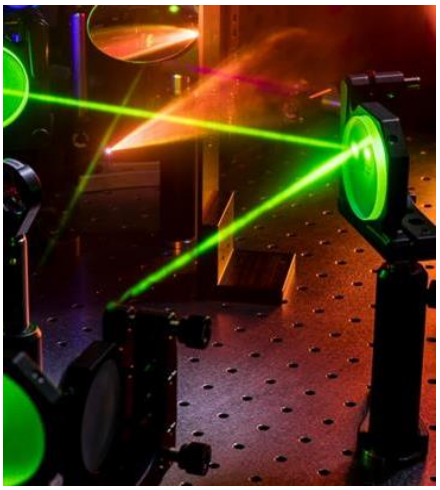
Model 686

14-Bit Arbitrary Waveform Generator



Features

- Function Generator Mode Interface
- AWG Mode Interface
- Pulse Pattern Generator Interface
- 2, 4 Analog Channels
- Up to 20 GS/s
- 14 Bit Vertical Resolution

Applications

- Optics, Photonics, RF Wireless
- Quantum Applications
- Automotive
- Advanced Research Applications
- Semiconductors Tests
- Aerospace and Defense

Model 686

20 GS/s - 14 Bit AWG

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MODEL 686 ARBITRARY WAVEFORM GENERATOR

Features & Benefits

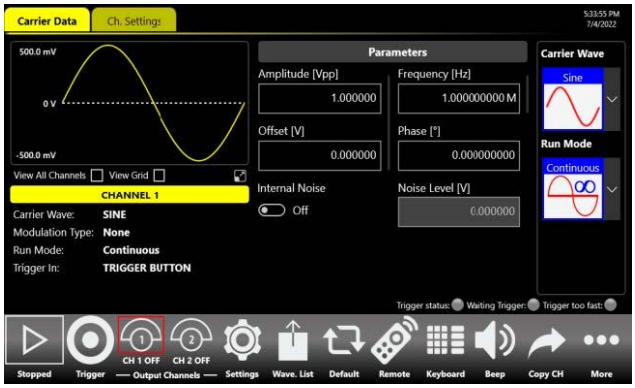
- Sample rate can be programmed in from 1 S/s up to 20 GS/s, with 14-bit vertical resolution, ensures exceptional signal integrity
- Arbitrary waveform memory up to 9 Gpts
- Mixed Signal Generation – 2 or 4 Analog channels with up to 32 synchronized Digital Channels for debugging and validating digital design
- Three operation modes – Simple Rider AFG (DDS AFG mode), True Arb (variable clock Arbitrary AWG mode) and PPG (Pulse/Serial Patter Generator – Optional)
- Digital outputs provide up to 10 Gb/s data rate in programmable CML standard. CML to LVTTL adapter is available
- Advanced sequencer with up to 16384 user defined waveforms provides the possibility of generating complex signal scenarios with the most efficient memory usage
- Windows based platform with 7in touchscreen, front panel buttons and knob
- Compact form factor, convenient for bench top and fully fit with 3U – 19” rackmount standard
- LAN, USB_TMC and GPIB interfaces for remote control

Model 686 Front

Model 868 Back

MODEL 686 USER INTERFACE

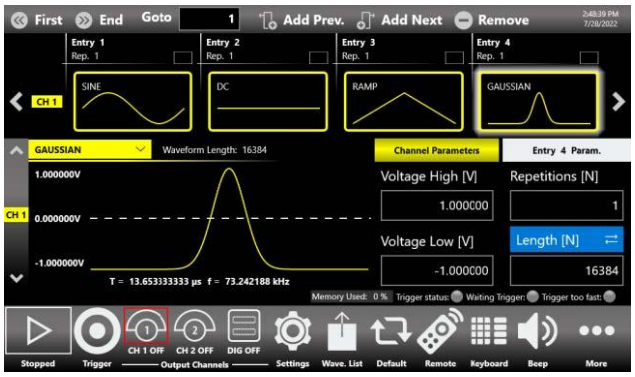
Simple Rider AFG: Function Generator Mode Interface

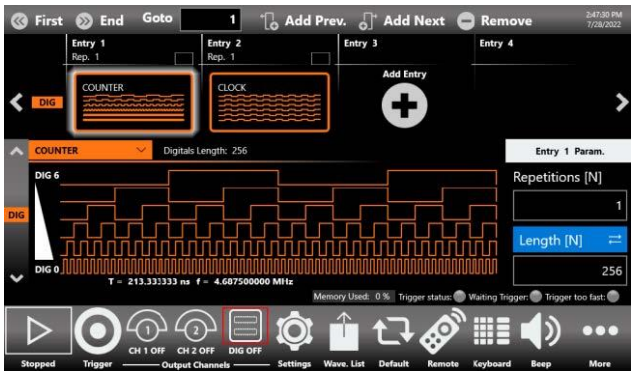


Simple Rider AFG UI is designed for touch and it has been developed to put all the capabilities of modern Waveform Generators right at your fingertips. All instrument controls and parameters are accessed through an intuitive UI that recalls the simplicity of Tablets and modern smart phones: touch features and gestures are available to engineers and scientists to create advanced waveforms or digital patterns in few touches.

