Lightning and EMP Protection Devices

Product Facts

- **Cellular operator protection against EMP (electro-magnetic pulses) caused by lightning strikes**
- **Two different categories: Surge protectors and Quarter wave stub tuners**
- **For use in cellular infra-structure including GSM, DCS 1800, and PCS 1900 systems**
- **Incorporates Gas Discharge Tube (GDT) technology**

Tyco Electronics has developed a unique series of Lightning and EMP protection devices for use in cellular infrastructure including GSM, DCS 1800, and PCS 1900 systems. These devices are designed to offer the cellular operator protection against EMP (electro-magnetic pulses) caused by lightning strikes. Direct or even near strikes produce fast rising electric fields within micro-seconds. These fields generate high voltage pulses through unprotected antennas and transmission lines which lead to the primary communication equipment. High voltage pulses can cause extensive damage leading to costly repairs as well as significant loss of service to subscribers. These protective devices come in two different categories: surge protectors and quarter wave stub tuners.

To ensure that proper, low level contact resistance is established between the LP device and mounting wall, it is recommended that a minimum torque of 50 in/lbs / 5.65 n/m be applied to tighten the connector mounting nut. A recommended minimum torque of 35 in/lbs / 3.95 n/m should also be applied for installation of replacement surge protector capsules to ensure proper protection performance.

In order to ensure that resultant currents from lightning or EMP strikes do not interfere with parallel transmission lines within protected electronic equipment, surge protector devices must be installed with proper orientation. The surge protector side of the device should be mounted in the unprotected side of the equipment while the mounting nut is positioned internally in the protected area.

It is important when planning lightning protection, that the user can estimate the potential number of direct strikes. This information may influence the type of device selected or the requirement for routine maintenance checks. Significant attention must be paid to the height of supporting structure as this, when related to the typical number of thunderstorms in a particular region, allows us to estimate the probability of a direct strike taking place. To assist our customers in this, the following table and chart has been included in this note. This should enable lightning protection planners to establish the likelihood of direct strikes across a network anywhere in the world.

Detailed application notes are available for proper selection of lightning protection devices (surge protectors & stub tuners) as well as intermodulation and White Bronze plating.

Selecting your RF Coaxial Lightning Protection Device

Between Series Adapters

For 7-16 Series and N Series Between Series Adapters, please see pages 251-260.

Number of Thunderstorm Days per year	hmax/m 10%	hmax/m 20%	hmax/m 50%
05	28	39	61
10	18	26	40
15	14	20	31
20	12	17	26
30	9.4	13	20
40	7.9	11	17
50	6.9	9.5	15
70	5.6	8.0	12
90	4.8	7.0	10.6
130	3.9	5.5	8.5
150	3.5	5.0	7.7
180	3.1	4.4	6.9

Table 1: Maximum height of supporting building for a given number of thunderstorm days (when hmax is exceeded, probability of direct strike to supporting building within 15 years is greater than 10% for hmax values given in second column, 20% for hmax values given in third column and 50% for hmax values given in the fourth column).

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Japan: 81-44-844-8013
UK: 44-8706-080-208

Surge Protectors

Product Facts

- **Excellent for Broadband Frequency Applications**
- **Field Replaceable Gas Discharge Tube**
- **Available Interfaces Facilitate Retrofit Capabilities**
- **Low VSWR up to 2.5GHz**
- **Specialized White Bronze Finish**

Selection of a Lightning Protection Device

At right are the basic advantages and limitations for both types of protection to use in the proper selection for your application.

Advantages

- Broadband
- Allows DC bias on the transmission line. (critical for applications using mast top electronics.)
- No harmonic passband
- Ease of retrofitting antenna sights
- GDT easily accessible for replacement

Limitations

- Routine maintenance recommended
- 3 GHZ maximum frequency
- Initial pass-through voltage

These devices incorporate Gas Discharge Tube (GDT) technology. A GDT is a hermetically sealed tube containing an inert gas. The tube is inserted in the side of the device through an easily accessible weather sealed port. During normal operation the tube is inactive. When an installation is struck by lightning, a high voltage impulse will appear on the coaxial line. As the impulse amplitude rises, a level is reached where the impulse surpasses the dynamic voltage threshold of the tube and the electrodes arc over to discharge the energy to ground. Prior to activation of the tube, there will be a short period of time where energy will be present on the line. This *residual pulse* is equal to the dynamic voltage threshold of the tube. The maximum impulse voltage a tube can handle without discharging is referred to as the *impulse sparkover voltage*. This capacity of the GDT is quoted as follows:

