FCA3000, FCA3100, & MCA3000 Series Timer/Counter/Analyzers

Specifications and Performance Verification

Revision A

077-0495-04

Tektronix®

FCA3000, FCA3100, & MCA3000 Series Timer/Counter/Analyzers

Specifications and Performance Verification

Revision A

www.tek.com

077-0495-04

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.tek.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 one (1) year 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.

[W2 – 15AUG04]

Table of Contents

List of Figures

List of Tables

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 vi, *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 access the power cord; it must remain accessible to the user at all times to allow for quick disconnection if needed.

Connect and disconnect properly. Do not connect or disconnect probes or test leads while they are connected to a voltage source.

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 apply a potential to any terminal, including the common terminal, that exceeds the maximum rating of 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.

Use only specified replacement parts.

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

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.

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

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:

Specifications

This chapter contains the specifications for the instrument. Specifications that are marked with the ✓symbol are checked in the manual. All specifications apply to all models unless noted otherwise.

Table 1: Input characteristics, channels A and B

Characteristic	Description	
Frequency Range, DC Coupled	DC to 300 MHz Verified as part of Sensitivity, DC to 300 MHz, 1X Attenuation	
Frequency Range, AC Coupled	10 Hz to 300 MHz, 1 MΩ input impedance 10 Hz to 300 MHz, 50 Ω input impedance 10 Hz to 400 MHz Manual Trigger Mode, DC Coupled, 50 Ω Verified as part of Sensitivity - DC–300 MHz, 1X Attenuation	
Impedance, Front Panel, 1 MΩ	1 MΩ, DC, 1X/10X mode: 1.0 MΩ (±5%) || 14 pF (±2 pF) 1 MΩ, AC, 1X mode: 1.3 MΩ (±5%) || 14 pF (±2 pF) 1 MΩ, AC, 10X mode: 1.0 MΩ (±5%) || 14 pF (±2 pF)	
✓Impedance, Front Panel, 50 Ω	50Ω, AC/DC, 1X/10X mode: 50 Ω (±5%); VSWR ≤2:1	
Impedance, Rear Panel inputs (Option RP)	1 MΩ || 50 pF 50 Ω (VSWR ≤2:1)	
50 Ω Input Protection	None	
Trigger Slope	Positive or negative	
Maximum Channel Timing Difference	500 ps	
✓Amplifier Noise Level (1X)	500 μV_{RMS} (guaranteed) 200 μV_{RMS} (typical)	
✓Amplifier Noise Level (10X)	5 mV_{RMS} (guaranteed) 2 mV_{RMS} (typical)	
✓Hysteresis Window, 1X	<(30 mV +|1% of trigger level|) for Pulse Width and Duty Factor measurements Hysteresis window compensation exists to: 6 mV ±1% of trigger level over a frequency range of DC to 10 kHz for other measurement functions	
✓Hysteresis Window, 10X	<(300 mV ±|1% of trigger level|) for Pulse Width and Duty Factor measurements Hysteresis window compensation exists to: 60 mV ±1% of trigger level over a frequency range of DC to 10 kHz for other measurement functions	
✓ Sensitivity, DC to 400 MHz, 1X Attenuation	DC to 200 MHz	15 mV_{RMS}
	200 MHz to 300 MHz	25 mV_{RMS}
	Auto Trig	35 mV_{RMS}
✓Attenuation	1X, 10X ratio within 5%	
Dynamic Range, 1X	Minimum Sensitivity to 10 V_{p-p} within ±5 V window	
Trigger Level	Trigger level as read out on display has the following characteristics	
Resolution	FCA3000, MCA3000 Series: 3 mV FCA3100 Series: 1 mV	

Table 1: Input characteristics, channels A and B (cont.)

