

## 2966 Series

2966 Series is based on the 2965 with the additional capabilities of digital radio testing. The current platform offers a package with both analog and GSM in a single unit with diagnostic as well as go/no go testing capabilities. Users familiar with the 2965's analog testing will find that the digital tests follow a very similar structure, reducing the training and increasing the familiarity with the product.

## 100 kHz to 1 GHz Radio Test Set



### Applications for Radio Test Sets

	2945	2946	2955	2957	2960	2965	2966
Research & Development	■ ■	■ ■	■	■	■	■ ■ ■ ■	■ ■ ■ ■
Production (Final Test) radios	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■ ■ ■ ■	■ ■ ■ ■ ■ ■
Production (Module Test) radios	■ ■	■ ■	■	■	■	■ ■ ■ ■ ■ ■	■ ■ ■ ■ ■ ■
Production (Base Stations)	■	■	■	■	■	■ ■ ■ ■ ■ ■	■ ■ ■ ■ ■ ■
Commissioning (Base Stations)	■ ■ ■ ■	■ ■ ■ ■	■	■	■	■ ■ ■ ■ ■ ■	■ ■ ■ ■ ■ ■
Maintaining Analog Radios	■ ■ ■ ■ ■ ■	■ ■ ■ ■ ■ ■	■ ■ ■ ■ ■ ■	■ ■ ■ ■ ■ ■	■ ■ ■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■
Maintaining Digital Radios	■ ■	■ ■	■	■ ■	■ ■	■ ■ ■ ■	■ ■ ■ ■ ■ ■
Maintaining Analog Base Stations	■ ■ ■ ■ ■ ■	■ ■ ■ ■ ■ ■	■ ■	■	■	■ ■ ■ ■ ■ ■	■ ■ ■ ■ ■ ■
Maintaining Digital Base Stations	■ ■ ■ ■	■ ■ ■ ■	■	■	■	■ ■ ■ ■	■ ■ ■ ■ ■ ■
Field Surveillance	■ ■ ■ ■ ■ ■	■ ■ ■ ■ ■ ■	■	■	■	■ ■ ■ ■ ■ ■	■ ■ ■ ■ ■ ■
Avionics Maintenance	■	■ ■ ■ ■ ■ ■	■	■	■	■ ■	■ ■

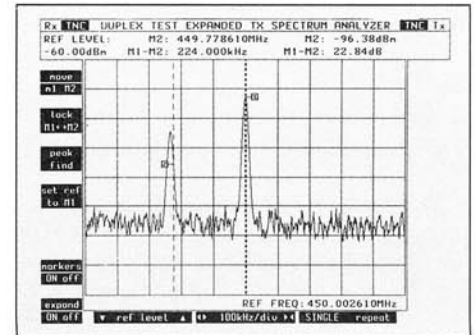
S  
nts

# 100 kHz to 1 GHz Radio Test Set

2965



measurement of level or frequency. A special autosest/autolevel control allows a signal to be placed in the centre of the screen at optimum level by one single key press.



- High performance, full span spectrum analyzer
- Tracking generator with variable level
- Fast analyzer for audio & modulation signals
- Large, bright CRT with fast high resolution graphics
- VGA colour monitor output
- Fast high resolution bar charts
- 500 kHz digital storage oscilloscope
- Built-in analog cellular standards
- Digital option for GSM and future systems
- PC compatible memory card and Autorun capability
- Fast, high performance signal generator
- Small lightweight package with compact footprint
- Built-in multimeter
- Comprehensive LF generators, with up to 6 sources
- Accurate broadband power meter from 1 mW to 150 W
- Selective power meter with 2  $\mu$ V sensitivity
- RS-232, IEEE 488.2 and Centronics interfaces
- Colour coded keyboard for ease of use
- Comprehensive filter capabilities
- Screen expand modes for more detailed displays
- English, French, Spanish and German versions

The 2965 Radio Test Set is the first in a new range of Radio Test Sets designed to address the needs of the 1990's. These needs include test capability for GSM and will cater for new emerging digital standards in future versions. As well as the new digital standards the 2965 includes all major analog cellular, trunking and PMR standards internally. Performance is uncompromised. The 2965 meets many of the requirements that previous test sets were unable to address, including applications where performance, speed and ease of use are essential.

The 2965 retains many of the familiar attributes of the 2955 – excellent price and performance, well proven ergonomics and broad range of applications and options. It includes many features that are not found in test sets selling for much higher prices. The design allows high speed of operation

and accuracy of results, allowing higher throughput and tighter limits to be set.

### STANDARD FEATURES

The 2965 follows the Marconi Instruments philosophy of offering a complete package with many of the features as standard and not as additional costly options.

### Spectrum Analysis

The 2965 includes RF and LF high performance spectrum analyzers with features that are normally only found on dedicated high performance spectrum analyzers.

The RF spectrum analyzer allows fast high resolution analysis of signals applied to either of the RF inputs over a very wide dynamic range including off-air signals. Facilities include flexible frequency setting, steerable markers for absolute or relative

The update rate is remarkable for this type of product, allowing real-time measurements on off-air signals.

The tracking generator provides a convenient method of alignment for filters and sub-modules. Synchronized mode of operation allows the operator to ensure that the generator frequency matches the analyzed signal.

The LF spectrum analyzer allows analysis of audio signals demodulated from RF or via the audio paths. Analysis is virtually real time and allows signals to be studied in much greater detail than previously available. Interference and intermodulation products can be analyzed and distortion observed at a range of frequencies and not limited to 1 kHz. The display update is very fast, so that results are real-time and alignment can be made with confidence.

### Comprehensive audio and modulation sources

Three LF generators are provided for audio stimulus along with three modulation sources — enabling the most complex signalling to be generated without the need for external oscillators.

