MPD MICROWAVE PRODUCT DIGEST

Skyworks' Broadband Isolator For Interstage Applications

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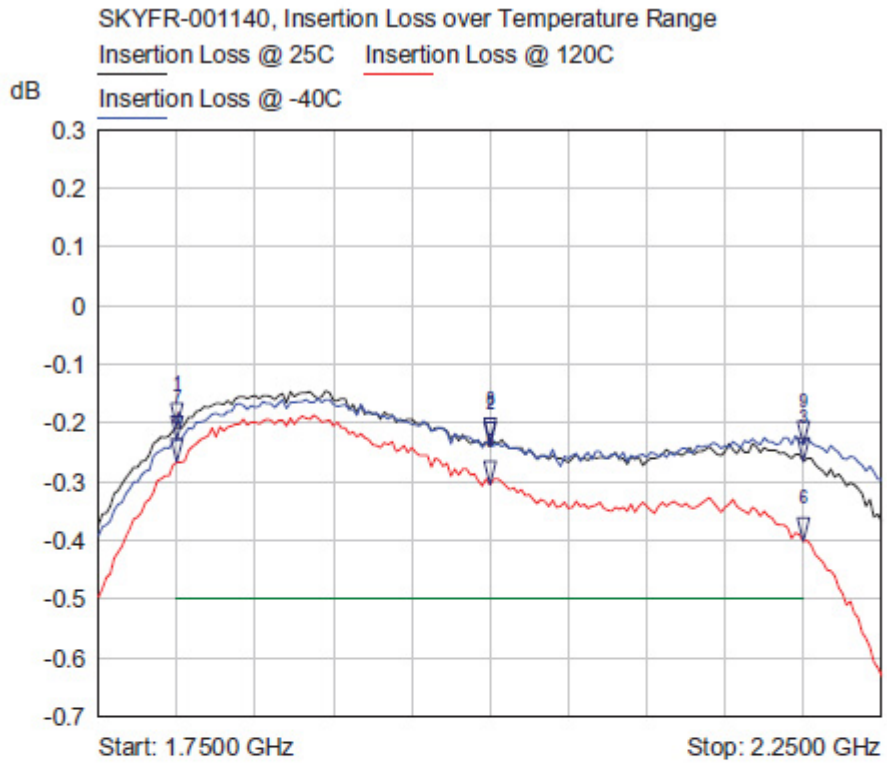
Skyworks Solutions recently released a broadband isolator specifically designed for interstage applications in wireless infrastructure power amplifiers. The SKYFR-001140 is less than 15 mm in diameter yet has an operating bandwidth of 400 MHz. It is designed to cover bands 01, 02 and 03, operating from 1800 MHz to 2200 MHz. The device is housed in a surface mount, "robust lead" package and shipped in tape-and-reel.



Figure 1: SKYFR-001140 image

Frequency spectrum is fast becoming a precious resource and its efficient use is a major concern for most carriers. To deliver higher data rates and increase spectral efficiency, the wireless industry is turning to carrier aggregation. Carrier aggregation achieves higher data rates by combining disparate contiguous and non-contiguous spectrum bands into a single channel. For example, if a service provider has 10 MHz of spectrum in the 1900 MHz band and 20 MHz of spectrum in the 1800 MHz band, then these can be combined into a 30 MHz carrier bandwidth channel. The upper limit of such aggregated spectrum is 100 MHz.

