

Agilent 71708A Microwave Source Agilent 70428A Microwave Source Module

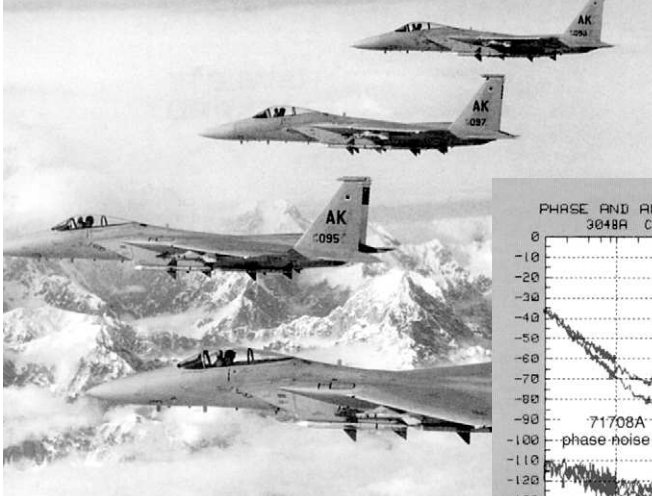
Data Sheet



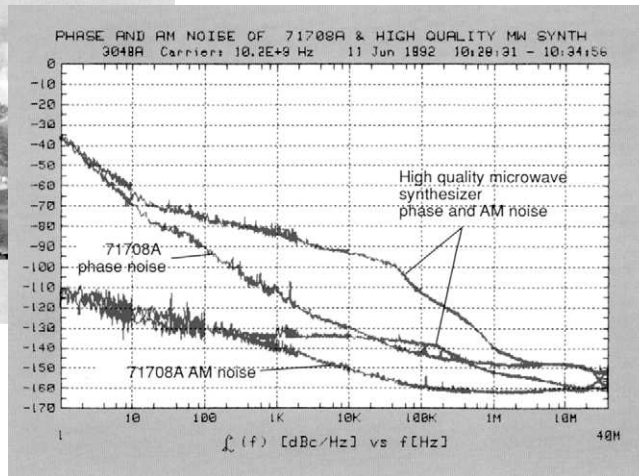
Variable frequency source with lowest phase noise



Agilent Technologies
Innovating the HP Way



Courtesy of McDonnell Douglas



Typical phase and AM noise of the Agilent 71708A microwave source and high quality microwave synthesizer

The Agilent Technologies 71708A microwave source provides signals with exceptionally low phase and AM noise performance from 2.4 to 26.4 GHz. Phase noise specifications are -113 dBc/Hz and -125 dBc/Hz at 1 kHz and 10 kHz offsets from a 10.2 GHz carrier. AM noise is as low as -150 dBc/Hz. Thus, the 71708A is an ideal source for testing microwave receivers, verifying noise floors of phase noise measurement systems, or substituting for the local oscillator in radar systems.

The 71708A consists of a $\frac{4}{8}$ width 70428A microwave source module and an 70004A color display/main-frame.

This system combines:

- Low phase noise
- Low AM noise
- Output frequency range from 2.4 to 26.4 GHz

- 600 MHz frequency resolution
- Optional 0.1 Hz frequency resolution
- Output power up to +16 dBm

Modular Measurement System (MMS) building block

The user interface of the 71708A is built into the firmware of the 70428A microwave source module. This allows you to easily integrate the 70428A into existing MMS systems with multiple instruments. Through the MMS user interface, you have complete control of all its functions.

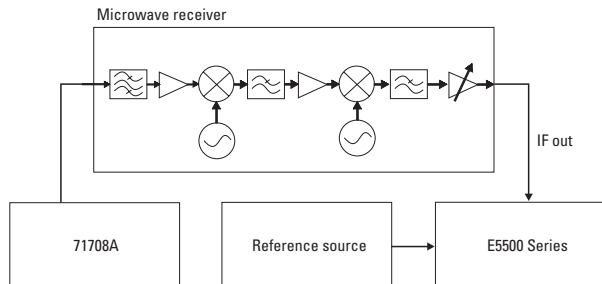
Some of these functions include:

- Output frequency
- Output power level
- Reference source configuration
- Calibration functions
- Tuning sensitivity

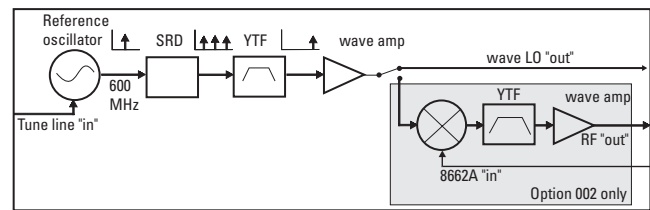
In addition to manual operation, all functions can be controlled over GPIB by a computer.

