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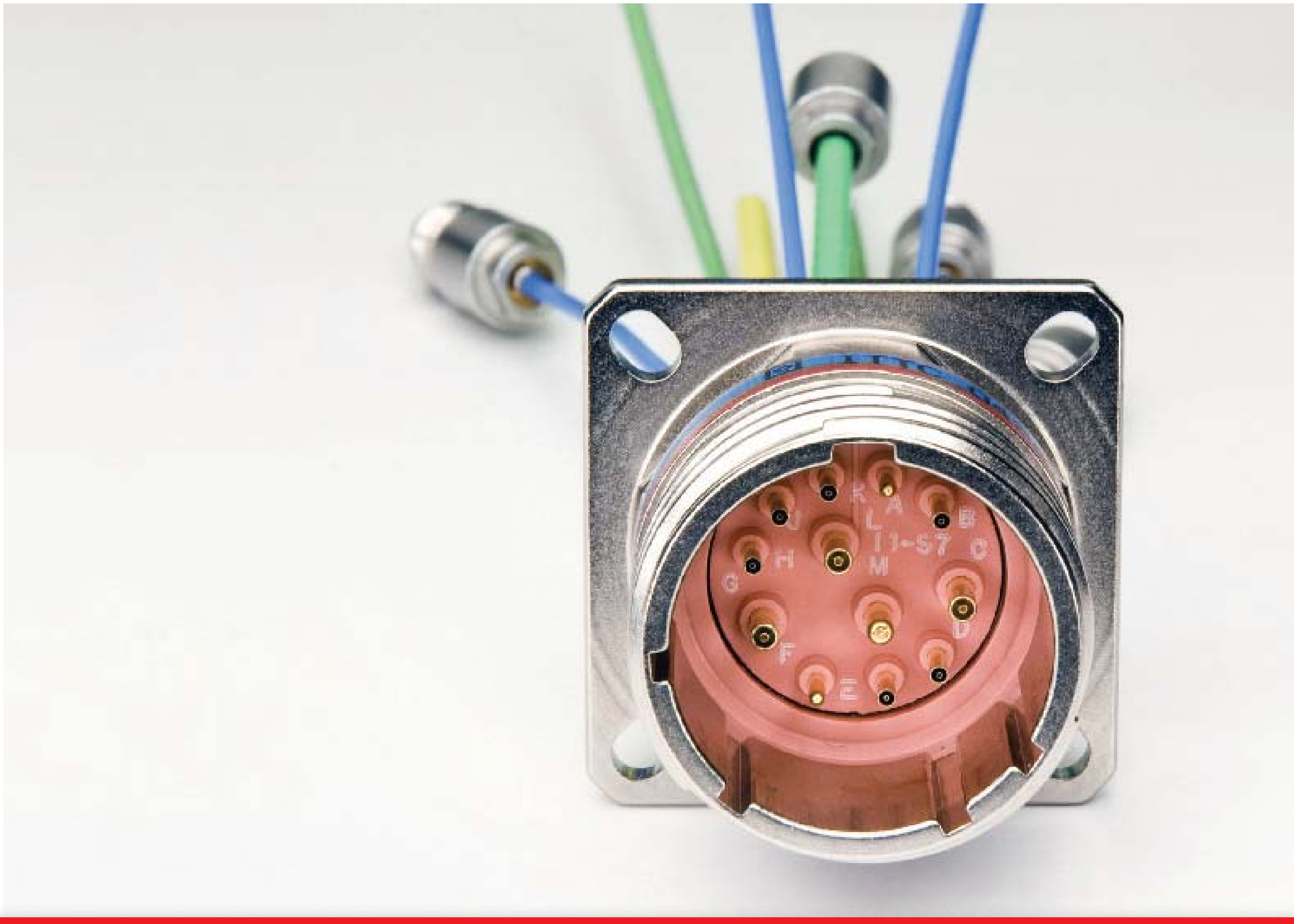
SOUTHWEST MICROWAVE

SSBP High Performance Blind-Mate Millimeter Wave Coax Contacts in Standard Multi-Contact Connectors



Southwest Microwave, Inc.

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Author's Biography

Bucky Clyatt received his BSME education at Arizona State University specializing in mechanical design and kinematics. He is the SSB* Product Development Manager at Southwest Microwave, Inc., Microwave Products Division, responsible for engineering and development of all SSB* connector products. He joined the company in 2003 as Engineering Manager and functioned in that position until 2006 when development of the growing, new SSB* products demanded full dedication to that effort. He has 30 years of experience in the connector industry including design, development, applications, and management engineering positions at ITT Cannon Special Connectors Division (special military/aerospace connectors including Ku band blind mate coaxes in rack and panel connectors, 1980), AVX/Kyocera Corp., ELCO Connector Division (commercial connectors), and Semflex, Inc. (microwave cable, connectors, and cable assemblies).

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Introduction

Engineers designing systems with multiple, high performance microwave and millimeter wave blind-mate coax connectors functioning as contacts in standard circular or rectangular host connector housings are no longer limited to host connectors with layouts accommodating only the large Size 8 or Size 12 contacts, or to special/custom connectors. Southwest Microwave, Inc. (SMI) has developed millimeter wave coax contacts with the same millimeter wave electrical connector performance from DC to greater than 65 GHz as standard ***Super SMA***, 2.92mm, 2.40mm and 1.85mm millimeter wave connectors. They are fully interchangeable with the standard, miniature, MIL-C-39029 (non-coax) signal contacts specified for MIL-DTL-38999, Series I, III, and IV and MIL-DTL-24308 (D Subminiature) connectors. They are now available for use in standard contact cavity Sizes 20, 20HD, 16 and 8. The Size 12 millimeter wave coax contacts will soon be available for use with standard MIL-DTL-38999 connectors. Applications for other standard multi-contact connectors are being evaluated.

For the purposes of this paper, the terms “coax contacts” and “coaxes” will be used interchangeably for these new millimeter wave coax connectors/contacts.

Blind Mate Coax Background

Several designs that use blind-mate coax connectors as “contacts” to route microwave coax signals through multi-contact host connectors are currently offered by other suppliers. Some are spring loaded variations of push-on SMA or SSMA connectors which are used in the Size 8 and Size 12 contact cavities, respectively, of various standard multi-contact connectors. Adaptations of BMA connectors are also used in some standard connector Size 8 contact cavities. There is also a non spring loaded coax connector used in Size 8 and Size 12 standard connector contact cavities. This is basically a sliding phase trimmer separated into pin and socket coax contacts.

For standard connector envelopes with custom, dedicated, multi-contact inserts, variations of reverse polarity, spring loaded push-on SMA and SSMA connectors in Sizes 8 and 12, and common interface coaxes in Size 12 or 10 (approximately) are available. Common interface coaxes have the same interface on both halves of the mating pair. The outer and center contacts on one of the mating coaxes are both spring loaded so each can maintain a butt-mated condition with its mating coax counterpart. Host connectors for these coaxes require additional positioning features such as alignment pins or custom nesting configurations in the plug and receptacle host connector interfaces to align the coax array and limit radial motion between the mated coax interfaces during exposure to vibration or shock environments.

All of the above coax configurations are intended for operation up to 26.5 GHz for Size 8 and up to 40 GHz for Sizes 12 or 10.

Motivation for New Development

Based upon review of the performance and sizes of the blind-mate coaxes presently available, it was apparent to SMI that applications would exist for higher density, higher frequency, lower loss blind mate coax contacts in sizes proportional to the latest high performance coax flex cables with outer conductor diameters from .047 to .265 for use in standard multi-contact host connectors. Market studies indicated that they must be completely interchangeable with equivalent standard, miniature signal contact sizes defined in MIL-C-39029. These are the most common miniature contacts used in popular industry standard multi-contact connectors. Standard host connectors could then become high performance, relatively low cost hybrid connectors with function complements including signal, shielded signal, power, fiber optic, and millimeter wave coax. The latter would operate to frequencies higher than any blind-mate coax presently or previously available.

To achieve these design goals, Southwest Microwave applied a new approach to millimeter wave coax contact design with utmost attention given to the interfaces and internal coax configurations. Blind-mate millimeter wave coax contact performance equivalent to conventional millimeter wave coax connectors such as 1.0 mm size demands dedicated, precision, matched impedance interfaces and fully compensated internal coax configurations. When mated, the interfaces must be maintained in a compressive, butt mated condition. EMI windows must be minimized.

The process involved combining component functions into fewer, smaller components; creating totally new outer and center contact engagement configurations; and utilizing the micro manufacturing capabilities of component suppliers not previously germane to the millimeter wave connector industry. Assembly procedures and tooling had to be re-thought. Micro versions of time-tested transmission line components and compensation features had to be incorporated. Millimeter wave connector knowledge had to be integrated with extensive working knowledge of MIL-SPEC and commercial, multi-contact connectors.

The result is a new family of impedance matched, fully compensated, millimeter wave coax contacts for standard multi-contact connectors.

Figure 1 shows comparisons of SSBP coaxes to their corresponding sizes of standard MIL-C-39029 signal contacts. The three current SSBP coax interfaces (4 contact envelops) are shown in Figure 2.

Figure 1: Comparisons of the SSBP coaxes to corresponding MIL-C-39029 contacts.