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

Simple Rider TrueArb: AWG Mode Interface





In **Simple Rider True-Arb** interface, the users can define complex waveforms with up to 16,384 sequence entries of analog waveforms and digital patterns, define their execution flow by means of loops, jumps and conditional branches.

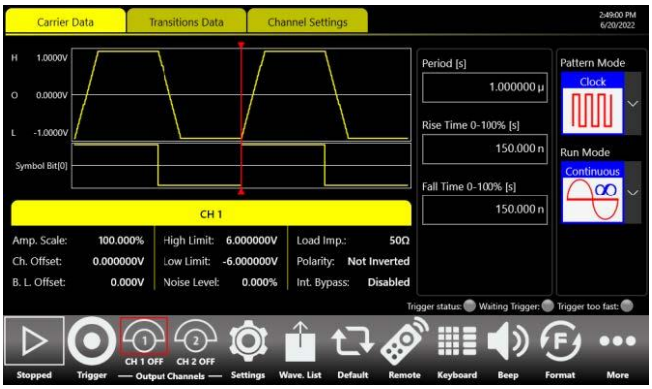
Digital output combined and synchronized with analog output signals represent an ideal tool to troubleshoot and validate digital design.

The waveform memory length of up to 9 GSamples on each channel combined with up to 16,384 and up to 4,294,967,294 repetitions, make the Model 686 the ideal generator for the most demanding technical applications.

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

Up to 4 instruments can be synchronized together in order to obtain a 16 analog – 128 digital channel generator. A dedicated synchronization bus guarantees the intra-chassis synchronization. Arb Rider supports the standard Ethernet interface for remote control and easy customized instrument programming.

Simple Rider PPG: Pulse Pattern Generator (PPG) Mode Interface



The easiest touch screen display interface allows to create patterns scenarios, only in a few screen touches.

In summary the Pulse Pattern Generator provides the capability to generate PRBS patterns and up to 12 MSymbols custom patterns where bit transitions can have arbitrarily user defined shapes. The Model 686 Pulse Pattern Generator can generate patterns up to 6.5Gbaud.

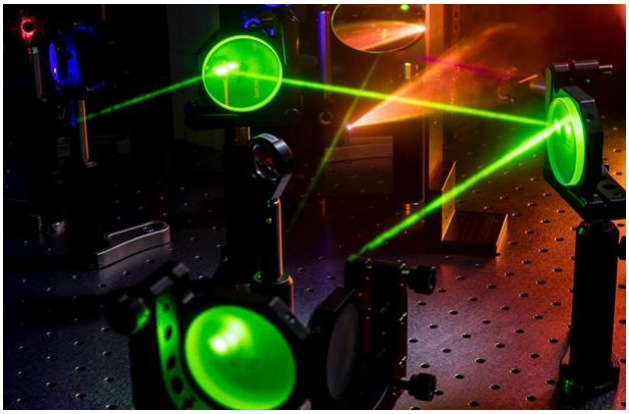
The software architecture provides the possibility to easily generate the patterns in different generation modality and also gives the opportunity to modulate the patterns with internal or external signals with the purpose to generate also different effects of noise (jitter, ripple, …).

Model 686 Applications

Optics & Photonics, RF Wireless

The Model 686 is the ideal choice for the frontier of science & technology experiments and cutting-edge challenges like High Energy Physics, Optical, laser and photonics and RF Wireless Communication.

The Model 686 Series Instrument can create virtually any signal – analog or digital, ideal or distorted, standard or custom.



You can easily build complex RF/IF/IQ waveform, extremely small width, high amplitude pulses to drive electro/acousto-optic modulators, pulsed laser diode or it can be used in quantum optics experiments like manipulating nitrogen vacancy color center in diamond.

Highlights

- Drive electro-optic modulator
- Modulating and driving laser diode
- Quantum optics emitters testing
- RF Wireless Digital modulation

Quantum Applications

Emergy Quantum technologies like Quantum Sensing, Quantum Key Distribution will improve our lives in the next years.

They will be fundamental tools for secure communication and how we measure, navigate, study, explore, see, and interact with the world around us by sensing changes in motion, and electric and magnetic fields.

Recently the investigation of light-matter coupling between ensembles of cold atoms and photons propagating in so-called optical nanofibers, i.e., glass fibers whose diameter is smaller than the optical wavelength.

The special properties of these fibers make them suitable for use as a “quantum laboratory.”

The Model 686 is the perfect tool to face all these new technologies challenges, since it allows you to generate pulses with ultra-fast rise and fall time, Gaussian shapes, multi-level PAM and PRBS signals, complex pulse trains, pulsed RF signals with impairments that are the key factors for those kind of tests.

Highlights

- PRBS signals generation
- QKD and Quantum sensing
- Cold atoms
- Manipulate nitrogen vacancy color center in diamond
- Minimum delay between Trigger In Analog Out
- Up to 16 analog channels and 128 digital channels fully synchronized
- Built-in sequencer with conditional/unconditional/dynamic jump features, two independent Trigger inputs, up to 4 Marker outputs

Automotive

Today's cars are including a lot of highly sophisticated electronic control unit with very sensitive electronic components.

