Application Note

Anritsu

ML2530A

Calibration Receiver

ML2530A Calibration Receiver

Application Note

Anritsu Corporation

Contents

Product overview

1.1 Overview

The ML2530A Calibration Receiver is used to measure the absolute and relative levels of RF instruments.

Absolute level measurement is for the output level of signal generators. Relative level measurement is for the attenuation of attenuators.

The frequency range covers the mobile band from 100 kHz to 3 GHz.

The level has a wide dynamic range from –140 to +20 dBm.

Product overview

1.2 Features

1. The wide frequency range (100 kHz to 3 GHz) supports the mobile band.
2. The wide level range (–140 to +20 dBm) supports many measuring instruments.
3. The in-range linearity is good and accurate.

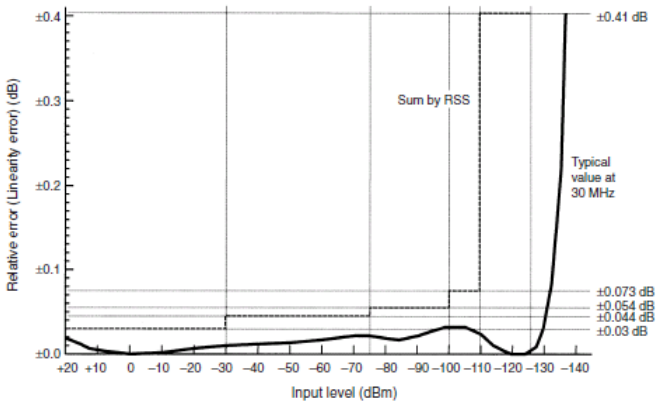
   Bandwidth: 100 Hz range (+20 to -30 dBm) ±0.030 dB
   range (–30 to –75 dBm) ±0.044 dB
   range (–75 to –110 dBm) ±0.073 dB

   Bandwidth: 1 Hz range (–110 to –140 dBm) ±0.040 dB
4. The frequency bandwidth is 1 Hz to 100 kHz.
5. The ML2530A has two modes; the Manual tuning mode, and the Monitor mode. The Manual tuning mode measures at high speed by displaying only frequency and level. The Monitor mode measures while observing the waveform spectrum.

Product overview

1.3 Overall level error

Relative error = In-range linearity error + Range switching error (Linearity error) + Error due to noise floor + Reading error due to minimum digit of level display



Relative error (Linearity error) at BW = 100 Hz on ≥11 MHz

Product overview

Absolute error = Relative error + Cal. output level error
+ MA2540A mis-match error after calibration
+ MA2540A uncertainty of Cal. Factor
+ ML2530A linearity error of power measurement section
+ MA2540A reproducibility of insertion loss
+ Mis-match error between MA2540A and measured object

e.g. Absolute error at BW 100 Hz, 1 GHz, and –100 dBm

Relative error at –100 dBm	±1.6% (±0.07 dB)
Cal. output level error	±0.9%
MA2540A mis-match error after calibration	±0.23%
MA2540A uncertainty of Cal. Factor	±1.1%
ML2530A linearity error of power measurement section	±1.0%
MA2540A reproducibility of insertion loss	±0.14% (±0.006 dB)
Mis-match error between MA2540A and measured object MA2540A + ML2530A VSWR: 1.2 typ.	±3.7%
Sum (RSS)	±4.4% (±0.19 dB)

Sum (RSS) $= \sqrt{0.016^2 + 0.009^2 + 0.0023^2 + 0.011^2 + 0.01^2 + 0.0014^2 + 0.037^2} = 0.044$

Configuration

2.1 MA2540A Sensor Module

(1) The MA2540A has two measurement paths—via either a power sensor, or a through circuit. The RF input signal is switched by coaxial relay.

(2) The power sensor uses a thermal sensor and built-in EEPROM with calibration factor.

Configuration

2.2 ML2530A Calibration Receiver

The ML2530A is composed of power measurement, level measurement, and control/display sections.

