MF2412B/MF2413B/MF2414B
Microwave Frequency Counter
Operation Manual

Seventh Edition

For safety and warning information, please read this manual before attempting to use the equipment.
Keep this manual with the equipment.

ANRITSU CORPORATION

Document No.: M-W1520AE-7.0

Safety Symbols

To prevent the risk of personal injury or loss related to equipment malfunction, Anritsu Corporation uses the following safety symbols to indicate safety-related information. Ensure that you clearly understand the meanings of the symbols BEFORE using the equipment. Some or all of the following symbols may be used on all Anritsu equipment. In addition, there may be other labels attached to products that are not shown in the diagrams in this manual.

Symbols used in manual

DANGER This indicates a very dangerous procedure that could result in serious injury or death if not performed properly.

WARNING This indicates a hazardous procedure that could result in serious injury or death if not performed properly.

CAUTION This indicates a hazardous procedure or danger that could result in light-to-severe injury, or loss related to equipment malfunction, if proper precautions are not taken.

Safety Symbols Used on Equipment and in Manual

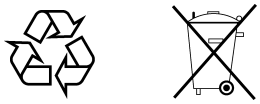
The following safety symbols are used inside or on the equipment near operation locations to provide information about safety items and operation precautions. Ensure that you clearly understand the meanings of the symbols and take the necessary precautions BEFORE using the equipment.

This indicates a prohibited operation. The prohibited operation is indicated symbolically in or near the barred circle.

This indicates an obligatory safety precaution. The obligatory operation is indicated symbolically in or near the circle.

This indicates a warning or caution. The contents are indicated symbolically in or near the triangle.

This indicates a note. The contents are described in the box.



These indicate that the marked part should be recycled.

MF2412B/MF2413B/MF2414B
Microwave Frequency Counter
Operation Manual

17 August 1998 (First Edition)
7 February 2007 (Seventh Edition)

For Safety

WARNING ⚠

1. ALWAYS refer to the operation manual when working near locations at which the alert mark shown on the left is attached. If the advice in the operation manual is not followed there is a risk of personal injury or reduced equipment performance. The alert mark shown on the left may also be used with other marks and descriptions to indicate other dangers.

2. IEC 61010 Standard
   The IEC 61010 standard specifies four categories to ensure that an instrument is used only at locations where it is safe to make measurements. This instrument is designed for measurement category I (CAT I). DO NOT use this instrument at locations specified as category II, III, or IV as defined below.
   Measurement category I (CAT I):
   Secondary circuits of a device that is not directly connected to a power outlet.
   Measurement category II (CAT II):
   Primary circuits of a device that is directly connected to a power outlet, e.g., portable tools or home appliance.
   Measurement category III (CAT III):
   Primary circuits of a device (fixed equipment) to which power is supplied directly from the distribution panel, and circuits running from the distribution panel to power outlet.
   Measurement category IV (CAT IV):
   Building service-line entrance circuits, and circuits running from the service-line entrance to the meter or primary circuit breaker (distribution panel).

Electric Shock

3. To ensure that the instrument is earthed, always use the supplied 3-pin power cord, and insert the plug into an outlet with an earth terminal. If power is supplied without earthing the equipment, there is a risk of receiving a severe or fatal electric shock or causing damage to the internal components.

For Safety

WARNING ⚠

Repair

WARNING ⚠

4. This equipment cannot be repaired by the operator. DO NOT attempt to remove the equipment covers or unit covers or to disassemble internal components. Only qualified service personnel with a knowledge of electrical fire and shock hazards should service this equipment. There are high-voltage parts in this equipment presenting a risk of severe injury or fatal electric shock to untrained personnel. In addition, there is a risk of damage to precision components.

Calibration

5. The performance-guarantee seal verifies the integrity of the equipment. To ensure the continued integrity of the equipment, only Anritsu service personnel, or service personnel of an Anritsu sales representative, should break this seal to repair or calibrate the equipment. If the performance-guarantee seal is broken by you or a third party, the performance of the equipment cannot be guaranteed.

Falling Over

6. This equipment should always be positioned in the correct manner. If the cabinet is turned on its side, etc., it will be unstable and may be damaged if it falls over as a result of receiving a slight mechanical shock.
   Always set up the equipment in a position where the power switch can be reached without difficulty.

Battery Fluid

7. DO NOT short the battery terminals and never attempt to disassemble the battery or dispose of it in a fire. If the battery is damaged by any of these actions, the battery fluid may leak. This fluid is poisonous.
   DO NOT touch the battery fluid, ingest it, or get in your eyes. If it is accidentally ingested, spit it out immediately, rinse your mouth with water and seek medical help. If it enters your eyes accidentally, do not rub your eyes, rinse them with clean running water and seek medical help. If the liquid gets on your skin or clothes, wash it off carefully and thoroughly.

LCD

8. This instrument uses a Liquid Crystal Display (LCD). DO NOT subject the instrument to excessive force or drop it. If the LCD is subjected to strong mechanical shock, it may break and liquid may leak.
   This liquid is very caustic and poisonous.
   DO NOT touch it, ingest it, or get in your eyes. If it is ingested accidentally, spit it out immediately, rinse your mouth with water and seek medical help. If it enters your eyes accidentally, do not rub your eyes, rinse them with clean running water and seek medical help. If the liquid gets on your skin or clothes, wash it off carefully and thoroughly.

For Safety

CAUTION ⚠

Fuse Replacement

CAUTION ⚠

1. Always remove the mains power cable from the power outlet before replacing blown fuses. There is a risk of electric shock if fuses are replaced with the power cable connected. Always use new fuses of the type and rating specified on the rear panel of the instrument. There is a risk of fire if a fuse of a different rating is used.

   T3.15A indicates a time-lag fuse.

Cleaning

2. Keep the power supply and cooling fan free of dust.
   - Clean the power inlet regularly. If dust accumulates around the power pins, there is a risk of fire.
   - Keep the cooling fan clean so that the ventilation holes are not obstructed. If the ventilation is obstructed, the cabinet may overheat and catch fire.

Check Terminal

3. Never input a signal of more than the indicated value between the measured terminal and ground. Input of an excessive signal may damage the equipment.

For Safety

CAUTION ⚠

Replacing Memory Back-up Battery

This equipment uses a Poly-carbomonofluoride lithium battery to backup the memory. This battery must be replaced by service personnel when it has reached the end of its useful life; contact the Anritsu sales section or your nearest representative.

Note: The battery used in this equipment has a maximum useful life of 7 years. It should be replaced before this period has elapsed.

Equipment Certificate

Anritsu Corporation certifies that this equipment was tested before shipment using calibrated measuring instruments with direct traceability to public testing organizations recognized by national research laboratories, including the National Institute of Advanced Industrial Science and Technology, and the National Institute of Information and Communications Technology, and was found to meet the published specifications.

Anritsu Warranty

Anritsu Corporation will repair this equipment free-of-charge if a malfunction occurs within one year after shipment due to a manufacturing fault, under the condition that this warranty is void when:

- The fault is outside the scope of the warranty conditions described in the operation manual.
- The fault is due to mishandling, misuse, or unauthorized modification or repair of the equipment by the customer.
- The fault is due to severe usage clearly exceeding normal usage.
- The fault is due to improper or insufficient maintenance by the customer.
- The fault is due to natural disaster including fire, flooding, earthquake, etc.
- The fault is due to use of non-specified peripheral equipment, peripheral parts, consumables, etc.
- The fault is due to use of a non-specified power supply or in a non-specified installation location.

In addition, this warranty is valid only for the original equipment purchaser. It is not transferable if the equipment is resold.

Anritsu Corporation will not accept liability for equipment faults due to unforeseen and unusual circumstances, nor for faults due to mishandling by the customer.

Anritsu Corporation Contact

In the event that this equipment malfunctions, contact an Anritsu Service and Sales office. Contact information can be found on the last page of the printed version of this manual, and is available in a separate file on the CD version.

Notes On Export Management

This product and its manuals may require an Export License/Approval by the Government of the product's country of origin for re-export from your country.

Before re-exporting the product or manuals, please contact us to confirm whether they are export-controlled items or not.

When you dispose of export-controlled items, the products/manuals need to be broken/shredded so as not to be unlawfully used for military purpose.

Crossed-out Wheeled Bin Symbol

Equipment marked with the Crossed-out Wheeled Bin Symbol complies with council directive 2002/96/EC (the “WEEE Directive”) in European Union.

For Products placed on the EU market after August 13, 2005, please contact your local Anritsu representative at the end of the product's useful life to arrange disposal in accordance with your initial contract and the local law.

CE Conformity Marking

Anritsu affixes the CE Conformity marking on the following product(s) in accordance with the Council Directive 93/68/EEC to indicate that they conform to the EMC and LVD directive of the European Union (EU).

CE marking

CE

1. Product Model

Model: MF2412B/MF2413B/MF2414B Microwave Frequency Counter

2. Applied Directive

EMC: Council Directive 89/336/EEC
LVD: Council Directive 73/23/EEC

3. Applied Standards

- EMC: Emission: EN 61326: 1997 + A1: 1998 + A2: 2001 + A3: 2003 (Class A)
  Immunity: EN 61326: 1997 + A1: 1998 + A2: 2001 + A3: 2003 (Annex A)

	Performance Criteria*
IEC 61000-4-2 (ESD)	B
IEC 61000-4-3 (EMF)	A
IEC 61000-4-4 (Burst)	B
IEC 61000-4-5 (Surge)	B
IEC 61000-4-6 (CRF)	A
IEC 61000-4-8 (RPFMF)	A
IEC 61000-4-11 (V dip/short)	B

*: Performance Criteria
A: During testing normal performance within the specification limits.
B: During testing temporary degradation, or loss of function or performance which is self-recovering.

Harmonic current emissions:
EN 61000-3-2: 2000 (Class A equipment)

- LVD: EN 61010-1: 2001 (Pollution Degree 2)

C-tick Conformity Marking

Anritsu affixes the C-tick marking on the following product(s) in accordance with the regulation to indicate that they conform to the EMC framework of Australia/New Zealand.

C-tick marking

1. Product Model

Model: MF2412B/MF2413B/MF2414B Microwave Frequency Counter

2. Applied Standards

EMC: Emission: EN 61326: 1997 + A1: 1998 + A2: 2001 + A3: 2003
(ISM, Group 1, Class A equipment)

Power Line Fuse Protection

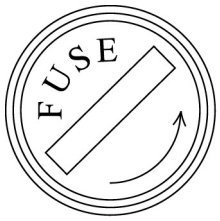
For safety, Anritsu products have either one or two fuses in the AC power lines as requested by the customer when ordering.

Single fuse: A fuse is inserted in one of the AC power lines.

Double fuse: A fuse is inserted in each of the AC power lines.

Example 1: An example of the single fuse is shown below:

Fuse Holder



Example 2: An example of the double fuse is shown below:

Fuse Holders

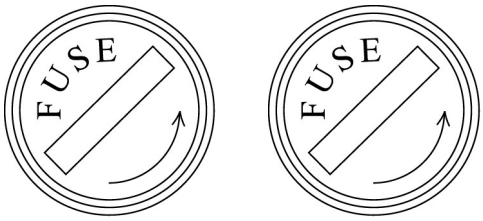


Table of Contents

Section 1 Overview

This chapter presents an overview of MF2412B/MF2413B/MF2414B, explains the structure of this manual, and describes the product's standard configuration, optional products and optional accessories for expanding functionality, and standard specifications and specification of optional products.

1.1 Product Overview

MF2412B/MF2413B/MF2414B are microwave frequency counters capable of directly measuring frequency without an external mixer. The unit also has burst wave carrier frequency measurement and pulse width measurement capabilities that are indispensable for evaluating circuits and mobile radio communications devices.

This device offers simple operability. With a simple one-step operation on the front panel, you can switch between continuous wave measurement and burst wave measurement. You can also directly enter a variety of settings from the front panel including measurement resolution, gate timing for pulse width measurement, and delay time.

The MF2412B/MF2413B/MF2414B are available depending on the available frequency range of input 1 you want to use. Table 1-1 lists the relationships between the model names and the available frequency ranges and input connector types.

Table1-1 Models, Available Frequency Ranges, and Input 1 Connector Types

Model	Available Frequency Range (Input 1 and Input 2)	Input 1 Connector Type
MF2412B	10 Hz to 20 GHz	N
MF2413B	10 Hz to 27 GHz	SMA
MF2414B	10 Hz to 40 GHz	K

Features

- Measurement of a wide band from 10 Hz to 40 GHz (MF2414B)
- High-speed measurement using a fast counter module
- High-Accuracy burst measurement
- Graphical display
- Built-in template feature (See Note 1)
- Transient measurement (See Note 2)
- GPIB standard unit

Note 1 :

This feature sets, in advance, a frequency range that decides an upper and lower value. If the measured frequency value is within that range, the unit displays Go, and if it not, the unit displays No-Go. This features will also output a TTL level high signal or low level signal from the AUX terminal.

Note 2 :

This feature measures the input frequency at a minimum sampling frequency of 10 μ sec without a measurement pausing time. You can use it to measure VCO start-up characteristics.

1.2 Manual Organization

This manual consists of a total of nine chapters and two appendices (A and B). Table 1-2 shows an overview of those chapters and appendices.

Table 1-2 Manual Organization

Section		Description
Section 1	Overview	Presents an overview of the product, explains the structure of this manual, and describes the product's standard configuration, optional products and optional accessories for expanding functionality, and product specifications.
Section 2	Before Using	Describes what you must do before using this unit.
Section 3	Panel Arrangement and Operation Overview	Describes the arrangement and function of the keys, switches, LEDs, connectors, and displays on the front, side, and back panels.
Section 4	Unit Operation	Describes detailed operation in manual mode.
Section 5	GPIB	Describes the functions, specifications, device messages, and program examples of the standard GPIB interface for controlling the unit remotely.
Section 6	Operating Principles	Describes the measurement principle, frequency measurement accuracy, pulse width measurement accuracy, and trigger error.
Section 7	Performance Test	Describes the measurement equipment, setup, and performance tests necessary for testing this unit's performance.
Section 8	Calibration	Describes the measurement equipment, setup, and calibration required to calibrate this unit.
Section 9	Storing and Transporting	Describes daily care for the unit and how to store, unpack, and transport it.
Appendix A	Initial Values/Preset Value List	Describes parameter values set automatically when the parameter initial value setting command is executed or either there is no backup data or backup data is damaged when you turn on power. Also describes parameter value set when you press the Preset key.
Appendix B	Performance Test Entry Table	Table for filling in performance test results.

1.3 Unit Configuration

The following section describes the configuration of the MF2412B/MF2413B/MF2414B Microwave Frequency Counter.

1.3.1 Standard Configuration

The following table shows the standard configuration for MF2412B/MF2413B/MF2414B.

Table 1-3 Standard Configuration

Item	Model Name/No.	Part Name	Quantity	Notes
Main unit	MF2412B MF2413B MF2414B	Microwave Frequency Counter	1	Select of three models to the left
Standard accessories		Power cord (2.5 m)	1	
	F0012	Fuse (T3.15 A)	2	Not included at present
	W1520AE	Operation Manual	1	

1.3.2 Options

Table 1-4 Options

Option No.	Model Name/No.	Part Name	Quantity	Notes
01	MF2412B-01 MF2413B-01 MF2414B-01	Crystal oscillator, 5×10^{-9}	1	Select one of three models to the left
02	MF2412B-02 MF2413B-02 MF2414B-02	Crystal oscillator, 2×10^{-9}	1	Select one of three models to the left
03	MF2412B-03 MF2413B-03 MF2414B-03	Crystal oscillator, 5×10^{-10}	1	Select one of three models to the left

1.3.3 Optional Accessories

The following shows MF2412B/MF2413B/MF2414B optional accessories.

Table 1-5 Optional Accessories

Model Name/No.	Part Name	Notes
	——Coaxial adapter——	
K224B	Coaxial adapter	K-P·K-J, SMAcompatible (DC to 40 GHz, SWR1.2)
34RKNF50	Coaxial adapter	Reinforced K-M·N-F (DC to 20 GHz, SWR1.25)
J0060	Coaxial adapter HRM553S	N-J·SMA-P
J0526	Coaxial adapter	N-J·SMA-J
	——Coaxial cord——	
J0527	Coaxial cord	K-P·K-P (DC to 40 GHz)
J0127A	Coaxial cord, 1 m	BNC-P·RG-58A/U·BNC-P
J0853	Coaxial cord, 2 m	Dual-end N-P (20GHz)
J0854	Coaxial cord, 2 m	Dual-end APC3.5-P (27GHz)
	——High-frequency fuse——	
MP612A	Fuse holder	N-P·N-J, DC to 1 GHz
MP613A	Fuse terminal	Rating +17 dBm, blowout power +35 dBm or more
	——Other——	
J0007	GPIB connection cable, 1 m	
J0008	GPIB connection cable, 2 m	
B0409	Carrying case	With protective cover
B0426A	Carrying bag (soft tipe)	
B0329L	Protective Cover	1/2MW2U
B0390G	Rack Mounting	19" type, for single unit
B0411A	Rack Mounting	19" type, for 2 parallel units

Note 1 :

When connecting or disconnecting the K plug connector for measuring to/from the K connector used on MF2414B Input 1, make sure that the center pin does not rotate. If you will be frequently connecting or disconnecting it, insert a coaxial adapter such as K224B between so as to prevent the cable from being damaged.

Note 2 :

If there is the danger of MF2412B/MF2413B/MF2414B being electrically overloaded, input the signal through the MP612A fuse holder and MP613A fuse terminal to prevent the counter's internal circuit from being damaged. Note that because the fuse holder's connector in shaped like an "N", you need a adapter that fits the connector type.

1.4 Specifications

1.4.1 Standard Specifications

Table 1-6 shows MF2412B/MF2413B/MF2414B specifications.

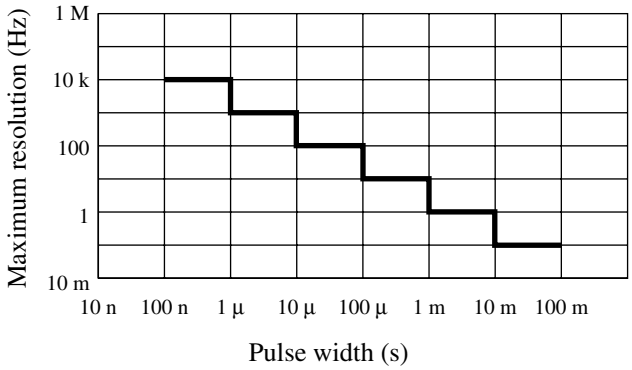
Table 1-6 Standard Specifications

Item			MF2412B	MF2413B	MF2414B
1	Frequency Range		10 Hz to 20 G Hz	10 Hz to 27 GHz	10 Hz to 40 GHz
1.1	CW	Input1	600 MHz to 20 GHz	600 MHz to 27 GHz	600 MHz to 40 GHz
	Measurement	Input2	10 MHz to 1 GHz (50 Ω) 10 Hz to 10 MHz (1 MΩ)		
1.2	Pulse-modulated wave measurement				
(1)	Carrier frequency				
		Input1	600 MHz to 20 GHz	600 MHz to 27 GHz	600 MHz to 40 GHz
		Input2	Cannot measure pulse-modulated wave		
(2)	Pulse width		Pulse Width Narrow : 100 ns to 0.1 s Wide : 1 us to 0.1 s		
(3)	Pulse repetition		10 Hz to 4 MHz (Pulse off time : ≥240 ns)		
2	External trigger pulse		≥1 us		
3	Reference input		1, 2, 5, 10 MHz		
4	Reference output		Internal reference signal (10 MHz) or External reference signal (1, 2, 5, or 10MHz)		
5	Input level		Input1 (sine wave input) : –33 dBm to +10 dBm (<12.4 GHz) : –28 dBm to +10 dBm (< 20 GHz) : –25 dBm to +10 dBm (<26.5 GHz) : {0.741×f (GHz) –44.6}dBm to +10 dBm (≤40 GHz) Input2 (sine wave input) : 25 mVrms to 10 Vrms (1 MΩ) 25 mVrms to 2 Vrms (50 Ω) External Trigger Input : 1.5 V_{dc} ± (2 to 10 V_{p-p}) Reference Input : 1 to 5 V_{p-p} Reference Output : ≥2 V_{p-p} (release terminal)		
6	Input/output impedance		Input1 : 50 Ω Input2 : 1 MΩ, ≤35 pF 50 Ω External Trigger Input : ≥100 Ω Reference Input : ≥1 kΩ Reference Output : ≤400 Ω		
7	Connection		Input1 : AC Input2 : AC External Trigger Input : DC Reference Input : AC Reference Output : AC		

Table 1-6 Standard Specifications (Continued)

<table>
<tr><th></th><th>Item</th><th>MF2412B</th><th>MF2413B</th><th>MF2414B</th></tr>
<tr><td>8</td><td>Input/output connectors</td><td>Input1

Input2
External Trigger Input
Reference Input
Reference Output</td><td colspan="2">: N (MF2412B)
: SMA (MF2413B)
: K (MF2414B)
: BNC
: BNC
: BNC
: BNC</td></tr>
<tr><td>9</td><td>Gating function</td><td colspan="3"></td></tr>
<tr><td>9.1</td><td>Trigger</td><td colspan="3">Int : Detects trigger using measurement signal
Ext : Detects trigger using External Trigger Input
Line : Detects trigger using AC LINE</td></tr>
<tr><td>9.2</td><td>Trigger delay</td><td colspan="3">Time from trigger detection to count start : OFF, 20 ns to 0.1 s
[≤320 ns can be changed in 20 ns increments
<1 us can be changed in 40 ns increments
≥1 us can be repeatedly changed by two significant digits]</td></tr>
<tr><td>9.3</td><td>Gate width</td><td colspan="3">100 ns to 0.1 s (Pulse Width Narrow) [<1 us can be changed in 20 ns increments
1 µs to 0.1 s (Pulse Width Wide) ≥1 µs can be repeatedly changed by two significant digits]</td></tr>
<tr><td>10</td><td>Pulse-modulated wave measurement</td><td colspan="3"></td></tr>
<tr><td>10.1

(1)</td><td>Carrier frequency measurement
Maximum resolution</td><td colspan="3">(Measurement in Manual measurement mode)
 
</td></tr>
<tr><td>(2)</td><td>Measurement time</td><td colspan="3">Resolution verses measurement time (measurement carrier frequency : 1 GHz)
<table>
<tr><th>Resolution</th><th>Measurement Time</th></tr>
<tr><td>1 Hz</td><td>200 s</td></tr>
<tr><td>10 Hz</td><td>20 s</td></tr>
<tr><td>100 Hz</td><td>2 s</td></tr>
<tr><td>1 kHz</td><td>200 ms</td></tr>
<tr><td>10 kHz</td><td>20 ms</td></tr>
<tr><td>100 kHz</td><td>5 ms</td></tr>
<tr><td>1 MHz</td><td>5 ms</td></tr>
</table>
measurement Time
T_{MS} = max (T,Ts)
× $(1/(f_R \times T_{GW}))^2$

Test data
f_R : Resolution ……(see table)
T_{GW} : Gate width ……$0.1/f_R$
Ts : Processing time ……50 us
T : Period ……$2/f_R$</td></tr>
<tr><td>(3)</td><td>Accuracy</td><td colspan="3">± 1 count ± time base accuracy × measurement frequency ± trigger error
± Residual error 2 (measurement frequency (GHz)/2 count (rms)) $\pm 1/T_{GW}$</td></tr>
</table>

Table 1-6 Standard Specifications (Continued)

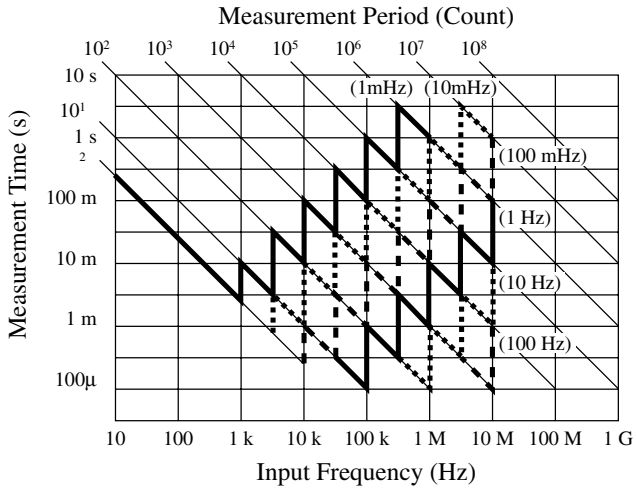
	Item	MF2412B	MF2413B	MF2414B
10.2	Modulated-pulse width measurement			
(1)	Resolution	1 ns		
(2)	Accuracy	± 20 ns ± time base accuracy × measurement pulse width ± trigger error		
(3)	Units displayed	µs fixed display		
10.3	Pulse-modulated measurement			
(1)	Resolution	1 ns		
(2)	Accuracy	± 20 ns ± time base accuracy × measurement pulse width ± trigger error		
(3)	Units displayed	µs fixed display		
11	Frequency (CW measurement)			
11.1	Resolution/counting time	Input1 : 1 MHz/1 us to 0.1 Hz/10 s (Normal) 1 MHz/0.18 us to 0.1 Hz/1.8 s (Fast, Typical value) Input2 : 10 MHz to 1 GHz (50 Ω) will be 1 MHz/1 us to 0.1 Hz/10s 10 Hz to 10 MHz (1 M Ω) will be according to the following chart  		
11.2	Measurement accuracy Input1	Count mode Normal : ±1 count ± time base accuracy × measurement frequency ± Residual error 1 (measurement frequency (GHz)/10 count (rms)) Fast : ±1 count ± time base accuracy × measurement frequency ± trigger error ± Residual error 2 (measurement frequency (GHz)/2 count (rms))		
	Input2	10 MHz to 1 GHz : ±1 count ± time base accuracy × measurement frequency 10 Hz to 10 MHz : ±1 count ± time base accuracy × measurement frequency ±trigger error		

Table 1-6 Standard Specifications (Continued)

<table>
<tr><th></th><th>Item</th><th>MF2412B</th><th>MF2413B</th><th>MF2414B</th></tr>
<tr><td>12</td><td>Auto/Manual measurement</td><td colspan="3"></td></tr>
<tr><td>12.1</td><td>Auto
(CW measurement)

(Burst measurement)</td><td colspan="3">FM tolerance : 35 MHz_{p-p}
Acquisition time : 50 ms or less
FM tolerance : 35 MHz_{p-p}
Acquisition time : Measured carrier frequency: 1 GHz, Level: 0dBm
Acquisition time $T_{ACQ} = T_{ACQ1} + T_{ACQ2}$
T_{ACQ1} from Table A
$T_{ACQ2} = 4 \times \{(T_p + 200\ us) \times K\}$
K : from Table B
T_p : pulse repetition period

Table A Pulse Repetition Period T_p vs. T_{ACQ1}
<table><tr><th>Pulse Repetition Period T_p</th><th>T_{ACQ1}</th></tr><tr><td>1 us < T_P ≤ 1 ms</td><td>1.1 s</td></tr><tr><td>1 ms < T_P ≤ 10 ms</td><td>1.6 s</td></tr><tr><td>10 ms < T_P ≤ 100 ms</td><td>6.1 s</td></tr></table>
Table B Gating Time T_G vs. K
<table><tr><th>Gating Time T_G</th><th>K</th></tr><tr><td>1 us ≤ T_G ≤ 10 us</td><td>10000</td></tr><tr><td>10 us < T_G ≤ 100 us</td><td>100</td></tr><tr><td>100 us < T_G ≤ 100 ms</td><td>5</td></tr></table>
Table C Trial Data Gate Time T_G=100 us: k=100
<table><tr><th>Pulse Repetition Period T_p</th><th>Acquisition time (max.) T_{ACQ}</th></tr><tr><td>200 us to 400 us</td><td>1790 ms</td></tr><tr><td>400 us to 600 us</td><td>1870 ms</td></tr><tr><td>600 us to 800 us</td><td>1950 ms</td></tr><tr><td>800 us to 1 ms</td><td>2030 ms</td></tr></table></td></tr>
<tr><td>12.2</td><td>Manual
(CW measurement)</td><td colspan="3">Input tolerance : ±30 MHz (0.6 to 1 GHz)
±40 MHz (≥1 GHz)
Acquisition time : ≤15 ms</td></tr>
<tr><td>12.3</td><td>Manual
(Burst measurement)</td><td colspan="3">Input tolerance range : ±30 MHz (0.6 to 1 GHz) ……Pulse Width Wide Only
±20 MHz (≥1 GHz) ……Pulse Width Narrow
±40 MHz (≥1 GHz) ……PulseWidth Wide
Acquisition time : ≤15 ms
(pulse repetition period < 1 ms)</td></tr>
<tr><td>13</td><td>Sample rate</td><td colspan="3">Auto : 10 ms to 10 s (1-2-5step), Hold
Manual : 1 ms to 10 s (1-2-5step), Hold</td></tr>
</table>

Table 1-6 Standard Specifications (Continued)

<table>
<tr><th></th><th>Item</th><th>MF2412B</th><th>MF2413B</th><th>MF2414B</th></tr>
<tr><td>14</td><td>High-speed sample</td><td colspan="3"></td></tr>
<tr><td>14.1</td><td>Frequency resolution</td><td colspan="3">
Input 1: High-speed sample rate vs. frequency resolution
<table>
<tr><th>High-speed Sample Rate</th><th>Frequency resolution</th></tr>
<tr><td>10 us</td><td>10 kHz</td></tr>
<tr><td>100 us</td><td>1 kHz</td></tr>
<tr><td>1 ms</td><td>100 Hz</td></tr>
</table>
Input 2: High-speed sample rate vs. frequency resolution
(Measurement frequency: 100 MHz)
<table>
<tr><th>High-speed Sample Rate</th><th>Frequency resolution</th></tr>
<tr><td>10 us</td><td>100 kHz</td></tr>
<tr><td>100 us</td><td>10 kHz</td></tr>
<tr><td>1 ms</td><td>1 kHz</td></tr>
</table>
</td></tr>
<tr><td>14.2</td><td>Frequency accuracy</td><td colspan="3">±1 count ±reference signal × measurement frequency ±trigger error
±Residual error 2 (measured frequency (GHz)/2 count (rms))</td></tr>
<tr><td>14.3</td><td>Time accuracy</td><td colspan="3">Input 1: ±reference signal accuracy × measurement time ±trigger error ±800 ns
Input 2: ±reference signal accuracy × measurement time ±trigger error
±64/measurement frequency</td></tr>
<tr><td>14.4</td><td>Data count</td><td colspan="3">100 to 2000 (1-2-5 step)</td></tr>
<tr><td>14.5</td><td>Sample rate</td><td colspan="3">10 us to 1 ms (1-2-5 step)</td></tr>
<tr><td>15</td><td>Template function</td><td colspan="3"></td></tr>
<tr><td>15.1</td><td>Limit frequency range</td><td colspan="3">MF2412A: 0 Hz to 20 GHz
MF2413A: 0 Hz to 27 GHz
MF2414A: 0 Hz to 40 GHz</td></tr>
<tr><td>15.2</td><td>Setting resolution</td><td colspan="3">1 Hz</td></tr>
</table>

Table 1-6 Standard Specifications (Continued)

<table>
<tr><th></th><th>Item</th><th>MF2412B</th><th>MF2413B</th><th>MF2414B</th></tr>
<tr><td>16</td><td>Allowable spurious range</td><td colspan="3">fc: Signal frequency
fs: Spurious signal
| fc-fs | ≤ 500 MHz
Signal level < -2 dBm
<table>
<tr><th>Signal frequency</th><th>Spurious signal</th></tr>
<tr><td>600 MHz ≤ fc ≤ 40 GHz</td><td>≤ -27 dBc</td></tr>
</table>
Signal level ≥ -2 dBm
<table>
<tr><th>Signal frequency</th><th>Spurious signal</th></tr>
<tr><td>600 MHz ≤ fc ≤ 40 GHz</td><td>≤ -35dBc</td></tr>
</table>
| fc-fs | > 500 MHz
Signal level < -2 dBm
<table>
<tr><th>Signal frequency</th><th>Spurious signal</th></tr>
<tr><td>600 MHz ≤ fc ≤ 20 GHz</td><td>≤ -27 dBc</td></tr>
<tr><td>20 GHz < fc ≤ 27 GHz</td><td>≤ -32 dBc</td></tr>
<tr><td>27 GHz < fc ≤ 40 GHz</td><td>≤ -{0.741 × fc (GHz) +12} dBc</td></tr>
</table>
Signal level ≥ -2 dBm
<table>
<tr><th>Signal frequency</th><th>Spurious signal</th></tr>
<tr><td>600 MHz ≤ fc ≤ 20 GHz</td><td>≤ -35 dBc</td></tr>
<tr><td>20 GHz < fc ≤ 27 GHz</td><td>≤ -40 dBc</td></tr>
<tr><td>27 GHz < fc ≤ 40 GHz</td><td>≤ -{0.741 × fc (GHz) +20} dBc</td></tr>
</table></td></tr>
<tr><td>17</td><td>Display</td><td colspan="3"></td></tr>
<tr><td>17.1</td><td>Digits displayed</td><td colspan="3">12 digits plus one digit for minus sign</td></tr>
<tr><td>17.2</td><td>Display type</td><td colspan="3">248 × 60 dot LCD with backlight</td></tr>
<tr><td>18</td><td>Backup</td><td colspan="3">Settings are stored in nonvolatile memory during power outages</td></tr>
<tr><td>19</td><td>Reference crystal oscillator stability</td><td colspan="3">Starting characteristics : -5×10^{-8}/day(after 30 minutes warm-up)
Aging rate : -2×10^{-8}/day (after 24 hours warm-up)
Temperature characteristics : -5×10^{-8} (25 °C –25 °C)
Frequency : 10 MHz</td></tr>
<tr><td>20</td><td>External control</td><td colspan="3">GPIB(conforms to IEEE 488.2 standard commands)
Interface function : SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT1, C0, E2</td></tr>
<tr><td>21</td><td>Power supply</td><td colspan="3">100 to 240 V (auto-switching)
47.5 to 63 Hz
When started ≤ 90 VA, under normal operation ≤ 80 VA</td></tr>
<tr><td>22</td><td>Temperature range</td><td colspan="3">0 to 50 °C</td></tr>
<tr><td>23</td><td>Dimensions</td><td colspan="3">213 W × 88 H × 350 D</td></tr>
<tr><td>24</td><td>Mass</td><td colspan="3">≤5 kg</td></tr>
</table>

1.4.2 Option 01, 02, and 03 Specifications

Tables 1-7, 1-8, and 1-9 show the specifications of options for MF2412B/MF2413B/MF2414B.

