BS EN 62037-5:2013

BSI Standards Publication

Passive RF and microwave devices, intermodulation level measurement

Part 5: Measurement of passive intermodulation in filters

National foreword

This British Standard is the UK implementation of EN 62037-5:2013. It is identical to IEC 62037-5:2013. Together with BS EN 62037-1:2012, BS EN 62037-2:2013, BS EN 62037-3:2012, BS EN 62037-4:2012 and BS EN 62037-6:2013, it supersedes BS EN 62037:2000, which will be withdrawn on 15 July 2015.

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A list of organizations represented on this committee can be obtained on request to its secretary.

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Foreword

The text of document 46/409/FDIS, future edition 1 of IEC 62037-5, prepared by IEC TC 46 "Cables, wires, waveguides, R.F. connectors, R.F. and microwave passive components and accessories" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 62037-5:2013.

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The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated r

Passive RF and microwave devices, intermodulation level measurement - Part 1: General requirements and measuring methods	EN 62037-1	2012

CONTENTS

PASSIVE RF AND MICROWAVE DEVICES, INTERMODULATION LEVEL MEASUREMENT –

Part 5: Measurement of passive intermodulation in filters

1 Scope

This part of IEC 62037 defines test fixtures and procedures recommended for measuring levels of passive intermodulation generated by filters, typically used in wireless communication systems. The purpose is to define qualification and acceptance test methods for filters for use in low intermodulation (low IM) applications.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 62037-1:2012, *Passive r.f. and microwave devices, intermodulation level measurement – Part 1: General requirements and measuring methods*

3 Abbreviations

DUT Device under test

IM Intermodulation

PIM Passive intermodulation

4 General comments on PIM testing of filter assemblies

4.1 Sources of error: back-to-back filters

Testing filter assemblies for PIM may be error prone if certain precautionary guidelines are not followed. Since PIM can be a frequency-dependent phenomena, mathematically related to the harmonics of the input signals and combinations thereof, consideration should be given not only to the behaviour of the test set-up under fundamental stimulation, but also its harmonic performance. In particular, consider a receive-band PIM test set-up as shown in Figure 1. As shown, this set-up could be used to measure the PIM in a two-port device under test (DUT); however, the accuracy of the measurement could be in question due to the back-to-back filters (diplexers) used.

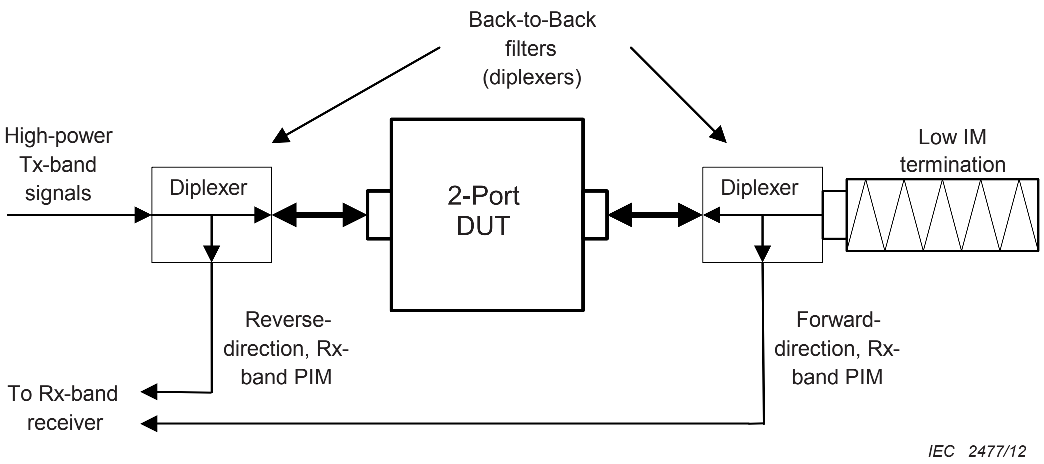


Figure 1 – Typical receive band PIM test set-up

While the diplexers certainly appear as a matched load around the fundamental frequencies and receive-band IM products, they may be very poorly matched at harmonics of the fundamentals. A poor match will set up a standing wave at the harmonic frequencies which may re-illuminate any PIM sources within the DUT with higher-than-typical current densities. Furthermore, the measured IM response will become highly dependent upon the electrical length of the DUT because the locations of the peaks and valleys of any standing waves will move with respect to the PIM sources as the electrical length of the DUT changes.

