Rev. 03 - 11/07/2011

C808

16 Channel Constant Fraction Discriminator

CAEN
Tools for Discovery

User Manual

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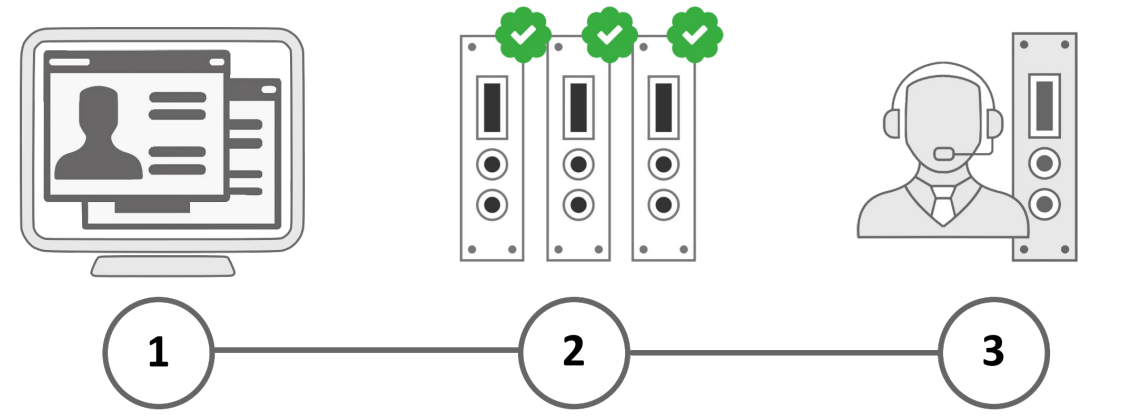

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Technical Information Manual

Revision n. 3
11 July 2011

MOD. C808

16 CH. CONSTANT FRACTION DISCRIMINATOR

NPO:
00101/97:C808x.MUTx/03

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CE

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MADE IN ITALY : We stress the fact that all the boards are made in Italy because in this globalized world, where getting the lowest possible price for products sometimes translates into poor pay and working conditions for the people who make them, at least you know that who made your board was reasonably paid and worked in a safe environment. (this obviously applies only to the boards marked "MADE IN ITALY", we can not attest to the manufacturing process of "third party" boards).

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1. DESCRIPTION

1.1. FUNCTIONAL DESCRIPTION

The CAEN Model C808 is a 16 CHANNEL CONSTANT FRACTION DISCRIMINATOR housed in a single width CAMAC module. The module accepts 16 negative inputs and produces 16 differential ECL outputs with a fan-out of two on two front panel header connectors (a functional block diagram is shown in Fig. 1.1).

Each channel can be turned on or off via CAMAC by using a mask register (Pattern of Inhibit). The constant fraction delay is defined by a delay line network of 20 ns with 5 taps (see fig. 2.2). The pulse forming stage of the discriminator produces an output pulse whose width is adjustable in a range from 15 ns to 250 ns via CAMAC. Moreover it is possible to program via CAMAC a dead time interval during which the discriminator is inhibited from retriggering, in order to protect against multiple pulsing.

The maximum time walk is ±400 ps (for input signals in the range from -50 mV to -5 V with 25 ns rise time). The constant fraction is 20%. The thresholds can be individually set in a range from -1 mV to -255 mV (-1 mV step), via CAMAC through an 8-bit DAC. The module can operate also with small (below 10 mV) input signals, though in this case the Constant Fraction operation is not performed, i.e. the jitter is higher.

VETO and TEST inputs are available on the back panel.

On the front panel there is also available a Current Sum output that generates a current proportional to the input multiplicity, i. e. to the number of channels over threshold, at a rate of -1.0 mA ±20% per hit.

A "MAJORITY" signal on a back panel connector provides a NIM signal if the number of input channels over threshold exceeds the MAJORITY programmed value.

Several C808 boards can be connected in a daisy chain via the Current Sum output: in this case, by switching the Majority logic to “External”, it’s possible to obtain a Majority signal when the number of over threshold channels in the daisy chained modules exceeds a global Majority level.

An "OR" output on a front panel connector provides the global OR of the outputs. The relevant "OR" LED lights up if at least one of the unmasked channels is over threshold.

