

N310

Contents

- 1 Notice
- 2 Device Overview
- 3 Key Features
 - ◆ 3.1 N300
 - ◆ 3.2 N310
- 4 RF Specifications
 - ◆ 4.1 Transmitter
 - ◆ 4.2 Receiver
 - ◆ 4.3 Onboard DRAM
- 5 Power
- 6 Hardware Specifications
 - ◆ 6.1 N310
 - ◆ 6.2 Clocking and Sampling Rates
- 7 Physical Specifications
 - ◆ 7.1 Dimensions
 - ◆ 7.2 Weight
 - ◆ 7.3 Drawings
 - ◇ 7.3.1 N300
 - ◇ 7.3.2 N310
 - ◆ 7.4 CAD/STP Models
 - ◇ 7.4.1 N310
- 8 Environmental Specifications
 - ◆ 8.1 Operating Temperature Range
 - ◆ 8.2 Storage Temperature Range
 - ◆ 8.3 Operating Humidity Range
- 9 Schematics
 - ◆ 9.1 N300/N310
- 10 GPSDO
 - ◆ 10.1 Sensors
 - ◆ 10.2 Specifications
 - ◆ 10.3 Datasheet
- 11 FPGA
 - ◆ 11.1 FPGA User Modifications
- 12 Interfaces and Connectivity
 - ◆ 12.1 Front Panel
 - ◆ 12.2 Rear Panel
 - ◆ 12.3 Ref Clock - 10 MHz
 - ◆ 12.4 PPS - Pulse Per Second
 - ◆ 12.5 Front Panel GPIO
 - ◇ 12.5.1 Power on state
 - ◇ 12.5.2 Pin Mapping
 - ◆ 12.6 Power Connector
 - ◇ 12.6.1 Pin Detail
- 13 Certifications
 - ◆ 13.1 RoHS
 - ◆ 13.2 China RoHS
- 14 Certificate of Volatility
- 15 Downloads
- 16 Choosing a Host Interface
 - ◆ 16.1 10 Gigabit Ethernet
- 17 International Power Supply Options
- 18 Option: USRP N300/N310 Rackmount
- 19 Guidance on SFP+ Adapters for Fiber Connectivity on USRP N310
 - ◆ 19.1 Known-Good Adapters
 - ◆ 19.2 Known-Good Cables
- 20 Guidance on 10Gb SFP+ to RJ45 Adapters
 - ◆ 20.1 Known-Good Adapters
- 21 Data Throughput Rates

When you receive a brand-new device, it is strongly recommended that you download the most recent filesystem image from the Ettus Research website and write it to the SD card that comes with the unit. It is not recommended that you use the SD card from the factory as-is. Instructions on downloading the latest filesystem image and writing it to the SD card are listed below.

Note that if you are operating the device in Network Mode, then the versions of UHD running on the host computer and on the USRP N300/N310 device must match.

The USRP N310 is a networked software defined radio that provides reliability and fault-tolerance for deployment in large scale and distributed wireless systems. This device simplifies control and management of a network of radios by introducing the unique capability to remotely perform tasks such as debugging, updating software, rebooting, factory resetting, self-testing, and monitoring system health. The USRP N310 is an all-in-one device that includes two AD9371 transceivers, the Zynq-7100 SoC baseband processor, two SFP+ ports, a built-in GPSDO module, and various other peripheral and synchronization features.

- Xilinx Zynq-7035 FPGA SoC
- Dual-core ARM A9 800 MHz CPU
- 2 RX, 2TX in half-wide RU form factor
- 10 MHz ? 6 GHz extended frequency range
- Up to 100 MHz of instantaneous bandwidth per channel
- RX, TX filter bank
- 16 bit ADC, 14 bit DAC
- Configurable sample rates: 122.88, 125, and 153.6 MS/s
- Two SFP+ ports (1 GbE, 10 GbE, [Aurora](#))
- RJ45 (1 GbE)
- 10 MHz clock reference
- PPS time reference
- Built-in GPSDO
- 1 Type A USB host port
- 1 micro-USB port (serial console, JTAG)
- Watchdog timer
- OpenEmbedded Linux
- High channel density
- Reliable and fault-tolerant deployment
- Remote management capability
- Stand-alone operation
- USRP N300 **does not** contain a Trusted Platform Module



