PM Series Microwave Power Calibration System

The PM Series calibrator simplifies the tedious and complex process of RF power sensor calibration. The goal is to realize consistent, cost effective and traceable calibrations. However, the manual approach is very demanding of even the most experienced technician.

A successful calibration involves:
- Setting instruments
- Keeping track of standards
- Computing mismatch ($\Gamma$)
- Computing calibration factors ($k$)
- Computing total uncertainties
- Programming EPROM sensors
- Generating reports and labels

The PM Series automates and standardizes this process while providing compatibility with a wide variety of instruments and power sensors.

The PM Series is built upon the 1830A metrology grade RF Power Meter. This is the only RF Power Meter on the market that is compatible with all known types of thermistor sensors including TEGAM, Agilent, Weinschel, Hughes and Millitech.

A new line of compatible RF power thermistor transfer and reference standards have also been developed that provide flexibility and expandability as your RF calibration needs grow. These standards are based on the same time proven method used by NIST, PTB, NIM and other national metrology organizations around the world.

- Supports Sensors from most major manufacturers from 6 kHz to 50 GHz
- Faster than direct compare method
- Lowest total uncertainty
- National Metrology Institute class thermistor reference standard
- Complete Automation by PS-Cal
Complete System Integration | PMX Series

TEGAM has condensed their experience with microwave calibration into one convenient and accurate automated system that operates from 6 kHz to 18, 26.5 or 50 GHz. One turnkey package includes the VNA, signal generator, microwave power standards, workstation, software and accessories required for immediate productivity. The system is configured with instruments from different manufacturers that have been tested and verified by TEGAM to produce an accurate and repeatable calibration. Onsite installation and training are included with each complete system for a fast and trouble free start up. Due to the wide range of options, the PMX system is quoted on an as requested basis.

Major System Components

PS-Cal allows for unmatched flexibility when it comes to hardware driver availability. Popular VNA’s like the Agilent/Keysite 8510C and PNA, Anritsu VectorStar and Shockwave, as well as the Rohde & Schwarz ZVA can all be fully utilized with PS-Cal. Any SCPI compliant signal generator can be utilized, the procedures allow for use up to two signal sources per procedure, including function generators. However, this chart consists of the equipment that best meets the specifications of both power and frequency requirements for power sensor calibration.

<table>
<thead>
<tr>
<th>6 kHz to 18 GHz</th>
<th>6 kHz to 26.5 GHz</th>
<th>6 kHz to 50 GHz</th>
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<tbody>
<tr>
<td><strong>Signal Generators</strong></td>
<td><strong>Network Analyzers</strong></td>
<td><strong>Microwave Standards</strong></td>
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<tr>
<td>Anritsu MG3692C</td>
<td>Anritsu MS4642B</td>
<td>1830A &amp; 2505A</td>
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<td>Gigatronics 2520B</td>
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<td>Rohde &amp; Schwarz ZVA</td>
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1 Keysight PNA Series and HP8510C do not operate down to 6 kHz.
## PM Series Package Summary*

<table>
<thead>
<tr>
<th>Part Number</th>
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<th>PMX18-012</th>
<th>PMX26-012</th>
<th>PMX50-002</th>
<th>PMX50-014</th>
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<td>✔</td>
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</table>

*Software purchased separately

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**PS-Cal calibration software delivers both automation and confidence to RF power sensor calibration.**

Correctly calibrating an RF power sensor is an involved process that requires numerous complex calculations of calibration factor, mismatch correction and uncertainty. PS-Cal is successfully deployed by many organizations who are ISO 17025:2005 accredited. Combined with the fastest calibration available across the greatest number of different sensors, it is the only real option for those who need automation with sensors from multiple manufacturers.

**Calibration Software**

- Fully automated RF power sensor calibration
- VNA support for automated SII parameter measurements
- User customizable calibration procedures
- Upload and download EPROM data of most Anritsu, Agilent (both E4400 and E9300 series), Boonton, and Giga-tronics power sensors
- Flexible standards allow the operator to use the instruments in their lab
- Data stored for easy manipulation
- Selecting calibration procedures fast and easy
- Dynamic Uncertainty Calculations
### Microwave Calibration Standards

- **MODEL F1135B**
  - Feedthrough design for calibrating microwave power sensors
  - Provide lowest-uncertainty monitoring of RF power supplied to a Device Under Test
  - Calibrate RF power sensors from 10 MHz to 26.5 GHz
  - Temperature controlled for minimal response to ambient environment
  - Thermistor bolometer for lowest drift of absolute power reading
  - 0.01 to 25 mW power range
  - Rack mount option available