4.2 Environmental and dynamic PIM testing

Environmental and dynamic PIM testing, which may include placing vibrational or thermal stresses upon filter assemblies while concurrently measuring the PIM produced, may not give accurate or repeatable results. There are several significant factors affecting the results of these types of PIM tests.

a) DUT/test system isolation – it is highly desirable that any environmental and dynamic stresses placed upon a DUT be isolated from the test system such that there are no measurable residual effects. This not only addresses the practical issues of test system reliability and maintenance, but it directly affects the issue of measurement repeatability. That is, should a particular piece of the test system require replacement after a set number of trials, then the results of subsequent measurements may be skewed by the performance of the replaced part.
b) Measurement repeatability – it should be possible to repeat the results obtained from a particular measurement within a specific precision. However, the inherent sensitivity of the PIM response may prevent a desired precision from being achieved.
c) Stress repeatability – the particular stress placed upon the DUT shall be repeatable both between tests upon the same DUT and tests between different DUTs. However, in the experience of many, it is likely that the repeatability of the particular stress will be far worse than that of the particular PIM test results so that the standard specifying the stress may not be unnecessarily rigorous.

Based upon these factors, measuring PIM from a filter assembly whilst it undergoes thermal or vibrational stresses is not currently recommended.

A less vigorous form of dynamic testing may be performed on a filter assembly, in order to demonstrate that stability of the PIM level is maintained after certain vibrational stresses have been applied. This style of dynamic test can take the form of tapping the assembly with an instrument that will not damage the surface of the assembly, such as a length of nylon rod or hard rubber hammer.

4.3 General test procedure

An appropriate test set-up can be selected from the example schematics described in Clause 4, according to the specific test requirements called for. The procedure is as follows:

a) calibrate the test set-up for correct carrier signal level and IM receiver level as described in Clause 7 of IEC 62037-1:2012;
b) connect the filter DUT in the test set-up;
c) measure the IM performance of the DUT on the receiver.

The results obtained should be expressed in one of the forms indicated in Clause 8 of IEC 62037-1:2012.

5 Example test equipment schematics for filter testing

5.1 General

Several example schematics are presented. Each figure corresponds to a particular test scenario as indicated in the matrix in Table 1. It will be noted that some of the example schematics are modifications of the test configurations shown in Figure 1 and Figure 2 of IEC 62037-1:2012. These modifications allow the operator to satisfactorily perform a range of tests which are more specific to the requirement of filter assemblies.

It is imperative that the residual PIM level of the test system be verified prior to measurement of the filter assembly. It is strongly recommended that this level be at least 10 dB below the PIM level requirement of the filter assembly, in order to minimize errors due to the system itself. This measurement can be carried out in the following example set-ups by precluding the DUT from the measurement system and monitoring the resultant PIM level under the normal test conditions. The only systems which deviate slightly from this are Figure 5 and Figure 8 and notes are provided for these two set-ups, indicating the test point at which the system residual intermodulation distortion can be measured with the DUT removed.

