

Passive Components

DC - 50.0 GHz

Spectrum Elektrotechnik GmbH is a leading manufacturer of RF and Microwave Components in the Frequency Range of DC to 50.0 GHz. The products are published in eight individual catalogs, showing detailed information and comprehensive data.

Adapters, DC - 50 GHz, 50 Ohms

Coaxial Adapters (In Series and Between Series)
High Power Adapters
Push-On Adapters
Waveguide to Coax Adapters

Microwave Connectors, DC - 50 GHz, 50 Ohms

Blind Mate Connectors
Coaxial Connectors
High Power Connectors
Multi Pin Connectors
Push-On Connectors

Cable Assemblies, DC - 50 GHz, 50 Ohms

ANA Test Cables
Flexible Cable Assemblies
Low Loss Cable Assemblies
Phase Stable Cable Assemblies
Semi Rigid Cable Assemblies (Dia. 0.34" to 1")

Test Necessities and Accessories, DC - 50 GHz, 50 Ohms

LRL, TRL Calibration and Verification Kits
ANA Cable Assemblies
Torque Wrenches
Interface Gauges
Calibration Kits
Terminations

Components, DC - 50 GHz, 50 Ohms

Coaxial Switches
Coaxial Terminations
DC - Block Connectors
Gain Amplitude Equalizers
Hybrid Housings
Phase Adjusters
Precision Coaxial Terminations
Precision Waveguide Terminations

Special Products and Services:

Adapter Sets, Antennas, Blind Mate Connectors,
Calibration Kits, Custom Connectors/Adapters, Delay Lines,
Detectors, Directional Couplers, Impedance Transformers,
Interface Gauges, Isolators & Circulators, Lightning Surge
Suppressors, Limiters, Phase Stable Assemblies, Precision
Mismatches, Push-Ons, RF-Multipin Connectors SQ-8,
Rotary Joints, Supercomponents, Torque Wrenches.

Quick Connections, 50 Ohms

Blind Mate Connectors
Push - On Adapters
Push - On Connectors
Push - On Cable Assemblies

Components, 75 Ohms

Adapters
Attenuators
Connectors
Switches
Transformers

Machines and Tools

Coax Cable Cutting/Stripping Machines
Flex Cable Cutting/Stripping Machines
Semi-Rigid Cable Bending Machines

This Handbook shows a most extensive line of Passive Components in the frequency range of DC to 50.0 GHz.

On pages 6 and 7 you will find a Quick Reference Guide by Sections, lining out the eleven sections covered in this Handbook, referencing in detail the content of the individual chapters. Sections I through VIII comprise products, Spectrum Elektrotechnik GmbH offers as standard. In most of those product categories the Company is a leading supplier and offers a large variety of state-of-the-art components. Section IX however, Special Products & Services, covers products the Company usually designs and manufactures to customer specifications. This section also contains some products that are standard, but covered already in other Spectrum Catalogs. As they are somehow components, or related to components, it seemed to be appropriate to at least mention them in the ninth section of the Component Handbook.

But just in case you still do not find exactly the product you require, please contact the factory or your nearest Spectrum Area Representative. Due to continuous development we may have solved a similar problem for someone else, or did develop already the product you require.

As it is our main goal to improve specification and performance of the products, Spectrum Elektrotechnik GmbH has to reserve the right to change specifications, design and any other information shown in this Handbook at any time without previous notice.

Because of the comprehensive information gathered in this volume, we call it a Handbook, hopefully the Handbook you like to work with best. If you find the time, we would appreciate your personal opinion about this Handbook.

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Spectrum Elektrotechnik GmbH was founded in 1981 and has become a leading supplier of state-of-the-art components used in the RF and Microwave Technology, such as Connectors, Adapters, Cable Assemblies, Phase Shifters, Couplers, Gain Amplitude Equalizers, Terminations, Calibration Kits, etc., etc. In addition, a number of complex and integrated components have been engineered and manufactured for certain programs and to the customers' needs.

Throughout the world, Spectrum Elektrotechnik GmbH has established a reputation as a design, development and manufacturing center. The Company has been recognized as setting standards, introducing new ideas and leading into new technologies.

The Products

The products are used in commercial systems such as Cellular Applications, Radios, SatCom/VSAT, Satellites and Space Applications, Test Centers and Wireless Communication: The products are used in defence applications such as Airborne Radars, Electronic Intelligence, Electronic Warfare, Jamming Systems, Missile Guidance, etc. Whenever RF or Microwave Expertise and Advanced Manufacturing Technologies are needed you will find Spectrum Elektrotechnik GmbH.

Capabilities and Facilities

The departments within the Company have been set up as an intelligent Network, guaranteeing complete in-house control of every operation and procedure, from design, development, manufacturing, assembly and testing.

Spectrum Elektrotechnik GmbH is small enough to react quickly and large enough to handle extensive orders of important programs successfully. This capability enables us to develop, manufacture and test the extensive range of Products meeting the highest standards of quality and performance. Spectrum Elektrotechnik GmbH introduced CAD design centers already in 1984 as well as CAD/CAM work stations to provide data to computer controlled machines. The Company operates the most advanced machines and uses Test Centers to 50.0 GHz from HP and to 40.0 GHz from Wiltron. Manufacturing and Quality Control comply with DIN - ISO 9000, permitting to meet strict requirements in Commercial, Avionics, Military and Hi-Rel applications. A Final Inspection to 100% is standard, Tests on electrical and physical performance, their tolerances, the workmanship, and the compliance to applicable specifications.

Support

An adequate and knowledgeable staff is always available to support the Customers in respect to Applications, Engineering and Sales. The staff acts as a Team, understanding applications, specifications, needs, priorities and problems as well. A net of distributors assures immediate delivery of off-the-shelf products. Authorized technical knowledgeable Representatives will provide immediate assistance to the customer's needs.

Ordering

Please include both, Spectrum Elektrotechnik GmbH part number, and a description of the item(s) ordered. If special features are required, describe them as completely as possible and include an engineering sketch. Orders may be placed directly with the factory in Munich or with any authorized Spectrum Elektrotechnik GmbH Representative. Minimum Factory Order is DM 250.00.

Acceptance of Orders

All orders are subject to acceptance at the discretion of the factory and with an Order Acknowledgment from Spectrum Elektrotechnik GmbH.

Terms

Upon approval of credit, payment is due Net 30 days from date of invoice. Late payments are subject to a 1.5 % monthly charge on past due balances.

Shipments

Spectrum Elektrotechnik GmbH ships via the most expedient reliable carrier. Shipment F.O.B., Spectrum Elektrotechnik GmbH plant, will be sent freight prepaid and billed unless other prior arrangements are made. Spectrum Elektrotechnik GmbH will use any acceptable method of delivery specifically requested by the customer.

Damaged Materials/Shortages

All orders should be inspected upon receipt for both completeness and to insure receipt of materials in proper condition. All claims for shortages must be made within thirty (30) days after date of shipment of material from Spectrum Elektrotechnik GmbH plant. Title to goods passes to the Buyer upon delivery to the carrier and risk of loss or damage shall thereafter rest with the Buyer. Claims for damage or loss while material is in transit must be made against the carrier by the Buyer.

Warranty

Spectrum Elektrotechnik GmbH warrants products of its manufacture to be free from defects in material and workmanship under conditions of normal use. If, within one year after delivery of the original owner and after prepaid return by the original owner, any Spectrum Elektrotechnik GmbH product is found to be defective, Spectrum Elektrotechnik GmbH shall, at its option, repair or replace said defective item. This warranty does not apply to products which have been disassembled, modified or subjected to conditions exceeding the applicable specifications or ratings.

Cancellation

Cancellation of, or changes to an order acknowledged by Spectrum Elektrotechnik GmbH are accepted only upon terms that protect Spectrum Elektrotechnik GmbH against loss.

Returns

Excess or unused material cannot be returned for credit without factory authorization. Such material is subject to a handling charge of not less than 15 % upon return and inspection of material at the factory. In no case will Spectrum Elektrotechnik GmbH authorize return of material beyond ninety (90) days after shipment from the factory. Credit for returned material is issued by Spectrum Elektrotechnik GmbH only to the original purchaser. Freight charges for returned material is the responsibility of the Buyer.

Defective Material

Claims for defective material or workmanship are subject to verification by Spectrum Elektrotechnik GmbH Quality Control, and must have prior factory authorization. Upon verification, Spectrum Elektrotechnik GmbH reserves the right to repair or replace, as deemed necessary.

Prices / Specifications

Unless otherwise specified, prices quoted are F. O. B. Spectrum Elektrotechnik GmbH plant. Both prices and specifications are subject to modification without prior notice.

Patent and Trademark Indemnity

Buyer agrees at Buyer's expense to protect and defend Seller against any and all claims of patent or trademark infringement arising from Seller's compliance with Buyer's designs or specifications or instruction and to hold Seller harmless from all losses, damages, costs and expenses attributable to any such claim or claims. Seller shall have the right to approve or disapprove counsel designated by Buyer to defend such claims.

Spectrum Elektrotechnik GmbH reserves the right to make design changes without notice on any of its products and without any obligation to make same or similar changes to items previously purchased. In no event does Spectrum Elektrotechnik GmbH assume liability for installation labor or for consequential damages. This warranty is the extent of the obligation or liability assumed by Spectrum Elektrotechnik GmbH with respect to its products, and no other warranty or guarantee is either expressed or implied.

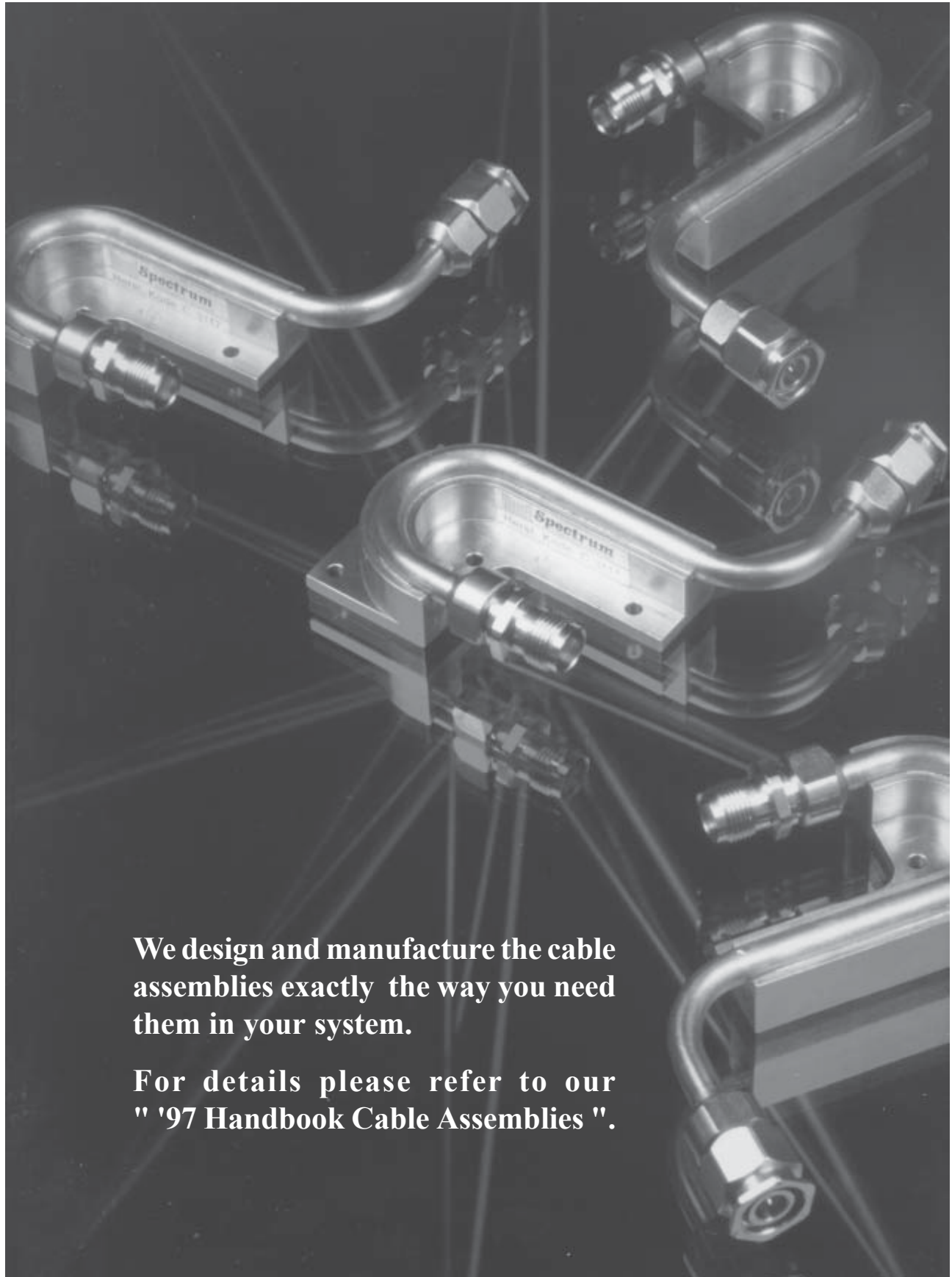
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We design and manufacture the cable assemblies exactly the way you need them in your system.

For details please refer to our " '97 Handbook Cable Assemblies ".

Section I



Phase Adjusters DC - 50.0 GHz

INTRODUCTION: The Precision Phase Shifters, or Phase Adjusters allow the adjustment of the electrical separation between components. A precision mechanical movement provides for smooth and accurate adjustment over the entire frequency range. A secure locking mechanism is furnished with every unit. A wide selection of components is available, offering different mechanical configuration, frequency range, electrical length, and/or connector configuration. The phase adjustment is a function of frequency, as shown in the individual diagrams of the following pages.

Phase Adjustment: The Phase Shifters are mechanical devices, therefore the change of phase depends on the adjustment of the electrical length of a line. For lower frequencies or longer phase adjustments, a trombone line is usually used; for higher frequencies or shorter adjustment, only a straight line may be sufficient. Using an air line results in low insertion loss and good VSWR. The designs of Spectrum Elektrotechnik GmbH employ air lines, whenever possible.

Frequency Range: Phase Adjusters are available for different frequency ranges, DC-2.0 GHz, DC-12.4 GHz, DC-18.0 GHz, DC-26.5 GHz, DC-40.0 GHz, and DC-50.0 GHz. For economical reasons the components have been engineered for these different frequency bands. A rather simple design will meet all the requirements at lower frequency ranges, while only a most precise design will work satisfactorily at highest frequencies.

Connector Configuration: Most of the Phase Adjusters of Spectrum Elektrotechnik GmbH are available with different connector configurations, providing that the frequency range of the connectors do not limit the frequency range of the application. The flatpack phase adjusters can be supplied with 7mm, SMA, N, and TNC, males and females, as standard. Besides the units being supplied with connectors, using the same style but different sex at input and output, it is even possible to have a unit being supplied with connectors of completely different connectors styles, e.g. N female as an input connector and SMA male as the output connector, etc.

The Adjustable Adapters and Components, serving to 26.5 GHz are offered with SMA connectors only, but are available with male or female connectors at the in- and output or vice-versa. To 40.0 GHz usually K* connectors will be used, and to 50.0 GHz the 2.4mm connectors have been chosen.

Applications: Mostly Phase Adjusters will be needed in systems where the adjustment of the phase is done for only a few times. As soon as the phase is set properly as needed in the system, the unit will usually be locked, and remain in this position. In other applications the phase shifters are installed in test sets where the adjustment of phase is made continuously. For these applications, only the Phase Adjusters using ball bearing adjustment and special mechanisms can be recommended.

VSWR: Every microwave component shows reflections and discontinuities within the circuit, as no design can be perfect, and manufacturing tolerances unfortunately do not allow theoretical results. VSWR is the ratio of the reflected signal and the incident signal. Phase Shifters are using a high number of parts. Therefore, the tolerances on the dimensions of the piece parts need to be as tight as possible not only for mechanical purposes, but also for electrical reasons, in order to assure that reflections cannot build up after some time of operation.

Power: The standard components are designed for low or moderate power applications. For higher power applications, units can be supplied as specials, engineered exactly to the customer's needs.

Custom Units: Although Spectrum Elektrotechnik GmbH offers a wide variety of standard phase adjusters, there will always be a need for a special component, using different mechanical configuration, wider phase adjustment, other frequency ranges, etc. Spectrum Elektrotechnik GmbH is a very innovative Company. It employs a strong and successful team of experienced engineers. They will always do their best to propose something that will perfectly fit the customer's needs.

Phase Adjuster Life: The life expectancy of a unit will depend in the first place on the operating environment versus unit design. Secondly, it will depend on the lifetime of the ball bearings, seals and contact junctions. Other parameters that are limiting life are rotational speed and external mechanical loading, or pressurizing the unit. Harsh environment, subjecting the component to vibrations, shock, extremely low or high temperatures, humidity, etc. may further shorten the lifetime. It is therefore of utmost importance to identify in detail the environment the device is supposed to operate in.

If the unit is installed in a system where the phase only will be adjusted a few times, it would not be necessary to select a device that is using ball bearings in the design, vice versa will a phase adjuster cause trouble in an environment where it is constantly adjusted, when not the appropriate mechanical design will be used.

Spectrum Elektrotechnik GmbH has a large number of available designs. Please take the time to decide on the unit that fits exactly your requirements.

Max. Power of Phase Adjusters at max. operating frequency												
Frequency in (GHz) →	2	10	12	14	20	24	26.5	30	40	50		
Operational Range →												
Power (W) ↑	300	2.0 GHz	LS - 0002 - xxxx, LS - B002 - xxxx, LS - M002 - xxxx									
	150	LS - 0112 - xxxx, LS - 0212 - xxxx, LS - A112 - xxxx, LS - A212 - xxxx			12.0 GHz							
	120	LS - 0118 - xxxx, LS - 218 - xxxx, LS - A118 - xxxx, LS - A218 - xxxx					18.0 GHz					
	100	LS - 0121 - xxxx, LS - 0221 - xxxx, LS - A121 - xxxx, LS - A221 - xxxx							26.0 GHz			
		LS - 0170 - 1121							26.0 GHz			
		LS - 0141 - 02							26.0 GHz			
	50	LS - 0012 - xxxx, LS - B012 - xxxx, LS - M012 - xxxx			12.0 GHz							
	30	LS - 0085 - S001					18.0 GHz					
		LS - 0085 - 02					18.0 GHz					
	20	LS - 0018 - xxxx, LS - B018 - xxxx, LS - M018 - xxxx					18.0 GHz					
6	LS - 0140 - KFKM, LS - P140 - KFKM								40.0 GHz			
5	LS - 0150 - HFHM, LS - P150 - HFHM									50.0 GHz		

example.png

Phase Adjusters: Connector Selection Chart 50 Ω



Connector Type	Connector Frequency Range	Sex	Connector Code	Outer Conductor and Finish
2.4mm As per Spectrum Specifications	DC - 50.0 GHz	Male	HM	passivated Stainless Steel
		Female	HF	
3.5mm As per Spectrum Specifications	DC - 35.0 GHz	Male	91	passivated Stainless Steel
		Female	92	
7mm As per IEC 457- 2	DC - 18.0 GHz	----	90	Copper Beryllium, gold plated
BNC As per MIL- C -39012 (IEC 169-2)	DC - 4.0 GHz	Male	71	passivated Stainless Steel
		Female	81	
K* As per Spectrum Specifications	DC - 40.0 GHz	Male	KM	passivated Stainless Steel
		Female	KF	
N As per MIL - C - 39012	DC - 18.0 GHz	Male	51	passivated Stainless Steel
		Female	61	
SMA As per MIL - C - 39012	DC - 18.0 GHz	Male	11	passivated Stainless Steel
		Female	21	
TNC As per MIL - C - 87104/2	DC - 18.0 GHz	Male	31	passivated Stainless Steel
		Female	41	
TNC As per MIL - C - 39012	DC - 11.0 GHz	Male	32	
		Female	42	

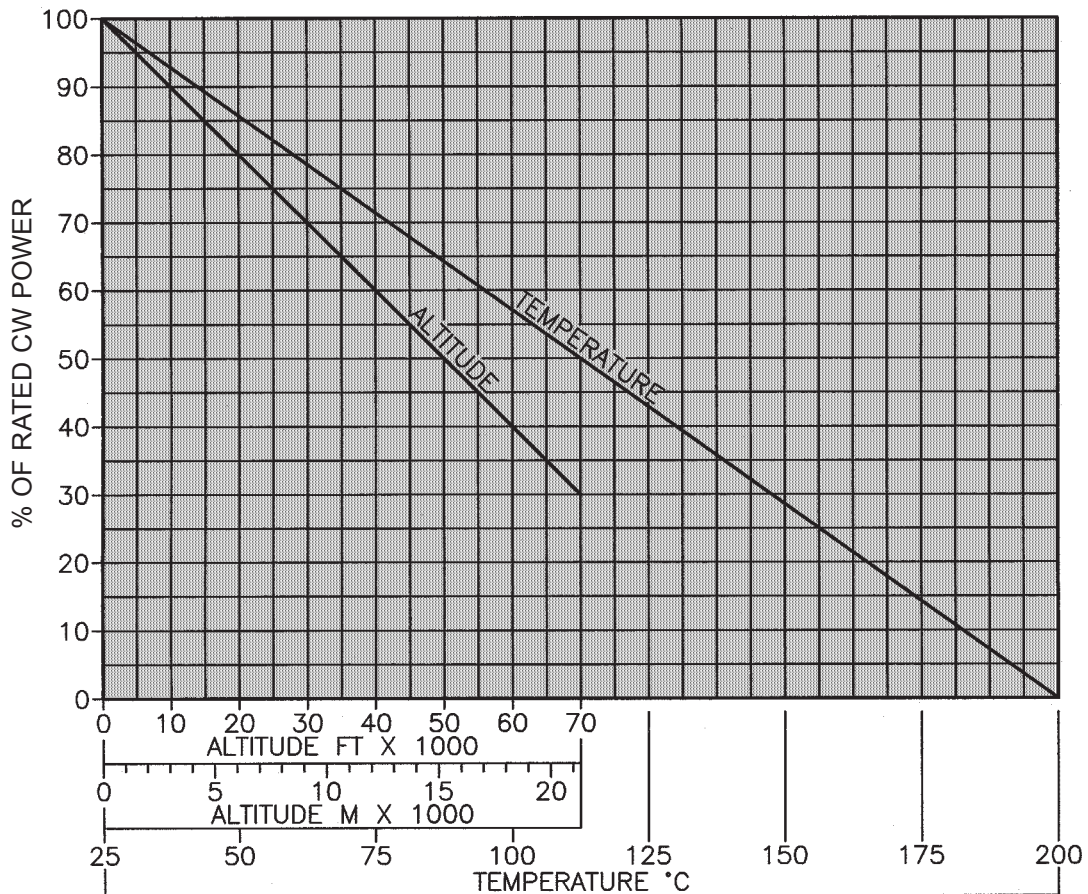
The Power Specifications, as listed on the Data Sheets, are based on Sea Level and an Ambient Temperature of 25°C.

Other altitudes and/or higher temperatures will limit the power. The power derating diagram below can be used to calculate the maximum power at certain altitudes and temperatures.

For information on Power Limits of the components, power limiting information on the connectors is also needed. To obtain this information, the factory may be consulted.

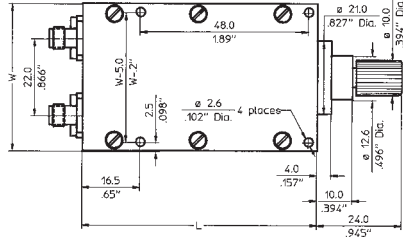
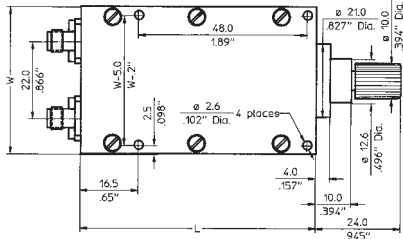
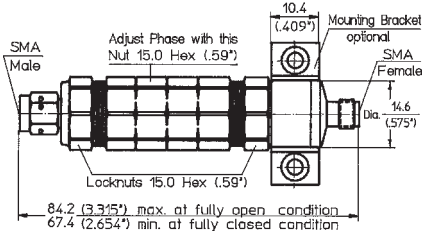
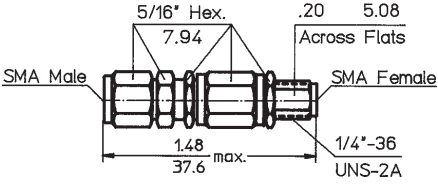
Additional Power Limits can be borne in the application, or the size and the heat dissipation of the unit. In addition, mechanical stress can be limiting the power.

% DERATING FOR ALTITUDE AND TEMPERATURE

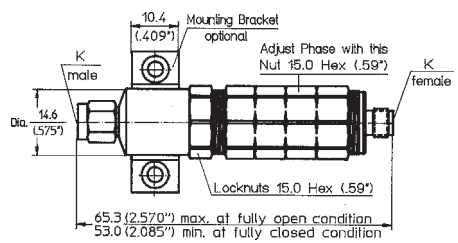
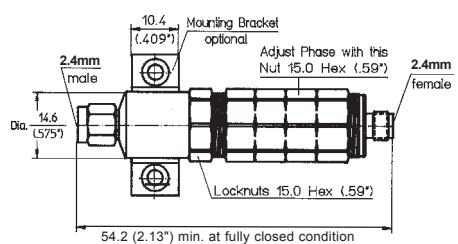
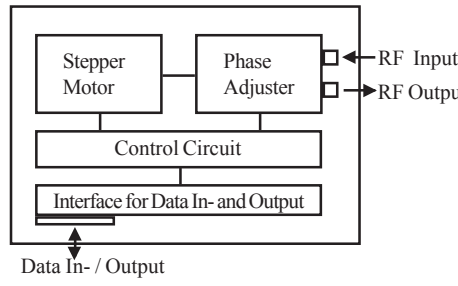
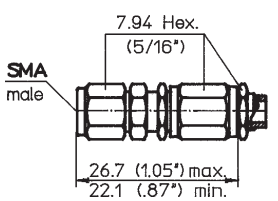
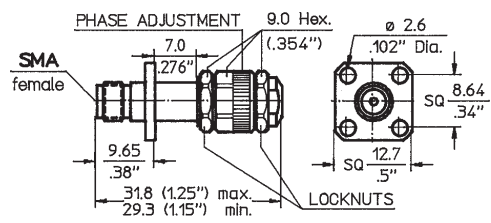


$$\text{COMPONENT POWER CAPABILITY} = (\text{RATED POWER}) \times (\text{TEMPERATURE DERATING}) \times (\text{ALTITUDE DERATING})$$

Phase Adjuster Selection Chart

Page	Frequency Range (GHz)	Features	Outline	
16	DC - 2.0 DC - 12.0 DC - 18.0	Phase Adjuster Series LS-00... Main application: System Available Connectors: 3.5mm, 7mm, N, SMA, and TNC.		
	18	DC - 2.0 DC - 12.0 DC - 18.0	Phase Adjuster using Ball Bearing Adjustment Series LS-B0... Main application: Test Set Available Connectors: 3.5mm, 7mm, N, SMA, and TNC.	
		20	DC - 2.0 DC - 12.0 DC - 18.0	Phase Adjuster with Micrometer Adjustment Series LS-M... Main application: Test Set Available Connectors: 3.5mm, 7mm, N, SMA, and TNC.
22	DC - 12.0 DC - 18.0 DC - 26.0		Phase Adjustable Adapter Main application: System/Test Set	
	25	DC - 26.0	Phase Adjustable Adapter Main application: System	

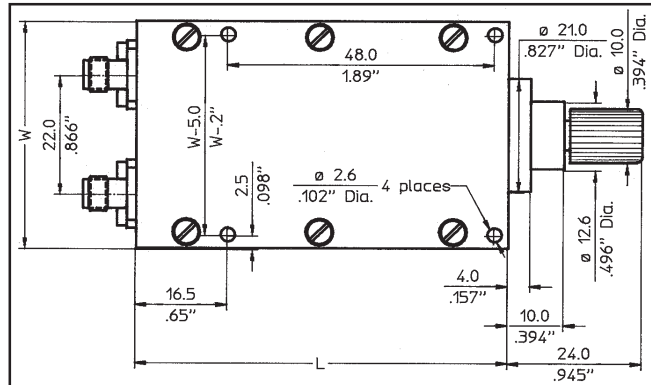
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Frequency Range (GHz)	Features	Outline	Page
DC - 40.0	Phase Adjustable Adapter Main application: System/Test Set		26
DC - 50.0	Phase Adjustable Adapter Main application: System/Test Set		28
DC - 2.0 DC - 12.4 DC - 18.0 DC - 26.0 DC - 40.0 DC - 50.0	Computer Controlled Phase Shifters Main application: Test Stations		30
DC - 26.0	Phase Adjustable Cable Connector of Type SMA for Semi - Rigid 0.085" and 0.141" Main application: System		32
DC - 18.0	Phase Adjustable Cable Connector of Type SMA for Semi - Rigid 0.085" Main application: System		32

Example page

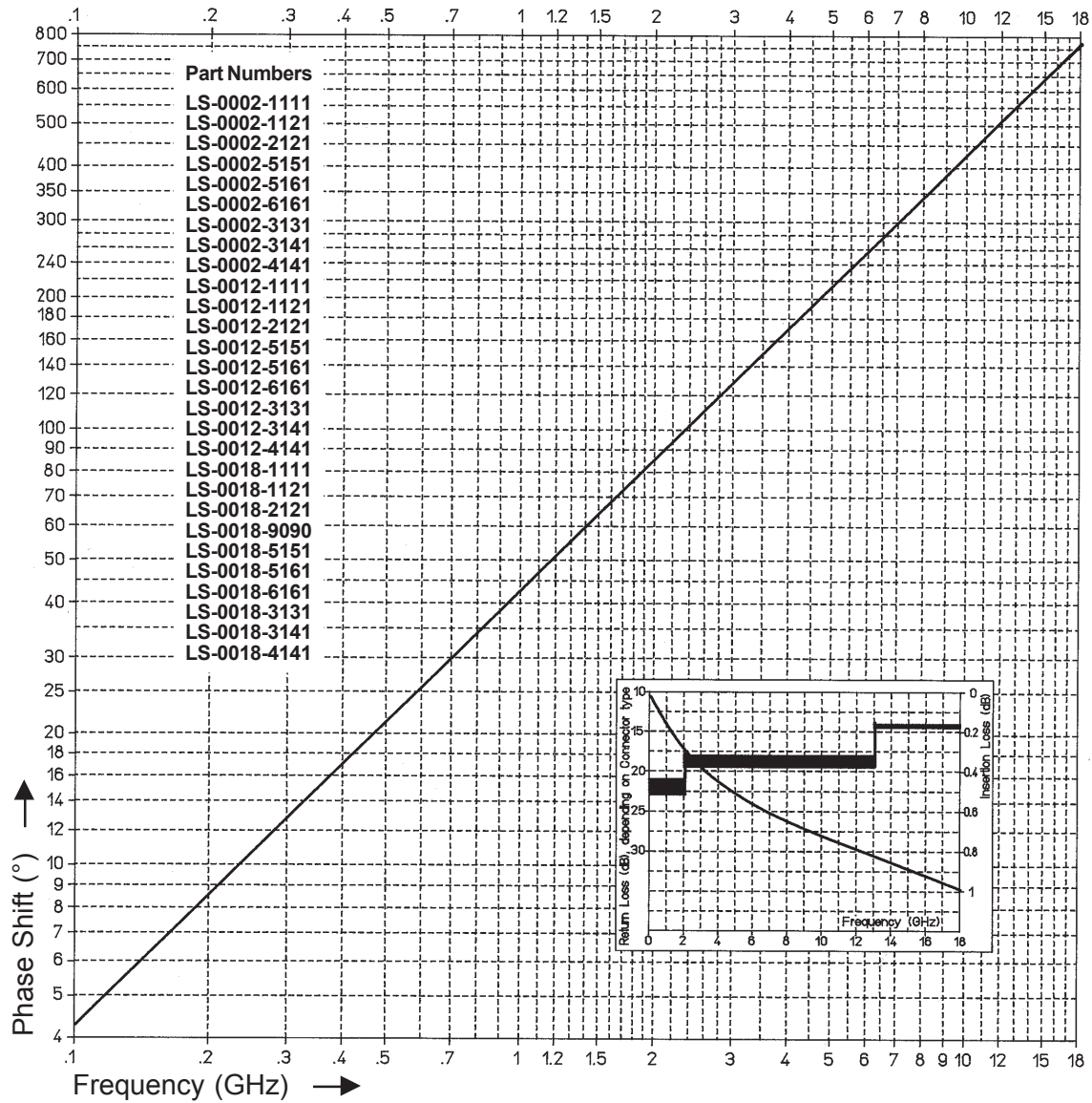
Phase Adjusters DC to 18.0 GHz

- **Application: System Use:**
"Set to the electrical length and lock."
- Precision Phase Adjusters, DC to 2.0, 12.0, and 18.0 GHz.
- Small housing, flat pack configuration.
- Housing Finish: Irridited. On special request, painting can be supplied.
- Four mounting locations are provided.
- Impedance of 50 Ohms is maintained over the full adjustment range.
- Positive resettable locking mechanism.
- Smooth continuous phase adjustment.
- Internal Trombone Line, no external physical length change.
- Rugged construction: housing is made from aluminum, connector outer conductors from stainless steel.
- Bead captivated center contacts.
- Spring fingers and center contacts are made from beryllium copper, heat treated and gold plated per MIL-G-45204, Type II, Grade C.



- Different connector configurations available, such as 3.5mm, 7mm, SMA, N, and TNC. For other connector configurations, please consult the factory.
- Operating temperature range: -54°C to +115°C.

Part Number	Frequency	VSWR max.	R.F. Insertion Loss	Phase Shift	Connectors	Outline Dimensions		
						Length	Width	Height
LS-0002-1111	DC to 2.0 GHz	1.15 : 1	0.3 dB max. at 2.0 GHz	85° min. at 2.0 GHz	SMA-M / SMA-M	68 mm 2.677"	42 mm 1.654"	12.7 mm .500"
LS-0002-1121					SMA-M / SMA-F			
LS-0002-2121					SMA-F / SMA-F			
LS-0002-5151		1.20 : 1	0.3 dB max. at 2.0 GHz	85° min. at 2.0 GHz	N - M / N - M	68 mm 2.677"	42 mm 1.654"	22 mm .866"
LS-0002-5161					N - M / N - F			
LS-0002-6161					N - F / N - F			
LS-0002-3131					TNC-M / TNC-M			
LS-0002-3141					TNC-M / TNC-F			
LS-0002-4141	TNC-F / TNC-F							
LS-0012-1111	DC to 12.0 GHz	1.25 : 1	0.8 dB max. at 12.0 GHz	520° min. at 12.0 GHz	SMA-M / SMA-M	68 mm 2.677"	40 mm 1.575"	12.7 mm .500"
LS-0012-1121					SMA-M / SMA-F			
LS-0012-2121					SMA-F / SMA-F			
LS-0012-5151		1.30 : 1	0.8 dB max. at 12.0 GHz	520° min. at 12.0 GHz	N - M / N - M	68 mm 2.677"	42 mm 1.654"	22 mm .866"
LS-0012-5161					N - M / N - F			
LS-0012-6161					N - F / N - F			
LS-0012-3131					TNC-M / TNC-M			
LS-0012-3141					TNC-M / TNC-F			
LS-0012-4141	TNC-F / TNC-F							
LS-0018-1111	DC to 18.0 GHz	1.50 : 1	1.0 dB max. at 18.0 GHz	770° min. at 18.0 GHz	SMA-M / SMA-M	68 mm 2.677"	40 mm 1.575"	12.7 mm .500"
LS-0018-1121					SMA-M / SMA-F			
LS-0018-2121					SMA-F / SMA-F			
LS-0018-9090		1.50 : 1	1.0 dB max. at 18.0 GHz	770° min. at 18.0 GHz	7 mm / 7 mm	68 mm 2.677"	70 mm 2.756"	30 mm 1.181"
LS-0018-5151					N - M / N - M			
LS-0018-5161					N - M / N - F			
LS-0018-6161					N - F / N - F			
LS-0018-3131					TNC-M / TNC-M			
LS-0018-3141					TNC-M / TNC-F			
LS-0018-4141					TNC-F / TNC-F			



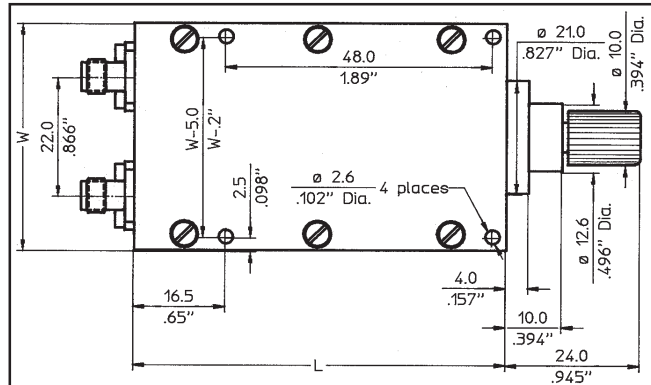
Part Number	LS - 0002 - xxxx	LS - 0012 - xxxx	LS - 0018 - xxxx
	xxxx: connector configuration, for details please refer to the table to the left and page 12.		
Frequency Range (GHz)	DC - 2.0	DC - 12.0	DC - 18.0
Min. Phase Shift (°)	85	520	770
Nominal Phase Shift Deg. / GHz / Shaft Turn	1.15	1.15	1.15
Max. number of Turns	37	37	37
Time Delay (psec)	min.	393	406
	max.	516	530

Example part 6

Phase Adjuster DC to 18.0 GHz Ball Bearing Adjustment

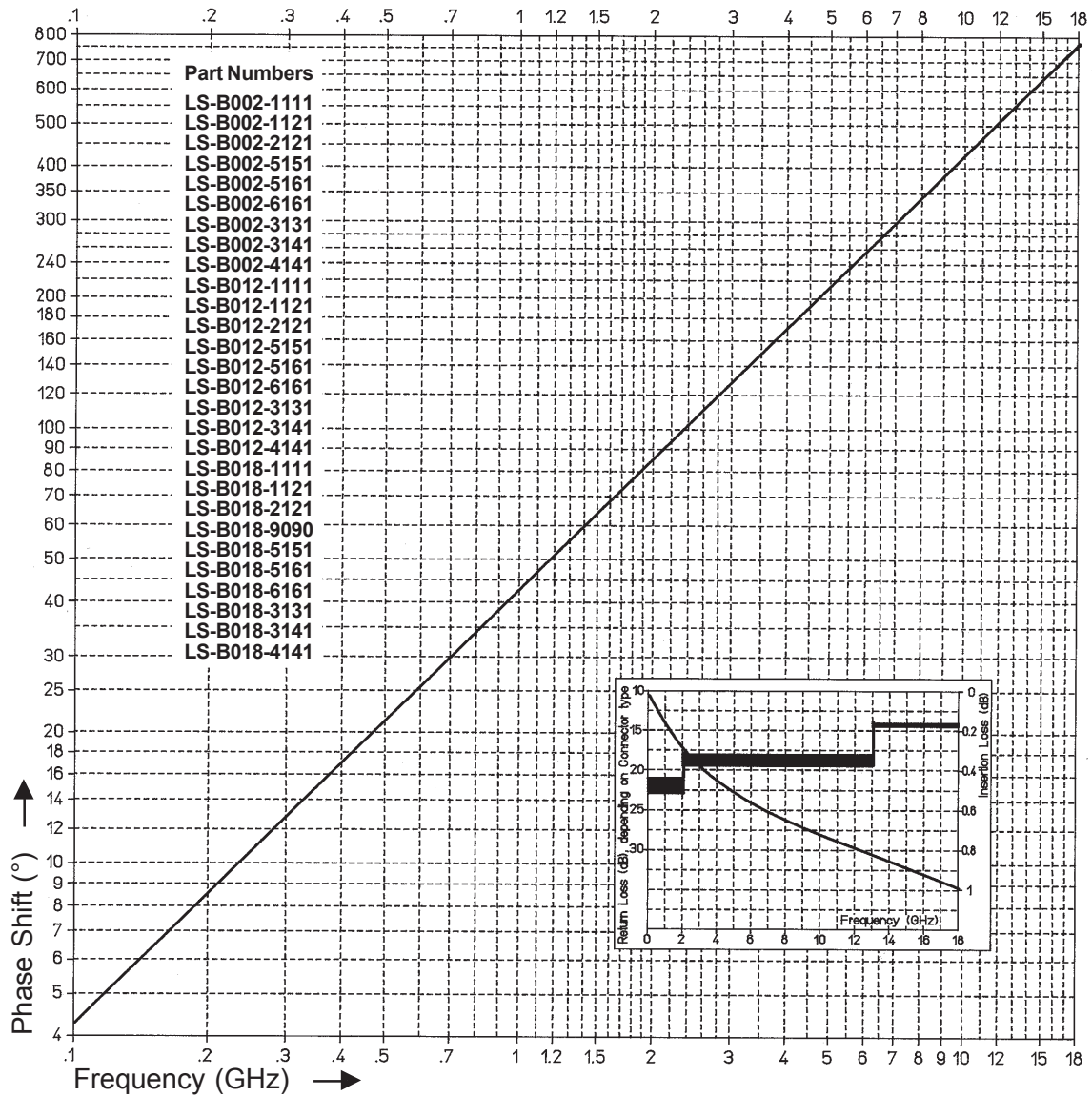


- **Application: Test Set & System Use:** "Adjust the electrical length many times"
- Ball Bearings adjustment.
- Precision Phase Adjusters, DC to 2.0, 12.0, and 18.0 GHz.
- Small housing, flat pack configuration.
- Housing Finish: Irridited. On special request, painting can be supplied.
- Four mounting locations are provided.
- Impedance of 50 Ohms is maintained over the full adjustment range.
- Positive resettable locking mechanism.
- Smooth continuous phase adjustment.
- Internal Trombone Line, no external physical length change.
- Rugged construction: housing is made from aluminum, connector outer conductors from stainless steel.
- Bead captivated center contacts.
- Spring fingers and center contacts are made from beryllium copper, heat treated and gold plated per MIL-G-45204, Type II, Grade C.



- Different connector configurations available, such as 3.5mm, 7mm, SMA, N, and TNC. For other connector configurations, please consult the factory.
- Operating temperature range: -54°C to +115°C.

Part Number	Frequency	VSWR max.	R.F. Insertion Loss	Phase Shift	Connectors	Outline Dimensions		
						Length	Width	Height
LS-B002-1111	DC to 2.0 GHz	1.15 : 1	0.3 dB max. at 2.0 GHz	85° min. at 2.0 GHz	SMA-M / SMA-M	68 mm 2.677"	42 mm 1.654"	12.7 mm .500"
LS-B002-1121					SMA-M / SMA-F			
LS-B002-2121					SMA-F / SMA-F			
LS-B002-5151		1.20 : 1	0.3 dB max. at 2.0 GHz	85° min. at 2.0 GHz	N - M / N - M	68 mm 2.677"	42 mm 1.654"	22 mm .866"
LS-B002-5161					N - M / N - F			
LS-B002-6161					N - F / N - F			
LS-B002-3131					TNC-M / TNC-M			
LS-B002-3141					TNC-M / TNC-F			
LS-B002-4141	TNC-F / TNC-F							
LS-B012-1111	DC to 12.0 GHz	1.25 : 1	0.8 dB max. at 12.0 GHz	520° min. at 12.0 GHz	SMA-M / SMA-M	68 mm 2.677"	40 mm 1.575"	12.7 mm .500"
LS-B012-1121					SMA-M / SMA-F			
LS-B012-2121					SMA-F / SMA-F			
LS-B012-5151		1.30 : 1	0.8 dB max. at 12.0 GHz	520° min. at 12.0 GHz	N - M / N - M	68 mm 2.677"	42 mm 1.654"	22 mm .866"
LS-B012-5161					N - M / N - F			
LS-B012-6161					N - F / N - F			
LS-B012-3131					TNC-M / TNC-M			
LS-B012-3141					TNC-M / TNC-F			
LS-B012-4141	TNC-F / TNC-F							
LS-B018-1111	DC to 18.0 GHz	1.50 : 1	1.0 dB max. at 18.0 GHz	770° min. at 18.0 GHz	SMA-M / SMA-M	68 mm 2.677"	40 mm 1.575"	12.7 mm .500"
LS-B018-1121					SMA-M / SMA-F			
LS-B018-2121					SMA-F / SMA-F			
LS-B018-9090		1.50 : 1	1.0 dB max. at 18.0 GHz	770° min. at 18.0 GHz	7 mm / 7 mm	68 mm 2.677"	70 mm 2.756"	30 mm 1.181"
LS-B018-5151					N - M / N - M			
LS-B018-5161					N - M / N - F			
LS-B018-6161					N - F / N - F			
LS-B018-3131					TNC-M / TNC-M			
LS-B018-3141	TNC-M / TNC-F							
LS-B018-4141	TNC-F / TNC-F							



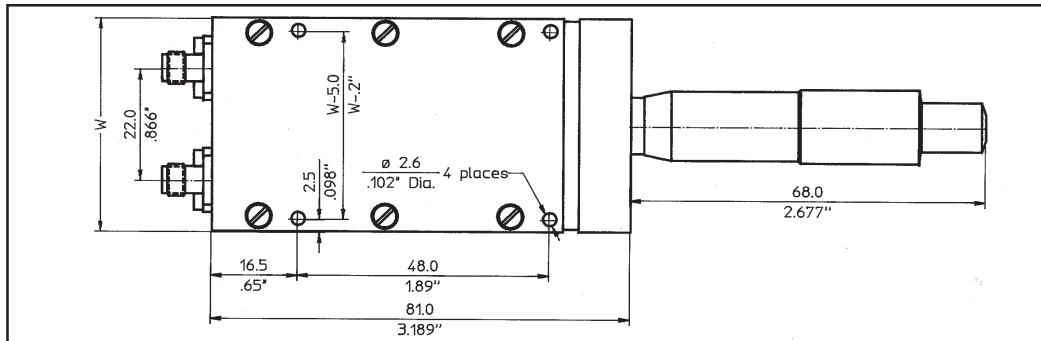
Part Number	LS - B002 - xxxx	LS - B012 - xxxx	LS - B018 - xxxx
	xxxx: connector configuration, for details please refer to the table to the left and page 12.		
Frequency Range (GHz)	DC - 2.0	DC - 12.0	DC - 18.0
Min. Phase Shift (°)	85	520	770
Nominal Phase Shift Deg. / GHz / Shaft Turn	1.15	1.15	1.15
Max. number of Turns	37	37	37
Time Delay (psec)	min.	393	406
	max.	516	530

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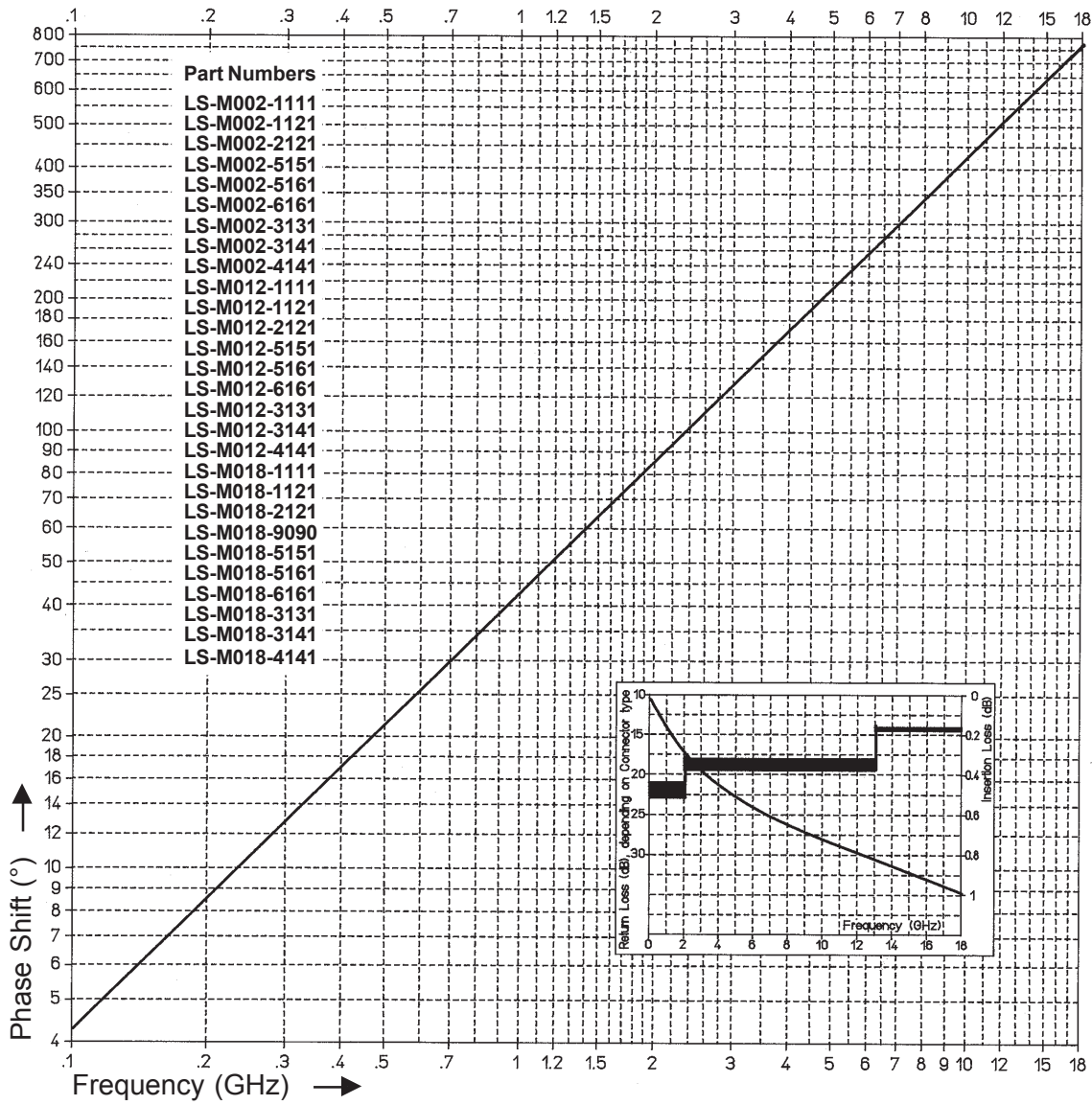
Phase Adjusters with Micrometer Adjustment DC to 18.0 GHz



- **Application: Test Set**
"Set the electrical length by micrometer adjustment".
- Precision Phase Adjusters, DC to 2.0, 12.0, and 18.0 GHz.
- Small housing, flat pack configuration.
- Housing Finish: Irridited. On special request, painting can be supplied.
- Four mounting locations are provided.
- Impedance of 50 Ohms is maintained over the full adjustment range.
- Smooth continuous phase adjustment.
- Internal Trombone Line, no external physical length change.
- Rugged construction: housing is made from aluminum, connector outer conductors from stainless steel.
- Bead captivated center contacts
- Spring fingers and center contacts are made from beryllium copper, heat treated and gold plated per MIL-G-45204, Type II, Grade C.
- Different connector configurations available, such as 3.5mm, 7mm, SMA, N, and TNC. For other connector configurations, please consult the factory.
- Operating temperature range: -54°C to +115°C.