The module's operations are completely controlled via software for each channel through the CAMAC bus. The most important are:

- setting of the Discrimination Thresholds (8 bit data) from -1 to -255 mV.
- setting Pattern of Inhibit; each channel can be turned "ON" or "OFF" by using a mask register.
- setting Output Width in a range from 15 to 250 ns.
- setting of the Majority Threshold value.
- selection of the Dead-Time value.
- Common TEST.

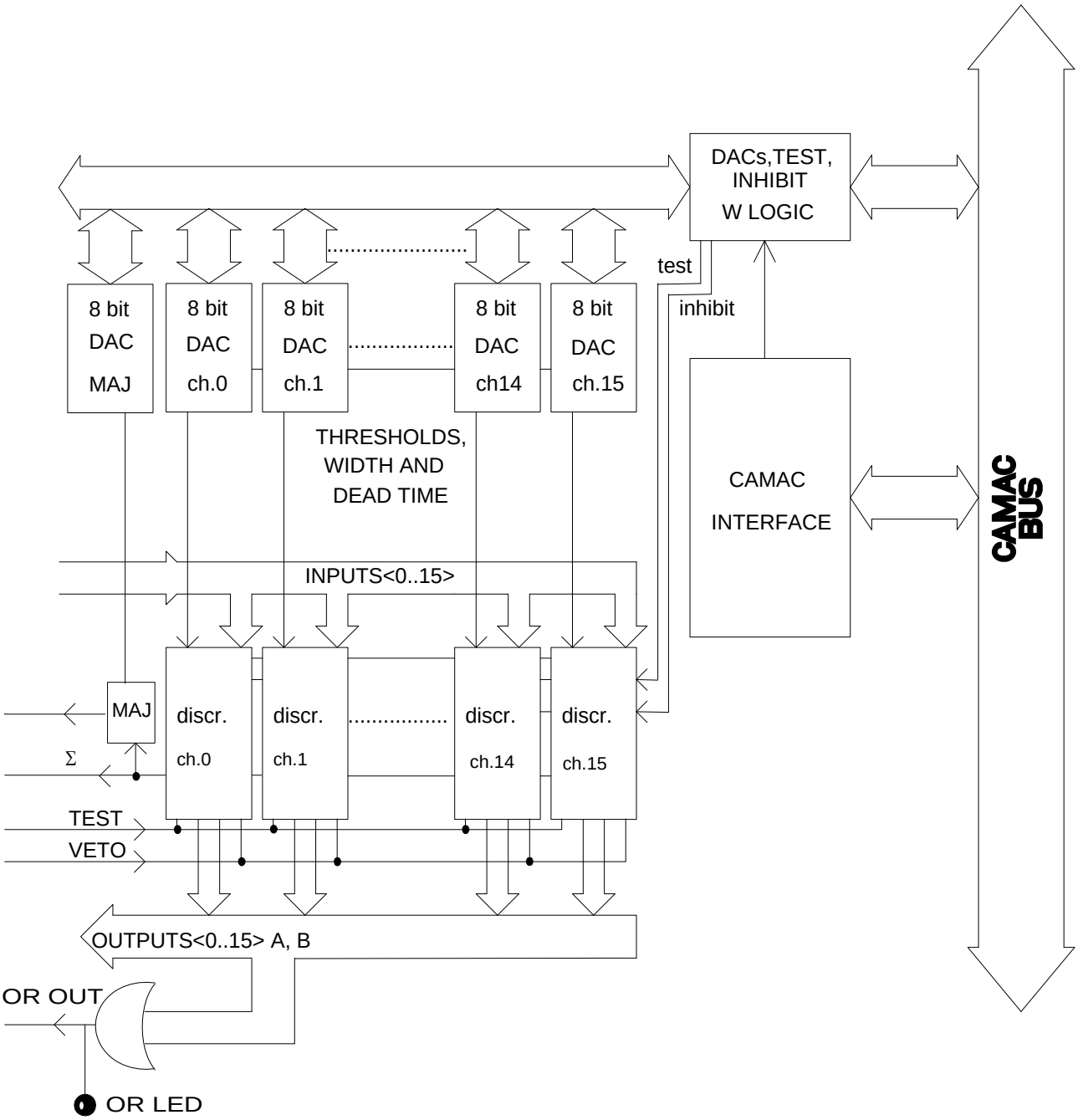


Fig. 1.1: C808 Block Diagram

1.2. PRINCIPLES OF OPERATION

The Constant Fraction Discriminator technique is based on summing the delayed, full height input signal to the inverted and attenuated signal. The resulting signal is fed to a zero-crossing comparator, thus obtaining a precise timing information that eliminates the walk errors induced by constant rise time and varying amplitudes signals.

