

MODEL CA100 “COMPACT CAL” CALIBRATOR

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We have developed Model CA100 “Compact CAL,” a portable calibrator, having 0.02% accuracy and the resistance generator function. The design objectives were excellent accuracy, the support of essential functions, and easy operation. The calibrator is ideal for maintaining the accuracy of such equipment as converters at an optimum level. In order to calibrate such equipment in the field, we have provided the compact, economical calibrator with the generator function, measurement function and 24-V DC output function.

This paper introduces the functional overview of the CA100 calibrator.

INTRODUCTION

In all kinds of industrial plants, physical quantities such as temperature, flowrate and pressure are changed to required electrical signals through converters to use them for monitoring, control or other purposes. The industry-standard accuracy of these converters, which was 0.25%, has been changed to 0.1% recently. Consequently, it has become a requirement for measuring instruments used to inspect or calibrate converters, receiving meters, and so on to also have higher accuracies.

The recently developed CA100 calibrator is a portable, highly accurate measuring instrument having an accuracy high enough to support the inspection and calibration of converters with a 0.1%-order accuracy in the field. In addition, CA100 is provided with the function for generating pseudo resistance temperature detector (RTD) signals, the DMM function used to measure the output signals of a converter, and the 24-V DC output function used to supply power separately to a converter, all of which were only available previously using a separate instrument.

Figure 1 is the external view of the CA100 calibrator.

DESIGN CONCEPTS

As trends in the latest measuring instruments, we often notice such products that are equipped with a variety of advanced functions to highlight the superiority in cost-performance. In contrast, users are hoping for a simple measuring instrument that has only necessary functions with required accuracies and does not mislead the operator during use. This requirement is all the more strong for the excellently portable CA100 calibrator in order to avoid accidents due to erroneous operation in the field. Users who make a business of engineering tend to implement their own know-how in the form of programs for a personal computer and



Figure 1 External View of CA100

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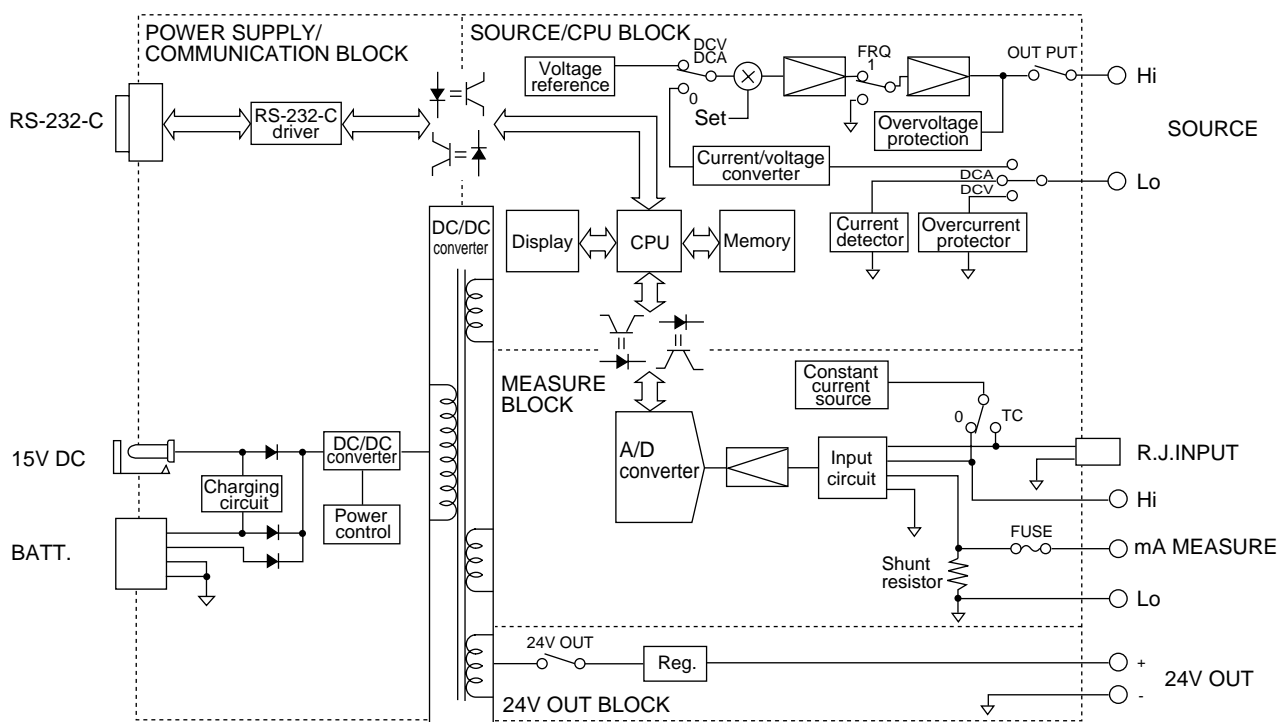