Characteristic	Symbol	Definition	Impulse	Typical Value
Impulse sparkover voltage	U_{zdyn}	Dynamic voltage threshold	1kV/µS	650V

In the case of the referenced chart, the voltage will rise at one kilovolt per microsecond and the tube will fire after 650 nanoseconds. During activation a small percentage of voltage (called arc voltage) will still pass through. This will be approximately 30 volts. When the pulse subsides, the tube again becomes inactive leaving a small *residual voltage* on the line. A direct lightning strike results in an impulse current of high amplitude. The capability of a device to protect a system is defined as the *impulse discharge current* rating. This is defined as the peak current of an impulse which the device can withstand ten times (5 at each polarity at fixed intervals) without affecting the device. *maximum impulse discharge current* is the peak current of an impulse the device can withstand once.

Surge protectors are often used in applications requiring a standing DC line voltage. This is typical in applications with mast top electronics. The maximum voltage capacity of a surge protector prior to it surpassing the static voltage threshold and discharging it to ground is defined as its D.C.

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Surge Protectors (Continued)

sparkover voltage. This capacity is quoted as follows:

Characteristic	Symbol	Definition	Impulse	Typical Value
d.c. sparkover voltage	U_{zstat}	Static voltage threshold	n/a	230V

In these applications it is important to select a device that will assure the tube can return to its inactive state after the passage of a surge. This feature of the Surge protector is known as the *holdover voltage*. If the device continues to conduct, the protected line will be short circuited and the tube will heat up (glow mode). If left in this state, the tube can overheat and destruct. GDT's have a finite life span which is inversely proportional to the energy dissipated. At extremes it is possible to reach a level where the tube is unable to discharge all the energy and is destroyed. It is therefore necessary to schedule routine maintenance checks and periodically replace the tube within the surge protector.

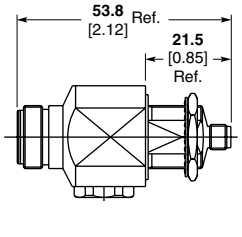
Surge protectors offer excellent lightning protection for broadband systems and are usable up to 3 GHz. Standard interfaces include 7-16, N, and SMA. Configurations include straight and bulkhead mounted adapters which allows for ease of assimilation into existing systems.

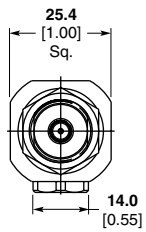
Specifications

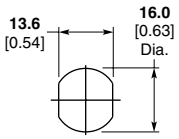
Requirement	Detail
Electrical	
Frequency Range	DC to 3GHz
Impedance	50Ω
VSWR Performance	≤ 1.33:1
Insertion Loss (Typical)	0.45dB
Impulse Discharge Current (8/20µs, multiple strike)	20kA
Maximum Impulse Discharge Current (8/20µs, single strike)	50kA
Dynamic Sparkover Voltage, NEMP (1kV/µs)	2,000V
Dynamic Sparkover Voltage, LEMP (1kV/µs)	800V
Dynamic Sparkover Voltage, Static (<100V/µs)	90V*
Materials	
Body Parts	Brass
Gaskets	Silicone Rubber
Female Contacts	Beryllium Copper
Male Contacts	Brass
Insulators	P.T.F.E.
Environmental	
Operating Temperature Range	-45° C to +85° C
Relative Humidity	up to 100%

* Determined by gas tube used, can be higher than value shown.

N Series Jack to SMA Bulkhead Jack Adapter







Recommended Mounting Hole

Part Number
6312079-1

Frequency Range	DC to 3GHz
Contact Plating	Gold
Body Plating	White Bronze
Max Panel	10.00mm
Compliant With	CECC22210/ CEC22110
Coupling Torque	0.7-1.1Nm
Proof Torque	1.7Nm both ends
Endurance	500 Matings

Note: Part Numbers are RoHS compliant except: ♦ Indicates non-RoHS compliant.

