

**TSG4100A Series
RF Signal Generators
Specifications and Performance Verification
Technical Reference**



077-1078-00

**TSG4100A Series
RF Signal Generators
Specifications and Performance Verification
Technical Reference**

Register now!

Click the following link to protect your product.

▶ www.tektronix.com/register

www.tektronix.com

077-1078-00

Tektronix

Copyright © Tektronix. All rights reserved. Licensed software products are owned by Tektronix or its subsidiaries or suppliers, and are protected by national copyright laws and international treaty provisions.

Tektronix products are covered by U.S. and foreign patents, issued and pending. Information in this publication supersedes that in all previously published material. Specifications and price change privileges reserved.

TEKTRONIX and TEK are registered trademarks of Tektronix, Inc.

Contacting Tektronix

Tektronix, Inc.
14150 SW Karl Braun Drive
P.O. Box 500
Beaverton, OR 97077
USA

For product information, sales, service, and technical support:

- In North America, call 1-800-833-9200.
- Worldwide, visit www.tektronix.com to find contacts in your area.

Warranty

Tektronix warrants that this product will be free from defects in materials and workmanship for a period of three (3) years from the date of shipment. If any such product proves defective during this warranty period, Tektronix, at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product. Parts, modules and replacement products used by Tektronix for warranty work may be new or reconditioned to like new performance. All replaced parts, modules and products become the property of Tektronix.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, with shipping charges prepaid. Tektronix shall pay for the return of the product to Customer if the shipment is to a location within the country in which the Tektronix service center is located. Customer shall be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to any other locations.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; c) to repair any damage or malfunction caused by the use of non-Tektronix supplies; or d) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

THIS WARRANTY IS GIVEN BY TEKTRONIX WITH RESPECT TO THE PRODUCT IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED. TEKTRONIX AND ITS VENDORS DISCLAIM ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. TEKTRONIX' RESPONSIBILITY TO REPAIR OR REPLACE DEFECTIVE PRODUCTS IS THE SOLE AND EXCLUSIVE REMEDY PROVIDED TO THE CUSTOMER FOR BREACH OF THIS WARRANTY. TEKTRONIX AND ITS VENDORS WILL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES IRRESPECTIVE OF WHETHER TEKTRONIX OR THE VENDOR HAS ADVANCE NOTICE OF THE POSSIBILITY OF SUCH DAMAGES.

[W4 – 15AUG04]

Table of Contents

Important safety information	iii
General safety summary	iii
Service safety summary	v
Terms in this manual	vi
Symbols and terms on the product	vi
Preface	vii
Related Manuals	vii
Specifications	1
Performance Conditions	1
Electrical Specifications	2
Physical Characteristics	13
Safety, Certifications, and Compliance	13
Environmental Characteristics	14
Performance Verification	15
Prerequisites	15
Required Equipment	16
Preliminary Checks	17
Warranted characteristics tests	17
Test Record	23

List of Tables

Table 1: Specification categories	1
Table 2: Frequency	2
Table 3: Phase noise.....	3
Table 4: Residual modulation	3
Table 5: RF output connectors	3
Table 6: RF output protection	4
Table 7: RF output attenuator	4
Table 8: Output level setting range and resolution.....	4
Table 9: Output level accuracy.....	5
Table 10: Harmonics	6
Table 11: Spurious.....	6
Table 12: Internal analog modulation	6
Table 13: External analog modulation output.....	7
Table 14: External analog modulation input.....	7
Table 15: Analog frequency modulation.....	8
Table 16: Analog phase modulation.....	9
Table 17: Analog amplitude modulation.....	9
Table 18: Pulse modulation	10
Table 19: Internal IQ modulation.....	11
Table 20: External IQ modulation	12
Table 21: Physical characteristics	13
Table 22: Display/computer.....	13
Table 23: Environmental characteristics	14
Table 24: Power requirements	14
Table 25: Equipment required for Performance Verification	16

Important safety information

This manual contains information and warnings that must be followed by the user for safe operation and to keep the product in a safe condition.

To safely perform service on this product, additional information is provided at the end of this section. (See page v, *Service safety summary*.)

General safety summary

Use the product only as specified. Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. Carefully read all instructions. Retain these instructions for future reference.

Comply with local and national safety codes.

For correct and safe operation of the product, it is essential that you follow generally accepted safety procedures in addition to the safety precautions specified in this manual.

The product is designed to be used by trained personnel only.

Only qualified personnel who are aware of the hazards involved should remove the cover for repair, maintenance, or adjustment.

Before use, always check the product with a known source to be sure it is operating correctly.

This product is not intended for detection of hazardous voltages.

Use personal protective equipment to prevent shock and arc blast injury where hazardous live conductors are exposed.

While using this product, you may need to access other parts of a larger system. Read the safety sections of the other component manuals for warnings and cautions related to operating the system.

When incorporating this equipment into a system, the safety of that system is the responsibility of the assembler of the system.

To avoid fire or personal injury

Use proper power cord. Use only the power cord specified for this product and certified for the country of use.

Do not use the provided power cord for other products.

Ground the product. This product is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, make sure that the product is properly grounded.

Do not disable the power cord grounding connection.

Power disconnect. The power cord disconnects the product from the power source. See instructions for the location. Do not position the equipment so that it is difficult to operate the power cord; it must remain accessible to the user at all times to allow for quick disconnection if needed.

Observe all terminal ratings. To avoid fire or shock hazard, observe all ratings and markings on the product. Consult the product manual for further ratings information before making connections to the product. Do not exceed the Measurement Category (CAT) rating and voltage or current rating of the lowest rated individual component of a product, probe, or accessory. Use caution when using 1:1 test leads because the probe tip voltage is directly transmitted to the product.

Do not apply a potential to any terminal, including the common terminal, that exceeds the maximum rating of that terminal.

Do not float the common terminal above the rated voltage for that terminal.

The measuring terminals on this product are not rated for connection to mains or Category II, III, or IV circuits.

Do not operate without covers. Do not operate this product with covers or panels removed, or with the case open. Hazardous voltage exposure is possible.

Avoid exposed circuitry. Do not touch exposed connections and components when power is present.

