

## Features:

- 12 dB Gain
- 40 dBm P<sub>-3dB</sub>
- 33 dBm Linear Pout @ 2.5% EVM (802.11 64QAM)
- 25% Efficiency at 33 dBm Linear Output Power
- Fully Matched Input and Output for Easy Cascade
- + 28V Bias Voltage
- Surface Mount Package with RoHS Compliance
- MTTF > 100 years @ 85°C ambient temperature

## Applications:

- 802.16d/e WiMax
- 802.11a WLAN
- Point-To-Point Radio Applications

## Description:

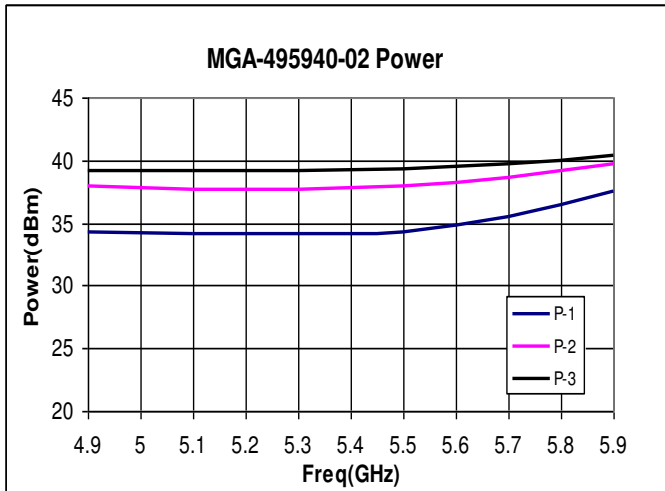
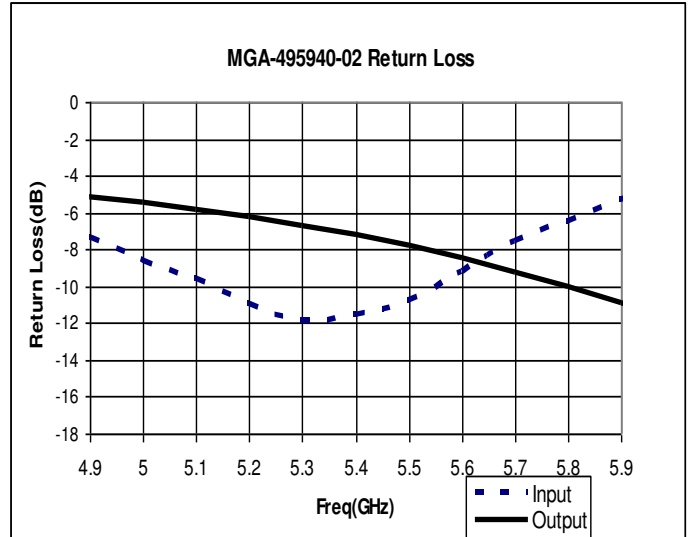
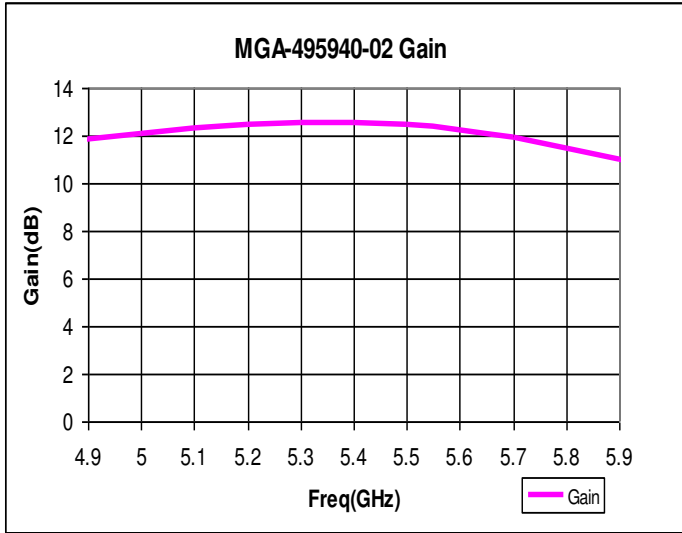
The MGA-495940-02 is a power amplifier with the State-of-the-Art linear power-added-efficiency between 4.9 GHz and 5.9 GHz frequency band. Based on advanced robust GaN device technology, the power-added-efficiency of this power amplifier is as high as 25% when it outputs 2W linear burst power with 2.5% EVM under the 802.16d/e 64QAM modulation schemes. The high efficiency linear power amplifier also has excellent reliability. Ideal applications include the driver and the output power stage of WiMax and WLAN infrastructures and access points. It also can be used for PTP (Point-To-Point) radio applications for this band.

