

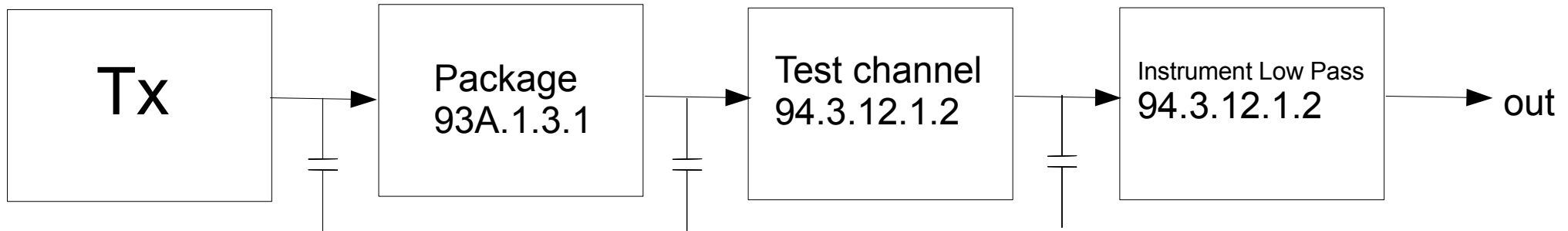
# Defining Tx bandwidth with pulse gain VS rise time

With illustration for clause 94

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2012 October 24

# Basic Tx model simulated

Based on specification on how Tx is measured.



