DIGITAL SCOPE DL708E

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This paper describes our recent development, the DL708E portable 8-channel digital scope with large color display. The DL708E is designed with plug-in module architecture and equipped with 7-types of interchangeable modules, including a high-speed isolation module (10 MS/s, 10 bits), a high-resolution isolation module (100 kS/s, 16 bits), and a temperature input module. It also has a bright 10.4-inch color TFT LCD display with a wide viewing angle and supports "real-time hard disk recording." This function is capable of recording up to 128 MW in real-time using the optional internal hard disk. The scope's large 16-MW memory also enables waveforms to be observed over a long period. By using a three-dimensional CAD system to construct the mechanical design, we were able to effectively minimize the size of the instrument into one small, light unit that measures 370 (W) × 260 (H) × 183 (D) mm and weighs in at 6.8 kg. The DL708E's multi-channel measurement makes it suitable for a variety of measurement needs ranging from temperature measurements to measurement of high-speed signals with frequencies up to the MHz range, such as is required for "mechatronics" measurements, resolving the problem of failures that result when conventional oscilloscopes are used.

INTRODUCTION

The increased usage of digital oscilloscopes has brought with it increasing demand for simultaneous viewing of fast and slow phenomena. The newly-developed compact and lightweight DL708E digital scope is able to answer to this demand, by incorporating a function to capture slow phenomena with the fast-phenomena capturing function of current DL series oscilloscopes. The large color display enables multi-channel isolated signal measurement and the use of plug-in modules for input circuits enables various other applications to be performed as well. Figure 1 shows an external view of the DL708E digital scope.

FEATURES

(1) Plug-in Input Modules (see Figure 2)
Various different input modules can be incorporated into the DL708E. By changing over the modules, the DL708E can be used to measure high-speed isolated signals (10 MS/s, 10 bits), high-resolution isolated signals (100 kS/s, 16 bits), and temperature input signals.

(2) Ultra-long Memory
The standard model digital scope can record 100 kilowords/

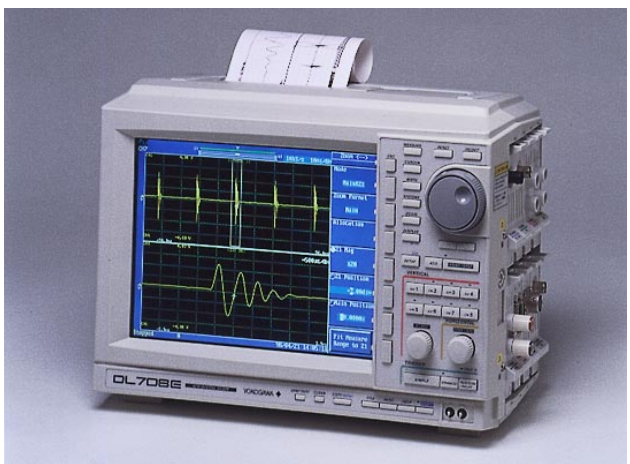

Figure 1 External View of the DL708E Scope

*1 Test & Measurement Business Division
*2 Windows 95 is a registered trademark of Microsoft Corporation, USA.

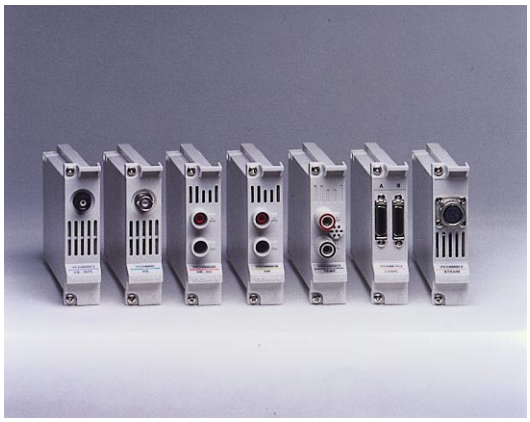

Figure 2 Plug-in Input Modules

channel when 2 channels of the standard 400-kiloword memory are used, while a model with the long-memory option can record up to 4 megawords/channel when 2 channels of the 16-megaword memory are used.

