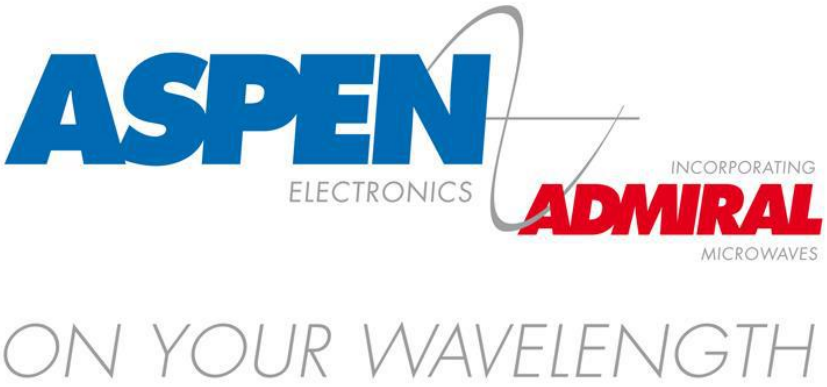
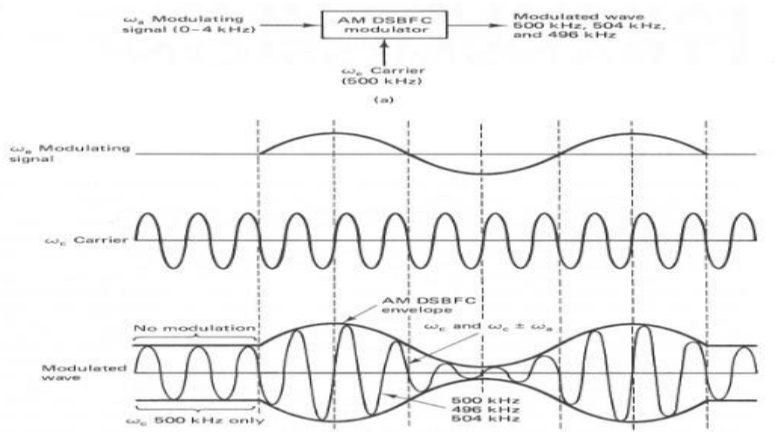


Statistical Power Sensor Technology

Statistical Power Measurement Fundamentals

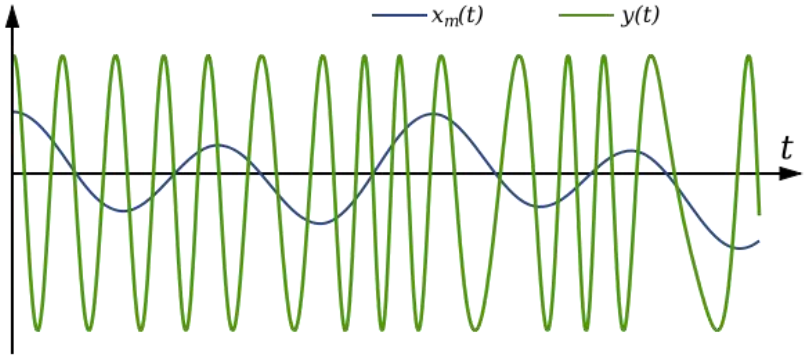
A Very Brief Look at Radio Communications Signals:

- **Signal Consists of Carrier Signal + Intelligence**
- **Intelligence May Be Encoded On Carrier By Changing Characteristics of Carrier**
- **Process is Known as Modulating the Carrier**
- **Amplitude (Strength), Frequency, or Phase (Timing) of Carrier May Be Altered**



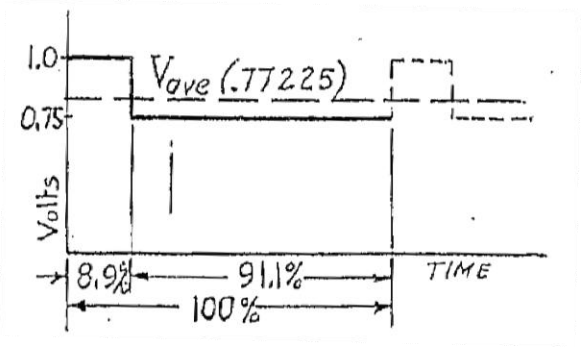
A Very Brief Look at Radio Communications Signals - *Modulation*:

- First 100 Years, Communications Systems Were Built Around a Single Modulation Type
- Amplitude Modulation (AM) and Frequency Modulation (FM) Were Main Focus
- Radio and Television Broadcast, Two Way Radio, Early Cellular Telephone Systems



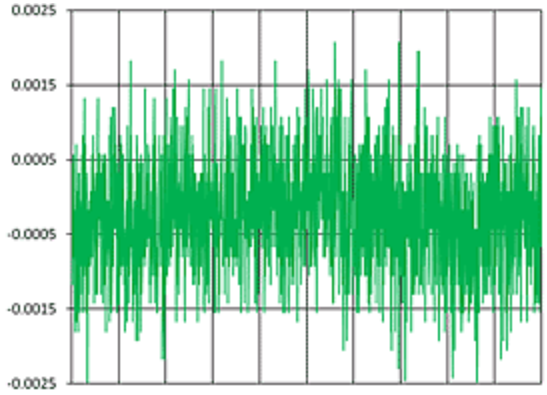
A Very Brief Look at Radio Communications Signals :

- **Power Measurement of Early Signals – Very Simple**
- **FM Systems Required Only Average Power Measurement Method**
- **AM Systems Used Both Average and Peak – of - Envelope Methods**
- **Health of Transmitter and Antenna System Very Easily Determined**



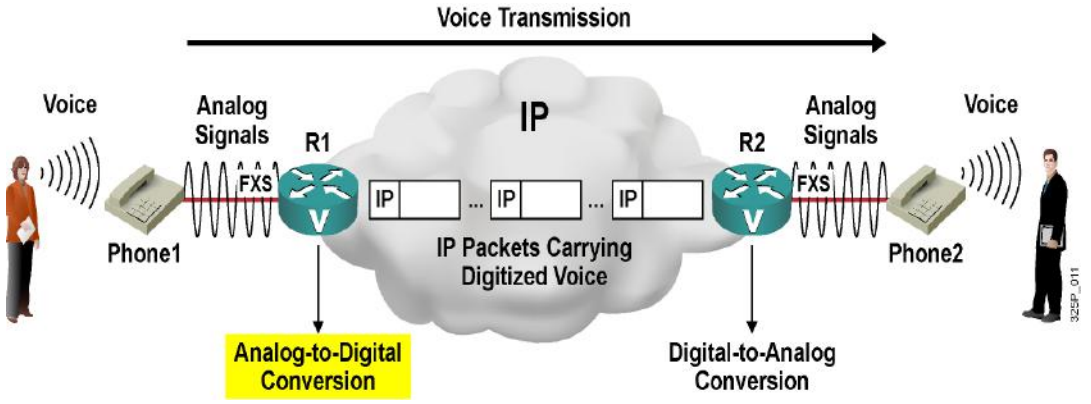
New Communications Signals :

- In Early 1990's Digital Modulation and Channel Access Methods Changed the Game
- Original Power Measurement Approaches Did Not Yield Accurate Results
- New Techniques Required Including Development of True-Average Responding Detectors



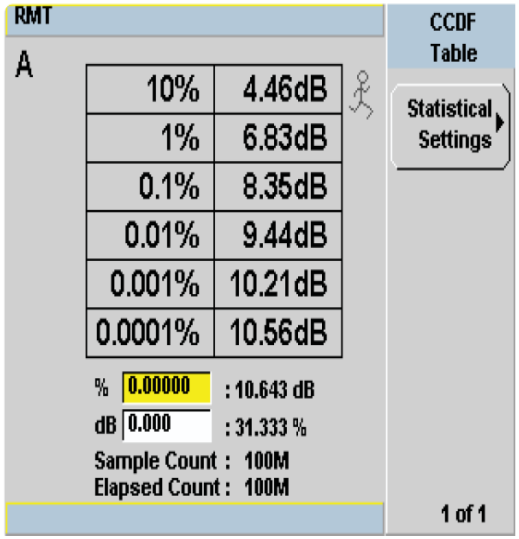
Newest Communications Signals :

