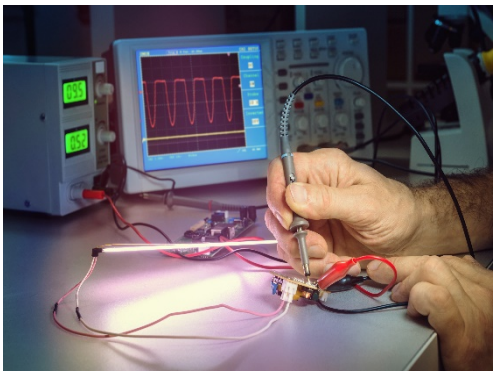
Model 685 High Performance Arbitrary Waveform and Digital Pattern Generator



Features

- 2, 4 or 8 Analog Channels
- 6.16 GS/s, 16-bit Vertical Resolution
- 180 MHz Bandwidth
- Up to 5 Vp-p Output Voltage and
  ± 2.5V Hardware Offset into 50 Ohm
- Up to 4 Gpts Waveform Memory per Channel
- Up to 32 Digital Channels in Synchronous with Analog Generation

Applications

- Aerospace and Defense
- Institute and University Research
- Semiconductor Tests
- Automotive
- Internet of Things (IoT)

Model 685 | 2 GHz 6.16 GS/s
Arbitrary Waveform Generator

Model 685 Arbitrary Waveform Generator

Model 685

Description

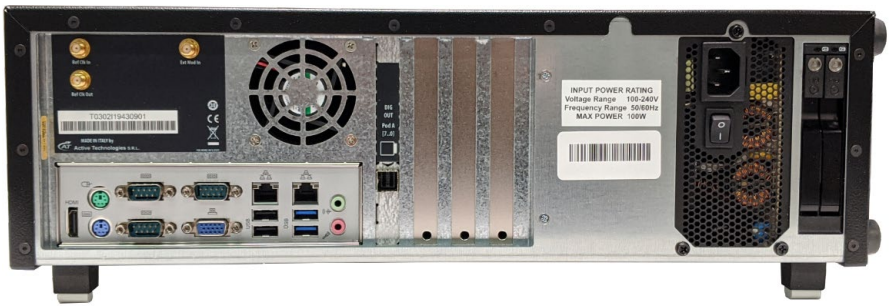
The Model 685 is a simple-to-use arbitrary waveform generator. It operates on a Windows-based platform with 7” touch screen, front panel buttons, and knob. The instrument has two operation modes--Simple Rider AFG (DDS AFG mode) and TrueArb (variable clock Arbitrary AWG mode)--which makes the instrument easier to control. The Model 685 supports a standard Ethernet interface for remote control and easily customizable instrument programming.

The Model 685 comes with a 2 GHz arbitrary frequency generator and 8 analog channels which operate at up to 5 Vp-p output voltage into 50 Ω load impedance. Up to 32 digital output option is also available. In this option, each digital output provides up to a 1.54 Gb/s data rate in LVDS output format. The Model 685 also boasts a 1 S/s (Sample/second) to 6.16 GS/s with 16-bit vertical resolution, providing outstanding signal integrity with a rise time/fall time of less than 1 ns.

Up to 4 instruments can be synchronized together in order to obtain a 32 analog – 128 digital channel generator. A dedicated synchronization bus guarantees intra-chassis synchronization. The synchronization bus feature is available only on the Model 685.

Model 685 Front

Model 685 Back



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Model 685 User Interface

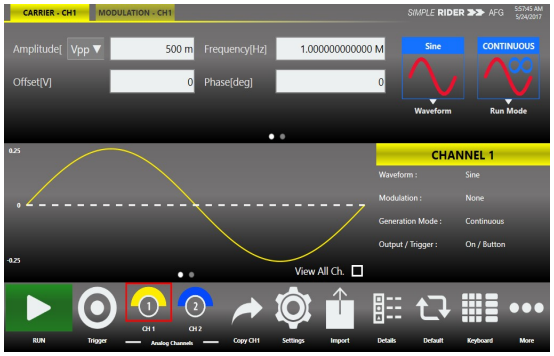
Simple Rider AFG: Function Generator Mode Interface

Simple Rider AFG UI is designed using a touchscreen interface; it has been developed to put all the capabilities of modern Waveform Generators right at your fingertips. All instrument controls and parameters are accessible through an intuitive UI that recalls the simplicity of modern tablets and smartphones. Scientists and engineers can use gestures and touch commands to create advanced waveforms or digital patterns with ease.