Characteristic	Description
✓ Trigger Level Uncertainty, 1X	±(15 mV + 1% of trigger level) TLU for uncertainty analysis purposes
✓Trigger Level Uncertainty, 10X	±(150 mV + 1% of trigger level) Tested as part of Trigger Level Uncertainty (1X)
AUTO Trigger Level	Trigger level is automatically set to 50% point of input signal (10% and 90% for Rise/Fall Time)
AUTO Hysteresis, Time	Minimum hysteresis window (hysteresis compensation)
AUTO Hysteresis, Frequency	One third of input signal level Instrument measures Signal(high) + Noise(pk) - ½ hysteresis and Signal(low) – Noise(pk) + ½ hysteresis to calculate 30% and 70% levels for auto-hysteresis
Analog LP Filter	Nominal 100 kHz, RC-type
Digital Hold-Off Filter	1 Hz to 50 MHz cut-off frequency Software filter programs FPGA to hold-off
Maximum Voltage Without Damage	1 MΩ: 350 V (DC + AC pk) to 440 Hz, falling to 12 V_{RMS} at 1 MHz 50 Ω: 12 V_{RMS}, 35 V peak for duty factor less than 0.1%
Connector	50 Ω BNC

Table 2: Input characteristics, Rear Panel I/O

Characteristic	Description
Reference Input	
✓Frequencies	1, 5, or 10 MHz
✓Amplitude	0.1 to 5 V_{RMS} sinewave
Input Impedance	>1 kΩ
Pull-In Range	5 ppm
Reference Output	Outputs the internal reference signal
Frequency	10 MHz
✓Amplitude	>1 V_{RMS} into 50 Ω
Arming Input	Arming of all measurement functions
Frequency Range	DC to 80 MHz
Input Impedance	1 kΩ
Threshold	TTL (1.4 V nominal, 0.8 V_{IL}, 2.0 V_{IH})
Slope	Selectable Positive or Negative
Pulse Output (FCA3100 Series)	Capable of outputting a variable mode pulse
Modes	Pulse Out, Gate Open, Alarm Out
Period	20 ns to 2 s in 10 ns increments
Pulse Width	10 ns to 2 s in 10 ns increments
Output Level	TTL into 50 Ω (1.4 V nominal, 0.4 V_{OL}, 2.4 V_{OH})

Table 3: Input characteristics, channel C (frequency and period only)

Characteristic	Description		
High Frequency Range	**Product**	**Min Frequency**	**Max Frequency**
	FCA3003, FCA3103	100 MHz	3 GHz
	FCA3020, FCA3120	250 MHz	20 GHz
	MCA3027	300 MHz	27 GHz
	MCA3040	300 MHz	40 GHz
Connector	FCA3003, FCA3103, FCA3020, FCA3120	Front panel: Type N female Rear panel: SMA female	
	MCA3027, MCA3040	Front Panel: 2.92 mm female with field replaceable fusible link	
Impedance	50 Ω nominal		
✓ VSWR	FCA3003, FCA3103, MCA3040: VSWR <2.5:1		
	FCA3020, FCA3120, MCA3027: VSWR <2.0:1		
Prescaler Factor	FCA3003, FCA3103: 16		
	FCA3020, FCA3120: 128		
✓ Sensitivity	Measured using a sine wave of stated level rms. Harmonic content -10 dBc or more. All inputs are 50 Ω.		
	FCA3003, FCA3103 100 MHz to 300 MHz 0.3 GHz to 2.5 GHz 2.5 GHz to 2.7 GHz 2.7 GHz to 3.0 GHz	 –21 dBm (20 mV_{RMS}) –27 dBm (10 mV_{RMS}) –21 dBm (20 mV_{RMS}) –15 dBm (40 mV_{RMS})	
	FCA3020, FCA3120 250 MHz to 500 MHz 0.5 GHz to 18 GHz 18 GHz to 20 GHz	 –21 dBm (20 mV_{RMS}) –27 dBm (10 mV_{RMS}) –21 dBm (20 mV_{RMS})	
	MCA3027, MCA3040 300 MHz to 18 GHz 18 GHz to 20 GHz 20 GHz to 27 GHz 27 GHz to 40 GHz:	 –33 dBm (5 mV_{RMS}) –29 dBm (8 mV_{RMS}) –27 dBm (10 mV_{RMS}) –23 dBm (16 mV_{RMS})	
Overload Indicator (MCA3027, MCA3040	+10 dBm (0.7 V_{RMS})		
Maximum Voltage Maintaining Function (MCA3027, MCA3040)	+13 dBm (1.0 V_{RMS})		
Maximum Voltage without Damage	FCA3003, FCA3103: +34 dBm (12 V_{RMS})		
	FCA3020, FCA3120: +27 dBm (5 V_{RMS})		
	MCA3027, MCA3040: +18 dBm (1.78 V_{RMS})		

