MU181500B
Jitter Modulation Source
Operation Manual

12th Edition

- **For safety and warning information, please read this manual before attempting to use the equipment.**
- **Additional safety and warning information is provided in the MP1800A Signal Quality Analyzer Installation Guide and the MT1810A 4 Slot Chassis Installation Guide. Please also refer to one of these documents before using the equipment.**
- **Keep this manual with the equipment.**

ANRITSU CORPORATION

Document No.: M-W3481AE-12.0

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.

MU181500B
Jitter Modulation Source
Operation Manual

15 April 2011 (First Edition)
5 February 2016 (12th Edition)

For Safety

⚠ WARNING

- 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.

Repair

- Only qualified service personnel with a knowledge of electrical fire and shock hazards should service this equipment. This equipment cannot be repaired by the operator. DO NOT attempt to remove the equipment covers or unit covers or to disassemble internal components. 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

- 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. Be careful not to break the seal by opening the equipment or unit covers. If the performance-guarantee seal is broken by you or a third party, the performance of the equipment cannot be guaranteed.

For Safety

⚠ CAUTION

Check Terminal

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.

Use in a Residential Environment

This equipment is designed for an industrial environment.
In a residential environment, this equipment may cause radio interference in which case the user may be required to take adequate measures.

Use in Corrosive Atmospheres

Exposure to corrosive gases such as hydrogen sulfide, sulfurous acid, and hydrogen chloride will cause faults and failures.
Note that some organic solvents release corrosive gases.

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. However, software fixes will be made in accordance with the separate Software End-User License Agreement. Moreover, Anritsu Corporation will deem this warranty void when:

- The fault is outside the scope of the warranty conditions separately 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, wind, flooding, earthquake, lightning strike, or volcanic ash, etc.
- The fault is due to damage caused by acts of destruction, including civil disturbance, riot, or war, etc.
- The fault is due to explosion, accident, or breakdown of any other machinery, facility, or plant, etc.
- The fault is due to use of non-specified peripheral or applied equipment or parts, or consumables, etc.
- The fault is due to use of a non-specified power supply or in a non-specified installation location.
- The fault is due to use in unusual environments(Note).
- The fault is due to activities or ingress of living organisms, such as insects, spiders, fungus, pollen, or seeds.

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

Anritsu Corporation shall assume no liability for injury or financial loss of the customer due to the use of or a failure to be able to use this equipment.

Note:
For the purpose of this Warranty, "unusual environments" means use:

- In places of direct sunlight
- In dusty places
- Outdoors
- In liquids, such as water, oil, or organic solvents, and medical fluids, or places where these liquids may adhere
- In salty air or in places where chemically active gases (sulfur dioxide, hydrogen sulfide, chlorine, ammonia, nitrogen dioxide, or hydrogen chloride etc.) are present
- In places where high-intensity static electric charges or electromagnetic fields are present
- In places where abnormal power voltages (high or low) or instantaneous power failures occur
- In places where condensation occurs
- In the presence of lubricating oil mists
- In places at an altitude of more than 2,000 m
- In the presence of frequent vibration or mechanical shock, such as in cars, ships, or airplanes

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.

Lifetime of Parts

The life span of certain parts used in this instrument is determined by the operating time or the power-on time. Due consideration should be given to the life spans of these parts when performing continuous operation over an extended period. These parts must be replaced at the customer's expense even if within the guaranteed period described in Warranty at the beginning of this manual.
Coaxial switch: 10 million times (BUJ and RJ jitter variation times)

Crossed-out Wheeled Bin Symbol

Equipment marked with the Crossed-out Wheeled Bin Symbol complies with council directive 2012/19/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.

Software End-User License Agreement (EULA)

Please read this Software End-User License Agreement (hereafter this EULA) carefully before using (includes executing, copying, registering, etc.) this software (includes programs, databases, scenarios, etc., used to operate, set, etc., Anritsu electronic equipment). By reading this EULA and using this software, you are agreeing to be bound by the terms of its contents and Anritsu Corporation (hereafter Anritsu) hereby grants you the right to use this Software with the Anritsu-specified equipment (hereafter Equipment) for the purposes set out in this EULA.

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1. Regardless of whether this Software was purchased from or provided free-of-charge by Anritsu, you agree not to rent, lease, lend, or otherwise distribute this Software to third parties and further agree not to disassemble, recompile, reverse engineer, modify, or create derivative works of this Software.
2. You may make one copy of this Software for backup purposes only.
3. You are not permitted to reverse engineer this software.
4. This EULA allows you to install one copy of this Software on one piece of Equipment.

2. Disclaimers

To the extent not prohibited by law, in no event shall Anritsu be liable for personal injury, or any incidental, special, indirect or consequential damages whatsoever, including, without limitation, damages for loss of profits, loss of data, business interruption or any other commercial damages or losses, arising out of or related to your use or inability to use this Software.

3. Limitation of Liability

a. If a fault (bug) is discovered in this Software, preventing operation as described in the operation manual or specifications whether or not the customer uses this software as described in the manual, Anritsu shall at its own discretion, fix the bug, or exchange the software, or suggest a workaround, free-of-charge. However, notwithstanding the above, the following items shall be excluded from repair and warranty.
   i) If this Software is deemed to be used for purposes not described in the operation manual or specifications.
   ii) If this Software is used in conjunction with other non-Anritsu-approved software.
   iii) Recovery of lost or damaged data.
   iv) If this Software or the Equipment has been modified, repaired, or otherwise altered without Anritsu's prior approval.
   v) For any other reasons out of Anritsu's direct control and responsibility, such as but not limited to, natural disasters, software virus infections, etc.

b. Expenses incurred for transport, hotel, daily allowance, etc., for on-site repairs by Anritsu engineers necessitated by the above faults shall be borne by you.

c. The warranty period for faults listed in article 3a above covered by this EULA shall be either 6 months from the date of purchase of this Software or 30 days after the date of repair, whichever is longer.

4. Export Restrictions

You may not use or otherwise export or re-export directly or indirectly this Software except as authorized by Japanese and United States law. In particular, this software may not be exported or re-exported (a) into any Japanese or US embargoed countries or (b) to anyone on the Japanese or US Treasury Department's list of Specially Designated Nationals or the US Department of Commerce Denied Persons List or Entity List. By using this Software, you warrant that you are not located in any such country or on any such list. You also agree that you will not use this Software for any purposes prohibited by Japanese and US law, including, without limitation, the development, design and manufacture or production of missiles or nuclear, chemical or biological weapons of mass destruction.

5. Termination

Anritsu shall deem this EULA terminated if you violate any conditions described herein. This EULA shall also be terminated if the conditions herein cannot be continued for any good reason, such as violation of copyrights, patents, or other laws and ordinances.

6. Reparations

If Anritsu suffers any loss, financial or otherwise, due to your violation of the terms of this EULA, Anritsu shall have the right to seek proportional damages from you.

7. Responsibility after Termination

Upon termination of this EULA in accordance with item 5, you shall cease all use of this Software immediately and shall as directed by Anritsu either destroy or return this Software and any backup copies, full or partial, to Anritsu.

8. Dispute Resolution

If matters of dispute or items not covered by this EULA arise, they shall be resolved by negotiations in good faith between you and Anritsu.

9. Court of Jurisdiction

This EULA shall be interpreted in accordance with Japanese law and any disputes that cannot be resolved by negotiation described in Article 8 shall be settled by the Japanese courts.

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

1. Product Model

Model: MU181500B Jitter Modulation Source

2. Applied Directive and Standards

When the MU181500B Jitter Modulation Source is installed in the MP1800A or MT1810A, the applied directive and standards of this unit conform to those of the MP1800A or MT1810A main frame.

PS: About main frame

Please contact Anritsu for the latest information on the main frame types that MU181500B can be used with.

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: MU181500B Jitter Modulation Source

2. Applied Directive and Standards

When the MU181500B is installed in the MP1800A or MT1810A, the applied directive and standards of this unit conform to those of the MP1800A or MT1810A main frame.

PS: About main frame
Please contact Anritsu for the latest information on the main frame types that MU181500B can be used with.

About This Manual

A testing system combining an MP1800A Signal Quality Analyzer or MT1810A 4-Slot Chassis mainframe, module(s), and control software is called a Signal Quality Analyzer Series. The operation manuals of the Signal Quality Analyzer Series consist of separate documents for the installation guide, the mainframe, remote control operation, module(s), and control software, as shown below.

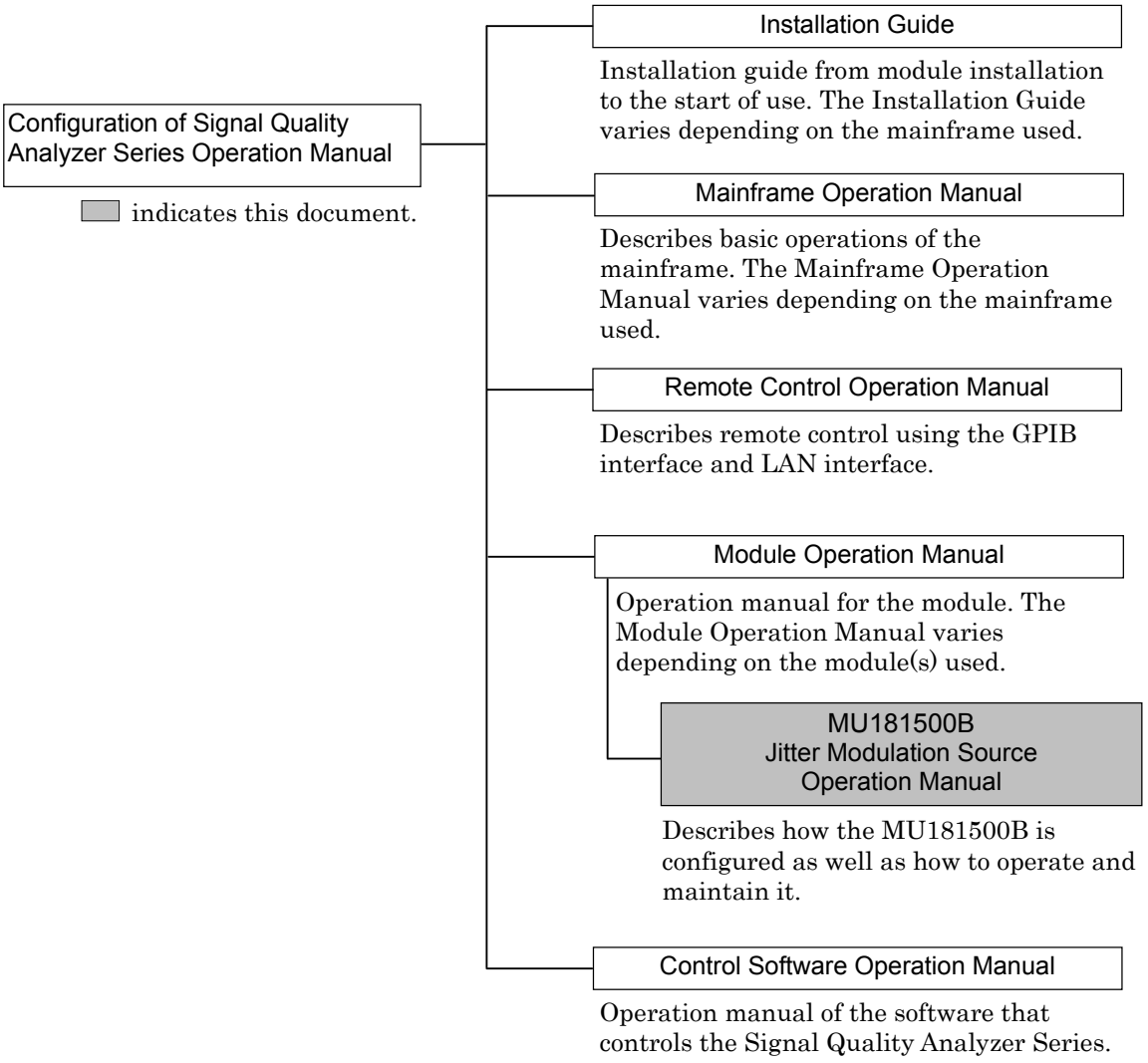

Table of Contents

IV.

Chapter 1 Overview

This chapter provides an overview of MU181500B Jitter Modulation Source (MU181500B hereafter).

1.1 Product Overview

The MU181500B Jitter Modulation Source is a plug-in module for the Signal Quality Analyzer series.

It generates the following jittered clocks for input and built-in clocks.

- BUJ: Bounded Uncorrelated Jitter
- RJ: Random Jitter
- SJ: Sinusoidal Jitter
- SSC: Spread Spectrum Clock
- External Jitter

Connecting the output clock of this module to the input of the Pulse Pattern Generator supports bit error measurement of the jittered signals.

The features of this module are listed below:

- Adds separate SJ, SSC, BUJ, and RJ to clocks from 800 MHz to 15 GHz
- Supports linked (tracked) operation with MU181000A/B installed in MP1800A Signal Quality Analyzer (MP1800A hereafter).
- Supports setting screen with intuitive image of clock inputs, added jitter, and output data signals.
- Outputs unmodulated divided clocks required by DUT and measurement system.

1.2 Product Composition

1.2.1 Standard configuration

Table 1.2.1-1 shows the standard configuration of the MU181500B.

Table 1.2.1-1 Standard Configuration (MU181500B)

Item	Model/Symbol	Name	Quantity	Remarks
Main frame	MU181500B	Jitter Modulation Source	1	
Accessories	J1137	Terminator	6	
	J1341A	Open	2	
	J1624A	Coaxial cable, 0.3 m	1	SMA connector
	J1508A	Coaxial cable	2	BNC-SMA connector
	Z0897A	MP1800A Manual CD	1	CD-ROM
	Z0918A	MX180000A Software CD	1	CD-ROM

1.2.2 Applicable parts

Table 1.2.2-1 shows the application parts for the MU181500B. They are sold separately.

Table 1.2.2-1 Applicable parts

Model Name	Name	Remarks
J1137	Terminator	SMA-P
J1342A	Coaxial cable, 0.8 m	APC 3.5 mm connector
J1625A	Coaxial cable, 1 m	SMA connector
J1359A	Coaxial Adaptor (K-P, K-J, SMA)	
41KC-3	Precision Fixed Attenuator 3 dB	
41KC-6	Precision Fixed Attenuator 6 dB	
41KC-10	Precision Fixed Attenuator 10 dB	
41KC-20	Precision Fixed Attenuator 20 dB	
K240C	Precision Power Divider	
J1624A	Coaxial Cable 0.3 m	SMA connector
J1550A	Coaxial skew match cable (0.8m, APC3.5 connector)	APC3.5 mm connector, Pair cable
J1551A	Coaxial skew match cable (0.8m, K connector)	K connector, Pair cable
J1611A	Coaxial cable (1.3m, K connector)	K connector
J1612A	Fixed Electrical Length Coaxial Cable (0.8 m, K Connector)	K connector
J1615A*	Coaxial Cable set (Jitter-PPG-Emphasis)	Cable set for jitter tolerance measurement
J1618A*	Coaxial Cable set (Jitter-2chPPG-Emphasis)	Cable set for jitter tolerance measurement
J1620A	Coaxial Cable (0.9 m K Connector)	K connector
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*: For examples of how to connect instruments with coaxial cables, refer to Appendix D.

1.3 Specifications

1.3.1 Input/Output Signal

Table 1.3.1-1 Input/Output Signal

Item	Specifications
External Clock Input	
Number of Connectors	1
Frequency Range	6.400 001 to 12.5 GHz (Clock Source: MU181000A/B) 0.8 to 15 GHz (Clock Source: External)
Input Amplitude	0.4 to 1.0 Vp-p
Termination	50 Ω/AC
Connector	SMA(f.)
External Jitter Input	
External Jitter	Various modulations according to input signal
Number of Connectors	1
Modulation Frequency	10 kHz to 1 GHz
Input Amplitude	0 to 2 Vp-p
Termination	50 Ω/GND
Connector	SMA(f.)
Jitter Clock Output*1	
Number of Connectors	2
Frequency	
Setting Range:	When Clock Source is MU181000A or MU181000B:

Setting Range (GHz)	Step
0.800 001 to 1.562 500	1 kHz
1.600 001 to 3.125,000	1 kHz
3.200 001 to 6.250 000	1 kHz
6.400 001 to 12.500 000	1 kHz
12.800 002 to 15.000 000	2 kHz

When Clock Source is External:
0.8 to 15 GHz
Same frequency as clock input to Ext Jitter Input connector

*1: Specified using the application part, J1342A Coaxial Cable 0.8 m.

Table 1.3.1-1 Input/Output Signal (Cont'd)

Item	Specifications
Jitter Clock Output (Continued)	
Frequency offset	When Clock Source is MU181000A or MU181000B: –1000 to +1000 ppm, 1 ppm step When Clock Source is External: Unspecified
Amplitude	0.4 to 1.0 Vp-p*2
Residual Jitter	≤350 fs*3
Termination	50 Ω/AC
Connector	SMA(f.)
IQ Output	
Number of Connectors	2 (I, Q)
Output Amplitude	≤1 Vp-p
Termination	50 Ω/GND
Connector	SMA(f.)

*2: The amplitude cannot be changed.

*3: At 4.25, 7.0125, 10, 12.5, 14, 15 GHz

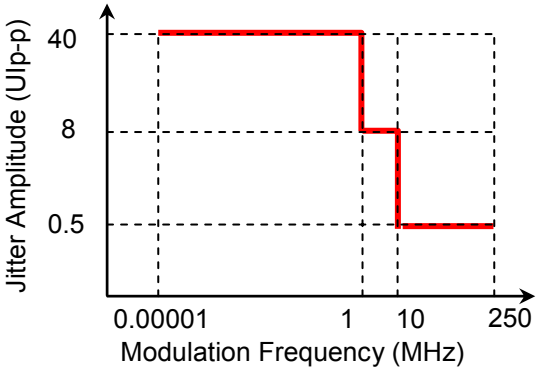
Table 1.3.1-1 Input/Output Signal (Cont'd)

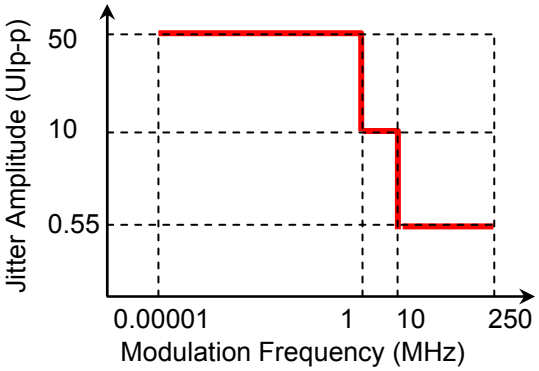
Item	Specifications
AUX Input	
Number of Connectors	1
Frequency	Same as clock frequency input to Ext Clock Input
Input Amplitude	0.4 to 1.1 Vp-p
Termination	50 Ω/AC
Connector	SMA(f.)
Reference Clock Output*1	
Number of Connectors	2
Reference Clock	Ext Clock Input or AUX Input (Clock Source: MU181000A/B.) Ext Clock Input (Clock Source: External)
Frequency setup range:	1/1, 1/2 or 1/4 of Jitter clock output frequency
Output Amplitude	Output clock frequency <4 GHz: 0.4 to 1.2 Vp-p*2 Output clock frequency ≥4 GHz: 0.4 to 1.0 Vp-p*2
Termination	50 Ω/AC
Connector	SMA(f.)
Sub-rate Clock Output*1	
Number of Connectors	2 (Differential)
Frequency	1/N of Jitter clock output frequency (N=8 to 256, 1 step)
Output Amplitude	
Setting Range:	0.1 to 0.7 Vp-p, Step 10 mV
Accuracy	±20% of 70 mV ±set Amplitude*4
Termination	50 Ω/AC
Connector	SMA(f.)

*4: At 12.5 GHz jitter clock frequency and 1/8 division ratio

1.3.2 Jitter Modulation Performance

Table 1.3.2-1 Sinusoidal Jitter (SJ)*1

<table>
<tr><th>Item</th><th>Specifications</th></tr>
<tr><td>Mask Setting Range
Full-rate (PPG)
Full-rate (MUX)</td><td>
<table>
<tr><th>Modulation Frequency (MHz)</th><th>Jitter Amplitude (UIp-p)</th></tr>
<tr><td>0.00001 to 1</td><td>≤40</td></tr>
<tr><td>1.001 to 10</td><td>≤8</td></tr>
<tr><td>10.01 to 250</td><td>≤0.5</td></tr>
</table>


Half-rate (MUX)
Quarter-rate (MUX)
<table>
<tr><th>Modulation Frequency (MHz)</th><th>Jitter Amplitude (UIp-p)</th></tr>
<tr><td>0.00001 to 1</td><td>≤50</td></tr>
<tr><td>1.001 to 10</td><td>≤10</td></tr>
<tr><td>10.01 to 250</td><td>≤0.55</td></tr>
</table>


</td></tr>
</table>

*1: Specified as data output of MU182020A or MU182021A in following diagram, 8 to 28 Gbit/s

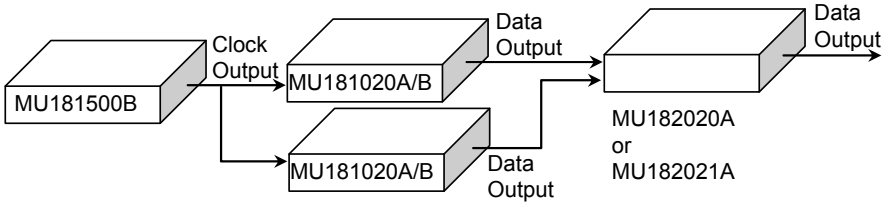


Table 1.3.2-1 Sinusoidal Jitter (SJ)*[1] (Cont'd)

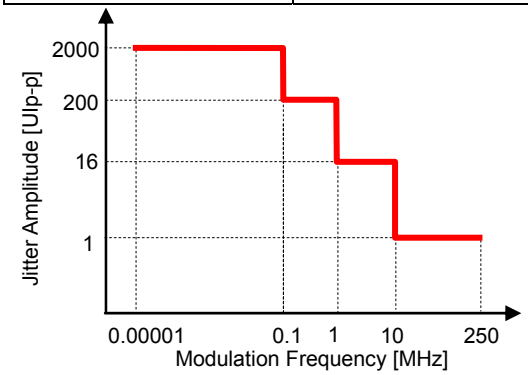
<table>
<tr><th>Item</th><th>Specifications</th></tr>
<tr><td>Modulation Frequency
Setting Range</td><td>
<table>
<tr><th>Setting Range</th><th>Step</th></tr>
<tr><td>10 Hz to 10 kHz</td><td>1 Hz</td></tr>
<tr><td>10 to 100 kHz</td><td>10 Hz</td></tr>
<tr><td>100 kHz to 1 MHz</td><td>100 Hz</td></tr>
<tr><td>1 to 10 MHz</td><td>1 kHz</td></tr>
<tr><td>10 to 100 MHz</td><td>10 kHz</td></tr>
<tr><td>100 to 250 MHz</td><td>100 kHz</td></tr>
</table>
</td></tr>
<tr><td>Modulation Bandwidth</td><td>
<table>
<tr><th>Clock Frequency</th><th>Bandwidth</th></tr>
<tr><td>0.8 < Fc ≤1.2 GHz</td><td>10 Hz to 50 MHz</td></tr>
<tr><td>1.2 < Fc ≤ 4 GHz</td><td>10 Hz to 100 MHz</td></tr>
<tr><td>4 < Fc ≤ 8.5 GHz</td><td>10 Hz to 200 MHz</td></tr>
<tr><td>8.5 < Fc ≤ 15 GHz</td><td>10 Hz to 250 MHz</td></tr>
</table>
</td></tr>
<tr><td>Accuracy</td><td>±100 ppm</td></tr>
</table>

Table 1.3.2-1 Sinusoidal Jitter (SJ)*[1] (Cont'd)

<table>
<tr><th>Item</th><th>Specifications</th></tr>
<tr><td>Amplitude
Setting Range</td><td>
<table>
<tr><th></th><th colspan="4">Data Pattern Generator</th></tr>
<tr><th></th><th colspan="2">Full-rate (PPG),
Full-rate (MUX)</th><th colspan="2">Half-rate (MUX)</th></tr>
<tr><th>Modulation Frequency</th><th>Setting Range (Ulp-p)</th><th>Step (UI)</th><th>Setting Range (Ulp-p)</th><th>Step (UI)</th></tr>
<tr><td>10 Hz to 1 MHz</td><td>0 to 40</td><td>0.001</td><td>0 to 50</td><td>0.002</td></tr>
<tr><td>1.001 to 10 MHz</td><td>0 to 8</td><td>0.001</td><td>0 to 10</td><td>0.002</td></tr>
<tr><td>10.01 to 250 MHz</td><td>0 to 0.5</td><td>0.001</td><td>0 to 0.55</td><td>0.002</td></tr>
</table>
<table>
<tr><th></th><th colspan="2">Data Pattern Generator</th></tr>
<tr><th></th><th colspan="2">Quarter-rate (MUX)</th></tr>
<tr><th>Modulation Frequency</th><th>Setting Range (Ulp-p)</th><th>Step (UI)</th></tr>
<tr><td>10 Hz to 1 MHz</td><td>0 to 50</td><td>0.004</td></tr>
<tr><td>1.001 to 10 MHz</td><td>0 to 10</td><td>0.004</td></tr>
<tr><td>10.01 to 250 MHz</td><td>0 to 0.548</td><td>0.004</td></tr>
</table>
</td></tr>
<tr><td>Accuracy</td><td>
<table>
<tr><th>Amplitude Settings</th><th>Accuracy</th></tr>
<tr><td>0.002 to 2.19 UIp-p</td><td>±(set amplitude×Q%)±0.03 UI</td></tr>
<tr><td>2.2 to 21.9 UIp-p</td><td>±(set amplitude×Q%)±0.2 UI</td></tr>
<tr><td>22 to 50 UIp-p</td><td>±(set amplitude×Q%)±2 UI</td></tr>
</table>
Values of Q is shown below
<table>
<tr><th>Modulation Frequency</th><th>Q</th></tr>
<tr><td>10 Hz to 500 kHz</td><td>7</td></tr>
<tr><td>500.1 kHz to 2 MHz</td><td>10</td></tr>
<tr><td>2.001 to 80 MHz</td><td>13</td></tr>
<tr><td>80.01 to 250 MHz</td><td>15</td></tr>
</table>
</td></tr>
<tr><td>Output Setting</td><td>ON/OFF switching</td></tr>
</table>