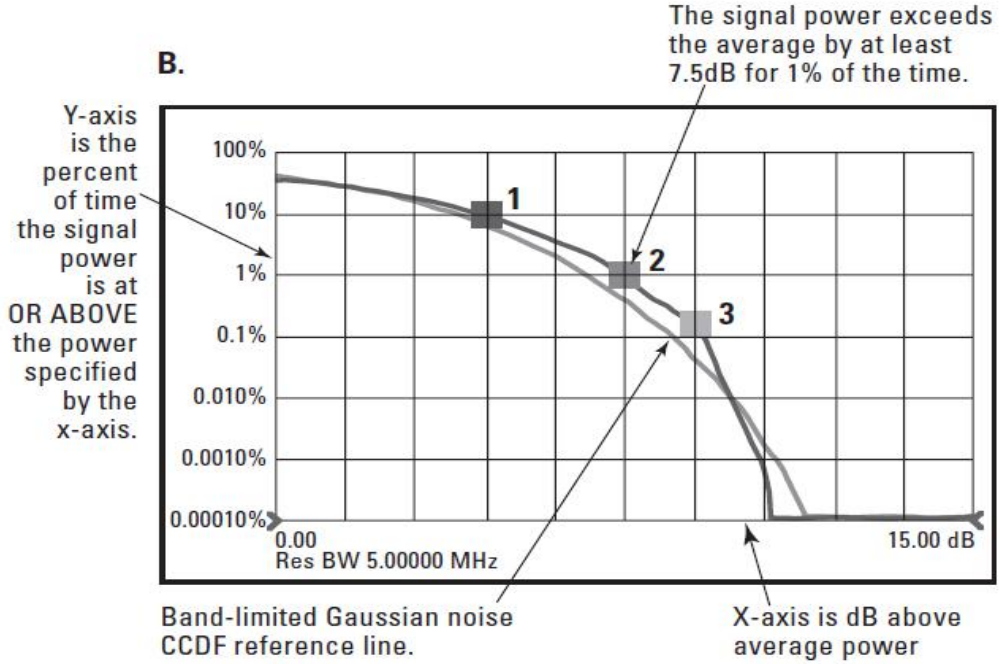
- **Newest Systems Based Completely on Data- No Discrete Voice Channels**
- **Packet Based Communications Formats**
- **Combination of Complex Modulation and Channel Access Result in Noise-Like Signals**
- **Average Power and Peak Power Measurements Do Not Adequately Describe Signal**



Statistical Power Measurements:

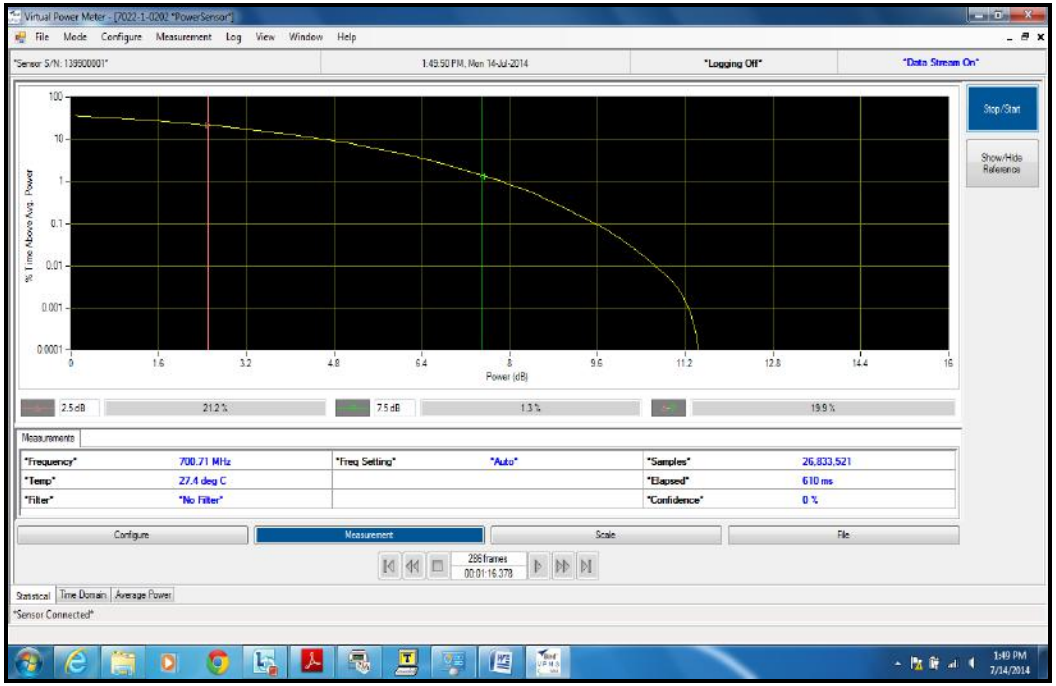
- **Statistical Power Measurement Provides an Indication as to Changes In Power Envelope**
- **Peak to Average Power Ratio of Signal Is a Key Measurement - CCDF**
- **Complementary Cumulative Distribution Function as a Function of Time**





