Power Sensor Calibration System

Automated calibration system for IFR and third party power sensors

- Based on the IFR factory calibration system
- Modular system covering frequencies 30 kHz to 46 GHz
- Results traceable to national standards
- Measures Cal Factor, VSWR and Linearity Factor

The Microwave Power Sensor Calibration system designed by IFR is based on the system that is in operation at its own production facility. The system is modular, and can be configured to calibrate a variety of power sensors and detectors, including the IFR EEPROM detectors and sensors from third party vendors.

The System

The core of the modular system has been designed to calibrate power sensors and detectors in the range 10 MHz to 26.5 GHz. Additional options are available for frequencies outside this range. A list detailing the sensors and detectors that can be calibrated is contained in the Specification section at the end of this data sheet.

The parameters provided by the system are detailed below. Where appropriate, they are measured against frequency and a printed table is produced for each device calibrated. In addition, the Cal Factor information is supplied on a label on the side of the sensor.

Calibration Factor (Cal Factor)

The Cal Factor gives an indication of the variation of the sensitivity of the device with frequency. It is used to provide a correction factor to compensate for the errors due to power dissipated within the sensor. This dissipation could be caused by, for example, the layout within the detector, or the errors due to reflections caused by mismatch at the source and device input. Both of these sources of error are frequency dependent. The Cal Factor is expressed as a percentage of the reference Cal Factor, measured at a defined frequency. The values of Cal Factor are normalized to the maximum value as 100%.

VSWR (Return Loss)

VSWR is a measure of the mismatch of the input of the device, and again is frequency dependent.

Uncertainty

The uncertainty, normally expressed as a percentage, is an indication of the maximum error associated with the measurements. It is mainly caused by the imported uncertainties from the audit sensor and from the instrumentation accuracy. Some uncertainty can also come from multiple reflections between source and device input.

Linearity Factor

In addition to using the standard power sensor calibration information, the IFR microwave test sets and power meters can make use of a sensor's linearity factor to further increase the accuracy of measurements.

Measurement Techniques Employed

The conventional method for establishing the Cal Factor is to use a substitution method. This is generally time consuming and very labor intensive. To ease these problems and yet maintain highly accurate calibration with very low uncertainties, an alternative method has been developed.

The technique used measures the Cal Factor relative to a reference head. With this method, the power from the source is passed through a splitter. One output of the splitter goes to the sensor under test (the test port), the other to a reference head. The combination of splitter and reference head is known as a splitter fixture. This is supplied with an initial set of calibration data (traceable to national standards) which characterizes it, and with documented uncertainties associated with it, supplied by the calibration laboratory.

In the IFR system, the device used for splitting the power is a 2 resistor splitter. For a 50 Ω system, both of these resistors are 50 Ω resistors. One option when using this method is to feed back the level detected by the reference head to keep the splitter output constant. The splitter resistor junction then acts as a virtual earth and makes the test port input appear as a perfect match. An alternative method used by IFR is not to keep the splitter output power constant but to measure the output from the reference head at the same time as the output from the device under test is measured. Calculations show that the expressions derived for matching for this ratio-based system are identical to those derived for the levelling system.

The system is fully automated and runs under software control, with the only manual intervention being the connection and disconnection of the device being calibrated.

Under ratio conditions, the Calibration

Power Sensor Calibration System

Factor of the device under test, CF, is given by:

$$CF = \frac{PI@f}{PR@f} \cdot \frac{PR@50MHz}{PI@50MHz} \cdot C(f)$$

Where:

PI	=	Indicated power at frequency f
PR	=	Reference indicated power at frequency f
C(f)	=	Cal Data at frequency f for standard head (Splitter / Reference Detector combination)
CF	=	Measured calibration factor for DUT at frequency f

The normalized Cal Factor is given:

$$CF = \frac{Cal@f}{\text{Max Cal Factor in range}} \times 100$$

Basic System Configuration

For frequencies from 10 MHz to 26.5 GHz, the signal source is an IFR Microwave Test Set, 6203B. This feeds the relevant test fixture. This is a precision mechanical design to hold the splitter fixture rigidly. The power measurements are made using two IFR power meters, one for each signal path. Each power meter is used to feed a DMM, for a more accurate reading.

For VSWR measurements for frequencies from 250 MHz to 26.5 GHz, the IFR Reflection Analyzer, 6210, is used in conjunction with the 6203B Microwave Test Set. Using the 6210 gives advantages over the conventional autotester as it makes return loss measurements with a much smaller measurement uncertainty. In addition, the test port match and directivity are significantly better, giving improved accuracy and reduced uncertainty. For frequencies from 10 MHz to 250 MHz VSWR measurements are made with 6203B and an autotester.

Linearity Factor

The linearity factor facility is implemented by the addition of a precision programmable attenuator, IFR type 2186.

Optional Configurations

To cover the lower frequency range 30 kHz to 10 MHz, additional instrumentation is required for measuring the Cal Factor. The power source in this range is the IFR signal source type 2030. In addition, for VSWR measurements, a network analyzer and reflection analyzer are used.

26.5 GHz to 46 GHz

To cover the higher frequency range, 26.5 GHz to 46 GHz, the IFR Microwave Test Set type 6203B is replaced by IFR Microwave Test Set type 6204B.

System Housing

The system is housed in a two bay 19 in desk/console. It is based on proprietary equipment and not specifically designed to meet any special environmental specifications.

The standard core system covers the frequency range 10 MHz to 26.5 MHz for Cal Factor and Return Loss measurements. It consists of:

- IFR Microwave Test Set, type 6203B
- IFR Reflection Analyzer, type 6210
- IFR Power Meter, type 6960B (2 off)
- IFR Autotester
- Digital Multimeter (2 off)
- PC (Pentium), Controller, Printer
- Cal Kits

Traceability of Measurements

The power sensors and power splitter fixtures used on this system can be NAMAS calibrated in IFR NAMAS calibration laboratory. The company has operated a NAMAS calibration laboratory (Reg. No LAB0006) since 1968, offering NAMAS calibration for 28 parameters covering DC to 40 GHz.

A suitable range of calibrated splitter fixtures/detector/sensor jigs and audit standards is offered as accessories.

Supplied Software

The system software is written in Visual BASIC and is based on the software system used in the IFR production facility at Stevenage. The software provides a graphical man-machine interface characteristic of Windows applications, and guides the operator actions. In addition to printing a full set of measurement results, the system will print labels for attaching to the devices under test.

Specification

Basic System - 10 MHz - 26.5 GHz

IFR				
Sensors	6910	6911	6913	6920
	6923	6930		
Detectors	6230	6230A	6230L	6233
	6233A	6233L		

Low Frequency Option: 30 kHz - 10 MHz

IFR			
Sensors	6912	6932	6232A

High Frequency Option: 26.5 GHz - 46 GHz

IFR			
Sensors	6914	6914S	6924
	6924S	6934	6934S
Detectors	6234	6234A	6234L

Linearity Factor Option

IFR	
Sensors	All listed Sensors

IFR Americas, Inc., 10200 West York Street, Wichita, Kansas 67215-8999, USA. E-mail: info@ifrsys.com
Tel: +1 316 522 4981 Toll Free USA: 1 800 835 2352 Fax: +1 316 522 1360

IFR Ltd, Longacres House, Norton Green Road, Stevenage, Herts SG1 2BA, United Kingdom. E-mail: info@ifrinternational.co.uk
Tel: +44 (0) 1438 742200 Freephone UK: 0800 282 388 Fax: +44 (0) 1438 727601

Part no. 46891-089
Revision A