Table 1-7 Option 01 Specifications

Option Model			MF2412B-01	MF2413B-01	MF2414B-01
Frequency			10 MHz		
Frequency stability	Aging rate	/day	5×10^{-9}/day		
		/week	2×10^{-8}/week		
		/month	5×10^{-8}/month		
		/year	7.5×10^{-8}/year		
		conditions	After 24 hours warm-up		
	Temperature characteristics		$\pm 5 \times 10^{-8}$		
			–10 ˚C to +60 ˚C (25 ˚C standard)		
	Short-term stability		5×10^{-10}/Second		
Starting characteristics			3×10^{-8}		
			Within 1 hour after turning power on		
Frequency variation range			$\pm 5 \times 10^{-7}$		
Mass			100 g		

Table 1-8 Option 02 Specifications

Option Model			MF2412B-02	MF2413B-02	MF2414B-02
Frequency			10 MHz		
Frequency stability	Aging rate	/day	2×10^{-9}/day		
		/week	1×10^{-8}/week		
		/month	3×10^{-8}/month		
		/year	4.5×10^{-8}/year		
		conditions	After 24 hours warm-up		
	Temperature characteristic		$\pm 1.5 \times 10^{-8}$		
			–10 ˚C to +60 ˚C (25 ˚C standard)		
	Short-term stability		1×10^{-10}/Second		
Starting characteristic			2×10^{-8}		
			Within 1 hour after turning power on		
Frequency variation range			$\pm 2.5 \times 10^{-7}$		
Mass			200 g		

Table 1-9 Option 03 Specifications

Option Model			MF2412B-03	MF2413B-03	MF2414B-03
Frequency			10 MHz		
Frequency stability	Aging rate	/day	5×10^{-10}/day		
		/week	5×10^{-9}/week		
		/month	1×10^{-8}/month		
		/year	1.5×10^{-8}/year		
		conditions	After 48 hours warm-up		
	Temperature characteristic		$\pm 5 \times 10^{-9}$		
			–10 ˚C to +60 ˚C (25 ˚C standard)		
	Short-term stability		5×10^{-11}/Second		
Frequency variation range			$\pm 1 \times 10^{-7}$		
Mass			200 g		

Section 2 Before Using

This chapter describes the preparation and safety measures you must perform before using this unit. The safety measures in this manual will help you avoid the risk of injury or damage to equipment. Read this chapter thoroughly and make the necessary preparations before using this unit.

2.1 Environment Conditions

This unit operates normally in a surrounding temperature of 0 to 50 ˚C. To maintain this unit in top-running form, avoid using it in the following locations :

- Areas prone to violent shaking
- Areas exposed to high humidity and large quantities of dust
- Areas exposed to direct sunlight
- Areas that may be exposed to volatile gases

In addition to the above conditions, we recommend you use the unit at room temperature or below and in a location with few power fluctuations to maintain stable operation for an extended period of time.

CAUTION ⚠

Using this unit for an extended period of time where the temperature is 0 ˚C or less and then using it under normal temperatures can cause condensation that shorts circuits, resulting in damage to the unit. To prevent this from happening, allow the condensation to thoroughly dry before turning on power to the unit.

Fan clearance :

This unit has fan for preventing the internal temperature from rising. Fig. 2-1 shows the proper placement of the unit. Allow at least 10 cm of space between a wall, peripheral, or other object.

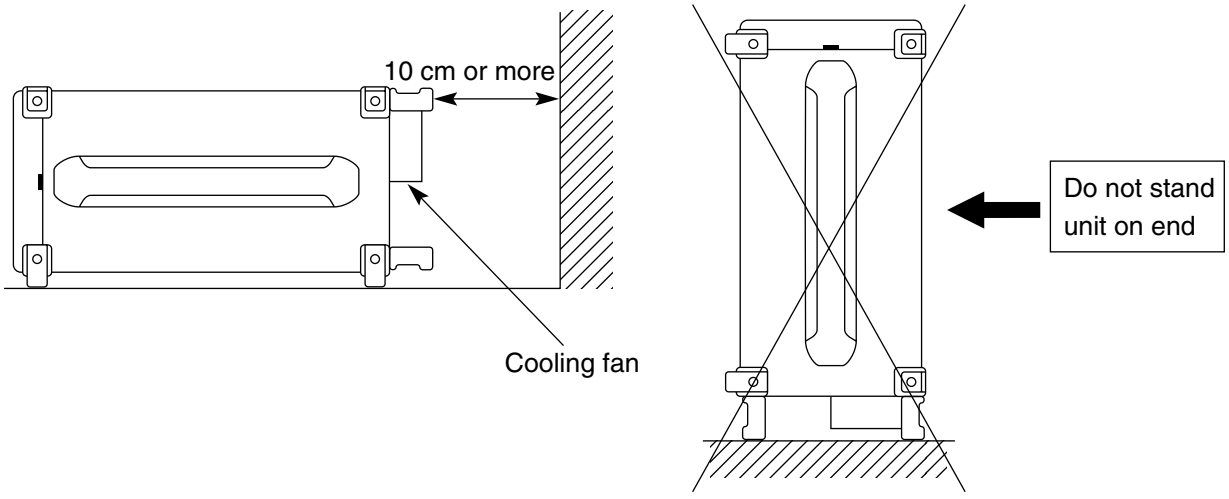


Fig. 2-1 Unit Placement

2.2 Safety Measures

This section describes the safety measures to take to prevent electric shock and damage to the unit.

2.2.1 Power-Related Safety Measures

WARNING ⚠

You must properly ground this unit before turning on power. Failing to do so may lead to electric shock causing injury or even death. You must also perform a voltage check. Applying an abnormal voltage exceeding this unit's specifications may damage the unit and cause fire. Have only service personnel with proper training perform maintenance on this unit.

2.2.2 Voltage Overload on Input1 Connector

CAUTION ⚠

The Input1 connector does not have a voltage protection circuit for protecting circuits from voltage overloads. The maximum value is +10 dBm. Do not input voltage higher than that value. Failing to obey this warning may cause internal circuits to burn out.

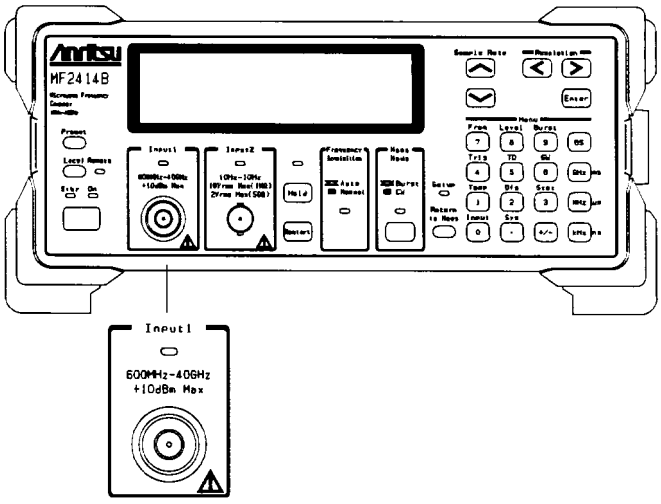


Fig. 2-2 Input1 Connector

2.2.3 Voltage Overload on Input2 Connector

CAUTION ⚠

The Input2 connector has a built-in a voltage overload protection circuit for protecting circuits should you accidentally apply to much power. The maximum value is 10 Vrms when impedance 1 MΩ is selected and 2 Vrms when 50 Ω is selected. Do not input voltage higher than those values. Failing to obey this warning may cause internal circuits to burn out.

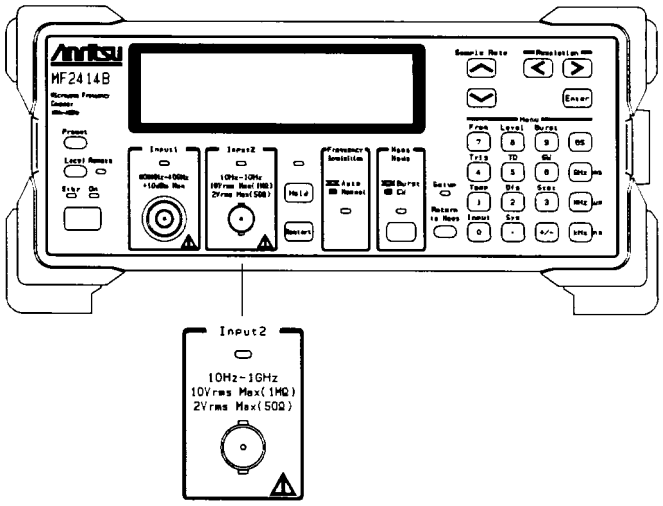


Fig. 2-3 Input2 Connector

2.2.4 Voltage Overload on Reference 1, 2, 5, and 10 MHz Input Connector

CAUTION ⚠

The input level for the reference 1, 2, 5, and 10 MHz Input connector is 1 to 5 Vp-p. Applying a voltage exceeding 7 Vp-p may cause internal circuits to burn out.

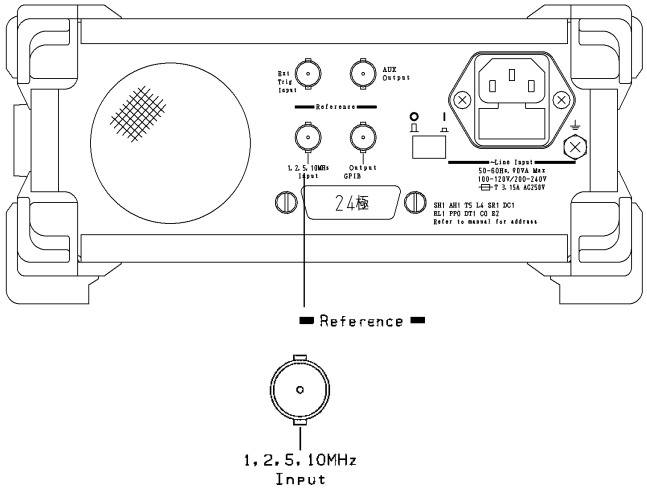


Fig. 2-4 Reference 1, 2, 5, and 10 MHz Input Connector

2.2.5 Voltage Overload on External Trigger Input Connector

CAUTION ⚠

The External Trigger Input has a built-in voltage overload protection circuit. The maximum value is 10 Vp-p. Never apply a voltage higher than that value. Failing to obey this warning may cause internal circuits to burn out.

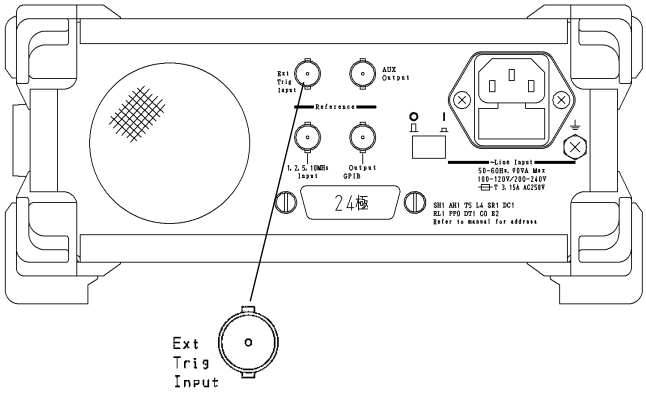


Fig. 2-5 External Trigger Input Connector

2.3 Before You Turn on Power

This unit operates normally when provided with an AC power supply of 100 to 240 Vac and 47.5 to 63 Hz. There is no need to switch between 100 Vac and 200 Vac. To prevent the following accidents from happening, you must take the following measures when supplying AC power to the unit :

- Injuries due to electric shock
- Internal damage to equipment dues to abnormal voltage
- Malfunctions due to ground current

To protect user safety, there are WARNING and CAUTION labels on the top panel of the unit.

WARNING

The unit cannot be repaired by the user. Do not open the unit's cover nor disassemble it. All maintenance should be performed by qualified service personnel who have experience dealing with the danger of fire and electric shock. This unit contains high-voltage components that may cause injury or death from electric shock if needlessly touched. Touching the inside of the unit may also damage precision components.

CAUTION

Replace burned-out fuses only with the specified type and rated fuse. Using the wrong type of fuse may cause a fire.

Be very careful to follow the instructions in the following subsections.

2.3.1 Power Requirements

For normal operation of the instrument, observe the power voltage range described below.

Power source	Voltage range	Frequency
100 Vac system	100 to 120 V	50 to 60 Hz
200 Vac system	200 to 240 V	50 to 60 Hz

Changeover between 100 and 200 V systems is made automatically.

CAUTION ⚠

Supplying power exceeding the above range may result in electrical shock, fire, failure, or malfunction.

2.3.2 Connecting the Power Cord

Check that the main power switch on the rear panel is turned off (switched to the (O) side).
Insert the power plug into an outlet, and connect the other end to the power inlet on the rear panel. To ensure that the instrument is earthed, always use the supplied 3-pin power cord, and insert the plug into an outlet with an earth terminal.

WARNING ⚠

If the power cord is connected without the instrument earthed, there is a risk of receiving a fatal electric shock. In addition, the peripheral devices connected to the instrument may be damaged.
When connecting to the power supply, DO NOT connect to an outlet without an earth terminal. Also, avoid using electrical equipment such as an extension cord or a transformer.

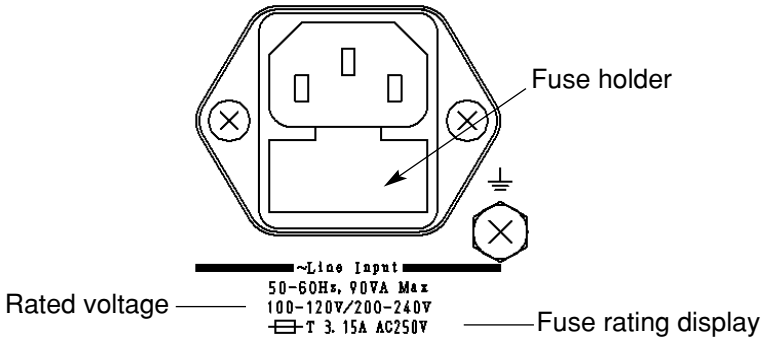
CAUTION ⚠

If an emergency arises causing the instrument to fail or malfunction, disconnect the instrument from the power supply by either turning off the main power switch on the rear panel (switch to the (O) side), or by pulling out the power cord or the power inlet.
When installing the instrument, place the instrument so that an operator may easily operate the main power switch.
If the instrument is mounted in a rack, a power switch for the rack or a circuit breaker may be used for power disconnection.
It should be noted that, the power switch on the front panel of the instrument is a standby switch, and cannot be used to cut the main power.

2.3.3 Changing Fuses

This unit comes with two fuses. Use them when the fuse in the unit burns out. If the fuses burns out due a problem with the unit, make sure to fix the problem before replacing the fuse.

Rated Voltage	Fuse Rating	Fuse Rating	Fuse Name	Model Name/No.
100 V	T3.15A	3.15 A, 250 V	T3.15A 250V	F0012
230 V	T3.15A	3.15 A, 250 V	T3.15A 250V	F0012



WARNING ⚠

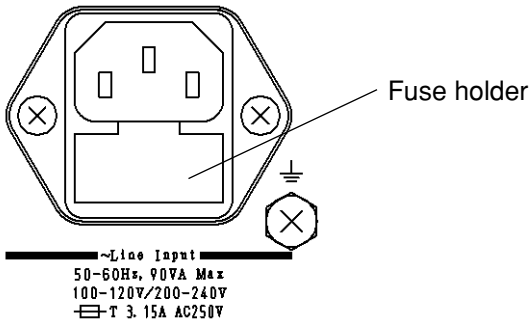
- **Make sure to switch off power and unplug the power cord from the power outlet before attempting to replace the fuse. Failing to obey this warning may result in electric shock.**
- **Before you turn power back on after replacing the fuse, make sure that the unit is grounded as discussed earlier and you have connected it to an AC power supply compatible with the unit. Failing to ground the unit may result in electric shock. Using the wrong AC power supply may damage the unit.**

CAUTION ⚠

If you run out of spare fuses, obtain new ones that have the same ratings as the one that originally came with the unit.

- **If you do not get the same type of fuse, you may experience problems such as not being able to install it, problems connecting it, or delays in blowout.**
- **If you get a fuse with a voltage rating that is too high, it may not blow out the next time there is a problem, putting the unit at risk of catching on fire.**

After following the safety measures covered so far, replace the fuse as described below.

Step	Fuse Replacement Procedure
1	Turn the power line switch off on the back panel. Make sure that the front panel LCD and all LEDs go out.
2	Remove the fuse holder shown below. 
3	Remove the fuse from the holder, and replace it with a new one.
4	Replace the fuse holder to its original position.

Note 1 :

If you do not have a replacement fuse, order one from our service department. Provide us with the model name and number, part name, and quantity you need.

Section 3 Panel Arrangement and Operation Overview

This chapter describes the arrangement and function of the keys, switches, LEDs, connectors, and displays on the front, side, and back panels of MF2412B/MF2413B/MF2414B. It also provides an overview on how to operate these controls. For more information on operating the unit, refer to Section 4.

3.1 Panel Arrangement

This section describes the keys, switches, LED, connectors, and displays on the front, side, and back panels of MF2412B/ MF2413B/MF2414B.

3.1.1 Front Panel

Fig. 3-1 shows the front panel and Table 3-1 describes its function.

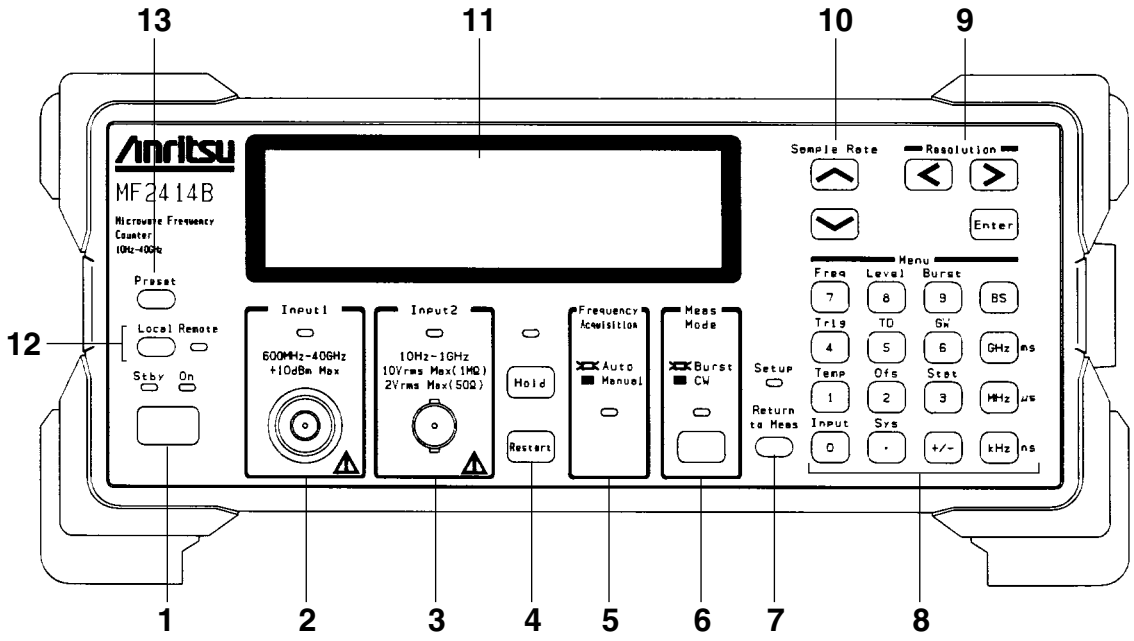


Fig. 3-1 Diagram of Front Panel

Table 3-1 Function of Front Panel Components

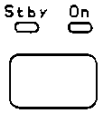
No	Label	Description
1		Power Switch, Stby LED and On LED Switching the Power Line switch on the rear panel from Off to On puts this unit on standby and supplies power only to the internal crystal oscillator. The green Stby LED lights when the unit enters the standby state. When the unit is in the standby state, pressing the Power switch turns on the unit and supplies power to all circuits, allowing you to use the unit. The On LED lights when the unit becomes ready. When the unit is on, pressing the Power switch again puts the unit on standby.

Table 3-1 Function of Front Panel Components (Continued)

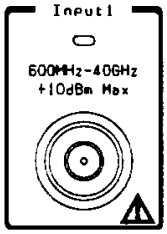
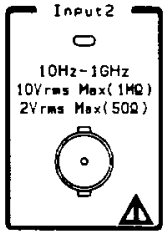
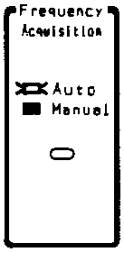
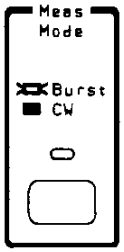
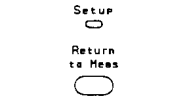
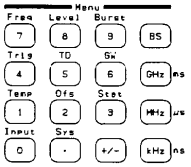
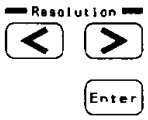
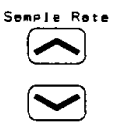
No	Label	Description
2		Input1 connector and Input1 LED Connect the signal to this connector when measuring frequencies of 600 MHz or higher, particularly frequencies of 1 GHz or higher. The maximum frequency and connector shape differ between models. The MF2412B/MF2413B/MF2414B has an N/SMA/K connector with a maximum input frequency of 20 GHz/27 GHz/40 GHz. The Input1 LED lights when the Input1 connector becomes usable. To use the Input1 connector, select "Input1" from the Input CH menu on the Input parameter setup screen.
3		Input2 connector and Input2 LED Connect the signal to this connector when measuring frequencies of 10 MHz to 1 GHz. The Input2 LED lights when the Input2 connector becomes usable. To use the Input2 connector, select "Input2" from the Input CH menu on the Input parameter setup screen.
4		[Hold] key, [Restart] key, and Hold LED While frequency measurement is being repeated, pressing the [Hold] key stops measurement and continues to display the current value. This state is called a hold state. While the unit is in the hold state, pressing the [Hold] key restarts measurement. The Hold LED lights when the unit enters the hold state. Pressing the [Restart] key restarts a measurement or statistical process. While the unit is in the hold state, pressing the [Restart] key performs a measurement or statistical process only once and places the unit in the hold state again (single measurement).
5		Frequency Acquisition LED This LED indicates whether the frequency of the signal input to the Input1 connector is to be acquired automatically (Auto) or manually (Manual). When "Auto" is selected, the unit will measure the input signal across the entire measurement frequency band and then measure only the signal frequencies that have reached the prescribed level. When "Manual" is selected and a signal within the prescribed frequency input tolerance is input, the unit will measure the frequency of that signal. The Frequency Acquisition LED lights when "Auto" is selected as the frequency acquisition mode. To select automatic frequency acquisition, select "Auto" from the Mode menu on the Freq Acq parameter setup screen.
6		[Meas Mode] key and Meas Mode LED This key is used to determine whether to measure burst waves (Burst) or continuous waves (CW). When burst wave measurement is selected, the unit can measure the carrier frequency, burst signal width, and burst repetition period. When continuous wave measurement is selected, the unit will measure that frequency. The Meas Mode LED lights when burst wave measurement is selected.

Table 3-1 Function of Front Panel Components (Continued)

No	Label	Description
7		[Return to Meas] key and Setup LED To return to the measurement screen from a parameter setup screen, press the [Return to Meas] key. The Setup LED lights when the parameter setup screen is selected.
8		Numeric and Direct keys In the numeric input mode, [0] to [9], [.], [±], [GHz], [MHz], [kHz], and [BS] keys are used to enter numeric values. These keys are collectively referred to as "numeric key". In modes other than the numeric input mode, the above keys are used to display the parameter setup screens corresponding to the items printed above the panel. These keys are collectively referred to as "direct key". [.]: Used as a [Sys] key for bringing up the System parameter setup screen. [0]: Used as an [Input] key for bringing up the Input parameter setup screen. [1]: Used as a [Temp] key for bringing up the Template parameter setup screen. [2]: Used as an [Ofs] key for bringing up the Offset parameter setup screen. [3]: Used as a [Stat] key for bringing up the Statistic parameter setup screen. [4]: Used as a [Trig] key for bringing up the Trigger parameter setup screen. [5]: Used as a [TD] key for bringing up the Trigger Delay parameter setup screen. [6]: Used as a [GW] key for bringing up the Gate Width parameter setup screen. [7]: Used as a [Freq] key for bringing up the Freq Acq parameter setup screen. [8]: Used as a [Level] key for bringing up the Level Acq parameter setup screen. [9]: Used as a [Burst] key for bringing up the Burst parameter setup screen. Pressing any of the above direct keys will bring up the associated parameter setup screen and turn on the Setup LED.
9		[<], [>], and [Enter] keys When a measurement screen is displayed, pressing the [<] or [>] key allows you to set the frequency measurement resolution. When a parameter setup screen is displayed, pressing the [<] or [>] key allows you to move the cursor. The [Enter] key is used to toggle between two parameters, select one of three or more parameters, or turn on/off the input mode of the numeric input menu.
10		[∧] and [∨] keys When a measurement screen is displayed, pressing the [∧] or [∨] key allows you to set the measurement pause time (sample rate). When the Level Acq parameter setup screen is displayed, pressing the [∧] or [∨] key allows you to set a manual amplitude discrimination value. When a Trig Delay or Gate Width parameter setup screen is displayed, pressing the [∧] or [∨] key allows you to increment or decrement the value of a numeric parameter.
11		248 * 60 dot LCD. This display is used to display frequency measurement results and set various parameters.
12		[Local] key and Remote LED Pressing this key changes the remote control state to the local control state. The Remote LED lights when the local state changes to the remote state.
13		[Preset] key Pressing this key sets the default values. For details on parameters, see Appendix A, "Initial Value/Preset Value List."

3.1.2 Side Panel

Fig. 3-2 shows the unit's side panel and Table 3-2 describes the functions of its components.

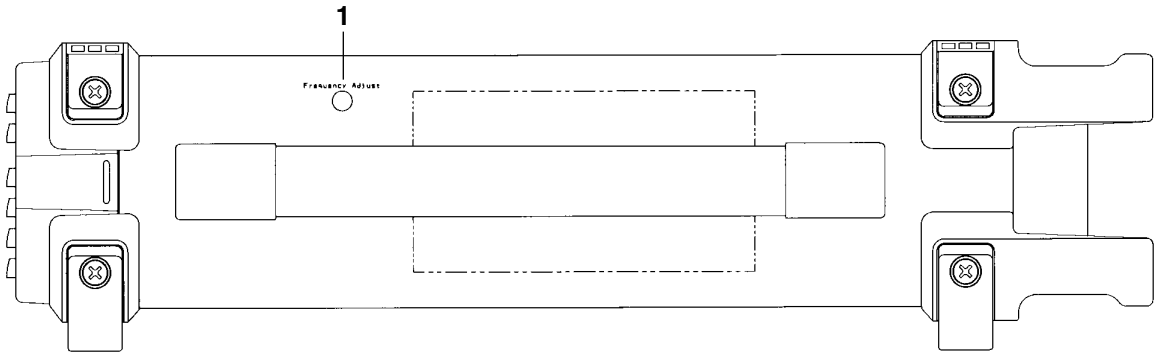


Fig. 3-2 Diagram of Side Panel

Table 3-2 Function of Side Panel Components

No	Label	Description
1	Frequency Adjust	Internal Reference Signal (10 MHz) Adjustment Hole Adjust the frequency of the reference crystal oscillator following the procedure described in Section 8, "Calibration."

3.1.3 Back Panel

Fig. 3-3 shows the unit's back panel and Table 3-3 describes the functions of its components.

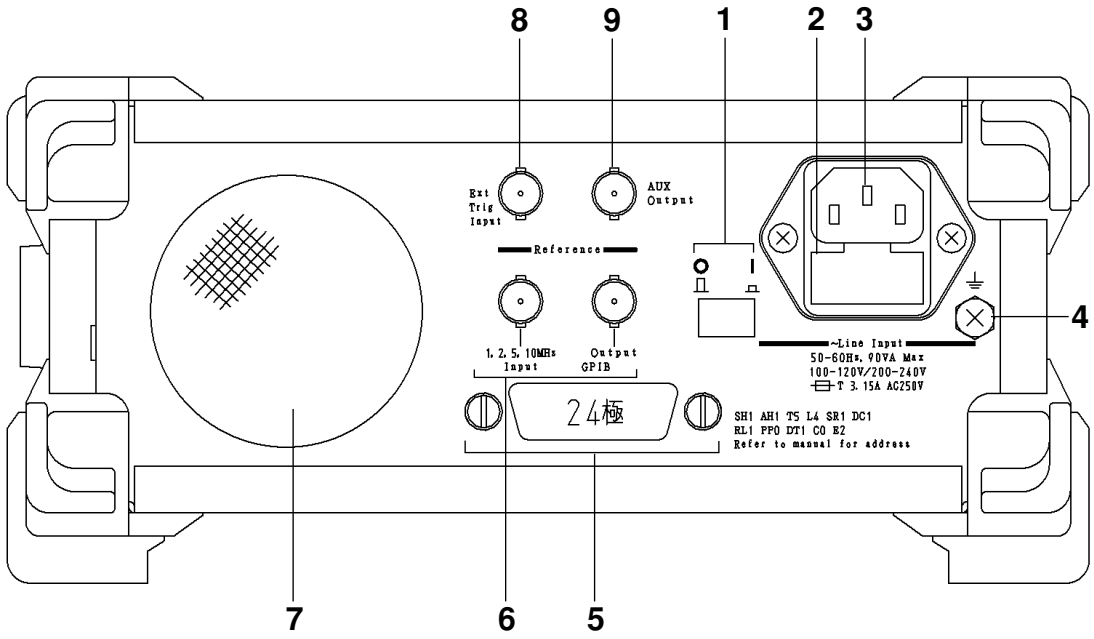


Fig. 3-3 Diagram of Back Panel

Table 3-3 Function of Back Panel Components

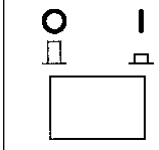
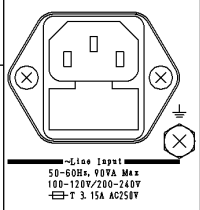
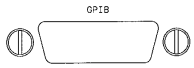
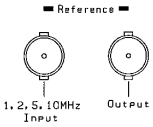
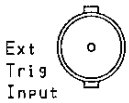
No	Label	Description
1		Power Line Switch Switch for supplying power to the unit. Moving the power switch from the Off to the On position (switch is pressed down) openly supplies power to the crystal oscillator. Turning on the power button on the front panel at this time will supply power to the various components on this unit.
2		Fuse Holder Contains a fuse. When replacing a fuse, make sure to use one of the same type and rating to avoid injury and damage to the unit.
3		AC Power Inlet Connect the power cord here. Make sure to use only a cord properly rated for this unit to avoid injury and damage to the unit.
4		Functional earth terminal This is the terminal that is electrically connected to the chassis of the equipment.

Table 3-3 Function of Back Panel Components (Continued)

No	Label	Description
5		GPIB Interface Connector If you want to control the unit from a host computer, connect a GPIB cable here and attach the other end to the host computer. Make sure you turn the unit and host computer power off before connecting this cable.
6		Reference Signal Input Connector and Reference Signal Output Connector When operating the unit using an external reference signal, input the signal to the reference input connector. The unit is ready for four frequencies: 1, 2, 5, and 10 MHz. The reference signal used by the unit is output from the reference signal output connector.
7		Fan Fan that lets out hot air from inside the unit. The fan must be at least 10 cm away from any surrounding obstacles.
8		Ext Trig Input Connector Input connector for timing frequency measurement with an external device. This input is active when you set Ext Trig to be used.
9		AUX Output Connector Connector for outputting signals from unit components. It outputs the signal selected by a parameter setting.

3.2 Operation Overview

3.2.1 Operation

Broadly speaking, this counter had two states: measurement and parameter setup. The display also has two screens corresponding to those states.
As Fig. 3-4 below shows, you can move between the two screens by pressing the direct key (menu groupe of front panel) for setting parameters and the [Return to Meas] key for exiting parameter setup.

