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MICROWAVE

Handheld Signal Analyzer

MSA500 series

The world's first handheld signal analyzer with REAL TIME plus SWEEP system

Signal analyzer MSA500 series offers both the real time system based on Fast Fourier Transform(FFT) and the conventional sweep system. Each strong point of both systems is effectively usable.

Strong and weak points of real time system and sweep system

Real time system

Strong points

1. The spectrum analysis of unsteady signal such as burst signal and noise is available.
2. The time domain analysis such as power vs. time, frequency vs. time, phase vs. time, IQ vs. time and Q vs. I is available.
3. Since the trigger function is substantial, the spectrum which rarely occurs can be also captured certainly.
4. Compared with OverWrite function in sweep mode, the spectra which are missed are much less.
   Especially, any spectrum isn't missed in the span narrower than 200kHz.
5. The change of frequency and power over time can be observed in spectrogram analysis.
6. Since the measured data is separated into I and Q data, modulation analysis of complicated signals such as phase modulation is possible.
7. The frequency accuracy is very high as ±0.5ppm±1 dot at all points of screen.

Weak point

1. The maximum frequency span is as narrow as 20MHz.

Sweep system

Strong points

1. The wide frequency range can be observed at a glance because the wide frequency span can be set.
2. The tracking generator can be equipped.
3. The EMI measurement conforming to the standard is possible.
4. Since the sweep mode is a system of the conventional spectrum analyzer, users are familiar with it and applications are also abundant.

Weak points

1. It is difficult to observe an unsteady signal, and even when it can be observed by using a MaxHold, it takes time to measure.
2. The analysis in time domain is only at the zero span mode.
3. The modulation analysis is impossible.
4. The frequency accuracy on the screen is inferior compared to real time mode.

Features of MSA500 series

1 Real time plus Sweep system

In real time system, the spectrum which occurs in an instant won't be missed. It is optimum for analyzing a noise and a transitional phenomenon. On the other hand, the sweep system is suitable for observing at wide frequency range. Various applications can be covered by making good use of advantage of each system.

2 Sufficient analysis functions

In real time system, Spectrogram analysis and OverWrite analysis can be performed besides Spectrum analysis.
Furthermore, Time domain analysis is also available.

3 Time domain analysis expanding analyzer capability

In real time system, time domain analyses such as power vs. time, frequency vs. time, phase vs. time, IQ vs. time and Q vs. I are possible.

4 Fast OverWrite analysis of 720 frames/ sec

Since OverWrite analysis in real time system is processed at high speed as 720 frames/sec, even unnecessary spectrum which appears rarely isn't missed.

5 Powerful trigger functions

In real time system, powerful trigger functions such as channel power trigger, power trigger, IF level trigger and external trigger can be used.

6 Real time operation by 20MHz maximum span

Since a signal can be observed with maximum span of 20MHz in real time system, the modulation signals of almost all of wireless communications can be captured.

7 Large memory of 16K frames and high speed USB communication

In real time system, data can be captured for a long time because the IQ memory is as large as 16K frames (64Mbytes). Moreover, IQ data can be transmitted to PC at speed of 19ms/frame.

8 Average noise level -162dBm/Hz

The average noise level of -162dBm/Hz at [MSA538/538TG/538E] and -157dBm/Hz at [MSA558/558E] is achieved.
At span 20kHz in real time mode, it is -140dBm and -135dBm respectively.

9 Compact and lightweight 1.8kg

The dimensions are as small as 162(W)×71(H)×265(D)mm, and the weight is only 1.8kg including the battery. It is very convenient for outdoor use and on business trip.

10 Four-hour battery operation

Lithium-ion battery MB400 (option) fully charged enables about four-hour battery operation at backlight off.

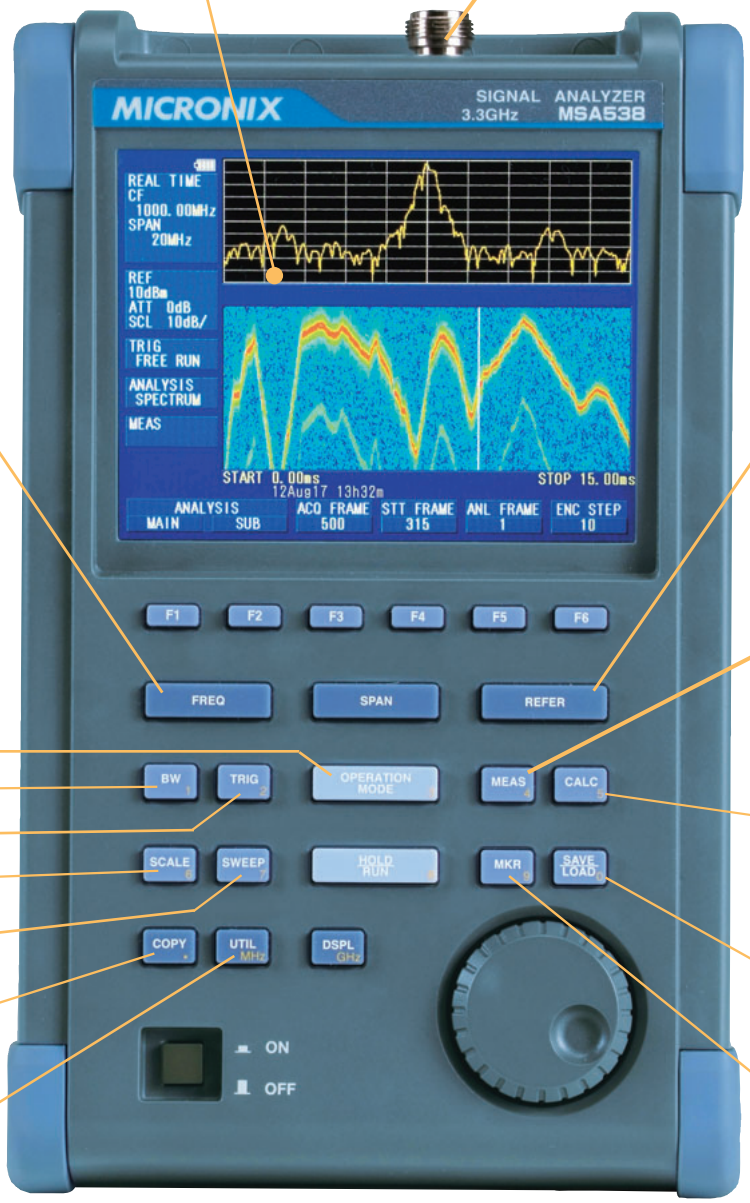
11 Data storage into USB memory

USB memory can be used as an external memory. The screen image is stored by BMP format. And the spectrum waveform, IQ data and setting parameters are stored by CSV format. Moreover, the screen image is copied on the optional USB printer as it is.

12 Functions comparable to a bench type

- Measuring functions : Channel power, Adjacent channel power, Occupied bandwidth, Electric field strength, Magnetic field strength and Noise measurement
- Calculation functions : MaxHold, MinHold, Averaging, OverWrite
- Marker measurement and peak search function

Model	Contents
MSA538	20kHz to 3.3GHz The most popular model
MSA558	20kHz to 8.5GHz Covering almost all wireless systems
MSA538TG	20kHz to 3.3GHz With TG from 5MHz to 3.3GHz
MSA538E	20kHz to 3.3GHz With 3.3GHz EMI measurement
MSA558E	20kHz to 8.5GHz With 8.5GHz EMI measurement



Setting of accurate center frequency by PLL synthesizer

Setting of reference level from +10 to -60dBm by 1dB step

Selection of real time mode or sweep mode

Setting of RBW and VBW

Setting of trigger

Setting of Y axis sensitivity (dB/div, Hz/div, °/div, V/div)

Setting of sweep time and detection mode

Printing on USB printer and storing image in USB memory

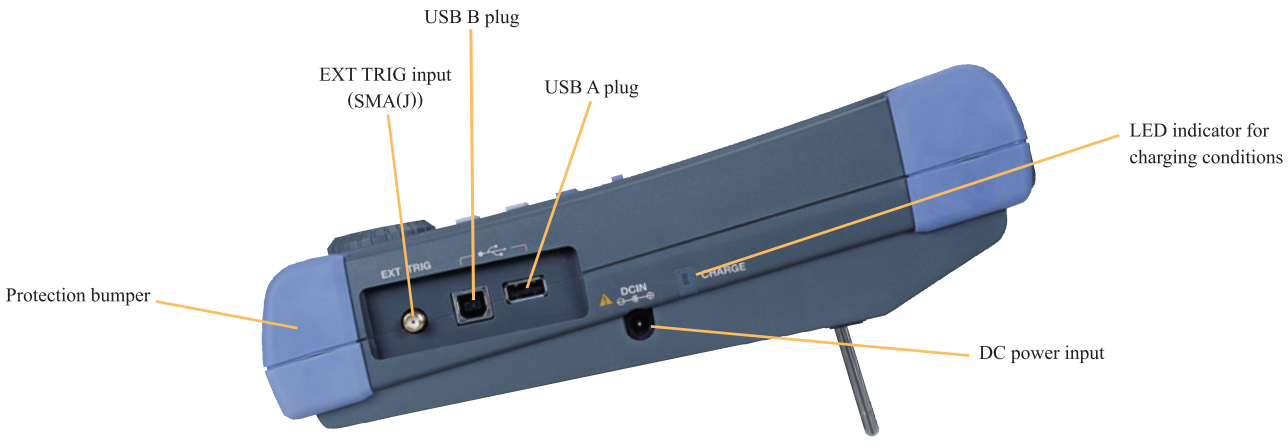
Label entry and others

Measuring functions
- Channel power
- Adjacent channel power
- Occupied bandwidth
- Electric field strength
- Magnetic field strength
- Noise

Calculation functions
- Max hold
- Min hold
- Averaging
- Overwriting

Spectrum and setting parameters are saved/loaded in/from internal memory or USB memory.

