SPECTRUM ANALYZER
MS710C/D/E/F
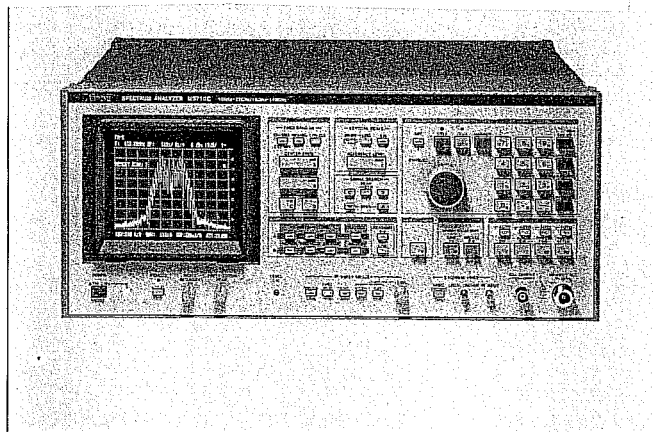
The MS710C/D/E/F Spectrum Analyzer design philosophy was development of high performance microwave spectrum analyzers with wide user applications. The MS710C/D/E/F is easy-to-use and has a variety of functions suited to users' requirements.

Use of a simplified PLL synthesizer local oscillator gives a high accuracy of 30 kHz/6.5 GHz (MS710C/E) and a high resolution of 100 Hz/6 dB (= 70 Hz/3 dB).

Other features include wide dynamic range (second harmonics ≤ -100 dB) and an optional, wide measurement frequency range of up to 140 GHz by using external mixers. This fundamental performance is required by most users. In addition, a two-channel digital memory enables simultaneous display of two measured data, display of subtraction results and processing functions such as MAX HOLD and AVERAGING. By using these functions, the MS710C/D/E/F can provide many display/record related functions such as signal search, and marker point data read out for numeric display and direct plotting. A new function

which enables store/recall of up to 9 sets of measured data and measurement conditions has also been added.

The MS710C/D/E/F has been designed for both easy manual operation and completely automatic operation via GP-IB. The design includes: (1) a grouped key layout different key sizes according to their functional importance, (2) an operation guide display for complicated operations such as SHIFT and MARKER functions, and (3) a preset memory which can memorize up to 10 sets of measurement conditions.

Main specifications
- Frequency range:
  - MS710C: 10 kHz to 23 GHz/18 to 140 GHz (with external mixer)
  - MS710D: 100 kHz to 23 GHz/18 to 140 GHz (with external mixer)
  - MS710E/F: 100 kHz to 23 GHz
- Amplitude range:
  - -125 to $+30$ dBm
- Resolution bandwidth:
  - 100 Hz to 3 MHz
- Dynamic Range:
  - 100 dB (1.7 to 23 GHz)
- GP-IB:
  - Fully programmable

Main applications
- Spectrum analysis of microwave devices and components
- Spurious emission and spectral distribution measurements of analog and digital communications transmitters
- Interference measurements for radio stations, satellite earth stations, etc.
- Spectrum analysis in basic research such as nuclear physics and radio-astronomy
- Spurious measurements for home-use satellite broadcast receivers and related equipment
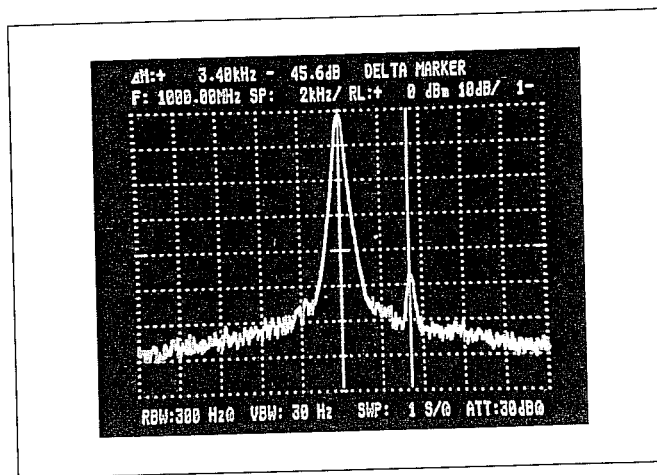
Functions
Wide variety of signal search functions

The special-purpose PEAK→CENTER SPAN UP / DOWN and HALF SCREEN SHIFT keys enable rapid location of the desired signal.