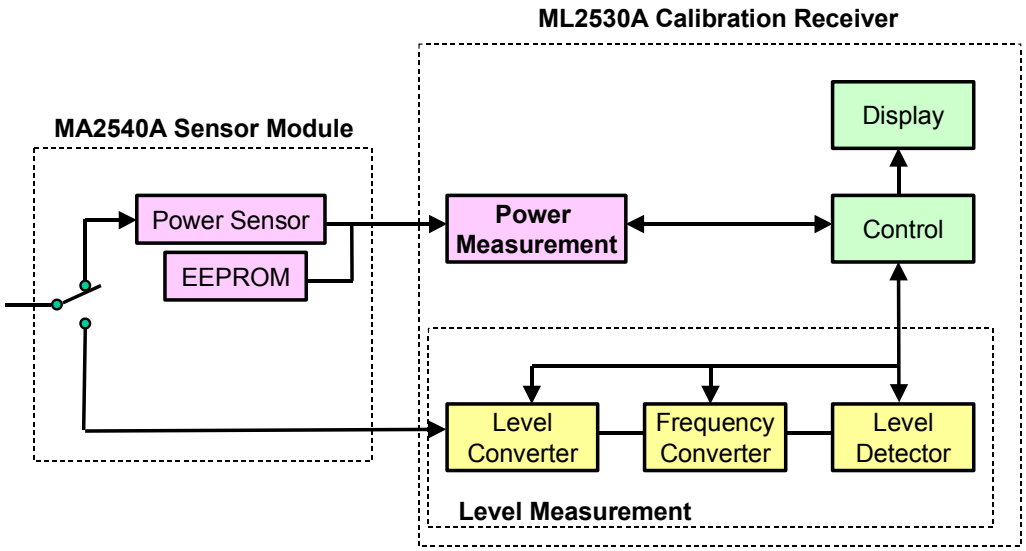
(1) Power measurement section

This is combined with the MA2540A power sensor to measure input signal power. The level dynamic range is narrow at 0 dBm ±5 dB, but the absolute level accuracy is high.

(2) Level measurement section

This is composed of a level converter, frequency converter and level detector. The wide dynamic-range level is from –140 to +20 dBm.

