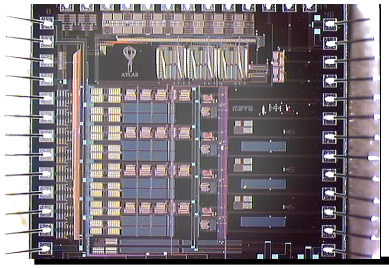
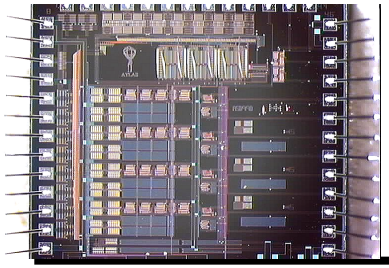


MDT Electronics PDR - Octal ASD
Specifications, Design and Performance

Overview

- ✓ Specifications
  - Functional
  - Analog
- ✓ Architecture
  - Analog channel
  - Programmable parameters, serial control port
- ✓ Fabrication process and layout
- ✓ Prototyping
  - Functionality and performance test results

What`s next …

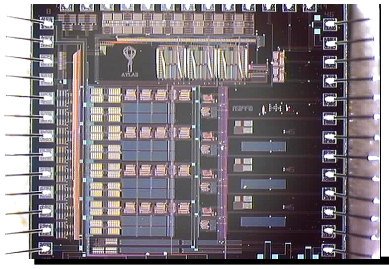


MDT Electronics PDR - Octal ASD
Functional Specifications

- ✓ Leading edge timing measurement
- ✓ Charge measurement

  Pulse width encoding - Wilkinson ADC
- ✓ Modes of operation:
  - Time-over-Threshold (ToT) mode
  - ADC mode

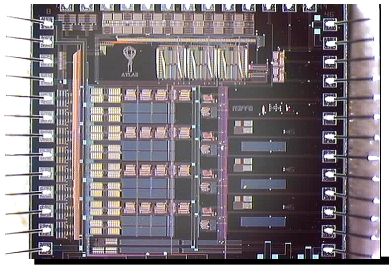
  Plus:
  - Calibration/Test pulse injection
  - Channel modes: Boundary scan
  - Programmability of analog and functional parameters
  - Serial control data I/O, communication protocol



MDT Electronics PDR - Octal ASD

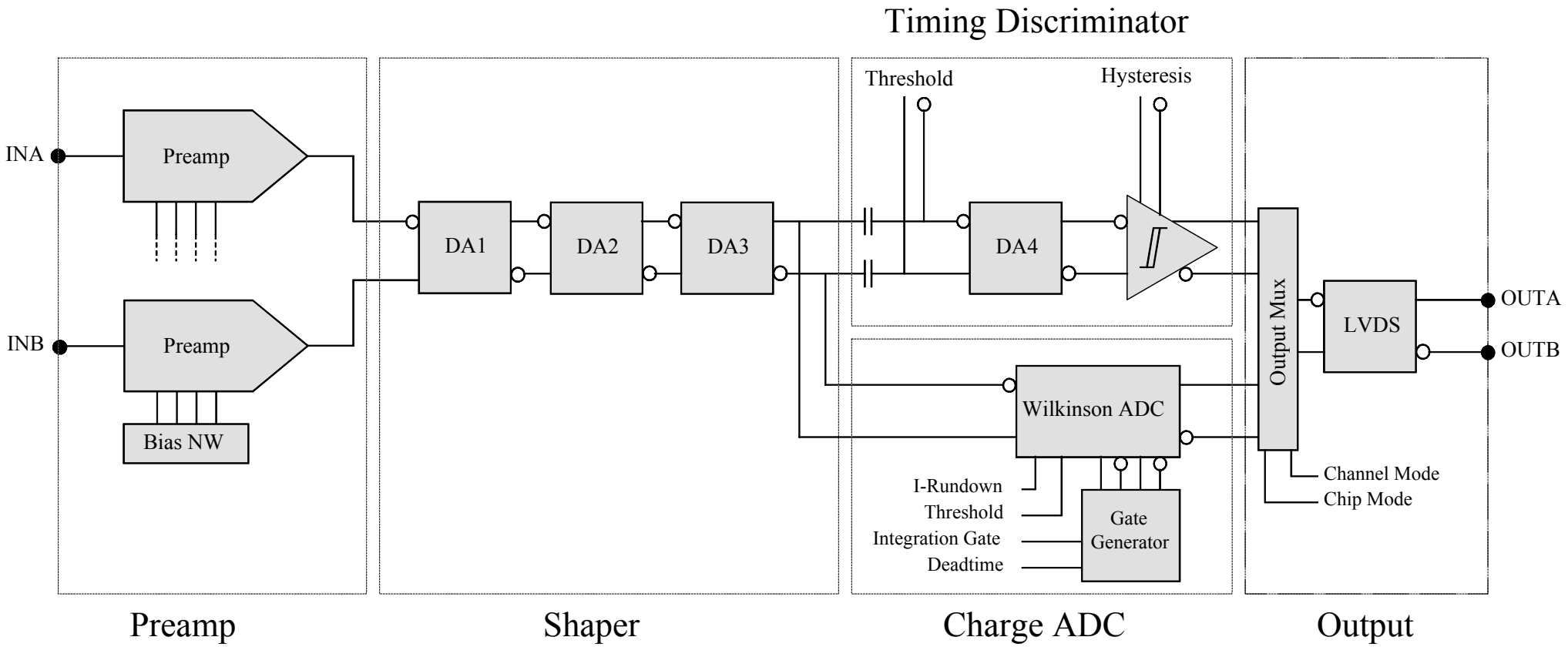
Analog Specifications

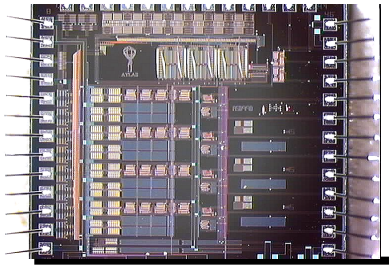
- Gain: 3 mV/ primary e^- (12 mV/fC)
- Peaking Time: 15 ns
- Shaping: bipolar, area balance < 500 ns
- Input Impedance: Z_{IN} = 120 Ω
- Noise Performance: ENC = 6000 e^- (~ 4 primary e^-)
- Crosstalk: < 1%
- Signal Path: differential
- Power Supply: Single, 3.3 V
- Power Consumption: < 35 mW/channel