- **MODEL M1135A**
  - Terminating Design
  - Can be calibrated at NIST with the lowest uncertainty of any sensor type
  - Transfer calibration from NIST (or other NMI) to feedthrough standards with the lowest possible uncertainty from 10 MHz to 26.5 GHz
  - Lowest uncertainty of any available CW absolute power sensor
  - Temperature controlled for minimal response to ambient environment
  - Thermistor bolometer for lowest drift of absolute power reading
  - 0.01 to 25 mW power range
  - Adjustable stand available

- **MODEL 2505A**
  - Feedthrough design for calibrating microwave power sensors
  - Provide lowest-uncertainty monitoring of RF power supplied to a Device Under Test
  - Calibrate RF power sensors from 6 kHz to 18 GHz
  - Temperature controlled for minimal response to ambient environment
  - Thermistor bolometer for lowest drift of absolute power reading
  - 0.01 to 25 mW power range
  - Rack mount option available

- **MODEL 1505A**
  - Terminating Design
  - Transfer calibration from NIST (or other NMI) to feedthrough standards with the lowest possible uncertainty from 6 kHz to 18 GHz
  - Lowest uncertainty of any available CW absolute power sensor
  - Temperature controlled for minimal response to ambient environment
  - Thermistor bolometer design
  - 0.01 to 25 mW power range

### RF Power Meter for Metrology

- **MODEL 1830A**
  - Frequency Range: 110 GHz (sensor dependent)
  - Meter Uncertainty: ±0.05% of reading, ±0.5 µW (0.1% at 1 mW)
  - Calibrate 50 MHz reference outputs (with appropriate sensor)
  - Compatible with most DC substitution thermistor sensors
  - Directly reads calibrated RF power
  - Replaces HP432

### PMX Series

- **MODEL 1830A**
  - RF Power Meter for Metrology
  - Frequency Range: 110 GHz (sensor dependent)
  - Meter Uncertainty: ±0.05% of reading, ±0.5 µW (0.1% at 1 mW)
  - Calibrate 50 MHz reference outputs (with appropriate sensor)
  - Compatible with most DC substitution thermistor sensors
  - Directly reads calibrated RF power
  - Replaces HP432

- **MODEL F1135B**
  - Microwave Calibration Standard
  - Feedthrough design for calibrating microwave power sensors
  - Provide lowest-uncertainty monitoring of RF power supplied to a Device Under Test
  - Calibrate RF power sensors from 10 MHz to 26.5 GHz
  - Temperature controlled for minimal response to ambient environment
  - Thermistor bolometer for lowest drift of absolute power reading
  - 0.01 to 25 mW power range
  - Rack mount option available

- **MODEL M1135A**
  - Microwave Calibration Standard
  - Terminating Design
  - Can be calibrated at NIST with the lowest uncertainty of any sensor type
  - Transfer calibration from NIST (or other NMI) to feedthrough standards with the lowest possible uncertainty from 10 MHz to 26.5 GHz
  - Lowest uncertainty of any available CW absolute power sensor
  - Temperature controlled for minimal response to ambient environment
  - Thermistor bolometer for lowest drift of absolute power reading
  - 0.01 to 25 mW power range
  - Adjustable stand available

- **MODEL 2505A**
  - Microwave Calibration Standard
  - Feedthrough design for calibrating microwave power sensors
  - Provide lowest-uncertainty monitoring of RF power supplied to a Device Under Test
  - Calibrate RF power sensors from 6 kHz to 18 GHz
  - Temperature controlled for minimal response to ambient environment
  - Thermistor bolometer for lowest drift of absolute power reading
  - 0.01 to 25 mW power range
  - Rack mount option available

- **MODEL 1505A**
  - Microwave Calibration Standard
  - Terminating Design
  - Transfer calibration from NIST (or other NMI) to feedthrough standards with the lowest possible uncertainty from 6 kHz to 18 GHz
  - Lowest uncertainty of any available CW absolute power sensor
  - Temperature controlled for minimal response to ambient environment
  - Thermistor bolometer design
  - 0.01 to 25 mW power range
Microwave Calibration Standard

**MODEL 2510A**

- Feedthrough design for calibrating microwave power sensors
- Provide lowest-uncertainty monitoring of RF power supplied to a Device Under Test
- Calibrate RF power sensors from 10 MHz to 50 GHz
- Temperature controlled for minimal response to ambient environment
- Thermistor bolometer design
- 0.01 to 25 mW power range
- Rack mount option available