Square wave  
PRBS13 PAM4

Multiple of  
Package model

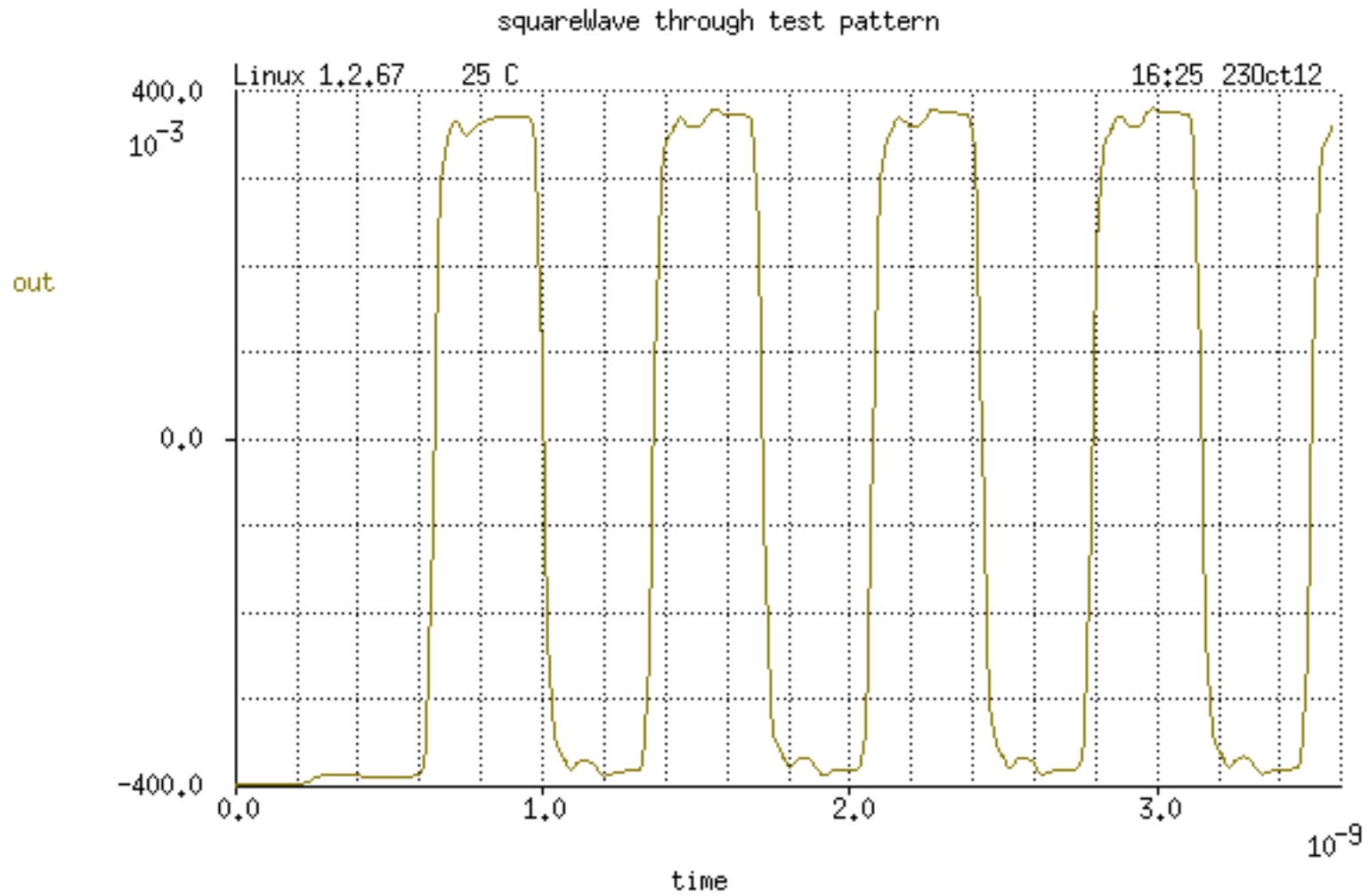
Per spec

4<sup>th</sup> order Bessel

Trapezoidal  
Rise time:  
0.1 UI  
0.5 UI

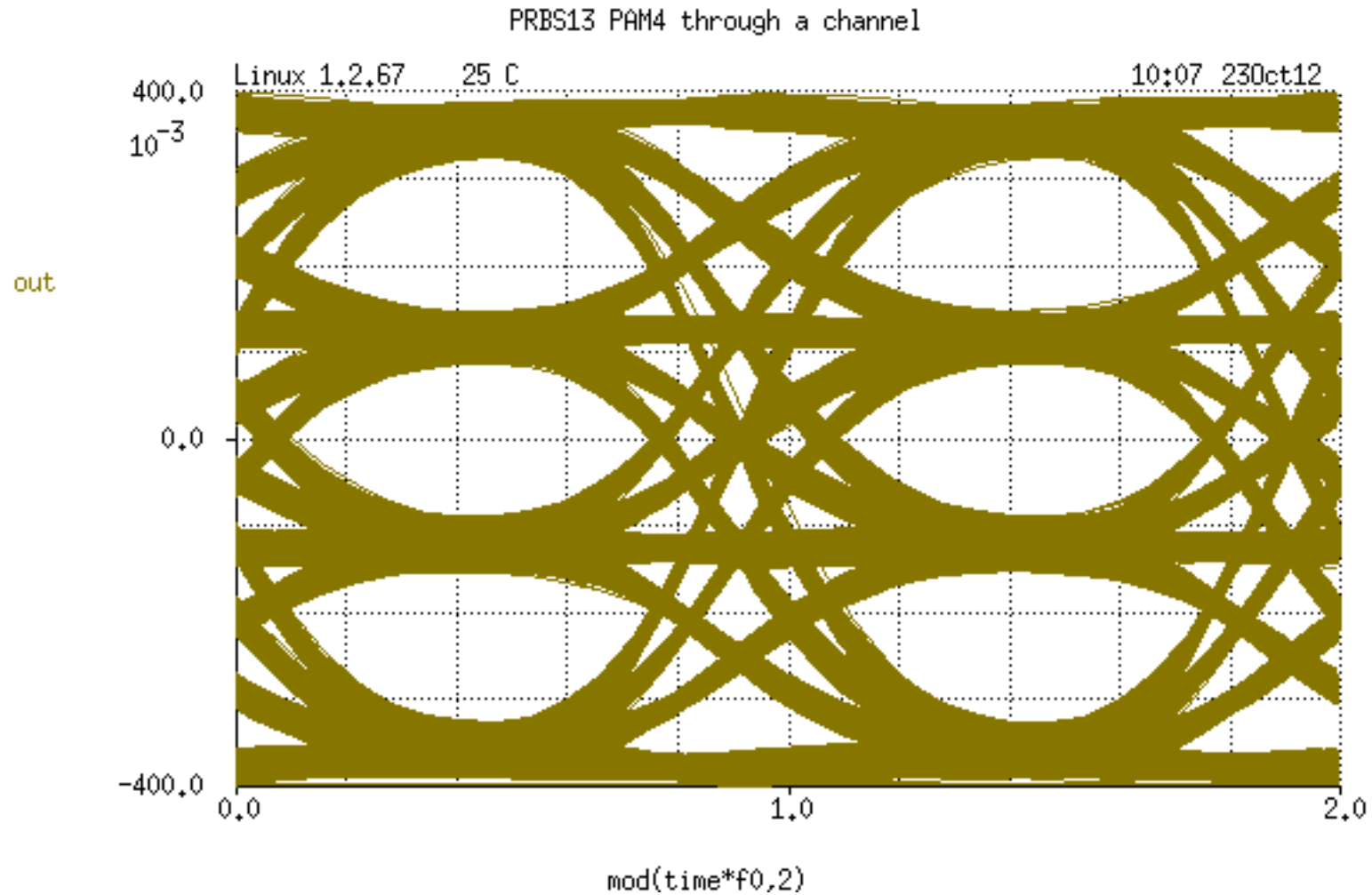
Capacitors represent reflections

