0·01 – 26·5 GHz Programmable Sweep Generators 6300 series

- ☐ CW accuracy typically ±3 MHz
- ☐ Full band power accuracy to 0·4 dB including flatness
- ☐ Sweep accuracy typically ±20 MHz
- ☐ High resolution of 100 kHz frequency and 0·01 dB power
- ☐ Automatic calibration using private GPIB in 15 minutes
- ☐ Automatic integration with Automatic Amplitude Analyzer 6500 series
- ☐ Low harmonics of −40 dBc and spurious of −60 dBc
- ☐ Custom front panel control displays

The 6300 series is a new generation of microwave sweep generators covering the frequency range 0·01 to 26·5 GHz with sophisticated control and outstanding accuracy. Typically ±3 MHz single frequency accuracy is provided with power level accuracy including flatness of ±0·4 dB.

Utilising YIG-tuned oscillators for signal generation, the series has impressive specifications of −40 dBc harmonic level with subharmonics and spurious outputs at better than −60 dBc.

With inbuilt firmware for control of other instruments, the 6300 series is able to perform an automatic calibration and integration with the 6500-001 Automatic Amplitude Analyzer to provide complete scalar network analyzer systems. This sophistication offers features normally associated with an external GPIB controller and so reduces system costs in both hardware and program control.

Operation

The operating status is displayed on a large clear backlit LCD. Operational control is simplified by the use of soft keys located below the display. Configuration keys provide the basic modes of operation: CW, levelled sweep, power sweep, power slope, etc., with the soft keys allowing parameters such as start and stop frequency, power level and sweep times to be changed readily.

Status information showing operating mode, calibration selected and GPIB status is displayed continuously with

additional status information easily accessible.

Change to a parameter can be made in 4 ways: Increments (e.g. channel spacing) using the up and down keys in predefined steps; using the rotary knob which provides small changes and is dynamically sensed so that fast rotation increases the rate of change; the numeric keypad and appropriate terminator (dBm, GHz, etc). Additionally, all functions and parameters may be controlled via the GPIB with exception of AC supply.

Display

The display can be arranged with user programming feature so that only data relevant to the particular test will be displayed. Any parameter available from the 6300 series can be positioned anywhere within the display field with up to a maximum of 11 parameters at any one time. This feature removes the restriction resident in fixed display sweepers and subsequently offers major improvements in operator efficiency with clear uncomplicated display of stimulus and status data.

Frequency sweep

In the levelled power F1-F2 and CF $\triangle$F modes the frequency is swept between the limits shown on the display. After a change to the frequency values, switching between the two modes is interactive so that the centre frequency is always defined as (F1+F2)/2 and F1−F2 = $\triangle$F. Both modes may be operated over the full 10 ms to 33·5 s sweep rates. The frequency accuracy at 100 ms or greater is maintained at ±30 MHz (±10 MHz typical). Sweep widths down to 500 kHz permit detailed examination of channel performance.

In the CW mode, the frequency is held at the value of CF within an overall accuracy of ±10 MHz (±3 MHz typical). A filter circuit is provided which reduces the incidental FM in the microwave output. Fine tuning with vernier (set on the rotary control) provides frequency adjustment to 10 kHz over any 20 MHz range. The power output is calibrated with overall accuracy including flatness of ±0·4 dB with a resolution of 0·01 dB.

The 6300 sweepers incorporate Digital Sweep. When used under GPIB control this provides improved measurement accuracy due to precise triggering. Using Digital Sweep in ATE systems it is possible to step through, say, 400 spot frequencies in typcally less than 100 ms.

Power sweep

The configuration keys also allow swept power measurements to be made. In the power sweep mode the values of P1 and P2 are independently adjustable and calibrated over the range −5 to +10 dBm (+7 dB from 18 to 26·5 GHz) with 0·01 dB or 100 μW resolution at the frequency defined by CF. The accuracy in this range is ±0·4 dB (±0·5 dB from ·01 to 2 GHz) with power sweep linearity of 0·1 dB typical. Dynamic range of power sweep is 25 dB from maximum output power. Sweep time is defined using TIME control. In the CF −$\triangle$F and F1 − F2 modes power control is via P1 and slope parameters defined as dB/GHz.

Status

The display is used with shifted functions STATUS 1, STATUS 2, SWP/TRG and $\triangle$ keys to reveal the current auxiliary control functions. Soft keys are assigned to amend them where required. The $\triangle$ key sets the increments for frequency, power in mW and dB and sweep time.

