Data Sheet

Pim 21

Portable Passive Intermodulation Test Set

Taking performance to a new peak

PIM 21 - Portable Passive Intermodulation Test Set

The PIM 21 is a microprocessor controlled, portable test set allowing detection of distortion components and assemblies in radio base station, in-building-DAS installations and other systems transmitting radio frequencies.

Non-linearity in radio frequency assemblies causes Intermodulation Distortion (IM). The purpose of the PIM 21 test set is to specifically test for this distortion in passive signal paths, known as Passive Intermodulation Distortion or PIM. Components in coaxial feeder assemblies such as connectors, jumper cables, splitters, hybrids, filters, DC blocks and antennas can cause PIM problems if they are not manufactured or assembled properly.

Depending on the application PIM can be measured in different ways. In manufacturing and in lab environments, analyzers which perform narrow frequency band sweeps are often used. These systems are costly, heavy and very bulky. PIM test systems for field technicians and engineers have to be accurate, but also cost efficient, portable and battery operated. By using two defined test frequencies, PIM 21 provides an excellent field proven combination of performance, price and portability.

The PIM 21 is designed specifically to aid communications technicians in the field locate components and assemblies which are creating PIM and degrading the performance of the installation.

Features

- Adjustable level of customer specific test frequencies to match power to application
- PIM Sensitivity of -153 dBc @ 850 MHz (typ -155 dBc)
- Self calibrating
- Rugged, weather-proof case (IP55 – closed lid)
- Very simple to operate
- Small, very portable
- Battery operated
- Communications port allows for documenting and storage of test results on an external PC

Benefits of PIM testing in the field

- Detects nonlinear passive system components quickly, thus reducing network maintenance costs
- Increased network quality
- Increased channel efficiency resulting in optimized investment effectiveness

Applications with PIM 21

- Identify outdoor base station antennas and feeds or in-building-DAS with poor or marginal PIM
- Identify broadband interference that affects antenna performance
- Antenna test (without overloading, using adjustable power level control)
- Helps technicians to locate discontinuities in coaxial assemblies
- Optimize position of indoor antennas to avoid interference caused by RF effects of ceiling grids, rusty rebar in concrete and even rusty bolts in building structure

Field Proven Features of PIM 21

The PIM 21 test system is a field unit designed for portability. This instrument allows field personnel to pinpoint the cause of PIM distortion quickly and easily.

Read PIM and ambient RF Noise in 3 ways.

- Numerically on the LCD in -dBc
- LCD Bar graph
- Quick view LED bar graph which indicates:
  Green for PIM < -140 dBc, and
  Red for PIM > -140 dBc

Alarms

A PIM Threshold Alarm is triggered whenever the PIM level exceeds -140 dBc (default). "PIM ALARM" LED and switching contact.

Audio Frequency Indicator

The frequency varies in pitch depending on the measured PIM level. Rising pitch indicates higher PIM. The volume of the frequency is adjustable. PIM 21 allows the audio signal to be connected to external devices, such as walkie talkies.

What is PIM?

PIM distortion is caused by non-linear mixing of two or more frequencies in passive devices like cables and connectors. Ideal passive devices are considered linear. PIM signals are unwanted because they interfere with signals in the receive path. In reality any linear component has a non-linear factor that can cause PIM distortion. For optimal operation of RF systems, PIM has to be kept at a very low level that has virtually no influence on the network operation.

What Causes PIM?

Passive intermodulation can be caused by a variety of factors. PIM distortion is often the result of flaws in component design and manufacturing processes. PIM distortion may also be caused by wear and tear on components due to mechanical constraints or environmental conditions.

Manufacturing & Design

- Use of ferromagnetic materials, such as nickel or steel, within the current path. Especially at higher power levels, PIM can be generated due to hysteresis effect of these materials and the non-linear voltage to current ratio.
- Contaminations, like particles from machining operations or soldering splatters that touch current carrying surfaces.
- Separation of current carrying contact zones through irregular contact surfaces, corrosion and insufficient contact pressure.
- Dissimilar metals at contact areas.
- Insufficient thickness of plated metal causing RF heating through the skin effect of RF.
- Bad solder joints.

Mechanical

- Poor mechanical alignment of components
- Too much or too little torque at connections
- Contaminated connectors

Environment

- Daily temperature variations, thermal loading by the sun and RF heating vary junctions and can cause, often intermittent, PIM distortions.
- Wind-induced vibrations vary junctions, and can weaken or break down joints.
- Airborne dirt and moisture cause oxidation of materials and cause PIM distortion.

Antenna showing oxidation within the power divider. Tests with vector analyzer line sweep test did not reveal the problem. PIM 21 test system could however clearly detect the issue and pinpoint the faulty component.

