DL2700 MULTICHANNEL, LONG-RECORDING DIGITAL OSCILLOSCOPE

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We have developed a digital oscilloscope with a maximum of 8 input channels, a maximum sampling rate of 500 MS/s and a maximum record length of 16 megawords. The multichannel configuration, long-recording memory, powerful analysis functions and excellent operability have enabled users to do efficient troubleshooting. This paper contains an overview of the instrument.

INTRODUCTION

In the development of electronic instruments or the analysis of abnormal phenomena, there is a demand for digital oscilloscopes that can observe multichannel waveforms or waveforms with higher sampling rates over prolonged periods. In 1990, Yokogawa Electric produced the DL2200 to meet these needs. The DL2200 is a digital oscilloscope with full-range four-channel inputs and a maximum record length of 1 megaword. However, as technologies advance, the need for more channels and longer recordings increases.

The DL2700, which we have developed recently, is available in either a 2, 4, 6 or 8 input-channel model with a maximum record length of 1, 4 or 16 megawords. Users can select one of these 12 models that is best suited to their needs of application. The printed circuit board is designed so that the oscilloscope can easily be upgraded by increasing the number of input channels and record length after purchase. The DL2700 features high waveform update rates, an intuitive, easy-to-use Zoom function, a History Memory function that allows earlier screens to be observed, a wealth of trigger functions, automatic measurement of waveform parameters, waveform computing, and so on. These features enable users to capture abnormal phenomena and analyze them smoothly and efficiently. The DL2700 digital oscilloscope is shown in Figure 1.

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FEATURES

(1) 150-MHz frequency bandwidth and a maximum of 8 full-range input channels
(2) 250-MS/s channel-by-channel A/D converters, providing a maximum sampling rate of 200 MS/s for the normal mode and 500 MS/s for the interleave mode (with the number of available channels halved)
(3) Maximum record length of 8 megawords for the normal mode and 16 megawords for the interleave, enabling measurement at high sampling rates even in slower Time/Div-axis ranges

Figure 1 External View of the DL2700

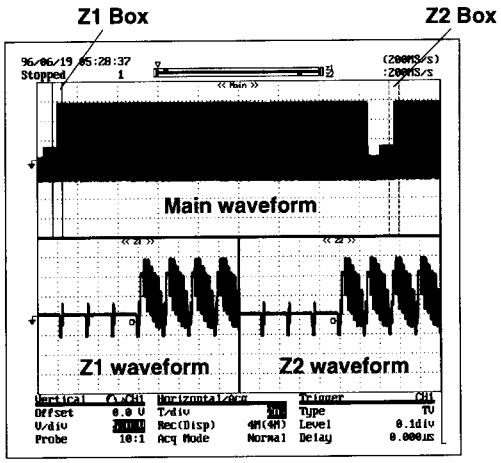

Figure 2 Two-Point Simultaneous Zooming

(4) Waveform update rate of approximately 3 cycles/s for a 1-megaword/channel, 8-channel application by means of the hardware-based, peak-to-peak compression function
(5) Enhanced Zoom functions such as two-point simultaneous zooming (Figure 2)
(6) A History Memory function which can save a maximum of 8,000 screens, enabling waveforms generated before measurement was interrupted to be recalled
(7) A Sequential Store function with a minimum dead time of 10 µs
(8) A Box Average function, enabling high-resolution measurement of one-shot signals
(9) Powerful trigger functions such as a gate trigger, pattern trigger, pulse-width trigger, window trigger and TV trigger
(10) High-speed data processing such as automatic measurement of waveform parameters, histogram analysis and waveform computing
(11) A maximum of 32 logic inputs using a dedicated logic probe

SYSTEM CONFIGURATION

Figure 3 shows the block diagram of a DL2700 digital oscilloscope. DL2700 exhaustively utilizes the technical resources of its predecessor models and, therefore, helped shorten the development lead-time. The front end including attenuators and preamplifiers is the same as the DL4100's and the processor system is common to both the DL5100's and AR4000's. Two new ASIC's were developed for the data acquisition stage. The front end and data acquisition stages are configured so that a single printed circuit board supports two channels for easier addition of channels. In the data acquisition stage, the acquisition memory is installed on a separate board so that record length can be changed simply by changing the type of memory board. Consequently, replacing the memory board also upgrades the record length. The display unit comprises an 8.4" TFT color LCD panel, the same as that of DL5100. In addition, DL2700 is equipped with a 3.5" floppy drive and a SCSI interface as a standard feature. The oscilloscope can also be supplied with an optional magneto-optic disk drive and a built-in printer.