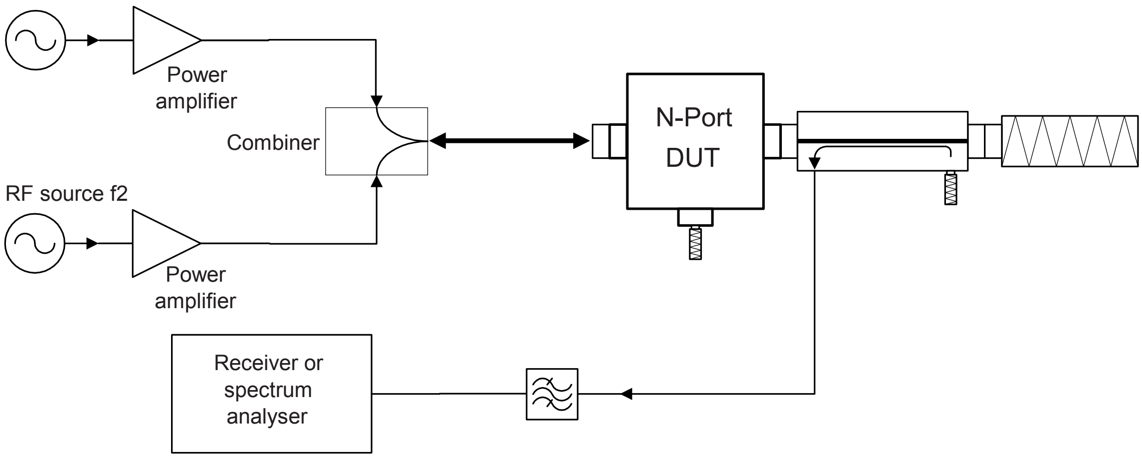
Table 1 – Summary table referencing example test equipment schematics for measuring PIM on filter-type devices

	Tx band	Rx band	
Measurement type	**2 high-power carriers**	**2 high-power carriers**	**1 high-power carrier + injected interferer**
N-port, forward IM	Figure 2	Figure 3	Figure 6
N-port, reverse IM		Figure 4	Figure 7
N-port, receive port IM		Figure 5	Figure 8

Figure 5 and Figure 8 outline equipment set-ups which measure the PIM present at a receive port of the filter assembly. These set-ups are distinct from those measuring PIM in the reverse direction (Figure 4 and Figure 7) and can give quite different results. It is therefore important that consideration is given to using the appropriate measurement system, in order to measure the required PIM performance.

5.2 Transmit band testing

Passive IM testing within the transmit band is typically performed on isolators and other relatively high PIM components. For this test, two carriers are combined into a single transmission line and then passed through the DUT. Once these are through the DUT, it is advisable to sufficiently attenuate the two carriers to prevent the generation of active IM products and possible damage within the receiver. A low noise amplifier is typically not required due to the high PIM signal levels present from the DUT in these tests. This is described in Figure 2.



The combiner port-to-port isolation plus band stop/low pass filters should be optimized to set the test bench system residual to an acceptable level.

Consideration should be given to the possible generation of IM products within the receiver/spectrum analyser and whether a sufficient dynamic range can be obtained. An optional IM band pass filter may be used to allow these conditions to be met.

Unused DUT ports shall be terminated in a matched load.

The low IM directional coupler could alternatively be replaced by an appropriate diplexer.

a) In this instance, it is strongly recommended that the replacement diplexer has a good VSWR in both the Tx and Rx bands.

