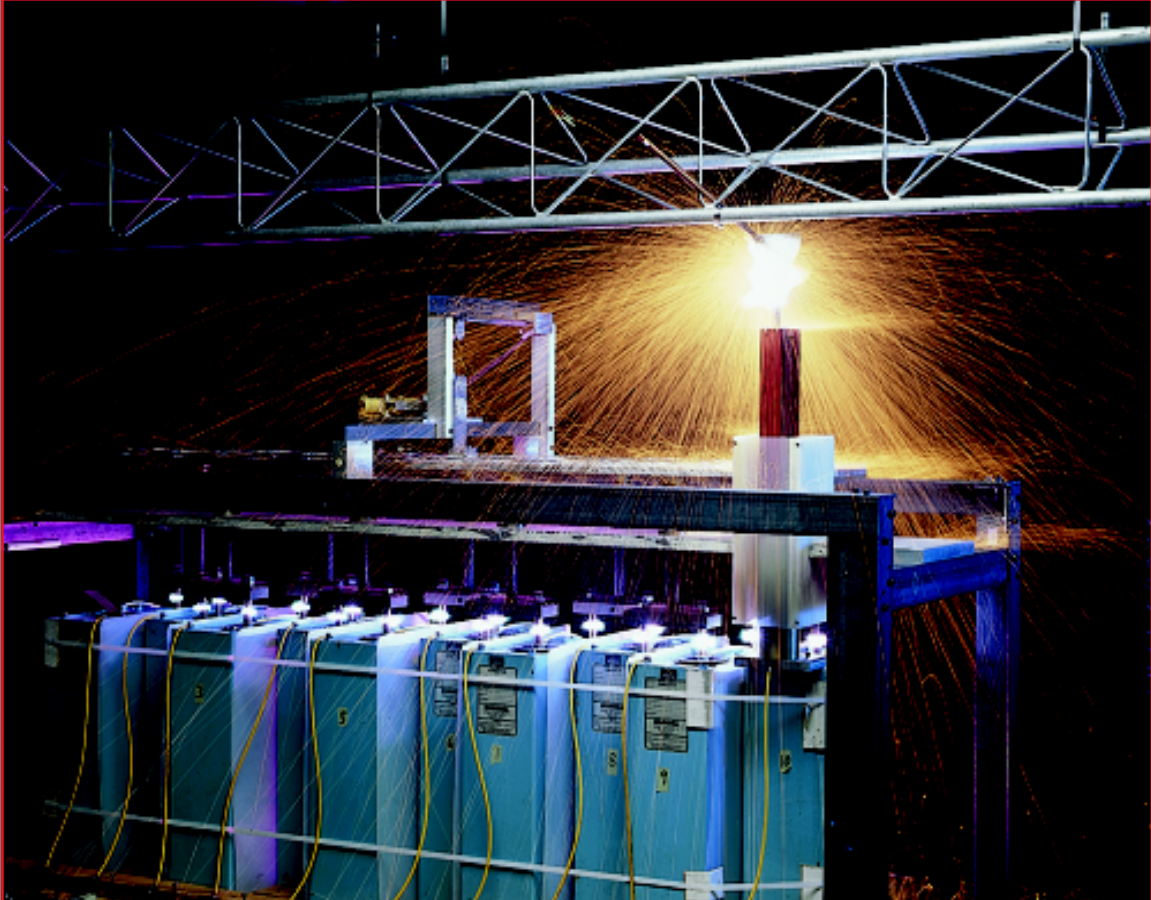


**PolyPhaser®**  
CORPORATION

A SMITHS INDUSTRIES COMPANY

THE INDUSTRY'S FINEST LIGHTNING PROTECTION PRODUCTS



# Lightning Protection & Grounding Solutions

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



## *The Industry Leader*

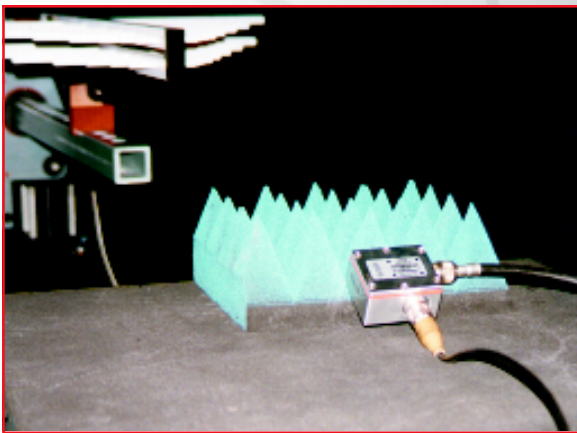
PolyPhaser Corporation offers total solutions for lightning protection, serving these markets since 1979:

- PCS
- Cellular
- GPS
- Land Mobile Radio
- Satellite
- Microwave
- GSM
- LMDS
- Broadcasting
- Military
- WLL
- Paging