Configuration



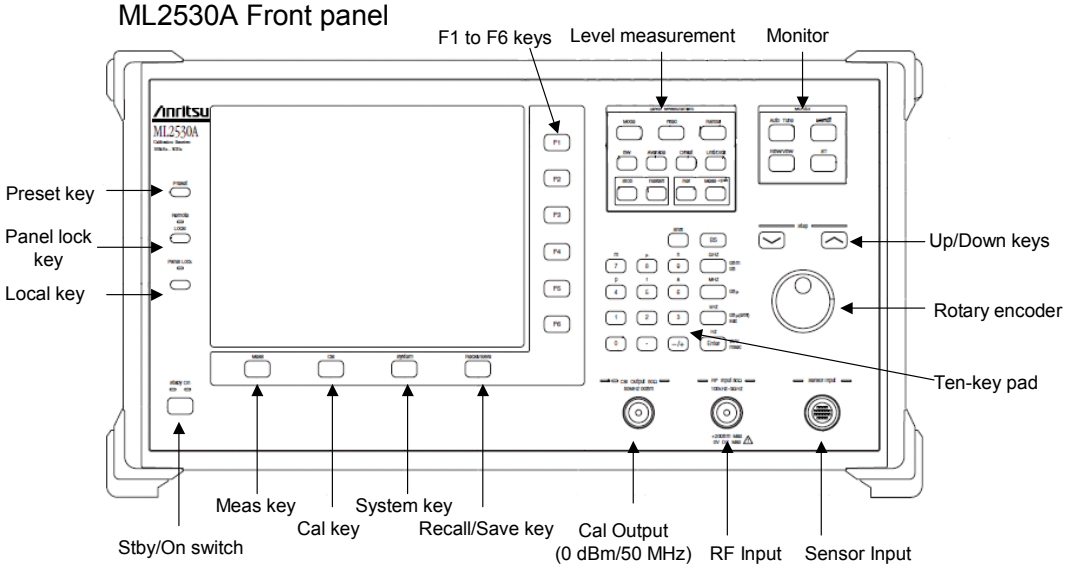
Basic operation

3.1 Name of each part
3.2 Setup
3.3 Level measurement
3.3.1 Manual tuning mode
3.3.2 Monitor mode

Basic operation

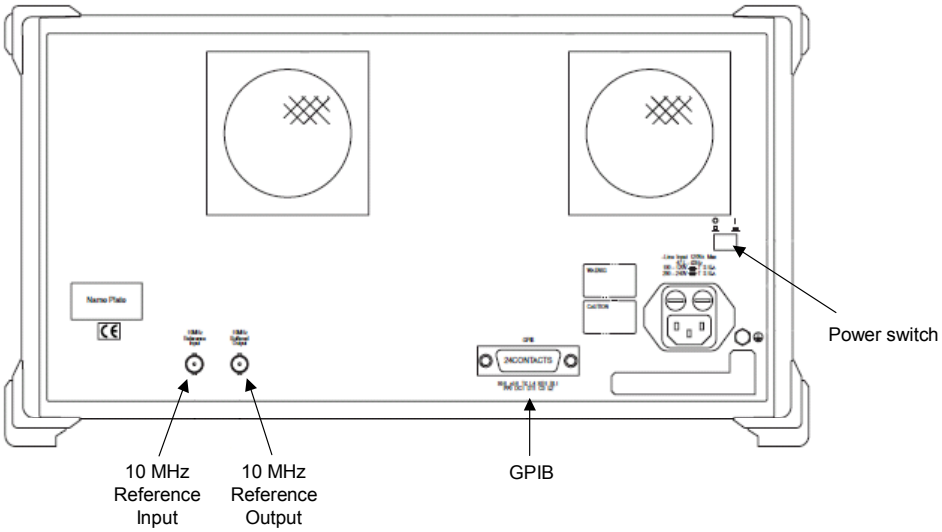
3.1 Name of each part

ML2530A Front panel



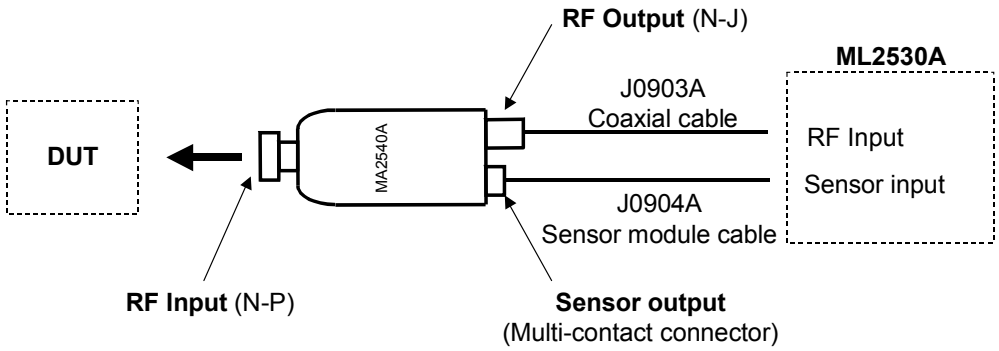
Basic operation

ML2530A Back panel



Basic operation

MA2540A Sensor Module



Basic operation

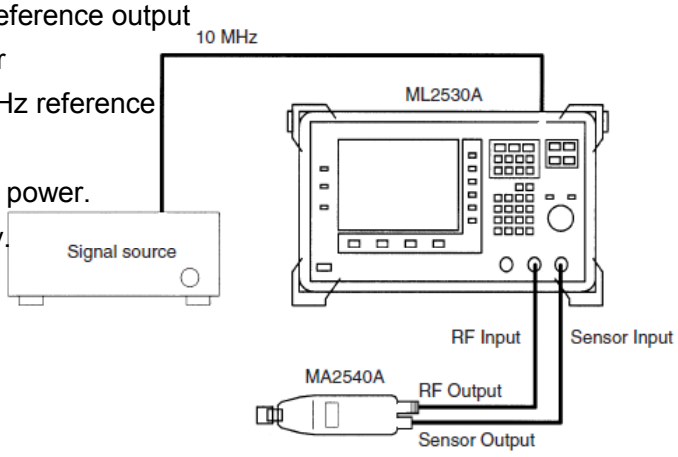
3.2 Setup

(1) Connect the MA2540A to the ML2530A using the dedicated cable.
Turn off the ML2530A power supply BEFORE connecting.

(2) Connect the 10 MHz reference output of the signal generator to the ML2530A 10 MHz reference input.

(3) Turn on the ML2530A power.

(4) Press the [Preset] key.



Basic operation

3.3 Level measurement

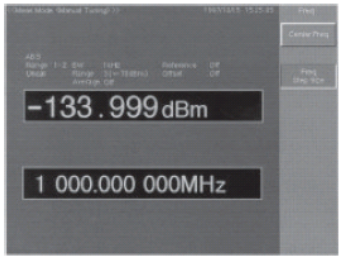
(1) Manual tuning mode

This mode sets the measured frequency directly and cuts the time required for measurement.