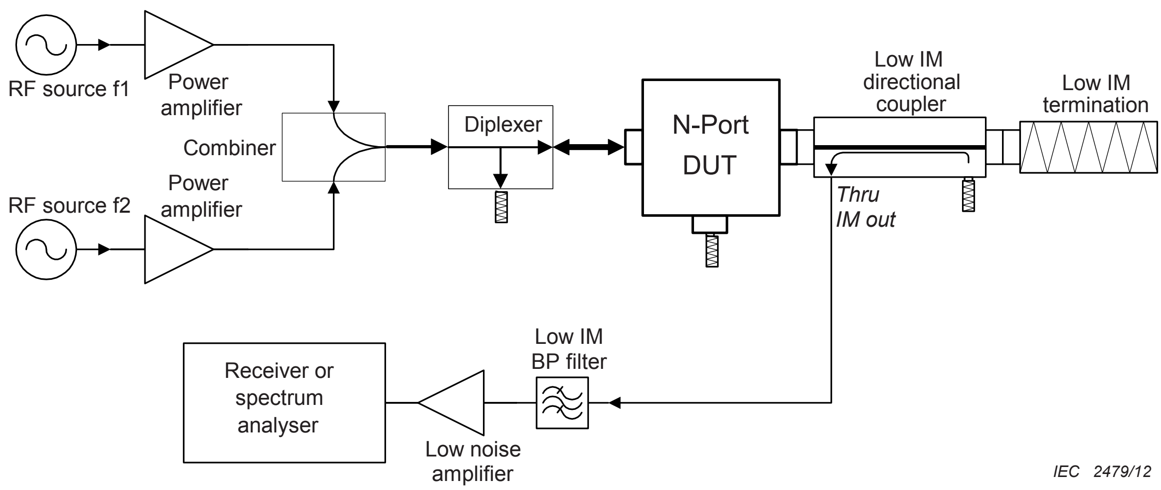
b) Due to the potentially reflective nature of the replacement diplexer and DUT, it should also be recognized that there would be a mechanism that supports multipathing.

Figure 2 – Typical test equipment schematic for measuring transmit-band, forward, passive IM products on an N-port DUT using two high-power carriers

5.3 Receive band testing: dual high-power carriers

When testing for PIM products in the receive band, a much greater measurement sensitivity is required than for transmit band testing. For this reason, a low-noise amplifier and bandpass filter are typically utilized before the measurement receiver (or spectrum analyser).

Example schematics for both forward and reverse PIM testing on N-port devices are shown in Figure 3, Figure 4 and Figure 5.



The low IM directional coupler could alternatively be replaced by an appropriate diplexer.

a) In this instance, it is strongly recommended that the replacement diplexer has a good VSWR in both the Tx and Rx bands.

b) Due to the potentially reflective nature of the replacement diplexer and DUT, it should also be recognized that there would be a mechanism that supports multipathing.

The combiner and diplexer could alternatively be replaced by an appropriate triplexer.

a) In this instance, it is strongly recommended that the replacement triplexer has a good VSWR in both the Tx and Rx bands.

b) Due to the potentially reflective nature of the replacement triplexer and DUT, it should also be recognized that there would be a mechanism that supports multipathing.

Figure 3 – Typical test equipment schematic for measuring receive-band, forward, passive IM products on an N-port DUT, using two high-power carriers

