

# 24 to 44 GHz Up/Down Converter

SC2444 | mmWave Converter

Product Brief

## Summary

The mmWave converter is a stand-alone platform for use in the 24 to 44 GHz range.

The module is designed to interface directly with software-defined radios, such as those commonly implemented using Analog Device's Mixed-Signal Front-End (MxFE), or similar Software Defined Radio, to obtain a complete mmWave system.

Up to four modules can be combined in parallel to create complex MIMO applications.



SC2444 – mmWave Converter Module

## Description

Power is provided via a 12-volt wall cube which is included with the Development Kit. An embedded fan and temperature monitoring are integrated into the unit to manage heat.

Control of the module is provided via the USB, UART, or SPI interfaces. Most users will find it convenient to control the module using the console interface over USB. Alternatively, embedded controllers may access the UART or SPI interfaces available on the external Control Ports.

Two API protocols are available. The first is ASCII-based, and its commands follow the SCPI structure as defined in IEEE 488.2. The second is a binary protocol, targeted at embedded control applications where speed and timing are critical. Both protocols are detailed in an API Specification.

Up to 4 units can be combined in a vertical stack to create a complex 4 x 4 MIMO radio system. In this scenario, the

internal control buses are routed to the cascaded modules over the Expansion Port. In this manner, API commands sent on the primary unit, can be redirected to the downstream modules. This eliminates the need for multiple controllers and simplifies timing and synchronization between units. Module addresses are set using a DIP switch on the Configuration Port.

A Secondary and External Control Port is also available. These ports expose Power, SPI, I2C, UART and GPIO that provide users with a convenient method of interfacing to external front-end modules, such as integrated antenna arrays or switched filter banks.

The low-frequency RF inputs include the IF, I/Q, external LO, and external frequency reference ports on SMA connectors.

The converters can be configured to interface with either IF or I/ Q signals. The IF port supports signals between 2 and 6 GHz. The I/Q inputs provide connectivity to external, single-ended DACs operating at up to 6 GHz. A low pass filter is included to help with alias and spurious rejection.

RadioThorium can be used in either Time Division Duplex (TDD) or Frequency Division Duplex (FDD) mode. The

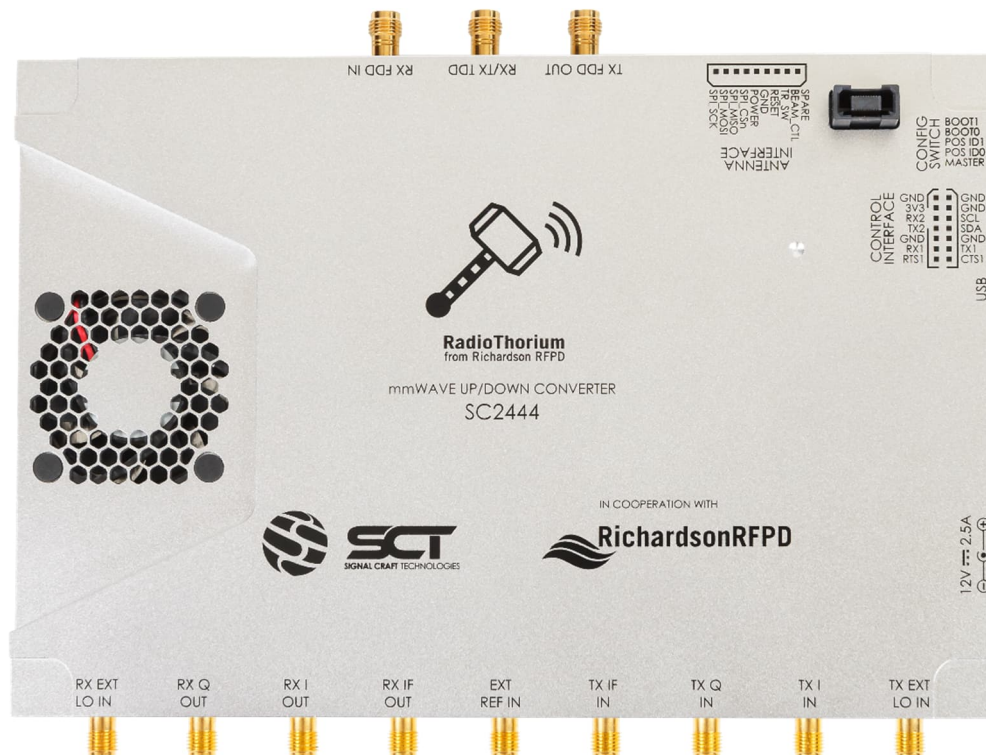
mmWave ports include 2.4 mm connectors for the FDD TX and RX functions, in addition to a bidirectional TDD port.

