Single Channel Analyzer

Model SCA 103

Instruction Manual

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1. Introduction

The model SCA 103 is a useful part in nuclear spectroscopy applications, where a large dynamic range, excellent suppression and a small deadtime at high input count rates is needed.
This device analyzes the amplitudes of e.g. energy pulses from nuclear pulse shaping amplifiers. The level settings and the mode of operation are determind by front panel controls to perform the logic decision. Due to the simple design of the SCA the user can easily adapt the unit to his individual desired performance.

2. Specifications

2.1   **Input:** proceeds positive unipolar input signals from less than +100mV to about +10V from spectrroscopy amplifiers (dynamic range larger 100:1). The unit is factory set for signals with a risetime of about 1μs. For signals with smaller/higher risetimes see scection 3.3. Front panel BNC connector

2.2   **Outputs:** two independent positive voltage outputs providing about 2V into 50Ω; output width adjustable by front panel trimming potentiometer. For the selection of the width range see section 3.5.

2.3   **Controls: ULD** – upper level discriminator, front panel 10-turn locking dial potentiometer to set the upper threshold.
LLD – lower level discriminator, front panel 10-turn locking dial potentiometer to set the lower threshold.
Front panel three position locking switch to select the mode of operation.
NORM: upper and lower thresholds can be varied independently
INT: only the lower level discriminator is in operation
WIN: the width of the amplitude window is determined by the setting of the ULD potentiometer. With the LLD potentiometer this selected window can be shifted over the whole amplitude range.
BLD-threshold (screwdriver)-potentiometer (positioned on the lower left corner of the printed board) to set a fixed lowest threshold of the unit. For the adjustment see section 3.4.
WIDTH: front panel (screwdriver) trimming potentiometer to set the width of the output pulses.

2.4   **Indicator:** LED indicates the activity of the discriminator. The colour of the LED changes by the count rate of the selected window: green up to ≈ 4 kHz, orange up to ≈ 10 kHz, red above.

2.5 **Performance:** dynamic range larger than 100:1, depending on the risetime of the input signal and the setting of the BLD-threshold. With a well shaped unipolar input signal a suppression factor of up to 10^4 can be achieved.
Count rate: up to 1 MHz, depending on the risetime of the input signal and the width of the output signal.
Threshold stability: better than $\pm$ 0.02%/°C ($\pm$ 200ppm/°C)
Temperature range: 0°C to +50 °C

2.6 **Power requirements:**

+ 6V, 75 mA
+12V, 50 mA
-12V, 40 mA
+24V, 10 mA

2.7 **Physical size:** single width NIM module (1.35x8.71 inches; 3.43x22.13 cm) per TID-20893 (Rev.)

3. Operation

3.1 **General**
The model SCA 103 can be operated in different system configurations with the selectable modes NORM, INT and WIN. The user has to decide which mode is best for his application. Basic performance tests of the SCA 103 may be exercised either in a rack mounted NIM BIN or on a laboratory bench with the unit powered by an extender cable from a NIM BIN (TID-20893), for example when the BLD-threshold must be set differently. It is recommended that changes (CR-bridge or W-bridge) be made with BIN power off.

3.2 **Input**
Suitable driving pulses may be obtained from fast spectroscopy amplifiers (or pulse generators). The unit is factory set for unipolar positive inputsignals with a risetime ot about 1μs. DC-offsets and negative underswings of the input signals should be avoided.

3.3 **Operating mode**
The selection of the operating mode depends on the requirements of the experiment.
In the NORM mode (locking switch on the front panel of the SCA 103 in the upper position) the upper and the lower thresholds can be varied independently from each other, the ULD has to be higher than the LLD setting. Only input signals with amplitudes larger than the lower threshold and smaller than the upper threshold give an output signal.

In the INT mode (locking switch in middle position) the ULD potentiometer is out of operation. All input signals exceeding the lower threshold will give an output signal.

