LIGHTNING SUPPRESSION AT TELEMETERED TRAFFIC MONITORING SITES (TTMS)

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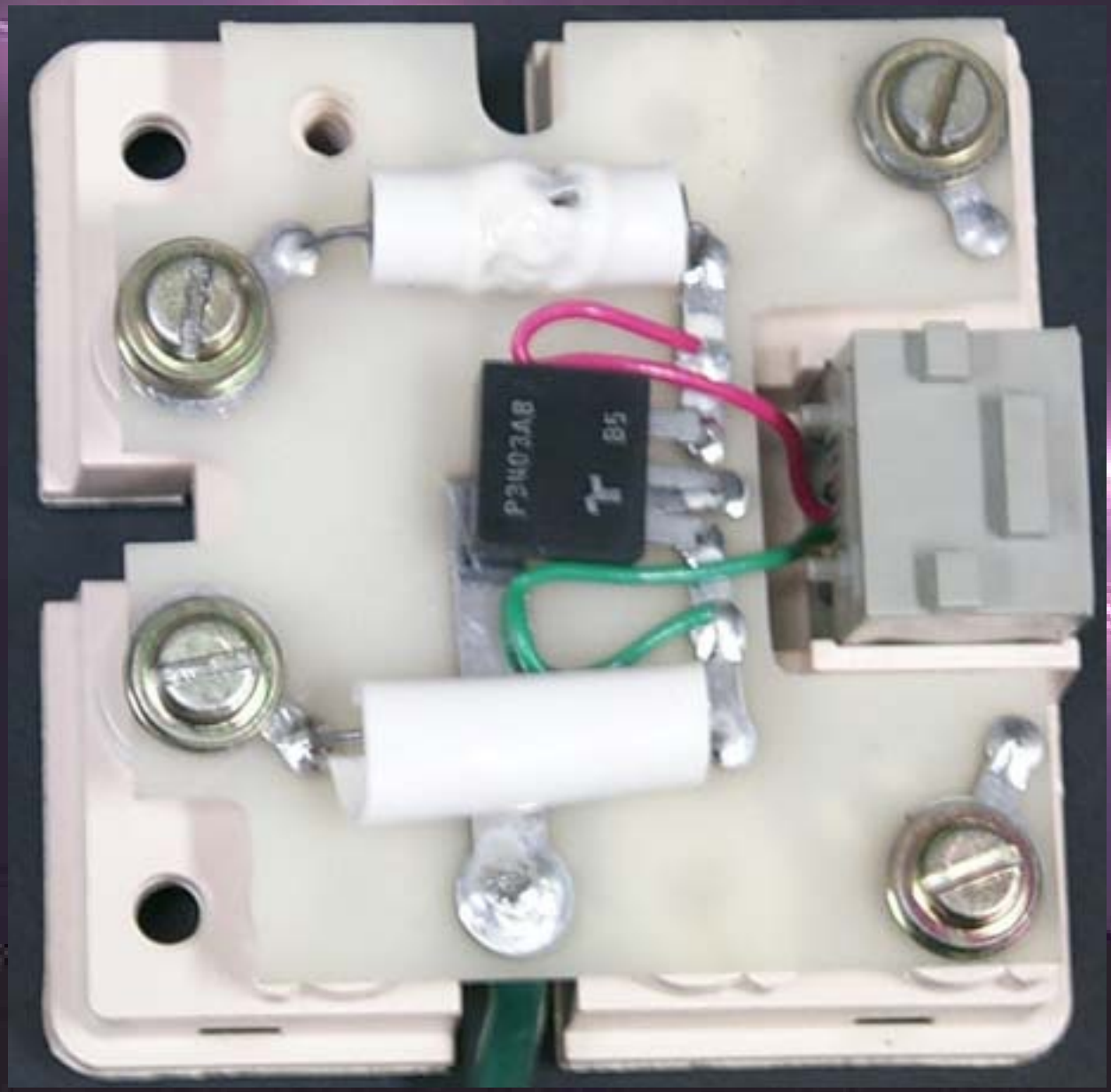
Purpose of This Effort

