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Lightning Protection and Grounding Solutions for Wireless Networks

Harris
June 2013





Few facts about the lightning event

Typically, more than 2,000 thunderstorms are active throughout the world at any given moment producing on the order of 100 flashes per second. As our society becomes more dependent upon computers and information/communications networks, protection from system disruptions becomes essentials.

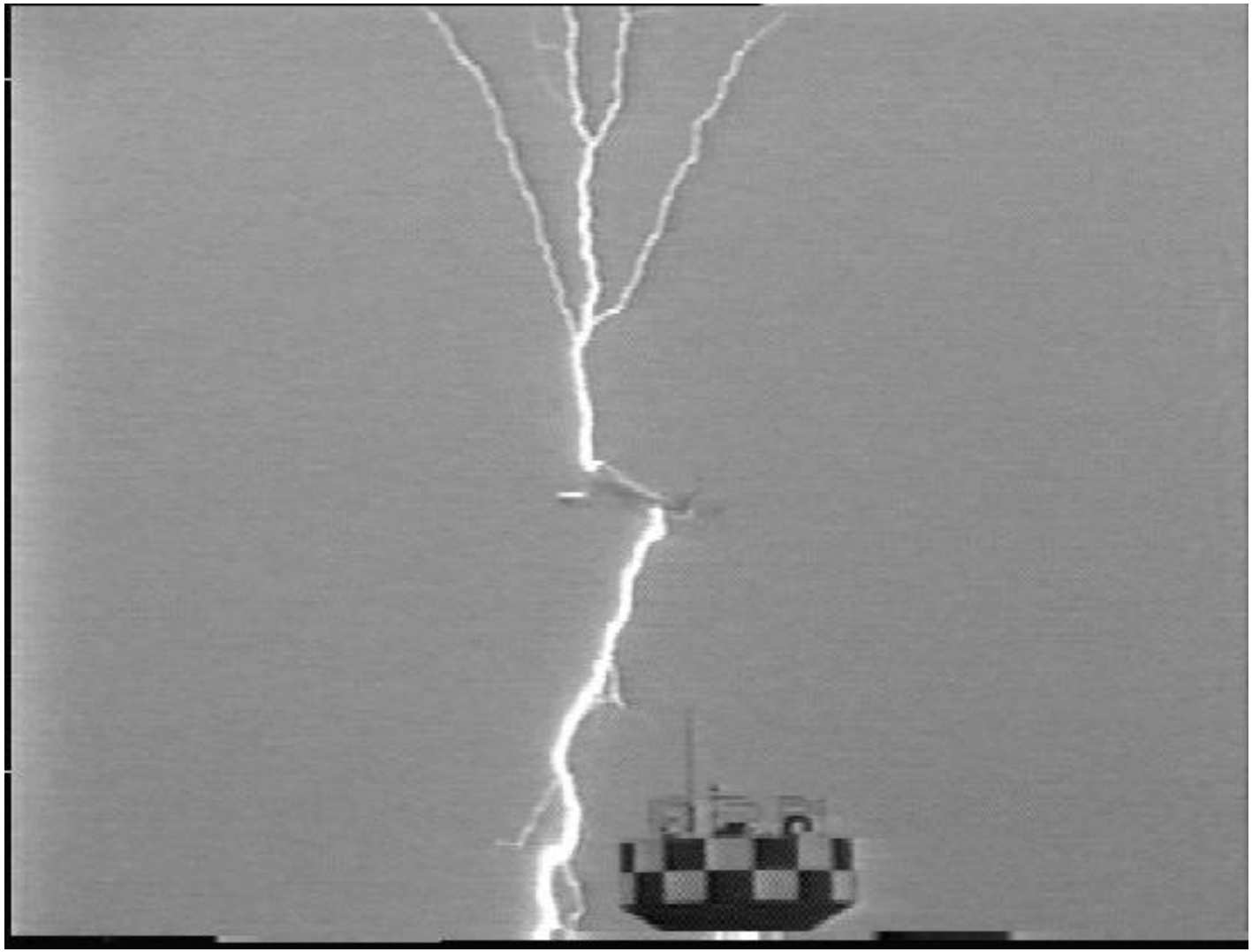
During fair weather, a potential difference of 200,000 to 500,000 Volts exists between the earth surface and ionosphere. In a lightning event this potential will be responsible for lightning discharge currents of up to 100,000 Ampere.

The average length and duration of each lightning stroke vary, but typically average about 30 microseconds producing average peak power per stroke of about 1 (one) Trillion Watts.

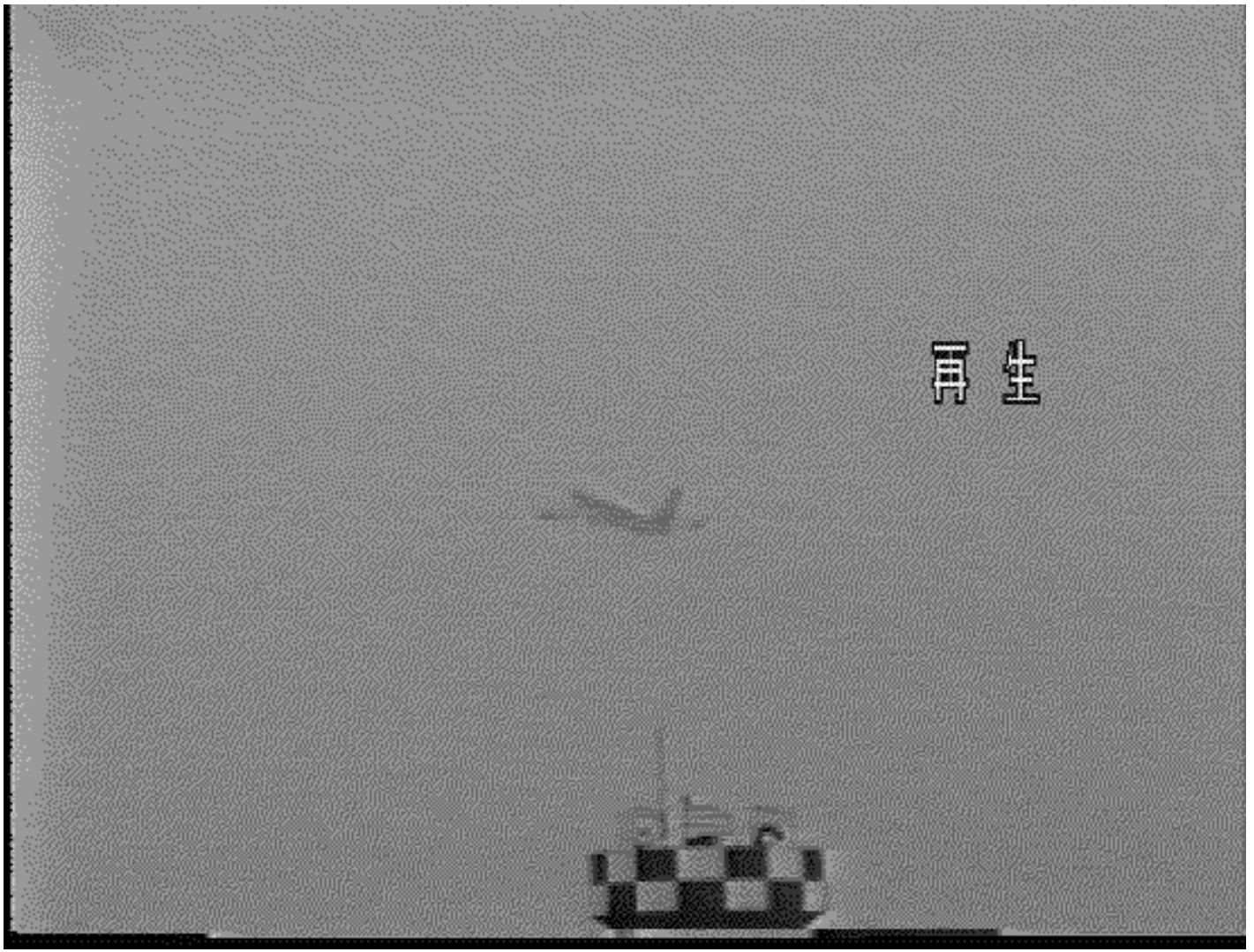
The temperature along the lightning channel (flash) during the electrical discharge is in the order of 20,000 degrees Celsius (three time the temperature of the surface of the Sun)

Wireless networks rely on communication towers for its transmission of Radio Frequency putting them statistically in a very high exposure zone. Average communication site in Florida, during thunderstorm season, will be exposed to 18 to 20 lightning strikes a year.

ANA 747 triggered strike at Kanazawa



Aircraft launching step leader



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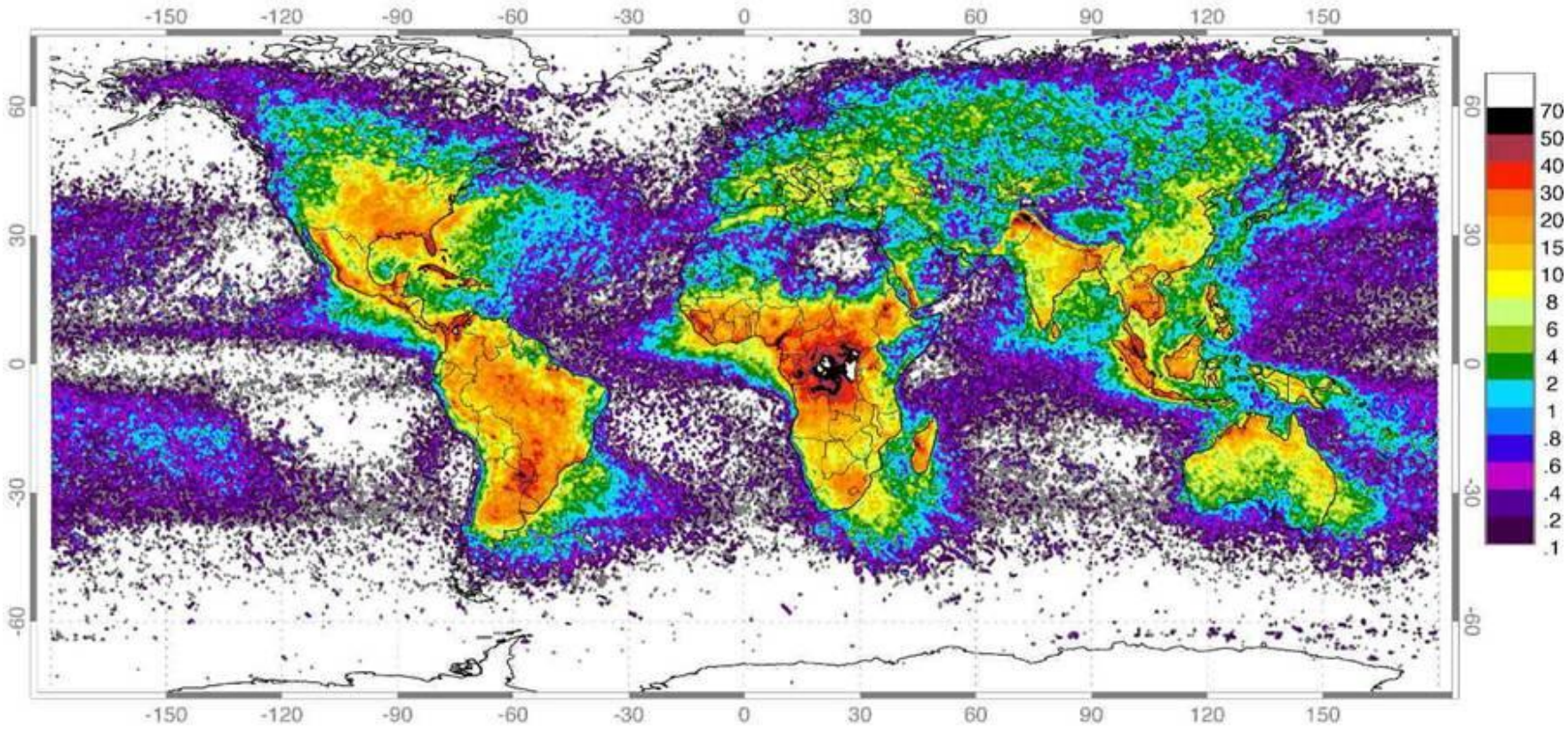
Return Stroke

Annual Lightning Flash Rate



High Resolution Full Climatology Annual Flash Rate

Global distribution of lightning April 1995-February 2003 from the combined observations of the NASA OTD (4/95-3/00) and LIS (1/98-2/03) instruments

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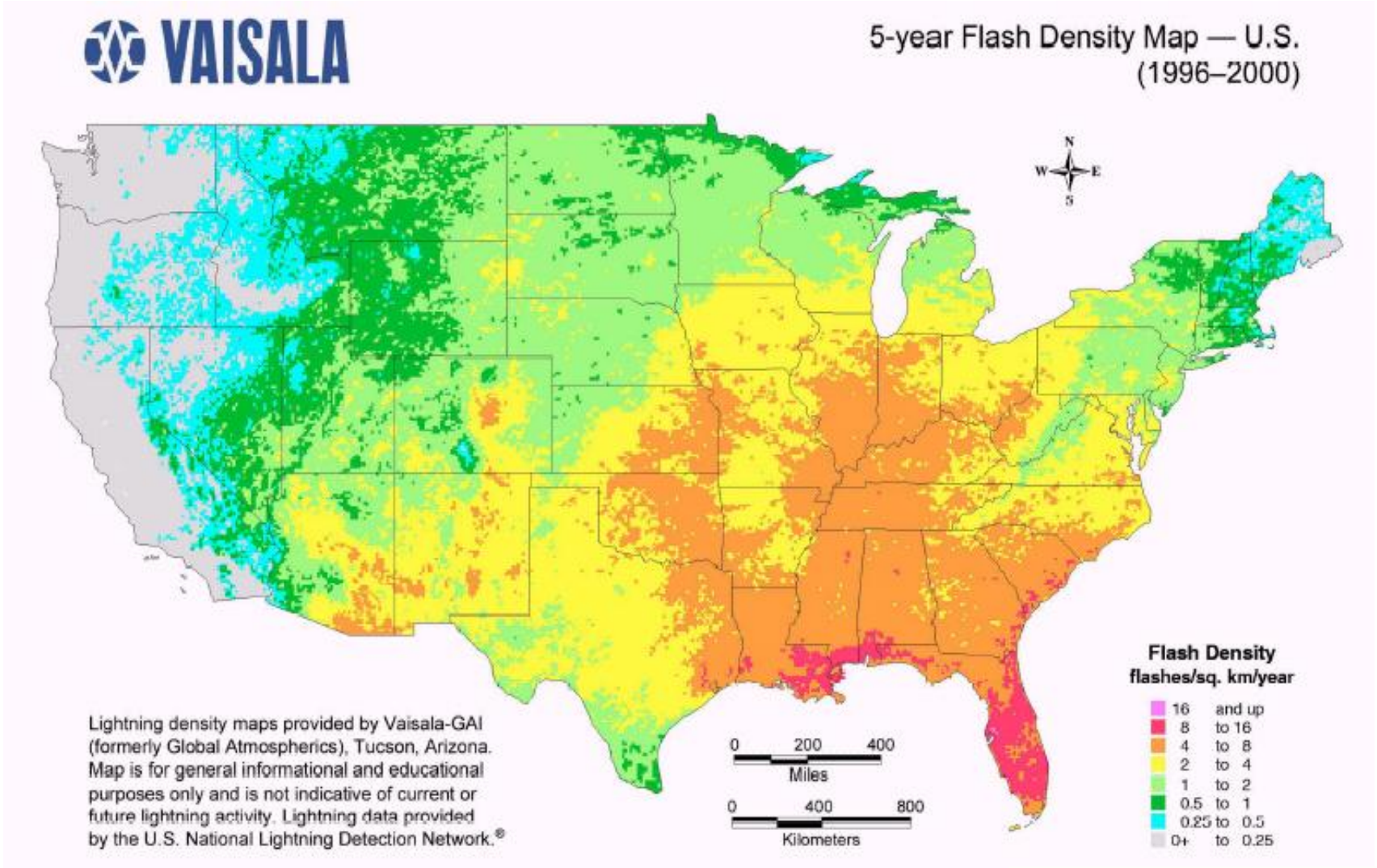
Annual Lightning Flash Density



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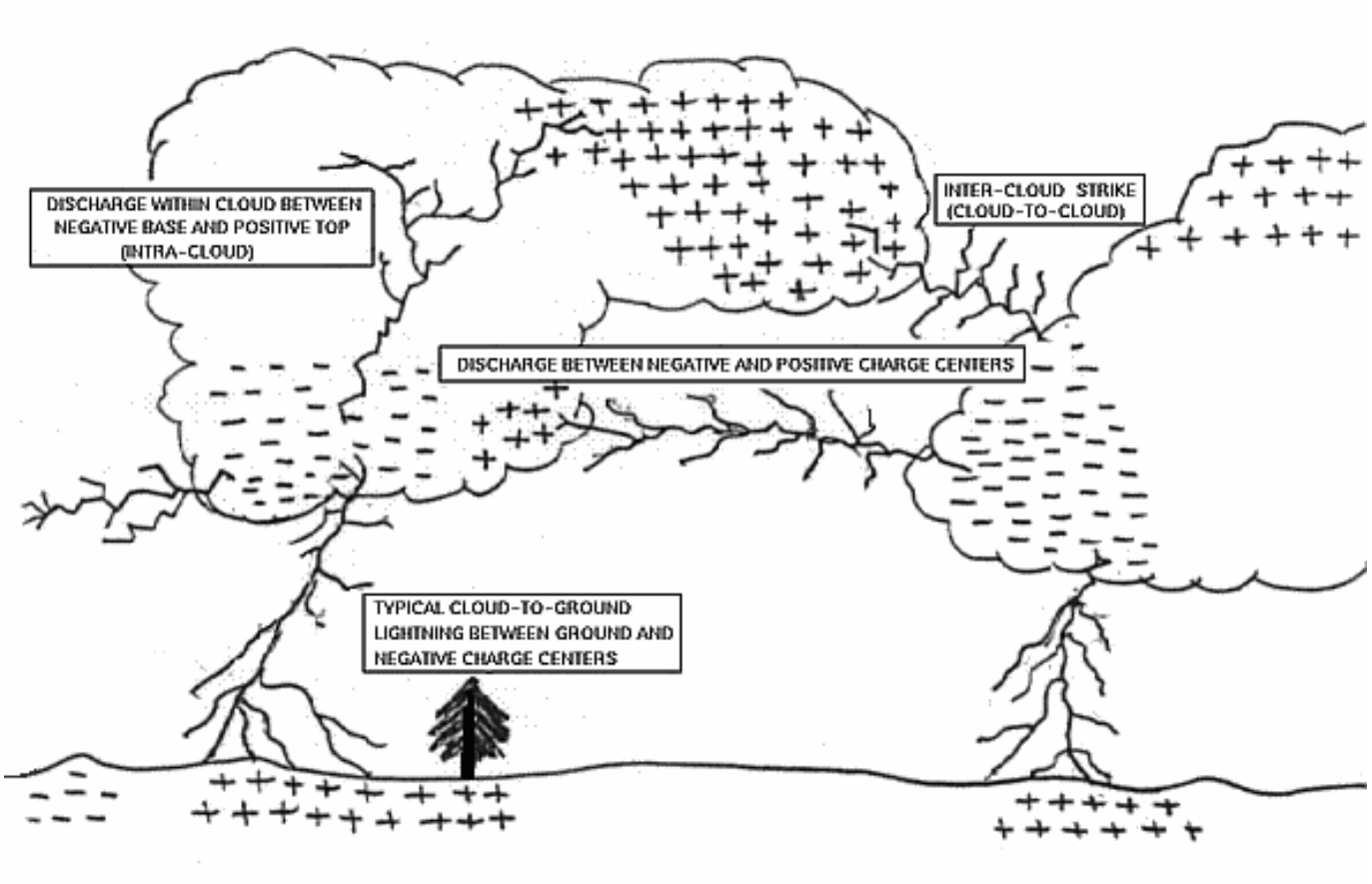
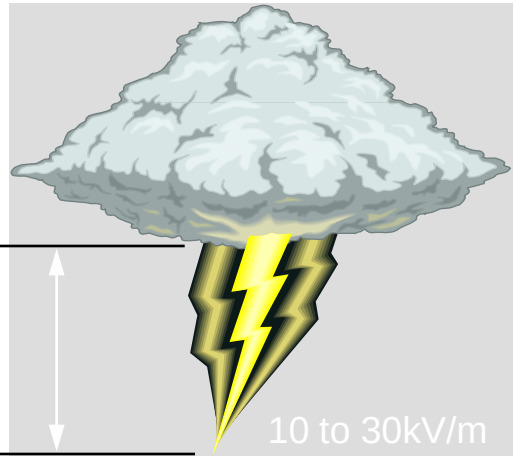
The Lightning Event



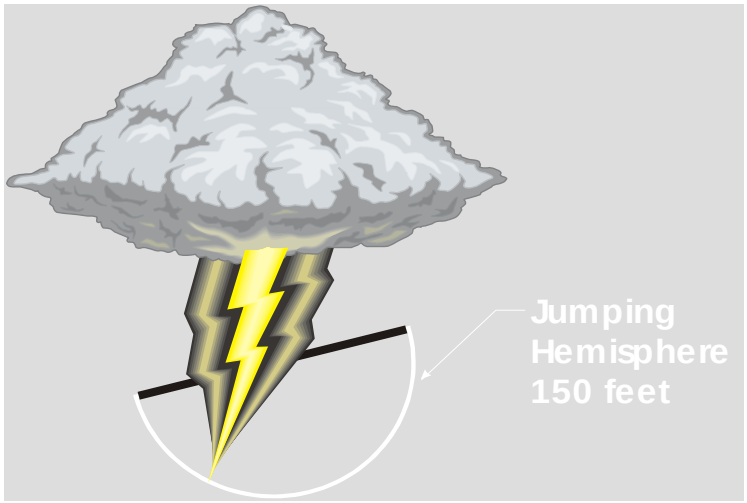
The lower part of a thundercloud is usually negatively charged. The upward area is usually positively charged. Lightning from the negatively charged area of the cloud generally carries a negative charge to Earth and is called a negative flash. A discharge from a positively-charged area to Earth produces a positive flash

Step Leader Length is Dependent on Cloud Charge Accumulation



The Larger the Charge, the Larger the Step

Typical Step 150ft. @ 50µS per Step
(1µS jump, 49µS pause)



Jumping Hemisphere "Rolling Ball Theory"

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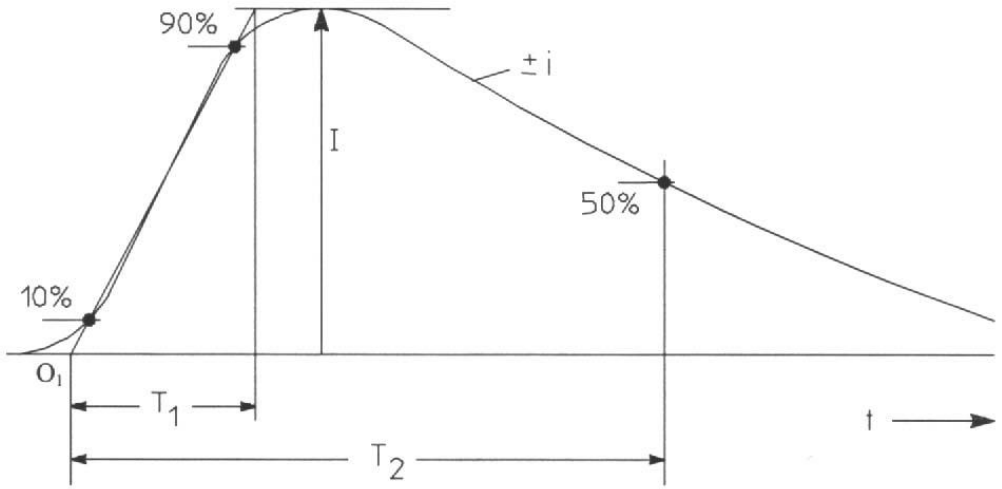
Definition of pulse wave-shape



O_1 = virtual origin

I = peak current

T_1 = front time

T_2 = time to half value

Figure A.1 - Definitions of short stroke parameters (Typically $T_2 < 2$ ms)

Measured Peak Lightning Current

350kA
Maximum with 99.5% Confidence level

AND

300kA
Maximum with 98% Confidence level

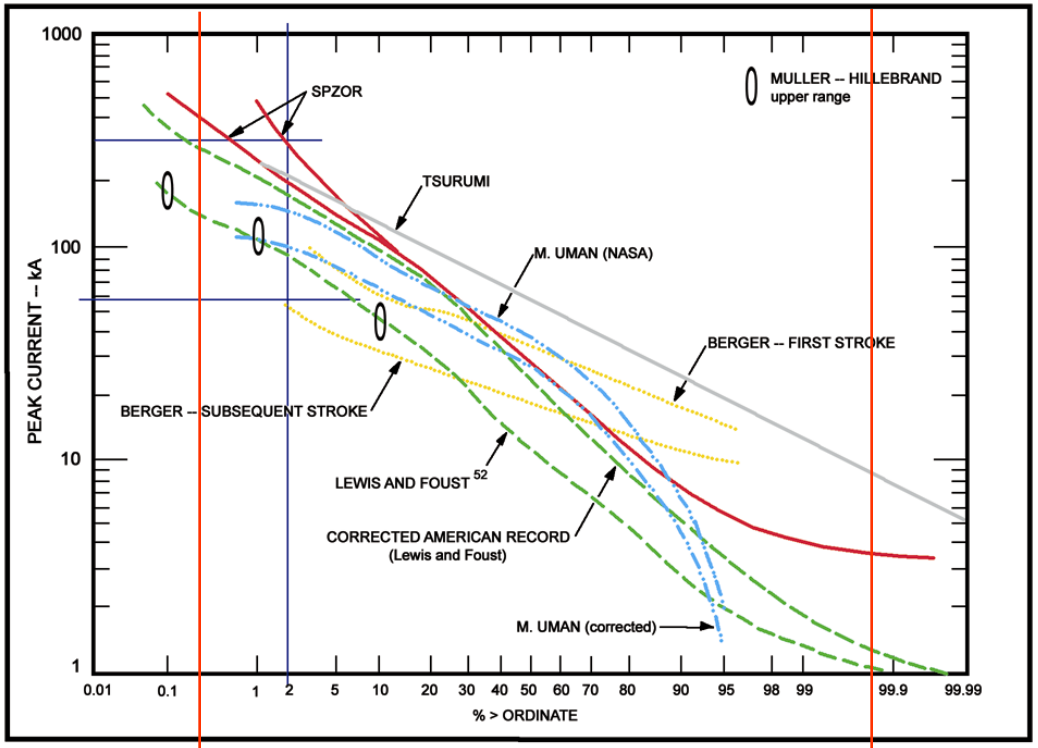


Figure 3.5 - Measured Peak Currents[2]

Six σ distribution

Ref: W.C. Hart, E. W. Malone, Lightning and Lightning Protection, EEC Press, 1979

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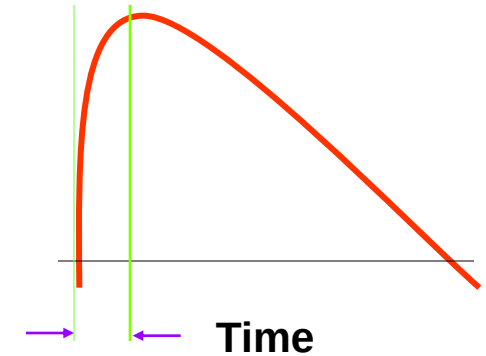
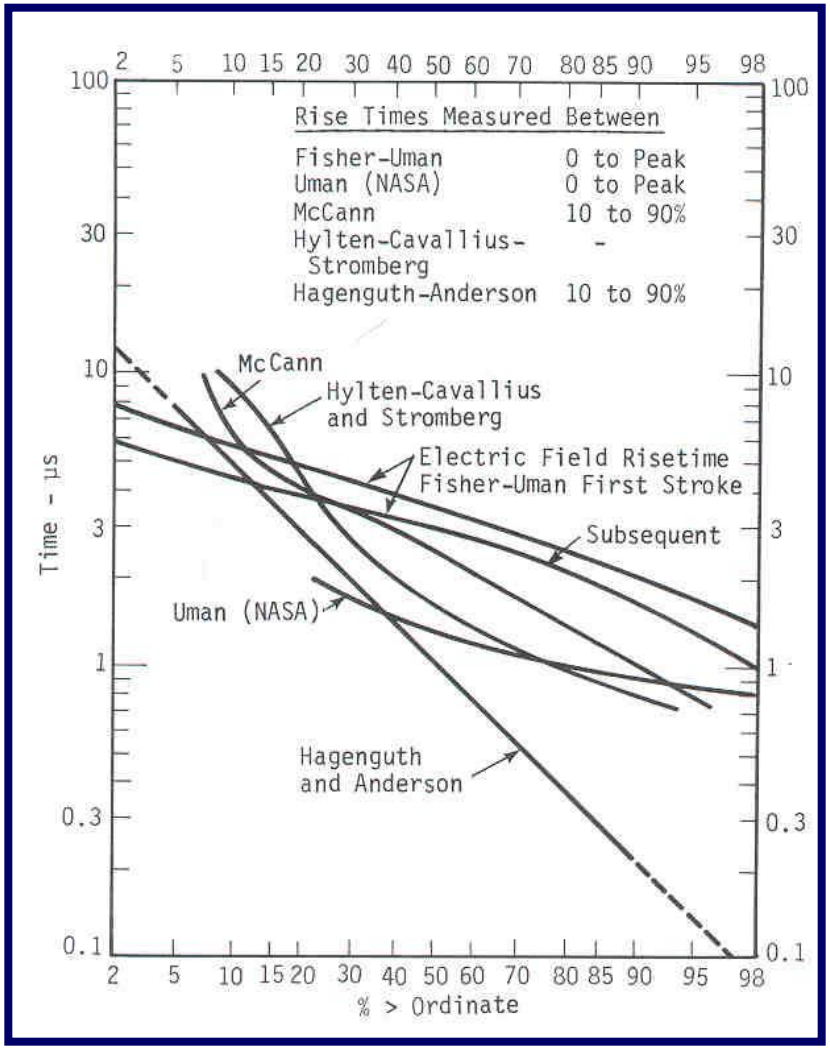
Time to Peak Lightning Currents

Max. 10μ-sec
Min. 0.7μ-sec
0 to peak current with 96% confidence level





Ref: W. C. Hart, E. W. Malone, Lightning and Lightning Protection, EEC Press, 1979

