User Manual

SONY Tektronix

DG2040
Data Generator

071-0257-04

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CE

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Tektronix warrants that the products that it manufactures and sells will be free from defects in materials and workmanship for a period of one (1) year from the date of shipment. If a product proves defective during this warranty period, Tektronix, at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, with shipping charges prepaid. Tektronix shall pay for the return of the product to Customer if the shipment is to a location within the country in which the Tektronix service center is located. Customer shall be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to any other locations.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; c) to repair any damage or malfunction caused by the use of non-Tektronix supplies; or d) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

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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.

Connect and Disconnect Properly. Do not connect or disconnect probes or test leads while they are connected to a voltage source.

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.

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

Use Proper Fuse. Use only the fuse type and rating specified for this product.

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.*

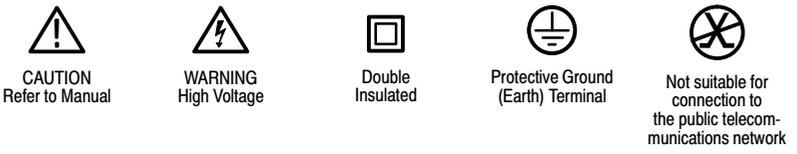
Terms on the Product. These terms may appear on the product:

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:



Preface

The user manual for the DG2040 Data Generator contains the following sections:

The *Getting Started* section briefly describes the DG2040 Data Generator and provides installation instructions, options listing, accessories listing, repacking instructions, and power on and off instructions.

The *Operating Basics* section introduces terminology specific to the DG2040 Data Generator and provides an overview of the internal structure of the instrument, operating principles, basic operating procedures, and numeric input methods. This section also provides examples of basic signal editing.

The *Reference* section provides detailed information about the functions and use of the DG2040 Data Generator's main menus.

The *Appendices* section provides product specifications, performance verification instructions, factory settings, conversion table examples, and inspection and cleaning instructions.

Related Manuals

Other documentation for the instrument includes:

- The *DG2040 Data Generator Programmer Manual* explains how to control the DG2040 Data Generator with a computer through the GPIB or RS-232-C interface. This programmer manual is a standard accessory.
- The *DG2040 Data Generator Service Manual* describes how to maintain and service the DG2040 Data Generator and provides a complete module-level description of the operation of the instrument. This manual is an optional accessory.

Conventions

The following typographical conventions are used in this manual:

- Names of front-panel controls and menu item names are in bold with the same case (initial capitals or all upper case) as they appear on the unit itself. For example, **SETUP**, **Sub-sequence**.
- Sections 2, 3, and Appendix B describe the instrument functions by using a table to list a sequence of steps. Each operating procedure is presented in order, starting with step 1, and progresses until the end of the procedures. Execute the action in the top-left table entry first. Then execute actions from left to right along each row. When you are done executing the steps in one row, move to the left end of the next row down, and continue executing the listed steps until the end of the table.
- When steps require that you make a sequence of selections using menu buttons, an arrow (→) marks each transition between menu buttons. Refer to *Menu Notation* on page 2-14 for further information.

  For pop-up menus, use the general-purpose knob to select items from the menu list. Operations, such as Operation 6 (below), do not involve pressing the buttons shown in the row above, but rather are descriptions of operations to be performed.

Menu button	Bottom button	Pop-up menu	Side button	Front panel button
Operation 1	Operation 2	Operation 3	Operation 4	Operation 5
Operation 6 (for example, “Use the general-purpose knob to set cursor field to 360.”)				
			Operation 7	

Contacting Tektronix

Product Support	For application-oriented questions about a Tektronix measurement product, call toll free in North America: 1-800-TEK-WIDE (1-800-835-9433 ext. 2400) 6:00 a.m. – 5:00 p.m. Pacific time Or contact us by e-mail: tm_app_supp@tektronix.com For product support outside of North America, contact your local Tektronix distributor or sales office.
Service Support	Contact your local Tektronix distributor or sales office. Or visit our web site for a listing of worldwide service locations. http://www.tektronix.com
For other information	In North America: 1-800-TEK-WIDE (1-800-835-9433) An operator will direct your call.
To write us	Tektronix, Inc. P.O. Box 1000 Wilsonville, OR 97070-1000

Getting Started

Getting Started

This section provides the following information:

- Description and features of the DG2040 Data Generator
- Initial inspection procedure
- Standard and optional accessories listings
- Installation procedures
- Power on and off procedures
- Repackaging procedure for shipment

Product Description

The DG2040 Data Generator is a programmable data generator with a 2-channel data output pattern memory. It accommodates a 4k-step sequence controller, which enables the generation of data patterns longer than the pattern memory and also the dynamic change of the patterns due to the external events. The operating parameters, the channel configuration, and the pattern data are displayed or set using the graphic menu on the CRT monitor. The menu has a tree structure and can be operated easily using the bottom and side bezel switches.

The DG2040 can be manually controlled from the front panel or remotely programmed via GPIB or RS-232-C.

Main Features

The DG2040 Data Generator includes the following main features:

- Maximum data rate of 1.1 GHz
- 256 K word pattern memory
- Flexible sequence looping (which does the equivalent of over a billion word patterns)
- Two channels (complementary) providing the following:

  Variable output levels (from –1.125 V to +3.5 V into 50 Ω)

  Edge Control function (CH0 only)

  Delay setting (10 ps resolution)
- Parallel and serial pattern editing

Any memory size from 360 words to 256 K words can be used with no restrictions within that range. Each of the two bit data channels can be assigned to any output channel. The output channels support the setting of high and low output voltage levels, delay time, and edge position.

The DG2040 Data Generator also provides a 4000-step sequence controller, which enables the generation of a data pattern longer than the pattern memory and dynamic pattern changes triggered by external events.

The DG2040 Data Generator provides flexible data editing functions, including word and line unit input and extended data creation functions. Also, the DG2040 Data Generator provides a set of functions required for system construction, such as a sequencing function and a jump function using external input.

Applications

The following lists some of the DG2040 Data Generator applications:

- Supports subassembly and system testing by simulating the digital signals from incomplete sections of a product
- Performs margin tests by using the DG2040 Data Generator to generate patterns that have a low probability of occurrence or are difficult to generate
- Constructs interactive digital simulation systems by using the sequence output, external jump, and tristate control functions
- Uses flexible data output functions to make the DG2040 Data Generator an ideal data generator for simulation of semiconductor devices and drivers specific to serial data communication and all types of digital circuits.
- Performs various timing analysis and jitter/wander tests by using the edge control function to generate jitter on all the edges or selected edge(s)

Initial Inspection

Inspect the DG2040 Data Generator shipping carton for external damage.

Remove the DG2040 Data Generator from its package and check that it has not been damaged in transit. Verify that the carton contains the basic instrument and its standard accessories. Refer to *Accessorie*s on page 1-5.

This instrument was thoroughly inspected for mechanical and electrical defects before shipment. It should be free of scratches and meet or exceed all electrical specifications. To confirm this, after inspecting the instrument for physical damage incurred in transit, test the electrical performance by following the procedures in *Appendix B: Performance Verification.* Contact your distributor if you find a discrepancy.

***NOTE**. Save the shipping carton and packaging materials for repackaging in case shipment becomes necessary.*

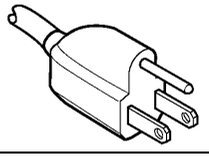
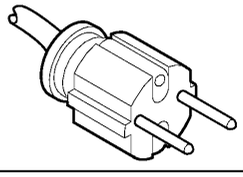
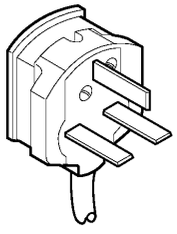
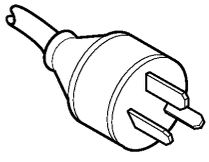
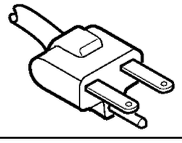
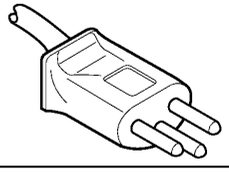
Power Cord Options

Table 1-1 lists the power cords available with the DG2040 Data Generator.

Table 1-1: Power cord options

Option	Description	Tektronix part number
A1	Europe	161-0104-06
A2	United Kingdom	161-0104-07
A3	Australia	161-0104-05
A4	North America	161-0104-08
A5	Switzerland	161-0167-00

Table 1-2: Power Cord Identification

Plug Configuration	Normal Usage	Option Number
	North America	Standard
	Europe	A1
	United Kingdom	A2
	Australia	A3
	North America	A4
	Switzerland	A5

Accessories

Standard Accessories

Table 1-3 lists the standard accessories provided with the DG2040 Data Generator.

Table 1-3: Standard accessories

Standard accessories	Tektronix part number
DG2040 Data Generator User Manual	071-0257-XX
DG2040 Data Generator Programmer Manual	071-0258-XX
Performance Check Disk, 3.5-inch	063-3121-XX
GPIB Sample Program Disk, 3.5-inch	063-3122-XX
DG-LINK Application Program Disk, 3.5-inch	063-2920-XX
Fuse 6A Fast 250 V (UL198G/3AG)	159-0239-00
Power cord 125 V/6A	161-0230-01

Optional Accessories

Table 1-4 lists the optional accessories that are recommended for use with the DG2040 Data Generator.

Table 1-4: Optional accessories

Optional accessory	Tektronix part number
DG2040 Data Generator Service Manual	071-0259-XX
Front Cover	200-3232-01
Accessory Pouch	016-1159-00
Rackmount kit	040-1444-00
Fuse 6A Fast 250 V (UL198G/3AG)	159-0239-00
Fuse cap	200-2264-00
Fuse 5A 250 V (T) (IEC127)	159-0210-00
Fuse cap	200-2265-00
GPIB Cable	012-0991-00
50 Ω SMA Cable, 1 m (39 inches), male	174-1341-00
50 Ω SMA Cable, 2 m (21 inches), male	174-0679-00
50 Ω SMA Cable, 0.5 m (20 inches), male	174-1427-00
SMA Precision Delay Cable, 1 ns, male	015-0562-00
SMA Precision Delay Cable, 2 ns, male	015-0560-00
SMA Precision Delay Cable, 4 ns, male	015-0561-00
50 Ω BNC Cable, 1 m (43 inches), male	012-0057-01
50 Ω BNC Cable, 0.6 m (24 inches), male	012-1342-00
50 Ω BNC Cable, double shield 2.5m (98 inches), male	012-1256-00
SMA T Connector, male to female, male	015-1016-00
50 Ω SMA termination, male	015-1022-00
50 Ω SMA Divider, male	015-1014-00
SMA Male to BNC Female Adapter,	015-0554-00
SMA Adapter Kit	020-1693-00

Options

This subsection describes the options available for the DG2040 Data Generator. The following options are available:

Option 1R (Rack mounting)
Option D1 (Test result report)

Each of these options is discussed in detail in the following paragraphs.

Option 1R (Rack Mount)

When ordered with option 1R, the DG2040 Data Generator is shipped configured for mounting in a 19-inch rack. The floppy disk drive is moved so that it can be accessed from the front panel in this instrument.

If you need to configure a standard DG2040 Data Generator for mounting in a 19-inch rack refer to Table 1-4 Optional accessories on page 1-6 for the Tektronix part number for the rackmount kit.

Option D1 (Test Result Report)

A calibration data test result report will be provided with the DG2040 Data Generator when this option is specified.

Installation

Before you begin the installation, refer to the *General Safety Summary* at the front of this manual for power source, grounding, and other safety information.

Environment

Verify that you have the correct operating environment.

CAUTION. *Damage to the instrument can occur if this instrument is powered on at temperatures outside the specified temperature range.*

The DG2040 Data Generator operates correctly in ambient temperatures from +10° C to +40° C and in relative humidity from 20% to 80%. For more operating environment information, refer to *Appendix A: Specifications*.

NOTE*. If you are installing the instrument in a dedicated rack, refer to the instruction sheet that comes with the rack mounting kit for proper installation procedures.*

Verify that there is at least 2.5 cm (1 inch) of clearance on top and bottom, 15.0 cm (6 inches) on the left and right sides, and 7.5 cm (3 inches) at the rear of the instrument to allow for heat dissipation. Verify that the air intake holes on the sides and bottom of the cabinet are not obstructed.

Check Fuse

Check the fuse to be sure it is the proper type and rating.

WARNING. *To avoid electrical shock, be sure that the power cord is disconnected before checking the fuse.*

Use a slotted screwdriver to remove the fuse. Push in and turn the fuse holder cap counterclockwise. See Figure 1-1 for the fuse location.

The instrument order specified either a UL approved or an IEC approved fuse. Each fuse requires its own cap. See Table 1-5.

Table 1-5: Fuse And Fuse Cap Part Numbers

Fuse	Tektronix Fuse Part Number	Tektronix Fuse Cap Part Number
0.25 inch × 1.25 inch (UL 198.6, 3 AG): 6 A fast, 250 V	159-0239-00	200-2264-00
5 mm × 20 mm (IEC 127): 5 A (T), 250 V	159-0210-00	200-2265-00

NOTE*. The second fuse listed in the table above is approved under the IEC standards. This fuse is used in equipment sold in the European market.*

Check Voltage Settings

Check that you have the proper electrical connections. Refer to Table 1-6 for power requirements.

Table 1-6: AC Line Power Requirements

Name	Description
Line Voltage Range	90 V – 250 V
Line frequency	48 Hz – 440 Hz (90 V – 127 V) 48 Hz – 63 Hz (127 V – 250 V)
Maximum power	300 W

Connect Power Cable

Connect the proper power cord from the rear panel power connector to the power system. Refer to Table 1-2 for power cord identification.

CAUTION. *The instrument is shipped with a power cord appropriate for use with your power systems (normal 115 V power system or 230 V power system). If the instrument is to be used with a power system other than what the order specified, the power cord must be replaced with one appropriate for the power source used.*

Standby Power

Apply power to the standby circuit of the instrument by pushing the **PRINCIPAL POWER SWITCH** on the rear panel of the instrument. Refer to Figure 1-1.

NOTE. After the instrument is installed, leave the **PRINCIPAL POWER SWITCH** on and use the **ON/STBY** switch as the power switch.

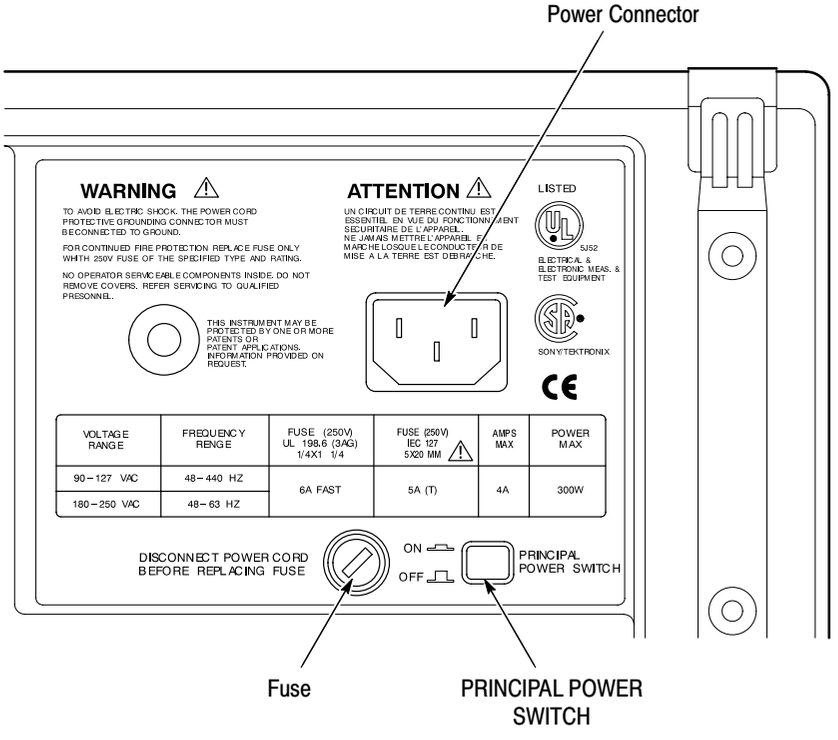


Figure 1-1: Rear panel power switch, fuse holder, and connector

Power On

Press the **ON/STBY** switch on the lower left side of the front panel to power on the instrument. Refer to Figure 1-2.

After power on, verify that the fan is operating.

***NOTE**. Allow a 20 minute warm-up period prior to calibrating the clock for the instrument to operate at its optimum precision.*

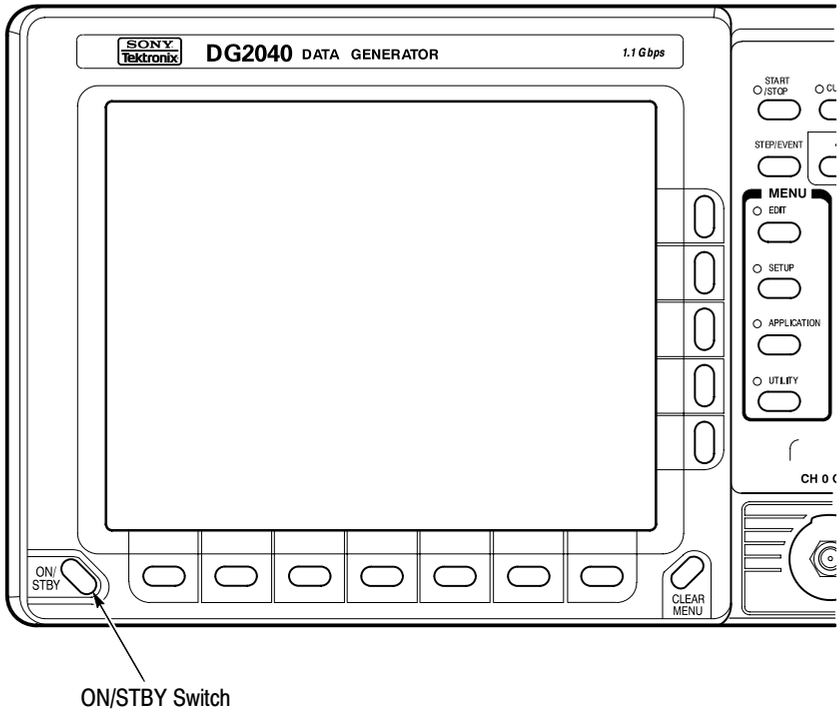


Figure 1-2: Location of the ON/STBY switch

Start-Up Diagnostics

The DG2040 automatically runs diagnostics when the instrument is powered on from the ON/STBY switch. These diagnostics check whether the instrument is performing within its defined operating characteristics. If all the diagnostic items have been completed without error, the instrument displays the EDIT menu.

***NOTE**. If the instrument chassis temperature is outside the specified operating range, an error will occur during the power-up diagnostics. If this happens, power off the instrument, wait until the chassis temperature is within normal operating range, and then power on the instrument again.*

If an error is displayed, contact your Tektronix Field Office or representative.

Power Off

To power off the DG2040 Data Generator, press the **ON/STBY** switch.

NOTE. The **ON/STBY** switch disables the outputs of the power supply. The **PRINCIPAL POWER SWITCH** on the rear panel disconnects the instrument from the primary voltage source.

Repackaging for Shipment

If this instrument is shipped by commercial transportation, use the original packaging material. If the original packaging is unfit for use or is not available, repackage the instrument as follows:

1. Obtain a corrugated cardboard shipping carton having inside dimensions at least six inches greater than the instrument dimensions and having a carton test strength of at least 125 kg (275 pounds).
2. If the instrument is being shipped to a Tektronix Service Center for repair or calibration attach a tag to the instrument showing the following information:
   - The owner of the instrument (with address).
   - The name of a person at your firm who may be contacted if additional information is needed.
   - The complete instrument type and serial number.
   - A description of the service required.
3. Wrap the instrument with polyethylene sheeting or equivalent to protect the outside finish and prevent entry of packing materials into the instrument.
4. Cushion the instrument on all sides by tightly packing dunnage or urethane foam between the carton and the instrument, allowing for three inches (7.62 cm) of padding on each side (including top and bottom).
5. Seal the carton with shipping tape or with an industrial stapler.
6. Mark the address of the Tektronix Service Center and your return address on the carton in one or more prominent locations.

Operating Basics

Operating Basics

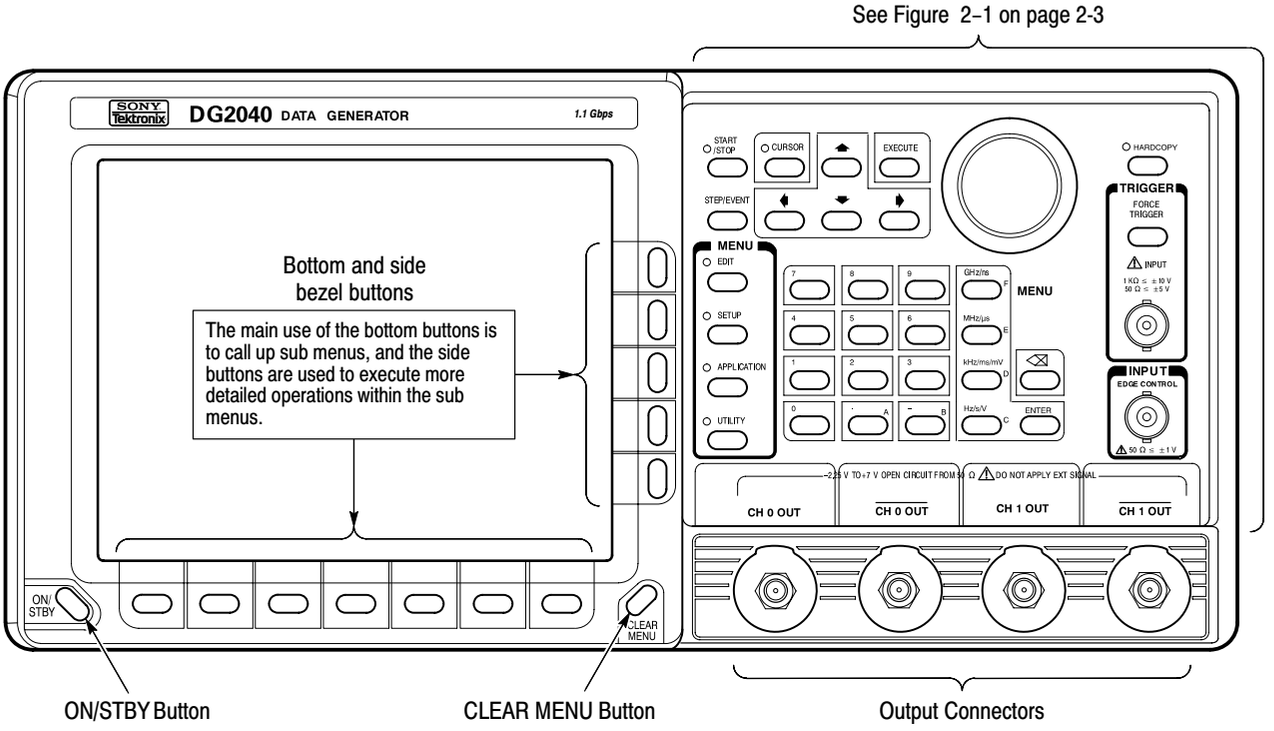
This section provides the following information:

- An overview of the instrument controls and their functions
- An overview of the DG2040 Data Generator hardware
- Information on operations commonly performed on the instrument and how to enter numbers
- Tutorials showing how to edit, save, and recall pattern data

Controls, Connectors, and Display

Front Panel

Figure 2-1 Shows the locations of the front panel controls and connectors.



ON/STBY Button

This button is used as the power switch in normal operation. The **PRINCIPAL POWER SWITCH** on the rear panel must be on.

CLEAR MENU Button

Cancels the current operation and closes side and submenus. The display can be returned to the top level by repeatedly pressing on the CLEAR MENU button.

Output Connectors

The CH 0 to CH 1 SMA connectors output pattern data with variable output level in the range –1.125 V to +3.50 V into 50 Ω. The delay times for each channel can be varied from –1.0 ns to +1.0 ns. If you use only one output connector for each channel, you must terminate the other connector using an SMA termination.

Figure 2-1: Front panel controls

CAUTION. *If external voltages are applied to the data output connectors, be sure to set the high-impedance control correctly. Signal collisions may result in output currents or voltages in excess of the rated values.*

START/STOP Button

Starts or stops pattern data output. When automatic pattern data update is not used, the pattern data is updated before output is started.

The indicator lights in the output state. It will flash when there is a discrepancy between the output data and the displayed data due to pattern data not being updated.

When automatic pattern data update is specified, the indicator flashes rapidly during data update. It flashes slowly when automatic update is not performed and data update is required.

Refer to *Update* on page 3-76 for update mode.

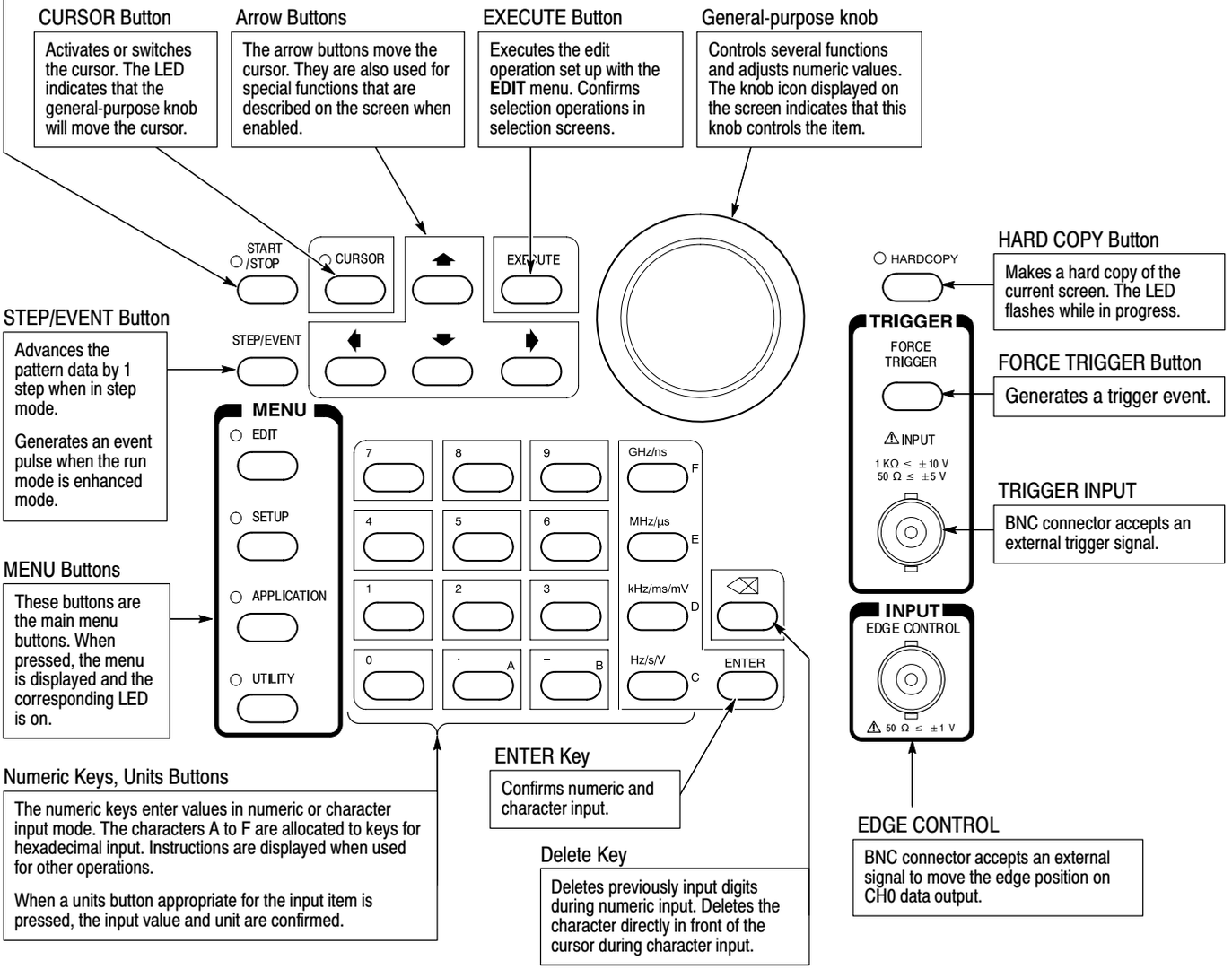


Figure 2-1 : Front panel controls (cont.)

CAUTION. *Only apply signals within the stipulated ranges to the* ***TRIGGER INPUT*** *connector. Signals that exceed those ranges can damage the instrument.*

Rear Panel Figure 2-2 shows the rear panel signal and power connectors.

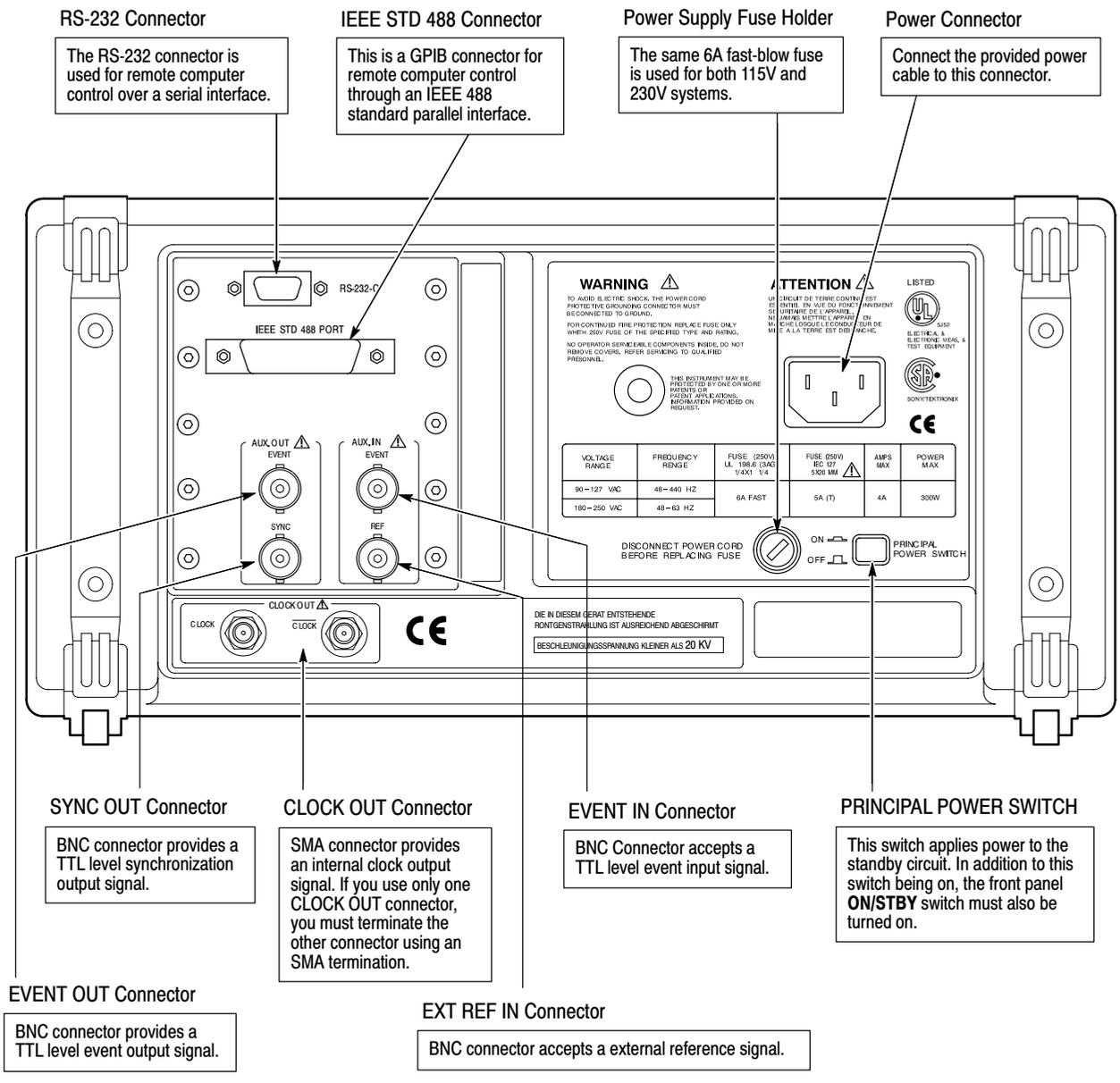


Figure 2-2: Rear panel connectors

CAUTION. *Voltages in excess of the stipulated range can damage the instrument. Apply signals within the stipulated range to the* ***AUX INPUT*** *connector.*

Floppy Disk Drive

Figure 2-3 shows the floppy disk drive controls and indicators. The floppy disk drive is located on the right side of the DG2040 Data Generator chassis. Use the floppy disk drive to save and recall instrument patterns and for setting data.

CAUTION. *Data corruption on the floppy disk may occur if the eject button is pressed while the DG2040 Data Generator is writing to the floppy disk.*

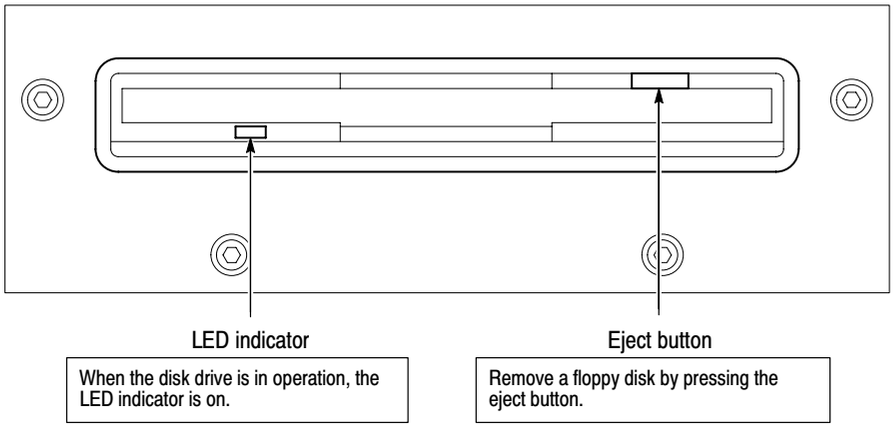


Figure 2-3: Floppy disk drive

Display Elements

Figure 2-4 shows the display elements, including bottom and side menus, work area, status lines, and so on. Also shown are a pop-up menu and message box. Table 2-1 describes each element in detail.

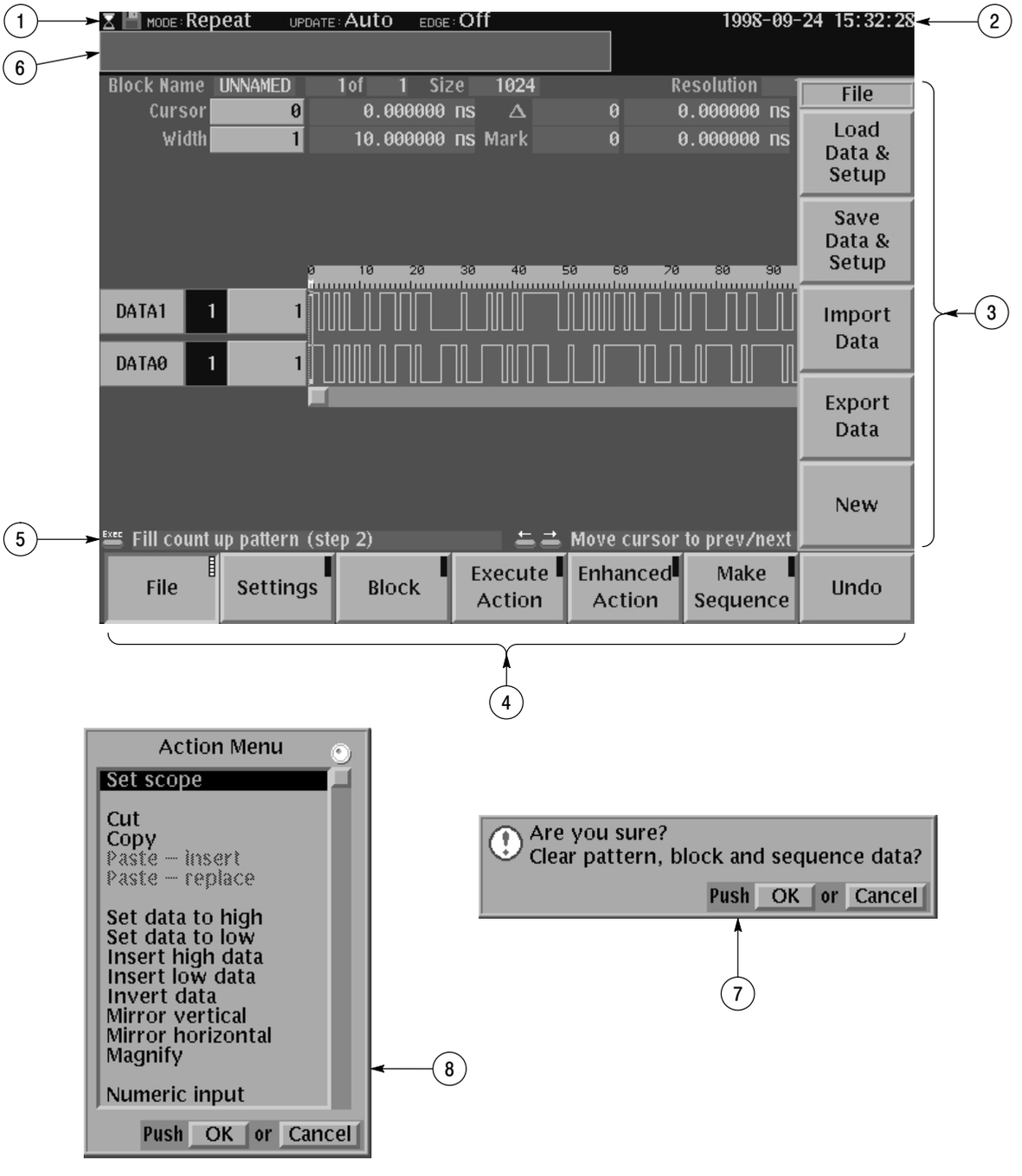


Figure 2-4: Display elements

Table 2-1: DG2040 display elements

Reference number	Label	Description	Page
1	Status area	Displays the current status of the instrument. This status line is always displayed. The status line displays the following two items: **MODE**: Displays the run mode in which pattern data will be output. **UPDATE**: Displays the update method for pattern data output when data is updated. In addition, there is also a disk icon that indicates if a floppy disk is inserted in the disk drive. A clock icon may also be displayed at the left end of the status line. When this icon is displayed, the instrument is busy with internal processing and cannot accept other inputs.	 3-74 3-76
2	Date and Time display area	The date and time display can be turned on or off using the display function of the UTILITY menu.	3-89
3	Side menu	Related side menu items are displayed here when a bottom menu item is selected. The topmost entry in the side menu displays either a label representing the side menu or the operation name for the confirmed item.	2-15
4	Bottom menu	When one of the buttons in the menu section is pressed, the corresponding bottom menu is displayed. When a bottom menu item is selected the corresponding side menu is displayed. Selecting the same bottom menu item again closes the side menu.	2-15
5	Button function description area	Displays descriptions of the functions of the front-panel buttons.	2-2 and 2-3
6	Message for display area	Displays messages regarding the current processing state. This area can be also used by remote commands to display user messages.	2-6
7	Pop-up for message box	When required, the instrument temporarily displays a window at the center of the screen to display a warning or question for the user.	2-25
8	Pop-up menu	The instrument sometimes displays a pop-up menu when a bottom menu or side menu item is selected. Enter a numeric value or select an item using either the general-purpose knob or the front-panel buttons.	2-6

Theory of Operation

This section presents an overview of the DG2040 Data Generator hardware, data structures, and operating modes to allow you to take full advantage of the DG2040 Data Generator.

Block Diagram

Figure 2-5 shows the main hardware blocks that make up the instrument. This section describes these hardware blocks to provide the background knowledge necessary to use the instrument effectively.

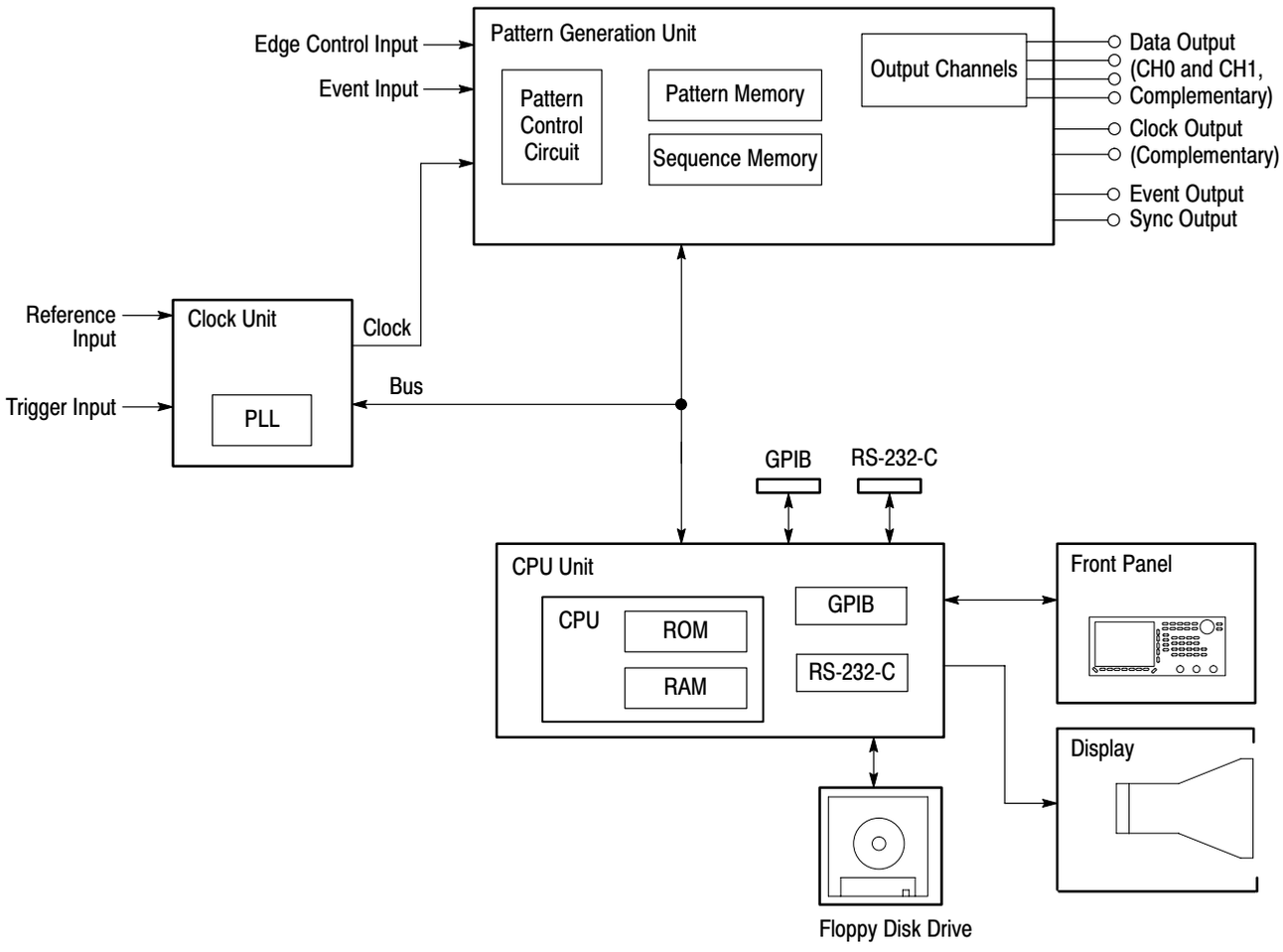


Figure 2-5: Hardware block diagram

CPU Unit

The CPU unit controls the instrument and includes read only memory (ROM), random access memory (RAM), and an input/output (I/O) interface.

The ROM memory holds the program code that implements all the supported functions. The ROM contents are loaded at the factory.

The RAM memory holds a variety of information required by the CPU. The contents of RAM change according to the instrument's operating state. The contents of RAM are retained by a built-in battery even when the instrument is turned off. The main instrument settings will still be in effect the next time the instrument is turned on. The pattern data memory and the sequence data memory, which are described later as a conceptual data model, are actually stored in one section of this RAM.

External interfaces include GPIB and RS-232 interfaces for remote control, a floppy disk drive controller, and a user interface consisting of the display and the front panel.

Pattern Generation Unit

The pattern generation unit generates digital pattern signals based on the pattern data and sequence data specified by the user. This unit includes a pattern control circuit, pattern memory, and sequence memory.

Pattern memory and sequence memory are high-speed memories that hold the pattern data and sequence data, which are described later in this section. These memories supply pattern data to the pattern control circuit.

Clock Unit

The clock unit provides the clock signals that generate the data patterns and detects and synchronizes external trigger signals.

The data generator uses the phase-lock-loop (PLL) circuit when generating the clock signals. This provides an output with excellent frequency precision.

Output Channels

The output channels provide variable output levels and digital signals to the device under test.

The output channels level-convert the pattern signals from the pattern generation unit to output signals appropriate for the device under test. They also handle fine adjustment of specific bit timing.

Display and Front Panel

The user interface consists of the display and front panel.

The display is a 16-level monochrome 640 × 480 pixel CRT. The front panel consists of menu buttons, numeric keys, bezel buttons, a general-purpose knob for changing numeric values and item selection, and several signal output connectors.

Data Structure Overview

To make full and efficient use of the DG2040 Data Generator, you need to understand the data structures of the DG2040 Data Generator. This section presents an overview of the pattern data, setup data, and sequence data. Figure 2-6 shows the data structures that are described in the following sections. Table 2-2 lists the data structure related technical terms that appear frequently in the operating procedure descriptions.

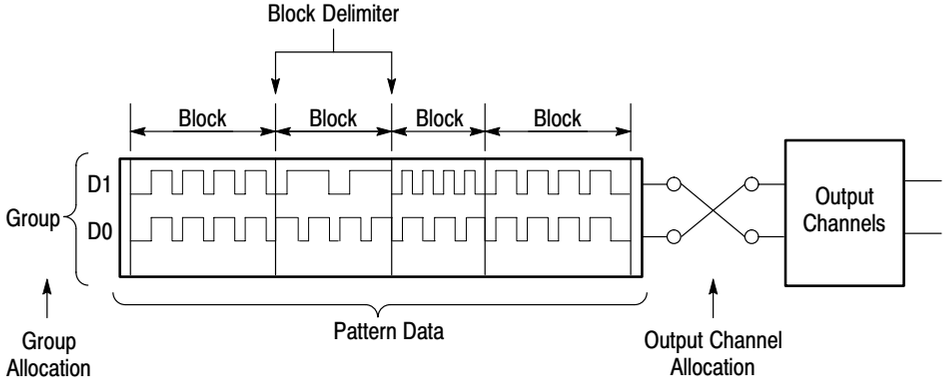


Figure 2-6: Data structures

Table 2-2: Data structure terms

Term	Meaning
Pattern data	Basic data for patterns, consisting of 2-bit words
Memory size	The number of pattern data words (360 words to 256 K words)
Group allocation	Definitions of pattern data bit combinations
Block delimiter	Delimiter that defines pattern data start and stop points
Block division	Pattern data division by block delimiters
Output channel allocation	Definition of the corresponding relationship between pattern data and output bits
Setup data	Settings for the above items
Sequence data	Pattern output sequence program

Pattern Data

Pattern data is the basic data that defines the digital signals to be output. The pattern data is a collection of 2-bit words. The total number of words is called the memory size. The memory size can be any value from a minimum of 360 words to a maximum of 256 K words (262,144).

Pattern data that has been transferred to the pattern memory in the pattern generation unit hardware can be output as digital signals. Pattern memory consists of 2-bit words, with the 2 bits in a one-to-one correspondence with the 2 output channels. The definition of the relationship between pattern data bits and pattern memory bits is called output channel allocation.

The pattern data to pattern memory transfer operation is performed automatically each time the data is modified, or you can manually cause the transfer to occur. This is called the data update mode, and it can be selected by user.

Setup Data

There are numerous settings that define data structures and relationships between data items and that specify output channel states and other parameters. These settings are collectively referred to as the setup data. Since this data is associated with the pattern data, it is handled together with the pattern data in operations, such as saving instrument settings and data to a floppy disk.

The setup data includes a wide range of settings, including output voltage levels, delay, and clock frequency settings in addition to the definitions described here.

Groups

Although each bit in the pattern data can be defined independently, it is easier to edit and display data if multiple bits are collected and handled as a single group. Any set of bits can be assigned as a group.

Blocks

Pattern data can be divided into blocks. A block is a user-specified range of pattern data identified with a unique label. Blocks are divided by setting delimiters called block delimiters. Block delimiters are set in word units. Sequences, which are described later, control data output in block units.

Sequence Data

The sequence data is a program that specifies the order in which the pattern data is output. The sequence data is used to set up operations, such as repeatedly putting out blocks of pattern data for a specified number of times and jumping to a specified block when an external event occurs. Sequences allow long patterns to be set up without preparing large quantities of data.

Sequences can include subsequences so that you can make complex sequence programming easier. Sequence data is transferred to the pattern generation unit sequence memory, and controls the operation of the pattern control circuit. When you use the run mode you can select whether all the sequence data is valid or whether enhanced mode settings, such as event jumps in the sequence, are ignored.

Operating Modes Overview

Run Modes

In the run modes, pattern output is controlled by the pattern generation units pattern control circuit. The DG2040 Data Generator supports four run modes: repeat, single, step, and enhanced. These run modes are specified with the **SETUP** → **Run Mode** menu. Table 2-3 provides functional information for each mode.

Table 2-3: Run modes

Run mode	Function
Repeat	Repeats the pattern data from the first to last data point indefinitely. If a sequence is defined, it repeats the output according to that sequence.
Single	Outputs the pattern data once from the first to last data point in point order. If a sequence is defined, outputs the pattern once according to that sequence.
Step	Operates identically to repeat mode, except that just one data point is output each time the **STEP/EVENT** button is pressed.
Enhanced	Same as Repeat with the addition that event jumps and trigger waits are also effective.

***NOTE**. The Repeat, Single, and Step modes ignore the event jump and trigger wait settings.*

Update Modes

When pattern data or sequence data is created or edited or the output channel allocations are changed, the pattern that is actually output will not be updated until the new settings are transferred to the pattern generation unit.