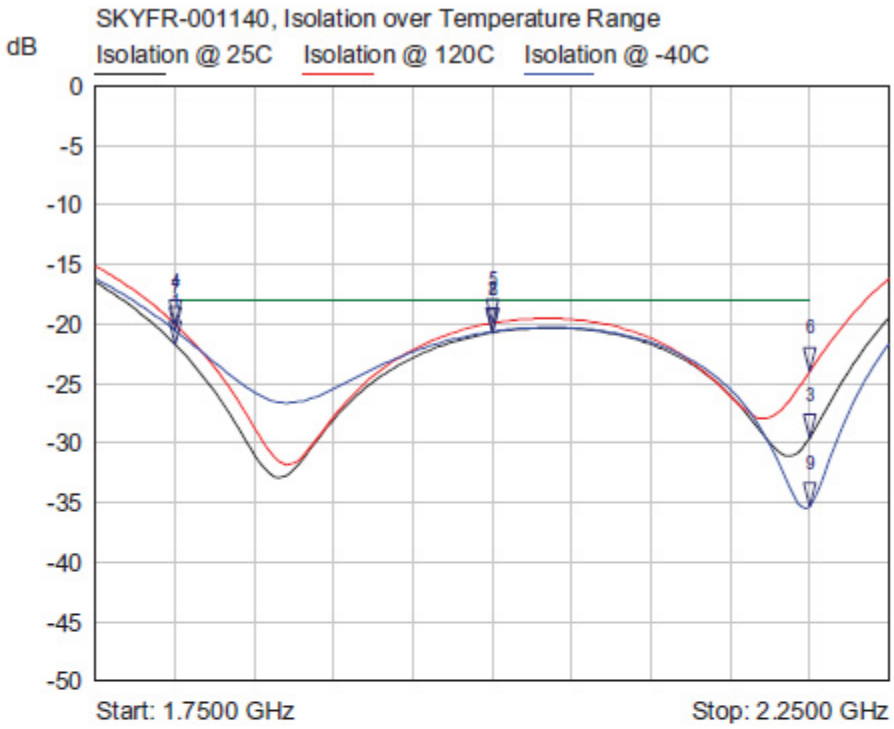
Carrier aggregation presents some difficult challenges for the wireless infrastructure front-end equipment suppliers. The need to support higher channel bandwidths requires a power amplifier with higher instantaneous bandwidths and the ability to cover multiple adjacent bands. This makes the job of designing the power amplifier much more difficult.



Mkr	Trace	X-Axis	Value
1	Insertion Loss @ 25C	1.8000 GHz	-0.21 dB
2	Insertion Loss @ 25C	2.0000 GHz	-0.24 dB
3	Insertion Loss @ 25C	2.2000 GHz	-0.27 dB
4	Insertion Loss @ 120C	1.8000 GHz	-0.27 dB
5	Insertion Loss @ 120C	2.0000 GHz	-0.31 dB
6	Insertion Loss @ 120C	2.2000 GHz	-0.40 dB
7	Insertion Loss @ -40C	1.8000 GHz	-0.23 dB
8	Insertion Loss @ -40C	2.0000 GHz	-0.23 dB
9	Insertion Loss @ -40C	2.2000 GHz	-0.24 dB

Figure 2: SKYFR-001140 insertion loss over operating temperature range

Inadequate reverse isolation between stages of a power amplifier can result in unwanted oscillation. Traditionally, a lumped element isolator is used to provide this interstage isolation. Lumped element isolators consist of a ferrite disk wrapped with three coils so that the RF magnetic fields are orientated at 120° with respect to each other. But the bandwidth of the lumped element isolator is narrow, typically less than 15%. The demand for broader bandwidth power amplifiers means the narrowband lumped element isolator can no longer do the job of providing isolation between the two stages.



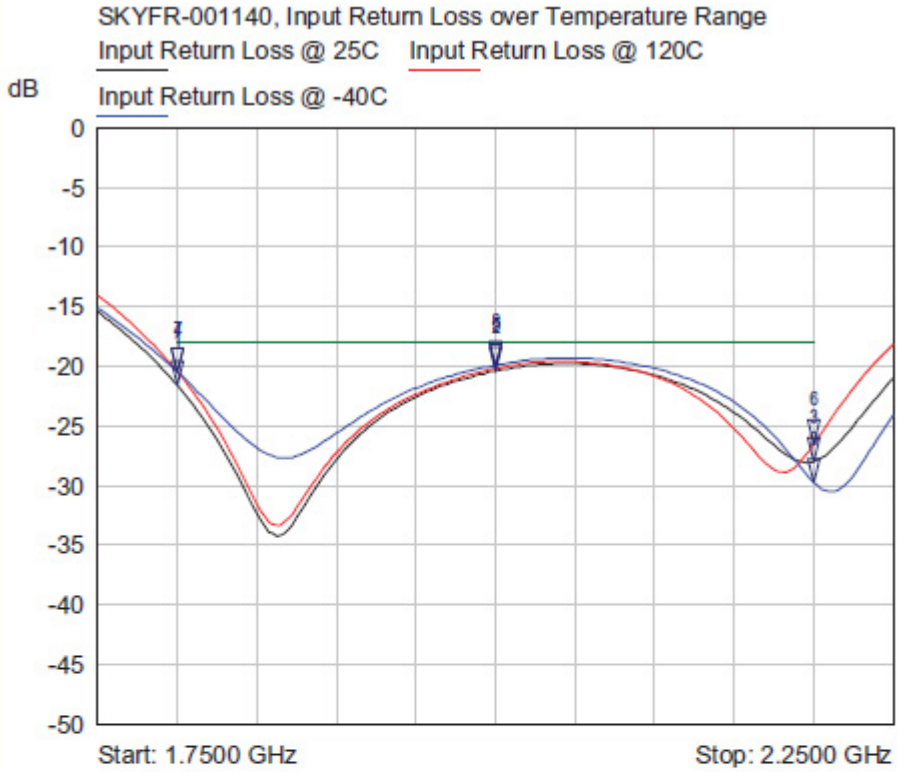
Mkr	Trace	X-Axis	Value
1 ▽	Isolation @ 25C	1.8000 GHz	-21.73 dB
2 ▽	Isolation @ 25C	2.0000 GHz	-20.73 dB
3 ▽	Isolation @ 25C	2.2000 GHz	-29.55 dB
4 ▽	Isolation @ 120C	1.8000 GHz	-20.00 dB
5 ▽	Isolation @ 120C	2.0000 GHz	-19.92 dB
6 ▽	Isolation @ 120C	2.2000 GHz	-23.98 dB
7 ▽	Isolation @ -40C	1.8000 GHz	-20.54 dB
8 ▽	Isolation @ -40C	2.0000 GHz	-20.63 dB
9 ▽	Isolation @ -40C	2.2000 GHz	-35.35 dB