- Xilinx Zynq-7100 FPGA SoC
- Dual-core ARM A9 800 MHz CPU
- 4 RX, 4TX in half-wide RU form factor
- 10 MHz ? 6 GHz extended frequency range
- Up to 100 MHz of instantaneous bandwidth per channel
- RX, TX filter bank
- 16 bit ADC, 14 bit DAC
- Configurable sample rates: 122.88, 125, and 153.6 MS/s
- Two SFP+ ports (1 GbE, 10 GbE, [Aurora](#))
- RJ45 (1 GbE)
- 10 MHz clock reference
- PPS time reference
- External RX, TX LO input ports
- Built-in GPSDO
- 1 Type A USB host port
- 1 micro-USB port (serial console, JTAG)
- Trusted Platform Module (TPM) v1.2
- Watchdog timer
- OpenEmbedded Linux
- High channel density
- Reliable and fault-tolerant deployment
- Remote management capability
- Stand-alone operation



- Number of channels: 4
- Frequency Range: 10 MHz to 6 GHz
- Maximum instantaneous bandwidth: 100 MHz
- Minimum frequency step
 - ◆ 7.32 Hz @ 122.88 MHz sample rate
 - ◆ 7.45 Hz @ 125 MHz sample rate
 - ◆ 9.15 Hz @ 153.6 MHz sample rate

- Maximum output power (P_{out}): See Table 1
- Gain range
 - ◆ -30 dB to 25 dB (10 MHz to 300 MHz)
 - ◆ -30 dB to 20 dB (300 MHz to 6 GHz)
- Gain step: 1 dB
- Supported I/Q sample rates:
 - ◆ 122.88 MHz, 125 MHz, 153.6 MHz
- Spurious-free dynamic range (SFDR) > 50 dBc
- Output third-order intercept (OIP3) See Table 2

Frequency	Maximum Output Power
10 MHz to 500 MHz	+16 dBm
500 MHz to 1 GHz	+18 dBm
1 GHz to 4 GHz	+18 dBm
4 GHz to 6 GHz	+12 dBm

Table 1: Maximum Output Power

Frequency	Output Third-Order Intercept (IP3)
10 MHz to 2 GHz	> 30 dBm
2 GHz to 4 GHz	> 20 dBm
4 GHz to 6 GHz	> 10 dBm

Table 2: Third-Order Intercept (IP3)

- Number of channels: 4
- Frequency Range: 10 MHz to 6 GHz
- Maximum instantaneous bandwidth: 100 MHz
- Minimum frequency step
 - ◆ 7.32 Hz @ 122.88 MHz sample rate
 - ◆ 7.45 Hz @ 125 MHz sample rate
 - ◆ 9.15 Hz @ 153.6 MHz sample rate
- Gain step: 1
- Maximum recommended input power (P_{in}) 1 dB: -15 dBm
- Noise figure: See Table 3
- Spurious-free dynamic range (SFDR): > 50 dBc
- Third-order intermodulation distortion (IMD3) See Table 4
- Supported I/Q sample rates
 - ◆ 122.88 MHz, 125 MHz, 153.6 MHz

Frequency	TX/RX Noise Figure	RX2 Noise Figure
1.8 GHz	6.8 dB	5.8 dB
2.4 GHz	7.5 dB	6.5 dB
4.4 GHz	7.0 dB	5.5 dB
5.8 GHz	6.4 dB	6.4 dB

Table 3: Noise Figure

Frequency	RX IMD3
0.5 GHz to 3 GHz	< -80 dBc
3 GHz to 4 GHz	< -74 dBc
4 GHz to 6 GHz	< -81 dBc

Table 4: RX Third-Order Intermodulation Distortion (IMD3)

- Noise figure is measured at maximum gain state on receiver signal path.
- DDR3 Memory size
 - ◆ 2,048 MB (PL)
 - ◆ 1,024 MB (PS)

You must use either the Level VI Efficiency power supply provided in the shipping kit, or another UL listed ITE power supply marked [?]LPS, with the USRP N310.

- Input voltage: 12 VDC
- Input current: 7.0 A, maximum
- Typical power consumption: 50 W to 80 W, varies by application

- Ettus Research recommends to always use the latest stable version of UHD
- If you need to clean the module, wipe it with a dry towel.

- Current Hardware Revision: D
- Minimum version of UHD required: 3.11.0.0
- Due to product compliance restrictions on products with TPM (Trusted Platform Module) components to a few countries, the USRP N310 is available in two variants:
 - ◆ Standard variant with TPM (P/N 785067-01)
 - ◆ Non-TPM variant (P/N 786465-01)

There are three master clock rates (MCR) supported on the N310: 122.88 MHz; 125.0 MHz; 153.6 MHz.