In FDD Mode, the Up-Conversion (UC) path has approximately 30 dB of gain and an output compression point, or P1dB, of 20 dBm at 40 GHz. In TDD mode, the gain is also 30 dB, but the P1dB reduces to 16 dBm at 40 GHz.

In FDD Mode, the Down-Conversion (DC) path has a maximum gain of approximately 65 dB, noise figure of 9 dB, and an input compression point, or P1dB, of 0 dBm at 40 GHz. In TDD mode, the gain is also 73 dB, noise figure 9 dB, but the P1dB reduces to -7 dBm at 40 GHz.

Two on-board Local Oscillators (LOs) are provided to facilitate standalone operation. Each LO can be configured independent of the other, providing users with complete control of the RF/LO/IF frequency plan specific to their application.

Optionally, the onboard synthesizers can be disabled when external LOs are supplied by the user.

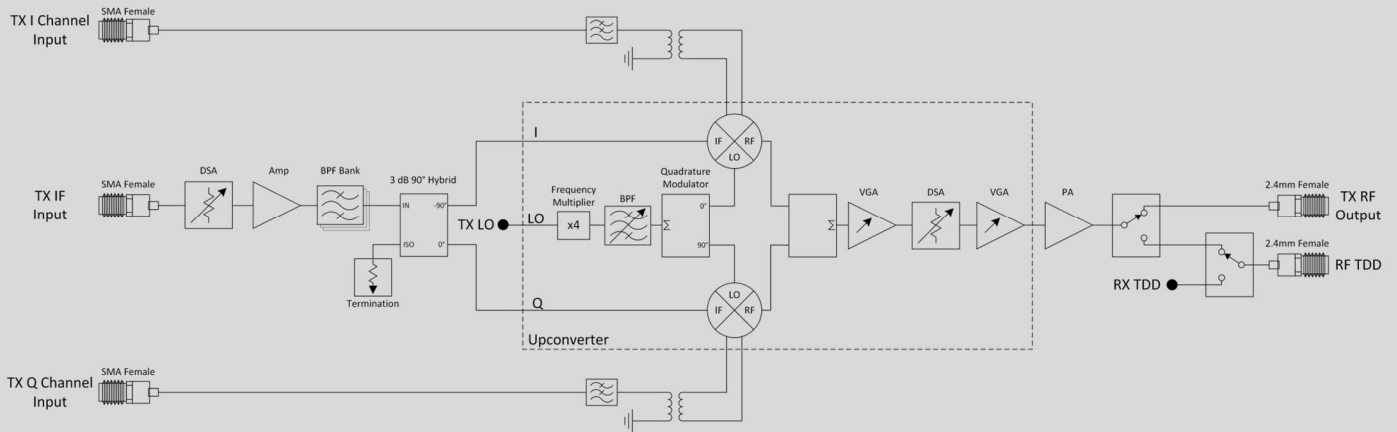


# Common Applications

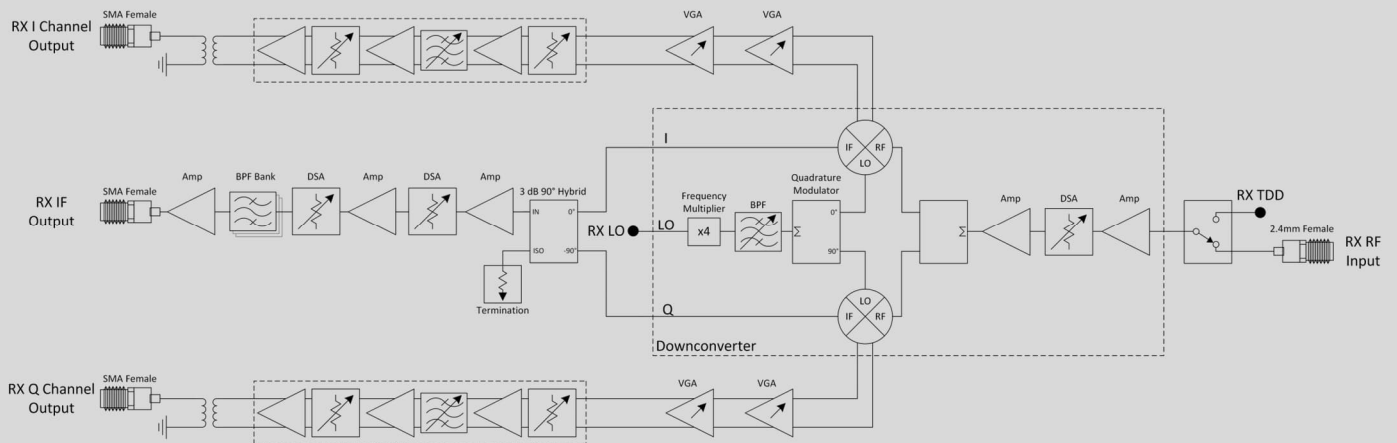
- 5G NR Frequency Range 2 Development
- Software Defined Radio Applications
- Aerospace and Defense
- Advanced Wireless Communications Research

