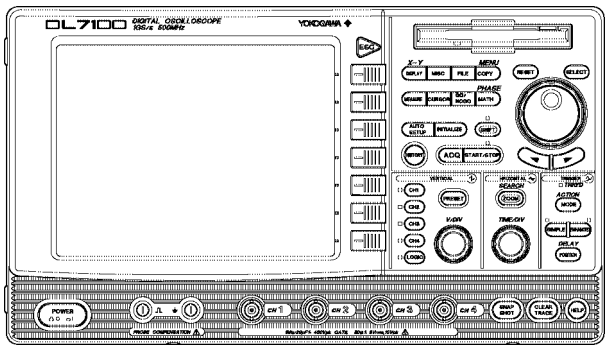
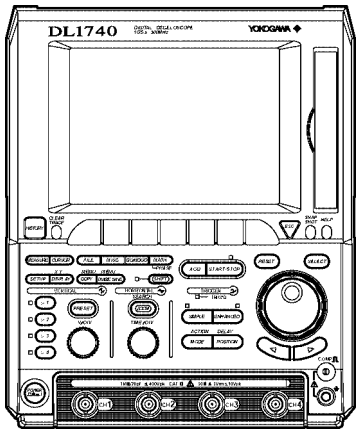
Technical Information

DL7100/DL7200/DL1740
Digital Oscilloscope
Data Sheets

TI 7014-00E





CONTENTS

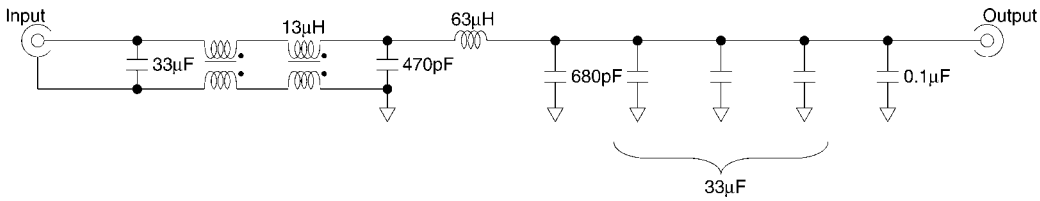
1. Introduction

These data sheets are a collection of characteristic data acquired mainly for parameters that are not defined in the specifications of the DL7100/DL7200/DL1740 digital oscilloscope. For this reason, the measurement results contained in these data sheets should just be regarded as reference data. Refer to the specifications included in the product catalog or instruction manual for information on the guaranteed characteristics of the DL7100/DL7200/DL1740. Unless otherwise specified, all data values contained in these data sheets are those measured at the standard ambient temperature (23°C ± 2°C). Also note that the voltage-axis accuracy is calculated at the full range of 8 div.

The measuring instruments used to prepare these data sheets are listed below.

Name of Instrument	Model		Supplier
DC voltage/current source	7651		Yokogawa
Function generator	FG120		Yokogawa
Oscilloscope calibrator	9500		Yokogawa
Programmable Head	9520		Yokogawa
Calibration generator	PG506A		Tektronix
Network analyzer	8753C		Hewlett-Packard
S-parameter test set	85047A		Hewlett-Packard
Synthesized signal generator	8663A		Hewlett-Packard
Filter	LBF 103	8G279	Tamagawa Electronics
Filter	LBF 103	8G280	Tamagawa Electronics
Filter	LBF 103	8G281	Tamagawa Electronics
Filter	LBF 103	8G282	Tamagawa Electronics
Filter	LBF 103	8G283	Tamagawa Electronics
Filter	LBF 126B	8D1438	Tamagawa Electronics
Filter	VBF 164D	9D1439	Tamagawa Electronics
Filter	VBF 166B	9D1441	Tamagawa Electronics
Filter	VBF 126B	9D1442	Tamagawa Electronics
DC filter	Prepared in-house*		

* The DC filter prepared in-house contains the fullowing circuits.



2. Vertical-axis Characteristics

2-1 Frequency Characteristics

Overview

A sine-wave signal is input from the 9500 oscilloscope calibrator through the 9520 programmable head to the DL main unit. Then, gain vs. frequency characteristics are measured from the amplitude observed on the DL main unit.

Measurement System

Equipment Used

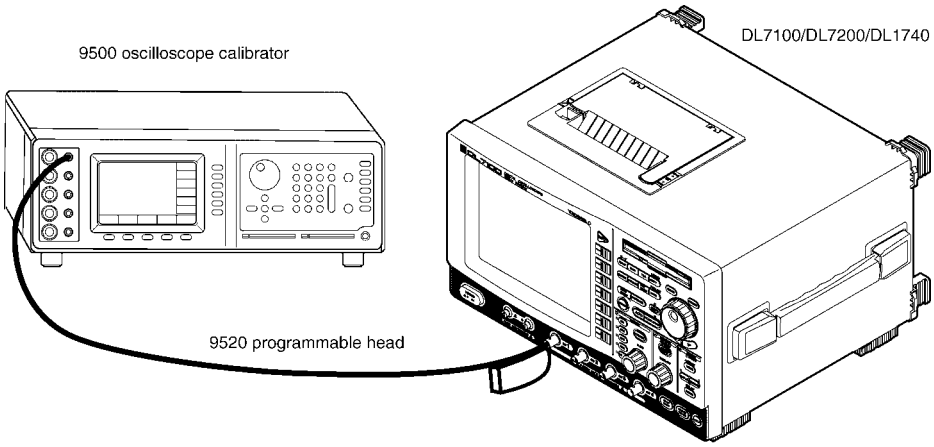
9500 oscilloscope calibrator

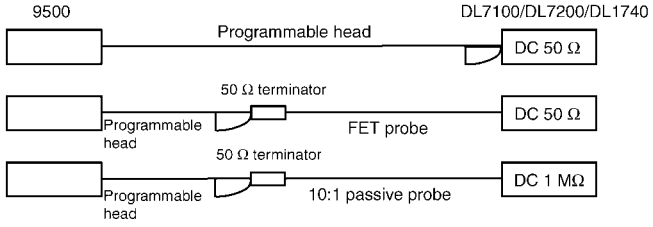
9520 programmable head

50 Ω terminator

Example of Interconnection

The frequency characteristics are measured by applying a 50 Ω direct input, FFT probe input and 10:1 passive probe input. The 50 Ω terminator is used to ensure impedance matching when a probe is used.





Equipment Settings

Number of averages: 8

For 50 Ω Direct Input

Voltage-axis range: 100 mV/div (probe's ratio = 1:1)

Input coupling: DC 50 Ω

For FET Probe Input

Voltage-axis range: 100 mV/div (probe's ratio = 10:1)