The sampling rate must be an integer decimation rate of the MCR. Ideally, this decimation factor should be an even number. An odd decimation factor will result in additional unwanted attenuation (roll-off from the CIC filter in the DUC and DDC blocks in the FPGA). The valid decimation rates are between 1 and 1024.

For the MCR of 122.88 MHz, the achievable sampling rates using an even decimation factor are 122.88, 61.44, 30.72, 20.48, 15.36, 12.288, 10.24, 8.777, 7.68 Msps, ... 120.0 Ksps.

For the MCR of 125.0 MHz, the achievable sampling rates using an even decimation factor are 125.0, 62.5, 31.25, 20.833, 15.625, 12.5, 10.41666, 8.9286 Msps, ... 122.07 Ksps.

For the MCR of 153.6 MHz, the achievable sampling rates using an even decimation factor are 156.3, 78.15, 39.075, 26.05, 19.5375, 15.63, 13.025, 11.16429 Msps, ... 152.637 Ksps

If the desired sampling rate is not directly supported by the hardware, then it will be necessary to re-sample in software. This can be done in C++ using libraries such as Liquid DSP [1], or can be done in GNU Radio, in which there are three blocks that perform sampling rate conversion.

(L x W x H)

- 35.71 cm x 21.11 cm x 4.37 cm
- 14.06 in. x 8.31 in. x 1.72 in.

- 3.13 kg

- [File:CU USRP-N300.pdf](#)

- [File:CU USRP-N310.pdf](#)

If you want any CAD / STP models beyond those found here, please send an email to Ettus Support at support@ettus.com noting your request and your use case for any such model. We will determine on a case-by-case basis whether we have any such requested model and, if so, whether to release it -- possibly requiring an NDA for any such release. Note that we do not have models on all USRPs and daughterboards, and requesting any model does not guarantee that either Ettus Research or NI will honor any such request.

- [Enclosure Bottom Panel](#)
- [Enclosure Top Panel](#)
- [Faceplate](#)
- [Full Enclosure](#)

- N310: 0 to 50 °C

- N310: -40 to 70 °C

- 10% to 90% non-condensing

- Motherboard: [File:USRP N310 N300 MB Schematic.pdf](#)
- Daughterboard: [File:USRP N310 N300 DB Schematic.pdf](#)

- Support GPSDO NMEA Strings

You can query the lock status with the `gps_locked` sensor, as well as obtain raw NMEA sentences using the `gps_gprmc`, and `gps_gpgga` sensors. Location information can be parsed out of the `gps_gpgga` sensor by using `gpsd` or another NMEA parser.

Module Specifications

1 PPS Timing Accuracy from GPS receiver	<8ns to UTC RMS (1-Sigma) GPS Locked
Holdover Stability (1 week with GPS)	<±50us over 3 Hour Period @+25°C (No Motion, No Airflow)
1 PPS Output	3.3VDC CMOS
Serial Port	TTL Level, GPS NMEA Output with 1Hz or 5Hz update rate, Integrated into UHD

GPS Frequency	L1, C/A 1574MHz
GPS Antenna	Active (3V compatible) or Passive (0dB to +30dB gain) 65 Channels, QZSS, SBAS WAAS, EGNOS, MSAS capable
GPS Receiver	Supports Position and Hold over-determined clock mode
Sensitivity	Acquisition -148dBm, Tracking -165dBm
TTF	Cold Start: <32 sec, Warm Start: 1 sec, Hot Start: 1 sec
ADEV	10s: <7E-011
Warm Up Time / Stabilization Time	10Ks: <2E-012 (GPS Locked, 25°C, no motion, no airflow)
Supply Voltage (Vdd)	<10 min at +25C to 1E-09 Accuracy
Power Consumption	3.3V Single-Supply, +0.2V/-0.15V
Operating Temperature	<0.16W
Storage Temperature	-10°C to +70°C
	-45C to 85C

Oscillator Specifications (internal)

