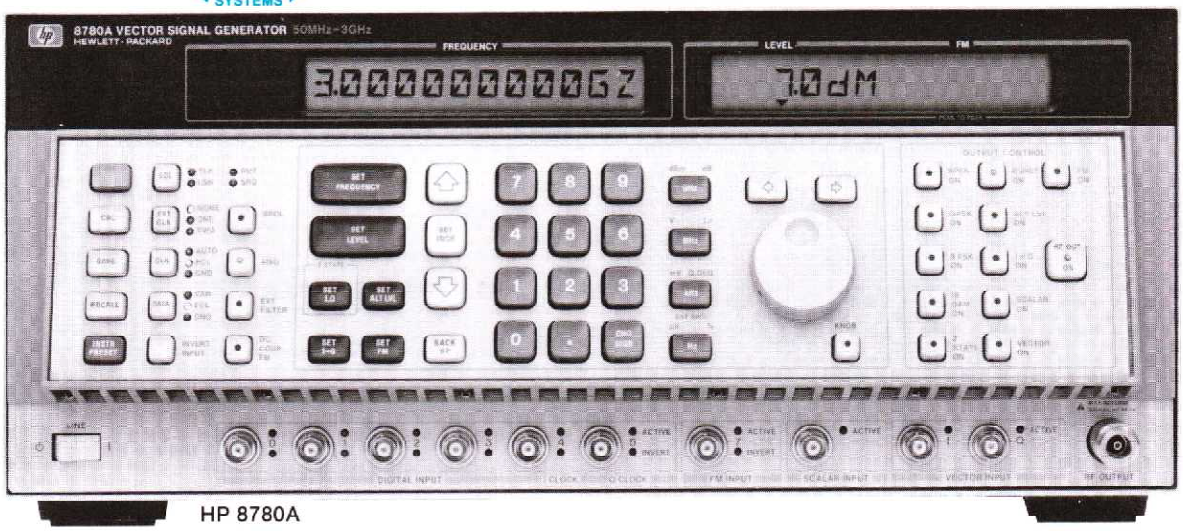
SIGNAL GENERATORS

Vector Signal Generator

Model 8780A

- 700 MHz of arbitrary modulation using vector or "I,Q" inputs
- 10 MHz to 3 GHz IF testing
- Pulse modulation with 1 ns rise times
- Coherent Carrier Output
- BPSK, QPSK, 8PSK, 16QAM, 64QAM, digital modulation and Pulse
- Wideband FM: over 50 MHz p-p deviations
- Linear amplitude modulation with >50 dB dynamic range and 350 MHz bandwidth

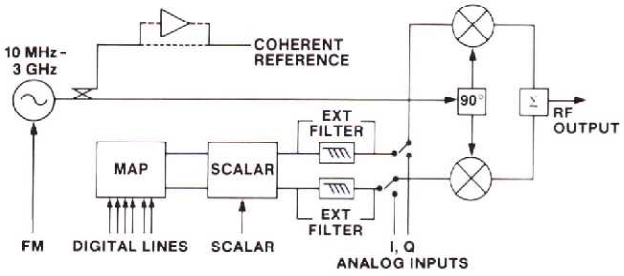
DESIGNED FOR HP-IB SYSTEMS



HP 8780A

Description

The HP 8780A Vector Signal Generator is a synthesized IF source with exceptional modulation for modern receiver and component testing. It is capable of modulation bandwidths almost 100 times wider than previous synthesizers, and has built-in DACs (digital-to-analog-converters) to simplify generation of common digital modulations. Its extra-wide modulation bandwidth comes from a vector modulator that effectively doubles baseband modulation bandwidths for 700 MHz of output modulation. The Vector Signal Generator's wideband modulation is complemented with an unmodulated coherent carrier output for demodulation of test signals.