Figure 3: SKYFR-001140 isolation over operating temperature range

To address this challenge, Skyworks developed the SKYFR-001140. It is a broadband isolator specifically designed for this new, broader bandwidth interstage application. This isolator has an operating bandwidth of 400 MHz yet is less than 15 mm in diameter.

The key to the extremely small junction size is a new, high dielectric ferrite material developed by our material scientists. Trans-Tech, a subsidiary of Skyworks Solutions, has created a new range of materials to enable size reduction of ferrite devices by manipulating the garnet structure to give much higher dielectric constants than previously available. By substituting ions of higher polarizability into the structure, while simultaneously keeping magnetocrystalline anisotropy low, it has been possible to achieve low magnetic and dielectric losses without compromising temperature, non-linear and power stability.

Magnetizations of up to 1850 Gauss are possible with this new range of materials, with dielectric constants up to 31. New nano-level powder processing techniques are an integral part of the manufacture of these materials. Patents on all aspects of the design, manufacture and application of these materials are pending.

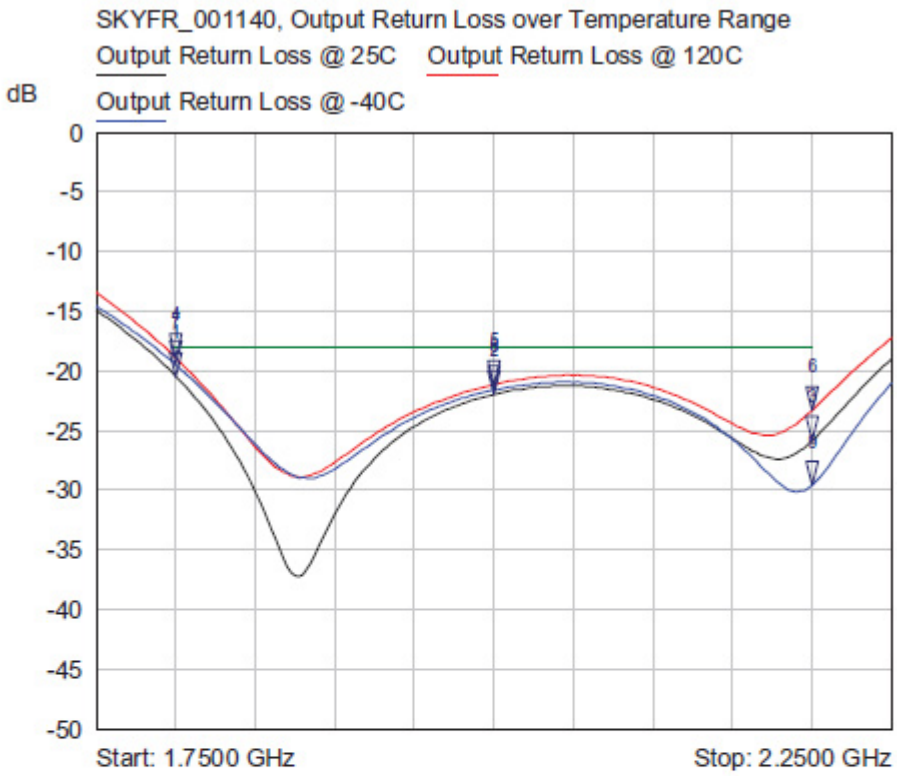


Mkr	Trace	X-Axis	Value
1	Input Return Loss @ 25C	1.8000 GHz	-21.61 dB
2	Input Return Loss @ 25C	2.0000 GHz	-20.39 dB
3	Input Return Loss @ 25C	2.2000 GHz	-27.99 dB
4	Input Return Loss @ 120C	1.8000 GHz	-20.47 dB
5	Input Return Loss @ 120C	2.0000 GHz	-20.18 dB
6	Input Return Loss @ 120C	2.2000 GHz	-26.54 dB
7	Input Return Loss @ -40C	1.8000 GHz	-20.48 dB
8	Input Return Loss @ -40C	2.0000 GHz	-19.91 dB
9	Input Return Loss @ -40C	2.2000 GHz	-29.74 dB

Figure 4: SKYFR-001140 input return loss over operating temperature range

The SKYFR-001140 is a single junction isolator in a 15 mm diameter housing (see **Figure 1**), designed to operate from 1800 MHz to 2200 MHz. This isolator can achieve insertion loss performance of 0.25 dB typical and is specified to 0.50 dB maximum over the operating temperature range of -40°C to +120°C. The isolation and the return loss are typically 20 dB at room temperature.