## Typical RF Performance: $V_{ds}=28V, I_{cq}=80mA, T_a=25^\circ C, Z_0=50\ ohm$

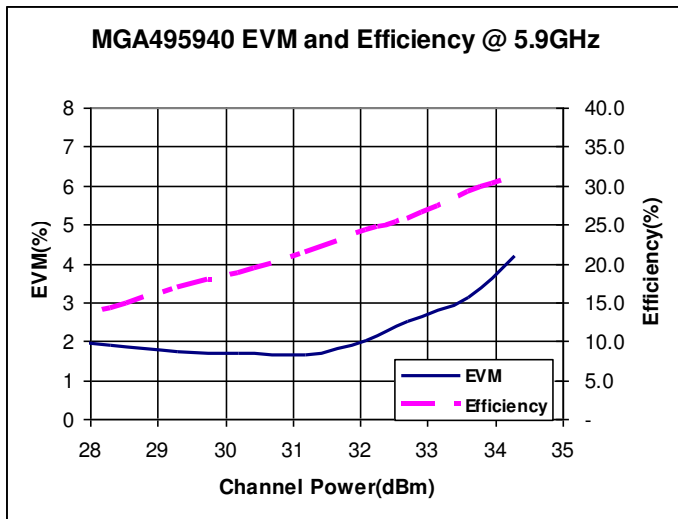
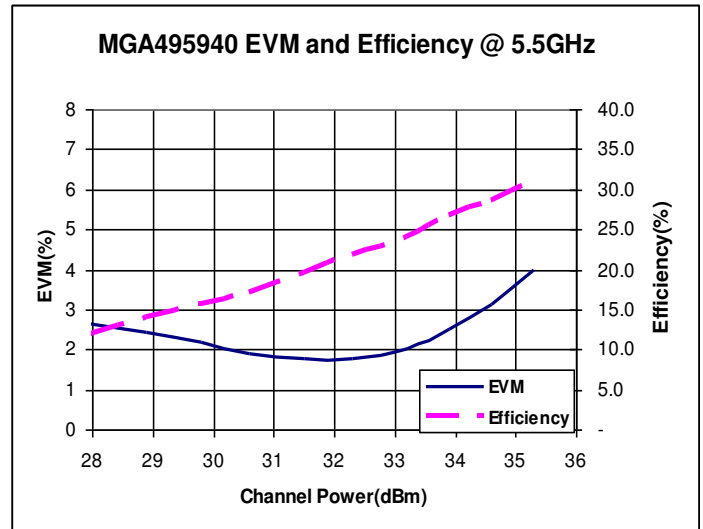
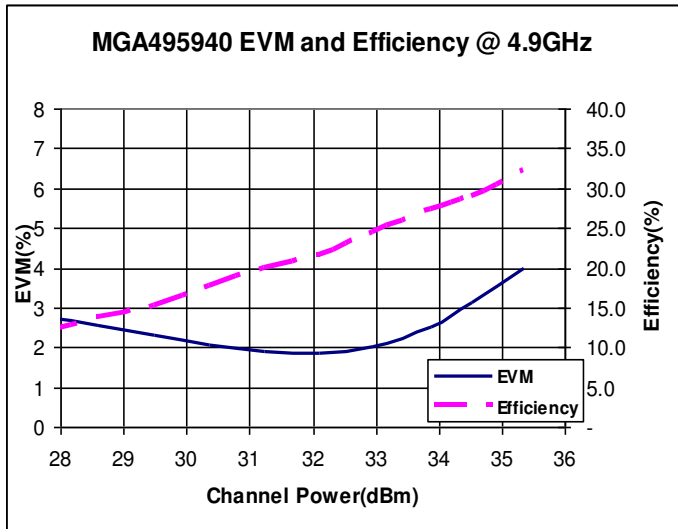
| Parameter                 | Units | Typical Data |
|---------------------------|-------|--------------|
| Frequency Range           | MHz   | 4900-5900    |
| Gain (Typ / Min)          | dB    | 12 / 10      |
| Gain Flatness (Typ / Max) | +/-dB | 1.0 / 1.5    |
| Input Return Loss         | dB    | 8            |
| Output Return Loss        | dB    | 8            |
| Output P3dB               | dBm   | 40           |
| Pout @ 2.5% EVM           | dBm   | 33           |
| Operating Current Range   | mA    | 100-400      |
| Thermal Resistance        | °C /W | 5            |