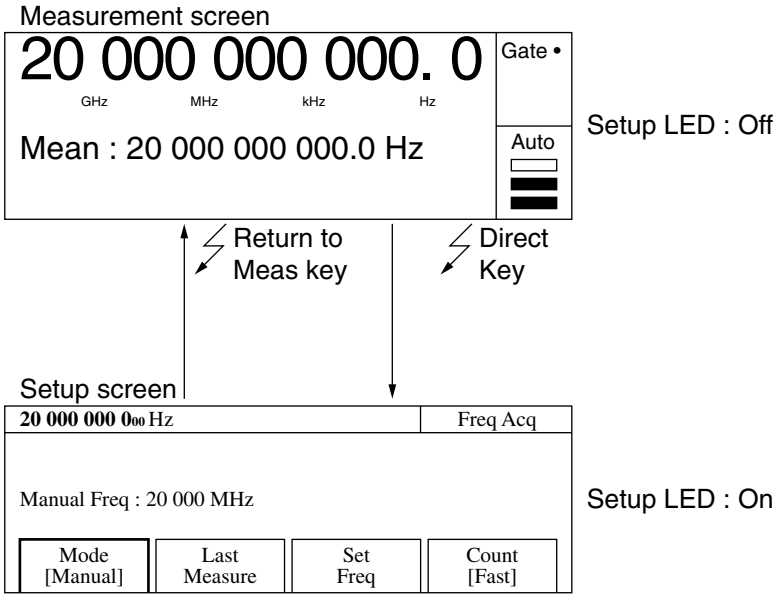


Fig. 3-4 Moving between Screens

3.2.2 Parameter Setup Hierarchy

Pressing the direct key to set parameters displays the corresponding setup screen. In the setup screen, you can set parameters listed in the first level column.
When there are more parameters than can be shown in level one, level two parameters will be displayed in the setup screen, and you can set the various parameters there. Table 3-4 shows the hierarchical structure of the setup screen.

Table 3-4 Hierarchical Structure of Setup Screen

Direct Key	Level 1	Level 2
Measurement mode [Meas Mode] CW/Burst	None	None
Frequency acquisition [Freq]	Mode [Mode] Auto/Manual Measurement result assignment [Last Measure] Frequency value input [Set Freq] Count method [Count] Fast/Normal	None
Level acquisition [Level]	Mode [Mode] Auto/Manual Auto setup value assignment [Last Measure] Level Up [∧] Level Down [∨]	None
Burst [Burst]	Burst measurement mode [Mode] Freq/Width/Period Bust measurement polarity [Polarity] ⎍ (Pos) / ⎏ (Neg) Burst width [Width] Wide/Narrow	None
Trigger and gate End [Trig]	Trigger mode [Mode] Int/Ext/Line Trigger polarity [Slope] ⟋ (Rise) / ⟍ (Fall) Gate End [Gate End] On/Off	None
Trigger delay [TD]	Trigger delay value input Burst monitor screen	None
Gate width [GW]	Gate width value input Burst monitor screen	None

Table 3-4 Hierarchical Structure of Setup Screen (Continued)

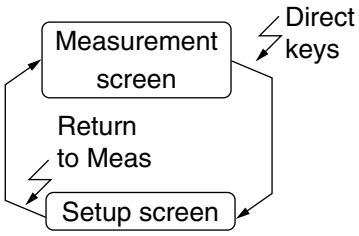
Direct Key	Level 1	Level 2
Template [Temp]	Template [Template] On/Off Upper frequency limit input [Upper Limit] Lower frequency limit input [Lower Limit] Shift direction indication [Indicate] On/Off	None
Offset [Ofs]	Offset mode [Mode] Off/+Offset/–Offset/ppm Measurement value assignment [Last Measure] Offset frequency input [Set Freq] Update mode [Update] On/Off	None
Statistics processing [Stat]	Statistics processing mode [Mode] Off/Mean/Max/Min/P-P Statistics processing extract mode [Extract] Disc/Overlap Statistics processing sampling [Sample] n {10^n, 2^n n=1, 2, 3, 4, 5, 6}	None
Input [Input]	Input connector [Input CH] Input1/Input2 Input impedance [Impd2] 50 Ω/1 MΩ Input ATT [ATT2] Recall [Recall]	None
System [Sys]	0 - 9 Save [Save] 0 - 9 GPIB [GPIB] Config [Config]	None None Address setup [Address] 0 - 30 Talk only [Talk Only] On/Off Reference signal [Freq Ref] Auto/Int AUX [AUX] Off/Go/END/LVL/Gate/Rest/Acq LCD intensity [Intensity] Bright/Dim System screen [System]

3.2.3 Function of Keys

The direct keys for setting parameters consist of the Menu keys (numeric keypad) on the front panel. The type of parameter set by a key is printed directly above each key. The following describes the function of each key when in the parameter setup state.

(1) Resolution key
Functions as a left and right cursor.
(2) Sample Rate key
Clears input before it has been entered.
(3) Menu keys
Consists of numeric keys, unit keys, and the BS (backspace) key.

Fig. 3-5 shows the function of keys and Setup LED status in the measurement screen and setup screen.



	Key Function			Set up LED
	[<], [>]	[∧], [∨]	Menu Keys (Numeric Keypad)	
Measurement screen	Sets resolution	Sets sampling rate	Direct keys	Off
Setup screen	Cursor	Changes setting	Numeric keypad or Direct keys	On

Fig. 3-5 Key Function and Setup LED Status in Measurement and Setup Screen

Section 4 Unit Operation

This chapter describes the manual operation of the MF2412B/MF2413B/MF2414B Microwave Frequency Counter. Refer to Section 5 concerning remote operation using GPIB.

4.1 Turning on Power/Self Check Screen

4.1.1 Turning on Power

Follow the procedure in order starting with step 1.

Step 1 :

Make sure that the voltage is the proper rating (100 to 230 V, 47.5 to 63 Hz) and the unit is properly grounded.
(See Sections 2.2 and 2.3).

Step 2 :

Turn power on from the back panel and front panel in that order.
If the backup memory contains settings stored when power was turned off the last time, the unit will read and then set those values. If there are no setting stored in memory, the unit will set the initial values listed in Appendix A. Note that setting the Power switch to ON with the [Enter] key pressed down allows you to operate the unit according to the initial values listed in Appendix A without using the settings stored in the backup memory.

Step 3 :

The unit will warm up until the frequency of the crystal oscillator has reached the rated level of stability. The time it takes for the crystal oscillator to reach the necessary level of stability depends on the type of crystal oscillator as shown in Table 4-1. Note that the time starts from the moment the back panel power switch is set to the On position.

Table 4-1 Required Warm-Up Time

Type of Crystal Oscillator	Startup Characteristics		Aging Rate	
	Warm-Up Time	Typical Value	Warm-Up Time	Typical Value
Standard Part	At least 30 min.	5×10^{-8}	At least 24 hrs.	2×10^{-8}/day
Option 01	At least 1 hr.	3×10^{-8}	At least 24 hrs.	5×10^{-9}/day
Option 02	At least 1 hr.	2×10^{-8}	At least 24 hrs.	2×10^{-9}/day
Option 03	----------	----------	At least 48 hrs.	5×10^{-10}/day

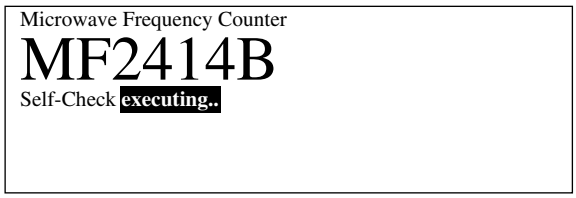
Step 4 :

You can now use the unit to measure frequency.

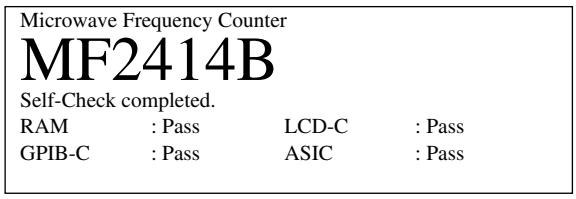
4.1.2 Self-Check

When you turn on power, the unit displays the self-check screen shown in Fig. 4-1(a). If the self-check is completed successfully, you will the self-check completion screen for about one second (see Fig. 4-1(b)), and then the measurement screen will appear. Measurement will begin according to parameters set in advance.
If the self-check finds something wrong with the unit, Fail will be displayed (see Fig. 4-1(c)), and then the unit will stop.
You can also conduct a self-check by holding down the [Return to Meas] key while turning on power using the front panel power button. This will perform a detailed self-check. The screens during a detailed self-check are the same as those during a simple self-check (see Fig. 4-1(a) and 4-1(b)).
If the detailed self-check finds something wrong with the unit, Fail will be displayed (see Fig. 4-1(d)), and then the unit will stop.
When the only problem discovered during a simple self-check is with GPIB as shown in Fig. 4-1(e), you will be able to continue operation by pressing the [Preset] key since the GPIB feature will be rendered unusable.

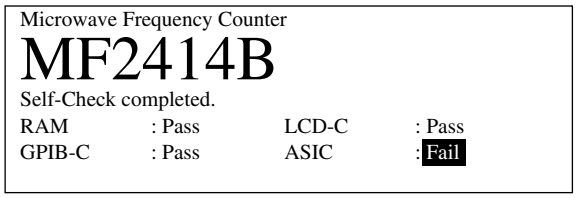
The model name shown in the screens is MF2412B. However, MF2413B and MF2414B also use the same screens.



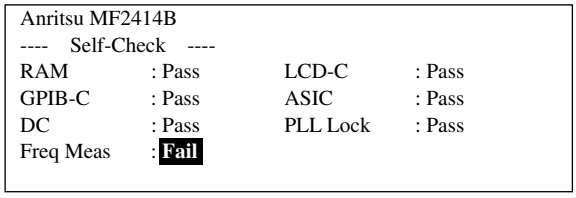
(a) Self-check (simple and detailed) screen



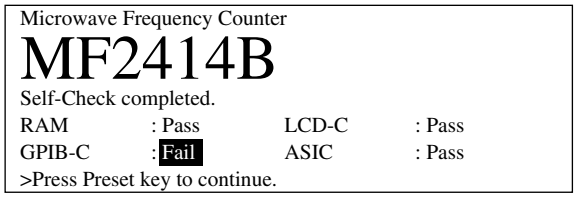
(b) Self-check completed (simple and detailed) screen



(c) Self-check failed (simple) screen



(d) Self-check failed (detailed) screen



(e) GPIB failed (simple) screen

Fig. 4-1 Self-Check Screens

4.2 Screen Description

This unit has three major screens: a measurement screen, a setup screen, and a system screen. The measurement screen further consists of two screens: a normal measurement screen and a template screen. The setup screen further consists of a menu screen and a burst monitor screen.

This section provides a basic description of screen display.

Table 4-2 Screen Configuration

Major Classification	Minor Classification
Measurement screen	Normal measurement screen
	Template screen
Setup screen	Menu screen
	Burst monitor screen
System screen	

4.2.1 Measurement Screen

Once you turn on power, the unit performs a self-check, and if it finds nothing wrong, it enters the measurement state and displays the measurement screen. This unit has two kinds of measurement screens: the normal measurement screen and the template screen.

[Normal Measurement Screen]

Figure 4-2 shows the normal measurement screen that displays frequency measurement results with numeric values. This screen is displayed when the initial setup has been done.

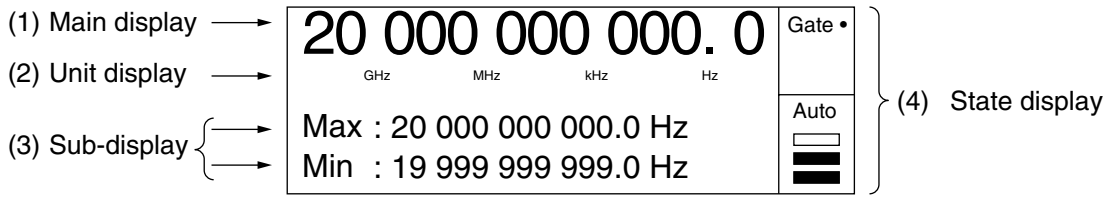


Fig. 4-2 Normal Measurement Screen

The following describes items (1) to (4) in Fig. 4-2.

(1) Main display
Displays frequency measurement results.

(2) Unit display
Displays units for frequencies displayed on the main display.

(3) Sub-display
Display changes depending on what function is specified such as statistical processing result, offset frequency value, pulse width during burst measurement, or continuous period.

(4) State display
Displays the unit's measurement state. Table 4-3 lists the measurement states and provides an overview.

Table 4-3 Measurement State Display and Overview

Display	Overview
Gate ·	When Gate is followed by a dot, the frequency of the input signal is being measured. If the dot is not displayed, measurement has halted.
UNCAL	This is displayed when the unit's specifications cannot be guaranteed because the input signal maintaining the level required to get the set resolution is not being supplied continuously.
Auto 	Displays the unit's level setting and input level.

The unit displays UNCAL in the following situations, indicating the measurements are not valid.

(1) The input signal is outside of the measurable range.
(2) The measurement resolution cannot be obtained from the measurement result.
(3) You have input a pulse burst signal that could not get measurement resolution that could be set even when averaged during burst carrier frequency measurement.
(4) You selected Input2 as the signal input terminal while the burst measurement mode was set.

Fig. 4-3 describes the level display of the Fig. 4-2 (4) state display in even more detail. The level display consists of an input display showing how to handle the input signal (1) and a level display showing the power of the input signal (2).

Fig. 4-3 Level Display

Tables 4-4 and 4-5 describe the input display (1) and level display (2) of the Fig.4-3.

Table 4-4 Input Display Description

Display	Description
Auto	Displays whether Input 1 level acquisition Auto or Input2 50 Ω is set.
L0 to L7	Displays which pulse amplitude discrimination value for L0 to L7 is set on Input 1 and level acquisition Manual.
ATTon	Indicates 1 MΩ impedance on Input2 and that 20 dBATT has been set.
No display	Indicates that 1 MΩ impedance has been set on Input2.

Table 4-5 Level Display Description

Display	Description
Over	Indicates that the input level is excessive. Proper measurement cannot be made until the input level is lowered.
	Indicates a perfect input level.
to	Indicates that the input level is measurable.
	Indicates that the input level is too low. Proper measurement cannot be made until the input level is raised.

[Template Screen]

Figure 4-4 shows the template screen that visually indicates whether the frequency measurement results fail in the preset range. This screen allows you to instantly make a decision without calculating frequency values when making adjustments.

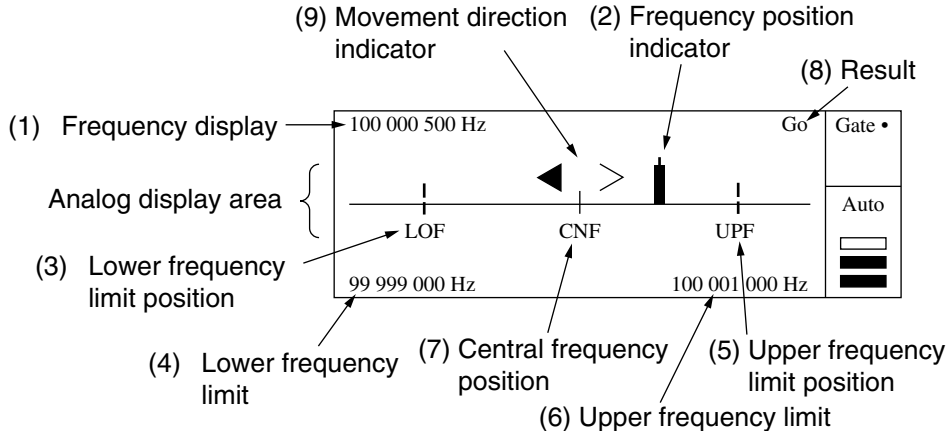


Fig. 4-4 Template Screen

The following describes (1) to (9) found in Fig. 4-4 above.

(1) Frequency display
Displays the results of frequency measurements.

(2) Frequency position indicator
Indicates current position of the frequency being measured within the range set in advance. This range consists of an upper frequency limit and a lower frequency limit. If the measured frequency exceeds the LCD display range, the frequency position indicator is held at the left or right end.

(3) Lower frequency limit position
Indicates the lower frequency limit on the LCD.

(4) Lower frequency limit
Displays the lower frequency limit value that was set.

(5) Upper frequency limit position
Indicates the upper frequency limit on the LCD.

(6) Upper frequency limit
Displays the upper frequency limit value that was set.

(7) Central frequency position
Indicates the central frequency position determined from the upper and lower frequency limits that were set.

(8) Result
Displays the result of determining whether the measured frequency value or statistic processing result is inside or outside of the frequency range defined by the upper and lower frequency limits.
Within the range: Displays “Go”
Outside of the range: Displays No Go

(9) Movement direction indicator
When the measured frequency value goes outside of the LCD display range, the unit compares the measured frequency value to the previously measured value to find out whether the frequency is going lower or higher and display the direction of movement.
◀ > : Indicates that the measured frequency value is moving to the left (low frequency direction).
< ▶ : Indicates that the measured frequency value is moving to the right (high frequency direction).
< > : Indicates that the measured frequency value is constant.
This movement direction display can be turned on or off by setting the appropriate parameter.

4.2.2 Setup Screen

Pressing a direct key when the unit is in the measurement state (the LCD will be displaying the measurement screen and the front panel Setup LCD will be lit) enters the parameter setup state (the LCD will be display the setup screen and the front panel Setup LED will light). The following describes the two types of setup screens.

[Menu Screen]

The menu screen displays a list of menu corresponding to direct keys. You can use the [<] and [>] keys to select parameters, select setting values, and enter numeric data.

Fig. 4-5 shows the basic screen.

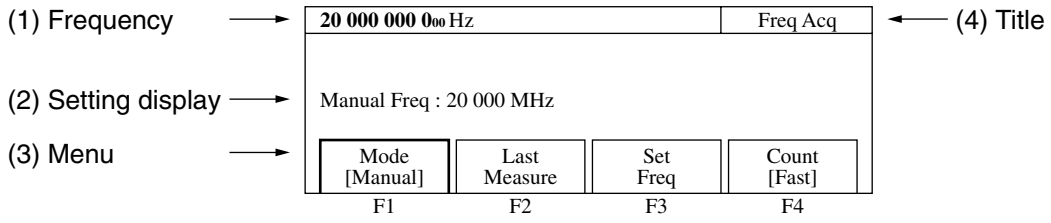


Fig. 4-5 Menu Screen

The following describes items (1) to (4) in Fig. 4-5 shown above.

(1) Frequency
Displays the results of frequency measurements.

(2) Setting display
Displays settings with a large number of digits such as frequencies. Displays numeric data such as frequencies.

(3) Menu
- The menu displays up to four function selections. For the sake of convenience, they are called F1, F2, F3, and F4 starting from the left.
- A selected functions is highlighted and displayed within a thick frame.
- The following describes menu structure.

(A)

Function name [Setting state] ← Displays the name of the function that can be set.
← The content between square brackets [ ], if displayed, consists of a number of possible parameter selections.

(B)

Lower screen * ← Displays a group name and an asterisk when the menu extends to a lower level.

- The following describes how to use menus.
  (1) Use the keys ([<] [>]) to select a function (F1 to F4) to set.
  (2) The way you set parameters depends on the menu type. Table 4-6 shows how to make settings for each menu type.

Table 4-6 Setting Menu

Item	How to Set
Two choices menu ([On/Off] for example)	Switches between two choices each time you press the [Enter] key, starting measurements under the set conditions. Pressing the Enter key when On is set will switch to Off.
Multiple choices menu ([Freq/Width/Period] for example)	Pressing the [Enter] key pops up a parameter menu. Select a parameter using [<] and [>] keys and determine it by pressing the [Enter] key. Measurements will start according to the determined parameter.
Numeric input menu	Pressing the [Enter] key highlights the setting value, allowing you to enter a numeric value using the numeric keypad. When you enter a numeric value, this area becomes a response data display area. Pressing the unit key determines the entered value and starts measurement. The setting value is still highlighted at this time, allowing you to enter another numeric value. To exit from the numeric input mode, press the [Enter], [Return to Meas], [<], or [>] key.

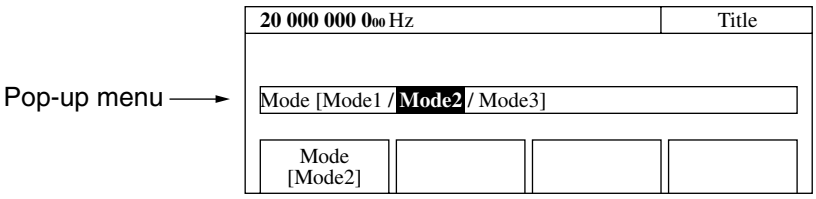


Fig. 4-6 Menu Screen with Pop-up Menu

(4) Title

Displays the title given to each setup screen.

Table 4-7 shows the parameters that can be set using the direct keys and menu screen.

Table 4-7 Direct Keys and Parameters

Direct Key	Level 1	Level 2
Measurement mode [Meas Mode] CW/Burst	None	None
Frequency acquisition [Freq]	Mode [Mode] Auto/Manual Measurement result assignment [Last Measure] Frequency value input [Set Freq] Count method [Count] Fast/Normal	None
Level acquisition [Level]	Mode [Mode] Auto/Manual Auto setup value assignment [Last Measure] Level Up [∧] Level Down [∨]	None
Burst [Burst]	Burst measurement mode [Mode] Freq/Width/Period Bust measurement polarity [Polarity] ⎍⎍ (Pos) / ⎍⎍ (Neg) Burst width [Width] Wide/Narrow	None
Trigger and gate End [Trig]	Trigger mode [Mode] Int/Ext/Line Trigger polarity [Slope] ⎍⎍ (Rise) / ⎍⎍ (Fall) Gate End [Gate End] On/Off	None
Trigger delay [TD]	Trigger delay value input Burst monitor screen	None
Gate width [GW]	Gate width value input Burst monitor screen	None

Table 4-7 Direct Keys and Parameters (Continued)

Direct Key	Level 1	Level 2
Template [Temp]	Template [Template] On/Off Upper frequency limit input [Upper Limit] Lower frequency limit input [Lower Limit] Shift direction indication [Indicate] On/Off	None
Offset [Ofs]	Offset mode [Mode] Off/+Offset/–Offset/ppm Measurement value assignment [Last Measure] Offset frequency input [Set Freq] Update mode [Update] On/Off	None
Statistics processing [Stat]	Statistics processing mode [Mode] Off/Mean/Max/Min/P-P Statistics processing extract mode [Extract] Disc/Overlap Statistics processing samplings [Sample] n {10^n, 2^n n=1, 2, 3, 4, 5, 6}	None
Input [Input]	Input connector [Input CH] Input1/Input2 Input impedance [Impd2] 50 Ω/1 MΩ Input ATT [ATT2] On/Off	None
System [Sys]	Recall [Recall] 0 - 9 Save [Save] 0 - 9 GPIB [GPIB] Config [Config]	None None Address setup [Address] 0 - 30 Talk only [Talk Only] On/Off Reference signal [Freq Ref] Auto/Int AUX [AUX] Off/Go/END/LVL/Gate/Rest/Acq LCD intensity [Intensity] Bright/Dim System screen [System]

[Burst Monitor Screen]

This is the screen where you set trigger delay values and gate widths.
Pressing [TD] or [GW] displays the burst monitor screen shown in Fig. 4-7 below. You can set values while monitoring the detection signal for individual burst signals that are input.

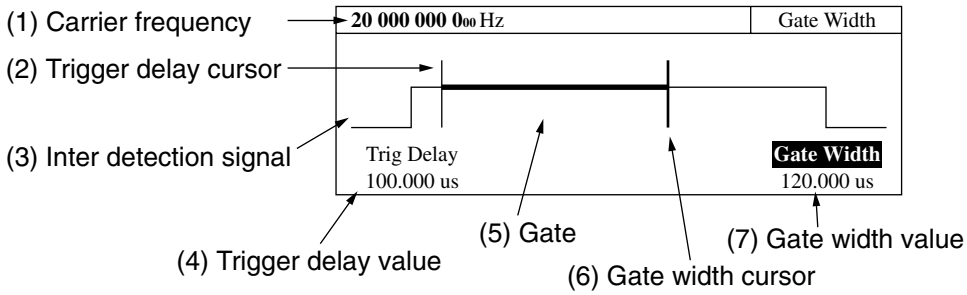


Fig. 4-7 Burst Monitor Screen

(1) Carrier frequency
Displays the carrier frequency measured by the currently selected gate.
(2) Trigger delay cursor
Shows the position of the trigger delay. It moves right and left accordingto the trigger delay value.
(3) Internal detection signal
Displays the burst detection signal.
(4) Trigger delay value
Displays the trigger delay value.
(5) Gate
Displays the count gate using a thick line. It moves right and left according to the trigger delay value and gate width value.
(6) Gate width cursor
Indicates the gate width. Moves to the right and left according to the gate width value.
(7) Gate width value
Displays the value of the gate width.

You can set a highlighted parameter. Use the cursor keys [<] [>] or numeric keypad to make your settings.

4.2.3 System Screens

Fig. 4-8 shows the system screen that displays self-check results.

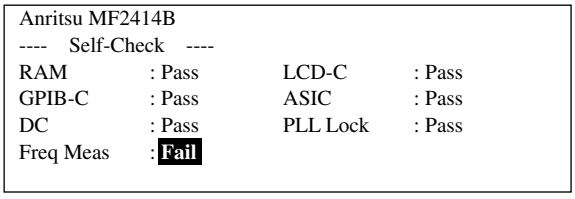


Fig. 4-8 System Screen

4.3 Parameters

The parameters and their setting method are described below.
When parameters are set using the panel keys, frequency measurement or statistics processing is restarted and a new measurement is performed.

Setting parameters when in the Hold State performs frequency measurement or statistics processing once and returns the unit to the Hold State.

4.3.1 Switching Input

Fig. 4-9 shows the screen where you set the connector where you will connect the signal to be measured, select the impedance of the input signal, and set the attenuator. Pressing the [Input] key displays the following screen where you can set parameters.

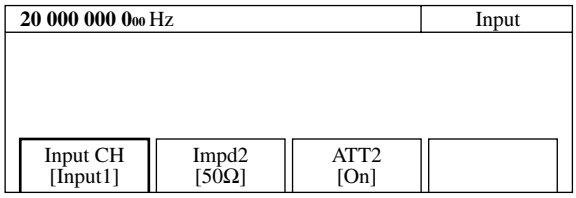


Fig. 4-9 Input Switching Screen

(1) Menu F1 : Selects the connector for inputting the signal to be measured along with the frequency that you want to measure. The following shows the frequency ranges of the connectors you can select :
Input1 : 600 MHz to 20 GHz : MF2412B
600 MHz to 27 GHz : MF2413B
600 MHz to 40 GHz : MF2414B
Input2 : 10 Hz to 1 GHz

(2) Menu F2 : Selects the input impedance of Input2. The input impedance of Input1 is fixed at 50 Ω, but you are able to switch the value for Input2 between 50 Ω and 1 MΩ. Note that the frequency that you can measure depends on the impedance you select as follows :
50 Ω : 10 MHz to 1 GHz
1 MΩ : 10 Hz to 10 MHz

(3) Menu F3 : Turns On/Off the 20 dB attenuator in the 1 MΩ system of Input2.

4.3.2 Sample Rate

To set a sample rate, use the [∧] and [∨] keys while the unit displays the measurement screen.

"Sample rate" refers to the measurement pause time between the completion of one measurement and the beginning of the next measurement. You can set the sample rate between 1 ms and 10 s in increments of 1, 2, or 5. Pressing the [∧] key increases sample rate length and pressing the [∨] key decreases sample rate length. Sample rate setup screen is as follows.

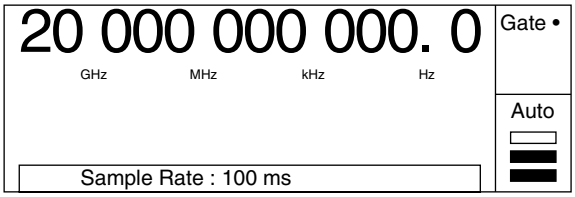


Fig. 4-10 Sample Rate Screen

Note :

When frequency acquisition Auto measurement is set on Input1, the minimum sample rate is 10 ms. If you set a sample rate of 5 ms or less, the unit will make measurements at a sample rate of 10 ms.

When setting Auto frequency acquisition in the burst measurement mode, the pause time may by greater than the set sample rate depending on the pulse width and/or cycle modulation.

4.3.3 Frequency Resolution

Use the [<] and [>] keys to set the number of digits to be displayed for frequency measurement results. The frequency measurement range varies depending on the input chanel and input impedance.
Consequently, the resolution you can set also varies. Fig 4-12 and 4-13 show the resolutions that you can set.

Input terminal : Input1 (50 Ω), Input2 (50 Ω)

Measurement Resolution	Display	[<] Key Function	[>] Key Function
0.1 Hz	20 000 000 000. 0 GHz MHz kHz Hz	↓	↑
1 Hz	20 000 000 000. GHz MHz kHz Hz		
10 Hz	20 000 000 00$_0$ GHz MHz kHz Hz		
100 Hz	20 000 000 0$_{00}$ GHz MHz kHz Hz		
1 kHz	20 000 000 GHz MHz kHz		
10 kHz	20 000 00$_0$ GHz MHz kHz		
100 kHz	20 000 0$_{00}$ GHz MHz kHz		
1 MHz	20 000 GHz MHz		

Fig. 4-12 Frequency Display (Measured at an Input Impedance of 50 Ω)

Input terminal : Input2 (1 MΩ)

Measurement Resolution	Display	[<] Key Function	[>] Key Function
1 mHz	10 000 000. 000 MHz kHz Hz		
10 mHz	10 000 000. 00 MHz kHz Hz		
100 mHz	10 000 000. 0 MHz kHz Hz		
1 Hz	10 000 000. MHz kHz Hz		
10 Hz	10 000 00$_0$ MHz kHz Hz		
100 Hz	10 000 0_{00} MHz kHz Hz		
1 kHz	10 000 MHz kHz		
10 kHz	10 00$_0$ MHz kHz		
100 kHz	10 0_{00} MHz kHz		
1 MHz	10 MHz		

Fig. 4-13 Frequency Display (Measured at an Input Impedance of 1 MΩ)

When measuring the carrier frequency of burst signal, the pulse width of the burst signal determines the maximum frequency resolution that can be measured. When you set a frequency resolution that is higher than the maximum frequency resolution that can be measured, the unit will display UNCAL and then measure at the maximum frequency resolution possible.

The unit will display the following when the frequency resolution is set to 1 kHz and the measurement result could only obtain a resolution up to 10 kHz.

20 000 00*
GHz MHz kHz

Fig. 4-14 shows the relationship between burst pulse width and the maximum frequency resolution.

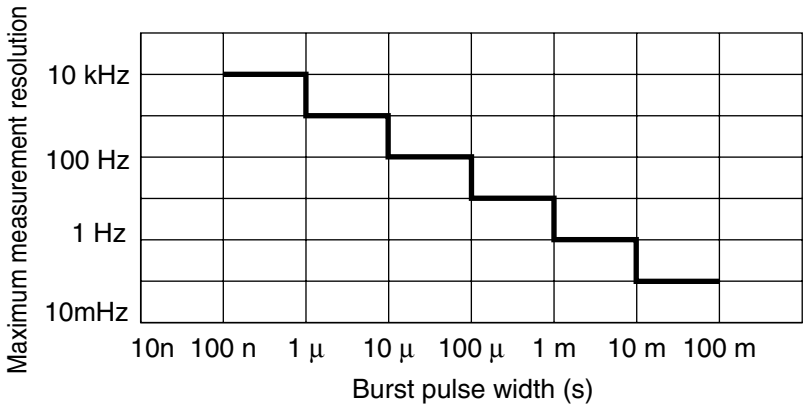


Fig. 4-14 Burst Width Versus Maximum Resolution

4.3.4 Measurement Mode

Using the [Meas Mode] key, determine whether to measure burst waves (Burst) or continuous waves (CW).
If you have selected burst signal measurement, press the [Meas Mode] key repeatedly so that the Burst LED lights. If you have selected continuous wave measurement, press the [Meas Mode] key repeatedly so that the Burst LED goes off.
When you have selected burst wave measurement, the unit can measure the carrier frequency, burst signal pulse width, and pulse repetition period.
The Input2 connector cannot be used for burst measurement. When you have selected the Input2 connector, select continuous wave measurement.

4.3.5 Level Acquisition

Level acquisition can be performed only when you have selected Input1. Determine whether to set the optimum amplitude discrimination value (level acquisition) in the Auto or Manual mode. You can set the manual amplitude discrimination value between the maximum attenuation level "L0" (42 dB) and the minimum attenuation level "L7" (0 dB) in steps of 6 dB.
Pressing the [Level] key displays the Level Acq parameter setup screen shown in Fig. 4-15. While this screen is on the display, you can set the manual amplitude discrimination value using [∧] and [∨] keys.

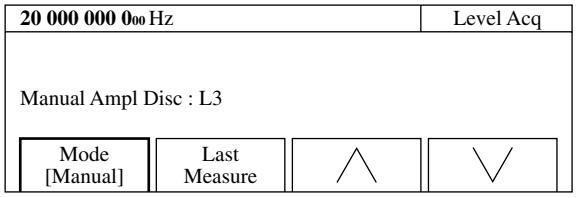


Fig. 4-15 Level Acquisition Parameter Setup Screen

(1) Menu F1: Select either the Auto or Manual mode for level acquisition.
Setting Auto automatically sets the optimum reception level.
Setting Manual sets the manual amplitude discrimination value.

(2) Menu F2: Set the amplitude discrimination value set in the Auto mode, as the manual amplitude discrimination value.

(3) Menu F3: Pressing [∧] key increments the manual amplitude discrimination value by 1. Use this when the input level is low. The manual amplitude discrimination value can be incremented up to L7. The [∧] key can be used if menu F3 is not enclosed by a thick frame.

(4) Menu F4: Pressing [∨] key decrements the manual amplitude discrimination value by 1. Use this when the input level is high. The manual amplitude discrimination value can be decremented down to L0. The [∨] key can be used if menu F4 is not enclosed by a thick frame.