Do not operate with suspected failures. If you suspect that there is damage to this product, have it inspected by qualified service personnel.

Disable the product if it is damaged. Do not use the product if it is damaged or operates incorrectly. If in doubt about safety of the product, turn it off and disconnect the power cord. Clearly mark the product to prevent its further operation.

Examine the exterior of the product before you use it. Look for cracks or missing pieces.

Use only specified replacement parts.

Use proper fuse. Use only the fuse type and rating specified for this product.

Wear eye protection. Wear eye protection if exposure to high-intensity rays or laser radiation exists.

Do not operate in wet/damp conditions. Be aware that condensation may occur if a unit is moved from a cold to a warm environment.

Do not operate in an explosive atmosphere.

Keep product surfaces clean and dry. Remove the input signals before you clean the product.

Provide proper ventilation. Refer to the installation instructions in the manual for details on installing the product so it has proper ventilation.

Slots and openings are provided for ventilation and should never be covered or otherwise obstructed. Do not push objects into any of the openings.

Provide a safe working environment. Always place the product in a location convenient for viewing the display and indicators.

Avoid improper or prolonged use of keyboards, pointers, and button pads. Improper or prolonged keyboard or pointer use may result in serious injury.

Be sure your work area meets applicable ergonomic standards. Consult with an ergonomics professional to avoid stress injuries.

Use only the Tektronix rackmount hardware specified for this product.

Service safety summary

The *Service safety summary* section contains additional information required to safely perform service on the product. Only qualified personnel should perform service procedures. Read this *Service safety summary* and the *General safety summary* before performing any service procedures.

To avoid electric shock. Do not touch exposed connections.

Do not service alone. Do not perform internal service or adjustments of this product unless another person capable of rendering first aid and resuscitation is present.

Disconnect power. To avoid electric shock, switch off the product power and disconnect the power cord from the mains power before removing any covers or panels, or opening the case for servicing.

Use care when servicing with power on. Dangerous voltages or currents may exist in this product. Disconnect power, remove battery (if applicable), and disconnect test leads before removing protective panels, soldering, or replacing components.

Verify safety after repair. Always recheck ground continuity and mains dielectric strength after performing a repair.

Terms in this manual

These terms may appear in this manual:



WARNING. *Warning statements identify conditions or practices that could result in injury or loss of life.*



CAUTION. *Caution statements identify conditions or practices that could result in damage to this product or other property.*

Symbols and terms on the product

These terms may appear on the product:

- DANGER indicates an injury hazard immediately accessible as you read the marking.
- WARNING indicates an injury hazard not immediately accessible as you read the marking.
- CAUTION indicates a hazard to property including the product.



When this symbol is marked on the product, be sure to consult the manual to find out the nature of the potential hazards and any actions which have to be taken to avoid them. (This symbol may also be used to refer the user to ratings in the manual.)

The following symbol(s) may appear on the product:



CAUTION
Refer to Manual



Protective Ground
(Earth) Terminal



Earth Terminal



Chassis Ground Standby



Preface

This document contains the Specifications and the Performance Verification for the TSG4100A Series RF Signal Generators. It contains procedures suitable for determining that your instrument functions, is adjusted properly, and meets the performance characteristics as warranted.

Related Manuals

The following documents relate to the operation or service of the generator:

- The *TSG4100A Series RF Signal Generators Installation and Safety Instructions* describes basic installation, connectors, controls, compliance, and safety of the generators.
- The *TSG4100A Series RF Signal Generators User Manual* describes how to use the generators.
- The *TSG4100A Series RF Signal Generators Programmers Manual* describes how to remotely control the analyzer through LAN or GPIB and RS-232 interfaces.
- The *TSG4100A Series RF Signal Generators Service Manual* provides information for maintaining and servicing your generator to the module level.

Specifications

This section contains specifications for the TSG4100A Series RF Signal Generators. All specifications are warranted unless noted as a typical specification.

Table 1: Specification categories

Category	Description
Specified Characteristics	These are the warranted characteristics of the device, and are tested either on each unit in manufacturing or by type-testing. Specified characteristics include measurement tolerance and temperature limits.
Typical	This is performance that will be met by 80% of instruments with 80% confidence, for ambient temperatures in the range of 18 °C to 28 °C, immediately after performing an alignment. Values include the effects of the uncertainties of external calibration references and aging over the course of the published calibration interval. These values are determined from qualification testing and are not warranted or tested in the performance verification.

Specifications that are marked with the ✓ symbol are checked in the Performance Verification section.

Performance Conditions

The performance limits in these specifications are valid with these conditions:

- The instrument must have been calibrated and adjusted at an ambient temperature between +18 °C and +28 °C.
- The instrument must be in an environment with temperature, altitude, humidity, and vibration within the operating limits described in these specifications.
- The instrument must have had a warm-up period of at least 20 minutes after starting.

Electrical Specifications

Table 2: Frequency

Characteristic	Description	
Measurement frequency		
Frequency range, nominal	BNC output (all models)	DC to 62.5 MHz
	Type N output	
	TSG4102A	950 kHz to 2 GHz
	TSG4104A	950 kHz to 4 GHz
	TSG4106A	950 kHz to 6 GHz
Frequency resolution	Readout Resolution	1 μ Hz
Reference Frequency		
Initial Accuracy at Cal ✓	After a 20 min warm-up at 18° C to 28° C	
	With Option M01	$\pm 1 \times 10^{-6}$
	With Option M00 or E1	$\pm 2 \times 10^{-8}$
Aging	Per year	3×10^{-6} (Option M01)
		5×10^{-8} (Option M00 or E1)
	Long term accuracy ✓ (Includes initial accuracy, aging, and temperature drift)	$\pm 9 \times 10^{-6}$ (Option M01) $\pm 7 \times 10^{-8}$ (Option M00 or E1)
Temperature drift	$\pm 5 \times 10^{-6}$ (5 °C to 40 °C, Option M01) $\pm 3 \times 10^{-9}$ (5 °C to 40 °C, Option M00 or E1)	
Reference Output Level	Internal or external, typical	>7.5 dBm
External Reference Input, nominal	BNC Connector, 50 Ω	
External Reference Input Frequency Range	$\pm 2 \times 10^{-6}$ (Spurious level on input signal must be < -80 dBc within 100 kHz offset to meet spurious specifications.)	
Reference Input Level ✓ External	-2 dBm to +13 dBm (Test at 10 MHz.)	