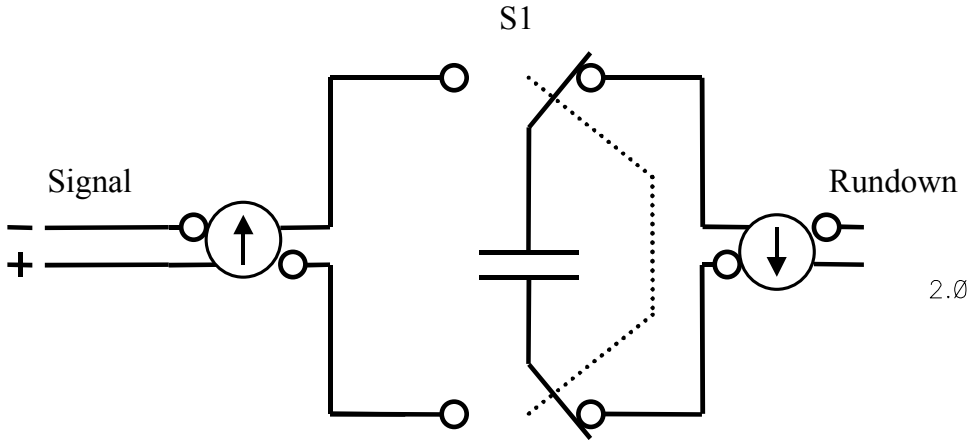
MDT Electronics PDR – Octal ASD

Analog Channel – block diagram





MDT Electronics PDR – Octal ASD
Wilkinson Charge ADC

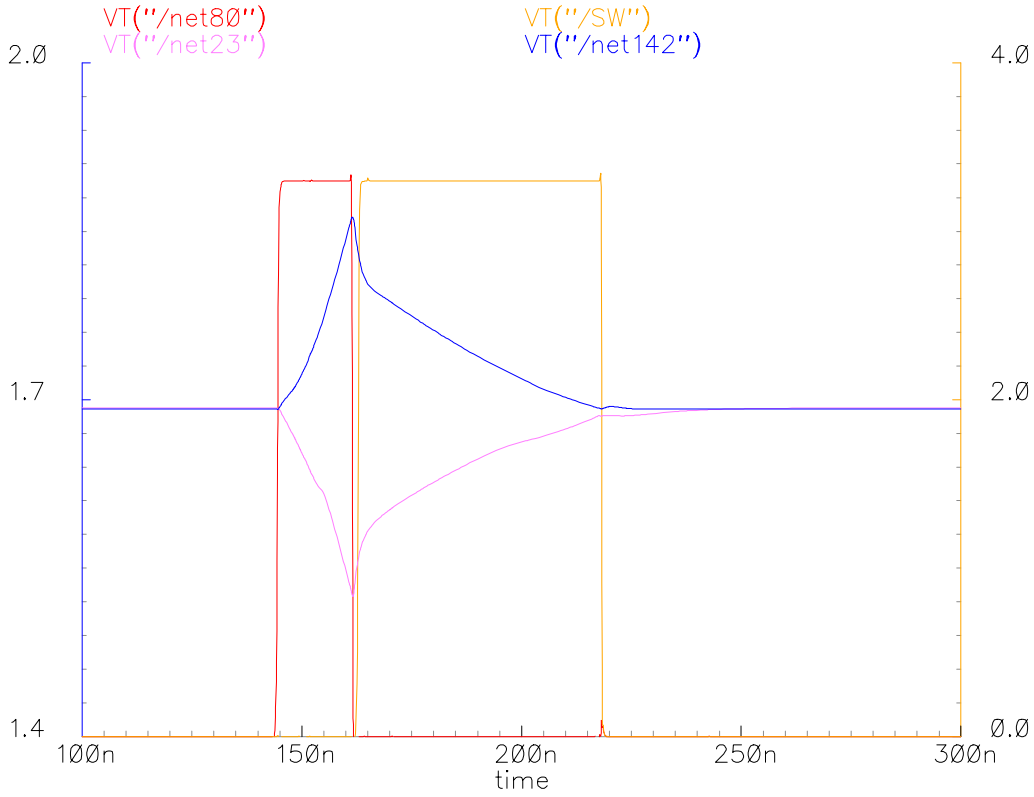


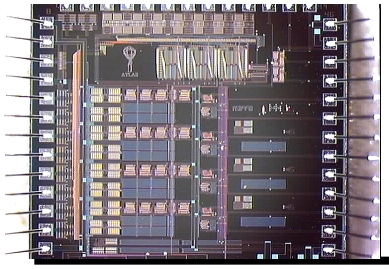
ASD output pulse:

edge → timing

width → charge

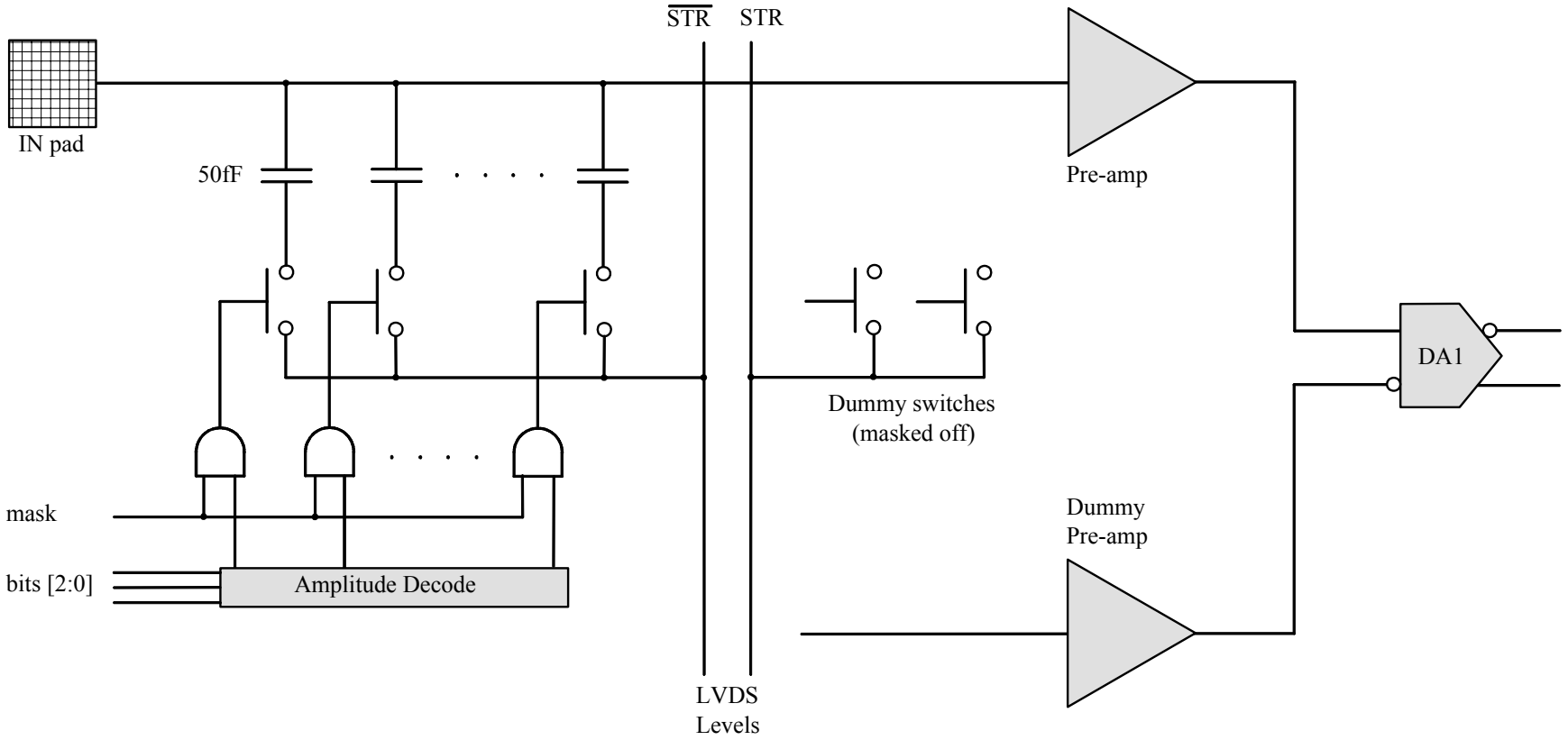
Charge encoded into pulse width

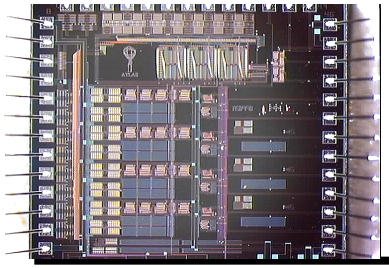




MDT Electronics PDR – Octal ASD

Calibration pulse injection





MDT Electronics PDR - Octal ASD
Programmable Parameters I

Timing Discriminator

① **Threshold:**
- Range: -256 – 256 mV
- Resolution: 2 mV (8-bit)
- Nominal: +60 mV (20 primary e^-)

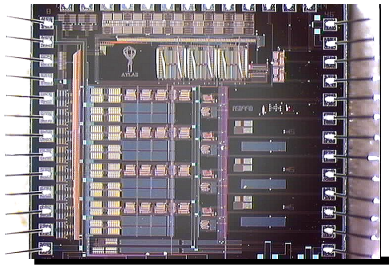
② **Hysteresis:**
- Range: 0 – 20 mV
- Resolution: 1.25 mV (4-bit)
- Nominal: 10 mV

Wilkinson Charge ADC

① **Integration Gate:**
- Range: 11 – 21 ns
- Resolution: 0.625 ns (4-bit)
- Nominal: 16 ns

② **"Run-down" current:**
- Range: 1.1 – 2.4 µA
- Resolution: 0.1857 µA (3-bit)
- Nominal: 1.3 µA

③ **Discriminator Threshold:**
- Range: 32 – 256 mV
- Resolution: 32 mV (3-bit)
- Nominal: 32 mV



MDT Electronics PDR - Octal ASD
Programmable Parameters II

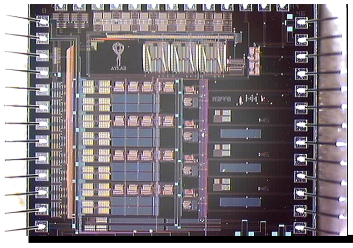
① **Dead Time:** ADC mode: Logic does not accept/process new hit
- Range: 300 - 1000 ns
- Resolution: 100 ns (3-bit)
- Nominal: 800 ns

② **Calibration/Test Pulse Injection**
- Range: 10 - 80 fC (50 – 400 fF Caps @ LVDS 200mV)
- Resolution: 10 fC (3-bit)
- Each channel individually selectable (8-bit mask register)
- "Delayless" (RC time constant ~ 150 ps)