SIGNAL SEARCH
PEAK
→CTR

<< [ ] >>

∨ SPAN ∧

PEAK→CENTER

PEAK
→CTR
[ ]

HALF SCREEN SHIFT

[<] [>]
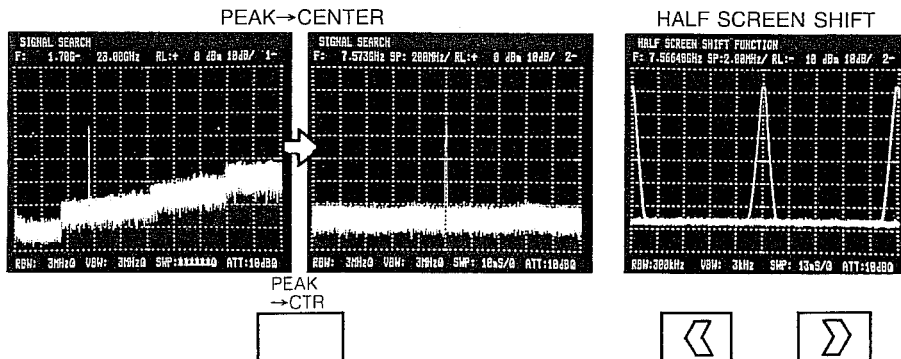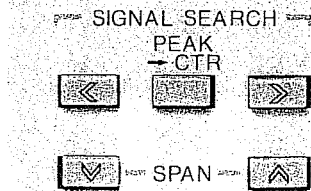
Markers

Four marker functions (Normal, Delta, Peak and Marker→CF) are provided. Especially, the peak marker is most helpful in monitoring signals with sharp fluctuation of frequency and level or in making VCO adjustments. The delta marker enables reading of the frequency and level differences between two markers.

Easy measurement condition setting

Using the preset memory, up to ten sets of measurement conditions (function parameters) can be stored or recalled from memory and displayed on the CRT.
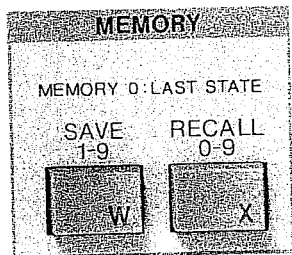
Example of the readout MEMORY list
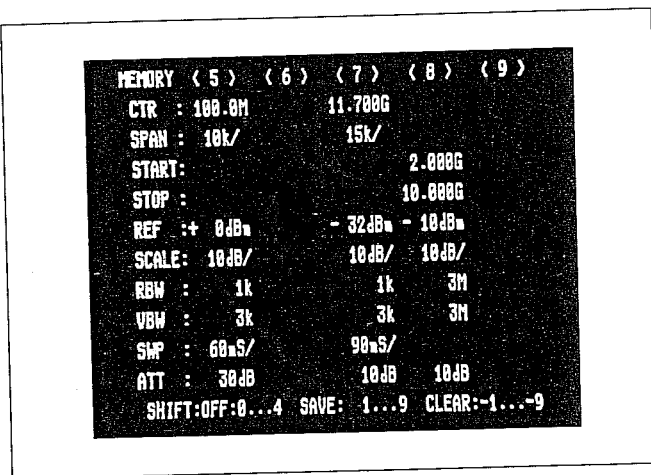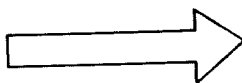
Nine display memories

Up to nine sets of displayed data including measurement conditions, titles and measured waveforms etc. can be stored in and recalled from the memories with battery backup. Stored titles can be displayed in a list format, so that all data stored in display memories can be easily recalled.
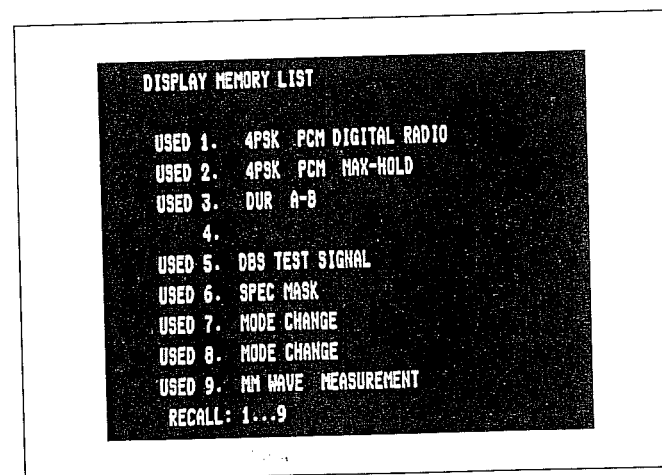
Easy to understand list display

This list display enables easy selection of extended frequency bands or shift functions. For frequency bands where external mixers are used, the list also shows the type of mixer to be used, bias voltage setting and conversion loss.

FREQUENCY BAND LIST

SHIFT FUNCTION LIST

```
FREQUENCY BAND LIST
                    BIAS PORT LOSS
  1.  18kHz--- 30MHz  ----   -    ---
  2.  18GHz- 26.5GHz  +  0   3     0
  3.  22GHz--- 33GHz  +  0   3     0
  4.  26.5GHz--- 40GHz + 0   3    30
 ±5.  40GHz--- 60GHz  - 62   2    37
  6.  60GHz--- 90GHz  +  0   3     0
  7.  90GHz-- 140GHz  +  0   3     0

( SELECT NO. 1-7 )
```

```
SHIFT FUNCTION LIST
   PRESELECTOR AUTO TUNING....START
   COPY WITHOUT PARAMETERS....COPY
   SAMPLING DATA MONITOR......MAX HOLD/AVERAGE
      DISPLAY MEMORY SAVE......RES BW
      DISPLAY MEMORY RECALL....VIDEO BW
      DISPLAY MEMORY SCAN......SWEEP TIME
      EXCHANGE A(-)B...........INPUT ATTEN
   EXTERNAL MIXER BIAS........CENTER FREQ
   EXTERNAL MIXER LOSS........FREQ SPAN/DIV
   EXTERNAL MIXER 2/3 PORT....STOP
( SELECT KEY )
```

Millimeter band measurement using an external mixer

Both two port and three port external mixers can be used with the MS710C/D; its measurement range can thus be extended up to 140 GHz.