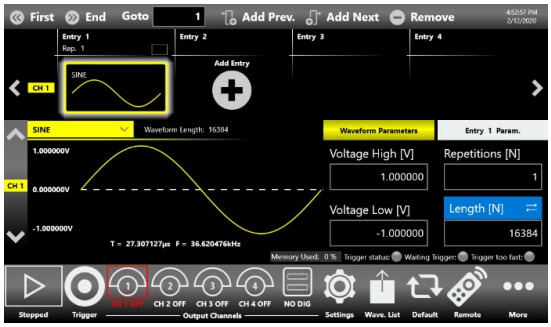
- The swipe gesture gives easy access to the output waveform parameters
- A touch-friendly virtual numeric keypad has been designed to improve the user experience with regard to entering data.
- Time-saving shortcuts and intuitive icons simplify the instrument setup.

Simple Rider TrueArb: AWG and DPG Mode Interface

In **Simple Rider TrueArb** interface, the users can define complex waveforms with up to 16,384 sequence entries of analog waveforms and digital patterns. Additionally, they can define their execution flow through loops, jumps, and conditional branches.



Digital output combined and synchronized with analog output signals is an ideal tool to troubleshoot and validate digital design. The waveform memory length of up to 4 GSamples on each channel combined with up to 16,384 and up to 4,294,967,294 repetitions, make the Model 685 the ideal generator for the most demanding technical applications.



Thanks to the intuitive and easy waveform sequencer user interface, you can create the most complex waveform scenarios with just a few screen touches.

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Model 685 Applications

Automotive

Today's cars include highly sophisticated electronic control units with sensitive electronic components. The Model 685 combines a 6.16 GSa/s sampling rate with a 16-bit vertical resolution, represents an ideal tool for successfully addressing the new testing challenges in the automotive industry. It includes these features.

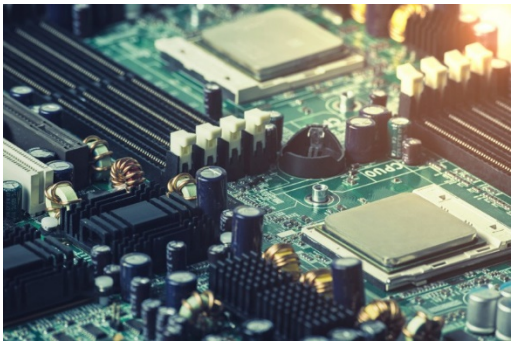
- EMI debugging, troubleshooting, and testing
- Electrical standards emulation up to 5V

IoT and Ind 4.0 Perfect RF Modulator

The Model 685 is the iconic instrument for this application. The possibility to emulate complex RF I/Q modulation for simulation and test vs wireless devices or working on Internet of things of industry 4.0 applications. Each engineer may import waveforms to emulate devices for test purposes and impose distortion on waveforms (such as noise) to test device compliance with standards.

Semiconductor Testing

Emulation of complex signals generated with inclusion of noise or distortions may became an excellent way to provide Compliance Components Test to help semiconductors engineers. The fast edges and pulse generation can be used to provide characterization in fast power devices.



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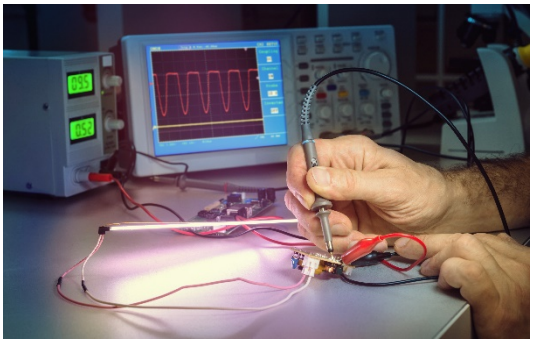
Research Applications

Research centers and universities use the Model 685 to produce complex waveforms, multilevel signals, and pulse emulation based on variable edges. The Model 685's fast edge generation, excellent dynamic range, and simple user interface meets the demands of scientists and engineers working on intensive experiments. Such experiments include accelerators, tokamak, or synchrotrons. The Model 685 allows them to emulate signals without creating specific test boards. The Model 685 includes these features useful for research applications.