(3) External Clock Input Function (optional)
A sampling clock (with a maximum sampling frequency of 100 kHz) can be externally added in order to make data sampling proportional to the varying speed of rotation systems.

(4) Large 10.4" Color TFT Display
The DL708E has a thin film transistor (TFT) liquid crystal display that has an upper and lower viewing angle of 110° (much higher than the 40° viewing angle of conventional models) and brightness of 200 candela (much brighter than the 140 candela of conventional models).

(5) Compact and Lightweight Body
All of the main circuits and the 8-channel input modules are housed in a small light body whose external dimensions are 370 (W) × 260 (H) × 183 (D) mm and whose weight (inclusive of the 8-channel high-speed isolation modules) is about 6.8 kg. The mechanical design of the instrument was achieved using three-dimensional CAD.

(6) Real-time Hard Disk Recording (optional)
Real-time recording of up to 128 megawords (when using one-channel only) can be achieved using the internal hard disk (hereafter abbreviated as HDD). Depending on the sampling rate and amount of memory, it may be possible to observe waveforms over a prolonged period such as several days.

(7) SCSI Interface (optional)
By connecting an SCSI cable between the DL708E and PC, file transfer can be made simply and at high speed enabling

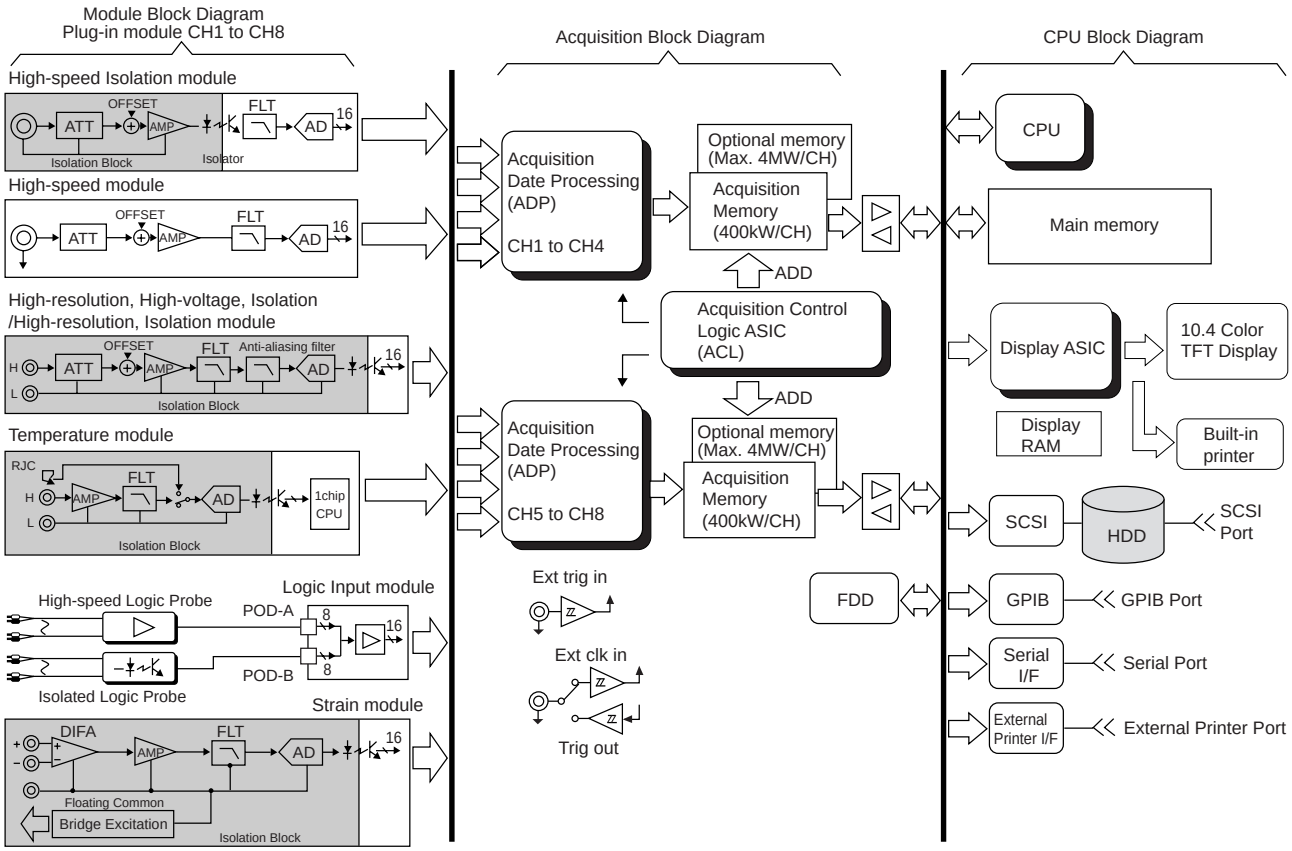

Figure 3 Block Diagram of the DL708E Digital Scope

Table 1 Features of Modules for the DL708E Digital Scope

■ High-speed Isolation Module (701850) ・ Maximum input voltage of 850 V (DC + AC peak) See Note ・ Maximum allowable common mode voltage of 400 Vrms See Note ・ Frequency characteristics ranging from DC to 2 MHz DC accuracy of ± 1.5% (except for 5 mV/div) Note: When combined with the dedicated probe.
■ High-speed Module (701851) ・ Maximum input voltage of 250 V (DC + AC peak) ・ Frequency characteristics ranging from DC to 4 MHz (or -1 dB when a sine wave with an amplitude of ± 3 div is input) DC accuracy of ± 1.5% (except for 5 mV/div)