Table 1.3.2-1 Sinusoidal Jitter (SJ)*2, *3 (Cont'd)

<table>
<tr><th>Item</th><th>Specifications</th></tr>
<tr><td>Mask Setting Range

32G PPG</td><td>Data rate is 15 to 32.1 Gbit/s for full-rate clock out setting.
Data rate is 2.4 to 32.1 Gbit/s for half-rate clock out setting.
<table>
<tr><th>Modulation Frequency (MHz)</th><th>Jitter Amplitude (UIp-p)</th></tr>
<tr><td>0.00001 to 0.1</td><td>≤2000</td></tr>
<tr><td>0.1001 to 1</td><td>≤200</td></tr>
<tr><td>1.001 to 10</td><td>≤8</td></tr>
<tr><td>10.01 to 250</td><td>≤0.5</td></tr>
</table>


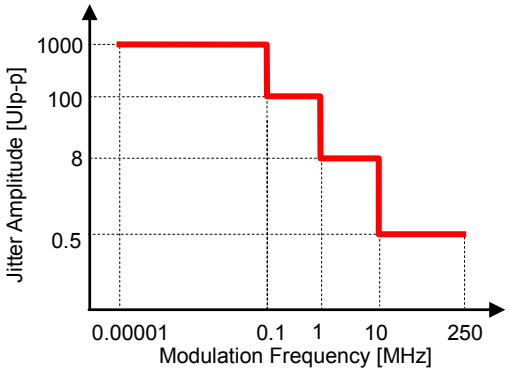
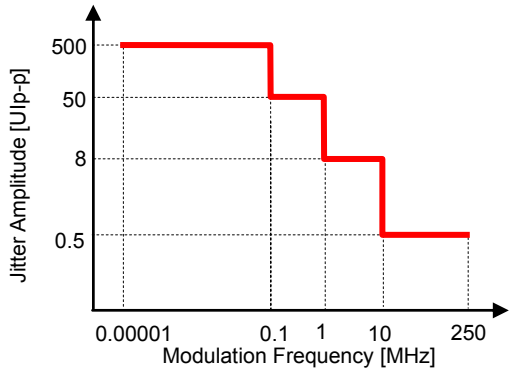
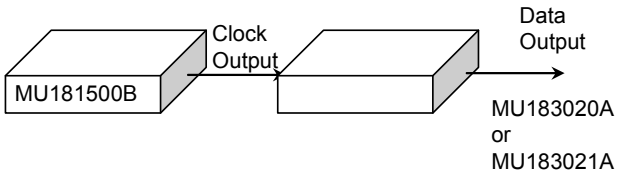
Data rate is 4 to 15 Gbit/s for full-rate clock out setting.
<table>
<tr><th>Modulation Frequency (MHz)</th><th>Jitter Amplitude (UIp-p)</th></tr>
<tr><td>0.00001 to 0.1</td><td>≤1000</td></tr>
<tr><td>0.1001 to 1</td><td>≤100</td></tr>
<tr><td>1.001 to 10</td><td>≤8</td></tr>
<tr><td>10.01 to 250</td><td>≤0.5</td></tr>
</table>

</td></tr>
</table>

Table 1.3.2-1 Sinusoidal Jitter (SJ)*2, *3 (Cont'd)

<table>
<tr><th>Item</th><th>Specifications</th></tr>
<tr><td>Mask Setting Range</td><td>Data rate is 2.4 to 4 Gbit/s for full-rate clock out setting.
<table>
<tr><th>Modulation Frequency (MHz)</th><th>Jitter Amplitude (UIp-p)</th></tr>
<tr><td>0.00001 to 0.1</td><td>≤500</td></tr>
<tr><td>0.1001 to 1</td><td>≤50</td></tr>
<tr><td>1.001 to 10</td><td>≤8</td></tr>
<tr><td>10.01 to 250</td><td>≤0.5</td></tr>
</table>

</td></tr>
</table>

*2: The performance is specified by the data output of MU183020A or MU183021A in the following figure.



*3: The range will be extended in Version 7.09.00 or any later version of MX180000A.

Table 1.3.2-1 Sinusoidal Jitter (SJ)*2, *3 (Cont'd)

<table>
<tr><th>Item</th><th>Specifications</th></tr>
<tr><td>Amplitude
Setting Range</td><td>
<table>
<tr><th rowspan="2">Modulation Frequency</th><th colspan="4">Data Pattern Generator</th></tr>
<tr><th colspan="2">32G PPG*4</th><th colspan="2">32G PPG*5</th></tr>
<tr><th></th><th>Setting Range (UIp-p)</th><th>Step (UI)</th><th>Setting Range (UIp-p)</th><th>Step (UI)</th></tr>
<tr><td>10 Hz to 1 00 kHz</td><td>0 to 1000</td><td>0.001</td><td>0 to 500</td><td>0.001</td></tr>
<tr><td>100.1 kHz to 1 MHz</td><td>0 to 100</td><td>0.001</td><td>0 to 50</td><td>0.001</td></tr>
<tr><td>1.001 to 10 MHz</td><td>0 to 8</td><td>0.001</td><td>0 to 8</td><td>0.001</td></tr>
<tr><td>10.01 to 250 MHz</td><td>0 to 0.5</td><td>0.001</td><td>0 to 0.5</td><td>0.001</td></tr>
</table>
<table>
<tr><th rowspan="2">Modulation Frequency</th><th colspan="4">Data Pattern Generator</th></tr>
<tr><th colspan="2">32G PPG*6</th><th colspan="2">32G PPG*7</th></tr>
<tr><th></th><th>Setting Range (UIp-p)</th><th>Step (UI)</th><th>Setting Range (UIp-p)</th><th>Step (UI)</th></tr>
<tr><td>10 Hz to 1 00 kHz</td><td>0 to 2000</td><td>0.002</td><td>0 to 2000</td><td>0.004</td></tr>
<tr><td>100.1 kHz to 1 MHz</td><td>0 to 200</td><td>0.002</td><td>0 to 200</td><td>0.004</td></tr>
<tr><td>1.001 to 10 MHz</td><td>0 to 16</td><td>0.002</td><td>0 to 16</td><td>0.004</td></tr>
<tr><td>10.01 to 250 MHz</td><td>0 to 1</td><td>0.002</td><td>0 to 1</td><td>0.004</td></tr>
</table>
</td></tr>
<tr><td>Accuracy</td><td>
<table>
<tr><th>Amplitude Settings</th><th>Accuracy</th></tr>
<tr><td>0.001 to 2.199 UIp-p</td><td>±(set amplitude×Q%)±0.03 UI</td></tr>
<tr><td>2.2 to 21.999 UIp-p</td><td>±(set amplitude×Q%)±0.2 UI</td></tr>
<tr><td>22 to 219.999 UIp-p</td><td>±(set amplitude×Q%)±2 UI</td></tr>
<tr><td>220 to 2000 UIp-p</td><td>±(set amplitude×Q%)±20 UI</td></tr>
</table>
Values of Q is shown below
<table>
<tr><th>Modulation Frequency</th><th>Q</th></tr>
<tr><td>10 Hz to 500 kHz</td><td>7</td></tr>
<tr><td>500.1 kHz to 2 MHz</td><td>10</td></tr>
<tr><td>2.001 to 80 MHz</td><td>13</td></tr>
<tr><td>80.01 to 250 MHz</td><td>15</td></tr>
</table>
</td></tr>
<tr><td>Output Setting</td><td>ON/OFF switching</td></tr>
</table>

*4: This applies when the data rate is 4 to 15 Gbit/s for full-rate clock out setting.

*5: This applies when the data rate is 2.4 to 4 Gbit/s for full-rate clock out setting.

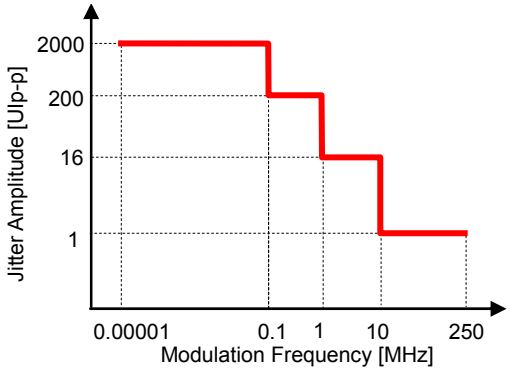
*6: This applies when the data rate is 15 to 30 Gbit/s for full-rate clock out setting or 2.4 to 30 Gbit/s for half-rate clock out setting.

*7: This applies when the data rate is 30 to 32.1 Gbit/s for full-rate clock out or half-rate clock out setting.

Table 1.3.2-1 Sinusoidal Jitter (SJ) *8, *9 (Cont'd)

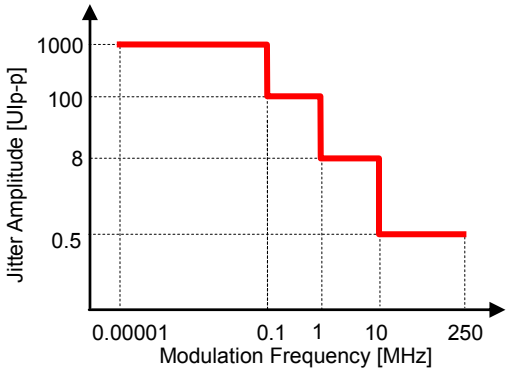
Item	Specifications
Mask Setting Range 64G MUX*8, *9	Data rate of MP1861A: 30 to 64 Gbit/s

Modulation Frequency (MHz)	Jitter Amplitude (Ulp-p)
0.00001 to 0.1	≤2000
0.1001 to 1	≤200
1.001 to 10	≤16
10.01 to 250	≤1.0

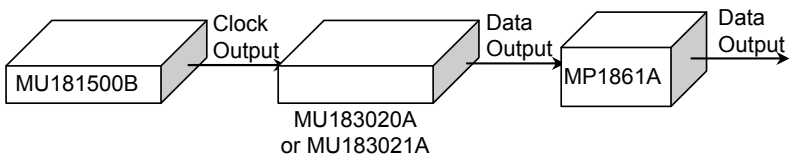


Data rate of MP1861A: 8 to 30 Gbit/s

Modulation Frequency (MHz)	Jitter Amplitude (Ulp-p)
0.00001 to 0.1	≤1000
0.1001 to 1	≤100
1.001 to 10	≤8
10.01 to 250	≤0.5



*8: The performance is specified by the data output of MP1861A in the following figure.



*9: The MP1861A 64G MUX is supported by version 8.00.00 or later of MX180000A.

Table 1.3.2-1 Sinusoidal Jitter (SJ) *8, *9 (Cont'd)

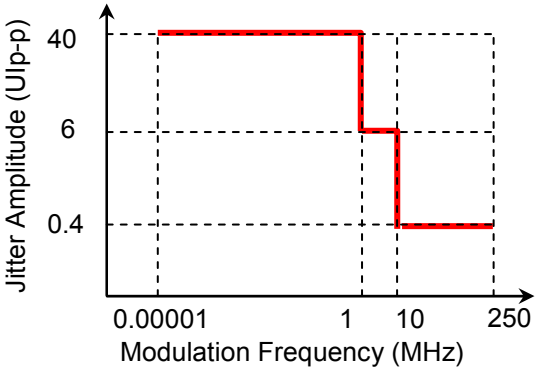
<table>
<tr><th>Item</th><th>Specifications</th></tr>
<tr><td>Amplitude
Setting Range</td><td>
<table>
<tr><th rowspan="3">Modulation Frequency</th><th colspan="4">Data Pattern Generator</th></tr>
<tr><th colspan="2">64G MUX*10</th><th colspan="2">64G MUX*11</th></tr>
<tr><th>Setting Range (UIp-p)</th><th>Step (UI)</th><th>Setting Range (UIp-p)</th><th>Step (UI)</th></tr>
<tr><td>10 Hz to 1 00 kHz</td><td>0 to 1000</td><td>0.002</td><td>0 to 2000</td><td>0.004</td></tr>
<tr><td>100.1 kHz to 1 MHz</td><td>0 to 100</td><td>0.002</td><td>0 to 200</td><td>0.004</td></tr>
<tr><td>1.001 to 10 MHz</td><td>0 to 8</td><td>0.002</td><td>0 to 16</td><td>0.004</td></tr>
<tr><td>10.01 to 250 MHz</td><td>0 to 0.5</td><td>0.002</td><td>0 to 1</td><td>0.004</td></tr>
</table>
<table>
<tr><th rowspan="2">Modulation Frequency</th><th colspan="2">Data Pattern Generator</th></tr>
<tr><th colspan="2">32G PPG*12</th></tr>
<tr><th>Setting Range (UIp-p)</th><th>Step (UI)</th></tr>
<tr><td>10 Hz to 1 00 kHz</td><td>0 to 2000</td><td>0.008</td></tr>
<tr><td>100.1 kHz to 1 MHz</td><td>0 to 200</td><td>0.008</td></tr>
<tr><td>1.001 to 10 MHz</td><td>0 to 16</td><td>0.008</td></tr>
<tr><td>10.01 to 250 MHz</td><td>0 to 1</td><td>0.008</td></tr>
</table>
Accuracy
<table>
<tr><th>Amplitude Settings</th><th>Accuracy</th></tr>
<tr><td>0.001 to 2.199 UIp-p</td><td>±(set amplitude×Q%)±0.03 UI</td></tr>
<tr><td>2.2 to 21.999 UIp-p</td><td>±(set amplitude×Q%)±0.2 UI</td></tr>
<tr><td>22 to 219.999 UIp-p</td><td>±(set amplitude×Q%)±2 UI</td></tr>
<tr><td>220 to 2000 UIp-p</td><td>±(set amplitude×Q%)±20 UI</td></tr>
</table>
Values of Q is shown below
<table>
<tr><th>Modulation Frequency</th><th>Q</th></tr>
<tr><td>10 Hz to 500 kHz</td><td>7</td></tr>
<tr><td>500.1 kHz to 2 MHz</td><td>10</td></tr>
<tr><td>2.001 to 80 MHz</td><td>13</td></tr>
<tr><td>80.01 to 250 MHz</td><td>15</td></tr>
</table>
</td></tr>
<tr><td>Output Setting</td><td>ON/OFF switching</td></tr>
</table>

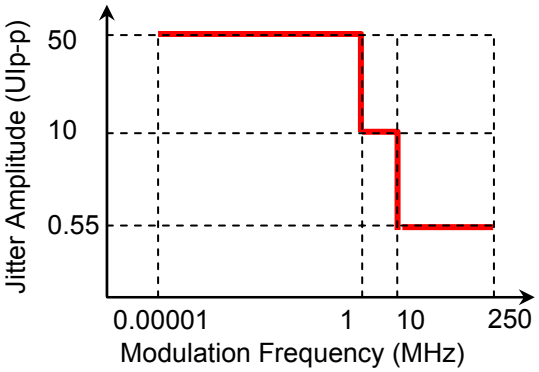
*10: This applies when the data rate of MP1861A is 8 to 30 Gbit/s.

*11: This applies when the data rate of MP1861A is 30 to 60 Gbit/s.

*12: This applies when the data rate of MP1861A is 60 to 64.2 Gbit/s.

Table 1.3.2-2 Sinusoidal Jitter (SJ2)*1

<table>
<tr><th>Item</th><th>Specifications</th></tr>
<tr><td>Mask Setting Range
Full-rate (PPG)
Full-rate (MUX)
32G PPG
64G MUX</td><td>
<table>
<tr><th>Modulation Frequency (MHz)</th><th>Jitter Amplitude (UIp-p)</th></tr>
<tr><td>0.00001 to 1</td><td>≤40</td></tr>
<tr><td>1.001 to 10</td><td>≤6</td></tr>
<tr><td>10.01 to 250</td><td>≤0.4</td></tr>
</table>


</td></tr>
<tr><td>Half-rate (MUX)
Quarter-rate (MUX)
32G PPG
64G MUX</td><td>
<table>
<tr><th>Modulation Frequency (MHz)</th><th>Jitter Amplitude (UIp-p)</th></tr>
<tr><td>0.00001 to 1</td><td>≤50</td></tr>
<tr><td>1.001 to 10</td><td>≤10</td></tr>
<tr><td>10.01 to 250</td><td>≤0.55</td></tr>
</table>


</td></tr>
</table>

*1: Specified as data output of MU182020A or MU182021A in following diagram, 8 to 28 Gbit/s

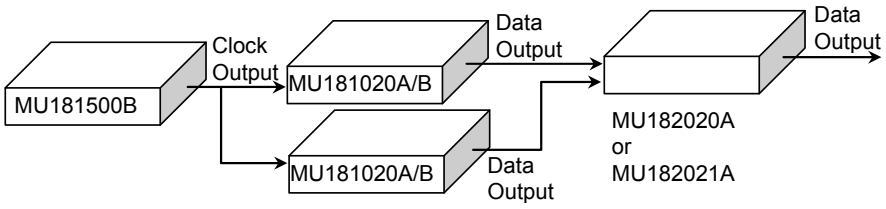


Table 1.3.2-2 Sinusoidal Jitter (SJ2)*1 (Cont'd)

<table>
<tr><th>Item</th><th>Specifications</th></tr>
<tr><td>Modulation Frequency
Setting Range</td><td>
<table>
<tr><th>Setting Range</th><th>Step</th></tr>
<tr><td>10 Hz to 10 kHz</td><td>1 Hz</td></tr>
<tr><td>10 to 100 kHz</td><td>10 Hz</td></tr>
<tr><td>100 kHz to 1 MHz</td><td>100 Hz</td></tr>
<tr><td>1 to 10 MHz</td><td>1 kHz</td></tr>
<tr><td>10 to 100 MHz</td><td>10 kHz</td></tr>
<tr><td>100 to 250 MHz</td><td>100 kHz</td></tr>
</table>
</td></tr>
<tr><td>Bandwidth</td><td>
<table>
<tr><th>Clock Frequency</th><th>Bandwidth</th></tr>
<tr><td>0.8 < Fc ≤ 1.5625 GHz</td><td>10 Hz to 10 MHz</td></tr>
<tr><td>1.6 < Fc ≤ 1.8 GHz</td><td>10 Hz to 100 MHz</td></tr>
<tr><td>1.8 < Fc ≤ 6.25 GHz</td><td>10 Hz to 200 MHz</td></tr>
<tr><td>6.4 < Fc ≤ 15 GHz</td><td>10 Hz to 250 MHz</td></tr>
</table>
</td></tr>
<tr><td>Accuracy</td><td>±100 ppm</td></tr>
<tr><td>Amplitude
Setting Range
Data Pattern Generator:
Full-rate (PPG)
Full-rate (MUX)
32G PPG*2</td><td>
<table>
<tr><th></th><th colspan="4">Jitter amplitude (Ulp-p)/Step (UI)</th></tr>
<tr><th>Jitter Clock Frequency
Modulation Frequency (MHz)</th><th>6.400001 to 15 GHz</th><th>3.200001 to 6.25 GHz</th><th>1.600001 to 3.125 GHz</th><th>0.800001 to 1.5625 GHz</th></tr>
<tr><td>0.00001 to 1</td><td>0 to 40/ 0.001</td><td>0 to 20/ 0.001</td><td>0 to 10/ 0.001</td><td>0 to 5/ 0.001</td></tr>
<tr><td>1.001 to 10</td><td>0 to 6/ 0.001</td><td>0 to 3/ 0.001</td><td>0 to 1.5/ 0.001</td><td>0 to 0.75/ 0.001</td></tr>
<tr><td>10.01 to 250</td><td>0 to 0.4/ 0.001</td><td>0 to 0.2/ 0.001</td><td>0 to 0.1/ 0.001</td><td></td></tr>
</table>
</td></tr>
</table>

*2: When the data rate is 2.4 to 15 Gbit/s for full-rate clock out setting.

Table 1.3.2-2 Sinusoidal Jitter (SJ2)*1 (Cont'd)

<table>
<tr><th>Item</th><th>Specifications</th></tr>
<tr><td>Amplitude(Cont'd)
Setting Range
Data Pattern Generator:
Half-rate (MUX)
32G PPG*3
64G MUX*5</td><td>
<table>
<tr><th></th><th colspan="4">Jitter amplitude (UIp-p)/Step (UI)</th></tr>
<tr><th>Jitter Clock Frequency
Modulation Frequency (MHz)</th><th>6.400001 to 15 GHz</th><th>3.200001 to 6.25 GHz</th><th>1.600001 to 3.125 GHz</th><th>0.800001 to 1.5625 GHz</th></tr>
<tr><td>0.00001 to 1</td><td>0 to 50/ 0.002</td><td>0 to 50/ 0.002</td><td>0 to 25/ 0.002</td><td>0 to 12.4/ 0.002</td></tr>
<tr><td>1.001 to 10</td><td>0 to 10/ 0.002</td><td>0 to 10/ 0.002</td><td>0 to 5/ 0.002</td><td>0 to 2.5/ 0.002</td></tr>
<tr><td>10.01 to 250</td><td>0 to 0.55/ 0.002</td><td>0 to 0.4/ 0.002</td><td>0 to 0.2/ 0.002</td><td></td></tr>
</table>
</td></tr>
<tr><td>Data Pattern Generator:
Quarter-rate (MUX)
32G PPG*4
64G MUX*6</td><td>
<table>
<tr><th></th><th colspan="4">Jitter amplitude (UIp-p)/Step (UI)</th></tr>
<tr><th>Jitter Clock Frequency
Modulation Frequency (MHz)</th><th>6.400001 to 15 GHz</th><th>3.200001 to 6.25 GHz</th><th>1.600001 to 3.125 GHz</th><th>0.800001 to 1.5625 GHz</th></tr>
<tr><td>0.00001 to 1</td><td>0 to 50/ 0.004</td><td>0 to 50/ 0.004</td><td>0 to 24.8/ 0.004</td><td>0 to 12.4/ 0.004</td></tr>
<tr><td>1.001 to 10</td><td>0 to 10/ 0.004</td><td>0 to 10/ 0.004</td><td>0 to 5/ 0.004</td><td>0 to 2.48/ 0.004</td></tr>
<tr><td>10.01 to 250</td><td>0 to 0.548/ 0.004</td><td>0 to 0.4/ 0.004</td><td>0 to 0.2/ 0.004</td><td></td></tr>
</table>
</td></tr>
</table>

*3: When the data rate is 15 to 30 Gbit/s for full-rate clock out setting or 2.4 to 30 Gbit/s for half-rate clock out setting.

*4: When the data rate is 30 to 32.1 Gbit/s for full-rate clock out or half-rate clock out setting.

*5: This applies when the data rate of MP1861A is 8 to 30 Gbit/s.

*6: This applies when the data rate of MP1861A is 30 to 60 Gbit/s.

*7: This applies when the data rate of MP1861A is 60 to 64.2 Gbit/s.

Table 1.3.2-2 Sinusoidal Jitter (SJ2)*1 (Cont'd)

<table>
<tr><th>Item</th><th>Specifications</th></tr>
<tr><td>Amplitude (Cont'd)
Setting Range
Data Pattern Generator:
64G MUX*7</td><td>
<table>
<tr><th rowspan="2">Jitter Clock Frequency
Modulation Frequency (MHz)</th><th colspan="4">Jitter amplitude (UIp-p)/Step (UI)</th></tr>
<tr><th>6.400001 to 15 GHz</th><th></th><th></th><th></th></tr>
<tr><td>0.00001 to 1</td><td>0 to 50/ 0.008</td><td></td><td></td><td></td></tr>
<tr><td>1.001 to 10</td><td>0 to 10/ 0.008</td><td></td><td></td><td></td></tr>
<tr><td>10.01 to 250</td><td>0 to 0.544/ 0.008</td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Accuracy*8</td><td>
<table>
<tr><th>Amplitude Settings</th><th>Accuracy</th></tr>
<tr><td>0.002 to 2.19 UIp-p</td><td>±(set amplitude×Q%)±0.03 UI</td></tr>
<tr><td>2.2 to 21.9 UIp-p</td><td>±(set amplitude×Q%)±0.2 UI</td></tr>
<tr><td>22 to 50 UIp-p</td><td>±(set amplitude×Q%)±2 UI</td></tr>
</table>
Values of Q is shown below
<table>
<tr><th>Modulation Frequency</th><th>Q</th></tr>
<tr><td>10 Hz to 500 kHz</td><td>10</td></tr>
<tr><td>500.1 kHz to 2 MHz</td><td>13</td></tr>
<tr><td>2.001 to 80 MHz</td><td>15</td></tr>
<tr><td>80.01 to 250 MHz</td><td>18</td></tr>
</table>
</td></tr>
<tr><td>Output Setting</td><td>ON/OFF switching</td></tr>
</table>

*7: This applies when the data rate of MP1861A is 60 to 64.2 Gbit/s.

*8: This is the accuracy used in conjunction with calibrated MU181000A/B with Option x80.

