

# RFXpress® – Advanced RF/IF/IQ Waveform Creation and Editing Software

RFX100



## RF Signal Generation Made Easy

RF signals are becoming more and more complex, making it more difficult for RF engineers to accurately create the signals required for conformance and margin testing. To address this design challenge, Tektronix' RFXpress delivers advanced RF/IF/IQ creation and editing tools. RFXpress is a software package that digitally synthesizes modulated base band, IF and RF signals taking signal generation to the new levels by fully exploiting the wideband signal generation capabilities of Tektronix arbitrary waveform generators (AWGs). Supporting a wide range of modulation schemes, the software allows users to duplicate standard waveforms or customized waveforms with specific modulation and frequency hopping criteria. In "Auto Mode", the software can automatically calculate the waveform length (in samples or packets) and the sampling rate required to accurately create the desired output from the arbitrary waveform generator. RFXpress also includes a calibration feature that can pre-distort the signals to provide flat frequency and linear phase response from the AWG output. RFXpress enables users to easily replicate waveforms from Tektronix oscillos-

copes (\*.wfm) and IQ waveforms of a real-time spectrum analyzer (\*.iqt, \*.tiq). Impairments, distortion or interference can be then added to thoroughly stress test designs.

UWB-WiMedia (UWBCF/UWBCT) is a software module for RFXpress that has the capability to digitally synthesize and generate signals in the UWB spectrum. As per the latest WiMedia specification, the software module can recreate signals that are required to band hop in real-time over 1.5 GHz modulation bandwidth. UWBCF/UWBCT gives users complete control over the characteristics of the WiMedia signal including the preamble synchronization sequences, cover sequences, TFCs in all band groups. All six band groups (BG1 – BG6) can be generated in either IQ, IF or Direct RF signals giving users three different options for creating/upconverting the signals. The software operates in two modes, in the conformance mode (UWBCF) users can generate the standard waveforms that conform to the latest version of the WiMedia's specifications, in the custom mode (UWBCT) users can adjust any part of the signal header or payload to perform for stress and margin testing.

## Features & Benefits

Define base band IQ, IF and RF signals using a variety of modulation schemes and create single and multi-carrier signals

Define and create hopping patterns

Apply linear and non-impairments such as quadrature error, IQ imbalance, interferences and multipaths during waveform creation

Replay baseband waveform files imported from oscilloscopes (\*.wfm), Real-time spectrum analyzers (\*.iqt, \*.tiq) and MATLAB®1 (\*.mat) files as IQ or IF/RF.

Apply calibration for flat frequency and linear phase response out of AWG

### UWB-WiMedia

- Direct RF generation of all the WiMedia band groups (BG1 to BG6) including band hopping\*2
- Comprehensive WiMedia signal generation support for MAC and PHY layers
- Gated noise feature can be used to define noise profiles, which can be defined individually for each section of the UWB Packet (preamble, PDU Header and PSDU)
- Create tone nulling with intermediate values for both amplitude (+20 dB to -40 dB) and phase (-180° to +180°) for OFDM carrier mapping
- Apply ready to use "Real-world interference" like WiFi (802.11a and MIMO), WiMAX, radar and captured baseband waveforms as interferer to the WiMedia waveform
- Define your own TFC pattern in custom mode

### Radar

- Create single or multiple pulse groups to form a coherent or a non-coherent pulse train
- Define each pulse group independently
- Define inter and intra pulse hopping patterns in both frequency and amplitude
- Define all pulse parameters including start time, rise time, off time, fall time, pulse width, droop, overshoot and ripple
- Define a staggered PRI with ramp and user-defined profiles
- Support for a variety of intra-modulation types including FM chirp, FM step, barker codes, polyphase codes, user-defined step FM and codes and custom modulation

## Applications

Design and debug wideband wireless communications receivers

Characterize WiMedia MB-OFDM ultra wideband (UWB) radio platform for applications like Wireless USB (WUSB), FireWire, Bluetooth and others

Design, debug and develop of radar receivers and radar systems

\*1 MATLAB® is a registered trademark of Math Works.

\*2 Using a Tektronix AWG7122B with Option 06, BG5 requires calibration.

Radar signal creation, a software module for RFXpress that provides the ultimate in flexibility for creating Pulsed Radar waveforms. It gives users the ability to build custom Radar pulse suite starting from pulse to pulse trains to pulse groups. It supports a variety of Modulation schemes including LFM, Barker and Poly phase Codes, User-defined codes, Step FM, Non-Linear FM, User-defined Step FM and Custom modulation. It also has the ability to generate pulse trains with staggered PRI to resolve Range and Doppler ambiguity, frequency hopping for Electronic Counter Counter Measures (ECCM) and Pulse-to-Pulse Amplitude variation to simulate Swerling target models.