# Square wave with baseline measurement channel



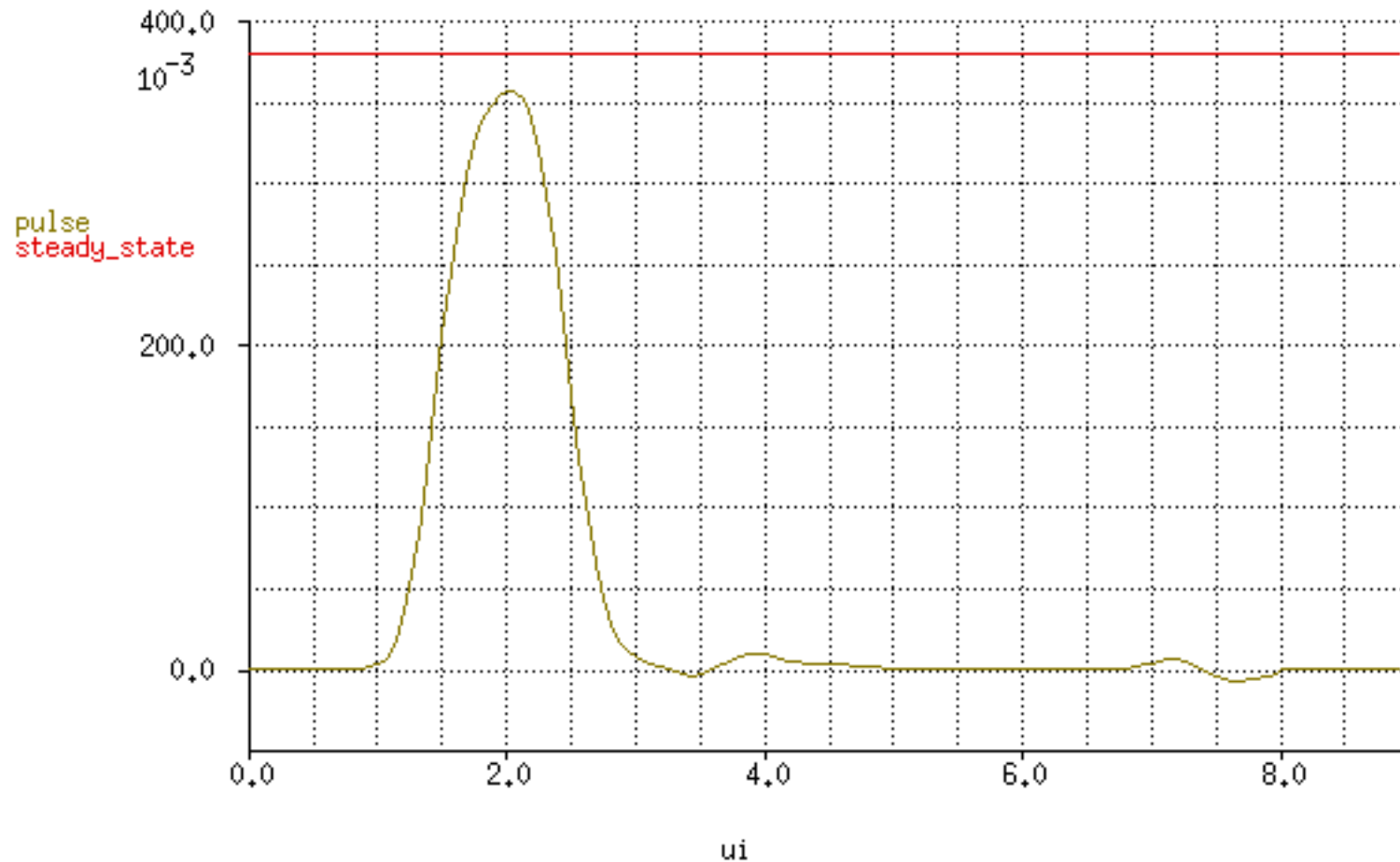
Rise time: 31.4ps

# PAM4 PRBS13 eye with baseline measurement channel



Eye: 0.65 UI x 170 mV

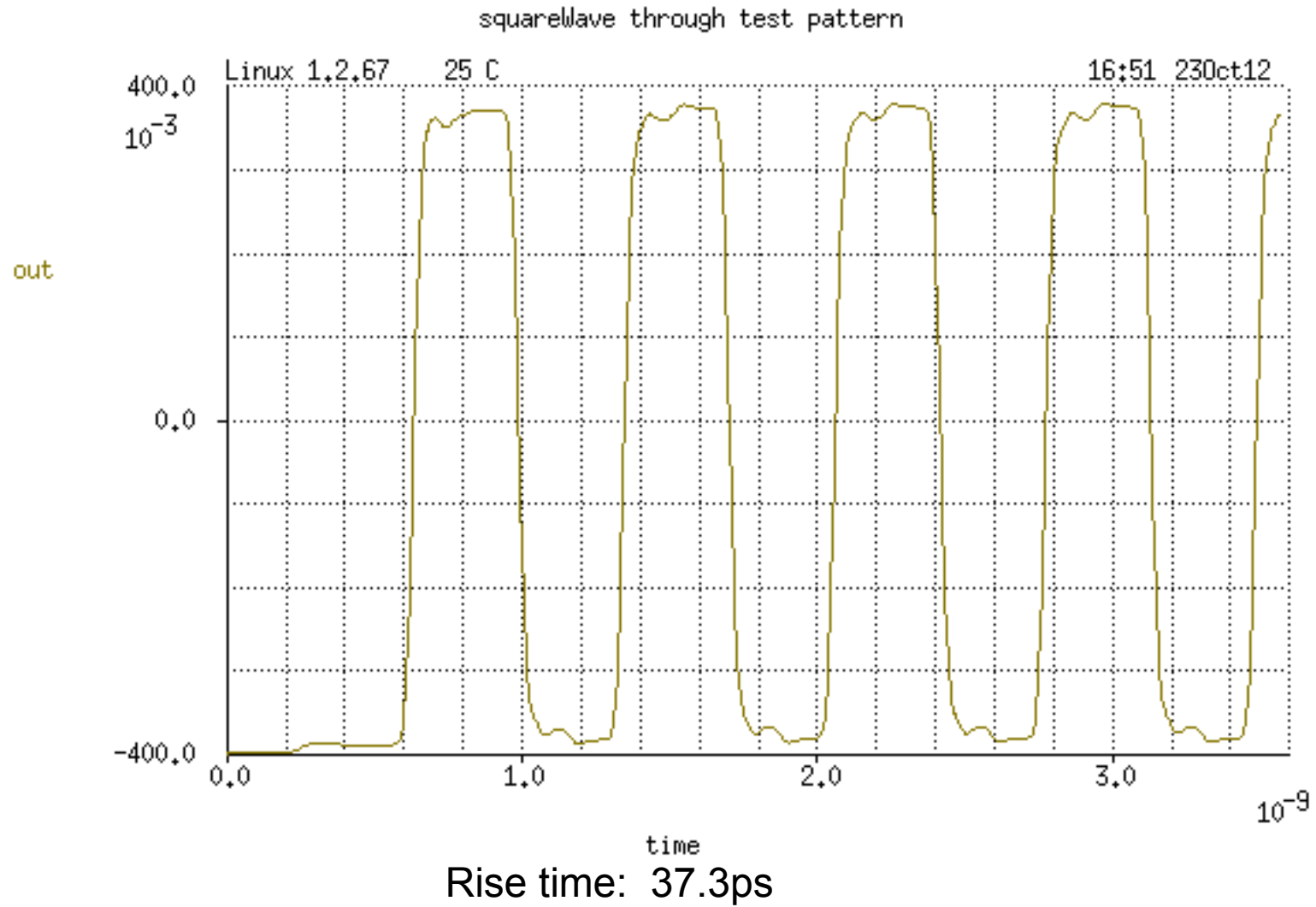
# PAM4 PRBS13 linear fit pulse with baseline measurement channel