Marker measurement and peak search

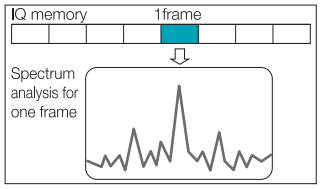


Explanation of real time mode

8 types of analysis functions

Spectrum analysis

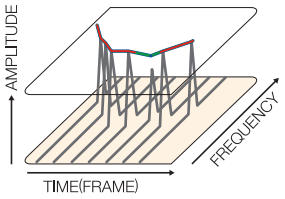
The biggest feature of real time mode is that all the signal spectra acquired in a certain period can be measured without being missed. In sweep mode, unless it is steady signal, some of spectra may be missed.
The span from 20kHz to 20MHz (1-2-5 step) and the center frequency with 100Hz resolution can be set.



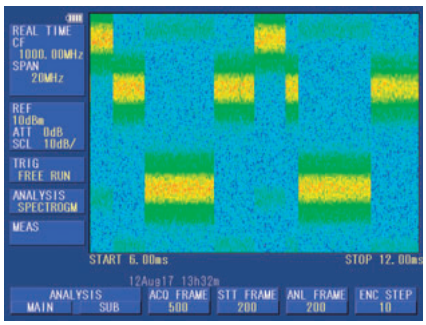
The data of the specified number of acquisition frames (16,383 frames maximum) is stored in IQ memory. One specified arbitrary frame (analysis start frame, 1024 data) of the stored data is calculated for spectrum.

Spectrogram analysis

The spectrogram is displayed by the three dimensions of time (frame) axis (X), frequency axis (Y) and power axis (Z) (magnitude is expressed by colors). In short, the time response of frequency and power can be observed by X-Y axis and by X-Z axis respectively.



Setting : X axis : Analysis start frame, Number of analysis frames
Y axis : Center frequency, Span

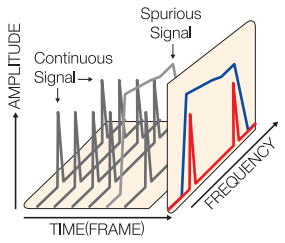


Application
Observation of frequency hopping

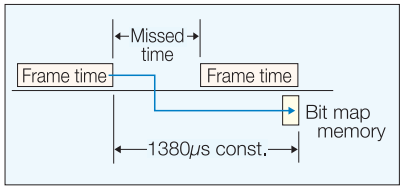
The time until the frequency and power, which instantaneously change, get stable can be observed.

OverWrite analysis

OverWrite is a function in which the spectrum waveform of each frame is piled up and then displayed. The spectrum waveform is continuously accumulated at the rate of 720 frames/sec. The occurrence frequency is expressed by colors. The trigger function cannot be used. The spurious response (unnecessary spectrum) which rarely appears can be captured.

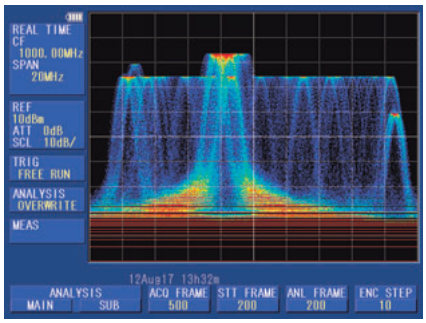


There is no guarantee that all spectra will be completely captured at all spans. As shown in the following table, some spectrum waveforms may be missed due to the span setting. However, any spectrum will not be missed in the span narrower than 200kHz.



span	Frame time	Missed time
20MHz	30μs	1350μs
10MHz	60μs	1320μs
5MHz	120μs	1260μs
2MHz	300μs	1080μs
1MHz	600μs	780μs
500kHz	1.2ms	180μs
200 to 20kHz	3 to 30ms	0μs (Not missed)

Setting : X axis : Center frequency, Span
Y axis : Reference level, Scale (2, 5, 10dB/div)
Accumulation frame number : 200, 500, 1000, 2000, 5000, ∞ frame



Application
Observation of unnecessary spectrum which appears rarely

The unnecessary spectrum (spurious) which disturbs a communication system may appear rarely. When span is wide, some spectra may be missed, but the probability of capturing spurious signal increases by setting the large accumulation frame number.

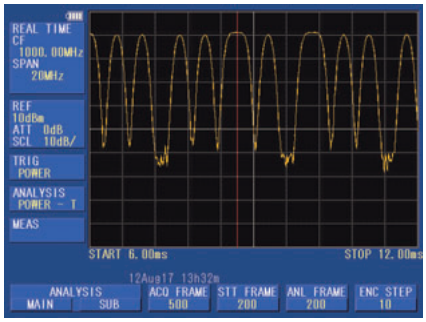
Time domain analysis

It is the big feature of MSA500 series that time domain analysis is available. The sampling frequency can be calculated by the following equation.

Sampling frequency=(34MHz*specified span)/20MHz

1 Power vs. time
The power is calculated from IQ data and its time response is displayed.

Setting : X axis : Analysis start frame, Number of analysis frames
Y axis : Offset, Scale (1, 2, 5, 10dB/div)

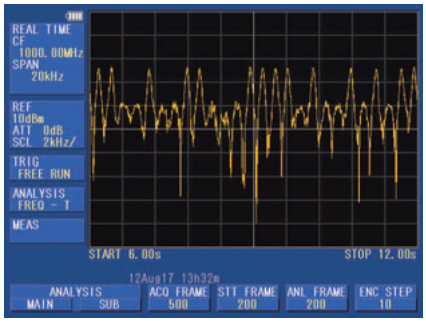


Application
Observation of ASK modulation signal

The ASK signal, which is appeared in burst and whose amplitude is digitally modulated, can be observed.

2 Frequency vs. time
The frequency is calculated based on the phase data and sampling time, and then the time response of the frequency is displayed. The frequency is 0Hz when the frequency doesn't change.
However, when the input frequency isn't coincident with the center frequency, the frequency difference is displayed as an offset.

Setting : X axis : Analysis start frame, Number of analysis frames
Y axis : Frequency (1,2,5,10%/div of span…actually,displayed by "Hz/div" coupled with span)

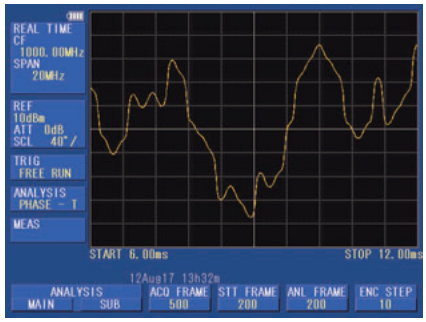


Application
Observation of FM modulation signal

The signal waveform which is modulated by frequency can be observed.

3 Phase vs. time
The phase is calculated based on the IQ data, and the time response of the phase is displayed.

Setting : X axis : Analysis start frame, Number of analysis frames
Y axis : Offset, Scale (5, 10, 20, 40°/div)



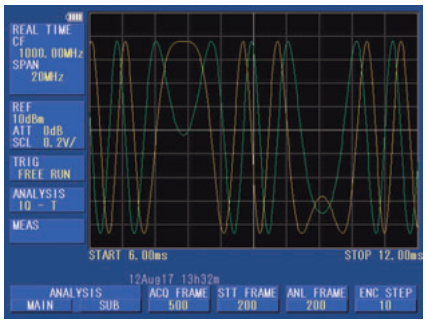
Application
Phase waveform of QPSK modulation

It can be observed how the phase of the QPSK modulation wave changes over time.

④ IQ vs. time

Two waveforms of "I versus time" and "Q versus time" are displayed. The time domain waveforms of I and Q of phase modulation such as QPSK can be observed directly.

Setting : X axis : Analysis start frame, Number of analysis frames
Y axis : Offset, Scale (0.1, 0.2, 0.4V/div)

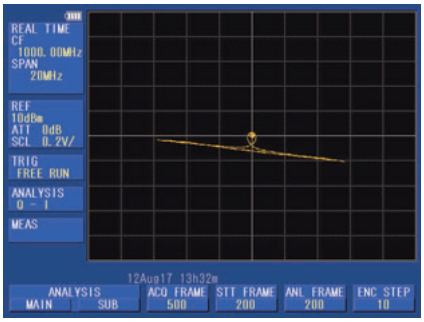


Application
I and Q waveforms of QPSK modulation.

⑤ Q vs. I

I data and Q data are set to X axis and Y axis respectively, and indicated by polar coordinates. The raw constellation waveform can be observed. It does not include the initial phase compensation and the frequency difference compensation of digital phase modulation.

Setting : Analysis start frame, Number of analysis frames



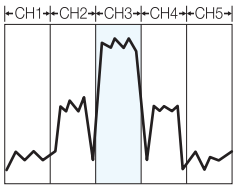
Application
Measurement of BPSK modulation

This observation example shows the constellation of digital phase modulation BPSK.