③ **Chip Mode:** Time-over-Threshold (ToT), ADC mode

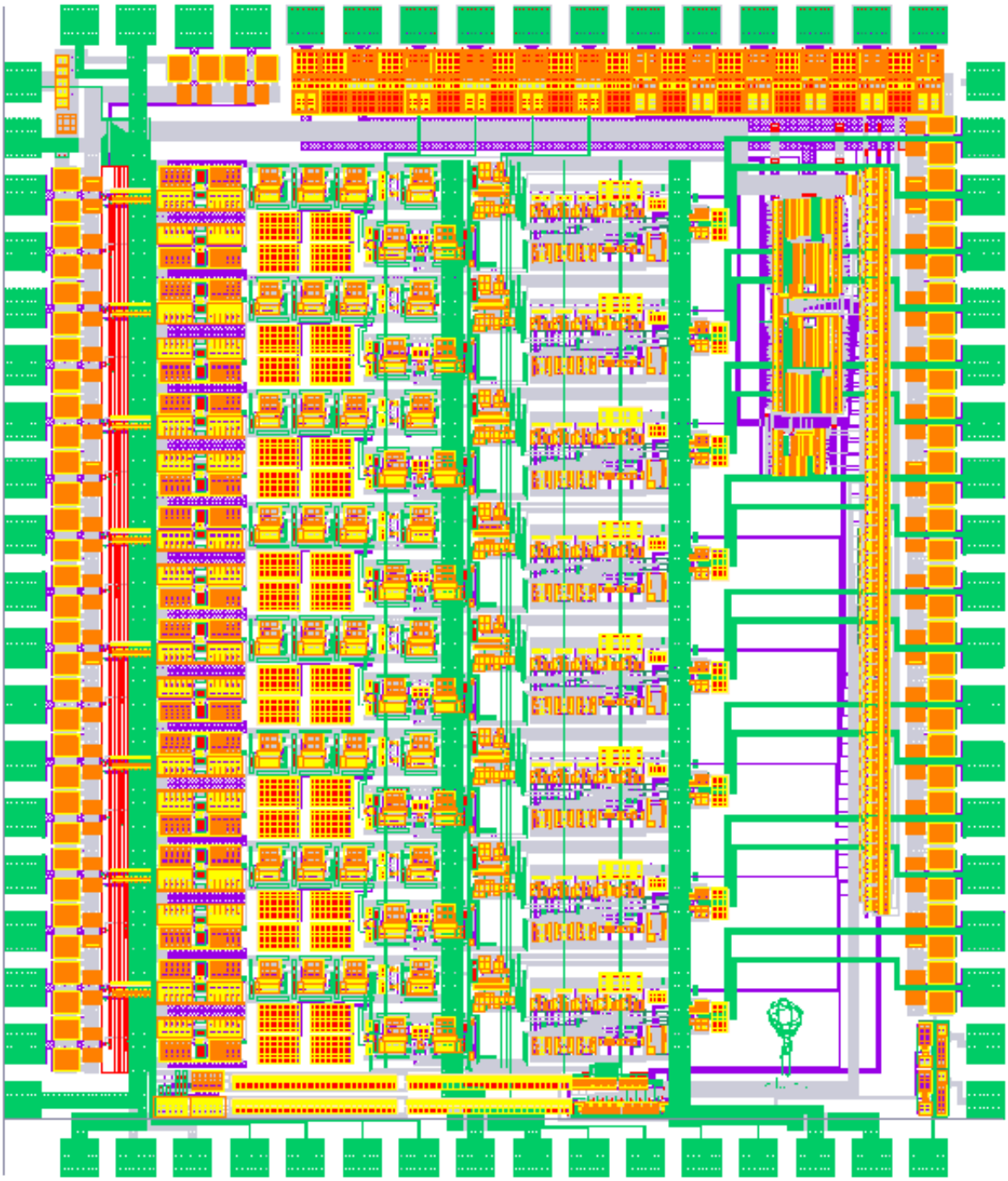
④ **Channel Output Mode:** Active, Set HI, Set LO

Total number of setup bits: 53 Serial I/O, shift + shadow registers, daisy chain

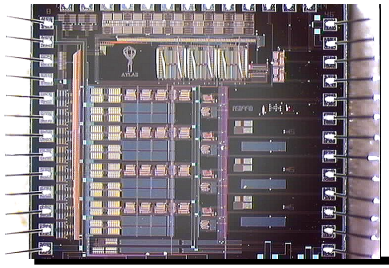


MDT Electronics - ASD octal

ASD00A - Octal I

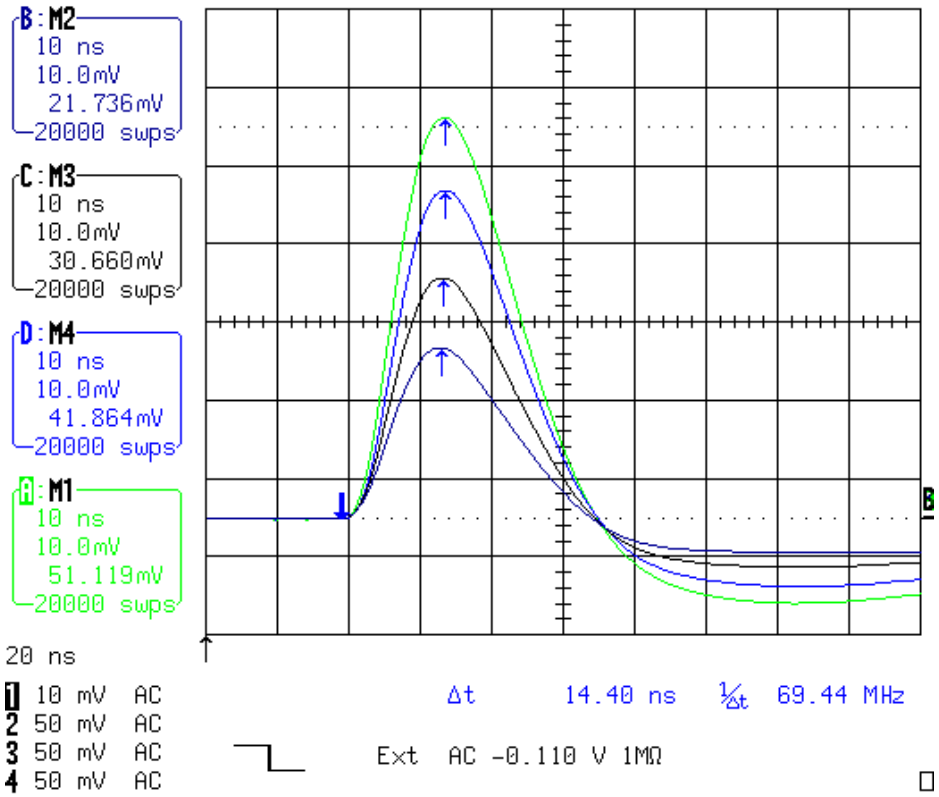


- **Octal - all specs, complete functionality, programmable**
- **All I/O pads ESD protected**
- **Die 3.2 × 3.7 mm, 70 bonding pads**
- **QFP80 package**
- **Process: 0.5 µm triple-metal N-well CMOS**
  linear capacitor, silicide block



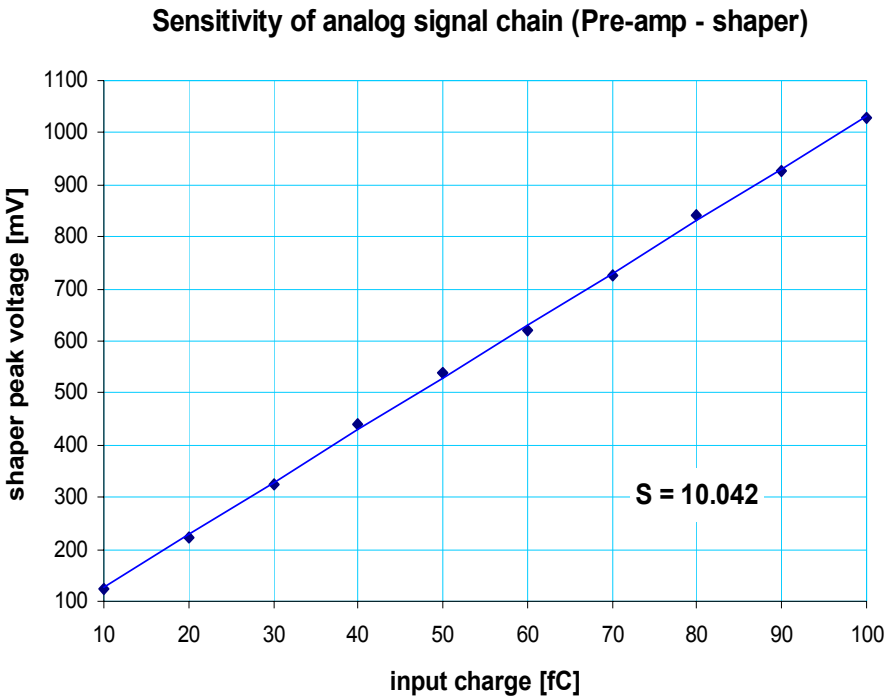
MDT Electronics PDR – ASD00A test results

