Model 7011

FAST AMPLIFIER / DISCRIMINATOR

Operating Manual

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Fast Amplifier/Discriminator Model 7011

Instruction Manual

Contents

1. Introduction

1.1 General Description

The model 7011 combines a fixed gain amplifier and a fast leading edge discriminator. Both subunits can be operated independently from each other.

The units accept negative or positive polarity pulses to their 50Ω terminated inputs.

The dc–level of the amplifier output (composite amplifier version) can be adjusted via front panel trimming (screwdriver) potentiometer.

The input polarity of the leading edge discriminator has to be set in order to match the polarity of the input signal.

An output signal of the discriminator is generated whenever the input signal exceeds the selected threshold (adjustable via a front panel 10–turn dial potentiometer).

Three output signals are available from the discriminator:

–an unshaped negative fast NIM signal for very high countrates (≈ 200MHz) shape and width depend on the input signal and the threshold setting

–a fixed–width, shaped negative fast NIM signal (width 4ns to 5ns, countrates up to ≈ 90MHz)

–and a positive TTL signal (countrates up to ≈ 50MHz).

The width of the positive TTL output can be adjusted. This width then refers to the internal deadtime setting for the TTL and the shaped negative NIM output.

1.2 Setup Information

The model 7011 is designed to be used in ultra high countrate applications, e.g. single photon counting with input signals of very small amplitude.

As the lower acceptance level of the discriminator is ≈ 10mV, there may be no need of the fast amplifier in many applications. Therefore in the basic model they are not connected internally.

The input polarity of the discriminator has to be set with the front panel two position switch to match the polarity of the input signal. The selected polarity is in addition indicated by the LED's (red or green). Any dc–offsets at the discriminator input should be avoided.

For signal amplitudes ≤ 10mV the combination amplifier + discriminator has to be used. The inverting amplifier has a fixed gain of about seven to ten. For higher amplification see section 5.

The output level of the amplifier (for the composite version) has to be adjusted to zero dc with the front panel (srewdriver) potentiometer and can then be fed via a short 50Ω BNC cable to the input of the discriminator (select the proper input polarity). If the shaped fast NIM output signal is used, the deadtime has to be set properly, regarding the countrate at the input.

2.Specifications

2.1 Inputs

Amplifier	accepts positive or negative polarity pulses typical range 2 mV to 100 mV risetime ≥ 500 ps typically, R_{in} = 50Ω, dc–coupled (see sec. 4.1.1), front panel BNC (ac–coupled version available)
Discriminator	proceeds 10 mV to about 3.5 V linear pulses (ref. to the common mode range of ultra fast comparators), input polarity must be set via a two position front panel switch, risetime ≥ 500 ps typically, minimum input pulse width ≥ 1 ns, R_{in} = 50Ω, dc–coupled, front panel BNC

2.2 Outputs

Amplifier	inverted output, risetime (limit) ≈ 1 ns or as given by the input signal.
Discriminator	negative fast NIM output, not shaped, risetime ≈ 2 ns, pulsewidth depends on input pulse and threshold setting, amplitude ≈ –0.7V (min. –0.65V, terminated on 50Ω), dc–offset ≤ 30mV; shaped negative fast NIM output, risetime ≈ 2ns, pulse width ≤ 5 ns nominal, amplitude ≈ –0.7V (min. –0.65V, terminated on 50Ω), dc–offset ≤ 30mV; positive TTL output, providing 2V into 50Ω, risetime ≈ 4 ns, width (min. ≈ 10 ns) adjustable by front panel trimming potentiometer. The width then determines the internal deadtime for the shaped fast NIM and the TTL signal. The processing of the unshaped signal is not affected by the deadtime setting; front panel BNC connectors.

2.3 Controls and Indicators

DC Adjust	front panel trimming potentiometer (screwdriver), to adjust the the dc–level of the amplifier output signal (composite version)
Polarity	front panel two position switch to match the polarity of the input signal, positions are marked with + and – sign

LED's	two LED's (red and green) indicate the chosen input polarity of the discriminator.
Threshold	front panel locking dial potentiometer to set acceptance level for the input pulse (range ≈ 10 mV to about 1.2 V, the polarity of the threshold voltage is automatically switched with the setting of the input polarity
DT	front panel trimming potentiometer (screwdriver) to set the internal deadtime in the discriminator part, where the shaped fast NIM and the TTL outputs are generated. The width of the positive output signal refers to the deadtime setting.

