Time to amplitude converter and single channel analyzer.

Model **NCB240.**

WARRANTY

NAICAM S.R.L. warrants this product to be free from defects in material and workmanship for a period of 1 year from date of shipment from headquarter in Italy.

NAICAM SRL warrants the following items for one year from the date of shipment: probes, cables, and documentation of specified equipment.

During the warranty period, we will, at our option, either repair or replace any product that proves to be defective.

To exercise this warranty, write or call your local NAICAM SRL representative, or contact NAICAM SRL headquarters in Italy. You will be given prompt assistance and return instructions. Send the product, transportation prepaid, to the indicated service facility. Repairs will be made and the product returned, transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period.

LIMITATION OF WARRANTY

This warranty does not apply to defects resulting from product modification without NAICAM SRL express written consent, or misuse of any product or part.

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VAL.START
NIM
TTL
TTL
NIM
VAL.CONV.
NAICAM
NCB240
SCA
Coinc.
Anti
Coinc.
ULD
100ns
200ns
50n
RANGE
LLD
MULTIPLIER
100
1k
10
10k
1
Out.
Delay
GATE
OUT BUSY
START
SCA_POS
STOP
SCA_NEG
OUT TAC
TAC & SCA
+6
-6
+24
-24
+12
-12

1. GENERAL DESCRIPTION.

1.1 DESCRIPTION.

The module NCB240 Time-to-amplitude converter (TAC) with single channel analyzer (SCA) measures the time interval between start-stop pulses and generates an analog output pulse proportional to the measured time. The module has two switches: first determines the range and second multiplier factor. Total time measurement ranges can be set from 50 ns to 2 ms. Valid Start and Valid Conversion outputs are provided for each accepted start and stop inputs. The duration of the Start output indicates the interval from the accepted start until the end of reset. The signal SCA_out is logic pulse

1.2. CIRCUIT LOGIC AND FUNCTIONAL BLOCK DIAGRAM.

The Conversion of time to Amplitude has strong logic to avoid invalid conversion. The START and STOP inputs are disabled during conversion time to avoid a pileup. The input GATE open gate time for the start circuit and this input can be operated in anticoincidence or a coincidence mode. Each time measurement is analog charging the high stability capacitance with current and is stored on the capacitance until a linear gate is opened by an internal strobe. The internal strobe can be obtained only from combination the START and the STOP input pulses.

To avoid wrong data acquisition there are two signal on the rear panel of the module: VAL.START and VAL.CONV. The VAL.START is present if present only START signal. If was both signals START and STOP , The VAL.CONV. signal is continued until the leading edge of a reset. The VAL.CONV. Output present after internal conversion delay time and is continued until the leading edge of a reset.

If no stop input is accepted before an over-range condition is sensed, the measurement will be aborted and no output signals for the TAC will be generated.

The OUTPUT of Time to Amplitude Converter always is gated by strobe signal. The source of the strobe selected from the internal signal or from an external signal. Standard solution is internal strobe, the strobe occurs after a delay that has been adjusted by trimmer on the front panel. The output delay control can be set from 0.5 **µ** s to 10 **µ** s after the leading edge of the signal.

An external strobe can be used only in optional version of NCB240 module and this optional must be should be specified in order.

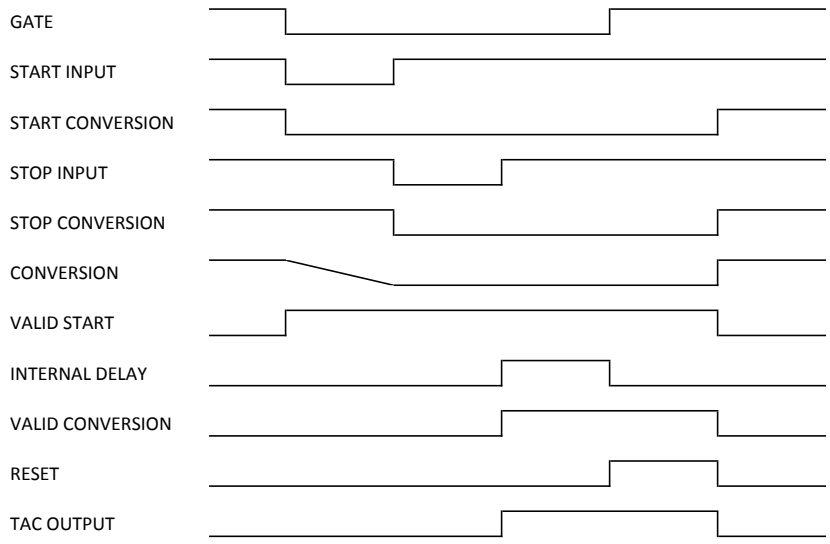

Figure 1. Time diagram of Time Amplitude conversion circuit

Single-Channel Analyzer.

The Single-Channel Analyzer (SCA) provides timing signal that can be used as either a single-channel analyzer or as an integral discriminator. The module has two SCA output: a NIM-standard fast negative signal and a NIM-standard positive signal.