The SWP/TRG key displays and allows control of the sweeper trigger conditions for internal, auto, line external or single shot sweep. An external counter can also be set to read at F1, F2 or markers. A cable assembly is available as an accessory for connection to the 2440 or 2442, 20 GHz or 26·5 GHz Microwave Counters.

The STATUS 1 key reveals settings and allows control of ALC from internal or external sources, sets the blanking and also the internal amplitude modulation. This may be set to frequencies in the range 1·0 to 100·0 kHz including 27·8 kHz for modulated scalar systems.

The STATUS 2 key displays and allows front panel control of the private and system GPIB addresses. A contrast control allows adjustment of the display for the most convenient contrast for particular viewing angles. On-board clocks keep track of operating hours. A resettable clock allows real time and date to be displayed and also elapsed hours.

RF generation

Fundamental YIG tuned oscillators provide low harmonic and sub-harmonic outputs. These are kept running for stability and are switched using a fast low loss attenuator and PIN switch so that the band switch delay is typically only 0·5 μs. The levelling circuit is a wideband coupler and detector diode.

The input to the YIG driver circuits is summed from digital to analog converters whose digital input is derived from calibration data points and correction details for YIG lag and other error effects. This enables 6310 series to provide the output frequency with accuracy of typically ±20 MHz at any point during the sweep, even at rates up to 100 ms.

The FM input allows direct access to the YIG oscillators so that external frequency locking equipments may be used.

A separate RF on/off key with LED status lamp is provided. Unlevelled operation is identified on the display.

Option −621 provides rear panel RF output and levelling connectors without degradation of RF performance.

Ease of calibration

Digital control of the RF generation system means that simple-to-operate automatic calibration is possible. Unlike older sweeper designs where recalibration involved numerous internal adjustments, the 6300 series may be calibrated in about 15 minutes without the need to remove any covers.

Using its private GPIB facility the sweeper controls a 6960 RF Power Meter and 2442 26·5 GHz Microwave Counter to make the necessary measurements. Clear instructions to the operator are provided by the LCD. This procedure achieves a power accuracy of ±0·4 dB and typical CW frequency of 3 MHz.

The 6300 series can store up to five sets of calibration data. These stores are labelled Primary, User 1, User 2, Limited 1 and Limited 2. Prior to delivery the instrument is

calibrated and the calibration data stored in the Primary store. The four User and Limited stores are available for special-purpose applications, for example calibration at elevated temperatures commonly found in an equipment rack or calibration at the output of an amplifier, filter, cable or autotester.

The User calibration routine performs a full frequency and power calibration over the entire frequency band of the instrument. The Limited calibration feature allows the user to calibrate power over any specified frequency range. This is particularly useful when the user wishes to perform a calibration referred to the output of a frequency selective device such as a filter or narrowband amplifier.

Access to the User and Limited calibration routines and selection of the current calibration store is restricted by the use of an authorisation code.

If required the user may transfer the calibration data from User 1 or User 2 stores to the Primary calibration store thus enabling him to perform the periodic instrument calibration without the 6300 leaving the site. Transfer is achieved after entering a second calibration authorization code. By restricting knowledge of this code to the relevant person or department the calibration integrity of the 6300 may be preserved.

Other power and frequency measuring instruments may be used with the software support pack provided for 6300 with the 6500 systems and a GPIB controller. This also allows a dump to a printer for a hard copy of performance data before and after calibration.

Memories

Up to 20 memories may be defined by the user for complete sweeper settings. The memory contents are held for at least 10 years. The memories can be viewed for each setting (and default setting) before selection by using the rotary or increment keys. This allows the user to review the values that are stored in each memory whilst the RF is automatically turned off and without changing the current settings. Any memory setting may be chosen as the start-up mode reducing operator error and training time.

An alternate function allows easy swapping between the sweeper's current settings and those stored in one of the memories. These could be different frequencies, for example full-band and pass-band of a filter or frequency, and power sweeps of an amplifier, so that the effect of matching could be observed on both parameters.

Markers

Unlike older sweepers where only one marker frequency can be displayed at a time, the 6300 series' display allows all five marker frequencies to be seen simultaneously. By referencing each marker to a particular frequency, analysis of complex scalar measurements can be performed very efficiently.

In-band and out-of-band performance tests can be alternately made using the Marker Sweep facility between any two of the assigned frequency markers. To attain a higher resolution of frequency at the point of interest, a microwave frequency counter such as 2442 26·5 GHz Microwave Counter can be connected via rear panel sockets.