It is possible to set parameters including mixer bias setting and reference level correction value derived from the external mixer's conversion loss.

Measured data processing can be made using these parameters. The corrected value and waveform can be observed directly on the CRT.


```
MM WAVE MEASUREMENT
F: 50.1622GHz SP: 20kHz/ RL:- 50 dB= 10dB/ 10-
```

```
RBW:  1kHzQ  VBW:100 Hz   SWP: 1 S/Q  ATT: 0dBQ
```


Two-port mixer — RF (Millimeter wave)

Three-port mixer — RF (Millimeter wave)
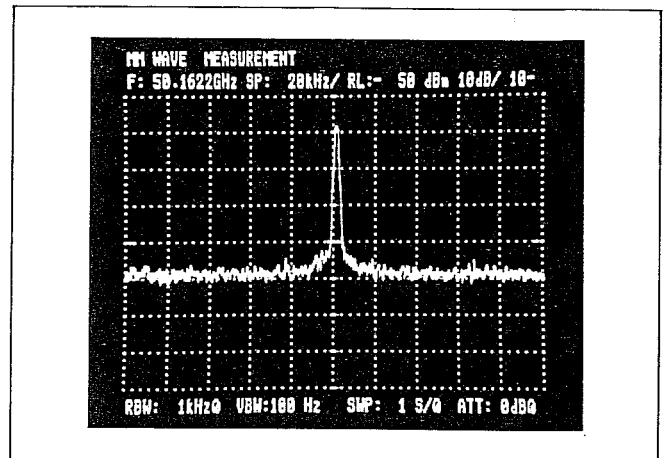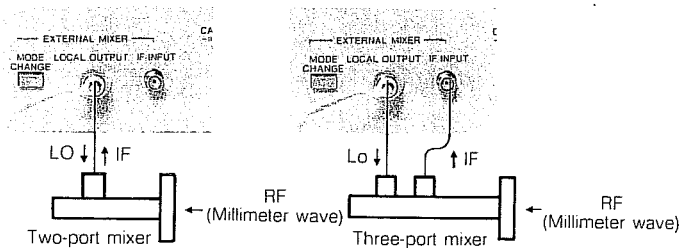
Rear view of the MS170C/D/E/F

The local output for interfacing with the tracking generator, connectors for parallel interface and GP-IB, output connecters for conventional X-Y recorders, active probes etc. are on the rear panel as shown here.
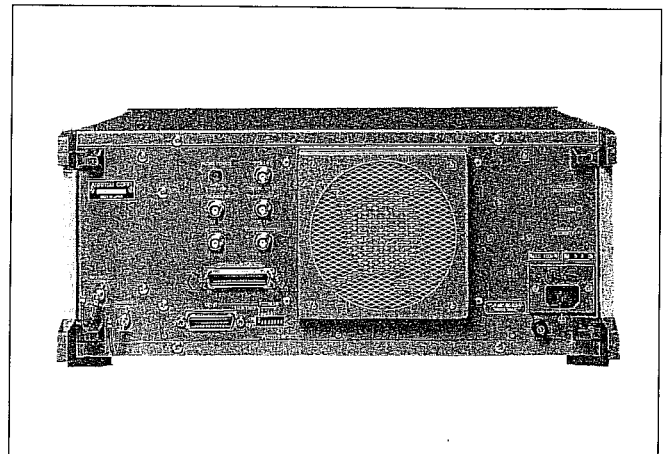
Typical characteristics

Resolution

The curve of the filters used in the MS710□ have approximately the same curve as Gaussian filters and the resolution bandwidths are specified at the 6 dB down points. As the shape factor (Selectivity or 60 dB/6 dB bandwidth ratio) is very good (< 10:1), signals with a small frequency separation can be resolved clearly. The typical filter shapes, and noise sideband levels are shown in this figure.

