TGV-32 TEST RESULTS SUMMARY

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INTRODUCTION

This document summarizes the testing of prototype TGV-32 die to confirm the design suitable for production. The chip has been fabricated in 1.2μ CMOS in both Orbit and HP processes. There is a long history of this family of preamps in the Orbit process however concerns over yield and discriminator threshold consistency in the Orbit process prompted a change to the HP process. Some differences were apparent between the two processes, while yield and particularly threshold repeatability were better, bias currents and discriminator promptness were worse. Taken as a whole the improvements, especially in discriminator threshold repeatability outweighed the concerns and the HP process was chosen for the production run.

YIELD

The first Orbit prototype run yielded zero good die, with half the devices being bricks. Additional die from a different wafer produced an acceptable yield but had channel to channel variation that exceeded the limits of compensation. All HP chips were functional and only one bad channel was observed in the eight packaged die.

PERFORMANCE

The TGV-32 consists of 32 channels of charge sensitive preamplifiers, 32 discriminators (read comparators) with wired or output current, and an output buffer amplifier under control of a 190 bit serial data string. Internal bias voltages are controlled by five 6 bit DAC's. Testing of the operable Orbit chips was done at some length measuring all relevant parameters of every channel on all devices. On the HP runs the testing tended to be more sampled since the time was limited and the design was fundamentally confirmed and how the performance changed in the new process was the primary question. The only significant difference was an unexpected 50 ηs delay in the discriminator response which simulations later reproduced and fears of a systematic problem were alleviated.

POWER CONSUMPTION

The HP bias resistors were higher than expected so bias currents were lower. These resistors were trimmed for the production fab.

Source	Orbit	HP
Vdd Pre	4.91 mA	3.88 mA
Vdd Post	5.6 mA	4.23 mA

DAC VOLTAGES

The DAC voltage ranges were closer to the expected values on the HP chips than the ORBIT chips. The connection left out of the orbit run was connected in the HP run.

Input word 000000

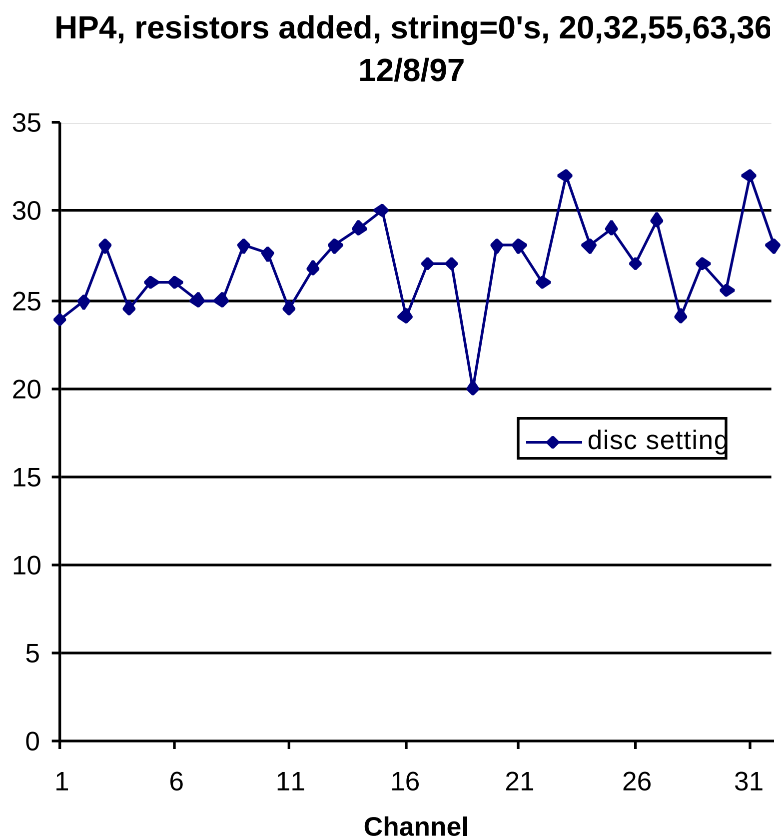
DAC ID	Orbit	HP
Vcal	4.01V	3.54V
Vgate	0.006V	0V
Vfb	0.005V	0V
Vmid	1.63V	1.74V
Ithresh	1.89V	1.81V

Input word 111111

DAC ID	Orbit	HP
Vcal	4.91V	5V
Vgate	3.83V	3.66V
Vfb	4.99V	5V
Vmid	4.66V	4.4V
Ithresh	0.001	0V

DISCRIMINATOR THRESHOLD

Evaluation of the discriminator threshold is somewhat subjective, and is also dependent upon some skill in choosing the optimum DAC settings to produce the low threshold without triggering on random noise. Our method is to set up a baseline that is quiet for all but the highest noise pulses then increase the input until the averaged discriminator current pulse amplitude is halfway between the baseline and a solidly triggered level, in other words, the discriminator is firing on 50% of the input pulses. The displayed results indicate sensitivity of the order of 0.25 mip after bias currents were adjusted to design values and the control DAC's were astutely tuned.



CHARGE GAIN

The TGV-32 preamp is an integrator with a virtual ground input. All detector signal current is collected and stored in the feedback capacitor. The output voltage is therefore determined by the value of the feedback capacitor. Charge gain is tested by driving the amplifier with a step function of known amplitude through a series capacitor of known value. Knowing the voltage and the series capacitance, the total charge is calculated. The amplifier output amplitude step is also measured and divided by the calculated charge giving the charge gain, usually expressed in milli-volts per femto-coulomb. The charge gain of the Orbit preamp was nominally 20mV/fC while the HP chip was 16.5mV/fC. The channel to channel matching of charge gain was within a few tenths of one percent and around 5% chip to chip. The feedback capacitor size has been adjusted to bring the HP charge gain back to 20mV/fC.

NOISE

The noise is measured by capturing two output voltage samples at a 250ηS interval taken approximately 2μS after the reset pulse. The reset occurs once every milli-second. The algebraic difference between the two samples is then taken as the noise sample. The output noise is then taken to be the rms value of 100 noise samples. Knowing the charge gain and the charge of the electron allows the noise to be expressed in rms electrons. The amplifier's feedback topology causes stray capacitance at the input to increase the amplifier's noise gain while the signal charge gain remains constant. The amplifier's signal to noise ratio is then directly diminished by the input capacitance. The total noise specification is then the zero capacitance noise plus some slope of electrons/pf of input capacitance. The Orbit chips had around 500e + 70e/pf noise on average. The HP chips were slightly noisier, about 700e+62e/pf.