HP 8780A Block Diagram

The Vector Signal Generator offers a wide variety of modulation using both digital and analog inputs. It generates many standard digital modulations like QPSK and 16QAM and traditional modulations like FM, AM and pulse. By combining the different modulation types, signals as diverse as Barker-coded radar pulses and doppler-shifted satellite signals can be simulated.

Applications

The Vector Signal Generator is well suited to receiver measurements where wideband or complex modulations are required. Its coherent carrier output makes it particularly valuable for systems employing vector demodulators and for pulsed phase measurements of components.

Modulation

The Vector Signal Generator vector modulation capabilities are some of its most valuable. The 350 MHz I and Q (In-phase and Quadrature-phase) analog inputs combine to generate arbitrary phase and amplitude modulation within a 700 MHz output bandwidth. With the proper I and Q signals, the Vector Signal Generator can generate an infinite variety of modulations. Some of the most likely sources for I and Q driving signals are two HP 8770A Arbitrary Waveform Synthesizers, the output of a signal generator and quadrature hybrid or other baseband waveform generators.

The HP 8780A generates extremely wideband AM (350 MHz) with typical dynamic range and accuracy of 50 dB and 2% respectively. A variety of amplitude-only modulations like gaussian-shaped pulses and pulse trains of different amplitudes can be easily generated using this technique.

Digital modulation

HP 8780A offers a more convenient way to generate modulations using only digital inputs. The Vector Signal Generator generates several standard modulations (BPSK, QPSK, 8PSK, 16QAM, and 64QAM with Opt. 064) using digital inputs, and other common modulations can be generated by combining the Vector Signal Generator modulations. For example, the HP 8780A can generate TDMA (time-division-multiple-access) modulation by combining Burst modulation with one of the PSK modulations. Radar Barker codes and spread spectrum modulations can be generated in similar ways.

The Vector Signal Generator frequency modulation capabilities are also wideband with peak-to-peak deviations up to 50 MHz and rates up to 12 MHz. The FM performance has low distortion and good low frequency response for satellite video applications. If wider deviations are required, the FM input can be safely overdriven for typical deviations of >200 MHz p-p.

The Vector Signal Generator also generates simultaneous modulations to simplify receiver tests and IF measurements. For example, the envelope of a digitally modulated signal can be varied to test receiver AGC performance, or a Barker-coded radar modulation can be simultaneously frequency modulated to simulate doppler shifts. The table below shows which modulations can be combined and some applications for the combinations.

	FM	Scalar
Digital	Receiver carrier recovery loop characterization	Receiver AGC testing and compression measurements
Vector	Simulating doppler shifts	N/A
FM	N/A	Receiver AGC testing
Scalar	Receiver AGC testing	N/A

HP 8780A Specifications

Frequency
Range: 10 MHz to 3 GHz.
Resolution: 1 Hz.
Switching speed: typically <220 ms normally
Accuracy and stability: Same as reference oscillator ($<5 \times 10^{-10}$/day after 10 day warm up for internal reference).

Output
Level range: +10 to −100 dBm <2.5 GHz,
+4 to −100 dBm ≧2.5 GHz.
(+12 dBm ≤3 GHz with Opt 064)
Resolution: 0.1 dB.
Accuracy: ±2.5 dB for levels ≥−30 dBm,
±3.5 dB for levels <−30 dBm and >−100 dBm.
SWR: typically < 1.3:1.
Flatness: ±1dB.

Coherent Carrier Output
Unmodulated (except for FM) and unleveled version of front panel RF output available at rear panel.
Frequency range: 10 MHz to 3 GHz.
Output level: typically >−20 dBm (+10 dBm with Opt. 002), specified >−20 dBm from 10 MHz to 200 MHz. Harmonics may be >−5 dBc with Opt. 002.

