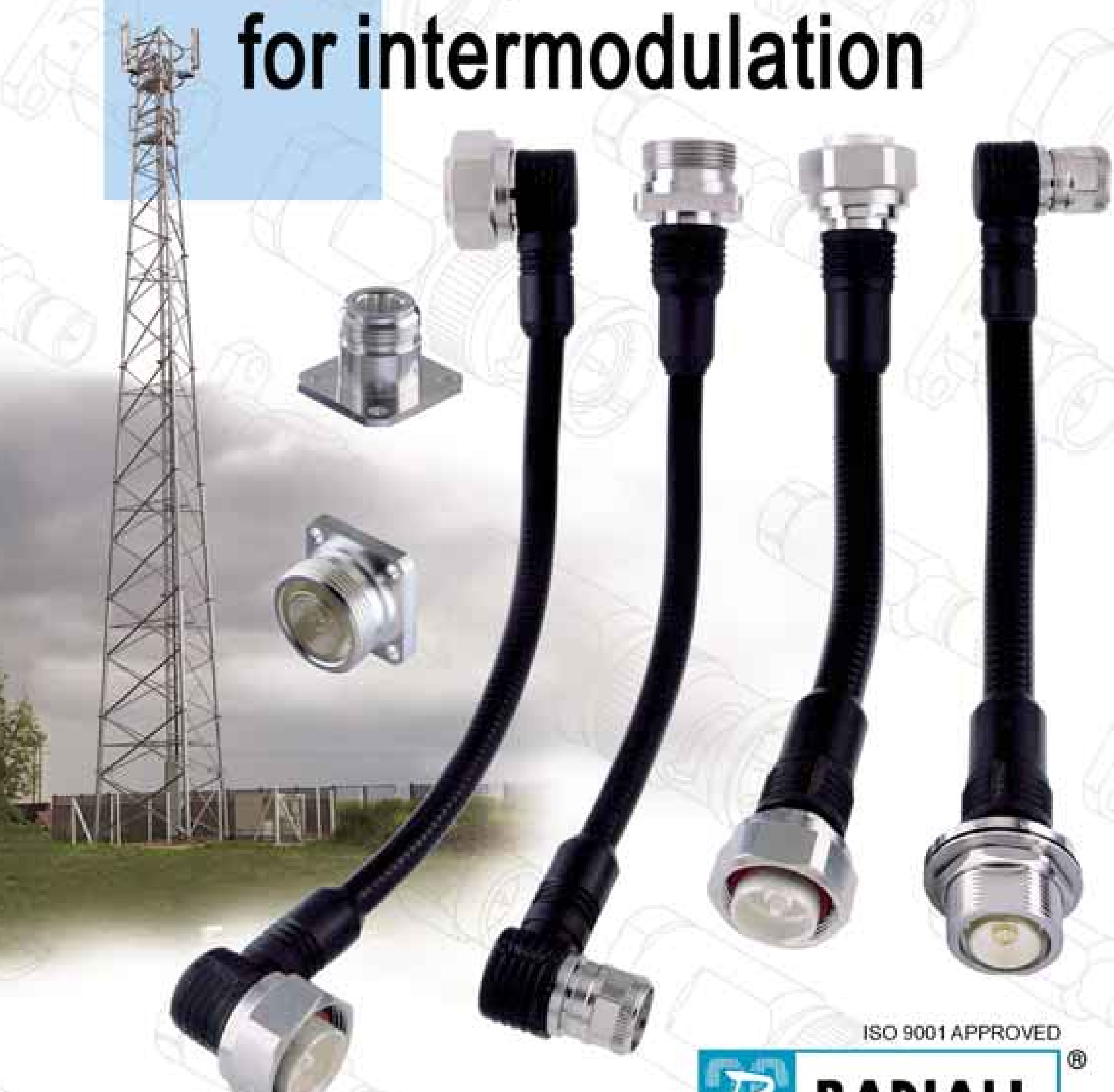
COAXIAL CONNECTORS AND CABLE ASSEMBLIES

Application guide for intermodulation



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CONTENTS

INTRODUCTION

After it was determined that Intermodulation due to active components in transmitters and receivers could be limited by cavity filters and isolators, yet additional Intermodulation sources have appeared.

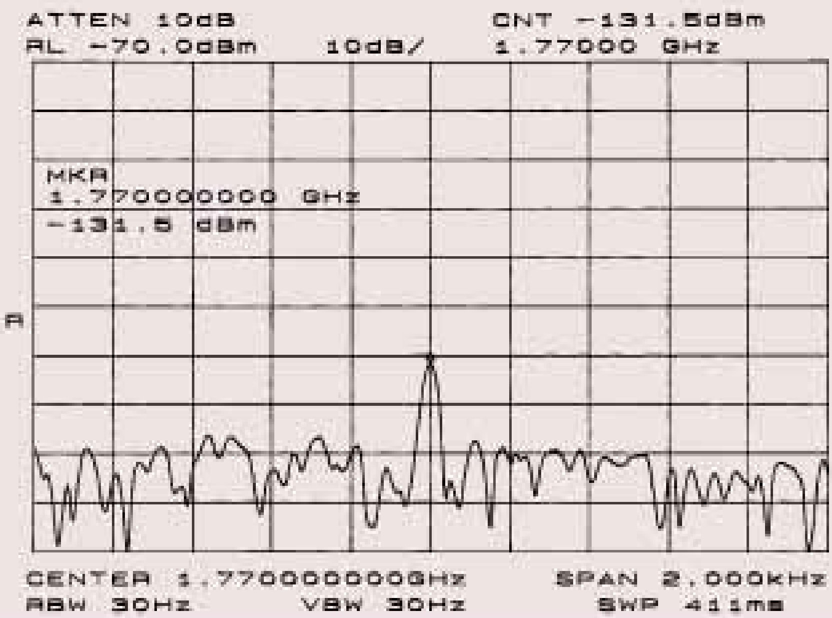
Intermodulation also results from the non-linear behaviors of some passive components.

Previously, passive components such as coaxial connectors and cable assemblies were considered to be linear. Actually, they behave as Intermodulation generators when transmission and reception signals of very different levels share the same electrical path or when transmission and reception channels are very close, to one another.

WHAT IS INTERMODULATION ?

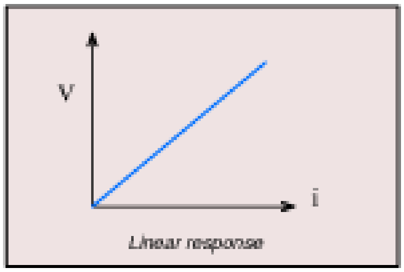
?

IM (abbreviation for InterModulation) is an undesired modulation which leads to a **distortion** of the output High Frequency carrier. It is defined as a **variation in amplitude, frequency and phase** of the HF carrier.