Table 3: Input characteristics, channel C (frequency and period only) (cont.)

Characteristic	Description	
AM tolerance	FCA3003, FCA3103	DC to 0.1 MHz modulation: up to 94% depth 0.1 MHz to 6 MHz modulation: Signal level with lowest output must meet sensitivity requirements. Signal level at highest level must not exceed maximum voltage requirements. Within these constraints >85% AM is acceptable.
	FCA3020, FCA3120	Signal level with lowest output must meet sensitivity requirements. Signal level at highest level must not exceed maximum voltage requirements. Within these constraints >90% AM is acceptable.
	MCA3027 MCA3040	Signal level with lowest output must meet sensitivity requirements. Signal level at highest level must not exceed maximum voltage requirements.
FM tolerance (MCA3027, MCA3040)	Manual: 50 MHz_{P-P} at f >3.5 GHz; 30 MHz_{P-P} at f ≤3.5 GHz	
	Auto: 20 MHz_{p-p} for modulation frequency >100 kHz	

Table 4: Timebase error characteristics

Characteristic	Description			
✓ Timebase Error	Timebase Error (TBE) is the sum of the relevant uncertainties depending upon aging, temperature, and option.			
	Option			
	Standard	*Option MS (Medium Stability)*	*Option HS (High Stability)*	*Option US (Ultra High Stability)*
Time base type	TCXO	OCXO	OCXO	OCXO
Uncertainty due to:				
Aging:				
per 24h	n.a.	$<5\times10^{-9}$ [1]	$<5\times10^{-10}$ [1]	$<3\times10^{-10}$ [1]
per month	$<5\times10^{-7}$	$<6\times10^{-8}$	$<1\times10^{-8}$	$<3\times10^{-9}$
per year	$<5\times10^{-6}$	$<2\times10^{-7}$	$<5\times10^{-8}$	$<1.5\times10^{-8}$
Temperature variation:				
0 °C - 50 °C	$<1\times10^{-5}$	$<5\times10^{-8}$	$<5\times10^{-9}$	$<2.5\times10^{-9}$
20 °C - 26 °C (typical)	$<3\times10^{-6}$	$<2\times10^{-8}$	$<1\times10^{-9}$	$<4\times10^{-10}$
Short term stability: t = 1 s	not specified	$<1\times10^{-10}$	$<1\times10^{-11}$	$<5\times10^{-12}$
(root Allan Variance) t = 10 s		$<1\times10^{-10}$	$<1\times10^{-11}$	$<5\times10^{-12}$

Table 4: Timebase error characteristics (cont.)

Characteristic	Description			
Power-on stability				
Deviation versus final value after 24h on time,	n.a.	<1×10^{-7}	<1×10^{-8}	<5×10^{-9}
after a warm-up time of:	30 min	30 min	10 min	10 min
Total uncertainty, for operating temperature				
20 °C to 26 °C, at 2σ (95%) confidence interval:				
1 year after calibration	<7×10^{-6}	<2.4×10^{-7}	<0.6×10^{-7}	<1.8×10^{-8}
2 years after calibration	<1.2×10^{-5}	<4.6×10^{-7}	<1.2×10^{-7}	<3.5×10^{-8}