Table 1.3.2-3 Random Jitter (RJ)*1

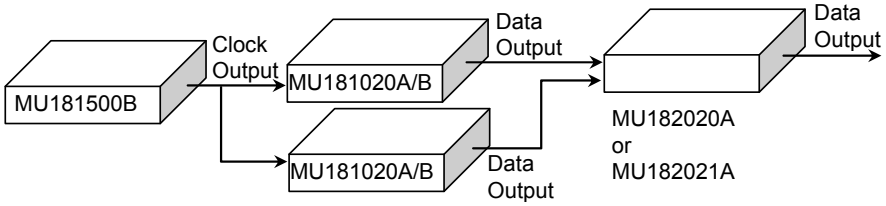
<table>
<tr><th>Item</th><th>Specifications</th></tr>
<tr><td>Bandwidth
Crest Factor
Filter
User Filter
3 dB Bandwidth

Amplitude
Setting Range</td><td>10 kHz to 1 GHz
16 dB
User, PCIe (Data clocked), PCIe (Common Ref. clock)

HPF: Through, 10 MHz, 20 MHz
LPF: Through, 100 MHz

<table>
<tr><th></th><th colspan="4">Data Pattern Generator</th></tr>
<tr><th></th><th colspan="2">Full-rate (PPG), Full-rate (MUX), 32G PPG*2</th><th colspan="2">Half-rate (MUX), 32G PPG*3, 64G MUX*5</th></tr>
<tr><th>Jitter Clock Frequency</th><th>Setting Range (Ulp-p)</th><th>Step (mUI)</th><th>Setting Range (Ulp-p)</th><th>Step (mUI)</th></tr>
<tr><td>≥2.5 GHz</td><td>0 to 0.5</td><td>2</td><td>0 to 0.5</td><td>4</td></tr>
<tr><td><2.5 GHz</td><td>0 to 0.2f</td><td>2</td><td>0 to 0.2f</td><td>4</td></tr>
</table>
<table>
<tr><th></th><th colspan="4">Data Pattern Generator</th></tr>
<tr><th></th><th colspan="2">Quarter-rate (MUX), 32G PPG*4, 64G MUX*6</th><th colspan="2">64G MUX*7</th></tr>
<tr><th>Jitter Clock Frequency</th><th>Setting Range (Ulp-p)</th><th>Step (mUI)</th><th>Setting Range (Ulp-p)</th><th>Step (mUI)</th></tr>
<tr><td>≥2.5 GHz</td><td>0 to 0.496</td><td>8</td><td>0 to 0.496</td><td>16</td></tr>
<tr><td><2.5 GHz</td><td>0 to 0.2f</td><td>8</td><td>0 to 0.2f</td><td>16</td></tr>
</table>
f: Jitter Clock Output Frequency (GHz)</td></tr>
</table>

*1: Specified as data output of MU182020A or MU182021A in following diagram, 8 to 28 Gbit/s



*2: When the data rate is 2.4 to 15 Gbit/s for full-rate clock out setting.

*3: When the data rate is 15 to 30 Gbit/s for full-rate clock out setting or 2.4 to 30 Gbit/s for half-rate clock out setting.

*4: When the data rate is 30 to 32.1 Gbit/s for full-rate clock out or half-rate clock out setting.

*5: This applies when the data rate of MP1861A is 8 to 30 Gbit/s.

*6: This applies when the data rate of MP1861A is 30 to 60 Gbit/s.

*7: This applies when the data rate of MP1861A is 60 to 64.2 Gbit/s.

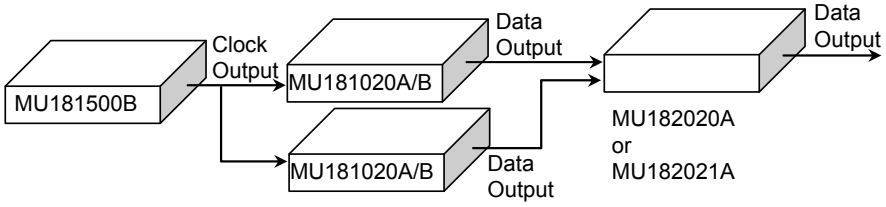
Table 1.3.2-3 Random Jitter (RJ)*1 (Cont'd)

<table>
<tr><th>Item</th><th>Specifications</th></tr>
<tr><td>Accuracy</td><td>Jitter Clock Output Frequency ≥4 GHz:±(set amplitude×15%)±4.9 ps
Jitter Clock Output Frequency <4 GHz:±(set amplitude×15%)±7 ps</td></tr>
<tr><td>PCIe Filter
User settings</td><td></td></tr>
<tr><td>BPF Bandwidth</td><td>LF (10 to 1500 kHz), or HF (1.5 to 100 MHz)</td></tr>
<tr><td>Amplitude
Setting Range</td><td>Jitter clock output frequency ≥ 4 GHz, LF Amplitude ≥ HF Amplitude
<table>
<tr><th colspan="4">Data Pattern Generator</th></tr>
<tr><th colspan="2">Full-rate(PPG), Full-rate(MUX), 32G PPG*2</th><th colspan="2">Half-rate(MUX), 32G PPG*3, 64G PPG*5</th></tr>
<tr><th>Setting Range (ps rms)</th><th>Step (ps rms)</th><th>Setting Range (ps rms)</th><th>Step (ps rms)</th></tr>
<tr><td>0 to 8.8</td><td>0.1</td><td>0 to 8.8</td><td>0.2</td></tr>
</table>
<table>
<tr><th colspan="4">Data Pattern Generator</th></tr>
<tr><th colspan="2">Quarter-rate (MUX), 32G PPG*4, 64G PPG*6</th><th colspan="2">64G MUX*7</th></tr>
<tr><th>Setting Range (ps rms)</th><th>Step (ps rms)</th><th>Setting Range (ps rms)</th><th>Step (ps rms)</th></tr>
<tr><td>0 to 8.8</td><td>0.4</td><td>0 to 8.8</td><td>0.8</td></tr>
</table></td></tr>
<tr><td>Accuracy</td><td>± (set amplitude × 10%) ± 0.6 ps</td></tr>
<tr><td>Output Setting</td><td>ON/OFF switching</td></tr>
</table>

Table 1.3.2-4 Bounded Uncorrelated Jitter (BUJ)*1

<table>
<tr><th>Item</th><th>Specifications</th></tr>
<tr><td>PRBS Pattern Length</td><td>2^n-1 (n=7, 9, 11, 15, 23, 31)</td></tr>
<tr><td>BUJ rate
Setting Range</td><td>
<table>
<tr><th>Bitrate (Gbit/s)</th><th>Step (kbit/s)</th></tr>
<tr><td>0.1 to 3.2</td><td>1</td></tr>
<tr><td>4.9 to 6.25*2</td><td>1</td></tr>
<tr><td>9.8 to 12.5*2</td><td>1</td></tr>
</table>
</td></tr>
<tr><td>LPF Bandwidth *3</td><td>Through, 500 MHz*2, 300 MHz, 200 MHz, 100 MHz, 50 MHz</td></tr>
<tr><td>Amplitude
Setting Range</td><td>
<table>
<tr><th></th><th colspan="4">Data Pattern Generator</th></tr>
<tr><th></th><th colspan="2">Full-rate (PPG), Full-rate (MUX), 32G PPG*4</th><th colspan="2">Half-rate (MUX), 32G PPG*5, 64 MUX*6</th></tr>
<tr><th>Jitter Clock Output Frequency</th><th>Setting Range (Ulp-p)</th><th>Step (mUI)</th><th>Setting Range (Ulp-p)</th><th>Step (mUI)</th></tr>
<tr><td>≥2.5 GHz</td><td>0 to 0.5</td><td>2</td><td>0 to 0.5</td><td>4</td></tr>
<tr><td><2.5 GHz</td><td>0 to 0.2f</td><td>2</td><td>0 to 0.2f</td><td>4</td></tr>
</table>
<table>
<tr><th></th><th colspan="4">Data Pattern Generator</th></tr>
<tr><th></th><th colspan="2">Quarter -rate(MUX), 32G PPG*7 64 MUX*8</th><th colspan="2">64G MUX*9</th></tr>
<tr><th>Jitter Clock Output Frequency</th><th>Setting Range (Ulp-p)</th><th>Step (mUI)</th><th>Setting Range (Ulp-p)</th><th>Step (mUI)</th></tr>
<tr><td>≥2.5 GHz</td><td>0 to 0.5</td><td>8</td><td>0 to 0.5</td><td>16</td></tr>
<tr><td><2.5 GHz</td><td>0 to 0.2f</td><td>8</td><td>0 to 0.2f</td><td>16</td></tr>
</table>
f: Jitter Clock Output Frequency (GHz)
</td></tr>
<tr><td>Accuracy *10</td><td>Jitter clock output frequency ≥ 4 GHz: ±(set amplitude × 15%) ± 4.9 ps
Jitter clock output frequency < 4 GHz: ±(set amplitude × 15%) ± 7 ps</td></tr>
<tr><td>Output Setting</td><td>ON/OFF switching</td></tr>
</table>

*1: Specified as data output of MU182020A or MU182021A in following diagram, 8 to 28 Gbit/s



*2: Jitter clock output frequency exceeds 4 GHz

*3: 3 dB Bandwidth

*4: When the data rate is 2.4 to 15 Gbit/s for full-rate clock out setting.

*5: When the data rate is 15 to 30 Gbit/s for full-rate clock out setting or 2.4 to 30 Gbit/s for half-rate clock out setting.

*6: This applies when the data rate of MP1861A is 8 to 30 Gbit/s.

*7: When the data rate is 30 to 32.1 Gbit/s for full-rate clock out or half-rate clock out setting.

*8: This applies when the data rate of MP1861A is 30 to 60 Gbit/s.

*9: This applies when the data rate of MP1861A is 60 to 64.2 Gbit/s.

*10: Specified as PRBS pattern length 2^7-1 or 2^9-1, and BUJ Rate and LPF shown below

BUJ Rate (Gbit/s)	LPF Bandwidth
4.9, 5.5, 6	500 MHz
3, 3.2	300 MHz
2, 3.2	200 MHz
1.1, 2	100 MHz

Table 1.3.2-5 External Jitter

Item	Specifications
Bandwidth	10 kHz to 1 GHz*1
Accuracy	±0.5 UI ±10%*1,*2
Linearity	± (set value × 10%) ± 6 ps*1
Output Setting	ON/OFF switching

*1: Specified as 5-GHz jitter clock output frequency and sine wave with 0.5-GHz input jitter

*2: Input amplitude 2 Vp-p

Table 1.3.2-6 Spread Spectrum Clock (SSC)

Item	Specifications
Spread Method	Down-Spread, Up-Spread, Center-Spread
Modulation Frequency	
Setting Range	28 to 37 kHz, 1 Hz step*
Accuracy	±100 ppm
Modulation Deviation	0 to 5300 ppm, 1 ppm step*

*: The range will be extended in Version 7.09.00 or any later version of MX180000A.

1.3.3 General Performance

Table 1.3.3-1 General Performance

Item		Specifications
Dimensions		234 mm (W) × 42 mm (H) × 175 mm (D) (for Compact-PCI 2 Slot and excluding protrusions)
Mass		5.0 kg or less
Operating Environment	Operating Temperature	+15 to +35°C (ambient temperature around equipment when installed in MP1800A or MT1810A)
	Storage Temperature	–20 to +60°C

Chapter 2 Before Use

This chapter explains the following items:

- Installation to Signal Quality Analyzer
- Names and operations of panel parts
- How to Operate Application

2.1 Installation to Signal Quality Analyzer

Refer to Section 2.3 "Installing and Removing Modules" in the *Signal Quality Analyzer Installation Guide* for how to install the module in the main frame and the power-on procedure.
Refer to the plug-in module release notes for the installation slot position.
Local sales regions can access information about the MP1800 Series Signal Quality Analyzer series from the Anritsu home page (http://www.anritsu.com).

⚠ CAUTION

Install the same unit as the MU181000A/B Synthesizer Module in this unit.

2.2 Explanation of Panels

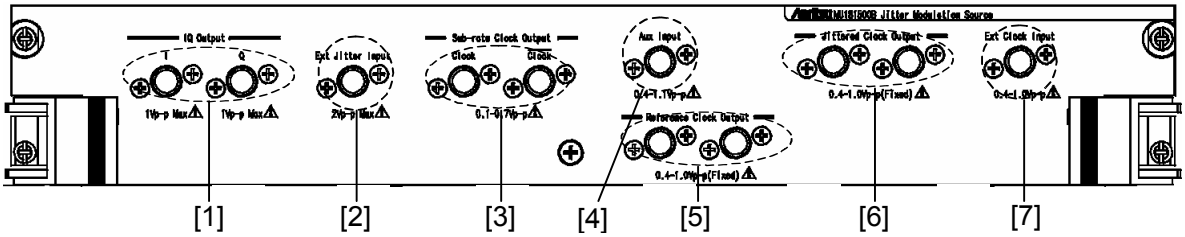


Figure 2.2-1 MU181500B panel

Table 2.2-1 Name and Function of MU181500B Panel Parts

No.	Name	Description
[1]	IQ Output Connector	Outputs IQ data. Sine wave jitter (SJ2) can be added to the system clock by connecting to the IQ input of the MU18100A/B.
[2]	Ext Jitter Input Connector	For inputting jitter modulation signal. Different modulations can be applied to this input signal.
[3]	Sub rate Clock Output Connector	Outputs 1/8 to 1/256 frequency divided clock input for clock input to either of following two connectors. Always connect the coaxial terminator accessory (J1137) to connectors without clock input. • Ext Clock Input Connector • Aux Input Connector When an unmodulated clock is input, a divided unmodulated clock is output at this connector.
[4]	Aux Input Connector	Inputs Clock signal.
[5]	Reference Clock Output Connector	Outputs 1/1, 1/1. or 1/64 divided signal for either of following input clocks. • Ext Clock Input Connector • Aux Input Connector When an unmodulated clock is input, a divided unmodulated clock is output at this connector.
[6]	Jittered Clock Output Connector	Outputs jitter-modulated clock signal
[7]	Ext Clock Input Connector	Outputs external Clock signal. This clock signal is jitter modulated and output from the Jittered Clock Output connector.

2.3 How to Operate Application

The modules connected to the Signal Quality Analyzer are controlled by operating the MX180000A Signal Quality Analyzer Control Software (hereinafter, referred to as "MX180000A").

For information on how to start up, shut down, and operate the MX180000A, refer to the *MX180000A Signal Quality Analyzer Control Software Operation Manual*.

2.4 Preventing Damage

Always observe the ratings when connecting to the input and output connectors of the MU181500B.
If an out-of-range signal is input, the MU181500B may be damaged.

⚠ CAUTION

- **When signals are input to the MU181500B, avoid voltages exceeding the ratings. Otherwise, the circuits may be damaged.**
- **When output is used at the 50 Ω/GND terminator, never feed any current or input signals to the output.**
- **As a countermeasure against static electricity, ground other devices to be connected (including experimental circuits) with ground wires before connecting the I/O connector.**
- **The outer conductor and core of the coaxial cable may become charged as a capacitor. Use any metal to discharge the outer conductor and core before use.**
- **Never open the MU181500B. If you open it and the MU181500B has failed or sufficient performance cannot be obtained, we may decline to repair the MU181500B.**
- **The MU181500B has many important circuits and parts including hybrid ICs. These parts are extremely sensitive to static electric charges, so never open the case of the MU181500B.**
- **The MMICs used in the MU181500B are sealed in airtight containers; never open them. If you open the MU181500B and it has failed or sufficient performance cannot be obtained, we may decline to repair the MU181500B.**

Chapter 3 Setting Jitter

This chapter explains the composition of the screens and the operation method.

3.1 Setting Procedure

The basic setting procedure is shown below.

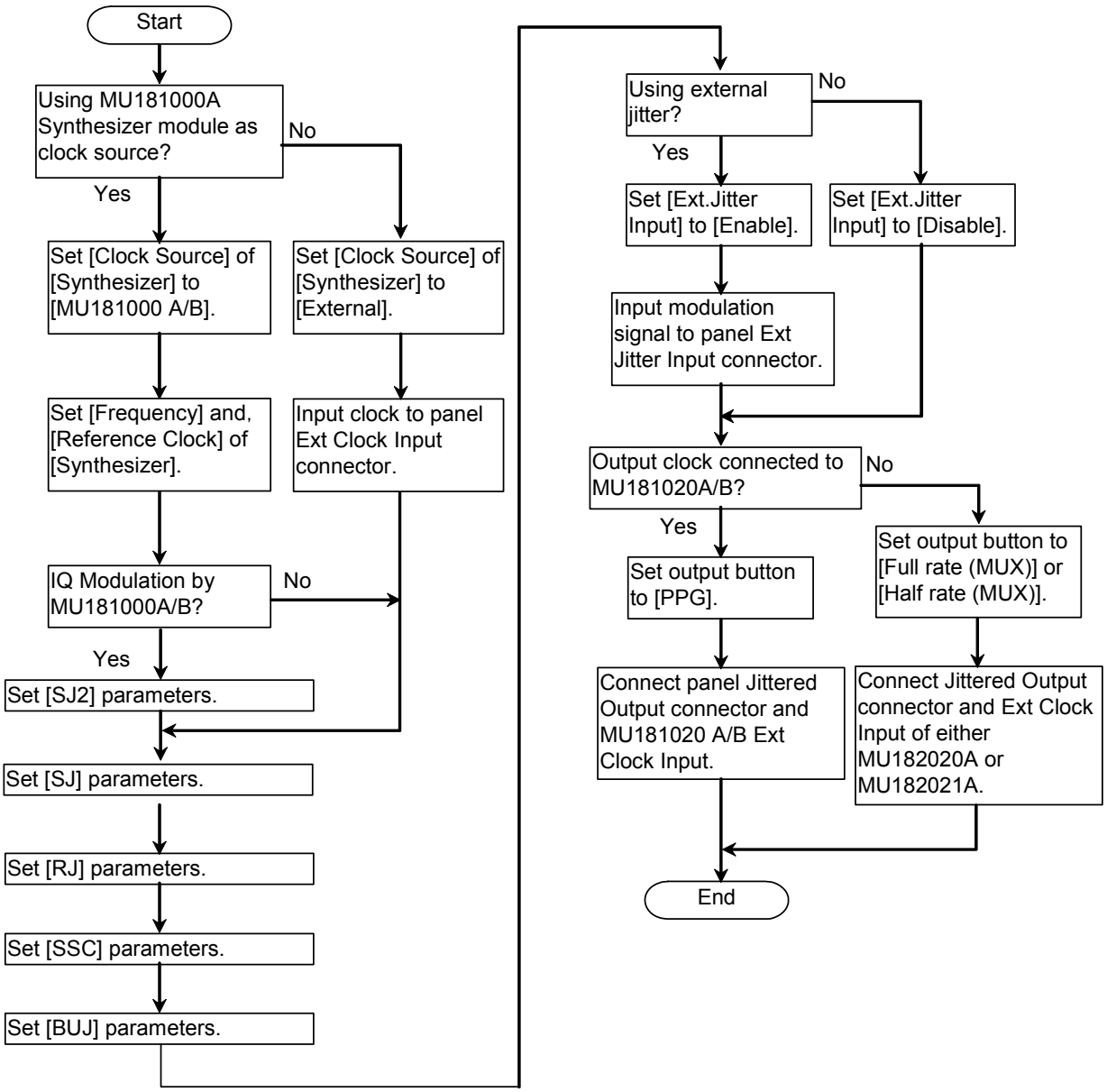


Figure 3.1-1 Jitter Modulation Source Basic Setting Procedure

3.2 Composition of Screens

3.2.1 Overall Composition of Screen

MU181500B screens have the following overall composition.

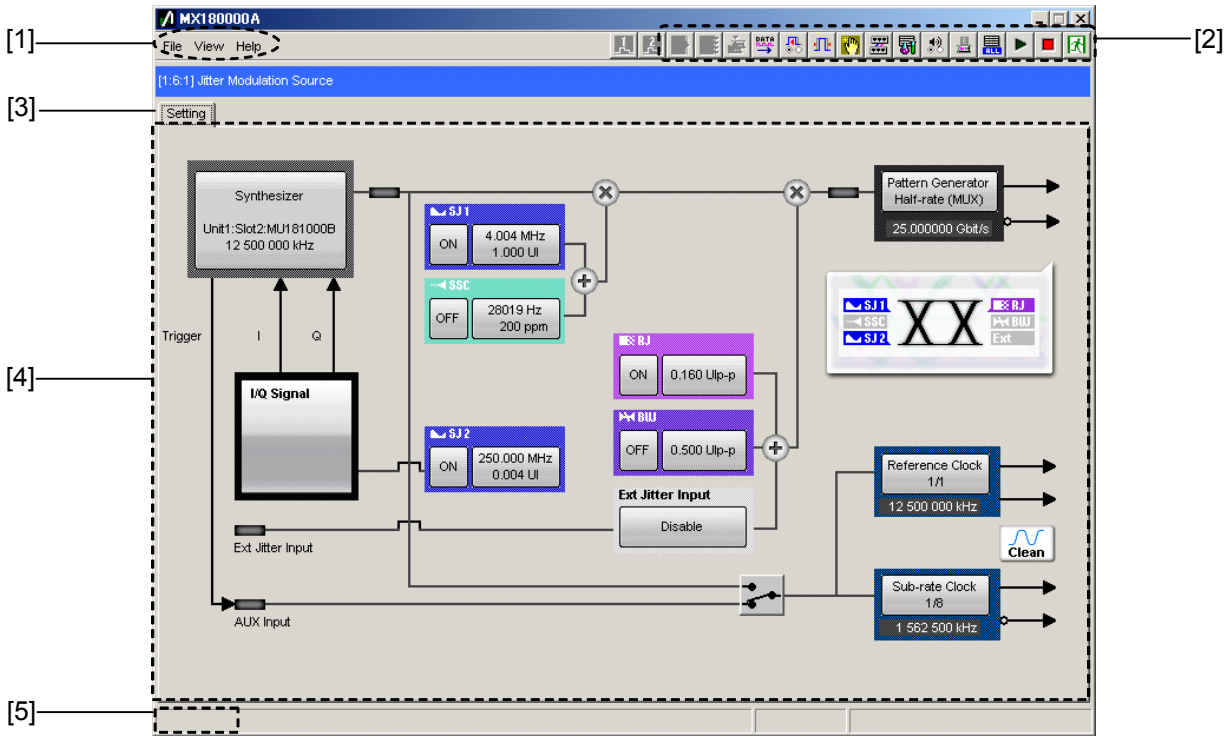


Figure 3.2.1-1 Overall Screen Composition

The MU181500B screens are composed of the four basic blocks shown in Figure 3.2.1-1. Table 3.2.1-1 explains each block.

Table 3.2.1-1 Screen Block Functions

No.	Block Name	Function
[1]	Menu bar	For selecting settings related to overall MU181500B
[2]	Module function buttons	Shortcut buttons to displayed unit functions Up to 17 functions can be selected by user customization of predefined function buttons.
[3]	Function setting selection tab	Switches module setting screen to each function item
[4]	Operation screen	Performs module settings
[5]	Tree view call area	Calls the Tree View screen by moving the cursor over this area.

3.2.2 MP181500B Control Screens

The MU181500B Control screens are shown in Figure 3.2.2-1.
When the MP181500B screen hides screens of other modules, press the slot key or Tree View to display the screen to the fore.

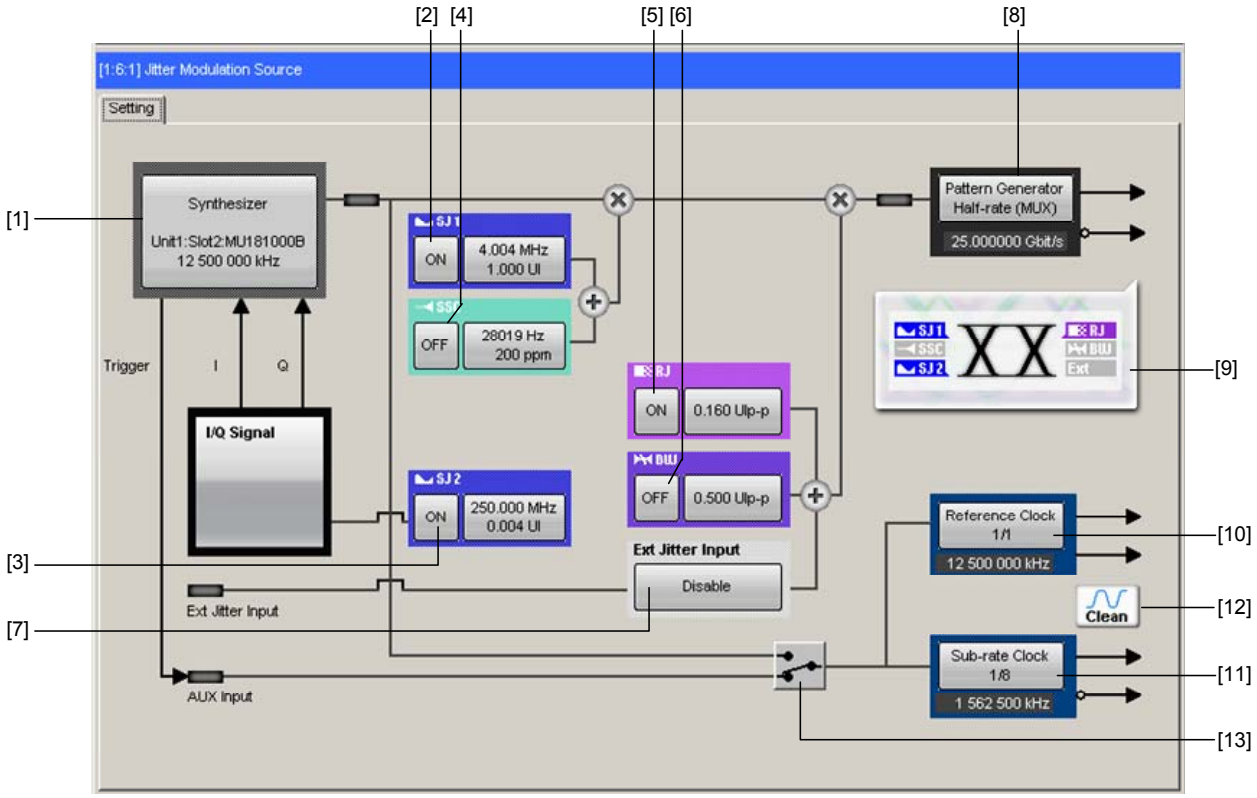


Figure 3.2.2-1 MU181500B Control Screens

Table 3.2.2-1 Composition of MP181500B Screen

No.	Name	Function
[1]	Synthesizer	Sets jitter modulation clock source
[2]	SJ	Sets sinusoidal jitter On/Off.
[3]	SJ2	Sets sine wave signal used for MU181000A/B external jitter modulation On/Off. This can be used when the clock source is the MU181000A/B-x01.
[4]	SSC	Sets spectrum spread clock On/Off
[5]	RJ	Sets random jitter On/Off
[6]	BUJ	Sets bounded uncorrelated jitter On/Off.
[7]	Ext. Jitter Input	Sets signal input to Ext. Jitter Input connector On/Off.
[8]	Data Output	Sets units connected to Jittered Clock Output connector.
[9]	Data output image	Displays applied jitter type as icon.
[10]	Reference Clock	Sets division rate of clock output at Reference Clock connector.
[11]	Sub Rate Clock	Sets division rate of clock output at Sub Rate Clock connector.
[12]	Clock icon	Displays output waveform status.
[13]	AUX switch button	Switches auxiliary clock input signal.