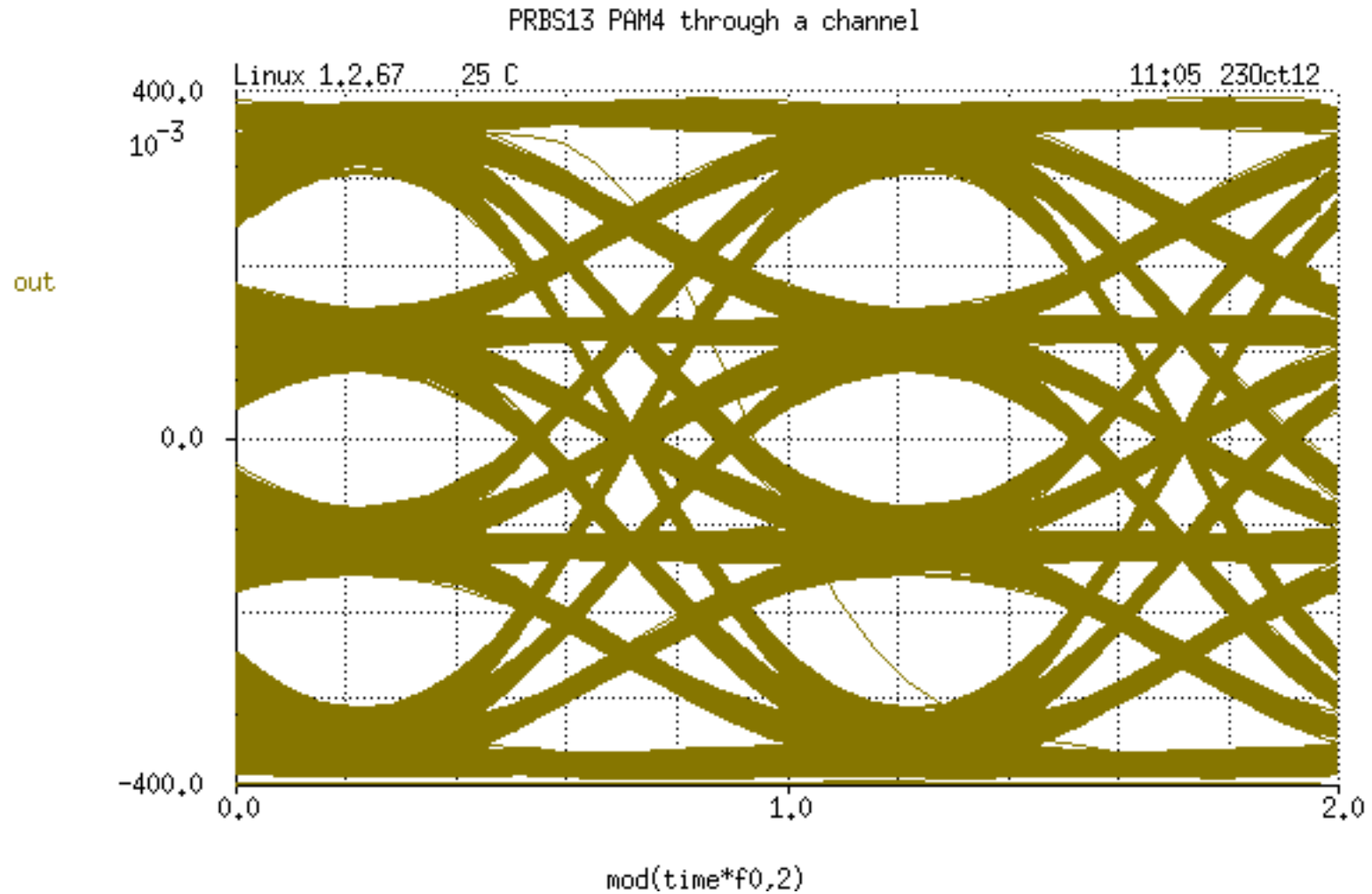
Rise time: 28.5p

Peak pulse / steady state: 0.94  $\rightarrow$  -0.56 dB

# Square wave with baseline measurement channel and 0.5 UI rise time