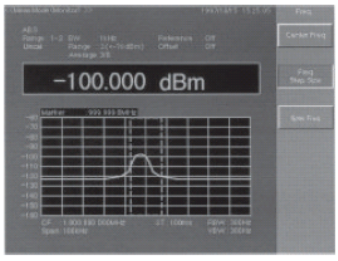
(2) Monitor mode

The same signal waveform as the spectrum analyzer is displayed, so level can be measured while observing the signal directly.

Manual tuning mode



Monitor mode



Basic operation

3.3.1 Manual tuning mode

(1) Press the [Meas] key on the panel.

(2) Press the [Mode] key on the panel and the [F1:Manual Tuning Mode] key.

(3) Press the [Freq] key and the [F1:Freq] key.

(4) Input the set frequency (500 MHz for example).

(5) When BW = Auto-setting

Press the [BW] key on the panel and press the [F2:Auto] key.

e.g. 100 Hz @ display BW:100Hz

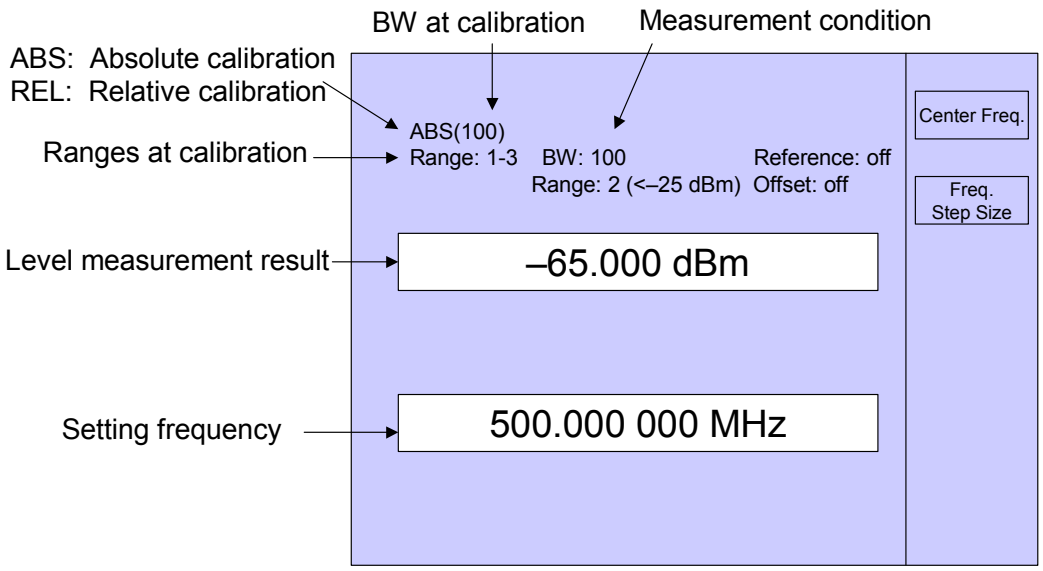
(6) When BW = Manual setting

Press the [BW] key on the panel and press the [F1:Manual] key.

e.g. 100 Hz @ display BW:100Hz #

(7) Level measurement starts.

Basic operation



Basic operation

3.3.2 Monitor mode

The same signal waveform as the spectrum analyzer waveform is displayed.

Level measurement measures the signal level of the frequency where the marker is positioned on the waveform. There are two monitor modes: automatic, and manual.

Automatic tuning

(1) Press the [Meas] key on the panel.

(2) Press the [Mode] key on the panel, and press the [F1: Monitor Mode] key.

(3) Press the [Auto tune] key. The waveform is displayed by detecting the input RF signal automatically.

If the input RF signal is less than –30 dBm, the signal cannot be detected by automatic tuning; use Manual tuning.

(4) Press the [BW] key on the panel, and press the [F2:Auto] key. The best BW is set for the frequency span, and the level is measured.

Basic operation

Manual setting

(1) Press the [Meas] key on the panel.

(2) Press the [Mode] key on the panel and the [F1: Monitor Mode] key.

(3) Press the [Freq] key on the panel and the [F1: Center Freq] key.

(4) Input the set frequency (500 MHz for example).

(5) Press the [F3:Freq Span] key and set the frequency span (100 kHz for example).