- Emulation of detectors
- Emulation of signal sources adding noise
- Generation/playback of real-world signals
- Emulation of long PRBS sequences
- Modulating and driving laser diode



Aerospace and Defense applications

The Model 685 works perfectly with electronic warfare signals, such as those produced by radar or sonar systems. This generator can also be fitted into a modular system for radio or I/Q signal modulation. It can create pulses useful in pulse electron beams, X-ray sources, flash X-ray radiography, lightning pulse simulators, and high-power microwave modulators. These features of the Model 685 are useful in the aerospace and defense industry.

- Frequency response, intermodulation distortion and noise-figure measurements
- Phase Locked Loop (PLL) pull-in and hold range characterization
- Radar base-band signals emulation

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Model 685 Specifications

All specifications are typical unless noted otherwise. The guaranteed performances are referred to a calibrated instrument that has been stored for a minimum of 2 hours within the operating temperature range of 5°C to 40°C and after a 45-minute warm up period. Within ±10°C after auto-calibration

General Specifications			
Number of Channels	**Model 685-2C**	**Model 685-4C**	**Model 685-8C**
Analog	2	4	8
Digital Out	0/8 optional	0/8/16 optional	0/8/16/32 optional
Marker Out	1	2	4
Operating Mode	AFG Mode True Arb Mode		
Amplitude			
Range (50 Ω into 50 Ω)	0 to 5 V_{p-p}		
Accuracy (1kHz sine wave, 0V offset, > 5mV_{p-p} amplitude, 50Ω load) (guaranteed)	±(1% of setting [V_{p-p}] + 5 mV)		
Resolution	<0.2 mV_{p-p} or 5 digits		
Output impedance	Single-ended: 50 Ω		
Baseline Offset			
Range (50 Ω into 50 Ω)	-2.5 V to +2.5 V		
Range (50 Ω into High Z load)	-2.5 V to +2.5 V		
Accuracy (50 Ω into 50 Ω) (guaranteed)	±(1% of |setting| ±5 mV)		
Resolution	<4 mV or 4 digits		
DC			
Amplitude range (50 Ω, single-ended)	-2.5 V to +2.5 V		
Amplitude accuracy (guaranteed)	±(1% of |setting| + 10 mV)		
AFG Mode Specifications			
Output Channels			
Connectors	SMA on front panel		
Output type	Single-ended		
Output Impedance	50 Ω		
General Specifications			
Operating mode	DDS mode		
Standard Waveforms	Sine, Square, Pulse, Ramp, more (Noise, DC, Sin(x)/x, Gaussian, Lorentz, Exponential Rise, Exponential Decay, Haversine)		
Run Modes	Continuous, modulation, sweep, burst		
Arbitrary Waveforms	Vertical resolution: 16-bit Waveform length: 16,384 points		
Internal Trigger Timer Range Resolution Accuracy	 10.4 ns to 88 s 80 ps ±(0.1% setting + 5 ps)		
Sine Waves			
Frequency Range Sine (50 Ω into 50 Ω)[1]	1 µHz to ≤ 1 GHz: 5 V_{p-p} 1 GHz to ≤ 2 GHz: 4 V_{p-p}		
Flatness (1 V_{p-p}, relative to 1 kHz)	DC to 2 GHz: ±0.5 dB		