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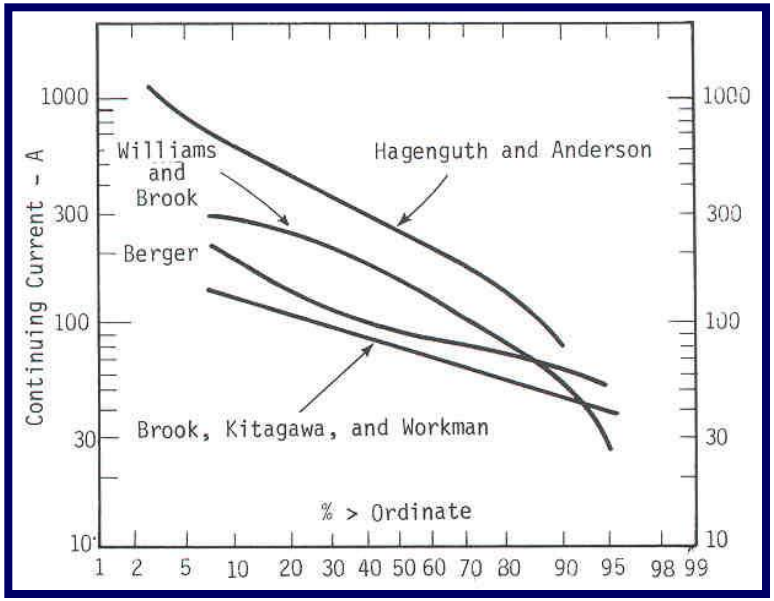
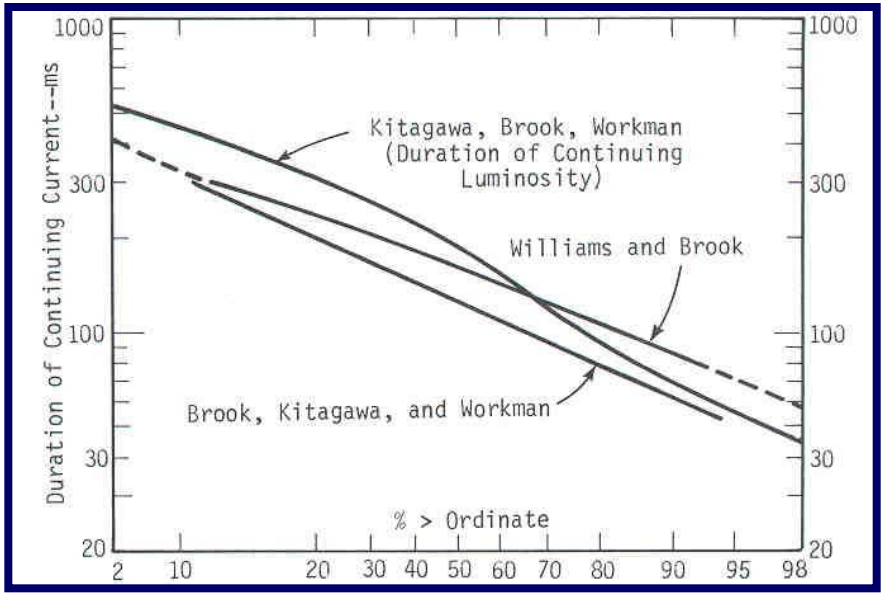
Duration and Amplitude of Continuing Currents





Max. 1000A
Min. 30A

Max. 550m-sec
Min. 35m-sec

Ref: N. Clanos and E.T. Pierce, "A Ground Lightning Environment for Engineering Usage", Contract L.S.-28170A-3, Stanford Research Institute, CA

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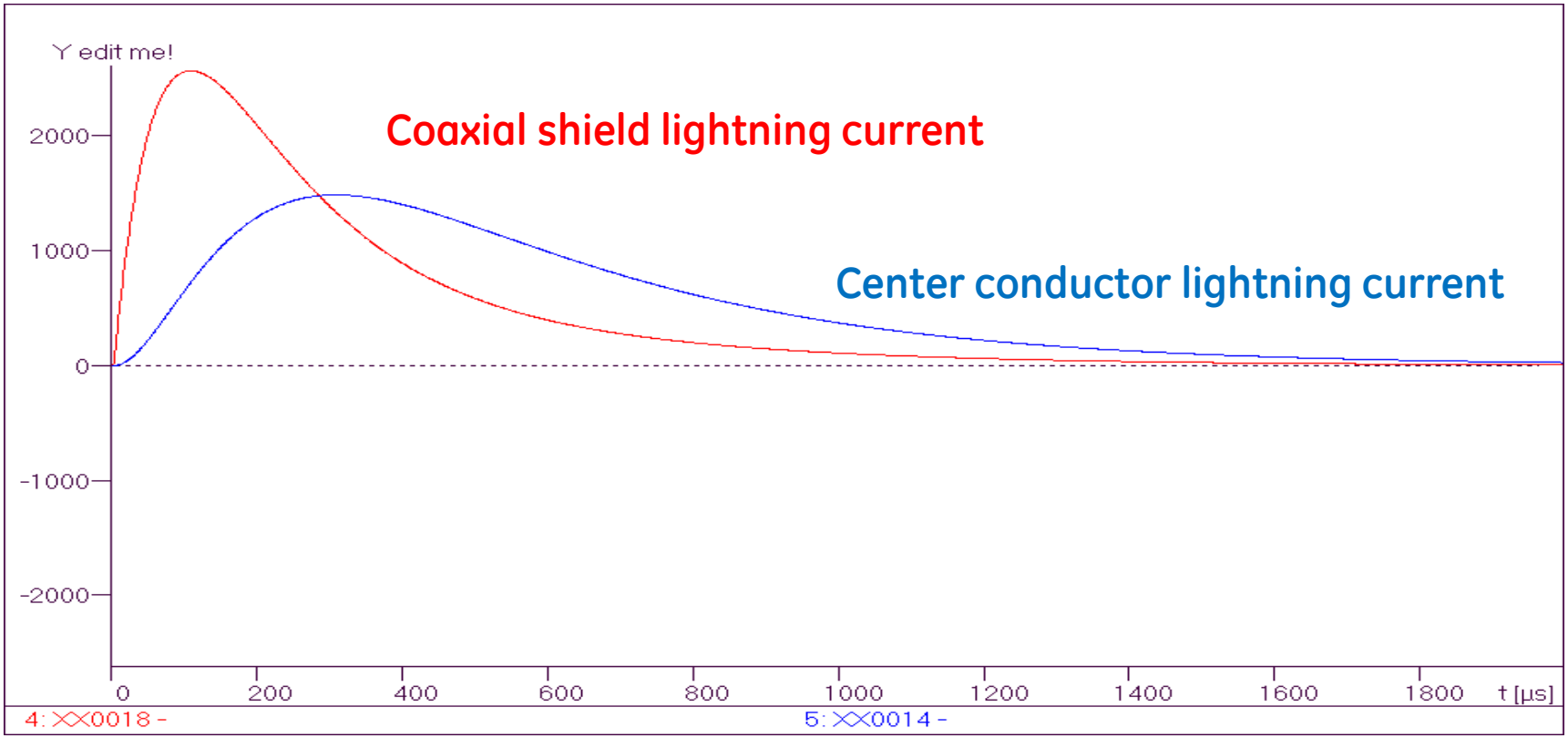
Lightning current distribution on coaxial cable



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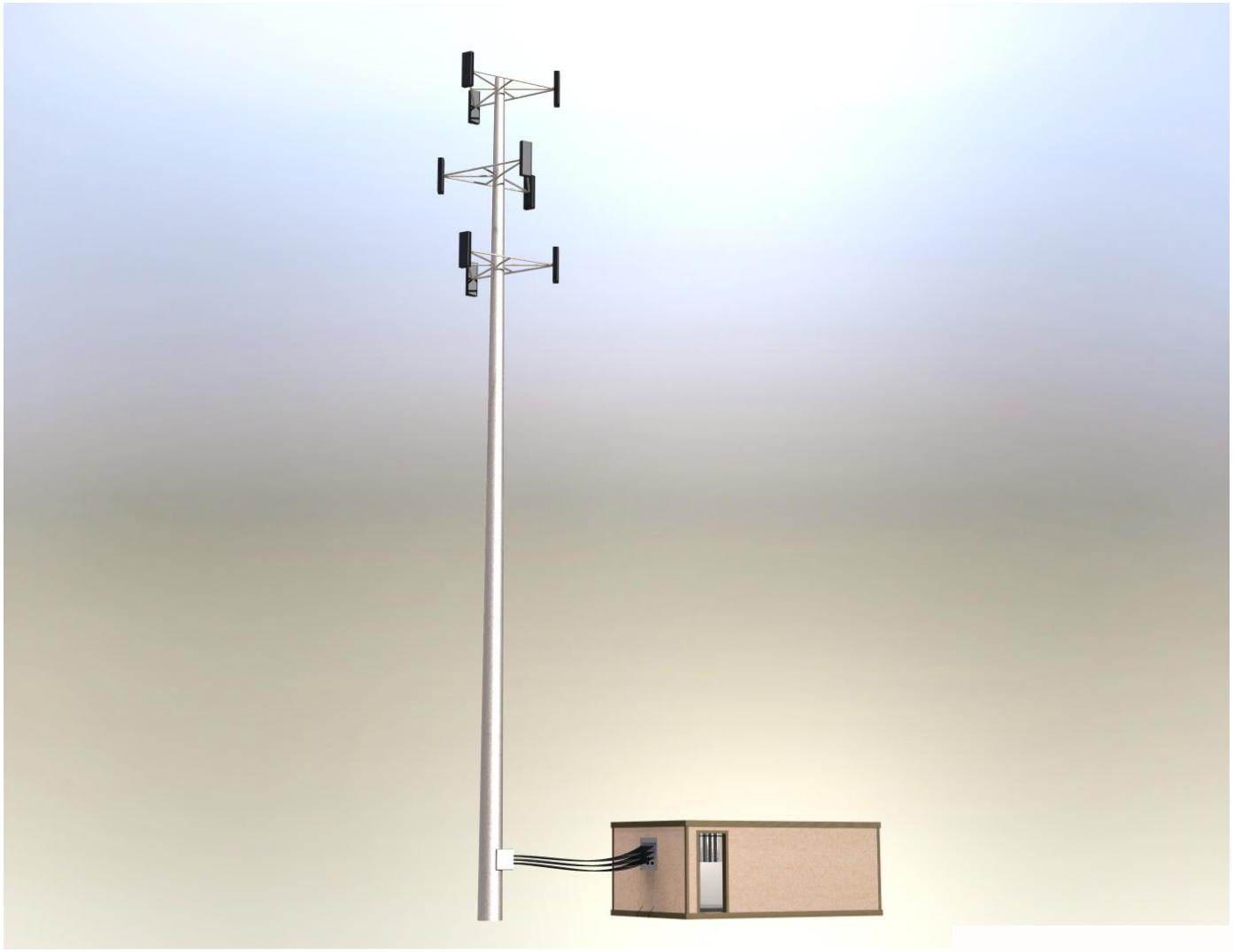
Grounding fundamentals for Lightning Protection



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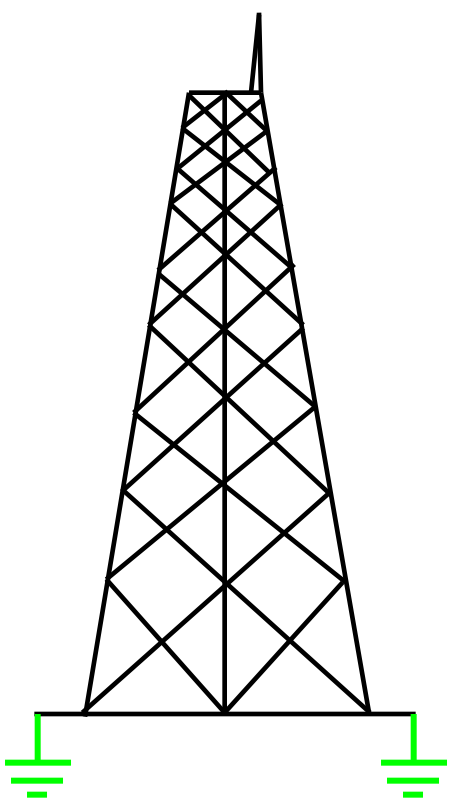
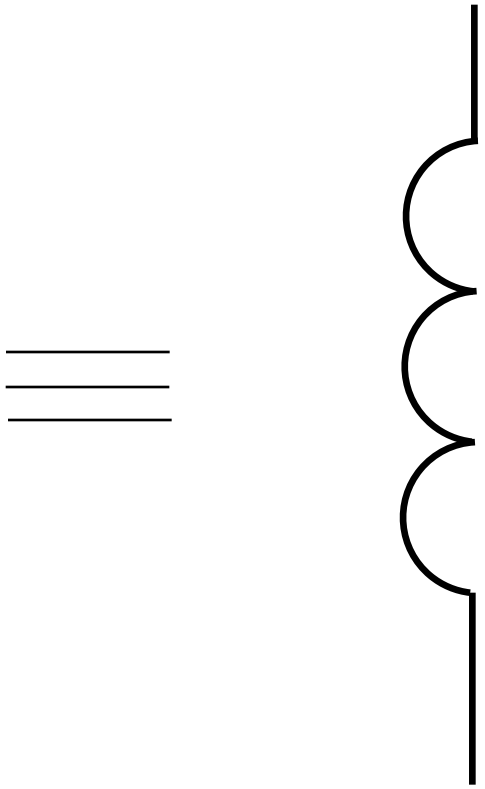
Any Conductor is an Inductor !



Communications Radio Tower



Inductance

Inductance considerations – monopole tower

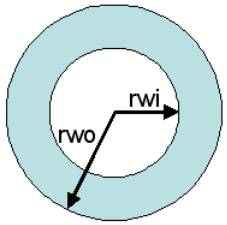
This is the inductance calculation for a round Tubular conductor

Input Parameters

$lth := 2 .. 100$ length of conductor in meters

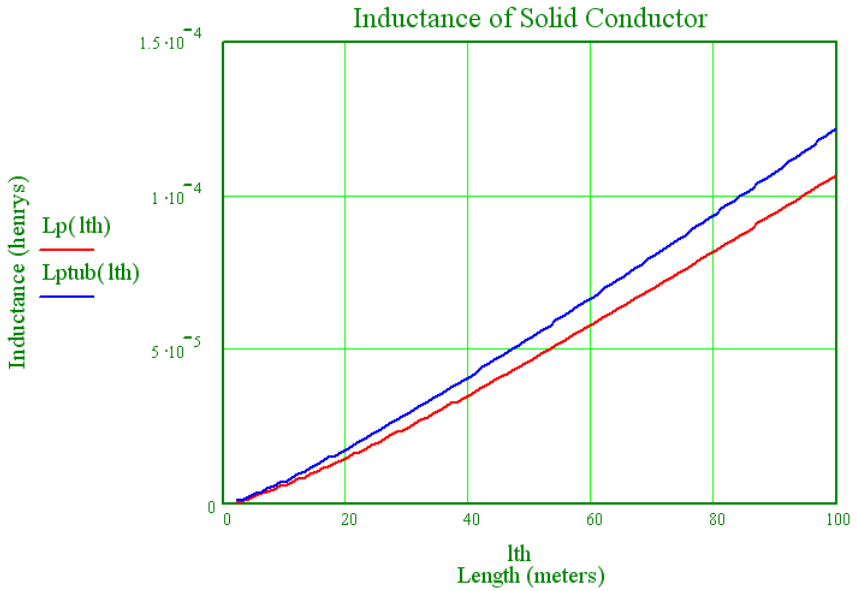
$rwo := 0.4445$ radius of outer conductor in meters

$rwi := 0.3937$ radius of inner conductor in meters



Low Frequency Inductance is: (for lth >>rwo)

$$Lptub(lth) := 2 \cdot 10^{-7} \cdot lth \cdot \left[\ln\left[\left(2 \cdot \frac{lth}{rwo} \right) - \left(\frac{3}{4} \right) - \left[0.028 \cdot \left(\frac{rwi}{rwo} \right) \right] - \left[0.38 \cdot \left(\frac{rwi}{rwo} \right)^2 \right] + 0.16 \cdot \left(\frac{rwi}{rwo} \right)^3 \right] \right]$$



$Lptub(50) = 5.412 \times 10^{-5}$

$Lp(50) = 4.666 \times 10^{-5}$

Tubular Plotted against the solid conductor

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Inductance consideration – three leg tower

This is the inductance calculation for 3 solid round conductors

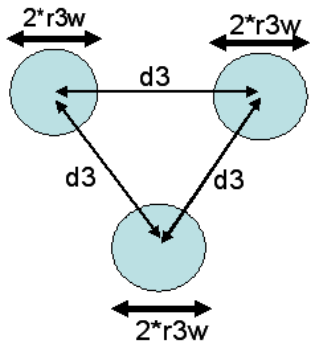
Input Parameters

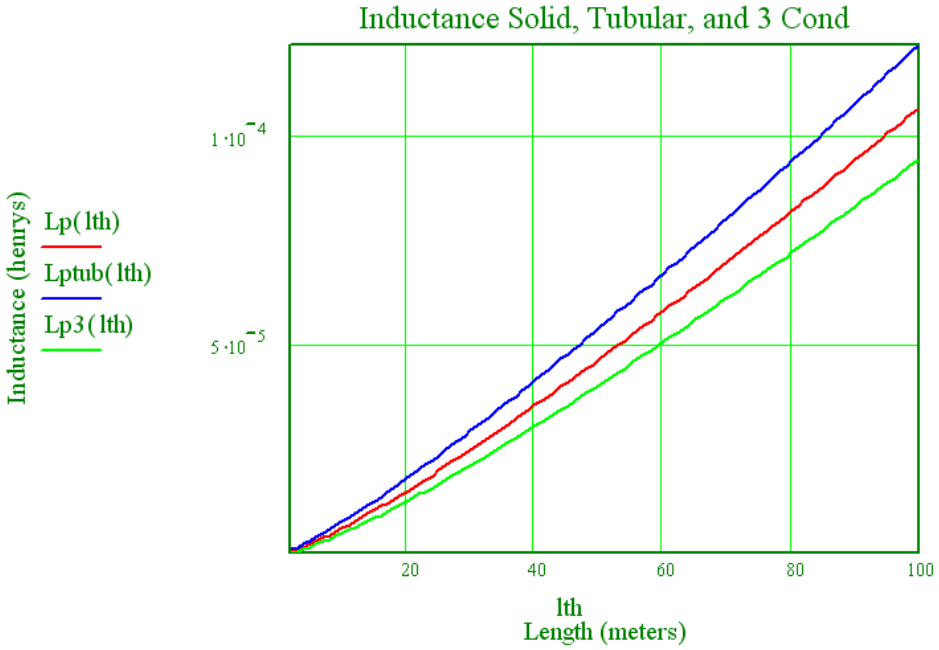
$lth := 2 .. 100$ length of conductor in meters

$r3w := 0.1016$ radius of outer conductor in meters

$d3 := 1.828$

$$Lp3(lth) := 2 \cdot 10^{-7} \cdot lth \cdot \left[\ln\left[\frac{(2 \cdot lth)}{\left(\sqrt[3]{r3w \cdot d3^2}\right)} \right] - \left(\frac{11}{12}\right) \right]$$





$Lp3(73) = 6.463 \times 10^{-5}$

$Lptub(46) = 4.902 \times 10^{-5}$

This distance is 6ft.

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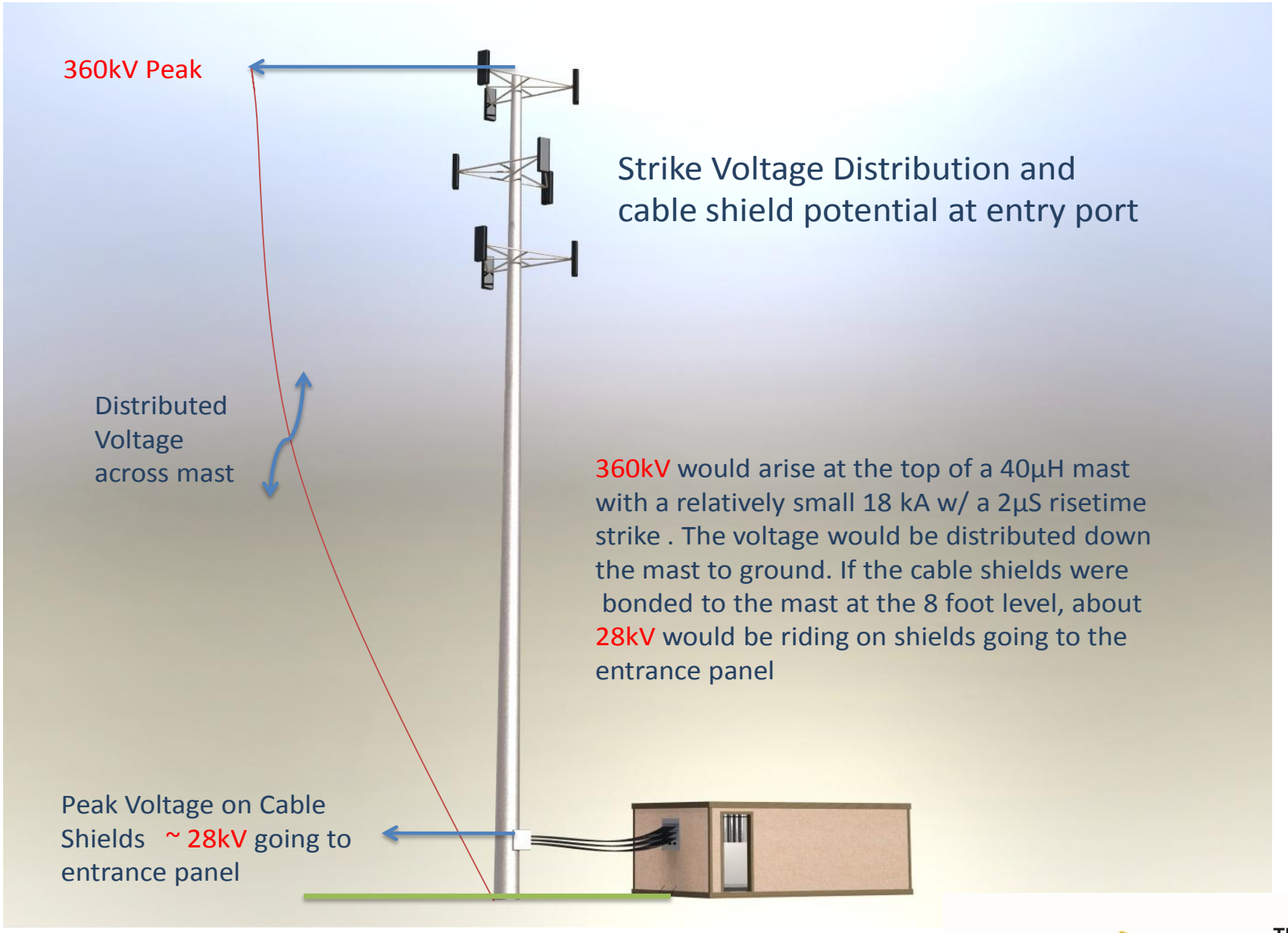

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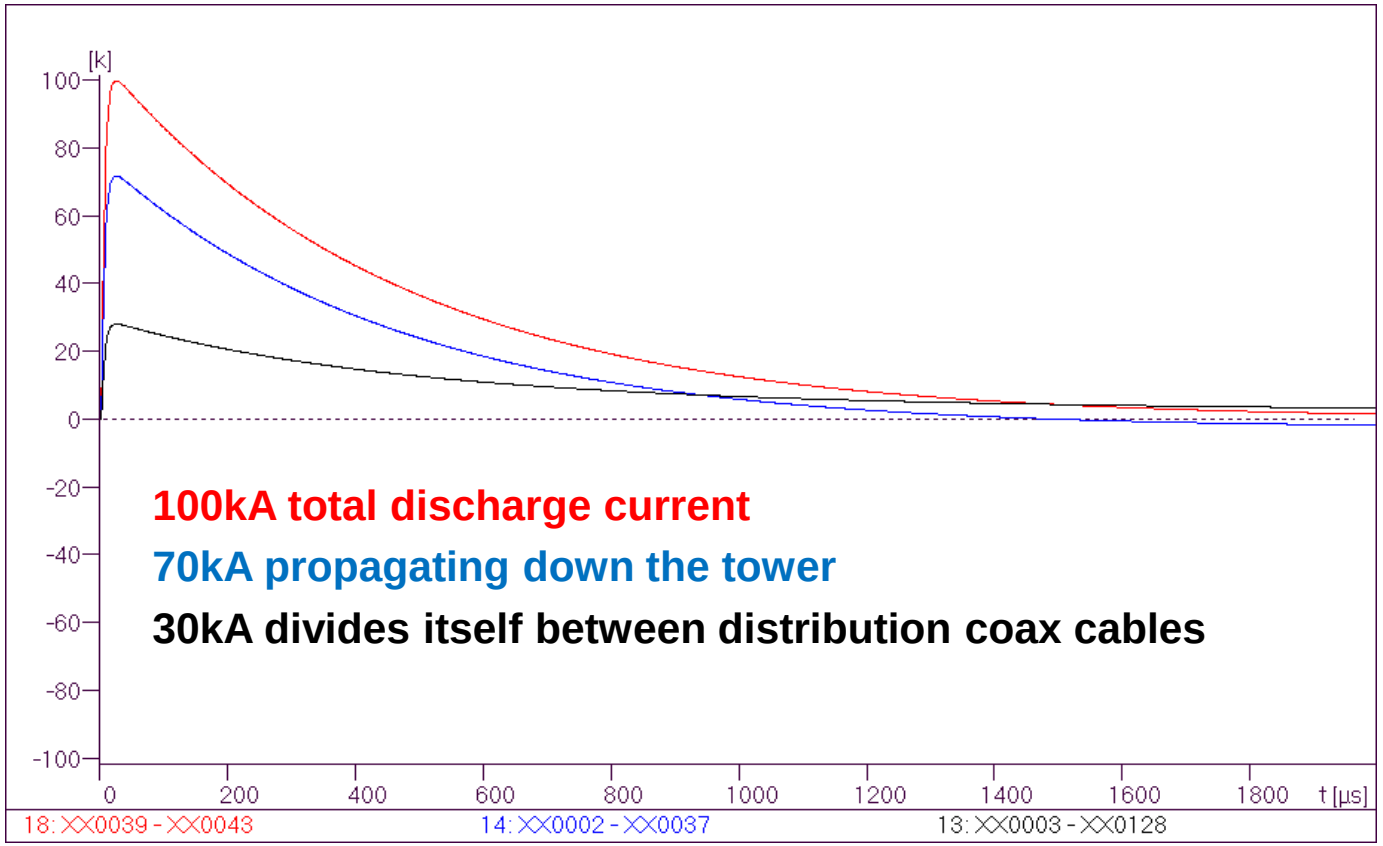
Lightning current sharing between tower and coaxial cables during the lightning event



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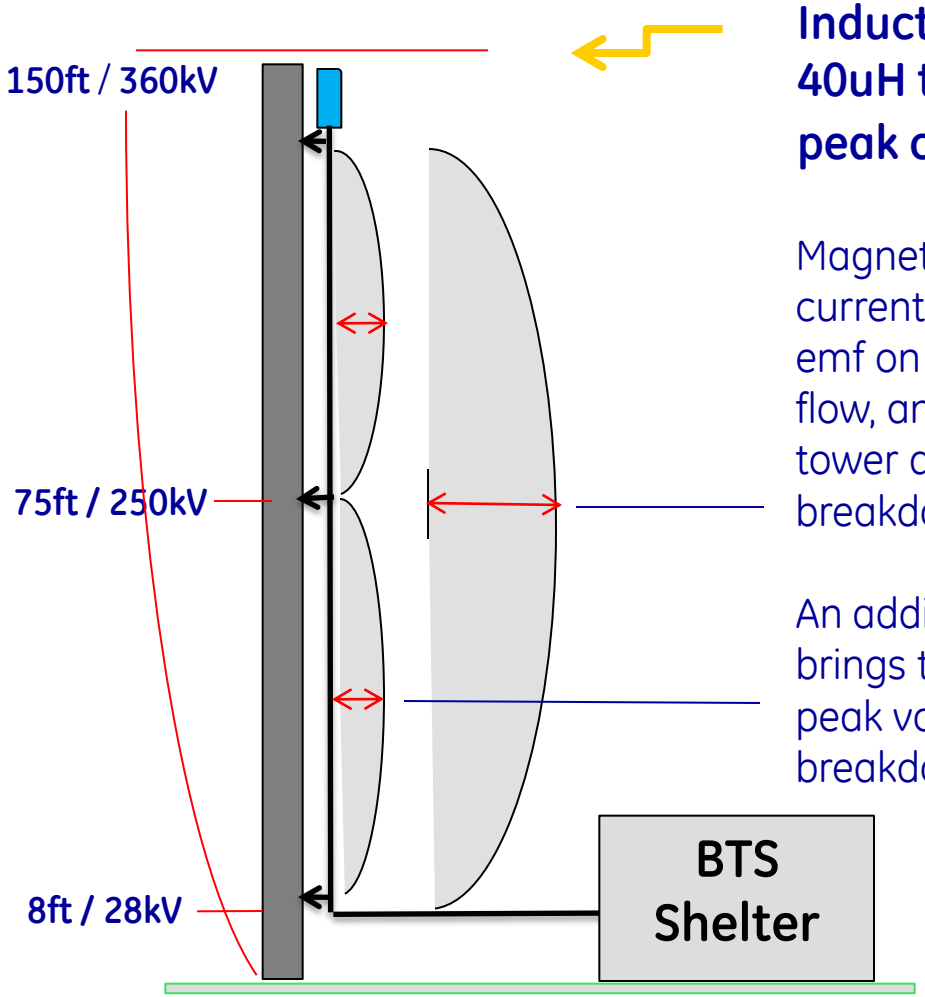
Why Coaxial Cable Ground Kits are Essential

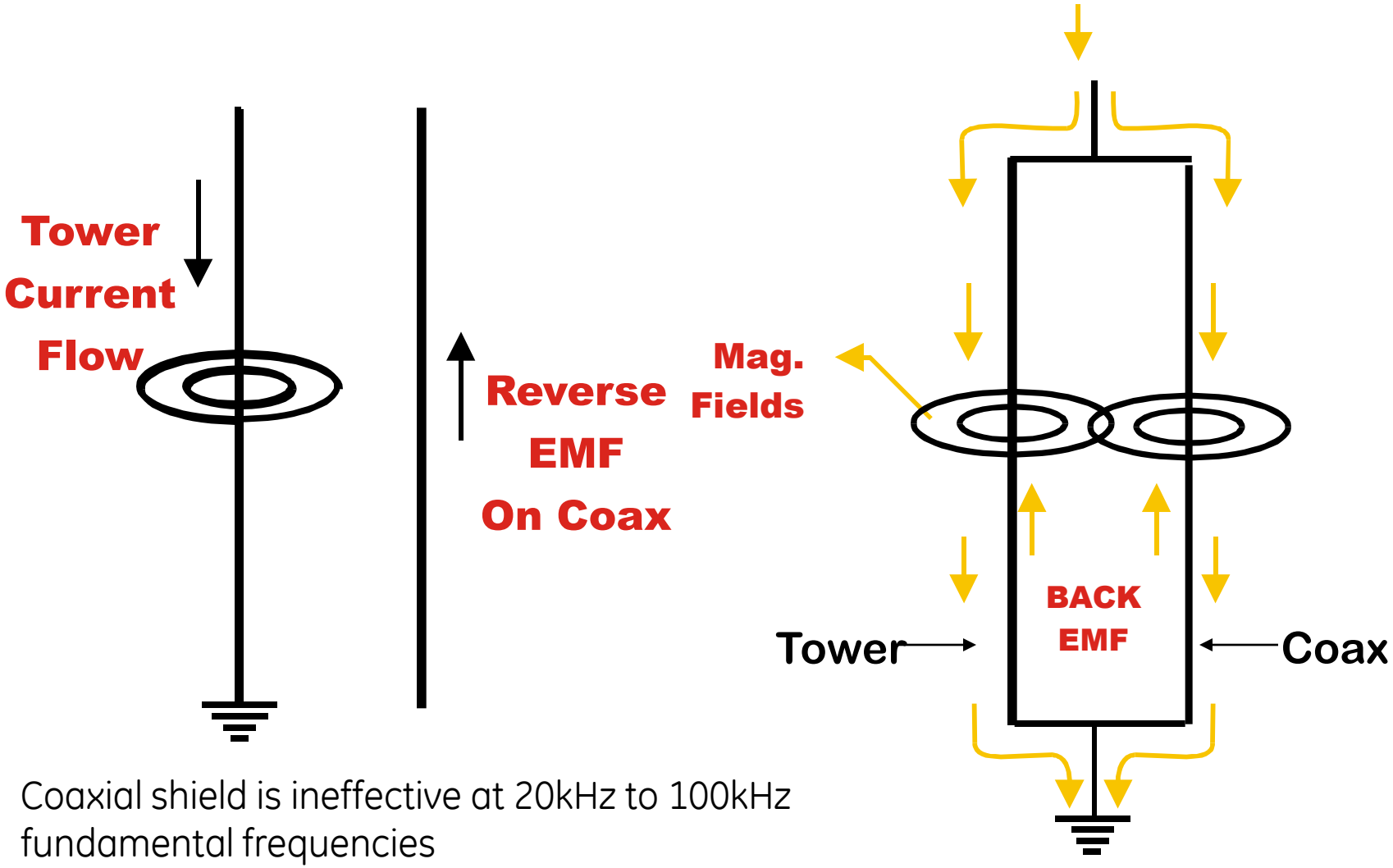


Inductive voltage drop across entire 40uH tower with 2us rise time and peak current of 18kA E=-Ldi/dt

Magnetic field coupling into coaxial cable from current flow down the tower can cause a reverse emf on the coax, opposing downward current flow, and creating a differential voltage between tower and coax. Coax cable insulation could breakdown and allow an arc back to the tower.