**MODEL 1510A**

- Terminating Design
- Transfer calibration from NIST (or other NMI) to feedthrough standards with the lowest possible uncertainty from 10 MHz to 50 GHz
- Lowest uncertainty of any available CW absolute power sensor
- Temperature controlled for minimal response to ambient environment
- Thermistor bolometer design
- 0.01 to 25 mW power range

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**Uncertainty Calculation for a Power Sensor Calibration**

*Example calibration:* Frequency: 18 GHz  
Power: 1 mW

\[
k_{DUT} = \frac{P_{DUT}}{P_{FT20}} (1 - \Gamma_{FT} \Gamma_{DUT})^2
\]

<table>
<thead>
<tr>
<th>Input Component</th>
<th>Value of Input</th>
<th>Uncertainty of Input Value</th>
<th>Uncertainty Contribution to ( k ) of Input</th>
</tr>
</thead>
<tbody>
<tr>
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<td>.8851 mW/mW</td>
<td>.01 mW/mW</td>
<td>.01 mW/mW</td>
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<tr>
<td>2505A Rho</td>
<td>.042 V/V</td>
<td>.03 V/V</td>
<td>.00114 mW/mW</td>
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<tr>
<td>2505A Phi</td>
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<td>8 degrees</td>
<td>.00111 mW/mW</td>
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<tr>
<td>1830A Power Reading</td>
<td>1.0000 mW</td>
<td>.07% of rdg</td>
<td>.00059 mW/mW</td>
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<tr>
<td>DUT Rho</td>
<td>.111 V/V</td>
<td>.03 V/V</td>
<td>.00014 mW/mW</td>
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<td>DUT Phi</td>
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<td>4 degrees</td>
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<td>.002 mW/mW</td>
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<td>RSS Uncertainty</td>
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Performance Graphs

**F1135B**

Typical Equivalent Source Match

Typical Cal Factors

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**2505A**

Typical Equivalent Source Match

Typical Cal Factors

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**2510A**

Typical Equivalent Source Match

Typical Cal Factors
## PM Series Supported Sensors

<table>
<thead>
<tr>
<th>SENSOR</th>
<th>FREQUENCY RANGE</th>
<th>EEPROM Read/Write</th>
<th>Required PM Series</th>
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<td></td>
<td>PMX18</td>
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<td>10 MHz to 18 GHz</td>
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<td>PMX18</td>
</tr>
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<td>10 MHz to 18 GHz</td>
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<td>PMX18</td>
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<td>10 MHz to 18 GHz</td>
<td></td>
<td>PMX18</td>
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<tr>
<td>8481D</td>
<td>10 MHz to 18 GHz</td>
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<td>PMX18</td>
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<tr>
<td>8481D-039</td>
<td>10 MHz to 22 GHz</td>
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<td>8482A</td>
<td>100 kHz to 4.2 GHz</td>
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<td>100 kHz to 4.2 GHz</td>
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<td>8482H</td>
<td>100 kHz to 4.2 GHz</td>
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<td>PMX18</td>
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<td>8483A</td>
<td>100 kHz to 2 GHz (75 Ohm)</td>
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## ANRITSU

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(Sensors continue on next page)
### PM Series Supported Sensors (continued)

#### BOONTON

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#### GIGA-TRONICS

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#### TEGAM

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# PM Series Accessories

## Attenuators

**138-645-1**
Coaxial fixed attenuator; 30 dB
- Frequency DC to 18 GHz
- Maximum Input Power: 2 W (average), 100 W (peak)
- Maximum SWR: 1.2 to 8 GHz, 1.3 to 12.4 GHz, 1.5 to 18 GHz
- Connector: Type-N male to female
- Includes S-parameter test data

**138-645-2**
Coaxial fixed attenuator; 30 dB
- Frequency DC to 26.5 GHz
- Maximum Input Power: 2 W (average), 5 µsec pulse width; 0.05% duty cycle (peak)
- Maximum SWR: 1.1 to 8 GHz, 1.15 to 12.4 GHz, 1.25 to 26.5 GHz
- Connector: 3.5 mm male to female
- Includes S-parameter test data

**2510-913-01**
Coaxial fixed attenuator; 30 dB
- Frequency DC to 50 GHz
- Maximum Input Power: 2 W (average)
- Maximum SWR: 1.3 to 26.5 GHz, 1.5 from 26.5 GHz to 50 GHz
- Connector: 2.4 mm male to female
- Includes S-parameter test data

## Adapters

**138-645-5**
Connector/Adapter
- Frequency DC to 18 GHz
- Maximum SWR: 1.065 to 4 GHz, 1.13 to 18 GHz
- Connector: Type-N male to 3.5 mm female
- Includes S-parameter test data