3.3 Input Signal Settings

Set the jitter modulation clock source.

This module can use two types of clock source.

- MU181000A/B Modulation Synthesizer output clock
- Clock input to Ext. Clock Input connector

Items such as the MU181000A/B Frequency Synthesizer frequency and reference clock are set from the MU181500B. Items cannot be set from the MU181000A/B Frequency Synthesizer screen.

When Option x01 is added to the MU181000A/B Frequency Synthesizer, the jitter waveform calibrated in combination with the main frame as well as the synthesizer module name and serial number are displayed on this screen.

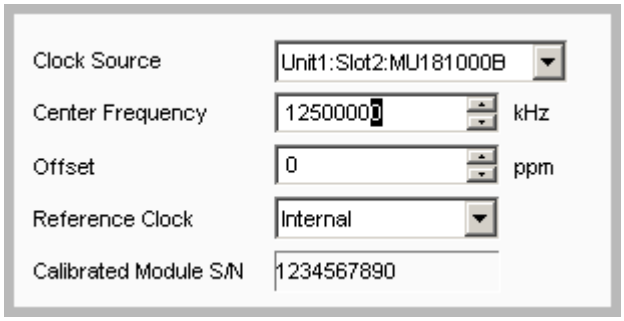


Figure 3.3-1 Synthesizer Settings (MU181000B)

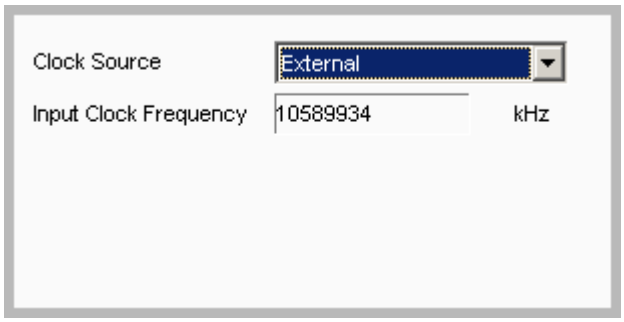


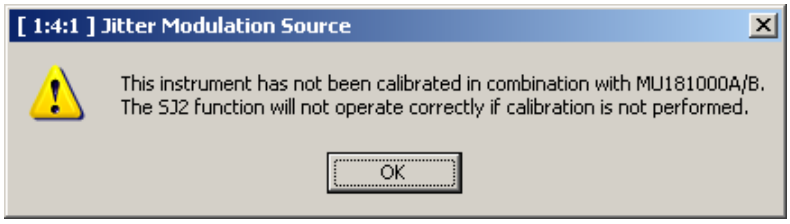
Figure 3.3-2 Synthesizer Settings (External)

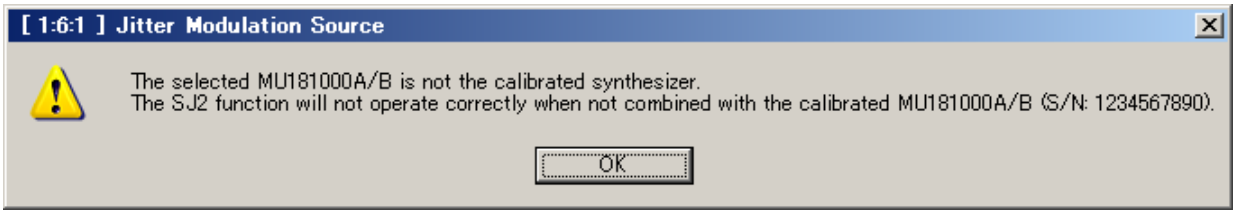
Table 3.3-1 Synthesizer Screen

Item	Function
Clock Source	Selects clock signal source. **External**: External clock source other than MU181000A/B **X:Y:MU181000A/B**: Synthesizer Module X is unit number and Y is slot number.
Center Frequency	Displays when **Clock Source** is **X:Y:MU181000A/B**. Sets synthesizer module frequency in kHz units
Input Clock Frequency	Displays when **Clock Source** is **External**. Displays frequency of clock input to Ext Clock Input connector in kHz units
Offset	Displays when **Clock Source** is **X:Y:MU181000A/B**. Sets frequency offset of synthesizer module in ppm units The setting range is –1000 to 1000.
Reference Clock	Displays when **Clock Source** is **X:Y:MU181000A/B**. Selects reference clock for synthesizer module **Internal**: Uses synthesizer module built-in clock **External 10 MHz**: Uses clock input to synthesizer module Ref. Input (10 MHz) connector
Calibrated Module S/N	Displays when **Clock Source** is **X:Y:MU181000A/B**. Displays serial number of MU181000A/B calibrated with sinusoidal jitter (SJ2) in combination with main frame

Note:

When Option x01 is added to the synthesizer, an error message is displayed when the sinusoidal jitter (SJ2) has not been calibrated in combination with the main frame.





If the error message is displayed, change to the synthesizer with the serial number displayed in “Calibrated Module S/N”.

The SJ2 performance is not assured if the correct synthesizer with sinusoidal jitter (SJ2) calibrated in combination with the main frame is not connected.

Clock connection and screen settings

The procedure for connecting MU181500B, clock source, and MU183020A/MU183021A (hereafter, MU183020A) and setting the screen items that varies by used clock source is described below.

Connection and setting of MU181500B used by the following configurations are described.

(1) MU183020A, MU181000A/B synthesizer, and MU181500B

(2) MU183020A, MU181500B, and external clock source

Note:

When the MU181000A/B synthesizer and MU181500B are included in the described configuration, install MU181500B and 32G PPG to the same main frame.

Description is given, considering the modules are installed to MP1800A according to the following configuration.

Slots 1 and 2: MU181000B

Slot 3: MU183020A

Slots 5 and 6: MU181500B

3.3.1 MU183020A, MU181000A/B synthesizer, and MU181500B

Connecting to the clock

For connecting MU183020A, MU181000A/B, and MU181500B to the clock, refer to the connection diagram and description in *MU183020A 28G/32G PPG MU183021A 28G/32G 4ch PPG Operation Manual, 3.2.2 "Adding Jitter to Output Signal"*.

Setting in the screen

1. Select **Unit1:Slot2: MU181000B** from the Synthesizer Clock Source drop-down list in the MU181500B screen to make MU181500B and MU181000B track each other. (Refer to Figure 3.3.1-1.)
2. Select **Unit1:Slot6: MU181500B** from the Clock Source drop-down list in the MU183020A screen to make MU183020A and MU181500B track each other. (Refer to Figure 3.3.1-2.)
3. Now, you can set the bit rate of the output data at the Bit Rate box in the MU183020A screen. Figure 3.3.1-2 shows an example that the output data is set to 32.1 Gbit/s.

Note:

Follow the above-mentioned procedure and set to make MU181500B and MU181000B track each other. If the steps are performed in the wrong order, a warning dialog box appears as shown in Figure 3.3.1-3.

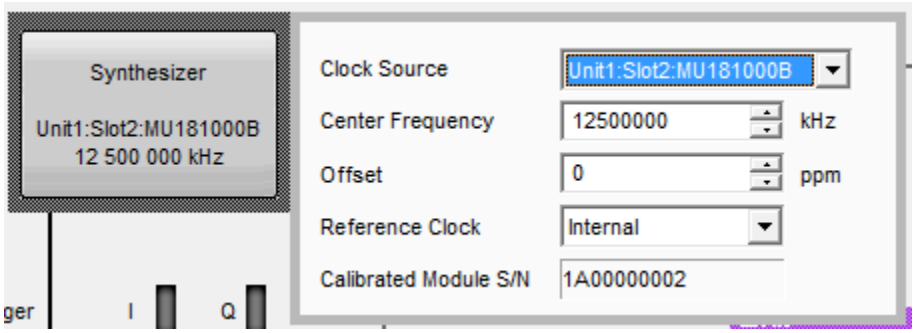


Figure 3.3.1-1 MU181500B Clock Source Settings

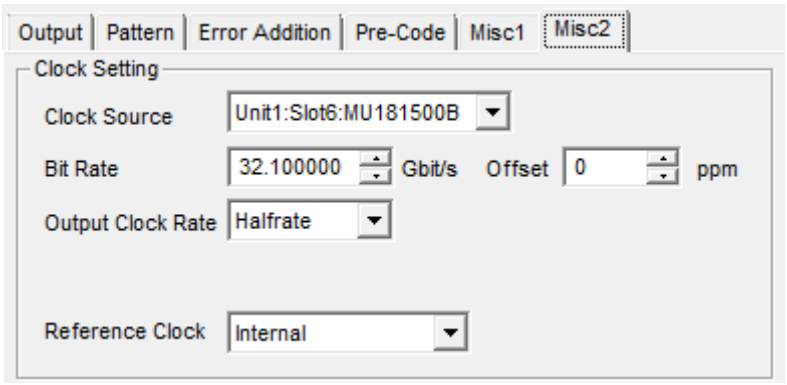


Figure 3.3.1-2 MU183020A Clock Source Settings (When Tracking Operation of Jitter and Synthesizer)

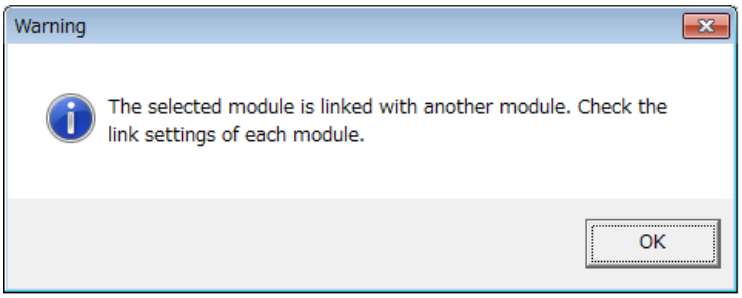


Figure 3.3.1-3 Warning Dialog Box for Module-Tracking Operation

3.3.2 MU183020A, MU181500B jitter signal source, and external clock source

Connecting to the clock

For connecting MU183020A, MU181500B, and the external clock source to the clock, refer to the connection diagram and description in *MU183020A 28G/32G PPG MU183021A 28G/32G 4ch PPG Operation Manual, 3.2.2 "Adding Jitter to Output Signal"*, replacing MU181000A with "external clock".

Setting in the screen

1. Select **Unit1:Slot6: MU181500B** from the Clock Source drop-down list in the MU183020A screen to make MU183020A and MU181500B track each other.
2. In the MU183020A screen, select a bit rate range of data to output from the Operation Bitrate drop-down list. For the example in Figure 3.3.2-1, select **2.4 to 30 Gbit/s** to output 28Gbit/s data.
3. To the Ext Clock Input connector of the MU181500B, input the clock of the frequency displayed in the **Input Clock Freq** box in the MU183020A screen. For the example in Figure 3.3.2-1, 14 GHz clock is input to output 28 Gbit/s data.
4. The **Bit Rate** box in the MU183020A screen displays the bit rate of the output data. Check that the clock that is input in step 3 can change the bit rate of the output data.

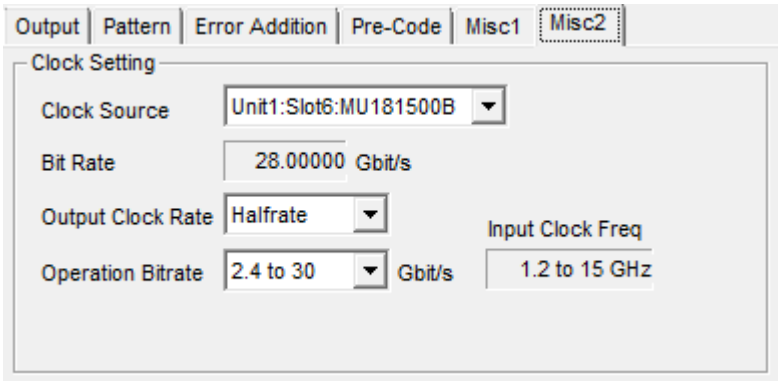


Figure 3.3.2-1 Clock Source Settings (When Using Jitter and External Clock Source)

3.4 Setting Jitter

Clicking the Jitter button displays the setting screen.
The setting items vary according to the type of jitter.

3.4.1 Sinusoidal Jitter (SJ)

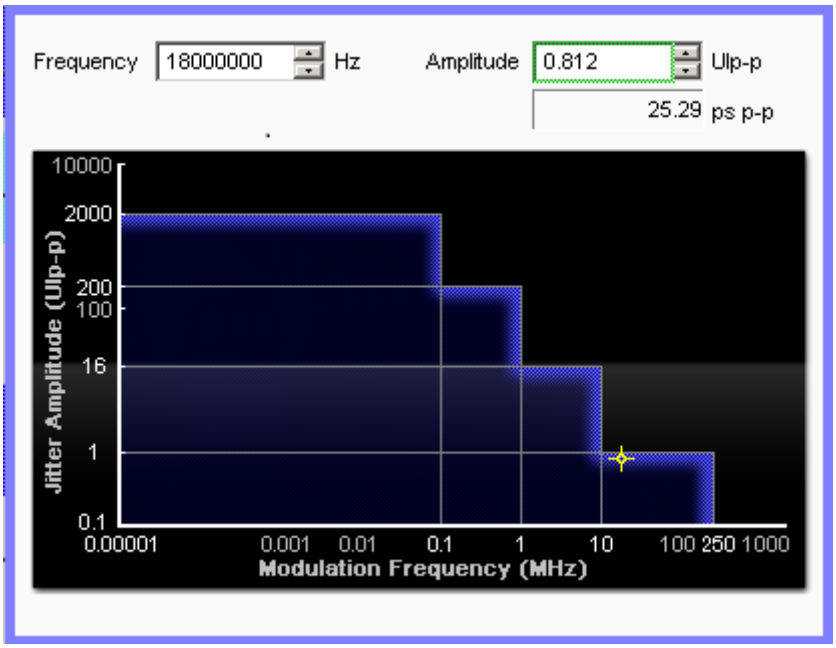


Figure 3.4.1-1 SJ Setting Screen

Table 3.4.1-1 SJ Screen Composition

Item	Function
Frequency	Sets jitter modulation frequency in Hz units
Amplitude	Sets amplitude in UIp-p units

The upper limit of the jitter modulation frequency setting range changes with the clock frequency. Additionally, the settable amplitude range varies according to the jitter modulation frequency and data output settings. For details on setting ranges and steps, refer to Table 1.3.2-1 “Sinusoidal Jitter (SJ)”.

Table 3.4.1-2 Frequency Setting Range

Clock Frequency (GHz)	Frequency (MHz)
0.800 001 to 1.200 000	0.000 010 to 50
1.200 001 to 4.000 000	0.000 010 to 100
4.000 001 to 8.500 000	0.000 010 to 150
8.500 001 to 15.000 000	0.000 010 to 250

Table 3.4.1-3 Amplitude Setting Range

Setting Data Output / Frequency	Amplitude (Ulp-p)		
	[Full-rate (PPG)], [Full-rate (MUX)]	[Half-rate (MUX)]	[Quarter-rate (MUX)]
10 Hz to 1 MHz	0 to 40	0 to 50	0 to 50
1.001 to 10 MHz	0 to 8	0 to 10	0 to 10
10.01 to 250 MHz	0 to 0.50	0 to 0.55	0 to 0.548

Table 3.4.1-4 Amplitude Setting Range (When Interacting With 32G PPG)

Setting Data Output / Frequency	Amplitude (Ulp-p)		
	Full rate 15 to 32.1G, Half rate 2.4 to 32.1G	Full rate 4 to 15G	Full rate 2.4 to 4G
10 Hz to 100 kHz	0 to 2000	0 to 1000	0 to 500
100.1 kHz to 1 MHz	0 to 200	0 to 100	0 to 50
1.001 to 10 MHz	0 to 16	0 to 8	0 to 8
10.01 to 250 MHz	0 to 1.0	0 to 0.5	0 to 0.5

Table 3.4.1-5 Amplitude Setting Range (When Interacting With 64G MUX + 32G PPG)

Bit Rate Setting for 64G MUX / Frequency	Amplitude (Ulp-p)	
	30 to 64.2Gbit/s	8 to 30Gbit/s
10 Hz to 100 kHz	0 to 2000	0 to 1000
100.1 kHz to 1 MHz	0 to 200	0 to 100
1.001 to 10 MHz	0 to 16	0 to 8
10.01 to 250 MHz	0 to 1.0	0 to 0.5

3.4.2 Spread Spectrum Clock (SSC)

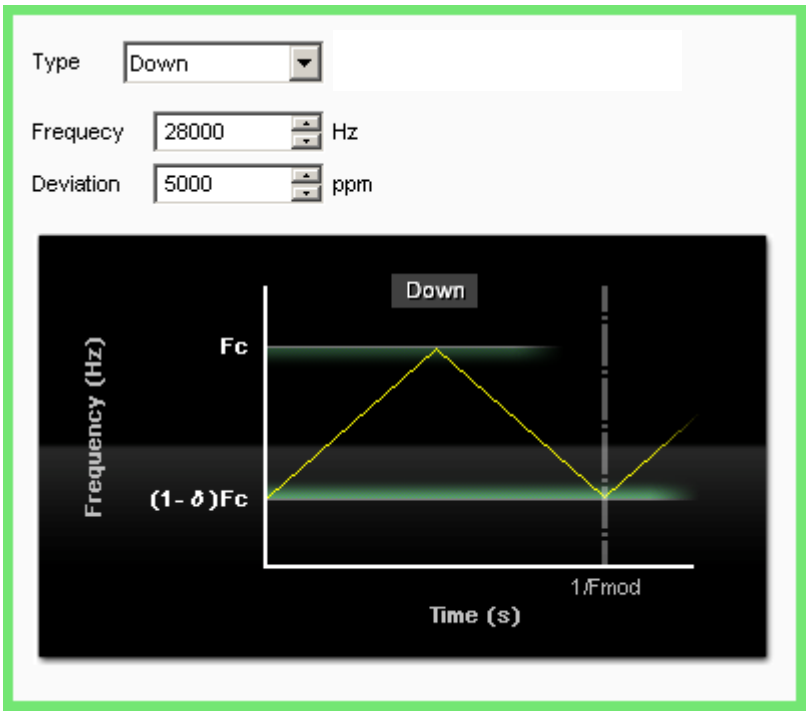


Figure 3.4.2-1 SSC Setting Screen

Table 3.4.2-1 SSC Screen Composition

Item	Function
Type	Sets spread method. **Down** Spreads frequency from reference frequency down to low-frequency side **Center** Spreads frequency equally on high- and low-frequency sides centered around reference frequency **Up** Spreads frequency from reference frequency up to high-frequency side
Graph Area	Displays changes in clock frequency with time as schematic diagram. Fc: **Center Frequency**, or **Input Clock Frequency** δ: **Deviation** setting 1/Fmod: Reciprocal of modulation frequency of **Frequency**
Frequency	Modulation frequency The setting range is 28 to 37 kHz. The modulation cycle 1/Fmod is the reciprocal of the modulation frequency.
Deviation	Frequency deviation. The setting range is 0 to 5300 ppm.

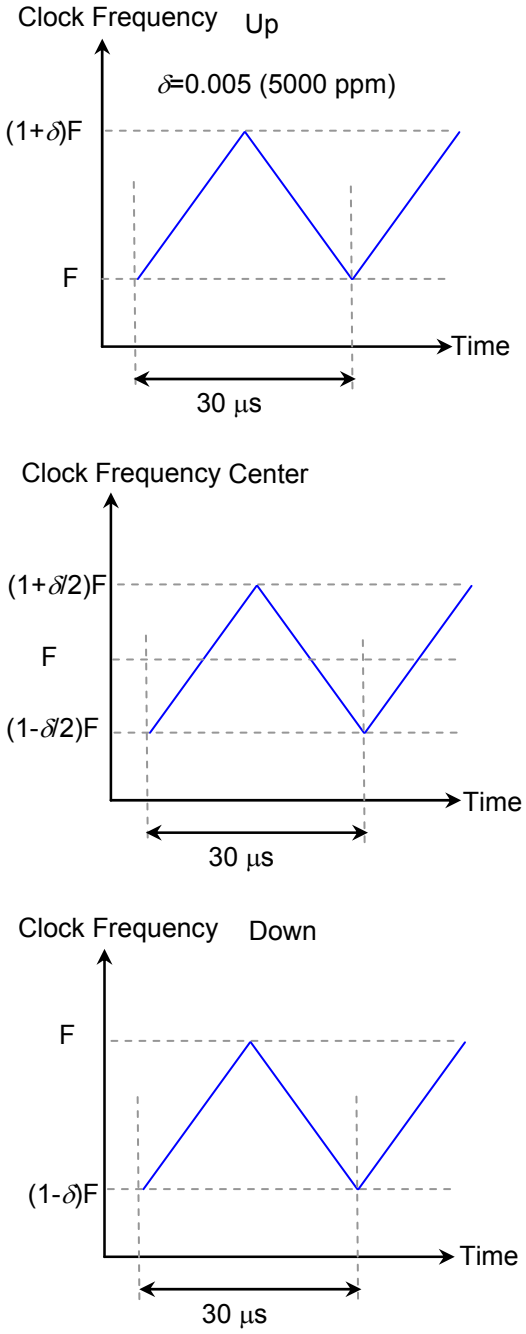


Figure 3.4.2-2 Setting Type and Changing Frequency (Frequency: 33 kHz)

3.4.3 Random Jitter (RJ)

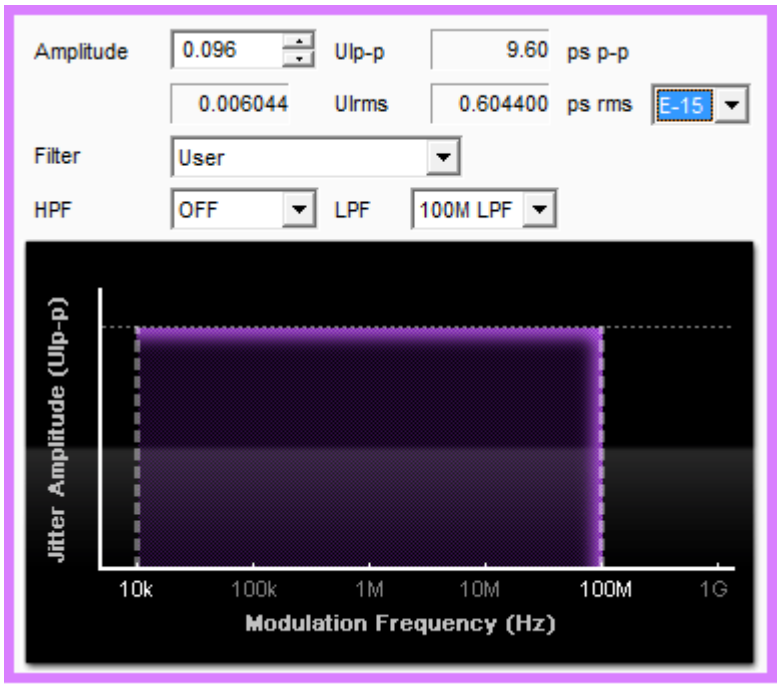


Figure 3.4.3-1 RJ Setting Screen

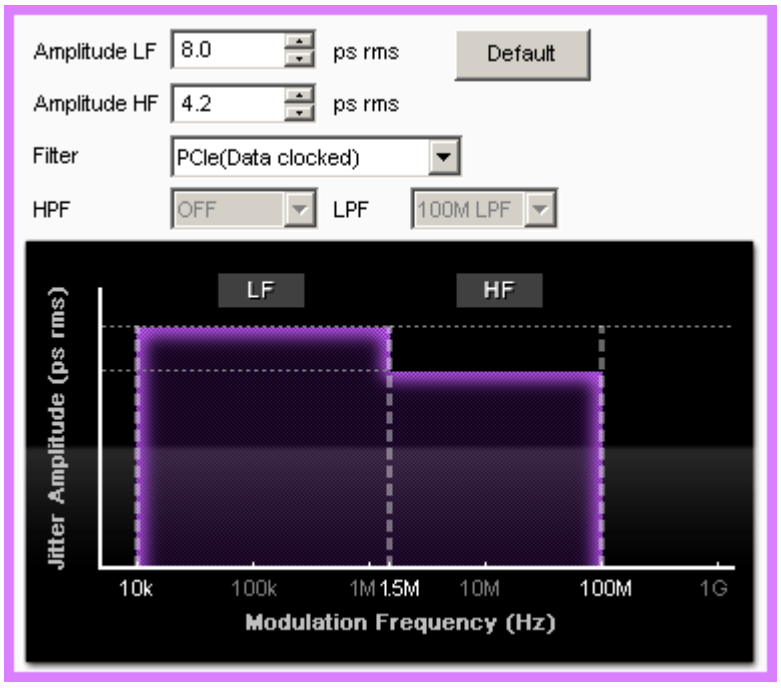


Figure 3.4.3-2 RJ Setting Screen (2)

Table 3.4.3-1 RJ Screen Composition

Item	Function
Amplitude	Sets maximum drift in UIp-p units. Displays UIrms, ps p-p, and ps rms conversion value. Also, sets a coefficient for p-p/rms conversion according to the specified BER. For conversion coefficients for [E–10] to [E–16], see Table 3.4.3-3.
Filter	Sets filter for controlling jitter frequency from: User, PCIe (Data clocked)*, PCIe (Common Ref. Clock)*
HPF	Sets high-pass filter from following: OFF, 10MHz, 20MHz
LPF	Sets low-pass filter from following: OFF, 100MHz
Amplitude LF	When the Filter setting is PCIe, the maximum deviation at the low-frequency side is set in ps rms units.
Amplitude HF	When the Filter setting is PCIe, the maximum deviation at the high-frequency side is set in ps rms units.
Default	When the Filter setting is PCIe, the Amplitude LF and Amplitude HF are set to the default values.

