATION	number ON OFF	MV UV V	
MB:FREQUENCY:TOGGLE	SEL_400 HZ SEL_1300 HZ SEL_3000 HZ OFF		AF frequencies of marker beacon (400 Hz, 1.3 kHz, 3 kHz or OFF)
MB:LEVEL	number	PCT	Marker beacon modulation
MB:LEVEL:VARIATION	number ON OFF	PCT	
MB:AUX:TOGGLE	ON OFF		Auxiliary tone on/off
MB:AUX:FREQUENCY	number	KHZ HZ MHZ	Frequency setting of the
MB:AUX:FREQUENCY:VARIATION	number ON OFF	KHZ HZ MHZ	auxiliary tone
MB:AUX:LEVEL	number	PCT	Modulation of the
MB:AUX:LEVEL:VARIATION	number ON OFF	PCT	auxiliary tone

Main menu		Submenu	
Index	Name	Index	Name
17	VOR menu	65	AF MODE
18	ILS-LOC menu		
19	ILS-GS menu		
20	MB menu		

6 Performance Test

6.1 Required Measuring Instruments and Accessories

Item No.	o Type of Instrument, Required Data • Recommended R&S Instrument	Type	Order No.	Application Section
1	o Modulation analyzer 70 to 350 MHz AM Distortion meter for the demodulated signal and external AF signals • Modulation Analyzer	FAM	334.2015.54	6.2.2
2	o RMS voltmeter (true RMS) 10 Hz to 20 kHz Resolution = 100 µV • RMS Voltmeter	URE	342.1214.02	6.2.6
3	o ILS test receiver for evaluation of the DDM			6.2.5
4	o VOR phase meter			6.2.3
5	o Oscilloscope			6.2.4

6.2 Testing the Rated Specifications

6.2.1 General Information

All the settings not stated below must be set to their preset values. Reset them by pressing the keys SHIFT and RESET.

6.2.2 AM Modulation and AM Distortion

The modulation analyzer is connected to the RF IN/OUT socket.

VOR:
-9 dBm, 113.0 MHz
Switch on the tones 30 Hz VAR, 9960 Hz CARRIER and 1020 Hz AUX separately. Measure the modulation and AM distortion.

ILS-LOC:
-9 dBm, 110.1 MHz
Switch on the tones 90 Hz, 150 Hz and 1020 Hz AUX separately. Measure the modulation and AM distortion.

ILS-GS:
-9 dBm, 332.0 MHz
Switch on the tones 90 Hz, 150 Hz and 1020 Hz AUX separately. Measure the modulation and AM distortion.

With AM modulation of the VOR- and ILS-signals, deviation from the nominal value must not be higher than 3 %. AM distortion may be max. 2 %.

MB:
-9 dBm, 70.0 MHz
Switch on the tones 400 Hz, 1300 Hz and 3000 Hz separately. Measure the modulation.

With AM modulation, deviation from the nominal value must not be higher than 5 %.

6.2.3 VOR Phase

The VOR phase meter is connected to the MOD GEN socket.

VOR:
AF REF = 2 V
The tones 30 Hz VAR and 9960 Hz FM must be switched on. The phase is measured at 0 °. Deviation must not be higher than 0.04 °.

6.2.4 ILS Phase

ILS-GS:
AF REF = 2 V
DDM = 0.000
PHASE = 120.00 °
Connect the oscilloscope to the MOD GEN socket. The input must be d.c. coupled. Set the time base, amplitude excursion and triggering such that the two lower amplitude peaks of the characteristic ILS signal are displayed optimally magnified on the screen (cf. fig. 11). With a phase shift of 0 ° and 120 ° the two peaks must be equally high. Otherwise the peaks can be made equally high by way of fine variation of the phase (VAR 0.1 °). Deviation from 0° and/or 120 ° must not be higher than ± 1 °.

Relevant detail

Fig. 11 ILS signal at the AF output (MOD GEN)

6.2.5 DDM Measurement at the RF Output with ILS Signals

RF LEV = -30 dBm
Both modulation tones 90 Hz and 150 Hz are switched on. Depending on the ILS test receiver used the DDM value is either directly measured or calculated using the selectively measured modulation depths of both tones.