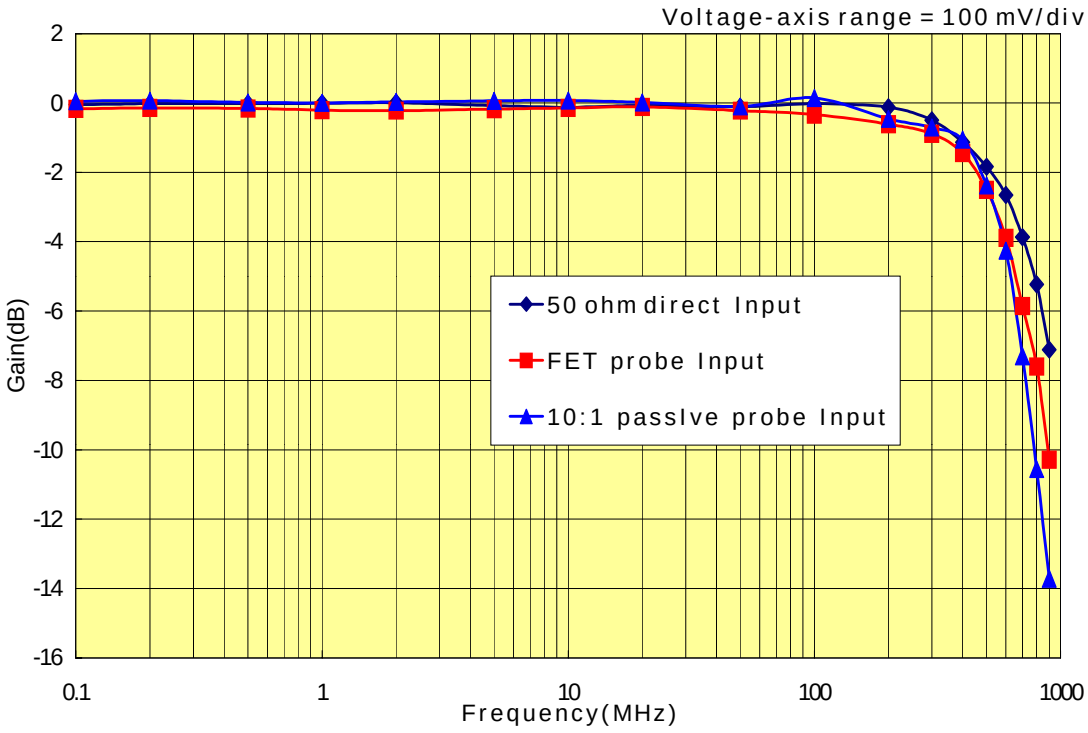
Input coupling: DC 50 Ω

For 10:1 Passive Probe Input

Voltage-axis range: 100 mV/div (probe's ratio = 10:1)

Input coupling: DC 1 MΩ

Measurement Results



2-2 Pulse Response

Overview

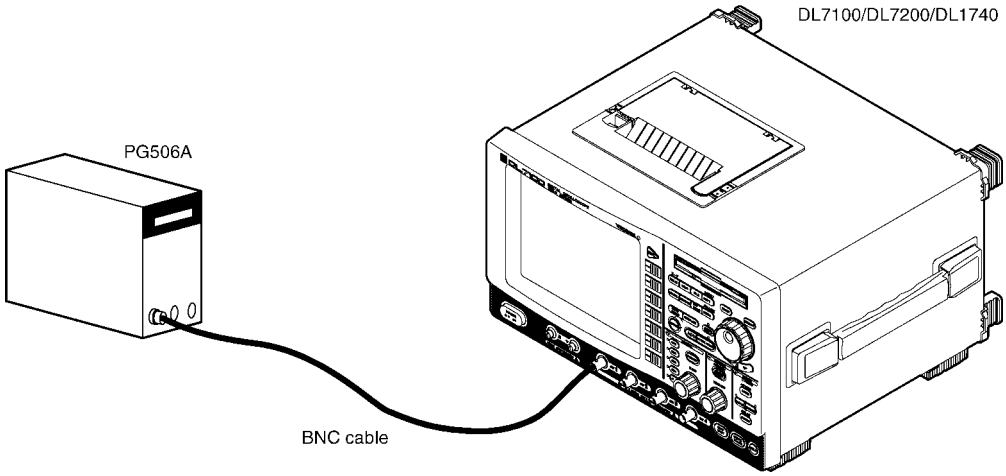
A pulse signal with an amplitude equivalent to 6 divisions of the DL main unit's on-screen scale is input to observe the step response. In addition, the timebase setting is varied to observe changes in the on-screen waveforms.

Measurement System

Equipment Used

PG506A calibration generator (used to generate a pulse of approximately 700 ps rise time)

Example of Interconnection

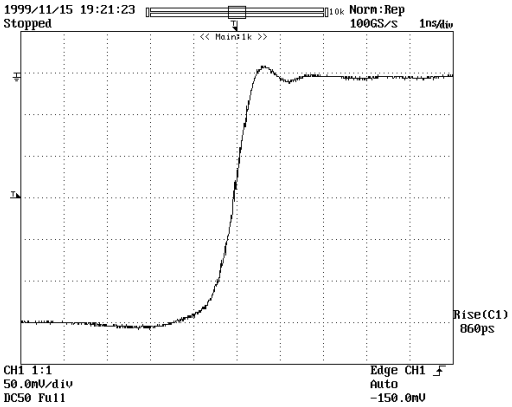


Equipment Settings

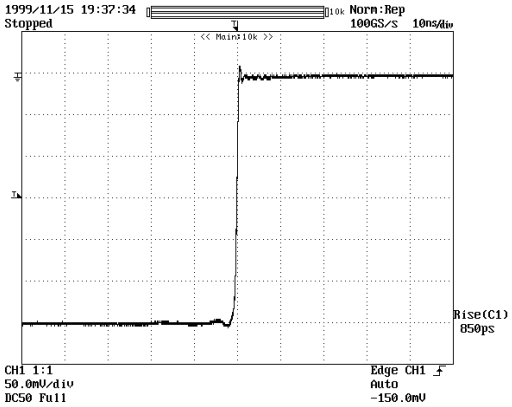
Voltage-axis range:	50 mV/div
Timebase range:	1 ns/div, 10 ns/div, 10 µs/div, 1 ms/div
Input coupling:	DC 50 Ω

Measurement Results

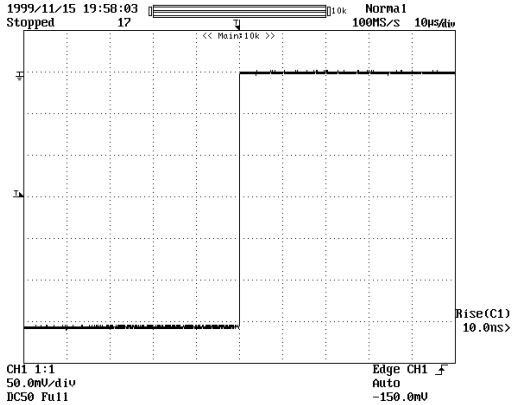
50 mV/div, 1 ns/div



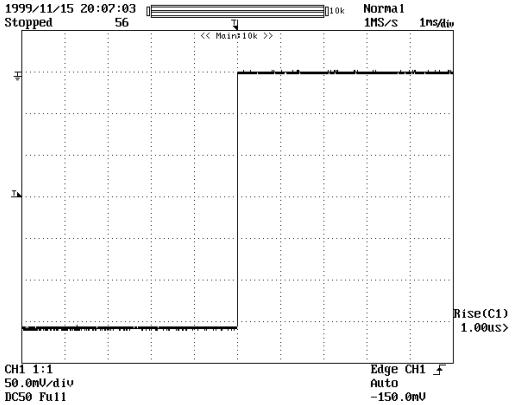
50 mV/div, 10 ns/div



50 mV/div, 10 µs/div



50 mV/div, 1 ms/div



2-3 Derating of Maximum Input Voltage vs. Frequency Characteristics for 1 MΩ Input

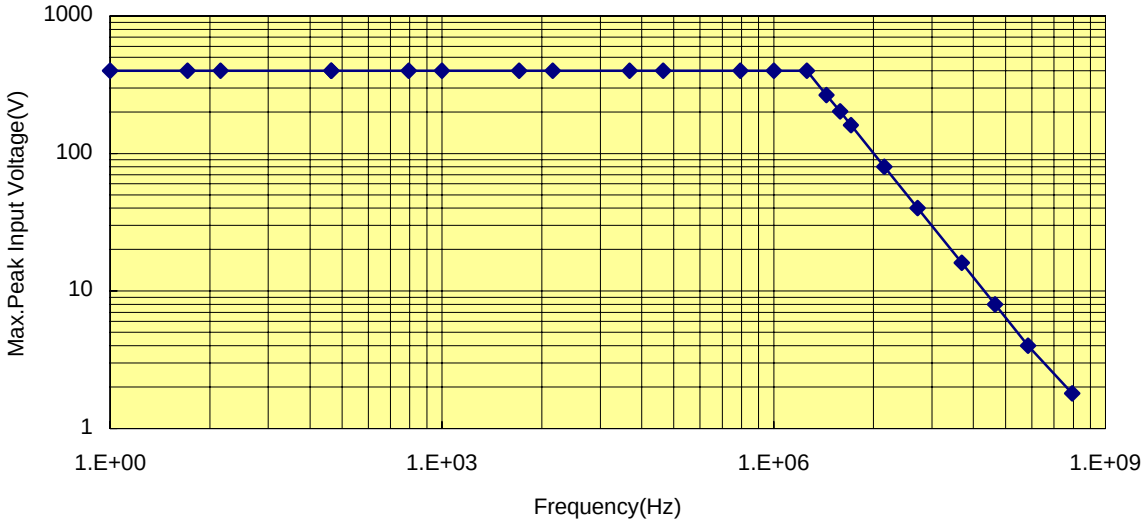
Overview

The derating of maximum input voltage vs. frequency characteristics are calculated from the characteristics of components that compose the front-end circuit of the input block.

