.FRONT END FOR RPC DETECTOR

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ABSTRACT

A prototype front-end amplifier-discriminator-monostable circuit for Resistive Plate Chamber detectors is presented. It has been designed and manufactured using the Maxim-SHPI bipolar technology. The aim of the circuit is to amplify a delta-like current signal ranging from 20fC to 20pC and to generate a fast output pulse for *timing* applications.

SUMMARY

The RPC detectors will be used in CMS experiment for the *muon trigger system*. The aim of this circuit is to amplify a delta-like current signal coming from a RPC (Resistive Plate Chamber) detector. The current signal is induced on strip lines whose characteristic impedance ranges from 30 to 60 Ohms. The input dynamic range is **20 fC < Qin < 20 pC**.

The main purpose of the circuit is to do ***TIMING.*** This means that the preamplifier must provide an output pulse having rise time as fast as possible, no matter the tail lenght, as the repetition rate of muon events is less than 10 KHz.

The main requirements of the circuit are:

- output pulse as fast as possible;
- low power consumption.

The circuit is made of **six channels**, each one consisting of an **amplfier**, a **discriminator-monostable** and a **differential 100 Ohm line driver**.

The discriminator serves the dual porpose of providing a logic pulse to indicate that a chamber has been fired and a timing edge to determine the exact bunch crossing related to the event.

POWER SUPPLIES: VP = 3V (±10%), VN = -2V (±10%), GND
POWER CONSUMPTION = ~ 30 mW / channel

THE AMPLIFIER

It’s made of:

1) a **common emitter transimpedance preamplifier**, whose main purpose is to match the impedance of the strip line. The input impedance of the preamplifier is 42 Ohm at the frequencies of our interest (100 MHz - 200 MHz).

2) an **integrator**, in order to introduce a dominant pole at ~ 18 MHz for charge integration and noise reduction. Being the input a delta-like pulse, the rise time of the output pulse is dependent on the integration time which is related to the duration of the input pulse; the amplifier bandwidth can be reduced at most at the repetition time of the events . It is made of a differential amplifier, which provides a balanced output and limits the output dynamic range.

The **charge sensitivity** is set to **1.5 mV/fC**, on the basis of our past experience on the detector;

3) a **threshold circuit,** by which the amplifier outputs can be unbalanced. By means of an external voltage, such a circuit allows the requested wide threshold range (10fC < Qth < 300 fC) and a differential-DC coupling to the discriminator.

POWER CONSUMPTION ~ 7 mW.

THE DISCRIMINATOR-MONOSTABLE

The discriminator is made of a two stage differential amplifier and it is DC coupled to the monostable. The RC of the monostable is set to ~ 144 ns. The monostable is another differential amplifier, driven on one branch by the discriminator output, on the other by the ac coupling with the first branch ouput. The required tuning of the pulse width is made by means of tunable positive feedback circuit. The purpose of the monostable is the following: sometimes, we get from the detector two current pulses in correspondence of a single physical event. The time separation between them ranges from 0 to ~ 100 nsec. The monostable allows to kill the second pulse.

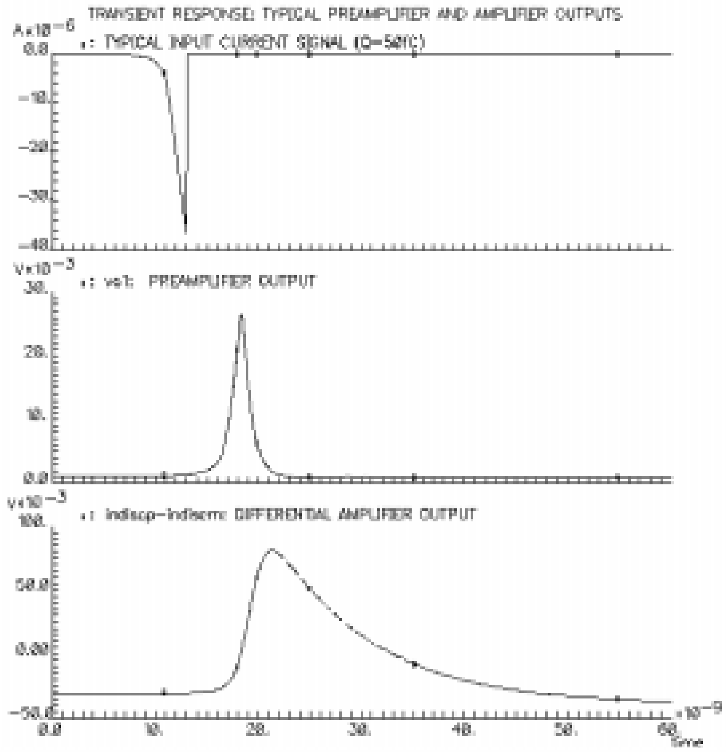
POWER CONSUMPTION ~ 7 mW.