0.1 Hz frequency resolution

For applications that demand frequency resolution finer than 600 MHz, add Option 002 and an Agilent 8662A/3A synthesized signal generator. This combination of instruments provides a signal from 2.4 GHz to 26.5 GHz with 0.1 Hz frequency resolution while preserving much of the low noise performance of the 71708A. With Option 002, simply enter the desired output frequency and the 71708A automatically sets the frequency of its internal microwave source and, over GPIB, the frequency and power of the 8662A/3A.



Block diagram for microwave receiver noise measurements



Agilent 70428A microwave source block diagram

Selectable tuning and phase noise performance

Along with low phase noise, the 71708A provides a DC coupled tuning port with three sensitivity settings. This allows you to phase-lock the 71708A when using it as a reference source for phase noise measurements on synthesized sources. The three tuning sensitivity settings are directly coupled to noise performance and allow the 71708A flexibility to adapt to your measurement needs.

Built-in output power calibration

Periodic calibration of the output power of the 71708A can be quickly and easily performed using built-in calibration functions and an external power meter. Over GPIB, the microwave source will automatically control an Agilent 437B, 438A, or 70100A power meter. Over MSIB, the 71708A will automatically control the 70100A.

Microwave receiver noise measurements

In the past, measuring the noise of microwave receivers required two receivers driven by a common microwave source. This was due to the inadequate phase and AM noise performance of the available microwave sources. Using this method, the noise of the microwave source cancels out and the combined noise of the two receivers can be measured. However, it is difficult to accurately determine the noise of

each of the individual receivers and two receivers are required.

With the low phase and AM noise of the 71708A and a 3048A phase noise measurement system, this measurement can be made directly. By driving the input of the microwave receiver with the low noise 71708A, the noise of the IF signal out of the receiver is dominated by the noise of its microwave conversion and IF processing components. The noise of the IF signal can then be measured using an RF reference source such as the 8662A, and the resulting absolute noise of the microwave receiver measured directly.

Low AM noise

Low AM noise allows the 71708A to be used as a source for AM noise measurements of signal processing components such as amplifiers and mixers. This low AM noise performance minimizes the degradation of residual PM measurements due to AM to PM conversion in the device under test or in the microwave phase detector.

Reference chain

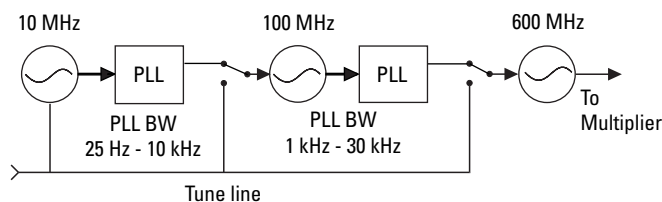
The heart of the 71708A microwave source is the reference chain which consists of a 10 MHz crystal oscillator, 100 MHz oscillator, and 600 MHz oscillator. Each of these oscillators can be the primary reference, providing three different tuning sensitivities with corresponding phase noise performance.

The 600 MHz signal from the reference chain is multiplied with a step recovery diode which generates harmonics from 2.4 to 26.4 GHz. To obtain a particular harmonic, this signal is filtered with a YIG tuned filter. A variable gain GaAs amplifier boosts the power of this signal.

Configuration 1

All oscillators locked

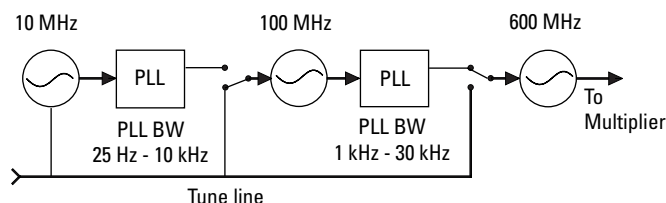
- For those applications that demand the lowest possible noise at all offsets
- Tuning sensitivity of 0.05 ppm/volt
- Phase noise of -65 dBc/Hz at 10 Hz offset, -113 dBc/Hz at 1 kHz offset and 10 GHz carrier frequency