An additional ground kit at the tower center brings the shield back to tower potential reducing peak voltages and the probability of coax breakdown

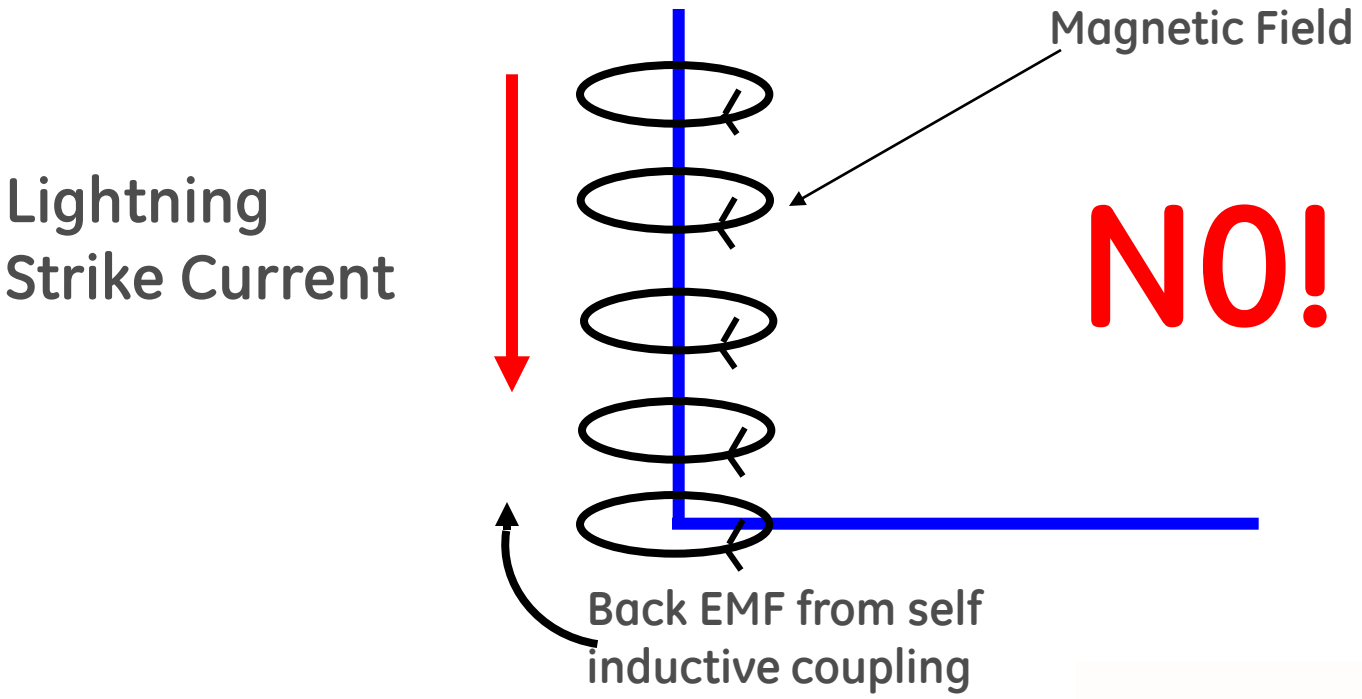
Coupling Effects



Coaxial shield is ineffective at 20kHz to 100kHz fundamental frequencies

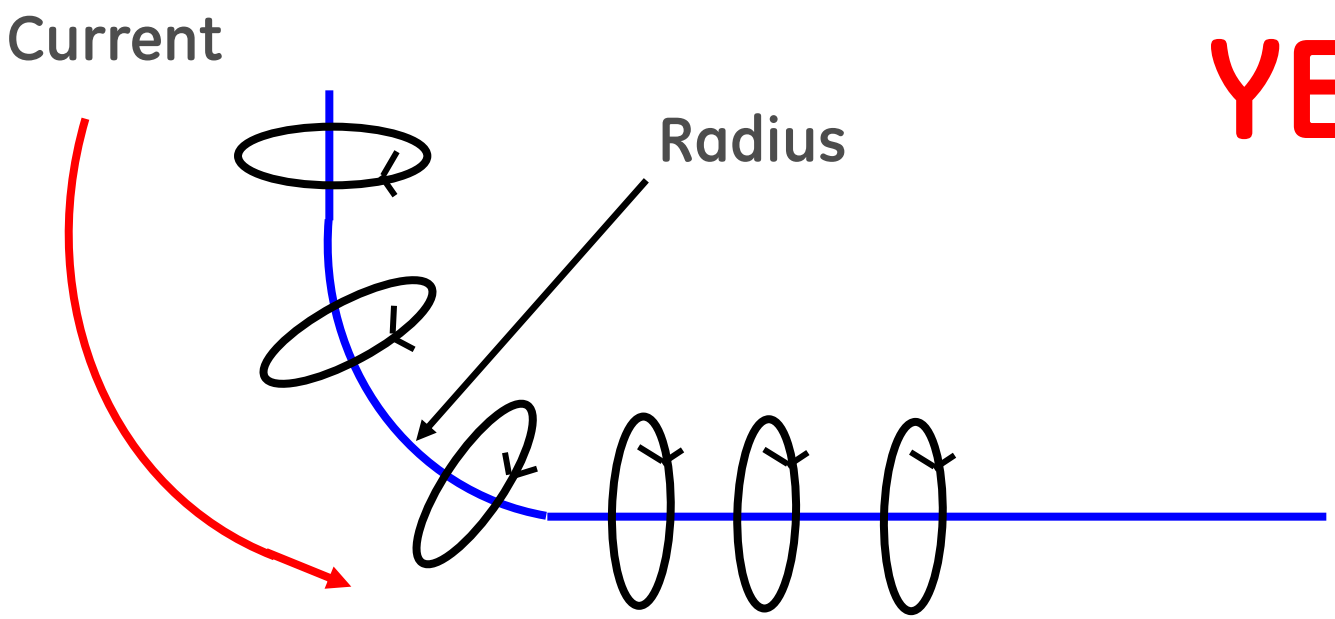
Down Conductors

Down conductors used for lightning protection must not have sharp bends.



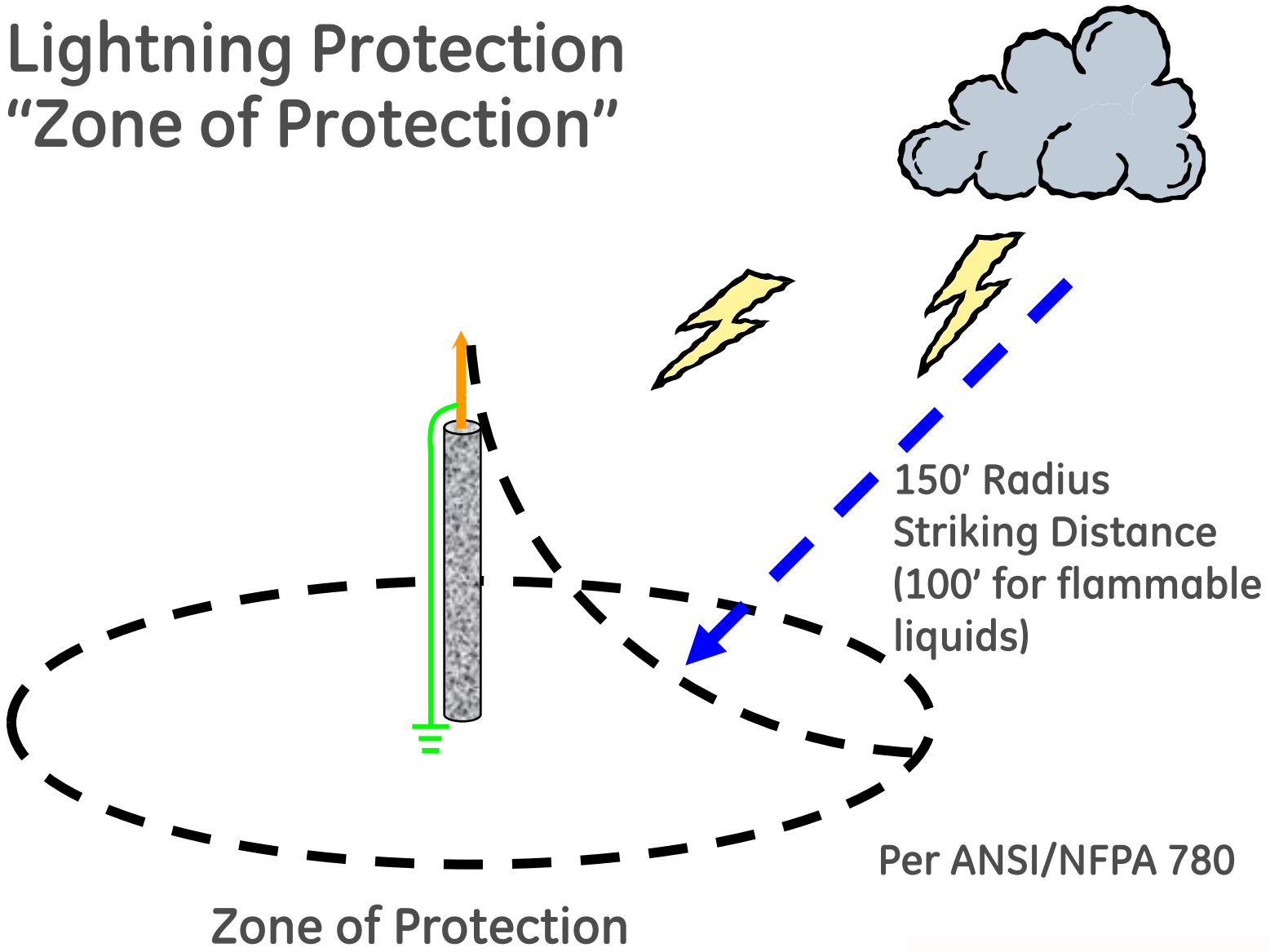
Down Conductors

Proper bending requires a sufficient radius and no bends less than 90 degrees



Lightning in the Ground

Lightning Protection
"Zone of Protection"



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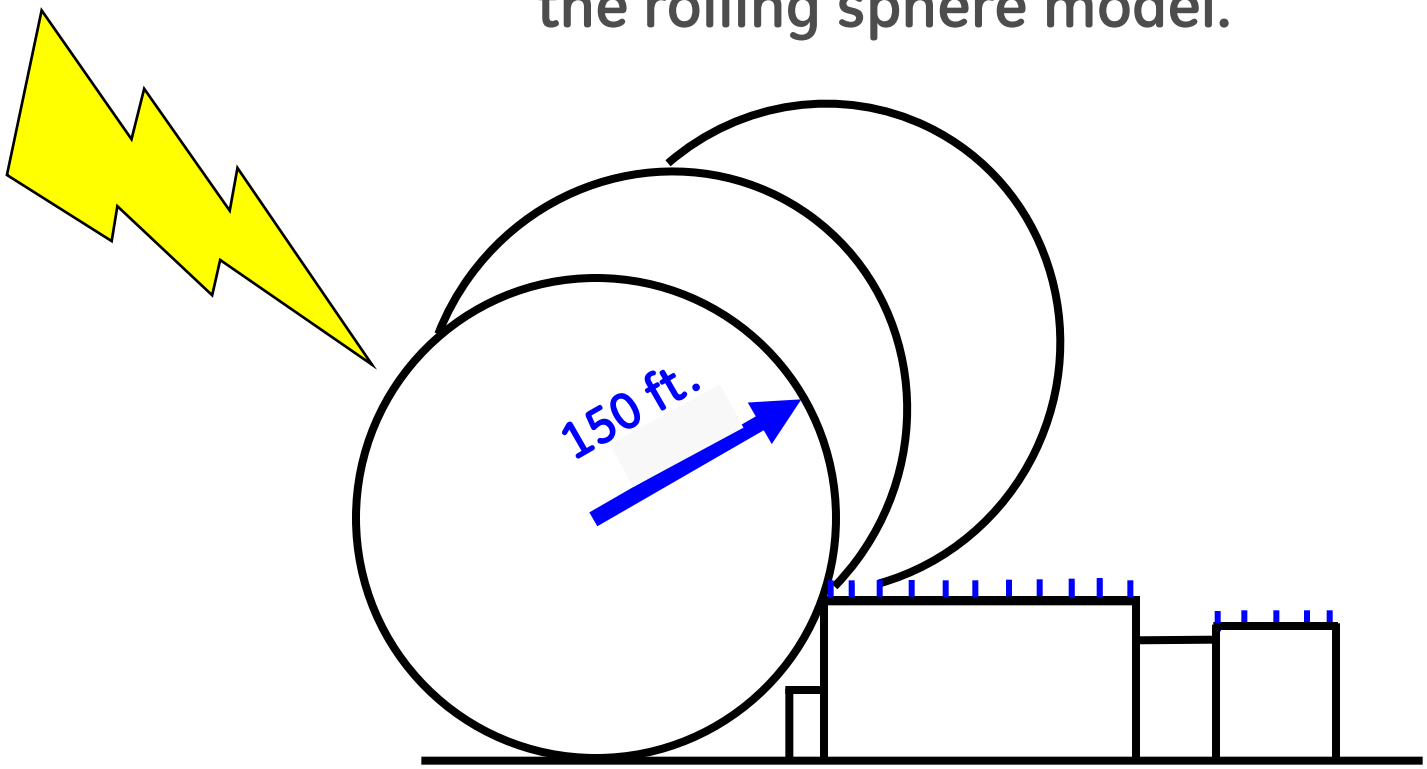
Placement of Air Terminals

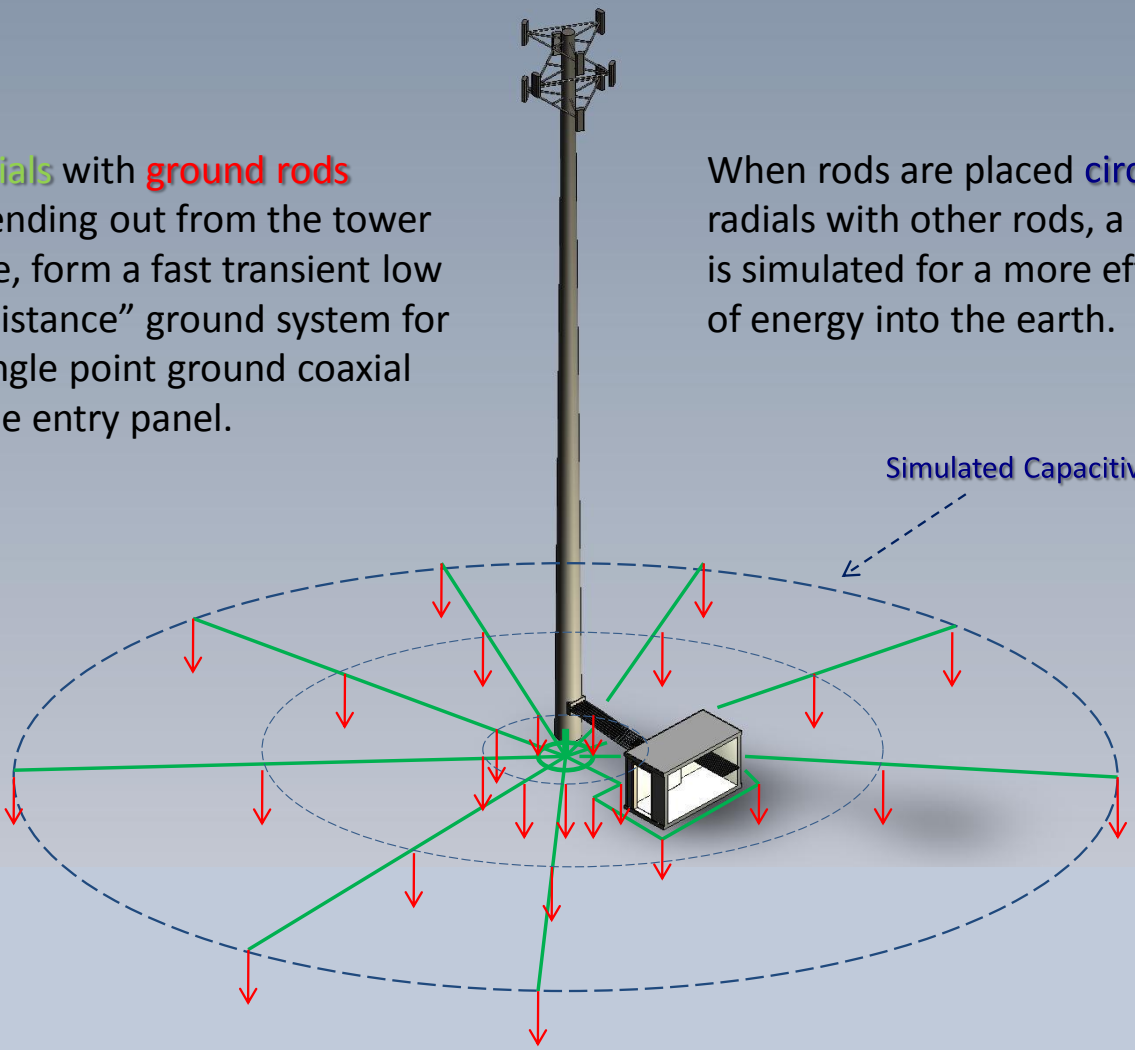
The Zone of Protection from lightning strikes can be defined using the rolling sphere model.



Radial and Ground Rod System

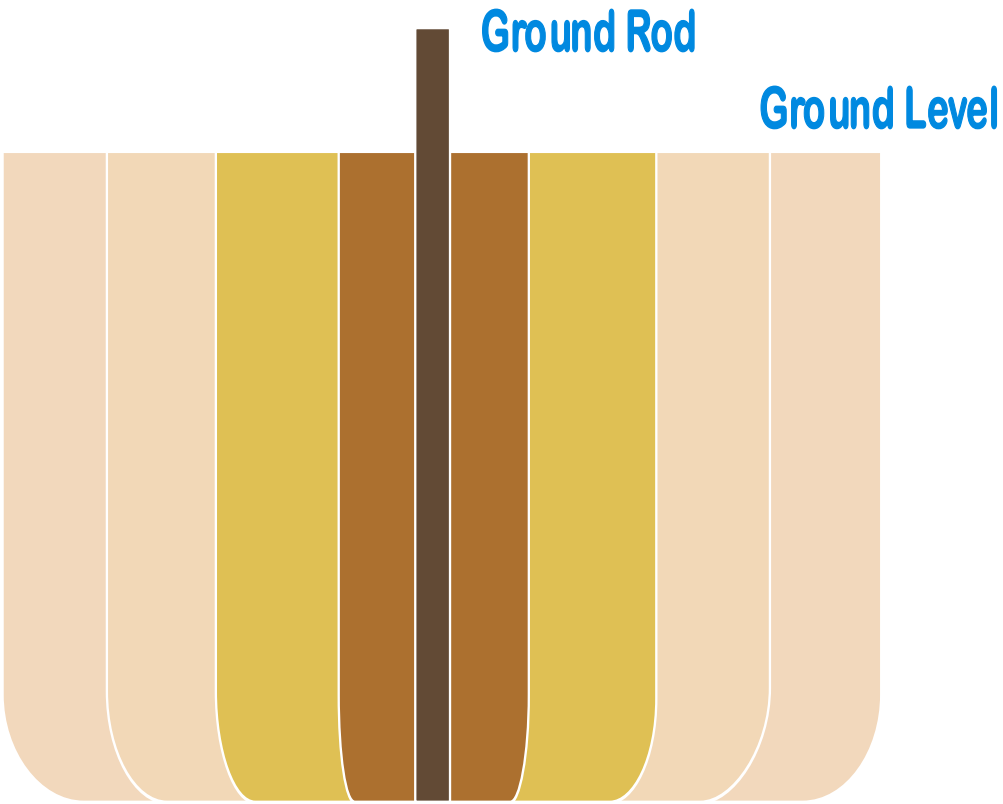
Radials with ground rods extending out from the tower base, form a fast transient low "resistance" ground system for a single point ground coaxial cable entry panel.

When rods are placed circularly along radials with other rods, a capacitive plate is simulated for a more efficient transfer of energy into the earth.



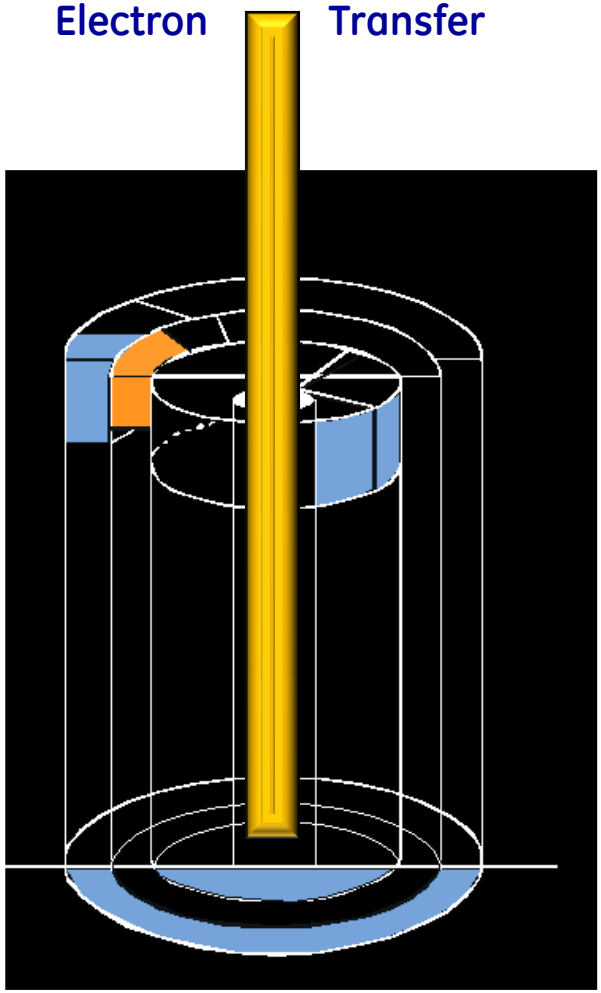
Ground Electrode

Sphere of Influence
Step Potential



Soil compaction-displacement

Electron Transfer



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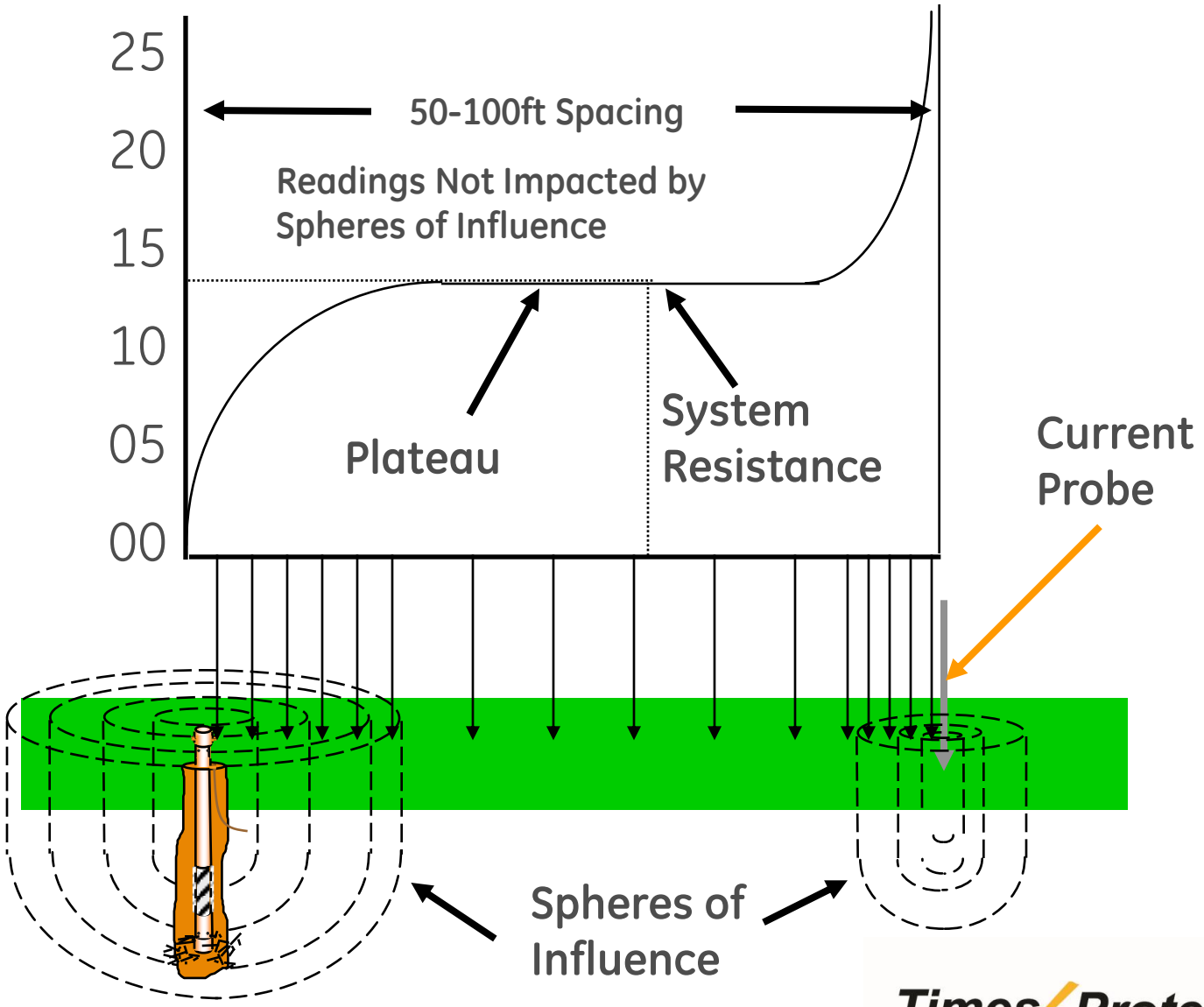
Fall of Potential Test



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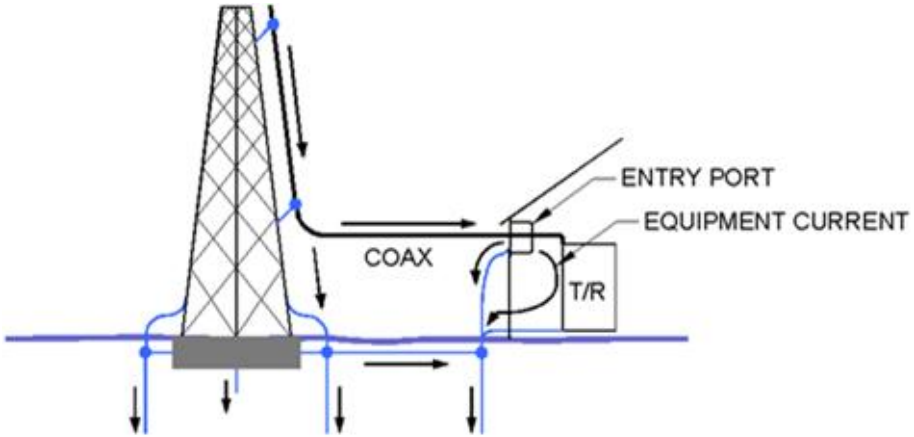
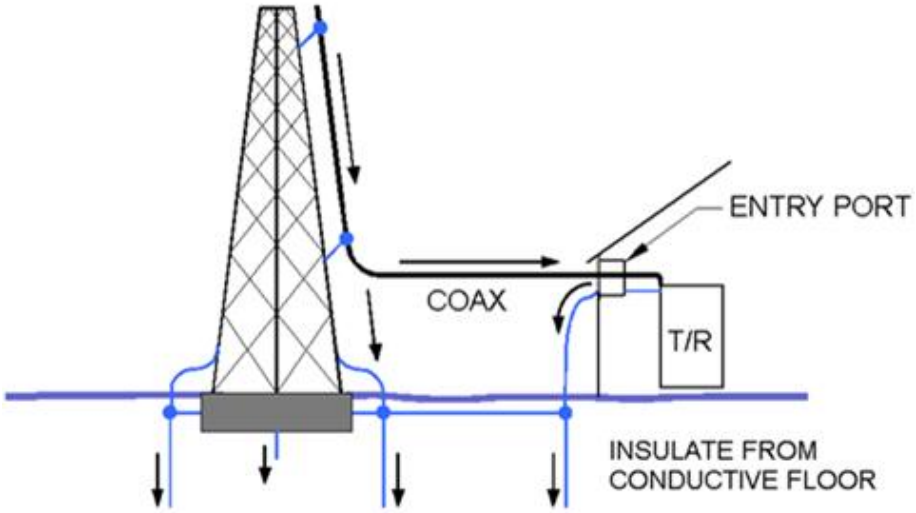
Typical Grounding Requirements:

– NFPA 70 NEC	< 25 OHMS or two rods
– IEEE Standard 142	Equipment Dependent
– IEEE Standard 1100	< 5 OHMS
– Motorola R-56	< 5 OHMS
– Verizon Wireless 8501	< 5 OHMS
– Bell Mobility Cellular	< 5 OHMS
– Essilor	< 3 OHMS
– GE Medical Systems	< 2 OHMS

Equipment Grounding with Coax Entering from a High Entry Panel



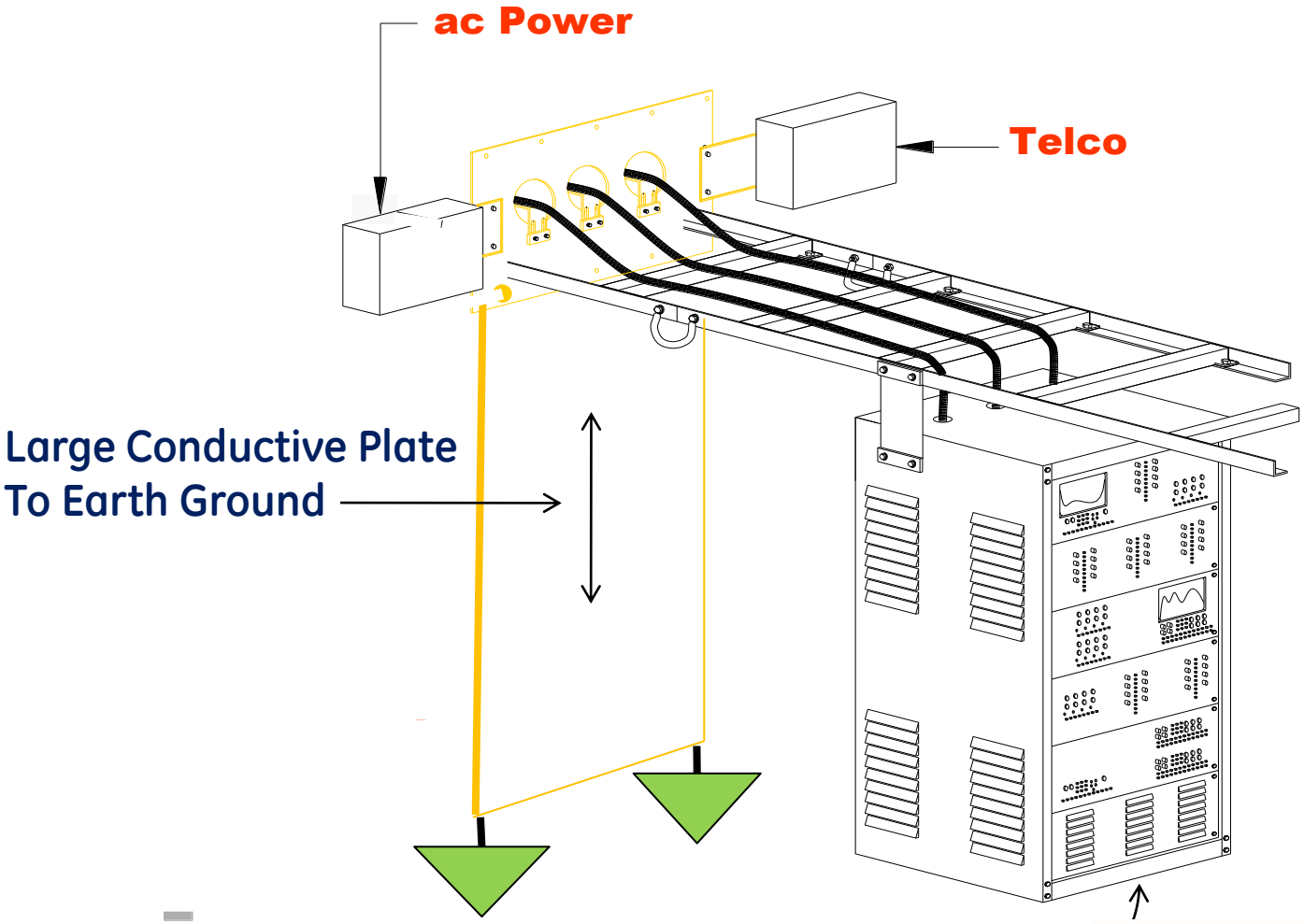
- Grounding at bottom of the rack creates a path for surge current to traverse the rack, upsetting or destroying equipment.