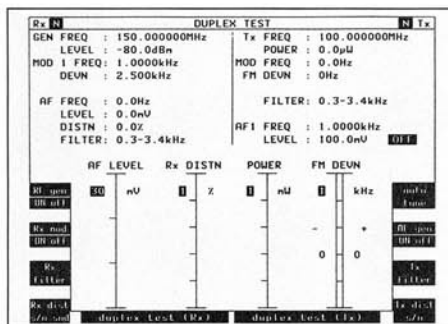
Modulation is included for all standard analog radios. Demodulation is also available with built-in filters for bandwidth limiting and weighting.

All major signalling protocols are included as standard to reduce the need for external encoders and decoders. User definable tones may be stored in non-volatile memory so that non-standard tone systems can easily be emulated.

### Large Bright Display

The man machine interface is a very important part of the 2965 operational philosophy. As no two human operators are identical, the 2965 is designed to allow intuitive operation to obtain the result required.

## 2965



The large, bright, high resolution screen with its 22 associated soft keys has significant benefits for automated as well as manual testing. Functions may be accessed directly from the soft keys, avoiding the need for complex menus and set-up screens. The fast update rates of the bar-graphs and other displays permit real time adjustments to be made. Any of the 2965 test screens can be called directly in programs and then used to simplify and speed up testing.

From switch on, the 2965 welcomes the user with features that make radio testing simple, fast and accurate.

### Selective Test Modes for Specific Tests

As the 2965 is designed to test radios and radio systems, several test modes have been designed to avoid compromising the different types of radio being tested.

The DUPLEX mode shows both transmit and receive paths so that any interaction can be observed. If one path needs closer examination, it may be selected without disturbing the other path. The use of soft keys around the display means that complex menus and set-ups are avoided in a particular test mode and only the relevant keys need to be displayed – this leaves more space on the screen for the measurements and settings, leading to a clear unambiguous display.

The RF test mode is for testing repeaters and RF systems where it would not be necessary to gain access to the audio; this mode also allows access to the tracking generator. Likewise, the AF Test mode provides audio testing when the RF is not required.

### Comprehensive Cellular Testing

Testing of cellular and trunked radio is required at many stages in the life-cycle of a radio. For applications ranging from factory production through to repair and customer assurance, the test requirements vary considerably. Simple checks, through to a full performance test of all the important radio parameters, are required. The 2965 meets all these demands and is flexible yet easy to operate: fast yet thorough.

Although radios can be tested using 'maintenance' or 'test' modes, this does not ensure that the unit will work when on the radio system. Traditionally radios are tested under controlled system environments, but cellular and trunked radios require comprehensive signalling and tone protocols.

To meet this need, the 2965 provides 'cell site simulation'. This provides the signalling protocol that the radio would see from the real network. It is then possible to place and receive calls. This activates the receiver and transmitter, so that normal parametric measurements can be made. The signalling may also be verified, permitting faults and errors to be traced before releasing a phone on to the network.

All system options allow 'system definition' so that future changes and new country variants can be defined by the user: this means that equipment and software is futureproofed as far as possible.

There are four built-in test routines, ranging from simple call processing to comprehensive performance testing. Because each of the tests may be run in a variety of ways to suit individual requirements, the 2965 can offer a solution for every application using internally run routines.

Although automatic testing offers a quick and simple solution to routine radio testing, it is not always suitable for trouble shooting. For this reason a manual testing mode is included, allowing tests to be repeated or varied to solve faults. There are also data displays showing the overhead messages to and from the radio. The displays are based as closely as possible on the air specifications and use the same nomenclature. Errors are indicated in reverse video and with an indicator beside the corrupted messages. To simplify the display, repetition of words are shown as a single message with a repeat count. Displays may be copied to any suitable printer, making it easy to report back problems to a central authority.

### Programming

Where larger service centres are automating testing in an attempt to pre-empt field failures, the control capabilities and Autorun facilities of the 2965 make the instrument very attractive. Programs can be written in an interpreted form of BASIC by the user and stored inside the instrument. Additional programs can be downloaded via the memory card interface or one of the other interfaces.

Speed is important in all aspects of testing, particularly in automatic control.

2965 allows multi-tasking for parallel measurements to be made enhancing its speed further.

### Size and Weight

Not only does the 2965 pack the performance you would normally see on a bench full of instruments, it weighs in at under 18 kg (39.5 lb) so is also portable when the need arises. It is also rugged and will withstand the kind of environment found in the harshest of field applications.

### Results Storage

Results may be stored in a number of ways. The internal memory allows a number of sets of results to be stored in non-volatile memory. When this is insufficient, they may be transferred to the PC compatible memory card or sent via the RS-232 or parallel interface to a printer. The memory card meets the JEIDA 4/PCMCIA2 standard for standardization of memory card formats. This means that information can be transferred easily to computers with card readers and subsequently information can be gathered or distributed.

### APPLICATIONS

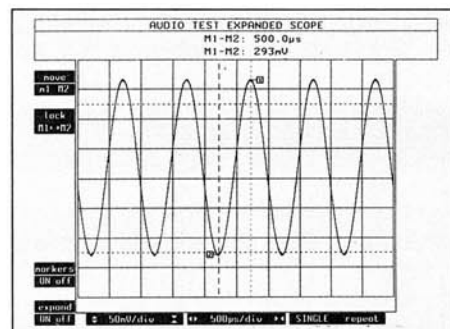
#### Base Stations

Because many base stations are co-sited with other transmitters the problems of out of band radiation and intermodulation products are very important to control. Most are multi-channel and operate in full duplex, which requires the use of combiners, duplexers and filters.

The quality spectrum analyzer with tracking generator will greatly facilitate base station testing. The sensitivity of the receiver also allows remote monitoring and field strength measurements to be taken. The 2965 is light enough and small enough to be easily carried on-site.

The 2965 has been designed with modern digital radio in mind and therefore includes: wide modulation bandwidths, DC FM and AM and continuous coverage up to 1 GHz.

Comprehensive audio waveform generation and analysis facilities are included for use with modems, speech processors, filters and tone encoders.