(1) Output IP3 is measured with two tones at output power of 13 dBm/tone separated by 10 MHz.

**Typical RF Performance:**  $V_{ds}=28.0V$ ,  $I_{cq}=80mA$ ,  $Z_0=50\text{ ohm}$ ,  $T_a=25\text{ }^\circ\text{C}$



**Typical RF Performance(Cont'l):**  $V_{ds}=28.0V$ ,  $I_{cq}=80mA$ ,  $Z_0=50\ ohm$ ,  $T_a=25\ ^\circ C$



**Absolute Maximum Ratings:** ( $T_a = 25\text{ }^\circ\text{C}$ )\*

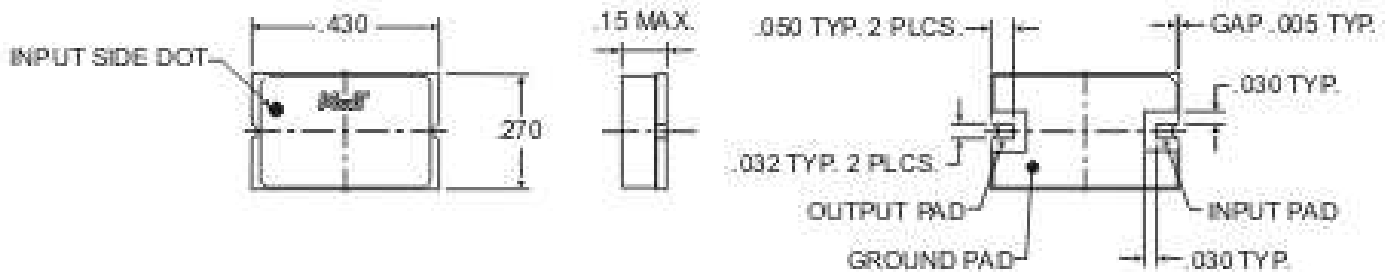
| SYMBOL  | PARAMETERS           | UNITS | ABSOLUTE MAXIMUM |
|---------|----------------------|-------|------------------|
| Vds     | Drain-Source Voltage | V     | 50               |
| Id      | Drain Current        | mA    | 1000             |
| Ig      | Gate Current         | mA    | 100              |
| Pdiss   | DC Power Dissipation | W     | 50               |
| Pin max | RF Input Power       | dBm   | +33              |
| Tch     | Channel Temperature  | °C    | 175              |
| Tstg    | Storage Temperature  | °C    | -55 to 150       |

\*Operation of this device above any one of these parameters may cause permanent damage.

