



# Intel® XMM™ 6255 with SMARTi™ UE2p

Connecting *your* breakthrough device effortlessly to the Internet of Things

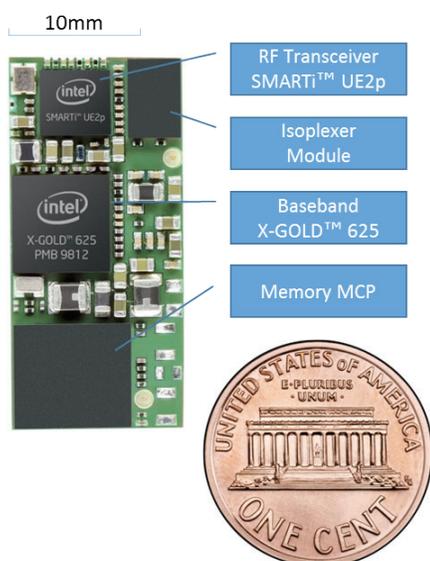


Figure 1: XMM™6255 size study

“We have made significant  
advancements in our mobile  
computing.”

~ Renee James,  
President of Intel Corporation  
MWC 2014

## Introduction

Smart devices and wearable devices connected to the Internet of Things (IoT) are one of the technology industry's next big trends, following in the footsteps of the smartphone revolution. At the forefront of this movement, Intel technology is enabling smaller and more affordable devices that both compute and connect. These capabilities are critical to increasing the adoption of connected devices that simplify and safeguard every aspect of our daily lives. Smartphones, connected cars, active road signs, self-monitoring power networks, smart watches, wearables, and the connected home are just a few examples. Thanks to tiny 3G modems like the XMM™6255 with SMARTi™ UE2p, any device imaginable can benefit from Internet connection.

Conventional products need to make trade-offs between size and robustness, resulting in compromises in the end product design. To solve this problem, Intel has introduced the SMARTi™ UE2p: the world's first RF transceiver with an integrated 3G power amplifier. This revolutionary incorporation of the power amplifier into the transceiver enables a tiny modem size for the XMM™6255 chipset. The high degree of integration also allows built-in protection circuits for the transceiver, making it robust in tough operating conditions while simultaneously reducing BOM cost. The antenna isolator provides excellent real-world performance: SMARTi™ UE2p stays connected in challenging network conditions and provides manufacturers the flexibility to design unconventional form factors.

When smart devices are paired with Big Data analysis, the user experience can be improved to provide a seamless and immersive environment while extracting greater value from the data generated. The XMM™6255 chipset with SMARTi™ UE2p provides the connected foundation to unlock the value of the Internet of Things in a small, robust package that is easy to apply to your breakthrough device.

## Sensation - What is SMARTi™ UE2p?

SMARTi™ UE2p is based on the unique Intel® Power Transceiver technology, the industry's first transceiver design with a built-in 3G amplifier. This unique technology provides many advantages over traditional 3G radios. SMARTi™ UE2p is an integrated part of the XMM™6255 chipset solution, shown in *Figure 1*: the world's smallest standalone 3G modem. The entire modem is barely larger than a U.S. penny!

Many IoT devices only transfer low volumes of data, so the ideal solution is a very small 3G-optimized modem embodied in the XMM™6255 chipset. A 2G/3G version is also available.

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**Technical Details**

The Intel® XMM™6255 solution is shown in [Figure 2](#).

By combining the transceiver with a co-designed Isoplexer module, the RF performance of the SMARTi™ UE2p's built-in CMOS power amplifier even surpasses that of leading GaAs solutions. This allows the XMM™6255 to deliver very robust RF results even under extreme antenna conditions, matching perfectly to challenging IoT devices and modules. The Isoplexer module itself features integrated RX and TX matching networks, duplexers, and TX isolators. Two Isoplexer variants are available:

- **3G configuration with integrated diplexer in bands 1/8, 2/5, or 1/5**
- **2G/3G configuration supporting bands 1/8 or 2/5**

**XMM™6255 with SMARTi™ UE2p is the world's smallest standalone 3G modem**

By integrating more parts together, Intel created a cellular modem with a tiny footprint—smaller than a mini-SIM card—enabling 3G data connectivity in places never previously imaginable:

- Connected smoke detectors
- Smart metering and energy management
- Smart lighting control
- Security devices

XMM™ 6255 enables all sorts of new cellular connectivity use cases, such as freezers or air conditioners that pre-cool at night to take advantage of lower electricity costs, linked to a smart power meter, or automated smart lighting for the home or office that can be remotely controlled to reduce energy usage.