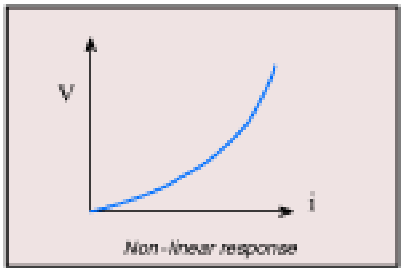
DEFINITION

Inputting a signal with frequency f1 into a linear passive device (linear voltage/current ratio) will produce an output signal with no modification on the frequency side. Only the amplitude and the phase can be modified.



Linear response

But, inputting the same signal into a passive device with non-linear v-i characteristics will result in distortions in the time scale, resulting in changes in the frequency. That means that in addition to the carrier frequency f1, several harmonics are produced : 2f1, 3f1, 4f1, ..., nf1.



Non-linear response

When the input signal contains 2, or more, frequency components f1 and f2, then the output signal will show a spectral composition containing the frequency combinations that conform to the following equation :

$$\textbf{IMP} = \textbf{nf1} + \textbf{mf2}$$
$$Q = |n| + |m|$$

IMP : InterModulation Products
Q : IMP order
(m and n positive, negative or null integers)

It is the harmonics combination of several frequencies that produces IM.

The third and fifth order intermodulation products usually make up 95 % of those encountered.

The most troublesome IM products are those of odd order since these are very close to the carrier fundamental frequency.
They can then appear within the received signal bandwidth and degrade the overall communication system performance.

The Total Intermodulation is defined as the ratio of the third order IMP against the incident signal power.
It is expressed in dBc :

$$\textbf{TIM} = 10 \log \frac{P_{IMP_3}}{P_{incident}} \textbf{(dBc)}$$

For a power of 1 mW, the TIM is expressed in dBm :

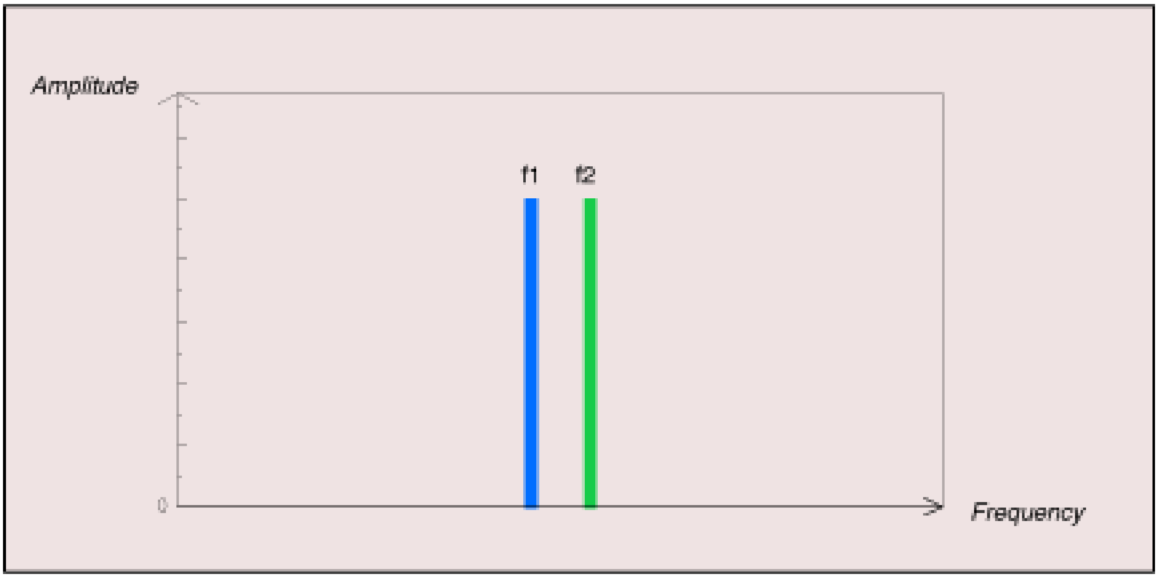
$$\textbf{TIM} = 10 \log P_{IMP_3} \textbf{(dBm)}$$

CONVERSION BOARD

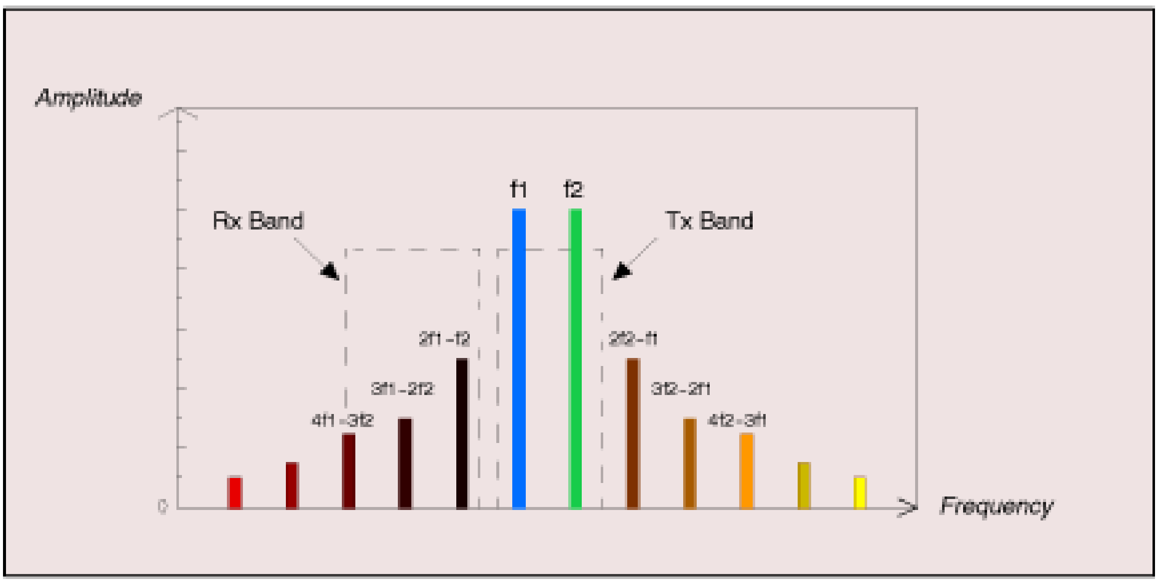
IMP_3 *(in dBm)*	**IMP** *(dBc)* = **IMP** *(dBm)* - **10.log P** *(mW)*				
	P = 20 W	**P = 25 W**	**P = 27 W**	**P = 80 W**	**P = 130 W**
-50	-93,0	-93,9	-94,3	-99,0	-101,1
-60	-103,0	-103,9	-104,3	-109,0	-111,1
-70	-113,0	-113,9	-114,3	-119,0	-121,1
-80	-123,0	-123,9	-124,3	-129,0	-131,1
-90	-133,0	-133,9	-134,3	-139,0	-141,1
-100	-143,0	-143,9	-144,3	-149,0	-151,1
-110	-153,0	-153,9	-154,3	-159,0	-161,1
-120	-163,0	-163,9	-164,3	-169,0	-171,1
-125	-168,0	-168,9	-169,3	-174,0	-176,1
-130	-173,0	-173,9	-174,3	-179,0	-181,1

DEFINITION

FREQUENCY SPECTRUM OF THE INPUT SIGNAL



FREQUENCY SPECTRUM OF THE OUTPUT SIGNAL



2f1 - f2 (or 2f2 - f1) = third order IM
3f1 - 2f2 (or 3f2 - 2f1) = fifth order IM
4f1 - 3f2 (or 4f2 - 3f1) = seventh order IM

f1, f2 : f1 and f2 fundamental frequencies
nf1 : n° harmonic of f1 fundamental
mf2 : m° harmonic of f2 fundamental

COMMUNICATION SYSTEMS

Newer multiple channel radio systems are designed to operate with an operating transmitting frequency range Tx and, a slightly shifted, receiving frequency range Rx.