Spectral Purity
Residual phase noise

Offset from carrier	CW* specified at 1 GHz	CW* typical 10 MHz-3 GHz	DCFM typical 10 MHz-3 GHz	ACFM typical 10 MHz-3 GHz
100 Hz	−84dBc	−93dBc	−74dBc	-
1 KHz	−100dBc	−107dBc	−103dBc	−55dBc
100 KHz	−110dBc	−115dBc	−115dBc	−106dBc
1 MHz	−114dBc	−117dBc	−117dBc	−117dBc
10 MHz (>+7dBm)	−130dBc	−130dBc	−130dBc	−130dBc

*Digital, vector, and scalar residual phase noise is the same as CW.

Harmonics: <−35dBc for output levels ≤+7dBm to 2.5 GHz.
Non-harmonically related spurious for CW, digital, vector, and scalar modulated signals >−40dBm:
<−60 dBc for 10 MHz to 3 GHz, ≥20 MHz from carrier
<−55 dBc for 10 MHz to 3 GHz, <20 MHz from carrier
<−55 dBc for <10 MHz & >3 GHz to 18 GHz.
Residual FM for CW, digital, vector or scalar modulated signals:
<4 Hz rms for 300 Hz to 3 kHz detection BW at 50 MHz.

AC Coupled Frequency Modulation
Rates (3 dB frequencies)**:** 20 Hz to 12 MHz.
Deviation ranges: 50 kHz to 50 MHz peak-to-peak (up to >200 MHz p-p possible with slightly higher distortion by overdriving FM input).
Sensitivity: 1V peak-to-peak for displayed deviation.
Sensitivity Accuracy: <7.5% for rates 50 Hz to 6 MHz and deviations <30 MHz p-p.
Input impedance: 50 ohms nominal.
Residual FM for 300 Hz to 3 kHz BW and 50kHz deviation range: <200 Hz rms.
Supplemental Characteristics
Distortion to 3 MHz rates at 10 MHz p-p: <.75%.
Carrier spurious responses (>20 kHz offset): <−60 dBc.
Frequency flatness (50 Hz to 8 MHz): <±0.5dB.
Differential gain at 27.6 MHz p-p: <2%.
Differential phase at 27.6 MHz p-p: <1 degree.
Field time distortion: <1%.
Luminance-to-chrominance delay: <20 ns.

DC Coupled Frequency Modulation
Maximum rate (3 dB frequency)**:** 10 kHz.
Deviation ranges: 150 Hz to 150 kHz peak-to-peak.
Sensitivity: 1V peak-to-peak for displayed deviation.
Sensitivity Accuracy: <10% for rates <1 kHz and deviations <150 kHz p-p.
Distortion at 1kHz rate and 150 kHz p-p deviation: <5%
Input impedance: 50 ohms nominal.
Residual FM for 300 Hz to 3 kHz BW and 150kHz deviation range: <5 Hz rms.
Supplemental Characteristics
Carrier spurious responses: <−60 dBc for >1 kHz offsets, <−50 dBc for 100 Hz - 1 kHz offsets.

Digital Modulation
Modulation types: BPSK, QPSK, 8PSK, 16QAM (64QAM with Opt. 064), Arbitrary 2-State, Burst.
Simultaneous burst: Available with BPSK, QPSK, 8PSK, or CW (Burst/8PSK not available with Opt. 064).
Alternate level: Available with BPSK, QPSK, BPSK and Burst, QPSK and Burst (last two not available with Opt. 064.)
I<Q: Available with all digital modulations.
Clock modes: Single, separate I and Q (except with Opt. 064), or asynchronous.
Parallel data rates: 0 to 150 MHz clocked (except 64 QAM), 0 to 100 MHz clocked 64QAM w/Opt. 064, 0 to 50 MHz asynchronous.
Serial data rates (only with Opt. 064)**:** 0 to 150 MHz clock and data line for 0 to 25 MHz 64QAM clock rate.
Data input levels: ECL (−2V termination), ground, or variable −2.5V to 2.5V.
Baseband filters: Three internal; external ports supplied.
Data and clock input impedances: 50 ohms nominal.
Data and clock drive requirements: 0.3 to 3.0 Vp-p.
Data dc accuracy at 140 MHz carrier and ≦+7dBm levels: ±1.0% of full scale for BPSK, QPSK, ±1.2% of full scale for 8PSK, ±2% of full scale for 16QAM, 2-state, alt-lvl, I<Q.
Burst dc on/off ratio: >50 dB for 140 MHz carrier.
Supplemental Characteristics 10 MHz to 3 GHz
Data asymmetry: <1 ns for clocked modes.
Data skew: <1 ns for single clock operation.