For correct operation the maximum of the attenuated pulse has to cross the delayed pulse at the selected fraction. This condition leads to the following relation:

$$t_{delay} = t_{rise} (1-F)$$

where:

t_{delay} = selected delay on the Constant Fraction Discriminator (see Fig. 2.2);

t_{rise} = rise time of the input signals:

F = Constant Fraction Value.

The Mod. C808 Constant Fraction Discriminator has a factory setting of 20% for the Fraction and 20 ns for the full scale delay. The delay can be chosen in 4 ns steps up to 20 ns (see § 3, Operating Modes).

2. SPECIFICATIONS

2.1. PACKAGING

1-unit wide CAMAC module.

2.2. EXTERNAL COMPONENTS

(Refer To Fig. 2.1)

CONNECTORS:

- N. 16, "IN", LEMO 00 type (front panel); input signals connectors from CH0 to CH15.

- N. 1, "CURRENT SUM", LEMO 00 type (front panel); it provides an output current proportional to the output multiplicity, i.e. to the number of input signals over threshold (rate: -1 mA per hit).

- N. 1, "OR", LEMO 00 type (front panel); an output signal standard NIM is the global OR of the outputs.

- N. 2, "OUTPUT 0...15 A, B", Header 3M 3431-5202 type (front panel), 17+17 pins; differential ECL level into 110 Ω twisted pair.

- N. 1, "MAJORITY", LEMO 00 type (rear panel); a standard NIM output signal present when the "CURRENT SUM" output is over a majority threshold level set via CAMAC.

- N. 2, "VETO", LEMO 00 type (rear panel); two bridged connectors (for daisy chaining). An input signal standard NIM is accepted to inhibit all channels simultaneously.

- N. 2, " TEST", LEMO 00 type (rear panel); two bridged connectors (for daisy chaining). An input pulse standard NIM allows to trigger all the unmasked channels at once.

DISPLAYS:

- N. 1, "OR" green LED; it lights up if at least one output signal is present.

2.3. INTERNAL COMPONENTS

(Refer To Fig. 2.2)

JUMPERS:

- N. 16, (one for each channel) for the selection of the Discriminator delay.
- N. 1, for the selection of External or Internal Majority.

2.4. CHARACTERISTICS OF THE SIGNALS

INPUTS

Channels: Negative polarity, 50 Ohm impedance;
Minimum ratings: - 5 mV. Maximum ratings: - 5 V.
the module Delay Tdel is related to the input signal rise time Trise and to the constant fraction value F by the following: Tdel=Trise*(1-F).

VETO: standard NIM logic signal, high impedance, 30 ns minimum width. Leading edge of the VETO signal must precede of at least 18 ns the leading edge of the input and overlap completely the input signal. Acts on all signals.

TEST: standard INPUT NIM logic signal, high impedance, 8 ns minimum width. Acts on all signals.

OUTPUTS

Outputs: Differential ECL level on 110 Ohm impedance. Pulse width adjustment: from 14.5±1.5 ns to 249±15 ns. Maximum time walk: ±400 ps for input signals in the range from -50 mV to -5 V with 25 ns rise time.

OR: standard NIM logic signal on 50 Ohm.

CURRENT SUM: high impedance with rate of -1 mA per hit.

MAJORITY: standard NIM logic signal on 50 Ohm.

2.5. GENERAL

Threshold range: -1 mV to -255 mV; -1 mV step. Fraction: 20%.Delay: 2.5 to 50 ns full scale, to be chosen upon order (20 ns full scale default value).
Interchannel Insulation: 60 dB for 2.5 ns rise time input signals.
Dead time programmable from 150 ns to 2 µs. Dispersion: ± 10%.
Autowalk: automatic adjustment to input offsets and low frequency input noise of ± 40 mV.
Input-Output delay: set delay + 6 ns ± 2 ns.