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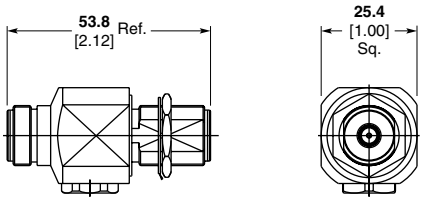
Surge Protectors (Continued)

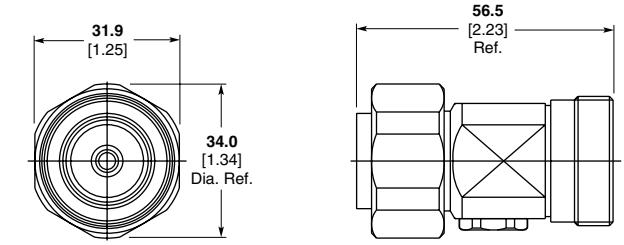
N Series Jack to N Series Bulkhead Jack Adapter



Part Number
6312138-1

Frequency Range	DC to 3.0 GHz
Contact Plating	Gold
Body Plating	White Bronze
Max Panel	10.00mm
Compliant With	CECC22210
Coupling Torque	0.7-1.1 Nm
Proof Torque	1.7 Nm
Endurance	500 Matings

7-16 Plug to 7-16 Jack Adapter



Part Number
6312121-1

Frequency Range	DC to 3.0 GHz
Contact Plating	Silver
Body Plating	White Bronze
Compliant With	CECC22190
Coupling Torque	25 - 30 Nm
Proof Torque	35Nm
Endurance	500 Matings

Gas Discharge Tube Replacement

Part Number
1402314-1

d.c. Sparkover Voltage:	230V ± 46V
Impulse Sparkover Voltage: (1kV/mS)	700V typ. (900V max)
Glow Discharge Voltage:	72V
Arc Discharge Voltage:	10V
a.c. Discharge Current: (1 sec, 50Hz)	20A
Impulse Discharge Current: (8/20mS waveform)	20kA (50kA for one strike)
Insulation Resistance (@100V):	10GW
Capacitance:	2pF

Note: Part Numbers are RoHS compliant except: ♦ Indicates non-RoHS compliant.

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λ/4 Stub Tuners

Product Facts

- **Ideal for use with GSM, PCS and DCS**
- **Maintenance Free Operation**
- **Low VSWR Within Specified Bandwidth**
- **Configurations include direct attachments to Cable variants**
- **Optional White Bronze Finish**

Advantages

- Low VSWR in pass-band
- Minimal maintenance
- Pass-through voltage eliminated
- No sparkover or residual voltage concerns
- Ease of retro-fitting antenna sights

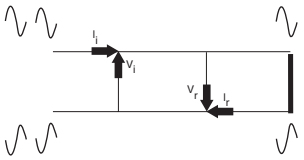
Limitations

- Frequency specific
- Harmonic passband
- Does not allow DC bias on transmission line

These devices are three port coaxial connectors. The third port extending from the main through path is terminated in a short circuit at a pre-determined distance calculated to be exactly one quarter wavelength at the desired center frequency (see graph).

Unlike surge protectors, this design eliminates concerns about residual pulse, sparkover voltage and residual voltage ensuring greater protection for sensitive electronic equipment. As opposed to surge protectors, stub tuners will absorb lightning strikes without need for replacing components. These devices yield very low VSWR and feature high attenuation within a relatively narrow pass-band (+/- 70 MHz) but are application specific. Stub tuners also pass energy in bands that are harmonically related to the fundamental center frequency. The graphs below show a typical test impulse and the response of a stub tuner.