There are two update methods: auto and manual. The update modes are set up with the **Update** item in the **SETUP → Run Mode** menu. Table 2-4 provides functional information for both modes.

Table 2-4: Update modes

Update mode	Function
Auto	Changes are reflected in the hardware as soon as they are entered.
Manual	Changes are reflected in the hardware when specified by you.

***NOTE**. The response to edit operations while in Auto mode may be slow when there is a large amount of data being edited. In such cases, it is more efficient to perform a number of edit operations and then update the output data in manual mode.*

Basic Menu Operations

This section describes the DG2040 Data Generator menu system and numeric input methods.

Menu System

The menu system is used for instrument settings, instrument operation, and selection of the pattern data output parameter. Pressing one of the menu buttons at the center of the front panel displays one of the menus that forms the basis of DG2040 Data Generator operation. There are four menu buttons, **EDIT**, **SETUP**, **APPLICATION**, and **UTILITY**, as shown in Figure 2-7.

The menu items displayed on the screen are selected by pressing the corresponding bottom or side bezel button. The bezel buttons consist of seven bottom buttons and five side buttons, as shown in Figure 2-7.

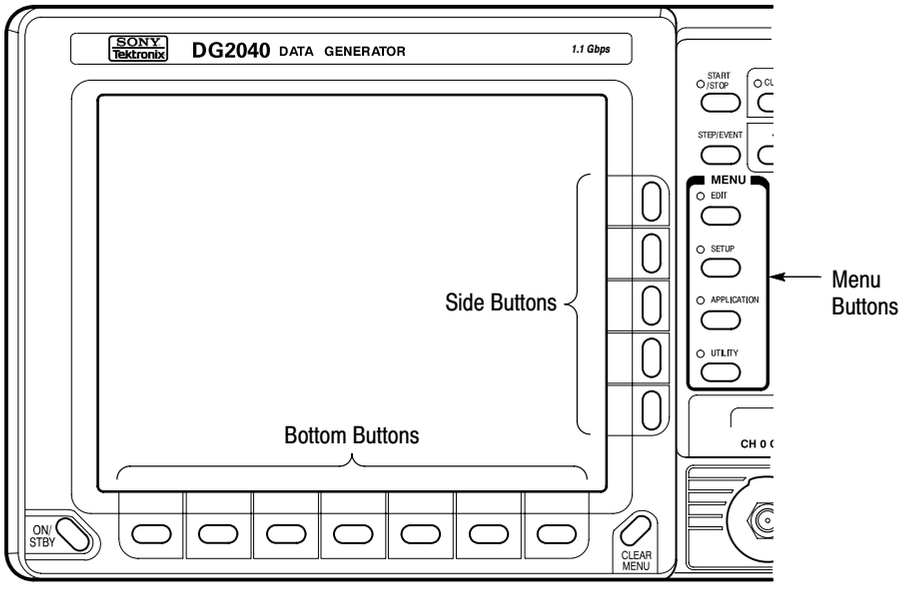


Figure 2-7: Menu and bezel buttons

When the target menu item is selected, the selection items and numeric input entries controlled by that menu are displayed. Items can be selected or numeric values changed using the numeric keys and the general-purpose knob.

Selecting a menu item causes one of the following operations:

- Invokes a lower level menu
- Selects an item:
  - The selected item changes each time a bezel button is pressed.
  - A list is displayed and an item is selected from that list.
- Enables a numeric input
- Executes the function associated with the menu item as soon as the menu item is selected.

Menu Notation

The following notation is used in this manual to show the order to push instrument buttons:

Front panel menu button → Bottom menu button → [Side menu button or pop-up menu item]

The menu path starts with a front panel menu button, followed by an arrow (→), and then a bottom menu. The item in parenthesis may be repeated more than

once, as needed. For example, **SETUP → Output Condition → Control Condition** is executed as follows:

1. Press the **SETUP** button on the front panel.
2. Press the **Output Condition** bottom button.
3. Press the **Control Condition** side button.

Menu Item Display

Starting with each main menu, the instrument displays bottom, side, and submenu items according to fixed rules.

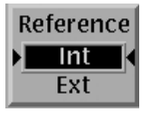
Bottom Menu. The bottom menu changes according to whether items are selected or not, and whether an item is valid or not, as shown in Table 2-5.

Table 2-5: Bottom menu elements

Menu item	Description
	Menu item in the unselected state. The small box in the upper right corner is black.
	Menu item in the selected state. The small box in the upper right corner is white.
	Menu item that cannot be selected, since it is invalid in the current state.

Side and Submenus. The menu items that are manipulated with the side buttons, can be classified according to the manipulations they support. These menu items can be differentiated visually as shown in Table 2-6.

Table 2-6: Side and submenu elements

Menu Item	Description	Menu item	Description
	Menu items that execute a function immediately		Menu items that call up submenus
	Menu items that switch between on and off each time the side button is pressed.		Menu items that allow selections to be made with the general-purpose knob
	Menu items that allow numeric values to be set using the numeric keys or the general-purpose knob		Menu items that cannot be used in the current instrument state

Numeric Input

Enter numeric values by using the front-panel keypad or the general-purpose knob. This section describes these numeric input methods.

Front-Panel Keypad. The numeric keys, the units buttons, the delete key and the **ENTER** key are used for entering numeric values. See Figure 2-8.

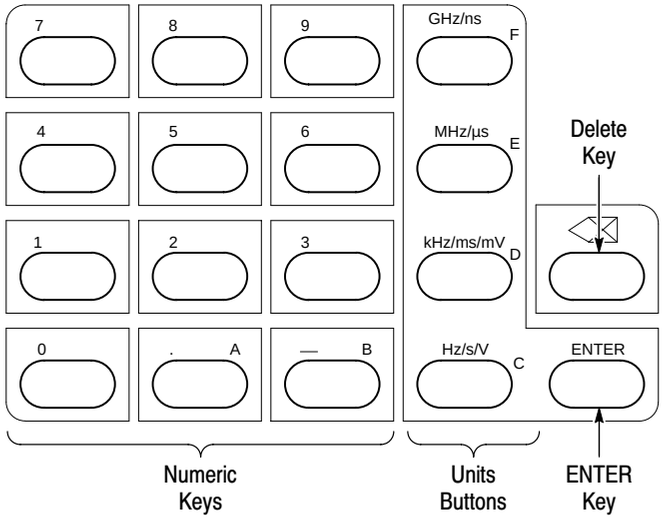


Figure 2-8: DG2040 front-panel keypad

Use the following procedure to input numeric values with the numeric keys, **ENTER** key, and units buttons on the front panel.

1. Press the button for the menu item to be changed.
2. Input the value using the numeric keys.
3. Press a units button or the **ENTER** key.

Figure 2-9 shows a menu display during numeric input. The asterisk to the left of the menu items indicates that you are entering a value in that field. Press the front panel **ENTER** key to confirm an entered value and to remove the asterisk from the menu item field.

Figure 2-9: Numeric entry in a menu item field

Numeric Input Example. Table 2-7 shows how to change the clock frequency to 12.3 Hz when the value, before entering the input state, was 100.0 Hz. Press the **1**, **2**, **.**, **3**, and **ENTER** keys in that order. The numeric input box changes as shown in Table 2-7.

Table 2-7: Numeric input example

Press keys in this order	Numeric input window display	State of the value
	100 Hz	Pre-numeric input
1	* 1	Numeric input in progress
2	* 12	
.	* 12.	
3	* 12.3	
ENTER	12.30000 Hz	Value confirmed

Press a units button after a value has been entered to confirm both the value and the unit in a single operation. Pressing a units button before entering the input state changes only the unit without changing the value.

Failure to press the **ENTER** key or a units button after entering a value, prior to switching menu items, will cause the entered value to be discarded. The value returns to the previous value.

Setting Values with the General-Purpose Knob. The general-purpose knob and the left and right arrow buttons can be used to set values in numeric input boxes. The knob icon is displayed close to the box to show that you can use the general-purpose knob to enter values. The general-purpose knob is used to increase or decrease the value of the digit indicated by the underscore. Rotating the knob to the left decreases the value and rotating it to the right increases the value.

Figures 2-10 shows the arrow keys and the general-purpose knob.

Figure 2-11 shows a menu element that can use the general-purpose knob to enter numeric values.

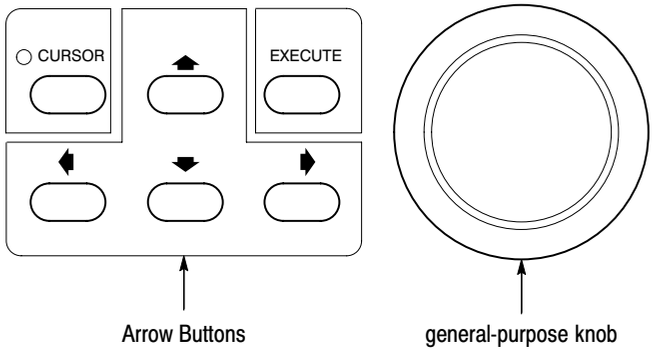


Figure 2-10: General-purpose knob and arrow buttons

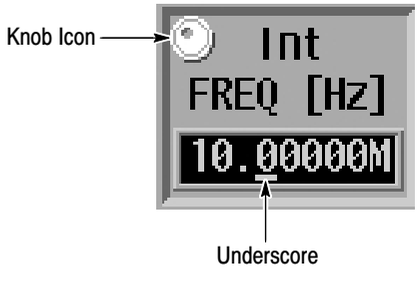


Figure 2-11: Menu element knob icon and underscore

You do not need to use the front panel **ENTER** key to confirm a value when using the general-purpose knob to change a value. The input value is confirmed automatically without pressing the **ENTER** key.

Follow the procedure below to change a value with the general-purpose knob.

1. Press the button for the menu item to be changed.
2. Use the left and right arrow buttons to move the underscore line to the digit to be modified.

   The front panel arrow buttons control the amount of change that can be achieved with the general-purpose knob. Pressing the ◀ button moves the underscore one digit to the left and thus multiplies the effect of turning the general-purpose knob by ten. Inversely, pressing the ▶ button moves the underscore one digit to the right and reduces the effect of turning the general-purpose knob by a factor of ten.
3. Change the value by turning the general-purpose knob.

Pattern Data Display Format

You can display pattern data in one of four formats: timing display, table display, binary display, and numeric display. Use the **EDIT → Settings** item to select the display format.

You get the same output results from whichever display format you select. Use these different formats according to your needs. These display formats are discussed below.

Timing Display Format. The Timing display format shows the waveform patterns for the data graphically with the time axis in the horizontal direction. The Timing display shows the data so that data transitions and the relationships between bits can be easily seen. Refer to Figure 2-12.

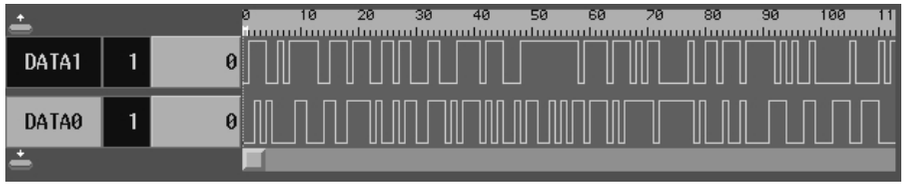


Figure 2-12: Timing display format

Table Display Format. The Table display format shows the data for each clock as numeric values for each group. Refer to Figure 2-13.

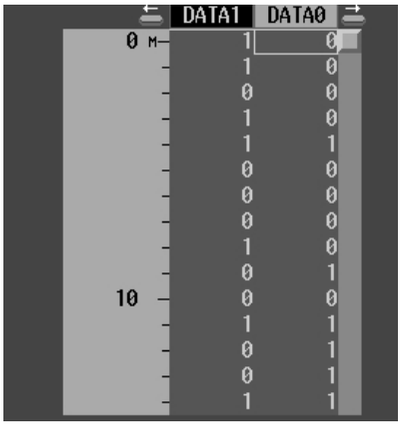


Figure 2-13: Table display format

Binary Display Format. The Binary display format shows the data bit states for each clock as 0 or 1. This is the basic display for digital signals and is an appropriate format for handling data in bit units. If no groups are defined, data can only be displayed in binary format. Refer to Figure 2-14.

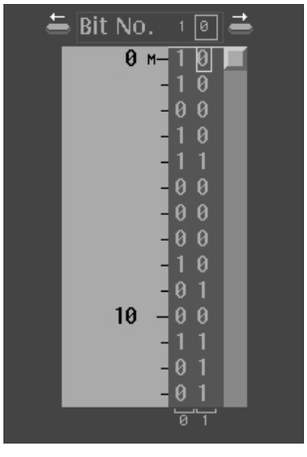


Figure 2-14: Binary display format

Numeric Display Format. The Numeric display format shows the data of specified bit width for binary or hexadecimal radix values. When using the numeric display format, parallel data can be displayed as serial data. Refer to Figure 2-15.

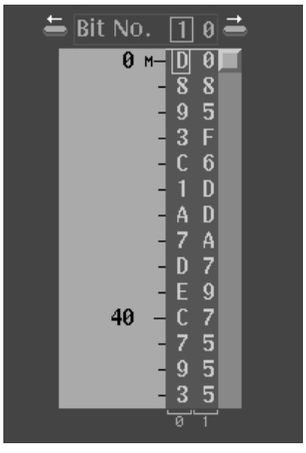


Figure 2-15: Numeric display format

Edit Operations

The different editing operations are selected from the **EDIT → Execute Action** menu. Press the front panel **EXECUTE** button to execute the selected operation. Editing can be accomplished quickly by using the general-purpose knob and the **CURSOR** button to move the cursor. Press the **EXECUTE** button to complete the process. Figure 2-16 shows the procedure used to select the Invert data editing operation and invert data bits at three locations.

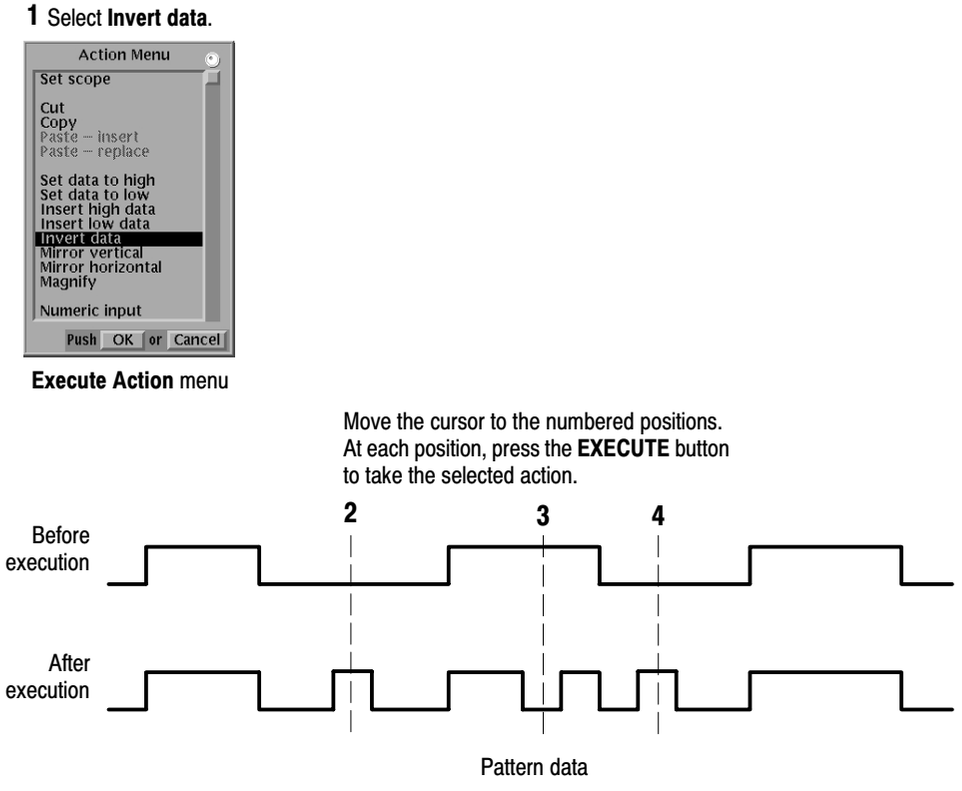


Figure 2-16: Pattern data editing procedure

Parallel/Serial Editing. The Numeric display format allows you to edit the data of every specified bit width in a selected data bit. You can select two to 32 bits and edit in BIN (binary) or HEX (hexadecimal) format. Figure 2-17 show an example of displaying and editing in 4 bit width in HEX format.

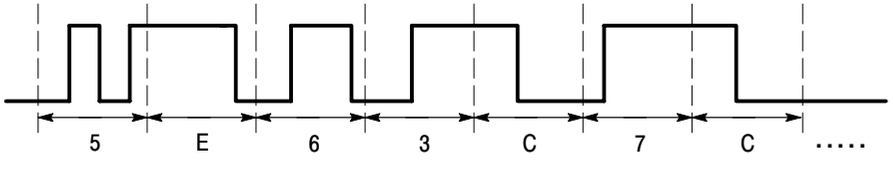


Figure 2-17: Serial/Parallel editing mechanism

To edit serial data as parallel data, select bit width in the Bit Width pop-up menu brought up by selecting **Settings → Set numeric view format**, select **Settings → Set view type of numeric**, and then select **Execute Action → Numeric Input**. Press the numeric key after you have pressed **EXECUTE** key on the front panel.

This editing function allows you to convert parallel data to serial data.

Area and Point Cursors

When editing pattern data, there are two types of cursors used for indicating the data that will be the object of the edit operation. The type of cursor used depends on whether a particular point in the data must be indicated, or an area of data must be indicated.

Each type of cursor has a different form. They are called the area cursor and the point cursor. Figure 2-18 shows these cursors.

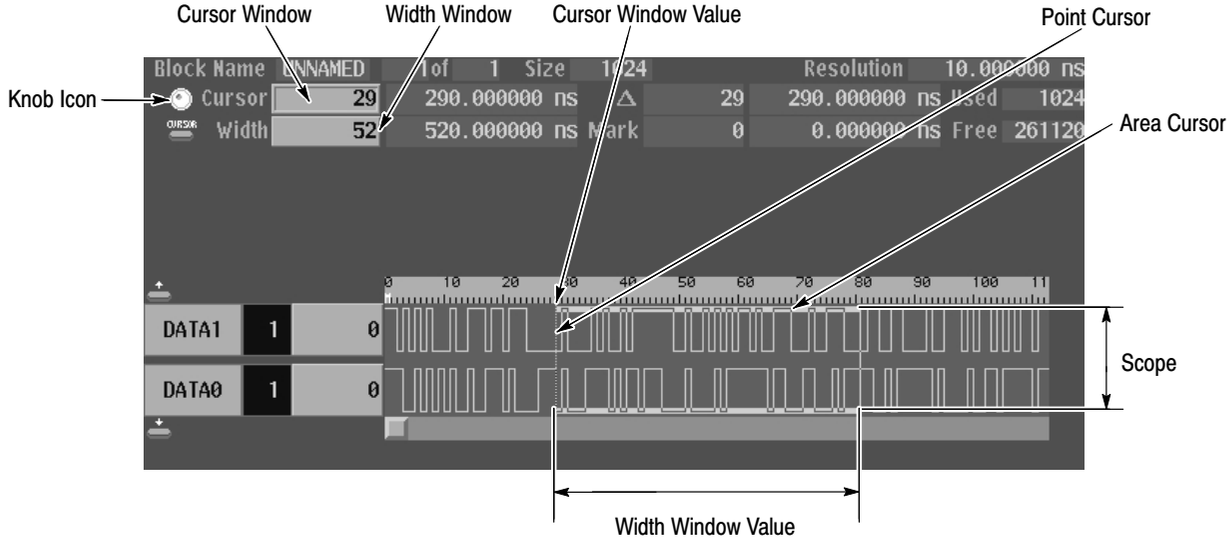


Figure 2-18: Area and Point cursors

The area cursor is used to select a range of signal data, such as during a copy operation. In this operation, the data in the area specified by the area cursor is copied to the edit buffer memory. The paste operation is an example where the point cursor is used. In this operation, data that was previously loaded into the edit buffer memory is copied into pattern memory at the point specified by the point cursor.

The area cursors area is determined by a combination of an area origin (as defined by a data group and a sample point position), the number of points (which corresponds to the width of the area) and the scope (which corresponds to the height of the area). The origin data group is set with the up and down arrow

buttons. The area cursor origin sample point is displayed in the **Cursor** window at the upper left of the screen in the same way as the point cursor is displayed. It can be manipulated in the same way as the point cursor.

The width of the area cursor is displayed in the Width window. It can be set with the general-purpose knob or numeric keys when the knob icon has been moved to the Width window using the **CURSOR** button. Use the **EDIT → Execute Action → Set Scope** item to set the area cursor height.

The position of the point cursor is determined by a data group and a sample point. The data group is set with the vertical arrow buttons. The sample point position is displayed in the **Cursor** window at the upper left of the screen. It can be set with the general-purpose knob or the numeric keys when the knob icon has been moved to the Cursor window with the front panel **CURSOR** button.

Text Input

Text input is required to enter the names for data groups, data blocks, floppy disk files, and other items. When such input is required, the instrument automatically brings up the dialog box shown in Figure 2-19.

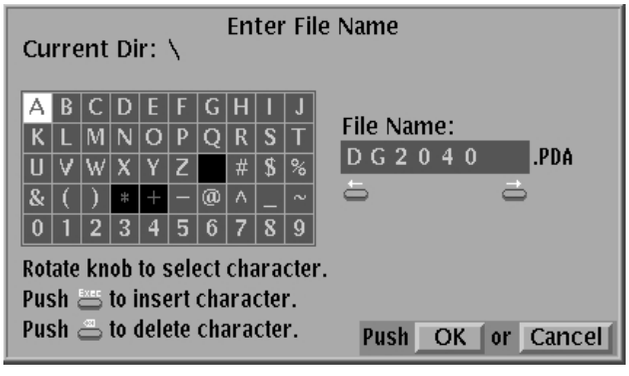


Figure 2-19: Text input menu

The text input menu displays a default string for the item. Use the side menu **Clear String** button to erase this default string. Use the arrow buttons or the general-purpose knob to move the reverse-video cursor to the desired character in the letter/digit matrix. Press the **EXECUTE** button to complete the process. Incorrect input can be erased with the delete key. The position where the character is inserted is indicated with an underscore. Use the left and right arrow buttons to change the position of the underscore. Select all the required characters then press the **OK** button on the side menu to complete the process. Press **Cancel** on the side menu to cancel text input and return to the previous menu.

Pop-up Message Box

The instrument displays a message box that prompts you to confirm operations that would be difficult to recover. Figure 2-20 shows the file deletion confirmation message box. Press the side menu **OK** button to execute the operation displayed in the box. Press **Cancel** to cancel the operation and return to the state prior to selecting the current menu.

Figure 2-20: Pop-up message box

Tutorials

This manual provides simple tutorials to learn the basic procedures for pattern signal creation and output. Following are the five tutorials that will be given:

- Creating a Pattern and Storing into a File on page 2-27
- Loading and Editing a Pattern Stored in a File on page 2-30
- Setting up Signal Output on page 2-34
- Creating a Sequence on page 2-37
- Controlling Pattern Edges on page 2-49

Refer to the menu descriptions in the *Reference* section for detailed explanations of the menus and functions used in these procedures.

***NOTE**. These tutorials do not cover all the features and functions of the DG2040 Data Generator. They are intended only to introduce the operations required to execute the instrument's basic functions.*

Be sure that the DG2040 Data Generator is properly installed. Refer to *Installation* on page 1-7.

Refer to *Power On* on page 1-9 for power-on instructions.

The following equipment is required for Tutorials 1 through 5:

- An IBM-formatted 3.5 inch floppy disk (2HD, 1.44 MB)
- A digital storage oscilloscope (a Tektronix TDS700-series oscilloscope or equivalent)
- A BNC cable
- Two SMA terminations
- Two SMA cables
- Two SMA female-to-BNC male adapters

Each operating procedure is presented in table format beginning with step 1 and progresses through the end of the procedure. Tables, such as the one shown on page 2-27, list the steps for each procedure task. For these steps, press the buttons in the order shown in the table, from left to right in each row, from top to bottom of the table.

If a number is shown in the front-panel button column, enter that value using the keypad.

Use the general-purpose knob to select items from the menu list on pop-up menus.

Operations such as Operation 6 (below) do not involve pressing the buttons shown in the row above, but rather are descriptions of operations to be performed. Figure 2-21 shows the buttons used and the menu layout.

Menu button	Bottom button	Pop-up menu	Side button	Front-Panel button
Operation 1	Operation 2	Operation 3	Operation 4	Operation 5
Operation 6 (For example, set to xx with general-purpose knob.)				
			Operation 7	

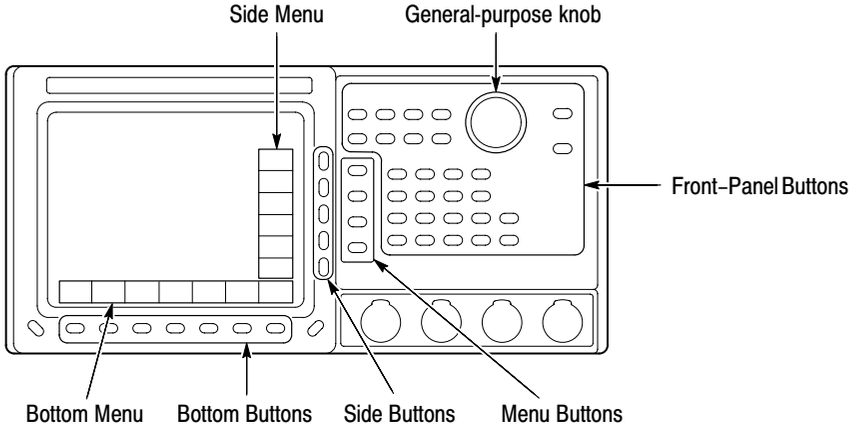


Figure 2-21: Operating buttons

Tutorial 1: Creating a Pattern and Storing the File

Tutorial 1 creates the output pattern for an 2-bit binary counter and stores that pattern onto a 3.5 inch floppy disk.

NOTE. Initialize the instrument's data and settings before creating new pattern data.

Follow the steps below by pressing the buttons in the order shown in the following tables (from left to right in each row and from top to bottom) to create a pattern and then store the file:

1. Clear the data memory.

Menu button	Bottom button	Pop-up menu	Side button	Front-panel button
EDIT	File		New	
			OK	

2. Set up the environment by setting the pattern memory length to 1024 points.

Menu button	Bottom button	Pop-up menu	Side button	Front–panel button
	Settings	Set memory size	OK	1024 *
				ENTER
			OK	

*** Use the front-panel keypad to enter numeric values.**

3. Set the data bit positions and bit widths by setting the height (scope) and width of the data that you are going to edit.

Menu button	Bottom button	Pop-up menu	Side button	Front-panel button
	Execute Action	Set scope	OK	
		2	OK	
Move the knob icon to the Cursor window in the upper left area of the screen by pressing the front-panel **CURSOR** button once or twice.				
				0
				ENTER
Move the knob icon to the Width window in the upper left area of the screen by pressing the front-panel **CURSOR** button once.				
				1024
				ENTER
Press the down arrow button until the area cursor covers DATA0 to DATA1.				

4. Create the binary pattern for a value increasing every 2 clock ticks.

Menu button	Bottom button	Pop-up menu	Side button	Front-panel button
	Execute Action	Binary up counter	OK	2
				ENTER
			OK	EXECUTE

The previous steps created the binary pattern shown in Figure 2-22 in DATA0 to DATA1.

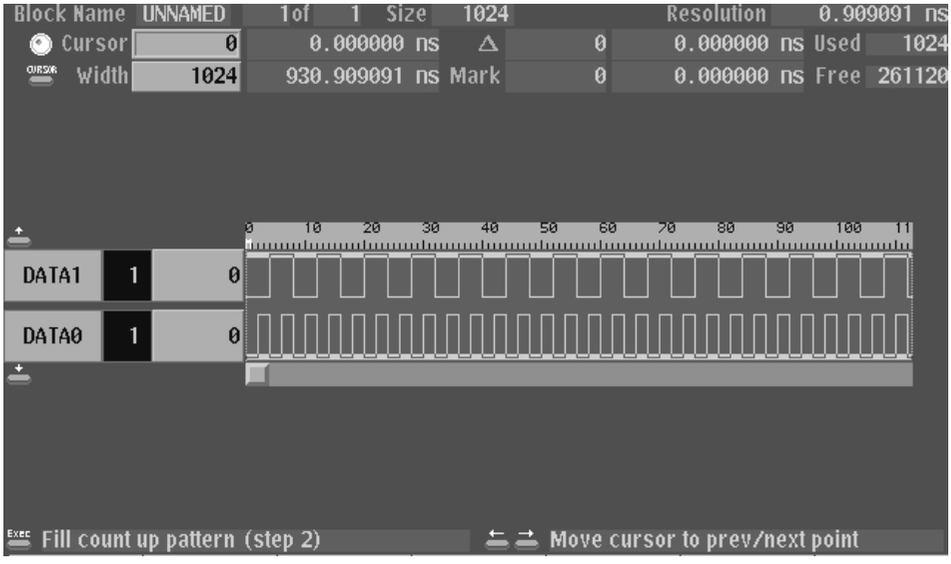


Figure 2-22: Binary pattern creation

Follow the steps below to save the created data on the 3.5 inch floppy disk.

5. Insert a blank IBM-formatted 3.5 inch floppy disk in the drive.

6. Name the new file COUNT1.

Menu button	Bottom button	Pop-up menu	Side button	Front-panel button
	File		Save Data & Setup	
			Clear String	
		COUNT1 *	OK	

*** Select each character in the file name using the general-purpose knob and the up and down arrow buttons. Press the EXECUTE button to insert the character in the file name.**

The data in this procedure is saved in the file named COUNT1.PDA.

Tutorial 2: Loading and Editing a Pattern Stored in a File

Tutorial 2 loads a file from a 3.5 inch floppy disk and demonstrates pattern editing using that data.

Before loading a file from the 3.5 inch floppy disk, initialize the instrument's data and settings. This allows you to see the effect of loading the file you previously saved in Tutorial 1.

1. Clear the data definitions.

Menu Button	Bottom Button	Pop-up Menu	Side Button	Front Panel Button
EDIT	File		New	
			OK	

Follow the steps below to load the Tutorial 1 file from the 3.5 inch floppy disk:

2. Insert the 3.5 inch floppy disk in the instrument's 3.5 inch floppy disk drive and complete the actions in the following table.

Menu Button	Bottom Button	Pop-up Menu	Side Button	Front Panel Button
EDIT	File		Load Data & Setup	
Select the file **COUNT1.PDA** from the file list using the general-purpose knob.				
			OK	

3. Select DATA1 as the area to be edited.

Menu Button	Bottom Button	Pop-up Menu	Side Button	Front Panel Button
	Execute Action	Set scope	OK	
		1	OK	
Move the knob icon to the **Cursor** window in the upper left area of the screen by pressing the front-panel **CURSOR** button once or twice.				
				0
				ENTER
Move the knob icon to the **Width** window in the upper left area of the screen by pressing the front-panel **CURSOR** button once.				
				1024
				ENTER
Press the up and down arrow buttons until the area cursor covers DATA1.				

4. Complete the following actions to shift the bits in DATA1 exactly one sample width to the right.

Menu Button	Bottom Button	Pop-up Menu	Side Button	Front Panel Button
	Execute Action	Shift right (add zero)	OK	EXECUTE

5. Complete the following actions to insert a glitch with a width of 1 sample in the DATA1 bits.

   a. Set DATA1 as the bits that will be the object of the edit.

Menu Button	Bottom Button	Pop-up Menu	Side Button	Front Panel Button
	Execute Action	Set scope	OK	
		1	OK	
Set the block cursor to cover DATA1 using the up and down arrow buttons.				

   b. Set the glitch width to be 1.

Menu Button	Bottom Button	Pop-up Menu	Side Button	Front Panel Button
Move the knob icon to the **Width** window in the upper left area of the screen by pressing the front-panel **CURSOR** button once or twice.				
				1
				ENTER

   c. Select invert as the edit operation.

Menu Button	Bottom Button	Pop-up Menu	Side Button	Front Panel Button
	Execute Action	Invert data	OK	

d. Insert two glitches.

Menu Button	Bottom Button	Popup Menu	Side Button	Front Panel Button
Move the knob icon to the **Cursor** window in the upper left of the screen by pressing the front panel **CURSOR** button once.				
				35
				ENTER
				EXECUTE
				91
				ENTER
				EXECUTE

This process inserted glitches at the points for cursor positions 35 and 91.

Figure 2-23 shows the pattern edited in Tutorial 2.

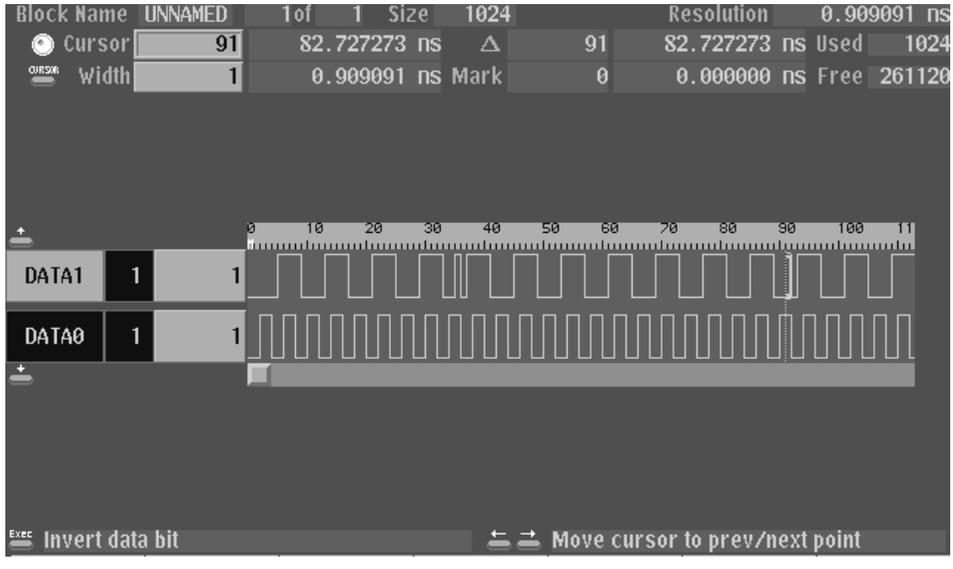


Figure 2-23: Pattern edited in Tutorial 2

6. Save the edited data on the 3.5 inch floppy disk.

   a. Insert a formatted 3.5 inch floppy disk in the drive.

   b. Name the new file COUNT2.

Menu Button	Bottom Button	Pop-up Menu	Side Button	Front Panel Button
	File		Save Data & Setup	
			Clear String	
		COUNT2	OK	

The data in this procedure will be saved in the file COUNT2.PDA.

Tutorial 3: Signal Output

Tutorial 3 sets all the settings required for signal output and actually outputs the signals.

1. Set the sampling clock frequency to 500 MHz.

Menu button	Bottom button	Pop-up menu	Side button	Front-panel button
	Clock		Reference (Select Int.)	
			Int FREQ	500
				MHz

2. Set the signal generation mode to continuous mode.

Menu button	Bottom button	Pop-up menu	Side button	Front-panel button
	Run Mode		Repeat	

3. Set the channel CH0 to CH1 output levels to 1 V for the high level and –1 V for the low level.

Menu button	Bottom button	Pop-up menu	Side button	Front-panel button
	Level Condition			
Select channel **CH0** by pressing the front-panel up and down arrow buttons.				
			High	1
				ENTER
			Low	–1
				ENTER
Set the output levels for channels **CH1** in the same manner.				

Follow the steps below to set the delay time for each channel.

4. Set the delays for the output channels **CH0** to **CH1** to 1 ns. Refer to Figure 2-24 for the output parameter settings example.

Menu button	Bottom button	Pop-up menu	Side button	Front-panel button
	Timing Condition			
Select channel CH0 by pressing the front-panel up and down arrow buttons.				
			Delay	1
				ENTER
Set the delays for channels **CH1** in the same manner.				

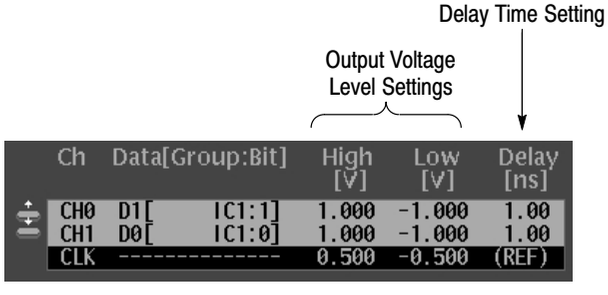


Figure 2-24: Output parameter settings

Follow the steps below to output the signals and confirm those signals with an oscilloscope.

5. Connect the DG2040 Data Generator outputs to the oscilloscope.

Connect the **CH0** and **CH1** on the front-panel to the oscilloscope CH1 and CH2. This requires two SMA cables and two SMA female-to-BNC male adapters. Connect two SMA terminations to the $\overline{\text{CH0}}$ and $\overline{\text{CH1}}$ outputs on the DG2040 Data Generator front panel. Refer to Figure 2-25.

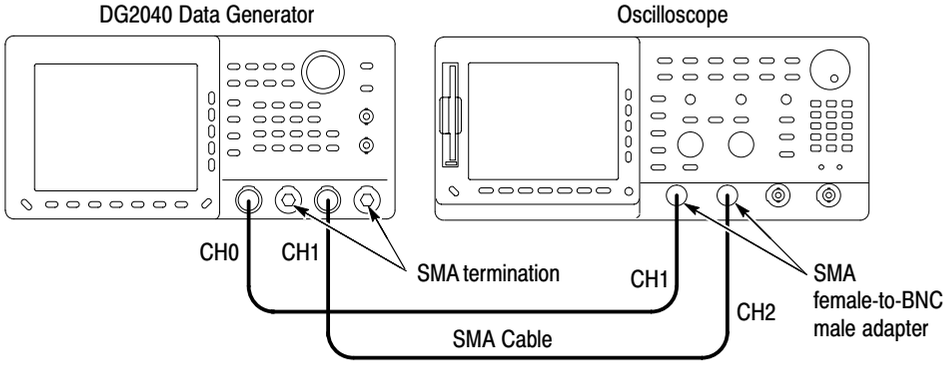


Figure 2-25: DG2040 Data Generator and oscilloscope connection

6. Press the **START/STOP** button on the front-panel.
7. Set up the oscilloscope appropriately and observe the pattern signals on the oscilloscope screen.
8. Save the state of the settings on the 3.5 inch floppy disk.
   a. Insert an IBM-formatted 3.5 inch floppy disk in the drive.
   b. Name the new file COUNT3.

Menu button	Bottom button	Pop-up menu	Side button	Front-panel button
EDIT	File		Save Data & Setup	
			Clear String	
		COUNT3	OK	

The data in this procedure is saved to a file named COUNT3.PDA.

Tutorial 4: Creating a Sequence

Tutorial 4 creates four 360-bit blocks and assigns the blocks to sequences, as shown in Figure 2-26.

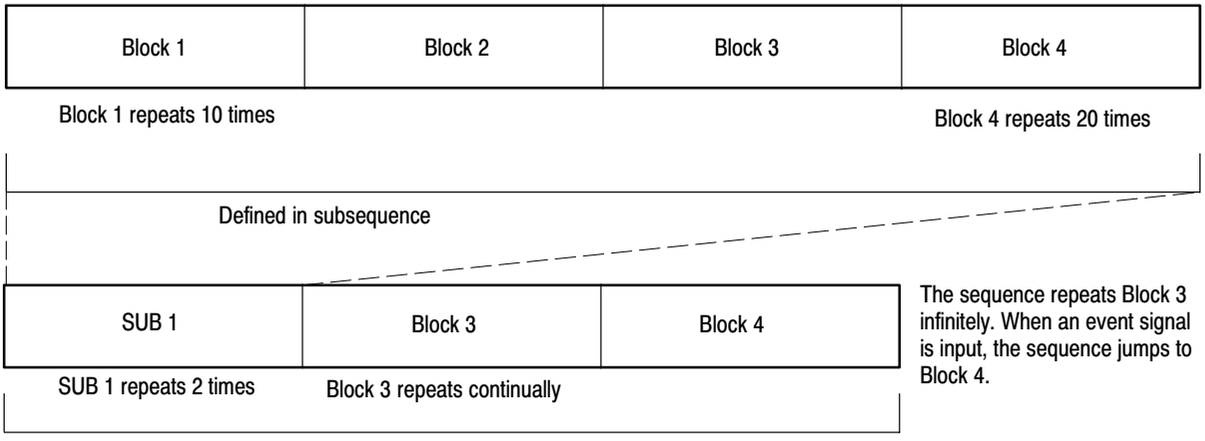


Figure 2-26: Tutorial 4 block sequence

Create the following data patterns for the blocks:

- Block 1: Binary up-counter pattern
- Block 2: Data pattern consisting of all zeros
- Block 3: Binary down-counter pattern
- Block 4: Data pattern consisting of all ones

1. Clear the data group definitions and pattern data.

Menu button	Bottom button	Pop-up menu	Side button	Front-panel button
SETUP	Group Assign		Reset All bits Assign	
			OK	
EDIT	File		New	
			OK	

2. Set the length of pattern memory (the number of samples) to 1440 points.

Menu button	Bottom button	Pop-up menu	Side button	Front-panel button
	Settings	Set memory size	OK	1440
				ENTER
			OK	

3. Set the block cursor position and width. This procedure sets a scope of 2 (DATA0 and DATA1) and a width of 360 samples.

Menu button	Bottom button	Pop-up menu	Side button	Front-panel button
	Execute Action	Set scope	OK	
		2	OK	
Move the knob icon to the **Width** window in the upper left area of the screen using the front-panel **CURSOR** button.				
				360
				ENTER

4. Divide the data between block 1 (point 0 to 359) and block 2 (point 360 to 719). Use BK2 as the name for block 2.

Menu button	Bottom button	Pop-up menu	Side button	Front-panel button
Move the knob icon to the **Cursor** window in the upper left area of the screen by pressing the front-panel **CURSOR** button once or twice.				
				360
				ENTER
	Block	Add block delimiter here	OK	
			Clear String	
		BK2	OK	

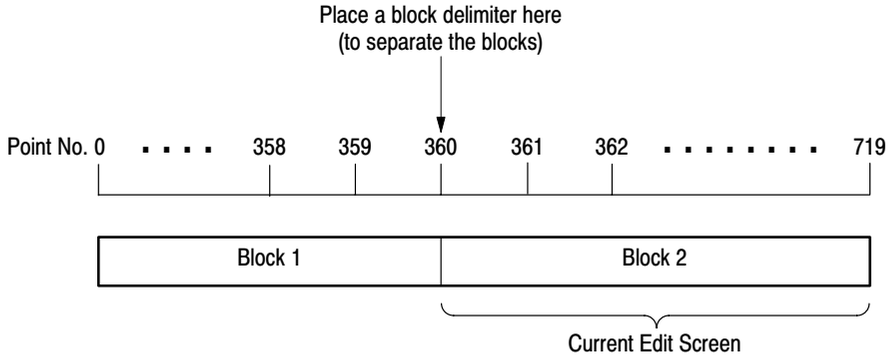


Figure 2-27: Block separation

5. Divide the data from point 360 to point 719 between block 2 (360 to 719) and block 3 (720 to 1079). Use BK3 as the name for block 3. Confirm that the knob icon appears in the **Cursor** window in the upper left area of the screen. If the icon is not in that window, move it there with the front-panel **CURSOR** button.

Menu button	Bottom button	Pop-up menu	Side button	Front-panel button
				720
				ENTER
	Block	Add block delimiter here	OK	
			Clear String	
		BK3	OK	

6. Divide the data from point 720 to point 1079 between block 3 (720 to 1079) and block 4 (1080 to 1339). Use BK4 as the name for block 4. Confirm that the knob icon appears in the **Cursor** window in the upper left area of the screen. If the icon is not in that window, move it there with the front-panel **CURSOR** button.

Menu button	Bottom button	Pop-up menu	Side button	Front-panel button
				1080
				ENTER
	Block	Add block delimiter here	OK	

Menu button	Bottom button	Pop-up menu	Side button	Front-panel button
			Clear String	
		BK4	OK	

7. Change the name for block 1 to BK1. Confirm that the knob icon appears in the **Cursor** window in the upper left area of the screen. If the icon is not in that window, move it there with the front-panel **CURSOR** button.

Menu button	Bottom button	Pop-up menu	Side button	Front-panel button
				0
				ENTER
	Block	Rename current block	OK	
			Clear String	
		BK1	OK	

8. Create block 1 data by creating a binary up-counter data in block 1. First make sure that the value of the Cursor window in the upper left area of the screen is 0 and set that value to 0 if it is not already 0. Complete the actions in the following table.

Menu button	Bottom button	Pop-up menu	Side button	Front-panel button
	Execute Action	Binary up counter	OK	1
				ENTER
				EXECUTE

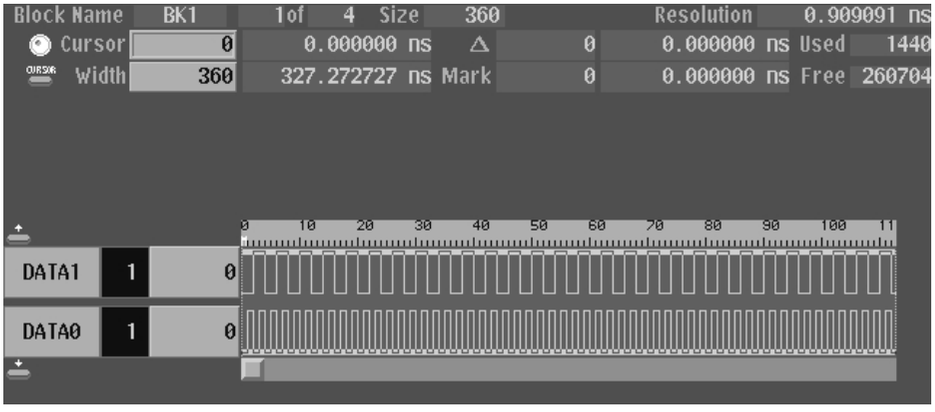


Figure 2-28: Creating a binary up-counter for block BK1

NOTE. The block 2 data is all zeros. The data can be used as is without editing.

9. Create binary down-counter data in block 3. Confirm that the knob icon appears in the **Cursor** window in the upper left area of the screen. If the icon is not in that window, move it there with the front-panel **CURSOR** button.

Menu button	Bottom button	Pop-up menu	Side button	Front-panel button
				720
				ENTER
	Execute Action	Binary down counter	OK	1
				ENTER
			OK	EXECUTE

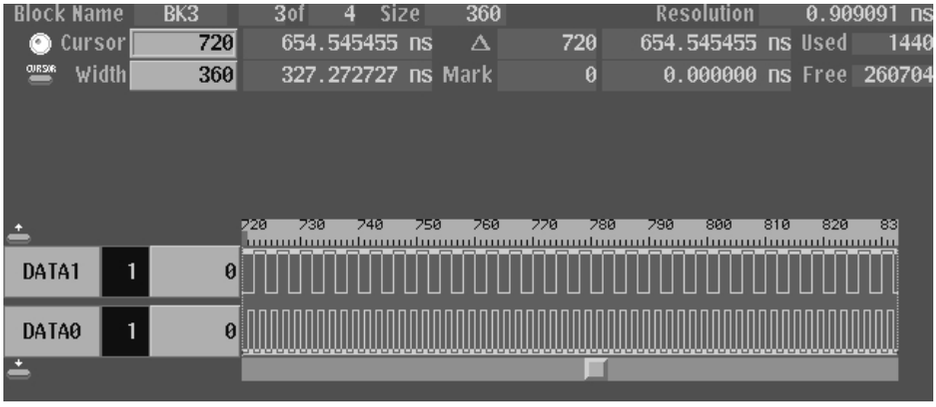


Figure 2-29: Creating a binary down-counter for block BK3

10. Create data consisting of all ones in block 4. Confirm that the knob icon appears in the **Cursor** window in the upper left area of the screen. If the icon is not in that window, move it there with the front-panel **CURSOR** button.

Menu button	Bottom button	Pop-up menu	Side button	Front-panel button
				1080
				ENTER
	Execute Action	Set data to High	OK	EXECUTE

11. Create one subsequence as shown in the example in Figure 2-30.

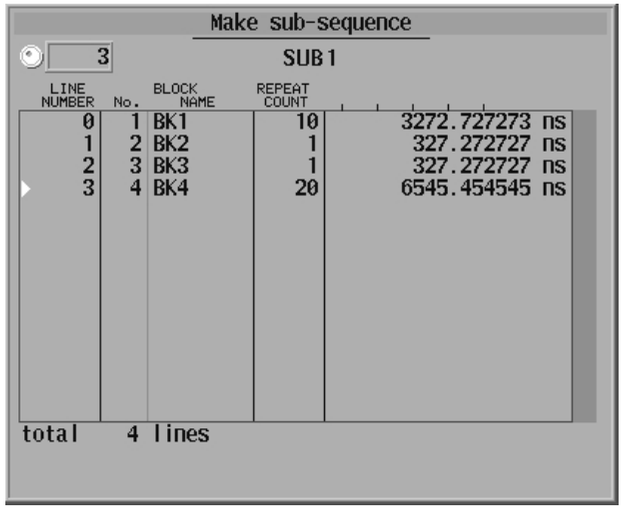


Figure 2-30: Sample subsequence

When you call the subsequence, the following outputs are made:

- The pattern in BK1 is output 10 times.
- The BK2 pattern is output once.
- The BK3 pattern is output once.
- The BK4 pattern is output 20 times.

Create a sequence as shown in Figure 2-31 and define each line as a block or subsequence. The lines defined with the subsequence are called and executed when the sequence is executed.

The lines defined with subsequences are highlighted within the BLOCK column. Refer to Figure 2-30.