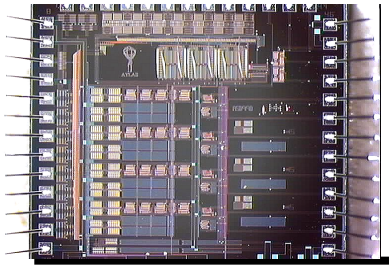
Sensitivity



Probe attenuation 10:1
Single ended pulses,
40, 60, 80, 100 fC

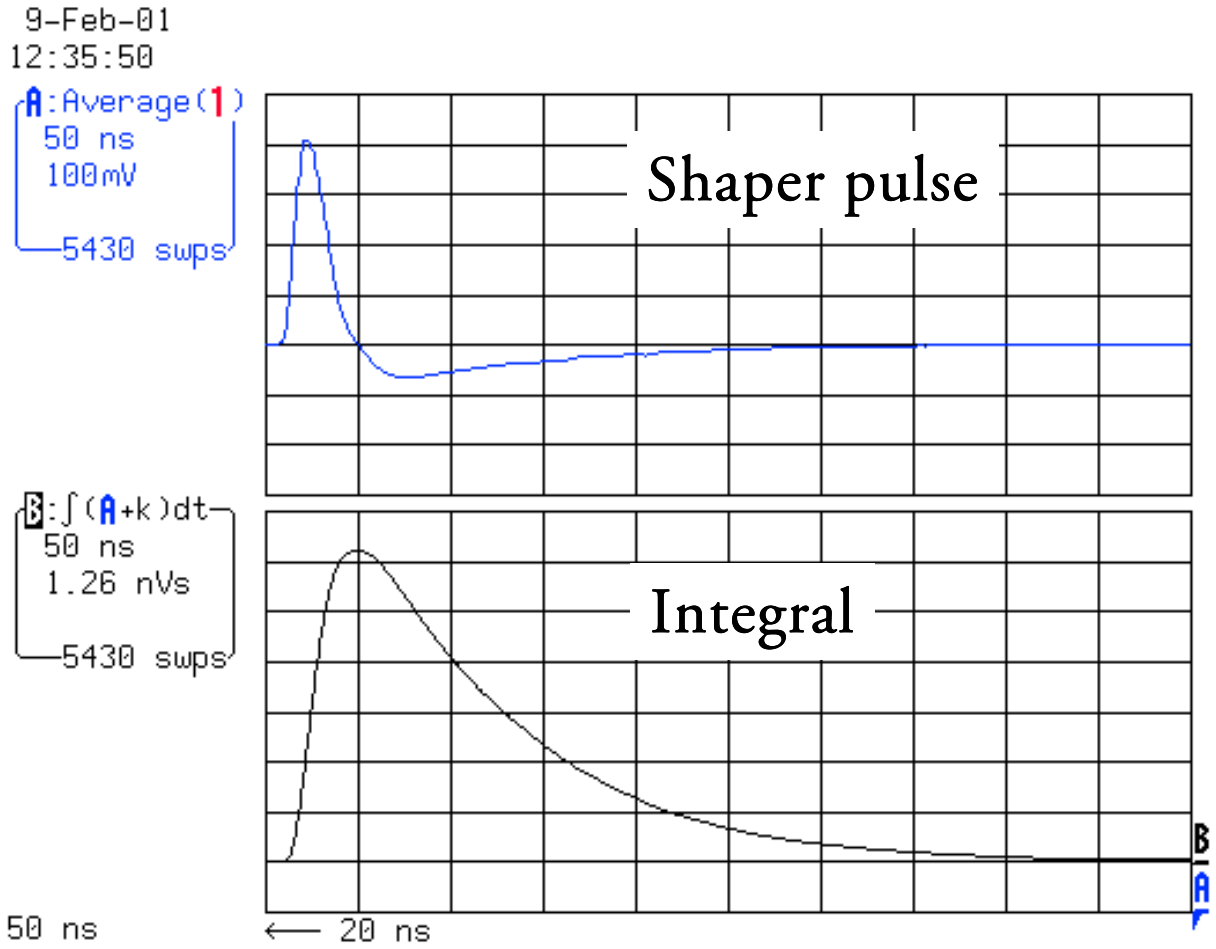
Sensitivity (differential):
10 mV/fC





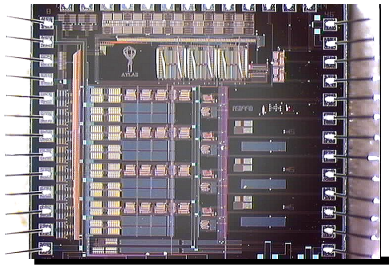
MDT Electronics PDR - ASD00A test results

