935A Quad 200-MHz Constant Fraction Discriminator

User's Manual

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TABLE OF CONTENTS

Warranty ..... **ii**
Table of Contents ..... **iii**
Figures ..... **iv**
Tables ..... **iv**
1. General Description **1**
2. Technical Specifications **3**
2.1 Packing 3
2.2 Power Requirements 3
2.3 Front and Back Panel 4
2.4 Front and Back Panel Connections 5
2.5 Internal Components 7
2.5.1 Veto Disable 8
2.5.2 Gate Mode 8
2.5.3 Output Mode 8
2.5.4 Width Range 9
2.5.5 AC/DC Coupling 9
2.6 Technical Specifications Table 10
2.7 UKCA/CE Compliant 10
3. Operating Modes **11**
3.1 Delay Setting 11
3.2 Threshold Setting 11
3.3 Walk Adjustment 11
3.4 Output Width Adjustment 11
Notes: **13**
Notes: **14**
Notes: **15**

FIGURES

Figure 1. Model 935A 2
Figure 2. Front and Back Panel 4
Figure 3. Front Panel Connections 5
Figure 4. Front Panel Connections Part 2 6
Figure 5. Back Panel Connection 6
Figure 6. Component Side 7
Figure 7. Soldering Side 7
Figure 8. Veto Disable 8
Figure 9. Gate Mode 8
Figure 10. Output Mode 8
Figure 11. Width Range 9
Figure 12. AC/DC Coupling 9

TABLES

Table 1. Power Requirements 3
Table 2. Front Panel Connections 5
Table 3. Front Panel Connection Part 2 6
Table 4. Back Panel Connection 6
Table 5. Technical Specifications 10
Table 6. Width Ranges 12

1. GENERAL DESCRIPTION

The 935A houses four independent 20% Constant Fraction Discriminators (CFD) in 1-unit wide NIM. The module is intended for high resolution time measurements, where fast signals with rise time as low as 0.8 ns are involved. Those may involve the use of radiation detectors made of fast scintillators, PMT, microchannel plates, and fast semiconductor detectors.

The module guarantees exceptional low walk jitter, lower than 50 ps, for signals spreading over a wide range of amplitude, from -5 V to -50 mV.

The unit is provided with independent threshold discriminators to reject signal baseline noise. Front panel test point and screwdriver permits the precise measurement of the threshold, in the range from -15 mV down to -1 V. Each channel can be adjusted for the zero-crossing level of the discriminator to minimize the time walk. Moreover, the 935A has a CFD signal monitor output connector on the front panel to facilitate the correct adjustment of the working parameters.

Each channel has a fan-out of three timing output signals provided with NIM standard. The outputs can be selected to operate both in blocking and updating mode: the former means that, while a logic output is produced, further incoming pulses are neglected; the latter means that if a new input pulse arrives while a logic output is produced, such output is extended for the corresponding amount of time, as long as the input is over discriminator threshold.

The board is provided with fast VETO input and individual GATE inputs to operate coincidence or anticoincidence logic conditions with the timing signal.

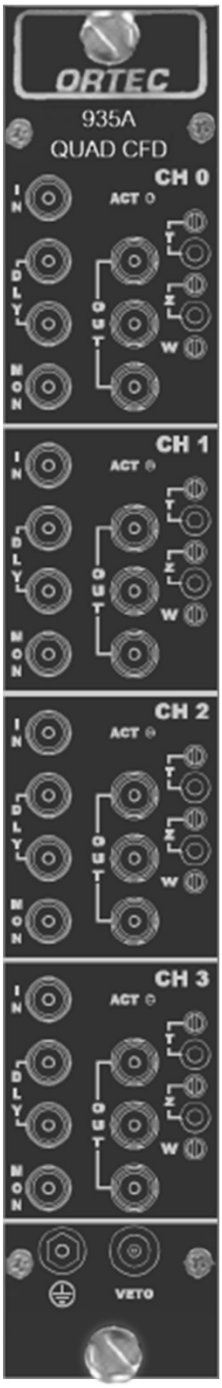


Figure 1. Model 935A

2. TECHNICAL SPECIFICATIONS

2.1 PACKING

NIM-standard single width model – weight: ~1kg.