**Typical Scattering Parameters:**  $V_{ds}=28V, I_{cq}=80mA, Z_0=50\text{ ohm}, T_a=25\text{ }^\circ\text{C}$

| Freq(GHz) | dB(S11) | Ang(S11) | dB(S21) | Ang(S21) | dB(S12) | Ang(S12) | dB(S22) | Ang(S22) |
|-----------|---------|----------|---------|----------|---------|----------|---------|----------|
| 4.50      | -4.69   | -43.52   | 10.55   | -141.90  | -33.06  | -144.90  | -4.14   | -142.40  |
| 4.60      | -5.11   | -50.54   | 10.90   | -152.80  | -32.87  | -152.70  | -4.42   | -151.70  |
| 4.70      | -5.87   | -56.32   | 11.18   | -164.00  | -32.51  | -159.70  | -4.66   | -161.40  |
| 4.80      | -6.51   | -61.08   | 11.51   | -175.90  | -32.07  | -168.00  | -4.93   | -171.30  |
| 4.90      | -7.39   | -66.87   | 11.83   | 172.30   | -31.71  | -177.20  | -5.19   | 178.50   |
| 5.00      | -8.62   | -68.72   | 12.08   | 159.90   | -31.52  | 172.80   | -5.49   | 167.40   |
| 5.10      | -9.60   | -69.53   | 12.34   | 146.80   | -31.24  | 162.00   | -5.85   | 156.40   |
| 5.20      | -10.95  | -67.66   | 12.50   | 133.80   | -31.05  | 150.90   | -6.21   | 144.60   |
| 5.30      | -11.84  | -58.77   | 12.52   | 120.10   | -30.84  | 139.60   | -6.67   | 132.30   |
| 5.40      | -11.59  | -49.87   | 12.57   | 106.30   | -30.96  | 127.60   | -7.21   | 120.40   |
| 5.50      | -10.77  | -42.44   | 12.48   | 92.66    | -31.15  | 115.20   | -7.76   | 107.30   |
| 5.60      | -9.20   | -39.10   | 12.20   | 78.48    | -31.29  | 103.10   | -8.48   | 94.20    |
| 5.70      | -7.62   | -41.41   | 11.90   | 64.56    | -31.78  | 91.87    | -9.28   | 81.16    |
| 5.80      | -6.53   | -45.95   | 11.48   | 50.88    | -32.39  | 79.12    | -10.07  | 67.42    |
| 5.90      | -5.35   | -51.14   | 11.01   | 37.53    | -32.88  | 67.90    | -10.94  | 53.45    |
| 6.00      | -4.49   | -59.01   | 10.45   | 24.92    | -33.57  | 57.35    | -11.91  | 38.94    |
| 6.10      | -3.99   | -65.82   | 9.80    | 12.18    | -34.36  | 44.67    | -12.77  | 24.35    |
| 6.20      | -3.22   | -73.37   | 9.23    | -0.24    | -35.20  | 33.93    | -13.60  | 8.06     |
| 6.30      | -2.90   | -81.86   | 8.62    | -11.31   | -36.03  | 24.04    | -14.51  | -7.53    |
| 6.40      | -2.63   | -88.27   | 7.89    | -22.43   | -37.27  | 13.47    | -14.93  | -23.85   |
| 6.50      | -2.15   | -96.78   | 7.23    | -33.40   | -38.15  | 2.63     | -15.33  | -42.38   |

**Mechanical Information:** *This Package is RoHS compliant*



**All dimensions are in mm**

| Pin Designation (Top View) |          |        |            |
|----------------------------|----------|--------|------------|
| Pin 1 (DOT Top Left)       | GND      | Pin 10 | GND        |
| Pin 2                      | GND      | Pin 9  | GND        |
| Pin 3                      | RF In/Vg | Pin 8  | RF Out/Vdd |
| Pin 4                      | GND      | Pin 7  | GND        |
| Pin 5                      | GND      | Pin 6  | GND        |

## Application Circuit

The evaluation board, shown in Figure 3, is fabricated with Rogers's 4003 material, 20 mil thick, 2 oz copper weight. The MGA495940-02 shown in the center of board is a 10 watt amplifier with high gain and high linearity. For best thermal performance, the PCB requires via holes with a diameter of 20 mils placed uniformly over the center pad for thermal relief and RF ground as shown in Figure 4. The via holes underneath the package are back filled with conductive epoxy as shown in Figure 4. The choice of capacitor bypassing near the amplifier should have a short circuit resonance at the frequency of operation. A small capacitor 3.9 pf 0603 from AVX has a series resonance at 5.5 GHz and will make a good choice for the first bypass capacitor.