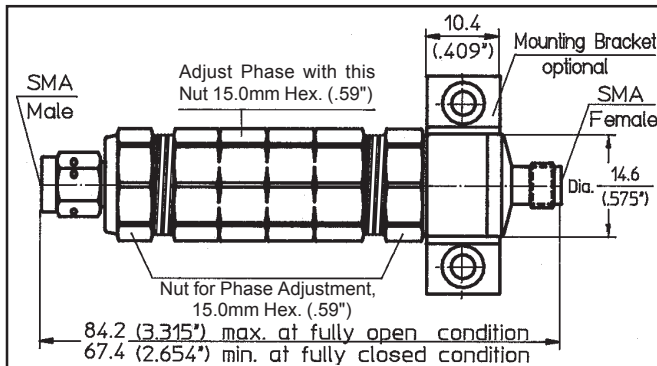
Part Number	Frequency	VSWR max.	R.F. Insertion Loss	Phase Shift	Connectors	Outline Dimensions		
						Length	Width	Height
LS-M002-1111	DC to 2.0 GHz	1.15 : 1	0.3 dB max. at 2.0 GHz	85° min. at 2.0 GHz	SMA-M / SMA-M	81 mm 3.189"	42 mm 1.654"	20.0 mm .787"
LS-M002-1121					SMA-M / SMA-F			
LS-M002-2121					SMA-F / SMA-F			
LS-M002-5151		1.20 : 1	0.3 dB max. at 2.0 GHz	85° min. at 2.0 GHz	N - M / N - M	81 mm 3.189"	42 mm 1.654"	22 mm .866"
LS-M002-5161					N - M / N - F			
LS-M002-6161					N - F / N - F			
LS-M002-3131					TNC-M / TNC-M			
LS-M002-3141					TNC-M / TNC-F			
LS-M002-4141	TNC-F / TNC-F							
LS-M012-1111	DC to 12.0 GHz	1.25 : 1	0.8 dB max. at 12.0 GHz	520° min. at 12.0 GHz	SMA-M / SMA-M	81 mm 3.189"	40 mm 1.575"	20.0 mm .787"
LS-M012-1121					SMA-M / SMA-F			
LS-M012-2121					SMA-F / SMA-F			
LS-M012-5151		1.30 : 1	0.8 dB max. at 12.0 GHz	520° min. at 12.0 GHz	N - M / N - M	81 mm 3.189"	42 mm 1.654"	22 mm .866"
LS-M012-5161					N - M / N - F			
LS-M012-6161					N - F / N - F			
LS-M012-3131					TNC-M / TNC-M			
LS-M012-3141					TNC-M / TNC-F			
LS-M012-4141	TNC-F / TNC-F							
LS-M018-1111	DC to 18.0 GHz	1.50 : 1	1.0 dB max. at 18.0 GHz	770° min. at 18.0 GHz	SMA-M / SMA-M	81 mm 3.189"	40 mm 1.575"	20.0 mm .787"
LS-M018-1121					SMA-M / SMA-F			
LS-M018-2121					SMA-F / SMA-F			
LS-M018-9090					7 mm / 7 mm			
LS-M018-5151		1.50 : 1	1.0 dB max. at 18.0 GHz	770° min. at 18.0 GHz	N - M / N - M	81 mm 3.189"	42 mm 1.654"	22 mm .866"
LS-M018-5161					N - M / N - F			
LS-M018-6161					N - F / N - F			
LS-M018-3131					TNC-M / TNC-M			
LS-M018-3141					TNC-M / TNC-F			
LS-M018-4141					TNC-F / TNC-F			



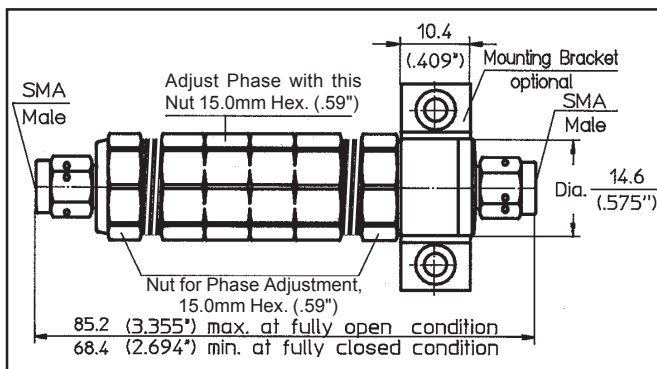
Part Number	LS - M002 - xxxx	LS - M012 - xxxx	LS - M018 - xxxx
	xxxx: connector configuration, for details please refer to the table to the left and page 12.		
Frequency Range (GHz)	DC - 2.0	DC - 12.0	DC - 18.0
Min. Phase Shift (°)	85	520	770
Nominal Phase Shift Deg. / GHz / Shaft Turn	1.15	1.15	1.15
Max. number of Turns	37	37	37
Time Delay (psec)	min.	393	406
	max.	516	530

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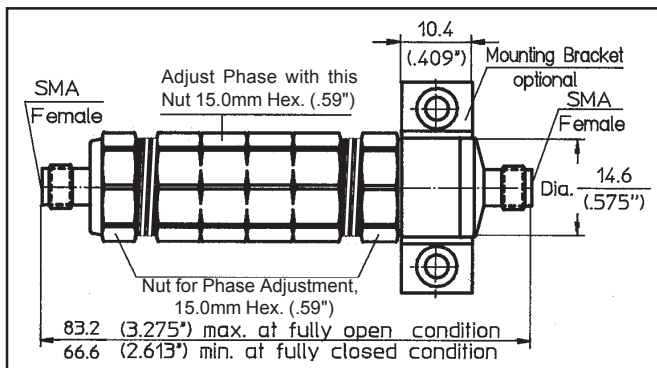
Phase Adjustable Adapters DC to 26.0 GHz



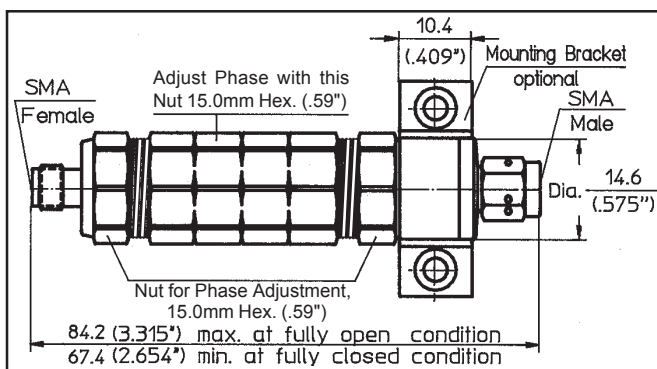
SMA Male to SMA Female		
Part Number	Frequency Range	Material
LS-0112-1121	DC - 12.0 GHz	Stainless Steel Body
LS-0118-1121	DC - 18.0 GHz	
LS-0121-1121	DC - 26.0 GHz	
LS-A112-1121	DC - 12.0 GHz	Aluminum Body
LS-A118-1121	DC - 18.0 GHz	
LS-A121-1121	DC - 26.0 GHz	



SMA Male to SMA Male		
Part Number	Frequency Range	Material
LS-0112-1111	DC - 12.0 GHz	Stainless Steel Body
LS-0118-1111	DC - 18.0 GHz	
LS-0121-1111	DC - 26.0 GHz	
LS-A112-1111	DC - 12.0 GHz	Aluminum Body
LS-A118-1111	DC - 18.0 GHz	
LS-A121-1111	DC - 26.0 GHz	



SMA Female to SMA Female		
Part Number	Frequency Range	Material
LS-0112-2121	DC - 12.0 GHz	Stainless Steel Body
LS-0118-2121	DC - 18.0 GHz	
LS-0121-2121	DC - 26.0 GHz	
LS-A112-2121	DC - 12.0 GHz	Aluminum Body
LS-A118-2121	DC - 18.0 GHz	
LS-A121-2121	DC - 26.0 GHz	



SMA Female to SMA Male		
Part Number	Frequency Range	Material
LS-0212-1121	DC - 12.0 GHz	Stainless Steel Body
LS-0218-1121	DC - 18.0 GHz	
LS-0221-1121	DC - 26.0 GHz	
LS-A212-1121	DC - 12.0 GHz	Aluminum Body
LS-A218-1121	DC - 18.0 GHz	
LS-A221-1121	DC - 26.0 GHz	

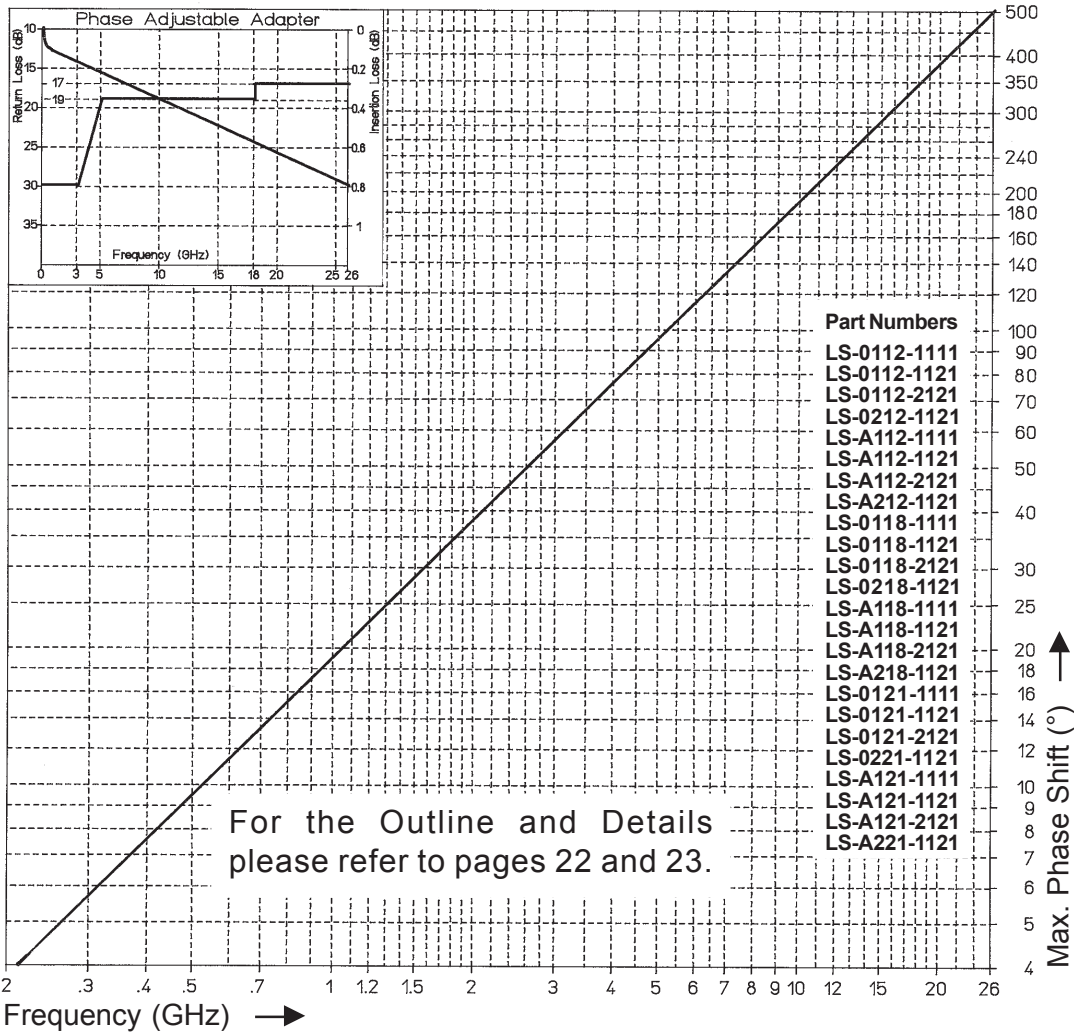
- Precision phase adjustable adapters, DC to 12.0, 18.0 and 26.0 GHz.
- Impedance of 50 Ohms is maintained over the full adjustment range.
- Positive resettable locking mechanism.
- Smooth continuous phase adjustment.
- Physical length change of the unit equals the electrical length change.
- Rugged construction, housing and outer conductors are made from stainless steel.
- Light weight components are available, using aluminum for the housing, but for physical endurance connector outer shells are still supplied in stainless steel.
- Captivated center contacts.
- Spring fingers and center contacts are made from beryllium copper, heat treated and gold plated per MIL-G-45204, Type II, Grade C.
- SMA connector interface specification per MIL-C-39012.
- Four different connector configurations can be obtained, as shown in the drawings: SMAm - SMAf, SMAm - SMAm, SMAf - SMAf, SMAf - SMAm.
- Operating temperature range: -54°C to +115°C, units with extended temperature range are available on request.
- Mounting Brackets are optional and are shown on the drawings on the next page.
- Diagram Phase Shift (°) versus Frequency (GHz), please refer to page 24.

Table for Phase Adjustable Adapters, as shown to the left.

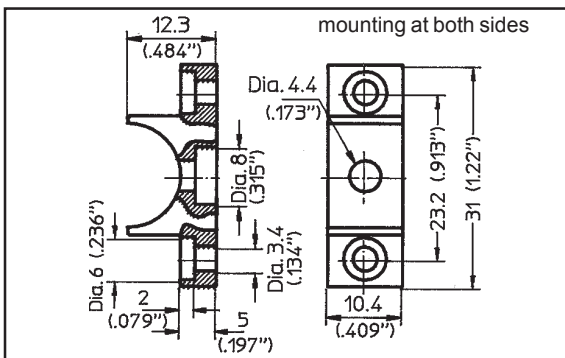
Part Number	Sex	Frequency Range	VSWR max.	Insertion Loss max.	Phase Shift min.	No. of Turns	Nom. Phase Shift Deg./GHz/Turn	Time Delay (psec.) min. max.	Material/ Weight max.
LS-0112-1111	M - M	DC - 12.0 GHz	1.25 : 1	0.4 dB	230° at 12.0 GHz	16.5	1.2	238 293	Stainless Steel
LS-0112-1121	M - F								70 g
LS-0112-2121	F - F								Aluminu
LS-0212-1121	M - F								
LS-A112-1111	M - M								
LS-A112-1121	M - F								
LS-A112-2121	F - F								
LS-A212-1121	M - F								
LS-0118-1111	M - M	DC - 18.0 GHz	1.25 : 1	0.6 dB	350° at 18.0 GHz	16.5	1.2	238 293	Stainless Steel
LS-0118-1121	M - F								70 g
LS-0118-2121	F - F								Aluminu
LS-0218-1121	M - F								
LS-A118-1111	M - M								
LS-A118-1121	M - F								
LS-A118-2121	F - F								
LS-A218-1121	M - F								
LS-0121-1111	M - M	DC - 26.0 GHz	1.30 : 1	0.8 dB	500° at 26.0 GHz	16.5	1.2	238 293	Stainless Steel
LS-0121-1121	M - F								70 g
LS-0121-2121	F - F								Aluminu
LS-0221-1121	M - F								
LS-A121-1111	M - M								
LS-A121-1121	M - F								
LS-A121-2121	F - F								
LS-A221-1121	M - F								

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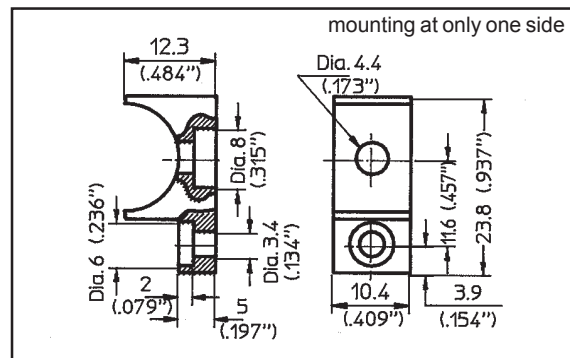
Phase Adjustable Adapters DC to 26.0 GHz



Two different Mounting Brackets are offered. They can easily be added to any Precision Phase Adjuster. Using these standard attachments makes it easy to mount the Phase Shifter in the system or to the test setup and ensures proper operation.

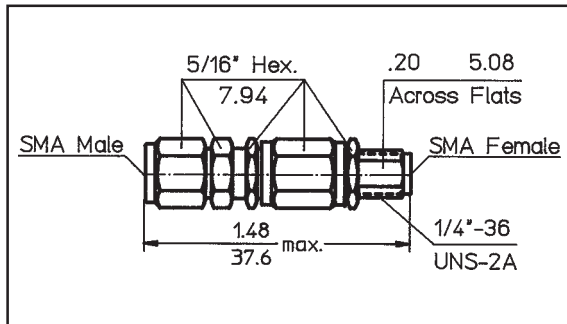


Bracket, Part No.: MB-0200-07
Material: Aluminium irridited



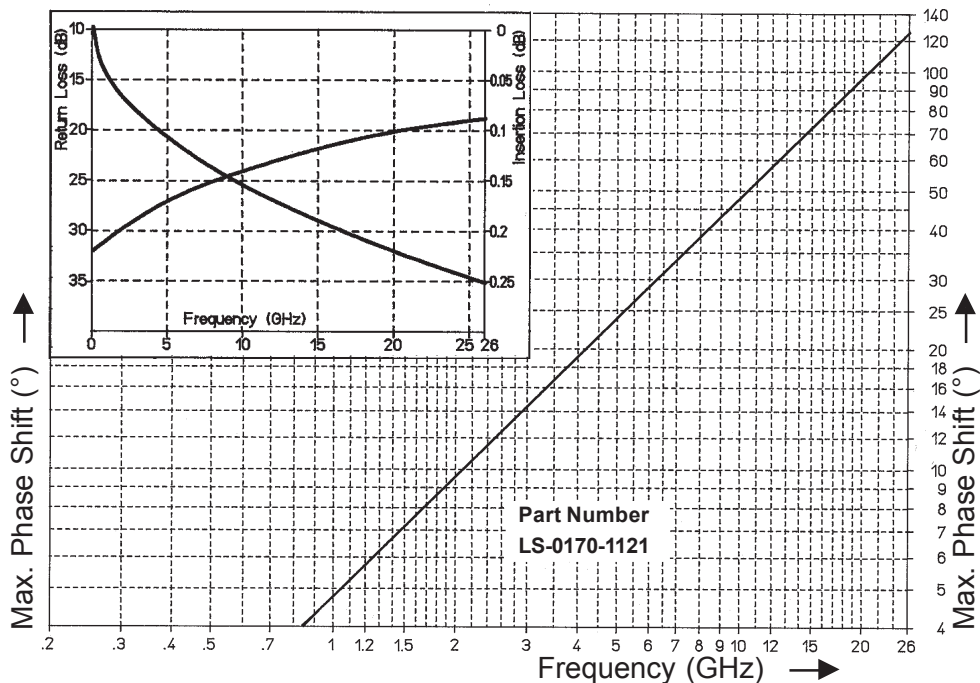
Bracket, Part No.: MB-0100-07
Material: Aluminium irridited

- Precision phase adjustable adapters, DC to 26.0 GHz. Impedance of 50 Ohms is maintained over the full adjustment range.
- Positive resettable locking mechanism.
- Smooth continuous phase adjustment.
- Physical length change of the unit equals the electrical length change.
- Rugged construction, housing and outer conductors are made from stainless steel.
- Captivated center contacts.
- Spring fingers and center contacts are made from beryllium copper, heat treated and gold plated per MIL-G-45204, Type II, Grade C.
- SMA connector interface specification per MIL-C-39012.
- Operating temperature range: -54°C to +115°C, units with extended temperature range are available on request.



- Physical length change per revolution of adjustment nut: ~ 0.46mm
- Electrical length change per revolution of adjustment nut: ~ 0.32mm
- Maximum change in physical length: $4.06 \pm 0.25\text{mm}$ of air
- Maximum change in electrical length: $2.87 \pm 0.18\text{mm}$ of teflon

Part Number	Frequency Range	VSWR max.	Insertion Loss max.	Phase Shift min.	No. of Turns	Nom. Phase Shift Deg./GHz/Turn	Time Delay (psec.) min. max.	Weight max.
LS-0170-1121	DC - 26.0 GHz	$1.05 + .008 * f(\text{GHz})$	0.26 dB	127° at 26.0 GHz	9	0.55	72.2 87.6	9 g

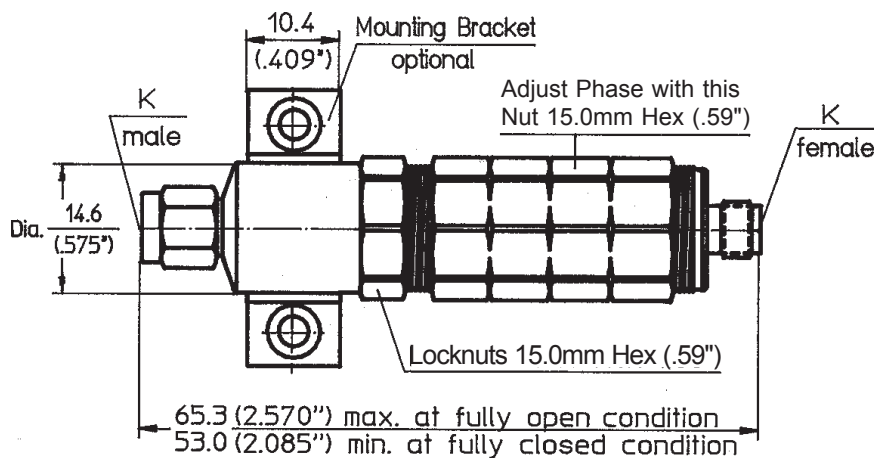


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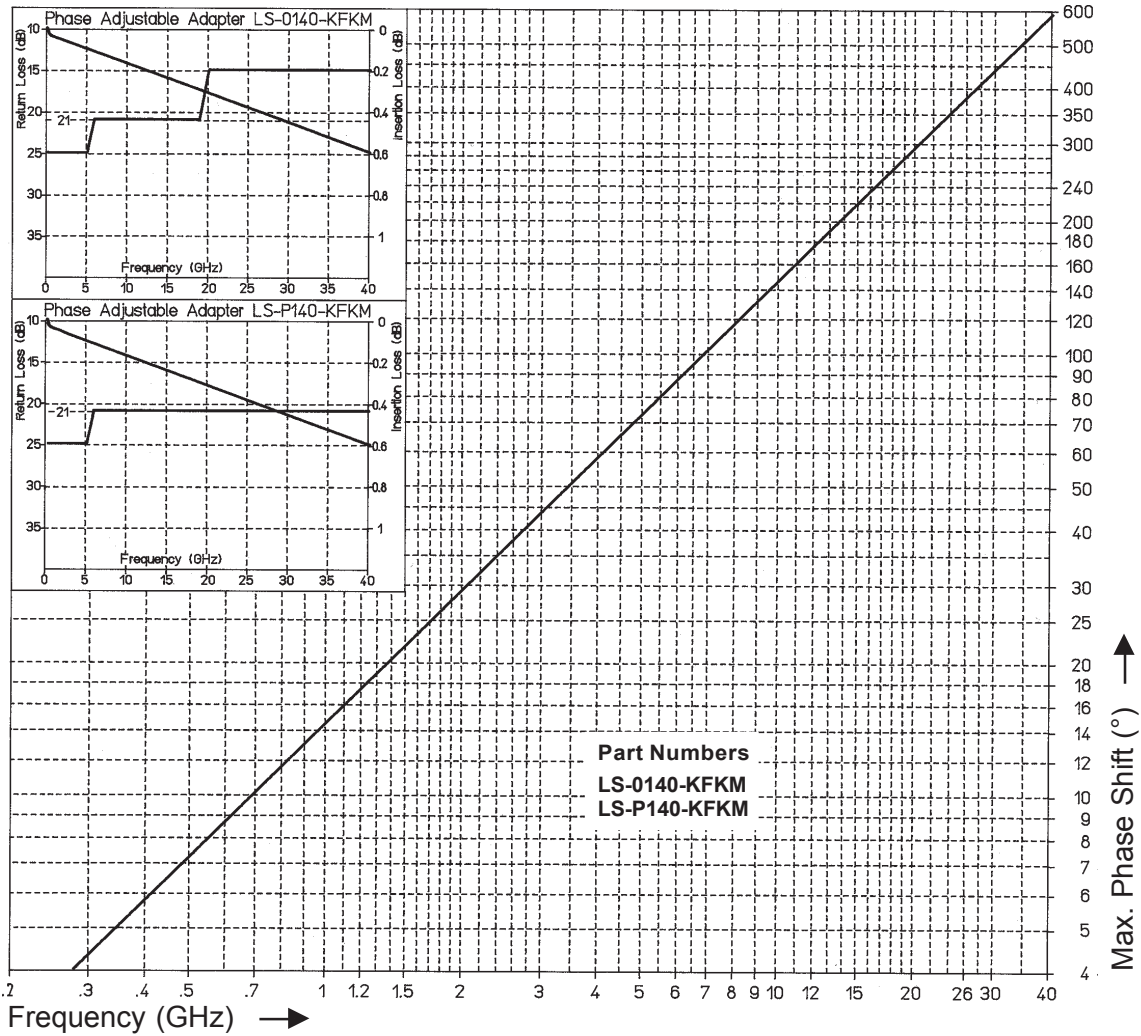
Phase Adjustable Adapters DC to 40.0 GHz



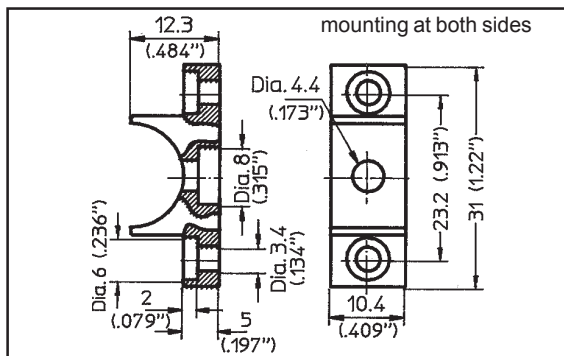
- Precision phase adjustable adapters, DC to 40.0 GHz.
- Impedance of 50 Ohms is maintained over the full adjustment range.
- Positive resettable locking mechanism.
- Smooth continuous phase adjustment.
- Physical length change of the unit equals the electrical length change.
- Rugged construction, housing and outer conductors are made from stainless steel.
- Besides the Standard Units, High Precision Components are offered, showing superior electrical performance to 40.0 GHz, being easily identified by their gold plated body.
- Bead captivated center contacts.
- Spring fingers and center contacts are made from beryllium copper, heat treated and gold plated per MIL-G-45204, Type II, Grade C.
- K* connector interface specification per Spectrum's Specification, as published in Spectrums Adapters and Connectors Handbooks and also available on request.
- Operating temperature range: -54°C to +85°C.
- Mounting Brackets are optional and are shown on the drawings below and to the right.



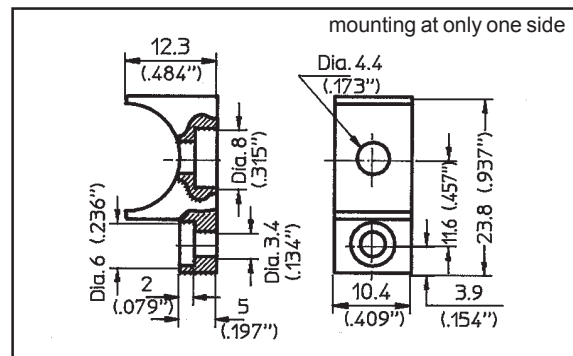
Part Number	Frequency Range	VSWR max.	Insertion Loss max.	Phase Shift min.	No. of Turns	Nom. Phase Shift Deg./GHz/Turn	Time Delay (psec.) min. max.	Weight max.
LS-0140-KFKM	DC - 40.0 GHz	1.40 : 1	0.6 dB	590° at 40.0 GHz	12	1.2	168 208	49 g
LS-P140-KFKM		1.20:1						51 g



Two different Mounting Brackets are offered. They can easily be added to any Precision Phase Adjuster. Using these standard attachments makes it easy to mount the Phase Shifter in the system or to the test setup and ensures proper operation.



Bracket, Part No.: MB-0200-07
Material: Aluminium irridited



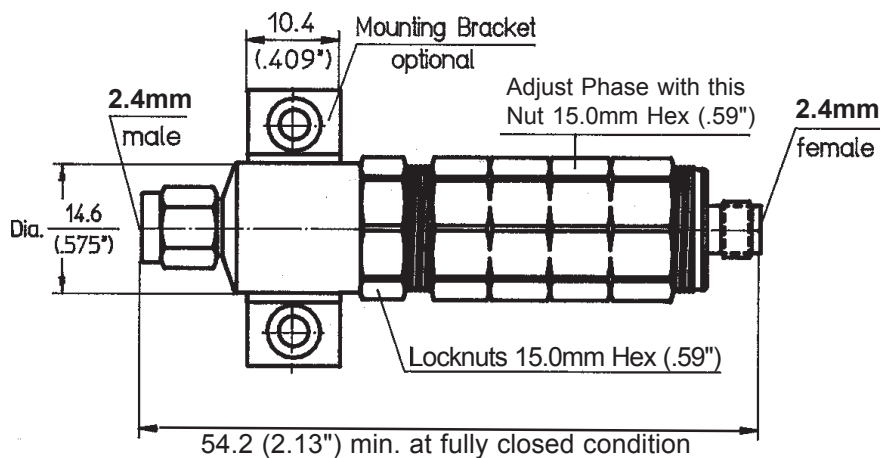
Bracket, Part No.: MB-0100-07
Material: Aluminium irridited

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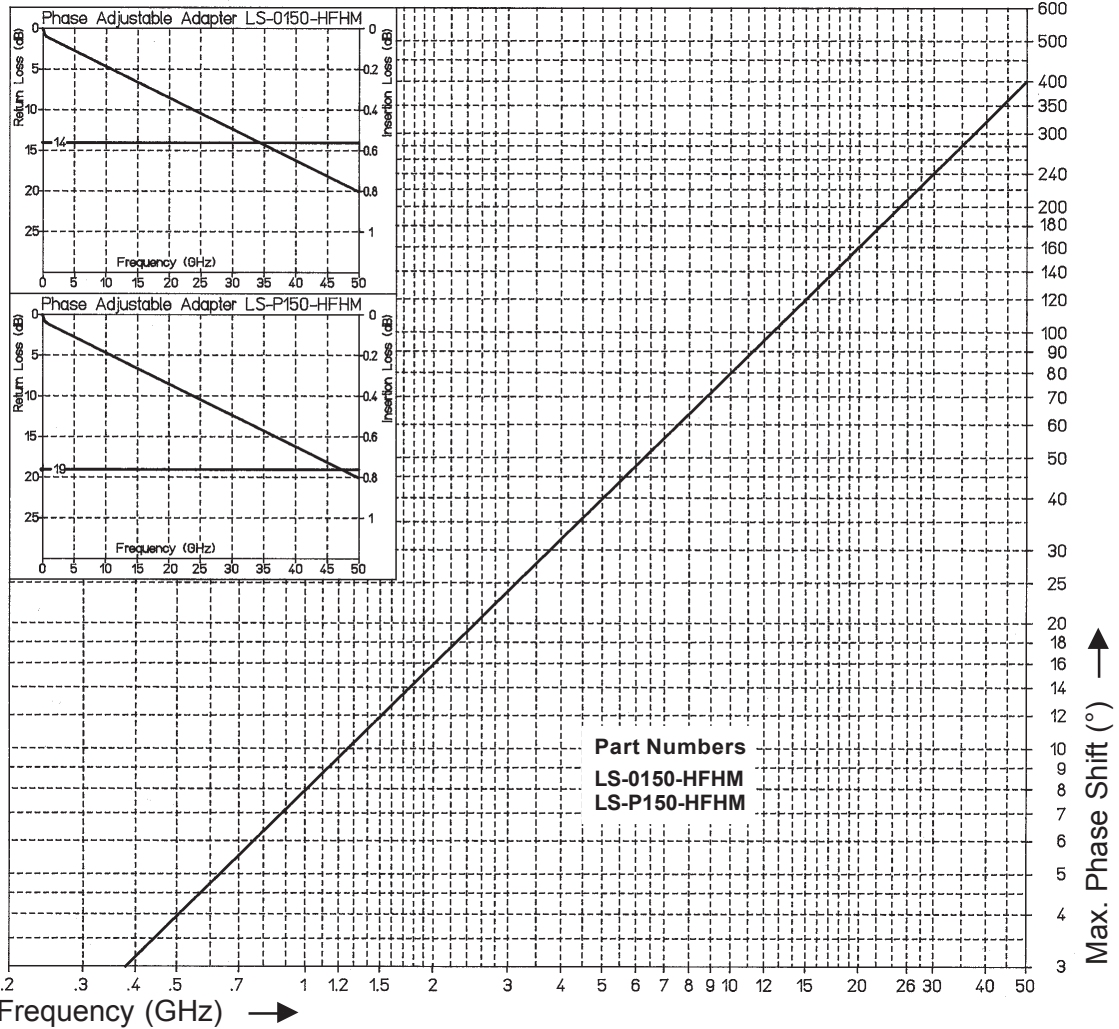
Phase Adjustable Adapters DC to 50.0 GHz



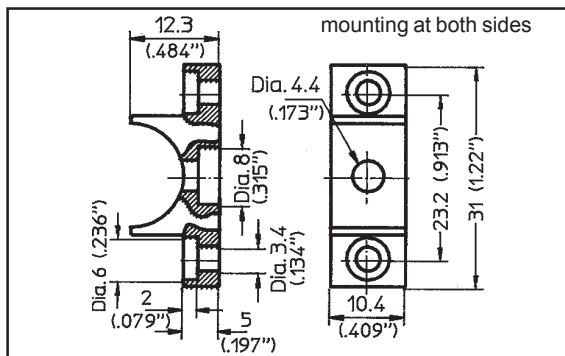
- Precision phase adjustable adapters, DC to 50.0 GHz.
- Impedance of 50 Ohms is maintained over the full adjustment range.
- Positive resettable locking mechanism.
- Smooth continuous phase adjustment.
- Physical length change of the unit equals the electrical length change.
- Rugged construction, housing and outer conductors are made from stainless steel.
- Besides the Standard Units, High Precision Components are offered, showing superior electrical performance to 50.0 GHz, being easily identified by their gold plated body.
- Bead captivated center contacts.
- Spring fingers and center contacts are made from beryllium copper, heat treated and gold plated per MIL-G-45204, Type II, Grade C.
- 2.4mm connector interface specification per Spectrum's Specification, as published in Spectrums Adapters and Connectors Handbooks, and are also available upon request.
- Operating temperature range: -54°C to +85°C.
- Mounting Brackets are optional and are shown on the drawings below and to the right.



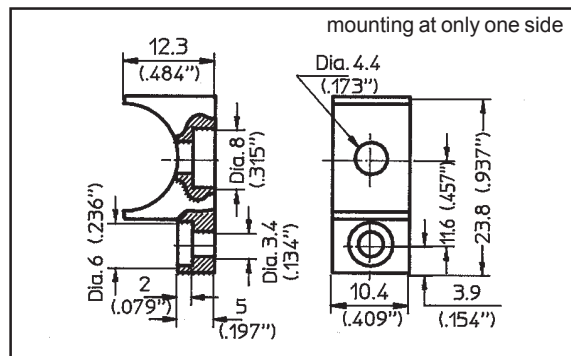
Part Number	Frequency Range	VSWR max.	Insertion Loss max.	Phase Shift min.	No. of Turns	Nom. Phase Shift Deg./GHz/Turn	Time Delay (psec.) min. max.	Weight max.
LS-0150-HFHM	DC - 50.0 GHz	1.50 : 1	0.8 dB	400° at 50.0 GHz	7	1.2	172 195	53 g
LS-P150-HFHM		1.30 : 1						55 g



Two different Mounting Brackets are offered. They can easily be added to any Precision Phase Adjuster. Using these standard attachments makes it easy to mount the Phase Shifter in the system or to the test setup and ensures proper operation.



Bracket, Part No.: MB-0200-07
Material: Aluminium irridited



Bracket, Part No.: MB-0100-07
Material: Aluminium irridited

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INTRODUCTION: The computer controlled Phase Shifters are subsystems, using one or more phase adjusters, allowing the adjustment of the electrical separation between components in increments and cycles, set by individual software, as needed in the project or the test station. Normally, a PC is used to design, drive and control the software, interfacing with driver circuits, operating stepper motor drives, providing a precision mechanical movement for smooth and accurate adjustment over the entire frequency range of the Phase Adjusters. Practically any of the mechanical Phase Adjusters, shown in this section, can be used and built into subsystems using computer controlled circuits, sometimes with redesigned or modified mechanical or electrical configuration.

Phase Adjustment: The Phase Adjustment depends on the increments and lengths changes as set by the software and the mechanical properties of the phase devices used in the subsystem.

Frequency Range: The frequency range of the subsystem depends on the frequency range of the Phase Adjusters. They are available for different frequency ranges, DC-2.0 GHz, DC-12.4 GHz, DC-18.0 GHz, DC-26.5 GHz, DC-40.0 GHz, and DC-50.0 GHz. For economical reasons the components have been engineered for these different frequency bands. A rather simple design will meet all the requirements at lower frequency ranges, while usually only a most precise and sometimes also most complicated design needs to be used at higher frequencies. For special requirements, standard units may be redesigned, or components engineered exactly to the customers needs can be offered.

Connector Configuration: Most of the Phase Adjusters of Spectrum Elektrotechnik GmbH are available with different connector configurations, providing that the frequency range of the connectors do not limit the frequency range of the application. 7mm, N, SMA and TNC connectors can be used to 18.0 GHz, 3.5mm connectors to 26.5 GHz, or respectively to 35.0 GHz, K* connectors to 40.0 GHz and 2.4mm connectors to 50.0 GHz. For the subsystem, almost any connector configuration will be possible, as the subsystem in general will be a custom design anyway. Therefore subsystems could also be supplied with BNC, C, HN, SC or any other connector configuration, assuming that the connectors are still manufactured by Spectrum Elektrotechnik GmbH or are at least available from other sources in the configuration needed.

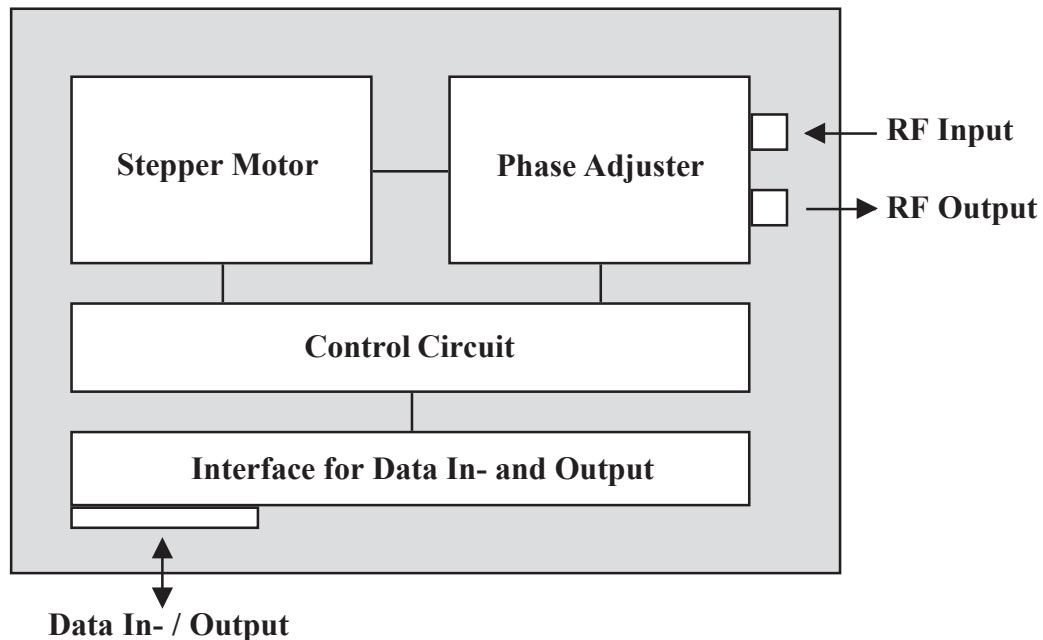
Power: Phase Adjusters are usually designed for low or moderate power applications. For higher power systems units can be supplied as special, engineered exactly to the customer's needs.

VSWR: Every microwave component shows reflections and discontinuities within the circuit, as no design can be perfect, and manufacturing tolerances unfortunately do not allow theoretical results. VSWR is the ratio of the reflected signal and the incident signal. Phase Shifters are usually using a high number of parts. Therefore the tolerances on the dimensions of the piece parts need to be as tight as possible, not only for mechanical purposes, but also for electrical reasons, in order to assure that reflections cannot build up or increase after some time of operation.

Custom Units: Computer controlled Phase Adjusters are mainly custom made subsystems, designed and manufactured to the customer's needs, exactly to his specification. Spectrum Elektrotechnik GmbH is a very innovative Company. It employs a strong and successful team of experienced engineers who always do their best to propose something that will perfectly fit the customer's needs.

Life: The life expectancy of the subsystem will depend in the first place on the operating environment versus unit design. Secondly, it will depend on the lifetime of the ball bearings, seals, and contact junctions, and of the lifetime of the stepper motor drives itself. Other parameters that are limiting life, are rotational speed, and external mechanical loading, or pressurizing the unit. Harsh environment, subjecting the component to vibrations, shock, extremely low or high temperatures, humidity, etc. may further shorten the lifetime as well. It is therefore of utmost importance to identify in detail the environment in which the device is supposed to operate at.

Applications: Computer controlled Phase Adjusters are needed in test stations for accurate and repeatable testing where the adjustment of the phase has to be repeated for many times, either in steps, or in cycles, as defined in a program. Subsystems usually work in a lab environment.



Schematic of a Computer Controlled Phase Shifter Assembly.

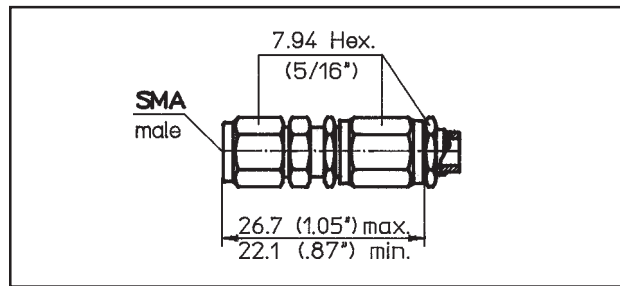
Phase & Amplitude Matched Cable Assemblies

Since 1981, Spectrum Elektrotechnik GmbH has been manufacturing high quality phase and amplitude matched cable assemblies. Experienced staff is available to assist the customer to select the proper component for the specific application and to provide information on the product performance.

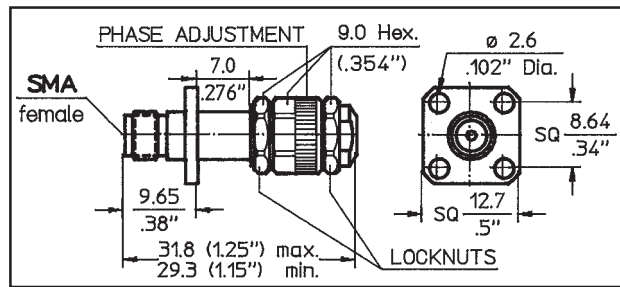
Matching cable assemblies for phase must not necessarily mean to trim the cables to the exact lengths. Spectrum Elektrotechnik GmbH manufactures a variety of Phase Adjusters that can be attached directly to the cable. Using these devices, cable assemblies can easily be matched to perfection, at any frequency. Examples of phase adjustable connectors are shown below.

Phase Adjustable SMA Connectors

Adjustable coaxial Phase Shifters Models LS-0141-02 and LS-0085-02	
Frequency Range	DC - 26.0 GHz
Adjustment	Max. 126° at 26.0 GHz
Impedance	50 Ohms
Max. VSWR	1.05 + .008f(GHz)
Insertion Loss	(.05 SQRT(f(GHz)))dB
R.F. Leakage	-90 dBC
Temperature Range	-65°C to +115°C

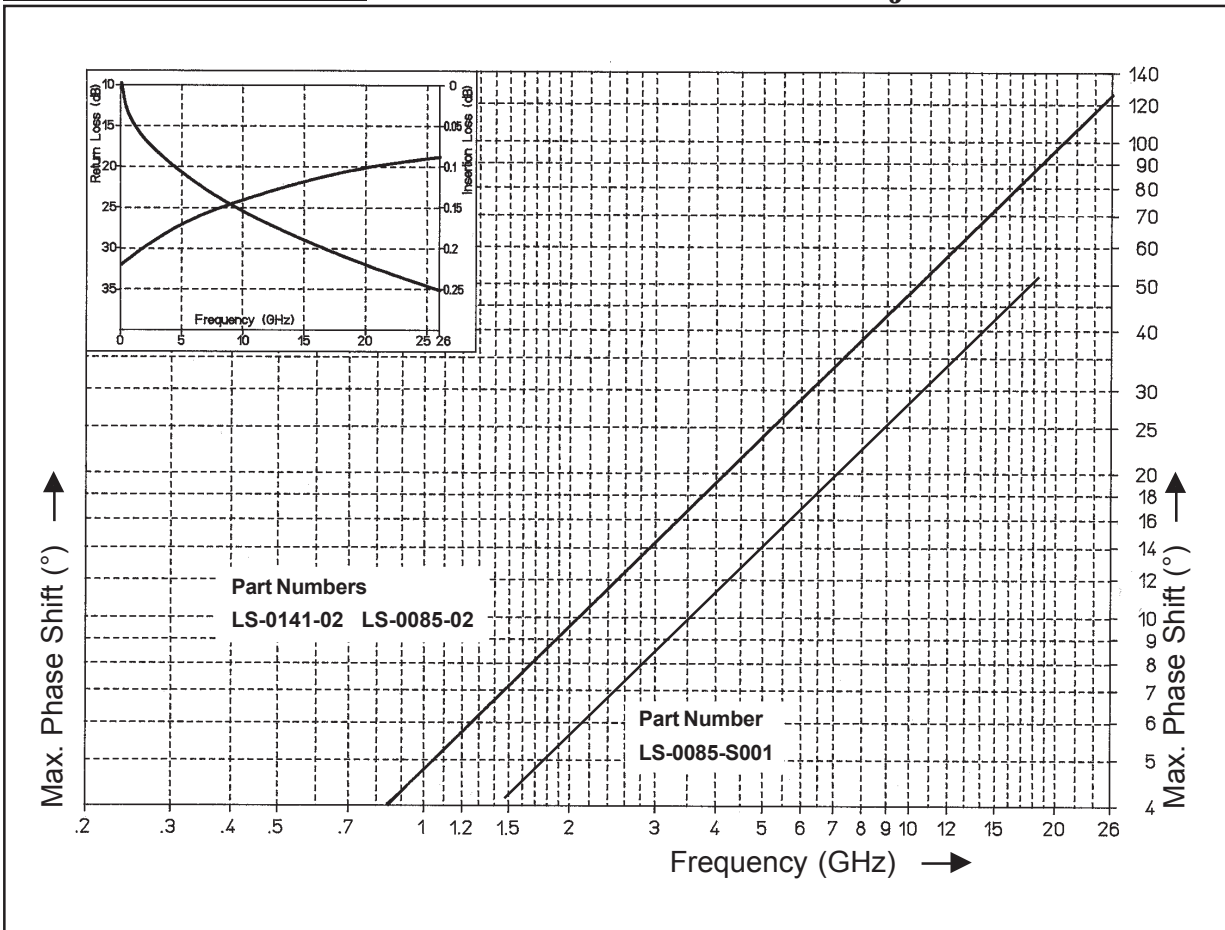


Adjustable coaxial Phase Shifter Model LS-0085-S001	
Frequency Range	DC - 18.0 GHz
Adjustment	Max. 50° at 18.0 GHz
Impedance	50 Ohms
Max. VSWR	1.12:1 at 18.0 GHz
Insertion Loss	0.25 dB at 18.0 GHz
R.F. Leakage	-90 dBC
Temperature Range	-65°C to +115°C



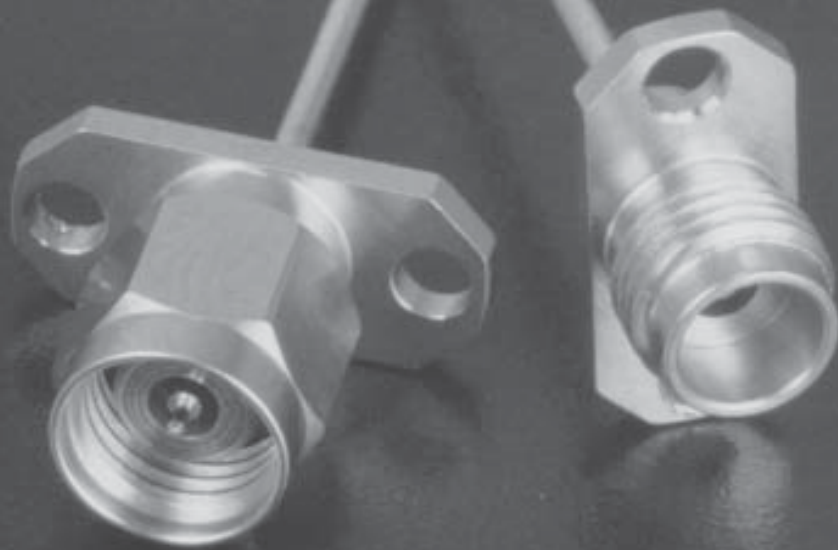
The Models LS-0141-02 and LS-0085-02 are phase adjustable coaxial connectors, covering the full frequency range of DC to 26.0 GHz with an adjustment capability of max. 127° at 26.0 GHz. Model LS-0085-S001 is a 4-hole flanged device, allowing a 50° phase shift at 18.0 GHz. Phase Shifters practically eliminate the need to trim cables to predetermined lengths, in order to achieve the exact phase requirements of a microwave network. Cables only need to be trimmed to the approximate electrical length. The Phase Shifter then allows to make the necessary adjustment between the other components in the system. As a result of the small size and light weight, these Phase Shifters can be used in applications with space limitations, such as airborne and satellite equipment.

Part Number	Cable Type	Frequency Range	VSWR max.	Insertion Loss max.	Phase Shift min.	No. of Turns	Nom. Phase Shift Deg./GHz/Tur	Time Delay (psec.) min. max.	Weight max.
LS-0141-02	0.141" Semi-Rigid	DC - 26.0 GHz	1.25 : 1	0.26 dB	127° at 26.0 GHz	9	0.55	72.2 87.6	9 g
LS-0085-02	0.085" Semi-Rigid								9 g
LS-0085-S00	0.085" Semi-Rigid	DC - 18.0 GHz	1.12 : 1	0.25 dB	50° at 18.0 GHz	5	0.55	85.3 93.7	9 g



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Precision
connectors are
shown in our
“ ‘98 Handbook
M i c r o w a v e
Connectors ” .



Section II



Precision Coaxial Terminations DC - 50.0 GHz

For easy product identification please refer to the Coaxial Termination Selection Chart on pages 38 and 39 or pages 40 and 41 for the Short/Open Circuit Terminations.

INTRODUCTION: Terminations are forming two different groups of devices: the Absorptive Devices and the Reflective Devices.

Terminations, or loads are power absorbing devices. They are matched to the characteristic impedance of the transmission line.

The power reflecting devices are Short Circuit Terminations and Open Circuit Terminations. Shorts and Opens are both fully reflective, with the difference of a quarter wavelength.

Frequency and Bandwidth: Coaxial Terminations do usually operate over a multi-octave bandwidth. In special applications they may be tuned to certain criteria in narrower bands.

VSWR: It is desired that the loads are ideal, absorbing the power completely. In reality, the units will show some reflections and discontinuities within the circuit, as no design is perfect, and manufacturing tolerances do not allow perfect designs anyway. VSWR is the ratio of the reflected signal and the incident signal.

The power reflecting devices, the Opens and Shorts, are reflecting the signal by 100%, this means that the VSWR will become infinite.

Operating Temperature Range: The temperature ranges from -54°C to $+85^{\circ}\text{C}$, or even wider, depending on the application. High Precision Terminations may have a rather limited temperature range for lowest possible VSWR, while Power Terminations in Systems are usually designed for extreme temperature ranges. The operating temperature will affect the power handling of absorptive units.

Average Power Handling: This is the maximum allowable CW power to which the unit can be subjected to without suffering permanent damage. The power handling of absorptive units is a function of temperature. High temperature units are supplied with cooling fins or heat sinks or both for better power dissipation.

Connectors: Terminations are available with a large variety of connectors, meeting the appropriate standard interface specifications, such as MIL-Standards, DIN- or IEC-Specifications, etc.

Custom Designs: In addition to the standard terminations, shown in this section, Spectrum Elektrotechnik GmbH has been designing and supplying special terminations to suit particular requirements, such as lowest VSWR, unique mechanical outline, unusual mounting or special connector requirements, higher power dissipation, characteristic impedance other than 50 Ohms, rough environment, etc., etc.

Applications: Power absorbing devices are needed during test and measurement, can also be integrated in components, and are used in systems applications as well. At a dual or multiport device, one terminal or the terminals that are not involved in the measurement or the function should be terminated in their characteristic impedance, in order to ensure proper measurement or function. Certain components require terminations at at least one port such as the directional couplers.

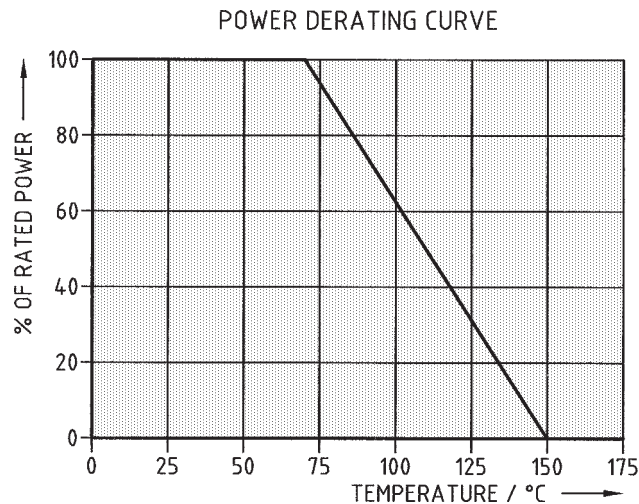
The Short Circuit and Open Circuit Terminations are mainly used for calibration purposes, to establish measurement planes for known reflection phase and magnitude in a test set. Without these short and open circuit terminations, usually no test set can be calibrated.

COLOUR CODING: Most of the Terminations, Spectrum Elektrotechnik GmbH has been designing and manufacturing, especially the new generations of Terminations, are colour coded for easy identification, especially during calibration sequences.

The system is most simple: Bright shiny nickel was chosen for the Shorts, easy to remember, as an electrical short circuit would cause bright lightning. Black endcaps were selected for the Opens, as with an open electrical circuit usually never anything happens, it is rather unexciting, or black. Gold plated endcaps were chosen for the Precision Terminations for convenience.

- **Short Circuit Terminations:** (Shorts) have bright shiny nickel plated endcaps.
- **Open Circuit Terminations:** (Opens) have black anodized endcaps.
- **Precision Terminations:** (Absorptive devices) have gold plated endcaps.