(6) Press the [RBW/VBW] key and the [F3:RBW VBW ST Auto] key.

The RBW, VBW and ST are set automatically and the waveform is displayed.

(7) Press the [BW] key and the [F2:Auto] key. The best BW is set for the frequency span and the level is measured.

Basic operation

RBW Setting

Combination of RBW and Frequency Span

Frequency Span	RBW
10 kHz ≤ SPAN ≤ 50 kHz	300 Hz, 1 kHz, 3 kHz
50 kHz < SPAN ≤ 200 kHz	300 Hz, 1 kHz, 3 kHz, 10 kHz
200 kHz < SPAN ≤ 500 kHz	300 Hz, 1 kHz, 3 kHz, 10 kHz, 30 kHz
500 kHz < SPAN ≤ 1 MHz	300 Hz, 1 kHz, 3 kHz, 10 kHz, 30 kHz, 100 kHz

Combination of RBW and VBW

VBW \ RBW	300 Hz	1 kHz	3 kHz	10 kHz	30 kHz	100 kHz
3 Hz	○					
10 Hz	○	○				
30 Hz	○	○	○			
100 Hz	○	○	○	○		
300 Hz	○	○	○	○	○	○
1 kHz	○	○	○	○	○	○
3 kHz		○	○	○	○	○
10 kHz			○	○	○	○
30 kHz				○	○	○
100 kHz					○	○

Basic operation

Choosing BW (Bandwidth)

1. When the frequency accuracy of the signal is high and the signal frequency stability is good, the noise floor level of ML2530A is reduced by setting a narrow BW, permitting measurement of lower levels. In the Manual tuning mode, level can be measured with BW = 1 Hz.
2. When the signal level stability is poor, change the BW to a wide value, and measure using the Monitor mode.

Combination of BW and Frequency Span

BW \ SPAN	10 kHz≤SPAN≤100 kHz	100 kHz<SPAN≤500 kHz	500 kHz<SPAN≤1 MHz
1 Hz			
10 Hz	○		
100 Hz	○	○	
1 kHz	○	○	○
10 kHz	○	○	○
100 kHz	○	○	○

Calibration

Calibration

4.1 Calibration types

(1) Calibration of power meter

This is zero-input calibration and power sensor calibration is built into the MA2540A.

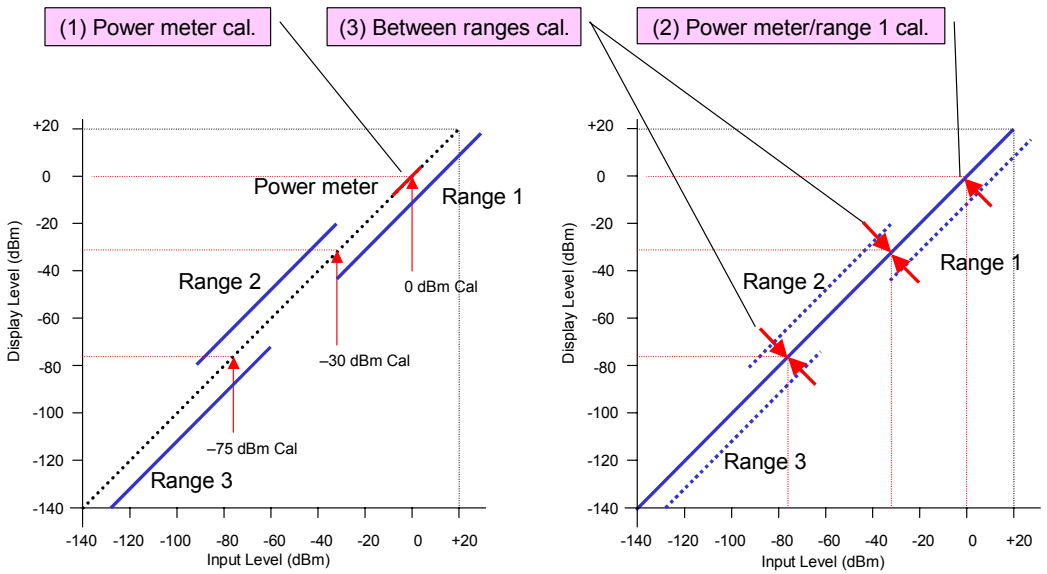
(2) Calibration between power meter and range 1

The same signal level is measured with the power sensor and range 1. The power sensor value and the value of range 1 are related.

