User Manual 2

Tektronix

DTG5078 & DTG5274 & DTG5334
Data Timing Generators

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www.tektronix.com

Contacting Tektronix

Tektronix, Inc.
14200 SW Karl Braun Drive
P.O. Box 500
Beaverton, OR 97077
USA

For product information, sales, service, and technical support:

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General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. To avoid potential hazards, use this product only as specified.

Only qualified personnel should perform service procedures.

To Avoid Fire or Personal Injury

Use Proper Power Cord. Use only the power cord specified for this product and certified for the country of use.

Ground the Product. This product is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, ensure that the product is properly grounded.

Observe All Terminal Ratings. To avoid fire or shock hazard, observe all ratings and markings on the product. Consult the product manual for further ratings information before making connections to the product.

The common terminal is at ground potential. Do not connect the common terminal to elevated voltages.

Do not apply a potential to any terminal, including the common terminal, that exceeds the maximum rating of that terminal.

Do Not Operate Without Covers. Do not operate this product with covers or panels removed.

Avoid Exposed Circuitry. Do not touch exposed connections and components when power is present.

Do Not Operate With Suspected Failures. If you suspect there is damage to this product, have it inspected by qualified service personnel.

Do Not Operate in Wet/Damp Conditions.

Do Not Operate in an Explosive Atmosphere.

Keep Product Surfaces Clean and Dry.

Provide Proper Ventilation. Refer to the manual's installation instructions for details on installing the product so it has proper ventilation.

Symbols and Terms   **Terms in this Manual.** These terms may appear in this manual:

⚠ **WARNING.** *Warning statements identify conditions or practices that could result in injury or loss of life.*

⚠ **CAUTION.** *Caution statements identify conditions or practices that could result in damage to this product or other property.*

Terms on the Product. These terms may appear on the product:

DANGER indicates an injury hazard immediately accessible as you read the marking.

WARNING indicates an injury hazard not immediately accessible as you read the marking.

CAUTION indicates a hazard to property including the product.

Symbols on the Product. The following symbols may appear on the product:

| WARNING
High Voltage | Protective Ground
(Earth) Terminal | CAUTION
Refer to Manual | Double
Insulated |
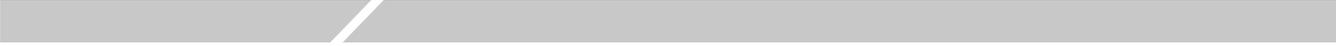
Preface

This is the user manual 2 for the DTG5000 Series Data Timing Generator.

About This Manual

This manual contains information on the various functions of the DTG5000 Series Data Timing Generator. This manual is composed of the following chapters:

■   *Reference* explains the functions that the Data Timing Generator. This section also describes the concept of data timing generator pattern data for the reference when dealing with pattern data.

■   *Appendices* provides information about system recovery, setting up the operating system, and setting up the display device.

Related Manuals and Online Documents

This manual is part of a document set of manuals and online documentation. This manual mainly focuses on functional, background information needed to use the product features. See the following list for other documents supporting the data timing generator operation and service. (Manual part numbers are listed in *Accessories & Options* section of the User Manual 1.)

Document name	Description
DTG5000 Series User Manual 1	Provides "getting started" and "operating basics" information, and gives information on how to use the data timing generator.
DTG5000 Series Technical Reference for Performance Verification & Specifications	Describes how to verify the performance of the data timing generator and lists its specifications.
DTG5000 Series Programmer Manual	Provides complete information on programming commands and remote control of the instrument. (Product Document CD)
DTG5000 Series Online Help	An online help system, integrated with the User Interface application that ships with this product. The help is pre-installed in the data timing generator.
DTG5000 Series Service Manual	Describes how to service the data timing generator to the module level. This optional manual must be ordered separately.

Reference

Reference

This chapter contains information on the various functions of the DTG5000 Series Data Timing Generator.

- Operating Modes

- Data Structure

- Pattern Edit

- Timing Parameters

- Output Level

- DC Output

- Trigger

- Sequence

- Jitter Generation

- DTG5000 Configuration Utility

- Master-Slave operation

- Pulse Generator Mode

- Offline Mode

- Remote Control

- Diagnostics and Calibration

Operating Modes

The DTG5000 Series data timing generator is controlled by the DTG5000 software running on the Windows 2000 operating system and operates in Data Generator (DG) mode or Pulse Generator (PG) mode.

Data Generator Mode

The DTG5000 Series operates as a data generator that outputs pattern data repeatedly. If you have defined a sequence, the DTG5000 Series runs it repeatedly. The DTG5000 Series either uses data created with the DTG's built-in pattern editor or imports data created with an external simulation software tool or other similar software, and then outputs the data. The output timing is determined by the sampling clock rate.

Pattern data can be controlled in the following ways:

■ Timing Control Delay, Width/Duty, Cross Point, Slew Rate

■ Level Control: Amplitude, offset

Pulse Generator Mode

The DTG5000 Series operates as a pulse generator. A typical clock pattern is generated as the data pattern being output. The output timing is determined by the output frequency.

Pattern data can be controlled in the following ways:

■ Timing Control Pulse Width, Delay, Duty, Tr/Tf

■ Level Control: Amplitude, offset

Comparison

The following table compares the Data Generator mode and Pulse Generator mode:

Table 1-1: Comparison between the Data Generator mode and Pulse Generator mode

Items	Data Generator mode	Pulse Generator mode
Data Rate (DG mode) Frequency (PG mode)	DTG5078: NRZ only: 50 kbps to 750 Mbps contains RZ, R1: 50 kbps to 375 Mbps DTG5274: NRZ only: 50 kbps to 2.7 Gbps contains RZ, R1: 50 kbps to 1.35 Gbps DTG5334: NRZ only: 50 kbps to 3.35 Gbps contains RZ, R1: 50 kbps to 1.675 Gbps	DTG5078: 50 kHz to 375 MHz DTG5274: 50 kHz to 1.35 GHz DTG5334: 50 kHz to 1.675 GHz
Available slots	DTG5078: A to H DTG5274: A to D DTG5334: A to D	DTG5078: A to D DTG5274: A to D DTG5334: A to D
Available windows	Channel Group, Blocks, Data-Listing, Data-Waveform, Level, Timing, Time Base, Sequence, Sub-sequences, Jitter Generation, DC Output	Level, Timing, Time Base, Sequence, Sub-sequences, DC Output
Channel Grouping	Available	Not available
Data Format	NRZ, RZ, R1	Pulse
Timing control	Delay, Pulse Width, Duty, Slew Rate, Polarity, Cross Point	Delay, Pulse Width, Duty, Slew Rate, Polarity, Pulse Rate
Level control resolution	High, Low, High Limit, Low Limit, Term.R, Term.V	High, Low, High Limit, Low Limit, Term.R, Term.V
Sequence operation	Available	Not available
Differential Timing Offset	Available	Available
Channel addition	AND, XOR	AND, XOR
Long delay	Available	Not available
Jitter range	Available	Available
Jitter generation	Available	Not available

Data Structure

This section contains the following two sections, which provide information on the DTG5000 Series Data Timing Generator data structure.

■ *Internal Pattern Data* section explains the data timing generator objects such as channel, group, block and sequence.

■ *Grouping and Channel Assignment* section defines the groups and tells how to use the Channel Group window.

Internal Pattern Data

This section explains the meanings of the data included in the windows. The data in the DTG5000 software consists of the channel, group, block, and sequence objects. This section details them in order.
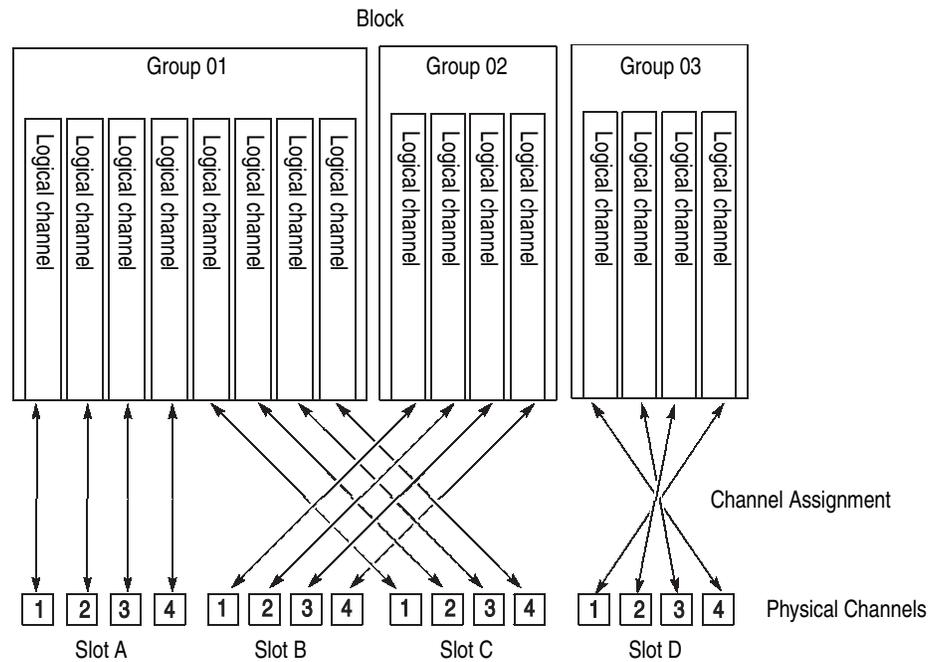
Figure 1-1: Channels, groups, blocks and channel assignment

Logical Channel   The data timing generator has two types of channels: logical and physical. Logical channels represent one-bit width pattern data. The number of logical channels is 32 (4 channels x 8 slots) for DTG5078, or 8 (2 channels x 4 slots) for DTG5274 and DTG5334.

Logical channels themselves do not have the concept of length. The length of the pattern data on a logical channel is the block size defined in the Blocks window. Each piece of the pattern data has a value of 0 or 1. To create the pattern data, you can use the Data-Listing or Data-Waveform window.

One of the key features of the data timing generator is that each logical channel has its attribute value of the output setting parameters such as the output level, pulse width or delay time. You can set these parameters using the Level and/or Timing windows.

Physical Channel   Physical channels are defined as the hardware channels of an output module installed in the data timing generator mainframe.

The number of physical channels available for the system is determined by the mainframe type and the types and number of output modules installed. Refer to Table 1-2.

Table 1-2: The number of available physical channels

Output module (on module)	DTG5078	DTG5274, DTG5334
DTGM10 (4)	4	2
DTGM20 (4)	4	2
DTGM21 (4)	4	2
DTGM30 (2)	2	2
DTGM31 (1)	1	1
DTGM32 (1)	1	1

The DTG5000 software has the output setup parameters, such as the output level or clock frequency, in its logical channels. To output actual data pattern outputs, do the following:

■ Specify the physical channels to output the data within the logical channels.

■ Send the output setup parameter to the physical channels to operate the hardware properly.

To associate the logical channel with physical channel (this is also called channel assignment), use the Channel Group window. Refer to "*Window Operation 4*" in the User Manual 1.

Groups   A group is defined as a set of logical channels. Grouping functions is especially useful depending on the DUT (Device Under Test). Several channels are sometimes used with the same output level and data format. In this case, handling multiple channels as one group is a useful method.

The number of logical channels that the system can accept is determined by the mainframe (32 for DTG5078, 8 for DTG5274, and 8 for DTG5334). In the Master-Slave operation mode, the number increases with the number of mainframes. The number of groups depends on how many groups the user divides into the logical channels. The total number of logical channels in each group cannot exceed the number of logical channels that the system can accept. By default, every logical channel is divided into an eight-channel group. To add a new group, you have to delete some groups or decrease the number of logical channels in a group to secure the logical channels required for the new group.

To create, delete, rename or resize a group, use the Channel Group window.

Blocks   A block is defined as a set of groups that consist of logical channels. The block is an elementary data of signal output. To specify the block length, use the block size located in the Blocks window. The block size represents the pattern data length, or vector length. The block width is the sum of bit width in the group to which it belongs, that is, the total number of logical channels.

By default, one block named Block1, whose size is 1000, is created.

Creating multiple blocks enables you to generate repetitive signal outputs by the blocks or sequential outputs with jumps. Even if two or more blocks exist in the system, only one method can be used for either grouping or channel assignment.

To create, rename, or resize a block, use the Blocks window.

Use the Data-Listing or Data-Waveform window to edit values (0 and 1) in the individual pattern data. Editing is possible by the block unit. To specify the block to be edited, you can use **Select Block...** from the Edit menu of the Data-Listing or Data-Waveform window, or use **View Data-Listing** or **View Data-Waveform** from the Edit menu of the Blocks window.

To set the voltage output setting parameter, use the Level window. To set the timing output setting parameter, use the Timing window. Both parameters can be set by the channel unit (except for clock frequency), but not by the block unit.

Sequence   A sequence consists of blocks and subsequences. As the subsequence elements, one or more block names and the repetition of the blocks are defined. Using a sequence, you can output complex signals by defining blocks, number of times the subsequence repeats, and jump conditions.

By default, a sequence that continuously repeats Block1 is provided. To create a sequence or sub-sequence, use the sequence table in the Sequence window or Sub-sequence window.
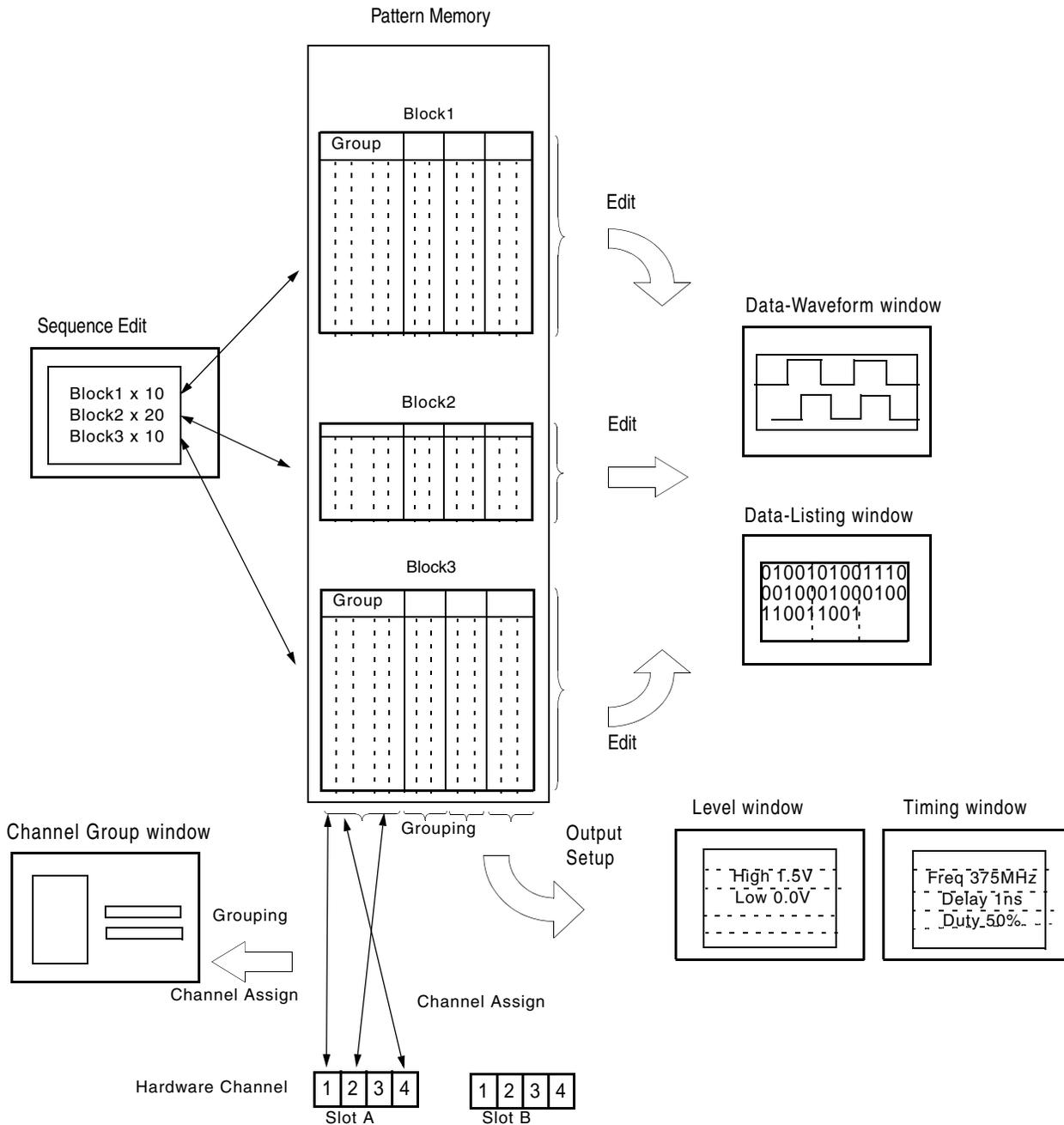
Figure 1-2: Concept of data and window

Grouping and Channel Assignment

Grouping collects channels in a single group to enable setup, edit or display by group. To define a group or perform a channel assignment, use the Channel Group window. You can use the grouping function only in the Data Generator mode.

Defining a Group   A group is defined by the name and the channels included in the group. The defined group and channels are used for display by the channel or by the group in the Data-Listing, Data-Waveform, Timing, or Level window.

The channels to be defined are logical channels but not physical channels, which are actually installed to the hardware. The pattern data you created by pattern edit and the setting parameters such as the voltage and/or delay are attributes with logical channels.

Assigning a Channel   To output a signal, you must assign the previously defined logical channels to physical channels. See Figure 1-3.

■ Assign only one physical channel to one logical channel.

■ Channel assignment can be performed, regardless of the bit sequence in the group; any physical channels can be assigned to logical channels as desired.

■ You can define the logical channels without being assigned to physical channels.

■ The physical channels that are not assigned to logical channels do not output any signals.
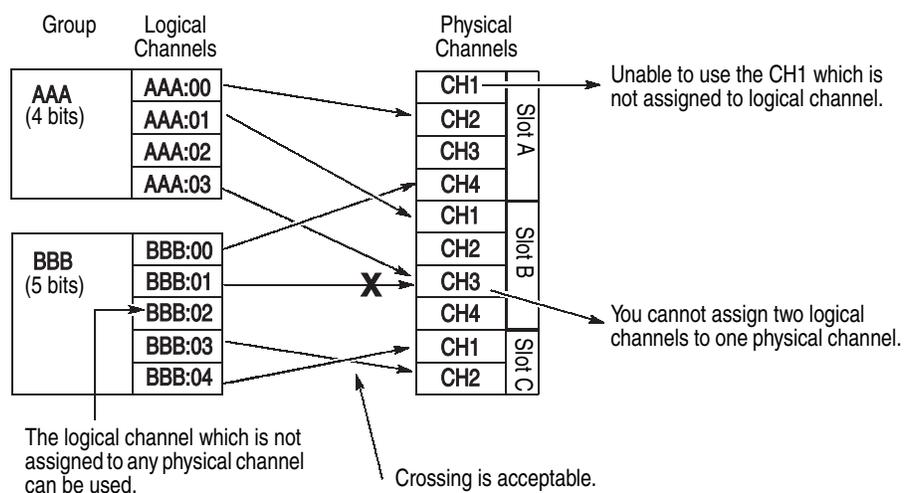
Figure 1-3: Channel assignment

Channel Group Window   To define a group or perform channel assignment, use the Channel Group window.

Figure 1-4: Channel Group window

Group List   The default group name(s) that appear in the Group List represent the maximum number of logical channels which can be used in the mainframe, and they are grouped by eight channels per group. The groups are independent of the installed output module(s).

Group Name. Assign a name to each group for identification. You can specify any 32-character or shorter string for a group. The name is case-sensitive, and the default is GroupXX.

Definable Number. Equal to or less than the number of physical channels supported by the mainframe. Up to 96.

Number of Channels. 1 to 96.

Predefined Grouping Options. The data timing generator provides three user-selectable predefined options for grouping:

- 8 channels per group

- 1 channel per group

- All channels in one group

Creating a New Group

To create a new group, there must be a logical channel not assigned to a group. By default, every logical channel has been assigned to groups in the data timing generator mainframe. You must delete several groups to make the logical channels available before creating a new group.

1. Push the front panel **MENU** button.

2. Select **Edit** menu, and then select **New Group...**.
   Alternatively, place the mouse pointer in the Group List table and right-click, then select **New Group...**.

3. The Grouping dialog box appears.
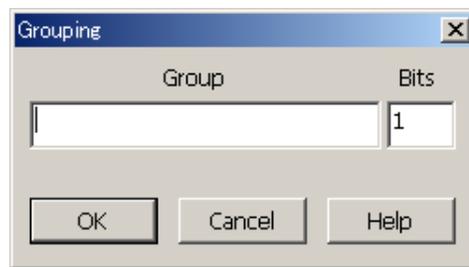
4. Enter a group name and the number of bits (number of logical channels) in the dialog box.

5. Select **OK** to create a new group.

Renaming and Resizing a Group

You can rename an existing group or change the number of its logical channels.

1. If the Group List is not activated on the screen, activate it by pressing the **TAB** key.

2. Select the target group using the Up or Down arrow key.

3. Push the front panel **MENU** button.

4. Select the **Edit** menu, and then select **Rename/Resize Group...**.
   Alternatively, place the mouse pointer in the Group List table and right-click, and then select the **Rename/Resize Group...**.

5. Edit the group name and the number of bits (the number of logical channels) in the Grouping dialog box.

6. Select **OK** to complete the change.

Deleting a Group You can delete the particular group(s) you selected or all the groups.

1. Activate the Group List in the Channel Group window.

2. To delete a group, select the group by using the Up or Down arrow key.

3. Push the front panel **MENU** button.

4. Select the **Edit** menu, and then select **Delete Group** or **Delete All Groups**. Alternatively, place the mouse pointer in the Group List table and right-click, and then select the **Delete Group** or **Delete All Groups**.

5. Select the menu option (Delete Group or Delete All Groups) to display the confirmation dialog.

6. Select **OK** to delete the group(s).

Selecting a Preset Grouping Option The following three combinations of a group and its logical channel are provided in the data timing generator.

■ 8 channels per group

■ 1 channel per group

■ All channels per group

To select one of these options, do the following.

1. Activate the Group List in the Channel Group window.

2. Push the front panel **MENU** button.

3. Select the **Edit** menu, and select **Preset**, and then select **8 Channels per Group** or **1 Channel per Group** or **All Channels in One Group**.

    Alternatively, place the mouse pointer in the Group List table and right-click, then select the **Preset**, and then select **8 Channels per Group** or **1 Channel per Group** or **All Channels in One Group**.

4. Select the menu item to display the confirmation dialog.

5. Select **OK** to create the group.

Channels Physical Channel The physical channel is identified by the mainframe number (1 to 3; for Master-Slave configuration), slot location (A to H), and channel number (1 to 4).

The installed physical channels are displayed in the right window pane of display area. Any channel indicated by a bullet in a white rectangle has already been assigned to a logical channel.

Assigning a Channel   Do the following steps to perform the channel assignment.

1. Activate the Group List in the Channel Group window.

2. Select the target logical channel with the Up or Down arrow key.

3. Activate the Channels with **TAB** key.

4. Select a physical channel with the Up/Down/Left/Right arrow keys.

5. Push **SELECT** button to complete the assignment. The physical channel name is displayed in the CH column of the Group List, indicating that the assignment is complete.

6. For the logical channel in the left of Group List, the next lower line is selected automatically. The channel assignments can be performed in sequence by repeating the selection of a physical channel in the right Channels.

De-assigning a Channel   You can de-assign a physical channel you selected. You can also de-assign all the physical channels currently assigned to logical channel(s).

1. Activate the Group List in the Channel Group window.

2. To de-assign a particular channel, select the channel with the Up or Down arrow key.

3. Push the front panel **MENU** button.

4. Select the **Edit** menu, and then select **De-assign** or **De-assign All**. Alternatively, place the mouse pointer in the Group List table and right-click, then select the **De-assign** or **De-assign All**.

5. A dialog box appears to prompt you for confirmation. Select **OK**.

6. The channels you selected are de-assigned.

Pattern Edit

This section describes how to prepare and edit pattern data

In pattern edit, you prepare or edit pattern data for each of the blocks. To perform the edit, you can use the Data-Listing and Data-Waveform windows. They differ only in display manners and manipulate the same data. Thus, any change in either window is concurrently reflected in the other window.

The cursor and the markers are updated in common in a Data-Listing and Data-Waveform window.

The selection domain has been independent although the cursor, marker 1, and marker 2 are updated in the common Data-Listing window and Data-Waveform window.
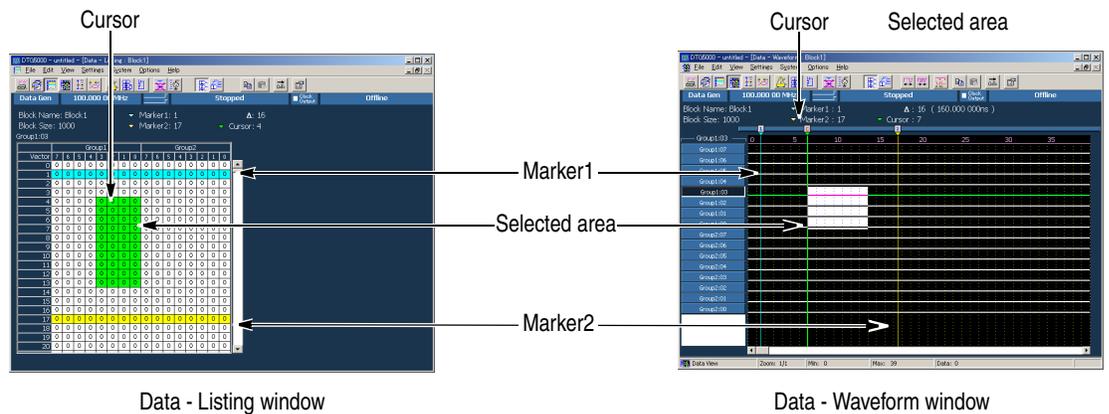
Figure 1-5: Data-Listing window and Data-Waveform window

Area

Data manipulated in the pattern edit is contained in a two-dimensional area that is defined by the bitwise dimension, i.e., width (horizontally in the Data-Listing window or vertically in the Data-Waveform window), and the dimension in the vector direction, i.e., length (vertically in the Data-Listing window or horizontally in the Data-Waveform window). Note that performing Paste or Shift does not resize the block.
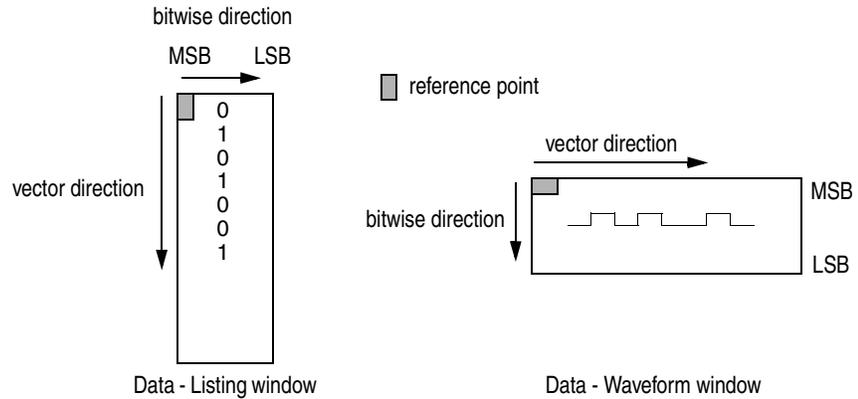
Figure 1-6: Area

Defining the Edited Area

For each editing operation, you must define the area to edit. The area is specified by the width in the bitwise direction and the length in the vector direction.

For the width in the bitwise direction, you can specify from 1 to the group width. You cannot specify a width greater than one group. To define the range in the bitwise direction, specify Channel or Group in the By: section associated with each edit command dialog box. When you select By: Channel, you can specify the width of the group indicated by the cursor or the width-in-bits you have selected using the the cursor. When you select By: Group, you can specify the width of the group indicated by the cursor. When you select View by Group as a viewing mode, By: Group is selected automatically as a width of the edit area.

For the length in the vector direction, you can specify any value from 1 to the block length. To define the range in the vector direction, specify All, Between Markers, or Selected in the Range: section associated with each edit command dialog box.

Table 1-3: Edited Area

Range	By	Vector direction	Bitwise direction
All	Group	All	Group indicated by cursor
	Channel	All	Channel indicated by cursor

Table 1-3: Edited Area (cont.)

Range	By	Vector direction	Bitwise direction
Between Markers	Group	Between two markers	Group indicated by cursor
	Channel	Between two markers	Channel indicated by cursor
Selected		Selected area	Selected area (within 1 group)
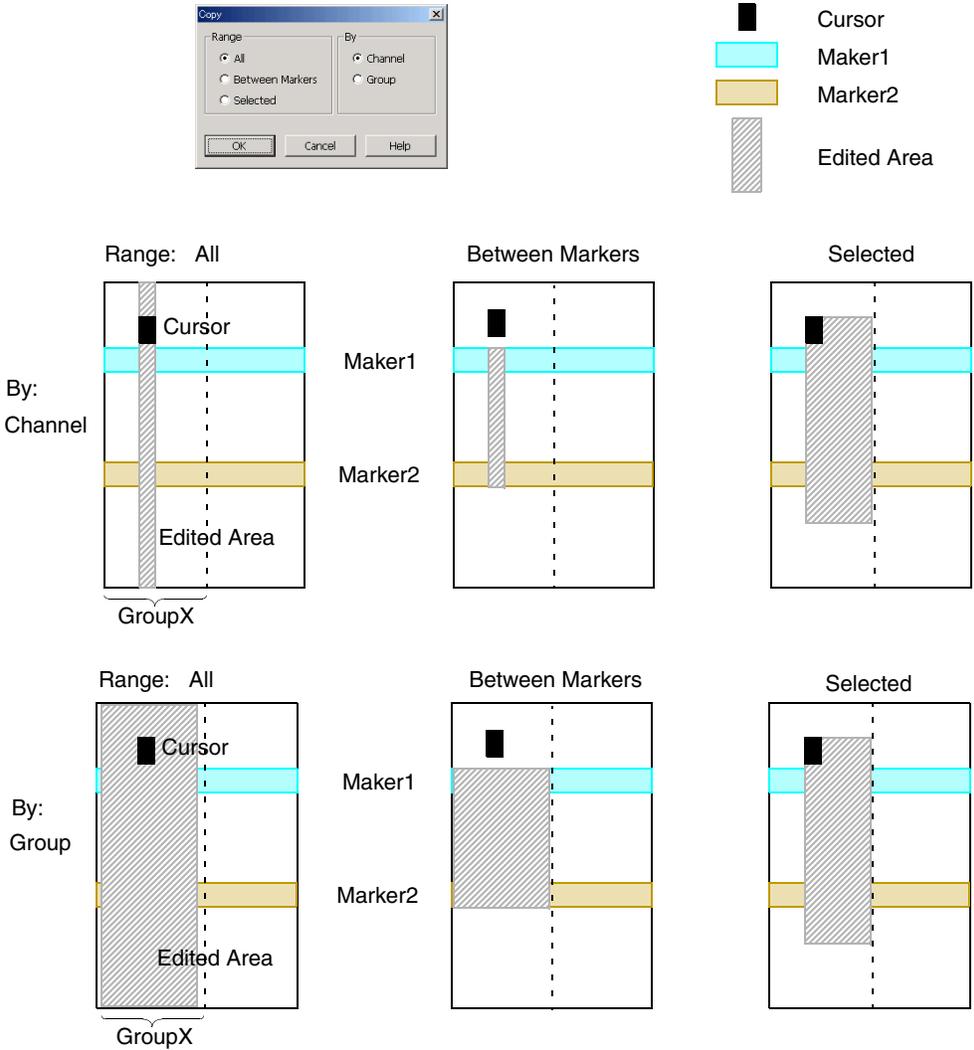
Figure 1-7: Selection of edited area (View by Channel)

Cursor and Markers

The cursor and the markers are provided to define the area edited.

Moving a Cursor   The cursor defines the point to be used as the reference of the area edited. To move the cursor, use the Up, Down, Left or Right arrow keys or the knob or MENU button.
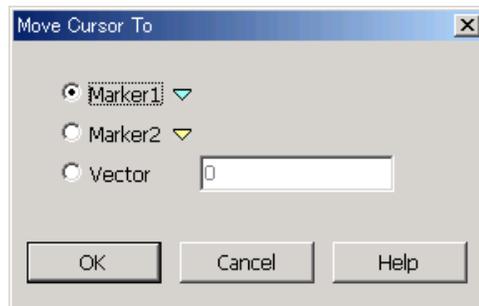
Figure 1-8: Move Cursor To dialog box

When moving the cursor using a menu, you can move it to the position of Marker1, the position of Marker2, or the specified vector position.

1. Press the **SELECT** or **MENU** key to display the menu. Then, select **Move Cursor To...**.

2. Use the **TAB** key and Up or Down arrow key to select **Marker1**, **Marker2** or **Vector**.

3. When you select Vector, enter the vector number where you want the cursor to move to using the numeric keys.

4. Use the **TAB** key to select the **OK** button, then press the **ENTER** key. The cursor moves to the specified position.

Moving Markers   The two markers define the range in the vector direction. Use the menu to move the markers.
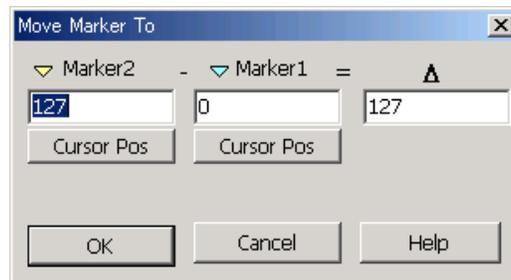
Figure 1-9: Move Marker To dialog box

When moving the markers using a menu, you can move it to the position of the cursor or the specified vector position.

1. When setting a marker as a cursor position, first move the cursor to the specified position.

2. Press the **SELECT** or **MENU** key to display the menu. Then, select **Move Marker To...**.

3. Use the **TAB** key and arrow keys to select **Marker1**, **Marker2** or Δ numeric box or Cursor Pos button.

4. When you select a numeric box, enter a numeric value. By setting the delta value, you can define the position of Marker2 relative to Marker1.

5. When you select a Cursor Pos button, press the ENTER key. The value of the cursor position is input in the numeric box.

6. Use the **TAB** key to select the **OK** button, then press the **ENTER** key. The marker moves to the specified position.

Defining an Area   To define a rectangular area as the range edited, do the following procedure. You must limit an area only in a single group because it cannot be defined in the bitwise direction over more than one group.

1. Move the cursor to either end of the area.

2. While holding down the **SHIFT** key, press the Up, Down, Left or Right arrow keys or turn the knob to define the area.

View

The edit windows offer the following features to facilitate editing.

Unit View
View by Channel
View by Group

You can view data by channel or group. To select either one, press the **MENU** key to display the **View** menu, and then select **View by Channel** or **View by Group**.

Zoom

The Data-Waveform window can zoom the view in or out in the vector direction horizontally.

The Zoom In/Out feature of the window can display the view from 10 to 2560 vectors. For example, if the Data-Waveform window displays 50 vectors and you zoom in, then 1/2 or 25 vectors will be displayed. If the Data-Waveform window displays 50 vectors and you zoom out, then 100 vectors will be displayed.

1. Press the **MENU** key to display the **View** menu, then select **Zoom In** or **Zoom Out**.

2. Press the **ENTER** key.

If you are using the mouse, you can click on the icon on the toolbar.

View with Timing   The pattern of a Data-Waveform window is displayed with the Format, Delay, Pulse Width, and Polarity settings you set in the Timing window.

View with Timing shows the details of pattern format, delay, polarity and soon.
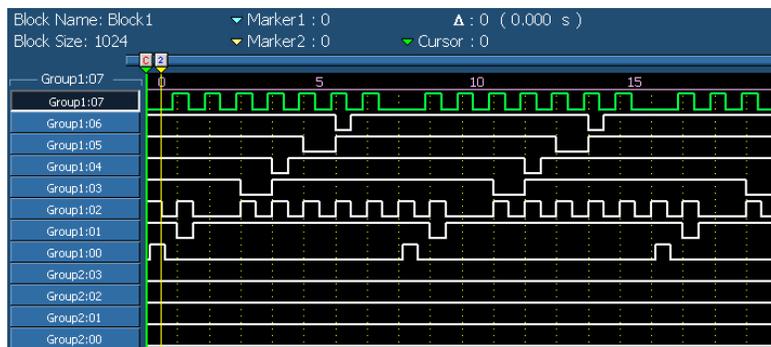
Figure 1-10: View with Timing

Display Order   You can change the display order of the groups when you select the view by group.

Select the group you want to move first. Then, press the **MENU** key to display the **View** menu. You can move a group in the Data-Listing window by using the **Move Left** or **Move Right** command. If you are in the Data-Waveform window, you can use the **Move Up** or **Move Down** command.