Statistical Power Measurements – Why?:

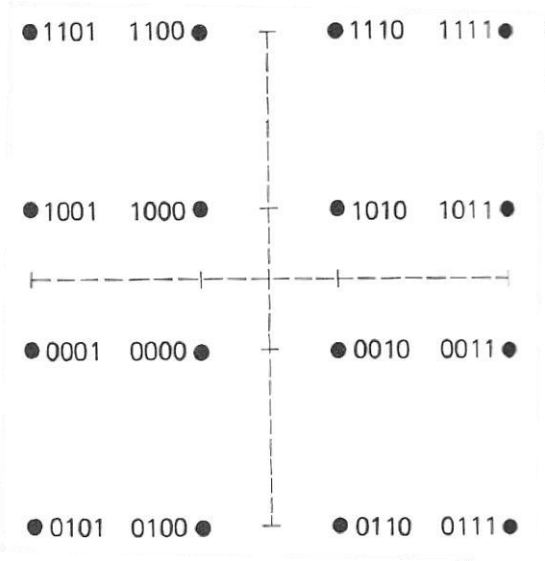
- In Today's Systems, Fidelity of Transmitted Signal Is Critical – No Waveform Distortion
- Fidelity of Waveform is a Tall Order Considering Nature of Signals – High Peak to Average Ratio
- Power Amplifiers in Transmitters Must Perform as Designed
- Waveform Distortion Due to Poor PA Performance Results in Lower Data Rate- ***Poor Performance!***
- Statistical Measurements Provide Rapid Assessment of PA / Transmitter Performance



Statistical Power Measurements – Why?:

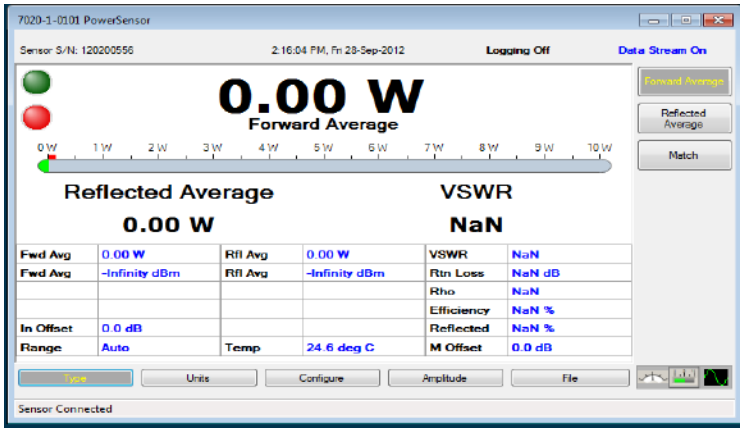
- **In Today's Systems, Position of Each Symbol In Complex Plane is Critical**
- **Position is Affected By Quality of Air Interface and Power Amplifier Characteristics**

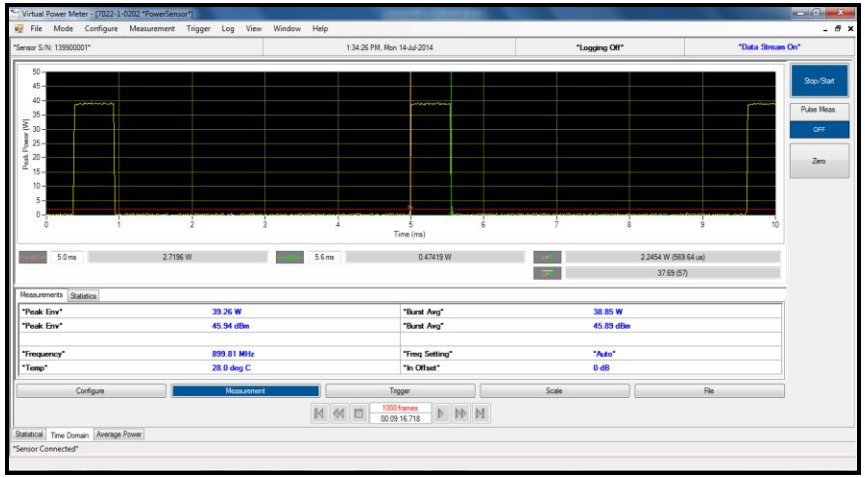
Binary input				16QAM output	
Q	$\overline{Q}$	I	$\overline{I}$		
0	0	0	0	0.311 V	−135°
0	0	0	1	0.850 V	−165°
0	0	1	0	0.311 V	−45°
0	0	1	1	0.850 V	−15°
0	1	0	0	0.850 V	−105°
0	1	0	1	1.161 V	−135°
0	1	1	0	0.850 V	−75°
0	1	1	1	1.161 V	−45°
1	0	0	0	0.311 V	135°
1	0	0	1	0.850 V	175°
1	0	1	0	0.850 V	45°
1	0	1	1	0.850 V	15°
1	1	0	0	0.850 V	105°
1	1	0	1	1.161 V	135°
1	1	1	0	0.850 V	75°
1	1	1	1	1.161 V	45°