- Proper grounding of the equipment rack. If coax jumper cables enter at the top, ground high. If they enter low, ground low. There will be minimal current flow through the rack.

Single Point Ground in a Communications Shelter

with bonded ac power and telephone protectors



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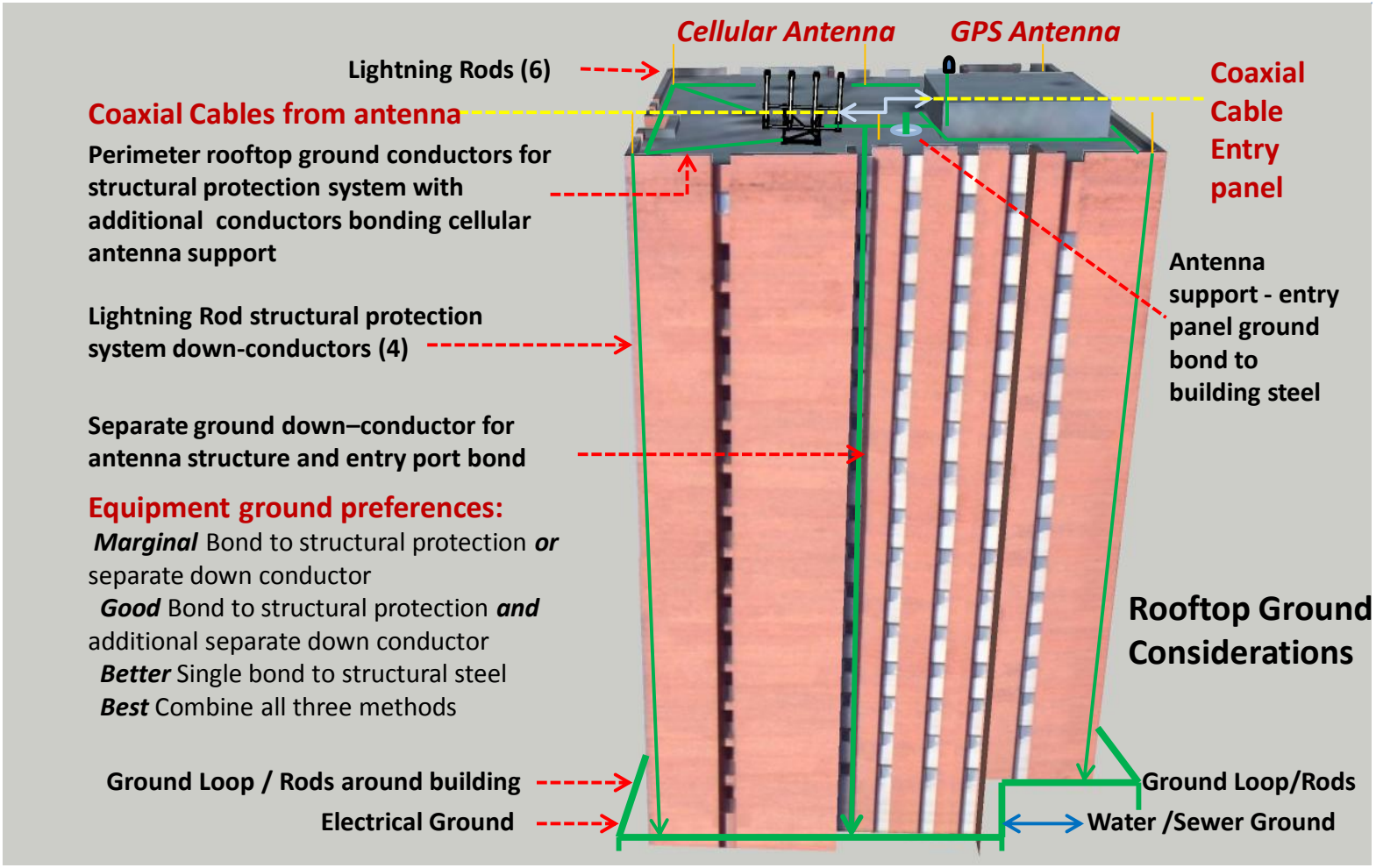
Rooftop Installations



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Tower Leg Grounding (UFER vs. AWG #2)

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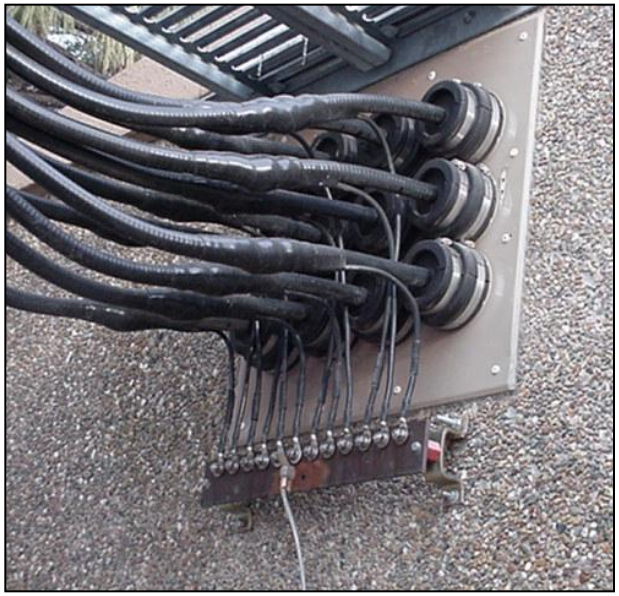
Outside communication shelter copper theft fix



After the fix

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Damage and Fix

External grounding after theft

The high impedance fix

Shelter exterior view

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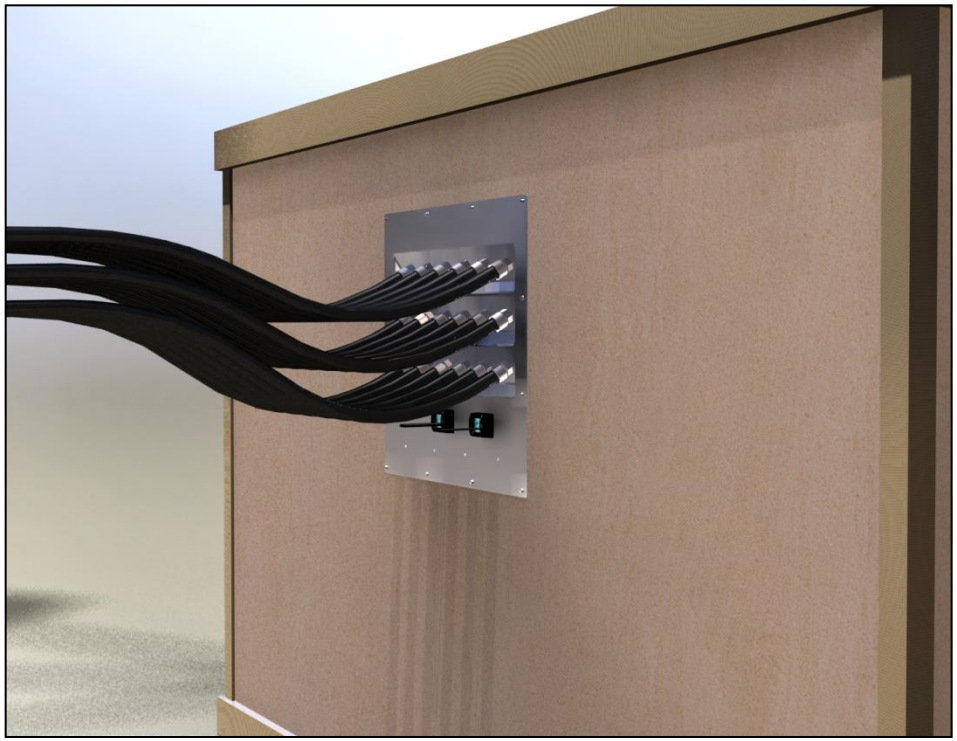
External view of traditional method and proposed solution



Traditional method consisting of:

- High material and labor cost
- Lack of provisions for other service entries
- Theft exposure
- Very high impedance return path to ground
- High preventative maintenance

Proposed method:

- Addresses theft issue
- Does not require external shield grounding kits
- Makes provisions for Coax/EWG/Data/DC and fiber
- Minimal labor cost
- All prep work performed at the shelter manufacturer

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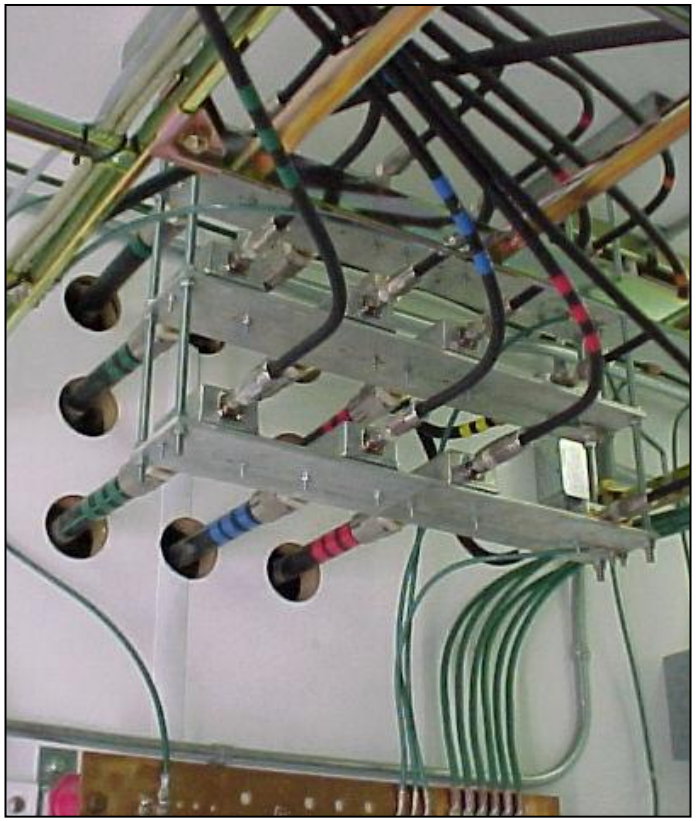
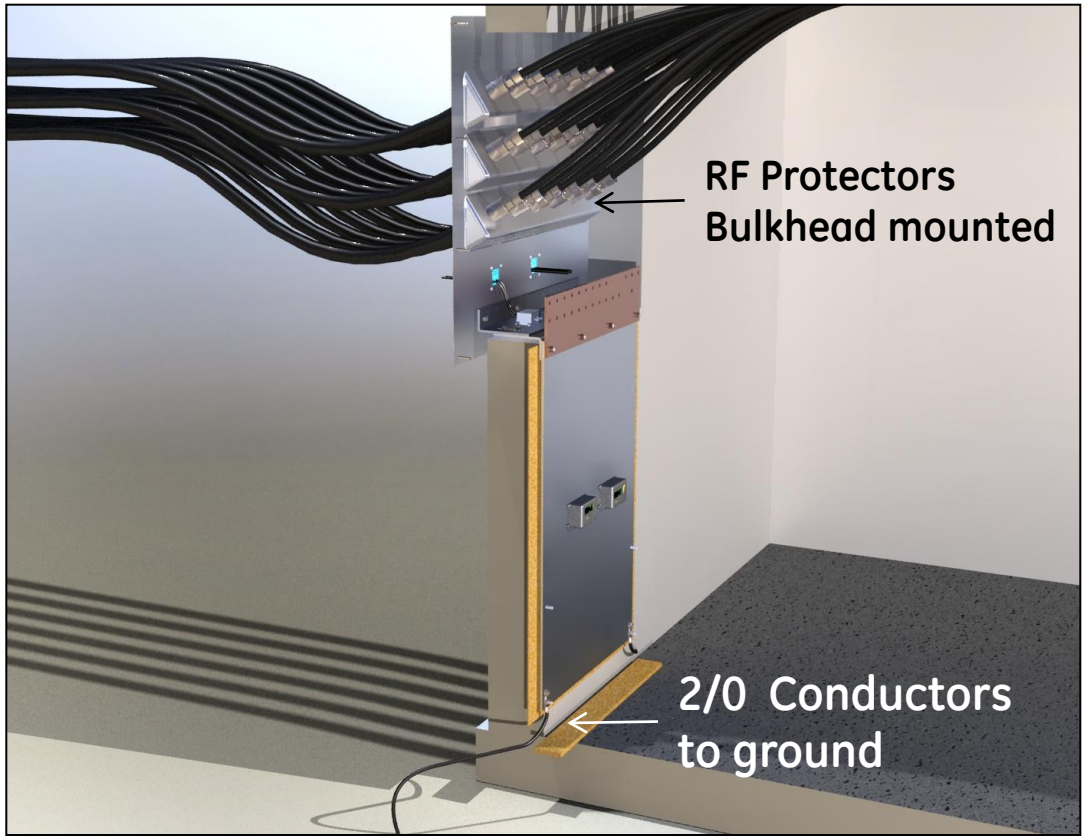
Interior view of traditional method and proposed solution





Traditional method:

- Requires separate Inside MGB (IMGB)
- Trapeze or other method to ground SPDs
- Performance affected by long ground wires
- High impedance IMGB ground conductor
- Single point ground by installation
- High ground loop probability

Propose method:

- All RF protectors bulkhead mounted for best surge performance
- Assembly accommodates different wall thickness
- Provisions for grounding of all protectors to the same SPG
- Low impedance ground path for lightning current
- Control of MGB potential rise due to low "L" of assembly
- Accommodates for additional equipment mounting

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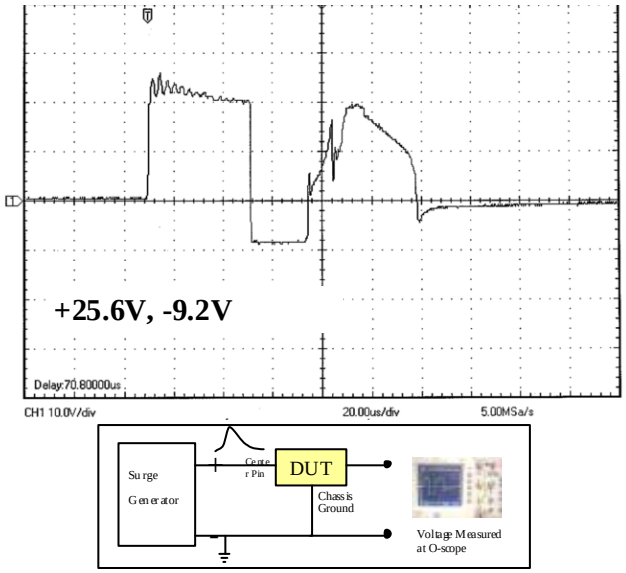
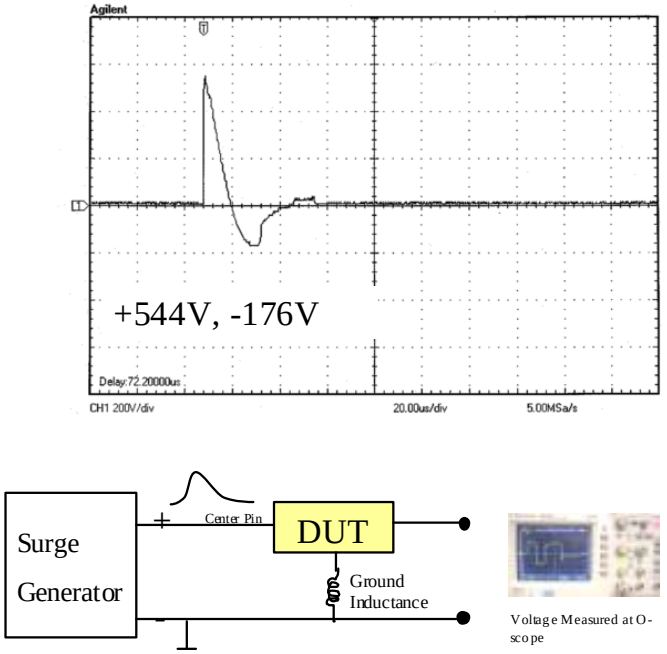
Ground lead considerations for installation of RF protectors
Applied surge wave-shape 6KV/3KA (8X20us)

Bulkhead mounted SPD without added ground "L"
Surge return directly connected to protector ground



Effects of 1.5 ft ground lead inductance of #1 AWG Cu wire
Voltage and energy throughput drastically increases

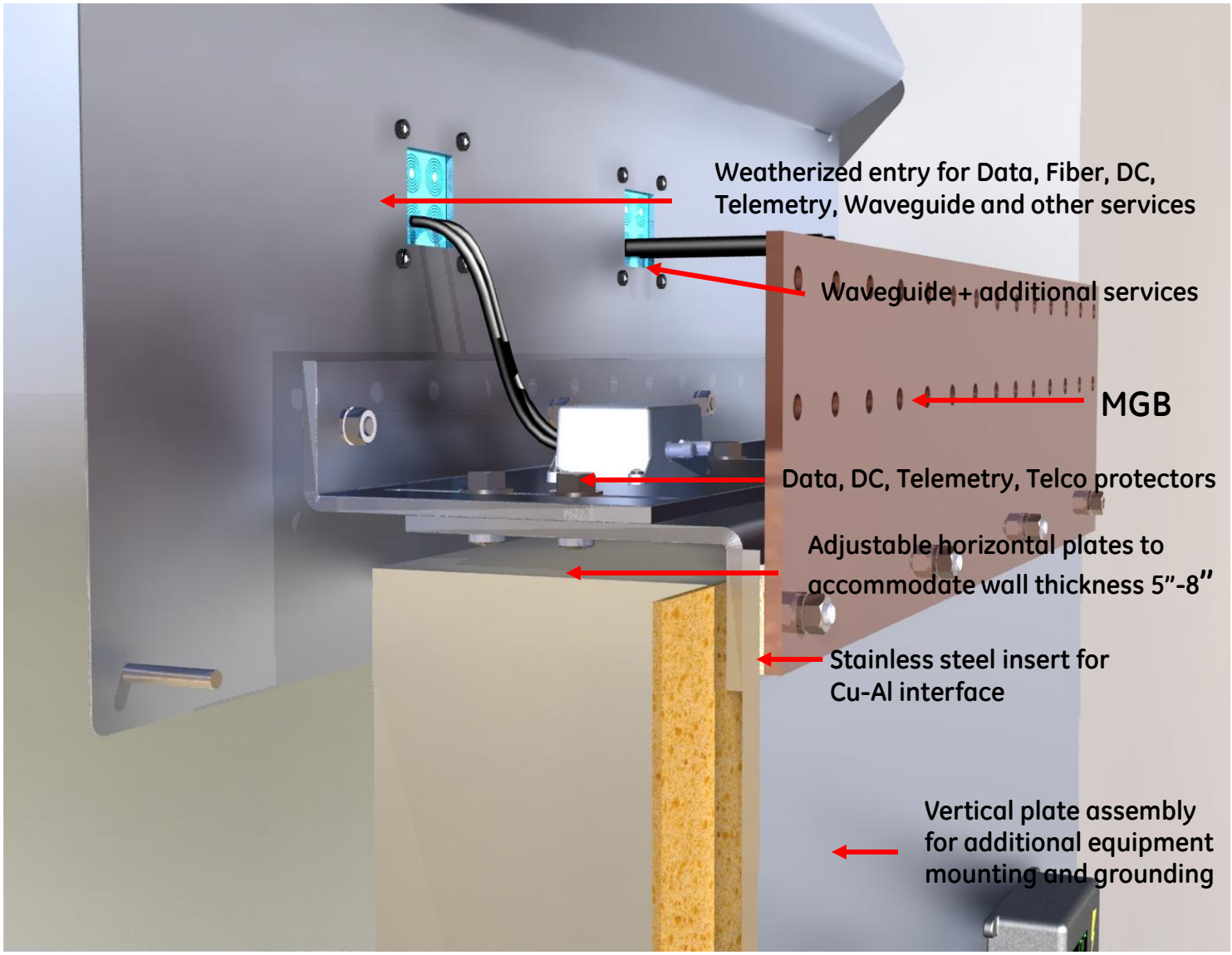


Note: The length of the grounding conductor connected to any lightning protection device has a major effect on the protector performance as illustrated by the above test. Leadless/Bulkhead installation technique for RF lightning protection devices will eliminate this additive voltage and energy throughput to the protected equipment

TIMES MICROWAVE SYSTEMS

Times Protect™

Inside Components Description



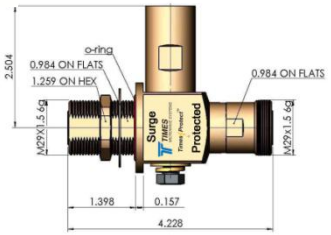
SmartPanel™

Intelligently designed to effectively conduct lightning current to earth ground while balancing the need for security and economy

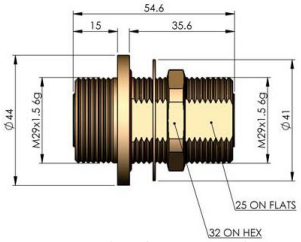
TIMES MICROWAVE SYSTEMS

TimesProtect™

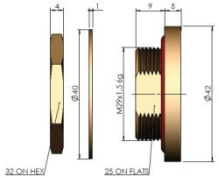
Smart Panel™



Lightning Protectors



Feed-through
LP-FT-DFDF
LP-FT-NFNF



Blank Plug
LP-DP
LP-NP

TIMES MICROWAVE SYSTEMS

Times Protect™

Smart Panel™

TIMES MICROWAVE SYSTEMS

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SmartPanel™

Included installation hardware

- 3/8” x 2” Tamper Resistant Galv Lag Screw
- 3/8” Short Galv Lag Shield
- 3/8” x 1-3/4” Tamper Resistant Bolt
- 3/8” SS Flat Washer
- 3/8” Lock Washer
- 3/8” SS Hex Nut
- Ground Lug 2/0 AWG
- Tamper Resistant Wrench
- Hole Cutout Template

Available accessories

- **Lightning Protectors**

Based on Network Requirements

- **Feed Through Connectors:**

LP-FT-DFDF (DIN Feed-Through)
LP-FT-NFNF (N Feed-Through)

- **Blank Hole Plugs:**

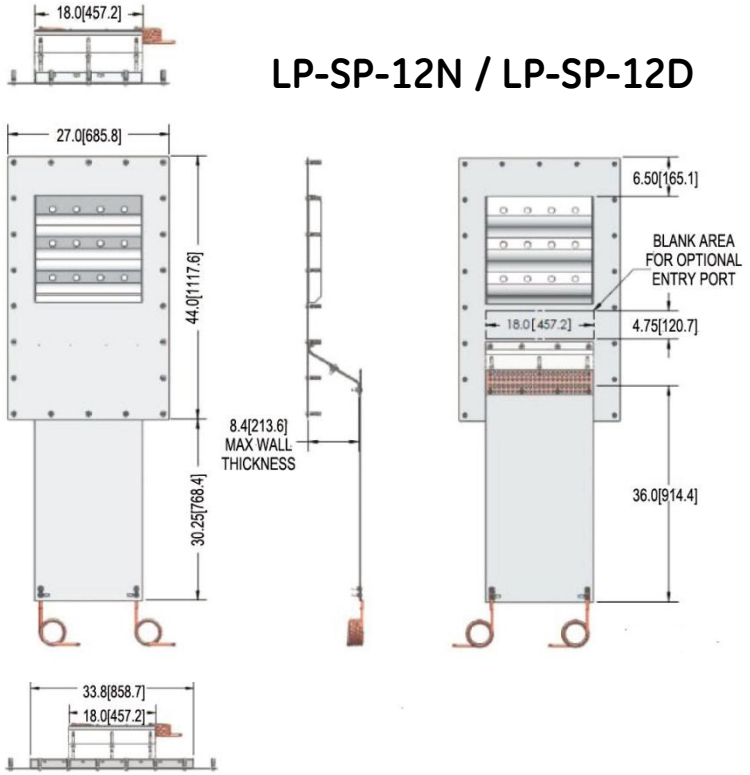
LP-DP (DIN Hole Plug)
LP-NP (N Hole Plug)

Specifications:

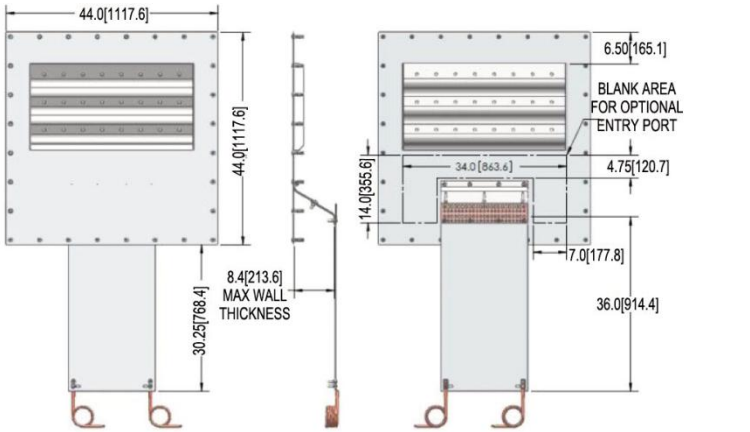
Material :	**6061-T6**
Master Ground Bar:	**C110 Copper**
Finish:	**Powder Coat**
Weight (lbs):	**50 (12 Port) 58 (24 Port)**