Properties   You can select how data is listed when viewed by group.

The Data-Listing window allows you to select a radix display option. Signed specifies whether to sign the MSB used for decimal display.
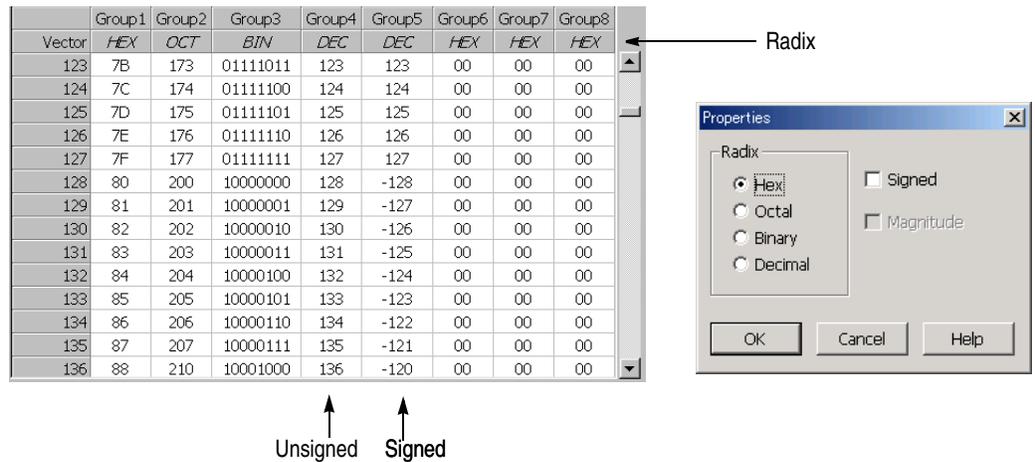
Figure 1-11: Data-Listing window properties

The Data-Waveform window allows you to additionally select magnitude display on the view in the bitwise direction. For Magnitude, when the group width is n bits, n-bit signed or unsigned values of the data of group are displayed by graphically with weighting of 2^n.
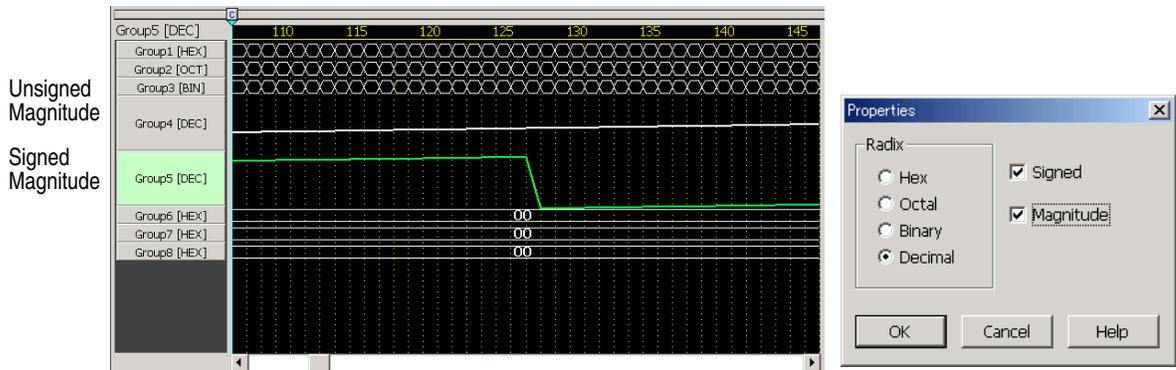
Figure 1-12: Data-Waveform window properties

Select Block   Selects the block you want to display or edit in the Data-Listing and Data-Waveform windows. To create a new block, you have to use the Blocks window.

1. Press the **MENU** key to display the **Edit** menu or the **SELECT** key to display the pop-up menu, then select **Select Block...**.

2. The block name defined now is displayed on a Select Block dialog box.

3. Select a block with arrow key, then press the ENTER key.

4. The contents of the selected block are displayed.

Edit Menu

The range which applies a command is specified by Range and By which are displayed on the dialog box of each command.

Several Edit commands are available from the Edit menu. A pop-up menu is displayed when you use the **SELECT** key and the Edit menu is displayed by the **MENU** key. The range is displayed and specified in the dialog box of each command.

Copy...   Copies the pattern data from the specified range to the DTG's own clipboard. Because it is copied as data, you can also Paste it to a group with a different radix display option specified.

Paste   Pastes the contents of the DTG 5000 software's own clipboard to the location starting from the cursor position. This command places the cursor at the top left corner of the rectangle (the MSB), or the position of the least vector number. If the rectangular area in the clipboard goes out of the width-in-bits and vector length of the group with the current cursor position as the base, an error will occur.

Invert...   Inverts data values 0 and 1 of the pattern data in the specified range.

Mirror...   Mirrors the arrangement of the pattern data in the specified range. You can select the arrangement in either the vector or bitwise direction.

```
      0 0 1 1 1              0 1 0 0 1            1 0 0 1 0
      1 0 1 0 0              1 1 1 0 0            0 0 1 1 1
      1 1 1 0 0     ◀——      1 0 1 0 0    ——▶     0 0 1 0 1
      0 1 0 0 1              0 0 1 1 1            1 1 1 0 0

     Mirror Vector          Selected area        Mirror Bit
```
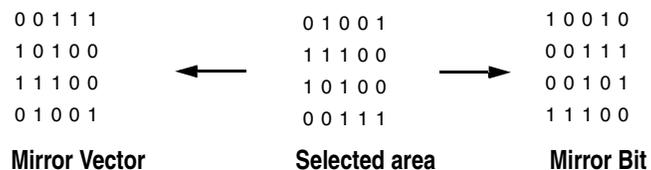
Figure 1-13: Mirror operation

Shift/Rotate... Moves the pattern data by Value in the specified range in either the vector or bitwise direction. When the Value is positive and a vector is selected as the direction, the data moves toward a large vector number. When bitwise is selected as the direction, the data moves toward the MSB.

Operation:

Shift. All the data moving outside the above range are lost, and the empty columns are filled with 0s.
Rotate. The data moving outside the range is moved to the empty columns to fill them.

Direction:

Bit. Moves the data in the bitwise direction.
Vector. Moves the data in the vector direction.

Fill with One/Zero... Fills the values of all the data in the specified range with 0s or 1s.

Clock Pattern... Creates a clock pattern of Low (0) and High (1) in the vector direction in the specified range. In Low or High Step, specify the number of vectors followed by 0s or 1s, respectively. The sum of the Low and High Step values is defined as the clock pattern cycle. For view by group, the same clock patterns are created for each of the channels in the group.

Predefined Pattern... Creates one of the six predefined patterns in the specified range. The pattern is created in a rectangular area defined by the width-in-bits and vector length. Therefore, if you select All or Between Markers for Range in View by Channel display, a pattern with a width of 1 bit will be created.

Figure 1-14: Predefined Pattern dialog box

■ Binary Counter

■ Johnson Counter

■ Graycode Counter

■ Walking Ones

■ Walking Zeros

■ Checker Board

In addition to the pattern type, you can specify Step, Skip, and Direction.

Table 1-4: Predefined Pattern settings

Items	Description
Step	Specifies the number of steps representing a counter value.
Skip	Available only for Binary Counter. Specifies the number of steps not used for counter values (this contains the initial value, unchanged). One step will be the sum of Step and Skip.
Direction	Selects either the up or down counter. The data created by the down counter is the reverse of data created by the up counter in the vector direction.

	Binary	Binary2	Binary3
Vector	*HEX*	*HEX*	*HEX*
0	00	00	00
1	01	00	00
2	02	01	00
3	03	01	01
4	04	02	01
5	05	02	00
6	06	03	02
7	07	03	02
8	08	04	00
9	09	04	03
10	0A	05	03
11	0B	05	00
12	0C	06	04
13	0D	06	04
14	0E	07	00
15	0F	07	05
	Step=1 Skip=0	Step=2 Skip=0	Step=2 Skip=1

Figure 1-15: Step and Skip

Binary							
Vector	7	6	5	4	3	2	1	0

Vector	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	1
2	0	0	0	0	0	0	1	0
3	0	0	0	0	0	0	1	1
4	0	0	0	0	0	1	0	0
5	0	0	0	0	0	1	0	1
6	0	0	0	0	0	1	1	0
7	0	0	0	0	0	1	1	1
8	0	0	0	0	1	0	0	0
9	0	0	0	0	1	0	0	1
10	0	0	0	0	1	0	1	0
11	0	0	0	0	1	0	1	1
12	0	0	0	0	1	1	0	0
13	0	0	0	0	1	1	0	1
14	0	0	0	0	1	1	1	0
15	0	0	0	0	1	1	1	1
16	0	0	0	1	0	0	0	0
17	0	0	0	1	0	0	0	1
18	0	0	0	1	0	0	1	0
19	0	0	0	1	0	0	1	1
20	0	0	0	1	0	1	0	0
21	0	0	0	1	0	1	0	1
22	0	0	0	1	0	1	1	0
23	0	0	0	1	0	1	1	1
24	0	0	0	1	1	0	0	0
25	0	0	0	1	1	0	0	1
26	0	0	0	1	1	0	1	0
27	0	0	0	1	1	0	1	1
28	0	0	0	1	1	1	0	0
29	0	0	0	1	1	1	0	1
30	0	0	0	1	1	1	1	0

Binary Counter

Johnson							
Vector	7	6	5	4	3	2	1	0

Vector	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	1
1	0	0	0	0	0	0	1	1
2	0	0	0	0	0	1	1	1
3	0	0	0	0	1	1	1	1
4	0	0	0	1	1	1	1	1
5	0	0	1	1	1	1	1	1
6	0	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	0
9	1	1	1	1	1	1	0	0
10	1	1	1	1	1	0	0	0
11	1	1	1	1	0	0	0	0
12	1	1	1	0	0	0	0	0
13	1	1	0	0	0	0	0	0
14	1	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	1
17	0	0	0	0	0	0	1	1
18	0	0	0	0	0	1	1	1
19	0	0	0	0	1	1	1	1
20	0	0	0	1	1	1	1	1
21	0	0	1	1	1	1	1	1
22	0	1	1	1	1	1	1	1
23	1	1	1	1	1	1	1	1
24	1	1	1	1	1	1	1	0
25	1	1	1	1	1	1	0	0
26	1	1	1	1	1	0	0	0
27	1	1	1	1	0	0	0	0
28	1	1	1	0	0	0	0	0
29	1	1	0	0	0	0	0	0
30	1	0	0	0	0	0	0	0

Johnson Counter

Graycode							
Vector	7	6	5	4	3	2	1	0

Vector	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	1
2	0	0	0	0	0	0	1	1
3	0	0	0	0	0	0	1	0
4	0	0	0	0	0	1	1	0
5	0	0	0	0	0	1	1	1
6	0	0	0	0	0	1	0	1
7	0	0	0	0	0	1	0	0
8	0	0	0	0	1	1	0	0
9	0	0	0	0	1	1	0	1
10	0	0	0	0	1	1	1	1
11	0	0	0	0	1	1	1	0
12	0	0	0	0	1	0	1	0
13	0	0	0	0	1	0	1	1
14	0	0	0	0	1	0	0	1
15	0	0	0	0	1	0	0	0
16	0	0	0	1	1	0	0	0
17	0	0	0	1	1	0	0	1
18	0	0	0	1	1	0	1	1
19	0	0	0	1	1	0	1	0
20	0	0	0	1	1	1	1	0
21	0	0	0	1	1	1	1	1
22	0	0	0	1	1	1	0	1
23	0	0	0	1	1	1	0	0
24	0	0	0	1	0	1	0	0
25	0	0	0	1	0	1	0	1
26	0	0	0	1	0	1	1	1
27	0	0	0	1	0	1	1	0
28	0	0	0	1	0	0	1	0
29	0	0	0	1	0	0	1	1
30	0	0	0	1	0	0	0	1

Graycode Counter

WalkingOnes							
Vector	7	6	5	4	3	2	1	0

Vector	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	1
1	0	0	0	0	0	0	1	0
2	0	0	0	0	0	1	0	0
3	0	0	0	0	1	0	0	0
4	0	0	0	1	0	0	0	0
5	0	0	1	0	0	0	0	0
6	0	1	0	0	0	0	0	0
7	1	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	1
9	0	0	0	0	0	0	1	0
10	0	0	0	0	0	1	0	0
11	0	0	0	0	1	0	0	0
12	0	0	0	1	0	0	0	0
13	0	0	1	0	0	0	0	0
14	0	1	0	0	0	0	0	0
15	1	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	1
17	0	0	0	0	0	0	1	0
18	0	0	0	0	0	1	0	0
19	0	0	0	0	1	0	0	0
20	0	0	0	1	0	0	0	0
21	0	0	1	0	0	0	0	0
22	0	1	0	0	0	0	0	0
23	1	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	1
25	0	0	0	0	0	0	1	0
26	0	0	0	0	0	1	0	0
27	0	0	0	0	1	0	0	0
28	0	0	0	1	0	0	0	0
29	0	0	1	0	0	0	0	0
30	0	1	0	0	0	0	0	0

Walking Ones

WalkingZeros							
Vector	7	6	5	4	3	2	1	0

Vector	7	6	5	4	3	2	1	0
0	1	1	1	1	1	1	1	0
1	1	1	1	1	1	1	0	1
2	1	1	1	1	1	0	1	1
3	1	1	1	1	0	1	1	1
4	1	1	1	0	1	1	1	1
5	1	1	0	1	1	1	1	1
6	1	0	1	1	1	1	1	1
7	0	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	0
9	1	1	1	1	1	1	0	1
10	1	1	1	1	1	0	1	1
11	1	1	1	1	0	1	1	1
12	1	1	1	0	1	1	1	1
13	1	1	0	1	1	1	1	1
14	1	0	1	1	1	1	1	1
15	0	1	1	1	1	1	1	1
16	1	1	1	1	1	1	1	0
17	1	1	1	1	1	1	0	1
18	1	1	1	1	1	0	1	1
19	1	1	1	1	0	1	1	1
20	1	1	1	0	1	1	1	1
21	1	1	0	1	1	1	1	1
22	1	0	1	1	1	1	1	1
23	0	1	1	1	1	1	1	1
24	1	1	1	1	1	1	1	0
25	1	1	1	1	1	1	0	1
26	1	1	1	1	1	0	1	1
27	1	1	1	1	0	1	1	1
28	1	1	1	0	1	1	1	1
29	1	1	0	1	1	1	1	1
30	1	0	1	1	1	1	1	1

Walking Zeros

CheckerBoard							
Vector	7	6	5	4	3	2	1	0

Vector	7	6	5	4	3	2	1	0
0	1	0	1	0	1	0	1	0
1	0	1	0	1	0	1	0	1
2	1	0	1	0	1	0	1	0
3	0	1	0	1	0	1	0	1
4	1	0	1	0	1	0	1	0
5	0	1	0	1	0	1	0	1
6	1	0	1	0	1	0	1	0
7	0	1	0	1	0	1	0	1
8	1	0	1	0	1	0	1	0
9	0	1	0	1	0	1	0	1
10	1	0	1	0	1	0	1	0
11	0	1	0	1	0	1	0	1
12	1	0	1	0	1	0	1	0
13	0	1	0	1	0	1	0	1
14	1	0	1	0	1	0	1	0
15	0	1	0	1	0	1	0	1
16	1	0	1	0	1	0	1	0
17	0	1	0	1	0	1	0	1
18	1	0	1	0	1	0	1	0
19	0	1	0	1	0	1	0	1
20	1	0	1	0	1	0	1	0
21	0	1	0	1	0	1	0	1
22	1	0	1	0	1	0	1	0
23	0	1	0	1	0	1	0	1
24	1	0	1	0	1	0	1	0
25	0	1	0	1	0	1	0	1
26	1	0	1	0	1	0	1	0
27	0	1	0	1	0	1	0	1
28	1	0	1	0	1	0	1	0
29	0	1	0	1	0	1	0	1
30	1	0	1	0	1	0	1	0

Checker Board

Figure 1-16: Predefined patterns

User Defined Pattern...   Fills the specified range with the user-defined pattern. If the width-in-bits of the specified range is smaller than that of the specified pattern, it will be filled, starting at the LSB of the pattern. A maximum of 1,000 vectors can be specified for the pattern. You can change the radix option of the input using Properties... of the View menu.
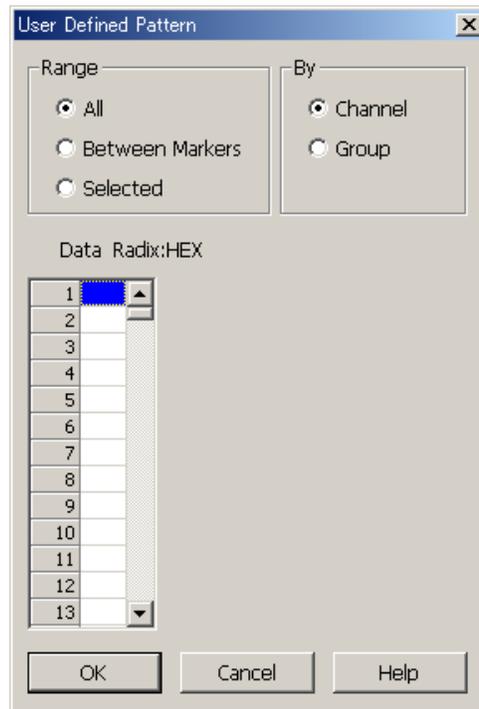

Figure 1-17: User Defined Patterns dialog box

PRBS/PRWS... Creates a pattern of a pseudo random pattern that uses the shift registers for the specified range.
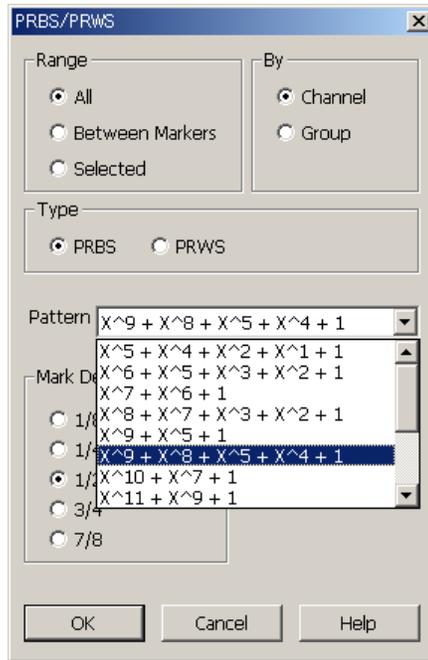
Figure 1-18: PRBS/PRWS dialog box

Figure 1-19 shows the correspondence between the pattern representations and the actual shift registers.
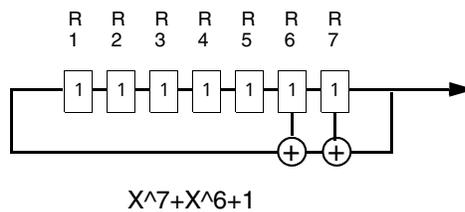
Figure 1-19: Shift register generator representation example

Set the following in the dialog box:

Table 1-5: PRBS/PRWS dialog box settings

Items	Description
Type	**PRBS:** Pseudo random bit sequence, a random pattern with a width of 1 bit. If you specify a range of two or more bits, the same pattern is created for all the bits. **PRWS:** Pseudo random word sequence, a two-dimensional random pattern that consists of those patterns generated with the PRBS that are arranged in the bitwise direction, starting at the LSB.
Pattern	The 14 patterns below are available. The register numbers are assigned, beginning at the register that will contain the feedback (Register 1). All the registers are initialized to 1 before calculation. For the shift register representations and the actual register image, see Figure 1-19 on page 1-28. PRBS5: X^5+X^4+X^2+X^1+1 PRBS6: X^6+X^5+X^3+X^2+1 PRBS7: X^7+X^6+1 PRBS8: X^8+X^7+X^3+X^2+1 PRBS9: X^9+X^5+1 PRBS9: X^9+X^8+X^5+X^4+1 PRBS10: X^10+X^7+1 PRBS11: X^11+X^9+1 PRBS11: X^11+X^8+X^5+X^2+1 PRBS12: X^12+X^9+X^8+X^5+1 PRBS13: X^13+X^12+X^10+X^9+1 PRBS14: X^14+X^13+X^10+X^9+1 PRBS15: X^15+X^14+1 PRBS23: X^23+X^18+1 Note: The pattern length of the PRBS23 is 8388608–1. The DTG5078 can create pattern data up to 8,000,000 vectors. Due to multiplier constraints of the DTG5274, output is not available with some clock frequency and data format settings.
Mark Density	PRBSn is a random pattern of 0s and 1s whose pattern cycle period is 2^n-1 (n = number of registers. In above Pattern, n = 5 to 23). Mark Density varies the percentage of 1s (= marks) in the cycle. Suppose that the pattern obtained by Left Rotating n patterns of PRBSn patterns (it shifts to the left by n piece, and a part to have overflowed is attached to the tail end) is $PRBSn_n$ and the pattern obtained by Left Rotating 2n patterns of PRBSn patterns is $PRBSn_{2n}$. If PRBSn is ANDed with $PRBSn_n$ or $PRBSn_{2n}$, this decreases the percentage of 1s. If it is ORed with them, this increases the percentage. Mark Density accepts 1/8 to 7/8. The following expressions are used to obtain the value: 1/8: $PRBSn$ & $PRBSn_n$ & $PRBSn_{2n}$ 1/4: $PRBSn$ & $PRBSn_n$ 1/2: $PRBSn$ 3/4: $PRBSn$	$PRBSn_n$ 7/8: $PRBSn$	$PRBSn_n$	$PRBSn_{2n}$

Table 1-5: PRBS/PRWS dialog box settings (cont.)

Items	Description
Invert	Inverts the values of 0s and 1s of the resulting random pattern.
	Setting Invert to Off generates a pattern that results from inversion of the PRBSn 0/1 pattern obtained by calculation. Setting Inversion to On generates the PRBSn pattern obtained by calculation.

Copy to Clipboard...   Copies the pattern data from the specified range to the Windows clipboard. Copy and Paste with the Windows clipboard manipulate the pattern data as text.

Paste from Clipboard...   Pastes the contents of the Windows clipboard to the location starting at the cursor position. This command places the cursor at the top left corner of the rectangle (at the MSB, or the position of the least vector number).

Importing a Pattern File   You can import to the DTG5000 software a pattern file created with other equipment or another application. The Import command, included in the File menu, is available while the Data-Listing or Data-Waveform windows is open. The Import command supports files of the following formats:

■ Tektronix TLA Data Exchange Format (*.txt)

■ Tektronix HFS Vector Files (ASCII) (*.vca)

■ Tektronix HFS Vector Files (Binary) (*.vcb)

■ Tektronix DG2000 series Files(*.pda)

■ Tektronix AWG2000 series Files (*.wfm)

■ Tektronix AWG400/500/600/700 series Files (*.pat)

Importing data is achieved block by block. The entire contents of the block you are editing are replaced with the data in the imported file. The vector length of the block is defined as the length of the data imported.

TLA, HFS and DG2000 files have grouping information (group name and width-in-bits). Data for several groups is included in a single TLA, HFS or DG2000 file.

When a group name is not defined or the same group name exists but the bit width differs, DTG5000 software will reorganize its groups to match the groups of the imported file. In these cases, all the assignments to the physical channels are reset.

If the groups are not reorganized, the assignments to the physical channels remain in the initial condition.

The sequence, all sub-sequences and all blocks included in the DG file are imported.

AWG pattern files do not include grouping information. The unique bit width pattern and marker data of each device are included in one file. The bits to import can be selected, and each selected bit is imported as one channel per group. Imported AWG pattern files, unlike other imported files, can be replaced and appended.

Only one grouping applies to the whole system. Redefining a group influences all the blocks other than the one you are editing. Although the vector lengths of the other blocks and the data for the channels remain unchanged, the channel information included may be changed as a result of change of the grouping.

The group names in the imported file are case-sensitive. Any group name exceeding the DTG5000 software-supported group name length (32 characters) causes an error. In addition to the group name, the radix option specified in the file is used as the group's radix option in the DTG5000 software.

Importing TLA, HFS, DG, and AWG files

1. Press the **MENU** key and in the **File** menu, select **Import...**. The Import dialog box appears.
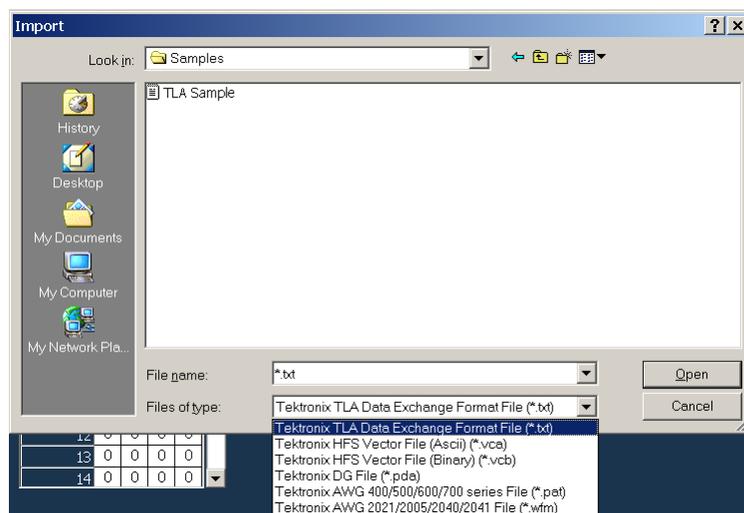
Figure 1-20: Import dialog box

2. Select the file to import. The type of file to import can be specified by selecting from "Files of type:".

3. Select **Open** and press the **ENTER** key.

When a TLAData file, an HFS Vector file, or a DG file is selected, import is executed.

Importing an AWG files

When an AWG file (.pat or .wfm file) is selected, the AWG File Import dialog box appears.

Figure 1-21: AWG File Import dialog box

The following parameters are set in this dialog box.

Table 1-6: AWG File Import dialog box settings

Items	Description
Input File Format	The bit width of an AWG pattern file differs by model. Select the model used to create the pattern file. The "AWG Data Bits to be Imported" data and the number of valid marker bits are determined by the selected format.
AWG Data Bits to be Imported	Select the bits to be imported. The maximum logical number of channels that can currently be imported is indicated by N in "You can select up to N bits." Select a number of bits within this range.
Group Name Prefix	Importing an AWG file generates the group names D0_, D1_, ..., D15_, M1_ and M2_, with one channel per group. Here, standard prefixes are ascribed to each group. Attaching the prefixes does not affect the one-channel-per-group grouping.

Table 1-6: AWG File Import dialog box settings (cont.)

Items	Description
If the group does not exist	The following import methods can be selected: **Delete all groups and create new ones:** If a group exists that is not currently defined, or if the same group name with a different bit width exists, all groups are deleted and new groups are defined. **Keep existing groups and append new group:** If a group name exists that is not currently defined, that group is added. If a group exists with the same name and different bit width, the bit width of that group is redefined. If a group exists with the same name and bit width, that group is overwritten.

1. After specifying the above parameters, select the **OK**.

   An AWG File Import is executed.

TLA Data Exchange Format

This format is used to replace data prepared in a TLA file. The following example lists data for two groups: Addr and Data, both of which have 16 channels and a vector length of 32. The example is followed by format description.

```
[vectors]
Sample[]   Addr[15:0](Hex)   Data[15:0](Hex)   Timestamp[]
0          0000              0000              0
1          FFFF              0001              10.0000000 ns
2          0000              0002              10.0000000 ns
3          FFFF              0003              10.0000000 ns
4          0000              0004              10.0000000 ns
5          FFFF              0005              10.0000000 ns
6          0000              0006              10.0000000 ns
7          FFFF              0007              10.0000000 ns
8          0000              0008              10.0000000 ns
9          FFFF              0009              10.0000000 ns
10         0000              000A              10.0000000 ns
11         FFFF              000B              10.0000000 ns
12         0000              000C              10.0000000 ns
13         FFFF              000D              10.0000000 ns
14         0000              000E              10.0000000 ns
```

15	FFFF	000F	10.0000000 ns
16	0000	0010	10.0000000 ns
17	FFFF	0011	10.0000000 ns
18	0000	0012	10.0000000 ns
19	FFFF	0013	10.0000000 ns
20	0000	0014	10.0000000 ns
21	FFFF	0015	10.0000000 ns
22	0000	0016	10.0000000 ns
23	FFFF	0017	10.0000000 ns
24	0000	0018	10.0000000 ns
25	FFFF	0019	10.0000000 ns
26	0000	001A	10.0000000 ns
27	FFFF	001B	10.0000000 ns
28	0000	001C	10.0000000 ns
29	FFFF	001D	10.0000000 ns
30	0000	001E	10.0000000 ns
31	FFFF	001F	10.0000000 ns

Figure 1-22: TLA data exchange format example

Each file contains the header on two lines and one-vector data on a line.

Header.

```
[vectors]
Sample[]        Addr[15:0](Hex)        Data[15:0](Hex)        Timestamp[]
0               0000                   0000                   0
1               FFFF                   0001                   10.0000000 ns
- -             - - - -                - - - -                - - - - - - - - - -
```

■ The first line starts with "[vectors]".

■ The second line starts with "Sample[]", ends with "Timestamp[]", and includes the group definition.

■ Items are Tab-separated.

■ Vectors (first line), Sample[] and Timestamp[] (second line) are optional. If Sample[] and Timestamp[] are omitted, it is also necessary to delete corresponding data on the third line. The tab delineated group definition in the second line and the data in the third and subsequent lines must correspond one to one.

Group Definition.

Syntax: <group name>[MSB:LSB](Radix)

Example: Data[31:0](Hex)

Rules

■ If channel information ([(MSB):(LSB)]) is missing, the data will not be regarded as a group.
Example: Samples[], Timestamp[], Addr[](Hex), Addr(Hex) will not be regarded as a group.

■ If radix information exists although channel information is missing (like Addr [:](Hex)), the data will be regarded as a group with one channel.

■ You can specify Binary, Octal, Decimal, or Hex for the radix option. Type three characters ("BIN", "OCT", "DEC" or "HEX"). It is case-insensitive.

■ If you do not specify the radix option, Hex will be assumed.

■ Data which is not assumed as group data on the data line is skipped.

■ Channels of group = MSB – LSB + 1

■ The offset value given by the LSB is disregarded.
Example: Data[50:40](Hex) of group definition becomes Data[10:0](Hex).

HFS Vector Files   A set of the HFS pattern definition GPIB commands stored in a file. Files with .vca or .vcb extensions are ASCII files whose data fields are represented in ASCII code and binary notation, respectively. They contain the group names and radix and display order information. The following is an example of a .vca file:

```
:FPAN:VRADIX DEC
:SIGNAL:CVIEW "Data3",CHANNEL;:SIGNAL:DRADIX "Data3",HEX
:SIGNAL:DATA
"Data3",0,50,"00001010010101111001011101110000001110011101001001"
:SIGNAL:DATA
"Data3",50,50,"11101011101010001001000011001110000101111011011001"
:SIGNAL:DATA "Data3",100,28,"1010000111011110000111111111"
:SIGNAL:CVIEW "Data2",CHANNEL;:SIGNAL:DRADIX "Data2",HEX
:SIGNAL:DATA
"Data2",0,50,"00011000110010100011010010111111101000101100011101"
:SIGNAL:DATA
"Data2",50,50,"01100101100111100011111101110100000110101011011101"
:SIGNAL:DATA "Data2",100,28,"1000001011010111110101010100"
:SIGNAL:CVIEW "Data1",CHANNEL;:SIGNAL:DRADIX "Data1",HEX
:SIGNAL:DATA
"Data1",0,50,"00100001000110000100111001010101100001101111010011"
```

```
:SIGNAL:DATA
"Data1",50,50,"01110010001010000101011010011111101100100100101101"
:SIGNAL:DATA "Data1",100,28,"1111100100110101001100110000"
:SIGNAL:CVIEW "Data0",CHANNEL;:SIGNAL:DRADIX "Data0",HEX
:SIGNAL:DATA
"Data0",0,50,"10000011110111110001011100110010000010010100111011"
:SIGNAL:DATA
"Data0",50,50,"01000111100111110011011000101010010001110001101101"
:SIGNAL:DATA "Data0",100,28,"0101110001001100010001000000"
:SIGNAL:CVIEW "Addr0",CHANNEL;:SIGNAL:DRADIX "Addr0",HEX
:SIGNAL:DATA
"Addr0",0,50,"00000000111111110000000011111111000000001111111100"
:SIGNAL:DATA
"Addr0",50,50,"00000011111111000000001111111100000000111111110000"
:SIGNAL:DATA "Addr0",100,28,"0000111111110000000011111111"
:SIGNAL:CVIEW "Addr1",CHANNEL;:SIGNAL:DRADIX "Addr1",HEX
:SIGNAL:DATA
"Addr1",0,50,"00001111000011110000111100001111000011110000111100"
:SIGNAL:DATA
"Addr1",50,50,"00111100001111000011110000111100001111000011110000"
:SIGNAL:DATA "Addr1",100,28,"1111000011110000111100001111"
:SIGNAL:CVIEW "Addr2",CHANNEL;:SIGNAL:DRADIX "Addr2",HEX
:SIGNAL:DATA
"Addr2",0,50,"00110011001100110011001100110011001100110011001100"
:SIGNAL:DATA
"Addr2",50,50,"11001100110011001100110011001100110011001100110011"
:SIGNAL:DATA "Addr2",100,28,"0011001100110011001100110011"
:SIGNAL:CVIEW "Addr3",CHANNEL;:SIGNAL:DRADIX "Addr3",HEX
:SIGNAL:DATA
"Addr3",0,50,"01010101010101010101010101010101010101010101010101"
:SIGNAL:DATA
"Addr3",50,50,"01010101010101010101010101010101010101010101010101"
:SIGNAL:DATA "Addr3",100,28,"0101010101010101010101010101"
:FPAN:SORDER
"Data3","Data2","Data1","Data0","Addr0","Addr1","Addr2","Addr3"
```

Figure 1-23: HFS vector file (*.vca) example

■ The group names, the number of channels, and the display order are determined by the SORDER command on the last line. The above example defines a block that consists of two groups. One is Data, which has four channels and has Data3 and Data0 as the MSB and LSB, respectively. The other is Addr, which has four channels and has Addr0 and Addr3 as the MSB and LSB, respectively.

■ In the example, channel assignments and view and radix information are specified using the SIGNAL commands, but the DTG5000 software imports only radix information.

■ DATA commands are used to specify the pattern data. In the example, the data for a total of 128 vectors (50 vectors beginning at vector number 0, 50 vectors beginning at vector number 50, and 28 vectors beginning at vector number 100) is set for each of the channels.

*.vcb files differ from *.vca files in the commands. They use BDATA command to specify the binary encoded pattern data.

Refer to the "DTG5000 Series Programmer Manual" for details, such as the BDATA commands.

DG2000 series Files   Pattern data (*.pda files) can be imported from the DG2020, DG2020A, DG2030 and DG2040. These are binary files. Group name, block name, sequence, sub-sequences information is included. Display order information is not included.

Importing a DG2000 series file imports the sequence, all sub-sequences and all blocks. While importing, any pre-existing sequence, sub-sequence and block data in the DTG is deleted. Group names of the DG2000 series and bit width group definition information are imported. Channel assignment information is not imported.

AWG series Files   Pattern data files can be imported from the AWG2000 series (*.wfm) and from the AWG400, AWG500, AWG600 and AWG700 series' (*.pat). These are binary files. These are binary files.

