FS2 Frequency Synthesizer

Model AP4001A

Wideband synthesizer
10 MHz to 20 GHz

KEYSIGHT

Definitions

The specifications in the following pages describe the warranted performance of the instrument for 23 ±5 °C after a 30-minute warm-up period.

Typical: Expected mean values, not warranted performance.

Min and max: Parameter range that is guaranteed by product design and / or production tested. Warranted performance specifications include guard-bands to account for the expected statistical performance distribution, measurement uncertainties, and changes in performance due to environmental conditions.

Introduction

Ultra-compact, fast and low power consumption frequency synthesizer with USB and LAN interface

The FS2 Frequency Synthesizer (AP4001A) is a wideband low phase-noise synthesizer operating from 10 MHz to 20 GHz. The nominal output power is +23 dBm.

The module has a milli-Hz frequency resolution and uses a high-stability internal reference. The internal reference can be phase-locked to a user-settable external reference. For highest phase coherence, multiple FS2 Frequency Synthesizers can be cascaded with just one master reference clock.

The FS2 Frequency Synthesizer offers dedicated sweeping capabilities with switching speeds of only 25 µs and wideband frequency modulation as well as narrow pulse modulation.

The module has USB and LAN interfaces and can be controlled using the SCPI 1999 command set. Operated with an external 6V DC supply, it consumes less than 10 watts.

Facts, Figures, and Specifications

Signal specifications

Parameter	Min	Typical	Max	Note
Frequency range	10 MHz		20 GHz	
Resolution		0.001 Hz		
Phase resolution		0.1 deg		
Switching speed CW mode Sweep / List mode		1.5 ms 180 µs 25 µs		after SCPI command received Option UNZ

Frequency reference

Parameter	Min	Typical	Max	Note
Internal reference frequency		100 MHz		
Internal reference output frequency				
Temperature stability			±100 ppb	0 to 45 degC
Aging 1st year		0.5 ppm	1 ppm	
Aging per day			5 ppb	after 30 days operations
Warm-up time		5 min		
Output of internal reference		100 MHz		
Output power		5 dBm		
Output impedance		50 Ohms		
Bypass internal reference Input		100 MHz		High phase synchronous mode
Phase lock to external reference	1 MHz	integer MHz	250 MHz	
Reference input level	-5 dBm	0 dBm	+13 dBm	
Reference Bypass mode	5 dBm		+15 dBm	
External reference lock range				
1-250 MHz			±1.0 ppm	
Bypass 100 MHz			>100 ppm	
Reference input impedance		50 Ohms		

Level performance

Parameter	Min	Typical	Max	Note
Output power	17 dBm	23 dBm	26 dBm	See plot

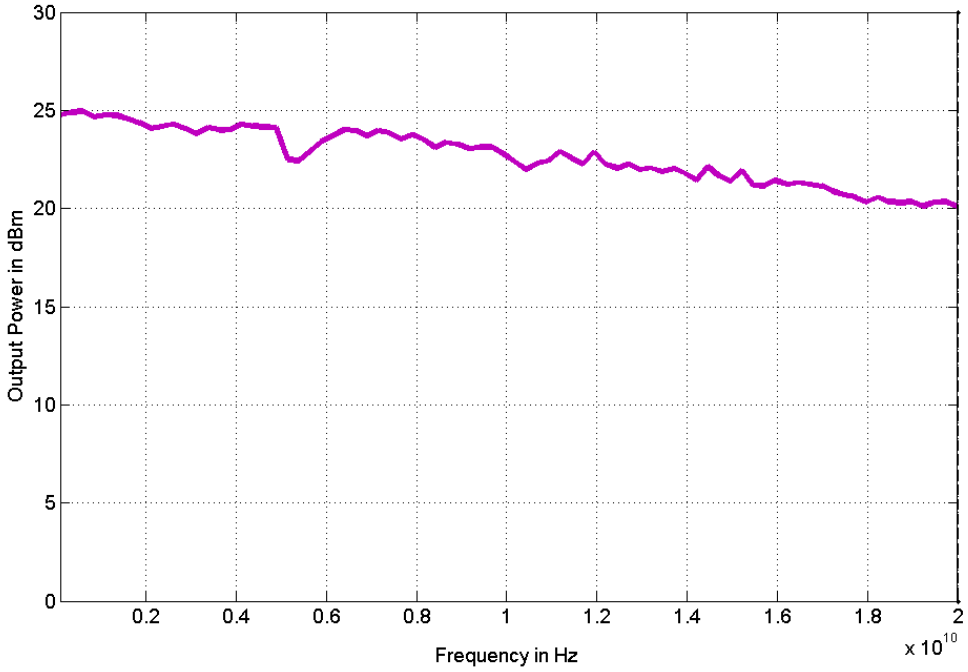


Figure 1. Output power 0.01 to 20 GHz

Reverse power protection and VSWR

Parameter	Min	Typical	Max	Note
Reverse power protection				
DC voltage		7 V		
RF power			23 dBm	
Output impedance		50 Ohms		
VSWR		1.8		