Power Derating versus Temperature



Selection Chart: Coaxial Terminations



Connector Type	Sex	Frequency Range	VSWR max.	Average Power max.	Part Number	Page						
2.4mm <small>As per Spectrum Specifications</small>	Female	DC - 50.0 GHz	1.12 : 1	0.5 Watts	TE-0050-HF00	42						
	Male				TE-0050-HM00							
3.5mm <small>As per Spectrum Specifications</small>	Female	DC - 35.0 GHz	1.10 : 1	0.5 Watts	TE-0035-9200	44						
					DC - 26.5 GHz		1 Watt	TE-0026-92P1				
							1 Watt	TE-0026-9200				
					DC - 4.0 GHz		1 Watt	TE-0004-92P1				
	1 Watt						TE-0004-9200					
	Male				DC - 35.0 GHz		1.10 : 1	0.5 Watts	TE-0035-9100	44		
									DC - 26.5 GHz		1 Watt	TE-0026-91P1
											1 Watt	TE-0026-9100
DC - 4.0 GHz		1 Watt	TE-0004-91P1									
TE-0004-9100												
7mm <small>As per IEC 457- 2</small>	----	DC - 18.0 GHz	1.05 : 1	1 Watt	TE-0018-90P1	46						
			1.15 : 1		TE-0018-9000							
7/16 <small>As per DIN 47223</small>	Female	DC - 7.5 GHz	1.10 : 1	1 Watt	TE-0010-7601	47						
	Male				TE-0010-7501							
BNC <small>As per MIL- C -39012 (IEC 169-2)</small>	Female	DC - 4.0 GHz	1.05 : 1	1 Watt	TE-0004-81P1	49						
					1.10 : 1		2 Watts	TE-0004-8101				
							5 Watts	TE-0004-8102				
			20 Watts	TE-0004-8105	50							
				TE-0004-8120								
				TE-0004-8120								
	Male		1.05 : 1	1 Watt	TE-0004-71P1	49						
					1.10 : 1		2 Watts	TE-0004-7101				
							5 Watts	TE-0004-7102				
			20 Watts	TE-0004-7105	50							
				TE-0004-7120								
			HN <small>As per MIL- C -3643</small>	Female	DC - 8.0 GHz	1.15 : 1	5 Watts	TE-0008-6805	51			
Male	TE-0008-6905											
K* <small>As per Spectrum Specifications</small>	Female	DC - 40.0 GHz	1.10 : 1	0.5 Watts	TE-0040-KF00	52						
	Male				TE-0040-KM00							
N <small>As per MIL- C -39012</small>	Female	DC - 18.0 GHz	1.07 : 1	1 Watt	TE-0018-61P1	53						
					1.15 : 1		2 Watts	TE-0018-6101				
							5 Watts	TE-0018-6102				
			10 Watts	TE-0018-6105	54							
				20 Watts		TE-0018-6110						
				TE-0018-6120								
	Male	DC - 18.0 GHz	1.02 : 1	1 Watt	TE-0002-61P1	53						
					1.07 : 1		1 Watt	TE-0018-51P1				
			2 Watts	TE-0018-5101								
			5 Watts	TE-0018-5102								
			10 Watts	TE-0018-5105								
			20 Watts	TE-0018-5110								
			TE-0018-5120	54								
TE-0018-5120												
DC - 2.0 GHz	1.02 : 1	1 Watt	TE-0002-51P1	53								

Connector Type	Sex	Frequency Range	VSWR max.	Average Power max.	Part Number	Page	
SC <small>As per MIL - C - 39012</small>	Female	DC - 10.0 GHz	1.15 : 1	2 Watts	TE-0010-7902	56	
				5 Watts	TE-0010-7905		
				10 Watts	TE-0010-7910		
				20 Watts	TE-0010-7920		
	Male			2 Watts	TE-0010-8002		
				5 Watts	TE-0010-8005		
				10 Watts	TE-0010-8010		
		20 Watts	TE-0010-8020				
SMA <small>As per MIL - C - 39012</small>	Female	DC - 20.0 GHz	1.05 : 1 DC - 12.4 GHz 1.10 : 1 12.4 - 18.0 GHz 1.15 : 1 18.0 - 20.0 GHz	0.5 Watts	TE-0020-21P0	57	
				1.10 : 1	0.5 Watts		TE-0020-2100
				1.15 : 1	1 Watt		TE-0020-2101
		DC - 18.0 GHz	1.20 : 1	2 Watts	TE-0018-2102		
				5 Watts	TE-0018-2105		
				10 Watts	TE-0018-2110		
			20 Watts	TE-0018-2120			
	Male	DC - 20.0 GHz	1.10 : 1	0.5 Watts	TE-0020-1100	58	
				1.15 : 1	1 Watt		TE-0020-1101
		DC - 18.0 GHz	1.20 : 1	2 Watts	TE-0018-1102		
				5 Watts	TE-0018-1105		
				10 Watts	TE-0018-1110		
20 Watts				TE-0018-1120			
SMP <small>As per DESC 94007 and DESC 94008</small>	Female	DC - 40.0 GHz	1.15 : 1	1 Watt	TE-0040-MP01	59	
		DC - 18.0 GHz	1.10 : 1		TE-0018-MP01		
	Male	DC - 40.0 GHz	1.15 : 1		TE-0040-MJ01		
		DC - 18.0 GHz	1.10 : 1		TE-0018-MJ01		
SPM <small>As per Spectrum Specifications</small>	Female	DC - 18.0 GHz	1.15 : 1	0.5 Watts	TE-0018-PJ00	60	
	Male				TE-0018-PM00		
TNC <small>As per MIL - C - 87104/2</small>	Female	DC - 18.0 GHz	1.10 : 1	1 Watt	TE-0018-41P1	61	
				1.15 : 1	TE-0018-4101		
					2 Watts		TE-0018-4102
					5 Watts		TE-0018-4105
					10 Watts		TE-0018-4110
					20 Watts		TE-0018-4120
	Male		1.10 : 1	1 Watt	TE-0018-31P1		
				TE-0018-3101			
				2 Watts	TE-0018-3102		
			1.15 : 1	5 Watts	TE-0018-3105		
				10 Watts	TE-0018-3110		
				20 Watts	TE-0018-3120		
TNX <small>As per Spectrum Specifications</small>	Female	DC - 18.0 GHz	1.15 : 1	1 Watt	TE-0018-4900	63	
	Male				TE-0018-3900		

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Selection Chart: Short/Open Circuit Coax. Terminations



Connector Type	Sex	Description	Frequency Range	Part Number	Page	
2.4mm <small>As per Spectrum Specifications</small>	Female	Short Circuit	DC - 50.0 GHz	1730-2101-02	43	
		Open Circuit		1730-2102-02		
		Male		Short Circuit		1740-2101-02
				Open Circuit		1740-2102-02
	Male			Short Circuit		1730-1101-02
				Open Circuit		1730-1102-02
		Male		Short Circuit		1740-1101-02
				Open Circuit		1740-1102-02
3.5mm <small>As per Spectrum Specifications</small>	Female		Short Circuit	DC - 26.5 GHz	2130-2101-02	45
			Open Circuit		2130-2102-02	
		Male	Short Circuit		2140-2101-02	
			Open Circuit		2140-2102-02	
	Male		Short Circuit		2130-1101-02	
			Open Circuit		2130-1102-02	
		Male	Short Circuit		2140-1101-02	
			Open Circuit		2140-1102-02	
7mm <small>As per IEC 457-2</small>	----		DC - 18.0 GHz	9030-1101-02	46	
	----			9040-1101-02		
7/16 <small>As per DIN 47223</small>	Female	Short Circuit	DC - 7.5 GHz	7530-2101-02	48	
		Open Circuit		7540-2101-02		
	Male	Short Circuit		7530-1101-02		
		Open Circuit		7540-1101-02		
BNC <small>As per MIL-C-39012 (IEC 169-2)</small>	Female	Short Circuit	DC - 4.0 GHz	4130-2101-02	50	
		Open Circuit		4140-2101-02		
	Male	Short Circuit		4130-1101-02		
		Open Circuit		4140-1101-02		
HN <small>As per MIL-C-3643</small>	Female	Short Circuit	DC - 8.0 GHz	7030-2101-02	51	
		Open Circuit		7040-2101-02		
	Male	Short Circuit		7030-1101-02		
		Open Circuit		7040-1101-02		
K* <small>As per Spectrum Specifications</small>	Female	Short Circuit	DC - 40.0 GHz	1530-2101-02	52	
		Open Circuit		1540-2101-02		
	Male	Short Circuit		1530-1101-02		
		Open Circuit		1540-1101-02		

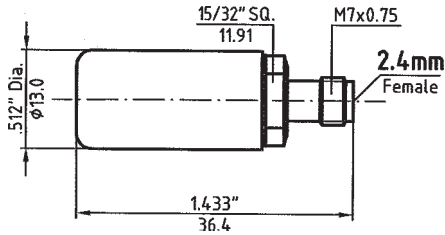
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Connector Type	Sex	Description	Frequency Range	Part Number	Page			
N <small>As per MIL - C - 39012</small>	Female	Short Circuit	DC - 18.0 GHz	3030-2101-02	55			
		Open Circuit		3030-2102-02				
		Male		Short Circuit		3040-2101-02		
				Open Circuit		3040-2102-02		
	Short Circuit			3030-1101-02				
	Open Circuit			3030-1102-02				
	SC <small>As per MIL - C - 39012</small>	Female		Short Circuit		DC - 10.0 GHz	6030-2101-02	56
				Open Circuit			6040-2101-02	
Male		Short Circuit	6030-1101-02					
		Open Circuit	6040-1101-02					
SMA <small>As per MIL - C - 39012</small>	Female	Short Circuit	DC - 18.0 GHz	2030-2101-02	58			
		Open Circuit		(Please refer to 3.5mm)	45			
	Male	Short Circuit		2030-1101-02	58			
		Open Circuit		(Please refer to 3.5mm)	45			
SMP <small>As per DESC 94007 and DESC 94008</small>	Female	Short Circuit	DC - 18.0 GHz	1130-2101-02	59			
		Open Circuit	DC - 40.0 GHz	1130-2102-02				
		Male	Short Circuit	DC - 18.0 GHz		1140-2102-02		
			Open Circuit	DC - 40.0 GHz		1140-2104-02		
	Short Circuit		DC - 18.0 GHz	1130-1101-02				
	Open Circuit		DC - 40.0 GHz	1130-1102-02				
	SPM <small>As per Spectrum Specifications</small>	Female	Short Circuit	DC - 18.0 GHz		2530-2101-02	60	
			Open Circuit			2540-2101-02		
Male		Short Circuit	2530-1101-02					
		Open Circuit	2540-1101-02					
TNC <small>As per MIL - C - 87104/2</small>	Female	Short Circuit	DC - 18.0 GHz	4030-2101-02	62			
		Open Circuit		4030-2102-02				
		Male		Short Circuit		4040-2101-02		
				Open Circuit		4040-2102-02		
	Short Circuit			4030-1101-02				
	Open Circuit			4030-1102-02				
	TNX <small>As per Spectrum Specifications</small>	Female		Short Circuit		DC - 18.0 GHz	3930-2101-02	63
				Open Circuit			3940-2101-02	
Male		Short Circuit	3930-1101-02					
		Open Circuit	3940-1101-02					

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Type 2.4mm Coaxial Terminations

2.4mm Female Termination

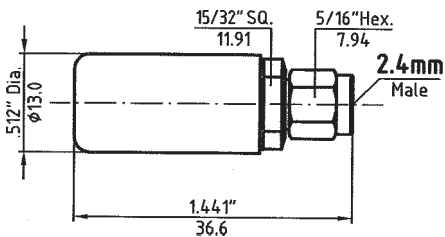


Connector Body is stainless steel, Cap is gold plated.

2.4mm Female Termination

Part No.	TE-0050-HF00
Frequency Range	DC - 50.0 GHz
Impedance	50 Ohms
Max. VSWR	1.12 : 1
Max. Average Power	0.5 Watts
Weight in g	25
Temperature Range	-54°C to + 85°C

2.4mm Male Termination



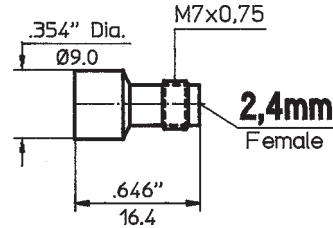
Connector Body is stainless steel, Cap is gold plated.

2.4mm Male Termination

Part No.	TE-0050-HM00
Frequency Range	DC - 50.0 GHz
Impedance	50 Ohms
Max. VSWR	1.12 : 1
Max. Average Power	0.5 Watts
Weight in g	26
Temperature Range	-54°C to + 85°C

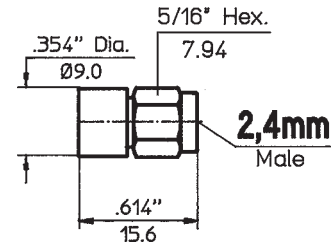
Dimensions shown are inches over millimeters. Standard connector parts are made from stainless steel passivated. The housings are made from stainless steel passivated, brass gold plated, brass nickel plated, aluminum anodized, depending on the type of termination or its application. Cooling fins are usually made from aluminum anodized. Connector interface specifications apply, as outlined in Section X: Connector Specifications.

2.4mm Female Open/Short Circuit Terminations			
Part No.	Description	Frequency Range	Weight (g)
1730-2101-02	Short Circuit	DC - 50.0 GHz	5
1740-2101-02	Open Circuit		5
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	



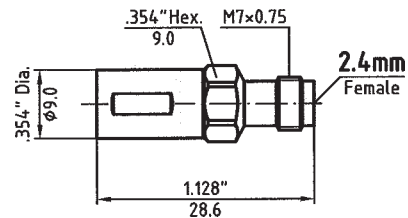
Connector Body is stainless steel passivated.

2.4mm Male Open/Short Circuit Terminations			
Part No.	Description	Frequency Range	Weight (g)
1730-1101-02	Short Circuit	DC - 50.0 GHz	5
1740-1101-02	Open Circuit		5
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	



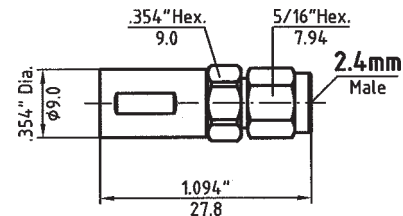
Connector Body is stainless steel passivated.

2.4mm Female Open/Short Circuit Terminations			
Part No.	Description	Frequency Range	Weight (g)
1730-2102-02	Short Circuit	DC - 50.0 GHz	In Development
1740-2102-02	Open Circuit		In Development
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	



Short: Connector Body is stainless steel, Cap is nickel plated.
Open: Connector Body is stainless steel, Cap is black anodized.

2.4mm Male Open/Short Circuit Terminations			
Part No.	Description	Frequency Range	Weight (g)
1730-1102-02	Short Circuit	DC - 50.0 GHz	In Development
1740-1102-02	Open Circuit		In Development
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	



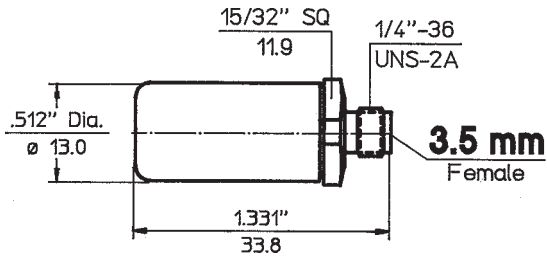
Short: Connector Body is stainless steel, Cap is nickel plated.
Open: Connector Body is stainless steel, Cap is black anodized.

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Dimensions shown are inches over millimeters. Standard connector parts are made from stainless steel passivated. The housings are made from stainless steel passivated, brass gold plated, brass nickel plated, aluminum anodized, depending on the type of termination or its application. Cooling fins are usually made from aluminum anodized. Connector interface specifications apply, as outlined in Section X: Connector Specifications.

Type 3.5mm Coaxial Terminations

3.5mm Female HIGH PRECISION

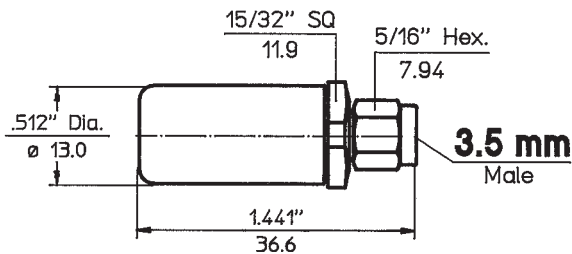


Connector Body is stainless steel, Cap is gold plated.

3.5mm Female HIGH PRECISION TERMINATIONS

Part No.	Frequency Range	VSWR max.	Power (W)
TE-0035-9200	DC - 35.0 GHz	1.10 : 1	0.5 Watts
TE-0026-92P1	DC - 26.5 GHz	1.07 : 1	1 Watt
TE-0004-92P1	DC - 4.0 GHz	1.01 : 1	1 Watt
Impedance		50 Ohms	
Weight in g		24	
Temperature Range		-54°C to +85°C	

3.5mm Male HIGH PRECISION

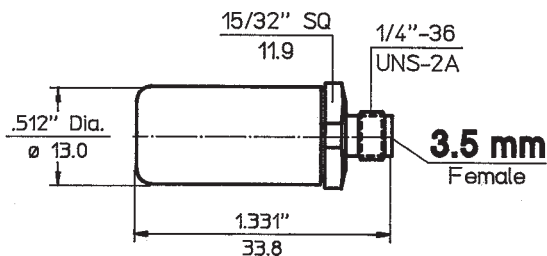


Connector Body is stainless steel, Cap is gold plated.

3.5mm Male HIGH PRECISION TERMINATIONS

Part No.	Frequency Range	VSWR max.	Power (W)
TE-0035-9100	DC - 35.0 GHz	1.10 : 1	0.5 Watts
TE-0026-91P1	DC - 26.5 GHz	1.07 : 1	1 Watt
TE-0004-91P1	DC - 4.0 GHz	1.01 : 1	1 Watt
Impedance		50 Ohms	
Weight in g		25	
Temperature Range		-54°C to +85°C	

3.5mm Female

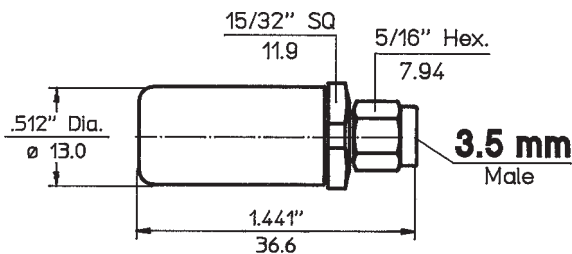


Connector Body is stainless steel, Cap is gold plated.

3.5mm Female Termination

Part No.	TE-0026-9200
Frequency Range	DC - 26.5 GHz
Impedance	50 Ohms
Max. VSWR	1.15 : 1
Max. Average Power	1 Watt
Weight in g	24
Temperature Range	-54°C to + 85°C

3.5mm Male



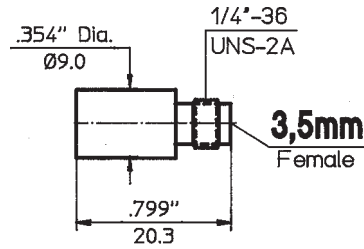
Connector Body is stainless steel, Cap is gold plated.

3.5mm Male Termination

Part No.	TE-0026-9100
Frequency Range	DC - 26.5 GHz
Impedance	50 Ohms
Max. VSWR	1.15 : 1
Max. Average Power	1 Watt
Weight in g	25
Temperature Range	-54°C to +85°C

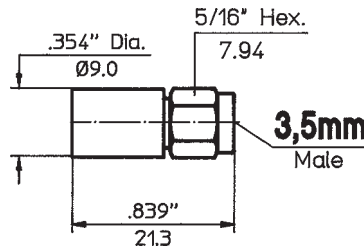
Dimensions shown are inches over millimeters. Standard connector parts are made from stainless steel passivated. The housings are made from stainless steel passivated, brass gold plated, brass nickel plated, aluminum anodized, depending on the type of termination or its application. Cooling fins are usually made from aluminum anodized. Connector interface specifications apply, as outlined in Section X: Connector Specifications.

3.5mm Female Open/Short Circuit Terminations			
Part No.	Description	Frequency Range	Weight (g)
2130-2101-02	Short Circuit	DC - 26.5 GHz	6
2140-2101-02	Open Circuit		6
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	



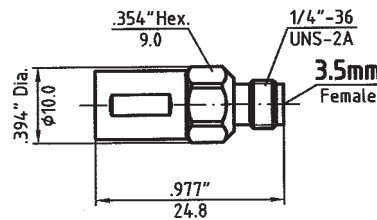
Connector Body and Cap are stainless steel passivated.

3.5mm Male Open/Short Circuit Terminations			
Part No.	Description	Frequency Range	Weight (g)
2130-1101-02	Short Circuit	DC - 26.5 GHz	7
2140-1101-02	Open Circuit		7
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	



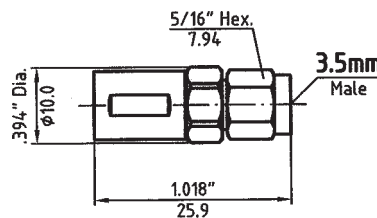
Connector Body and Cap are stainless steel passivated.

3.5mm Female Open/Short Circuit Terminations			
Part No.	Description	Frequency Range	Weight (g)
2130-2102-02	Short Circuit	DC - 26.5 GHz	In Development
2140-2102-02	Open Circuit		In Development
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	



Short: Connector Body is stainless steel, Cap is nickel plated.
Open: Connector Body is stainless steel, Cap is black anodized.

3.5mm Male Open/Short Circuit Terminations			
Part No.	Description	Frequency Range	Weight (g)
2130-1102-02	Short Circuit	DC - 26.5 GHz	In Development
2140-1102-02	Open Circuit		In Development
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	



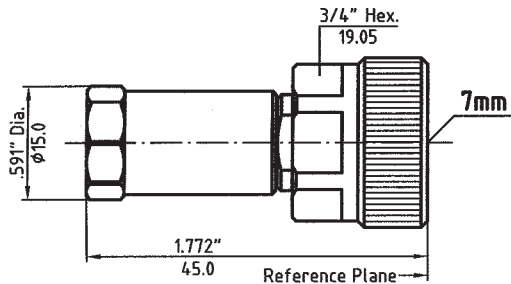
Short: Connector Body is stainless steel, Cap is nickel plated.
Open: Connector Body is stainless steel, Cap is black anodized.

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Dimensions shown are inches over millimeters. Standard connector parts are made from stainless steel passivated. The housings are made from stainless steel passivated, brass gold plated, brass nickel plated, aluminum anodized, depending on the type of termination or its application. Cooling fins are usually made from aluminum anodized. Connector interface specifications apply, as outlined in Section X: Connector Specifications.

Type 7mm Coaxial Terminations

7mm HIGH PRECISION

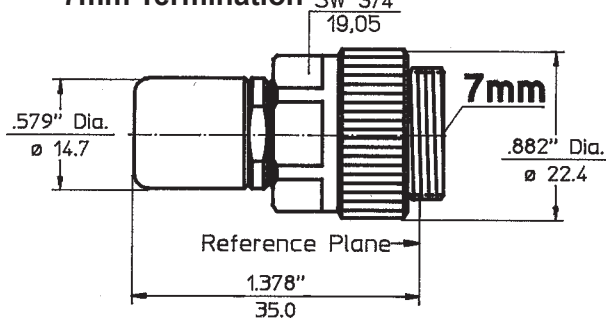


Connector Body is CuBe2 gold plated, Cap is gold plated as well.

7mm HIGH PRECISION TERMINATION

Part No.	TE-0018-90P1
Frequency Range	DC - 18.0 GHz
Impedance	50 Ohms
Max. VSWR	1.05 : 1
Max. Average Power	1 Watt
Weight in g	58
Temperature Range	-54°C to +85°C

7mm Termination SW 3/4"

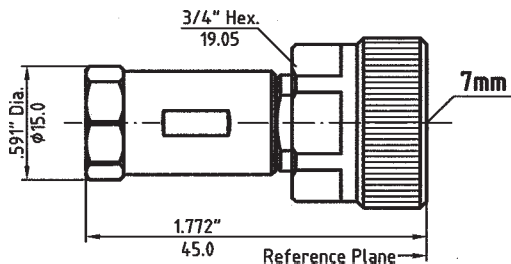


Connector Body is CuBe2 gold plated, Cap is stainless steel.

7mm Termination

Part No.	TE-0018-9000
Frequency Range	DC - 18.0 GHz
Impedance	50 Ohms
Max. VSWR	1.15 : 1
Max. Average Power	1 Watt
Weight in g	55
Temperature Range	-54°C to +85°C

7mm Short/Open Circuit Terminations



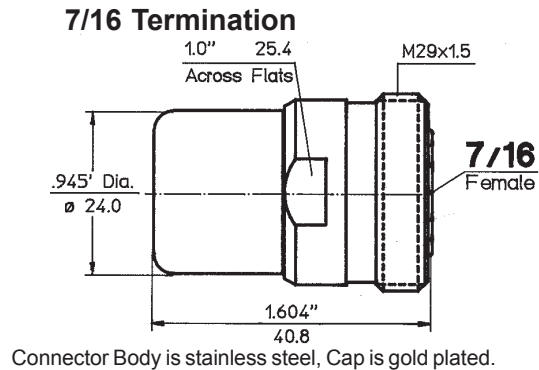
Short: Connector Body is stainless steel, Cap is nickel plated.
Open: Connector Body is CuBe2 gold plated, Cap is black anodized.

7mm Open/Short Circuit Terminations

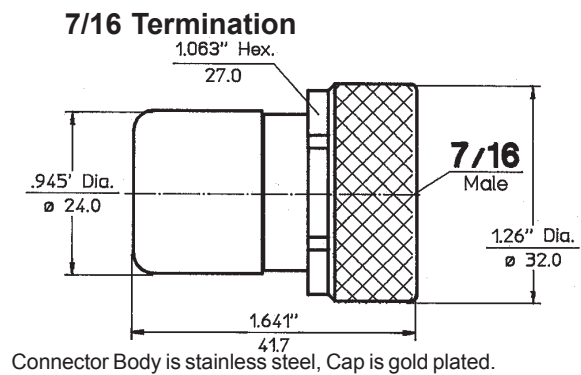
Part No.	Description	Frequency Range	Weight (g)
9030-1101-02	Short Circuit	DC - 18.0 GHz	70
9040-1101-02	Open Circuit		47
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	

Dimensions shown are inches over millimeters. Standard connector parts are made from stainless steel passivated. The housings are made from stainless steel passivated, brass gold plated, brass nickel plated, aluminum anodized, depending on the type of termination or its application. Cooling fins are usually made from aluminum anodized. Connector interface specifications apply, as outlined in Section X: Connector Specifications.

7/16 Female Termination	
Part No.	TE-0010-7601
Frequency Range	DC - 7.5 GHz
Impedance	50 Ohms
Max. VSWR	1.10 : 1
Max. Average Power	1 Watt
Weight in g	118
Temperature Range	-54°C to + 115°C

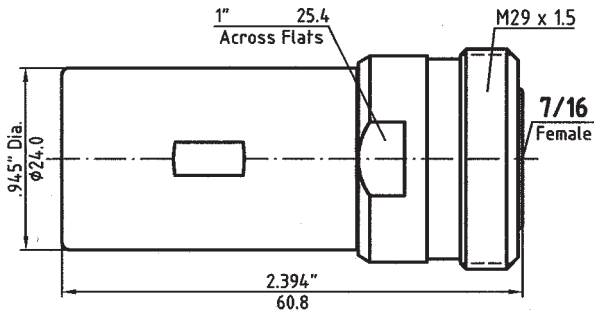


7/16 Male Termination	
Part No.	TE-0010-7501
Frequency Range	DC - 7.5 GHz
Impedance	50 Ohms
Max. VSWR	1.10 : 1
Max. Average Power	1 Watt
Weight in g	123
Temperature Range	-54°C to + 115°C



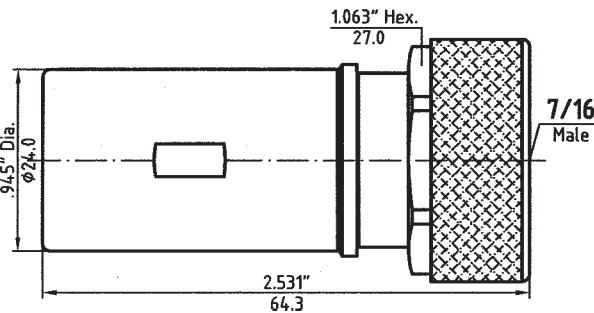
Dimensions shown are inches over millimeters. Standard connector parts are made from stainless steel passivated. The housings are made from stainless steel passivated, brass gold plated, brass nickel plated, aluminum anodized, depending on the type of termination or its application. Cooling fins are usually made from aluminum anodized. Connector interface specifications apply, as outlined in Section X: Connector Specifications.

Type 7/16 Short/Open Circuit Coaxial Terminations



Short : Connector Body is stainless steel, Cap is nickel plated.
 Open: Connector Body is stainless steel, Cap is black anodized.

7/16 Female Open/Short Circuit Terminations			
Part No.	Description	Frequency Range	Weight (g)
7530-2101-02	Short Circuit	DC - 7.5 GHz	160
7540-2101-02	Open Circuit		75
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	



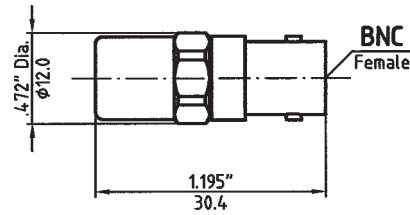
Short : Connector Body is stainless steel, Cap is nickel plated.
 Open: Connector Body is stainless steel, Cap is black anodized.

7/16 Male Open/Short Circuit Terminations			
Part No.	Description	Frequency Range	Weight (g)
7530-1101-02	Short Circuit	DC - 7.5 GHz	165
7540-1101-02	Open Circuit		80
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	

Dimensions shown are inches over millimeters. Standard connector parts are made from stainless steel passivated. The housings are made from stainless steel passivated, brass gold plated, brass nickel plated, aluminum anodized, depending on the type of termination or its application. Cooling fins are usually made from aluminum anodized. Connector interface specifications apply, as outlined in Section X: Connector Specifications.

BNC Female HIGH PRECISION TERMINATION	
Part No.	TE-0004-81P1
Frequency Range	DC - 4.0 GHz
Impedance	50 Ohms
Max. VSWR	1.05 : 1
Max. Average Power	1 Watt
Weight in g	14
Temperature Range	-54°C to + 115°C

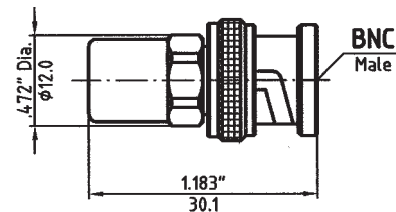
BNC Female HIGH PRECISION



Connector Body is stainless steel, Cap is gold plated.

BNC Male HIGH PRECISION TERMINATION	
Part No.	TE-0004-71P1
Frequency Range	DC - 4.0 GHz
Impedance	50 Ohms
Max. VSWR	1.05 : 1
Max. Average Power	1 Watt
Weight in g	19
Temperature Range	-54°C to + 115°C

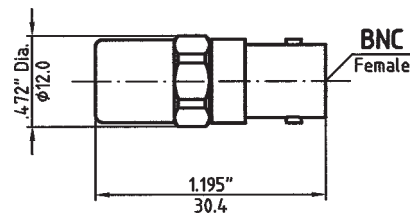
BNC Male HIGH PRECISION



Connector Body is stainless steel, Cap is gold plated.

BNC Female Termination	
Part No.	TE-0004-8101
Frequency Range	DC - 4.0 GHz
Impedance	50 Ohms
Max. VSWR	1.10 : 1
Max. Average Power	1 Watt
Weight in g	14
Temperature Range	-54°C to + 115°C

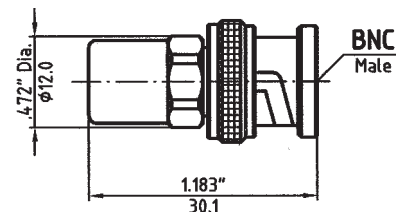
BNC Female Termination



Connector Body is stainless steel, Cap is gold plated.

BNC Male Termination	
Part No.	TE-0004-7101
Frequency Range	DC - 4.0 GHz
Impedance	50 Ohms
Max. VSWR	1.10 : 1
Max. Average Power	1 Watt
Weight in g	19
Temperature Range	-54°C to + 115°C

BNC Male Termination



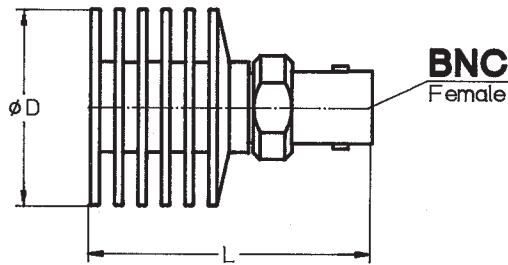
Connector Body is stainless steel, Cap is gold plated.

Dimensions shown are inches over millimeters. Standard connector parts are made from stainless steel passivated. The housings are made from stainless steel passivated, brass gold plated, brass nickel plated, aluminum anodized, depending on the type of termination or its application. Cooling fins are usually made from aluminum anodized. Connector interface specifications apply, as outlined in Section X: Connector Specifications.

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Type BNC Coaxial Terminations

BNC Female

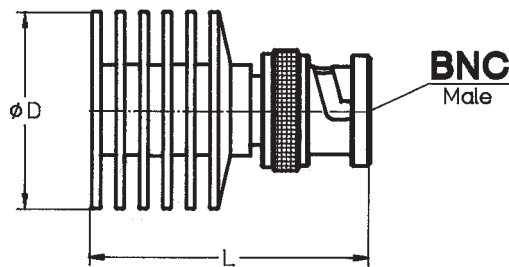


Connector Body is stainless steel, Fins are black anodized.

BNC Female Terminations

Part No.	Power (W)	Weight (g)	D (mm)	L (mm)
TE-0004-8102	2.0	26	26.0	36.6
TE-0004-8105	5.0	34	30.0	40.1
TE-0004-8120	20.0	89	30.0	105.3
Frequency Range	DC - 4.0 GHz			
Impedance	50 Ohms			
Max. VSWR	1.10 : 1			
Temperature Range	-54°C to +115°C			

BNC Male

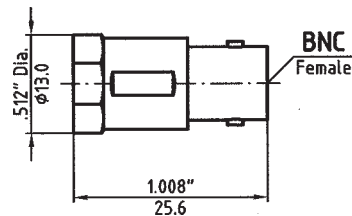


Connector Body is stainless steel, Fins are black anodized.

BNC Male Terminations

Part No.	Power (W)	Weight (g)	D (mm)	L (mm)
TE-0004-7102	2.0	31	26.0	36.3
TE-0004-7105	5.0	39	30.0	39.8
TE-0004-7120	20.0	94	30.0	105.0
Frequency Range	DC - 4.0 GHz			
Impedance	50 Ohms			
Max. VSWR	1.10 : 1			
Temperature Range	-54°C to +115°C			

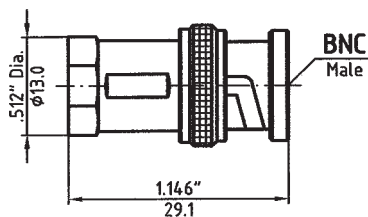
BNC Short/Open Circuit Terminations



Short : Connector Body is stainless steel, Cap is nickel plated.
Open: Connector Body is stainless steel, Cap is black anodized.

BNC Female Open/Short Circuit Terminations

Part No.	Description	Frequency Range	Weight (g)
4130-2101-02	Short Circuit	DC - 4.0 GHz	10
4140-2101-02	Open Circuit		7
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	



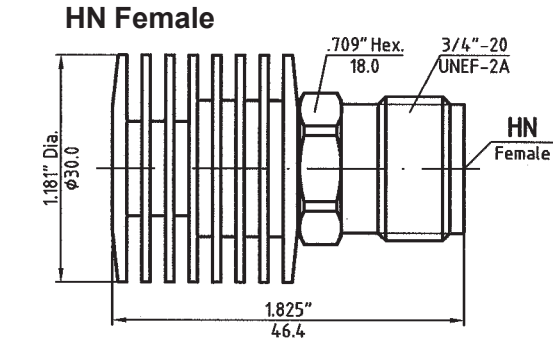
Short : Connector Body is stainless steel, Cap is nickel plated.
Open: Connector Body is stainless steel, Cap is black anodized.

BNC Male Open/Short Circuit Terminations

Part No.	Description	Frequency Range	Weight (g)
4130-1101-02	Short Circuit	DC - 4.0 GHz	13
4140-1101-02	Open Circuit		11
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	

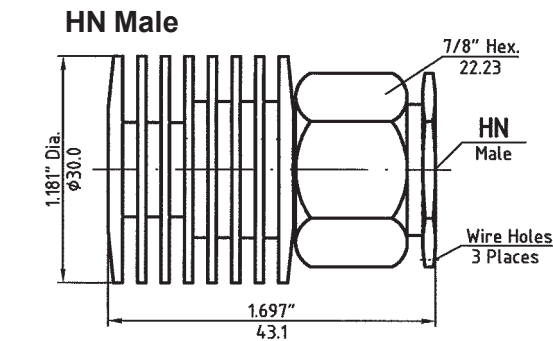
Dimensions shown are inches over millimeters. Standard connector parts are made from stainless steel passivated. The housings are made from stainless steel passivated, brass gold plated, brass nickel plated, aluminum anodized, depending on the type of termination or its application. Cooling fins are usually made from aluminum anodized. Connector interface specifications apply, as outlined in Section X: Connector Specifications.

HN Female Termination	
Part No.	TE-0008-6805
Frequency Range	DC - 8.0 GHz
Impedance	50 Ohms
Max. VSWR	1.15 : 1
Max. Average Power	5 Watts
Weight in g	In Development
Temperature Range	-54°C to + 115°C



Connector Body is stainless steel, Fins are black anodized.

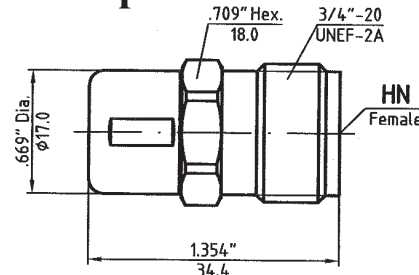
HN Male Termination	
Part No.	TE-0008-6905
Frequency Range	DC - 8.0 GHz
Impedance	50 Ohms
Max. VSWR	1.15 : 1
Max. Average Power	5 Watts
Weight in g	In Development
Temperature Range	-54°C to + 115°C



Connector Body is stainless steel, Fins are black anodized.

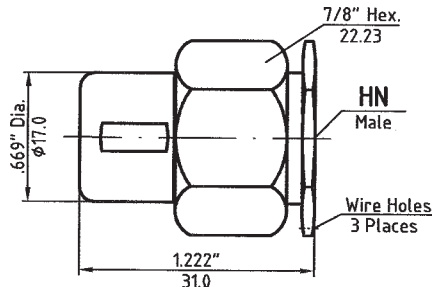
HN Female Open/Short Circuit Terminations			
Part No.	Description	Frequency Range	Weight (g)
7030-2101-02	Short Circuit	DC - 8.0 GHz	In Development
7040-2101-02	Open Circuit		In Development
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	

HN Short/Open Circuit Terminations



Short : Connector Body is stainless steel, Cap is nickel plated.
Open : Connector Body is stainless steel, Cap is black anodized.

HN Male Open/Short Circuit Terminations			
Part No.	Description	Frequency Range	Weight (g)
7030-1101-02	Short Circuit	DC - 8.0 GHz	In Development
7040-1101-02	Open Circuit		In Development
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	



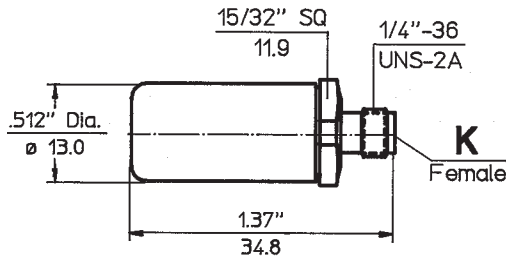
Short : Connector Body is stainless steel, Cap is nickel plated.
Open : Connector Body is stainless steel, Cap is black anodized.

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Dimensions shown are inches over millimeters. Standard connector parts are made from stainless steel passivated. The housings are made from stainless steel passivated, brass gold plated, brass nickel plated, aluminum anodized, depending on the type of termination or its application. Cooling fins are usually made from aluminum anodized. Connector interface specifications apply, as outlined in Section X: Connector Specifications.

Type K* Coaxial Terminations

K* Female HIGH PRECISION

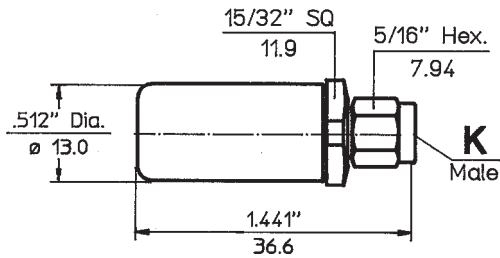


Connector Body is stainless steel, Cap is gold plated.

K* Female HIGH PRECISION TERMINATION

Part No.	TE-0040-KF00
Frequency Range	DC - 40.0 GHz
Impedance	50 Ohms
Max. VSWR	1.10 : 1
Max. Average Power	0.5 Watts
Weight in g	24
Temperature Range	-54°C to + 85°C

K* Male HIGH PRECISION

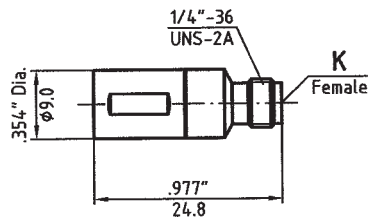


Connector Body is stainless steel, Cap is gold plated.

K* Male HIGH PRECISION TERMINATION

Part No.	TE-0040-KM00
Frequency Range	DC - 40.0 GHz
Impedance	50 Ohms
Max. VSWR	1.10 : 1
Max. Average Power	0.5 Watts
Weight in g	25
Temperature Range	-54°C to + 85°C

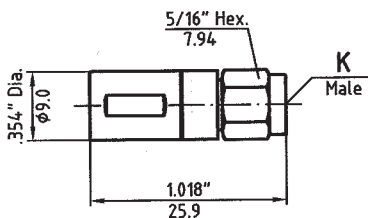
K* Short/Open Circuit Terminations



Short : Connector Body is stainless steel, Cap is nickel plated.
Open: Connector Body is stainless steel, Cap is black anodized.

K* Female Open/Short Circuit Terminations

Part No.	Description	Frequency Range	Weight (g)
1530-2101-02	Short Circuit	DC - 40.0 GHz	9
1540-2101-02	Open Circuit		5
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	



Short : Connector Body is stainless steel, Cap is nickel plated.
Open: Connector Body is stainless steel, Cap is black anodized.

K* Male Open/Short Circuit Terminations

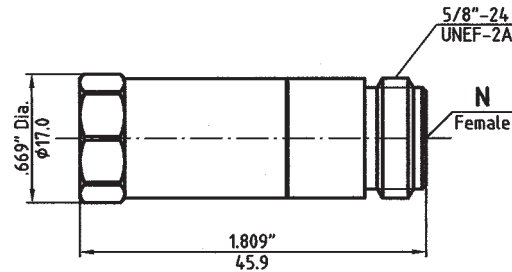
Part No.	Description	Frequency Range	Weight (g)
1530-1101-02	Short Circuit	DC - 40.0 GHz	11
1540-1101-02	Open Circuit		6
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	

Dimensions shown are inches over millimeters. Standard connector parts are made from stainless steel passivated. The housings are made from stainless steel passivated, brass gold plated, brass nickel plated, aluminum anodized, depending on the type of termination or its application. Cooling fins are usually made from aluminum anodized. Connector interface specifications apply, as outlined in Section X: Connector Specifications.

Coaxial Terminations, Type N

N Female HIGH PRECISION TERMINATION	
Part No.	TE-0018-61P1
Frequency Range	DC - 18.0 GHz
Impedance	50 Ohms
Max. VSWR	1.07 : 1
Max. Average Power	1 Watt
Weight in g	55
Temperature Range	-54°C to + 85°C

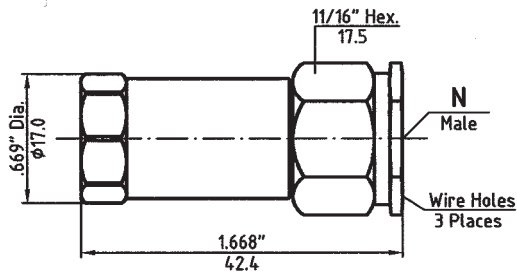
N Female HIGH PRECISION



Connector Body is stainless steel, Cap is gold plated.

N Male HIGH PRECISION TERMINATION	
Part No.	TE-0018-51P1
Frequency Range	DC - 18.0 GHz
Impedance	50 Ohms
Max. VSWR	1.07 : 1
Max. Average Power	1 Watt
Weight in g	48
Temperature Range	-54°C to + 85°C

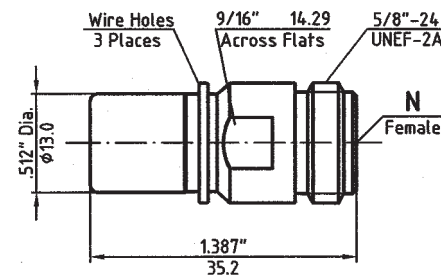
N Male HIGH PRECISION



Connector Body is stainless steel, Cap is gold plated.

N Female HIGH PRECISION TERMINATION	
Part No.	TE-0002-61P1
Frequency Range	DC - 2.0 GHz
Impedance	50 Ohms
Max. VSWR	1.02 : 1
Max. Average Power	1 Watt
Weight in g	31
Temperature Range	-54°C to + 115°C

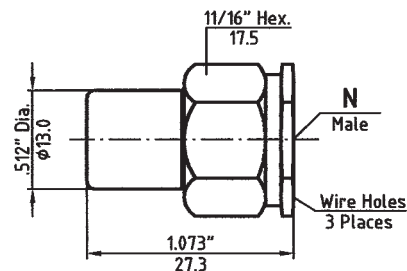
N Female HIGH PRECISION



Connector Body is stainless steel, Cap is gold plated.

N Male HIGH PRECISION TERMINATION	
Part No.	TE-0002-51P1
Frequency Range	DC - 2.0 GHz
Impedance	50 Ohms
Max. VSWR	1.02 : 1
Max. Average Power	1 Watt
Weight in g	24
Temperature Range	-54°C to + 115°C

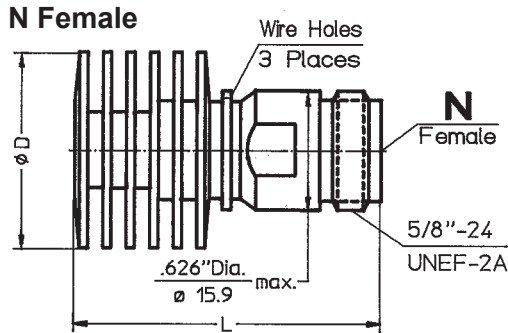
N Male HIGH PRECISION



Connector Body is stainless steel, Cap is gold plated.

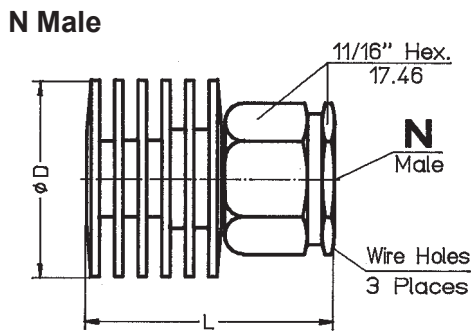
Dimensions shown are inches over millimeters. Standard connector parts are made from stainless steel passivated. The housings are made from stainless steel passivated, brass gold plated, brass nickel plated, aluminum anodized, depending on the type of termination or its application. Cooling fins are usually made from aluminum anodized. Connector interface specifications apply, as outlined in Section X: Connector Specifications.

Type N Coaxial Terminations



Connector Body is stainless steel, Fins are black anodized.

N Female Terminations					
Part No.	VSWR max.	Power (W)	Weight (g)	D (mm)	L (mm)
TE-0018-6101	1.15 : 1	1.0	30	21.0	37.3
TE-0018-6102		2.0	35	26.0	40.5
TE-0018-6105		5.0	43	30.0	44.0
TE-0018-6110		10.0	61	30.0	68.8
TE-0018-6120		20.0	98	30.0	109.2
Frequency Range		DC - 18.0 GHz			
Impedance		50 Ohms			
Temperature Range		-54°C to +115°C			

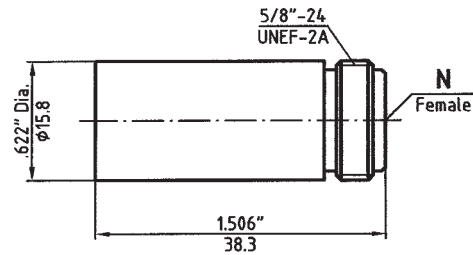


Connector Body is stainless steel, Fins are black anodized.

N Male Terminations					
Part No.	VSWR max.	Power (W)	Weight (g)	D (mm)	L (mm)
TE-0018-5101	1.15 : 1	1.0	23	21.0	29.4
TE-0018-5102		2.0	28	26.0	32.6
TE-0018-5105		5.0	36	30.0	36.1
TE-0018-5110		10.0	54	30.0	60.9
TE-0018-5120		20.0	91	30.0	101.3
Frequency Range		DC - 18.0 GHz			
Impedance		50 Ohms			
Temperature Range		-54°C to +115°C			

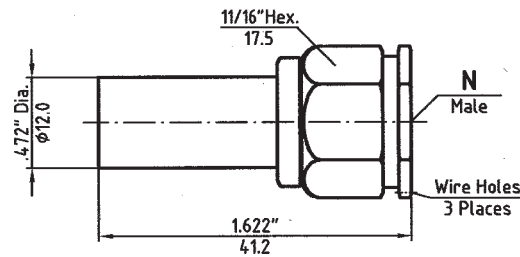
Dimensions shown are inches over millimeters. Standard connector parts are made from stainless steel passivated. The housings are made from stainless steel passivated, brass gold plated, brass nickel plated, aluminum anodized, depending on the type of termination or its application. Cooling fins are usually made from aluminum anodized. Connector interface specifications apply, as outlined in Section X: Connector Specifications.

N Female Open/Short Circuit Terminations			
Part No.	Description	Frequency Range	Weight (g)
3030-2101-02	Short Circuit	DC - 18.0 GHz	44
3040-2101-02	Open Circuit		44
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	



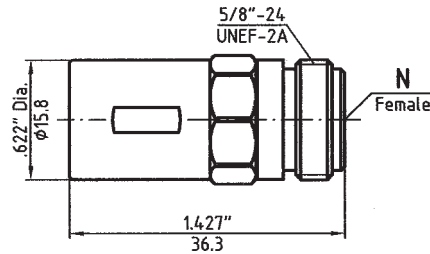
Connector Body and Cap are stainless steel passivated.

N Male Open/Short Circuit Terminations			
Part No.	Description	Frequency Range (GHz)	Weight (g)
3030-1101-02	Short Circuit	DC - 18.0 GHz	31
3040-1101-02	Open Circuit		31
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	



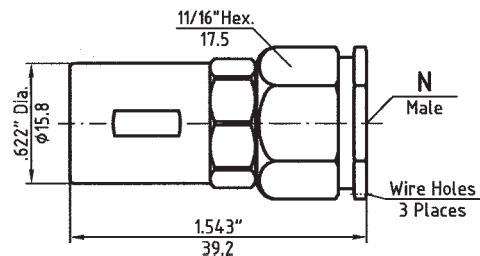
Connector Body and Cap are stainless steel passivated.

N Female Open/Short Circuit Terminations			
Part No.	Description	Frequency Range	Weight (g)
3030-2102-02	Short Circuit	DC - 18.0 GHz	In Development
3040-2102-02	Open Circuit		In Development
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	



Short : Connector Body is stainless steel, Cap is nickel plated.
Open : Connector Body is stainless steel, Cap is black anodized.

N Male Open/Short Circuit Terminations			
Part No.	Description	Frequency Range	Weight (g)
3030-1102-02	Short Circuit	DC - 18.0 GHz	In Development
3040-1102-02	Open Circuit		In Development
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	



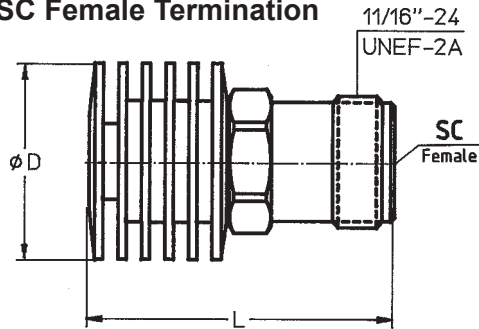
Short : Connector Body is stainless steel, Cap is nickel plated.
Open : Connector Body is stainless steel, Cap is black anodized.

Dimensions shown are inches over millimeters. Standard connector parts are made from stainless steel passivated. The housings are made from stainless steel passivated, brass gold plated, brass nickel plated, aluminum anodized, depending on the type of termination or its application. Cooling fins are usually made from aluminum anodized. Connector interface specifications apply, as outlined in Section X: Connector Specifications.

I:compa2.ppt6

Type SC Coaxial Terminations

SC Female Termination

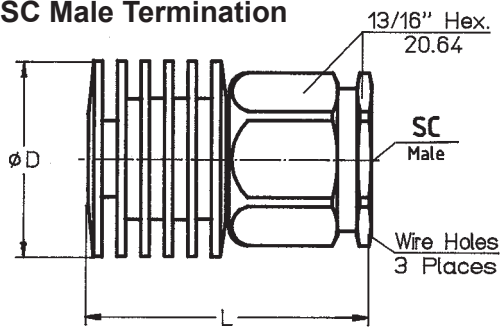


Connector Body is stainless steel, Fins are black anodized.

SC Female Terminations

Part No.	VSWR max.	Power (W)	Weight (g)	D (mm)	L (mm)
TE-0010-7902	1.15 : 1	2.0	34	26.0	42.9
TE-0010-7905		5.0	42	30.0	46.4
TE-0010-7910		10.0	60	30.0	71.2
TE-0010-7920		20.0	97	30.0	111.6
Frequency Range		DC - 10.0 GHz			
Impedance		50 Ohms			
Temperature Range		-54°C to +115°C			

SC Male Termination

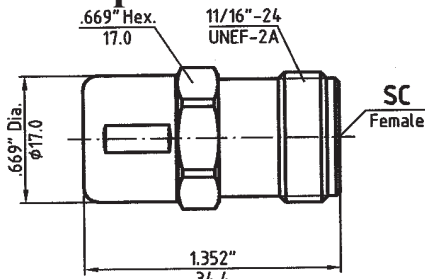


Connector Body is stainless steel, Fins are black anodized.

SC Male Terminations

Part No.	VSWR max.	Power (W)	Weight (g)	D (mm)	L (mm)
TE-0010-8002	1.15 : 1	2.0	38	26.0	40.1
TE-0010-8005		5.0	46	30.0	43.6
TE-0010-8010		10.0	64	30.0	68.4
TE-0010-8020		20.0	100	30.0	108.8
Frequency Range		DC - 10.0 GHz			
Impedance		50 Ohms			
Temperature Range		-54°C to +115°C			

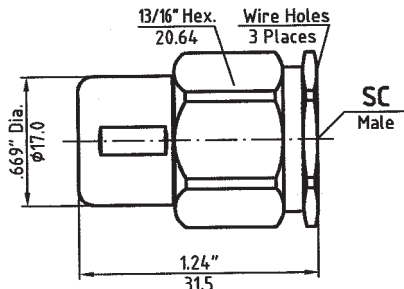
SC Short/Open Circuit Terminations



Short: Connector Body is stainless steel, Cap is nickel plated.
Open: Connector Body is stainless steel, Cap is black anodized.

SC Female Open/Short Circuit Terminations

Part No.	Description	Frequency Range	Weight (g)
6030-2101-02	Short Circuit	DC - 10.0 GHz	34
6040-2101-02	Open Circuit		In Development
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	



Short: Connector Body is stainless steel, Cap is nickel plated.
Open: Connector Body is stainless steel, Cap is black anodized.

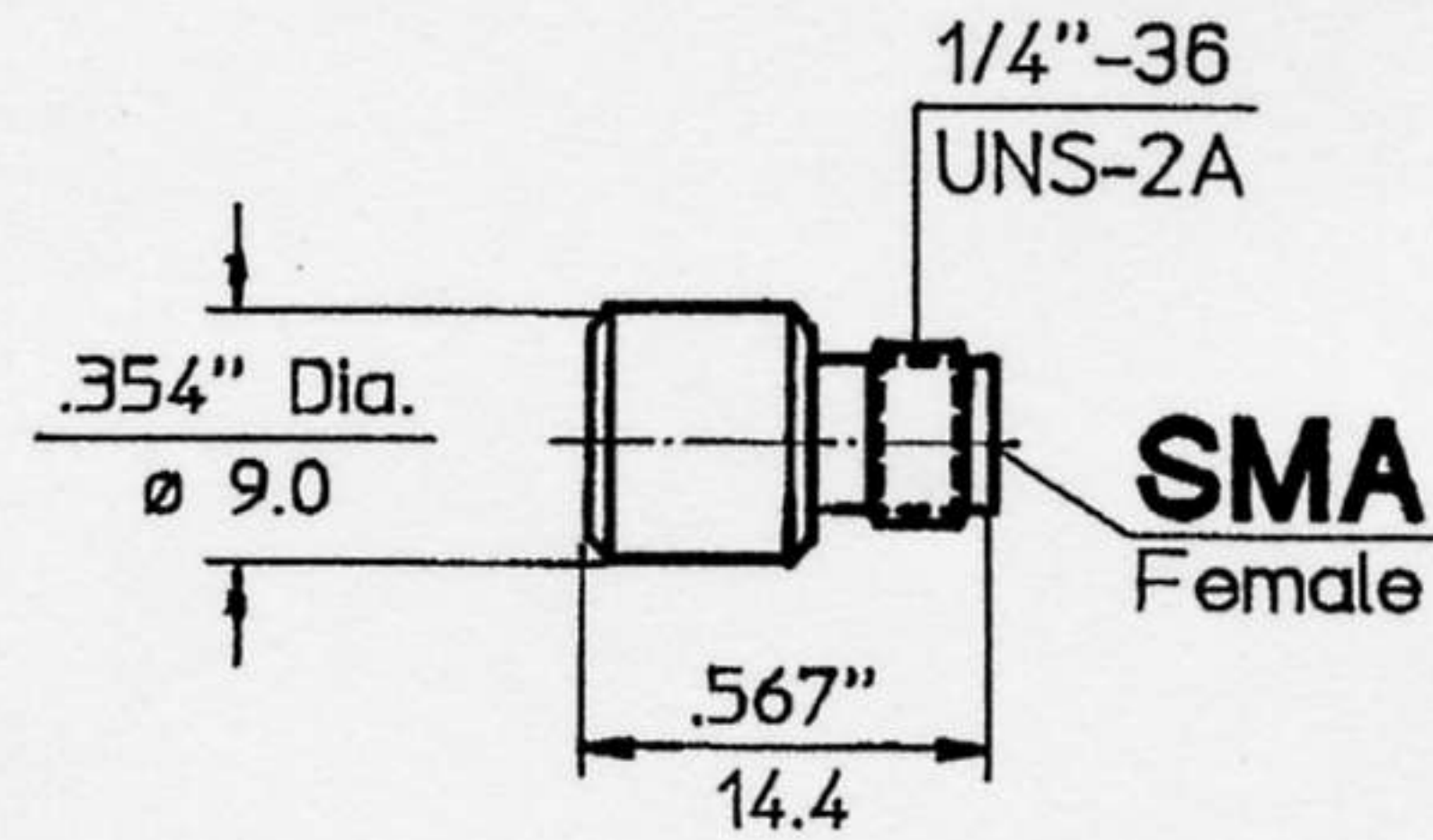
SC Male Open/Short Circuit Terminations

Part No.	Description	Frequency Range	Weight (g)
6030-1101-02	Short Circuit	DC - 10.0 GHz	30
6040-1101-02	Open Circuit		In Development
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	

Dimensions shown are inches over millimeters. Standard connector parts are made from stainless steel passivated. The housings are made from stainless steel passivated, brass gold plated, brass nickel plated, aluminum anodized, depending on the type of termination or its application. Cooling fins are usually made from aluminum anodized. Connector interface specifications apply, as outlined in Section X: Connector Specifications.