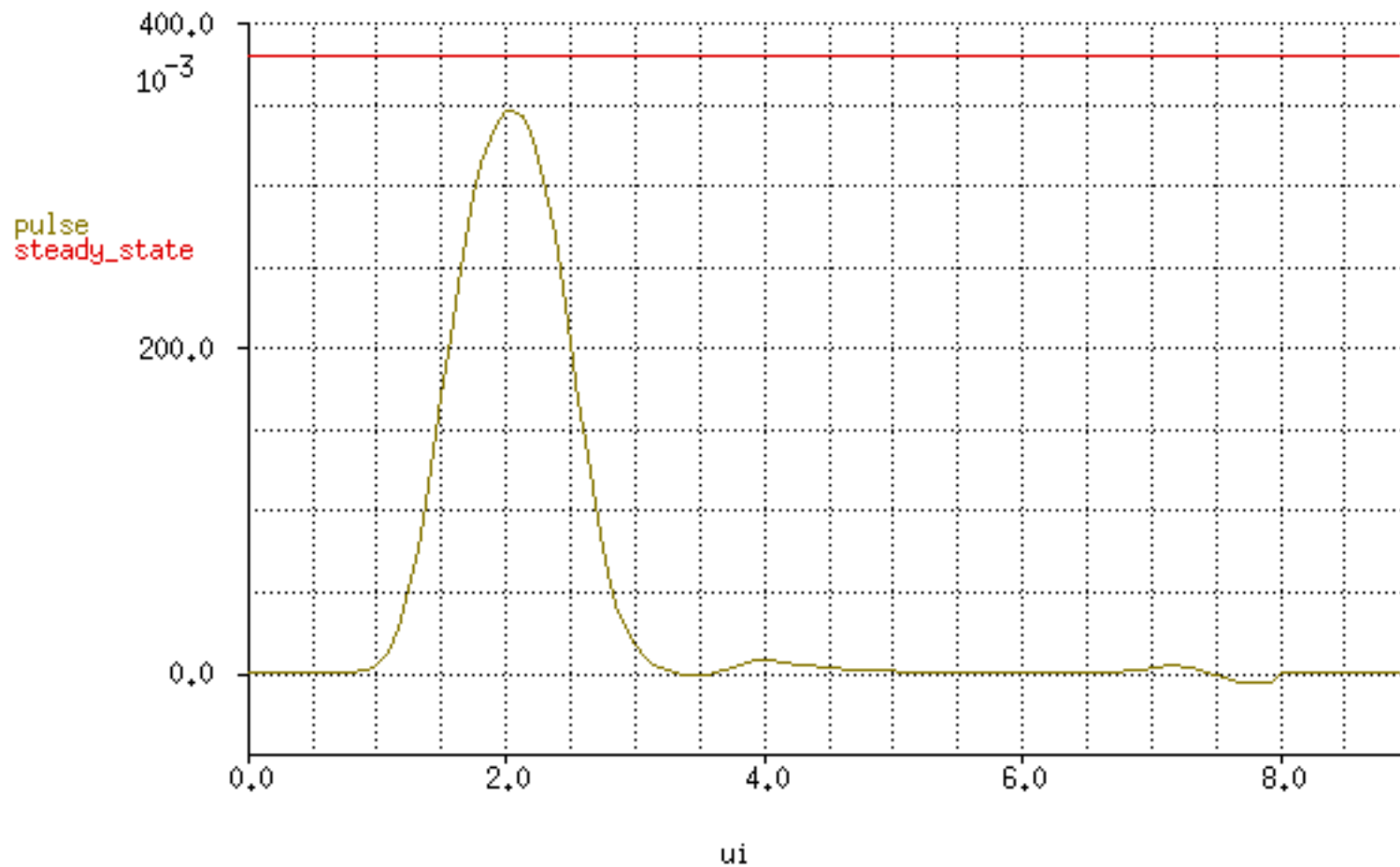


# PAM4 PRBS13 eye with baseline measurement channel and 0.5 UI rise time



Eye: 0.57 UI x 154 mV

# PAM4 PRBS13 linear fit pulse with baseline