In GSM systems, the TX frequency range is 935-960 MHz and the RX frequency range is 890-915 MHz.

In DCS systems, the TX frequency range is 1805-1880 MHz and the RX frequency range is 1710-1785 MHz.

Some intermodulation products of odd order, emanating from the high power Tx carrier, will appear in the receiving Rx frequency range and will degrade the reception performance. It is therefore essential to maintain these IMP's at a very low level, ideally below the sensitivity of the receiving equipment.

Cellular and PCS systems may require maximum generated IM levels of about -110 dBm at transmitter powers of 20 W (43 dBm) for a transmission path containing a number of components.

This is extremely severe considering 124 transmit and receive channels share a common transmission media (cables, connectors, antennas...) at transmitter power levels of 2.5 W to 320 W (34 dBm to 55 dBm).

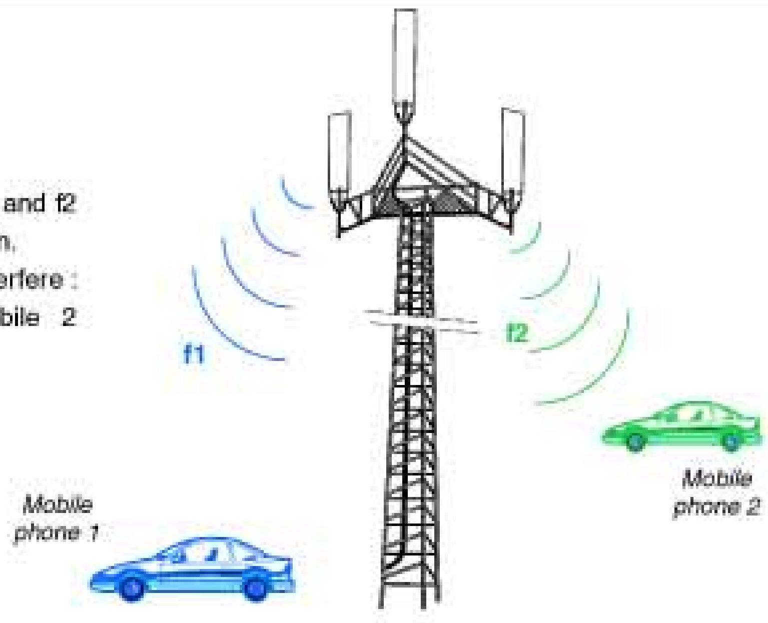
But to make the whole communication system reach such an IM level, better levels are required for each individual component of the system.

For example, the IM level required from a cable assembly is usually - 120 dBm for the same transmit powers of + 43 dBm.

With these requirements in mind, RADIALL has developed a range of N series and 7/16 series connectors which make it possible to achieve levels of -125 dBm on cable assemblies. See page 17.

Example :

Two mobile phones, whose frequencies f1 and f2 are close, depend on the same base station.
The two communications should not interfere : mobile 1 should not receive the mobile 2 communication and conversely.



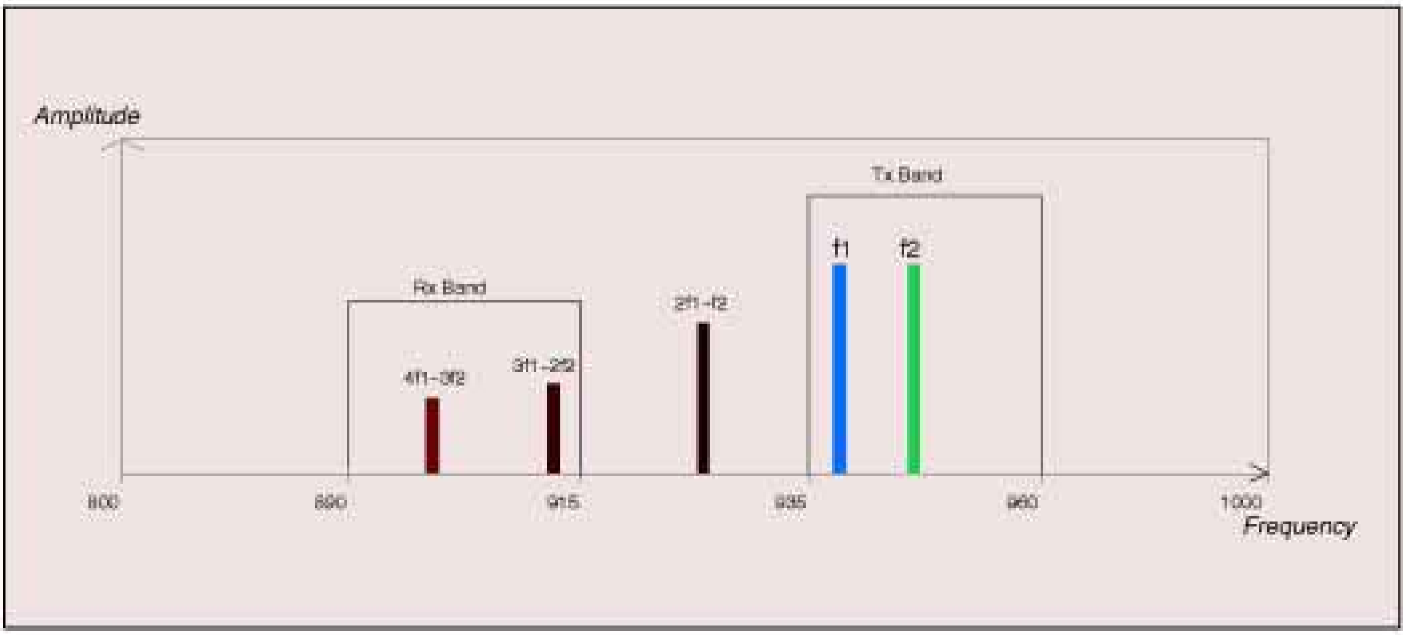
COMMUNICATION SYSTEMS

Example : The GSM case

Transmit Frequencies (MHz)		Intermodulation Products (MHz)		
		3rd Order	5th Order	7th Order
f1	f2	2f1 - f2	3f1 - 2f2	4f1 - 3f2
935	960	910*	885	860
937	955	919	901*	883
935	945	925	915*	905*

* Interfering IM Products in the Rx band

GSM BASE STATION TX AND RX BANDS



INTERMODULATION GENERATION

While there are some high power signals with different frequencies, any device with non-linear v-i characteristics will generate Intermodulation Products.
Their level will depend on the slope of the v-i curve and on the powers of the incident frequencies.