As demands go up, next-generation advanced driver-assistance systems (ADAS) require camera and radar systems with increasingly high resolution. Camera, LIDAR, Radar and Ultrasound devices need higher bandwidth and lower latency networking and complex automotive technologies to come.

Physical layer testing, transmit & receiver testing and channel testing need a high performance and easy-to-use tools to satisfy the latest automotive challenges.

The Model 686 combines 20 GS/s with 14-bits vertical resolution, represents the ideal instrument for generating the real-world signals that are necessary to emulate the most demanding testing cases.

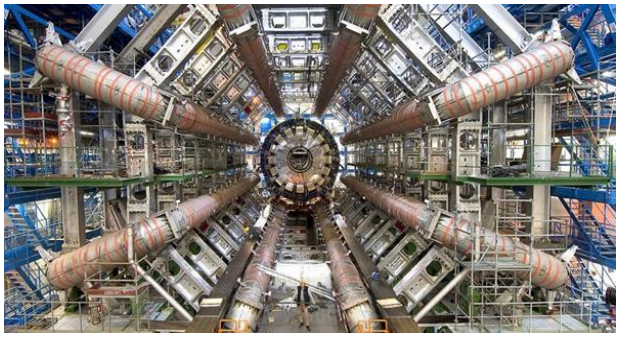
Highlights

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

Advanced Research Applications

The Model 686 has the best overall product in the market between signal amplitude and bandwidth: you can generate 5Vpp pulses with more than 6.5 GHz of analog bandwidth.

The combination of ultra-fast edge & minimum pulse width generation, excellent dynamic range and easy to use interface perfectly meet the scientists and engineers working on large experiments such Accelerators, Tokamak or synchrotrons to emulate signals without creating specifics test boards.

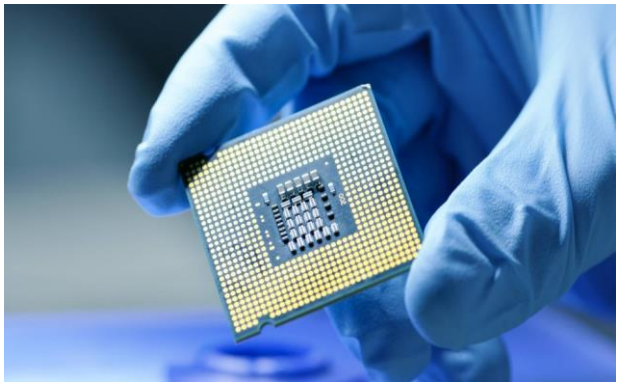


Pulses may be easily generated for applications such Pulse Electron Beam or X Ray Sources, Flash X-ray Radiography, Lighting pulse simulators, high Power Microwave modulato.

Highlights

- Emulation of detectors
- Emulation of signal sources adding noise
- Generation/playback of real-world signals

Semiconductors Test



Consumers continually demand better performance in a smaller form factor with reduced power requirements.

This in turn has led to devices with much smaller footprints, much higher data throughput, and lower power requirements. These features enable many of the technologies that consumers take advantage of today such as SATA, USB, and PCI Express.

The Model 686 Series allows the testing of these high-speed devices, since it can provide up to 16 analog output channels with a maximum data rate of 8 Gbps and it can perform PCI-Express Gen. 3 debugging.

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.

Highlights

- High-speed serial testing
- Semiconductors characterization
- High-speed clock generation
- Frequency response, intermodulation distortion and noise-figure measurements
- Pulse pattern generator

Aerospace and Defense

Radar, Lidar and Sonar design and testing perfectly match with the Model 686 Series.

Moreover the capability to generate high bandwidth signals can be used on digital modulation systems for Radio Applications or others I/Q signal modulation.

The generation of high-speed signals combined to the advanced sequencer with the fast sequence switch feature, allow the emulation of complex real world signal scenarios.

Highlights

- Radar and Lidar RF modulated signals emulation
- Electronic Warfare complex scenarios generation
- Avionics testing

TABLE OF AVAILABLE MODELS

Model	Description
686-2C-SE	2 CH – 5Vpp Single ended outputs - 20 GS/s
686-2CD	2 CH – 2.5Vpp (1.25Vpp single ended) Differential outputs - 20 GS/s
686-4C-SE	4 CH – 5Vpp Single ended outputs - 20 GS/s
686-4CD	4 CH – 2.5Vpp (1.25Vpp single ended) Differential outputs - 20 GS/s

OPTIONS AND ACCESSORIES

Item	Description
686-PAT	Serial Pattern Generator (SPG)
686-8DIG	8CH Dig license (available only for 4-channels models)
686-16DIG	16CH Dig license (available only for 4-channels models)
686-32DIG	32CH Dig license (available only for 4-channels models)
686-FSS	Fast Sequence Switch
686-WAR	3 years warranty extension
RIDER-MINI-SAS-HD	Mini Sas HD cable for digital probe, 8 Differential signal (available only for 4-channels models)
RIDER-686-SYNC	Synchronization cable for all 686 models
AT-DTTL8	LVDS to LVTTL digital adapter probe (available only for 4-channels models)
AT-LVDS-SMA8	CML to SMA digital adapter cable (available only for 4-channels models)
GP-IB / USB-TMC	GPIB and USBTMC Ports for Remote Control
RIDER-RACK	Rackmount kit for Rider instrument system

MEMORY VS. MODEL AND OPERATING MODES

			Memory per channel (Msamples)			
	Channel count	MODEL	FULL RATE mode (20 Gsps max sampling rate)			
			CH1	CH2	CH3	CH4
20 GS/s	2	686-2C-SE 686-2CD	9600	1.17		
	4	686-4C-SE 686-4CD	9600	0.589	9600	0.589

TECHNICAL SPECIFICATIONS

General 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 a ±10°C after auto-calibration.