TIMES MICROWAVE SYSTEMS

LP-SP-12N / LP-SP-12D



LP-SP-24N / LP-SP-24D



TimesProtect™

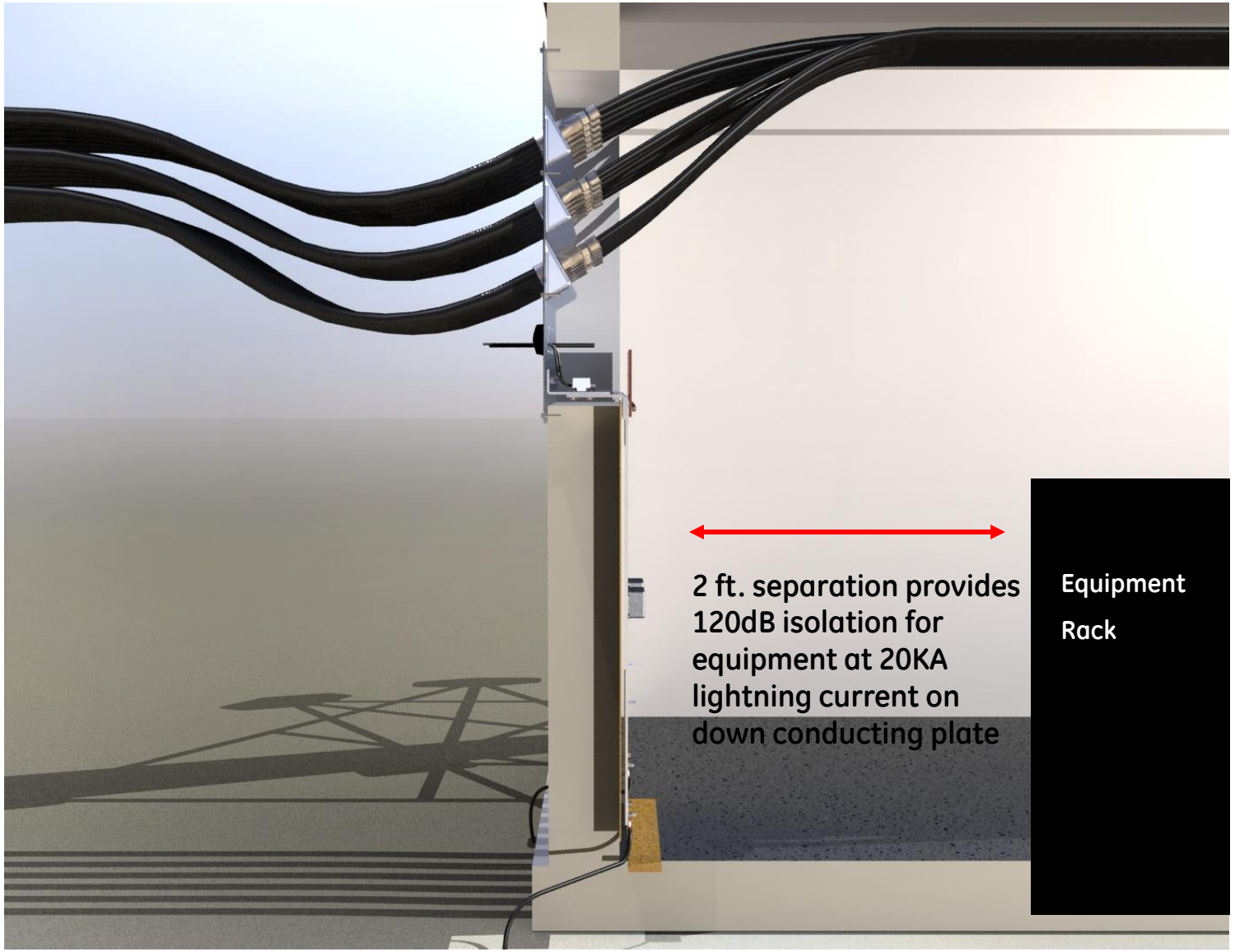
Installed view-metal building

Installed views

TIMES MICROWAVE SYSTEMS

TimesProtect™

Mutual coupling and isolation considerations



TIMES MICROWAVE SYSTEMS

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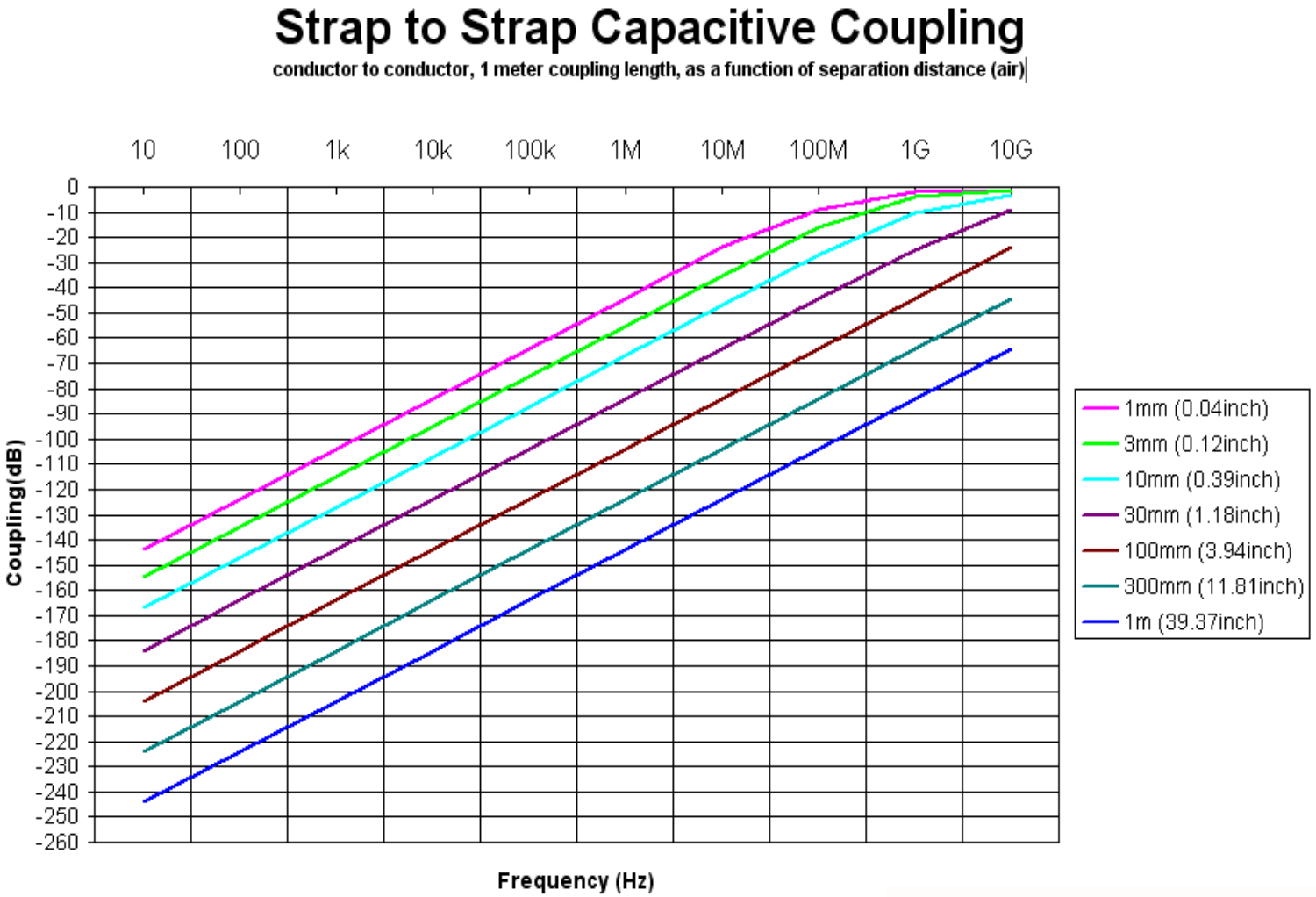
EMI coupling effects

$$dB = 20\log\left(\frac{A_1}{A_2}\right)$$



TIMES MICROWAVE SYSTEMS

Times Protect™

Material Conductivity Comparison

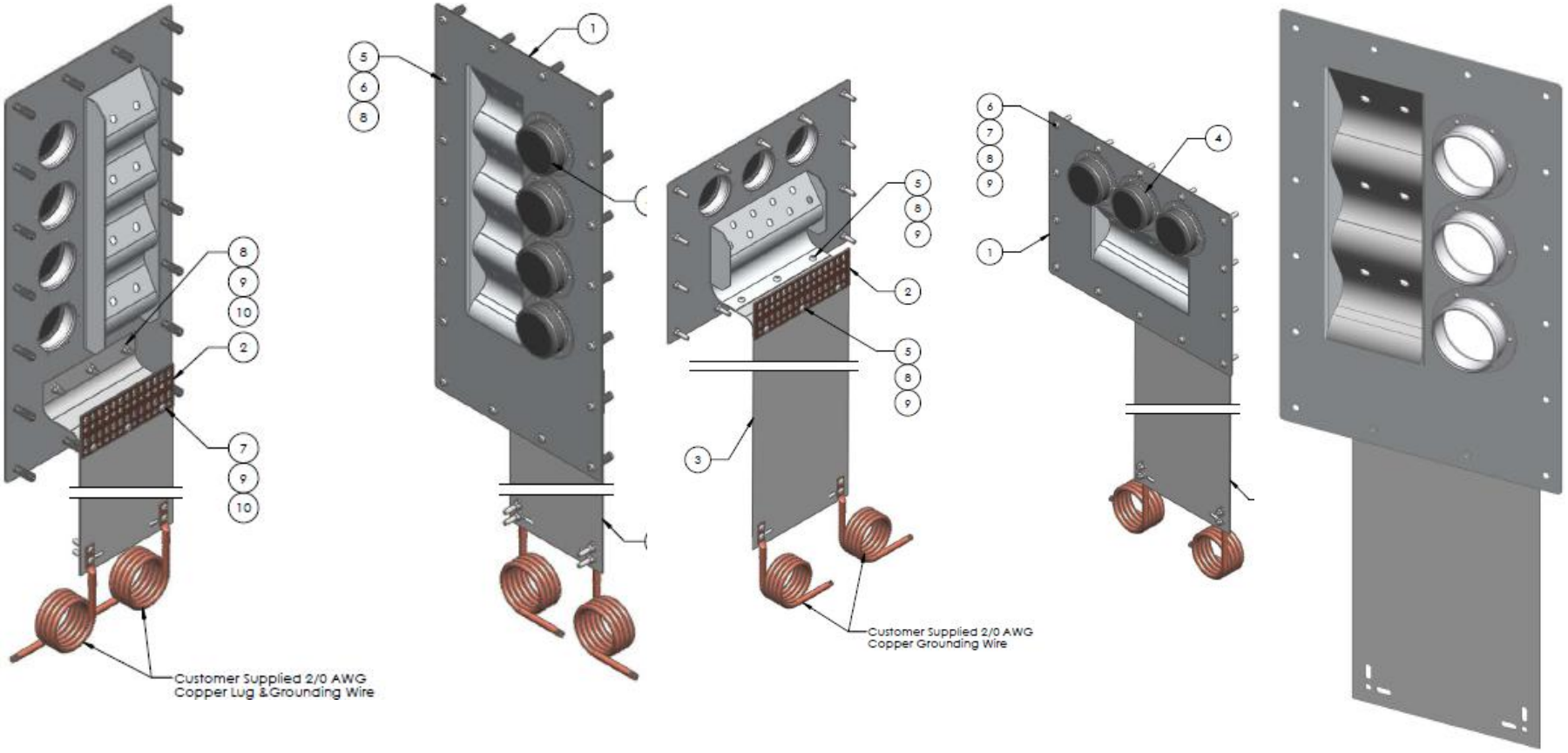
Some typical electrical conductivities [edit]

	Electrical Conductivity ($S \cdot m^{-1}$)	Temperature (°C)	Notes
Silver	63.01×10^6	20	Highest electrical conductivity of any metal
Copper	59.6×10^6	20	
Annealed Copper	58.0×10^6	20	Referred to as 100 %IACS or International Annealed Copper Standard. The unit for expressing the conductivity of nonmagnetic materials by testing using the eddy-current method. Generally used for temper and alloy verification of Aluminium.
Aluminium	37.8×10^6	20	

Benefits of New Design Approach

- Single point grounding accomplished by design.
- 30 Degree RF feeder entries for easy access, better weatherization, and water drip curve.
- Accommodates 12 or 24 RF feeder cables, wave guide, data, telemetry, DC & fiber entries .
- Impedance and inductance controlled through geometry of design.
- Provisions for installation of LP Devices to create true single point grounding.
- Materials: Al 6061-T6 Standard, C110 copper optional.
- No external coax ground kits required, eliminating potential water ingress.
- Theft proof design.
- Weatherized to IP-65.
- Protector throughput voltage lower than other panel designs using long ground conductors.
- Adjustable to shelter wall thickness.
- Provisions for lightning strike counter and ground resistance monitor with remote alarms.
- Allows installation of multiple lightning protectors on the same ground reference plane.
- Easily connects to external lightning designed ground system. A low impedance, fast transient response Radial and Ground Rod System is best.

Various “Smart-Panel” Configurations



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Protector Grounding ???

TIMES MICROWAVE SYSTEMS

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When everything else fails, there is always plastic tie!

Applications overview

DC blocked for isolation of antenna and equipment ports for superior surge performance. These designs consisting of DC blocked and DC short do not allow for passing power on the center pin.

DC pass designs for applications requiring power to be supplied to the Tower Top Electronics. Selection of RF Power and DC Voltage is critical to ensure proper operation.

Wireless Broadband applications requiring DC blocking on Center Pin operating from 2000-6000MHz.
L1, L2 and L3 GPS protectors with High Pass filter in the RF path and DC pass solid state protection for powering GPS systems

TIMES MICROWAVE SYSTEMS

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RF Protection Technologies Performance Overview

TIMES MICROWAVE SYSTEMS

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The preferred method for product recommendation is by obtaining the actual network operating data as opposed to competitor part number as cross-ref.
There are many overlaps in competitive products which might otherwise disqualify our parts, even though our products could satisfy customer requirements.

Product Application Selection Guide

Impedance (Ohms):_____

Operating frequency: _____

Maximum RF power (CW):_____

Peak power (if required): _____

IL/RL/VSWR (if required): IL_____RL_____VSWR_____

PIM (if required): _____

Maximum surge current (kA) (if required): _____

Voltage and energy throughput (if required):_____

Single or multichannel application: _____

If power is required on center pin provide the following data? Yes No

- Maximum Voltage and polarity (+/-): _____
- Maximum Current: _____
- Maximum Power: _____

Connector type (DIN/N): _____

Connector gender (F/M): Surge site_____ Protected site_____

Grounding (check one) (bulkhead) (flange) (screw terminal) (BF adaptor)
Operating temp range (if known): _____

Weatherization requirements: _____

APPLICATION NOTES:

_____
_____
_____

Customer: _____

Address: _____

Contact:_____

Email: _____

Phone: _____

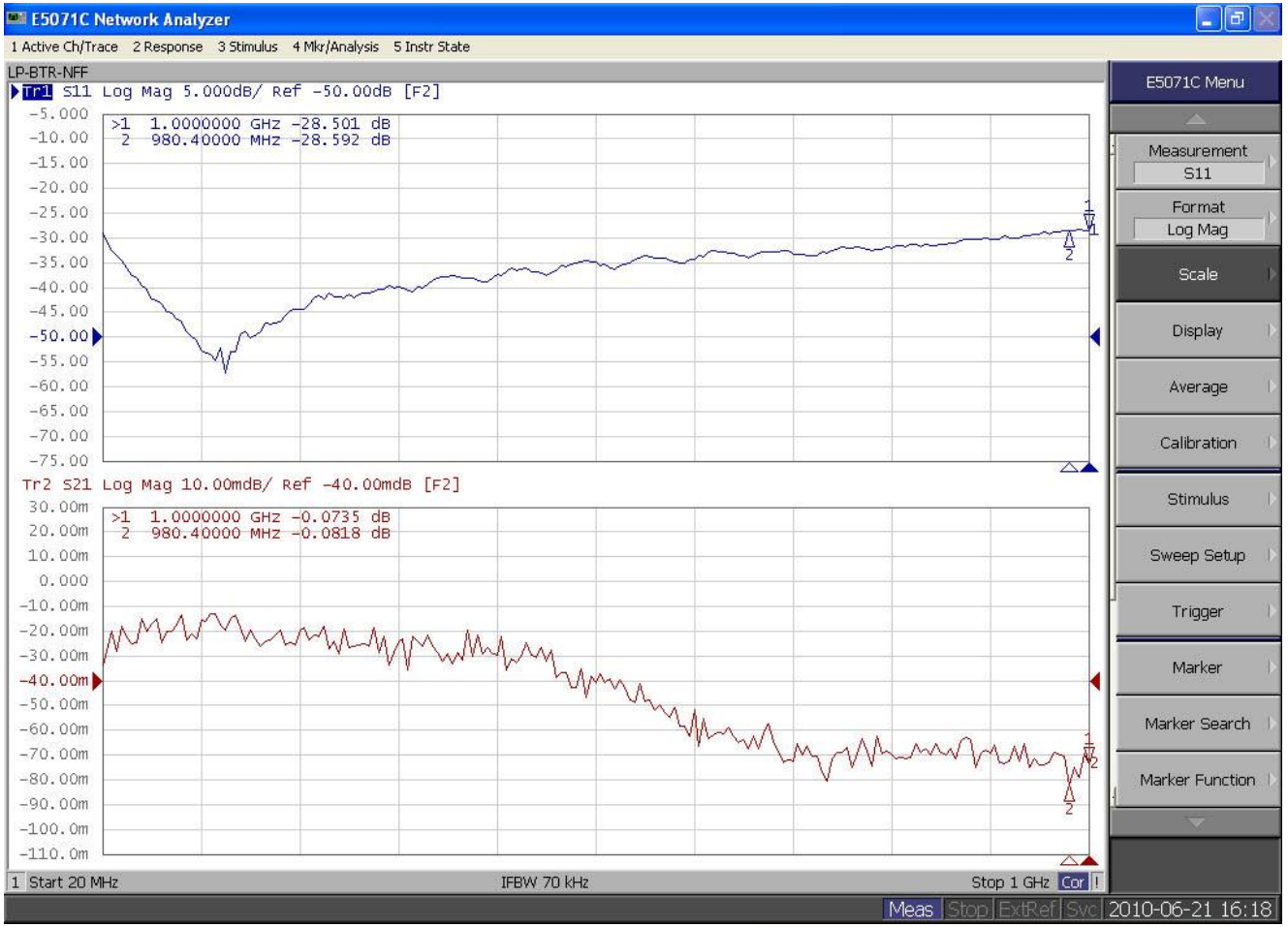
Forward To:
Your Times Inside Sales Rep, or Times Regional Sales Manager, or Bogdan.Klobasa@timesmicro.com

TIMES MICROWAVE SYSTEMS

Times Protect™

LP-BTR-N Series DC blocked (20-1000MHz)

- •LP-BTR-NFF N Female/Female
- •LP-BTR-NMP N Male on Protected
- •LP-BTR-NMS N Male on Surge

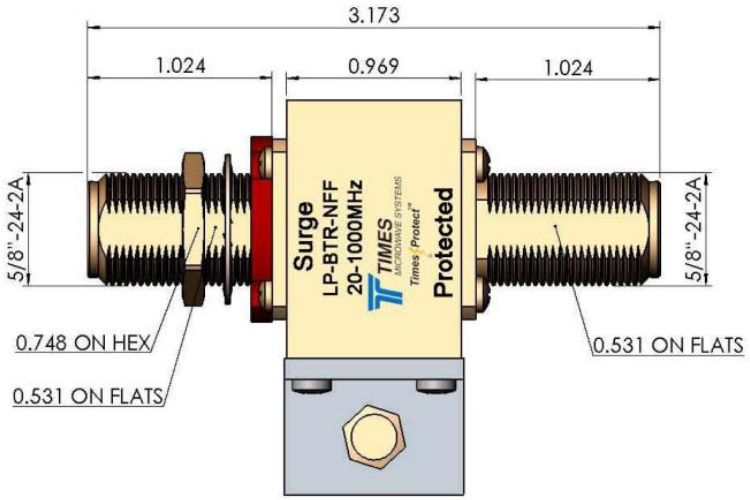


- •DC blocked design
- •Multi-strike capability
- •Broad band performance up to 1GHz
- •Exceptional RF characteristics
- •Universal bulkhead and flange mounting
- •Elongated Female connectors
- •Weatherization gasket included
- •Solid Brass design / White Bronze plating
- •Phosphor Bronze center pin construction
- •Silver plated center pin
- •Insertion Loss: < 0.1dB
- •Return Loss: <-26dB
- •VSWR: <1.1:1
- •Energy throughput: <200uJ

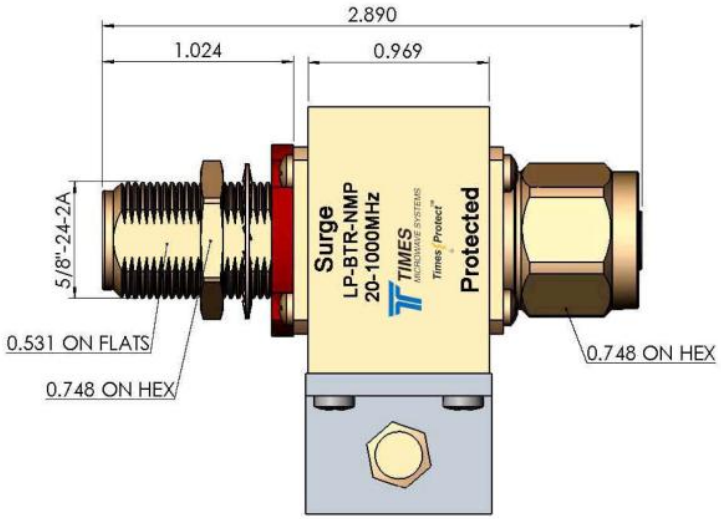
TIMES MICROWAVE SYSTEMS

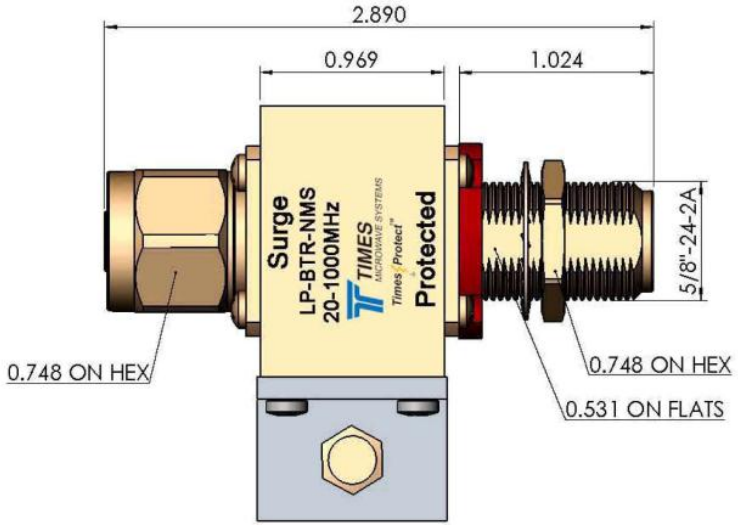
Times Protect™

LP-BTR-N Series mechanical specifications



- LP-BTR-NFF — N Female/Female
- LP-BTR-NMP — N Male on Protected
- LP-BTR-NMS — N Male on Surge



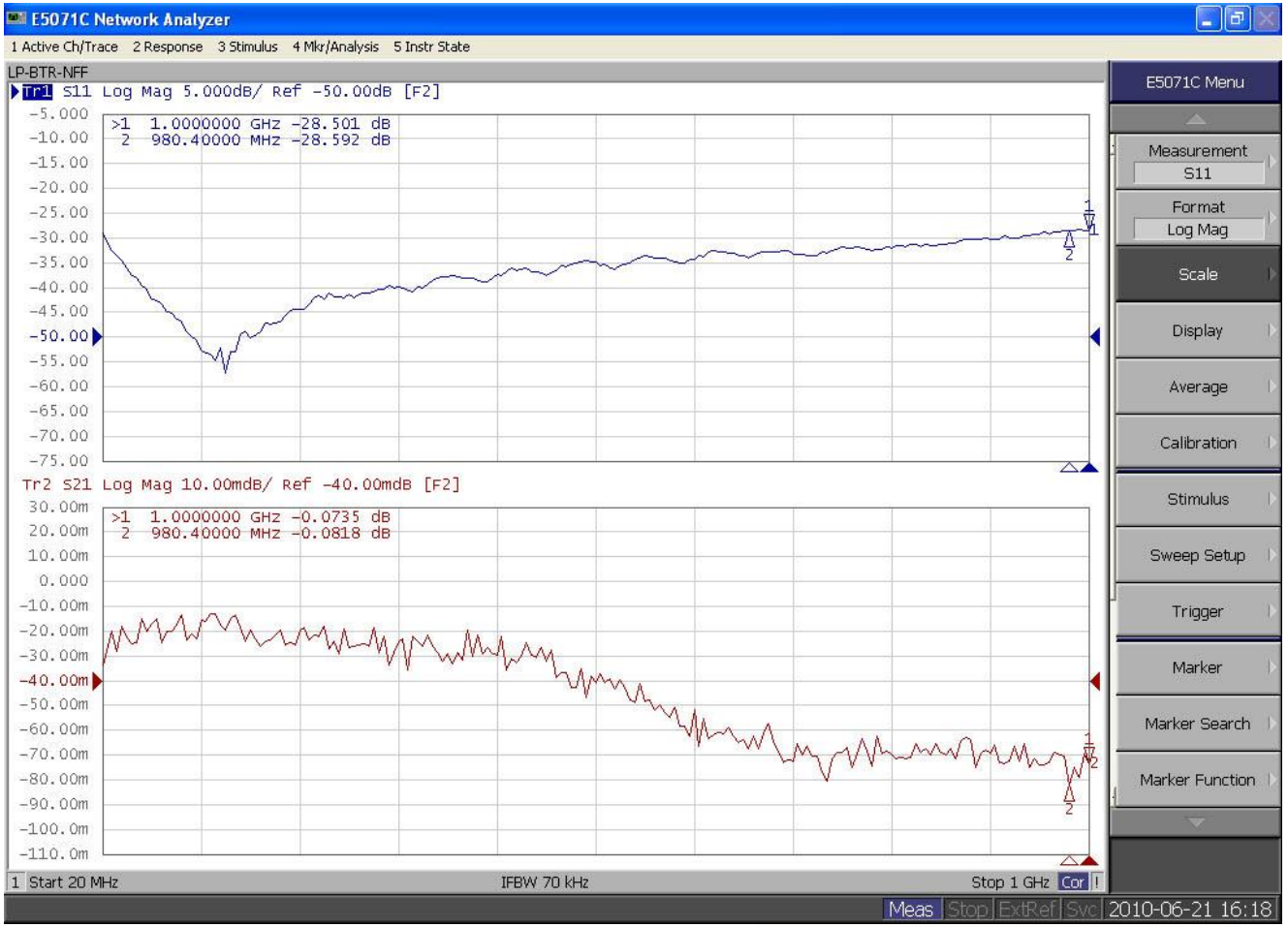


TIMES MICROWAVE SYSTEMS

Times Protect™

IP67 Weatherized LP-BTRW-N Series DC blocked (20-1000MHz)

- •LP-BTRW-NFF N Female/Female
- •LP-BTRW-NMP N Male on Protected
- •LP-BTRW-NMS N Male on Surge

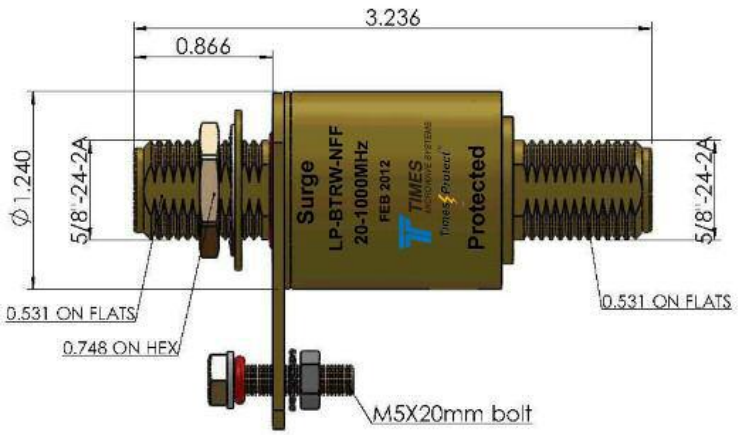


- •DC blocked design
- •Multi-strike capability
- •Broad band performance up to 1GHz
- •Exceptional RF characteristics
- •Universal bulkhead and flange mounting
- •Elongated Female connectors
- •Weatherization gasket included
- •Solid Brass design / White Bronze plating
- •Phosphor Bronze center pin construction
- •Silver plated center pin
- •Insertion Loss: < 0.1dB
- •Return Loss: <-26dB
- •VSWR: <1.1:1
- •Energy throughput: <200uJ
- • IP67 Weatherized

TIMES MICROWAVE SYSTEMS

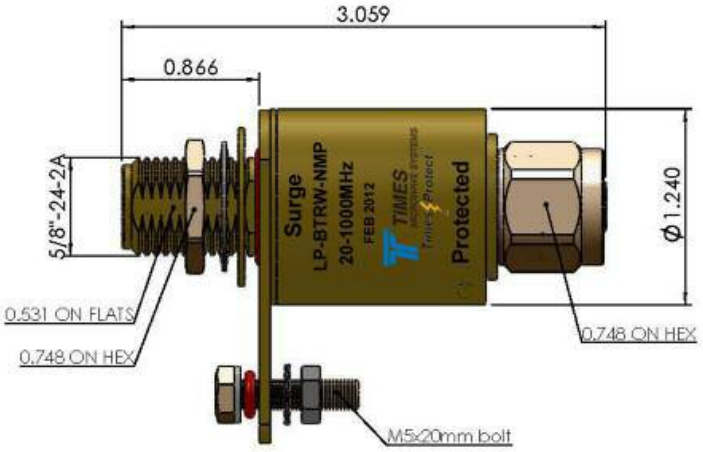
Times Protect™

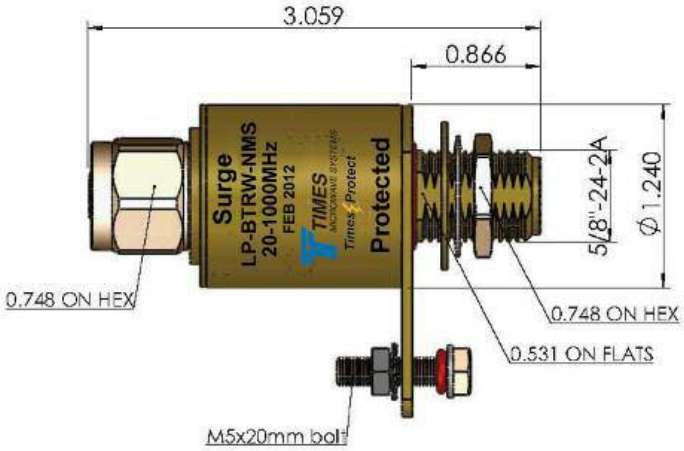
IP67 Weatherized LP-BTRW-N Series mechanical specifications



- LP-BTRW-NFF N Female/Female
- LP-BTRW-NMP N Male on Protected
- LP-BTRW-NMS N Male on Surge

- All Units Weatherized to IP67



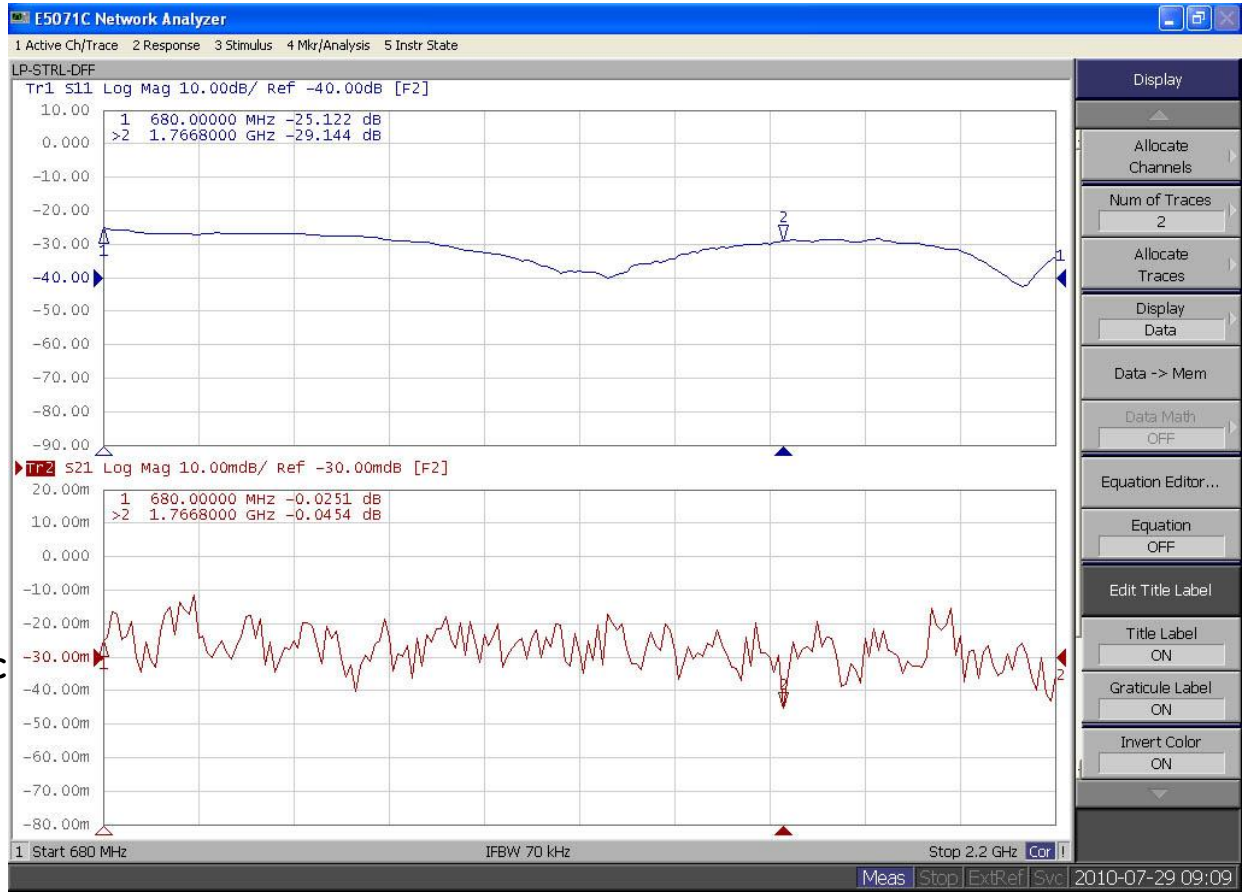


TIMES MICROWAVE SYSTEMS

Times Protect™

LP-STRL-D series DC Blocked (680-2200MHz)