Time

Sweep times of 10 ms to 33.5 s are provided with calibrated power and frequency. Manual frequency setting and single sweep on trigger are also allowed. Three on-board clocks allow (factory set) total elapsed operating time; user resettable elapsed time and a user resettable real time.

User programming

The user may configure 6 separate operating and control modes together with display set ups using the PROG function. These are non-volatile and will remain for over 10 years. Comprehensive programming facilities allow the user to choose a basic operating mode of C.W., frequency and/or power sweep, then to re-configure the operator soft key controls and the 6300 series display.

For example, only operator control of power in a defined frequency sweep may be appropriate with a display of elapsed time showing the time spent in tuning up a circuit for optimum performance. The frequency may be hidden for security reasons or to avoid confusion. Other examples include displaying marker frequencies and sweep status together with primary frequency and power details.

The 6300 optional footswitch may be used to control any function assigned to softkey four. By using the PROG KEY editor any function may be assigned and thus brought under the footswitch control. One major application of this is that the alternate function may be operated by the footswitch thus allowing the operator to toggle between different sweep widths whilst using both hands to adjust a device.

Test

Access to the diagnostic parameters is via the user programming facility and allows the maintenance team access to the control circuitry for the microwave components should any problems develop. Self test routines check the operation of the microprocessor and its associated circuitry. The display provides diagnostic messages.

Scalar analysis system

The 6300 series with the 6500-001 Automatic Scalar Analyzer uses the private GPIB to provide an automatic test system. The sweep details are displayed on 6500 screen with 100 kHz frequencies resolution. With power sweep in the CW mode the P1 and P2 values are written to the horizontal scale so that testing of gain compression can be easily displayed. The graticule lines are positioned for convenient intervals. Frequency and sweep speed control can be either through 6500 or the sweeper.

The private GPIB provides enhanced facilities for an intelligent scalar analysis system. Frequency auto normalisation is provided if the sweep frequency is reduced over a narrower operating band. This avoids the need to set up new open/short calibration or through-line reference memories. The AUTO ZERO operation on 6500 appropriately controls the RF power on the sweeper. Digital plotting of 6500 display to HP-GL compatible plotters is available without a separate controller. A title can be written to screen using 6500 keys in a second function mode and then printed in PLOT mode. The title may be held in non-volatile memory. In addition time and date may

be output on plots.

A comprehensive test program (eg. with a large number of changes to the instrument settings) can be set up and stored within the 20 available non-volatile memories. When connected with the 6500 Scalar Analyzer via the private GPIB, all of the command data necessary to set up is downloaded for immediate execution simply by pressing the MEMORY key for the particular memory number or sequence of the test program. This feature can also be remotely commanded via the external GPIB, thereby creating savings in program generation and bus control time by the output of a simple bus command in place of a larger string of control data.

Using an external GPIB controller with a system bus, performance limit checking to complex masks is readily obtainable. Data and GPIB commands may be passed through the sweeper from 6500.

Up to 5 line markers may be displayed on the 6500 screen, selected via the sweeper or via the Analyzer Brightline cursor. △ marker facilities allow read outs of amplitude and frequency. Marker skip provides a simple way to measuring critical specification points.

FREQUENCY	
Range	See version number
Resolution	500 kHz in all modes. 10 kHz in CW vernier mode, manually (rotary control) and with GPIB control
Display	100 kHz in all modes
Accuracy at Cal. temp.	
F1 and CW 6310, II	±10 MHz, ±3 MHz typical
6313	±15 MHz ±10 MHz, ±3 MHz typical at 23°C ±5°C
CF, F2, sweep modes at 100 ms sweep or slower	±30 MHz, ±20 MHz typical
Stability	
With temperature	±1 MHz per °C typical. Total shift of no more than 60 MHz over 0–50 °C range.
With 10% supply voltage change:	10 kHz
With 10 dB power level change	±300 kHz over calibrated power range
With 3:1 load VSWR at +10 dBm output (+7 dBm 18 - 26.5 GHz)	
10 MHz – <2 GHz	±10 kHz typ ±100 kHz max
2 GHz – <8 GHz	±50 kHz typ ±500 kHz max
8 GHz – ≤12 GHz	±250 kHz typ ±500 kHz max
12 GHz – ≤20 GHz	±50 kHz typ ±500 kHz max
20 GHz - 26.5 GHz	±500 kHz max
With time at constant temp after 1 hour warm-up	±100 kHz max
RESIDUAL FM	In 10 Hz to 10 kHz bandwidth CW mode with filter On
10 MHz - 2 GHz	8 kHz peak typical, 10 kHz peak max
2 GHz - 8 GHz	6 kHz peak typical, 10 kHz peak max
8 GHz - 12 GHz	7.5 kHz peak typical, 10 kHz peak max
12 GHz - 20 GHz	10 kHz peak max
20 GHz - 26.5 GHz	10 kHz peak typical 15 KHz peak max
RESIDUAL AM	–50 dBc (in 100 kHz bandwidth.)
FREQ SWEEP CHARACTERISTICS	
Sweep time	Selectable between 10 ms and 33.5 s full band. Add 5 ms if the sweep crosses the bandswitch at 2 GHz
Resolution	1 ms
Displayed Resolution	3 digits
Sweep resolution	500 kHz for any span
MARKERS	Up to 5 markers, independantly adjustable and fully calibrated over the full sweep range, any one of which can be designated 'Reference marker'
Accuracy	±20 MHz typical, ±30 MHz at cal. temp
Resolution	0.025% (4096 points)
Marker output	TTL compatible output pulse for reference marker on rear panel auxillary connector