What about a hidden security camera in your house door? This tiny module could stealthily call the police and send a photo if someone enters your home without an authorized electronic key.

**Technical Details**

The entire 3G modem:

- Fits into 300 mm<sup>2</sup> effective PCB area
- Has less than 99 components
- Requires only one shielding chamber

XMM™6255 is designed to optimize area and BOM cost for 3G solutions. However, adding 2G is as simple as including a 2G PA and front end switch module in the design, enabling even wider network coverage if desired.

This is the RF lineup for the Intel® XMM™6255 with SMARTi™ UE2p and it is available for customer shipments today.

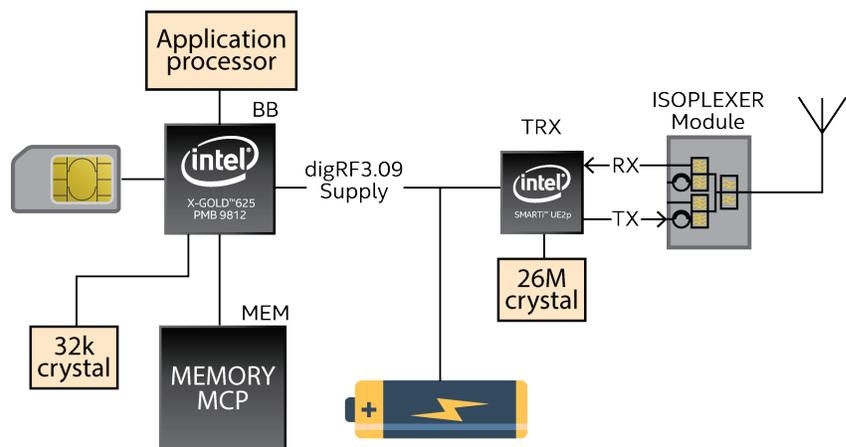


Figure 2: XMM™6255 diagram

## XMM™6255 with SMARTi™ UE2p is robust and highly integrated

IoT devices and modules subject RF modems like the XMM™6255 to severe stresses, such as heat, antenna mismatch, and rough environmental conditions.

SMARTi™ UE2p's innovative integration concept, isolator use, and built-in controls protect the transceiver and PA from overheating, voltage peaks, overcurrent and damage under tough usage conditions.

This means the transceiver is extremely robust, while requiring fewer external components to monitor its performance, which lowers XMM™6255's BOM cost compared to previous generations.

*Isolators are two-port microwave devices that pass radio frequency power one way. The transfer in reverse direction is strongly attenuated. Therefore, isolators are used to shield RF devices at one port of the isolator from influence on the second port of the isolator.*

### Technical Details

**Integrated DCDC converter** – besides its namesake power amplifier, the SMARTi™ UE2p also has an energy-saving integrated buck/boost DCDC converter. This reduces current consumption compared to existing low-cost solutions in which the power supply directly powers the PA.

**Using an isolator for the TX3G ports provides numerous advantages due to the very well controlled PA load impedance.**

- **No external coupler needed for power control loop** – the coupling from PA output to integrated feedback receiver is done on chip.

## Does your device have enough space for an ideal antenna?



vs.



Figure 3: Ideal vs. real world antenna

Figure 3 shows a comparison between an ideal, optimal size antenna and a much smaller, less effective antenna such as one commonly found in a mobile device.

Soon, antenna designs will become even smaller and more challenging as manufacturers begin to produce antennas using 3D printers.

- **Improved device reliability for odd antenna load conditions** – voltage peaks occurring at the power amplifier output are predictable. Therefore, they can be compensated by internal controls, and device reliability is ensured even for drastic antenna impedance changes.