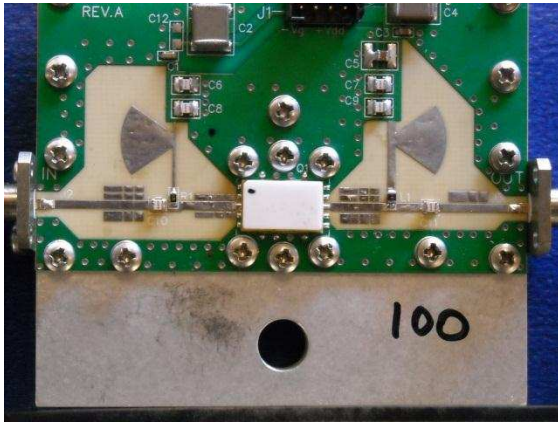


Figure 3 Evaluation board

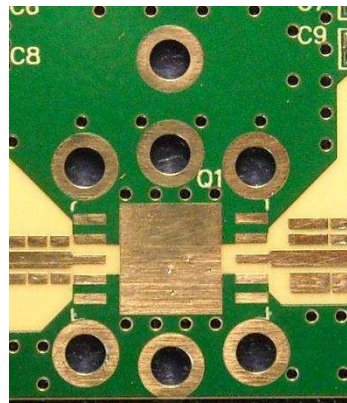


Figure 4 Hole Pattern

Followed up with larger value capacitors 100pf, 1000pf and 2.2 uF can be used to maintain voltage stability under peak current conditions. The DC ground via holes should be laid out to minimized inductive returns associated with ground loops. Use of stitch ground vias holes can help control the return current and also maintain ground continuity between the top and bottom ground layers. Biasing with quarter-wave stubs at the gate and drain are shown in Figure 3. A 56 ohm resistor is added in series to the gate bias and a 2.2 nH choke is added in series to the drain bias. The effective impedance is increased which reduces the risk of low frequency oscillations.

## Application Notes:

**802.16 256 carriers, 64 QAM @ 4.9GHz, Pavg=33.40dBm @ EVM=2.5%**

| IEEE 802.16-2004 OFDM     |                                |   |
|---------------------------|--------------------------------|---|
| Frequency: 4.9 GHz        | Signal Level Setting: 16.1 dBm | Ref. Level / Ext. Att: 26.1 dBm / 17.9 dB |
| Sweep Mode: Continuous    | Trigger Mode: External         | Trigger Offset: -10 $\mu$ s               |
| Burst Type: OFDM DL Burst | Modulation: ALL                | No Of Data Symbols: 1/2425                |

| Result Summary          |        |        |             |        |             |      |
|-------------------------|--------|--------|-------------|--------|-------------|------|
| No. of Bursts           | 4      |        |             |        |             |      |
|                         | Min    | Mean   | Limit       | Max    | Limit       | Unit |
| EVM All Carriers        | 2.45   | 2.48   | 2.82        | 2.55   | 2.82        | %    |
| EVM Data Carriers       | 2.46   | 2.48   |             | 2.55   |             | %    |
| EVM Pilot Carriers      | 2.34   | 2.41   |             | 2.54   |             | %    |
| IQ Offset               | 0.34   | 0.34   | 17.78       | 0.34   | 17.78       | %    |
| Gain Imbalance          | 0.12   | 0.12   |             | 0.12   |             | %    |
| Quadrature Error        | 0.013  | 0.013  |             | 0.013  |             | °    |
| Center Frequency Error  | 149.15 | 149.15 | $\pm$ 39200 | 149.15 | $\pm$ 39200 | Hz   |
| Clock Error             | 0.03   | 0.03   | $\pm$ 8     | 0.03   | $\pm$ 8     | ppm  |
| Burst Power             | 33.37  | 33.40  |             | 33.43  |             | dBm  |
| Crest Factor            | 9.15   | 9.18   |             | 9.21   |             | dB   |
| RSSI                    | 36.31  | 36.31  |             | 36.31  |             | dBm  |
| RSSI Standard Deviation |        | - 3.06 |             |        |             | dB   |
| CINR                    | 15.98  | 15.98  |             | 15.98  |             | dB   |
| CINR Standard Deviation |        | 2.75   |             |        |             | dB   |

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## Application Notes(Con't):