**RFXpress** runs on a PC or as an integral part of Tektronix AWG5000/AWG5000B and AWG7000/AWG7000B Series arbitrary waveform generators.

## Characteristics\*1

### Software

#### Software Applications –

RFXpress for General Purpose: General Purpose Signal Creation IQ, IF and RF signal creation.  
RFXpress plug-In for Conformance Signal Creation.  
UWB-WiMedia IQ, IF and RF: Custom Signal Creation  
RFXpress plug-In for Radar IQ, IF and RF: Radar Signal Creation.

**User Interface** – Resides and runs on Windows XP Professional or Windows Vista Business Edition (English Language).

#### Compatibility for Import and Replication of Waveform Files

**Oscilloscopes** – Tektronix TDS6000, DSA70000, DPO70000 and DPO7000 Series (\*.wfm).

**Arbitrary Waveform Generators** – Tektronix AWG400, AWG500, AWG600 and AWG700 Series (\*.wfm).

**Real-time Spectrum Analyzers** – Tektronix RSA3000 and RSA6000 Series (\*.iqt, \*.tiq).

**MATLAB®** – MATLAB Binary Formats (\*.mat).

### Instrument Control

**Tektronix Arbitrary Waveform Generators – RFXpress** runs on an external PC or an integral part of the AWG7000/AWG7000B and AWG5000/AWG5000B Series. When installed as an integral part of the instrument waveform transfer and control can be performed directly from RFXpress.

Controls:

Analog: Sampling Rate, Interleave and Zeroing On/Off, Amplitude, Offset, Run, Stop and Channel Output On/Off, Sequence Run Mode (For Radar Plug-in only).  
Digital Markers: Amplitude High, Low and Delay.

**Tektronix Oscilloscopes** – Remote control Tektronix oscilloscope parameters from RFXpress.

Controls:

General settings: Run, Stop, Single and Autose. Vertical settings: Channel, Scale.  
Horizontal settings: Scale, Record length, sampling rate.

**IQ Modulators** – Remote control PSG®\*2–E8267D modulator parameters from RFXpress.

Controls: Frequency, Frequency Offset, Amplitude, Amplitude Offset, Output RF On/Off, Output Mod On/Off, Source type, Frequency mode, ALC On/Off, ALC mode, ALC band width, ALC levels, Attenuation hold On/Off, ALC power, Attenuation. Carrier Leakage Suppression: IQ state, IQ adjustment, I offset and Q offset.

### RFXpress for General Purpose IQ, IF and RF Signal Creation\*3

**Carrier Definition** – Single Carrier, Multi-carrier (1 to 512).

**Amplitude** – IF/RF: –100 dBm to +30 dBm; IQ: 0 VRMS to 5 VRMS.

**Base Data** – All 0 (Zero), All 1 (One), PRBS (7, 9, 15, 16, 20, 21, 23, user-defined), Pattern and file input.

**Modulation Schemes** – No Modulation, QPSK, BPSK, Pi/4-QPSK, O-QPSK, 8PSK, O-8PSK, SD-PSK, QAM16, QAM32, QAM64, QAM128, QAM256, QAM512, QAM1024, GMSK, 2-FSK, 4-FSK, 8-FSK, 16-FSK, 32-FSK, ASK, AM, FM, PM, File1 (I and Q Samples), File2 (I and Q Symbols), File3 (Symbol maps).

**Symbol Map** –

Total symbols: 2 to 512.

Modulation Modes: Normal, Diff (Continuous), Diff (Alternate).

Rotation angle: –180 to +180 degrees.

Offset Modulation: On/Off.

Pre-defined Map – None, BPSK, QPSK, QAM16, QAM32, QAM64, QAM128, QAM256.

**Filter** – No Filter, Raised Cosine, Rectangular, Triangular, Square Root Raised Cosine, Gaussian (Dirac Delta), Gaussian (Rectangular), EDGE, user-defined Filter (from a file).

**Window** – No Window, Triangular, Hamming, Kaiser, Hamming, Chebyshev, Ripple, Blackman, Blackman-Harris, Tapered Cosine, Exact Blackman and Flat Top.

**Window Parameters** –

Kaiser Parameter: 1 to 10.

Chebyshev Ripple: 10 db to 80 dB.

**Coding** – Gray, Differential, Gray differential, GSM differential, NADC, TFTS, MSAT differential.

**Hopping** –

Hopping Parameters: Hop, Start Symbol, End Symbol, Frequency Offset (+/- MHz), Relative Amplitude (+/- dB).