MIL-DTL-38999 Series I, III, and IV / MIL-DTL-24308

Figure 2: Size 20HD, Size 20, Size 16, and Size 8 SSBP coax connector/contact pairs.

Southwest Microwave has designated them as SSBP. They are now available in Sizes 20, 16, and 8 for MIL-DTL-38999 Series I, III, and IV connectors and Size 20HD for MIL-DTL-24308 connectors. Because of their envelope commonalities with contact envelopes per MIL-C-39029, the SSBP coaxes are adaptable to many standard host connectors for future design consideration. Our present focus is on MIL-DTL-38999, MIL-DTL-24308 and one special host connector application to be mentioned later in this paper.

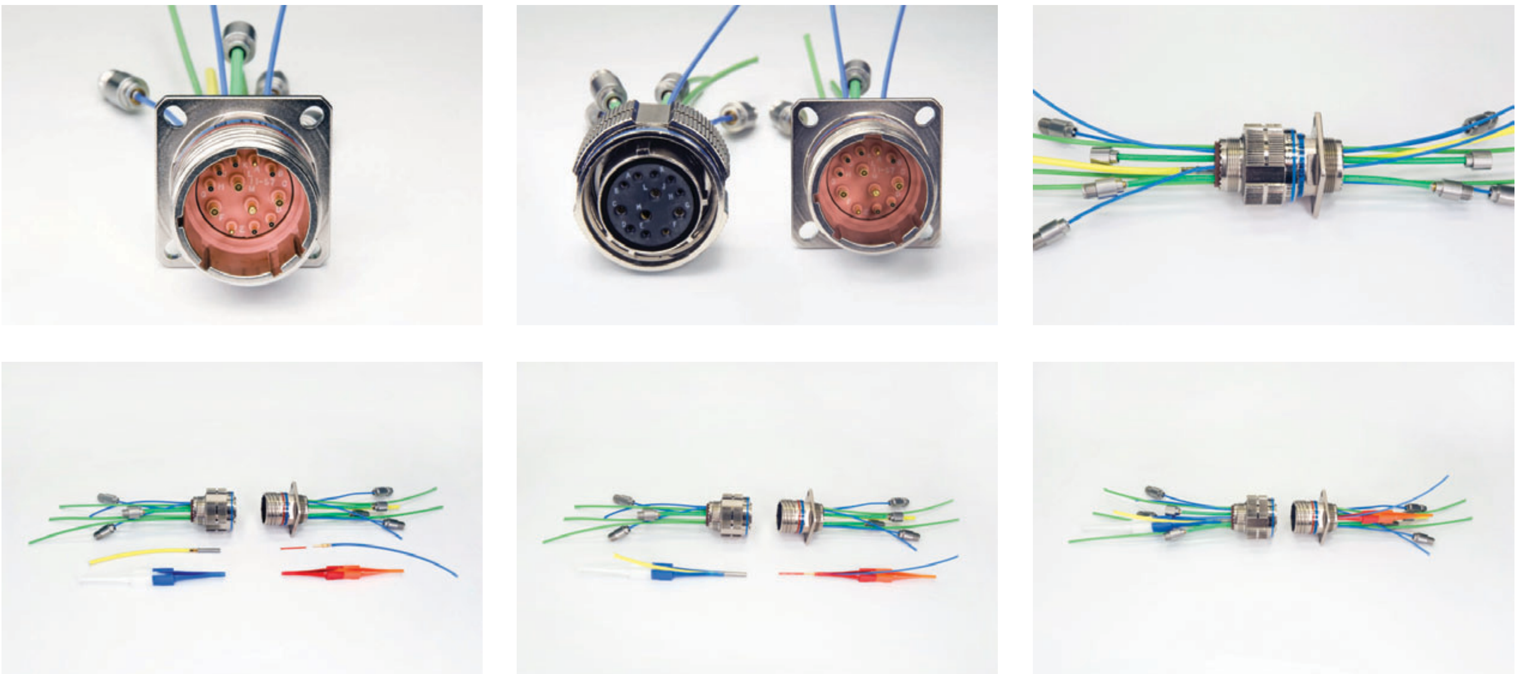

Figure 3: Detail view of the 38999 connector and SSBP coax installation sequence.

SSBP Coax Design Overview

All SSBP coaxes are fully interchangeable with their same size signal or power contact counterparts using the standard MIL-I-81969 insertion/extraction tools specified for use with respective host connector specifications. This means that in any single standard host connector accommodating the desired contact sizes and contact arrangement a system designer can mix signal or power (Sizes 22D and larger), fiber optic (Size 16), shielded signal (Sizes 16 and larger), and millimeter wave coax beyond 65 GHz (currently Sizes 20, 16 and 8) in almost any conceivable combination.

The photographs in Figures 3 and 4, show mixed Size 20, and Size 16 SSBP coaxes and signal contacts installed in a MIL-DTL-38999 Series III connector pair. The photographs in figure 5 show Size 20HD SSBP coaxes installed in a MIL-DTL-24308 connector pair. All illustrate the interchangeability of SSBP coaxes with corresponding standard signal contacts. Insertion and extraction of signal contacts and SSBP coaxes use the same, corresponding size standard insertion/extraction tools.

Figure 4: Mixed Size 20 and Size 16 SSBP coaxes and signal contacts installed in a MIL-DTL-38999 Series III connector pair.

SSBP Coax features

The SSBP pin coax outer contact mating end is a solid, heat treated beryllium copper tube with a nose radiused edge. All beryllium copper (BeCu) parts are plated gold over nickel per MIL-G-45204 and MIL-C-26074. There are no exposed spring fingers or slots that could be damaged or contribute to EMI emission. In standard host connectors, the alignment of SSBP coaxes is triple redundant. As the host connectors are initially mated, each pin coax outer contact tube encounters the closed entry socket contact insulator chamfer, the SSBP socket coax alignment sleeve entry chamfer, and the entry chamfer of the SSBP socket coax outer contact spring fingers. This sequence occurs before the center contacts engage and the outer contact tube of the SSBP pin coax butts against the reference plane in the SSBP socket coax outer contact. Each SSBP socket coax has an integral stainless steel compression spring preloaded to a higher force than the maximum mating force for that size coax. As the host connectors are fully mated, the resultant increasing compressive force at each pin and socket coax interface overcomes the socket coax spring preload and depresses the spring. The final spring force at each coax interface is a compressive force greater than preload. This design guarantees a matched impedance, EMI tight, highly reliable and repeatable mating for every SSBP coax in the host connector contact arrangement.

The envelope dimensions and features of SSBP coaxes closely conform to their corresponding signal contacts as defined in MIL-C-39029. Since SSBP is a coaxial configuration, the contact nose radii of solid pin contacts could not be preserved, but the pin coax protrusion lengths are identical to those of the standard signal contacts. Therefore, the MIL-DTL-24308 contact recesses and the MIL-DTL-38999 Series I, III, and IV scoop-proof features are preserved.

Test Methods

SSBP involves a set of non-standard millimeter wave interfaces. This is also true for many existing blind-mate microwave coaxes. Consequently, testing methods currently are limited. Comparative return loss or VSWR and insertion loss (IL) measurements are made using a mated pair of SSBP coaxes installed midway in coax cable assemblies with MIL-PRF-39012 standard interface connectors on each end. Comparison to the baseline data for those cable assemblies before SSBP installation provides useful, subjective information. The original baseline cable assembly lengths are maintained after SSBP coax inclusion which provides for a relatively accurate determination of SSBP insertion loss (IL) for each of the various SSBP sizes and types. For VSWR or return loss measurements, minimizing overall cable assembly length helps reduce masking effects due to cable losses.

Figure 5: Installation sequence for inserting SSBP coaxes into a D-Sub connector.

A better blind-mate coax test method suggested by William Oldfield[1] is Frequency Gating by Time Domain (FGT). This allows gating of the time domain location of interest and displaying the return loss of this portion as return loss versus frequency. Data using each of the above two methods for evaluating insertion loss and return loss or VSWR is displayed in Tables 1 & 2.

SSBP Test Data*

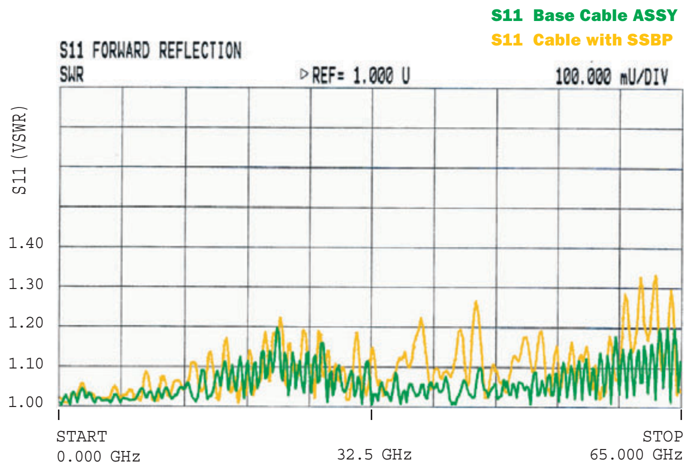

Table 1: Comparison of base cable assembly to cable assembly with Size 16 SSBP.