Phase noise

Parameter	Min	Typical	Max	Note
SSB phase noise at 1 GHz				See plot
at 1 kHz from carrier		-118 dBc / Hz		
at 100 kHz from carrier		-128 dBc / Hz		
Wideband noise		-150 dBc / Hz		
SSB phase noise at 10 GHz				
at 1 kHz from carrier		-100 dBc / Hz		
at 100 kHz from carrier		-108 dBc / Hz		
Wideband noise		-150 dBc / Hz		

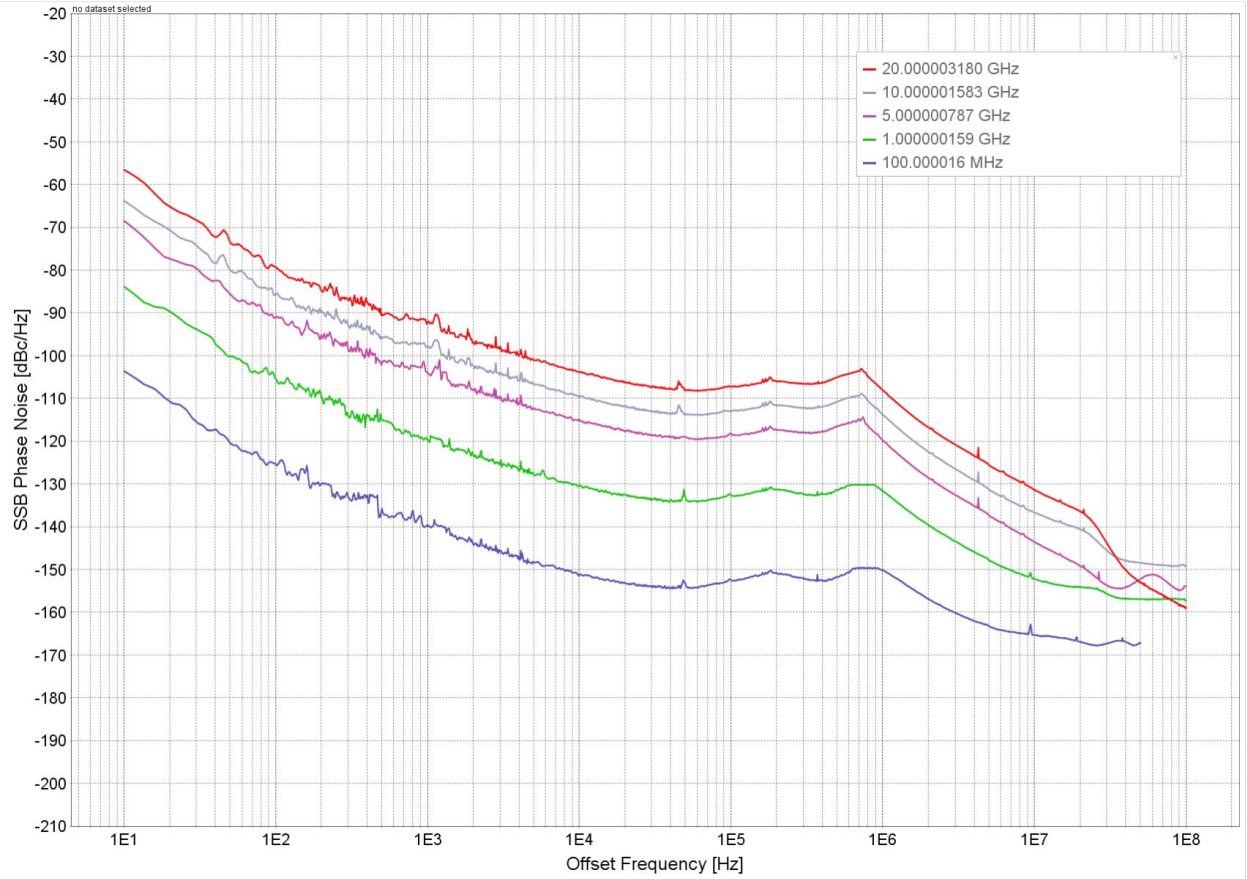


Figure 2. Phase noise performance

Spectral purity

Parameter	Min	Typical	Max	Note
Spectral purity				
Output harmonics		-15 dBc		
Sub-harmonics		-75 dBc		
Non-harmonic spurious		-75 dBc		