*: Settable when jitter output frequency exceeds 4 GHz

The deviation setting range varies according to the synthesizer frequency. For details on setting ranges and steps, refer to Table 1.3.2-3 “Random Jitter (RJ)”.

Table 3.4.3-2 Deviation Setting Range

Frequency	Amplitude (UIp-p)
≥2.5 GHz	0 to 0.5
<2.5 GHz	0 to 0.2f

f: Synthesizer frequency (GHz)

Table 3.4.3-3 p-p/rms Conversion Coefficient

BER	Conversion Coefficient ($^{p-p}/_{rms}$)
1E–10	12.723
1E–11	13.412
1E–12	14.069
1E–13	14.698
1E–14	15.301
1E–15	15.883
1E–16	16.444

3.4.4 Bounded Uncorrelated Jitter (BUJ)

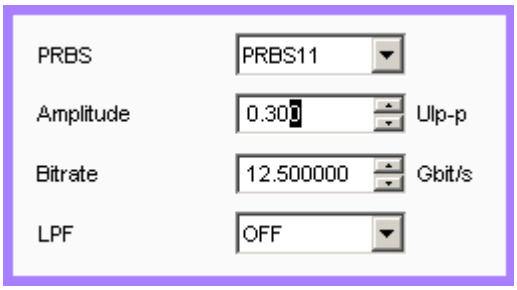


Figure 3.4.4-1 BUJ Setting Screen

Table 3.4.4-1 BUJ Screen Composition

Item	Function
PRBS	Sets the PBRS type.
Amplitude	Sets maximum drift in UIp-p units.
Bitrate	Sets BUJ modulation bit rate in range 0.1 to 3.2 Gbit/s. The following bit rates can be set when the jitter output frequency exceeds 4 GHz. 4.9 to 6.25 Gbit/s, 9.8 to 12.5 Gbit/s
LPF	Sets low-pass filter from following: OFF, 500MHz, 300MHz, 200MHz, 100MHz, 50MHz

The deviation setting range varies according to the synthesizer frequency. For details on setting ranges and steps, refer to Table 1.3.2-5 “Bounded Uncorrelated Jitter (BUJ)”.

Table 3.4.4-2 Deviation Setting Range

Frequency	Amplitude (UIp-p)
≥2.5 GHz	0 to 0.5
<2.5 GHz	0 to 0.2f

f: Synthesizer frequency (GHz)

Note:

The BUJ amplitude accuracy is assured for the bit rates and the LPF conditions specified by the standards. When setting BUJ at other conditions, monitor the main-frame signal output with an oscilloscope and confirm the jitter amplitude.

3.4.5 Sinusoidal Jitter (SJ2)

SJ2 can be set when Synthesizer is set to either **X:Y:MU1810000A**, or **X:Y:MU181000B** and Option x01 is installed in the synthesizer.

⚠ CAUTION

When using SJ2, connect the MU181000A/B with the serial number displayed in Calibrated Module of the Synthesizer screen.

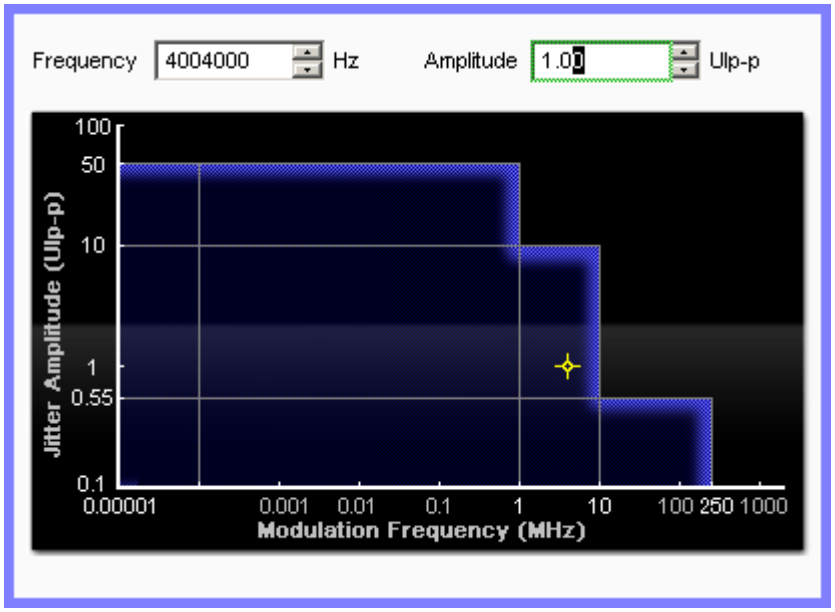


Figure 3.4.5-1 SJ2 Setting Screen

Table 3.4.5-1 SJ2 Screen Composition

Item	Function
Frequency	Sets jitter modulation frequency in Hz units
Amplitude	Sets amplitude in UIp-p units

The upper limit of the jitter modulation frequency changes with the clock frequency. For details on setting ranges and steps, refer to Table 1.3.2-2 “Sinusoidal Jitter (SJ2)”.

Table 3.4.5-2 Frequency Setting Range

Clock Frequency (GHz)	Frequency (MHz)
0.800001 to 1.562500	0.000 010 to 10
1.600001 to 1.800000	0.000 010 to 100
1.800001 to 6.250000	0.000 010 to 150
6.400001 to 15.000000	0.000 010 to 250

Additionally, the settable amplitude range changes according to the jitter modulation frequency and data output setting. For details on setting ranges and steps, refer to Table 1.3.2-1 “Sinusoidal Jitter (SJ)”.

Table 3.4.5-3 Amplitude Setting Range (Clock Frequency 0.800001 to 1.562500 GHz)

Setting Data Output / Frequency	Amplitude (Ulp-p)		
	[Full-rate (PPG)], [Full-rate (MUX)]	[Half-rate (MUX)]	[Quarter-rate (MUX)]
10 Hz to 1 MHz	0 to 5	0 to 12.4	0 to 12.4
1.001 to 10 MHz	0 to 0.75	0 to 2.5	0 to 2.48

Table 3.4.5-4 Amplitude Setting Range (Clock Frequency 1.600001 to 3.125000 GHz)

Setting Data Output / Frequency	Amplitude (Ulp-p)		
	[Full-rate (PPG)], [Full-rate (MUX)]	[Half-rate (MUX)]	[Quarter-rate (MUX)]
10 Hz to 1 MHz	0 to 10	0 to 25	0 to 24.8
1.001 to 10 MHz	0 to 1.5	0 to 5	0 to 5
10.01 to 150 MHz	0 to 0.1	0 to 0.2	0 to 0.2

Table 3.4.5-5 Amplitude Setting Range (Clock Frequency 3.200001 to 6.250000 GHz)

Setting Data Output / Frequency	Amplitude (Ulp-p)		
	[Full-rate (PPG)], [Full-rate (MUX)]	[Half-rate (MUX)]	[Quarter-rate (MUX)]
10 Hz to 1 MHz	0 to 20	0 to 50	0 to 50
1.001 to 10 MHz	0 to 3	0 to 10	0 to 10
10.01 to 150 MHz	0 to 0.2	0 to 0.4	0 to 0.4

Table 3.4.5-6 Amplitude Setting Range (Clock Frequency 6.400001 to 15.000000 GHz)

Setting Data Output / Frequency	Amplitude (Ulp-p)		
	[Full-rate (PPG)], [Full-rate (MUX)]	[Half-rate (MUX)]	[Quarter-rate (MUX)]
10 Hz to 1 MHz	0 to 40	0 to 50	0 to 50
1.001 to 10 MHz	0 to 6	0 to 10	0 to 10
10.01 to 250 MHz	0 to 0.4	0 to 0.55	0 to 0.48

3.5 Setting Data Output

The jitter calculation method varies according to the jittered clock source.

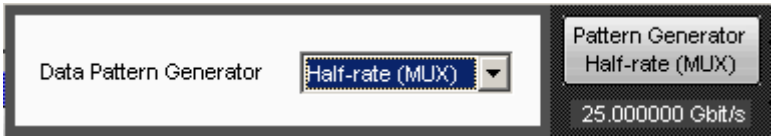


Figure 3.5-1 Data Output Setting Screen

Table 3.5-1 Data Output Screen Composition

Item	Function
Data Pattern Generator	Sets units connected to Jittered Clock Output connector. **Full-rate (PPG)**: MU181020A, MU181020B **Half-rate (MUX)**: MU182020A, MU182021A **Full-rate (MUX)**: MU182020A, MU182021A **Quarter-rate(MUX)**: MP1821A [32G PPG] MU183020A, MU183021A [64G MUX] MP1861A
Bitrate	Displays bit rate of output data

The jitter added to the data output is indicated by the icon displayed under the Data Output button. A message “Overload” appears when the sum of RJ and BUJ exceeds 0.5UI or the total amplitude of the jitters (SJ, RJ and BUJ) exceeds the total modulation in Table 3.5-2 or Table 3.5-3.

Figure 3.5-2 Jitter Icon Display (Overload)

Table 3.5-2 Total Modulation Causing Overload Display

SJ Frequency (MHz)	Total Modulation (UIp-p)
0.000010 to 1.000000	50
1.001000 to 10.000000	10
10.010000 to 250.000000	0.7

Table 3.5-3 Total Modulation Causing Overload Display (When Interacting With 32G PPG)

SJ Frequency (MHz)	Total Modulation (UIp-p)
0.000010 to 0.0075	2000.3
0.007501 to 1.00000	20 dB/decade (Figure 3.5-3) +0.3
1.001000 to 10.000000	20 dB/decade (Figure 3.5-3) +0.3
10.010000 to 250.000000	1.3

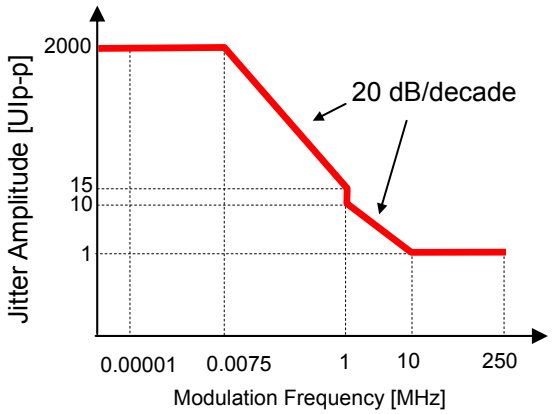


Figure 3.5-3 Total Jitter Added (When Interacting With 32G PPG)

Table 3.5-4 Total Modulation Causing Overload Display (When Interacting With 64G MUX)

SJ Frequency (MHz)	Total Modulation (UIp-p)
0.000010 to 0.0075	2000.3
0.007501 to 1.00000	20 dB/decade (Figure 3.5-4) +0.3
1.001000 to 10.000000	(Figure 3.5-4) +0.3
10.010000 to 250.000000	0.85

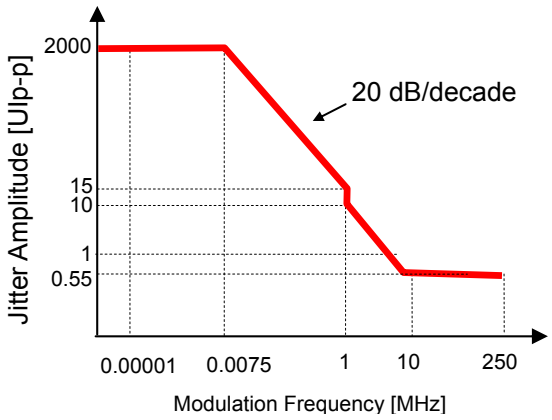


Figure 3.5-4 Total Jitter Added (When Interacting With 64G MUX)

3.6 Setting Auxiliary Output

The clock output at the AUX Output and Reference Clock Output connectors can be set.

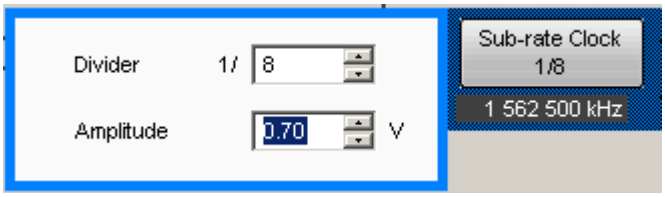


Figure 3.6-1 Sub-Rate Clock Setting Screen

Table 3.6-1 Sub-Rate Clock Screen Composition

Item	Function
Divider	Sets clock division rate in range from 1/8 to 1/256.
Amplitude	Sets amplitude in range from 0.1 to 0.7 V.

The frequency of the clock to be output appears below the button.

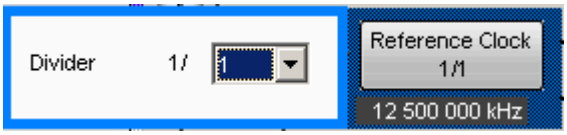


Figure 3.6-2 Reference Clock Setting Screen

Table 3.6-2 Reference Clock Screen Composition

Item	Function
Divider	Sets clock division rate from following: 1/1, 1/2, 1/4

The frequency of the clock to be output appears below the button.

3.7 Setting Restrictions for Other Modules

When the Data Input setting described in item 3.3 “Input Signal Settings” is set to something other than External, there are some restrictions on the settings for the selected module.
The restricted settings and values are shown in the following table.

Table 3.7-1 Restrictions for Other Modules

Clock Source Setting	Restricted Item	Settings
X:Y:MU181000A/B*	All setting items	

*: Input the unit number at X and the slot number at Y.

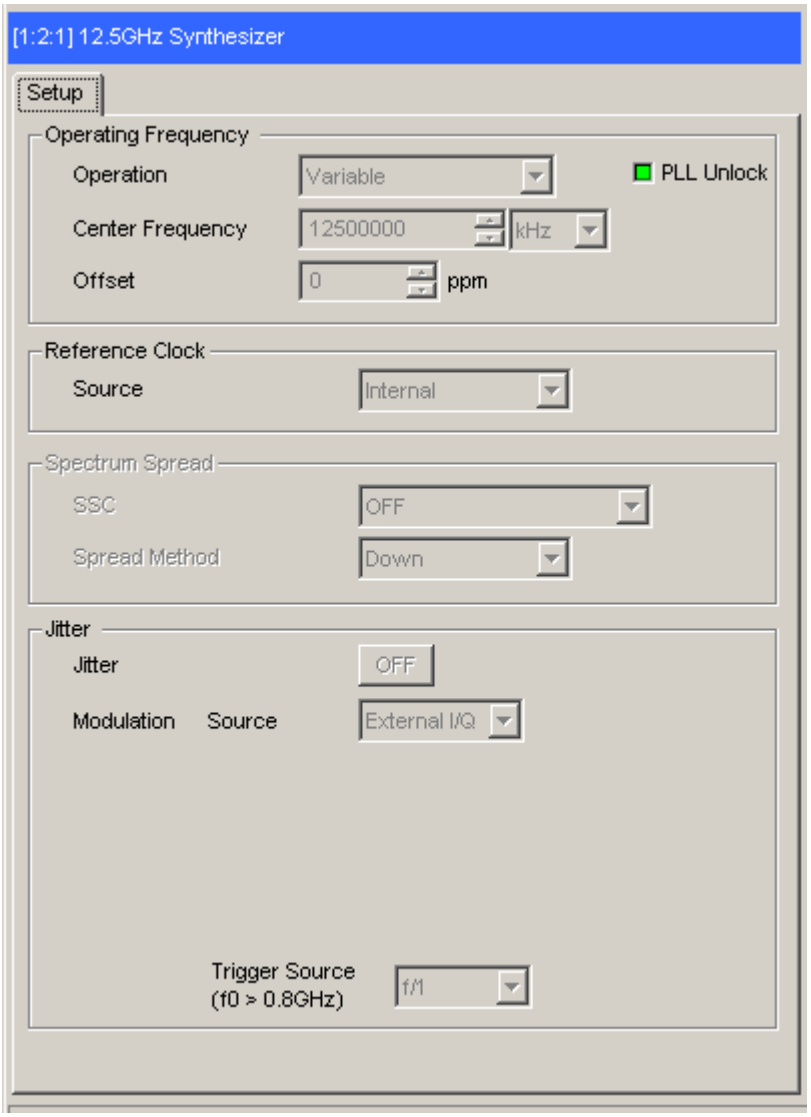


Figure 3.7-1 Example of Restricted Settings Screen

Figure 3.7-1 shows an example of the Module screen with restricted settings.
Text boxes with restricted setting items and labels on restricted buttons are displayed in gray.
The status field displays various messages, including the status of the connection with the MU181500B.

3.8 Saving and Reading Settings

The MU181500B settings can be saved to a file.

1. Click **File** on the menu bar.
2. Click **Save**. The **Save** Screen is displayed.
3. Set the **Modules** pull down menu to **MP181500B**.
   The **File Type** becomes **Binary**.
4. Set the saved file destination at **Drives** and **Directories**.
5. Input the name of the saved file at **File Name**. The file extension is JMS (and can be omitted).
6. Click **OK** to save the file with the MU181500B setting conditions.

The saved settings file can be read using the following procedure.

1. Click **File** on the menu bar.
2. Click **Open**. The **Open** screen is displayed.
3. Set the **Modules** pull down menu to **MP181500B**.
4. Specify the path to the saved settings file using **Drives** and **Directories**.
5. Select the file name from **File List**.
6. Click the **OK** button to set the file settings at the MU181500B.

Chapter 4 Use Example

This chapter explains some usage examples.

4.1 Measuring Jitter Tolerance

This section explains how to use two MP1800A with the following modules to measure the jitter tolerance of a digital data receiver with built-in CDR (clock data recovery).

- MU181000A 12.5GHz Synthesizer
- MU181500B Jitter Modulation Source
- MU181020A 12.5Gbit/s PPG, 2 units
- MU181040A 12.5Gbit/s ED, 2 units
- MU182020A 25Gbit/s 1ch MUX
- MU182040A 25Gbit/s 1ch DEMUX

1. Connect Clock Output of the MU181000A Synthesizer to Ext Clock Input of this module using a coaxial cable.
2. Connect the Jittered Clock Output of this module to the Ext Clock Input of the MU182020A 25Gbit/s MUX (hereafter MU182020A) using coaxial cable.
3. Use coaxial cables to connect 1/2 Clock Output of the MU182020A to Ext Clock Input of the MU181020A (two connections).
4. Use coaxial cables to connect Data Output of the MU181020A to 1/2 Data Input of the MU182020A (two connections).
5. Use the coaxial cable to connect Clock Output of the MU181020A to 1/2 Clock Input of the MU182020A.
6. Connect the input terminals of the device under test to Data Output and $\overline{\text{Data}}$ Output of the MU182020A using coaxial cables.
   If the device under test has only one input connector, connect it to Data Output of the MU182020A.
7. Connect Data Input and $\overline{\text{Data}}$ Input of the MU182040A 25Gbit/s DEMUX (MU182040A hereafter) to the output terminals of the device under test using coaxial cables.
   If the device under test has only one output connector, connect to MU182040A Data Input. Do not connect anything to $\overline{\text{Data}}$ Input.
8. Connect Clock Output of the MU182020A to Ext Clock Input of MU182040A using a coaxial cable.
9. Connect the MU182040A 1/2 Clock output and MU181040A Error Detector (MU181040A hereafter) Clock Input using coaxial cables (two connections).
10. Use coaxial cables to connect Data Output of the PPGED to 1/2 Data Input of the MU182040A (two connections).
11. Press the MU181500B Slot button.

12. Set Clock Source of **Synthesizer** to **X:Y:MU181000A**.
    Set the Frequency and Offset.
13. Click the data output button to set the display to **Half-rate(MUX)**.
14. Click **SJ**, **RJ**, or **BUJ** to select the jitter to add and set the button display to ON.
15. Click the button of jitter to add to display the jitter parameter setting screen.
    Set each jitter parameter.
16. Press the MU181020A Slot button.
17. Click the **Pattern** tab. Set the data pattern.
18. Press the MU182020A Slot button.
19. Click the **Output** tab. Set the MU182020A output voltage.
20. Press the MU181040A Slot button.
21. Click the **Pattern** tab. Set the data pattern.
22. Press the MU182040A Slot button.
23. Click the **Input** tab. Sets input voltage of MU181040A.
24. Click the **Result** tab. Measure the bit error rate.
25. Change the jitter parameters at step 14 and repeat the bit error rate measurement procedure of step 23.

Refer to the following operation manual for the operation screens of each module.

- *MU181020A 12.5 Gbit/s PPG MU181020B 14 Gbit/s PPG Operation Manual*
- *MU181040A 12.5 Gbit/s ED MU181040B 14 Gbit/s ED Operation Manual*
- *MU182020A 25Gbit/s 1ch MUX MU182021A 25Gbit/s 2ch MUX Operation Manual*
- *MU182040A 25Gbit/s 1ch MUX MU182041A 25Gbit/s 2ch DEMUX Operation Manual*

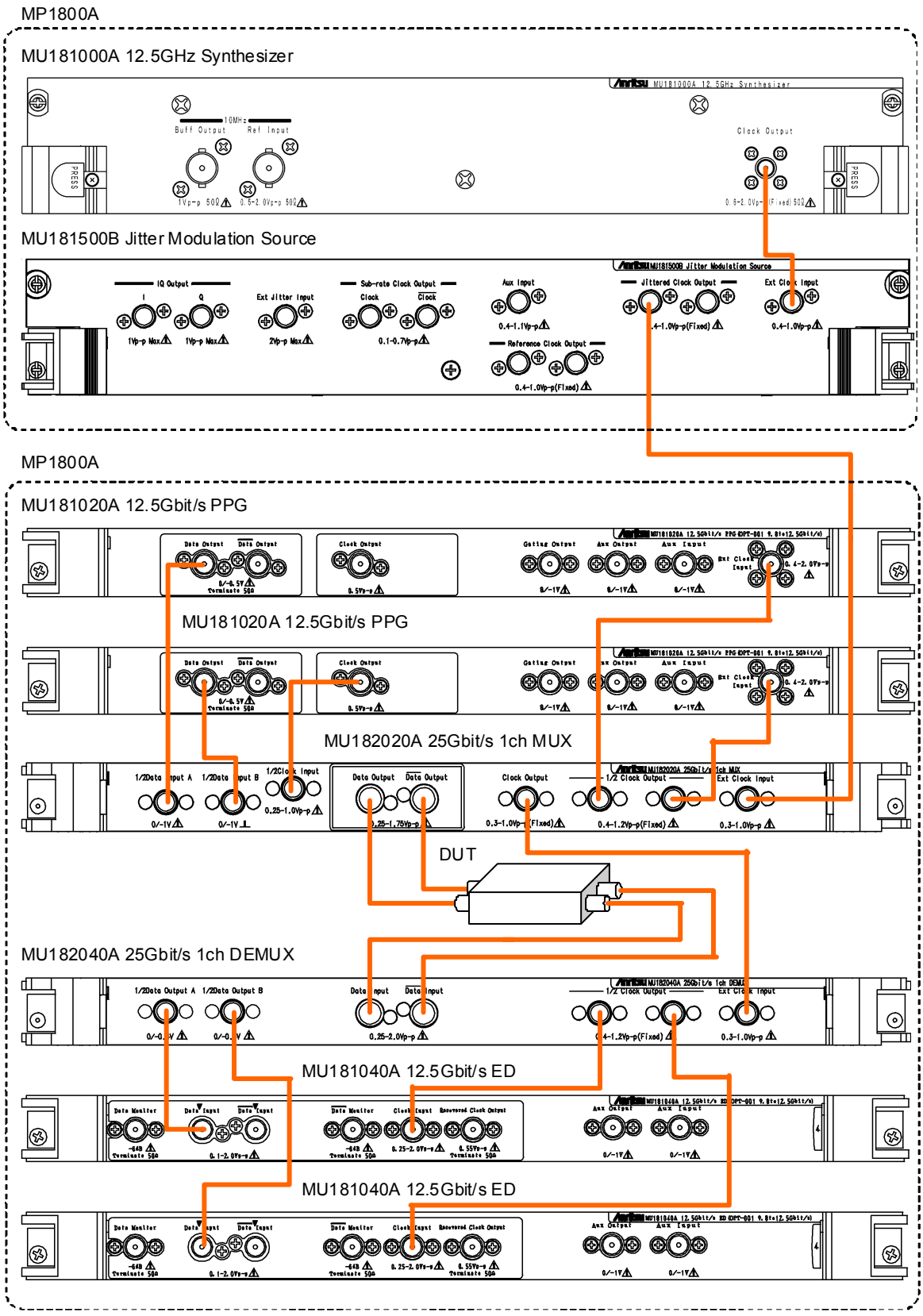


Figure 4.1-1 Jitter Tolerance Measurement System Setup

4.2 Measuring Spectrum Spread

This section explains how to use the following modules and a spectrum analyzer to measure the spectrum spread results of a digital data receiver.

- MU181000A 12.5GHz Synthesizer
- MU181500B Jitter Modulation Source
- MU181020A 12.5Gbit/s PPG, 2 units
- MU182020A 25Gbit/s MUX

This measurement uses two MP1800A units.
This plug-in module is installed in the MU181000A in one MP1800A unit.
Two MU181020A PPG units and one MU182020A 25 Gbit/s MUX are installed in the other MP1800A.