2.2 POWER REQUIREMENTS

Power absorption requirements are the following:

Table 1. Power Requirements

+6V	300mA
-6V	1600mA
+12V	-
-12V	100mA
+24V	-
-24V	-

2.3 FRONT AND BACK PANEL

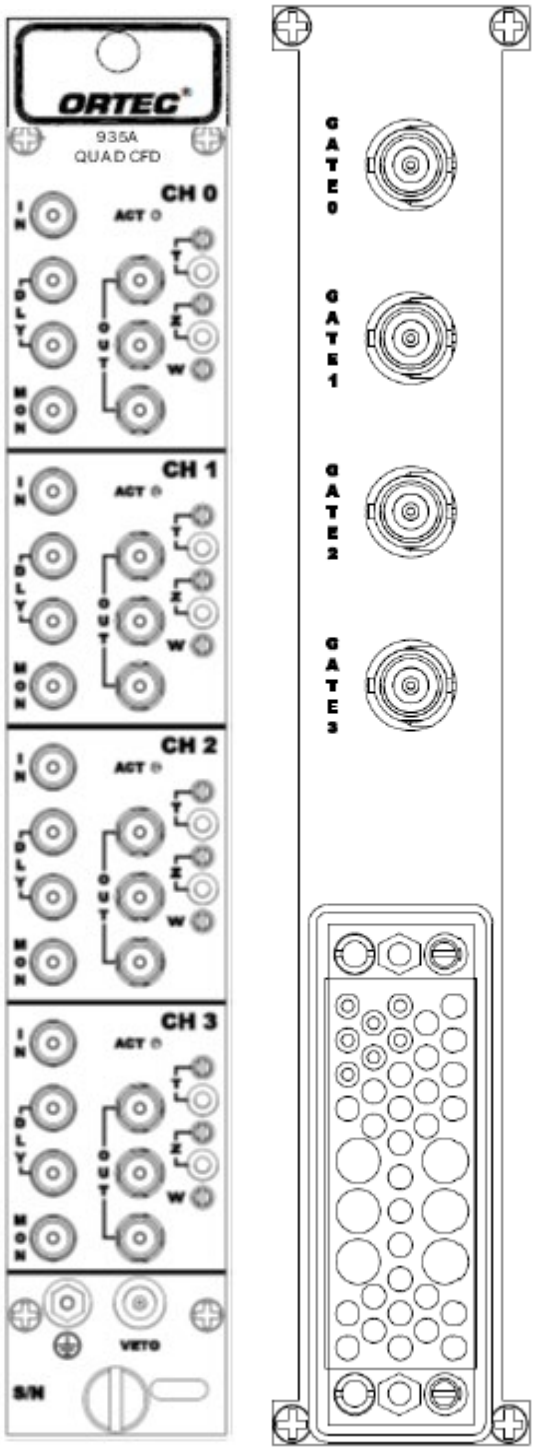


Figure 2. Front and Back Panel

2.4 FRONT AND BACK PANEL CONNECTIONS

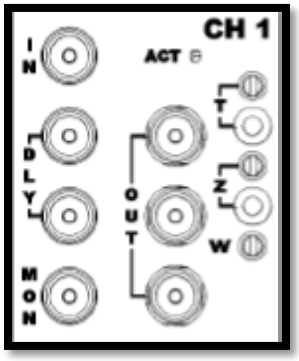


Figure 3. Front Panel Connections

Table 2. Front Panel Connections

IN	LEMO 00 Connector	Analog Input	Analog signal from detector for constant-fraction timing. Linear range from -20mv to -5V. 50 Ohm, DC coupled; protected with diode clamps at ±10V. Input reflections <10% for input rise times >2ns.
DLY	2 LEMO 00 Connectors	Delay Stub	Allows for selecting the CF shaping delay. 50-Ohm cable to be inserted between connectors. For triggering at 20% fraction, the shaping delay duration must be set equal to input pulse rise time plus 1ns.
MON	LEMO 00 Connector	Monitor Output	Allows monitoring of the CF shaped signal. 50 Ohm, AC coupled. The MON output is proportional to the input signal CF minus the delayed input; the zero-crossing threshold is compared to the input signal for minimized walk.
OUT	3 LEMO 00 Connectors	Discriminator Output	Three bridged outputs, updating or blocking, fast negative NIM output signals, mark the CF zero-crossing time. Amplitude –800 mV on 50-Ohm load. Each connector has its own 50-Ohm resistor in series with the common output driver. Unused output connectors must be terminated on 50 Ohm.
T	20-Turn Trimmer; Test Point	Threshold Setting	Sets the minimum pulse amplitude that will produce a timing output. Variable from –15 to –1000 mV. The relevant test point monitors the discriminator threshold setting. The test point voltage is 10X the actual threshold setting. Zout ≤2 kOhm.