Pulse Modulation (Burst)
Pulse rates: 0 to 75 MHz.
Pulse dc on/off ratio: >50 dB for 140 MHz carrier (except Opt. 064).
Pulse rise/fall times: ≦ 1ns

Scalar Modulation/AM
Traditional AM modulation requires a dc offset of 0.5 V to be added to the scalar input.
Sensitivity: 0 to +1 volt for 0 to full scale envelope modulation
DC accuracy: <2% of full scale for 140 MHz carrier and for +7 dBm levels.
DC offsets: <1% of full scale
Frequency response: dc to 500 kHz (−3dB).
Input impedance: 10k ohms nominal.

Vector Modulation (using analog I/Q inputs)
Frequency response: dc to 350 MHz (−3dB) at 1 GHz carrier frequency.
DC accuracy: <1.5% of full scale for 140 MHz carrier at ≤+7 dBm and $\sqrt{I^2 + Q^2} \leq 0.5V$.
DC offsets: <1% of full scale for 140 MHz carrier.
Sensitivity: ±0.5V into 50 ohms for ±100% I and Q.
Supplemental Characteristics over 10 MHz to 3 GHz frequency range
Input impedance: 50 ohms.
SWR: <1.5:1 dc to 350 MHz.
Frequency Response: dc to 350 MHz for carriers 400 MHz to 3 GHz.

Remote Programming
All functions HP-IB programmable except line switch. The HP 8780A can output over the interface frequency and output level settings, error/malfunction codes, and operational status codes.
Interface Functions: SH1, AH1, T6, TE0, L3, LE0, SR1, RL1, PP1, DC1, DT0, C0.

General
Operating temperature range: 0 degrees C to +55 degrees C.
Power: 100, 120, 220, 240 V, +5%, −10%, 48-440 Hz; 500 VA max.
Weight: net, 31.5 kg (70 lb). Shipping, 35.5 kg (78 lb).
Size: 177 mm H × 425 mm W × 637 mm D (7.0″ × 16.7″ × 25.1″).

Ordering Information

	Price
HP 8780A Vector Signal Generator	$58,000
Option 001: Rear panel output and modulation inputs	$450
Option 002: +10 dBm Coherent Carrier output	$1,900
Option 064: 64 QAM modulation	$0
Option 907: Front Panel Handles	$65
Option 908: Rack Mount Flanges	$35
Option 909: Handles and Flanges	$90
Option 915: Service Manual	$45
Option 916: Extra Operating Manual	$25

SIGNAL GENERATORS

Signal Simulation for Agile and Wideband Modulation Systems

Models 86792A, 8770A, 8780A

NEW

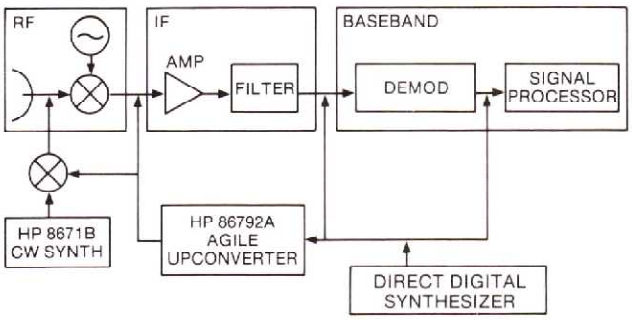
Frequency Agile Signal Simulator

Description

Combining the modulation flexibility of direct-digital synthesis with a frequency-agile direct synthesizer sets a new standard in high-performance signal simulation. Especially suited for radar/EW threat simulation and secure communications tranceiver test, the Frequency Agile Signal Simulator switches from 10 MHz to 3 GHz in less than 250 nanoseconds. With a 40-MHz modulation bandwidth and 0.125 Hz carrier resolution, this system has arbitrary and independent control of carrier modulation including FM, ØM, AM, and pulse. Real-time data downloading facilitates generation of signals whose characteristics change dynamically.

