

# White Paper

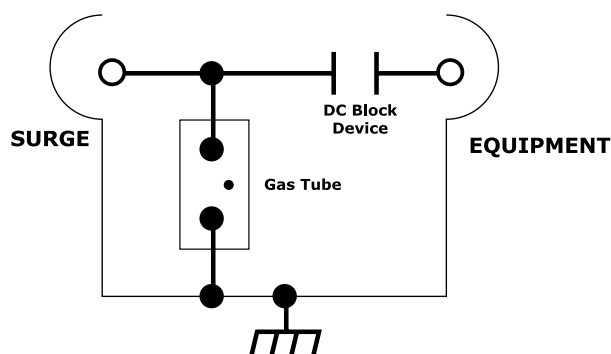
## Testing RF Lightning Protectors Without Indicators

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RF lightning protectors are designed to protect RF equipment by equalizing the potential difference between the center pin of the coax cable and its shield. The majority of RF protectors do not feature indicator lights to show whether or not they are still functioning. Since power is not readily available at some installation points, an indicator light is not practical and would add significant cost to the protector. So how do we know if the protector is still functional?

Since the IS-50 and IS-B50 are the most widely used PolyPhaser RF protector series, finding their application in Land Mobile Radio, SCADA systems, amateur radio and many others, this paper focuses on their specific testing condition.

IS50/B50 DC block RF protectors



The IS-50/B50 series products are capacitive coupled gas tube protectors with multi-strike capability. As DC block products, they do not provide continuity from center-pin to center-pin, or from center-pin to shield. Low frequency surge current induced onto the center-pin from the antenna side is blocked by the capacitor until the gas tube reaches its “turn-on” voltage to shunt the surge to ground (assuming the IS-50/B50 unit is properly grounded).

Once the gas tube ionizes, the potential on the center conductor is equalized with the protector’s shield. The lightning protector’s gas tube is connected between the center conductor and the coax cable shield. Its purpose is to bring the center conductor up to the same potential as the shield during a surge event. Once the center conductor and shield are equalized, current cannot flow between the circuitry connected to the center conductor (base station – etc.) and the shield/equipment chassis’ ground. The radio equipment is protected.

Conversely, at the equipment input little potential difference exists, which hinders damaging current from flowing through it.

It should be mentioned that the majority of the lightning current is generally grounded through the protector’s shield, not having to pass the gas tube at all. The only current through the gas tube is caused by the potential difference between the shield and the center conductor from the antenna (surge) side, because the gas tube, in a PolyPhaser protector, is connected between the shield and the center conductor on the surge side (before the capacitor on the equipment side). Although tests still estimate peak currents between ~100 to ~500 Amps, the current is further divided by the number of coax cables on the tower. Hence, the gas tubes generally last a very long time and their failure rate is more influenced by the site installation and number of thunderstorms per year than component failures.

## **Damage assessment**

According to gas tube manufacturers, the components can take 1,000 events @ 500 Amp, 10/100 microsecond, or 5 events @ 20,000 Amp, 8/20 microsecond surge. Expected life of the gas tube without experiencing a surge strike is 175K hours (20 years). However, predicting a gas tube's lifespan is impossible since lightning is a natural event with varying current waveforms and return strokes. The weak link in all protectors is the contacts in the connectors. The center pin that makes the connection between the cable connector and protector can get damaged from high currents. If that is the case insertion loss and SWR (Standing Wave Ratio) increase. The IS-50/B50 protector should be replaced if insertion loss and SWR are greater than they would be through a straight through barrel adapter, as full failure may or may not pass RF.

## **How to test for damage**

Since the IS-50/B50 protectors are DC Block devices, they cannot be tested with a resistance or ohm-meter. A properly functioning product will show the same results as a damaged one, because the unit does not have any continuity between center-pins. Furthermore, roughly 95% of the time a gas tube will fail open, which is also indicative of a functioning state, as well as a failed state.

To test the IS-50/B50 units, without expensive test equipment, check the VSWR (Voltage Standing Wave Ratio, or return loss) of the radio transmission line. If it has increased significantly from the time it was first installed, then damage to the unit can be expected. To determine if the damaged component is the protector, it should be removed from the line and replaced with a barrel adapter. If the radio's VSWR performance has improved far beyond the VSWR specification of the protector, the unit should be replaced.

The failure rate is affected by where and how the protector is installed and the natural variation in the intensity and number of return strokes per lightning event. The tower size and placement, the ground conductivity, and number of storms per year also influence the life expectancy of the unit.

Generally gas tubes will withstand multiple hits of <20kA each. However, since that much current could only ride on the shield, it would indicate that the coax cable shield or tower ground connection may not be grounded properly. The N connector center pin can also degrade with numerous smaller hits. This degradation of the center pin will happen on any connector in the transmitter line. For this reason a scheduled yearly testing of the system's VSWR is recommended.

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Please contact us for questions or further information on this topic.

Contact:

Tel: +1 (208) 635-6400

Email: [sales@transtector.com](mailto:sales@transtector.com)

[www.transtector.com](http://www.transtector.com)