**Integration enables features that provide unprecedented performance and robustness from a CMOS PA.**

**Digital pre-distortion** – ensures outstanding ACLR across the entire power range with virtually no calibration time penalty.

**Autonomous PA protection on-chip** Temperature, peak voltages, and current consumption are constantly monitored. As soon as one parameter trends to critical values, the output power is reduced. No need to design in any additional sensors or protection control logic.

## XMM™6255 with SMARTi™ UE2p provides outstanding real-world performance

The SMARTi™ UE2p transceiver, with its monolithically integrated 3G power amplifier and unique RF front end, performs exceptionally well in challenging real-world situations, such as:

- Bad network coverage zones – e.g. in a home's basement, or far from a cellular tower
- Small-sized devices with little space for a well-designed antenna – connected health monitor, smoke detector, and many more
- Poor antenna conditions – spotlight attached to a metal pole, a device laying on a desk or in the trunk of a car

This exceptional antenna performance means the device can stay connected even when network reception is poor, expanding its installation range. It also enables small-sized or unconventional devices, which might not have the space or shape for a conventional modem antenna.

**Technical Details**

SMARTi™ UE2p keeps performing in real-world conditions where conventional radios would lose connection.

Benchmark tests performed by Intel comparing XMM™6255 with two common phones on the market that use standard non-integrated PAs are illustrated in this section.

- XMM™6255 with SMARTi™ UE2p
- Solution with GaAs PA
- Solution with external CMOS PA

The benchmark was conducted on key TX3G parameters over varying antenna impedance. Benchmark results for band 1 are shown.

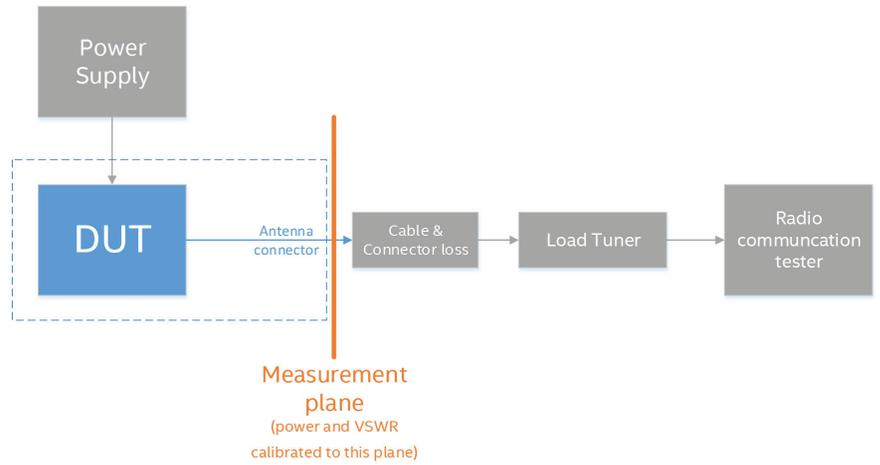


Figure 4: Measurement setup used for benchmarking

Figure 4 depicts the measurement setup. The device under test (DUT) was supplied by an external power supply. The measurement was conducted using a radio communication tester. The conducted measurement was chosen in order to characterize the DUT and to rule out masking of the results by different antenna performances. In order to investigate the impact of the antenna impedance conditions, an adjustable load tuner was applied. The measurement plane was defined to be the antenna connector of the DUT. Output power values, as well as VSWR values shown in the plots, are valid at the measurement plane.