Configuration 2

100 MHz and 600 MHz oscillators locked

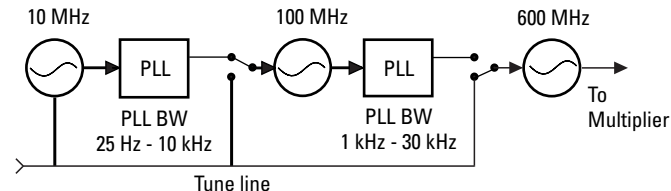
- For those applications that require the best phase noise >1 kHz and a moderate tuning range
- Tuning sensitivity of 1 ppm/volt
- Phase noise of -33 dBc/Hz at 10 Hz offset, -113 dBc/Hz at 1 kHz offset and 10 GHz carrier frequency



Configuration 3

600 MHz free-running oscillator

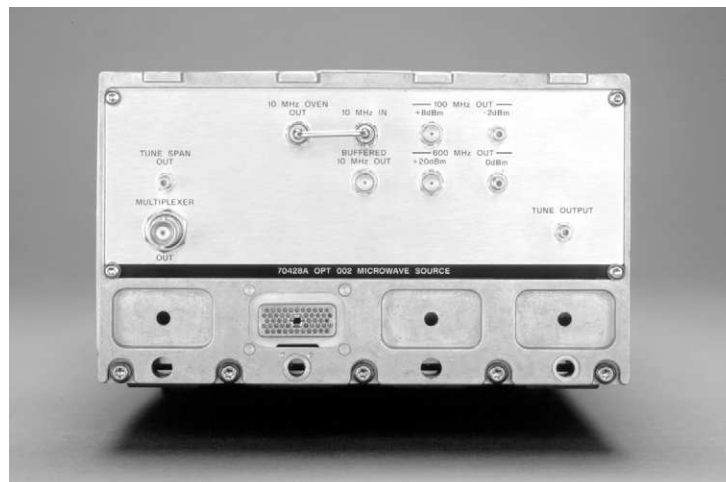
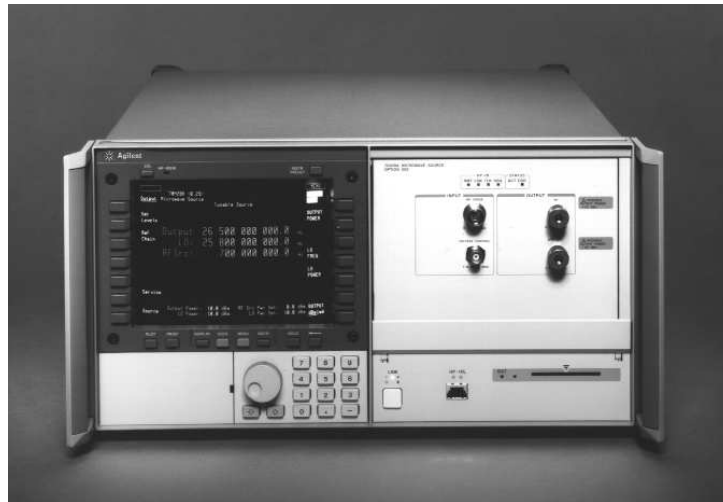
- For those applications that require a wide tuning range and a low broadband noise floor
- Tuning sensitivity of 20 ppm/volt
- Phase noise of -20 dBc/Hz at 10 Hz offset, -100 dBc/Hz at 1 kHz offset and 10 GHz carrier frequency



Option 002

Option 002 of the 71708A adds the capability to mix the internal microwave source with an external RF source. This option adds a microwave mixer, a second YIG tuned filter, a second GaAs amplifier, and associated signal switching. Once the first YIG tuned filter is tuned and the RF source frequency and power set, the second YIG tuned filter is tuned to the correct frequency. The variable gain GaAs amplifier provides output power control of this composite signal.