Instruments-on-a-Disk (ID's)

To exploit the broad variety of potential applications, the simulator includes an easy-to-use system interface that supports Instruments-on-a-Disk. These ID's make the system test-specific, such as the Radar Simulator ID suited for simulating agile threats including antenna scans, windows, exotic profiles, and unintentional modulation-on-pulse.



A complete simulation system for your EW, radar, and communication testing requirements

Specifications

Frequency
Range: 10 MHz to 3 GHz
Resolution: 0.125 Hz
Switching Speed: 250 nsec over full 3-GHz agile bandwidth
Modulation Capability
Bandwidth: 40 MHz p-p
Types: Simultaneous FM, ØM, AM, pulse, agility, user-defined
Output
Power Range: +10 to −107 dBm
Spectral Purity
SSB Phase Noise: −120 dBc/Hz (typical @ 10 kHz offset from 2 GHz carrier)
Harmonics: < −35 dBc
Spurious: < −55 dBc

Contact HP for more technical and performance information.

Vector Arbitrary Waveform Synthesizer

Simulation of Complex Wideband Signals with I/Q Modulation

The Vector Arbitrary Waveform Synthesizer (VAWS) simulates extremely complex signals which allow the functional testing of non-agile communications, radar and EW systems and subsystems. Two HP 8770A Arbitrary Waveform Generators provide the complex modulating signals to an HP 8780A Vector Signal Generator's I and Q modulation inputs. Because I/Q or Vector modulation is used, the signal can be completely defined in terms of phase, magnitude and frequency. The modulation can be arbitrarily defined, and the effects of actual hardware and environment on a signal can be simulated.

A sample of communications simulation capabilities:

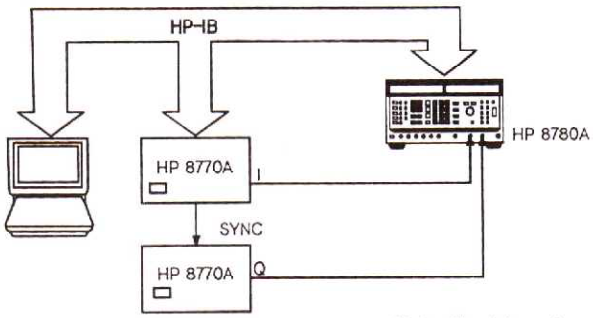
- BPSK to 256 QAM
- QPR
- GMSK
- TDMA
- Filter Simulation
- Compression
- Static and Dynamic Multipath Fading
- Doppler
- System (RF) or subsystem (IF and BB) level signals
- Coherent reference and Baseband I & Q signals

These capabilities allow the functional testing of complete receivers or receiver subsystems. Dynamic equalizers, carrier recovery, and dynamic linearization circuits are among those that can be fully stressed with calibrated repeatable signals from VAWS.

A sample of Radar simulation capabilities:

- Fully synthesized 100 MHz chirps
- Phase coded signals
- Coherent transmitter simulation
- Coherent reference and Baseband I & Q signals

These capabilities allow the testing of compression radar receivers at the system or subsystem level. Compressors and other components can be characterized with a precise synthesized signal. The coherent reference and baseband I & Q signals simplify coherent receiver testing.



- HP Series 200/300 Computer
- 2 Arbitrary Waveform Synthesizers
- Vector Signal Generator
- HP 11775A/76A Waveform generation Software

Contact HP for more technical and performance information.