The inclusion of a 500 kHz DSO (Digital Storage Oscilloscope) allows audio and demodulated signals to be analyzed including sequential tones. The multimeter function completes the picture. Although DVMs are not expensive, this one benefits from being always ready for action, can be included in any automatic programs and is not lost when out on site.

### Production

Modern production facilities for mobile radio equipment fall into two classes – fully automated and fully de-skilled. In the former case, remote control is of primary importance. The use of IEEE-488.2 commands and syntax, multi-tasking and high speeds make the 2965 ideal. In the latter case the ease of use, the Autorun capability, the small footprint and the low capital outlay per work station make it very attractive. Much attention has been paid to the speed of the graphic displays such as the oscilloscope, both spectrum analyzers and the bar charts. All have update rates and latencies fast enough for manual adjustments and insignificant operator idle time.

### Quality Assurance

Quality assurance is an area normally associated with production, however with increasing exports of mobile radio equipment around the world the need for acceptance testing and quality audits remote from the production facility becomes evermore likely. It is essential in these situations that the tests be performed with equipment comparable to that used in production. It is often the case however that these remote centres are poorly funded and therefore the price/performance of the instrument is a key issue.

### Research and Development

The use of test sets in R&D has traditionally been discounted on grounds of performance. There are advantages in using test sets in R&D for their completeness. This has the benefit of the production test systems being based on similar instruments. The 2965 with its spectrum analyzer and high performance signal generator is ideal for use in such laboratories. The concept of the RF multimeter applies with portability and can easily be used off-site during trials and trouble-shooting.

### Surveillance

Although only a small market, the needs for this market are growing. The basic tools of this trade are the spectrum analyzer and receiver. The 2965 combines both these requirements and even allows the spectrum analyzer marker to be used as a

tuning device. It is then possible to listen to the selected signal in between the analyzer sweeps.

### Military

The capabilities of the 2965 allow a wide range of military AM, FM & SSB radio equipment to be tested, including systems using tone signalling. High power handling capability (up to 150 W) saves the need for external power attenuators when testing vehicle radios.

### Analog Cellular

2965 has optional software for all major analog systems. It retains the ease of use and comprehensive test capability that the 2955 series set in the 1980's.

### Digital radio communication

The needs of this market are dominated by the burst nature of the signals and the precision of the modulation required. For distortion and sensitivity measurements, PRBS and bit error ratios replace the familiar 1 kHz tones. The 2965 has been designed to cater for these emerging technologies with synchronization, communication interfaces and clocks built-in for future digital systems. The oscilloscope can be used for bit level analysis of the signals and triggering capabilities allow power control measurement to be quantified.

An optional digital systems card is offered for the 2965 which adds the necessary hardware and computing power to cope with GSM and future digital systems inside the instrument.

## SPECIFICATION

Certain characteristics are shown as typical. These provide additional information for use in applying the instrument but they are unwarranted.

(Applies to version 5.10 and above)

### RF SIGNAL GENERATOR

#### FREQUENCY

**Range**  
100 kHz to 1 GHz, usable to 1.1 GHz.

**Resolution**  
1 Hz.

**Indication**  
10 digit display.

**Setting**  
Keyboard entry, delta increment/decrement function and rotary variable control.

**Accuracy**  
As frequency standard.

#### OUTPUT LEVEL

**Range**  
Rx Test and 2 port Duplex modes:  
N-Type socket: -135 dBm to -7 dBm (-17 dBm with AM).  
TNC socket: -115 dBm to +13 dBm (+3 dBm with AM).

One-port duplex:  
N-Type socket: -135 dBm to -40 dBm.  
TNC socket: -115 dBm to -20 dBm.

**Resolution**  
0.1 dB.

**Indication**  
4 digits plus sign (dBm, dBμV, μV, mV PD/EMF).

**Accuracy**  
N-Type socket:  
±1 dB up to 500 MHz,  
±1.5 dB up to 1 GHz for levels above -120 dBm.  
±1.2 dB up to 1 GHz over the temperature range 15 to 35°C.

**Carrier On/Off**  
Keyboard operation, reduces signal generator output to less than -120 dBm.

**Reverse Power Protection**  
N-Type socket: With instrument switched on 150 W. Overload indicated by visual and audible warning.  
  
TNC socket: Protection up to 10 W. Reset available on removal of RF power. Excess power indicated by visual and audible warnings.

**Output Impedance**  
50 Ω nominal.

**VSWR**  
N-Type socket: better than 1.2 up to 500 MHz; better than 1.3 up to 1 GHz (typically 1.2).  
TNC socket: typically 1.3.

### SPECTRAL PURITY

**Residual FM (CCITT weighted)**  
Less than 6 Hz RMS up to 575 MHz.  
Less than 12 Hz RMS up to 1 GHz.

**Residual AM (CCITT weighted)**  
Less than 0.05% RMS.

**Harmonics**  
Better than -30 dBc for levels up to +7 dBm.

**Spurious signals**  
Better than -45 dBc for carrier frequencies from 100 kHz to 36 MHz;  
Better than -50 dBc for carrier frequencies above 36 MHz.

**SSB Phase Noise (20 kHz offset)**  
Better than -114 dBc/Hz up to 575 MHz;  
Better than -108 dBc/Hz up to 1 GHz.

**RF Carrier Leakage**  
Less than 0.5 μV PD generated at the carrier frequency in a 50 Ω load by a 2 turn loop 25 mm or more from the case with output level set to below -60 dBm and terminated in a sealed 50 Ω load.

### AMPLITUDE MODULATION – INTERNAL

**Frequency Range**  
100 kHz to 400 MHz, usable to 1.1 GHz.

**AM Depth Range**  
0 to 99%.

**Resolution**  
0.1%.

**Indication**  
3 digits.

**Setting**  
Keyboard entry, delta increment/decrement function and rotary variable control.

**Accuracy<sup>(1)</sup> (up to 85% AM)**  
±4% of setting ±1 digit for modulation frequency at 1 kHz.  
±6% of setting ±1 digit for modulation frequencies from 30 Hz to 20 kHz.