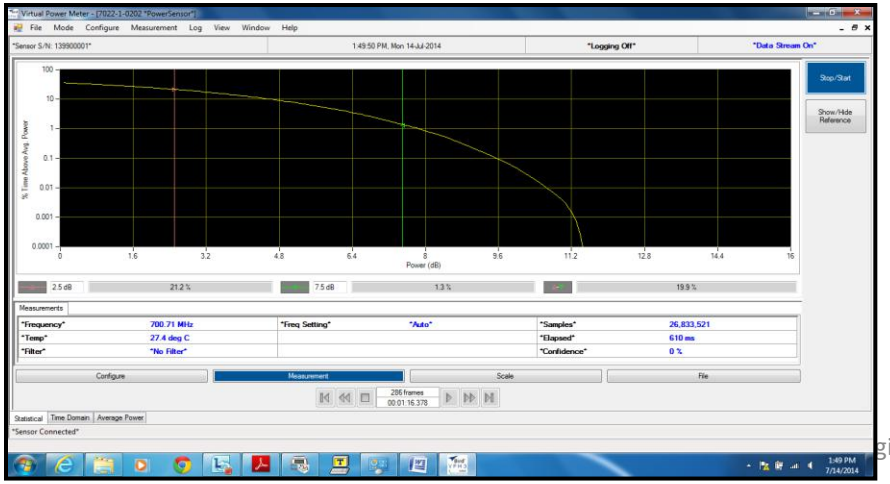


Bird Statistical Power Meter:

- **Provides Forward and Reflected Power, Peak / Pulse Power, Time Domain and Statistical Measurements**
- **Three Operating Modes: Average Power, Time Domain, and Statistical Mode**