Bipolar Shaper



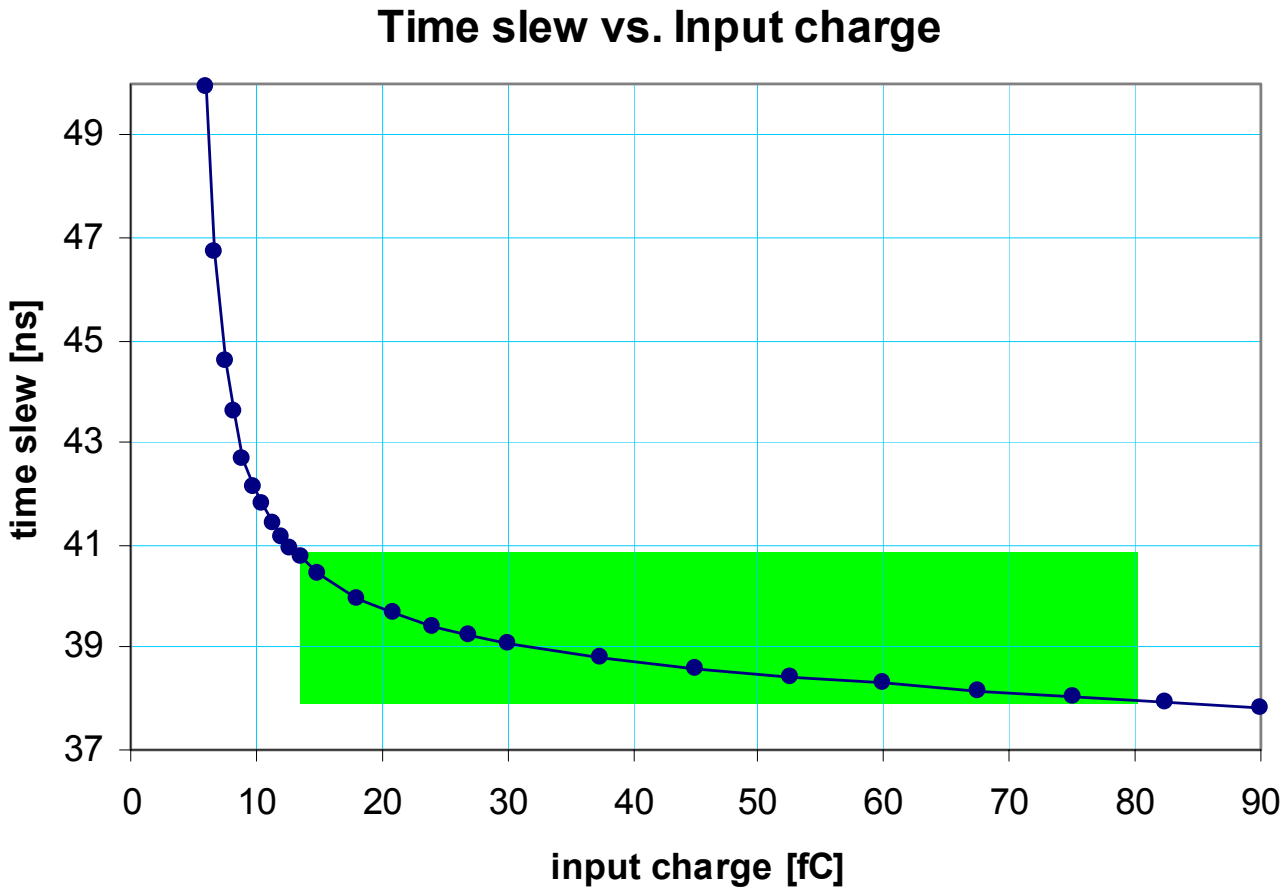
Area balance after
~ 400 ns

background rate MAX
2.5 µs (400 kHz)

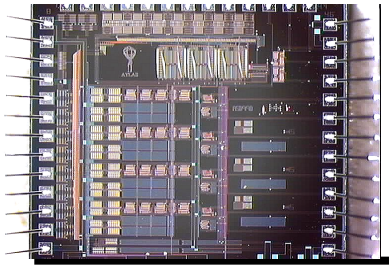


MDT Electronics PDR - ASD00A test results

Time Slew



Time slew for expected input signal range of the order of 2 – 3 ns



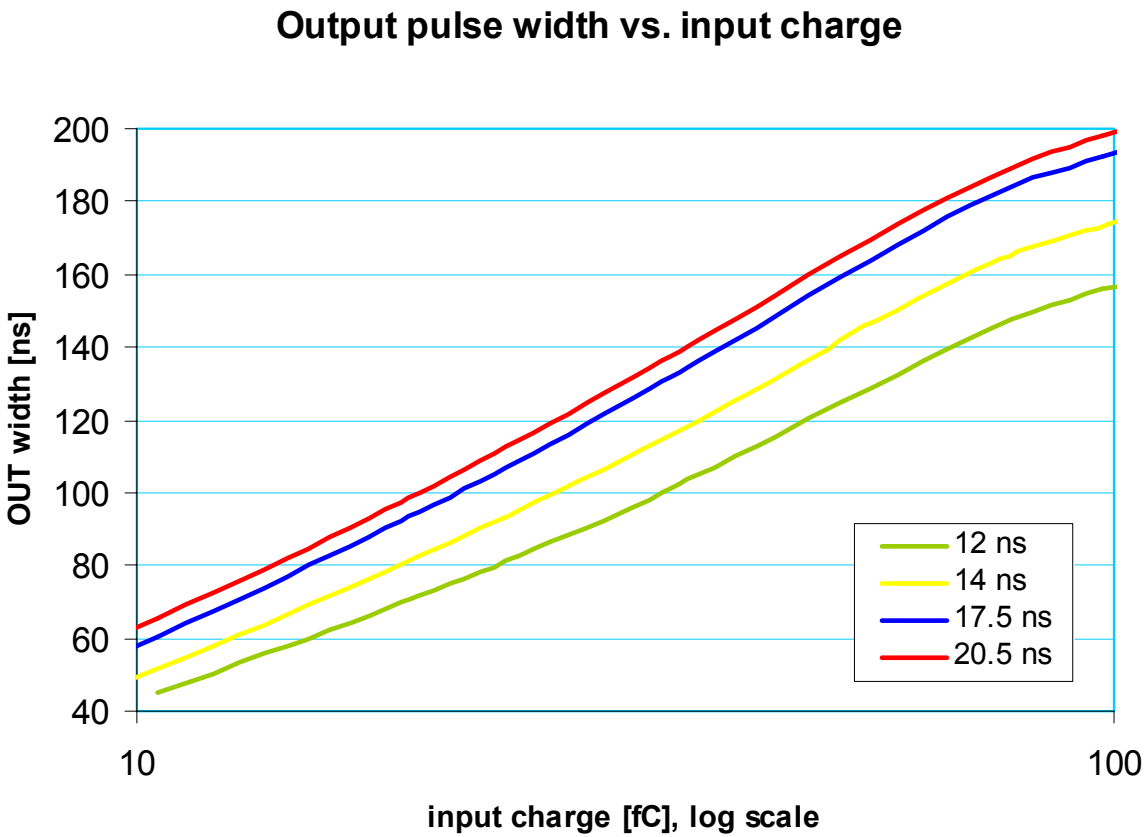
MDT Electronics PDR – ASD00A test results

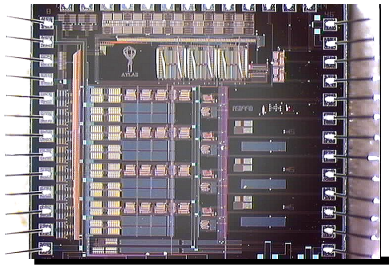
Charge Measurement: Wilkinson ADC

- A Wilkinson type ADC measures the charge in the leading edge of the MDT signal within a given time window and encodes it into a pulse width. (Charge-to-Time Conversion)

- The information will be used for time slew correction.