ANALOG STAGE

DL2700 uses Yokogawa-developed preamplifiers at its front end, featuring the 150-MHz input frequency bandwidth and the direct-current accuracy of ±1.5%. The 2 mV/div maximum sensitivity is increased to 4 mV/div at the front end stage by doubling the A/D-converted data at the digital stage. The multiplexer circuitry is made up of discrete components and the circuitry alone has a frequency bandwidth of no less than 200 MHz. The channel-to-channel isolation across the whole circuitry of the oscilloscope, including the multiplexer circuitry,

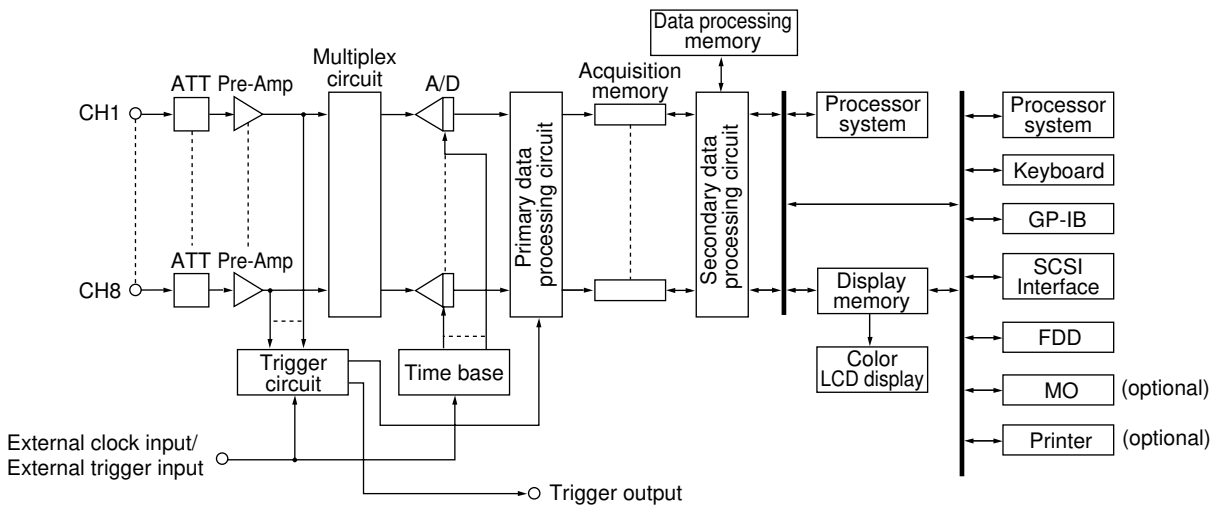

Figure 3 Block Diagram of DL2700

is -40 dB.

An 8-bit, 250 MS/s A/D converter is incorporated in every channel. The converter normally operates at 200 MS/s. In the interleave mode, however, an analog signal is multiplexed by the multiplexer circuitry so the converter operates at 250 MS/s by means of the interleave method, thus achieving a sampling rate of as high as 500 MS/s.

In the trigger stage, each channel contains one comparator, while only channel 1 includes two comparators for the Window Trigger function. Channel 1 also contains the circuitry for the TV Trigger function. The TV Trigger function is compatible with the NTSC, PAL and HDTV systems. Three digital ASIC's and one analog ASIC that were developed for DL4100 and DL5100 are used in the trigger logic circuitry.

WAVEFORM DATA PROCESSING STAGE

The waveform data processing stage consists of the primary data processing circuitry that writes A/D-converted data into the acquisition memory, the secondary data processing circuitry that performs such processes as the sorting of acquired data or peak-to-peak compression, and the acquisition and data processing memories.