2.6. POWER REQUIREMENTS

+ 24 V	80 mA	
- 24 V	60 mA	
+ 6 V	1 A	(NB: requires Y2 rail connected in parallel to +6 V rail on CAMAC Crate)
- 6 V	3.2 A	(NB: requires Y1 rail connected in parallel to -6 V rail on CAMAC Crate)

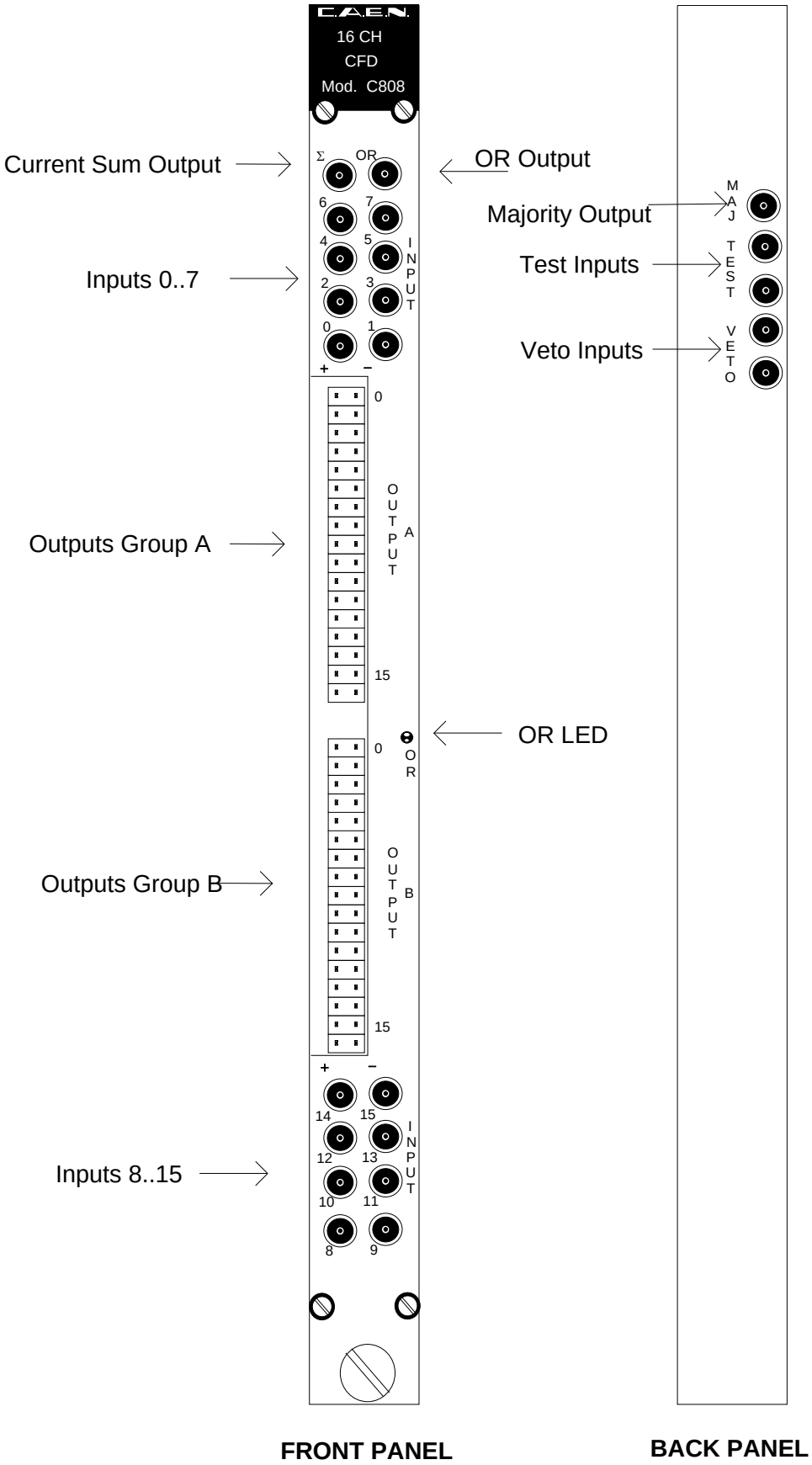


Fig. 2.1: C808 Front and Back Panels

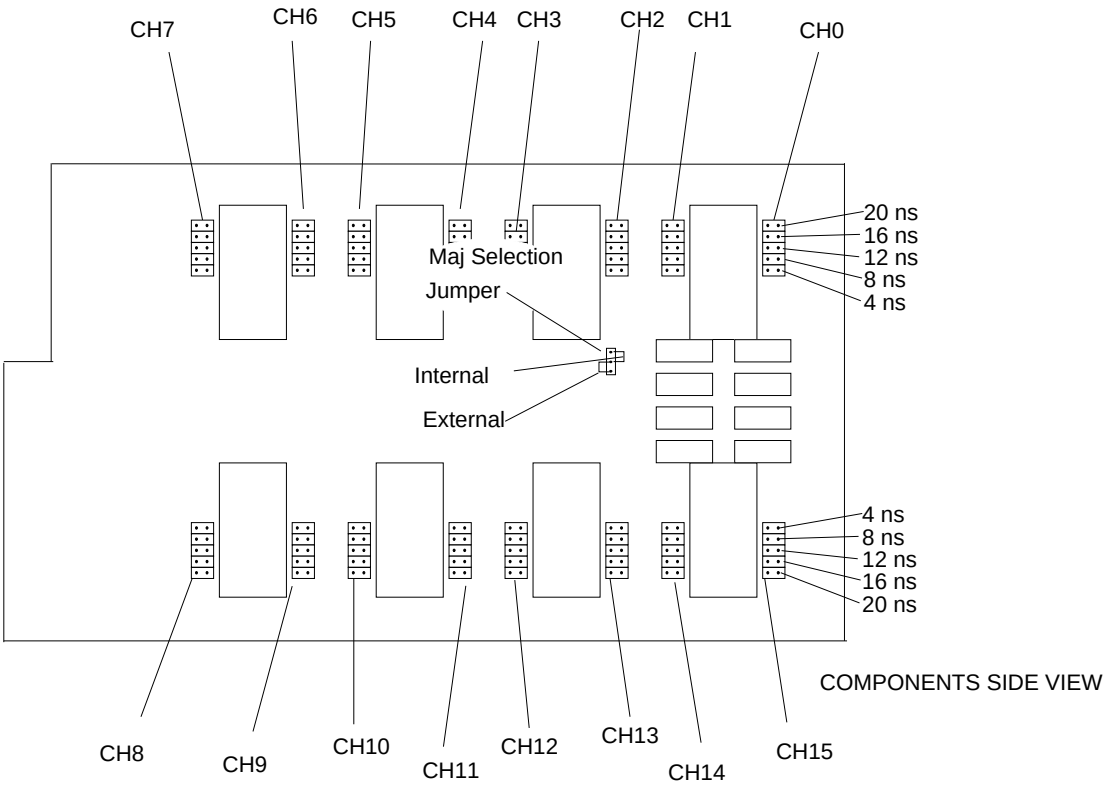


Fig. 2.2: C808 Jumpers Location

3. OPERATING MODES

3.1. SETTING OF THE DELAY

For each channel, a 5-positions jumper allows to set the Delay according to the formula expressed in §1.2. The Delay values range up to 20 ns with 4 ns steps.
Factory setting is 20 ns (8 ÷ 20 ns range).
Optionally is also available 5ns full scale with 1ns steps (4 ÷ 5 ns range), 50ns full scale with 10ns steps (10 ÷ 50 ns range) and 100ns full scale with 20ns steps (20 ÷ 100 ns range).
See Fig. 2.2 for the jumpers location on the C808 board. The fraction is a fixed 20% value.

3.2. MOD. C808 POWER-ON

At Power-On the contents of all the module's Registers are not determined. A setting of the Registers must be performed before any other operation.

3.3. ENABLING/DISABLING OF THE CHANNELS

The User can enable or disable each of the 16 channels via CAMAC by performing a F(17) N A(0) CAMAC Function with the Write Lines W1-W16 set to 1 or 0 according to the chosen configuration (16 bit Pattern of Inhibit). A channel is enabled if the corresponding bit of the Pattern is high (e. g., bin. 1111111111110011, or hex FFF3, disables channels 2 and 3 of the discriminator).

It is also possible to inhibit all channels via a CAMAC I (Inhibit) operation.