4.3.6 Frequency Acquisition

Frequency acquisition can be performed only when you have selected Input1. Select an Auto or Manual mode in which the acquisition frequency of this unit is to be preset for measuring the input signal frequency. When you have selected Manual, you can set the acquisition frequency (manual frequency) in steps of 1 MHz. Frequency ranges you can set are as follows:

- MF2412B: 600 MHz to 20 GHz in steps of 1 MHz
- MF2413B: 600 MHz to 27 GHz in steps of 1 MHz
- MF2414B: 600 MHz to 40 GHz in steps of 1 MHz

Pressing the [Freq] key displays the screen shown in Fig. 4-16, allowing you to set parameters.

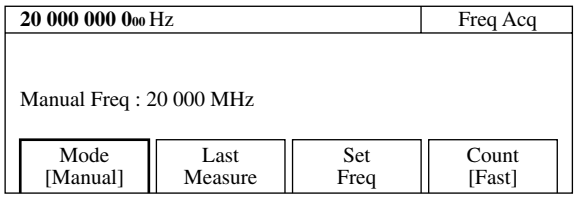


Fig. 4-16 Frequency Acquisition Parameters Setup Screen

(1) Menu F1: Select either the Auto or Manual mode for frequency acquisition.
Setting Auto automatically gets and measures the input frequency.
Setting Manual measures the frequency of the manual frequency value plus the input tolerance. Set the manual frequency value.

Tables 4-8 and 4-9 show input tolerances.

Table 4-8 Input Tolerances (CW Measurement Mode)

Manual Frequency Value	Input Tolerance
600 MHz to 1 GHz	±30 MHz
1 GHz or higher	±40 MHz

Table 4-9 Input Tolerances (Burst Measurement Mode)

Manual Frequency Value	Burst Width Setting	Input Tolerance
600 MHz to 1 GHz	Wide	±30 MHz
1 GHz or higher	Narrow	±20 MHz
	Wide	±40 MHz

Note:

Manual mode operation is not guaranteed when the manual setting value for the input signal exceeds the input tolerance. If this happens, an incorrect measurement result may be displayed. Check the input signal before deciding the manual setting value.

(2) Menu F2: Set the frequency measurement result as a manual frequency value.

(3) Menu F3: Sets the manual frequency value. Selecting Set Freq by pressing the [Enter] key highlights Manual Freq, allowing you to set the manual frequency value using the numeric keypad. Figure 17 shows the screen displayed after you have entered "12". Pressing the [GHz] key at this point sets 12 GHz as the acquisition frequency value, thus starting measurements.

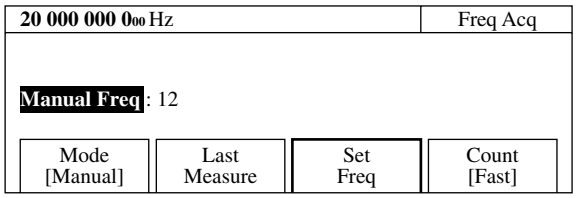


Fig. 4-17 Setting Manual Frequency

After you have entered a numeric value and a unit of measure, Manual Freq is highlighted, allowing you to enter another frequency continuously.

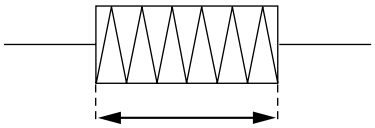
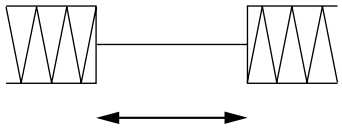
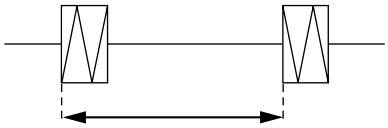
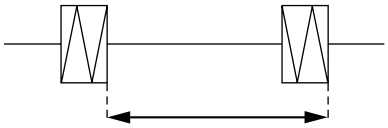
To exit from the numeric input mode, press the [Enter], [<], [>], or [Return to Meas] key.

(4) Menu F4 : Sets the count method to either Fast or Normal.
Pressing F4 when Fast is set will change the setting back to Normal, and change the display to Count [Normal]. When Fast is set, the unit will perform countings using the reciprocal method. When Normal is set, the unit will perform countings using direct count method. However, when Meas Mode is set to Burst, the unit will count using the Fast (reciprocal) setting even if Mode is set to Normal.

4.3.7 Burst Measurement Mode

The burst measurement mode is only available when you set Meas Mode to Burst. Select either carrier frequency, burst width, or burst period. You can also set whether to perform burst width measurements and burst period measurements with burst On (positive polarity) or burst Off (negative polarity) and set the burst wave to be measured to correspond with the burst width.
Table 4-10 shows the measurement range.

Table 4-10 Measurement Subject Relationship According to Burst Measurement Polarity

		Burst Measurement Polarity	
		Positive	**Negative**
Measurement	Burst Width	Measurement at Burst On time 	Measurement at Burst Off time 
	Burst Period	Measurement of On-On period 	Measurement of Off-Off period 

Pressing the [Burst] key displays the screen where you can set parameters (see Fig. 4-18).

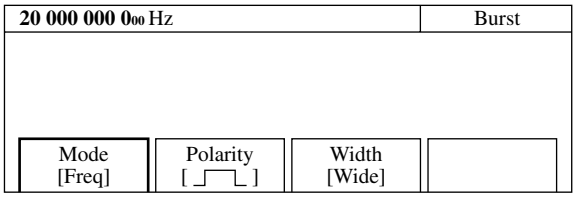


Fig. 4-18 Burst Mode Screen

(1) Menu F1 : Sets carrier frequency measurement, burst width measurement, or burst frequency measurement. Selecting menu F1 displays the mode selection screen shown in Fig. 4-19 below. Use the cursor in this screen to select either Freq, Width, or Period, and then Press the [Enter] key to enter your selection and return to the burst mode screen shown in Fig. 4-18. At that point, you will see the parameter you set displayed within the square brackets [ ] of the menu F1.

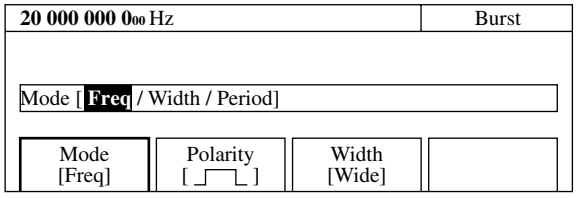


Fig. 4-19 Mode Selection Screen

(2) Menu F2 : Sets the polarity (positive or negative) during burst measurement.
Selecting menu F2 when positive polarity is set, changes the polarity to negative and displays Pol [┐└┘┌] on the screen. Conversely, selecting menu F2 when negative polarity is set changes the polarity to positive.

(3) Menu F3 : Selects Wide or Narrow depending on the burst width of the burst wave to be measured.

Table 4-11 Burst Width Setting and Relationship between Measurable Burst Width and Input Tolerance

Type of Crystal Oscillator	Startup Characteristics		Aging Rate	
	Warm-Up Time	Typical Value	Warm-Up Time	Typical Value
Standard Part	At least 30 min.	5×10^{-8}	At least 24 hrs.	2×10^{-8}/day
Option 01	At least 1 hr.	3×10^{-8}	At least 24 hrs.	5×10^{-9}/day
Option 02	At least 1 hr.	2×10^{-8}	At least 24 hrs.	2×10^{-9}/day
Option 03	----------	----------	At least 48 hrs.	5×10^{-10}/day

Note :

Narrow is only effective when the manual frequency value is 1 GHz or higher. When it is less than 1 GHz, measurement will be performed in Wide mode regardless of the burst width setting.

4.3.8 Gating

This function allows you to measure a frequency in any interval of the signal to measure. Based on the trigger signal, it defines the interval for measuring the frequency according to the specified parameters such as a trigger delay, gate width, and gate end. Note that the signal to measure at the prescribed level must exist in the measurement interval. Figure 4-20 shows the relationship between the parameters.
This function enables you to measure the frequency at a specific position of a burst signal.

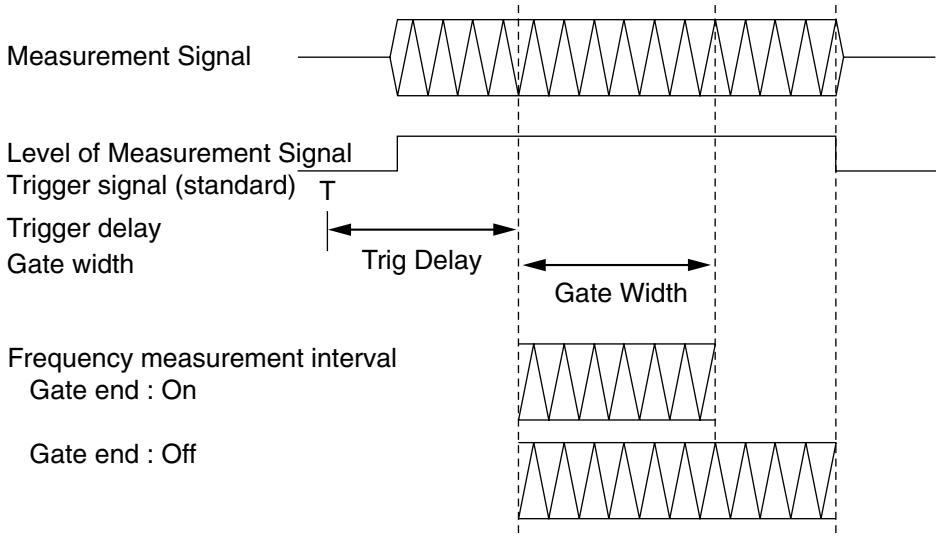


Fig. 4-20 Gating Function Overview

The trigger delay width and gate width can be set while looking at the burst signal On/Off state shown on the screen.

The trigger delay width can be set between 0 ns and 100 ms. The setting resolutions are as follows:

Table 4-12 Trigger Delay Width Setting Resolutions

Trigger Delay Width	Setting Resolution
0 ns to 320 ns	20 ns
320 ns to 1 us	40 ns
1 us to 100 ms	Number of significant digits = 2

The gate width can be set between 100 ns and 100 ms. The setting resolutions are listed below.
When "Wide" is set as the burst width, the minimum value of the gate width becomes 1 us. If Wide is set as the burst width and a value less than 1 us is set as the gate width, measurement will be performed at the gate width of 1 us.

Table 4-13 Gate Width Setting Resolutions

Gate Width	Setting Resolution
100 ns to 1 us	20 ns
1 us to 100 ms	Number of significant digits = 2

Pressing the [TD] key displays the burst monitor screen for trigger delay setting (Fig. 4-21). [∧] and [∨] keys allow you to set a trigger delay. Pressing the [∧] key increases the trigger delay value, and pressing the [∨] key decreases the trigger delay value.
To enter a numeric value using numeric keys, press the [Enter] key here.
"Trig Delay" is highlighted, allowing you to enter a numeric value. After entering a numeric value, pressing the [Enter] key displays "Trig Delay".
Pressing the [>] key displays "Gate Width", allowing you to set the gate width. Pressing the [<] key at this time displays the "Trig Delay", allowing you to set the delay width from the trigger.

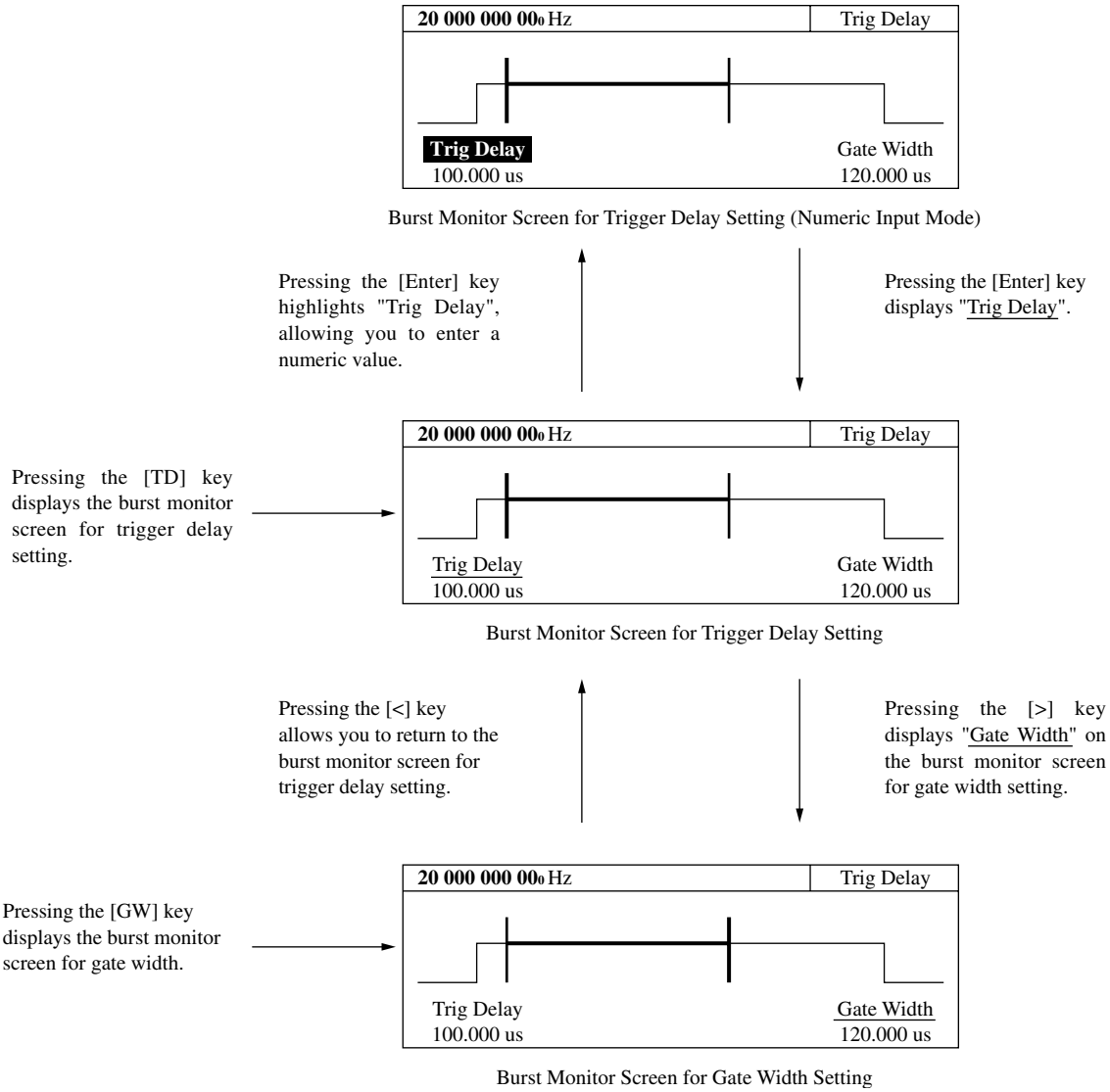


Fig. 4-21 Burst Monitor Screen

Pressing the [GW] key displays the burst monitor screen for gate width setting (Fig. 4-21). [∧] and [∨] keys allow you to set a gate width. Pressing the [∧] key increases the gate width, and pressing the [∨] key decreases the gate width.
The numeric value input method and screen switching method are the same as those for the burst monitor screen for trigger delay setting.

4.3.9 Trigger and Gate End

This function selects the trigger signal identifying the start of frequency measurement, select trigger polarity, and sets the gate end. Pressing the [Trig] key displays the screen where you can set parameters (see Fig. 4-22).

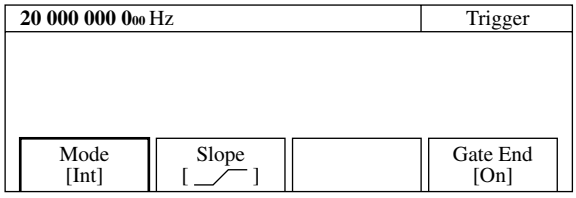


Fig. 4-22 Trigger Setup Screen

(1) Menu F1 : Selects whether to use one of the available triggers: internal trigger (Int), external trigger (Ext), or line trigger (Line). Selecting menu F1 displays the trigger selection screen shown in Fig. 4.23.
Use the cursor keys to select either Int, Ext, or Line, and then press. Enter to return to the trigger setup screen shown in Fig. 4-22. The parameter that you see is displayed within the square brackets [ ] of the F1 menu.

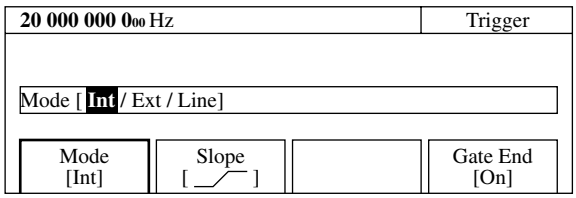


Fig. 4-23 Trigger Selection Screen

(2) Menu F2 : Sets the polarity for detecting an external trigger signal and line trigger.

(3) Menu F4 : Sets whether or not (On/Off) to determine the end of carrier frequency measurement using gate width. When gate end is On, the unit measures carrier frequency using the gate within the width set by the gate value. When gate end if Off, the unit measures carrier frequency using the gate within a width until the burst wave goes off.

4.3.10 Offset

This function uses the offset frequency value set in advance for the frequency value to perform the following calculation and display the result.

<+ Offset>

Adds the offset value to the frequency measurement value.

<–Offset>

Subtracts the offset value from the frequency measurement value.

<ppm>

Expresses the deviation from the frequency measurement value in parts per million.

Pressing the [Ofs] key display the screen where you can set parameters (see Fig. 4-24).

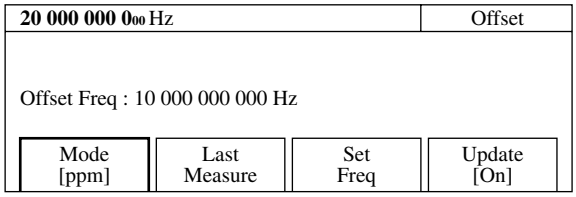


Fig. 4-24 Setting Offset Parameter

(1) Enclosing the menu F1 in a thick frame and then pressing the [Enter] key displays the offset mode selection screen shown in Fig. 4-25. Selecting Off, +Offset, -Offset, or ppm using [<] and [>] keys and then pressing the [Enter] key allows you to return to the screen shown in Fig. 4-24. The parameter you selected is displayed in [ ] of menu F1.

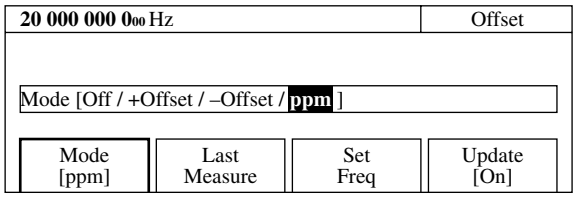


Fig. 4-25 Selecting Offset Mode

(2) Menu F2: Enclosing menu F2 in a thick frame and then pressing the [Enter] key sets the current frequency measurement value as the offset frequency value.

(3) Menu F3 : Select to use the front panel numeric keypad to set an offset frequency value. Enclosing menu F3 in a thick frame and then pressing the [Enter] key highlights Offset Freq, allowing you to enter a numeric value. After entering a value, pressing the [Enter], [<], [>], or [Return to Meas] key allows you to exit from the numeric input mode.

You can set offset frequency between 0 Hz and Fmax in units of 1 mHz.

Note, Fmax= 20 GHz..... MF2412B
27 GHz..... MF2413B
40 GHz..... MF2414B

(4) Menu F4 : Turns the update mode On/Off. When the update mode is On, the unit sequentially updates the previous measurement value as an offset value. Fig. 4-26 shows the situation when –Offset is selected when the update mode is On.

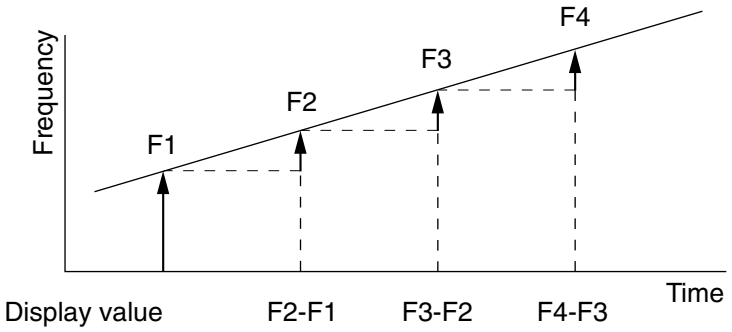


Fig. 4-26 Display Value when Update is On and –Offset is Selected

4.3.11 Statistics Processing

This function calculates mean, minimum, and maximum values from frequency measurement results, and then displays the result. The statistics processing mode setting selects whether to calculate the mean value or minimum and maximum value or perform another calculation. Number (1) that follows describes the statistics processing mode.
Statistics processing requires that you collect data (samples) to calculate. The number (frequency measurement count) you collect will be set as the sample number in advance. Number (3) that follows describes the sample number.
You must set which combination you will use to calculate the sample data you collected. Number (2) that follows describes how to set a combination.

Pressing the [Stat] key displays the screen shown in Fig. 4-27 where you can set parameters.

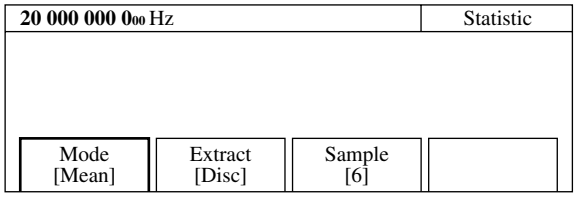


Fig. 4-27 Setting Statistics Processing Parameters

(1) Menu F1 : Sets the statistics processing mode. Selecting menu F1 displays the statistics processing mode selection screen shown in Fig. 4-28. Use the cursor keys to select either Off, Mean, Max, Min, or p-p, and then press the [Enter] key to return to the screen shown in Fig. 4-30. The parameter that you set will be displayed within the square brackets [ ] of the F1 menu.

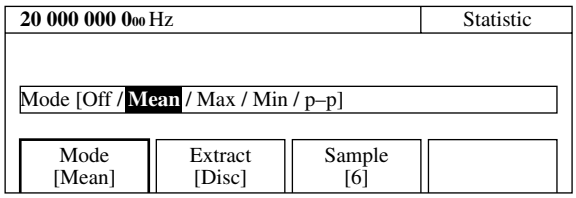


Fig. 4-28 Selecting Offset Mode

Statistics processing does the following according to its combination with the statistics processing extraction mode. Dn is the nth measurement value, and N is the number of samples set.

- Mean (extraction mode : Discrete)
  Finds the arithmetic mean value of the N number of measurement values in the sample.
  $\text{Mean} = (1/N) \cdot \{\sum_{i=1}^{N} (D_i)\}$
- Mean (extraction mode : Overlap)
  Finds the running average of the N number of measurement values in the sample.
  $\text{Mean} = (1/N) \cdot \{\sum_{i=n-N+1}^{N} (D_i)\}$

  Note that n≥N

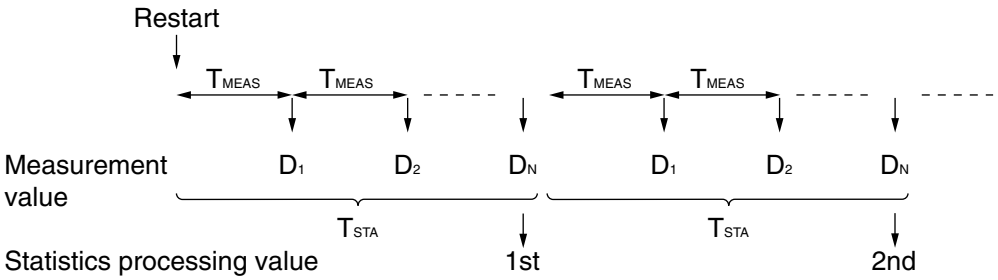
- Max · Min (extraction mode : Discrete)
  Max=maximum (D_i i=1,2,…,N)
  Max=maximum (D_i i=1,2,…,N)

- Max · Min (extraction mode : Overlap)
  Max=maximum (D_i i=n-N+1, …,n-1,n)
  Max=maximum (D_i i=n-N+1, …,n-1,n)

Note that n≥N

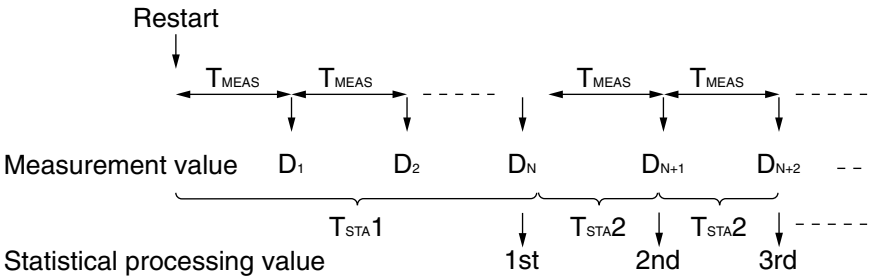
- P–P
  P–P=Max–Min

(2) Menu F2 : Sets Overlap/Disc (Discrete) for the statistics processing extraction mode.
Selects one of two modes: Discrete mode that outputs statistics processing results for collected data and Overlap mode that outputs statistics processing results for each data sample. Fig. 4-29 shows the two modes.



N : Number of samples
T_{MEAS} : Continuous measurement period = acquisition time*1 + measurement time*2 + sample rate
T_{STA} : Statistics processing time = number of samples N × T_{MEAS}

(a) Statistics processing in Discrete mode



N : Number of samples
T_{MEAS} : Continuous measurement period = acquisition time*1 + measurement time*2 + sample rate
$T_{STA}1$: Statistics processing time 1 : T_{MEAS} × N
$T_{STA}2$: Statistics processing time 2 : T_{MEAS}

(b) Statistics processing in Overlap mode

*1 The acquisition time is generated outside of the acquisition when acquisition processing Auto is set (max : 50 ms).
*2 The measurement time is determined from the frequency of the input signal and the measurement resolution.

Fig. 4-29 Statistics Processing Extraction Mode

(3) Menu F3 : Sets n for the sample number (2^n: Overlap mode, 10^n : Discrete mode). Selecting menu F3 displays the sample number selection screen shown in Fig, 4-30. Use the cursor keys in this screen to select either 1, 2, 3, 4, 5, or 6, and then press the [Enter] key to return to the screen shown in Fig. 4-30. The parameter you set will be displayed within the square brackets [ ] of the F3 menu.

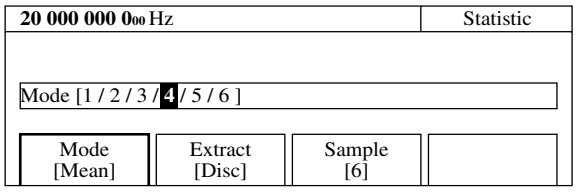


Fig. 4-30 Selecting Sample Number

Sets the sample number for statistics processing. The setting range K is as follows :

k = 1, 2, 3, 4, 5, or 6

The number of samples depends on the statistics processing sample mode as shown in Table 4-14.

Table 4-14 Extraction Mode and Number of Samples

k Value / Extraction mode	1	2	3	4	5	6
Discrete	10	100	1000	10000	100000	1000000
Overlap	2	4	8	16	32	64

4.3.12 Template Function

This function displays the frequency of the signal being measured, determines whether the measured frequency is within the range of the upper and lower frequency limit, and then displays Go/No-Go for the result.
You can output this result from the Aux terminal using the TTL level.
During that time you can use the indicator shown in Fig. 4-31 to visually determine whether the measurement results are within the range set in advance.

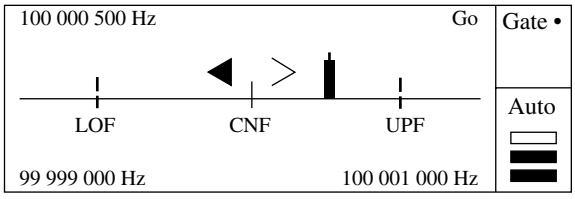


Fig. 4-31 Measurement Screen Using a Template

To display the template screen, you must turn the template function On, and then set the various parameters.
Pressing the [Temp] key displays the template setup screen shown in Fig. 4-32. Pressing the [Return to Meas] key in the displays shown below displays the measurement screen. Fig. 4-31 shows the measurement screen when the template function is On.

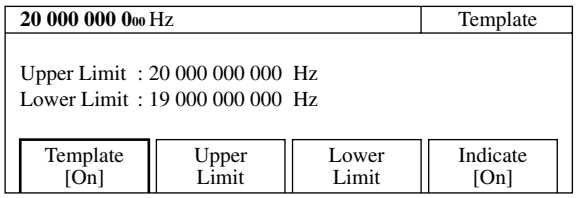


Fig. 4-32 Template Setup

(1) Menu F1 : Sets the template function to On or Off.

(2) Menu F2 : Sets the upper frequency limit using the front panel numeric keypad. Selecting Upper Limit will highlight it so that it can be set.

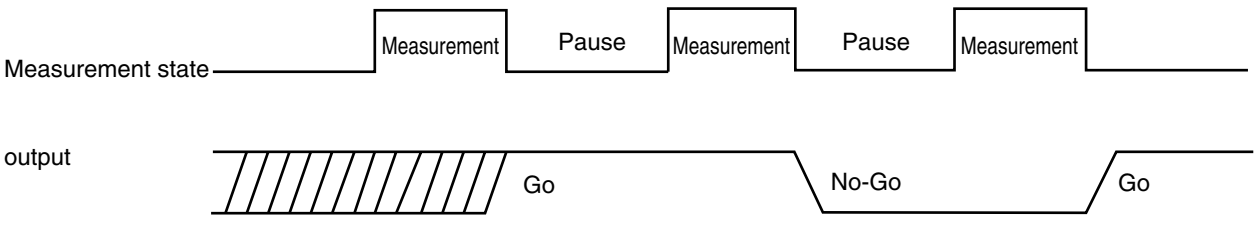
(3) Menu F3 : Sets the lower frequency limit using the front panel numeric keypad. Selecting Lower Limit will highlight it so that it can be set.

(4) Menu F4 : Turns On/Off the indicator for showing when the measurement frequency strays off of the display screen (see Fig. 4-4). Select On to display it and Off to not display it.

The upper and lower frequency limit is between 0 Hz and Fmax set in 1 Hz units.
Note, Fmax= 20 GHz..... MF2412B
27 GHz..... MF2413B
40 GHz..... MF2414B

Note :

The Go/No-Go result is stored until the following decision is made.



4.3.13 Hold

This function stops frequency measurement operation and maintains the display of the final measurement value. Pressing the [Hold] key lights the LED above the key to let you know that the unit is in the hold state.
Pressing [Restart] or setting parameter by the panel key, at this time makes one measurement and then once again enters the hold state. In addition, when statistics processing is active, it calculates the first statistics processing result and then once again enters the hold state. Pressing the [Hold] key while in the hold state turns out the LED and enters the normal measurement state in which you can perform continuous measurements.

4.3.14 Restart

Pressing [Restart], this function restarts frequency measurement. During statistics processing, it clears the sample measurement execution count and then starts statistics processing from the first sample. When in the hold state, this function performs one measurement or runs one statistics process and then enters the hold state once again.

4.3.15 System

This function performs a variety of tasks such as saving and recalling parameters, selection of a reference signal, selection of an output signal to the AUX terminal, setting the GPIB, and checking the self-check result.

Ten parameters (0-9) can be saved.

The external reference signals that can be input are 1 MHz, 2 MHz, 5 MHz, and 10 MHz. When the reference signal is selected automatically, this function automatically distinguishes these reference signals and uses them as the reference signals for the counter.

Pressing the [Sys] key displays the system setup screen shown in Fig. 4-33.

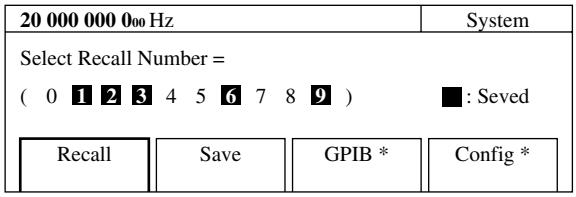


Fig. 4-33 System Setup Screen

(1) Menu F1: Set the saved parameters for this unit. Enclosing the menu F1 in a thick frame with the [>] and [<] keys and then pressing the [Enter] key display the system setup screen shown in 4-34. Parameters corresponding to the high-lighted numbers have been set. Pressing a desired numeric key sets the corresponding parameter for this unit.

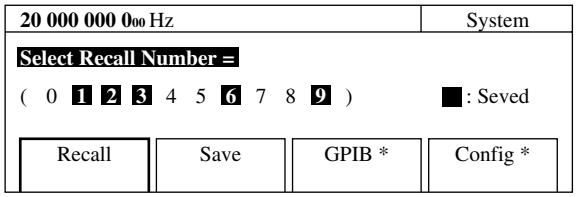


Fig. 4-34 System Setup Screen

(2) Menu 2: Saves the parameters set for this unit. Enclosing menu F2 in a thick frame with the [>] and [<] keys and then pressing the [Enter] key displays the system setup screen shown in 4-35. When initialization is performed (the unit is turned on with the [Enter] key depressed), the saved data will be cleared completely.

The saved data will not be cleared if you press the [Preset] key.

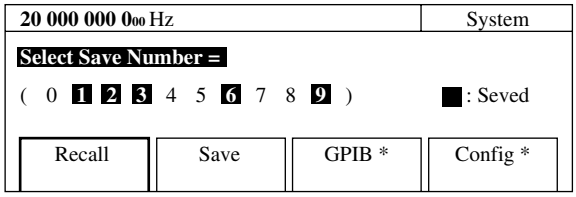


Fig. 4-35 System Setup Screen

(3) Menu F3: Enclosing the menu F3 in a thick frame with the [>] and [<] keys and then pressing the [Enter] key display the GPIB setup screen shown in 4-36.