This stage uses two newly developed ASIC's (CMOS gate arrays). One is responsible for performing primary data processing. The other generates various timing signals for the primary data processing, controls the memories, and performs secondary data processing, acting as an interface between respective memories and CPUs.

1. Primary Data Processing Stage

The primary data processing stage reduces the rate of A/D-converted data to a one-fourth, performs the processes described below, and further reduces the rate to a half depending on such conditions as the Time/Div-axis settings.

This stage:

(1) decimate the data density so the data rate is consistent with the Time/Div-axis settings,
(2) detects the peaks of data for operation in the envelope mode, and

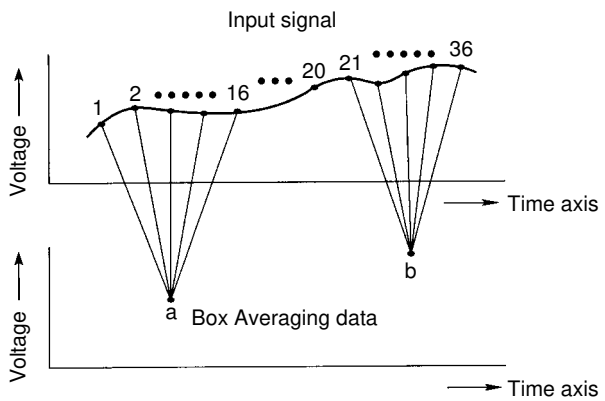

Figure 4 "Box Averaging" Data at 10-MS/s Sampling

(3) averages data for operation in the "box average" mode.

The Box Average function has been introduced in the DL series of oscilloscopes for the first time. Data that have undergone the process of this function are theoretically equivalent to those that have undergone the moving-average process and then the data density is decimated. In fact, this function takes an average of consecutive 2^n data items (256 maximum) within the period of decimation and writes the average into the acquisition memory (Figure 4). Acquired data, which normally consist of 8 bits, are treated as 16-bit data during "box averaging." This strategy has made high-resolution measurement possible even for one-shot signals.

2. Secondary Data Processing Stage

As the major actions, the secondary data processing stage:

(1) calculates the first address from the trigger address and the amount of pre-trigger to sort acquired data within the free space of the acquisition memory, and shifts the slots in that space successively, one by one, to use it as the history memory,
(2) sorts data during equivalent sampling,
(3) performs linear averaging and exponential averaging,
(4) performs peak-to-peak compression consistent with the Time/Div-axis settings to write the resulting data into the data processing memory, and
(5) determines the histogram of acquired data for waveform parameter measurement and writes it into the data processing memory.

These processes are executed by means of hardware to achieve a waveform update rate of approximately 3 cycles/s for a 1-megaword/channel, 8-channel application.

PROCESSOR SYSTEM

The processor system consists of two processors: Intel 80960KB that performs input control, computing and display processing, and Toshiba TMP68303 that assumes user interface , communication control and so forth.

FIRMWARE

DL2700 succeeds the human-machine interface used in its predecessor model DL5100 for consistent operability. Functionally, it also succeeds the DL5100's features including the capability of outputting screen image data. Using the standard floppy drive and SCSI interface as well as an optional built-in magneto-optic disk drive, users can easily exchange data with a personal computer (Figure 5). For waveform display, the firmware has been designed to take advantage of the long-recording memory. The modes of display include simultaneous view of both the entire waveform and its partial close-up, view of partial close-up only, and view of an indicator that enables users to keep track of which part of the entire waveform they are viewing. These features have made the oscilloscope even easier to use.