**Distortion**  
Less than 1% at 1 kHz for modulation depths up to 30%, CCITT weighted.  
Less than 2% for modulation frequencies from 100 Hz to 20 kHz and depths up to 85%.

**Modulation Frequency**  
Range: 20 Hz to 15 kHz for carrier frequencies up to 36 MHz; 20 Hz to 20 kHz for carrier frequencies up to 400 MHz.  
Resolution: 0.1 Hz below 10 kHz; 1 Hz below 20 kHz.

### AMPLITUDE MODULATION – EXTERNAL

**Input impedance**  
Nominally 1 MΩ in parallel with 100 pF.

## 2965

### Frequency Range

As internal AM.

### Modulation Frequency Range

As internal AM with AC or DC coupling.

### Accuracy

As internal  $\pm 2\%$ .

### Input Sensitivity

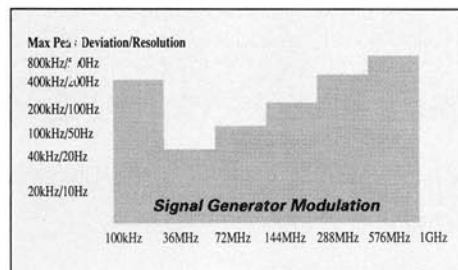
2.828 V pk-pk for indicated modulation depth.

### FREQUENCY MODULATION – INTERNAL

#### Frequency Range

100 kHz to 1 GHz, usable to 1.1 GHz.

#### Maximum Deviation



### Indication

4 digits.

### Setting

Keyboard entry, delta increment/decrement function and rotary variable control.

### Accuracy<sup>(1)</sup>

$\pm 3\% \pm 1$  digit at 1 kHz over the range 10-35°C (0.1% per °C outside this range).  
Typically  $\pm 3\% \pm 1$  digit for modulation frequencies from 20 Hz to 5 kHz.  
Typically  $\pm 7\% \pm 1$  digit for modulation frequencies from 5 kHz to 20 kHz.

### Distortion<sup>(1)</sup>

Less than 0.5% for modulation frequencies from 250 Hz to 5 kHz (for deviation 1 kHz to 800 kHz).  
Less than 1% for modulation frequencies from 50 Hz to 20 kHz (for deviation 1 kHz to 800 kHz).

### Modulation Frequency Range

20 Hz to 20 kHz.

### Resolution

0.1 Hz.

### FREQUENCY MODULATION – EXTERNAL

#### Input Impedance

Nominally 1 M $\Omega$  in parallel with 100 pF.

#### Frequency Range

As internal FM.

#### Modulation Frequency Range

DC to 100 kHz (DC coupled).  
10 Hz to 100 kHz (AC coupled).

#### Input Sensitivity

2.828 V pk-pk for indicated deviation.

#### Accuracy

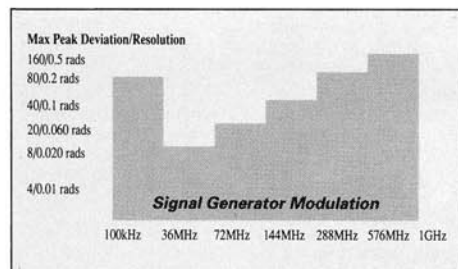
As internal  $\pm 2\%$  for frequencies up to 20 kHz.

### PHASE MODULATION – INTERNAL

#### Frequency Range

100 kHz to 1 GHz, usable to 1.1 GHz.

#### Maximum Deviation



### Indication

4 digits.

### Setting

Keyboard entry, delta increment/decrement function and rotary variable control.

### Accuracy

$\pm 5\% \pm 1$  digit for modulation frequencies from 250 Hz to 3.4 kHz, over the range 10-35°C (0.1% per °C outside this range).

### Distortion<sup>(1)</sup>

Less than 1% for modulation frequencies from 250 Hz to 5 kHz (for deviation 1 rad to 160 rads).

### Modulation Frequency

Range: 250 Hz to 5 kHz.

### Resolution

0.1 Hz.

### PHASE MODULATION – EXTERNAL

#### Input Impedance

Nominally 1 M $\Omega$  in parallel with 100 pF.

#### Frequency Range

As internal phase modulation.

#### Modulation Frequency Range

250 Hz to 5 kHz.

#### Input Sensitivity

2.828 V pk-pk for indicated deviation.

#### Accuracy

As internal  $\pm 2\%$ .

### INTERNAL MODULATION AND AUDIO SOURCES

Up to 6 tone sources can be assigned as 3 modulation generators and 3 audio tone generators.

#### Modulation Modes

Internal generators may be assigned to AM, FM,  $\emptyset$ M or SSB.

### AUDIO ANALYZER

#### AUDIO VOLTMETER

##### Input Impedance

Nominally 1 M $\Omega$  in parallel with 100 pF.

##### Frequency Range

DC and 20 Hz to 500 kHz.  
AC only 20 Hz to 500 kHz.  
Polarised DC less than 10 Hz.

##### Level Ranges

0-10, 0-30, 0-100, 0-300 mV, 0-1, 0-3, 0-10, 0-30 V RMS reading (autoranging or fixed).

##### Level Indication

4 digits and bar chart, volts.

##### Level Accuracy (DC Coupled)<sup>(2)</sup>

$\pm 2\%$  of reading  $\pm 1$  mV  $\pm$  resolution, DC and 100 Hz to 20 kHz.  
 $\pm 4\%$  of reading  $\pm 1$  mV  $\pm$  resolution, 40 Hz to 100 kHz.

##### Level Accuracy (AC Coupled)<sup>(2)</sup>

As DC coupled from 150 Hz upwards.

##### Residual Noise

100  $\mu$ V RMS CCITT weighted.

### AUDIO FREQUENCY METER

#### Range

10 Hz to 500 kHz.

#### Resolution

0.1 Hz from 10 Hz to 5 kHz.  
1 Hz from 5 kHz to 50 kHz.  
10 Hz from 50 kHz to 500 kHz.

#### Indication

6 digits.