1. Connect Clock Output of the MU181000A Synthesizer to Ext Clock Input of this module using a coaxial cable.
2. Connect the Jittered Clock Output of this module to the Ext Clock Input of the MU182020A using coaxial cable.
3. Use coaxial cables to connect 1/2 Clock Output of the MU182020A to Ext Clock Input of the MU181020A (two connections).
4. Use coaxial cables to connect Data Output of the MU181020A to 1/2 Data Input of the MU182020A (two connections).
5. Use the coaxial cable to connect Clock Output of the MU181020A to 1/2 Clock Input of the MU182020A.
6. Connect the input terminals of the device under test to Data Output and $\overline{\text{Data}}$ Output of the MU182020A using coaxial cables.
   If the device under test has only one input connector, connect it to Data Output of the MU182020A.
7. Connect the output connector of the device under test to the input terminal of the spectrum analyzer using a coaxial cable.
   Insert an attenuator if necessary.
8. Press the MU181500B Slot button.
9. Set Clock Source of **Synthesizer** to **X:Y:MU181000A**.
   Set the Frequency and Offset.
10. Click the data output button to set the display to **Half-rate (MUX)**.
11. Click the **SSC** button to set the button display to **ON**.
12. Click the **SSC** button to display the parameter setting screen.
    Set the spectrum spread clock parameters.
13. Press the MU181020A Slot button.

14. Click the **Pattern** tab. Set the data pattern.
15. Press the MU182020A Slot button.
16. Click the **Output** tab. Set the MU181020A output voltage.
17. Measure the signal output from the device under test at the spectrum analyzer.

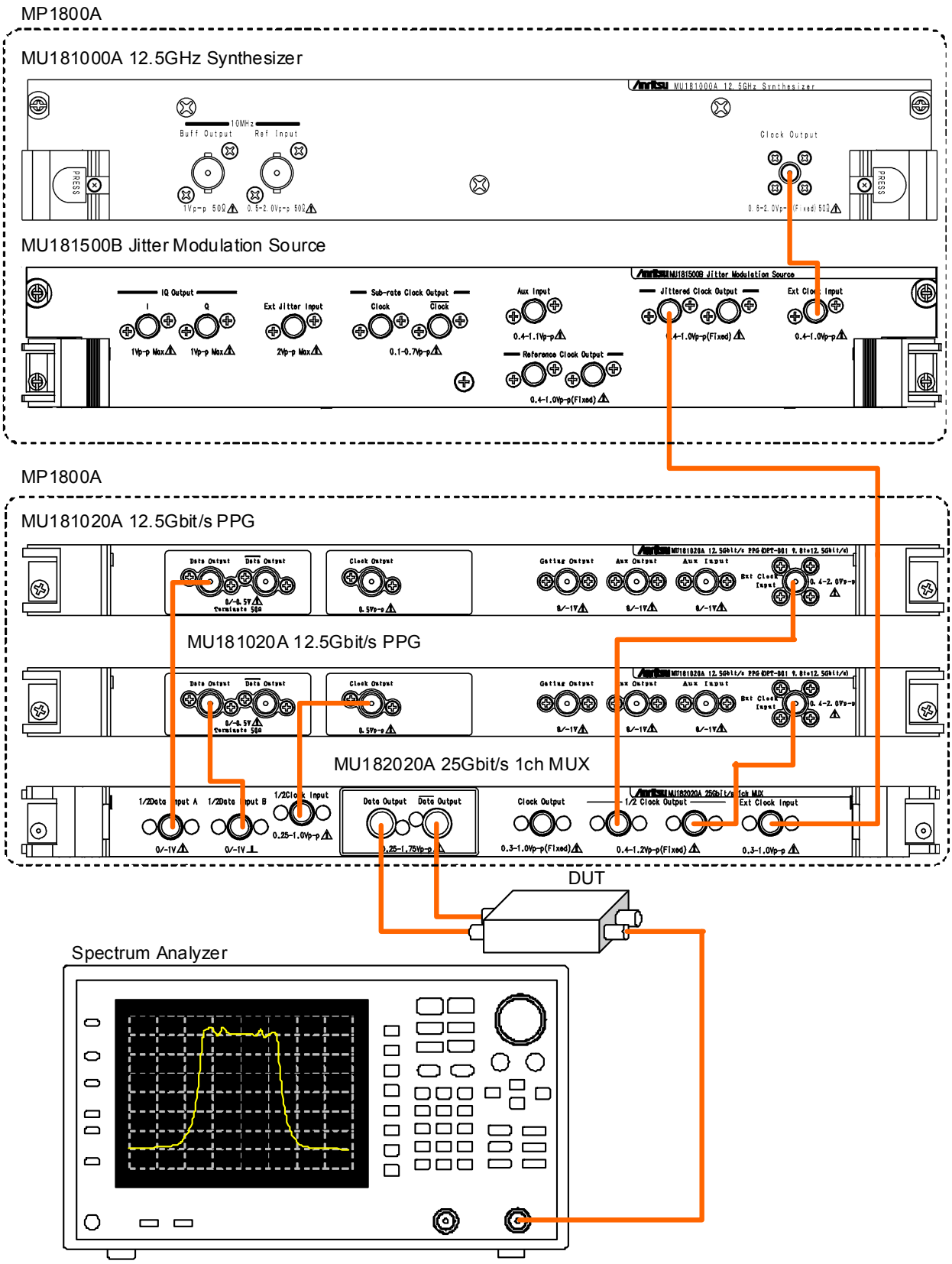


Figure 4.2-1 Spectrum Spread Measurement System Setup

Chapter 5 Remote Commands

For remote control commands of MU181500B jitter modulation source, refer to Section 7.10 “Jitter Command” in the *MX180000A Signal Quality Analyzer Control Software Operation Manual Remote Control*.

Chapter 6 Performance Test

This chapter explains the main-frame performance tests.

6.1 Performance Test

The Performance Test is run to confirm that the main functions of the instrument meet the standards. Run the Performance Test at acceptance inspection, after service repairs, and at fixed intervals (every 6 months).

6.2 List Of Performance Test Equipment

Warm-up the main frame and each instrument for at least 30 minutes before starting the Performance Test. The following table lists the equipment required for the performance test.

Table 6.2-1 Equipment Required for Performance Test

Equipment Name	Required Performance	Recommend Model
Sampling Oscilloscope	Band: 50 GHz min. Residual jitter: 200 fs max.	86100C, 86107A, 86117A (Agilent Technology)
Spectrum Analyzer	Band: 26.5 GHz min.	MS2692A (Anritsu)
Divider	Two-way or more	MU181020A（Anritsu）

Note:

Warm up the device to be measured and the measuring instruments for at least 30 minutes except if specified otherwise, in order to stabilize them sufficiently before running performance tests. Maximum measurement accuracy requires, in addition to the above, conducting performance tests under ambient temperatures and with little AC power supply voltage fluctuations, as well as the absence of noise, vibrations, dust, humidity and other problems.

6.3 Performance Test Method

The test items and procedures are explained below.

(1) SJ

(2) RJ

(3) BUJ

Furthermore, to record the test result, use Appendix B “Performance Test Result Sheet”.

6.3.1 SJ

Measure the output clock level and sideband level when SJ is ON and find the SJ amplitude by calculation.
Figure 6.3.1-1 and Figure 6.3.1-3 show the instrument setup when measuring SJ.

⚠ CAUTION

When inputting a signal to the spectrum analyzer input connectors, always use an attenuator to cut the level to less than the maximum level for the connector.

There is a risk of damage to the spectrum analyzer if a signal exceeding the maximum level is input to the analyzer.

Measurement procedure when SJ amplitude ≤ 0.4 UIp-p

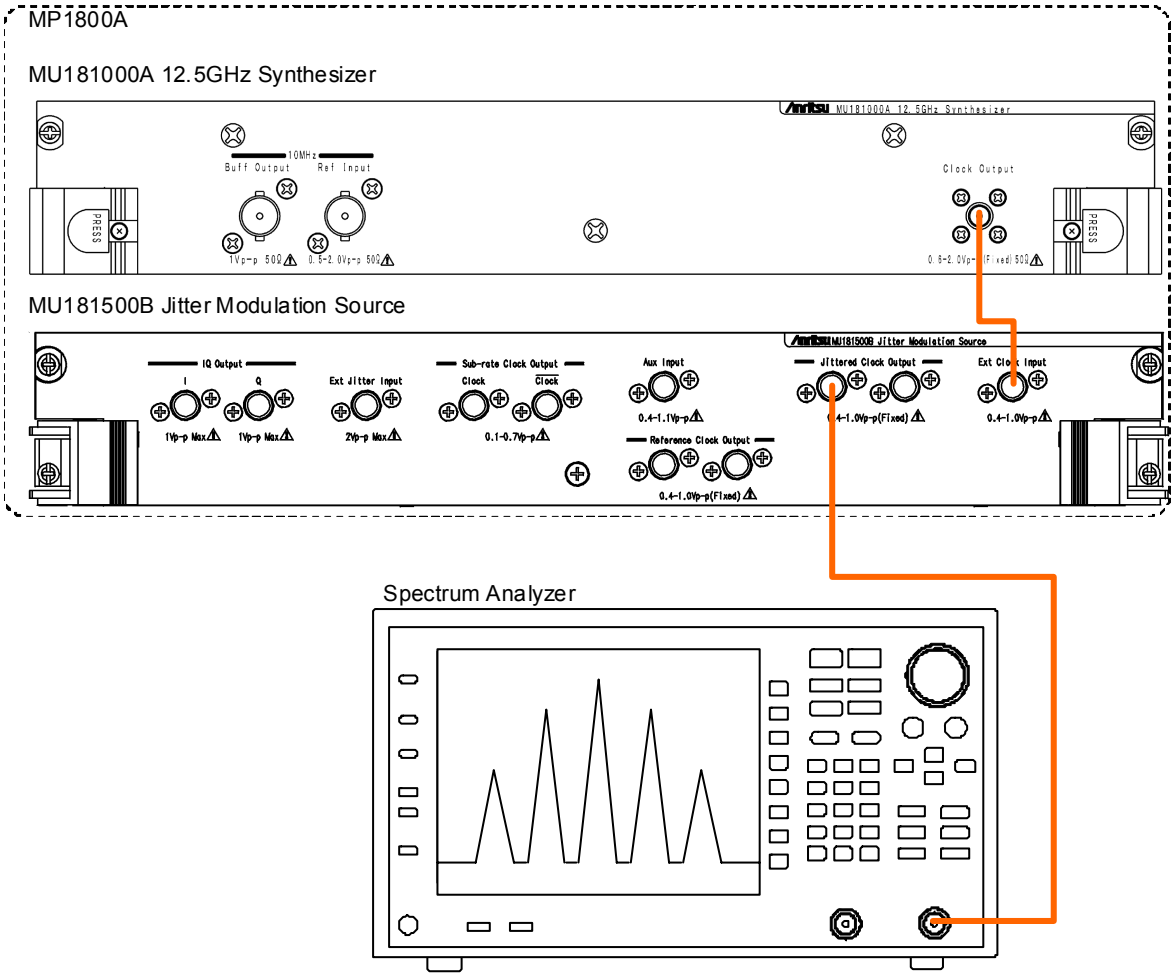


Figure 6.3.1-1 Setup when SJ Amplitude ≤ 0.4 UIp-p

1. When the SJ setting is 0.4 UIp-p or less, use a coaxial cable to connect the Jittered Clock Output connector and the spectrum analyzer RF Input.
2. Set the main frame as follows:
   Synthesizer: 12 500 000 kHz
   SJ: Frequency 50 MHz, Amplitude 0.300 UI
   Pattern Generator: Full rate (PPG)
3. Set the spectrum analyzer as follows:
   Center Frequency: 12 500 MHz, Span: 250 MHz, RBW: 1 MHz
4. Measure the following carriers and sideband powers with the spectrum analyzer.

   J0 : Carrier power (dBm)
   J1U : First sideband Upper Frequency power (dBm)
   J1L : First sideband Lower Frequency power (dBm)
   J2U : Second sideband Upper Frequency power (dBm)
   J2L : First sideband Lower Frequency power (dBm)

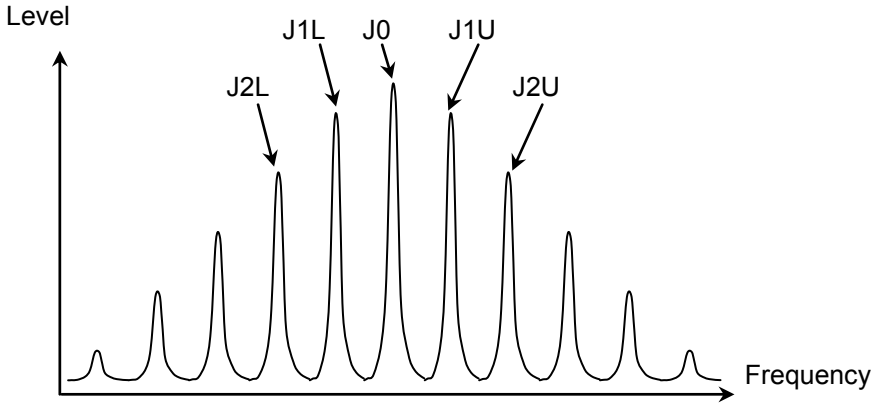


Figure 6.3.1-2 Power Measurement with Spectrum Analyzer

5. Use the following equation to calculate the Jitter Amplitude.

$$J1 = \frac{J1U + J1L}{2} \text{ (dBm)}$$

$$J2 = \frac{J2U + J2L}{2} \text{ (dBm)}$$

$$j0 = 10^{(\frac{J0}{20})}$$

$$j1 = 10^{(\frac{J1}{20})}$$

$$j2 = 10^{(\frac{J2}{20})}$$

$$jitter\_Amplitude = \frac{1}{\pi} \times \frac{2 \times j1}{j0 + j2} \text{ (UIp-p)}$$

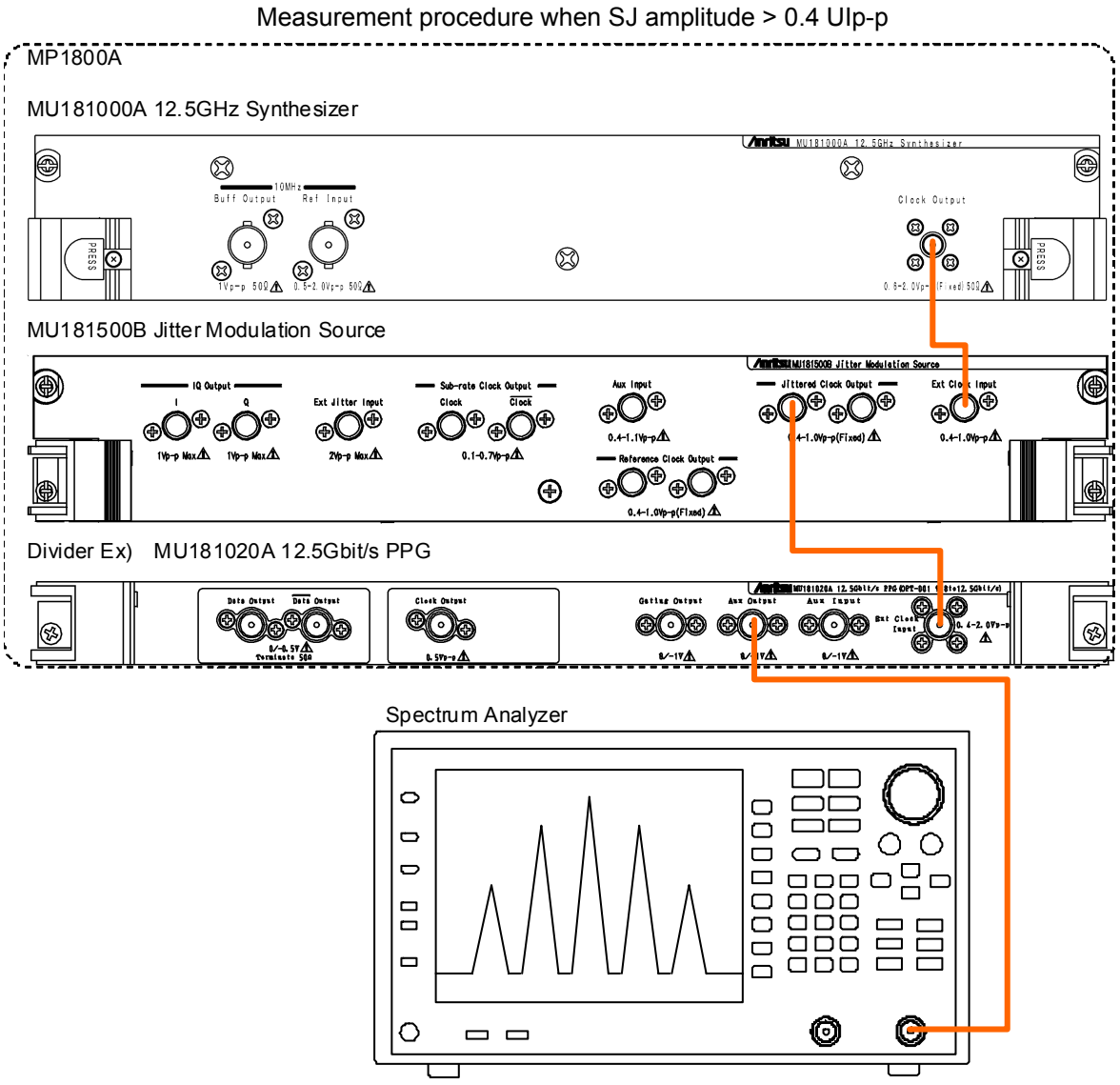


Figure 6.3.1-3 Setup when SJ Amplitude > 0.4 UIp-p

1. When the SJ amplitude is greater than 0.4 UIp-p, use a coaxial cable to connect the Jittered Clock Output connector and Input of the Divider.
   Figure 6.3.1-3 shows the instrument setup using the MU181020A as the Divider.
2. Use a coaxial cable to connect Output of the Divider to RF Input of the spectrum analyzer.
3. Set the main frame as follows:
   Synthesizer: 12 500 000 kHz
   SJ: Frequency 50 MHz, Amplitude 0.500 UI
   Pattern Generator: Full rate (PPG)

4. Set the spectrum analyzer as follows:
   Center Frequency: 6 250 MHz
   Span: 250 MHz
5. Measure as described in step 4 of Measurement procedure when SJ amplitude ≤ 0.4 UIp-p.
6. Calculate as described in step 5 of Measurement procedure when SJ amplitude ≤ 0.4 UIp-p
   However, jitter amplitude is found using the following equation.

$$jitter\_Amplitude = \frac{2}{\pi} \times \frac{2 \times j1}{j0 + j2} \quad \text{(UIp-p)}$$

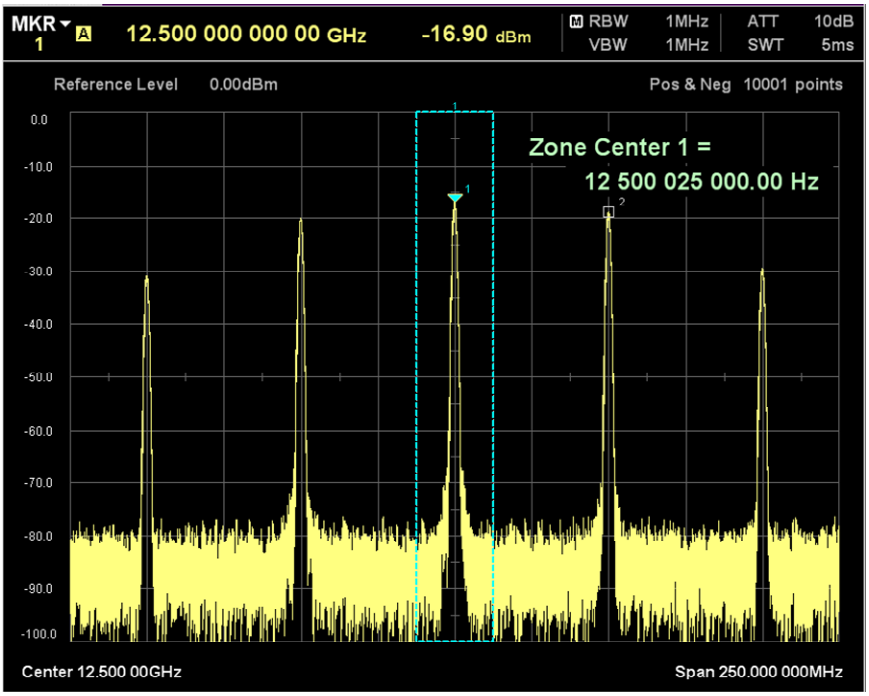


Figure 6.3.1-4 Example of Spectrum Analyzer Waveform

6.3.2 RJ

Measure the SSB noise level of the output clock when RJ is ON with the spectrum analyzer and find the RJ amplitude from the integrated values.

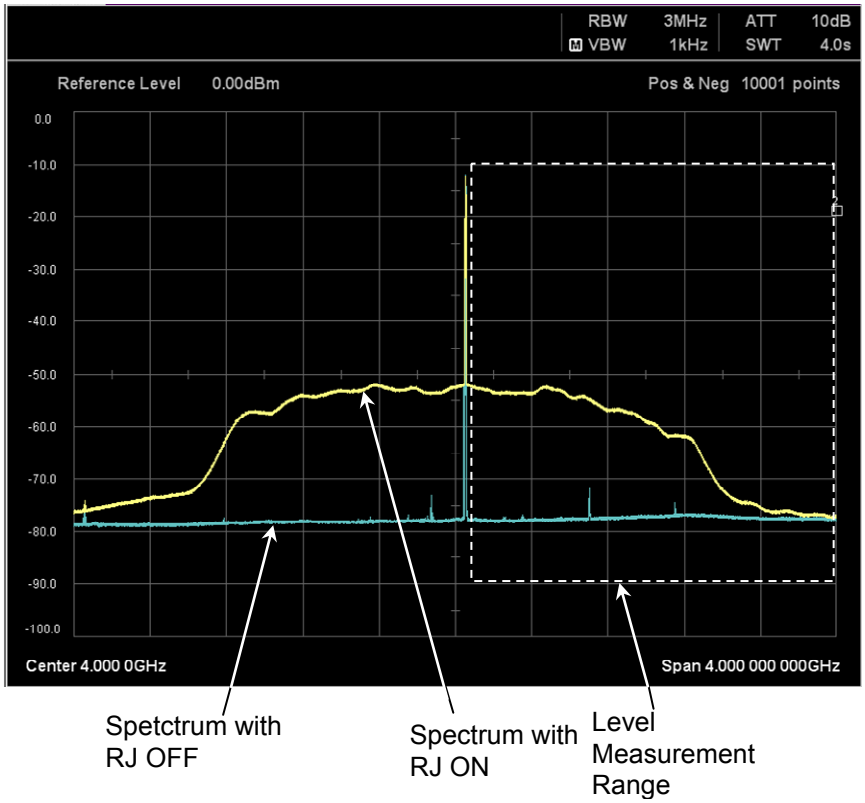


Figure 6.3.2-1 Power Measured by Spectrum Analyzer

Figure 6.3.2-2 shows the instrument setup when measuring RJ.

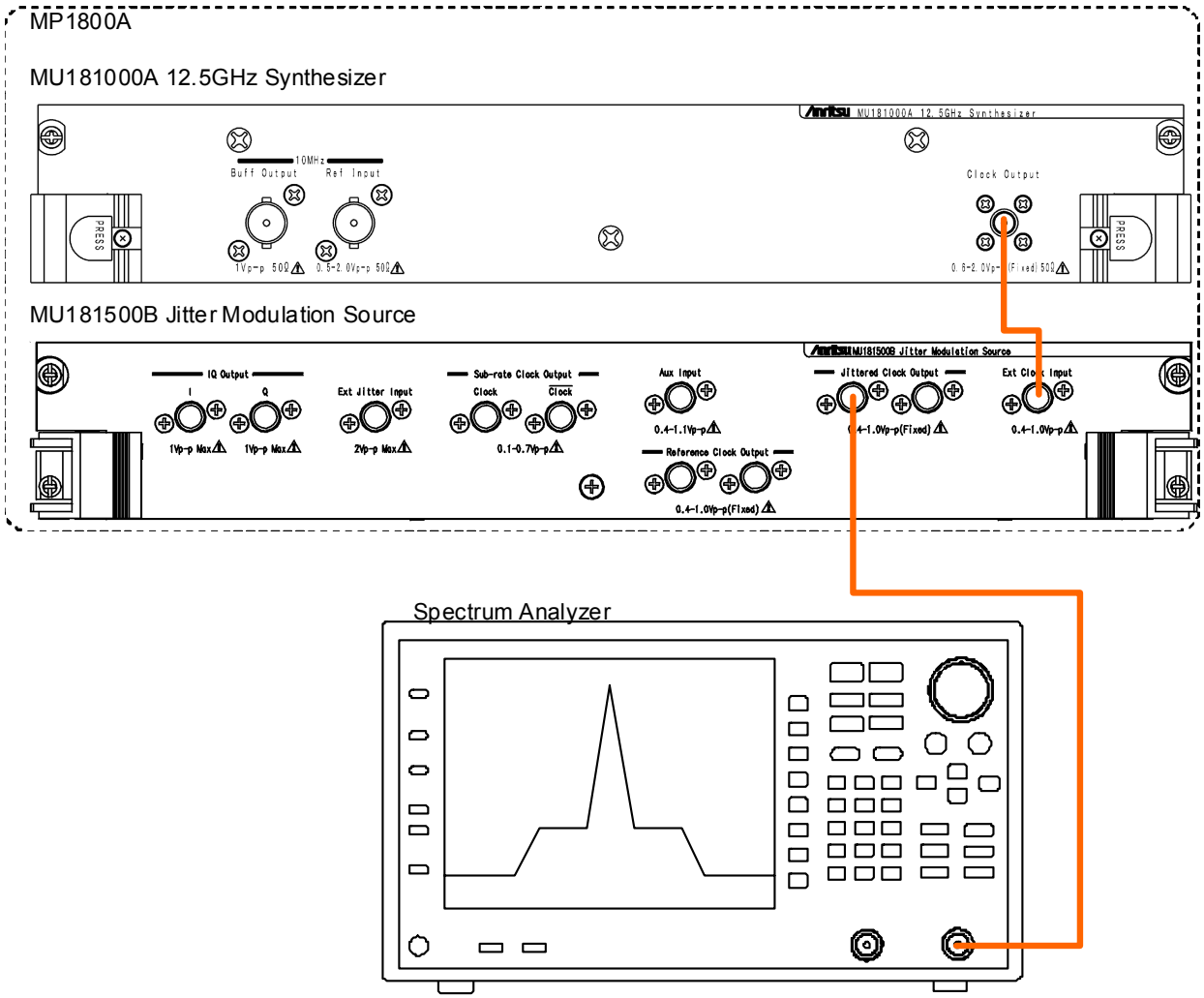


Figure 6.3.2-2 RJ Measurement Setup

1. Use a coaxial cable to connect the Jittered Clock Output connector and RF Input of the spectrum analyzer.
2. Set the main frame as follows:
   Synthesizer : 4 000 000 kHz
   RJ: Amplitude 0.500 UIp-p, Filter User, HFP OFF, LPF 100 MHz
   Pattern Generator: Full rate (PPG)
3. Set the spectrum analyzer as follows:
   RBW: 1 MHz
   VBW: 1 kHz
   Span: 100 MHz
4. Set the spectrum analyzer Center Frequency to 4050 MHz.
5. Measure the level L(*f*) at 1-MHz intervals from 4001 MHz to 4100 MHz.