Timing Parameters

This section provides information about the timebase-related items. To set the timing parameters, use the Timing window.
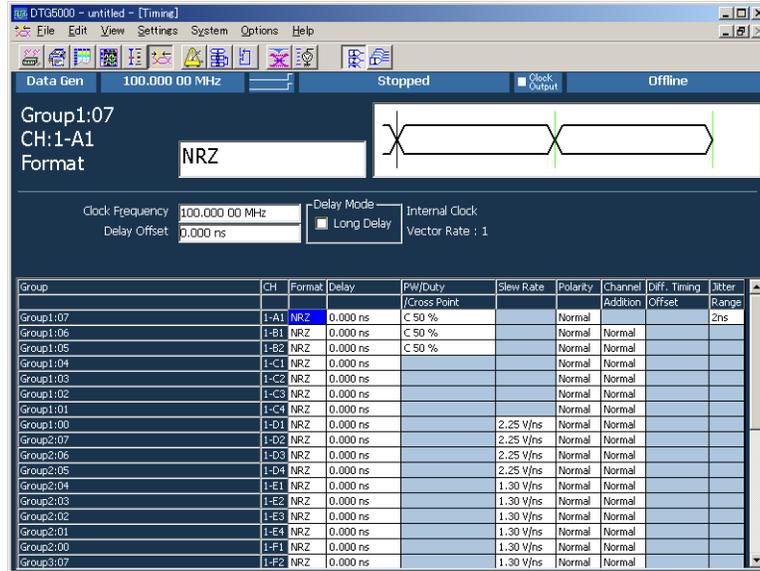
Figure 1-24: Timing window (Data Generator mode)

Data Format

For the output data format, you can select NRZ (Non Return to Zero), RZ (Return to Zero), or R1 (Return to One) for each of the channels. For the channels of Slots A to D, you can select from among three formats. For the DTG5078, the channels of Slots E to H, you can only use NRZ.
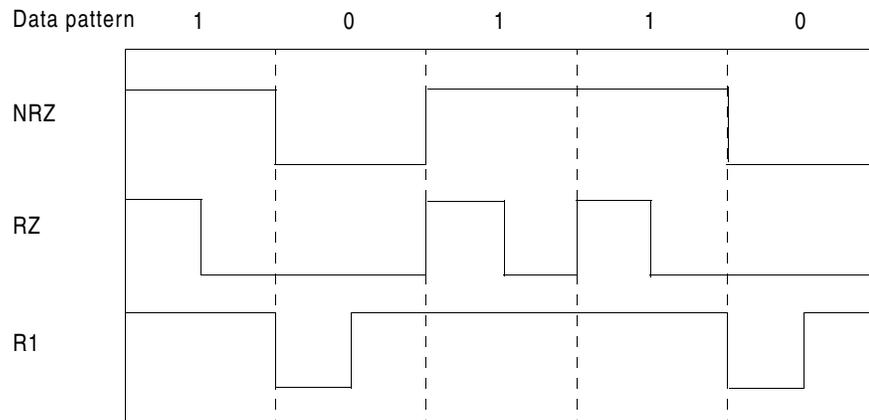
Figure 1-25: Data format

For RZ, Data 1 is output as '10'. Similarly, for R1, Data 0 is output as '01'. To enable this, one set of data is represented using two sets of data; the clock frequency is doubled for output. For example, if a 10 MHz RZ pattern of '10' with a vector length of 2 is output, Data 1000 with a vector length of 4 is created internally before being output with a 20 MHz clock frequency. For this reason, the maximum clock frequency of a pattern including RZ or R1 in the data format is half the maximum clock frequency each model. The maximum frequency is actually 375 MHz for DTG5078 or 1.35 GHz for DTG5274 or 1.675 GHz for DTG5334.

Clock Source

To select the clock source, use the Time Base window. You have the four options listed in Table 1-7. If you use the External PLL or Clock Input signal, the DTG5000 software measures the frequency of the connected signal and displays the measured values in the Timing window. Figure 1-27 on page 1-42 shows the internal connections of each clock source.

Figure 1-26: Clock Source in Time Base window

Table 1-7: Clock source

Clock Source	Description
Internal	Generates the clock signal with the programmable oscillator that contains the DDS, PLL, and VCO circuits based on the 10 MHz internal reference clock.
External 10MHz Reference	Generates the clock signal using the external reference signal instead of the 10 MHz internal reference clock.
	You can use the following signals: Frequency range 10 ± 0.1 MHz, Input voltage swing 0.2 to 3 Vp-p, Maximum input voltage ± 10 V, Impedance 50 Ω, and AC coupled.
	If you use the 10 MHz external reference signal, the valid clock frequency range and step size you can set are the same as when you use Internal for the clock source.

Table 1-7: Clock source (cont.)

| Clock Source	Description
External PLL Input	Specifies that the external signal connected to PHASE LOCK IN is used as the input signal to the PLL circuit.
	You can use the following signals: Frequency range 1 to 200 MHz, Input voltage swing 0.2 to 3 Vp-p, Maximum input voltage ±10 V, Impedance 50 Ω, and AC coupled.
	When you use the External PLL Input signal, the DTG5000 software measures the frequency of the input signal and shows the result in PLL Input: in the Timing window. The output frequency basically varies in steps of the amount that is n times larger than the frequency of the External PLL Input signal. The step size varies, depending on the data format and Long Delay On/Off setting.
External Clock Input	Specifies that the external clock signal is fully used as the clock signal.
	You can use the following signals: Frequency range 1 to 750 MHz for DTG5078 (1 MHz to 2.7 GHz for DTG5274), Input voltage swing 0.2 to 2 Vp-p, Duty cycle 50 ±10%, Impedance 50 Ω, and AC coupled. When you use the External Clock Input signal, the DTG5000 software measures the frequency of the input signal and shows the result in Clock Input: in the Timing window. The output frequency is basically fixed to the frequency of the External Clock Input signal. However, it varies, depending on the data format or Long Delay On/Off setting.
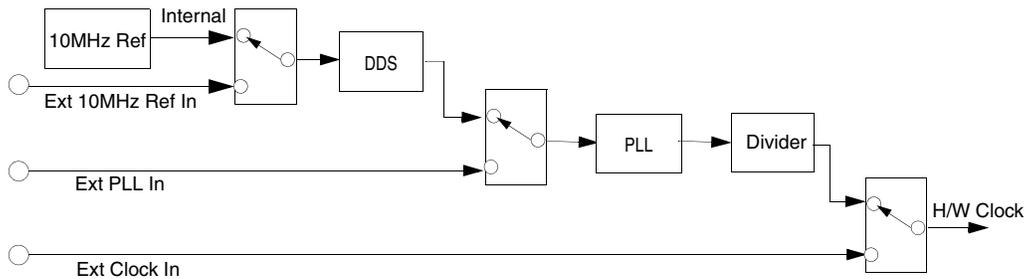
Figure 1-27: Selecting a clock source

The DTG5000 software sometimes prompts you to confirm that you are saving the current settings. You see the prompt when you attempt to load the settings file or to change the mode from Data Generator to Pulse Generator, after having modified the internal settings. If you are currently using an External PLL or External Clock Input signal as the clock source, the timing parameters in the DTG5000 software change when the external clock source state changes. This occurs even if you have not modified the settings. For this reason, even if you have not modified the settings, you may be prompted to confirm that you are saving the settings

Valid Frequency Range and Step Size

Table 1-8 and 1-9 summarize the valid setting ranges of clock frequencies, which depend on the clock source, data format, and Long Delay On/Off setting.

Table 1-8: Valid frequency range and step size by clock source (Data Generator mode)

Clock Source	Internal	Ext 10 MHz Ref Input	Ext PLL Input	Ext Clock
External signal frequency range	none	10 MHz ± 0.1 MHz	Fextpll = 1 MHz to 200 MHz	Fextcl =1 MHz to 750 MHz (DTG5078) Fextcl =1 MHz to 2.7 GHz (DTG5274)
Long Delay OFF				
Clock Frequency range	NRZ only: 50 kHz to 750 MHz includes RZ or R1: 50 kHz to 375 MHz (DTG5078) NRZ only: 50 kHz to 2.7 GHz includes RZ or R1: 50 kHz to 1.35 GHz (DTG5274) NRZ only: 50 kHz to 3.35 GHz includes RZ or R1: 50 kHz to 1.675 GHz (DTG5334)	NRZ only: 50 kHz to 750 MHz includes RZ or R1: 50 kHz to 375 MHz (DTG5078) NRZ only: 50 kHz to 2.7 GHz includes RZ or R1: 50 kHz to 1.35 GHz (DTG5274) NRZ only: 50 kHz to 3.35 GHz includes RZ or R1: 50 kHz to 1.675 GHz (DTG5334)	NRZ only: Fextpll to 750 MHz includes RZ or R1: Fextpll / 2 to 375 MHz (DTG5078) NRZ only: Fextpll to 2.7 GHz includes RZ or R1: Fextpll / 2 to 1.35 GHz (DTG5274) NRZ only: Fextpll to 3.35 GHz includes RZ or R1: Fextpll / 2 to 1.675 GHz (DTG5334)	NRZ only: Fextcl includes RZ or R1: Fextcl / 2 (DTG5078) NRZ only: Fextcl includes RZ or R1: Fextcl / 2 (DTG5274) NRZ only: Fextcl includes RZ or R1: Fextcl / 2 (DTG5334)
Frequency step	8 digit	8 digit	Fextpll / Vector Rate	0 (fixed)

Table 1-8: Valid frequency range and step size by clock source (Data Generator mode) (cont.)

Clock Source	Internal	Ext 10 MHz Ref Input	Ext PLL Input	Ext Clock
Long Delay ON				
Clock Frequency range	NRZ only: 50 kHz to 750 MHz includes RZ or R1: 50 kHz to 375 MHz (DTG5078) NRZ only: 50 kHz to 2.7 GHz includes RZ or R1: 50 kHz to 1.35 GHz (DTG5274) NRZ only: 50 kHz to 3.35 GHz includes RZ or R1: 50 kHz to 1.675 GHz (DTG5334)	NRZ only: 50 kHz to 750 MHz includes RZ or R1: 50 kHz to 375 MHz (DTG5078) NRZ only: 50 kHz to 2.7 GHz includes RZ or R1: 50 kHz to 1.35 GHz (DTG5274) NRZ only: 50 kHz to 3.35 GHz includes RZ or R1: 50 kHz to 1.675 GHz (DTG5334)	NRZ only: $50 \text{ kHz} <$ $Fextpll \times N$ / Vector Rate $< 750 \text{ MHz}$ includes RZ or R1: $50 \text{ kHz} <$ $Fextpll \times N$ / Vector Rate $< 375 \text{ MHz}$ (DTG5274) NRZ only: $50 \text{ kHz} <$ $Fextpll \times N$ / Vector Rate $< 2.7 \text{ GHz}$ includes RZ or R1: $50 \text{ kHz} <$ $Fextpll \times N$ / Vector Rate $< 1.35 \text{ GHz}$ (DTG5274) NRZ only: $50 \text{ kHz} <$ $Fextpll \times N$ / Vector Rate $< 3.35 \text{ GHz}$ includes RZ or R1: $50 \text{ kHz} <$ $Fextpll \times N$ / Vector Rate $< 1.675 \text{ GHz}$ (DTG5334)	NRZ only: Fextcl / Vector Rate includes RZ or R1: Fextcl / Vector Rate (DTG5078) NRZ only: Fextcl / Vector Rate includes RZ or R1: Fextcl / Vector Rate (DTG5274) NRZ only: Fextcl / Vector Rate includes RZ or R1: Fextcl / Vector Rate (DTG5334)
Frequency step			Fextpll / Vector Rate	0 (fixed)

Table 1-9: Valid frequency range and step size by clock source (Pulse Generator mode)

Clock Source	Internal		Ext PLL Input	Ext Clock
External signal frequency range	none	10MHz ± 0.1MHz	Fextpll = 1MHz to 200MHz	Fextcl =1MHz to 750MHz (DTG5078) Fextcl =1MHz to 2.7GHz (DTG5274)
Clock Frequency range	50kHz to 375MHz (DTG5078) 50kHz to 1.35GHz (DTG5274) 50kHz to 1.675GHz (DTG5334)	50kHz to 375MHz (DTG5078) 50kHz to 1.35GHz (DTG5274) 50kHz to 1.675GHz (DTG5334)	50kHz < Fextpll × N / Vector Rate < 375MHz (DTG5078) 50kHz < Fextpll × N / Vector Rate < 1.35GHz (DTG5274) 50kHz < Fextpll × N / Vector Rate < 1.675GHz (DTG5334)	Fextcl / Vector Rate (DTG5078) Fextcl / Vector Rate (DTG5274) Fextcl / Vector Rate (DTG5274)
Frequency step			Fextpll / Vector Rate	0 (fixed)

Restrictions on using External Clock and PLL Input

If you use either External Clock or External PLL Input, the user-defined clock frequency setting is restricted as below, depending on the frequency of the external input signal, use of Long Delay, and the data format condition.

Table 1-10, "Restrictions on using External Clock Input" summarizes the restrictions that arise when you select External Clock Input for the clock source. Table 1-11, "Restrictions on using External PLL Input" on page 1-47 summarizes the restrictions that arise when you select External PLL Input.

Table 1-10: Restrictions on using External Clock Input

External Clock Frequency	Data Generator mode Long Delay ON		Data Generator mode Long Delay OFF	Pulse Generator mode
	NRZ only	includes RZ or R1		
Fextcl < 400 MHz	Error. (The sequence cannot start.)		As an external clock signal, you can input the signal of the frequency range of following Fextcl. Fextcl =1 MHz to 750 MHz (DTG5078) Fextcl =1 MHz to 2.7 GHz (DTG5274) Fextcl =1 MHz to 3.35 GHz (DTG5334)	Error. (The sequence cannot start.)
400 MHz $\leqq$ Fextcl $\leqq$ 800 MHz	You can change the clock range. The vector rate is uniquely determined according to the change of the clock range, resulting in a fixed clock frequency of Fextcl / Vector Rate.			You can not select the clock range, but DTG5000 selects it automatically. The vector rate is uniquely determined according to the change of the clock range, resulting in a fixed clock frequency of Fextcl / VectorRate.
800 MHz < Fextcl	The clock range is fixed to 400 MHz or more. The vector rate is 1, while the clock frequency is fixed to Fextcl.	The clock range is fixed to 200 MHz or more. The vector rate is 2, while the clock frequency is fixed to Fextcl / 2.	The clock frequency is fixed to Fextcl (NRZ only), or Fextcl / 2 (includes RZ or R1) according to the Fextcl.	The internal clock range is fixed to 200 MHz or more. The vector rate is 2, while the clock frequency is fixed to Fextcl / 2.

Table 1-11: Restrictions on using External PLL Input

Data Generator mode Long Delay OFF	Data Generator mode Long Delay OFF		Pulse Generator mode
	NRZ only	includes RZ or R1	
For the user-defined clock frequency, you can change the setting only within the clock range. Changing the user-defined clock frequency does not cause automatic change of the clock range. You can set the user-defined clock frequency to [Fextpll (input frequency of External PLL In) × N / vector rate].	You can set the user-defined clock frequency to [Fextpll (input frequency of External PLL In) × N].	You can set the user-defined clock frequency to [Fextpll (input frequency of External PLL In) × N / 2].	You can set the user-defined clock frequency to [Fextpll (input frequency of External PLL In) × N].

There is the following relationship between the user-defined clock frequency (displayed in Frequency in the Timing window) and the hardware clock frequency (the clock frequency in the DTG5000 Series Data Timing Generator):

User-defined clock frequency = Hardware clock frequency / vector rate

Hardware clock frequency = Fextpll × PLL_Multiplier Rate

$$
\begin{aligned}
\text{User-defined clock frequency} \;&= \text{Fextpll} \times \text{n} \\
&= \text{Fextpll} \times \text{n} \times \text{vector rate} \,/\, \text{vector rate} \\
&= \text{Fextpll} \times \text{PLL\_Multiplier Rate} \,/\, \text{vector rate} \\
&= \text{Hardware clock frequency} \,/\, \text{vector rate}
\end{aligned}
$$

Vector Rate

When outputting pattern data of a given vector length with a given frequency, the DTG5000 software enlarges the vector length of the pattern data internally by a factor of an integral multiple. In proportion to the resulting vector length, it may output the signal of the given frequency with the clock frequency increased. (This is detailed in the "Data Format" section.) Output of R1 or RZ and the Long Delay feature are obtained in this way.

The ratio between the vector length (in the pattern memory) in the DTG5000 software and that of the pattern data is called the vector rate. If we turn our attention to the frequency, we can define it also as the ratio between the clock frequency in the hardware and the user-defined frequency.

The vector rate is displayed in the Timing window (see Figure 1-28). Whatever the Clock Source you specify, it remains on-screen. If Long Delay is off and neither RZ nor R1 exists, the vector rate will be always $\times 1$. If Long Delay is off and RZ or R1 exists, it will be $\times 2$. If Long Delay is on, the rate will change from $\times 1$, 2, 4, 8, 10, 20, and so on to 8000. The vector rate helps you to get information including the utilization of the pattern memory in the DTG5000 software, the internal operating frequency, and the clock frequency output from Clock Out.

PLL Clock Multiple Rate

The PLL clock multiple rate is the HW clock frequency divided by the External PLL Input frequency in the DTG5000 Series Data Timing Generator. This value is displayed in the form of '×n' after the input frequency, only if Clock Source is External PLL Input.
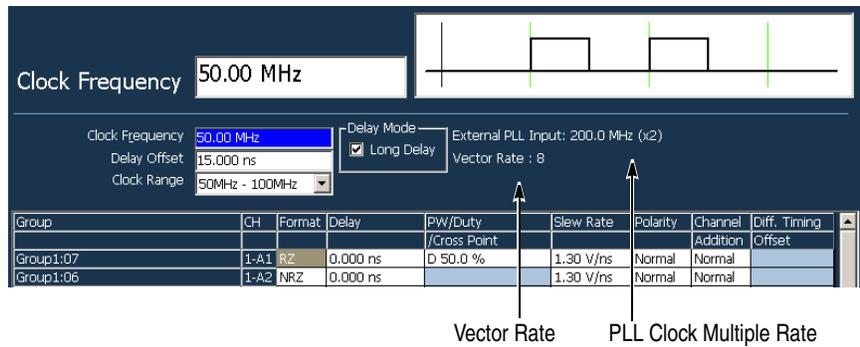

Figure 1-28: PLL Clock Multiple Rate

Figure 1-29 shows the relationship among the user-defined frequency (Clock Frequency), the External PLL Input frequency, the clock frequency in the hardware, and the Clock Out frequency. This relationship depends on the PLL Clock Multiple Rate and the vector rate.
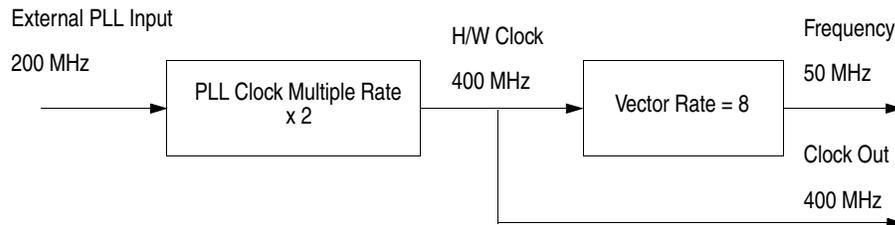

Figure 1-29: Rates and Frequencies

Definition of Pulse Parameters

The DTG5000 software defines the parameters of the output pulse as shown below.

RZ, R1 and Pulse Generator

Period

Trail Delay

Lead Delay

Pulse Width

Duty = Pulse Width / Period x 100 (%)
Phase = Lead Delay / Period x 100 (%)

NRZ

Period

Lead Delay

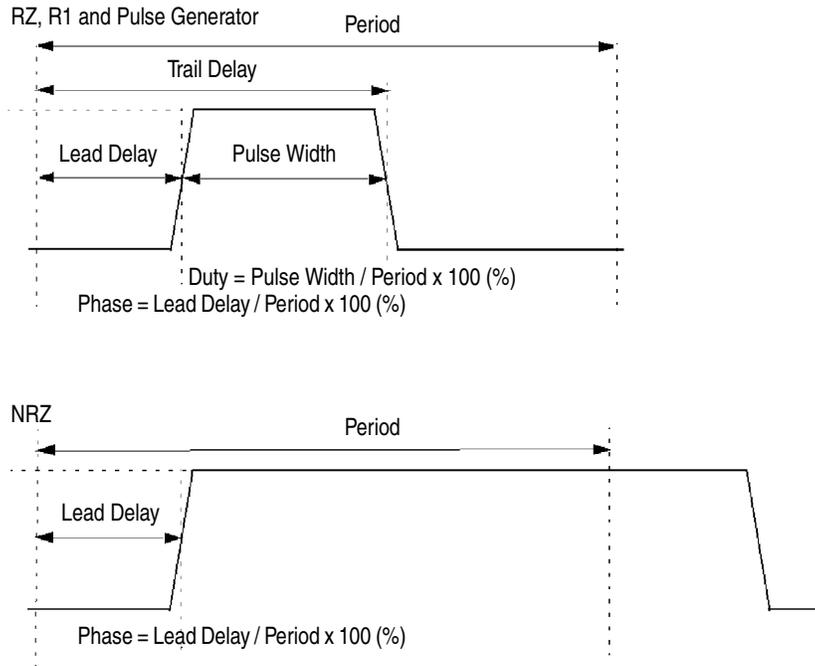Phase = Lead Delay / Period x 100 (%)

Figure 1-30: Definition of Pulse parameters

You must set the pulse parameters for each of the channels.

For the Delay parameter, you can select either Lead Delay (s) or Phase (%). You can even set it to a value larger than Period.

For Width, you can select Duty (%), Pulse Width (s), or Trail Delay (s).

Table 1-12: Pulse parameters

	RZ, R1 and Pulse Generator mode	NRZ
Delay	Lead Delay (s)	Lead Delay (s)
	Phase = Lead Delay / (Period x Pulse Rate) x 100 (%)	Phase = Lead Delay / (Period x Pulse Rate) x 100 (%)
Width	Duty (%)	none
	Pulse Width (s)	
	Trail Delay (s)	

Delay Offset

This feature shifts the Delay setting reference point of the entire system. By default (Delay Offset = 0 s), you can set only a positive value for the delay of any channel relative to 0 s. This feature allows you to set a negative value as well by shifting the whole delay settings accordingly. The valid ranges are summarized in the table below.

You can set the value in steps of 0.2 ps for DTG5274 and DTG5334 or 1 ps for DTG5078.

Table 1-13: Valid ranges of Delay Offset

Operation Mode	Long Delay	Format	Period	Delay Offset
Data Generator	Off			0 to H/W Maximum Delay[1]
	On	NRZ only	$\geq$ 1.25 ns	S/W Sequence: 0 to 600 ns H/W Sequence: 0 to 300 ns
			$\leq$ 1.25 ns	S/W Sequence: 0 to 480 x Period H/W Sequence: 0 to 240 x Period
		includes RZ or R1	$\geq$ 2.5 ns	S/W Sequencer: 0 to 600 ns H/W Sequencer: 0 to 300 ns
			$\leq$ 2.5 ns	S/W Sequence: 0 to 240 x Period H/W Sequence: 0 to 120 x Period
Pulse Generator				0 to 3 μs
				1. H/W Maximum Delay = 5 ns

Figure 1-31 shows a graph indicating the valid ranges that apply if Long Delay is on in the Data Generator mode. When Delay Offset is 0, it shows the same valid ranges of Lead Delay.
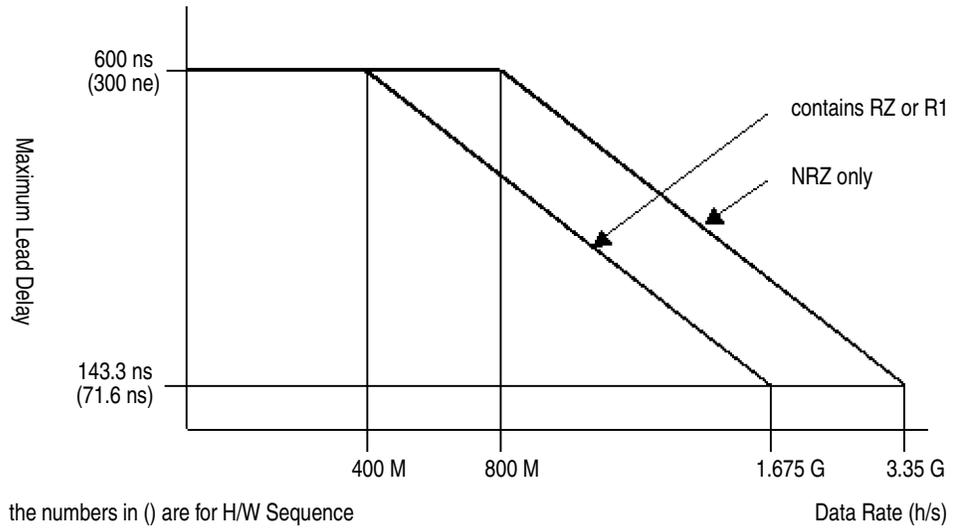
Figure 1-31: Definition of Pulse parameters

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Valid Ranges of Pulse Parameters

The pulse pattern is determined by a combination of multiple pulse parameters. This section summarizes the valid ranges of the Lead Delay and Trail Delay parameters.

Lead Delay   Like Delay Offset, you can set the Lead Delay in steps of 0.2ps for DTG5274 and DTG5334, or 1 ps for DTG5078.

Table 1-14: Valid ranges of Lead Delay

Operation Mode	Long Delay	Format	Period	Lead Delay
Data Generator	Off			0 (– Delay Offset) to H/W maximum delay[1] (– Delay Offset)
	On	NRZ only	$\geq$ 1.25 ns	S/W Sequence: 0 (– Delay Offset) to 600 ns (–Delay Offset) H/W Sequence: 0 (– Delay Offset) to 300 ns (– Delay Offset)
			$\leq$ 1.25 ns	S/W Sequence: 0 (– Delay Offset) to 480 x Period (– Delay Offset) H/W Sequence: 0 (–Delay Offset) to 240 x Period (–Delay Offset)
		includes RZ or R1	$\geq$ 2.5 ns	S/W Sequence: 0 (– Delay Offset) to 600 ns (– Delay Offset) H/W Sequence: 0 (– Delay Offset) to 300 ns (– Delay Offset)
			$\leq$ 2.5 ns	S/W Sequence: 0 (– Delay Offset) to 240 x Period H/W Sequence: 0 (– Delay Offset) to 120 x Period (– Delay Offset)
Pulse Generator			$\geq$ 3 µs	0 (– Delay Offset) to Period (–Delay Offset)
			$\leq$ 3 µs	0 (– Delay Offset) to 3 µs (– Delay Offset)
				1. H/W maximum delay = 5 ns

Phase   To set the Lead Delay (s), you can also use Phase (%). You can use the following expression to obtain the phase setting value based on the setting range of Lead Delay. You can set the value in steps of 0.1%.

Phase = Lead Delay / (Period$\times$ Pulse Rate)$\times$ 100 (%)

$$\text{Pulse Rate}: \quad 2^0 \text{ to } 2^4 \qquad \text{(Pulse Generator mode)}$$
$$1 \qquad \text{(Data Generator mode)}$$

Operations.
To specify the pulse change position, you can select Delay or Phase. If you want to use Phase, move the cursor over the Delay column. Next, press the **SELECT** key to open the pop-up menu. Alternatively, press the **MENU** key to open the Edit menu. Then, select Phase from the menu.

Trail Delay   You can set Trail Delay in steps of 5 ps.

Table 1-15: Valid ranges of Trail Delay

Operation Mode	Long Delay	Period	Trail Delay
Data Generator	Off	≦ H/W maximum delay x 2	If Jitter Generator is on and the channel has been assigned to Slot A CH1 of the mainframe: Minimum Pulse Width (– Delay Offset) to H/W Maximum Delay + Minimum Pulse Width (– Delay Offset) Otherwise: Minimum Pulse Width (– Delay Offset) to H/W Maximum Delay + Period / 2 (– Delay Offset) The value converted into Duty must be 0% to 100%. In addition, the pulse width must be in the range from 'Minimum Pulse Width' to 'Period – Minimum Pulse Width.'
		≧ H/W maximum delay x 2	Period / 2 (– Delay Offset) to H/W Maximum Delay + Period / 2 (–Delay Offset) The value converted into Duty must be 0% to 100%. In addition, the pulse width must be in the range from 'Minimum Pulse Width' to 'Period – Minimum Pulse Width.'
Data Generator	On		The value converted into Duty must be 0% to 100%. In addition, the pulse width must be in the range from 'Minimum Pulse Width' to 'Period – Minimum Pulse Width.'
Pulse Generator		≧ 3 μs	The value converted into Duty must be 0% to 100%. In addition, the pulse width must be in the range from 'Minimum Pulse Width' to 'Period x Pulse Rate – Minimum Pulse Width.'
			Minimum Pulse Width = 290 ps H/W maximum delay = 5 ns

Duty   You can use the following expression to obtain the valid range of Duty based on the Trail Delay setting range. You can set the value in steps of 0.1%.

Duty = (Trail Delay - Lead Delay) / (Period $\times$ Pulse Rate) $\times$ 100(%)

Pulse Rate : 2^0 to 2^4 (Pulse Generator mode)
                    1   (Data Generator mode)

Operation.
You can set Duty when the Format is either RZ or R1. To specify the pulse width, you can select either Duty or Pulse Width. If you want to use Duty, move the cursor over the PW/Duty/Cross Point column. Next, press the **SELECT** key to open the pop-up menu. Alternatively, press the **MENU** key to open the Edit menu. Then, select Duty from the menu.

If you use Duty for the setting, the value will be prefixed with the letter 'D'.

Pulse Width   You can use the following expression to obtain the valid range of pulse width from the setting range of Trail Delay or Duty. You can set the value in steps of the same size as for Trail Delay.

Pulse Width = Duty $\times$ (Period $\times$ Pulse Rate) / 100 = Trail Delay - Lead Delay

Pulse Rate : 2^0 to 2^4 (Pulse Generator mode)
                    1   (Data Generator mode)

Operation.
You can set the Pulse Width when the Format is either RZ or R1. To specify the pulse width, you can select either Duty or Pulse Width. If you want to use Pulse Width, move the cursor over the PW/Duty/Cross Point column. Next, press the **SELECT** key to open the pop-up menu. Alternatively, press the **MENU** key to open the Edit menu. Then, select Pulse Width from the menu.

If you use Pulse Width for the setting, the value will be prefixed with letter 'W'.

Slew Rate

Slew Rate indicates the pulse responsiveness (rise and fall times) by showing the variation in output voltage per nanosecond (V/ns). Larger the value, shorter the pulse rise or fall times.
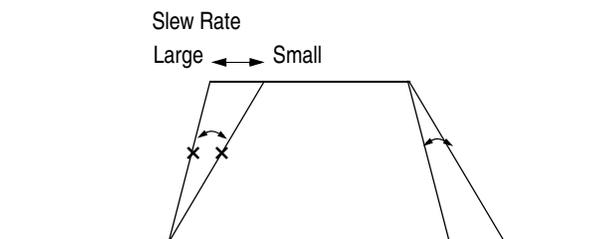
Figure 1-32: Slew Rate

For the Slew Rate setting, there are no differences that depend on the mainframe or slot position. However, you can find slight differences in the settings or other conditions, depending on the output module currently installed in the slot. Table 1-16, "Slew Rate control" summarizes the differences.

■ You can change Slew Rate before output only for the DTGM10 and DTGM20 output module channels.

■ The slopes vary simultaneously by the same amount relative to both the rising and falling edges.

■ The amplitude of the output signal may not reach the setting, depending on the Slew Rate, pulse width, and/or amplitude settings.

■ Varying Slew Rate shifts the 50% amplitude position. When Slew Rate is at the maximum level, Delay and Width are calculated at the 50% amplitude position before being output. This produces a difference between the setting and the value obtained from the actual output signal.

Table 1-16: Slew Rate control

	DTGM10	DTGM20	DTGM30, DTGM31, DTGM32
Range	0.65 V/ns to 1.30 V/ns into 50 Ω to GND	0.63 V/ns to 2.25 V/ns into 50 Ω to GND	fixed
Resolution	0.01 V/ns	0.01 V/ns	

Cross Point Control

This feature raises or lowers the cross point of the rising and falling lines, which is displayed in the eye pattern of the output signal. To achieve this, the feature adjusts the rising and falling edge delay positions of data format NRZ. Set the cross point position (%) relative to the amplitude. The low level position is 0%, the middle 50%, and the high level position 100%. If you make the rising edge later and make the falling edge earlier, the cross point will be lowered.

■   This feature is available only in the Data Generator mode on the DTGM30, DTGM31 and DTGM32 output modules installed in Slots A to D. This feature is not available in the Pulse Generator mode.

■   You can set the value in steps of 5% in the 30% to 70% range.
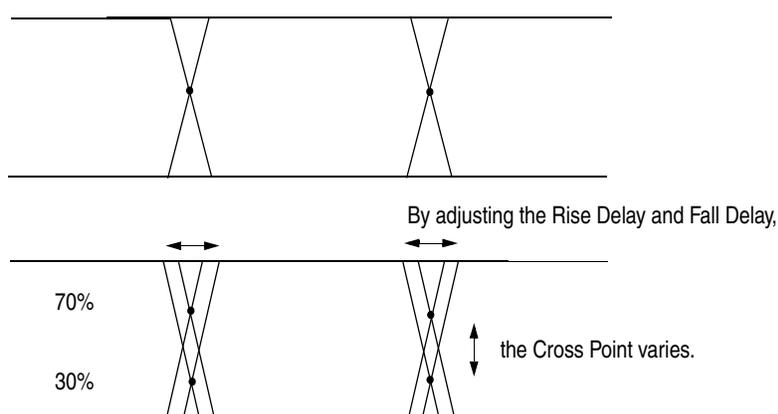
Figure 1-33: Cross Point control

Table 1-17: Cross Point control

	DTGM10, DTGM20, DTGM21	DTGM30, DTGM31, DTGM32
Range	Not available	30 % to 70 %
Resolution	Not available	2 %

Operation.
You can set up Cross Point only in a PW/Duty/Cross Point cell for either of the following channels:

- A channel has not been assigned and its format is NRZ

- A channel of the DTGM30, DTGM31 or DTGM32 installed in Slots A to D has been assigned and its format is NRZ

If you use Cross Point for the setting, the value will be prefixed with the letter "C".

Long Delay

For each Delay and Pulse Width, the variable range supported by the DTG5000 Series hardware is only approximately 5 ns. For greater amounts of Delay and Pulse Width, 480 ns is enabled at the maximum by internally manipulating the data pattern by software.

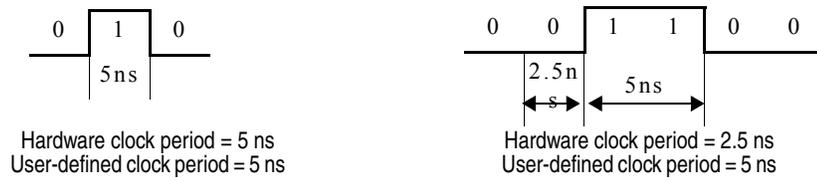Long Delay writes the pattern into the pattern memory while displacing it by software.

When a clock frequency is 100MHz
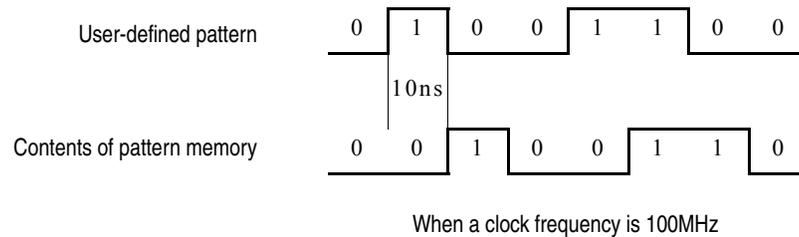
Figure 1-34: Writing the pattern into the memory while displacing it

Displacement of the pattern allows you to set the value only with an integral multiple of the clock frequency. Therefore, the section under the clock frequency is required to be delayed by hardware.

If the clock frequency is later than the valid range of hardware delay, you cannot set the Delay value in a certain range. To avoid this problem, the software enlarges the pattern.

For example, if you want to output a "010" pattern with a clock frequency of 200 MHz, you cannot set the Delay to 9 ns. This is because the hardware delay can be up to 5 ns. In this case, the software writes a double-length enlarged pattern internally into the pattern memory to operate the clock at the double rate.

Hardware clock period = 5 ns
User-defined clock period = 5 ns

Hardware clock period = 2.5 ns
User-defined clock period = 5 ns

When a clock frequency is 100MHz

Figure 1-35: Enlarging the clock pattern and speeding up the hardware clock

The pattern is displaced backward by three patterns so that the hardware delay is 1.5 ns. This causes a delay of 9 ns.
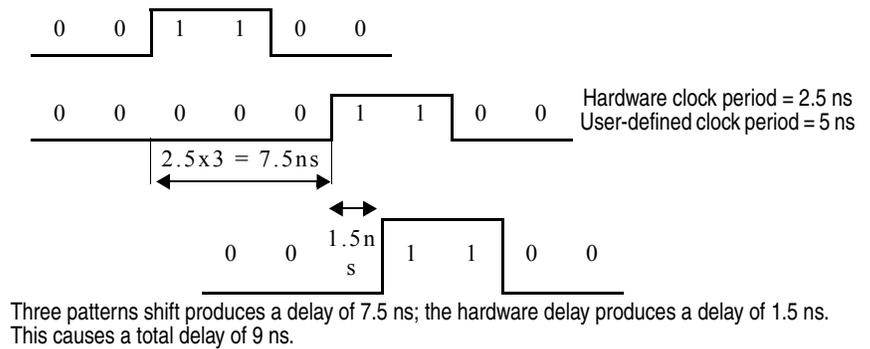

Hardware clock period = 2.5 ns
User-defined clock period = 5 ns

Three patterns shift produces a delay of 7.5 ns; the hardware delay produces a delay of 1.5 ns. This causes a total delay of 9 ns.

Figure 1-36: Obtaining a long delay

The Data Generator mode allows you to toggle Long Delay on or off in the Timing window. In the Pulse Generator mode, Long Delay is always enabled internally. Therefore it does not have a Long Delay On or Off setting.