- Reduce the Number of Failed Telephone Line Surge Suppressors at TTMSs
  - Analyze Failed Devices
  - Identify Lightening Environment (Florida)
  - Test Surge Suppressors
  - Develop Standards Recommendations
- Other Surge Suppressors Not Analyzed at This Time

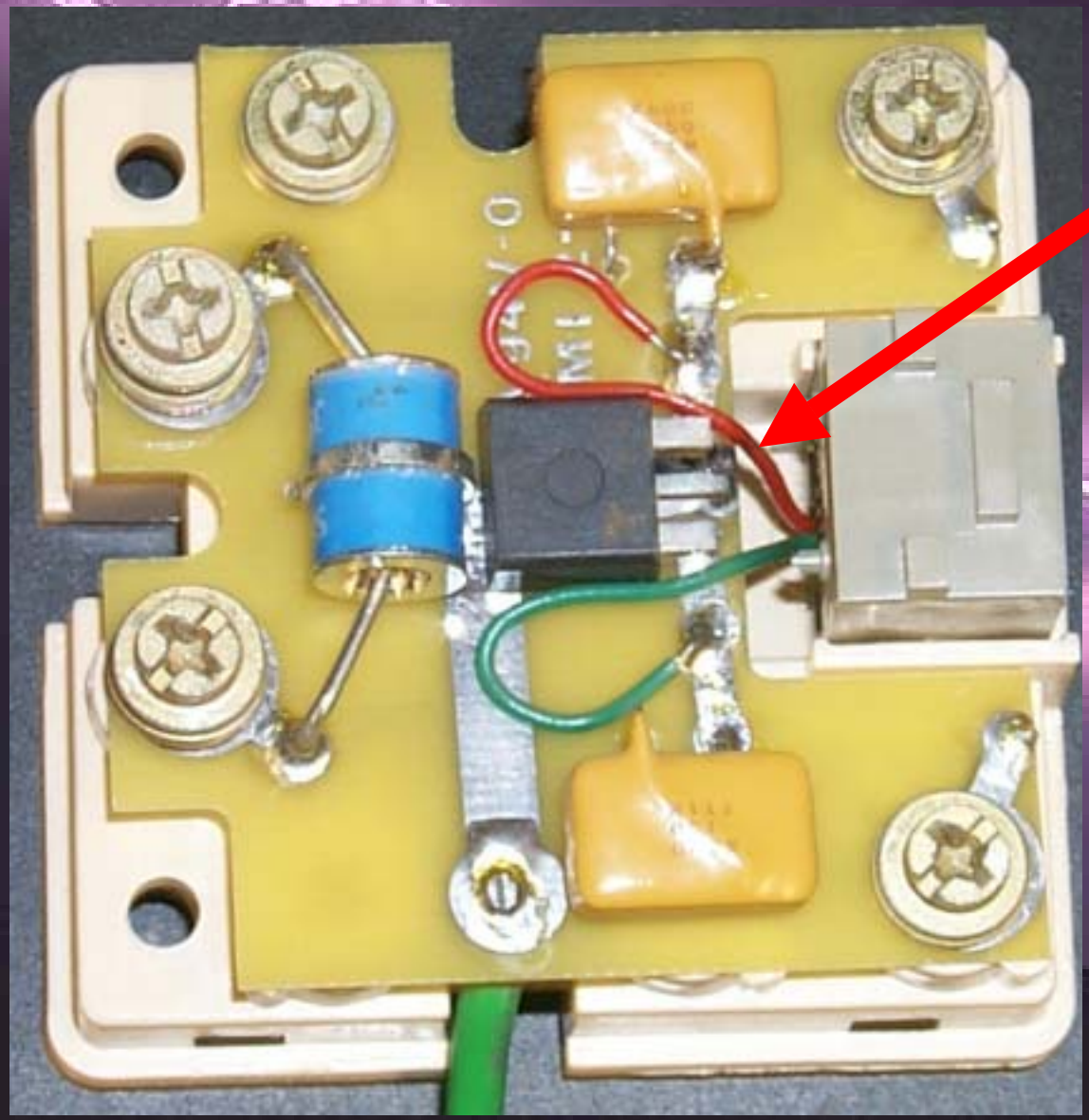
Analysis of Failed Telephone Line Surge Suppressors