3 dB down bandwidths are approx. 70% of specified resolution (6 dB down) bandwidths. For example, when a 100 Hz resolution is selected, the 3 dB down bandwidth is as narrow as approx. 70 Hz.
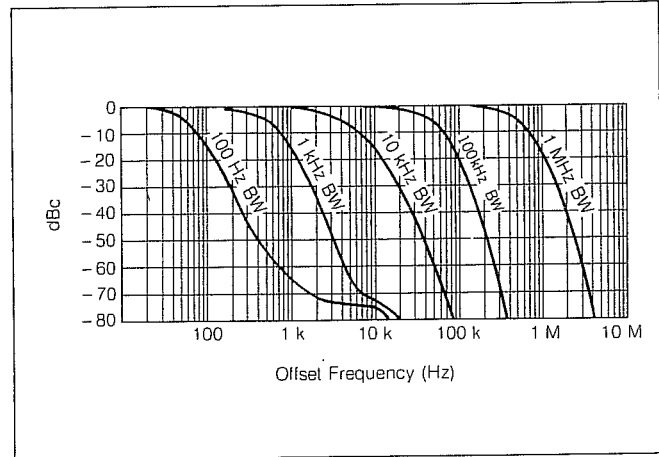
Measurements at low frequencies

Low frequency bands ranging from 10 kHz to 30 MHz are provided in the MS710C for application of low frequency signal analysis. 3 kHz frequency display accuracy and 100 Hz resolution is guaranteed for this frequency range, therefore precise measurement on low frequency signals is possible without an additional low frequency spectrum analyzer.
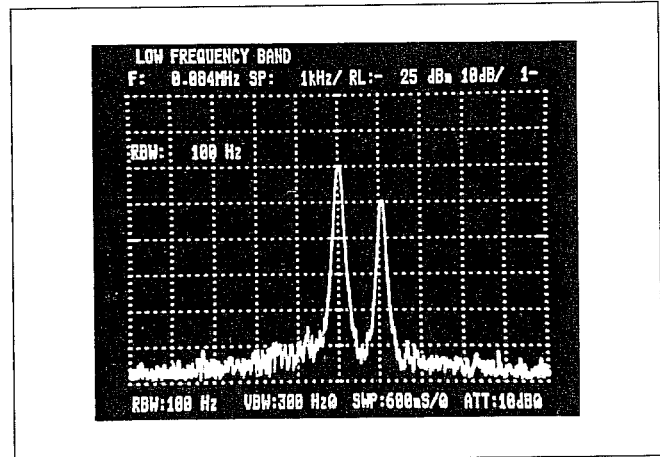
Frequency stability

Because the local oscillator of the MS710□ is precisely controlled by using the sophisticated PLL technique, the frequency accuracy and stability are excellent. This figure shows typical frequency drift data starting at power-on.

Center Frequency Drift of MS710C (Typical)
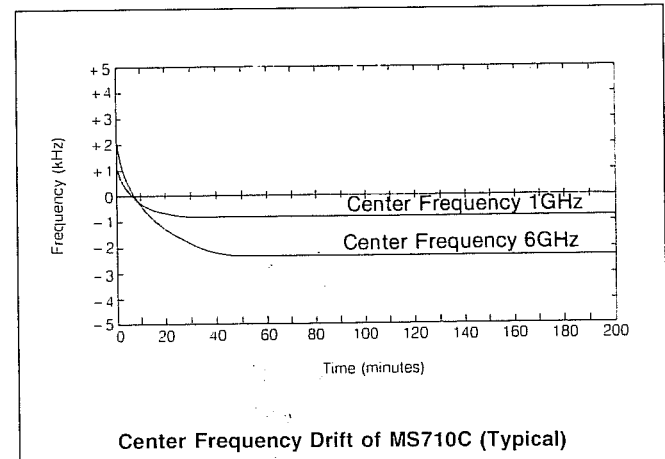
Application example
Satellite earth stations and digital microwave radio communications equipment

The following items must be measured in TDMA and TDM-PCM system radio-link:

(a) Transmitter output spurious emission level
(b) Receiver interference level and frequencies (for interference protection).
(c) Occupied bandwidth of spectrum

```
        START
          │
   ┌──────────────┐
   │ Data         │
   │ collection   │
   │ by spectrum  │
   │ analyzer     │
   └──────────────┘
          │
   ┌──────────────┐
   │ Spectrum ana-│
   │ lyzer data   │
   │ read in by   │
   │ Packet III   │
   └──────────────┘
          │
   ┌──────────────┐
   │ Occupied     │
   │ bandwidth    │
   │ calculation  │
   │ by Packet III│
   └──────────────┘
          │
   ┌──────────────┐
   │ Raw data     │
   │ and calcu-   │
   │ lated values │
   │ output       │
   └──────────────┘
          │
         END
```
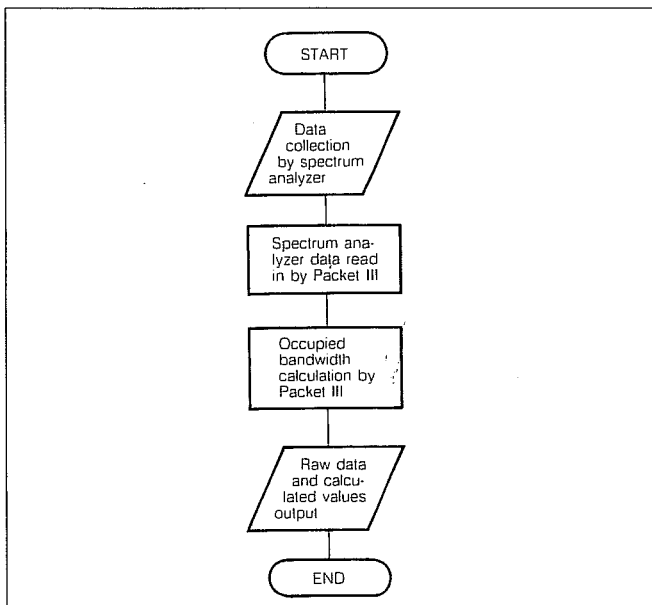
Spurious Signal Measurement Example
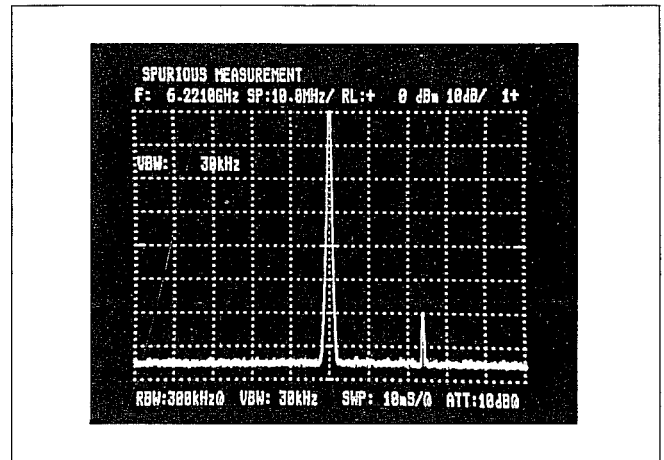
Occupied Bandwidth Measurement Example

TX	MS710C	Packet III	Plotter or Printer
Transmitter	Spectrum analyzer	Personal computer	
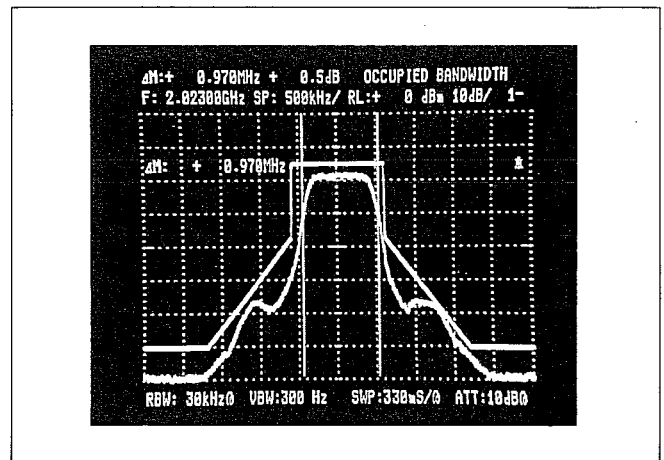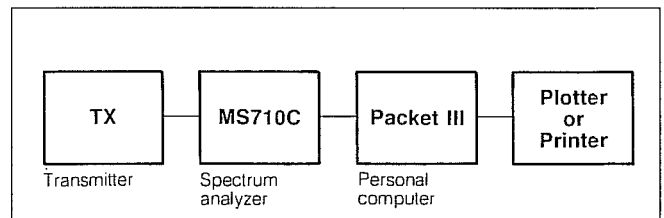
MS710C/D/E/F selection guide

	10 kHz to 30 MHz bands	100 kHz to 2 GHz band, 1.7 to 23 GHz band	18 to 140 GHz 6 bands (with External Mixer)	High Frequency Accuracy
MS710C	○	○	○	○
MS710D	—	○	○	—
MS710E	—	○	—	○
MS710F	—		—	—