**802.16 256 carriers, 64 QAM @ 5.5GHz, Pavg=33.54dBm @ EVM=2.5%**

| IEEE 802.16-2004 OFDM            |                                |   |
|----------------------------------|--------------------------------|---|
| Frequency: 5.5 GHz               | Signal Level Setting: 16.7 dBm | Ref. Level / Ext. Att: 26.7 dBm / 17.9 dB |
| Sweep Mode: Continuous           | Trigger Mode: External         | Trigger Offset: -10 $\mu$ s               |
| Burst Type: <b>OFDM DL Burst</b> | Modulation: <b>ALL</b>         | No Of Data Symbols: 1/2425                |

| Result Summary          |         |               |             |               |             |      |
|-------------------------|---------|---------------|-------------|---------------|-------------|------|
| No. of Bursts           | 4       |               |             |               |             |      |
|                         | Min     | Mean          | Limit       | Max           | Limit       | Unit |
| EVM All Carriers        | 2.47    | <b>2.50</b>   | 2.82        | <b>2.54</b>   | 2.82        | %    |
| EVM Data Carriers       | 2.48    | 2.50          |             | 2.54          |             | %    |
| EVM Pilot Carriers      | 2.38    | 2.45          |             | 2.56          |             | %    |
| IQ Offset               | 0.21    | <b>0.21</b>   | 17.78       | <b>0.21</b>   | 17.78       | %    |
| Gain Imbalance          | 0.14    | 0.14          |             | 0.14          |             | %    |
| Quadrature Error        | - 0.017 | - 0.017       |             | - 0.017       |             | °    |
| Center Frequency Error  | 166.88  | <b>166.88</b> | $\pm$ 44000 | <b>166.88</b> | $\pm$ 44000 | Hz   |
| Clock Error             | 0.02    | <b>0.02</b>   | $\pm$ 8     | <b>0.02</b>   | $\pm$ 8     | ppm  |
| Burst Power             | 33.50   | 33.54         |             | 33.57         |             | dBm  |
| Crest Factor            | 9.12    | 9.25          |             | 9.30          |             | dB   |
| RSSI                    | 36.45   | 36.45         |             | 36.45         |             | dBm  |
| RSSI Standard Deviation |         | - 5.47        |             |               |             | dB   |
| CINR                    | 15.94   | 15.94         |             | 15.94         |             | dB   |
| CINR Standard Deviation |         | 2.20          |             |               |             | dB   |