#### Accuracy

As frequency standard  $\pm 1$  digit  $\pm$  resolution.

#### Sensitivity

On bar chart greater than 25% FSD.

### AUDIO SINAD METER

#### Frequency

1 kHz.

#### SINAD Range

5 to 50 dB.

### Resolution

0.1 dB for readings less than 20 dB.  
0.2 dB for readings less than 25 dB.

### Indication

3 digits and bar chart.

### Accuracy

$\pm 0.5$  dB  $\pm$  resolution.

### Sensitivity

100 mV for 46 dB SINAD.

### AUDIO DISTORTION METER

#### Frequency

1 kHz.

#### Distortion Range

0 to 30%.

#### Resolution

0.1% distortion for readings greater than 1%.  
0.2% distortion for readings less than 1%.

#### Indication

3 digits and bar chart.

#### Accuracy

$\pm 5\%$  of reading  $\pm$  resolution.

#### Sensitivity

100 mV for 0.5% distortion.

### AUDIO S/N METER

#### S/N Range

0 to 100 dB.

#### Resolution

0.1 dB for readings less than 50 dB.  
0.2 dB for readings less than 70 dB.

#### Indication

3 digits and bar chart.

#### Accuracy

$\pm 0.5$  dB  $\pm$  resolution.

#### Sensitivity

2 V for 60 dB, 200 mV for 40 dB.

### AUDIO OSCILLOSCOPE

#### Operating Modes

Single or Repetitive sweep.

#### Frequency Range

DC to 500 kHz.  
10 Hz to 500 kHz (AC coupled).

#### Glitch Catching

1  $\mu$ s minimum.

#### Voltage Ranges

2 mV/div to 10 V/div in a 1, 2, 5 sequence.

#### Voltage Accuracy

$\pm 5\%$  of full scale.

#### Timebase

5  $\mu$ s/div to 10 s/div in a 1, 2, 5 sequence.

#### Timebase Accuracy

As frequency standard.

#### Trigger Mode

Auto trigger.

#### Marker Indication

Level: M1, M2, M1-M2.  
Time: M1-M2.

#### Graticule

10 Horizontal by 8 Vertical divisions.  
Can be magnified to full screen.

### AUDIO FFT ANALYZER

#### Span Widths

50 Hz to 50 kHz in a 5, 10, 25 sequence.  
Above 40 kHz signals are attenuated by 80 dB/octave.

#### Graticule

10 Horizontal by 8 Vertical divisions.  
Can be magnified to full screen.

#### Level Reference (top of screen)

10 mV to 20 V, in a 1, 2, 5 sequence.

#### Level Accuracy

$\pm 0.3$  dB 100 Hz to 15 kHz; typically  $\pm 1$  dB 40 Hz to 40 kHz.

**Vertical Scaling**  
 10 dB/div.

**Dynamic Range**  
 60 dB.

**Marker Indication**  
 Level: M1, M2, M1-M2  
 Frequency: M1, M2, M1-M2.

**AUDIO BAR CHARTS**

Displays: AF voltage, SINAD, Distortion, S/N.  
 Vertical Resolution: 1% of full scale.  
 Ranging: Autoranging, range hold or manual selection (up/down), 1, 3, 10 sequence with hysteresis.

**AUDIO AND MODULATION FILTERS**

300 Hz Lowpass ( $\pm 0.1$  dB less than 150 Hz,  $\pm 0.2$  dB, 150-200 Hz relative to 100 Hz).  
 300 Hz to 3.4 kHz Bandpass ( $\pm 0.4$  dB, 400-2100 Hz relative to 1 kHz).  
 5 kHz ( $\pm 0.3$  dB at  $< 3$  kHz relative to 1 kHz).  
 20 kHz Lowpass ( $\pm 0.3$  dB at less than 12 kHz relative to 1 kHz).  
 CCITT Psophometric.  
 C-MESSAGE.  
 See also under Environmental-User Calibration.

**MULTIMETER**

**Input Terminals**  
 3 x 4 mm, 'Volt/ohm', 'Current' and 'Common'.

**Maximum Input Voltage**  
 375 V with respect to instrument chassis.

**VOLTMETER**

**Voltage Range**  
 0-300 V, 0-30 V, 0-3 V, 0-300 mV, Terminals, 'Volt/ohm' and 'Common', maximum crest factor 3:1 at range full scale.

**Frequency Range**  
 Polarized DC or 40 Hz to 1 kHz.

**Input Impedance**  
 Nominally 6 M $\Omega$  in parallel with 100 pF.

**Resolution**  
 0.1% of FSD.

**Accuracy**  
 $\pm 3\%$  of reading  $\pm 1$  mV  $\pm 1$  digit.  
 See also under Environmental-User Calibration.

**Indication**  
 4 digits and bar chart.

**AMMETER**

**Current Range**  
 0 to 1 A and 0 to 10 A.

**Frequency Range**  
 Polarized DC or 40 Hz to 1 kHz.

**Resolution**  
 1 mA below 1 A; 10 mA below 10 A.

**Accuracy**  
 $\pm 5\%$  of reading  $\pm 1$  mA  $\pm 1$  digit.

**Indication**  
 4 digits and bar chart.

**RESISTANCE METER**

**Resistance Ranges**  
 100  $\Omega$ , 1 k $\Omega$ , 10 k $\Omega$ , 100 k $\Omega$ , 1 M $\Omega$ .

**Resolution**  
 1  $\Omega$  below 1 k $\Omega$  or 3 digits.

**Accuracy**  
 $\pm 5\%$  of reading  $\pm 1$   $\Omega$   $\pm 1$  digit.  
 Continuity Test continuous tone if reading is less than 10  $\Omega$ .

