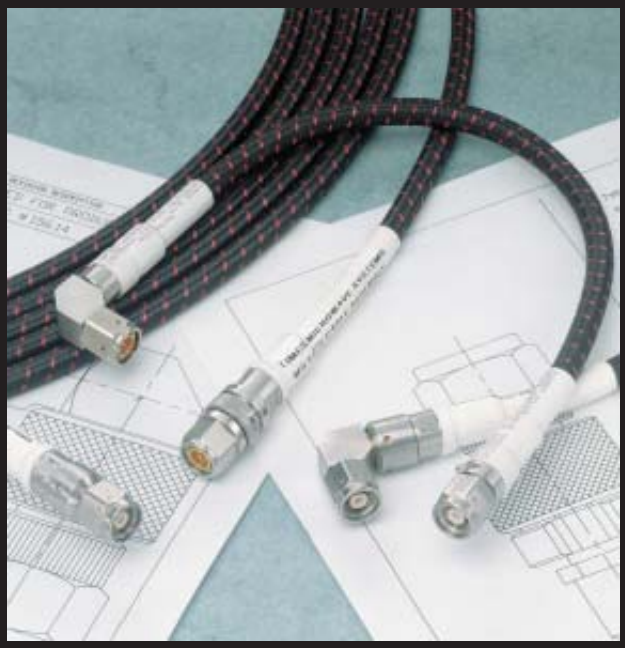
COAXIAL CABLE ASSEMBLIES PRODUCTS & CAPABILITIES



TIMES MICROWAVE SYSTEMS

TIMES MICROWAVE SYSTEMS

TIMES MICROWAVE SYSTEMS, Inc. has been designing and manufacturing coaxial cables and cable subsystems for more than fifty years. From its inception, TIMES (TMS) continues to be in the forefront of this industry, pioneering a wide range of coaxial cable and connector developments. TMS cable assemblies are used to interconnect microwave transmitters, receivers, and antennas on commercial and military airframes, missiles, ships, satellites, and ground based communications systems. TMS cable assemblies are also used as test leads for test and instrumentation applications.

TIMES MICROWAVE SYSTEMS is a technically oriented coaxial cable manufacturer that has been able to continually meet and exceed the challenges for specialty engineered transmission lines for both the commercial and military sectors, drawing upon:

- Thousands of cable and connector designs
- Material and process controls
- ISO 9001 Certification
- RF and microwave design capability
- Unique in-house testing capabilities including RF shielding/leakage, vibration, moisture/vapor sealing, phase noise, flammability, etc.
- MIL-T-81490, MIL-C-87104, and MIL-PRF-39012 experience
- FAA, FAR25, DO-160

Customized solutions to meet the system interconnect needs of our customers that you can count on day in and day out is our business. We invite you to put TIMES MICROWAVE SYSTEMS to the test:

The test of experience, innovation, and support!

TMS QUALIFICATIONS & CAPABILITIES

QUALIFICATIONS

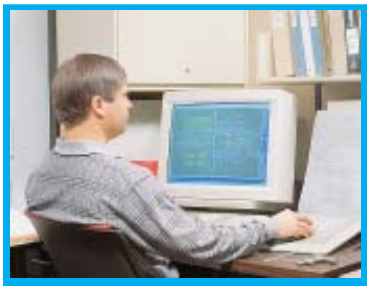
TIMES MICROWAVE SYSTEMS products are qualified for service on the following airframes and platform applications:

A-10
AGM-129A (ACM)
AH-IS COBRA
AH-64 APACHE
AIRBUS A300
AIRBUS A319
AIRBUS A320
AIRBUS A321
BAe 146
AWACS
B-52
B-717
BAe 125
BAe 146
BOEING 727
BOEING 737
BOEING 747
BOEING 757
BOEING 767
BGM-109 (TLAM & TASM)
C-17
C-130
C-160
CANADAIR CL-600
CG-47
CESSNA 208
CN 235
CP-140
DD-963
DDG-51
DDG-91
E-2C
EA-6H
EF-111
EH-101
EH-IX
F-14
F-15
F-16
F-18
F-22
F-111
F-117
GRIPEN
HARRIER
JSF
L-159
LAMPS
LOCKHEED L-1011
LYNX
McDONNELL DC-8
McDONNELL DC-9
McDONNELL DC-10
McDONNELL MD-10
McDONNELL MD-11
McDONNELL MD-80
McDONNELL MD-81
McDONNELL MD-82
McDONNELL MD-83
McDONNELL MD-87
McDONNELL MD-88
MH-47
MH-60
MIRAGE 2000-5
NIMROD MR4A
OH-X
OV-10
OV-1D
P-3C
PILATUS PC-12
PPG-7
S-3
SOCATA TBM-700
SEA KING
SH-60 BLACK HAWK
TA-4
TORNADO
V-22

MARKETS SERVED

CAPABILITIES

TIMES MICROWAVE SYSTEMS is a vertically integrated organization, allowing us to maintain complete control over all aspects of our business.



ENGINEERING:

- Complete in-house design, development, prototyping and trouble-shooting capabilities
- Four CAD stations
- Twelve network analyzers
- Degreed engineers comprise over 25% of Times Microwave Systems' workforce

TESTING:

- Complete parametric testing of all assemblies performed on state-of-the-art Network Analyzer equipment
- Assemblies sealed per MIL-T-81490 and MIL-C-87104 are verified by advanced Helium mass spectrometer equipment

QUALITY:

- Manufacturing managed by the most advanced SPC techniques
- Quality system per MIL-I-45208
- Soldering per MIL-STD-2000

TIMES QUALIFIED MILTECH™ CABLE ASSEMBLIES

Starting on page 5

MILTECH Qualified Cable Assemblies

- Manufactured to the requirements of MIL-C-87104 and MIL-T-81490, FAA FAR25 and DO-160
- Fully vapor sealed for system longevity
- Highly ruggedized for severe environments
- Used on the most advanced commercial and military platforms

Starting on page 18

Special Products

- Phase matched/Amplitude matched cable assemblies
- Phase adjustable trimmers
- Equalized cable assemblies
- Millimeter wave cable products
- 18 GHz test leads
- Test adapters
- Tools

Starting on page 22

MILTECH Qualified Cable Assemblies

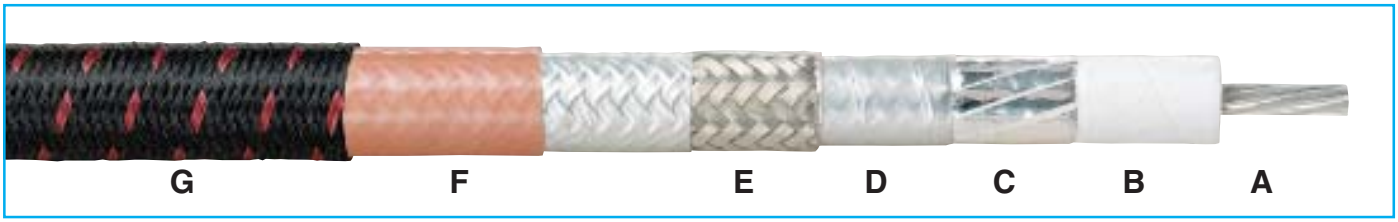
- Standard interface for the F-22
- 1.2:1 VSWR per mated pair through 20 GHz
- Available for flexible and semi-rigid cables from 0.086"/2.18 mm through 0.340"/8.64 mm OD
- Many sizes available
- Redundant gasket seals
- Qualified for high vibration environments
- Simple field replacement of individual cables

TIMES QUALIFIED MILTECH™ CABLE ASSEMBLIES

The Times Qualified *MILTECH* family of hermetically sealed flexible RF and microwave transmission line assemblies are optimized and qualified for commercial, military and other demanding applications. The proprietary application of a spiral flat strip braid results in a cable assembly with superior phase coaxial cables without sacrificing flexibility! There are now three versions of the popular *MILTECH* 340 cable, all providing the same electrical performance, but allowing a choice of cable weights – ideal for applications where both low loss and reduced weight are required. These *MILTECH* cable assemblies exhibit extremely long life in the rigorous environments found in airborne, shipboard and ground based applications.

TMS distinguishes itself by designing and manufacturing the cable, the connectors, and the cable/connector junction. This engineered integration of cable and connectors makes TMS cable assemblies unique. The integration optimizes the electrical and mechanical performance and includes a 1 x 10^{-5} cc/sec/ft vapor seal that ensures longevity. This control of the cable/connector interface guarantees the right mix of electrical and mechanical characteristics, strength and durability, resulting in a broadband transmission line perfectly suited for severe environments.

Cable Characteristics



Cable materials – typical

A Center conductor – Solid silver-plated copper*
A Dielectric – Taped polytetrafluoroethylene
C First shield – Silver-plated copper strip
D Interlayer – Aluminum backed tape
E Second shield – Silver plated copper braid
F Vapor shield – composite tapes/extruded FEP
G Outer jacket – Nomex ®

*Solid silver-plated copper covered steel on *MILTECH 210*
Stranded silver-plated copper on *MILTECH 480*

Times qualified *MILTECH* flexible RF and microwave transmission line assemblies described here meet the following performance criteria:

Cable Type	Recommended Cable Clamp
MILTECH 210	MS2919-4
MILTECH 230	MS2919-4
MILTECH 265	MS2919-5
MILTECH 340	MS2919-7
MILTECH 480	MS1919-8

Times Qualified *MILTECH* Cable

Times Qualified Assembly Type	Cable Diameter (In./mm.)	Loss@ 18 GHz (dB/ft.)	TMS Specification	Minimum Bend Radius (In./mm.)	Mass
MILTECH™ 210	0.21/5.3	0.48	*MILTECH 210*	1.00/25.4	0.035lb/ft (52g/m)
MILTECH™ 230	0.23/5.8	0.38	*MILTECH 230*	1.15/29.2	0.045lb/ft (68g/m)
MILTECH™ 265	0.265/6.7	0.32	*MILTECH 265*	1.30/33.0	0.065lb/ft (97g/m)
MILTECH™ 340	0.34/8.6	0.22	*MILTECH 340*	1.90/48.3	0.105lb/ft (157g/m)
MILTECH™ 340XL	0.34/8.6	0.22	*MILTECH 340XL*	1.90/48.3	0.080lb/ft (120g/m)
MILTECH™ 340EL	0.34/8.6	0.22	*MILTECH 340EL*	1.90/48.3	0.070lb/ft (105g/m)
MILTECH™ 480	0.46/12.2	0.13 (@ 10 GHz)	*MILTECH 480*	2.25/57.2	0.200lb/ft (303g/m)

DETAILED PERFORMANCE SPECIFICATIONS

Times qualified *MILTECH* flexible RF and microwave transmission line assemblies described here meet the following performance criteria:

Electrical Characteristics

Tested frequency range	0.5 to 18 GHz (10 GHz for *MILTECH 480*)
Characteristic impedance	50 Ohms
VSWR	1.4:1 maximum; add 0.05 per angle connector
Insertion loss	see following pages
Velocity of propagation	76% Nom. For *MILTECH* 210, 230, 265 80% Nom. For *MILTECH* 340/340XL 78% Nom. For *MILTECH* 480
Maximum operating voltage	2500 Volts (1000 Volts with SMA) 1000 Volts for *MILTECH 210 and 230*
RF leakage	-90 dB maximum per foot over tested Frequency range including connectors
Insertion loss stability	In accordance with MIL-T-81490
VSWR stability	In accordance with MIL-T-81490

Mechanical Characteristics

Temperature range	-55°C to +200°C
Chemical resistance	In accordance with MIL-T-81490 and MIL-C-87104
Flexure	In accordance with MIL-T-81490 and MIL-C-87104
Salt fog	In accordance with MIL-T-81490 and MIL-C-87104
Humidity	In accordance with MIL-T-81490 and MIL-C-87104
Abrasion resistance	In accordance with MIL-T-81490 and MIL-C-87104
Cable/connector tensile strength	45 lbs. minimum (*MILTECH 210, 230, 265)* 75 lbs. minimum (*MILTECH 340/340XL, 480)*
Vapor leakage	1 x 10^{-5} cc/sec/ft of Helium maximum including connectors
Vibration	In accordance with MIL-T-81490
Shock	In accordance with MIL-T-81490

Assembly Performance Overview

Electrical characteristics – All of the cable assembly styles noted above provide low loss, low VSWR and inherently stable performance. These sealed transmission line products provide the longest service life available.

Mechanical characteristics – The cable assemblies are designed, manufactured and tested to provide reliable interconnections in the most demanding installations and environments. This unparalleled combination of bending, torque and tensile strengths guarantee a long service life.

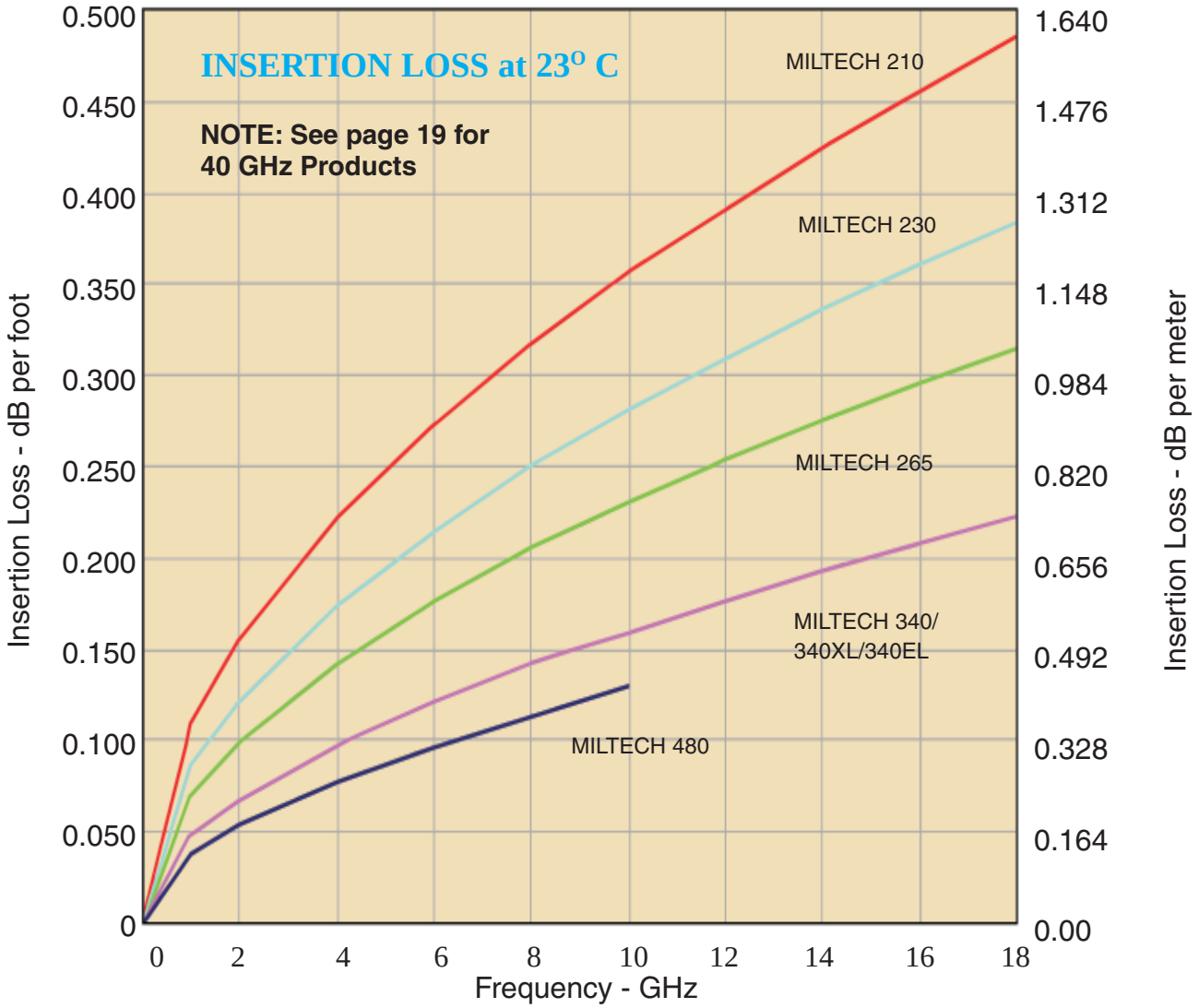
Insertion loss - Following is a graph of loss vs. frequency for *MILTECH* cables and equations to be used for calculating the loss at specific frequencies.

Testing - Each cable assembly is measured for insertion loss and VSWR over the test frequency range.

Connectors - All of the connectors used in these cable assemblies are of precision stainless steel design which meet or exceed the requirements of MIL-PRF-39012. They are uniquely designed to provide maximum electrical, mechanical and environmental performance.

INSERTION LOSS

The following graph illustrates the cable insertion loss for each *MILTECH* cable at specific frequencies. The insertion loss at intermediate frequencies can be calculated from the formula below for each cable type. The loss for each pair of connectors must be added to the overall cable loss to determine the insertion loss for the complete cable assembly.