- Florida DOT Collected a Number of Failed Surge Suppressors
- Suppressors Analyzed Through
  - Visual Inspection
  - Component Testing
- Goal: Determine Mode of Failure

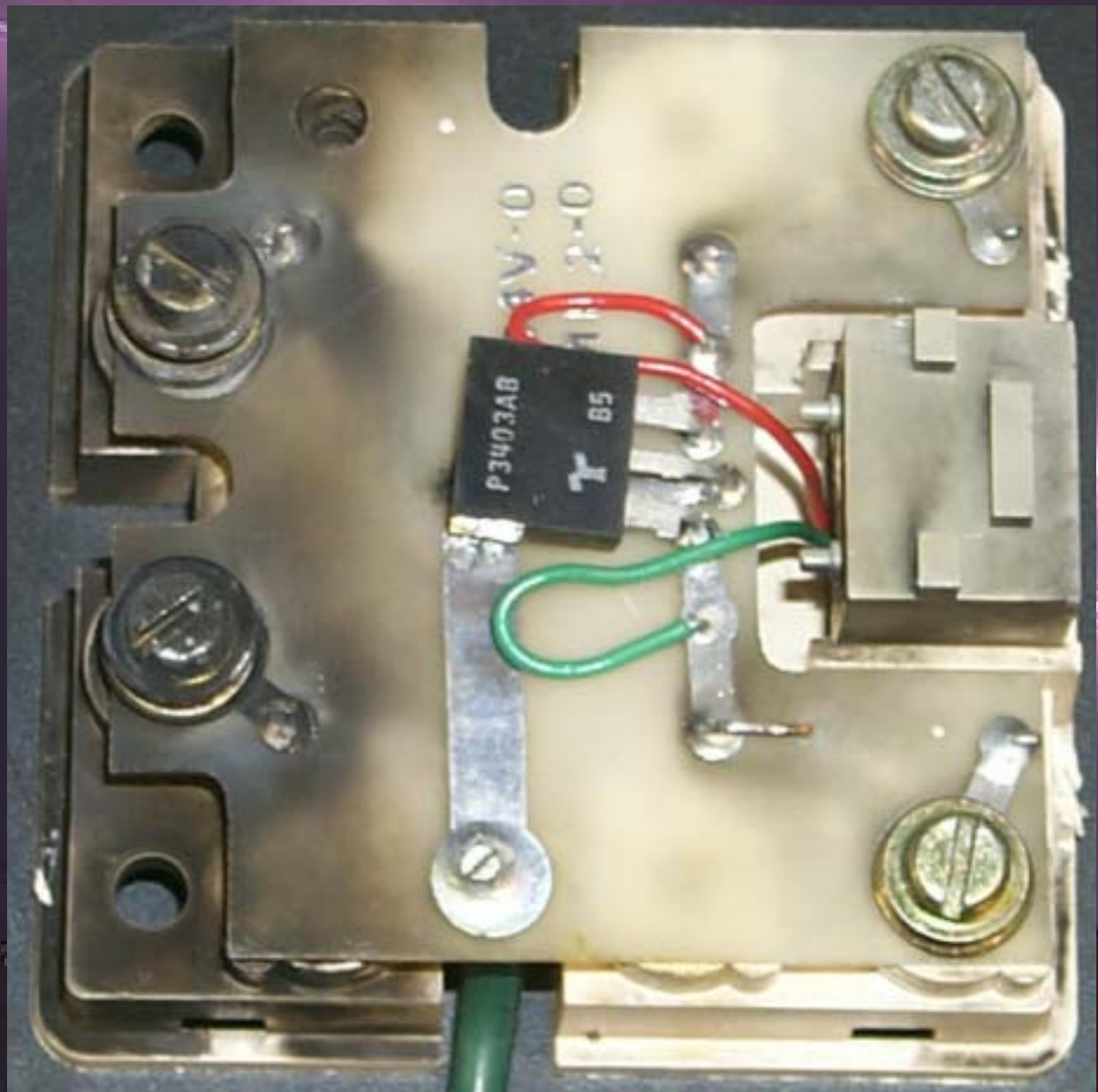
Typical Failed Surge Suppressor



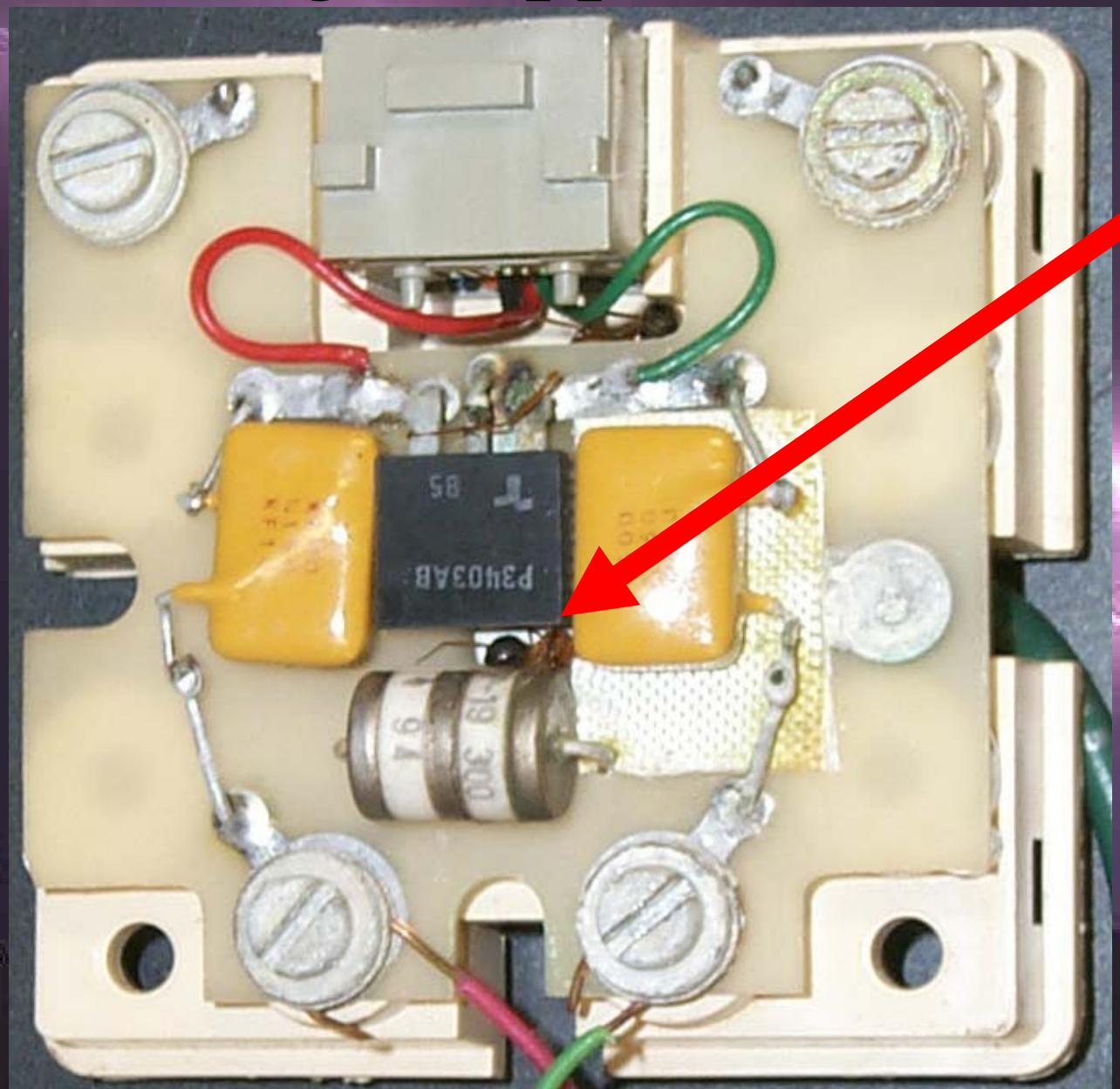
Typical Failed (?) Surge Suppressor



Atypical Failed Surge Suppressor



Other Surge Suppressor Hazards



Analysis of Failed Surge Suppressors

- Early Surge Suppressors had Fuses Blown
- Most Times the Blown Fuse was the Only Damage Noted (>75% Failures Due to Fuse)
- Occasionally Catastrophic Damage
- Newer Devices:
  - Gas Tubes – More Reliable than Fuses, Fast
  - Resettable Fuses – Slow, for Safety
  - Sidactor – Solid-State Voltage Limiter, Very Fast
    Now the Likely "Weakest Link"
- None of the Newer "Failed" Suppressors Not Working