[1] Amplitude doubles on HiZ load

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Harmonic Distortion (1 V_{p-p})	1 µHz to ≤ 20 kHz: < -75 dBc > 20 kHz to ≤ 400 MHz: < -70 dBc > 400 MHz to ≤ 1 GHz<: < -60 dBc > 1 GHz to ≤ 2 GHz: < -55 dBc
Total Harmonic Distortion (1 V_{p-p})	10 Hz to 20 kHz: < 0.05% TBC
Spurious (1 V_{p-p}) (measured across DC to Fs/2)	1 µHz to ≤ 1.5 GHz: < -65 dBc 1.5 GHz to ≤ 1.7 GHz: < -55 dBc 1.7 GHz to ≤ 2 GHz: < -50 dBc
Phase Noise (1 V_{p-p}, 10 kHz offset)	20 MHz: < -127 dBc/Hz typ. 100 MHz: < -123 dBc/Hz typ. 1 GHz: < -105 dBc/Hz typ.
Square Waves	
Frequency Range	1 µHz to ≤ 770 MHz: 5V_{p-p}
Rise/fall time (10% to 90%)	400 ps
Rise/fall time (20% to 80%)	300 ps
Overshoot (1 V_{p-p})	< 2%
Jitter (rms)	< 2 ps
Pulse Waves	
Frequency Range	1µHz to ≤770 MHz: 5V_{p-p}
Pulse Width	500 ps to (Period – 500 ps)[2]
Pulse Width Resolution	20 ps or 15 digits
Pulse Duty Cycle	0.1% to 99.9% (limitations of pulse width apply)
Leading/trailing edge transition time (10% to 90%)	400 ps to 1000 s
Leading/trailing edge transition time (20% to 80%)	300 ps to 1000 s
Transition time Resolution	2 ps or 15 digits
Overshoot (1 V_{p-p})	< 2%
Jitter (rms, with rise and fall time ≥ 400 ps)	< 2 ps
Double Pulse Waves	
Frequency Range	1µHz to ≤ 385 MHz: 10V_{p-p} where V_{p-p} =| V_{p-p} 1|+| V_{p-p} 2|
Other Pulse Parameters	Same as Pulse Waves
Ramp Waves	
Frequency Range	1 µHz to 75 MHz
Linearity (< 10 kHz, 1 V_{p-p}, 100%)	≤ 0.1%
Symmetry	0% to 100%
Other Waves	
Frequency Range Exponential Rise, Exponential Decay Sin(x)/x, Gaussian, Lorentz, Haversine	 1 µHz to 75 MHz 1 µHz to 1500 MHz
Additive Noise Bandwidth (-3 dB) Level Resolution	 2 GHz 0 V to 2.5 V – | carrier max value [V_{pk}] | 1 mV
Arbitrary	
Number of Samples	2 to 16,384
Frequency range	1 µHz to ≤ 770 MHz

[2] Below 500 ps width, the pulse amplitude will have some reduction respect to the set value

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Analog Bandwidth (-3 dB)	950 MHz
Rise/fall time (10% to 90%)	400 ps
Rise/fall time (20% to 80%)	300 ps
Jitter (rms)	< 2 ps
Frequency Resolution	
Sine, square, pulse, arbitrary, Sin(x)/x	1 µHz or 15 digits
Gaussian, Lorentz, Exponential Rise, Exponential Decay, Haversine	1 µHz or 14 digits
Frequency Accuracy	
Non-ARB	± 2.0 ppm of setting | ± 500 ppb of setting (Opt.)
ARB	± 2.0 ppm of setting ±1 µHz | ± 500 ppb of setting ±1 µHz(Opt.)
Modulations	
Amplitude Modulation (AM)	
Carrier Waveforms	Standard waveforms (except Pulse, DC and Noise), ARB
Modulation Source	Internal or external
Internal Modulating Waveforms	Sine, Square, Ramp, Noise, ARB
Modulating Frequency	Internal: 500 µHz to 61 MHz, External: 10 MHz maximum
Depth	0.00% to 120.00%
Frequency Modulation (FM)	
Carrier Waveforms	Standard waveforms (except Pulse, DC and Noise), ARB
Modulation Source	Internal or external
Internal Modulating Waveforms	Sine, Square, Ramp, Noise, ARB
Modulating Frequency	Internal: 500 µHz to 61 MHz, External: 10 MHz maximum
Peak Deviation	DC to 2 GHz
Phase Modulation (PM)	
Carrier Waveforms	Standard waveforms (except Pulse, DC and Noise), ARB
Modulation Source	Internal or external
Internal Modulating Waveforms	Sine, Square, Ramp, Noise, ARB
Modulating Frequency	Internal: 500 µHz to 61 MHz, External: 10 MHz maximum
Phase Deviation Range	0° to 360°
Frequency Shift Keying (FSK)	
Carrier Waveforms	Standard waveforms (except Pulse, DC and Noise), ARB
Modulation Source	Internal or external
Internal Modulating Waveforms	Square
Key Rate	Internal: 500 µHz to 61 MHz, External: 10 MHz maximum
Hop Frequency	1 µHz to 2 GHz
Number of Keys	2
Phase Shift Keying (PSK)	
Carrier Waveforms	Standard waveforms (except Pulse, DC and Noise), ARB
Modulation source	Internal or external
Internal Modulating Waveforms	Square
Key Rate	Internal: 500 µHz to 61 MHz, External: 10 MHz maximum
Hop Frequency	0° to +360°
Number of Keys	2