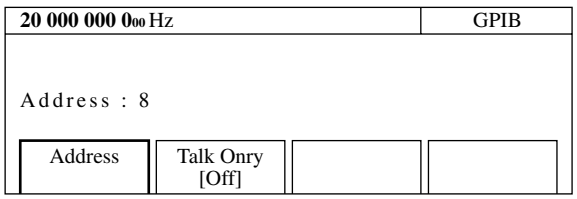


Fig. 4-36 System Setup Screen

(3-1) Menu F1: Set the GPIB address. Selecting the menu F1 highlights "Address", allowing you to set an address using numeric keys. You can set the address between 0 and 30.

(3-2) Menu F2: Turn on or off the GPIB talk-only function. Pressing the [Enter] key toggles between On and Off.

(4) Menu 4: Enclosing the menu F4 in a thick frame with the [>] and [<] keys and then pressing the [Enter] key display the Config Setup screen shown in Fig. 4-37.

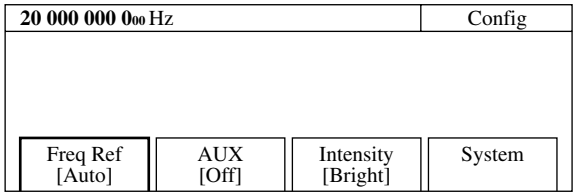


Fig. 4-37 Config Setup Screen

(1-1) Menu F1: Select a reference signal. Determine whether only the internal reference signal is used as the counter's reference signal (Int) or it is automatically switched to the external reference signal when the external signal is input from the outside (Auto).

The set parameter is displayed in the square brackets of menu F1.

(1-2) Menu F2: Choice of the signal output to the AUX output connector determines the signal output from the AUX terminal. When menu F2 is selected, the AUX signal selection screen shown in Fig. 4-41 pops up. Selecting one of Off, Go, End, Lvl, Gate, Rest, and Acq using [<] and [>] keys and pressing the [Enter] key display the Config setup screen shown in Fig. 4-37. At this time, the set parameter is displayed in the square brackets of menu F2.

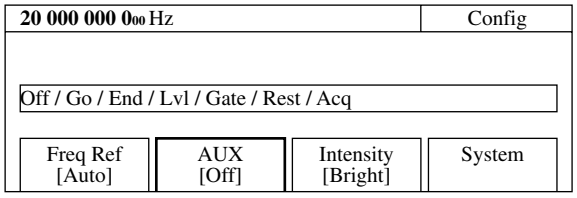


Fig. 4-38 Config Setup Screen

1) Off: No signal is output. The output level is always high.

2) Go: The Go/No-Go judgment result is output.
The result of judgment made with the template function enabled is output.
High: The measurement frequency is within the set range.
Low: The measurement frequency is outside the set range.
When the template function is not selected, a low level is output.

3) End: Count End output
A low pulse of 1 us ±50 ns is output each time frequency measurement is completed.

4) Lvl: Level Det output
In the burst wave measurement mode, the detection signal in the counter is monitored. In the CW measurement mode, a high level is output constantly.

5) Int: Internal Count Gate Output
The internal gate signal used for frequency counting is output. A high level is constantly output while the gate is open.

6) Rest: Restart
A low pulse of 1 us ±50 ns is output when a Restart command is executed.

7) Acq: Acquisition output
A low level is output during counter's acquisition operation. A high level is output during frequency measurement.

(4-3) Menu F3: Sets intensity of the LCD [Bright/Dim].

(4-4) Menu F4: Displays the result of the self-check performed at power-on in the format shown in Fig. 4-39. MF24**B indicates the counter's model name.

```
Anritsu MF24**B
----  Self-Check  ----
RAM          : Pass      LCD-C      : Pass
GPIB-C       : Pass      ASIC       : Pass
DC           : Pass      PLL Lock   : Pass
Freq Meas    : Pass
```

Fig. 4-39 System Setup Screen

4.3.16 High-Speed Sampling Function

This function is effective only when the unit is controlled through the GPIB.

This features repeats to measure the signal for each time interval (T) and stores the results without discontinuing measurement.
It allows you to get stored data through GPIB, making it possible to measure frequency variation in a short time as well as VCO startup characteristics. If you will use Input1 to input a signal, set the manual frequency value and manual amplitude discrimination value in advance Fig. 4-40 shows parameter-related information.

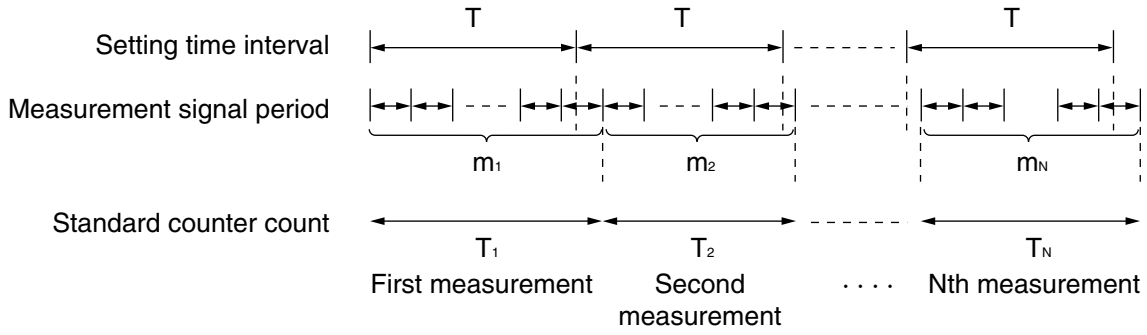


Fig. 4-40 High-Speed Sampling Function

The various frequencies (Fi) during the short measuring time (Ti) are calculated as follows :

$$Fi=(m_i/T_i)\times 10^9 \quad (Hz) \qquad i=1, 2, \cdots, N$$

To multiply the frequency resolution K times, the following combination is used.

$$F_i=(\sum_{p=0}^{k-1} m_{i+p}/\sum_{p=0}^{k-1} T_{i+p})\times 10^9 \quad (Hz)$$

$$i=1, 2, \cdots, N-k+1$$

When Input2 is used for the input terminal for the signal to be measured, you can find the frequency using the above formulas. When using Input1, add the offset frequency value F_0 to the frequency value Fi that you calculated. See the Section 5 “GPIB” regarding the setting of parameters and the offset frequency value F_0.

4.3.17 Data Storage Function

This function is effective only when the unit is controlled through the GPIB.

After execution of a data storage start command, 100 pieces of frequency measurement data are stored in the internal memory. When the 101st data is stored, the first data is invalidated, validating the second to 101st data (a total of 100 pieces of data). 100 pieces of data stored in the internal memory are updated until a data storage stop command is executed. A stored data read command is executed to read the stored data.

0 Hz (execution error) is output in the following cases:

- When a stored data read command is executed without executing a data storage stop command after executing a data storage start command
- When a data storage stop command or stored data read command is executed before 100 pieces of data have been stored

For details on the data storage start command, data storage stop command, and stored data read command, see Section 5, “GPIB.”

4.4 Measuring

4.4.1 Continuous Wave Frequency Measurement via Input1 (Frequency Acquisition Mode = Auto; Level Acquisition Mode = Auto)

Ranges of frequencies that can be measured via Input1 are as follows:

- MF2412B: 600 MHz to 20 GHz
- MF2413B: 600 MHz to 27 GHz
- MF2414B: 600 MHz to 40 GHz

(1) Connecting the input signal
Connect the signal to measure to the Input1 connector on the front panel.

Note:

Do not connect a signal of +10 dBm or higher to the Input1 connector.

(2) Setup

1) Press the [Preset] key to preset this unit. This selects Input1, continuous wave measurement, auto frequency acquisition, and auto level acquisition.

2) Using the [<] and [>] keys, set a desired frequency measurement resolution.

3) Using the [∧] and [∨] keys, set a desired sample rate.

4.4.2 Continuous Wave Frequency Measurement via Input1 (Frequency Acquisition Mode = Manual; Level Acquisition Mode = Auto)

When the frequency of the input signal is known, you can manually measure the frequency by setting Frequency Acquisition Mode to Manual and then setting a manual frequency value.

Manual measurement of frequency can start quickly because it is not accompanied by frequency acquisition. It is effective when measurement cannot be performed due to a spurious signal.

(1) Connecting the input signal
Connect the signal to measure to the Input1 connector on the front panel.

Note:

Do not connect a signal of +10 dBm or higher to the Input1 connector.

(2) Setup

1) Press the [Preset] key to preset this unit.

2) Set Frequency Acquisition Mode to Manual.
Press the [Freq] key to bring up the Freq Acq Setup screen. Enclosing the menu F1 in a thick frame with the [>] and [<] keys and then pressing the [Enter] key set the Manual mode.

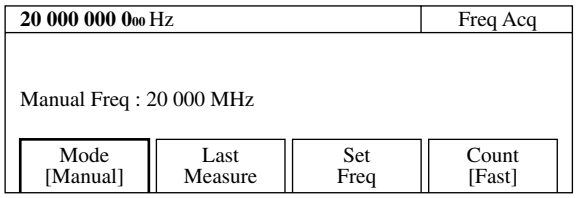


Fig. 4-41 Frequency Acquisition Setup Screen

3) Set the manual frequency value.
Enclosing the menu F3 in a thick frame with the [>] and [<] keys then pressing the [Enter] key highlights "Manual Freq", allowing you to enter a manual frequency value using numeric keys.

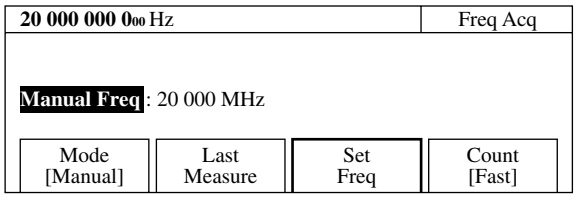


Fig. 4-42 Frequency Acquisition Setup Screen

This unit measures the manual frequency value within the input tolerance. If the signal to measure is not within the input tolerance, it cannot be measured properly.

In the frequency range of 600 MHz to 1 GHz, the manual frequency value is ±30 MHz. In the frequency range of 1 GHz or higher, the manual frequency value is ±40 MHz.

4) Press the [Return to Meas] key to display the normal measurement screen.

5) Using the [<] and [>] keys, set a desired frequency measurement resolution.

6) Using the [∧] and [∨] keys, set a desired sample rate.

4.4.3 Continuous Wave Frequency Measurement via Input1 (Frequency Acquisition Mode = Auto; Level Acquisition Mode = Manual)

You can manually measure the level by setting Level Acquisition Mode to Manual. Manual measurement of level can start quickly because it is not accompanied by level acquisition. When performing continuous measurement with Frequency Acquisition Mode set to Manual and Level Acquisition Mode set to Manual, follow the procedure discussed in this section while referring to Section 4.4.2.

(1) Connecting the input signal
Connect the signal to measure to the Input1 connector on the front panel.

Note:

Do not connect a signal of +10 dBm or higher to the Input1 connector.

(2) Setup

1) Press the [Preset] key to preset this unit.

2) Set Level Acquisition Mode to Manual.
Press the [Level] key to bring up the Level Acq Setup screen. Enclosing the menu F1 in a thick frame with the [>] and [<] keys and then pressing the [Enter] key set the Manual mode.

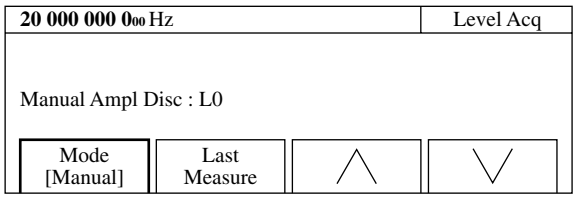


Fig. 4-43 Level Acquisition Setup Screen

3) Set the manual amplitude discrimination value.
Select it using the [∧] and [∨] keys.

4) Press the [Return to Meas] key to display the normal measurement screen. If the displayed level is not optimum, press the [Level] key again and set the optimum level.

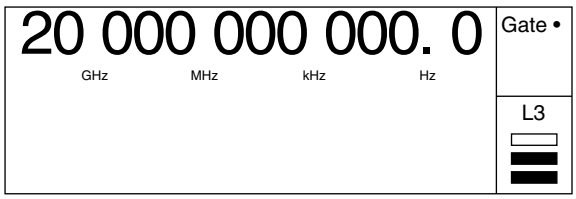


Fig. 4-44 Level Acquisition Setup Screen

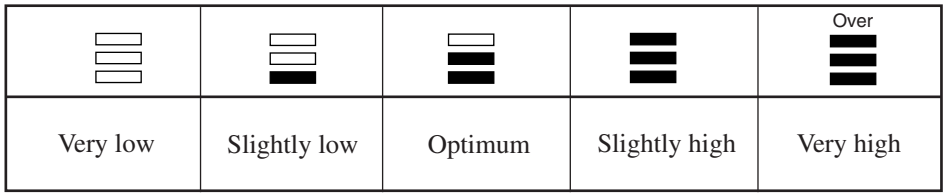


Fig. 4-45 Level indication

5) Using the [<] and [>] keys, set a desired frequency measurement resolution.

6) Using the [∧] and [∨] keys, set a desired sample rate.

4.4.4 Burst Wave Measurement via Input1 (Frequency Acquisition Mode = Auto; Level Acquisition Mode = Auto)

Setting Measurement Mode to Burst allows you to measure the carrier frequency, pulse width, and pulse repetition period of the pulse-modulated signal.

(1) Connecting the input signal
Connect the signal to measure to the Input1 connector on the front panel.

Note:

When Auto frequency capture measurement is carried out, the pulse modulation width must be more than 1 us.
Do not connect a signal of +10 dBm or higher to the Input1 connector.

(2) Setup

1) Press the [Preset] key to preset this unit.

2) Select the Burst mode.
Press the [Meas Mode] key. The Burst LED lights up.

3) Using the [<] and [>] keys, set a desired frequency measurement resolution.

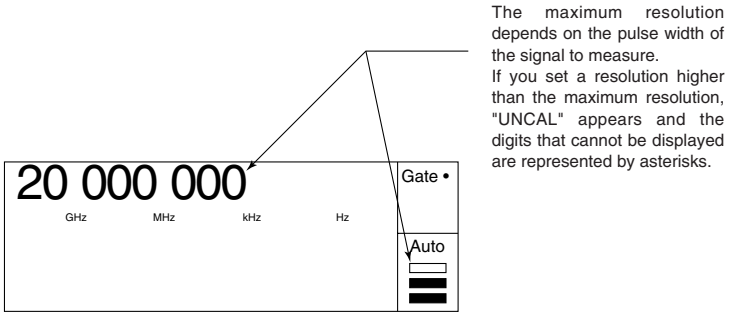


Fig. 4-46 Burst Carrier Frequency Measurement

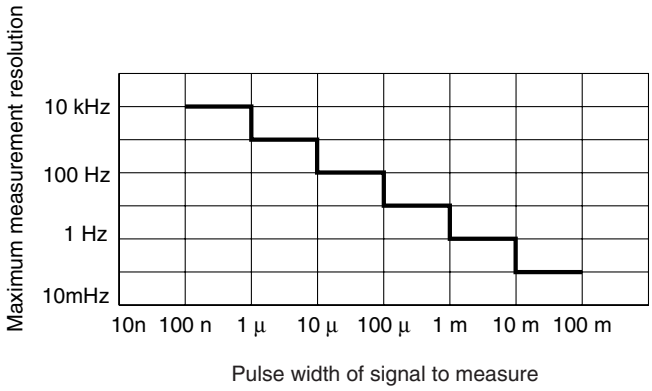


Fig. 4-47 Pulse Width Vs. Maximum Resolution

4) Using the [∧] and [∨] keys, set a desired sample rate.

Note:

In the case of frequency acquisition Auto measurement, the pause time may be greater than the set sample rate depending on the pulse width and/or cycle modulation.

4.4.5 Burst Wave Measurement via Input1 (Frequency Acquisition Mode = Manual; Level Acquisition Mode = Auto)

Setting Measurement Mode to Burst allows you to measure the carrier frequency, pulse width, and pulse repetition period of the pulse-modulated signal. Perform steps (1) and (2) below.

(1) Connecting the input signal
Connect the signal to measure to the Input1 connector on the front panel.

Note:

Do not connect a signal of +10 dBm or higher to the Input1 connector.

(2) Setup

1) Press the [Preset] key to preset this unit.

2) Select the Burst mode.
Press the [Meas Mode] key. The Burst LED lights up.

3) For how to set the manual frequency value, see Section 4.4.2. Note that the input tolerance for burst measurement is different from that for continuous wave measurement.
When the manual frequency value is within the range of 600 MHz to 1 GHz, the input tolerance is ±30 MHz. When the manual frequency value is higher than 1 GHz and the narrow burst width is selected, the input tolerance is ±20 MHz. When the manual frequency value is higher than 1 GHz and the wide burst width is selected, the input tolerance is ±40 MHz.

4) To measure the pulse width and pulse repetition period at the same time, follow the procedure discussed in Section 4.4.7.

Note:

If the frequency is not displayed at all or just not displayed properly, set Level Acquisition to Manual and then perform measurements.

4.4.6 Burst Wave Measurement via Input1 (Frequency Acquisition Mode = Manual; Level Acquisition Mode = Manual)

Setting Measurement Mode to Burst allows you to measure the carrier frequency, pulse width, and pulse repetition period of the pulse-modulated signal. Perform steps (1) and (2) below.

(1) Connecting the input signal
Connect the signal to measure to the Input1 connector on the front panel.

Note:
Do not connect a signal of +10 dBm or higher to the Input1 connector.

(2) Setup

1) Press the [Preset] key to preset this unit.

2) Select the Burst mode.
Press the [Meas Mode] key. The Burst LED lights up.

3) For how to set the manual frequency value, see Section 4.4.2.

4) For how to set the manual amplitude discrimination value, see Section 4.4.3.

5) To measure the pulse width and pulse repetition period at the same time, follow the procedure discussed in Section 4.4.7.

4.4.7 Burst Wave Pulse Width and Repetition Period Measurement via Input1

When the Input1 connector and Burst mode are selected, the carrier frequency can be measured along with either the burst signal pulse width or pulse repetition period.

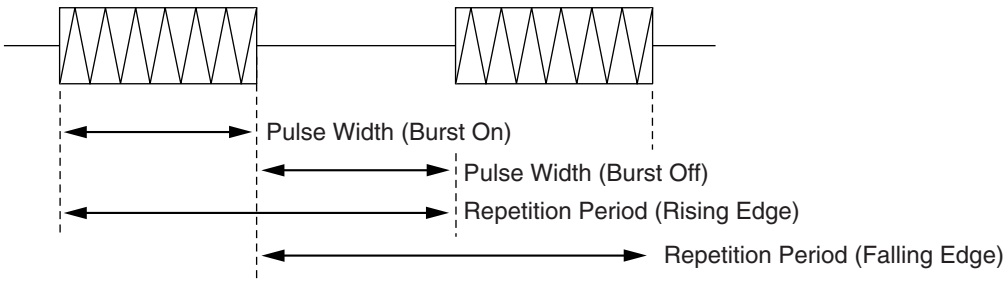


Fig. 4-48 Burst Wave Measurement

(1) Connecting the input signal
Connect the signal to measure to the Input1 connector on the front panel.

Note:

Do not connect a signal of +10 dBm or higher to the Input1 connector.

(2) Setup

1) Press the [Preset] key to preset this unit.

2) Select the Burst mode.
Press the [Meas Mode] key. The Burst LED lights up.

3) Select the frequency acquisition mode.
To select the Manual mode, follow the procedure discussed in Section 4.4.2. Note that the Auto mode was previously set at presetting.

4) Select the level acquisition mode.
To select the Manual mode, follow the procedure discussed in Section 4.4.3. Note that the Auto mode was previously set at presetting.

5) Select the pulse width or pulse repetition period.
Press the [Burst] key to bring up the Burst Setup Screen. Enclosing the menu F1 in a thick frame with the [<] and [>] keys and then pressing the [Enter] key pop up a measurement mode list.

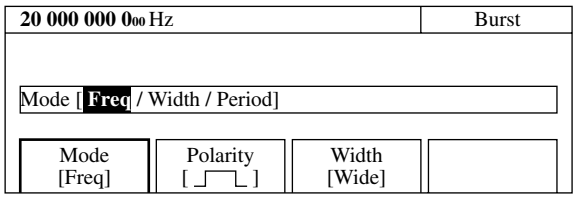


Fig. 4-49 Burst Mode Setup Screen

Highlight the desired measurement mode using the [<] and [>] keys and then press the [Enter] key.
To measure the pulse width, select Width. To measure the pulse repetition period, select Period.

6) Select a measurement polarity.
To measure the negative polarity, enclose the menu F2 in a thick frame with the [<] and [>] keys and then press the [Enter] key.

When the negative polarity is selected for pulse width measurement, the pulse width in the burst-off interval is measured. When the negative polarity is selected for pulse repetition period measurement, the period between the falling edge and rising edge is measured.

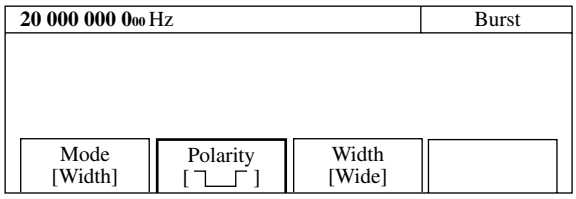


Fig. 4-50 Burst Mode Setup Screen

7) Select a Wide or Narrow mode.
When the burst pulse width is 1 us or less, measurements cannot be performed if Width is not set to Narrow.
Enclosing menu F3 in a thick frame with the [<] and [>] keys and then pressing the [Enter] key sets the Narrow mode.

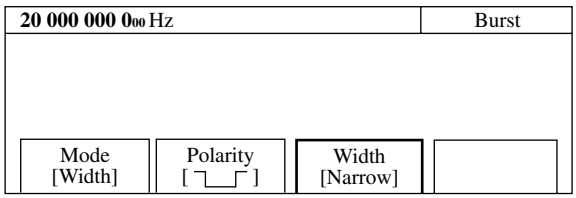
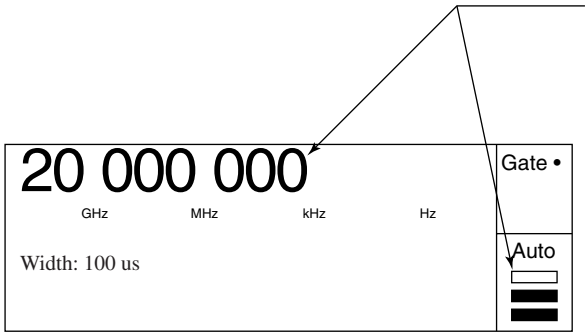


Fig. 4-51 Burst Mode Setup Screen

8) Press the [Return to Meas] key to display the measurement screen.

9) Using the [<] and [>] keys, set a desired frequency measurement resolution.



The maximum resolution depends on the pulse width of the signal to measure.
If you set a resolution higher than the maximum resolution, "UNCAL" appears and the digits that cannot be displayed are represented by asterisks.

Fig. 4-52 Burst Carrier Frequency Measurement

10) Using the [∧] and [∨] keys, set the desired sample rate.

Note:

If the frequency is not displayed at all or just not displayed properly, set both Frequency Acquisition and Level Acquisition to Manual and then perform measurements.

4.4.8 Burst Wave measurement via Input1 Using Gating

The gating function enables you to measure the frequency at a specific position of a burst signal.

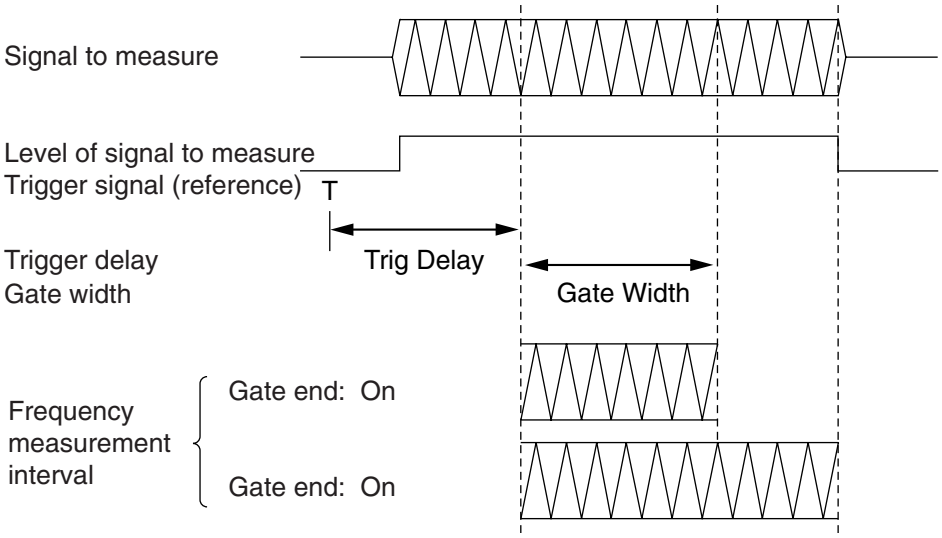


Fig. 4-53 Gating Function Overview

(1) Connecting the input signal
Connect the signal to measure to the Input1 connector on the front panel.

Note:

Do not connect a signal of +10 dBm or higher to the Input1 connector.

(2) Setup

1) Press the [Preset] key to preset this unit.

2) Select the Burst mode.
Press the [Meas Mode] key. The Burst LED lights up.

3) Select the frequency acquisition mode.
To select the Manual mode, follow the procedure discussed in Section 4.4.2. Note that the Auto mode was previously set at presetting.

4) Select the level acquisition mode.
To select the Manual mode, follow the procedure discussed in Section 4.4.3. Note that the Auto mode was previously set at presetting.

5) Set the trigger delay.
Pressing the [TD] key brings up the burst monitor screen. You can also bring up the burst monitor screen for trigger delay setting by pressing the [<] key on the burst monitor screen for gate width setting.
"Trig Delay" is displayed at the lower left. Pressing the [Enter] key highlights "Trig Delay", allowing you to change the set value using the [∧] and [∨] keys. You can enter a value directly using numeric keys.
After setting a new value, pressing the [Enter] key again displays "Trig Delay" in normal video.

6) Set the gate width.
Pressing the [GW] key brings up the burst monitor screen for gate width setting. You can also bring up the burst monitor screen for gate width setting by pressing the [>] key on the burst monitor screen for trigger delay setting.

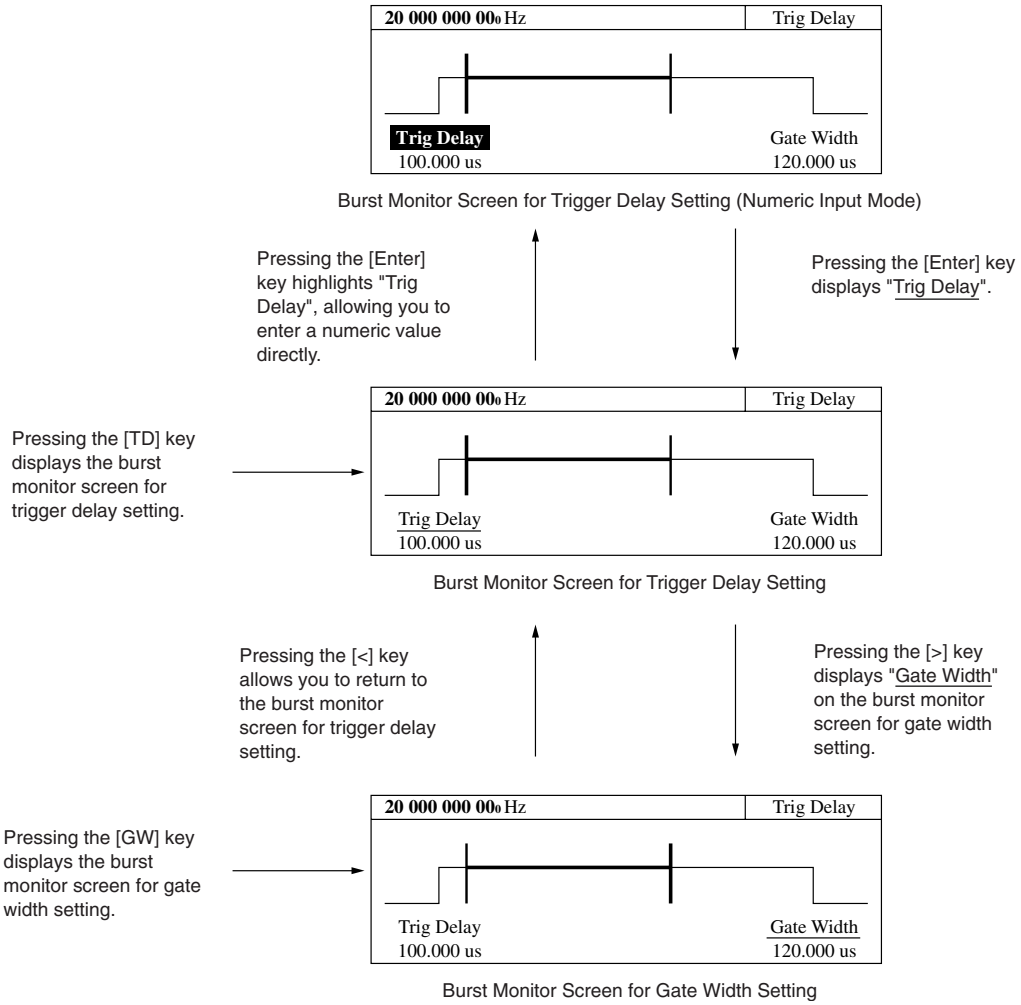


Fig. 4-54 Burst Monitor Screen

7) Pressing the [Return to Meas] key displays the normal measurement screen.

8) Using the [<] and [>] keys, set a desired frequency measurement resolution.

9) Using the [∧] and [∨] keys, set a desired sample rate.

4.4.9 Frequency Measurement via Input2 (10 MHz to 1 GHz)

To measure frequencies between 10 MHz and 1 GHz, select the Input2 connector and an impedance of 50 W.

To measure frequencies between 10 Hz and 10 MHz, select the Input2 connector and an impedance of 1M Ω. For more details, see section 4.4.10.

(1) Connecting the input signal
Connect the signal to measure to the Input2 connector on the front panel.

Note:

Do not connect a signal of 10 Vrms (at 1M Ω)/2Vrms (at 50 Ω) or higher to the Input2 connector.

(2) Setup

1) Press the [Preset] key to preset this unit.

2) Set the input channel to Input2.
Press the [Input] key to display the input parameter setup screen. Enclosing the menu F1 in a thick frame with the [<] and [>] keys and then pressing the [Enter] key select Input2.

3) Pressing the [Return to Meas] key displays the normal measurement screen.

4) Using the [<] and [>] keys, set a desired frequency measurement resolution.

5) Using the [∧] and [∨] keys, set a desired sample rate.

4.4.10 Frequency Measurement via Input2 (10 Hz to 10 MHz)

To measure frequencies between 10 Hz and 10 MHz, select the Input2 connector and an impedance of 1M Ω.

To measure frequencies between 10M Hz and 1 GHz, select the Input2 connector and an impedance of 50 Ω. For more details, see 4.4.9.

(1) Connecting the input signal
Connect the signal to measure to the Input2 connector on the front panel.

Note:

Do not connect a signal of 10 Vrms (at 1M Ω)/2Vrms (at 50 Ω) or higher to the Input2 connector.

(2) Setup

1) Press the [Preset] key to preset this unit.

2) Set the input channel to Input2.
Press the [Input] key to display the input parameter setup screen. Enclosing the menu F1 in a thick frame with the [<] and [>] keys and then pressing the [Enter] key select Input2.

3) Select an input impedance.
Enclosing the menu F2 in a thick frame with the [<] and [>] keys and then pressing the [Enter] key select 1M Ω.

4) Switch between input attenuators.
When the input level of the signal to measure is low, turn off the attenuator. Enclosing the menu F3 in a thick frame with the [<] and [>] keys and then pressing the [Enter] key select Off.

5) Pressing the [Return to Meas] key displays the normal measurement screen.

6) Using the [<] and [>] keys, set a desired frequency measurement resolution.

7) Using the [∧] and [∨] keys, set a desired sample rate.

Section 5 GPIB

This chapter describes remote operation using the GPIB interface that comes standard on the MF2412B/MF2413B/MF2414B Microwave Frequency Counter.

5.1 Overview

MF2412B/MF2413B/MF2414B comes standard with a GPIB interface that allows you to automatically perform measurements by connecting the unit to a host computer. It also makes it possible to measure short frequency fluctuations such as VCO startup characteristics using high-speed sampling functions on a host computer.

5.2 Function

MF2412B/MF2413B/MF2414B offers the following functions when using GPIB.