The two main categories of non-linearities are :

- *Contact non-linearities at metal-metal junctions*
- *Material and surface plating non-linearities.*

CONTACT NON-LINEARITIES

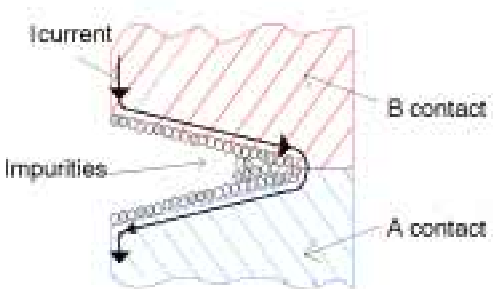
Contact non-linearities are formed when discontinuities exist in the current carrying path of the contact, when contacts are less than 360°. These discontinuities may have various causes and are usually not visible to the naked eye. The following are potential causes:

- Surface condition in the contact joint e.g., dirt, surface texture, microfissures in the material, ill mating parts.... all of these lead to microdischarges and random broadband noise.

- Rusty bolt effect. This is more accurately known as electron tunnelling effect and is present in metal-insulator-metal transitions.

- Contact mating, be it by poor contact spring force or simply by the quality of the contact.

Contact non-linearities are most commonly encountered in passive RF components, where contact interfaces can be oxidized or corroded, loose fitting, and may be subject to surface contamination.... this is almost always attributable to the connectors.



Non-linear contact area

The schematic below-left shows a non linear joint contact as seen through a microscope. This clearly shows a cavity with impurities present. The effect of these impurities is to alter the current (I) path from one which can pass straight through the joint to one which needs to travel around this cavity. This in turn means that an impedance (Z) is created which then produces a voltage potential barrier. This voltage potential barrier may be responsible for microscopic arcing or electron tunnelling (diode effect) which in turn leads to a non linear voltage to current ratio across the junction path. When this occurs, IM products are generated.

MATERIAL NON-LINEARITIES

- Resistive heating in non-linear conductors leads to non-linearities.

Since the conductor resistivity is not null, power is spread into the component walls and causes a temperature rise and a local variation in resistivity.

In most systems with contacts and connectors, those low levels of non-linearities will not be noticed.

However, the thermal-resistive effect may not be negligible when a low conductivity oxide layer covers the conductor and generates significant heating at high frequencies by Joule effect.

- Magneto-resistance effect in non-magnetic materials. The magnetic fields that are applied to the conductor alter its resistivity. So that they, in conjunction with the RF current, can create intermodulation signals. These IMP are 50 dB below the IMP generated by the thermal-resistive effect. They can be neglected.

- Non-linearity due to non-linear dielectric.
- Non-linearity due to variations of permeability into ferromagnetic materials.

The susceptibility of ferromagnetic materials to be magnetized is not constant and varies as a function of the magnetic field. This behavior produces non linear variations in a circuit inductance, which is an important source of IMP.

A material non-linearity is an important source of IMP when 2 or more signals travel through a ferromagnetic material.
But, the result of a poor contact joint is far more significant than a non-linearity in the conductor material.

CONTACT DESIGN

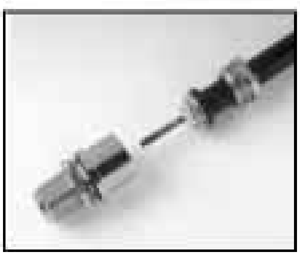
In designing a connector, particular care must be taken to ensure that at the point where current flow will take place a good metal to metal joint exists. High contact pressures are necessary to ensure that this takes place throughout the connector's life. This is particularly critical when the cables will be subject to vibration and flexing (both static and dynamic).

There are five commonly used joints to connect two conductors. These are: solder, butt contact, clamp, spring fingers and crimp joints.

The optimum electrical connection between two conductors is achieved by **soldering or brazing** them together. It employs a filler metal to overcome the problems of contact pressure, present in other joints. This is most often used to join the center contact of a connector to the center conductor of a cable.

A proper solder joint is simply the best electrical connection to link 2 conductors, together.

A butt joint is less sure than a solder one, but transmission line components make regular use of butt joints (for example, connector mating interface) from a practical ground. However, high tightening torques are necessary to get sufficient and lasting pressure contacts. This is the mating arrangement of N and 7/16 series.



A **clamp joint** is often chosen to join the connector outer conductor to the cable.
However, both junctions should be used only if they can maintain the required pressure at the contact.

A spring finger joint is commonly used to join a plug inner contact to a socket or to link the connector center contact to the cable.

Crimp joints on standard flexible cables offer the poorest performance when used in the RF and microwave frequency range. Thermal expansion and contraction can cause the joints to work loose over a period of time and the presence of an air cavity means that they offer poor contact.

CONNECTOR CONSTRUCTION

In addition to the contact joint, the connector construction must also be considered.

In order to reduce the current density, an increased contact diameter should be employed whilst ensuring that the profile of the contact is free of sharp edges and section changes which help to concentrate the current density.

Since any junction may produce a non linearity, and thus IM, it is advisable to keep the number of internal joints to a minimum.

Components must be well shielded to ensure that they do not pick up IMP generated by any non linear structures adjacent to the system.

INTERFACE TYPE

N and 7/16 series are most suitable for low IM applications. These connectors handle high power, their interfaces are robust and withstand high mating force.

RF CABLES

In order to achieve the best performance a cable with a single (solid) center conductor and a single (tubular) outer conductor should be selected. The logic behind this is clear in that current flow in a coaxial cable is longitudinal, and multistrand designs require that currents cross numerous conductor boundaries. As it is not possible to apply high contact pressures to these internal junctions, they are capable of generating IM.

RF cables with solid inner and outer conductors achieve the best performance for intermodulation.

MATERIAL SELECTION

Since ferromagnetic materials have non linear characteristics it is important that these be eliminated from the current path.

Only non magnetic materials and alloys such as copper, brass, beryllium-copper, phosphor-bronze should be used for all passive component construction.
Stainless steel should not be used.

The preferred materials for the construction of 50 Ohm RF coaxial connectors for the communications industry are generally copper alloy. Brass is usually used since. It offers excellent electrical, mechanical and machining properties as well as being low cost.

Materials such as Aluminum and its alloys which employ a tough oxide layer for corrosion protection cannot be used directly. To avoid metal-insulator-metal joints a plating of non oxidizing conductive material must be employed. It is recommended to avoid the use of Aluminum and its alloys.