When the output signal is internally generated, SCA generate the signal using a time recognition technique called Constant Fraction Discrimination (CFD). This technique provides timing on either unipolar or bipolar signals. A displaces of this signal during amplitude variation is less then leading-edge discriminator. The thresholds for the upper level discriminator (ULD) and low level discriminator (LLD) are adjusted with the front panel Upper Level and Low Level controls. Inside of SCA board are generated LLD, ULD and CFD responses. The logic of module combines these signals and output SCA compare in range between LLD and ULD settings.

1.3. PERFORMANCE.

TIME RESOLUTION FWHM	≤0.01% of full scale plus 5 ps for all ranges.
TEMPERATURE INSTABILITY	≤±0.01%/°C of full scale, in range 0 to 50°C.
DIFFERENTIAL NONLINEARITY	Typically, <1% from 10 ns or 2% of full scale.
INTEGRAL NONLINEARITY	≤±0.1% from 10 ns or 2% of full scale.
MULTIPLIER RANGE	Fixed 1.0 µs for x1 and x10 Multipliers, fixed 5 µs for x100 Multiplier, and fixed 50 µs for x1K, and x10K Multipliers.
START-to-STOP CONVERSION TIME	Minimum ≤5 ns.
RESET CYCLE	Fixed 1.0 **µ**s for X1 and X10 multipliers; fixed 5 **µ**s for X100 multiplier; and fixed 50 **µ**s for X1k and X10k multipliers.

2. TECHNICAL SPECIFICATIONS.

2.1 FRONT PANEL CONTROLS

RANGE (ns) Three-position rotary switch selects full-scale time interval of 50, 100, or 200 ns between START and STOP input signals.

MULTIPLIER six-position rotary switch extends time range by a multiplying factor of 1, 10, 100, 1k, or 10k. last to position are equal and corresponds 10k.

DELAY (µs) 10-turn screwdriver-adjustable potentiometer varies the delay of the TAC output from 0.5 **µ**s to 10 **µ**s.

GATE MODE Two-position locking toggle switch selects Coincidence or Anticoincidence mode of operation for the Start circuit.

STROBE MODE (only in optional version)
The Internal strobe generated after valid conversion. Two-position locking toggle switch selects either Internal or External source.

2.2. INPUT/OUTPUT CONNECTIONS AND SIGNAL CHARACTERISTIC

INPUTS

GATE Front panel BNC connector provides an external means of gating the start circuitry in either Coincidence or disabled state with the START input signal (Fig 5). Minimum time between edges GATE and START is 10 ns. Factory-set in accepting the NIM standard signals.

START Front panel BNC connector initiates time conversion when Start input signal exceeds threshold (Fig 5). Factory-set in accepting the NIM standard signals.

STOP Front panel BNC connector terminates time conversion when Stop input signal exceeds threshold. (Fig 5). Factory-set in accepting the NIM standard signals.

STROBE (only in optional version)
Front panel BNC connector provides an external strobe signal for output signal (Fig 5). Factory-set in accepting the NIM standard signals.

SCA (ULD) Ten-turn precision locking potentiometer sets the SCA upper-level discriminator threshold from 0.05V to 10.05V above the Lower-Level (T) setting .

SCA (LLD) Ten-turn precision locking potentiometer sets the SCA lower-level discriminator threshold from 0.05V to 10.05V.

FRONT PANEL OUTPUT

TAC OUTPUT Front panel BNC connector provides unipolar pulse.
Amplitude 0 V to +10 V (without termination) proportional to Start/Stop input time difference. The end of output signal corresponding reset time of conversion in Internal Strobe mode.
The output can be terminated to 50 **Ω**.
Output signal width is adjustable by potentiometer on PCB from 0,7 **µ**s to 5 **µ**s.
Output impedance Zo = 100 **Ω**.
Rise Time 260 ns.
Fall Time 260 ns.

SCA_POS Front panel connectors provide NIM- standard positive logic level signals.

SCA_NEG Front panel connectors provide NIM- standard negative logic level signals.

OUT_BUSY Front panel connectors provide NIM- standard positive logic level signals.

The GATE, START, STOP and STROBE input circuits accept positive or negative NIM-standard signals. Each of these input circuits is jumper selectable. Input impedance of 50 Ω for negative signals or >1 kΩ for positive signals is intended. The positive input circuits accept positive signal from 4 volt up to 10 Volt .

The polarity of inputs signals should be changed before installation in Bin crate. On the picture 1 the position of jumpers are shown.

The rice time of input signals has been less then 10 ns to reduce jitter effect of inputs signals.

REAR PANEL OUTPUTS.

VAL START TTL Rear panel BNC connector, Output signal is TTL standard signals that can be terminated to 50 **Ω**..
Rise /Fall Time 5 ns.

VAL. START NIM. Rear panel BNC connector. Output signal is NIM standard signals.
Rise /Fall Time 2,5 ns.