Table 5-1 Functions and Device Messages

Function	Device Message
Input :	
Switching of measurement signal input channels	INPCH
Input2 attenuator switching	ATTN
Input2 input impedance switching	INP2Z
Setting of manual frequencies	AF
Switching of frequency acquisition mode	ACF
Switching of level acquisition mode	ACL
Setting of amplitude discrimination values	AD
Reference signal :	
Reference signal selection	REF
Measurement :	
Switching of count mode	CNTMD
Switching of hold on/off	SH
Setting measurement resolution	RES
Setting of sample rate	SMP
Burst signal :	
Switching of burst measurement on/off	BST
Selecting of burst measurement mode	BSTMD
Switching to burst polarity	BSTPL
Switching of burst measurement width	BSTWDT
Gate :	
Switching of gate end on/off	GTEND
Setting of gate width	GTWDT

Table 5-1 Functions and Device Messages (Continued)

Function	Device Message
Trigger :	
Switching of trigger source	TRG
Seting of trigger delay	TRGDLY
Selecting of trigger polarity	TRGPL
Template :	
Switching of template function on/off	LMT
Switching of movement direction indicator on/off	LMTDIR
Setting of template lower frequency limit	LMTL
Setting of template upper frequency limit	LMPU
Data output :	
Switching data output format/timing	OM
Reading of measurement results :	
Carrier frequency of burst signal	MBCF
Burst width	MBWDT
Continuous period of burst signal	MBPRD
Continuous wave frequency	MCW
Offset frequency	MOFS
Statistical processing value	MSTA
High-speed sampling count	MTRS
Offset value calculation processing :	
Selecting of offset function	OFS
Selecting of the offset value method	OFSDT
Setting of the offset frequency value	OFSFRQ
Statistics processing :	
Selecting of the statistics processing function	STS
Selecting of sample data extraction method	STSBLK
Setting of sample point	STSMPL
High-speed sampling function :	
Switching of transient mode On/Off	TRS
Setting of sample point	TRSSMP
Setting of sampling rate	TRSRT
Reading of offset frequency	TRSOFS
Data storage function:	
Data storage start	DSTA
Data storage stop	DSTP
Stored data read	MDS
GPIB :	
Terminator selection	TRM
Ending status register	ESE2, ESR2
Error status register	ESE3, ESR3
Others :	
Selecting of AUX terminal output signal	AUX
Switching to measurement screen	RTM

5.3 Interface Function

MF2412B/MF2413B/MF2414B provides the GPIB interface functions shown in Table 5-2.

Table 5-2 Interface Functions

Code	Interface Function
SH1	Full source handshake
AH1	Full acceptor handshake
T5	Basic talker Serial poll Talk only Talk release using MLA
L4	Basic listener No listen only Listen release using MTA
SR1	Full service request and status byte
RL1	Full remote/local
PP0	No parallel poll
DC1	Full device clear
DT1	Full device trigger
C0	No controller function

5.4 Device Message List

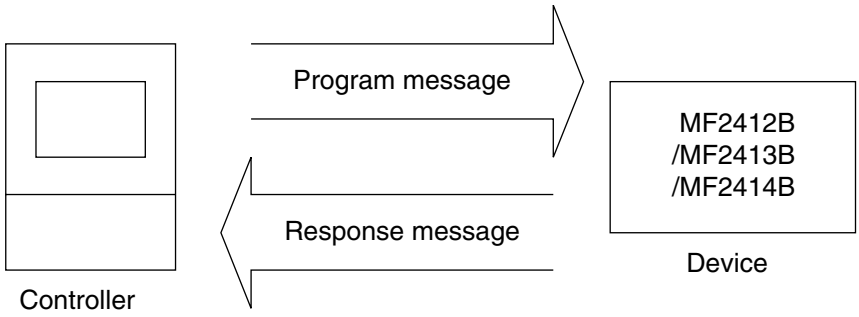
5.4.1 Overview

Device messages refer to messages sent and received between a controller and device (in this case the MF2412B/MF2413B/MF2414B) over the GPID interface. There are two types of device messages: program messages and response messages. In addition, these messages consist of common commands conforming to IEEE 488.2 and messages unique to this unit. For more information, refer to 5.4.2 “IEEE 488.2 Common Commands” and 5.4.4 “Device Message List.”

(1) Program messages
ASCII data messages sent by a controller to a device. The following describes the two kinds of messages :

1) Commands : Instruct the starting of parameter setup and measurement for a device.
2) Queries : These are commands that wait for device state. Use them when you want to output response messages to a controller.

(2) Response messages
ASCII data messages sent by a device to a controller. These messages transfer device state information and measurement data to the controller.



When using device messages to send and receive numeric data such as frequencies, you can attach units (suffix code) to the data being transferred. For example, if you want to set 1 MHz for the frequency data, you can attach a suffix code and send 1000000 Hz, 1000 KHz, or 1 MHZ instead of 1000000.
The following shows the suffix commands that this unit can use :

(1) Suffixes when transferring frequency data

Unit	Suffix code (all suffixes converted to uppercase even if entered in lower case)
GHz	GHZ , G
MHz	MHZ , MA
kHz	KHZ , K
Hz	HZ
Default	HZ

(Millihertz : No support for mHz)

(2) Suffixes when transferring time data

Unit	Suffix code (all suffixes converted to uppercase even if entered in lower case)
second	S
m second	MS , M
μ second	US , U
n second	NS , N
Default	NS

5.4.2 IEEE 488.2 Common Commands

Table 5.3 provides an overview of the common commands this unit supports from among the thirty-nine kinds of common commands established by IEEE 488.2.

Table 5-3 Overview of Unit's Common Commands

Command Name	Command Function
*IDN?	Returns MF24**B, ANRITSU, 0, n ** : 12 · · (MF2412B),** : 13 · · (MF2413B), ** : 14 · · (MF2414B) n : 1 to 99 (firmware version no.)
*RST	Executes unit presets (same as Preset key)
*TST?	Returns the value n that set the following bits when an error occurs during a self-check. bit0 (LSB) : CPU, bit1 : EXT-RAM, bit2 : GPIB, bit3 : LCD bit4 : ASIC, bit5 :+12 V, bit6 : +15 V, bit7 : –15 V bit8 : –5 V, bit9 : PLL1 , bit10 : PLL2 bit11 : Frequency Measure
*OPC	Sets SESR Bit0 when the previous command ends. If SESER bit0 is set at that time, and SRQ will occur.
*OPC?	Returns 1 when the previous command stops executing. Nothing is returned until it stops.
*WAI	The next command is not executed until the previous command stops executing.
*CLS	Executes the clear function defined by IEEE 488.2.
*ESE n	Sets the value n of Standard Event Status Enable Register. n=0 to 255
*ESE?	Returns the value 0 to 255 of Standard Event Status Enable Register.
*ESR?	Returns the value 0 to 255 of Standard Event Status Register.
*SRE n	Sets the value n of Service Request Enable Register. n=0 to 255
*SRE?	Returns the value 0 to 255 of Service Request Enable Register.
*STB?	Returns the value 0 to 255 of Status Byte Register
*TRG	Executes the same function as Group Execute Trigger.
*RCL n	Recalls the equipment state stored from the specified memory (0-9).
*SAV n	Saves the current equipment state in the specified memory (0-9).

5.4.3 Status Register

Fig. 5-1 shows the structure of the status register.

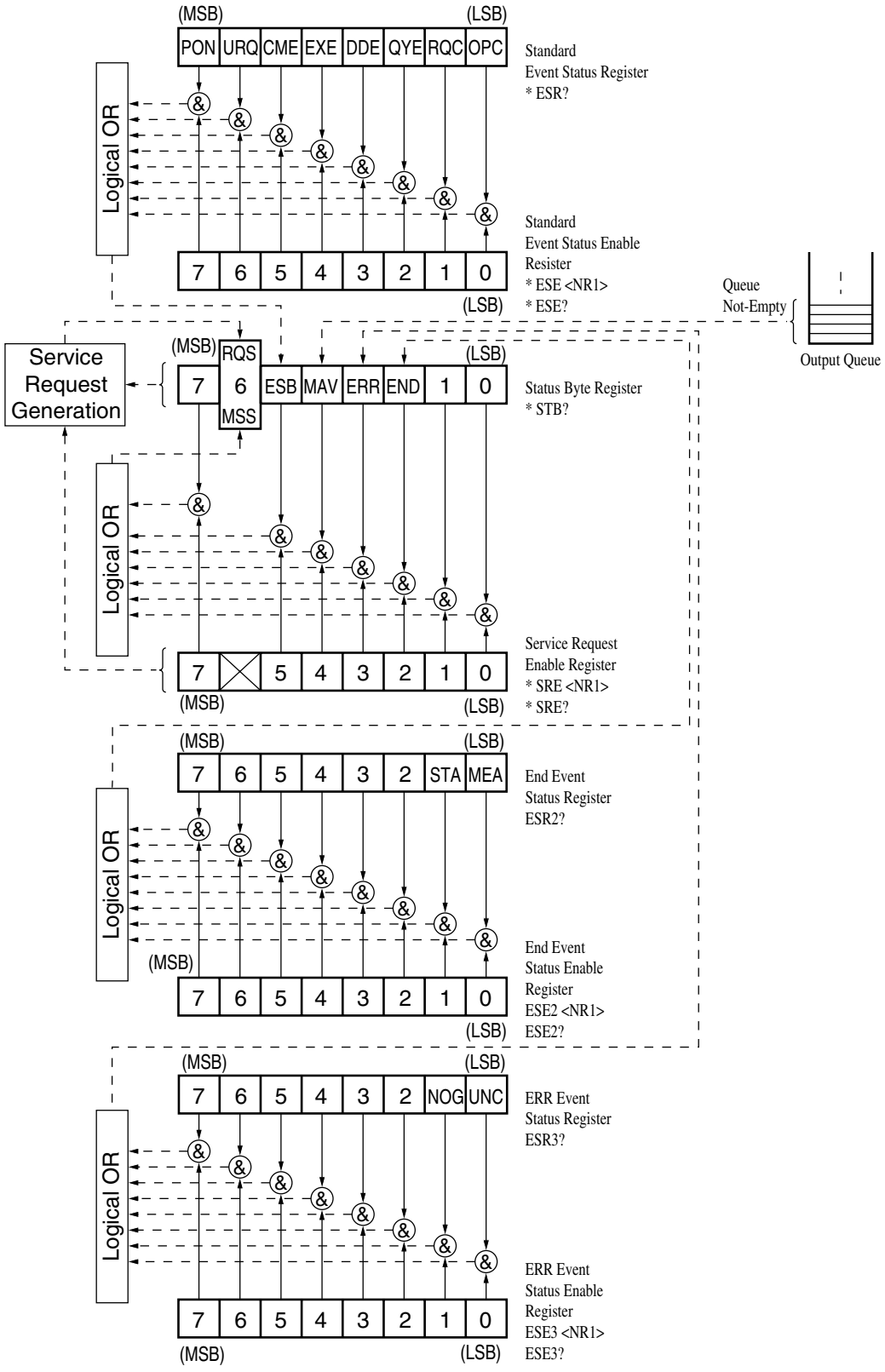


Fig. 5-1 Structure of Status Register

(1) Standard Event Status Register

The following shows the bit functions and setting conditions.

- PON (Power On)
  When power is turned on (Power Off → On)
- URQ (User Request)
  When there is a user request (not used so always “0”)
- CME (Command Error)
  When format of received message cannot be interpreted, an unsupported header was received, or a GET was detected within a received program message
- EXE (Execution Error)
  When the program data following the header is outside the normal range or the program message cannot be processed due to a previously set value
- DDE (Device Dependent Error)
  When a device dependent error occurs (not used so always “0”)
- QYE (Query Error)
  When there was a read request even though the output queue was empty or output queue data was lost
- RQC (Request Control)
  There is no controller function. Always “0”.
- OPC (Operation Complete)
  When responding to *OPC and all specified operations are complete.

(2) Standard Event Status Enable Register

This register permits events of the standard event status register to be reflected in the ESB of the status byte register.

(3) Status Byte Register

The following shows the functions and setting conditions of each bit.

- MSS (Master Summary Status)
  When events concerning END, ERR, MAV, and ESB occur
- RQS (Request Service)
  When service requests concerning END, ERR, MAV, and ESB occur
- ESB (Event Status Bit)
  When one or more events permitted by the standard event status enable register occur
- MAV (Message Available)
  When there is data in the output queue
- Other bits are undefined and always “0”

(4) Service Request Enable Register

Register permitting service requests.

(5) END Event Status Register

The following shows the functions and setting conditions of each bit.

- MEA : End of measurement
- STA : End of statistics processing
- Other bits are undefined and always “0”

(6) END Event Status Enable Register

Register that permits the end event status register to be reflected in the status byte register END bit.

(7) ERR Event Status Register

The following shows the functions and setting conditions of each bit.

- UNC : When the measurement result it UNCAL
- NOG : When the template feature is active and there was a No-Go decision
- Other bits are undefined and always “0”

(8) ERR Event Status Register

Register that permits the error event status register to be reflected in the status byte register ERR bit.

5.4.4 Device Message List

(1) A

1) ACF frequency acquisition

Sets whether to acquire frequency manually or automatically, use the frequency value as value (manual frequency) to measure during manual acquisition, or use the frequency value set by the manual frequency setting command AF.

Command : ACF n (, s)
Query : ACF?
Response : ACF n

<Program data>
Value of n Value set
0 ..... AUTO (initial value)
1 ..... MANUAL

Value of s
0 ..... Measures at the frequency set by command AF. (default value)
1 ..... Measures at the frequency measured previously.
(AF setting is overwritten.)

2) ACL level acquisition

Set whether to acquire the level manually or automatically, use the current setting as the amplitude discrimination value during manual acquisition, or use the frequency value set by the manual frequency setting command AF.

Command : ACL n (, s)
Query : ACL?
Response : ACL n

<Program data>
Value of n Value set
0 ..... AUTO (initial value)
1 ..... MANUAL

Value of s
0 ..... Measures at the frequency set by command AD. (default value)
1 ..... Measures at the level measured previously.
(AD setting is overwritten.)

3) AD manual amplitude discrimination

Sets the Input1 internal attenuator value used at a frequency discrimination value.

Command : AD n
Query : AD?
Response : AD n

<Program data>

Value of n	Value set
7	0 dB
6	6 dB
5	12 dB
4	18 dB
3	24 dB
2	30 dB
1	36 dB
0	42 dB (initial value)

4) AF frequency for manual acquisition

Sets manual frequency.

Command : AF n
Query : AF?
Response : AF n

<Program data>

Value of n

600×10^6 to 20×10^9 (Hz) MF2412B
600×10^6 to 27×10^9 (Hz) MF2413B
600×10^6 to 40×10^9 (Hz) MF2414B

Suffixes : GHZ, MHZ, KHZ, HZ, G, MA, K (Unit Hz)

Value set

MHz is the lowest unit. Digits lower that MHz are rounded down.

5) ATTN input2 attenuater

Sets up the input attenuator set to Input2 1 MΩ.

Command : ATTN n
Query : ATTN?
Response : ATTN n

<Program data>

Value of n	Value set
0	ATT THRU
1	20 dB ATT ON (initial value)

6) AUX auxiliary output

Selects the signal output from the rear AUX terminal.

Command : AUX n
Query : AUX?
Response : AUX n

<Program data>

Value of n	Value set
0	(initial value)
1	Go/No-Go
2	Count End
3	Level Det
4	Int Gate
5	Restart
6	Acquisition

Go/Nogo : Outputs the decision result of the template function.
When High, the measurement frequency is within the setting range.
When Low, the measurement frequency is outside of the setting range.
Outputs High when the template function is not selected.
Coun End : A Low pulse is output each time frequency measurement ends.
Level Det : Outputs a counter internal detection signal during burst signal measurement.
Int Gate : Outputs an internal gate signal used in the frequency count.
Restart : Outputs a Low pulse when the Restart command is executed.
Acquisition : Outputs Low during acquisition operation.

(2) B

1) BST burst measurement

Specifies whether to perform burst measurement or CW measurement.

Command : BST n
Query : BST?
Response : BST n

<Program data>

Value of n	Value set
0	BURST OFF : CW measurement (initial value)
1	BURST ON : Burst measurement

2) BSTMD burst mode

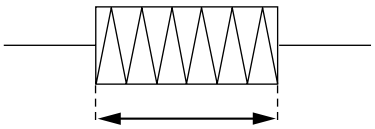
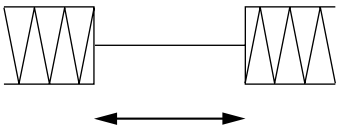
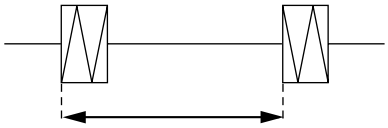
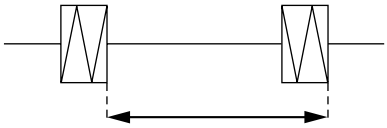
Sets whether to measure carrier frequency, burst width, or burst period during burst measurement.

Command : BSTMD n
Query : BSTMD?
Response : BSTMD n

<Program data>
Value of n Value set

0 ..... CARRIER FREQUENCY (initial value)
1 ..... BURST WIDTH
2 ..... BURST PERIOD

Table 5-4 Relationship Measurements According to Burst Measurement Polarity

		Burst Measurement Polarity	
		Positive	**Negative**
Measurement	Burst Width	Measurement at Burst On time 	Measurement at Burst Off time 
	Burst Period	Measurement of On-On period 	Measurement of Off-Off period 

3) BSTPL burst polarity

Specifies the position (see BSTMD message) as follows when measuring pulse width and burst period.

Command : BSTPL n
Query : BSTPL?
Response : BSTPL n

<Program data>
Value of n Value set
0 ..... POSITIVE (initial value)
1 ..... NEGATIVE

4) BSTWDT burst width

Specifies burst width to measure.

Command : BSTWDT n
Query : BSTWDT?
Response : BSTWDT n

<Program data>

Value of n	Value set
0	Wide (initial value : burst width of 1 us to 0.1 s)
1	Narrow (burst width of 100 ns to 0.1 s)

Note that Wide requires a carrier frequency of 600 MHz and Narrow requires 1 GHz.

(3) C

1) CNTMD count mode

Sets whether the Input1 count method will be high speed (reciprocal) or normal (direct count).

Command : CNTMD n
Query : CNTMD?
Response : CNTMD n

<Program data>

Value of n	Value set
0	FAST (initial value)
1	NORMAL

(4) D

1) DSTA data storage start

Starts the data storage function which is used to trace the frequency measurement values in the internal memory.

Command : DSTA

2) DSTP data storage stop

Stops the data storage function that is used to trace the frequency measurement values in the internal memory.

Command : DSTP

(5) E

1) ESE2 End Event Status Enable Register

Sets (0 to 255) each bit of the End Event Status Enable Register which is one of the GPIB status enable registers.

Command : ESE2 n
Query : ESE2?
Response : ESE2 n

<Program data>

Value of n	Value set
0 to 255	See 5.4.3 “Status Register.”

2) ESE3 ERR Event Status Enable Register

Sets (0 to 255) each bit of the ERR Event Status Enable Register which is one of the GPIB status enable registers.

Command : ESE3 n
Query : ESE3?
Response : ESE3 n

<Program data>

Value of n	Value set
0 to 255	See 5.4.3 “Status Register.”

3) ESR2 END Event Status Register

Returns the value of the END Event Status Register which is one of the GPIB status registers.

Query : ESR2?
Response : n

<Response Data>
See 5.4.3 “Status Register.”

4) ESR3 ERR Event Status Enable Register

Returns the value of the ERR Event Status Register which is one of the GPIB status registers.

Query : ESR3?
Response : n

<Response Data>
See 5.4.3 “Status Register.”

(6) G

1) GTEND gate end

Determines whether the carrier frequency measurement range is to be extended to the end of the gate width specified by the gate width parameter or to the end of the burst.

Command : GTEND n
Query : GTEND?
Response : GTEND n

<Program data>
Value of n
0 ..... Off (initial value: until the end of the burst)
1 ..... On (Until the end of the gate width. Note that when the burst ends before the end of the gate width, the measurement will be to the end of the burst.)

2) GTWDT gate width

Sets the gate width.

Command : GTWDT n
Query : GTEDT?
Response : GTWDT n

<Program data>
Value of n
100×10^{-9} to 100×10^{-3} (sec) .... Suffix : NS, US, MS, S, N, U, M (Unit sec)
Note that the value set n is in 20 ns increments from 100 ns to 1 μs and two significant digits between 1 μs and 100 ms. Values set outside those ranges will be rounded down.

(7) I

1) INPCH input channel

Selects the terminal to which to input the signal.

Command : INPCH n
Query : INPCH?
Response : INPCH n

<Program data>
Value of n Value set
1 ..... CHANNEL 1 (initial value)
2 ..... CHANNEL 2

2) INP2Z ch2 input impidance
Switches the input impedance of CH2

Command : INP2Z n
Query : INP2Z?
Response : INP2Z n

<Program data>
Value of n Value set
0 ..... 50 Ω (initial value)
1 ..... 1 MΩ

(8) L

1) LMT limit on/off (template function)
Sets whether to activate or deactivate the template function.

Command : LMT n
Query : LMT?
Response : LMT n

<Program data>
Value of n Value set
0 ..... Off (initial value: template function inactive)
1 ..... On

2) LMTDIR limit direction indicator
Turn On/off the indicator for showing when the measurement frequency strays off of the display screen.

Command : LMTDIR n
Query : LMTDIR ?
Response : LMTDIR n

<Program data>
Value of n Value set
0 ..... Off (initial value : do not display indicator)
1 ..... On

3) LMTL lower limit

Sets the lower frequency limit for the template function.

Command : LMTL n
Query : LMTL ?
Response : LMTL n

<Program data>
Value of n
0 to Fmax (Hz) ..... Suffixes : GHZ, MHZ, KHZ, HZ, G, MA, K (Unit Hz)
Note : Fmax= 20 GHZ MF2412B
27 GHZ MF2413B
40 GHZ MF2414B

4) LMTU upper limit

Sets the upper frequency limit for the template function.

Command : LMTU n
Query : LMTU?
Response : LMTU n

<Program data>
Value of n
0 to Fmax (Hz) ..... Suffixes : GHZ, MHZ, KHZ, HZ, G, MA, K (Unit Hz)
Note : Fmax= 20 GHZ MF2412B
27 GHZ MF2413B
40 GHZ MF2414B

(9) M

1) MBCF measurement data (burst carrier frequency)

Outputs a burst carrier frequency when there is one measurement result read function during burst measurement.

Query : MBCF?
Response : n

<Response data>
Value of n ..... Output in frequency (HZ) units.
During CW measurement (when burst is Off), 0 HZ is returned.

2) MBWDT measurement data (burst width)
Outputs burst width when there is one measurement result read function during burst measurement.

Query : MBWDT?
Response : n

<Response data>
Value of n ..... Output is units of time (NS)
During CW measurement (when burst is Off), 0 NS is returned.

3) MBPRD measurement data (burst period)
Outputs burst period when there is one measurement result read function during burst measurement.

Query : MBPRD?
Response : n

<Response data>
Value of n ..... Output in units of time (NS)
During CW measurement (when burst is Off), 0 NS is returned.

4) MCW measurement data (continuous wave)
Outputs a frequency measurement value when there is one measurement result read function during CW measurement.

Query : MCW?
Response : n

<Response data>
Value of n ..... Output in frequency (HZ) units.
Returns 0 HZ in other cases (during burst measurement).

5) MOFS measurement data (offset frequency)
Outputs the +/–offset calculation result and ppm calculation result with a single measurement read function.

Query : MOFS?
Response : n

<Response data>
- +Offset or –Offset :
  Value of n ..... Output in frequency (HZ) units.
- ppm :
  Value of n ..... Output in deviation (ppm) units.

Returns 0 HZ in other cases.

6) MSTA measurement data (frequency from the statistic point of view)

Function that outputs statistics processing results for mean, p–p, min, and max.

Query : MSTA?
Response : n1 (, n2)

<Response data>

- Uses n1 for mean or p-p.
  Value of n1 ..... Output in frequency (HZ) units.
- Uses n1 or n2 for max.
  Value of n1 ..... Outputs max frequency in (HZ) units.
  Value of n2 ..... Outputs min frequency in (HZ) units.
- Uses n1 or n2 for min.
  Value of n1 ..... Outputs min frequency in (HZ) units.
  Value of n2 ..... Outputs max frequency in (HZ) units.

Returns 0 HZ when statistics processing is OFF.

7) MTRS measurement data (transient frequency)

Reads the result obtained by the high-speed sampling function. It uses this result to calculate the deviation (Δfi) from the standard frequency (fo) and then calculate input frequency (Xfi) by adding this to the standard frequency.

Query : MTRS? n
Response : T_1, m_1
T_2, m_2
:
T_n, m_n

<Program data>
Value of n
100, 200, 500, 1000, 2000

<Response data>
Reads n group data of i = 1 to n in the T_i, m_i combination.

Using this result, the frequency fi for each measurement time i is calculated using the following formula :

$\Delta fi=(mi/Ti)\times 10^9$ (Hz) i=1, 2, · · · , n

To multiply the frequency resolution K times, the following combination is used.

$\Delta fi= (\sum_{p=0}^{k-1} m_{i+p}/\sum_{p=0}^{k-1} T_{i+p})\times 10^9$ (Hz) i=1, 2, · · · , n–k+1

The standard frequency fo is returned by the query message TRSOFS?. The input frequency Xfi is calculated by the following formulae :

Xfi=abs (fo)+Δfi when fo ≥ 0
Xfi=abs (fo)–Δfi when fo < 0

Note that abs (fo) is the absolute value of fo.

8) MDS measurement data (frequency from the data storage memory)

Reads the data traced in the internal memory.

100 pieces of data are output, starting with the oldest one (r_1).

Query : MDS?

Response : r_1
r_2
:
T_{100}

(10) O

1) OFS offset

Adds the frequency value obtained in advance to the frequency measurement result and calculates the subtraction or deviations

Command : OFS n (, s)

Query : OFS?

Response : OFS n

<Program data>

Value of n	Value set
0	Off (initial value)
1	+OFFSET On
2	–OFFSET On
3	ppm

Value of s	Value set
0	Offset value of the value set by the command OFSFRQ. (default value)
1	Offset value of the previous measurement value. (The value set by OFSFRQ is overwritten.)

2) OFSDT offset data

Selects whether to switch the offset value update mode On or Off. When the update mode is On, the previous measurement values are successively updated as offset values.

Command : OFSDT n

Query : OFSDT?

Response : OFSDT n

<Program data>

Value of n	Value set
0	Update mode Off (initial value).
1	Update mode On

3) OFSFRQ offset frequency

Sets the offset frequency.

Command : OFSFRQ n
Query : OFSFRQ?
Response : OFSFRQ n

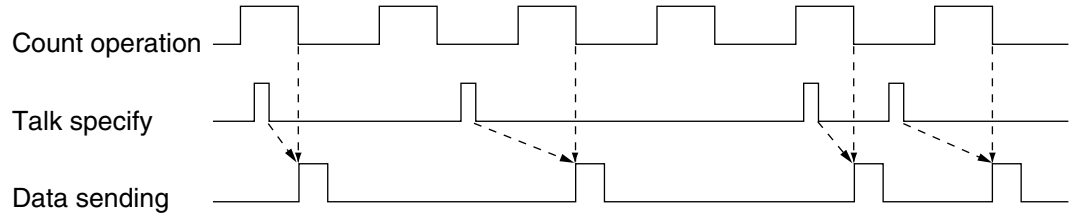
<Program data>
Value of n
0 to Fmax (Hx) ..... Suffixes : GHZ, MHZ, KHZ, HZ, G, MA, K (Unit Hz)
Note : Fmax= 20 GHZ MF2412B
27 GHZ MF2413B
40 GHZ MF2414B

4) OM output mode

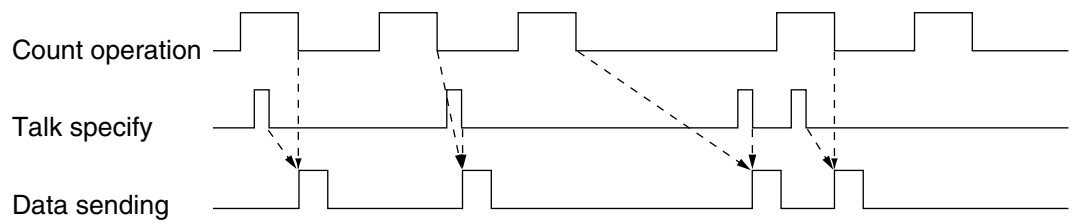
Set this unit to the continuous output mode for numeric output format data used by the MF76 counter. The host CPU can continuously read measurement data if you insert an Input statement (specify talk for this unit) after the following command message.

Command : OM n
Query : OM?
Response : OM n

<Program data>
Value of n Setting
0 ..... Outputs the latest measurement result generated by the data output request and specified as talk by the host CPU Input statement.



1 ..... The output request and frequency measurement timing of data generated and specified as talk by the host CPU Input statement are synchronized. When the measurement result is not obtained, the new measurement is not executed.

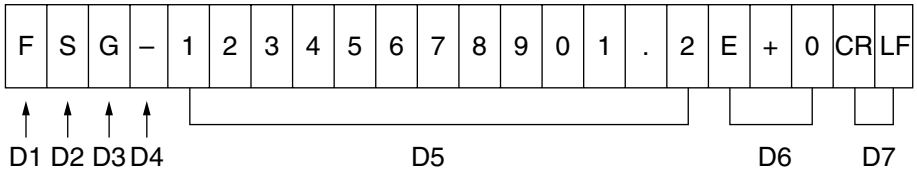


2 ..... Reverts to the IEEE 488.2 communication format.

Note :

When sending a program message and OM is 0 or 1, the OM mode will automatically switch to 2.

<Numeric output format>



D1 : Indicates the data type.
- F : Frequency (Hz)
- R : Parts per million (ppm)
- W : Pulse width (s)
- P : Pulse continuous period (s)

D2 : Indicates whether or not to perform an offset calculation.
- S : Offset On
- Blank space : Offset Off

D3 : Indicates whether or not to perform invalid display for read values, judgment results for specifications, or statistics processing.

High (priority)
- U : UNCAL
- L : No-Go (Lower side)
- H : No-Go (Higher side)
- G : Go
- M : Mean value
- X : Maximum value
- N : Minimum value
- P : P–P
- (Blank) : The above is Off

Low

(When there is more than one condition, the one with the highest priority is attached.)

D4 : A data code is attached.
- – : Data code is a minus sign –
- Blank space : Data code is a plus sign +

D5 : Numeric data represented by twelve digits and one floating point digit.

D6 : Indicates the exponent for numeric data.
E+0=10^0, E+3+10^3, E+6+10^6, E+9+10^9

D7 : Dummy data
LF ^ EOI : TRM0 (Initial value)
CR LF ^ EOI : TRM1

(11) R

1) REF reference frequency
Selects whether to switch the reference signal Auto or Internal.

Command : REF n
Query : REF?
Response : REF n

<Program data>

Value of n	Set value
0	Auto (Initial value)
1	Internal

2) RES frequency resolution
Sets the frequency measurement resolution.

Command : RES n
Query : RES?
Response : RES n

<Program data>

Value of n	Set value
0	1 mHz
1	10 mHz
2	100 mHz
3	1 Hz
4	10 Hz
5	100 Hz (Initial value)
6	1 kHz
7	10 kHz
8	100 kHz
9	1 MHz

3) RTM return to measure
Displays the measurement screen.

Command : RTM

(12) S

1) SH sampling hold

Starts and stops frequency measurement.

Command : SH n
Query : SH?
Response : SH n

<Program data>

Value of n	Set value
0	Sampling (Initial value)
1	Hold

Note :

When the unit is in the Hold state (SH1), it is restarted with either *TRG or GET (address commands).

2) SMP sample rate

Sets the sampling rate (pause time).

Command : SMP n
Query : SMP?
Response : SMP n

<Program data>

Value of n	Set value
0	1 ms
1	2 ms
2	5 ms
3	10 ms
4	20 ms
5	50 ms
6	100 ms (Initial value)
7	200 ms
8	500 ms
9	1 s
10	2 s
11	5 s
12	10 s

3) STS statistic function

Selects statistics processing.

Command : STS n
Query : STS?
Response : STS n

<Program data>

Value of n	Set value
0	off (Initial value)
1	mean
2	max
3	min
4	p–p

4) STSBLK statistic sample extraction

Sets whether to perform overlap processing or to not overlap during statistics processing.

Command : STSBLK n
Query : STSBLK?
Response : STSBLK n

<Program data>

Value of n	Set value
0	discrete block sequence (Initial value)
1	overlap block sequence

5) STSMPL statistic sample point

Sets the number of samples used in statistics processing to 10 to the nth power (STSBLK = 0, and in discrete mode) or 2 to the nth power (STSBLK = 1, and in overlap mode).

Command : STSMPL n
Query : STSMPL?
Response : STSMPL n

<Program data>
Value of n
1 to 6, initial value : 1

When STSBLK is 0, there will be 10 to the nth power samples (n is a value you set).
When STSBLK is 1, there will be 2 to the nth power samples (n is a value you set).

(13) T

1) TRG trigger mode
Selects the trigger source.

Command : TRG n
Query : TRG?
Response : TRG n

<Program data>
0 ..... INT (Initial value)
1 ..... EXT
2 ..... LINE

2) TRGDLY trigger delay
Sets the trigger delay value.

Command : TRGDLY n
Query : TRGDLY?
Response : TRGDLY n

<Program data>
Value of n
0,
20 10^{-9} to 100 10^{-3} (sec) ..... Suffix : NS, US, MS, S, N, U, M (Unit sec)

Note that you should set n to a value between 20 ns to 320 ns in increments of 20 ns, 320 ns to 1 μs in increments of 40 ns, or 1 μs to 100 ms with two significant digits. If you make a setting outside of those ranges, it will be rounded down. In addition, setting a value of 20 ns or lower sets the delay to Off.

3) TRGPL trigger edge polarity
Sets the trigger detection polarity.

Command : TRGPL n
Query : TRGPL?
Response : TRGPL n

<Program data>
Value of n Set value
0 ..... positive (Initial value)
1 ..... negative

4) TRM terminator

Selects the terminator when sending response data.

Program message : TRM n

<Program data>

Value of n	Set value
0	LF (Initial value)
1	CR LF

5) TRS transient mode

Sets the high-speed sampling function ON/OFF.