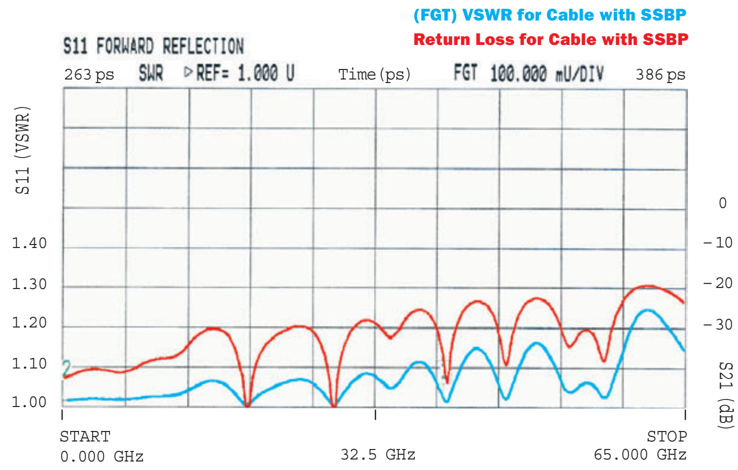

Table 2: VSWR and Return Loss for time gated Size 16 SSBP section of cable assembly using (FGT).

Test Measurement Reference

All data was measured using an ANRITSU VNA 37297D with 1.85 mm test port connectors. Calibration was broadband SOLT (fixed load). Test frequency range was DC to 65 GHz. SSBP Size 16 baseline cable assemblies were made using Insulated Wire IW 1251 cable with 2 direct solder 1.85 mm plug/male connectors produced by Southwest Microwave. The baseline cable assembly and the cable assembly with mated Size 16 SSBP coaxes installed both measured 6 inches between the reference planes of the 1.85 mm connectors. The SSBP cabled coaxes were installed in a mated pair of M38999 series III connectors. * ***Additional data is included in the Appendix.***

Additional Applications

Low reflection, low loss performance at high, continuous millimeter wave frequencies is shown by the data in Tables 1 & 2. This performance indicates that SSBP coaxes are also well suited for digital and fast rise time pulse signals where such performance is essential to preserve signal information content. A representative high end digital signal could be a 40 G-bit/second square wave pulse with a 20 GHz clock frequency. The third harmonic, f_3, induced in the rise time would be a 60 GHz sine wave. Similarly, using the basic relationship, $t_r = 0.35/BW$, between pulse rise time, t_r (sec), and bandwidth, BW (Hz), where bandwidth is equal to the high frequency cutoff, f_H (Hz), at the 90% pulse rise time level, a radar pulse with f_H equal to 60 GHz would have a rise time of 5.833 picoseconds. Available SSBP coaxes have calculated first order mode (cutoff) frequencies of 145 GHz for Sizes 20 and 20HD and 104 GHz for Size 16 which correspond to rise time response capabilities of 2.41 picoseconds and 3.36 picoseconds, respectively.

The measured performance and design features of SSBP coaxes assure signal integrity in high performance digital and pulse signal applications.

System impedances other than 50Ω can also be provided using SSBP coaxes. 50Ω Sizes 20, 20HD, and 16 are already available as previously noted. We have verified the feasibility of 75Ω in Size 16 and Size 12 SSBP and 95Ω in Size 12 SSBP. All SSBP coax Sizes, regardless of impedance value, use the same outer contacts and hardware as the corresponding 50Ω SSBP coax sizes. Therefore, respective size envelopes remain unchanged.

SSBP EMI Features

The configurations of the interfaces in all sizes of SSBP coaxes provide a high level of EMI isolation. The only openings in the outer conductor of a mated pair are .004 in. wide longitudinal slots in the socket coax outer contact interface. These are recessed in the outer sleeve and located behind the alignment chamfer at the entry of the socket coax assembly. When mated, a maximum .001 in. annular space exists between the socket coax alignment sleeve entry I.D. and the O.D. of the mating SSBP pin coax outer contact tube. The combination of contact configuration including the narrow slots at the plane of electrical contact between the pin and socket coax outer contacts, the labyrinth EMI path inside the socket coax interface, and the small annular opening at the socket coax entry provides exceptional EMI isolation for a blind-mate coax. This is shown by the data in Table 3 for Size 20 SSBP coaxes tested in non-grounded MIL-DTL-38999 Series I connectors.

EMI Data

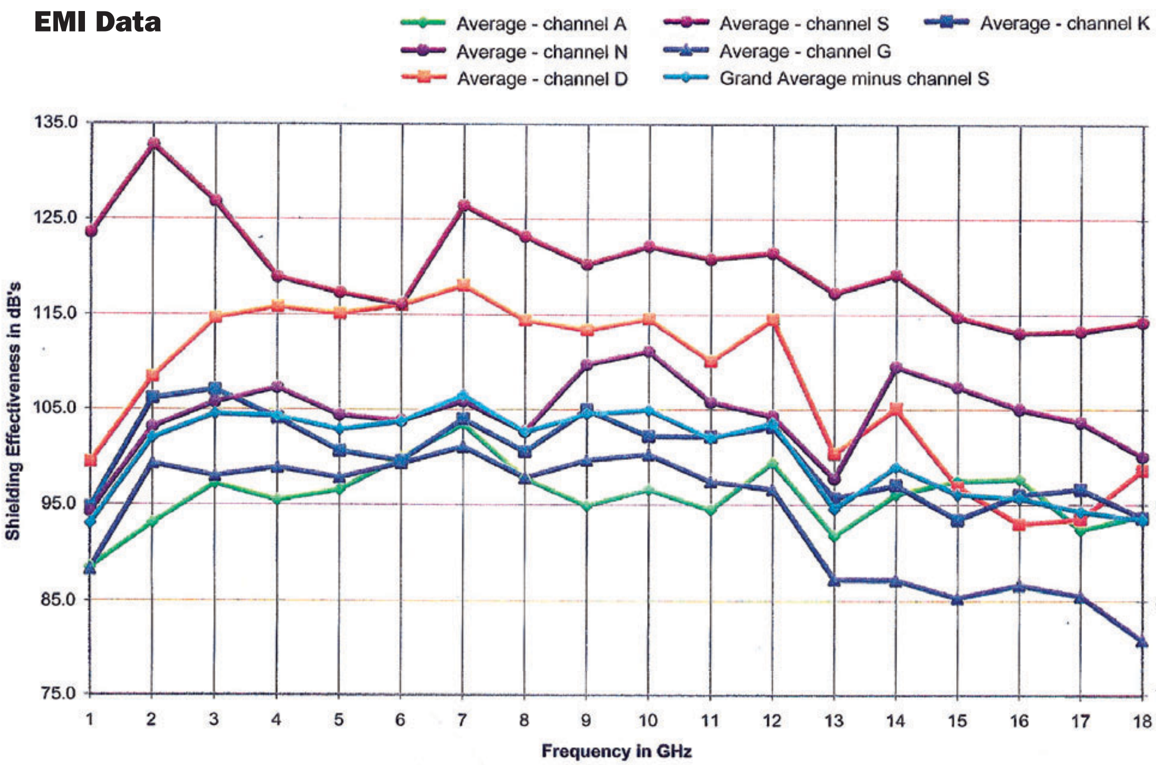

Table 3: Shielding Effectiveness of SSBP #20 contacts on 047 SR cable. 6 assemblies - 5 mated SSBP #20 contacts with SMA, 1 2X SMA connectors (channel S), 7/22/2005. Data is from 3 runs each channel. All data taken using MIL-STD-1344 Method 3008. [2]

SSBP Cable Applications

A variety of solid PTFE dielectric and low density dielectric, low loss cables have been used thus far with SSBP coaxes. These are listed in Table 4 along with some of the respective cable properties. Maximum cable size for any SSBP coax size is limited by the maximum allowable O.D. of the SSBP pin or socket coax cable bushing which corresponds to the contact crimp barrel O.D. for the same size signal contact per MIL-C-39029. These limits must be maintained for connector applications which use rear insertion, rear release contacts in order for the standard contact insertion/extraction tools to be used.

For microwave systems engineers considering millimeter wave interconnects, the contact size designations and definitions in MIL-C-39029 are of little use. Table 4 also provides a correlation between the MIL-C-39029 contact size designations and the corresponding SSBP millimeter wave coax sizes. The metric diameters listed are the I.D.s of the SSBP outer conductors.

SSBP cable preparation involves jacket trimming, outer conductor braid tinning and trimming, and center conductor trimming. The termination sequence for SSBP coaxes is as follows and is illustrated in Figure 6:

1) Cable insertion into the SSBP cable bushing followed by center conductor insertion into the socket contact inside the rear of the SSBP coax.

2) Bottoming of the tinned cable outer conductor against the step in the I.D. of the SSBP cable bushing.

3) Soldering the cable outer conductor directly into the I.D. of the SSBP cable bushing.

Figure 6: Typical SSBP Termination Configuration.