Table 3: Phase noise

Characteristic	Description		
Specified	Noise sideband	Offset	
	Frequency = 1000 MHz	-95 dBc/Hz	1 kHz
		-106 dBc/Hz	10 kHz
		-107 dBc/Hz	20 kHz
		-120 dBc/Hz	1 MHz
Typical (mean)	Frequency = 1000 MHz	-78 dBc/Hz	10 Hz
		-102 dBc/Hz	1 kHz
		-110 dBc/Hz	10 kHz
		-113 dBc/Hz	20 kHz
		-124 dBc/Hz	1 MHz
	Frequency = 2000 MHz	-96 dBc/Hz	1 kHz
		-104 dBc/Hz	10 kHz
		-107 dBc/Hz	20 kHz
		-118 dBc/Hz	1 MHz
	Frequency = 3000 MHz (TSG4104A, TSG4106A)	-93 dBc/Hz	1 kHz
		-102 dBc/Hz	10 kHz
		-105 dBc/Hz	20 kHz
		-120 dBc/Hz	1 MHz
	Frequency = 6000 MHz (TSG4106A)	-87 dBc/Hz	1 kHz
		-96 dBc/Hz	10 kHz
-99 dBc/Hz		20 kHz	
-114 dBc/Hz		1 MHz	

Table 4: Residual modulation

Characteristic	Description
Residual FM, typical	<1 Hz _{RMS} in a 300 Hz to 3 kHz BW, 1 GHz
Residual AM, typical	<0.006% RMS in a 300 Hz to 3 kHz BW, 1 GHz

Table 5: RF output connectors

Characteristic	Description
RF Output Connector, nominal	N type: 950 kHz to the maximum frequency of the instrument BNC for DC to 62.5 MHz
RF Output Impedance, nominal	50 Ω
RF VSWR (BNC), typical	<1.6 : 1 (For all output levels.)
RF VSWR (Type N), typical	<1.5 for all output levels < -15 dBm (2 MHz to 2.0 GHz) <1.8 for all output levels < -15 dBm (2.0 GHz to 6.0 GHz)

Table 6: RF output protection

Characteristic	Description
Maximum safe reverse power	
RF Type N connector	30 VDC, +25 dBm RF
LF BNC connector	±5 VDC

Table 7: RF output attenuator

Characteristic	Description
RF attenuator, nominal	0 dB to 126 dB (0.55 dB step)

Table 8: Output level setting range and resolution

Characteristic	Description
Output level setting range for CW signals (Type N output), nominal	-110 dBm to +16.5 dBm, (≤ 4 GHz, CW) Accuracy is not guaranteed above +5 dBm. For modulated signals, the settable output level will be reduced by an amount dependant on the modulation type.
Output level setting range (BNC output), nominal	-47 dBm to 14.96 dBm from DC to 62.5 GHz BNC Output (1 mV _{rms} to 1 V _{rms})
Output level setting resolution, nominal	0.01 dB
Output DC offset (LF BNC connector)	±1.5 V

Table 9: Output level accuracy

Characteristic	Description				
Output level accuracy ✓					
BNC output (50 Ω Load, CW operation)					
At 5 °C to 40 °C (-30 dBm to +13 dBm)	± 0.7 dB				
Type-N output (50 Ω Load, CW operation)					
At 18 °C to 28 °C (-30 dBm to +5 dBm)					
10 MHz to 4 GHz	± 0.6 dB				
4 GHz to 6 GHz	± 1 dB				
At 5 °C to 40 °C (-30 dBm to +5 dBm)					
10 MHz to 4 GHz	± 1 dB				
4 GHz to 6 GHz	± 1.5 dB				
At 18 °C to 28 °C, typical					
	>+10 dBm	+10 to -30 dBm	-30 to -60 dBm	-60 to -100 dBm	-100 to -110 dBm
10 MHz to 100 MHz	± 0.2 dB	± 0.25 dB	± 0.35 dB	± 0.45 dB	± 0.6 dB
100 MHz to 2 GHz	± 0.15 dB	± 0.15 dB	± 0.25 dB	± 0.35 dB	± 0.6 dB
2 GHz to 4 GHz	± 0.3 dB	± 0.2 dB	± 0.35 dB	± 0.6 dB	± 0.8 dB
4 GHz to 6 GHz	N/A	± 0.3 dB	± 0.4 dB	± 0.75 dB	± 1.25 dB
At 5 °C to 40 °C (-30 dBm to +10 dBm), typical					
10 MHz to 100 MHz	± 0.7 dB				
100 MHz to 2 GHz	± 0.6 dB				
2 GHz to 4 GHz	± 0.7 dB				
4 GHz to 6 GHz	± 0.9 dB				
Type-N output (50 Ω Load, IQ Modulation relative to CW level at the same frequency)					
18 °C to 28 °C (at -5 dBm)					
0.4 GHz to 2 GHz	± 0.4 dB				
2 GHz to 4 GHz	± 0.6 dB				
4 GHz to 6 GHz	± 0.8 dB				
18 °C to 28 °C (at -5 dBm), typical					
0.4 GHz to 2 GHz	± 0.1 dB				
2 GHz to 4 GHz	± 0.2 dB				
4 GHz to 6 GHz	± 0.4 dB				
5 °C to 40 °C (at -5 dBm), typical					
0.4 GHz to 2 GHz	± 0.4 dB				
2 GHz to 4 GHz	± 0.4 dB				
4 GHz to 6 GHz	± 0.7 dB				

Table 10: Harmonics

Characteristic	Description	
Type-N output (CW operation) ✓ For output harmonics <6 GHz.		
TSG4102A, TSG4104A	1 GHz	<-38 dBc (output level ≤0 dBm)
TSG4106A	1 GHz	<-30 dBc (output level ≤0 dBm)
Type-N output (CW operation), typical For output harmonics <6 GHz.		
TSG4102A, TSG4104A	1 GHz	<-35 dBc (output level ≤0 dBm)
TSG4106A	1 GHz	<-25 dBc (output level ≤0 dBm)
BNC output, typical		
	DC to 62.5 MHz	<-40 dBc (output level <-25 dBm)
Subharmonics, nominal		None. (Architecture generates no subharmonics.)