Specifications
1. 100 kHz to 2 GHz, 1.7 to 23 GHz band

			MS710 C/E	MS710 D/F
Frequency	Measuring range		100 kHz to 2 GHz, 1.7 to 23 GHz 2 bands	
	Center frequency	Setting range	0 MHz to 2 GHz, 1.7 to 23 GHz	
		Readout resolution	10 kHz (10 MHz to 2 GHz) 10 kHz (1.7 to 23 GHz)	100 kHz (0 MHz to 2 GHz) 1 MHz (1.7 to 23 GHz)
		Readout accuracy	±(The following accuracy +2% of frequency span +10% of resolution bandwidth) 30 kHz/0 MHz to 2 GHz 30 kHz/1.7 GHz to 6.5 GHz 60 kHz/6.5 GHz to 12.5 GHz 90 kHz/12.5 GHz to 18.5 GHz 120 kHz/18.5 GHz to 23 GHz	1 MHz/0 MHz to 2 GHz 1 MHz/1.7 GHz to 6.5 GHz 2 MHz/6.5 GHz to 12.5 GHz 3 MHz/12.5 GHz to 18.5 GHz 4 MHz/18.5 GHz to 23 GHz
		Setting	Number/unit keys, data knob, peak center key, or half-screen shift key	
	Frequency span	Setting range and resolution	The following and 0 Hz (fixed tuning) in number/unit keys and in data knob: 1 kHz/div to 200 kHz/div in 1 kHz increments 210 kHz/div to 2 MHz/div in 10 kHz increments 2.1 MHz/div to 20 MHz/div in 100 kHz increments 21 MHz/div to 200 MHz/div in 1 MHz increments For span up/down keys: 1 kHz/div to 200 MHz/div in 1, 2, 5, 10 sequence	
		Readout accuracy	±5% (6 kHz/div to 200 MHz/div), ±10% (1 kHz/div to 5 kHz/div)	
		Setting	Number/unit keys, data knob, or span up/down keys	
	Start frequency/ Stop frequency	Setting range	In each band (Span ≥ 10 kHz)	In each band (Span ≥ 1 MHz)
		Readout resolution	Min. 10 kHz (Varies depending on span settings) (Span = Stop frequency—Start frequency)	1 MHz (span ≤ 200 MHz) 10 MHz (span ≤ 210 MHz) (Span = Stop frequency—Start frequency)
		Readout accuracy	±(Center frequency accuracy +2.5% of span)	
		Setting	Number/unit keys or data knob	
	Resolution	Resolution bandwidth (6 dB bandwidth) — Setting range	100 Hz to 3 MHz in a 1, 3, 10 sequence	
		Setting	May be selected manually or automatically coupled to frequency span	
		Selectivity (60 dB/6 dB)	≤ 10:1 (Resolution bandwidth ≥ 1 kHz)	
	Stability	Residual FM	≤ 200 Hzp-p/0.1 s (Center frequency ≤ 6.5 GHz, Span ≤ 100 kHz/div)	
		Noise sidebands	≤ −75 dB (1 kHz resolution bandwidth, 10 Hz video bandwidth, 30 kHz away from signal, center frequency ≤ 6.5 GHz)	
Amplitude	Measuring range		Average noise level to +30 dBm	
	Display	Graticule	Vertical 8 division, reference level is the top line of graticule	
		LOG — 10 dB/div	0 to −70 dB from reference level	
		LOG — 5 dB/div	0 to −40 dB from reference level	
		LOG — 2 dB/div	0 to −16 dB from reference level	
		LOG — 1 dB/div	0 to −8 dB from reference level	
		LIN	12.5%/div	
		Linearity	±0.2 dB/1 dB, ±1.5 dB/70 dB	
	Reference level	Setting range	−109 to +30 dBm	
		Calibration output accuracy	−10 dBm ±0.3 dB (100 MHz ±10 kHz)	
		Reference level accuracy	±2.0 dB (Reference level −99 dBm to −10 dBm, frequency 100 MHz, 0 dB input attenuator, and after calibrated using CAL OUTPUT)	
		Input attenuator accuracy — Setting range	0 to 70 dB, 10 dB steps May be selected manually or automatically coupled to reference level	
		Input attenuator accuracy — Error between steps	±1 dB (0 to 60 dB, 100 kHz to 2 GHz) ±2 dB (0 to 40 dB, 100 kHz to 23 GHz)	
		Input attenuator accuracy — Error of maximum accumulation	±2.2 dB (0 to 60 dB, 100 kHz to 2 GHz) ±3 dB (0 to 40 dB, 100 kHz to 23 GHz)	
		Frequency response	10 dB input attenuator after Preselector peaking adjustment to obtain the maximum response. ±2.5 dB (100 kHz start frequency, 10 MHz stop frequency) ±1.5 dB (10 MHz start frequency, 2 GHz stop frequency) ±2.5 dB (1.7 GHz start frequency, 5.48 GHz stop frequency) ±3 dB (5.48 GHz start frequency, 12.52 GHz stop frequency) ±4 dB (12.52 GHz start frequency, 23 GHz stop frequency)	