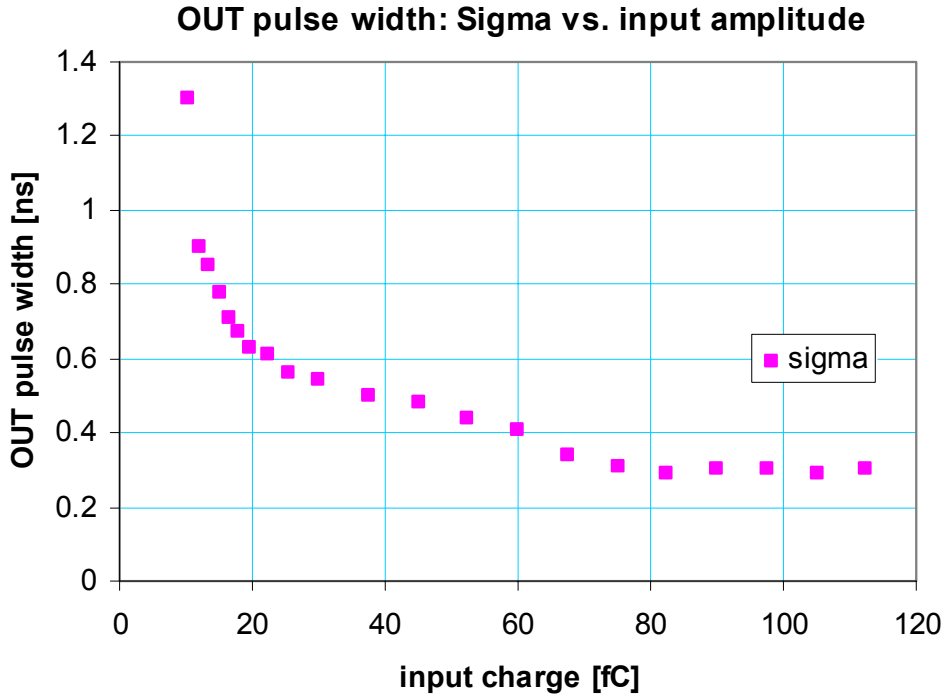
- Other applications: Diagnostics, chamber monitoring, dE/dx, …





MDT Electronics PDR - ASD00A test results

Charge Measurement: Wilkinson ADC II

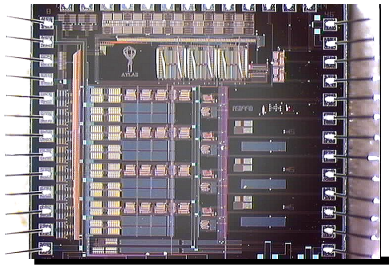


Wilkinson "noise" small

σ_{width} = 0.2 – 0.5 ns

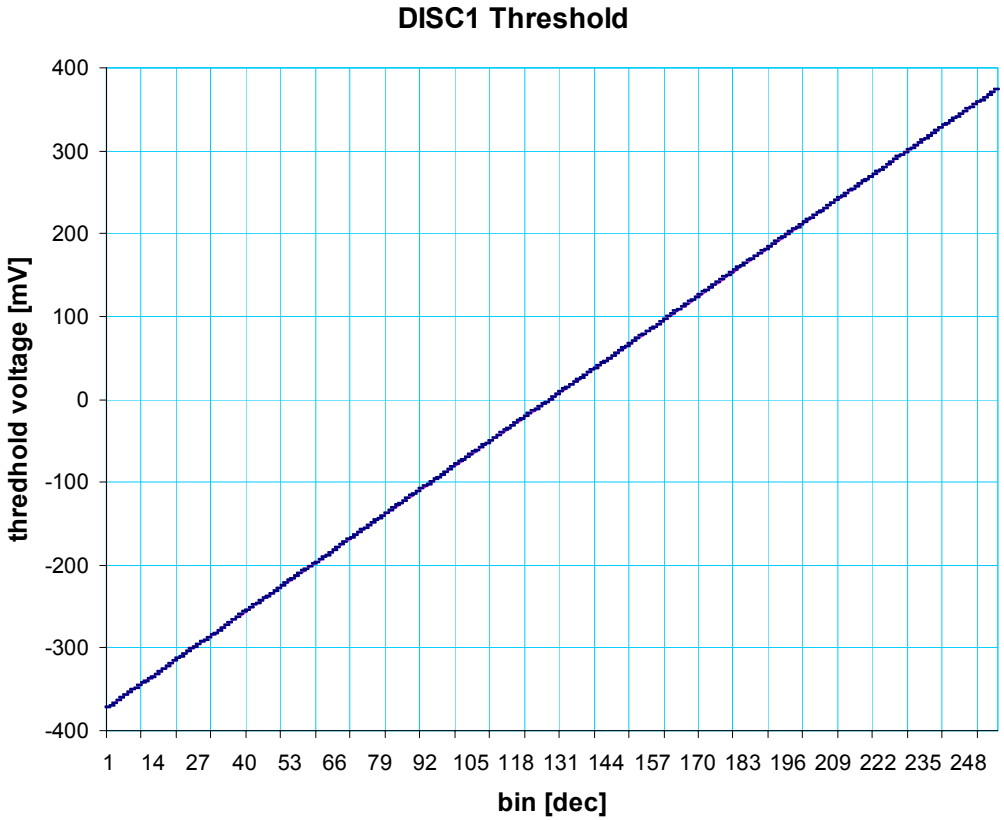
Wilkinson ADC requires calibration per channel/tube
due to non-linear characteristic
and channel-channel variation.