SMA Female HIGH PRECISION TERMINATION	
Part No.	TE-0020-21P0
Frequency Range	DC - 20.0 GHz
Impedance	50 Ohms
Max. VSWR	1.05 : 1 DC - 12.4 GHz 1.10 : 1 12.4 - 18.0 GHz 1.15 : 1 18.0 - 20.0 GHz
Max. Average Power	0.5 Watts
Weight in g	4
Temperature Range	-54°C to + 115°C

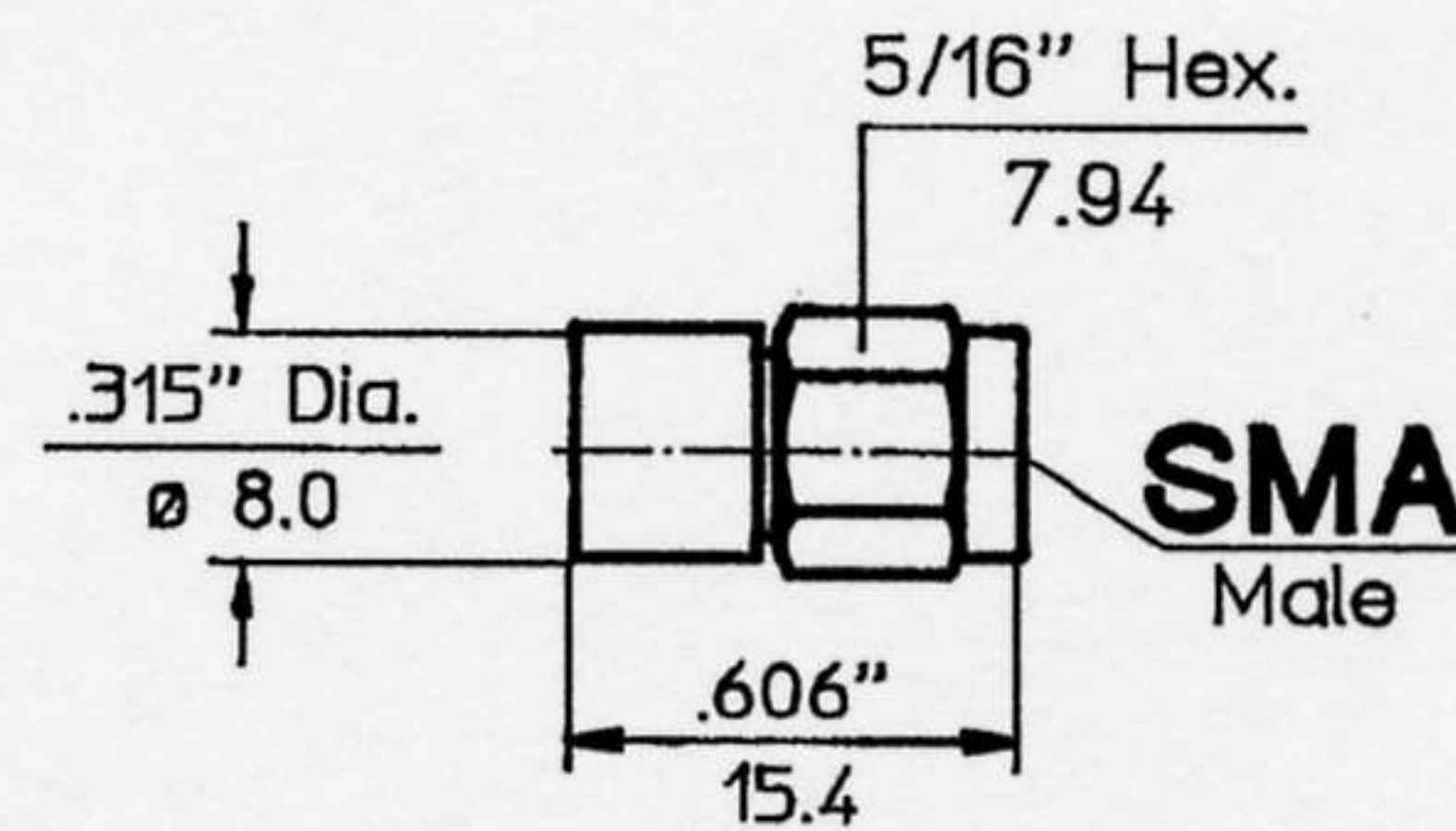
SMA Female HIGH PRECISION



Connector Body and Cap are stainless steel passivated.

SMA Male Termination	
Part No.	TE-0020-1100
Frequency Range	DC - 20.0 GHz
Impedance	50 Ohms
Max. VSWR	1.10 : 1
Max. Average Power	0.5 Watts
Weight in g	4
Temperature Range	-54°C to + 85°C

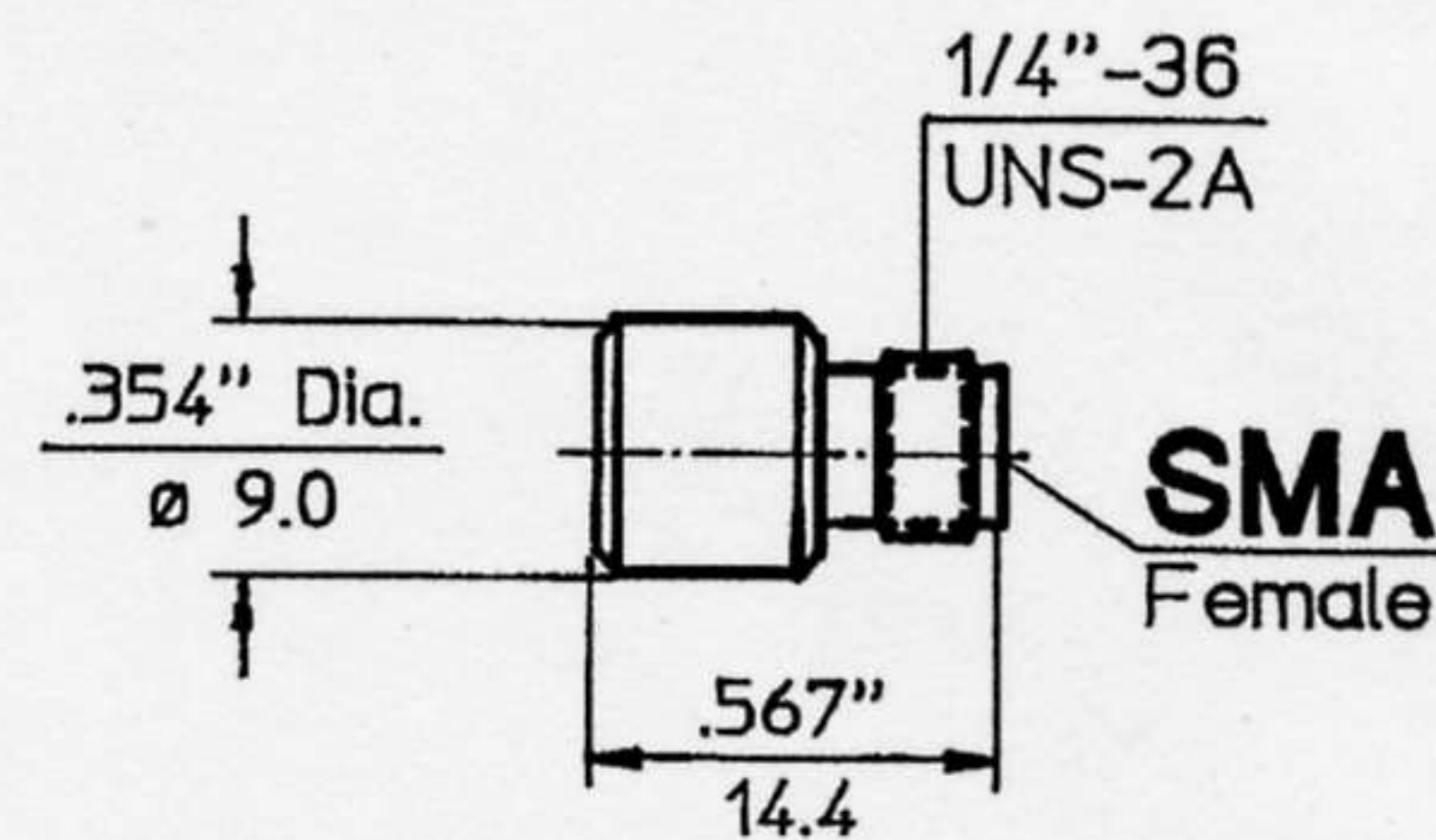
SMA Male



Connector Body and Cap are stainless steel passivated.

SMA Female Terminations			
Part No.	Frequency Range	VSWR max.	Power (W)
TE-1220-2100	DC - 12.4 GHz	1.05 : 1	0.5 Watts
	12.4 - 20.0 GHz	1.10 : 1	
TE-0020-2100	DC - 20.0 GHz	1.10 : 1	
Impedance			50 Ohms
Weight in g			4
Temperature Range			-54°C to +115°C

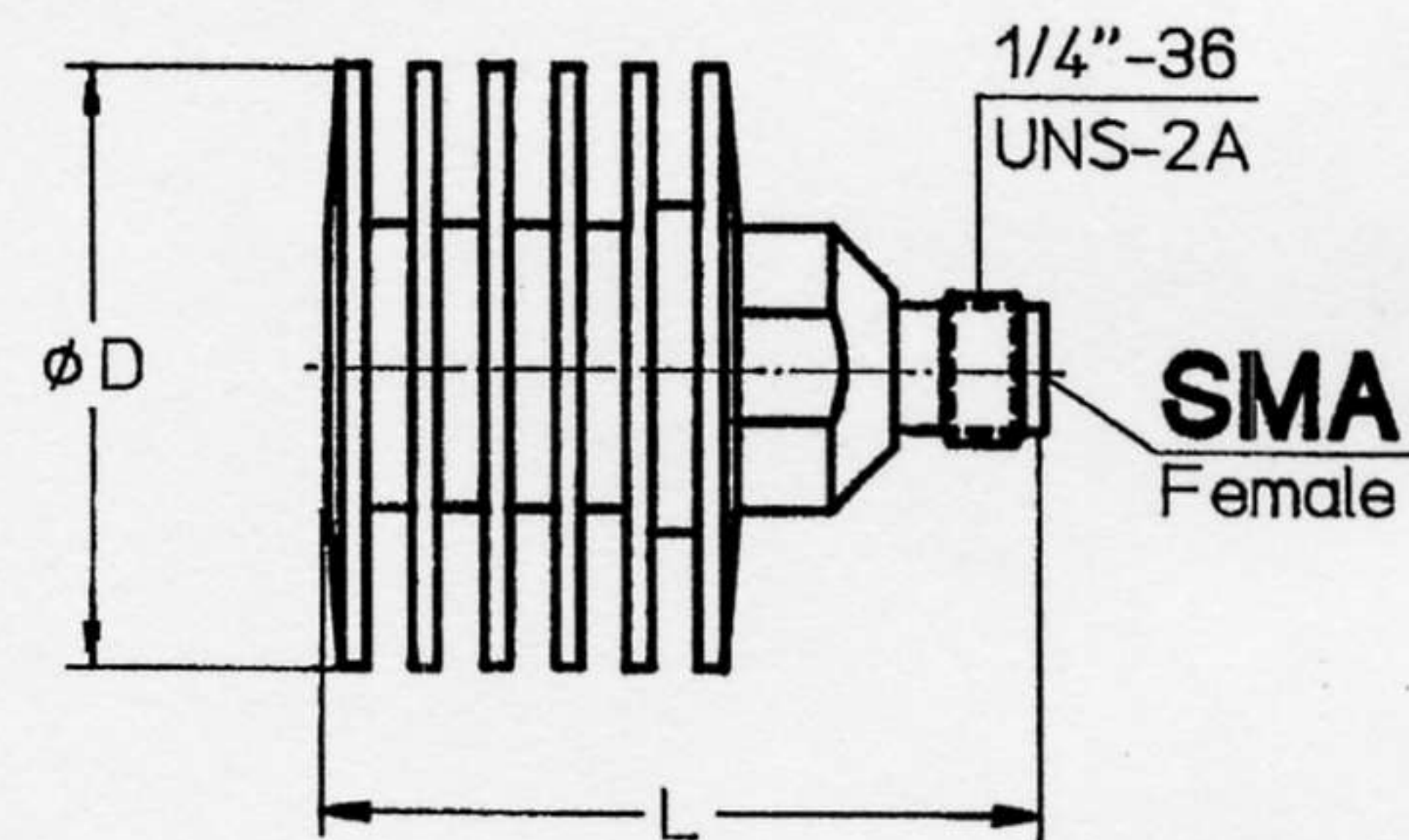
SMA Female



Connector Body and Cap are stainless steel passivated.

SMA Female Terminations						
Part No.	VSWR max.	Frequency Range (GHz)	Power (W)	Weight (g)	D (mm)	L (mm)
TE-0020-2101	1.15 : 1	DC-20.0	1.0	19	21.0	28.0
TE-0018-2102	1.20 : 1	DC-18.0	2.0	24	26.0	33.7
TE-0018-2105			5.0	33	30.0	36.6
TE-0018-2110			10.0	51	30.0	58.5
TE-0018-2120			20.0	88	30.0	98.9
Impedance			50 Ohms			
Temperature Range			-54°C to +115°C			

SMA Female

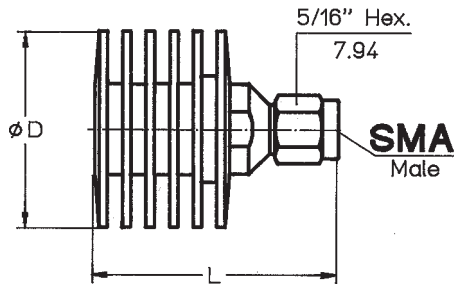


Connector Body is stainless steel, Fins are black anodized.

Dimensions shown are inches over millimeters. Standard connector parts are made from stainless steel passivated. The housings are made from stainless steel passivated, brass gold plated, brass nickel plated, aluminum anodized, depending on the type of termination or its application. Cooling fins are usually made from aluminum anodized. Connector interface specifications apply, as outlined in Section X: Connector Specifications.

Type SMA Coaxial Terminations

SMA Male

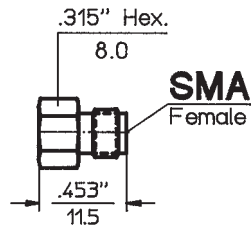


Connector Body is stainless steel, Fins are black anodized.

SMA Male Terminations

Part No.	VSWR max.	Frequency Range (GHz)	Power (W)	Weight (g)	D (mm)	L (mm)
TE-0020-1101	1.15 : 1	DC-20.0	1.0	19	21.0	29.0
TE-0018-1102	1.20 : 1	DC-18.0	2.0	24	26.0	34.7
TE-0018-1105			5.0	33	30.0	37.6
TE-0018-1110			10.0	51	30.0	59.5
TE-0018-1120			20.0	88	30.0	99.9
Impedance			50 Ohms			
Temperature Range			-54°C to +115°C			

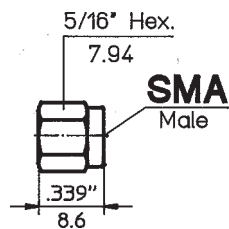
SMA Short Circuit-, Open Circuit Terminations



Connector Body and Cap are stainless steel passivated.

SMA Female Short Circuit Termination

Part No.	Description	Frequency Range	Weight (g)
2030-2101-02	Short Circuit	DC - 18.0 GHz	3
Impedance		50 Ohms	
Temperature Range		-54°C to +115°C	



Connector Body and Cap are stainless steel passivated.

SMA Male Short Circuit Termination

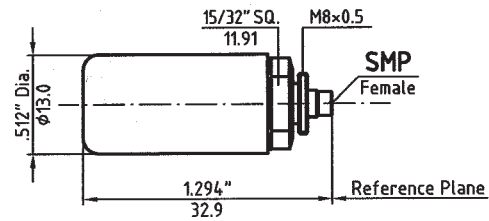
Part No.	Description	Frequency Range	Weight (g)
2030-1101-02	Short Circuit	DC - 18.0 GHz	2
Impedance		50 Ohms	
Temperature Range		-54°C to +115°C	

SMA Open Circuit Terminations are not manufactured at this time. It is recommended to use 3.5mm Open Circuit Terminations instead. Please refer to page 45.

Dimensions shown are inches over millimeters. Standard connector parts are made from stainless steel passivated. The housings are made from stainless steel passivated, brass gold plated, brass nickel plated, aluminum anodized, depending on the type of termination or its application. Cooling fins are usually made from aluminum anodized. Connector interface specifications apply, as outlined in Section X: Connector Specifications.

SMP Female Terminations			
Part No.	Frequency Range	VSWR max.	Power (W)
TE-0018-MP01	DC - 18.0 GHz	1.10 : 1	1 Watt
TE-0040-MP01	DC - 40.0 GHz	1.15 : 1	
Impedance		50 Ohms	
Weight in g		23	
Temperature Range		-54°C to +85°C	

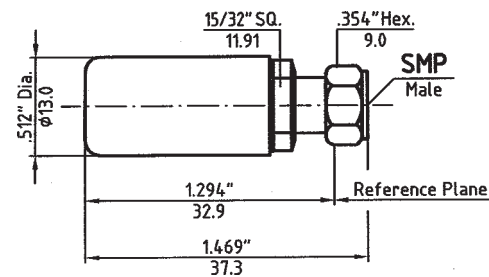
SMP Female



Connector Body is stainless steel, Cap is gold plated.

SMP Male Terminations			
Part No.	Frequency Range	VSWR max.	Power (W)
TE-0018-MJ01	DC - 18.0 GHz	1.10 : 1	1 Watt
TE-0040-MJ01	DC - 40.0 GHz	1.15 : 1	
Impedance		50 Ohms	
Weight in g		25	
Temperature Range		-54°C to +85°C	

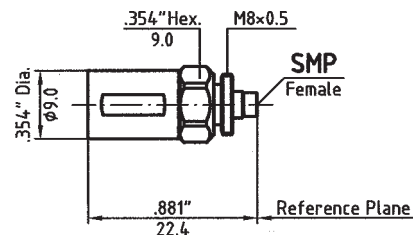
SMP Male



Connector Body is stainless steel, Cap is gold plated.

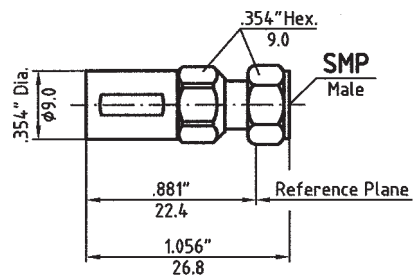
SMP Female Open/Short Circuit Terminations			
Part No.	Description	Frequency Range (GHz)	Weight (g)
1130-2101-02	Short Circuit	DC - 18.0	10
1130-2102-02		DC - 40.0	
1140-2102-02	Open Circuit	DC - 18.0	4
1140-2104-02		DC - 40.0	
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	

SMP Short/Open Circuit Terminations



Short: Connector Body is stainless steel, Cap is nickel plated.
Open: Connector Body is stainless steel, Cap is black anodized.

SMP Male Open/Short Circuit Terminations			
Part No.	Description	Frequency Range (GHz)	Weight (g)
1130-1101-02	Short Circuit	DC - 18.0	12
1130-1102-02		DC - 40.0	
1140-1102-02	Open Circuit	DC - 18.0	7
1140-1104-02		DC - 40.0	
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	



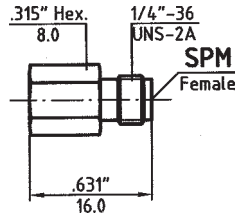
Short: Connector Body is stainless steel, Cap is nickel plated.
Open: Connector Body is stainless steel, Cap is black anodized.

Dimensions shown are inches over millimeters. Standard connector parts are made from stainless steel passivated. The housings are made from stainless steel passivated, brass gold plated, brass nickel plated, aluminum anodized, depending on the type of termination or its application. Cooling fins are usually made from aluminum anodized. Connector interface specifications apply, as outlined in Section X: Connector Specifications.

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Type SPM Coaxial Terminations

SPM Female

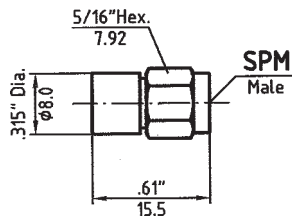


Connector Body and Cap are stainless steel passivated.

SPM Female Termination

Part No.	TE-0018-PJ00
Frequency Range	DC - 18.0 GHz
Impedance	50 Ohms
Max. VSWR	1.15 : 1
Max. Average Power	0.5 Watts
Weight in g	5
Temperature Range	-54°C to + 115°C

SPM Male

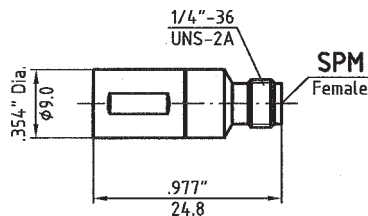


Connector Body is stainless steel, Cap is gold plated.

SPM Male Termination

Part No.	TE-0018-PM00
Frequency Range	DC - 18.0 GHz
Impedance	50 Ohms
Max. VSWR	1.15 : 1
Max. Average Power	0.5 Watts
Weight in g	4
Temperature Range	-54°C to + 115°C

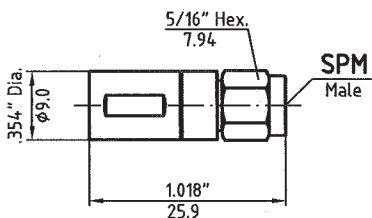
SPM Short/Open Circuit Terminations



Short: Connector Body is stainless steel, Cap is nickel plated.
Open: Connector Body is stainless steel, Cap is black anodized.

SPM Female Open/Short Circuit Terminations

Part No.	Description	Frequency Range	Weight (g)
2530-2101-02	Short Circuit	DC - 18.0 GHz	In Development
2540-2101-02	Open Circuit		In Development
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	



Short: Connector Body is stainless steel, Cap is nickel plated.
Open: Connector Body is stainless steel, Cap is black anodized.

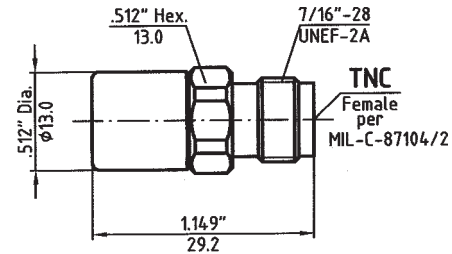
SPM Male Open/Short Circuit Terminations

Part No.	Description	Frequency Range	Weight (g)
2530-1101-02	Short Circuit	DC - 18.0 GHz	In Development
2540-1101-02	Open Circuit		In Development
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	

Dimensions shown are inches over millimeters. Standard connector parts are made from stainless steel passivated. The housings are made from stainless steel passivated, brass gold plated, brass nickel plated, aluminum anodized, depending on the type of termination or its application. Cooling fins are usually made from aluminum anodized. Connector interface specifications apply, as outlined in Section X: Connector Specifications.

TNC Female HIGH PRECISION TERMINATION	
Part No.	TE-0018-41P1
Frequency Range	DC - 18.0 GHz
Impedance	50 Ohms
Max. VSWR	1.10 : 1
Max. Average Power	1 Watt
Weight	16
Temperature Range	-54°C to + 115°C

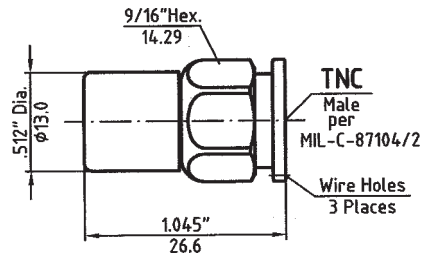
TNC Female HIGH PRECISION



Connector Body is stainless steel, Cap is gold plated.

TNC Male HIGH PRECISION TERMINATION	
Part No.	TE-0018-31P1
Frequency Range	DC - 18.0 GHz
Impedance	50 Ohms
Max. VSWR	1.10 : 1
Max. Average Power	1 Watt
Weight	18
Temperature Range	-54°C to + 115°C

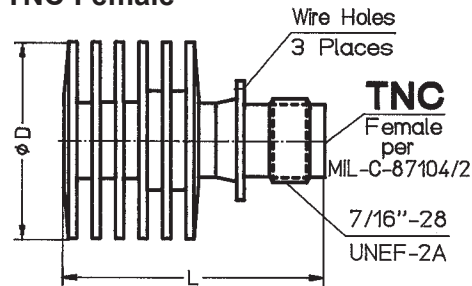
TNC Male HIGH PRECISION



Connector Body is stainless steel, Cap is gold plated.

TNC Female Terminations					
Part No.	VSWR max.	Power (W)	Weight (g)	D (mm)	L (mm)
TE-0018-4101	1.15 : 1	1.0	18	21.0	31.3
TE-0018-4102		2.0	23	26.0	34.5
TE-0018-4105		5.0	31	30.0	38.0
TE-0018-4110		10.0	49	30.0	62.8
TE-0018-4120		20.0	86	30.0	103.2
Frequency Range		DC - 18.0 GHz			
Impedance		50 Ohms			
Temperature Range		-54°C to +115°C			

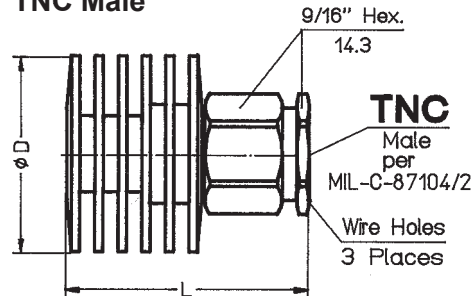
TNC Female



Connector Body is stainless steel, Fins are black anodized.

TNC Male Terminations					
Part No.	VSWR max.	Power (W)	Weight (g)	D (mm)	L (mm)
TE-0018-3101	1.15 : 1	1.0	20	21.0	28.7
TE-0018-3102		2.0	25	26.0	31.9
TE-0018-3105		5.0	33	30.0	35.4
TE-0018-3110		10.0	51	30.0	60.2
TE-0018-3120		20.0	88	30.0	100.6
Frequency Range		DC - 18.0 GHz			
Impedance		50 Ohms			
Temperature Range		-54°C to +115°C			

TNC Male

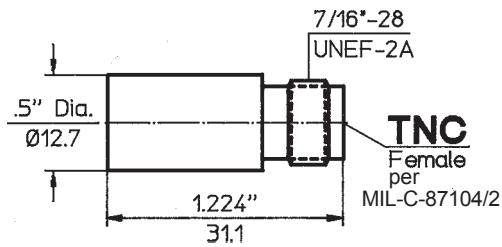


Connector Body is stainless steel, Fins are black anodized.

Dimensions shown are inches over millimeters. Standard connector parts are made from stainless steel passivated. The housings are made from stainless steel passivated, brass gold plated, brass nickel plated, aluminum anodized, depending on the type of termination or its application. Cooling fins are usually made from aluminum anodized. Connector interface specifications apply, as outlined in Section X: Connector Specifications.

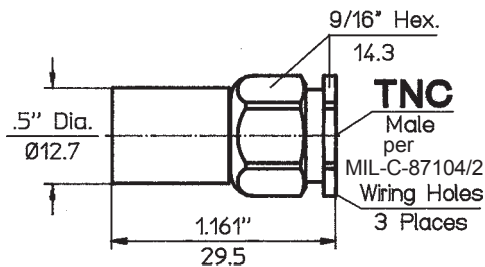
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Type TNC Short /Open Circuit Coaxial Terminations



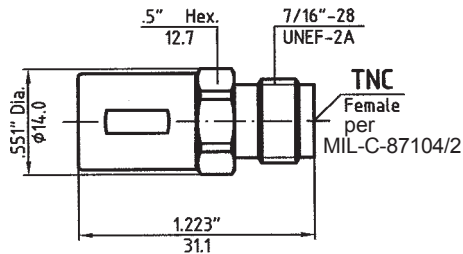
Connector Body and Cap are stainless steel passivated.

TNC Female Open/Short Circuit Terminations			
Part No.	Description	Frequency Range	Weight (g)
4030-2101-02	Short Circuit	DC - 18.0 GHz	21
4040-2101-02	Open Circuit		20
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	



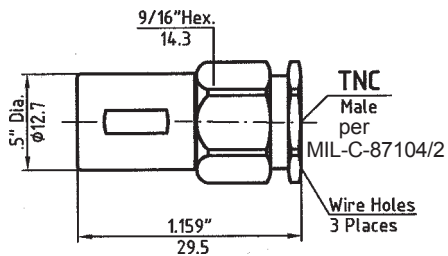
Connector Body and Cap are stainless steel passivated.

TNC Male Open/Short Circuit Terminations			
Part No.	Description	Frequency Range	Weight (g)
4030-1101-02	Short Circuit	DC - 18.0 GHz	24
4040-1101-02	Open Circuit		24
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	



Short: Connector Body is stainless steel, Cap is nickel plated.
Open: Connector Body is stainless steel, Cap is black anodized.

TNC Female Open/Short Circuit Terminations			
Part No.	Description	Frequency Range	Weight (g)
4030-2102-02	Short Circuit	DC - 18.0 GHz	In Development
4040-2102-02	Open Circuit		In Development
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	



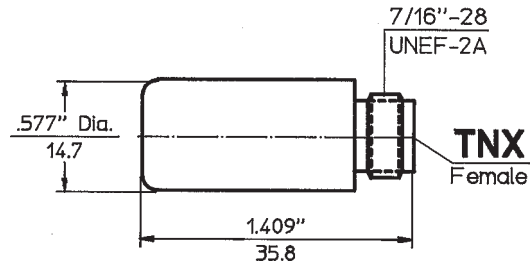
Short: Connector Body is stainless steel, Cap is nickel plated.
Open: Connector Body is stainless steel, Cap is black anodized.

TNC Male Open/Short Circuit Terminations			
Part No.	Description	Frequency Range	Weight (g)
4030-1102-02	Short Circuit	DC - 18.0 GHz	In Development
4040-1102-02	Open Circuit		In Development
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	

Dimensions shown are inches over millimeters. Standard connector parts are made from stainless steel passivated. The housings are made from stainless steel passivated, brass gold plated, brass nickel plated, aluminum anodized, depending on the type of termination or its application. Cooling fins are usually made from aluminum anodized. Connector interface specifications apply, as outlined in Section X: Connector Specifications.

TNX Female Termination	
Part No.	TE-0018-4900
Frequency Range	DC - 18.0 GHz
Impedance	50 Ohms
Max. VSWR	1.15 : 1
Max. Average Power	1 Watt
Weight in g	33
Temperature Range	-54°C to + 115°C

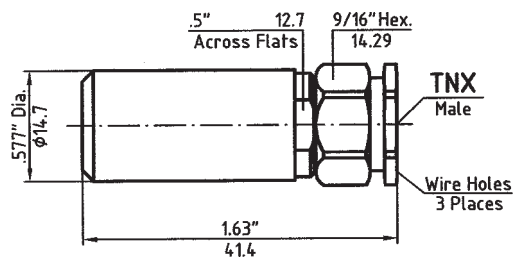
TNX Female



Connector Body and Cap are stainless steel passivated.

TNX Male Termination	
Part No.	TE-0018-3900
Frequency Range	DC - 18.0 GHz
Impedance	50 Ohms
Max. VSWR	1.15:1
Max. Average Power	1 Watt
Weight in g	35
Temperature Range	-54°C to + 115°C

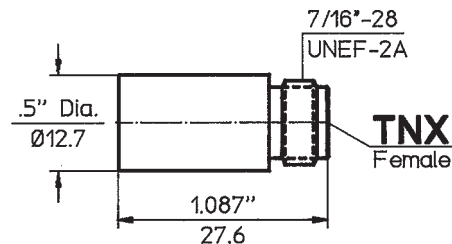
TNX Male



Connector Body and Cap are stainless steel passivated.

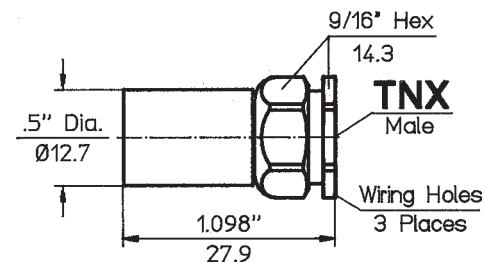
TNX Female Open/Short Circuit Terminations			
Part No.	Description	Frequency Range	Weight (g)
3930-2101-02	Short Circuit	DC - 18.0 GHz	20
3940-2101-02	Open Circuit		20
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	

TNX Short /Open Circuit Terminations



Connector Body and Cap are stainless steel passivated.

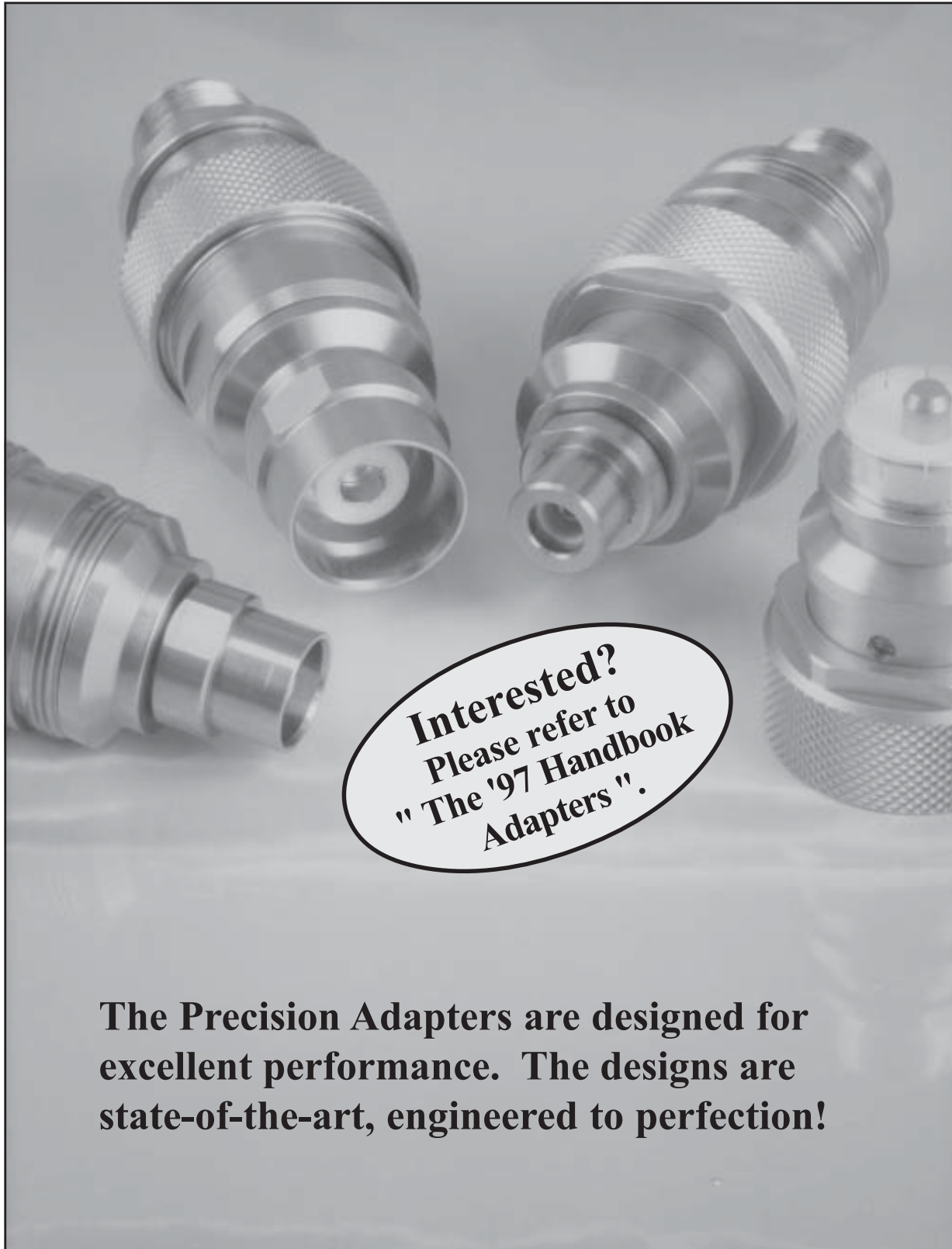
TNX Male Open/Short Circuit Terminations			
Part No.	Description	Frequency Range	Weight (g)
3930-1101-02	Short Circuit	DC - 18.0 GHz	22
3940-1101-02	Open Circuit		22
Impedance		50 Ohms	
Temperature Range		-54°C to +85°C	



Connector Body and Cap are stainless steel passivated.

Dimensions shown are inches over millimeters. Standard connector parts are made from stainless steel passivated. The housings are made from stainless steel passivated, brass gold plated, brass nickel plated, aluminum anodized, depending on the type of termination or its application. Cooling fins are usually made from aluminum anodized. Connector interface specifications apply, as outlined in Section X: Connector Specifications.

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**Interested?
Please refer to
"The '97 Handbook
Adapters".**

The Precision Adapters are designed for excellent performance. The designs are state-of-the-art, engineered to perfection!

1comp2.ppt6

Section III



Precision Waveguide Terminations

INTRODUCTION: Waveguide Terminations or loads, are power absorbing devices. They are matched to 50 Ohms, the characteristic impedance of the transmission line. The standard product line of precision low power Waveguide Terminations are using custom machined load elements for optimum electrical performance.

Applications: The waveguide power absorbing devices are needed during test and measurement, can be integrated in components and are used in systems applications.

Average Power Handling: This is the maximum allowable CW power to which the unit can be subjected to without suffering permanent damage. The power handling of absorptive units is a function of temperature. High temperature units are supplied with cooling fins or heat sinks or both for better power dissipation.

Custom Designs: Spectrum Elektrotechnik GmbH has been designing and supplying Waveguide Terminations to suit standard and particular requirements as well, such as unique lightweight and non typical mechanical outline, e.g. very short length, unusual mounting or special flange requirements, high power terminations, constructed of heavy wall aluminum waveguide and extruded heat sink material, load elements shaped for optimum power handling and heat transfer while maintaining excellent VSWR, or devices engineered for applications in rough environment, etc., etc.

Flanges: Waveguide Terminations are available with variety of flanges, meeting the appropriate standard interface specifications.

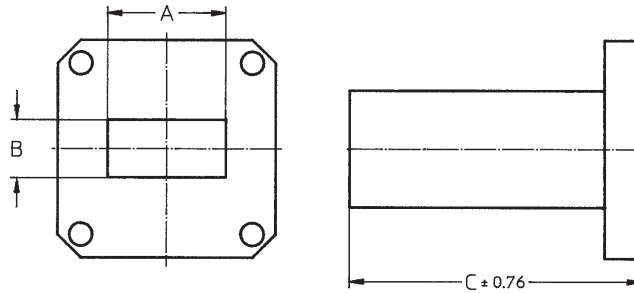
Frequency and Bandwidth: Waveguide Terminations do operate over their waveguide band. In special applications they may be tuned to certain criteria in narrower bands.

Materials: Aluminum, copper and brass are the materials used for Waveguide Terminations. For the flanges aluminum and brass are offered. The waveguide itself can be either made from aluminum with aluminum flanges, brass or copper, when a brass flange is used.

Operating Temperature Range: The temperature ranges from -54°C to $+125^{\circ}\text{C}$, or even wider, depending on the application. Precision Waveguide Terminations may have a rather limited temperature range, while the Power Terminations in Systems are usually designed for extreme temperature ranges. The operating temperature however, will reduce the power limit.

Standard Products: A standard product line of Waveguide Terminations is available with short deliveries. But if the product needed is not listed, there is always a possibility that the product required has been designed already or that a design, very close to the requirement exists. Therefore, please check your requirements with our sales force or our engineering staff.

VSWR: VSWR is the ratio of the reflected signal and the incident signal. It is desired that the loads are ideal, absorbing the power completely. In fact, Waveguide Terminations can be designed and manufactured almost ideally. But the units will still show some reflections and discontinuities within the circuit, as no design is perfect, and manufacturing tolerances do not allow perfect designs anyway. The VSWR of Precision Waveguide Terminations is less than 1.02 : 1 over the full waveguide bandwidth.

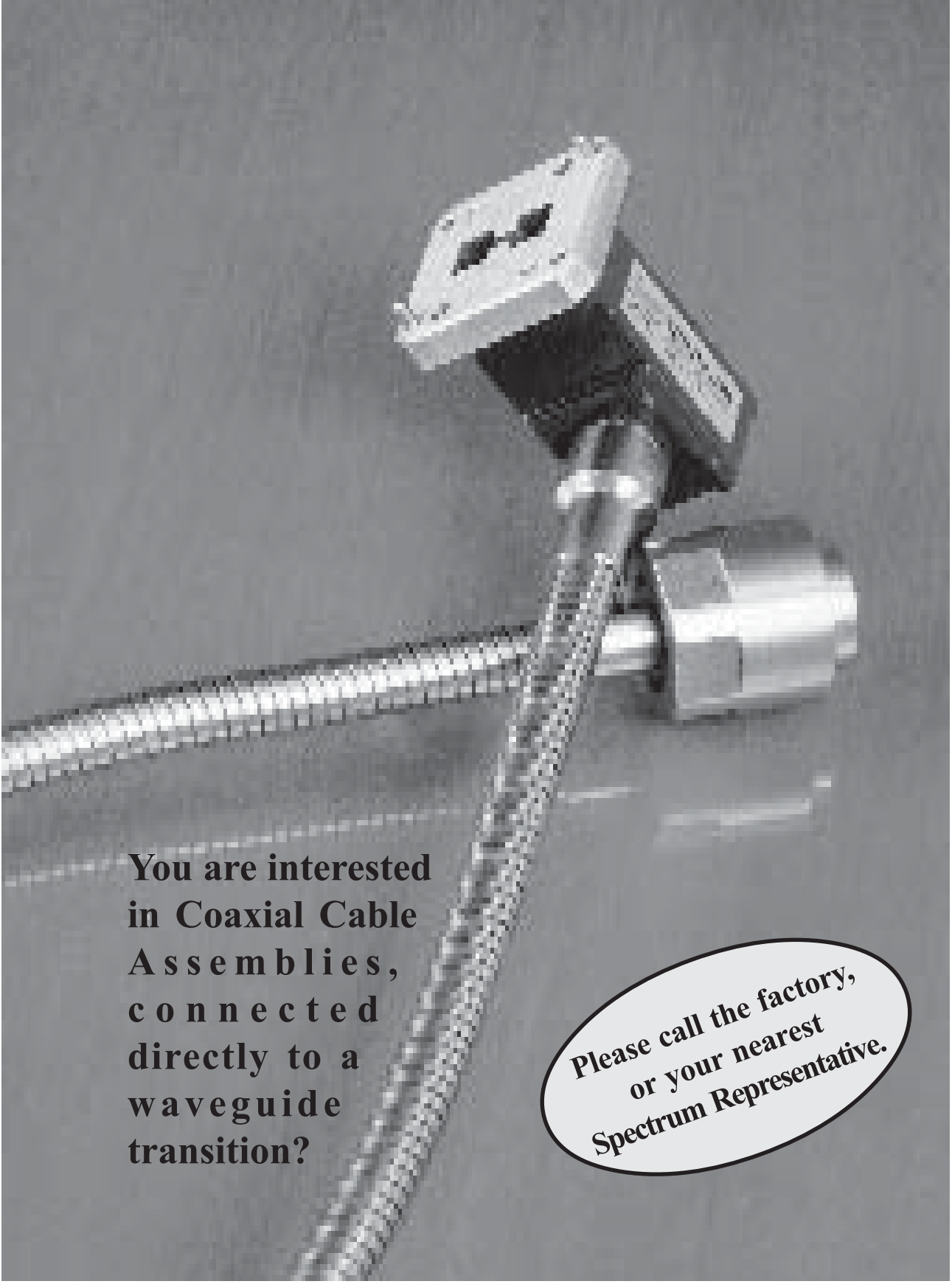


Designation			Frequency (GHz)	Radar Band	VSWR max.	Power Rating ¹⁾ CW (W)	Termination Dimensions (mm)			Standard Flange	Standard Flange Material	Part Number ²⁾
EIA (WR)	DEF (WG)	IEC (R)					A	B	C			
430	8	22	1.70-2.60	R	1.02	5	109.22	54.61	508.0	UG1711/U	Aluminum	TP-R437-AL01
										UG1716/U	Brass	TP-R437-BR01
340	9A	26	2.20-3.30		1.02	5	86.36	43.18	457.2	UG1713/U	Aluminum	TP-R340-AL01
										UG1712/U	Brass	TP-R340-BR01
284	10	32	2.60-3.95	S	1.02	5	72.136	34.036	457.2	UG1725/U	Aluminum	TP-R284-AL01
										UG1724/U	Brass	TP-R284-BR01
284R/H					1.02		17.018			Aluminum	TP-H284-AL01	
										Brass	TP-H284-BR01	
229	11A	40	3.30-4.90		1.02		58.166	29.083	355.6	UG1727/U	Aluminum	TP-R229-AL01
										UG1726/U	Brass	TP-R229-BR01
187	12	48	3.95-5.85	H	1.02		47.549	22.149	304.8	UG1729/U	Aluminum	TP-R187-AL01
										UG1728/U	Brass	TP-R187-BR01
159	13	58	4.90-7.05		1.02	4	40.386	20.193	304.8	UG1731/U	Aluminum	TP-R159-AL01
										UG1730/U	Brass	TP-R159-BR01
137	14	70	5.85-8.20	C	1.02	3	34.849	15.799	304.8	UG1733/U	Aluminum	TP-R137-AL01
										UG1732/U	Brass	TP-R137-BR01
112	15	84	7.05-10.0	B	1.02	2	28.499	12.624	254.0	UG138/U	Aluminum	TP-R112-AL01
										UG51/U	Brass	TP-R112-BR01
102			7.00-11.0		1.02	2	25.908	12.954	254.0		Aluminum	TP-R102-AL01
										UG1493/U	Brass	TP-R102-BR01
96			7.00-17.0		1.02	2	24.511	8.128	254.0		Aluminum	TP-R096-AL01
											Brass	TP-R096-BR01
90	16	100	8.20-12.4	X	1.02	2	22.860	10.160	304.8	UG135/U	Aluminum	TP-R090-AL01
												UG39/U
90R/H					1.02	2		5.080			Aluminum	TP-H090-AL01
											Brass	TP-H090-BR01
75	17	120	10.0-15.0		1.02	2	19.050	9.525	203.2	UBR120	Aluminum	TP-R075-AL01
												Brass
75R/H			10.0-15.0		1.02	2		5.080			Aluminum	TP-H075-AL01
											Brass	TP-H075-BR01
67			11.0-17.0		1.02	2	16.967	8.636	203.2		Aluminum	TP-R067-AL01
											Brass	TP-R067-BR01
62	18	140	12.4-18.0	KU	1.02	2	15.799	7.899	152.4	UG1665/U	Aluminum	TP-R062-AL01
											UG419/U	Brass
51	19	180	15.0-22.0		1.02	2	12.954	6.477	152.4	UBR180	Aluminum	TP-R051-AL01
											Brass	TP-R051-BR01
42	20	220	18.0-26.5	K	1.02	2	10.668	4.318	152.4	UG597/U	Aluminum	TP-R042-AL01
											UG595/U	Brass
34	21	260	22.0-33.0		1.02	2	8.636	4.318	152.4	UBR260	Aluminum	TP-R034-AL01
											Brass	TP-R034-BR01
28	22	320	26.5-40.0	KA	1.02	2	7.112	3.556	152.4	UBR320	Aluminum	TP-R028-AL01
											UG-599/U	Brass
22	23	400	33.0-50.0		1.02	2	5.690	2.845	152.4		Aluminum	TP-R022-AL01
											U383/U	Brass

1) At a pressure of one atmosphere.

2) For non Standard Flanges and/or Specifications, a special Part Number will be assigned.

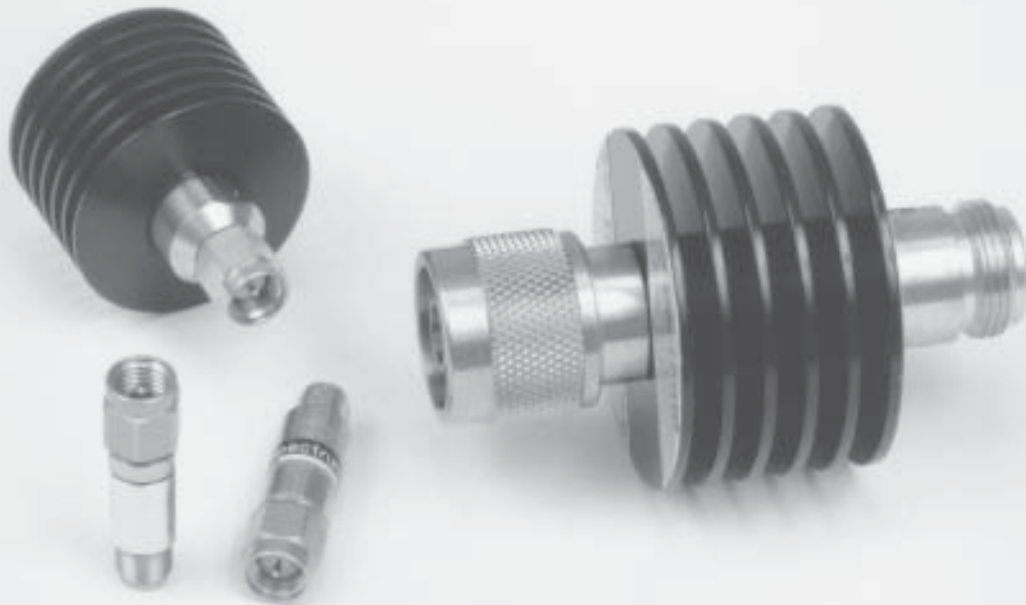
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**You are interested
in Coaxial Cable
Assemblies,
connected
directly to a
waveguide
transition?**

**Please call the factory,
or your nearest
Spectrum Representative.**

Section IV



Coaxial Attenuators

INTRODUCTION: Attenuators are passive linear components, being used to reduce the input power in a system by a certain amount. The ratio of input power versus output power is generally expressed in Decibels (dB).

Applications: Attenuators are needed to control the microwave energy, mainly during measurement. They are also used to protect systems from excess energy, to extend the dynamic range of measuring equipment, such as power meters, spectrum analyzers, amplifiers, receivers, etc.

Attenuation: The attenuation or insertion loss of an attenuator is the ratio of input power versus output power, providing that the input power is generated by a matched generator and the output of the attenuator is delivered into a perfectly matched load.

Attenuation Values: The standard attenuation values are available from 0 dB to 60 dB. In the range of 0 dB to 20 dB, smaller attenuation ranges are available, e.g. in steps of 1/2 dB. Above 20 dB and up to 30 dB, step sizes of 1 dB are standard, while the higher attenuation values are then usually specified by the customer.

Average Power Handling: This is the maximum allowable CW power to which the unit can be subjected to without suffering permanent damage, or without changing permanently the specified characteristics of the device. The power handling of absorptive units is a function of temperature. High temperature units are supplied with cooling fins or heat sinks or both for better power dissipation.

Connectors: Attenuators are available with a large variety of connectors, meeting the appropriate standard interface specifications, such as MIL-Standards, DIN- or IEC-Specifications, etc.

Custom Designs: In addition to the standard terminations shown in this section, Spectrum Elektrotechnik GmbH has been designing and supplying special models to suit particular requirements, such as unique mechanical outline, unusual mounting or special connector requirements, extended frequency operation, special attenuation values, or in between attenuation values, higher power dissipation, harsh environment, etc.

Frequency and Bandwidth: Coaxial Attenuators do usually operate over a multi-octave bandwidth. In special applications they may be tuned to certain criteria in narrower bands.

High Reliability Components: Most of the attenuators can also be supplied to Customers High Reliability Specifications, environmental, military or governmental requirements, and/or to customer specified test procedures.

Peak Power Handling: This is the maximum allowable Peak power to which the unit can be subjected to without suffering permanent damage, or without changing permanently the specified characteristics of the device. The peak power is transmitted using a certain pulse width and pulse repetition rate. The percentage of transmitted power, compared to CW power is called Duty Cycle

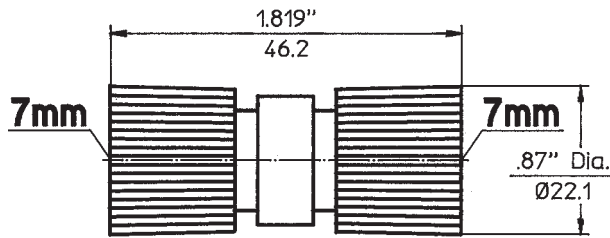
Temperature Coefficient: The attenuation value of an attenuator will vary with temperature. The maximum change of attenuation or insertion loss per degree Centigrade over a specified temperature range is called the temperature coefficient.



Spectrum Elektrotechnik GmbH offers custom compiled sets of attenuators, if needed optimized for specific frequency bands. Each attenuator within any set is 100% tested to ensure optimum performance over its full frequency range. To enable the user to maintain these quality attenuators in pristine condition, they are supplied in a nicely finished wooden case. For details please call your nearest Spectrum Representative.

Attenuators

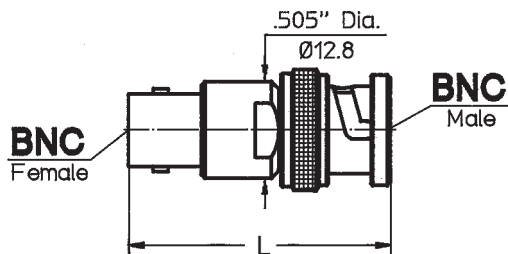
7mm to 7mm



Attenuator 7mm to 7mm

Part No.	DG-0018-XX90*
Frequency Range	DC - 18.0 GHz
Attenuation Values	3, 6, 10 and 20 dB
Attenuation Accuracy	3 and 6 dB: ± 0.3 dB 10 and 20 dB: ± 0.5 dB
Max. VSWR	DC to 4.0 GHz: 1.12 4 to 8.0 GHz: 1.15 8 to 18.0 GHz: 1.20
Max. Input Power	2 Watts average at + 25°C 0.5 Watts average at +125°C
Operating Temp. Range	-54°C to + 125°C
* XX: Please specify the attenuation value (dB) required.	

