# TSG4100A Series
# RF Signal Generators
# Specifications and Performance Verification

## Technical Reference

**Revision C**

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- In North America, call 1-800-833-9200.
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[W4 – 15AUG04]

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# 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.*

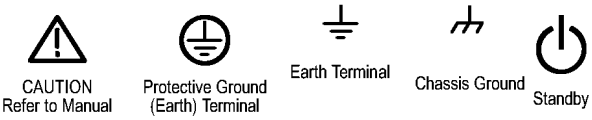
## Symbols and terms on the product

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:



# 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**

| Catagory | 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 µHz |
| Reference Frequency | | |
| Initial Accuracy at Cal ✓ | After a 20 min warm-up at 18° C to 28° C | |
| | With Option M01 | ±1 x $10^{-6}$ |
| | With Option M00 or E1 | ±2 x $10^{-8}$ |
| Aging | Per year | 3 x $10^{-6}$ (Option M01)<br>5 x $10^{-8}$ (Option M00 or E1) |
| | Long term accuracy ✓<br>(Includes initial accuracy, aging, and temperature drift) | ±9 x $10^{-6}$ (Option M01)<br>±7 x $10^{-8}$ (Option M00 or E1) |
| Temperature drift | | ±5 x $10^{-6}$ (5 °C to 40 °C, Option M01)<br>±3 x $10^{-9}$ (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 | | ±2 x $10^{-6}$<br>(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<br>(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<br>(For all output levels.) |
| RF VSWR (Type N), typical | <1.5 for all output levels < -15 dBm (2 MHz to 2.0 GHz)<br><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)<br>Accuracy is not guaranteed above +5 dBm.<br>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) ✓<br>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<br>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.<br>(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<br>(< 20 KHz audio frequency) | –74 dBc |
| Modulation rate resolution, nominal | 1 µHz |
| Modulation rate accuracy, nominal | 1 part in $2^{31}$ ± Time base error |

**Table 12: Internal analog modulation (cont.)**

| Characteristic | Description |
|---|---|
| Noise function, nominal | White Gaussian noise, RMS= Dev/5<br>Noise BW : 1 µHz to 50 kHz |
| Pulse generator, nominal | |
| Period | 1 µs to 10 s |
| Width | 100 ns to 9999.9999 ms |
| Noise BW | 1 µHz to 50 KHz |
| Pulse timing resolution | 5 ns |
| Pulse noise function | Length $2^N$-1 PRBS 5≤N≤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, ΦM, Pulse |
| Scale factor | ± 1V for ± full deviation |
| Pulse | Low: 0 V<br>Hi: 3.3 V |

**Table 14: External analog modulation input**

| Characteristic | Description |
|---|---|
| Input, nominal | |
| Connector | Rear panel BNC |
| Impedance | 100 kΩ |
| Function | AM, FM, ΦM, Pulse |
| Scale factor | ± 1V for ± full deviation |
| Pulse | Low: 0 V<br>Hi: 3.3 V |
| Input coupling | DC or 4 Hz High-pass |
| Pulse threshold | +1 VDC |
| Input offset | < 500 µV |

