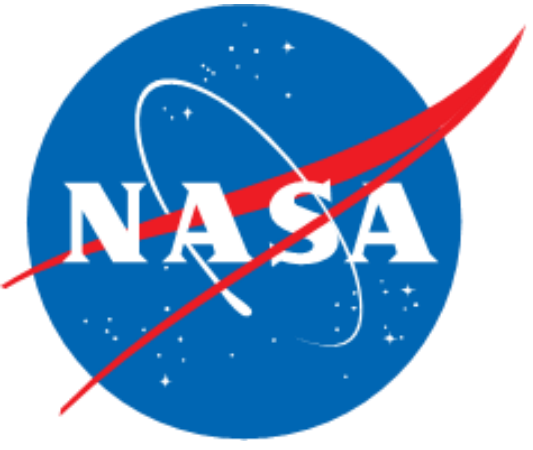


# Single Event Effects Testing of a Vertical Optocoupler with Unmodified Packaging



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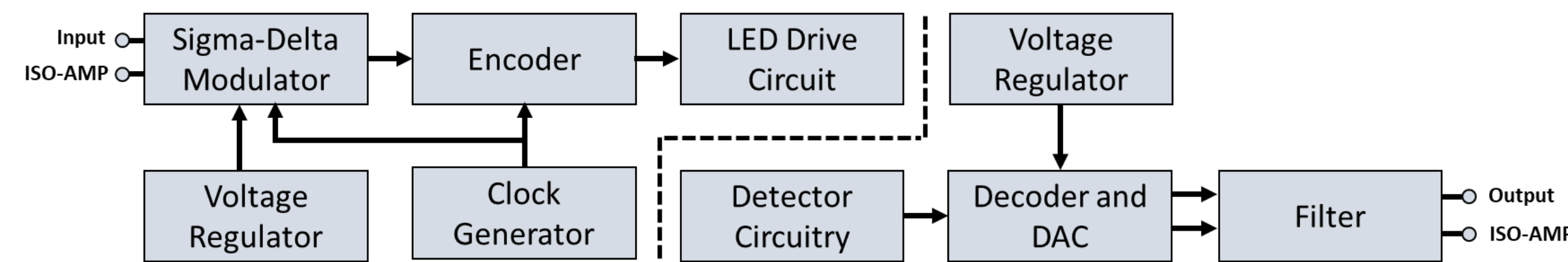
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## ABSTRACT

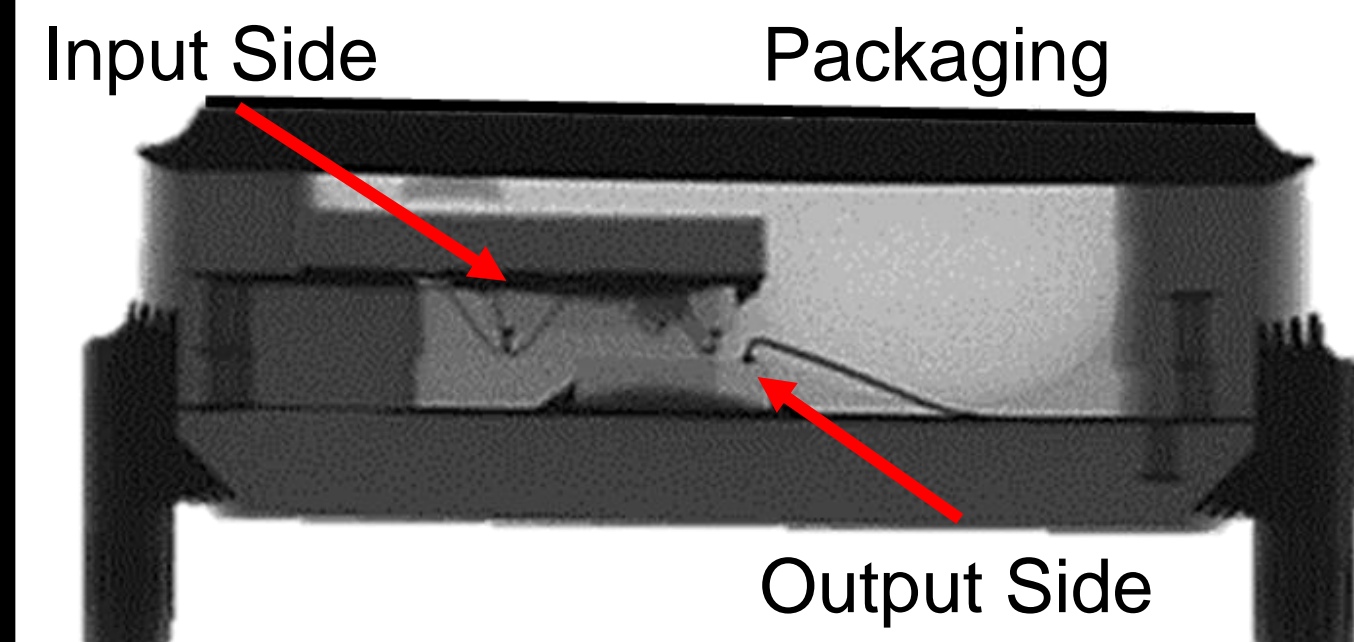
Single event effects testing was conducted on an ACPL-785E optocoupler at NASA Space Radiation Laboratory at several linear energy transfer (LETs) values. Measurements with a periodic input signal show single event transients (SETs) and a radiation-induced time delay of the output signal.