## Radio Path Block Diagram

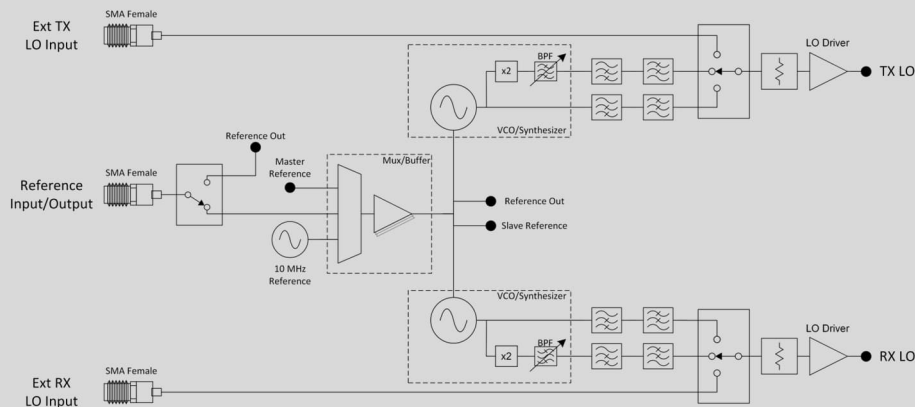
### Transmit Channel



### Receive Channel

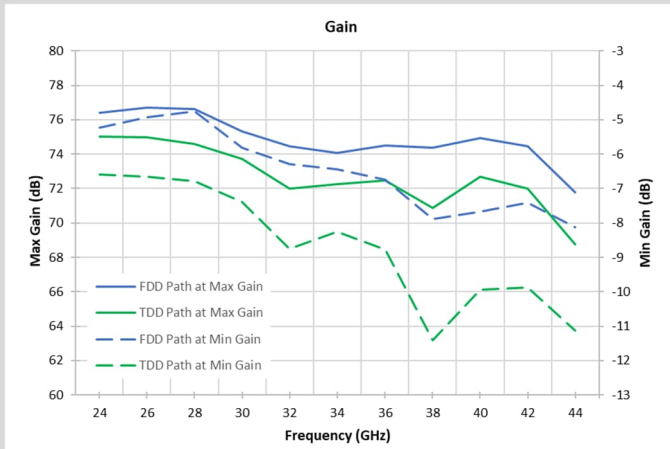


### Local Oscillators

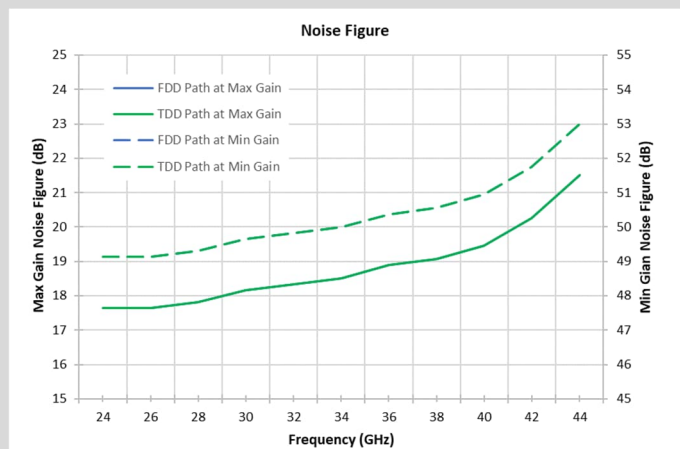