VAL CONV TTL Rear panel BNC connector, Output signal is TTL standard signals that can be terminated to 50 **Ω**.. Time and Width from end of internal delay after STOP to end of reset.
Rise /Fall Time 5 ns.

VAL CONV NIM Rear panel BNC connector. Output signal is NIM standard signals. Time and Width from end of internal delay after STOP to end of reset.
Rise /Fall Time 2,5 ns.

Output signal NIM is intended NIM standard signals. This output has been terminated to 50 Ω.
Output signal TTL is intended TTL standard signals. This output can be terminated to 50 Ω.

2.3 OPERATING INSTRUCTIONS

TIME-TO-AMPLITUDE CONVERSION SCALE SET

There are two switches to set maximum conversion scale of NCB240 module: RANGE and MULTIPLIER.

RANGE control (ns) Three-position rotary switch selects full scale time interval of 50, 100, or 200 ns between accepted START and STOP input signals.

MULTIPLIER control is five-position rotary switch extends time range by a multiplying factor of 1, 10, 100, 1K, or 10K.

The RANGE (ns) and MULTIPLIER switches determine the full-scale conversion time. The combinations can be selected as follows table 1. Conversion coefficient can be adjusted by trimmer on the board (fig 6).

Table 1.

Switch Settings		Full-Scale Time Limit
Range (ns)	Multiplier	
50	X1	50 ns
100	X1	100ns
200	X1	200ns
50	X10	500ns
100	X10	1µs
200	X10	2µs
50	X100	5µs
100	X100	10µs
200	X100	20µs
50	X1K	50µs
100	X1K	100µs
200	X1K	200µs
50	X10K	200µs
100	X10K	1ms
200	X10K	2 ms

For example,
The Range switch set at 100 and the Multiplier switch at X10, the full-scale time range is 1 **µ**s. After the START signal any STOP input signal that arrive during 1 **µ**s time generate valid conversion signal.

OUTPUT WIDTH ADJUSTMENT

Potentiometer that is located on the PCB, adjusts the TAC output pulse width (Fig 6). The potentiometer value determines the output pulse width from 1 **µ**s to 5 **µ**s. The width can be adjusted to customer requirements; factory-set at 1 **µ**s.

OUTPUT DELAY ADJUSTMENT

Potentiometer that is located on the front panel, adjusts the TAC delay of out signal (Fig 1). The potentiometer value determines the delay of pulse from 0,5 **µ**s to 10 **µ**s. The width can be adjusted to customer requirements; factory-set at 1 **µ**s.

OUTPUT OFFSET

Output offset voltage regulation potentiometer located on the PCB (Fig 6), adjusts the TAC output offset from -**1**00 mV to +100 mV. To set right level output offset remove the START and STOP signals from the TAC input. Measure the offset voltage at the TAC output connector with a voltmeter. Adjust potentiometer until the offset voltage is 0 mV ± 1 mV.

GATE MODE

Two-position locking toggle switch selects Coincidence or Anticoincidence mode of operation for the Start circuit. Coincidence mode means the GATE signal polarity must be standard NIM signal. Anticoincidence mode means the GATE signal is disabled.

STROBE MODE
(Only in optional version).
This Switch permit select internal or external strobe of output signal.
If the EXT position is selected on the STROBE switch, the logic signal supplied by the user on the STROBE input will control the timing of the TAC output.

CDF LEVEL SET.

On SCA PCB board there is one trimmer to set level of constant fraction. Fabric set is -15 mV (Fig.7). This level guaranty optimum time-significant SCA output timing, the trimmer Walk Adj must be trimmed to the combined effects of the input shaping of conversion internal signal. Range of threshold is +/-150 mV.

EASY TEST STARTE:

1. Set GATE MODE switch to anticoincidence position.
2. Set RANGE switch to 50 ns.
3. Set Multiplier switch to the 1.
4. Connect the NIM signal from FAN UNIT (for example NCB211) to START

input.

5. Connect other the NIM signal from FAN UNIT to input switchable DELAY unit (for example NCB233).
6. Connect the signal from output DELAY unit to STOP input.
7. Connect TAC OUTPUT to scope input. Input impedance of scope 1 Mega **Ω**.
8. Set delay time about 20 ns and observe the output amplitude of the module NCB240. Output signal should be about at 1 **μ**s width and amplitude will be changed after changing delay time by DELAY unit. Note that the length of cable is significant parameters of this set up because of the delay 50 **Ω**. coaxial cable is 5 ns for one meter. The amplitude of signal must be proportional of time of delay switch about 200 mV/ns.