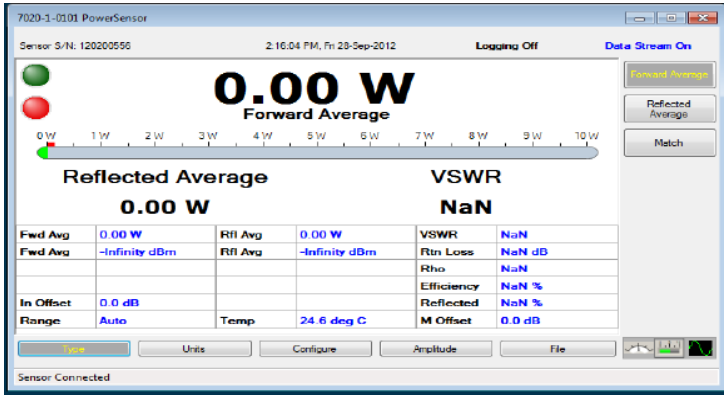


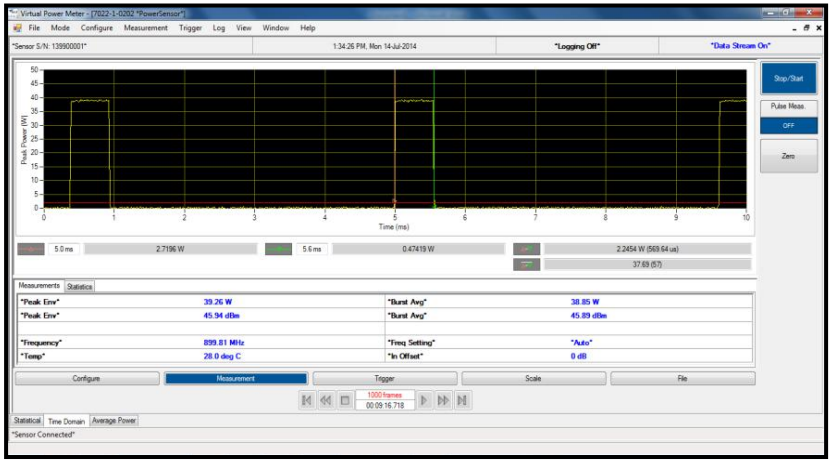


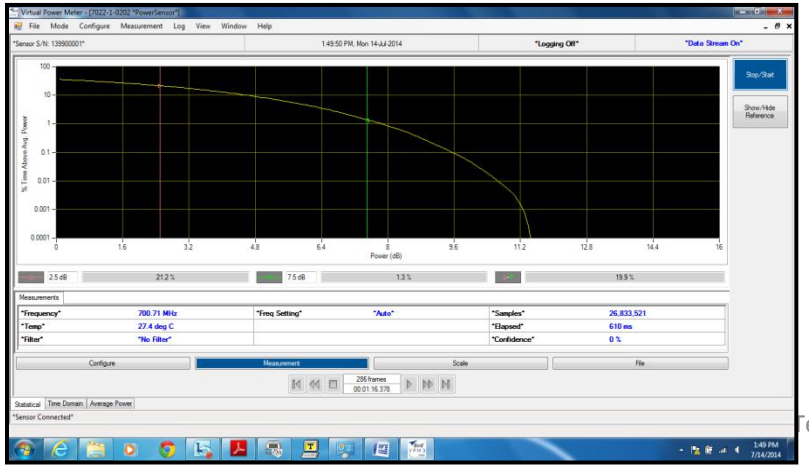


Bird Statistical Power Meter: Three Operating Modes

- **Average Power Mode- Useful for Making Typical Forward and Reflected Average Power Measurements**
- **Time Domain Mode- Useful for TDMA and Other Burst / Peak Measurement Needs (DMR, TETRA, etc)**
- **Statistical Mode – Useful for LTE and Other Systems Incorporating Complex Modulation/ Spread Spectrum Approaches**



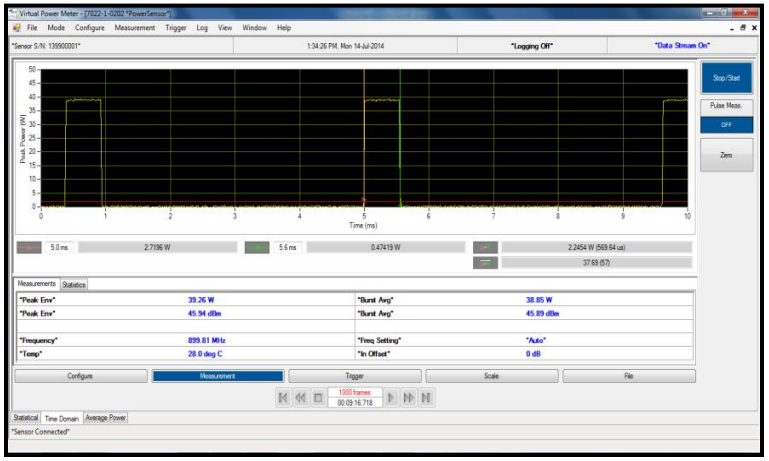




Statistical Power Measurement Technology

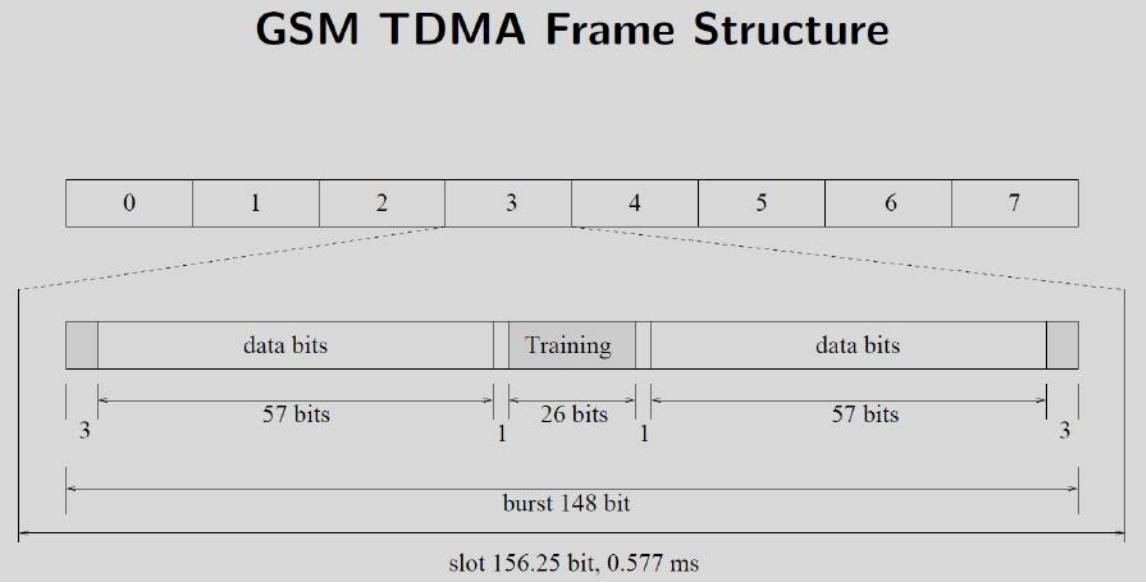
Critical Specifications:

Frequency Range: 350 MHz to 6 GHz
Power Measurement Range: 250mW mW to 500W Average
Dynamic Range: 33 dB
Accuracy: +/-5% of Reading
Interface: USB 2.0
Directivity: 30 dB Up to 1000MHz, 28 dB 1000 MHz to 6000MHz
Display: VPM3



Example: GSM Cellular Telephone

- **8- Slot TDMA Channel Access Method**
- **Use the Time Domain Function of the Statistical Sensor to View Any Slot Individually**



Other Waveforms:

- **LTE (4G Cellular Telephone) Uses Both Time Domain and Frequency Domain Channel Access Methods**
- **Modulation Formats are Complex – Amplitude and Phase Modulation**
- **Dynamic Allocation of Modulation Based Upon Radio Channel Quality**
- **PERFECT Application for the Bird Model 7022 Statistical Power Measurement Methods**

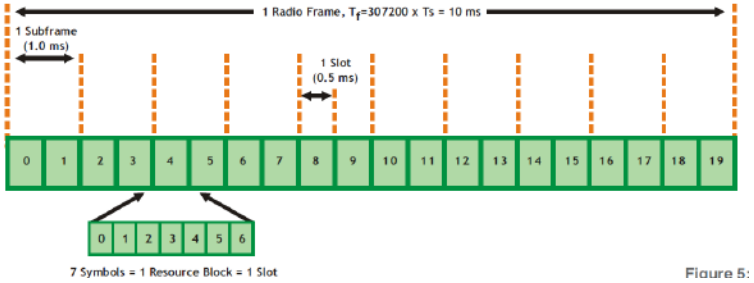
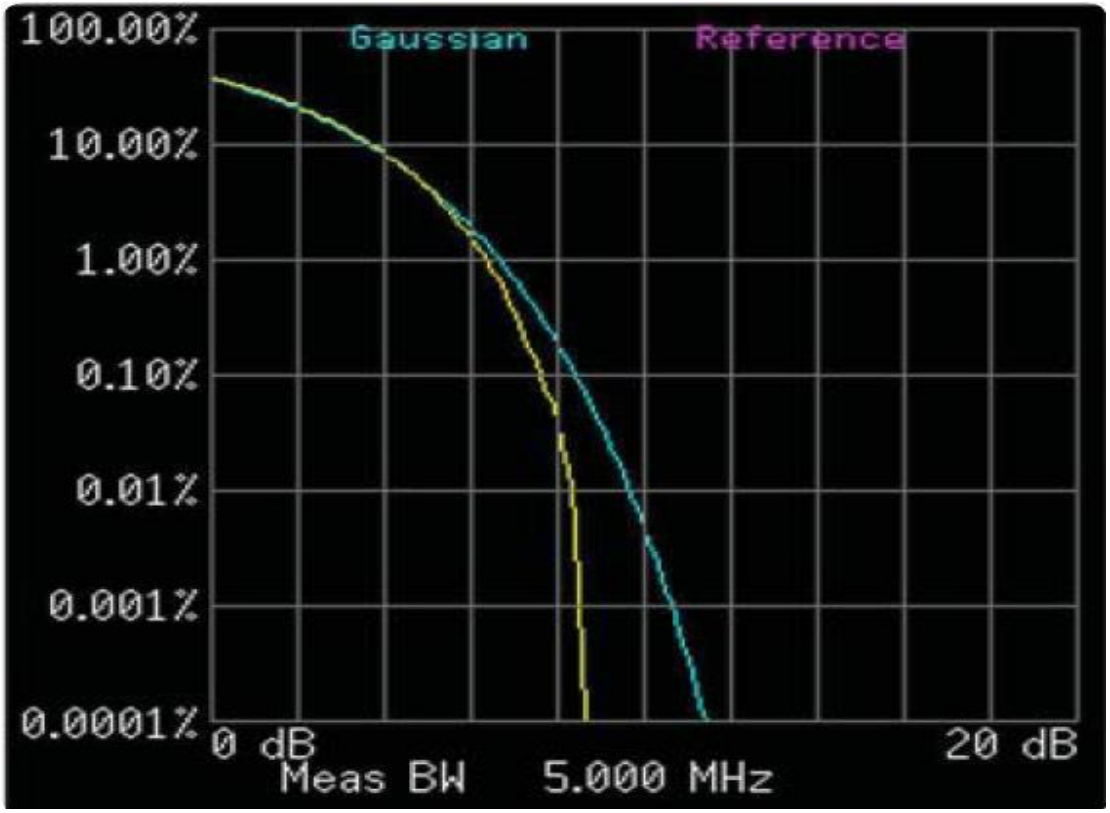