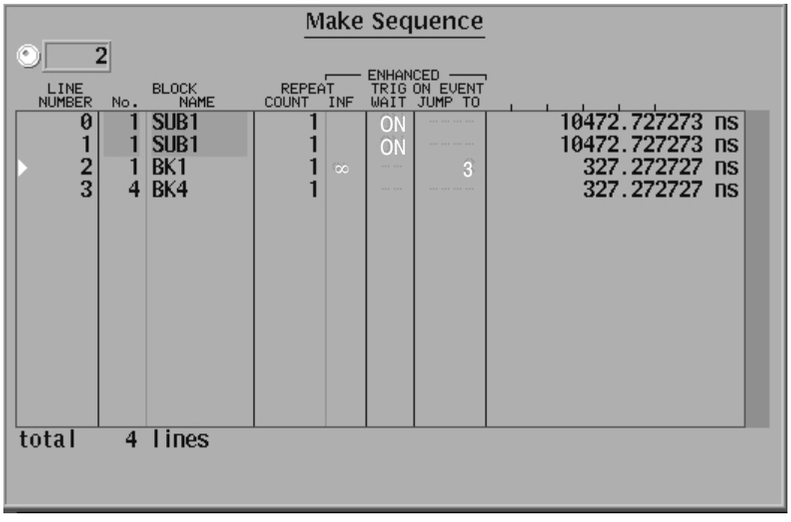


Figure 2-31: Sample sequence

The sample sequence in Figure 2-31 is performed as follows:

- **Line 0:** Wait trigger event and then call the subsequence.
- **Line 1:** Wait trigger event and then call the subsequence.
- **Line 2:** While waiting event signal, the BK1 pattern is repeatedly output. When the event condition has been satisfied, the process jumps to the line 3.
- **Line 3**: The BK4 pattern is output.

The following two steps create the subsequence:

12. Open the **Make Subsequence** pop-up menu.

Menu button	Bottom button	Pop-up menu	Side button	Front-panel button
	Make Sequence		Special	
			Edit Sub-Sequence	
			New	

13. Create the lines in the pop-up menu and assign the name SUB1 to the subsequence.

Menu button	Bottom button	pop-up menu	Side button	Front-panel button
			Insert	
Select the BK1 from the Select block pop-up menu using the front-panel knob.				
			OK	
			Repeat	10
				ENTER
With the front-panel down arrow button, advance the line pointer to the next line. See Figure 2-32.				
Using the same procedures as above, insert BK2, BK3 and BK4 into the line 1, 2 and 3, respectively, and set the repeat count to 20 for the BK4.				
			OK	
			Clear String	
		SUB1	OK	
			Go Back	
			Go Back	

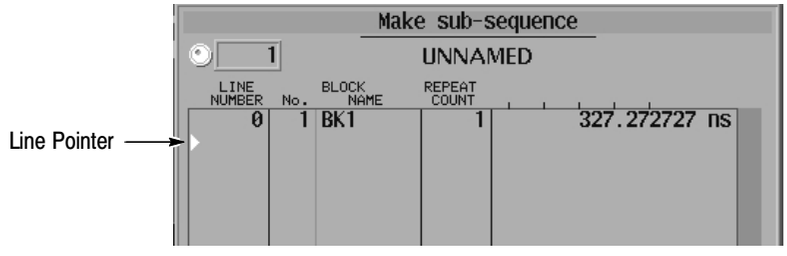


Figure 2-32: Line pointer

Do the following three steps to create the sequence:

14. Create line 0 and line 1 in the sequence.

Menu button	Bottom button	Pop-up menu	Side button	Front-panel button
			Insert	
Select the SUB1 from the Select block and Sub-sequence pop-up menu using the front-panel knob.				
			OK	
			Set Enhanced Control	
			Trig Wait (Set to On)	
			Go Back	
With the front-panel down arrow button, advance the line pointer to the next line.				
Using above procedures, insert SUB1 into the line 1 and set the Trig Wait.				

15. Create line 2 and line 3. Note that you cannot set the jump address (line number) that has not been created. The jump condition is set in step.

Menu button	Bottom button	pop-up menu	Side button	Front-panel button
			Insert	
Select the BK1 from the Select block and Sub-sequence pop-up menu using the front-panel knob.				
			OK	
			Set Enhanced Control	
			Repeat (Set to Infinite)	
			Go Back	
With the front-panel down arrow button, advance the line pointer to the next line.				
Using above procedures, insert BK4 into the line 3.				

16. Create line 3 and then terminate the editing.

Menu button	Bottom button	pop-up menu	Side button	Front-panel button
With the front-panel up arrow button, move the line pointer back to the line 2.				
			Set Enhanced Control	
			Event Jump (Set to On)	
			Jump to	3
				ENTER
			Go Back	

The following two steps set the trigger and run mode for output.

17. Set the trigger source to external and the trigger interval to off.

Menu button	Bottom button	pop-up menu	Side button	Front-panel button
SETUP	Trigger		Source (Set to Ext)	
			Interval	
			State (Set to Off)	
			Go Back	

18. Set the run mode to Enhanced.

Menu button	Bottom button	pop-up menu	Side button	Front-panel button
	Run Mode		Enhanced	

***NOTE**. When the run mode is set to Enhanced, the displayed settings in the **ENHANCED** columns of the Make Sequence menu become gray. See Figure 2-33.*

19. Output the sequence and observe the pattern using an oscilloscope. Refer to Figure 2-25 on page 2-36 for the connections between the DG2040 Data Generator and the oscilloscope.

Press **START/STOP** button on the front-panel to start the output. The message, **Waiting for Trigger**, is displayed in the upper right part of the screen.

The first two lines in the sequence wait for a trigger event. Press the **FORCE TRIGGER** button on the front-panel to generate the trigger event.

The sequence in line 2 outputs the BK1 pattern repeatedly until the event condition is satisfied. Press the **STEP/EVENT** button on the front-panel to quit the loop and to advance to sequence line 3.

In Enhanced mode, the entire sequence is repeatedly output. So the message *Waiting for Trigger* is displayed again and again until you press the **START/STOP** button on the front-panel.

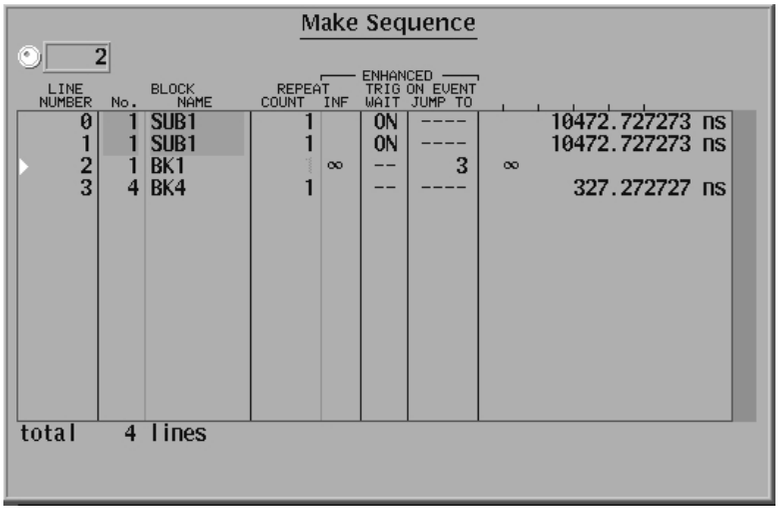


Figure 2-33: Sample sequence

20. Exit sequence creation mode and save the data in a file. Name the file SEQ1.

Menu button	Bottom button	pop-up menu	Side button	Front-panel button
Insert a formatted 3.5 inch floppy disk into the 3.5 inch floppy disk drive.				
	File		Save Data & Setup	

Menu button	Bottom button	pop-up menu	Side button	Front-panel button
			Clear String	
		SEQ1	OK	

The file called SEQ1.PDA is created. If a file of the same name already exists, a message asking if that file should be overwritten will be displayed. Press **OK** once more if that message is displayed.

Tutorial 5: Controlling Pattern Edges

The instrument has a function to move the specified pattern edges within the range of ±100 ps relative to the original position. You can specify the pattern edge(s) in the DATA0 by using the DATA1 pattern.

In the following procedures, you create the pattern in the DATA0 as shown in Figure 2-34, in which the highlighted edges are controlled and moved.

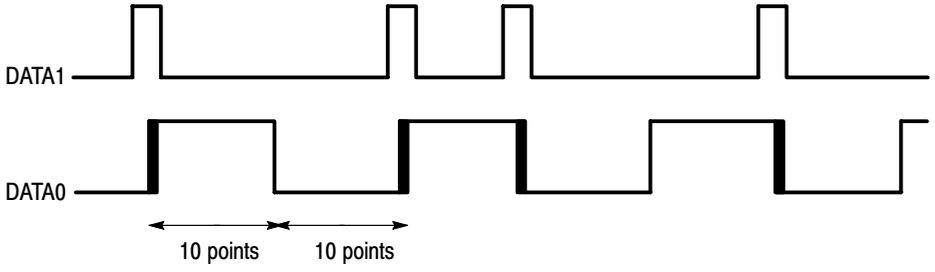


Figure 2-34: Pattern and edges to be controlled in the DATA0

To specify those edges to be controlled, you also create the pattern in the DATA1 as shown in Figure 2-34.

1. Follow the steps below to create a pattern in the DATA0.

   a. Reset to factory setting.

Menu button	Bottom button	pop-up menu	Side button	Front-panel button
UTILITY	System		Reset to Factory	
			OK	

b. Set the clock pattern.

Menu button	Bottom button	pop-up menu	Side button	Front-panel button
EDIT	Enhanced Action	Clock Pattern		
			OK	
		Low Data (Set 10)		
Select High Data by pressing the front-panel up and down arrow buttons.				
		High Data (Set 10)		
			OK	

2. Create a pattern in the DATA1.

Menu button	Bottom button	Popup menu	Side button	Front panel button
Select **DATA1** by pressing the front panel up and down arrow buttons.				
	Execute Action	Numeric input	OK	
			OK	EXECUTE
Move cursor to point 9.				
				1
Move cursor to point 29.				
				1
Move cursor to point 39.				
				1
Move cursor to point 49.				
				1

3. Set the instrument edge control to On.

Menu button	Bottom button	pop-up menu	Side button	Front-panel button
APPLICATION	Edge Control		Edge Ctrl (Select On.)	
Press **EDIT** button to display edit screen.				

The edges to be controlled are highlighted. Figure 2-35 shows the created patterns and highlighted edges.

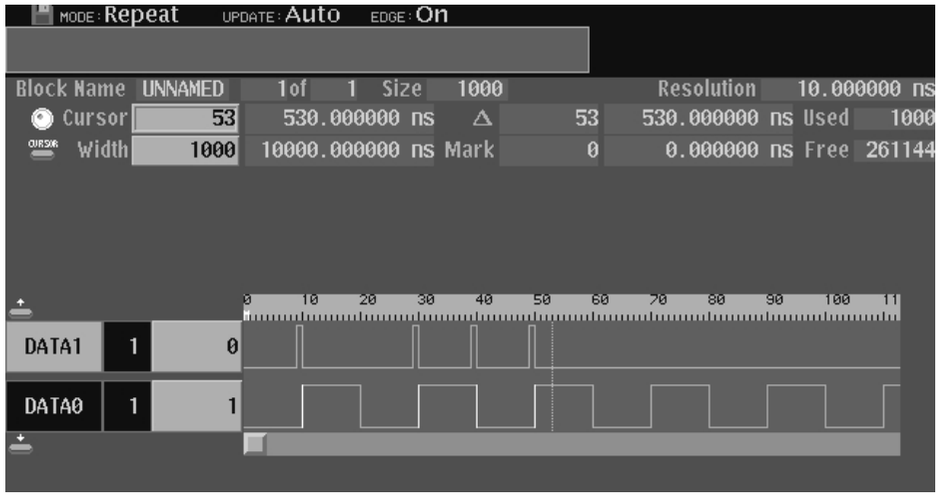


Figure 2-35: Created pattern and highlighted edges

Follow the steps below to change the edge position:

4. Connect the DG2040 to the oscilloscope. Refer to Figure 2-25 on page 2-36.
5. Press the **START/STOP** button on the front-panel to start output.
6. Set the trigger to CH2 in the oscilloscope. Adjust the oscilloscope setting to display the DATA0 pattern output.
7. Change the edge position.

Menu button	Bottom button	pop-up menu	Side button	Front-panel button
APPLICATION	Edge Control		Position Offset	

8. Change the edge position with the general-purpose knob. Use the oscilloscope to verify that the edge was moved.

For example, when an output signal has been input from a function generator (Tektronix AFG310) to the EDGE CONTROL INPUT on the DG2040 front panel, you can continuously change the specified edge position.

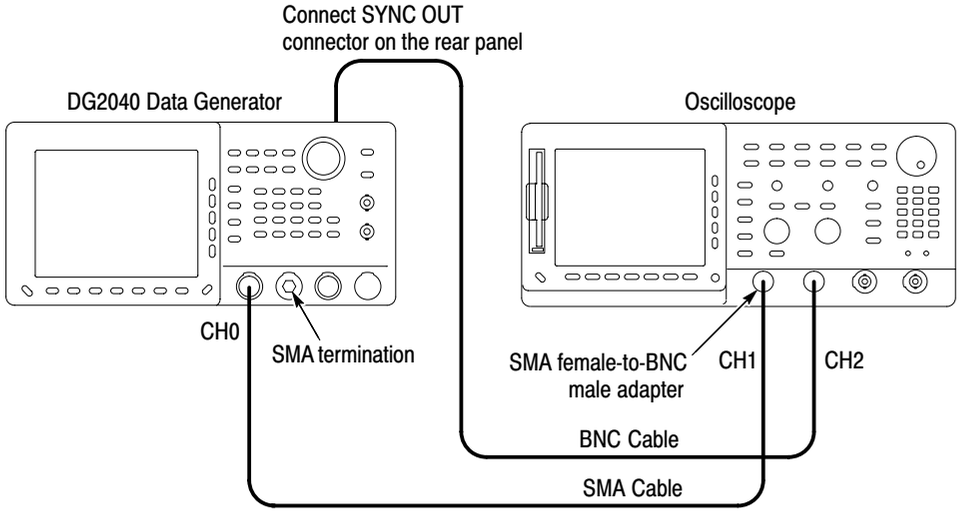


Figure 2-36: DG2040 and oscilloscope connection

Reference

Reference

This section provides the following information:

- Description of the Edit, Setup, Application, and Utility menus.
- Procedures for editing pattern data and creating sequences.
- Procedures for defining groups, setting up channels, setting operating modes, and triggers.
- Procedures for setting and saving instrument settings.

Edit Menu Screen

This section describes the **EDIT** menu screen shown in Figure 3-1. Table 3-1 provides a description and page number references.

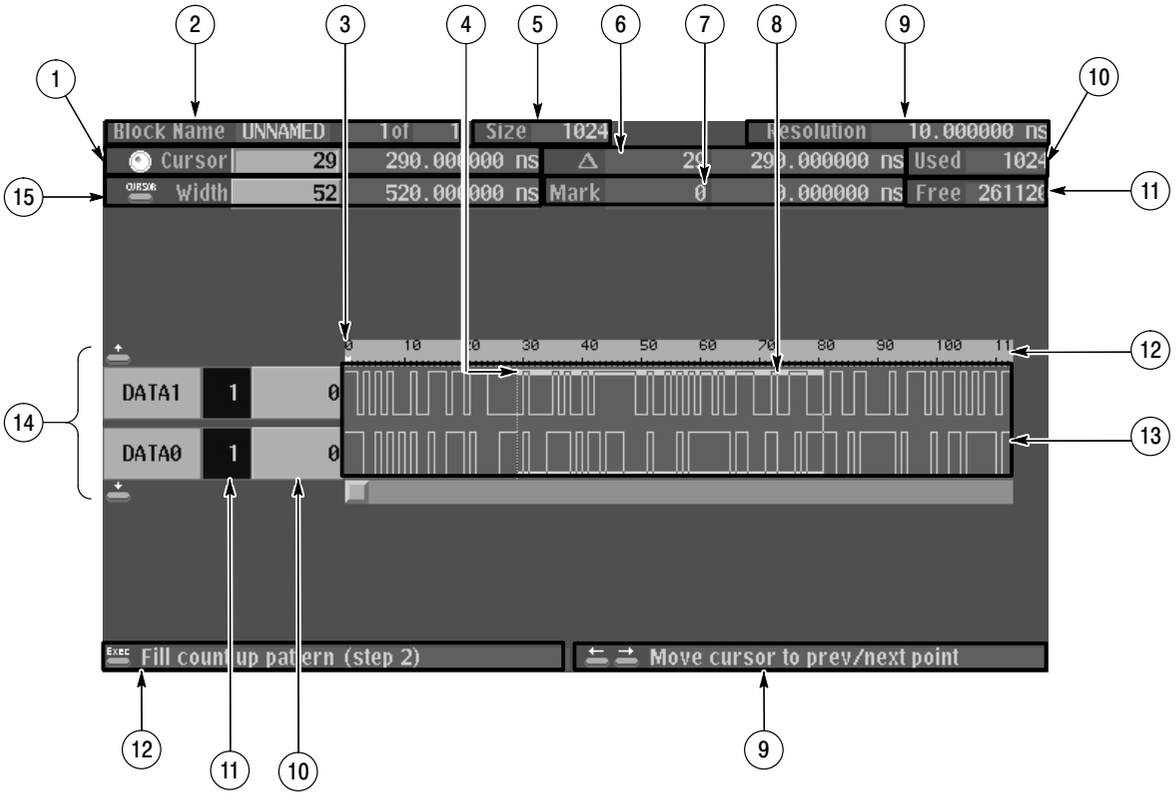


Figure 3-1: EDIT menu (timing display)

Table 3-1: Edit menu display

Screen Reference	Function	Page
1	Displays the point position of the cursor pointer, and the time from the start of the data. When the knob icon is displayed at the left edge, the cursor can be moved with the general purpose knob.	3-1 and 2-23
2	The block name. Also the adjacent area is used to display the position of the current block with respect to the total number of blocks. There is only one block in the example shown in the figure, and currently the block UNNAMED is being displayed.	3-1 and 3-28
3	Displays a **M** to mark the position of the reference.	3-1 and 3-19
4	The cursor	3-1 and 2-23
5	Displays the memory size of the block at the cursor position.	3-1 and 3-19
6	Displays the difference between the reference mark (3) and the cursor as a number of points and also as a time.	3-1 and 3-19
7	Displays the position of the reference mark (3) as a point value and as a time.	3-1 and 3-19
8	The area cursor. The area enclosed by this cursor is the object of the execute action editing operations. The area is set by the **Set scope** (vertical) in the **Execute Action** menu and **Width** (horizontal) items.	3-1 and 2-23
9	Displays the time per point.	3-1
10	Displays the total memory size for all blocks.	3-1
11	Displays the size of the remaining available memory.	3-1
12	A scale which shows point positions.	3-1
13	Display area for the pattern data.	3-1
14	Describes the current action of the arrow buttons.	3-21
15	Displays the value of the data at the cursor position (4).	3-1
16	Displays the number of bits in the data bit group.	3-1
17	Describes the function of the front panel **EXECUTE** button. Pressing the **EXECUTE** button executes the editing function for the indicated cursor position or area.	3-32
18	Indicates the data bits or the data bit groups. Data bits that are set up to be the object of editing operations are displayed at a higher intensity (bright).	3-1
19	Displays the width of the area cursor as a number of points and as a time.	3-1

Menu Trees

Menu trees are shown for the **EDIT**, **SETUP**, **APPLICATION,** and **UTILITY** menus.

Edit Menu Tree

Figure 3-2 shows the bottom and side or pop-up menus associated with the Edit menu.

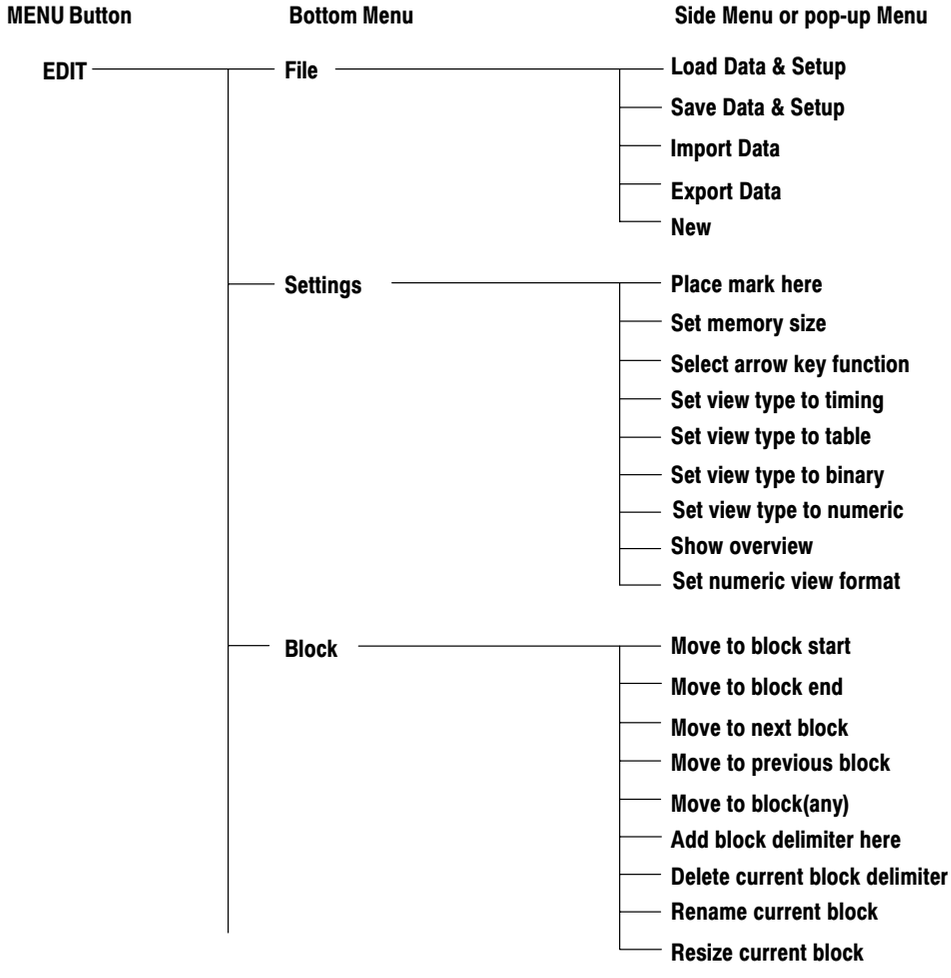


Figure 3-2: Edit Menu tree

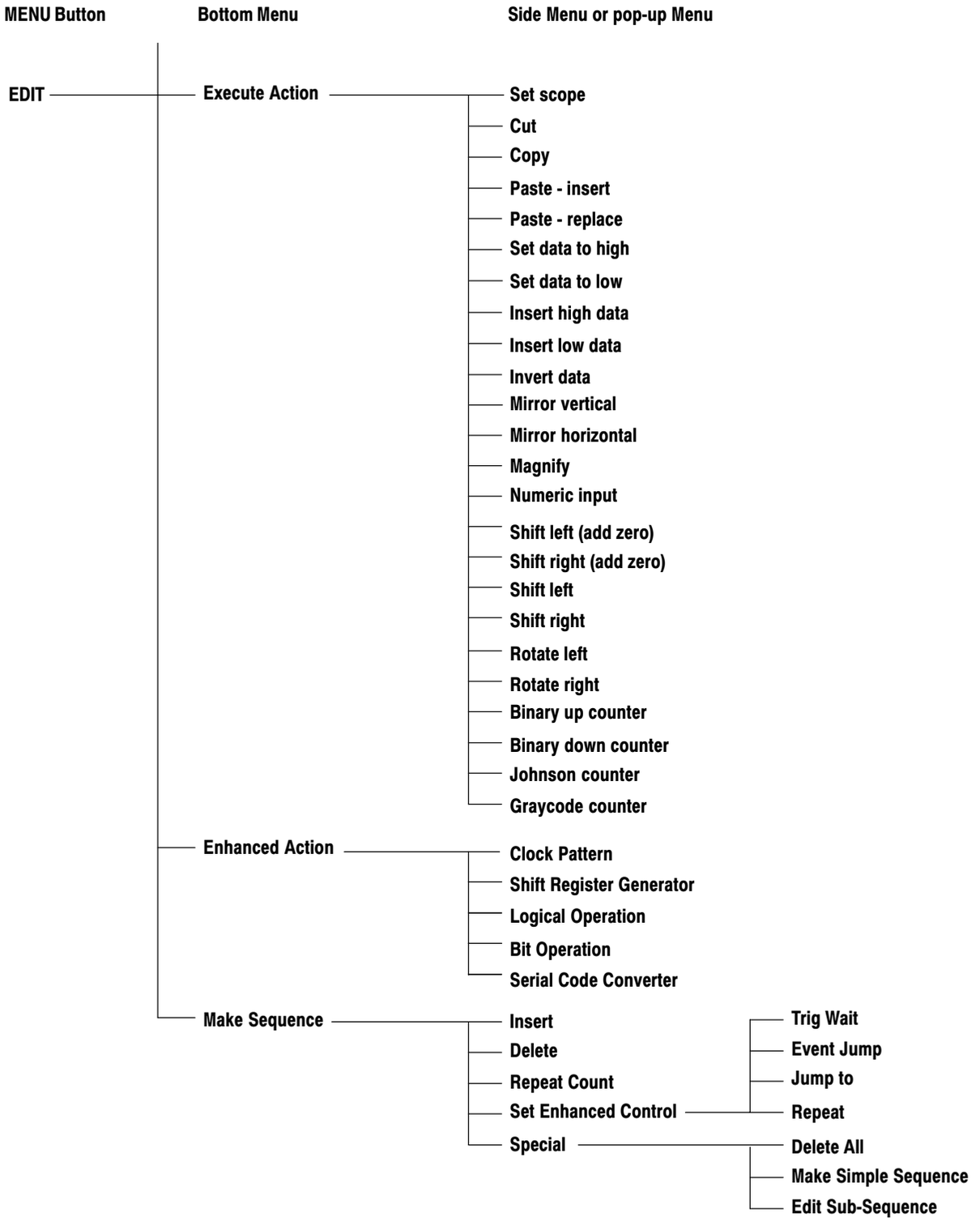


Figure 3-2: Edit Menu tree (cont)

Setup Menu Tree

Figure 3-3 shows the bottom and side menus associated with the Setup menu.

Figure 3-3: Setup Menu tree

Application Menu Tree

Figure 3-4 shows the bottom and side menus associated with the Application menu.

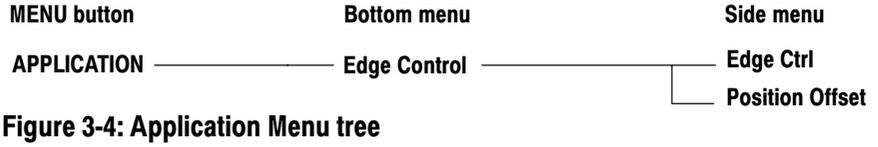


Figure 3-4: Application Menu tree

Utility Menu Tree

Figure 3-5 shows the bottom and side menus associated with the Utility menu.

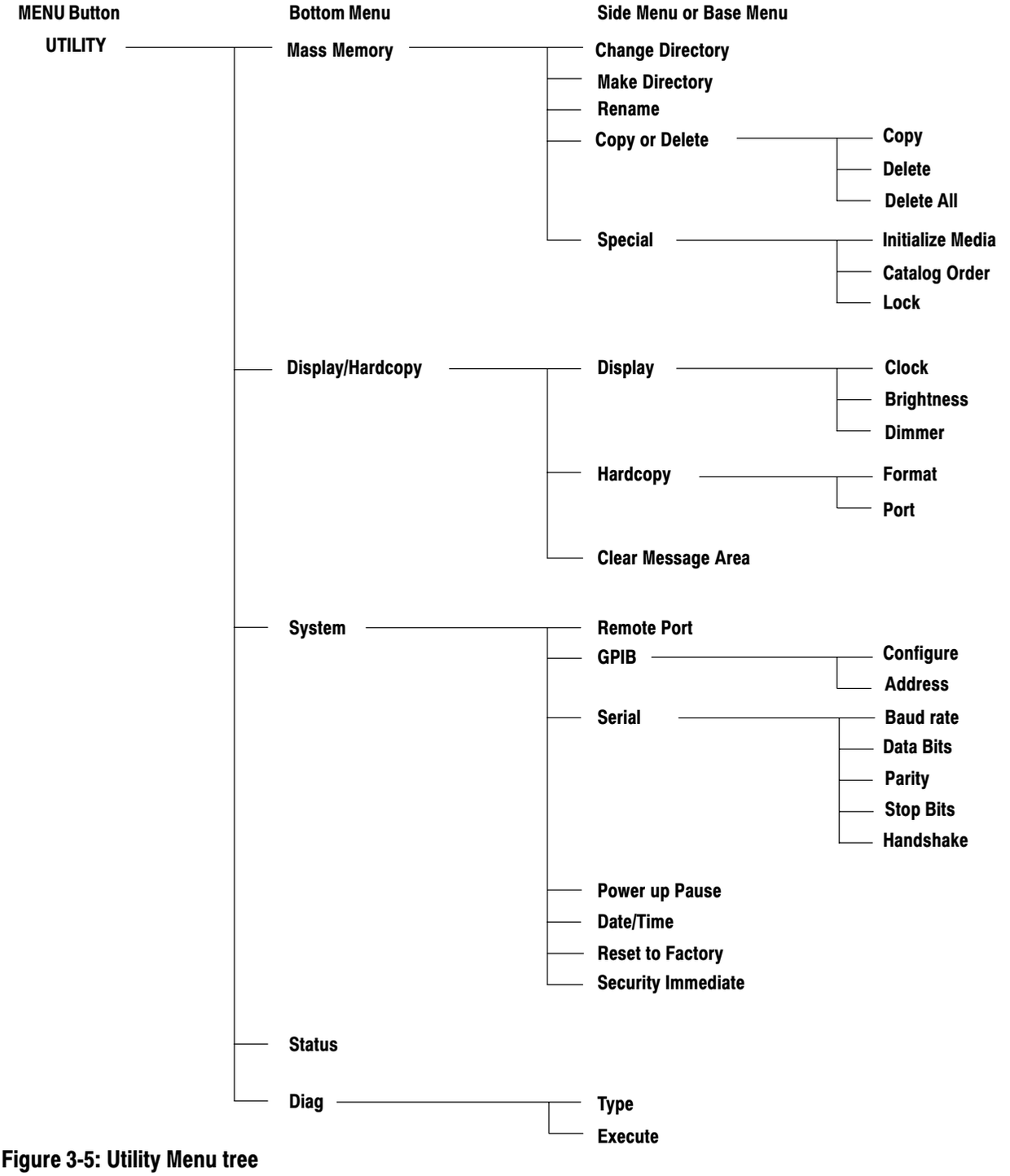


Figure 3-5: Utility Menu tree

Edit Menu Functions

Table 3-2 lists the functions of the **EDIT** menu items and the pages where their documentation appears.

Table 3-2: EDIT menu functions

Bottom	Base or side menu	Function	Page
File	Load Data & Setup	Loading pattern data and setup parameters	3-9
	Save Data & Setup	Saving pattern data and setup parameters	3-9
	Import Data	Loading pattern data from mass memory	3-10
	Export Data	Writing pattern data to mass memory	3-15
	New	Initialization for data creation	3-18
Settings	Place mark here	Setting the reference mark	3-19
	Set memory size	Setting the memory size	3-19
	Select arrow key function	Setting the operation of the arrow buttons	3-20
	Set view type to timing	Setting the pattern data display format	3-22
	Set view type to table		
	Set view type to binary		
	Set view type to numeric		
	Show overview	Setting the pattern data display format	
	Set numeric view format	Setting the numeric view format	3-27
Block	Move to block start	Moving the cursor for the block	3-28
	Move to block end		
	Move to next block		
	Move to previous block		
	Move to block(any)		
	Add block delimiter here	Delimiting blocks	3-29
	Delete current block delimiter	Combining blocks	3-30
	Rename current block	Changing a block name	3-31
	Resize current block	Changing the size of a block	3-31

Table 3-2: EDIT menu functions (Cont.)

Bottom	Base or side menu	Function	Page
Execute Action	Set scope	Setting the scope	3-34
	Cut	Deleting pattern data	3-35
	Copy	Copying pattern data	3-35
	Paste - insert	Pasting (inserting) pattern data	3-35
	Paste - replace	Pasting (replacing) pattern data	3-36
	Set data to high	Setting pattern data to high	3-36
	Set data to low	Setting pattern data to low	3-36
	Insert high data	Inserting high data	3-37
	Insert low data	Inserting low data	3-37
	Invert data	Inverting data	3-37
	Mirror vertical	Swapping pattern data in the vertical direction	3-38
	Mirror horizontal	Swapping pattern data in the horizontal direction	3-39
	Magnify	Magnifying pattern data	3-39
	Numeric input	Inputting pattern data numerically	3-39
	Shift left (add zero) or Shift right (add zero)	Shifting pattern data left or right by inserting zeros	3-40
	Shift left or Shift right	Shifting pattern data left or right	3-41
	Shift up (add zero) or Shift down (add zero)	Shifting pattern data up or down by inserting zeros	3-40
	Shift left or Shift right	Shifting pattern data left or right	3-40
	Rotate left or Rotate right	Rotating pattern data left or right	3-43
	Rotate up or Rotate down	Rotating pattern data up or down	3-43
	Binary up counter	Creating standard pattern data	3-44
	Binary down counter		
	Johnson counter		
	Graycode counter		
Enhanced Action	Clock Pattern	Clock pattern generation	3-45
	Shift Register Generator	Pseudorandom pulse generation	3-47
	Logical Operation	Logical operations between pattern data items	3-50
	Bit Operation	Moving or copying pattern data	3-52
	Serial Code Converter	Serial code data conversion	3-53

Table 3-2: EDIT menu functions (Cont.)

Bottom	Base or side menu	Function	Page
Make Sequence	Insert	Sequence definition	3-58
	Delete		3-59
	Repeat Count		3-59
	Set Enhanced Control		3-59
	Special		3-60
Undo		Cancel the latest operation and restore the previous setting	3-63

File Menu

This subsection contains information on the bottom menu functions for the Edit Menu.

The File menu saves and loads data between the instruments internal memory and mass memory (3.5 inch floppy disk). When the **File** bottom menu item is selected, a side menu with **Load Data & Setup**, **Save Data & Setup**, **Import**, **Export**, and **New** items is displayed.

Load Data & Setup

The Load Data & Setup function reads format pattern data, block, group, sequence and setup data into the instruments internal memory from mass memory (3.5 inch floppy disk).

The DG2040 Data Generator can read data created and stored from the DG2000 series. The DG2040 will use the pattern data in the lower 2 bits. Also, the DG2040 Data Generator can read DG2000 series setup information except for those settings that are not common to both platforms.

Submenu

Item	Function
Change Directory	Changes the current directory.

Operation. Do the following to load the pattern data and setup parameters.

Bottom button	Pop-up menu	Side button
Insert a 3.5 inch floppy disk in the floppy disk drive.		
File		Load Data & Setup
	Select the file to be loaded.	OK

Save Data & Setup

The Save Data & Setup functions stores the pattern data, block, group, sequence and setup data from the instruments internal memory to mass memory (3.5 inch floppy disk) in the DG2040 Data Generator format.

Submenu

Item	Function
Clear String	Deletes the current displayed string.
Change Directory	Changes the current directory.

Operation Do the following to save the pattern data and setup parameters:

Bottom button	Pop-up menu	Side button
Insert a write-enabled 3.5 inch floppy disk in the floppy disk drive.		
File		Save Data & Setup
	Enter the file name for the data to be saved.	OK

Import

The Import function loads the pattern data from mass memory (3.5 inch floppy disk) into pattern memory. The DG2040 can read the following data formats:

- Tektronix TDS series waveform data (file extension: .WFM)
- Tektronix TLS series group data (file extension: .GRP)
- Tektronix AWG2000 series waveform data (file extension: .WFM)
- Tektronix DG2000-Series and DG2040 Data Generator waveform data (file extension: .PDA)
- CSV format data (file extension: .CSV). Refer to page 3-13 for instructions regarding formatting data in a CSV format.

Pop-up menu parameter settings are used to specify the read-in method.

Operation. Do the following to import pattern data from mass memory.

Bottom button	Pop-up menu	Side button
Insert the 3.5 inch floppy disk in the drive.		
File		Import Data
	Select the file to be read in.	OK
	Change the parameters as required.	OK

Pop-up Menu. Figure 3-6 shows the data read-in configuration window. The parameters that appear in this window differ depending on which data format was read in.

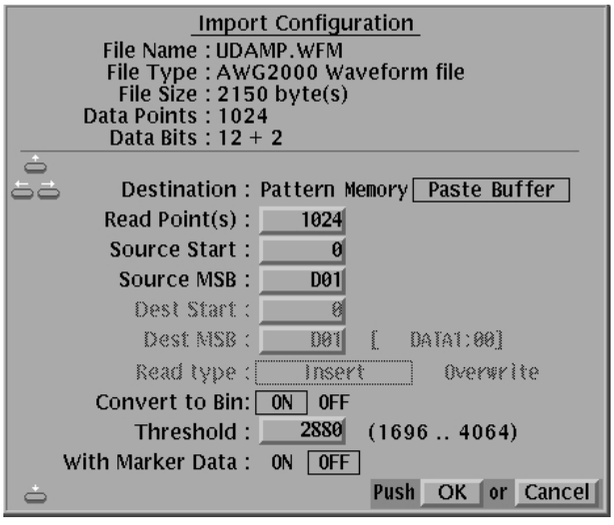


Figure 3-6: Import Configuration Menu (File format: AWG2000 series waveform file)

Table 3-3 describes the input parameters.

Table 3-3: Import parameters

Parameter	Function
Destination	Sets the place where the read-in data is to be written. Either Pattern memory or the Paste buffer can be selected. If data is read into the paste buffer, data can be pasted to the data bit specified by the Paste item in the Execute Action menu.
Read Point(s)	Sets the number of data points to be read. Data in excess of the specified memory size cannot be read in.
Source Start	Specifies the starting position from which the data is read in from the file.
Source MSB	Specifies the position of the MSB from which data in the file will be read.
Dest Start	Specifies the position which data is read in when pattern memory is the destination.
Dest MSB	Specifies the position of the MSB to which data will be written when pattern memory is the destination.
Read type	Sets the data read-in method when pattern memory is the destination. Either Insert or Overwrite can be selected.

Table 3-3: Import parameters (Cont.)

Parameter	Function
Convert to Bin	When this setting is set to ON, the waveform is compared to a threshold level and the data is converted to binary. RP binary data from the Tektronix TDS and TLS series products are read in as RI data. The data cannot be converted to binary data if it is left in the RP state.
Threshold	Sets the threshold level used to convert read-in data to binary when the Convert to Bin parameter is set to ON.
With Marker Data	Sets whether or not marker data is read, in addition to waveform data, for Tektronix AWG2000 series waveform file format data.

Figures 3-7 and 3-8 show the data write operations in terms of point positions and data bit positions when pattern memory is the write destination.

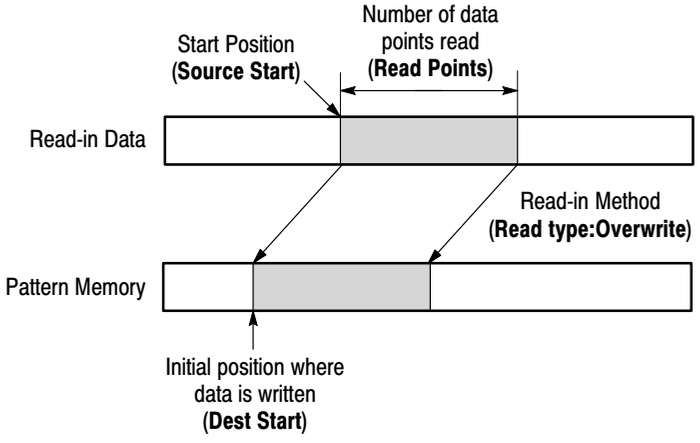


Figure 3-7: Data write in terms of point positions

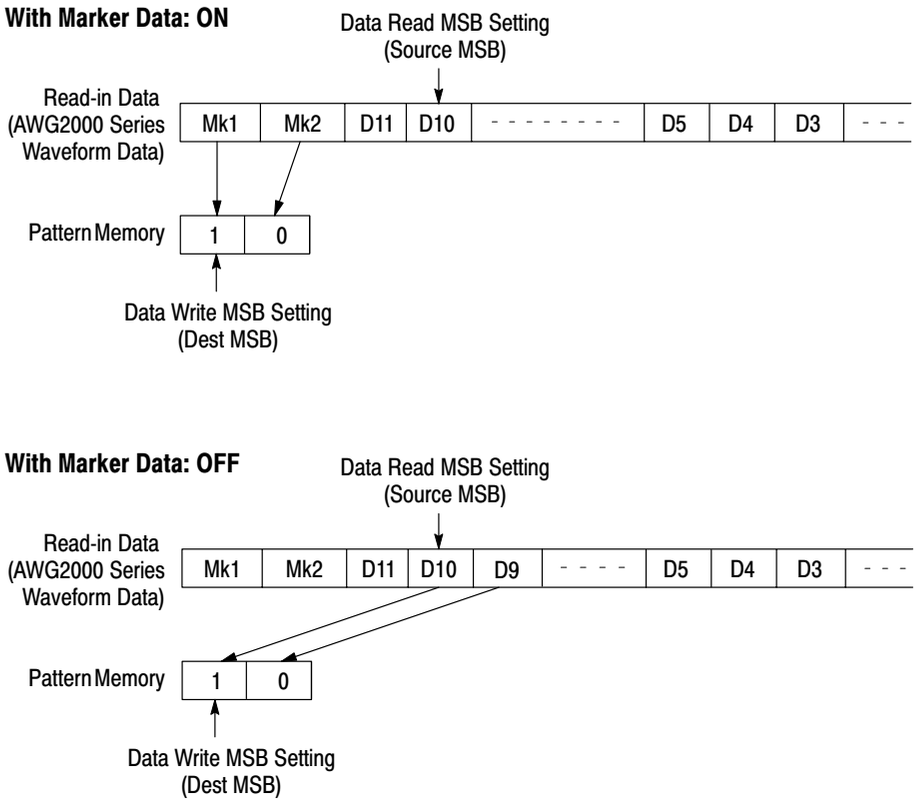


Figure 3-8: Data write in terms of data bit positions

CSV Data Format

The DG2040 Data Generator can import vector data from the built-in floppy drive using a simple ASCII Comma Separated Variable (CSV) format. This section defines how the data is formatted for importing into the DG2040 Data Generator. The CSV format is defined as follows:

<1DB0><Comma><1DB1><Comma>.....<1DBx><CR>	! The number of bits (x) defines the width of the pattern
<2DB0><Comma><2DB1><Comma>.....<2DBx><CR>	! Second word
... ...	
<yDB0><Comma><yDB1><Comma>.....<yDBx><CR>	! The number of lines (y) defines the depth of the pattern

When formatting data in the CSV format, note the following:

- Each data byte is defined by the ASCII character: zero <0>, ASCII 48 or one <1>, ASCII 49

- Each data byte is separated by the ASCII character: comma <,> (ASCII 44), space (ASCII 32), or TAB (ASCII 9)
- Each line is terminated with the ASCII character: carriage return <CR>, ASCII 13
- The number of bits in a line defines the word width. For example, if the first line consists of pattern: 1,0,1,1 then the word width is 4-bits wide
- For Importing, the specified 2 bit wide data can be imported. For Exporting , the specified one bit or two bits can be exported to a file.
- The number of lines in the file defines the number of words in the pattern. For example, 10 lines defines 10 data words.
- The DG2040 Data Generator CSV format file is a DOS-compatible file formatted as defined above with a .CSV file extension.

CSV Format Example. To export a 2-bit pattern that is 3 words long, create the following data, as an example, and save it using filename: PATTERN.CSV. This can be created using a spreadsheet program, a text editor, or a custom filter program to convert data from one format to another.

1,1<CR>
0,1<CR>
0,0<CR>

NOTE. *Bit pattern data must have at least 360 words. The above pattern data cannot be read into the DG2040 Data Generator. Note that this is a simple example.*

Once the data words have been imported, parameters including clock rate, output levels and interchannel timing need to be set since the CSV format does not transfer this information. After all operating parameters have been set, the entire pattern can be stored on a floppy for nonvolatile storage. The entire pattern will fit on one floppy since the DG2040 Data Generator uses an instrument specific binary format that is more compact than ASCII format.

Importing Large Data Files. It may be possible to create a large CSV file. Depending on what kind of operation is currently performed, the DG2040 Data Generator may not allocate the internal work space for creating CSV format data larger than 128 K words. An extreme example is a 2-bit wide word pattern that has 262144 (256 K) words. For the data to fit into the work space and onto a 3.5 inch floppy disk capacity, the pattern must be segmented into 128 K (131072 words) blocks and saved to a separate 3.5 inch floppy disks. To import the data do the following:

1. Insert the 3.5 inch floppy disk with the first 128 K words into the drive.
2. Select **File → Import Data** and select a file to be imported.
3. Press the **OK** button. The Import Configuration pop-up menu appears. This menu allows you to configure how the data will be imported. In this example, only the **Dest Start** point will be modified.
4. Set the **Dest Start** point to zero for the first 3.5 inch floppy disk.
5. Set the **Dest Start** point to 65536 for the second 3.5 inch floppy disk.
6. Set the **Dest Start** point to 131072 for the third 3.5 inch floppy disk.
7. Repeat the steps above changing the **Dest Start** point until the data from the last 3.5 inch floppy disk is read.

Once the data words have been imported, parameters including clock rate, output levels, and interchange timing need to be set, since the CSV format does not transfer this information.

Export

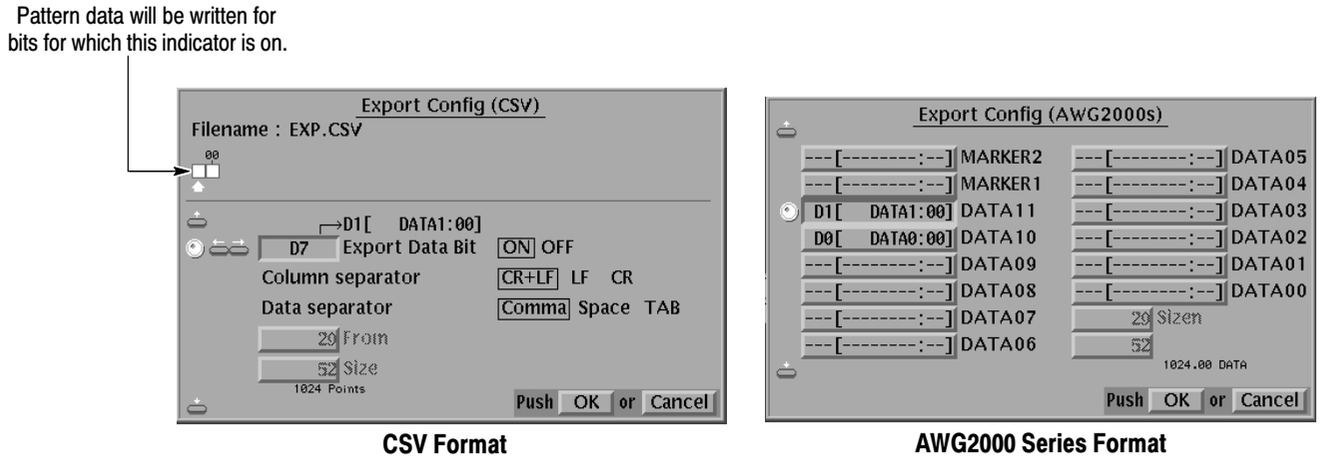
The **Export** function writes pattern data to mass memory (3.5 inch floppy disk). Data is written either as CSV data or as Tektronix AWG2000-Series waveform data. The write method is specified by setting a parameter in a pop-up menu.

***NOTE**. Icon data and hardware setup data are not saved in the output AWG2000 Series waveform data. When this data is read in to an AWG2000 Series instrument, default setup data will be added. PCs and some other systems may not be able to read this data directly.*

Operation. Do the following to write pattern data to mass memory.

Bottom button	Pop-up menu	Side button
Insert a write-enabled 3.5 inch floppy disk in the floppy disk drive.		
File		Export Data
	Select the format of the data to be written (either CSV data or AWG2000s Waveform data).	OK
	Enter the file name for the data to be written.	OK
	Change the parameters as required.	OK

Pop-up Menu. Figure 3-9 shows the configuration windows for the two formats.



CSV Format **AWG2000 Series Format**

Figure 3-9: The Export Config menu

When CSV format is selected, the instrument displays a menu for selecting which bits should be written to the file, delimiter symbols, and other parameters. Table 3-4 describes the parameter items that are set using this menu.

Table 3-4: Export parameters

Parameter	Function
Export Data Bit	Specifies the data bits to be written to the pattern data. Bits for which this indicator is on are written. Bits can be selected using the general purpose knob, and the on/off state can be changed with the left and right arrow buttons. Consecutive bits can be turned on or off using the 1 and 0 numeric keys.
Column separator	Sets the line separator symbol. The delimiter symbols are usually used as follows: CR+LF: MS-DOS and Windows LF: UNIX CR: Macintosh
Data separator	Sets the interbit delimiter. Comma, space, or tab can be selected for this parameter. Comma is the most common setting.
From	This field is valid when Entered is specified for the Region in the submenu. It specifies the starting position for the data written.
Size	This field is valid when Entered is specified for the Region in the submenu. It specifies the number of data points written.

When the AWG2000 Series format is selected, a menu that allocates data for a total of 14 bits, **MARKER 1** and **2** and **DATA00** to **DATA11**, is displayed. Use the arrow buttons to select the AWG2000 Series bit and use the general purpose knob to allocate the DG2040 Data Generator bit. Allocate all bits to be written by repeating this operation.

Submenu

Item	Function
Set All Data bits (CSV only)	Sets the data bit write settings for all data bits.
Clear All Data bits (CSV only)	Clears the data bit write settings for all data bits.
Region	When this setting is set to All, the whole data area is written, and when it is set to Entered, the data in the area specified by From and Size is written.

Exporting Large Data. The DG2040 Data Generator's internal memory capacity can not export a 2-bit wide pattern data in CSV format that is larger than 131072 (128 K) words. The data that is to be written onto a 3.5 inch floppy disk must have the pattern segmented into 128 K (131072 words) blocks and saved to separate 3.5 inch floppy disks.