Identifying Lightening Environment

- Questions:
  - How Often Are Surges Present?
  - How Intense are the Surges?
- Approach:
  - Install Portable Data Logger at TTMSs
  - Detect Voltages in Excess of Normal Telephone Line (50 Vdc + 90 Vac ring)
  - Current Measurements Unsuccessful

Equipment for Monitoring Surges

- MetraHit 29S Multimeter
  - Can Record Pulses ≥ 5 μsec and Over 200 V
  - Event Recorder to Store Events (Pulses) with Magnitude and Time/Date
  - Current Probe had Insufficient Magnitude for Pulse Detection
  - Sampling Rate (non-pulse) ≥ 5 msec (too slow)
- 12V Battery and Voltage Regulators for Monitoring over 1 Week
- Installed at 3 TTMS Locations (2 successful)

Results of Surge Monitoring

- Site 245: Hwy 59 LLoyd, FL
  - Monitored for 37 days (6/28 to 8/3/2001)
  - Total Surges: 26 (9 ring surges)
  - Average: 0.7 per day
  - Peak: 9 Surges on 6/29/2001
- Site 192: Hwy 20 Youngstown (N. of Panama City)
  - Monitored for 92 days (7/3 to 10/2/2001) inc. T.S. Barry
  - Total Surges: 4460 (556 ring surges)
  - Average: 48.5 per day (6 ring surges)
  - Peak: 461 Surges on 8/16/2001
- Site 906: I-4 Deltona
  - Monitoring Problems (voltage dropouts): 2 successful days
  - Total 90 Surges (3 ring surges) all on 9/4/2001