Frequency	20MHz
Output of crystal	20MHz CMOS 3Vpp
Phase Noise	-135ps rms (100Hz to 10MHz)
Frequency Stability	±0.1ppm (internal TCXO without GPS) (0°C to +60°C)
Warm Up Time	1 min at +25C
Phase Noise at 100Hz	-65 dBc/Hz
Phase Noise at 10MHz	-97 dBc/Hz
Phase Noise at 100kHz	-116 dBc/Hz
Phase Noise at 10kHz	-136 dBc/Hz
Phase Noise at 100 kHz	<-148 dBc/Hz
Phase Noise at 100 kHz	<-155 dBc/Hz

- Spec Sheet: http://www.jackson-labs.com/assets/uploads/main/LTE-Lite_specsheet_20MHz.pdf
- User Manual: <http://www.jackson-labs.com/assets/uploads/main/LTE-Lite.pdf>

The Verilog code for the FPGA in the USRP N300/N310 is open-source, and users are free to modify and customize it for their needs. However, certain modifications may result in either bricking the device, or even in physical damage to the unit. Specifically, changing the I/O interface of the FPGA in any way, or modifying the pin and timing constraint files, could result in physical damage to other components on the motherboard, external to the FPGA, and doing this will void the warranty. Also, even if the PCIe interface is not being used, you cannot remove or reassign these pins in the constraint file. The constraint files should not be modified. Please note that modifications to the FPGA are made at the risk of the user, and may not be covered by the warranty of the device.

- **PWR:**
Power switch
- **RF 0 Group**
 - ◆ **TX/RX SMA/LED:**
RF Input Port / Indicates that data

is streaming on the TX/RX channel on daughterboard 0, channel 0

- ◆ **RX2 SMA/LED:** RF Input Port / Indicates that data is streaming on the RX2

channel on daughterboard 0, channel 0



• **RF 1 Group**

- ◆ **TX/RX SMA/LED:** RF Input Port / Indicates that data is streaming on the TX/RX channel on daughterboard 0, channel 1.

- ◆ **RX2 SMA/LED:** RF Input Port / Indicates that data is streaming on the RX2 channel on daughterboard 0, channel 1.

• **RF 2 Group**

- ◆ **TX/RX SMA/LED:** RF Input Port / Indicates that data is streaming on the TX/RX

channel
on
daughterboard
1,
channel
0.

◆ **RX2**
SMA/LED:
RF
Input
Port
/
Indicates
that
data
is
streaming
on
the
RX2
channel
on
daughterboard
1,
channel
0.

• **RF 3**
Group

◆ **TX/RX**
SMA/LED:
RF
Input
Port
/
Indicates
that
data
is
streaming
on
the
TX/RX
channel
on
daughterboard
1,
channel
1.

◆ **RX2**
SMA/LED:
RF
Input
Port
/
Indicates
that
data
is
streaming
on
the
RX2
channel
on
daughterboard
1,
channel
1.

• **LO**
IN
0/1

◆ **TX:**
Input
port
for
TX
LO
of
Daughterboard
0.
The
LO
input
frequency
must
be
twice
the
frequency

of
the
desired
RF
output
frequency.
An
LO
input
frequency
range
of
600
MHz
to
8000
MHz
corresponds
to
an
RF
output
frequency
of
300
MHz
to
4000
MHz.
LO
inputs
above
8000
MHz,
and
RF
outputs
above
4000
MHz,
are
not
supported.

The
LO
input
signal
level
should
be
+3
dBm,
but
may
be
between
0
dBm
and
+6
dBm.

◆ **RX:**
Input
port
for
RX
LO
of
Daughterboard
0.

The
LO
input
frequency
must
be
twice
the
frequency
of
the
desired
RF
output
frequency.
An
LO
input
frequency
range
of

600
MHz
to
8000
MHz
corresponds
to
an
RF
output
frequency
of
300
MHz
to
4000
MHz.
LO
inputs
above
8000
MHz,
and
RF
outputs
above
4000
MHz,
are
not
supported.
The
LO
input
signal
level
should
be
+3
dBm,
but
may
be
between
0
dBm
and
+6
dBm.

• **LO
IN
2/3**

◆ **TX:**
Input
port
for
TX
LO
of
Daughterboard
1.
The
LO
input
frequency
must
be
twice
the
frequency
of
the
desired
RF
output
frequency.
An
LO
input
frequency
range
of
600
MHz
to
8000
MHz
corresponds
to
an

RF
output
frequency
of
300
MHz
to
4000
MHz.
LO
inputs
above
8000
MHz,
and
RF
outputs
above
4000
MHz,
are
not
supported.