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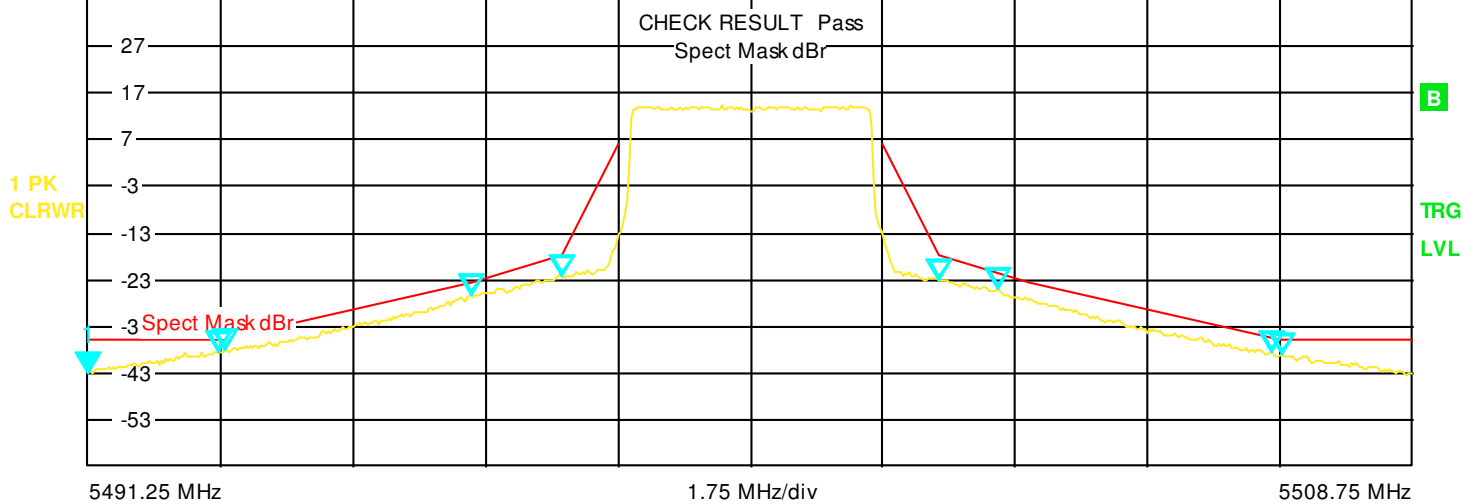
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| IEEE 802.16-2004 OFDM     |                 |                              |                     |   |           |            |  |
|---------------------------|-----------------|------------------------------|---------------------|---|-----------|------------|--|
| Frequency: 5.5 GHz        |                 | Signal Level Setting: 18 dBm |                     | Ref. Level / Ext. Att: 19.5 dBm / 17.9 dB |           |            |  |
| Sweep Mode: Continuous    |                 | Trigger Mode: External       |                     | Trigger Offset: -10 µs                    |           |            |  |
| Burst Type: OFDM DL Burst |                 | Modulation: ALL              |                     | No Of Data Symbols: 1/2425                |           |            |  |
| Spectrum Emission Mask    |                 |                              |                     |   |           |            |  |
| Tx Channel:               |                 | Bandwidth                    | 3.5 MHz             | Power                                     | 14.26 dBm |            |  |
| Start Freq. Rel.          | Stop Freq. Rel. | RBW                          | Freq. at Δ to Limit | Pwr Abs                                   | Pwr Rel   | Δ to Limit |  |
| -8.750 MHz                | -7.000 MHz      | 30 kHz                       | 5.492988782 GHz     | -38.54 dBm                                | -52.79 dB | -2.79 dB   |  |
| -7.000 MHz                | -3.700 MHz      | 30 kHz                       | 5.493044872 GHz     | -38.05 dBm                                | -52.30 dB | -2.46 dB   |  |
| -3.700 MHz                | -2.500 MHz      | 30 kHz                       | 5.496326122 GHz     | -26.39 dBm                                | -40.65 dB | -2.78 dB   |  |
| -2.500 MHz                | -1.750 MHz      | 30 kHz                       | 5.497504007 GHz     | -22.05 dBm                                | -36.31 dB | -4.44 dB   |  |
| 1.750 MHz                 | 2.500 MHz       | 30 kHz                       | 5.502495994 GHz     | -23.01 dBm                                | -37.27 dB | -5.39 dB   |  |
| 2.500 MHz                 | 3.700 MHz       | 30 kHz                       | 5.503281250 GHz     | -25.19 dBm                                | -39.44 dB | -3.53 dB   |  |
| 3.700 MHz                 | 7.000 MHz       | 30 kHz                       | 5.506899039 GHz     | -38.57 dBm                                | -52.83 dB | -3.20 dB   |  |
| 7.000 MHz                 | 8.750 MHz       | 30 kHz                       | 5.507011218 GHz     | -38.94 dBm                                | -53.20 dB | -3.20 dB   |  |