**RF FREQUENCY METER**

**Range**  
 100 kHz to 1 GHz.

**Resolution**  
 1 Hz or 10 Hz selectable.

**Indication**  
 Up to 10 digits.

**Accuracy**  
 As Frequency Standard  $\pm 2$  Hz  $\pm$  resolution.

**Acquisition Time**  
 Nominally less than 1 second.

**Dynamic Range (Auto tuned)**  
 As RF Power Meter (broadband).

**Frequency Range (Auto tuned)**  
 10 MHz to 999.9 MHz.

**Sensitivity**  
 Manual tuned:  $-100$  dBm (TNC) dependent on receiver bandwidth in off air test mode.

**Offset Frequency Range**  
 $\pm 1$  MHz dependent on receiver bandwidth.

**RF POWER METER (BROADBAND)**

**Frequency Range**  
 100 kHz to 1 GHz.

**Dynamic Range (Auto tuned)**  
 10 mW to 150 W (N-Type), 100  $\mu$ W to 0.5 W (TNC).

**Power Reading**  
 True mean power.

**Indication Units**  
 Watts.

**Resolution**  
 Better than 1%.

**Indication**  
 3 digits + bar chart.

**Accuracy**  
 100 kHz to 500 MHz:  
 $\pm 7\%$  (0.3 dB), 0.1 W to 50 W (N-Type).  
 $\pm 10\%$  (0.4 dB), 20 mW to 150 W (N-Type).  
 $\pm 12\%$  (0.5 dB), 200  $\mu$ W to 50 mW (TNC).

500 MHz to 1 GHz:  
 $\pm 10\%$  (0.4 dB), 0.1 W to 50 W (N-Type).  
 $\pm 12\%$  (0.5 dB), 20 mW to 150 W (N-Type).  
 $\pm 15\%$  (0.6 dB), 200  $\mu$ W to 50 mW (TNC).

100 kHz to 1 GHz:  
 $\pm 7\%$  (0.3 dB), 0.1 W to 50 W (N-Type)  $\pm 10\%$  (0.4 dB)  
 1 mW to 50 mW (TNC) for ambient temperatures in the range 15°C to 35°C.  
 See also under Environmental-User Calibration.

**Maximum Safe Continuous Rating**  
 N-Type: 50 W.  
 TNC: 0.5 W; overload protected to 10 W.

**Intermittent Rating**  
 N-Type: 150 W for limited periods, typically 2 minutes at 20°C. Typical off to on ratio is 6:1. Overload indicated by audible and visual warning.

**RF POWER METER (SELECTIVE)**

**Frequency Range**  
 100 kHz to 1 GHz.

**IF Bandwidth**  
 300 Hz to 30 kHz in a 1, 3, 10 sequence and 110 kHz, 280 kHz and 3 MHz.

**Dynamic Range (Manual tuned)**  
 0 dBm to +50 dBm (110 kHz IF bandwidth) (N-Type).  
 $-90$  dBm to +20 dBm (110 kHz IF bandwidth) (TNC).

**Accuracy**  
 Typically  $\pm 2.5$  dB N-Type & TNC.  
 See also under Environmental-User Calibration.

**Power Reading**  
 Average.

**Indication Units**  
 dBm.

**Resolution**  
 Better than 0.1 dB.

**Indication**  
 3 digits + bar chart.

**MODULATION ANALYZER**

**Dynamic Range (Auto tuned)**  
 As RF Power Meter (Broadband).

**Sensitivity (Manual tuned)**  
 N-Type  $-30$  dBm (110 kHz IF bandwidth).  
 TNC  $-50$  dBm (110 kHz IF bandwidth).  
 TNC (off-air test mode)  $-101$  dBm (2  $\mu$ V 10 dB SINAD in 30 kHz IF bandwidth and CCITT weighting).

**Demodulation**  
 Accuracy maintained on signals greater than  $-60$  dBm.

**Receiver Bandwidths**  
 3 MHz, 280 kHz, 110 kHz, 30 kHz and 10 kHz nominal (manual or auto selection).

**Demodulation Filters**  
 As audio analyzer plus 5 kHz low pass ( $\pm 0.3$  dB at less than 3.4 kHz relative to 1 kHz).

**Audio Output**  
 Available into an internal loudspeaker, demodulated output or accessory socket for external loudspeaker or headphones.

**Switching Speed**  
 Nominally less than 1 ms channel to channel up to 50 MHz apart, settling to within 1 kHz of final frequency.

**Demodulated Output**  
 Nominal output impedance less than 10  $\Omega$ . Output voltage is range dependent (2 V peak at top of range).

**Squelch**  
 A manual squelch control is provided with a variable threshold.

**AMPLITUDE MODULATION**

**Frequency Range**  
 100 kHz to 1 GHz.

**Modulation Frequency Range**  
 20 Hz to 20 kHz.

**AM Depth Range**  
 0 to 99%.

**Resolution**  
 0.1% AM.

**Indication**  
 3 digits and bar chart.

**Accuracy (up to 85% AM)<sup>(1)</sup>**  
 $\pm 3\%$  of reading,  $\pm 1\%$  AM, 250 Hz to 5 kHz.  
 Typically  $\pm 5\%$  of reading,  $\pm 1\%$  AM, 50 Hz to 15 kHz.

**Demodulation Distortion<sup>(1)</sup>**  
 Less than 1% at 1 kHz, CCITT weighted.

**Residual AM**  
 Less than 0.1% AM, CCITT weighted.

**FREQUENCY MODULATION**

**Frequency Range**  
 1 MHz to 1 GHz.

**Modulation Frequency Range**  
 20 Hz to 20 kHz.

**Deviation Range**  
 0 to 100 kHz.

**Resolution**  
 10 Hz below 10 kHz deviation; 100 Hz below 100 kHz deviation.

**Indication**  
 3 digits and bar chart.

**Accuracy<sup>(1)(2)</sup>**  
 $\pm 3\%$   $\pm$  resolution for modulation frequency of 1 kHz.  
 $\pm 5\%$   $\pm$  resolution for modulation frequencies from 100 Hz to 15 kHz.