Figure 2 Block Diagram of CA100

Table 1 Typical Examples of Accuracies of the Basic Functions

Function Category	Function	Range	Accuracy (%)
Generation	DC voltage	1V	$\pm(0.02\% \text{ of setting} + 0.005\% \text{ of range})$
	DC current	20mA	$\pm(0.025\% \text{ of setting} + 0.015\% \text{ of range})$
	Resistance	500 Ω	$\pm(0.02\% \text{ of setting} + 0.02\% \text{ of range})$
Measurement	DC voltage	5V	$\pm(0.02\% \text{ of setting} + 0.01\% \text{ of range})$
	DC current	20mA	$\pm(0.025\% \text{ of setting} + 0.02\% \text{ of range})$

connect a measuring instrument to the computer to efficiently inspect equipment and make reports. Earlier advanced functions are being absorbed in such computer programs. The result is a demand that measuring instruments have the communication function, in addition to their essential functions and high accuracy, so they serve as I/O units for personal computers.

In the design of CA100, efforts were concentrated on high accuracy and the enhancement of basic functions, as voiced by users. For a human-machine interface, operability was considered first; therefore, multiple definitions of keys and their degree of multilayer structure were minimized and the number of keys was reduced in order to achieve the principle of “one key-one-action” with the minimum number of required keys. Advanced functions that would make operation complex were removed by equipping the calibrator with the communication interface to enable online control. All these efforts led to the precision measuring instrument that can be used like a common, commercially available hand-held tester.

FUNCTIONAL OVERVIEW AND FEATURES

The generator function covers DC voltage, DC current, resistance, thermocouple (TC) signals, resistance temperature detector (RTD) signals, frequency and pulses to support different types of input to a converter. The measurement function is designed to support DC voltage, DC current and resistance with the aim of measuring 1-5 V and 4-20 mA signals. The accuracies have been made as high as possible, as shown in Table 1. In other areas of functionality, the calibrator supports not only the source mode but also the sink mode for DC current generation, enabling inspection of receiving meters. For resistance generation, the calibrator is provided with a 500 Ω range so the single range covers up to 332.66 Ω which corresponds to 650°C for a Pt100 RTD. The response time has also been improved (10 ms), considering signal generation for scan-mode input devices. For TC signal generation, the function is made switchable taking into consideration a case where equipment being measured is a combination of earlier and later versions of JIS-standard products. The calibrator is provided with the 24-V DC power supply output function, in addition to the generator and measurement functions. The display (as wide as 35% the area of the operation panel) is located in the upper-middle of the operation panel for better visibility. Integral, silicone-rubber flat keys are employed to make the key panel dustproof. To protect against a possible failure due to aging, mechanical switches are placed on the circuit board so each rubber keytop pushes down