The
LO
input
signal
level
should
be
+3
dBm,
but
may
be
between
0
dBm
and
+6
dBm.

◆ **RX:**
Input
port
for
RX
LO
of
Daughterboard
1.

The
LO
input
frequency
must
be
twice
the
frequency
of
the
desired
RF
output
frequency.

An
LO
input
frequency
range
of
600
MHz
to
8000
MHz
corresponds
to
an
RF
output
frequency
of
300
MHz
to
4000
MHz.
LO
inputs
above

8000 MHz, and RF outputs above 4000 MHz, are not supported. The LO input signal level should be +3 dBm, but may be between 0 dBm and +6 dBm.

- **GPIO**

- ◆ **GPIO:** DB15 GPIO Interface. Additional details below.

- **GPS ANT:** Connection for the GPS antenna

- **REF IN:** Reference clock input

- **PPS/TRIG IN:** Input port for the PPS signal

- **TRIG OUT:** Output port for the exported reference clock

- **PWR:** Connector for the USRP N310 Series power supply

- **RESET:** Input button to reset device

- **MicroSD:** MicroSD Card



for
OE
Linux
File
System
• **Console**
JTAG:
Micro
USB
connector
for
the
on-board
USB-JTAG
programmer
as
well
as
TTY
login
to
the
console
• **USB**
2.0:
Host
USB
connector
to
ARM
CPU
• **SFP+:**
1/10Gb
SFP+
ports
for
Ethernet
interfaces

• **10/1000/1000:**
10/100/1000
Mb
Ethernet
interface
to
ARM
CPU

An external 10 MHz reference clock may be used. The optimal signal is a square wave as created by the [OctoClock/CDDA-2990](#). The input signal power level of the reference clock must not exceed +15 dBm.

Using a PPS signal for timestamp synchronization requires a square wave signal (a typical PPS signal has a 20%-25% duty cycle) with a 5Vpp amplitude.

To test the PPS input, you can use the following tool from the UHD examples:

- `<args>` are device address arguments (optional if only one USRP device is on your machine)

```
cd <install-path>/lib/uhd/examples ./test_pps_input ?args=<args>
```

The GPIO port is not meant to drive big loads. You should not try to source more than 5mA per pin.

The +3.3V is for ESD clamping purposes only and not designed to deliver high currents.

The hardware power on state and UHD initial state for the front-panel GPIOs is high-Z. For the N310, there are no external pull-ups/pull-downs for the GPIO pins, but the FPGAs do have them and they are configured as follows: N310: pull-down.

- Pin 1: +3.3V
- Pin 2: Data[0]
- Pin 3: Data[1]
- Pin 4: Data[2]
- Pin 5: Data[3]
- Pin 6: Data[4]
- Pin 7: Data[5]
- Pin 8: Data[6]
- Pin 9: Data[7]
- Pin 10: Data[8]
- Pin 11: Data[9]
- Pin 12: Data[10]
- Pin 13: Data[11]
- Pin 14: 0V
- Pin 15: 0V

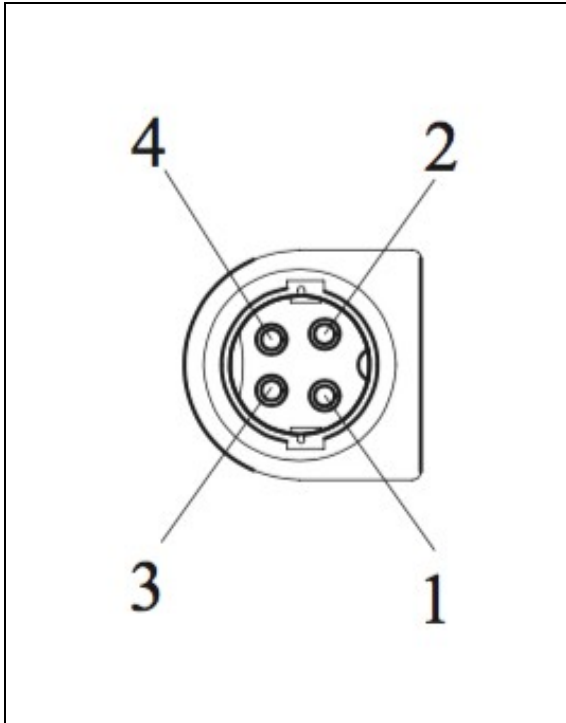
Note: Please see the [E3x0/X3x0/N3x0 GPIO API](#) for information on configuring and using the GPIO bus.