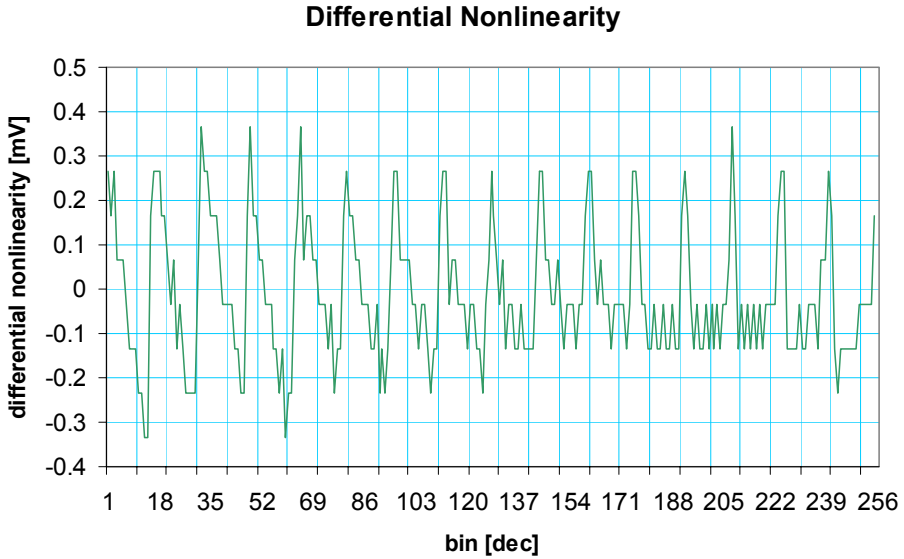
Also after each change of parameter settings.



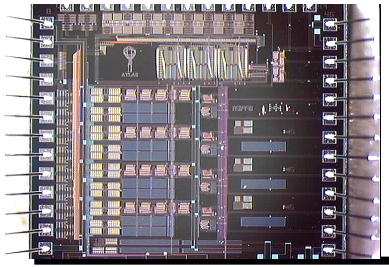
MDT Electronics PDR – ASD00A test results

Main Threshold DAC



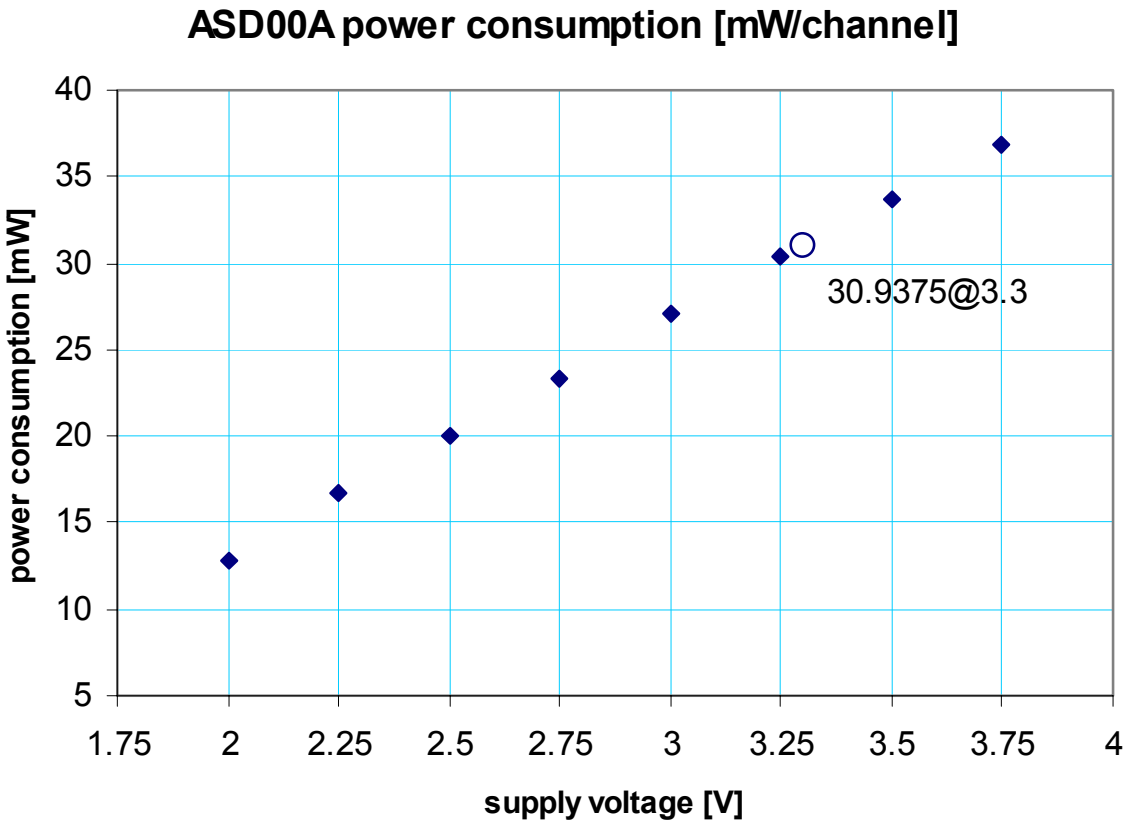


8-bit VDAC
Range: -370 to 370 mV
LSB: 2.9 mV
MAX diff nonlin: ±0.35 mV

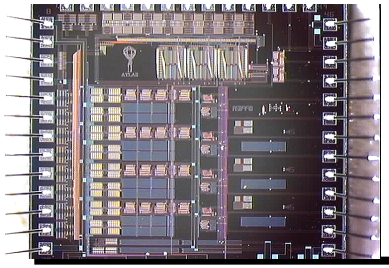


MDT Electronics PDR – ASD00A test results

Power Consumption



31 mW/channel

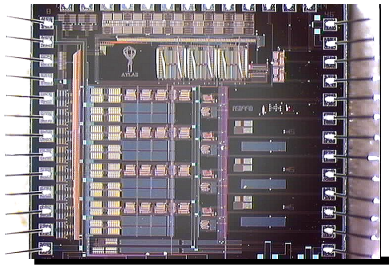


MDT Electronics PDR - Octal ASD

Iteration ASD00B

Power Buses	reduce voltage drop
Wilkinson	reduce channel-channel variations (revert to ASD99c: ramp slope, integration capacitor, rundown current sources. Increase rundown current)
Voltage Refs	adjust (VDAC ranges)
LVDS drivers	increase drive strength
"dead time"	adjust to specs

Submission: March 26



MDT Electronics PDR - Octal ASD

Conclusions

- ✓ First octal prototype ASD00A tested
- ✓ Shows complete functionality
- ✓ One more iteration for fine tuning (03/01)
- ✓ Production start on schedule