BNC Male to BNC Female

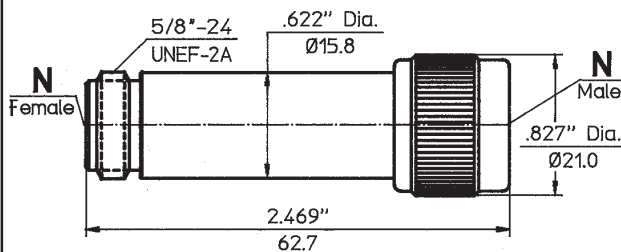


Length L:
1 - 20 dB: 34.5mm
21 - 60 dB: 41.9mm

Attenuator BNC Male to BNC Female

Part No.	DG-0004-XX71*
Frequency Range	DC - 4.0 GHz
Attenuation Values	1 - 60 dB in 1 dB increments
Attenuation Accuracy	1 to 6 dB: ± 0.3 dB 7 to 10 dB: ± 0.5 dB 11 to 20 dB: ± 0.75 dB 21 to 40 dB: ± 1.0 dB 41 to 60 dB: ± 1.5 dB
Max. VSWR	1.25 : 1
Max. Input Power	2 Watts average at + 25°C 0.5 Watts average at +125°C
Operating Temp. Range	-54°C to + 125°C
* XX: Please specify the attenuation value (dB) required.	

N Male to N Female

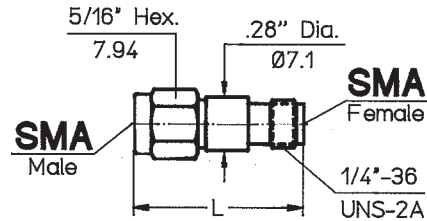


Attenuator N Male to N Female

Part No.	DG-0018-XX51*
Frequency Range	DC - 18.0 GHz
Attenuation Values	3, 6, 10 and 20 dB
Attenuation Accuracy	3 and 6 dB: ± 0.3 dB 10 and 20 dB: ± 0.5 dB
Max. VSWR	DC to 4.0 GHz: 1.12 4 to 8.0 GHz: 1.15 8 to 18.0 GHz: 1.20
Max. Input Power	2 Watts average at + 25°C 0.5 Watts average at +125°C
Operating Temp. Range	-54°C to + 125°C
* XX: Please specify the attenuation value (dB) required.	

SMA Male to SMA Female

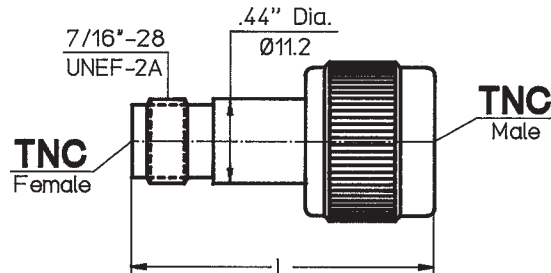
Attenuator SMA Male to SMA Female	
Part No.	DG-0018-XX11*
Frequency Range	DC - 18.0 GHz
Attenuation Values	1 - 30 dB in 1 dB increments
Attenuation Accuracy	1 to 6 dB: ± 0.3 dB 7 to 20 dB: ± 0.5 dB 21 to 30 dB: ± 1.0 dB
Max. VSWR	1.07 + 0.015 f(GHz)
Max. Input Power	2 Watts average at + 25°C 0.5 Watts average at +125°C
Operating Temp. Range	-54°C to + 125°C
* XX: Please specify the attenuation value (dB) required.	



Length L:
 1 - 12 dB: 21.8mm
 13 - 30 dB: 25.9mm

TNC Male to TNC Female

Attenuator TNC Male to TNC Female	
Part No.	DG-0018-XX31*
Frequency Range	DC - 18.0 GHz
Attenuation Values	1 - 60 dB in 1 dB increments
Attenuation Accuracy	1 to 6 dB: ± 0.3 dB 7 to 20 dB: ± 0.5 dB 21 to 40 dB: ± 1.0 dB 41 to 60 dB: ± 1.5 dB
Max. VSWR	1.07 + 0.015 f(GHz)
Max. Input Power	2 Watts average at + 25°C 0.5 Watts average at +125°C
Operating Temp. Range	-54°C to + 125°C
* XX: Please specify the attenuation value (dB) required.	



Length L:
 1 - 20 dB: 39.9mm
 21 - 60 dB: 46.7mm

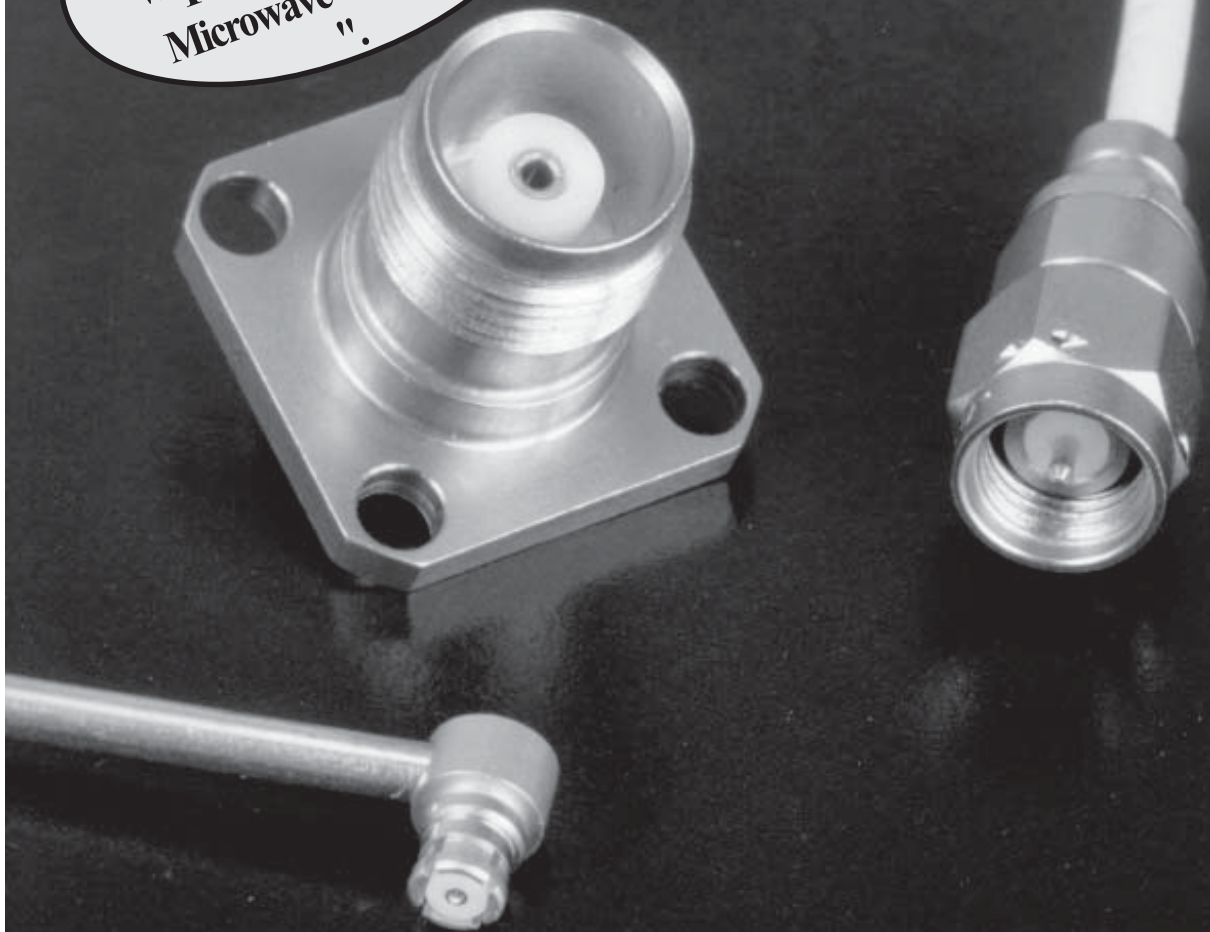
**YOU NEED SOMETHING DIFFERENT?
 YOU NEED TECHNICAL ASSISTANCE?**

You will find immediate support from our Engineering and Marketing Staff. Please give us a call, send us a fax or an e-mail, indicating your needs, problems and/or specifications, or contact the nearest Spectrum Representative for more information.

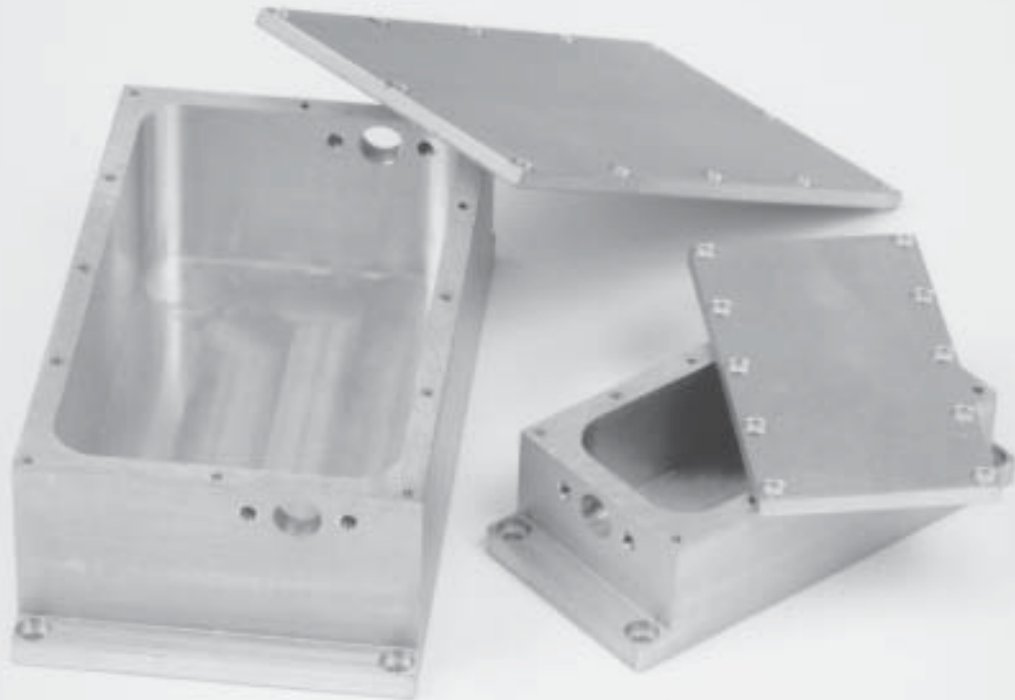
Telephone: {49}(89) 3548 040
 Fax: {49}(89) 3548 0490
 E-mail: specelek @ CompuServe.com

**We design and manufacture
the connectors exactly the way
you need them in your System.**

**Interested?
Please refer to
"The '98 Handbook
Microwave Connectors
".**



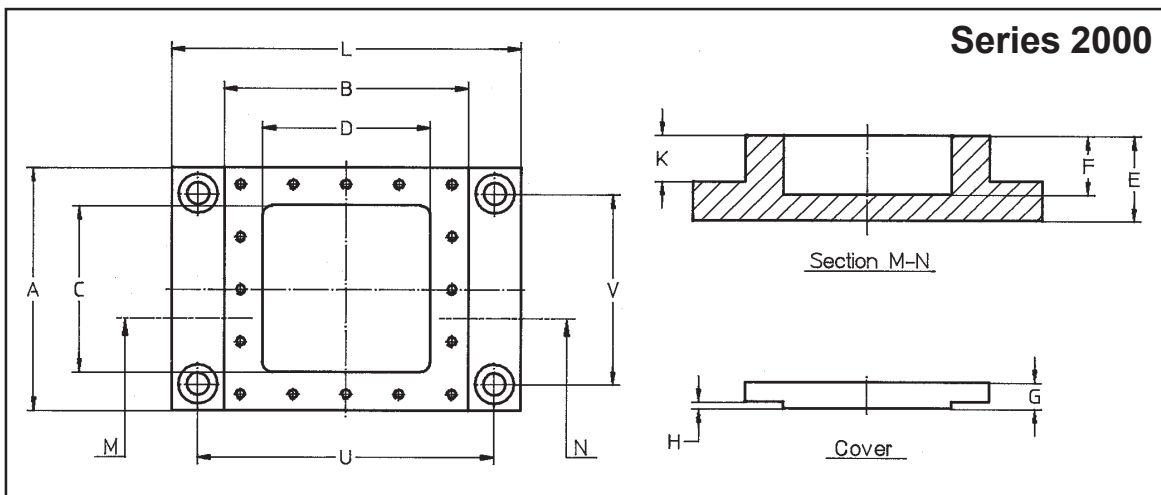
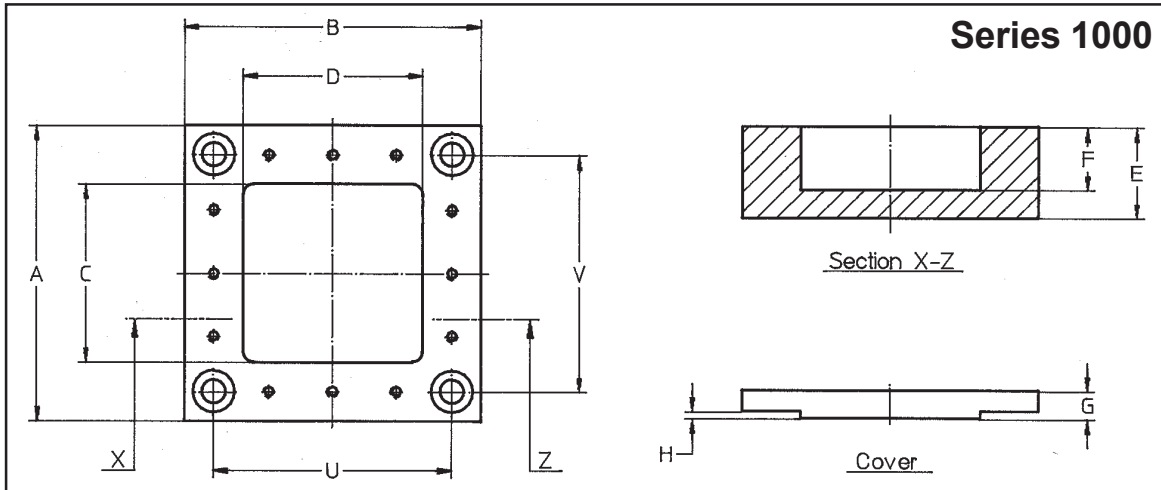
Section V



Hybrid Housings

Hybrid Housing

Spectrum Elektrotechnik GmbH manufactures and stocks a variety of excavated aluminum Housings. These housings are used to install RF circuits. Each housing consists of the bottom section and the cover. For prototype applications the housings of Series 1000 and 2000 were designed. Openings for connector locations can easily be fitted when needed. The housings of Series 3000 do have already openings for the connectors at the shown locations. If not specified differently, the housings are made from Al Mg 4.5 Mn.



Housing Type	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)	F (mm)	G (mm)	H (mm)	K (mm)	L (mm)	U (mm)	V (mm)
GE-1001	42.0	42.0	25.4	25.4	13.0	9.0	4.0	1.0	-	-	33.4	33.4
GE-1002	42.0	67.0	25.4	50.8	13.0	9.0	4.0	1.0	-	-	33.4	59.0
GE-1003	67.0	67.0	50.8	50.8	13.0	9.0	4.0	1.0	-	-	59.0	59.0
GE-1004	96.0	96.0	76.2	76.2	13.0	9.0	4.0	1.0	-	-	86.0	86.0
GE-2001	37.0	37.0	25.4	25.4	13.0	9.0	4.0	1.0	7.0	53.0	29.0	45.0
GE-2002	38.0	63.0	25.4	50.8	13.0	9.0	4.0	1.0	7.0	79.0	30.0	71.0
GE-2003	63.0	63.0	50.8	50.8	13.0	9.0	4.0	1.0	7.0	79.0	55.0	71.0
GE-2004	88.0	88.0	76.2	76.2	13.0	9.0	4.0	1.0	7.0	108.0	80.0	100.0

Section VI



Gain Amplitude Equalizers



lcomp3.ppt6

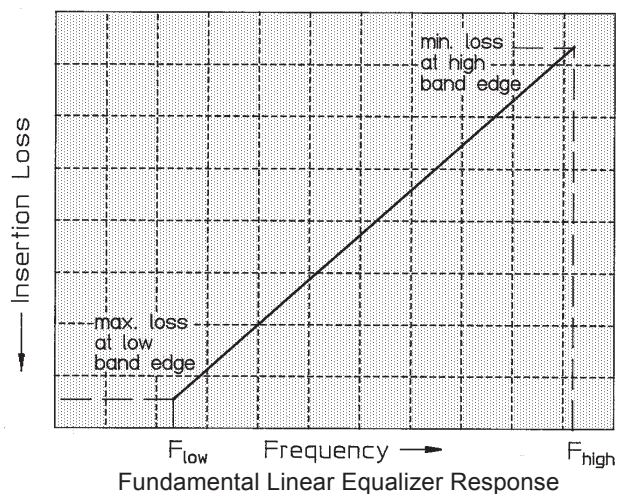
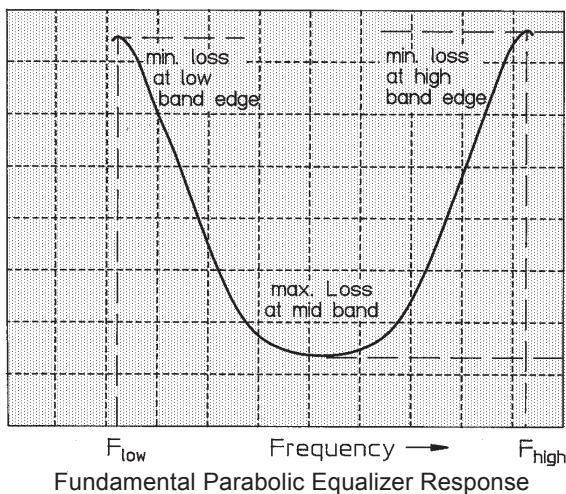
Spectrum Elektrotechnik GmbH has been successfully developing and manufacturing Gain Amplitude Equalizers showing particular attenuation characteristics, and allowing the compensation of the frequency response of certain components in a system. Gain amplitude equalization is utilized on TWT amplifiers, long coaxial cables, delay lines, oscillators and solid state amplifiers. Spectrum Elektrotechnik GmbH offers its capability to design, develop and to manufacture custom designed Gain Amplitude Equalizers to satisfy distinct requirements. Rugged construction assures high performance in military and commercial applications as well.

Fundamentals:

The Gain Amplitude Equalizer is an absorptive device having a particular attenuation curve. Two significant categories can be described:

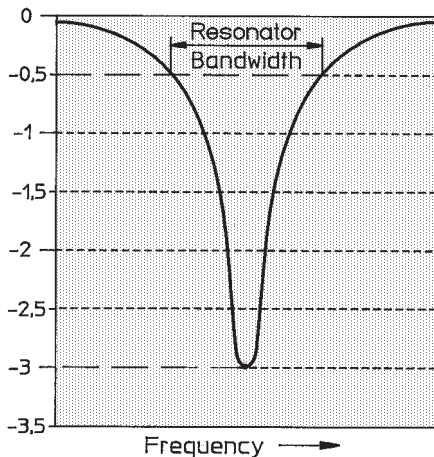
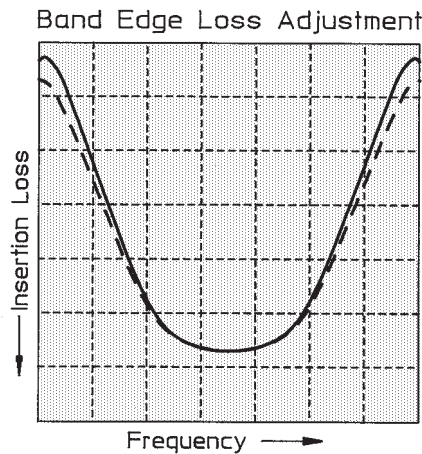
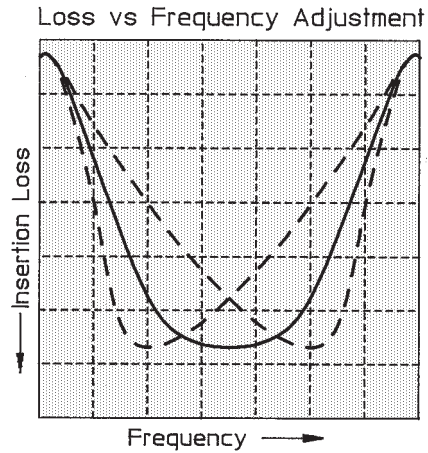
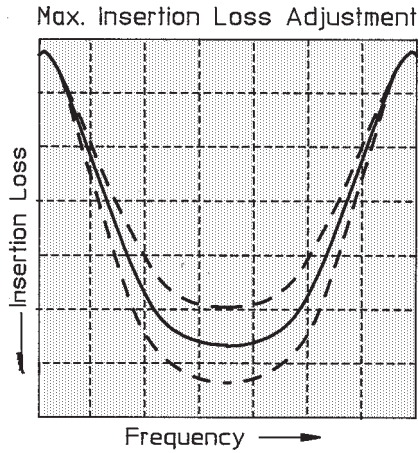
Parabolic or Sinusoidal Equalizers. These devices are mainly used at TWT's to compensate the saturated gain. The maximum attenuation is expected in mid band, the minimums are at the band ends. The maximum attenuation can be a few dB or even more than 30 dB. At the band edge losses of less than 1 dB are desirable.

Linear or Slope Equalizers. The application of these units is to compensate the frequency dependant loss of long coaxial cable assemblies or delay lines. The maximum loss at the low band edge can be a few dB or as much as 30 dB, while at high band end edge losses as little as possible are desirable. The loss at the higher frequency limit is usually less than 1 dB.



The parabolic as well as the linear equalizers can be subdivided into three groups:

- 1.) **Fixed Equalizer.** The insertion loss curve of the unit is engineered to meet the customer requirements in the system. The attenuation curve is set to the specification. This type of unit is normally used on components that are very predictable.



2.) **Adjustable Equalizer.** The fixed insertion loss versus frequency is specified. All units will be set to meet this predetermined curve. Additionally, if the system requires a similar but a slightly different loss curve, a certain number of adjustments will be available to change the nominal attenuation curve. The type of adjustments can be rising or lowering the maximum attenuation value, shifting the maximum value of the response from the center to lower or higher frequencies, or establishing a change of the attenuation at the band edges, upper, lower or both. A unit can be designed to meet all these requirements for adjustment.

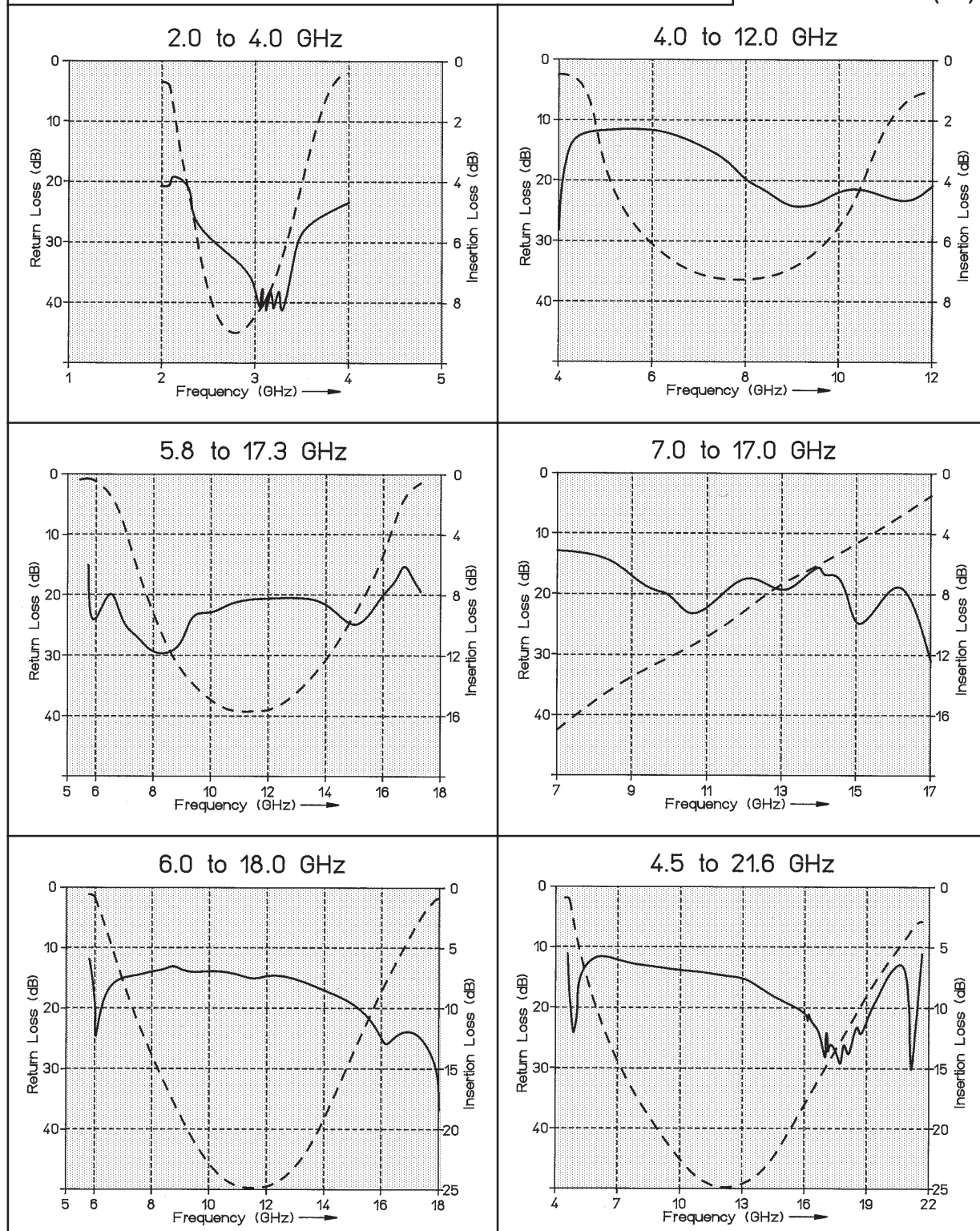
3.) **Fine Grain Equalizer.** This group of devices usually combines with all the characteristics of the "Adjustable Equalizers", but has added a certain number or resonators capable of individual fine grain cancellation. By specification the bandwidths of the resonators can be equal or different, measured at a certain insertion loss characteristic and when its peak loss is set to a specific value. A typical resonator bandwidth can be any value between 100 MHz and 1.0 GHz measured e.g. at the 0.5 dB point, when for example its peak loss is 3 dB. The device can be equipped with as many as 20 resonators of different values. The frequency range for tunability of the individual resonators for fine grain cancellation can be specified anywhere in the frequency range of the equalizer.

Frequency Range and Bandwidth. The current capability covers the frequency range from 1.0 GHz to over 30.0 GHz. Bandwidths were achieved, ranging from only a few percent to almost three octaves. Several examples are shown on page 80.

Gain Amplitude Equalizers

The diagrams shown on this page are actual data from existing designs.

--- Insertion Loss (dB)
— Return Loss (dB)



Parabolic (half sine)					
Frequency (GHz)	Insertion Loss at upper Frequency Limit (dB, max.)	Insertion Loss at Mid-Band (dB)	Return Loss (dB) min.	Dimensions (mm)	Connectors
2.0 - 4.0	0.9 The insertion loss of the upper frequency limit may be optimized with most models to show loss below 0.7 dB.	5.0 - 30.0 Designs are available to set the differential loss within the limits shown, or even below and above.	12 Return loss can be optimized on special request. Broad band units have been designed showing a return loss of 19 dB min. over full bandwidth.	The dimensions depend on the differential loss. As soon as the differential loss is specified, the dimensions can be advised.	SMA Connectors other than SMA can be supplied upon request.
2.0 - 8.0					
4.0 - 8.0					
4.0 - 20.0					
4.0 - 21.0					
6.0 - 18.0					
6.0 - 20.0					
7.0 - 17.0					
7.0 - 18.0					
8.0 - 16.0					
Linear					
Frequency (GHz)	Insertion Loss at upper Frequency Limit (dB, max.)	Insertion Loss at lower Frequency Limit (dB)	Return Loss (dB) min.	Dimensions (mm)	Connectors
4.0 - 8.0	1.0 The insertion loss of the upper frequency limit may be optimized with most models to show loss below 0.7 dB.	5.0 - 25.0 Designs are available to set the differential loss within the limits shown, or even below and above.	12 Return loss can be optimized on special request. Broad band units have been designed showing a return loss of 19 dB min. over full bandwidth.	The dimensions depend on the differential loss. As soon as the differential loss is specified, the dimensions can be advised.	SMA Connectors other than SMA can be supplied upon request.
6.0 - 12.0					
6.0 - 18.0					
6.0 - 20.0					
10.0 - 15.0					
12.0 - 18.0					

example3.ppt6

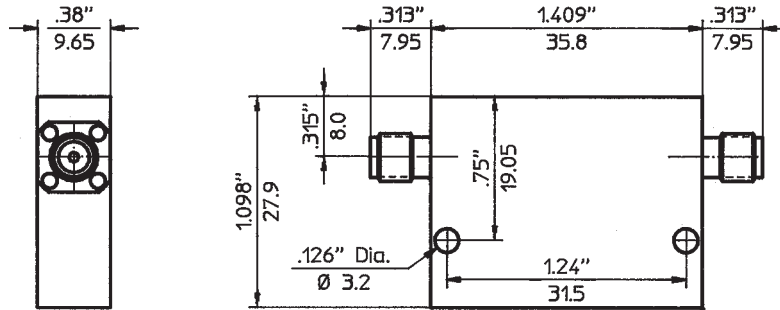


Spectrum Elektrotechnik GmbH has been developing state-of-the-art components for a number of very special programs, such as very unique gain amplitude equalizers.

The waveguide gain equalizer, as shown above, has been designed for a Ka-Band Jamming System in a military program. The equalizer's sinusoidal loss curve is matched to the gain curves of both, the Driver TWT and the subsequently following Power TWT. The equalizer has very little loss around the band edges, which is desired, as the TWTs do have only little gain there. In midband the loss rises to a maximum, as needed. The curve is smooth and does not show ripples.

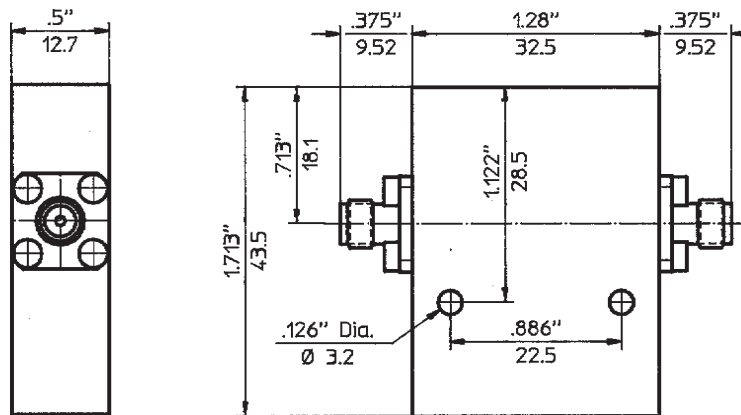
For delivery, the equalizer is set to a nominal insertion loss curve, as specified. The tuning and set screws are not locked and not sealed, allowing the customer to do final adjustments in the system, several dBs in insertion loss and a certain shift of the insertion loss curve versus frequency. Thus, the equalizer's loss curve can be perfectly matched to the TWTs gain curves for optimum system performance. After the final adjustment the customer can lock and seal the unit.

lcomp3.pmf6



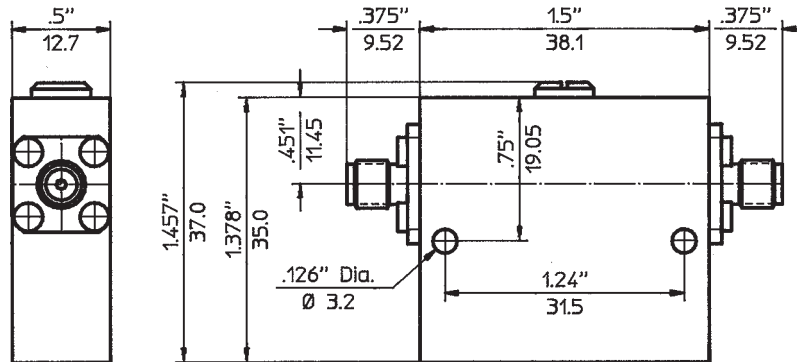
Housing Style

H1



Housing Style

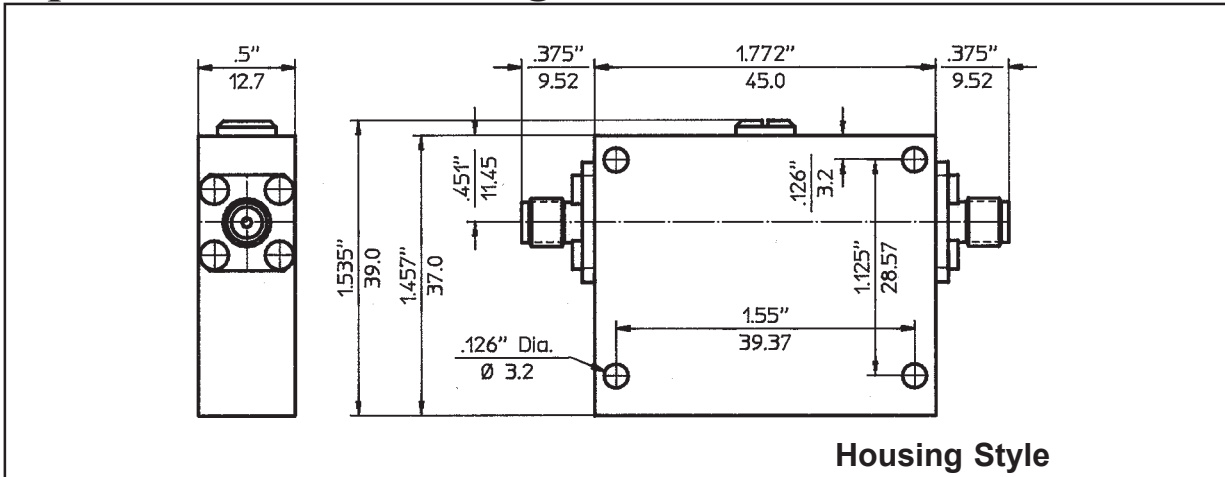
H2



Housing Style

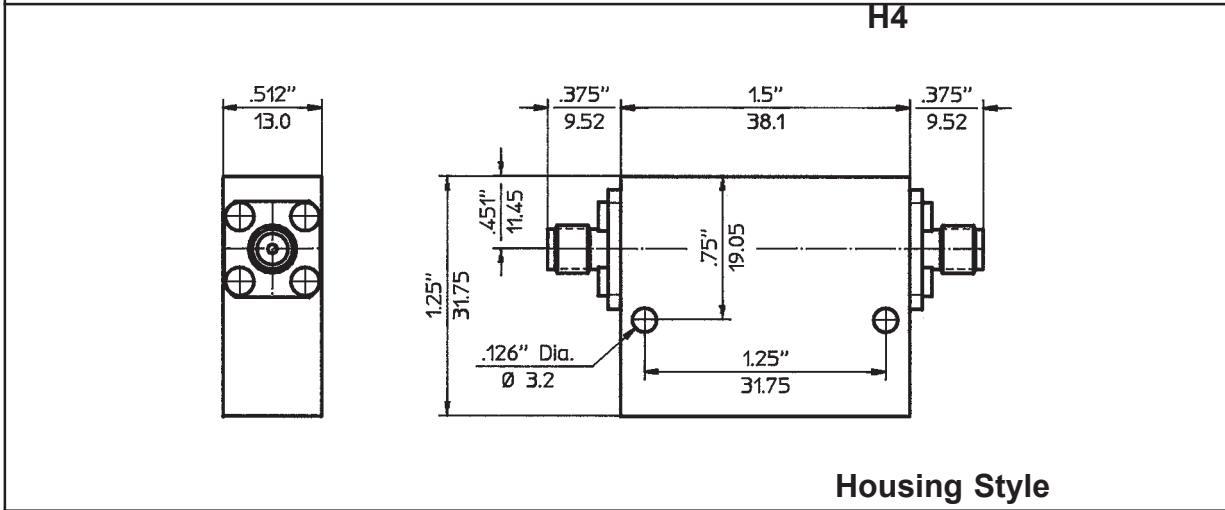
l:comp3.ppt6

Equalizer Outline Drawings



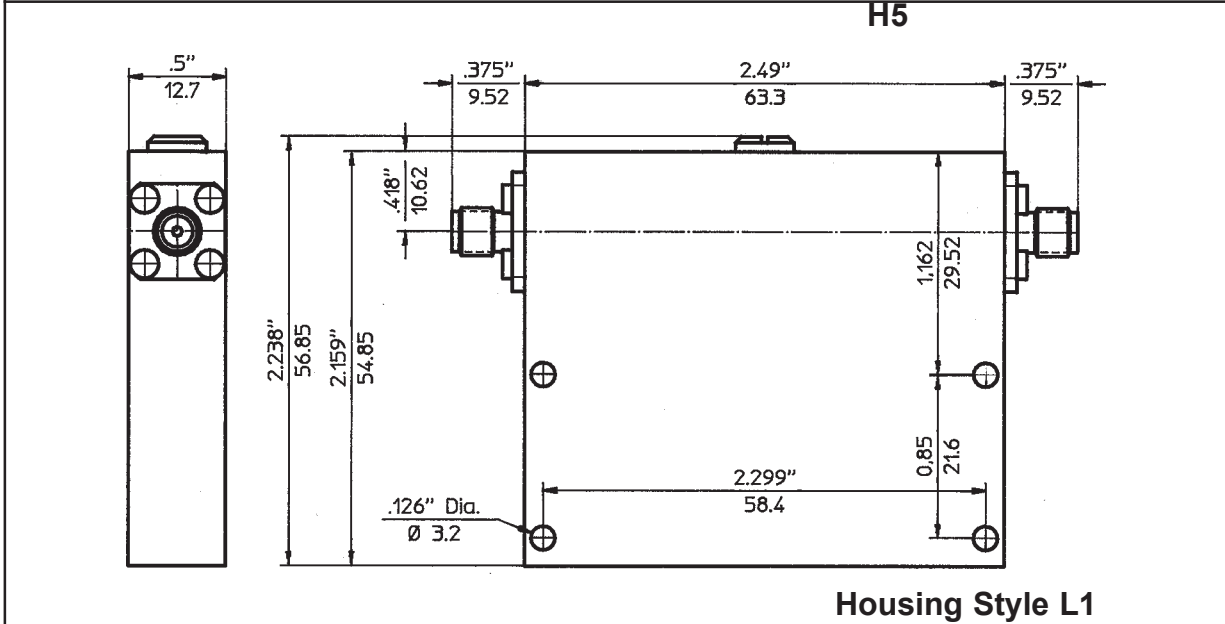
Housing Style

H4

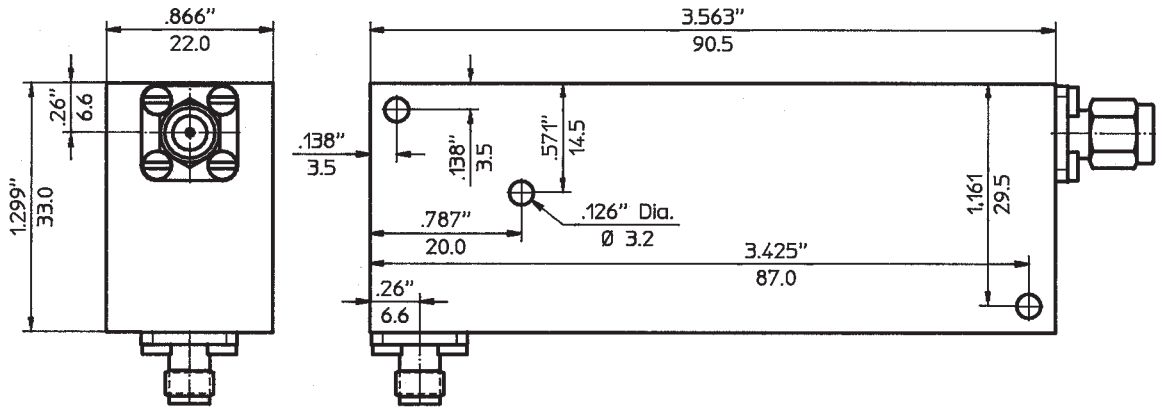


Housing Style

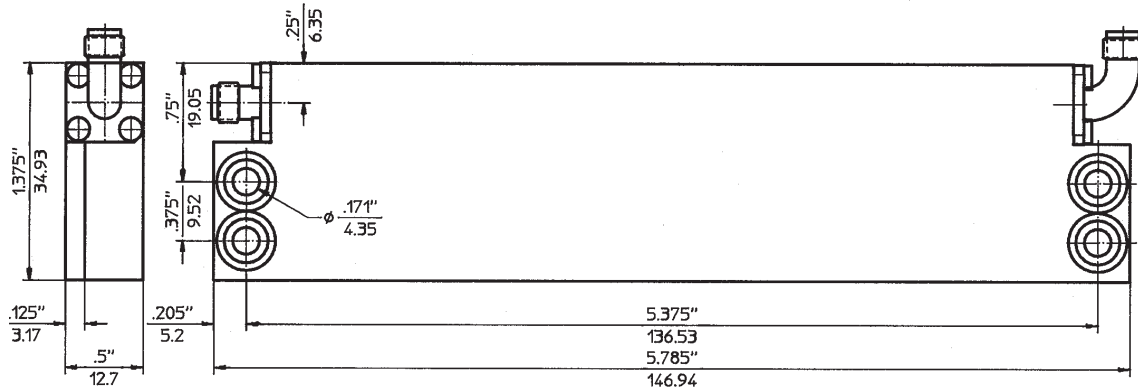
H5



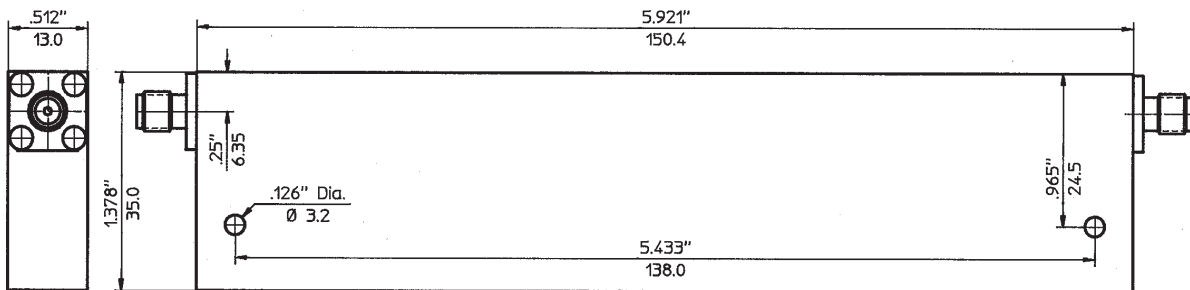
Housing Style L1



Housing Style F1



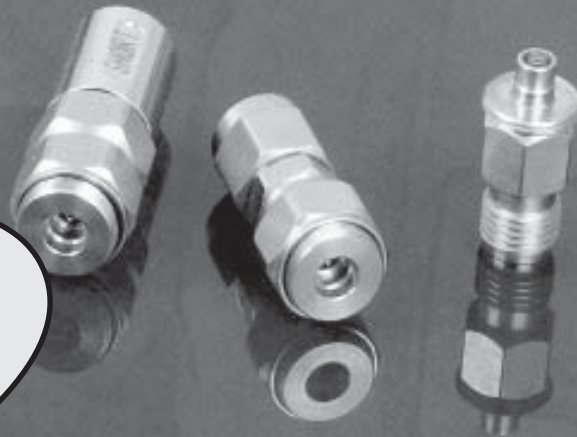
Housing Style F2



Housing Style F3

Are you a Believer ? Or: Can you test your SMP- Component and -Assembly?

Interested?
Please refer to
" The '98 Handbook
Test Necessities
& Accessories ".



We make the Calibration Kits, also for SMPs

Please ask for our other Products in the Frequency Range of DC to 50 GHz:

Adapters, ANA Test Cables, Antennas, Attenuators, Blind Mate Connectors, Circulators, CDM-Components, Coax Switches, Couplers, Custom Components, DC-Block Connectors & Adapters, Gain-Equalizers, Flexible Cable Assemblies, Isolators, Limiters, Mismatches, Multi Pin Connectors, Phase Shifters, Phase Stable Cable Assemblies, Precision Terminations, Push-On Connectors & Adapters, Semi Rigid Cable Assemblies, Waveguide Components, Waveguide to Coax Adapters, etc.



Spectrum
Elektrotechnik GmbH

80905 Munich, Germany

P.O. Box 45 05 33

Fax (89) 354-804-90

Telephone: (89) 354-804-0

smp0996

Section VII



DC - Block Connectors

INTRODUCTION: DC-Block Connectors consist of a short length of a coaxial transmission line and having a capacitance in series with the center conductor or the outer conductor, or both. The RF is transmitted with negligible reflections and attenuation while the DC or video frequencies are blocked. The DC-Blocks are carefully designed and matched to work to higher frequencies, e.g. 18.0 GHz.

Applications: DC-Blocks are used to prevent the flow of direct current or video along a transmission line while permitting the uninterrupted flow of RF. DC-Blocks are mostly needed in systems applications, occasionally also during test and measurement.

Average Power Handling: This is the maximum allowable CW power to which the unit can be subjected to without suffering permanent damage.

Connectors: DC-Block Connectors are available with a large variety of connectors, meeting the appropriate standard interface specifications, such as MIL-Standards, DIN- or IEC-Specifications, etc.

Custom Designs: In addition to the standard Internal DC-Block Connectors, using the SMA connector style, as shown in this section, Spectrum Elektrotechnik GmbH has been designing and supplying special DC-Block Connectors and Adapters to suit particular requirements, such as unique mechanical outline, unusual mounting or special connector requirements, higher power dissipation, rough environment, etc., etc.

Frequency and Bandwidth: DC-Block Connectors do usually operate over a multi-octave bandwidth. In special applications they can be designed for certain criteria in narrower bands.

High Reliability Components: DC-Block Connectors can also be supplied to Customers High Reliability Specifications, environmental, military or governmental requirements, and/or to customer specified procedures.

Inner Block: The Inner Blocks have a capacitance in series with the center conductor to prevent the flow of DC current along the center line. They are employed when unwanted DC current is monitored on the center conductor, or when DC current is injected onto the center of part of the system and is undesired in the RF section, as it would damage sensitive RF components.

Inner-Outer Block: The inner-outer blocks have both, a capacitance in series with the center conductor and a capacitance in series with the outer conductor to prevent the flow of DC current on both conductors.

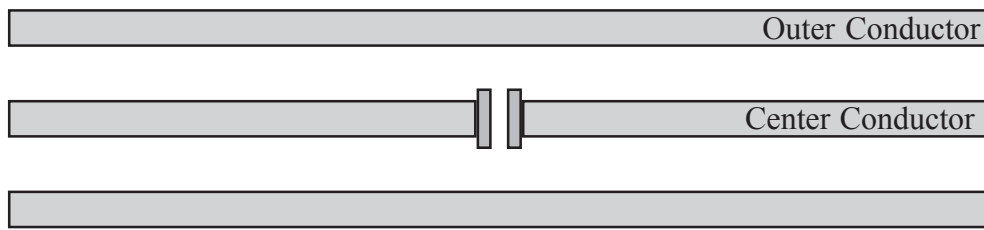
Operating Temperature Range: The temperature ranges usually from -54°C to $+115^{\circ}\text{C}$, or even wider, depending on the application and the design.

Outer Block: The outer blocks have a capacitance in series with the outer conductor to prevent the flow of DC current along the outer shell. Outer blocks are employed when the outer conductor of part of the system is necessary to be operated with a potential.

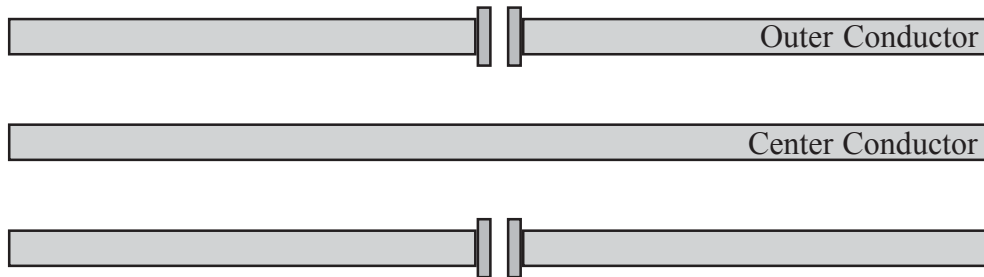
Outline: The outline dimensions of the standard components are usually same as for standard connectors or adapters. Special components can be engineered to customer specifications, showing almost any dimensions as needed in the application.

Peak Power Handling: This is the maximum allowable power to which the unit can be subjected to without suffering permanent damage or without changing permanently the specified characteristics of the device. The peak power is transmitted with a certain pulse width and pulse repetition rate.

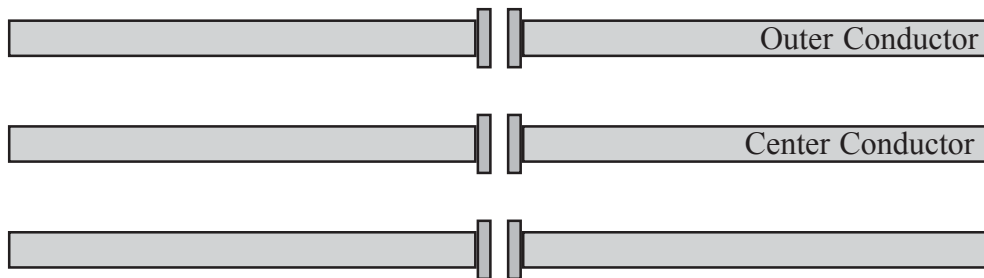
VSWR: VSWR is the ratio of the reflected signal and the incident signal. It is desired that the DC-Blocks have little reflections. But the built-in capacitance will show some reflections and discontinuities within the circuit, and manufacturing tolerances will cause some additional reflections.



Inner Block



Outer Block



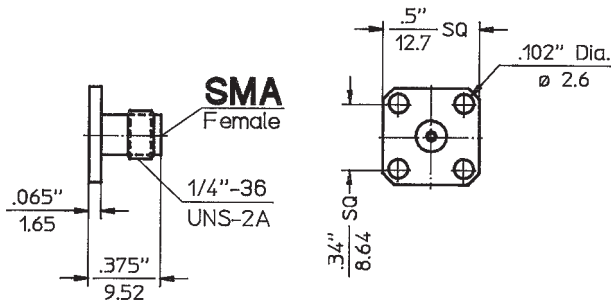
Inner-Outer Block

DC - Block Connectors (Inner Block)

The DC Block is used to prevent the flow of direct current or video along a transmission line while permitting the uninterrupted flow of RF. The unit consists of a short length of coaxial line, having a capacitance in series with the center conductor. The RF is transmitted with negligible reflection or attenuation while the DC or video frequencies are blocked. The outline dimensions of the components are same as for standard connectors and adapters. Special components can be engineered to customer specification.

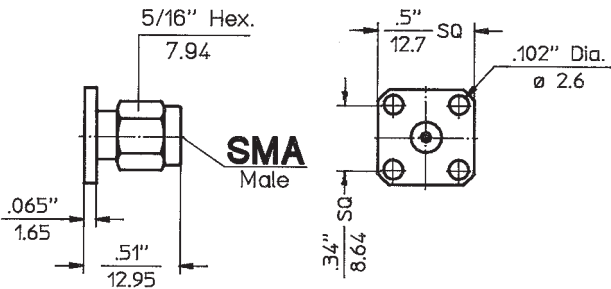
Frequency Range:	0.5 - 18.0 GHz
VSWR:	1.25 max.
Insertion Loss:	.5 dB max.
DC Voltage:	100 V max.
Capacitance:	100 pF, other values available
Operating Temperature:	-54°C to +115°C
Impedance:	50 Ohms

SMA Female, Panel Mount Contact Termination



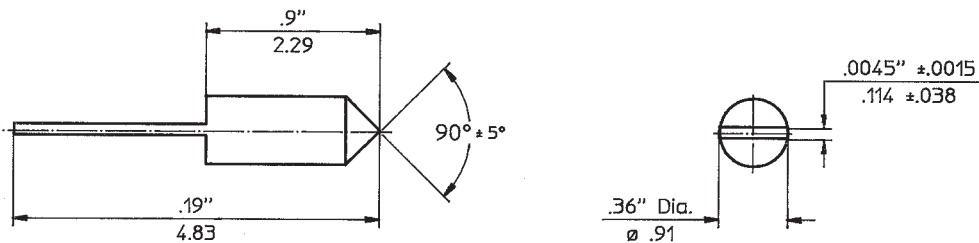
Part No.	DC-0018-2100
Frequency Range	0.5 - 18.0 GHz
Max. VSWR	1.25 max.

SMA Male, Panel Mount Contact Termination



Part No.	DC-0018-1100
Frequency Range	0.5 - 18.0 GHz
Max. VSWR	1.25 max.

Center Conductor

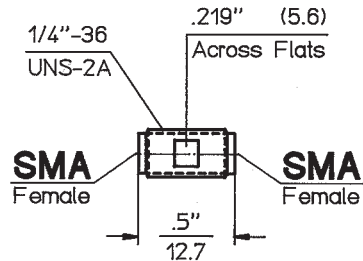


Part No.	90-059-1
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Dimensions shown are inches over millimeters. Standard connectors are made from stainless steel passivated. Connector interface specifications apply, as outlined in Section X: Connector Specifications.

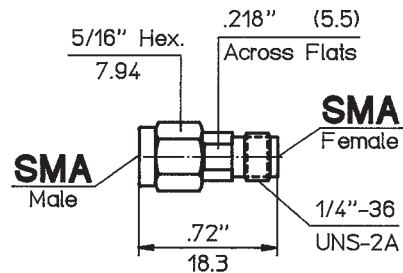
SMA Female to SMA Female

Part No.	DC-0018-2121
Frequency Range	0.5 - 18.0 GHz
Max. VSWR	1.25 max.



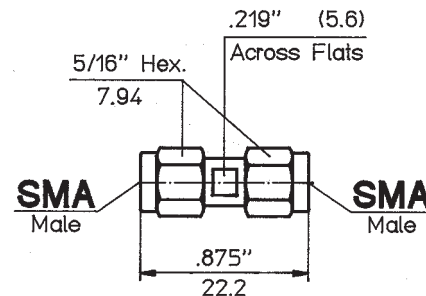
SMA Female to SMA Male

Part No.	DC-0018-1121
Frequency Range	0.5 - 18.0 GHz
Max. VSWR	1.25 max.



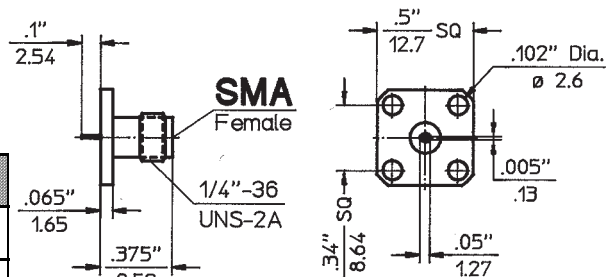
SMA Male to SMA Male

Part No.	DC-0018-1111
Frequency Range	0.5 - 18.0 GHz
Max. VSWR	1.25 max.



SMA Female Flange Mount, Stripline

Part No.	DC-0018-2101
Frequency Range	0.5 - 18.0 GHz
Max. VSWR	1.25 max.



Dimensions shown are inches over millimeters. Standard connectors are made from stainless steel passivated. Connector interface specifications apply, as outlined in Section X: Connector Specifications.