Command : TRS n
Query : TRS?
Response : TRS n

<Program data>

Value of n	Set value
0	Off (Initial value)
1	On

Note :

High-speed sample measurement is started with either *TRG or GET (address commands).

6) TRSOFS transient offset

Outputs the standard frequency fo to the input frequency calculation using high-speed sampling. (see MTRS message)

Query : TRSOFS?
Response : n

<Response data>

Value of n ..... Output in frequency (HZ) units.
Sending back 0 Hz when selects the input2.

7) TRSSMP transient sample point

Sets the number of points for measuring using the high-speed sampring function.

Command : TRSSMP n
Query : TRSSMP?
Response : TRSSMP n

<Program data>

Value of n
100, 200, 500, 1000, 2000 (Initial value)

8) TRSRT transient sample rate

Sets the high-speed sampling data fetch interval.

Command : TRSRT n
Query : TRSRT?
Response : TRSRT n

<Program data>
Value of n
10×10^{-6} to 1000×10^{-6} (sec)
(1-2-5 step)..... Suffix NS, US, MS, S, N, U, M (Unit sec)
(Initial value) 1000×10^{-6} (sec)

10 us is the smallest unit you can set. In addition, the value you set is changed inintervals of 1, 2, or 5 by rounding off. (Example : 700 us → 500 us)

5.4.5 MF76 Compatibility List

Table 5-4 contains a MF76A compatibility list. Executing the MF76A commands shown on the left side of the table results in similar results as the MF24 series commands shown on the right side. The MF76A commands are only listed here to provide the minimum necessary level of compatibly with older models. You should not use them on new designs.

Table 5-5 MF76A GPIB Program Message Compatibility

MF76A GPIB Commands		MF2410 GPIB Commands		
Service request generation mode RQ	RQ0	*SRE 0		
	RQ1	ESE2 1	*SRE 4	
	RQ2	*ESE 32	*SRE 32	
	RQ3	ESE2 1	*ESE 32	*SRE 36
	RQ4	*SRE 16	*SRE32	
	RQ5	ESE2 1	*ESE16	*SRE 36
	RQ6	*ESE 48	*SRE 32	
	RQ7	ESE2 1	*ESE 48	*SRE 36
Data terminator DT	DT0	TRM 1		
	DT1	No corresponding command		
Measurement start command	RS	*TRG		
Initialization command	CL	*RST		
Switching of input range IN	IN10	INPCH 2	INP2Z 0	
	IN11	INPCH 2	INP2Z 1	
	IN2	INPCH 1		
Switching of measurement resolution RE	RE2	RES 2		
	RE3	RES 3		
	RE4	RES 4		
	RE5	RES 5		
	RE6	RES 6		
	RE7	RES 7		
	RE8	RES 8		
	RE9	RES 9		
	RE13	RES 0		
	RE14	RES 1		
	RE15	RES 2		
	RE16	RES 3		
Switching of sample rate SR	SR0	SH 0		
	SR1	SH 1		
	SR2	SH 0	SMP 0	

Table 5-5 MF76A GPIB Program Message Compatibility (Continued)

MF76A GPIB Commands		MF2410 GPIB Commands		
Manual mode selection MA				
	MA0	ACF 0		
	MA10	ACF 1,1		
Offset mode selection OF				
	OF0	OFS 0		
	OF10+	OFS 1,1		
	OF10–	OFS 2,1		
	OF20+	OFSDT 1	OFS 1	
	OF20–	OFSDT 1	OFS 2	
Parts per million mode selection RA				
	RA0	OFS 0		
	RA1	OFS 3		
Burst mode selection BU				
	BU0	BST 0		
	BU1	BST 1		
Switching of amplitude discrimination AD				
	AD0	ACL 0		
	AD10	ACL 1,1		
Switching of output mode OM				
	OM0	OM 0		
	OM1	OM 1		

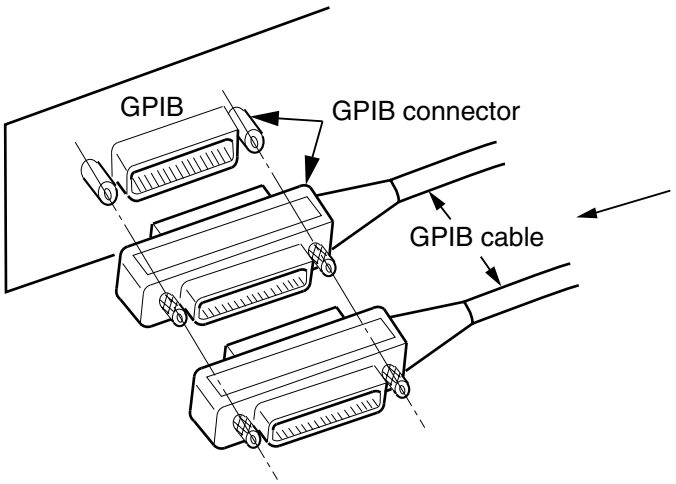
5.5 Setting and Checking GPIB

This section describes how to set and check cable connections and parameter settings that must be performed before using GPIB.

5.5.1 GPIB Cable Connection

The connector for the GPIB cable is on the back panel.

GPIB allows you to connect up to fifteen devices including the controller on a single system. Connect the cable as shown in the following diagram.



Total cable length	≤20 m
Cable length between devices	≤4 m
Number of devices that can be connected	≤15

CAUTION ⚠

Make sure the unit is turned off before connecting a GPIB cable.

5.5.2 Setting and Checking GPIB Parameters

You cannot externally set and check the GPIB operation environment parameter. Set it using the panel as shown below.

Item	Range	Factory Setting
GPIB address	0 to 30	8

Note :

The above setting is saved even when power is turned off.

5.6 Sample Programs

This section lists some sample programs for your reference. It has examples of using an NEC-standard GPIB board and controlling with N88-BASIC and examples using an NI GPIB board and NI-488.2™ software and controlling with Visual Basic.

(1) The following is an example of a program that sets CW, Auto measurement, sample rate of 1 s and resolution of 1 Hz on Input1, uses serial polling to wait for measurement to end, and then reads and displays the frequency measurement value.

1) Program example using N88–BASIC

```
10'*** SAMPLE PROGRAM1***
20 CMD DELIM=0
30 ADRS=8
40 ISET IFC                          : Interface clear
50 ISET REN                          : Remote enable
60 WBYTE &H14;                       : Device clear
70 PRINT @ADRS;"*RST;*CLS;TRM1"      : Preset, status clear, and terminator settings
80 PRINT @ADRS;"ESE2 1"              : Permits measurement end event status
90 PRINT @ADRS;"SMP 9;RES3"          : Sets sample rate of 1 s and resolution of 1 Hz
100 PRINT @ADRS;"*CLS;*TRG"          : Status clear and trigger command
110 FOR I=1 TO 10
120 GOSUB *WAITMEND                  : Waits for measurement to end
130 PRINT @ADRS;"MCW?"               : Reads CW frequency value
140 INPUT @ADRS;FREQ$
150 PRINT FREQ$                      : Displays CW frequency value
160 NEXT I
170 END
180 '*** WAIT MEASURE END***         : Routine for waiting for measurement end
190 *WAITMEND
200 POLL ADRS,S                      : Serial polling
210 IF (S AND 4)=0 GOTO 200          : Checks that measurement ends
220 PRINT @ADRS;"*CLS"               : Status clear
230 RETURN
240 END
```

2) Program example using Visual Basic

```
Sub SAMP1 ()
ADRS%=8
Cls
Call SendIFC(0)                                  : Interface clear
If ibsta% And EERR Then
Call ERRMSG(ADRS%, "Error: IFC")
End If
Call DevClear(0, ADRS%)                          : Device clear
If ibsta% And EERR Then
Call ERRMSG(ADRS%, "Error: DCL")
End If                                           : Specifies presets, status clear, and terminator

Call Send(0,ADRS%, "*RST;*CLS;TRM 1", NLend)
If ibsta% And EERR Then
Call ERRMSG(ADRS%, "Error: SENDING COMMAND")
End If
Call Send(0, ADRS%, "*ESE2 1", NLend)            : Permits measurement end event status
Call Send(0, ADRS%, "SMP 9;RES 3", NLend)        : Sets sample rate of 1 s and resolution of 1 Hz
Call Send(0, ADRS%, "CLS;*TRG",NLend)            : Status clear and trigger command
For I%=1 To 10
FREQ$=Space$(20)
Call Serpoll(ADRS%)                              : Serial polling
Call Send(0, ADRS%, "MCW?", NLend)               : Reads frequency measurement value
Call Receive(0, ADRS%, FREQ$, STOPend)
Print FREQ$                                      : Displays frequency measurement value
Next I%
Call ibonl(ADRS%, 0)
End Sub

Sub Serpoll(ADR%)                                : Serial polling routine
Do
Call ReadStatusByte(0, ADR%, Status%)
If ibsta% And EERR Then
Call ERRMSG(ADRS%, "Error: could not read status byte. ")
End If
Loop Until (Status% And &H4)=&H4
Call Send(0, ADR%, "*CLS", NLend)
End Sub
```

(2) The following is an example of a program that sets Input 2, 50 Ω impedance, 10 ms sample rate, 10 Hz resolution, Max statistics processing and hold, uses a service request to wait for measurement to end, and then reads and displays the statistics processing value.

1) Program example using N88–BASIC

```
10'***SAMPLE PROGRAM2***
20 CMD DELIM=0
30 ADRS=8
40 ISET IFC                              : Interface clear
50 ISET REN                              : Remote enable
60 WBYTE &H14;                           : Device clear
70 PRINT @ADRS;"*RST;*CLS;TRM 1"         : Sets presets, status clear, and terminator
80 PRINT @ADRS;"ESE2 2;*SRE 4"           : Statistics processing end event status
                                         : Statistics processing end event status
90 PRINT @ADRS;"INPCH 2"                 : Sets input channel Input2
100 PRINT @ADRS;"STS 2"                  : Sets Max statistics processing
110 PRINT @ADRS;"SMP 3;RES 4;SH 1"       : Specifies 10 ms sample rate, 10 Hz resolution, hold
120 ON SRQ GOSUB *SRQMEND                : Specifies routine during service request
130 '
140 '***MAIN ROUTINE***
150 SRQ ON                               : Permits service request
160 ENDFLG=0:CNT=0
170 PRINT @ADRS;"*CLS;*TRG"              : Status clear and trigger command
180 ENDFLG=0
190 IF ENDFLG><1 GOTO 190
200 CNT=CNT+1
210 IF CNT<10 GOTO 170
220 END
230 '
240 '***SRQ ROUTINE***                   : SRQ routine
250 *SRQMEND
260 POLL ADRS,S                          : Serial polling
270 IF (S AND 4)=0 GOTO 330              : Checks that measurement ends
280 PRINT @ADRS;"*CLS"                   : Status clear
290 PRINT @ADRS;"MSTA?"                  : Reads statistics processing
300 INPUT @ADRS;MAX$,MIN$
310 PRINT MAX&,MIN$                      : Displays statistics processing
320 ENDFLG=1
330 SRQ ON
340 RETURN
350 END
```

2) Program example using Visual Basic

```
Sub SAMP2 ()
ADRS%=8
Cls
Call SendIFC(0)                                  : Interface clear
If ibsta% And EERR Then
Call FRRMSG(ADRS%, "Error: IFC")
End If
Call DevClear(0, ADRS%)                          : Device clear
If ibsta% And EERR Then
Call ERRMSG(ADRS%, "Error: DCL")
End If
                                                 : Specifies presets, status clear, and terminator
Call Send(0, ADRS%, "*RST;*CLS;TRM 1", NLend)
If ibsta% And EERR Then
Call ERRMSG(ADRS%, "Error: SENDING COMMAND")
End If
Call Send(0, ADRS%, "ESE2 2;*SRE 4", NLend)      : Statistics processing end event status
                                                 : Statistics processing end event status
Call Send(0, ADRS%, "INPCH 2", NLend)            : Input channel Input2
Call Send(0, ADRS%, "STS 2", NLend)              : Sets Max statistics processing
Call Send(0, ADRS%, "SMP 3;RES 4;SH 1", NLend) : Sets 10 ms sample rate, 10 Hz resolution,
                                                 : hold
For I%=1 To 10
FREQ$=Space$(40)
Call Send(0, ADRS% "*CLS;*TRG", NLend)           : Status clear and trigger command
Call Waisrq(ADRS%)
Call Send(0, ADRS%, "MSTA?", NLend)              : Reads statistics processing
Call Receive(0, ADRS%, FREQ$, STOPend)
Print FREQ$
Next I%
Call ibonl(ADRS%, 0)
End Sub

Sub Waisrq (ADR%)                                : SRQ routine
Do
Call WaitSRQ(0, SRQasserted%)
If SRQasserted%=0 Then
Call ERRMSG(ADRS%, "Error: did not assert SRQ. ")
End If
Call ReadStatusByte(0, ADR%, Status%)
If ibsta% And EERR Then
Call ERRMSG(ADRS%, "Error: could not read STB.")
End If
Loop Until (Status% And &H4)=&H4
Call Send(0, ADRS%, "*CLS", NLend)
End Sub
```

(3) The following is a program example that sets Input1, burst mode, 100 ms sample rate, 100 kHz resolution, 10 GHz manual frequency, hold, uses a service request to wait for measurement to end, and then reads and displays the carrier frequency and pulse width value.

1) Program example using N88–BASIC

```
10'***SAMPLE PROGRAM3***
20 CMD DELIM=0
30 ADRD=8
40 ISET IFC                              : Interface clear
50 ISET REN                              : Remote enable
60 WBYTE &H14;                           : Device clear
70 PRINT @ADRD;"*RST;CLS;TRM 1"          : Specifies presets, status clear, and terminator
80 PRINT @ADRD;"ESE2 1;*SRE 4"           : Permits measurement END service request
                                         : and END service request
90 PRINT @ADRD;"ACF 1;AF 1GHZ"           : Sets manual measurement and 1 GHz manual frequency value
100 PRINT @ADRD;"BST 1:BSTMD 1"          : Sets burst measurement and width measurement
110 PRINT @ADRD;"SMP 6;RES 8;SH 1"       : Specifies 100 ms sample rate, 100 kHz resolution, and hold
120 ON SRQ GOSUB *SRQMEND                : Specifies processing routine during service request
130 '
140 "*** MAIN ROUTINE***
150 SRQ ON                               : Permits service request
160 ENDFLG=0:CNT=0
170 PRINT @ADRD;"*CLS;*TRG"              : Status clear and trigger command
180 ENDFLG=0
190 IF ENDFLG><1 GOTO 190
200 CNT=CNT+1
210 IF CNT<10 GOTO 170
220 END
230 '
240 '*** SRQ ROUTINE***                  : SRQ routine
250 *SRQMEND
260 POLL ADRD,S                          : Serial polling
270 IF (S AND 4)=0 GOTO 350              : Checks that measurement ends
280 PRINT @ADRD;"*CLS"                   : Status clear
290 PRINT @ADRD;"MBCF?"                  : Reads burst carrier frequency
300 INPUT @ADRD;FREQ$
310 PRINT @ADRD;"MBWDT?"                 : Reads burst width measurement
320 INPUT @ADRD;WDT$
330 PRINT FREQ$,WDT$                     : Displays measurement result
340 ENDFLG=1
350 SRQ ON
360 RETURN
370 END
```

2) Program example using Visual Basic

```
Sub SAMP3 ()
ADRS%=8
Cls
Call SendIFC(0)                                  : Interface clear
If ibsta% And EERR Then
Call ERRMSG(ADRS%, "Error: IFC")
End If
Call DevClear(0, ADRS%)                          : Device clear
If ibsta% And EERR Then
Call ERRMSG(ADRS%, "Error: DCL")
End If
Call Send(0, ADRS%, "*RST;*CLS;TRM 1", NLend): Specifies presets, status clear,
If ibsta% And EERR Then                          : and terminator
Call ERRMSG(ADRS%, "Error: SENDING COMMAND")
End If
Call Send(0, ADRS%, "ESE2 1;*SRE 4", NLend)      : Permits measurement END service request
                                                 : and END service request
Call Send(0, ADRS%, "ACF 1;AF 1GHZ", NLend)      : Sets manual measurement and
                                                 : 1 GHz manual frequency value
Call Send(0, ADRS%, "BST 1;BSTMD 1", NLend)      : Sets burst measurement and width measurement
Call Send(0, ADRS%, "SMP 6;RES 8;SH 1", NLend) : Specifies 100 ms sample rate, 100 kHz resolution, and hold
For I%=1 To 10
FREQ$=Space$(20)
WDT$=Space$(20)
Call Send(0, ADRS%, "*CLS;*TRG", NLend)          : Status clear and trigger command
Call Waisrq(ADRS%)                               : See 2) under number (2).
Call Send(0, ADRS%, "MBCF?", NLend)              : Reads burst carrier frequency
Call Receive(0, ADR%, FREQ$, STOPend)
Call Send(0, ADRS%, "MBWDT?", NLend)             : Reads burst width measurement
Call Receive(0, ADRS%, WDT$, STOPend)
Print FREQ$; WDT$                                : Displays measurement result
Next I%
Call ibonl(ADRS%, 0)
End Sub
```

(4) The following is a sample program that sets Input2, 1 MΩ impedance, ATT On, 10 ms sample rate, 1 Hz resolution, and arithmetic mean for statistics processing, and then reads and outputs the measurement value using the output mode 0 numeric format.

1) Program example using N88–BASIC

```
10'***SAMPLE PROGRM4***
20 CMD DELIM=0
30 ADRS=8
40 ISET IFC                                  : Interface clear
50 ISET REN                                  : Remote enable
60 WBYTE &H14;                               : Device clear
70 PRINT@ADRS;"*RST;*CLS;TRM 1"              : Specifies presets, status clear, and terminator
80 PRINT @ADRS;"INPCH 2;INP2Z 1;ATTN 1"      : Set input channel Input2, 1 MÉð, and ATT On
90 PRINT @ADRS;"SMP 3;RES 3;STS 1"           : Sets 10 ms sample rate, 1 Hz resolution, and arithmetic mean
100 PRINT @ADRS;"OM 0"                       : Specifies output mode 0 numeric format
110 INPUT @ADRS;FREQ$                        : Reads measurement value
120 PRINT FREQ$
130 GOTO 110
140 END
```

2) Program example using Visual Basic

```
Sub SAMP4 ()
ADRS%=8
Cls
Call SendIFC(0)                              : Interface clear
If ibsta% And EERR Then
Call ERRMSG(ADRS%, "Error: IFC")
End If
Call DevClear(0, ADRS%)                      : Device clear
If ibsta% And EERR Then
Call ERRMSG(ADRS%, "Error: DCL")
End If
Call Send(0, ADRS%, "*RST;TRM 1", NLend)     : Specifies presets and terminator
If ibsta% And EERR Then
Call ERRMSG(ADRS%, "Error: SENDING COMAND")
End If                                       : Set input channel Input2, 1 MΩ, and ATT On
Call Send(0, ADRS%, "INPCH 2;INP2Z 1;ATTN 1", NLend)
                                             : Sets 10 ms sample rate, 1 Hz resolution, and arithmetic mean
Call Send(0, ADRS%, "SMP 3;RES 3;STS 1", NLend)
Call Send(0, ADRS%, "OM 0", NLend)           : Specifies output mode 0 numeric format
For I%=1 To 10
FREQ$=Space$(40)
Call Receive(0, ADRS%, FREQ$, STOPend)       : Reads measurement value
Print FREQ$
Next I%
Call ibonl(ADRS%, 0)
End Sub
```

(5) The following is a sample program that sets Input1, manual frequency 1 GHz, amplitude discrimination L3, 100 high-speed samples, 100 µs high-speed period, and internal trigger, uses serial polling for high-speed sample measurement with a 100 µs trigger delay to wait for measurement to end, and then reads the count value and converts it to a frequency value.

1) Program example using N88–BASIC

```
10 '***SAMPLE PROGRAM5***
20 CMD DELIM=0:DIM CNT1#(100),CNT2#(100), FREQ#(100)
30 ADRS=8
40 ISET IFC
50 ISET REN
60 PRINT @ADRS;"*RST;*CLS;TRM 1"              : Specifies presets, status clear, and terminator
70 PRINT @ADRS;"ACF 1;AF 1GHZ;ACL 1;AD 3" : Manual measurement and 1 GHz manual frequency
                                               : Manual level measurement and manual level L3
80 PRINT @ADRS;"TRSSMP 100;TRSRT 100US"   : 100 high-speed samples and 100 µs high-speed sample period
90 PRINT @ADRS;"TRG 1;TRGDLY 100US"         : External trigger and 100 µs trigger delay
100 PRINT @ADRS;"TRS 1"                       : High-speed sample On
110 PRINT @ADRS;"ESE2 1"                      : Permits measurement end event status
120 PRINT @ADRS;"*CLS"                        : Status clear
130 PRINT@ADRS;"*TRG"                         : Trigger command
140 GOSUB *WAITMEND                           : Waits for measurement end
150 '                                         :
160 PRINT @ADRS;"TRSOFS?"                     : Reads high-speed sample offset frequency
170 INPUT @ADRS;OFS$
180 OFS#=VAL(OFS$)
190 PRINT @ADRS;"MTRS? 100"                   : Gets high-speed sample data
200 FOR I=1 TO 100
210 INPUT @ADRS;CNT1$,CNT2$
215 CNT1#(I)=VAL(CNT1$),CNT2#(I)=VAL(CNT2$)
220 IF OFS#<0 GOTO 250                        : Distributes processing by offset frequency sign
230 FREQ#(I)=(CNT2#(I)/CNT1#(I))*1E+09+ABS(OFS#): When offset is positive
240 GOTO 260
250 FREQ#(I)=ABS(OFS#)(CNT2#(I)/CNT#(I))*1E+09  : When offset is negative
260 FREQ$=STR$(FREQ#(I))+"HZ"                 : Displays frequency value
270 PRINT FREQ$
280 NEXT I
290 PRINT @ADRS;"*RST"
300 END
310 *WAITMEND                                 : Routine that waits for measurement to end
320 POLL ADRS,S                               : Serial polling
330 IF (S AND 4)=0 GOTO 320                   : Checks that measurement ends
340 RETURN
350 END
```

2) Program example using Visual Basic

```
Sub SAMP5 ()
ADRS%=8
Static FREQ#(100)
Cls
Call SendIFC(0)                                    : Interface clear
If ibsta% And EERR Then
Call ERRMSG(ADRS%, "Error: IFC")
End If
Call DevClear(0, ADRS%)                            : Device clear
If ibsta% And EERR Then
Call ERRMSG(ADRS%, "Error: DCL")
End If
Call Send(0, ADRS%, "*RST;*CLS;TRM 1", NLend): Specifies presets, status clear,
If ibsta% And EERR Then                            : and terminator
Call ERRMSG(ADRS%, "Error: SENDING COMMAND")
End If
Call Send(0, ADRS%, "ESE2 1:*SRE 4", NLend)        : Permits measurement end event status, and END
                                                     service request
Call Send(0, ADRS%, "ACF 1;AF1 GHZ;ACL 1;AD 3", NLend)
                                                   : Manual measurement, 1 GHz, and L3
Call Send(0, ADRS%, "TRG 1;TRGDLY 100US", NLend)
                                                   : External trigger and 100 µs trigger delay
                                                   : 100 high-speed samples and 100 µs high-speed sample period
Call Send(0, ADRS%, "TRSSMP 100;TRSRT 100US;TRS 1", NLend)
                                                   : High speed sample On
Call Send(0, ADRS%, "*CLS;*TRG", NLend)            : Status clear and trigger command
Call Waisrq(ADRS%)                                 : See 2) under (2)
OFS$=Space$(40)
Call Send(0, ADRS%, "TRSOFS?", NLend)              : Reads offset value
Call Receive(0, ADRS%, OFS$, STOPend)
FOFS#=Val(OFS$)
Call Send(0, ADRS%, "MTRS? 100", NLend)
For I%=0 To 99
BUF$=Space$(40)
Call Receive(0, ADRS%, BUF$, STOPend)
SEP%=InStr(BUF$, ",")
CNT1#=Mid(BUF$, 1, SEP%–1)
CNT2#=Mid(BUF$, SEP%+1)
```

```
If FOFS#>=0 Then                                    : Distributes processing by offset frequency sign
FREQ#(I%)=Abs(FOS#)+(CNT2#/CNT1#)*1000000000  : When offset is positive
Else
FREQ#(I%)=Abs(FOS#)–(CNT2#/CNT1#)*1000000000  : When offset is negative
End If
Print FREQ#(I%)                                     : Displays frequency value
Next I%
Call Send(0, ADRS%, "TRS 0;RTM", NLend)
Call ibonl(ADRS%, 0)
End Sub
```

Section 6 Operating Principles

This chapter describes the measurement principle, frequency measurement accuracy, pulse width measurement accuracy, and trigger error for the MF2412B/MF2413B/MF2414B Microwave Frequency Counter.

6.1 Configuration

Figure 6.1 shows this unit's configuration.

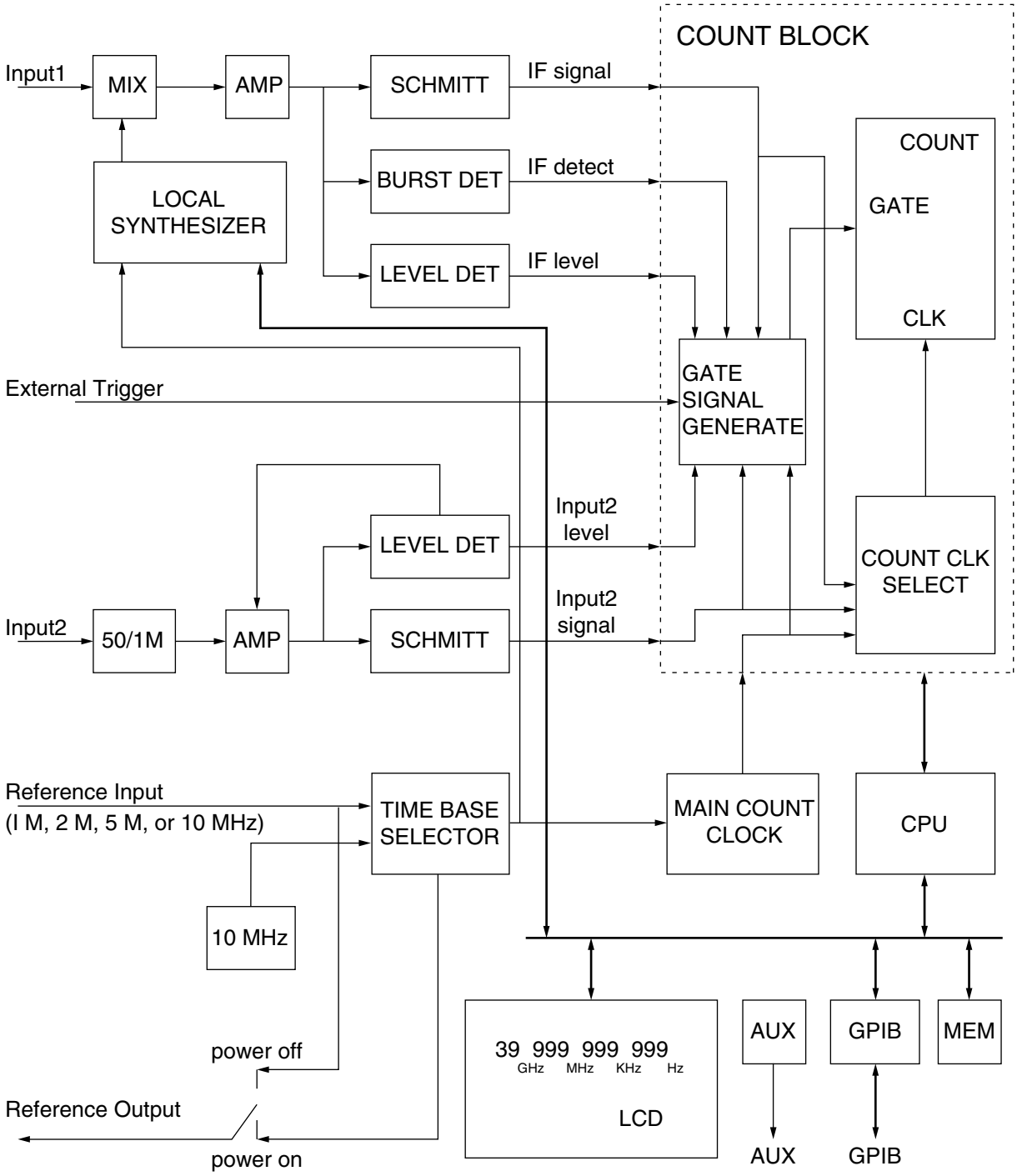


Fig. 6.1 Block Diagram

6.2 Frequency Measurement

Frequency means the number of vibrations per unit of time. Operating principle, which is called the most basic direct counting of frequency measurement opens a gate between a precise unit of time created by a time base generation circuit, passes through the signal to be measured, counts it using a counting circuit, and then displays the result.
The 50 Ω system (measurement frequency of 10 MHz to 1 GHz) on Input2 of this unit uses a direct count method.
Connecting the signal to be measured to the Input2 connector passes a 50 Ω/1 MΩ input impedance switch and adds the AMP and SCHMITT circuits. To prevent miscounts due to noise, the AMP amplitude is controlled so that the input level of the SCHMITT circuit remains constant regardless of the size of the input level.
The SCHMITT circuit converts the wave form of the amplified signal to a pulse and then sends it to the counting circuit.
The counting circuit uses the time base generator as the standard, opens the gate only as long as the gate time of the count signal time (1 sec at a resolution of 1 Hz and 1 msec at a resolution of 1 kHz) for obtaining the necessary resolution, and then counts the number of pulses. This pulse number is sent to the CPU which displays it as a measurement frequency.

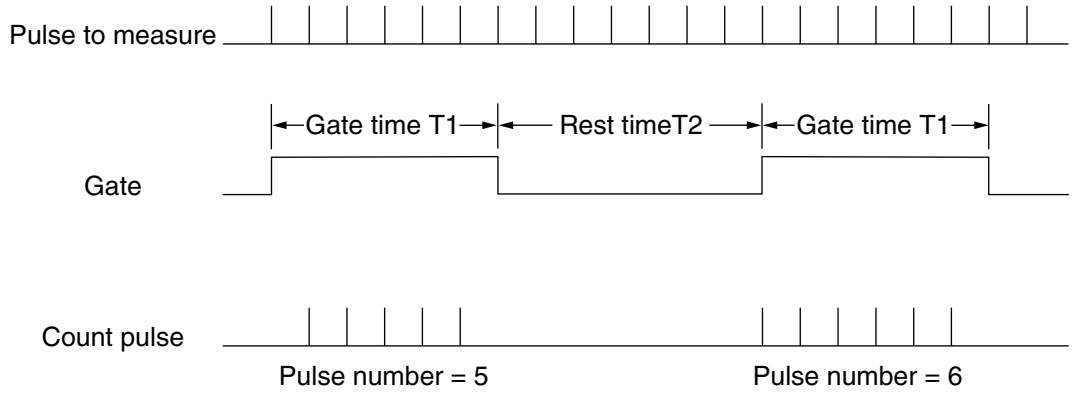


Fig. 6-2 Direct Counting

The pulse that is input has a ±1 count error for the number of pulses due to the gate and unsynchronized signal. This error is the ±1 count item noted in the measurement error. Consequently, the final measurement accuracy is as follows :

$$\text{Measurement accuracy} = \pm 1 \text{ count} \pm \text{time base accuracy} \times \text{measurement frequency}$$

The 1 MΩ system (measurement frequency of 10 Hz to 10 MHz) on Input2 employs a reciprocal method. The signal to measure, which was converted into a pulse wave form, is divided between 1/2 to $1/10^9$ by the counting circuit. This division rate is decided by calculating the optimum value on the CPU from the correspondence between the necessary frequency resolution and the frequency of the signal to measure.
The counting circuit opens the gate for the amount of time required to divide the signal to measure only by the division rate, measures the gate time, and then uses the CPU to calculate the frequency of the signal to measure from this gate time and the division rate.

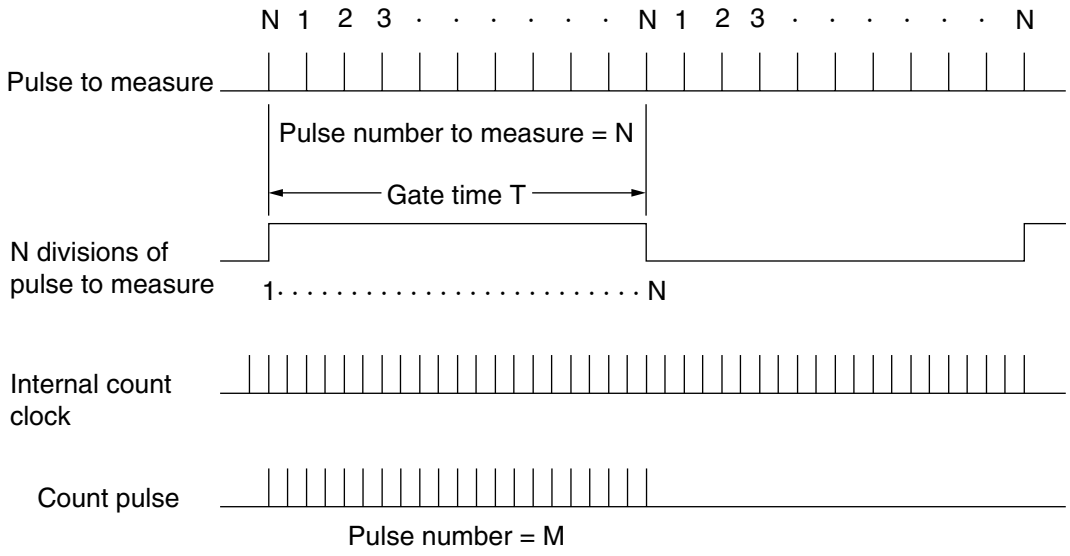


Fig. 6-3 Reciprocal Method

In the reciprocal method, the count error value will vary according to the size of the noise applied to the input signal because the gate time is determined by the input signal. This is added as trigger error noted by measurement error. 6.4 “Trigger Error” describes count error due to trigger error. The final measurement accuracy is as follows:

$$\text{Measurement accuracy} = \pm 1 \text{ count} \pm \text{time base accuracy} \times \text{measurement frequency} \pm \text{trigger error}$$

After Input1 uses the heterodyne down converter method to convert the signal ™to measure to an IF signal, it displays the count results using either the direct count method (when count mode is NORMAL) or the reciprocal method (when count mode is FAST).
Connecting the signal to measure to the Input 1 connector mixes it with the local N harmonics in the harmonic mixer to obtain the IF signal.