2.4 Performance

Amplifier

Gain	approximately 7 to 10
Noise	≤ 50μV referred to the input
Bandwidth	≈ 20 kHz to ≥ 200 MHz (composite version)

Discriminator

Countrate	up to 200 MHz *)
Pulse Pair	
Resolution	less than 5 ns *)
	*) for the unshaped fast NIM output
Threshold	
Stability	better than ± 0.02 % / ^{o}C
Linearity	± 0.25 % integral

Temperature	
Range	0 °C to +50 °C

2.5 Power Requirements

Version 7011 : +6V ≈ 300mA, –6V ≈ 400mA

(for operation from ±12V, see section 5)

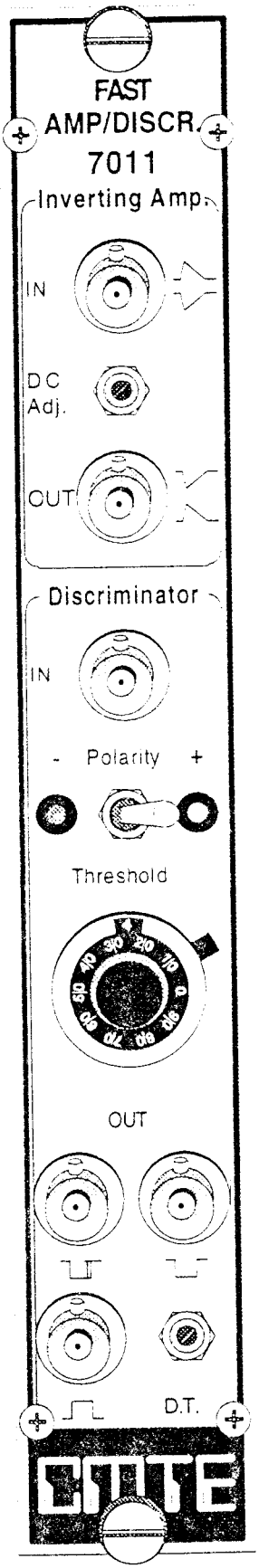
Version 7011–D : 220/110 V ac, 0.2A

(see section 5)

2.6 Physical

Size	single width NIM module (1.35 x 8.71 inches; 3.43 x 22.13 cm) as per TID – 20893 (rev.)
	net weight: 0.85 kgs
	shipping weight: 1.9 kgs
	for version 7011–D see section 5.

3. Front Panel



dc–level adjust of the output signal

input accepts positive or negative polarity signals

inverted output signal; risetime limit ≈ 1ns or as given by the input signal

input accepts ≤ 10mV to about 3.5V linear signals, minimum input pulse width ≥ 1ns

LED red or green shows the selected polarity

two position switch to match the input polarity

threshold setting from ≤ 10mV to 1.2V for signal acceptance

unshaped fast negative NIM output ≈ –700mV (terminated on 50Ω)

shaped fast negative NIM output ≈ –700mV (terminated with 50Ω)

positive output signal supplies a TTL signal into a 50Ω load

width control, sets the width of the positive output and the internal deadtime of the shaped signals

4. Operation and Circuit Description

4.1 General

This section will help the user to become familiar with the operation of the model 7011. It is somewhat difficult to give strict operating instructions because the module can be operated in many different system configurations. However some hints should be followed to ensure the proper operation of the model 7011.

4.1.1 Amplifier

The amplifier accepts positive or negative polarity pulses. A typical input range with a good linearity of the amplification is from ≈ 2 mV to ≈ 100 mV (see figures section 6.3).

The input impedance of the amplifier is matched to 50Ω.

Two types of amplifiers are available, an extremely fast ac–coupled one or a fast dc–coupled one. The dc–coupled amplifier of the model 7011 is a good compromise to meet the requirements of high speed and dc precision. As a single device cannot simultaneously achieve the desired characteristics, a composite amplifier design was chosen (see e.g. Linear Technology Application Note 21).

As can be seen from the circuit diagram (see section 6.1) the amplifier is built up with a mimimum of components. For the high speed stage a 50Ω gain block (Monolithic Microwave Integrated Circuit, e.g. Avantek MSA 0685). The internal structure of the MMIC is a Darlington connected pair of transistors with resistive feedback. Detailed information is given in the relevant data sheets.

The low frequencies and the dc–path are provided by a high speed monolithic operational amplifier (e.g. Analog Devices AD 844). The dc–level of the output (for the composite version) can be adjusted via front panel trimming (screwdriver) potentiometer.