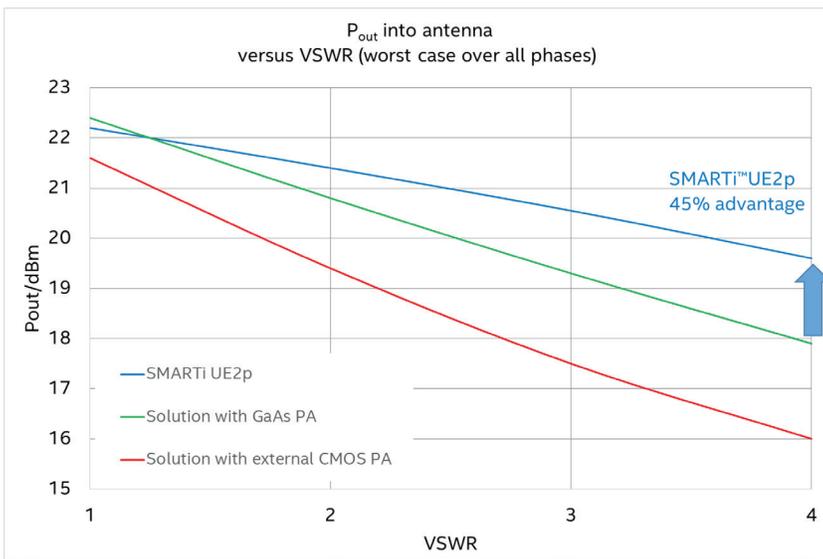


Figure 5 shows output power versus antenna mismatch. Output power was similar for all PA types at 50Ω “perfect” antenna load (VSWR=1), but XMM™6255 delivered much more output power when real-world antenna mismatch was introduced. This highly improved Total Radiated Power (TRP) performance, eliminating the need to compensate poor TRP by cranking up power at 50Ω (at the cost of current consumption).

Figure 5: Achieved output power under antenna mismatch conditions

XMM™6255 increases network capacity by reducing unwanted (adjacent channel) emissions – even when presented with bad antenna conditions.

Figure 6 demonstrates this outstanding performance: ACLR is < 36dBc for an antenna mismatch up to VSWR 4:1. Adjacent Channel Leakage Ratio (ACLR) is the ratio of wanted in-band power relative to unwanted emissions in the neighbor channel.

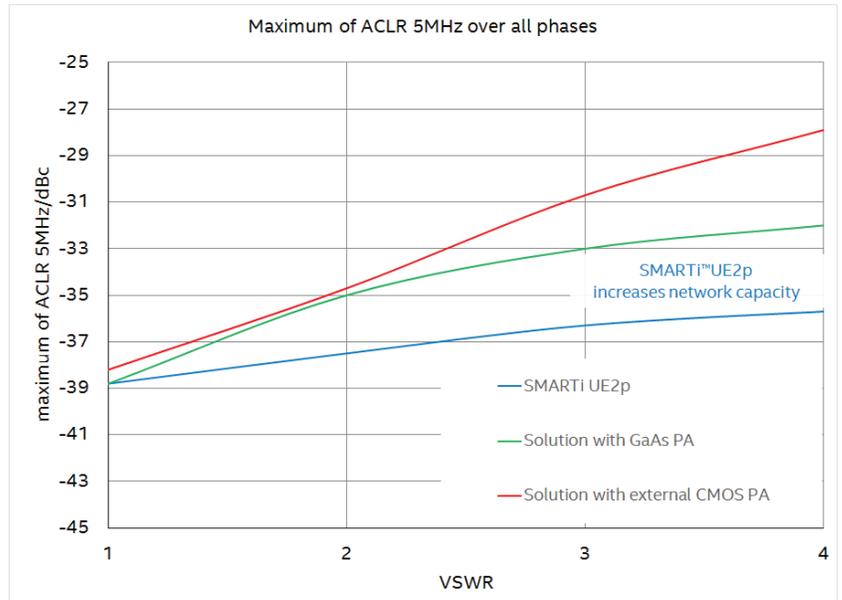


Figure 6: ACLR±5MHz under antenna mismatch conditions up to VSWR 4:1.

EVM AT 22.5 DBM OUTPUT POWER REQUESTED	BAND 1
XMM™6255 with SMARTi™ UE2p	3.9%
Solution with GaAs PA	5.1%
Solution with external CMOS PA	8.6%

Table 1

In benchmark testing, reflected in Table 1, XMM™6255 achieved outstanding EVM values below 4% in band 1 under VSWR 4:1 and all phases. This results in less data transmission errors, translating to reduced re-transmission of data and improved operator bandwidth.