Table 11: Spurious

Characteristic	Description	
Type-N output, typical mean		
>10 kHz from carrier	950 kHz to 1 GHz	<-68 dBc
	1 GHz to 2 GHz	<-60 dBc
	2 GHz to 4 GHz	<-55 dBc
	4 GHz to 6 GHz	<-55 dBc
>1 kHz to 10 kHz from carrier	950 kHz to 500 MHz	<-71 dBc
	500 MHz to 1 GHz	<-65 dBc
	1 GHz to 2 GHz	<-59 dBc
	2 GHz to 4 GHz	<-53 dBc
	4 GHz to 6 GHz	<-50 dBc
BNC output, typical		
	DC to 62.5 MHz	<-65 dBc

Table 12: Internal analog modulation

Characteristic	Description
Internal modulation waveforms, nominal	Sine, Ramp, Saw, Square, Pulse, Noise
Total harmonic distortion (THD), typical (< 20 KHz audio frequency)	-74 dBc
Modulation rate resolution, nominal	1 μHz
Modulation rate accuracy, nominal	1 part in $2^{31} \pm$ Time base error

Table 12: Internal analog modulation (cont.)

Characteristic	Description
Noise function, nominal	White Gaussian noise, RMS= Dev/5 Noise BW : 1 μ Hz to 50 kHz
Pulse generator, nominal	
Period	1 μ s to 10 s
Width	100 ns to 9999.9999 ms
Noise BW	1 μ Hz to 50 KHz
Pulse timing resolution	5 ns
Pulse noise function	Length 2^N-1 PRBS $5 \leq N \leq 32$, Bit period 100 ns to 10 s

Table 13: External analog modulation output

Characteristic	Description
Output, nominal	
Connector	Rear panel BNC
Impedance	50 Ω
Function	AM, FM, Φ M, Pulse
Scale factor	± 1 V for \pm full deviation
Pulse	Low: 0 V Hi: 3.3 V

Table 14: External analog modulation input

Characteristic	Description
Input, nominal	
Connector	Rear panel BNC
Impedance	100 k Ω
Function	AM, FM, Φ M, Pulse
Scale factor	± 1 V for \pm full deviation
Pulse	Low: 0 V Hi: 3.3 V
Input coupling	DC or 4 Hz High-pass
Pulse threshold	+1 VDC
Input offset	< 500 μ V

Table 15: Analog frequency modulation

Characteristic	Description
Modulation source, nominal	Internal or external
Minimum frequency deviation, nominal	0.01 Hz
Maximum frequency deviation, nominal	
TSG4102A, TSG4104A	Smaller of f_c and $(64 \text{ MHz} - f_c)$ when $0 \leq f_c \leq 62.5 \text{ MHz}$
	1 MHz $62.5 \text{ MHz} < f_c \leq 126.5625 \text{ MHz}$
	2 MHz $126.5625 \text{ MHz} < f_c \leq 253.125 \text{ MHz}$
	4 MHz $253.125 \text{ MHz} < f_c \leq 506.25 \text{ MHz}$
	8 MHz $506.25 \text{ MHz} < f_c \leq 1.0125 \text{ GHz}$
	16 MHz $1.0125 \text{ GHz} < f_c \leq 2.025 \text{ GHz}$
TSG4104A	32 MHz $2.025 \text{ GHz} < f_c \leq 4 \text{ GHz}$
TSG4106A	Smaller of f_c and $(96 \text{ MHz} - f_c)$ when $0 \leq f_c \leq 93.75 \text{ MHz}$
	1 MHz $93.75 \text{ MHz} < f_c \leq 189.84375 \text{ MHz}$
	2 MHz $189.84375 \text{ MHz} < f_c \leq 379.6875 \text{ MHz}$
	4 MHz $379.6875 \text{ MHz} < f_c \leq 759.375 \text{ MHz}$
	8 MHz $759.375 \text{ MHz} < f_c \leq 1.51875 \text{ GHz}$
	16 MHz $1.51875 \text{ GHz} < f_c \leq 3.0375 \text{ GHz}$
	32 MHz $3.0375 \text{ GHz} < f_c \leq 6 \text{ GHz}$
FM deviation resolution, nominal	0.1 Hz
FM deviation accuracy, typical	
	TSG4102A, TSG4104A
	<0.1% of selected deviation + 5 Hz, $f_c \leq 62.5 \text{ MHz}$
	<2% of selected deviation + 20 Hz, $f_c \leq 62.5 \text{ MHz}$
	TSG4106A
	<0.1% of selected deviation + 5 Hz, $f_c < 93.75 \text{ MHz}$
	<2% of selected deviation + 20 Hz, $f_c > 93.75 \text{ MHz}$
FM modulation distortion, typical	< -60 dB ($f_c=100 \text{ MHz}$, $f_m=1 \text{ kHz}$, $f_D= 3 \text{ kHz}$)
External FM carrier offset, typical	< $\pm 0.001 \times \text{FM deviation}$
FM modulation BW (external), typical	
	TSG4102A, TSG4104A
	500 kHz, $f_c \leq 62.5 \text{ MHz}$
	100 kHz, $f_c > 62.5 \text{ MHz}$
	TSG4106A
	500 kHz, $f_c \leq 93.75 \text{ MHz}$
	100 kHz, $f_c > 93.75 \text{ MHz}$

Table 16: Analog phase modulation

Characteristic	Description	
Modulation source, nominal	Internal or external	
Phase deviation range, nominal	0 to 360 degrees	
ΦM deviation resolution, nominal		
	DC to 100 MHz	0.01 degrees
	>100 MHz to 1000 MHz	0.1 degrees
	>1000 MHz	1.0 degrees
ΦM deviation accuracy, typical		
TSG4102A, TSG4104A	2%	$f_c \leq 62.5$ MHz
	3%	$f_c > 62.5$ MHz
TSG4106A	2%	$f_c \leq 93.75$ MHz
	3%	$f_c > 93.75$ MHz
ΦM modulation distortion, typical	< -60 dB ($f_c = 100$ MHz, $f_m = 1$ kHz, $f_d = 50$ degrees)	
ΦM modulation BW (external), typical		
TSG4102A, TSG4104A	500 kHz	$f_c \leq 62.5$ MHz
	100 kHz	$f_c > 62.5$ MHz
TSG4106A	500 kHz	$f_c \leq 93.75$ MHz
	100 kHz	$f_c > 93.75$ MHz