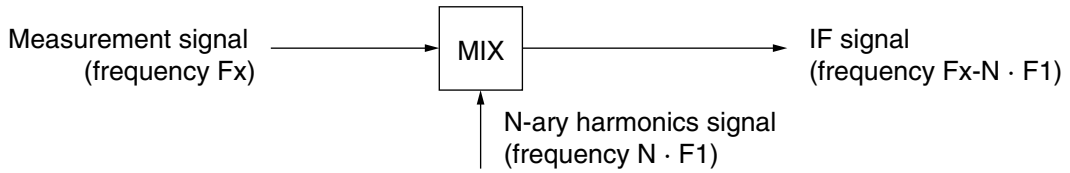


Fig. 6.4 Heterodyne Method

The IF signal is fed into the counter circuit after being amplified by the AMP, and it is then counted. If Fx is the frequency of the signal to measure, F1 is the local frequency, and F2 is the frequency of the IF signal counted, we get the following calculation :

$$Fx = N \cdot F1 \pm F2$$

When the count mode is NORMAL, measurement error is the same as the direct count method, and when it is FAST, it is the same as the reciprocal method. In addition, error due to harmonic mixing is not ignored on Input1. This error is called residual error. The following shows whether to operate the source of the signal to measure this unit at the same standard signal and the accuracy when the unit uses a highly stable external reference signal :

(Count mode = Normal)
Measurement accuracy = ±1 count ± time base accuracy × measurement frequency ± residual error 1

(Count mode = FAST)
Measurement accuracy = ±1 count ± time base accuracy × measurement frequency ± trigger error ± residual error 2

Note the following :

Residual error 1 = measurement frequency (GHz) /10 count (rms)
Residual error 2 = measurement frequency (GHz) /2 count (rms)

6.3 Burst Width Measurement/Burst Period Measurement

The signal to measure input from Input1 is detected by BURST DET and generates a pulse signal. This pulse signal is taken as the gate time, and the clock number of the internal count clock is counted. For the pulse period, the time from the start of a burst to the time of the start of the next burst (or the time from an end to the next end) is taken as the gate time, and the same operation takes place.

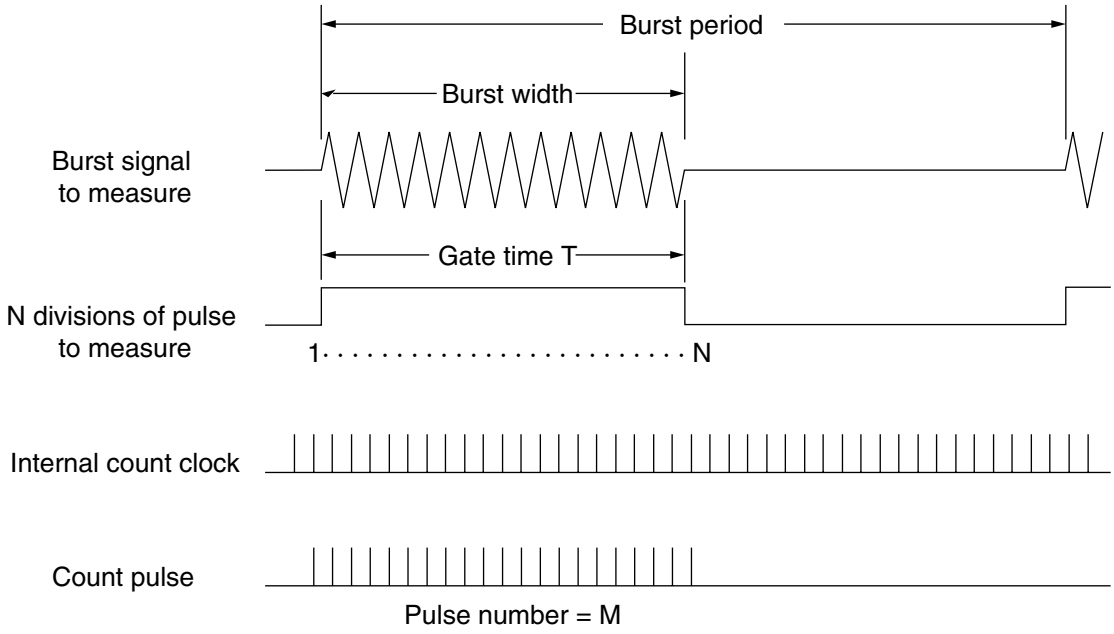


Fig. 6-5 Burst Width Measurement

The gate is generated from the signal to measure, and the method for counting using the counting circuit is the same as that for the reciprocal method. The error is also the same.
Note that error due to detection is newly added for burst width and period measurement. This will be ± 20 ns when using this unit to measure a burst signal at an On/Off ratio of 40 dB and 0 cross (when On/Off is performed while the carrier signal phase is 0 degrees). Consequently, measurement accuracy is as follows :

Measurement accuracy = ±20 ns ± time base accuracy × measurement pulse width ± trigger error

Burst signal to measure : On/Off ratio of 40 dB, 0 cross

6.4 Trigger Error

When the count mode on INPUT1 is FAST and INPUT2 is the 1 MΩ system, this unit employs measurements using the reciprocal method that calculates and displays frequency by making calculations from period measured value. When performing period measurements, it takes the signal to measure as the gate time unlike the frepuency measurement, therefore the error will be occured by minute noise components as fluctuation of the count time.
As shown in Fig. 6-6, when the gate is opened and closes due to a noise signal at the trigger point, the gate item lengthens and shortens by onlyΔT.
If S is the gradient (V/sec.) of the ideal signal in the trigger level and E_N is the peak value of the noise signal, the following relationship is established :

$$S = E_N/\Delta T$$

This means that the maximum measurement period deviation due to noise is $2\Delta T$, and if the measurement period is T, the trigger error is expressed by the ratio of $2\Delta T$ and the measurement period T as follows :

$$2\Delta T/T = T2E_N \text{ (peak value)}/TS$$

For example, if period T and amplitude E_S are sine waves, the gradient S of the trigger level is $2\pi E_S/T$, resulting in the following equation :

$$2\Delta T/T = E_N \text{ (peak value)}/\pi E_S \text{ (amplitude)}$$

As shown in Fig. 6-6, an error of $2\Delta T$ occurs when there was trigger error for the ideal GATE. This is the counter error in the reciprocal frequency measurement from section 6.2 and burst width measurement/burst period measurement from section 6.3.

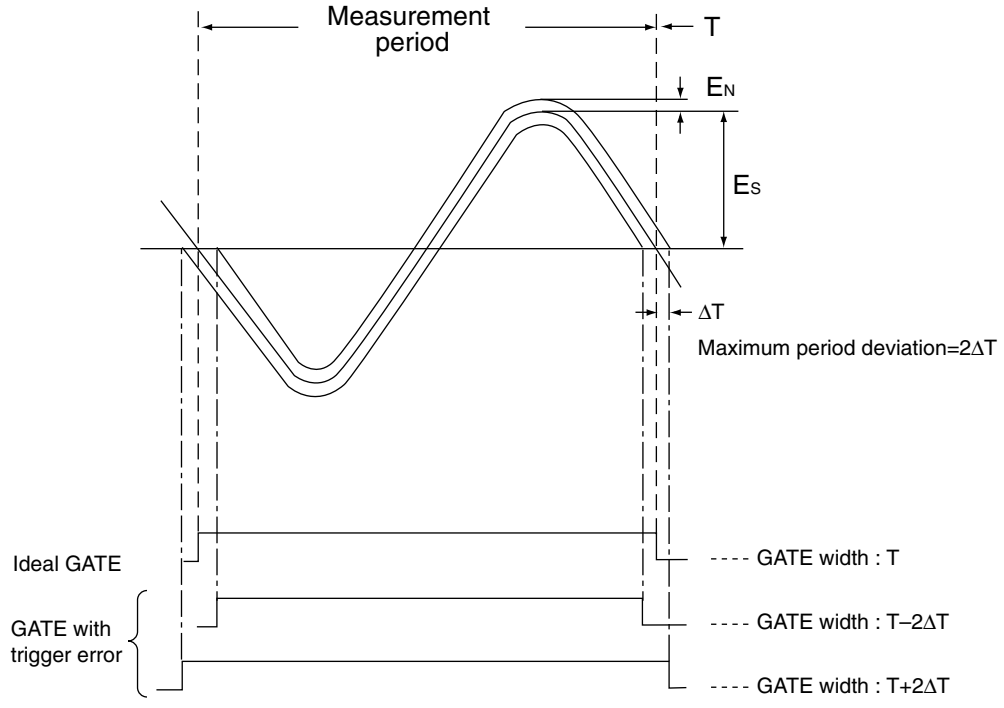


Fig. 6-6 Trigger Error Due to Noise

Fig. 6-7 to 6-10 show the relationship between count error and input level only when noise is assumed to be due to MF2412B/MF2413B/MF2414B (assumes there is no input signal noise).

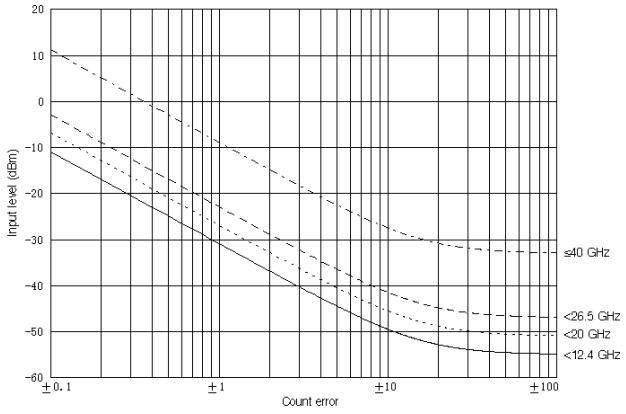


Fig. 6-7 Input1 Frequency Measurement Count Error Versus Input Level

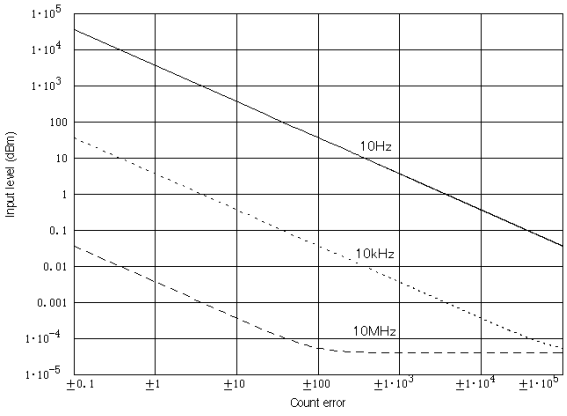


Fig. 6-8 Input2 Frequency Measurement Count Error Versus Input Level

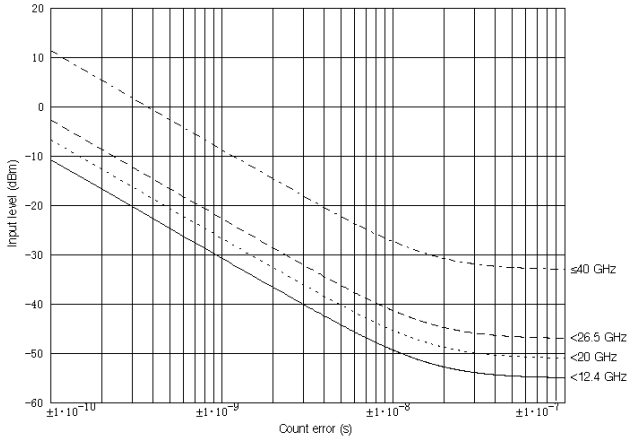


Fig. 6-9 Input1 Pulse Width Measurement (Wide) Count Error Versus Input Level

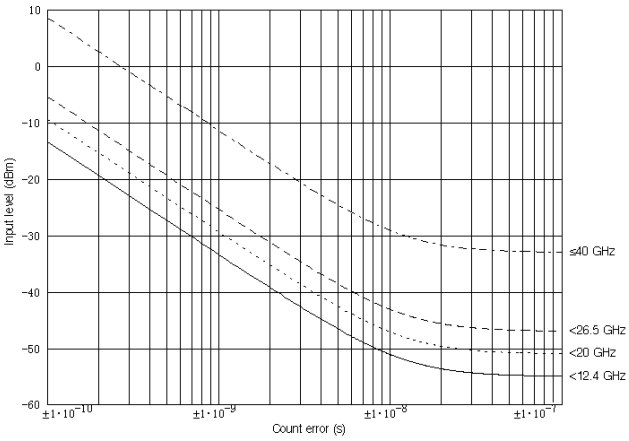


Fig. 6-10 Input1 Pulse Width Measurement (Narrow) Count Error Versus Input Level

Section 7 Performance Test

This chapter describes the measurement equipment, setup, and performance tests necessary for testing MF2412B/ MF2413B/MF2414B Microwave Frequency Counter performance.

7.1 When to Run Performance Tests

The purpose of performance tests is preventative maintenance in order to detect and head off degraded performance before it occurs. The performance tests that are required include a test after purchase, routine test, and performance test after repairs.
The following items are tested during each of the above mentioned tests.

- Continuous frequency measurement
- Burst wave carrier frequency measurement
- Burst width measurement

Periodically carry out performance tests for preventative maintenance. The minimum recommended number of tests is one or two a year.

Contact our service department if a performance test discovers that the unit is not performing according to its specifications.

7.2 List of Performance Test Equipment

Table 7-1 shows the equipment for performance tests.

Table 7-1 List of Performance Test Equipment

Test Item	Recommended Equipment (Anritsu Model No.)	Required Performance *1
7.3.1.1, 7.3.1.2 Continuous frequency measurement (Input1, Input2 50 Ω) 7.3.2 Burst wave carrier frequency measurement	Power meter (ML4803A) Power sensor (MA4701A) (MA4703A) (MA4705A) (MP713A) Fixed attenuator (20 dB)*2 (MP721D)	Frequency range 10 MHz to 20 GHz : MF2412B 10 MHz to 26.5 GHz : MF2413B 0 MHz to 40 GHz : MF2414B Sensitivity –33 dBm to 0 dBm
7.3.3 Burst width measurement	Signal generator (68247B) (68259B) (68269B)	Frequency range 10 MHz to 20 GHz : MF2412B 10 MHz to 26.5 GHz : MF2413B 10 MHz to 40 GHz : MF2414B Output level –33 dBm to 0 dBm Pulse modulator 100 ns Pulse modulation accuracy ±10 ns or less
7.3.1.3 Continuous frequency measurement (Input2 1MΩ)	Power meter Power sensor	Frequency range 10 Hz to 10 MHz Sensitivity 25mVrms
	Signal generator	Frequency range 10 Hz to 10 MHz Output level 25mVrms

1 :

Some of the performance items that can cover performance measurement tests have been excluded.

2 :

Used when testing at –33 dBm.

7.3 Performance Test

When performing the performance tests discussed below, warm up the unit to be tested and the measuring equipment for at least 30 minutes unless directed otherwise and wait for it to stabilize before proceeding with testing. To achieve maximum measurement sensitivity, you must also perform tests at room temperature and make sure there is little fluctuation in the AC power supply and that there is not a harmful amount of noise, vibration, dust, or humidity.

7.3.1 Continuous Frequency Measurement

7.3.1.1 Continuous Frequency Measurement on Input1

(1) Test specifications

- Frequency range
  600 MHz to 20 GHz MF2412B
  600 MHz to 27 GHz MF2413B
  600 MHz to 40 GHz MF2414B
- Input sensitivity
  –33 dBm : ..... <12.4 GHz
  –28 dBm : ..... <20 GHz
  –25 dBm : ..... <26.5 GHz
  {0.741 × f (GHz)–44.6} dBm : < 40 GHz
- Measurement accuracy
  Count mode Normal (direct count) :
  ± count ± time base accuracy × measurement frequency ± residual error 1
  Note: residual error1 = {measurement frequency (GHz)/10 count (rms)}
  Count mode Fast (reciprocal)
  ± count ± time base accuracy × measurement frequency ± residual error 2 ± trigger error
  Note: residual error2 = {measurement frequency (GHz)/2 count (rms)}

(2) Test equipment

- Signal generator
- Power meter
- Power sensor

(3) Test procedure

1) Set the unit to preset values. To perform a test in Normal mode, switch the count mode setting.
2) Connect the Reference Output terminal on the back of the unit to the external standard input on the signal generator.
3) Use a measurement cable to connect the signal generator output connector to the power meter input connector.
4) Adjust the signal generator output level to the rated sensitivity of the power meter.
5) Disconnect the measurement cable you connected to the power meter input connector and connect it to the unit's Input1 connector.
6) Check that the output frequency of the signal generator is being displayed on the counter.
7) Disconnect the measurement cable you connected to the unit's Input1 connector, change the output frequency of the signal generator, repeat steps 3) to 6), and check that frequency is properly displayed within the specified range.

7.3.1.2 Continuous Frequency Measurement on Input2 (50 Ω : 10 MHz to 1 GHz)

(1) Test specifications
- Frequency range : 10 MHz to 1 GHz
- Input sensitivity : 25 mVrms
- Measurement accuracy : ±1 count × time base accuracy × measurement frequency

(2) Test equipment
- Signal generator
- Power meter
- Power sensor

(3) Test procedure
1) Set the unit to preset values and set the input channel to Input2.
2) Connect the Reference Output terminal on the back of the unit to the external standard input on the signal generator.
3) Use a measurement cable to connect the signal generator output connector to the power meter input connector.
4) Adjust the signal generator output level to the rated sensitivity of the power meter.
5) Disconnect the measurement cable you connected to the power meter input connector and connect it to the unit's Input2 connector.
6) Check that the output frequency of the signal generator is being displayed on the counter.
7) Disconnect the measurement cable you connected to the unit's Input2 connector, change the output frequency of the signal generator, repeat steps 3) to 6), and check that frequency is properly displayed within the specified range.

7.3.1.3 Continuous Frequency Measurement on Input2 (1Ω : 10 Hz to 10 MHz)

(1) Test specifications
- Frequency range : 10 Hz to 10 MHz
- Input sensitivity : 25 mVrms
- Measurement accuracy : ± 1 count ± time base accuracy × measurement signal frequency ± trigger error

(2) Test equipment
- Signal generator
- Power meter

(3) Test procedure
1) Set the unit to preset values, set the input channel to Input2, and then set the impedance to 1 MΩ and ATT to Off.
2) Connect the Reference Output terminal on the back of the unit to the external standard input on the signal generator.
3) Use a measurement cable to connect the signal generator output connector to the power meter input connector.
4) Adjust the signal generator output level to the rated sensitivity of the power meter.
5) Disconnect the measurement cable you connected to the power meter input connector and connect it to the unit's Input2 connector.
6) Check that the output frequency of the signal generator is being displayed on the counter.
7) Disconnect the measurement cable you connected to the unit's Input2 connector, change the output frequency of the signal generator, repeat steps 3) to 6), and check that frequency is properly displayed within the specified range.

7.3.2 Burst Wave Carrier Frequency Measurement

(1) Test specifications

- Frequency range
  600 MHz to 20 GHz MF2412B
  600 MHz to 27 GHz MF2413B
  600 MHz to 40 GHz MF2414B
- Input sensitivity
  –33 dBm : ..... <12.4 GHz
  –28 dBm : ..... <20 GHz
  –25 dBm : ..... <26.5 GHz
  {0.741 × f (GHz) –44.6} dBm : ≤ 40 GHz
- Pulse width
  100 ns..... Burst width Narrow
- Measurement accuracy
  ± 1 count ± time base accuracy × measurement frequency ± trigger error ± residual error 2 ± 1/T_{GW}
  Note : residual error2 = {measurement frequency (GHz)/2 count (rms)}
  T_{GW} = Gate width

(2) Test equipment

- Signal generator capable of pulse modulation or a signal generator and pulse modulator
- Power meter
- Power sensor

(3) Test procedure

1) Set the unit to preset values and then make the following settings:
   Pulse width : Narrow
   Measurement resolution : 1 MHz
   Frequency acquisition mode : Manual
   Manual frequency : Output frequency of signal generator
2) Connect the Reference Output terminal on the back of the unit to the external standard input on the signal generator.
3) Set signal generator output to continuous wave (pulse modulation Off), and then use a measurement cable to connect the signal generator output connector to the power meter input connector.
4) Adjust the signal generator output level to the rated sensitivity of the power meter.
5) Disconnect the measurement cable you connected to the power meter input connector and connect it to the unit's Input1 connector.
6) Check that the output frequency of the signal generator is being displayed on the counter.
7) Sets the pulse modulation width to 100 ns, continuous period to 500 ns, and turn pulse modulation On.
8) Set the unit's Meas Mode to Burst.
9) Check that the output frequency of the signal generator is being displayed on the counter.
10) Disconnect the measurement cable you connected to the unit's Input1 connector, change the output frequency of the signal generator, repeat steps 3) to 9), and check that frequency is properly displayed.

7.3.3 Burst Width Measurement

(1) Test specifications

- Pulse width
  100 ns to 100 ms ..... Burst width Narrow
  ..... Manual frequency 1 GHz or more
  1 µs to 100 ms ..... Burst width Wide
- Input sensitivity
  –33 dBm : ..... <12.4 GHz
  –28 dBm : ..... <20 GHz
  –25 dBm : ..... <26.5 GHz
  {0.741 × f (GHz)–44.6} dBm : ≤40 GHz
- Measurement accuracy
  ± 20 ns ± time base accuracy × measurement pulse width ± trigger error

(2) Test equipment

- Signal generator capable of pulse modulation or a signal generator and pulse modulator
- Power meter
- Power sensor

(3) Test procedure

1) Set the unit to preset values and then make the following settings :
   Pulse width : Narrow
   Burst mode : Width
   Measurement resolution : 1 MHz
   Frequency acquisition mode : Manual
   Manual frequency : Output frequency of signal generator
2) Set the pulse modulation width to 100 ns and continuous period to pulse modulation width + 1 µs.
3) Connect the Reference Output terminal on the back of the unit to the external standard input on the signal generator.
4) Set signal generator output to continuous wave (pulse modulation Off), and then use a measurement cable to connect the signal generator output connector to the power meter input connector.
5) Adjust the signal generator output level to the rated sensitivity of the power meter.
6) Disconnect the measurement cable you connected to the power meter input connector and connect it to the unit's Input1 connector.
7) Check that the output frequency of the signal generator is being displayed on the counter.
8) Turn pulse modulation On.
9) Set the unit's Meas Mode to Burst.
10) Check that the burst width measurement value displays the pulse modulation width.
11) Disconnect the measurement cable you connected to the unit's Input1 connector, change the output frequency of the signal generator, repeat steps 4) to 10), and check that the burst width measurement value is properly displayed.

[Notes on Testing]

When using signal generator 68200B to test burst width measurement performance, the accuracy of pulse modulation is ±10 ns, and the precision ratio against the accuracy ±20 ns of the unit's burst width measurement is 2.0. In this case, the tolerance coefficient (gard band coefficient) is 0.935, which means that the pass-fail decision standard when using signal generator 68200B is as follows :

$$(\pm 20 \text{ ns} \pm \text{time base accuracy} \times \text{measurement pulse width} \pm \text{trigger error}) \times 0.935$$

Table 7-2 shows the main precision ratios and tolerance coefficients.

Table 7-2 Main Precision Ratios and Tolerance Coefficients

Precision Ratio	Tolerance coefficient
4.0	1.00
3.5	0.990
3.0	0.975
2.5	0.960
2.0	0.935
1.5	0.895
1.0	0.825

Section 8 Calibration

This section describes the measuring equipment, setup, and calibration procedures required to calibrate the MF2412B/MF2413B/MF2414B Microwave Frequency Counter.

8.1 When to Perform Calibration

Calibration is preventive maintenance for preventing degraded performance before it occurs. Even if it appears that the unit is running normally, you should calibrate the unit to keep in top shape. We recommend you calibrate the unit one to two times a year. Contact our service department if calibration fails to bring the unit within its rated specifications.

8.2 List of Calibration Equipment

Table 8-1 show the equipment used to calibrate the unit.

Table 8-1 List of Calibration Equipment

Calibration Item	Recommended Equipment (Anritsu Model Name)	Required Performance *1
Reference oscillator	Host standard Frequency standard, standard radio wave receiver Color TV subcarrier	Accuracy $\leqq 1 \times 10^{-9}$
	Signal generator	Frequency 1 GHz Level 0 dBm

1 :

Some of the performance items that can cover the measurement range are given.

8.3 Calibration

The frequency of the internal reference oscillator that creates time base is a critical element influencing measurement accuracy of a frequency counter. This means that in order to maintain a high degree of measurement accuracy you must periodically calibrate the frequency of the reference oscillator using a standard frequency with guaranteed accuracy.
Even if you have a reference oscillator with good stability, the measurement result will not exceed the calibrated accuracy if the calibrated accuracy was a low value. For example, the accuracy variation is 5×10^{-10} or less per day when using a signal with an accuracy of 5×10^{-8} to calibrate a reference oscillator that has a high stability of aging rate 5×10^{-10}. However, the measurement accuracy will never be better than 5×10^{-8}. In other words, this calibration method is not getting the most out of the performance of the high stability of 5×10^{-10}/day.
Conversely, if the stability lowers, the high degree of accuracy is meaningless. Consequently, matching the stability and accuracy of the reference oscillator is the most effective calibration method.
When continually use the frequency counter more than one month or storage it more than one month, the reference osillator should be calibrated as following procedure.

(1) Turn the counter on for at least 24 hours in a 25 ˚C ±5 ˚C room until it warms up adequately.

(2) Receive a frequency standard, standard radio wave receiver, or color TV subcarrier (NHK and TV Asahi use signals locked to a rubidium atom standard), and then connect the signal generator for generating a signal locked to this and this unit as shown in Figure 8-1.

(3) Set the signal generator to 1 GHz.

(4) Set the unit as follows after settings presets.

Input channel : Input2
Measurement resolution : 10 Hz or less

(5) While turning the crystal oscillator's correcting potentiometer from the internal standard adjustment aperture on the right side board, read the equipment's frequency value and adjust to a resolution up to 10 Hz. Adjust options 01 and 02 of the crystal oscillator to a resolution up to 1 Hz and option 03 to a resolution up to 0.1 Hz.

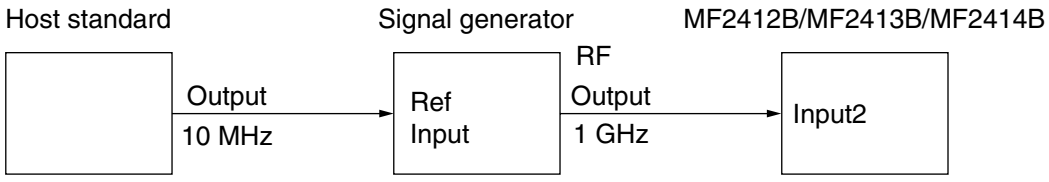


Fig. 8-1 Example of Connections for calibration

Section 9 Storing and Transporting

This chapter describes daily care for the MF2412B/MF2413B/MF2414B Microwave Frequency Counter and how to store, repackage, and transport it.

9.1 Cleaning the Cabinet

Make sure to turn power off and unplug the unit before cleaning it. Clean the outside cabinet of the unit as follows:

- Wipe it with a soft, dry cloth.
- When the unit is really dirty, you have been using it in an area with a lot of dust, or it has been stored away for a long period of time, apply a diluted mild cleaner to a soft cloth and use it to wipe the unit clean. Immediately wipe the unit dry with a soft, dry cloth.
- If you notice any of the screws or other parts are loose, use the proper tools to tighten them.

CAUTION ⚠

- **Make sure to turn power off and unplug the unit before cleaning it.**
- **Do not use benzene, thinner, alcohol, or other strong chemicals to clean the cabinet. Failing to obey this warning may damage or discolor the it.**

9.2 Notes on Storage

This section provides information for storing the unit for extended periods of time.

9.2.1 Before Storing

(1) Wipe away any dust, finger prints, or stains from the unit.

(2) Avoid storing in the following locations:
   1) Areas exposed to direct sunlight or large amounts of dust.
   2) Areas with high humidity where condensation may occur.
   3) Areas exposed to volatile gases or areas where the unit might oxidize.
   4) Areas with the following temperature and humidity:
      - Temperature..... >70 ˚C, <–20 ˚C
      - Humidity..... ≥90 %

9.2.2 Recommended Storage Conditions

In addition to the above mentioned conditions, make sure to observe the following environment conditions when storing the unit for a long period of time.

- Temperature ..... 0 to 30 ˚C
- Humidity ..... 40 to 80 %
- Place with little daily temperature and humidity variation

9.3 Repackaging and Transporting

Note the following information when sending this unit to Anritsu for repairs.

9.3.1 Repackaging

Use the packaging materials and box the unit originally came with. If they are not available, use the following materials:

(1) Wrap the unit in plastic or similar material.

(2) Obtain a cardboard or aluminum box large enough to hold material for absorbing physical shock from all sides.

(3) Fill the box on all sides with material for absorbing physical shock so that the unit will not move within the box.

(4) Seal the box shut tight with plastic bands, adhesive tape, or other suitable means.

9.3.2 Transporting

Transport by avoiding vibrations as much as possible and fulfilling the conditions recommended above.

Appendix

Appendix

Appendix-2.

Appendix A Initial Values/Preset Value List

The following is a list of initial value/presets for the MF2412B/MF2413B/MF2414B Microwave Frequency Counter.

Group	Parameter	Initial Value/Preset Value
Measurement mode	Measurement mode	CW/CW
Resolution	Resolution	100 Hz/100 Hz
Sample rate	Sample rate	100 ms/100 ms
Input	Input connector	Input1/Input1
	Input2 impedance	50 Ω/50 Ω
	Input2·1 MΩ system	On/On
	20 dbmATT	
Frequency	Frequency acquisition	Auto/Auto
	Manual frequency value	Fmax*/Fmax*
	Count method	Fast/Fast
Level	Level acquisition	Auto/Auto
	Manual amplitude discrimination value	L0/L0
Burst	Burst mode	Freq/Freq
	Burst measurement polarity	Pos/Pos
	Burst width	Wide/Wide
Trigger	Trigger mode	Int/Int
	Trigger polarity	Rise/Rise
	Trigger delay value	Off/Off
Gate	Gate width value	100 ms/100 ms
	Gate end	Off/Off
Template	Template	Off/Off
	Upper frequency limit value	Fmax*/Fmax*
	Lower frequency limit value	0 Hz/0 Hz
	Movement direction indication	Off/Off
Offset	Offset	Off/Off
	Offset value	0 Hz/0 Hz
	Update mode	Off/Off
Statistics processing	Statistics processing	Off/Off
	Sampling mode	Disc/Disc
	Number of samples	1/1
High-speed sampling	High-speed sampling	Off/Off
	Sampling period	1 ms/1 ms
	Save	2000/2000
Memory	Sample count	All clear/(unavailable)
Standard signal selection	Standard signal selection	Auto/Auto
GPIB	Address	8/ (unavailable)
	Talk on	Off /(unavailable)
AUX	AUX	Off/Off
Intensity	Intensity	Bright/(unavailable)

Fmax* : 20 GHz for MF2412B
27 GHz for MF2413B
40 GHz for MF2414B

Appendix

Appendix B Performance Test Entry Table

Test location : _____ Report no : _____

_____ Date : _____

_____ Tester : _____

Model name : MF2412B/MF2413B/MF2414B
Microwave Frequency Counter

Model number : _____ Surrounding temperature : _____ %

Power frequency : _____ Hz Relative humidity : _____ ˚C

Notes :

_____

_____

_____

_____

Equipment used to test performance

Power meter : _____

Power sensor : _____

Signal generator : _____

Others : _____

Performance test name : Continuous wave frequency measurement (Input1) Notes : _____

Measurement Frequency	600 MHz	1 GHz	10 GHz	20 GHz	26.5 GHz	30 GHz	40 GHz	
Measurement Uncertainty								

Performance test name : Continuous wave frequency measurement (Input2) Notes : _____

Measurement Frequency	10 Hz	100 Hz	1 MHz	10MHz	100 MHz	500 MHz	1 GHz	
Measurement Uncertainty								

Performance test name : Burst wave carrier measurement Notes : _____

Measurement Frequency	600 MHz	1 GHz	10 GHz	20 GHz	26.5 GHz	30 GHz	40 GHz	
Measurement Uncertainty								

Performance test name : Burst width measurement Notes : _____

Measurement Frequency	100 ns	1 us	10 us	100 us	1 ms	10 ms	100 ms	
Measurement Uncertainty								

Index

I

L

M

N

O

P

R

S

T

U