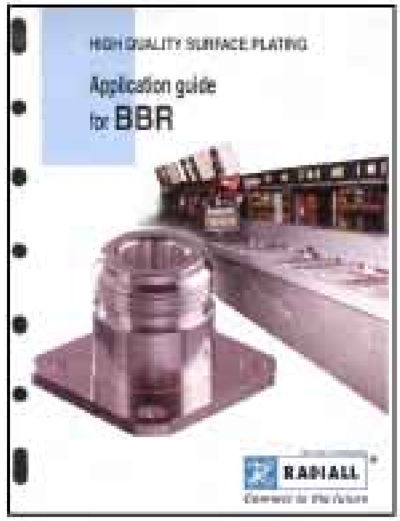
PLATING SELECTION

Plating materials for all passive component, must be chosen among non-magnetic materials and alloys.
Nickel should not be used even as an underplate.

Nickel, which has for many years been the most popular plating material because of its wear and environmental properties as well as its cost, is ferromagnetic and therefore an IM generator. Nickel is also used as underplating in processes for non ferromagnetic plating such as gold. Again, current can flow through the underplate and therefore generate IM.

***BBR** plating has been specifically developed and employed by Radiall for excellence in intermodulation sensitive applications. BBR is a copper-tin-zinc non-magnetic alloy.*
It combines the properties of :

- *gold : wear and tarnish resistance*
- *silver : high conductivity*
- *nickel : corrosion resistance.*

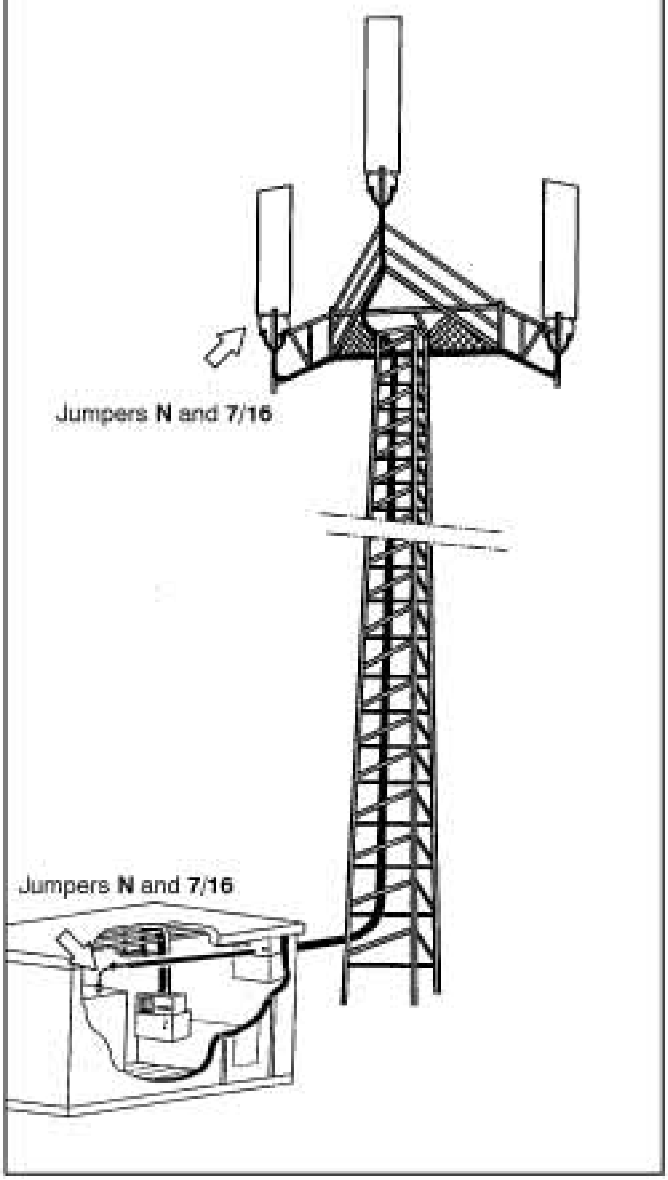


*For more detailed information, an application guide about BBR high quality plating is available upon request by specifying part number **D1 030 DE**.*

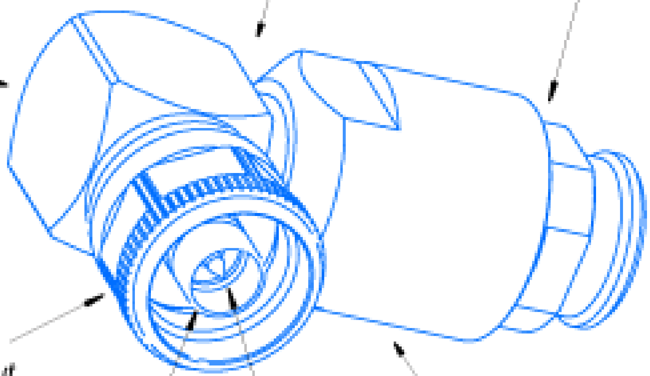
Radiall electroplating facilities stand as one of the most advanced in the electronic industry.

OTHER PASSIVE IM SOURCES

The environment of the system should also be taken into consideration. A high number of other passive IM sources can exist around the system. Among the most common, which warrant inclusion are dissimilar metal contact and the presence of their oxides can form interference receiving cells, antennas, connectors, antenna tower hangers, on site wire fencing, oxidized battery terminals, towers that are in poor condition, anchor rods, metallic doors, air conditioning ducts...



CONCLUSION



ELEMENTARY RULES FOR COAXIAL CONNECTORS

- Prefer N and 7/16 interfaces that offer high tightening torques.
- Insure that ferromagnetic materials are not used in the signal path.
- Reject non-linear dielectrics.
- Do not use tough oxide protected materials.
- Select suitable high quality non magnetic plating with sufficient thickness.
- Minimize the number of internal junctions.
- Maintain a high contact pressure. Use solder joints where possible.
- Avoid the use of crimped or sliding contacts.
- Keep surface quality for contact areas very high.
- Optimize shielding of devices.
- Check that parts are free from dirt and other contaminants prior to use.
- Select coaxial cables with single inner and outer conductors.

INTERMODULATION MEASUREMENT SYSTEM

The problems caused by IMP generation have motivated RADIALL to create several Intermodulation test systems to investigate the phenomena and characterize their coaxial connectors and cable assemblies.

The intermodulation measurement equipment developed by RADIALL, following the IEC 46D/292/NP standard proposal, is aimed at third order IMP measurements through the reflection method. The block diagram of this system, working at PCN frequencies, is shown in the figure 1. Its range is -132 dBm (- 175 dBc) under an input power of 2 x 20 W.