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				MS710 C/E	MS710 D/F
Amplitude	Dynamic range	2nd harmonic distortion		≤ -60 dB (Input frequency 100 kHz to 10 MHz. Value obtained by subtracting the input attenuator value from the input level -40 dBm) ≤ -70 dB (Input frequency 10 to 200 MHz. Value obtained by subtracting the input attenuator value from the input level -30 dBm) ≤ -80 dB (Input frequency 200 to 850 MHz. Value obtained by subtracting the input attenuator value from the input level -30 dBm) ≤ -100 dB* (Input frequency 850 MHz to 11.5 GHz (1.7 to 23 GHz band). Value obtained by subtracting the input attenuator value from the input level -10 dBm)	
		Two signal 3rd intermodulation distortion		≤ -80 dB (Input frequency 100 kHz to 2 GHz. Frequency difference of two signal input ≥ 2.5 MHz Value obtained by subtracting the input attenuator value from the input total level -30 dBm) ≤ -100 dB* (Input frequency 1.7 to 12.5 GHz. Frequency difference of two signal input ≥ 70 MHz. Value obtained by subtracting the input attenuator value from the input total level -10 dBm) ≤ -100 dB* (Input frequency 12.5 to 23 GHz. Frequency difference of two signal input ≥ 100 MHz. Value obtained by subtracting the input attenuator value from the input total level -10 dBm)	
		Residual response		≤ -90 dBm (0 dB input attenuator, 10 MHz to 6.5 GHz fundamental mixing, and 50 Ω termination)	
		Average noise level		≤ -95 dBm (100 kHz to 1 MHz) ≤ -115 dBm (1 MHz to 2 GHz) ≤ -110 dBm (1.7 to 6.5 GHz) ≤ -100 dBm (6.5 to 12.5 GHz) ≤ -95 dBm (12.5 to 18.5 GHz) ≤ -88 dBm (18.5 to 23 GHz)	1 kHz resolution bandwidth, 0 dB input attenuator, and 3 Hz video bandwidth
		Video bandwith		1 Hz to 3 MHz, 1, 3, 10 sequence May be selected manually or automatically coupled to frequency span	
	Input	Connector		N type (nominal 50 Ω)	
		Maximum input level		$+30$ dBm, DC ± 0 V	
Marker		Normal		Frequency and level of the marker position is displayed.	
		Frequency	readout resolution	1/50 of span/div or 1 kHz whichever greater	1/50 of span/div or 10 kHz whichever greater
		Level	readout resolution	1/100 of scale/div	
		Δ(delta)		Frequency and level difference of the two marker positions is displayed.	
		Frequency	readout resolution	1/50 of span/div	
		Level	readout resolution	1/100 of scale/div	
	Peak			Marker always tracks the peak position and shows its frequency and level. (Readout resolution is same as Normal Marker resolution)	
	MKR→CF			Marker frequency set to center frequency	
CRT display	CRT		Display area	80 mm × 100 mm	
			Display item	Graticule, signal traces, function setting value, error message, title, frequency band list, shift function list, and memory list	
	Signal traces		Memory capacity	Horizontal 501 points, vertical 801 points, A and B traces, backed up by battery	
			Display	NORMAL, MAX HOLD, AVERAGE, A—B, A↔B	
Function setting memory				Up to 10 sets of each function setting value can be saved or recalled. The memory list can be displayed on the CRT, backed up by battery	
Display memory				Up to 9 sets of display (title, function settings, signal trace) can be saved or recalled	
Sweep	Sweep time			2 ms/div to 10 s/div. May be selected manually or automatically coupled to frequency span, resolution bandwidth, and video bandwidth. For 0 Hz frequency span, 2μs/div to 10 s/div with manual setting. When (Stop frequency—Start frequency) >2 GHz, the previously given time is set and time cannot be set manually.	
	Trigger			Single, free run, line, video, and external trigger	
Remote control				GP-IB (IEEE488, IEC625-1, 24 pins) All front panel functions (except power switch, CRT intensity, level calibration, and trigger level adjustment knob) can be remote-controlled.	
Direct plotting				CRT information can be plotted by the specified plotter or printer	
Power				AC 100 V $^{+10}_{-15}$ %, 50/60 Hz, ≤ 200 VA	
Dimensions and weight				177H × 426W × 451D mm, ≤ 27 kg	
Accessories supplied				Power cord, coaxial cable for calibration, fuse, and manual	

*Less than specified level or average noise level.

2. 10 kHz to 30 MHz band (MS710C)

<table>
<tr><td rowspan="5">Frequency</td><td colspan="2">Measuring range</td><td>10 kHz to 30 MHz</td></tr>
<tr><td rowspan="3">Center frequency</td><td>Setting range</td><td>0 kHz to 30 MHz</td></tr>
<tr><td>Readout resolution</td><td>1 kHz</td></tr>
<tr><td>Readout accuracy</td><td>± (3 kHz + 2% of frequency span + 10% of resolution bandwidth)</td></tr>
<tr><td colspan="2">Frequency span setting range and resolution</td><td>The following and 0 Hz (fixed tuning) in number/unit keys and in data knob:
1 to 200 kHz/div in 1 kHz increments
210 kHz/div to 2 MHz/div in 10 kHz increments
2.1 to 3 MHz/div in 100 kHz increments
For span up/down keys: 1 kHz/div to 2 MHz/div in a 1, 2, 5, 10 sequence and 3 MHz/div</td></tr>
<tr><td rowspan="7">Amplitude</td><td colspan="2">Frequency response</td><td>± 1.5 dB (10 kHz start frequency, 30 MHz stop frequency, 10 dB input attenuator)</td></tr>
<tr><td rowspan="6">Dynamic range</td><td>2nd harmonic distortion</td><td>≤ − 60 dB (Input frequency 10 to 300 kHz, Value obtained by subtracting the input attenuator value from the input level − 40 dBm)
≤ − 70 dB (Input frequency 300 kHz to 15 MHz, Value obtained by subtracting the input attenuator value from the input level − 30 dBm)</td></tr>
<tr><td>Two signal 3rd intermodulation distortion</td><td>≤ − 70 dB (Input frequency 10 to 100 kHz, Frequency difference of two signal input ≧ − 2.5 MHz, Value obtained by subtracting the input attenuator value from the input total level − 30 dBm)</td></tr>
<tr><td>Residual response</td><td>≤ − 90 dBm</td></tr>
<tr><td>Average noise level</td><td>≤ − 95 dBm (100 kHz to 1 MHz)   1 kHz resolution bandwidth, 0 dB input attenuator, and
≤ − 115 dBm (1 to 30 MHz)   3 Hz video bandwidth</td></tr>
</table>

* Specifications except above are same as 100 kHz to 2 GHz, 1.7 to 23 GHz bands' specifications.