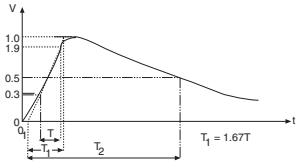
λ/4 Shorting Stub Basics



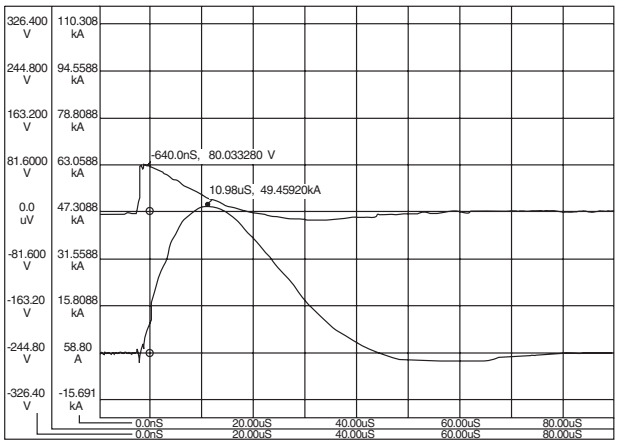
Stub tuners are classified into two broad categories—simple and broadband. The simple stub tuner exhibits a V-shaped response on the VSWR vs. frequency plot. The trough of the V is designed to occur at the required Fo and the bandwidth is restricted to approximately 8%. The broadband tuner employs extra RF techniques, similar to multiple cavity filtering, which increase the effective bandwidth by approximately 20%.

Tyco Electronics offers a wide variety of stub tuners for the most popular frequency bands to facilitate purchase without need for custom design and manufacturing. Designs exist for GSM, PCS 1900, DCS 1800 frequencies with standard industry interfaces including SMA, 7-16, and Type N. Configurations include cable assemblies, cabled connectors, and adapters for ease of assimilation into existing systems. Stub tuners are maintenance free since they incorporate no active components though it is recommended that a check of the stub tuner affixment be made following heavy discharges at an installation.

Typical Test Impulse



Typical λ/4 Test Response



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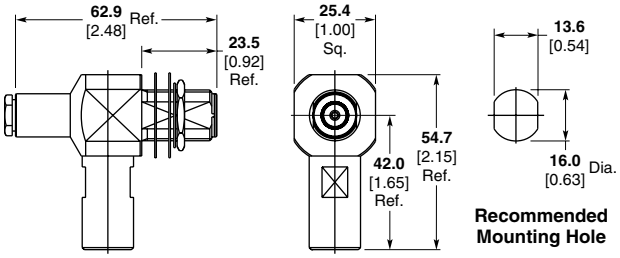
λ/4 Stub Tuners (Continued)

Requirement	Detail (Type-N, 7-16)
Electrical	
Impedance	50Ω
VSWR Performance in Band	≤1.2:1
Insertion Loss (Typical)	0.2dB
DC Resistance (stub outer to inner)	1mΩ
Dynamic Voltage @ 250A/ms	≤15V
Residual Voltage @ 2500A, 8/20μs	≤15V
Outer Conductor Contact Resistance	10mΩ
DC Resistance (through-path center contact)	100mΩ
Materials	
Body parts	Brass
Gasket	Silicone Rubber
Female contacts	Beryllium Copper
Male Contacts	Brass
Insulators	P.T.F.E.
Environmental	
Operating temperature range	-45°C to +85°C
Relative humidity (non-condensing)	up to 100%

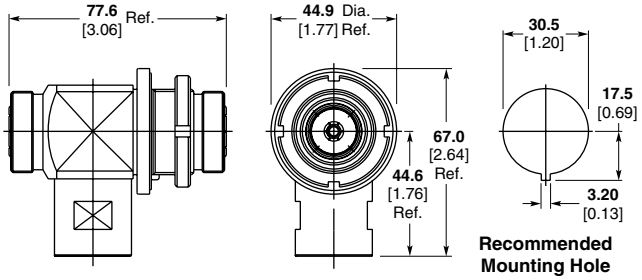
DCS 1800
Type N Clamp Bulkhead Jack



Cable	Part No.
T-Flex402	**6329818-1**

Bandwidth	± 70 MHz
Center Frequency	1795 MHz
Contact Plating	Silver
Body Plating	Silver
Max Panel	10.00mm
Compliant With	CECC22210
Coupling Torque	0.7-1.1Nm
Proof Torque	1.7Nm
Endurance	500 Matings

7-16 Jack to 7-16 Bulkhead Jack Adapter



Part Number
6361137-1

Bandwidth	± 70 MHz
Center Frequency	1795 MHz
Contact Plating	Silver
Body Plating	White Bronze
Max Panel	8.00mm
Compliant With	CECC22190
Coupling Torque	25 - 30Nm
Proof Torque	35Nm
Endurance	500 Matings

Note: Part Numbers are RoHS compliant except: ♦ Indicates non-RoHS compliant.