4.1.2 Discriminator

The discriminator accepts positive or negative signals to its 50Ω terminated input.
The input polarity is selectable by a front panel two position switch. Relevant signal paths and level voltages are automatically switched (see section 6.2).
LED's (red or green) indicate the chosen polarity. The input network is protected for pulses exceeding 5V in amplitude.
The ultra fast comparator (e.g. SP9680 or VC7690) provides an ECL logic pulse whenever the selected (front panel 10–turn dial locking potentiometer) discriminator threshold is exceeded.
One output of the comparator is level–translated via a transistor network an fed to the frontpanel BNC connector. Shape and width of this output depends on the input signal and on the level setting.
The second output of the comparator is fed to a clipping and deadtime stage configured with two master–slave type D flip–flops. The Q–output of the first flip–flop is shifted to fast NIM level and fed to the front panel BNC connector.
This fast output (shaped) has a fixed width of about 4 ns. The second flip–flop is used to form the deadtime stage for the shaped (positive or negative) signals. One output of the second flip–flop is fed to an ECL–to–TTL translator to form the positive output signal. The deadtime can be adjusted via a frontpanel trimming (screwdriver) potentiometer. The width of the positive output signal reflects the selected deadtime.

4.2 Laboratory Bench Tests

Basic performance tests of the model 7011 (NIM version) may be exercised either in a rack mounted BIN or on a laboratory bench with the unit powered by an extender cable from a NIM BIN (TID–20893). It is recommended that electrical connections be made first with BIN power off.

4.2.1 Inputs

Suitable driving pulses may be obtained from laboratory pulsers or pulse generators, or readily available detector pulse signals. DC–off sets at the discriminator input should be minimized. The input network of the discriminator is protected for pulses exceedeing 5V in amplitude.

4.2.2 Outputs

All output pulses from the model 7011 are intended to drive 50Ω loads through any reasonable length of suitable 50Ω coaxial cables (such as RG–58). As the setting of the width of the positive output signal of the discriminator is consistent with the internal deadtime for the shaped signals, the user should set this control due to the requirements of the pulse rate for the given experiment. To use the full countrate capability (≈90MHz) of the shaped fast negative output the deadtime must be set to minimum.

5. Special Options

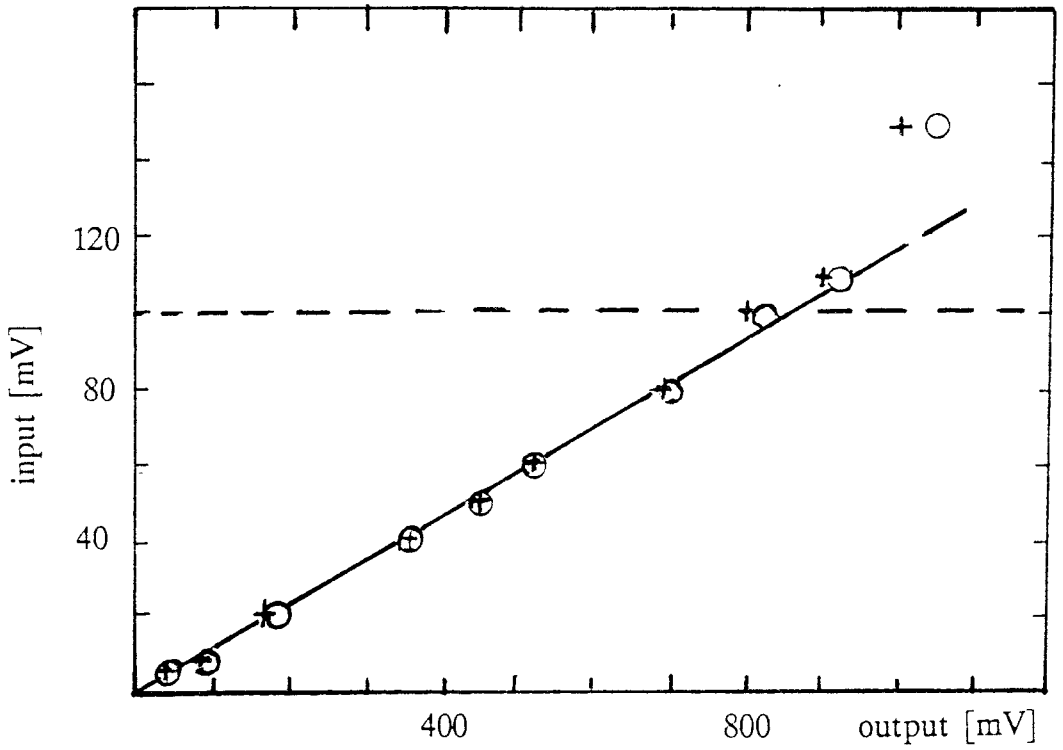
The standard version of the amplifier is dc–coupled (composite amplifier) with a gain factor of about 7 to 10 (see section 6.3).Higher amplifications (with some restriction to the bandwidth) are available on request.