Modulation capabilities

Pulse modulation

Parameter	Min	Typical	Max	Note
Modulation source		Internal / external		
Pulse rise / fall time		7 ns		
On / off ratio	30 dB	45 dB		Pout > +10 dBm
Pulse overshoot			10%	Excluding video feedthrough
Pulse delay		20 ns		
Pulse polarity	1V	2V TTL		AC coupled DC coupled
External input threshold	0.85 V	0.9 V	0.95 V	TTL compatible
External input voltage range	-0.5 V		+5.5 V	TTL compatible
External input hysteresis		60 mV		

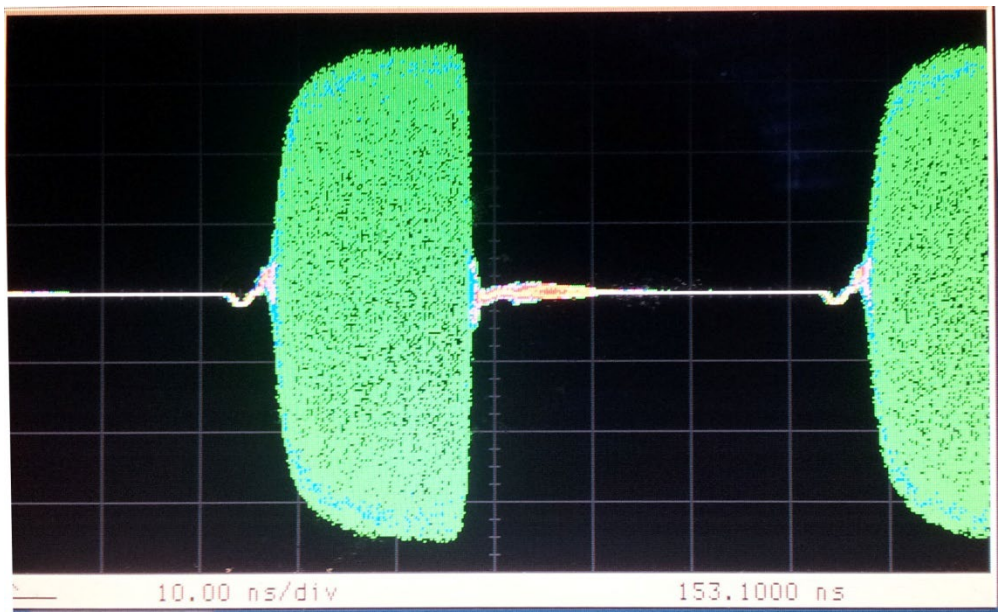


Figure 3. Pulse modulation (20 ns width, 100 ns period)

Internal pulse generator

Parameter	Min	Typical	Max	Note
Duty cycle	1 % to 99 % in 1% steps			within specified minimum pulse width
Pulse width settling range	30 ns		1 s	
Pulse pattern modulation and staggered PRF				Using internal pattern generator
Programmable pattern length	2		4096	
Pulse width resolution		15 ns		
Pulse jitter		2 ns	10 ns	
Polarity		Normal, inverse		selectable

Frequency modulation

Parameter	Min	Typical	Max	Note
Modulation source		Internal		
Maximum frequency deviation (peak)	N · 500 MHz			< 1.25 GHz (N=1) 1.25 GHz to 2.5 GHz (N=0.125) 2.5 GHz to 5 GHz (N=0.25) 5 GHz to 10 GHz (N=0.5) 10 GHz to 20 GHz (N=1) 20 GHz to 40 GHz (N=2)
Deviation accuracy		0.50%	2%	
Distortion (THD)		< 1 %		1 kHz rate, 10 kHz deviation
Modulation rate	0.1 Hz		800 kHz	3dB
Modulation waveforms	Sine			