1 After 1 month of continuous operation.

Table 5: Guaranteed measurement capabilities

Characteristics	Description	
Measurement Control		
Measuring Time	20 ns to 1000 s for Frequency, Burst, and Period Average Single cycle for other measuring functions.	
✓ Quantization Error	FCA3000 Series	100 ps_{RMS}
	FCA3100 Series	65 ps_{RMS}
	MCA3000 Series	100 ps_{RMS}
Trigger Error	$\sqrt{\left(\frac{\sqrt{ANL^2 + CNL^2}}{SSR}\right)^2 + SPJ^2}$ Where: **ANL** = Input Noise Level (Amplifier Noise Level) (3.1.6) **CNL** = Customer Input Signal Noise Level **SSR** = Signal Slew Rate at trigger level **SPJ** = Customer Signal Single Period Jitter	
Gate Time Uncertainty	200 ps_{RMS}	
Mixer Jitter (MCA3000 channel C only)	50 ps_{RMS}	
Timebase Reference	Internal, External, or Automatic	
Display Hold	Freezes result, until a new measurement is initiated via Restart.	

Table 5: Guaranteed measurement capabilities (cont.)

Characteristics	Description
Limit Alarm Settings	Graphical indication on front panel and/or SRQ using GPIB, plus pulse on output connector (FCA3100 Series)
	Limit Values: Lower limit, Upper limit
	Settings: OFF or Alarm if value is above/below/inside or outside limits
	On Alarm: STOP or CONTINUE
	Display: Numeric and Graphic
Frequency	Capable of measuring frequency on any of up to three inputs.
Resolution	12 digits in 1 s measuring time (normal)
Low Frequency Capability	Ch A and B : 0.002 Hz Ch C: Specification covered in Channel C table
Total Measurement Uncertainty (FCA3000, FCA3100, MCA3000 Series channels A and B)	$2 \times \sqrt{RMU^2 + SMU^2}$ Where: RMU = Random Measurement Uncertainty SMU = Systemic Measurement Uncertainty
Total Measurement Uncertainty (MCA3000 Series channel C)	$TMU = 2 \times \sqrt{\left(\frac{F \times MJ}{MT}\right)^2 + \left(\frac{TBE \times F}{3}\right)^2 + \left(\frac{0.0151}{MT}\right)^2}$ $TMU = 2 \times \sqrt{RMU^2 + SMU^2}$ Where: RMU = Random Measurement Uncertainty SMU = Systemic Measurement Uncertainty MT is driven by customer F is the input Frequency rounded to the next GHz up TBE is Time Base Error verified in the PV MJ is Mixer Jitter, and the only VISIBLE unknown. There is an uncertainty in the .02 that becomes part of the .0151

Table 5: Guaranteed measurement capabilities (cont.)

Characteristics	Description
Random Measurement Uncertainty (FCA3000, FCA3100, MCA3000, channels A and B)	For measurement time ≥200 ms and Smart Freq = Auto or ON: ***NOTE.*** *This equation is the default on FCA3100 Series.* $2.5 \times MR \times \sqrt{\frac{\sqrt{QE^2 + 2 \times TE^2}}{MT \times \sqrt{N}}}$ Where: MR = Measurement reading QE = Quantization Error TE = Trigger Error MT = Measurement Time N = 800/MT with the following limits: 6 ≤ N ≤ 1000 and N<((MR/2)*MT) – 2 For FCA3100, additionally, N < MT/8 µs For measurement time <200 ms and Smart Freq = Auto or OFF: $MR \times \frac{\sqrt{QE^2 + 2 \times TE^2}}{MT}$ Where: MR = Measurement reading QE = Quantization Error TE = Trigger Error MT = Measurement Time
Systemic Measurement Uncertainty (FCA3000, FCA3100, MCA3000 channels A and B)	$\sqrt{\frac{1}{3} \times \left[(TBE \times MR)^2 + \left(\frac{MR \times GTU}{MT}\right)^2\right]}$ Where: TBE = Timebase Error MR = Measurement Reading MT = Measurement Time GTU = Gate Time Uncertainty
Ancillary Measurements	Vmax, Vmin, $V_{p\text{-}p}$
Period	Capable of measuring period on any of up to three inputs
Mode	Single, Average
Range	Channel A, B: 3.3 ns to 1000 s (single, average) Channel C (Option): 10 ns down to 330 ps, 125 ps, 70 ps, or 50 ps
Resolution (FCA3000 Series)	100 ps (single shot) 12 digit/s (average)

Table 5: Guaranteed measurement capabilities (cont.)