■ High-resolution High-voltage Isolation Module (701852) ・ 100 kS/s, 16 bits ・ DC accuracy of ± 0.5% (except for 50 mV/div) ・ Maximum input voltage of 850 V (DC + AC peak) ・ Maximum allowable common mode voltage of 400 Vrms
■ High-resolution Isolation Module (701853) ・ 100 kS/s, 16 bits ・ DC accuracy of ± 0.3% (except for 5 mV/div and 10 mV/div) ・ Maximum input voltage of 100 V (DC + AC peak) ・ Maximum allowable common mode voltage of 400 Vrms
■ Temperature Module (701860) ・ Isolated input ・ Twelve types of thermocouples are accepted.
■ Logic Input Module (701870) ・ Sixteen-bit input composed of two probes of eight-bit inputs. ・ Can select between a non-isolated type (700986) or isolated type (700987) input probe.
■ Strain Module (701880) ・ Isolated floating input ・ Applicable to bridge voltage of 2 V or 5 V ・ Provides two dedicated small bridge heads: 700932 (120 Ω) and 700933 (350 Ω).

users to directly access the contents of the DL708E's internal HDD from a Windows 95[*2] environment.

(8) External Printer Interface and Built-in Printer
In addition to the built-in thermal printer, an interface for an external printer is also provided as standard. This allows users to use any of the low-cost high-speed printers on the market and enables color printing on normal paper.

HARDWARE CONFIGURATION

Figure 3 is a block diagram showing the configuration of the DL708E digital scope.

We used Hitachi's SH2 (SH7604) processor for the central processing unit. This achieved a low-cost CPU that has a bus width of 32 bits and a super-fast processing rate of 28 million instructions per second (MIPS), enabling processing that was previously performed by hardware to be performed by software. We developed one application-specific integrated circuit (ASIC) for display purposes (that is, for both the LCD and internal thermal-printer control) and two types of ASICs for acquisition purposes. This optimizes the circuits and enables all of the functions (of the 8-channel acquisition system, CPU system, and several interfaces) except for those in the analog section, to be mounted on a single printed wiring board that measures 185 × 190 mm (approx. half the area required on the present model).

