Emerging Switch Developments for Embedded WLAN Solutions in Smart Phones

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This article will elaborate on two key trends that are facilitating the growth of embedded WLAN communications in smart phones and other mobile connected devices:

1. ***The development of pHEMT wafer level chip scale packaging (wlCSP), alternatively known as flip chip or bumped die.*** These devices are typically encountered in integrated modules that incorporate WLAN and BT BB/RF chips along with front-end switching. The smaller size wlCSP die allow for small footprint designs.

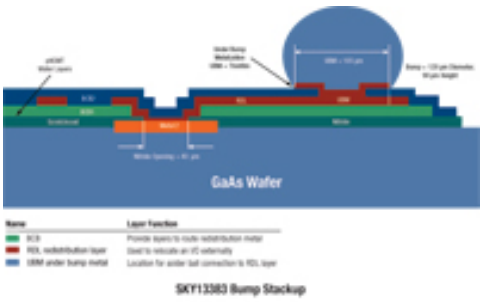
2. ***The use of low level logic (1.8 V) for WLAN chipsets being designed and optimized for battery powered mobile devices.*** Skyworks and other companies are employing silicon on insulator (SOI) technology to maintain good RF performance at low voltage bias level conditions. We will brief the reader on some of the unique features of SOI designs used in embedded WLAN applications.

The rapid proliferation of smart phones and mobile Internet connected devices (tablets) is creating and driving the need for 3G and Wi-Fi broadband data connections, as consumers increasingly vote to have always on mobile connections for work and lifestyle enhancements. Cisco recently published their Visual Networking Index Global Mobile Data Forecast for the years 2010 to 2015. Their research predicts mobile data traffic passed thru smart phones and mobile data devices (tablets and laptops) to grow at a compounded annual rate of 92 percent, aided in part by data and mobile video content.

This discussion will focus on two aspects of the mobile data phenomenon that are impacting technology choices for embedded WiFi/WLAN.

(Note: WiFi /WLAN used interchangeably are intended to mean IEEE 802.11 a/b/g/n compliant wireless connection to the Internet).

Wafer Level Chip Scale Packaging (wlCSP)



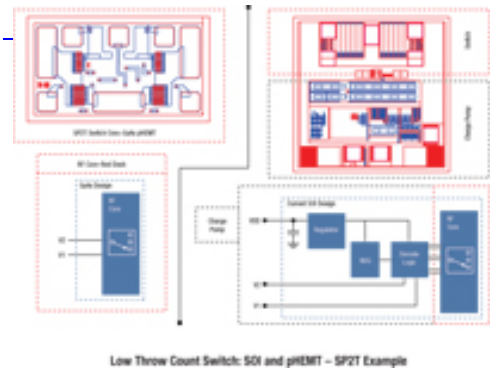
[1]

Wafer level chip scale packaging means that no external packaging is added to the integrated circuit (IC) device. For our purposes, wlCSP will connote a single die with solder bump interconnects, that may or may not have a redistribution layer. The redistribution layer can be used to move device input/output (I/O) pads from where they currently are in wafer form to another location. This additional level of interconnection redistributes the peripheral bonding pads of each chip to an area array of under bump metal (UBM) pads that are evenly deployed over the chip's surface. The solder balls or bumps used in connecting the device to the application circuit board are subsequently placed over these UBM pads.

Figure 1 represents a cross section picture of a typical wlCSP device.

In this instance, the device is a single pole three throw (SP3T) gallium arsenide (GaAs pHEMT) RF switch suitable for low band 2.4 GHz WiFi applications. While the wlCSP concept can be used in many different applications, this device specifically is intended to enable ultra thin and small modules that include Wi-Fi 802.11 baseband and transceivers along with the RF front end components such as switches and filters in a single placement module. As expected, these new full featured phones and tablets are full of many new components and features (gyroscopes, large displays, gaming and audio blocks) such that interior volume is at a premium. WlCSP is an enabling technology that can be used to reduce the overall size of these modules, thereby helping to make the overall package more attractive to the consumer.

Changing CMOS Processes are Impacting RF Switch Technology Choices



[2]

While the march towards smaller modules is taking place, there is another trend that component manufactures are adapting to. We noted previously that mobile data in handsets and tablets is a large and fast growing trend. These devices have low power consumption requirements due to the fact that they typically operate wirelessly on battery power. Over the last several years, the Wi-Fi chipset manufactures have adopted low power, low voltage CMOS technology that uses advanced and small geometry processing nodes. One offshoot of the new CMOS technology is that the logic voltage levels used to drive the switch are becoming lower in voltage. If the control voltages become too low (below 1.4 V) then the current generation of RF switches may fail to operate in a consistent manner.

This has lead to the introduction of silicon on insulator (SOI) switch technology to be commercialized. While this causes designers to make a more complicated device, some chipset providers prefer the ability to maintain RF switch performance even at low voltage levels, often encountered in battery operated handhelds. The reason that the SOI devices can maintain performance at low logic levels is that there is an integrated charge pump in the IC that is used to maintain a stable positive and negative voltage in order to bias the switch transistors, somewhat immune to the applied battery voltage. While this makes the SOI device more complicated to design and manufacture, the benefits for some of the new low power optimized, small geometry Wi-Fi chipsets is an appealing feature.

Figure 2 shows the differences between an SOI and GaAs single pole two throw (SP2T switch). While not drawn to full scale, it is important to note that the RF switch portion (switch field effect transistor) is approximately the same for GaAs or SOI, but with SOI the added charge pump circuitry is a large proportion of the die size and hence makes SOI low throw count switches incrementally larger die size than their GaAs-only counterparts.

There are other design considerations that can come into play when deciding which technology is the right choice for embedded WiFi RF switch designs. If there is a requirement for reduced control pins or possibly a programmable interface, then the ability to incorporate logic functions and charge pump functionality in a single die could be an important factor weighing in to the benefit of SOI.

Conclusion

The importance of mobile data in our everyday lives is growing at a seemingly unending rate. The ability for mobile data appliances, whether it is cell phones or tablets, to connect wirelessly to the Internet thru IEEE 802.11 protocols is nearly universal in current and next-generation products. Both wafer level chip scale packaging (wlCSP) and silicon on insulator (SOI) technology are some of the important RF switch developments to ensure an always on connection.

For more information, please visit www.skyworksinc.com.

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