- Output power up to +16 dBm provides sufficient drive level for your test applications
- Adding Option 002 and an 8662A/3A extends the superior noise performance with 0.1 Hz frequency resolution from 2.4 GHz to 26.5 GHz
- 10 MHz crystal, 100 MHz and 600 MHz oscillator outputs on rear panel
- Low AM noise is ideal for microwave residual measurements
- MMS user interface and modular functionality integrates easily into existing MMS systems
- Low phase noise yields state-of-the-art microwave receiver measurement capability
- Variable tuning sensitivity allows you to optimize the noise performance for your application



Agilent 71708A/70428A

Specifications

Specifications describe the instrument's warranted performance and apply after a 30 minute warm-up. These specifications are valid over its operating/environmental range unless otherwise noted.

Supplemental Characteristics (shown in *italics*) are intended to provide additional information, useful in applying the instrument by giving typical (expected), but not warranted performance parameters. These characteristics are shown in *italics* or labeled as "typical," "usable to," or "nominal."

Microwave source

RF output

Frequency range 2.4 GHz to 25.8 GHz

Frequency resolution 600 MHz

Output power

2.4 to 6.6 GHz 0 to +16 dBm

7.2 to 25.8 GHz 0 to +10 dBm

Spectral purity

The internal reference oscillators can be locked together in three configurations, each with different phase noise performance and tuning bandwidths. All noise levels are in units of dBc/Hz unless otherwise noted. Spurious and phase noise specifications at any offset can be determined by drawing a line, on a log-log plot between specification points given.

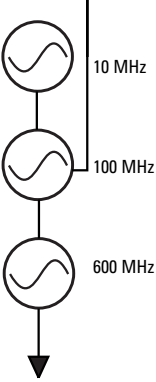
Configuration 1. All oscillators locked

<div>Customer tune range: ±.25 ppm</div> <div><div><div></div><div></div><div></div></div><div>10 MHz</div><div>100 MHz</div><div>600 MHz</div><div></div></div>	Output frequency		Offset from carrier (Hz)								Spurious (dBc)		
			1 ¹	10	100	1k	10k	100k	1M	10M	40M	10 to 100	≥1k
	2.4 to 3.0 GHz	Typ.	−50	−80	−100	−128	−138	−148	−152	−152	−152	−60	−80
		Spec.	−45	−75	−95	−123	−133	−143	−147	−147	−147	−50	−70
	3.0 to 4.2 GHz	Typ.	−47	−77	−97	−125	−136	−146	−150	−150	−150	−54	−80
		Spec.	−42	−72	−92	−120	−131	−141	−145	−145	−145	−44	−70
	4.2 to 6.0 GHz	Typ.	−44	−74	−94	−122	−134	−144	−148	−148	−148	−54	−80
		Spec.	−39	−69	−89	−117	−129	−139	−143	−143	−143	−44	−70
	6.0 to 7.8 GHz	Typ.	−42	−72	−92	−120	−132	−143	−147	−147	−147	−54	−80
		Spec.	−37	−67	−87	−115	−127	−138	−142	−142	−142	−44	−70
	7.8 to 10.2 GHz	Typ.	−40	−70	−90	−118	−130	−141	−145	−145	−145	−50	−80
		Spec.	−35	−65	−85	−113	−125	−136	−140	−140	−140	−40	−70
	10.2 to 12.6 GHz	Typ.	−38	−68	−88	−116	−128	−140	−143	−143	−143	−50	−80
		Spec.	−33	−63	−83	−111	−123	−135	−138	−138	−138	−40	−70
	12.6 to 18.0 GHz	Typ.	−35	−65	−85	−113	−125	−137	−140	−140	−140	−47	−70
		Spec.	−30	−60	−80	−108	−120	−132	−135	−135	−135	−37	−60
	18.0 to 25.8 GHz	Typ.	−32	−62	−82	−110	−122	−134	−136	−136	−136	−44	−70
		Spec.	−27	−57	−77	−105	−117	−129	−131	−131	−131	−34	−60

Best phase noise <100 Hz frequency offsets — narrow tuning sensitivity

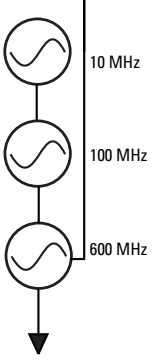
1. All noise levels above -30 dBc/Hz are 3 dB below $S_{\phi}(f)$ expressed in dB with respect to 1 rad²/Hz.