(3) Calibration between ranges

The same signal level is measured in each range, and the measured value of each range is related.

Calibration



Calibration

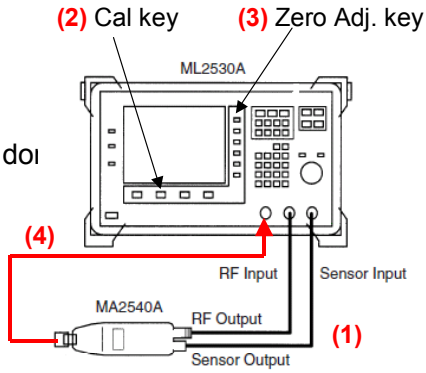
4.2 Calibration of sensor module (power sensor)

(1) Connect the ML2540A to the MA2530A using the cable.

(2) Pres the [Cal] key.

(3) Zero-input calibration
The MA2540A has no input.
Press the [F1: Zero Adj.] key.
Calibration is completed when 'Calibration do
is displayed.

(4) Sensor calibration
Connect the MA2540A to Cal Output
(0 dBm/50 MHz) of the ML2530A.
Press the [F2:Sensor Cal] key.
Calibration is completed when 'Calibration done'
is displayed.



Calibration

4.3 Calibration between ranges

(1) Connect the 10 MHz reference output of the signal generator to the 10 MHz reference input of the ML2530A.

(2) Set the level measurement mode to the Manual tuning mode.

Press the [Meas] key on the panel.

Press the [Mode] key on the panel and the [F2:Manual Tuning Mode] key.

(3) Set the frequency.

Press the [Freq] key on the panel and the [F1:Freq] key.

Press the [5], [0], [0], and [MHz] keys (for 500 MHz).

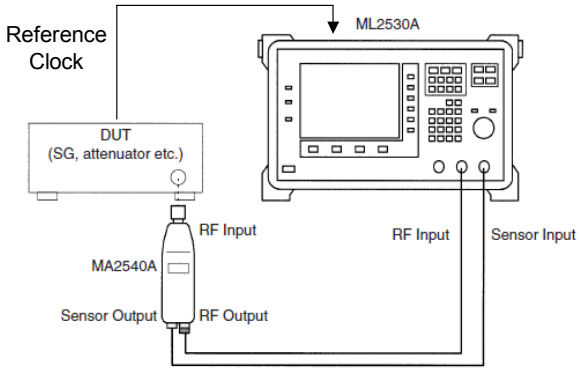
(4) Set the bandwidth (BW).

Press the [BW] key on the panel and the [F1:Manual] key.

Press the [1], [0], [0], and [MHz] keys (for 100 MHz).

(Note) It is possible to calibrate in the Monitor mode. In this case, confirm the frequency change in the signal source, and decide the BW.

Calibration



(Note) Signal generator

There are three supported output levels (0, –30, and –75 dBm).

The level accuracy must be within +3/–4 dB.

Calibration

4.3.1 Calibration between power meter and range 1

(1) Press the [Cal] key on the panel and the [F3:Range Ca] key.

(2) Press the [F1: R1&Sensor] key to enter the calibration mode between the power meter and range 1.

(3) Set the frequency of the signal generator to the frequency used (e.g. 500 MHz) and the level to 0 dBm.

(4) Press the [F1:Execute] key. Calibration is completed when 'Calibration done' is displayed.

4.3.2 Calibration between range 1 and 2

(1) Press the [F2: R1&R2] key to enter the calibration mode between the power meter and range 2.

(2) Set the frequency of the signal generator to the frequency used (e.g. 500 MHz) and level to –30 dBm.

(3) Press the [F1: Execute] key. Calibration is completed when 'Calibration done' is displayed.

Calibration

4.3.3 Calibration between range 2 and 3

(1) Press the [F2: R2&R3] key to enter the calibration mode between range 2 and range 3.

(2) Set the frequency of the signal generator to the frequency used (e.g. 500 MHz) and the level to –75 dBm.

(3) Press the [F1: Execute] key. Calibration is completed when 'Calibration done' is displayed.

(4) When [F3: End] key is pressed, the entire calibration procedure is completed and the Uncal display disappears.

4.3.4 Confirming calibration data

When the [F4:Data Manage] key is pressed, all the calibration data is displayed for confirmation.