	686-2C-SE 686-2CD	**686-4C-SE 686-4C-SE**
Operating Mode	AFG Mode – True Arb Mode – SPG Mode (optional)	
Number of Markers and Analog Channels		
Analog channels	2	4
Markers	2	4
	686-2C-SE 686-2CD 686-4C-SE	**686-4C-SE 686-4C-D**
Number of Digital Channels		
Digital Channels	-	32
	686-2C-SE 686-4C-SE	**686-2CD 686-4CD**
Output Channels		
Output Type	Single ended DC coupled	Differential DC coupled
Output Impedance	Single ended: 50 Ω	Single edned: 50 Ω Differential: 100 Ω
Connectors	SMA on front panel	
DC Amplitude		
Amplitude range	±2.5 V (into 50 Ω)	±0.625 V Se. (into 50 Ω) ±1.25 V Diff. (into 100 Ω)
Resolution	500 µV (nom), 5 digits	100 µV (nom), 5 digits
Amplitude accuracy	±(1.5% of |setting| + 15mV)[3]	±(1% of |setting| + 2mV)[3]
DC Baseline Hardware Offset (Common mode offset)		
Resolution	< 4 mV or 4 digits	
Range (50 Ω into 50 Ω)	-2.5 V to +2.5 V	-2 V to +2 V
Range (50 Ω into High Z load)	-2.5 V to +2.5 V	-4 V to +4 V
Accuracy (50 Ω into 50 Ω) (guaranteed)	±(1% of |setting| + 15 mV)	±(1% of |setting| + 5 mV)
AC Accuracy (1 kHz sine wave, 0 V offset, > 5 mV_{p-p} amplitude, 50 Ω load) (guaranteed)	±(1% of setting [Vpp] + 5mV) [3]	

[3]The specification is guaranteed in the range 0% to 80% of full scale output

True Arb – Baseband mode specifications

	686-2C-SE 686-4C-SE	**686-2CD 686-4CD**
Operating Modes	Full Rate Mode (Variable clock) Half Rate Mode (Variable clock)	
Sampling Rate	**686-XD**	**686-4CD**
Full Rate Mode	1 S/s to 20 GS/s[4]	1 S/s to 20 GS/s[4]
Half Rate Mode	1 S/s to 10 GS/s[4]	
Sin(x)/x	8.85 GHz @ 20GS/S (686-2CD/686-4CD)	

Run Modes	Continuous, triggered continuous, single/burst, stepped, advanced	
Vertical Resolution	14 bit	
Max Waveform Memory		
Full Rate Mode (20 GS/s)	**686-2C-SE / 686-2CD** CH1: 9.6 Gsamples; CH2:1.17 Msamples **686-4C-SE / 686-4CD** CH1, CH3: 9.6 Gsamples; CH2, CH4: 589 ksamples	
Waveform Granularity	1 if the entry length is > 8928 samples 288 if entry length is ≥ 288 and ≤ 8928 samples	
Sequence Length	1 to 16384	
Sequence Repeat Counter	1 to 4294967294 or infinite	
Timer		
Range	17.6 ns to 429 ms	
Resolution	±1 sampling clock cycle	
Analog Channel to Channels skew		
Range	0 to 1.63 µs	
Resolution	**4C Models:** CHx to CHx (x=1,2,3,4): 1 sampling Clock Cycle CH1/CH2 couple to CH3/CH4 couple: 100 fs **2CH Models:** CHx to CHx (x=1,2): 100 fs	
Accuracy	±(1% of setting + 20 ps)	
Initial skew	< 20 ps	
Calculated bandwidth (0.35 / rise or fasll time$_{10\text{-}90}$)	≥ 5 GHz	≥ 5.8 GHz
Measured 3dB bandwidth (sin(x)/x compensated)	5.8 GHz	
SFDR @ 100 MHz[5] Measured across DC to Fs/2 where Fs is: Fs = 20 Gsa/s	< -65 dBc	
SFDR Measured across DC to Fs/2 where Fs is: Fs = 20 Gsa/s	18 mHz to ≤ 100MHz: < -65dBc	
[5]Measured excluding Fs – 2*fout and Fs – 3*fout and excluding harmonic		
Rise/fall time (1 $V_{p\text{-}p}$ single-ended 20% to 80%)	≤ 50 ps	≤ 45 ps
Rise/fall time (1 $V_{p\text{-}p}$ single-ended 10% to 90%)	≤ 70 ps	≤ 60 ps
Overshoot (1 $V_{p\text{-}p}$ single-ended)	< 8%	<6 %
Random jitter on clock pattern	< 2 ps	