Configuration 2. 100 and 600 MHz oscillators locked

<div> Customer tune range: ±5 ppm  </div>	Output frequency		Offset from carrier (Hz)									Spurious (dBc)	
			1 ¹	10 ²	100	1k	10k	100k	1M	10M	40M	10 to 100	21k
2.4 to 3.0 GHz	Typ.	+2	-48	-98	-128	-138	-148	-152	-152	-152	-152	-60	-80
	Spec.	+7	-43	-93	-123	-133	-143	-147	-147	-147	-147	-50	-70
3.0 to 4.2 GHz	Typ.	+5	-45	-95	-125	-136	-146	-150	-150	-150	-150	-54	-80
	Spec.	+10	-40	-90	-120	-131	-141	-145	-145	-145	-145	-44	-70
4.2 to 6.0 GHz	Typ.	+8	-42	-92	-122	-134	-144	-148	-148	-148	-148	-54	-80
	Spec.	+13	-37	-87	-117	-129	-139	-143	-143	-143	-143	-44	-70
6.0 to 7.8 GHz	Typ.	+10	-40	-90	-120	-132	-143	-147	-147	-147	-147	-54	-80
	Spec.	+15	-35	-85	-115	-127	-138	-142	-142	-142	-142	-44	-70
7.8 to 10.2 GHz	Typ.	+12	-38	-88	-118	-130	-141	-145	-145	-145	-145	-50	-80
	Spec.	+17	-33	-83	-113	-125	-136	-140	-140	-140	-140	-40	-70
10.2 to 12.6 GHz	Typ.	+14	-36	-86	-116	-128	-140	-143	-143	-143	-143	-50	-80
	Spec.	+19	-31	-81	-111	-123	-135	-138	-138	-138	-138	-40	-70
12.6 to 18.0 GHz	Typ.	+17	-33	-83	-113	-125	-137	-140	-140	-140	-140	-47	-70
	Spec.	+22	-28	-78	-108	-120	-132	-135	-135	-135	-135	-37	-60
18.0 to 25.8 GHz	Typ.	+20	-30	-80	-110	-122	-134	-136	-136	-136	-136	-44	-70
	Spec.	+25	-25	-75	-105	-117	-129	-131	-131	-131	-131	-34	-60

Better phase noise <10 kHz frequency offsets — moderate tuning sensitivity

Configuration 3. 600 MHz free running oscillator

<div> Customer tune range: ±100 ppm  </div>	Output frequency		Offset from carrier (Hz)									Spurious (dBc)		
			1 ¹	10 ²	100	1k	10k	100k	1M	10M	40M	100	1k	≥10k
2.4 to 3.0 GHz	Typ.	+15	-35	-75	-118	-138	-148	-152	-152	-152	-152	-40	-80	-80
	Spec.	+20	-30	-70	-108	-133	-143	-147	-147	-147	-147	-30	-70	-70
3.0 to 4.2 GHz	Typ.	+18	-32	-72	-111	-136	-146	-150	-150	-150	-150	-34	-70	-80
	Spec.	+23	-27	-67	-106	-131	-141	-145	-145	-145	-145	-24	-64	-70
4.2 to 6.0 GHz	Typ.	+21	-29	-69	-109	-134	-144	-148	-148	-148	-148	-34	-74	-80
	Spec.	+26	-24	-64	-104	-129	-139	-143	-143	-143	-143	-24	-64	-70
6.0 to 7.8 GHz	Typ.	+23	-27	-67	-107	-132	-143	-147	-147	-147	-147	-34	-74	-80
	Spec.	+28	-22	-62	-102	-127	-138	-142	-142	-142	-142	-24	-64	-70
7.8 to 10.2 GHz	Typ.	+25	-25	-65	-105	-130	-141	-145	-145	-145	-145	-30	-70	-80
	Spec.	+30	-20	-60	-100	-125	-136	-140	-140	-140	-140	-20	-60	-70
10.2 to 12.6 GHz	Typ.	+27	-23	-63	-103	-128	-140	-143	-143	-143	-143	-30	-70	-80
	Spec.	+32	-18	-58	-98	-123	-135	-138	-138	-138	-138	-20	-60	-70
12.6 to 18.0 GHz	Typ.	+30	-20	-60	-100	-125	-137	-140	-140	-140	-140	-27	-67	-70
	Spec.	+35	-15	-55	-95	-120	-132	-135	-135	-135	-135	-17	-57	-60
18.0 to 25.8 GHz	Typ.	+33	-17	-57	-97	-122	-134	-136	-136	-136	-136	-24	-64	-70
	Spec.	+38	-12	-52	-92	-117	-129	-131	-131	-131	-131	-14	-54	-60