Figure 7 shows the XMM™6255’s outstanding performance against three significant RF parameters: achievable output power, ACLR, and EVM. The measurement shows performance under mismatch conditions of VSWR 4:1, worst case over all phases.

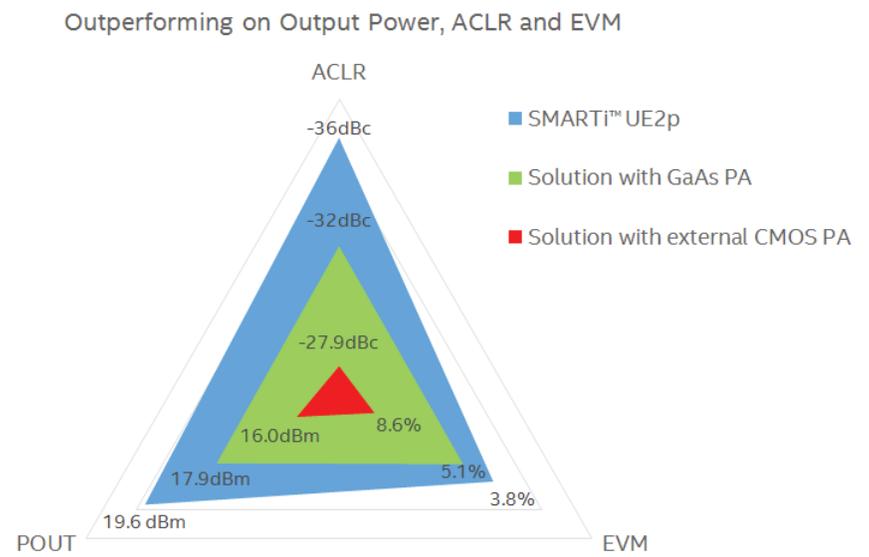


Figure 7: Pout, ACLR and EVMrms at VSWR 4:1 while requesting 20 dBm power

MODEM CURRENT AT 3.8V VBAT	BAND 1	BAND 8
Idle Current	1.1mA	1.1mA
0dBm	127mA	124mA
22.5dBm	530mA	473mA

Table 2

Power consumption is industry standard, see Table 2. The exceptional performance improvements of XMM™6255 come without any power penalty.

**XMM™6255 with SMARTi™ UE2p is simple to apply**

With the XMM™6255 modem chipset, you can move quickly from game-changing idea to product launch.

Based on the popular XMM™6260 platform (>180 million sold), certification approval is straightforward and uncomplicated. Carrier-certified modules are also available in the market for manufacturers that prefer a turnkey solution.

There are many advantages to a solution this easy to apply, including accelerating the transition from breakthrough idea to product in market.

**Technical Details**

Thanks to the small size and high level of integration, customers can use XMM™ 6255 to replace existing 2G models with 3G-only models in the same form factor.

Supply Chain benefits: CMOS foundry silicon and industry-standard Flip chip packaging ensure low cost of ownership and a secure supply, especially considering the predicted steep growth rates for IoT devices.

“[We needed] one fourth the time in network certification, with approval in less than one week.”

~ Customer quote after successful carrier certification

**Conclusion**

Years ago, the car phone was a small piece of luggage and the smart watch existed only in comic books. Today, smartphones, fitness bands, smart traffic monitors, and a myriad of other connected devices are becoming an integral and indispensable part of our daily lives. Those who are first into the market with game-changing devices may have a distinct advantage over the competition.

Where are you able to position the antenna in a wearable? The excellent antenna performance of XMM™6255 across impedance mismatch improves output power and increases network capacity: an especially valuable feature for challenging form factors with limited options for antenna placement.

To empower breakthrough connected devices for the Internet of Things, inventors rely on the tiny, effective cellular modem. With its first-of-a-kind integrated CMOS power amplifier and outstanding antenna performance, the XMM™6255 modem chipset with SMARTi™ UE2p is at the forefront to enable new devices that were previously just science fiction! Intel is shipping XMM™6255 to customers today.

For more information on **XMM™ 6255 with Intel® SMARTi™ UE2p** visit [www.intel.com/mobilecommunications](http://www.intel.com/mobilecommunications)

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