In the WIN mode (locking switch in lower position) the width of the desired amplitude window can be selected by the setting of the ULD potentiometer. With the setting of the LLD potentiometer this selected window can be shifted over the whole amplitude range.

As already stated above, the unit is factory set for positive unipolar input signals with a risetime of about 1μs (zero to peak; for a more detailed description see section 4). For other (smaller or larger) risetimes (t_r) the CR-differentiation can be changed by the user. This can be simply performed by changing the resistor and/or capacitor values values on the CR-bridge (situated on the lower left part of the printed board, marked with CR). As a guideline the following relation can be used:

$$C{\cdot}R = 12.7x10^4 \text{ x } t_r \text{ ; with C in pF, R in } \Omega \text{ and } t_r \text{ in } \mu s$$

The best matching values of commercially available R- and C- series should be used. For short risetimes of the input signal (which means smaller CR-values) the dynamic range may be smaller than 100:1.

3.4 BLD-threshold adjust

The BLD-threshold is factory set for positive unipolar input signals exceeding an amplitude of 100 mV. If a different threshold setting is necessary (e.g., due to a high noise level on the input signal) the threshold can be changed with the screwdriver trimming potentiometer (marked T) on the lower left part of the printed board. The value of the threshold (A_T) can be adjusted by sensing the voltage (V_T) at the test pin (marked with a colour dot). The BLD-threshold (for input signals with risetimes of about 1μs) is given by the relation:

$$A_T(mV) = 12.2 \text{ x } V_T(mV)$$

3.5 Outputs

The SCA 103 has two independent positive voltage outputs with about 2 V into 50Ω. The output width can be adjusted by a front panel (screwdriver) trimming potentiometer. The range of the width can be selected by a simple bridge with with an appropriate capacitor value (located on the upper right part of the printed board marked with W). A desired range selection can be performed as follows:

output width:	from 100 ns to 600 ns	C = 10 pF
	from 600 ns to 3.5μs	C = 100 pF
	from ≈ 2 μs to > 10 μs	C = 470 pF

The factory set range is from 600 ns to 3.5 μs (C = 100pF). On the bridge a 10 pF capacitor is implemented, therefore by simply inserting the bridge turned around the smaller range of the output witdh is available.

4. Circuit description

The complete circuit diagram is shown in section 5. The input signal processing is performed in two paths. In the upper path the input signal passes a high speed Op Amp (AD847), a delay line (necessary to compensate for the delay in the BLD-path if input signals with short risetimes are processed) and a post amplifier (Op Amp AD847). The output signal of this AD847 is fed to the fast precission comparators AD790. The level inputs of the AD790's are given by the operational amplifiers OP 27, where the upper and lower threshold levels are set. When the switches S1 and S2 are in the upper position (see circuit diagram), the levels from the voltage buffers (OP 27) are independent and the SCA 103 is working in the NORM mode (thresholds can be set independently). In the lower position the value of the ULD depends on the voltage drop on the upper front panel potentiometer (10k) plus the voltage of the LLD. In this WIN mode the window is set by the ULD value and the LLD tracks its position.

In the lower path the input signal is CR-differentiated. When the peak of the signal occurs, its derivative is zero. The BLD-threshold is set in the following fast comparator (AD790) and determines the output signal of this AD790. This output signal is narrowed in a gate (74F00) and provides a logic signal for the monostable multivibrator (74LS122). The logic combines the three signals (BLD, LLD, ULD) to generate the appropriate decision. Only if BLD and LLD is present an output signal of the 74LS122 is generated. No output occurs if ULD has also fired. The output of the 74LS122 is fed to a linedriver (74128) to generate the positive output signals of the SCA. The width of the output signals is set by C_W and R_W (see circuit diagram).

A Q-output of the multivibrator is used to serve the logic (74HC4538, 74F00) for the rate LED's.

The unit can be easily adapted for different risetimes of the input signal. High count rates up to 1 MHz are possible because of the fact, that when to input signal is gone, the system is ready to process another event. The device adds no time to the total duration of the incomming signal.