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3. 18 to 140 GHz Band (With External Mixer)

			MS710 C	MS710 D
Frequency	Frequency band and harmonic number		18.0 to 26.5 GHz 6 22.0 to 33.0 GHz 6 26.5 to 40.0 GHz 8 40.0 to 60.0 GHz 10 60.0 to 90.0 GHz 16 90.0 to 140.0 GHz 26	
	Center frequency	Setting range	In each band	
		Readout resolution	100 kHz (18 to 60 GHz), 1 MHz (60 to 140 GHz)	1 MHz
		Readout accuracy	30 kHz × harmonic number	1 MHz × harmonic number
		Setting	Number/unit keys, data knob, peak center key, or half-screen shift key	
	Frequency span	Setting range and resolution	The following and 0 Hz (fixed tuning) in number/unit keys and in data knob: 1 kHz × n/div to 200 kHz × n/div in 1 kHz × n increments 210 kHz × b/div to 2 MHz × n/div in 10 kHz × n increments 2.1 MHz × n/div to 20 MHz × n/div in 100 kHz × n increments 21 MHz × n/div to 200 MHz × n/div in 1 MHz × n increments For span up/down keys: 1 kHz × n/div to 200 MHz × n/div in a 1 × n, 2 × n, 5 × n, 10 × n sequence (n: harmonic number)	
		Readout accuracy	±5% (6 kHz × n/div to 200 MHz × n/div), ±10% (1 kHz × n/div to 5 kHz × n/div)	
		Setting	Number/unit keys, data knob, or span up/down keys	
	Start frequency/ Stop frequency	Setting range	In each band (Span ≧ 10 kHz × n)	In each band (Span ≦ 1 MHz × n)
		Readout resolution	Min. 10 kHz × n (varies depending on span settings) (Span = Stop frequency—Start frequency)	1 MHz (span ≦ 200 MHz × n) 10 MHz (span ≦ 210 MHz × n) (Span = Stop frequency—Start frequency)
		Readout accuracy	± (Center frequency accuracy + 2.5% of span)	
		Setting	Number/unit keys or data knob	
	Resolution bandwidth (6 dB bandwidth)	Setting range	100 Hz to 3 MHz in a 1, 3, 10 sequence	
		Setting	May be selected manually or automatically coupled to frequency span	
	Selectivity (60 dB/6 dB)		≦10: (Resolution bandwidth ≦ 1 kHz)	
Amplitude	Measuring range		Average noise level to +30 dBm	
	Display	Graticule	Vertical 8 division, reference level is the top line of graticule	
		LOG 10 dB/div	0 to −70 dB from reference level	
		LOG 5 dB/div	0 to −40 dB from reference level	
		LOG 2 dB/div	0 to −16 dB from reference level	
		LOG 1 dB/div	0 to −8 dB from reference level	
		LIN	12.5%/div	
		Linearity	±0.2 dB/1 dB, ±1.5 dB/70 dB	
	Reference level	Setting range	−105 to +30 dBm (LOG), −95 to +30 dBm (LIN)	
		Calibration output accuracy	−10 dBm ±0.3 dB (100 MHz ±10 kHz)	
		Reference level accuracy	±2.0 dB (Reference level −99 to −10 dBm, frequency 100 MHz, 0 dB input attenuator, and after calibration using CAL OUTPUT)	
		Frequency response	Depends on External Mixer	
	Average noise level		Depends on External Mixer (−100 dBm typical with 30 dB External Mixer Conversion Loss, 1 kHz resolution bandwidth)	
	Video bandwith		1 Hz to 3 MHz, 1, 3, 10 sequence May be selected manually or automatically coupled to frequency span	
Marker	Normal		Frequency and level of the marker position is displayed	
		Frequency readout resolution	1/50 of span/div or 1 kHz × n whichever greater	1/50 of span/div 10 kHz × n whichever greater
		Level readout resolution	1/100 of scale/div	
	Δ (delta)		Frequency and level difference of the two marker positions is displayed	
		Frequency readout resolution	1/50 of span/div	
		Level readout resolution	1/100 of scale/div	
	Peak		Marker always tracks the peak position and shows its frequency and level (Readout resolution is same as Normal Marker resolution)	
	MKR→CF		Marker frequency set to center frequency	
Local output for External Mixer			3 to 6 GHz, ≧ +7 dBm	