measurement channel

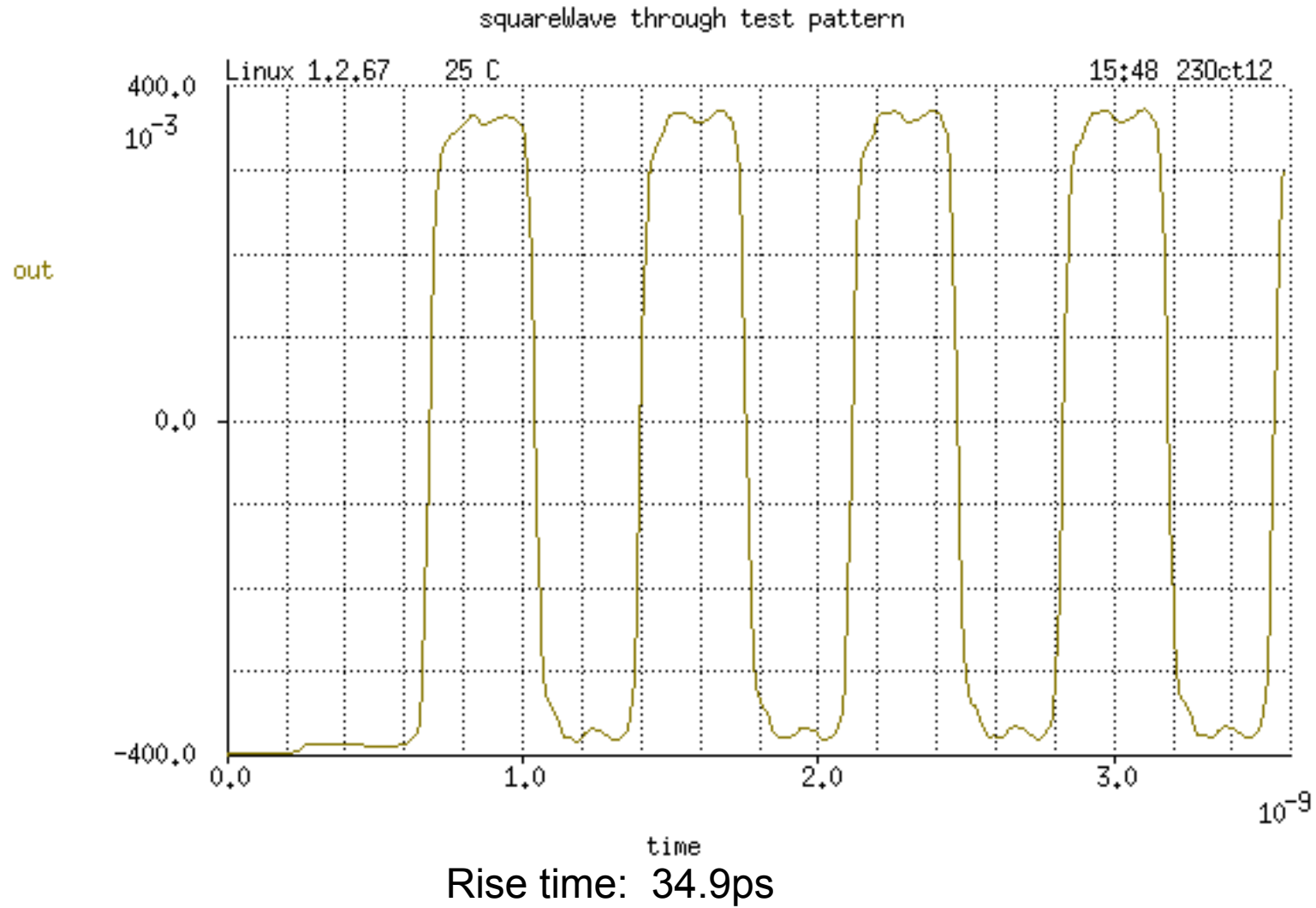


Rise time: 34.4 ps

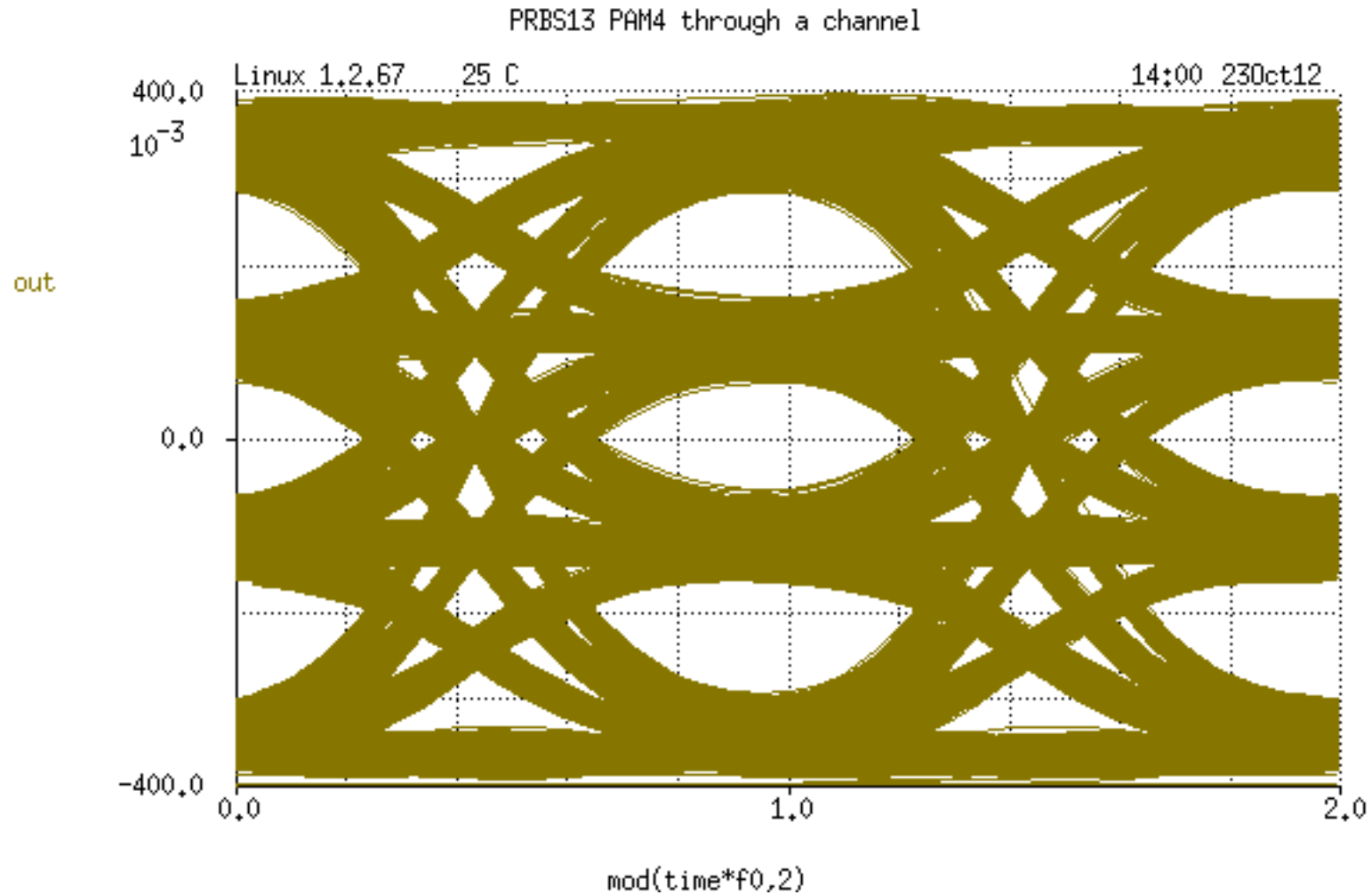
Peak pulse / steady state: 0.912  $\rightarrow$  -0.80 dB