Characteristics	Description
Total Measurement Uncertainty	$2 \times \sqrt{RMU^2 + SMU^2}$ Where: RMU = Random Measurement Uncertainty SMU = Systemic Measurement Uncertainty
Total Measurement Uncertainty (MCA3000 channel C)	$TMU = 2 \times \sqrt{\left(\frac{F \times MJ}{MT}\right)^2 + \left(\frac{TBE \times F}{3}\right)^2 + \left(\frac{0.0151}{MT}\right)^2}$ $TMU = 2 \times \sqrt{RMU^2 + SMU^2}$ Where: RMU = Random Measurement Uncertainty SMU = Systemic Measurement Uncertainty MT is driven by customer F is the input Frequency rounded to the next GHz up TBE is Time Base Error verified in the PV MJ is Mixer Jitter, and the only VISIBLE unknown. There is an uncertainty in the .02 that becomes part of the .0151
Random Measurement Uncertainty (FCA3000, FCA3100, MCA3000 Series, channels A and B)	For measurement time ≥200 ms and Smart Freq = Auto or ON: ***NOTE.*** *This equation is the default on FCA3100 Series.* $2.5 \times MR \times \sqrt{\frac{\sqrt{QE^2 + 2 \times TE^2}}{MT \times \sqrt{N}}}$ Where: MR = Measurement reading QE = Quantization Error TE = Trigger Error MT = Measurement Time N = 800/MT with the following limits: 6 ≤ N ≤ 1000 and N<((MR/2)*MT) – 2 For FCA3100, additionally, N < MT/8 µs For measurement time <200 ms and Smart Freq = Auto or OFF: $MR \times \frac{\sqrt{QE^2 + 2 \times TE^2}}{MT}$ Where: MR = Measurement reading QE = Quantization Error TE = Trigger Error MT = Measurement Time
Ancillary Measurements	V_{MAX}, V_{MIN}, V_{p-p}

Table 5: Guaranteed measurement capabilities (cont.)

Characteristics	Description
Time Interval Error (TIE) FCA31xx only	Normalized Period Back-to-back measurements, calculated as: $TIE(k) = kT_{REF} - T_i$ where: T_i = individual period back-to-back T_{REF} = Reference period value
Time Interval	Capable of measuring time from one event until the next. Time intervals only measurable on the A and B channels.
Range, Nominal Calculation	0 ns to $+10^6$ s
Range, Smart Calculation	-10^6 s to $+10^6$ s
Resolution (FCA3000 Series)	100 ps
Minimum Pulse Width	1.6 ns
Smart Calculation	Smart Time Interval determines sign (A before B or A after B)
Total Measurement Uncertainty	$2 \times \sqrt{RMU^2 + SMU^2}$ Where: RMU = Random Measurement Uncertainty SMU = Systemic Measurement Uncertainty
Random Measurement Uncertainty	$\sqrt{QE^2 + TE_{start}{}^2 + TE_{stop}{}^2}$ Where: QE = Quantization Error TE_X = Trigger Error for a particular edge X
Systemic Measurement Uncertainty	$\sqrt{\frac{Etl^2 + CTD^2 + (TBE \times MR)^2}{3}}$ Where: Etl = Trigger Level Timing Error CTD = Channel Timing Difference TBE = Timebase Error MR = Measurement Result
Trigger Level Timing Error (Etl)	$\sqrt{\left(TLU + \frac{Hyst}{2}\right)^2 \times \left(\frac{1}{S_{start}{}^2} + \frac{1}{S_{stop}{}^2}\right)}$ Where: TLU = Trigger Level Uncertainty Hyst = Hysteresis Window S_X = Slew Rate at the trigger point for timing location X

Table 5: Guaranteed measurement capabilities (cont.)