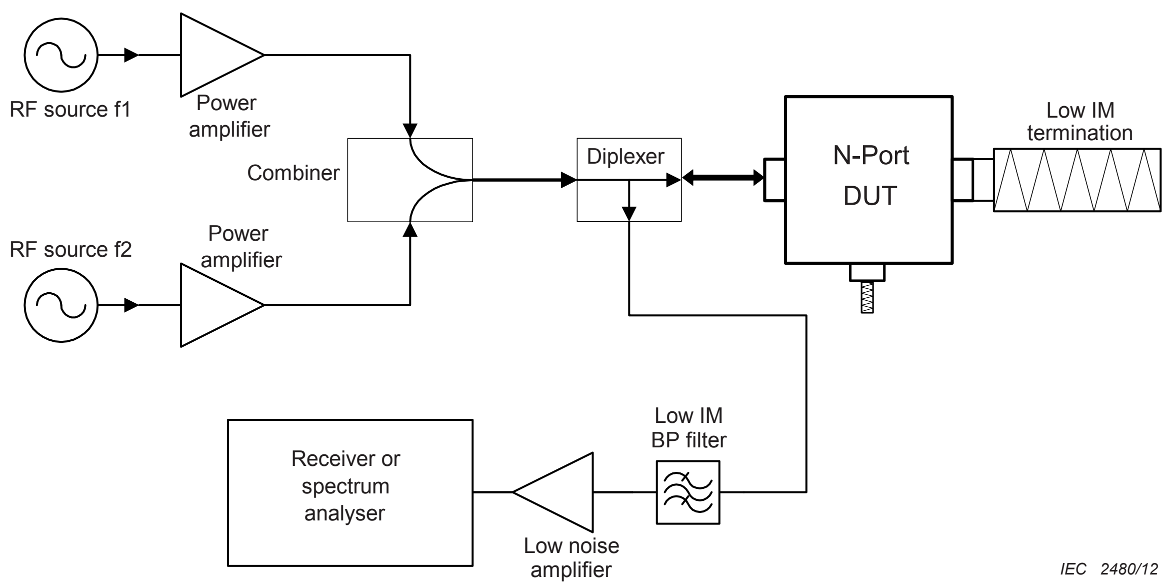
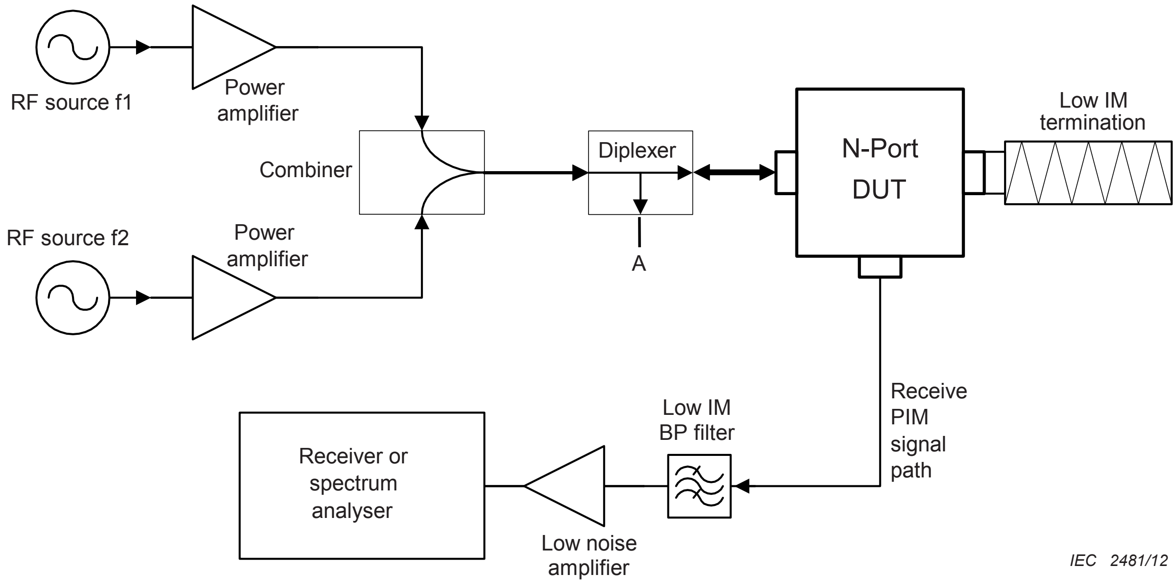


Figure 4 – Typical test equipment schematic for measuring receive-band, reverse, passive IM products on an N-port DUT, using two high-power carriers



Point A can be used as a test point to monitor the system residual level (with the DUT removed). To be terminated during DUT measurement.

The combiner and diplexer could alternatively be replaced by an appropriate triplexer.

a) In this instance, it is strongly recommended that the replacement triplexer has a good VSWR in both the Tx and Rx bands.

b) Due to the potentially reflective nature of the replacement triiplexer and DUT, it should also be recognized that there would be a mechanism that supports multipathing.

Figure 5 – Typical test equipment schematic for measuring receive-band, passive IM products on an N-port DUT, using two high-power carriers

Remarks to Figure 4 and Figure 5:

1) The combiner port-to-port isolation plus diplexer should be optimized to set the test bench system residual to an acceptable level.

2) Consideration should be given to the possible generation of IM products within the receiver/spectrum analyser and whether a sufficient dynamic range can be obtained. An optional IM band pass filter plus low noise amplifier may be used to allow these conditions to be met.