Conclusions From Environmental Studies

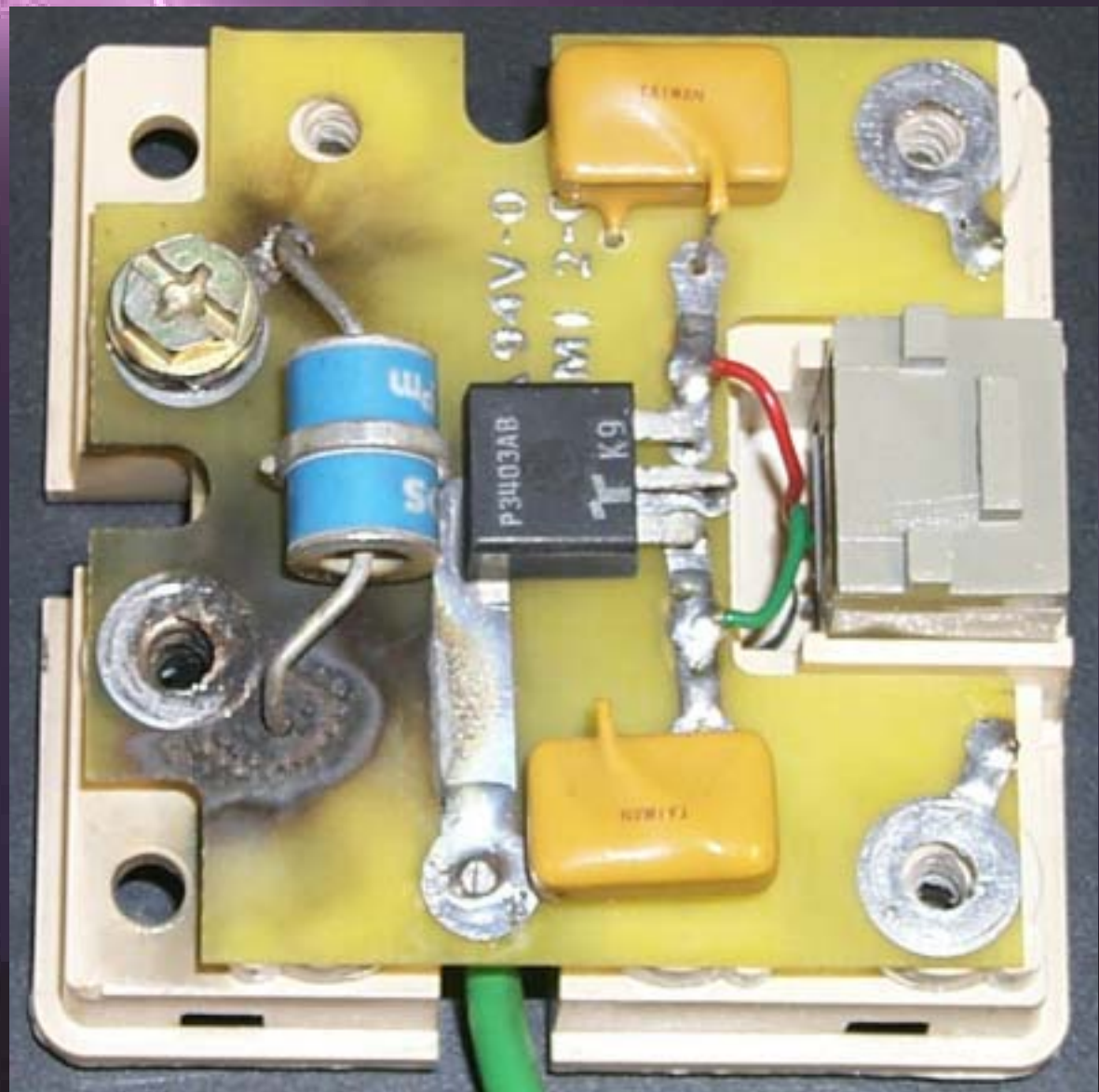
- "Killer Surges" NOT the Most Troublesome
  - Newer Devices Rated to 10 kA typical
  - Older Devices Rated Much Lower
  - Consistent with Analysis of Failed Suppressors
- Problem Appears to be Frequency of Lightening Surges
  - Need Devices With Greater Endurance Rather Than Higher Peak Current Capability
  - **May Need More Resilient Solid-State Dev.**

Surge Suppressor Lab Testing

- Purchased Lightening Surge Generator
  - MIG 0606 (HV Technologies)
  - Impulse Current: 0.5 to 6 kA (8/20 μsec)
- Purpose: Endurance Tests of Surge Suppressors
  - Repeated Surges at Various Current Levels
  - Identify Failure Modes
  - Verify Damage with Experiences in Field

Coupling of Surges Critical

- Wire Not Secured Tightly Between Washers
- Surges Destroyed Circuit Traces
- NOT Typical of Devices Failed in Field