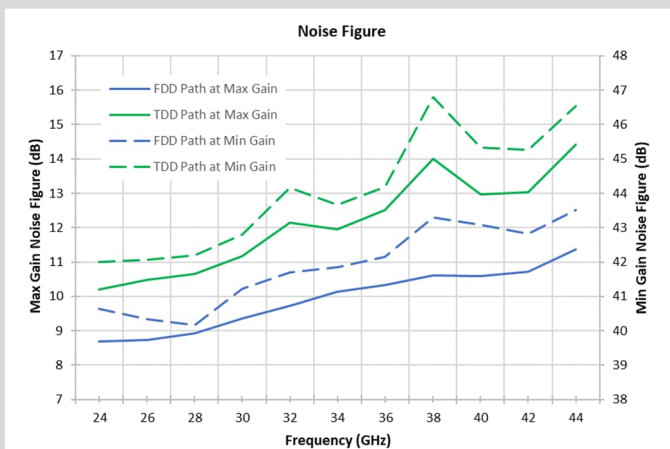
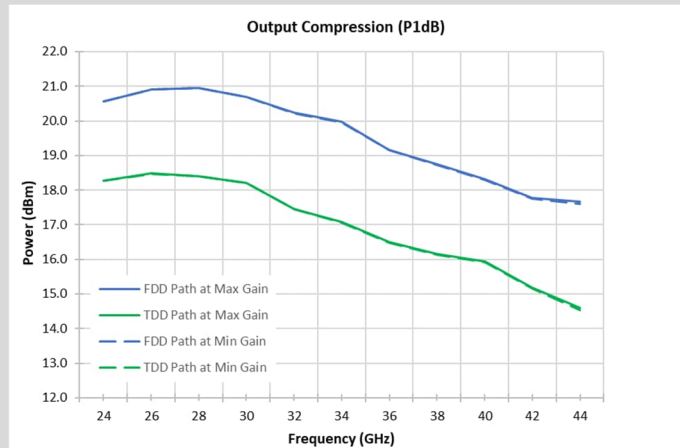
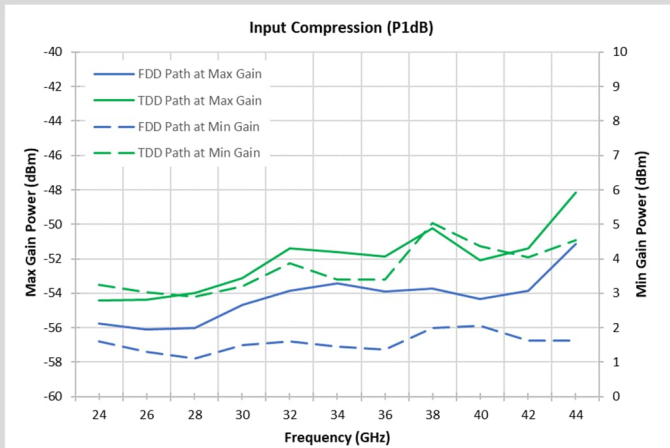
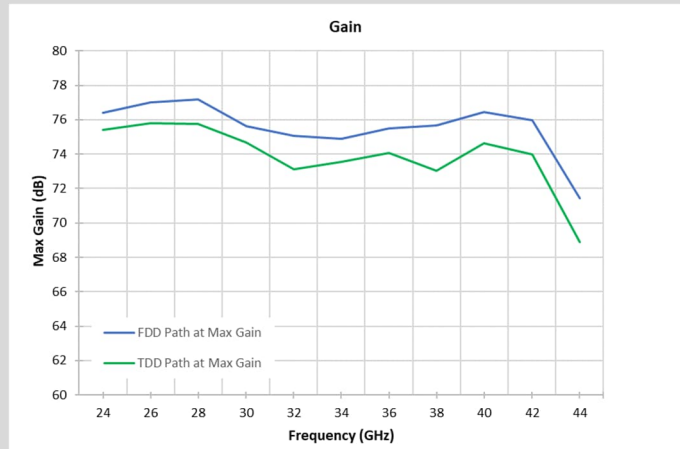