**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 fc. and (64 MHz – fc) when 0 ≤ fc ≤ 62.5 MHz | |
| | 1 MHz | 62.5 MHz < fc ≤ 126.5625 MHz |
| | 2 MHz | 126.5625 MHz < fc ≤ 253.125 MHz |
| | 4 MHz | 253.125 MHz < fc ≤ 506.25 MHz |
| | 8 MHz | 506.25 MHz < fc ≤ 1.0125 GHz |
| | 16 MHz | 1.0125 GHz < fc ≤ 2.025 GHz |
| TSG4104A | 32 MHz | 2.025 GHz < fc ≤ 4 GHz |
| TSG4106A | Smaller of fc and (96 MHz – fc) when 0 ≤ fc ≤ 93.75 MHz) | |
| | 1 MHz | 93.75 MHz < fc ≤ 189.84375 MHz |
| | 2 MHz | 189.84375 MHz < fc ≤ 379.6875 MHz |
| | 4 MHz | 379.6875 MHz < fc ≤ 759.375 MHz |
| | 8 MHz | 759.375 MHz < fc ≤ 1.51875 GHz |
| | 16 MHz | 1.51875 GHz < fc ≤ 3.0375 GHz |
| | 32 MHz | 3.0375 GHz < fc ≤ 6 GHz |
| FM deviation resolution, nominal | 0.1 Hz | |
| FM deviation accuracy, typical | | |
| | TSG4102A, TSG4104A | <0.1% of selected deviation + 5 Hz, fc ≤ 62.5 MHz<br><2% of selected deviation + 20 Hz, fc ≤ 62.5 MHz |
| | TSG4106A | <0.1% of selected deviation + 5 Hz, fc < 93.75 MHz<br><2% of selected deviation + 20 Hz, fc > 93.75 MHz |
| FM modulation distortion, typical | < -60 dB (fC=100 MHz, fM=1 kHz , fD= 3 kHz | |
| External FM carrier offset, typical | < ±0.001 X FM deviation | |
| FM modulation BW (external), typical | | |
| | TSG4102A, TSG4104A | 500 kHz, fc ≤ 62.5 MHz<br>100 kHz, fc >62.5 MHz |
| | TSG4106A | 500 kHz, fc ≤ 93.75 MHz<br>100 kHz, fc > 93.75 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% | fc ≤ 62.5 MHz |
| | 3% | fc > 62.5 MHz |
| TSG4106A | 2% | fc ≤ 93.75 MHz |
| | 3% | fc > 93.75 MHz |
| ΦM modulation distortion, typical | < –60 dB (fc= 100 MHz, fm= 1 kHz , fd= 50 degrees | |
| ΦM modulation BW (external), typical | | |
| TSG4102A, TSG4104A | 500 kHz | fc ≤ 62.5 MHz |
| | 100 kHz | fc > 62.5 MHz |
| TSG4106A | 500 kHz | fc ≤ 93.75 MHz |
| | 100 kHz | fc > 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 | fm= 1 kHz, depth= 50% |
| Type N output | <3%, >0.95 MHz | fm= 1 kHz, depth= 50% |
| AM modulation BW (external), typical | >100 kHz | |
| AM modulation accuracy, typical | | |
| BNC output | <1%, DC to 62.5 MHz | fm= 1 kHz, depth= 50% |
| Type N output | <3%, >0.95 MHz | fm= 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<br>Blank mode makes Logic High turn RF output OFF | |
| ON/OFF ratio, typical | | |
| BNC output | >70 dB | |
| Type N output | >57 dB | fc < 1 GHz |
| | >40 dB | 1 GHz ≤ fc < 4 GHz |
| | >35 dB | 4 GHz ≤ fc < 6 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≤N≤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 µHz 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<br>PSK, QAM, FSK, CPM, MSK, ASK, VSB<br>(Option dependent.) | |
| BPSK, QPSK, OQPSK, DQPSK, π/4DQPSK, 8PSK, 18PSK, 3π/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 (π/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 (3π/8 8PSK, 270.833 ksps, 935 MHz) | 0.30% |

**Table 19: Internal IQ modulation (cont.)**

| Characteristic | Description |
|---|---|
| EDGE (3π/8 8PSK, 270.833 ksps, 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 | |
| fc ≤ 3 GHz | >–45 dBc |
| 3 GHz < fc ≤ 5 GHz | >–40 dBc |
| fc > 5 GHz | >–35 dBc |
| IQ modulation baseband BW, typical | |
| -3 dB from center frequency, fc ≤ 2.5 GHz (RF BW > 400 MHz) | >200 MHz |
| -3 dB from center frequency, fc > 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<br>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<br>5% to 45% RH above +30 °C up to 40 °C, non-condensing |
| Non-operating | 5% to 95% RH at up to +30 °C<br>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)<br>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)<br>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)<br>(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 MHz ±2 x $10^{-8}$. Enter the frequency in the test record.

    For Option M01 models, check that the frequency counter reads 10 MHz ±0.5 x $10^{-6}$. 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 90, frequency to 1 MHz, and amplitude to 1 Vp-p.
   b. Set phase on Channel 2 to zero, frequency to 1 MHz, and amplitude to 1 Vp-p.
   c. Press **Phase/Delay** and then **Align** phase in the menu. This aligns 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. Connect the output from the TSG to the input of the spectrum analyzer.
   h. Select **RF Output** from the menu to turn the RF output to ON (text will turn blue).
   i. Press the black Mod button on the front panel to access the modulation parameters menu.
   j. Set the Source to Ext.

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. Set the MOD Type to Vector -> QAM and the Source to External.
8. Write down the 2000 + 1 MHz amplitude level from the RSA and note it is = B for later reference.
9. Calculate the IQ modulation value B–A. Record this value in the test record.
10. 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 | $-2 \times 10^{-8}$ | | $+2 \times 10^{-8}$ |
| Option M01 | $-0.5 \times 10^{-6}$ | | $+0.5 \times 10^{-6}$ |

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

| 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 |