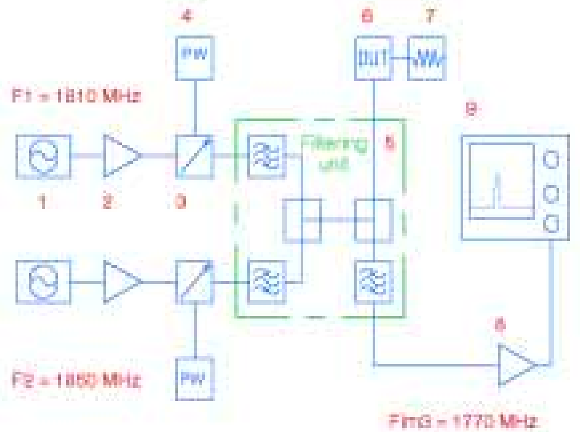


Figure 1 : RADIALL Intermodulation test set-up

1 Signal generator
2 High Power amplifier
3 20dB directional coupler
4 Power meter
5 Filtering unit
6 Device Under Test
7 Linear load (lossy cable)
8 Low noise amplifier
9 Spectrum analyzer

DESCRIPTION OF RADIALL MEASURING SYSTEM

Two frequency generators (HP 8648B and RS 819-0010-52) respectively calibrated at 1850 MHz and 1810 MHz produce the two frequency carriers. Both carriers are filtered and amplified with a variable gain that allows adjustment of their power to a maximum 2x35W : however measurements are usually made under 2x20 W.

Power control is made at the amplifier output by two powermeters whose output levels are predetermined during the calibration stage.

The carriers go then into the filtering unit where two high Q band pass filters remove the harmonic and spurious frequencies resulting from the HPA (High Power Amplifier), and give an excellent spectral purity to the carriers.

This unit consists of a one-piece machined part (limited number of junctions) containing a multicoupler as well, where both carriers are mixed together before proceeding via a duplexer toward :

- in one direction, the device under test
- in the other direction, a spectrum analyzer through a third high Q band pass filter, calibrated at 1770 MHz, and a low-noise amplifier.

All the parts are silver-plated.

The range of RADIALL's intermodulation test set-up is - 132 dBm (-175 dBc) under an input power of 2 x 20 W.

INTERMODULATION MEASUREMENT SYSTEM

TWO CONFIGURATIONS

Before choosing one of the two test set-ups (See figures 2 and 3), we tried to answer the following question : "Is it better to be able to measure a component in transmitted and reflected ways in spite of poor sensitivity, or is it better to achieve the highest sensitivity without being able to measure the component in the transmitted way ?"

To answer this question, we have performed some comparison tests between both configuration test set-ups.

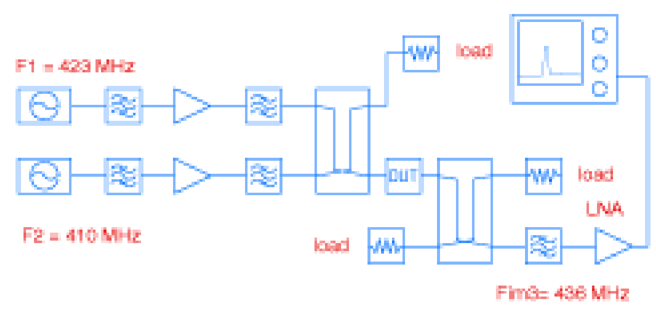


figure 2 : Transmission configuration

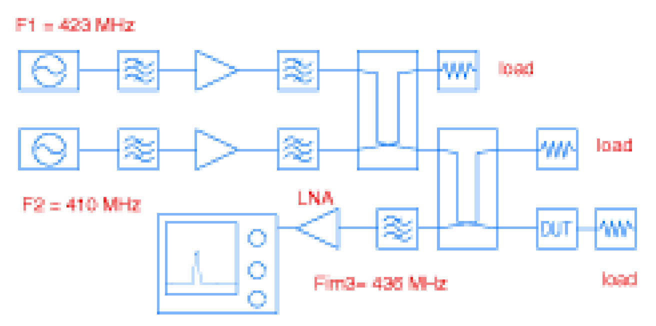


figure 3 : Reflection configuration

In fact, when a low intermodulation component is designed, cautions are obviously taken. In this way, all magnetic materials and non-linear dielectrics are avoided. Hence, the phase cumulative effects due to the above types of materials are suppressed.

The only remaining effect which can generate a cumulative phase effect is resistive heating, but its power is so low that it is completely masked.

For these specific applications, the electrical non-linearities due to contacts are predominant and can be essentially considered as the only ones. They generate IMP for which the magnitude at each new installation follows a Gaussian law and for which the phase is random.

In the reflection configuration, there are fewer contacts, and therefore fewer potential IM sources. The dynamic range of the test set-up is better with a reflection configuration than with a transmission one.

In this case, the detection port is on the isolated output from the first coupler in the reflection configuration. It means that the intermodulation products generated by the first coupler are attenuated by 30 dB, and therefore don't interfere with the IMP resulting from the device under test.

In other cases, with a duplexer for example, the dynamic range of the intermodulation measurement test set-up will be better in the reflection configuration, because the intermodulation of the combiner itself is stopped by the TX filter.

CONCLUSION

IM measurements from both test systems are about the same. But the IM level generated by the test set-up itself is lower with a reflection configuration.

Therefore it is possible to measure lower IM levels generated by non-directive passive components, through a test set-up by reflection.

After analyzing these results, RADIALL considers the reflection configuration to be the best one for 3rd order IMP measurement of any coaxial connector or cable assembly. Therefore, RADIALL's intermodulation test set-up conforms to that configuration.

Its range is very sensitive : -132 dBm (-175 dBc) under 2x20W.

IMP_3 : -125 dBm

VERY LOW INTERMODULATION N and 7/16 CABLE ASSEMBLIES
-125 dBm (-168 dBc) under 2 X 20 W

To meet IM sensitive application requirements, RADIALL presents you with a specifically designed N & 7/16 cable assembly range.

For best service, this range includes standard and custom cables assemblies, offering excellent performance; and at the same time, flexibility.

An IM level of -125 dBm can be obtained due to our expertise and our quality equipment. Every Intermodulation cable assembly is carefully checked and measured through static and dynamic tests on our intermodulation test system.

CHARACTERISTICS (typical values)

- **N** and **7/16** Interfaces
- Impedance : 50 Ω
- Frequency range
  - **N** : 0-11 GHz
  - **7/16** : 0-7.5 GHz
- IMP_3 : -125 dBm at 20 W
- V.S.W.R. : ≤ 1.06 up to 1 GHz
  ≤ 1.08 up to 2 GHz
- Insertion loss : ≤ 0.3 dB up to 2 GHz
  for a 1 meter long cable assembly
- Hexagonal coupling nut with high tightening torque.
  - **N** : 170 N.cm
  - **7/16** : 3500 N.cm
- Endurance : 500 cycles
- Non slotted outer contact
- Moisture resistance : IP68 (overmolding)
- Material : Brass
- Non-magnetic plating : Silver
- Anti-tarnishing finish : Strike of BBR
- Only solder type models

IMP_3 : -125 dBm

VERY LOW INTERMODULATION (-125 dBm)
N and 7/16 CABLE ASSEMBLIES

CONNECTOR 1 Series	CONNECTOR 1 Model	CABLE Type	CABLE Length (m)	CONNECTOR 2 Series	CONNECTOR 2 Model	Cable assembly P / N	Fig
N	Straight plug	3/8"	1,5	N	Straight plug	R285 780 063	1
		1/2"				R285 780 083	
		3/8"			R/A plug	R285 783 063	2
	R/A plug				Straight bulkhead jack	R285 786 063	3
7/16	Straight plug	3/8"	1,5	7/16	Straight plug	R285 700 063	4
		1/2"	1,0			R285 700 082	
			1,5			R285 700 083	
			2,0			R285 700 084	
			1,5		R/A plug	R285 703 083	5
	R/A plug	3/8"	1,5		Straight flange jack	R285 704 063	6
		1/2"				R285 704 083	
N	Straight plug	3/8"	1,5		Straight plug	R285 720 063	7
		1/2"				R285 720 083	
		3/8"			Straight flange jack	R285 725 063	8
		1/2"				R285 725 083	
	R/A plug	1/4"	1,0			R285 724 042	9

For other lengths of cable or other connector combinations than above, see page 22 "HOW TO ORDER".