# Downconverter Typical Performance

## Downconverter IF Path



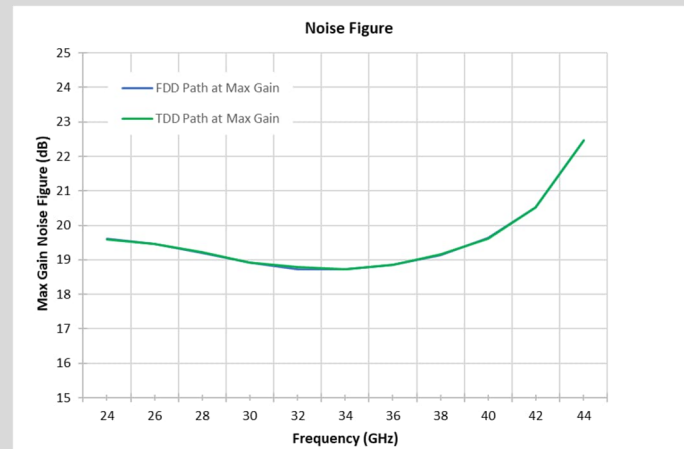
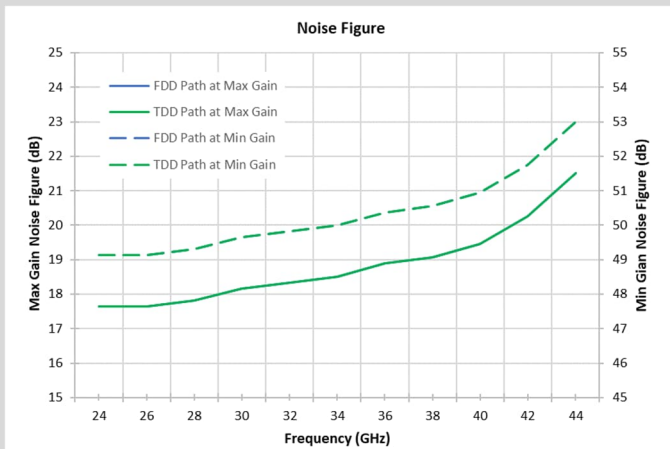
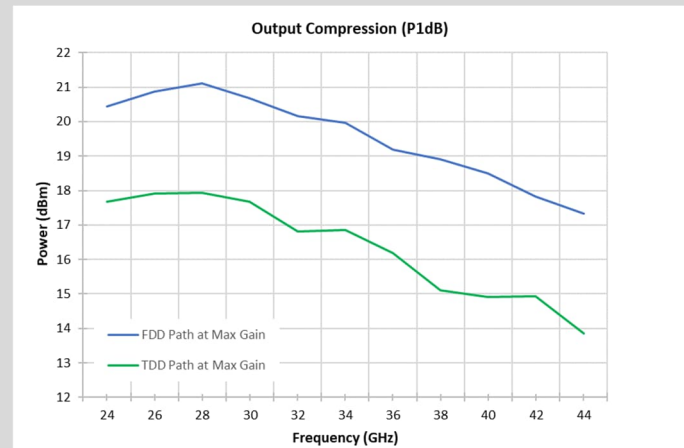