AFG Mode Specifications

	686-2C-SE 686-4C-SE	686-2CD 686-4CD
Amplitude		
Range	0 to 5 Vpp (into 50 Ω)	0 to 2.5 Vpp Diff. (into 100 Ω) 0 to 1.25 Vpp Se. (into 50 Ω)
Resolution	500 µV (nom), 5 digits	100 µV (nom), 5 digits
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 Modes	Vertical resolution: 14-bit Waveform length: 16,384 points	
Internal Trigger Timer		
Range	6.5 ns to 100 s	
Resolution	31.25 ps	
Accuracy	±(0.1% setting + 5 ps)	
Sine Waves		
Max Frequency	6.5 GHz	
Frequency Range Sine (50 Ω into 50 Ω)	18 mHz to ≤ 3.5 GHz: 5 Vpp 3.5 GHz to ≤ 4.5 GHz: 4 Vpp 4.5 GHz to ≤ 6.5 GHz: 3 Vpp	18 mHz to ≤ 6.5 GHz: 2.5 Vpp Diff. 18 mHz to ≤ 6.5 GHz: 1.25 Vpp Se.
Flatness	DC to 6 GHz: ±0.5 dB (1 Vpp, relative to 1 kHz)	DC to 6.5 GHz: ±0.5 dB (1 Vpp diff., relative to 1 kHz)
Harmonic Distortion (1 V_{p-p})	18mHz to ≤ 1MHz < -60 dBc 1MHz to ≤ 1GHz < -50 dBc 1GHz to ≤ 6.5GHz < -40 dBc	
Total Harmonic Distortion (1 V_{p-p})	10 Hz to 20 kHz < 0.2%	
Spurious[6] Measured across DC to Fs/2 where Fs is Fs = 20 Gsa/s	18 mHz to ≤ 1 MHz < -60 dBc	
Phase Noise (1 V_{p-p}, 10 kHz offset)	20 MHz: < -127 dBc/Hz typ. 100 MHz: < -124 dBc/Hz typ. 1 GHz: < -105 dBc/Hz typ.	
[6] For Single ended models, the spurious are evaluated @1Vpp single ended nominal output amplitude		
Square Waves		
Channels with Square Wave	All Channels	
Frequency Range	18 mHz to ≤ 2.5 GHz	
Rise/fall time (10% to 90%)	120 ps	
Rise/fall time (20% to 80%)	90 ps	
Overshoot (1 V_{p-p})	< 2%	
Jitter (rms)	< 2 ps	
Pulse Waves		
Channel with Pulse Wave	All Channels	
Frequency Range	18 mHz to ≤ 2.5 GHz	
Pulse Width	150 ps to (Period – 150 ps) [7]	
Pulse width resolution	20 ps or 15 digits	
Pulse duty	0.1% to 99.9% (limitations of pulse width apply)	
Leading/trailing edge transition time (10% to 90%)	120 ps to 1000 s	

[7] Below 150 ps width, the pulse amplitude will have some reduction with respect to the set value)

Transition time Resolution	2 ps or 15 digits	
Overshoot (1 V_{p-p})	< 2%	
Jitter (rms, with rise and fall time ≥ 400ps)	< 2 ps	
Double Pulse Waves		
Frequency Range (Vpp= |Vpp1| + |Vpp2|)	18 mHz to ≤ 1.25 GHz: 10Vpp	18 mHz to ≤ 1.25 GHz: 5Vpp Diff. (18 mHz to ≤ 1.25 GHz: 2.5Vpp Se)
Other Pulse Parameters	Same as Pulse Waves	
Ramp Waves		
Frequency Range	18 mHz to 250 MHz	
Linearity (< 10 kHz, 1 V_{p-p}, 100%)	≤ 0.1%	
Symmetry	0% to 100%	
Other Waves		
Frequency Range		
Exponential Rise, Exponential Decay	18 mHz to 250 MHz	
Sin(x)/x, Gaussian, Lorentz, Haversine	18 mHz to 500 MHz	
Additive Noise		
Bandwidth (-3 dB)	4 GHz	
Level	0 V to 2.5 V - abs(carrier max value [V_{pk}])	0 V to 0.625 V Single Ended – abs (carrier max value [V_{pk}]) 0 V to 1.25 V Differential – abs (carrier max value [V_{pk}])
Resolution	1 mV	
Arbitrary		
Number of Samples	2 to 16384	
Frequency Range	1 µHz to 2.5 GHz	
Analog Bandwidth (-3 dB)	2.9 GHz	
Rise/fall time (10% to 90%)	120 ps	
Rise/fall time (20% to 80%)	90	
Jitter (rms)	< 2 ps	
Frequency Resolution		
Sine, square, pulse, arbitrary, Sin(x)/X Gaussian, Lorentz, Exponential Rise, Exponential Decay, Haversine	18 mHz or 15 digits 18 mHz or 14 digits	
Frequency Accuracy Non-ARB ARB	 ±2.0 ppm of setting | ±500 ppb of setting (Opt.) ±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: 18 mHz to 80 MHz, External: 1 GHz max.	
Depth	0.00% to 120.00%	
Frequency Modulation (FM)		
Carrier waveforms	Standard waveforms (except Pulse, Square, DC and Noise), ARB	
Modulation sources	Internal or external	
Internal modulating waveforms	Sine, Square, Ramp, Noise, ARB	
Modulating frequency	Internal: 18 mHz to 80 MHz, External: 1 GHz max.	
Peak deviation	DC to 6.5 GHz	