**Power Ramp** –

Ramp Functions: None, Linear and Cosine.

Ramping Time: 0 to 1 second.

Power level for the symbols: form –60 dB to +20 dB.

**IQ Impairments** –

Carrier Leakage: I: –50% to +50%; Q: –50% to +50%.

Quadrature Error: –30 degrees to +30 degrees.

IQ Imbalance: 30% to +30%.

AM/AM Conversion: k2: –3 dB +3 dB.

k3: –3 dB to +3 dB.

AM/PM Conversion: k2: –30 degrees to +30 degrees.

k3: –30 degrees to +30 degrees.

Hardware Skew: –100 ps to +100 ps (AWG7000B).  
–5 ns to +5 ns (AWG5000B).

**IQ Swap** – On/Off.

I Invert: On/Off.

Q Invert: On/Off.

**Distortion Addition** –

Amplifier Distortion: Amplifier–Non linear, soft limiting, hard limiting.

AM/AM Conversion: k3: –3 dB +3 dB.

k5: –3 dB to +3 dB.

AM/PM Conversion: k3: –30 degrees to +30 degrees.

k5: –30 degrees to +30 degrees.

**Interference Addition** –

Offset: –6 GHz to +6 GHz (AWG7000B option 02/06).

Frequency: –3 GHz to +3 GHz (AWG7000B standard option). –185 MHz to +185 MHz (AWG5000B).

Sinusoidal Interference:

C/I: –40 dB to +40 dB.

Frequency Offset: –6 GHz to +6 GHz (AWG7000B option 02/06). –3 GHz to +3 GHz (AWG7000B standard option). –185 MHz to +185 MHz (AWG5000B).

Signal Addition: Software, Hardware

IQ and RF/IF.

\*1 All ranges mentioned in the data sheet are for AWG7122B with Opt. 06 until and otherwise explicitly stated.

\*2 PSG® is a registered trademark of Agilent Technologies.

\*3 All ranges mentioned in the data sheet are for AWG7122B with Opt. 06 until and otherwise explicitly stated.

**Multi-path –**

Number of Paths: 0 to 10.  
 Delay: –80 Symbols to +80 Symbols.  
 Amplitude: –60 dB to 0 dB.  
 Phase: –180 degrees to +180 degrees.

**Graphs –**

In-phase i(t) and quadrature q(t) component vs. time.  
 Eye diagram I.  
 Eye diagram Q.  
 Constellation (Vector q (t) vs. i (t)).  
 Spectrum for both RF/IF and I/Q signals (magnitude spectrum of the I/Q signal vs. frequency).  
 Pulse Shape.  
 CCDF.  
 Spectrogram.  
 Correction plot of phase and amplitude after calibration.  
 CPI Plot (only for Radar Plug-In).

**Calibration –** Calibrate the signal or calibrate the image.

Average: 1 to 100.  
 Start Frequency: 10 MHz to 0.49 fs.  
 End Frequency: 10 MHz to 0.49 fs.  
 Frequency Resolution: 1 MHz to 10 MHz in increments of 1 MHz.

**RFXpress Plug-In for UWB-WiMedia Signal Generation\*1****RFXpress Plug-In for –** Conformance signal creation (UWBCF).**UWB-WiMedia IQ, IF and RF –** Custom signal creation (UWBCT).**Setup –**

In addition to user-defined setup via “My setup”, three example setups are provided:  
 WiMedia Specs example packet.  
 53.3, 80 and 106.7 Mbps packets.  
 480 Mbps Burst Mode packets.

**Marker Mapping –** Two markers can be mapped for each of the bands with a marker delay ranging from: –312.5 ns to +312.5 ns.**Number of Packet groups –** 1 to 100.

Number of packets in a packet group – 1 to 30.

**Packet Group Repetition –** 1 to 100 times.**Group Start Delay –** 0 to 200 symbols.**Group End Delay –** 0 to 200 symbols.**Spacing between Packets –**

Standard Mode: 6 symbols to 200 Symbols.  
 (Can be defined in pSIFS and pMIFS).

**Payload Source –**

WiMedia Spec example.  
 ALL 0 (Zero), ALL 1 (One).  
 PRBS7, 9, 15, 16, 20, 21 and 23.  
 User-defined (By File Input).

**Tone Nulling –** –40 dB to +20 dB.**MAC Header –**

10 byte MAC header data can be selected from WiMedia Spec example.  
 ALL 0 (Zero), ALL 1 (One).  
 PRBS7, 9, 15, 16, 20, 21 and 23.  
 User-defined: wherein user can enter the MAC header pattern and file input.