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Pulse Width Modulation (PWM)	
Carrier Waveforms	Pulse
Modulation Source	Internal or external
Internal Modulating Waveforms	Sine, Square, Ramp, Noise, ARB
Modulating Frequency	Internal: 500 µHz to 61 MHz, External: 10 MHz maximum
Deviation Range	0% to 50% of pulse period
Sweep	
Type	Linear, Logarithmic, staircase, and user defined
Waveforms	Standard waveforms (except Pulse, DC and Noise), ARB
Sweep Time	30 ns to 2000 s
Hold/return Times	0 to (2000 s - 30 ns)
Sweep/Hold/Return Time Resolution	15 ns or 12 digits
Total Sweep Time Accuracy	≤ 0.4%
Start/Stop Frequency Range	Sine: 1 µHz to 2 GHz, Square: 1 µHz to 770 MHz
Trigger Source	Internal/External/Manual
Burst	
Waveforms	Standard waveforms (except DC and Noise), ARB
Type	Trigger or gated
Burst Count	1 to 4,294,967,295 cycles or Infinite
True Arb Mode Specifications	
Output Channels	
Connectors	SMA on front panel
Output Type	Single-ended DC coupled
Output Impedance	50 Ω
General specifications	
Operating Mode	Variable clock (True Arbitrary)
Run Modes	Continuous, Triggered Continuous, Single/Burst, Stepped, Advanced
Vertical Resolution	16 bit
Waveform Length	128 to 2G samples per channel (up to 4G samples optional)
Waveform Granularity	1 if the entry length is >416 samples 32 if entry length is ≥128 and ≤416 samples
Sequence Length	1 to 16,384
Sequence Repeat Counter	1 to 4,294,967,295 or infinite
Timer Range Resolution	 20 ns to 1.39 s ±1 sampling clock period
Analog Channel to Channels skew	
Range	0 to 2.65 us
Resolution	≤ 100 fs
Accuracy	±(1% of setting + 20 ps)
Initial skew	< 20 ps
Calculated bandwidth (0.35 / rise or fall time)	≥ 2 GHz
Harmonic distortion (Sine wave 128 pts, 1 V_{p-p})	< -70 dBc (48.125MHz@ 6.16 GS/s)
Spurious (Sine wave 128 pts, 1 V_{p-p}	< -70 dBc (48.125MHz@ 6.16 GS/s)
SFDR (Sine wave 128 pts, 1 V_{p-p})	< -70 dBc (48.125MHz@ 6.16 GS/s)

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Rise/fall time (1 V_{p-p} single-ended 10% to 90%)	≤ 175 ps
Rise/fall time (1 V_{p-p} single-ended 20% to 80%)	≤ 110 ps
Overshoot (1 V_{p-p} single-ended)	< 5%
Timing and Clock	
Sampling Rate	
Range	1 S/s to 6.16 GS/s
Resolution	32 Hz
Accuracy	± 2.0 ppm | ± 500 ppb (Opt.)
Digital outputs (Optional)	
Output Channels	
Connectors	Mini-SAS HD connector on rear panel (custom pin-out)
Number of connectors	1, 2, 4
Number of outputs	8-bits,16-bits,32-bits
Output impedance	100 Ω differential
Output type	LVDS
Rise/fall time (10% to 90%)	< 1 ns
Jitter (rms)	20 ps
Maximum update rate	1.54 Gbps per channel
Memory depth	512M Samples per digital channel (up to 1G optional)
8 bit LVDS to LVTTL Converter Probe (Optional AT-DLL8)	
Output Connector	20 position 2.54 mm 2 Row IDC Header
Output Type	LVTTL
Output Impedance	50 Ω nominal
Output Voltage	0.8 V to 3.8 V programmable in group of 8 bits
Maximum Update Rate	125 Mbps@0.8V and 400 Mbps@3.6V
Dimensions	W 2in x H 0.9in x D 3in [52mm x 22mm x 76mm]
Input Connector	Proprietary standard
Cable Length	1 meter
Cable Type	Proprietary standard
Proprietary Mini SAS HD to SMA cable (Optional)	
Output Connector	SMA