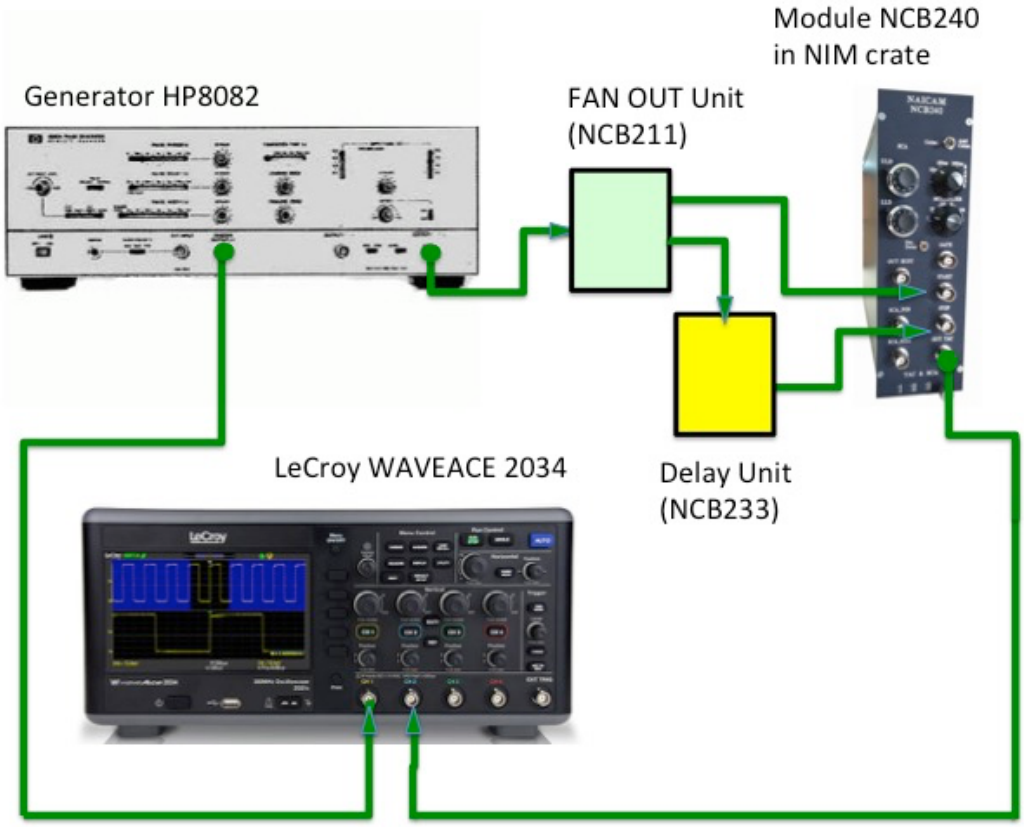

Figure 2. Easy Test block diagram.

All inputs signals in this test set up NIM standard signals are used. Change the type of inputs signals is possible by changing jumper position (Fig.5). Output signals OUT_BUSY, SCA_POS and output TAC positions should are correspond to figure 3.