Phase Modulation (PM)	
Carrier waveforms	Standard waveforms (except Pulse, Square, DC and Noise), ARB
Modulation source	Internal or external
Internal modulating waveforms	Sine, square, ramp, noise, ARB
Modulating frequency	Internal: 18 mHz to 80 MHz, External: 1 GHz max.
Phase deviation range	0° to 360°
Frequency Shift Keying (FSK)	
Carrier waveforms	Standard waveforms (except Pulse, Square, DC and Noise), ARB
Modulation source	Internal or external
Internal modulating waveforms	Square
Key rate	Internal: 18 mHz to 80 MHz, External: 1 GHz max.
Hop Frequency	1 µHz to 6.5 GHz
Number of Keys	2
Phase Shift Keying (PSK)	
Carrier waveforms	Standard waveforms (except Pulse, Square, DC and Noise), ARB
Modulation source	Internal and External
Internal modulating waveform	Square
Key rate	Internal: 18 mHz to 80 MHz, External: 1 GHz max.
Hop phase	0° to +360°
Number of keys	2
Pulse Width Modulation (PWM)	
Carrier Waveforms	Pulse
Modulation Source	Internal or external
Internal modulating waveforms	Sine, Square, Ramp, Noise, ARB
Modulating frequency	Internal: 18 mHz to 80 MHz, External: 1 GHz max.
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	4ns ≤ Rise time + Hold time + Fall time ≤ 2000s
Rise/Hold/return times	0 to 2000 s
Rise/Hold/return time resolution	1ps or 12 digits
Total sweep time accuracy	≤ 0.4%
Start/stop frequency range	18 mHz to Max Waveform frequency (see Frequency Range for the Specific Waveform)
Trigger Source	Internal/External
Burst	
Waveforms	Standard waveforms (except DC and Noise), ARB
Type	Trigger or gated
Burst count	1 to 4,294,967,295 cycles or Infinite

Pulse Pattern Generator (PPG) Specifications – Optional

	686-2C-SE 686-4C-SE	**686-2CD 686-4CD**
General Specificatons		
Operating Mode	NRZ, RZ or R1 bitstream Pattern generator	
Pattern types	Clock Pattern, Custom Pattern, PRBS pattern, Go-Through Pattern, Pulse Pattern	

Run Modes	Continuous, modulation, burst (Triggered, Gated, Continuous triggered)
Internal Trigger Timer	
Range	6.5 ns to 100 s
Resolution	31.25 ps
Accuracy	±(0.1% setting + 5 ps)
Transition Specifications	
Transition peculiarity	Arbitrarily user defined transition shapes Programmable duration for any transition
Transition types	Arbitrary, predefined
Transitions memory length	64 points
Predefined transition shapes	Sine, Square, Pulse, Ramp_up, Ramp_down, DC, Sin(x)/x, Gaussian, Lorentz, Exponential Rise, Exponential Decay, Haversine
Transition duration [0-100%]	150ps to Symbol duration for Custom, PRBS and Go-Through pattern 150ps to Period/2 for Clock Pattern 150ps to (Period-150ps) for Pulse Pattern 24
Clock Pattern	
Max clock pattern frequency	3.25 GHz
Pattern levels	2 levels
Overshoot (1 V_{p-p})	< 2%
Jitter (rms)	< 2 ps
Custom Pattern	
Max custom pattern rate	Up to 6.5 Gbaud
Pattern levels	2, 3 or 4 levels
Predefined custom patters	Zero, one, clock, counter
Pattern memory channel	Up to 12 MBit (2 levels) Up to 6 MSymbols (3 or 4 levels) (For 2 channel models) Up to 6 MBit (2 levels) Up to 3 MSymbols (3 or 4 levels) (For 4 channel models)
Pattern length resolution	1 bit
Min pattern length	16 bits
Overshoot (1 V_{p-p})	< 2%
PRBS Pattern	
Max PRBS pattern rate	Up to 6.5 Gbaud
Pattern levels	2 levels
PRBS types	PRBS -7,9,11,15,23,31
Overshoot (1 V_{p-p})	< 2%
Go-Through Pattern	
Max Go-Through pattern rate	Up to 6.5 Gbaud
Pattern levels	2, 3, or 4 levels
Max External Pattern Rate	Up to 1 Gbit/s
Overshoot (1 V_{p-p})	< 2%
Pulse Pattern	
Max pulse pattern frequency	Up to 3.25 GHz
Pattern levels	2 levels
Min Rise/Fall time (0-100%)	150 ps