Marker sweep	RF output is swept between the designated reference marker and the stop marker, both of which can be any of the five available markers
Marker display	All marker frequencies can be displayed simultaneously. Delta marker shows the frequency difference between the reference marker and the stop marker
Marker depth	5 dB min
SPURIOUS SIGNALS	
Harmonics	10 MHz to 2 GHz –30 dBc 2 to 8 GHz –40 dBc typical –35 dBc worst case under all load conditions 8 to 26.5 GHz –40 dBc
Spurious	10 MHz to 2 GHz –40 dBc 2 to 26.5 GHz –60 dBc
OUTPUT POWER	Maximum levelled power at 23 deg ±5 deg C
10 MHz to 18 GHz	>10 dBm
18 GHz to 26.5 GHz	>7 dBm
POWER LEVEL ACCURACY*	Including flatness at 0 dBm in range 0 to 50°C.
Internally levelled	±0.5 dB (below 2 GHz) ±0.4 dB (2 - 26.5 GHz).
Externally levelled	Only dependent on coupler and detector used.
External levelling input	Detector of either polarity or power meter (0 to ±1 V)
Calibrated Power Range	-5 dBm to +10 dBm (10 MHz - 18 GHz) -5 dBm to +7 dBm (18 - 26.5 GHz)
Dynamic Range	25 dB below maximum output power
Displayed range	–15 to +20 dBm (31 μW to 100 mW)
Resolution over calibrated power range	0.01 dB or 100 μW
POWER STABILITY WITH TEMPERATURE	
0.01 – 2 GHz	0.05 dB/ deg C
2 – 26.5 GHz 6310/II	
0 to 20°C	0.02 dB/ deg C
20 to 40°C	0.04 dB/ deg C
40 to 50°C	0.08 dB/ deg C
6313	
0 to 20°C	0.1 dB/ deg C, 0.09 dB/ deg C typical
20 to 30°C	0.08 dB/ deg C, 0.07 dB/ deg C typical.
30 to 50°C	0.06 dB/ deg C, 0.05 dB/ deg C typical.
POWER SWEEP CHARACTERISTICS	
Displayed Units	Power levels can be displayed in dBm or linear units (mW/μW)
Power Sweep Range	P1 & P2 are independently adjustable and calibrated over the range –5 to +10 dBm

	(−5 to +7 dBm from 18 to 26 5 GHz)
Displayed Range	−15 to +20 dBm (31 μW to 100 mW)
Accuracy*	At 0 dBm at Calibration Temperature.
10 MHz – <2 GHz	±0 5 dB
2 GHz – <26.5 GHz	±0 4 dB
Linearity	0 1 dB typical, 0 2 dB max
Sweep Time	Selectable between 10 ms and 33 5 s.
Resolution	1 ms.
Displayed resolution	3 digits
Power slope	
Slope range	0 dB/GHz to 20 dB/GHz power over calibrated range
Accuracy*	At 0 dBm at Calibration Temperature
10 MHz – <2 GHz	±0 5 dB
2 GHz – <26 5 GHz	±0 4 dB
Linearity	0 1 dB typical, ±0 2 dB max
Time	As for frequency sweep