**Packet Mode –** Standard, Burst.**Preamble Type –** Standard or Burst for data rates greater than 200 Mbps.**Packet Size –**

Standard Mode: 0 to 4095.  
 Burst Mode: 1 to 4095.

**BandGroup –** BandGroup1 to BandGroup 6.**TF Code –** TFC1 to TFC10.**BandGroup Center Frequency –** Can be defined by the user.**Calibration –** RF and IF.**IQ Impairments –**

Carrier Leakage: I: –50% to +50%; Q: –50% to +50%.  
 Quadrature Error: –30 degrees to +30 degrees.  
 IQ Imbalance: –30% to +30%.  
 AM/AM Conversion: k2: –3 dB +3 dB.  
 k3: –3 dB to +3 dB.  
 AM/PM Conversion: k2: –30 degrees to +30 degrees.  
 k3: –30 degrees to +30 degrees.  
 Hardware Skew: –100 ps to +100 ps (AWG7000B);  
 –5 ns to +5 ns (AWG5000B).

**Distortion Addition –**

Amplifier Distortion Amplifier: No linear, soft limiting, hard limiting.  
 AM/AM Conversion: k3: –3 dB + 3 dB.  
 k5: –3 dB to +3 dB.  
 AM/PM Conversion: k3: –30 degrees to +30 degrees.  
 k5: –30 degrees to +30 degrees.

**Interference Addition –**

Offset Frequency:  
 –6 GHz to +6 GHz (AWG7000B Option 02/06).  
 –3 GHz to +3 GHz (AWG7000B standard option).  
 –185 MHz to +185 MHz (AWG5000B).  
 Sinusoidal Interference C/I: –60 dB to 60 dB.  
 Frequency Offset:  
 –6 GHz to +6 GHz (AWG7000B Option 02/06).  
 –3 GHz to +3 GHz (AWG7000B standard option).  
 –185 MHz to +185 MHz (AWG5000B).

**Real-World Signal Interference –** WiMax, WiFi (MIMO), WiFi (802.11a), Radar, IQ interference signal as file input.

Frequency: 1 Hz to 12 GHz.  
 Amplitude: –60 dB to +60 dB.

**Signal Addition Software, Hardware IQ and RF/IF****Gated Noise –**

Packets: Preamble S/N, PLCP header S/N, Payload S/N “–40 dB to +20 dB.”  
 Symbols S/N: –40 dB to +20 dB.

**Multi-path –**

Number of Paths: 0 to 10.  
 Delay: –2 Symbols to +2 Symbols.  
 Amplitude: –60 dB to 0 dB.  
 Phase: –180 degrees to +180 degrees.

**Conformance Mode –**

Data Rates: 53.3, 80, 106.7, 160, 200, 320, 400 and 480 Mbps.

**Custom Mode –**

TF Code: TFC1 to TFC10 and user-defined. User can define his/her own hopping sequence and number the TFC code from 1 to 15. Select this option to generate signals for the selected TF code without hopping. However, markers still continue to hop based on the TFC pattern.  
 User-defined components in the PPDU structure: Preamble Time domain base sequence, cover sequence, reserved bits, tail bits, HCS, channel estimation, frame payload, sequence, length, scrambler init, hopping pattern, Reed-Solomon parity bits and FCS can either be calculated/ taken from standard or can be defined by the user.  
 Provision to switch off the PLCP Header and the PSDU.

**RFXpress Plug-In for Radar Signal Creation\*1****Number of Pulses –** 4096 max.**Pulse Shape –** Trapezoidal, Raised Cosine, Exponential, Rectangular, Saw Tooth and Custom.**Pulse Parameters –** Start Time (To), Rise Time (Tr), Pulse Width (Ton), Fall Time (Tf), Off Time (Toff).**Amplitude Relative to Carrier –** –80 dB to 0 dB.**Offset from Carrier Frequency –**

–6 GHz to +6 GHz (AWG7000B option 02/06),  
 –3 GHz to +3 GHz (AWG7000B standard option),  
 –185 MHz to +185 MHz (AWG5000B).

**Staggered PRI –**

Ramp: –180 degrees to +180 degrees.  
 User-defined.

**Modulation****Linear Frequency Modulation (LFM) –**

Sweep Range: 0 to 12 GHz.  
 Frequency Sweep: Low to high, High to low.

**Bi-phase Coded Pulse - Barker –** 2, 3, 4, 5, 7, 11, 13.**Poly Phase Codes –**

Number of Steps: 200.  
 Initial Offset: –180 degrees to +180 degrees.  
 Phase Offset: –180 degrees to +180 degrees.