**Demodulation Distortion<sup>(1)</sup>**  
 Less than 0.5% at 1 kHz, CCITT weighted.

**Residual FM**  
 Less than 25 Hz RMS CCITT weighted.

**PHASE MODULATION**

**Frequency Range**  
 1 MHz to 1 GHz.

**Modulation Frequency Range**  
 250 Hz to 5 kHz.

**Deviation Range**  
 0 to 20 rads.

**Resolution**  
 0.01 rads.

**Indication**  
 3 digits and bar chart.

**Accuracy<sup>(1)(3)</sup>**  
 $\pm 5\%$   $\pm$  resolution.

**Demodulation Distortion<sup>(1)</sup>**  
 Less than 0.5% at 1 kHz, CCITT weighted.

## 2965

### SSB MODULATION

Available as an option for audio recovery.

### Frequency Range

100 kHz to 1 GHz.

### Demodulation Filters

2.2 kHz, 7.5 kHz and 15 kHz.

### Demodulation Distortion

Less than 2% at 1 kHz, CCITT weighted.

### Sideband Selection

USB, LSB or CW.

### RF SPECTRUM ANALYZER

#### Frequency

Range: 100 kHz to 1 GHz, usable to 30 kHz.

#### Spans

500 Hz/div to 100 MHz/div, in a 1, 2, 5 sequence.

#### Resolution Bandwidth

300 Hz to 30 kHz in a 1, 3, 10 sequence and 110 kHz, 280 kHz and 3 MHz (automatically selected according to span).

#### Filter Shape

Nominally 3 dB/60 dB, 1:11 (300 Hz to 30 kHz bandwidth).

#### Reference Level (top of screen)

-90 dBm to +60 dBm.

#### On Screen Dynamic Range

80 dB.

#### Vertical Resolution

0.5 dB on 10 dB/div, 0.05 dB on 1 dB/div.

#### Level Accuracy

Typically  $\pm 2.5$  dB.

See also under Environmental-User Calibration.

#### Intermodulation Distortion

Less than 80 dB for 2 signals on screen at reference level.

#### Sweep Speeds

Optimum sweep speed and bandwidth selected according to span.

#### Modes

Single sweep, continuous and autoselect/autolevel on key selection.

#### Graticule

10 horizontal by 8 vertical divisions.

#### Expanded Mode

Can be made to occupy full screen for high definition.

#### Markers

M1 and M2.

#### Indication

Level: M1, M2, M1-M2.

Frequency: M1, M2, M1-M2.

### TRACKING GENERATOR

Available in RF TEST mode.

### Frequency Range

100 kHz to 1 GHz.

### Level Range

-135 dBm to +13 dBm.

### AUDIO GENERATORS

See section on modulation generators for interaction of audio and modulation generators.

### FREQUENCY

#### Range

1 Hz to 20 kHz.

#### Setting

Keyboard entry, delta increment/decrement function and rotary control.

#### Indication

6 digits.

#### Resolution

0.1 Hz.

#### Accuracy

As frequency standard.

### LEVEL

#### Range

0.1 mV to 5 V RMS (maximum AF output 7 V peak, all generators combined).

### Setting

Keyboard entry, delta increment/decrement function and rotary control.

### Indication

4 digits.

### Resolution

0.1 mV.

### Accuracy

$\pm 3\% \pm 1$  digit, 250 Hz to 5 kHz.

$\pm 5\% \pm 1$  digit, 10 Hz to 20 kHz.

### Output Impedance

Nominally 5  $\Omega$ .

### Protection

Maximum applied voltage 50 V.

### SIGNAL PURITY

#### Distortion<sup>(2)</sup>

Less than 0.5% at 1 kHz measured in a 30 kHz bandwidth.

Less than 1% from 20 Hz to 20 kHz measured in an 80 kHz bandwidth.

Typically 0.1% for levels greater than 100 mV.

#### Residual Noise

Less than 50  $\mu$ V RMS (CCITT weighted).

#### DC Offset

Less than 10 mV.

### SIGNALLING ENCODER/DECODER

#### Sequential tones functions

Encodes and decodes up to 40 tones.

CCIR, ZVEI, DZVEI, EEA, EIA or user defined.

Any of the tones may be extended.

Continuous, burst and single step modes available.

#### User defined tones

Up to three frequency plans may be defined and stored within the 2965 for sequential tones.

Any of the standard tone frequency plans may be copied to user defined and modified.

Tone length 10 ms to 1 s.

Extended tone length 100 ms to 10 s.

#### CTCSS tones mode

Standard tone frequencies may be selected from a menu.

#### DTMF Encoder

Generation of DTMF tones.

#### DCS Encode

Generation of digitally coded squelch.

#### POCSAG generator

Generation of POCSAG code CCIR No. 1

Rec 584. Bit rates from 400 to 9600 bit/s.

### AUDIO MONITOR

Demodulated signals and audio signals may be monitored via the internal loudspeaker or via the accessory socket output or BNC socket on the rear panel.

### GENERAL FEATURES

#### INTERFACES

##### Keyboard and Display

Logical colour coded keyboard with bright high resolution CRT.

##### GPIB

Full control of all major instrument functions via the GPIB interface.

Flexibility is further enhanced by Marconi Instruments implementation of IEEE-488.2.

##### Capability

Complies with the following subsets as defined in IEEE-488.1-1978:- SH1, AH1, T5, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C1, E1.

##### Serial

Serial interface is provided for connection of RS-232 for instrument remote control. 9 Way socket. Control language is based on IEEE P1174.

##### Parallel

Connector 25 way female D-Type. Provision made for graphics screen dump. A selection of printer drivers are included.

### Accessory Socket

Allows the connection of various optional accessories. With suitable adapters is compatible with most 2955 series accessories.

### Memory Card

Meets PCMCIA2/JEIDA - 4 standard. The memory card facility allows the storage of results and set-ups.

### Video Output

Colour, compatible with most VGA monitors. 15 way Sub Miniature D-Type.