Phase modulation

Parameter	Min	Typical	Max	Note
Modulation source		Internal		
Phase deviation (peak)	0		100 · N· rad	
Deviation accuracy		0.50%	2%	
Modulation rate	0.1 Hz		800 kHz	
Modulation waveforms	Sine			
Distortion (THD)	< 1%			1 kHz rate and N x rad deviation

Frequency chirps

Parameter	Min	Typical	Max	Note
Frequency chirps		Linear, ramp, up / down		
Modulation source		Internal		
Bandwidth			10%	
Dwell time	1 ns		10 ms	
Slope	0.1 Hz		100 MHz / µs	

Sweeping capability, sweep type: Linear, logarithmic, random

Parameter	Min	Typical	Max	Note
Frequency sweep				
Step time (t_{step})	180 µs 25 µs			Option UNZ
Dwell time (t_{dwell})	15 µs			

Trigger (TRIG IN): Input is TRIG IN at front panel

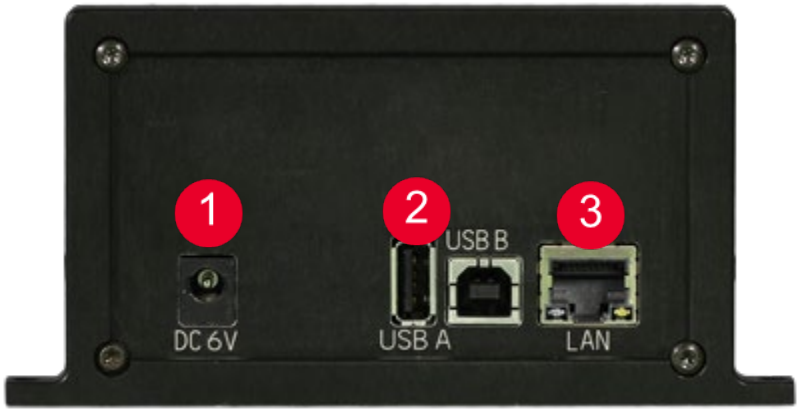
Parameter	Min	Typical	Max	Note
Trigger types				Continuous, single (point), (gated, gated direction without UNZ)
Trigger source				External, bus (LAN, USB)
Trigger modes				Continuous free run, trigger and run
Trigger uncertainty		5 µs		
External trigger delay	50 µs		20 s	
External delay resolution		15 ns		
Trigger modulo	1		255	Execute only on Nth trigger event
Trigger polarity		Rising, falling		
External trigger input threshold	0.85 V	0.9 V	0.95 V	TTL compatible
External trigger input voltage range	-0.5 V		+5.5 V	TTL compatible
External trigger input hysteresis		60 mV		

Connectors

Front panel

1. **Power switch**
2. **RF connector** SMA-type (female)
3. **REF IN** external reference input: BNC female
4. **REF OUT** internal reference output: BNC female
5. **PULSE** pulse modulation input: BNC female
6. **TRIG** trigger input: BNC female

Rear panel



1. **DC power plug** (6.3 V, 3 A)
2. **USB 2.0** host and device
3. **LAN connection** RJ-45

Order Information

Model number	Option number	Description
AP4001A	**520**	Frequency range, 10 MHz to 20 GHz
AP4001A	**UNZ**	Fast switching
AP4001A	**UK6**	Commercial calibration certificate with test data

General Characteristics

Remote programming interfaces:

Ethernet 100BaseT LAN interface

USB 2.0 host and device

Control language SCPI Version 1999.0

Power requirements 6.3 V VDC; 20 W maximum

Mains adapter supplied: 100-240 VAC in / 6.3 V 5 A DC out

Environmental (Levels similar to MIL-PRF-28800F Class 3 / 4)
Environmental stress Samples of this product have been type tested to be robust against the environmental stresses of storage, transportation, and end-use; those stresses to temperature, humidity, shock, vibration, altitude, and power line conditions.

Operating temperature range 0 to 45 °C

Storage temperature range -40 to 70 °C

Operating and storage altitude up to 15,000 feet (4600 m)

CE

Safety / EMC complies with applicable Safety and EMC regulations and directives.

Weight: ≤ 1.0 kg (2.2 lbs) net
Dimensions (W x L x H): 10.5 x 21 x 6 cm [4.13 x 8.27 x 2.36 in]
10.5 x 27 x 6 cm [4.13 x 10.63 x 2.36 in] (with option UNZ)