**User-defined Codes****Step Frequency Modulation**

Number of Steps: 200.  
 Initial Step: –100 KHz to 6 GHz.  
 Step Size: –100 KHz to 6 GHz.

**Non Linear FM****User-defined Step FM****Custom Modulation****Pulse-to-Pulse Hopping –** Frequency offset (±MHz), Relative Amplitude (±dB).**Pulse Impairments –**

Edge jitter: Gaussian, Uniform.  
 Width jitter: Gaussian, Uniform.

\*1 All ranges mentioned in the data sheet are for AWG7122B with Opt. 06 until and otherwise explicitly stated.

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**Amplitude Deviation –**

- Drop: -50% to 0%.
- Over Shoot: 0% to 50%.
- Ripple: 0% to 50%.
- Ripple Frequency: 1 Hz to 6 GHz.

**IQ Impairments –**

- Carrier leakage: I: -50% to +50%; Q: -50% to +50%.
- Quadrature error: -30 degrees to +30 degrees.
- IQ imbalance: -30% to +30% .
- Hardware skew: -100 ps to +100 ps (AWG7000B), 5 ns to +5 ns (AWG5000B).
- IQ swap: On/Off.

**Signal Addition –** Software, Hardware, IQ and RF/IF.

**Noise –**

- SNR: -60 dB to +60 dB.
- Bandwidth: 0.01 fs to 0.50 fs.

**System Requirements**

The following PC configuration is required to install the offline version.

**Note:** The hardware requirements detailed here are the minimum required. Additional processing

power and memory will increase the performance of the generation software.

- PC with genuine Intel Pentium class >1.2 GHz processor recommended
- Intel or 100% compatible motherboard chipset
- Windows XP Operating System or Windows Vista Business Edition (English Language)
- 512 megabytes (MB) RAM
- 2 Gb of available hard disk space for the applications and documentation
- XVG 1024X768 with 120 dpi font size recommended
- CD-ROM or DVD drive
- Keyboard and Microsoft mouse or compatible pointing device

**Ordering Information**

**RFX100**

RFX100 can be ordered as follows:

**Contact Tektronix:**

- ASEAN/Australasia (65) 6356 3900
- Austria +41 52 675 3777
- Balkans, Israel, South Africa and other ISE Countries +41 52 675 3777
- Belgium 07 81 60166
- Brazil & South America (11) 40669400
- Canada 1 (800) 661-5625
- Central East Europe, Ukraine and the Baltics +41 52 675 3777
- Central Europe & Greece +41 52 675 3777
- Denmark +45 80 88 1401
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- France +33 (0) 1 69 86 81 81
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- Hong Kong (852) 2585-6688
- India (91) 80-22275577
- Italy +39 (02) 25086 1
- Japan 81 (3) 6714-3010
- Luxembourg +44 (0) 1344 392400
- Mexico, Central America & Caribbean 52 (55) 5424700
- Middle East, Asia and North Africa +41 52 675 3777
- The Netherlands 090 02 021797
- Norway 800 16098
- People's Republic of China 86 (10) 6235 1230
- Poland +41 52 675 3777
- Portugal 80 08 12370
- Republic of Korea 82 (2) 6917-5000
- Russia & CIS +7 (495) 7484900
- South Africa +27 11 206 8360
- Spain (+34) 901 988 054
- Sweden 020 08 80371
- Switzerland +41 52 675 3777
- Taiwan 886 (2) 2722-9622
- United Kingdom & Eire +44 (0) 1344 392400
- USA 1 (800) 426-2200

For other areas contact Tektronix, Inc. at: 1 (503) 627-7111  
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**For Further Information**

Tektronix maintains a comprehensive, constantly expanding collection of application notes, technical briefs and other resources to help engineers working on the cutting edge of technology. Please visit [www.tektronix.com](http://www.tektronix.com)

**RFXpress**

Product	Option	Description
RFX100		Base Software: RFXpress for general purpose RF, IF and IQ signal creation

**RFXpress plug-In for:**

Opt. UWBCF	UWB-WiMedia IQ, IF and RF conformance signal creation (requires RFX100 as prerequisite)
Opt. UWBCF	UWB-WiMedia IQ, IF and RF custom and conformance signal creation (requires RFX100 as prerequisite and includes Option UWBCF)
Opt. RDR	RADAR signal creation (requires RFX100 as prerequisite)



Product(s) are manufactured in ISO registered facilities.

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C and with Tektronix Standard Codes and Formats.

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