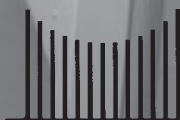
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CNCA - 700

**Cuts your Manufacturing Cost
Increases your Quality Standard**

Features:

- * Cuts and trims coaxial cables automatically.
- * Cuts and trims interfaces on Semi-Rigid Cables of diameters from 0.034" (0.86mm), or even smaller, and up to 1/2" (12.7mm).
- * Cuts and trims interfaces on Flexible Cables from smallest diameter up to a diameter of 1/2" (12.7mm).
- * Easy adjustments in cutting lengths and cutting diameters.
- * Two simultaneously working spindles.
- * Inexpensive tooling cost. * Easy programming * Easy set up.



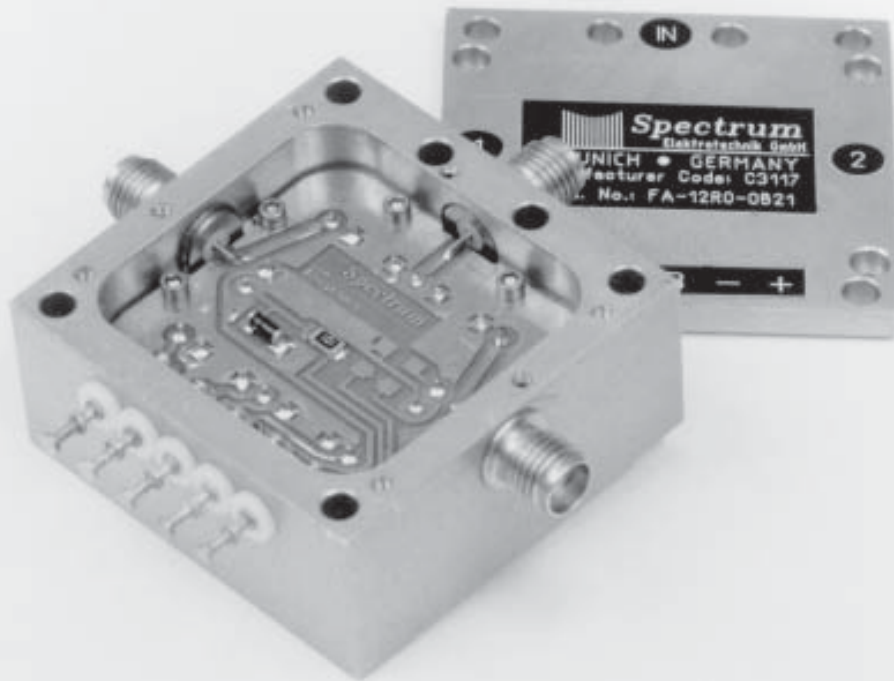
Spectrum
Elektrotechnik GmbH

80905 Munich, Germany
P.O. Box 45 05 33

Fax: {49}-(89)-354-804-90, Telephone: {49}-(89)-354-804-0

E-mail: specelek @ CompuServe.com

Section VIII



Coaxial Switches DC - 3.0 GHz

INTRODUCTION: Coaxial Switches are broadband electromechanical devices, engineered for connecting microwave signals from a common input to two or more outputs. They are designed for either 50 Ohms or 75 Ohms transmission lines.

Actuator: This is the electromechanical mechanism that moves the RF contacts from one position to another.

Actuator Voltage: The nominal voltage that is needed to switch the RF contacts from one position to another.

Arc Suppression Diodes: It is a diode, connected in parallel with the coil. The diode will clip the back spike to 0.7 volts when the coil is deenergized. The cathode of the diode is connected to the side of the coil where the positive voltage is applied, the anode of the diode is connected to ground.

Failsafe: The switch is using an actuator that contains a spring back mechanism, providing RF position to one selected position when no voltage is applied. The switch requires maintaining continuous voltage for RF connection to any other position.

Indicator Contacts: The contacts are provided to indicate the position of the RF path. The indicator contacts are usually in one-to-one correspondance with the RF contacts.

Insertion Loss: Insertion Loss is the difference in power level between input port and the output port it is switched to, the specific path being in the low loss condition.

Internal Termination: Any unselected input or output port will be connected to an internal termination of 50 Ohms, or 75 Ohms respectively at 75 Ohms switches.

Isolation: Isolation is the difference in power level between an output port that is connected to the input and terminated properly, and an output port that is in the off condition.

Latching: The switch is using an actuator that contains a mechanism that always will remain in the last position after switching, regardless whether voltage is maintained or not.

Multi-Throw Switch: The switch has one input and more than two outputs. Multi-Throw is another expression for SPNT.

RF Power Handling: This is the maximum allowable CW power to which the unit can be subjected to without suffering permanent damage. The rating is based on source and load being ideally 50 Ohms and the operating temperature being within the specified limits.

Self Deenergizing: It applies to Latching Switches only: The actuator drive circuit is disconnected and, not using DC current any more after switching has been accomplished. Self Deenergizing, also known as Self Cutoff can be accomplished by using mechanical contacts or integrated drive circuits.

SPDT: A switch with one input and two outputs. SPDT means Single Pole Double Through.

SPNT: A switch with one input and N outputs. SPNT means Single Pole N Through, where N is the number of outputs.

Switching Time: The total switching time depends on the inductive delay in the actuator coil, the transfer time on the RF contacts and the bounce time of the Rf contacts. It is the total amount of time between actuator voltage being applied and the completion of the switching.

Transfer Switch: A four port device, providing two independent pairs of RF paths. The pairs are actuated simultaneously.

VSWR: Voltage Standing Wave Ratio is the ration of the reflected signal and the incident signal. Every microwave component shows reflections and discontinuities within the circuit, as no design is perfect, and manufacturing tolerances do not allow perfect designs anyway.

Ordering Information for Coaxial Switches

A	B	-	C	D	E	F	-	G	H	J	K
F=Fail-safe L=Latching	Input/ Output Port Conf. as specified on the outline drawings.		Input number max. 9	Output number max. 9				Power Supply E = 5 V L = 12 V N = 24 V O = 15 V Z = 26 V	Frequency Range B = 0.2 GHz C = 0.5 GHz D = 1.2 GHz E = 1.5 GHz F = 2.0 GHz G = 3.0 GHz	Connectors 50 Ohms Connectors 75 Ohms	Please use Connector code as per table below.

E
0 = no Indicators
R = Indicators

F
A = unused ports are
 terminated
0 = unused ports are
 not terminated
T = Transfer Switch

J K

Connectors 50 Ohms
 03 = 1.4/4.4
 04 = 1.8/5.6 - Female
 05 = 1.8/5.6 - Male
 11 = SMA - Male
 21 = SMA - Female
 31 = TNC - Male
 41 = TNC - Female
 51 = N - Male
 61 = N - Female
 71 = BNC - Male
 81 = BNC - Female

Connectors 75 Ohms
 A1 = 1.6/5.6 - Male
 A2 = 1.6/5.6 - Female
 7B = BNC - Male
 8B = BNC - Female
 7N = N - Male
 8N = N - Female

I:compas.ppt6

SPDT Switches

Description:

The SPDT switch is a broadband electromechanical, coaxial switch, designed to switch microwave signals from a common input to either of two outputs, designed for 50 and 75 Ohms transmission lines respectively. The switch is set up with minimum size, compatible with BNC, TNC, N, and SMA connector spacing. The SPDT comes with either failsafe or latching actuator.

SPDT Ordering Information

F L	A B C	No. of Inputs	No. of Outputs	0 R	A 0	E L N	0 Z	B C D	E F G	03 04 05 11	21 31 41 51	61 71 81	A1 A2 7B 8B	7N 8N
F=Failsafe L=Latching	Input/Output Port Config. A,B = unused ports are not terminated C = unused ports are terminated	1	2	0 = without indicators R = with indicators	A = unused ports are terminated 0 = unused ports are not terminated		Power Supply E = 5 V L = 12 V N = 24 V 0 = 15 V Z = 26 V		Frequency Range B = 0.2 GHz C = 0.5 GHz D = 1.2 GHz E = 1.5 GHz F = 2.0 GHz G = 3.0 GHz	Connectors 50 Ohms Connectors 75 Ohms Explanation of Connector codes as per Table below.*				

Specifications

RF Contacts	Break before make
Actuator Voltage	5, 12, 15, 24 and 26 VDC
Actuator Current	Failsafe: { Depending on voltage and configuration, Latching: { please refer to the specific data sheet.
Switching Time	10 msec. maximum at nominal voltage
Weight	Depending on housing/connector configuration
Temperature Range	-50°C to +60°C
Life	10 ⁵ cycles
RF Power Handling	5 Watts
Optional Features	- Indicator Circuits Port Configuration A and B - Special Actuator Voltages - TTL Compatible Drivers - Arc Suppression Diodes - Power Connectors - Internal Termination different Port Configuration available.

Connectors 50 Ohms

03 = 1.4/4.4
04 = 1.8/5.6-Female
05 = 1.8/ 5.6-Male
11 = SMA-Male
21 = SMA-Female
31 = TNC-Male
41 = TNC-Female
51 = N-Male
61 = N Female
71 = BNC-Male
81 = BNC-Female

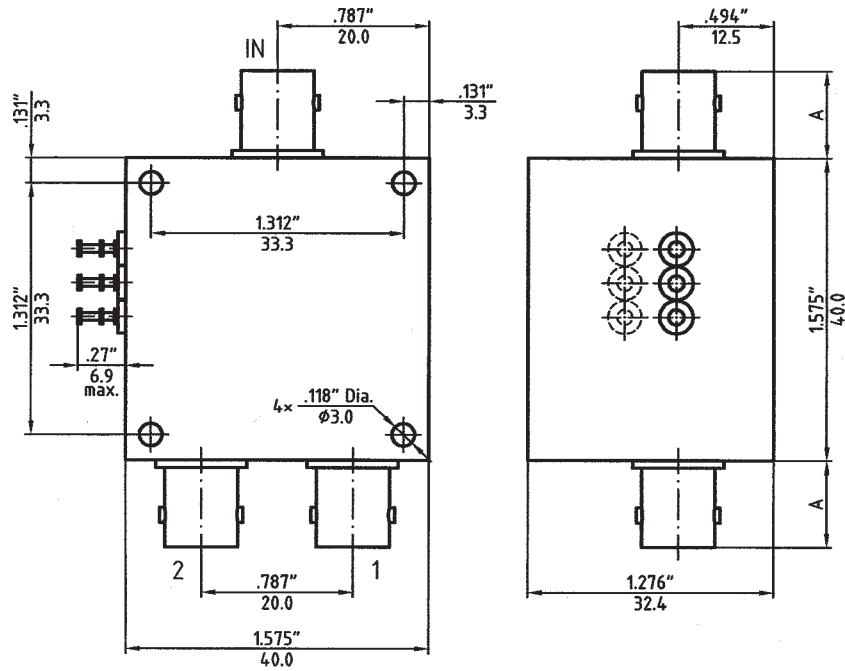
Connectors 75 Ohms

A1 = 1.6/5.6-Male
A2 = 1.6/5.6-Female
7B = BNC-Male
8B = BNC-Female
7N = N-Male
8N = N-Female

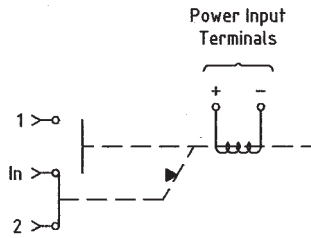
RF Performance

Frequency	DC - 0.5 GHz	0.5 - 1.0 GHz	1.0 - 2.0 GHz	2.0 - 3.0 GHz
VSWR (maximum)	1.20 : 1	1.30 : 1	1.40 : 1	1.50 : 1
Insertion Loss (maximum)	0.2 dB	0.4 dB	0.5 dB	0.6 dB
Isolation (minimum)	70 dB	60 dB	50 dB	40 dB

* If you need different connectors at the Input/Output, a special part number will be assigned.

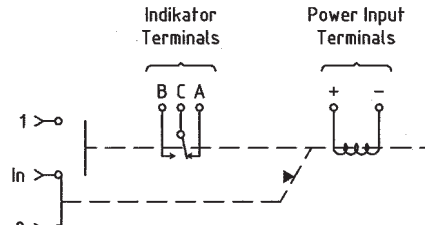


**SPDT, Port Configuration/Housing Style C
(unused ports are terminated)**



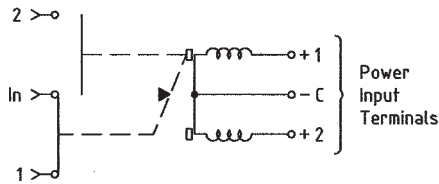
Failsafe, SPDT

Position	RF-Continuity
De-Energized	IN - 2
Energized	IN - 1



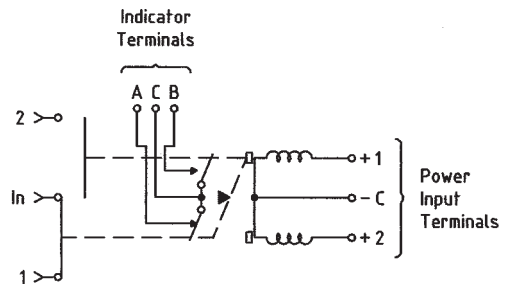
Failsafe, SPDT with Indicator

Position	RF-Continuity	Indicator
De-Energized	IN - 2	A - C
Energized	IN - 1	B - C



Latching, SPDT

Position	RF-Continuity	Voltage
1	IN - 1	+1 - C
2	IN - 2	+2 - C



Latching, SPDT with Indicator

Position	RF-Continuity	Voltage	Indicator
1	IN - 1	+1 - C	A - C
2	IN - 2	+2 - C	B - C

Multi - Through Switches



Description:

The SPNT switch is a broadband electromechanical coaxial switch, designed to switch microwave signals from one common port to anyone of 3, 4, 5, 6 or more ports. Overall size has been optimized for minimum spacing of N connectors and the switch is designed for 50 or 75 Ohms transmission line systems, respectively.

Multi - Through Switches Ordering Information

F L	A B C	No. of Inputs	No. of Outputs	0 R	A 0	E L N	0 Z	B C D	E F G	03 04 05 11	21 31 41 51	61 71 81	A1 A2 7B 8B	7N 8N
F=Fail-safe L=Latching	A <small>Port configuration/ housing style for SP3T.</small>	1	N <small>Please specify No. of outputs.</small>	0 = without indicators R = with indicators	A = unused ports are terminated 0 = unused ports are not terminated		Power Supply E = 5 V L = 12 V N = 24 V 0 = 15 V Z = 26 V	Frequency Range B = 0.2 GHz C = 0.5 GHz D = 1.2 GHz E = 1.5 GHz F = 2.0 GHz G = 3.0 GHz		Connectors 50 Ohms Connectors 75 Ohms		Explanation of Connector codes as per Table below.*		

Specifications

RF Contacts	Break before make
Actuator Voltage	5, 12, 15, 24 and 26 VDC
Actuator Current	Fail-safe: { Depending on voltage and configuration, Latching: { please refer to the specific data sheet.
Switching Time	10 msec. maximum at nominal voltage
Weight	Depending on housing/connector configuration
Temperature Range	-50°C to +60°C
Life	10 ⁵ cycles
RF Power Handling	5 Watts
Optional Features	<ul style="list-style-type: none"> - Indicator Circuits - Special Actuator Voltages - TTL Compatible Drivers - Arc Suppression Diodes - Power Connectors - Internal Terminations

Connectors 50 Ohms

03 = 1.4/4.4
04 = 1.8/5.6-Female
05 = 1.8/ 5.6-Male
11 = SMA-Male
21 = SMA-Female
31 = TNC-Male
41 = TNC-Female
51 = N-Male
61 = N Female
71 = BNC-Male
81 = BNC-Female

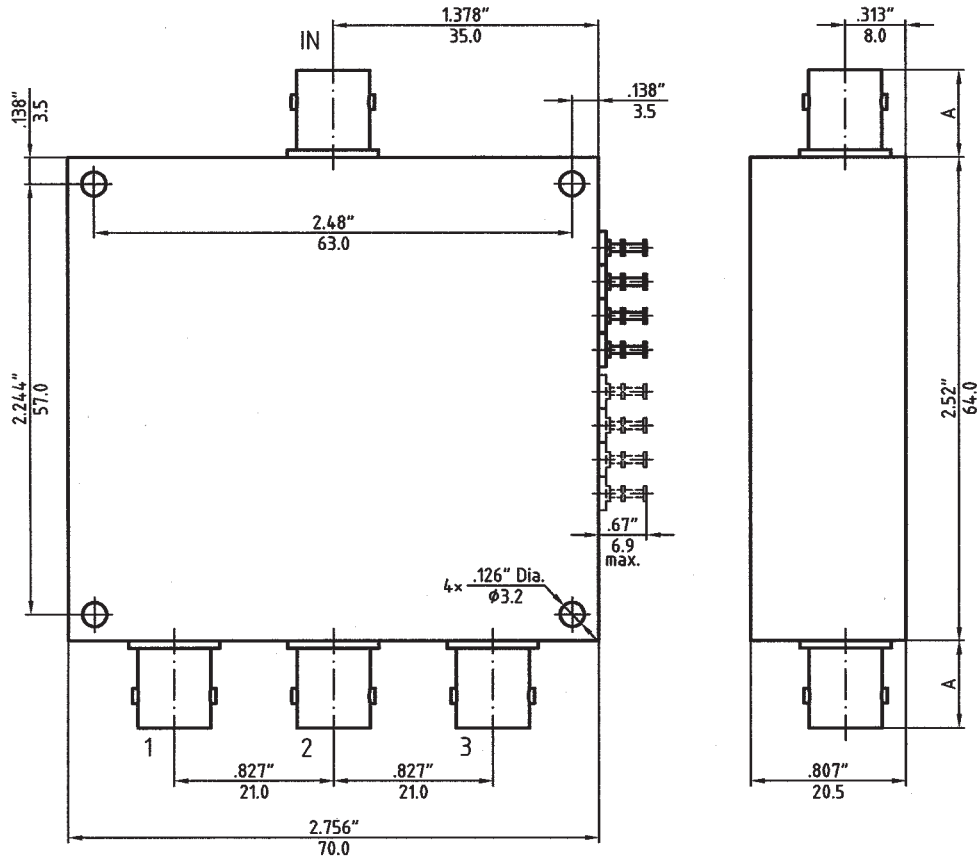
Connectors 75 Ohms

A1 = 1.6/5.6-Male
A2 = 1.6/5.6-Female
7B = BNC-Male
8B = BNC-Female
7N = N-Male
8N = N-Female

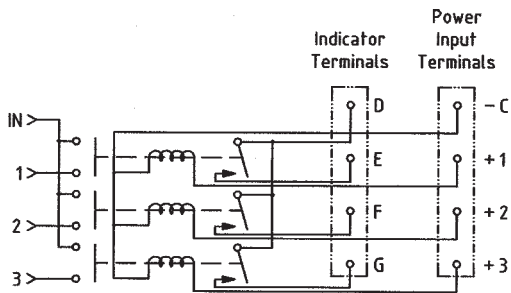
RF Performance

Frequency	DC - 0.5 GHz	0.5 - 1.0 GHz	1.0 - 2.0 GHz	2.0 - 3.0 GHz
VSWR (maximum)	1.20 : 1	1.30 : 1	1.40 : 1	1.50 : 1
Insertion Loss (maximum)	0.2 dB	0.4 dB	0.5 dB	0.7 dB
Isolation (minimum)	70 dB	60 dB	50 dB	40 dB

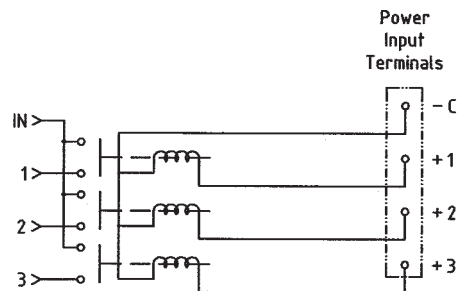
* If you need different connectors at the Input/Output, a special part number will be assigned.



SP3T, Port Configuration/, Housing Style A



Latching, SP3T with Indicator



Latching, SP3T

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Transfer Switches



Description:

The transfer switch is designed for use in 50 Ohms and 75 Ohms coaxial transmission lines respectively, operating over frequencies, ranging from DC to 3.0 GHz. The switch is designed for minimum size, compatible with N connector spacing.

Transfer Switches Ordering Information

F L	A	No. of Inputs	No. of Outputs	0 R	T	E L N	0 Z	B C D	E F G	03 04 05 11	21 31 41 51	61 71 81	A1 A2 7B 8B	7N 8N
F=Fail-safe L=Latching	A <small>Port configuration/ housing style.</small>	2	2	0 = without indicators R = with indicators	T	Power Supply E = 5 V L = 12 V N = 24 V 0 = 15 V Z = 26 V		Frequency Range B = 0.2 GHz C = 0.5 GHz D = 1.2 GHz E = 1.5 GHz F = 2.0 GHz G = 3.0 GHz		Connectors 50 Ohms Connectors 75 Ohms	Explanation of Connector codes as per Table below.*			

Specifications

RF Contacts	Break before make
Actuator Voltage	5, 12, 15, 24 and 26 VDC
Actuator Current	Fail-safe: { Depending on voltage and configuration, Latching: { please refer to the specific data sheet.
Switching Time	10 msec. maximum at nominal voltage
Weight	Depending on housing/connector configuration
Temperature Range	-50°C to +60°C
Life	10 ⁵ cycles
RF Power Handling	5 Watts
Optional Features	<ul style="list-style-type: none"> - Indicator Circuits - Special Actuator Voltages - TTL Compatible Drivers - Arc Suppression Diodes - Power Connectors - Internal Terminations

Connectors 50 Ohms

03 = 1.4/4.4
04 = 1.8/5.6-Female
05 = 1.8/ 5.6-Male
11 = SMA-Male
21 = SMA-Female
31 = TNC-Male
41 = TNC-Female
51 = N-Male
61 = N Female
71 = BNC-Male
81 = BNC-Female

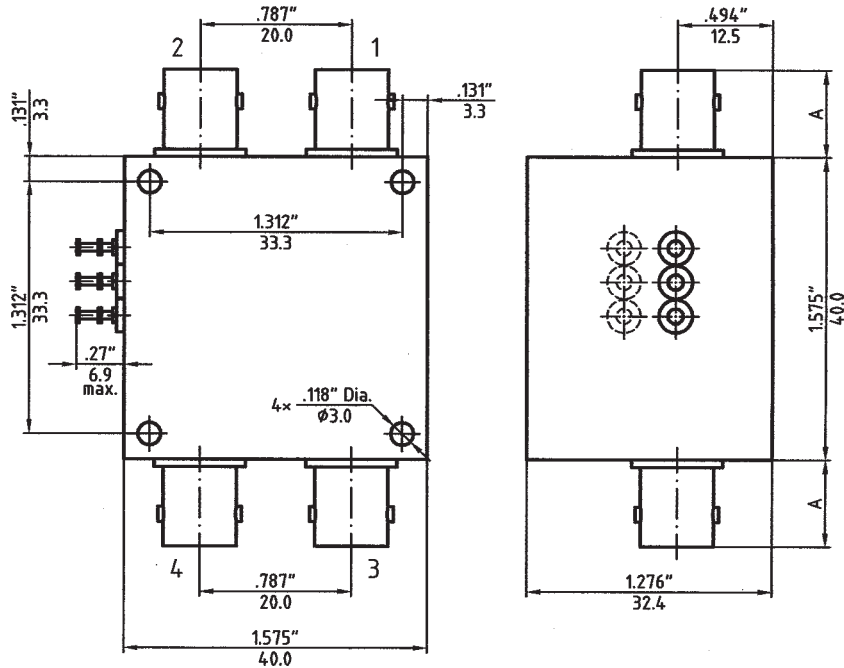
Connectors 75 Ohms

A1 = 1.6/5.6-Male
A2 = 1.6/5.6-Female
7B = BNC-Male
8B = BNC-Female
7N = N-Male
8N = N-Female

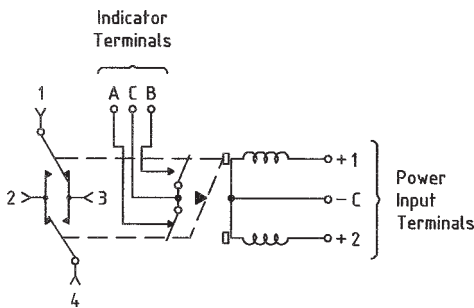
RF Performance

Frequency	DC - 0.5 GHz	0.5 - 1.0 GHz	1.0 - 2.0 GHz	2.0 - 3.0 GHz
VSWR (maximum)	1.20 : 1	1.30 : 1	1.40 : 1	1.50 : 1
Insertion Loss (maximum)	0.2 dB	0.4 dB	0.5 dB	0.6 dB
Isolation (minimum)	70 dB	60 dB	50 dB	40 dB

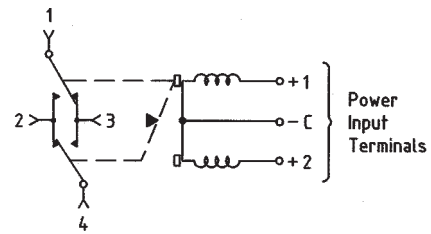
* If you need different connectors at the Input/Output, a special part number will be assigned.



Transfer Switch, Port Configuration/Housing Style A



Latching, Transfer with Indicator



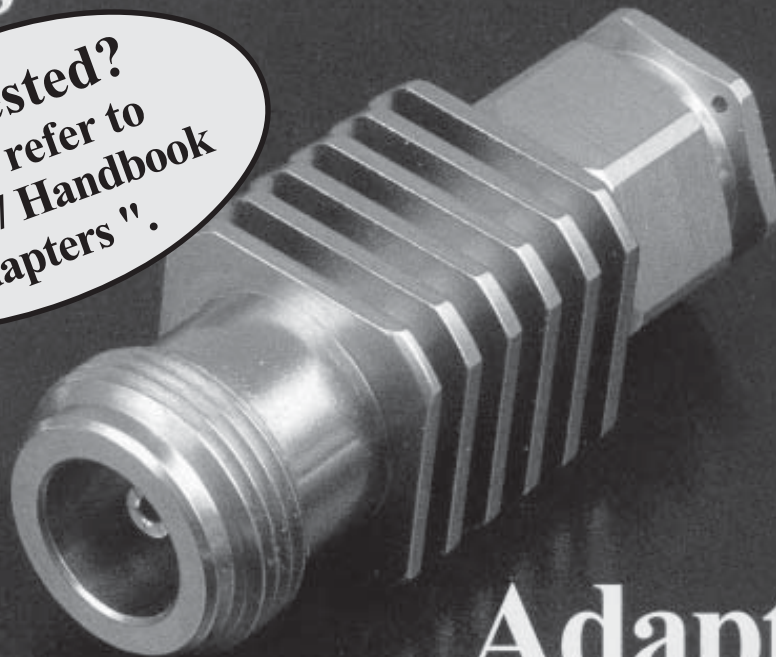
Latching, Transfer

Position	RF-Continuity	Voltage	Indicator	Position	RF-Continuity	Voltage	Indicator
1	1 - 3 2 - 4	+1 - C	A - C	1	1 - 3 2 - 4	+1 - C	A - C
2	1 - 2 3 - 4	+2 - C	B - C	2	1 - 2 3 - 4	+2 - C	B - C

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High Power

**Interested?
Please refer to
"The '97 Handbook
Adapters".**



Adapters

High Power Adapters are not only designed for excellent Heat Dissipation, but also for Altitude and Temperature. Our Designs are state-of-the-art, engineered to perfection!

Please ask for our Products in the Frequency Range of DC to 50 GHz:

Adapters, ANA Test Cables, Antennas, Attenuators, Blind Mate Connectors, Circulators, CDM-Components, Connectors (RF), Couplers, Custom Components, DC-Block Connectors & Adapters, Gain-Equalizers, Flexible Cable Assemblies, Isolators, Limiters, Mismatches, Multi Pin Connectors, Phase Shifters, Phase Stable Cable Assemblies, Precision Terminations, Push-On Connectors & Adapters, Semi Rigid Cable, Switches, Waveguide Components, Waveguide to Coax Adapters, etc.



Spectrum
Elektrotechnik GmbH

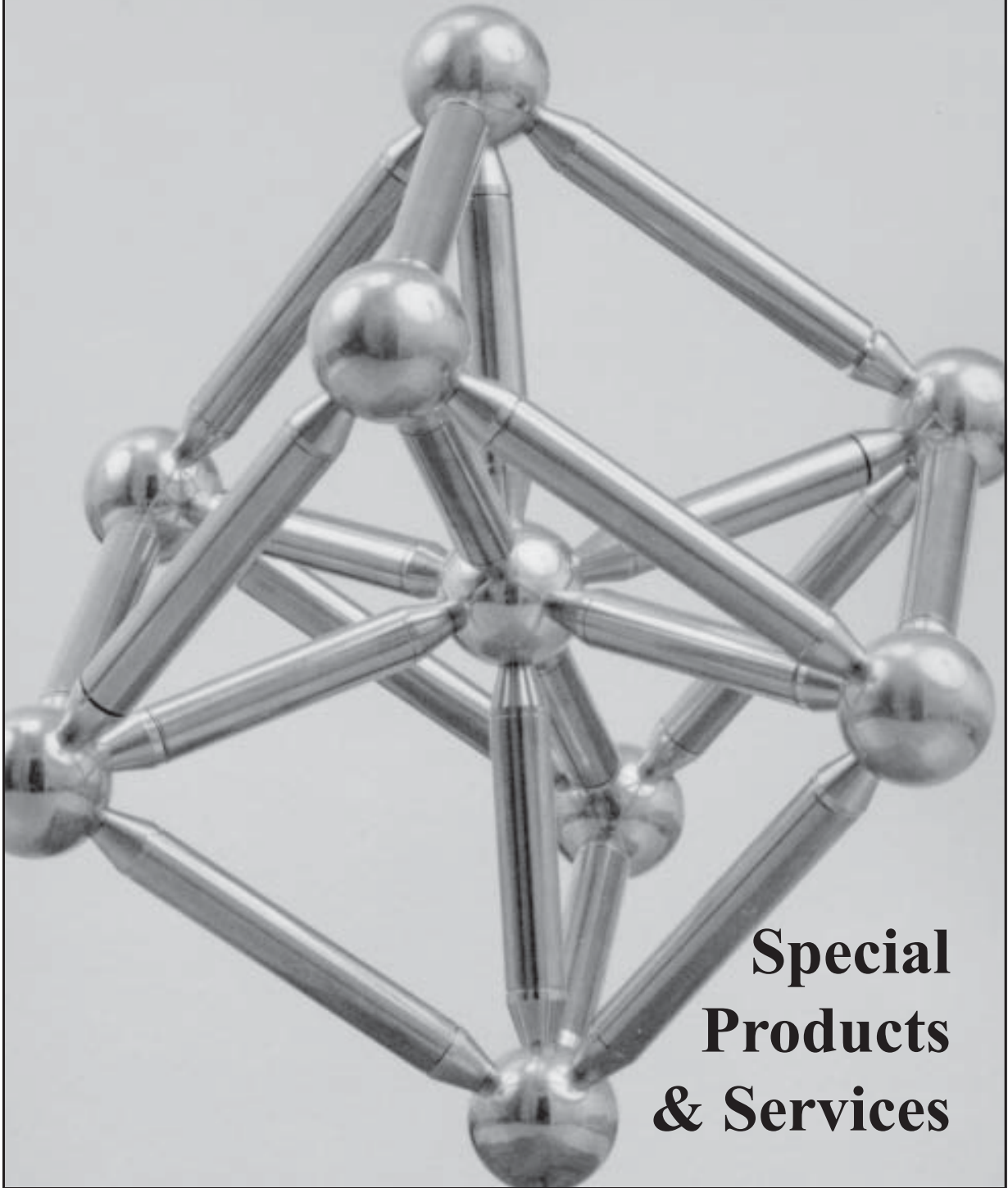
80905 Munich, Germany

P.O. Box 45 05 33

Fax: { 49 } (89) 354-804-90, Telephone: { 49 } (89) 354-804-0

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Section IX



**Special
Products
& Services**

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Design and Engineering: Spectrum Elektrotechnik GmbH is a very innovative Company. It employs a strong and successful team of experienced engineers. If your application requires a product that is not available as standard, Spectrum Elektrotechnik GmbH is the Company to contact. Our engineers are ready and willing and capable to listen to your problem and they will try their best to propose something that will fit your needs perfectly. There is also a possibility that we may have solved already a similar problem for somebody else and that we have a solution available, almost off the shelf.

Following a few examples of areas where our engineering staff has proposed and designed and manufactured hardware to the customers requirements, or has developed successfully Products to widen and strengthen our Product Range:

The Cable Assembly Group: Designing and manufacturing of Low Loss Cable Assemblies, Extra Light Weight Assemblies, Phase & Amplitude Matched Cable Assemblies, High Velocity and Thermal Stable Dielectrics, Delay Lines, etc.

The Connector Group: Designing and manufacturing successfully new Connector Series, e.g. of Types SBX, SBY and SPM, connectors that were not available at all with the physical and electrical performance as needed for specific programs.

Adapters for special applications were designed to fit exactly the customer's needs, mechanically and electrically.

A whole new Product Line was developed and successfully introduced to the market: the PUSH-ON Connectors and Adapters for series 3.5mm, K*, SMA, N and TNC, using 50 Ohms impedance, and for F, N and TNC as well, using 75 Ohms impedance.

The Component Group: Besides the Standard Product Lines, Spectrum Elektrotechnik GmbH offers Engineering and Manufacturing Services, to design and manufacture Components exactly to Customer's Specification. Whatever cannot be found in anybody else's catalog, Spectrum Elektrotechnik GmbH is definitely worthwhile to contact. There is even always a possibility that a similar product has already been designed for somebody else.

The Table to the right shows the areas where Spectrum Elektrotechnik GmbH has successfully designed and manufactured products to customer specifications. On pages 108 through 146 detailed information will be given on these components.

Process Engineering: This Group has been developing tools and machines that are needed in manufacturing but were not available on the market as standard. Currently the design, manufacturing and testing of an Automatic Cable Cutting and Stripping Machine has been completed and the machine has been introduced to the market as CNCA-700.

Quick Response Manufacturing: The Quick Response Manufacturing is another good example for the commitment to providing excellent Customer Service. The Quick Response Group was implemented to react immediately to customer's needs. Sometimes Products will be shipped within 24 hours. All Products manufactured in the Quick Response Area will meet the same Quality Standards as all the other products, they are submitted to the same inspection.

Product	Please refer to page(s):
Adapter Sets	108 - 109
Antennas	110 - 111
Blind Mate Connectors	112 - 113
Calibration Kits	114 - 115
Circulators & Isolators	128 - 129
Couplers	124 - 125
Custom Connectors/Adapters	118 - 119
Delay Lines	120 - 121
Detectors	122 - 123
Directional Couplers	124 - 125
Impedance Transformers	126 - 127
Interface Gauges	116
Isolators & Circulators	128 - 129
Lightening Surge Suppressors	130 - 131
Limiters	132 - 133
Phase Stable Assemblies	134 - 135
Precision Mismatches	136 - 137
PUSH - ONs	138 - 139
RF-Multipin Connector SQ - 8	140 - 141
Rotary Joints	142 - 143
Supercomponents	144 - 145
Torque Wrenches	117

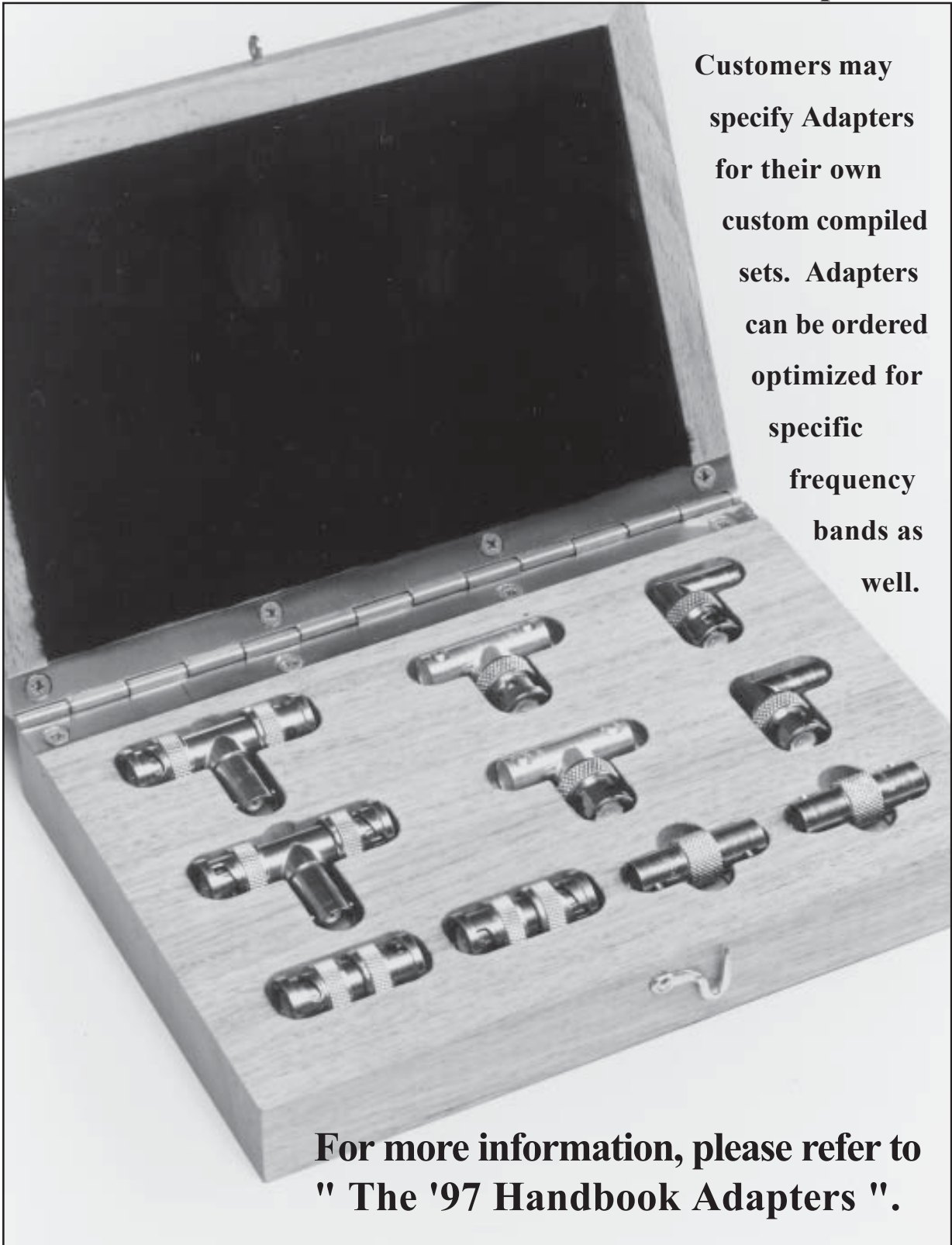
Adapter Sets



Spectrum Elektrotechnik GmbH offers a standard range of precision adapter sets. Each set comprises a commonly used grouping of series and inter-series adapters. Each adapter within any set is 100% tested, and ensures low reflection and optimum phase performance over its full frequency range. To enable the user to maintain these quality adapters in pristine condition, they are supplied in a nicely finished wooden case.

Customers can also specify adapters for their own custom compiled sets. For details please call your Spectrum Representative.

<p>Between Series Kit 7mm, consisting of the following Precision Adapters: SET7-MINI-S1</p> <p>1 Adapter straight 7 mm to 2.4 mm-Female: P/N 8001-HF90-02 1 Adapter straight 7 mm to 2.4 mm-Male: P/N 8001-HM90-02 1 Adapter straight 7 mm to K*-Female: P/N 8001-KF90-02 1 Adapter straight 7 mm to K* -Male: P/N 8001-KM90-02 1 Adapter straight 7 mm to 3.5-Female: P/N 8001-9092-02 1 Adapter straight 7 mm to 3.5-Male: P/N 8001-9091-02 1 Adapter straight 7 mm to SMA-Female: P/N 8001-2190-02 1 Adapter straight 7 mm to SMA-Male: P/N 8001-1190-02</p>	<p>Between Series Kit Type N, consisting of the following Precision Adapters: SETN-MINI-S1</p> <p>1 Adapter straight N-Fem. to 3.5 mm-Fem.: P/N 8002-6192-02 1 Adapter straight N-Fem. to 3.5 mm-Male: P/N 8002-6191-02 1 Adapter straight N-Male to 3.5 mm-Fem.: P/N 8002-5192-02 1 Adapter straight N-Male to 3.5 mm-Male: P/N 8002-5191-02 1 Adapter straight N-Female to SMA-Fem.: P/N 8001-2161-02 1 Adapter straight N-Female to SMA-Male: P/N 8001-1161-02 1 Adapter straight N-Male to SMA-Fem.: P/N 8002-2151-02 1 Adapter straight N-Male to SMA-Male: P/N 8002-1151-02</p>
<p>Between Series Kit 7mm, consisting of the following Precision Adapters: SET7-MINI-S2</p> <p>2 Adapter straight 7 mm to 3.5-Female: P/N 8003-9092-02 2 Adapter straight 7 mm to 3.5-Male: P/N 8003-9091-02 2 Adapter straight 7 mm to SMA-Female: P/N 8001-2190-02 2 Adapter straight 7 mm to SMA-Male: P/N 8001-1190-02</p>	<p>Between Series Kit BNC, consisting of the following Precision Adapters: SETB-TSMA-S1</p> <p>1 Adapter straight BNC-Fem. to SMA-Fem.: P/N 8001-2181-02 1 Adapter straight BNC-Fem. to SMA-Male: P/N 8001-1181-02 1 Adapter straight BNC-Male to SMA-Fem.: P/N 8001-2171-02 1 Adapter straight BNC-Male to SMA-Male: P/N 8001-1171-02</p>
<p>Between Series Kit 7mm, consisting of the following Precision Adapters: SET7-TNCN-S1</p> <p>2 Adapter straight 7 mm to TNC-Female: P/N 8002-4190-02 2 Adapter straight 7 mm to TNC-Male: P/N 8002-3190-02 2 Adapter straight 7 mm to N-Female: P/N 8001-6190-02 2 Adapter straight 7 mm to N-Male: P/N 8001-5190-02</p>	<p>In-Series Kit Type SMA, consisting of the following Precision Adapters: SETS-TSMA-S1</p> <p>1 Adapter straight SMA-Fem. to SMA-Fem.: P/N 8001-2121-02 1 Adapter straight SMA-Fem. to SMA-Male: P/N 8001-1121-02 1 Adapter straight SMA-Male to SMA-Male: P/N 8001-1111-02 1 Adapter radius angle SMA-Fem. to SMA-Fem.: P/N 8091-2121-02 1 Adapter radius angle SMA-Fem. to SMA-Male: P/N 8091-1121-02 1 Adapter radius angle SMA-Male to SMA-Male: P/N 8091-1111-02</p>
<p>Between Series Kit 7mm, consisting of the following Precision Adapters: SET7-UNIV-S1</p> <p>1 Adapter straight 7 mm to 3.5 mm-Female: P/N 8001-9092-02 1 Adapter straight 7 mm to 3.5 mm-Male: P/N 8001-9091-02 1 Adapter straight 7 mm to SMA-Female: P/N 8001-2190-02 1 Adapter straight 7 mm to SMA -Male: P/N 8001-1190-02 1 Adapter straight 7 mm to TNC-Female: P/N 8002-4190-02 1 Adapter straight 7 mm to TNC-Male: P/N 8002-3190-02 1 Adapter straight 7 mm to N-Female: P/N 8001-6190-02 1 Adapter straight 7 mm to N-Male: P/N 8001-5190-02</p>	<p>In-Series Kit, Type N, consisting of the following Precision Adapters: SETN-TYPN-S1</p> <p>2 Adapter straight N-Female to N-Female: P/N 8001-6161-02 2 Adapter straight N-Female to N-Male: P/N 8001-5161-02 2 Adapter straight N-Male to N-Male: P/N 8001-5151-02</p>
<p>Between Series Kit N-TNC, consisting of the following Precision Adapters: SETN-TTNC-S1</p> <p>2 Adapter straight N-Female to TNC Fem.: P/N 8001-4161-02 2 Adapter straight N-Female to TNC Male: P/N 8001-3161-02 2 Adapter straight N-Male to TNC Female: P/N 8001-4151-02 2 Adapter straight N-Male to TNC Male: P/N 8001-3151-02</p>	<p>In-Series Kit Type TNC, consisting of the following Precision Adapters: SETT-TTNC-S1</p> <p>2 Adapter straight TNC-Fem. to TNC Fem.: P/N 8001-4141-02 2 Adapter straight TNC-Fem. to TNC Male: P/N 8001-3141-02 2 Adapter straight TNC-Male to TNC Male: P/N 8001-3131-02</p>
<p>Between Series Kit TNC-SMA, consisting of the following Precision Adapters: SETT-TSMA-S1</p> <p>2 Adapter straight TNC Fem. to SMA-Fem.: P/N 8001-2141-02 2 Adapter straight TNC Fem. to SMA-Male: P/N 8001-1141-02 2 Adapter straight TNC Male to SMA-Fem.: P/N 8001-2131-02 2 Adapter straight TNC Male to SMA-Male: P/N 8001-1131-02</p>	<p>How to order your Personal Set:</p> <p>Please use the temporary P/N: SET-PERS, and specify all the Adapters you want to include in your Set. The individual Kit will be showing your name plate, identifying your own compiled Set.</p>



Customers may specify Adapters for their own custom compiled sets. Adapters can be ordered optimized for specific frequency bands as well.

For more information, please refer to " The '97 Handbook Adapters ".

INTRODUCTION: Antennas are employed to couple electromagnetic energy between free space propagation and the energy received or transmitted as a guided wave by a radar system. Antenna dimensions of several wavelengths may be needed to confine an adequate amount of energy.

Application: Most antennas are used to serve as both, transmitters and receivers of microwave systems. Most systems require an antenna that tends to concentrate the transmitted energy into a small solid angle, or to receive energy from a specific direction.

Antenna Gain: The ability of an antenna to concentrate energy in a particular direction or to be more sensitive to energy incident from a specific direction is described in terms of the antenna gain. Denoted only as the gain, the exact definition would be the power gain of an antenna, which includes losses associated with the antenna, such as ohmic and RF heating.

Antenna Radiation Pattern: The spatial distribution of energy when plotted on a relative basis is called the antenna radiation pattern and it is a measure of the power per unit area, also called the power pattern. When measuring the unit per solid angle in a given direction, it is called the radiation intensity pattern.

Average Power Handling: This is the maximum allowable power to which the antenna can be subjected to without suffering permanent damage.

Connectors: Antennas can be supplied with almost any connector or waveguide configuration, supposing that frequency range and power level are within the connector/waveguide limits.

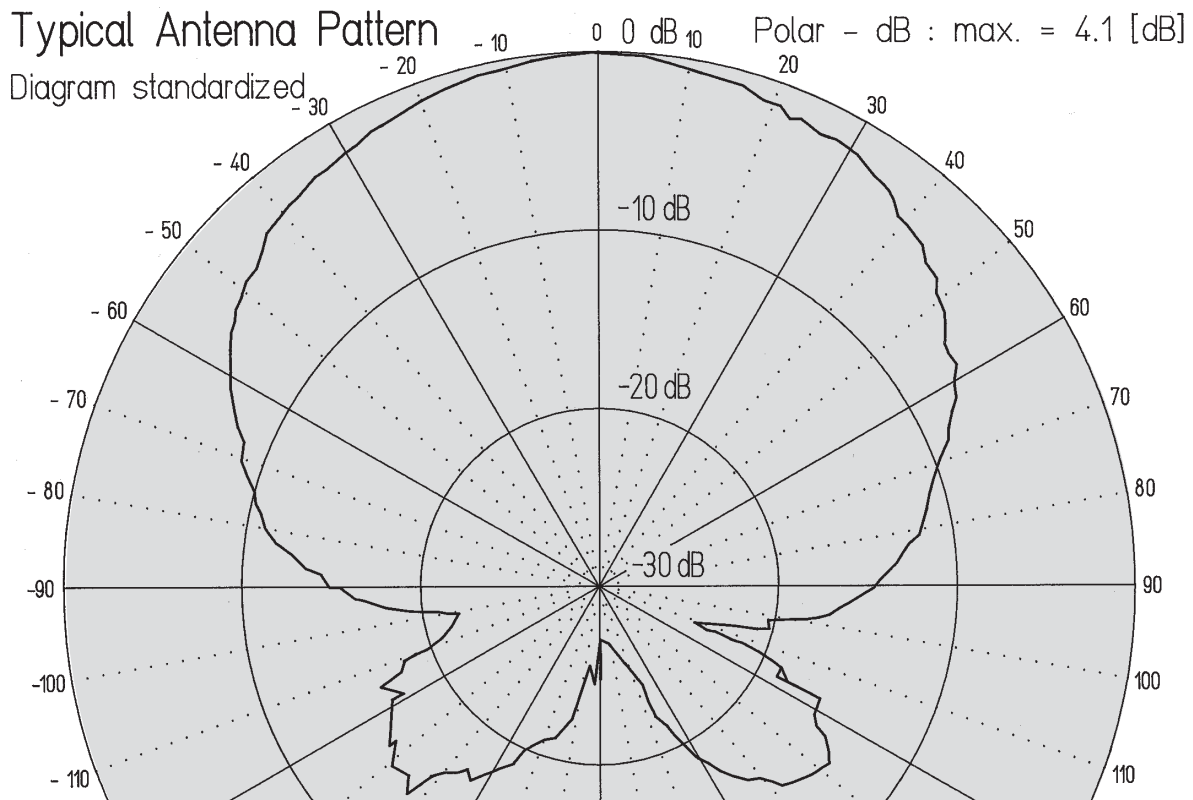
Custom Designs: Spectrum Elektrotechnik GmbH has been supplying only antennas that are designed to special requirements. At the time being the company does not compete with standard products that are available from various suppliers.

Frequency and Bandwidth: The frequency and bandwidth depend on many parameters, the type and physical structure, dimensions and materials of the antenna, the gain, beam width, polarization, radome, material, shape, etc.

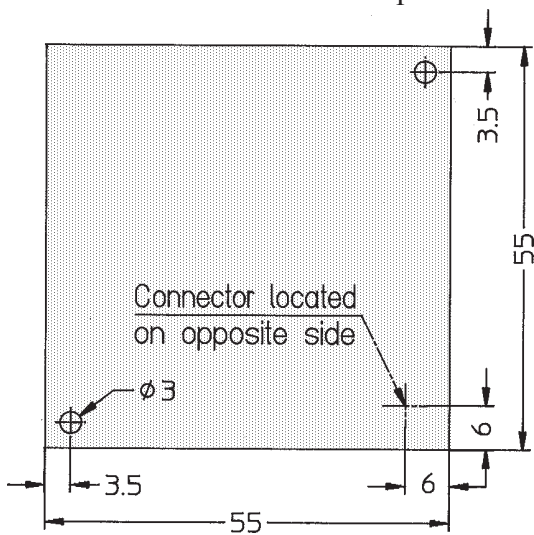
Operating Temperature Range: The temperature range is usually very wide, especially for outdoor applications.

Polarization: The direction of the polarization is defined as the direction of the electric field vector. The principal planes of the antenna pattern are associated with a linearly polarized component of the electric field and are commonly designated as horizontal or vertical polarizations, so that the antenna patterns are specified as being either horizontal or vertical patterns. For circular polarization the electric field rotates at a frequency equal to the frequency of the propagating wave, e.g. right handed when the direction of rotation of the electric-field vector is clockwise when viewed as a receding wave away from the antenna.

VSWR: VSWR is the ratio of the reflected signal and the incident signal, when looking into the antenna from system side. The VSWR for receive and transmit of an antenna may be different.



The Planar Antenna has been designed for OEM - Applications and is operating in the 2.4 GHz Band. The small dimensions and the rugged construction of the device are ideally suited for all applications regarding Wireless Telecommunication such as LAN, PBXs, PCS, PCN, Laptops, etc. The unique design utilizes a board construction that allows lowest cost at high volume. The Antenna can be optimized for any frequency in the ISM band.



Specification	
Model-No. AN-2424-21	
Frequency Range	2.45 GHz
Antenna Gain	3.5 dBi
Polarization	linear
Dimensions	55mm * 55mm
Connector	SMA female

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INTRODUCTION: Regular connectors have to be aligned properly for mating purposes. Whenever the connecting parts are fully visible, there is no problem in alignment. But putting connectors together, without seeing and feeling them, is usually a challenge and always almost impossible, if they are not designed for such purpose.

With Blind Mate Connectors there is at least one of the two mating connectors designed to move or shift in location for self aligning, proper and safe mating purposes.

Frequency: Blind Mate Connectors do usually operate over a wide frequency range. But the bigger the connector series, the lower the upper frequency limit becomes, as known by the law of physics. The SBX works to 8.0 GHz, and it can take a tremendous lot of power. The SBY operates safely to 12.0 GHz, the BMA to 18.0 GHz, and the SMP to 40.0 GHz.

VSWR: VSWR is the ratio of the reflected signal and the incident signal, caused by reflections and discontinuities within the circuit, as no design is perfect, and manufacturing tolerances do not allow perfect devices anyway. But it is the fact that the Blind Mate Connection has a much lower VSWR, compared to the VSWR as seen on most cable assemblies.

Operating Temperature Range: The standard temperature range is normally specified from -54°C to $+125^{\circ}\text{C}$. Depending on the application, the temperature range can be widened by using special design techniques and selecting appropriate materials and dielectrics.