## DEVICE DETAILS

- Optocouplers provide electrical isolation between systems through a LED/photodetector pair - Single plane or multilayer configurations
- Broadcom's ACPL-785E utilizes additional circuitry to transmit an analog signal across isolation layer<sup>1</sup>, introduces additional SET sensitivities



## SEE TESTING OF UNMODIFIED PACKAGING



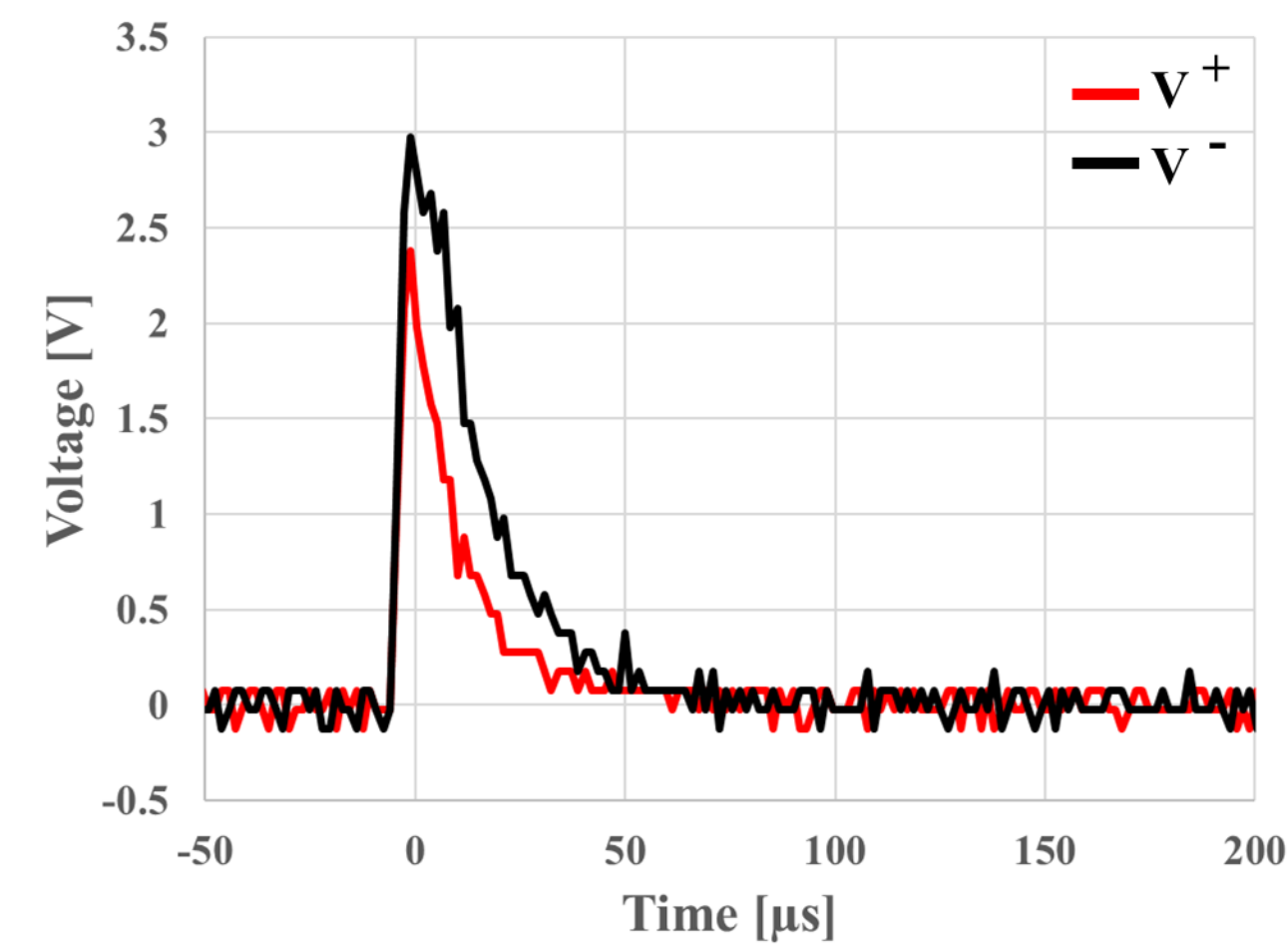