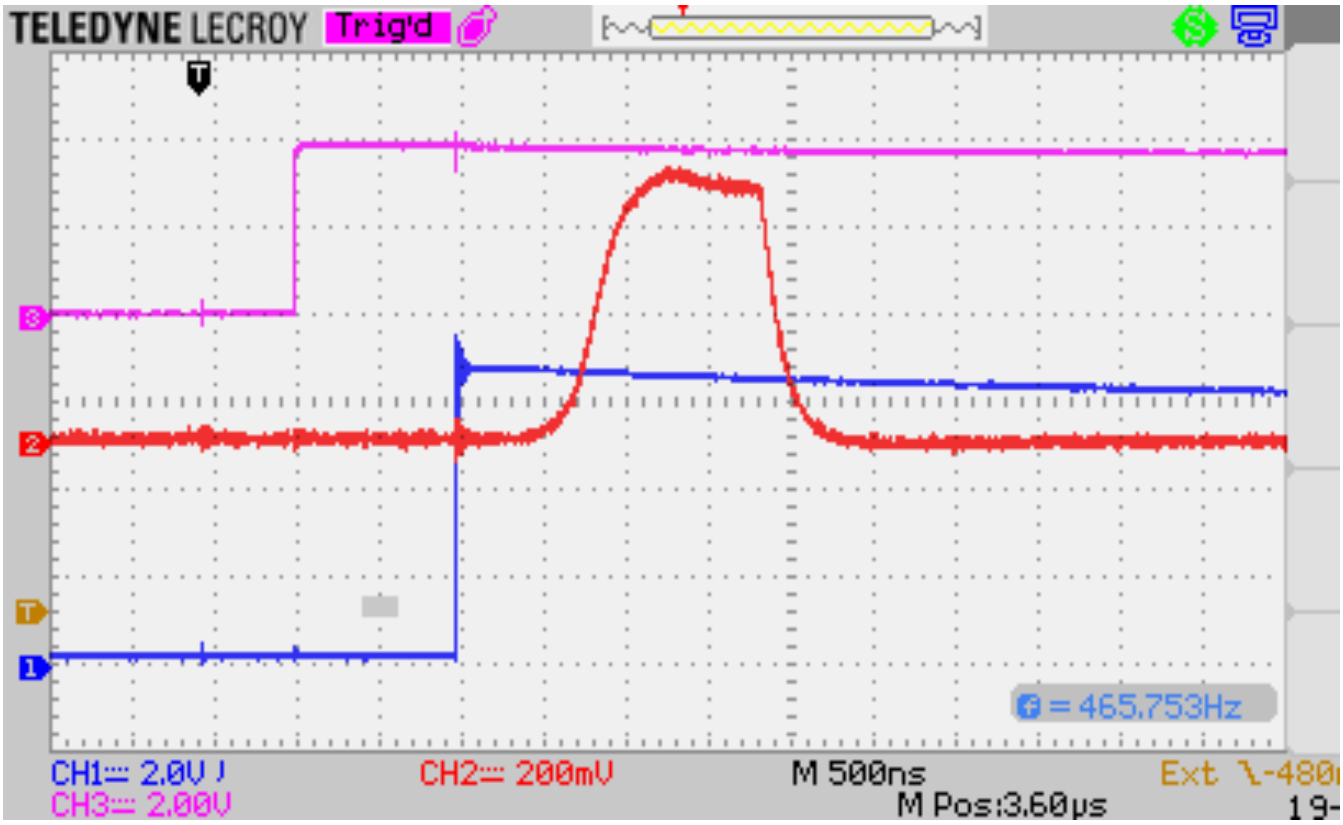

Figure 3. Position of signals OUT_BUSY (CH3 magnet), SCA_POS (CH1 blue) and output TAC(CH2 - red).

TWO PMTs SET UP EQUIPMENTs.

The module NCB240 (or NCB238) can be used with different mode. Usually this module can be used for measurement Time of Fly (TOF) the particle between two detector (Fig.4). The following equipment's are recommended to build complete measurement chain. Obviously an equivalent unit may be substituted for any item in the list, providing that the function required for each specific application. The SCA signal can be used for gate generation for MCA.

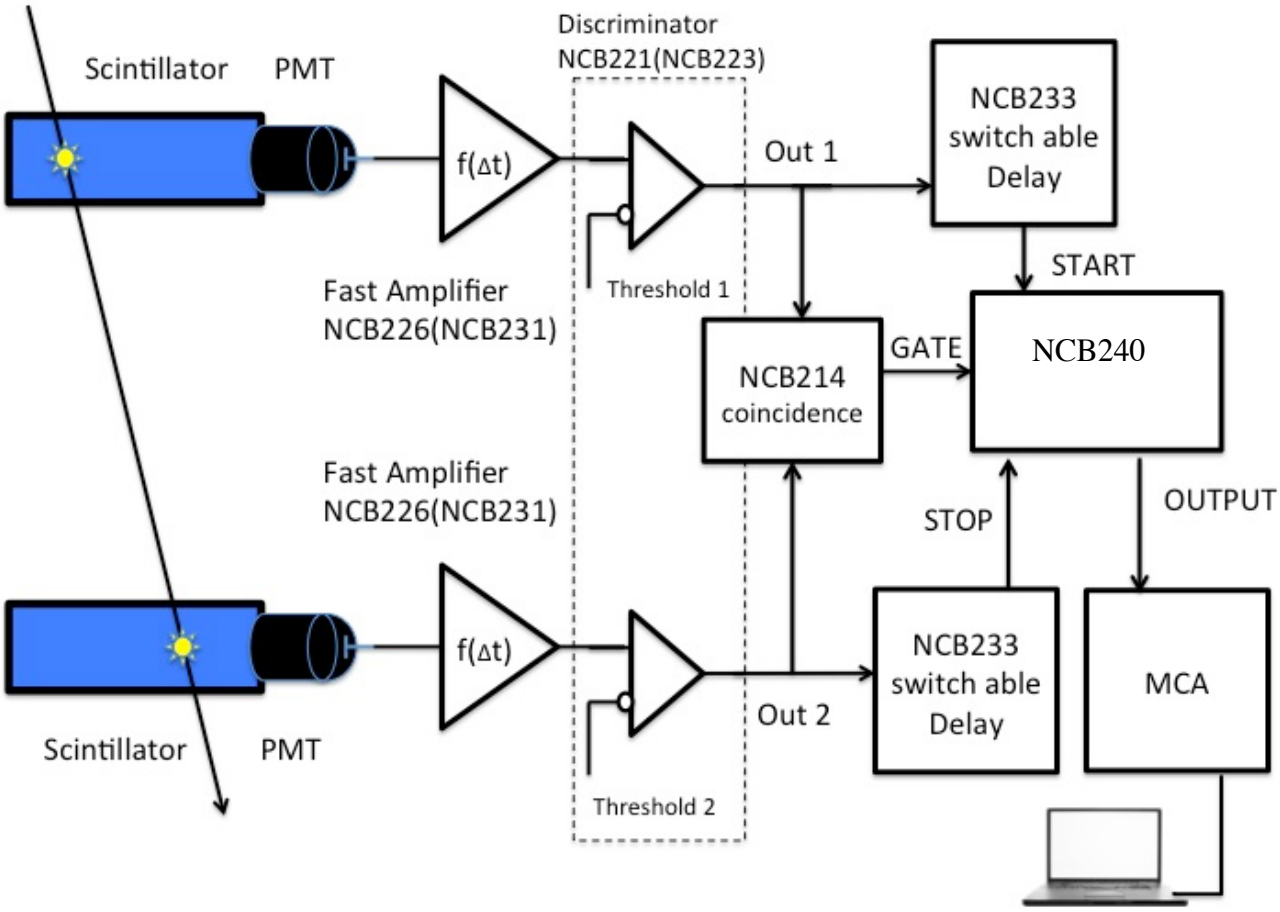

Figure 4. Using NCB240 for measurements Time of fly with two scintillators.