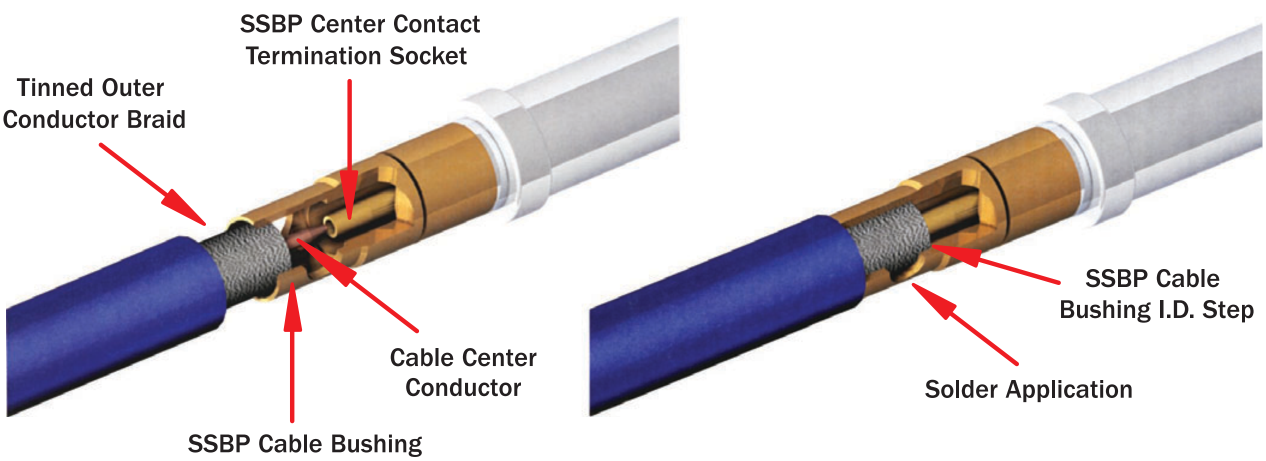

Table 4: SSBP Connector / Contact Applications and Cable Accommodations

SSBP Connector / Contact Size* and Application	Max. Allowable Cable Outer Conductor O.D. (in)	Existing Cable Accommodations	Planned Cable Accommodations	Velocity of Propagation (%e)	Attenuation @ 18 GHz (dB/100ft)	Theoretical First Order Mode (cutoff) Frequency (GHz) $F_c = [7.52/(D+d)]VP$
#20 SSBP (0.9 mm) for	0.048	Storm Products, Inc.				
MIL-DTL-38999 - I, III, IV		Stormflex 047		70	182.0	109.0
		Haverhill Cable & Mfg.				
		H-Flex HF 047		70	182.0	109.0
		Semflex, Inc.				
		SW060		74	169.3	129.4
		047 Semi-Rigid		70	182.0	109.0
		047 Conformable		70	182.0	109.0
			Temp-Flex Cable, Inc.			
			047-2801 (Low Loss)	84	158.8	135.4
#20HD SSBP (0.9 mm) for MIL-DTL-24308 and MIL-C-83513 w/Special Contact Layouts	0.048	(Same as #20 SSBP for MIL-C-38999)	(Same as #20 SSBP for MIL-C-38999)	(Same as #20 SSBP for MIL-C-38999)		
#16 SSBP (1.2 mm) for	0.09	Storm Products, Inc.				
MIL-DTL-38999 - I, III, IV		Stormflex 086		70	110.0	61.1
		Haverhill Cable & Mfg.				
		H-Flex HF 086		70	110.0	61.1
		Temp-Flex Cable, Inc.				
		086-2201 (Low Loss)		88.5	TBD	83.6
		Insulated Wire, Inc.				
		IW 1251 (Low Loss)		75	TBD	70.0
		086 Semi-Rigid		70	110.0	61.1
		086 Conformable		70	110.0	61.1
# 12 SSBP (1.7 mm) for	0.133	Temp-Flex Cable, Inc.				
MIL-DTL-38999 - I, III, IV		100-2001 (Low Loss)		88	TBD	58.5
			Temp-Flex Cable, Inc.			
			086-2201 (Low Loss)	88.5	TBD	83.6
			Harbour Industries			
			LL 120 (Low Loss)	80	74.0 MAX	55.4
			LL 155	83	45.8 MAX	41.5
			Semflex, Inc.			
			RH 110	75	75.5	56.4
			HP 120	75	75.5	56.4
			Haverhill Cable & Mfg.			
			** H-Flex HF 141	70	64.0	34.0
			H-Flex HF 086	70	110.0	61.1
			Insulated Wire, Inc.			
			IW 1251 (Low Loss)	75	TBD	70.0
			** 141 Semi-Rigid	70	64.0	34.0
			** 141 Conformable	70	64.0	34.0
			086 Semi-Rigid	70	98.0	61.1
			086 Conformable	70	98.0	61.1
#12 SSBP (1.7 mm) Discrete Panel / Bulkhead Mount (BMMA Mounting and Operating Envelope)	0.182	Temp-Flex Cable, Inc. 108-2001 (Low Loss, Triple Shielded)		88	TBD	58.5
			Temp-Flex Cable, Inc.			
			100-2001 (Low Loss)	88	TBD	58.5
			Plus (Same as #12 SSBP for MIL-DTL-38999)	Plus (Same as #12 SSBP for MIL-DTL-38999)		
#8 SSBP (3.3 mm) for	0.265	Harbour Industries				
MIL-DTL-38999-I, III, IV		LL 285		84	23.4	18.9
		Semflex, Inc.				
		LA 290		85	20.1	19.7
			Temp-Flex Cable, Inc.			
			260-1601(75Ω)	TBD	TBD	TBD
			1415C-1901	70	63.0	34.0
			141X-1701	86	59.4	39.8
			Harbour Industries			
			LL 235	80	37.0	27.7
			LL 160	84	45.8	42.0
			Plus Semi-Rigid and Conformable up to .250 OD			

* "Size" refers to the contact dimensional envelopes and configurations of standard signal contacts as defined by MIL-C-39029 which are used in the indicated multi-contact host connector applications listed for each size of SSBP microwave/millimeter wave coax connector/contact. All SSBP's listed for multi-contact applications use the same standard insertion/extraction tools as those specified for each applicable host connector and corresponding signal contact size.

** Size 12 SSBP's using cables with outer conductor O.D.'s larger than .133 up to and including .141 for any rear insertion/rear removal multi-contact connector application require use of modified standard insertion/extraction tool. Consult factory for details.

_Consult factory for mechanical installation and operation requirements regarding the use of semi-rigid or conformable cables with spring loaded SSBP socket connectors/contacts.

Special Applications

Although the focus for SSBP applications is on full interchangeability with MIL-C-39029 contacts used in standard multi-contact connectors, plausible special applications are encouraged. One current special application referenced earlier involves MIL-DTL-83513 Micro-D connector envelopes.

A standard envelope Micro-D 25 contact cable plug and a special PC End Launch receptacle (with two mounting lugs for firm attachment to a PC board) are each fitted with insulators that accept six (6) Size 20HD SSBP coaxes. The cabled socket coax used in the Micro-D plug is the same coax used in the MIL-DTL-24308 D-Subminiature connectors and is insertable/removable using the same standard D-Subminiature contact tool. The pin coaxes in the Micro-D receptacle each have an End Launch "dog house" style termination oriented and epoxy potted in place. The outer and center contact solder surfaces of all coaxes are coplanar with the mounting surfaces of the micro-D receptacle shell lugs. Standard jackscrew hardware is used to mate the cable plug to the PC End Launch receptacle and maintain firm engagement.

Following the success of the Micro-D SSBP cable plug and End Launch PC receptacle application, a standard envelope Micro-D SSBP cable receptacle was designed. This receptacle uses the same rear insertion, rear removable SSBP Size 20HD pin coax as used in the MIL-DTL-24308 D-Subminiature receptacle.

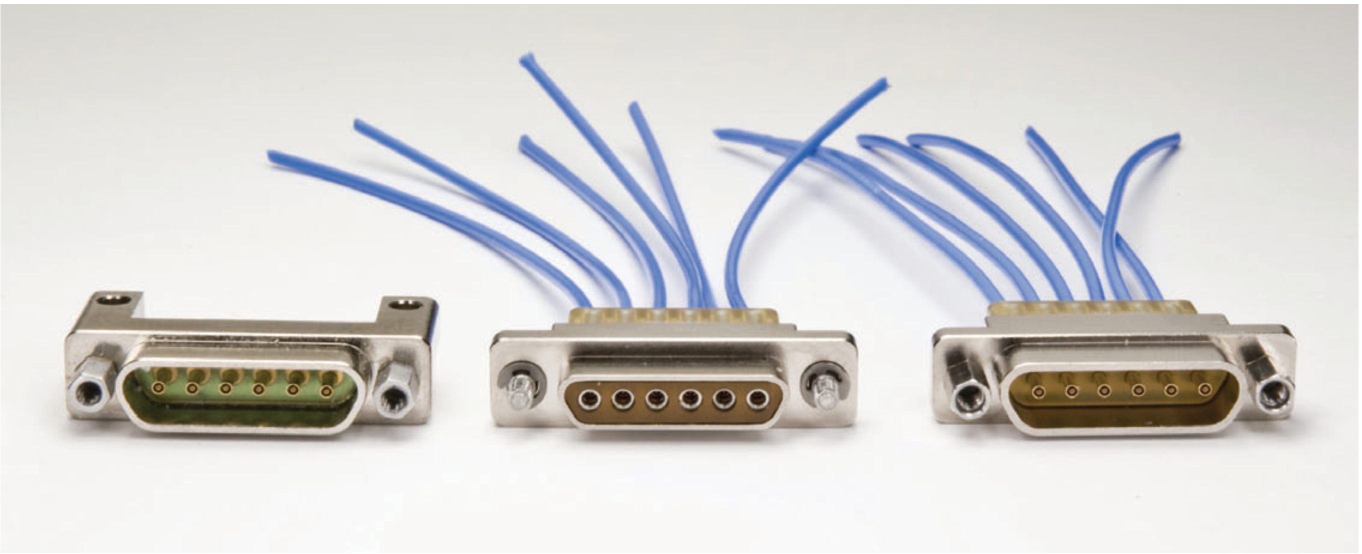

Figure 7: Close-up views of all three Micro-D SSBP connectors showing installed Size 20HD SSBP coaxes (see page 14 for installation sequence).