Model: PDP-40 by CUI Inc.

Power plug connectors for custom power harnesses can be purchased here:
https://www.digikey.com/products/en?Keywords=CP-7340-ND&WT.z_cid=sp_102_buynow

Assembly instructions: [Media:pdp-40.pdf](#)

- Pins #1 / #2: 12v
- Pins #3 / #4: Ground



As of December 1st, 2010 all Ettus Research products are RoHS compliant unless otherwise noted. More information can be found at <http://ettus.com/legal/rohs-information>

Management Methods for Controlling Pollution Caused by Electronic Information Products Regulation

Chinese Customers

National Instruments is in compliance with the Chinese policy on the Restriction of Hazardous Substances (RoHS) used in Electronic Information Products. For more information about the National Instruments China RoHS compliance, visit ni.com/environment/rohs_china.

Found on the [NI Product Certifications lookup tool](#) here.

[FPGA Resources](#)

[UHD Stable Binaries](#)

[UHD Source Code on Github](#)

Recommended 10 Gigabit Ethernet Cards

- Intel X520-DA2
 - ◆ [Intel® Ethernet Converged Network Adapter X520-DA2](#)
- Intel X520-DA1
 - ◆ [Intel® Ethernet Converged Network Adapter X520-DA1](#)
- Intel X710-DA2
 - ◆ [Intel® Ethernet Converged Network Adapter X710-DA2](#)
- Intel X710-DA4
 - ◆ [Intel® Ethernet Converged Network Adapter X710-DA4](#)
- Mellanox MCX4121A-ACAT
 - ◆ [Mellanox MCX4121A-ACAT](#)

The power supply provided with the USRP N310 kit is packaged with a power cord that is compatible with power outlets in the US/Japan. If you are not using the USRP N310 in the US/Japan, we recommend purchasing the International USRP N310 Power Cord set.

The USRP N300/N310 was designed to be used with a [1U Rackmount Assembly](#) for building high-density MIMO systems in a compact and well-organized setup. This mount *requires* two compatible USRPs, and provides rubber standoffs between the USRPs to avoid both direct contact and surface scratching. If the user will be developing in a laboratory environment or building a high-channel count USRP system, then a 1U Rackmount

Assembly is highly recommended. This specific mount is compatible with only the USRP N300, N310, N320, and N321, and allows the integration of up to eight bidirectional RF channels per 1U.

Ettus Research currently offers direct-connect, copper cabling accessories for the USRP N300/N310. However, it is also possible to use multi-mode fiber instead of copper connections for these devices. In this section, we will provide general guidance on the types of fiber adapters and cables that can be used with these products.

The USRP N300/N310 USRP is compatible with most brands of SFP+ fiber adapters. In some cases, other equipment in the systems such as 1/10 Gigabit Ethernet switches are only compatible with specific brands of SFP+ adapters and cables. As a general rule, we recommend checking compatibility with the switches and network cards in your system before purchasing an adapter.

Ettus Research does test the USRP N300/N310 USRP devices with our [10 Gigabit Ethernet Connectivity Kit](#) and a Blade Networks G8124 1/10 GigE switch. Here are is a list of known-good cables and adapters.

Ettus Research has only tested multi-mode fiber accessories.

- [Approved Optics BN-CKM-SP-SR-A](#)
- [Elpeus 10GbE SFP+ AOC Cable, 3 meters](#)

Many new motherboards come equipped with an onboard 10Gb RJ45 NIC. It is possible to use a SFP+ to RJ45 adapter and operate at 10Gb speeds using a Cat6/7 Ethernet cables.

Ettus Research has tested the adapters linked below.

- [10Gtek SFP+ to RJ45 Copper Module](#)
- [ProLabs 10G-SFPP-T-C](#)

As of UHD version 3.14.0.0, the following data rates have been tested and validated.

Number of TX Channels	Number of RX Channels	Maximum Sampling Rate
1	0	153.6 MS/s
0	1	153.6 MS/s
1	1	153.6 MS/s
2	0	125 MS/s
0	2	125 MS/s
2	2	125 MS/s
3	0	62.5 MS/s
0	3	125 MS/s
3	3	62.5 MS/s TX, 125 MS/s RX
4	0	62.5 MS/s
0	4	125 MS/s
4	4	62.5 MS/s TX, 125 MS/s RX