MODULATION

Internal Square Wave AM	
Frequency Range	1 0 to 100 kHz
Accuracy	±0·05%
Resolution	0·1 kHz up to 32·5 kHz 1 KHz 32·5 KHz to 100 KHz
Depth	
10 MHz – <2 GHz	−55 dBc.
2 GHz – <12·5 GHz	−60 dBc
12·5 GHz – <26·5 GHz	−45 dBc
Rise and fall time (10% to 90%)	0·5 μS

EXTERNAL PULSE AM

Frequency Response	DC – 100 kHz
Depth	As internal square wave AM
Rise and fall time (10% to 90%)	As internal square wave AM

EXTERNAL AM

Frequency response	DC – 100 KHz
Input Impedance	10 KΩ
Dynamic Range	25 dB

EXTERNAL FM

Deviation	50 MHz peak to peak 25 MHz peak to peak at 1 MHz rate
Sensitivity	−6 MHz (±1 MHz) per Volt
Input impedance	10 kOhms nominal

OUTPUT CONNECTOR

6310	Type N (female) precision 50 ohm.
6311	Type N (female) precision 50 ohm.
6313	Type MPC 3 5 (female) precision 50 ohm.
Reverse input power	100 mW max

Source VSWR

10 MHz – <2 GHz	2 0 1 max
2 GHz – <12 GHz	1 25 1 typical 1 5 1 max
12 GHz – <20 GHz	1 4 1 typical, 1 7 1 max
20 GHz – 26 5 GHz	1 7 1 max

AUXILIARY OUTPUTS

1 V/GHz Accuracy	
10 MHz – <2 GHz	±0 3 V
2 GHz – 21 GHz	±10%
Sweep Output	0 – 10 V ±2 mV

GPIB INTERFACE

System and private buses. All functions except supply switch are remotely programmable

Capabilities

SYSTEM

Complies with sub-sets SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0 and E2 as defined by IEEE 488 – 1978 and IEC 625-1

PRIVATE

Controller function provided for connection of 6500-001 Automatic amplitude analyser, 2440 20 GHz microwave counter, 2442 26·5 GHz microwave counter, 6960A or 6960-001 RF power meters and digital plotter. INIT softkey provides bus initialisation at any time.

ENVIRONMENTAL

Safety — Complies with IEC 348

RATED RANGE OF USE

Temperature — 0 to 50 deg C.

CONDITIONS OF STORAGE AND TRANSPORT

Temperature	−40 to +70°C
Humidity	Up to 90% RH
Altitude	Up to 2500 m (pressurized freight at 27 kPa differential i e 3 9 lbf/sq in)

POWER REQUIREMENTS

Voltage ranges (switchable)	105 to 120 V AC 210 to 240 V AC.
Frequency range	45 to 400 Hz
Consumption	300 W max. 580 VA max
Radio Frequency Interference	Conforms to the requirements of EEC. Directive 76/889

DIMENSIONS AND WEIGHT (excluding handles and feet)

Height	Width	Depth	Weight
133 mm (5 2 in)	433 mm (17 1 in)	485 mm (19 1 in)	15 Kg (33 lb)

GENERAL

Display	Contrast of liquid crystal display can be adjusted for viewing angle convenience
RF blanking	RF can be blanked or present during sweep retrace using STATUS 1 functions and can be blanked or present during parameter alteration using the 'rf_on' parameter which is available using the PROG key editor
Counter trigger	Provides a TTL drive for counter trigger and hold on F1, F2, CF and reference marker. Use connector number 06310-176F for connection to the 2442 26 5 GHz microwave counters
Stop sweep	Holds up sweep with TTL drive (eg from counter until valid count obtained)
Non-volatile memories	Up to 20 complete test set-ups may be stored for up to 10 years including those on 6500-001 when connected on the private GPIB Memories and default settings may be reviewed with RF power off
Start up mode	Any memory or preset default or power-down settings may be chosen for power up conditions
Alternate sweep	Allows operation to toggle between current setting and any memory with RF on
Digital sweep interface	Provides a means by which the RF output is swept over a range of discrete values, with each individual step being controlled by a digital signal. The SYSTEM GPIB interface is the only connection required. Sweep conditions are set up in advance using a number of GPIB commands. Thereafter Group Executive Trigger (GET) is sent over the GPIB to the sweeper to step to the next position. This has advantages in fast ATE applications where it is required to step the RF output faster than can be achieved by sending new, explicit values of frequency or power over the GPIB
Clocks/calender	Selection of DATE allows the user to set/display the current date in the format HH MM SS DD MM YYYY. If a 6500 and digital plotter are connected to the private GPIB the date may be plotted in the bottom right hand corner of the scalar analysis plot