- •LP-STRL-DFF DIN Female/Female
- •LP-STRL-DMP DIN Male on Protected
- •LP-STRL-DMS DIN Male on Surge

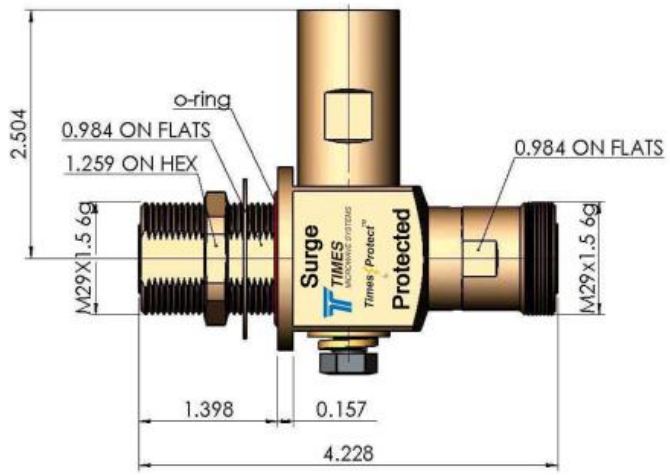


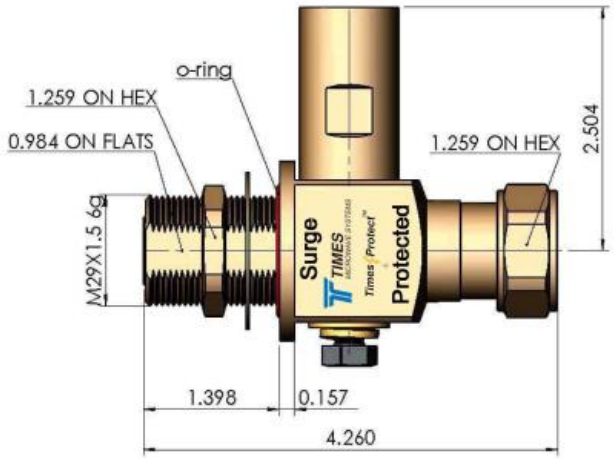
- •Fully weatherized body to IP67
- •Broadband RF performance
- •Multi-strike capability
- •Maintenance free design
- •Maximum surge current: 50kA
- •Throughput voltage: 440mV
- •Throughput energy: 700pJ
- •PIM@ 900/1900/2100MHz: <-160dBc
- •Insertion Loss: < 0.1dB
- •Return Loss: <-26dB

TIMES MICROWAVE SYSTEMS

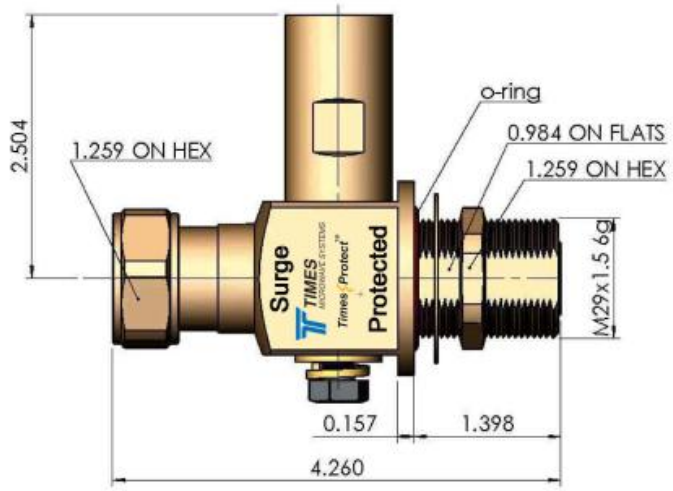
Times Protect™

LP-STRL-D series mechanical specifications





- LP-STRL-DFF DIN Female/Female
- LP-STRL-DMP DIN Male on Protected
- LP-STRL-DMS DIN Male on Surge

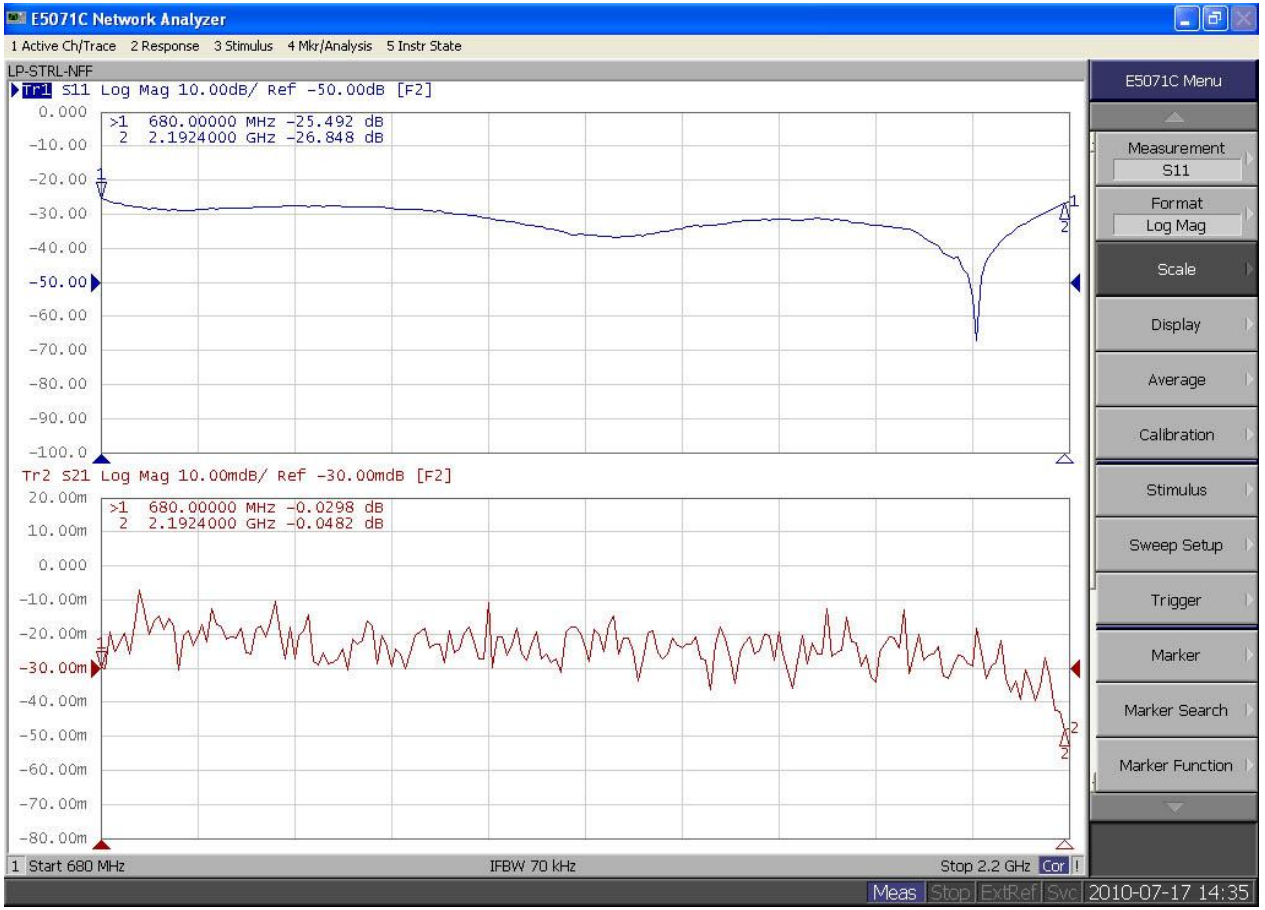


TIMES MICROWAVE SYSTEMS

Times Protect™

LP-STRL-N series DC Blocked (680-2200MHz)

- LP-STRL-NFF N Female/Female
- LP-STRL-NMP N Male on Protected
- LP-STRL-NMS N Male on Surge



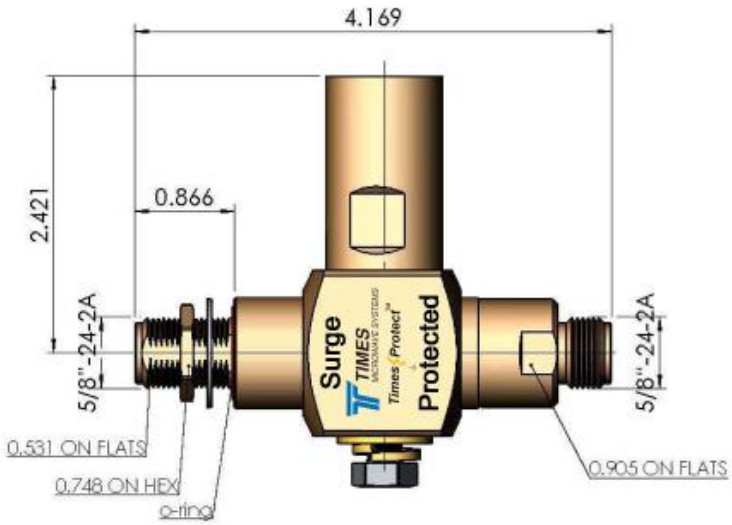
- Fully weatherized body to IP67
- Broadband RF performance
- Multi-strike capability
- Maintenance free design
- Maximum surge current: 50kA
- Throughput voltage: 440mV
- Throughput energy: 700pJ
- PIM@ 900/1900/2100MHz: <-160dBc
- Insertion Loss: < 0.1dB
- Return Loss: <-26dB

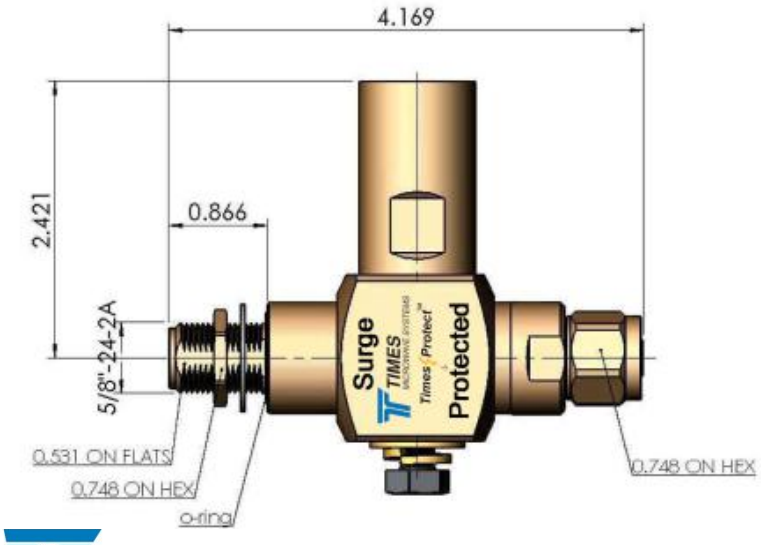
TIMES MICROWAVE SYSTEMS

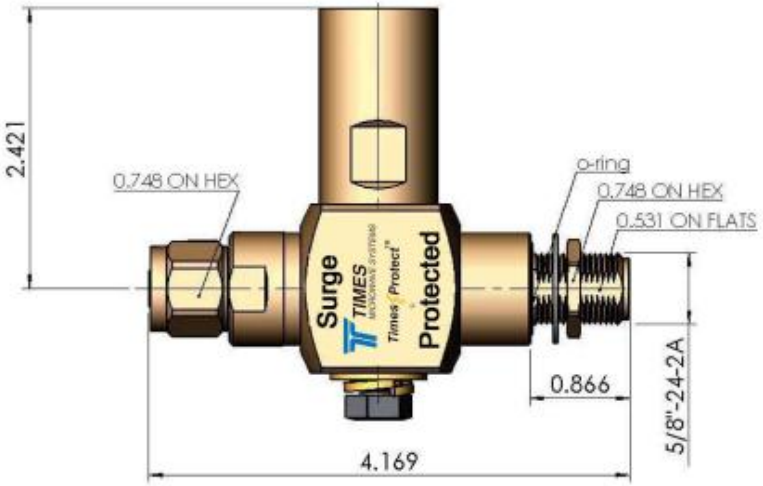
Times Protect™

LP-STRL-N series mechanical specifications

- LP-STRL-NFF N Female/Female
- LP-STRL-NMP N Male on Protected
- LP-STRL-NMS N Male on Surge





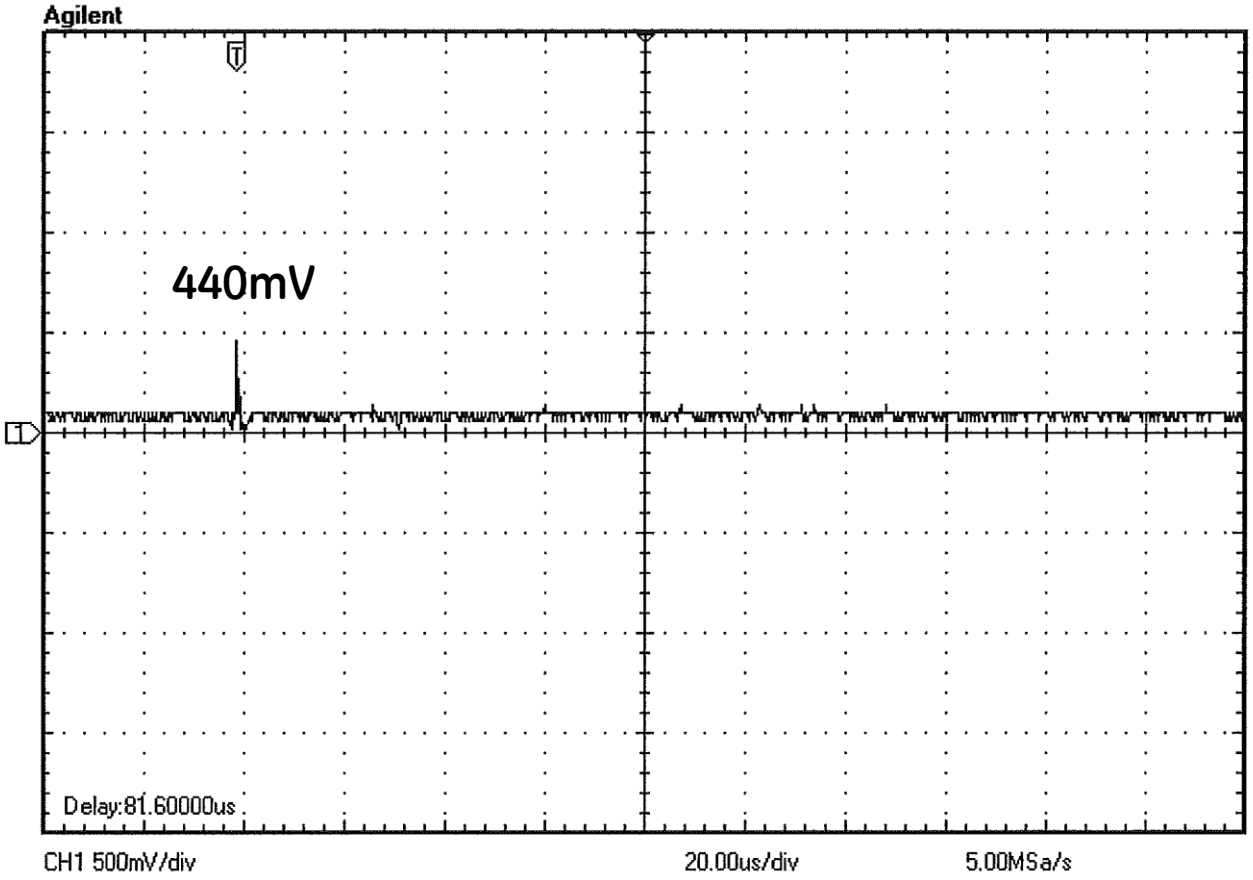


TIMES MICROWAVE SYSTEMS

Times Protect™

LP-STRL Series Voltage Throughput

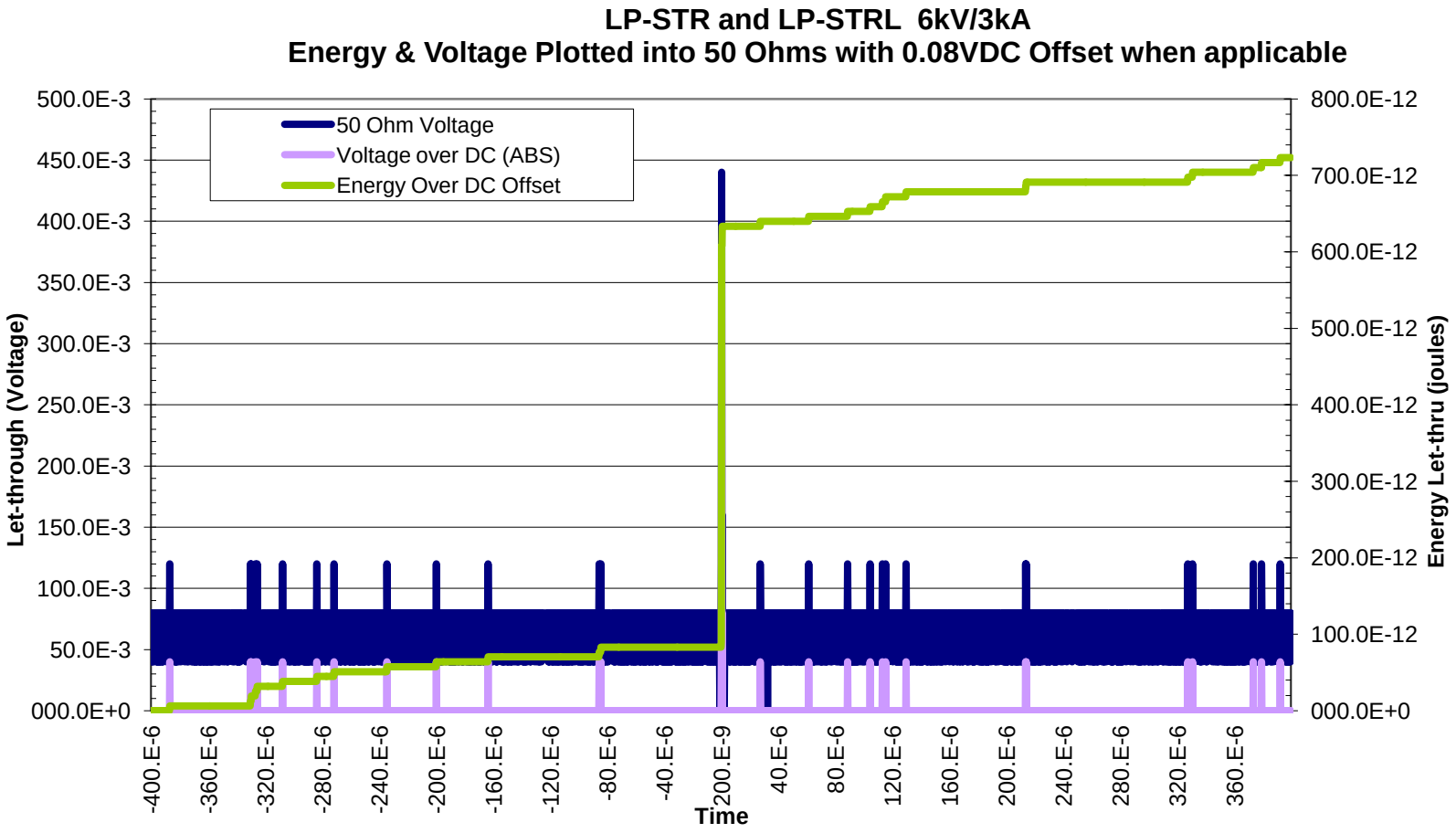
6kV/3kA 1.2x50us/8x20us wave-shape



TIMES MICROWAVE SYSTEMS

Times Protect™

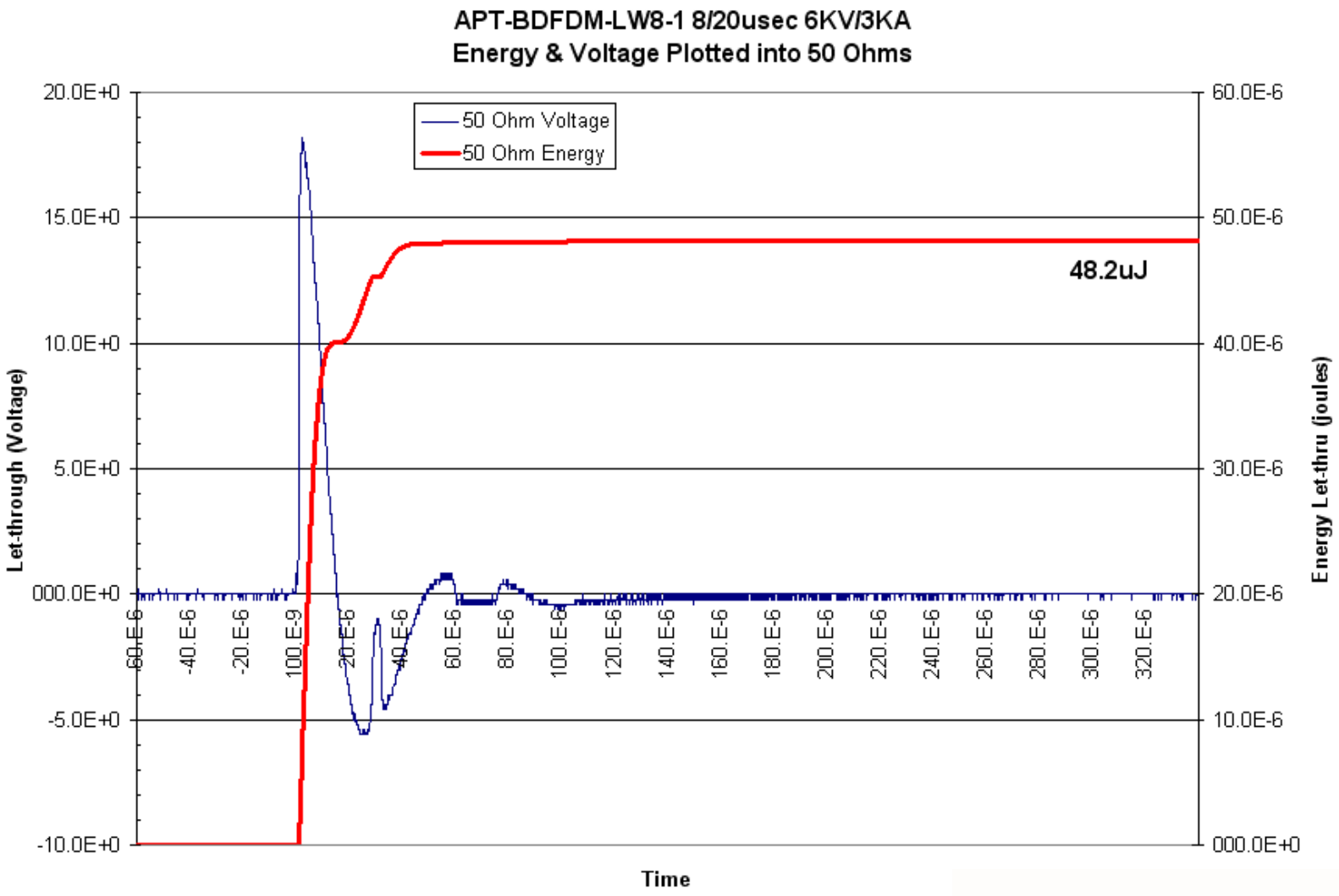
LP-STRL Series Energy Throughput



TIMES MICROWAVE SYSTEMS

Times Protect™

QWS voltage and energy plotted into 50 Ohm load (8x20us)



TIMES MICROWAVE SYSTEMS

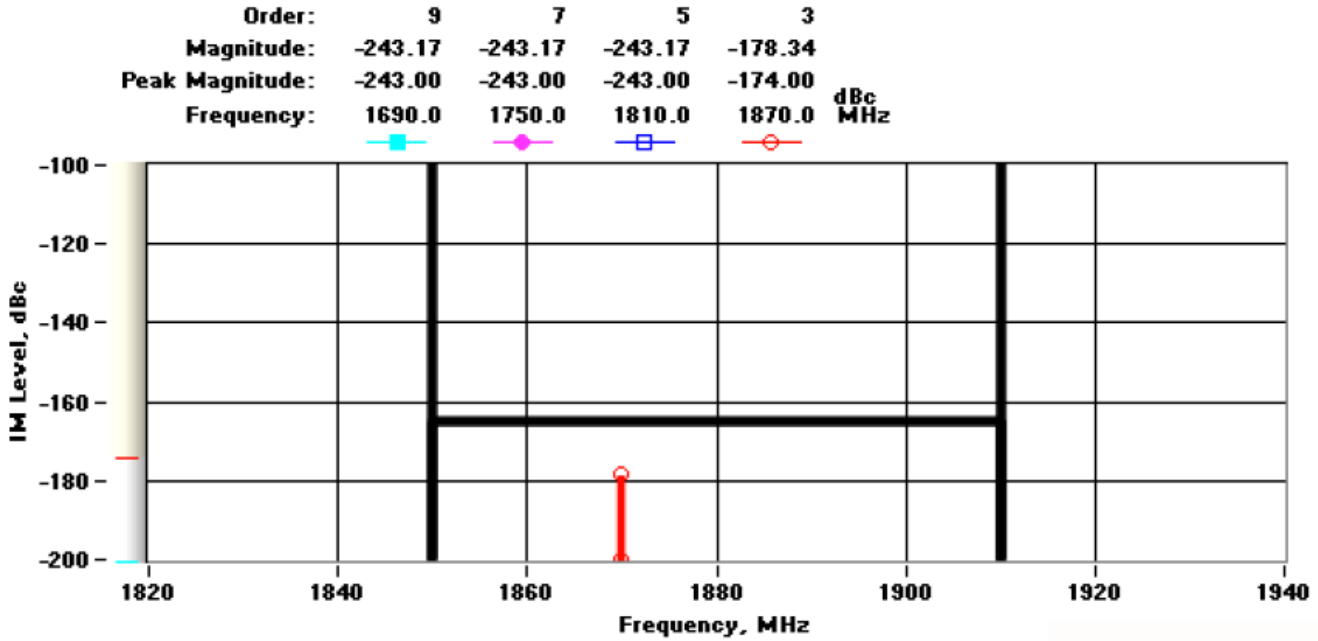
Times Protect™

Times-Protect PIM Test Data – LP-STRL Series / <-160dBc

Carrier Status

ALC is on	Frequency	Measured Power	Requested Power	Offset
CARRIER 1	1930.0 MHz	42.8 dBm	43.00	0.0 dB
CARRIER 2	1990.0 MHz	43.2 dBm	43.00	0.0 dB

Passive IM Response



TIMES MICROWAVE SYSTEMS

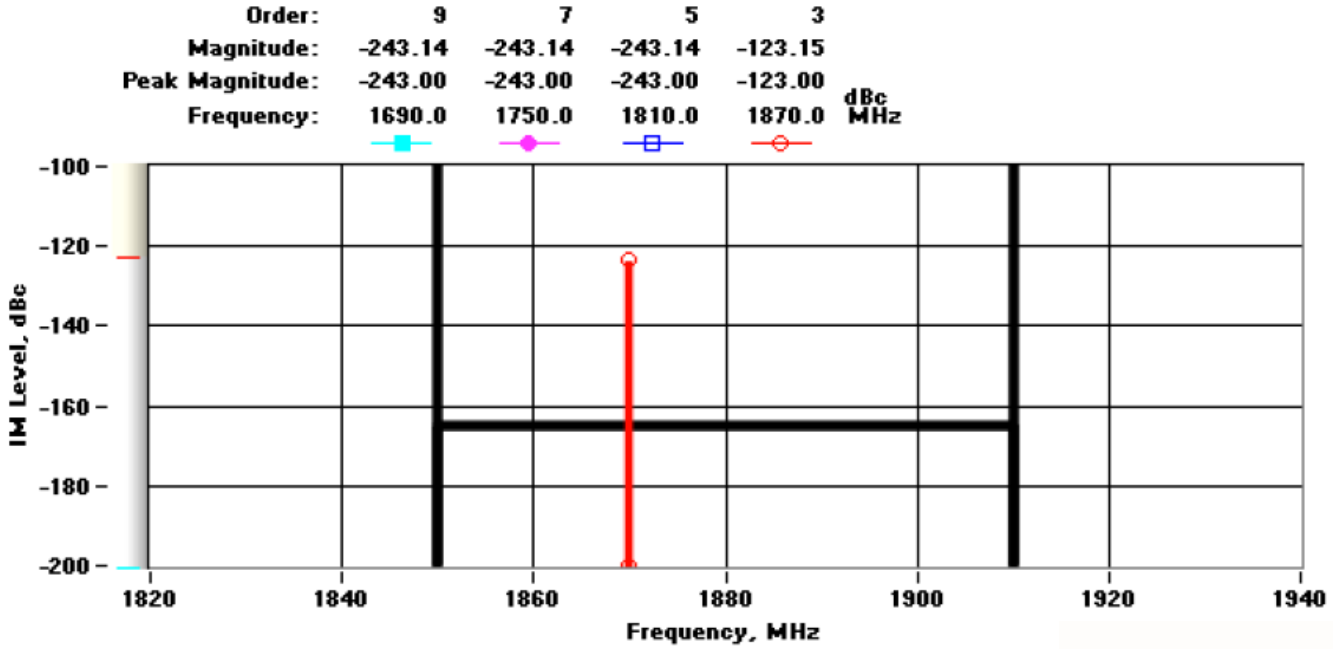
Times Protect™

“Other Brand” Ultra Low PIM protector / <-155dBc

Carrier Status

ALC is on	Frequency	Measured Power	Requested Power	Offset
CARRIER 1	1930.0 MHz	43.1 dBm	43.00	0.0 dB
CARRIER 2	1990.0 MHz	43.1 dBm	43.00	0.0 dB

Passive IM Response



TIMES MICROWAVE SYSTEMS

Times Protect™

LP-STRL Series PIM data at 900MHz

Date: 2/4/2010 **Time:** 9:31 AM

Passive IM Test Results

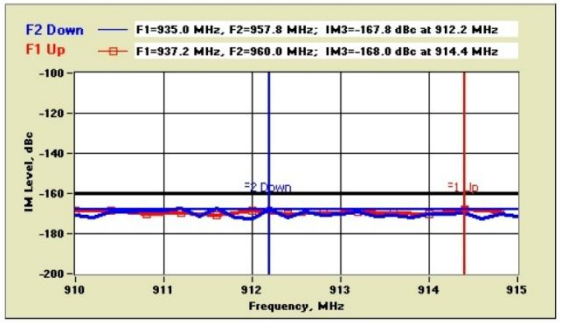
Description

LP-STRDFF
NO:0001

Carrier Sweep

ALC is on	Measured Power	Offset
F2 DOWN from 960.0 to 955.2 MHz. F1 Fixed at 935.0 MHz	43.0 dBm	0.0 dB
F1 UP from 935.0 to 937.4 MHz. F2 Fixed at 960.0 MHz	43.0 dBm	0.0 dB