(Simulation is carried out under the conditions of direct input and the voltage-axis range of 2 mV/div to 50 mV/div.)

Measurement Results

(Note that the specifications guarantee these characteristics only for frequencies no higher than 1 kHz.)



2-4 Input Characteristics (Return Loss VSWR) when 50 Ω Output Signal Is Observed

Overview

The 8753C network analyzer is used to measure VSWR of the DL7100/DL7200/DL1740.

Equipment Used

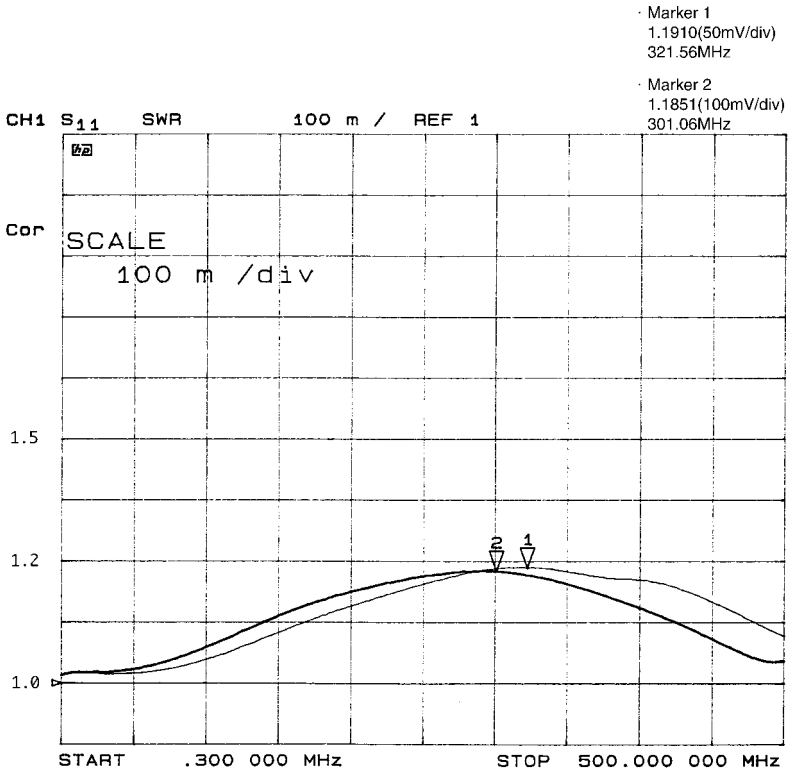
8753C network analyzer

87047A S-parameter test set

N-BNC adapter

BNC-SMA adapter

Measurement Results



2-5 Voltage-axis Accuracy vs. Frequency Characteristics

Overview

The DC accuracy of the DL main unit is measured using the DC voltage source while the ambient temperature is varied from 23°C to 33°C, 40°C, 13°C, and then 5°C. Calibration is carried out only once at 23°C and no self-calibration is applied thereafter, in order to verify how the voltage-axis accuracy changes.

Measurement System

Equipment Used

7651 DC voltage/current source

DC filter

Equipment Settings

Voltage-axis range: 50 mV/div

Timebase range: 1 ms/div

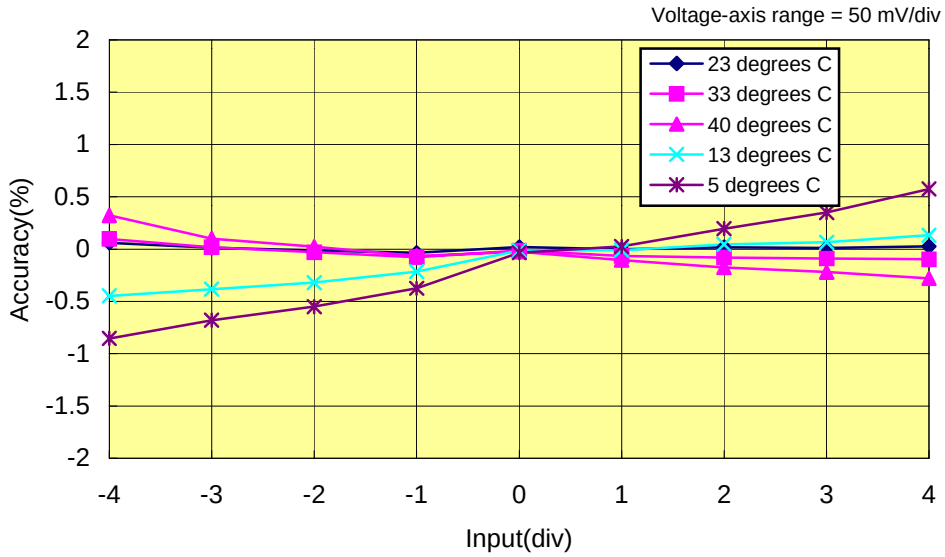
Input coupling: DC 1 MΩ

Number of averages: 8

Bandwidth (20 MHz): ON

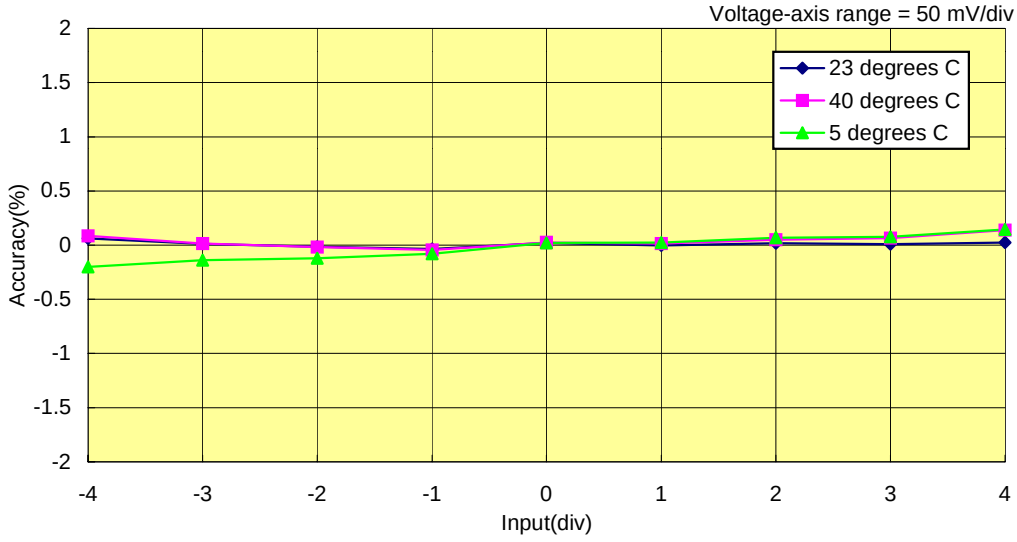
Measurement Results

Voltage-axis Accuracy vs. Temperature Characteristics



Supplementary Notes: The DL7100 can be calibrated to eliminate the effects of temperature on voltage-axis sensitivity (see the figure below).

Voltage-axis Accuracy vs. Temperature Characteristics (immediately after calibration)



2-6 Linearity

Overview

The input voltage is varied using the DC voltage source to measure the linearity of the DL7100/DL7200/DL1740.

