SKYWORKS®

Mobile Antenna Solutions

Billions of Connections, One Solution

Skyworks has been enabling wireless connectivity for over a decade. However, given rising consumer demand for wireless ubiquity and the desire for anytime, anywhere access, there are billions of connections yet to be made. We are at the forefront of developing revolutionary solutions as global demand for emerging 5G applications is set to explode.

We innovate and create highly configurable and customizable architectures that reduce complexity, deliver unparalleled levels of integration and superior analog performance.

Skyworks is a global company with engineering, marketing, operations, sales and support facilities located throughout Asia, Europe and North America.

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Connecting Everyone and Everything, All the Time

Understanding Antenna Management

Intelligent antenna management plays a critical role in today's high performance smartphones, particularly with the onset of 5G and the addition of new functionality. In fact, the number of embedded antennas in mobile devices is increasing, while board space is being reduced to accommodate the adoption of full screen infinity displays and other features.

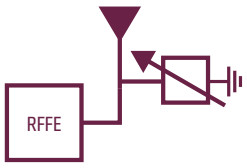
Skyworks' portfolio addresses this need to integrate more RF functionality into smaller and smaller form factors by offering innovative tuners, swaps and couplers that enable system engineers to optimize antenna power and efficiency.

Antenna Management Functions

Intelligent antenna management supports three main functions: tuning, swapping, and RF coupling.

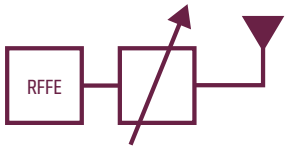
Tuning includes both aperture and impedance options, which have been shown to improve antenna gain by 1.5 to 3 dB and enhance battery life since less current is required to deliver the same output power.

Aperture tuning changes the electrical length of an antenna to shift its resonance to the desired frequency band of operation. This is achieved by locating the tuner on the antenna and using it to switch various passive components to attain the desired resonant frequency. Antenna aperture tuners improve the total radiated power (TRP) and total isotropic sensitivity (TIS) by increasing the effective size of an antenna or by altering its radiation pattern.



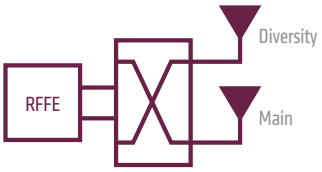
Aperture Tuning

Impedance tuning aims to match the impedance of the antenna with the impedance of the RF front-end, thus, optimizing the power transfer to the antenna. This is accomplished by locating the tuner along the RF line feeding the antenna and switching various passive components to match the RF feed and antenna impedances. Successful matching improves TRP and TIS.



Impedance Tuning

Swapping is utilized by system designers to steer the RF signals to the antenna that will provide the best performance. Selecting the antenna that delivers the best transmit power and receive sensitivity will greatly reduce the occurrence of dropped calls.



Antenna Swap

RF Coupling is applied to sense the output power of the front-end and manage transmit power appropriately. RF couplers may also be used to measure reflected power in a closed loop system, thereby facilitating the impedance match between the front-end and the antenna to optimize power delivery to the antenna and improve battery life.

RF Coupler

Antenna Tuners

Key Attributes

R_{ON} The resistance presented by the antenna tuner while the switch is enabled. Lower R_{ON} typically results in higher antenna efficiency, and improved TRP and TIS. R_{ON} is measured in Ohms (Ω).

C_{OFF} The capacitance presented by the antenna tuner while the switches are in the off state. Lower C_{OFF} increases the Q of the antenna tuner which affects antenna efficiency and effective tuning range. C_{OFF} is measured in femto farads (fF).

Insertion Loss A measure of loss introduced by an RF component such as a tuning switch.

Isolation A measure of the magnitude of a signal on one switch node that leaks to another switch node. Poor isolation in antenna tuners can result in unwanted resonance shifts in the tuned frequency. Shunt tuners usually have higher isolation than Series tuners.

Multi-On Capability Multi-on means that more than one switch arm may be activated at one time. This feature may be used to create more tuning options, e.g. up to 16 state in multi-on four throw tuner, and can be used in parallel tuning arms, thereby reducing R_{ON}.

Tuner Interface How the state of a tuner is controlled, with either a GPIO or MIPI® digital interface.

Tuning Switch Topology Series topology tuning switches are similar to traditional RF switches containing a single-pole and one or more throws (e.g. SPST, SP2T, SP4T), and may be used for either impedance or aperture tuning. Utilized as aperture tuners, Series switches may have their RF common (RFc) port connected to either the antenna or ground.

Shunt topology tuning switches are composed of N-number of SPST switches (e.g. 2xSPST, 3xSPST, 4xSPST), with one end of the SPST switch connected to ground and may only be used for aperture tuning.