Insertion loss at intermediate frequencies can be calculated as follows:

$IL = K_1 \times SqRt(FMHz) + 0.000146 \times (FMHz)$ dB per 100 feet

or

$IL = K_2 \times SqRt(FMHz) + 0.000480 \times (FMHz)$ dB per 100 meters

(where FMHz is the frequency in MHz)

Cable Type	K_1, dB/100 feet.	K_2, dB/100 meters.
MILTECH 210	0.34158	1.1207
MILTECH 230	0.26643	0.87390
MILTECH 265	0.21603	0.70876
MILTECH 340/340XL /EL	0.14582	0.47775
MILTECH 480	0.11462	0.37605

CONNECTOR LOSS

Frequency MHz	Straight connectors* Connector loss/pr.
500	0.075
1000	0.10
2000	0.15
4000	0.20
6000	0.22
8000	0.25
10000	0.27
12000	0.28
14000	0.30
16000	0.31
18000	0.33

Insertion Loss @23°C

*For angled connectors, add 0.1dB/conn.

POWER HANDLING

The power handling values shown here apply to complete *MILTECH* assemblies with TNC connectors, based on a maximum assembly component temperature of 200°C. Figures 1 and 2 below illustrate the average power handling capability of the cable at 25° C/sea level and at 100°C/70,000 ft. *MILTECH* assemblies may be used at higher power levels if required, however, high ambient temperature and high altitude reduce the power rating of a particular cable by impeding the heat transfer out of the cable. The CW power rating must be derated by a correction factor for the ambient temperature and altitude. For estimated power ratings in conditions other than those shown, the derating factors shown in Tables 1 and 2 must be applied to the 25°C/sea level data to determine the power handling capability. Please consult the factory or your TMS representative for special conditions or requirements.

Fig. 1: MILTECH Maximum Power Handling Characteristics
25°C/Sea Level

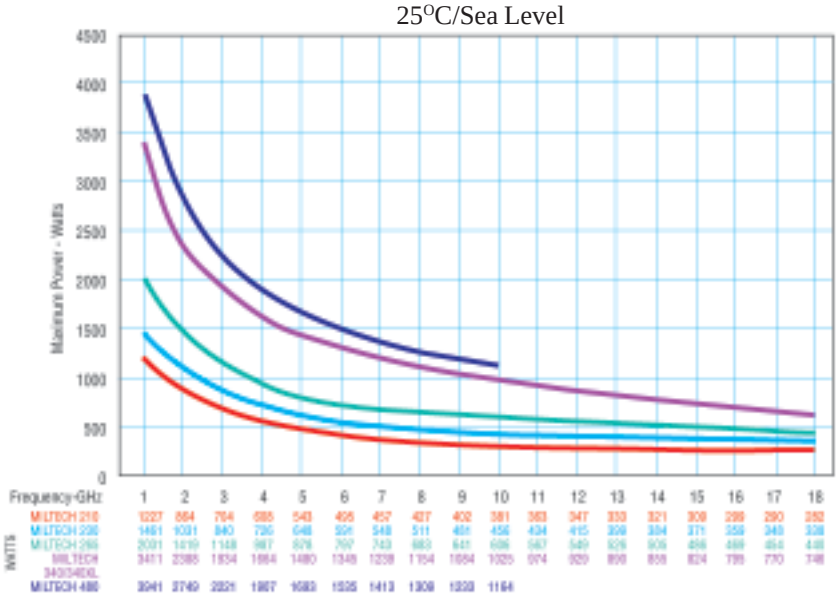


Fig. 2: MILTECH Maximum Power Handling Characteristics
100°C/70,000 ft. (21.34 km)

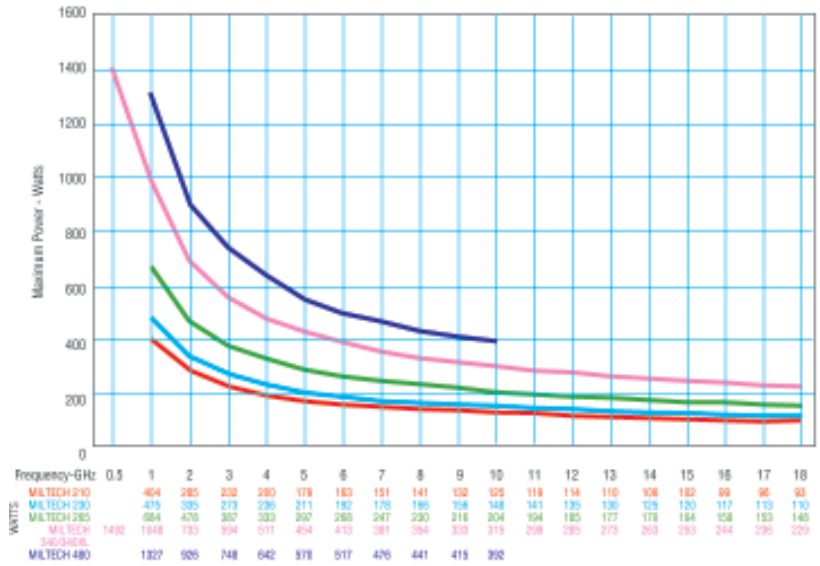


Table 1
Altitude Correction Factor

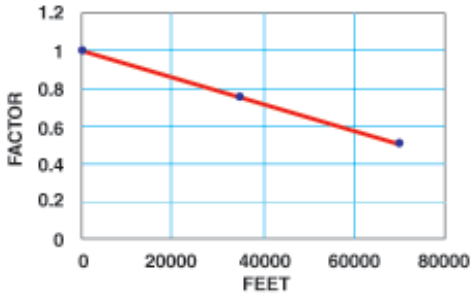
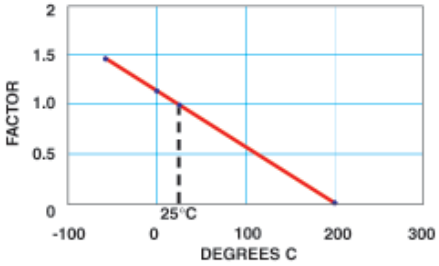


Table 2
Temperature Correction Factor



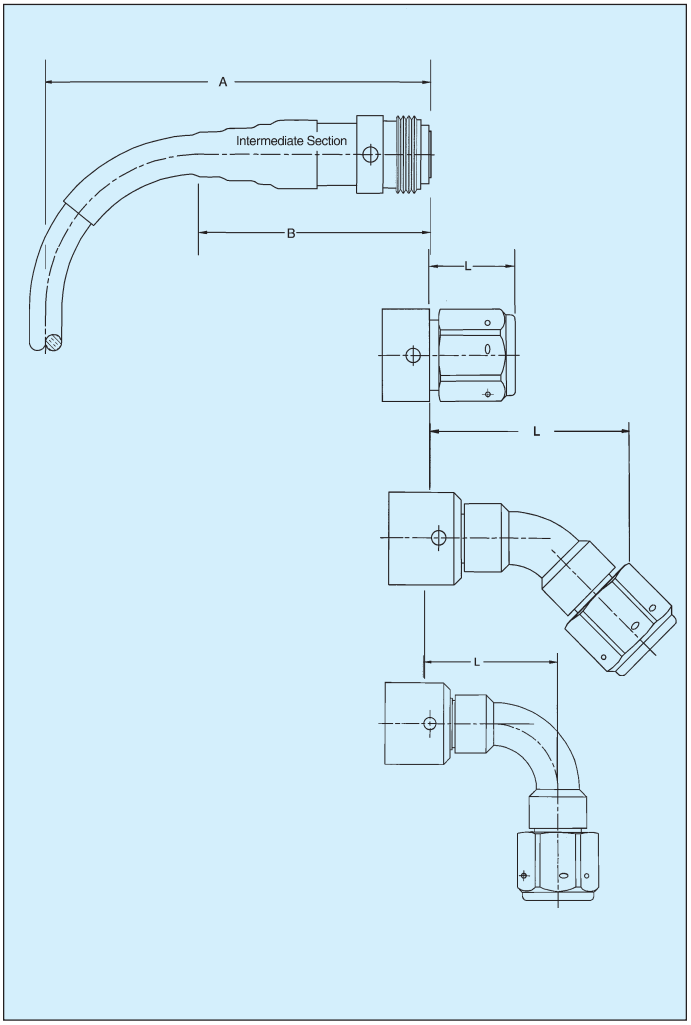
Apply straight line derating factors, as follows:
TEMPERATURE: Choose the applicable power level from the 25ºC/sea level chart and multiply by the correction factor corresponding to the desired ambient temperature.
ALTITUDE: After obtaining the temperature adjusted power handling, multiply by the correction factor corresponding to the desired ambient altitude.

MILTECH™ CABLE ASSEMBLY CONFIGURATIONS

MILTECH cable assemblies consist of a *MILTECH* cable terminated with specially designed and fabricated connectors. *TIMES MICROWAVE SYSTEMS* manufactures a complete line of connectors to complement the *MILTECH* coaxial cables. The completed assemblies are available with either non-replaceable or replaceable connectors. The replaceable feature allows a damaged front end interface to be quickly replaced in the field without the need to remove the complete transmission line. All connector interfaces are designed to comply with various requirements of *MIL-STD-348, MIL-PRF-39012, MIL-C-87104, OR MIL-T-81490* and feature passivated stainless steel bodies and coupling nuts, PTFE dielectrics and gold-plated beryllium copper center contacts. An intermediate section, ruggedly attached to the cable itself, provides the point of attachment for the replaceable connector front end without sacrificing the vapor seal of the cable assembly. To determine the insertion loss for the complete assembly, add the cable loss to the connector loss shown on page 7.

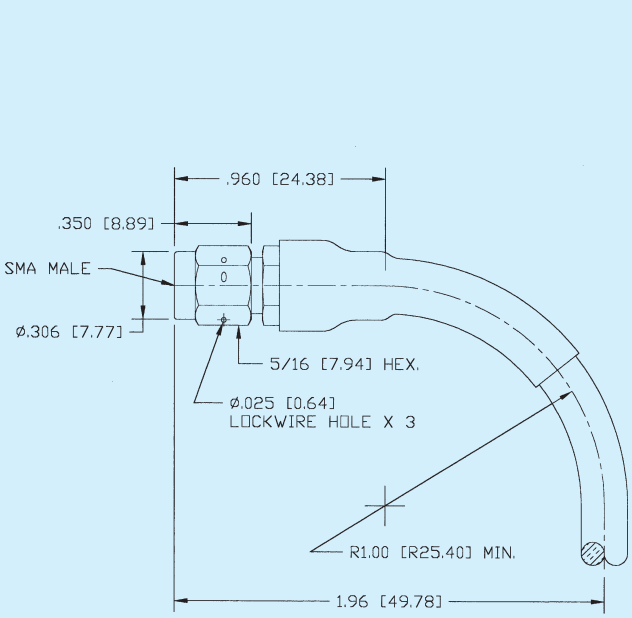
MILTECH™ Cable Assembly Connector Envelopes

The installation envelopes for common *MILTECH* connectors installed on cables can be determined from the data on the following pages organized by the specific *MILTECH* cable size. The figure shown represents a typical transmission line assembly with the intermediate section attached. Dimension A is the distance from the front end dimension datum to the centerline of the cable when bent 90 degrees at the minimum bend radius of the cable. Dimension B is the solid length of the intermediate section where a cable can begin to be bent. Care must be exercised to be sure that the minimum bend radius of the cable is not reduced. For applications where space is limited, an angled connector (30, 45, or 90 degrees) should be considered to minimize stresses placed on the cable-to-connector junction. To determine the overall installation envelope, simply add dimension A to the overall connector length L. Dimensions for all replaceable front end connectors can be found on pages 14-17.

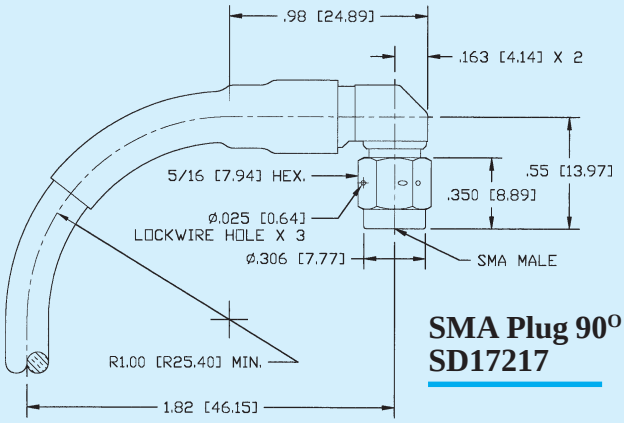


MILTECH™ 210 ENVELOPE DIMENSIONS

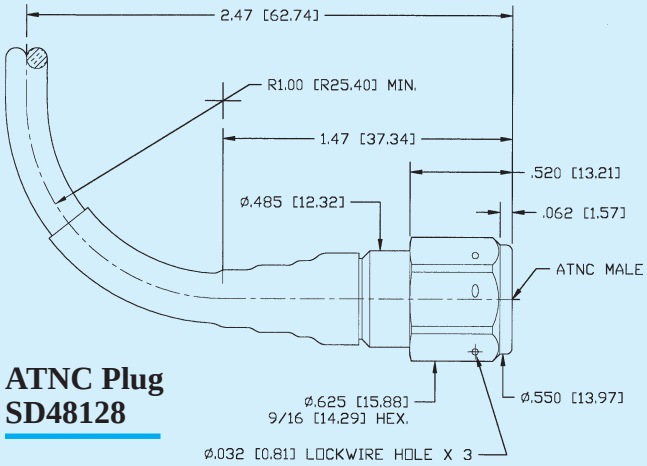
Non-replaceable Connectors



SMA Plug
SD17218

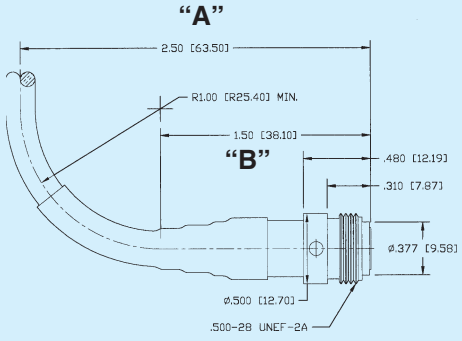


SMA Plug 90°
SD17217



ATNC Plug
SD48128

Replaceable Connectors

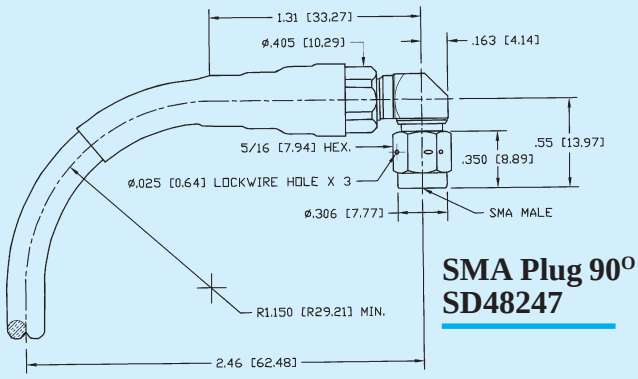


Connector Type	Part Number	Weight (oz/g)	Tool P/N
N Plug	SD48721	0.97/28	TN550-688
SMA Plug	SD48530	0.62/18	TN550-625
TNC Plug	SD48555	0.62/18	TN550-625
TNC Jack BKHD	SD48590	0.79/23	TN550-625
TNC Plug 90°	SD48572	1.41/40	TN550-625
TNC Plug 45°	SD48576	1.32/38	TN550-625
TK Plug	SD48554	0.73/21	TN550-625
Intermediate Section	SD17966	1.28/37	TN550-500

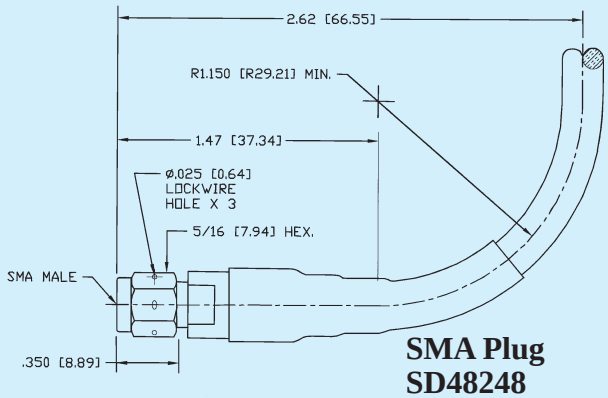
Dimensions for all replaceable connectors may be found on pages 14-17.