Measurement System

Equipment Used

7651 DC voltage/current source

DC filter

Equipment Settings

Voltage-axis range: 50 mV/div

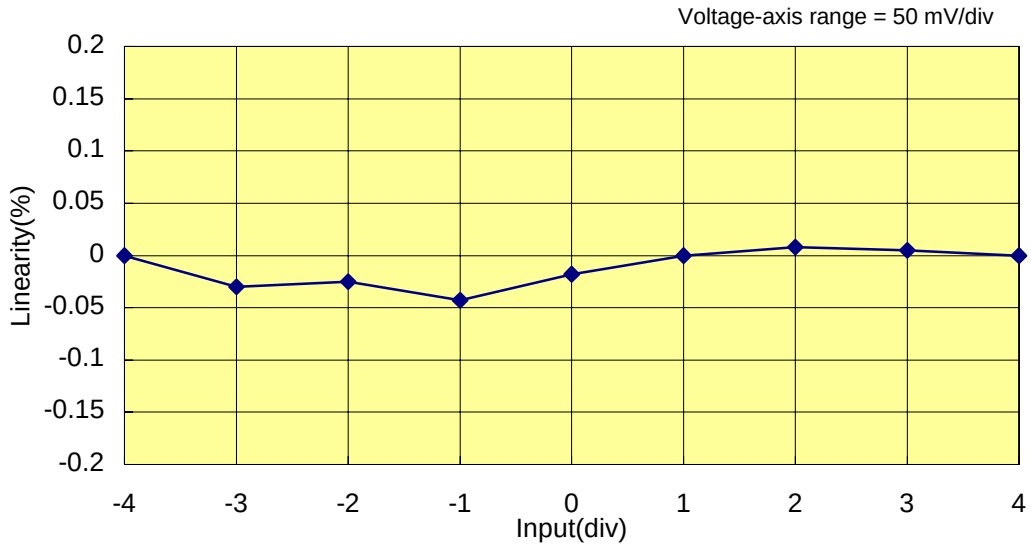
Timebase range: 1 ms/div

Input coupling: DC 1 MΩ

Number of averages: 8

Bandwidth (20 MHz): ON

Measurement Results



2-7 Effective Bits

Overview

A sine-wave signal is input to the DL main unit. Then, effective bits are determined using the curve fitting method, from a difference between the data value of an ideal sine wave and the data value resulting from quantization carried out by the DL main unit.

Measurement System

Equipment Used

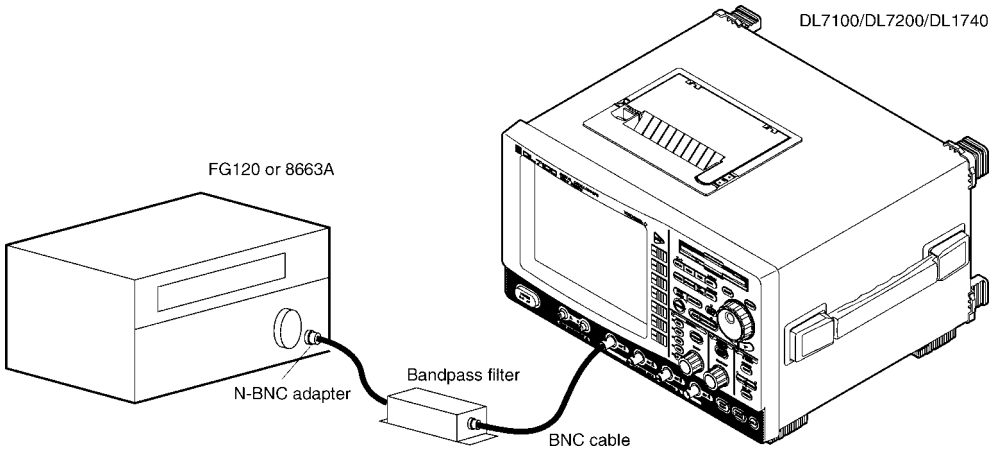
FG120 function generator (100 kHz)

8663A synthesized signal generator (500 kHz or higher)

N-BNC adapter (for use with the 8663A)

Bandpass filter

Example of Interconnection

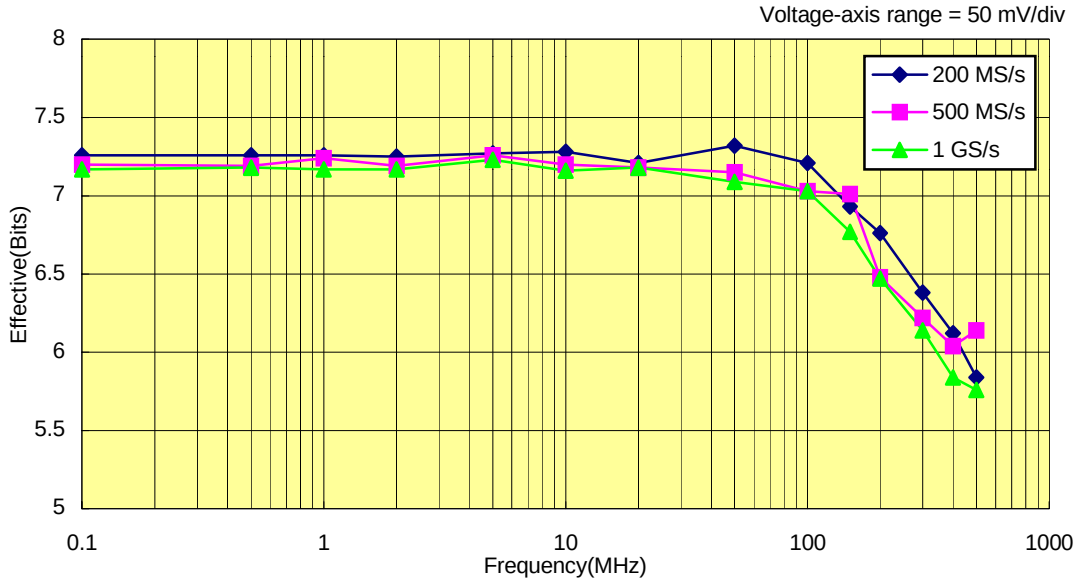


Equipment Settings

Voltage-axis range:	50 mV/div
Input coupling:	DC 50 Ω
Input voltage:	6 div or greater

Measurement Results

The data based on "box averaging" is shown in tabular format here since its primary objective is to verify the effect of the Box Average function.



Change in the Number of Effective Bits when "Box Average" Is Applied

- Data acquired when the sampling rate is changed with the input frequency kept constant (10 kHz)

Sampling Rate (MS/s)	Number of Effective Bits
0.2	7.95
0.5	7.95
1	7.95
2	7.95
5	7.91
10	7.89
20	7.82
50	7.73
100	7.57

- Data acquired when the frequency is changed (with the sampling rate set in such a manner that two periods' worth of the signal can be observed)

Input Frequency (kHz)	Sampling Rate (MS/s)	Number of Effective Bits
20	10	7.87
50	20	7.78
100	50	7.65
200	100	7.52
500	200	7.3

2-8 Overdrive Recovery Time

Overview

A pulse having an amplitude greater than the full span of the DL main unit's preset voltage-axis range is input to the DL main unit, in order to measure the time taken for the observed signal to settle into the input signal level with a tolerance range of ±1%.