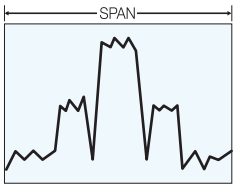
Trigger function

Since MSA500 series is equipped with the powerful trigger function, the desired signal will be able to be captured in every application exactly. In addition to the trigger source and pre-trigger described below, trigger mode to select "free run" or "trigger" is available. Also, scan mode to select "single" or "continuous" is available.

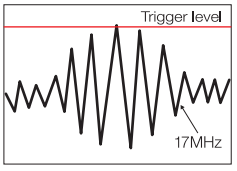
Trigger source



①Channel power trigger
Span is equally divided into five channels (CH1 to CH5). When the instantaneous value of whole power in the specified channel crosses the trigger preset value, the trigger signal is generated. The slope of "rising" or "falling" can be also set. It is convenient when acquiring the hopping signal.



②Power trigger
When the instantaneous value of whole power in the screen crosses the trigger preset value, the trigger signal is generated. The slope of "rising" or "falling" can be also set.

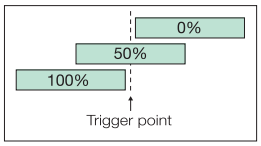


③IF level trigger
When the level of IF signal (modulated with 17MHz) crosses the trigger preset value, the trigger signal is generated. The slope of "rising" and "falling" is not available.

④External trigger
The trigger signal is generated by the signal input to EXT TRIG connector. The input voltage range is from 1 to 10Vp-p, and the frequency range is from DC to 5MHz. The slope of "rising" or "falling" can be also set.

Pre-trigger

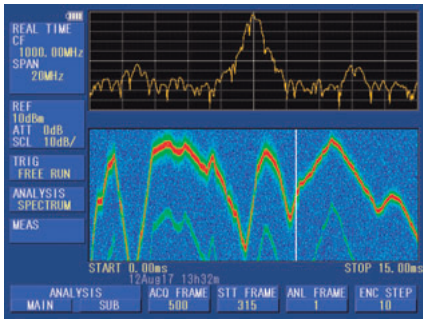
By setting Pre-trigger, the signal before a trigger point is analyzable. When Pre-trigger is set to 0%, the signal after trigger point is captured. When being set to 50%, each 50% of signal after and before trigger point is captured.



When being set to 100%, the signal before trigger point is captured. Five positions can be set 0% to 100% in 25% step.

Screen display

There are two ways of screen display. One is Single view displaying one waveform. Another is Dual view displaying two waveforms.



Dual view consists of MAIN screen (upper screen) and SUB screen (lower screen). The waveforms displayed on MAIN screen and SUB screen are as follows.

Single view	Dual view	
	MAIN screen	SUB screen
·Spectrum ·Spectrogram ·OverWrite ·Power vs. time ·Frequency vs. time ·Phase vs. time ·IQ vs. time ·Q vs. I	·Spectrum ·Spectrogram ·Power vs. time ·Frequency vs. time ·Phase vs. time ·IQ vs. time ·Q vs. I	·Power vs. time ·Spectrogram

Large IQ memory of 16K frames

The data after A/D conversion is separated into I and Q. These I and Q data are led to DDC (Digital Down Converter), and then DDC output data is stored in IQ memory of 16K frames (16,383 frames, 64Mbytes). The number of acquisition frames is specified for IQ memory beforehand.
This IQ data besides displayed waveform can be transferred to PC by USB communication.
The longest continuous record time is shown by the below equation.

Longest continuous record time = 30.112μs ＊ (20MHz / specified span) ＊ 16,383

For example, when the specified span is 1MHz, the longest continuous record time will be 9.87seconds, so that the analysis for a long time is possible.

USB communication and modulation analysis on PC

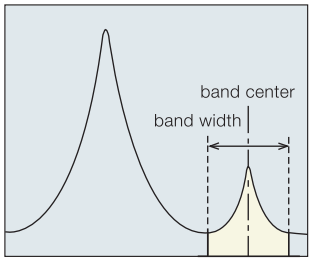
MSA500 series has the large IQ memory of 16K frames (64Mbytes). The data can be transferred as fast as 19ms/frame from IQ memory to PC through USB interface. The modulation analyses such as EVM measurement and constellation display can be accomplished by demodulating the transferred IQ data on PC. The transfer time of 100 frames of IQ data is only 1.9 seconds.
It is very useful for the analysis of the digital phase modulation such as QPSK and QAM. However, it is necessary to design PC software at the user side. Moreover, the size of the transfer data by USB communication is shown in the following table.

Kind of data	USB transfer data
IQ data	64MByte maximum
Spectrum waveform	Sweep mode : 1001×2Bytes Real time mode : 501×2Bytes

Measuring functions

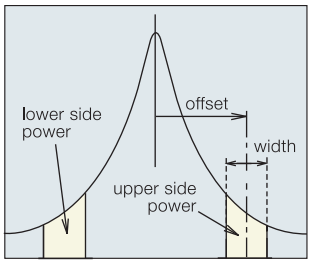
Channel power measurement

The sum of power in the band specified by band center and band width (colored area) is measured. In short, it is possible to measure the total power in the specified frequency band. Of course, this function enables to measure a noise power.
There is also a function which displays the average power in the specified zone besides the total power.



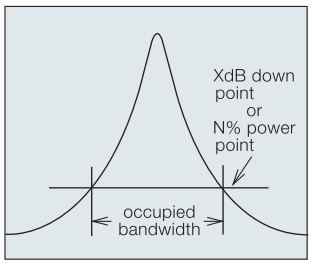
Adjacent channel power measurement

The adjacent channel leakage power is measured as the ratio of power in the range specified by offset frequency and bandwidth (colored area) to carrier power. Both of leakage power at the upper and lower side are measured.
Furthermore, the method for measurement is selected out of three methods based on the classification of definition of carrier power ; total power method, reference level method and in-band method.



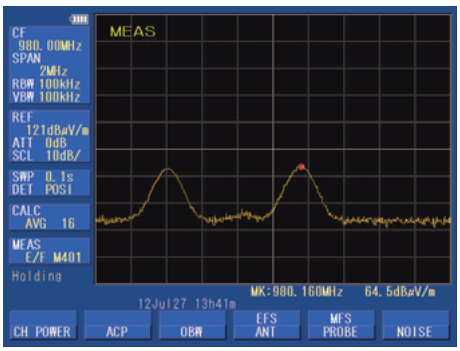
Occupied bandwidth measurement

It is possible to measure the occupied frequency bandwidth defined as the width of points that are X(dB) lower than the peak level, or as the width of points at N(%) of the total power.

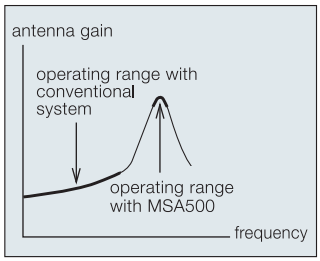


Electric field strength measurement

A dipole antenna (option) connected to the RF input enables the measurement of the electric field strength. According to the measuring frequency band, one antenna can be chosen from seven kinds of antennas. M401 is mainly for LTE, RFID and MCA, M402 is mainly for LTE and GPS, M403 is mainly for LTE, W-CDMA and CDMA2000, M404 is mainly for 2.4GHz wireless LAN, WiMAX, ZigBee and Bluetooth, M405 is mainly for smart entry, M406 is mainly for 5GHz wireless LAN and 5.8GHz DSRC (ETC), and M407 is mainly for digital terrestrial television broadcasting.

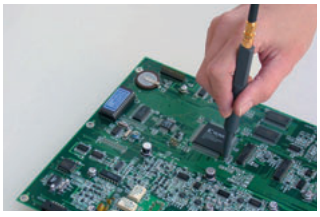


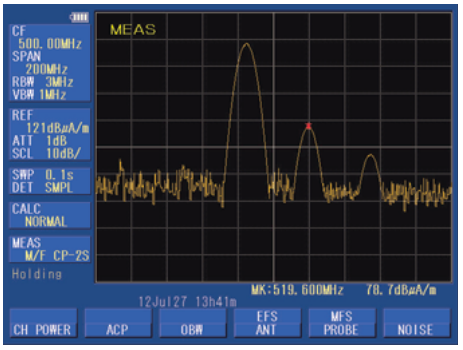
The conventional method covering the wide band with a single antenna results in low antenna gain because of using the range away from an antenna resonance point, and the dynamic range extremely worsens as a result. To use a resonance point where the antenna gain is high, seven kinds of antennas are provided according to the frequency bands. Therefore,each antenna secures a wide dynamic range. Antennas of other bands will be also provided if requested.
Since the electric field strength is calibrated for each antenna in MSA500 series, it is possible to directly read the measured value.
Moreover, the electric field strength is also measured with an user's antenna besides antennas from M401 to M407 if "USER" antenna is selected.
Furthermore, the power density (dBμW/m^2) and magnetic field strength (dBμA/m) can be measured by calculating based on the electric field strength.