List of the equipment that can be used together NCB240 for Time measurement's:

1. NAICAM module **NCB223** Discriminator.
2. NAICAM module **NCB221** Leading edge Discriminator.
3. NAICAM module **NCB237** Gate and Delay Generator

4. NAICAM module **NCB233** Nanosecond Delay
5. Photomultiplier tube with scintillator.
6. MCA (Multichannel Analyzer).
7. NAICAM module **NCB211** NIM FANOUT.:
8. NAICAM module **NCB214** Fast Coincidence.
9. NAICAM module **NCB226** Fast Filter Amplifier.
10. NAICAM module **NCB231** Quad Filter Amplifier.

2.4 INTERNAL HARDWARE SETTINGS

JUMPERS POSITIONS.

Positive or NIM logic can be selected for all inputs by jumpers on the top part of PCB. On the picture 3 shown the layout of PCB jumpers.

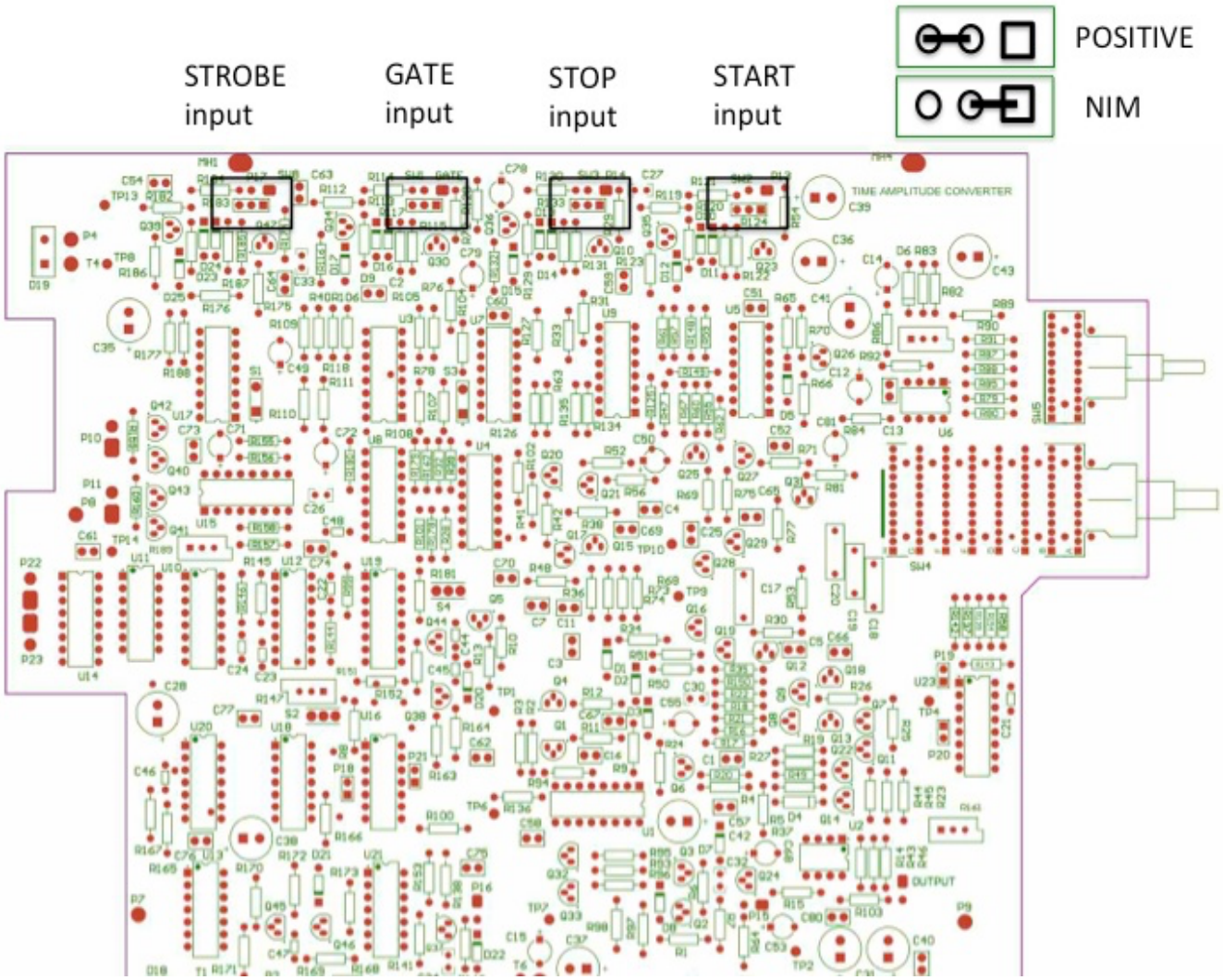

Figure 5. Jumpers positions on the Printed circuit board.