Min Pulse Width	300 ps
Overshoot (1 V_{p-p})	< 2%
Pattern Modulation	
Amplitude Modulation (AM)	
Carrier patterns	All types
Modulation sources	Internal or external
Internal modulating waveforms	Sine, Square, Triangular, Ramp_up, Ramp_down, DC, Sin(x)/x, Gaussian, Lorentz, Exponential Rise, Exponential Decay, Haversine, Noise, ARB
Modulating frequency	Internal: 18 mHz to 80 MHz, External: 1 GHz max.
Depth	0.00% to 120.00%
Frequency Modulation (FM)	
Carrier patterns	All types
Modulation source	Internal or external
Internal modulating waveforms	Sine, Square, Triangular, Ramp_up, Ramp_down, DC, Sin(x)/x, Gaussian, Lorentz, Exponential Rise, Exponential Decay, Haversine, Noise, ARB
Modulating frequency	Internal: 18 mHz to 80 MHz, External: 1 GHz max.
Peak deviation	DC to 6.5 GSymbols/s
Phase Modulation (PM)	
Carrier patterns	All types
Modulation source	Internal or external
Internal modulating waveforms	Sine, Square, Pulse, Ramp_up, Ramp_down, DC, Sin(x)/x, Gaussian, Lorentz, Exponential Rise, Exponential Decay, Haversine, Noise, ARB
Modulating Frequency	Internal: 18 mHz to 80 MHz, External: 1 GHz max.
Phase deviation range	0° to 360°
Frequency Shift Keying (FSK)	
Carrier Patterns	All types
Modulation source	Internal or external
Internal modulating waveforms	Square
Key rate	Internal: 18 mHz to 80 MHz, External: 1 GHz max.
Hop Symbol Rate	1uSymbols/s to 6.5 GSymbols/s for Custom and PRBS pattern 18 mHz to 3.25 GHz for Clock pattern
Number of keys	2
Phase Shifting Keying (PSK)	
Carrier patterns	All types
Modulation source	Internal or external
Internal modulating waveforms	Square
Key rate	Internal: 18 mHz to 80 MHz, External: 1 GHz max.
Hop phase	0° to +360°
Number of keys	2
Burst	
Patterns	All types
Type	Block mode or bit mode
Burst count	1 to 4,294,967,295 cycles or Infinite

Timing and Clock

Sampling Rate	

Range	1 S/s to 20 GS/s
Resolution	64 Hz
Accuracy	± 2.0 ppm | ± 500 ppb (Opt.)

Digital Outputs

Output Channels	
Connectors	Mini-SAS HD connector on rear panel (custom pin-out)
Number of connectors	4
Number of outputs	32-bits
Output impedance	100 Ω differential
Output type	CML with programmable pk-pk amplitude
Maximum update rate	10 Gbps per channel
Memory depth	4.5 Gbit per digital channel

8 bit CML to LVTTL Converter Probe (Optional AT-DTLL8)

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 @ 0.8 V and 400 Mbps @ 3.6 V
Dimensions	W 52 mm – H 22 mm – D 76 mm
Input Connector	Propietary standard
Cable Length	1 meter
Cable Type	Proprietary standard

Proprietary Mini SAS HD to SMA cable (Optional) (TBD)

Output Connector	SMA
Output Type	CML
Number of SMA	16 (8 differential bits)
Cable type	Proprietary standard
Cable length	1 meter
Rise/fall time (10% to 90%)	< 300 ps
Jitter (rms)	< 5 ps

Auxiliary input and output characteristics

Sync in/out	QSFP connector on rear panel (custom pinout)
Connector Type	
Master to Slave delay (typical)	-
Modulation Input (MOD_IN)	
Connector type	SMA on front panel
Number of connectors	2 (for 2 channel models) 4 (for 4 channel models)
Input impedance	50 Ω

Voltage Window	± 1 V
Marker Output	
Connector type	SMA on front panel
Number of connectors	2 (for 2 channel models) 4 (for 4 channel models)
Output impedance	50 Ω
Output level (into 50 Ω)	
Voltage Window	-0.5 V to 1.65 V
Amplitude	100 mVpp to 2.15 Vpp
Resolution	1 mV
Accuracy	±(5% setting + 25 mV)
Switching characteristics	
Max Update Rate (True Arb Mode)	20 Gbps
Max Data Rate (True Arb Mode)	>4 Gbps @ 1 Vpp swing
Max Frequency (AFG Mode)	125 MHz (continuous mode)
Rise/Fall time (10% to 90%, 2 Vpp)	< 150 ps
Jitter (rms)	< 10 ps
Marker out to analog channel skew	
Range	True Arb Mode: 0 to 1.368 µs AFG Mode: 0 to 8.5 sec. in Contin. Mode, 0 to 1.8 µs in Trig. Mode
Resolution	**True Arb Mode:** 1/64 of DAC sampling period **AFG Mode:** 1.5625 ps
Accuracy	±(1% of setting + 50 ps)
Initial skew	< 20 ps
Marker Width	
Value/Range	**True Arb Mode** (Marker Automatic Mode): 36 sampling clock cycles (Full Rate Mode) 18 sampling clock cycles (Half Rate Mode) **AFG Mode** (Continuous Mode): 50% of waveform period (Automatic Marker Width Mode), 500 ps to waveform period – 2,1 ns (Manual Marker Width Mode) **AFG Mode** (Burst/Sweep Mode): Burst Duration or half of sweep duration
Trigger/Event Inputs	
Connector	SMA on the Front Panel
Number of Trigger Inputs	2 (for 2 channel models) 4 (for 4 channel models)
Input Impedance	50 Ω / 1 kΩ
Slope/Polarity	Positive or negative or both
Range	± 3.5 V (50 Ohm input impedance) ± 10 V (1K Ohm input impedance)
Threshold control level	-8 V to 8 V
Threshold control Resolution	10 mV
Threshold control accuracy	± 100 mV
Minimum pulse width (1 V_{p-p})	1 ns
Trigger/gate input to Analog Output Delay	**Slow (synchronous) trigger:** AFG mode: < 205 ns (< 240 ns in triggered sweep mode) True Arb mode: <4392 * DAC clock period(ns) + 17.6 ns