No	Freq:MHz	Data	Time	Cal	BW	Range	Sensor
15	500	2005/09/18	12:56:12	ABS	100	R1-R3	6100139811

Calibration

4.4 Absolute and Relative level calibration

4.4.1 Absolute level

(1) Absolute level calibration uses the MA2540A sensor module.

Zero-input calibration: Zero Adj

Sensor calibration: Sensor Cal

(2) Level calibration with R1&Sensor operation

Calibration mode between power mater and range 1: R1&Sensor

Calibration mode between range 1 and range 2: R1&R2

Calibration mode between range 2 and range 3: R2&R3

(3) This calibration is used to measure the output level of signal generators.

4.4.2 Relative level

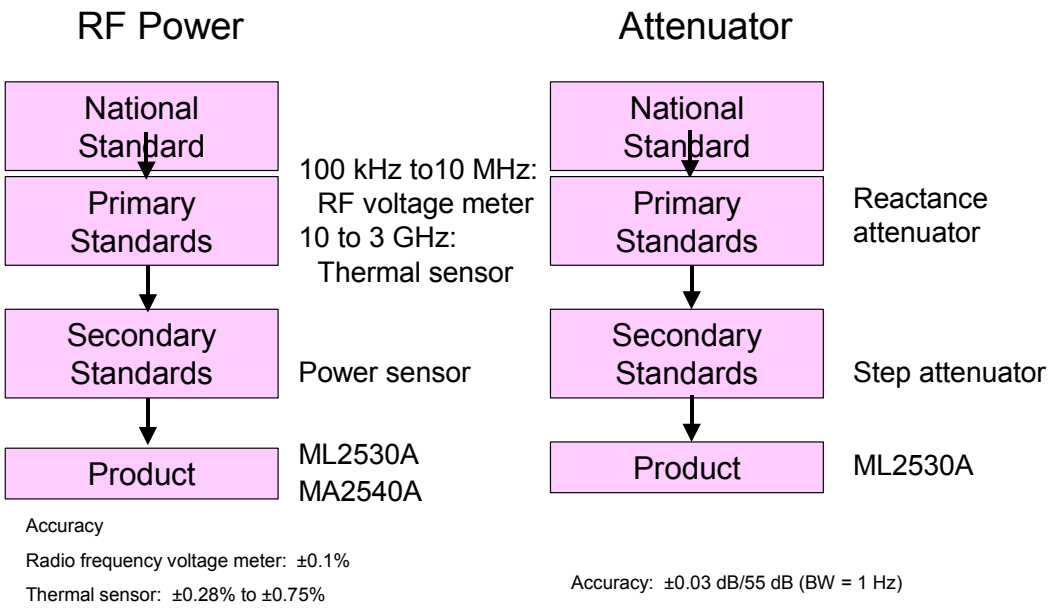
(1) Level calibration without R1&Sensor operation

Calibration mode between range 1 and range 2: R1&R2

Calibration mode between range 2 and range 3: R2&R3

(2) This calibration is used to measure the attenuation of attenuators.

Traceability



Accuracy

Radio frequency voltage meter: ±0.1%

Thermal sensor: ±0.28% to ±0.75%

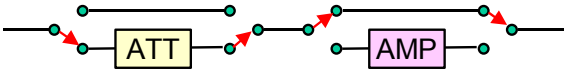
Accuracy: ±0.03 dB/55 dB (BW = 1 Hz)

Appendix

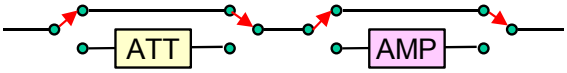
1. Block diagram
2. Level converter

Level converter

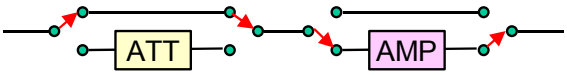
Range 1: –35 to +20 dBm

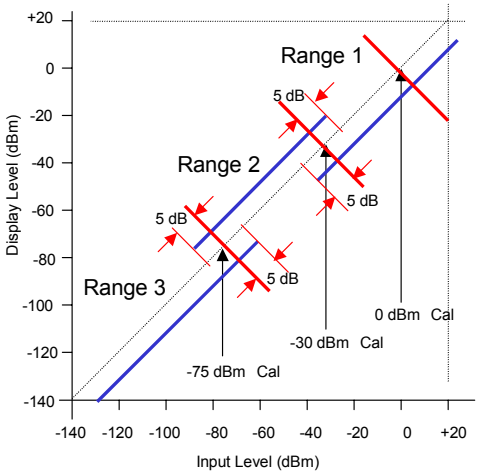


Range 2: –80 to –25dBm



Range 3: –140 to –70dBm





Anritsu

Specifications are subject to change without notice.