## *Engineering Capabilities*

- Software: Pspice Circuit Analysis, MM Cad RF Circuit Analysis, Finite Element Analysis, Mechanical Desktop 3-D CAD System
- Test Equipment: Network Analyzers, Digital Oscilloscopes, Environmental Chambers, Surge Generators, RF Power Source, Wind-Driven Test Range, Salt Spray Tank, Intermodulation Test, Access to Anechoic Chamber, Shock & Vibration Table
- Test Capabilities: Bell Core, UL, CSA, IEEE, IEC, ANSI, Mil-Std and other industry and international standards
- Custom Designed Products: RF, ac/dc, Telco, Data Line surge suppressors and grounding solutions



## *Value-Added Services*

- Site Protection Design Assistance
- Consulting and Educational Services
- System Integration Services (Packaging)
- Global sales enhanced through a dedicated network of 40 worldwide representatives and distributors
- Online catalog at [www.polyphaser.com](http://www.polyphaser.com)
- System Testing



**PolyPhaser®**  
CORPORATION



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

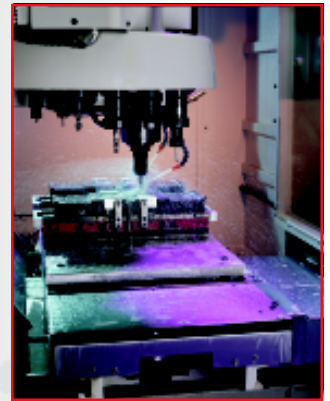




## *Manufacturing Capabilities*

---

- 53,000 Square Foot Facility
- More than 3,000 Catalog and Custom Products
- ISO 9001 Registered Quality System
- Approved Manufacturer for Many OEMs
- Exports to more than 75 Countries
- Flexible Process Layout



## *Setting the Standard*

---



PolyPhaser Corporation designs quality lightning protection and grounding solution products to safeguard today's sophisticated communication equipment. Setting the standards for the lightning protection industry, PolyPhaser Corporation believes in providing products which far exceed customer requirements. All products are fully tested and inspected prior to shipment. PolyPhaser shows innovation by holding three new patents for the PSX, GSIE and W-Chip.

Stringent quality standards are met for each product. All additional avenues of continuous improvement are taken from company employees, customers and industry resources.

## *Seminars, Training & Consulting Services*

---

At our corporate training center, specialists will guide you from lightning theory and protection techniques to practical application. PolyPhaser can provide the latest information to assist in developing and maintaining the best in lightning protection. Video clips from worldwide consultations supplement classroom experience. Specialized training, consultation, and on- or off-site seminars are also available.



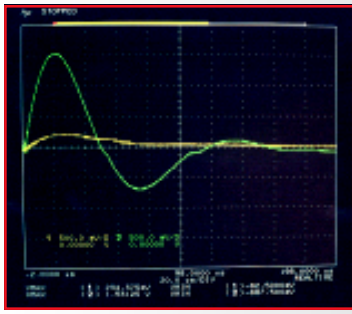
## *A Smiths Group Company*

---

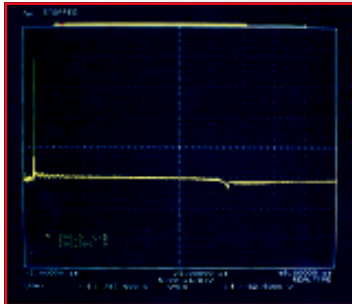


Smiths is a London-based company which has grown substantially from the family clock and watch-making business started by Samuel Smith in 1851. It now operates 50 different businesses around the world and is organized into three distinct activities: specialized industrial products, aerospace electronics and medical systems. Smiths has achieved a strong record of growth through investment in research and development, new manufacturing technology and closely focused marketing.

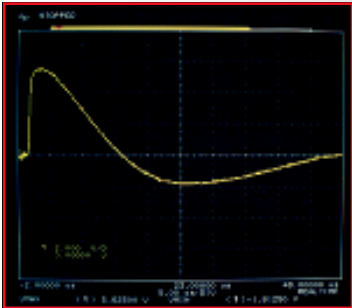
PolyPhaser was acquired by Smiths on June 1, 1997 and is part of the Industrial Group. This group is the fastest growing part of Smiths and has tripled in size over the past five years.



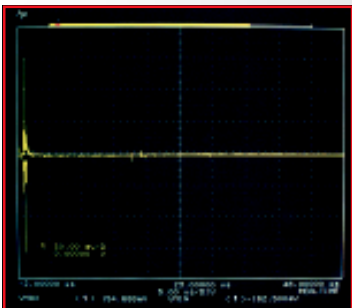
An  $8 \times 20 \mu\text{s}$   $1.75 \text{ kA}$  pulse was applied to a  $50'$  length of  $7/8"$  coaxial cable. The surge end of the cable was shorted to simulate a shunt fed antenna. The voltage drop across separate .001 Ohm resistors in series with the shield and center conductor at the terminating end was observed on a  $500 \text{ MHz}$ ,  $2 \text{ Gigasamples/second}$  oscilloscope, and represents peak Amps  $\times 1000$ .