Characteristics	Description
Positive and Negative Pulse Width	Capable of measuring Pulse Width on A or B channels
Range	2.3 ns to 10^6 s
Minimum Pulse Width	2.3 ns
Total Measurement Uncertainty	$2 \times \sqrt{RMU^2 + SMU^2}$ Where: RMU = Random Measurement Uncertainty SMU = Systemic Measurement Uncertainty
Random Measurement Uncertainty	$\sqrt{QE^2 + {TE_{start}}^2 + {TE_{stop}}^2}$ Where: QE = Quantization Error TE_X = Trigger Error for a particular edge X
Systemic Measurement Uncertainty	$\sqrt{\frac{Etl^2 + CTD^2 + (TBE \times MR)^2}{3}}$ Where: Etl = Trigger Level Timing Error CTD = Channel Timing Difference TBE = Timebase Error MR = Measurement Result
Trigger Level Timing Error (Etl)	$\sqrt{\left(TLU + \frac{Hyst}{2}\right)^2 \times \left(\frac{1}{{S_{start}}^2} + \frac{1}{{S_{stop}}^2}\right)}$ Where: TLU = Trigger Level Uncertainty Hyst = Hysteresis Window S_X = Slew Rate at the trigger point for timing location X
Ancillary Measurements	V_{max}, V_{min}, $V_{p\text{-}p}$
Rise and Fall Time	Capable of measuring Rise or Fall Time on A or B channels
Range	1.5 ns to 10^6 sec.
Trigger Levels	10% and 90% of signal level
Pulse Width	1.6 ns
Total Measurement Uncertainty	$2 \times \sqrt{RMU^2 + SMU^2}$ Where: RMU = Random Measurement Uncertainty SMU = Systemic Measurement Uncertainty

Table 5: Guaranteed measurement capabilities (cont.)

Characteristics	Description
Random Measurement Uncertainty	$\sqrt{QE^2 + TE_{start}{}^2 + TE_{stop}{}^2}$ Where: QE = Quantization Error TE_X = Trigger Error for a particular edge X
Systemic Measurement Uncertainty	$\sqrt{\frac{Etl^2 + CTD^2 + (TBE \times MR)^2}{3}}$ Where: Etl = Trigger Level Timing Error CTD = Channel Timing Difference TBE = Timebase Error MR = Measurement Result
Trigger Level Timing Error (Etl)	$\sqrt{\left(TLU + \frac{Hyst}{2}\right)^2 \times \left(\frac{1}{S_{start}{}^2} + \frac{1}{S_{stop}{}^2}\right)}$ Where: TLU = Trigger Level Uncertainty Hyst = Hysteresis Window S_X = Slew Rate at the trigger point for timing location X
Ancillary Measurements	Slew rate, V_{MAX}, V_{MIN}
Positive and Negative Duty Factor	Capable of measuring Positive or Negative Duty Factor on A or B channels
Range	0.000001 to 0.99999
Frequency Range	0.1 Hz to 300 MHz
Total Measurement Uncertainty	$2 \times \sqrt{RMU^2 + SMU^2}$ Where: RMU = Random Measurement Uncertainty SMU = Systemic Measurement Uncertainty
Random Measurement Uncertainty	$\sqrt{QE^2 + TE_{start}{}^2 + TE_{stop}{}^2}$ Where: QE = Quantization Error TE_X = Trigger Error for a particular edge X

Table 5: Guaranteed measurement capabilities (cont.)