3.4. FRONT-BACK PANEL SIGNALS

Some operations can be performed by two external NIM signals (indicated on the back panel connectors with "VETO", "TEST"):

- TEST: an input signal sent through this connector triggers all the enabled channels at once. This useful feature allows a complete test of the module without removing any input cable as well as it allows generation of a pattern of pulses suitable to test any following electronics.
- VETO: an input signal sent through this connector allows vetoing of all channels simultaneously. A veto pulse of width T will veto the input during this time T. Its leading edge must precede the input leading edge by at least 18 ns and overlap completely the input signal.

These are high impedance inputs and each one is provided with two bridged connectors for daisy chaining.

> Note that, since these are high impedance inputs, the chain has to be terminated on 50 Ohm on the last module; the same is needed also if one module only is used, whose inputs have thus to be properly matched.

On the front panel there is also available a Current Sum (Σ) output connector that generates a current proportional to the input signal multiplicity, i. e. to the number of channels over threshold, at a rate of -1.0 mA per hit (-50 mV per hit into a 50 Ohm load) ±20%. The Σ output requires a 50 Ohm termination for a correct operation of the Majority logic. An OR output

connector provides also the logical OR of the output channels.

3.5. CHANNELS TEST

It is possible to obtain pulses on all channels:

- by sending a NIM pulse through one of the two "TEST" connectors located on the back panel.
- by performing a F(25) N CAMAC Function.

3.6. SETTING THE THRESHOLDS

For each channel of the C808 there is an 8 bit DAC to allow the Discriminator Threshold setting. The threshold values can be programmed in a range from -1 mV to -255 mV with -1 mV steps (set values: 1 to 255). As in all Constant Fraction Discriminators, these thresholds are to be set above the noise level: they do NOT correspond to the actual level that triggers the discriminator outputs, the latter being a "constant fraction" of the input signals.

In order to write the Threshold for each channel, the User must perform an F(16) N A(0-15) CAMAC Function.

3.7. SETTING THE OUTPUT PULSE WIDTH

The output pulse width is adjustable on 8 bit from 15 to 250 ns (set values: 0 to 255) and the chosen value is applied to each group of 8 channels. It can be set by an F(18) N A(0) for channels 0 to 7 and by an F(18) N A(1) for channels 8 to 15. The set value corresponds to the Width as follows: 255 leads to a 250 ns value, 0 leads to a 15 ns value, with a non-linear interpolation for intermediate values.

3.8. SETTING THE DEAD TIME

It is possible via CAMAC to set a Dead Time value in common to a group of 8 channels. This allows to avoid the triggering of the discriminator for unwanted pulses occurring within the dead time programmed value. It can be set by an F(19) N A(0) CAMAC Function for channels 0 to 7 and by an F(19) N A(1) CAMAC Function for channels 8 to 15 (set values: 0 to 255). The set value corresponds to the Dead Time as follows: 255 leads to a 2 μs value, 0 leads to a 150 ns value with a non-linear interpolation for intermediate values.
N.B.: The actual Dead Time is equal to the greater between Output Width and Dead Time set values.

3.9. SETTING THE MAJORITY

Majority output provides a NIM signal if the number of over threshold channels exceeds the programmed majority level (MAJLEV).
To set a valid Majority level, the User must perform an F(20) N A(0) CAMAC function with a proper value (MAJTHR) in the WRITE lines W1..W8 (set values: 0 to 255).
MAJTHR can be calculated according to the following relation:

MAJTHR = NINT [(MAJLEV*50 -25)/4] (NINT is the Nearest Integer function)