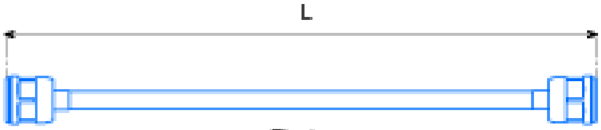


Fig 1


Fig 2

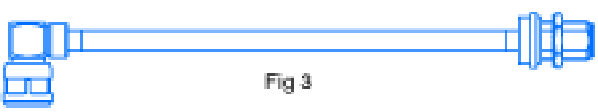


Fig 3


Fig 4

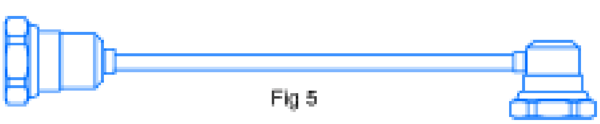


Fig 5

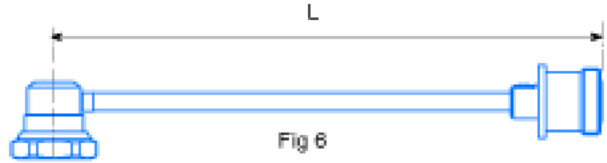


Fig 6

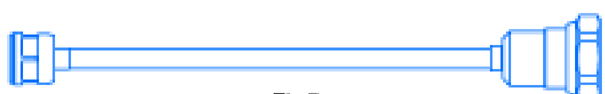


Fig 7

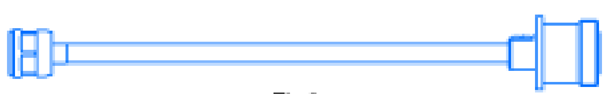


Fig 8

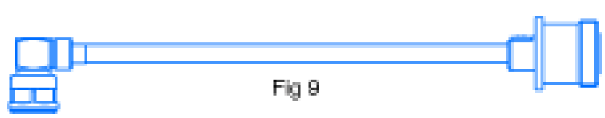


Fig 9

IMP_3 : -125 dBm

VERY LOW INTERMODULATION (-125 dBm) CUSTOM N and 7/16 CABLE ASSEMBLIES

CONNECTOR RANGE

SERIES	MODEL Solder Type	SPIRALED			SEMI RIGID	RG CABLES (PTFE)	
		1/4"	3/8"	1/2"	.141	RG 400	RG 393
N	Straight plug	865 48 030	865 48 080	865 48 120	865 48 000	Please consult us	
	R/A plug	865 48 040	865 48 090	865 48 130	865 48 010		
	Straight jack	865 48 050	865 48 100	865 48 140			
	Straight panel sealed bulkhead jack	865 48 060	865 48 110	865 48 150	865 48 020		
	Straight flange mount jack	865 48 070	865 48 170	865 48 160			
7/16	Straight plug	865 06 250	865 06 260	865 06 270		Please consult us	
	R/A plug	865 06 350	865 06 360	865 06 370			
	Straight jack	865 06 300	865 06 310	865 06 320			
	Straight flange mount jack	865 06 400	865 06 410	865 06 420			

Attention ! These connectors are only available for cable assemblies made by Radiall.

*Note : low intermodulation N & 7/16 receptacles can be designed and manufactured upon request. See our N catalog P/N : **D1 161 CE** and 7/16 catalog P/N : **D1 185 CE**.*

CABLE RANGE See page 21

HOW TO ORDER See page 22

ADAPTERS

N - 7/16 adapters and 7/16 in-series adapters allow a maximum level of -125 dBm under 2 X 20 W, due to their design which limits the number of internal junctions (single piece inner and outer contacts) and their plating.

	Part number	Description
Between series adapters	**R191 720 000**	N male - 7/16 female
	R191 721 000	N male - 7/16 male
	R191 722 000	N female - 7/16 male
	R191 723 000	N female - 7/16 female

IMP$_3$: -110 dBm

LOW INTERMODULATION N and 7/16 CABLE ASSEMBLIES
-110 dBm (-153 dBc) under 2 X 20 W

CHARACTERISTICS (typical values)

- Impedance : 50 Ω
- Endurance : 500 cycles
- IMP$_3$ (cable assembly) : -110 dBm (-153 dBc)
- Non slotted outer contact
- Coupling nut : Hexagonal
- Material : Brass
- Plating : Silver
- Frequency range **N** : 0-11 GHz; **7/16** : 0-8 GHz
- Tightening torque **N** : 170 N.cm; **7/16** : 3500 N.cm
- Anti-tarnishing finish : Strike of BBR

This range of N and 7/16 series connectors make it possible to achieve levels of -110 dBm at 20 W on cable assemblies. All these connectors are also available unassembled, except for models sold on SHF cable assemblies made by RADIALL. See page 21.

HOW TO ORDER See page 22

CONNECTOR RANGE CABLES

Series	MODEL		RG CABLES			SPIRALED CABLES			ANNEALED CABLES	SHF CABLES	
			8/50 D	10/50 D	11/50 D	1/4"	3/8"	1/2"	1/2"	SLI	SMD
N	Straight plug	Full crimp	R161 083 137		R161 088 137						
		Clamp				R161 036 007	R161 036 207	R161 037 020			
	R/A plug	Crimp	R161 183 137		R161 188 137						R161 199 020•
		Clamp				R161 177 007	R161 177 207	R161 177 137			
		Solder								R161 195 200•	
	Straight jack	Clamp				R161 232 007	R161 232 207	R161 232 407			
	Straight bulkhead jack	Clamp				R161 341 007	R161 341 207	R161 341 407			
	Straight flange mount jack	Clamp				R161 279 007	R161 279 207	R161 279 407			
7/16	Straight plug	Full crimp		R185 074 000	R185 077 000						
		Clamp		R185 010 000		R185 090 200		R185 091 200	R185 091 000		
	R/A plug	Crimp		R185 174 000	R185 177 000						R185 199 020•
		Clamp				R185 164 200		R185 165 200	R185 165 000		
	Straight jack	Full crimp		R185 234 000	R185 237 000						
		Clamp		R185 210 000		R185 215 200					
		Solder								R185 195 220•	
	Straight jack bulkhead mount	Full crimp		R185 304 000	R185 307 000						
		Clamp		R185 310 000		R185 315 200		R185 316 200	R185 316 000		
	Straight jack flange mount	Full crimp		R185 274 000	R185 277 000						R185 258 400•
		Clamp		R185 260 000		R185 265 200		R185 266 200	R185 266 000		
		Solder								R185 257 000•	
	R/A jack flange mount	Solder								R185 357 000•	

