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10 mm Diameter Circulators and Isolators for Wireless Infrastructure

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Targeting wireless infrastructure, Skyworks Solutions has developed the world's smallest stripline junction circulators and isolators. The junction of this new product family is only 8.5 mm in diameter, with the contact pins on a 10.2 mm diameter circle. Both circulators and isolators are available for all standard wireless bands between 1.8 and 3.6 GHz (see ***Table 1***). These devices are all housed in a surface-mount package with robust leads and shipped in tape and reel packaging.

NEW HIGH K FERRITE MATERIAL

The key to the extremely small junction size is a new, high dielectric ferrite material developed by Skyworks. Manipulating the garnet structure yielded much higher dielectric constants than previously available, which enabled the size reduction. Garnets are crystalline materials with ferrimagnetic properties. Yttrium iron garnet (YIG) is a synthetic form of garnet widely used in ferrite devices because of its favorable magnetic properties, such as narrow line absorption at its ferromagnetic resonance frequency. YIG is generally composed of yttrium, iron and oxygen and is doped with one or more other rare earth metals such as the lanthanides or scandium. Substituting ions of higher polarizability into the structure, while simultaneously keeping magnetocrystalline anisotropy low, achieves low magnetic and dielectric losses without compromising temperature, linearity and power stability. Magnetization up to 1950 G is possible with this new range of materials, with dielectric constants up to 31.

New nano-level powder processing techniques are integral to manufacturing these materials. Various aspects of the design, manufacturing and application of these materials are patented (US 8696925 and US 9263175).

TABLE 1

WIRELESS INFRASTRUCTURE CIRCULATOR AND ISOLATOR PRODUCTS

Part Number	Type	Cellular Band	Start Frequency (MHz)	Stop Frequency (MHz)	Insertion Loss, Max (dB)	Return Loss, Min (dB)	Isolation, Min (dB)
SKYFR-001387	Circulator	3	1805	1880	0.25	20	20
SKYFR-001436	Isolator	3	1805	1880	0.25	20	20
SKYFR-001388	Circulator	2	1930	1990	0.25	20	20
SKYFR-001437	Isolator	2	1930	1990	0.25	20	20
SKYFR-001389	Circulator	1	2110	2170	0.25	20	20
SKYFR-001438	Isolator	1	2110	2170	0.25	20	20
SKYFR-001390	Circulator	40	2300	2400	0.25	20	20
SKYFR-001439	Isolator	40	2300	2400	0.25	20	20
SKYFR-001461	Circulator	7	2620	2690	0.25	20	20
SKYFR-001460	Isolator	7	2620	2690	0.25	20	20
SKYFR-001452	Circulator	42	3400	3600	0.25	20	20
SKYFR-001512	Isolator	42	3400	3600	0.25	20	20

PERFORMANCE AND PACKAGING

The SKYFR-001438 shows the typical performance from this new product family. A single junction isolator in a 10 mm diameter housing, the SKYFR-001438 operates from 2110 to 2170 MHz (Band 1). Typical insertion loss is 0.12 dB and is specified to be a maximum of 0.25 dB over the operating temperature range from -40° to +125°C (see ***Figure 1***). Isolation (see ***Figure 2***) and return loss (see ***Figure 3***) are both typically 25 dB at room temperature. The typical intermodulation distortion (IMD) performance is 65 dBc with two 10 W CW tones.

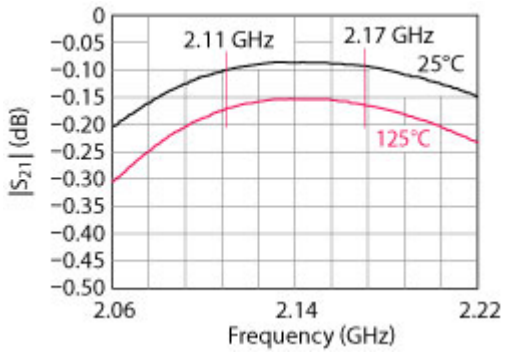

Figure 1 Band 1 isolator insertion loss (SKYFR-001438).

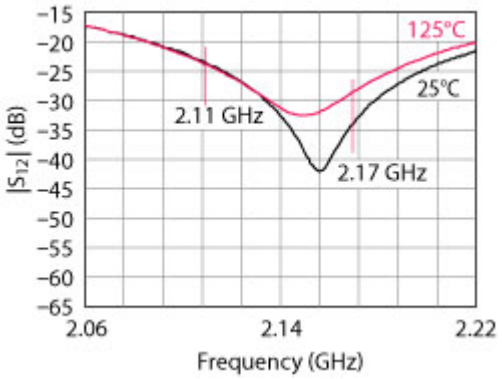

Figure 2 Typical isolation of the isolator.

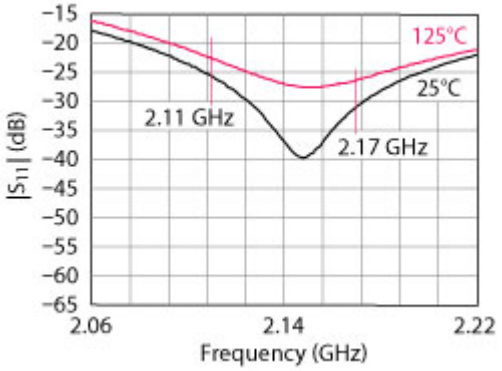

Figure 3 Typical return loss of the isolator.

Skyworks' patented "robust lead" package allows the circulators and isolators to be populated on a printed circuit board (PCB) using automated surface-mount assembly. The package has a unique vertical lead that connects the center conductor of the circulator to the customer's PCB. The silver plated lead is firmly encased inside high temperature plastic, ensuring a robust design with excellent coplanarity. The main body of the device is also silver plated for excellent solderability; it can be attached to the PCB using a standard reflow profile. All robust lead devices are shipped in tape and reel packaging for automated placement.

The 10 mm circulator and isolator product family is extremely reliable. Skyworks subjected this new platform to extensive reliability testing, including thermal shock, humidity, vibration and high temperature soak. These devices will withstand up to 50 W average CW RF forward power when mounted on a PCB with good thermal grounding. The isolators include an aluminum nitride (AlN) termination and can handle up to 30 W of reverse power.

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