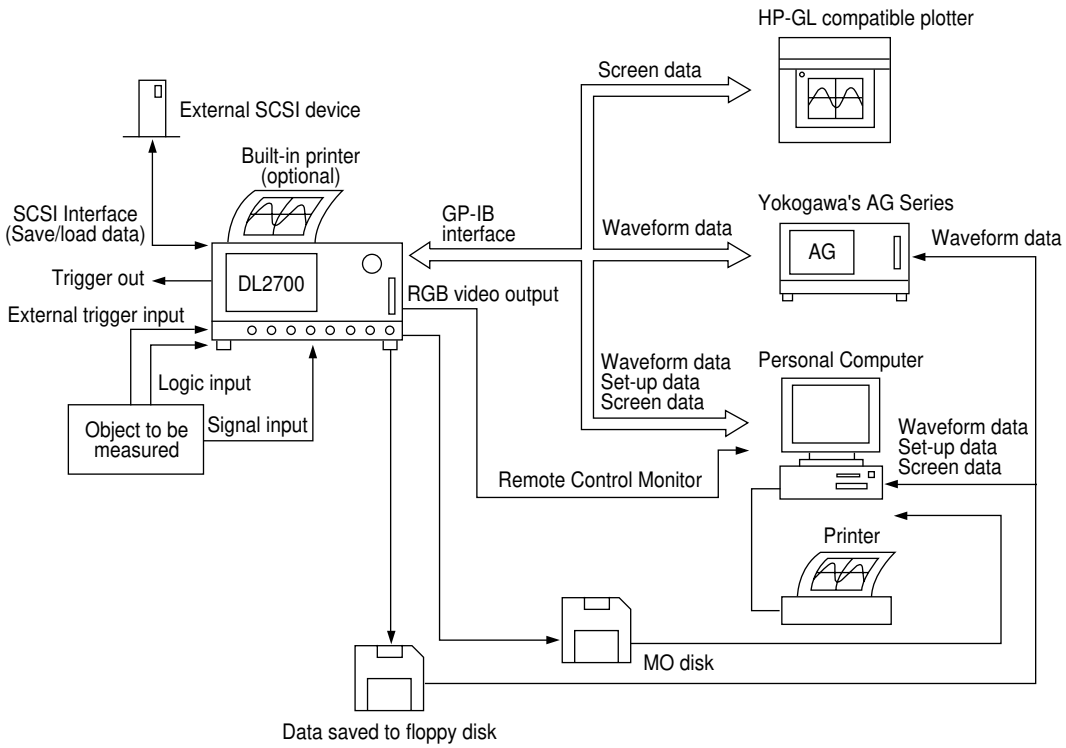

Figure 5 System Configuration

1. Zooming

Zooming that provides partial close-ups of a captured waveform is a critical function for digital oscilloscopes having long-recording memory. The DL2700 has materialized the Zoom function with which users can easily take a closer look at desired parts by using the following intuitive operations.

(1) Press the ZOOM key.
(2) Select the ZOOM mode.
(3) Using the rotary knob, select the magnification—zooming factor (common to both Zoom 1 and Zoom 2).
(4) Using the rotary knob, select the position to be zoomed into (separate for Zoom 1 and Zoom 2).

In addition, the following six modes are provided to facilitate waveform observation using zooming functions.

a) Display of the main waveform only
b) Simultaneous display of both the main and Zoom 1 waveforms
c) Display of the Zoom 1 waveform only
d) Simultaneous display of the main, Zoom 1 and Zoom 2 waveforms
e) Display of the Zoom 2 waveform only
f) Simultaneous display of Zoom 1 and Zoom 2 waveforms

When displaying main and zoomed waveforms simultaneously, the user can use the "zoom-box" to immediately see which part of the main wave they are viewing in close-up. This was a feature in the DL4000 and 5000 series and is now available on the DL2700 also. As an additional feature, an indicator was incorporated to identify which part of a waveform is being zoomed currently when only a zoomed waveform is displayed. For the modes of the display, hardware-based, high-speed peak-to-peak compression is also done using the secondary data processing stage mentioned before. This enables comfortable zooming without slowing down the waveform update rate.

CONCLUDING REMARKS

In this paper, we have introduced the features and system configuration of the DL2700 digital oscilloscope. The DL2700 has been developed in pursuit of not only a multichannel scope with long-recording memory, but also for an effective use of the long-recording memory and an easy-to-use ZOOM function. We are confident that the DL2700 will be used in a wide range of applications, including the analysis of abnormal phenomena. ◆

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