	Fast (asynchronous) trigger: AFG mode: < 195 ns (< 230 ns in triggered sweep mode) True Arb mode: <4392 * DAC clock period(ns) + 17.6 ns
Trigger In to Output jitter (rms)	**AFG mode:** < 20 ps **True Arb mode:** 0.29*DAC clock period
Trigger In programmable delay range	0 ps to 2418 ps
Trigger In programmable delay resolution	78 ps
Maximum Frequency	**AFG:** 75 MTps on Rising/Falling Edge, 100 MTps on Both Edges **True Arb mode:** 1/ (Period of the Analog Waveform + 293 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	0.2 Vpp to 3.3 Vpp
Damage level	**Maximum Input voltage:** 3.6 Vpp **Maximum input power:** 15 dBm (50 Ω)
Frequency range	5 MHz to 500 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 @ 10 MHz carrier	-120 dBc/Hz at 100 Hz ; -140 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[8]	**True Arb:** SampleRate / N where: N = 8, 16, 32, 64 for every SampleRate [8 - 9] **AFG:** 312.5 MHz, 625 MHz, 1250 MHz or 2500 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	**AFG Mode:** 20 Ghz / N where N=40, 80, 160, …, 5120 **AWG Mode:** Sampling Rate/N, N=64, 128,.., 8192[9]
Amplitude	1 Vpp into 50 Ohm
External Modulation Input (AFG only)	
Conector Type	SMA on front panel (MOD.IN)
Input Impedance	50 Ω
Number of inputs	2 (for 2 channel models) 4 (for 4 channel models)
Bandwidth	1 GHz
Input voltage range	1 Vpp (0,5 V to 0.5 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

[8]When using the External Clock Input the SampleRate must be in the range 0÷20 GHz, but the entire Sample Rate interval is not continuous (see the corresponding section in the User manual)
[9]For AWG-717x(D) and AWG-7174(D)-S models the max Sampling rate is limited to 17Gsps

Number of addressable entries	16384
Data Range	DC to 1 MHz
Input Range	VIL = 0 V to 0.8 V / VIH= 2 V to 3.3 V
Impedance	Internal 1 kΩ pull-up resistor to Vcc (3.3 V)
Power	
Source voltage and frequency	100 to 240 VAC ± 10% @ 45-66 Hz
Max. power consumption	Max. 250 W
Environmental Characteristics	
Temperature (operating)	+5 °C to +40 °C (+41 °F to 104 °F)
Temperature (non-operating)	-20 °C to +60 °C (-4 °F to 140 °F)
Humidity (operating)	5% to 80% relative humidity with a maximum wet bulb temperature of 29°C at or below +40°C, (upper limit de–rates to 20.6% relative humidity at +40°C). Non-condensing.
Humidity (non-operating)	5% to 95% relative humidity with a maximum wet bulb temperature of 40°C at or below +60°C, upper limit de-rates to 29.8% relative humidity at +60°C. Non-condensing.
Altitude (operating)	3,000 meters (9,842 feet) maximum at or below 25°C
Altitude (non-operating)	12,000 meters (39,370 feet) maximum
EMC and Safety	
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 inch, 1024x600, capacitive touch LCD
Operative System	Windows 10
External Dimensions	W 445 mm – H 135 mm – D 320 mm (3U 19” rackmount)
Weight	Max. 26.45 lbs (12 Kg)
Front panel connectors	CH N OUTPUT (SMA) where N=2,4 depending on the model MOD N INPUT (SMA) where N=2,4 depending on the model MARKER N OUT (SMA) where N=2,4 depending on the model TRG IN N(SMA) where N=2,4 depending on the model 2 USB 3.0 ports
Rear panel connectors	Ref. Clk. IN (SMA) Ref. Clk. Out (SMA) Sync Clk Out (SMA) Ext Clk IN(SMA) Sync IN (QSFP cable) Sync OUT (QSFP cable) Pattern Jump In (DSUB15) (AWG-7000-FSS opt. only) POD X[7..0] where X=A,B,C,D (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	1 TB SSD or better
Processor	Intel® Pentium Gold G6400 4 GHz (or better)
Processor Memory	32 GB or better

DOCUMENT HISTORY

Version	Date	Author	Notes
V1	2024 – 04	At	Created datasheet

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