Output Type	LVDS
Number of SMA	16 (8 bits)
Cable Type	Proprietary standard
Cable Length	1 meter
Auxiliary Input and Output Characteristics	
Sync in/out	
Connector type	Infiniband 4X connector on rear panel (custom pinout)
Master to Slave delay (typical)	TBD
Marker Output	
Connectors	SMA on front panel
Number of Connectors	1|2|4
Output Impedance	50 Ω
Output level (into 50 Ω)	
Voltage Window	-0.5V to 1.65V
Amplitude	100 mVpp to 2.15 Vpp
Resolution	1 mV
Accuracy	±(5% setting + 25 mV)
Max Update Rate	True Arb Mode: 6.16 Gbit, AFG Mode: 96.5 MHz (continuous mode)
Rise/fall time (10% to 90%, 2 V_{p-p})	<150 ps
Jitter (rms)	<10 ps
Marker out to analog channel skew	
Range	True Arb Mode:0 to 2.3µs AFG Mode:0 to 11 sec. in Contin. Mode, 0 to 2.3 µs in Trig. Mode
Resolution	True Arb Mode:1/64 of DAC sampling period, AFG Mode: 5 ps
Accuracy	±(1% of setting + 5 ps)
Initial skew	< 20 ps
Trigger/Gate Inputs	
Connector	SMA on the Front Panel
Number of Trigger Inputs	2 (Trig.in 1, Trig.in 2)
Input Impedance	50Ω/1 kΩ
Slope/Polarity	Positive or negative or both
Input Damage Level	< -15 V or > +15 V
Threshold Control Level	-10 V to 10 V
Resolution	50 mv
Threshold Control Accuracy	±(10% of |setting| + 0.2 V)
Input Voltage Swing	0.5 V_{p-p} minimum
Minimum Pulse Width (1 V_{p-p})	3 ns
Trigger/gate input to Analog Output delay	**Slow (synchronous) trigger** AFG mode: < 355 ns (< 405 ns in triggered sweep mode) True Arb mode: <1550 * DAC clock period(ns) + 10 ns **Fast (asynchronous) trigger** AFG mode: < 335 ns (< 385 ns in triggered sweep mode) True Arb mode: <1360 * DAC clock period(ns) + 27 ns
Trigger In to output jitter (rms)	AFG mode: < 20 ps True Arb mode: 0.29*Dac clock period

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Maximum Frequency	AFG: 65 MTps on Rising/Falling Edge, 80 MTps on Both Edges True Arb mode: 1/ (Period of the Analog Waveform + 48 DAC Clock period) MTps = Mega Transitions per second
Reference clock input	
Connector type	SMA on rear panel
Input impedance	50 Ω, AC coupled
Input voltage range	0.2Vpp to 2Vpp
Damage level	Maximum Input voltage: -0.3V to 3.6V Maximum input power: 30 dBm (50 Ω)
Frequency range	5 MHz to 200 MHz
Frequency Resolution	1 Hz
Reference clock output	
Connector type	SMA on rear panel
Output impedance	50 Ω, AC coupled
Frequency	10 MHz TCXO | 100 MHz VCOCXO (Optional)
Initial accuracy @ 25 °C	± 1.0 ppm | ± 500 ppb (Opt.)
Aging	± 1.0 ppm/year | ± 500 ppb/year (Opt.)
Stability vs. temperature	± 1 ppm | ± 50 ppb(Opt.)
Amplitude	1.65 Vpp
Phase Noise @ 20 MHz carrier	-120 dBc/Hz at 100 Hz ; -140 dBc/Hz at 1KHz; -150 dBc/Hz at 10 KHz
Phase Noise @ 100 MHz carrier(Opt.)	-120 dBc/Hz at 100 Hz ; -145 dBc/Hz at 1KHz; -150 dBc/Hz at 10 KHz
External Clock Input	
Connector type	SMA on rear panel
Input impedance	50 Ω, AC coupled
Frequency	True Arb : 96.25 MHz to 192.5 MHz, 192.5 MHz to 385 MHz, 385 MHz to 770 MHz, 770 MHz to 1540 MHz (selectable) AFG : 192.5 MHz, 385 MHz, 770 MHz,1540 MHz (selectable)
Input Power Range	+0 dBm to +10 dBm
Damage Level	15 dBm
Sync Clk Out	
Connector type	SMA on rear panel
Output impedance	50 Ω, AC coupled
Frequency	Sampling Frequency / N where N=16,32,64,128,256,512,1024,2048 (selectable)
Amplitude	1Vpp into 50 Ohm