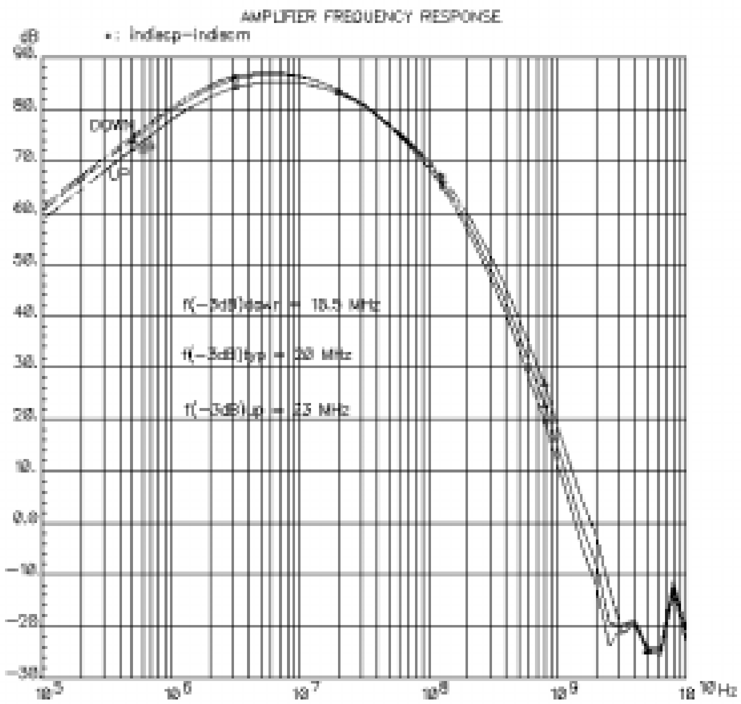
THE OUTPUT DRIVER

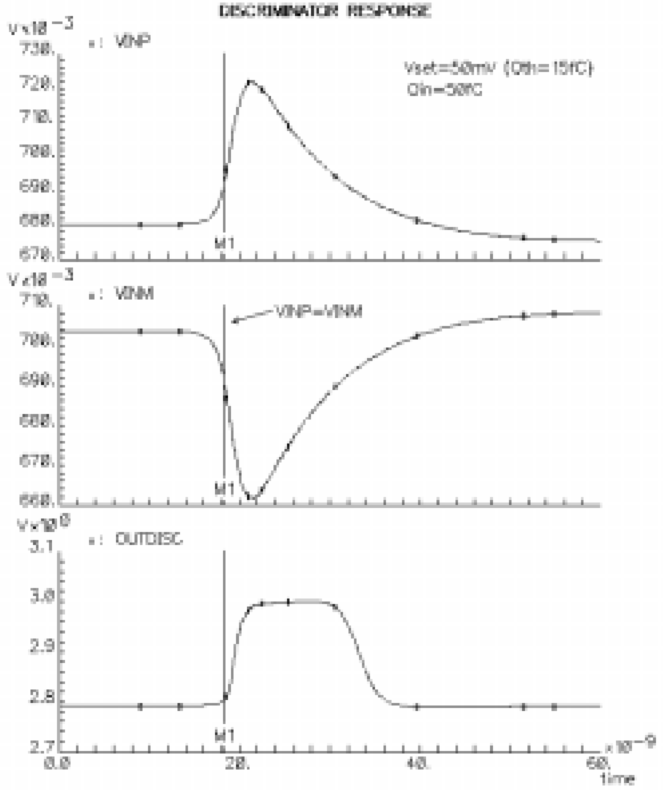
We have to transmit our signals to the receiver (probably an LVDS receiver) by means of a twisted pair cable. The main problem is power consumption, because a 300 mV signal on a100 Ohm termination requires *at least* 3 mA, that means **15 mW** .