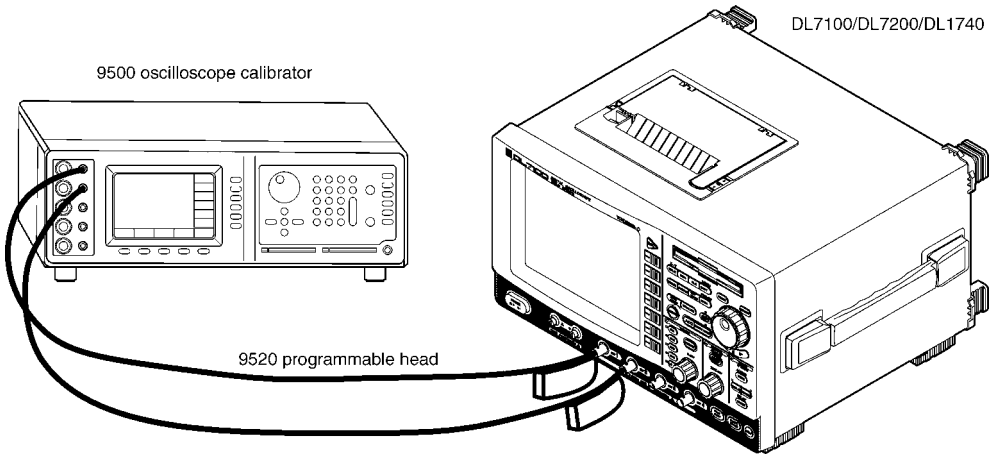
Measurement System

Equipment Used

9500 oscilloscope calibrator

9520 programmable head (two units)

Example of Interconnection



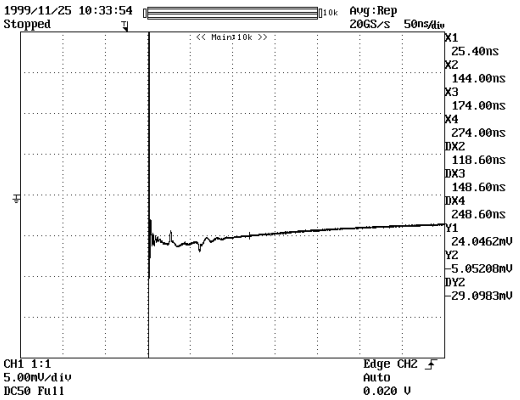
Equipment Settings

Voltage-axis range:	5 mV/div, 10 mV/div, 20 mV/div, 50 mV/div
Input coupling:	DC 50 Ω
Number of averages:	16
Input waveform:	Pulse with amplitude rising from -500 mV to 0 mV

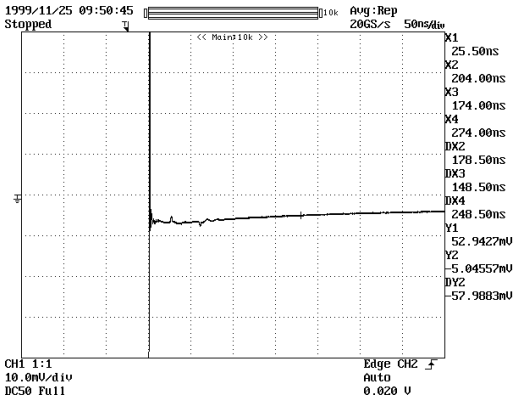
Measurement Results

Measurement No.	Voltage Range	Recovery Time
(1)	5 mV/div	118.60 ns
(2)	10 mV/div	178.50 ns
(3)	20 mV/div	233.50 ns
(4)	50 mV/div	238.80 ns

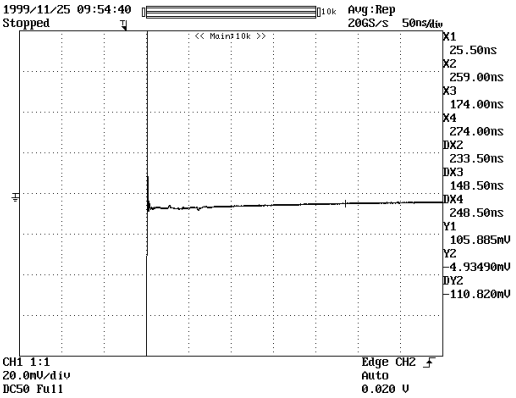
Measurement (1)



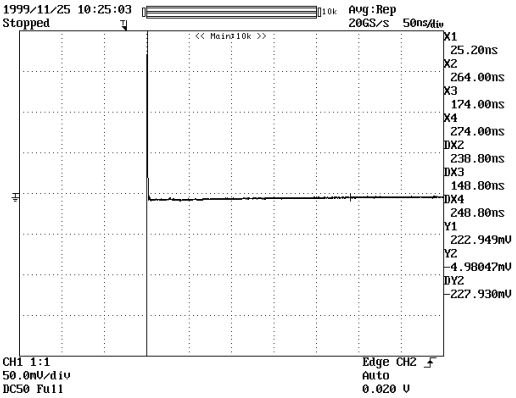
Measurement (2)



Measurement (3)



Measurement (4)



2-9 Residual Noise

Overview

The input channel is terminated to observe residual noise.

Measurement System

Equipment Used

50 Ω terminator

Equipment Settings

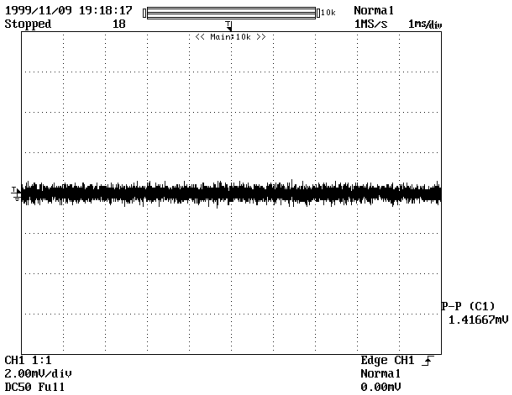
Voltage-axis range: 2 mV/div, 10 mV/div

Input coupling: DC 50 Ω

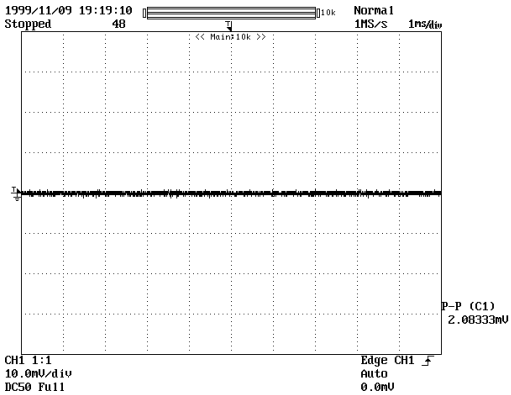
DC 1 MΩ (The input channel is terminated with 50 Ω terminator)

Measurement Results

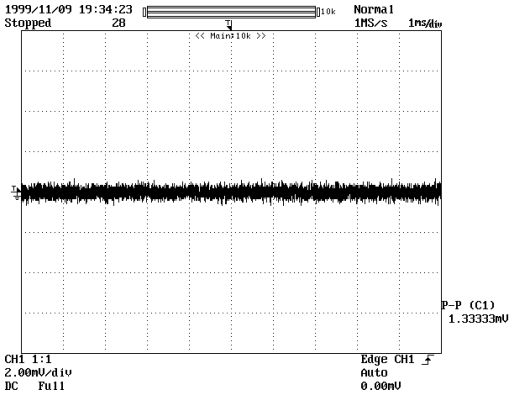
DC 50 Ω Input Coupling, 2 mV/div



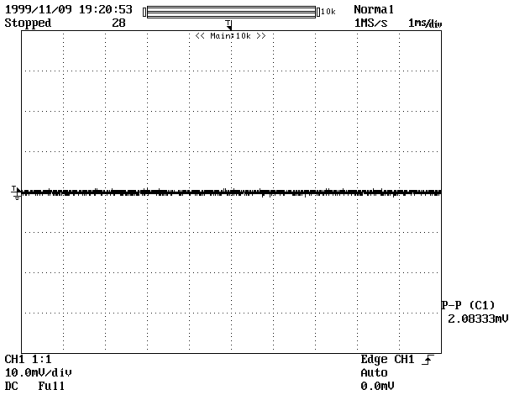
DC 50 Ω Input Coupling, 10 mV/div



DC 1 MΩ Input Coupling, 2 mV/div



DC 1 MΩ Input Coupling, 10 mV/div



2-10 Frequency Characteristics of Logic Probe Input - Toggle Frequency (Only DL7100/DL7200)

Overview

A sine-wave signal is input from the signal generator to the logic probe input terminals to measure the maximum frequency at which each bit of the logic input is triggered.