Table 17: Analog amplitude modulation

Characteristic	Description	
AM modulation range, nominal	0 to 100%	
AM modulation resolution, nominal	0.1%	
AM modulation source, nominal	Internal or external	
AM modulation distortion, typical		
BNC output	<1%, DC to 62.5 MHz	$f_m = 1$ kHz, depth= 50%
Type N output	<3%, >0.95 MHz	$f_m = 1$ kHz, depth= 50%
AM modulation BW (external), typical	>100 kHz	
AM modulation accuracy, typical		
BNC output	<1%, DC to 62.5 MHz	$f_m = 1$ kHz, depth= 50%
Type N output	<3%, >0.95 MHz	$f_m = 1$ kHz, depth= 50%

Table 18: Pulse modulation

Characteristic	Description	
Pulse modulation source, nominal	Internal or external	
Pulse mode, nominal	Logic High turns RF output ON Blank mode makes Logic High turn RF output OFF	
ON/OFF ratio, typical		
BNC output	>70 dB	
Type N output	>57 dB	$f_c < 1 \text{ GHz}$
	>40 dB	$1 \text{ GHz} \leq f_c < 4 \text{ GHz}$
	>35 dB	$4 \text{ GHz} \leq f_c < 6 \text{ GHz}$
Pulse feed through, typical	10% of carrier for 20 ns at turn on	
Turn off delay, nominal	60 ns	
Rise and fall time, typical	20 ns	

Table 19: Internal IQ modulation

Characteristic	Description
Symbol source, nominal	User symbol data, PRBS, or 16 bit settable data
PRBS length, nominal	$2^N - 1$, where $5 \leq N \leq 32$
Number of user symbols, nominal	1 to 16 M bits
Symbol rate, nominal	1 Hz to 6 MHz (12 MHz for VSB) with 1 μ Hz resolution
Symbol length, nominal	1 to 9 bits (maps to constellation) or two 16 bit values for I and Q)
Symbol mapping, nominal	Default or user defined constellation
Digital filters, nominal	24 Bit length FIR with Nyquist, Root Nyquist, Gaussian, rectangular, triangle, sinc, linearized Gaussian, C4FM, User defined FIR
DAC data source, nominal	Computed in real time from symbols, constellations and filter
IQ DAC configuration, nominal	Dual 14 Bit 125 MSPS
Reconstruction filter, nominal	10 MHz, 3rd order Bessel Low-pass filter
Vector modulation types, nominal	
PSK, QAM, FSK, CPM, MSK, ASK, VSB	
(Option dependent.)	
	BPSK, QPSK, OQPSK, DQPSK, $\pi/4$ DQPSK, 8PSK, 18PSK, $3\pi/8$ 8PSK
	4,16,32, 64, 256 QAM
	2ASK, 4ASK, 8ASK, 16ASK
	BFSK, 4FSK, 8FSK, 16FSK with deviations up to 6 MHz
	BCPM, 4CPM, 8CPM, 16CPM with modulation indices from 0 to 1.0
	8 and 16 VSB with rates up to 12 MSPS
Preset modes	GSM, GSM-EDGE, W-CDMA, APCO 25, DECT, NADC, PDC, TETRA, audio clip for analog AM and FM
Additive noise, nominal	White, Gaussian, -70 dBc to -10 dBc band limited by selected digital filter
Real marker outputs, nominal	Symbol clock, data frame, TDMA, and user-defined
EVM performance, typical	
	DQPSK (18.0 ksps, 420MHz) 0.76%
	NADC ($\pi/4$ DQPSK, 24.3 ksps, 875 MHz) 0.33%
	APCO-25 (FSK4-C4FM, 4.8 ksps, 850 MHz) 0.46%
	DECT (FSK2, 1.152 Mbps, 1.925 GHz) 1.5%
	GSM (GMSK, 270.833 ksps, 935 MHz) 0.30%
	GSM (GMSK, 270.833 ksps, 1.932 GHz) 0.60%
	EDGE ($3\pi/8$ 8PSK, 270.833 ksps, 935 MHz) 0.30%

Table 19: Internal IQ modulation (cont.)

Characteristic	Description
EDGE (3π/8 8PSK, 270.833 kcps, 1.932 GHz)	0.50%
W-CDMA (QPSK, 3.840 Mcps, 2.1425 GHz)	0.7%
QAM256 (6 Msps, 2.450 GHz)	1.1%
QAM32 (6 Msps, 5.800 GHz)	1.6%

Table 20: External IQ modulation

Characteristic	Description
Modulated output, nominal	Front panel Type-N only
Carrier frequency range, nominal	
TSG4102A	400 MHz to 2 GHz
TSG4104A	400 MHz to 4 GHz
TSG4106A	400 MHz to 6 GHz
IQ inputs, nominal	Rear panel BNC, ± 0.5V, 50 Ω
IQ full scale, nominal	$(I^2+Q^2)^{0.5} = 0.5$ V produces an output signal nominally equal to the amplitude set by the amplitude control.
Carrier suppression, typical	
$f_c \leq 3$ GHz	>-45 dBc
3 GHz < $f_c \leq 5$ GHz	>-40 dBc
$f_c > 5$ GHz	>-35 dBc
IQ modulation baseband BW, typical	
-3 dB from center frequency, $f_c \leq 2.5$ GHz (RF BW > 400 MHz)	>200 MHz
-3 dB from center frequency, $f_c > 2.5$ GHz (RF BW > 300 MHz)	>150 MHz

Physical Characteristics

Table 21: Physical characteristics

Characteristic	Description	
Dimensions	mm	in
Width	216	8.5
Height (with feet)	102	4
Length	356	14
Weight (without accessories)	kg	lb
Net (all models)	<5.4	12

Table 22: Display/computer

Characteristic	Description
LCD Panel Size	264 mm (4.3 in)
Display Resolution	
Color TFT LCD	480 x 272 pixels
Colors	RGB 18-bits in HW (SW uses 16-bits)
I/O Ports	
USB	USB 2.0 (1 front panel)
GPIB	IEEE 488.2, 24-pin (rear panel)
LAN	10/100 Base-T (rear panel)
RS232	9pin, 4800 to 115,200 baud, RTS/CTS flow (rear panel)

Safety, Certifications, and Compliance

For detailed information on Safety, Certifications, and Compliance see the *TSG4100A Series RF Signal Generator Installation and Safety Instructions*. This manual ships with each instrument. It is also available for download from www.tektronix.com/manuals.