V_{PEAK} The maximum voltage the antenna tuner can support while still delivering acceptable harmonic performance. Skyworks is unique in that we guarantee harmonics (2fo and 3fo) will be less than -36 dBm at the specified V_{PEAK} value of the antenna tuner. V_{PEAK} is measured in volts.

Antenna Tuners

Product Number	Topology	V_{PEAK} (v)	R_{ON} (Ohm)	C_{OFF} (fF)	Interface	Package (mm)
SKY19237-001	3xSPST	83	2.1	190	MIPI®	WLCSP 11-bump 1.685 × 1.775 × 0.5
SKY19243-686LF	SP2T	42	0.8	195	GPIO	QFN 10-pin 1.5 x 1.1 x 0.5
SKY19245-686LF	SP4T	39	0.8	150	GPIO	QFN 10-pin 1.5 x 1.1 x 0.5
SKY19249-686LF	SP4T	40	0.9	150	MIPI®	QFN 10-pin 1.5 x 1.1 x 0.45
SKY19250-001	SPST	70	1.8	139	GPIO	WLCSP 6-bump 1.175 x 0.775 x 0.395
SKY19256-701LF	4xSPST	48	1.1	150	MIPI®	QFN 10-pin 1.5 x 1.1 x 0.45
SKY5™-9269-702LF	SP4T	82	1.4	105	MIPI®	QFN 12-pin 1.6 x 1.6 x 0.45

Sky5™ Sky5™ is Skyworks' unifying platform powering revolutionary 5G applications.

Antenna Swaps

Key Attributes

Insertion Loss — A measure of loss introduced by an RF component such as an antenna swap switch.

Isolation — A measure of the magnitude of a signal on one switch node that leaks to another switch node. Poor isolation in antenna swap switch can result in unwanted signal mixing and degraded receiver sensitivity.

Linearity — Linearity parameters that describe RF switch behavior include 2nd (2fo) and 3rd (3fo) harmonic generation, input third order intermodulation point (IIP3), or intermodulation distortion (IMD2 & and IMD3). These parameters indicate whether the switch will meet system linearity and spurious emission requirements at the actual input signal levels, which will be incident upon the switch in a system. Insufficient switch linearity may result in receiver desense or spurious emissions which may corrupt the transmit signal and lead to certification failures.

$P_{1\,dB}$ — The 1 dB compression point defined as either the input power ($IP_{1\,dB}$) or output power ($OP_{1\,dB}$) at which the insertion loss increases by 1 dB from its small signal value. The performance of the switch will become non-linear at input power levels several dB below the $IP_{1\,dB}$ point. As antenna swap devices must be able to handle the highest power transmit signals in the system, it is standard to require $P_{1\,dB}$ values on the order of 39 dBm for these applications.

Antenna Swaps

Product Number	Description	Insertion Loss @ 2.7 GHz (dB)	Isolation @ 2.7 GHz (dB)	$P_{0.1\,dB}$ (dBm)	Interface	Package (mm)
SKY13596-397LF	DPDT	0.5	35	39	GPIO	QFN 12L 2 x 2 x 0.55
SKY13598-683LF	DPDT	0.7	39	39	GPIO	QFN 12L 1.8 x 1.8 x 0.5
SKY13630-11	Dual DPDT + Dual Diplexer	0.95	27	39	MIPI®	MCM 28L 2.4 x 4 x 0.9
SKY13698-694LF	DPDT	0.27	38	39	GPIO	QFN 12L 1.8 x 1.8 x 0.5
SKY13699-21	DPDT	0.3	38	39	GPIO	QFN 10L 1.1 x 1.5 x 0.59

RF Couplers

Key Attributes

Insertion Loss — The loss the RF coupler is adding to the system. The through path of the RF coupler is essentially an RF line that has energy coupled off of the device. By itself, it has extremely low loss. The insertion loss increases as the coupling factor decreases. This can be viewed as energy siphoned to the coupled port that gives the impression that the insertion loss has increased.

Isolation — Signal loss between the RF in / RF out pins and any other pins is critical to maintaining the accuracy of the coupler. In the case of dual couplers, the isolation between one coupler and the other is critical to ensure the power measured is not corrupted by signal leakage between pins.

Linearity — Linearity of an RF coupler is generally very high as the RF path is usually an RF through path with no active components in series. This is important since the RF coupler is best placed close to the antenna and there are no other opportunities to filter out non-linearities.

Directivity — The delta between the measured forward coupling factor and reverse coupling factor. With high directivity, the system can determine if the power is being delivered or being reflected.

Coupling Factor — Identifies the amount of RF energy that is siphoned from the RF through line. Coupling factor is the ratio of power between the coupled port and the output port of the through line, measured in dB.