# Square wave with baseline measurement channel and long package

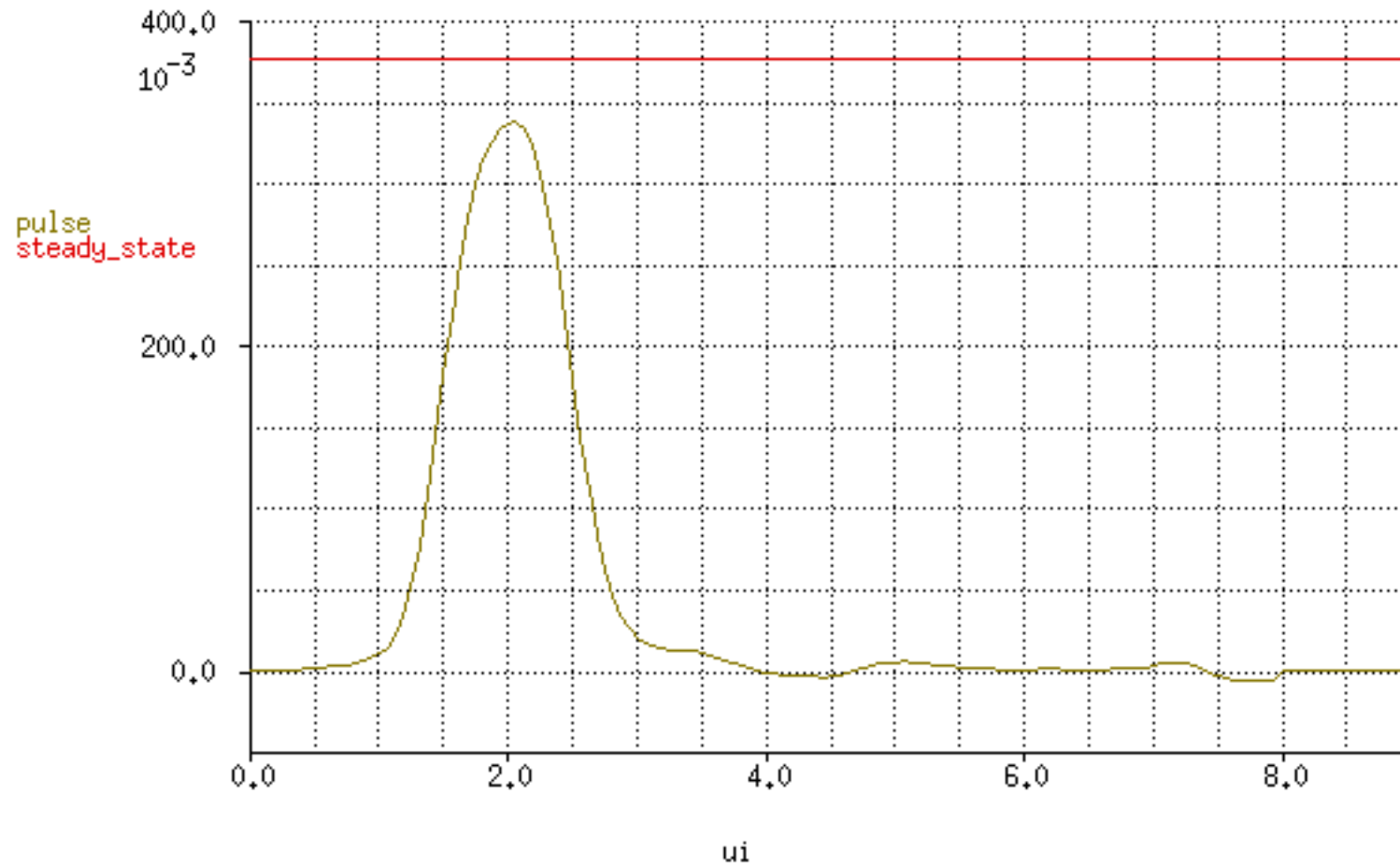


# PAM4 PRBS13 eye with baseline measurement channel and long package



Eye: 0.57 UI x 117 mV

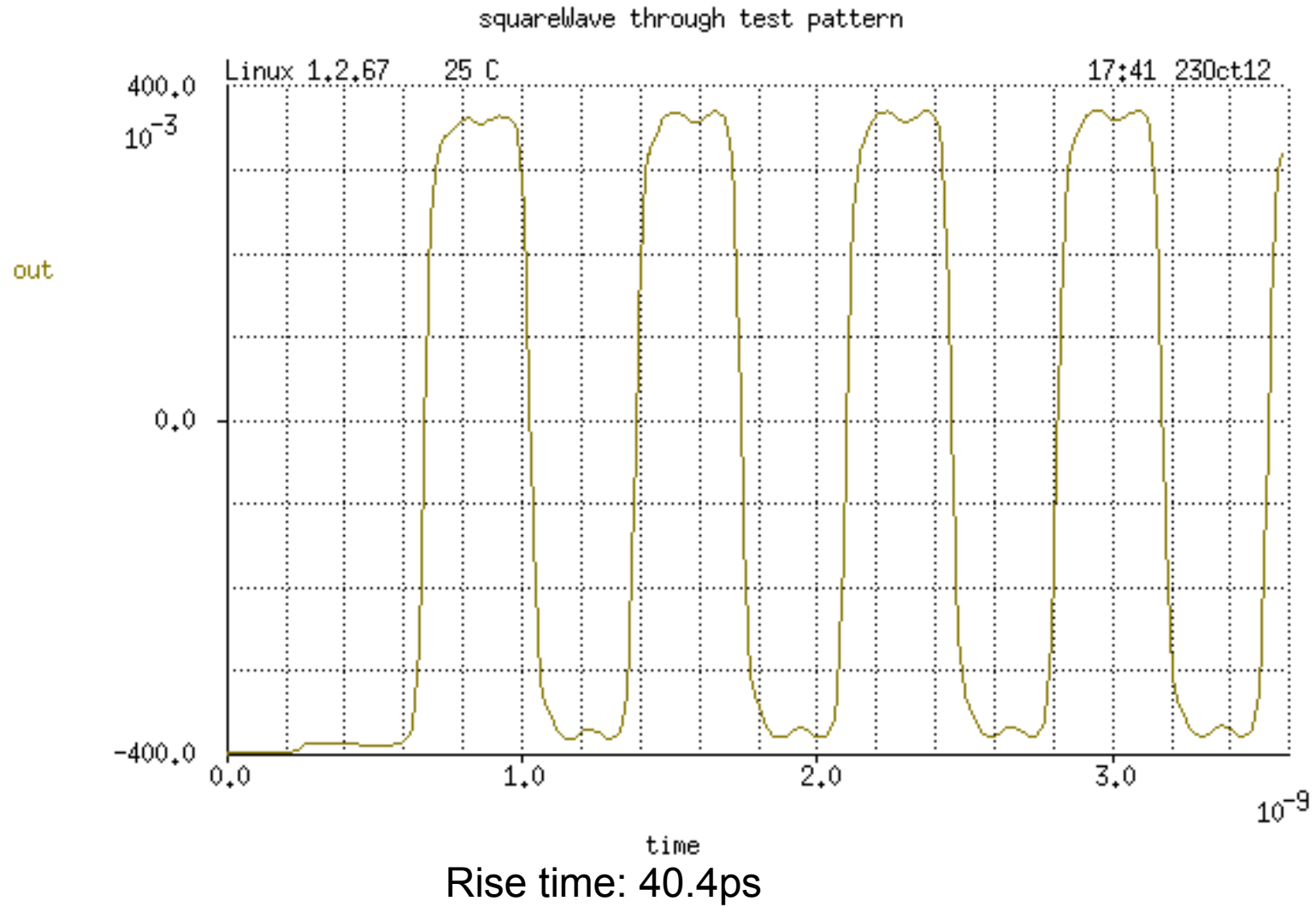
# PAM4 PRBS13 linear fit pulse with baseline measurement channel and long package