To import large data files, do the following:

1. Insert a 3.5 inch floppy disk into the drive.
2. Select the **File → Export Data** to display Export Data Format pop-up menu.
3. Select **CSV data** and then press the **OK** side button.
4. Enter a file name and then press the **OK** side button. The Export Config (CSV) pop-up menu appears. This menu allows you to configure how the data will be exported. In this example, only the **Size** and **From** will be modified.
5. Confirm that the **Region** is set to **Entered**. If it is not set correctly, press the **Region** side button to set to **Entered**.
6. Enter 0 into the **From** and 131072 into the **Size**, and then press the **OK** side button.
7. Repeat the procedures from Step 2 through Step 6, changing the file name and incrementing **From** point by 131072 until all pattern data are stored into 3.5 inch floppy disks. Note that two blocks of 32 K word pattern data in the CSV format can be stored in a 3.5-inch 2HD floppy disk.

New

The **New** function initializes all data, including the pattern data, the block divisions, and the sequence data to the default state.

Operation. Do the following to initialize for pattern data creation:.

Bottom button	Pop-up menu	Side button
File		New
		OK

Settings Menu

The settings menu sets all the **EDIT** menu internal settings and supports the following operations:

- Setting the reference mark
- Setting the reference group
- Setting the memory size
- Setting the arrow button operating mode
- Setting the display type (format)

The item to be set is selected from the pop-up list using the general purpose knob. Figure 3-10 shows the pop-up menu.

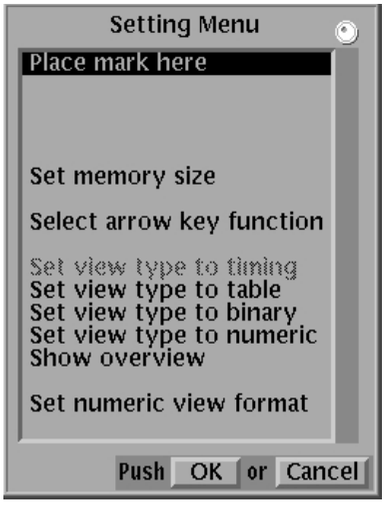


Figure 3-10: Settings pop-up menu

Place Mark Here

The **Place Mark Here** selection sets the reference mark at the current cursor position. The reference mark is displayed as an "**M**" on the point scale as shown in Figure 3-11. The interval (**Δ**) between the set reference mark and the current cursor position is displayed as a point difference and as a time difference.

The reference mark only specifies the origin of the delta display. It does not affect the pattern data definition itself.

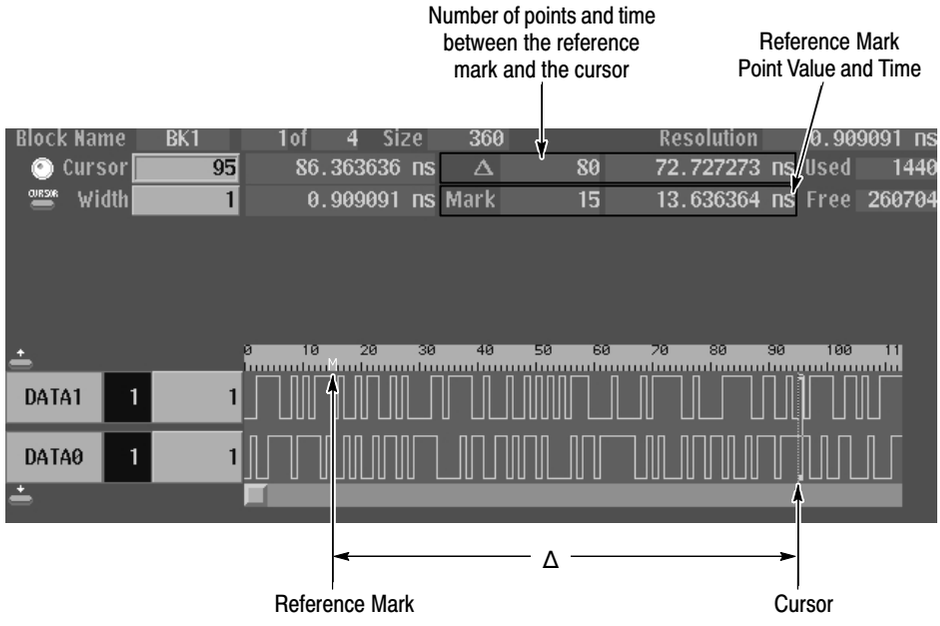


Figure 3-11: Reference mark "M" display

Operation. Do the following to set the reference mark:

Bottom button	Pop-up menu	Side button
Move the knob icon to the Cursor window in the upper left area of the screen using the up and down arrow buttons.		
Set the cursor to the reference point using the general purpose knob or the numeric keys.		
Settings	Place mark here	OK

Select Memory Size

The **Select Memory Size** function sets the pattern data memory size. The size can be set to a value in the range from 360 words to 256K (262144) words. In some cases the memory size setting is changed by operations that change the block length. Items that exceed the memory size due to editing operations are either ignored or discarded.

Operation. Do the following to set the memory size.

Bottom button	Pop-up menu	Side button
Settings	Set memory size	OK
	Set the number of points.	OK

Select Arrow Key Function

The **Select Arrow Key Function** defines the actions of the arrow buttons. The term arrow button, refers to the left and right arrow buttons for the timing display, and the up and down arrow buttons for the table and binary display. Arrow button actions include those associated with cursor movement and those associated with editing operations. Also, note that the arrow button action is sometimes changed automatically by the **Execute Action** menu functions described on page 3-32. Figure 3-12 shows an action display within the timing display.

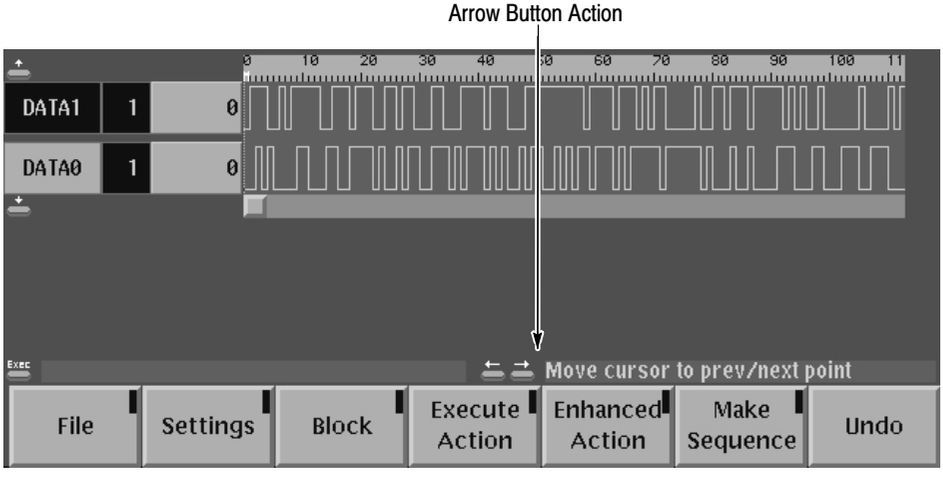


Figure 3-12: Arrow button action display (timing display)

Operation. Do the following to set the arrow button action.

Bottom button	Pop-up menu	Side button
Settings	Select arrow key function	OK
	Select the arrow button action.	OK

Pop-up Menu. Use the general purpose knob to select one of the following actions from the displayed pop-up menu. Items that currently cannot be used are not highlighted. Refer to Figure 3-13.

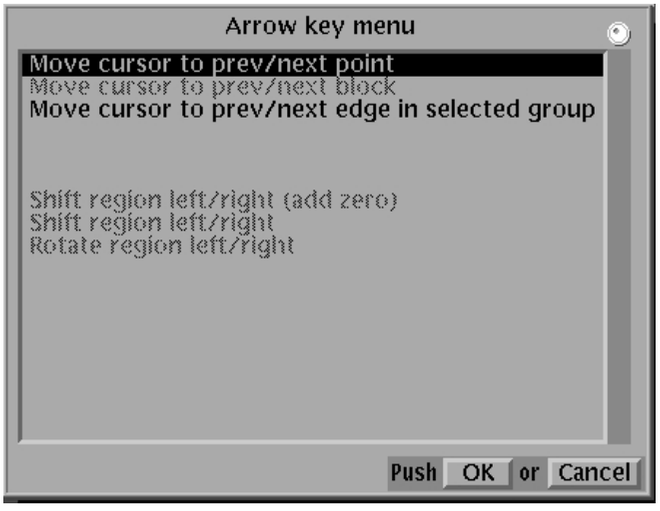


Figure 3-13: The Arrow button menu

Table 3-5: Arrow button functions

Arrow button functionality	Selection item	Description
Cursor movement	Move cursor to prev/next index	Moves the cursor to the immediately preceding or immediately following data point.
	Move cursor to prev/next block	Moves the cursor to the start of the block immediately preceding or immediately following the block where the cursor is currently located.
	Move cursor to prev/next edge in selected group	Moves the cursor to the next place in the currently selected group where the data value changes. This function cannot be used if multiple groups are selected.
Cursor movement associated with editing operations	Shift region left/right (add zero) (Timing display only) Shift region up/down (add zero) (Table, binary, and numeric display only)	The data in the edit area is shifted left (or up) or right (or down) one point at a time. See the descriptions of the Execute Action menu, on page 3-40, for the Shift region left/right (add zero) and Shift region up/down (add zero) items.
	Shift region left/right (Timing display only) Shift region up/down (Table, binary, and numeric display only)	Except for the data point at the end of the editing area, the data in the editing area is shifted left (or up) or right (or down) by 1 point at a time. See the descriptions of the Execute Action menu, on page 3-40, for the Shift region left/right and Shift region up/down items.
	Rotate region left/right (Timing display only) Rotate region up/down (Table, binary, and numeric display only)	The data in the editing area is rotated left (or up) or right (or down) by 1 point at a time. See the descriptions of the Execute Action menu, on page 3-42 for the Rotate region left/right and Rotate region up/down items.

Setting Pattern Data Display Format

The Setting Pattern Data display format is selected from the following options:

- Timing display
- Table display
- Binary display
- Numeric display
- Overview display

Table 3-6 presents descriptions and examples of the pattern data display formats.

Operation. Do the following to set the pattern data display format.

Bottom button	Pop-up menu	Side button
Settings	Select from the following items. Set view type to timing Set view type to table Set view type to binary Set view type to numeric Show overview	OK

Table 3-6: Pattern data display format

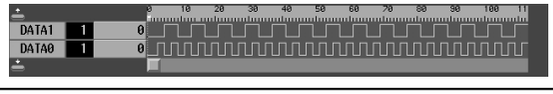
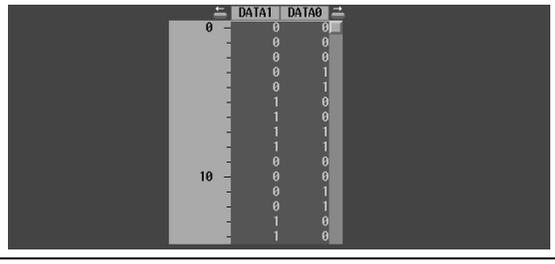
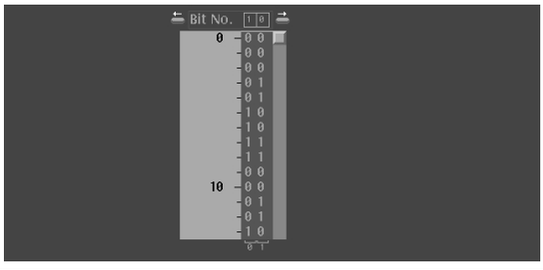
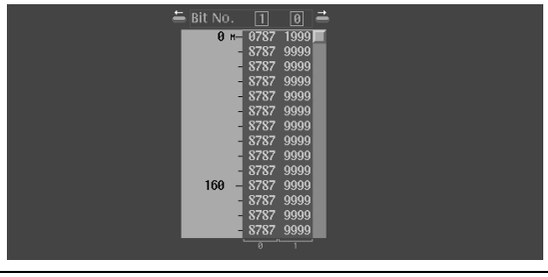
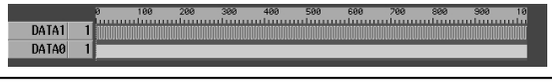
Display format menu item	Description
Set view type to timing	Sets the pattern data display method to the timing format. Hexadecimal editing is possible if groups are defined. 
Set view type to table	Sets the pattern data display method to the table format. Hexadecimal editing is possible if groups are defined. 

Table 3-6: Pattern data display format (Cont.)

Display format menu item	Description
Set view type to binary	Sets the pattern data display method to the binary format. 
Set view type to numeric	Sets the pattern data display method to the numeric format. In this format, serial data can be displayed in specified bit width. This means that you can edit parallel data in specified bit width and expand them into a channel as serial data. 
Show overview	Displays the whole pattern data on allocated memory area. Editing cannot be performed in this mode. 

Creating Pattern Data and Sequences

Pattern data can be created and edited with functions in the EDIT menu.

Pattern Data. Follow the steps below to create pattern data:

1. Set memory size with **EDIT → Settings → Set memory size**. The default memory size is 1000 words.
2. Specify work area with **EDIT → Execute Action → Set scope** and **Width** on the screen.
3. Create a pattern with the functions in **EDIT → Execute Action**.
4. Repeat step 2 and 3 until the pattern data that you want is created.

Sequence. Follow the steps below to create a sequence:

1. Create more than one block (pattern data delimited by block delimiter) on the pattern memory by doing the following:
   a. Create the pattern data using the procedures described previously in *Pattern Data*.
   b. Change the block name with **EDIT → Block → Rename current block**.
   c. Move the cursor to the data point next to the end of the pattern data by changing the value in the **Cursor** on the screen.
   d. Mark the block delimiter with **EDIT → Block → Add block delimiter here**. This creates a new block. The block must have a unique name, which you can enter at this time.
   e. Create the next block pattern using the procedures described previously in *Pattern Data*.
   f. Repeat Step c through Step e until you have created all the blocks that you need.
2. Create a sequence table by doing the following:
   a. Open the sequence editor with **EDIT → Make Sequence**.
   b. If you need, create subsequence(s) with **EDIT → Make Sequence → Special → Edit Sub-Sequence → New**.
   c. Compose the lines by inserting the blocks and/or subsequences with **EDIT → Make Sequence → Insert**.
   d. Define the control conditions in each line with **EDIT → Make Sequence → Repeat Count** and/or the functions of **EDIT → Make Sequence → Set Enhanced Control**.

Setups for Output

Do the following steps to configure the instrument hardware and set the output parameters:

1. Assign data bits (DATA0 and DATA1) to output channels (CH0 and CH1) with **SETUP → Output Condition → Assign Condition**. By default, DATA0 and DATA1 are assigned to CH0 and CH1, respectively.
2. Set the pulse high and low levels with **SETUP → Level Condition**.
3. Set the delay with **SETUP → Timing Condition**.
4. Set the output frequency with **SETUP → Clock**.

Outputting Pattern Data

Output your pattern data using the following steps:

1. Press the **START/STOP** button on the front panel to start signal output.
2. Press the **START/STOP** button again to stop output.

Figure 3-14 and 3-15 shows a typical example for operation flow from creating and editing pattern data to outputting it.

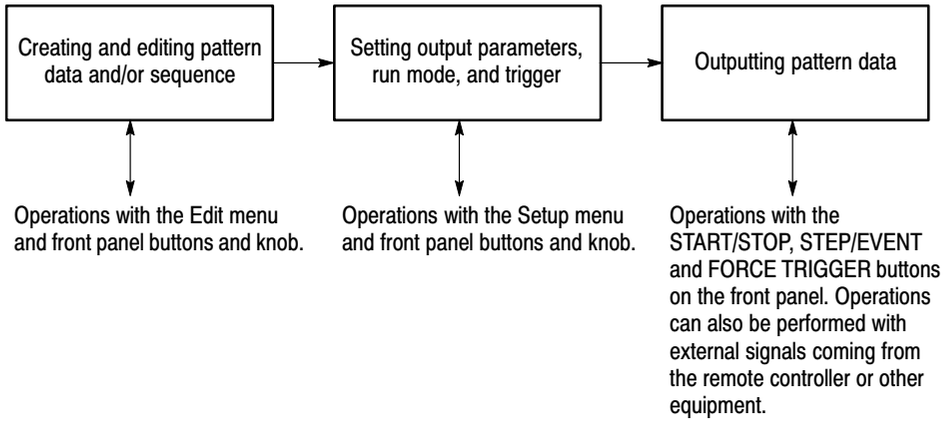


Figure 3-14: Operation flow for pattern data output #1

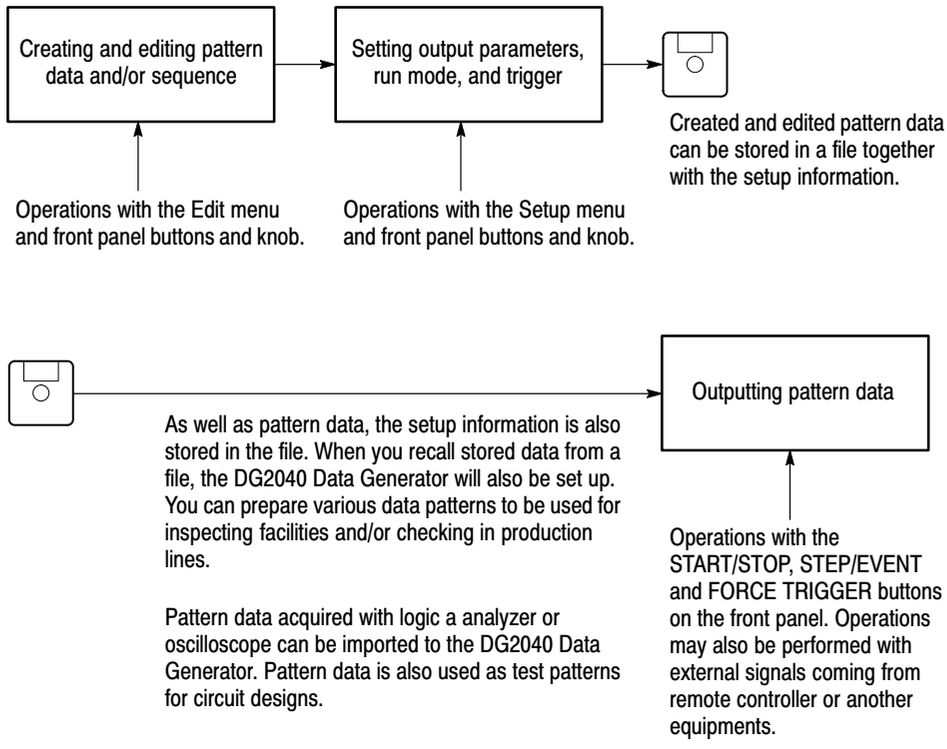


Figure 3-15: Operation flow for pattern data output #2

Advanced Control for Sequence

Using the event, trigger, and run modes, you can control the pattern data output timing and sequence from an external controller or by pressing the front panel buttons. For advanced control, do the following steps:

1. Set the trigger wait and/or event jump into each line on the sequence with the functions of **EDIT → Make Sequence → Set Enhanced Control**. Refer to *Sequence* on page 3-24.
2. Set the trigger parameters with **SETUP → Trigger**.
3. Set the event parameters with **SETUP → Output Condition → Control Condition**.
4. Set the run mode with **SETUP → Run Mode**.

Set Numeric View Format

Specify the bit width from 2 to 32, select BIN or HEX from the display/edit format, and the MSB/LSB position. These settings can be used for numeric view format. Refer to Table 3-6 on page 3-23 to set view type to numeric. Refer to page 2-22 for Parallel/Serial editing.

Pop-up Menu. Use the general purpose knob or the numeric key to set the bit width. The value can be set from 2 to 32. Figure 3-16 shows the pop-up menu.

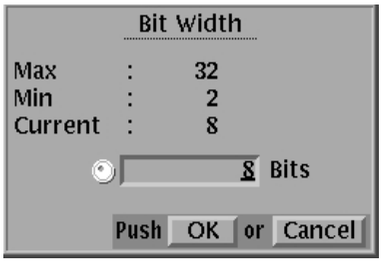


Figure 3-16: Bit Width pop-up menu

Operation. Do the following to set the display format for the numeric view.

Bottom button	Pop-up menu	Side button
Settings	Select numeric view format	
		Format (Select BIN or HEX)
		First (Select LSB or MSB)
Set the bit width in the pop-up menu using the general purpose knob or the numeric keys.		
		OK

Block Menu

The block menu is used to define packets of data called blocks and the cursor movement with respect to those blocks. The items to be set are selected from a pop-up list using the general purpose knob.

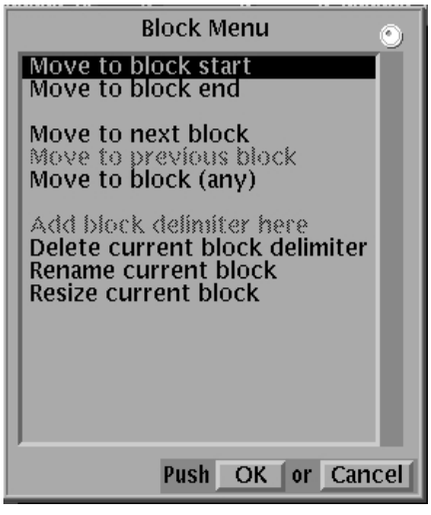


Figure 3-17: Block pop-up menu

Block Cursor Movement. The cursor is moved relative to the current block. Table 3-7 provides a description for each item in the Block menu.

Table 3-7: Block cursor movement

Select item	Description
Move to block start	Moves the cursor to the start of the block in which the cursor is currently located.
Move to block end	Moves the cursor to the end of the block in which the cursor is currently located.
Move to next block	Moves the cursor to the start of the block following the block in which the cursor is currently located.
Move to previous block	Moves the cursor to the start of the block preceding the block in which the cursor is currently located.
Move to block (any)	Moves the cursor to the start of a block selected from a list of blocks in a pop-up menu.

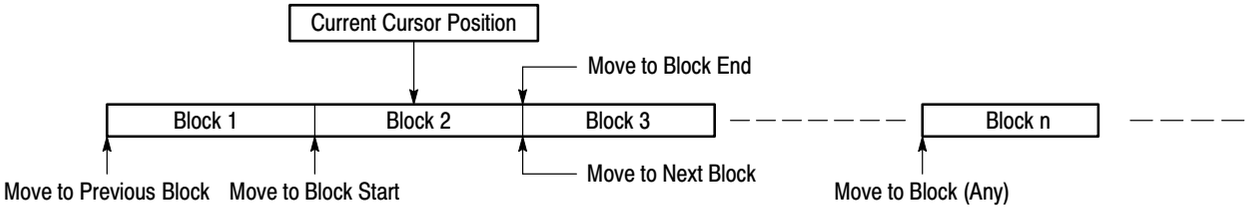


Figure 3-18: Block cursor movement

Operation. Do the following to move the cursor relative to the current block.

Bottom button	Pop-up menu	Side button
Block	Select from the following items: Move to block start Move to block end Move to next block Move to previous block Move to block (any)	OK
	Select the block to move to. (Move to block (any) only)	OK

Add Block Delimiter Here

The **Add block delimiter here** item in the pop-up menu sets a block delimiter at the current cursor position. The delimiter point becomes the starting point of the new block. The block delimiter is marked on the point scale.

***NOTE**. A block delimiter cannot be set at a point that is not at least 360 points away from both the start and the end of the block in which the delimiter is being set.*

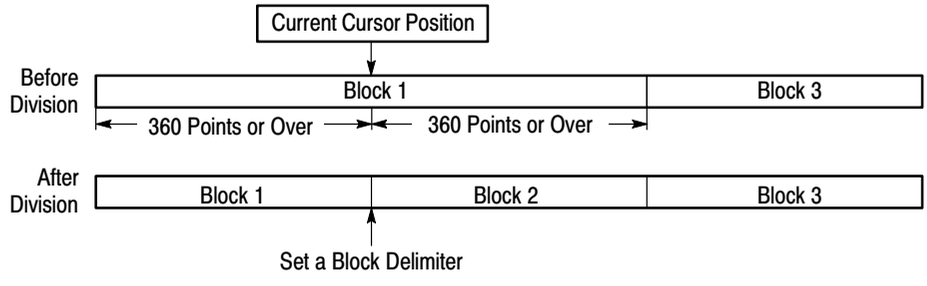


Figure 3-19: Dividing a block

Operation. Do the following to divide a block.

Bottom button	Pop-up menu	Side button
Move the knob icon to the Cursor window in the upper left area of the screen.		
Move the cursor to the location where the block delimiter is to be placed.		
Block	Select Add block delimiter here.	OK
		Clear String
	Input a block name.	OK

Delete Current Block Delimiter

The **Delete current block delimiter** item in the pop-up menu deletes the block delimiter between the current block and the preceding block to combine the block with the immediately preceding block.

***NOTE**. To delete the block delimiter, at least one block must exist before the current block.*

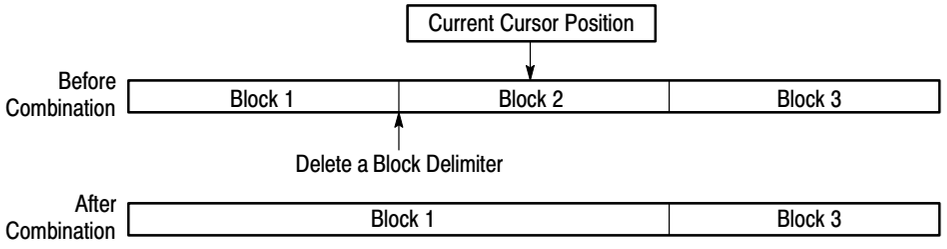


Figure 3-20: Combine blocks

Operation. Do the following to combine blocks.

Bottom button	Pop-up menu	Side button
Move the knob icon to the Cursor window in the upper left area of the screen.		
Move the cursor to the block where the block delimiter is to be deleted.		
Block	Select Delete current block delimiter.	OK

Rename Current Block

The **Rename current block** item in the pop-up menu changes the name of the block at the current cursor position.

Operation. Do the following to change a block name.

Bottom button	Pop-up menu	Side button
Move the knob icon to the Cursor window in the upper left area of the screen.		
Move the cursor to the block where the name is to be changed.		
Block	Select Rename current block.	OK
		Clear String
	Enter the new block name.	OK

Resize Current Block

The **Resize current block** item in the pop-up menu changes the size of the block and the memory size at the current cursor position only.

When increasing the size of the current block, only set a size that does not cause the total number of points to exceed the maximum memory size. Zero data corresponding to the increase in size is added at the end of the block.

Data is deleted from the end of the block when the size of the current block is decreased.

Note that the range of allowable block sizes starts at a minimum size of 360 points.

***NOTE**. Changing the block size cannot be reversed with the **Undo** operation.*

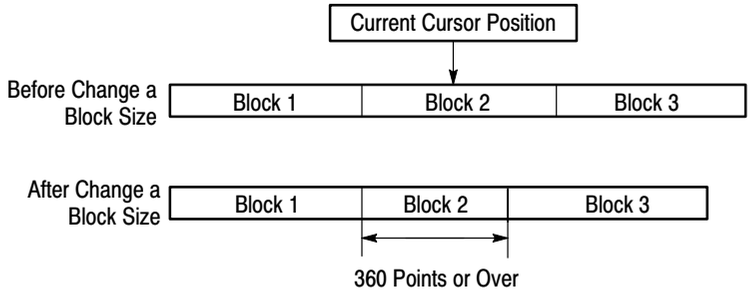


Figure 3-21: Change a block size

Operation. Do the following to change a block size.

Bottom button	Pop-up menu	Side button
Move the knob icon to the **Cursor** window in the upper left area of the screen.		
Move the cursor to the block whose size is to be changed.		
Block	Select Resize current block.	OK
	Enter the new block size.	OK

Execute Action Menu

The **Execute Action** menu sets up a variety of editing operations. The editing operation is selected from the **Action Menu** (Figure 3-22) using the general purpose knob. The editing operation is applied to the editing object area when the front panel **EXECUTE** button is pressed.

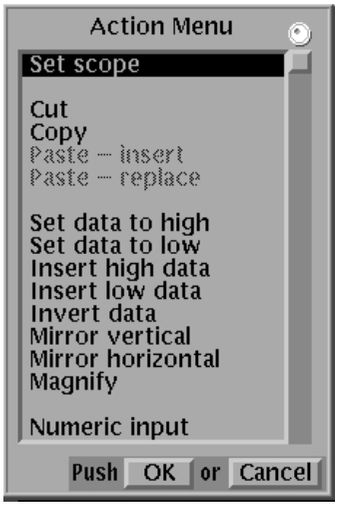


Figure 3-22: Pop-up action menu

The area of the pattern data that will be the object of the edit may consist of the range enclosed by the area cursor and may consist of the area following the cursor, depending on the selected editing operation.

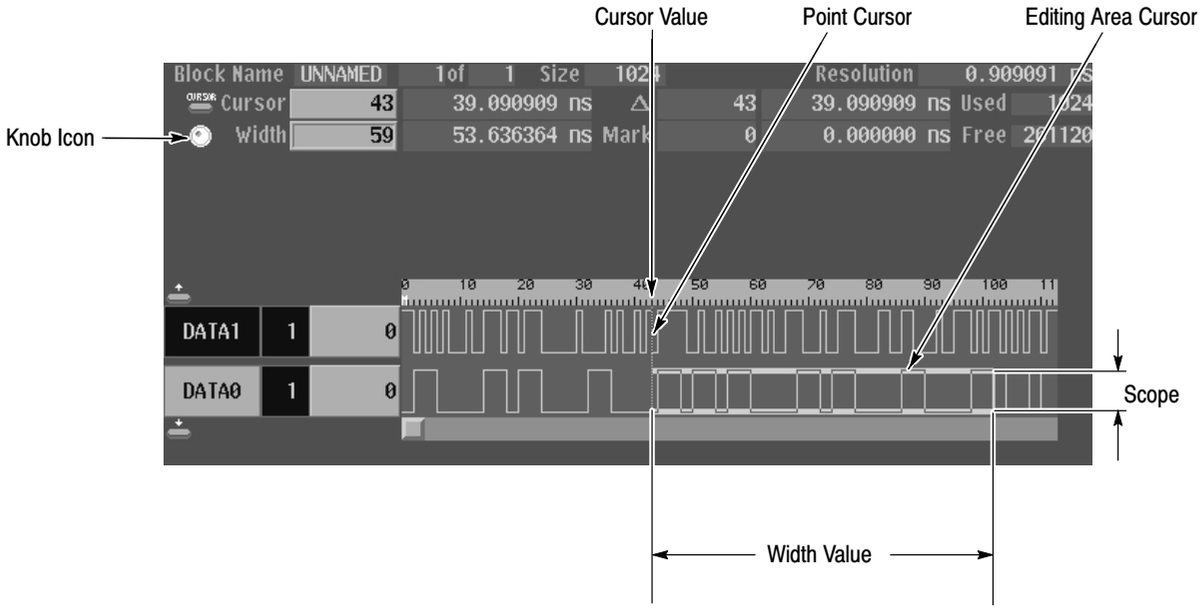


Figure 3-23: Edit area

The location or range that the editing operation applies to is set as follows:

- Point Position Input. The range is determined by the **Width** value. To set the width value, move the knob icon to the **Width** value display by pressing the front panel **CURSOR** button. Enter the value with the general purpose knob or the numeric keys.

  To set the position move the knob icon next to the **Cursor** position display by pressing the front panel **CURSOR** button. Enter the value with the general purpose knob or the numeric keys.

- Group/bit Input. The groups or bits to be included in the range are set using the **Execute Action → Set scope** item.

Bottom button	Pop-up menu	Side button
Execute Action	Select Set scope.	OK
	Determine the scope.	OK

The buttons used to change the groups or bits in the editing range will differ depending on the display format. Use the up and down arrow buttons for timing display format, and use the left and right arrow buttons for table and binary display formats.

- Editing Operation. Use the following editing procedure when the area enclosed by the area cursor is the object of the editing operation.

Bottom button	Pop-up menu	Side button
Execute Action	Select the editing operation.	OK
Set the value of the Cursor item in the upper left area of the screen.		
Set the value of the Width item in the upper left area of the screen.		
Set the groups/bit.		
		EXECUTE

Use the following editing procedure when the area following the cursor is the object of the editing operation.

Bottom button	Pop-up menu	Side button
Execute Action	Select the editing operation.	OK
Determine the value of the Cursor item in the upper left area of the screen.		
Determine the group/bit.		
		EXECUTE

***NOTE**. Press the **CLEAR MENU** button to clear the selected editing operation.*

Set Scope

The **Set scope** item in the Action menu, sets the range of groups or bits that will be the object of an editing operation executed by the **EXECUTE** button.

The meaning of a scope element differs depending on the pattern data display format. For the timing and table display format, an element group is a single scope element. For the binary display format, a single bit is a single scope element. Therefore, in timing and table displays, the number of bits that will be edited may change depending on which groups are within the selected range, even though the scope does not change as it is moved.

Operation. Do the following to set the scope.

Bottom button	Pop-up menu	Side button
Execute Action	Select Set scope.	OK
	Set the number of scope elements using the knob.	OK

Cut

When **Cu**t in the Action menu is selected, the cursor becomes an area cursor. The data in the editing range is deleted, and data is filled in at the end of memory in an amount equal to the amount of data deleted. The filled data (the tail) is set to 0. Note that the deleted data is inserted in the paste buffer and can be used as paste data.

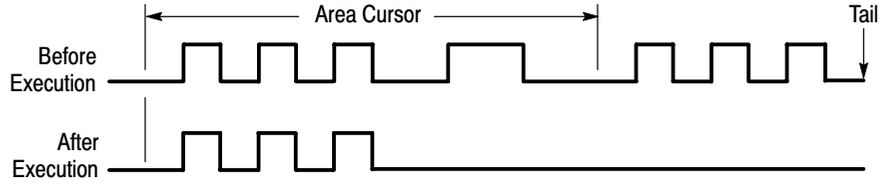


Figure 3-24: Cut

Copy

When **Copy** in the Action menu is selected, the cursor becomes an area cursor. The data in the editing range is copied to the paste buffer. The pattern data itself is not affected.

Paste-insert

When **Paste-insert** in the Action menu is selected, data in the paste buffer is inserted at the current cursor position. The data after the cursor is moved to the rear by the length of the pasted data. After the data is moved, data that exceeds the set memory size is lost.

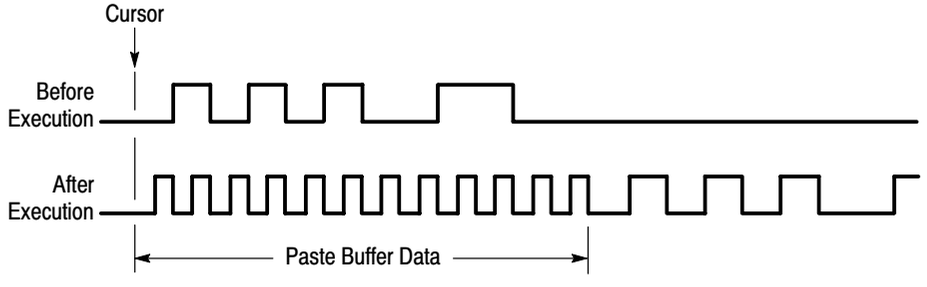


Figure 3-25: Paste-insert

Paste-replace

When **Paste-replace** is selected in the Action menu, the data paste buffer writes over the data starting at the current cursor position.

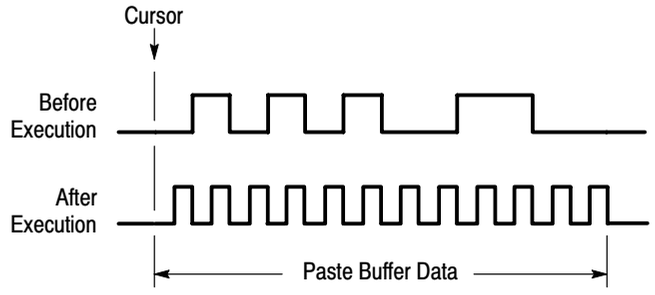


Figure 3-26: Paste-replace

Set Data To High

When **Set data to high** is selected in the Action menu, the cursor becomes the area cursor, and all the data bits in the editing area are set to 1.

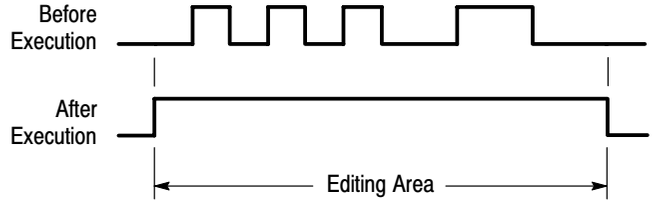


Figure 3-27: Set data to high

Set Data To Low

When **Set data to low** is selected in the Action menu, the cursor becomes the area cursor, and all the data bits in the editing area are set to 0.

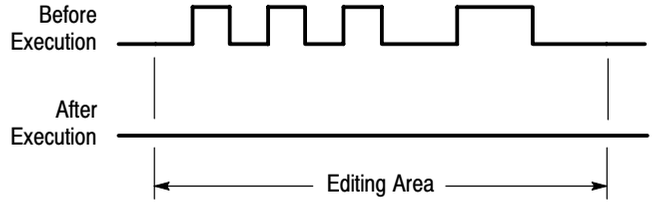


Figure 3-28: Set data to low

Insert High Data

When **Insert high data** is selected in the Action menu, the cursor becomes the area cursor, and the data following the cursor is moved to the rear by the amount specified for the editing area. The data in the editing area is set to 1.

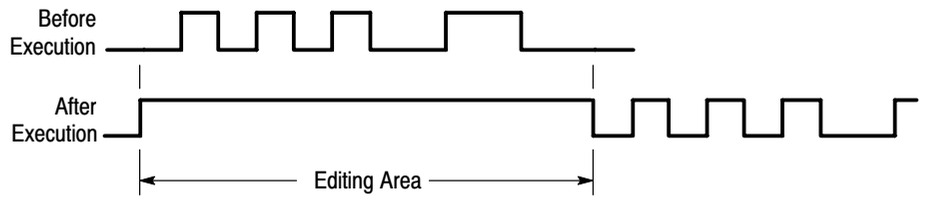


Figure 3-29: Insert high data

Insert Low Data

When **Insert low data** is selected in the Action menu, the cursor becomes the area cursor, and the data following the cursor is moved to the rear by the amount specified for the editing area. The data in the editing area is set to 0.

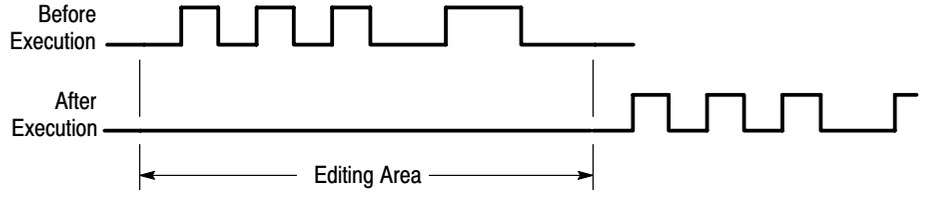


Figure 3-30: Insert low data

Invert Data

When **Invert data** is selected in the Action menu, the cursor becomes the area cursor, and the data in the editing area is inverted. That is 0 becomes 1 and 1 becomes 0.

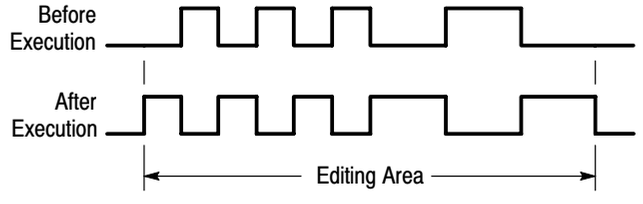


Figure 3-31: Invert data

Mirror Vertical

This Action menu function is used for the timing display format, and the cursor becomes the area cursor. The area specified as the editing area is reordered in the group/bit direction in a mirror-image manner. This editing operation operates on bit units regardless of any group definitions. In display formats other than timing display (such as table and binary), the reordering is performed in the point direction.

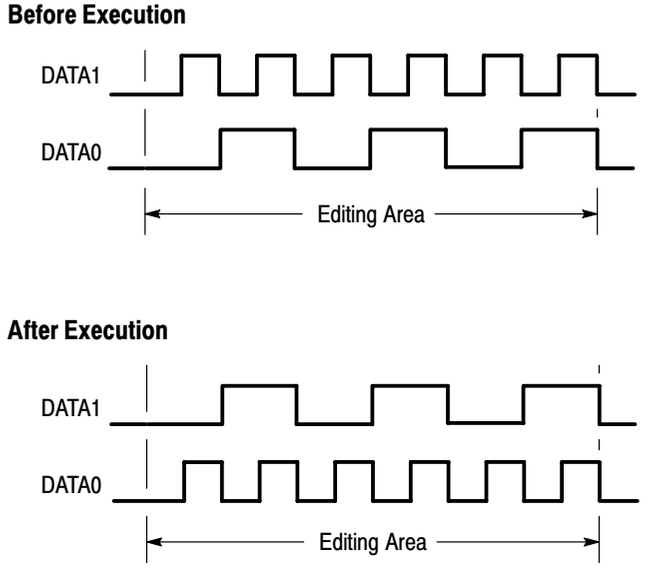


Figure 3-32: Mirror vertical

Mirror Horizontal

This Action menu function is used for the timing display format and the cursor becomes the area cursor. The area specified as the editing area is reordered in the point direction in a mirror-image manner. In display formats other than timing display (such as table and binary), the reordering is performed in the group/bit direction.

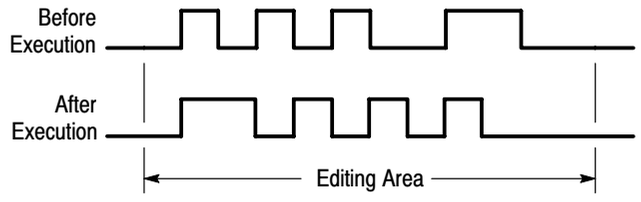


Figure 3-33: Mirror horizontal

Magnify

In this Action menu function, the cursor becomes the area cursor, and the data in the area specified as the editing area is magnified in the direction of the time axis. This function has one parameter, the magnification factor (**Mag Factor**). This can be set to any integer from 2 to 100.

For example, if the **Mag Factor** is 2, then magnifying a data range with the data 0101 would give the data 00110011. This editing operation repeats each data item the number of times specified by the **Mag Factor** parameter.

The data following the edit area is moved to the rear from the editing area by the amount of the data increased due to the magnification. The data in the tail that exceeds the memory size is lost.

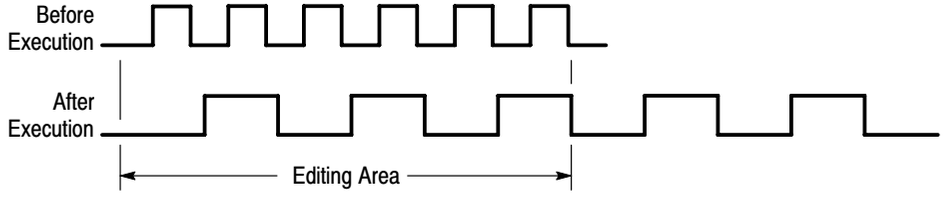


Figure 3-34: Magnify

Numeric Input

In this Action menu function, the cursor switches to the point cursor, and the input position is indicated on the display. Data can then be changed by input of numeric values. As data is input, existing data at the input position is overwritten.

After selecting **Numeric input** from the **Action Menu**, step is set using the **Points/Step** pop-up window. A “step” is the number of points that are set for each number that is input.

Press the **EXECUTE** button to start the input. Press the front-panel keys to set the required data values. The kind of input that is possible differs according to the display format, as shown in Table 3-8.

Table 3-8: Numeric input differences

Display Method	Input Position	Numeric Input Type
Timing	Display of that group data value is selected.	Binary
Table	Data at the object position is displayed highlighted.	Binary
Binary	Data at the object position is displayed highlighted.	Binary
Numeric	Data at the object position is displayed highlighted.	Binary or Hexadecimal

The input of each data value finishes and the data is set when the number of input digits is sufficient to set all the bits in the group. You do not need to press the enter button.

The cursor moves along the data by the number of points in a step for each input operation when the scope is only one bit deep for binary format. The next input operation sets the data at the new cursor position for the same group.

However, when the scope is more than one bit deep for binary format, the cursor does not immediately move. Instead, the next input action will be directed at the next group down (or to the right). Only when input to the last group in the scope is complete does the cursor move along the data.

Operation. Do the following to perform numeric input.

Bottom button	Pop-up menu	Side button	Front Panel button
Executed Action	Numeric input	OK	
Set the Points/Step using the general purpose knob.			
		OK	EXECUTE
Input data using numeric keys.			

Shifting

The DG2040 Data Generator provides several methods for the shifting of data in a timing, table, or binary display.

Timing. In a timing display you can shift data using any one of the following:

- Shift left (add zero)

- Shift right (add zero)
- Shift left
- Shift right

The cursor becomes the area cursor, and the data inside the editing area is shifted one point to the left or right. Data that overflows the edit area is lost. Zeros are added at the right or left if you select any one of the add zero selections. If you select shifting without adding zeros, values added at the right or left are equal to the right- or left-most values for each bit in the edit area when shifting started.

Figures 3-35, 3-36, 3-37, and 3-38 illustrate the different shifting selections for timing.

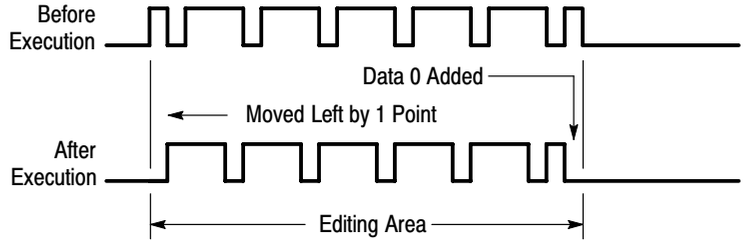


Figure 3-35: Shift left (add zero)

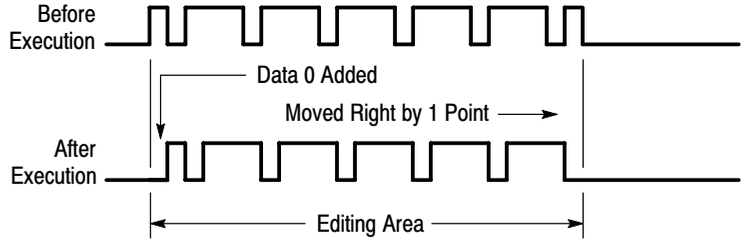


Figure 3-36: Shift right (add zero)

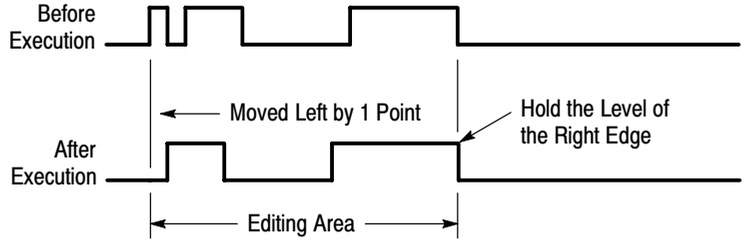


Figure 3-37: Shift left

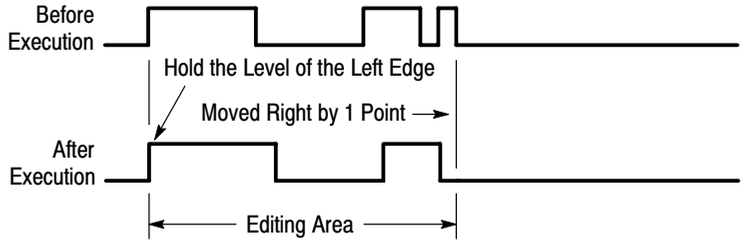


Figure 3-38: Shift right

Data can be shifted to the left or right with the arrow buttons if a shifting operation is selected when the **Select arrow key function** item is selected in the **Settings** menu.

Table, Binary, and Numeric. You can shift data in the table, binary, and numeric displays using any of the following:

- Shift up (add zero)
- Shift down (add zero)
- Shift up
- Shift down

The cursor becomes the area cursor and the data inside the editing area is shifted one point up or down. Data that overflows the edit area is lost. If you select any one of the add zero selections, zeros are added to the top or bottom. If you select shifting without adding zeros, values added at the top or bottom are equal to the top or bottom-most values for each bit in the edit area when shifting started.

Data can be shifted up or down with the arrow buttons if a shifting operation is selected when the **Select arrow key function** item is selected in the **Settings** menu.

Rotating

The DG2040 Data Generator provides several methods for rotating data in a timing, hexadecimal, or binary display.

Timing. In a timing display you can rotate data using rotate left or rotate right.

The cursor becomes the area cursor and the data inside the editing area is rotated one point to the left or right. Data that overflows the editing area cycles around and is added at the left or right of the edit area. Figures 3-39 and 3-40 illustrate the different rotating selections for timing.

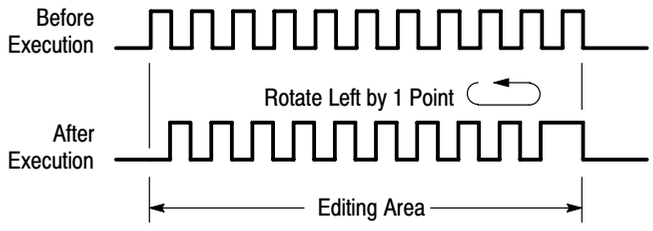


Figure 3-39: Rotate left

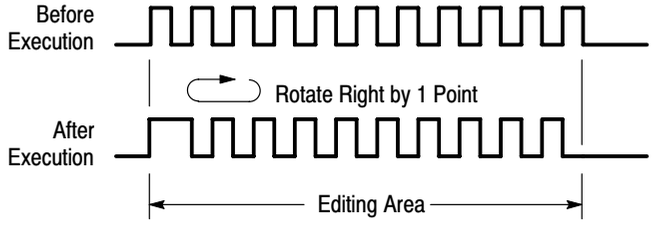


Figure 3-40: Rotate right

Data can be rotated to the left or right with the arrow buttons if **Rotate region left/right** is selected when the **Select arrow key function** item is selected in the **Settings** menu.