Z	20-Turn Trimmer; Test Point	Walk Adjustment	Adjustment for fine-tuning the zero-crossing discriminator threshold to achieve minimum walk. Adjustable over a ±15 mV range. The relevant test point monitors the actual setting of the zero-crossing discriminator. The test point voltage is 100X the actual zero crossing discriminator threshold setting. Zout: 1 kOhm.
W	20-Turn Trimmer	Output Width Adjustment	Adjustment for each discriminator channel sets the width of the three output logic pulses. The range of width adjustment depends on the positions of jumpers, see page 18.
ACT	Red LED	Activity	Signals presence of output.

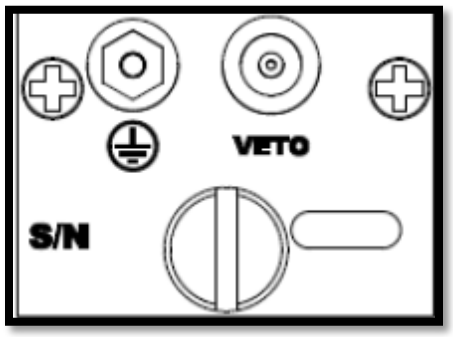


Figure 4. Front Panel Connections Part 2

Table 3. Front Panel Connection Part 2

VETO	LEMO 00 Connector	Veto Input	Accepts negative NIM level to inhibit the timing outputs on all the channels chosen with the internal VETO disable switch. Input impedance, 50 ohm. For proper FAST VETO operation, the leading edge of the VETO signal must precede the IN1 (IN2, IN3, or IN4) signal by 3 ns and have a width equal to the CF Shaping Delay plus 5 ns.
GND	Test Point	Probe GND	Front-panel test point provides a ground connection for test probes.

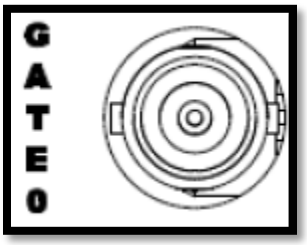


Figure 5. Back Panel Connection

Table 4. Back Panel Connection

GATE	BNC	GATE IN	Accepts a negative NIM level to gate the respective constant-fraction timing output. Coincidence or anticoincidence gating is selected via jumper (see page 18). Input impedance, 50 ohm. GATE INPUT leading edge should precede the Analog input by 1 ns and have a width equal to the CF Shaping Delay plus 5 ns.

2.5 INTERNAL COMPONENTS

Several settings can be made via internal jumpers (whose position is indicated by colored boxes in the figures below), accessible by removing the unit side covers.