ANRITSU CORPORATION
5-1-1 Onna, Atsugi-shi, Kanagawa, 243-8555 Japan
Phone: +81-46-223-1111
Fax: +81-46-296-1264

U.S.A.
ANRITSU COMPANY
1155 East Collins Blvd., Richardson, TX 75081, U.S.A.
Toll Free: 1-800-ANRITSU (267-4878)
Phone: +1-972-644-1777
Fax: +1-972-671-1877

Canada
ANRITSU ELECTRONICS LTD.
700 Silver Seven Road, Suite 120, Kanata,
Ontario K2V 1C3, Canada
Phone: +1-613-591-2003
Fax: +1-613-591-1006

Brazil
ANRITSU ELETRÔNICA LTDA.
Praca Amadeu Amaral, 27 - 1 Andar
01327-010-Paraiso-São Paulo-Brazil
Phone: +55-11-3283-2511
Fax: +55-11-3288-6940

U.K.
ANRITSU EMEA LTD.
200 Capability Green, Luton, Bedfordshire LU1 3LU, U.K.
Phone: +44-1582-433280
Fax: +44-1582-731303

Germany
ANRITSU GmbH
Nemetschek Haus, Konrad-Zuse-Platz 1
81829 München, Germany
Phone: +49 89 442308-0
Fax: +49 89 442308-55

France
ANRITSU S.A.
9, Avenue du Québec, Z.A. de Courtabœuf, 91951 Les
Ulis Cedex, France
Phone: +33-1-60-92-15-50
Fax: +33-1-64-46-10-65

Italy
ANRITSU S.p.A.
Via Elio Vittorini, 129, 00144 Roma, Italy
Phone: +39-6-509-9711
Fax: +39-6-502-2425

Sweden
ANRITSU AB
Borgarfjordsgatan 13, 164 40 KISTA, Sweden
Phone: +46-853470700
Fax: +46-853470730

Finland
ANRITSU AB
Teknobulevardi 3-5, FI-01530 Vantaa, Finland
Phone: +358-20-741-8100
Fax: +358-20-741-8111

Denmark
Anritsu A/S
Kirkebjerg Allé 90, DK-2605 Brøndby, Denmark
Phone: +45-72112200
Fax: +45-72112210

Singapore
ANRITSU PTE LTD.
10, Hoe Chiang Road, #07-01/02, Keppel Towers,
Singapore 089315
Phone: +65-62828-2400
Fax: +65-6282-2533

P.R.China (Hong Kong)
ANRITSU COMPANY LTD.
Suite 923, 9/F., Chinachem Golden Plaza, 77 Mody
Road, Tsimshatsui East, Kowloon, Hong Kong, P.R.China
Phone: +852-2301-4980
Fax: +852-2301-3545

P.R.China (Beijing)
ANRITSU COMPANY LTD.
Beijing Representative Office
Room 1515, Beijing Fortune Building,
No. 5, Dong-San-Huan Bei Road,
Chao-Yang District, Beijing 10004, P. R. China
Phone: +86-10-6590-9230
Fax: +86-10-6590-9235

Korea
ANRITSU CORPORATION
8/F Hyunjuk Building, 832-41, Yeoksam dong,
Kangnam-ku, Seoul, 135-080, Korea
Phone: +82-2-553-6603
Fax: +82-2-553-6604

Australia
ANRITSU PTY LTD.
Unit 3/170 Forster Road, Mt. Waverley, Victoria, 3149,
Australia
Phone: +61-3-9558-8177
Fax: +61-3-9558-8255

Taiwan
ANRITSU COMPANY INC.
7F, No. 316, Sec. 1, Neihu Rd., Taipei 114, Taiwan
Phone: +886-2-8751-1816
Fax: +886-2-8751-1817

India
ANRITSU CORPORATION
India Liaison Office
Unit No. S-3, Second Floor, Esteem Red Cross Bhavan,
No. 26, Race Course Road, Bangalore 560 001, India
Phone: +91-80-30944707
Fax: +91-80-22356648

Please Contact :

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