6. Increase the spectrum analyzer Center Frequency in 100-MHz steps up to 5950 MHz and repeat the measurement in step 5 each time (2000 data measurements).
7. Calculate the integrated value of the spectrum analyzer SSB noise and find the RJ rms σ value as follows:

$$Lin(f) = 10^{(\frac{L(f)}{10})} \quad \text{(mW)}$$

$$\sigma = \frac{1}{2\pi f_0}\sqrt{2\times \sum_{f=4001}^{6000} Lin(f)} \quad \text{(UIrms)}$$

f_0: 4 000 MHz
$Lin(f)$: Linear value of frequency level f (MHz)

6.3.3 BUJ

Figure 6.3.3-1 shows the equipment setup when measuring BUJ.

⚠ CAUTION

When inputting a signal to the sampling oscilloscope input connectors, always use an attenuator to cut the level to less than the maximum level for the connector.

There is a risk of damage to the sampling oscilloscope if a signal exceeding the maximum level is input to the scope.

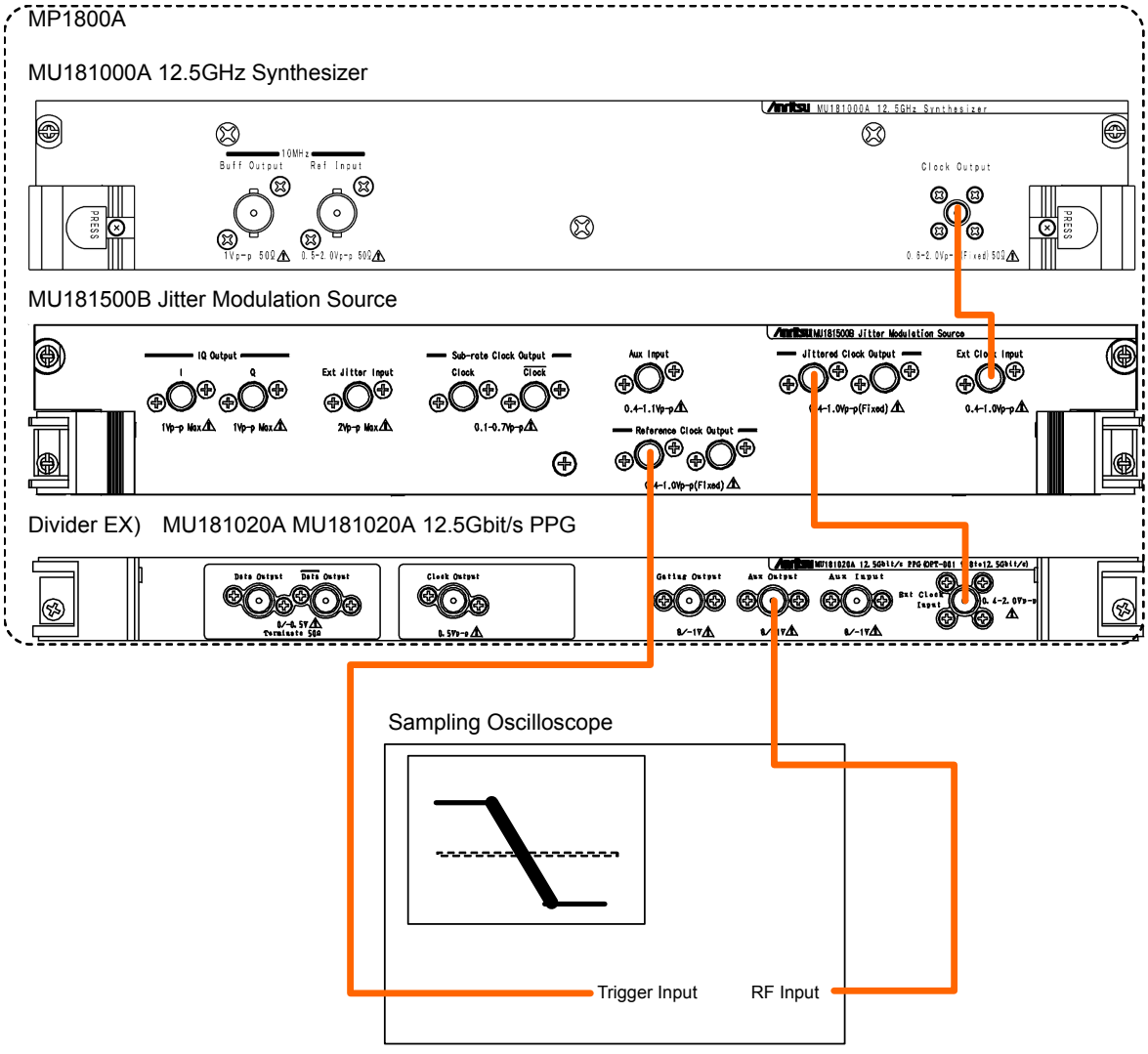


Figure 6.3.3-1 BUJ Measurement Setup

1. Use a coaxial cable to connect the Jittered Clock Output connector and Input connector of the Divider.
   Figure 6.3.3-1 shows the setup when using the MU181020A as the Divider.
2. Use a coaxial cable to connect the Output connector of the Divider and RF Input of the sampling oscilloscope.
3. Use a coaxial cable to Reference Clock Output connector and Trigger input of the sampling oscilloscope.
4. Set the main frame as follows:
   Synthesizer : 12 500 000 kHz
   BUJ: PRBS PRBS7, Amplitude 0.300 UIp-p,
   Bitrate 3.200000 GHz, LPF 300 MHz
   Pattern Generator: Full rate(PPG)
5. Set the sampling oscilloscope as follows:
   Amplitude: 150 mV/div
   Time: 10 ps/div
   Histogram Window:10 mVp-p
6. Use the sampling oscilloscope histogram function to measure the jitter peak.
7. Jitter amplitude is found using the following equation:

$$jitter\_Amplitude = \frac{J_{pp}}{80} \quad \text{(UIp-p)}$$

   Jpp: Peak value of jitter (ps)
   When the clock frequency is 12.5 GHz, 1 UI corresponds to 80 ps.

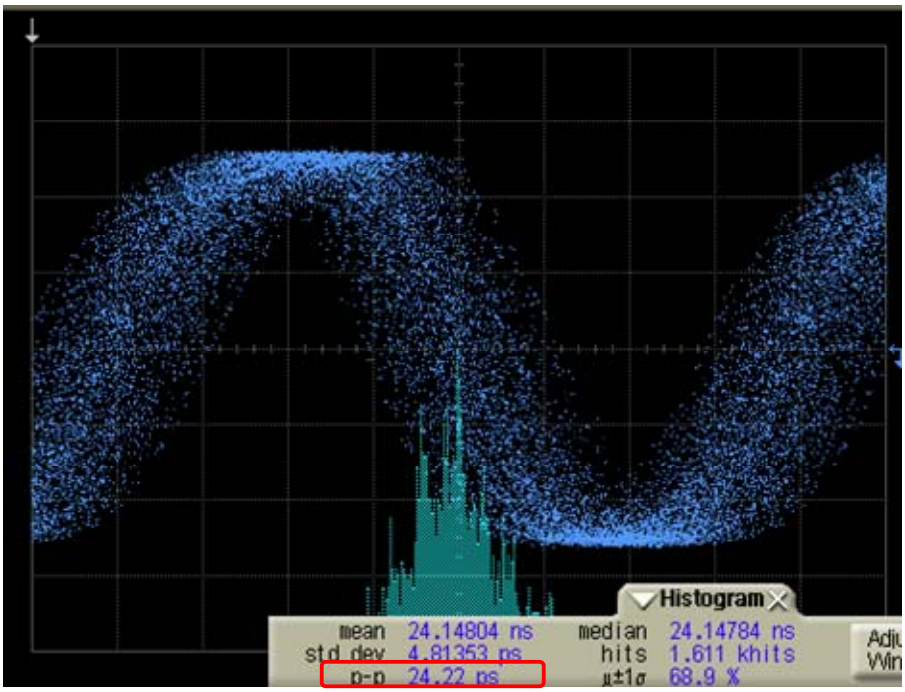


Figure 6.3.3-2 Jitter Measurement Example

Chapter 7 Maintenance

This chapter describes the maintenance of the MU181500B.

7.1 Daily Maintenance

Wipe off any external stains with a cloth damped with diluted mild detergent.

Vacuum away any accumulated dust or dirt with a vacuum cleaner.

Tighten any loose parts fixed with screws, using the specified tools.

7.2 Storage Precautions

Wipe off dust, fingerprint marks, stains, spots, etc. from the surface of the MU181500B before storing it. Avoid storing the MU181500B in these places.

- In direct sunlight
- Dusty places
- Damp places where condensation may occur on the equipment's surface
- Places where there the MU181500B may be corroded by active gases
- Places where the equipment may be oxidized
- Where there is strong vibration
- Under either of the following temperature and humidity conditions:
  Temperature range of –20°C or +60°C
  Humidity range of +85%

Recommended storage conditions

It is recommended that the MU181500B be stored in a place that meets the ambient conditions suggested above, plus the following conditions, if it is not to be used for a long period of time:

- Temperature: 5 to 30°C
- Humidity: 40 to 75%
- Little temperature and humidity fluctuations within one day

7.3 Transportation

Use the original packing materials, if possible, when packing the MU181500B for transport. If you do not have the original packing materials, pack the MU181500B according to the following procedure. When handling the MU181500B, always wear clean gloves, and handle it gently so as not to damage it.

<Procedure>

1. Use a dry cloth to wipe off any stain or dust on the exterior of the MU181500B.
2. Check for loose or missing screws.
3. Provide protection for structural protrusions and parts that can easily be deformed, and wrap the MU181500B with a sheet of polyethylene. Finally, cover with moisture-proof paper.
4. Place the wrapped MU181500B into a cardboard box, and tape the flaps with adhesive tape. Furthermore, store it in a wooden box as required by the transportation distance or method.
5. During transportation, place it under an environment that meets the conditions described in Section 7.2 "Storage Precautions".

7.4 Calibration

Regular maintenance such as periodic inspections and calibration is essential for the Signal Quality Analyzer Series for long-term stable performance. Regular inspection and calibration are recommended for using the Signal Quality Analyzer Series in its prime condition at all times. The recommended calibration cycle after delivery of the Signal Quality Analyzer Series is twelve months.

If you require support after delivery, 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.

We may not provide calibration or repair if any of the following cases apply.

- Five or more years have elapsed after production and parts for the instrument are difficult to obtain, or it is determined that reliability cannot be maintained after calibration/repair due to significant wear.
- Circuit changes, repair, or modifications are done without our approval.
- It is determined that the repair cost would be higher than the price of a new item.

7.5 Disposal

Confirm the notes described in the *Signal Quality Analyzer Series Installation Guide* and observe national and local regulations when disposing of the MU181500B.

Appendix A List of Default Settings

Table A-1 List of Default Settings for MU181500B

Item	Default	Remarks
AUX Switch	Internal	
BUJ		
Amplitude	0	UIp-p
LPF	Off	
Output	Off	
PRBS	PRBS7	
Bitrate	12.500000	Gbit/s
Data Pattern Generator	Half-rate (MUX)	
Ext. Jitter Input		
Output	Disable	
Reference Clock		
Divider	1/1	
RJ		
Amplitude	0	UIp-p
Amplitude HF	4.2*1	ps rms
	3.4*2	
Amplitude LF	8.0*1	ps rms
	4.2*2	
Filter	User	
HPF	Off	
LPF	Off	
Output	Off	
SJ		
Amplitude	0	UIp-p
Frequency	10	Hz
Output	Off	
SJ2		
Amplitude	0	UIp-p
Frequency	10	Hz
Output	Off	

*1: When the Filter setting is PCIe (Data Clocked).

*2: When the Filter setting is PCIe (Common Ref. Clocked).

Table A-1 List of Default Settings for MU181500B (Cont'd)

Item	Default	Remarks
SSC		
Deviation	0	ppm
Frequency	33000	Hz
Output	Off	
Type	Down	
Sub Rate Clock		
Amplitude	0.7	Vp-p
Divider	1/8	
Synthesizer		
Center Frequency	12 500 000	kHz
Clock Source	External	
Offset	0	ppm
Reference Clock	Internal	

Appendix B Performance Test Result Sheet

Document number: _____

Test Location: _____

Date: _____

Test person in charge: _____

Product name: MU181500B Jitter Modulation Source _____

Serial number: _____

Software version: _____

_____

Option: _____

Ambient temperature: _____ °C

Relative humidity: _____ %

Equipment used: Model Name _____ Serial number _____

Model Name _____ Serial number _____

Model Name _____ Serial number _____

Model Name _____ Serial number _____

Model Name _____ Serial number _____

Remarks _____

_____

_____

Table B-1 SJ

Amplitude Settings (UIp-p)	Measurement Value (UIp-p)	Maximum Value (UIp-p)	Measurement Value – Amplitude Settings (UIp-p)	Minimum Value (UIp-p)

Find the maximum and minimum specification values from the following table.

Amplitude Settings	Accuracy
0.002 to 2.19 UIp-p	± (set amplitude × Q%) ± 0.03 UI
2.2 to 21.9 UIp-p	± (set amplitude × Q%) ± 0.2 UI
22 to 50 UIp-p	± (set amplitude × Q%) ± 2 UI

Values of Q is shown below

Modulation Frequency	Q
10 Hz to 500 kHz	7
500.1 kHz to 2 MHz	10
2.001 to 80 MHz	13
80.01 to 250 MHz	15

Table B-2 RJ

Amplitude Settings (Ulp-p)	Measurement Value (Ulp-p)	Maximum Value (Ulp-p)	Measurement Value – Amplitude Settings (Ulp-p)	Minimum Value (Ulp-p)

Find the maximum and minimum specification values from the following equations.
Jitter clock output frequency ≥ 4 GHz: ± (Setting amplitude × 15%) ± 4.9 ps
Jitter clock output frequency < 4 GHz: ± (Setting amplitude × 15%) ±7 ps

Table B-3 BUJ

Amplitude Settings (UIp-p)	Measurement Value (UIp-p)	Maximum Value (UIp-p)	Measurement Value – Amplitude Settings (UIp-p)	Minimum Value (UIp-p)

Find the maximum and minimum specification values from the following equations.

Jitter clock output frequency ≥ 4 GHz: ± (Setting amplitude × 15%) ± 4.9 ps

Jitter clock output frequency < 4 GHz: ± (Setting amplitude × 15%) ± 7 ps

Appendix C Bibliography

(1) IEEE 802.3 *Local and metropolitan area networks— Specific requirements*
Part 3: Carrier sense multiple access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications

(2) ITU-T G.825 *The control of jitter and wander within digital networks which are based on the synchronous digital hierarchy (SDH)*

(3) ITU-T G.8251 *The control of jitter and wander within the optical transport network (OTN)*

(4) ITU-T O.172 *Jitter and wander measuring equipment for digital systems which are based on the synchronous digital hierarchy (SDH)*

(5) ITU-T O.173 *Jitter measuring equipment for digital systems which are based on the Optical Transport Network (OTN)*

(6) Anritsu Corporation *Best Practical Jitter Tolerance Testing with MP1800A*
http://www.anritsu.com/en-US/test-measurement/support/downloads/application-notes/dwl010885

(7) Kuo, A. Farahmand, T. Ou, N. Tabatabaei, S. Ivanov, A *Jitter models and measurement methods for high-speed serial interconnects* Test Conference, 2004. Proceedings. ITC 2004. International

Appendix D Connection Examples for Jitter Measurement

Appendix B describes recommended examples of how to connect MU183020A, MU183040A/B, MU181500B, MP1825B, MP1861A and MP1862A by using applicable coaxial cables. When measurement is performed with jitter added to clock signals by using MU181500B, performance of each instrument is ensured by connecting as described below.

D.1 Jitter-PPG Connection

[Equipment configuration]
MU183020A
MU181500B
DUT

[How to connect instruments, Cable length requirements]

1. Connect a synthesizer and MU181500B's **Ext. Clock Input** connector. The cable length is not especially specified.
2. Connect MU181500B's **Jittered Clock Output** connector and MU183020A's **Ext. Clock Input** connector. The cable length is not especially specified.

3, 4. Use a J1551A coaxial skew match cable (applicable part, pair cable, 0.8 m) to connect MU183020A's **Data Output** and **XData Output** connectors to a DUT.

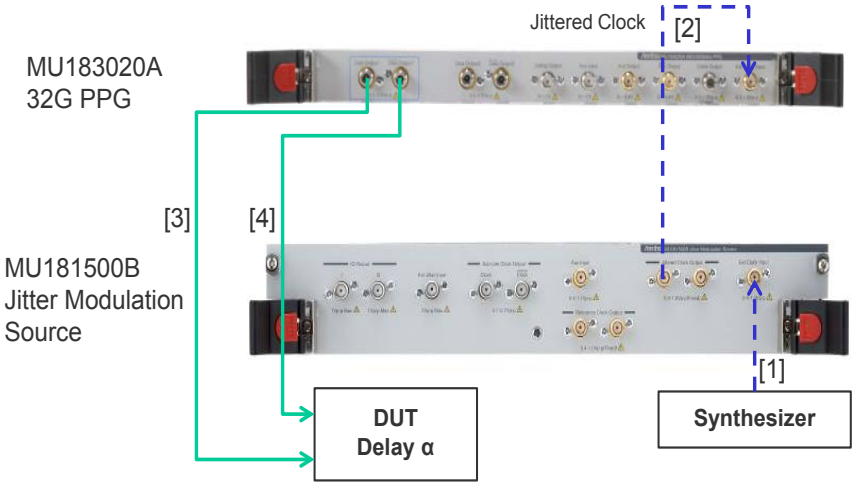


Figure D.1-1 Jitter-PPG Connection Example

D.2 Jitter-PPG-ED Connection

[Equipment configuration]
MU183020A
MU183040B
MU181500B
DUT

[How to connect instruments, Cable length requirements]

1. Connect a synthesizer and MU181500B's **Ext. Clock Input** connector. The cable length is not especially specified.
2. Connect MU181500B's **Jittered Clock Output** connector and MU183020A's **Ext. Clock Input** connector. The cable length is not especially specified.

3, 4. Use a J1551A coaxial skew match cable (Pair cable, 0.8 m) to connect MU183020A's **Data Output** and **XData Output** connectors to a DUT.

5, 6. Use a J1551A coaxial skew match cable (Pair cable, 0.8 m) to connect MU183040B's **Data Input** and **XData Input** connectors to a DUT.

7. Anritsu recommends use of the MU183040B Clock Recovery Option-x22/x23 to supply clock signals to ED. If the option is used, you don't need to connect Cable [7]. If the option is not used, connect the MU183020A's **Clock Output** connector and MU183040B's **Ext. Clock Input** connector with a cable having a length equivalent to the sum of the following:
   - Length of the cable that connects MU183020A's Data Output connector and MU183040B's Data Input connector.
   - Length of the cable that has a length corresponding to a DUT delay amount.
     In the following example, a cable having a length of (1.6m + α) is used to connect the connectors:

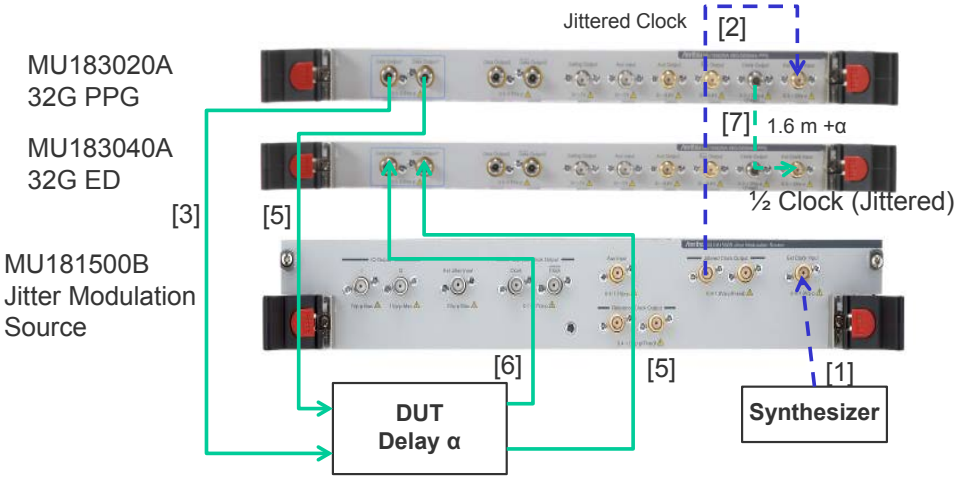


Figure D.2-1 Jitter-PPG-ED Connection Example

D.3 Jitter-PPG-Emphasis Connection

[Equipment configuration]
MU183020A
MU181500B
MP1825B
DUT
J1615A Coaxial Cable Set (Jitter-PPG-Emphasis)

[How to connect instruments, Cable length requirements]

1. Connect a synthesizer and MU181500B's **Ext. Clock Input** connector. The cable length is not especially specified.
2. Connect MU181500B's **Jittered Clock Output** connector and MU183020A's **Ext. Clock Input** connector. The cable length is not especially specified.
3. Use a coaxial cable (applicable part, 0.8 m, K connector) to connect MU183020A's **Data Output** connector and MP1825B's **Data Input** connector.
4. Use a coaxial cable (applicable part, 1.3 m, K connector) to connect MU183020A's **Clock Output** connector and MP1825B's **Clock Input** connector. Then, on the **Misc2** tab of MU183020A, select **Full Rate Clock** in the **Output Clock Rate** box. (Figure B.3-2)

5, 6. Use a J1551A coaxial skew match cable (applicable part, pair cable, 0.8 m) to connect MP1825B's **DataOutput** and **XData Output** connectors to a DUT.

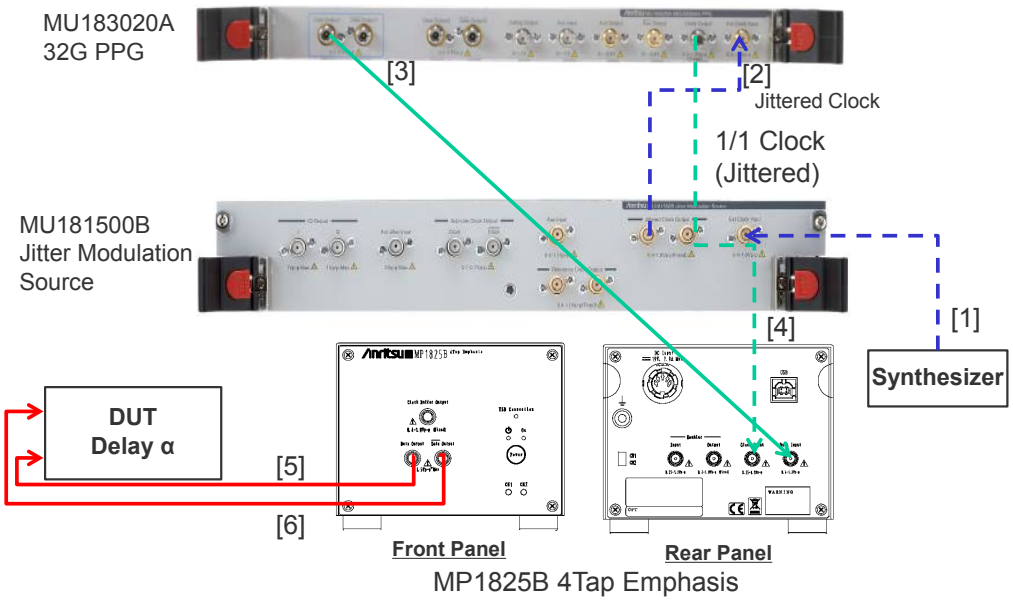


Figure D.3-1 Jitter-PPG-Emphasis Connection Example

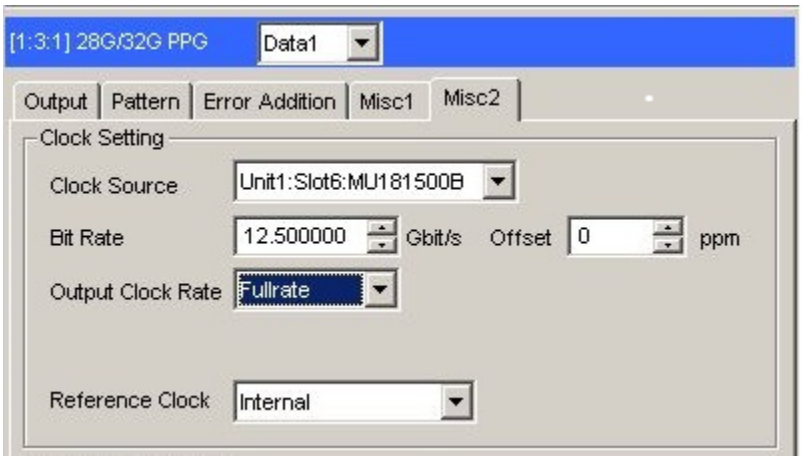


Figure D.3-2 Output Clock Rate Setting on the Misc2 Tab of MU183020A

D.4 Jitter-PPG-Emphasis-ED Connection

[Equipment configuration]
MU183020A
MU183040B
MU181500B
MP1825B
DUT
J1615A Coaxial Cable Set (Jitter-PPG-Emphasis)

[How to connect instruments, Cable length requirements]

1. Connect a synthesizer and MU181500B's **Ext. Clock Input** connector. The cable length is not especially specified.
2. Connect MU181500B's **Jittered Clock Output** connector and MU183020A's **Ext. Clock Input** connector. The cable length is not especially specified.
3. Use a coaxial cable (applicable part, 0.8 m, K connector) to connect MU183020A's **Data Output** connector and MP1825B's **Data Input** connector.
4. Use a coaxial cable (applicable part, 1.3 m, K connector) to connect MU183020A's **Clock Output** connector and MP1825B's **Clock Input** connector. Then, on the **Misc2** tab of MU183020A, select **Fullrate** in the **Output Clock Rate** box. (Figure B.3-2)

5, 6. Use a J1551A coaxial skew match cable (applicable part, pair cable, 0.8 m) to connect MP1825B's **Data Output** and **XData Output** connectors to a DUT.