Measurement System

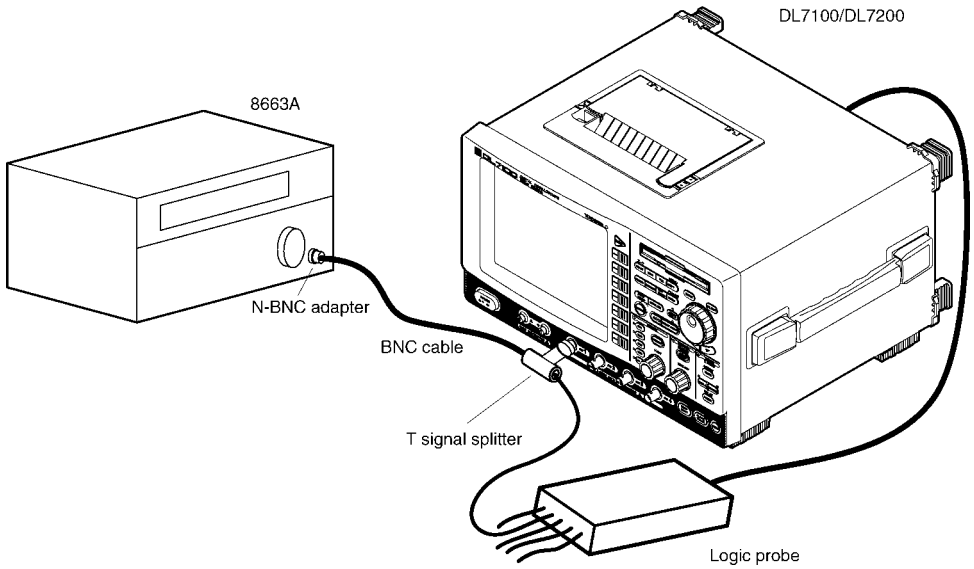
Equipment Used

8663A synthesized signal generator

T signal splitter

Example of Interconnection

An 80 MHz 500 mVp-p sine-wave signal is input from the 8663A to the CH1 terminal of the DL7100/DL7200, as well as to the logic probe through a T signal splitter. All the bits that are given no input are connected to the GND terminal. The bit under test is triggered by a logic signal while the frequency of the signal generator is being increased, in order to determine the highest possible frequency available for triggering.



Equipment Settings

Threshold level: 0 V for bits 0 to 6

0.1 V for bit 7

Measurement Results

Input Bit	Maximum Frequency (MHz)
bit 0	112
bit 1	114
bit 2	96
bit 3	93
bit 4	94
bit 5	117
bit 6	97
bit 7	91

3. Horizontal Axis Characteristics

3-1 Timebase Accuracy

Overview

A sine-wave signal is input from the signal generator to the DL main unit. Then, the difference between the input frequency and the observed frequency is determined from the beat waveform during normal sampling. Likewise, the error is determined by directly measuring the input frequency during equivalent time sampling.

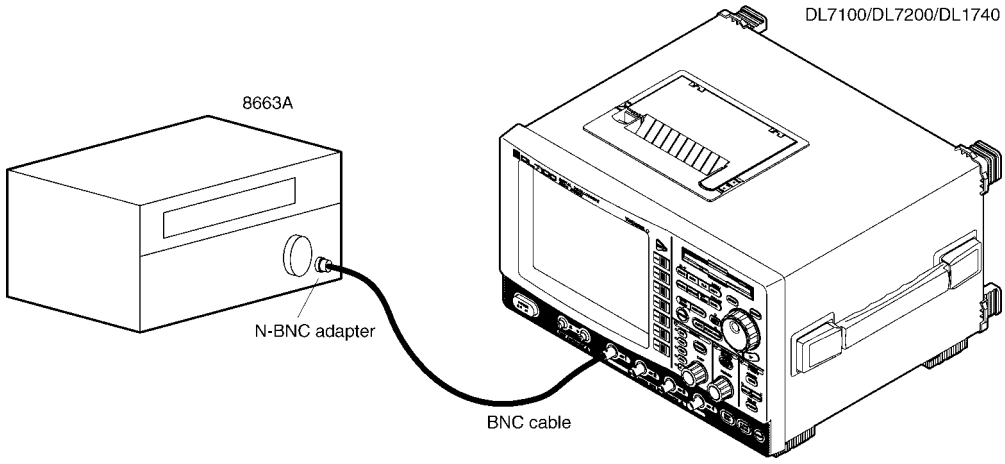
Measurement System

Equipment Used

8663A synthesized signal generator

N-BNC adapter

Example of Interconnection



Equipment Settings

Voltage-axis range:	50 mV/div
Input voltage:	6 div or greater
Input coupling:	DC 50 Ω

Measurement Results

(1) Normal Sampling

Sampling rate:	100 MS/s (timebase range = 10 µs/div)
Input frequency:	100.05 MHz
Measured beat frequency:	51.77 kHz
Error:	17.7 ppm

Sampling rate:	500 MS/s (timebase range = 1 µs/div)
Input frequency:	500.25 MHz
Measured beat frequency:	257.6 kHz
Error:	15.2 ppm

(2) Equivalent Time Sampling (100 GS/s, 1 ns/div)

Input frequency:	251 MHz
Measured frequency:	250.9 MHz
Error:	-0.04%

Input frequency:	500.9 MHz
Measured frequency:	501.3 MHz
Error:	0.07%

3-2 Channel-to-channel Skew (Including Logic Input : Only DL7100/DL7200 in the case of Logic Input)

Overview

Rising signals of the same phase are input to the respective channels at the same time. Then, the signals' time difference is measured between channel 1 and each of the remaining channels and between channel 1 and each bit of the logic probe.
(Logic Input is available for optional of DL7100/DL7200)

Measurement System

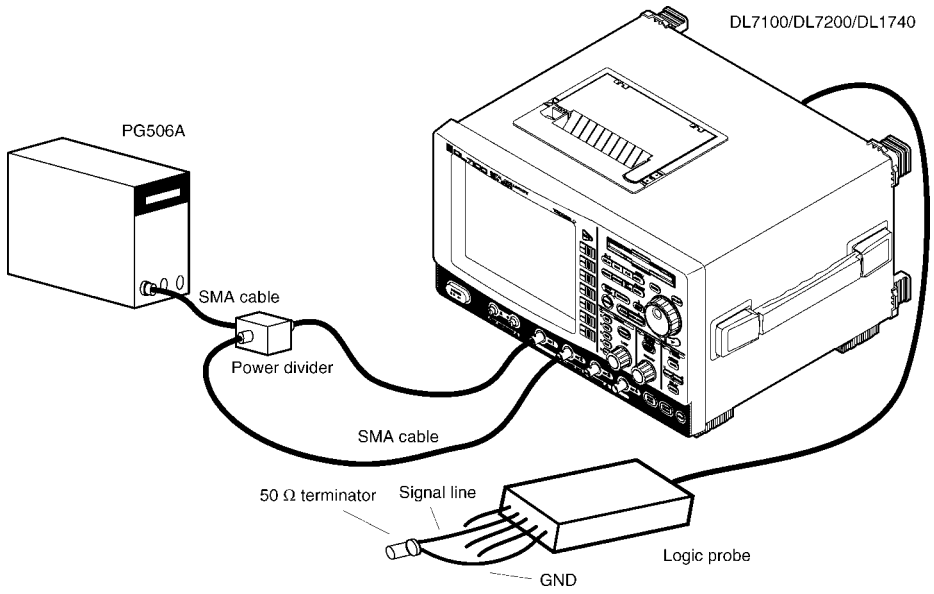
Equipment Used

PG506A calibration generator

Power divider

50 Ω terminator (for use with the logic probe)

Example of Interconnection



Equipment Settings

Voltage-axis range:	50 mV/div
Timebase range:	1 ns/div
Input coupling:	DC 50 Ω
Number of averages:	32
Input voltage:	5 div or greater

Measurement Results

Channel-to-channel Skew

Between channels 1 and 2: +60 ps

Between channels 1 and 3: -40 ps

Between channels 1 and 4: +100 ps

Channel-to-logic-input Skew

The same trigger level of 200 mV is used to measure the difference between the time taken for channel 1 to reach 200 mV and the rise time of logic input.