Table, Binary, and Numeric. You can rotate data in the table, binary, and numeric displays using rotate up and rotate down.

The cursor becomes the area cursor and the data inside the editing area is rotated by one point up or down. Data that overflows the editing area cycles around and is added to the top or bottom of the edit area.

If **Rotate region up/down** is selected when the **Select arrow key function** item is selected in the **Settings** menu, data can be rotated up or down with the arrow buttons.

Creating Standard Pattern Data

Table 3-9 and Figure 3-41 present descriptions and examples of the standard pattern data.

Table 3-9: Standard pattern data descriptions

Standard pattern data	Description
Binary up counter	Creates a binary up counter data pattern. The cursor becomes the area cursor. The number of bits in the counter is the total number of bits in the group set up with the Set scope item in the Execute Action menu. When Binary up counter is selected, the instrument asks for the Points/Step value. This value sets the number of data points per counter step. When the counter reaches its maximum value, the value returns to 0 and it repeats the count-up operation.
Binary down counter	The use is the same as Binary up counter. The action is the same except that a binary down counter is created. When the counter reaches 0, the value returns to its maximum value and the count-down operation is repeated.
Johnson counter	Creates a Johnson counter data pattern. When this menu item is selected, the instrument asks for the Points/Step value. This value sets the number of data points per counter step.
Graycode counter	Creates a Gray code counter data pattern. When this menu item is selected, the instrument asks for the Points/Step value. This value sets the number of data points per counter step.

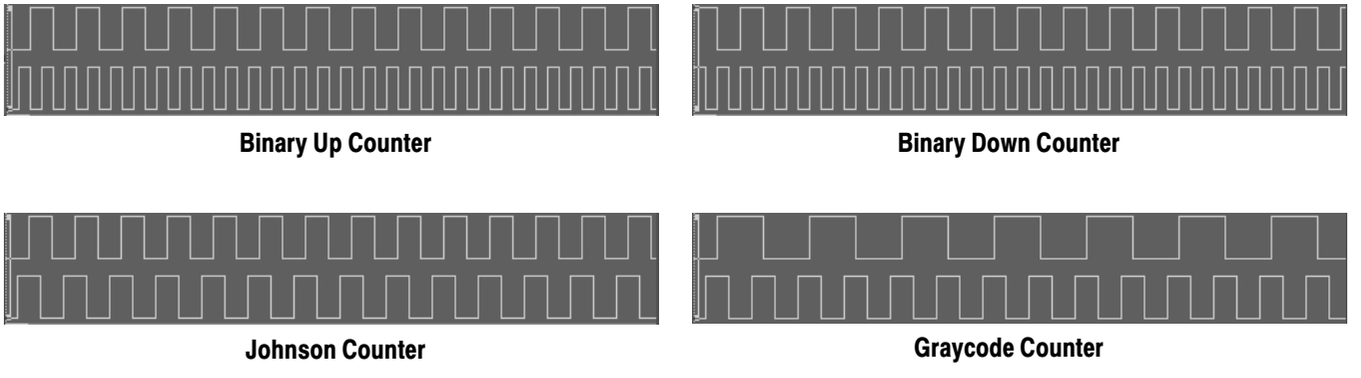


Figure 3-41: Standard pattern data

Operation. Creating the standard pattern data.

Bottom button	Pop-up menu	Side button
Set the editing range in the point direction.		
Set the editing range in the group/bit direction.		
Execute Action	Select from the following items: Binary up counter Binary down counter Johnson counter Graycode counter	OK

Enhanced Action Menu

The **Enhanced Action** menu uses special editing functions. When **All** is selected from the **Region** side menu, the whole area is edited. When **Entered** is selected from the **Region** side menu, **From** and **Size** parameters can be specified.

Clock Pattern

This Enhanced Action menu item generates a clock pattern. The edit object can be any bit. Figure 3-42 shows the creation of a clock pattern enclosed in a frame and the generation of the pattern in the target bit.

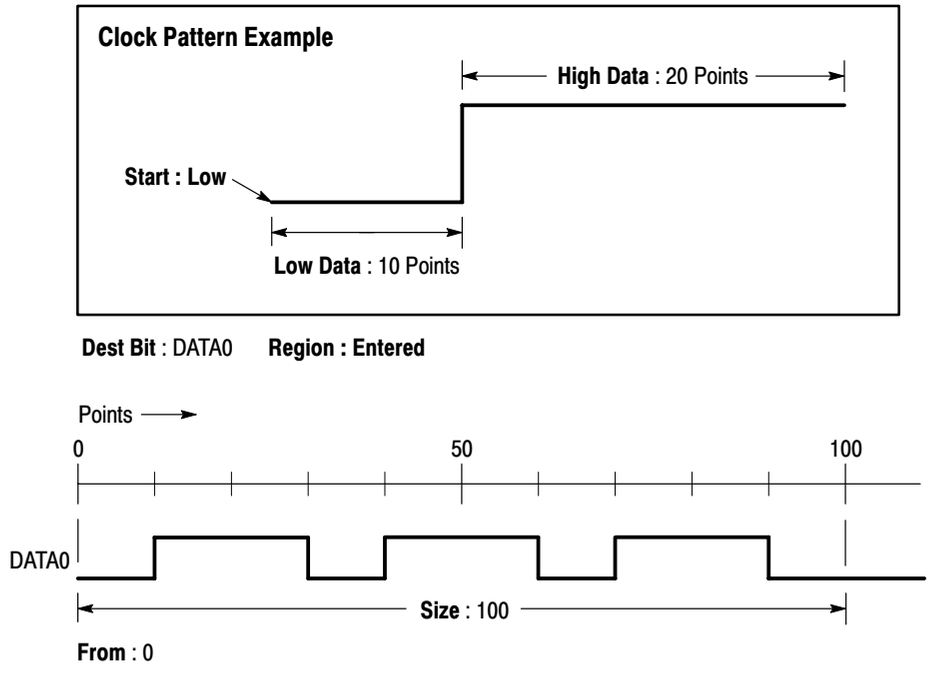


Figure 3-42: Creating the clock pattern

Pop-up Menu.

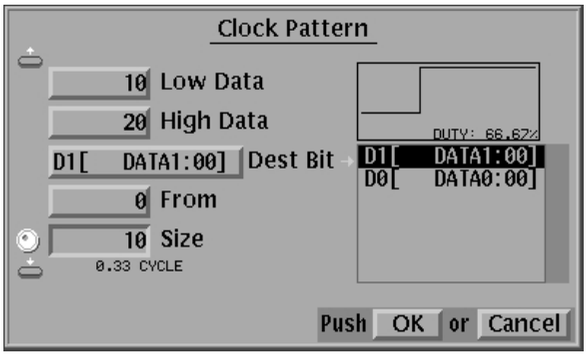


Figure 3-43: Clock Pattern pop-up menu

Table 3-10 describes the parameter items.

Table 3-10: Parameter Items

Parameter item	Function
Low Data	The length (number of points) of the data 0 part of the clock pulse. The maximum is 100 points.
High Data	The length (number of points) of the data 1 part of the clock pulse. The maximum is 100 points.
Dest Bit	The bit in which to write the pattern.
From	When Entered is selected from the Region side menu item, it specifies the first point in the bit from which the pattern is written.
Size	When Entered is selected from the Region side menu item, it specifies the length (number of points) of the clock pattern.

Side Menu

Menu item	Function
Start	Determines the state at pulse start. When **Low** is selected, the value will be 0. When High is selected, the value will be 1.
Region	The values All and Entered can be set. When All is selected, all of the Dest Bit memory is filled with the pattern. When Entered is selected, the pattern is written to the area specified by the **From** and **Size** parameters.

Operation. Do the following to generate a clock pattern.

Bottom button	Pop-up menu	Side button
Enhanced Action	Clock Pattern	OK
		Region (Select All or Entered)
		Start (Select Low or High)
Set the parameters in the pop-up menu. (Low Data, High Data, Dest Bit, From, Size)		
		OK

Shift Register Generator

This Enhanced Action menu function sets up the configuration for the pseudo-random pulse generator that uses a shift register.

The shift register pseudo-random pulse generator consists of a register that is between 1 and 32 bits and a feedback loop. This feedback loop takes the value that is shifted out of the register, performs the exclusive OR with one or more bits within the register, and places the result in the first bit of the register. The position at which an exclusive OR is set is called a tap, and certain tap configurations produce series that are the longest possible. The data generated by such a configuration is called an M-series. If the number of stages in the shift register is n, then an M-series pseudo-random signal will have a length of 2^n–1.

Create a simple register and tap setup as follows:

- Register length: 3
- Register value: 101
- Set the tap with the **Maximum Length Taps** item.

Figure 3-44 shows the output for the above settings.

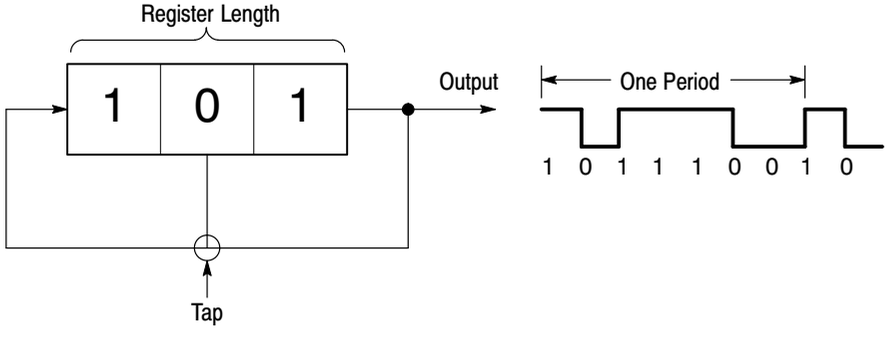


Figure 3-44: Register value and tap setting example

Pop-up Menu.

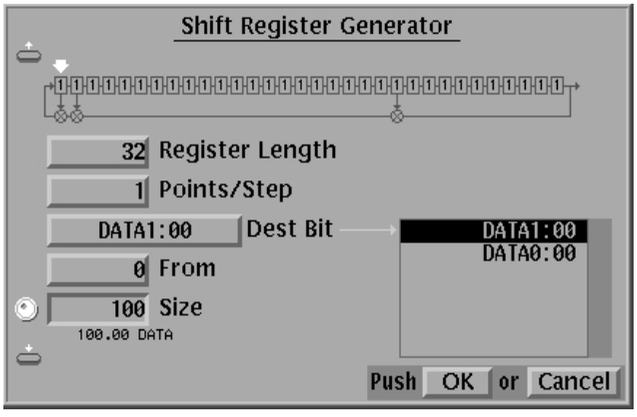


Figure 3-45: Shift Register Generator pop-up menu

Table 3-11 describes the parameter items.

Table 3-11: Shift register generator parameters

Parameter	Function
Register Diagram	Use the 0 and 1 numeric keys to set the register's initial value. Use the "–" button to toggle taps.
Register Length	Sets the register length. The register length can be set to a value between 1 and 32.
Points/Step	The number of data points set for each shift of the register.
Dest Bit	The bit to which the pattern is written.
From	When Entered is selected from the Region side menu item, it specifies the first point from which the pattern is written.
Size	When Entered is selected from the Region side menu item, it specifies the number of points into which the pattern is written.

Side Menu

Item	Function
Set All Registers	Sets the value of all the register bits to 1.
Maximum Length Tap	Sets the taps to positions so that the output becomes a tap M-series for the current register length. There are multiple tap combinations for M-series bit series. Each time the Maximum Length Tap button is pressed, the tap combination changes.
Region	The values All and Entered can be set. When All is selected, all of the Dest Bit memory is filled with the pseudo-random pulse pattern. When Entered is selected, the pattern is written to the area specified by the From and Size parameters.

Operation. Do the following to set the register value input and taps.

Bottom button	Pop-up menu	Side button
Enhanced Action	Shift Register Generator	OK
		Region (Select All or Entered)
Set the parameters in the pop-up menu. (Register Length, Points/Step, Dest Bit, From, and Size)		
Use the general purpose knob to select bits for setting in the register.		
Set the value of a bit in the register with the 0 and 1 numeric keys.		
Set the tap on/off state for a bit using the “–” numeric key.		
		OK

Logical Operation

This Enhanced Action menu function performs a logical operation between pattern data in two (source) bits, and replaces the data in a destination bit with the result. Figure 3-46 shows an example of a logical operation where the **AND** operator was selected.

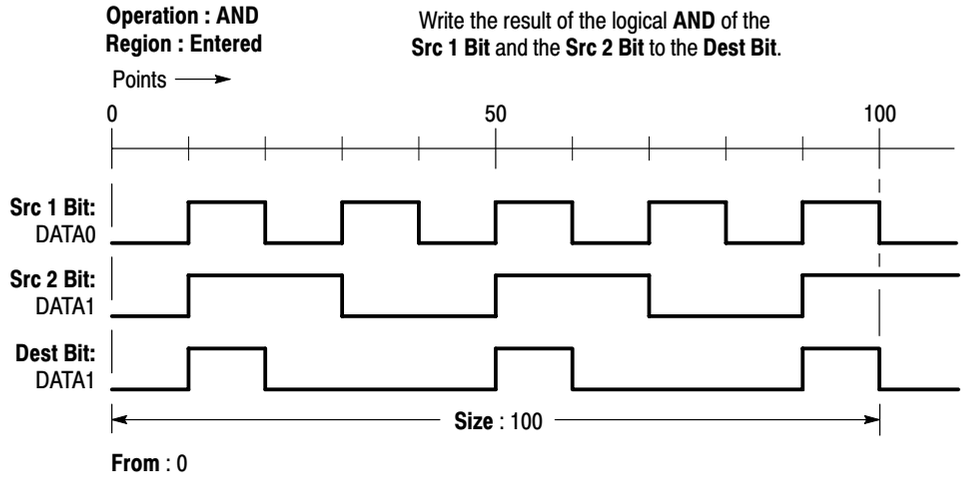


Figure 3-46: Logical AND Operation Example

Pop-up Menu.

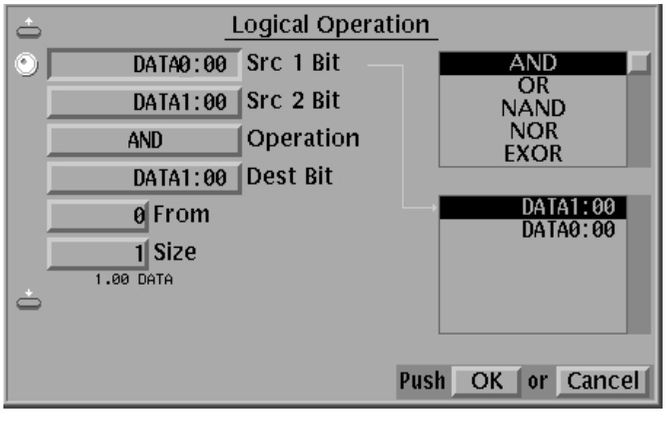


Figure 3-47: Logical Operation pop-up menu

Table 3-12 describes the parameter items.

Table 3-12: Logical operation parameters

Parameter	Function	
Src 1 Bit	Specifies a bit that will be used as an operand to the operation.	
Src 2 Bit	Specifies the other bit that will be used as the other operand to the operation.	
Operation	Specifies the type of the operation.	
	Selection item	**Description**
	AND	Logical AND
	OR	Logical OR
	NAND	Logical NAND
	NOR	Logical NOR
	EXOR	Logical exclusive OR
	EXNOR	Logical exclusive NOR
Dest Bit	The bit to which the result pattern is written.	
From	When Entered is selected from the Region side menu item, it specifies the first point in the bit from which the pattern is written.	
Size	When Entered is selected from the Region side menu item, it specifies the number of points in the bit in which the pattern is written. The Maximum 9999 points can be entered. Entering 0 closes the pop-up menu.	

Operation. Do the following to apply a logical operation to two data items

Bottom button	Pop-up menu	Side button
Enhanced Action	Logical Operation	OK
		Region (Select All or Entered)
Set the parameters in the pop-up menu. (Src 1 Bit, Src 2 Bit, Operation, Dest Bit, From, Size)		
		OK

Bit Operation

This Enhanced Action menu function copies or moves data between bits in the specified area.

Pop-up Menu.

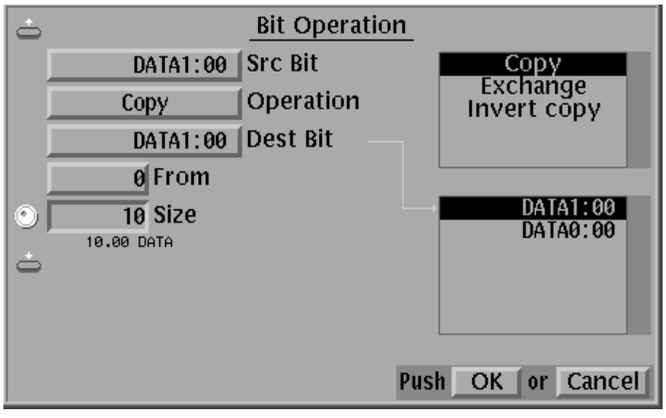


Figure 3-48: Bit Operation pop-up menu

Table 3-13 describes the parameter items.

Table 3-13: Bit operation parameters

Parameter	Function	
Src Bit	Specifies the source data for the operation.	
Operation	Specifies the type of the operation.	
	Selection item	**Description**
	Copy	Copies the data, overwriting the destination data.
	Exchange	Exchanges the data in the source and destination bits.
	Invert copy	Copies and logically inverts the data before overwriting the destination data.
Dest Bit	The bit to which the pattern is written.	
From	When Entered is selected from the Region side menu item, it specifies the first point in the bit from which the pattern is written.	
Size	When Entered is selected from the Region side menu item, it specifies the number of points in the bit in which the pattern is written. The Maximum 9999 points can be entered. Entering 0 closes the pop-up menu.	

Operation. Do the following to move or copy pattern data.

Bottom button	Pop-up menu	Side button
Enhanced Action	Bit Operation	OK
		Region (Select All or Entered)
Set the parameters in the pop-up menu. (Src Bit, Operation, Dest Bit, From, and Size)		
		OK

Serial Code Converter

This Enhanced Action menu function converts data in the source by writing specified output data to the destination as one set of patterns is found in the source data.

Refer to *Conversion Table Examples* on page C-3 for examples of how to convert pattern data to different format.

Pop-up Menu. The menu for setting the bit and area that will be the code conversion source data, and the bit and area where the result of the code conversion will be written is displayed using the following operation. (See Figure 3-49.) Select the item with the up and down arrow buttons, and use the general purpose knob and the numeric keys to set the parameter value.

Bottom button	Pop-up menu	Side button
Enhanced Action	Serial Code Converter	OK

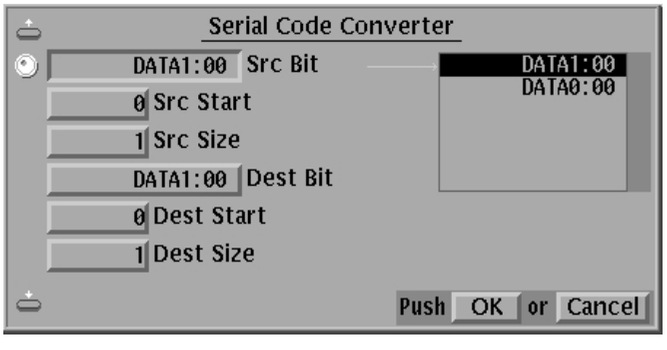


Figure 3-49: Serial Code Converter menu

Table 3-14 describes the parameter items.

Table 3-14: Serial code converter parameters

Parameter	Function
Src Bit	Specifies the bit from which the source data will be read.
Src Start	Specifies the point from which reading the source data will begin.
Src Size	Specifies the number of points of source data that will be read.
Dest Bit	Specifies the bit into which the converted data will be written.
Dest Start	Specifies the point from which converted data will be written.
Dest Size	Specifies the number of points of converted data that will be written.

Press the **OK** side button to start the conversion.

Side Menu

Menu item	Function
Load Table Data1	Reads in a code conversion table from mass memory. The file will be an ASCII file with the extension .TBL. The operation is identical to that for Load Data & Setup from the File menu.
Save Table Data	Writes a code conversion table to mass memory. The file must be an ASCII file with the extension .TBL. The operation is identical to that for Save Data & Setup from the File menu.
Edit Table Data	Edits a code conversion table. This is explained in the following paragraph.

Code Conversion Table Editing. Figure 3-50 shows the **Edit Code Table** menu, which is displayed when the **Edit Table Data** side menu item is selected. The **SOURCE CONDITION** section of this table defines the templates used for pattern matching. The instrument compares these templates with data sequences in the source data to find matching patterns.

***NOTE**. The data code conversion table files are arranged in essentially the same manner as displayed on the table editing screen. In these files, a comma is used to delimit fields and CR+LF to delimit lines. No spaces appear in the file.*

Pattern matching is performed in order, starting at the top of the table. Pattern matching is more reliable if templates with more bits (longer templates) appear towards the top of the table.

The matching process moves along the input data as follows. The current position is set to the start point, and the table is used to find a match for the data at that position. When a match is found, the output code for that template is

written to the destination. The current position is then moved on by the width of the pattern in the **CURRENT** column, and the process is repeated.

This continues until the destination is full. If the end of the input data is reached before the destination is full, the current position returns to the start point in the source data.

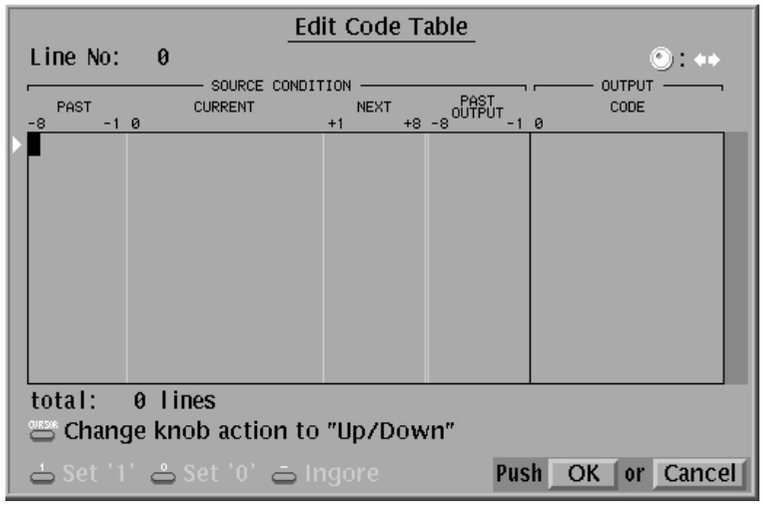


Figure 3-50: Edit Code Table menu

Table 3-15 describes the parameter items in the **Edit Code Table** menu.

Refer to *Conversion Table Examples* on page C-3 for examples of how to convert pattern data to different format.

Table 3-15: Edit Code Table parameters

Parameter	Function
PAST	For the template to match, the data in the source immediately behind the current position (that is, data that has already been read) must match this pattern.
CURRENT	For the template to match, the data in the source at the current position must match this pattern.
NEXT	For the template to match, the data in the source at a position ahead of the current position by the width of the pattern in the CURRENT column must match this pattern.
PAST OUTPUT	For the template to match, the data at the end of the destination (that is, most recently written data) must match this pattern.
OUTPUT CODE	When the whole template matches, the data specified in this column is written to the destination.

Submenu

Item	Function
Insert Empty Line	Inserts an empty line before the line currently indicated by the block cursor.
Delete Line	Deletes the line currently indicated by the block cursor.
Delete All Lines	Deletes all lines in the table.

***NOTE**. The maximum size of the table data is 1024 lines.*

Operation. The process for editing a code conversion table is as follows:

- The four arrow buttons are used to move the cursor
- The general purpose knob can also be used for cursor movement
- The **CURSOR** button causes the general purpose knob to switch between controlling vertical and horizontal movement

Use this process to move the cursor to the target location and then use the numeric keys to edit the data. Table 3-16 lists the roles of the numeric keys.

Table 3-16: Numeric key description

Numeric Key	Description
0	Sets the table data at the cursor to 0.
1	Sets the table data at the cursor to 1.
–	Sets the table data at the cursor to the don't-care state.

The delete key clears the table data in the area that contains the cursor.

Sometimes, data at positions other than the cursor position may be changed. For example, pressing 0 or 1 near the center of the **SOURCE CONDITION CURRENT** field when the field is empty, changes data from the start of that area to the cursor position.

Make Sequence Menu

A sequence is a function to output blocked pattern data in a predetermined order as specified in a sequence table. In the sequence table, repeat count, trigger wait, event jump, and calling subsequences are used, as well as placing the blocked patterns in a sequential order.

- The blocked patterns are output in the line-numbered order defined in the sequence table.
- A patterned data or subsequence can be defined in each line in the sequence table.
- A line can be repeated on output from 1 to 65536 times or continuously.
- A line can wait trigger event for output.
- A line can be jumped to a specified line by the trigger of event signal.

Figure 3-51 shows an example of a sequence. In this example, two subsequences SUB1 waiting trigger event, a blocked pattern data BK1 to be infinitely repeated and jumped to the line 3 on event signal, and blocked pattern data BK4 are defined.

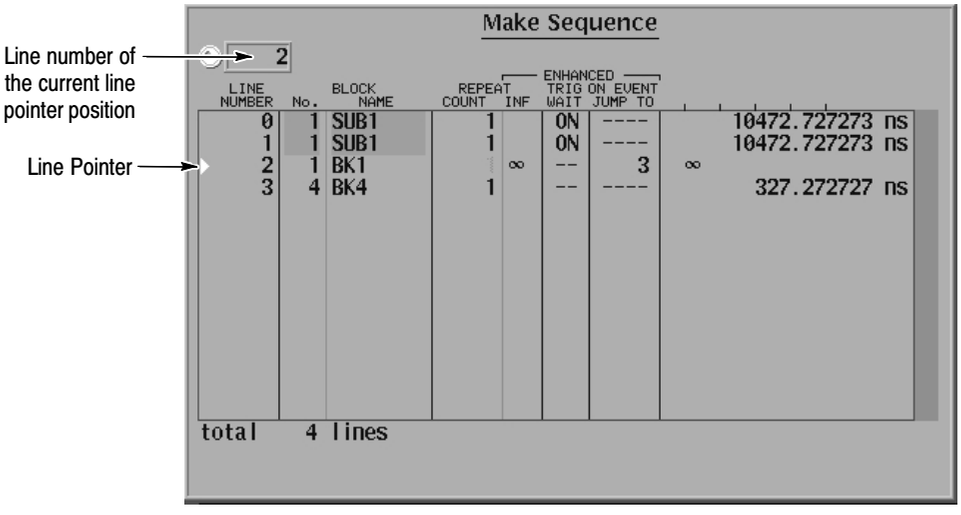


Figure 3-51: Make Sequence menu and a sequence example

***NOTE**. Enhanced columns in Figure 3-51 does not become effective unless the run mode is not set to Enhanced. For enhanced mode, refer to* Run Mode Menu *on page 3-74.*

As already stated, a sequence can call subsequences. Each subsequence is composed of blocked patterns with specified repeat count.

Figure 3-52 shows an example of a subsequence. This subsequence is called by the sequence shown in Figure 3-52.

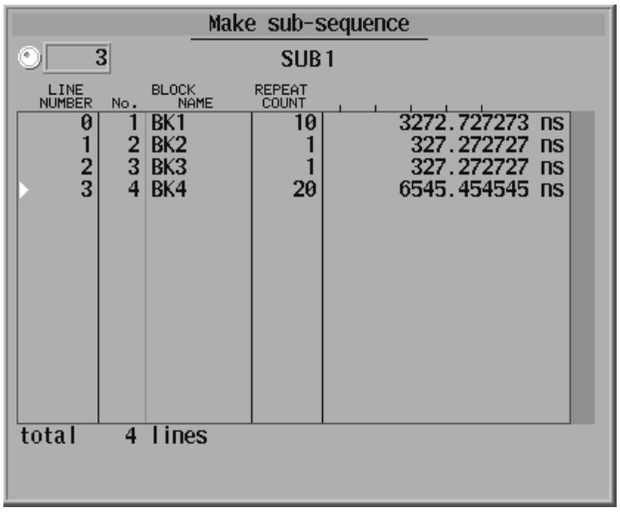


Figure 3-52: Make Subsequence menu and a subsequence example

Insert

This Make Sequence menu function inserts a new sequence step at the position of the line pointer. In the Make Sequence menu, block or subsequence can be inserted in each line. The BLOCK column of the lines inserted with subsequences becomes highlight gray to distinguish from those inserted with blocks, as shown in Figure 3-51.

Operation. Do the following to insert a sequence step.

Bottom button	Pop-up menu	Side button
Make Sequence		
Use the general purpose knob to move the cursor to the line where the step is to be inserted.		
		Insert
	Select the block.	OK

Delete

This Make Sequence menu function deletes the sequence step at the position of the line pointer.

Operation. Delete a sequence step

Bottom button	Pop-up menu	Side button
Make Sequence		
Use the general purpose knob to move the cursor to the line where the step is to be inserted.		
		Delete

Repeat Count

This Make Sequence menu function sets the block repeat count for the step at the position of the line pointer.

Operation. Set the block repeat count for the step

Bottom button	Pop-up menu	Side button
Make Sequence		
Use the general purpose knob to move the cursor to the line where the step is to be inserted.		
		Repeat Count (set the repeat count)

Set Enhanced Control

This Make Sequence menu function sets up the sequence control options that become valid when the instrument is in enhanced mode. See the **SETUP→ Run Mode → Enhanced** for the enhanced operation.

Submenu

Item	Function
Trig Wait	When set to ON, data output stops when the specified sequence position is reached, and the instrument waits for a trigger input.
Event Jump	When set to ON, if an event occurs during output of the specified line, control jumps to the set line.
Jump to	Specifies the jump destination (line number) for the Event Jump function.
Repeat	When Count is selected, that block is repeated the number of times specified by the Repeat Count setting. When Infinite is selected, the block is repeated continuously.

Special

This Make Sequence menu function deletes and registers sequences.

Submenu

Item	Function
Delete All	Deletes all sequences.
Make Simple Sequence	Registers all currently defined blocks in order as a sequence.
Edit Subsequence	Creates or edits a subsequence. This subsequence can be included in the sequence and will be expanded into the sequence when executed. A subsequence can be created and edited the same as a sequence, using the reduced menu structure. However only block and repeat count can be defined in the subsequence. Refer to *Creating and Editing Subsequences.*

Creating and Editing Subsequences

In this Make Sequence menu function you can create a subsequence or edit an existing subsequence. Use the menu items under the **Edit Subsequence** menu item.

Item	Function
New	Creates a new subsequence. When New is selected, the Make Sub-Sequence pop-up menu and the side menus, including Insert, Delete, Repeat and OK also appear. Use these menu items to create a subsequence.
Open	Opens a subsequence to be edited. When the Open is selected, the pop-up menu appears for the subsequence selection list. Select a subsequence from the list, then the Make Sub-Sequence pop-up menu and the side menu including Insert, Delete, Repeat and OK appear. Use these menu items to edit the subsequence.
Remove	Removes a subsequence. When Remove is selected, the pop-up menu for the subsequence selection list appears. Select a subsequence to be removed.
Clear	Removes all existing subsequences.

Limitations on Using Subsequences

The following list describes the limitations on using subsequences:

- Each line can contain only one data pattern block.
- Each line can be repeated up to 65,536 times.
- Each subsequence can contain up to 256 lines.
- You can define up to 50 subsequences.

Sequence memory usage. Sequence memory controls the maximum number of subsequence calls and their repeat counts that can be run. When you run a sequence, the DG2040 Data Generator compiles the sequence and subsequence lines into internal codes that are stored in the sequence memory. The DG2040 Data Generator then uses the sequence memory code to output the block data. There is one internal code item for each sequence line except for lines that contain a subsequence call.

For subsequence calls without a repeat count, the DG2040 Data Generator compiles a number of internal code items equal to the number of lines in the subsequence.

For subsequence calls with a repeat count, the DG2040 Data Generator compiles a number of internal code items equal to the repeat count for that subsequence call times the number of lines in the subsequence. For example, if a sequence line has a subsequence call with the repeat count of 25 and that subsequence has two lines, the DG2040 Data Generator generates 50 internal code items for that sequence line and stores them in the sequence memory. This occurs for each subsequence call. Figure 3-53 illustrates how the DG2040 Data Generator compiles the sequence and subsequences into the internal codes and stores them in the sequence memory.

Defining subsequence calls with large repeat counts can generate internal code that consumes a large amount of sequence memory. This can result in insufficient memory errors. The DG2040 Data Generator does not check for sequence memory availability errors. If you run a sequence and the DG2040 Data Generator displays a memory error message, reduce the number of subsequence calls, the number of repeat counts and/or the number of lines in the subsequences.

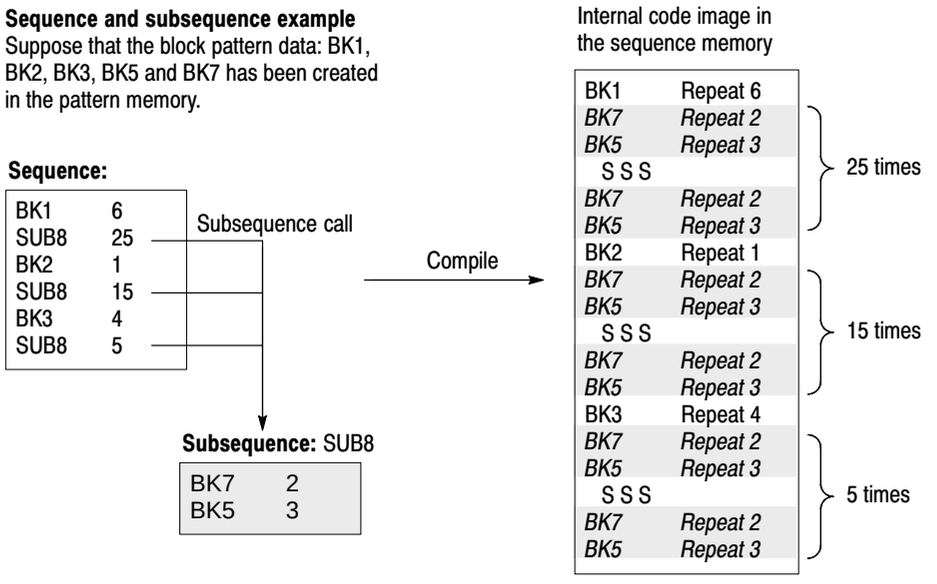


Figure 3-53: Example of a sequence expanded into sequence memory

About Event Jump

In enhanced mode the sequence program can jump to the line number set in the **Event Jump** field in response to an event input from the rear panel connector when the output reaches the end of the block in the block field. This is called the event jump function.

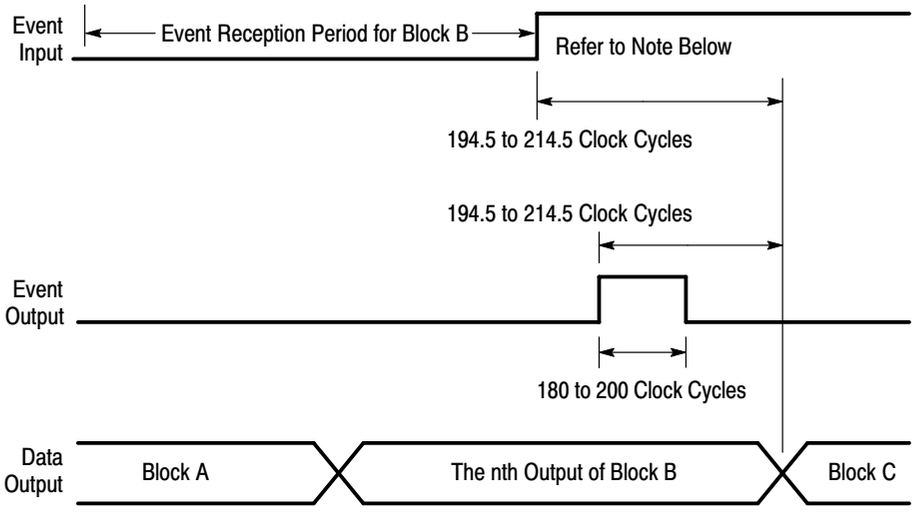
The event jump function can be applied to any line in the sequence program with the **Make Sequence → Set Enhanced Control → Event Jump** menu item.

In the enhanced mode, after the block data for a sequence program for which the event jump function has been set and has finished outputting, the DG2040 Data Generator determines whether to perform an event jump.

The fact that an event request occurred is stored in a flip-flop in the pattern control circuit when either a low level to high level transition occurs in the event input or the front panel **STEP/EVENT** button is pressed.

Then, when the end of the output of the block in a line for which the **Event Jump** item is set approaches, the DG2040 Data Generator checks the state of that flip-flop, activates the event jump operation, and clears the flip-flop. A rising edge in the signal applied to the event input is seen as an event request, and causes the next event jump operation to occur. This happens also in the trigger wait state and during the output of data for a block for which the **Event Jump** item was set to off.

The event jump operation occurs even if the block pattern has not been output for the number of repeats set in the sequence program. When an event jump operation occurs, a positive TTL-level pulse, from 194.5 to 214.5 clocks wide, is output from the front–panel event output connector 180 to 200 clocks before the block pattern switches. One half of one clock is the falling edge of the clock.



n: A value between 1 and the value determined by the iteration count

Note: If an event exists before the event out starts rising, the event jump will be made at the next block. If the the event is coming after the event out starts rising, the event jump will be performed at the block after the next block.

The number of clock varies depending on the pattern size of that block. This is because the clock is generated from the ECL clock circuit by dynamically dividing into 9 or 10 cycles.

Figure 3-54: Event jump operation timing

Undo

After performing an edit function, you can press the **Undo** button to return to the state immediately prior to your edit.

Setup Menu

The bottom menu for the **SETUP** menu includes the **Group Assign**, **Output Condition**, **Level Condition**, **Timing Condition**, **Run Mode**, **Trigger**, and **Clock** items. This section describes these items. Table 3-17 lists the functions of the **SETUP** menu items and the pages where their documentation appears.

Table 3-17: SETUP menu functions

Bottom	Side or pop-up menu		Function	Page
Output Condition	Assign Condition		Assigning data bit to output channel	3-70
	Control Condition	Event Level	Setting the event control input level	3-71
		Event	Setting the event control to enable or disable	
Level Condition	High		Setting the output high level	3-72
	Low		Setting the output low level	3-72
Timing Condition	Delay		Setting the delay timing	3-73
Run Mode	Repeat		Selecting a run mode	3-74
	Single			3-74
	Step			3-75
	Enhanced			3-75
	Update		Setting the data update method	3-76
Trigger	Slope		Selecting a trigger slope	3-77
	Trigger Level		Setting the trigger level	3-77
	Impedance		Setting the trigger input impedance	3-78
	Source		Selecting a trigger source	3-78
	Interval	State	Specifying the trigger interval	3-78
		Time		
Clock	Reference		Setting the clock source	3-79
	Int FREQ		Setting the internal clock frequency	3-79
	Ext FREQ		Setting an external clock frequency	3-79

Setup Display

This section describes the **SETUP** menu screen. Figure 3-55 shows the menu. Table 3-18 provides descriptions and page number references.

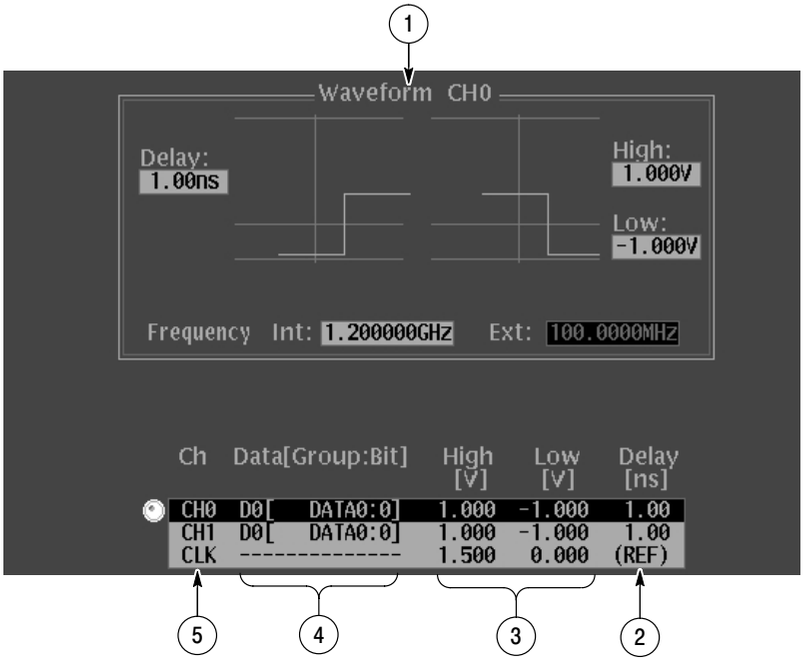


Figure 3-55: SETUP menu display

Table 3-18: Setup menu display

Screen reference	Function	Page
1	Shows the pulse parameters set for a selected output channel and the frequency currently set.	3-73
2	Shows the output delays. Delays can only be set for each output channel.	3-73
3	Shows the high and low values of the output voltage. These voltages can be set to arbitrary values between –1.125 and 3.5 V.	3-72
4	Shows the data bits and the group to which each data bit belongs.	– – – – – – –
5	Shows the output channel. The channels are labeled number 0 and number 1.	– – – – – – –

Group Assign Menu

***NOTE**. The Group assign function becomes important if the number of data bits (channels) increases. However, this function is not important for the DG2040 that has only two channels. This function remains for increased number of channels in the future.*

This menu is used to define groups for data bits. The pop-up menu shown in Figure 3-56 lists the currently defined groups.

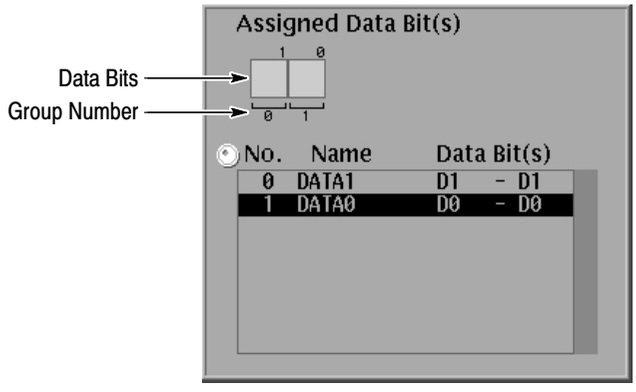


Figure 3-56: Group Assign pop-up menu

See Figure 2-6 for the group allocation.

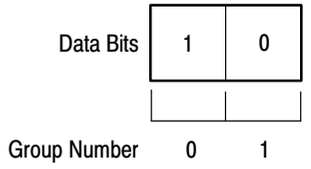
Add Group

The Add Group menu allows you to add a new group. A new group cannot be added if there is already two groups defined.

Each data bit has a default group name. The default group names are DATA1 for data bit 1, and DATA0 for data bit 0. You can combine several data bits into a new group and define a new group name.

The bit structure of a group is defined by specifying the Most Significant Bit (MSB) and Least Significant Bit (LSB) of the group. If the bit structure of a new group overlaps with that of an existing group, the newly defined group takes precedence and the structure of the existing group is automatically modified. Figure 3-57 shows an example of a bit structure assignment.

Current data bit assignments (see Figure 3-56)



Data bit assignments for an added group (an Example)

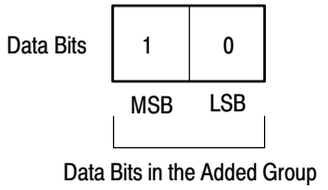


Figure 3-57: Bit structure assignment

Operation. Do the following to add a group.

Bottom button	pop-up menu	Side button
Group Assign		Add Group
	Input the name of the new group.	OK
		MSB (Specify the MSB)
		LSB (Specify the LSB)
		OK
		OK

Delete Group

The Delete Group menu allows you to delete the group selected with the cursor. This function asks for confirmation before actually deleting the group.

Operation. Do the following to delete a group.

Bottom button	pop-up menu	Side button
Group Assign	Select the group to be deleted.	Delete Group
		OK

Rename

The Rename menu allows you to change the name of the group selected with the cursor.

Operation. Do the following to rename a group.

Bottom button	pop-up menu	Side button
Group Assign	Select the group whose name is to be changed.	Rename
	Input a new name.	OK

Group Bit(s) Config

The Group Bit(s) Config menu allows you to change the bit configuration of the group selected with the cursor. If the result of the changed configuration overlaps an existing group, the newly defined group takes precedence.

Operation. Do the following to change a groups bit configuration.

Bottom button	pop-up menu	Side button
Group Assign		Group Bit(s) Config
		MSB (Specify the MSB)
		LSB (Specify the LSB)
		OK

Reset All bits Assign

The Reset All bits Assign menu allows you to delete the currently defined group definitions and returns the group settings to the initial state. Refer to Factory Settings in *Appendix C*.

Operation. Do the following to delete a group definition.

Bottom button	pop-up menu	Side button
Group Assign		Reset All bits Assign
		OK

Output Condition Menu

The Output Condition menu defines which data bits are assigned to which output channel. The menu lists the data bits at the right and the output channels at the left. Refer to Figure 3-58. Use the general-purpose knob to select data bits and the up and down arrow buttons to select output channels.

Assign Condition

The **Assign Condition** function assigns the selected data bit to the selected output channel. The currently set value is overwritten.

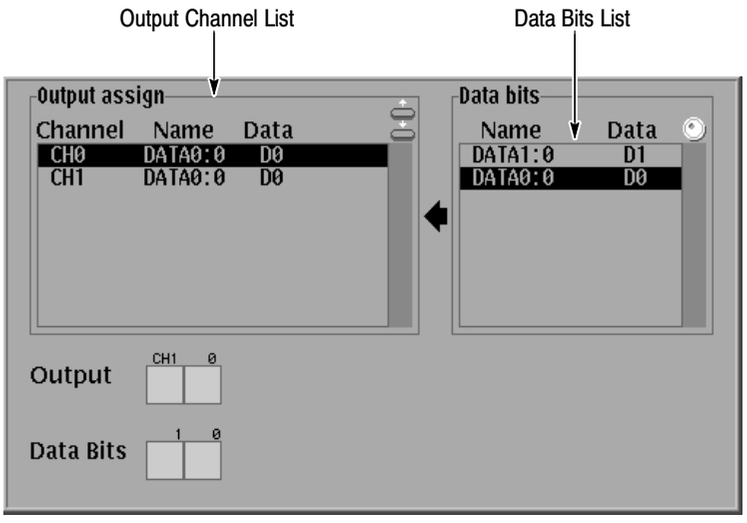


Figure 3-58: Output channel assign pop-up menu

See Figure 2-6 for the output channel allocation.

Sub Menu

Item	Function
Assign	Assigns the selected data bit to the selected output channel using the pop-up menu brought up at the same time as the pop-up menu. Refer to Figure 3-58. The currently set value is overwritten.
Release	Clears the data for the selected assignment.

Operation. Do the following to assign a data bit to the output channel.

Bottom button	Pop-up menu	Side button
Output Condition		Assign Condition
Select a data bit with the general-purpose knob.		

Operation. Do the following to assign a data bit to the output channel.

Bottom button	Pop-up menu	Side button
Select the channel to be assigned using the up and down arrow buttons.		
		Assign

***NOTE**. Note that the settings performed using the **Output Channel Assign** menu do not take effect unless the **OK** button is pressed.*

Operation. Do the following to clear the output channel assignment.

Bottom button	Pop-up menu	Side button
Output Condition		Assign Condition
Select the channel for which the data assignment is to be cleared using the up and down arrow buttons.		
		Release

Control Condition

The **Control Condition** function sets the event control input level and whether the event control is enabled or disabled.

Sub Menu

Item	Function
Event Level	Sets the event control input threshold level. This level can be set in the range of –5 V to +5 V.
Event	Enables or disables the event control.

Operation. Do the following to set the event input level.

Bottom button	Pop-up menu	Side button
Output Condition		Control Condition
		Event Level (Set the event level)

Operation. Do the following to enable or disable the event control.

Bottom button	Pop-up menu	Side button
Output Condition		Control Condition
		Event (Select Enable or Disable)

Level Condition Menu

This menu sets the channel output high and low voltage levels and controls whether output is disabled in the output stopped state.

High

The **High** function determines the output voltage when the data value is 1 (high level state). You can set the level within the range between –0.875 V and +3.50 V (into 50 a Ω load). The difference between the high level and low level voltages must be between 0.25 V and 2.5 V. The displayed voltages are the voltages when the outputs are open.

Operation. Do the following to set the output to high level.

Bottom button	Pop-up menu	Side button
Level Condition		High (the high level setting)

Low

The **Low** function determines the output voltage when the data value is 0 (low level state). You can set the level within the range of –1.125 V and +3.25 V (into 50 a Ω load). The difference between the low level and high level voltages must be between 0.25 V and 2.5 V. The displayed voltages are the voltages when the outputs are open.

Operation. Do the following to set the output to low level.

Bottom button	Pop-up menu	Side button
Level Condition		Low (the low level setting)

Timing Condition Menu

This menu lets you set the delay timing parameters of each channel . Figure 3-59 shows the current delay time settings of an example output channel. You can also see the same image in the SETUP menu. Highlighted lines indicate the pulse edges currently set. The three nonhighlighted horizontal lines from the top indicate the highest, 0, and lowest voltage levels that can be set. The two nonhighlighted vertical lines indicate the signals rising edge at left and falling edge at right.

If the pulse edges are positioned at the nonhighlighted vertical lines, the positive delay is currently set to zero. If the pulse edges are positioned left of the nonhighlighted lines, the output pattern data will be delayed.

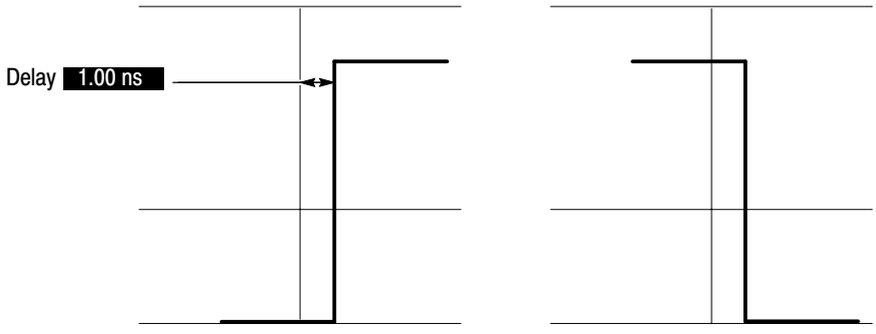


Figure 3-59: Example delay parameter

Delay

The delay can be adjusted in the range of –1.0 ns to 2.0 ns in 10 ps steps for each output.