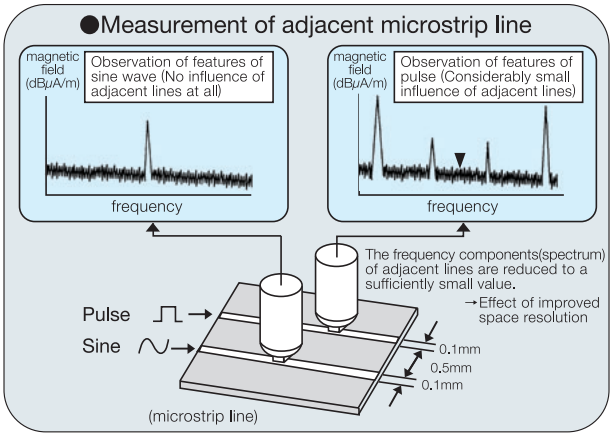
Magnetic field strength measurement

MSA500 series measures precisely the magnetic field distribution on LSI or PCB using the magnetic field probe CP-2S (option). As the magnetic field detection portion of CP-2S is of a shielded loop structure using a glass ceramic multi-layer board technology with excellent high frequency characteristics, it enables the measurement with high reproducibility by detecting magnetic field components only. The measuring frequency range is as broad as 10MHz to 3GHz, and the measured value is calibrated in the instrument.



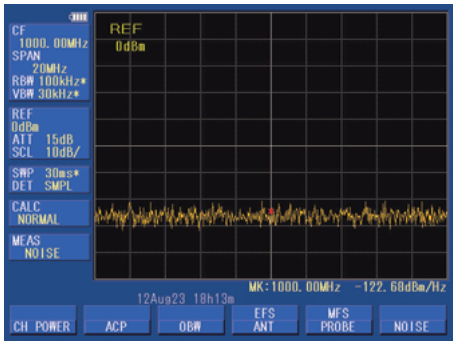


The typical applications of CP-2S are the evaluation of effectiveness of a bypass capacitor located at a power supply terminal of LSI and the evaluation of wiring rule of PCB. CP-2S is not affected by adjacent patterns because of high space resolution.



Noise measurement

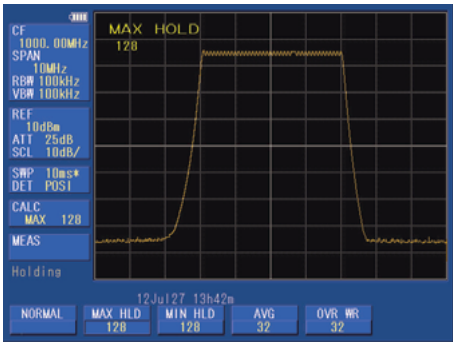
The amount of noise is measured. The unit can be selected from dBm/BW, dBμV/√BW, dBmV/√BW and dBV/√BW. Moreover, the bandwidth BW can be set to a value of 1Hz to 3MHz (1-3 step). If BW is set to 1Hz, the unit of noise will be expressed as dBm/Hz or dBμV/√Hz.



Calculation functions

Max hold

The update spectrum data is compared with the data left last time at each point on X axis, and the larger one is retained and displayed. The number of times of the sweep (number of times of the scan in real time mode) can be set in the range from 2 to 1024 times by a power of 2, or by infinite. It is possible to observe a burst signal generated intermittently like a cellular phone and a frequency drift. In addition, this function is effective when the maximum level such as EMI test should be measured.

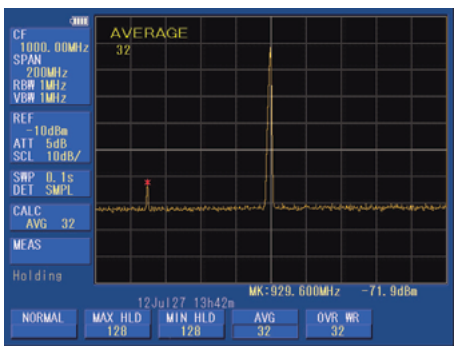


Min hold

The update spectrum data is compared with the data left last time at each point on X axis, and the smaller one is retained and displayed. The number of times of the sweep (number of times of the scan in real time mode) can be set in the range from 2 to 1024 times by a power of 2, or by infinite.

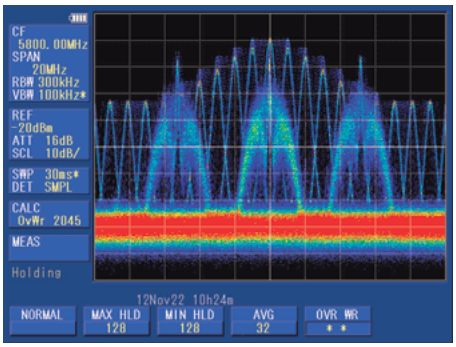
Averaging

The simple averaging processing is executed at each sweep (at each scan in real time mode). The number of times of the averaging can be set in the range from 2 to 1024 times by a power of 2. Even the spectrum buried in noise is observed.



OverWrite

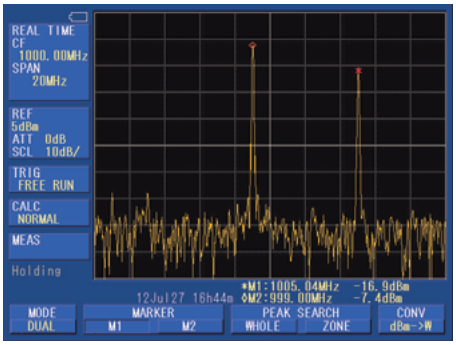
The image on the screen is not cleared at each sweep (at each scan in real time mode), and the overwriting display is executed. The number of times of overwriting can be set in the range from 2 to 1024 times by a power of 2, or by infinite. This function is, therefore, convenient for observing a process of changes of the signal. Moreover, it is effective for observing a signal occasionally generated.
In real time mode, this function should be selected in analysis function.



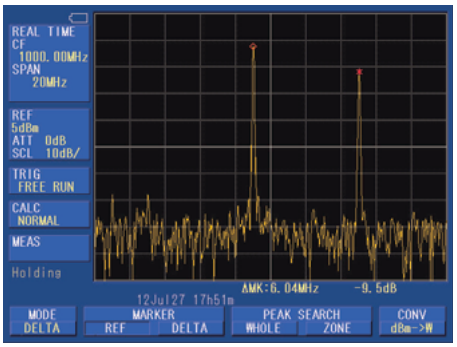
Marker and Peak search

Marker measurement

Two different modes are available for the marker measurement. One is SINGLE or DUAL marker mode to calculate and display the frequency (maximum effective digits : 8) and the level (maximum effective digits : 4) at one or two marker points respectively. And another is DELTA marker mode to calculate and display the frequency difference and the level difference between two markers (one of which is the reference marker).
Marker measurement cannot be applied in OverWrite mode.



DUAL marker measurement

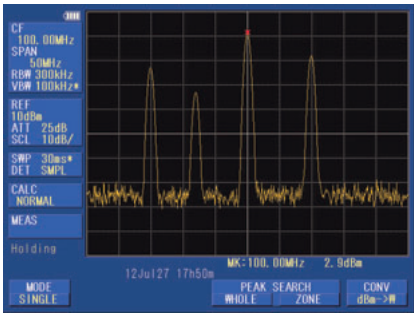


DELTA marker measurement

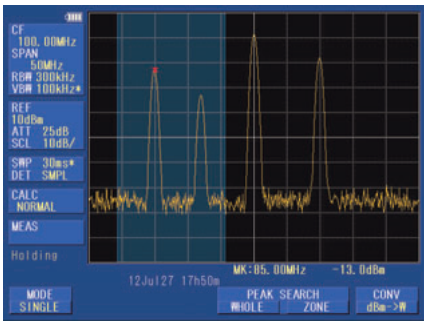
Peak search

Two different modes are available for the peak search. One is WHOLE peak search mode to search for a peak level within all of 10div of the frequency axis as the search range. And another is ZONE peak search mode to search for a peak level in the range specified by the center value and width.

At WHOLE mode, the marker moves to a peak level only when the search key is pushed, but at ZONE mode, it follows to a peak level at each sweep (each scan at real time mode). In addition, the NEXT search to search for the next higher level is permitted in WHOLE peak search mode.
Furthermore, there is a function to convert the unit into such linear system as Watt from such dB system as dBm.



WHOLE
peak search



ZONE
peak search

Storage of measurement data

The following four methods allow you to store the spectrum waveform, IQ data and the setting parameters. The storage data is easily managed because the label or the file name is attached to the collected data.

- Label function

The named label is displayed in the label area on the screen. As for the characters, four kinds of numerals (0 to 9), sma11 1etter alphabet (a to z), capital letter alphabet (A to Z) and marks (@, #, ! and etc.) are available. The number of characters is 16 or less.

Label example : BASE352acp8 (refer to screen in next item)

This label is useful as a comment sentence in case of storing the screen image by BMP format in USB memory, or printing on the printer. Furthermore, it is used as a part of the file name at SAVE/LOAD function.

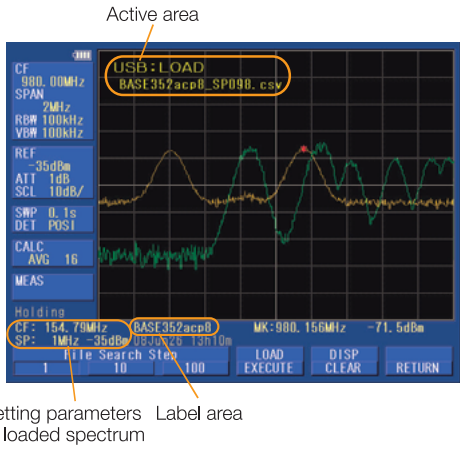
Storage into USB memory

The storage into USB memory is executed with SAVE/LOAD key or COPY key.