Between Channel 1 and Pod A

Bit 0: 300 ps

Bit 1: 120 ps

Bit 2: 280 ps

Bit 3: 1210 ps

Bit 4: -560 ps

Bit 5: 160 ps

Bit 6: 340 ps

Bit 7: 100 ps

Between Channel 1 and Pod B

Bit 0: 530 ps

Bit 1: 460 ps

Bit 2: 500 ps

Bit 3: 1360 ps

Bit 4: -230 ps

Bit 5: 490 ps

Bit 6: 600 ps

Bit 7: 440 ps

4. Trigger Characteristics

4-1 Trigger Sensitivity vs. Frequency Characteristics

Overview

A signal is input from the signal generator to the DL main unit to examine the relationship between frequency and the minimum voltage amplitude at which the DL main unit can be triggered.

Measurement System

Equipment Used

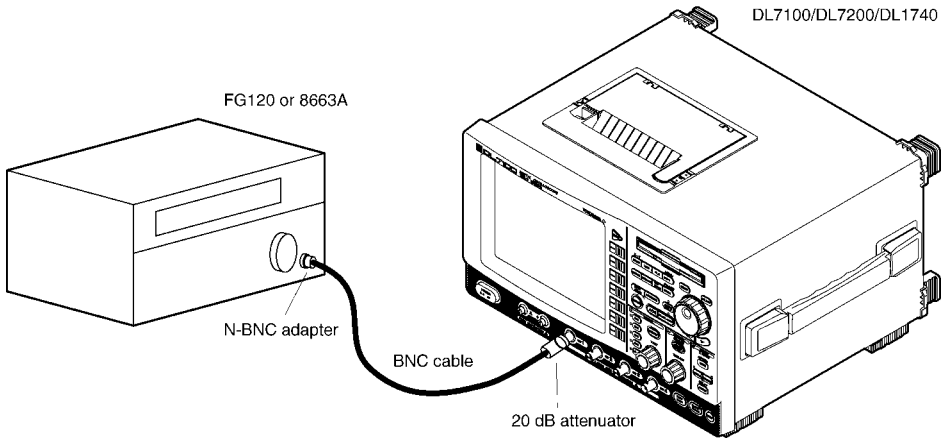
FG120 function generator (10 Hz to 500 kHz)

8663A synthesized signal generator (1 MHz or higher)

20 dB attenuator

N-BNC adapter (for use with the 8663A)

Example of Interconnection

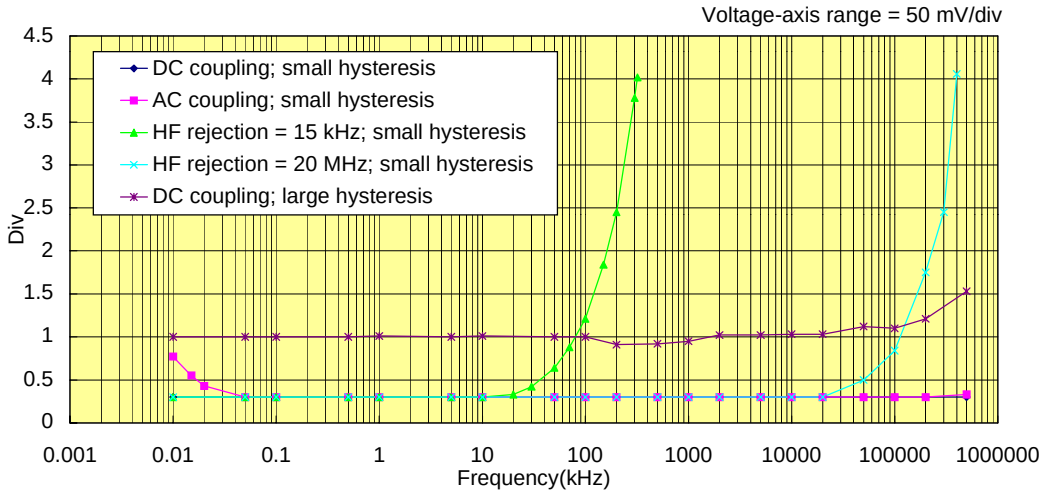


Equipment Settings

Voltage-axis range: 50 mV/div

Input coupling: DC 50 Ω

Measurement Results



4-2 Trigger Delay Characteristics

Overview

The absolute accuracy of a trigger delay setpoint is determined theoretically from the accuracy of the crystal osillator used for the DL main unit. In addition, the short-term stability is calculated by 1) applying a trigger delay and accumulating waveform data for as long as 10 minutes at the timebase range of 1 ns/div and 2) determining the amount of shift in the reproduced waveforms.

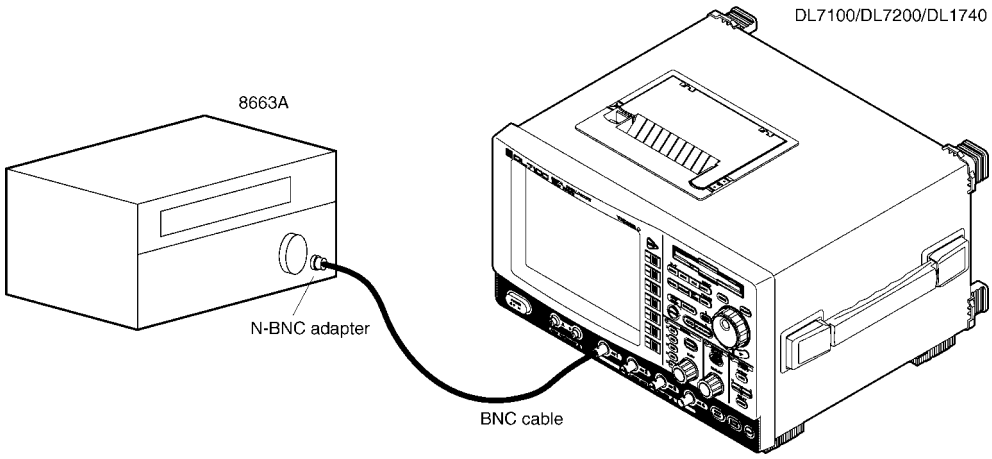
Measurement System

Equipment Used

8663A synthesized signal generator (1 MHz minimum)

N-BNC adapter

Example of Interconnection



Equipment Settings

Voltage-axis range:	50 mV/div
Timebase range:	1 ns/div (equivalent time sampling)
Input coupling:	DC 50 Ω
Trigger delay:	0.1 s
Accumulation:	ON (Persist)
Input voltage:	6 div or grater
Input frequency:	1 GHz

Measurement Results

Absolute accuracy:	±50 ppm of setpoint
Short-term stability:	3.08 ns (= fluctuation of 0.03 ppm)

4-3 Trigger Skew

Overview

Each of the four channels is used as a trigger source to measure the channel-to-channel maximum skew.

Measurement System

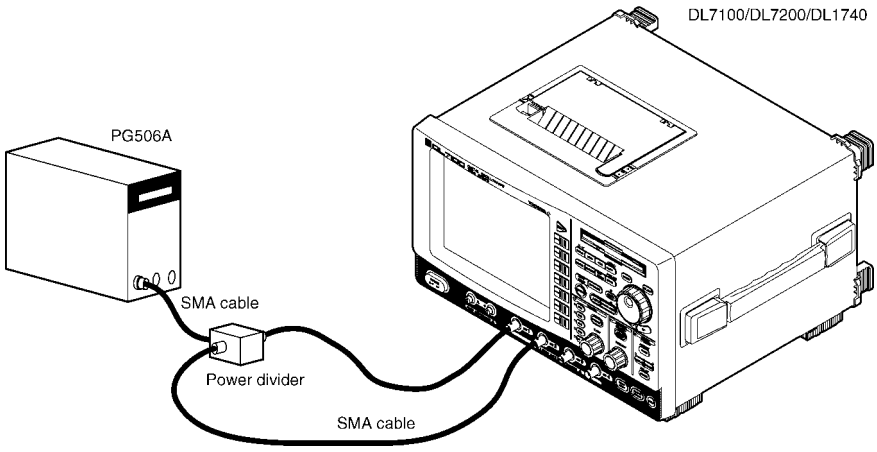
Equipment Used

PG506A calibration generator

Power divider

Example of Interconnection

The output signal of the PG506A is split into two signals by the power divider, one of which is fed to channel 1 and the other is fed to one of channels 2 to 4.