MILTECH™ 230 ENVELOPE DIMENSIONS

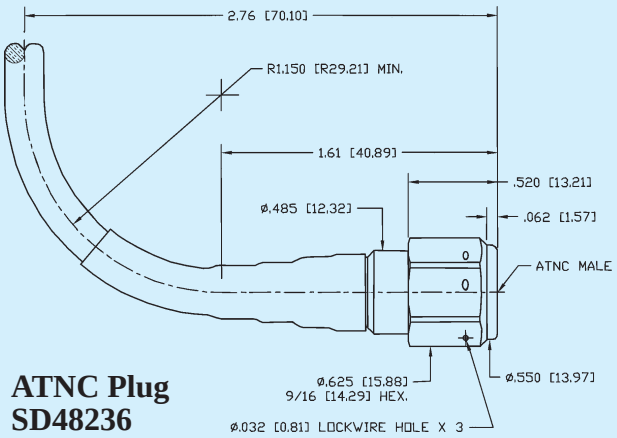
Non-replaceable Connectors



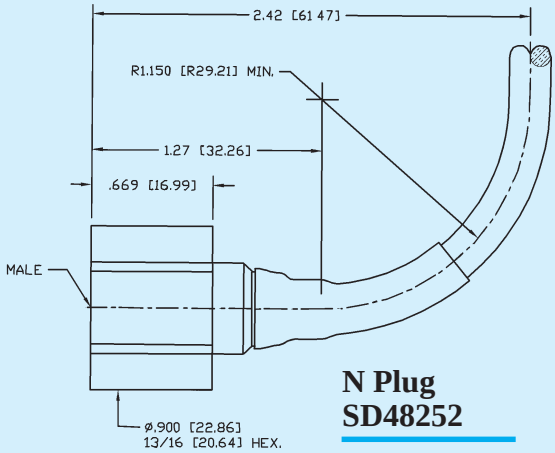
SMA Plug 90°
SD48247



SMA Plug
SD48248

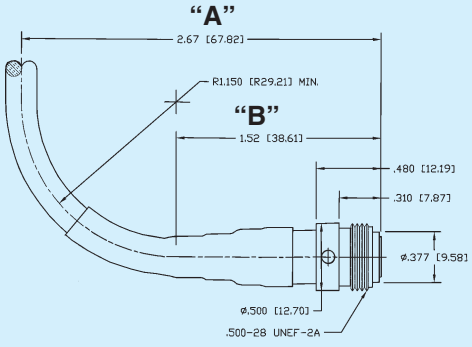


ATNC Plug
SD48236



N Plug
SD48252

Replaceable Connectors

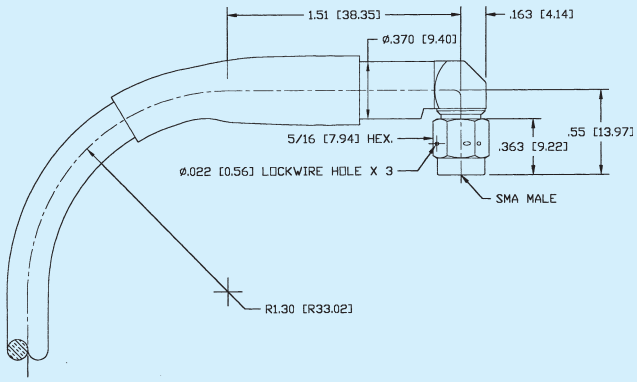


Connector Type	Part Number	Weight (oz/g)	Tool P/N
N Plug	SD48721	0.97/28	TN550-688
SMA Plug	SD48530	0.62/18	TN550-625
TNC Plug	SD48555	0.62/18	TN550-625
TNC Jack BKHD	SD48590	0.79/23	TN550-625
TNC Plug 90°	SD48572	1.41/40	TN550-625
TNC Plug 45°	SD48576	1.32/38	TN550-625
TK Plug	SD48554	0.73/21	TN550-625
Intermediate Section	SD17966	1.28/37	TN550-500

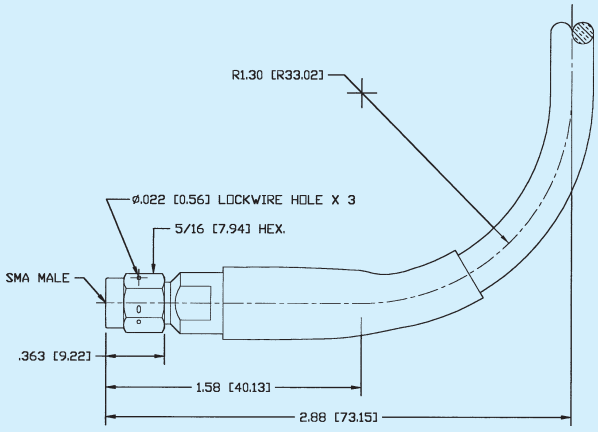
Dimensions for all replaceable connectors may be found on pages 14-17.

MILTECH™ 265 ENVELOPE DIMENSIONS

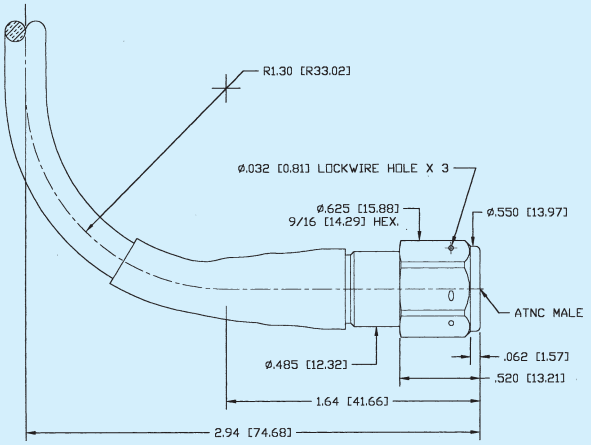
Non-replaceable Connectors



SMA Plug 90°
SD48217

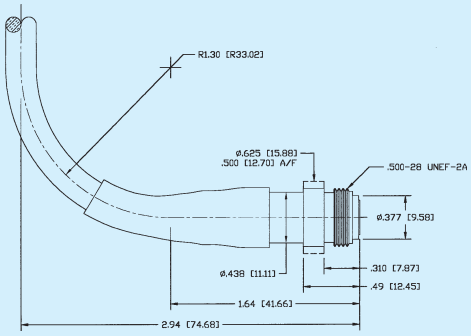


SMA Plug
SD48214



ATNC Plug
SD48190

Replaceable Connectors

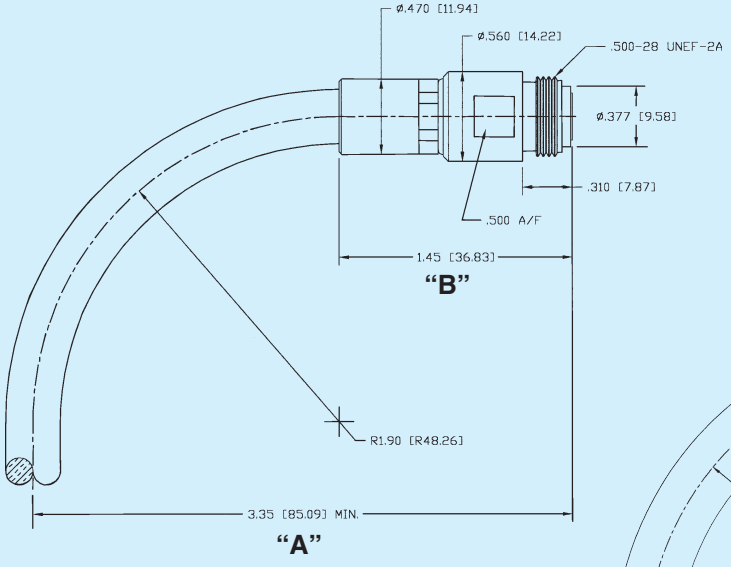


Connector Type	Part Number	Weight (oz/g)	Tool P/N
N Plug	SD48721	0.97/28	TN550-688
SMA Plug	SD48530	0.62/18	TN550-625
TNC Plug	SD48555	0.62/18	TN550-625
TNC Jack BKHD	SD48590	0.79/23	TN550-625
TNC Plug 90°	SD48572	1.41/40	TN550-625
TNC Plug 45°	SD48576	1.32/38	TN550-625
TK Plug	SD48554	0.73/21	TN550-625
Intermediate Section	SD17945	1.128/32	1/2” Open End

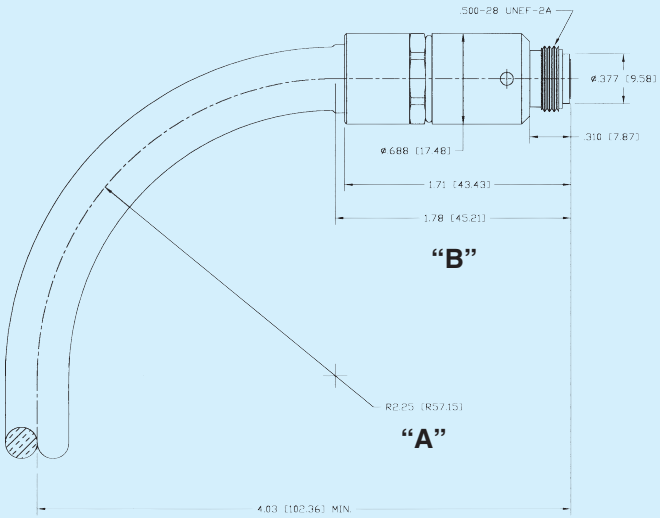
Dimensions for all replaceable connectors may be found on pages 14-17.

MILTECH 340/340XL and MILTECH 480

MILTECH 340/340XL/EL



MILTECH 480



Standard Replaceable Connectors

COMMON FRONT ENDS

Connector Type	Part Number	Weight (oz/g)	Tool P/N
ATNC Plug	SD48555	0.62/18	TN550-625
ATNC Plug 45°	SD48576	1.32/38	TN550-625
ATNC Plug 90°	SD48572	1.41/40	TN550-625
ATNC Plug 90°	SD48573	1.50/43	TN550-625
ATNC Jack	SD48601	0.62/18	TN550-625
ATNC Jack BKHD	SD48590	0.79/23	TN550-625
ATNC 90° Jack BKHD	SD48609	1.58/45	TN550-625
ATNC 90° Jack BKHD	SD48569	1.76/50	TN550-625
N Plug	SD48721	0.97/28	TN550-688
N Plug 90°	SD48628-1	2.06/59	TN550-625
N 90° Jack BKHD	SD48629	2.90/83	TN550-625
N Jack BKHD	SD48667	1.25/36	TN550-625
SC Plug	SD48642	1.65/47	TN550-688
SC Jack BKHD	SD48680	2.50/71	TN550-625
SMA Plug	SD48530	0.62/18	TN550-625
SMA Plug 90°	SD48608	1.02/30	TN550-625
TK Plug	SD48554	0.73/21	TN550-625
MILTECH 340/340XL Int. Sec	SD17944	1.12/32	½" Open End
MILTECH 480 Int. Sec.	SD17935	1.60/46	TN550-688

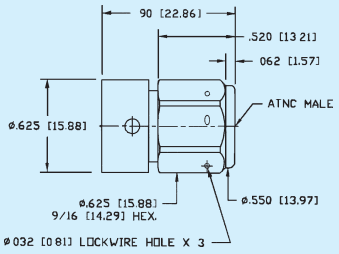
Self-Locking Replaceable Connectors

COMMON FRONT ENDS

Connector Type	Part Number	Weight (oz/g)	Tool P/N
ATNC Plug	SD48606	1.06/30	TN550-688
ATNC Plug 90°	SD48645	2.11/60	TN550-625
N Plug	SD48669	1.55/44	TN550-625
N Plug 90°	SD48647	2.55/73	TN550-625
SMA Plug	SD48689	1.30/37	TN550-625
SMA Plug 90°	SD48688	0.70/20	TN550-625
TNC Plug 45°	SD48674	2.15/61	TN550-625

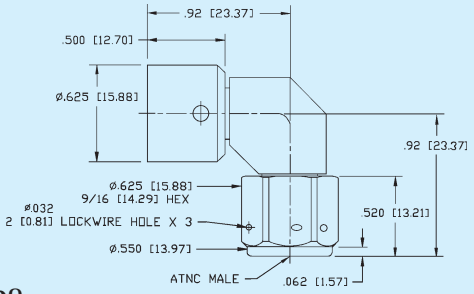
Dimensions for all replaceable connectors may be found on pages 14-17

MILTECH™ REPLACEABLE FRONT END CONNECTORS



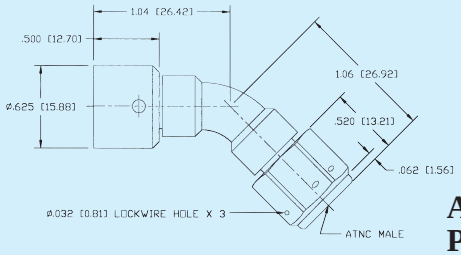
L = 0.605 (15.37)

ATNC Plug SD48555



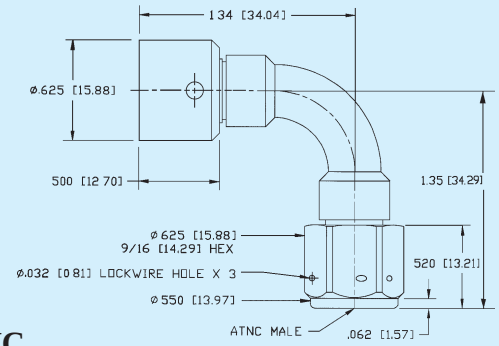
ATNC Plug 90° SD48573

L = 0.640 (16.26)



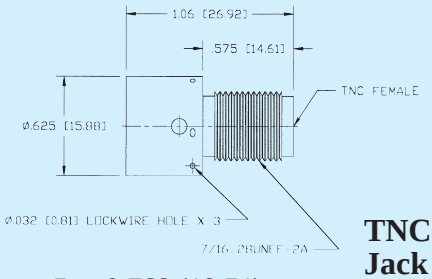
L = 1.505 (38.23)

ATNC Plug 45° SD48576



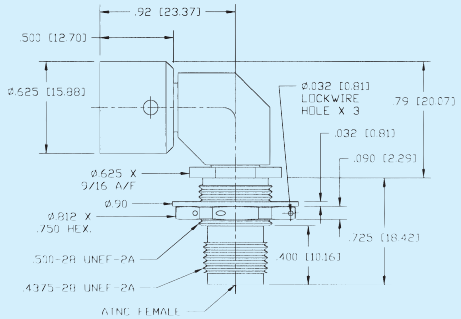
ATNC Plug 90° SD48572

L = 1.05 (26.67)



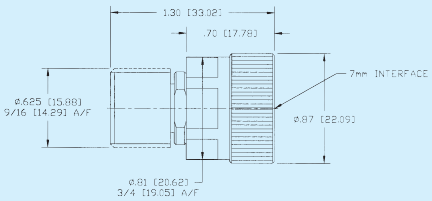
L = 0.768 (19.51)

TNC Jack SD48621-1



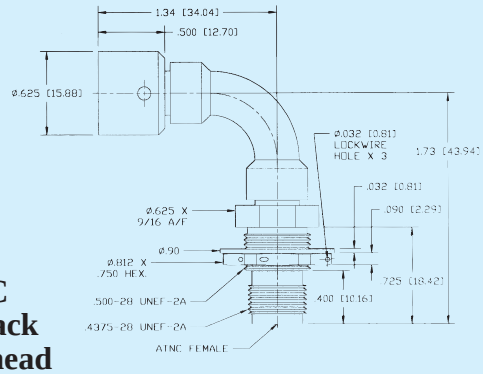
ATNC 90° Jack Bulkhead SD48609

L = 0.640 (16.26)



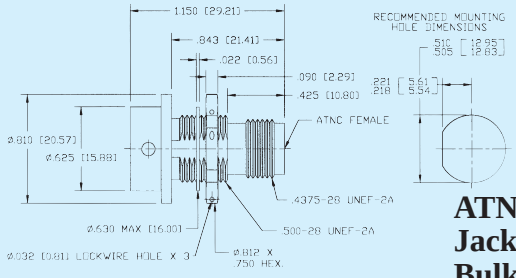
L = 1.050 (26.67)

7MM SD48703



ATNC 90° Jack Bulkhead SD48569

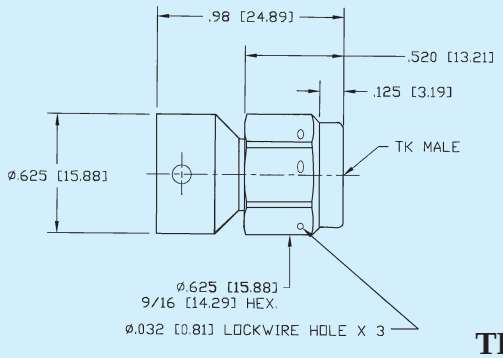
L = 1.05 (26.67)



L = 0.863 (21.92)

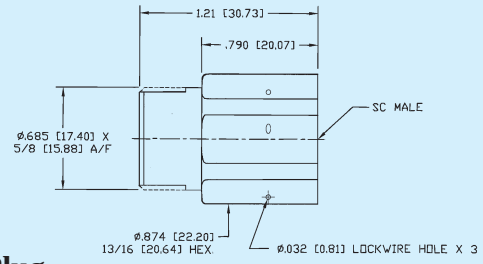
ATNC Jack Bulkhead SD48590

MILTECH™ REPLACEABLE FRONT END CONNECTORS



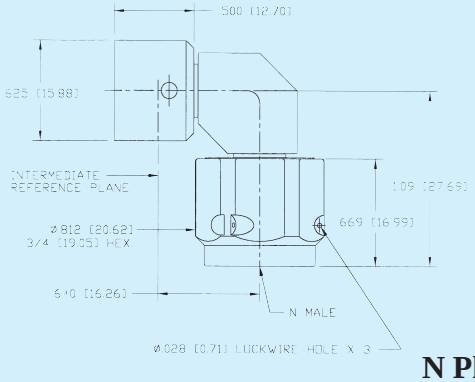
TK Plug
SD48554

L = 0.690 (17.53)