Table 1-18 summarizes the characteristics of Long Delay.

Table 1-18: Characteristics of Long Delay

	Long Delay Off	Long Delay On
Changing the delay and pulse width	By hardware	By hardware and software
Valid ranges of delay and pulse width	Small	Large
Pattern memory usage	Fixed Vector length itself if the pattern contains only NRZ. Double length of the vector, if the pattern includes RZ or R1.	Increases in proportion to the vector rate. (The lower the user-defined frequency, the higher the vector rate.) If the program includes Jump, Goto, or Wait, the memory usage increases correspondingly.
Sequence memory usage	Sequence definition itself	If the program includes Jump, Goto, or Wait, the memory usage increases correspondingly.
Command jump/Event jump	Available	Not available
Wait, Goto, Inf., subsequence	Available	Available

Clock Range In any section in which the output clock frequency (user-defined clock frequency) is slow, the data is enlarged by a factor of the vector rate according to the output clock frequency. In addition, the internal hardware clock frequency is increased to cause a long delay. As described here, the factor for enlarging the data and that for increasing the internal clock frequency are determined according to the output frequency. Therefore, before using Long Delay, you must specify the output clock frequency value in the Clock Range.

Clock Range is displayed and available if Long Delay is on in the Data Generator mode.

Table 1-19 and 1-20 summarize the relationship among the Clock Range settings, the vector rate, and the hardware frequency.

Table 1-19: Clock Range if the pattern contains only NRZ

User-defined clock frequency		User-defined period		Hardware clock frequency	Vector Rate	Minimum number of blocks during hardware sequence (DTG5334 /DTG5274 / DTG5078)	Restrictions on multiple during hardware sequence (DTG5334 / DTG5274 / DTG5078)
from	to	from	to				
>400 MHz		<2.5 ns		>400 MHz	1	960 / 960 / 240	4 / 4 / 1
400 MHz	200 MHz	2.5 ns	5 ns	800 MHz to 400 MHz	2	480 / 480 / 120	2 / 2 / 1
200 MHz	100 MHz	5 ns	10 ns		4	240 / 240 / 60	1 / 1 / 1
100 MHz	50 MHz	10 ns	20 ns		8	120 / 120 / 30	
50 MHz	25 MHz	20 ns	40 ns		16	60 / 60 / 15	
40 MHz	20 MHz	25 ns	50 ns		20	48 / 48 / 12	
20 MHz	10 MHz	50 ns	100 ns		40	24 / 24 / 6	
10 MHz	5 MHz	100 ns	200 ns		80	12 / 12 / 3	
5 MHz	2.5 MHz	200 ns	400 ns		160	6 / 6 / 2	
4 MHz	2 MHz	250 ns	500 ns		200	5 / 5 / 2	
2 MHz	1 MHz	500 ns	1 μs		400	3 / 3 / 1	
1 MHz	500 kHz	1 μs	2 μs		800	2 / 2 / 1	
500 kHz	250 kHz	2 μs	4 μs		1600	1 / 1 / 1	
400 kHz	200 kHz	2.5 μs	5 μs		2000	1 / 1 / 1	
200 kHz	100 kHz	5 μs	10 μs		4000		
100 kHz	50 kHz	10 μs	20 μs		8000		

Table 1-20: Clock Range if the pattern includes RZ or R1

User-defined clock frequency		User-defined period		Hardware clock frequency	Vector Rate	Minimum number of blocks during hardware sequence (DTG5334 / DTG5274 / DTG5078)	Restrictions on multiple during hardware sequence (DTG5334 / DTG5274 / DTG5078)
from	to	from	to				
>200 MHz		<5ns		>200 MHz	2	480 / 480 / 120	2 / 2 / 1
200 MHz	100 MHz	5 ns	10 ns	800 MHz to 400 MHz	4	240 / 240 / 60	1 / 1 / 1
100 MHz	50 MHz	10 ns	20 ns		8	120 / 120 / 30	
50 MHz	25 MHz	20 ns	40 ns		16	60 / 60 / 15	
40 MHz	20 MHz	25 ns	50 ns		20	48 / 48 / 12	
22 MHz	10 MHz	50 ns	100 ns		40	24 / 24 / 6	
10MHz	5 MHz	100 ns	200 ns		80	12 / 12 / 3	
5 MHz	2.5 MHz	200 ns	400 ns		160	6 / 6 / 2	
4 MHz	2 MHz	250 ns	500 ns		200	5 / 5 / 2	
2 MHz	1 MHz	500 ns	1 µs		400	3 / 3 / 1	
1 MHz	500 kHz	1 µs	2 µs		800	2 / 2 / 1	
500 kHz	250 kHz	2 µs	4 µs		1600	1 / 1 / 1	
400 kHz	200 kHz	2.5 µs	5 µs		2000		
200 kHz	100 kHz	5 µs	10 µs		4000		
100 kHz	50 kHz	10 µs	20 µs		8000		

Clock Range is not available in Pulse Generator mode. If the Clock Source is either Internal or External 10 MHz Reference in the Pulse Generator mode, the internal clock range and vector rate are determined automatically according to the user-defined frequency. For details, refer to the Table 1-21.

If the frequency is just at a boundary in the table below, the settings in the higher range of the hardware clock frequencies are applied.

Table 1-21: Clock Range used internally in Pulse Generator mode

User-defined clock frequency		User-defined period		Hardware clock frequency	Vector Rate	Minimum number of blocks during hardware sequence (DTG5334 / DTG5274 / DTG5078)	Restrictions on multiple during hardware sequence (DTG5334 / DTG5274 / DTG5078)
from	to	from	to				
>200 MHz		<5ns		>200 MHz	2	480 / 480 / 120	2 / 2 / 1
200 MHz	100 MHz	5 ns	10 ns	800 MHz to 400 MHz	4	240 / 240 / 60	1 / 1 / 1
100 MHz	50 MHz	10 ns	20 ns		8	120 / 120 / 30	
50 MHz	25 MHz	20 ns	40 ns		16	60 / 60 / 15	
40 MHz	20 MHz	25 ns	50 ns		20	48 / 48 / 12	
22 MHz	10 MHz	50 ns	100 ns		40	24 / 24 / 6	
10MHz	5 MHz	100 ns	200 ns		80	12 / 12 / 3	
5 MHz	2.5 MHz	200 ns	400 ns		160	6 / 6 / 2	
4 MHz	2 MHz	250 ns	500 ns		200	5 / 5 / 2	
2 MHz	1 MHz	500 ns	1 µs		400	3 / 3 / 1	
1 MHz	500 kHz	1 µs	2 µs		800	2 / 2 / 1	
500 kHz	250 kHz	2 µs	4 µs		1600	1 / 1 / 1	
400 kHz	200 kHz	2.5 µs	5 µs		2000		
200 kHz	100 kHz	5 µs	10 µs		4000		
100 kHz	50 kHz	10 µs	20 µs		8000		

Differential Timing Offset (DTO)

This feature generates two types of patterns. One is a pattern for a logical channel. The other is the inverted pattern that is obtained by displacing the rising and falling edges in the same direction in time. To do this, the feature uses two adjacent channels that have an odd and an even channel number, respectively.

Differential output
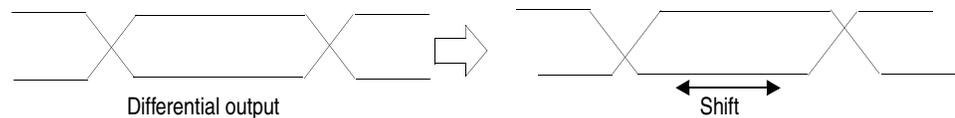
Shift

Figure 1-37: Differential Timing Offset

At the inverted output, the rising and falling edges shift in the same direction. You can set the amount of shift in the −1.0 to 1.0 ns range. It must meet both of two conditions:

- Lead Delay + DTO ≦ maximum Lead Delay, and

- Trail Delay + DTO ≦ maximum Trail Delay.

If you set a positive value for the amount of shift, the pattern will shift so that the signal at the inverted output will delay. You can set the value in steps of 1 ps for DTG5078 or 0.2 ps for DTG5274 and DTG5334.

You can set up the DTO feature independently of the mainframe, the currently installed modules, and the slots. Note the following, however:

- Because the DTGM31 and DTGM32 are single-channel output modules, this function cannot be used.

- To turn on or off the DTO feature or set its Offset value, use the Diff. Timing Offset cell in the Timing window. Since the settings in this window are for the logical channels rather than the physical channels, the channel assign may be unassigned. For example, suppose that you have assigned physical channel CH1 to logical channel Group1:07. Because the non-inverted output of CH1 and CH2 are used for DTO on the Group1:07, you can not assign physical channel CH2 to any other logical channel. If you have assigned physical channel CH2 to a logical channel, the assignment is unassigned.

- You cannot set DTO to any logical channel to which you have already assigned an even-numbered physical channel (CH2 or CH4).

- You cannot assign any even-numbered physical channel (CH2 or CH4) to a logical channel for which DTO has been turned on.

■ If you assign an odd-numbered physical channel (CH1 or CH3) to a logical channel for which DTO has been turned on, the assignment to the associated channel (CH2 or CH4) will be unassigned. This rule applies if the assignment has been established.

■ The DTO feature is available also in the Pulse Generator mode.

Operation.
The Differential Timing Offset cell usually remains grayed out. To enable setup of this feature, do the following:

On an unassigned channel or a channel to which you have assigned an odd-numbered physical channel, press the **SELECT** key to open the pop-up menu. Alternatively, on such a channel, press the **MENU** key to open the Edit menu. Then, select Differential Timing Offset from the menu.

Channel Addition

This feature obtains the result of XOR or AND between (1) the output which is subject to Delay of the adjacent physical odd- and even-numbered channels of Slots A to D, and (2) the signal from the further adjacent physical channel.

For the odd-numbered channel, you can select Normal (through) or XOR (XOR with the signal from the even-numbered channel). For the even-numbered channel, you can select Normal (through) or AND (AND with the signal from the odd-numbered channel).

For this setting, use Channel Addition in the Timing window. The settings in this window are for the logical channels rather than the physical channels. You can set Normal, XOR, and AND to a logical channel that you have not assigned a physical channel. You can set Normal or XOR to a logical channel that you have assigned an odd-numbered physical channel. Also you can set Normal or AND to a logical channel that you have assigned an even-numbered physical channel.

The channel addition feature is available also in the Pulse Generator mode.

The amount of Delay you have set in Delay applies to any input signal used for channel addition. Invert, which controls Polarity, is included after channel addition.
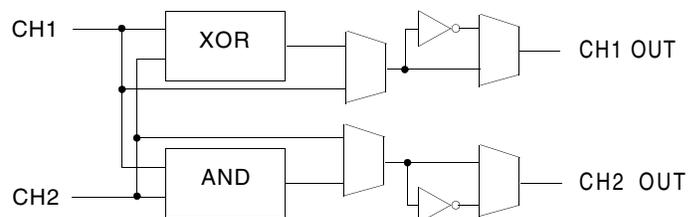
Figure 1-38: Channel Addition

■ Because the DTGM31 and DTGM32 are single-channel output modules, this function is disabled on logical channels assigned to these output modules.

Operations.
Set up Channel Addition in the Channel Addition column.

You can set Normal or XOR on a channel to which you have assigned an odd-numbered physical channel. You can set Normal or AND to a logical channel to which you have assigned an even-numbered physical channel. You can set Normal, XOR, or AND to a channel to which you have not assigned a physical channel.

For this setting, select the Channel Addition cell. Next, press the **SELECT** key to open the pop-up menu. Alternatively, press the **MENU** key to open the Edit menu. Then, select the desired item(s) from the menu. Alternatively, in the character input mode, you can type 'n' for Normal, 'x' for XOR, or 'a' for AND from the external keyboard.

Polarity

Set the polarity of the output signal. If you set Invert, Data 0 and 1 are output at the High and Low levels, respectively. Polarity takes effect on signals generated after channel addition.

Operations.
Select the Polarity cell. Next, press the **SELECT** key to open the pop-up menu. Alternatively, press the **MENU** key to open the Edit menu. Then, select Normal or Invert from the menu. Alternatively, after you have selected the Polarity cell, press the **SPACE** or **ENTER** key to toggle between the settings.

Jitter Range

Sets the jitter operation range of the external signal from the DTGM32 output module. Jitter durations of 1 or 2 ns are changed to an input voltage of ±0.5V. Only the logical channel assigned to the DTGM32 is valid. If range is changed during output operation, signal for after change 1 clock will become unstable.

Input Voltage vs. Jitter Amplitude (DTGM 32)
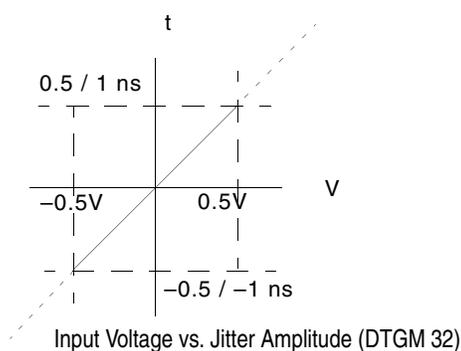
Figure 1-39: Jitter Range of the DTGM32

Operations.

1. Select 1 ns or 2 ns from the menu that appears by pressing the **SELECT** key after selecting a Jitter Range cell, or from the Edit menu displayed by the **MENU** key. Alternatively, when a Jitter Range cell is selected, press the **SPACE** key or **ENTER** key to toggle the setting.

Output Level

This section provides information about the Level window, including the output level.
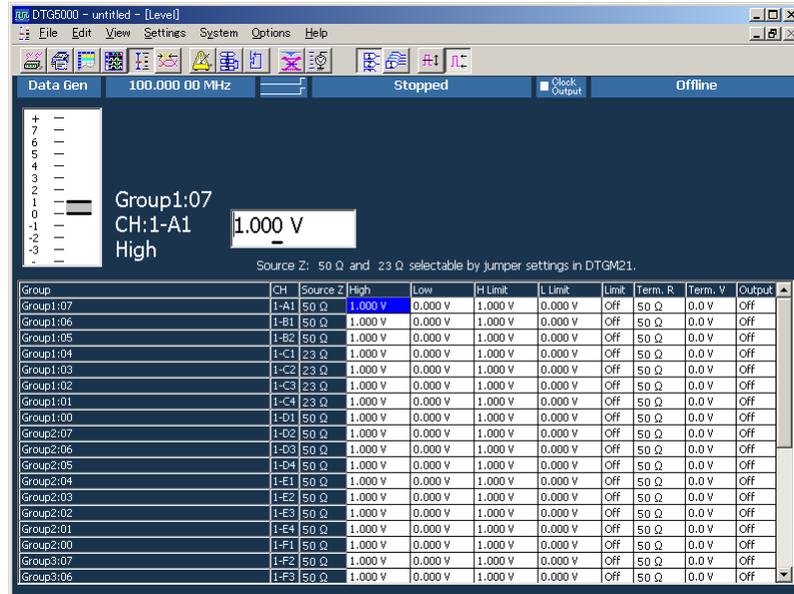
Figure 1-40: Level window (Data Generator mode)

Output Level

You can use the Level window to set the parameters related with the output level. These parameters include the output level, the output level limits, and the termination resistance and voltage. You can set the parameters for each of the channels. The Level window allows you to view the information by either channel or group. If a mismatch exists in terms of the parameter value for the channel when the information is viewed by group, the item is marked with a question mark (?).

The source impedance of the DTGM21 output module can be switched between 23 Ω and 50 Ω

Frequently used set values are available as predefined levels, which include information about the termination resistance and voltage as well as the High and Low values.

To set the output level, use a pair of the High and Low values and or of the Amplitude and Offset values. You must choose the same pair (of High/Low and Amplitude/Offset) for all the channels. You can set the level of the channels independently.

The DTG5000 software sets the hardware output level, considering the termination resistor and voltage of the connected device under test (DUT) relative to the output level you set.
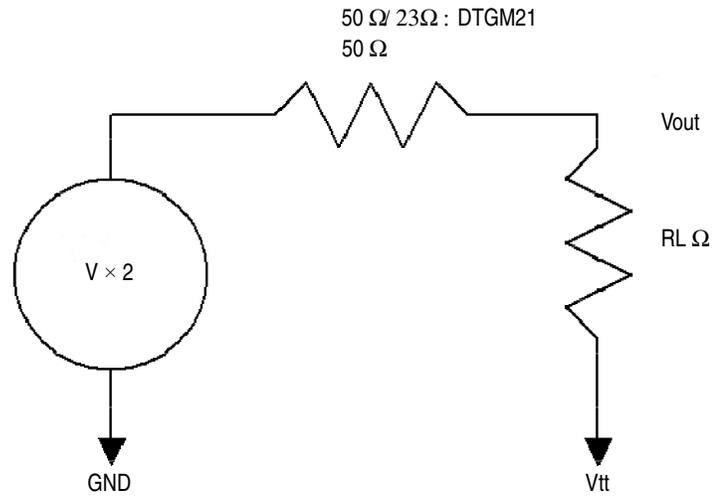
V: Hardware output voltage for 50 Ω to GND
Vout: Output voltage for the termination voltage Vtt and the termination resistor RL Ω
Source Impedance: 50 Ω, 50 Ω / 23 Ω (DTGM21only)

Figure 1-41: Output level, termination resistor, termination voltage

Range of output level

The setting range of an output level differ by output/modules. The value which can be set up by High/Low or Amplitude/Offset is as follows.

The setting ranges of an output level differ by the kind of output module currently used. The value which can be set up by High/Low or Amplitude/Offset is as shown in Table 1-22.

Table 1-22: Range of output level parameters

Item	Range
DTGM10	
Output Voltage (V_{OUT})	$-0.04 \times R_L + Vtt \quad V_{OUT} \quad 0.04 \times R_L + Vtt$ $-3.00 \quad V_{OUT} \quad 7.00$
High Level (V_{OH})	-1.25 V to $+2.00$ V into 50 Ω to GND -2.50 V to $+7.00$ V into 1 MΩ to GND
Low Level (V_{OL})	-1.50 V to $+1.75$ V into 50 Ω to GND -3.00 V to $+6.50$ V into 1 MΩ to GND

Table 1-22: Range of output level parameters (cont.)

Item	Range
Amplitude ($V_{OH} - V_{OL}$)	0.25 $V_{p\text{-}p}$ to 3.50 $V_{p\text{-}p}$ into 50 Ω to GND 0.50 $V_{p\text{-}p}$ to 10.00 $V_{p\text{-}p}$ into 1 MΩ to GND
Resolution	5 mV
DTGM20	
Output Voltage (V_{OUT})	$-0.08 \times R_L + Vtt \quad V_{OUT} \quad 0.08 \times R_L + Vtt$ $-2.00 \quad V_{OUT} \quad 5.00$
High Level (V_{OH})	-0.90 V to $+2.50$ V into 50 Ω to GND -1.80 V to $+5.00$ V into 1 MΩ to GND
Low Level (V_{OL})	-1.00 V to $+2.40$ V into 50 Ω to GND -2.00 V to $+4.80$ V into 1 MΩ to GND
Amplitude ($V_{OH} - V_{OL}$)	0.10 $V_{p\text{-}p}$ to 3.50 $V_{p\text{-}p}$ into 50 Ω to GND 0.20 $V_{p\text{-}p}$ to 7.00 $V_{p\text{-}p}$ into 1 MΩ to GND
Resolution	5 mV
DTGM21	
Output Voltage (V_{OUT})	$-0.08 \times R_L + Vtt \quad V_{OUT} \quad 0.08 \times R_L + Vtt$ $-2.40 \quad V_{OUT} \quad 5.40$
High Level (V_{OH})	-1.55 V to $+3.70$ V into 50 Ω to GND at 23Ω Source Imp. -1.10 V to $+2.70$ V into 50 Ω to GND at 50Ω Source Imp. -2.20 V to $+5.40$ V into 1 MΩ to GND at 50Ω Source Imp.
Low Level (V_{OL})	-1.65 V to $+3.60$ V into 50 Ω to GND at 23Ω Source Imp. -1.20 V to $+2.60$ V into 50 Ω to GND at 50Ω Source Imp. -2.40 V to $+5.20$ V into 1 MΩ to GND at 50Ω Source Imp.
Amplitude ($V_{OH} - V_{OL}$)	0.10 $V_{p\text{-}p}$ to 5.350 $V_{p\text{-}p}$ into 50 Ω to GND at 23Ω Source Imp. 0.10 $V_{p\text{-}p}$ to 3.90 $V_{p\text{-}p}$ into 50 Ω to GND at 50Ω Source Imp. 0.20 $V_{p\text{-}p}$ to 7.80 $V_{p\text{-}p}$ into 1 MΩ to GND at 50Ω Source Imp.
Resolution	5 mV
DTGM30	
Output Voltage (V_{OUT})	$-0.07 \times R_L + Vtt \quad V_{OUT} \quad 0.07 \times R_L + Vtt$ $-2.00 \quad V_{OUT} \quad 7.00$
High Level (V_{OH})	-1.00 V to $+3.27$ V into 50 Ω to GND -1.94 V to $+7.00$ V into 1 MΩ to GND The following relational expressions must be satisfied: $V_{OH} \quad 7.00$ $V_{OH} \quad (7.00 \times R_L + 50 \times Vtt) / (R_L + 50)$ $V_{OH} \quad R_L / 50 \times (2.5 - 0.06 \times R_L / (R_L + 50)) + Vtt$ $(-2.00 \times R_L + 50 \times Vtt) / (R_L + 50) \quad V_{OH}$ $V_{OH} \quad Vtt - R_L / 50$

Table 1-22: Range of output level parameters (cont.)

Item	Range
Low Level (V_{OL})	-2.00 V to $+3.24$ V into 50 Ω to GND -2.00 V to $+6.94$ V into 1 MΩ to GND The following relational expressions must be satisfied: $V_{OL} \geqq -2.00$ $V_{OL} \geqq (50 \times Vtt - 4.5 \times R_L) / (R_L + 50)$ $V_{OL} \geqq Vtt - R_L \times (0.02 + 2.5 / (R_L + 50)) + Vtt$ $(-2.00 \times R_L + 50 \times Vtt) / (R_L + 50) \geqq V_{OL}$ $V_{OL} < ((2.5 - 0.06) \times R_L / 50) + Vtt$
Amplitude ($V_{OH} - V_{OL}$)	0.03 $V_{p\text{-}p}$ to 1.25 $V_{p\text{-}p}$ into 50 Ω to GND 0.06 $V_{p\text{-}p}$ to 2.50 $V_{p\text{-}p}$ into 1 MΩ to GND The following relational expressions must be satisfied: $(V_{OH} - V_{OL}) > 2 \times (Vtt - R_L / 50 - Offset)$ $(V_{OH} - V_{OL}) > 2 \times (((R_L \times (-2) + 50 \times Vtt) / (R_L + 50) - Offset)$ $(V_{OH} - V_{OL}) > 2 \times ((2.5 \times R_L - 50 \times Offset + 50 \times Vtt) / (2 \times R_L + 50))$ $(V_{OH} - V_{OL}) > 2 \times ((7 \times R_L - 50 \times Vtt) / (R_L + 50) - Offset)$
Resolution	5 mV
DTGM31	
Output Voltage (V_{OUT})	$-0.07 \times R_L + Vtt \leqq V_{OUT} \leqq 0.07 \times R_L + Vtt$ $-2.00 \leqq V_{OUT} \leqq 7.00$
High Level (V_{OH})	-1.00 V to $+2.47$ V into 50 Ω to GND -1.94 V to $+7.00$ V into 1 MΩ to GND The following relational expressions must be satisfied: $V_{OH} \leqq 7.00$ $V_{OH} \leqq (7.00 \times R_L + 50 \times Vtt) / (R_L + 50)$ $V_{OH} \leqq R_L / 50 \times (2.5 - 0.06 \times R_L / (R_L + 50)) + Vtt$ $(-2.00 \times R_L + 50 \times Vtt) / (R_L + 50) \leqq V_{OH}$ $V_{OH} \geqq Vtt - R_L / 50$
Low Level (V_{OL})	-2.00 V to $+2.44$ V into 50 Ω to GND -2.00 V to $+6.94$ V into 1 MΩ to GND The following relational expressions must be satisfied: $V_{OL} \geqq -2.00$ $V_{OL} \geqq (50 \times Vtt - 4.5 \times R_L) / (R_L + 50)$ $V_{OL} \geqq Vtt - R_L \times (0.02 + 2.5 / (R_L + 50)) + Vtt$ $(-2.00 \times R_L + 50 \times Vtt) / (R_L + 50) \geqq V_{OL}$ $V_{OL} < ((2.5 - 0.06) \times R_L / 50) + Vtt$
Amplitude ($V_{OH} - V_{OL}$)	0.03 $V_{p\text{-}p}$ to 1.25 $V_{p\text{-}p}$ into 50 Ω to GND 0.06 $V_{p\text{-}p}$ to 2.50 $V_{p\text{-}p}$ into 1 MΩ to GND The following relational expressions must be satisfied: $(V_{OH} - V_{OL}) > 2 \times (Vtt - R_L / 50 - Offset)$ $(V_{OH} - V_{OL}) > 2 \times (((R_L \times (-2) + 50 \times Vtt) / (R_L + 50) - Offset)$ $(V_{OH} - V_{OL}) > 2 \times ((2.5 \times R_L - 50 \times Offset + 50 \times Vtt) / (2 \times R_L + 50))$ $(V_{OH} - V_{OL}) > 2 \times ((7 \times R_L - 50 \times Vtt) / (R_L + 50) - Offset)$
Resolution	5 mV

Table 1-22: Range of output level parameters (cont.)

Item	Range
DTGM32	
Output Voltage (V_{OUT})	$-0.07 \times R_L + Vtt \leqq V_{OUT} \leqq 0.07 \times R_L + Vtt$ $-2.00 \leqq V_{OUT} \leqq 7.00$
High Level (V_{OH})	-1.00 V to $+2.47$ V into 50 Ω to GND -1.94 V to $+7.00$ V into 1 MΩ to GND The following relational expressions must be satisfied: $V_{OH} \leqq 7.00$ $V_{OH} \leqq (7.00 \times R_L + 50 \times Vtt) / (R_L + 50)$ $V_{OH} \leqq R_L / 50 \times (2.5 - 0.06 \times R_L / (R_L + 50)) + Vtt$ $(-2.00 \times R_L + 50 \times Vtt) / (R_L + 50) \leqq V_{OH}$ $V_{OH} \geqq Vtt - R_L / 50$
Low Level (V_{OL})	-2.00 V to $+2.44$ V into 50 Ω to GND -2.00 V to $+6.94$ V into 1 MΩ to GND The following relational expressions must be satisfied: $V_{OL} \geqq -2.00$ $V_{OL} \geqq (50 \times Vtt - 4.5 \times R_L) / (R_L + 50)$ $V_{OL} \geqq Vtt - R_L \times (0.02 + 2.5 / (R_L + 50)) + Vtt$ $(-2.00 \times R_L + 50 \times Vtt) / (R_L + 50) \geqq V_{OL}$ $V_{OL} < ((2.5 - 0.06) \times R_L / 50) + Vtt$
Amplitude ($V_{OH} - V_{OL}$)	0.03 V_{p-p} to 1.25 V_{p-p} into 50 Ω to GND 0.06 V_{p-p} to 2.50 V_{p-p} into 1 MΩ to GND The following relational expressions must be satisfied: $(V_{OH} - V_{OL}) > 2 \times (Vtt - R_L / 50 - Offset)$ $(V_{OH} - V_{OL}) > 2 \times (((R_L \times (-2) + 50 \times Vtt) / (R_L + 50) - Offset)$ $(V_{OH} - V_{OL}) > 2 \times ((2.5 \times R_L - 50 \times Offset + 50 \times Vtt) / (2 \times R_L + 50))$ $(V_{OH} - V_{OL}) > 2 \times ((7 \times R_L - 50 \times Vtt) / (R_L + 50) - Offset)$
Resolution	5 mV

Source Impedance

The source impedance of the output module is displayed. The source impedance of the DTGM21 output module can be switched between 23 Ω and 50 Ω The source impedance is switched by replacing a jumper on the DTGM21. Other models are fixed at 50 Ω

When the DTG application launches, source impedance of the output module installed in each slot is checked and displayed. No user settings are needed in the Level window.
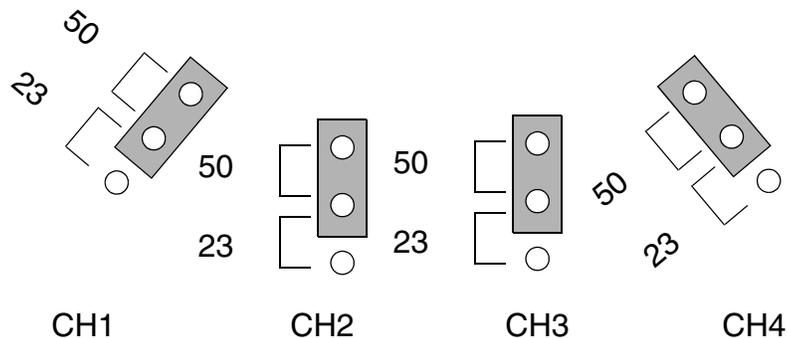
Figure 1-42: Jumpers on the DTGM21

H and L Limits of Output Level

The High and Low Levels can be limited to the values of the High and Low Limits. You can set them for each channel independently. You can also turn on or off the limit separately for each of the channels. If you set the high or low level beyond the Limit setting when Limit is enabled, the High or Low Limit value will be selected.

Operations

1. To set High or Low Limit, select the cell to set and then enter a value using numeric keys or the knob.

2. To turn Limit on or off, select the cell to set and then press the **ENTER** key. Press the **ENTER** key to toggle between On and Off. Alternatively, press the **SELECT** or **MENU** key, and then set to On or Off in the menu displayed.

Termination resistor

Sets the DUT's termination resistance numerically in ohms. You can set a value from 10 Ω to 1 MΩ or Open. Varying the termination resistance changes the DTG5000 Series hardware level settings with the High/Low levels. Note that the DTG5000 Series output impedance is fixed to 50 Ω

Operations

1. Select the cell to set and then enter a value using numeric keys or the knob. If you use numeric keys, you do not need to add Ω

2. If you want to set Open, in the displayed menu, select the cell and then press either the **SELECT** or **MENU** key. (You can also use the **minus** or **ENTER** key for setting.)

Termination Voltage

Sets the DUT's termination voltage numerically in volts. You can set a value from +5.0 to −2.0 V in 0.1 V steps. Varying the termination voltage changes the DTG5000 Series hardware level settings with the High/Low levels unchanged.

Operations

1. Select the cell to set and then enter a value using numeric keys or the knob.

Output On/Off

Simultaneously turn on or off the output relay for all the channels. The RUN button comes on by turning it on and the signal is output. If you have not assigned a physical channel to the logical channel, you cannot turn it on.

Operations

1. Select the cell to set and press the **ENTER** key. Pressing ENTER toggles between On and Off. Alternatively, press the **SELECT** or **MENU** key, and then set On or Off in the menu displayed. Pressing the **ALL OUTPUTS ON/OFF** button on the front panel allows you to set all the channels to On or Off.

Predefined Level

The typical level settings are predefined as shown below. The High/Low levels, the termination resistance and voltage can be specified together.

Table 1-23: Predefined Output Levels

Name	High Level	Low Level	Termination Voltage	Termination Impedance
TTL (into open)	2.5 V	0.0 V	0.0 V	Open
TTL (into 50 Ω to GND)	2.5 V	0.0 V	0.0 V	50 Ω
CMOS 5V (into open)	5.0 V	0.0 V	0.0 V	Open
CMOS 3.3V (into open)	3.3 V	0.0 V	0.0 V	Open
ECL (into 50 Ω to –2 V)	–0.9 V	–1.7 V	–2.0 V	50 Ω
PECL (into 50 Ω to +3 V)	4.1 V	3.3 V	3.0 V	50 Ω
PECL (into 50 Ω to +5 V)	4.1 V	3.3 V	5.0 V	50 Ω
LVPECL (into 50 Ω to +1.3 V)	2.4 V	1.6 V	1.3 V	50 Ω
LVPECL (into 50 Ω to +3.3 V)	2.4 V	1.6 V	3.3 V	50 Ω
LVDS (into 100 Ω differential)	1.4 V	1.0 V	1.2 V	50 Ω
TMDS (into 50 Ω to +3.3 V)	3.3 V	2.8 V	3.3 V	50 Ω
RSL (into 28 Ω to 1.8 V)	1.8 V	1.0 V	1.8 V	28 Ω
CML (into 50 Ω to GND)	0.0 V	–0.41 V	0.0 V	50 Ω

Operations

1. Select the cell for the channel to be set. Press either the **SELECT** or **MENU** key and select **Predefined Level...** in the menu displayed.

2. In the Predefined Level dialog box, use the Up, Down, Left, or Right arrow key to select the level name.

3. Use the **TAB** key to activate OK. Then, press the **ENTER** key to determine the selection.

DC Output

This section describes DC output.

The DC output connectors for eight channels are provided on the right side of the front panel. To set up the DC output, you can use the DC Output window. You can set Level, High Limit, Low Limit and Limit On/Off for each of the channels. The DC Output exists independently without being included in the grouping of the logical channels. In addition, it does not enable grouping setup.

Figure 1-43: DC output pin assignments
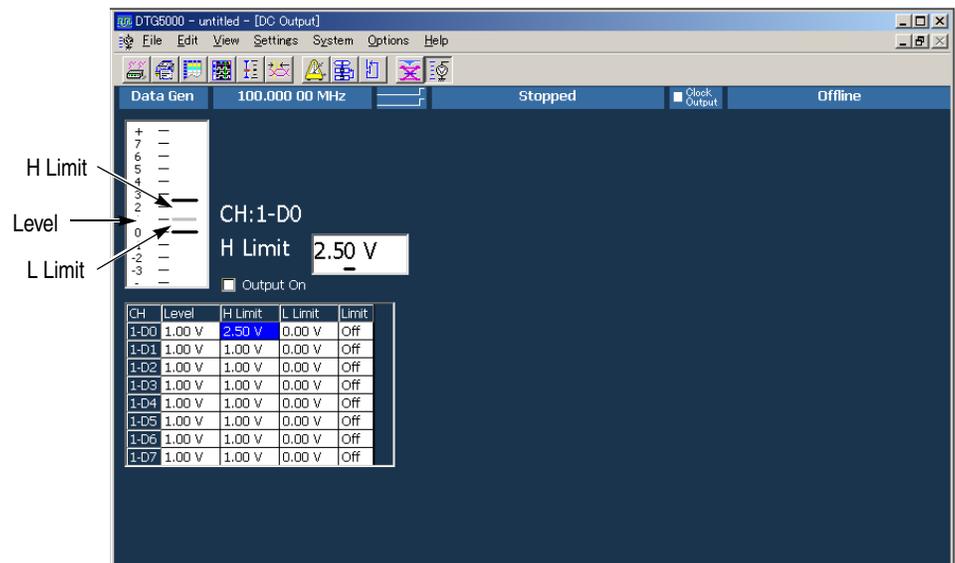
Figure 1-44: DC Output window

The DC Output window initially contains mainframe numbers 1 to 3 and Dn (n = 0 to 7) names assigned. D0 corresponds to CH0.

Output Level and Limit

You can set the output level (Level) and limits H Limit and L Limit within the following ranges:

$-3.0 \text{ V} \leqq \text{Level} \leqq +5.0 \text{ V}$
$-3.0 \text{ V} \leqq \text{L Limit} \leqq \text{H Limit} \leqq +5.0 \text{ V}$

If Limit is set to On, the Level setting is adjusted to satisfy the following:

$-3.0 \text{ V} \leqq \text{L Limit} \leqq \text{Level} \leqq \text{H Limit} \leqq +5.0 \text{V}$

Operations

1. Select the cell containing the desired Level or H Limit or L Limit setting.

2. Then, set the value using numeric keys or the knob.
   Or press the **SELECT** key to open the pop-up menu. Alternatively, press the **MENU** key to open the Edit menu. The edit menu shows frequently used set values.

3. Turn the Limit on or off by selecting the cell to set and press the **ENTER** key to toggle on or off. Alternatively, press the **SELECT** or **Menu** key to display the menu, and then set to On or Off.

Predefined level

Frequently used set values are available as predefined levels. Unlike Preset Level in the Level window, you can use them only for the Level setting. The value chosen with the menu is set to a cell with cursor.

Table 1-24: Predefined DC levels

Clock Source	High l	Low
TTL	2.5 V	0.0 V
CMOS 5V	5.0 V	0.0 V
CMOS 3.3V	3.3 V	0.0 V
ECL	−0.9 V	−1.7 V
PECL	4.1 V	3.3 V
LVPECL	2.4 V	1.6 V
LVDS	1.4 V	1.0 V
TMDS	3.3 V	2.8 V
RSL	1.8 V	1.0 V
CML	0.0 V	−0.41 V

Output On

This check box sets to turn On or Off for the DC outputs of all the channels. While a check mark is placed on the check box, the DC output is on. Operating the ALL OUTPUTS ON/OFF button on the front panel also controls the DC output. When you turn on or off the pattern signal output using the ALL OUTPUTS ON/OFF button, the DC output state also changes correspondingly.