The DDM value is obtained using the following formula:

DDM = (150-Hz modulation - 90-Hz modulation) / 100 %

ILS-LOC menu:
The DDM value may deviate from the displayed value by ± (3 % + 0.002 DDM).

ILS-GS menu:
The DDM value may deviate from the displayed value by ± (3 % + 0.004 DDM).

6.2.6 DDM Measurement at the AF Output with ILS Signals

AF REF = 3.5 V
The levels of the individual tones are measured at the MOD GEN output using the RMS voltmeter. The 90-Hz and 150-Hz tone are switched on separately.

The DDM value is obtained using the following formula:

$$DDM = (150\text{-}Hz\ level - 90\text{-}Hz\ level) / AF\ REF$$

In the ILS-LOC menu and ILS-GS menu the deviation from the displayed DDM value must not be higher than 3 % + 0.0002 DDM.

6.3 Performance Test Report

ROHDE & SCHWARZ Date .....

RADIOCOMMUNICATION SERVICE MONITOR CMS*) Name .....

Order. No. 840.0009*)

F. Nr. .....

*)for certain models

Item no.	Characteristic	Measure-ment to section	Min.	Actual	Max.	Unit
1	**AM modulation**	6.2.2				
	VOR:					
	30 Hz VAR					
	Modulation = 30 %		29.1	.....	30.9	%
	9960 Hz CARRIER					
	Modulation = 30 %		29.1	.....	30.9	%
	1020 Hz AUX					
	Modulation = 20 %		19.4	.....	20.6	%
	Modulation = 10 %		9.7	.....	10.3	%
	ILS-LOC:					
	90 Hz, DDM = 0.0					
	Modulation 20 %		19.4	.....	20.6	%
	150 Hz, DDM = 0.0					
	Modulation = 20 %		19.4	.....	20.6	%
	1020 Hz AUX					
	Modulation = 20 %		19.4	.....	20.6	%
	Modulation = 10 %		9.7	.....	10.3	%
	ILS-GS:					
	90 Hz, DDM = 0.0					
	Modulation = 40 %		38.8	.....	41.2	%
	150 Hz, DDM = 0.0					
	Modulation = 40 %		38.8	.....	41.2	%
	1020 Hz AUX					
	Modulation = 20 %		19.4	.....	20.6	%
	Modulation = 10 %		9.7	.....	10.3	%
	MB:					
	MB = 400 Hz					
	MB modulation = 95 %		90.25	.....	99.75	%
	MB = 1300 Hz					
	MB modulation = 95 %		90.25	.....	99.75	%
	MB = 3000 Hz					
	MB modulation = 95 %		90.25	.....	99.75	%

Item no.	Characteristic	Measure-ment to section	Min.	Actual	Max.	Unit
2	**AM distortion**	6.2.2				
	VOR:					
	30 Hz VAR		---	.....	2	%
	9960 Hz CARRIER		---	.....	2	%
	1020 Hz AUX					
	Modulation 20 %		---	.....	2	%
	Modulation 10 %		---	.....	2	%
	ILS-LOC:					
	90 Hz		---	.....	2	%
	150 Hz		---	.....	2	%
	ILS-GS:					
	90 Hz		---	.....	2	%
	150 Hz		---	.....	2	%
3	**VOR phase**	6.2.3				
	Phase = 0 °		359.96	.....	0.04	°
4	**ILS phase**	6.2.4				
	Phase = 120 °		119	.....	121	°
5	**DDM (RF)**	6.2.5				
	ILS-LOC:					
	DDM = 0.0		-0.002	.....	0.002	---
	DDM = 0.04		0.0368	.....	0.0432	---
	ILS-GS:					
	DDM = 0.0		-0.004	.....	0.004	---
	DDM = 0.04		0.0348	.....	0.0452	---
6	**DDM (AF)**	6.2.6				
	ILS-LOC:					
	DDM = 0.0		-0.0002	.....	0.0002	---
	DDM = 0.2		0.1938	.....	0.2062	---
	ILS-GS:					
	DDM = 0.0		-0.0002	.....	0.0002	---
	DDM = 0.2		0.1938	.....	0.2062	---