TRIMMER POSITIONS.

There are 3 trimmers on the TAC board: fine gain conversion regulator, output width regulator and Output voltage offset trimmer.

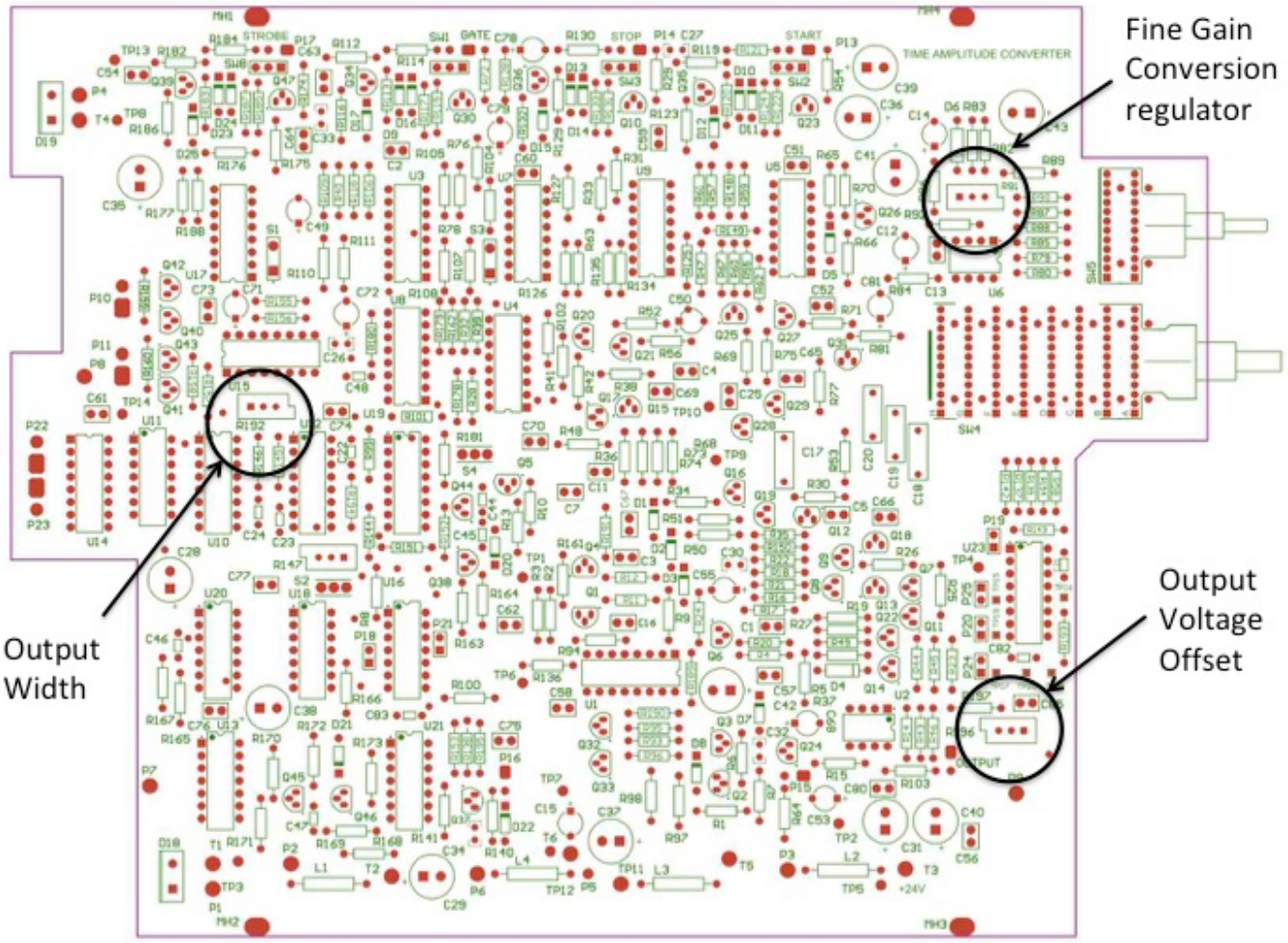

Figure 6. Trimmers positions on the TAC printed circuit board.