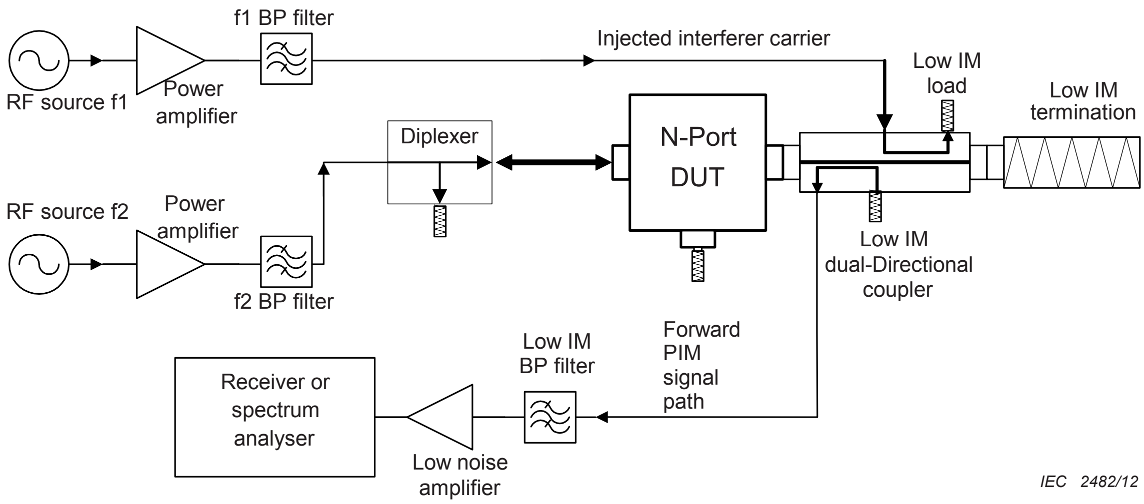
3) Due to the potentially reflective nature of the diplexer and DUT, it should be recognized that there is a mechanism that supports multipathing.

4) It is strongly recommended that the diplexer has a good VSWR in both the Tx and Rx bands.

5) Unused DUT ports shall be terminated in a matched load.

5.4 Receive band testing: injected interferer

To simulate the PIM performance of filters due to signals originating both internal to the system and external to the system, injected interferer testing may be performed. For these tests, one carrier remains at full power. The other carrier is typically reduced in power by some 20 dB to 40 dB relative to the strongest carrier. Typical test equipment schematics are shown in Figure 6, Figure 7 and Figure 8.



The low IM dual directional coupler could alternatively be replaced by an appropriate diplexer.

a) In this instance, it is strongly recommended that the replacement diplexer has a good VSWR in both the Tx and Rx bands.

b) Due to the potentially reflective nature of the replacement diplexer and DUT, it should also be recognized that there would be a mechanism that supports multipathing.

Figure 6 – Typical test equipment schematic for measuring receive-band, forward, passive IM products on an N-port DUT, using the injected interferer technique