Operation. Do the following to set the output delay.

Bottom button	Pop-up menu	Side button
Timing Condition		
Select the channel for which the rise time is to be set using the knob.		
		Delay (the delay setting)

Run Mode Menu

This menu sets the run mode used to output pattern data, and sets the pattern data output update method used when data is changed.

Operation. Do the following to set the run mode.

Bottom button	Pop-up menu	Side button
Run Mode		Select the run mode (Repeat, Single, Step, or Enhanced)

Repeat Repeats the pattern data output. When no sequence is defined, all of the pattern data is output repeatedly as a single pattern as shown in Figure 3-60. If a sequence is defined, the sequence ordering and repeat (**Repeat Count**) functions are applied. The extended sequence functions (trigger input, event jump, and so on) are ignored as shown in Figure 3-61.

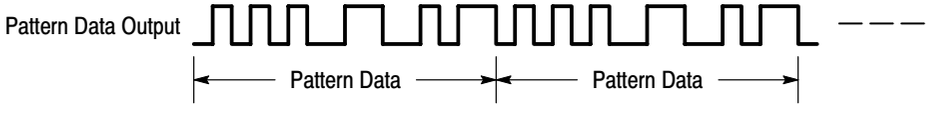
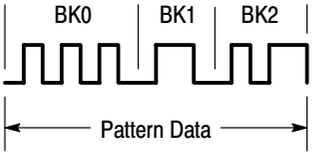


Figure 3-60: Repeat Mode pattern data output (when no sequence is defined)

Line No.	Block	Repeat Count
0	BK0	1
1	BK1	3
2	BK2	2



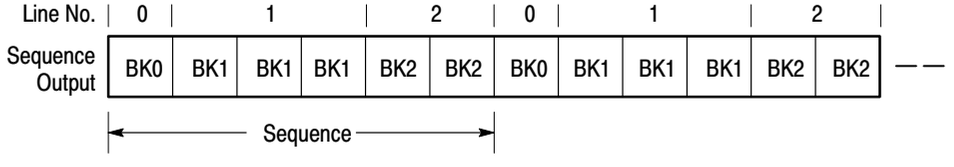


Figure 3-61: Repeat Mode pattern data output (when a sequence is defined)

Single Pattern data is output only once when a trigger input is received. A trigger signal is received either when the front-panel **FORCE TRIGGER** button is pressed or when an external trigger signal is input to the **TRIGGER INPUT** connector.

When no sequence is defined, all of the pattern data is output as a single waveform as shown in Figure 3-62. If a sequence is defined, the sequence ordering and repeat (**Repeat Count**) functions are applied as shown in Figure 3-63. The extended sequence functions (trigger input, event jump, etc.) are ignored.

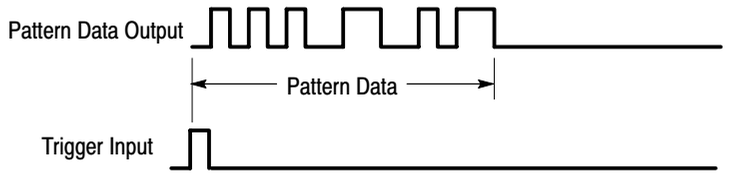


Figure 3-62: Single Mode pattern data output (when no sequence is defined)

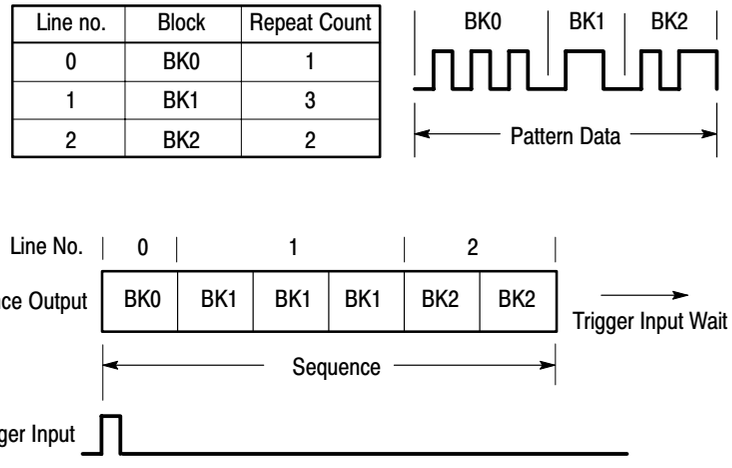


Figure 3-63: Single Mode pattern data output (when a sequence is defined)

Step Pattern data is output not according to the internal clock, but rather according to a clock signal generated manually with the **STEP/EVENT** button. Pattern data is output using the method used by the **Repeat** item.

Enhanced Pattern data is output as defined by the sequence. The extended sequence functions (trigger input, event jump, etc.) are valid during this output. The **Repeat Count** item setting is used for sequences for which the repeat count is not set to **Infinite**. Figure 3-64 shows an example of an enhanced mode sequence. Also refer to the description of the **EDIT** menu **Make Sequence** menu on page 3-57.

Line No.	Block	Repeat Count	Trigger Input (Trig Wait)	Event Jump
0	BK0	1	On	
1	BK1	Infinite		2
2	BK2	2		
3	BK3	2	On	
4	BK4	5		0

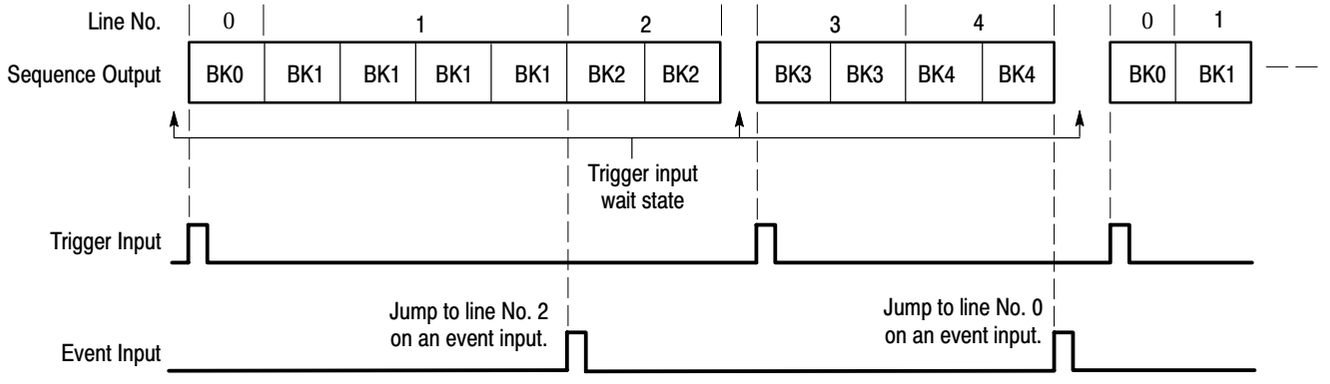


Figure 3-64: Enhanced Mode sequence output

Update

This **Run Mode** function sets the update method for rewriting data to the output when pattern data, the sequence, or other items are changed. Select **Auto** or **Manual**.

Auto. Rewrites the output data with new data immediately at the point when any change occurs to the pattern data. The **START/STOP** button LED indicator blinks rapidly during data update.

Manual. The output data is not immediately rewritten when the pattern data is changed. When the displayed data and the output data differ, the **START/STOP** buttons LED indicator blinks slowly. To rewrite the pattern data, stop data output temporarily by pressing the **START/STOP** button, and then restart output by pressing the **START/STOP** button once again. Also note that changed pattern data is also written when the run mode changes.

Operation. Do the following to set the data update method.

Bottom button	Pop-up menu	Side button
Run Mode		Update (Select Auto or Manual)

Trigger Menu

The **Trigger** menu sets the trigger settings. Figure 3-65 shows the setting selections.

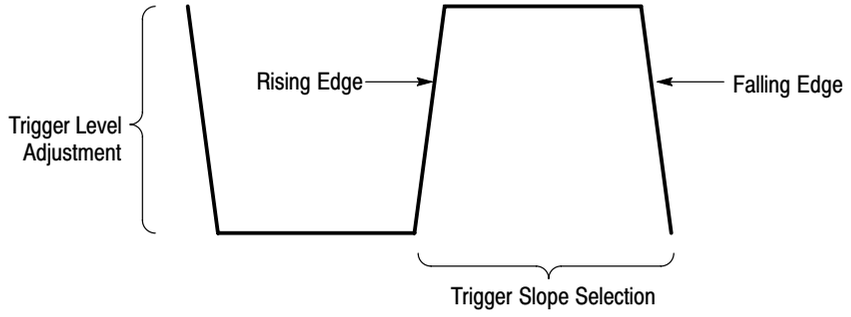


Figure 3-65: Trigger slope and level control

Slope

The **Slope** function sets whether a trigger is recognized on either a rising or falling edge of the signal applied to the trigger input.

Positive: Rising edge
Negative: Falling edge

Operation. Do the following to set the slope.

Bottom button	Pop-up menu	Side button
Trigger		Slope (Select Positive or Negative)

Level

The **Level** function sets the threshold voltage for detecting a trigger. The value can be set from –5 V to +5 V in 0.1 V steps.

Operation. Do the following to set the level.

Bottom button	Pop-up menu	Side button
Trigger		Level (Set the trigger level.)

Impedance

The **Impedance** function sets the trigger input connection impedance. An impedance of either 50 Ω or 1 kΩ can be set.

Operation. Do the following to set the trigger input impedance.

Bottom button	Pop-up menu	Side button
Trigger		Impedance (Select 50 Ω or 1 kΩ)

Source

The **Source** function selects internal (**Int**) or external (**Ext**) as a trigger source. When **Int** is selected, the signal generated from the internal trigger generator is used. In this case, the trigger signal can be generated repeatedly at a certain interval specified with the **Interval** menu item. When **Ext** is selected, the trigger signal connected to the **TRIGGER INPUT** connector on the front panel is used.

Operation. Do the following to select a source.

Bottom button	Pop-up menu	Side button
Trigger		Source (Select Int or Ext)

NOTE. *Press **FORCE TRIGGER** on the front panel to create a trigger event.*

Interval

The **Interval** function sets the trigger generator to repeatedly generate the trigger signal at a certain interval. Set the trigger interval to On and then set the interval period.

When the trigger source is set to internal and the trigger interval state is set to Off, a trigger signal is generated by pressing the **FORCE TRIGGER** button on the front panel.

Operation. Do the following to set the trigger interval to on or off.

Bottom button	Pop-up menu	Side button
Trigger		Interval
		State (Select On or Off)
		Time (Set the interval time)

Clock Menu

The **Clock** menu determines the reference clock (and clock rate) used when pattern data is output.

Reference

The **Reference** function determines whether the internal clock (**Int**) or an external input clock (**Ext**) is used as the reference clock.

Operation. Do the following to set the clock source.

Bottom button	Pop-up menu	Side button
Clock		Reference (Select Int or Ext)

Int FREQ

The **IntFREQ** function sets the internal clock frequency. The frequency can be set in the range of 100 MHz to 1.125 GHz. When **Reference** is set to **Int**, the time axis resolution used for the display of pattern data will be the reciprocal of this setting.

Operation. Do the following to set the internal clock frequency.

Bottom button	Pop-up menu	Side button
Clock		Int FREQ (Set the frequency)

Ext FREQ

The **ExtFREQ** function sets the external clock frequency. The frequency can be set in the range of 100 MHz to 1.125 GHz. When **Reference** is set to **Ext**, the time axis resolution used for the display of pattern data will be the reciprocal of this setting.

Operation. Do the following to set the external clock frequency.

Bottom button	Pop-up menu	Side button
Clock		Ext FREQ (Set the frequency)

Application Menu

The bottom menu for the **APPLICATION** menu includes the **Edge Control** item. This section describes this item. Table 3-19 lists the functions of the **APPLICATION** menu items and the pages where their documentation appears.

Table 3-19: APPLICATION menu functions

Bottom	Side or pop-up menu	Function	Page
Edge Control	Edge Ctrl	Setting the edge control	3-83
	Position Offset	Setting the edge timing	3-83

Edge Control Menu

The DG2040 Data Generator has an edge control function that moves the specified rising and/or falling edge(s) in the pattern set in the DATA0. The edge(s) can be specified using the edge control window.

An external edge control signal coming from the EDGE CONTROL input connector on the front panel moves the specified edge position according to the edge control transfer function shown in Figure A-2 on page 0-9. When you input a sine wave to the EDGE CONTROL input connector, the specified edge(s) move(s) as shown in Figure 3-66.

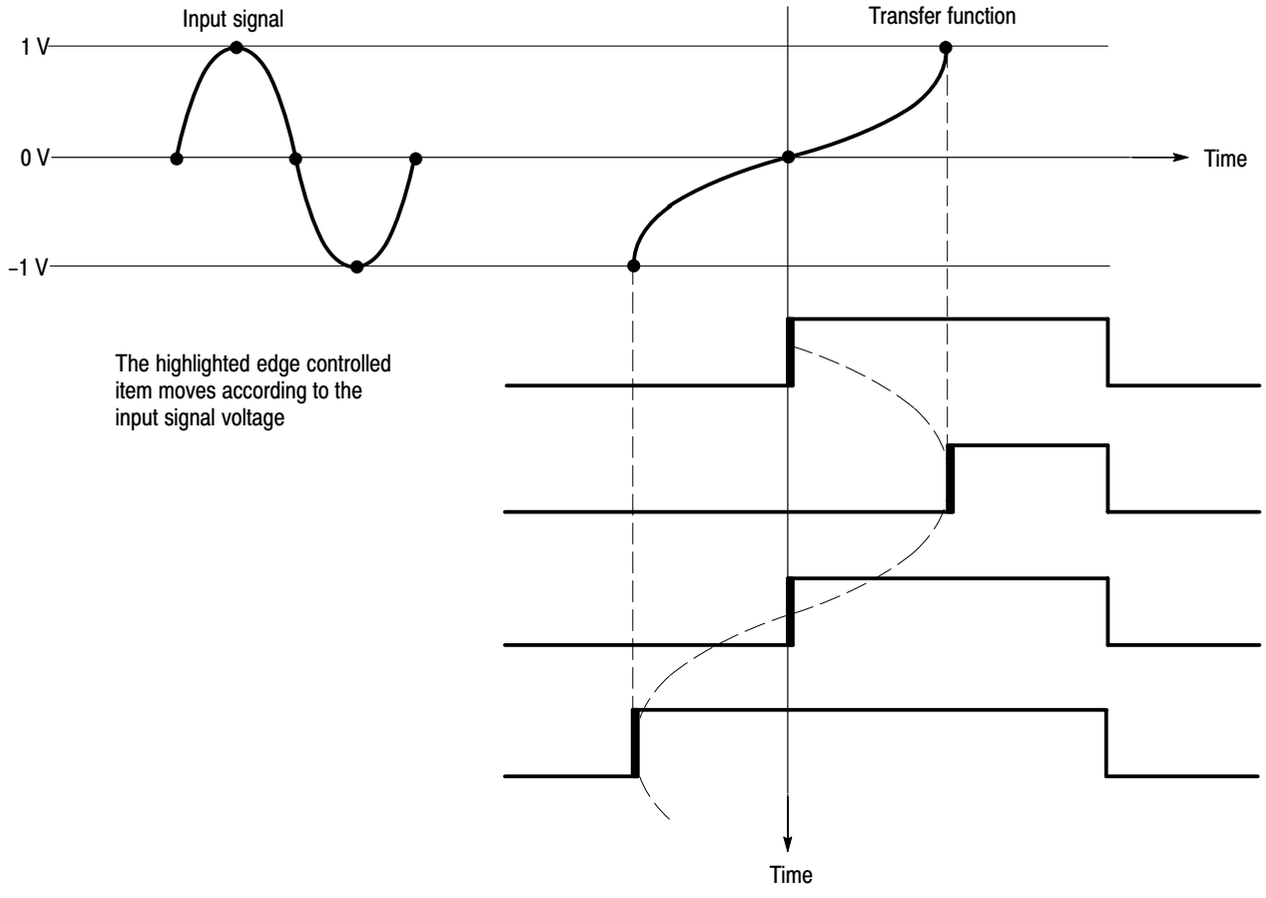
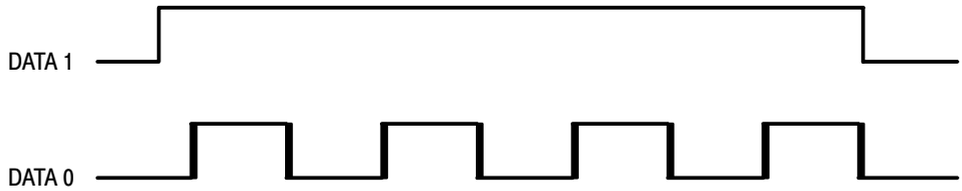
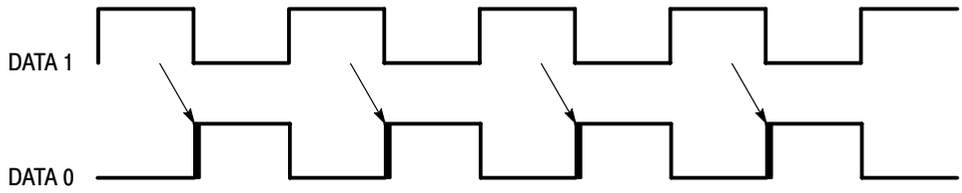


Figure 3-66: Relation between incoming signal and edge position shift

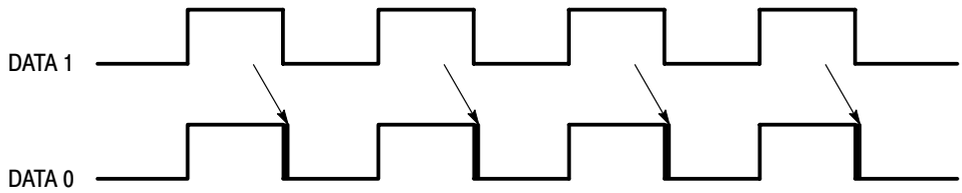
You can also set the edge offset position within the range from –100 ps to 100 ps with the Position Offset side menu. Both the incoming signal voltage and the setting in the Position Offset side menu affect the specified edge to be moved. Figure 3-67 shows an example of the edge control window.



(a) To specify all rising and falling edges in the DATA0, set the all bits in the DATA1 to 1.



(b) To specify all rising edges in the DATA0, copy the DATA0 pattern to DATA1, and then shift the DATA1 pattern to right or left.



(c) To specify all falling edges in the DATA0, copy the DATA0 pattern to DATA1.

Figure 3-67: Examples of the edge control bit

The specified edges are highlighted in the EDIT menu.

Edge Ctrld. The **EdgeCtrl** function sets the edge control to on or off.

Operation. Do the following to set the edge control to on or off.

Bottom button	Pop-up menu	Side button
Edge Control		Edge Ctrl (Select On or Off)

If necessary, go into the EDIT menu by pressing the **EDIT** button after you have set the Edge Control to On.

Position Offset. Set the deviation time from the original position. The position offset can be set from –100 ps to + 100 ps in 5 ps steps.

Operation. Do the following to set the time.

Bottom button	Pop-up menu	Side button
Edge Control		Position Offset (Set the time)

Utility Menu

The bottom menus for the **UTILITY** menu include the **Mass Memory**, **Cal**, **Display/Hardcopy**, **System**, **Deskew, Status**, and **Diag** items. When one of the bottom menu items is selected the related base menu is displayed. Parameters are selected using these base menus. Table 3-20 lists the functions of the **UTILITY** menu items and the pages where their descriptions appear.

Table 3-20: UTILITY menu functions

Bottom	Base menu or Side menu		Function	Page
Mass Memory (Floppy Disk)	Change Directory		Changing the current directory	3-85
	Make Directory		Creating directories	3-85
	Rename		Changing a file or directory name	3-85
	Copy or Delete	Copy	Copying files	3-86
		Delete	Deleting files	3-86
		Delete All	Deleting all files	3-86
	Special	Initialize Media	Formatting a 3.5 inch floppy disk	3-87
		Catalog order	Setting the directory listing order	3-87
		Lock	Locking a file	3-87
Display/Hardcopy	Clear Message Area		Removing message displays	3-91
System	Reset to Factory		Restoring the factory settings	3-95
	Security Immediate		Erasing internal memory data	3-95
Status			Displaying the instrument information	3-96
Diag	Type	All	Selecting functional block or all block and executing the diagnostic test.	3-96
		CPU		
		Display		
		FPanel		
		Clock		
		Trig		
		SMem		
		TPMem		
	Execute			

Mass Memory Menu

The **Mass Memory** menu is used to access the contents of the 3.5 inch floppy disk inserted in the instruments disk drive. This menu supports changing and creating directories, file copying and deleting, and 3.5 inch floppy disk formatting.

Change Directory. The **Change Directory** function changes the current directory.

Operation. Do the following to change the directory.

Bottom button	Pop-up menu	Side button
Mass Memory		Change Directory
	Select the directory to switch to.	OK

Make Directory. The **Make Directory** function creates a subdirectory in the current directory.

Operation. Do the following to create a directory.

Bottom button	Pop-up menu	Side button
Mass Memory		Make Directory
	Enter the name of the directory.	OK

Rename. The **Rename** function changes the name of a file or directory on the 3.5 inch floppy disk. The file extension is not changed by this function.

Operation. Do the following to change a file or directory name.

Bottom button	Pop-up menu	Side button
Mass Memory	Select the file or directory to be renamed.	Rename
		Clear String
	Enter the new file or directory name.	OK

Copy or Delete. The **Copy or Delete** function copies or deletes files on the 3.5 inch floppy disk.

Sub Menu

Item	Function
Copy	Copies the selected file on the 3.5 inch floppy disk, creating a new file.
Delete	Deletes the selected file from the 3.5 inch floppy disk.
Delete All	Deletes all the files in the current directory.
	Note: *If there is a subdirectory that is not empty in the current directory,, it will not be deleted. Also, locked files will not be deleted.*

Operation. Do the following to copy a file.

Bottom button	Pop-up menu	Side button
Mass Memory		Copy or Delete
	Select the file to copy.	Copy
		OK
	Enter the name of the copy of the file.	OK

Operation. Do the following to delete a file.

Bottom button	Pop-up menu	Side button
Mass Memory		Copy or Delete
	Select the file to delete.	Delete
		OK

Special. The **Special** function supports formatting 3.5 inch floppy disks, setting the file listing display order, and setting file locks.

Side Menu

Item	Function	
Initialize Media	Formats a 3.5 inch floppy disk. Selecting this menu item pops up a list of floppy disk formats. Choose the format from the following list to format the 3.5 inch floppy disk: IBM-PC 2HD PC9800 2HD J3100 2HD IBM-PC 2DD PC9800 2DD The volume label DG2040 Data Generator is automatically assigned to the 3.5 inch floppy disk by the formatting operation.	
Catalog Order	Specifies the order for display when listing a directory. Select the order from the following types:	
	Type	**Order**
	NAME1	ASCII order
	NAME2	Reverse ASCII order
	TIME1	In the order created, starting with the oldest
	TIME2	In the order created, starting with the newest
Lock	Changes the write protect attribute of the selected file. When the lock attribute is On, writing is prohibited, and when the lock attribute is Off, writing is allowed.	

Operation. Do the following to format a 3.5 inch floppy disk.

CAUTION. *All data on a disk is deleted by the formatting operation. To prevent data loss, always check the contents of a disk before formatting it.*

Bottom button	Pop-up menu	Side button
Mass Memory		Special
		Initialize Media
	Select the format type.	OK
		OK

Operation. Do the following to set the directory listing order.

Bottom button	Pop-up menu	Side button
Mass Memory		Special
		Catalog Order (Select the display type)

Operation. Do the following to lock a file.

Bottom button	Pop-up menu	Side button
Mass Memory		Special
		Lock (Select On)

Display/Hardcopy Menu

This menu is used to set the display and hardcopy settings. Select the items to be changed using the up and down arrow buttons, and change the value or the item using the left and right arrow buttons or the general-purpose knob.

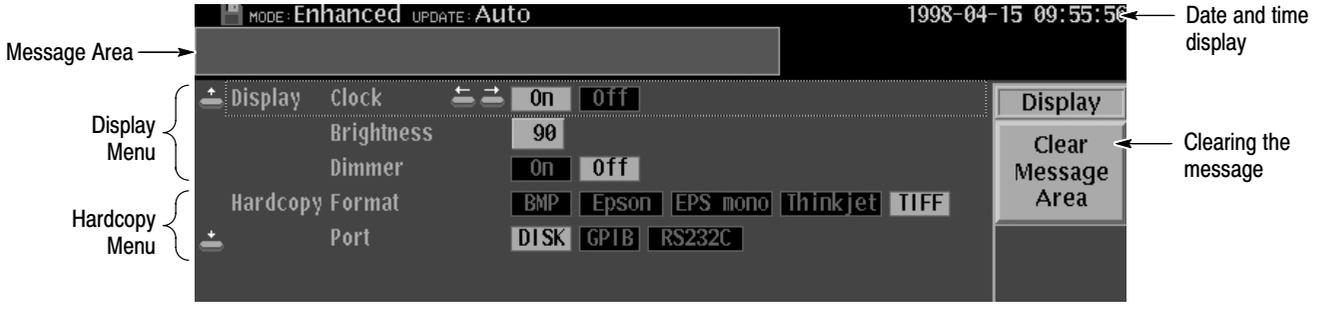


Figure 3-68: Display/hardcopy menu

Display. The **Display** function sets the date and time display, adjusts the screen brightness, and sets the dimmer. The dimmer function automatically reduces the screen brightness if the DG2040 Data Generator is left for 10 minutes without any controls being used.

Base menu

Item	Function
Clock	The date and time are displayed at the upper right of the screen when this setting is On.
Brightness	Adjusts the screen brightness. The value can be set in the range from 0 to 100, with 100 being the maximum brightness. The default value is 70.
Dimmer	When set to On, the screen brightness is reduced if 10 minutes elapses without any front-panel control being used. The screen returns to its original brightness when any key is pressed.

Operation. Do the following to display the date and time.

Bottom button	Pop-up menu	Side button
Display/Hardcopy	Select Display Clock with the up and down arrow buttons.	
	Select On with the left and right arrow buttons.	

Operation. Do the following to adjust the screen brightness.

Bottom button	Pop-up menu	Side button
Display/Hardcopy	Select Display Brightness with the up and down arrow buttons.	
	Adjust the brightness.	

Operation. Do the following to set the dimmer.

Bottom button	Pop-up menu	Side button
Display/Hardcopy	Select Display Dimmer with the up and down arrow buttons.	
	Select On with the left and right arrow buttons.	

Hardcopy. The **Hardcopy** function sets the screen hard copy data format settings, and sets the hard copy output port. For connecting the printer to the GPIB or RS-232-C port, also refer to *System Menu* on page 3-92. When you select Disk as a hard copy port, you can capture and save a screen image to a file in a specific format.

Base menu

<table>
<tr><th>Item</th><th colspan="3">Function</th></tr>
<tr><td rowspan="7">Format</td><td colspan="3">Sets the screen hard copy data format. The following are the menu options and the formats they specify.</td></tr>
<tr><td>Menu item</td><td colspan="2">Format</td></tr>
<tr><td>BMP</td><td colspan="2">Windows BMP</td></tr>
<tr><td>Epson</td><td colspan="2">Epson ESC-P</td></tr>
<tr><td>EPS mono</td><td colspan="2">Encapsulated Postscript</td></tr>
<tr><td>Thinkjet</td><td colspan="2">HP Thinkjet</td></tr>
<tr><td>TIFF</td><td colspan="2">TIFF</td></tr>
<tr><td rowspan="11">Port</td><td colspan="3">Sets the device for screen hard copy data output.</td></tr>
<tr><td>Menu item</td><td colspan="2">Device</td></tr>
<tr><td>DISK</td><td colspan="2">Floppy disk</td></tr>
<tr><td>GPIB</td><td colspan="2">GPIB</td></tr>
<tr><td>RS-232-C</td><td colspan="2">Serial port</td></tr>
<tr><td colspan="3">When hard copy output is to the disk, a file name with the format HC_XXX.YYY is used. Here, XXX is a serial number that is started from 000, and YYY is an extension that depends on the format used. XXX is chosen so as not to overwrite existing data. The table below lists the correspondence between formats and extensions.</td></tr>
<tr><td>Menu item</td><td>Format</td><td>Extension</td></tr>
<tr><td>BMP</td><td>Windows BMP</td><td>BMP</td></tr>
<tr><td>Epson</td><td>Epson ESC-P</td><td>ESC</td></tr>
<tr><td>EPS mono</td><td>Encapsulated Postscript</td><td>EPS</td></tr>
<tr><td>Thinkjet</td><td>HP Thinkjet</td><td>TJ</td></tr>
<tr><td>TIFF</td><td>TIFF</td><td>TIF</td></tr>
</table>

Operation. Do the following to set the hard copy format.

Bottom button	Pop-up menu	Side button
Display/Hardcopy	Select Hardcopy Format with the up and down arrow buttons.	
	Select the format with the left and right arrow buttons.	

Operation. Do the following to select hardcopy output port.

Bottom button	Pop-up menu	Side button
Display/Hardcopy	Select Hardcopy Port with the up and down arrow buttons.	
	Select the port with the left and right arrow buttons.	

Clear Message Area. The **Clear Message Area** function clears the message displayed in the message area.

Operation. Do the following to remove message displays.

Bottom button	Pop-up menu	Side button
Display/Hardcopy		Clear Message Area

System Menu

The **System** menu sets the instrument date, time, and the GPIB/serial port settings. The GPIB and serial ports can be used for remote control and screen hardcopy. Select the items to be changed using the up and down arrow buttons, and change the value or the selection using the left and right arrow buttons or the general-purpose knob.

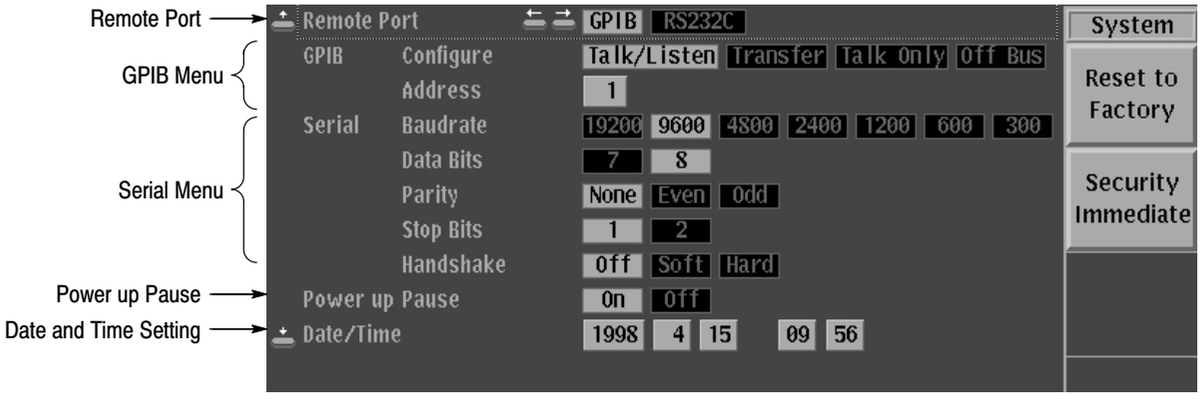


Figure 3-69: System menu

Remote Port. The **Remote Por**t function sets the port used for external remote control. The **GPIB** or the **RS-232-C** can be selected.

Operation. Do the following to set the port.

Bottom button	Pop-up menu	Side button
System	Select Remote Port with the up and down arrow buttons.	
	Select the port with the left and right arrow buttons.	

GPIB. The **GPIB** function sets the GPIB operating mode and address of the DG2040 Data Generator for remote control or hardcopy.

Base Menu

Item	Function	
Configure	Sets the GPIB operating mode.	
	Operating Mode	**Function**
	Talk/Listen	Normal remote control
	Talk Only	Used for hard copy output.
	Off Bus	The connection between the instrument and the bus is set to the disconnected state.
Address	Sets the instruments GPIB address. The address can be set to a value between 0 and 30.	

Operation. Do the following to set the GPIB operating mode.

Bottom button	Pop-up menu	Side button
System	Select GPIB Configure with the up and down arrow buttons.	
	Select the operating mode with the left and right arrow buttons.	

Operation. Do the following to set the GPIB address.

Bottom button	Pop-up menu	Side button
System	Select GPIB Address with the up and down arrow buttons.	
	Select the address with the general-purpose knob.	

Serial. The **Serial** function sets the baud rate, data length for transmitted data, parity, number of stop bit, and flow control method for the serial port. These parameters are set to match the settings of the connected external controller for remote control or printer for hardcopy.

Base Menu

Item	Function
Baud rate	Sets the transmission rate for the serial port. A transmission rate of 300, 600, 1200, 2400, 4800, 9600, or 19200 can be set.
Data Bits	Sets the data length for the transmitted data. A data length of 7 or 8 bits can be set.
Parity	Sets the kind of parity bit attached to transmitted data. The parity can be set to None, Even, or Odd.
Stop Bits	Sets the number of stop bits. 1 or 2 stop bits can be set.
Handshake	Sets the flow control method. Either Off, Soft, or Hard can be set for the flow control.

Operation. Do the following to set the serial interface parameters.

Bottom button	Pop-up menu	Side button
System	Select the Serial parameter with the up and down arrow buttons.	
	Select the item with the left and right arrow buttons.	

Power up Pause. The **Power Up Pause** function sets whether or not the instrument should wait for key input before starting operation in the event a diagnostics error was detected at start up. This setting is useful in cases where, for example, you do not want the system to wait for key input.

Operation. Do the following to set the power up pause.

Bottom button	Pop-up menu	Side button
System	Select Power up Pause with the up and down arrow buttons.	
	Select On with the left and right arrow buttons.	

Date/Time. The Date/Time function sets the internal clock date and time.

Operation. Do the following to set the date and time.

Bottom button	Pop-up menu	Side button
System	Select Date/Time with the up and down arrow buttons.	
	Select the parameter to change with the left and right arrow buttons.	
	Set the date and time with the general-purpose knob.	

Reset to Factory. The **Reset to Factory** function resets the instrument settings to the default factory settings. The instrument internal memory is not cleared by resetting to the factory settings. Refer to *Factory Settings* on page C-1 for a listing of the instrument factory settings.

Operation. Do the following to restore the factory settings.

Bottom button	Pop-up menu	Side button
System		Reset to Factory
		OK

Security Immediate. Erases the instruments internal memory data. At the same time, the instrument is reset to the factory settings state.

Operation. Do the following to erase memory data.

Bottom button	Pop-up menu	Side button
System		Security Immediate
		OK

Status Display

The **Status Display** function displays the instruments model number, the firmware version, the instruments configuration, and other information. See Figure 3-70.

Figure 3-70: Status display

Diag Menu

The **Diag Menu** function tests the instruments internal hardware. Diagnostics can be run as individual tests, or all tests can be run in one operation. If the diagnostics complete with no errors, **Pass** is displayed in the **Status** display area. If an error occurs, **Fail** is displayed. An error code is displayed in the **Comment** display area if a diagnostic test fails. See Figure 3-71.

***NOTE**. Contact your Tektronix sales representative if any errors occur.*

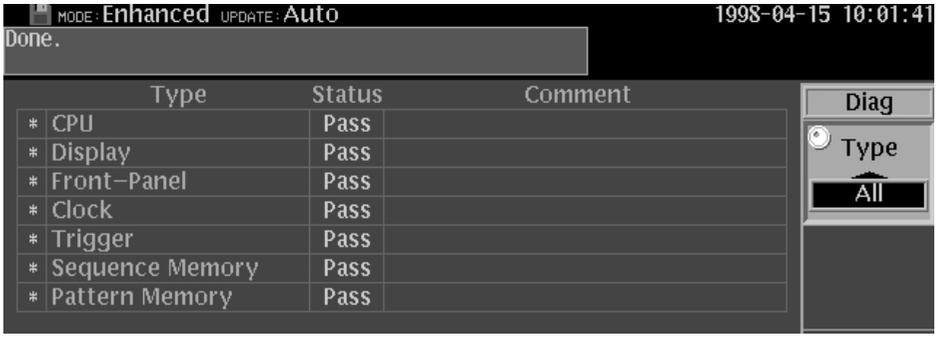


Figure 3-71: Diag menu

Table 3-21 lists the error codes, their meaning, and the failed board for the error code.

Table 3-21: Error Code

Error code	Description	Failed component
1XX	CPU diagnostics error	A6 CPU board
2XX	Display diagnostics error	A6 CPU board
3XX	Front panel diagnostics error	A12 Key board
4XX	Clock diagnostics error	A40 Clock board
5XX	Trigger diagnostics error	A40 Clock board
6XX	Sequence memory error	A50 PG & Output board
7XX	Pattern memory diagnostics error	A50 PG & Output board

Side Menu

Item	Function
Type	Selects the diagnostics test. Either individual items or all tests (All) can be selected. An asterisk is displayed next to selected items.
Execute	Executes the diagnostic tests for the items marked with an asterisk.

Operation. Do the following to select a diagnostic test.

Bottom button	Pop-up menu	Side button
Diag		Type (Select a diagnostic test or All with the general-purpose knob.)
		Execute

Appendices

Appendix A: Specifications

General Characteristics

This section describes the general characteristics of the DG2040 Data Generator.

All specifications are guaranteed unless labeled “typical”. Typical specifications are provided for your convenience but are not guaranteed. Specifications marked with the √ symbol are checked in the performance verification procedure beginning on page B-1.

The certification and compliances for the DG2040 Data Generator are found at the end of this appendix.

Performance Conditions

The electrical characteristics are valid under the following conditions:

- The instrument must be in an environment with temperature, altitude, humidity, and vibration within the operating limits described in these specifications.
- The instrument must have had a warm-up period of at least 20 minutes.
- The instrument must have been calibrated and adjusted at an ambient temperature between +20° C and +30° C.
- The instrument must be operating at an ambient temperature between +10° C to +40° C, unless otherwise noted.

Table A-1: Electrical characteristics

Characteristics	Description
Operation mode [1]	
Repeat	Pattern data is repeatedly output. When a sequence is specified, patterns are repeated according to the sequence order. The extended sequence functions such as trigger wait, event jump, and so on are ignored in this mode.
Single	Pattern data is output only once. When a sequence is specified, a trigger signal outputs according to the sequence order.
Step	Pattern data is output based on the clock, not specified by the clock source, but generated by pressing the **STEP/EVENT** button on the front panel. This mode is the same as the Repeat mode except for the clock.
Enhanced	Pattern data is output completely according to a sequence. All extended sequence functions, such as trigger wait, and event jump, are valid in this mode. This mode is the same as the Repeat mode except for the extended sequence functions.

Table A-1: Electrical characteristics (Cont.)

Characteristics	Description
Output pattern	
Pattern length	360 to 262144 points
Number of channels	2 Channels, Complementary
Sequence	Maximum 4000 steps
Number of blocks	Maximum 256
Internal trigger generator	
Internal trigger rate	
Range	1.0 µs to 10.0 s
Resolution	3 digits, 0.1 µs min.
Accuracy	± 0.01 %
Clock generator	
√ Internal clock	
Frequency	0.1 Hz to 1.1 GHz
Resolution	7 digits
Accuracy	± 0.0001 %, 1 year after shipment from factory
Data and clock out[1, 2]	
Connectors	CH0, $\overline{\text{CH0}}$, CH1, $\overline{\text{CH1}}$. (SMA connectors at front panel) CLOCK OUT, $\overline{\text{CLOCK OUT}}$ (SMA connector at rear panel) All outputs are complementary.
√ Output voltage	
Accuracy	
DC (data out)	(± 3 % of setting) ± 50 mV (into 50 Ω)
Amplitude (clock out)	(± 5 % of setting) ± 50 mV (into 50 Ω) at 1 MHz
Maximum Output Current	± 100 mA
Aberration	
Overshoot	< 5 % at 1.5 V_{p-p} at 10 MHz
Undershoot	< 5 % at 1.5 V_{p-p} at 10 MHz
√ Rise/fall time (20% to 80%)	< 150 ps at 1 V_{p-p} at 10 MHz, measured with a 0.5 m (20 inches), 50 Ω cable. See Optional Accessories on page 1-6 for details.
√ Channel skew	< ± (| 25° C – T_a | × 15 ps ± 100 ps), where T_a is the ambient temperature °C. At 10 MHz, 1.0 V high, 0 V low, in Repeat Mode, the pattern is Clock except when using the Edge Control function.

Table A-1: Electrical characteristics (Cont.)

Characteristics	Description
Period jitter	Measured by TDS694C–1MHD with TDSJIT1
(typical)	Refer to Table A-2.
Cycle to cycle jitter	Measured by TDS694C–1MHD with TDSJIT1
(typical)	Refer to Table A-3.
√ Delay function	
Delay channel	CH0 ($\overline{CH0}$), and CH1 ($\overline{CH1}$),
Delay time	–1.0 ns to +2.0 ns
Resolution	10 ps
Accuracy	$<(\pm 3\ \%$ of setting$) \pm \mid 25^\circ$ C – $T_a \mid \times 15$ ps $\pm$ 100 ps, where T_a is the ambient temperature °C. At 10 MHz, 1.0 V high, 0 V low, in Repeat Mode, the pattern is Clock except when using the Edge Control function.
Output impedance (typical)	50 Ω
Output voltage	
High level (V_{OH})	–1.75 V to +7.00 V (into 1 MΩ) –0.875 V to +3.5 V (into 50 Ω)
Low level (V_{OL})	–2.25 V to +6.50 V (into 1 MΩ) –1.125 V to +3.25 V (into 50 Ω)
Resolution	10 mV (into 1 MΩ) 5 mV (into 50 Ω)
Voltage swing ($V_{OH} - V_{OL}$)	0.5 V to 5 V (into 1 MΩ) 0.25 V_{p-p} to 2.5 V_{p-p} (into 50 Ω)
Event input	
Connector	BNC at rear panel
Threshold level	–5.0 V to +5.0 V, +1.4 V at default
Resolution	0.1 V
Input impedance (typical)	1 kΩ
Turning point for event jump	230.5 to 254.5 clocks before the next block. Refer to T_{ac} in Figure A-3 on page A-9.
Maximum input voltage	± 5 V
Polarity	Positive (rising edge)
Minimum pulse width	≧ 100 ns
Sensitivity	≧ 1.0 V_{p-p}

Table A-1: Electrical characteristics (Cont.)

Characteristics	Description
Event output	
Connector	BNC at rear panel
Level	
High level (V_{hi})	Approximately 5 V into 1 MΩ Approximately 2.5 V into 50 Ω
Low level (V_{lo})	Approximately 0 V into both 1 MΩ and 50 Ω
Delay time	194.5 to 214.5 clocks before data output change. Refer to T_{d5} in Figure A-3 on page A-9.
Pulse width	180 to 200 clocks. Refer to P_{W2} in Figure A-3 on page A-9.
Impedance	50 Ω
Sync output	
Connector	BNC at rear panel
Level (typical)	
High level (V_{OH})	Approximately 5 V (into 1 MΩ) Approximately 2.5 V (into 50 Ω)
Low level (V_{OL})	Approximately 0 V (into both 1 MΩ and 50 Ω)
Trigger Input (typical)	$55\ ns + 8/F_{clk\ (GHz)} \leqq T_{d1} \leqq 55\ ns + 12/F_{clk\ (GHz)}$ (Typical)
Delay time from external trigger input signal (typical)	Internal Reference. Refer to T_{d1} in Figure A-3 on page A-9.
Delay time to clock out and data out (typical)	1.5 Clocks, Refer to T_{d2} in Figure A-3 on page A-9.
Pulse width (typical)	32 or 36 clocks. Refer to P_{W1} in Figure A-3 on page A-9.
Impedance (typical)	50 Ω
Trigger input	
Connector	BNC at front panel
Threshold level	–5.0 V to +5.0 V, +1.4 V at default
Resolution	0.1 V
Threshold accuracy	(± 5 % of setting) ± 0.1 V
Minimum pulse width	≧ 10 ns
Sensitivity	≧ 0.5 V_{p-p}
Impedance	50 Ω ± 2 Ω 1 kΩ ± 100 Ω
Polarity	Positive or Negative
Maximum input	± 10 V into 1 kΩ ± 5 V into 50 Ω
Trigger holdoff	Minimum 100 ns

Table A-1: Electrical characteristics (Cont.)

Characteristics	Description
Reference 10 MHz clock input	
Connector	BNC at front panel
Input voltage range	0.2 V to 3.0 V_{p-p}
Input voltage level	± 10 V Max
Impedance	50 Ω, AC Coupling
Frequency Range	10 MHz ± 0.1 MHz
Edge control input	
Connector	BNC at front panel
Voltage Range (typical)	– 1 V to +1 V
Input Impedance (typical)	50 Ω
Frequency Range (typical)	DC to less than 500 MHz (–3 dB)
Transfer Function (typical)	See Figure A-2 on page A-9.
Display	
Display area	Width: 13.2 cm (5.2 inches) Height: 9.9 cm (3.9 inches)
Resolution	Horizontal: 640 pixels Vertical: 480 pixels
AC line power	
Rating Voltage	100-240 V AC
Voltage Range and Frequency Range	90-250 V AC, Input voltage frequency range is 48 Hz to 63 Hz
	90-127 V AC, Input voltage frequency range is 48 Hz to 440 Hz
Maximum power	300 W
Maximum current	4 A
Fuse rating	6A FAST, 250 V, UL 198G (3AG) 5A (T), 250 V, IEC 127

1 Clock outputs continuously regardless of the operation mode.

2 The data output duty cycle varies from 3:7 to 7:3 at 1.0 V_{p-p} during the 10 μs just after the output has been started. The clock continuously outputs regardless of the run mode or sequence.

Table A-2: Period JItter

Clock frequency	1.1 GHz		800 MHz	
Measurement	StdDev	Pk–Pk	StdDev	Pk–Pk
Clock output	3.0 ps	16 ps	3.0 ps	13 ps
CH0 output	3.5 ps	20 ps	3.5 ps	20 ps

Table A-3: Cycle to Cycle JItter

Clock frequency	1.1 GHz		800 MHz	
Measurement	StdDev	Pk–Pk	StdDev	Pk–Pk
Clock output	5.0 ps	28 ps	4.0 ps	22 ps
CH0 output	5.5 ps	32 ps	5.5 ps	32 ps

Table A-4: Mechanical characteristics

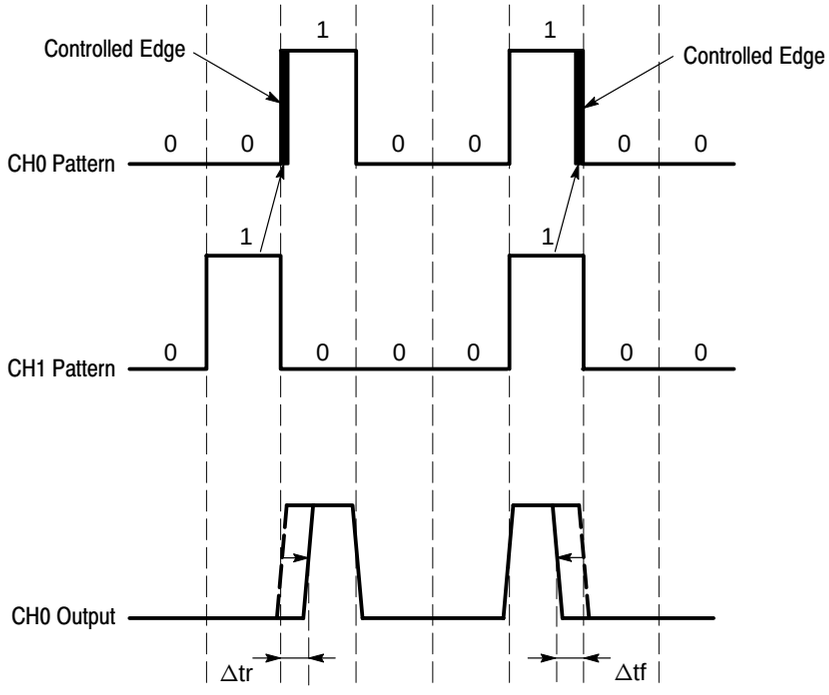
Characteristics	Description
Net weight	
Standard	10.3 kg (22.7 lb)
Dimensions	
Height	164 mm (6.4 inches) including feet
Width	362 mm (14.3 inches) including handle
Length	491 mm (19.25 inches) including front cover
	576 mm (22.2 inches) with handle extended

Table A-5: Environmental characteristics

Characteristics	Description
Temperature	
Operating	+10° C to +40° C
Nonoperating	–20° C to +60° C
Relative humidity	
Operating	20% to 80% (No condensation)
	Maximum wet-bulb temperature 29.4° C
Nonoperating	5% to 90% (No condensation)
	Maximum wet-bulb temperature 40.0° C

Table A-5: Environmental characteristics (Cont.)

Characteristics	Description
Altitude	
Operating	To 4.5 km (15,000 feet).
	Maximum operating temperature decreases 1 °C each 300 m above 1.5 km.
Nonoperating	To 15 km (50,000 feet).
Dynamics	
Vibration	
Operating	0.27 G_{rms}, 5 to 500 Hz
Nonoperating	2.28 G_{rms}, 5 to 500 Hz
Shock	
Nonoperating	294 m/s^2 (30 G), half-sine, 11 ms duration.
	Three shocks per axis in each direction (18 shocks total)
Installation requirements	
Power consumption	300 watts maximum. Maximum line current is 4 A_{rms} at 50 Hz
Dissipation (fully loaded)	90 V line, with 5% clipping
Surge current	≦ 9 A peak for less than 5 line cycles at 25° C after product has been off for at least 30 s.
Cooling clearance	
Top clearance	2.5 cm (1 inch)
Side clearance	15 cm (6 inches)
Rear clearance	7.5 cm (3 inches)



The rising edge moves to the right and falling edge moves to the left, when the position offset is set to more than 0 ps or when the edge control input is more than 0V.