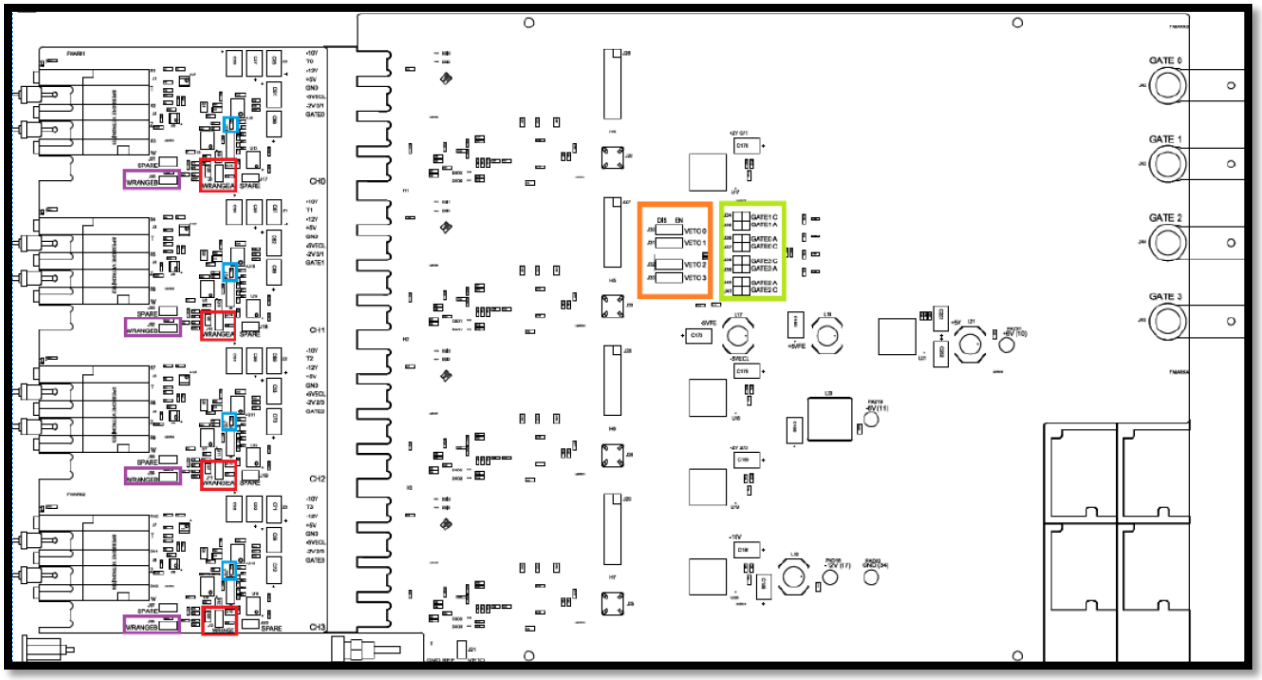


Figure 6. Component Side

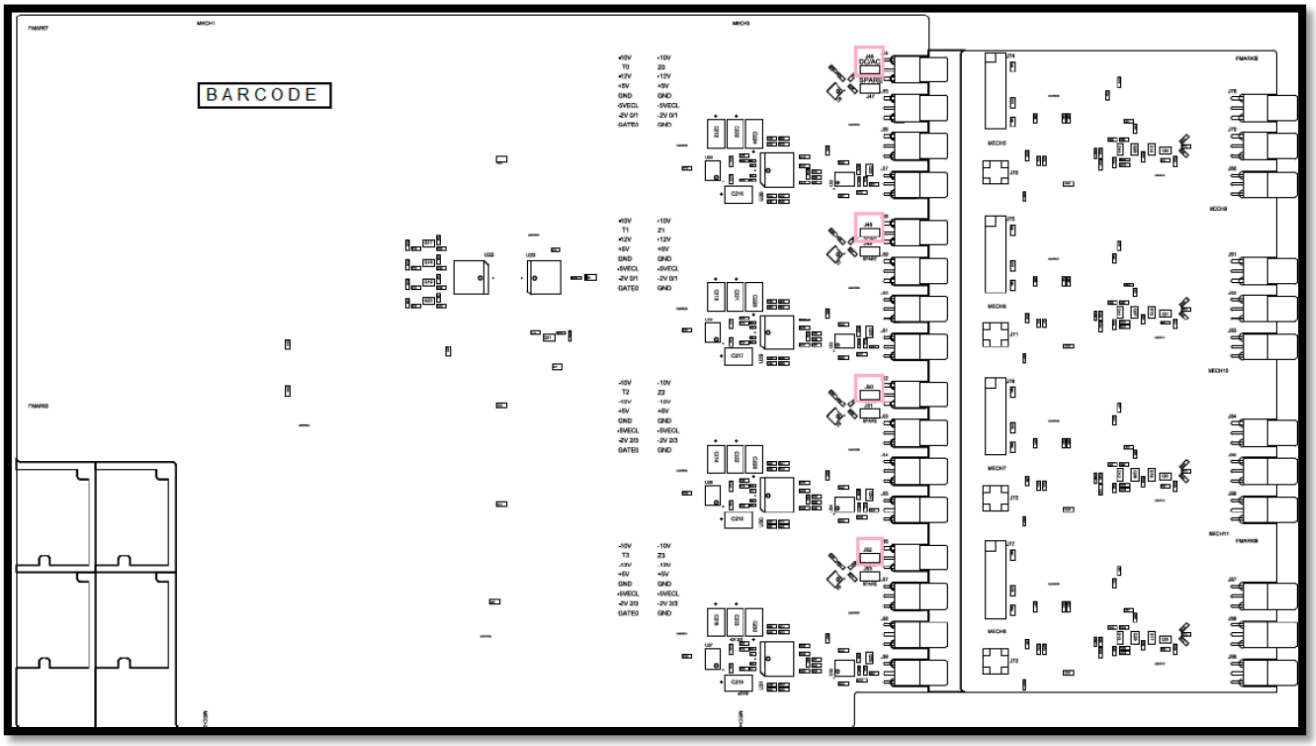


Figure 7. Soldering Side

2.5.1 Veto Disable

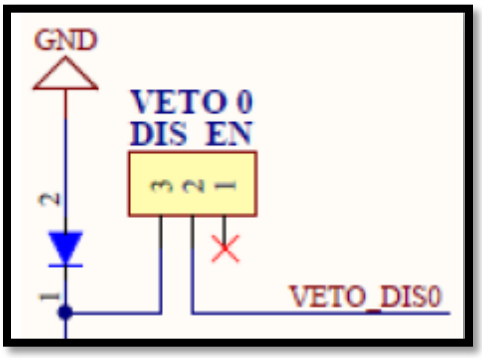


Figure 8. Veto Disable

One jumper per channel (Ch0: J30; Ch1: J31; Ch2: J32; Ch3: J33) on PCB component side (orange box); short pin 1 and pin 2 in order to enable VETO (the channel output is disabled in presence of VETO signal); short pin 2 and pin 3 in order to disable it (channel output ignores the presence of VETO signal).

2.5.2 Gate Mode

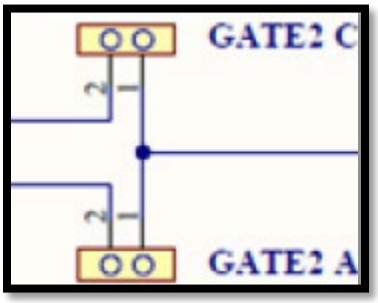


Figure 9. Gate Mode

Two jumpers per channel (Ch0: J37, J36; Ch1: J34, J35; Ch2: J41, J40; Ch3: J38, J39) on PCB component side (green box), allow to choose either Coincidence or anticoincidence gating. Insert GATE# C jumper to select “coincidence” and GATE# A jumper to select “anticoincidence”.

2.5.3 Output Mode

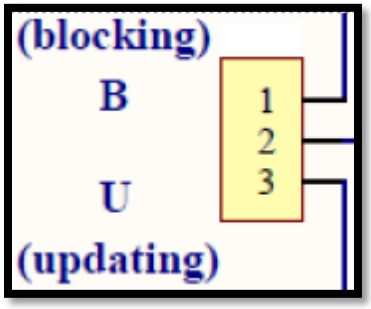


Figure 10. Output Mode

The outputs pulse can be either updating or blocking. One short circuitable socket per channel (Ch0: J13; Ch1: J14; Ch2: J15; Ch3: J16) on PCB component side (blue boxes), allows to choose the

desired modality: short pin 1 and pin 2 in order to select Blocking mode; short pin 2 and pin 3 in order to select Updating mode.