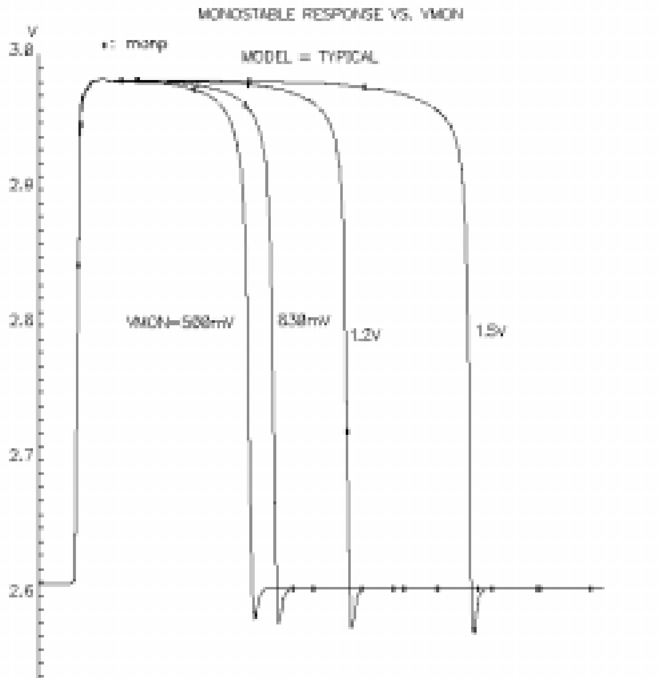
There is also the possibility that the receiver will be placed on the same PCB, near this chip. In this case, the 100 Ohm termination is no more necessary, the driver

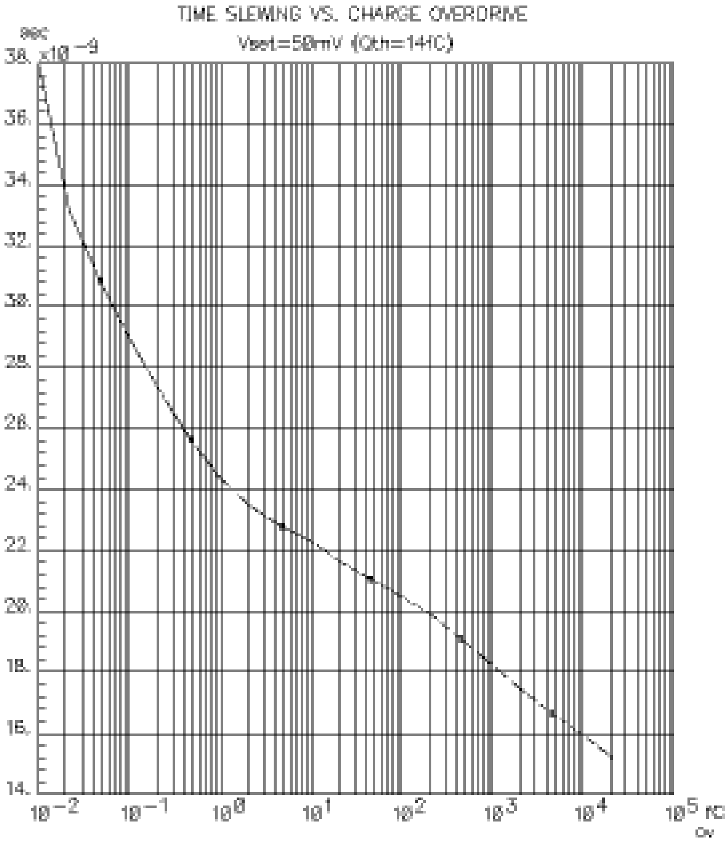
current could be lowered by means of the external signal *vdrive* and the power consumption becomes **4.5 mW**.






DISCRIMINATOR RESPONSE
V x10 −3
*: VINP
Vset=50mV (Qth=15fC)
Qin=50fC
M1
*: VINM
VINP=VINM
V x10 0
*: OUTDISC
x10 −9
time


MONOSTABLE RESPONSE VS. VMON
V
*: monp
MODEL = TYPICAL
VMON=500mV
830mV
1.2V
1.5V
x10 −9
time


TIME SLEWING VS. CHARGE OVERDRIVE
Vset=50mV (Qth=14fC)
sec
x10 −9
38.
36.
34.
32.
30.
28.
26.
24.
22.
20.
18.
16.
14.
10 −2
10 −1
10 0
10 1
10 2
10 3
10 4
10 5
fC
Ov