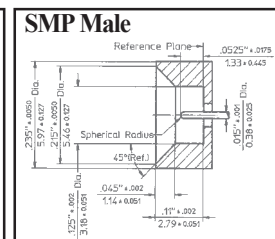
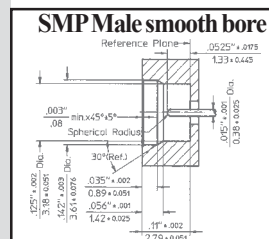
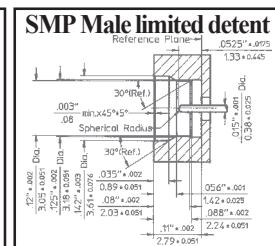
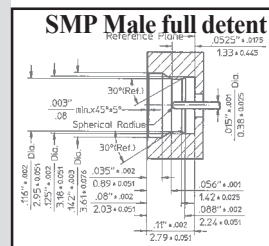
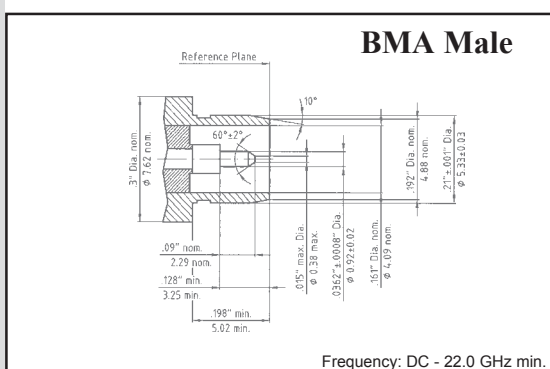
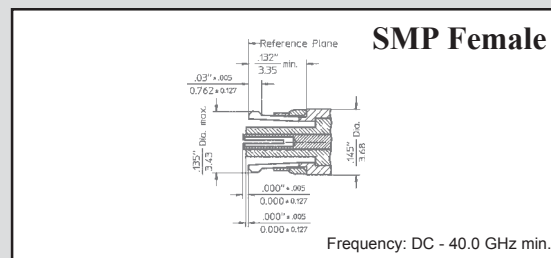
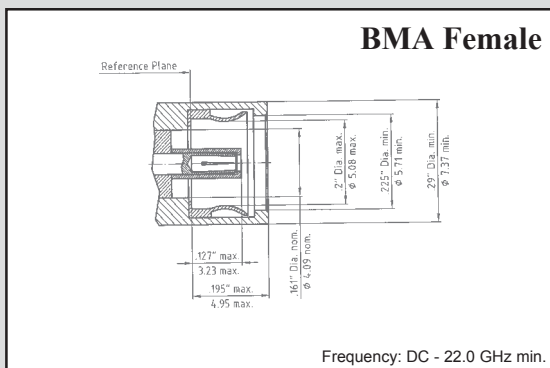
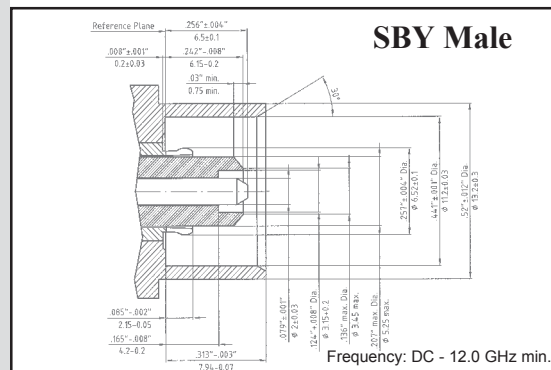
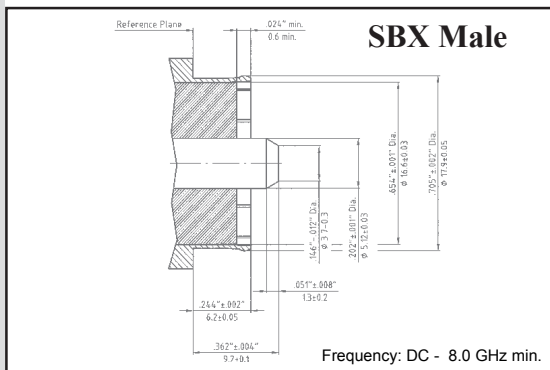
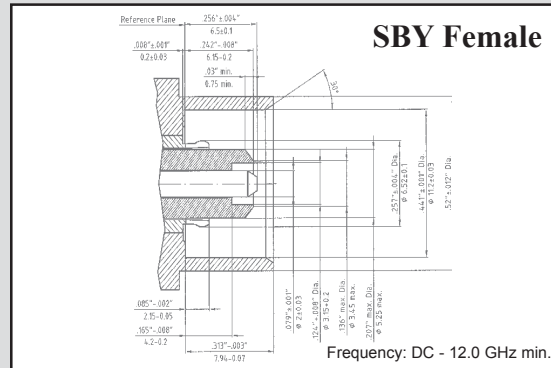
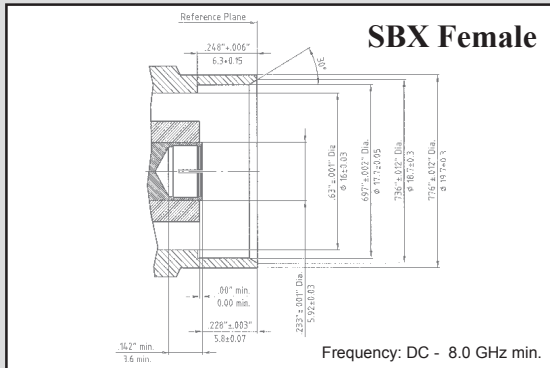
Average Power Handling: This is the maximum allowable CW power to which the unit can be subjected to without suffering permanent damage.

Standard Connectors: The complete line of Blind Mate Connectors will be shown in the "The '98 Handbook Quick Connections". The " '97 Handbook Adapters" lines out a number of in-series and between-series adapters and references complete dimensions of the interfaces.

Custom Designs: Spectrum Elektrotechnik GmbH will always be designing and supplying connectors to suit particular requirements, such as low VSWR, unique mechanical outline, unusual mounting, better power dissipation, characteristic impedance other than 50 Ohms, rough environment, etc., etc. If a special unit is needed, it is recommended to contact our sales force or the engineering department, as there is always a good chance that a similar problem was already solved for somebody else, or only a minor change is needed to an existing design in order to meet the new requirement.

Applications: Blind Mate Connectors are used to interconnect components, replacing cable assemblies. The advantages are: lower cost, less insertion loss and a more rugged construction. Blind mate connectors are often used on the back of drawers as well.

Blind Mate Connectors are advanced connections for the newer systems. Full details, interface mating dimensions and product information are shown in : " The '97 Handbook Adapters", " The '98 Handbook Quick Connections" and " The '98 Handbook Microwave Connectors" .



lcomp66.ppt6

INTRODUCTION: Vector Network Analyzers are needed to accurately determine the RF Characteristics of Microwave Components. For true and accurate measurement the Network Analyzers have to be calibrated with known standards. As Network Analyzers have the ability to reduce error terms to negligible values, they depend on the quality and the integrity of the Calibration Standards used.

Spectrum Elektrotechnik GmbH produces a comprehensive line of Coaxial Calibration Kits, incorporating most accurate and stable calibration standards. A true and precise evaluation of the performance of the device under test can therefore be ensured.

Methodology: Two different techniques are commonly used for coaxial calibration, the open-short-load-through calibration technique and the Through-Reflective-Line (TRL), also known as Line-Reflective-Line (LRL).

Open-Short-Load-Through: Calibration Standards, using this method, do consist of high precision male and female Opens, Shorts and fixed wideband Loads. As an option sliding loads can be supplied.

Through-Reflective-Line: These Calibration Kits consist of high precision shorts and ideal through lines.

Calibration Kit Components: The most important Components of the Calibration Kits are the Calibration Standards. Discs will be supplied, showing the data on the properties of the Calibration Standards. The discs are ready to be used on the Scalar Network Analyzers of Hewlett Packard and Wiltron.

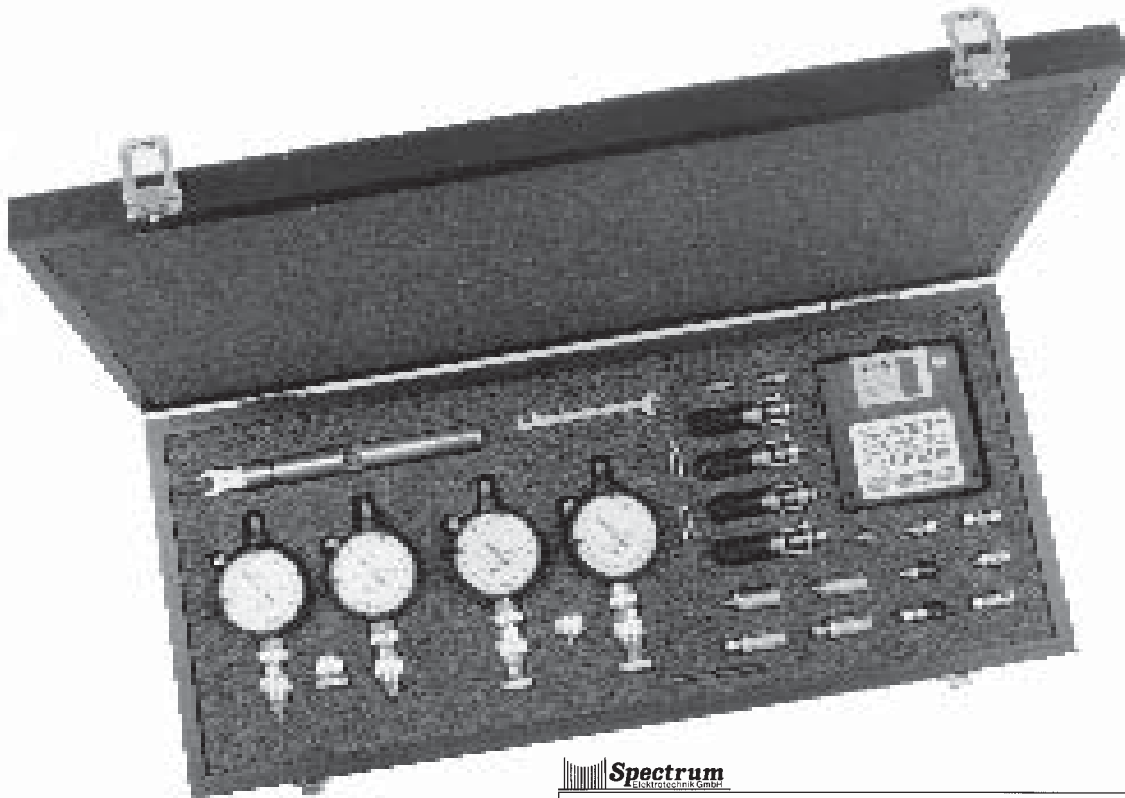
But also other components will be needed during testing and therefore be included in the Kit as well, such as precision adapters, torque wrenches, regular wrenches, as needed for any hex supplied with the components in the calibration kit. A set of precision gauges will be included, for checking the interfaces of the devices before test.

Interface Gauges: Before testing any device, the interfaces of the connectors have to be checked to ensure that they meet the appropriate specification. Protruding interfaces will damage the mating connector. Interfaces that are recessed below the allowed level will lead to useless test results.

Torque Wrench: In order to ensure accurate testing the connectors of the components under test always should be torqued for proper connection, as outlined in the applicable specifications and to avoid damaging the connectors by over torquing.

Coaxial Connector Series: Kits are available for the following connector series: 3.5mm, 7mm, K*, N, SMP and TNC. In addition calibration components have been designed and manufactured for the series BNC, C, HN and SC.

Phase Stable Test Cable Assemblies: Spectrum Elektrotechnik GmbH offers phase stable test cable assemblies, fitted with the appropriate connector on one end of the assembly to connect directly with Hewlett Packards or Wiltrons Network Analyzers, using NMD 2.4mm, 3.5mm or K*. For the other end of the cable assembly a wide variety of connectors can be selected, such as 2.4mm, 3.5mm, K*, SMP, N, TNC, etc. More information can be derived from " The '98 Handbook Test Accessories and Necessities ".



18.0 GHz SMP Calibration Kit

MODEL NO.:CSMP-WILT-18

Parts List S/N: 011

MODEL NO.:CSMP-WILT-18

Precision 18.0 GHz Calibration Kit supplied for Wiltron 360, using K*connectors.
The Calibration Kit consists of the following:

1 pce Precision Standard SMP Short female	1130-2101-02 S/N
1 pce Precision Standard SMP Open female	1130-1101-02 S/N
1 pce Precision Standard SMP Open male	1140-2102-02 S/N
1 pce Precision Standard SMP Open male	1140-1102-02 S/N
2 pcs Precs.Stand.Terminations SMP female	TE-4018-MP01
2 pcs Precs.Stand.Terminations SMP male	TE-4018-MJ01
1 pce Throughline SMP female/SMP female	8002-MPMP-02
1 pce Throughline SMP female/SMP male	8001-MJMP-02
1 pce Throughline SMP male/SMP male	8001-MJMJ-02
1 pce Interface Gauge SMP female, CC	IG-SMPF-CC01 S/N
1 pce Interface Gauge SMP female, Diel.	IG-SMPF-D001 S/N
1 pce Interface Gauge SMP male, CC	IG-SMPM-CC01 S/N
1 pce Interface Gauge SMP male, Diel.	IG-SMPM-D001 S/N
1 pce Master female	IG-SMPF-M001 S/N
1 pce Master male	IG-SMPM-M001 S/N
1 pce Torque Wrench, 0.6 Nm for SMP	WE-9109
5 pcs Regular Wrenches	7mm, 9mm, 12mm, 5/16", 11/32"
1 pce SMP Withdrawal Tool	T-6298
2 pcs I.H.W. Tool for straight connectors	2x WE-SMPL
2 pcs I.H.W. Tool for straight connectors	2x WE-SMPS
1 pce Prec. Adapter/B.M. SMPm. to K*male	8009-KMMLJ-02
1 pce Prec. Adapter/B.M. SMPm. to K*fem.	8005-KFMLJ-02
1 pce Comm. Adapter/B.N. SMPm. to K*m.	8010-KMMJ-02
1 pce Comm. Adapter/B.N. SMPm. to K*fem.	8010-KFMJ-02
1 pce Precision Adapter SMP fem. to K*male	8003-KMMP-02
1 pce Precision Adapter SMP fem. to K*fem.	8003-KFMP-02
1 pce Disc containing Calibration Properties	

ABBREVIATIONS:

B.M.: Bayonet Mount, used to hold in place during testing the SMP right angle.
CC: Center Contact
Diel.: Dielectric
I.H.W.: Insertion/Holding/Withdrawal

K Connector is a trademark of Wiltron Company.

Spectrum Elektrotechnik GmbH P.O. Box 45 05 33, 80905 Munich, Germany Tel. (89) 354 804-0, Fax (89) 354 804-90 (Country Code: 49)

Calibration Kits are designed and manufactured to the highest standards. A Calibration Kit should not only include the standards needed for the calibration. It is furthermore very helpful to have handy the necessary adapters, gauges and wrenches as well.

Every Calibration Kit is supplied with a parts list, identifying the individual components and their part numbers. A certificate guarantees that the calibration Kit meets the appropriate standards and requirements.



Interface Gauges: Before testing any device, the dimensions of the interfaces of the connectors should be checked, to ensure that they do meet specification. Protruding interfaces will damage the mating connector. Interfaces that are recessed below the allowed level will lead to useless test results.

Interface gauges are usually supplied in sets of 2 to 4 units, for checking the center contacts of the male and female connectors and their dielectrics for protrusion and recession. Interface gauges are available for most connector series, such as 2.4mm, 3.5mm, 7mm, N, SC, SMA, TNC, etc. More information can be found in "The '98 Handbook Test Necessities and Accessories " .



Torque Wrenches: In order to ensure accurate testing of components, the connectors always should be torqued for optimum connection, as outlined in the applicable specifications, to avoid useless test results because of loose connectors, or from damaged connectors because of over torquing.

Torque Wrenches are available for most connector series, such as 2.4mm, 3.5mm, 7mm, N, SMA, TNC, etc. The torque wrenches may also be supplied in sets for other connector series, clearly marked and supplied in a wooden box. The customer also may specify the wrenches that are to be included in his personal box. More information can be found in "The '98 Handbook Test Necessities and Accessories".

INTRODUCTION: Spectrum Elektrotechnik GmbH offers a large variety of standard Connectors and Adapters, as shown in "The '97 Handbook Adapters " and " The '98 Handbook Microwave Connectors ".

In many applications a standard component will not fit perfectly, or maybe it cannot be used at all. It would be needed a little bit shorter or longer, or narrower, or wider, or would have to meet special electrical requirements, such as higher power or better return loss, oretc.,

Applications: Special Connectors and Adapters are needed in state-of-the-art systems. These systems are following design criteria that are quite different to the standard scheme.

Mechanically they may be more compact, and of lighter weight, therefore cannot use some existing designs. Electrically these systems are to be of superior performance, therefore they have to meet specifications that are almost impossible, needing components to be engineered to excellence, and in detail.

Frequency: The frequency for custom designed connectors and adapters ranges is from DC to 50.0 GHz. For this frequency range complete test equipment is available.

Connector Types: Besides the connectors, meeting the standard interface specifications, such as MIL-Standards, DIN- or IEC- Specifications, Spectrum Elektrotechnik GmbH has been designing, manufacturing and introducing to the market successfully new Connector Series of Types **SBX**, **SBY** and **SPM**, connectors that were not available at all with the physical and electrical performance, as needed for applications in certain programs.

Additionally, a whole new Product Line was designed: the **PUSH-ON** Connectors and Adapters, being available in **50 Ohms** impedance for Series **7/16**, **SMA**, **N** and **TNC**. In **75 Ohms** impedance **PUSH-ON** Connectors of styles **F** and **N** were developed.

Spectrum Elektrotechnik GmbH is open for almost any engineering task. If none of the existing designs can be used, experienced engineering staff is available to develop the component that will meet exactly the requirements.

Operating Temperature Range: The normal operating temperature ranges from -54°C to $+115^{\circ}\text{C}$. For certain programs however, connectors and adapters were designed, allowing a much wider environmental temperature range.

Successful performance has been achieved at lowest temperatures of 20 K, in programs where the components in receivers, used for exploring the universe, are being cooled down to those temperatures because of noise level reasons.

In other programs the opposite was needed, environmental temperatures above 200°C . Using special design techniques and dielectrics, also these requirements were met.

VSWR: VSWR is the ratio of the reflected signal and the incident signal.

Spectrum Elektrotechnik GmbH has designed for several programs connectors and adapters showing lowest VSWR. Especially with high power components, reflections are unwanted, as the reflected power will be transformed into heat, causing even higher temperatures and consequently limiting the performance, especially when already operating at higher environmental temperatures.



These special adapters were designed to replace a semi rigid cable of 0.250" diameter. There was a major problem with the cable assembly: it could not be manufactured with repeatable performance, as the cable is quite big in diameter for its short length, therefore difficult to bend. Soldering connectors to such a short assembly is extremely difficult in addition. Using newest complex CNC machinery the outer conductor of the replacing mitre angled adapter was machined in one piece. Designing and developing components using state-of-the-art manufacturing features, results in outstanding mechanical designs with unknown electrical performance to higher frequencies.



The special connector above was developed to hook up directly to an aerial, a long whip antenna, as used on radio equipment of vehicles. For achieving superior electrical performance, it incorporates a matching circuit in the connector body. A special quick connection/disconnection mechanism was developed for this special unit.

Microwave delay devices are designed and manufactured to meet delay requirements in frequency ranges from UHF through KA-Band. Several techniques are used to achieve the delays. It is the responsibility of the design engineer to decide about the best method for delaying the signals in his particular application. The decision depends on the frequency range, the delay needed, the VSWR, the suppression of undesired signals, the size of the device and its form, and last but not least the price of the device will be an important factor.

The coaxial delay line is the classical device. The length of the delay line can easily be calculated from the propagation delay of the signal within the coaxial cable and the delay needed. Other advantages are the good electrical performance of the professional delay line, the usually fast availability and the attractive price. Disadvantages are in some cases the large size and the high insertion loss, especially for longer delays at higher frequencies.

Spectrum Elektrotechnik GmbH offers a wide variety of coaxial delay lines. All the designs use Semi-Rigid Cable, from very small diameters, such as 0.047" up to diameters of 0.250", for certain applications even bigger. The Semi-Rigid Cables are using either Solid Dielectric, or Low Density Dielectric. The advantage of the Low Density Dielectric is lower insertion loss, a wider temperature range and better performance over temperature.

All Delay Lines are made to the customer specifications: a specific delay that is needed in the applications, a minimum attenuation, a maximum return loss, a minimum change over temperature, a certain mechanical configuration and for an environment that often only allows the best.

Delay Lines Packaging Options

The delay line can be packaged in a number of different ways, such as:

- **An especially designed housing:** it can be made of any kind of material, although mostly used is aluminum excarvated.
- **19" Rack Mounting:** this is common for larger delay lines, or for applications in laboratories or test sets.
- **Spool Mounting:** this is an economical way of packaging, using a spool as supporting and mounting fixture.
- **Free Coils:** this is definitely the most inexpensive packaging, winding the delay line in a free coil and then using either tape, plastic or stainless steel ties, or just solder, to hold the delay line together.

The following Table can be used as a quick reference. Comparing the data of the different cables listed in attenuation, diameter, length and weight will allow a fast decision about which cables may be suited best in a specific application.

Dielectric	Cable P/N	Code	Outer Diameter	Attenuation dB (10 Ghz)			Phase Stability	Min. Bend Radius (mm)	Length (Nom.) (m)			Weight (grs)		
				/10ns	/50ns	/100ns			/10ns	/50ns	/100ns	/10ns	/50ns	/100ns
Low Density	421-307	05	0.085"	5.00	24.9	49.8		15.2	2.33	11.6	23.3	54	272	544
	422-700-3	-	0.085"	4.20	21.1	43.3		15.0	2.43	12.2	24.3	50	250	501
	421-069	-	0.116"	3.10	15.5	31.0	Best	17.80	2.35	11.7	23.5	82	408	816
	421-298	98	0.141"	2.40	12.0	24.0	Best	25.4	2.43	12.2	24.3	100	499	998
	422-900-3	141L	0.141"	2.24	11.2	22.4		25.4	2.43	12.2	24.3	102	508	1017
	421-336	36	0.250"	1.12	5.6	11.2	Best	50.8	2.40	12.0	24.0	327	1633	3266
	421-281	81	0.250"	1.12	5.6	11.2	Best	50.8	2.40	12.0	24.0	181	907	1814
Solid	RG-405 421-086	89	0.086"	5.22	26.10	52.2	Note "A"	5.1	2.12	10.6	21.2	45	226	454
	RG-402 421-669	69	0.141"	2.92	14.60	29.2	Note "A"	8.9	2.12	10.6	21.2	100	499	998
	RG-401 421-252	52	0.250"	1.80	9.0	18.0	Note "A"	12.7	2.12	10.6	21.2	318	1588	3175
	421-250	50	0.250"	1.80	9.0	18.0		12.7	2.12	10.6	21.2	315	1575	3150

* "A" - At higher temperatures, 21 to 120 degrees C, microporous PTFE dielectric Cable has only slightly better phase response than solid PTFE dielectric cable. However, from 21°C to -50°C microporous cable displays far superior phase response.

Quick Response Manufacturing

The Quick Response Manufacturing is another good example for the commitment to providing excellent Customer Service. The Quick Response Group was implemented to react immediately to customer's needs. Sometimes Products will be shipped within 24 hours. All Products manufactured in the Quick Response Area will meet the same Quality Standard as all the other products, they are submitted to the same inspection criteria, they are tested with the same procedures as used on standard products.

INTRODUCTION: Detectors are needed to monitor power levels of microwave signals or to identify modulation wave shapes, using one of three different semiconductor types: Tunnel Diodes, Biased Schottky Diodes and Zero Bias Schottky Diodes.

Tunnel Diode Detectors: Excellent sensitivity at zero bias, good VSWR and flat response over multi-octave bands can be named to describe the semiconductor. Tunnel detectors are preferred for CW and pulse detection at higher pulse repetition rate. They are suitable for narrow and fast pulse processing, have excellent temperature stability and are ideal for DC coupled applications. They are also in used in DLVAs (direct log video amplifiers).

Schottky Detectors: These devices have excellent sensitivity at optimum bias, and operate in an extended dynamic range of 20 dBm. They show moderate temperature stability and they are typically used for power monitoring and threshold circuits, as with AC coupled DLVAs as well.

Zero Bias Schottky Detectors: They do have good sensitivity at zero bias with an extended dynamic range. Zero Bias Schottky Detectors are very suitable for applications in power monitoring applications and in instrumentation as well.

Applications: Detectors are needed during monitoring, test and measurement, they also can be integrated in components and they are used in systems applications as well.

Connectors: Detectors are available with a large variety of connectors, meeting the appropriate standard interface specifications, such as MIL-Standards, DIN- or IEC-Specifications, etc.

Custom Designs: Spectrum Elektrotechnik GmbH has been designing and supplying special detectors to suit particular requirements in flatness, sensitivity, leakage, lower output capacitance, mechanical outline, mounting, special connector requirements, rough environment, etc., etc.

Dynamic Range: It covers the input power range from the minimum power, which is defined by the TSS, and the maximum power, which will cause the diode to burn out.

Frequency and Bandwidth: The detectors of Spectrum Elektrotechnik GmbH are designed to operate in frequency ranges of 500 MHz to 26.5 GHz. For certain applications, units may be tuned for certain criteria in narrower bands.

Flatness: The logarithmic ratio of the maximum to the minimum output voltage of the detector with constant input power over the whole specified frequency range is called the Flatness.

$$\text{Flatness (dB)} = 10 \text{ Log (Umax/Umin)}$$

K Factor: The min. ratio of output voltage versus the RF input power is specified as the Output Voltage Sensitivity. Measured is the output voltage at an open circuit with a known RF input power.

Operating Temperature Range: The temperature range applies from -54°C to +115°C for Schottky Detectors and -54°C to +125°C for Tunnel Detectors. Storage temperature will be -54°C to +125°C for all devices.

Output Voltage Sensitivity: The ratio of output voltage versus the RF input power is specified as the Output Voltage Sensitivity. Measured is the output voltage at an open circuit with a known RF input power.

Peak Power Handling: This is the maximum allowable Peak power to which the unit can be subjected to without suffering permanent damage, or without changing permanently the specified characteristics of the device. Regular Tunnel detectors can usually withstand a CW power of 17 dBm, Schottky detectors 20 dBm.

Polarity: In general detectors can be supplied with positive video output and with negative video output as well.

Square Law Range: The range where the video output power remains proportional to the square of the input signal power.

Survival Power: This is the maximum allowable peak power at 25°C, 1 microsecond pulse and 0.1% duty to which the unit can be subjected to without suffering permanent damage.

TSS: Tangential Signal Sensitivity is the amount of power required to produce an output pulse of an amplitude, which is sufficient to raise the noise fluctuation by an amount equal to the average noise level.

VSWR: The Voltage Standing Wave Ratio is measured at the signal input port of the detector.

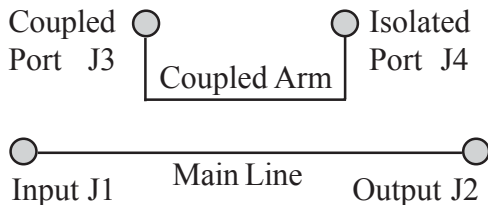
Video Bandwidth: This is the bandwidth of the video modulated signal.

Video Capacitance: The capacitance, which can be measured in parallel to the video output of the detector.

Video Resistance: The resistance which can be measured at the video output of the detector.



INTRODUCTION: Directional Couplers are Four Port devices. The design uses the coupling between two transmission lines. The distance between the main line where the energy is propagating through, and the coupling arm is a function of the energy coupled. All ports of the couplers are matched to 50 Ohms impedance.



Theoretically, the Power transmitted into port J1 is partially coupled into port J3. At port J2 the remaining power will be received. In reality however, the components behave differently: Injected Power into port J1, minus Coupled Power at Port J3, minus Insertion Loss of the Circuit, minus power reflected into port J4, equals the Output Power at port J2. An ideal coupler, would not receive power at port J4.

Main Line: The RF-Circuit between the input and output ports is called the Main Line.

Coupled Line: The transmission line into which the main signal is coupled, is called the Coupled Line. Normally one port of the coupled line is terminated with a 50 Ohms load.

Frequency: The Coupling Characteristics are limited over finite frequency bands. Using creative ideas, Spectrum Elektrotechnik GmbH has designed Directional Couplers for higher power applications, operating over wider frequency ranges of more than one octave.

Coupling: The coupled power can be 40 dB below the power introduced into the main arm, depending on the specification. It varies with frequency at a limited amount. But the variation, or ripples can usually be optimized very well.

$$\text{Coupling (dB)} = -10 \text{ Log } (P3/P1)$$

Insertion Loss: Every transmission line will cause loss, as energy will be dissipating into the circuit. A good design will offer good trade off between size of the component and its loss.

$$\text{Insertion Loss (dB)} = -10 \text{ Log } (1-P3/P1)$$

Directivity: The power ratio between isolated port and coupled port is called Directivity. Ideal would be no power at Port 4, resulting in infinite Directivity, but in actual the isolated port never will become completely power free.

$$\text{Directivity (dB)} = -10 \text{ Log } (P4/P3)$$

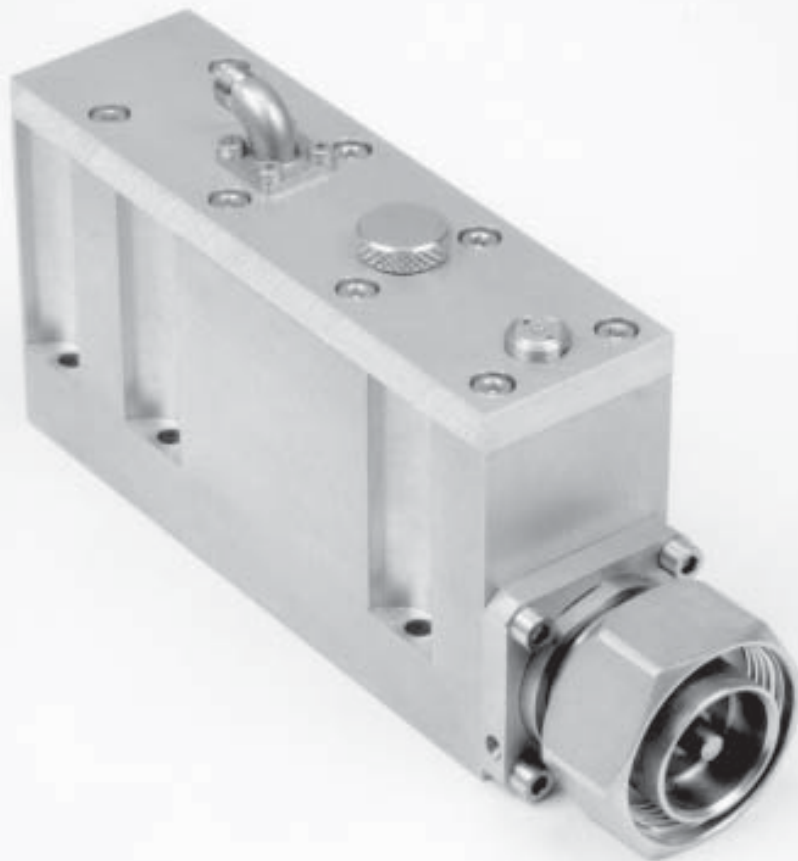
Isolation: The power ratio between port 4 and port 1 is called Isolation. Isolation is also another term to measure reflections into port 4.

$$\text{Isolation (dB)} = -10 \text{ Log } (P4/P1)$$

$$\text{Isolation (dB)} = \text{Coupling (dB)} + \text{Directivity (dB)}$$

VSWR: Every microwave component shows reflections and discontinuities within the circuit, as no design can be perfect, and manufacturing tolerances do not allow perfect designs anyway. coupled port reduces the directivity by an amount, equal to the return loss of the mismatches.

$$\text{Return Loss (dB)} = -10 \text{ Log } ((\text{VSWR}-1)/(\text{VSWR}+1))^2$$



**High Power Directional Coupler, used
in an L - Band Radar Application.**

INTRODUCTION: Impedance Transformers are passive linear coaxial components used to transform 50 Ohms impedance levels to 75 Ohms impedance levels or vice versa.

Application: Impedance Transformers are mainly used to connect components and measurement systems of different impedances. Signal sources and test systems using 50 Ohms impedances are mostly used. Some test systems may even be only available with 50 Ohms impedance. Employing an Impedance Transformer means that these 50 Ohms systems can be used for testing 75 Ohms components.

Resistance Network Impedance Transformers: These components are using a resistor network to transform from 75 Ohms to 50 Ohms or vice versa. As the resistors need to be small for integration into the coaxial circuit, and because of little reflections, the component is only specified for low power, normally 0.5 Watts, or even less. The operating frequency is only to a few hundred MHz, e.g. DC to 200 MHz. The insertion loss is high. Often the component is designed to have a voltage insertion loss of 10 dB.

Multiple Quarterwave Impedance Transformers: The unit consists of multiple sections of quarterwave length, properly cascaded for optimum performance and broad band properties. The operating bandwidths may be to 3.0 GHz with a max. insertion loss of 5 dB, an average power of 2 Watts and a peak power of 2 KW.

Inductive Impedance Transformers: These components consist of two windings, linked by a mutual magnetic field. The relationship between impedance of input and output depends on the ratio of the number of windings between primary and secondary coil. These components have low loss, but are only usable at lower frequencies. Normally the design is not used at all in coaxial Impedance Transformers.

Average Power Handling: This is the maximum allowable CW power to which the unit can be subjected to without suffering permanent damage.

Connectors: Impedance Transformers can be fitted with a number of connector styles. Of special interest are: N(50 Ohms) to N(75 Ohms), BNC(50 Ohms) to BNC(75 Ohms), TNC(50 Ohms) to TNC(75 Ohms), and 1.8/5.6 to 1.6/5.6. For special applications also units can be offered with different connector styles at the input and output.

Custom Designs: Spectrum Elektrotechnik GmbH has been designing and supplying special Impedance Transformers to suit particular requirements, such as certain bandwidths, unique mechanical outline, unusual mounting or special connector requirements, etc., etc.

Frequency and Bandwidth: As 75 Ohms systems are usually designed to operate at lower frequencies, there seems to be no need for Impedance Transformers operating at higher frequencies. Depending on the designs, Impedance Transformers may operate up to a few hundred MHz, only some are designed for frequencies to 3.0 GHz.

High Reliability Components: Impedance Transformers can also be supplied to Customers High Reliability Specifications, environmental, military or governmental requirements, and/or to customer test procedures.

Impedance Transformers for other impedances: Basically a unit for any impedance transformation needed, can be designed. Depending on the operating frequency and bandwidth, the appropriate design will be chosen for low development cost.

Insertion Loss: This is the amount of power lost through the Impedance Transformer under matched conditions.

One dB Bandwidth: This is the frequency range over which the insertion loss variation is less than 1 dB, referenced to the midband insertion loss.

Operating Temperature Range: The temperature ranges from -54°C to $+125^{\circ}\text{C}$, or even wider, depending on the application.

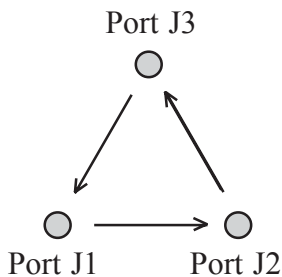


Peak Power Handling: This is the maximum allowable power to which the unit can be subjected to without suffering permanent damage, or without changing permanently the specified characteristics of the device. The peak power is transmitted at a certain pulse width and pulse repetition rate.

Standard Products: Although a number of products have been supplied to customers' orders, a standard product line on Impedance Transformers has not been designed yet. But there is a possibility that the product required has been designed already or that a design, very close to the requirement exists. Therefore please check your requirements with our sales force, or our engineering staff.

VSWR: VSWR is the ratio of the reflected signal and the incident signal. It is desired that the Impedance Transformers have little reflections. In reality, the units will show some reflections and discontinuities within the circuit, as no design is perfect, and manufacturing tolerances do not allow perfect designs anyway.

INTRODUCTION: Isolators and Circulators are usually three port devices, and they are used to force the microwave energy into one direction only. The typical junction Circulator consists of a stripline circuit, sandwiched between two ferrite discs or triangles, an upper and a lower ground plane, magnetically biased by permanent magnets located outside the ground planes. In a Circulator, the magnetic field, applied through the vertical axis of the assembly, results into a circulation of the microwave energy from one port to the other, depending on where the energy is coming from.



Microwave energy entering the device from port J1 is directed to port J2. Energy entering from port J2, is directed to port J3. Signals entering from port J3, are directed to port J1, etc. If one of the ports is terminated into a 50 Ohms load, the device becomes an Isolator. Signals then only can pass the unit with low loss in one direction, and only with high loss in the reverse direction. If e.g. port J3 is terminated into a 50 Ohms line, microwave energy only can pass the device with low loss from port J1 to port J2. An Isolator is used to "isolate" microwave

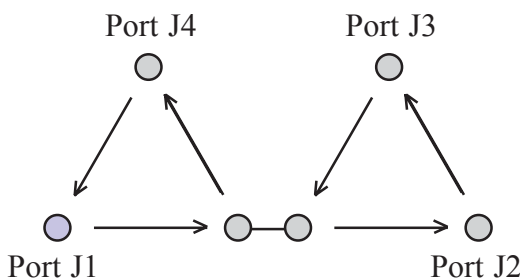
components from each other, or to protect units to receive damages by working into an open or short circuit. The output of an oscillator is usually protected by an isolator.

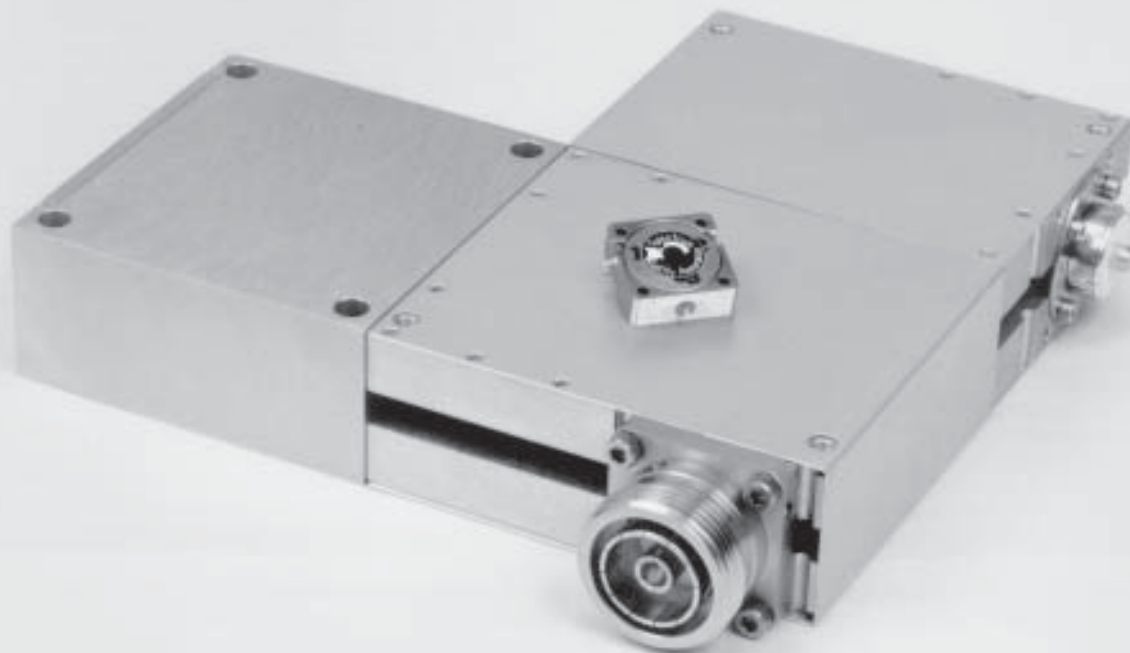
Frequency and Bandwidth: Coaxial and microstrip circulators and isolators operate either in the bias region above resonance or below resonance. Above-resonance circuits are usually used for smaller bandwidths and higher power designs, while below-resonance circuits achieve wider bandwidths. Theoretically, the above-resonance circuits have no lower frequency limit.

Operating Temperature: The performance depends on the magnetic field, applied to saturate the ferrite material. Temperature compensated magnets and ferrites need to be used where wide temperature ranges are required. Internal heaters can be installed, where temperature range and ferrite material do not allow other compensation.

Input VSWR: The input VSWR is a function of the VSWR of the other ports. At an isolator the higher output VSWR will cause reflected energy towards the terminated port, where it will be attenuated by the value of the isolation, and the balance is reflected back to the input, increasing the input VSWR.

Four Port Devices: Four Port Circulators and Isolators are used where higher directivity is needed. An Isolator would have the ports J3 and J4 terminated. In the schematic to the left, microwave energy is forced from port J1 to J2, or from port J3 to port J4, when crossing two ferrite junctions. The high isolation only applies when two ferrite junctions have been crossed, here between ports J2 and J1 with ports J3 and J4 terminated with matched loads.





**Designing Components to
Customer Specifications!**

**Circulators for High Power Applications vs.
Smallest Devices for Employment as "Drop In".**

I:comp08.ppt6

INTRODUCTION: Lightning has potential damaging effects on electronic equipment. Therefore modern equipment usually incorporates surge suppressors in the RF path in order to protect the equipment.

Spectrum Elektrotechnik GmbH has developed several types of lightning surge suppressors. They were engineered especially for the cellular communications industry. The designs are usually employing in the connector or the adapter a built-in fuse. But it has to be noted that the surge suppressor needs maintenance and replacement as soon as it has done its job of protection.

Another method for protecting the circuits against lightning, is the use of quarter wave stub devices. They have the advantage of being maintenance free, offer high attenuation and effectively a short circuit to incoming pulses outside the operating frequency. On the other hand they have the big disadvantage of needing to be tuned by the stub length to the center frequency, the equipment is working at, and have an operating bandwidth which is very narrow and usually only in the range of only +/- 70 MHz around the center frequency.

Application: Not protecting equipment against lightning strikes and allowing the energy of the surge to enter the equipment is a quite dangerous practice and usually ends up in destroyed equipment.

Lightning surge suppressing devices are therefore likely to be found in most applications, especially when modern systems are being designed. The protection of the equipment of cellular communication base station, connected directly with the antenna is one of the most important criteria.

Good applications for surge suppressors are also the protection of transceivers of radios on vehicles. The arc suppression device is usually built into the input connector at the long whip antenna.

Connectors: Surge Suppression devices are available with a large variety of connectors, such as 7/16, HN, N, SMA, etc., meeting the appropriate standard interface specifications, such as MIL-Standards, DIN- or IEC- Specifications.

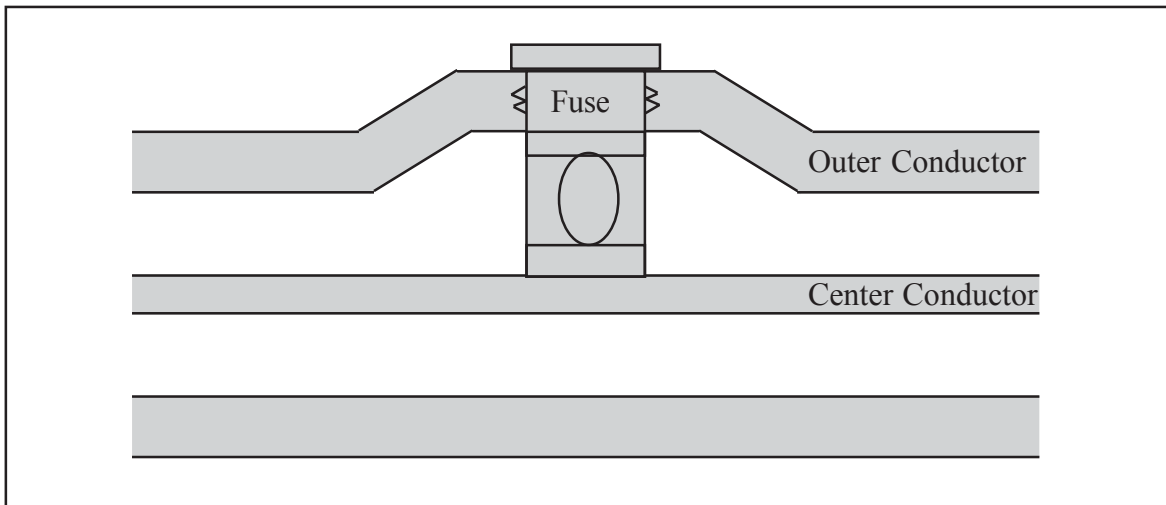
Custom Designs: Designs have been made to suit particular specifications, such as unique mechanical outline, unusual mounting, special electrical requirements, rough environment, etc., etc. Experienced engineers are available and they are interested to hear about the system needs and they are eager to offer solutions that meet exactly the requirements needed in the application.

Frequency: The frequency range for the connectors and adapters being equipped with surge suppression is usually below 3.0 GHz.

Operating Temperature Range: The temperature ranges from -54°C to +125°C, or even wider, depending on the application, the design and the materials used. Engineering can usually offer something that fits perfectly the system use.

Risetime/Voltage: Depending on the design and the type of fuse being incorporated, the devices will trigger in microseconds, or even nanoseconds. The pulse rise time is normally very fast and measured in kV/ μ s.

VSWR: VSWR is the ratio of the reflected signal and the incident signal. Because of the built in fuse, incorporated in the RF path, electrically the device is not ideal at all anymore. But as the fuse is normally small, compared to the wavelength of the operating frequency, the voltage standing wave ratio is in general still good enough for the application, or in other words: a degradation in VSWR is not noticeable. Corrective actions integrated in the design, will help in addition to keep the reflected signal to a minimum.



Schematic cross section view of a lightning surge suppressor, to demonstrate the structural arrangement between outer conductor, center conductor and fuse.



The picture shows a four hole flange mount adapter with surge suppression, being used between the antenna and the vehicle mount radio equipment.

INTRODUCTION: Limiters are used to protect RF components against excessive incident power levels. The devices are designed and manufactured to meet stringent requirements, mechanically, electrically and environmentally. It is the specialty of Spectrum Elektrotechnik GmbH to design and manufacture devices to meet stringent specifications, electrically, mechanically and environmentally.

Fundamentals: The power limiting circuit consists of a single PIN diode or several diodes, shunted across a transmission line, requiring a dc return in order to achieve proper limiting operation. Low input power passes with the minimum insertion loss of the circuit. Power levels, greater than the threshold level will cause greater insertion loss, resulting in leakage power that the output power of the device remains at constant level.

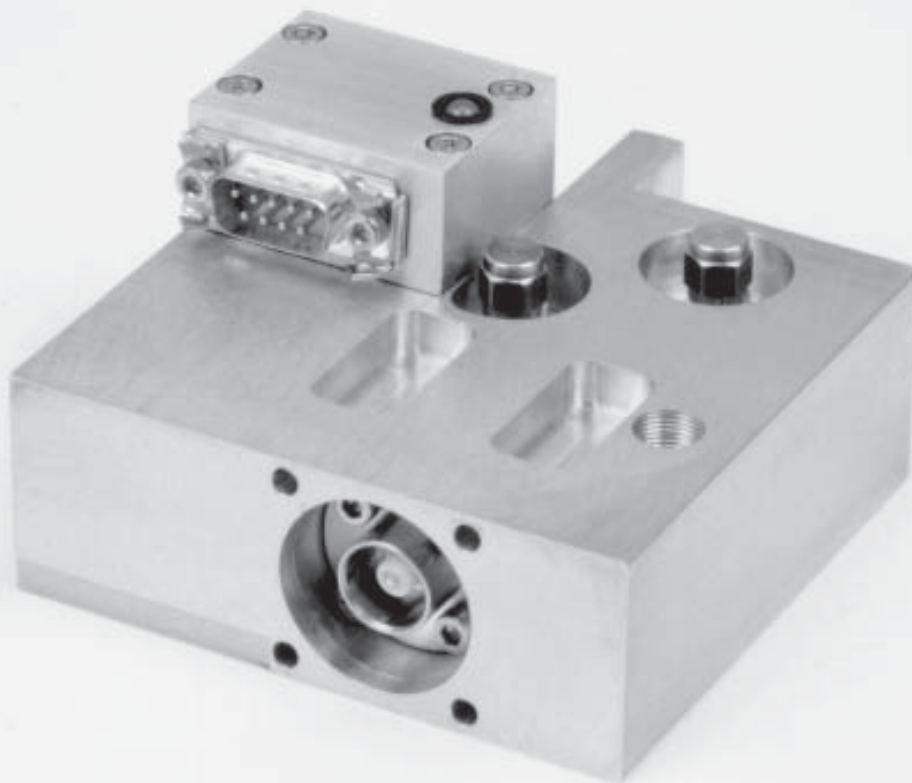
High Power Limiters: In radar applications a limiter is normally installed to protect the receiver against excessive power, caused by unwanted reflections from other nearby radars or objects that accidentally come close to the radar. For normal power levels the limiter will operate like the classic device. But even high power levels arrive, the limiter will act as a reflective unit, protecting the receiver by returning all the power that cannot be absorbed back into the line. To control the reflected power, usually a circulator is installed at the input of the limiter, directing the excessive power to a high power load where it will be absorbed.

Custom Units: Spectrum Elektrotechnik GmbH offers mainly custom designed limiters, special components, using different or an even unique mechanical configuration, special frequency ranges than normally offered, higher power levels, etc. Spectrum Elektrotechnik GmbH is a very innovative company. It employs a strong and successful team of experienced engineers. They will always do their best to propose something that will perfectly fit the requirements.

Frequency and Bandwidth: Limiters have been designed and manufactured to serve multi octave bandwidths, from very low frequencies up to Ku band. Wide operating bandwidths usually apply for low power limiters. The higher the power level becomes, the narrower the bandwidth will be.

Housing and Connector Configuration: Most of the designs, Spectrum Elektrotechnik GmbH can offer, will be engineered exactly to the customer specifications, size and shape of the housing supplied with the necessary connector configuration, providing that the frequency range of the connectors do not limit the frequency range of the application. As Spectrum Elektrotechnik GmbH is manufacturing its own housings and its own connectors, almost every mechanical configuration needed and every connector style preferred may become reality.

VSWR: VSWR is the ratio of the reflected signal and the incident signal. Every microwave component shows reflections and discontinuities within the circuit, as no design is perfect, and manufacturing tolerances do not allow perfect designs anyway.



**High Power Limiter,
built on a Modular Bases,
using the SBY - Connector.**

Phase Stable Assemblies (ANA-Cable Assemblies)



The Cable Assemblies of Series 16, 18 and 22 are Phase Stable Assemblies, designed for the Vector Network Analyzers of HP and Wiltron.

The Cables of Types 18 and 22 operate to 26.5 GHz, while Cable Type 16 works to 50.0 GHz (when supplied with 2.4mm connectors).

One end of the Assembly is usually terminated with a "special" 2.4mm, 3.5mm, or K* connector. These connectors are designed with a larger than standard coupling nut for greater stability, mating directly with the RF ports of the Network Analyzers.

The other end of the ANA - Assembly may be terminated with any of the connectors available and needed in the customers test application, mating in direct connection with the device under test. By eliminating expensive adapters the test setup becomes simple and trustworthy.

The cable assemblies can be manufactured in various lengths up to 6 meters (20ft.). All necessary piece parts will be carried in stock, helping to facilitate fast deliveries.

Cable assemblies of the most popular lengths, e.g. 45 cm. (17.7") and 60 cm. (2.36"), terminated with preferred connector styles, such as 2.4mm and 3.5mm for the Hewlett-Packard 8510 and K* for Wiltron 360, will be available, in most cases, within a few days of order placement.

Note:

For special requirements, the cable can be terminated with almost any connector style. Please call your nearest Spectrum Representant or contact our Marketing or Engineering Staff.

ANA Cable Assembly Characteristics:

Cable Code	16	18	22
Frequency Range	50.0 GHz	26.5 GHz	26.5 GHz
Cable Outer diameter	9.2 mm. (.36")	6.0 mm. (.24")	9.2 mm. (.36")
Mechanical length	custom-made up to 6m	custom made up to 6m	custom made up to 6m
Electrical length	~ 1.44 x mechan. length	~1.36 x mechan. length	~1.36 x mechan. length
Bend radius min.	6 cm. (2.36")	6 cm. (2.36")	6 cm. (2.36")
Pull resistance	10 kg. (22 pounds)	2 Kg. (4.4 pounds)	10 kg. (22 pounds)
Crush resistance	62 kg./cm ² (880 psi)	16 kg./cm ² (225 psi)	62 kg./cm ² (880 psi)
Return loss, min. /Assembly			
2.4mm connectors	17 dB up to 50.0 GHz	20 dB up to 26.5 GHz	20 dB up to 26.5 GHz
3.5mm connectors	20 dB up to 26.5 GHz		
7mm connectors	20 dB up to 18.0 GHz	20 dB up to 18.0 GHz	20 dB up to 18.0 GHz
K* connectors	20 dB up to 40.0 GHz	20 dB up to 26.5 GHz	20 dB up to 26.5 GHz
N connectors	20 dB up to 18.0 GHz	20 dB up to 18.0 GHz	20 dB up to 18.0 GHz
SMA connectors			
TNC connectors			
Return loss stability	40 dB min.	40 dB min.	40 dB min.
Phase stab., 2 x 45 cm. assies manual flexing/torque	Please refer to: "The '97 Handbook Cable Assemblies ". 5.0° max. @ 40.0 GHz	Please refer to: "The '97 Handbook Cable Assemblies ". 4.0° max. @ 26.5 GHz	Please refer to: "The '97 Handbook Cable Assemblies ". 4.0° max. @ 26.5 GHz
Straight vs. 90° bend	4.0° max. @ 40.0 GHz	2.5° max. @ 26.5 GHz	2.5° max. @ 26.5 GHz
Straight after 3 x 90° bends	3.0° max. @ 40.0 GHz	2.0° max. @ 26.5 GHz	2.0° max. @ 26.5 GHz
Amplitude stab., 2 x 45 cm. assies manual flexing/torque	<0.05dB @ 40.0 GHz	-	-
Straight vs. 90° bend	<0.05dB @ 40.0 GHz	<0.05dB @ 26.5 GHz	<0.05dB @ 26.5 GHz
Straight after 3 x 90° bends	<0.05dB @ 40.0 GHz	<0.05dB @ 26.5 GHz	<0.05dB @ 26.5 GHz
Insertion Loss / m (39.37")	1.0 GHz	0.65	0.40
	10.0 GHz	2.50	1.34
	18.0 GHz	3.60	1.80
	26.5 GHz	4.50	2.20
	40.0 GHz	5.70	-
	50.0 GHz	6.60	-



Phase Stable Assemblies

**For complete information please refer to:
" The '97 Handbook Cable Assemblies " or
" The '97 Handbook Test Necessities and Accessories ".**

INTRODUCTION: Mismatches for a 50 Ohms line are terminations which have been designed for terminating lines with a characteristic impedance other than 50 Ohms. For example a termination, designed for reflectionless termination of a 25 Ohms line, will cause a mismatch of 2:1 when used on a 50 Ohms line ($50:25 = 2:1$).

Applications: Mismatches are used as standards of reflections in calibrating reflectometer setups and/or other impedance measurement devices. Mismatches are also used to simulate known impedances other than 50 Ohms, to introduce test conditions in a system and to measure the results that would be encountered, once the actual component is installed in the system.

Mismatch Values: Standard Mismatch Values for a 50 Ohms transmission line are known as 1.25:1, 1.5:1, 2:1, 4:1, etc. For specific applications any mismatch value can be designed.

Frequency Range: The frequency range of the Mismatches depends on the design. Theoretically Mismatches can be designed for almost any frequency range.

Power: Precision Mismatches are usually designed and needed for test and calibration purposes, operating at low power. For other applications units can be supplied as special, engineered exactly to the customers' needs.

VSWR: VSWR is the ratio of the reflected signal and the incident signal. Mismatches are designed to provide reflectionless termination of a line other than 50 Ohms. For the 50 Ohms line however they show a known VSWR over the frequency range specified. The better the design and the lower the manufacturing tolerances, the more constant will the VSWR be over the frequency range.

Connector Configuration: Most of the Mismatches manufactured by Spectrum Elektrotechnik GmbH are available with different connector configurations, providing that the frequency range of the connectors do not limit the frequency range of the application. BNC connectors operate to 4.0 GHz, HN and SBX connectors to 8.0 GHz, C, SC and 1.8/5.6 to 10.0 GHz, TNC (per MIL-C-39012) operate min. to 11.0 GHz (as per MIL-Specification, but this can be extended to 14 or even 16 GHz). SBY work to 12.0 GHz, 2/5.5 connectors operate to 14.0 GHz, SMA, SPM, N, TNC (per MIL-C-87104/2), TNX, BMA and 7mm connectors can be used to 18.0 GHz, 1.4/4.4 to 20.0 GHz, 3.5mm connectors to 26.5 GHz, or respectively to 35.0 GHz. K* and SMP connectors are designed to operate to 40.0 GHz and 2.4mm connectors to 50.0 GHz.