2.5.4 Width Range



Figure 11. Width Range

The output width range selection is achieved through the combination of a couple of short circuitable sockets per channel, on PCB component side: “Width range A”, one per channel (Ch0: J9; Ch1: J10; Ch2: J11; Ch3: J12) [red boxes]and “Width range B” (Ch0: J90; Ch1: J92; Ch2: J94; Ch3: J96) [purple boxes]; the combination result is explained at page 11.

2.5.5 AC/DC Coupling



Figure 12. AC/DC Coupling

One short circuitable socket per channel (Ch0: J46; Ch1: J48; Ch2: J50; Ch3: J52) on PCB soldering side (pink boxes), allows to choose the desired modality: short pin 1 and pin 2 in order to select DC coupling; contact open for AC coupling.

2.6 TECHNICAL SPECIFICATIONS TABLE

Table 5. Technical Specifications

Packaging	1U-Wide NIM Unit
Input Channels	4 inputs (negative polarity, 50 ohm impedance)
Input Linear Range	-20mV ÷ -5V
Max Input Voltage	-10V
Max Input Frequency	250 MHz
Threshold Range	-15mV ÷ 1V
Output Width	From 2ns to 500ns (jumper setting)
Output Rise Time	<600 ps
Output Fall Time	<950 ps
Walk	<±30ps on -50mV ÷ -5V input with 2.5ns rise/fall time <±25ps on -50mV ÷ -2V input with 1.6ns rise/fall time
Constant Fraction	20%
Double Pulse Resolution	<4ns
Transmission Delay	Typically <7ns with 3ns external delay
Operating Temperature Range	0 to 50°C
Threshold Temperature Sensitivity	t.b.d.
Transmission Delay Temperature Sensitivity	<±10ps/°C from 0 to 50°C

2.7 UKCA/CE COMPLIANT

This instrument conforms to UKCA/CE standards for radiated and conducted emissions, susceptibility, and low-voltage power directives.

3. OPERATING MODES

3.1 DELAY SETTING

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

For correct operation, the maximum of the attenuated pulse has to cross the delayed pulse at the selected fraction. This condition leads to a delay setting equal to the input rise time plus 1ns; the correct delay value is obtained by inserting a cable segment of proper length between the front panel Delay connectors.

3.2 THRESHOLD SETTING

The 935A produces an output signal as the analog input signal exceeds the threshold, i.e., the lowest energy of interest.

To adjust the threshold level of a channel, measure the dc voltage between the front-panel Threshold test point and ground for the relevant channel. The ground test point is located next to Veto Input connector. The nominal range of voltages at the test point is -150 mV to -10 V, corresponding to the actual threshold which is 10% of the test point voltage, i.e., a 5V reading leads to a 500mV threshold. Use a screwdriver to adjust the threshold level with the “T” trimmer.

3.3 WALK ADJUSTMENT

To adjust the Walk characteristics, connect the signal source to be used to the Input connector in the active channel and connect the signal from the constant-fraction Monitor connector to the oscilloscope (bandwidth > 300 MHz) through a 50-Ohm cable. Select the CF Shaping Delay according to the instruction given above. The Bipolar signal can be observed on the oscilloscope, externally triggered by the corresponding discriminator output. Adjust the Walk (Z) control, which sets the zero-crossing reference, so that the bipolar constant-fraction signals for all input amplitudes cross the baseline at about the same time. The relevant test point can be used for fixing the zero-crossing reference; the nominal range of voltages at the test point is -1.5 V to 1.5 V, corresponding to the actual threshold which is 1% of the test point voltage. Use a screwdriver to adjust the “Z” trimmer.

3.4 OUTPUT WIDTH ADJUSTMENT

In order to adjust the output width, provide an input pulse that exceeds the threshold at a rate lower than 500 KHz and measure the width of the relevant output pulse. Terminate the unused output connectors on 50 Ohm. Use a screwdriver to set the “W” trimmer for the output width in the active channel. The use of Output Mode and Width jumpers (see page 18), allows to adjust the width in the following ranges:

Table 6. Width Ranges

Width Jumper A	Width Jumper B	Min. Width Updating	Max. Width Updating
Open	Closed	2ns	60ns
Closed	Closed	10ns	240ns
Closed	Open	240ns	500ns

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