Coupling of Surges Critical

- Surge Mode
  - Line-to-Line
- Destroyed Connector

- NOT Typical of Field Experience

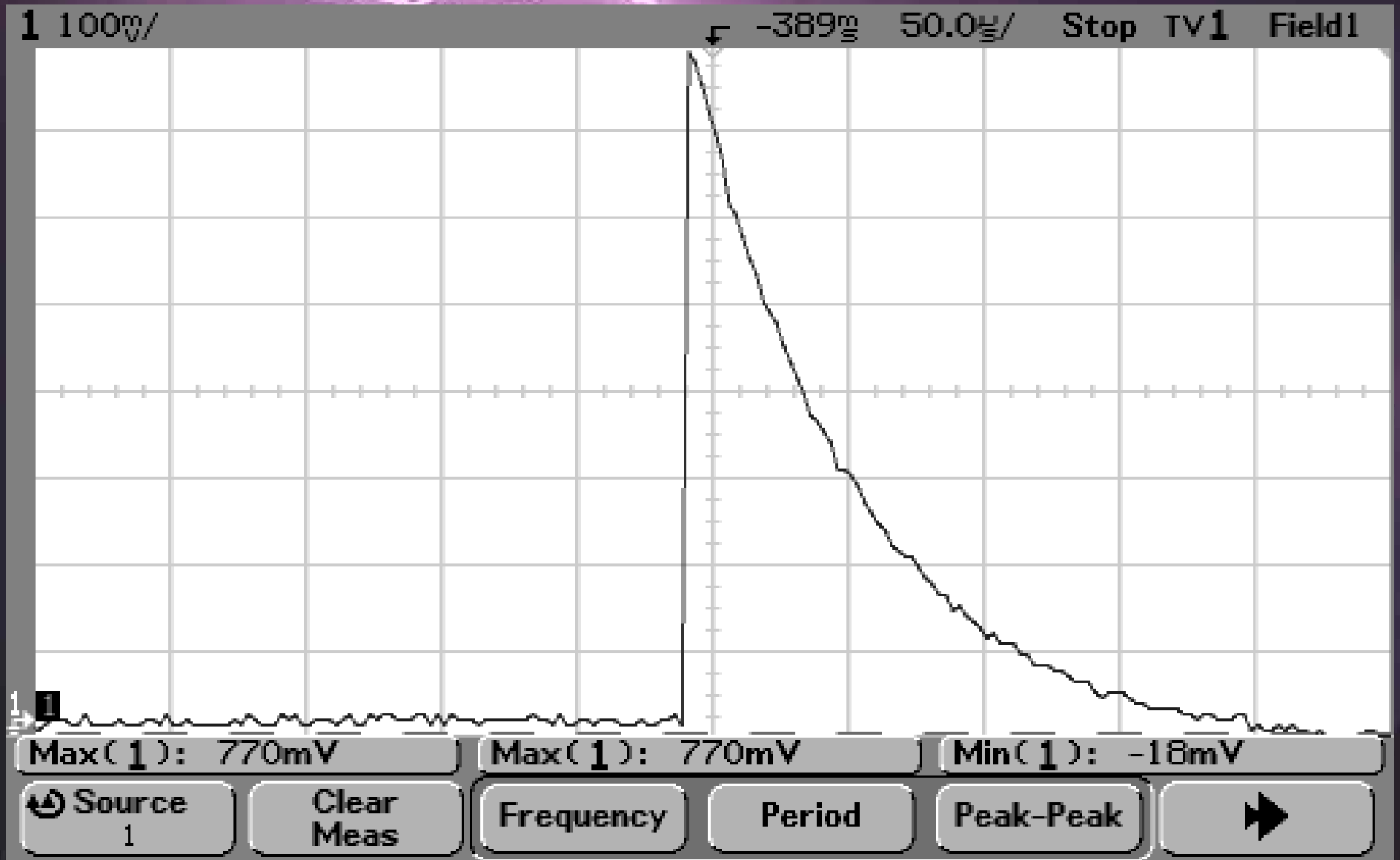
Ongoing Test of EDCO and Citel Surge Suppressors

- Current Telephone Surge Suppressors Based on Gas Tubes with Supporting Electronics
- Much More Resilient to Surges (up to 10 kA)
- Multiple Surges from 500 A to 6 kA Have Been Applied ; None Have Failed
- Older (Fuse Based) Suppressors Had Catastrophic Failures at 6 kA
- Endurance Tests Not Yet Completed