Nota : • Manufactured upon request

CABLE SELECTION

Cable type	Power Handling	Attenuation	Shielding	Flexibility	Price	Preferred Intermod cable Assemblies	
						Inside BTS	Outside BTS
RG (PE)	Poor	Poor	Poor	Excellent	Excellent	Average	Average
RG (PTFE)	Good	Poor	Poor	Excellent	Good	Good	Good
Spiraled	Excellent	Good	Excellent	Average	Poor	Average	Excellent
Annealed	Excellent	Excellent	Excellent	Poor	Average	Poor	Average
RADIALL SHF*	Good	Good	Good	Good	Average	Excellent	Excellent

RADIALL CABLE PART NUMBERS

Cable type			P/N	Intermodulation level		Frequency range
				– 125 dBm	– 110 dBm	
Semi-rigid	.141	RG402	**C291 860 001**	O		DC – 20 GHz
RG (PE)	5 / 50 D	RG223	**C291 330 000**		O	DC – 12.4 GHz
	11 / 50 D	RG214	**C291 600 000**		O	DC – 11 GHz
RG (PTFE)	5 / 50 D	RG400	**C291 324 007**	Please consult us		DC – 12.4 GHz
	10 / 50 D	RG393	**C291 511 007**			DC – 3 GHz
Spiraled	1/4"	High flexible CELLFLEX	**C291 993 170**	O	O	DC – 20 GHz
		HELIAX	**C291 993 070**	O	O	
	3/8"	High flexible CELLFLEX	**C291 996 170**	O	O	DC – 13 GHz
		HELIAX	**C291 996 070**	O	O	
	1/2"	High flexible CELLFLEX	**C291 994 170**	O	O	DC – 10 GHz
		HELIAX	**C291 994 070**	O	O	
Annealed	1/2"	CELLFLEX	**C291 972 080**		O	
		HELIAX	**C291 972 085**		O	
SHF*	5/50	RADIALL	**5 TD**		O	DC – 3 GHz
			5 LI		O	DC – 26.5 GHz
			5 MD		O	DC – 3 GHz

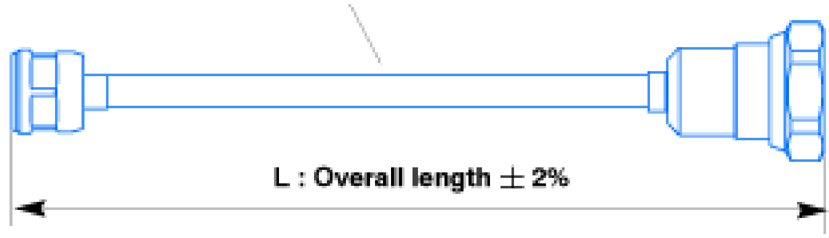
** For more details about SHF cables, see our catalog **D1 287 CE**.*

HOW TO ORDER

CUSTOM CABLE ASSEMBLIES :

Please make a copy of page 23 and fill the form in using the explanations below.

With very low intermodulation - 125 dBm (-168 dBc)

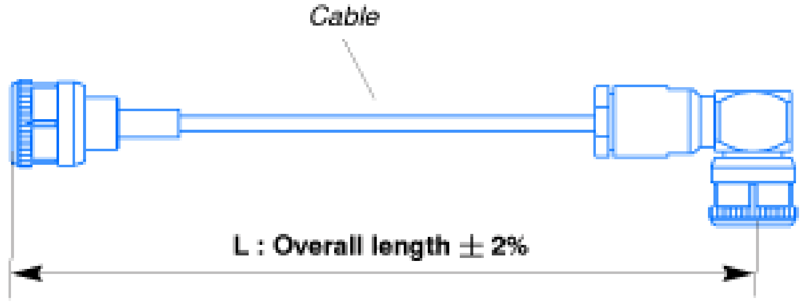


Example : Straight plug N / 1/4" high flexible Cellflex cable / straight plug 7/16 / length 50 cm

865 48 030 / C291 993 170 / 865 06 250 / 50

Connector 1 part number (see connector range page 19)
Coax cable part number (see cable range page 21)
Connector 2 part number (connector range page 19)
Overall length in cm

With low intermodulation - 110 dBm (-153 dBc)

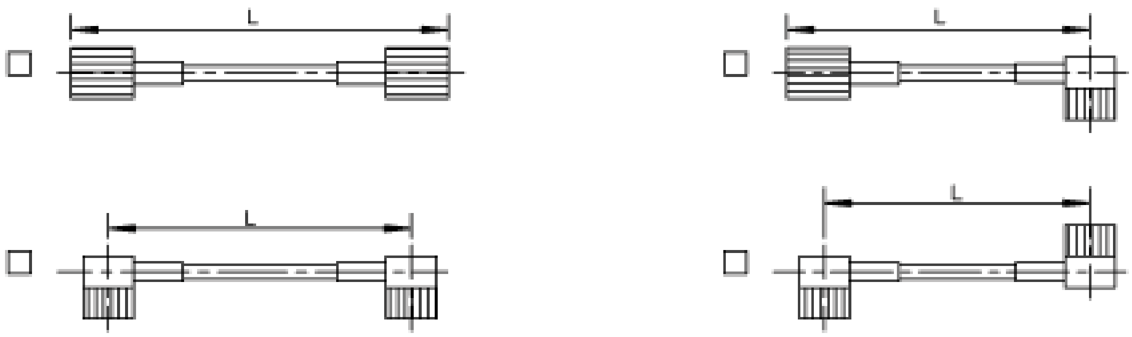


Example : Straight plug N / Cable 11/50 D RG214 / Right angle plug N / length 100 cm

R161 088 137 / C291 600 000 / R161 186 137 / 100

Connector 1 part number (see connector range page 20)
Coax cable part number (see cable range page 21)
Connector 2 part number (connector range page 20)
Overall length in cm

CABLE ASSEMBLY ORDERING



For all other designs, please add your specification.

CUSTOMER SPECIFICATION . . . .

PERFORMANCE

Performance required :

IMP$_3$ level : . . . .

V.S.W.R. : . . . .

Max insertion loss : . . . .

CONSTRUCTION

Quantity : . . . .

CONNECTOR 1 ....

CABLE : ___________________

CONNECTOR 2 ....

LENGTH: ______ ±____(cm)

[STANDARD TOLERANCE: ±2% length]