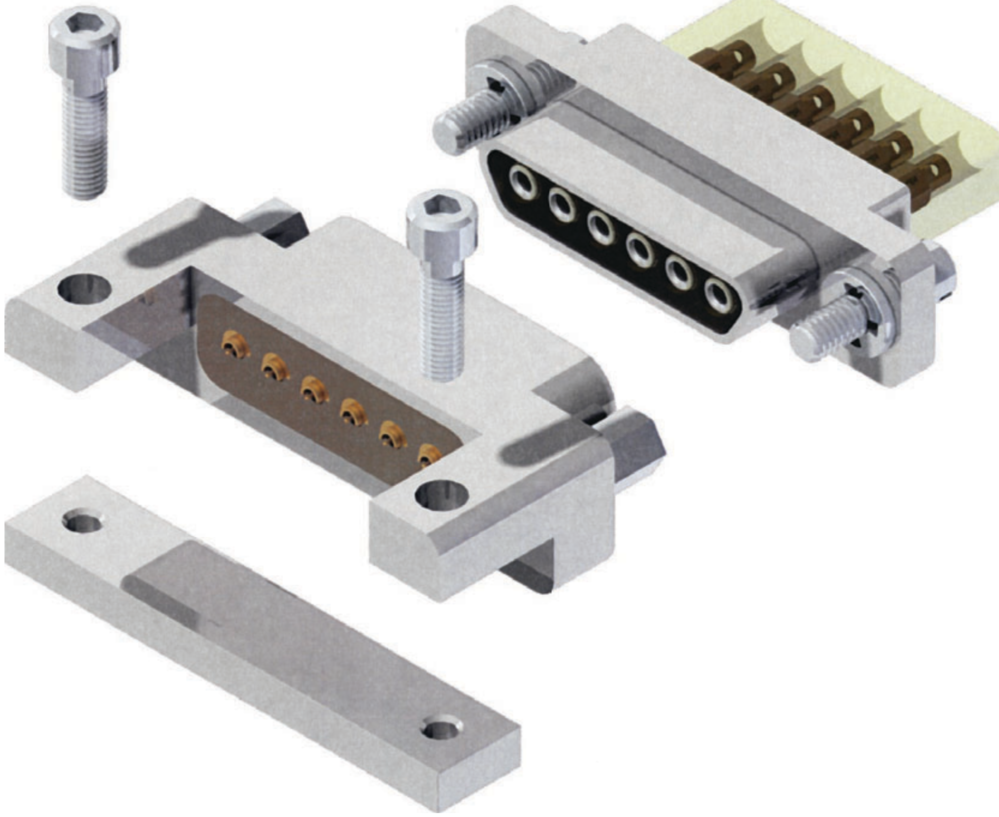

Figure 8: 6 SSBP Micro-D End Launch receptacle and cable plug.

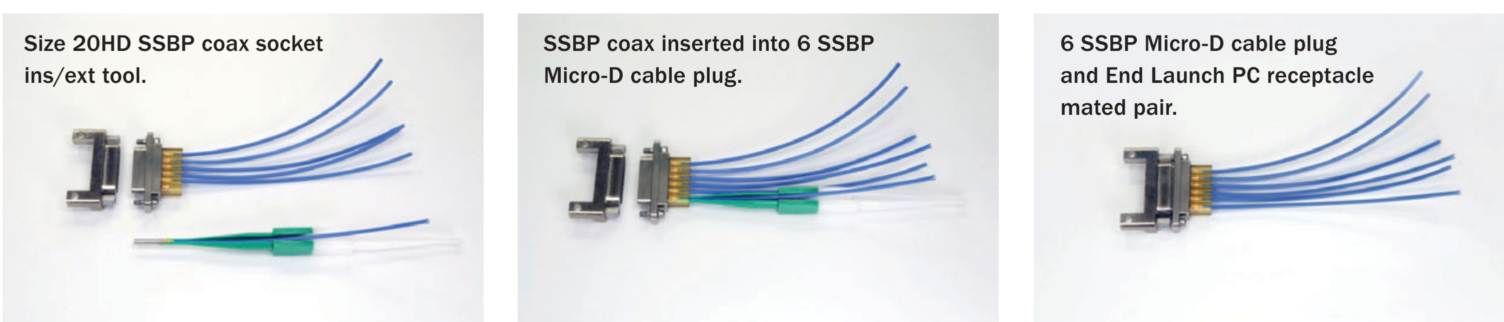

Figure 9: Installation sequence for inserting SSBP coaxes into a Micro-D connector.

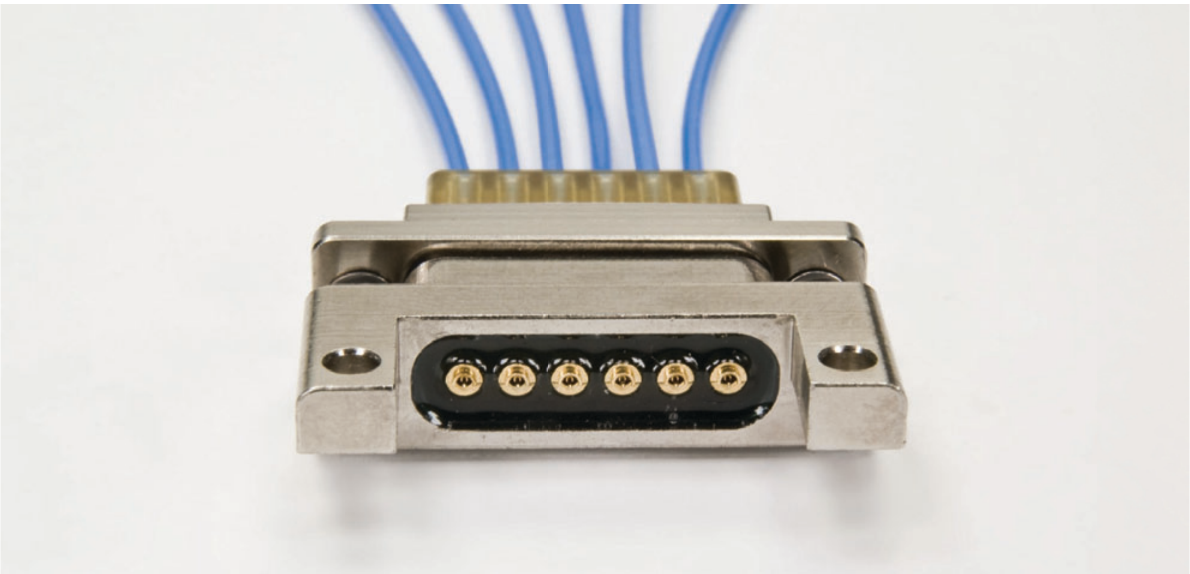

Figure 10: A rear view of the coplanar End Launch receptacle connector with mated cable plug.

Figure 11: SSBP Micro-D cable plug and receptacle mated pair.

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Reliability Predictions

Connector reliability often is predicted by calculation using the formulas and tables in MIL-HDBK-217F, Reliability Prediction of Electronic Equipment, Notice 2, Section 15.1 and is expressed in terms of failures per million hours of operation. All values shown in Table 5 are per mated connector pair or, in the case of discrete coaxes, the mated connector group. For a system configured with 3 or more input/output coaxes, the predicted failure rate for a MIL-DTL-38999 host connector with 3 coaxes is notably lower than that of a group of 3 or more discrete MIL-PRF-39012 microwave connectors, all other factors being constant. As the number of coaxes increases, the net failure rate for the discrete coax connector group increases whereas the failure rate for the host connector containing any number of contacts of any type, including coaxes, remains constant.

Although it may be subject to debate, according to MIL-HDBK-217F, Notice 2, pin count in a multi-contact connector is not considered a factor in predicting failure rates. However, for the same comparisons as described above, reliability calculations (not shown) using MIL-HDBK-217 revisions prior to Notice 2 which include pin count factors (contact quantities are doubled for coax contacts in multi-contact connectors) result in failure rates for multi-contact connectors with coaxes that are considerably lower than those for groups of discrete coaxes. The failure rate margins between each pair of configurations are also greater for calculations using revisions prior to Notice 2 than for those using Notice 2.

Table 5 compares the predicted failure rates for MIL-DTL-38999 host connectors containing 3, 16, and 32 coaxes to those of groups of 3, 16, and 32 discrete coax connectors per MIL-PRF-39012. Blind-mate coaxes are not specifically covered by MIL-PRF-39012, nor are their failure rate factors presently included in MIL-HDBK-217F, Notice 2. The predicted reliabilities in Table 5 are also expressed in terms of Mean Time Between Failure, MTBF (hrs), which is the mathematical inverse of failure rate.