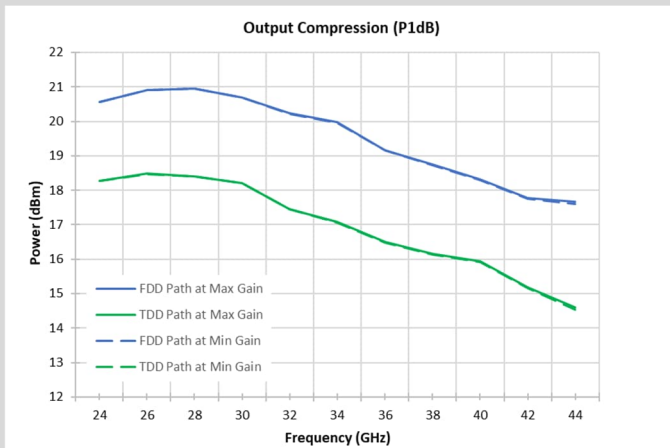
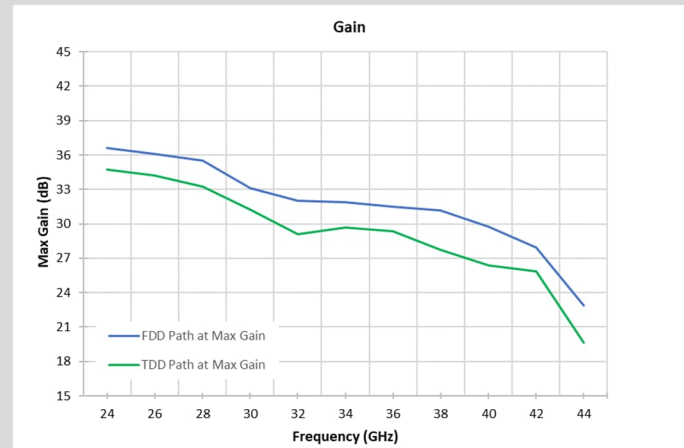
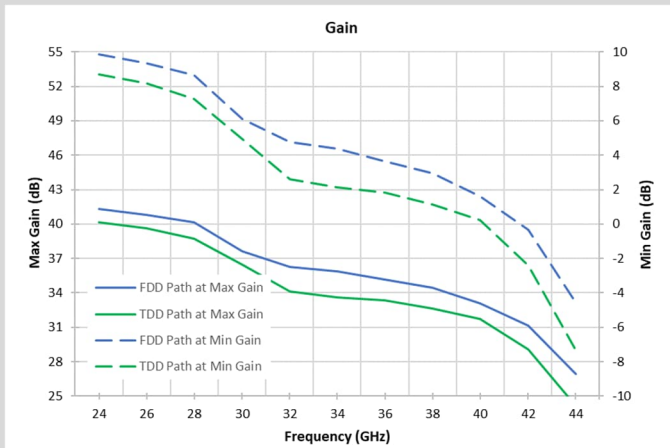
## Downconverter I/Q Path