Operations

1. Activate **Output On** using the **TAB** key.

2. Press the **SPACE** key to toggle between the check mark on and off settings.

3. Pressing the **ALL OUTPUTS ON/OFF** button on the front panel also allows you to set the DC Output channels to On or Off.

The RUN button on the front panel, which controls the pattern signal output, does not control the DC output. The DC output is controlled by check the check mark in the Output On box or the ALL OUTPUTS ON/OFF button.

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Trigger

The trigger is used to control signal output. In the Data Generator mode, you can start the output by pressing the RUN button, regardless of the trigger signal. The trigger signal is used for Wait Trig in the sequence table. In the Pulse Generator mode, the trigger signal is used for starting the output when the Run mode is the burst mode.

The trigger signal is generated by pressing the MANUAL TRIGGER button on the front panel as well as by specifying the signal with the trigger source. When the MANUAL TRIGGER button was pushed, it becomes an effective trigger regardless of the trigger source.

Parameters

The following trigger parameters are available. You can set them using the Timebase window.
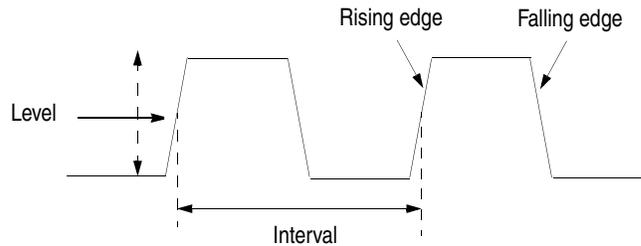
Figure 1-45: Trigger parameters
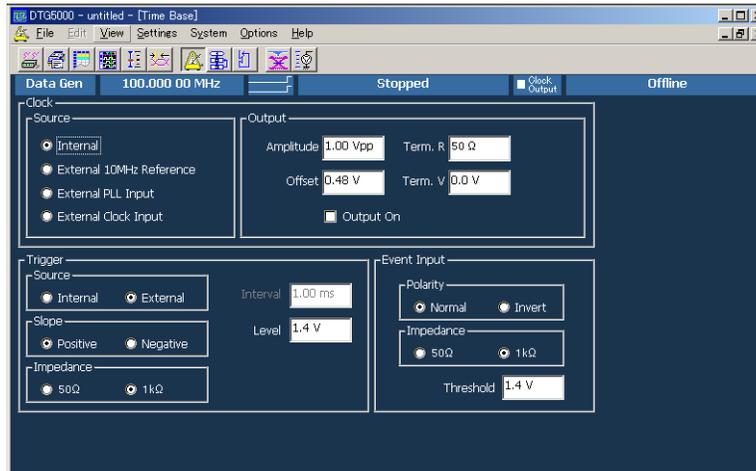
Figure 1-46: Time Base window (Data Generator mode)

Table 1-25 shows setup items of trigger parameters in the Time Base window.

Table 1-25: Trigger parameters on Time Base window

Items	Description
Source	Internal: Uses the trigger signal generated in the DTG5000 Series. External: Uses the external signal connected to the trigger connector on the front panel. You can use signal from –5 to +5 V for 50 Ω, or from –10 to +10 V for 1 kΩ source.
Interval	Specifies the interval of the internal trigger. You can set a value from 1.0 μs to 10.0 s.
Slope	Specifies the edge at which the trigger is to be generated. Specify this when you use the external trigger. Positive: Generates the trigger at the rising edge. Negative: Generates the trigger at the falling edge.
Level	Specifies the trigger level at which the external trigger is generated. You can set a value from –5 to +5 V in 0.1 V steps.
Impedance	Specifies external trigger impedance. Selects either 50 Ω or 1 kΩ for the impedance when the external trigger is used.

Sequence

This section describes sequences and tells how to create a sequence.

What is a Sequence?

A sequence is a list of data that is prepared by combining blocks. You can output a complex pattern by controlling listed blocks with a sequence definition, which contains the settings of Repeat (number of repetitions), WaitTrig (wait for trigger), Jump If (jump determined by the event information), and Goto (change the output sequence).

Each sequence may be defined as either the main sequence or a subsequence. The main sequence consists of one or more blocks and zero or more subsequence. One main sequence can be defined in the whole system. A subsequence consists of one or more blocks.

In a subsequence, define the number of block repetitions. In a sequence, you can define blocks, the number of subsequence repetitions, and jumps determined by the conditions to output complex signals.

Procedure for Creating a Sequence

The DTG5000 software default setup contains a defined sequence that outputs a continuously repeated pattern of Block1. This means that the DTG5000 software signal output is performed according to the sequence definition and output of the signal requires definition of the sequence. To define a sequence, do these steps:

1. Using the Blocks window, create the necessary number of blocks, which are elemental units of pattern data.

2. Create the pattern of each block using the Data-Listing or Data-waveform window.

3. If necessary, define subsequences using the Sub-sequences window. In each subsequence, define a list of blocks and the number of block repetitions.

4. In the Sequence window, specify the blocks and subsequences to use. Define the number of repetitions, whether to wait for the trigger, and the sequence for the destination of Jump and the other required sections.

5. In the Sequences window, also define the parameters related with sequence operation (Sequence Mode, Jump Mode, and Jump Timing). The sequence that can be output depends on the option you select in Sequence Mode.

For creating a pattern of blocks, refer to the "Pattern Edit" section.

The following trigger parameters are available. You can set them using the Timebase window.
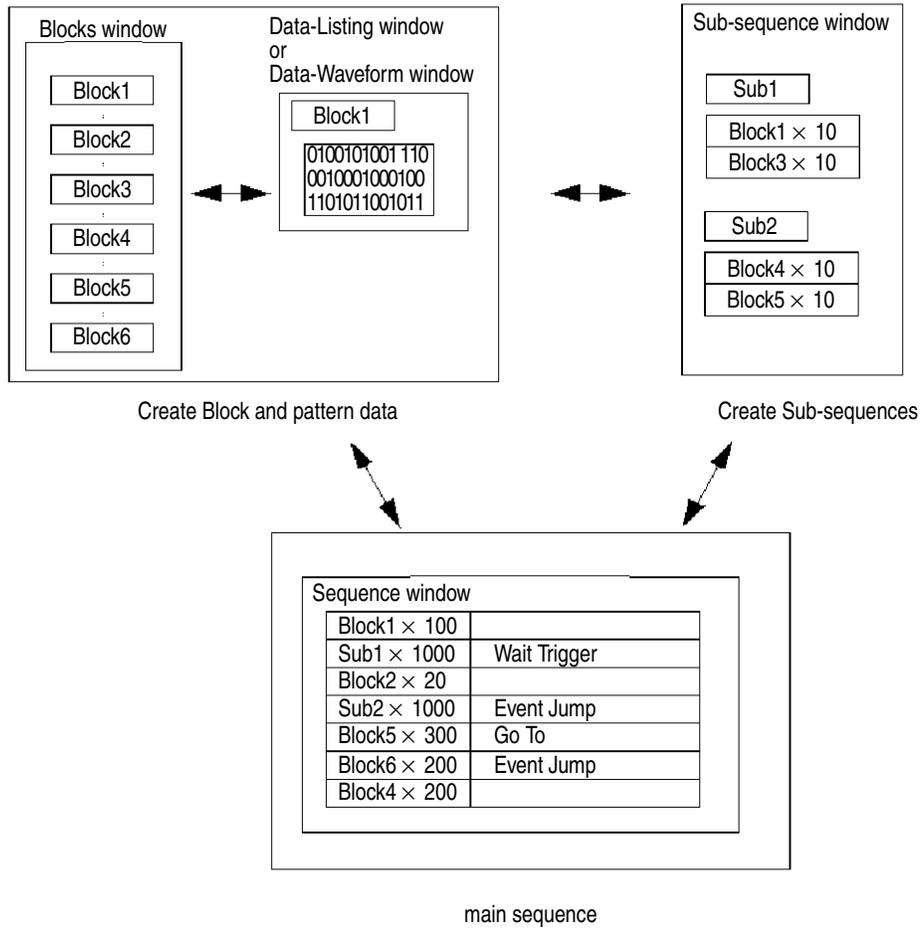
Figure 1-47: The procedure of sequence creation

Sequencer Mode

The sequencer runs sequences that you have created using the Sequence window. Two sequencer modes are available: Hardware and Software Sequencer.

Hardware Sequencer implements sequence output by controlling the hardware's sequencer with software.

Software Sequencer deploys the sequence definition in pattern memory by means of software without using the hardware's sequencer. This enables the Software Sequencer to meet two purposes:

■ Restricting the minimum block length

■ Enabling the output of patterns without the limit of the Block size granularity

■ Expanding the nesting level of subsequence up to 5 levels

Therefore, there are restrictions on the operation and functions that may vary in state during execution of an instruction such as Event Jump. Table 1-26 summarizes the differences between the two sequencers:

Table 1-26: Differences between Hardware and Software Sequencers

	Hardware Sequence	Software Sequencer
Limit of minimum block size	Applied (usually, 240 words/channel for DTG5078, or 960 words/channel for DTG5274 and DTG5334)	Not applied
Block size granularity	Applied for DTG5274 and DTG5334	Not applied
Nesting level of subsequence	1 level only	Up to 5 levels
Jump	Not limited	Disabled
Go to	Not limited	Disabled (You can specify the destination of Go To only on the last line in the main sequence.)
Trigger Wait	Not limited	Disabled (You can specify this only on the first line in the main sequence.)
Infinite Loop	Not limited	Disabled (You can specify this only on the last line in the main sequence.)
Restrictions on use of pattern memory	Not applied	Because all the sequences are deployed in pattern memory, a memory overflow error may occur with an excessive loop count.

Jump Mode

For the jump mode during sequence output, event jump and command jump are available. You can select jump mode in the Data Generator mode only when the sequencer mode is the Hardware Sequencer.

Table 1-27: Jump modes

Items	Description
Event jump	Jumps to the line that has the label defined with Event Jump To in the sequence table, when an event is received. There are three acceptable events: generation of the input signal to the front panel's EVENT IN connector, pressing the MANUAL EVENT button, and issuing remote command TBAS:EIN:IMMEdiate.
Command jump	Jumps to the line that has the specified label, when remote command TBAS:JUMP<label> is received. If the long delay is on, the command jump is disabled.

Jump Timing

Specifies the timing of the control jumps when a trigger for the event or command jump is generated. When selection of the jump mode is enabled, you can also select the jump timing.

Table 1-28: Jump timing

Items	Description
Async	Jumps as soon as an event or remote command is received.
Sync	Jumps after completing output of the current block, when an event or remote command is received. For example, suppose that a line defines that Block1 repeats 10 times. If an event occurs while the third run is in progress, control jumps after completing data output of the block of the third run.

Main Sequence

Only one main sequence exists in the whole system. By default, you have a main sequence that outputs a continuously repeated pattern of Block1. The main sequence contains up to 8,000 lines for definition. To define sequences including the main sequence, you can use the Sequence window.
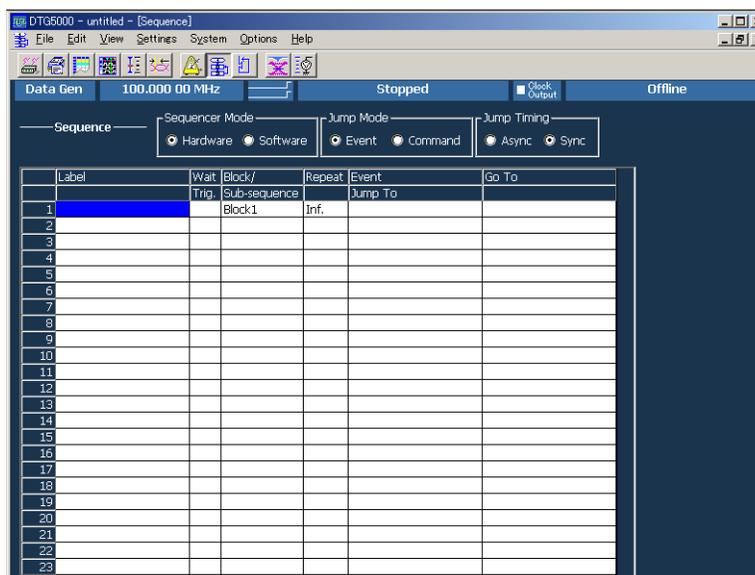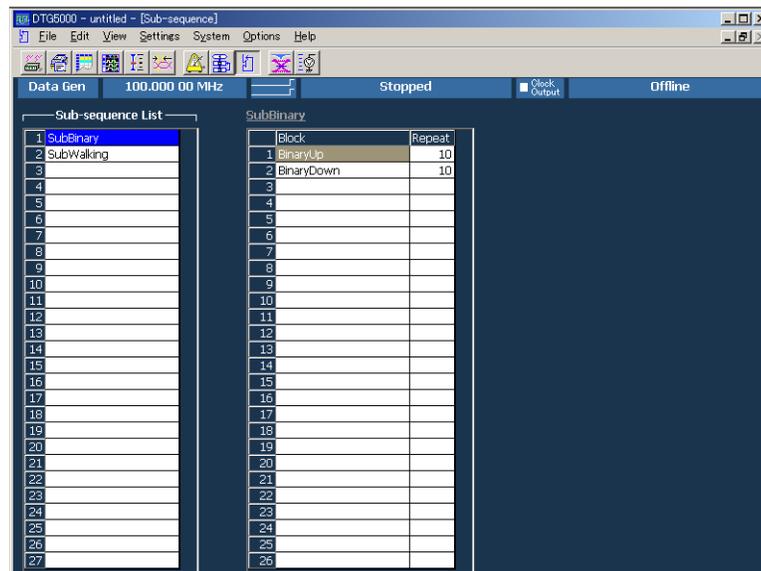

Figure 1-48: Sequence window

In the Sequence window, you can set the following:

Table 1-29: Setup items for Sequence window

Items	Description
Sequence Mode	Specifies the sequencer mode (Hardware or Software Sequencer).
Jump Mode	Specifies a jump by an event caused by an external event signal, a press of a front panel button, or a remote command. Also specifies a command jump caused by a remote command.
Jump Timing	Selects ASync, which jumps immediately or Sync, which waits for the completion of current blocks outputs.
Label	Sets the line name. Accepts up to 16 characters for the label name. You can define up to 8,000 lines for a sequence. This label may be used as a destination of Jump To and Go To.
Wait Trig.	Specifies whether to wait for the trigger before the contents of the line are output. Select On or Off (blank) for setting. You can also use the SPACE or ENTER key, instead of setting in the menu.

Table 1-29: Setup items for Sequence window (cont.)

Items	Description
Block/Sub-sequence	Specifies the name of the block or subsequence to be output on the line. Accepts up to 32 characters. The already defined block and subsequence names are listed in the menu displayed by pressing the MENU, SELECT, or right mouse button. You can select the desired one also from the list.
Repeat	Specifies the number of block or subsequence repetitions. Accepts an integer from 1 to 65536 or Infinite. To set Inf., use the menu that is displayed by pressing the MENU, SELECT, or right mouse button, or press 0 + ENTER keys. Note: When the number of Repeat is set as a subsequence, "the number of times of a sub-sequence$\times$ the number of Repeat" of lines are required on the sequence memory. Example: If Repeat=5000 are set as the subsequence of two lines, it requires 2x5000=10000 (>8000) lines of sequence memory. and will make to an error at the time of loading a sequence.
Event Jump To	Specifies the label of the line to which control jumps when an event occurs while the contents of the current line are being output. If the cell is left blank, control will not jump.
Go To	Specifies the label of the line to which control jumps unconditionally after the contents of the current line are output. If the cell is left blank, control goes to the next line.

Subsequence

A sequence in the main sequence is called a subsequence. A subsequence permits you to define the blocks and the number of block repetitions. You can define up to 256 lines in a subsequence, and define up to 50 subsequences. The subsequence nesting level can be up to 1 for the Hardware Sequencer or 5 for the Software Sequencer.

Sub-sequences Window

In the Sub-sequences window, you can display and edit information about subsequences. The Sub-sequence List (left) contains the names of the already created subsequences. Selecting a subsequence from the lists shows its details on the right. When you create a new Sub-sequence, input a name into a Sub-sequence list.

Figure 1-49: Sub-sequence window

In the Sub-sequence table, you can set the following:

Table 1-30: Setup items for Sequence window

Items	Description
Block	Specifies the name of the block to be output on the line. Accepts 32 characters for a block name. Enter the name in ALPHA input mode or from the external keyboard. The already defined block names are listed in the menu displayed by pressing the MENU, SELECT, or right mouse button. You can thus select the desired one from the list. You can set up the sequence nesting by defining the subsequences. If you use the Software Sequencer, you can set up nesting of up to 5 levels.
Repeat	Specifies the number of block repetitions. Accepts an integer from 1 to 65536. Does not accept Infinite.

Jitter Generation

This section details the Jitter generation of the DTG5000 Series.

Jitter generation on the DTG5000 series

The jitter generation function that the DTG5000 Series allows you to write a pattern in RAM in advance and move the delay value of the signal of Channel 1 by the value of that pattern. You can select Sine, Square, Triangle, or Gaussian Noise for the jitter pattern. Because Channel 2 is used for jitter generation, it will be not available for signal output.

Two modes are available for jitter type: All, which swings the whole and Partial By, which allows jitter to be partially inserted. You can select "Rise only," "Fall only," or "Both" for the edge(s) where jitter is applied.

The following restrictions are imposed on jitter generation:

■ It is enabled when Long Delay is off in the Data Generator mode.

■ In the Pulse Generator mode, a jitter generation is disabled.

■ The jitter can be applied only to Channel 1 of Slot A of the master.

■ Using channel combination while CH2 of Slot A is used for internal jitter generation means that CH2 is otherwise unavailable, so any attempt to assign CH2 is rejected.

■ Channel 2 of Slot A is internally used for jitter generation. Channel 2 will thus be disabled, so any attempt to assign CH2 is rejected. However, because the jitter generation function uses the CH2 circuit on the mainframe side, the function can be used with DTGM31 and DTGM32 output modules.

■ For the same reason, the channel composition function of Channel 1 is disabled.

■ In the DTG5000 Series, the timebase for pattern generation (clock) and for jitter generation is entirely independent of each other (async); no repeatability is included in the characteristics of jitter generation. In addition, there is no guarantee that jitter generation starts at the head of the jitter profile.
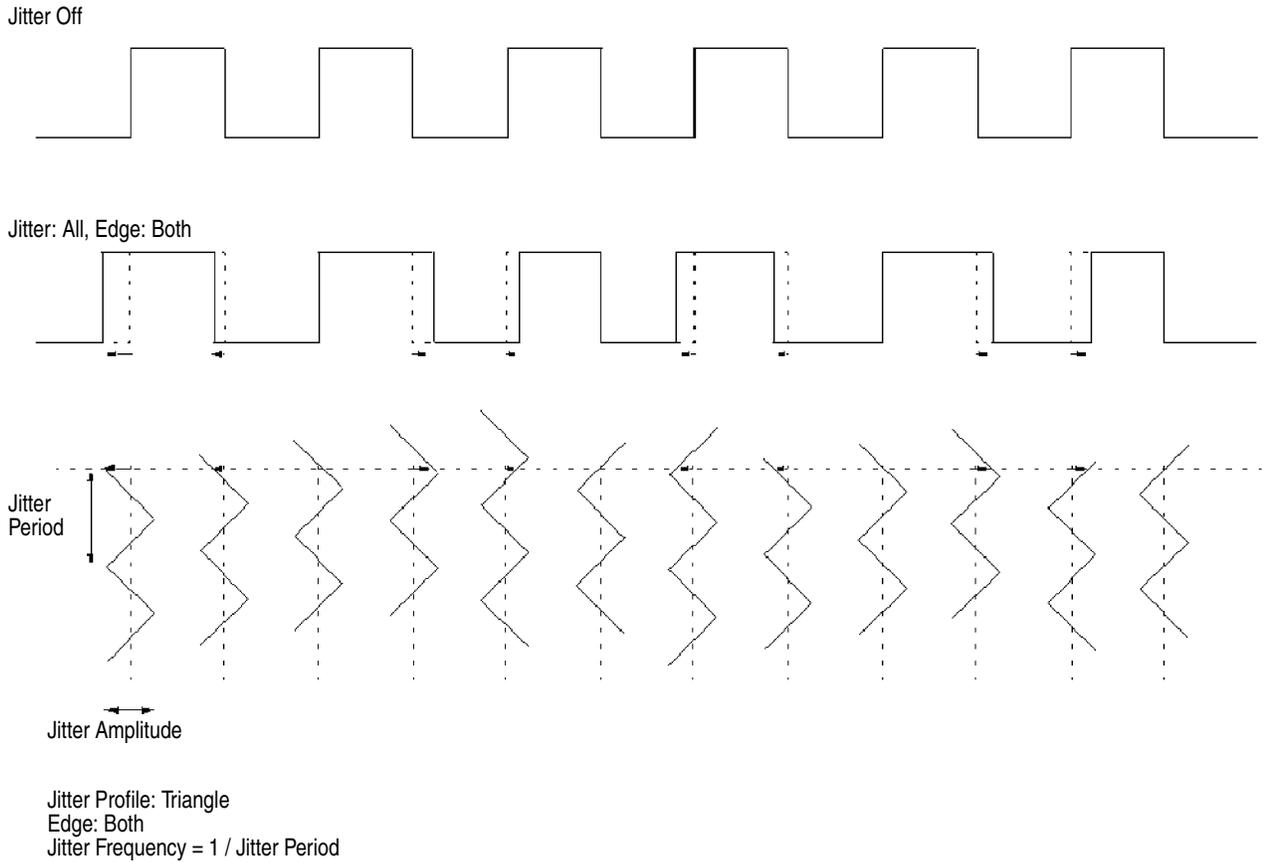
Figure 1-50: Jitter Generation parameters

All Pattern Jitter

To generate jitter, vary the delay of the leading and/or trailing edge of Channel 1 by using the data generator, which is controlled with the specified Jitter Profile (the transition pattern of the amount of delay(s)), Frequency (jitter frequency), and Amplitude (width of jitter).

Connect the same signal of Channel 1 to the Channel 1 and Channel 2 delay lines, and use them while switching the delay line with the switch.

Actually, the amount of delay is varied according to the sequence below, and jitter is generated while the delay line is switched with the timing. The amount of delay of the output signal is varied consecutively.

■ Set the switch to Delay Line #2. (The signal is output with the amount of delay that was set for Delay Line #2.)

■ Wait until Delay Line #1 is emptied.

■ Set the amount of delay for Delay Line #1 for the amount of jitter that will be output next.

■ After completion, set the switch to Delay Line #1 at a convenient point to partition the pattern from Delay Line #2. (The signal is output with the amount of delay that was set for Delay Line #1.)

■ Wait until Delay Line #2 is emptied.

■ Set the amount of delay for Delay Line #2 for the amount of jitter that will be output next.

■ After completion, set the switch to Delay Line #2 at a convenient point to partition the pattern from Delay Line #1. (The signal is output with the amount of delay that was set for Delay Line #2.)

. . . .
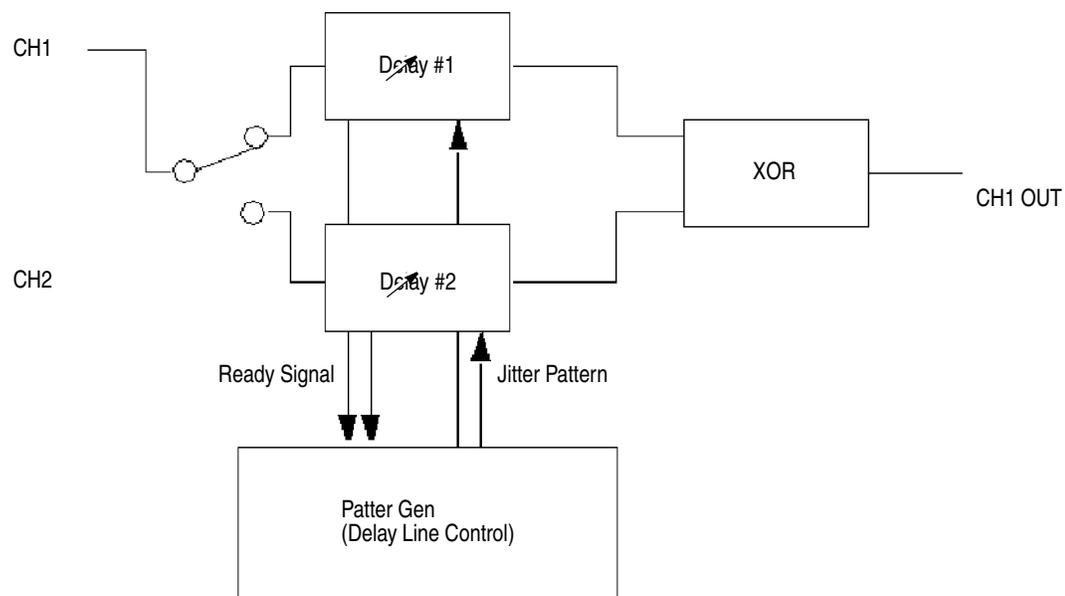
Figure 1-51: Jitter Generation (All pattern jitter)

Partial Pattern Jitter

You can apply jitter to any specified section of the pattern. To specify the section to which jitter is applied (called the Jitter On area), use the pattern data for the logical channel you specified by Partial By.

Actually, partial pattern jitter is applied using the following procedure internally:

■ In Channel 1, enter the Channel 1 data from which the data in the Jitter On area was cut, that is, the Jitter On area data replaced with 0s.

■ In Channel 2, enter the Jitter On area data that was cut from Channel 1, that is, all 0 data except the Jitter On area.

■ Fix the amount of delay of Channel 1 to 0.

■ To generate jitter, vary the delay of the leading and/or trailing edge of Channel 2 by using the pattern generator, which is controlled with the specified Jitter Profile (the transition pattern of the amount of delay(s)), Frequency (jitter frequency), and Amplitude (width of jitter).

■ Obtain the XOR value of the two signals.
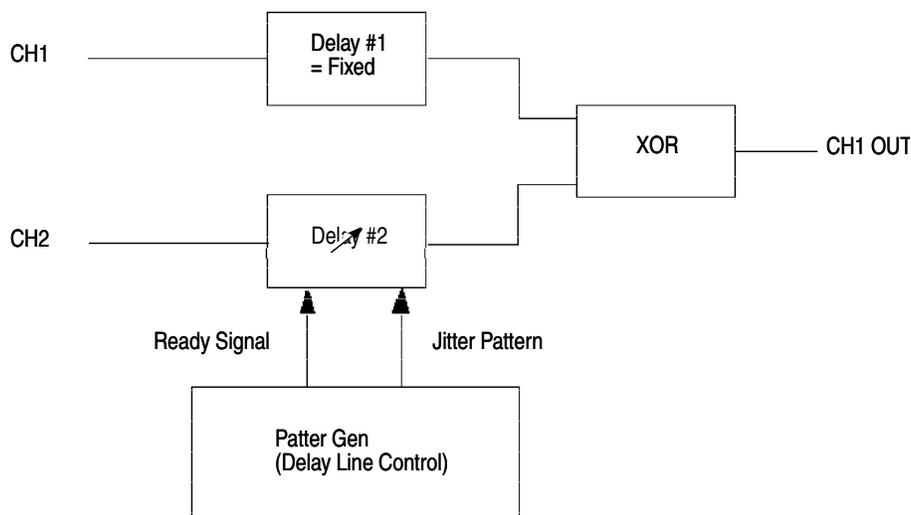
Figure 1-52: Jitter Generation (Partial pattern jitter)

The sections in which jitter is applied are those sections denoted by "Gate on" that have 1 as the value of the specified logical channel. The NRZ format is used as for a gate pattern regardless of the specified logic channel. You can set any number of Jitter On areas.

If the data format of Channel 1 is NRZ or RZ, jitter is applied at the edge of the pulse the rising section of which is included in the Gate On area. This occurs for each positive pulse, for the Rise/Fall pairs. Also if you have selected Fall for Edge, whether jitter is applied depends on whether the rising section of the pulse is included in the Gate On area. This occurs for each positive pulse, for the Rise/Fall pairs.

If the data format of Channel 1 is R1, jitter is applied at the edge of the pulse the falling section of which is included in the Gate On area. This occurs for each negative pulse, for the Fall/Rise pairs. Also if you have selected Rise for Edge, whether jitter is applied depends on whether the falling section of the pulse is included in the Gate On area.

In addition, when a data format is NRZ, Jitter may not be applied in a Gate On area at the beginning of or end of a block.
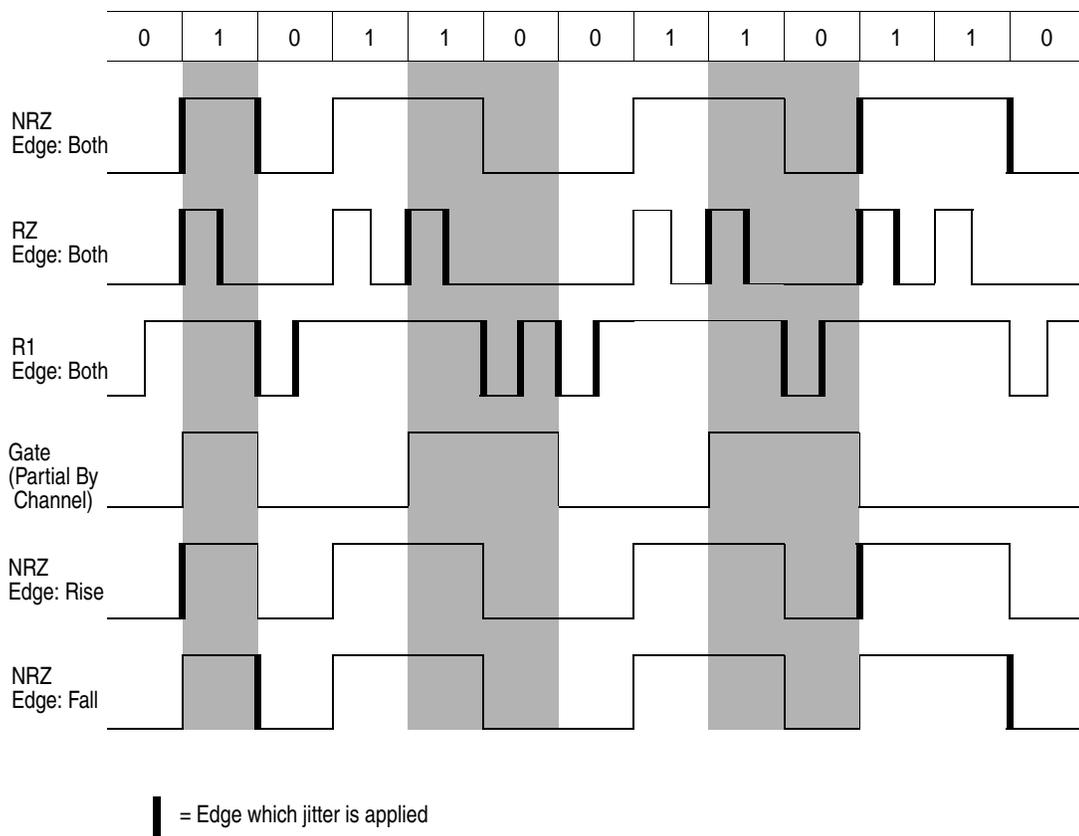
Figure 1-53: Edge which jitter is applied

Parameters

In the Jitter Generation window, you can set the following jitter parameters:
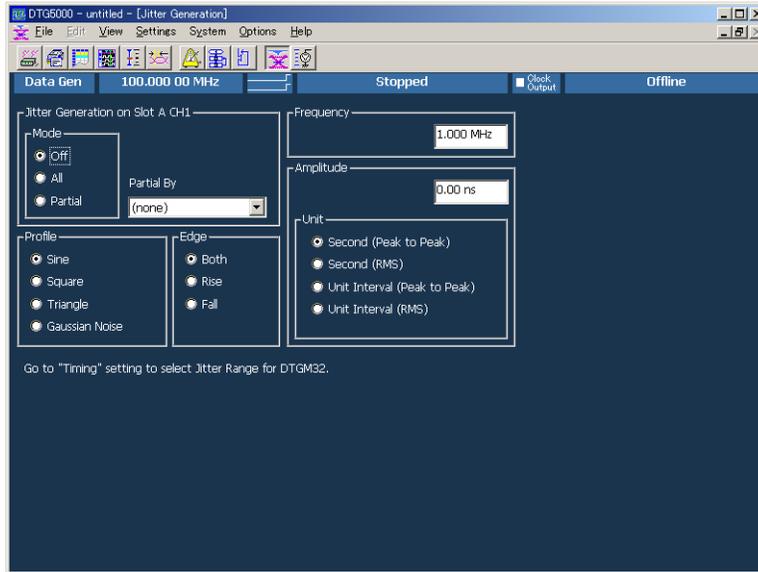
Figure 1-54: Jitter Generation window

Table 1-31: Jitter Generation window settings

Setting	Description
Jitter Generation in Slot A CH1 (Jitter Mode)	Off: Turns off jitter generation.
	All: Applies a jitter to the whole pattern of Channel 1 in Slot A.
	Partial: Applies a jitter to part of the pattern of Channel 1 in Slot A. Using the combo box of the Partial By, select the channel to be used as the gating source. Partial pattern jitter is applied at a point where the logical channel you selected for the gating source is 1.
Profile	Select Sine, Square, Triangle, or Gaussian Noise for the profile of jitter.
Edge	Specifies the edge at which to apply the jitter. You can specify Rise, Fall, or Both.
	Rise: Applies jitter only at the rising edge.
	Fall: Applies jitter only at the falling edge.
	Both: Applies jitter at each of the rising and falling edges.

Table 1-31: Jitter Generation window settings (cont.)

Setting	Description
Frequency	Sets the repetitive frequency of the profile. Accepts a value from 0.015 Hz to 1.56 MHz. Not available if you have selected Gaussian Noise for the profile.
Amplitude Unit	Set the profile amplitude and jitter width. For the unit, you can select either Second or UI (unit interval, 1 clock period in DTG5000 Series). To specify these, use the peak-to-peak or RMS value, respectively. The relationship between peak-to-peak and RMS is as follows: Sine: 1 UIrms = 2√2 UIp-p Square: 1 UIrms = 2√3 UIp-p Triangle: 1 UIrms = 2 UIp-p Gaussian Noise: 1 UIrms = 12 UIp-p Because the width of jitter swings the same amount toward the positive and negative directions, you cannot set it if the amount of Lead Delay is 0. The maximum jitter amplitude will be obtained when the value of Delay Offset is set as 2.5ns.

The setting state (Edge information at the time of Jitter ON) of Jitter is displayed on the Data-Waveform window of a View by Channel display.
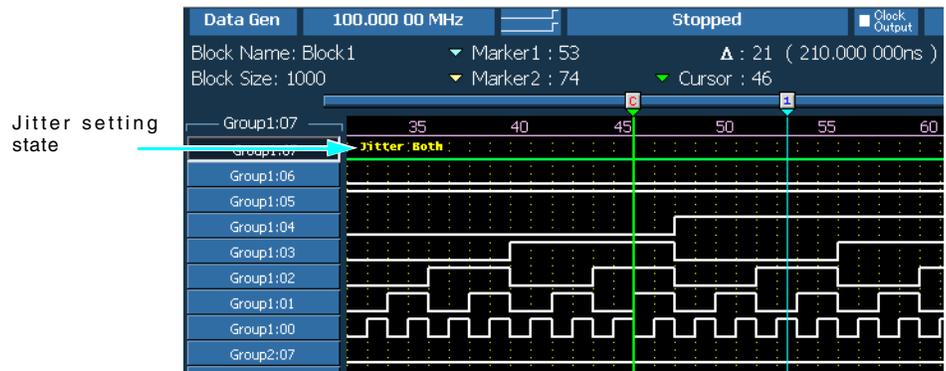
Figure 1-55: Jitter setting state on the Data-Waveform window

Table 1-32 summarizes the valid ranges of the jitter amplitude.

Table 1-32: Maximum jitter amplitude

Jitter Edge	Data Format	Jitter Mode	Jitter Profile	Maximum jitter amplitude (UIp-p)
Both	NRZ only	All pattern jitter	Sine	$(1 - 290\ ps\ /\ Period)\ \times\ 9.9\ e5\ /\ Fj$ Condition1 must be satisfied.
			Other than Sine	$1 - 290\ ps\ /\ Period$ Condition1 must be satisfied.
		Partial pattern jitter	any	
	includes RZ or R1	All pattern jitter	Sine	$(Period - Pulse\ width - 290\ ps)\ /\ Period\ \times\ 9.9\ e5\ /\ Fj$ Condition1 must be satisfied.
			Other than Sine	$(Period - Pulse\ width - 290\ ps)\ /\ Period$ Condition1 must be satisfied.
		Partial pattern jitter	any	
Rise/Fall	NRZ only	any	any	$(Period - 290\ ps)\ /\ Period \times 2$ Condition1 must be satisfied.
	includes RZ or R1	any	any	$(Min\ \{Pulse\ width,\ Period - Pulse\ width\} - 290\ ps)\ /\ Period \times 2$ Condition1 must be satisfied.