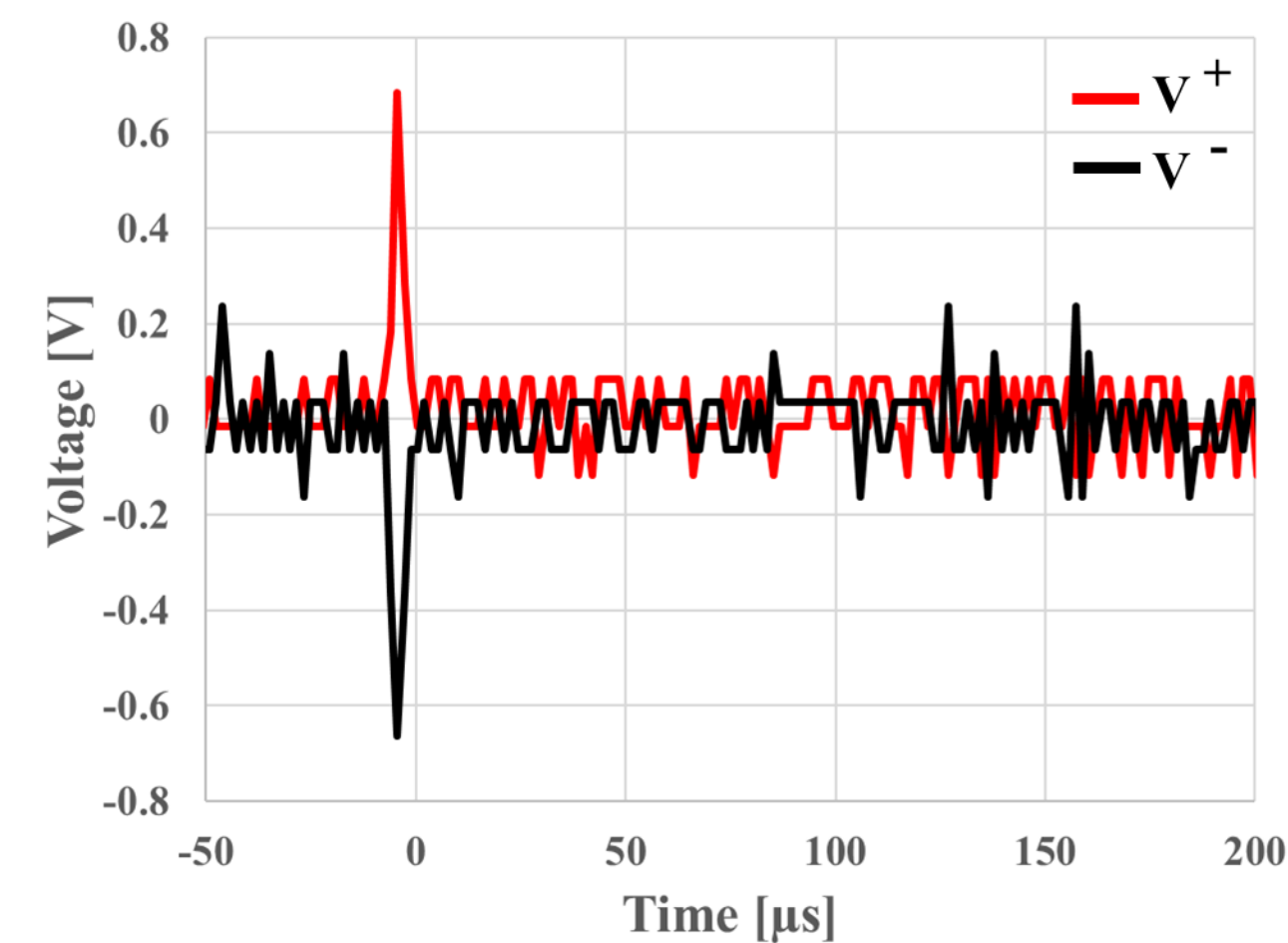
Particle Species + Energy [GeV]	Incident LET [MeV-cm <sup>2</sup> /mg]	Estimated LET [MeV-cm <sup>2</sup> /mg]	Input Signal
Tantalum - 28.0	21.0	27.2	Square
Tantalum - 25.3	22.2	31.3	DC
Tantalum - 22.6	23.8	37.6	DC
Tantalum - 21.7	24.0	41.8	DC
Gold - 39.3	21.3	25.7	DC
Gold - 35.4	22.6	30.1	DC
Gold - 27.6	24.2	33.4	DC