Environmental Characteristics

Table 23: Environmental characteristics

Characteristic	Description
Temperature range ¹	
Operating	+5 °C to +40 °C
Non-operating	-20 °C to +60 °C
Relative Humidity	
	+40 °C at 95% relative humidity (%RH), meets intent of EN 60068-2-30 Frequency amplitude response may vary up to ±3 dB at +40 °C and greater than 45% RH.
Operating	5% to 95% RH at up to +30 °C 5% to 45% RH above +30 °C up to 40 °C, non-condensing
Non-operating	5% to 95% RH at up to +30 °C 5% to 45% RH above +30 °C up to 40 °C, non-condensing
Altitude	
Operating	Up to 3000 m (approximately 10000 ft)
Non-operating	Up to 12000 m (approximately 39370 ft)
Vibration (random)	
Operating	0.27 G rms, 5.500 Hz, 3 axes at 10 min/axis (30 minutes total for Option M01) 0.22 G rms, 5.500 Hz, 3 axes at 10 min/axis (30 minutes total for Option M00 or E1 and E1)
Non-operating	2.28 G rms, 5.500 Hz, 3 axes at 10 min/axis (30 minutes total for Option M01) 2.13 G rms, 5.500 Hz, 3 axes at 10 min/axis (30 minutes total for Option M00 or E1 and E1)
Shock (mechanical)	
Non-operating	(50 G peak amplitude), half-sine, 11 ms duration. Three shocks per axis in each direction (18 shocks total for Option M01) (30 G peak amplitude), half-sine, 11 ms duration. Three shocks per axis in each direction (18 shocks total for Option M00 or E1 and E1)
Cooling Clearance	
Both Sides	50 mm (1.97 in)

¹ Measured one inch (2.5 cm) away from the ventilation air intake (located at the left side of the instrument when viewed from the front).

Table 24: Power requirements

Characteristic	Description
Voltage range	
	47 to 63 Hz with PFC 90 V to 264 VAC
Line power	<90 W

Performance Verification

NOTE. *The performance verification procedure is not a calibration procedure. The performance verification procedure only verifies that your instrument meets key specifications. For your instrument to be calibrated, it must be returned to a Tektronix service facility.*

Prerequisites

The tests in this section make up an extensive, valid confirmation of performance and functionality when the following requirements are met:

- The instrument must have passed the Power On Self Tests (POST).
- The instrument must have been last adjusted at an ambient temperature between +18 °C (+64 °F) and +28 °C (+82 °F), must have been operating for a warm-up period of at least 20 minutes, and must be operating at an ambient temperature. (See Table 23 on page 14.)

Required Equipment

The following procedures use external equipment to directly check warranted characteristics. (See page 17, *Warranted characteristics tests*.) Some procedures only require a subset of the equipment listed. The following table lists the equipment required to perform all of the procedures. A procedure specific equipment list is provided at the start of each procedure.

Table 25: Equipment required for Performance Verification

Item number and	Minimum requirements	Example
1. Frequency counter	Frequency Range: 10 MHz	Tektronix FCA3000
2. GPS clock	—	—
3. Power sensor	Frequency range: 9 kHz to 6 GHz	Rohde & Schwarz NRP-Z92
4. Power Meter	Frequency range: DC to 110 GHz	Rohde & Schwarz NRP2
5. BNC to BNC cables	50 Ω , male to male BNC cable	2 required
6. Type-N (female) to BNC (male) adapter	50 Ω , Type-N (female) to BNC (male) adapter	Pasternack PE9005
7. Type-N (male) to Type-N (male) cable	50 Ω , male to male cable	—
8. Arbitrary function generator	—	Tektronix AFG3252C
9. Reference TSG4100A Series instrument	—	Tektronix TSG4102A
10. Spectrum analyzer	—	Tektronix RSA5106B

NOTE. *Be sure that any adaptor and cable you use is specified to operate at the frequency range of the test you are performing.*

Preliminary Checks

These steps should be performed before proceeding to the Warranted Characteristics tests.

- Warm-up** Make sure the instrument is running, and allow the instrument to warm up for at least 20 minutes.
- Self test** Run a self test
1. Select **Utility > System > Self Test** from the menu to start the self test.
 2. Verify there are no failure (error) messages listed.
 3. Select **Return** twice from the menu to return to the main menu.

Warranted characteristics tests

The following procedures verify that instrument performance is within the warranted specifications.

Frequency accuracy (Options M00, E1, and M01)

This test checks the initial frequency accuracy at calibration (Options M00, E1, and M01).

Required equipment

Frequency counter: Tektronix FCA3000

BNC (male) - BNC (male) cable (50 Ω)

1. Use a BNC to BNC 50 Ω precision coaxial cable to connect the **LF Out** output on the TSG front panel to the Frequency Counter input.
2. Connect a precision frequency reference (GPS clock) to the Frequency Counter.
3. Set the Frequency Counter as the external reference.
4. Reset the TSG by pressing and holding the Preset button.
5. Press the **RF/LF** button to access the output settings menu.
6. Press the **Freq** button on the generator front panel.
7. Set the frequency to 10 MHz using the general knob or the number keys.
8. Select **LF Ampt** from the menu.
9. Set the LF amplitude to +5 dBm using the general knob or number keys.

10. Select **LF Output** from the menu to turn the LF output to ON (text will turn blue).
11. For Option M00 or E1 models, check that the frequency counter reads $10\text{ MHz} \pm 2 \times 10^{-8}$. Enter the frequency in the test record.