### FREQUENCY STANDARD

#### Internal Frequency Standard

##### Frequency

10 MHz.

##### Temperature Stability

Better than 5 in  $10^6$ , 5°C to 55°C.

##### Ageing Rate

Better than 2 in  $10^7$  per year, after 1 month continuous use.

##### Warm Up Time

Less than 10 minutes to within 2 in  $10^7$  at 20°C.

#### External Frequency Standard Input

##### Frequencies

1, 2, 5 and 10 MHz.

##### Level

Greater than 2 V pk-pk.

##### Input Impedance

Nominally 1 M $\Omega$  in parallel with 40 pF.

#### Frequency Standard Output

##### Frequency

10 MHz.

##### Level

Nominally 2 V pk-pk.

##### Output Impedance

Nominally 50  $\Omega$ .

### POWER REQUIREMENTS

#### AC supply

##### Voltage

88 V to 132 V and 188 V to 265 V.

##### Supply frequency

45 Hz to 440 Hz.

##### Power

Nominally 135 W, 260 W maximum, for future options.

#### DC supply

##### Voltage

11 to 32 V.

##### Power

110 W nominal; 225 W maximum.

### ELECTROMAGNETIC COMPATIBILITY

Conforms with the requirements of EEC directive 89/336/EEC by complying with standards EN 55011 Curve B (RF Emissions).

Conforms to International Standards CISPR 11.

### SAFETY

Complies with IEC 348.

### ENVIRONMENTAL

#### Rated Range Of Use

0°C to 55°C and up to 95% relative humidity at 40°C.

#### User Calibration

User calibrations are provided to maintain high accuracy for any ambient temperature (e.g. in ATE racks or in field measurements). Having allowed the instrument to stabilize, running the user calibrations optimises the performance at that temperature. A change in temperature of 5°C from the calibration temperature affects the readings as given below. These figures are provided as a guide to typical performance. Typical variations are as follows.

Power Meter:	Broadband	2%
	Selective	0.5 dB
Spectrum Analyzer Level		0.5 dB
Audio Analyzer & Modulation Filters		
	Audio Voltage	0.4%
	Demod depth & deviation	0.4%
Multimeter:	Voltage	0.5%
	Current	0.5%

### Storage and Transport

**Temperature**  
-40°C to +70°C.

**Altitude**  
Up to 2500 m (pressurized freight at 27 kPa differential).

### DIMENSIONS AND WEIGHT

Excluding handle, feet and covers.

Height	Width	Depth
177 mm	370 mm	540 mm
(6.9 in)	(14.5 in)	(21.2 in)

Including handle, feet and covers.

Height	Width	Depth
203 mm	420 mm	600 mm
(7.9 in)	(16.5 in)	(23.6 in)

**Weight**  
Less than  
18 kg  
(39.5 lb)

### VERSIONS AND ACCESSORIES

Ordering numbers	Versions
<b>2965</b>	Radio Test Set
<b>Option 01</b> <b>Option 02</b> <b>Option 03</b> <b>Option 09</b>  <b>Option 10</b> <b>Option 11</b>  <b>Option 12</b>  <b>Option 13</b>  <b>Option 14</b> <b>Option 21</b>	<b>Options</b> French Language Version. Spanish Language Version. German Language Version. SSB and narrowband receiver option. NMT Cellular Radio option.* AMPS Cellular Radio option (including N-AMPS).* TACS Cellular Radio option (including N-TACS).* MPT1327/MPT1343 Trunked Radio option.* PMRTEST for AM/FM/QM radios. Digital Systems Card (for GSM) *Specify which analog cellular option (options 10 to 14) is required at time of ordering. <i>Contact sales office for details of availability of options.</i>
	<b>Supplied with</b> AC Supply lead. Operating Manual. Multimeter Lead Kit (two 4 mm leads to test points).
<b>54311-153G</b> <b>54421-001N</b> <b>54431-023A</b> <b>54112-158V</b> <b>46662-426J</b> <b>54462-025T</b> <b>54462-026P</b> <b>54127-310K</b> <b>59000-189M</b> <b>54411-052M</b> <b>46884-645L</b>  <b>46884-646J</b> <b>46884-560M</b> <b>46884-649V</b> <b>46884-650F</b> <b>43129-189U</b> <b>43130-596E</b>  <b>54311-095C</b>  <b>54311-071Z</b> <b>54311-092P</b> <b>52388-900D</b> <b>54441-012P</b>	<b>Accessories</b> DC supply cable. BNC Telescopic antenna. 20 dB AF attenuator (BNC). Hard Transit Case. Soft Carrying Case. Battery pack for 2965. AC charger for 2965 battery pack Rack Mounting Kit. Memory Card (128 K). Impedance Matching Unit (Note 1). Accessory socket adapter (for use with 2955 accessories). Accessory Socket 'Y' adapter. Parallel Printer Interface Cable. Serial port to PC Cable 25 way. Serial port to PC Cable 9 way. GPIB Cable. Coaxial cable N-Type(m) to TNC(m) (double screened). Coaxial cable N-Type(m) to N-Type(m) (1 metre). TNC(m) to BNC(f) adapter. N-Type(m) to BNC(f) adapter. 1 GHz Active Probe. Power supply for probe 52388-900D.  <i>Note 1 – requires 46884-645L Accessory socket adapter.</i>
<b>W2</b> <b>W3</b> <b>WP1</b> <b>WP2</b> <b>WP3</b>	<b>Service Support</b> Two year warranty. Three year warranty. Warranty PLUS for 1st year. Warranty PLUS for 2 years. Warranty PLUS for 3 years. (Warranty PLUS provides a full software upgrade service in addition to standard warranty.) * Contact your local representative for availability of these and other service plans.

<sup>(1)</sup> At low modulation levels the residual AM/FM may become significant.  
<sup>(2)</sup> At low audio levels the residual noise may become significant.  
<sup>(3)</sup> Audio and Modulation filter passband errors not included.