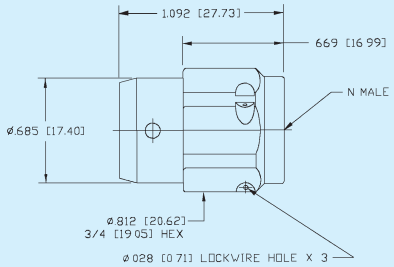
SC Plug
SD48642

L = 0.915 (23.24)



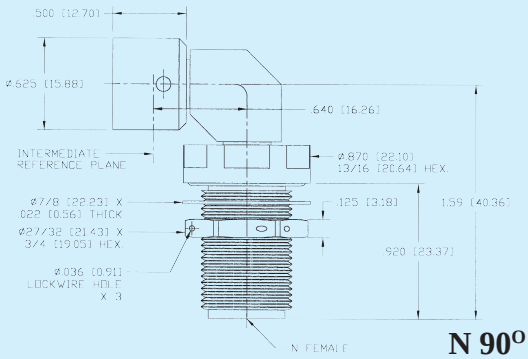
N Plug 90°
SD48628-1

L = 0.640 (16.26)



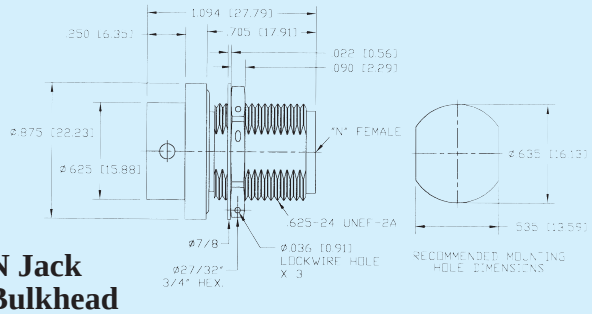
N Plug
SD48721

L = 0.802 (20.37)



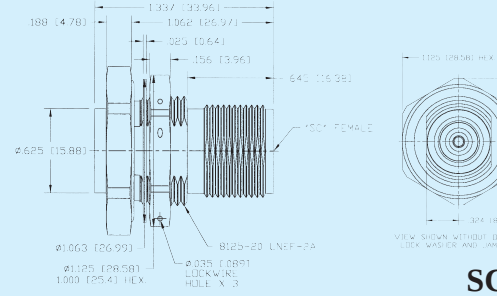
N 90° Jack
Bulkhead
SD48629

L = 0.640 (16.26)



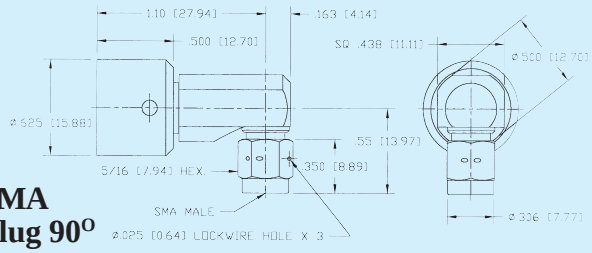
N Jack
Bulkhead
SD48667

L = 0.805 (20.45)



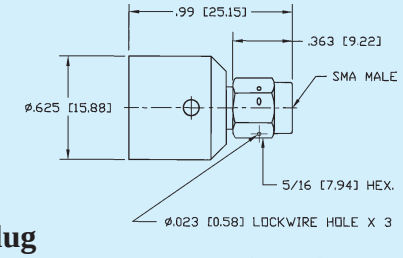
SC Jack
Bulkhead
SD48680

L = 1.047 (26.59)



SMA
Plug 90°
SD48608

L = 0.815 (20.70)



SMA Plug
SD48530

L = 0.700 (17.78)

SELF LOCKING CONNECTORS

TIMES MICROWAVE SYSTEMS has been a pioneer in the development of self-locking connectors for high performance connectors used in the aerospace industry. Originally developed for the USAF F-15 Program, the self-locking feature eliminates the need for expensive torque wrenches and makes the mating connection a simple, one hand operation! The self-locking feature eliminates the need for time consuming safety wire connectors, yet they provide positive engagement during vibration. All interfaces comply with MIL-PRF-39012 and the connectors are made from the same high quality corrosion resistant materials used on other TMS connectors.

Illustrated below are two different styles of self-locking connectors. Figure 1 utilizes a "lock collar" to provide the locking mechanism and is typically used on smaller connectors, i.e. SMA. Figure 2 utilizes a "bayonet" locking collar and is typically used on larger connectors. Both designs incorporate a knurled outer surface for slip free hand operation. Both are illustrated in the locked and unlocked positions.

Figure 1

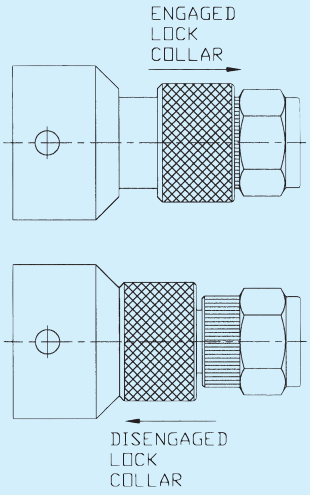
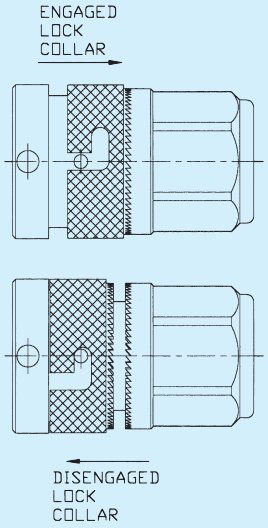
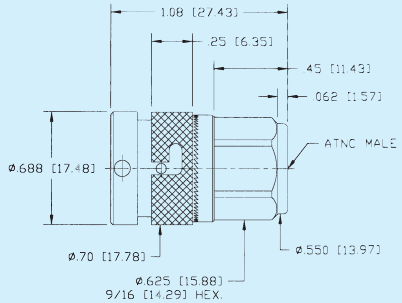


Figure 2

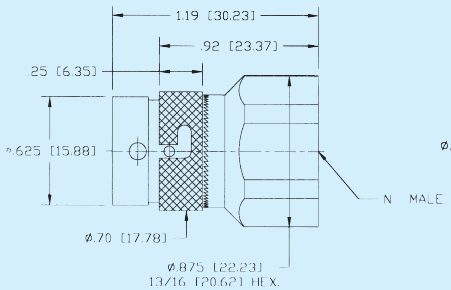


MILTECH™ REPLACEABLE FRONT END SELF-LOCKING CONNECTORS



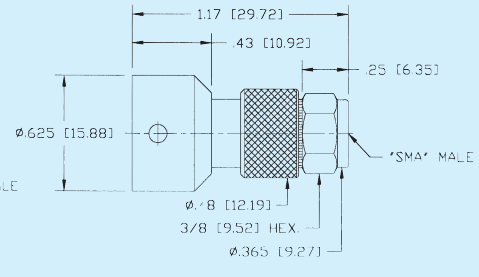
L = 0.788 (20.02)

ATNC Plug
SD48606



L = 0.905 (22.99)

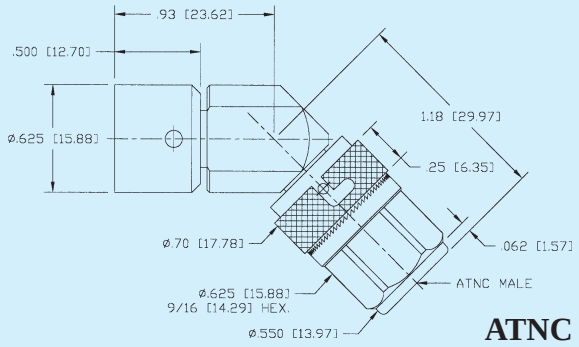
N Plug
SD48669



L = 0.878 (22.30)

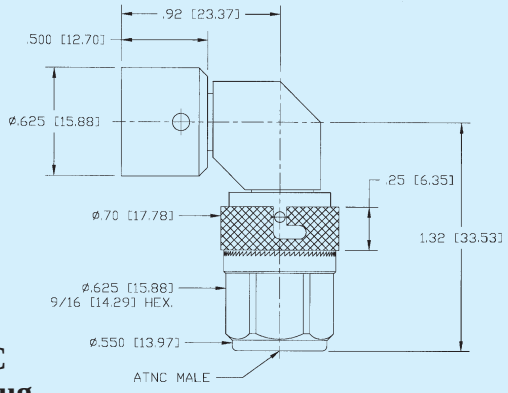
SMA Plug
SD48689

MILTECH™ REPLACEABLE FRONT END SELF-LOCKING CONNECTORS



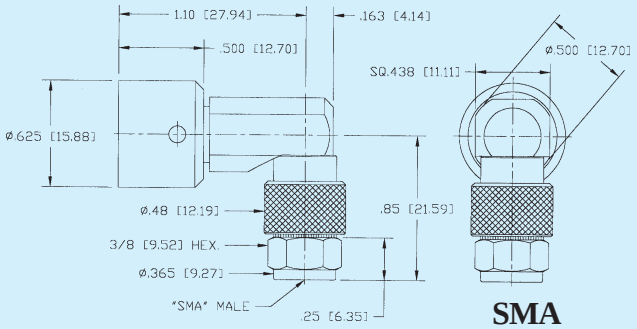
ATNC
45° Plug
SD48674

L = 1.475 (37.47)



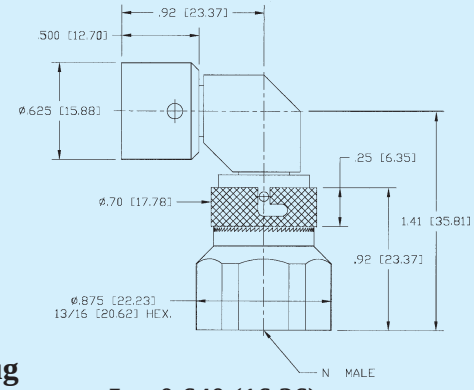
ATNC
90° Plug
SD48645

L = 0.640 (16.26)



SMA
Plug 90°
SD48688

L = 0.815 (20.70)



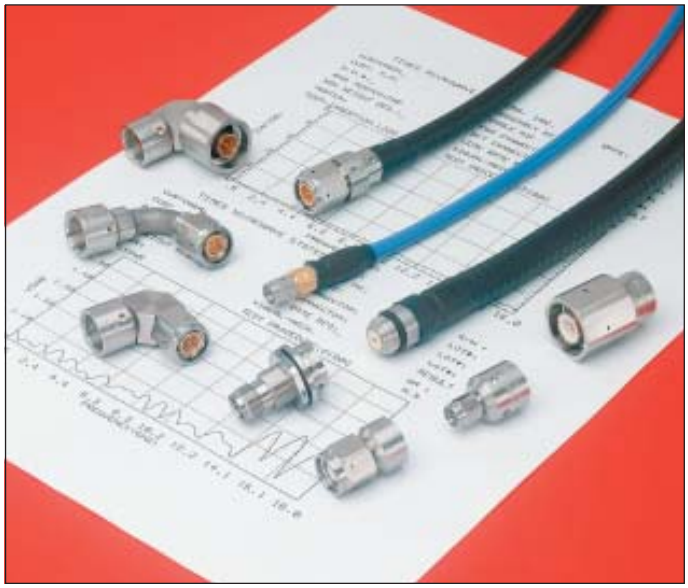
N
90° Plug
SD48647

L = 0.640 (16.26)

SPECIALIZED CONNECTORS

TIMES MICROWAVE SYSTEMS has produced specialized connectors for unique applications that require modifications to the standard connectors and interfaces. Most are manufactured to the requirements of MIL-T-81490, MIL-C-87104 and MIL-PRF-39012. With almost 10,000 connector designs to choose from, there's a good chance that we have the connector you need for your application with little or no modification.

Please contact us regarding your specific requirements.



PHASE MATCHED/AMPLITUDE MATCHED CABLE ASSEMBLIES

TIMES MICROWAVE SYSTEMS has extensive experience in the design and manufacture of phase and amplitude matched cable assemblies for use in a broad range of applications. We fabricate and store reference standards. In many cases, our existing cable designs will satisfy the requirements, however, when necessary, a new cable can be designed to meet the specific application.

For phase sensitive applications, *TIMES MICROWAVE SYSTEMS* has a dedicated temperature and humidity controlled facility in which we assemble and test all high precision, phase-matched cable assemblies. Our facility includes HP8510 Vector Automatic Network Analyzers.

Precise temperature and humidity control allows us to establish an unmistakable reference base line for all tests related to phase. This dedicated facility is used for both the development and high-volume production of cable assemblies. The primary benefits of such a dedicated facility include unambiguous results and prompt delivery of cable assemblies that meet the most demanding state-of-the-art requirements such as those found in MIL-C-87104 or MIL-T-81490.

Please contact us regarding your specific needs.

PHASE ADJUSTABLE TRIMMERS

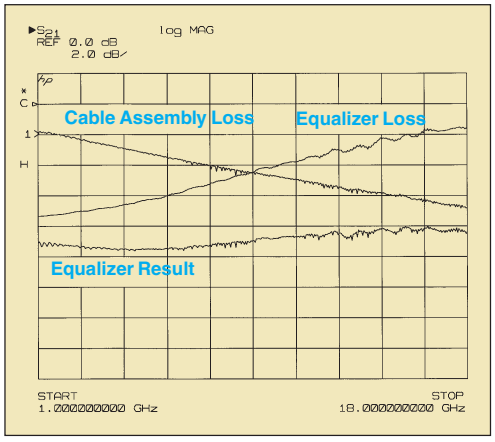
As high performance aircraft are upgraded with the latest technology EW and ESM systems, the need for phase matched cable assemblies is increasing. Phased array antennas often need multiple cable assemblies that require the cable assemblies to be phase matched after they are installed in the aircraft, some of which are routed through areas that subject the cables to multiple bends and twists, ofTEN exceeding the capabilities of the most phase stable cables. *TIMES MICROWAVE SYSTEMS* has developed in-line phase trimmers qualified to MIL-T-81490 requirements that can be adjusted to compensate for phase changes that occur as the result of installation. Typical phase adjustment is +/-100 degrees at 18 GHz.

Please contact us regarding your specific needs.

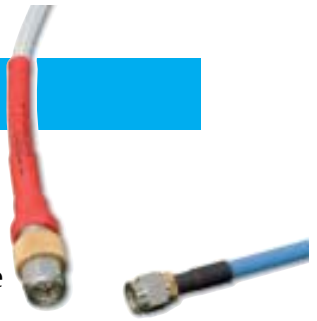
EQUALIZED CABLE ASSEMBLIES

For applications requiring a flat signal response as the frequency is swept, *TIMES MICROWAVE SYSTEMS* has developed cable assemblies with built-in signal equalizers. As most aerospace applications require commonality between “black boxes” for ease of maintenance and repair, a cable assembly with a built-in equalizer eliminates the need to incorporate the equalizer with the LRU. The equalizer is uniquely packaged to fit into the back end of the connector, with a minimal increase in the overall connector length. For existing cable assemblies, the equalizer can be packaged into a simple adapter that mates with the cable connector. *TIMES MICROWAVE SYSTEMS* can design an equalizer assembly that will maintain a flat signal response over a wide frequency range.

Please contact us regarding your specific needs.



MILLIMETER WAVE CABLE ASSEMBLIES



TIMES MICROWAVE SYSTEMS millimeter wave coaxial cable assemblies are designed to meet MIL-T-81490 as applicable and provide a highly reliable and ruggedized answer to your difficult signal transmission problems. Available in two cable sizes, these cable assemblies deliver lower losses (down to 0.820 dB/ft. at 40 GHz) and improved flexibility while maintaining an amplitude change during flexure of less that 0.1 dB.

Our standard construction, designed for maximum flexibility, can replace 0.141"/3.58mm hard-line in many internal "black box' applications, eliminating costly tooling expenses and facilitating assembly and repair. Typical applications extend to equipment racks, test leads and low cost equipment interconnections as well. These highly reliable assemblies will survive high concentrated loads and flexure without degradation in electrical performance.

Technical Data

	MILTECH 130 **0.130"/3.30mm Cable Assemblies**	*MILTECH 175* **0.175"/4.45 mm Cable Assemblies**
Electrical performance:		
Maximum VSWR:2-12.4 GHz	1.30:1	1.30:1
12.4-40 GHz	1.40:1	1.40:1
Maximum insertion loss:	0.98dB per ft @ 40 GHz	0.82dB per ft @ 40 GHz
	0.78dB per ft @ 26 GHz	0.66dB per ft @ 26 GHz
	0.65dB per ft @ 18 GHz	0.54 dB per ft @ 18 GHz
Shielding efficiency:	Better than –90dB	Better than –90dB
Mechanical performance:		
Connector retention:	25 lbs.	35 lbs.
Minimum bend radius:	0.650"	0.875"
Environmental performance:		
Temperature range:	-65 to +200°C	-65 to +200°C
Moisture resistance:	MIL-STD 202, Method 106	MIL-STD 202, Method 106
Vibration:	MIL-STD 202, Method 204, Cond. C	Mil-STD 202, Method 204, Cond. C
Shock:	MIL-E-5272, Para. 4.15.5.1	MIL-E-5272,Para 4.15.5.1
Connectors:		
Passivated stainless steel	2.9 mm, plug and jack (K)	2.9 mm, plug and jack (K)
	2.4 mm, plug and jack	2.4 mm, plug and jack

Please contact us regarding your specific needs.