Condition1	Lead Delay + Ajs_p-p / 2 $\leqq$ Maximum of Lead Delay
	and
	Lead Delay – Ajs_p-p / 2 $\geqq$ Minimum of Lead Delay
	
	      where Ajs_p-p = Ajui_p-p $\times$ Period (Period = 1 UIp-p)
	                   Ajui_p-p = Jitter Amplitude on UIp-p
	
	If the data format for Channel 1 is R1 or RZ, Condition2 below must be satisfied:			

Condition2	Trail Delay + Ajs_p-p / 2 $\leqq$ Maximum of Trail Delay and Trail Delay – Ajs_p-p / 2 $\geqq$ Minimum of Trail Delay			
Where	Fj: Jitter Frequency Ajui_p-p: Jitter amplitude represented by UIp-p Ajui_rms: Jitter amplitude represented by UIrms Ajs_p-p: Jitter amplitude represented by Sec p-p Ajs_rms: Jitter amplitude represented by Sec rms Ajui_p-p $\times$ Period = Ajs_p-p Ajui_rms $\times$ Period = Ajs_rms			

External Jitter

The DTGM31 and DTGM32 output modules provide a supplemental jitter function by an external signal connected to the Jitter Control In connector(s). The output frequency is modulated by the signal level applied to the Jitter Control In connector(s).

Two external signals can be applied to the DTGM32, both of which operate in the same way. Also, two jitter amplitude ranges can be selected. The jitter range is set in the Timing window.

Table 1-33: External jitter

Jitter Control	DTGM31	DTGM32
number of the Jitter Control In connectors	1	2 Jitter profile is the composite of InputA and InputB.
Impedance	50 Ω, DC coupled	50 Ω, DC coupled
Input Amplitude Range	0 Vp-p to 1 Vp-p (DC coupled)	0 Vp-p to 1 Vp-p (DC coupled)
Maximum Input Voltage	±1.0 V	±1.0 V
Maximum Jitter Amplitude	240 ps : at Data Rate ≤2.7 GBps (240 – 61.5 x (Data Rate – 2.7)) : at Data Rate ≥ 2.7 Gbps	Range1: 1 ns Range2: 2 ns

Input Voltage vs. Jitter Amplitude (DTGM 31)
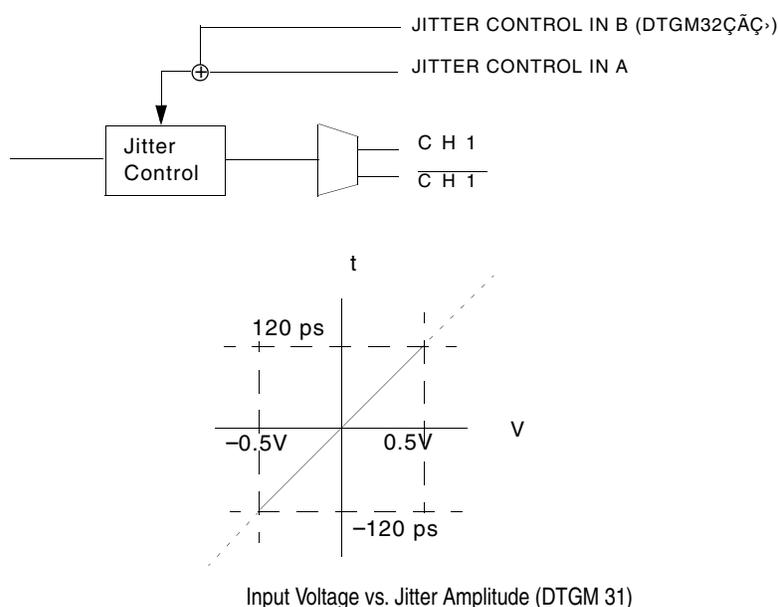
Figure 1-56: External Jitter Control

DTG5000 Configuration Utility

The DTG5000 Configuration Utility software is independent of the DTG5000 software. This utility allows you to switch the DTG5000 software between online and offline or set up Master-Slave operation.

Startup

You can start the DTG5000 Configuration Utility from the Start menu. (It is actually a file named Config.exe, which is located in the folder containing the DTG5000 software.) If you attempt to start the utility while the DTG5000 software is running, you will enter the View-Only mode, which prevents you from performing setup and other operations. If you want to modify the settings with this utility, be sure to first exit the DTG5000 software.

1. If the DTG5000 software is running, press the **MENU** key and select Exit from the File menu to exit the software.

2. Press **CTRL + ESC** to open the Start menu. Using the Up, Down, Left, and/or Right arrow key, select **Programs / Tektronix / DTG5000 / DTG5000 Configuration Utility**.

3. Press the **ENTER** key to start the DTG5000 Configuration Utility. The utility provides you with two windows: for Online and Offline modes. Actually, you see the window corresponding to the current mode setting.
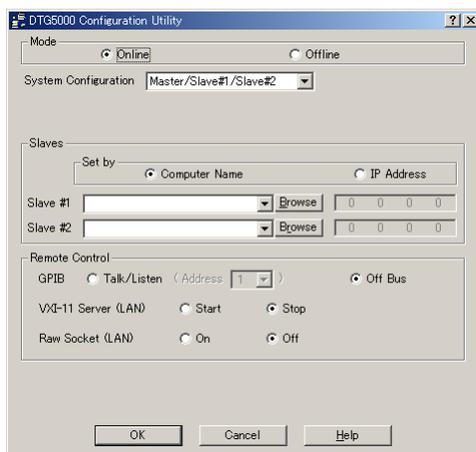
Online mode   Selecting Mode   Offline mode
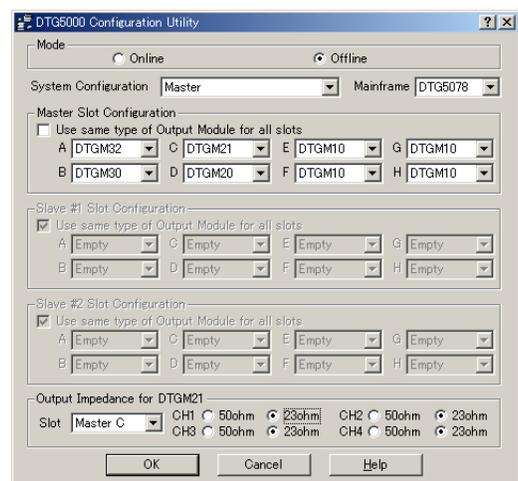
Figure 1-57: DTG5000 Configuration Utility

Mode

The DTG5000 software runs in either the Online or Offline mode. The DTG5000 Configuration Utility opens the window corresponding to the mode. To select the mode, use the Mode area in the Configuration dialog box.

Online Mode
The Online mode runs on the DTG5000 Series mainframe and performs the entire process to control the DTG5000 Series hardware. You use this mode to output a signal. Your system configuration is recognized and applied automatically, including the mainframe you are using, currently installed output modules and their counterpart slots.

Offline Mode
The Offline mode runs on the PC or DTG5000 Series mainframe. It performs the entire process from creating and editing the pattern data to setting up the output parameters, with the hardware disconnected. You can combine the mainframe and output modules as desired, provided they meet the restrictions. You can use this mode until you press the RUN button to output signals. It allows you to save the results of the work in a settings file, and then loads and outputs it in the Online mode.

DTG5000 Configuration Utility in Online Mode

Select the Online checkbox in the Mode area in the DTG5000 Configuration Utility software. The window for the Online mode appears.
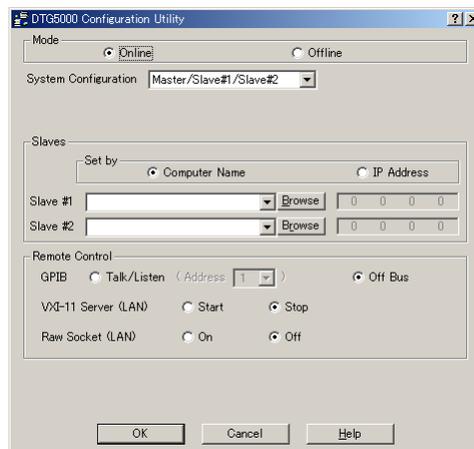
Figure 1-58: DTG5000 Configuration Utility Online mode

Table 1-34: Setting for DTG5000 Configuration Utility in Online mode

Setting	Description
System Configuration	Specifies whether the Master-Slave operation can be performed, and (if you select it) its configuration.
	Master: If you do not specify that Master-Slave operation be performed, select Master.
	Master/Slave#1, Master/Slave#1/Slave#2: If you specify that Master-Slave operation be performed, specifies as the master machine. Select either according to the number of slave machines. For DTG5274, you can use only one slave machine.
	Slave: If you specify that Master-Slave operation be performed, specifies as the slave machine.
Slaves	In Master-Slave operation, the slave machines are controlled via LAN. Specify the names or IP addresses of the desired slave machines in the DTG5000 Configuration Utility on the master machine.
Set by	Selects the way in which you will specify each slave machine.
	Computer Name: Specifies that you will use the computer name. If you select Computer Name, enter the name in the combo box under this field. If you set it previously, you can use the Up and/or Down arrow key to select the previously set name from the list. Selecting the Browse button displays the network computer's browser, where you can select the slave machine.
	IP Address: Specifies that you will use the IP address. If you select IP Address, enter the address in the box under this field.
Remote Control	For DTG5000 Series, you can enable remote control only through GPIB or LAN interface. Specify the GPIB configuration and control of a LAN program in this box.

DTG5000 Configuration Utility in Offline Mode

Select the Offline checkbox in the Mode area in the DTG5000 Configuration Utility, the window for the offline mode appears.
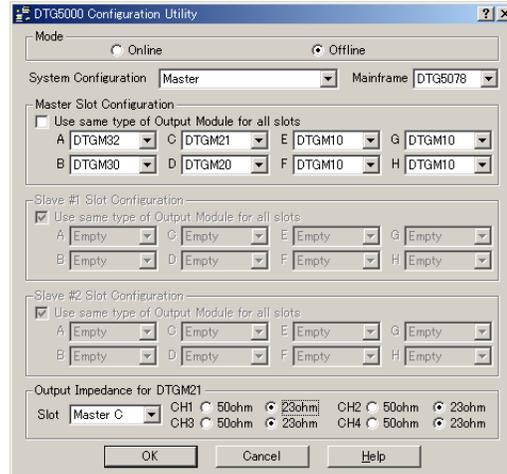
Figure 1-59: DTG5000 Configuration Utility Offline mode

Table 1-35: Setting for DTG5000 Configuration Utility in Offline mode

Setting	Description
System Configuration	Specifies whether the Master-Slave operation can be performed, and (if you select it) its configuration.
	Master: If you do not specify that Master-Slave operation be performed, select Master.
	Master/Slave#1, Master/Slave#1/Slave#2: Specify the number of slave machines used for Master-Slave operation. Select either according to the number of slave machines. If you are using DTG5334 or DTG5274 for the mainframe, you can use only one slave machine.
	Slave: Not available in Offline mode.
Mainframe	Selects either DTG5078, DTG5274 or DTG5334 for the mainframe.
Master Slot Configuration	Specifies the conditions of the master machine's slots. For each of the slots, specify the slots and the output modules installed in the slots. The available slots vary depending on the mainframe.
	For the installation condition of each slot, you can select one of the following: DTGM10, DTGM20, DTGM21, DTGM30, DTGM31, DTGM32 or no module (empty).
	If you check the Use same type of Output Module for all slots checkbox, the settings specified for a slot will be applied to all the other slots.

Table 1-35: Setting for DTG5000 Configuration Utility in Offline mode (cont.)

Setting	Description
Slave #1 Slot Configuration Slave #2 Slot Configuration	If you have specified that the Master-Slave operation be performed in System Configuration, set the slot conditions of the slave machines. The setting details are the same as for the master machine.
Source Impedance for DTGM21	When the DTG application launches, source impedance of the DTGM21 output module installed in each slot is checked and displayed. But in the Offline mode, you need to specify each of them. Slot: Specifies the slot of which DTGM21 installed CH1,...CH4: Select the sauce impedance of each channel.

Exit

After you have completed the required settings in Online or Offline mode, click the **OK** button to exit the DTG5000 Configuration Utility.

Then, select the Start menu > Programs > Tektronix > DTG5000 > DTG5000 to start the DTG5000 software. The settings made with the DTG5000 Configuration Utility will take effect on the DTG5000 software.

Master-Slave Operation

When you use one unit of the DTG5000 Series mainframe, the DTG5078 can output up to 32 channels of signals, and the DTG5274 / DTG5334 up to 8 channels. The Master-Slave operation is a feature that allows you to use more channels of signals than the maximum number of channels of one unit. This is possible by operating multiple units of the same model of mainframes. A unit that controls the overall system is called Master, and a unit that is used for additional channels is called Slave. If the DTG5274/DTG5334 is used as a master, one unit of DTG5274/DTG5334 can be used as a slave. If the DTG5078 is used as a master, up to two units of DTG5078 can be used as slaves.

In the Master-Slave operation, the master and slaves should be connected directly for the Clock and Event signals, because the timing is critical. For other signals, the master controls the slaves through a LAN. You can configure the overall system, prepare pattern data and set output parameters through the corresponding windows of the master unit. The screen of each slave unit displays only its operating status and does not allow any operation other than exiting the program

Preparing the Master/Slave Operation

To execute the Master-Slave operation, you must connect the master unit and each slave unit with cables and configure the master unit's system for Master-Slave operation.

Connecting the Cables   To synchronize the clock and jump timing on the overall system, connect the two types of signals and establish a LAN as shown in Figure 1-60 on page 1-108 and Figure 1-61 on page 1-109.

As a clock source, use the clock selected on the master. To supply the clock signal Sync Clock Out generated from the master to all the units:

- Connect the Sync Clock Out/$\overline{\text{Out}}$ signals of the master unit to Sync Clock In/$\overline{\text{In}}$ of the slave units.

- Also connect the Sync Clock Out/Out signals of the master unit to Sync Clock In/$\overline{\text{In}}$ of the master unit.

- Use only the Textronix SMA cable, part number 174-1427-00.

Also for the Sync Jump control signals:

■ Connect Sync Jump Out1, Out2, and Out3 of the master to Sync Jump In of the master, to that of slave 1, and to that of slave 2, respectively.

■ For the connection, use the Tektronix BNC cable, part number 012-0076-00.

NOTE. Use the specified cables for connection. If you use cables other than those specified, the operation cannot be guaranteed.
Do not apply any signal other than specified to the Sync Clock In and Sync Jump In input connectors because doing so may cause a fault.

When stacking the mainframes for use, do not stack more than three units. Do not forget to fold the stand at the bottom of the cabinet.
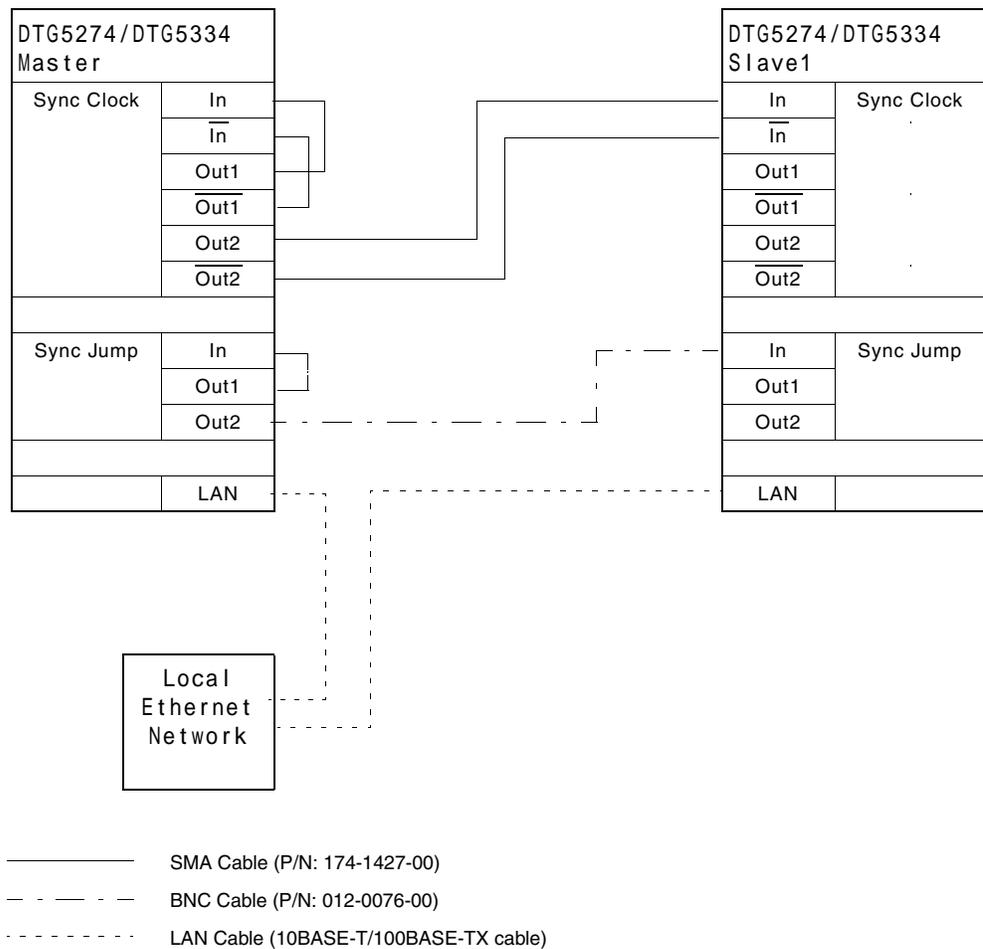
Figure 1-60: Master-Slave cable connection (DTG5274 and DTG5334))
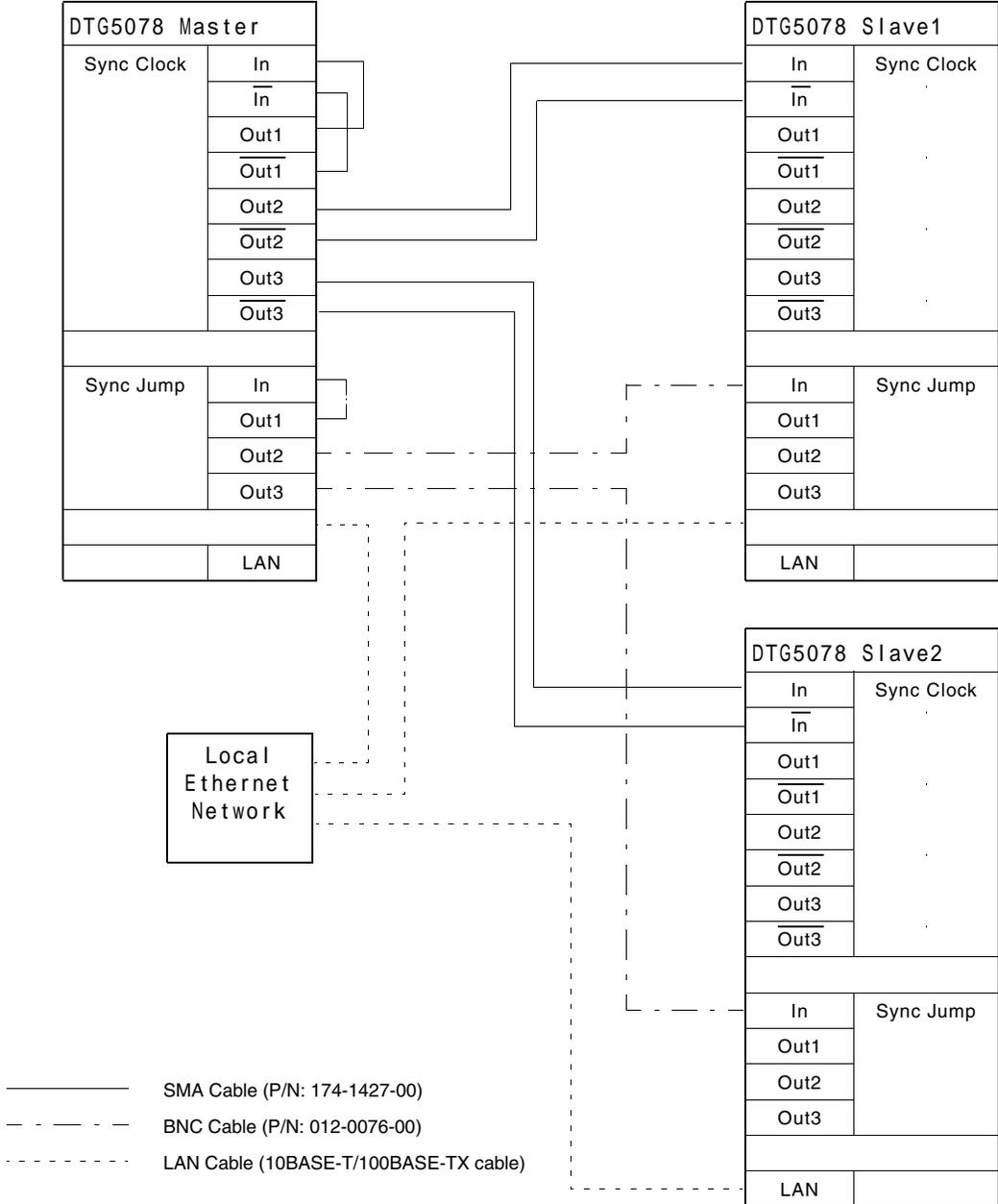
Figure 1-61: Master-Slave cable connection (DTG5078)

Changing the Computer Name

Before connecting LAN cables, check that the master and slave DTG5000 Series units have different computer names. If the same name is used for multiple units, give different names.

NOTE. Setting or changing a computer name requires the Administrators access level.

Although it can be operated from a front panel with text input mode, if an external keyboard and mouse are used, setting or changing the operation can be performed more easily.

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1. Press the **CTRL+ESC** keys to display the Start menu.

2. Select **Settings/Control Panel** by pressing the arrow keys and press the **ENTER** key.

3. Select **System** in Control Panel by pressing the arrow keys and press the **ENTER** key. System Properties will be displayed.

4. Select the **NetworkIdentification** tab by pressing the **CTRL+TAB** keys. The computer identification information will be displayed. Check the computer name here.

5. To change the computer name, select the **Properties** button by pressing the **TAB** key, then press the **ENTER** key.

6. Select **Computer Name** and press the ALPHA key to activate the text input mode. Enter a new computer name.

7. Select the **OK** button and press the **ENTER** key.

Check that all of the master and slave computers have different computer names.

To Find the IP address

DHCP automatically acquires the IP address of DTG by default. To find the IP address of a DTG unit, follow the steps below.

NOTE. Although it can be operated from a front panel with text input mode, if an external keyboard and mouse are used, setting or changing the operation can be performed more easily.

1. Press the **CTRL+ESC** keys to display the Start menu.

2. Select **Programs/Accessories/Command Prompt** by pressing the arrow keys and press the **ENTER** key.

3. In the Command Prompt window, enter "**ipconfig"**. The IP Configuration information will be displayed.

4. To exit the Command Prompt, enter "**exit"**.

If the IP address has been set manually, you can find the IP address from the Internet Protocol setting dialog box as well as by using the Command Prompt above.

1. Press the **CTRL+ESC** keys to display the Start menu.

2. Select **Settings/Network and Dial-up Connections** by pressing the arrow keys and press the **ENTER** key.

3. In the **Network and Dial-up Connections**, select the **Local Area Connection** icon and press the **ENTER** key.

4. The **Local Area Connection Status** dialog box will be displayed. Select the **Properties** button and press the **ENTER** key.

5. In the **Components checked that are used by this connection:** box, select **Internet Protocol (TCP/IP)**, then select the **Properties** button, and press the **ENTER** key.

6. In the **Internet Protocol (TCP/IP) Properties** dialog box, the TCP/IP information will be displayed. You can change the settings here.

Setting the Master-Slave Operation

After checking that the master and the slaves have different computer names, connect LAN cables and restart them. Use the DTG5000 Configuration Utility to configure each DTG as a master or a slave.

Configuring DTG5000 Series as a Slave

First, quit the DTG5000 software at step 1, next, start the DTG5000 Configuration Utility software (Config.exe) by step 2 through step 6.

1. Select **Exit** (not ShutDown) from the File menu by pressing the **MENU** and arrow keys to exit the DTG5000 software and return to the Windows desktop.

2. Press **CTRL + ESC** to open the Start menu. Using the Up, Down, Left, and/or Right arrow key, select **Programs / Tektronix / DTG5000 / DTG5000 Configuration Utility**.

3. Select the **OK** and press the **ENTER** key to start the DTG5000 Configuration Utility.
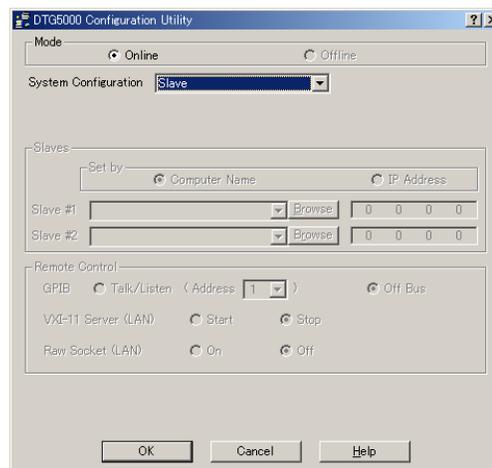
Figure 1-62: Configuring as a slave in the Configuration Utility dialog box

4. Select Mode: **Online** by pressing the **TAB** key and the left or right arrow key.

5. Select System Configuration: **Slave** by pressing the **TAB** key and the up or down arrow key.

6. Select the **OK** by pressing the **TAB** and press the **ENTER** to exit the DTG5000 Configuration Utility.

7. Press the **CTRL+ESC** to display the Start menu. Select **Programs/Tektronix/DTG5000/DTG5000** by pressing the arrow keys and

press the **ENTER**. The DTG5000 software will start. The DTG5000 Series unit will start as a slave.

While the DTG5000 Series unit operates as a slave, the DTG5000-Slave dialog box is displayed. At this time, all operations for the slave unit except for exiting the DTG5000 software should be performed from the master unit.

Figure 1-63: Dialog box in operation as a slave

8. Pressing the **ENTER** (selecting the **Close**) on the slave unit exits the DTG5000 software.

Configuring DTG5000 Series as a Master

With the DTG5078 model as a master, two units of the same model can be set as slaves. With the DTG5274/DTG5334 model, one unit of the DTG5274/DTG5334 model can be set as a slave.

First, quit the DTG5000 software at step 1, next, start the DTG5000 Configuration Utility software (Config.exe) by step 2 through step 7.

1. Select **Exit** (not ShutDown) from the File menu by pressing the **MENU** and arrow keys to exit the DTG5000 software and return to the Windows desktop.

2. Press **CTRL + ESC** to open the Start menu. Using the Up, Down, Left, and/or Right arrow key, select **Programs / Tektronix / DTG5000 / DTG5000 Configuration Utility**.

3. Select the **OK** and press the **ENTER** to start the DTG5000 Configuration Utility.
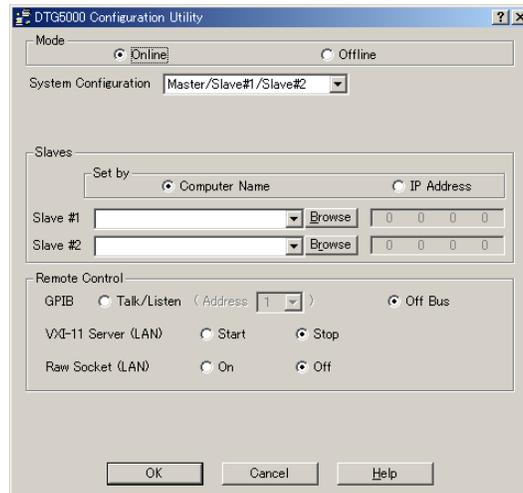
Figure 1-64: Configuring as a master in the Configuration Utility dialog box

4. Set System Configuration to **Master/Slave#1** or **Master/Slave#1/Slave#2** by pressing the **TAB** key and the up or down key, according to the number of slave units to be connected.

5. Specify the slave units to be connected in the Slave Computer Name area. You can specify a unit by entering the **Computer Name** (Name) or the **IP address** (IP address).

6. To specify the units with the names, select the **Computer Name** radio button, press the **ALPHA** key to activate the text input mode, and enter the names in the Slave #1 and Slave #2 combo boxes. You can also browse the Network Computers by pressing the **Browse** button and specify the slave units from the computers displayed.

7. To specify the slave units with the IP addresses, select the **IP Address** button and enter the addresses using numeric keys.

8. When the setting is complete, select the **OK** button and press the **ENTER** key to exit the DTG5000 Configuration Utility.

9. The following message prompting you to restart the DTG software will be displayed:
"Please restart DTG software."

NOTE. *Do not restart the DTG software until you read "Master-Slave Operation Procedure" beginning on page 1-115.*

Master-Slave Operation Procedure

During the Master-Slave operation, multiple DTG units are communicating together through the LAN.

Before connecting the LAN cables

Before connecting the LAN cables, make sure that all the master and slave units have their unique computer names on the network. If multiple DTG units have the same name, rename them. If multiple units of computers have the same name on the network, it can cause a trouble with the Master-Slave Operation.

Connecting the LAN cables and starting the computers

After checking that each DTG unit has a unique computer name, connect the LAN cables and restart the computers.

Configure the master and slaves with the DTG5000 Configuration Utility

To configure the master and slave units, exit the DTG5000 software and use the DTG5000 Configuration Utility.

■ When you configure the master unit with the DTG5000 Configuration Utility, you cannot browse the slave units unless the LAN cables are connected.

■ The computer names or the IP addresses are required to specify the slave units.

Restarting the DTG5000 software

After configuring the master and slave units using the DTG5000 Configuration Utility, start the DTG5000 software on the slave units first, and then start it on the master unit. The DTG5000 software on the master unit cannot start until it detects that the DTG5000 Series that were specified as slave units actually operate as its slaves.

■ After the slave units and the master unit are started, the parameters for all channels are displayed in the Channel Group, Data-Waveform, Data-Listing, Timing, and Level windows on the master unit. Perform all operations on the master unit such as assigning channels, creating and editing pattern data, and setting each output parameter. The operations are the same as those in the single unit system except for the increased number of channels that become available on the master unit.

■ DC Output signals of the slaves are also output from their connectors.

■ You can turn on or off the channels of all units by pressing the ALL OUTPUTS ON/OFF button on the master unit. The ALL OUTPUTS ON/OFF button can be operated only on the master unit.

■ External Clock Out is output only from the master unit.

■ The Pulse Generator mode during the Master-Slave operation is available only for the channels of slots A to D on the master unit.

**Terminating the
Master-Slave operation**

To terminate the Master-Slave operation, exit or shut down the master unit first and then exit or shut down the slave units.

Pulse Generator mode

The DTG5000 Series Data Timing Generator operates as a pulse generator that outputs a simple pulse pattern. The Pulse Generator mode is designed to easily output simple pulse patterns. It does not support the editing feature that the Data Generator supports.

To switch between the Data and Pulse Generator modes, push the PULSE GEN button on the front panel, or click the Data Gen/Pulse Gen button at the left end of the Status bar on the screen.

Features

The following are the features and restrictions of the Pulse Generator mode, as well as the differences from the Data Generator mode:

■ Use the Level, Timing, Time Base, and DC Output windows for setting purposes.

■ The Pulse Generator mode does not contain the concept of group or channel assignment. It sequentially uses all the channels of the installed output module. However, you can switch the view between View by Group and View by Group Channel.

■ Even if you have set up Master-Slave operation, you can use only the channels of the master machine.

■ The Pulse Generator mode supports neither the sequence definition nor pattern definition feature.

■ You can use all the channels of the output modules installed in Slots A to D.

■ You can specify the Pulse Rate to Off, 1/1, 1/2, 1/4, 1/8, or 1/16 for each channel.

■ You can select either Continuous or Burst for the run mode. The Continuous mode outputs the pulse consecutively without waiting for the trigger. The Burst mode outputs the pulse the specified number of times after waiting the trigger. If you have set 9 (times) for Burst and 2 for Pulse Rate, the analyzer outputs the pulse five times because it divides 9 by 2 and rounds up the quotient (4.5).

■ The Pulse Generator mode does not contain the concept of format (NRZ, RZ, R1). While internally performing Long Delay with the RZ waveform, the Pulse Generator mode controls Delay, Width, Slew Rate, and so on.

■ The Pulse Generator mode represents each channel in the format of "mainframe number-slot name channel number".
Examples: 1-A1, 1-A2, , 1-A4,1-B1,1-B2, , , 1-D1, , ,1-D4

■ You can remotely change and set the operating mode and various options, including the output level, in the Pulse Generator mode.

To control the data pattern, the following are possible:

■ Timing Control: Pulse Rate, Pulse Width, Delay, Duty, Slew Rate, Polarity, Channel Addition, Differential Timing Offset (Timing window)

■ Level Control: Amplitude, offset (or combination of High and Low), Term.R, Term. V (Level window)

Table 1-36 compares the Data Generator mode and Pulse Generator mode:

Table 1-36: Comparison between the Data Generator mode and Pulse Generator mode

Key features	Data Generator mode	Pulse Generator mode
Data Rate (DG mode) Frequency (PG mode)	DTG5078: NRZ only: 50 kbps to 750 Mbps contains RZ, R1: 50 kbps to 375 Mbps DTG5274: NRZ only: 50 kbps to 2.7 Gbps contains RZ, R1: 50 kbps to 1.35 Gbps DTG5334: NRZ only: 50 kbps to 3.35 Gbps contains RZ, R1: 50 kbps to 1.675 Gbps	DTG5078: 50 kHz to 375 MHz DTG5274: 50 kHz to 1.35 GHz DTG5334: 50 kHz to 1.675 GHz
Available slots	DTG5078: A to H DTG5274: A to D DTG5334: A to D	DTG5078: A to D DTG5274: A to D DTG5334: A to D
Available windows	Channel Group, Blocks, Data-Listing, Data-Waveform, Level, Timing, Time Base, Sequence, Sub-sequences, Jitter Generation, DC Output	Level, Timing, Time Base, Sequence, Sub-sequences, DC Output
Channel Grouping	Available	Not available
Data Format	NRZ, RZ, R1	Pulse
Timing control	Delay, Pulse Width, Duty, Slew Rate, Polarity, Cross Point	Delay, Pulse Width, Duty, Slew Rate, Polarity, Pulse Rate
Level control resolution	High, Low, High Limit, Low Limit, Term.R, Term.V	High, Low, High Limit, Low Limit, Term.R, Term.V
Sequence operation	Available	Not available
Differential Timing Offset	Available	Available
Channel addition	AND, XOR	AND, XOR
Long delay	Available	Not available
Jitter range	Available	Available
Jitter generation	Available	Not available

Time Base window

This window allows you to set the Clock Source, Clock Output, Run Mode, and Trigger. In comparison with the Data Generator mode, the window adds the Run Mode settings, but does not have the Event signal settings.
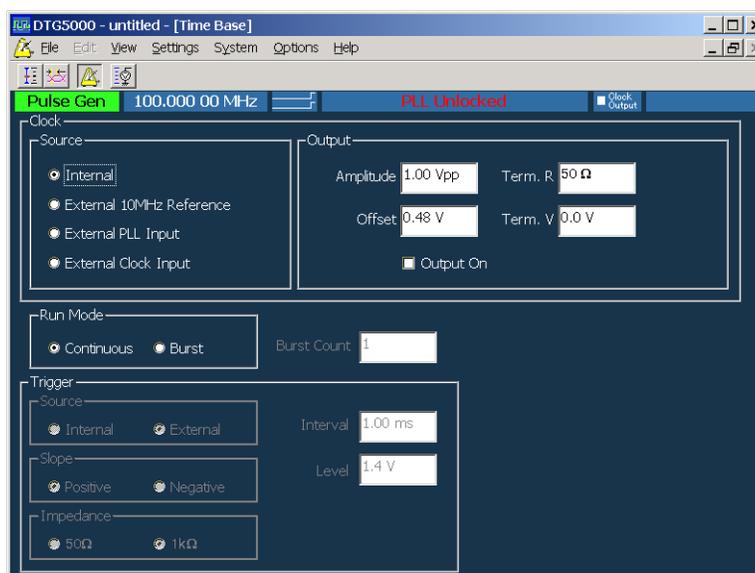
Figure 1-65: Time Base window (Pulse Generator mode)

Table 1-37 shows setup items in the Time Base window.