# Upconverter Typical Performance

## Upconverter IF Path

## Upconverter I/Q Path



## Typical Performance - Summary

### Down Conversion (DC) Path

- Input Frequency Range: 24 to 44 GHz
- Maximum Input Power: 0 dBm
- IF Output Frequency Range: 2 to 6 GHz
- Maximum I/Q Bandwidth: 1250 MHz
- Internal LO: 5.4 to 10.25 GHz
- Internal LO Phase Noise:
  - -109 dBc/Hz @ 100kHz
  - -133 dBc/Hz @ 1 MHz
- Optional External LO: 5.4 to 10.25 GHz

### Up Conversion (UC) Path

- IF Input Frequency Range: 2 to 6 GHz
- Maximum I/Q Bandwidth: 1250 MHz
- Maximum Input Power: +5 dBm
- Output Frequency Range: 24 to 44 GHz
- Internal LO: 5.4 to 10.25 GHz
- Internal LO Phase Noise:
  - -109 dBc/Hz @ 100kHz
  - -133 dBc/Hz @ 1 MHz
- Optional External LO: 5.4 to 10.25 GHz

### DC IF Output Path – FDD Mode

- Conversion Gain (at Max Gain Setting):
  - 75 dB @ 29 GHz
  - 74 dB @ 35 GHz
  - 74 dB @ 40 GHz
  - 71 dB @ 44 GHz
- Gain Control Range: 70 dB in 0.5 dB Steps
- Noise Figure:
  - 9 dB @ 29 GHz
  - 10 dB @ 35 GHz
  - 11 dB @ 40 GHz
  - 12 dB @ 44 GHz
- 1 dB Input Compression Point: 0 dBm

### UC IF Input Path – FDD Mode

- Conversion Gain (at Max Gain Setting):
  - 38 dB @ 29 GHz
  - 35 dB @ 35 GHz
  - 33 dB @ 40 GHz
  - 27 dB @ 44 GHz
- Gain Control Range: 70 dB in 0.5 dB Steps
- Noise Figure:
  - 18 dB @ 29 GHz
  - 18 dB @ 35 GHz
  - 20 dB @ 40 GHz
  - 22 dB @ 44 GHz
- 1 dB Input Compression Point: 0 dBm

### DC I/Q Output Path – FDD Mode

- Conversion Gain (at Max Gain Setting):
  - 76 dB @ 29 GHz
  - 75 dB @ 35 GHz
  - 75 dB @ 40 GHz
  - 72 dB @ 44 GHz
- Gain Control Range: 70 dB in 0.5 dB Steps
- Noise Figure:
  - 11 dB @ 29 GHz
  - 12 dB @ 35 GHz
  - 13 dB @ 40 GHz
  - 14 dB @ 44 GHz
- 1 dB Input Compression Point: 0 dBm

### UC I/Q Input Path – FDD Mode

- Conversion Gain (at Max Gain Setting):
  - 34 dB @ 29 GHz
  - 32 dB @ 35 GHz
  - 30 dB @ 40 GHz
  - 22 dB @ 44 GHz
- Gain Control Range: 70 dB in 0.5 dB Steps
- Noise Figure:
  - 19 dB @ 29 GHz
  - 19 dB @ 35 GHz
  - 19 dB @ 40 GHz
  - 22 dB @ 44 GHz
- 1 dB Output Compression Point: 20 dBm



## Support

Technical support is available through our website, [www.signalcraft.com/support](http://www.signalcraft.com/support), or by contacting us at [support@signalcraft.com](mailto:support@signalcraft.com).

## Warranty

Full one-year parts and labor when used under normal installation and operation conditions. Repair services are available for products no longer covered under warranty.

## Ordering Information

Send inquiries to [info@signalcraft.com](mailto:info@signalcraft.com).