Table 5 : Reliability Predictions Per MIL-HDBK-217F, Notice 2

NUMBER OF COAXES	MIL-DTL-38999 w/COAX		MIL-PRF-39012 COAX GROUP	
	Failure Rate (Failures/10^6 HRS)	MTBF (HRS)	Failure Rate (Failures/10^6 HRS)	MTBF (HRS)
3	0.288	3.472×10^6	0.354	2.825×10^6
16	0.288	3.472×10^6	1.888	0.530×10^6
32	0.288	3.472×10^6	3.776	0.265×10^6

All of the values displayed in Table 5 apply to existing multi-coax designs as well as SSBP coaxes.
The reliability advantages offered by SSBP coaxes are as follows:

1) Increased coax line count per application due to higher density in the same or smaller footprint than previous configurations resulting in correspondingly higher MTBF values compared to the same number of discrete coaxes, and

2) Triple redundant alignment for the individual SSBP coaxes in standard connectors which, although not separately considered in MIL-HDBK-217F, Notice 2, is a feature which assures the mating reliability of each coax.

An additional advantage pertains to environmental sealing. Environmentally sealed, multi-contact connectors provide a proven moisture seal in a single connector for all installed contacts. Sealing individual blind-mate coaxial connectors requires small, individual seals that must not affect mating forces, mating alignment, or electrical performance. The individual seals must seal simultaneously at every mating cycle. These concerns are eliminated when environmentally sealed connectors such as MIL-DTL-38999 are used.

Summary

SSBP coaxes deliver exceptional performance for microwave and millimeter wave blind-mate applications. They offer microwave packaging density, application flexibility, and systemic reliability at unprecedented levels. They provide the lowest VSWR, lowest IL per unit length, and the highest EMI isolation of any available blind-mate coax from DC through 65 GHz. When future demands for operation beyond 65 GHz become reality and cables are produced to meet those demands, SSBP coaxes are already there.

In MIL-DTL-38999 Series I, III, or IV connectors, any shell size with any contact arrangement for Size 20, Size 16 and/or Size 8 contacts now (and for Size 12 in the near future) is an SSBP host connector. Where Size 12 is otherwise the smallest available blind mate microwave coax for .086 flexible or semi-rigid cable, SSBP Size 16 millimeter wave coaxes now provide a 30% size reduction in contact size for .086 size cable in addition to all of the other higher level SSBP performance improvements.

All standard contact arrangement versions of MIL-DTL-24308 D-Subminiature connectors using Size 20 contacts can now be populated entirely with Size 20HD SSBP coaxes using flexible or semi-rigid cables up to size .047. Millimeter wave applications are no longer limited to only the Size 8 cavity positions.

SSBP coax design technology allows all SSBP coaxes to fit within any of the respective MIL-C-39029 Size 20 or larger contact envelopes. This means that SSBP applications are possible in any standard connector that uses these contacts. Special multi-contact connector applications can be designed to use SSBP coaxes as in the MIL-DTL-83513 Micro-D example described earlier. Completely new SSBP configurations and/or special housings can also be developed to accommodate almost any application.

The inherent reliability of coaxes in multi-contact connectors compared to equal numbers of discrete coaxes in groups, the increased densities provided by the SSBP millimeter wave coax designs compared to prior available microwave coaxes, and the added reliability of the triple redundant alignment features of SSBP coaxes when used in standard multi-contact connectors are all important considerations for microwave systems designers. These characteristics along with all of the performance, packaging, and application features provided by Southwest Microwave SSBP coaxes represent a paradigm shift in millimeter wave, blind mate coax design and offer an expanded set of design choices formerly unavailable to Systems Engineers.

Acknowledgements

[1] Credit: "Measurement of Blind Mate Connectors" by William Oldfield, Applied Microwave, Spring 1993

[2] Credit: EMI data was provided by Storm Products, Inc.

SOUTHWEST MICROWAVE

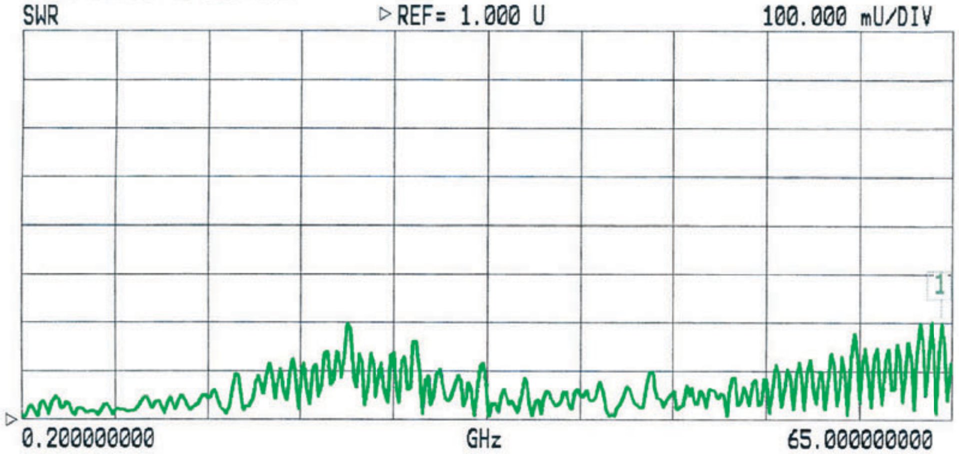
VNA: 37297D

MODEL:	03S107	DATE:	05/01/2008 16:42
DEVICE:		OPERATOR:	

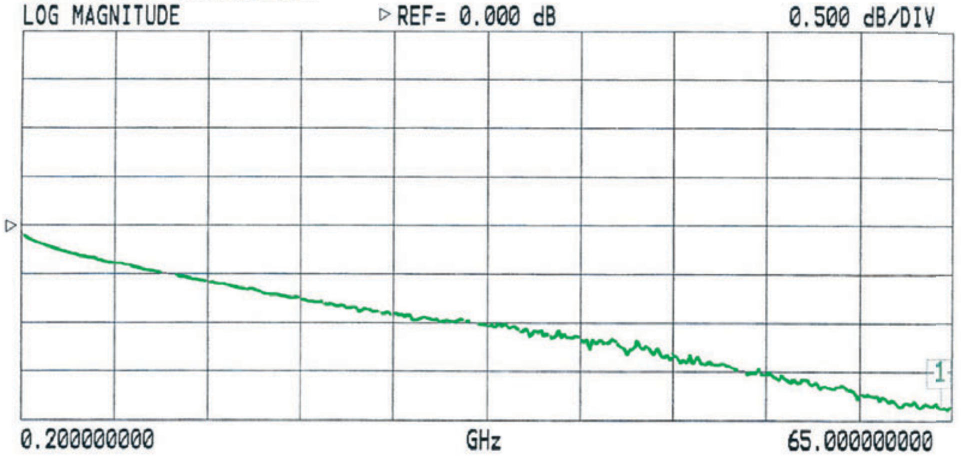
START:	0.200000000 GHz	GATE START:		ERROR CORR: 12-TERM
STOP:	65.000000000 GHz	GATE STOP:		AVERAGING: 1 PT
STEP:	0.200000000 GHz	GATE:		IF BNDWDTH: 100 Hz
		WINDOW:		

S11 Base Cable ASSY

S11 FORWARD REFLECTION
SWR ▷REF= 1.000 U 100.000 mU/DIV



S21 FORWARD TRANSMISSION
LOG MAGNITUDE ▷REF= 0.000 dB 0.500 dB/DIV



MARKER 1
ALL DISPLAYED
CHANNELS

CH 1 - S11
64.400000000 GHz
1.204 U

CH 2 - S12

CH 3 - S21
64.400000000 GHz
-1.884 dB

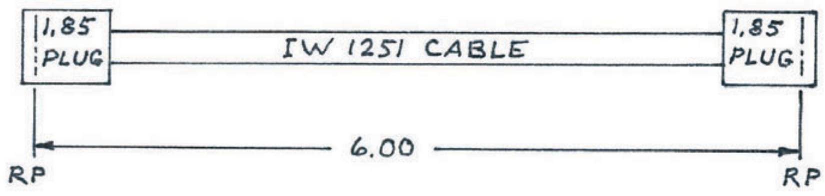
CH 4 - S22

MARKER TO MAX
MARKER TO MIN

MARKER READOUT
FUNCTIONS

PRESS <ENTER>
TO SELECT

CABLE ASSEMBLY BASELINE VSWR AND IL



SOUTHWEST MICROWAVE

VNA: 37297D

MODEL:
DEVICE:

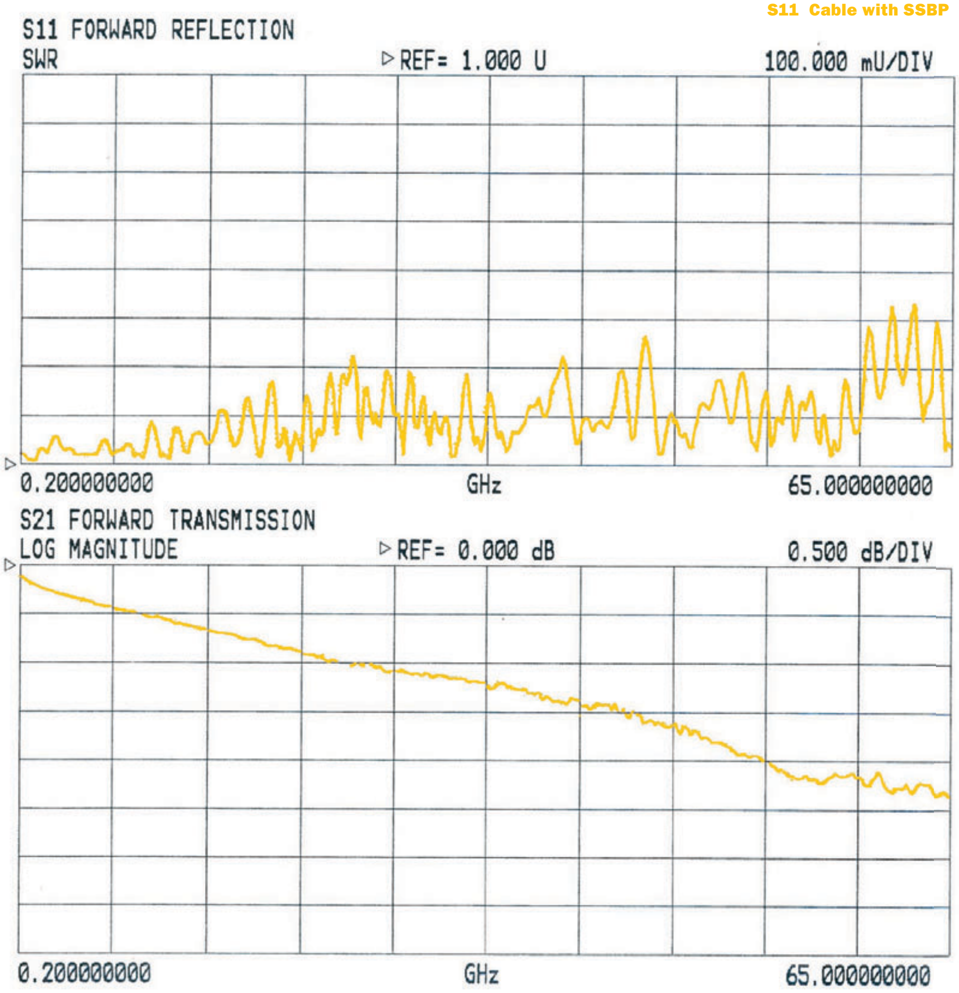
DATE: 05/02/2008 10:51
OPERATOR:

START: 0.200000000 GHz
STOP: 65.000000000 GHz
STEP: 0.200000000 GHz

GATE START:
GATE STOP:
GATE:
WINDOW:

ERROR CORR: 12-TERM
AVERAGING: 1 PT
IF BNDWDTH: 100 Hz

S11 Cable with SSBP



DOMAIN

FREQUENCY

FREQUENCY
WITH TIME GATE

TIME
LOWPASS MODE

TIME
BANDPASS MODE

SETUP

DISPLAY
TIME/ DISTANCE

SET RANGE

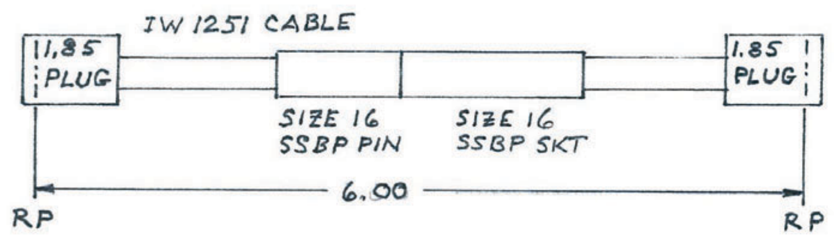
SET GATE

GATE OFF

HELP

PRESS <ENTER>
TO SELECT
OR SWITCH

VSWR AND IL FOR CABLE ASSEMBLY WITH SSBP COAXES



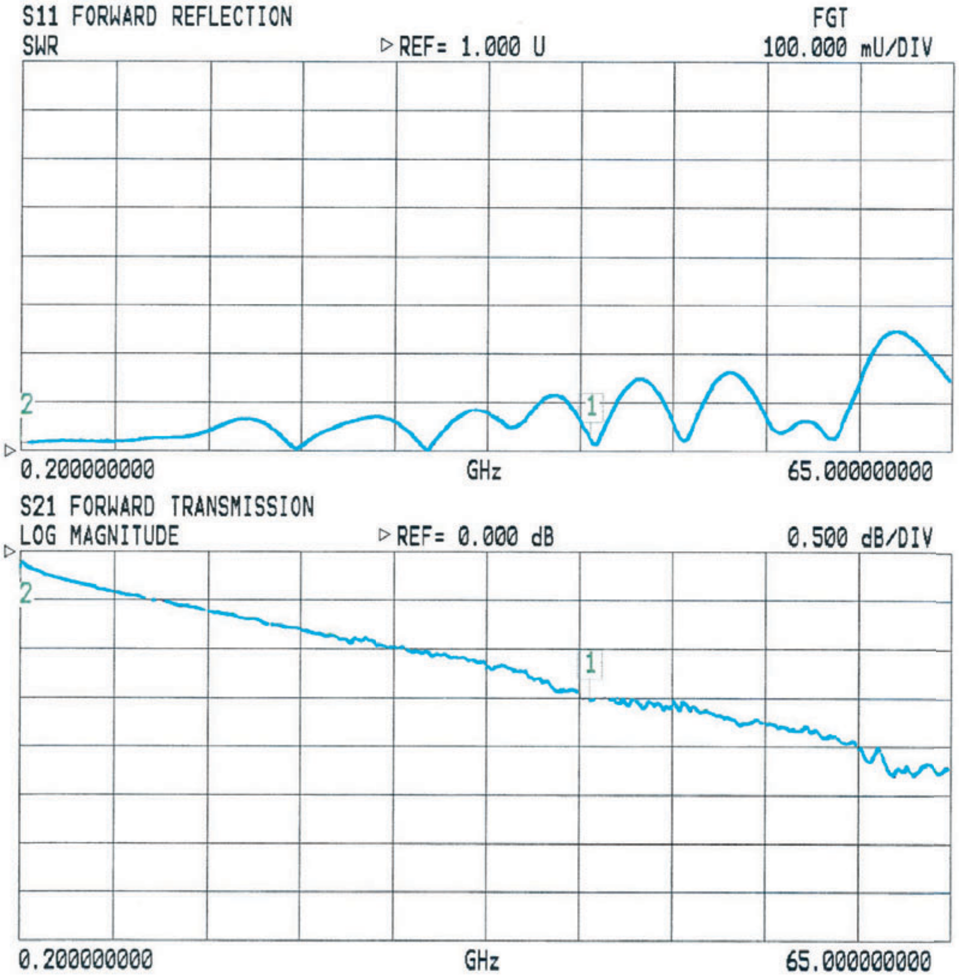
SOUTHWEST MICROWAVE

VNA: 37297D

MODEL:		DATE:	05/02/2008 11:14
DEVICE:		OPERATOR:	

START:	0.200000000 GHz	GATE START:	263.0000 ps	ERROR CORR:	12-TERM
STOP:	65.000000000 GHz	GATE STOP:	386.0000 ps	AVERAGING:	1 PT
STEP:	0.200000000 GHz	GATE:	NOMINAL	IF BNDWDTH:	100 Hz
		WINDOW:	RECTANGULAR		

(FGT) VSWR for Cable with SSBP



DOMAIN

FREQUENCY

FREQUENCY WITH TIME GATE

TIME LOWPASS MODE

TIME BANDPASS MODE

SETUP

DISPLAY TIME/ DISTANCE

SET RANGE

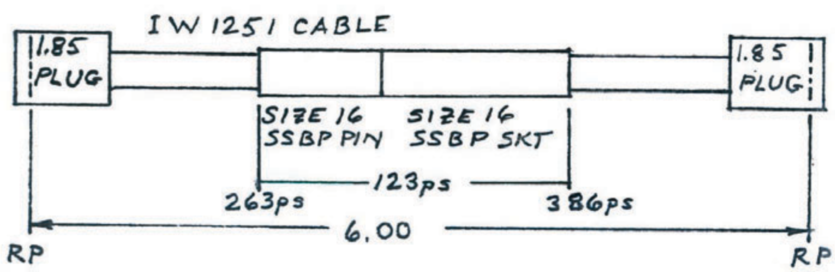
SET GATE

GATE ON

HELP

PRESS <ENTER> TO SELECT OR SWITCH

FREQUENCY GATED TIME DOMAIN (FGT) VSWR FOR CABLE ASSEMBLY WITH SSBP COAXES



VNA: 37297D

MODEL:
DEVICE:

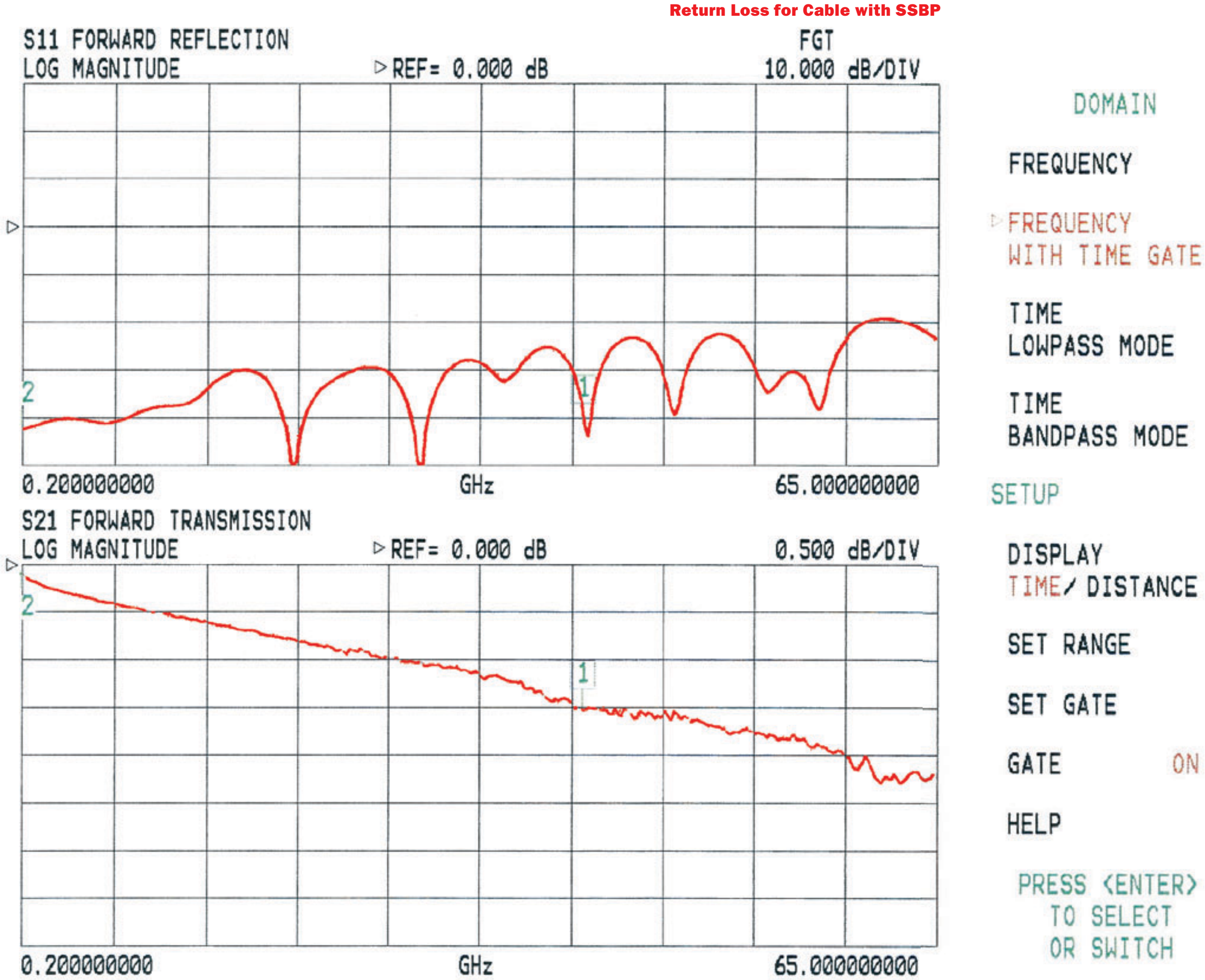
DATE: 05/02/2008 11:15
OPERATOR:

START: 0.200000000 GHz
STOP: 65.000000000 GHz
STEP: 0.200000000 GHz

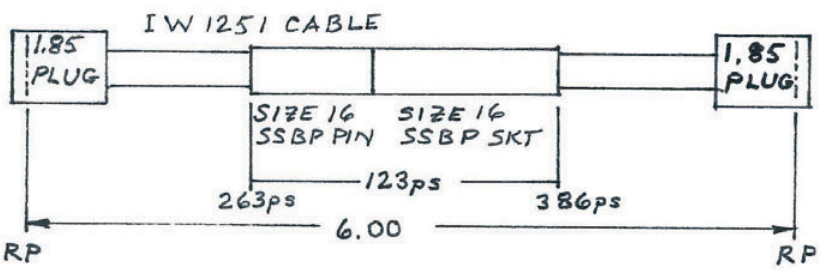
GATE START: 263.0000 ps
GATE STOP: 386.0000 ps
GATE: NOMINAL
WINDOW: RECTANGULAR

ERROR CORR: 12-TERM
AVERAGING: 1 PT
IF BNDWDTH: 100 Hz

Return Loss for Cable with SSBP



FREQUENCY GATED TIME DOMAIN (FGT) RETURN LOSS FOR CABLE ASSEMBLY WITH SSBP COAXES



SOUTHWEST MICROWAVE

SSB High Density Interconnect Solutions

A Family of Connectors for Microwave and Digital Applications

Typical Test Data

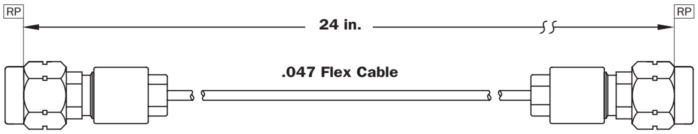
To electrically evaluate the SSB interface a pair of SSBP contacts was inserted into a reference cable assembly and tested to 65 GHz.

The data shows the baseline cable assembly, then the same cable with the SSBP contact pair added. The data is overlaid on the same graph shown below.

The difference is the contribution of the SSBP pair.

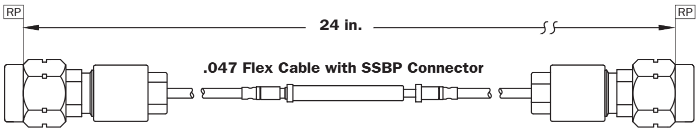
The diagrams on the right show the test configurations.

Baseline Cable

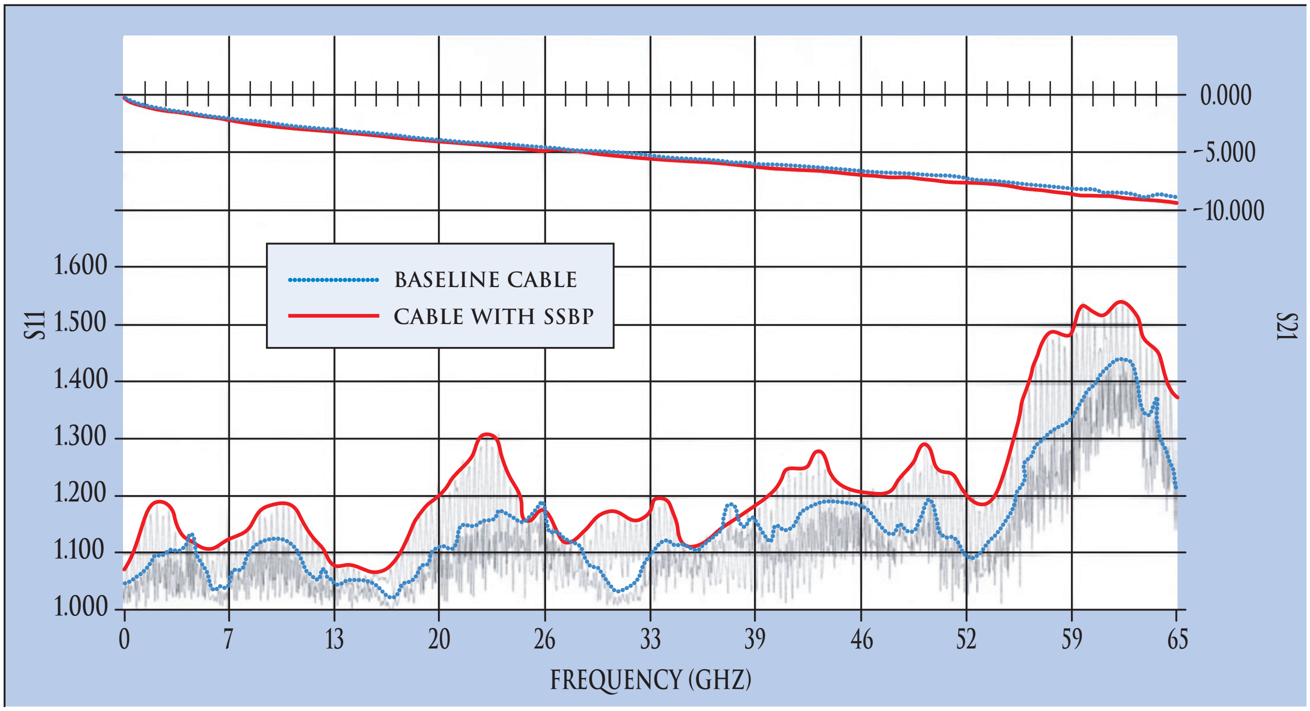


1.85 mm male to male cable connector assembly mounted on 24 inch Stormf ex 047 cable.

Cable with SSBP



Cable assembly "split" and reconnected with an SSBP contact pair.



Notes

SOUTHWEST MICROWAVE

SOUTHWEST MICROWAVE

The Performance Leader in Microwave Connectors

Southwest Microwave, Inc. *is the leader in hi-performance interconnect products for millimeter wave and microwave applications. Providing the best value through performance as well as:*

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- *Low Insertion Loss*
- *Low RF Leakage*
- *High Temperature*
- *Higher Power Handling*
- *Excellent Repeatability*
- *Rugged & Durable*

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