An ac–coupled version using the full bandwidth of the MMIC to about 4 GHz, is available on request.

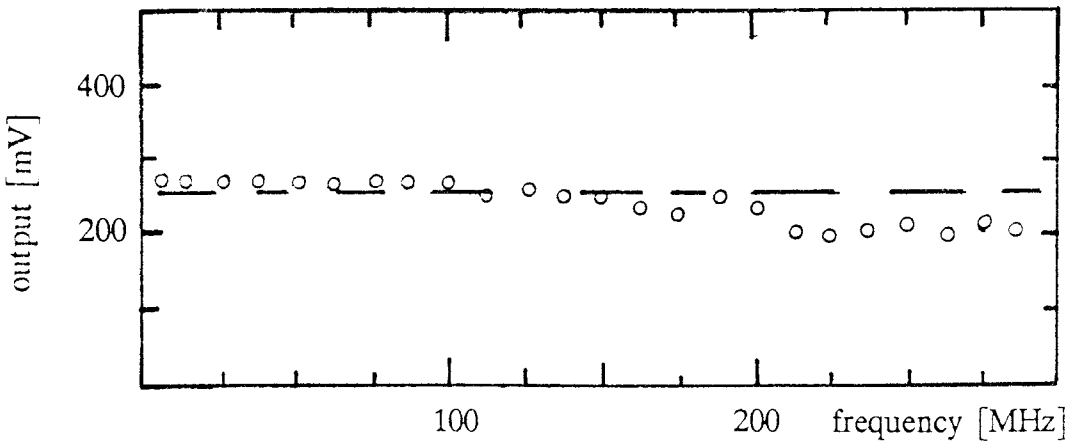
The width of the shaped fast negative NIM output of the discriminator can be changed on request. A second positive TTL output on the rear panel is available.

The standard version of the model 7011 is operated from the ±6V rail of a normal NIM BIN power supply. A ±12V version is available on request.

The 7011–D version has its own ac–power supply (220Vac or 110Vac).
This version is configured in a special housing and can be operated independently from a NIM BIN (stand alone version).