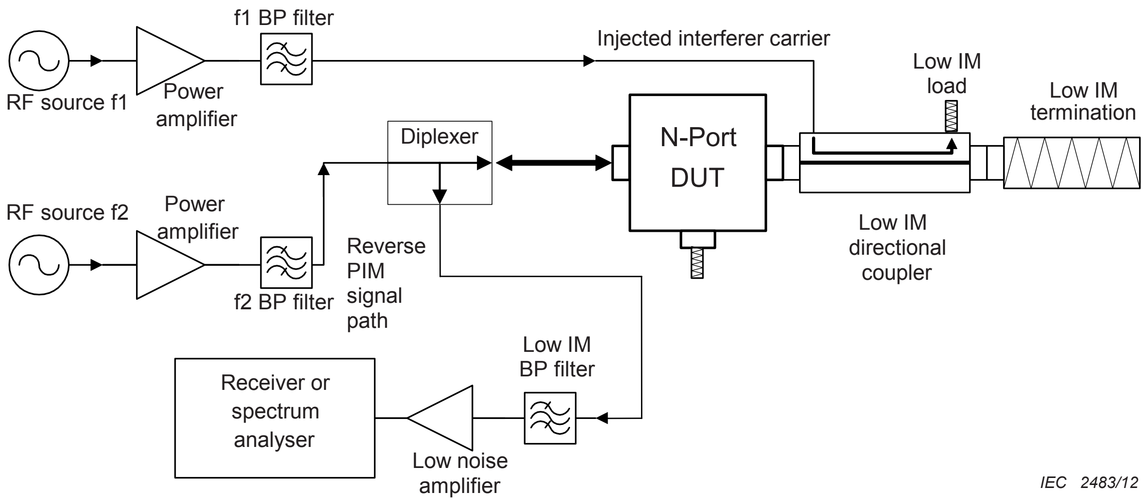
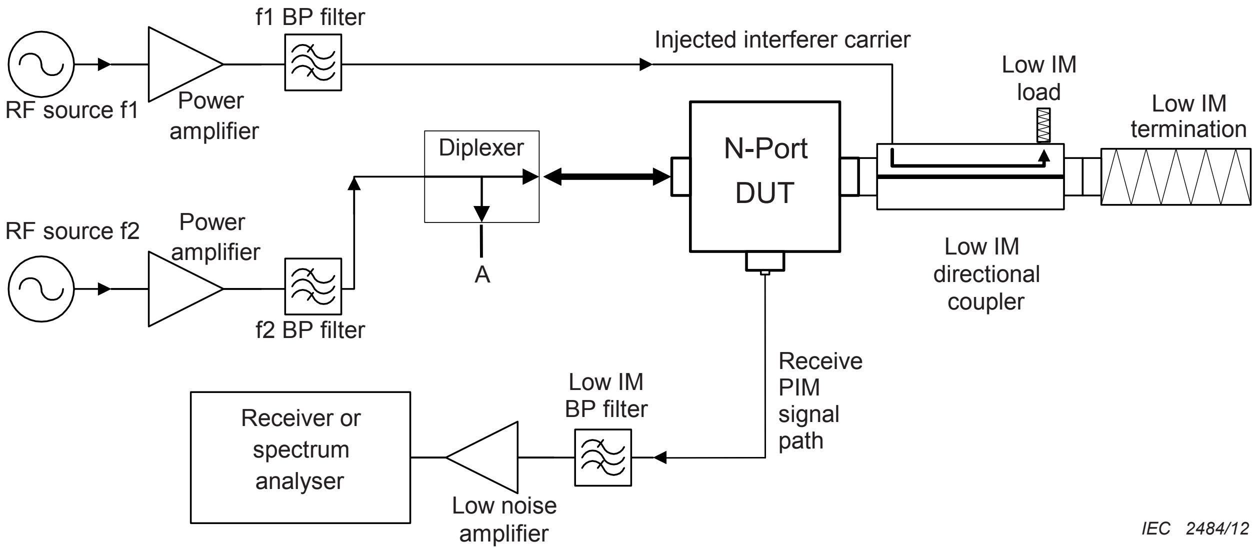


Figure 7 – Typical test equipment schematic for measuring receive-band, reverse, passive IM products on an N-port DUT, using the injected interferer technique



Point A can be used as a test point to monitor the system residual level (with the DUT removed). To be terminated during DUT measurement.

Figure 8 – Typical test equipment schematic for measuring receive-band, passive IM products on an N-port DUT, using the injected interferer technique

Remarks to Figure 6, Figure 7 and Figure 8:

1) Due to the potentially reflective nature of the diplexer and DUT, it should be recognized that there is a mechanism that supports multipathing.

2) Care should be taken to minimise generation of IM in the injected interferer power amplifier. This may be achieved by the use of an f1 band pass filter.

3) Unused DUT ports shall be terminated in a matched load.

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