Skyworks' patented "robust lead" package allows the isolator to be populated onto the customer's PCB using modern surface mount technology. The package uses a unique vertical lead to connect the center conductor of the circulator to the customer's PCB. The silver plated lead is firmly encased inside a high temperature plastic, providing a robust design and excellent co-planarity. The main body of the device is also silver plated for excellent solderability and can be attached to the PCB using a standard reflow profile. The robust lead isolator is shipped in tape-and-reel for automated placement.



Mkr	Trace	X-Axis	Value
1	Output Return Loss @ 25C	1.8000 GHz	-20.46 dB
2	Output Return Loss @ 25C	2.0000 GHz	-21.99 dB
3	Output Return Loss @ 25C	2.2000 GHz	-25.86 dB
4	Output Return Loss @ 120C	1.8000 GHz	-18.90 dB
5	Output Return Loss @ 120C	2.0000 GHz	-21.13 dB
6	Output Return Loss @ 120C	2.2000 GHz	-23.32 dB
7	Output Return Loss @ -40C	1.8000 GHz	-19.50 dB
8	Output Return Loss @ -40C	2.0000 GHz	-21.59 dB
9	Output Return Loss @ -40C	2.2000 GHz	-29.59 dB

Figure 5: SKYFR-001140 output return loss over operating temperature range

The best-in-class performance of Skyworks ferrite isolators and circulators is achieved through a systematic approach that emphasizes quality and reliability from product development through volume production. Six Sigma tools and methodologies are used to build quality into our designs, to control manufacturing

processes, and to drive continuous improvement. The reliability of Skyworks isolator and circulator products is assured by completing extensive stress testing during the qualification stage of all new product designs.

The surface-mount robust lead isolator is extremely reliable, which has been confirmed by extensive reliability testing, including thermal shock, humidity, vibration and high temperature soak. The part will also withstand up to 50 W average CW RF power when mounted on a PCB with good thermal grounding. The isolator includes an aluminum nitride termination and can handle up to 4 W of reverse power. See Skyworks application note 201790, Robust Lead Circulators and Isolators, for more information.

Figures 2, 3, 4 and 5 show the S-Parameter performance of the SKYFR-001140 over the operating temperature range. The small size is the result of new magnetic materials developed by Trans-Tech for the exclusive use of Skyworks. The device is housed in a surface mount “robust lead” package and shipped on tape-and-reel, making it ideal for today’s surface mount assembly processes. Skyworks has a wide range of circulators and isolators for all of the wireless infrastructure frequency bands. All Skyworks circulators and isolators are RoHS (EU directive 2011/65/EC) and REACH (EU regulation 1907/2006) compliant.

Skyworks Solutions, Inc.