Good phase noise <10 kHz frequency offsets — wide tuning sensitivity

1. All noise levels above -30 dBc/Hz are 3 dB below S ϕ (f) expressed in dB with respect to 1 rad²/Hz.
2. All noise levels above -40 dBc/Hz are 3 dB below S ϕ (f) expressed in dB with respect to 1 rad²/Hz

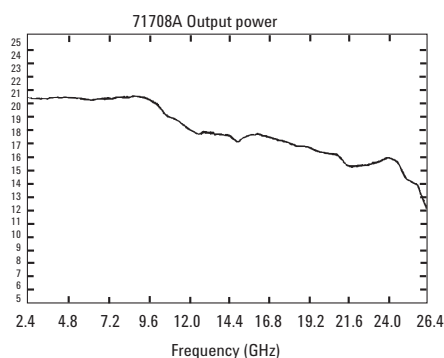
AM noise

Specifications apply for +10 dBm output power. All noise levels in dBc/Hz. AM noise specifications at any offset can be determined by drawing a line on a log-log plot between specification points given.

Output frequency		Offset from carrier (Hz)									Spurious (dBc)	
		1	10	100	1k	10k	100k	1M	10M	40M	10	1k to 40M
2.4 to 25.8 GHz	Typ.	-100	-110	-117	-133	-143	-153	-155	-155	-155	-60	-80
	Spec.	-95	-105	-112	-128	-138	-148	-150	-150	-150	-50	-70

Supplemental characteristics

Frequency overrange	26.4 GHz with degraded output power
Output level entry resolution	0.1 dB
Absolute power accuracy	±3 dB
Harmonics	-10 dBc
Frequency switching transients	Output power can peak at +22 dBm during frequency switching
Output power drift	<1 dB after warm-up
Output power settling time	<100 ms
Frequency switching speed	3 seconds, standard; 6 seconds, Option 002
Reference tuning	Voltage control of the internal reference oscillators is available through a port on the front panel.
Tuning range (sensitivity)	
Configuration 1	±0.25 ppm (0.05 ppm/volt)
Configuration 2	±5 ppm (1 ppm/volt)
Configuration 3	±100 ppm (20 ppm/volt)
Tuning port voltage range	±5 volts (overrange to ±10 volts)
Tuning port input impedance	2 kΩ



Maximum output power vs frequency

Option 002 specifications

Requires an Agilent 8662A or 8663A as an RF source

Adds capability to the 71708A such that an RF source can be mixed with the microwave source. The front panel frequency of the RF source is automatically controlled by the 71708A over GPIB.

Option 002 spectral purity

The following spectral purity table combines the effects of the 71708A Option 002, Configuration 1, and 8662A/3A when used together as a microwave source. All noise levels are in units of dBc/Hz unless otherwise noted. Spurious and phase noise specifications at any offset can be determined by drawing a line on a log-log plot between specification points given. To combine the 8662A/3A phase noise with Configuration 2 and 3 tables, use the phase noise numbers from this table for offsets ≥ 1 kHz and Configuration 2 and 3 tables for offsets ≤ 100 Hz.

AM noise of Option 002¹

Specifications apply for +10 dBm output power. All noise levels in dBc/Hz. AM noise specifications at any offset can be determined by drawing a line on a log-log plot between specification points given.

Output frequency		Offset from carrier (Hz)									Spurious (dBc)	
		1	10	100	1k	10k	100k	1M	10M	40M	10	1k to 40M
2.4 to 26.5 GHz	Typ.	-97	-107	-114	-130	-140	-150	-152	-152	-152	-60	-80
	Spec.	-92	-102	-109	-125	-135	-145	-147	-147	-147	-50	-70