USB memory

- Storage with SAVE/LOAD key

The data is stored in USB memory by CSV format. The data which can be stored are spectrum waveform, IQ data and setting parameters. It is managed by the file name as shown below, and the file name is displayed in the active area on the screen when pushing SAVE/LOAD key.



File name : BASE352acp8_SP 098
① ② ③

① The named label is pasted.

② The type of storage data chosen is attached.

S : spectrum, **I** : IQ data, **P** : setting parameters,
SP : spectrum+setting parameters, **IP** : IQ data+setting parameters

③ The consecutive number is automatically attached only to the same label name.

Only one spectrum is loaded on the screen, and at the same time the setting parameters attached to the spectrum are displayed on the screen.

- Storage with COPY key

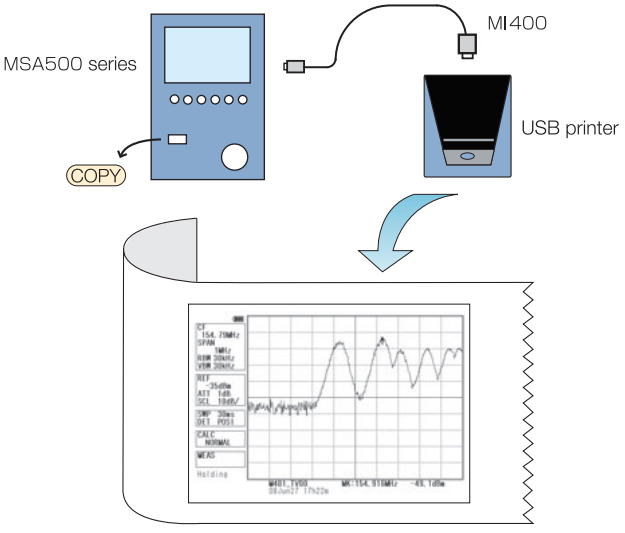
The number of storage data is not limited and depends only on the capacity of USB memory. The whole screen image (excluding function menu) or the waveform area image (excluding active area) can be selected, and it is stored by BMP format. This storage data cannot be loaded on the screen of MSA500 series. Besides, it is possible to transfer the storage data in the internal memory to USB memory in a lump sum.

Storage into internal memory

The operation of SAVE, LOAD or DELETE is achieved in the same way as "Storage with SAVE/LOAD key" in the item of USB memory. The data which can be stored is only spectrum waveform and setting parameters. However, the number of storage data is limited to 200 data or less.

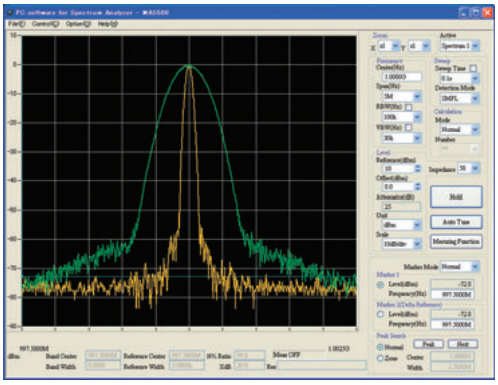
Print on printer

The MSA500 series enables a hard copy of the screen by connecting USB printer (option) to USB A plug with USB cable MI400 (option).
Comes into the print mode when pushing COPY key. Since the printer corresponds to two kinds of power supplies of dedicated AC adaptor and dry battery, the hard copy of the screen image is easily accomplished even in the open where there is no AC power supply. The dry battery allows the hard copy of almost 140 images.



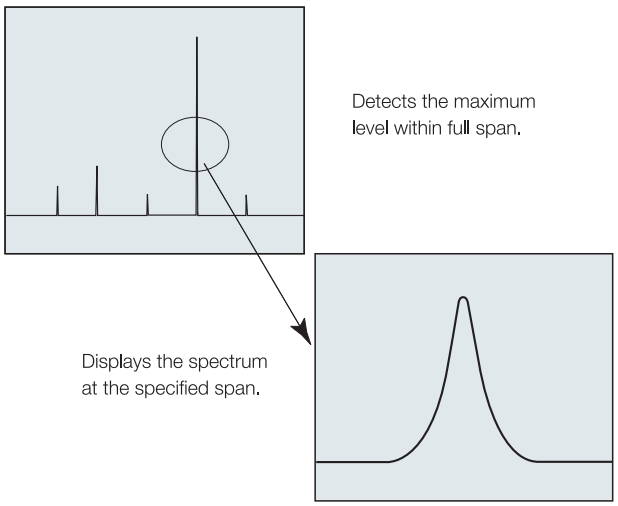
Storage with PC software and Logging software

It is possible to store the data in the PC by using PC software MAS500 (option), which enables to set the setting parameters with the PC and display the measured waveform on the PC screen.
In addition, Logging software MAS510 (option) makes it possible to collect the data by uninhabited for a long time and store them.



Auto tuning

When pushing AUTO TUNE key which is one of function keys of FREQ key, the spectrum with the maximum level is searched within full span (3.3GHz@MSA538/538TG/538E and 8.5GHz@MSA558/558E), and then it is adjusted to the center of the screen and set to optimum reference level. That spectrum is displayed on the screen at the specified frequency span. Moreover, resolution bandwidth, video bandwidth and sweep time are automatically set to the optimum parameters based on the span.
This function is very convenient when the unknown signal is measured.
Valid only in sweep mode.



Easy operation by AUTO mode

Resolution bandwidth, video bandwidth and sweep time are set automatically based on the specified frequency span. Furthermore, it is also possible to automatically set one or two parameters of either resolution bandwidth, video bandwidth or sweep time.
The operator is released from troublesome operation because these three parameters accompanying the frequency span are set automatically. Auto operation is valid only in sweep mode.
Moreover,the input attenuator and the IF amplifier are automatically set to the optimum values based on the reference level.

Battery operation

Almost four hours battery opeation (at backlight off) has been achieved without enlarging the main body by adopting a lithium-ion battery (MB400, option) as a built-in battery. The battery is easily installed or removed because the cover is removed by hand without any tool.
In addition, the battery fuel gauge is displayed on the screen with five levels.

- Battery charge

The time from empty state to full charge is only almost four hours because each model is equipped with the rapid charging circuit.
Under the conditions of power-off and connecting the AC adaptor MA400 of a standard accessory, the battery is charged. The charging conditions are indicated by two colors LED on the right side as shown in the table below.

Charging condition	Color of LED
On charge	red
Completion of charge	green
No battery	green
Abnormal	blinking in red

※LED is turned off at power-on.

The abnormal condition means that the charging time is more than the time decided beforehand, or that the battery voltage becomes too high.

with Tracking Generator

MSA538TG

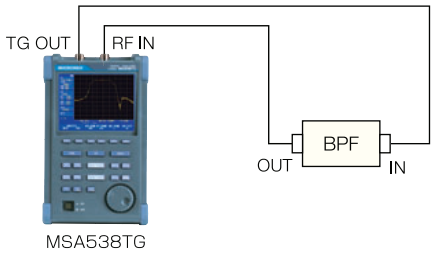
MA430

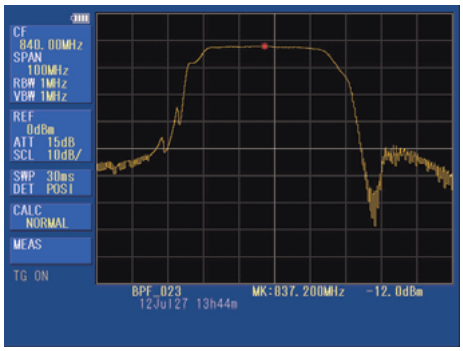
MVS300B

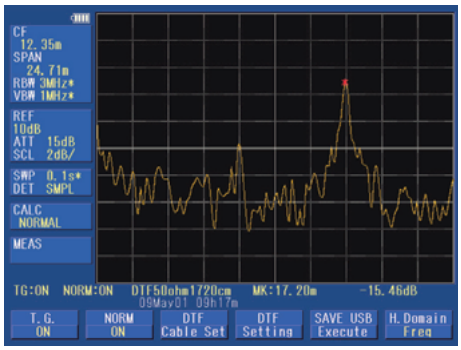
The tracking generator is a signal source which generates the sine wave synchronizing with the sweep, and is valid only in sweep mode.
For example, the tracking generator outputs 1MHz sine wave when the signal analyzer is at 1MHz sweep point. The 1GHz is output at 1GHz sweep point as well. Therefore, the amplitude frequency characteristics of various electronic components and circuits can be observed on the screen without any troublesome operation.
Moreover, DTF adapter MA430 (option) and VSWR bridge MVS300B (option) enable the measurements of the distance to discontinuity point of cable and of the return loss respectively.

Frequency response of filter

The input and the output of a filter are connected to TG OUT and RF IN respectively. The frequency response of a filter is observed in the range of 5MHz to 3.3GHz.
The frequency response of the coaxial cable and MSA538TG is compensated by using the NORMALIZING function.