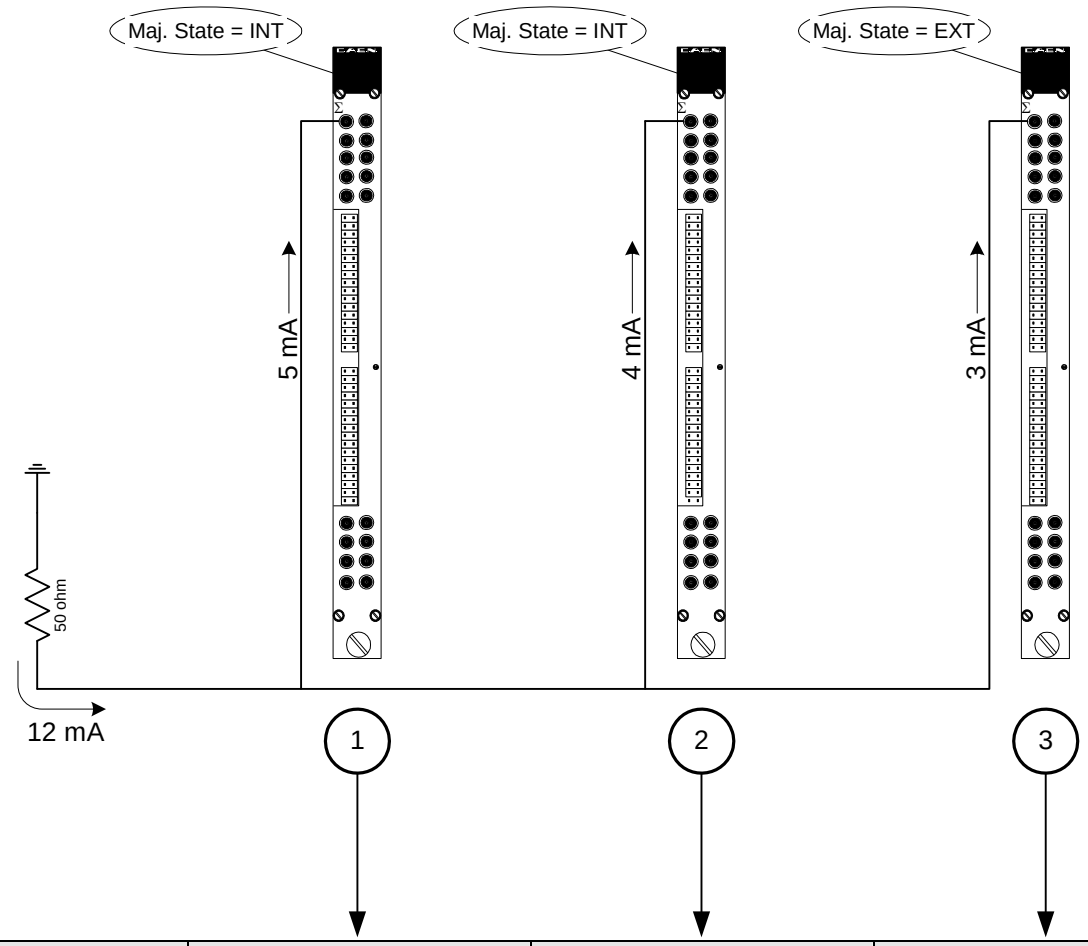
MAJLEV	MAJTHR	MAJLEV	MAJTHR
1	6	11	131
2	19	12	144
3	31	13	156
4	44	14	169
5	56	15	181
6	69	16	194
7	81	17	206
8	94	18	219
9	106	19	231
10	119	20	244

Table 3.1: Majority Level setting values

The Majority logic can be switched from an "Internal" to an "External" position by means of an internal Jumper (see Fig. 2.2).

Internal: With the jumper on the "Internal" position Majority output provides a NIM signal if the number of over threshold channels of the module exceeds the programmed majority level (MAJLEV). In this case valid values of MAJLEV are from 1 to 16

External: If desired, more than one module can be connected in daisy chain via the Σ outputs. In this case, by setting the Jumper to the "External" position, the Majority logic will act on the sum of the Σ outputs of the connected modules. So a Majority NIM signal will indicate if the number of over threshold channels in the daisy-chained modules exceeds the programmed “External” MAJLEV. (An example with three chained modules is shown in Fig. 3.1). The User must take care of terminating on 50 Ohm the Σ outputs line.



Module Number	1	2	3
Majority State	INT	INT	EXT
Majority Level (MAJLEV)	2 (referred to internal over th. channel)	5 (referred to internal over th. channel)	10 (referred all chained modules over th. channels)
Number of Module's active Channels	5	4	3
Majority Output	ACTIVE (5 > MAJLEV)	NON Active (4 < MAJLEV)	ACTIVE (5+4+3 > MAJLEV)

Fig. 3.1: Example of three C808 in daisy chain

4. CAMAC FUNCTIONS

The standard CAMAC Functions listed in Table 4.1 allow the User to perform the required control and readout operations on the C808 module.