Configuration 1. All oscillators locked

Output frequency		Offset from carrier (Hz)											Spurious ² (dBc)	
		1 ¹	10	100	1k	3k	5k	10k	100k	1M	10M	40M	10 to 100	$\geq 1k$
2.4 to 3.0 GHz	Typ.	-50	-80	-100	-119	-121	-124	-130	-130	-135	-147	-147	-60	-80
	Spec.	-43	-73	-92	-112	-112	-114	-124	-124	-130	-142	-142	-50	-70
3.0 to 4.2 GHz	Typ.	-47	-77	-97	-122	-129	-130	-133	-136	-141	-149	-149	-54	-80
	Spec.	-42	-72	-92	-115	-117	-120	-128	-131	-136	-144	-144	-44	-70
4.2 to 6.0 GHz	Typ.	-44	-74	-94	-120	-122	-124	-131	-136	-141	-148	-148	-54	-80
	Spec.	-39	-69	-89	-114	-117	-119	-126	-131	-136	-143	-143	-44	-70
6.0 to 7.8 GHz	Typ.	-42	-72	-92	-119	-123	-125	-130	-136	-140	-147	-147	-54	-80
	Spec.	-37	-67	-87	-113	-116	-118	-125	-131	-135	-142	-142	-44	-70
7.8 to 10.2 GHz	Typ.	-40	-70	-90	-118	-121	-124	-129	-135	-139	-145	-145	-50	-80
	Spec.	-35	-65	-85	-112	-115	-117	-124	-130	-134	-140	-140	-40	-70
10.2 to 12.6 GHz	Typ.	-38	-68	-88	-116	-121	-123	-128	-134	-138	-143	-143	-50	-80
	Spec.	-33	-63	-83	-111	-114	-116	-123	-129	-133	-138	-138	-40	-70
12.6 to 18.0 GHz	Typ.	-35	-65	-85	-113	-119	-121	-125	-133	-137	-140	-140	-47	-70
	Spec.	-30	-60	-80	-108	-112	-114	-120	-128	-132	-135	-135	-37	-60
18.0 to 25.8 GHz	Typ.	-32	-62	-82	-110	-115	-117	-122	-128	-133	-136	-136	-44	-70
	Spec.	-27	-57	-77	-105	-108	-110	-117	-123	-127	-131	-131	-34	-60

Best phase noise <100 Hz frequency offsets — narrow tuning sensitivity.

1. All noise levels above -30 dBc/Hz are 3 dB below $S_{\phi}(f)$ expressed in dB with respect to 1 rad²/Hz.
2. Mixing an RF source with the microwave LO in the 71708A Option 002 may result in some mixing spurious exceeding spurious specifications, see mixing spurious table on page 10.

Supplemental characteristics

Mixing spurious

Carrier frequency range (GHz) where a mixing spur will occur ≤ 40 MHz from the carrier	Typical spurious level (dBc)
2.990–3.010	–40
2.392–2.408, 2.737–2.749, 2.793–2.807 2.995–3.005, 3.592–3.608	–60
2.493–2.507, 2.929–2.938, 3.493–3.507, 4.109–4.120	–70

LO feedthrough 430–80 MHz offset below carrier

<–50 dBc typical

General specifications

Agilent 71708A system components

70004A color display/mainframe

70428A microwave source module

Internal reference oscillator

Internal 10 MHz

reference oscillator

10 MHz quartz oscillator

Aging rate

< 1×10^{-8} /day after 10 day warm-up

Temperature stability

< $\pm 2 \times 10^{-8}$ over 0 to 55° C

Rear panel connections

10 MHz IN (+7 dBm required)
 BUFFERED 10 MHz OUT
 (Typical +7 dBm)
 10 MHz OVEN OUT (Typical +10 dBm)
 100 MHz OUT (Typical –2 dBm)
 100 MHz OUT (Typical +8 dBm)
 600 MHz OUT (Typical +20 dBm)
 600 MHz OUT (Typical 0 dBm)
 TUNE SPAN OUT (not specified)
 MULTIPLEXER OUT (not specified)
 TUNE OUTPUT (not specified)

Environmental temperature

Operational, 0 to +55° C;
 storage, –40 to +75° C

Humidity

Operational, 0 to 95% relative
 humidity at 45° C

Warm-up time

30 minutes recommended

EMC

Meets MIL-STD 461B

1. AM noise specifications apply when an Agilent 8662A or 8663A is used as the RF source.

Power requirements

Agilent 71708A

See requirements for 70004A. All power supplied by the mainframe (70004A).

Agilent 70428A

Requires as much as 80 watts of regulated power from mainframe.