MILLIMETER WAVE CABLE ASSEMBLIES

- Operation to 40 GHz • MIL-T-81490 features
- Stainless steel connectors
- 2 sizes for low insertion loss
- Operation to 200°C

Insertion loss at intermediate frequencies can be calculated as follows:

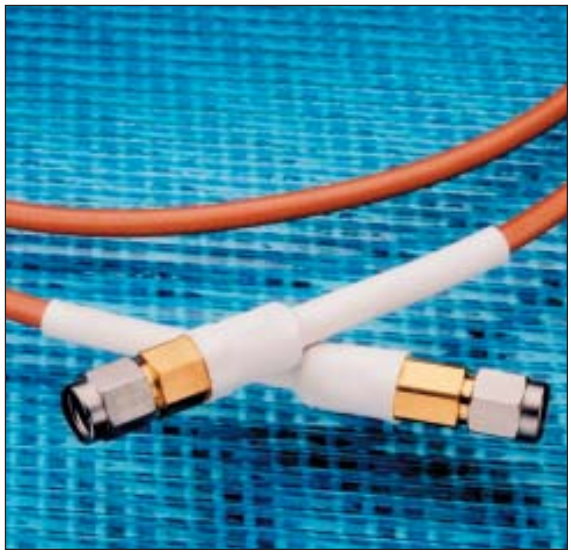
$IL=K_1 \times SqRt(FMHz) + 0.000146 \times (FMHz)$dB per 100 feet

or

$IL = K_2 \times SqRt(FMHz) + 0.000480 \times (FMHz)$ dB per 100 meters

(where FMHz is the frequency in MHz)

Cable	K_1, dB/100 ft.	K_2, dB/100 meters.
MM 0.130	0.4622	1.5160
MM 0.175	0.3822	1.2536



TESTMATE MICROWAVE TEST LEADS

TIMES MICROWAVE SYSTEMS Testmate cables have the flexibility, durability and reliability required for laboratory, manufacturing and field testing applications. A variety of *MILTECH* male and female replaceable interfaces are available, allowing a single cable to be customized by the end used for multiple interconnect solutions without degrading the low loss and VSWR of the cable assembly. For general purpose testing requirements up to 18 GHz, *TIMES MICROWAVE SYSTEMS* offers 2 cable sizes. Using the same construction techniques as the military qualified *MILTECH* cable described elsewhere in the catalog, these cables provide the flexibility and low loss required for testing applications. Our ¼" cable offers the lowest loss and best flexibility for its size. For test applications requiring long cable lengths, our ½" cable offers the lowest loss up to 18 GHz, while still providing excellent flexibility.

18 GHz Test leads

- Customer replaceable *MILTECH* connector front ends
- Excellent electrical characteristics
- Heavy wall polyurethane jacket provides excellent abrasion resistance
- 2 sizes for low insertion loss

Additional Testmate literature is available at: www.timesmicrowave.com

Technical Data

	Testmate – 230 test leads	Testmate – 340 test leads
Electrical performance:		
Maximum VSWR: 0.5–18 GHz	1.35:1	1.35:1
Maximum insertion loss:	0.43 dB per ft @ 18 GHz	0.26 dB per ft. @ 18 GHz
Shielding efficiency	Better than –90 dB	Better than –90 dB
Mechanical performance:		
Outside diameter:	¼"/6.4 mm	½"/12.7 mm
Connector retention:	75 lbs.	150 lbs.
Minimum bend radius:	1.25"/31.8 mm	2.00"/50.8 mm
Environmental performance:		
Operating temperature:	-65 to +90°C	-65 to +90°C
Moisture resistance:	MIL-STD 202, Method 106	MIL-STD 202, Method 106
Vibration	MIL-STD 202, Method 204, Cond.C	MIL-STD 202, Method 204, Cond.C
Shock:	MIL-E-5272, Para. 4.15.5.1	MIL-E-5272, Para 4.15.5.1
Connectors:		
Passivated stainless steel -	SMA, plug and jack	SMA, plug and jack
(works with all MILTECH	TNC, plug and jack	TNC, plug and jack
replaceable front ends)	N, plug and jack	N, plug and jack
	7 mm	7mm

Please contact us regarding your specific needs. See pages 14 and 15 for part numbers for additional connectors.

TEST ADAPTERS

TIMES MICROWAVE SYSTEMS provides test adapters and between series test adapters for test labs and systems use. These durable, precision coaxial test adapters provide superior electrical performance and reliable service as test interfaces. Used as "connector savers", they also can protect panel connectors from wear.

Constructed from gold-plated beryllium copper and stainless steel, these 50 ohm adapters operate from DC to 18 GHz. Typical electrical specifications are 0.15 dB insertion loss and 1.40:1VSWR at 18 GHz. The mating interfaces conform to MIL-PRF-39012.

Type	Part Number
N jack – TNC jack	OE5062-1
N plug – TNC jack	OE5062-2
N jack – TNC plug	OE5062-3
N jack– TK jack	OE5062-4
N plug – TK jack	OE5062-5
N jack – TK plug	OE5062-6
N plug– TK plug	OE5063-7
TK plug – TK plug	OE6063-8
TNC plug – TNC plug	OE5063-9

Please contact us regarding your specific needs

Type	Part Number
N plug – N plug	OE5108-7
N plug – N jack	OE5108-9
N plug – PTNC plug	OE5108-11
N plug –SMA jack	OE5108-13
N jack – SMA plug	OE5108-16
N jack – SMA jack	OE5108-17
PTNC jack – PTNC jack	OE5108-31
N plug – HN jack	OE5108-35
N plug – HN plug	OE5108-36
N plug – PTNC jack	OE5109-10
N plug - PTNC plug	OE5109-11
N plug – SMA jack	OE5109-13
N jack – PTNC jack	OE5109-15
N jack – SMA jack	OE5109-17
PTNC plug – PTNC plug	OE5109-30
PTNC jack – PTNC plug	OE5109-32
SMA jack – SMA jack	OE5109-33
SMA plug – SMA plug	OE5109-34
SMA plug – PTMC plug	OE5109-35

Please contact us regarding your specific needs

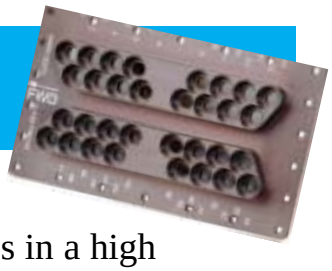
Tools

- Sold separately or in kits
- Can be customized to meet individual requirements
- Corrosion free stainless steel

TOOLS, SPANNER WRENCHES, & TORQUE WRENCHES

TIMES MICROWAVE SYSTEMS can provide the necessary tooling to facilitate the removal and replacement of replaceable connector interfaces for our cable assemblies. Most applications require only a simple open end or spanner wrench to complete the process. The correct tools are specified along with the replaceable connectors shown elsewhere in this catalog, however, custom tool and connector kits can be supplied for unique applications. Please contact us for your specific needs.

M8 MULTI-PORT INTERCONNECTION SYSTEM



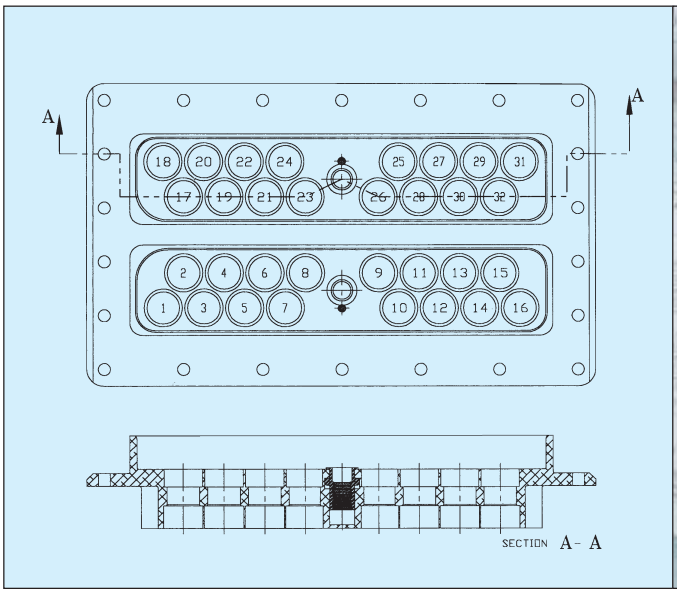
The *TIMES MICROWAVE SYSTEMS* M8 Multi-Port Connector family was specially designed and developed to mate multiple coaxial cable interfaces in a high performance environment not previously achievable with other multi-port connectors. The *TIMES MICROWAVE SYSTEMS* housings and contacts have been tested and qualified to such demanding transmission line assembly specifications as MIL-T-81490 and MIL-C-87104 and feature excellent phase stability with low VSWR and insertion loss up to 20 GHz. The M8 interconnection system easily survives harsh environments where high vibration, shock, temperature and humidity could cause serious cable and system performance degradation where other multi-port connection systems have been used. The *TIMES MICROWAVE SYSTEMS* M8 Multi-port interconnect system is presently used on a number of airborne applications.

To enhance the versatility of the multi-port interconnection system, the following features have been incorporated:

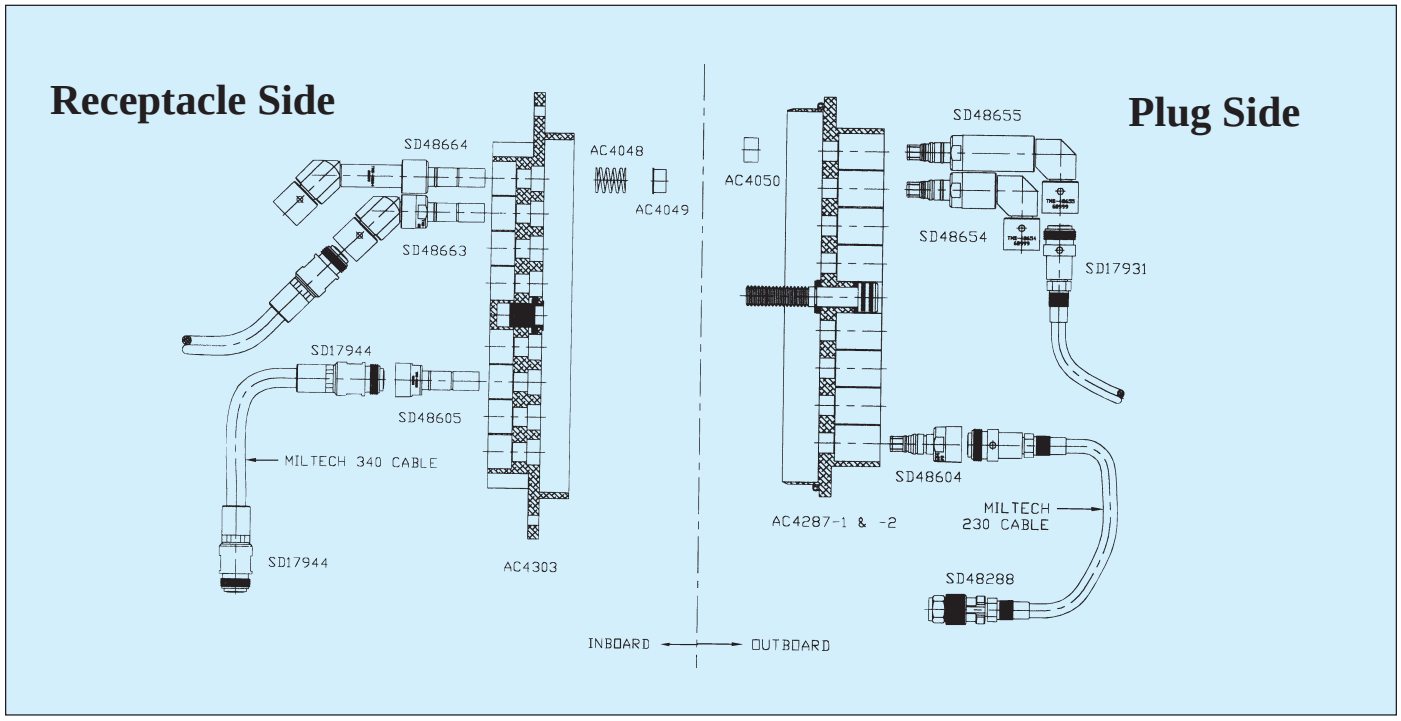
- The connector housing and each cable assembly is individually sealed.
- The M8 interface design includes spring loading to guarantee full mating under all conditions, providing reliable VSWR performance.
- Individual cable assemblies are inserted and removed easily from the rear of the connector housing using a simple hand tool.
- A single housing can accept all *MILTECH* cables as well as transmission lines of different sizes, including flexible and semi-rigid types from 0.086"/2.18mm to 0.480"/12.2mm OD.
- M8 Multi-Port housings are available in several configurations.
- Rack and panel or jackscrew mounts are available.

Electrical Specifications

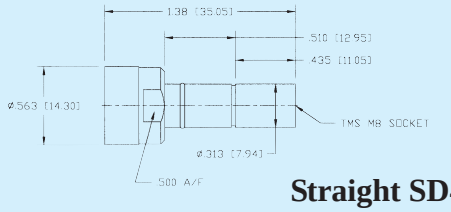
Insertion Loss and VSWR per *MILTECH* Cable and Connector Specifications.



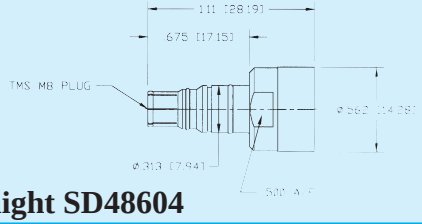
Typical System Interface



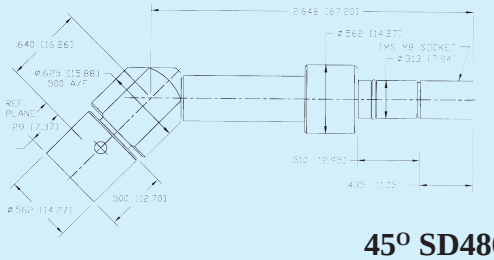
Standard Connectors



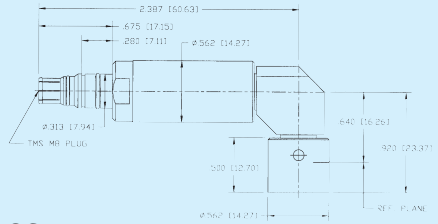
Straight SD48605



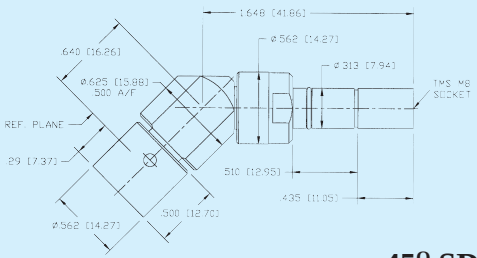
Straight SD48604



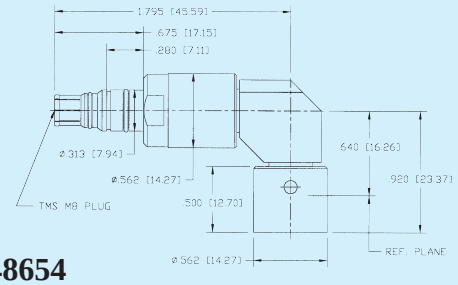
45° SD48664



90° SD48655



45° SD48663

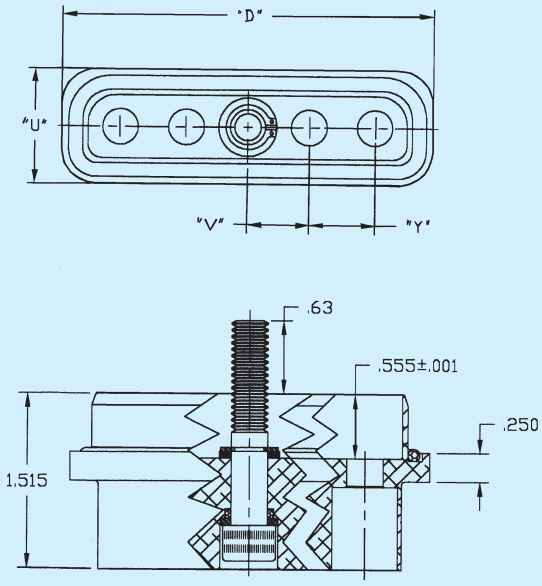


90° SD48654

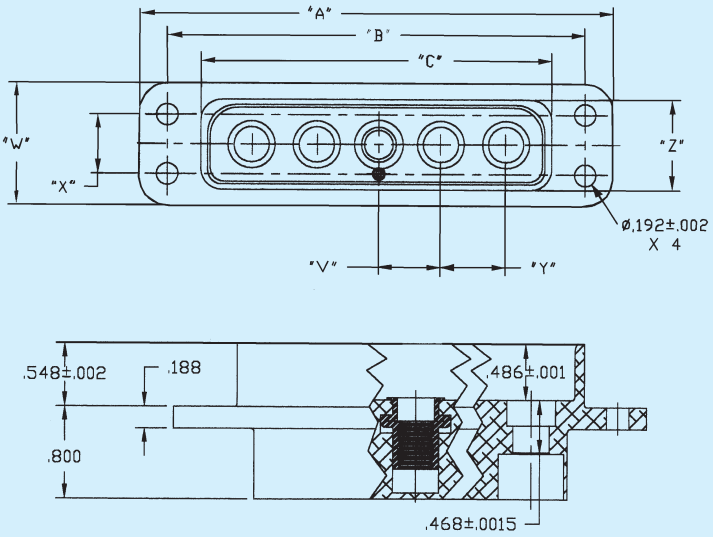
Dimensions vs. Number of Ports

The *TIMES MICROWAVE SYSTEMS* M8 Multi-Port connector is available with replaceable or non-replaceable cables/contacts. The non-replaceable version, with 0.440"/11.18cmm contact spacing, can accept cable diameters up to 0.31"/7.88mm. The replaceable version, with 0.585"/14.86mm contact spacing, can accept cable diameters up to 0.48"/12.19mm. Either version will accept flexible or a combination of flexible and semi-rigid cable.