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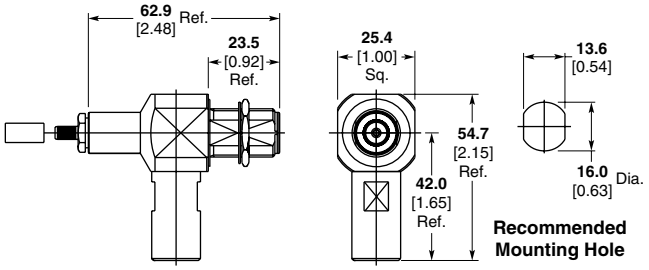
λ/4 Stub Tuners (Continued)

DCS 1800 (Continued)

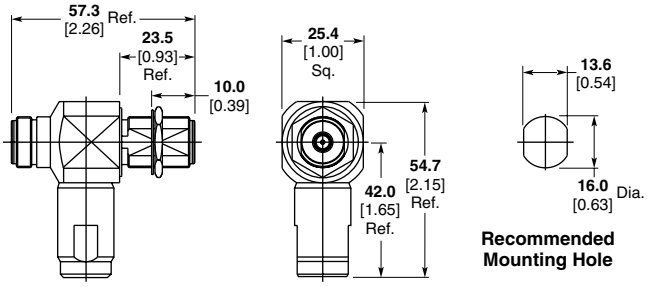
Type N Crimp Bulkhead Jack



Cable	Part No.
RG58C/U	**1329819-1**

Bandwidth	± 70 MHz
Center Frequency	1795 MHz
Contact Plating	Silver
Body Plating	Silver
Max Panel	10.00mm
Compliant With	CECC22210
Coupling Torque	0.7-1.1Nm
Proof Torque	1.7Nm
Endurance	500 Matings

Type N Jack to Type N Bulkhead Jack Adapter

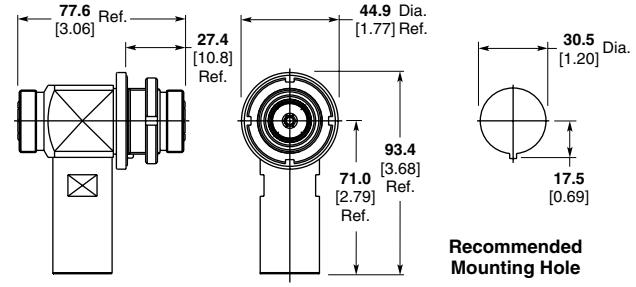


Part Number
1361138-1

Bandwidth	± 70 MHz
Center Frequency	1795 MHz
Contact Plating	Silver
Body Plating	Silver
Max Panel	10.00mm
Compliant With	CECC22210
Coupling Torque	0.7-1.1Nm
Proof Torque	1.7Nm
Endurance	500 Matings

GSM

7-16 Bulkhead Jack to 7-16 Bulkhead Jack

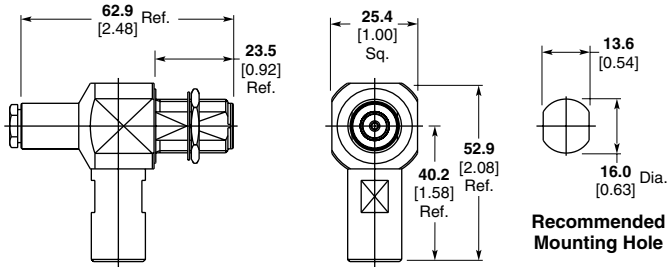


Cable	Part No.
T-Flex 402 Cable	**6408399-1**

Bandwidth	± 70 MHz
Center Frequency	925 MHz
Contact Plating	Silver
Body Plating	White Bronze
Max Panel	8.00mm
Compliant With	CECC22190
Coupling Torque	25 - 30Nm
Proof Torque	35Nm
Endurance	500 Matings

PCS 1900

Type N Clamp Bulkhead Jack



Cable	Part No.
T-Flex 402	**1312137-1**

Bandwidth	± 70 MHz
Center Frequency	1920 MHz
Contact Plating	Silver
Body Plating	Silver
Max Panel	10.00mm
Compliant With	CECC22210
Coupling Torque	0.7-1.1Nm
Proof Torque	1.7Nm
Endurance	500 Matings

Note: Part Numbers are RoHS compliant except: ♦ Indicates non-RoHS compliant.