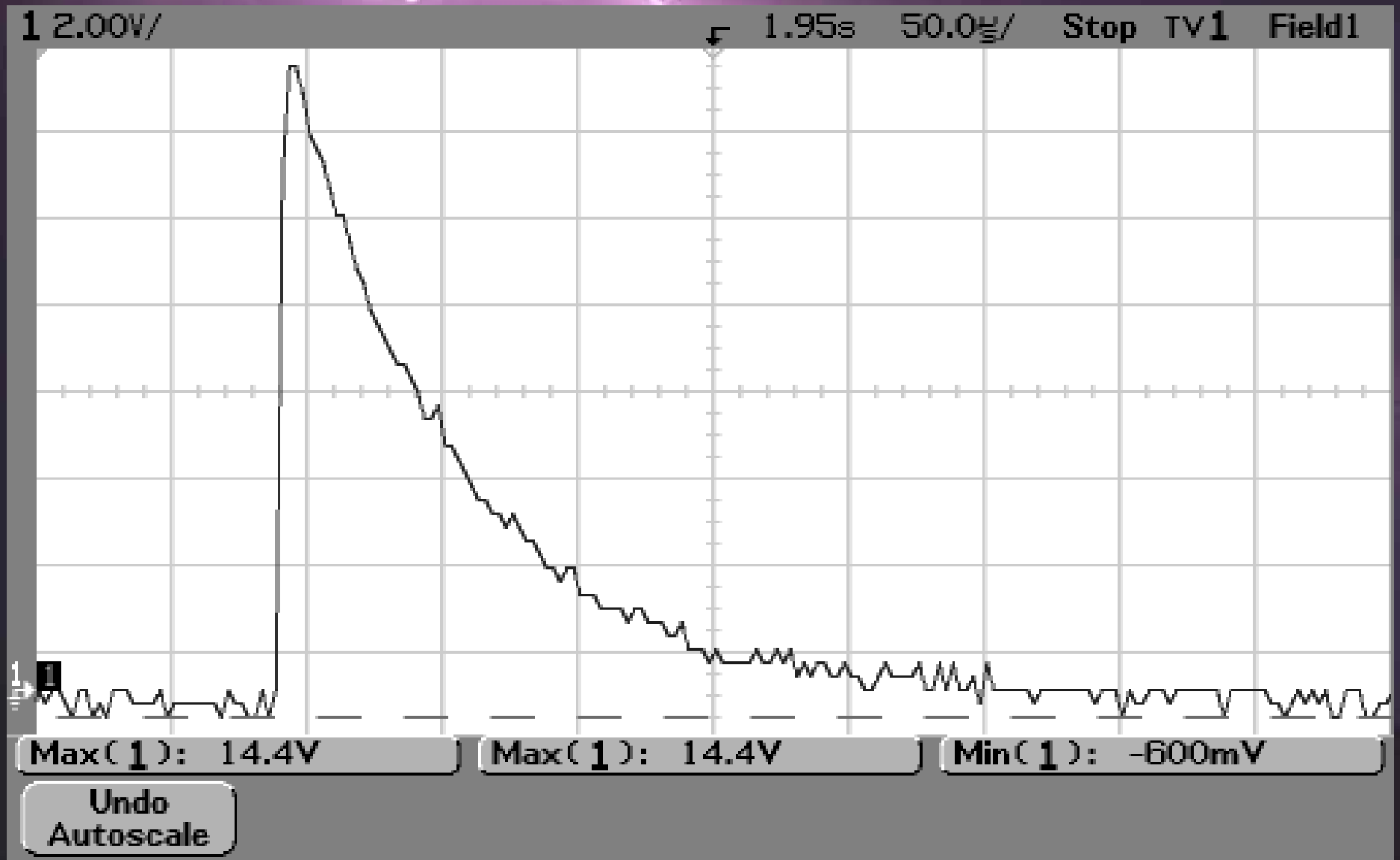
Gas Tubes Very Resilient

- None Have Failed Even With Repeated 6 kA Surges
- One Gas Tube has been Subjected to Over 1000 Surges – STILL WORKS!
- Clamping Voltage ≥ 90V typically

1 kA Current Surge (1 V = 1 kA)



1 kV Voltage Surge (2V = 1 kV)



Conclusions

- Surge Environment in Florida
  - High Number of Surges (poss. near 100/day)
  - Direct Strikes Unlikely and Impossible to Protect Against
- Surge Protectors Necessary to Protect More Expensive Equipment
  - Very Few Modems Damaged By Lightening
- Older Fuse-Based Suppressors Protect Well, But Require Replacement Often ($$$)

Conclusions & Recommendations

- Telephone Line Surge Suppressors Should Use Gas Tubes as Primary Protection
- Current Rating of 10 kA is Sufficient
- High Endurance Chosen Over Current Rating
  - Over 100 Strikes at 5-10 kA
  - Over 1000 Strikes at ~1 kA

Future Work

- Continuing Endurance Tests on EDCO and Citel Surge Suppressors
- Other Suppressors with Higher Endurance Ratings Possibly Added
- Decide on Specification for FDOT
- Investigate Lower Voltage Suppressors for Loops and Piezo Sensors
  - Gas Tubes Likely Not Useful