Plug



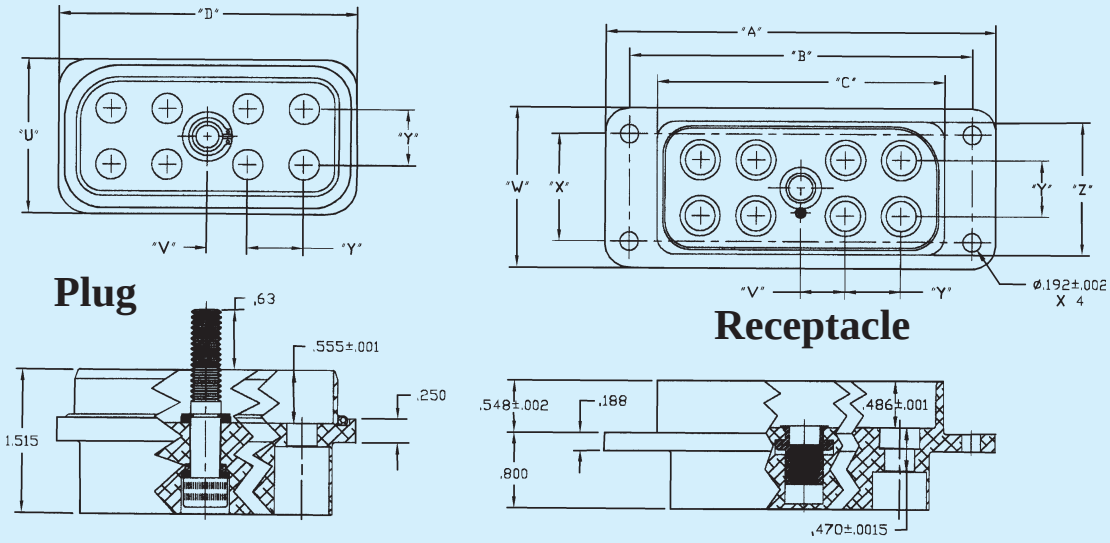
Receptacle



Port Spacing	"U"	"V"	"W"	"X	"Y"	"Z"
0.440	0.960	0.512	1.020	0.500	0.440	0.734
0.585	1.035	0.585	1.093	0.531	0.585	0.807

No. of Ports	Plug P/N	Receptacle P/N	Port Spacing	"A"	"B"	"C"	"D"
4	AC4512	AC4513	0.440	3.700	3.300	2.800	3.000
6	AC4514	AC4515	0.440	4.580	4.180	3.680	3.880
8	AC4516	AC4517	0.440	5.460	5.060	4.560	4.760
4	AC4518	AV4519	0.585	4.290	3.790	3.210	3.410
6	AC4520	AC4521	0.585	5.460	4.960	4.380	4.580
8	AC4522	AC4523	0.585	6.630	6.130	5.550	5.750

Dimensions vs. Number of Ports

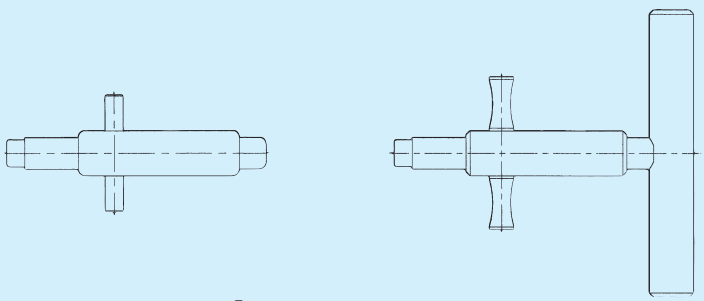


Port Spacing	"U"	"V"	"W"	"X	"Y"	"Z"
0.440	1.400	0.504	1.460	0.875	0.440	1.174
0.585	1.620	0.507	1.678	1.125	0.585	1.392

No. of Ports	Plug P/N	Receptacle P/N	Port Spacing	"A"	"B"	"C"	"D"
4	AC4524	AC4525	0.440	2.720	2.320	1.820	2.020
8	AC4526	AC4527	0.440	3.600	3.200	2.700	2.900
12	AC4528	AC4529	0.440	4.480	4.080	3.580	3.780
16	AC4530	AC4531	0.440	5.360	4.960	4.460	4.660
4	AC4532	AC4533	0.585	2.910	2.410	1.830	2.030
8	AC4534	AC4535	0.585	4.080	3.580	3.000	3.200
12	AC4536	AC4537	0.585	5.250	4.750	4.170	4.370
16	AC4538	AC4539	0.585	6.420	5.920	5.340	5.540

Insertion/Extraction Tools

The insertion and extraction of M8 Multi-Port contacts from the M8 shell is a simple process that uses an easily operated insertion/extraction hand tool. Both field and factory tool styles are available. The field tool will conveniently fit into a technician's pocket or toolbox and was designed for routine insertion or extraction of the M8 contacts. The factory tool was designed for production line applications, however, both are interchangeable.

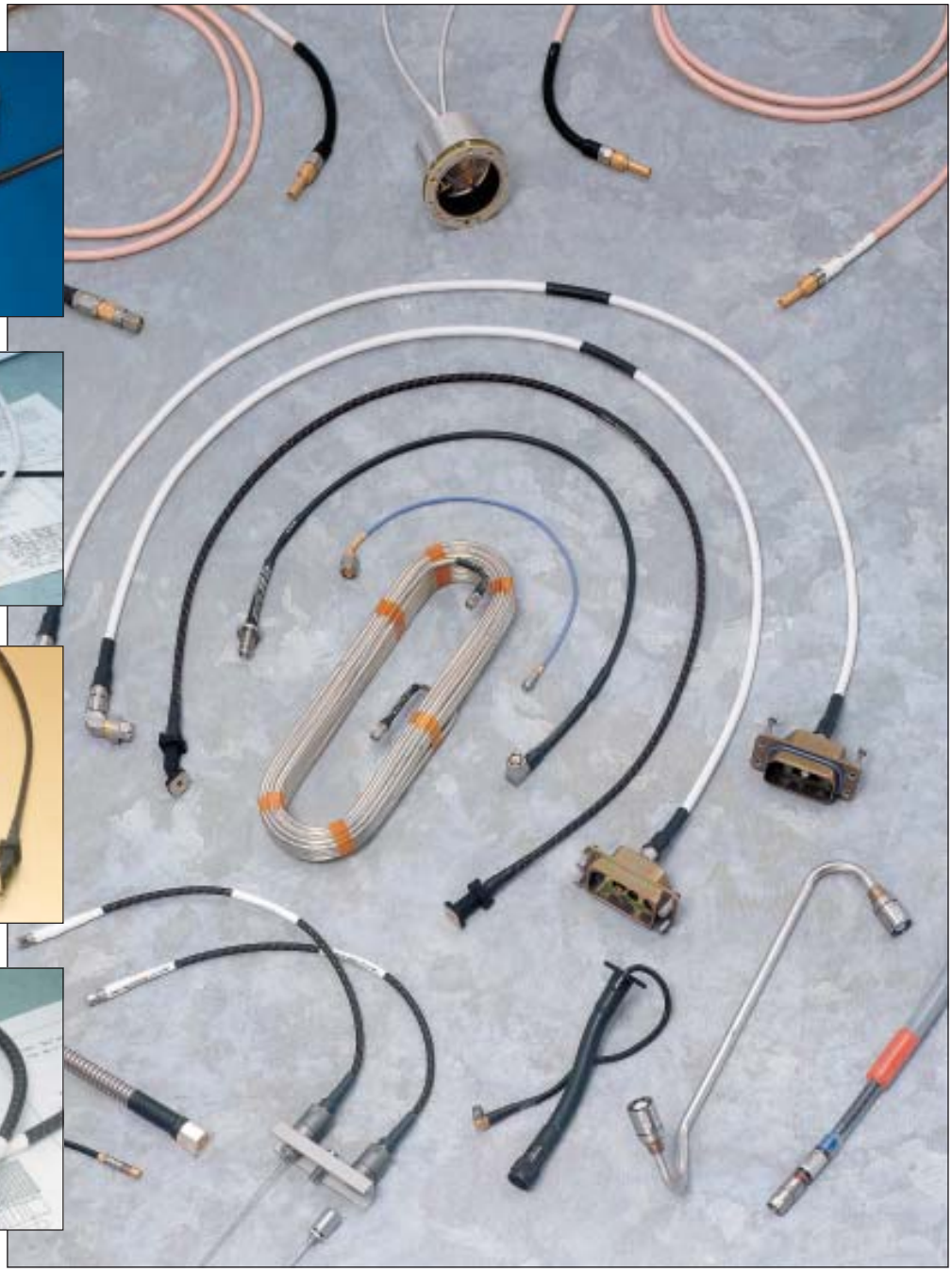


FaIELD Tool TN-2478

Factory Tool TN-2964

CUSTOM PRODUCTS

TIMES MICROWAVE SYSTEMS also manufactures coaxial products for a broad range of unique applications in addition to the cable and connector products described elsewhere in this catalog. To date, we have designed more than 10,000 different flexible and semirigid cables and connectors to meet customer requirements. We will design and manufacture coaxial cables, connectors, adapters, test kits and tools to meet any specialized customer requirements. Prior applications include wave guide to coax adapters, impedance transforming cable assemblies, broadband delay lines, high shielding effectiveness assemblies, antenna extender assemblies, high pressure fuel resistant assemblies, high vibration assemblies, and low smoke/zero halogen cable assemblies. Please contact us regarding your specific needs.



SPECIAL APPLICATION WORKSHEET

Copy and fax this form to Times Microwave Systems Applications Engineering, or contact a TMS applications engineering manager directly at (203) 949-8400. You may also fax this form or call the sales manager for your area at the offices listed on the back cover.

FAX TO: (203) 949-8423

From: _____

Phone: _____

E-mail _____

Company _____

City: _____ State _____ ZIP _____

APPLICATION

1. Ground, airborne, shipboard or submarine, etc: _____
2. System name: _____
3. Platform: _____
4. Use (receive, transmit): _____
5. Number of this assembly per system: _____
6. Cable type (flex, rigid, semi-rigid): _____

DESIGN

Electrical

1. Frequency band: _____
2. Insertion loss: _____
3. VSWR (over frequency): _____
4. Power (rms, CW, or peak): _____

Mechanical

1. Length and tolerance: _____
2. Sealing requirements: _____
3. Connector requirements: _____
4. Cable diameter: _____
5. Crush resistance: _____
6. Impact shock: _____
7. Vibration levels: _____
8. Marking: _____

Environmental

1. Temperature (operating and non-operating): _____
2. Altitude: _____
3. Pressure: _____
4. Severe environments (salt fog, humidity, fuel, hydraulic fluid, solvents, etc): _____

SPECIAL CONSIDERATIONS: _____

Mockup Assistance

TIMES MICROWAVE SYSTEMS applications and engineering personnel are available to discuss customer requirements, to make recommendations for the best use of our products and to assist with mockup services as customer facilities. Such services generally include determining the cable types to be used, including cable lengths and routing, as well as connector configurations. Mockup assistance may also include installation procedures, specifications and testing procedures, as required.

SIMPLIFIED ORDERING

We have included cable and connector part numbers throughout this catalog as much as practicable. Please fill out the simplified ordering guide below and we will be happy to prepare a quotation.

Connector A	Cable Type and Length	Connector B

Field-tested, high performance coaxial cable assemblies
Pioneering a wide range of coaxial cable and connector developments

Let our experience, innovation and support work for you!

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MA 02664
Tel: 978-352-6882
Fax: 978-352-7188
Fkaczor@timesmicrowave.com

4 School Brae, Dysart
Kirkcaldy, Fife
Scotland KY1 2XB UK
Tel: +44 (0) 1592655428
Fax: +44 (0) 1592653162
timesmicrowave@aol.com

5 Lippizaner Fields
Whiteley, Nr Fareham
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CCA-4

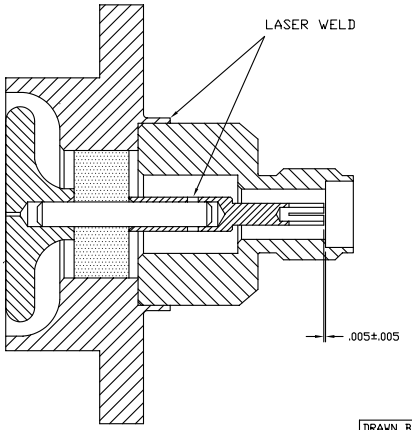
TIMES MICROWAVE SYSTEMS

The new leader in custom, high reliability microwave Feedthru's

- UHV Capability
- Precision Microwave design
- High Radiation Compatibility
- Crack Free high reliability glass seal designs
- Extreme environment designs
- Ideal for demanding High Energy Physics and Satellite test chambers

Times Microwave Systems introduces a new capability in ultra-high vacuum and high reliability hermetic Feedthru's. Based on twenty plus years of experience with innovative and improved glass to metal seal technology, our latest proprietary custom designs set a new standard for quality and high performance in the most demanding Feedthru and Beam position Monitor applications.

- Wide range of shell materials including stainless, cupro-nickel, Inconel and most other ferrous and non-ferrous alloys.
- SMA, N-type, TNC and most microwave interfaces.
- Extreme high power capability.
- 10^{-13} stdcc he/SEC Vacuum retention
- VSWR 1.15:1 @ 18GHz
- Microwave, capacitance and high power custom modeling capability.
- We understand and deliver against the toughest microwave and hi-reliability requirements for your Feedthru needs.



358 Hall Avenue Wallingford, CT 06492 203-949-8400 www.timesmicrowave.com

F-35 Joint Strike Fighter - Multiple Contact RF Coaxial Harness Options

A White Paper written by:
Times Microwave Systems
February 2003

David L. Murray
(480) 786-1656
Timeswest@aol.com

Overview

A major consideration of any aircraft is the wiring necessary to support it's various electronic systems. The F-35 Joint Strike Fighter is certainly no exception with the number of these electronic systems being greater than those found in a typical fighter. The integrated RF systems of this aircraft will require many coaxial cable assemblies to interconnect from system to system within the aircraft and many more to connect from these systems to their respective apertures. Some of these RF runs will be "singles" and have their terminations handled using standard self-locking TNC connectors. Some of the RF runs will have "multiple coaxial" RF paths that terminate into ganged connectors to save space. The CNI, EW, and Radar systems alone are responsible for the majority of these "multiple coaxial "RF paths. These assemblies, or RF harnesses, and more specifically their terminations, is the major point of this paper.

Comparison of Variables

The two most common methods to terminate these harnesses are standard MIL-C-38999 shells (using MIL-C-39029 specifications for external contact dimensions) and the Times Microwave Systems Multi-port™ contacts and shells. This paper will address the #8 and #12 contact arrangements as used for 38999 shells and the various options of the multi-port system. It will compare the following:

1) Contact spacing
2) Maximum number of contacts per shell
3) Compatibility of each contact to various cable types
4) Expected contact life with number of insertions
5) Field replaceability of contacts
6) Tooling required for initial assembly, repair, and or replacement
7) Environmental sealing considerations.

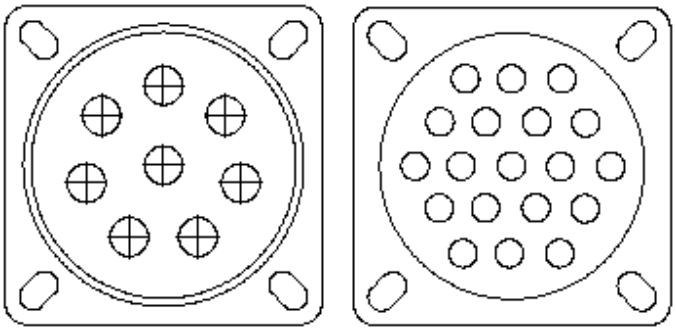
MIL-C- 38999 Shells

Number 8's

There are two "standard" sets of 39029 contacts in wide use today for RF pins and sockets. The first of these is the 39029/59 and 39029/60 contact pair. These are usually referred to as #8 contacts. What seems to be the current "preferred version" is one that has an interface based on the DSCC standardized BMB connector. This contact is actually more commonly referred to as the Corning Gilbert GMS™ interface. What has taken place over the last few years is that this GMS/BMB interface has been incorporated into a contact with the external dimensions of the aforementioned 39029 specifications. These contacts are currently in use for various aerospace applications including the Mast Mounted Fire Control Radar systems of the Apache and Comanche helicopters as well as the F-16 Block 60 EW system and it's Fire Control Radar system. They are also currently being projected as the contact of choice to be used on the F-35 Radar system. This contact is currently available from multiple sources and since it has a military standard (BMB) they tend to be predominately interchangeable. The different sources of these contacts have varying degrees of aircraft experience and varying degrees of experience with the field use of the 38999 shells in general. This experience level is probably a better indicator than any salient characteristic as the reason behind choosing a particular contact or assembly supplier.