For Option M01 models, check that the frequency counter reads $10\text{ MHz} \pm 0.5 \times 10^{-6}$. Enter the frequency in the test record.

**Long term accuracy
(Options M00, E1, and M01)**

Follow the steps in the previous test and enter the results under *Long term accuracy* in the test record to test the long term frequency accuracy. (See page 17, *Warranted characteristics tests*.)

**External reference input
level**

This test checks the external reference input level.

Required equipment

Reference Tektronix TSG4100A Series instrument

BNC (male) - BNC (male) cable (50 Ω)

1. Use a BNC to BNC 50 Ω precision coaxial cable to connect the **LF Out** output on the reference TSG4100A Series instrument front panel to **Timebase IN** input on the DUT TSG.
2. Reset the reference TSG by pressing and holding the **Preset** button.
3. Press the **RF/LF** button on the reference TSG to access the output settings menu.
4. Press the **Freq** button on the reference TSG front panel.
5. Set the frequency to 10 MHz using the general knob or the number keys.
6. Select **LF Ampt** from the menu on the reference TSG.
7. Set the LF amplitude to +13 dBm using the general knob or number keys.
8. Select **LF Output** from the menu to turn the LF output to ON (text will turn blue) on the reference TSG.
9. Check that an *EXT REF* message appears on the DUT screen.
10. Increase the output amplitude level until the *EXT REF* message disappears.
11. Record the output amplitude at which the message disappeared into the test record for the test High limit value.
12. Decrease the output amplitude level until the *EXT REF* message disappears.
13. Record the output amplitude at which the message disappeared into the test record for the test Low limit value.

**Output level accuracy
(BNC)**

This test checks the output level accuracy of the BNC output.

Required equipment

Power meter: NRP2 power meter

Power sensor: NRP-Z92 power sensor

Type-N (female) - BNC (male) connector: Pasternack PE9005

Connecting cable

1. Connect the PE9082 to the power meter type-N input.
2. Connect the power sensor to the TSG BNC **LF Out** output on the front panel.
3. Connect the power sensor to the power meter.
4. Reset the TSG by pressing and holding the **Preset** button.
5. Reset the power meter.
6. Press the **RF/LF** button on the TSG to access the output settings menu.
7. Press the **Freq** button on the TSG front panel.
8. Set the frequency to 950 kHz using the general knob or the number keys.
9. Select **LF Ampt** from the menu on the TSG.
10. Set the LF amplitude to +13 dBm using the general knob or number keys.
11. Calibrate the power meter to zero.
12. Select **LF Output** from the menu to turn the LF output to ON (text will turn blue) on the TSG.
13. Set the frequency of the power meter to 950 kHz.
14. Record the data from the power meter in the test record for the 950 kHz level (BNC, CW).
15. Change the frequency to 60 MHz.
16. Set the frequency of the power meter to 60 MHz.
17. Record the data from the power meter in the test record for the 60 MHz level (BNC, CW).

**Output level accuracy
(Type-N, 5 °C to 40 °C)**

This test checks the output level accuracy of the Type-N output.

Required equipment

Power meter: NRP2 power meter

Power sensor: NRP-Z92 power sensor

Connecting cable

1. Connect the power sensor to the TSG Type-N **RF Out** output on the front panel.
2. Connect the power sensor to the power meter.
3. Reset the TSG by pressing and holding the **Preset** button.
4. Reset the power meter.
5. Press the **RF/LF** button on the TSG to access the output settings menu.
6. Press the **Freq** button on the TSG front panel.
7. Set the frequency to 950 kHz using the general knob or the number keys.
8. Select **RF Ampt** from the menu on the TSG.
9. Set the RF amplitude to +5 dBm using the general knob or number keys.
10. Calibrate the power meter to zero.
11. Select **RF Output** from the menu to turn the RF output to ON (text will turn blue) on the TSG.
12. Set the frequency of the power meter to 10 MHz.
13. Record the data from the power meter in the test record for the 10 MHz level (Type-N, 5 °C to 40 °C).
14. Change the frequency to 1500 MHz.
15. Set the frequency of the power meter to 1500 MHz.
16. Record the data from the power meter in the test record for the 1500 MHz level (Type-N, 5 °C to 40 °C).
17. Continue to test the output at each frequency listed in the test record for the specific instrument model you are testing. Record the results.

Output level accuracy (IQ modulation relative to CW)

This test checks the output level accuracy of the IQ modulation inputs relative to continuous waveform.

Required equipment

Spectrum analyzer: Tektronix RSA5106B

Arbitrary function generator: Tektronix AFG3252C

Two BNC - BNC cables

Type-N (male) - Type-N (male) cable

1. Using a BNC to BNC cable, connect the AFG3252C (Channel 1) to the Vector Modulation **I** input of the TSG (located on the rear panel).
2. Using the second BNC to BNC cable, connect the AFG3252C (Channel 2) to the Vector Modulation **Q** input of the TSG (located on the rear panel).
3. Set the AFG3252C as follows:
 - a. Set phase on Channel 1 to zero.
 - b. Set phase on Channel 2 to 90.
 - c. Align the phase between Channel 1 and Channel 2 to obtain the quadrature input for the TSG.
4. Set the TSG as follows:
 - a. Press and hold the **Preset** button to reset the instrument.
 - b. Press the **RF/LF** button to access the output settings menu.
 - c. Press the **Freq** button on the front panel.
 - d. Set the frequency to 2000 MHz (fc) using the general knob or the number keys.
 - e. Select **RF Ampt** from the menu.
 - f. Set the RF amplitude to 0 dBm using the general knob or number keys.
 - g. Select **RF Output** from the menu to turn the RF output to ON (text will turn blue).
5. Set the spectrum analyzer as follows:
 - a. Reset the instrument.
 - b. Set the center frequency to 2000 MHz and the span to 5 MHz.
 - c. Set markers to peak search.
 - d. Write down the peak value and note it is = A for later reference.
6. Press the **Mod** button on the TSG front panel to turn modulation on. Notice that **MODON** indicator will appear in yellow in the top right portion of the screen.