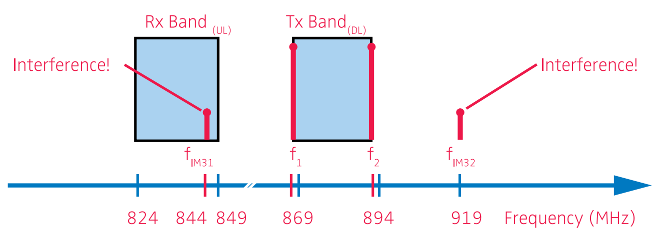
How to test PIM

PIM testing for field applications requires the injection of two CW signals (f1 and f2) into a system under test. Intermodulation products (IM) of the 3rd, 5th, 7th... order, caused by faulty components, appear immediately. The strongest intermodulation product is that of the 3rd order (IM3), which is measured. Frequencies for these intermodulation products are calculated as follows:

$$f_{IM31} = (2 \times f_1) - f_2$$

$$f_{IM32} = (2 \times f_2) - f_1$$

The picture below shows an example of passive intermodulation. Frequencies f1 (869 MHz) and f2 (894 MHz) are located in the Tx range, causing intermodulation f_{IM31} (844 MHz) and f_{IM32} (919 MHz). Both IM products can cause serious interference.



Example of intermodulation caused by two CW signals. Since the channel bandwidth of RF transmitters occupies usually a frequency range, resulting IM appears in a range of frequencies.

Ideally, f1 and f2 should be at the edge of the transmit guard bands, so that the IM3 products, f_{IM3} fall at the edge of the receive guard band(s). This would minimize interference within the system under test and also eliminates potential interference to other wireless carriers.

One system for PIM measurement at all frequencies

For field applications, passive intermodulation can be considered frequency independent. PIM 21 test systems are designed for everyday use in the field. For this purpose, the test frequency is considered of little relevance in getting meaningful PIM readings. Frequencies used by the PIM 21 will find faulty system components independent of the operating band. Exceptions to this are selective components (e.g. filters). The PIM 21 uses a dual signal measurement method that provides meaningful PIM readings for all components used in frequency bands between 800 and 2200 MHz.

Specifications

PIM Test:	Single port reflection measurement
Test Frequencies	2 custom frequencies*

Carrier Power

Cellular	+20 to +33 dBm, in 1dB steps
PCS	+33 dBm
Power Accuracy	±1 dB / carrier

PIM Measurements

Range	-80 to -153 dBc @ 850 MHz (typical -155 dBc)
Accuracy	±2 dB to -153 dBc @ 850 MHz ±3 dB to -155 dBc @ 850 MHz

VSWR 2 frequency test	0 ~ 15 dB (Return Loss), ±3 dB
Display	LCD screen and LED bar
RF Calibration	Automatic with RF Power On
Internal Checks	All rails checked on power up.
Level Alarms	Selectable VSWR and PIM in both audible and external jack
External Power	DC 10~16 V @ 3.5 Amps max
Battery Power	Cellular, typically 30 minutes PCS, 20 minutes
Weight	17.6 lbs, 8 kg, nominal
Dimensions	13.5 x 12.9 x 6.0 inches 343 x 327 x 152 mm
Enclosure	Waterproof, IP55 stored, lid closed IP40 operating, lid open
Operating Temp	0 – 45°C / 32 – 113°F, 85% RH (non-condensing)
Storage Temp	-10 – 60°C, 14 – 140°F, 85% RH (non-condensing)

*Please contact factory for any special frequencies of interest.

Standard accessory kit

57500100A Test Cable
Type N(m) - N(m), 4m (13 ft)

48000100A Connector Adaptor
7/16″(m) - N(f)

48400700A Power Supply
90 - 264 VAC / 12 VDC, 4 Amp

56810400A Power Cord
2m (6 ft)

56811400A DC Charging Cable
for Car Accessory Socket

70047300A Accessories Pouch

95951301A Cable (6 ft)

95951201A RS232 to USB
Converter

95950101A Low PIM Cable Load
5 W, N(f) connector

95950301A Connector Adaptor
7/16″(f) - 7/16″(f)

95950501A Connector Adaptor
N(f) - N(f)

95950401A Connector Adaptor
7/16″(f) - N(m)

95951401A Connector Adaptor
7/16 DIN(F) to N(F)

Recommended optional accessories

95950701A ZB-B11 Test Cable,
7/16″(m)-7/16″(m), 3m (10 ft)

95951001A Torque Wrench
18 ft-lbs

Boonton has the following standard PIM21 test systems available. For any special request on measurement frequencies, please contact factory for the availability and pricing.

Standard Types

Type	F1	F2	IM3
GK-A01	869	891.5	846.5
GK-A02	1945	1989.7	1900.3
GK-A04	947.6	960	935.2
GK-A05	935	960	910
GK-A08	1855	1930	1780
GK-A09	835	875	795

Ordering Information

PIM 21 Passive Intermodulation (PIM) Test System

Two CW carrier frequencies between 800 MHz and 2200 MHz (to be specified with PO), PIM measurement range -80 to -150dBc (typ -155dBc), carrier power 20 to 33 dBm*, LCD Display, battery, 17.6lbs / 8 kg, enclosure IP55 / IP40 (closed / open), includes the standard accessories kit.

-WARR1	Warranty extension one additional year
-CARE1	One additional calibration and one additional year of warranty extension

* Model Dependent

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B/PIM21/1010/EN
Note: Specifications, terms and conditions are subject to change without prior notice.

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