The most commonly used shell for these contacts is the 38999 series 25 shell as shown in Figure 1*. It will allow 8 of these #8 contacts to be used with a contact center-to-center spacing of about 0.400" ea. Including the shell's mounting requirements, this shell will require slightly less than 4 sq. inches of surface area for these 8 contacts. Assuming this surface area is available, these contacts will accept a cable with a maximum diameter of about 0.210". If a larger cable is needed, a splice 6" to 12" behind the backshells is the typical solution. While effective, this concept has the disadvantage of both degrading insertion loss as well as detracting from the VSWR performance.

Since these shells all mate using a coupling nut, human factors must be taken into consideration when deciding where to mount these shells. A minimum of 1 inch, for 270 degrees, of access is necessary to effectively tighten and loosen these coupling nuts. Another consideration is that to remove these contacts from their shells, a tool must be "snapped" over the cable itself behind the MIL-C-38999 shell and then inserted (slid up) from the rear through the environmental seal to open the contacts lock ring. This also requires the loosening, or complete removal, of the backshell clamps. If sufficient maintenance access is not available for this removal action (which is often the case), this interconnect system is probably not the best choice. The fact that a tool needs to slide over the assembly itself also makes location of strain relief and ID markers difficult.



8 ea. #8 contacts 19 ea. #12 contacts

Figure 1 – 38999 series 25 Shell

**Note: all drawings shown in this paper are shown to app. scale unless otherwise noted*

The initial assembly of these contacts to the cable is usually done on a bench and finished assemblies are usually installed into harnesses during the normal aircraft installation process. Environmental sealing of these contacts is accomplished by the use of the integral rubber back seal that is a part of the 38999 shells themselves. One of the major considerations as the contacts are installed is that they are not excessively side loaded by the use of a right angle cable clamp or a low profile angular backshell. These contacts can be side loaded to such an extent that the mating of the male to female shell can actually damage them.

Assuming that the contacts are correctly aligned prior to initial mating, the mating and demating of them would be expected to survive well over the 500 mates and demates that their shells are limited to. However, maintaining alignment during maintenance and repair operations must still be addressed.

If one of these contacts does become damaged, the preferred repair method is to replace the broken cable assembly. Replacing the complete assembly is desired because these contact designs are not easily field replaceable. If a contact must be repaired on the aircraft, soldering of the center conductor will most probably be required. Assuming the soldering unit is allowed on the aircraft, these contacts can usually be replaced by a certified technician. This does not imply that this will be easy, just that it is an option. This all assumes that the cable itself isn't damaged during removal from the shell and backshell. It further assumes that the electrical length wasn't critical to begin with.

If these assemblies were originally phase matched, or time matched, then the repair procedures listed above would most likely not be practical. The only feasible repair procedure therefore of a phase or time matched assembly would replacement.

MIL-C-38999 Shells

Number 12's

The other "standard" is the #12 contact set. These meet the outline dimensions of the 39029/55, 39029/56, and 39029/57 specifications. There is also a coaxial contact specification (39029/102 and /103), but as it is only applicable for use up to 1 GHz, it is only mentioned here as a side note. The "preferred version" of these #12 contacts is the TM-12 contact (see figures 2 and 3) as supplied by Times Microwave Systems. While these contacts don't have a DSCC controlled interface standard, the interface dimensions have been standardized and released by Times Microwave Systems. They are currently in use on numerous airborne platforms including the C/V-22, the AH-64D, the RAH-66, as well as one or two additional classified programs.

There are four 38999 shells that are in common use to support these contacts. The one with the highest density is the 38999 series 25 series (see Figure 1). It will allow 19 of these #12 contacts to be used with a center-to-center spacing of about 0.220" ea. Including the shell mounting requirements, this shell will require slightly less than 4 sq. inches of surface area for these 19 contacts. Assuming this surface area is available, these contacts will accept a cable with a maximum diameter of about 0.140". If larger cables are needed, a splice 6" to 12" behind the backshells is the typical solution.

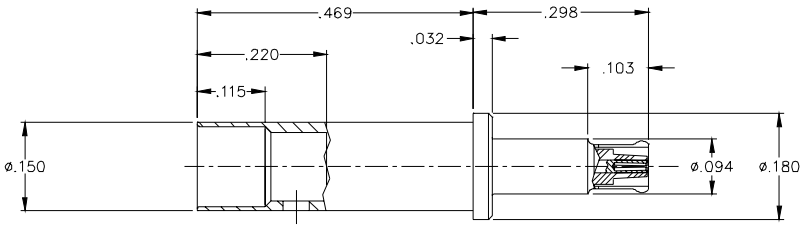


Figure 2. Female TM-12/38999 plug contact (shown enlarged for clarity)

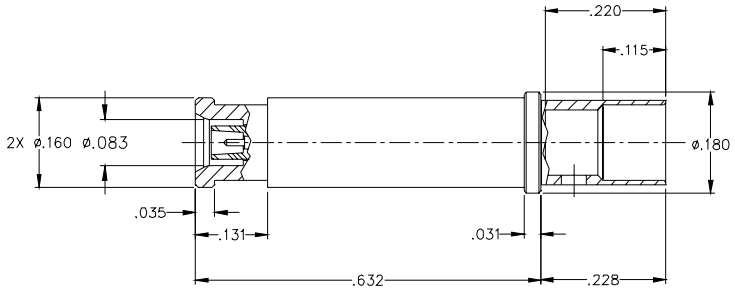


Figure 3. Male TM-12/38999 Contact (shown enlarged for clarity)

The other three #12 shells are the 38999 series 21, 38999 series 17, and the 38999 series 11 shells. These are shown in Figure 5. (The 4 position 38999 series 11 shell is not shown as it is only used for things where 4 contacts are normal like the fiberchannel data bus connections).

The initial assembly of these contacts is also done on a bench and finished assemblies are usually installed into harnesses during the aircraft installation process. Environmental sealing of these contacts is accomplished in two places. First, by the use of the integral rubber back seal that is a part of the 38999 shells themselves. The second seal (shown colored in figure 4) is the interfacial seal that actually fills the lead in bevel detail area upon final contact engagement. One of the major considerations to this process is that as these contacts are installed, they are not excessively side loaded by the use of a right angle cable clamp or low profile angular backshell. Because of the 38999 shell contact retention mechanism, these contacts are especially susceptible to this. Specifically, they can be side loaded to such an extent that the mating of the male to female shell can damage the interfaces of these miniature contacts. Notice in figure 3 and 4 that the male TM-12 contact has an enlarged diameter at the forward most edge of the contact itself. This enlarged diameter minimizes the “rocking” or side loading effects on this contact. The opposite contact side (the female TM-12) only has a single mount point and therefore is much more susceptible to being side loaded. This is usually overcome by carefully dressing the individual assemblies such that they aren’t side loaded during harnessing.

These contacts are specifically designed for aviation use. They employ an overlapping dielectric design to improve the power and voltage handling capability of the junction at altitude; they also have very short slots and a radiused “bump” at the interface itself to improve the mating life. This combination is needed to ensure extremely high shielding effectiveness (typically better than -100 dB) without the use of an EMI collet, which has proven to be a foreign object debris (FOD) problem on other aircraft. This “radiused” bump also minimizes the effect of lead in side loading as it helps guide the contact without getting caught on the edges.

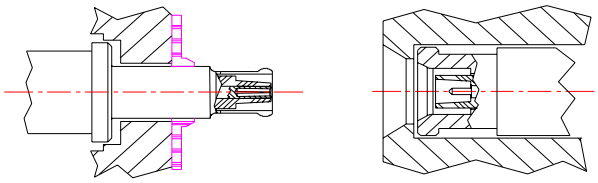
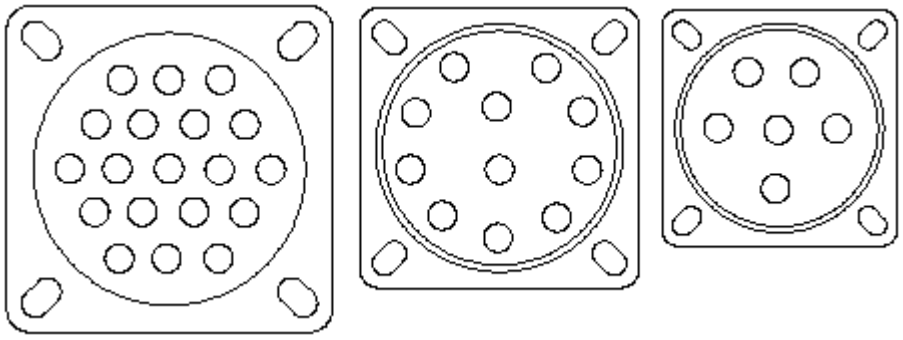


Figure 4. TM-12 contact interfaces shown installed in 38999 shell (shown enlarged)



38999 series 25-21 38999 series 21-11 38999 series 17-6

Figure 5. #12 shell options

If one of these contacts does become damaged, the preferred (standard) repair method is to replace the complete cable assembly, as these contact designs are not typically field replaceable. If a contact must be repaired on the aircraft, soldering of the center conductor, and sometimes the outer conductor, will most probably be required. Assuming the soldering unit is allowed on the aircraft, these contacts can usually be replaced, but it takes a very skilled assembler to perform these repairs, as the piece parts, and cable preparation dimensions, are very small. These contacts also require a rear removal process and since the cable used here has a maximum diameter of 0.140", they are sometimes damaged during this removal.

Due to the small interface diameter of these contacts, careful handling procedures must be followed during testing to insure that these contacts are not damaged. While it is possible to test a single contact by plugging a test adapter into it, it is recommended that a mating harness be made and the test equipment connections be done at a normal connector interface 6" or so behind that mating harness. History has shown this writer that the handling and actual connection during the testing of these contacts is the most common time to damage them. The test cables tend to be large diameter cables and can quite easily side load any particular contact. Once side loaded the contact might break (usually indicated by a broken tine). **It is highly recommended that during the early learning curve process typical of any new aircraft, particular care be given to this area.**

Multi-Port Options

M-8 Multi-ports

Higher power, lower loss RF interconnections employ the M8 Multi-Port Interface from Times Microwave Systems. The main benefit of the vapor sealed M8 is the ability to use larger diameter cables, for reduced insertion loss. Many different Multi-Port shell configurations have been developed to allow using M8 interfaces on 0.440" and 0.585" spacing. The 0.440" spacing shells limit cable size to 0.32" diameter maximum. The 0.585" spacing shells have been developed to allow usage of the standard Times Microwave Systems MILTECH™ line of replaceable front end cable assemblies, with cable diameters up to 0.48".

M8 shells are available in standard configurations from 4 to 16 ports, and many custom shells have been developed, some allowing mixing of center-to-center spacing to fully maximize interconnect panel density when using different diameter cables.

The M8 interface is also designed using overlapping dielectrics to maximize the voltage and power handling capabilities of any assembly in a typical airborne environment. This feature still allows and maintains the vapor seal of the assembly in both mated and unmated conditions while supporting TEM mode propagation at frequencies in excess of 20 GHz.

Because of the front-release design of the M8 contact/shell engagement scheme, the resulting simple shell designs allow easy customization for specific space critical applications. This front release feature is also responsible for the trouble-free insertion and removal procedure (vastly easier to perform than the notorious efforts associated with the 38999 contacts and shell), and is also the design feature that allows using the wide range of cable sizes. However, like the 38999 type shells and contacts, M8 specific insertion and removal tools are required.

Proper mating of the shells when installing M8 equipment is important due to the high spring loading forces employed in each contact. This force (approximately 10 pounds) is used to enable the M8 contacts to float, allowing the multiple contacts to provide stable performance when employed in high vibration areas. Various methods have been devised to provide the required mating force, including jackscrews integral to the shells, and blind-mating guide posts.

M8 interfaces are being used throughout the F/A-22 EW and CNI systems, as well as in systems on board C/V-22, F-111, F-16, E-2C, E/A-6B, F/A-18E/F, and the Saab Gripen. It is currently being designed into and qualified for applications on the Tornado aircraft and both the Comanche and the NH-90 helicopters, to name a few.

Some of the standard M8 components are shown in figure 6, this figure is copied directly from the Times Microwave Systems High Performance Assembly catalog. Other, more specialized, versions of the M8 interface have also evolved, including pin launch M8 contacts that interface directly with hermetic feedthru's on module faces as well as the newer low insertion force versions of the contacts.

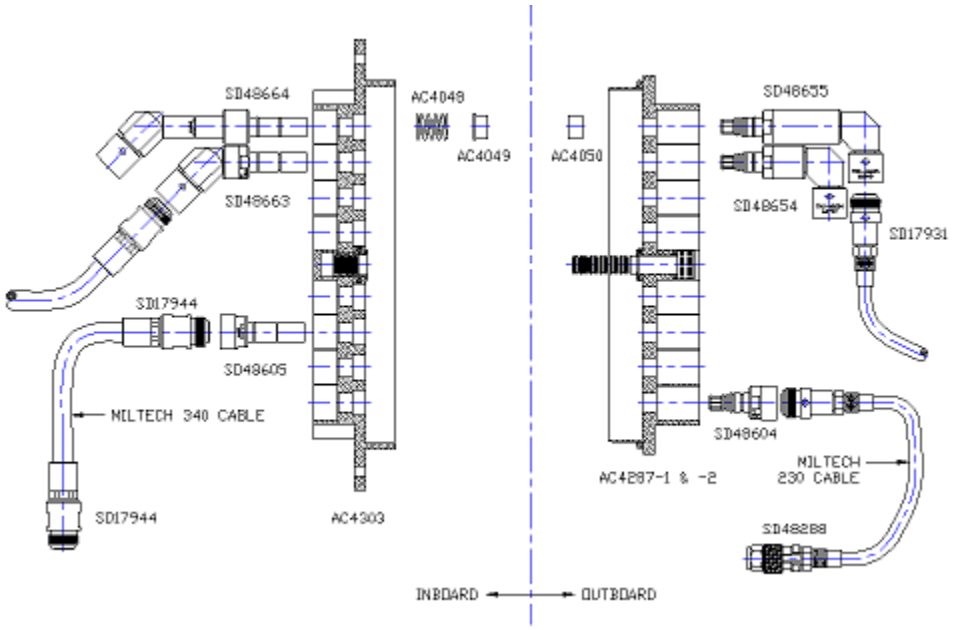


Figure 6. Typical M8 System Interface Shells and Components

P-8 Multi-ports

An extension of the M8 design, known as the P8 contact, was devised when these contacts were designed into the airborne version of the Navy's CEC system. This system required the actual penetration of the skin of the E-2C aircraft. To achieve this, the P8 contact transfers the spring function to the plug side and provides for a simplified, tool-free installation of the jack contacts into a shell from the inside of the aircraft. (Extraction tool still required). The P8 versions of the multi-ports are currently in use on E/A-6B and E-2C airframes and are currently being incorporated into the Wedgetail aircraft as well.

Mini Multi-Port™

Due to contact density requirements increasing, the development of a smaller, higher density, multi-port system seemed obvious. Since the Times Microwave #12 contacts (previously discussed) were already in wide use; a decision was made to incorporate this same interface into the popular front release multi-port styles.

Contacts

The male and female mini multi-port contacts are shown in the figures below. These are shown enlarged for clarity.

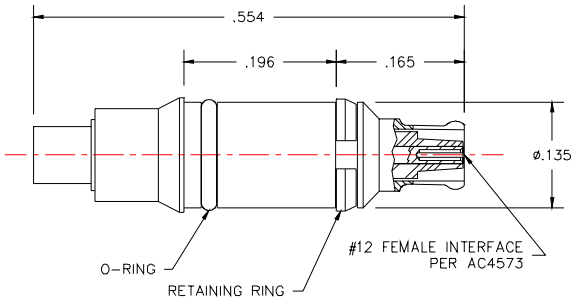


Figure 7. #12 Mini multi-port female contact (shown enlarged)

As these contacts are all nonreplaceable, each of them will be designed for a specific diameter cable. For scale purposes, the female contact as shown above is shown designed to accept an 0.047" semi rigid cable, or it's flex equivalent. Figure 8 shows one that is designed for the Times Microwave Miltech 130 cable

Sealing of these contacts takes place in two areas. The first is the o-ring shown in figures 7 and 8. This is where sealing takes place between each contact and the shells they are mounted into. The second seal is done at the shell mate area. Here another o-ring is used to seal the open face area once properly mated.

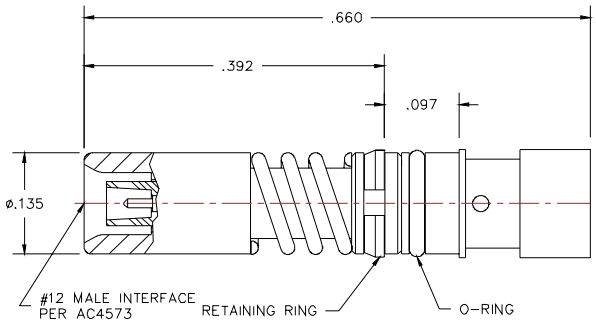


Figure 8. #12 Mini Multi-port Male

Figure 8 shows the male contact. This is the contact that employs the spring that is necessary to insure reliable RF performance over a wide dynamic vibration range. It is classically the one that would be mounted to a fixed surface and “accept” the other contact. While this can be reversed, it must me noted that the resultant harness must be allowed to move (compress) this 0.020” or so to insure reliable, long term, operation. If this contact is the one mounted to the “box”, this slight movement room should be allowed for in the box design itself.