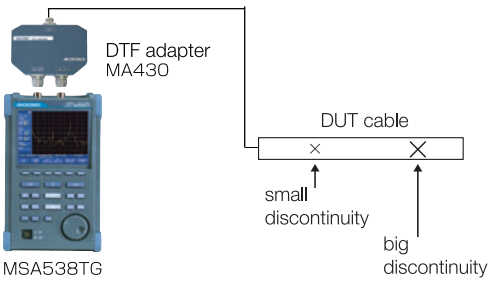






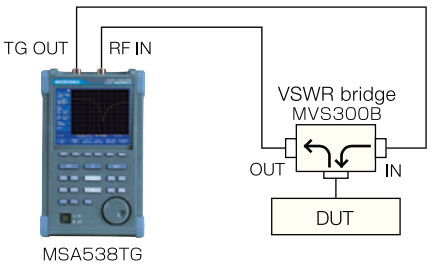
DTF measurement

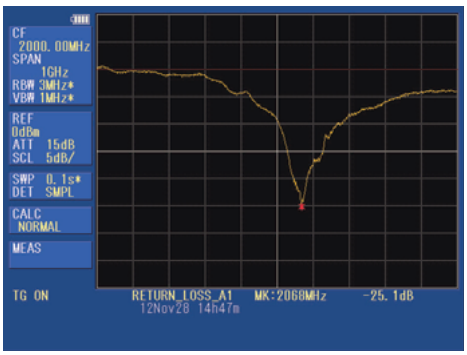
The distance to discontinuity point of cable and the length of normal cable can be measured. The cable length to be measured is 0.3 to 1,000 meters for 50Ω cable and 1 to 400 meters for 75Ω cable. The conventional TDR method has been able to detect only maximum reflection point, but MA430 will not miss even a small discontinuity point.



Return loss measurement

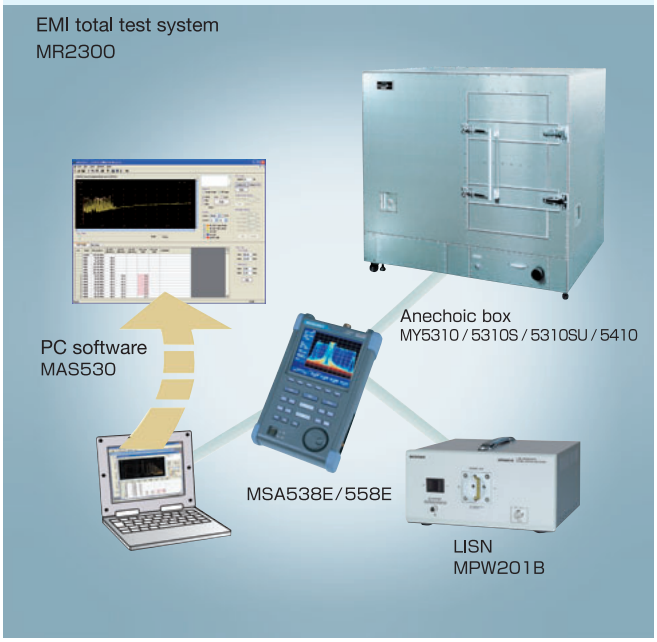
VSWR bridge MVS300B (option) connected to TG OUT and RF IN of MSA538TG enables the return loss measurement. The measured frequency range is from 5MHz to 3GHz.
Additionally, the calibration of the return loss 0dB is done by using the NORMALIZING function.





for EMI Test

MSA538E/558E



MSA538E/558E is a key instrument of EMI measurement. Since it has functions such as PK detection, QP detection, AV detection and RBW 9kHz/120kHz/1MHz (6dB), it enables the radiated emission measurement and the conducted emission measurement for precompliance.
Furthermore, the magnetic field probe CP-2S (option) finds out the source of disturbance noise.

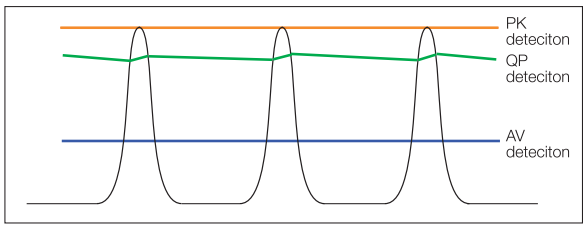
Measurement mode and Preset

Three measurement modes shown below are available. The troublesome setting for EMI test is unnecessary because the parameters corresponding to the measurement mode are automatically preset.

Measurement mode	Function key	Preset
Normal measurement	NORM (F1)	Presets initial parameters of normal mode
Conducted emission measurement	EMI-C (F2)	Presets initial parameters of conducted emission mode
Radiated emission measurement	EMI-R (F3)	Presets initial parameters of radiated emission mode

Detection mode

MSA538E/558E has three detection modes of PK (peak), QP (quasi-peak) and AV (average). This mode is valid only in sweep mode. As for the detection level, the relational expression of PK ≧ QP ≧ AV is valid as shown in the figure below. Additionally, PK=QP=AV is correct in case of a narrow bandwidth signal like CW wave.



The PK detection is achieved by setting the measurement mode to normal measurement, the detection mode to positive peak and the calculation function to MaxHold.
When observing a disturbance noise, the PK detection enables the fast sweep because its time constant is much smaller than QP or AV.
Therefore, it is convenient to use the PK detection when narrowing the disturbance noise spectrums out of specification down to small number.

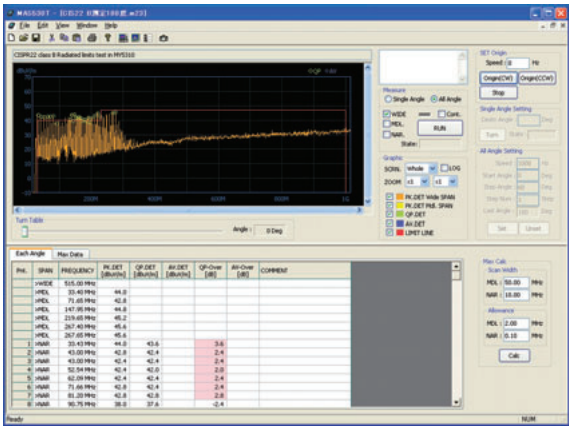
The QP detection is usually used in both of the radiated and conducted emission measurements, and the AV detection is usually used in the conducted emission measurement. The measurement time is shortened if they are finally used only for the measurement of the spectrums narrowed down by the PK detection.

Resolution bandwidth (RBW)

CISPR standard provides that the radiated (30 to 1,000MHz) and conducted emissions should be measured with RBW filters of 9kHz and 120kHz respectively. The radiated emission above 1GHz should be measured with RBW 1MHz. The bandwidth is defined as 6dB width. MSA538E/558E also has nine RBW filters besides these three filters, whose bandwidth at 3dB is from 300Hz to 3MHz (1-3 step).

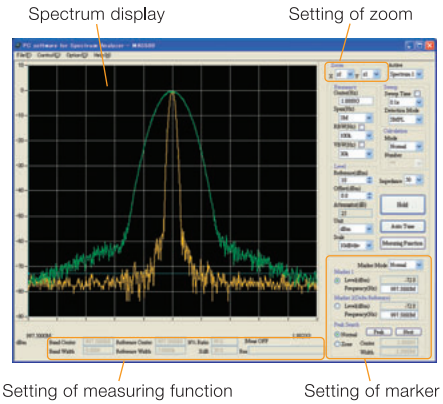
Horizontal axis data of 1001 points

Although the spectrum is displayed by 501 points on the horizontal axis of the screen of MSA538E/558E, it is captured by 1001 points per sweep in the instrument. All of these 1001 points are transferred to a personal computer and displayed on the PC screen after processed by PC software MAS530. The image, therefore, becomes clearer.



Option

PC software MAS500



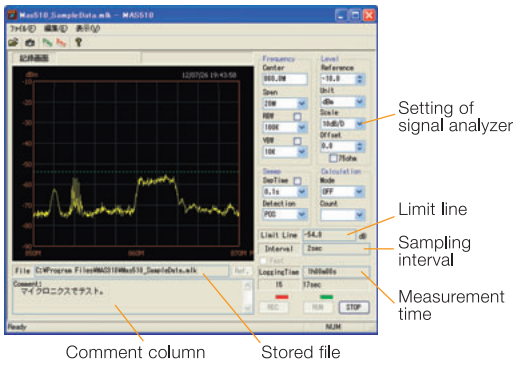
MAS500 is a software that controls the signal analyzers of five models by the PC and displays the spectrum waveform on PC screen.
The screen image is stored by BMP format and the spectrum waveform is stored by CSV format.
Furthermore, the IQ data in real time mode can be transferred to PC at a rate of 19ms/frame.

Logging software MAS510

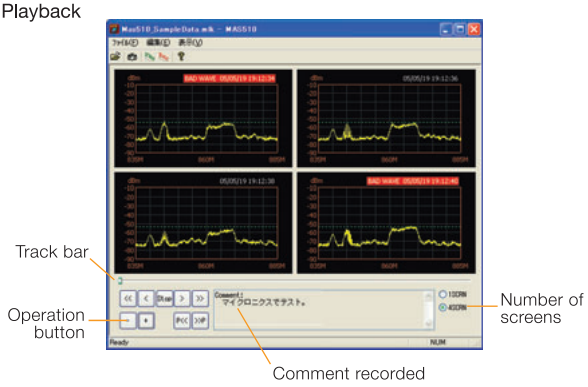
MAS510 is a logging software that collects the measurement data by uninhabited. It is optimum for watching an abnormal signal at night and recording the data by uninhabited for a long time.