Table 1-37: Setup items for Time Base window

Items	Description
Clock Source	Selects clock source.
Internal	Use internal clock.
External 10MHz Reference	Use 10 MHz reference clock connected to 10 MHz Reference In.
External PLL Input:	Use external PLL signal connected to Phase Lock In.
External Clock Input:	Use signal connected to External Clock In as an external clock.
Clock Output	Sets the clock output parameters.
Amplitude	Sets clock output signal amplitude.
Offset	Sets offset.
Term.R	Sets termination impedance.
Term.V	Sets termination voltage.

Table 1-37: Setup items for Time Base window (cont.)

Items	Description
Output On	Specifies on/off of clock output.
Run Mode	Continuous: Outputs the pulse consecutively when you press the Run button. Burst: Outputs the specified number of pulses you set in Burst Count when a trigger event occurs. Sets the event input signal parameters.
Burst Count	Specifies the count of pulse output in the Burst mode (1 to 65,536). Counts any pulse that is generated when Pulse Rate is 1.
Trigger	Sets the trigger parameter. Available when you set Burst for Run Mode.
Source	Selects trigger source from internal/external. Specifying Internal allows you to set the Interval. Specifying External allows you to set the Level, Slope and Impedance.
Slope	Specifies the trigger point (rising edge or falling edge of external trigger signal). Selects either Positive or Negative.
Impedance	Specifies external trigger impedance. (50 Ω or 1 kΩ)
Interval	Specifies internal trigger interval.
Level	Specifies external trigger level.

Level window

In this window, you can set the High/Low levels and the termination voltage or impedance for logic channel. It also allows you to turn on or off the output. The level of output signal can be specified by combining the High/Low levels or Amplitude/Offset values.
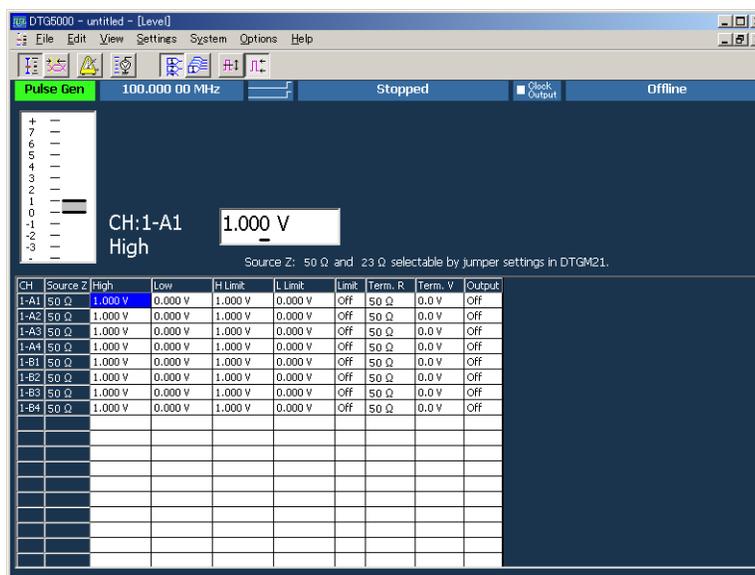
Figure 1-66: Level window

The Level window allows you to set the following for each channel:

Table 1-38: Setup items for Level window

Items	Description
Source Z	Displays the source impedance of physical channel. (Display only)
High	Sets the High level value.
Low	Sets the Low level value.
H Limit	Sets the High level limit value.
L Limit	Sets the Low level limit value.
Limit	Turns the High/Low feature on or off.
Term R	Sets the termination impedance of the destination of the output signal.
Term V	Sets the termination voltage of the destination of the output signal.
Output	Turns the output on or off.

Timing window

This window allows you to set the time base related parameters such as the pulse rate, clock frequency, delay, pulse width, and slew rate. The Data and Pulse Generator modes differ in some parameters you must set.

The Pulse Generator mode is internally performing Long Delay; it does not allow you to specify Long Delay. Based on the predefined table, the Pulse Generator mode automatically and internally changes the clock range.
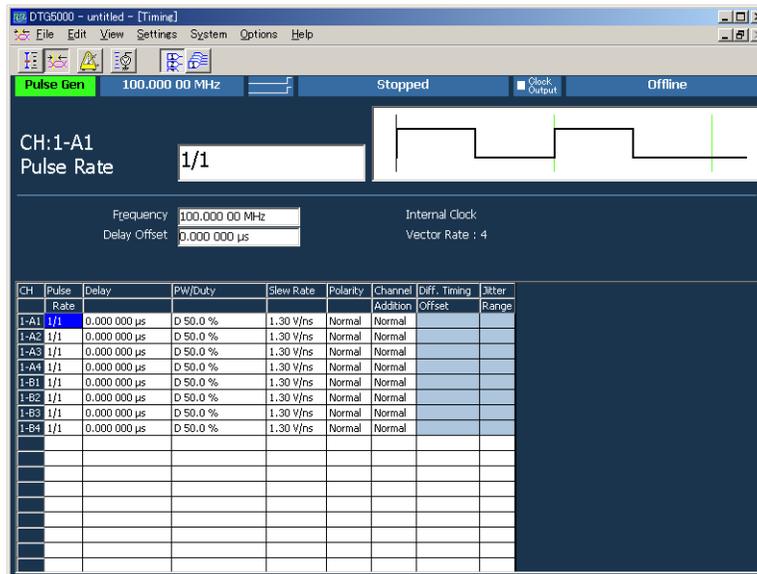
Figure 1-67: Timing window (Pulse Generator mode)

Table 1-39: Setup items for Timing window

Items	Description
Frequency	Sets the clock frequency of the data timing generator system. Either Frequency or Period is available for this setting.
Delay Offset	Sets the offset amount of the delay time. You can set a value from 0 to 3μs.
Internal Clock, PLL Input, External Reference Input, External Clock Input	Shows current clock source or the frequency of the external clock signal.
Vector Rate	Vector rate (viewed only)
CH	Lists the channels of the currently installed output modules in order.

Table 1-39: Setup items for Timing window (cont.)

Items	Description
Pulse Rate	Specifies 1, 1/2, 1/4, 1/8, 1/16, or Off (no output) for the pulse rate.
Delay	Sets the lead delay (time or percentage).
PW/Duty	Sets the pulse width or the duty. Any of Duty(%), Pulse Width(s) or Trail Delay(s) is available for this setting.
Slew Rate	Sets the slew rate (V/ns). Available for any channel to which a DTGM10 or DTGM20 channel has been assigned.
Polarity	Selects Normal or Invert for the polarity of the pattern.
Channel Addition	Sets the channel addition. Selects from Normal, XOR, or AND. If the odd CH is assigned to physical channel, Normal and XOR can be selected. If the even CH is assigned to physical channel, Normal and AND can be selected.
Diff. Timing Offset	Shifts timing for only inverted side of differential output. Sets differential timing offset on/off and timing volume.
Jitter Range	Sets the jitter range of jitter by the external signal. Available for any channel assigned to a DTGM32 channel.

Pulse Rate   The Pulse Generator mode allows you to specify the pulse rate within the range from 1 to 1/16 for each channel. Changing the pulse rate causes the pulse shape to change as shown below:
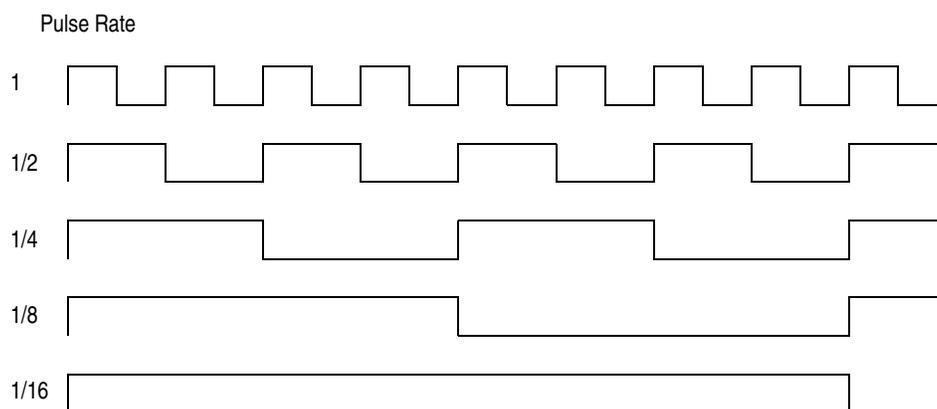
Figure 1-68: Pulse rate

Burst Count   The Bust Count in the Bust mode counts the number of pulses that are at pulse rate 1. If you specify 9 for Burst Count, the analyzer outputs the pulse five times for the channel of 1/2 pulse rate, because it divides 9 by 2 and rounds up the quotient (4.5).

After a lapse of the delay time you set, the analyzer outputs the specified number of pulses you set for Pulse Rate.

Frequency Range and Step Size   The valid frequency range and step size vary depending on the clock source as listed in Table 1-40.

Table 1-40: Valid frequency range and step size by clock source (Pulse Generator mode)

Clock Source	Internal	Ext 10 MHz Ref Input	Ext PLL Input	Ext Clock
External signal frequency range	none	10 MHz ± 0.1 MHz	Fextpll = 1 MHz to 200 MHz	Fextcl =1 MHz to 750 MHz (DTG5078) Fextcl =1 MHz to 2.7 GHz (DTG5274) Fextcl =1 MHz to 3.35 GHz (DTG5334)
Clock Frequency range	50 kHz to 375 MHz (DTG5078) 50 kHz to 1.35 GHz (DTG5274) 50 kHz to 1.675 GHz (DTG5334)	50 kHz to 375 MHz (DTG5078) 50 kHz to 1.35 GHz (DTG5274) 50 kHz to 1.675 GHz (DTG5334)	50 kHz < Fextpll × N / Vector Rate < 375 MHz (DTG5078) 50 kHz < Fextpll × N / Vector Rate < 1.35 GHz (DTG5274) 50 kHz < Fextpll × N / Vector Rate < 1.675 GHz (DTG5334)	Fextcl / Vector Rate (DTG5078) Fextcl / Vector Rate (DTG5274) Fextcl / Vector Rate (DTG5334)
Frequency step	8 digits	4 digits	Fextpll / Vector Rate	0 (fixed)

DC Output window

DC Output window In this window you can set the parameters of the DC output located at the front right of the data timing generator. Eight channel DC outputs are equipped with a mainframe. While the system configuration is in Master-Slave mode, the master machine can control the DC Outputs of all the slave machines.
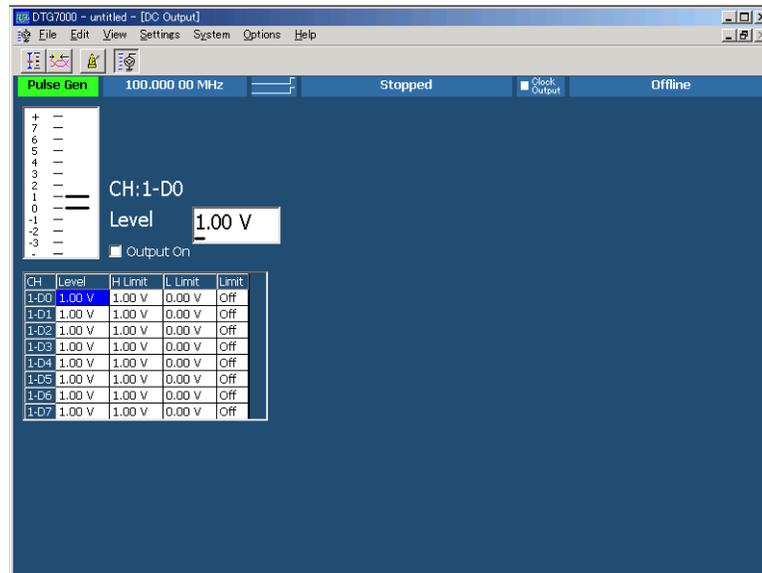
Figure 1-69: DC Output window

The DC Output window allows you to set the following for each channel:

Table 1-41: Setup items for DC Output window

Items	Description
Level	Sets the DC level value.
H Limit	Sets the maximum value of DC level setting range.
L Limit	Sets the minimum value of DC level setting range.
Limit	Turns the High/Low limit function on or off.
Output On	Selects on or off for the output.

Offline mode

The DTG5000 software runs on an ordinary PC as well as a DTG5000 Series mainframe. Running and using this software on PCs is called the Offline mode.

The Offline mode allows you to create and edit pattern data and set the output parameters. By saving the result of a setting file and loading in the DTG5000 series, a pattern can be output.

Operating Environment

■ OS

  ■ Windows 2000 SP4

  ■ Windows XP Professional

■ Internet Explorer 5.0 or later

■ Display Requirements

  ■ Colors: High Color (16 bits or higher)

  ■ Definition: 800 x 600 pixels or higher

Installing the DTG5000 Software on Your PC

The DTG5000 software is included in the DTG5000 Series Product Software CD-ROM that is supplied with the DTG5000 Series Data Timing Generator. Log on the instrument with the administrator name to install the DTG5000 software.

NOTE. The DTG5000 software supports Windows 2000 Service Pack 4 or later and Windows XP Professional.

You can install the software on an unlimited number of PCs.

The DTG5000 software is not available in hibernation mode. If your PC (including a notebook PC) enters the sleep or suspend mode during operation, we do not guarantee normal operation of the DTG5000 software after the restoration.

1. Load the DTG5000 Series Product Software CD-ROM in the CD-ROM drive. The installer starts automatically. If it does not start, double-click the setup.exe icon to start the installer.

2. The message "Welcome to the InstallShield Wizard for Tektronix...." appears. Click **Next**.

3. The message "Choose Destination Location." appears. Select the directory in which you want to install the software. Click **Next**.

4. The Select Program Folder appears. Select the folder in which to create a shortcut icon of the program. Click **Next**.

5. The message "Start Copying Files" appears. Click **Next**.

6. The message "InstallShield Wizard Complete" appears. Click **Finish**.

Uninstalling DTG5000 Software

To uninstall the software, use the Add/Remove Programs dialog box in the Control Panel. Log on the instrument with the administrator name to uninstall the DTG5000 software.

Starting the DTG5000 Software in Offline Mode

To enable the software to start in Offline mode, use the DTG5000 Configuration Utility for setup.

1. If the DTG5000 software is running, press the **MENU** key and select **Exit** from the File menu to exit the software.

2. Press the **CTRL + ESC** keys to open the Start menu. Using the Up, Down, Left, and/or Right arrow key, select **Programs / Tektronix / DTG5000 / DTG5000 Configuration Utility**.

3. Press the **ENTER** key to start the DTG5000 Configuration Utility. If the window for the Online mode opens, select the **Offline** checkbox in the Mode area.
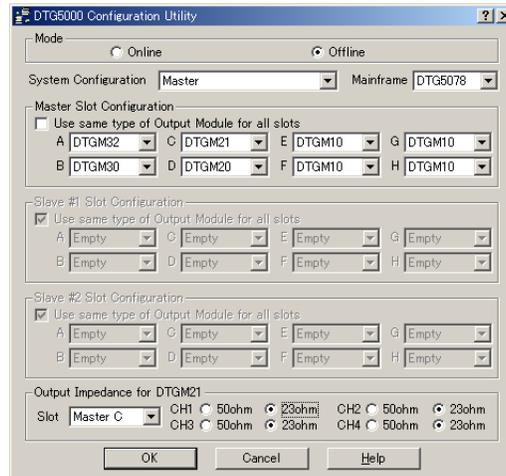
Figure 1-70: DTG5000 Configuration Utility Offline mode

4. Using the Offline mode DTG5000 Configuration Utility, set up the system configuration including the output modules and the Master-Slave configuration. For details of the DTG5000 Configuration Utility, see "DTG5000 Configuration Utility" on page 1-101.

5. Click **OK** to exit the DTG5000 Configuration Utility.

6. In the Start menu, select **Programs / Tektronix / DTG5000 /DTG5000** to start the DTG5000 software in Offline mode.

Remote Control

The DTG5000 Series supports GPIB interface and LAN interface. To set the GPIB address, you can use either the DTG5000 Configuration Utility or the System menu in the menu bar.

Remote Control dialog box   DTG5000 Utility Configuration
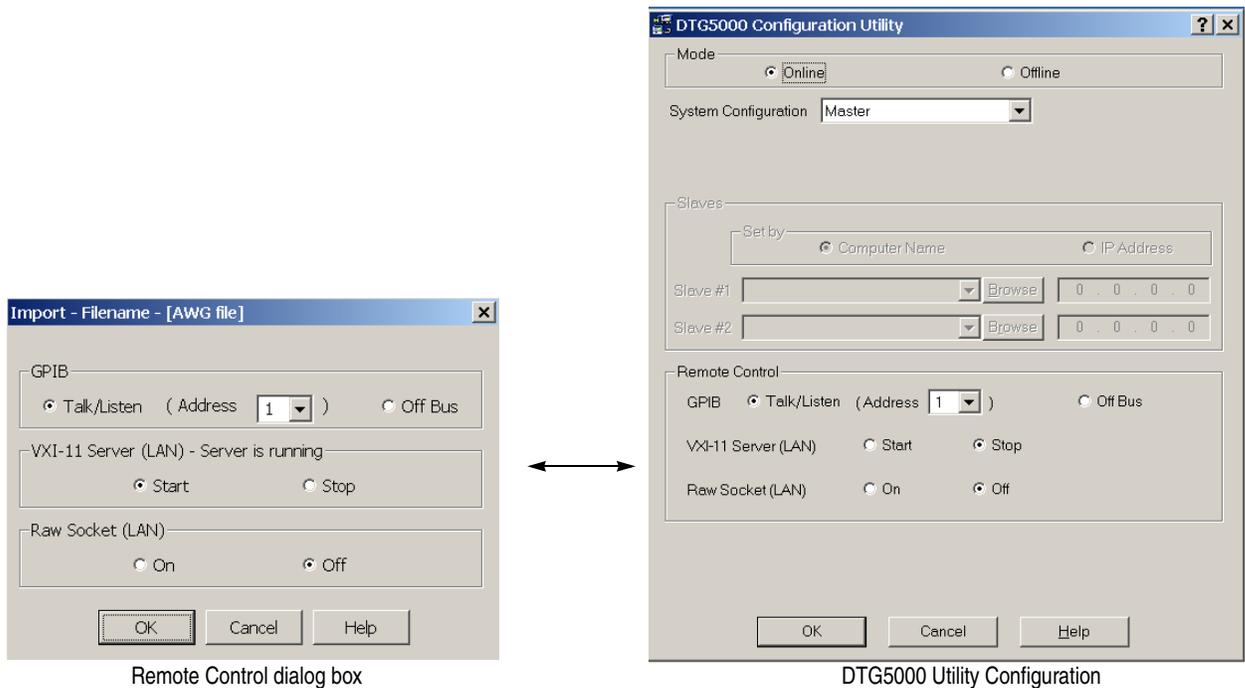
Figure 1-71: Setting the GPIB address

GPIB Interface

The GPIB enables up to 15 devices (including the controller) to be connected for concurrent use. With the DTG connected with an external computer via GPIB, you can use the computer as the controller to remotely control your DTG5000 Series. The DTG5000 Series is not available as the controller. For control with the GPIB, refer to the Programmer's Manual.

GPIB parameters

To use the GPIB, the DTG5000 Series requires you to set a configuration and the GPIB address.

■ **Talk/Listen:** Select this mode to remotely control your DTG5000 Series from an external computer as a controller.

■ **Off Bus:** Select this mode to electronically disconnect the DTG5000 series from the GPIB bus.

■ **Address:** This address is a number that allows the software to identify each device connected to the GPIB bus. You must specify a unique number from 0 to 30 for each device.

GPIB Driver

Note the following about the GPIB board and driver software.

NOTE. The DTG5000 Series contains the National Instruments GPIB board and driver software. They are used to control the DTG5000 Series from the external controller.

While the DTG5000 software is running, you cannot use any GPIB device in order to control another external device.

CAUTION. About the GPIB Driver Version:
The DTG5000 Series are shipped with the Version 1.7 GPIB drivers with the system operation capabilities that have been confirmed with the test using the drivers.

If you install National Instruments LabView or other software on the DTG5000 Series, this may change the version of the driver of the GPIB board.
If you want to install such software on your DTG5000 Series, skip installation of the GPIB driver to avoid the overwrite.

LAN Interface

The DTG5000 Series supports two Ethernet LANs. One of these is a conventional LAN using TCP/IP protocol, and the other is the Tek VISA LAN, which uses VXI-11 protocol.

LAN parameters

In the DTG5000 series, set parameters to start or stop a process that performs communication by LAN.

■ **VXI-11 Server (LAN):** VXI-11 protocol used via Tek VISA. In order to use this protocol, Tek VISA must also be installed on the remote controller (PC). Starting and stopping the VXI-11 server are controlled here.

■ **Raw Socket (LAN):** TCP/IP protocol is used. On and Off of socket communication are controlled here. The port number is fixed to 4003. This port number must be assigned to the application software or the Ethernet driver on the external controller.

By default, the DTG5000 Series is specified to automatically acquire an IP address by DHCP. Refer to Windows documentation regarding network-related parameters. For Tek VISA, refer to the Tek VISA manual.

Setting the Remote Control parameters

To set the GPIB address, you can use either the DTG5000 Configuration Utility or the System menu in the menu bar. The setting procedure is the same.

.
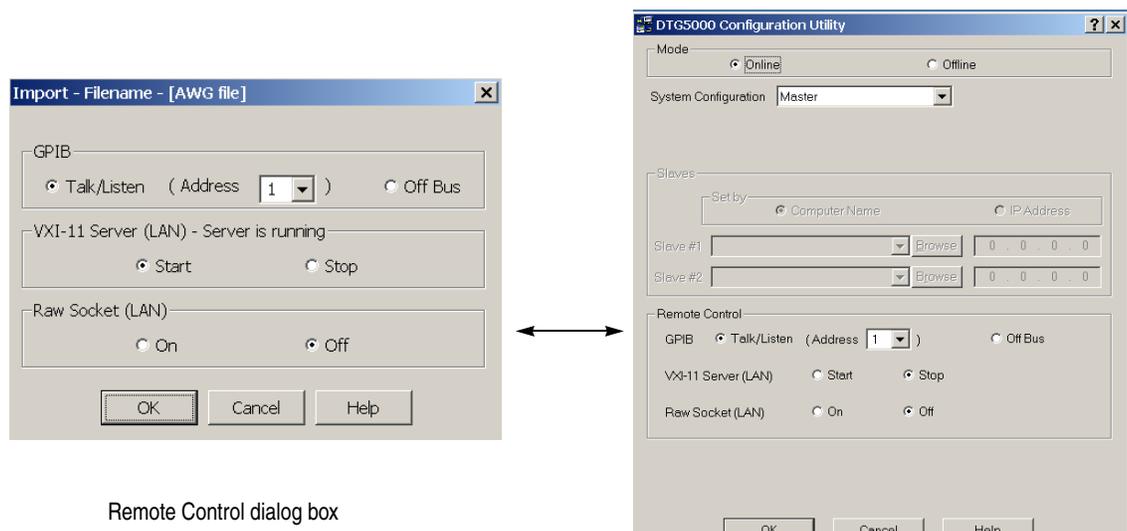
Remote Control dialog box

Figure 1-72: Setting the GPIB address

Using the DTG5000 Configuration Utility for setting

1. If the DTG5000 software is running, press the **MENU** key and select Exit from the File menu to exit the software.

2. Press **CTRL + ESC** to open the Start menu. Using the Up, Down, Left, and/or Right arrow key, select **Programs / Tektronix / DTG5000 / DTG5000 Configuration Utility**.

3. Press the **ENTER** key to start the DTG5000 Configuration Utility. The utility provides you with two windows: for Online and Offline modes. If the utility opens the Offline mode dialog box, select Online in the Mode area.

4. Using the **TAB** key, activate the required item in Remote Control. Then, set the parameters using the Up and/or Down arrow key.

5. Press the **ENTER** key to exit the DTG5000 Configuration Utility. In the Start menu, select **Programs / Tektronix / DTG5000 /DTG5000** to start the DTG5000 software.

Using the System menu for setting

You can change the address while the DTG5000 software is running.

1. Press the *MENU* key. Next, select **Remote Control...** in the System menu. Then press the **SELECT** key.

2. The Remote Control dialog box appears. Using the **TAB** key, activate the required item in Remote Control. Then, set the parameters using the Up and/or Down arrow key.

3. Press the **ENTER** key to close the dialog box. The address you have just set takes effect immediately.

Tek Visa VXI-11 Server

TekVisa version 2.03 is pre-installed on DTG5000 instrument. When the DTG5000 starts, TekVisa's Resource Manager and VXI server applications start automatically. You can detect if they are started on your instrument by checking for the Remote Control menu of the System menu of DTG5000 application software, and Remote Control of DTG5000 Configuration Utility. You can also detect by checking for the following tray icons on your DTG5000 instrument.

Tek Visa Resource Manager   VXI-11 Server: Running   VXI-11 Server: Stopped

Figure 1-73: Icons on the task tray

VXI server control may or may not be running when the DTG5000 starts. If it is not running, you will see the VXI server control icon as shown above

To run the VXI server control, select the Start button of the VXI-11Server on the Remote Control dialog box of the System menu of DTG5000 application software, or on the Remote Control of DTG5000 Configuration Utility. Or right click the icon and choose "Start VXI Server" command from the context menu.

About VXI-11 Server Control...

Start VXI-11 Server

Stop VXI-11 Server

Server Status

Server Properties

Exit

Figure 1-74: Start from the task tray

Connecting to DTG5000 from an application running in the DTG5000 instrument

1. Start VisaAPIDemo.exe application. This application is available in the following path
C:\vxipnp\winnt\TekVISA\VISASamples\VisaAPIDemo\Release

You can use the VisaAPIDemo.exe to connect to an instrument and read/write any GPIB queries and commands.

Alternatively you can use any application that uses TekVisa API to connect to the instrument. The source code for VisaAPIDemo.exe is also available in the path **C:\vxipnp\winnt\TekVISA\VISASamples\VisaAPIDemo**, which can be used as a sample.

2. Type the following resource string in the Resource Name edit box of the VisaAPIDemo application.
GPIB8::1::INSTR.

This is the standard resource string to be used when you want to connect to the instrument from an application running in the instrument. The APIDemo.exe application appears as shown below after a successful connection.
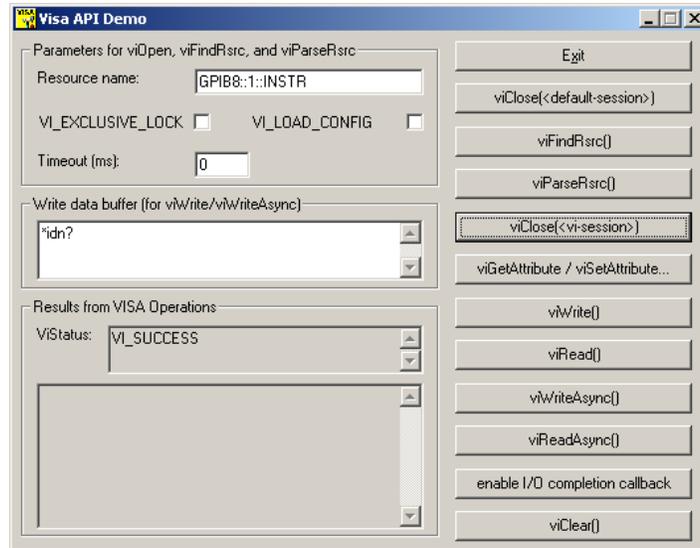
Figure 1-75: VisaAPIDemo

3. Now you can communicate with the instrument using viWrite() and viRead() buttons.

4. Click on viClose() button when you want to close the connection.

Connecting to DTG5000 from an external PC using VXI server

1. Ensure that the Visa resource manager on the external PC has detected the DTG5000 instrument you want to connect to. You can check this as shown below.

   a. Right click on the Visa Resource Manager tray icon on the PC. From the context menu select the "**Configure...**" command.

   b. It will show a list of detected instruments as Visa Resources as shown below.
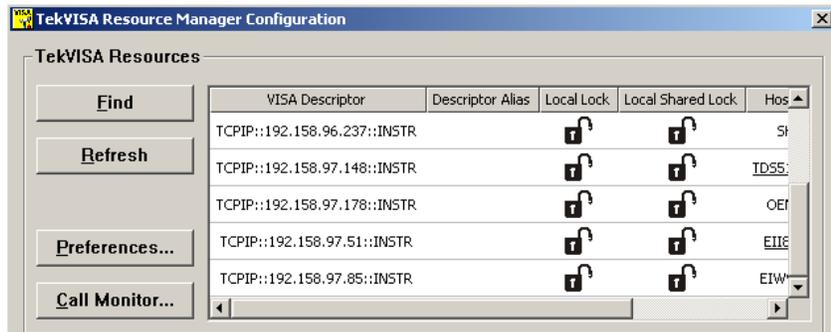
Figure 1-76: TekVisa Resource Manager Configuration

    c. If the DTG5000 you are trying to connect to is listed here, you should see its IP address in "Visa Descriptor" column.

2. If you don't see the IP address of the DTG5000 click "**Preferences**" in the dialog shown above. This brings up the following Dialog.
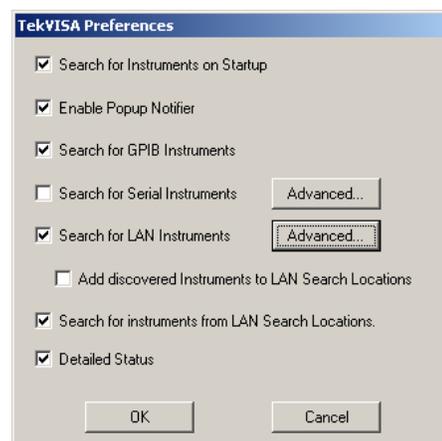
Figure 1-77: TekVisa Preferences

3. Check the "**Search for LAN Instruments**" option and click **OK**.

4. Click "**Refresh**" in the previous Visa Resource Manager Configuration dialog. Wait while the TekVisa resource manager finds the instruments. Once you see the IP Address of your DTG5000 in the Visa Descriptor column of the Configure dialog, you are ready to connect.

5. Bring up the VisaAPIDemo.exe on your PC as described above.

6. In the "**Resource Name**" edit box, type the following string:
TCPIP::<ip address of the DTG5000>::INSTR

7. Click **viOpen** to connect.

Trouble shooting   If you don't see the IP address of your DTG5000 even after you refresh the Visa Resource Manager from an external PC, check the following:

■ On the DTG5000 you are trying to connect to, check if the VXI server control is running. If it is not running, start it as described above.

■ Check if the DTG5000 is connected to a properly configured network.

■ Bring up the Visa resource manager's configuration dialog on the DTG5000 (not on your PC). Check if you see "GPIB8::1::INSTR" in the Visa Descriptor column of the dialog. If you start the instrument without the VXI server control in the "Run" state, you won't see this entry.

If you can detect the DTG5000 from your PC but are not able to connect, check the resource string. The resource string should be in the following format:

TCPIP::<IP address of the DTG5000>::INSTR

Diagnostics and Calibration

This section describes Diagnostics, Calibration and two checking features, which are available on the DTG5000 Series. These test items are located in the System menu.

Diagnostics

Diagnostics is a hardware diagnostic feature that executes a comprehensive test on the DTG5000 Series. The feature usually executes the diagnostic test automatically when you power on the DTG5000 Series. You can also have this feature execute the test, if necessary, through the System menu or using remote commands. By executing the diagnostic test, you can verify whether the hardware is running normally. The Diagnostics feature of the DTG5000 Series tests the following items:

- Registers

- Clocks

- Outputs

- Sequence memory

- Pattern memory

Diagnostics on slave machines are not executed individually; they are executed simultaneously on the master machine.

Power On Diagnostic Test   When you power on the DTG5000 Series, it automatically executes a diagnostic test for all the diagnostics items, except the pattern memory cell test, while the Startup window remains on-screen. When detecting an error, this test displays an error message. If you see such a message, press the ENTER key and click the OK button to proceed with the next step. The DTG5000 software starts. When the DTG5000 Series contains an unsolved error, the test cannot be conducted normally. In such a case, contact our Customer Service Center.

Diagnostic Test from Menu   When you select Diagnostics... in the System menu, the Diagnostics dialog box appears. This box lists the results of the power-on or the latest diagnostic test. This test allows you to select the desired diagnostic items and the number of repetitions.
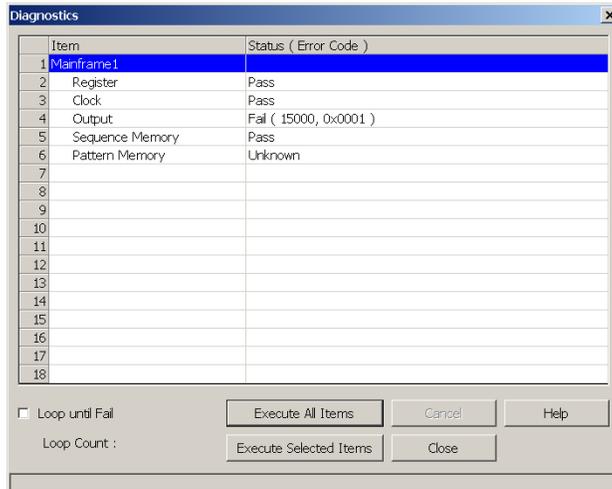
Figure 1-78: Diagnostics dialog box

Table 1-42: Diagnostics dialog box buttons

Button	Description
Execute All Items	Executes diagnostics on all the test items.
Execute Selected Items	Executes diagnostics on one or more consecutive test items you selected. To select a test item, use the Up and/or Down arrow key. To select two or more items, use the Up and/or Down arrow key while holding down the SHIFT key.
Loop until Fail	If you select this checkbox, the diagnostic test repeats until it detects a failure. To cancel the test, click the Cancel button.
Cancel	Stops the test. Available only during the test.
Close	Closes the dialog box.

Operating Procedure

1. If you want to execute all the test items, click the **Execute All Items** button.

   If you want to execute only the desired test items, select them by using the Up and/or Down arrow keys holding the SHIFT button, and then click the **Execute Selected Item** button.
   If you select the **Loop Until Fail** checkbox, the diagnostic test repeats until it detects Fail.

2. Press the **ENTER** key to start the diagnostics.

   The diagnostic test resets all the hardware settings to the defaults. Before the test begins, you see a confirmation dialog box that asks you whether you want to save the current settings. Choose to save the settings, if necessary.

3. When the test is finished, the results are listed. Select the **Close** button. Then, press the **ENTER** key to close the dialog box.

Diagnostic Results

Status lists the diagnostic results. When the DTG5000 Series contains an unsolved error, it cannot operate normally. In such a case, contact our Customer Service Center.

Table 1-43: Information on Status

Status	Description
Pass	The DTG5000 Series is operating normally.
Unknown	The results are unknown because the test has not finished yet. Because the power-on diagnostic test can diagnose only part of the pattern memory, this message is displayed.
Fail (xxxxxxx)	The test detected an error. xxxxxxx represents an error code.
Executing	Now executing.

Error Codes

If Diagnostics detects a malfunction, it displays character string "Fail" and the error code. The error code consists of a five-digit code and three arguments. The five-digit code consists of the mainframe number, the category, and the board and slot positions. The three arguments include supplementary information which depends on the code.

```
15112, 0xNN, 0xNN, 0xNN
```

Argument3

Argument2

Argument1

Slot position

Board position

Category

Mainframe number

Slot position

		x0	x1	x2	x3		x0	x1	x2	x3	
Board position	Upper 0x	A	C	E	G		A	B	C	D	Upper 0x
	Lower 1x	B	D	F	H						

DTG5078

DTG5274 / DTG5334
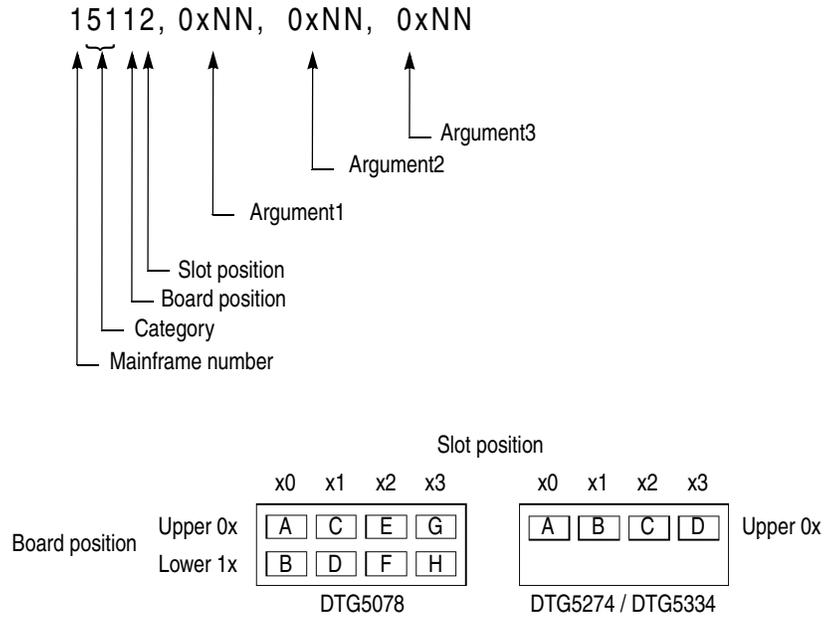
Figure 1-79: Diagnostics error code format

In such a case, DTG5000 Series cannot operate normally. Contact our Customer Service Center.