Mini Multi-Port™

Circular Packages

Figures 9 and 10 show the maximum density that can be achieved if a full optimization of the available space is used. Here the 38999 series 25 and 17 shells are shown compared to circular mini multi-port shells. The left picture shows the typical center-to-center spacing (app. 0.220") of the 38999 shell while the mini multi-port contacts are located on a 0.175" center-to-center spacing as shown on the right. A shell of this design could either use a coupling nut (similar to 38999 shells), a center attach screw, or ½ turn fastener (see figure 14) for quick mate/demate to greatly improve maintainability.

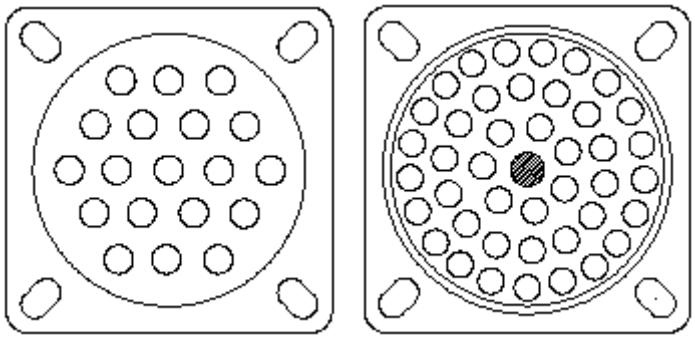


Figure 9 – 38999 series 25-19 as compared to a Mini Multi-port shell with 41 contacts

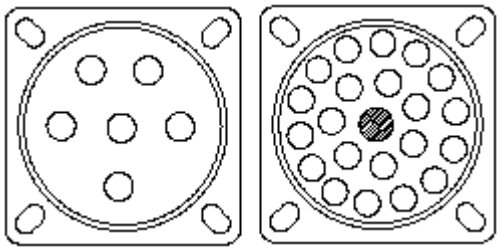


Figure 10 – 38999 series 17-6 as compared to a Mini Multi-port with 21 contacts

While the removal tool is used on the front of these contacts, they are designed not to need a backshell. If a backshell were required, it would obviously need to be removed before any contact could be removed. One other noteworthy item is that since the tools are not ever required to "snap" over the cable itself, each assembly can have heat shrink boots brought up to the back of the shells. This would greatly improve the strain relief, and resultant tensile strength, of the small diameter (0.135") coaxial cables themselves.

Sealing of the individual contacts is as previously described (each contact contains an independent o-ring that seals it into its contact channel). There is also an interfacial seal that exists on both the 38999 and the mini multi-port versions.

Mini Multi-Port™

Rectangular Packages

Since not all applications lead themselves to circular patterns, Times Microwave Systems also developed a mounting scheme utilizing the more classic rectangular profiles. A perfect example of this is the F-35 wing chords themselves. These wings are actually much thinner than those of past fighters. Add to that the fact that these leading edges are actually phased array antennas, it became quite apparent that an inline mini multi-port shell needed to be developed as well as the aforementioned circular options.

Figures 11a and 11b show a jack shell as mated to a jackscrew mounted plug shell and a blind mate mounted plug shell. It should be emphasized that in addition to using the same contacts as mentioned in the circular mini multi-port section above, this jack shell will actually allow the mating of either a blind mate plug (figure 11b) or a jack screw plug (figure 11a). This jackscrew may actually become the ½ turn fastener as shown in figure 14. Since these shells use the same contacts, they would also utilize the same removal tools (no tools necessary for installation).

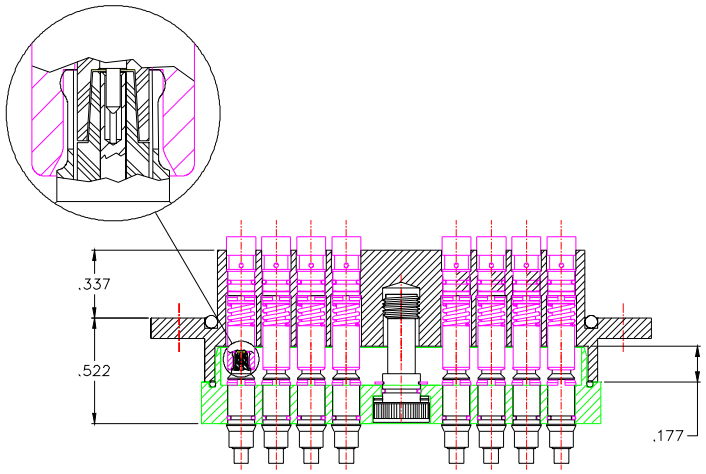


Figure 11a – Jackscrew mounted set

The dimensions of these shells (app 5/8" x 2 ¾") should make them small enough to be useable in the U channel area located directly behind the projected aperture mounting areas on the leading edges. It is for this reason that the dual use shells mentioned here were designed. Some are envisioned as blind mate areas whereas some will most likely need small harnesses between the Aperture Electronics Units and the Apertures themselves.

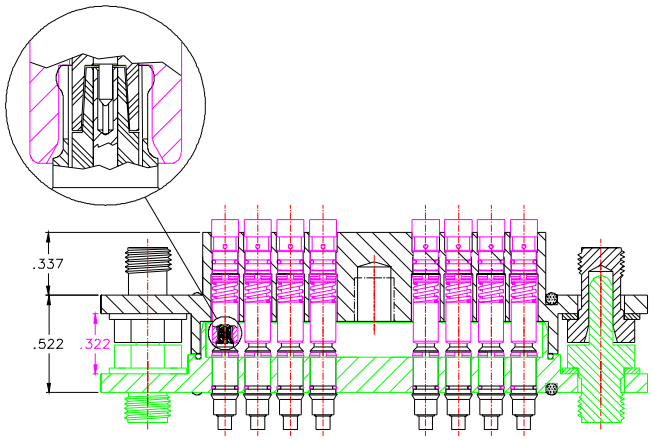


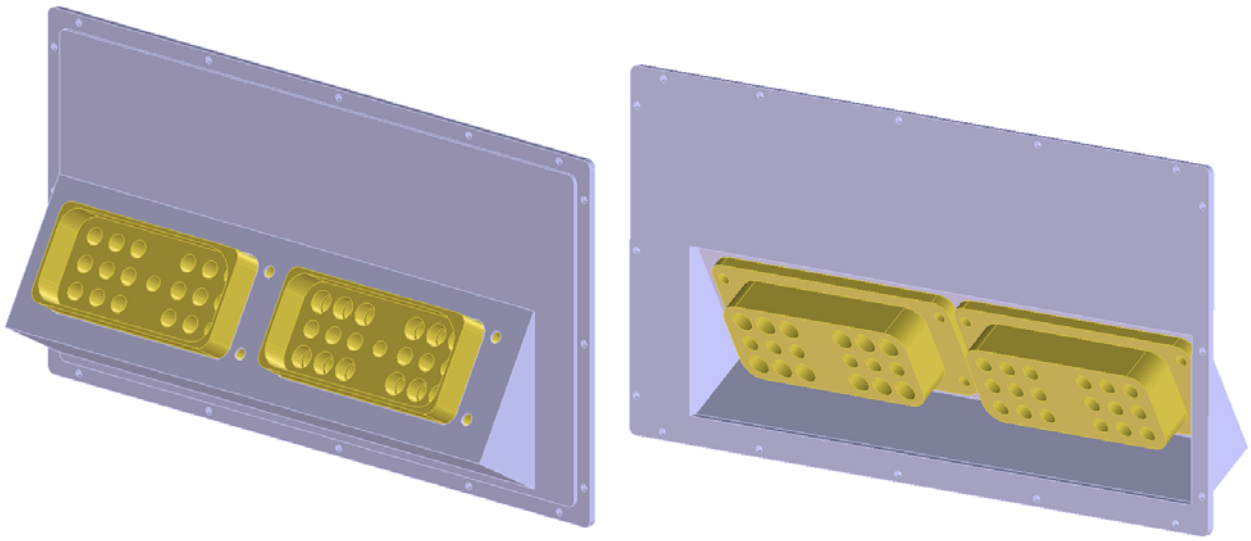
Figure 11b – Blindmate mounted set

The idea behind the set as shown in figure 11b is that one side is hard mounted to the antenna while the other side would be mounted into the U channel itself. Upon mating the aperture to the U channel, the contacts would be bottomed as shown in the exploded area directly above this figure.

Special Multi-port Shells

In addition to the standard catalog M8 and P8 contact shells, Times Microwave Systems, and more appropriately its aerospace customers, have used specially designed multi-port shells as fuel tank penetrations, fuselage and bulkhead breaks, and even LRU surfaces (see Figure 12). While standard multi-port contacts fit either on 0.585 centers (necessary for Miltech 340 cable) or 0.440" centers, it is expected that the center to center spacing on the F-35 will be the 0.440" center (or smaller) shells (like the F/A–22). Replaceable contacts (M8 and low insertion force M8) are available for virtually all footprint options. One major proposed difference is that the latest generation of multi-port components will typically utilize a center jackscrew mount scheme (as shown in figure 6) instead of the scheme used on the F/A-22 (a shell with four captive screws, one on each corner). This center jackscrew will be required if standard M8 contacts are used due to the collective mating forces required. If the low insertion force M8 contacts are used, the most probable center mount feature will be the ½ turn locking handle as shown in figure 14.

To allow for the maximum of possibilities, the EW runs, and the lower power CNI runs, will most probably utilize the mini multi-port contacts. An example of this jointly integrated shell design is shown in figures 12 and 13. Here they are shown integrated into the projected LRU surfaces of the F-35's CNI racks.



Front View Rear View

Figure 12, Proposed F-35 CNI Rack SR3A RF Interconnect (not to scale)

Figures 12 and 13 illustrate integrating contacts of different sizes into these housings. To minimize the weight, the smaller mini multi-port contact (and most probably a smaller cable as well) is used where power levels permit. These contacts can actually be center to center sized as close as 0.175" (cable diameter permitting). Here they are shown on the 0.440" pitch for maximum versatility of both contact and cable choices. Shown here are really two housing varieties. The first (left side of front view of figure 12) shows a shell with 18 size #12 low power mini multi-port contacts, while the other (right side of front view of figure 12) has 6 size #12's and 12 size #8 high power low insertion force contacts.

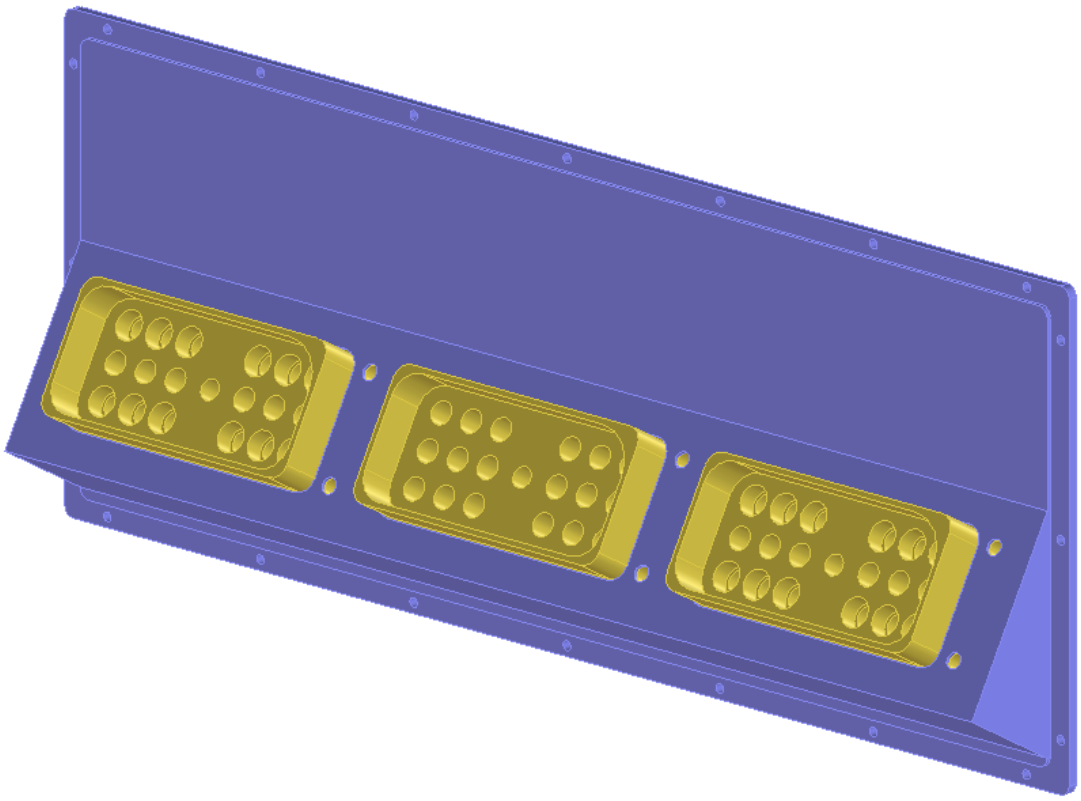


Figure 13. CNI Rack SR3B RF Integrated Multi-Port Shell (not to scale)

The Multi-Port housings in figures 12 and 13 are shown as separate pieces, but most likely will be machined into the mounting plates themselves to save weight. As such, some form of keying will be required. This keying can be done at the shell level (different radius on one specific corner of each shell) so as to eliminate the need to use a contact position for this purpose. Or more probably the keying action will become a part of the ½ turn fastener. This will allow a shell design to be reused while the attaching ½ fastener shaft and mating detail (similar to a low pitch count nut) will contain the keying details. It is envisioned that three separate key options can easily be accommodated.

If integrated as a separate shell, an EMI gasket will likely be required around the plates mounting flange. The ½ turn retention feature on the mating plug (See figure 14) will most likely be common to both the EW racks as well as the CNI racks.

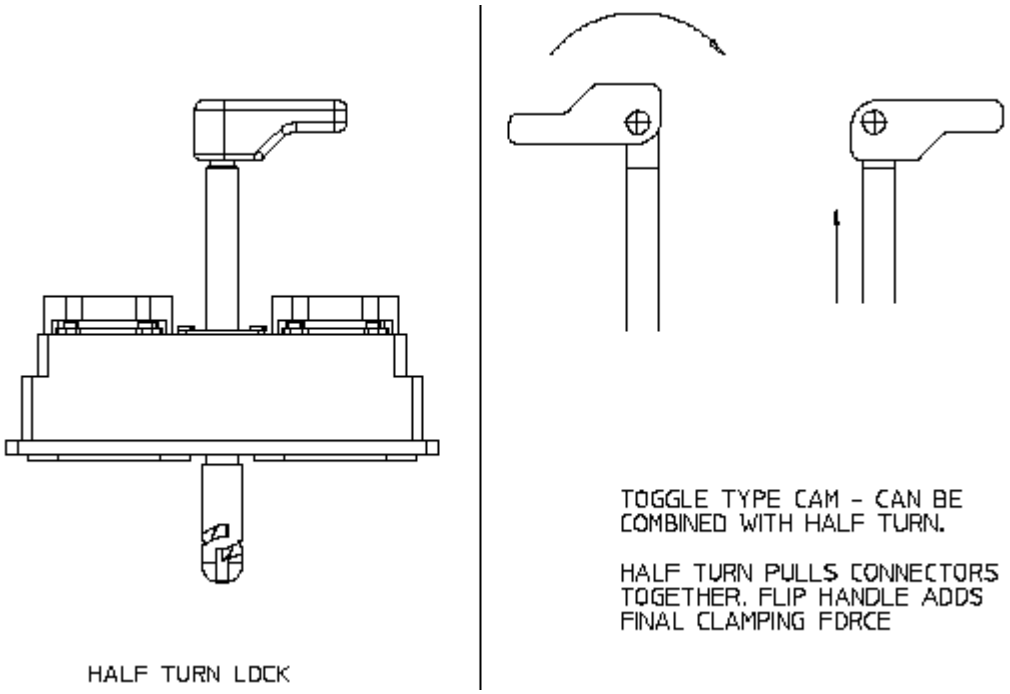


Figure 14. ½ Turn Locking Handle

Figure 14 shows the ½ turn locking handle that is proposed for use on the shells that mate with those shown in figures 12 and 13. This feature will allow the mating of the CNI and EW rack harnesses to be accomplished by hand, in a virtually blind environment, and then toggled (or locked).

As previously mentioned, another feature that in envisioned here (not shown in this drawing) is the keying of multiple shells. It is believed that the tip of the ½ turn shaft will also be able to serve as a limiting keyed entry by limiting the angular range of any particular shaft to it's mate. By separating these into 120-degree segments, these shafts will allow three shell-keying options. This will allow every available contact positions to be used for contacts, not keyed inserts.

Since these shafts and the mating entry nuts are separate, second operations, this function should minimize both cost and weight increases of this additional keying function.