X response is generated for each valid function.

Q response is generated for each valid function unless otherwise specified.

Table 4.1: Mod. C808 CAMAC Functions

F(16) N A(0..15)	Writes Discriminator Threshold on W1..W8.
F(17) N A(0)	Writes Pattern of Inhibit on W1..W16 (1=enabled).
F(18) N A(0)	Writes Output Width on W1-W8 for channels 0 to 7.
F(18) N A(1)	Writes Output Width on W1-W8 for channels 8 to 15.
F(19) N A(0)	Writes Dead Time on W1-W8 for channels 0 to 7.
F(19) N A(1)	Writes Dead Time on W1-W8 for channels 8 to 15.
F(20) N A(0)	Writes Majority Threshold on W1-W8.
F(25)	Common Test.
I	Inhibits all the Channels.

4.1. F(16) N A(0-15) FUNCTION (Write Discr. Threshold)

This CAMAC Function writes on 8 bit the Threshold Discriminator values. The threshold values can be programmed (set values: 0 to 255) in a range from -1 mV to -255 mV with -1 mV steps, though a minimum threshold of -5 mV is required; the Channel thresholds are individually settable: Subaddresses 0 through 15 select the desired channel.

4.2. F(17) N A(0) FUNCTION (Write Pattern of Inhibit)

This CAMAC Function writes the Pattern of Inhibit (W1..W16), a 16 bit register that contains information on which Channels are enabled/disabled (bit=1 $\Rightarrow$ Ch. enabled). Channel refers to W1, and Channel 15 refers to W16.

4.3. F(18) N A(0) FUNCTION (Write Output Width Ch. 0 to 7)

The Output Width value is settable with this CAMAC function. W1 through W8 are used to set the chosen value adjustable in a range of 15 ns to 250 ns (set values: 0 to 255). The value is valid for Channels 0 to 7. The set value corresponds to the Width as follows: 255 leads to a 250 ns value, 0 leads to a 15 ns value, with a non-linear interpolation for intermediate values.

4.4. F(18) N A(1) FUNCTION (Write Output Width Ch. 8 to 15)

The Output Width value is settable with this CAMAC function. W1 through W8 are used to set the chosen value adjustable in a range of 15 ns to 250 ns (set values: 0 to 255). The value is valid for Channels 8 to 15. The set value corresponds to the Width as follows: 255 leads to a 250 ns value, 0 leads to a 15 ns value, with a non linear interpolation for intermediate values.

4.5. F(19) N A(0) FUNCTION (Write Dead Time Ch. 0 to 7)

This CAMAC function is used to select the Dead Time value in common to all Channels from 0 to 7. This command allows to select on 8 bit (set values: 0 to 255) the Dead Time value between 150 ns and 2 μs. The set value corresponds to the pulse width as follows: 255 leads to a 2 μs value, 0 leads to a 150 ns value.
N.B.: The actual Dead Time is equal to the greater between Output Width and Dead Time set values.

4.6. F(19) N A(1) FUNCTION (Write Dead Time Ch. 8 to 15)

This CAMAC function is used to select the Dead Time value in common to all Channels from 8 to 15. This command allows to select on 8 bit (set values: 0 to 255) the Dead Time value between 150 ns and 2 μs. The set value corresponds to the pulse width as follows: 255 leads to a 2 μs value, 0 leads to a 150 ns value.
N.B.: The actual Dead Time is equal to the greater between Output Width and Dead Time set values.

4.7. F(20) N A (0) FUNCTION (Write Majority Threshold)

This CAMAC Function (see § 3.10) allows to set the Majority Threshold (MAJLEV) between 1 and 16 for Internal Majority and between 1 and 20 for External Majority by performing the Function with an appropriate value (MAJTHR) in the WRITE lines W1..W8 (set values: 1 to 244).

The relation to use is the following:

MAJTHR = NINT[(MAJLEV*50 -25)/4],

where NINT is the Nearest Integer function (allowed values for MAJLEV: 1 to 20). E.G., if the User wants to use a majority level of 5, the correct MAJTHR value to use is 56.

4.8. F(25) N FUNCTION (Common Test)

This CAMAC Function generates a test pulse on all output Channels.

4.9. I FUNCTION (INHIBIT)

This CAMAC Function inhibits all Channels.

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