Figure A-1: Timing definition in edge control input

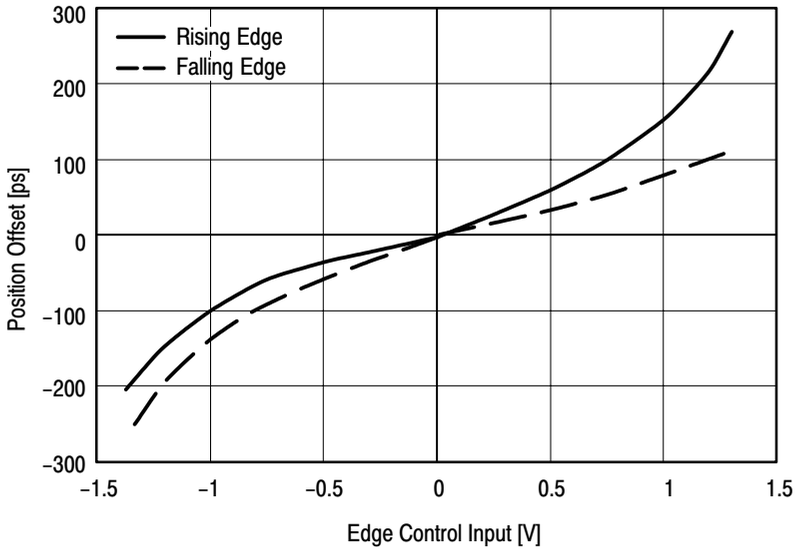


Figure A-2: Transfer function for edge control input

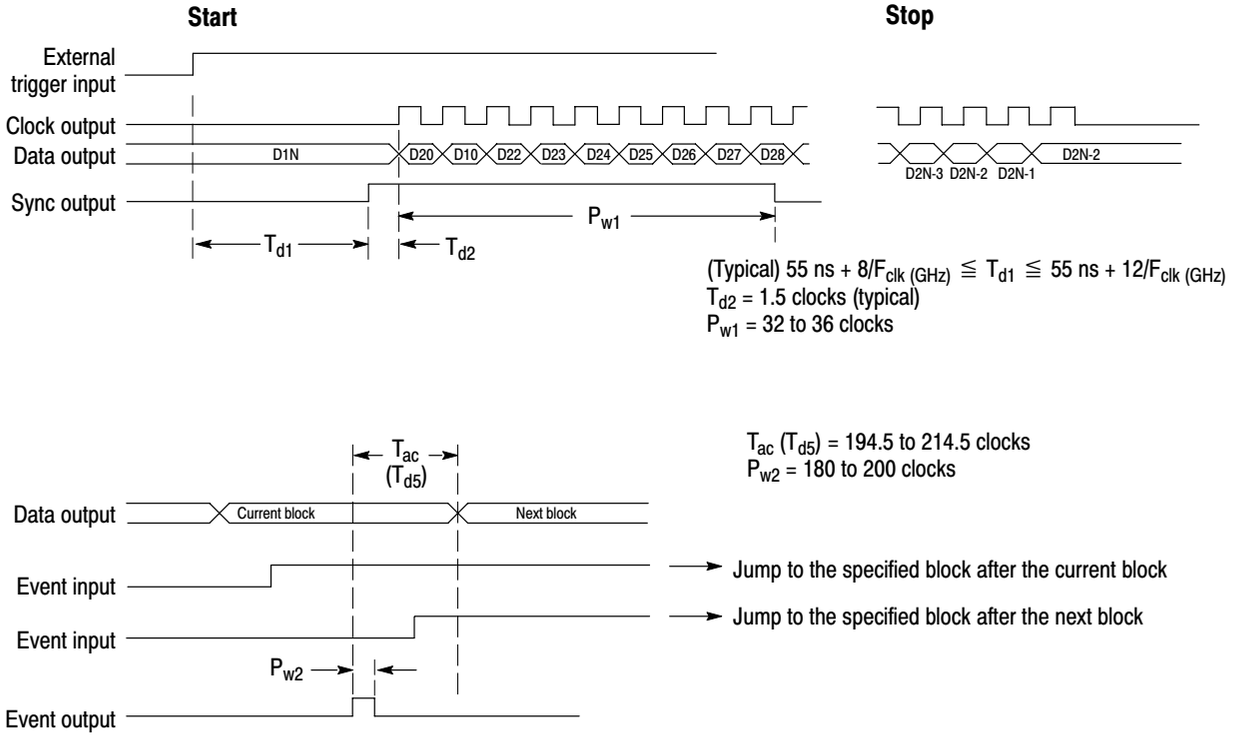


Figure A-3: Signal timing

Certification and Compliances

The certification and compliances for the DG2040 Data Generator are listed in Table A-6.

Table A-6: Certifications and compliances

Category	Standards or description
EC Declaration of Conformity – EMC	Meets intent of Directive 89/336/EEC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities: EMC Directive 89/336/EEC: EN 55011 Class A Radiated and Conducted Emissions EN 50081-1 Emissions: EN61000-3-2 AC Power Line Harmonic Emissions EN 50082-1 Immunity: EN61000-4-2 Electrostatic Discharge Immunity EN61000-4-3 RF Electromagnetic Field Immunity EN61000-4-4 Electrical Fast Transient/Burst Immunity EN61000-4-6 Conducted Disturbance Induced by Radio–frequency Field EN61000-4-8 Power Frequency Electromagnetic Field Immunity EN61000-4-11 Voltage Dips and Interruptions Immunity
Australian/New Zealand declaration of Conformity - EMC	Complies with EMC provision of Radio–communications Act per the following standard: AS/NZS 2064.1/2 Industrial, Scientific, and Medical Equipment: 1992
EC Declaration of Conformity – Low Voltage	Compliance was demonstrated to the following specification as listed in the Official Journal of the European Communities: Low Voltage Directive 73/23/EEC, amended by 93/68/EEC EN 61010-1/A1:1992 Safety requirements for electrical equipment for measurement, control and laboratory use.
Approvals	Complies with the following safety standards: UL3111–1, First Edition Standard for electrical measuring and test equipment. CAN/CSA C22.2 No.1010.1-92 Safety requirements for electrical equipment for measurement, control and laboratory use.
Installation Category Description	Terminals on this product may have different installation (over–voltage) category designations. The installation categories are: Category Examples of products in this category CAT III Distribution-level mains (usually permanently connected). Equipment at this level is typically in a fixed industrial location. CAT II Local-level mains (wall sockets). Equipment at this level includes appliances, portable tools, and similar products. Equipment is usually cord-connected. CAT I Secondary (signal level) or battery operated circuits of electronic equipment.

Table A-6: Certifications and compliances (cont.)

Category	Standards or description
Pollution Degree	A measure of the contaminates that could occur in the environment around and within a product. Typically the internal environment inside a product is considered to be the same as the external. Products should be used only in the environment for which they are rated. Pollution Degree 2 — Normally only dry, nonconductive pollution occurs. Occasionally a temporary conductivity that is caused by condensation must be expected. This location is a typical office/home environment. Temporary condensation occurs only when the product is out of service.
Conditions of Approval	Safety Certifications/Compliances are made for the following conditions: Altitude (maximum operation): 2000 meters
IEC Characteristics	Equipment type: Test and Measuring Installation Category II (as defined in IEC 61010–1, Annex J) Pollution Degree 2 (as defined in IEC 61010–1) Safety Class I (as defined in IEC 61010–1, Annex H)

Appendix B: Performance Verification

Two types of performance tests can be performed on this product. You may not need to perform all of these procedures, depending on what you want to accomplish.

- Self test

  The DG2040 Data Generator incorporates a diagnostic system that performs comprehensive instrument testing. This system verifies that the DG2040 Data Generator is operating correctly. The self tests execute quickly and require no special equipment during execution.

- Performance test

  The performance test verifies the operation of the items that are marked with a (√) symbol in *Appendix A:Specifications*. The equipment listed in Table B-2 is required to perform these performance tests.

Before Running the Performance Tests

Do the following before running the performance tests:

Warm Up

A 20 minute warm up period is required prior to running the operation tests.

File Loading

The performance check disk provided with the DG2040 Data Generator includes the files listed in Table B-1. The specified file must be loaded into the DG2040 Data Generator for each operation test item. These files include pattern data and setup information.

Table B-1: Performance check disk files

File name	Operation test
TP1CLK.PDA	Internal clock frequency
TP2PG.PDA	Sequence and data output
TP3EXREF.PDA	External reference input
TP4CONT.PDA	Maximum operating frequency (Continuous)
TP5TRIG.PDA	Maximum operating frequency (Trigger operation)
TP6GEN.PDA	Internal trigger generator and external trigger input
TP7EDGE.PDA	Edge control mode
TP8LVL.PDA	Data output level
TP9PULSE.PDA	Clock output amplitude
TP10DLY.PDA	Delay time
TP11RISE.PDA	Rise and fall time

Follow the procedure below to load the file required by a performance test into the instrument:

1. Insert the performance check disk into the DG2040 Data Generators floppy disk drive.
2. Select **EDIT → File → Load Data & Setup**.
3. Select the required file using the general purpose knob.
4. Select **OK** from the submenu.

Required Equipment

Table B-2 lists the equipment required for the performance tests.

Table B-2: Required equipment

Item	No.	Required precision	Recommended equipment
Frequency counter	1	Frequency range: 0.1 Hz to 1250 MHz Precision: 7 digits or higher	ANRITSU MF 1603A
Digital multimeter	1	DC voltage range: ±10 V Precision: 0.01 V	Tektronix DM2510
Performance check disk	1		Tektronix part no. 063-3121-XX (provided with the DG2040 Data Generator)
Oscilloscope	1	Bandwidth: 1 GHz or higher	Tektronix TDS784D
Sampling oscilloscope with head	1	Bandwidth: 6 GHz or higher	Tektronix 11801C with head SD-22
Function generator	1	Amplitude: 4 V, offset: 2 V (50 Ω termination), Frequency: 1 MHz or higher	Tektronix AFG320
BNC cable	5	Impedance: 50 Ω Length: 24 inches	Tektronix part no. 012-1342-00
SMA cable	5	Impedance: 50 Ω Length: 20 inches	Tektronix part no. 174-1427-00
SMA female–to–BNC male adapter	2		Tektronix part no. 015-0572-00
Precision 50 Ω termination	1	Impedance: 50 Ω (0.1 %)	Tektronix part no. 011-0129-00
SMA X5 attenuator (14 dB)	3		Tektronix part no. 015-1002-00
N-to-BNC adapter	1		Tektronix part no. 103-0045-00
BNC-dual-banana adapter	1		Tektronix part no. 103-0090-00
50 Ω SMA termination	2		Tektronix part no. 015-1022-00

Test Procedure Notes

The following conventions are used in this section for describing the self tests and performance tests.

- The test items are described in the following order.
  - Characteristic tested
  - Required equipment
  - Connections
  - Test procedure
- The test procedure is presented in order starting with step 1, and progresses through the end of the procedure. Tables such as the one shown below appear in these steps. For these steps, press the buttons in the order shown in the table, either from left to right or from top to bottom, to select the required menu item. For pop-up menus, use the general purpose knob to select items from the menu list. Operations such as Operation 6 do not involve pressing the buttons shown in the row above, but rather are descriptions of operations to be performed. Figure B-1 shows the buttons used and the menu layout.

Menu button	Bottom button	Pop up menu	Side button	Front panel button
Operation 1	Operation 2	Operation 3	Operation 4	Operation 5
Operation 6 (for example, insert a disk in the disk drive.)				
			Operation 7	

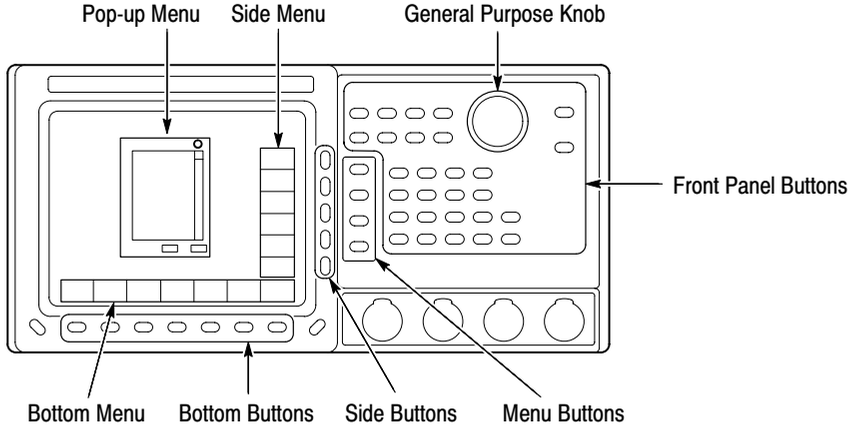


Figure B-1: Operating buttons and menu layout

Self Tests

Execute the DG2040 Data Generator self tests and verifies that no errors occurred.

1. Press the required buttons in the following order. Selecting **All** from the **Type** side button causes the instrument to run the self-test on all test items.

Menu button	Bottom button	Pop up menu	Side button	Front panel button
UTILITY	Diag		Type (Select All)	
			Execute	

2. Verify that all self tests passed by checking the **Status** display area shown in Figure B-2.

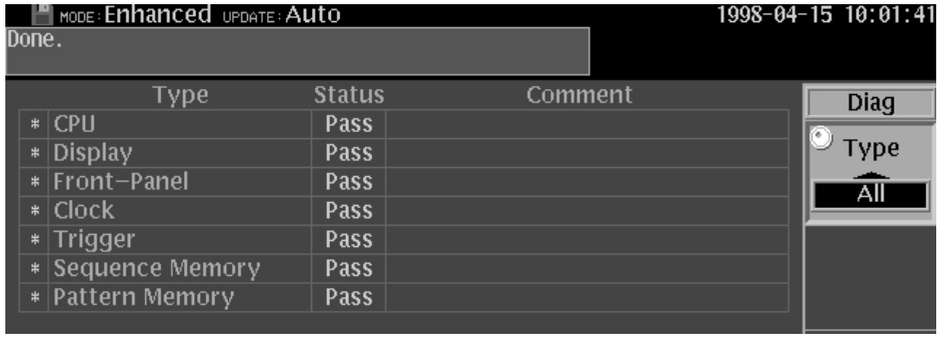


Figure B-2: Diagnostics menu

If **Fail** is listed in the **Status** display area, an error code will be displayed in the **Comment** column. See Table B-3 for the meanings of the error codes.

***NOTE**. Contact your Tektronix sales representative if an error occurs.*

Table B-3: Error codes

Error code	Error meaning	Failed component
1XX	CPU diagnostics error	A6 CPU board
2XX	Display diagnostics error	A6 CPU board
3XX	Front panel diagnostics error	A12 Key board
4XX	Clock diagnostics error	A40 Clock board
5XX	Trigger diagnostics error	A40 Clock board
6XX	Sequence memory diagnostic error	A50 PG & Output board
7XX	Pattern memory diagnostics error	A50 PG & Output board

Performance Tests

The performance test for the DG2040 Data Generator must be completed in the following order:

1. Internal clock frequency
2. Sequence and data output
3. External reference input
4. Maximum operating frequency
5. Internal trigger generator and external trigger input
6. Edge control mode operation
7. Output level accuracy
8. Clock output amplitude accuracy
9. Delay time accuracy
10. Rise and fall time accuracy

Internal Clock Frequency

This test verifies the frequency accuracy of the internal clock of the DG2040 Data Generator.

The following equipment is required.

Equipment Required	Frequency counter
	Two SMA cables
	Two 50 Ω terminations
	Two SMA female-to-BNC male adapters
	N-to-BNC adapter
	Performance check disk

Connections. Refer to Figure B-3 for connections.

Use the N-to-BNC adapter, an SMA female-to-BNC male adapter, and an SMA cable to make the following connection:

- Connect the CLOCK output from the DG2040 Data Generator rear panel to the frequency counter input (INPUT B).

Use the second SMA cable, the second female-to-BNC male adapter, and the 50 Ω termination to make the following connection:

- Terminate the $\overline{\text{CLOCK}}$ output.

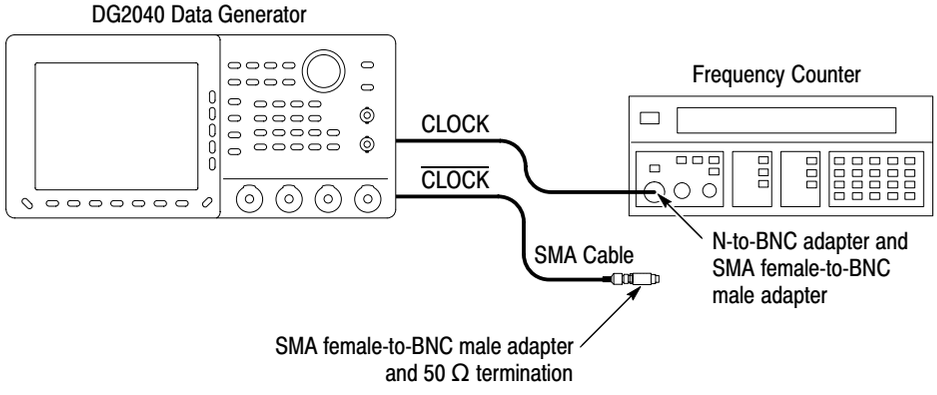


Figure B-3: Frequency measurement connections

Setup. Set the frequency counter to frequency measurement mode.

Procedure. Follow the steps below to verify the accuracy of the internal clock frequencies:

1. Load the **TP1CLK.PDA** test pattern file from the performance check disk. When the file is loaded, the DG2040 Data Generator clock frequency will be set to 1100 MHz internally.

***NOTE**. Refer to Table B-4 for steps 2 through 5.*

2. Perform the following steps to check the 1.100000 GHz clock frequency accuracy:

   a. Press the **START/STOP** button on the front panel. The LED corresponding to the button should be on.

b. Set the counter trigger to an appropriate value and verify that the counter displays a frequency in the range of 1.09999989 to 1.1000011 GHz. Refer to Table B-4.

3. Perform the following steps to check the 650.1000 MHz clock frequency accuracy:

a. Press the following buttons to set the DG2040 Data Generator clock frequency to 650.1 MHz.

Menu button	Bottom button	Pop up menu	Side button	Front panel button
SETUP	Clock		Int FREQ	650.1 MHz/µs

b. Set the counter trigger to an appropriate value, and verify that the counter displays a frequency in the 650.09935 MHz to 650.10065 MHz range.

4. Perform the following steps to check the 200.0000 kHz clock frequency accuracy:

a. Change the frequency counter input to INPUT A through the 50 Ω termination with the SMA cable.

b. Set the DG2040 Data Generator clock frequency to 200 kHz.

c. Set the counter trigger to an appropriate value, and verify that the counter displays a frequency in the 199.99980 kHz to 200.00020 kHz range.

5. Perform the following steps to check the 100.0000 mHz clock frequency accuracy:

a. Set the DG2040 Data Generator clock frequency to 100 mHz (0.1 Hz).

b. Set the counter trigger to an appropriate value, and verify that the counter displays a frequency in the range 99.99990 mHz to 100.00010 mHz.

Table B-4: Internal clock frequency accuracy

Internal clock frequencies	Clock frequency ranges
1.100000 GHz	1.0999989 GHz ~ 1.1000011 GHz
650.1000 MHz	650.09935 MHz ~ 650.10065 MHz
200.0000 kHz	199.99980 kHz ~ 200.00020 kHz
100.0000 mHz (10.0 s)	99.99990 mHz ~ 100.00010 mHz

6. Press the **START/STOP** button on the front panel to stop the output (the buttons LED goes off).

Sequence & Data Output

This test verifies that the pattern data that is output from the DG2040 Data Generator output channel ports (CH0, $\overline{\text{CH0}}$, CH1, and $\overline{\text{CH1}}$) is functioning correctly.

The following equipment is required.

Equipment Required	Oscilloscope
	Function generator
	Three BNC cables
	Two SMA cables
	Two SMA female-to-BNC male adapters
	Performance check disk

Connections. Refer to Figure B-4 for connections.

Use the SMA cables and the SMA female-to-BNC male adapters to make the following connections:

- Connect CH0 output from the DG2040 Data Generator front panel to the oscilloscope CH1 input.
- Connect $\overline{\text{CH0}}$ output from the DG2040 Data Generator front panel to the oscilloscope CH2 input.

Use the BNC cables to make the following connections:

- Connect the function generator CH1 output to the DG2040 Data Generator rear panel event input.
- Connect the event output from the DG2040 Data Generator rear panel to the oscilloscope CH3 input.

- Connect the sync output from the DG2040 Data Generator rear panel to the oscilloscope CH4 input.

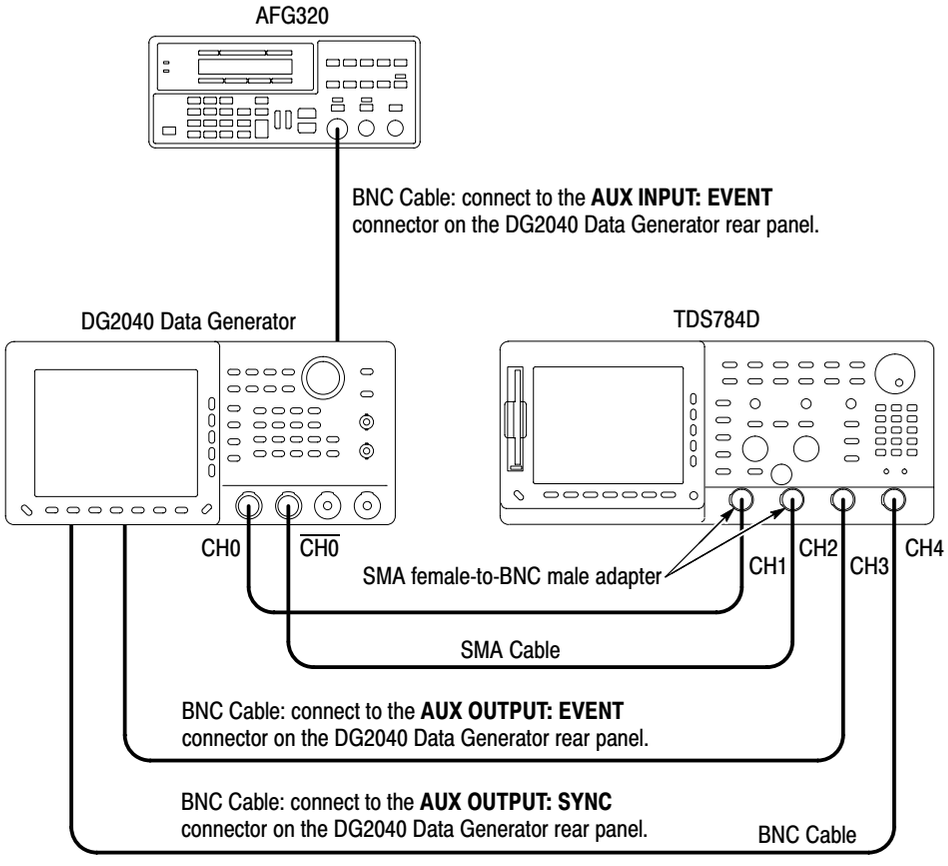


Figure B-4: Sequence & data output connections

Setup. Set the oscilloscope and AFG320 Function Generator as indicated below:

- Oscilloscope

Displayed channel	CH1, CH2, CH3 and CH4
Vertical axis	1 V/div for CH1 and CH2 5 V/div for CH3 and CH4
Horizontal axis . . .	5 µs/div
Record length	500
Acquire mode	Peak Detect
Acquire sequence .	RUN/STOP button only
Trigger mode	Auto
Trigger level	2 V
Trigger source	CH3
Trigger position . .	50 %
Trigger slope	Falling Edge
Input coupling	DC
Input impedance . .	50 Ω for CH1 and CH2 1 MΩ for CH3 and CH4

- Function generator

Output channel . . .	CH1
Waveform	Square wave
Frequency	500 Hz
Amplitude	1 V (50 Ω termination))
Offset	500 mV

Procedure. Follow the steps below to verify pattern data output:

1. Load the **TP2PG.PDA** test pattern file from the performance check disk.
2. Press the **START/STOP** button on the front panel. The LED, corresponding to the button, should be on.
3. Verify that the data pattern shown in Figure B-5 appears on the oscilloscope.
4. Disconnect the SMA cable from the CH0 output connector and the $\overline{\text{CH0}}$ output connector on the DG2040 Data Generator , and then connect them to the CH1 output connector and the $\overline{\text{CH1}}$ output connector on the DG2040 Data Generator.
5. Verify that the pattern data shown in Figure B-5 appears on the oscilloscope.
6. Disconnect the BNC cable from event input connector on the DG2040 Data Generator rear panel.
7. Change the oscilloscope acquisition sequence to Single Acquisition Sequence.

8. Press the **STEP/EVENT** button on the front panel.
9. Verify that the data pattern shown in Figure B-5 appears on the oscilloscope.
10. Press the **START/STOP** button on the front panel to stop output (the buttons LED goes off).

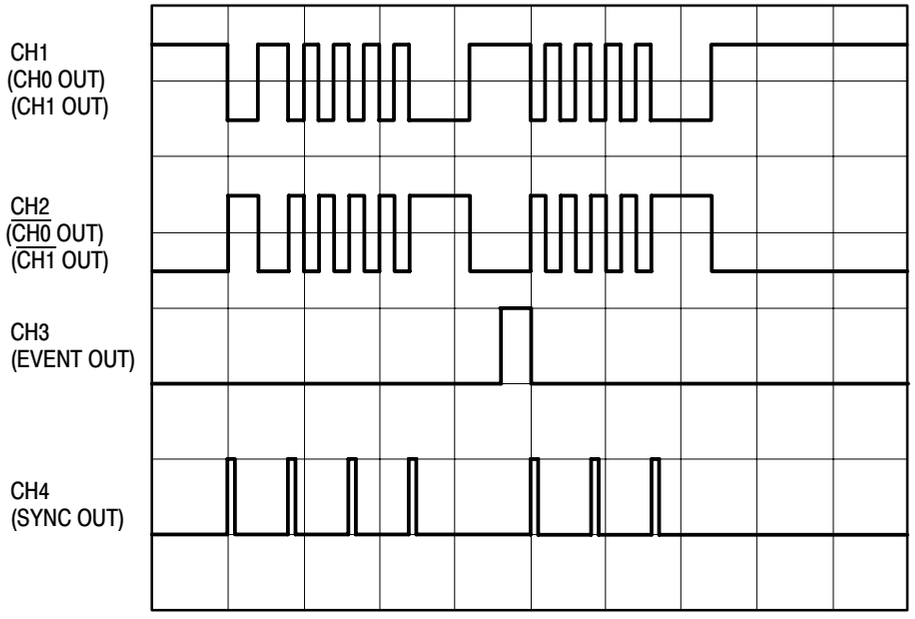


Figure B-5: Sequence & data output timing chart

External Reference Input

This test verifies that the external reference input operation is functioning correctly.

The following equipment is required.

Equipment Required	Oscilloscope
	Function generator
	Four BNC cables
	Two SMA cables
	Two SMA female-to-BNC male adapters
	Performance check disk

Connections. Refer to Figure B-6 for connections.

Use the SMA cables and the SMA female-to-BNC male adapters to make the following connections:

- Connect CH1 output from the DG2040 Data Generator front panel to the oscilloscope CH1 input.
- Connect $\overline{\text{CH1}}$ output to the DG2040 Data Generator front panel to the oscilloscope CH2 input.

Use the BNC cables to make the following connections:

- Connect the function generator CH1 output to the DG2040 Data Generator rear panel event input.
- Connect the function generator CH2 output to the DG2040 Data Generator rear panel reference input.
- Connect the event output from the DG2040 Data Generator rear panel to the oscilloscope CH3 input.
- Connect the sync output from the DG2040 Data Generator rear panel to the oscilloscope CH4 input.

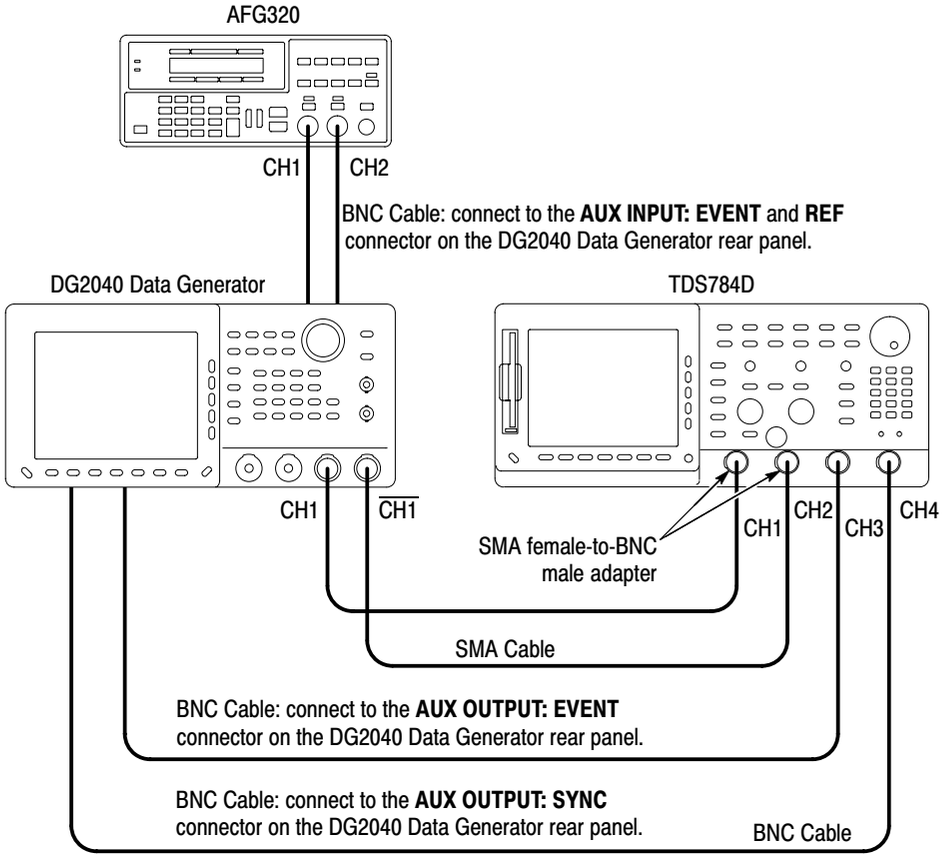


Figure B-6: External reference input connections

Setup. Set the oscilloscope and AFG320 Function Generator as indicated below:

- Oscilloscope

Displayed channel	CH1, CH2, CH3, and CH4
Record length	500
Acquisition mode .	Peak Detect
Acquire sequence .	RUN/STOP button only
Vertical axis	1 V/div for CH1 and CH2
	5 V/div for CH3 and CH4
Input coupling	DC
Input impedance . .	50 Ω for CH1 and CH2
	1 MΩ for CH3 and CH4
Horizontal axis . . .	10.00 µs/div
Trigger mode	Auto
Trigger level	2 V
Trigger source	CH3
Trigger coupling . .	DC
Trigger slope	Falling Edge
Trigger position . .	50 %

- Function generator

Output channel . . .	CH1 and CH2
Waveform	Square wave for CH1
	Sine wave for CH2
Frequency	500 Hz for CH1
	10 MHz for CH2
Amplitude	1 V for CH1 and CH2(50 Ω termination)
Offset	500 mV for CH1
	0 mV for CH2

Procedure. Follow the steps below to verify the external reference input operation:

1. Load the **TP3EXREF.PDA** test pattern file from the performance check disk.
2. Press the **START/STOP** button on the front panel. The LED, corresponding to the button, should be on.
3. Run the oscilloscope for acquisition, and verify that the data pattern shown in Figure B-5 appears on the oscilloscope.
4. Press the **START/STOP** button on the front panel to stop output (the button's LED goes off).

Maximum Operating Frequency (Continuous)

This test verifies maximum operating frequency (continuous) is functioning correctly.

The following equipment is required.

Equipment Required	Oscilloscope
	Function generator
	Three BNC cables
	Four SMA cables
	Four SMA female-to-BNC male adapters
	Performance check disk

Connections. Refer to Figure B-7 for connections.

Use the SMA cables and the SMA female-to-BNC male adapters to make the following connections:

- Connect CH0 output from the DG2040 Data Generator front panel to the oscilloscope CH1 input.
- Connect CH1 output to the DG2040 Data Generator front panel to the oscilloscope CH2 input.
- Use the remaining two SMA cables, the remaining two SMA female-to-BNC male adapters, and the 50 Ω terminations to terminate the $\overline{\text{CH0}}$ and $\overline{\text{CH1}}$ outputs.

Use the BNC cables to make the following connections:

- Connect the function generator Ch1 output to the DG2040 Data Generator rear panel event input.
- Connect the event output from the DG2040 Data Generator rear panel to the oscilloscope CH3 input.
- Connect the sync output from the DG2040 Data Generator rear panel to the oscilloscope CH4 input.

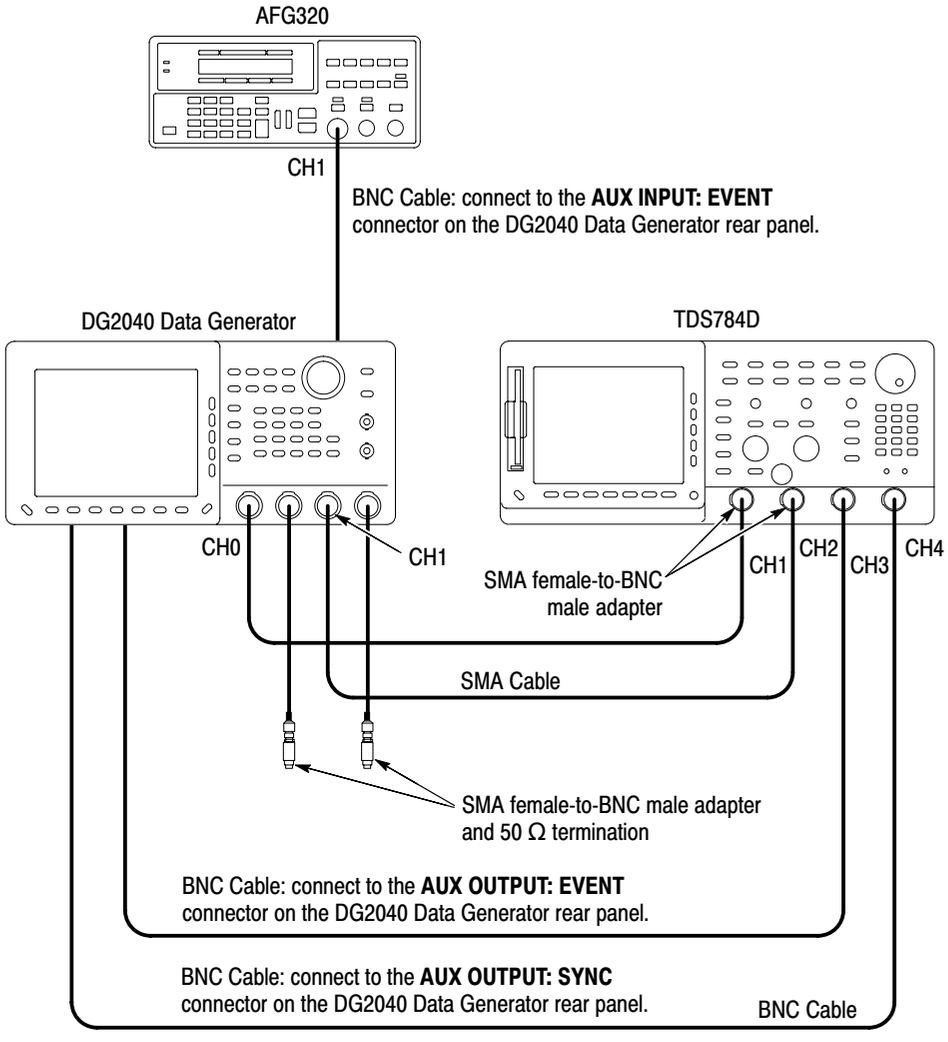


Figure B-7: Maximum operating frequency connections

Setup. Set the oscilloscope and AFG320 Function Generator as indicated below:

- Oscilloscope

Displayed channel	CH1 and CH2
Vertical axis	1 V/div for CH1 and CH2 5 V/div for CH3 and CH4
Horizontal axis . . .	5.00 ns/div
Record length	15000
Acquire mode	Peak Detect
Acquire sequence .	RUN/STOP button only
Trigger mode	Auto
Trigger level	2 V
Trigger source	CH3
Trigger slope	Falling Edge
Trigger position . .	50 %
Input coupling	DC
Input impedance . .	50 Ω for CH1 and CH2 1 MΩ for CH3 and CH4
InstaVu	Infinite Persistence

- Function generator

Output channel . . .	CH1
Waveform	Square wave
Frequency	500 Hz
Amplitude	1 V (50 Ω termination)
Offset	500 mV

Procedure. Follow the steps below to verify the maximum operating frequency (continuous):

1. Load the **TP4CONT.PDA** test pattern file from the performance check disk.
2. Press the **START/STOP** button on the front panel. The LED, corresponding to the button, should be on.
3. Verify that a stable data pattern as shown in Figure B-8 appears on the oscilloscope screen.
4. Change the oscilloscope trigger slope setting to Rising Edge.
5. Verify that a stable data pattern as shown in Figure B-9 appears on the oscilloscope screen.
6. Change the oscilloscope trigger source to CH4 and trigger slope to Falling Edge.
7. Verify that a stable data pattern as shown in Figure B-10 appears on the oscilloscope screen.

8. Press the **START/STOP** button on the front panel to stop output (the buttons LED goes off).

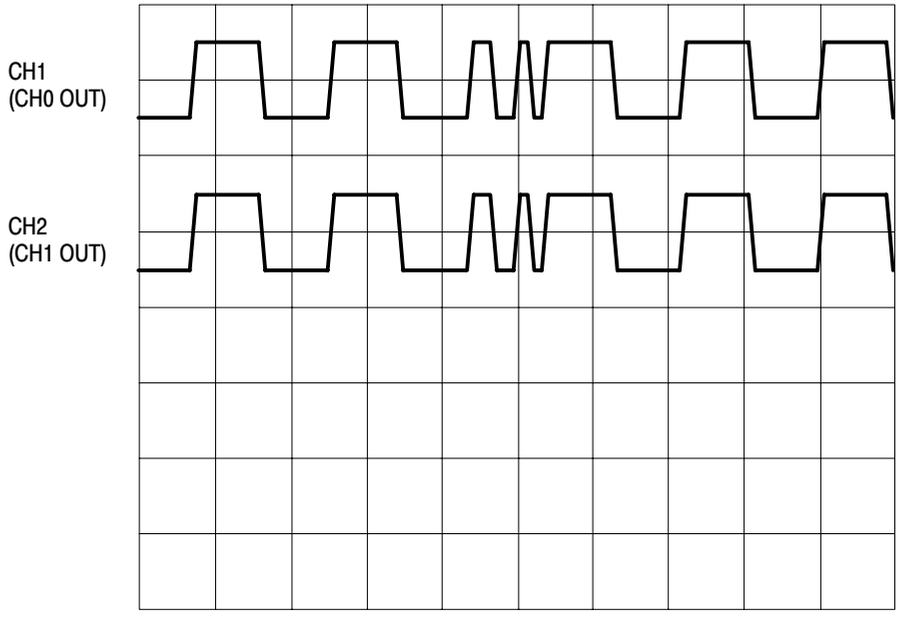


Figure B-8: Maximum operating frequency (1)

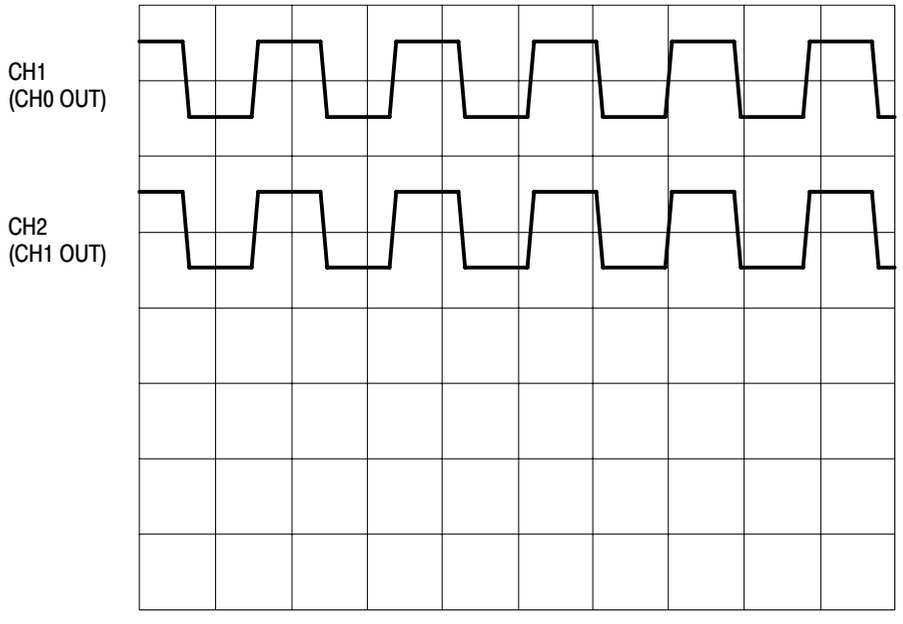


Figure B-9: Maximum operating frequency (2)

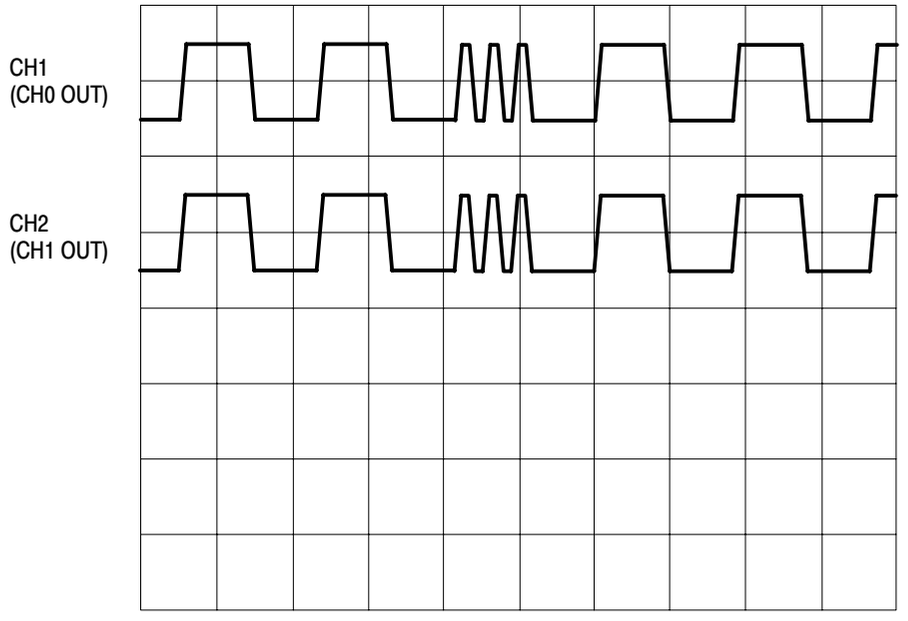


Figure B-10: Maximum operating frequency (3)

Maximum Operating Frequency (Trigger Operation)

This test verifies that the maximum operating frequency (trigger operation) is functioning correctly.

The following equipment is required.

Equipment Required	Oscilloscope
	Function generator
	Three BNC cables
	Four SMA cables
	Four SMA female-to-BNC male adapters
	Performance check disk

Connections. Refer to Figure B-11 for connections.

Use the SMA cables and the SMA female-to-BNC male adapters to make the following connections:

- Connect CH0 output from the DG2040 Data Generator front panel to the oscilloscope CH1 input.
- Connect CH1 output from the DG2040 Data Generator front panel to the oscilloscope CH2 input.
- Use the remaining two SMA cables, the remaining two SMA female-to-BNC male adapters, and the 50 Ω terminations to terminate the $\overline{\text{CH0}}$ and $\overline{\text{CH1}}$ outputs.

Use the BNC cables to make the following connections:

- Connect the function generator CH1 output to the DG2040 Data Generator rear panel event input.
- Connect the event output from the DG2040 Data Generator rear panel to the oscilloscope CH3 input.
- Connect the sync output from the DG2040 Data Generator rear panel to the oscilloscope CH4 input.

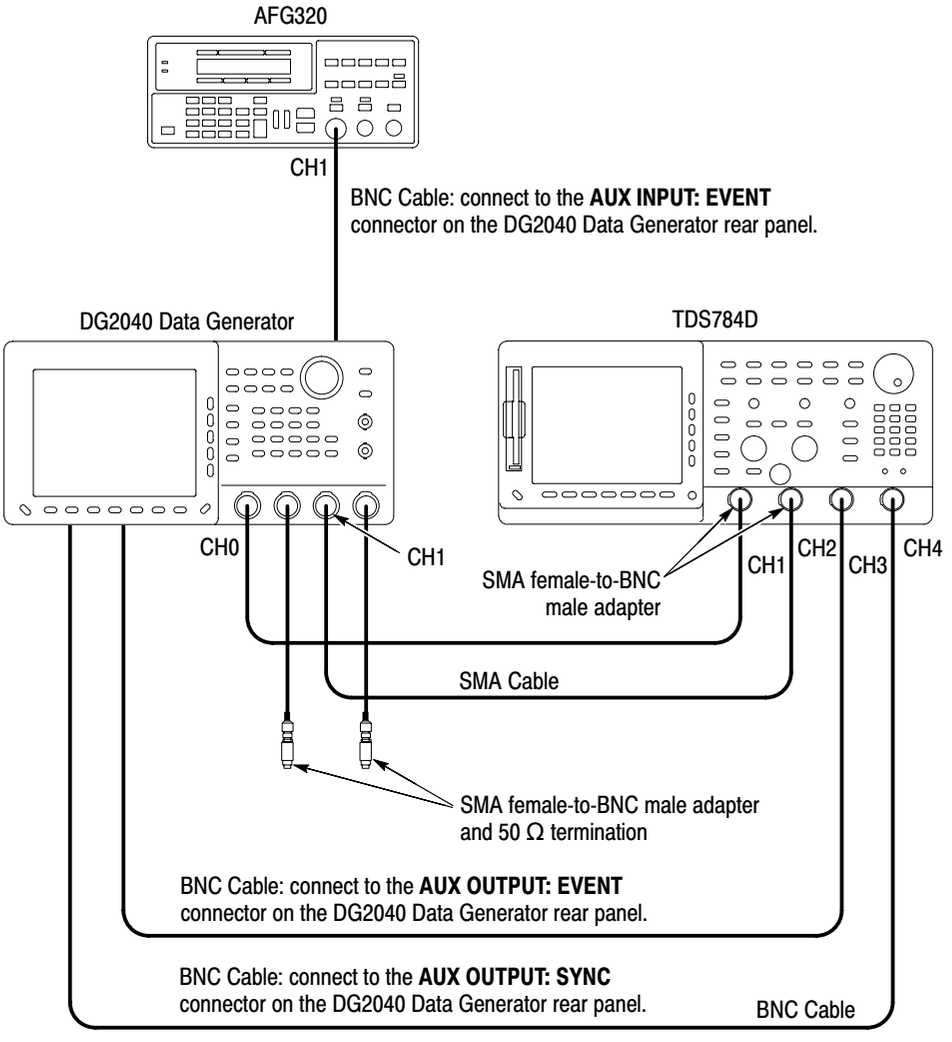


Figure B-11: Maximum operating frequency connections

Setup. Set the oscilloscope and AFG320 Function Generator as indicated below:

- Oscilloscope

Displayed channel	CH1 and CH2
Vertical axis	1 V/div for CH1 and CH2 5 V/div for CH3 and CH4
Horizontal axis . . .	5.00 ns/div
Record length	15000
Acquire mode	Peak Detect
Acquire sequence .	RUN/STOP button only
Trigger mode	Auto
Trigger level	2 V
Trigger source	CH3
Trigger slope	Falling Edge
Trigger position . .	50 %
Input coupling	DC
Input impedance . .	50 Ω for CH1 and CH2 1 MΩ for CH3 and CH4
InstaVu	Infinite Persistence

- Function generator

Output channel . . .	CH1
Waveform	Square wave
Frequency	500 Hz
Amplitude	1 V (50 Ω termination)
Offset	500 mV

Procedure. Follow the steps below to verify that the maximum operating frequency (trigger operation) is functioning correctly.

1. Load the **TP5TRIG.PDA** test pattern file from the performance check disk.
2. Press the **START/STOP** button on the front panel. The LED, corresponding to the button, should be on.
3. Verify that a stable data pattern as shown in Figure B-12 appears on the oscilloscope screen.
4. Change the oscilloscope trigger source to CH4 and trigger slope to Rising Edge.
5. Verify that a stable data pattern as shown in Figure B-13 appears on the oscilloscope screen.
6. Press the **START/STOP** button on the front panel to stop output (the buttons LED goes off).