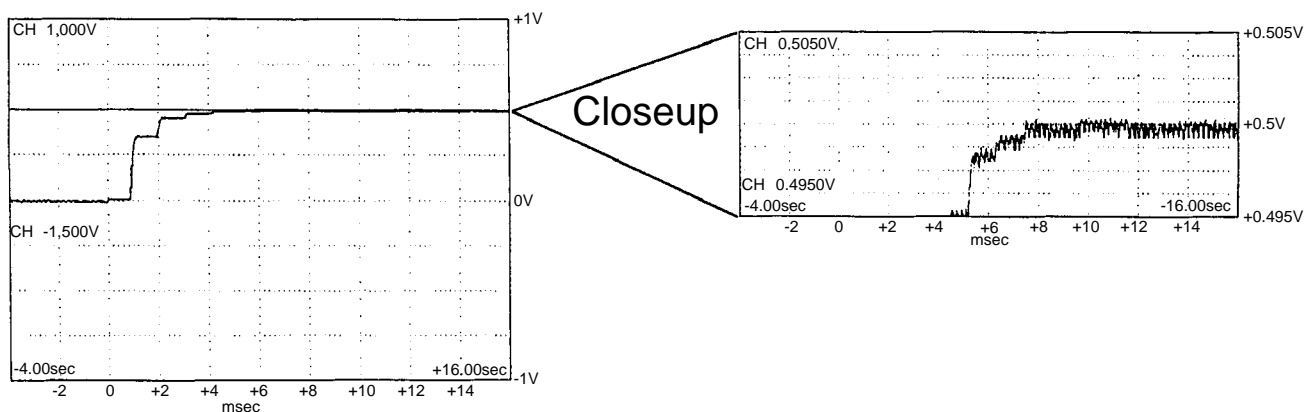


Figure 3 Response Waveform during Resistance Generation

the underneath mechanical switch. This arrangement gives the operator a click feeling each time, ensuring that the key has been pressed securely. As a main source of power to the calibrator, we have selected an AA-size battery, among other batteries, which is available almost anywhere and even when the calibrator is used unexpectedly. In addition to the battery, dedicated Ni-Cd battery packs and AC adapters are available. The Ni-Cd battery pack is rechargeable through the calibrator using the AC adapter. For communication, the calibrator is provided with the serial communication function based on start-stop synchronization, as standard, so generator-function settings and measured values can be printed by connecting a printer externally. CA100 is compact and lightweight, having an outline nearly the size of an A5 paper—237 (W) × 137 (H) × 63 (D) (mm)—and weighing only 1.2 kg (including batteries).

CONFIGURATION

Figure 2 illustrates the block diagram of the CA100 calibrator. The diagram can roughly be divided into four blocks: the power supply/communication block, generator block, measurement block and 24-V power supply block. To enable these four blocks to be used separately, they are electrically isolated from each other. The MPU, which controls the entire calibrator, is located in the generator block. Control of the respective blocks is done through photocouplers. The communication section, which is connected to an external device, is located in the power supply section and isolated from other blocks. The 24-V power supply block for converters being calibrated is isolated using a transformer and outputs power through a three-terminal voltage regulator. Details on the power supply, generator and measurement blocks are given in the following paragraphs.

1. Power Supply Block

Since CA100 is a portable calibrator, the power supply block needs to be highly efficient and emit less noise to support prolonged operation on batteries and higher accuracy. The block

first regulates input voltage from such unstable, varying types of power sources as an AC adapter, a Ni-Cd battery pack or dry cells using a DC/DC converter; then using a transformer-based switching regulator, the block generates and supplies electrically isolated power to other blocks. The power is further processed through a three-terminal voltage regulator to produce a stable source of power. Each winding of the transformer is shielded to prevent switching noise from mixing into the secondary stage. Each switching regulator is as efficient as no less than 90% and the three-terminal voltage regulator has a saturation voltage as excellent as approximately 0.2 V. The generator block can deliver an output voltage of up to 28 V (for generation of -22 mA); therefore, a switching regulator is used as the power source to the output amplifier to control the power supply voltage by means of the output voltage. This strategy achieves low power consumption when the output voltage is low. All these features have made it possible to produce a power supply that is extremely immune to voltage variations in the power source, far less noisy and highly efficient.

2. Generator Block

The generator block consists of a voltage reference, a multiplier, amplifiers, output selector contacts, a current/voltage converter and protection circuits. For voltage generation, the output of the voltage reference is varied by the multiplier to produce a desired voltage through the output amplifier. For current generation, the output amplifier works as a voltage/current converter. In the case of resistance generation, the block does not actually generate resistance. Rather, the block uses a means known as the “active impedance method” that generates a voltage consistent with the resistance being generated when a current is applied externally. A current entering through the Lo terminal is transduced to a voltage by the current/voltage converter, the voltage is varied by the multiplier, and then a desired voltage is outputted across the Hi and Lo terminals. This strategy enables free generation of a desired voltage consistent with the preset resistance for an incoming current simply by changing the setpoint of the multiplier. This means the desired

compensation data for the TC output mode.

As the A/D converter, CA100 employs a delta-sigma-conversion CMOS LSI having 20-bit resolution. The block performs averaging on measured data within an interval between display updates to reduce effects due to output noise, thus suppressing instability in readings.

OVERVIEW OF FIRMWARE

The internal firmware consists of three types of interruption and eight tasks (Figure 4). It undertakes different types of hardware control such as processing for generation, processing for measurement, measurement for RJC, processing for communication, control of the keys and LCD display, power monitoring and automatic power-on/off. Our conventional precision instruments would use MPU's of different types and from different manufacturers in different ways. Beginning with the newly developed products, however, we will use the 32 bit-

MPU models in the SH series. This approach is a first step toward the unification of development environments (use of μ ITRON, an OS that supports the SH series and development tools, such as a compiler, linker and debugger, from Greenhills) and the sharing of resources for a reduction in development work processes.

CONCLUDING REMARKS

In this paper, we have discussed the functions, features and internal circuits of CA100. Because of the instrument's high accuracy, wealth of basic functions and simple operation, we expect it to win backing from a wide range of user classes in the on-site inspection of various converters and receiving meters. The resistance (RTD-signal) generator function, among other functions, has been designed in pursuit of high speeds and, therefore, is outstanding and unrivaled. We are confident the function will be useful in a wide variety of applications. ◆