- Logging at specified frequency band, sampling interval and measurement time.
- Makes it possible to fast-forward and fast-rewind the images in the file like a video recorder, and moreover, to jump to the image with spectrum exceeding the limit line.
- ERROR is automatically displayed when the signal exceeding the limit line is input.

Recording



Playback



DTF adapter MA430

Distance range :
0.3 to 1,000 meters @50Ω cable
1 to 400 meters @75Ω cable
Cable characteristics list :
111 types of cables @50Ω cable
11 types of cables @75Ω cable
Option : 50Ω measurement kit
75Ω measurement kit

VSWR bridge MVS300B

Frequency range : 5 to 3000MHz
Directivity : more than 40dB @50 to 3000MHz
more than 25dB @5 to 50MHz
Insertion loss :
less than 7dB @SOURCE to DUT
less than 8dB @DUT to REFLECTED
Dimensions : 50(W)×32(H)×113(D)mm
Weight : approx.240g
Connectors : SMA(J) (for three ports)

Antenna

Dipole antenna M401 to M407

Model	Freq.range	Antenna gain (typ)	VSWR	Dimensions	Weight
M401	0.8 to 1GHz	2.15dBi	<1.5	7.5φ×280mm	65g
M402	1.25 to 1.65GHz	2.15dBi	<1.5	7.5φ×280mm	65g
M403	1.7 to 2.2GHz	2.15dBi	<1.8	7.5φ×210mm	65g
M404	2.25 to 2.65GHz	2.15dBi	<1.8	7.5φ×210mm	65g
M405	300 to 500MHz	2.15dBi	<1.5	8.0φ×212mm	62g
M406	4.8 to 6.2GHz	2.15dBi	<1.8	7.5φ×152mm	65g
M407	470 to 770MHz	2.15dBi	<1.5	8.0φ×138mm	56g

1) Antenna gain and VSWR are specified at a center of frequency range.
2) Connector : N(P)

Loop antenna MAN120

Antenna suitable for detection of low frequency signal and noise.

Frequency range : 50kHz to 33MHz
Dimensions : 420(φ)×13(T)mm
Weight : approx. 1.2kg

Biconical antenna MAN150

Broadband, compact and lightweight antenna.

Frequency range : 20MHz to 3GHz
Gain : -45 to +1dBi
Antenna factor : 20 to 51dB/m
Dimensions : 350(L)×160(W)×140(D)mm
Weight : approx. 350g

Low noise amplifier MAP301/302

Available for a preamplifier of signal analyzer.

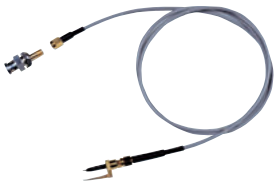
Item	MAP301	MAP302
Freq. range	100kHz to 500MHz	20MHz to 3GHz
Gain	50dB	20dB
Noise figure	3.5dB	3.5dB

Probe

Magnetic field probe CP-2S

Frequency range : 10MHz to 3GHz
Space resolution : approx.0.25mm
(depending on objects)
Dimensions : outside 12ϕ×135mm
probe tip 2mm(W)×1mm(T)
Connector : SMA(P)

Wideband passive prove MP300



MP300 is a passive probe with low input capacitance and wide frequency band. It should be connected to the instrument with 50Ω input.

Frequency range : DC to 6GHz
Attenuation ratio : 10 : 1, ±2%
Input resistance : 500Ω ±2%
Input capacitance : 0.25pF(typ)
Connector : SMA(P)

USB printer

(With AC adaptor and one rollpaper)

※Option : Rollpaper (10 rolls)

Printing method : Thermal line dot method
Paper : 80mm width thermal paper
Power source :
internal : AA-sized alkaline battery(4 pcs)
external : 7.5VDC/3A(dedicated AC adapter)
Dimensions : 134(W)×60(H)×180(D)mm
Weight : approx.450g (mainframe only)
Interface : USB 2.0

Lithium-ion battery MB400

7.4V/5000mAh

USB cable MI400

Connector : A plug / B plug
Length : 1m

Coaxial components

Coaxial attenuator MG-XXdB

Model	Attenuation error		VSWR	Rated power
	DC to 12.4GHz	12.4GHz to 18GHz		
MG-1dB, 2dB, 3dB, 4dB	＜±0.5dB	＜±1dB	＜1.15@DC to 4GHz ＜1.2@4 to 12.4GHz ＜1.3@12.4 to 18GHz	1W
MG-5dB, 6dB, 7dB, 8dB	＜±0.7dB	＜±1.2dB		
MG-9dB,10dB,12dB,13dB	＜±1.0dB	＜±1.25dB		
MG-14dB, 15dB, 20dB	＜±1.2dB	＜±1.3dB		
MG-30dB	＜±1.2dB @DC to 8GHz		＜1.2@DC to 8GHz	

※Connector, impedance : SMA(P)/SMA(J), 50Ω

Terminator

Model	Freq. range	VSWR				Rated power	Connector
		DC to 4GHz	4 to 8GHz	8 to12.4GHz	12.4 to18GHz		
MG-50S	DC to18GHz	＜1.08	＜1.10	＜1.15	＜1.20	0.25W	SMA(P)
MG-50N	DC to 8GHz	＜1.2 @DC to 8GHz				2W	N(P)

※Impedance : 50Ω

Coaxial cable

Model	Connector	Length	Freq. range
MC102	SMA(P)/BNC(P)	1.5m	DC to 2GHz
MC201	SMA(P)/SMA(P)	0.5m	DC to 18.5GHz
MC202	SMA(P)/SMA(P)	3m	DC to 18.5GHz
MC203	SMA(P)/SMA(P)	4m	DC to 18.5GHz
MC204	SMA(P)/SMA(P)	1.5m	DC to 12.4GHz
MC301	SMA(P)/SMA(P)	0.5m	DC to 10GHz
MC302	SMA(P)/SMA(P)	1m	DC to 10GHz
MC303	SMA(P)/SMA(P)	1.5m	DC to 10GHz
MC304	SMA(P)/N(J)	0.2m	DC to 4GHz
MC305	SMA(P)/N(P)	0.2m	DC to 4GHz
MC306	SMA(P)/BNC(J)	0.2m	DC to 2GHz
MC307	SMA(P)/BNC(P)	0.2m	DC to 2GHz
MC308	N(P)/N(P)	0.5m	DC to 10GHz
MC309	N(P)/N(P)	1m	DC to 10GHz
MC310	N(P)/N(P)	1.5m	DC to 10GHz
MC311	N(P)/SMA(J)	0.2m	DC to 10GHz
MC312	N(P)/BNC(J)	0.2m	DC to 2GHz
MC313	N(P)/BNC(P)	0.2m	DC to 2GHz
MC314	BNC(P)/BNC(P)	1.5m	DC to 2GHz

※Impedance : 50Ω

Adapter

Model	Connector	Impedance	Freq. range
MA301	BNC(P)/BNC(J)	50Ω/75Ω	DC to 2GHz
MA302	BNC(P)/N(J)	75Ω/75Ω	DC to 1.8GHz
MA303	BNC(P)/N(P)	75Ω/75Ω	DC to 1.8GHz
MA304	BNC(P)/F(J)	75Ω/75Ω	DC to 1.8GHz
MA305	BNC(P)/F(P)	75Ω/75Ω	DC to 1.8GHz
MA306	N(P)/SMA(J)	50Ω/50Ω	DC to 12.4GHz
MA307	N(P)/BNC(J)	50Ω/50Ω	DC to 2GHz
MA308	N(P)/BNC(J)	50Ω/75Ω	DC to 2GHz
MA309	N(J)/BNC(P)	50Ω/50Ω	DC to 2GHz

Specifications

Frequency section

Frequency range	20kHz to 3.3GHz <MSA538/538TG/538E> 20kHz to 8.5GHz <MSA558/558E>
Center frequency	
Setting resolution	100Hz Allows rotary encoder, numeric key and function key.
Accuracy	Sweep mode : ±(30+20T) kHz±1dot @span≦10MHz,※1 ±(60+300T) kHz±1dot @span≧20MHz,※1 Real time mode : ±0.5ppm±1dot
Frequency span	
Setting range	Sweep mode : 0Hz(zero span), 100kHz to 2GHz(1-2-5 step) and 3.3GHz(full span) <MSA538/538TG/538E> 0Hz(zero span), 100kHz to 5GHz(1-2-5 step) and 8.5GHz(full span) <MSA558/558E> Real time mode : 20kHz to 20MHz (1-2-5 step)
Accuracy	Sweep mode : ±3%±1dot @one step slower sweep time than AUTO,※1 Real time mode : ±0.1%±1dot
Display dots	501dots
Resolution bandwidth	Valid only in sweep mode, 3dB BW.
Setting range	300Hz to 3MHz(1-3 step) and AUTO <MSA538/538TG/558> 300Hz to 3MHz(1-3 step) and AUTO, in addition 9k(6dB), 120k(6dB) and 1MHz(6dB) <MSA538E/558E>
Accuracy	±5%
Selectivity	1:4.5 typ @3dB:60dB
Video bandwidth	Valid only in sweep mode, 3dB BW.
Setting range	100Hz to 1MHz (1-3 step) and AUTO
SSB phase noise	-95dBc/Hz typ @100kHz offset
Spurious response	less than -60dBc @sweep mode, applied to 5dB lower signal from REF level, spurious free mode at MSA558/558E less than -60dBc @real time mode, applied to 5dB lower signal from REF level, to be no signal of (REF-30dB) or more outside center frequency ±200MHz at MSA558/558E
Residual response	-80dBm typ @REF level≦-15dBm
Harmonics	-40dBc typ @≧10MHz
Reference frequency	
Temperature stability	±0.2ppm @0 to 50℃
Aging rate	±0.5ppm @1 year