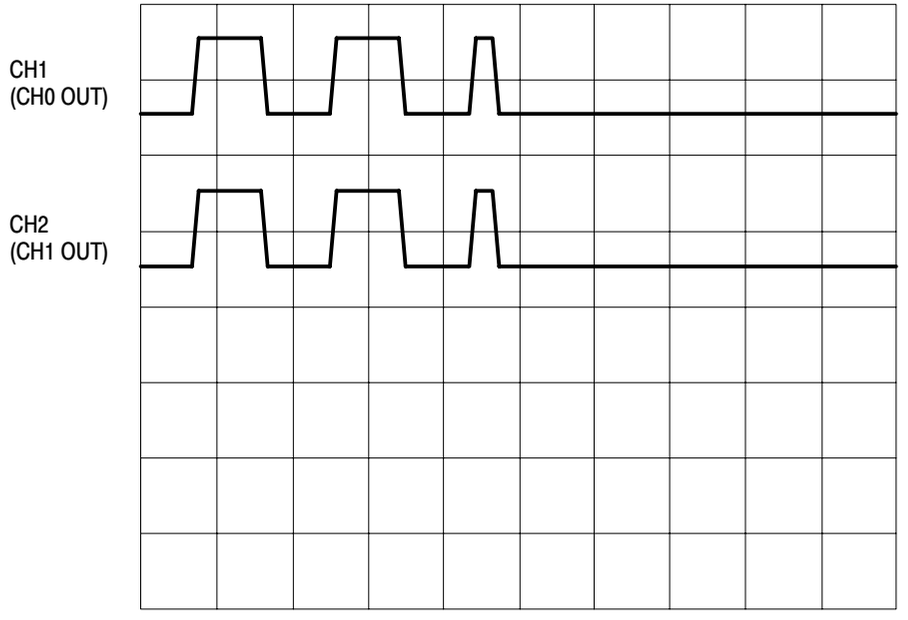


Figure B-12: Maximum operating frequency (4)

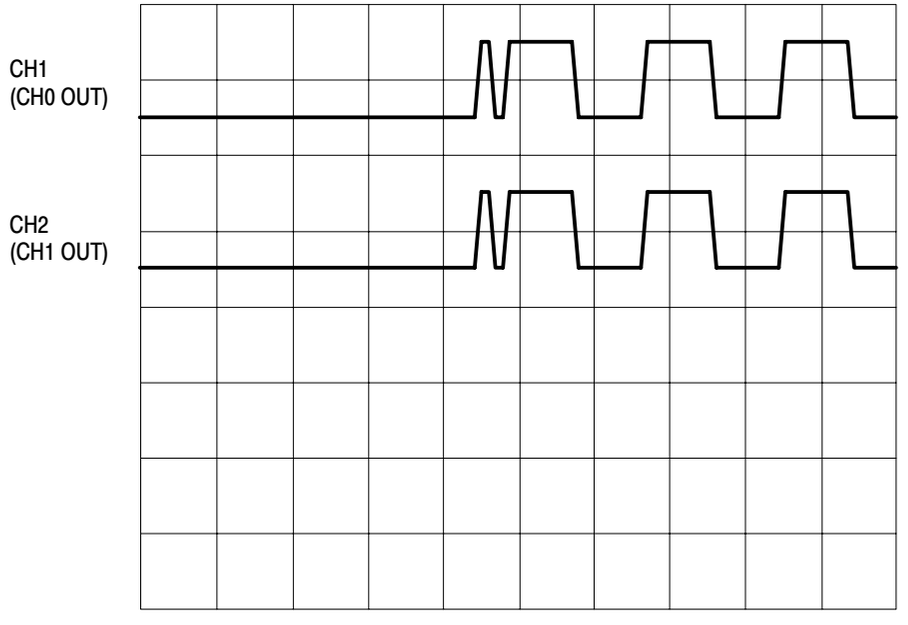


Figure B-13: Maximum operating frequency (5)

Internal Trigger Generator & External Trigger Input

This test verifies that the internal trigger generator and the external trigger input are functioning correctly.

The following equipment is required.

Equipment Required	Oscilloscope
	Function generator
	Two BNC cables
	Performance check disk

Connections. Refer to Figure B-14 for connections.

Use the BNC cables to make the following connections:

- Connect the sync output from the DG2040 Data Generator rear panel to the oscilloscope CH4 input.
- Connect the function generator output to the DG2040 Data Generator front panel trigger input.

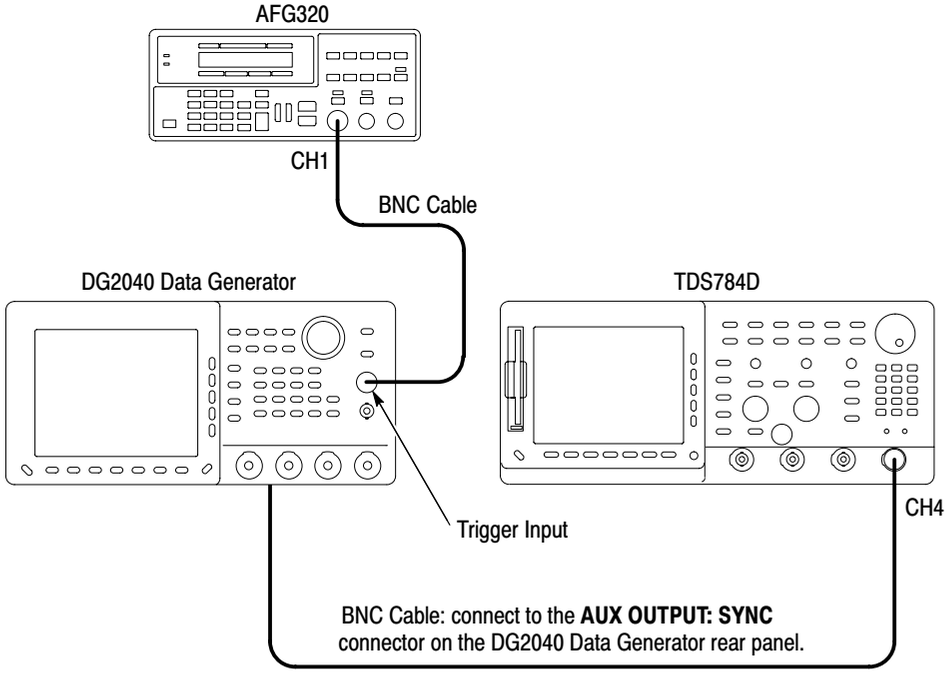


Figure B-14: Internal trigger generator & external trigger input connection

Setup. Set the oscilloscope and AFG320 Function Generator as indicated below:

- Oscilloscope

  Displayed channel CH4
  Vertical axis . . . . . 5 V/div for CH4
  Horizontal axis . . . 1.00 µs/div
  Record length 500
  Acquire mode . . . . Peak Detect
  Acquire sequence . RUN/STOP button only
  Trigger mode . . . . Auto
  Trigger level . . . . . 2 V
  Trigger source CH4
  Trigger slope . . . . . Falling Edge
  Trigger position . . 50 %
  Input coupling . . . . DC
  Input impedance . . 1 MΩ for CH4
  InstaVu . . . . . off

- Function generator

  Output channel . . . CH1
  Waveform . . . . . Square wave
  Frequency . . . . . 500 Hz
  Amplitude . . . . . 1 V (50 Ω termination))
  Offset . . . . . 500 mV

Procedure. Follow the steps below to verify that the Internal Trigger Generator and the External Trigger Input are functioning correctly:

1. Load the **TP6GEN.PDA** test pattern file from the performance check disk.
2. Press the **START/STOP** button on the front panel. The LED, corresponding to the button, should be on.
3. Verify that the sync signal appears every 1 µs on the oscilloscope screen.
4. Press the following buttons to set the DG2040 Data Generator trigger interval to 10 s.

Menu button	Bottom button	Pop up menu	Side button	Front panel button
SETUP	Trigger		Interval	
			State (Set to On)	
			Time	10 Hz/s/V

5. Change the oscilloscope horizontal axis setting to 2.00 s/div.
6. Verify that the sync signal appears in every 10 s on the oscilloscope screen.
7. Press the following buttons to set the DG2040 Data Generator trigger interval to 10 ms.

Menu button	Bottom button	Pop up menu	Side button	Front panel button
SETUP	Trigger		Interval	
			State (Set to On)	
			Time	10 kHz/ms/mV

8. Change the oscilloscope horizontal axis setting to 2.00 ms/div.
9. Press the following buttons to set the DG2040 Data Generator trigger interval to turn off.

Menu button	Bottom button	Pop up menu	Side button	Front panel button
SETUP	Trigger		Interval	
			State (Set to Off)	

10. Verify that **Waiting for trigger** message appears on the DG2040 Data Generator screen, and no waveform appears on the oscilloscope screen.
11. Press the following buttons to set the DG2040 Data Generator trigger interval to Ext.

Menu button	Bottom button	Pop up menu	Side button	Front panel button
SETUP	Trigger		Source (set to Ext)	

12. Verify that the sync signal appears every 2 ms on the oscilloscope screen.
13. Press the **START/STOP** button on the front panel to stop output. The LED, corresponding to the button, is turned off.

Edge Control Mode Operation

This test verifies the edge control mode operation is functioning correctly.

The following equipment is required.

Equipment Required	Sampling oscilloscope with head
	Function generator
	BNC cable
	Four SMA cables
	SMA female-to-BNC male adapter
	50 Ω termination
	Three SMA X5 attenuators
	Performance check disk

Connections. Refer to Figure B-15 for connections.

Use the SMA cables and the SMA 5X attenuators to make the following connections:

- Connect CH0 output from the DG2040 Data Generator front panel to the sampling oscilloscope CH1 input.
- Connect CH1 output to the DG2040 Data Generator front panel to the sampling oscilloscope CH2 input.
- Connect the $\overline{\text{CH1}}$ output from the DG2040 Data Generator front panel to the sampling oscilloscope TRIGGER INPUTS DIRECT.
- Use the remaining SMA cable, the SMA female-to-BNC male adapter, and the 50 Ω termination to terminate the DG2040 Data Generator $\overline{\text{CH0}}$ output.

Use the BNC cable to make the following connection:

- Connect the function generator CH1 output to the DG2040 Data Generator front panel edge control input.

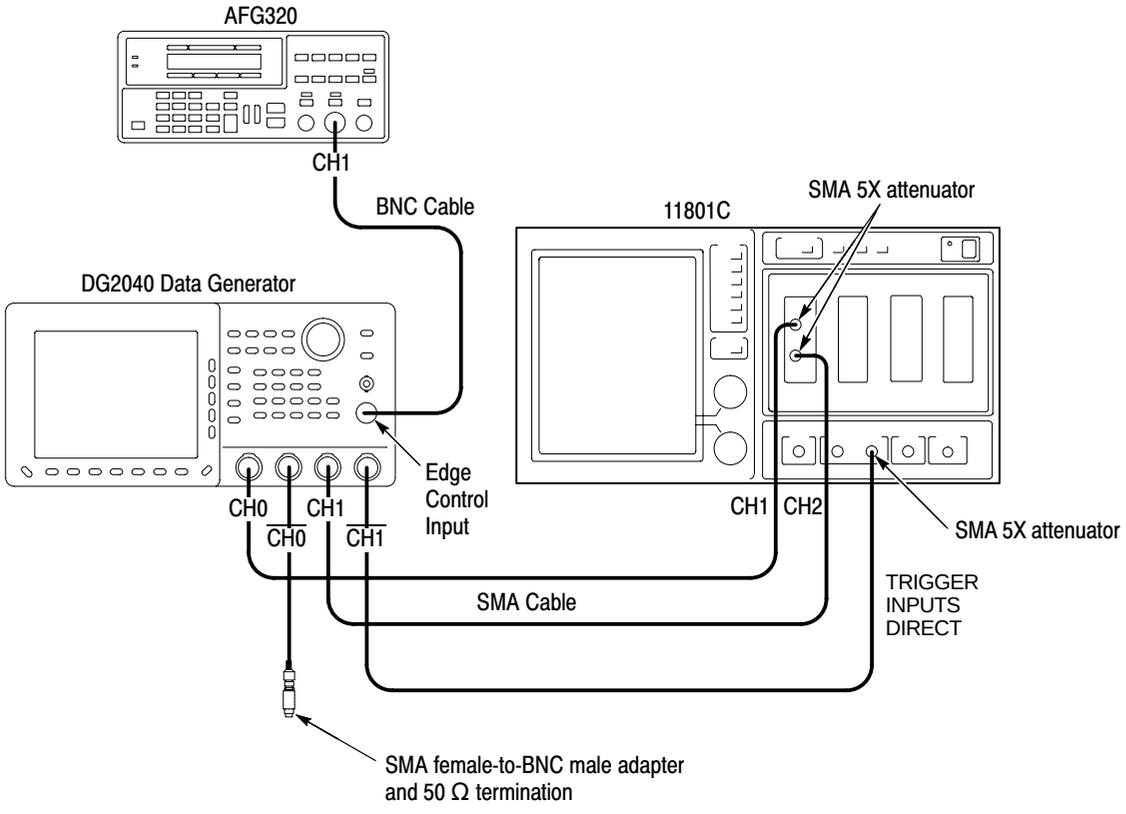


Figure B-15: Edge control mode operation connection

Setup. Set the sampling oscilloscope and AFG320 Function Generator as indicated below:

- Sampling oscilloscope

Displayed channel	CH1 and CH2
Vertical axis	100 mV/div for CH1 and CH2
Horizontal axis . . .	500 ps/div
Trigger mode	Norm
Trigger level	0 V
Trigger source	External Direct
Trigger slope	Falling Edge
Trigger position . .	50 %
Vectored Trace . . .	Off

- Function generator

  Output channel . . . CH2
  Waveform . . . . . Square wave
  Frequency . . . . . 10 MHz
  Amplitude . . . . . 2 V
  Offset . . . . . 0 mV

Procedure. Follow the steps below to verify that the edge control mode operation is functioning correctly.

1. Load the **TP7EDGE.PDA** test pattern file from the performance check disk.
2. Press the **START/STOP** button on the front panel. The LED, corresponding to the button, should be on.
3. Adjust the Main Pos control on the sampling oscilloscope front panel. Verify that jitter appears only on the rising edge portion on the CH0 output signal after the CH1 output signal rises. See figure B-16.
4. Press the **START/STOP** button on the front panel to stop output. The LED, corresponding to the button, is turned off.

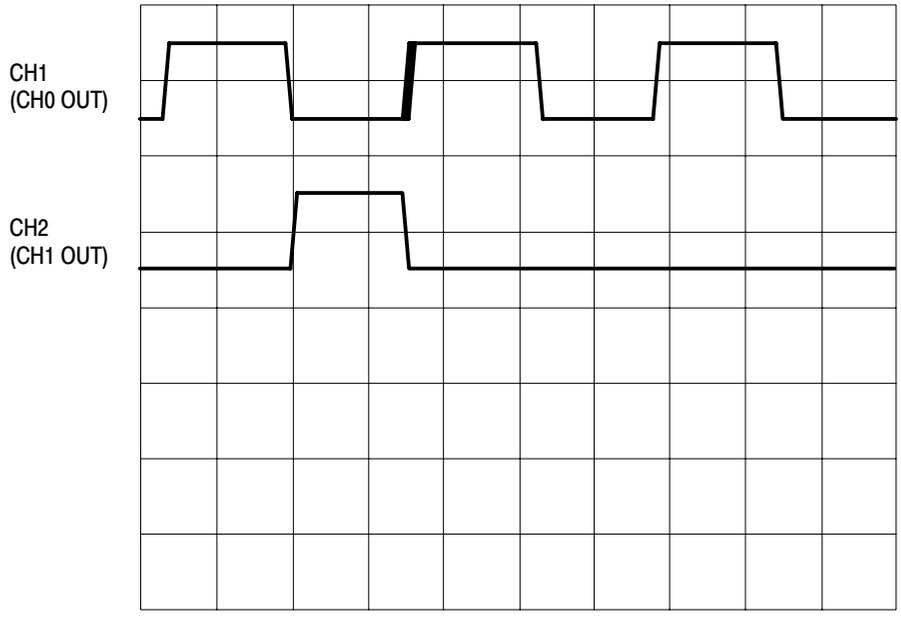


Figure B-16: Edge control mode

Output Level Accuracy

This test verifies that the output level accuracy of the DG2040 Data Generator output is functioning correctly.

Variable voltage levels for the amplitude

High level: –0.875 V to +3.50 V into 50 Ω
Low level: –1.125 V to +3.25 V into 50 Ω

Output Level (CH0, $\overline{\text{CH0}}$, CH1, and $\overline{\text{CH1}}$)

Accuracy: ± (3 % of setting) ± 50 mV into 50 Ω

The following equipment is required.

Equipment Required	Digital multimeter (DMM)
	SMA cable
	SMA female-to-BNC male adapter
	Precision 50 Ω termination
	BNC to dual banana adapter
	Performance check disk

Connections. Refer to Figure B-17 for connections.

Use the SMA cable, the SMA female-to-BNC male adapter, the precision 50 Ω termination, and the BNC to dual banana adapter to make the following connection:

- Connect CH0 output from the DG2040 Data Generator front panel to the digital multimeter input.

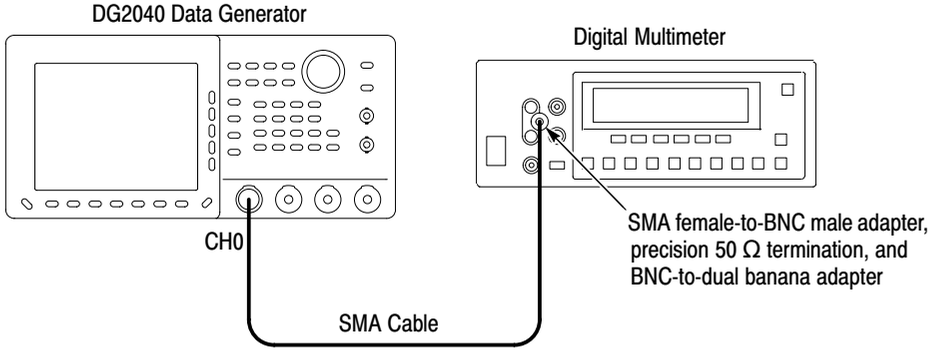


Figure B-17: Output level measurement connections

Setup. Set the digital multimeter as indicated below:

- Digital multimeter

  Function . . . . . DCV
  Range . . . . . Auto

Procedure. Follow the steps below to verify the output level accuracy:

1. Load the **TP8LVL.PDA** test pattern file from the performance check disk.
2. Press the following buttons to set the DG2040 Data Generator high and low voltage levels.

Menu button	Bottom button	Pop up menu	Side button	Front panel button
SETUP	Level Condition			
Move the cursor to CH0 with the general purpose knob.				
			High	–0.875 ENTER
			Low	–1.125 ENTER

3. Press the **START/STOP** button on the front panel. The LED, corresponding to the button, should be on.
4. Verify the high voltage level by following the procedures below:
   a. Press the **STEP/EVENT** button on the DG2040 Data Generator front panel once to output high voltage level.
   b. Set the high and low voltage levels to the values indicated in Table B-5, and verify that the digital multimeter reading for each high voltage level setting falls within the specified voltage range.
   c. Repeat Step b for all high and low voltage settings in Table B-5.

d. Repeat Steps a to c for output channels $\overline{\text{CH0}}$, CH1, and $\overline{\text{CH1}}$ output each time the SMA cable connection is changed.

Table B-5: High level output voltage accuracy

Settings		
High voltage level (V)	**Low voltage level (V)**	**High level output voltage ranges**
–0.875	–1.125	–0.951 V to –0.799 V
0	–1.125	–0.050 V to +0.050 V
+1.00	–1.1265	+0.920 V to +1.080 V
+2.00	–0.500	+1.890 V to +2.110 V
+3.50	+1.00	+3.345 V to +3.655 V

5. Verify the low voltage level by following the procedure below:

a. Change the SMA cable connection of the DG2040 Data Generator from $\overline{\text{CH1}}$ output to CH0 output.

b. Press the **STEP/EVENT** button on the DG2040 Data Generator front panel once to output low voltage level.

c. Set the low and high voltage levels to the values as shown in Table B-6, and verify that the digital multimeter reading for each voltage setting falls within the specified voltage range.

d. Repeat Step c for all high and low voltage settings in Table B-6.

e. Repeat Steps b to d for output channels $\overline{\text{CH0}}$, CH1, and $\overline{\text{CH1}}$ each time the SMA cable connections changed.

Table B-6: Low level output voltage accuracy

Settings		
Low voltage level (V)	**High voltage level (V)**	**Low level output voltage ranges**
–1.125	+1.375	–1.209 V to –1.041 V
0	+2.50	–0.050 V to +0.050 V
+1.00	+3.50	+0.920 V to +1.080 V
+2.00	+3.50	+1.890 V to +2.110 V
+3.25	+3.50	+3.103 V to +3.398 V

6. Press the **START/STOP** button on the front panel to stop output. The LED, corresponding to the button, is turned off.

Clock Output Amplitude Accuracy

This test verifies the clock output amplitude accuracy of the DG2040 Data Generator

Variable voltage levels for the amplitude

High level: –0.875 V to +3.50 V into 50 Ω
Low level: –1.125 V to +3.25 V into 50 Ω

Output Level (CLOCK and $\overline{\text{CLOCK}}$)

Accuracy: ± (5 % of setting) ± 50 mV into 50 Ω

The following equipment is required.

Equipment Required	Oscilloscope
	Two SMA cables
	Two SMA female-to-BNC male adapters
	Performance check disk

Connections. Refer to Figure B-18 for connections.

Use the SMA cables and the SMA female-to-BNC male adapters to make the following connections:

- Connect the CLOCK output from the DG2040 Data Generator rear panel to the oscilloscope CH1 input.
- Connect the $\overline{\text{CLOCK}}$ output from the DG2040 Data Generator rear panel to the oscilloscope CH2 input.

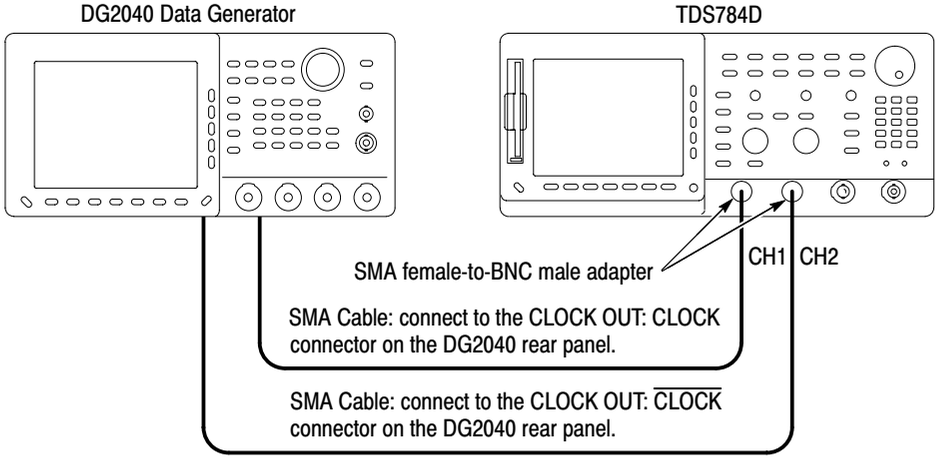


Figure B-18: Clock output amplitude measurement connection

Setup. Set the oscilloscope as indicated below:

- Oscilloscope

Displayed channel	CH1 and CH2
Vertical axis	100 mV/div for CH1 and CH2
Horizontal axis . . .	200 ns/div
Record length	500
Acquire mode	Average 32
Acquire sequence .	RUN/STOP button only
Vertical offset	–1 V
Trigger mode	Norm
Trigger level	–200 mV
Trigger source	CH2
Trigger slope	Rising Edge
Trigger position . .	50 %
Trigger coupling . .	DC
Display	Vectors
Input coupling	DC
Input impedance . .	50 Ω for CH1 and CH2

Procedure. Follow the steps below to verify the clock output amplitude accuracy:

1. Load the **TP9PULSE.PDA** test pattern file from the performance check disk.

2. Press the following buttons to set the DG2040 Data Generator high and low voltage levels.

Menu button	Bottom button	Pop up menu	Side button	Front panel button
SETUP	Level Condition			
Move the cursor to CLK with the general purpose knob.				
			High	–0.875 ENTER
			Low	–1.125 ENTER

3. Adjust the trigger level and vertical scale settings to get trace on the oscilloscope. Perform the measurement under the low and high voltage settings shown in Table B-7 and verify that the peak-to-peak amplitude for each voltage setting is within the specified range.

Table B-7: Clock output voltage accuracy

Settings		
Low voltage level (V)	**High voltage level (V)**	**Low level output voltage ranges**
–1.125	–0.875	0.250 V, ± 0.062 V (0.188 V to 0.312 V)
+1.000	+1.25	0.250 V, ± 0.062 V (0.188 V to 0.312 V)
+3.250	+3.50	0.250 V, ± 0.062 V (0.188 V to 0.312 V)
–1.125	+1.375	2.50 V, ± 0.175 V (2.325 V to 2.675 V)
0.000	+2.50	2.50 V, ± 0.175 V (2.325 V to 2.675 V)
+1.000	+3.50	2.50 V, ± 0.175 V (2.325 V to 2.675 V)

4. Press the **START/STOP** button on the front panel to stop output. The LED, corresponding to the button, is turned off.

Delay Time Accuracy

This test verifies the delay time accuracy referenced to the clock output on each channel of the DG2040 Data Generator.

Accuracy: ±(3 % of setting) ± | T_a – 25 °C | × 15 ps ±100 ps

The following equipment is required.

Equipment Required	
	Sampling oscilloscope with head
	Five SMA cables (three of them must be same length)
	Two SMA female-to-BNC male adapters
	Two 50 Ω terminations
	Three SMA X5 attenuators
	Performance check disk

Connections. Refer to Figure B-19 for connections.

Use the SMA cables (three cables must be same length) and the SMA 5X attenuators to make the following connections:

- Connect the CLOCK output from the DG2040 Data Generator rear panel to the sampling oscilloscope CH1 input.
- Connect the CH0 output from the DG2040 Data Generator front panel to the sampling oscilloscope CH2 input.
- Connect the $\overline{\text{CH1}}$ output from the DG2040 Data Generator front panel to the sampling oscilloscope TRIGGER INPUTS DIRECT.

Use the SMA female-to-BNC male adapter and the 50 Ω termination to make the following connection:

- Terminate the $\overline{\text{CH0}}$ output of the DG2040 Data Generator.
- Terminate the CH1 output of the DG2040 Data Generator.

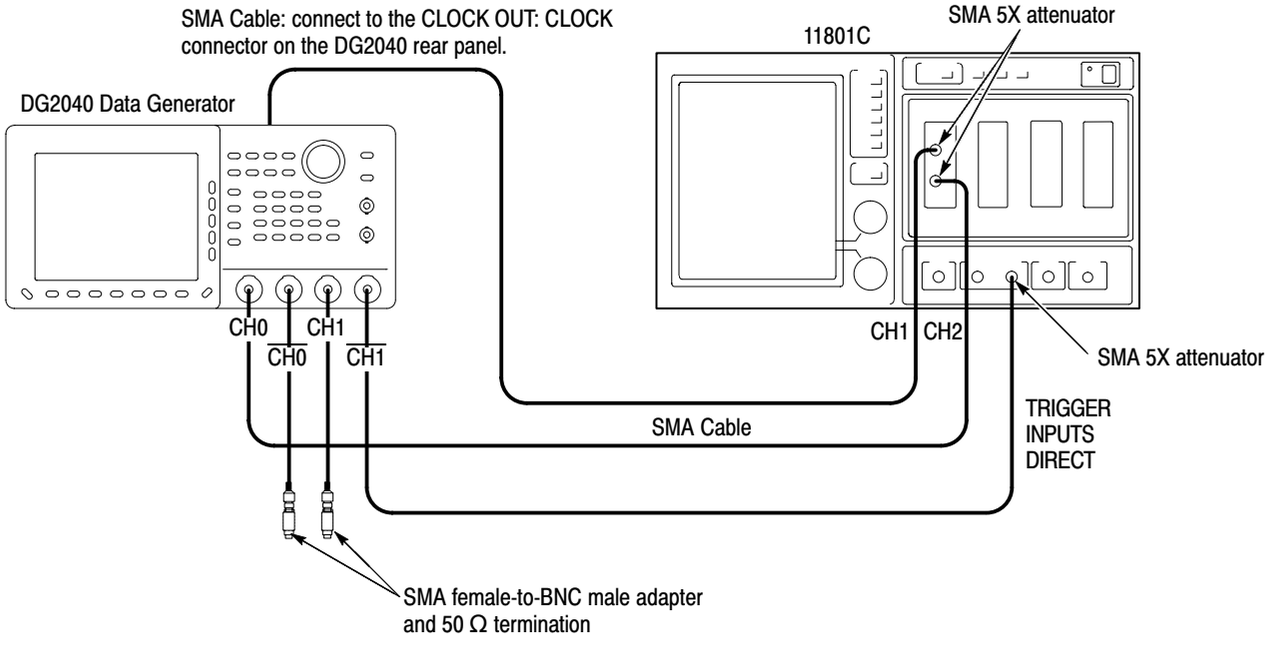


Figure B-19: Delay time measurement connection

Setup. Set the sampling oscilloscope as indicated below:

- Sampling oscilloscope

Displayed channel	CH1 and CH2
Vertical axis	50 mV/div for CH1 and CH2
Horizontal axis . . .	500 ps/div
Acquire mode	Average 32
Vertical offset	100 mV
Trigger mode	Norm
Trigger level	100 mV
Trigger source	CH2
Trigger slope	Rising Edge
Trigger position . .	50 %
Vectored Trace . . .	Off

Procedure. Follow the steps below to verify the delay time accuracy:

1. Load the **TP10DLY.PDA** test pattern file from the performance check disk.
2. Press the **START/STOP** button on the front panel. The LED, corresponding to the button, should be on.
3. Press the following buttons to set the DG2040 Data Generator CH0 output delay time to –1.00 ns.

Menu button	Bottom button	Pop up menu	Side button	Front panel button
SETUP	Timing Condition			
Move the cursor to CH0 with the general purpose knob.				
			Delay	–1.0 ENTER

4. Set the delay time to –1.00 ns, –0.50 ns, +0.50 ns, +1.00 ns, and +2.00 ns in turn. Perform the delay time measurement for each delay time setting with the sampling oscilloscope. Verify that the data output delay times referenced to the clock signal are within the accuracy ($\pm$(3 % of setting) $\pm$ | T_a – 25°C | $\times$ 15 ps $\pm$ 100 ps) for each of these delay time settings.

5. Change the SMA cable connection from the DG2040 Data Generator CH0 output to CH1 and repeat step 4. When measuring $\overline{\text{CH1}}$ output delay time, connect the CH0 output on the DG2040 Data Generator front panel to the TRIGGER INPUTS DIRECT connector on the sampling oscilloscope front panel.

6. From above measurement results at 0.00 ns delay time setting on two output channels, verify that the delay time differences between two channels is within $\pm$ | T_a – 25°C | $\times$ 15 ps $\pm$ 100 ps.

7. Press the **START/STOP** button on the front panel to stop output. The LED, corresponding to the button, is turned off.

Rise Time and Fall Time Accuracy

This test verifies the rise and fall time accuracies of the DG2040 Data Generator output.

Rise/Fall Times

Limit: < 150 ps (20 % to 80 %)

The following equipment is required.

Equipment Required	Sampling oscilloscope with head
	Three SMA cables (three must be same length)
	Three SMA X5 attenuators
	SMA female-to-BNC male adapter
	Performance check disk

Connections. Refer to Figure B-20 for connections.

Use the SMA cables and the SMA 5X attenuators to make the following connections:

- Connect CLOCK OUT on the DG2040 Data Generator rear panel to the CH1 input on the sampling oscilloscope .
- Connect $\overline{\text{CLOCK OUT}}$ on the DG2040 Data Generator rear panel to the CH2 input on the sampling oscilloscope.

Use the SMA female-to-BNC male adapter, the third SMA cable, and the third SMA 5X attenuator to make the following connections:

- Connect SYNC OUT from the DG2040 Data Generator rear panel to the TRIGGER INPUTS DIRECT on the sampling oscilloscope .

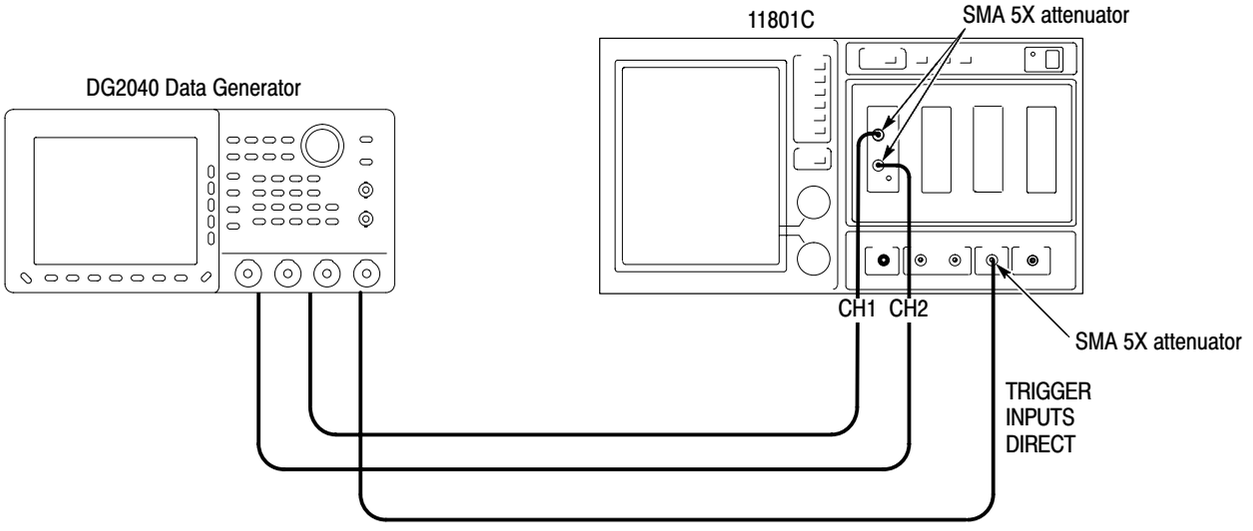


Figure B-20: Rise time and fall time measurement connection

Setup. Set the sampling oscilloscope as indicated below:

- Sampling oscilloscope

Displayed channel	CH1 and CH2
Vertical axis	50 mV/div for CH1 and CH2
Horizontal axis . . .	200 ps/div
Record length	500
Acquire mode	Average 32
Timebase position .	0s
Vertical offset	100 mV
Trigger mode	Norm
Trigger level	100 mV
Trigger source	DIRECT
Trigger slope	Rising Edge

Procedure. Follow the steps below to verify the rise and fall time accuracy:

1. Load the **TP11RISE.PDA** test pattern file from the performance check disk.
2. Press the following buttons to set the DG2040 Data Generator clock frequency.

Menu button	Bottom button	Pop up menu	Side button	Front panel button
SETUP	Clock		Int FREQ	100 MHz/µs

3. Use the sampling oscilloscope measurement functions to perform the clock signal rise and fall time measurement under the clock frequency settings shown in Table B-8.

4. Change the SMA cable connection from the CLOCK and $\overline{\text{CLOCK}}$ outputs to CH0 and $\overline{\text{CH0}}$ outputs, respectively, and repeat step 3 for each of these channels. Verify that the rise and fall times are within the specified ranges.

5. Change the SMA cable connection from the CH0 and $\overline{\text{CH0}}$ outputs to CH1 and $\overline{\text{CH1}}$ outputs, respectively, and repeat step 3 for each of these channels. Verify that the rise and fall times are within the specified ranges.

Table B-8: Rise and fall time accuracies

Voltage settings			
Low level	**High level**	**Clock frequency**	**Rise and fall time limit**
0 V	+1.00 V	100 MHz	< 150 ps (20 % – 80 %)
0 V	+1.00 V	500 MHz	< 150 ps (20 % – 80 %)
0 V	+1.00 V	1100 MHz	< 150 ps (20 % – 80 %)

6. Press the **START/STOP** button on the front panel to stop output (the button's LED goes off).

This completes the performance verification procedures.

Test Record

Photocopy the following 4 pages and use them to record the performance test results for your DG2040 Data Generator.

DG2040 Test Record

Serial Number: Certificate Number:

Calibration Date: Technician:

Table B-9: DG2040 test record

Clock frequency tests		**Low limit**	**Test result**	**High limit**
Internal clock frequency accuracy	1.100 000 GHz	1.099 998 9 GHz		1.100 001 1 GHz
	650.100 0 MHz	650.099 35 MHz		650.100 65 MHz
	200.000 0 kHz	199.999 80 kHz		200.000 20 kHz
	100.000 0 mHz	99.999 90 mHz		100.000 10 mHz
High level output voltage accuracy (DC Data Out)		**Low limit**	**Test result**	**High limit**
CH0 Output	−0.875 V	−0.951 V		−0.799 V
	0 V	−0.050 V		0.050 V
	+1.00 V	0.920 V		1.080 V
	+2.00 V	1.890 V		2.110 V
	+3.50 V	3.345 V		3.655 V
$\overline{\text{CH0}}$ Output	−0.875 V	−0.951 V		−0.799 V
	0 V	−0.050 V		0.050 V
	+1.00 V	0.920 V		1.080 V
	+2.00 V	1.890 V		2.110 V
	+3.50 V	3.345 V		3.655 V
CH1 Output	−0.875 V	−0.951 V		−0.799 V
	0 V	−0.050 V		0.050 V
	+1.00 V	0.920 V		1.080 V
	+2.00 V	1.890 V		2.110 V
	+3.50 V	3.345 V		3.655 V
$\overline{\text{CH1}}$ Output	−0.875 V	−0.951 V		−0.799 V
	0 V	−0.050 V		0.050 V
	+1.00 V	0.920 V		1.080 V
	+2.00 V	1.890 V		2.110 V
	+3.50 V	3.345 V		3.655 V

Table B-9: DG2040 test record (cont.)

Low level output voltage accuracy (DC Data Out)		Low limit	Test result	High limit
CH0 Output	−1.125 V	−1.209 V		−1.041 V
	0 V	−0.050 V		0.050 V
	+1.00 V	0.920 V		1.080 V
	+2.00 V	1.890 V		2.110 V
	+3.25 V	3.103 V		3.398 V
$\overline{CH0}$ Output	−1.125 V	−1.209 V		−1.041 V
	0 V	−0.050 V		0.050 V
	+1.00 V	0.920 V		1.080 V
	+2.00 V	1.890 V		2.110 V
	+3.25 V	3.103 V		3.398 V
CH1 Output	−1.125 V	−1.209 V		−1.041 V
	0 V	−0.050 V		0.050 V
	+1.00 V	0.920 V		1.080 V
	+2.00 V	1.890 V		2.110 V
	+3.25 V	3.103 V		3.398 V
$\overline{CH1}$ Output	−1.125 V	−1.209 V		−1.041 V
	0 V	−0.050 V		0.050 V
	+1.00 V	0.920 V		1.080 V
	+2.00 V	1.890 V		2.110 V
	+3.25 V	3.103 V		3.398 V
Delay time accuracy		**Low limit**	**Test result**	**High limit**
CH0 Delay Time Settings	Ta[1]: Room temperature Nominal value	[2]		[3]
−1.00 ns	−1.00 ns			
−0.50 ns	−0.50 ns			
+0.50 ns	+0.50 ns			
+1.00 ns	+1.00 ns			
+2.00 ns	+2.00 ns			
CH1 Delay Time Settings	Ta[1]: Room temperature Nominal value	[2]		[3]
−1.00 ns	−1.00 ns			
−0.50 ns	−0.50 ns			

Table B-9: DG2040 test record (cont.)

Delay time accuracy			**Low limit**	**Test result**	**High limit**
+0.50 ns		+0.50 ns			
+1.00 ns		+1.00 ns			
+2.00 ns		+2.00 ns			
Output voltage accuracy (Clock Out)			**Low limit**	**Test result**	**High limit**
CLOCK Output					
Settings High level	Low Level	Nominal value			
–1.125 V	–0.875 V	0.250 V	0.188 V		0.312 V
+1.000 V	+1.25 V	0.250 V	0.188 V		0.312 V
+3.250 V	+3.50 V	0.250 V	0.188 V		0.312 V
–1.125 V	+1.375 V	2.500 V	2.325 V		2.675 V
0.000 V	+2.50 V	2.500 V	2.325 V		2.675 V
+1.000 V	+3.50 V	2.500 V	2.325 V		2.675 V
$\overline{\text{CLOCK}}$ Output					
Settings High level	Low Level	Nominal value			
–1.125 V	–0.875 V	0.250 V	0.188 V		0.312 V
+1.000 V	+1.25 V	0.250 V	0.188 V		0.312 V
+3.250 V	+3.50 V	0.250 V	0.188 V		0.312 V
–1.125 V	+1.375 V	2.500 V	2.325 V		2.675 V
0.000 V	+2.50 V	2.500 V	2.325 V		2.675 V
+1.000 V	+3.50 V	2.500 V	2.325 V		2.675 V
Rise time and fall time accuracy		**Frequency**	**Low limit**	**Test result**	**High limit**
CLOCK signal Rise time		100 MHz			< 150 ps
		500 MHz			< 150 ps
		1100 MHz			< 150 ps
CLOCK signal Fall time		100 MHz			< 150 ps
		500 MHz			< 150 ps
		1100 MHz			< 150 ps
$\overline{\text{CLOCK}}$ signal Rise time		100 MHz			< 150 ps
		500 MHz			< 150 ps
		1100 MHz			< 150 ps

Table B-9: DG2040 test record (cont.)

Rise time and fall time accuracy	Frequency	Low limit	Test result	High limit
$\overline{\text{CLOCK}}$ signal Fall time	100 MHz			< 150 ps
	500 MHz			< 150 ps
	1100 MHz			< 150 ps
CH0 signal Rise time	100 MHz			< 150 ps
	500 MHz			< 150 ps
	1100 MHz			< 150 ps
CH0 signal Fall time	100 MHz			< 150 ps
	500 MHz			< 150 ps
	1100 MHz			< 150 ps
$\overline{\text{CH0}}$ signal Rise time	100 MHz			< 150 ps
	500 MHz			< 150 ps
	1100 MHz			< 150 ps
$\overline{\text{CH0}}$ signal Fall time	100 MHz			< 150 ps
	500 MHz			< 150 ps
	1100 MHz			< 150 ps
CH1 signal Rise time	100 MHz			< 150 ps
	500 MHz			< 150 ps
	1100 MHz			< 150 ps
CH1 signal Fall time	100 MHz			< 150 ps
	500 MHz			< 150 ps
	1100 MHz			< 150 ps
$\overline{\text{CH1}}$ signal Rise time	100 MHz			< 150 ps
	500 MHz			< 150 ps
	1100 MHz			< 150 ps
$\overline{\text{CH1}}$ signal Fall time	100 MHz			< 150 ps
	500 MHz			< 150 ps
	1100 MHz			< 150 ps

1 Ta = Degree C = (Fahrenheit + 32)5/9

2 Low limit = |Ta – 25 degree C| X 15 ps – 100ps

3 High Limit = |Ta – 25 degree C| X 15 ps + 100ps

Appendix C: Miscellaneous

This appendix covers the following items:

- Factory Settings
- Conversion Table Examples
- Inspection and cleaning

Factory Settings

When **Reset to Factory** is selected from the **UTILITY System** menu, the DG2040 Data Generator parameters are reset to the values that were set at the factory. Table C-1 lists these factory settings.

Table C-1: Factory settings

SETUP menu	
Output Condition	
Event Level	1.4 V
Event	Enable
Level Condition	
High	1.5 V (into 50 Ω) (for all channels)
Low	0.0 V (for all channels)
Timing Condition	(for all channels)
Delay	0.0 ns
Run Mode	
Run mode	Repeat
Update	Auto
Trigger	
Slope	Positive
Level	1.4 V
Impedance	1 kΩ
Source	Ext
Interval → State	Off
Interval → Time	10.0 s
Clock	
Reference	Int

Table C-1: Factory settings (Cont.)

SETUP menu	
Int FREQ	100.00 MHz
Ext FREQ	100.00 MHz
APPLICATION menu	
Edge Control	
Edge Ctrl	Off
Time	0 ps
UTILITY menu	
Mass Memory	
Special → Catalog Order	NAME1
Display	
Clock	Off
Brightness	70%
Dimmer	Off
Hardcopy	
Format	BMP
Port	DISK
System	
Power up Pause	On
Diag	
Type	All

The following menu items are not affected by **Reset to Factory**.

- Menu items in the **EDIT** menu
- The following **SETUP** items:

  Group number

  Channel allocation

***NOTE**. When **Security Immediate** item is selected in the **UTILITY System** menu, the above items are reset.*

- The following **UTILITY** items :

  Remote Port

  GPIB operation mode and address

  Serial parameters

  Date/Time

Conversion Table Examples

Using the code conversion table, a bit pattern can be converted to another bit pattern. Figure C-1 shows how the code conversion table is used.

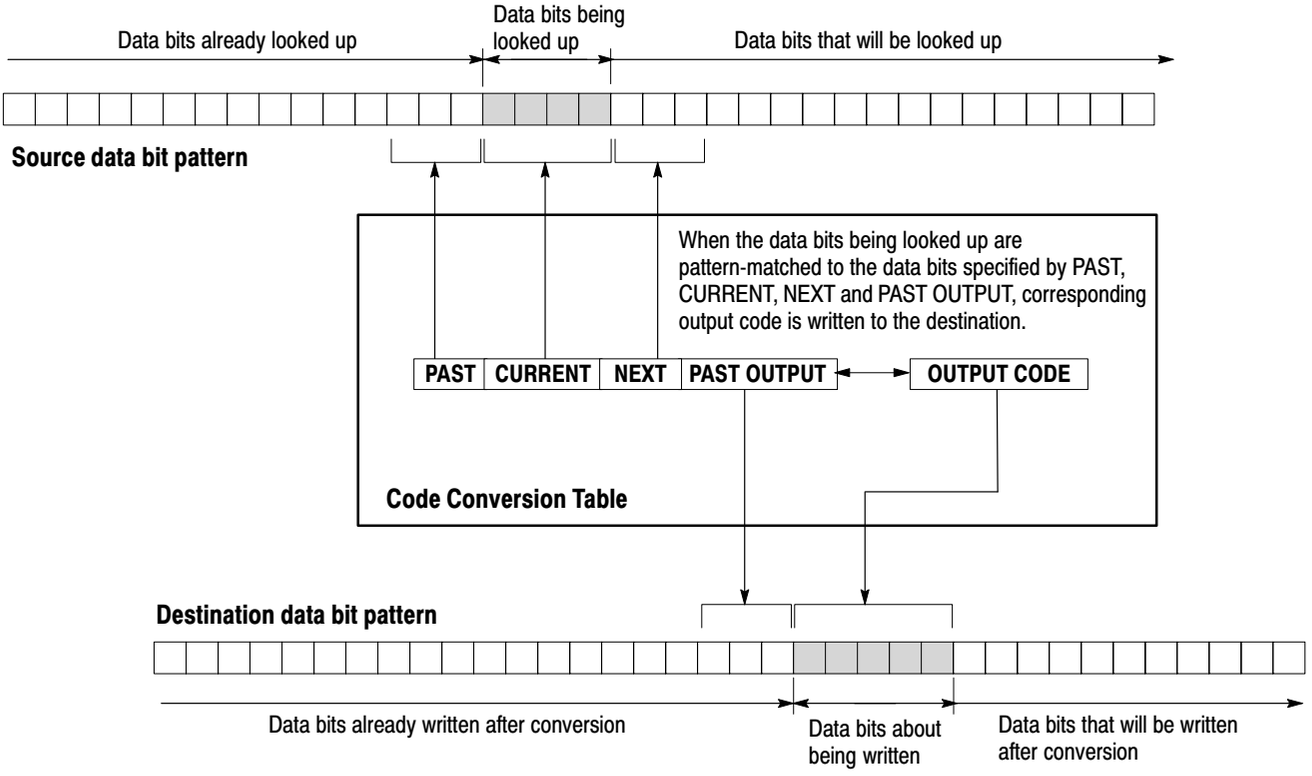


Figure C-1: Conversion image example

Examples

In the following examples, data bits to be written in the tables are introduced. Following each table is the resulting input and output data bit pattern example.

- Inverting a bit(s) of the **NRZ** data.

Past	Current	Next	P.OUT	Output code
	0			1
	1			0

Example									
Input	0	1	0	0	1	1	0	0	0
Output	1	0	1	1	0	0	1	1	1

- Converting NRZ data to **NRZI**.

Past	Current	Next	P.OUT	Output code
	1		0	1
	1		1	0
	0		0	0
	0		1	1

Example									
Input	0	1	0	0	1	1	0	0	0
Output	0	1	1	1	0	1	1	1	1

- Converting NRZ data to **NRZI**. Two bits are generated for each input bit.

Past	Current	Next	P. OUT	Output code
	1		0	01
	1		1	10
	0		0	00
	0		1	11

Example									
Input	0	1	0	0	1	1	0	0	0
Output	00	01	11	11	10	01	11	11	11

- Converting NRZ data to **FM**. Two bits are generated for each input bit.

Past	Current	Next	P. OUT	Output code
	0		0	11
	0		1	00
	1		0	10
	1		1	01

Example									
Input	0	1	0	0	1	1	0	0	0
Output	11	01	00	11	01	01	00	11	00

- Converting NRZ data to **BI-PHASE**. Two bits are generated for each input bit.

Past	Current	Next	P. OUT	Output code
	0			01
	1			10

Example									
Input	0	1	0	0	1	1	0	0	0
Output	01	10	01	01	10	10	01	01	01

- Converting NRZ data to **RZ**. Two bits are generated for each input bit.

Past	Current	Next	P. OUT	Output code
	0			00
	1			10

Example									
Input	0	1	0	0	1	1	0	0	0
Output	00	10	00	00	10	10	00	00	00

- The output bit is always set to 1 when input the bit changes from 1 to 0 or 0 to 1.

Past	Current	Next	P. OUT	Output code
0	1			1
1	0			1
	1			0
	0			0

Example									
Input	0	1	0	0	1	1	0	0	0
Output	0	1	1	0	1	0	1	0	0

- Converting NRZ data to **1-7 RLL (Run-length Limited Codes)**.

Past	Current	Next	P. OUT	Output code
	0000		1	100000
	0000		0	011111
	0001		00	111111
	0001		01	111111
	0001		10	000000
	0001		11	000000
	0010		01	111110
	0010		10	000001
	0010		00	111110
	0010		11	000001
	0011		1	100001
	0011		0	011110
	01		1	100
	01		0	011
	10		01	111
	10		10	000
	10		00	111
	10		11	000
	11		01	110
	11		10	001
	11		00	110
	11		11	001
	0			0
	1			1

Example											
Input	01	10	11	0010	10	0011	11	0001	0011	10	0000
Output	011	000	110	000001	111	100001	110	000000	011110	000	011111

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. *Avoid the use of chemical cleaning agents that might damage the plastics used in this instrument. Use only deionized water when cleaning the menu buttons or front-panel buttons. Use a ethyl alcohol solution as a cleaner and rinse with deionized water. Before using any other type of cleaner, consult your Tektronix Service Center or representative.*

Avoid the use of high-pressure compressed air when cleaning dust from the interior of this instrument. High-pressure air can cause Electrostatic Discharge (ESD). Instead, use low-pressure compressed air (about 9 psi).

Exterior Inspection

Using Table C-2 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-2: 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 the Instrument Exterior

WARNING. *To avoid injury or death, unplug the power cord from line voltage before cleaning the instrument. 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 DG2040 Data Generator for inspection and cleaning, refer to the *Maintenance* section in the DG2040 Data Generator service manual.

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