Table 2 Main Acquisition Functions

Display updating speed	A maximum of 30 frames per second
Maximum recording length	400 kilowords (for standard 100-kilowords/channel model) 16 megawords (for 4-megawords/channel model with optional memory)
Envelope mode	Peak hold at the module's maximum sampling rate
Box average	Expansion of AD resolution by up to 4 bits
History memory	Up to 1000 sheets of waveforms are stored in memory.
Sequential saving	From 2 to 1000 saving sequences can be specified.
Roll	Roll at a maximum of 100 kS/s available
Average	Averaging can be carried out from 2 to 65536(2 steps)
Trigger mode	AUTO, AUTO-LEVEL, NORMAL, or SINGLE
Simple trigger	Edge trigger (Rise, Fall, or Both)
Enhanced trigger	A → B(n), A delay B, Edge on A, Edge OR, B>Time, B<Time, B TimeOut, or Window

Input Modules

Seven types of input modules are presently being prepared, each of which measures approximately 96 × 25 × 150 mm. The high-speed isolation module is the core module for the product. Isolation is achieved by employing an analog photo-coupler, which offers benefits resulting from its high speed, small size and consequent space savings. The common mode rejection ratio has been improved by incorporating a common mode compensation circuit.

The high-speed module was quite quick, as it simply required making its circuits common to that of the high-speed isolation module. Table 1 shows the features of each module.

Acquisition System

The acquisition system is composed of acquisition memory and the two types of ASICs that were developed on the basis of the proven waveform processing technology of the DL series oscilloscopes, namely the Acquisition Data Processor (ADP) and Acquisition Control Logic (ACL) circuits. An ADP processes four channels of data and implements all kinds of waveform data processing, including sample rate conversion, envelope processing, averaging, data compression, and trigger processing. The ADP also has a circuit configuration that can accept various modules (serial transfer AD, parallel transfer AD, and logic). An ACL controls the ADP and the acquisition memory and interfaces the acquisition memory with the CPU. The cost has been further reduced and the memory made super long by optimizing the processing of waveform data, minimizing the number of memory types and employing EDO DRAM for the acquisition memory. The main acquisition functions are summarized in Table 2.

FIRMWARE

Re-use of the superior DL2700 model and use of the latest integrated development environments for the CPU, have greatly reduced development time and improved efficiency. In the

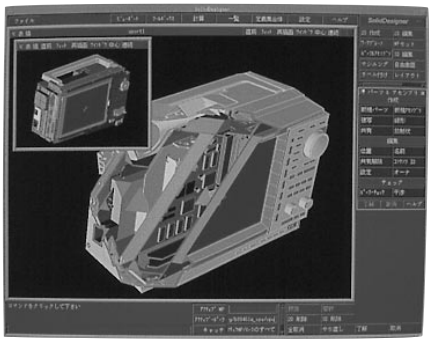

Figure 4 Display of Three-dimensional CAD Application

DL708E digital scope, the following functions were enhanced.

(1) Split Print
Waveforms can be zoomed in on at every screen division (split display) and output to a printer.

(2) Expansion of Multilingual Help Function
Due to increasing internationalization, the Help function is now being made available in Italian in addition to the Japanese, English, French and German versions supported by the conventional models.

(3) High-Speed Displaying of Real-time HDD Records
The simultaneous writing of actual measured data and data compressed at 100 sampling points to the HDD, enables you to obtain a high-speed scrolling display by selecting either of these two types of data for display.

MECHANICAL DESIGN

A three-dimensional CAD was used to achieve the mechanical design of the DL708E. The use of this tool produced the following results:

(1) Trial production lead time was shortened by about 60% as a result of rapid prototyping.

(2) The metallic mold production time for molding products was shortened (by automating work that required manual intervention).

(3) Designing mistakes, such as dimensional interference, were eliminated.

(4) Persons responsible for the circuit development came to fully understand what the users of the DL708E want.
As a result, the target development time is shortened by about 40%. In addition, the use of this tool enables difficult-to-use spaces to be easily deleted from the design, which is a time-consuming task when attempted using the two-dimensional design techniques. This results in the effective utilization of three-dimensional volumes and enabled the digital scope to be incorporated into a small light body. Figure 4 shows a display of the three-dimensional CAD application.

CONCLUDING REMARKS

The DL708E digital scope not only achieves multi-channel operation without any downgrade in the operability of conventional digital oscilloscopes, but can also respond to a wide range of high-speed signals, from those for temperature measurement to those with MHz frequencies, and measurement needs. We shall continue to develop new modules with more functions to add to this series in the future. ◆