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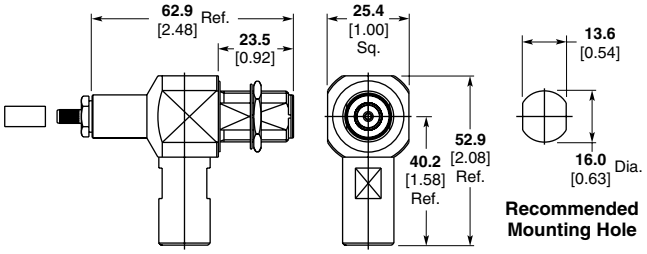
λ/4 Stub Tuners (Continued)

PCS 1900 (Continued)

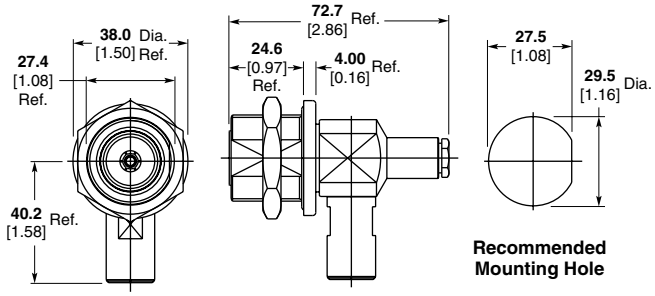
Type N Crimp Bulkhead Jack



Cable	Part No.
RG58 C/U	**6312139-1**

Bandwidth	± 70 MHz
Center Frequency	1920 MHz
Contact Plating	Silver
Body Plating	Silver
Max Panel	10.00mm
Compliant With	CECC22210
Coupling Torque	0.7-1.1Nm
Proof Torque	1.7Nm
Endurance	500 Matings

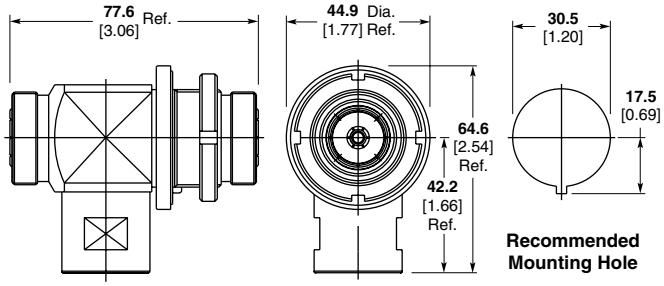
7-16 Clamp Bulkhead Jack



Cable	Part No.
T-Flex402	**6312123-1**

Bandwidth	1920 MHz
Center Frequency	± 70 MHz
Contact Plating	Silver
Body Plating	Silver
Max Panel	8.00mm
Compliant With	CECC 22190
Coupling Torque	25-30 Nm
Proof Torque	35 Nm
Endurance	500 Matings

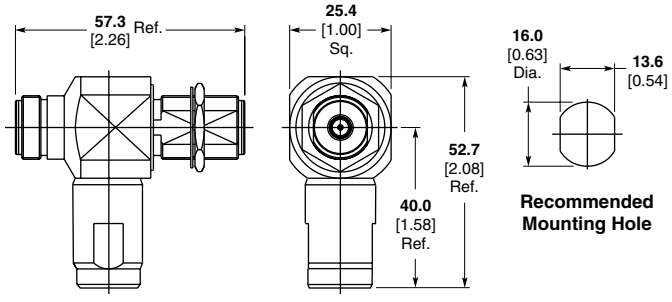
7-16 Bulkhead Jack to 7-16 Bulkhead Jack Adapter



Part Number
6312124-1

Bandwidth	1920 MHz
Center Frequency	± 70 MHz
Contact Plating	Silver
Body Plating	White Bronze
Max Panel	8.00mm
Compliant With	CECC 22190
Coupling Torque	25-30 Nm
Proof Torque	35 Nm
Endurance	500 Matings

Type N Bulkhead Jack to Type N Bulkhead Jack Adapter



Part Number
6361139-1

Bandwidth	± 70 MHz
Center Frequency	1920 MHz
Contact Plating	Silver
Body Plating	Silver
Max Panel	10.00mm
Compliant With	CECC22210
Coupling Torque	0.7-1.1Nm
Proof Torque	1.7Nm
Endurance	500 Matings

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