Spectrum MASK ETSI RBW 30 kHz Marker 1 -42.87 dBm

VBW 100 Hz 5.49125 GHz

Ref 19.5 dBm Att/EL 30.00 / 0.00 dB SWT 5.7 s Sweep 1 of 1



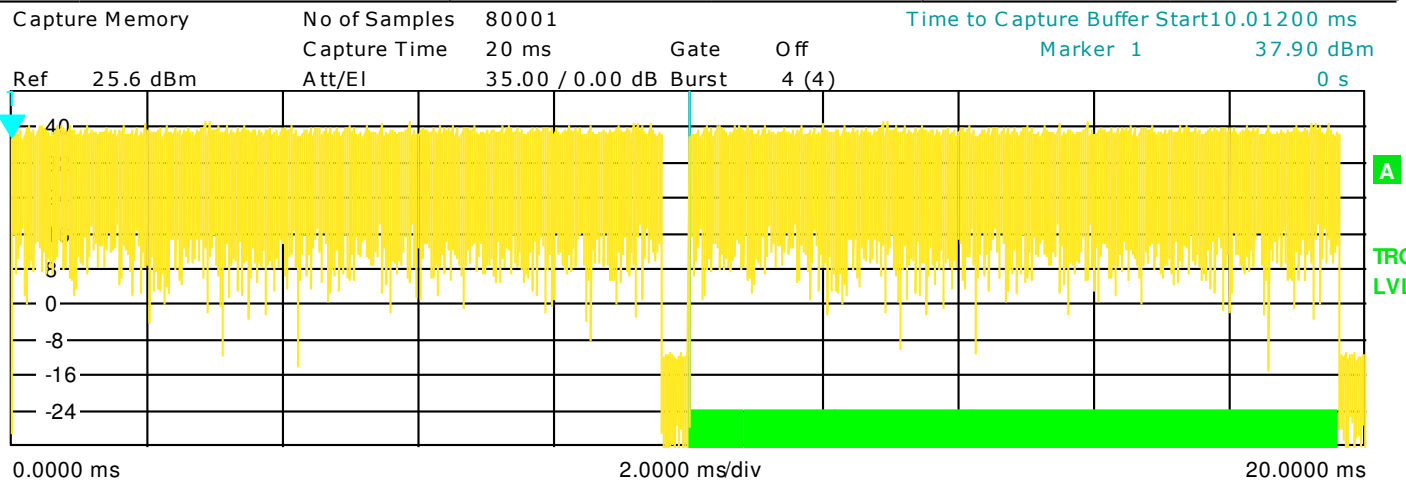
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**Application Notes(Con't):**

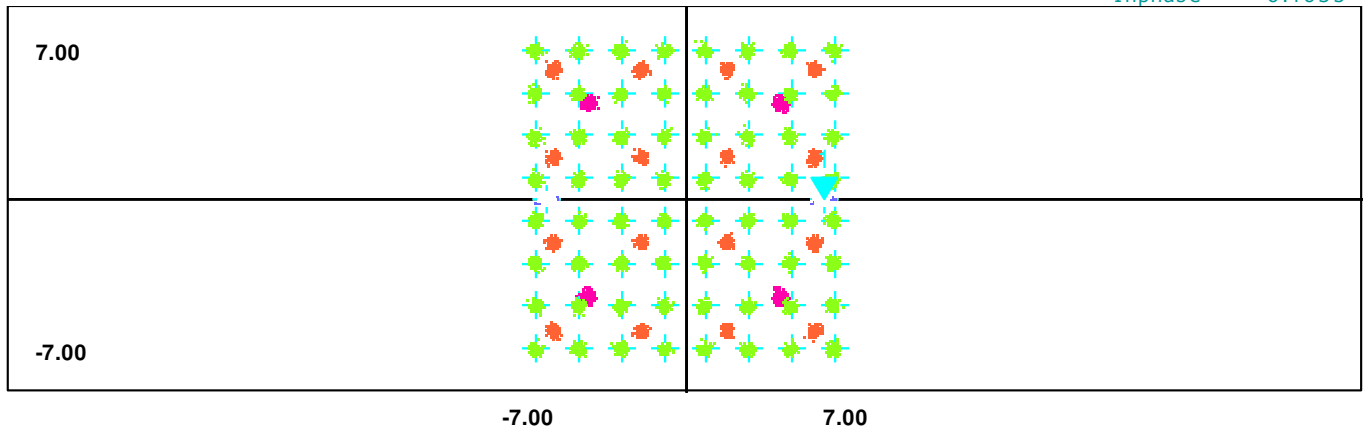
**Typical constellation response for 802.16 Pavg=32.5dBm @ 2.5% EVM, 5.9GHz**

| IEEE 802.16-2004 OFDM     |                                |   |  |
|---------------------------|--------------------------------|---|--|
| Frequency: 5.9 GHz        | Signal Level Setting: 15.6 dBm | Ref. Level / Ext. Att: 25.6 dBm / 17.9 dB |  |
| Sweep Mode: Continuous    | Trigger Mode: External         | Trigger Offset: -10 μs                    |  |
| Burst Type: OFDM DL Burst | Modulation: ALL                | No Of Data Symbols: 1/2425                |  |



Constellation vs Symbol

Marker 1    Quadrature    0.0185  
 Inphase      6.4635



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