



*PIM 20*  
**Portable Passive  
Intermodulation  
Test Set**



Data Sheet

***Taking performance to a new peak***

# PIM 20 - Portable Passive Intermodulation Test Set

The PIM 20 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 20 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 20 provides an excellent field proven combination of performance, price and portability.

The PIM 20 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

It identifies field PIM problems of passive system components like antennas, feeder cables or connectors.

- 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



## 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 20

- 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 20

The PIM 20 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 20 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 20 test system could however clearly detect the issue and pinpoint the faulty component.

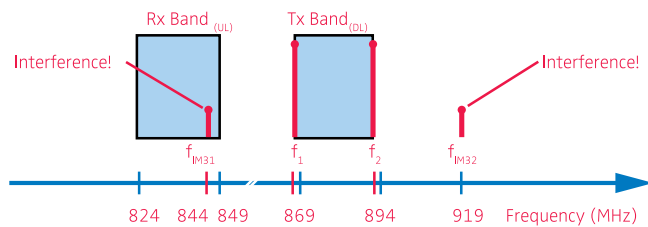
## How to test PIM

PIM testing for field applications requires the injection of two CW signals ( $f_1$  and  $f_2$ ) 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  $f_1$  (869 MHz) and  $f_2$  (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,  $f_1$  and  $f_2$  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 20 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 20 will find faulty system components independent of the operating band. Exceptions to this are selective components (e.g. filters). The PIM 20 uses a dual frequency 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	+20 to +30 dBm, in 1dB steps
Power Accuracy:	±1 dB / carrier

### PIM Measurements with 1W test frequency

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:	typically 1 hour (with RF carriers continuously on @ +30 dBm)

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
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Operating Temp:	0 - 45°C / 32 - 113°F, 85% RH (non-condensing)
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Storage Temp:	-10 - 60°C, 14 - 140°F, 85% RH (non-condensing)
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\*Manufactured to customer specific frequencies.

**Standard accessory kit**



ZB-B05 Test Cable, Type N(m) - N(m), 4m (13 ft)



ZB-B06 Connector Adaptor, 7/16''(m) - N(f)



ZB-B03 Power Supply, 90 - 264 VAC / 12 VDC, 4 Amp



ZB-B04 Power Cord, 2m (6 ft)



ZB-B08 DC Charging Cable for Car Accessory Socket



ZB-B07 Accessories Pouch

**Recommended optional accessories**



Opt-01 TK-A01 Low P1M Cable Load, 5 W, N(f) connector



Opt-03 ZB-A96 Connector Adaptor, 7/16''(f) - 7/16''(f)



Opt-05 ZB-A98 Connector Adaptor, N(f) - N(f)



Opt-07 ZB-B11 Test Cable, 7/16''(m)-7/16''(m), 3m (10 ft)



Opt-02 TK-10DN Low P1M Cable Load, 40W, with 7/16'' (f) & N(f) connectors (at either end of cable)



Opt-04 ZB-A97 Connector Adaptor, 7/16''(f) - N(m)



Opt-06 ZB-B09 Low power P1M source, 7/16''(m)



## Frequencies

The measurement frequencies  $f_1$  and  $f_2$  are customized and have to be specified by the customer on the purchase order. Due to the PIM test receiver selectivity,  $f_1$  and  $f_2$  should be at least 10 MHz (preferably more than 20 MHz) apart. Please call or email for assistance in selecting the optimal test frequencies for your PIM 20 test system.

## Ordering Information

### PIM 20 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 30 / 33 dBm\*, VSWR measurement 0 to 15 dB, LCD Display, battery, 17.6lbs / 8 kg, Enclosure IP55 / IP40 (closed / open), includes power supply 90 - 240VAC (specify connector type w/ PO), Test Cable N-N, 4m (13ft), Adapter,  $7/16$  to N, 12V Car adapter, accessories pouch, user manual, quick start guide.

-01	Low PIM cable Load, 5 W, N(f)
-02	Low PIM cable Load, 40 W, with $7/16$ (f) plus N(f) connectors at either end of the load
-03	Adaptor $7/16$ (f) - $7/16$ (f), low PIM
-04	Adaptor $7/16$ (f) - N (m), low PIM
-05	Adaptor N (f) - N (f), low PIM
-06	Low power PIM source, $7/16$ (m)
-07	Test cable $7/16$ (m) - $7/16$ (m), low PIM, 3m, 10 ft
-WARR1	Warranty extension one additional year
-CARE1	One additional calibration and one additional year of warranty extension

\* Model Dependent

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