- In-situ SET testing of multilayer optocouplers requires long range particles to pass through the unmodified packaging, multiple chip substrates<sup>2</sup>
- SEE testing was conducted at the NASA Space Radiation Laboratory
  - SRIM was used with material stack to estimate LET at circuit dies<sup>3</sup>

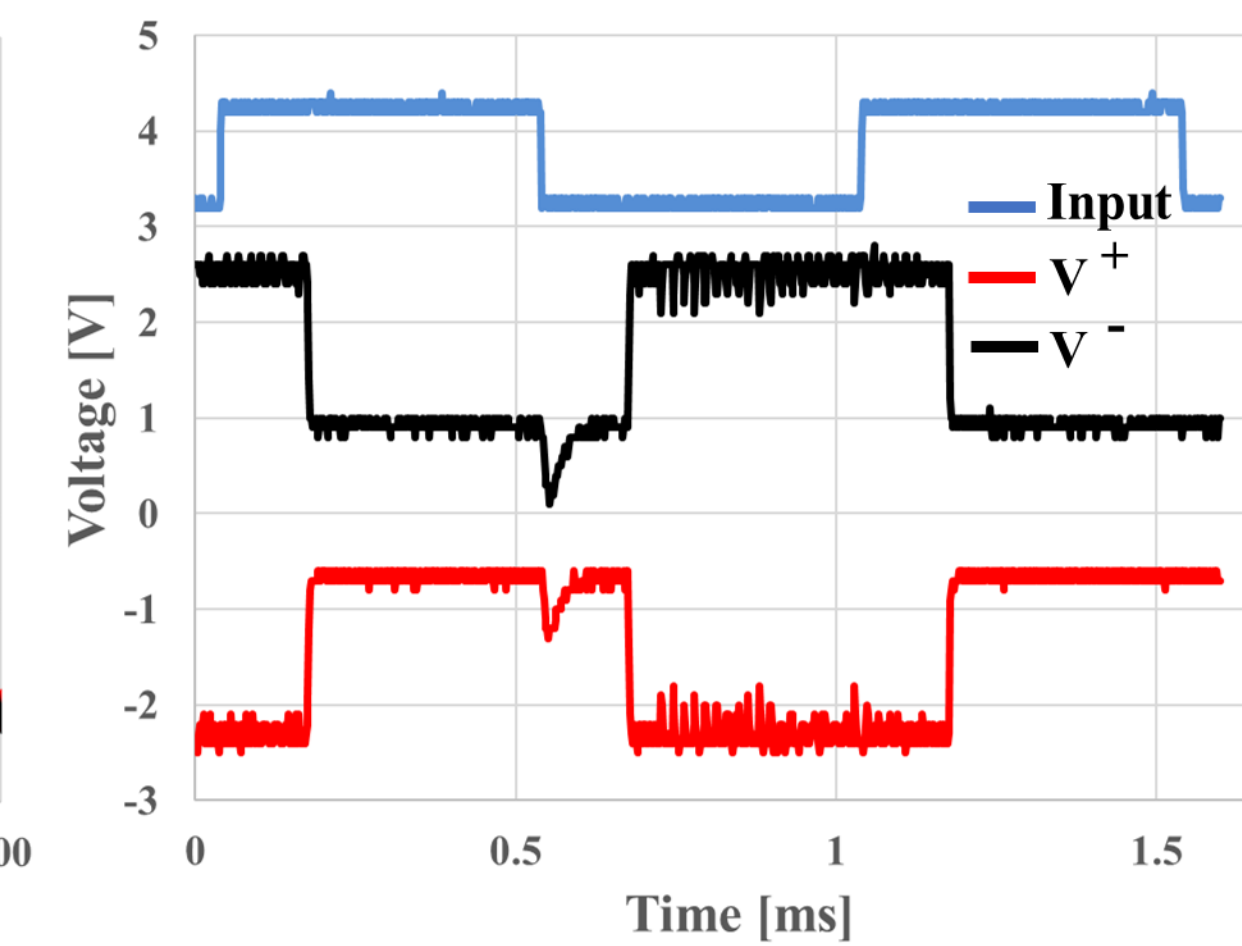
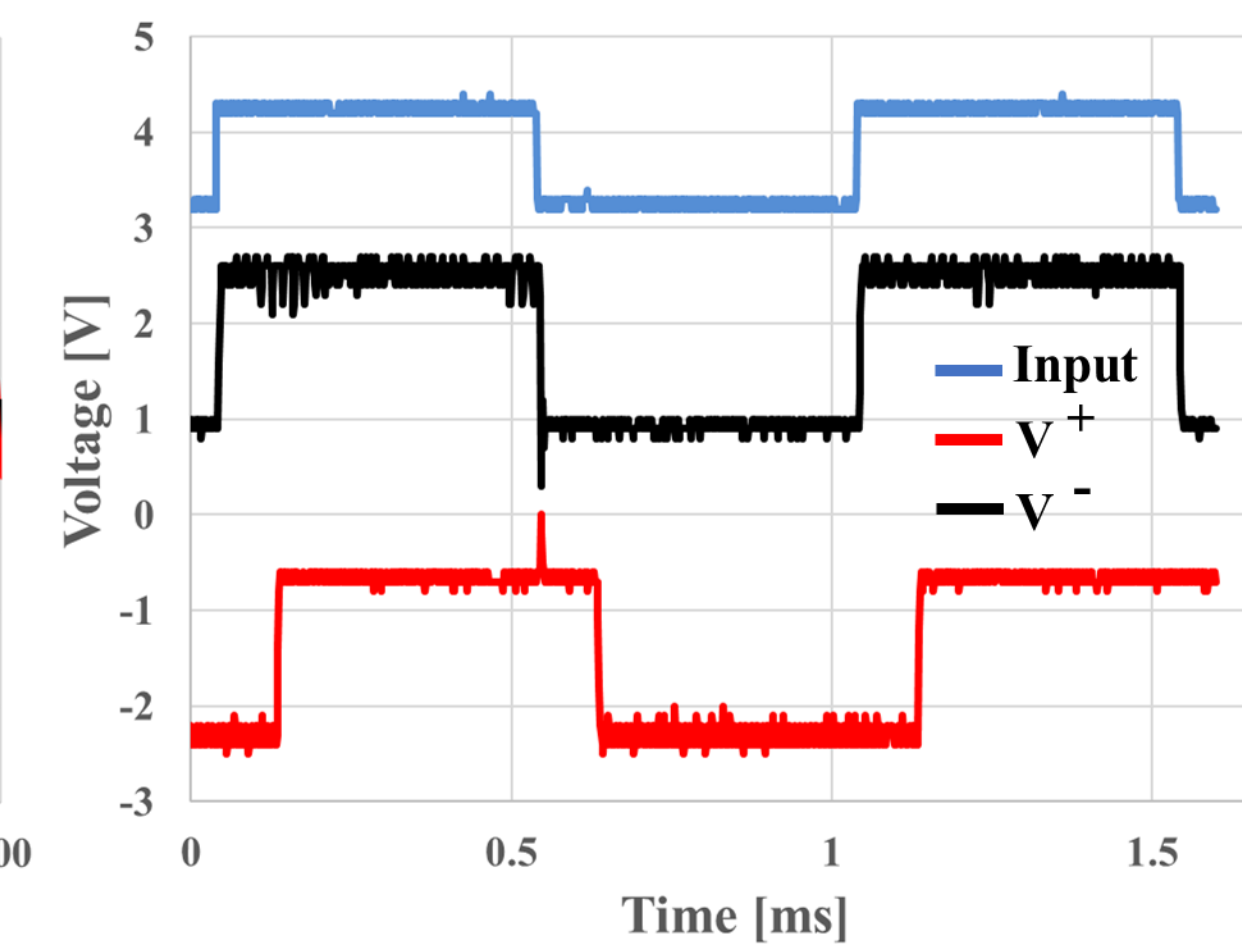
## EXPERIMENTAL RESULTS