Standard Products: Although a number of products have been supplied to customer orders, a standard product line on Mismatches has not been established yet. But there is a possibility that the product required has been designed already or that a design, very close to the requirement exists. Therefore please check your requirements with our sales force, or our engineering staff.

Custom Designs: Spectrum Elektrotechnik GmbH has been designing and supplying special Mismatches to suit particular requirements, such as wide bandwidths, unique mechanical outline, unusual mounting or special connector requirements, etc., etc.

Operating Temperature Range: It usually ranges from -54°C to $+125^{\circ}\text{C}$, or it is even wider. The temperature range will affect the power handling of the devices.



Spectrum Elektrotechnik GmbH manufactures precision mismatches to customer specifications: To the requested mismatch value, frequency range, power limits, temperature range, connector configuration, mechanical outline, etc., etc.

The Problem:

Testing Components means connecting the units under test to the test equipment, time consuming, tightening, torquing and loosening of connectors, many times, every day.

The Answer:

PUSH-ON Connectors and Connector Savers were developed to eliminate all this time consuming tightening, torquing and loosening of the connectors during test.

The PUSH-ON end slides directly onto any of the Standard female Connector of the same series, allowing quick and easy connection and disconnection.

Modify your Cable Assembly with the PUSH-ON Adapter:

If you have a Cable Assembly, using SMA, N, TNC or 7/16 as Test Connector, you can easily modify your assembly. Just order the appropriate PUSH-ON Adapter. The Adapter consists of the PUSH-ON and the female standard type connector at the opposite end. Put the connector saver onto the male connector of your Cable Assembly. With the PUSH-ON side of the Adapter you can slide now onto any standard female connector of the same connector style.

PUSH-ON Cable Connectors:

There are also PUSH-ON connectors available for direct cable attachment. Some of the connectors can be purchased for making the own individual cable assembly, using RG-400/U and RG-142B/U. Additional a variety of High Performance Cable Assemblies can be ordered, completely terminated with the connectors needed, e.g. one side with a regular connector, the other end with the PUSH-ON, fully tested and delivered with a test report showing complete data on VSWR and Insertion Loss.

The Advantage of the PUSH-ONs:

- **Repeatable Performance**
- **Reduced Test Time**
- **Low Return Loss**
- **Long Life**

PUSH-ON Connector Styles:

- In 50 Ohms Impedance: Types 7/16, N, SMA, TNC
- In 75 Ohms Impedance: Type F, N

For Details please refer to the following Spectrum Elektrotechnik GmbH literature:

- " **The '97 Handbook Adapters** "
- " **The '97 Handbook Cable Assemblies** "
- " **The '98 Handbook Quick Connections** "

Repeatable Performance
Reduced Test Time
Low Return Loss
Long Life

PUSH-ONs

SMA & TNC & N & 7/16

The PUSH - ON Connectors and Connector Savers were developed to eliminate all the time consuming tightening, torquing and loosening of the connectors during test.

The PUSH - ON end slides directly onto any of the Standard female Connector of the same series, allowing quick and easy connection and disconnection.

You are not doing it the old-fashioned, time consuming way, do you?



Also designed now for
75 Ω connectors:
F & N

Please ask for our other Products in the Frequency Range of DC to 50 GHz: Adapters, ANA Test Cables, Antennas, Attenuators, Blind Mate Connectors, Circulators, CDM-Components, Coax Switches, Couplers, Custom Components, DC-Block Connectors & Adapters, Gain-Equalizers, Flexible Cable Assemblies, Isolators, Limiters, Mismatches, Multi Pin Connectors, Phase Shifters, Phase Stable Cable Assemblies, Precision Terminations, Push-On Connectors & Adapters, Semi Rigid Cable Assemblies, Waveguide Components, Waveguide to Coax Adapters, etc.



Spectrum
Elektrotechnik GmbH

80905 Munich, Germany

P.O. Box 45 05 33

Fax (89) 354-804-90

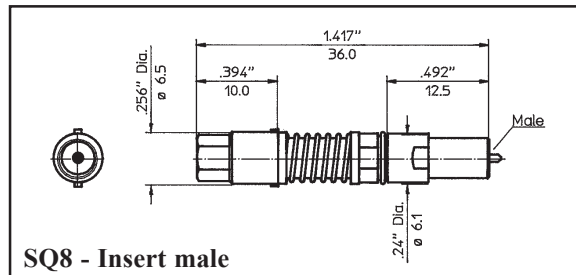
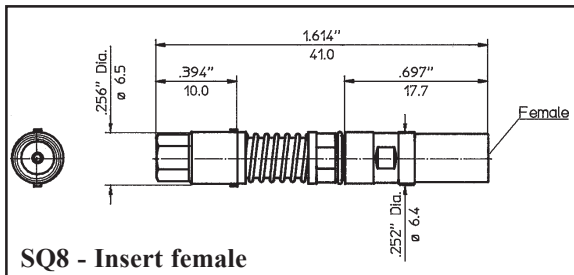
Telephone: (89) 354-804-0

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RF-Multipin Connector SQ-8



Spectrum's new 'SQ-8' Multipin Connector incorporates EIGHT NEW GENERATION precision microwave connectors. The advantage of being able to connect and disconnect EIGHT microwave links simultaneously is one of its major benefits. The 'SQ-8' is blind mating and automatically locks the individual links into place. The need for a torque wrench, and the difficulties sometimes experienced with mating miniature connectors in confined space, is also eliminated. Although designed and constructed with reliability and performance foremost in mind, every individual microwave assembly within the component is field replaceable. These connector inserts can be exchanged or replaced in the very minimum of time, by the simple task of disengaging or engaging a bayonet catch. When using the 'SQ-8' Multipin Connector, the design, manufacture, and servicing of RF and microwave systems and test equipments is made infinitely easier. Electrically, the individual RF connector inserts used, offer an excellent performance, and are comparable, and in some cases better than those exhibited by SMA series connectors. The 'SQ-8' Multipin Connector has been designed to accommodate a variety of different cable types. These include cable diameters from 3mm to 5mm; from ultra flexible to extremely rugged; electrically phase stable and very low loss. The 'SQ-8' is the fore runner of a series of NEW MULTIPIN CONNECTOR developments. Other choices of outer body shell styling with different number of microwave inserts, are to be made available. Frequencies up to 40.0 GHz, and above, with combinations of RF-Inserts and regular pins will be available.



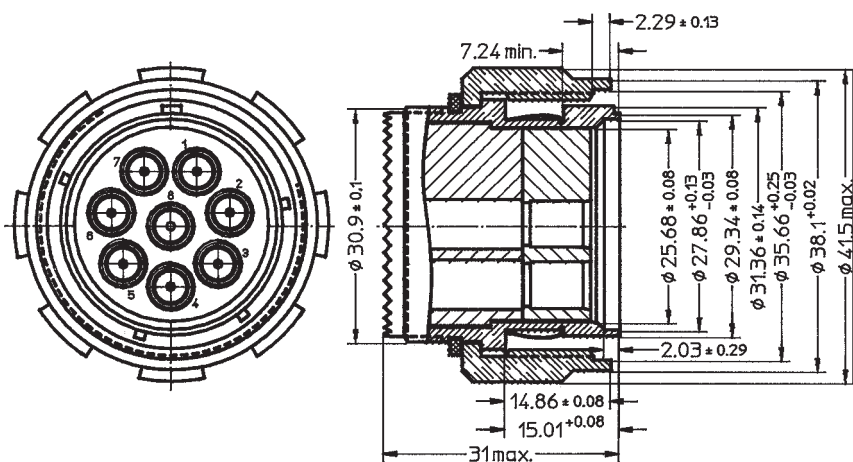
SPECIFICATIONS

ELECTRICAL

Frequency Range	DC - 24.0 GHz min., DC - 40.0 GHz optional.
Insulation Resistance	The insulation resistance shall not be less than 5,000 megohms.
Voltage Standing Wave Ratio (VSWR)	$1.02 + .005 * f$ (GHz)
Contact Resistance	The center contact resistance drop shall not exceed 3.0 milliohms and the outer contact resistance drop shall not exceed 2.0 milliohms.
Dielectric Withstanding Voltage	The magnitude of the test voltage shall be 1,000 volts rms at sea level.
RF High Potential Withstanding Voltage	The RF high potential withstanding Jvoltage is 670 volts rms at 5 MHz. Leakage is not applicable.
RF Leakage	$-(100 - f)$ (GHz) dB
Insertion Loss	$(.03 \text{ SQT}(f(\text{GHz})))$ dB

MECHANICAL

Connector Durability	The connector is to be tested and its mating connector shall be subjected to 500 insertions and withdrawal cycles at 12 cycles per minute max. The connector shall show no evidence of mechanical failure and the connector shall meet the mating characteristic requirements.
Cable Retention Force	60 pounds (267 N) min., without stress relief.
Coupling Nut Retention Force	Not applicable.
Force to Engage and Disengage	Not applicable.
Longitudinal Force max.	Longitudinal force is not applicable.
Mating Characteristics	Applicable to Females only: oversize pin .0372 inch (.945 mm) max. dia., .045 inch (1.14 mm) deep; insertion force 3 lbs. (13.34 N) max. with .037 inch (.94 mm) min. dia. pin; withdrawal force 1.00 oz (.278 N) min. with .0355 inch (.90 mm) max. dia. pin.
Recommended Mating Torque	Not applicable.

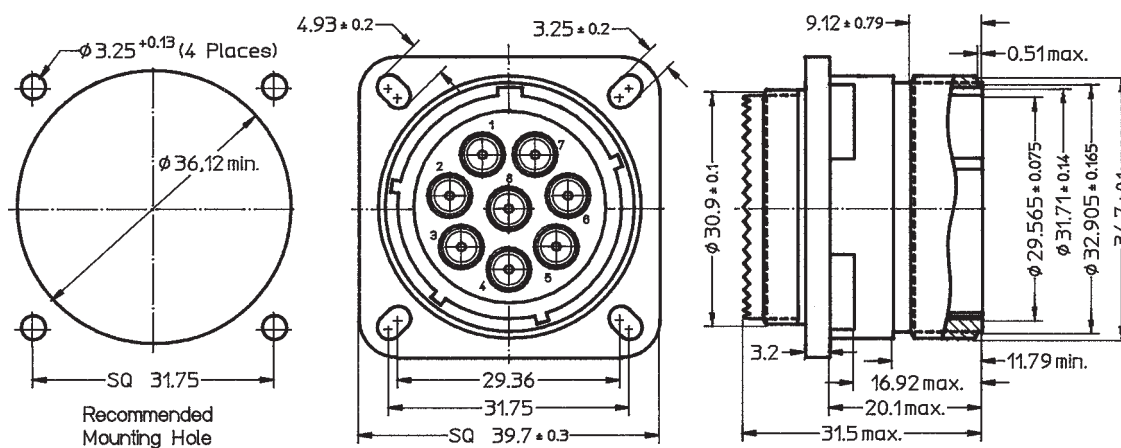


**RF-Multipin
Connector
SQ-8**

Interface Mating Dimensions
(Per MIL-C-38999)

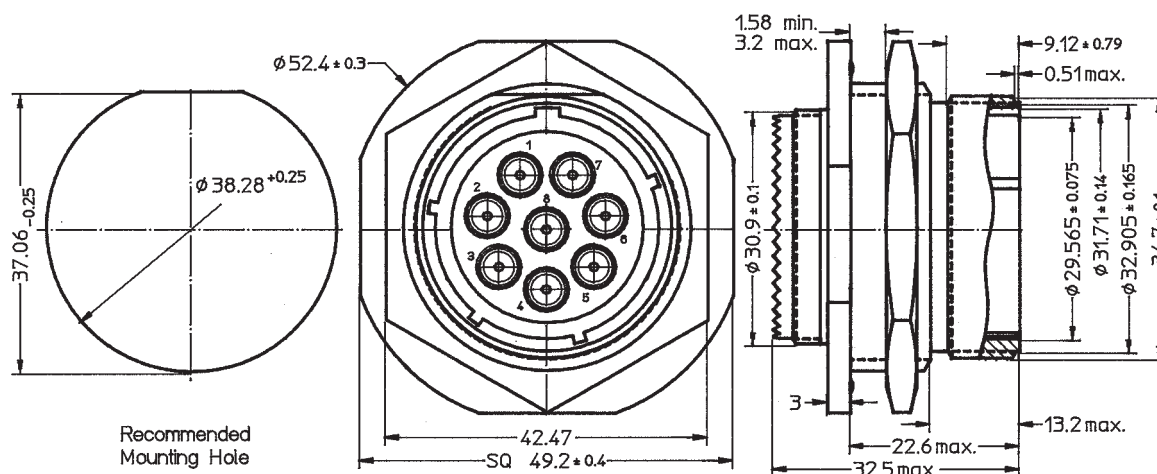
SQ-8 MALE Cable Connector

P/N SQ-8MLE



SQ-8 4 - Hole Flange Mount Jack

P/N SQ-8FMJ



SQ-8 Bulkhead Feedthrough Jack

P/N SQ-8BFJ

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INTRODUCTION: There are applications where a stationary RF line needs to be connected to a rotating component. The Rotary Joint has been developed to service these needs, translating the electromagnetic energy from a stationary line to a rotating line. As the Rotary Joint is a dynamic device, the electrical performance depends very much on a reliable mechanical design that is engineered for the satisfaction of the dynamic requirements and the RF performance. The electrical specification of the Rotary Joint is not supposed to change over its guaranteed lifetime.

The Coaxial Line Rotary Joint: The device has coaxial input and output terminals and is using a transmission path that is also a coaxial line. For the electromagnetic propagation the TEM mode is used. The unit can usually cover a wide frequency range. The power handling capability is normally only restricted by the power limits of the connectors.

The Waveguide Rotary Joint: This device is using rectangular waveguide for input and output, and for the transmission line itself. The unit operates in the TE₁₀ mode and can provide low VSWR at high power levels. As coupling for the rotation element, normally a noncontacting choke coupling is employed. The frequency band of operation is limited by the waveguide and in addition by the frequency sensitivity of the coupling choke.

The Waveguide to Coaxial Rotary Joint: For Input and output of the device rectangular waveguide is used, while the transmission line path is provided as coaxial line, connecting to the waveguide sections. The modes of operation are TE₁₀ mode in the waveguide sections and TEM in the coaxial path. The operating frequency is limited by the waveguide, the power is limited by the coaxial part.

The Rectangular to Circular Waveguide Rotary Joint: Input and output of the device are provided as rectangular waveguide, the transmission line uses circular waveguide. The modes of operation are the TE₁₀ mode in the rectangular sections and the TM₀₁ mode in the circular waveguide. As coupling for the rotation element, normally a noncontacting choke coupling is used. The frequency band of operation is limited by the waveguide and in addition by the frequency sensitivity of the coupling choke.

Frequency Range: Spectrum Elektrotechnik GmbH has manufactured units in different frequency bands, usually designed exactly to the customers' specifications. Engineering is currently designing Standard Coaxial Rotary Joints for the frequency ranges DC-2.0 GHz, DC-18.0 GHz and DC-26.5 GHz, operating in regular environment.

A rather simple design will meet all the requirements at lower frequency ranges, while only a most precise and state-of-the-art unit can be used at higher frequencies.

Rotary Joint Life: The life expectancy will mainly depend on the lifetime of the ball bearings, seals, and contact junctions. Other parameters that are limiting life, are rotational speed, and external mechanical loading, or pressurizing the unit. Harsh environment, subjecting the rotary joint to vibrations, shock, extremely low or high temperatures, humidity, etc. may further shorten the lifetime. It is therefore of utmost importance to identify in detail the environment the device is supposed to operate in.

VSWR: Every microwave component shows reflections and discontinuities within the circuit, as no design can be perfect, and manufacturing tolerances unfortunately do not allow perfect designs. VSWR is the ratio of the reflected signal and the incident signal. Rotary Joints are also characterized by the tendency of having to use a high number of parts. The tolerances on the dimensions need to be as tight as possible, not only for mechanical purposes, but also for electrical reasons, in order to assure that reflections cannot increase after some time of operation.



Spectrum Elektrotechnik GmbH manufactures coaxial rotary joints to customer specifications: To the specific frequency range, power limits, return loss, insertion loss, temperature range, rotational speed, connector configuration, mechanical outline, etc., etc.

INTRODUCTION: By integrating components, assemblies are engineered that exhibit a number of advantages against the common designs, such as reduced package size at lower cost and superior RF performance. A Supercomponent can achieve a volume reduction of 10 to 1, or even more. Electrically, the integration may result into lower transmission loss, flat attenuation and improved VSWR.

The success on integrated packaging depends on the total understanding and the control of the components that are supposed to be integrated. Spectrum Elektrotechnik GmbH has an extensive capability in a variety of passive and active components.

Modular Packaging: Spectrum Elektrotechnik GmbH has an intensive product capability in devices such as attenuators, limiters, couplers, detectors, filters, power dividers, terminations, etc. By using this specific component experience, Spectrum Elektrotechnik GmbH can produce effectively integrated packages, using stripline or microstrip circuitry.

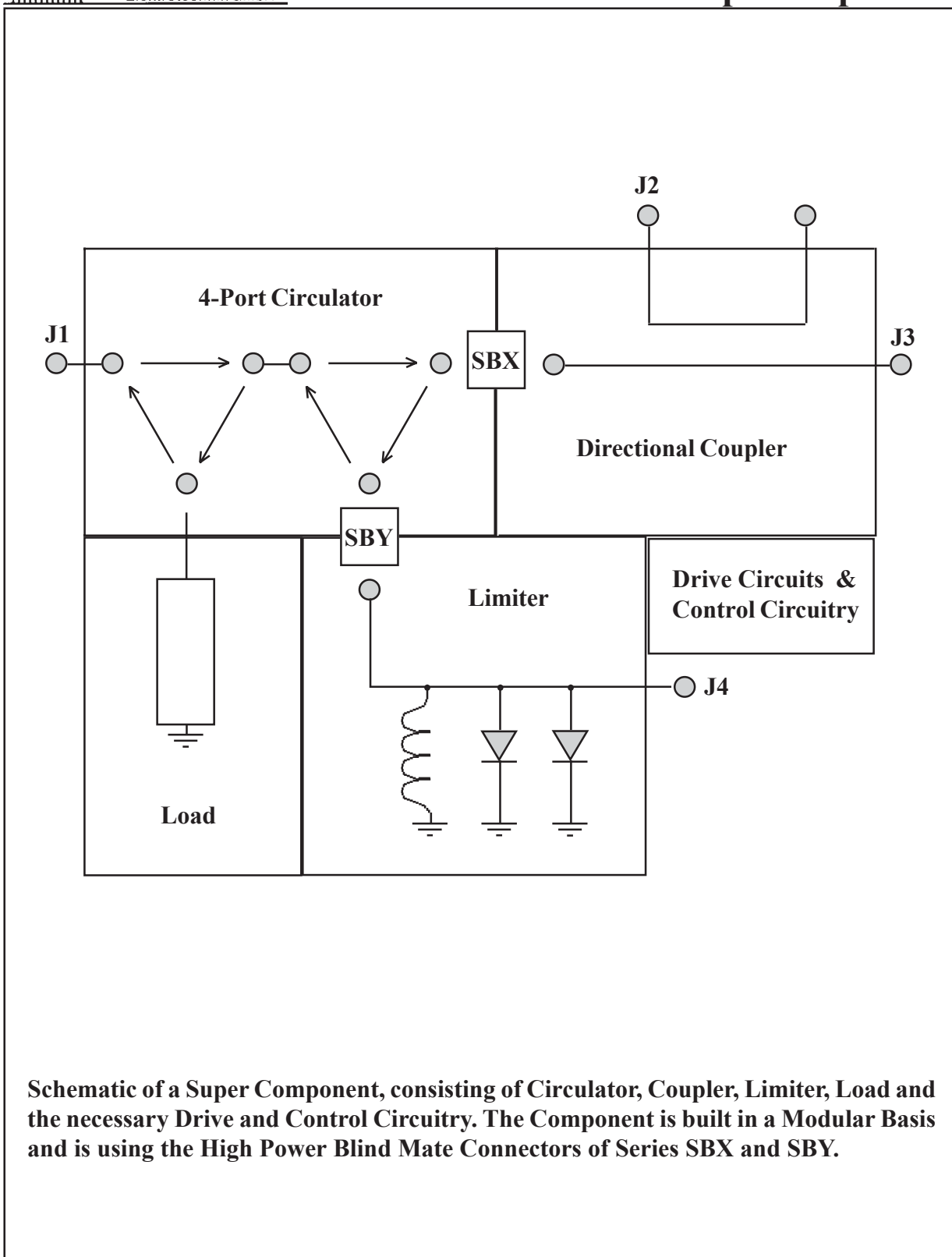
Modular Power Component Packaging : This is a higher level of components integration, in general used for higher power devices. The components or groups of components are usually interconnected by special blind mate connectors, integrated directly into the component housings. Such, the connectors can't even be seen, when the components are connected, providing shortest distance between the components, which is desirable, especially at those high power levels.

Power Interconnections: Spectrum Elektrotechnik GmbH did design and manufacture two completely new connector series, the SBX and SBY, and is offering these now to other manufacturers for modular packaging purposes. Modular Packaging means not only integration, it furthermore reserves the advantage of easy maintainability and replacement of faulty components. Spectrum Elektrotechnik GmbH has been a leader in modular integration of high power components.

Example: A High Power Duplexer in a Radar Program did consist of several individual components: a Circulator, a Load, a Directional Coupler, a Limiter and Drive Circuitry. The Components were mounted to heat sinks and interconnected by cable assemblies.

For the next generation radar Spectrum Elektrotechnik GmbH was awarded the contract for a complete redesign: The modular components were laid out densely and the package was shaped to fit into a small area. All interconnecting cable assemblies were eliminated, and replaced by using the connector series SBX and SBY. A drive circuit was added and accommodated into the limiter housing, together with an over temperature sensor circuit.

In case one of the components becomes defective, or needs to be tested or replaced, only the locking screws have to be unfastened, and the component can be removed, and replaced, within no time.



Schematic of a Super Component, consisting of Circulator, Coupler, Limiter, Load and the necessary Drive and Control Circuitry. The Component is built in a Modular Basis and is using the High Power Blind Mate Connectors of Series SBX and SBY.

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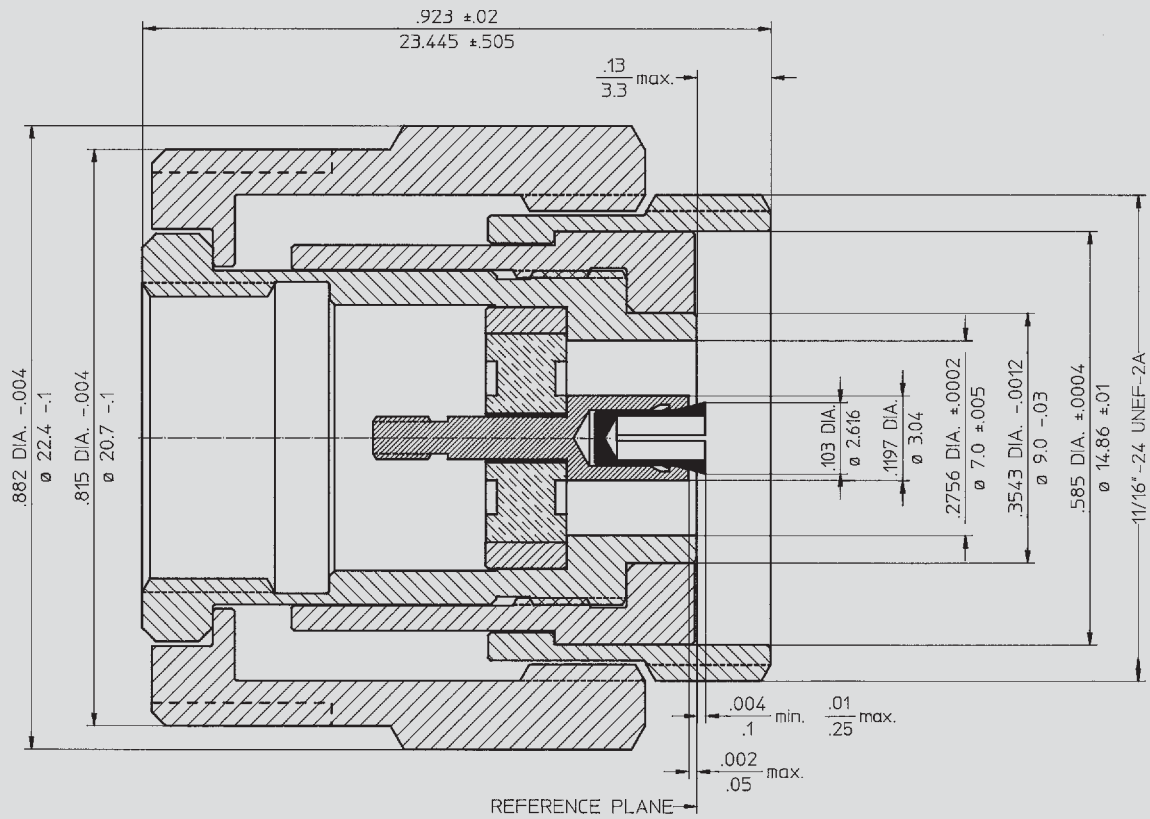


Right Angled Connectors:

- **Smallest Size!**
- **Large Variety of Connector Styles!**
- **Excellent Return Loss!**

**Please refer to
"The '98 Handbook
Microwave Connectors".**

Section X



Connector Specifications

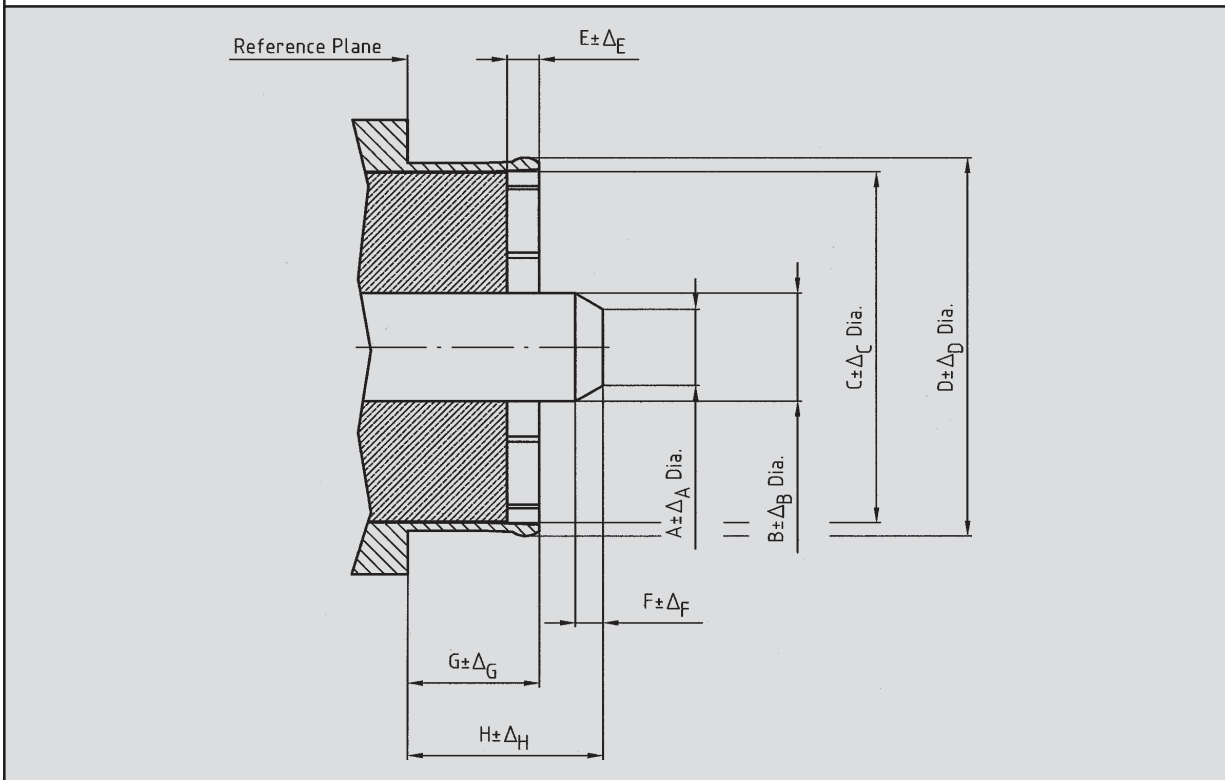
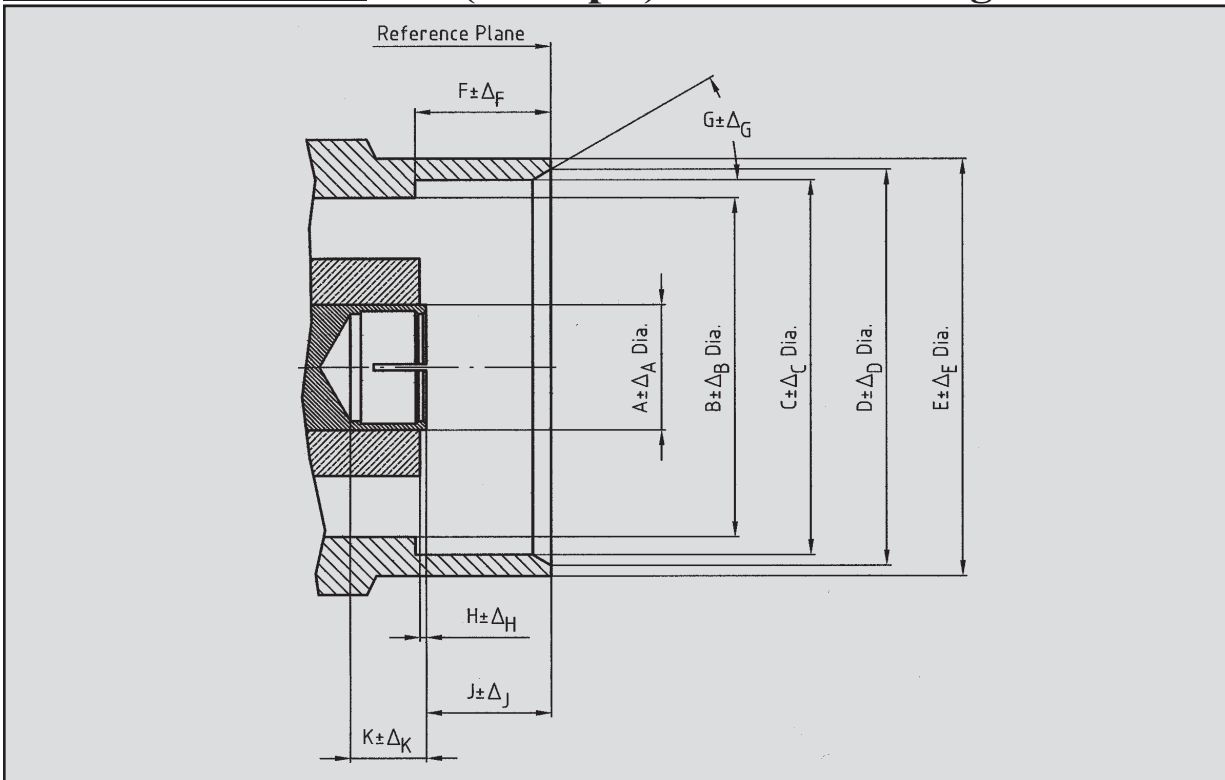
Connector Specifications (Example)



The specifications below are general specifications for connectors. Specific Data for VSWR, Insertion loss, R.F. leakage etc., are available from the factory upon request. Specifications in the following table are recommended for any procurement documents or drawings. In the event of any conflict between these specifications and other documentation, these specifications shall govern. These specifications are subject to change according to the latest revision.

REQUIREMENT	GENERAL SPECIFICATIONS
GENERAL	
Standard Materials	STEEL corrosion resistant 1.4305 per DIN 17440 (QQ-S-764, class 303 or ASTM-A-582-80). ALUMINUM AlMg4.5Mn per DIN 1725, AlMgSi0.5 per DIN 1725, AlMgSi1 per DIN 1725 (6061-T6 per QQ-A-225/8). BRASS CuZn39Pb3 per DIN 17660 (QQ-B-626, half hard). COPPER BERYLLIUM 33-25 CuBe2Pb H per DIN 17666 (QQ-C-530). TFE Fluorocarbon per DIN 52900 (MIL-P-19468 and L-P403). SILICONE RUBBER per DIN 3771 (MIL-R-5847 and ZZ-R-765, Class II B,) Grade 65 - 75. BORRIUM NITRITE Dielectric for high power applications per inhouse specification.
Finish for COPPER BERYLLIUM STAINLESS STEEL ALUMINUM BRASS VARIOUS	Center Contacts shall be gold plated to a minimum thickness of .00005 inch (1.27 µm) in accordance with MIL-G-45204, Type II, Grade C. shall be passivated per QQ-P-35. Conductive Parts shall have an iridited finish per MIL-C-5541. Other parts, such as Coupling Nuts and Back-Bodies shall be anodized per MIL-A-8625. .00003 inch (0.8 µm) min. gold plating per MIL-G-45204, or nicle plating per QQ-N-190, as specified. Imoloy .0001 inch (2.5 µm) min. plating, consisting of 55% Copper / 20% Zinc / 25% Tin (on special request).
Design	The design shall be such that the outline dimensions in this catalog are met. In addition, the assembled connector shall meet the interface dimensions.
ELECTRICAL	
Frequency Range Insulation Resistance Voltage Standing Wave Ratio (VSWR) Contact Resistance Dielectric Withstanding Voltage RF High Potential Withstanding Voltage RF Leakage Insertion Loss	Please refer to the appropriate data sheet as shown in: " The '97 Handbook Adapters " and " The '98 Handbook Microwave Connectors " .
MECHANICAL	
Connector Durability Cable Retention Force Coupling Nut Retention Force Force to Engage and Disengage Longitudinal Force max. Mating Characteristics Recommended Mating Torque	Please refer to the appropriate data sheet as shown in: " The '97 Handbook Adapters " and " The '98 Handbook Microwave Connectors " .
ENVIRONMENTAL	
Corrosion (Salt Spray) Vibration Shock Thermal Shock Moisture Resistance	Specification MIL-STD-202, Method 101, Test Condition B. The salt solution shall be 5%. Specification MIL-STD-202, Method 204, Test Condition B. Specification MIL-STD-202, Method 213, Test Condition 1. Specification MIL-STD-202, Method 107, Test Condition B, except high temperature shall be + 200°C. Specification MIL-STD-202, Method 106. Step 7b (vibration) shall be omitted. Insulation resistance shall be 200 megohms min. within 5 minutes of removal from humidity.










(Example) Interface Mating Dimensions



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Connector Specifications Summary

All the connectors manufactured and used by Spectrum Elektrotechnik GmbH, if not specified differently in the order, will meet the following standard specifications:

1.4/4.4	DIN 47298
1.8/5.6	DIN 47226
2/5.5	 Specifications
2.4mm	 Specifications
3.5mm	 Specifications
7mm	IEC 457-2
7/16	DIN 47223
BMA	 Specifications
BNC	MIL-C-39012 (IEC 169-2)
C	MIL-C-39012 (IEC 169-7)
HN	MIL-C-3643
K*	 Specifications
N	MIL-C-39012
SBX	 Specifications
SBY	 Specifications
SC	MIL-C-39012
SMA	MIL-C-39012
SMB	MIL-C-39012
SMC	MIL-C-39012
SMP	DESC 94007 and DESC 94008
SPM	 Specifications
TNC	MIL-C-39012 or MIL-C-87104/2
TNX	 Specifications

The Specifications listed above are available upon request. The Specifications are also shown in full detail in "The '97 Handbook Adapters", and "The '98 Handbook Microwave Connectors". The Handbooks can be supplied free of charge. An example of a typical connector specification is shown on pages 148 and 149. Connectors that do not meet the appropriate specifications can ruin the mating connectors, test sets, etc.

Section XI

- **Glossary**
- **Part Number Index**
- **Index**
- **Sales Representatives**

RF Measurement Chart



VSWR 1 + R 1 - R	Reflection Coefficient R	Return Loss (dB)	Relative to Unity Reference			
			X dB Below Reference	Ref + x (dB)	Ref - x (dB)	Ref ± x Pk to Pk Ripple (dB)
∞	1.00	0	0	-6.00	∞	∞
17.40	0.891	1	1	-5.53	19.28	24.81
8.72	0.794	2	2	-5.08	13.74	18.81
5.85	0.708	3	3	-4.65	10.69	15.34
4.42	0.631	4	4	-4.25	8.66	12.91
3.57	0.562	5	5	-3.87	7.18	11.05
3.01	0.501	6	6	-3.53	6.22	9.75
2.61	0.447	7	7	-3.21	5.14	8.35
2.32	0.398	8	8	-2.91	4.41	7.32
2.10	0.355	9	9	-2.64	3.81	6.45
1.92	0.316	10	10	-2.39	3.30	5.69
1.78	0.282	11	11	-2.16	2.88	5.03
1.67	0.251	12	12	-1.95	2.51	4.46
1.58	0.224	13	13	-1.76	2.20	3.96
1.50	0.200	14	14	-1.58	1.93	3.51
1.43	0.178	15	15	-1.42	1.70	3.12
1.38	0.159	16	16	-1.28	1.50	2.78
1.33	0.141	17	17	-1.15	1.32	2.47
1.29	0.126	18	18	-1.03	1.17	2.20
1.25	0.112	19	19	-0.92	1.03	1.96
1.22	0.100	20	20	-0.83	0.92	1.74
1.196	0.0891	21	21	-0.741	0.811	1.552
1.172	0.0794	22	22	-0.644	0.719	1.382
1.152	0.0708	23	23	-0.594	0.638	1.232
1.134	0.0631	24	24	-0.531	0.566	1.098
1.119	0.0562	25	25	-0.475	0.502	0.977
1.107	0.0501	26	26	-0.434	0.446	0.880
1.096	0.0447	27	27	-0.380	0.397	0.777
1.083	0.0398	28	28	-0.338	0.353	0.691
1.074	0.0355	29	29	-0.303	0.314	0.556
1.065	0.0316	30	30	-0.270	0.279	0.549
1.058	0.0282	31	31	-0.242	0.248	0.490
1.052	0.0251	32	32	-0.215	0.221	0.436
1.046	0.0224	33	33	-0.192	0.197	0.389
1.041	0.0200	34	34	-0.172	0.174	0.347
1.036	0.0178	35	35	-0.153	0.156	0.309
1.032	0.0159	36	36	-0.137	0.138	0.275
1.029	0.0141	37	37	-0.122	0.123	0.245
1.026	0.0126	38	38	-0.109	0.110	0.219
1.023	0.0112	39	39	-0.098	0.098	0.196
1.020	0.0100	40	40	-0.086	0.087	0.173
1.0112	0.0056	45	45	-0.049	0.049	0.097
1.0064	0.0032	50	50	-0.028	0.028	0.056
1.0036	0.0018	55	55	-0.016	0.016	0.031
1.0020	0.0010	60	60	-0.0086	0.0086	0.0172

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To Convert	Into	Multiply by	Conversely Multiply by
Ampere-hours (Ah)	coulombs (C)	3600	2.778×10^{-4}
Celsius (centigrade, °C)	Fahrenheit (°F)		$^{\circ}\text{C} = (^{\circ}\text{F} - 32) / 1.8$
centimeters (cm)	feet (ft)	0.03281	30.48
centimeters (cm)	inches (in)	0.3937	2.54
ergs (erg)	joules (J)	10^{-7}	10^7
Fahrenheit (°F)	Celsius (centigrade, °C)		$^{\circ}\text{F} = ^{\circ}\text{C} * 1.8 + 32$
feet (ft)	centimeters (cm)	30.48	0.03281
feet (ft)	yards (yd)	0.33333	3
gallons, US (gal)	liters (l)	3.785	0.2642
grams (g)	ounces (oz)	0.03527	28.35
horsepower (hp)	kilowatts (kW)	0.745	1.342
inches (in)	centimeters (cm)	2.54	0.3937
inches (in)	feet (ft)	0.08333	12
inch-pounds (inlbf)	newton-meters (Nm)	0.11298	8.8512
joules (J)	ergs (erg)	10^7	10^{-7}
joules (J)	kilowatt-hours (kWh)	2.778×10^{-7}	3.6×10^6
kilograms (kg m/s ²)	kilopond (kp)	0.1020	9.807
kilograms (kg)	pounds (lb)	2.205	0.4536
kilopond (kp)	kilograms (kg m/s ²)	9.807	0.1020
kilopond (Kp)	newtons (N)	9.807	0.1020
kilowatt-hours (kWh)	joules (J)	3.6×10^6	2.778×10^{-7}
kilowatts (kW)	horsepower (hp)	1.342	0.745
liters (l)	gallons, US (gal)	0.2642	3.785
meters (m)	microns [micrometer], (μm)	10^6	10^{-6}
meters (m)	miles [nautical], (nmi)	5.4×10^{-4}	1852
meters (m)	miles [statue], (mi)	6.215×10^{-4}	1609
meters (m)	mils (mil)	3.937×10^{-4}	2.54×10^{-5}
microns [micrometer], (μm)	meters (m)	10^{-6}	10^6
miles [nautical], (nmi)	meters (m)	1852	5.4×10^{-4}
miles [statue], (mi)	meters (m)	1609	6.215×10^{-4}
mils (mil)	meters (m)	2.54×10^{-5}	3.937×10^{-4}
newtons (N)	kilopond (kp)	0.1020	9.807
newtons (N)	ounces [force], (oz)	3.5968	0.2780
newtons (N)	pounds [force], (lbf)	0.2248	4.448
newton-meters (Nm)	inch-pounds (inlbf)	8.8512	0.11298
newton-meters (Nm)	ounce-inches	1.416×10^2	7.062×10^{-3}
ounces (oz)	grams (g)	28.35	0.03527
ounces [force], (oz)	newtons (N)	0.2780	3.5968
ounce-inches	newton-meters (Nm)	7.062×10^{-3}	1.416×10^2
pounds (lb)	kilograms (kg)	0.4536	2.205
pounds [force], (lbf)	newtons (N)	4.448	0.2248
yards (yd)	feet (ft)	3	0.33333

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Equations for Coaxial Transmission Lines

		Formulae	
Attenuation (Theoretical)	$\alpha \left[\frac{\text{dB}}{\text{m}} \right]$	$\alpha = \alpha_c + \alpha_d$	α_d = Attenuation dielectric α_c = Attenuation conductors
Attenuation (Inner/Outer Conductor)	$\alpha_c \left[\frac{\text{dB}}{\text{m}} \right]$	$\alpha_c = \frac{\sqrt{\pi \cdot f \cdot \mu_o \cdot \mu_r \cdot \epsilon_r}}{6 \cdot \ln 10 \cdot \ln \left(\frac{D}{d} \right)} \left(\sqrt{\rho_i} + \sqrt{\rho_a} \right)$	d = Outer Diameter of Inner Conductor [cm] D = Inner Diameter of Outer Conductor [cm] ϵ_r = Relative Permittivity (Dielectric Constant) f = Frequency [Hz] μ_r = Relative Permeability μ_o = Permeab. of Free Space $\left[\frac{\text{H}}{\text{m}} \right]$ $\mu_o = 4\pi \cdot 10^{-7} \left[\frac{\text{H}}{\text{m}} \right]$ ρ_i = Resistivity of Inner Conductor [Ωcm] ρ_a = Resistivity of Outer Conductor [Ωcm] $\pi = 3.1415927$
Attenuation (Dielectric)	$\alpha_d \left[\frac{\text{dB}}{\text{m}} \right]$	$\alpha_d = \frac{20\pi\sqrt{\epsilon_r}}{\lambda \cdot \ln 10} \cdot \tan\delta$	ϵ_r = Relative Permittivity (Dielectric Constant) λ = Wavelength in Free Space [m] $\tan\delta$ = Loss tangent
Capacitance	$C \left[\frac{\text{F}}{\text{m}} \right]$	$C = \frac{2\pi\epsilon_o\epsilon_r}{\ln \left(\frac{D}{d} \right)}$	d = Outer Diameter of Inner Conductor [cm] D = Inner Diameter of Outer Conductor [cm] ϵ_o = Permittivity of Free Space [F/m] $\epsilon_o = 8.855 \cdot 10^{-12} \left[\frac{\text{F}}{\text{m}} \right]$ ϵ_r = Relative Permittivity (Dielectric Constant) $\pi = 3.1415927$
Cutoff Frequency	$f_c \left[\text{Hz} \right]$	$f_c = \frac{2 \cdot c}{\pi (D + d) \sqrt{\mu_r \epsilon_r}}$	c = Velocity of Light in Free Space [cm/s] $c = 2.997925 \cdot 10^{10} \left[\frac{\text{cm}}{\text{s}} \right] \approx 3 \cdot 10^{10} \left[\frac{\text{cm}}{\text{s}} \right]$ d = Outer Diameter of Inner Conductor [cm] D = Inner Diameter of Outer Conductor [cm] μ_r = Relative Permeability $\pi = 3.1415927$ ϵ_r = Relative Permittivity (Dielectric Constant)
Electrical Phase	$\phi \left[^\circ \right]$	$\phi = \frac{-360^\circ \sqrt{\epsilon_r} \cdot f \cdot l}{c}$	c = Velocity of Light in Free Space [cm/s] $c = 2.997925 \cdot 10^{10} \left[\frac{\text{cm}}{\text{s}} \right] \approx 3 \cdot 10^{10} \left[\frac{\text{cm}}{\text{s}} \right]$ f = Frequency [Hz] ϵ_r = Relative Permittivity (Dielectric Constant) l = Mechanical Length [cm]
Inductance	$L \left[\frac{\text{H}}{\text{m}} \right]$	$L = \frac{\mu_o \mu_r}{2\pi} \cdot \ln \left(\frac{D}{d} \right)$	d = Outer Diameter of Inner Conductor [cm] D = Inner Diameter of Outer Conductor [cm] μ_o = Permeability of Free Space $\left[\frac{\text{H}}{\text{m}} \right]$ $\mu_o = 4\pi \cdot 10^{-7} \left[\frac{\text{H}}{\text{m}} \right]$ μ_r = Relative Permeability $\pi = 3.1415927$

		Formulae	
Impedance	$Z_o \left[\Omega \right]$	$Z_o = \frac{59.959}{\sqrt{\epsilon_r}} \cdot \ln\left(\frac{D}{d}\right)$ $\approx \frac{60}{\sqrt{\epsilon_r}} \cdot \ln\left(\frac{D}{d}\right)$	d = Outer Diameter of Inner Conductor [cm] D = Inner Diameter of Outer Conductor [cm] ϵ_r = Relative Permittivity (Dielectric Constant)
Reflection Coefficient	r	$r = \frac{Z_r - Z_o}{Z_r + Z_o} = \frac{VSWR - 1}{VSWR + 1}$	Z_o = Characteristic Impedance [Ω] Z_r = Terminating Impedance [Ω]
Skin Depth	$\delta_s \left[\mu\text{m} \right]$	$\delta_s = \frac{10^{-6}}{\sqrt{\frac{\pi f \mu_o \mu_r}{\delta}}}$	f = Frequency [Hz] μ_o = Permeability of Free Space $\left[\frac{\text{H}}{\text{m}} \right]$ $\mu_o = 4\pi \cdot 10^{-7} \left[\frac{\text{H}}{\text{m}} \right]$ μ_r = Relative Permeability $\pi = 3.1415927$ δ = Resistivity [Ωm]
Time Delay	$T_D \left[\text{s} \right]$	$T_D = \frac{\sqrt{\epsilon_r}}{f}$	ϵ_r = Relative Permittivity (Dielectric Constant) f = Frequency [Hz]
Velocity of Propagation	$V_p \left[\frac{\text{cm}}{\text{s}} \right]$	$V_p = \frac{c}{\sqrt{\epsilon_r}}$	c = Velocity of Light in Free Space [cm/s] $c = 2.997925 \cdot 10^{10} \left[\frac{\text{cm}}{\text{s}} \right] \approx 3 \cdot 10^{10} \left[\frac{\text{cm}}{\text{s}} \right]$ ϵ_r = Relative Permittivity (Dielectric Constant)
VSWR (Voltage Standing Wave Ratio)		$VSWR = \frac{1+r}{1-r} = \frac{U_{\text{max}}}{U_{\text{min}}} = \frac{I_{\text{max}}}{I_{\text{min}}}$	I = Current r = Reflection Coefficient U = Voltage
Wavelength	$\lambda \left[\text{cm} \right]$	$\lambda = \frac{c}{f} \cdot \frac{1}{\sqrt{\epsilon_r}}$	c = Velocity of Light in Free Space [cm/s] $c = 2.997925 \cdot 10^{10} \left[\frac{\text{cm}}{\text{s}} \right] \approx 3 \cdot 10^{10} \left[\frac{\text{cm}}{\text{s}} \right]$ ϵ_r = Relative Permittivity (Dielectric Constant) f = Frequency [Hz]

Dielectric Properties					
Material	Dielectric Constant	Dissipation Factor (1KHz)	Velocity %	Time Delay Nanosecond/m	Loss Angle $\tan\delta$ ($\cdot 10^{-3}$)
FEP Fluorethylenpropylen	2.05	0.0002	69.4	4.79	0.5 ... 1.0
Low Density FEP	1.3 - 1.8	0.0002/0.0004	74 - 87	3.8 - 4.5	
PE Polyethylen	2.25	0.0002	65.9	5.05	0.3 ... 1.0
PTFE Polytetrafluorethylen	2.05	0.0002	69.4	4.79	0.1 ... 0.3

Material Properties										
Material		Resistivity ρ	Conductivity χ	Conductivity Temp. Coefficient	Thermal Expansion Coefficient	Thermal Conductivity	Density	Gravity	Specific Heat	Melting Point
		$[\mu\Omega\text{cm}]$	$\frac{10^4}{\Omega\text{cm}}$	10^{-3}	10^{-6}	W/(mK)	(g/cm ³)	(N/cm ³)	kJ/(kgK)	°C
Aluminum	(Al)	2.85 ... 3.33	30 ... 35	3.8	23	210	2.7	0.0265	0.92	660
Brass¹⁾		6.66 - 8.33	12 ... 15	1.6	18	90	8.4	0.0824		
Chromium	(Cr)	12.98	7.7	21	7.5	64	7.2	0.0705	0.68	1890
Copper	(Cu)	1.72	58	3.9	17	360	8.9	0.0878	0.38	1080
Gold	(Au)	2.43	41	4.1	14	270	19.3	0.1895	0.13	1060
Graphit	(C)	833.0	0.12	-10	7.5	80	1.7	0.0167		
Iron	(Fe)	10.0 - 14.3	7 ... 10	4.5	12	50	7.9	0.0774	0.46	1530
Lead	(Pb)	20.0	5	4.0	30	34	11.3	0.1108	0.13	330
Magnesium	(Mg)	4.54	22	4.2	26	153	1.7	0.0167	1.03	650
Mercury	(Hg)	100.0	1	0.9	182	8.4	13.6	0.1334	0.14	-39
Nichrome²⁾		100.0	1	0.17		13.0	7.9	0.0775		
Nickel	(Ni)	9.09 - 11.11	9 ... 11	4.4	13	57	8.9	0.0873	0.44	1450
Platinum	(Pt)	10.0	10	3.9	9	65	21.4	0.2104	0.13	1770
Silver	(Ag)	1.61	62	3.6	20	410	10.5	0.1029	0.23	960
Tantalum	(Ta)	14.28	7	3.5	6.5	50	16.6	0.1628	0.54	2990
Tin	(Sn)	11.11 ... 14.29	7 ... 9	4.4	27	60	7.1	0.0697	0.23	232
Titanium	(Ti)	55.56	1.8	4.1	9	16	4.5	0.0445	0.47	1700
Tungsten	(W)	5.56	18	4.0	5	120	19.3	0.1893	0.13	3380
Zinc	(Zn)	6.25	16	3.7	29	110	7.3	0.0716	0.38	419

1) Brass: 66%Cu, 34%Zn

2) Nichrome: 65%Ni, 12%Cr, 23%Fe

Part Number	Description	Page(s)
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LS-B002-3141	Ball Bearing Phase Adjuster TNC Male to TNC Female	18 - 19
LS-B002-4141	Ball Bearing Phase Adjuster TNC Female to TNC Female	18 - 19
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LS-B012-3131	Ball Bearing Phase Adjuster TNC Male to TNC Male	18 - 19
LS-B012-3141	Ball Bearing Phase Adjuster TNC Male to TNC Female	18 - 19
LS-B012-4141	Ball Bearing Phase Adjuster TNC Female to TNC Female	18 - 19
LS-B012-5151	Ball Bearing Phase Adjuster N Male to N Male	18 - 19
LS-B012-5161	Ball Bearing Phase Adjuster N Male to N Female	18 - 19
LS-B012-6161	Ball Bearing Phase Adjuster N Female to N Female	18 - 19
LS-B018-1111	Ball Bearing Phase Adjuster SMA Male to SMA Male	18 - 19
LS-B018-1121	Ball Bearing Phase Adjuster SMA Male to SMA Female	18 - 19
LS-B018-2121	Ball Bearing Phase Adjuster SMA Female to SMA Female	18 - 19
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Europe

France

ELHYTE
1, Rue du Ruisseau Blanc
B.P. 34
91620 Nozay - France
Contact Person: Yvan van Belle
Phone: {33}(1) 69-01-68 51
Fax: {33}(1) 69-01-50 75

Great Britain

Rhophase Microwave Ltd.
Rhophase House,
2 Earlstrees Court,
Earlstrees Ind. Est.,
Corby,
Northants, NN174AX
Great Britain
Contact Person: Bryon Putt
Phone: {44}(15) 36 263440
Fax: {44}(15) 36 260764

Italy

Selint S.r.l.
Viale Erminio Spalla, 41
00142 Rome - Italy
Contact Person: Roberto Mazza
Phone: {39}(6) 50-43-781/
51-91-784
Fax: {39}(6) 50-42-276

Spain and Portugal

SpanTech Ltd.
Apartado 5
Churriana,
29140 Málaga - Spain
Contact Person: Michael Chadwick
Phone: {34}(5) 262-2466
Fax: {34}(5) 262-2220
E-mail: span.@ccuma0.sci.uma.es

Sweden

RF Partner AB
Fiskhamngatan 10
414 55 Göteborg - Sweden
Contact Person: Tomas Ornstein
Phone: {46}(31) 47-51-00
Fax: {46}(31) 47-51-21

Asia

India

Deltronic Marketing Corp.
146 - 148, Chenoy Trade Centre,
Parklane
Secunderabad 500 003 - India
Contact Person: D. Khushlani
Phone: {91}(40) 819514 /867157
Fax: {91}(40) 846989 /841211
E-mail: dmci@hdl.vsnl.net.in

Israel

RCM Ltd.
P.O.B. 39844
Tel-Aviv 61397 - Israel
Contact Person: Avi Vardy
Phone: {972}(3) 6487885
Fax: {972}(3) 6487290

Japan

AmTechs Corp.
5-20-2, Kyodo
Setagaya-Ku
Tokyo 156 - Japan
Contact Person: A. Kaeriyama
Phone: {81}(3) 5450-5311
Fax: {81}(3) 5450-5312

Korea

Dongdo Trading Co., Ltd.
RM. 703, Kwang Sung Bldg.,
831-47, Youksam-Dong,
Kangnam-Ku
Seoul - Korea
Contact Person: Keol Lee
Phone: {82}(2) 556-2292
Fax: {82}(2) 556-2902