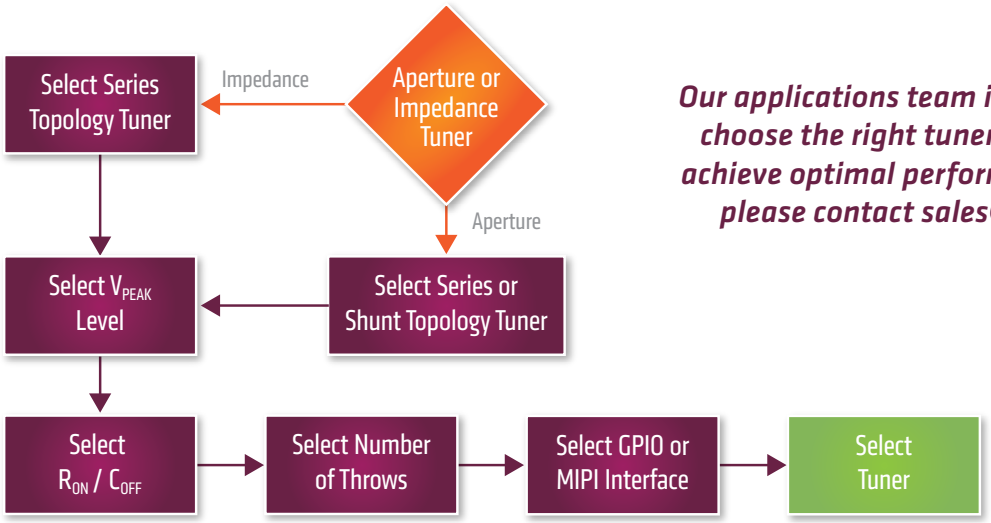
Wi-Fi Filtering — The removal of power at 2.4 and/or 5 GHz from the coupled port.

RF Coupler

Product Number	Description	Insertion Loss @ 2.7 GHz (dB)	Directivity @ 2.7 GHz (dB)	Coupling Factor @ 2.7 GHz (dB)	Interface	Package (mm)
SKY16706-11	Dual Bi-Directional Smart Coupler	0.2	27	25	MIPI®	SMT 16L 1.6 × 1.6 × 0.54

Tuner Selection Process

Many factors go into selecting the correct antenna tuner for an application. These include the type of tuning being performed as well as system attributes such as the style of antenna being tuned, the location of the tuner on the antenna, and the number of bands being tuned. The flow chart below provides a step-by-step process for selecting the appropriate antenna tuner.



Our applications team is available to help you choose the right tuner for your system and achieve optimal performance. For assistance, please contact sales@skyworksinc.com.

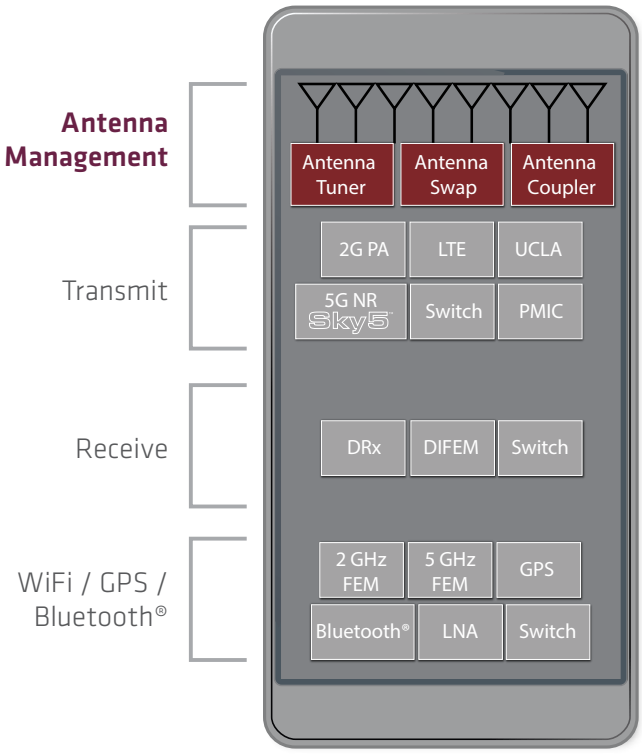
Additional Mobile Solutions

In addition to our antenna portfolio for cellular applications, Skyworks offers a suite of transmit, receive and Wi-Fi, Bluetooth® and GPS connectivity solutions that are addressing the increasing complexity of mobile devices.

Our high-performance analog semiconductors are linking people, places, and things across a growing number of markets and applications – bringing everyone closer to vital information wherever it is needed and transforming the way the world communicates.

For more information, please visit Skyworks' website at www.skyworksinc.com.

Sky5™



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