**138-645-6**
Connector/Adapter
- Frequency DC to 18 GHz
- Maximum SWR: 1.065 to 4 GHz, 1.08 from 18 GHz to 26.5 GHz
- Connector: 2.4 mm male to 3.5 mm female
- Includes S-parameter test data

**2510-912-01**
Connector/Adapter
- Frequency DC to 26.5 GHz
- Maximum SWR: 1.05 DC to 18 GHz, 1.08 from 18 GHz to 26.5 GHz
- Connector: 2.4 mm male to 3.5 mm female
- Includes S-parameter test data

**2510-911-01**
Connector/Adapter
- Frequency DC to 40 GHz
- Maximum SWR: 1.05 DC to 4 GHz, 1.08 from 4 GHz to 20 GHz, 1.12 from 20 GHz to 40 GHz
- Connector: 2.4 mm male to 2.92 mm female
- Includes S-parameter test data

**1510-912-01**
Connector/Adapter
- Frequency DC to 26.5 GHz
- Maximum SWR: 1.05 DC to 18 GHz, 1.08 from 18 GHz to 26.5 GHz
- Connector: 2.4 mm female to 3.5 mm male
- Includes S-parameter test data

**1510-911-01**
Connector/Adapter
- Frequency DC to 40 GHz
- Maximum SWR: 1.05 DC to 4 GHz, 1.08 from 4 GHz to 20 GHz, 1.12 from 20 GHz to 40 GHz
- Connector: 2.4 mm female to 2.92 mm male
- Includes S-parameter test data
Cables

CA-11-15 and CA-11-48 (15” or 48” length)
Heater cable (4-pin mini to 4-pin mini)
For use with the following combinations:
• 1806A connected to F1130A/B and F1135A/B
• 1830A connected to F1130A/B and F1135A/B

CA-10-48 (48” length)
Heater cable (4-pin mini to 4-pin large)
For use with the following combinations:
• 1806A connected to M1130A and M1135A
• 1830A connected to M1130A and M1135A

CA-7-15 and CA-7-48 (15” or 48” length)
Sensor cable for use with the following combinations:
• 1830A connected to F1130A/B, F1135A/B, M1130A or M1135A

CA-27-48
Heater cable for 1805, 1806 to F1109, F1110, M1110, M1118, M1130 and M1135

CA-21-15 and CA-21-48 (15” or 48” length)
Heater and sensor cable for use with the following combinations:
• 1830A connected to 1505A and 2505A
• 1830A connected to 1510A and 2510A

CA-6-48 (48” length)
Sensor cable for use with the following combinations:
• 1830A connected to 478A and 8478B

CA-9-48 (48” length)
Sensor cable; un-terminated cable for customers that wish to make their own cables to interface with the 1830A

CA-20-48 (48” length)
Sensor cable; lug-terminated cable for calibration of the 1830A

CA-23-12 (12” length)
Low loss RF cable, 50 GHz, 2.4 mm male connectors
• Insertion loss max 1.8 dB

CA-23-36 (36” length)
Low loss RF cable, 50 GHz, 2.4 mm male connectors
• Insertion loss max 4.0 dB

CA-14-2M (2-meter length)
USB cable, USB A to USB A; communication cable for the 1830A

1585-1000 (36” length)
Test cable with SMA straight plug connectors, DC to 18 GHz
• Insertion loss max 1.9 dB

1585-1008 (36” length)
Low loss RF cable, 26.5 GHz, 3.5 mm male connectors
• Insertion loss max 3.0 dB

1585-1009 (36” length)
Low loss RF cable, 40.0 GHz, 2.92mm male connectors
• Insertion loss max 3.6 dB

Torque Wrenches

1130-910-01
Torque wrench, 8mm, 5 in-lbs

1130-911-01
Torque wrench, 3/4”, 12 in-lbs

1130-912-01
Torque wrench, 13/16”, 14 in-lbs

2510-910-01
Torque wrench, 8mm, 8 in-lbs

Rack Mount Kits

1830-910
Single unit rack mount, 1830A, F113XB, 2505A and 2510A

1830-911
Dual rack mount kit, 1830A, F113XB, 2505A and 2510A

F1120-RMK
Rack mount kit, F11XX Series (before “B” suffix only)

Transport Cases

1500-910
Transport case for 1505A and 1510A power standard
Note: 1510-910 is a standard item with a new purchase of the 1505A or 1510A

2500-910
Transport case for 1830A, F113X, 2505A, 2510A, M1130 and M1135

8000
RF mount transport case for F1109, F1117, M1110, M1118, M1130 and M1135

1800
Transport case, 1806A