LCD Panel Check

This test turns the entire screen area white, black, red, green, and blue in order. When the screen displays these colors, you can verify that the LCD operates normally.

Operating Procedure

1. Select **LCD Panel Check...** in the System menu. Then, press the **SELECT** key. The entire screen area turns white.

2. Press the **ENTER** key (or any key), repeatedly. The color of the screen area changes in order. After it turns blue, the DTG5000 software screen returns.

Front Panel Key Check

This test checks operation of all the keys, except Power On keys, and the knob on the front panel.

Operating Procedure

1. Select **Front Panel Key Check...** in the System menu. Then, press the **SELECT** key. The dialog box appears as shown in Figure 1-80.

2. Pressing a key on the front panel turns the key light blue, with the key name displayed in the screen area. When the view in the dialog box changes in this manner, you can verify that each key and the knob operate normally as a hardware component.

3. Press the **ENTER** key twice, or click the **OK** button to terminate the key check.
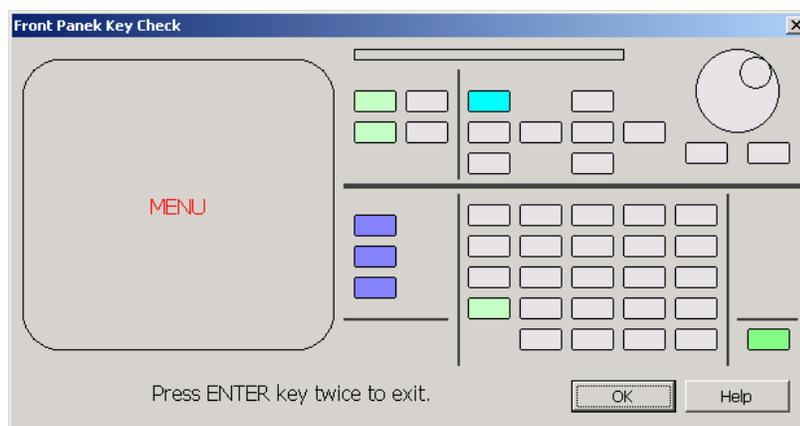
Figure 1-80: Front Panel Key Check dialog box

Skew Calibration

The Skew Calibration compensates for the propagation delay times of output signals from each channel which are caused by differences in the attributes and the length of the cables connected to the DTG5000 Series and its circuitry. This feature then provides proper timing at the output cable ends.

Without requiring any external measuring equipments, this feature measures and calibrates the timing by returning the DTG5000 Series output signals to SKEW CAL IN. The calibration works at the level of ECL into 50 Ω to –2 V.

In addition, it can adjust the timing of the output signals from two or more DTG5000 Series by calibration in the Master-Slave configuration.

NOTE. For a DTGM30, DTGM31, and DTGM32 output module of differential output (Complementary), the amount of calibration for the inverted channels is the same as the normal channels. Thus, the delay time caused by the cables of the normal channels is reflected on the amount of calibration for the inverted channels.

The Skew Calibration does not cover the Clock Output.

Calibration range

There is no restriction for the cables to be the same length. The range for which the calibration works is up to approximately 1.5 ns in the circuitry in a DTG5000 Series, or 500 ps (10 cm) in dispersion of cable length. This feature regards more dispersion as an error.

When to Perform

The DTG5000 Series performs calibration for the cables connected to its internal circuitry and to the output connectors, the cables connected to the CLK and JUMP used for controlling the slave machines (in Master-Slave operation), all the signal paths, and the temperature conditions during operation and so on. Thus, you should perform Skew Calibration in the following cases:

■   You changed a cable, including a cable used for connection with the master or a slave machine in Master-Slave operation.

■   You changed an output module slot position.

■   The system configuration changed (addition or removal of output module; Master-Slave operation).

■   The temperature at which you use the analyzer changed.

Operating Procedure   Perform the calibration according to the instructions shown on the screen. Reconnect the cable from the output channel connected to SKEW CAL IN before beginning.

Before starting the calibration

1. Power on the DTG5000 Series mainframe. Warm up the mainframe for 20 minutes at the normal operating temperature.

2. Install the output modules in the slots you want to use, and connect the cables to the associated channels. For the Master-Slave operation, set the hardware components so that the controlling CLK and JUMP signal cables are also connected for using the DTG5000 Series mainframe.

3. The Skew Calibration clears all the created pattern data and settings. So, before proceeding with the execution, you should save the settings as necessary. The Skew Calibration shows this warning message immediately before it starts.

Starting the calibration

1. Make sure that no signals are being output. If the RUN button indicator remains lit, push this button to stop the output. If even one output module LED remains lit, push the ALL OUTPUTS ON/OFF button and check that all the output connector LEDs have gone out.

Execute Skew Calibration using the following procedure. Check that no error message appears.

2. Select **Skew Calibration...** in the System menu. Then, press the **SELECT** key. The dialog box appears.
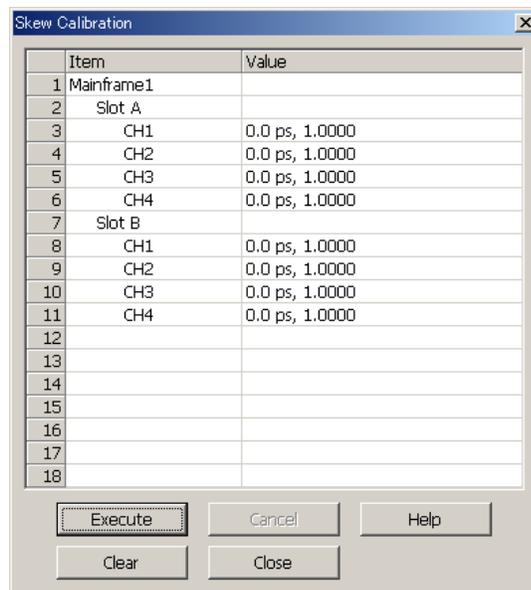
Figure 1-81: Skew Calibration dialog box

The dialog box lists the current calibration constants. The table below summarizes the button functions.

Table 1-44: Skew Calibration dialog box buttons

Button	Description
Execute	Initiates the calibration.
Cancel	Stops execution of the calibration. Available only in execution. Use of this button clears all the calibration data currently being executed; the initial calibration data returns.
Clear	Clears all the calibration data that the DTG5000 Series currently retains. The calibration data returns to the initial values.
Close	Closes the dialog box.

3. Select/Click the **Execute** button. You cannot choose to execute the calibration in one or more channels or slots.

4. Following the on-screen instructions, connect the **SKEW CAL IN** connectors on the front panel (of the master also in the Master-Slave operation) to the **OUTPUT** connectors on the output module channels. Once you have finished the connections, click **OK**. For connection between SKEW CAL IN and the output module channels, use the cables you normally use.
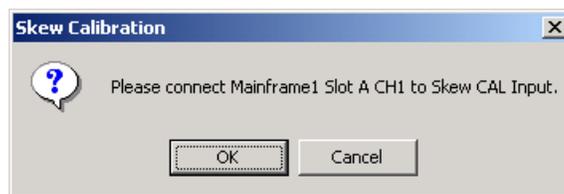
Figure 1-82: Example of cable connection message

If you perform erroneous operations, you may receive a warning message.

Figure 1-83: Example of warning message

If the calibration does not completely succeed, the error message dialog box appears.
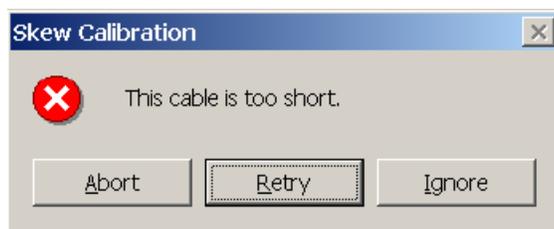
Figure 1-84: Example of error message

Table 1-45 summarizes the functions of the message buttons inFigure 1-83 and Figure 1-84.

Table 1-45: Skew Calibration Warning buttons

Button	Description
Abort	Returns to the calibration window. Use of this button clears the calibration constants of the channels on which the calibration has worked up to then; the initial calibration constants return.
Retry	Retry the calibration on the current channel.
Ignore	Proceeds with the next step/channel, ignoring the calibration on the current channel.

5. Executes the calibration on all the channels of the currently installed output modules.

The Status (Value) column lists the calibration times and coefficients. Check that all the calibration times are in the 0 ps to 1.5 ns range.

6. Select the **Close** button. Then, press the **ENTER** key to terminate Skew Calibration.

⚠ *CAUTION. Powering off the DTG5000 Series during calibration may clear the calibration data from memory.*

Level Calibration

Level Calibration calibrates the levels of the output signals in the total circuitry that contains the DTG5000 Series and output modules combined. This calibration does not require any cables or measuring equipments.

When to Perform   The DTG5000 software automatically executes Level Calibration every time it starts. If you have set up the DTG5000 Series for Master-Slave operation, an attempt to start the master machine (that is, the slave machine is already operating) causes Level Calibration to work on all the channels of the master and slave machines.

Output level is affected by environmental temperature. Thus, you should perform Level Calibration in the following cases:

■   The temperature of the DTG5000 Series mainframe varies during operation.

■   Optimum accuracy is required when you output the signal.

Operating Procedure   You can perform the calibration only by clicking the Execute button on the screen.

Before starting the calibration

Power on the DTG5000 Series mainframe. Warm up the mainframe for 20 minutes at the normal operating temperature.

Starting the calibration

1.   Select **Level Calibration...** in the System menu. Then, press the **SELECT** key. The Level Calibration dialog box appears.
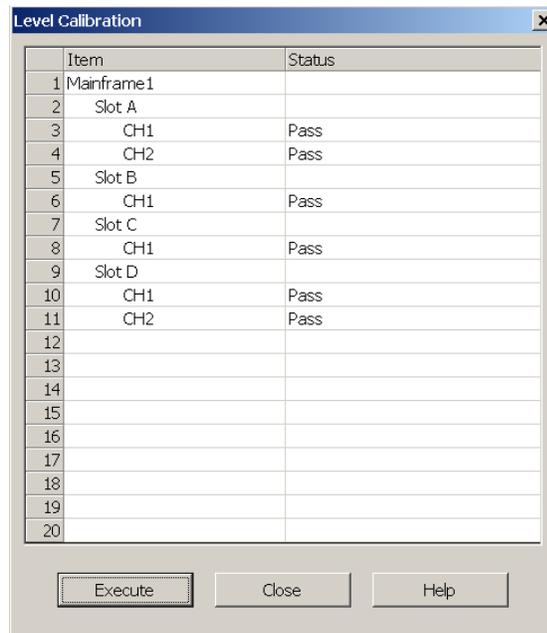
Figure 1-85: Level Calibration dialog box

Status in the dialog box lists the results of the calibration at the time that the DTG5000 software started (or the results of the latest calibration).

2. Select/Click **Execute** to initiate the calibration. You cannot choose specific channels or slots to execute the calibration.

3. The Status column shows the result of the calibration as "Pass" or "Fail". Check that "Pass" appears for all the channels.

4. Select the **Close** button. Then, press the **ENTER** key to terminate Level Calibration.

DTGM31 Dj Adjustment

The Dj adjustment controls four parameters to minimize the deterministic jitter (Dj) of the output signal of the DTGM31 output module. It is available only for the combination of the DTG5000 Series mainframe and the DTGM31 output module. Four parameters for the adjustment are saved in the non-volatile memory of the DTGM31 output module. The deterministic jitter of the DTGM31 output module varies depending on the mainframe and the output pattern data. The factory default values are adjusted by using PRBS15 pattern data. You can minimize the deterministic jitter in the output signal by executing this adjustment with the output pattern data and the setting of the DTG5000 Series required actually use.

When to Perform

The DTGM31 Dj adjustment should be performed when the deterministic jitter performance is not sufficient for your application. The following are situation for Dj adjustment:

- When using the DTGM31 output module the first time after purchase.

- When changing the installed slot.

- When installing an existing DTGM31 output module in a new DTG5000 main frame.

- When significantly changing the operating frequency and Dj is too large for your application.

Equipment Required

- One sampling oscilloscope or digital storage oscilloscope (Recommended equipment: Tektronix TDS8000B or TDS6804)

- Two 50 Ω SMA coaxial cables

- Two attenuators

- One 50Ω SMA terminator

Operating Procedure

Perform the adjustment according to the instructions shown on the screen.

Before starting the adjustment

1. Install the DTGM31 output module in the slot you want to use, and connect the cables as follows:

    - Attach the attenuators to the CH1 input and the Trigger Direct Input of the sampling oscilloscope (if needed).

    - Attach the SMA terminator to the $\overline{\text{CH1}}$ (CH1 Complementary) output of the DTGM31.

■ Connect an SMA coaxial cable from the CH1 connector of the DTGM31 output module to the CH1 input of the sampling oscilloscope.

■ Connect a second SMA coaxial cable from the CLOCK OUT on the front (rear) panel of the DTG5334 (DTG5274 or DTG5078) to the Trigger Input of the sampling oscilloscope.
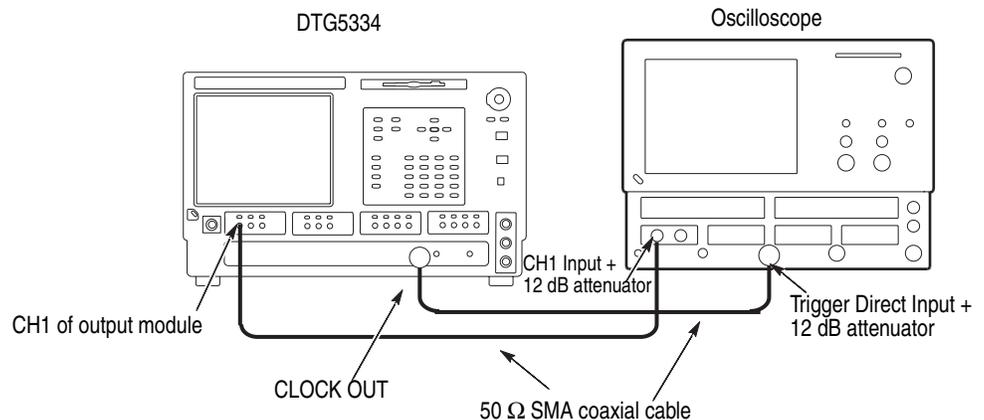
Figure 1-86: Dj adjustment setup (DTG5334)

2. Power on the DTG5000 Series mainframe and the oscilloscope. Warm up the mainframe for 20 minutes at the normal operating temperature.

Starting the adjustment

1. Set the actual parameters (such as Clock Frequency, Output Level) and the actual data pattern required by your application to the DTG5000 mainframe.

NOTE. In this adjustment, set value of Cross Point in the Timing window to 50%.

During the adjustment, some parameters are changed as follows; Term.R: 50 Ω, Term.V: 0 V, Delay: 0 ns, Delay Offset: 0 ns, Jitter Generation Mode: Off. After the adjustment, these parameters will return to your original settings.

In the case of general adjustment, a useful "typical" pattern is PRBS14, with data length (block size) set to 65532 (16383 × 4).

The example below shows Dj adjustment for a clock patter because the individual edges can be easily identified. The adjustment process for PRBS, clock or user-defined patterns is the same.

---

2. Push the **RUN** button and **ALL OUTPUTS ON/OFF** button to activate the output.

3. Set the oscilloscope controls so that an eye pattern is displayed on the screen.
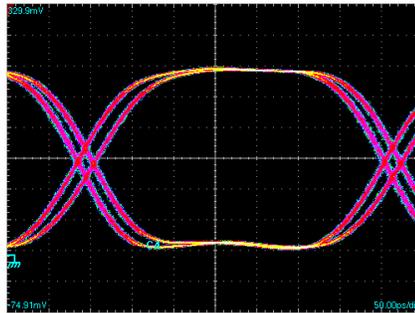
Figure 1-87: Typical waveform before adjustment

4. Select/Click the System/DTG31 Dj Adjustment menu.
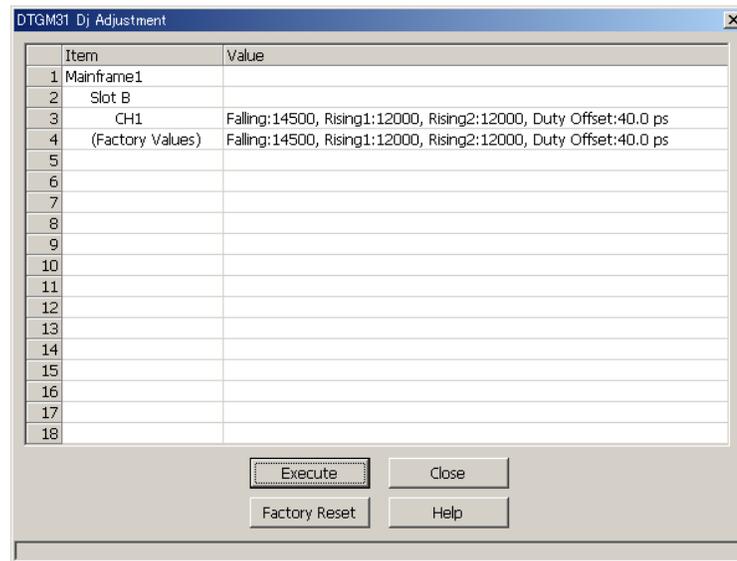
Figure 1-88: DTGM31 Dj Adjustment dialog box

This dialog box lists the current parameters adjusted by user and Factory values adjusted by factory. Adjustment parameters are stored in non-volatile memory in the DTGM31 output module and typically do not need to be changed after a power cycle or if the module is used again in the same mainframe and slot.

Table 1-46: DTGM31 Dj Adjustment dialog box buttons

Button	Description
Execute	Initiates the adjustment.
Factory Reset	Clears all the user optimized values then reset to the factory optimized values.
Close	Closes the dialog box.

5. Select/Click **Execute**. You can only execute the adjustment on one channel or slot at a time.

6. Following the on-screen instructions, confirm the connection, then select/click **OK**.

Figure 1-89: Example of cable connection message

The DTGM31 Dj adjustment Input dialog box is displayed.

Figure 1-90: DTGM31 Dj Adjustment Input dialog box.

Table 1-47: Dj adjustment parameters

Parameter	Description
Falling Edge	This parameter controls the width of a falling edge portion of the waveform.
Rising Edge1, Rising Edge2	These parameters control the width of a rising edge portion of the waveform.
Duty Offset	This parameter controls the position of the cross point of the waveform (Does not operate for slots E to H of the DTG5078).

7. Adjust the deterministic jitter by using each of the parameters such that the waveform improves as shown in Figure 1-91 Typical waveforms.

Change four parameters in this dialog box by turns until the jitter is minimized and the cross point is at 50%. The order of an adjustment should normally be from top to bottom as displayed in the M31 Dj adjustment input dialog box.

a. Start with the **Falling Edge** parameter and increase or decrease the value to see a waveform as in Waveform A below.

b. When satisfied with Falling Edge of the waveform as in Waveform B below, adjust the **Rising Edge 1**. If needed, also adjust the **Rising Edge 2** until the waveform is displayed as Waveform C or D below. In some cases, the interaction of Rising Edge 1 and 2 are such that the signals can "meet" in the middle of the two traces by increasing one value and decreasing the other.

c. Once Falling and Rising Edges have been adjusted, it may be necessary to adjust the **Duty Offset** as in Waveform C, to achieve a balanced signal as in Waveform D below. In cases of significant Duty Offset adjustment, there is a slight possibility that iterative adjustment of Falling or Rising Edge values will be needed.

NOTE. For fastest results, make changes to the edge parameters by increasing or decreasing each value by 100. This can easily be achieved by setting the curser in the "100's" location for the parameter and then turning the multi-purpose adjustment knob on the DTG5000 front panel.

Waveform A: Before calibration

Waveform B: Falling Edge calibrated

Waveform C: Rising and Falling Edges calibrated,
Duty Offset adjustment needed

Waveform D: Fully calibrated with correct Duty Offset
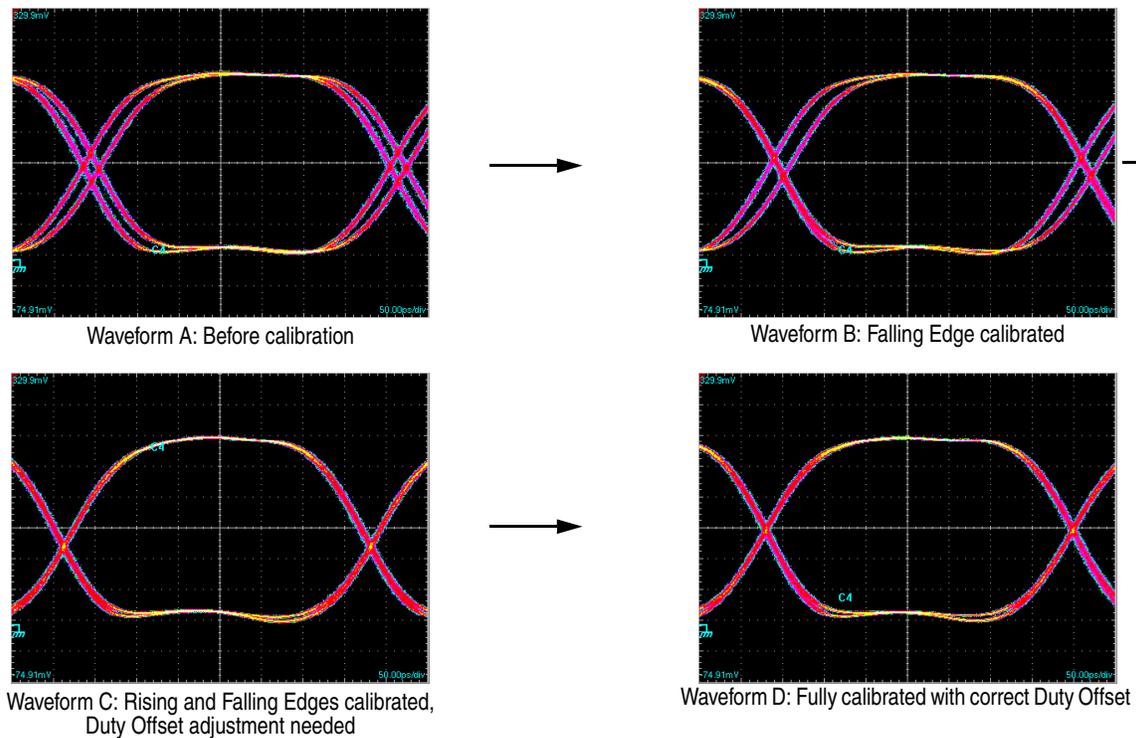
Figure 1-91: Typical waveforms

8. Select/Click **OK**.

9. If there are additional M31 output modules installed in other slots, repeat the same adjustment process for each DTGM31in the mainframe.

10. When finished making adjustments, select/click the **Close** button.
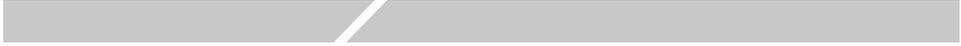
Appendices

Appendix A: Setting Up the Display Device

This section describes how to set up the DTG5000 Series Data Timing Generator when connecting an external monitor to it.

Selecting the Device

1. Connect the monitor cable and mouse to the DTG5000 Series mainframe. Then power on the mainframe.

2. In the Start menu, select **Settings / Control Panel**. Click the **Display** icon in the Control Panel.

3. In the Display Properties dialog box, click the **Settings** tab and click the **Advanced...** button.
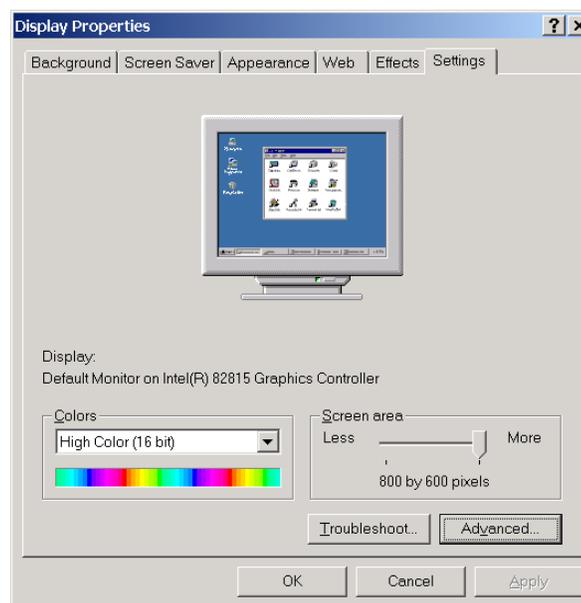
Figure A-1: Display Properties dialog box

4. In the Default Monitor and Intel(R) 82815 Graphics Controller Properties dialog box, click the **Intel(R) Graphics Technology** tab.
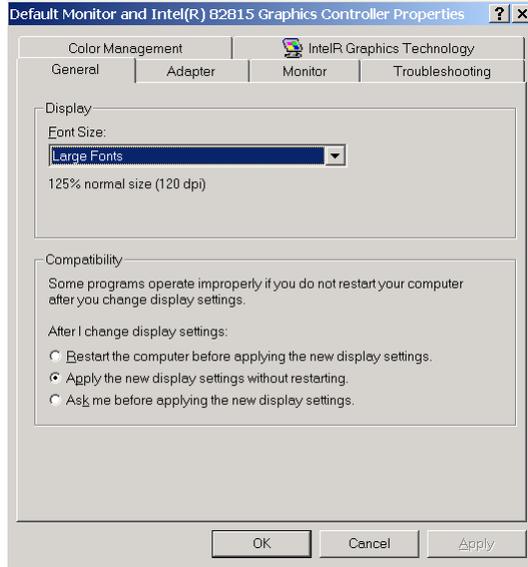
Figure A-2: Default Monitor and Intel (R) 82815 Graphics Controller Properties dialog box

5. In Intel(R) Graphics Technology tab, click the **Graphics Properties...** button.
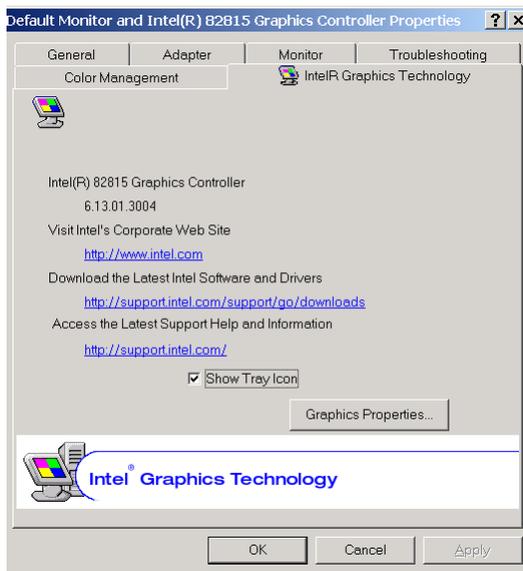
Figure A-3: Intel (R) Graphics Technology tab

6. The Intel(R) 82815 Graphics Controller Properties dialog box opens. Click the **Device** tab. Select and set the display device here.
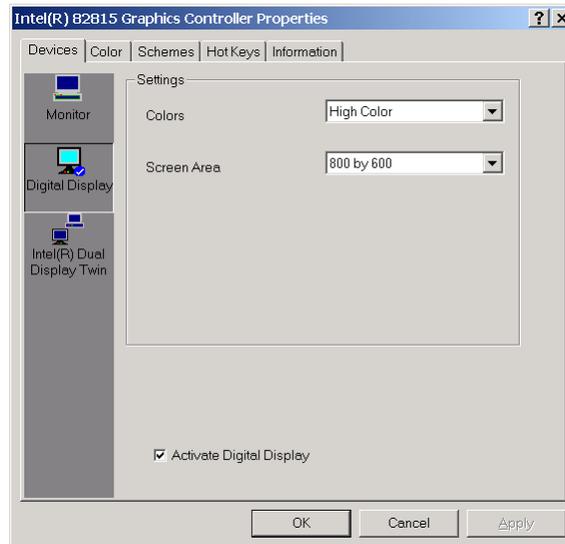
Figure A-4: Intel (R) 82815 Graphics Controller Properties dialog box

7. Select the device icons you want on the left.

Table A-1: Selecting the display device

Items	Description
Monitor	Enables only the external monitor.
Digital Display	Enables the display of the DTG5000 Series main unit.
Inter (R) Dual Display Twin	The display screen of the DTG5000 Series main unit and the external monitor display same image.

8. Select the **Activate xxx** checkbox at the bottom left corner. Then click **OK**

9. The device you specified is enabled, then the confirmation dialog box appears. Click **OK** within 15 s to determine the device change.

Figure A-5: Confirmation dialog box

10. The screen returns to the display shown in Figure A-4.

Display Definition

If the display device of the DTG5000 Series is enabled, the display definition including the external monitor is up to 800 x 600.

1. If only the external monitor is enabled, you can set the definition for up to 1,600 x 1,200. In the dialog box shown inFigure A-4, click again the **Graphics Properties...** button. In the Intel(R) 82815 Graphics Controller Properties dialog box, set the definition in the **Screen area** on the Device tab.
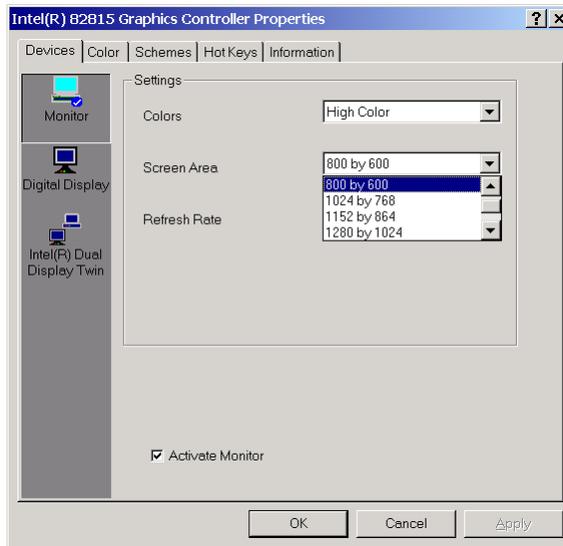
Figure A-6: Setting the definition of the external monitor

2. Click **OK** to change the definition. The confirmation dialog box appears. Click **OK** within 15 s to determine the change.

3. Click **OK** to close the dialog box.

Appendix B: System Recovery

If the operating system will not start, you have to recover the OS by starting it from the recovery disk supplied with the OS. Recovering the system using the recovery disk deletes all data from the hard disk.

For this reason, you have to perform the following operations:

■ Reinstalling the Windows 2000 operating system

■ Setting up the Windows 2000 operating system

■ Reinstalling the DTG5000 software

■ Reinstalling the TekVISA software

Requirements for System Recovery

Prepare the following:

■ Recovery disk labeled "Windows 2000 Professional Operating System Recovery Disk"

■ Application installation disk labeled "DTG5000 Series Product Software"

The system cannot recognize any USB device during operation with the recovery disk. Thus prepare the following as well:

■ PS/2 keyboard and PS/2 mouse

Operating Procedure

⚠ *CAUTION. Recovering the system using the recovery disk deletes all data from the hard disks. Back up the necessary data on a routine basis to avoid data loss.*

Installing the Windows 2000 Operating System

1. With the power off, connect the PS/2 keyboard and PS/2 mouse to the connectors on the rear panel.

2. Power on the unit.

3. Load the recovery CD-ROM in the CD-ROM drive on the rear panel.

4. Power off the DTG5000 Series and then power it on again. The system starts from the recovery disk.

5. The "PowerQuest EasyRestore End User License Agreement" window appears. Press any key as instructed in the message.

6. The EasyRestore dialog box opens. Click the **Continue** button.

7. The Warning dialog box opens. Click **Yes**.

8. After the entire image data in the drive has been copied, the Reboot dialog box opens. Remove the recovery CD-ROM from the drive, and then click the **Reboot** button.

9. The system restarts, and Windows 2000 Setup begins.
   Go to the next step, "Setting Up Windows 2000".

Setting Up Windows 2000

1. The Windows 2000 setup wizard "Welcome to the Windows 2000 Setup Wizard" appears on the data timing generator screen.

2. Click the Next button. The "License Agreement" dialog box appears.

3. Follow the on-screen instructions.

4. When the "**Personalize Your Software**" dialog box appears, "Name" and "Organization" have been added. Be sure to input "Name". "Organization" can be left blank.

5. Click the **Next** button.

6. When **"Your Product Key"** dialog box appears, enter the bar code number which is located at the rear panel of the mainframe.

7. Click the **Next** button to display the **Date and Time Settings** dialog box.

8. Confirm that the Date and the Time Settings information is correct, and the click the **Next** button.

9. The dialog box informs you of the completion of Windows 2000 setup.

10. Click **Restart Now**, and Windows runs.

The computer name is DTG5000, and you can log on to Windows 2000 using the following user name and password.

■ User name: Administrator

■ Password: dtg5000

If you want to add the user name, or want to change the password, always use the **Control Panel > Users and Passwords**. For more information, consult Windows 2000 Help.

NOTE. If you connect a second or third DTG5000 series data timing generator to the network, use different computer names for additional instruments.

Reinstalling the DTG5000 Software

1. Load the "**DTG5000 Series Product Software CD-ROM**" in the CD-ROM drive. Double-click the **setup.exe** icon in the DTG5000Firmware folder to start the installer.

2. The message "Welcome to the InstallShield Wizard for Tektronix..." appears. Click **Next**.

3. The message "InstallShield Wizard Complete" appears. Click **Finish**. Windows 20000 operating system restarts, then the DTG5000 Software starts automatically.

Go to the next step, "Reinstalling the TekVISA Software".

Reinstalling the TekVISA Software

1. Before installing the TekVISA software, exit the DTG5000 software.

2. Double-click the **setup.exe** icon in the TekVISAforDTG5000 folder to start the installer.

3. Following the on-screen instructions of the installation wizard, install the software.

4. The message "InstallShield Wizard Complete" appears. Click **Finish**. Windows 20000 operating system restarts, then the DTG5000 Software starts automatically.

Appendix C: Inspection and Cleaning

Inspect and clean the instrument as often as operating conditions require. The collection of dirt can cause instrument overheating and breakdown. Dirt acts as an insulating blanket, preventing efficient heat dissipation. Dirt also provides an electrical conduction path that can cause an instrument failure, especially under high-humidity conditions.

⚠ **CAUTION.** *To prevent damage avoid the use of chemical cleaning agents that might damage the plastics used in this instrument. Use only deionized water when cleaning the front-panel buttons. Use a ethyl alcohol solution as a cleaner and rinse with deionized water.*

Avoid the use of high pressure compressed air when cleaning dust from the interior of this instrument. (High pressure air can cause ESD.) Instead, use low pressure compressed air (about 9 psi).

Inspection - Exterior Using Table C-1 as a guide, inspect the outside of the instrument for damage, wear, and missing parts. You should thoroughly check instruments that appear to have been dropped or otherwise abused to verify correct operation and performance. Immediately repair defects that could cause personal injury or lead to further damage to the instrument.

Table C-1: External inspection check list

Item	Inspect for	Repair action
Cabinet, front panel, and cover	Cracks, scratches, deformations, damaged hardware or gaskets	Replace defective module
Front-panel knobs	Missing, damaged, or loose knobs	Repair or replace missing or defective knobs
Connectors	Broken shells, cracked insulation, and deformed contacts. Dirt in connectors	Replace defective modules; clear or wash out dirt
Carrying handle and cabinet feet	Correct operation	Replace defective module
Accessories	Missing items or parts of items, bent pins, broken or frayed cables, and damaged connectors	Replace damaged or missing items, frayed cables, and defective modules

**Cleaning Procedure -
Exterior**

⚠ **WARNING.** *To avoid injury or death, unplug the power cord from line voltage before cleaning the instrument. To avoid getting moisture inside the instrument during external cleaning, use only enough liquid to dampen the cloth or applicator.*

1. Remove loose dust on the outside of the instrument with a lint-free cloth.

2. Remove remaining dirt with a lint free cloth dampened in a general purpose detergent-and-water solution. Do not use abrasive cleaners.

3. Clean the monitor screen with a lint-free cloth dampened with either ethyl alcohol or, preferably, a gentle, general purpose detergent-and-water solution.

**Cleaning the
Instrument Interior**

Only qualified personnel should access the inside of the DTG5000 Series for inspection and cleaning, refer to the *Maintenance* section in the DTG5000 Series service manual.

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