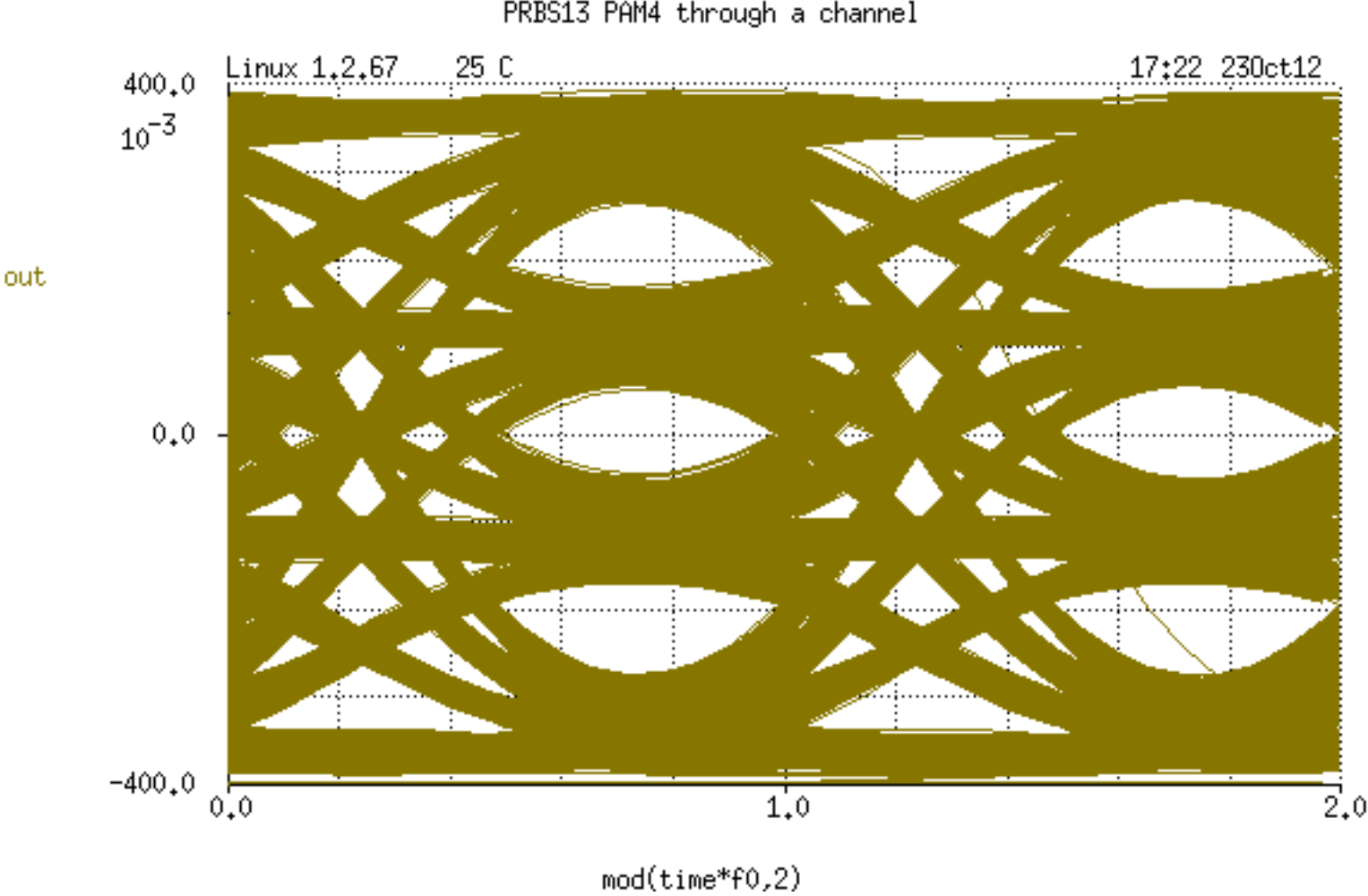
Rise time: 33.0 ps

Peak pulse / steady state: 0.895  $\rightarrow$  -0.96 dB

# Square wave with baseline measurement channel and long package and 0.5 UI rise time

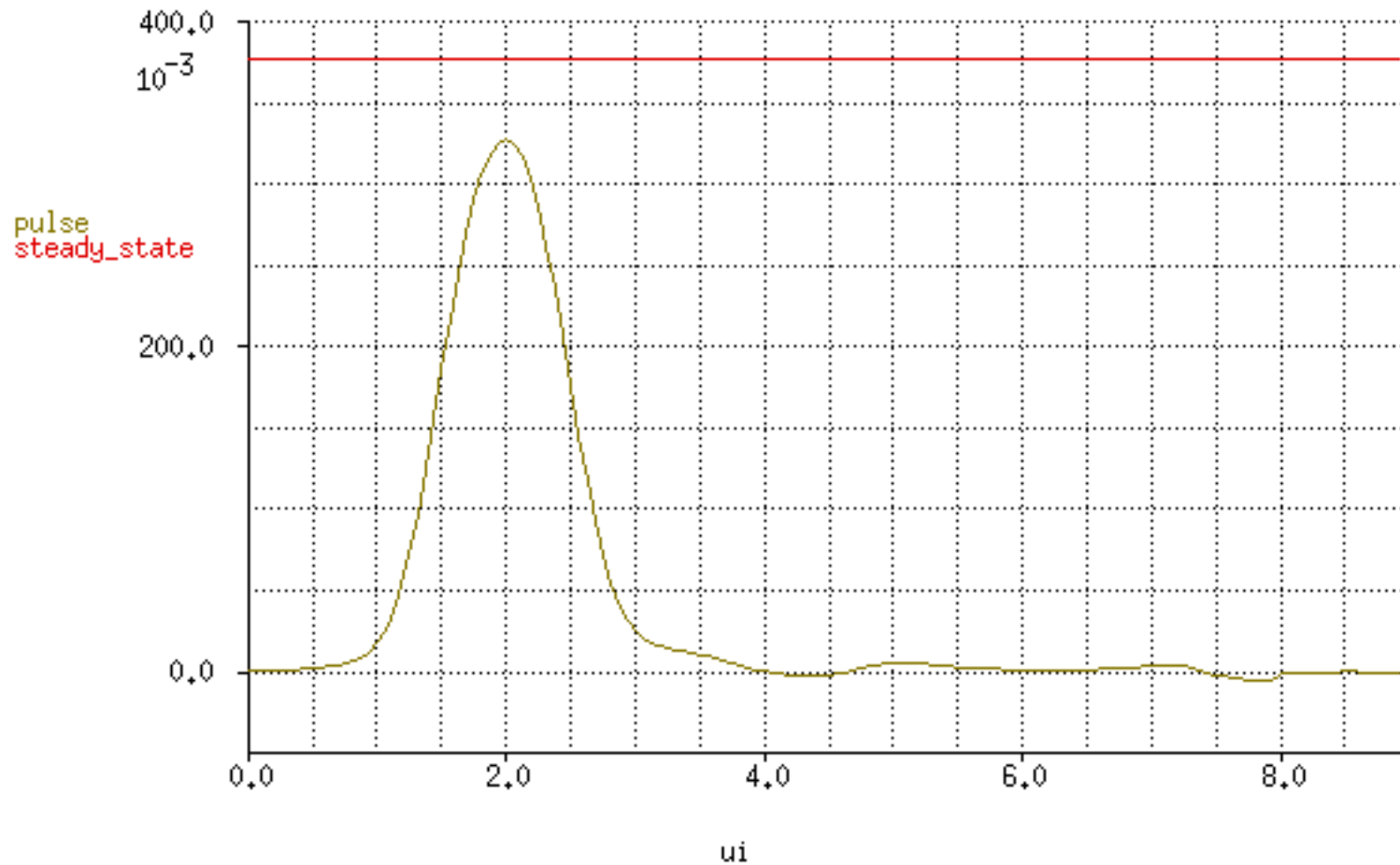


PAM4 PRBS13 eye with baseline measurement channel and long package and 0.5 UI rise time



Eye: 0.51 UI x 91 mV

# PAM4 PRBS13 linear fit pulse with baseline measurement channel and long package and 0.5UI rise time



Rise time: 39.0 ps

Peak pulse / steady state: 0.868  $\rightarrow$  -1.23 dB

# Summary of simulations

	Eye width	Eye Height	Rise time <sub>square</sub>	Rise time <sub>pulse</sub>	Pulse gain	dB pulse gain
clean	.65 UI	170 mV	31.4 ps	28.5 ps	.94	-0.56 dB
Slow rise	.57 UI	154 mV	37.3 ps	34.4 ps	.912	-0.80 dB
Long package	.57 UI	117 mV	34.9 ps	33.0 ps	.895	-0.96 dB
Slow rise and Long package	.51 UI	91 mV	40.4 ps	39.0 ps	.868	-1.23 dB

# Conclusions

- Rise time is not a very good predictor of eye quality
- Measured rise time using specified test method are unlikely ever to be shorter than a reasonable EMI based limit ~18 ps
- Pulse gain, ratio of peak linear extracted pulse to steady state voltage, seems to be a better predictor of eye quality
- Drop rise time specification and use pulse gain.
- Recommend minimum pulse gain of 0.85