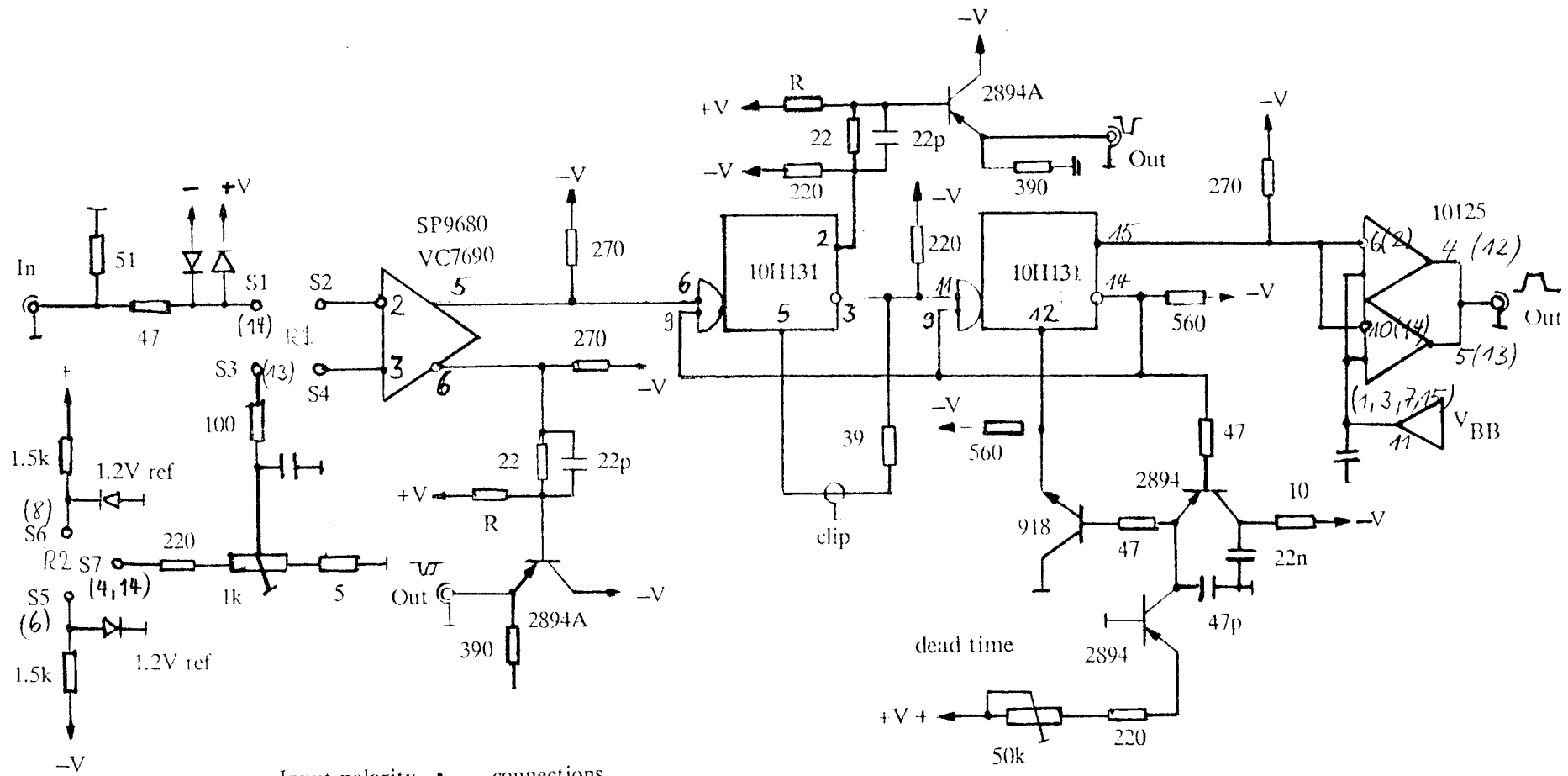


Input vs. output amplitude (typical) for positive (o) and negative (+) polarity signals achieved with the standard version amplifier (input 100MHz, output terminated with 50Ω). The amplification (gain ≈ 9.5) is linear to about 100 mV input amplitude.



Typical gain vs. frequency behaviour (standard version of the amplifier) tested with a sine wave signal.

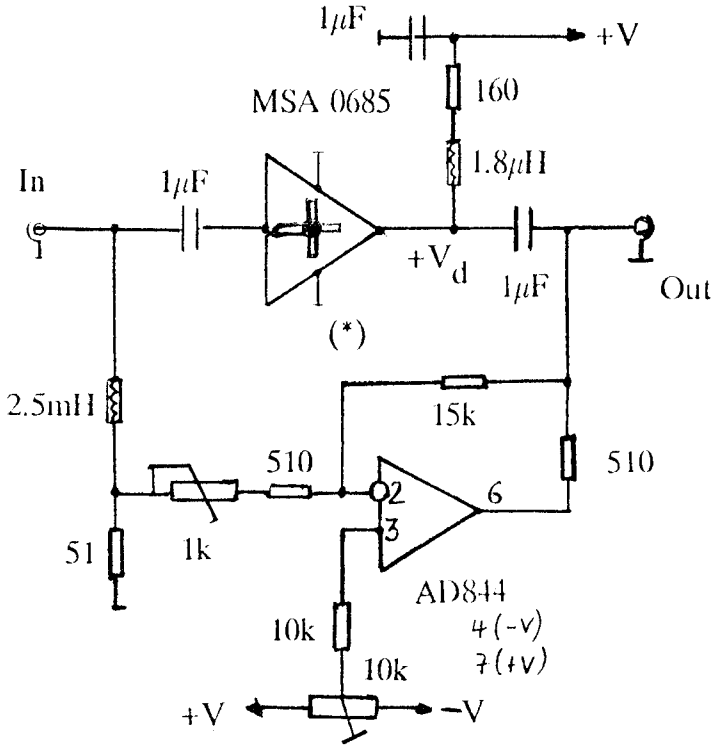
Leading Edge Discriminator



Input polarity	connections
negative	S1–S2 S3–S4 S5–S7
positive	S1–S4 S3–S2 S6–S7

Inverting Amplifier 7011

standard version



Inverting Amplifier 7011/H

high amplification (optional)