Weight

71708A	26.8 kg (58.9 lb) nominal
71708A Option 002	29.3 kg (64.5 lb) nominal
70428A	7.4 kg (16.1 lb) nominal
70428A Option 002	9.9 kg (21.7 lb) nominal

Warranty

One year (extendable with options)

Calibration cycle

One year recommended

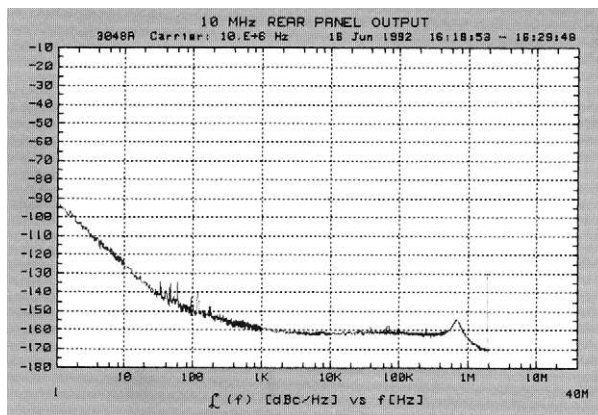
Supported power meters for output power calibration

70100A power meter
437B power meter
438A power meter

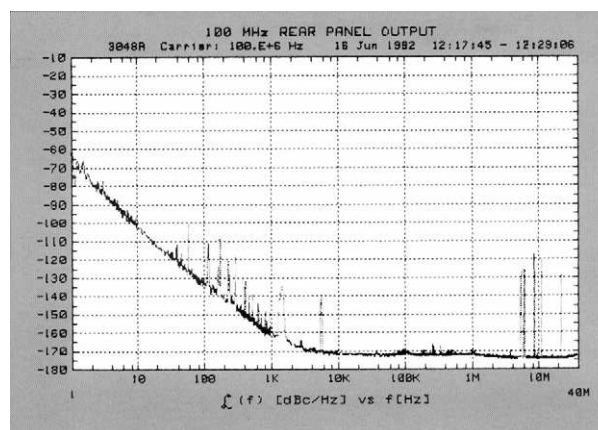
Supported displays and mainframes

70004A color display/mainframe
70206A display with 70001A mainframe

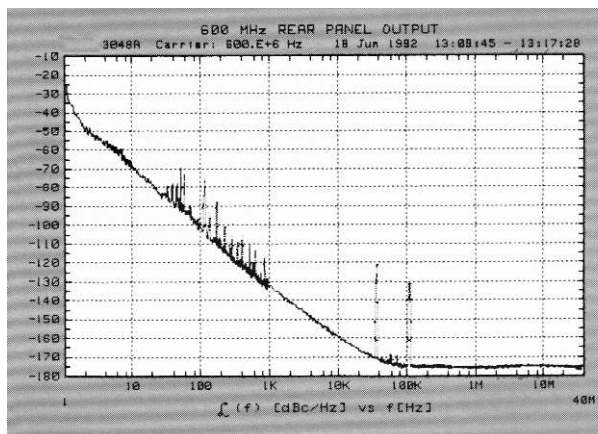
Supplemental characteristics



100 MHz rear panel output: Typical phase noise performance



600 MHz rear panel output: Typical phase noise performance



10 MHz rear panel output: Typical phase noise performance

Ordering information

Agilent 71708A microwave source

Option 002	0.1 Hz frequency resolution capability (requires an 8662A/3A Option 003)
Option 003	Add 8662A Option 003 synthesized signal generator
Option 004	Add 8663A Option 003 synthesized signal generator
Option W30	Extended service and repair (std) or with Option 002
Option 908	Rack flange kit without handles (product number 5062-3979)
Option 910	Provides two sets of user guides (product number 70427-90002), component level information packets (product number 70427-90004), and service documentation disks (product numbers 70428-90007 and 70428-90008)
Option 913	Rack flange kit with handles (product number 5062-4073)
Option OBW¹	Service documentation on a disk (product numbers 70428-90007 and 70428-90008)

Agilent 70428A microwave source module

Option 002	0.1 Hz frequency resolution capability (requires an 8662A/3A Option 003)
Option W30	Extended service and repair (std) or with Option 002
Option 910	Provides two sets of user guides (product number 70427-90002), component level information packets (product number 70427-90004), and service documentation disks (product numbers 70428-90007 and 70428-90008)
Option OBW¹	Service documentation on a disk (product number 70428-90007 and 70428-90008)

1. Requires a PC, Windows 3.0/3.1, 3 1/2-inch 1.44 Mbyte floppy drive, 4 Mbyte RAM, VGA monitor, and 7 Mbyte available hard disk space

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