Gas tube @  $200 \text{ V/div V}$  &  $5 \mu\text{s/div H}$ ,  $8 \times 20 \mu\text{s/3kA}$



$1/4$  wave stub @  $2 \text{ V/div V}$  &  $5 \mu\text{s/div H}$ ,  $8 \times 20 \mu\text{s/3kA}$



PolyPhaser @  $0.05 \text{ V/div V}$  &  $5 \mu\text{s/div H}$ ,  $8 \times 20 \mu\text{s/3kA}$



## RF Suppression Technology Overview

Lightning damages communications sites all over the world every day. Most lightning strikes are to the tower. Although lightning is a dc pulse, the time from zero current to peak current can be very fast. The fast rise current pulse generates significant RF components up to frequencies greater than  $1 \text{ GHz}$ . Most of this RF energy is distributed between dc and  $1 \text{ MHz}$ . When lightning energy traverses a coaxial cable there is high frequency roll-off and a slight propagation delay that occurs due to the unbalanced inductances of the shield and the center conductor and the center conductor's capacitive relationship through the dielectric to the shield. The higher frequency shield energy will arrive at the equipment first, followed by the center conductor energy spread out over time. Since the pulse energy arrives at different times, a differential voltage can occur that must be equalized and prevented from reaching the equipment. The amount of energy reaching the equipment through the coaxial protector is known as "Throughput Energy."

The rated "Throughput Energy" specification indicates how much lightning energy can reach the equipment input during a standard waveform test. A very low throughput energy specification can be achieved with a "dc blocking mechanism" inside the protector (no dc continuity through the protector). This "mechanism" can be a capacitor or "strip line" coupling. Coaxial protectors utilizing gas tubes or inductors to ground can be combined with dc blocking to reduce the throughput energy to insignificant levels, and still maintain a low IMD ( $-\text{dBc}$ ). The patented PolyPhaser® dc blocked coaxial protector line has the lowest throughput specifications in the industry.

A gas tube type coaxial protector without dc blocking has dc continuity from surge side connector center pin to equipment side connector center pin. The fast rise time lightning pulse can achieve over  $1,000$  volts across the gas tube before the gas can ionize and become conductive. Since there is no dc blocking mechanism, this high voltage pulse is applied directly to the equipment input before the gas tube "turns on." If the equipment input is through a ferrite circulator/isolator, the incoming pulse is converted to current in the ferrite's resistive load, creating a magnetic field that can re-align the critically adjusted field in the circulator, change the magnet's flux density, and damage or destroy the resistive load. If the incoming voltage pulse appears across a coupling loop (as in most filters & combiners), it sees a low resistance short and is almost entirely converted to current. A dc shorted equipment input loop directly shorts the gas tube. The gas tube might never see enough voltage to "turn on" until the equipment has been damaged since current flow must go through the coaxial cable jumper and equipment input before an inductive voltage drop across the gas tube could reach a potential high enough to ionize the gas.

The "quarter wave stub" coaxial protector is based on well known bandpass/band reject principles. By using a coaxial "T" fitting, and calculating the length of a quarter wave coaxial section from the horizontal center conductor to the grounded base of the "T," a bandpass filter can be formed at a given frequency. Since most of the energy in a lightning strike is from dc to  $1 \text{ MHz}$ , it would fall on the lower frequency reject side of the bandpass filter and be conducted to ground. However, if the equipment input is also dc shorted as in the above gas tube example, the quarter wave stub will allow significant divided dc and low frequency energy to flow towards the equipment input. While the above gas tube protector could eventually "crowbar" to ground, the quarter wave stub will continue dividing energy between the protector's ground and the equipment input for the entire duration of the strike or series of strikes, typically a  $+6 \text{ V}$ ,  $-2 \text{ V}$  peak ringing waveform across a  $50 \text{ Ohm}$  resistive load. The grounding conductor applied to either the straight through gas tube or quarter wave stub protector must be short and very low inductance, or the inductive voltage drop across the grounding conductor will be additive to the center conductor voltage applied to the equipment input.

PolyPhaser's dc blocked filter type protectors, when tested with the same pulse in the same test environment as the above protectors, will typically let through *less than 500 millivolts peak for less than 10 nanoseconds*. A new series of PolyPhaser® coaxial protectors dc blocks the rf path and also injects, passes through, or picks off a specified dc voltage on the coaxial cable center conductor for tower mounted amplifiers. The dc is de-coupled from the rf, passes through a dc protection circuit, and can be re-coupled to the coaxial cable center conductor, or the rf protector can be used as a dc injector or "bias T" pick-off circuit. This combines the lightning protection for the rf and dc in one unit while eliminating separate devices for dc injection at the equipment or dc pick-off at tower mounted amplifiers. An injector/pick-off combination can eliminate a separate dc feed to the tower mounted amplifier and the dc conductor's lightning protection requirements.

## Printed Resources

Lightning Protection & Grounding Solutions for Communication Sites, a PolyPhaser® publication, contains important information analyzing proper techniques for grounding and protection against destructive lightning (LEMP) energy. Applicable to all types of communications equipment, topics also include telephone, central offices, computers, Local Area Networks, cable TV, satellite communications and security cameras.

**PolyPhaser®**  
CORPORATION