7. Write down the 2000 + 1 MHz amplitude level from the RSA and note it is = B for later reference.
8. Calculate the IQ modulation value B–A. Record this value in the test record.
9. Continue to test the modulation at each frequency listed in the test record for the specific instrument model you are testing. Record the results.

Harmonics (Type-N, CW)

This test checks the continuous waveform harmonics of the Type-N output.

Required equipment

Spectrum analyzer: Tektronix RSA5106B

Type-N (male) - Type-N (male) cable

1. Connect the TSG Type-N **RF Out** output to the Type-N **RF IN** input on the spectrum analyzer using a connecting cable.
2. Set the TSG as follows:
 - a. Press and hold the **Preset** button to reset the instrument.
 - b. Press the **RF/LF** button to access the output settings menu.
 - c. Press the **Freq** button on the front panel.
 - d. Set the frequency to 1000 MHz using the general knob or the number keys.
 - e. Select **RF Ampt** from the menu.
 - f. Set the RF amplitude to 0 dBm using the general knob or number keys.
 - g. Select **RF Output** from the menu to turn the RF output to ON (text will turn blue).
3. Set the spectrum analyzer as follows:
 - a. Reset the instrument.
 - b. Set the center frequency to 1000 MHz and the span to 1 MHz.
 - c. Set markers to peak search.
 - d. Record the peak value for later reference.
 - e. Set the center frequency to N x 1000 MHz (where N=2, 3, 4, 5, 6).
 - f. Find the maximum value of all harmonic amplitudes and subtract the recorded peak value at 1000 MHz.
4. Record the dBc value in the test record.

Test Record

Print out the following test record pages and use them to record the performance test results for your instrument.

Model:

Serial Number:

Certificate Number:

Calibration Date:

Technician:

Frequency accuracy	Minimum	Test result	Maximum
Option M00 or E1	-2×10^{-8}		$+2 \times 10^{-8}$
Option M01	-0.5×10^{-6}		$+0.5 \times 10^{-6}$

Long term accuracy	Minimum	Test result	Maximum
Option M00 or E1 instruments	-7×10^{-8}		$+7 \times 10^{-8}$
Option M01 instruments	-9×10^{-6}		$+9 \times 10^{-6}$

External reference input level	Minimum	Test result (minimum)	Maximum	Test result (maximum)
	-2 dBm		+13 dBm	

BNC output level accuracy (CW), all models and options

Frequency	Output amplitude	Minimum	Test result	Maximum
950 kHz	+13 dBm	+12.3 dBm		+13.7 dBm
	0 dBm	-0.7 dBm		+0.7 dBm
	-30 dBm	-30.7 dBm		-29.3 dBm
60 MHz	+13 dBm	+12.3 dBm		+13.7 dBm
	0 dBm	-0.7 dBm		+0.7 dBm
	-30 dBm	-30.7 dBm		-29.3 dBm

Type-N output level accuracy (CW)

Instrument model	Frequency	Output amplitude	Minimum	Test result	Maximum
TSG4102A	10 MHz	+5 dBm	+4 dBm		+6 dBm
		-15 dBm	-16 dBm		-14 dBm
		-30 dBm	-31 dBm		-29 dBm
	1500 MHz	+5 dBm	+4 dBm		+6 dBm
		-15 dBm	-16 dBm		-14 dBm
		-30 dBm	-31 dBm		-29 dBm
TSG4104A	10 MHz	+5 dBm	+4 dBm		+6 dBm
		-15 dBm	-16 dBm		-14 dBm
		-30 dBm	-31 dBm		-29 dBm
	1500 MHz	+5 dBm	+4 dBm		+6 dBm
		-15 dBm	-16 dBm		-14 dBm
		-30 dBm	-31 dBm		-29 dBm
	3000 MHz	+5 dBm	+4 dBm		+6 dBm
		-15 dBm	-16 dBm		-14 dBm
		-30 dBm	-31 dBm		-29 dBm
	4000 MHz	+5 dBm	+4 dBm		+6 dBm
		-15 dBm	-16 dBm		-14 dBm
		-30 dBm	-31 dBm		-29 dBm
TSG4106A	10 MHz	+5 dBm	+4 dBm		+6 dBm
		-15 dBm	-16 dBm		-14 dBm
		-30 dBm	-31 dBm		-29 dBm
	1500 MHz	+5 dBm	+4 dBm		+6 dBm
		-15 dBm	-16 dBm		-14 dBm
		-30 dBm	-31 dBm		-29 dBm
	3000 MHz	+5 dBm	+4 dBm		+6 dBm
		-15 dBm	-16 dBm		-14 dBm
		-30 dBm	-31 dBm		-29 dBm
	4000 MHz	+5 dBm	+4 dBm		+6 dBm
		-15 dBm	-16 dBm		-14 dBm
		-30 dBm	-31 dBm		-29 dBm
	5000 MHz	+5 dBm	+3.5 dBm		+6.5 dBm
		-15 dBm	-16 dBm		-13.5 dBm
		-30 dBm	-31 dBm		-28.5 dBm
	6000 MHz	+5 dBm	+3.5 dBm		+6.5 dBm
		-15 dBm	-16 dBm		-13.5 dBm
		-30 dBm	-31 dBm		-28.5 dBm

Output level accuracy of IQ modulation input relative to CW (18 °C to 28 °C)

Instrument	Frequency	Amplitude	Output amplitude	Minimum	Test result	Maximum
TSG4102A	2000 MHz	5 dBm	0 dBm	-0.4		+0.4
TSG4104A	2000 MHz	5 dBm	0 dBm	-0.4		+0.4
	4000 MHz	5 dBm	0 dBm	-0.6		+0.6
TSG4106A	2000 MHz	5 dBm	0 dBm	-0.4		+0.4
	4000 MHz	5 dBm	0 dBm	-0.6		+0.6
	6000 MHz	5 dBm	0 dBm	-0.4		+0.4

Harmonics at Type-N output (CW)

Instrument	Frequency	Output amplitude	Test result	Maximum
TSG4102A	1000 MHz	0 dBm		-38 dBc
TSG4104A	1000 MHz	0 dBm		-38 dBc
TSG4106A	1000 MHz	0 dBm		-30 dBc