Measurement Method

A rising waveform signal is input from the PG506A to channel 1 so that channel 1 is used as the trigger source. The waveform at this point is recorded as a snapshot and used as the reference. Then, a waveform signal is input to channel 1 and one of the other channels using a power divider. From the cursor settings, the time difference is determined between the channel-1 waveform that is observed by using a channel other than channel 1 as the trigger source and the waveform recorded as a snapshot. The trigger skew is calculated as the time difference between the waveform that shows the largest lead and the one that shows the largest lag, compared with the reference waveform.

Equipment Settings

Voltage-axis range:	50 mV/div
Timebase range:	1 ns/div (equivalent time sampling)
Input coupling:	DC 50 Ω
Number of averages:	16
Input voltage:	5 div or grater
Trigger level:	-125 mV

Measurement Results

Trigger skew: 180 ps

5. Other Data

5-1 Screen Update Rate

For each of the conditions summarized in the table below, the screen update rate (Hz) is determined from the frequency of a trigger signal output from the TRIG OUT terminal.

Interleave = On

	10 kW	100 kW	500 kW	1 MW	4 MW	8 MW	16 MW
Normal	60 Hz	60 Hz	30 Hz	30 Hz	12 Hz	6 Hz	3 Hz
Env.	60 Hz	60 Hz	30 Hz	30 Hz	12 Hz	6 Hz	3 Hz
Box.	60 Hz	60 Hz	30 Hz	30 Hz	12 Hz	6 Hz	---
Math *1	60 Hz	30 Hz	30 Hz	30 Hz	12 Hz	6 Hz	---
*2	30 Hz	30 Hz	25 Hz	15 Hz	4 Hz	2 Hz	---
Main & z1 & z2 *3	30 Hz	30 Hz	30 Hz	20 Hz	8 Hz	4 Hz	2 Hz

Interleave = Off

	10 kW	100 kW	500 kW	1 MW	4 MW	8 MW
Normal	60 Hz	30 Hz	30 Hz	30 Hz	8 Hz	4 Hz
Env.	60 Hz	30 Hz	30 Hz	30 Hz	8 Hz	4 Hz
Box.	60 Hz	30 Hz	30 Hz	30 Hz	8 Hz	---
Math *1	30 Hz	30 Hz	25 Hz	13 Hz	3 Hz	---
*2	30 Hz	30 Hz	25 Hz	13 Hz	3 Hz	---
Main & z1 & z2 *3	30 Hz	30 Hz	30 Hz	20 Hz	6 Hz	3 Hz

*1 : + , -, ×

*2 : Bin, Invert, Diff, Integ, Pass-Thru

*3 : Zoom magnification × 2

In the table above, the functions are independent of each other. In addition, the data values were determined by measuring the signal output from the TRIG OUT terminal using a DL1540L oscilloscope.

5-2 MTBF

Overview

The MTBF value is calculated from the reliability of components that compose the DL7100 (equipped with 8 MB memory, built-in printer and logic input).

DL7200 (equipped with 16 MB memory, built-in printer and logic input).

DL1740 (equipped with FDD and built-in printer).

Calculation Results

MTBF value of the DL7100: 16298 FIT

DL7200: 23056 FIT

DL1740: 15498 FIT

(FIT denotes the number of failures that occur during 10^9 hours)

5-3 Speed of Data Transfer Using GP-IB Interface

Overview

A check program is used to measure the speed at which data is transferred or the operation panel is set up.

Measurement System

Equipment Used

Personal computer

GP-IB board

Measurement Results

DL7100/DL7200

Number of Data Items	Byte Data	Word Data	ASCII Data
1000	Approx. 25 ms	Approx. 28 ms	Approx. 650 ms
10000	Approx. 60 ms	Approx. 100 ms	Approx. 6.4 s
100000	Approx. 410 ms	Approx. 950 ms	Approx. 63 s
1000000	Approx. 4 s	Approx. 8.5 s	Approx. 622 s

DL1740

Number of Data Items	Byte Data	Word Data	ASCII Data
1000	Approx. 13 ms	Approx. 17 ms	Approx. 411 ms
10000	Approx. 52 ms	Approx. 87 ms	Approx. 4 s
100000	Approx. 463 ms	Approx. 818 ms	Approx. 41 s
1000000	Approx. 4.59 s	Approx. 8.18 s	Approx. 420 s

5-4 Speed of Data Transfer Using SCSI Interface

Overview

A check program is used to measure the speed at which data is transferred.

Measurement System

Equipment Used

8 GB hard disk drive with SCSI interface

Measurement Results

DL7100/DL7200

Binary data:	Approx. 300 KB/s (when transferring 1 MB of data)
ASCII data:	Approx. 60 KB/s (when transferring 1 MB of data)
Floating data:	Approx. 350 KB/s (when transferring 1 MB of data)

DL1740

Binary data:	Approx. 500 KB/s (when transferring 1 MB of data)
ASCII data:	Approx. 80 KB/s (when transferring 1 MB of data)
Floating data:	Approx. 400 KB/s (when transferring 1 MB of data)

5-5 Speed of Data Transfer Using Ethernet Interface

Overview

FTP server software or FTP client soft ware is used to measure the speed at which data is trahsferred.

Measurement System

Equipment Used

Personal Computer

Measurement Results

FTP Client Function

DL7100/DL7200

Save:	Approx. 250 KB/s (when transferring 1 MB of data)
	Approx. 500 KB/s (when transferring 4 MB of data)
Load:	Approx. 200 KB/s (when transferring 1 MB of data)
	Approx. 200 KB/s (when transferring 4 MB of data)

DL1740

Save:	Approx. 250 KB/s (when transferring 1 MB of data)
	Approx. 550 KB/s (when transferring 4 MB of data)
Load:	Approx. 250 KB/s (when transferring 1 MB of data)
	Approx. 350 KB/s (when transferring 4 MB of data)

FTP Server Function

DL7100/DL7200

PC card of DL7100/DL7200 -> Hard Disk of personal computer:
Approx. 350 KB/s (when transferring 1 MB of data)

PC card of DL7100/DL7200 <- Hard Disk of personal computer:
Approx. 200 KB/s (when transferring 1 MB of data)

DL1740

Zip of DL1740 -> Hard Disk of personal computer:
Approx. 250 KB/s (when transferring 1 MB of data)

Zip of DL1740 <- Hard Disk of personal computer:
Approx. 170 KB/s (when transferring 1 MB of data)

5-6 Speed of Data Transfer Using USB Interface

Overview

A check program/Waveform Viewer (700919) is used to measure the speed at which data is transferred.

Measurement System

Equipment Used

Personal Computer

Measurement Results

Using a check program

Waveform data

Number of Data Items	Byte Data	Word Data	ASCII Data
1000	Approx. 14 ms	Approx. 11 ms	Approx. 2368 ms
10000	Approx. 29 ms	Approx. 54 ms	Approx. 24 s
100000	Approx. 221 ms	Approx. 375 ms	Approx. 240 s
1000000	Approx. 2.249 s	Approx. 3.892 s	Approx. 2400 s

Screen image data

	Monochrome	Color
BMP	1.992 s	4.356 s
TIFF	2.003 s	4.416 s

Screen setting

	V/Div	T/Div	V/Div	T/Div
On Starting	80.75 ms	80.75 ms	10.1 ms	10.1 ms
On Stopping	67.13 ms	27.96 ms	10.1 ms	10.1 ms

Using a Waveform Viewer

Waveform data

ACQ Memory	Setting of CH	Time
10 kW	4 CH ON	1.484 s
100 kW	4 CH ON	2.728 s
500 kW	4 CH ON	8.188 s

Screen image data

	Monochrome	Color
BMP	2.276 s	4.695 s