7, 8. Use a J1551A coaxial skew match cable (applicable part, pair cable, 0.8 m) to connect a DUT with MU183040B's **Data Input** and **XData Input** connectors.

9.10 Anritsu recommends use of the MU183040B Clock Recovery Option-x22/x23 to supply clock signals to ED. If the option is used, you don't need to connect Cables [9] and [10]. If the option is not used, connect MU183020A's **AUX Output** connector and MP1825B's **Doubler Input** connector, and MP1825B's **Doubler Output** connector and MU183040B's **Ext. Clock Input** connector respectively with each cable having a length equivalent to the sum of the following:

- Length of the cable that connects MP1825B's Data Output connector and MU183040B's Data Input connector.
- (Length of the cable that has a length corresponding to DUT delay amount) – 0.5 m.
  In the following example, a cable having a length of (1.6 m – 0.5

m + α) is used. Then, on the Misc1 tab of MU183020A, set the clock rate to 1/4 Clock in the AUX Output area. (Figure D.4-2.)

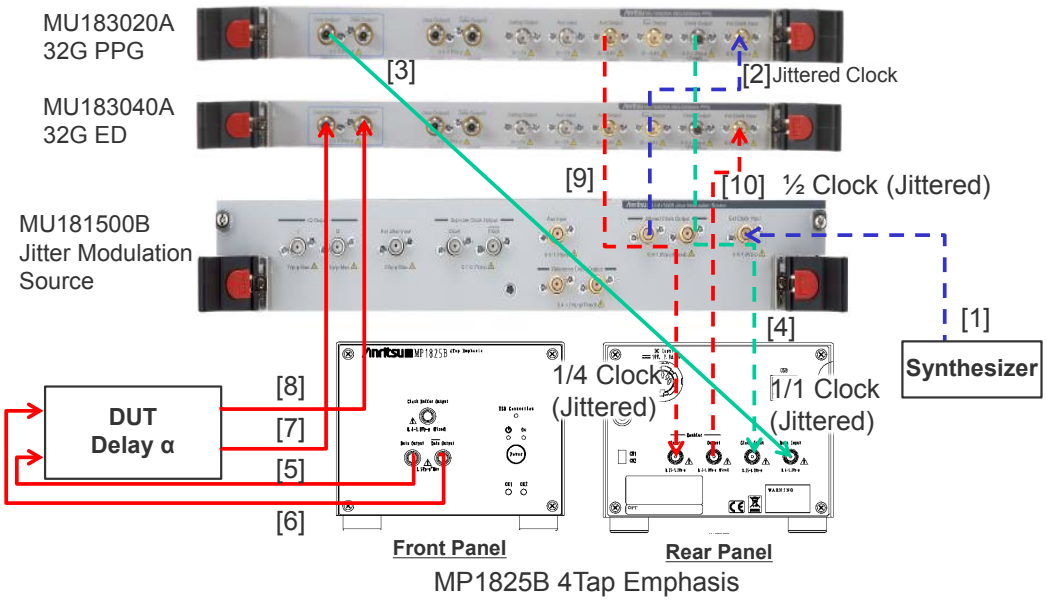


Figure D.4-1 Jitter-PPG-Emphasis-ED Connection Example

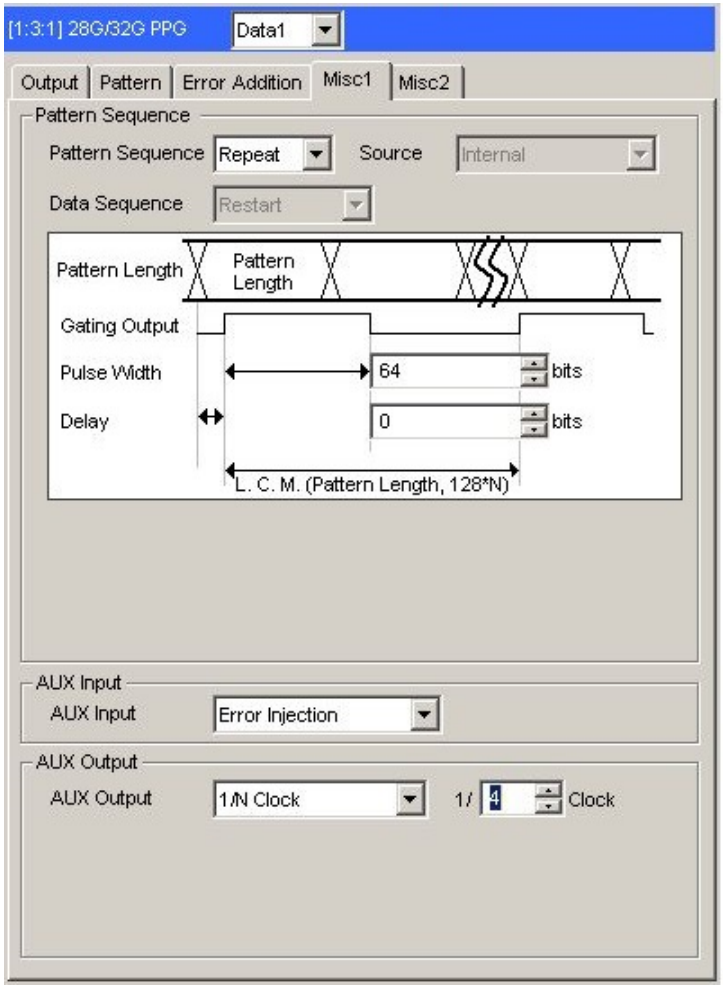


Figure D.4-2 AUX Output Setting on the Misc1 Tab of MU183020A

D.5 Jitter-2ch PPG-Two Emphasis Units Connection

[Equipment configuration]
MU183020A-22/23 2ch PPG
MU181500B
MP1825B-02 (Two units)
DUT
J1618A Coaxial Cable Set (Jitter-2chPPG-Emphasis)

[How to connect instruments, Cable length requirements]

1. Connect a synthesizer and MU181500B's **Ext. Clock Input** connector. The cable length is not especially specified.
2. Use a coaxial cable (applicable part, 0.9 m, K connector) to connect MU181500B's **Jittered Clock Output** connector and MU183020A's **Ext. Clock Input** connector.

3, 4. Use coaxial cables (applicable part, 0.8 m, K connector) to connect MU183020A's **Data Output1** and **Data Output2** connectors respectively with the **Data Input** connector of each MP1825B No.1 and 2. Then, on the **Misc2** tab of MU183020A, select **Halfrate** in the **Output Clock Rate** box. (Figure B.5-2)

5. Use a coaxial cable (applicable part, 0.3 m, APC 3.5mm connector) to connect MU181500B's **Jittered Clock Output** connector and **AUX Input** connector.

6, 7. Use coaxial cables (applicable part, 0.8 m, APC 3.5 mm connector) to connect MU181500B's **Reference Clock Output** connectors respectively with the **Doubler Input** connector of each MP1825B No.1 and 2.Then, connect MP1825B's **Doubler Output** and **Clock Input** connectors with the semi-rigid coaxial cable that comes with MP1825B. After that switch MU181500B's AUX clock input signal to **AUX Input** and set the Reference Clock to **1/1**. (Figure B.5-3)

8, 9. Use J1439A coaxial cables (applicable part, 0.8 m) to connect the **Data Output** connector of each MP1825B No.1 and 2 to a DUT.

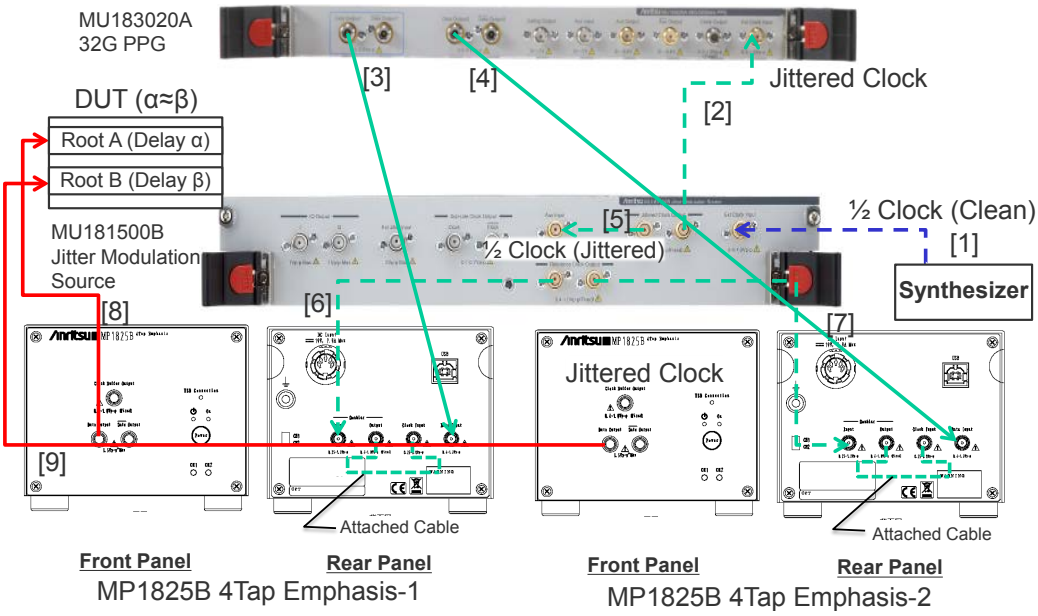


Figure D.5-1 Jitter-2ch PPG-Two Emphasis Units Connection Example

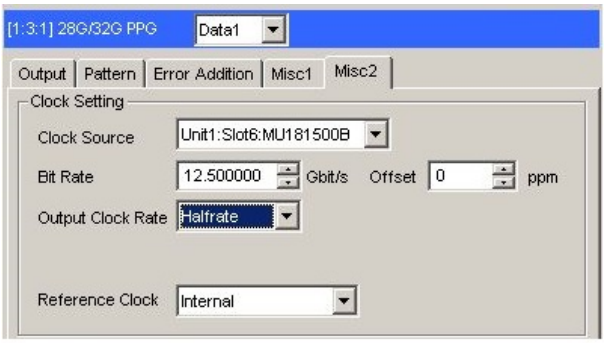


Figure D.5-2 Output Clock Rate Setting on the Misc2 Tab of MU183020A

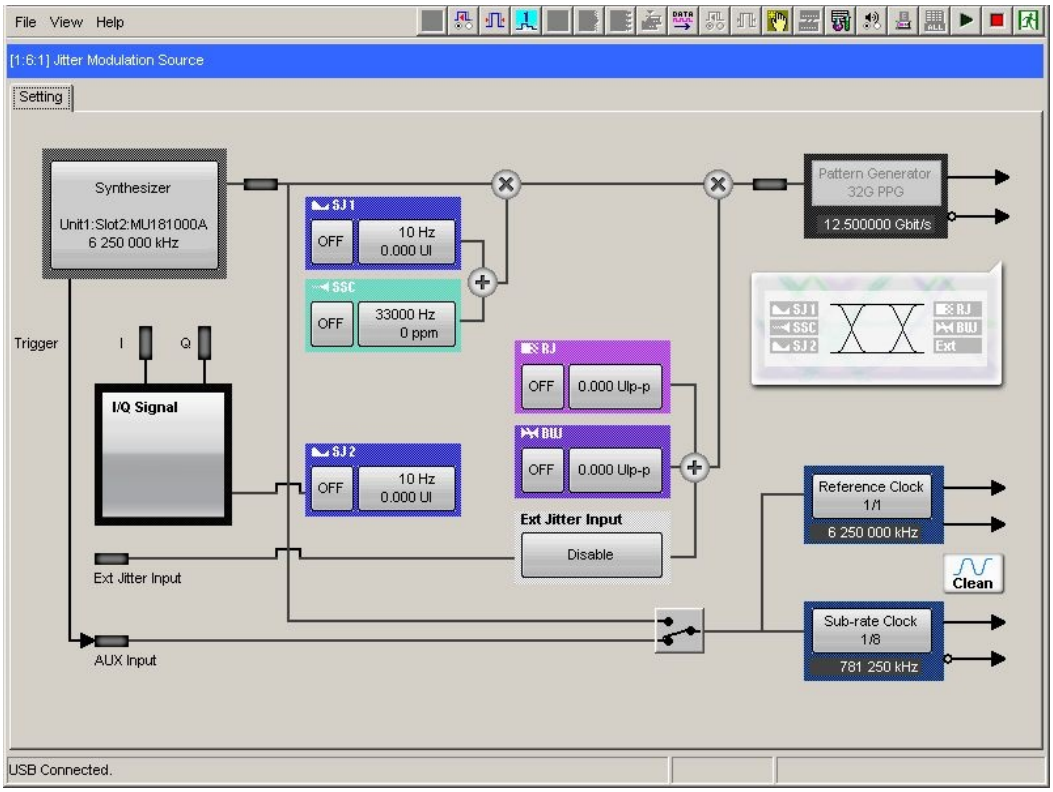


Figure D.5-3 Setting MU181500B's AUX and Reference Clock

D.6 Jitter-2ch PPG-Two Emphasis Units-ED Connection

[Equipment configuration]
MU183020A-22/23 2ch PPG
MU181500B
MP1825B-02 (Two units)
MU183040B-20 2ch ED
DUT
J1618A Coaxial Cable Set (Jitter-2chPPG-Emphasis)

[How to connect instruments, Cable length requirements]

1. Connect a synthesizer and MU181500B's **Ext. Clock Input** connector. The cable length is not especially specified.
2. Use a coaxial cable (applicable part, 0.9 m, K connector) to connect MU181500B's Jittered Clock Output connector and MU183020A's Ext. Clock Input connector.

3, 4. Use coaxial cables (applicable part, 0.8 m, K connector) to connect MU183020A's **Data Output1** and **Data Output2** connectors respectively with the **Data Input** connector of each MP1825B No.1 and 2. Then, on the **Misc2** tab of MU183020A, select **Halfrate** in the **Output Clock Rate** box. (Figure B.5-2)

5. Use a coaxial cable (applicable part, 0.3 m, APC 3.5mm connector) to connect MU181500B's **Jittered Clock Output** connector and **AUX Input** connector.

6, 7. Use coaxial cables (applicable part, 0.8 m, APC 3.5 mm connector) to connect MU181500B's **Reference Clock Output** connectors respectively with the **Doubler Input** connector of each MP1825B No.1 and 2. Then, connect MP1825B's **Doubler Output** and **Clock Input** connectors with the semi-rigid coaxial cable that comes with MP1825B. After that switch MU181500B's AUX clock input signal to **AUX Input** and set the Reference Clock to **1/1**. (Figure B.5-3)

8, 9. Use J1439A coaxial cables (applicable part, 0.8 m) to connect the **Data Output** connector of each MP1825B No.1 and 2 to a DUT.

10, 11. Use J1439A coaxial cables (applicable part, 0.8 m) to connect a DUT with MU183040B's **Data Input1** and **Data Input2** connectors.

12. Anritsu recommends use of the MU183040B Clock Recovery Option-x22/x23 to supply clock signals to ED. If the option is used, you don't need to connect Cable [12]. If the option is not used, connect the MP1825B's **Clock Buffer Output** connector and MU183040B's **Ext. Clock Input** connector with a cable having a length equivalent to the sum of the following:

- Length of the cable that connects MP1825B's Data Output connector and MU183040B's Data Input connector.
- (Length of the cable that has a length corresponding to DUT delay amount (α to β)) + 0.5 m.
  In the following example, a cable having a length of (1.6 m + 0.5 m + α) is used.

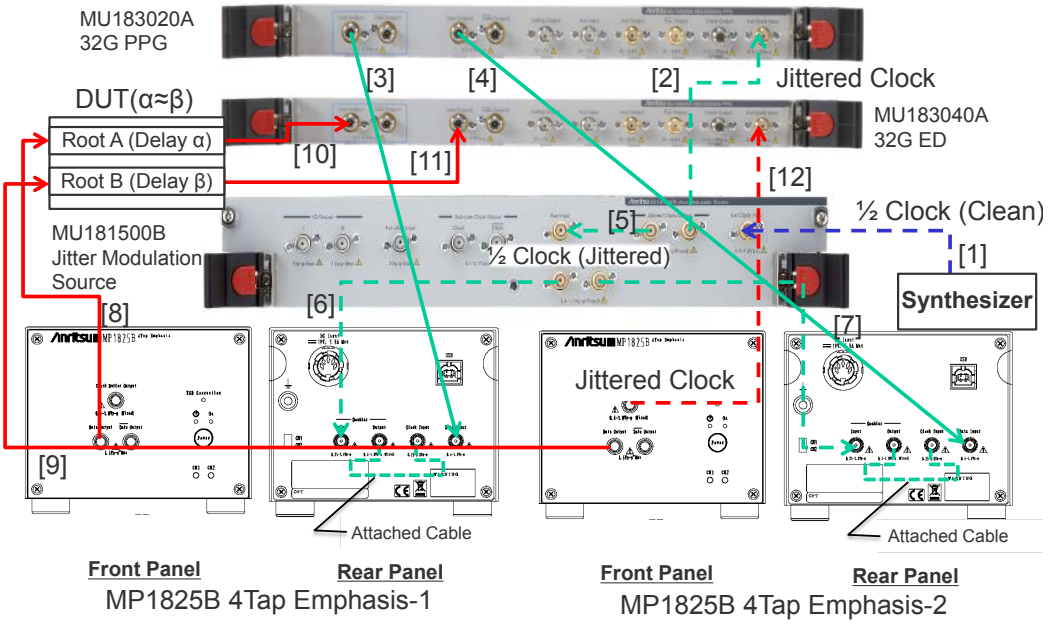


Figure D.6-1 Jitter-2ch PPG-Two Emphasis Units-ED Connection Example

D.7 Jitter-64G MUX-64G DEMUX Connection

[Equipment configuration]
MP1861A
MP1862A
MP1800A
MU183020A-x22/x23+x31
MU183040B
MU181500B
MU181000A
DUT
J1656A Coaxial Cable Set (A two-cable set for jitter tolerance measurement)

[How to connect instruments, Cable length requirements]

1. Connect the **Clock Output** connector of MU181000A and the **Ext. Clock Input** connector of MU181500B by using the J1624A coaxial cable that comes with MU181000A.
2. Connect the **Jittered Clock Output** connector of MU181500B and the **Ext. Clock Input** connector of MU183020A by using the J1624A coaxial cable that comes with MU181500B.
3. Connect the **Data Input1/2** connectors on the rear panel of MP1861A and the **Data Output1/2** connectors of MU183020A respectively by using coaxial cables. Use the J1658A coaxial skew match pair cable that comes with MP1861A, or cables that are of the same length with each other.
4. Connect the **Clock Output** connector of MU183020A and the **Ext. Clock Input** connector on the rear panel of MP1861A by using the J1652A coaxial cable that comes with MP1861A.
5. Connect the **Delayed Clock Output** and **MUX Clock Input** connectors on the rear panel of MP1861A by using the J1654A cable that comes with MP1861A.
6. Connect the **Data Output** (**XData Output**) connector to the DUT by using the J1656A coaxial cable that can be purchased separately.
7. Connect the **Clock Output** connector on the front panel of MP1861A and the **Ext. Clock Input** connector on the front panel of MP1862A by using a coaxial cable.
   The formula to obtain the length of the coaxial cable is:
   (Length of cables between the **Data Output** connector of MP1861A and the **Data Input** connector of MP1862A) + 0.5 m + α (Equivalent to the delay length of the DUT)
   In this case, use the cable with a length of (1.6 m + 0.5 m + a).

8. Connect the DUT and the **Data Input (XData Input)** connector on the front panel of MP1862A by using the J1656A coaxial cable set that can be purchased separately.
9. Connect the **Delayed Clock Output** and **DEMUX Clock Input** connectors on the rear panel of MP1862A by using the J1654A cable that comes with MP1862A.
10. Connect the **Data Output1/2** connectors on the rear panel of MP1862A and the **Data Input1/2** connectors of MU183040B respectively by using coaxial cables. Use the J1657A coaxial cable that comes with MP1862A, or cables that are of the same length with each other.
11. Connect the **1/2 Clock Output** connector on the rear panel of MP1862A and the **Ext. Clock Input** connector of MU183040B by using the J1668A coaxial cable that comes with MP1862A.

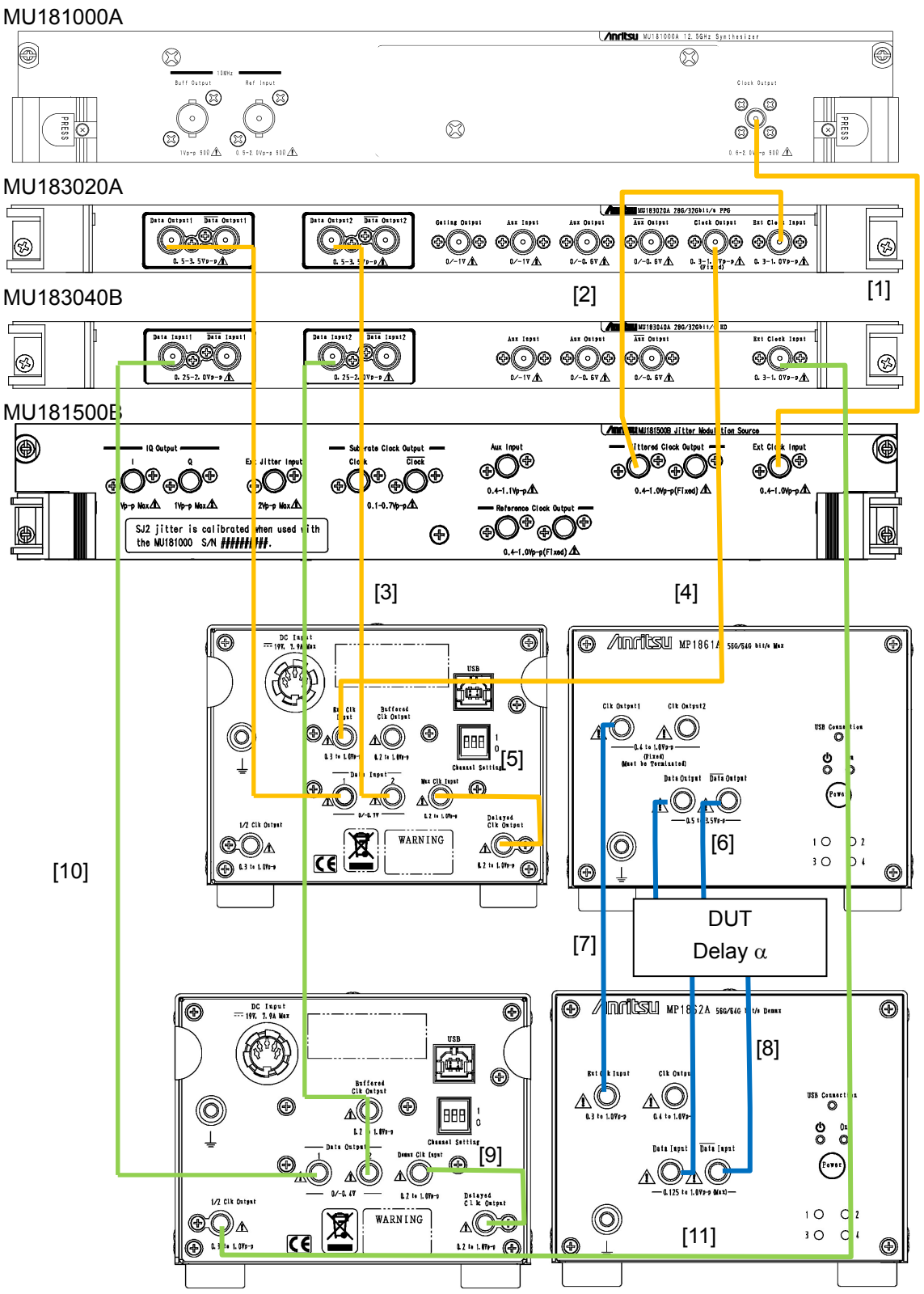


Figure D.7-1 Jitter-64G MUX-64G DEMUX Connection Example

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