- SET measurements conducted with constant and square wave input signals the output voltage channels  $V^+$  and  $V^-$  were monitored for comparison
- No destructive SETs were observed over multiple LETs
- Constant input signals: SETs of different amplitudes, polarity were observed
- Square wave input signal: SETs of different amplitude and polarity, radiation induced time delay in one or both output voltage signals

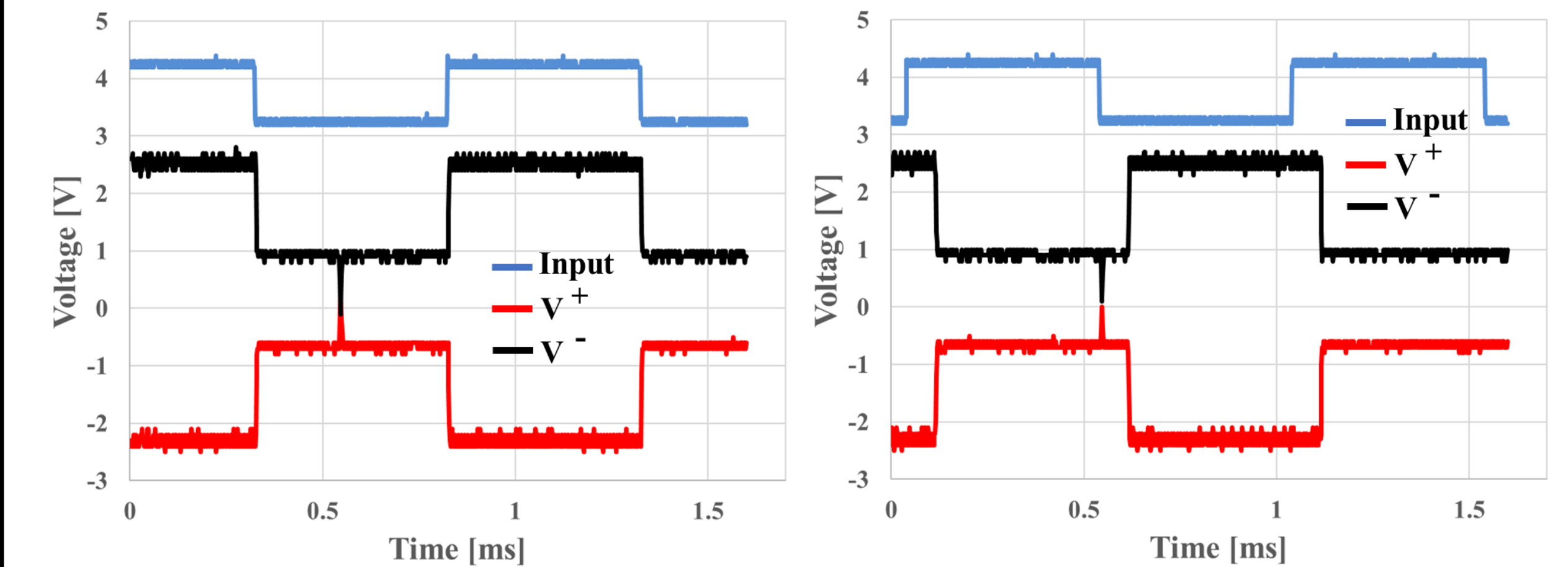
### Constant Input



### Square Wave Input



## DISCUSSION



- Radiation-induced time delay independent of SETs observed in the output a consequence of disrupting time circuitry
- Under nominal operation, an input signal induces a symmetric output
  - SET originating in the input side will result in symmetric response
  - SET originating in the output side will result in asymmetric response

## CONCLUSIONS

- Heavy ion SEE measurements were conducted on Broadcom's ACPL-785E optocoupler w/ unmodified packaging NASA Space Radiation Laboratory
- During nominal operation, SETs of varying amplitude and polarity were observed as well as a radiation-induced time delay for periodic input signal
- SEE response a consequence of additional circuitry for analog functionality, introduces extra susceptibility not covered by normal mitigation techniques

## REFERENCES

- Broadcom, "ACPL-785E Hermetically Sealed Analog Isolation Amplifier SRIM," Available: [docs.broadcom.com/doc/AV02-3479EN](https://docs.broadcom.com/doc/AV02-3479EN).
- J. A. Pellish, et al. "Heavy ion testing at the galactic cosmic ray energy peak." in 2009 European Conference on Radiation and Its Effects on Components and Systems, pp. 559-562, Sept. 2009.
- F. Ziegler, "SRIM - The Stopping and Range of Ions in Matter," Accessed: Jan. 2021 . Available: <http://www.srim.org/>