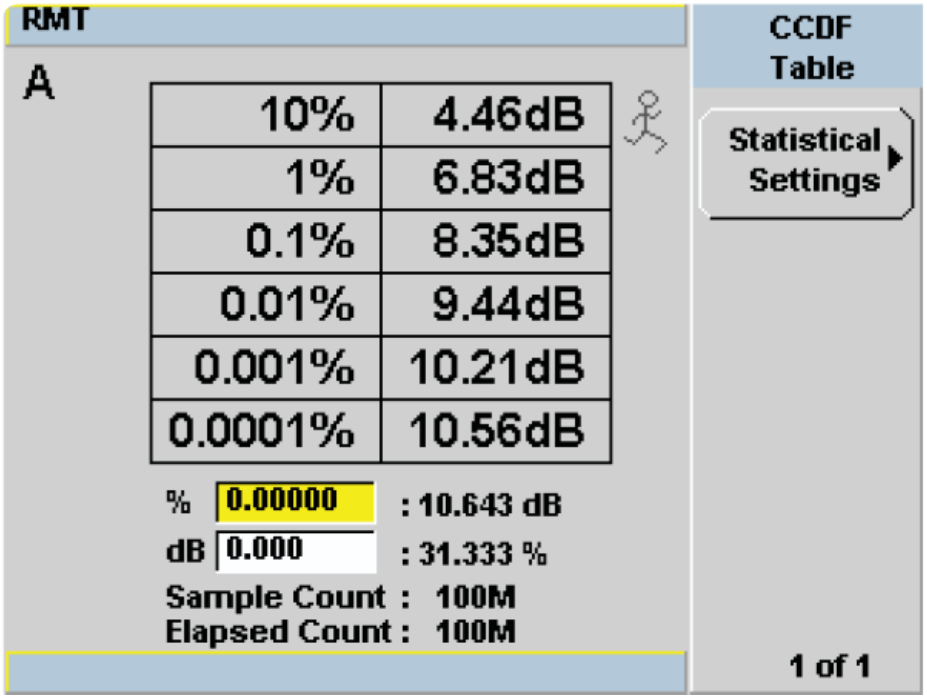
Figure 5:

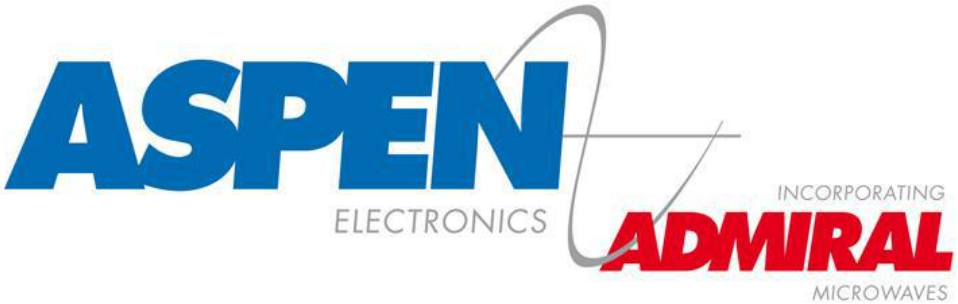
Transmission bandwidth for LTE FDD (MHz)	1.4	3	5	10	15	20
Number of sub-carriers	72	180	300	600	900	1200

Other Waveforms: LTE



Other Waveforms: LTE





ON YOUR WAVELENGTH

Contact us for more information and discuss your requirements for this product.