Passive IM Response (IM3)



REVERSE IM

Date: 2/4/2010 **Time:** 9:41 AM

Passive IM Test Results

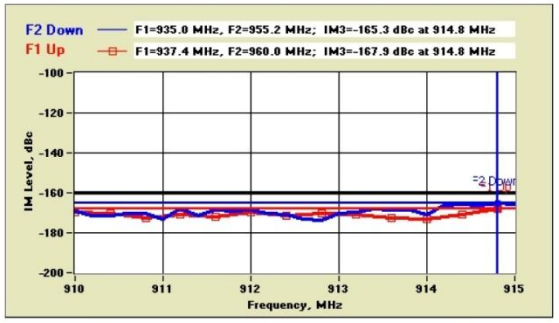
Description

LP-STRDMP
NO:0001

Carrier Sweep

ALC is on	Measured Power	Offset
F2 DOWN from 960.0 to 955.2 MHz. F1 Fixed at 935.0 MHz	43.0 dBm	0.0 dB
F1 UP from 935.0 to 937.4 MHz. F2 Fixed at 960.0 MHz	43.0 dBm	0.0 dB

Passive IM Response (IM3)



REVERSE IM

TIMES MICROWAVE SYSTEMS

Times Protect™

LP-STRL Series PIM data at 1800MHz

Times Protect™

Date: 2/3/2010 SUMMITEK Time: 2:47 PM

Passive IM Test Results

Description: LP-STRDFF

Model Number: 0001

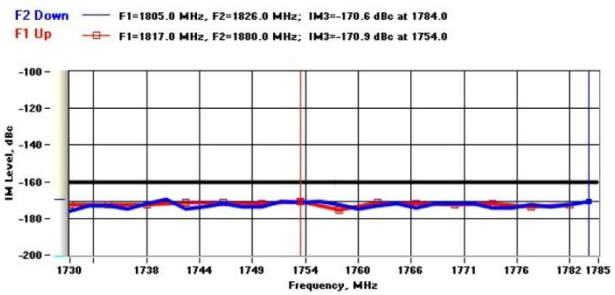
Serial Number:

Operator: Wang Ru Qin

Carrier Sweep

ALC is on	Measured Power	Offset
F2 DOWN from 1880.0 to 1828.0 MHz. F1 Fixed at 1805.0 MHz	43.0 dBm	0.0 dB
F1 UP from 1805.0 to 1831.0 MHz. F2 Fixed at 1880.0 MHz	42.9 dBm	0.0 dB

Passive IM Response (IM3)



REVERSE IM

Summitek Instruments VFP (v7.0.1013): SI-1800 Rev. 7.0.1013

Times Protect™

Date: 2/3/2010 SUMMITEK Time: 2:44 PM

Passive IM Test Results

Description: LP-STRDMP

Model Number: 0001

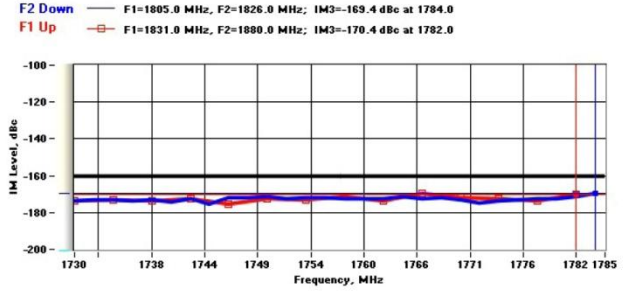
Serial Number:

Operator: Wang Ru Qin

Carrier Sweep

ALC is on	Measured Power	Offset
F2 DOWN from 1880.0 to 1828.0 MHz. F1 Fixed at 1805.0 MHz	43.0 dBm	0.0 dB
F1 UP from 1805.0 to 1831.0 MHz. F2 Fixed at 1880.0 MHz	43.1 dBm	0.0 dB

Passive IM Response (IM3)



REVERSE IM

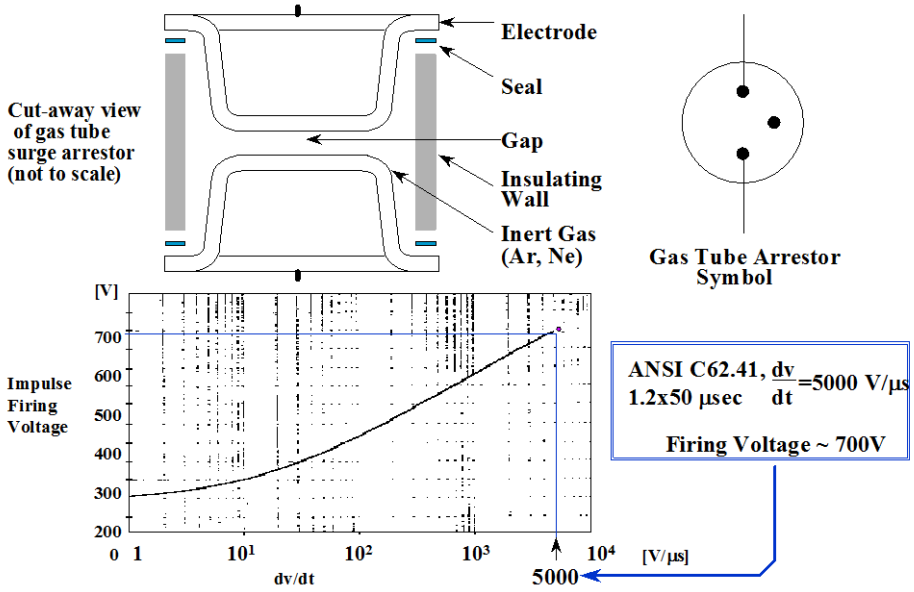
Summitek Instruments VFP (v7.0.1013): SI-1800 Rev. 7.0.1013

TIMES MICROWAVE SYSTEMS

Times Protect™

DC Pass product family

- Applications requiring power
- Broadband design
- Bi-directional operation
- Multi strike capability
- Fully weatherized to IP67

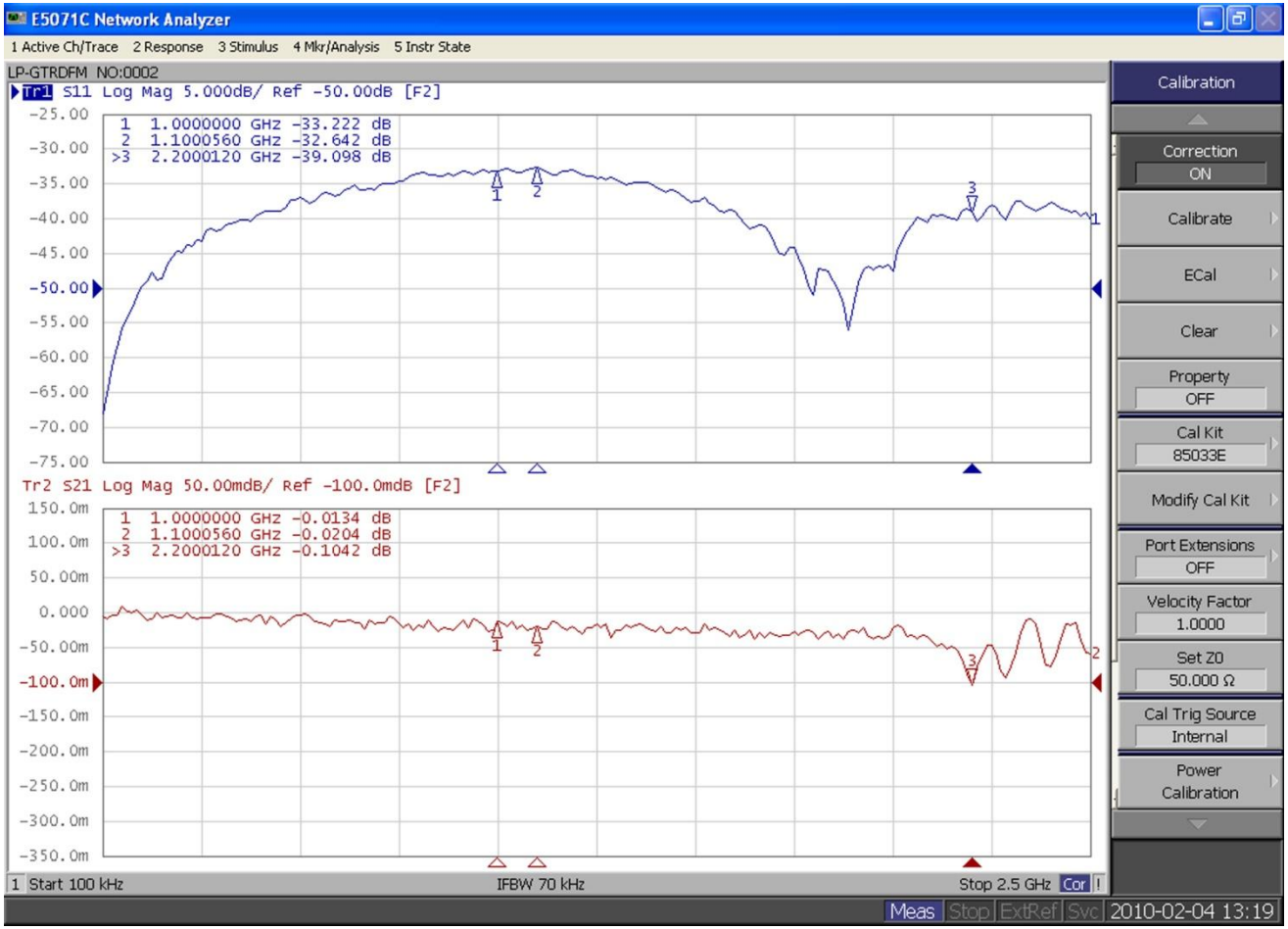


TIMES MICROWAVE SYSTEMS

Times Protect™

LP-GTR-D Series DC pass (DC-2500MHz)

- LP-GTR-DFF/23/35 DIN Female/Female
- LP-GTR-DFM/23/35 DIN Female/Male



- Fully weatherized body to IP67
- Broadband RF performance
- Multi-strike capability
- Bi-directional operation
- 90Vdc turn on (50 Watts)
- 230Vdc turn on (210 Watts)
- 350Vdc turn on (550 Watts)
- White Bronze plated body
- Phosphor Bronze center pin
- Silver plated center pin
- Insertion Loss: < 0.2dB
- Return Loss: <-26dB

TIMES MICROWAVE SYSTEMS

LP-GTR-N Series DC Pass (DC-3000MHz)

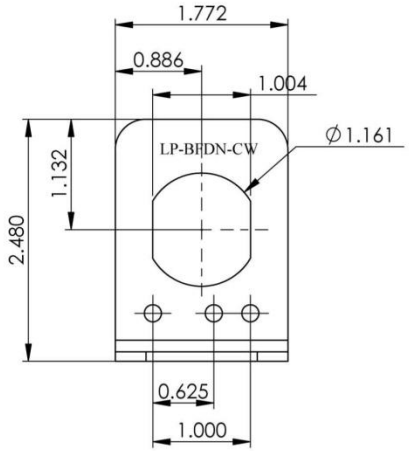
- LP-GTR-NFF/23/35 N Female/Female
- LP-GTR-NFM/23/35 N Female/Male

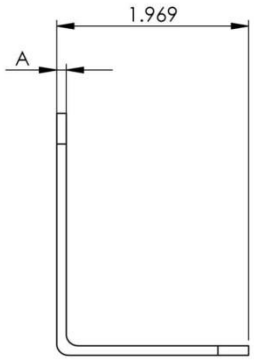
- Fully weatherized body to IP67
- Broadband RF performance
- Multi-strike capability
- Bi-directional operation
- 90Vdc turn on voltage (50 Watts)
- 230Vdc turn on voltage (210 Watts)
- White Bronze plated body
- Phosphor Bronze center pin
- Silver plated center pin
- Insertion Loss: < 0.25dB
- Return Loss: <-26dB

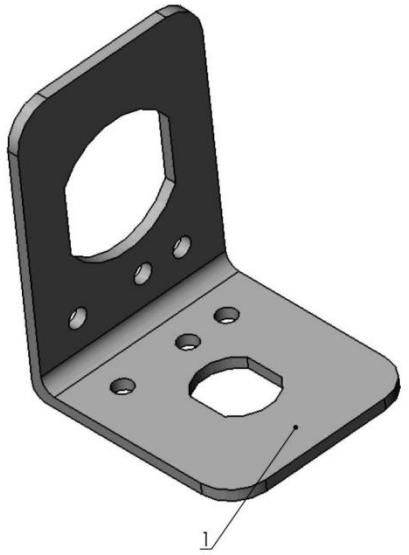
TIMES MICROWAVE SYSTEMS

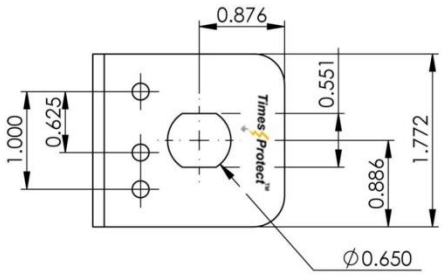
Times Protect™

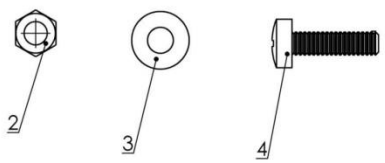
Universal mounting and grounding bracket LP-BFDN-CW











Material	A (Thinckness)	print
Aluminium	0.098	
Copper	0.079	Times Protect™ & LP-BFDN-CW

No.	Name	Material	Plating	Qty
4	M4x15 Screw	Stainless steel304		2
3	M4 Washer	Stainless steel304		4
2	M4 Nut	Stainless steel304		2
1	BFDN-CW	Copper	Copper-tinzine2um	1
	BFDN-AL	Aluminium		1

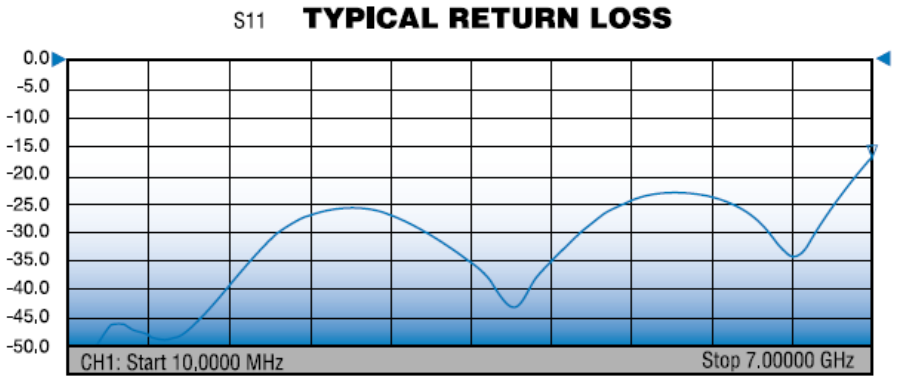
Drw		Description		Drawing No.(P/N)	Ver	Rev
Chk		LP-BFDN-AL and LP-BFDN-CW			0	3
App		Sheet 1/1	Metric Inch			

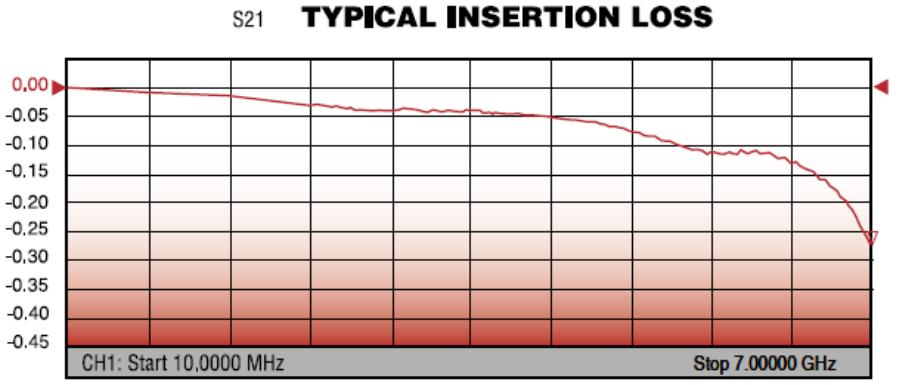
TIMES MICROWAVE SYSTEMS

Times Protect™

LP-GTV-N Series DC Pass (DC-7000MHz)

- LP-GTV-NFF N Female/Female
- LP-GTV-NFM N Female/Male





- Fully weatherized body to IP67
- Broadband RF performance
- Multi-strike capability
- Bi-directional operation
- 180 Vdc turn on voltage (150 Watts)
- White Bronze plated body
- Phosphor Bronze center pin
- Silver plated center pin
- Insertion Loss: <20dB (DC-6.7GHz)
- Insertion Loss: < 0.3dB (6.7-7.0GHz)
- Return Loss: <20dB (DC-6.7GHz)
- Return Loss: <17dB (6.7-7.0GHz)

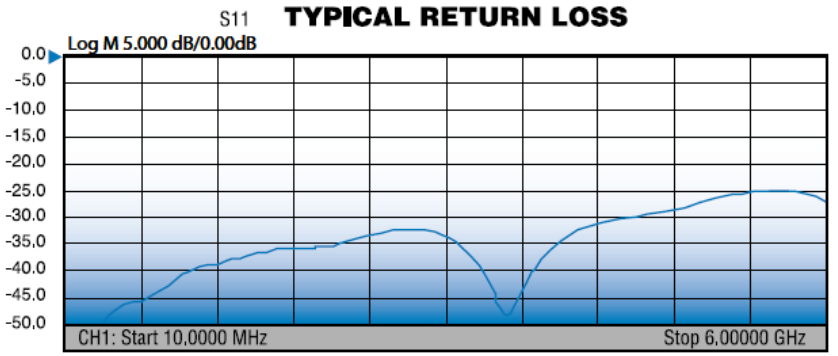
TIMES MICROWAVE SYSTEMS

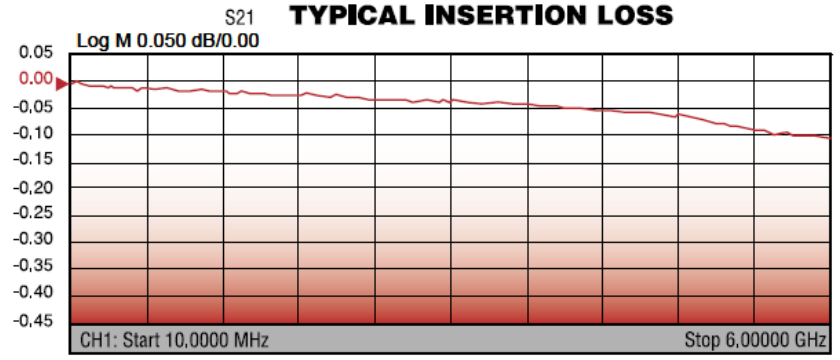
Times Protect™

LP-18-400-N series DC Pass (DC-6000MHz)

Cable Connector & Lightning Protector in One!

- LP-18-400-NMH-X N type Male
- LP-18-400-NF-X N type Female



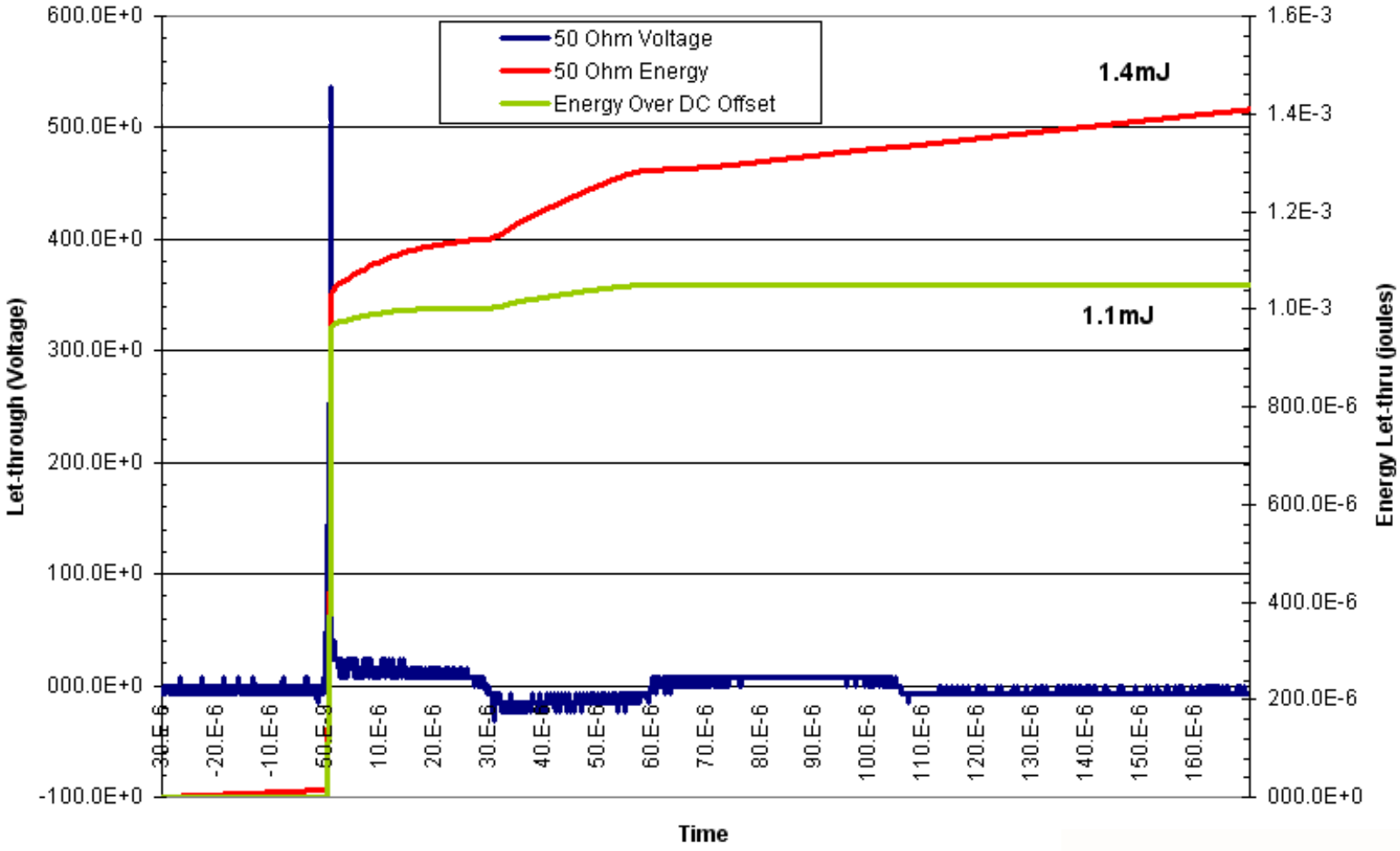


- Fully weatherized body to IP67
- Broadband RF performance
- Multi-strike capability
- Bi-directional operation
- 180 Vdc turn on voltage (150 Watts)
- White Bronze plated body
- Phosphor Bronze center pin
- Silver plated center pin
- Insertion Loss: < 0.15dB
- Return Loss: <-23dB

TIMES MICROWAVE SYSTEMS

Times Protect™

Gas Tube voltage and energy plotted into 50 Ohm load (8x20us)



TIMES MICROWAVE SYSTEMS

Times Protect™

Wireless Broadband and GPS designs

LP-WBX-N Series:

- LP-WBX-NFF (Female-Female)
- LP-WBX-NMP (Male on Protected)
- LP-WBX-NMS (Male on Surge)

LP-GPX-05-N Series:

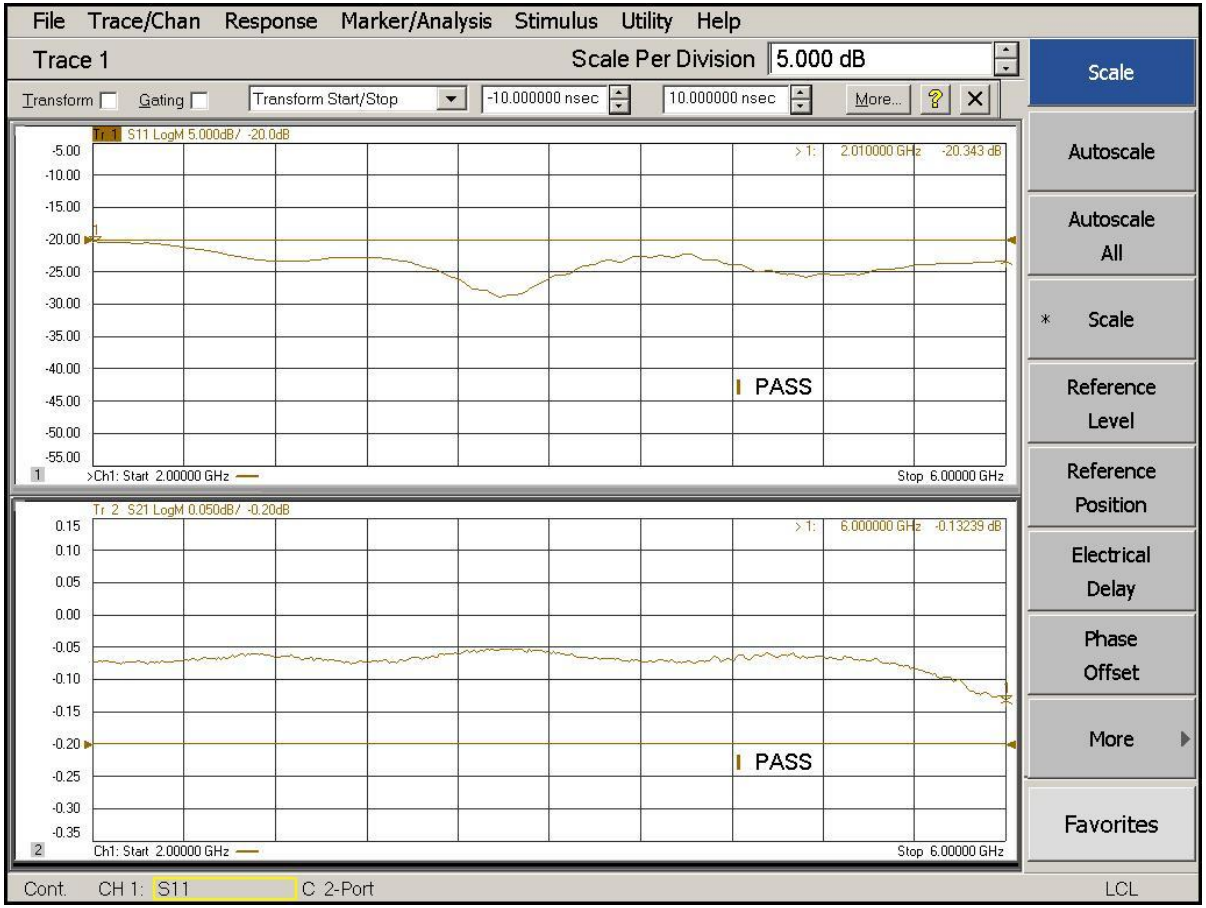
- LP-GPX-05-NFF (Female-Female)
- LP-GPX-05-NFM (Female-Male)

TIMES MICROWAVE SYSTEMS

Times Protect™

LP-WBX-N series DC blocked (2000-6000)MHz

- LP-WBX-NFF N Female/Female
- LP-WBX-NMP N Male on Protected
- LP-WBX-NMS N Male on Surge

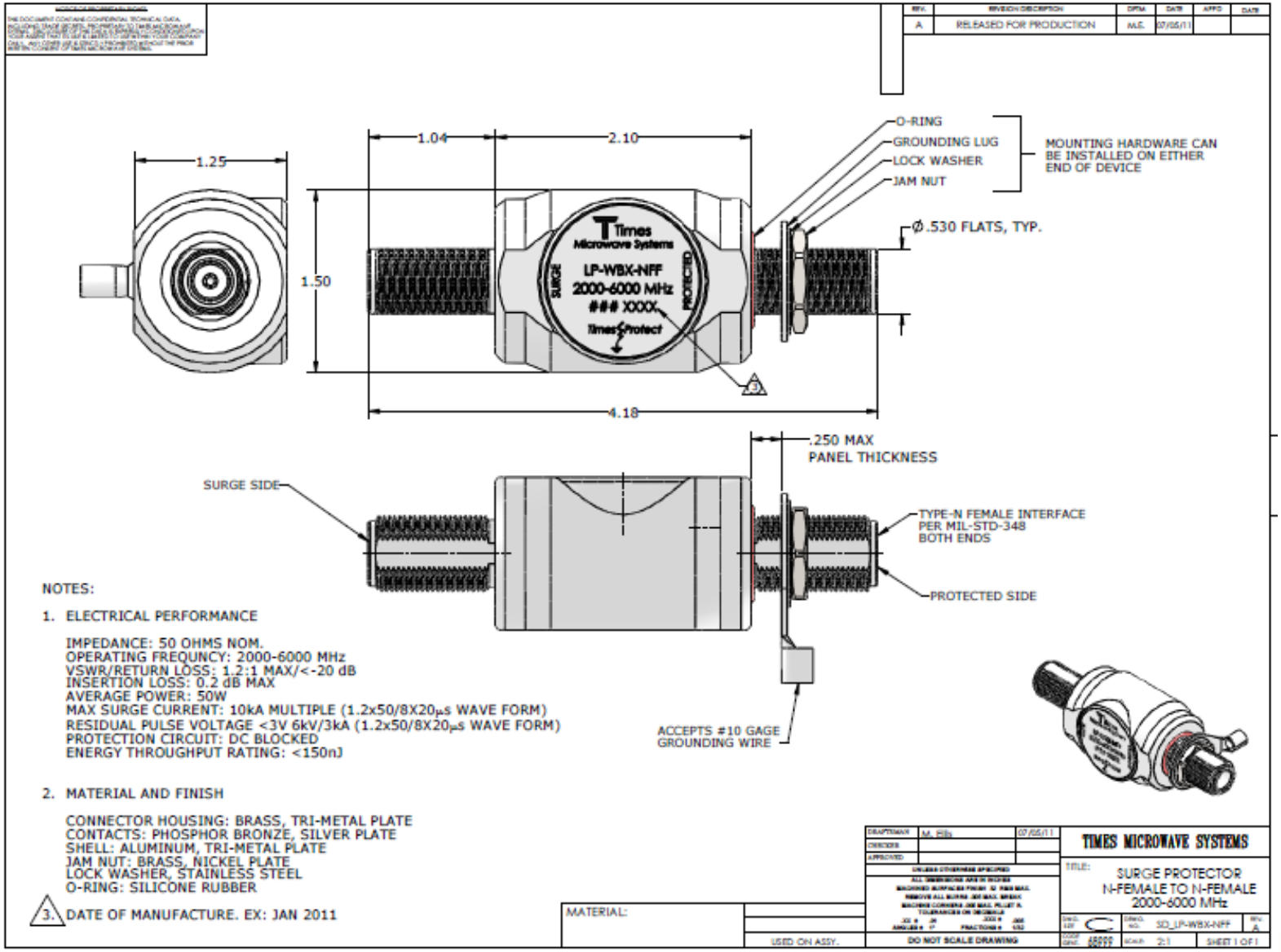


- Fully weatherized body to IP65
- Broadband RF performance
- Multi-strike capability
- Maintenance free design
- Maximum surge current: 20kA
- Throughput voltage: 2Vpk
- Throughput energy: 150nJ
- Insertion Loss: <-0.2dB
- Return Loss: <-18dB
- RF power: 50Watts