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External Modulation input	
Connector type	SMA on rear panel
Input impedance	10 KΩ
Number of inputs	1
Bandwidth	10 MHz with 50 MS/s sampling rate
Input voltage range	-1 V to +1 V (except FSK, PSK) FSK, PSK: 3.3 V
Vertical resolution	14-bit
Pattern Jump In (optional)	
Connector type	DSUB15
Input signals	DATA[0..7] + Data Select + Load
Internal Data Width	14 bit, multiplexed using Data Select
Number of addressable entries	16384
Data Rate	DC to 1 MHz
Input Range	VIL = 0V to 0.8V / VIH= 2V to 3.3V
Impedance	Internal 1kΩ pull-up resistor to Vcc (3.3V)
Power	
Source Voltage and Frequency	100 to 240 VAC ±10% @ 45-66 Hz
Max. power consumption	Max. 185W
Environmental Characteristics	
Temperature (operating)	+41 ºF to 104 ºF [+5 ºC to +40 ºC]
Temperature (non-operating)	-4 ºF to 140 ºF [-20 ºC to +60 ºC]
Humidity (operating)	5% to 80% relative humidity with a maximum wet bulb temperature of 84°F at or below +104°F, (upper limit de–rates to 20.6% relative humidity at +104°F). Non-condensing.
Humidity (non-operating)	5% to 95% relative humidity with a maximum wet bulb temperature of 104°F at or below +140°F, upper limit de–rates to 29.8% relative humidity at +140°F. Non-condensing.
Altitude (operating)	9,842 feet (3,000 meters) maximum at or below 77°F
Altitude (non-operating)	39,370 feet (12,000 meters) maximum
EMC and Safety	
Compliance	CE compliant
Safety	EN61010-1
Main Standards	EN 61326-1:2013 – Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements
Immunity	EN 61326-1:2013
System Specifications	
Display	7”, 1024x600, capacitive touch LCD
Operative System	Windows 10
External Dimensions	W 17.6 in – H 5.4 in – D 12.6 in (3U 19” rackmount) (445 mm – 135 mm – 320 mm)
Weight	26.45 lbs (12 kg) TBC
Front panel connectors	CH N OUTPUT (SMA) where N=2,4,8 depending on the model MARKER N OUT (SMA) where N=1,2,4 depending on the model TRG IN N(SMA) where N =1,2 2 USB 3.0 ports

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Rear panel connectors	Ref. Clk. IN (SMA) Ref. Clk. Out (SMA) Ext. Mod. IN (SMA) Sync Clk Out (SMA) Ext Clk IN (SMA) Sync IN (Infiniband 4X) (for 8 channel model only) Sync OUT (Infiniband 4X) (for 8 channel model only) Pattern Jump In (DSUB15) (Optional) POD X[7..0] where X=A,B,C,D depending on the model (Customized Mini SAS HD) External Monitor ports (one or more) 2 USB 2.0 ports or more 4 USB 3.0 ports Ethernet port (10/100/1000BaseT Ethernet, RJ45 port) 2 PS/2 keyboard and mouse ports 2 DPI ports 1 DVI port
Hard Disk	256 GB SSD
Processor	Intel® Pentium 3.7 GHz (or better)
Processor Memory	8 GB or better

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