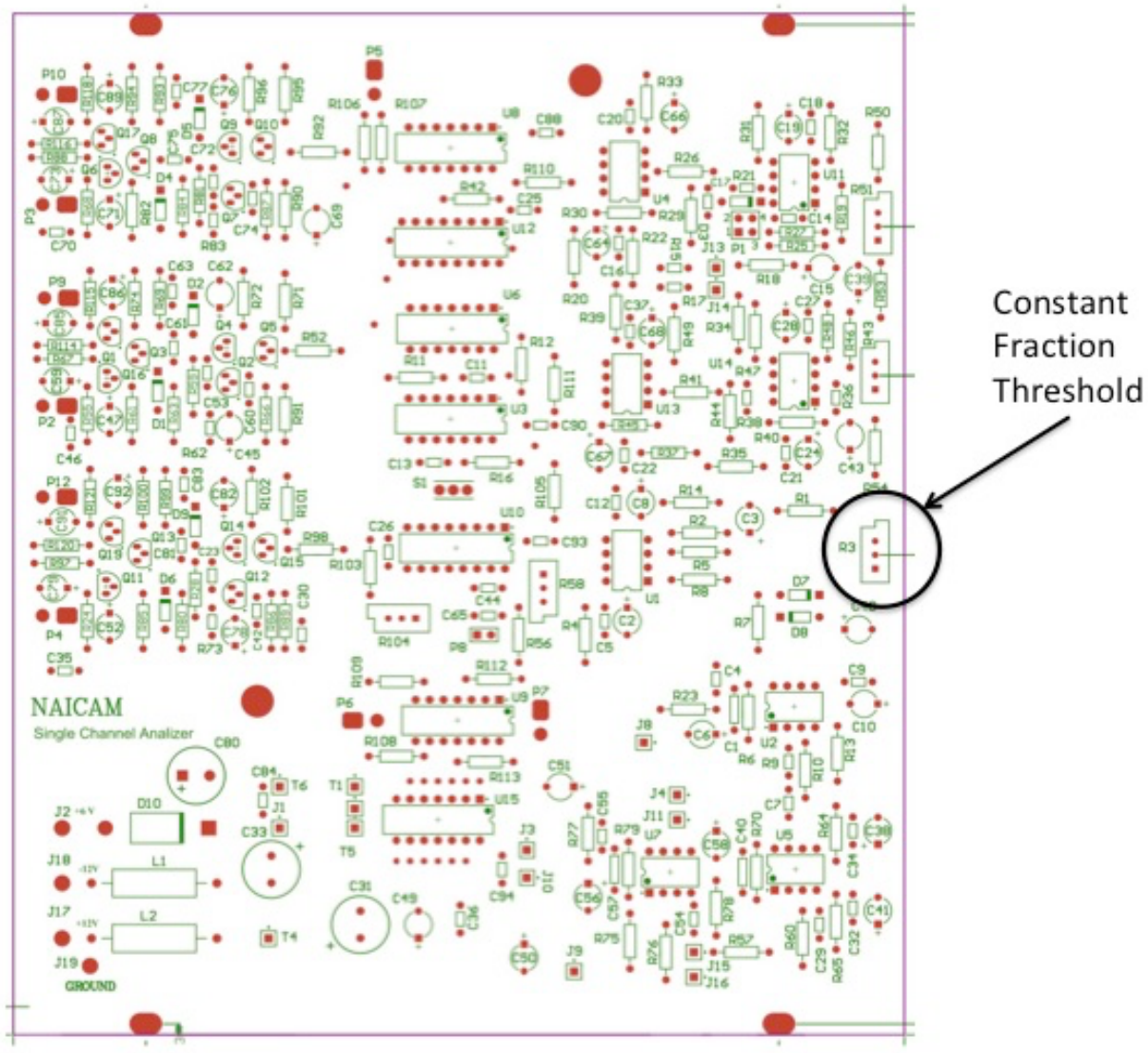

Figure 7. Trimmer position on the SCA printed circuit board.

2.5 POWER REQUIREMENTS

The module NCB240 can be installed in NAICAM NC150W or NC305 Bin (or equivalent). It is very important prevent localized heating of the all circuits in the module. For safety reason always turn of the power supply before inserting or removing any modules.

The module use NIM standard power supply.

P. Voltage (V)	Current (mA)
+24	20
-24	37
+12	213
-12	240
+6	180
-6	443

NIM standard connector pin out.

PIN	Function	PIN	Function
1	+3 V	23	Reserved
2	- 3 V	24	Reserved
3	Spare bus	25	Reserved
4	Reserved bus	26	Spare
5	Coaxial	27	Spare
6	Coaxial	28	+24 V
7	Coaxial	29	- 24 V
8	200 V DC	30	Spare bus
9	Spare	31	Spare
10	+6 V	32	Spare
11	- 6 V	33	117 V AC
12	Reserved bus	34	Power return ground
13	Spare	35	Reset (Scaler)
14	Spare	36	Gate
15	Reserved	37	Reset (Auxiliary)
16	+12 V	38	Coaxial
17	- 12 V	39	Coaxial
18	Spare bus	40	Coaxial
19	Reserved bus	41	117 V AC (neutral)
20	Spare	42	High-quality ground
21	Spare	G	Ground guide pin
22	Reserved		

2.6 DIMENSION AND WEIGHT

DIMENSIONS NIM-standard double-width
module 6.84 X 22.13 cm per DOE/ER-0457T.

WEIGHT
Net 1,3 kg.

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