TIMES MICROWAVE SYSTEMS
An Amphenol Company

Times Protect™

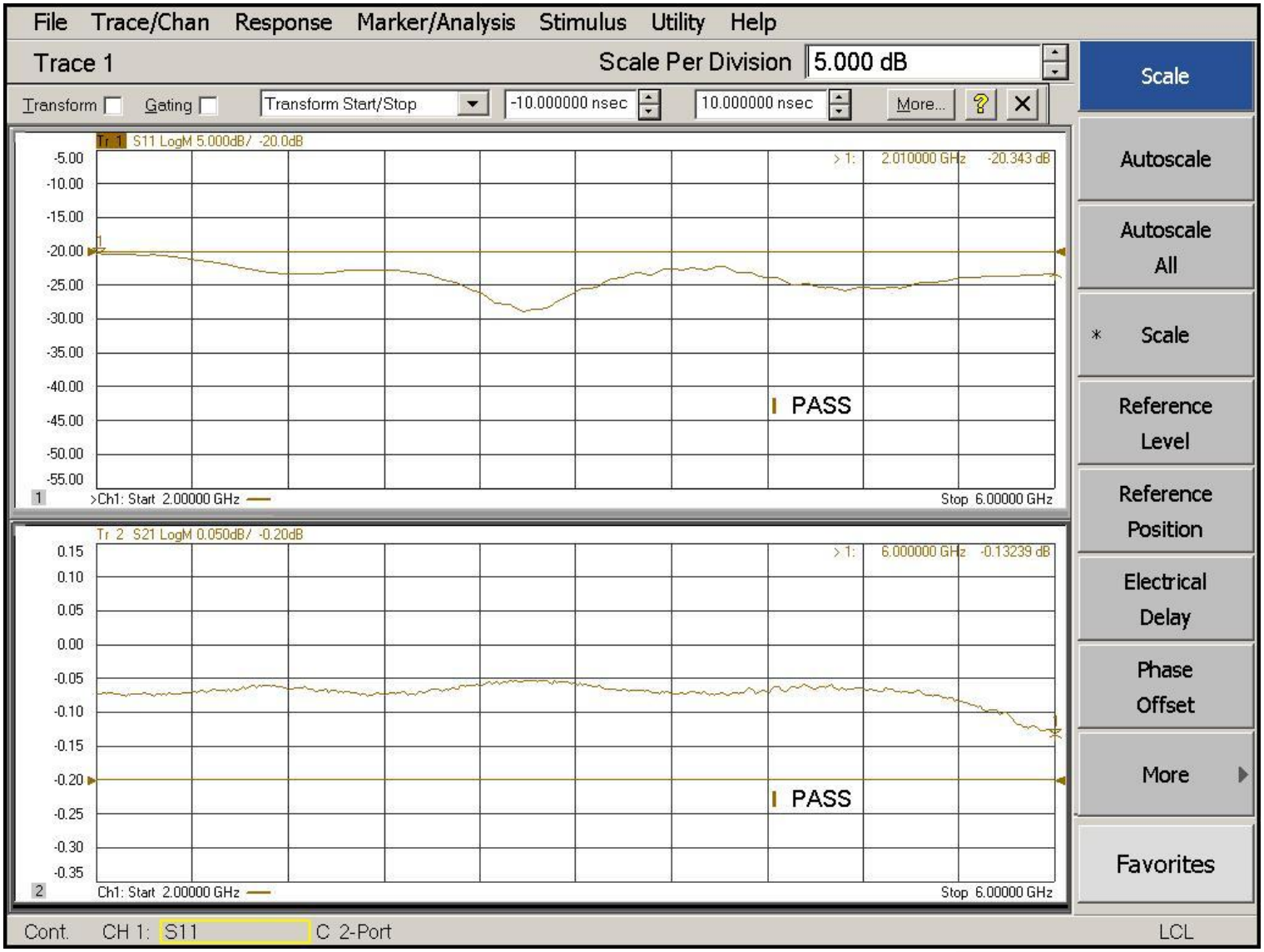
LP-WBX-NFF/NMP/NMS (2000-6000MHz) operation



TIMES MICROWAVE SYSTEMS

Times Protect™

LP-WBX-N Series S11 & S21 parameters

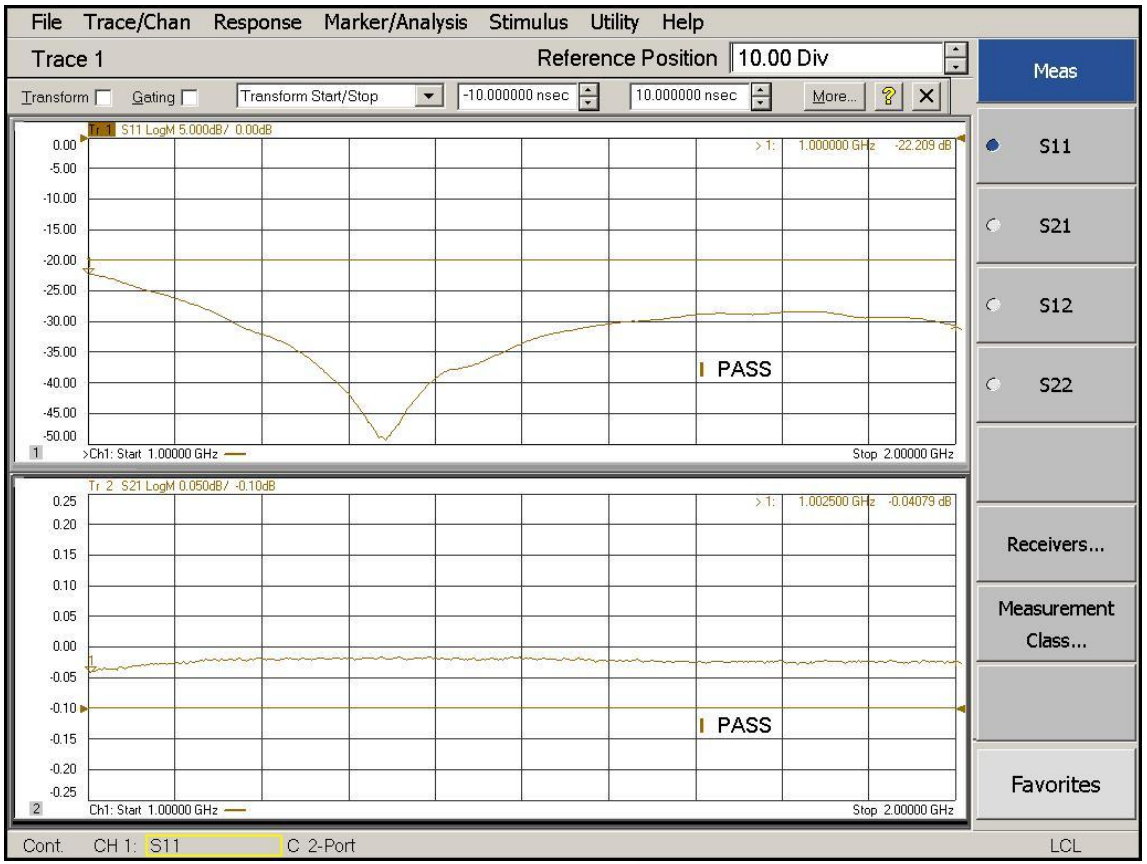


TIMES MICROWAVE SYSTEMS

Times Protect™

LP-GPX-05-N series DC pass (1000-2000)MHz

- LP-GPX-05-NFF N Female/Female
- LP-GPX-05-NFM N Female/Male
- LP-GPX-05-SFF SMA Female/Female
- LP-GPX-05-SFM SMA Female/Male
- LP-GPX-05-TFF TNC Female/Female
- LP-GPX-05-TFM TNC Female/Male

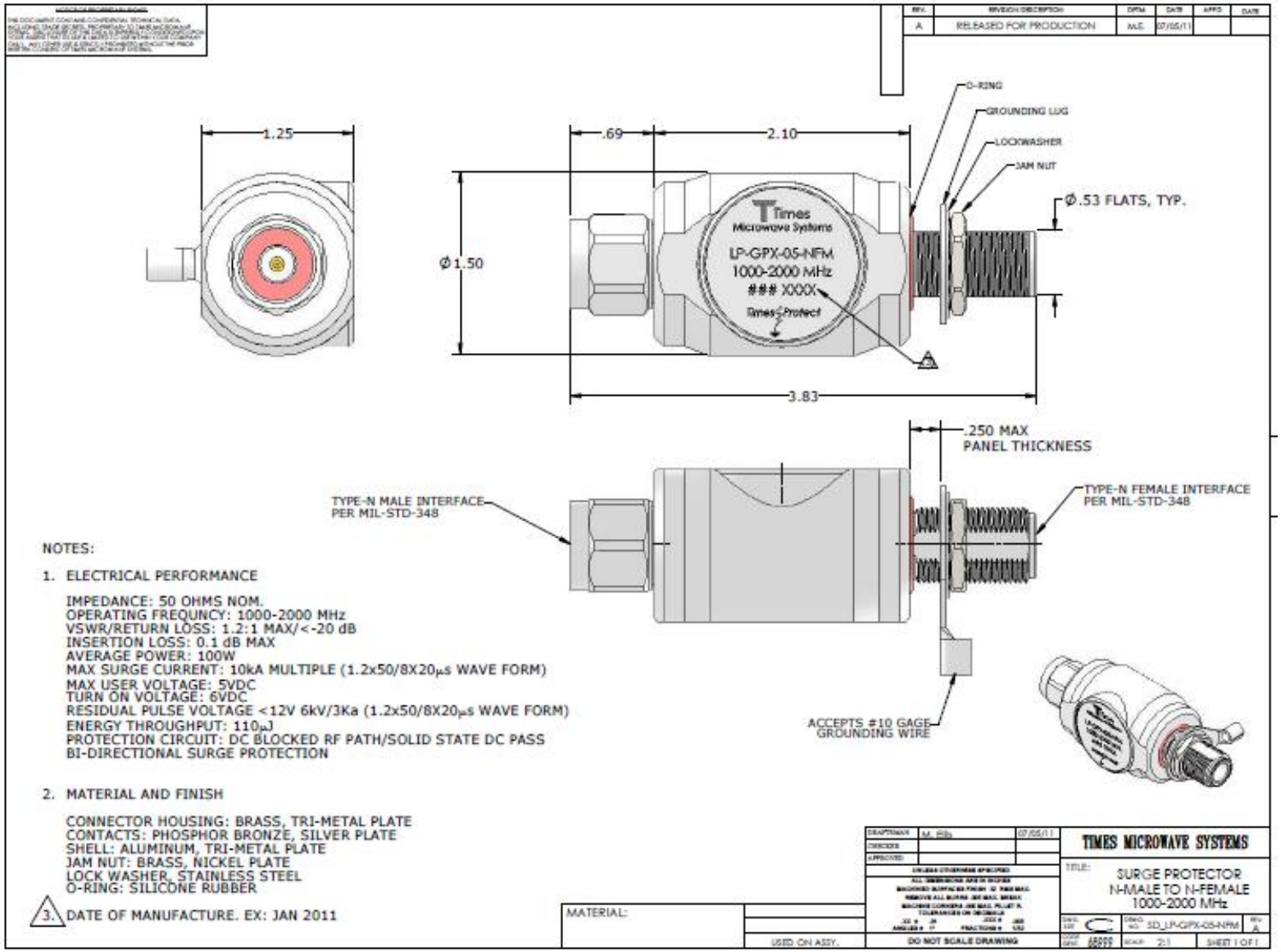


- Fully weatherized body to IP65
- L1, L2 & L3 RF performance
- DC blocked RF path
- Solid State DC protection circuit
- Multi-strike capability
- Maintenance free design
- Maximum surge current: 10kA
- User Voltage: 5Vdc
- Throughput voltage: <12Vpk
- Throughput energy: 150nJ
- Insertion Loss: <-0.1dB
- Return Loss: <-26dB

TIMES MICROWAVE SYSTEMS
An Amphenol Company

Times Protect™

LP-GPX-05-NFF & NFM (L1, L2 & L3) Bidirectional GPS Protector

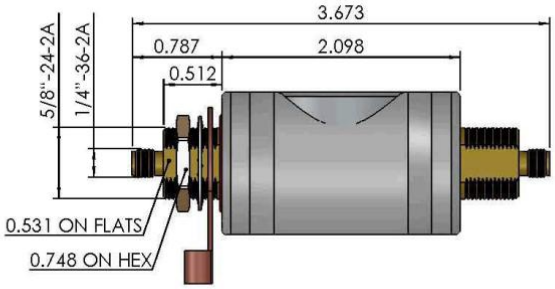


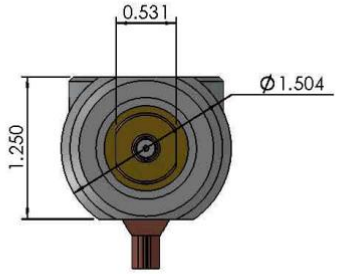
TIMES MICROWAVE SYSTEMS

Times Protect™

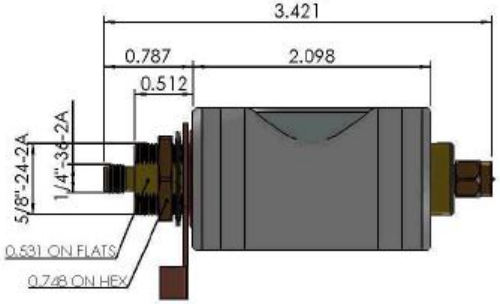
LP-GPX-05-SFF & LP-GPX-05-SFM Bidirectional L1, L2 & L3 Protector

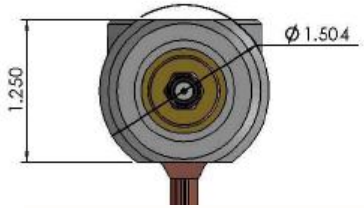
LP-GPX-05-SFF





LP-GPX-05-SFM

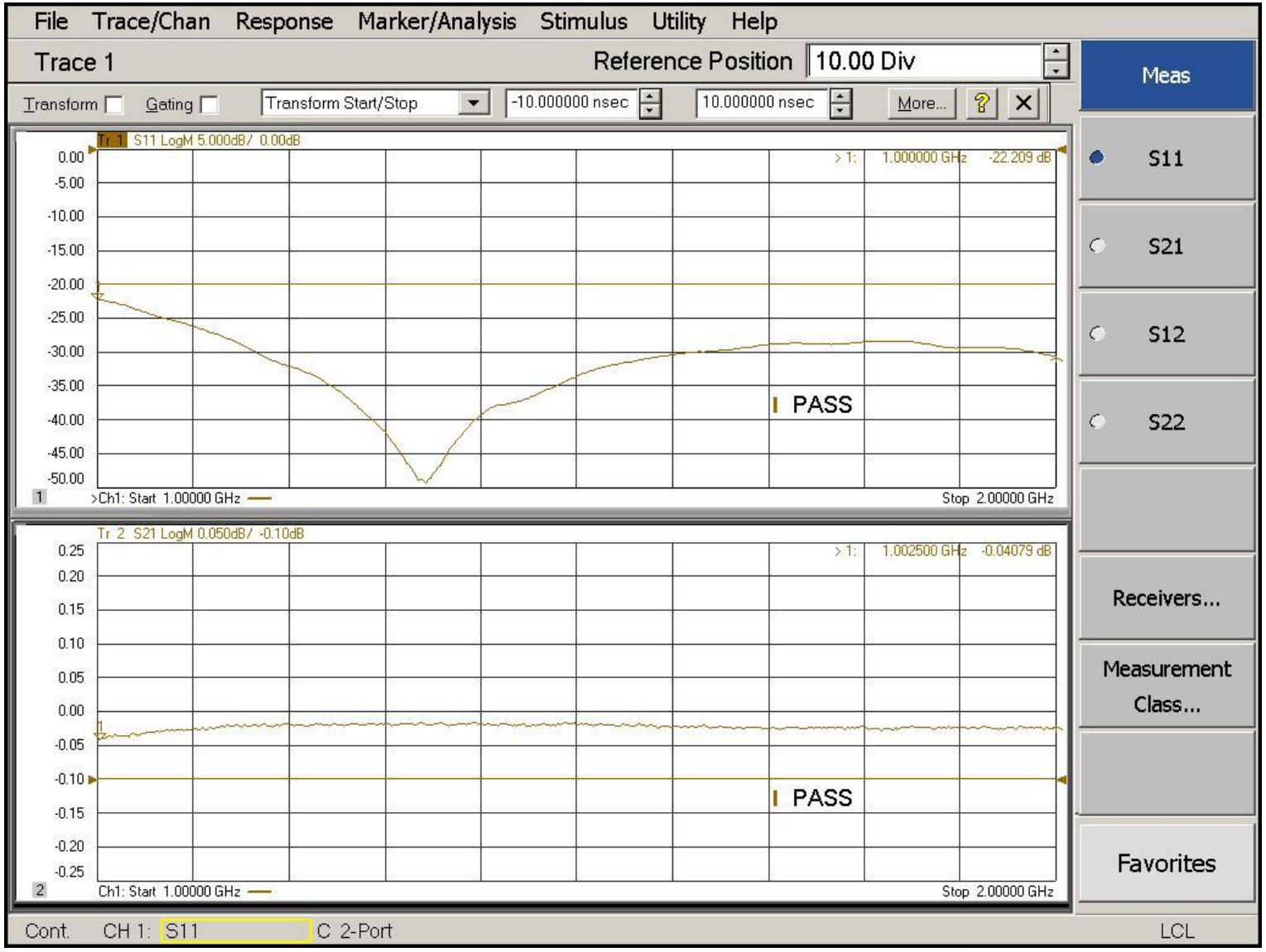




TIMES MICROWAVE SYSTEMS

Times Protect™

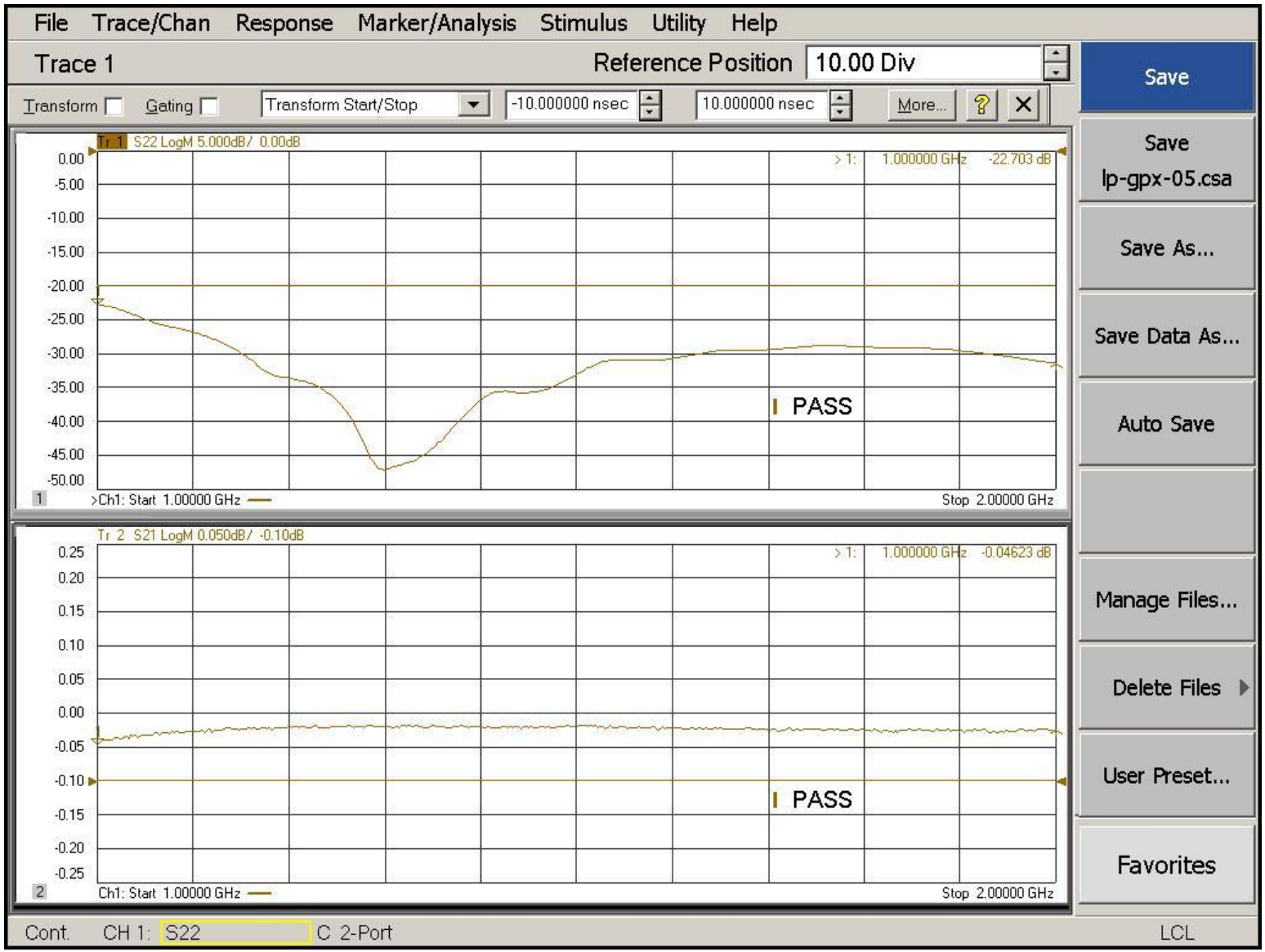
LP-GPX-05-N & S Series S11 & S21 parameters



TIMES MICROWAVE SYSTEMS

Times Protect™

LP-GPX-05-N & S Series S22 & S21 parameters

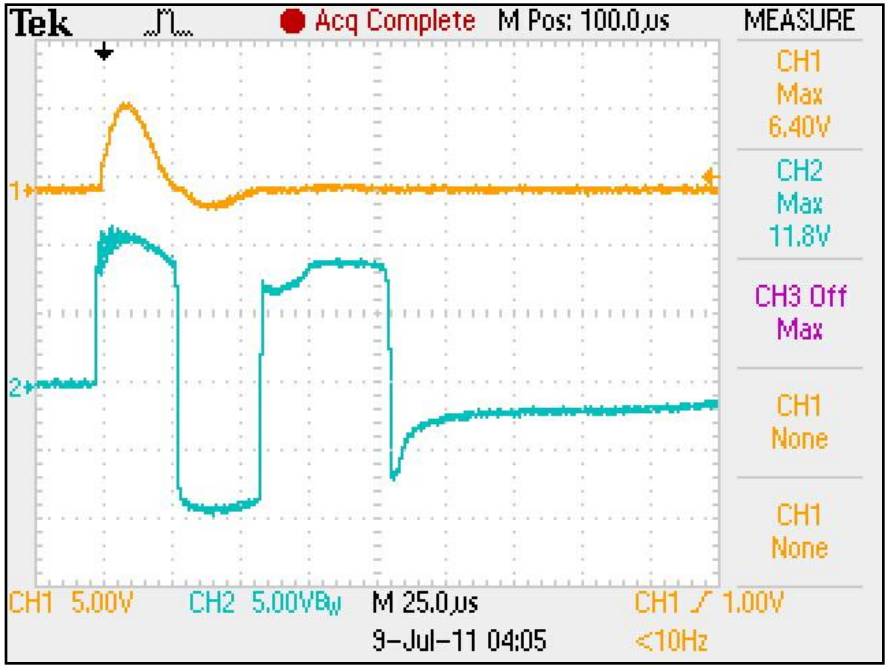


TIMES MICROWAVE SYSTEMS

Times Protect™

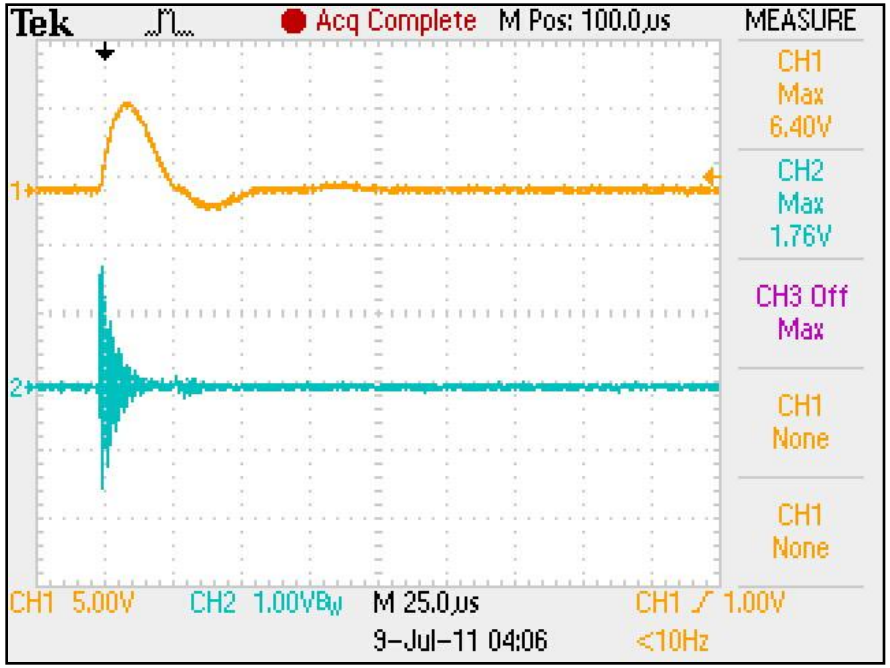
Surge Performance Data for LP-GPX and LP-WBX Series at 6kV/3kA (1.2x50/8x20us) wave-shape

LP-GPX-05-NFF
LP-GPX-05-NFM
Bidirectional operation



User voltage: 5Vdc
Voltage throughput: <12Vpk
Energy throughput: <110uJ

LP-WBX-NFF
LP-WBX-NMP
LP-WBX-NMS

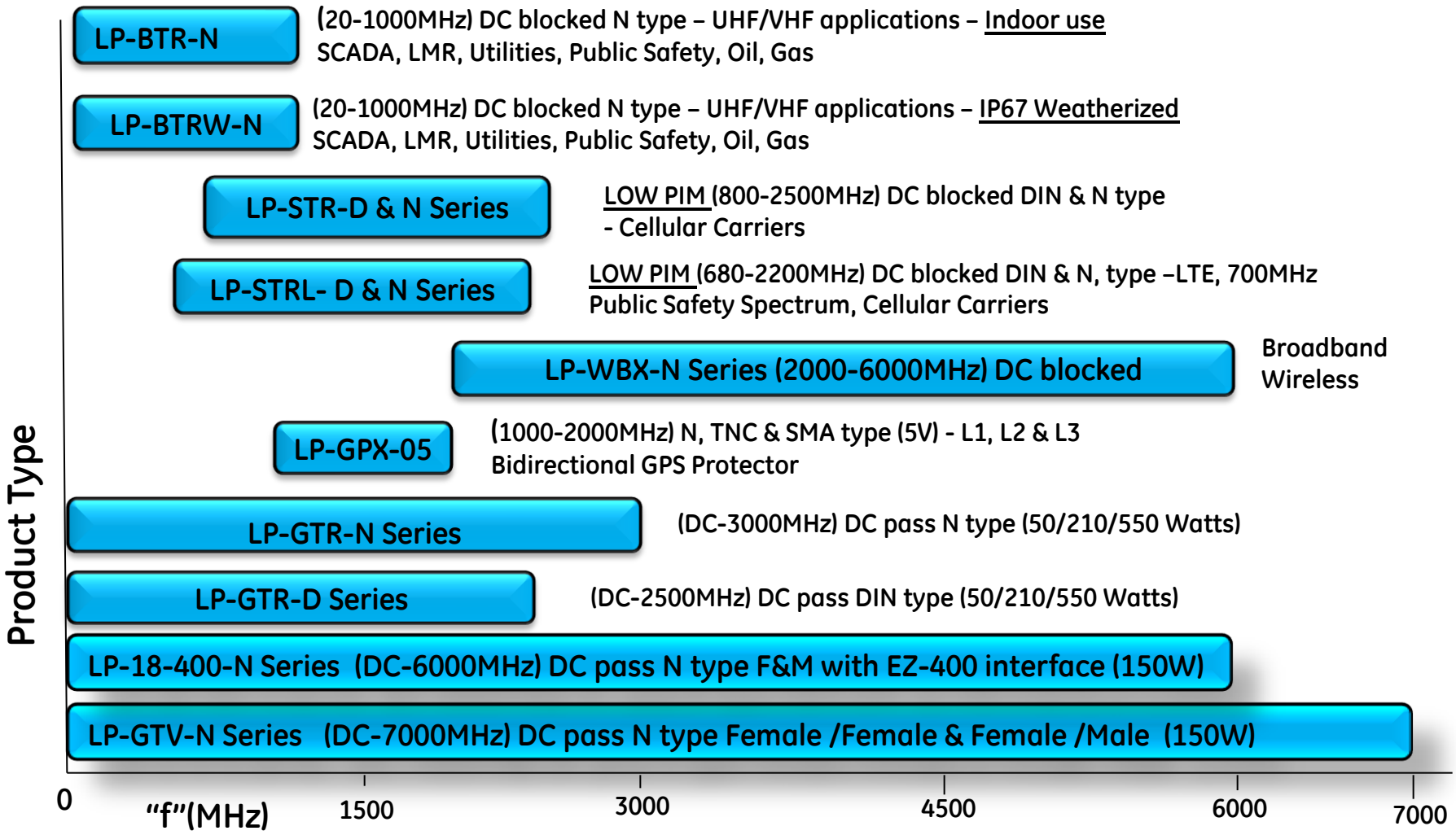


Voltage throughput: <2Vpk
Energy throughput: <150nJ

TIMES MICROWAVE SYSTEMS

Times Protect™

Product Selection Matrix



TIMES MICROWAVE SYSTEMS
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Smart – Panel & Grounding Accessories

Times Protect™

Planned future product development

Products for DC block applications:

LP-LBX-NFF/DFF (700-2700MHz) LTE and Cellular bands

LP-LBX-NMP/DMP

LP-LBX-NMS/DMS

LP-HBX-NFF/DFF (100-700MHz) high power HF/VHF/UHF combining applications

LP-HBX-NMP/DMP

LP-HBX-NMS/DMS

Products for DC pass applications:

LP-LPX-60-NFF/DFF (700-2700MHz) LTE and cellular bands with telemetry)

LP-LPX-60-NMP/DMP

LP-LPX-60-NMS/DMS

LP-IPX-60-NFF (IF protector)

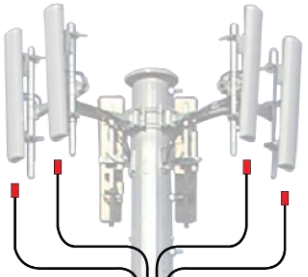
LP-IPX-60-NMP

LP-IPX-60-NMS

Notes:

- BX designates DC blocking
- PX designates DC passing
- First letter designates frequency and application
- -# designates operating DC voltage
- The connector designation will change to D/TNC/SMA etc. as applicable.

We are the Single Source for Wireless Infrastructure



Antennas / DAS

RF Connectors

Tower Mounted Amplifiers

Jumper Cables

Lightning Protectors

Filters/Combiners

Installation Accessories

Base Station

TIMES MICROWAVE SYSTEMS

Times Protect™

Thank you and Questions ???

TIMES MICROWAVE SYSTEMS

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