Amplitude section

Reference level	
Setting range	+10 to -60dBm,1dB step
Accuracy	±0.8dB±1dot @CF 100MHz, REF -15dBm,※1
Unit	dBm, dBV, dBmV, dBμV, dBμV/m, dBμA/m
Average noise level	-162dBm/Hz typ @1GHz <MSA538/538TG/538E> -157dBm/Hz typ @1GHz <MSA558/558E> (Ref.) At real time mode,1GHz and span 20kHz : -140dBm typ <MSA538/538TG/538E> -135dBm typ <MSA558/558E>
Frequency response	±2.6dB±1dot @<10MHz ±1.0dB±1dot @≧10MHz
Input impedance	50Ω
Input VSWR	2.0 typ
Input attenuator	
Attenuation range	0 to 25dB (1dB step), coupled with reference level
Switching error	±0.6dB @100MHz
Display scale	
Display dots	381 dots/10div
Scale	Spectrum and OverWrite : 2, 5, 10dB/div Power vs. time : 1, 2, 5, 10dB/div Frequency vs. time : 1, 2, 5, 10%/div of span (actually, displayed by "Hz/div" coupled with span) Phase vs. time : 5,10,20,40°/div IQ vs. time : 0.1,0.2,0.4V/div
Accuracy	±(0.1dB+1dot)/2dB, ±(0.2dB+1dot)/5dB, ±(0.4dB+1dot)/10dB, ±(0.9dB+1dot)/83dB
Offset	Spectrum : ±200dB, resolution 0.1dB Power vs. time : ±100dB, resolution 1dB Frequency vs. time : ±(span/2), resolution (span/100) Phase vs. time : ±200°, resolution 1° IQ vs. time : ±1V, resolution 10mV
Input damage level	+27dBm (CW average power), 25VDC
RF input connector	N(J) connector

Sweep section

Sweep time	Valid only in sweep mode.
Setting range	10ms to 30s (1-3 step, span 0 to 2GHz) and AUTO 30ms to 30s (1-3 step, span 5GHz @only MSA558/558E, full span) and AUTO
Accuracy	±0.1%±1dot @excluding full span ±1.5%±1dot @full span <MSA538/538TG/538E> ±2.5%±1dot @full span <MSA558/558E>
Trigger	Valid only in real time mode and zero span of sweep mode.
Trigger mode	Free run, Trigger
Scan mode	Single, Continuous @valid only in real time mode
Trigger source	Sweep mode : Internal and External Real time mode : Channel power, Power, IF level and External
Level setting range	Internal : fixed @sweep mode Channel power : 0dB (REF level) to -40dB, 1dB step Power : 0dB (REF level) to -40dB,1dB step IF level : 1 to 100% (full scale of A/D converter), 1% step
Slope	Rising, Falling @valid only in real time mode.
Pre-trigger	Valid only in real time mode.
Setting range	0 to 100%, 25% step
External trigger	
Voltage range	1 to 10Vp-p
Frequency range	DC to 5MHz
Input RC	approx. 10kΩ//less than 15pF
Input coupling	DC coupling
Trigger level	approx. 0.56V (fixed)
Input damage level	±50V (DC+ACpeak)
Input connector	SMA(J) connector
Time resolution	5 samples @channel power 1 sample @power 14.7ns @IF level
Detection mode	Positive peak, Negative peak and Sample @valid only in sweep mode. ※As for MSA538E/558E, QP and AV are added further.

Real time mode

IQ memory size	64Mbytes
Number of frames	16,383 frames max
Frame time	30.1μs (span 20MHz) to 30.1ms (span 20kHz)
Analysis function	
Spectrum analysis	Data of one frame is calculated and displayed as spectrum.
Window function	4-term Blackman-Harris window
Equivalent noise BW	Span/301

Spectrogram analysis	Three dimensional display of X axis : time (frame), Y axis : frequency and Z axis: power (magnitude is expressed by colors)
OverWrite analysis	Spectrum waveform of each frame is accumulated.
Overwriting frequency	Expressed by colors.
Accumulation rate	720 frames/s
Accumulation frame number	200, 500, 1000, 2000, 5000, ∞ frames
Time domain analysis	Following five types of analyses based on IQ data are displayed.
Power vs. time	Displayed as time on X axis and power on Y axis.
Frequency vs. time	Displayed as time on X axis and frequency on Y axis.
Phase vs. time	Displayed as time on X axis and phase on Y axis.
IQ vs. time	Displayed with two traces as time on X axis and IQ data on Y axis.
Q vs. I	Displayed with polar coordinates as I data on X axis and Q data on Y axis.

Common function

Measuring function	Channel power (total power and average power), Adjacent channel power, Occupied bandwidth, Electric field strength (in addition, power density and magnetic field strength measurements, and needs optional dipole antenna), Magnetic field strength (needs optional magnetic field probe) and Noise measurements
Calculation function	Norm, MaxHold, MinHold, Averaging, OverWrite Sweep mode : number of sweeps is 2 to 1024 (power of 2) and infinite Real time mode : number of scans is 2 to 1024 (power of 2) and infinite ※Valid only in spectrum waveform.
Marker measurement	Invalid in OverWrite analysis. Single : displays frequency (8digits max) and level (4digits max) at one marker point. Dual : displays each frequency and level at two marker points. Delta : displays frequency difference and level difference between two markers.
Peak search function	Searches for peak level within all of 10 div (WHOLE) or within specified zone (ZONE) and displays frequency and level at peak level, and moreover NEXT peak search is possible at WHOLE mode. Available for unit conversion from dB to linear system. Invalid in OverWrite analysis.
Auto tuning	When pressing AUTO TUNE of function key, the spectrum of maximum level within full span is adjusted to the center, and is set to optimum reference level. Moreover, RBW, VBW and sweep time are also set to optimum parameters. Valid only in sweep mode.
Save /Load	
Save	Saves 200 spectrum waveforms and 200 setting parameters. ※Spectrogram waveform, OverWrite waveform, five kinds of time domain waveforms and IQ data cannot be stored in real time mode.
Load	Loads one spectrum waveform and one setting parameter.

Tracking generator (only MSA538TG/Sweep mode)

Frequency range	5MHz to 3.3GHz
Output level	-10dBm±1dB @1GHz
Output level flatness	±1.5dB
Normalizing function	Compensates input frequency response flat on screen.
Output impedance	50Ω
Output VSWR	less than 2.0
Output connector	N(J) connector

EMI measurement function (only MSA538E/558E)

Detection mode	PosPK (positive peak), QP (quasi peak), AV (average) detections ※valid only in sweep mode.
Resolution bandwidth	9kHz (6dB), 120kHz (6dB), 1MHz (6dB) and 300Hz to 3MHz (1-3 step) ※RBW without "(6dB)" is 3dB BW.

Time constant of QP

Time constant \ RBW	9kHz	120kHz	1MHz
Charge	1ms	1ms	1ms
Discharge	160ms	550ms	550ms

General

Communication	
Interface	Corresponds to USB2.0
Connector	B plug (device)
Transfer rate	Full speed (12Mbps)
Transfer data number	501points (spectrum)/ 64Mbytes max (IQ data) @real time mode 1001points @sweep mode
Hard copy	USB printer (option) connected to A plug (host) enables hard copy of screen image.
USB memory	Uses A plug (host), and stores spectrum waveform, IQ data, setting parameters and 〔(spectrum waveform or IQ data) + (setting parameters)〕. ※Only [IQ data + setting parameters] is re-analyzable after loading.
Display	
Display	5.7inches and color LCD
Backlight	LED backlight
Number of dots	640(H)×480(V) dots
Power supply	
Source of power supply	External DC source (dedicated AC adapter MA400) and Lithium-ion battery (MB400/option)
Dedicated AC adapter	Input : 100 to 240VAC Output : 9VDC/2.6A
Lithium-ion battery	7.4V/5000mAh
Charge function	Capable of charging only during power-off. Indicates 4 conditions with two colors LED (red and green).
Remainder indication	5 levels indication

Other

Operating temperature	0 to 50℃ (guaranteed at 23±10℃ but at 23±5℃ as to items with ※1, without carrying case)
Operating humidity	less than 40℃/80%RH (guaranteed at less than 33℃/70%RH but at less than 28℃/70%RH as to items with ※1, without carrying case)
Storage temperature	-20 to 60℃, less than 60℃/70%RH
Dimensions	162(W)×71(H)×265(D)mm (excluding projections, protection bumper and stand)
Weight	approx.1.8kg (including battery)
EMC	Complies with EMC Directive 2004/108/EC • IEC/EN61326-2-1:2012 • CISPR Pub11 Group1, class A
Standard accessories	· AC adapter MA400 · Carrying case · Accessory pouch · Operation manual

T : sweep time(s), ※1 : 23±5℃, less than 28℃/70%RH

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