Characteristics	Description
Systemic Measurement Uncertainty	$\sqrt{\dfrac{Etl^2 + CTD^2 + (TBE \times MR)^2}{3}}$ Where: Etl = Trigger Level Timing Error CTD = Channel Timing Difference TBE = Timebase Error MR = Measurement Result
Trigger Level Timing Error (Etl)	$\sqrt{\left(TLU + \dfrac{Hyst}{2}\right)^2 \times \left(\dfrac{1}{S_{start}{}^2} + \dfrac{1}{S_{stop}{}^2}\right)}$ Where: TLU = Trigger Level Uncertainty Hyst = Hysteresis Window S_X = Slew Rate at the trigger point for timing location X
Ancillary Measurements	Period, Pulse width
Time stamping	Capable of providing raw time stamp data together with pulse counts on inputs. Accessible over programmatic interfaces only. Timestamping is not available for MCA3000 Series channel C.
Time-Stamp-capable channels	FCA3000 Series: A, B, C FCA3100, MCA3000 Series: A, B
Maximum Sample Speed	See GPIB specifications. I/O Transfer Rate determines Maximum Sample Speed.
Maximum Frequency	160 MHz
Maximum Frequency to catch each edge	250 kHz (FCA3000, FCA3100 Series)
Minimum Pulse Width	2.5 ns (FCA3000, FCA3100 Series)
Timestamp Resolution	70 ps (FCA3000 Series) 50 ps (FCA3100 Series)
Voltage Measurement, Channels A and B	Capable of identifying positive peak and negative peak voltages Vmax = Signal (positive peak) + Noise (pk) – 1/2 hysteresis Vmin = Signal (negative peak) – Noise (pk) + 1/2 hysteresis
Range	1X attenuator: –5 V to +5 V 10X attenuator: –50 V to +50 V
Frequency Range	DC, 1 Hz to 300 MHz
Modes	V_{MAX}, V_{MIN}, V_{p-p} V_{p-p} is calculated from the Vmax and Vmin values. Thus it has twice the error band.
Resolution (FCA3000 Series)	1X attenuator: 3 mV 10X attenuator: 30 mV

Table 5: Guaranteed measurement capabilities (cont.)

Characteristics	Description	
Accuracy (5 V range)	***1X Attenuator***	
	DC, 1 Hz to 1 kHz:	1% +15 mV
	1 kHz to 20 MHz:	3% + 15 mV
	20 MHz to 100 MHz:	10% + 15 mV
	100 MHz to 300 MHz:	30% + 15 mV
	10X Attenuator	
	DC, 1 Hz to 1 kHz:	1% +150 mV
	1 kHz to 20 MHz:	3% + 150 mV
	20 MHz to 100 MHz:	10% + 150 mV
	100 MHz to 300 MHz:	30% + 150 mV
Power (MCA3000 Series channel C)	Product can measure the power input to channel C	
Power Range	-35 dBm to +10 dBm	
Frequency Range	MCA3027: 0.3 GHz to 27 GHz MCA3040: 0.3 GHz to 40 GHz	
Resolution	0.01 dBm at 100 ms measuring time	
Accuracy	MCA3027: 0.3 GHz to 27 GHz: ±1 dBm MCA3040: 0.3 GHz to 20 GHz: ±3 dBm >27 GHz to 40 GHz: ±2 dBm	
Totalize A, B (FCA31XX Only)	The instrument is capable of totalizing counts	
Totalize Modes	Tot A, Tot B, Tot A+B, Tot A–B	
Totalize Range	1 to 10^{10} counts	
Totalize Frequency Range	< 160 MHz	
Totalize Controls	**Start:** Manual or Start Arming **Stop:** Manual or Stop Arming or Timed	
Ancilliary Measurements	**Totalize A:** A–B, A/B **Totalize B:** A–B, A/B **Totalize A+B:** A, B **Totalize A–B:** A, B **Totalize A/B:** A, B	

Table 6: Other available readings

Characteristic [1]	Description
Frequency Ratio	Able to provide the ratio of two input signals. Available measurements may depend upon selected options
Range	10^{-9} to 10^{11}
Lowest Input Frequency for Correct Operation	0.1 Hz

Table 6: Other available readings (cont.)

Characteristic [1]	Description
Ancillary Measurements	Frequency of either input signal
Phase	Capable of measuring Phase between the A and B channels using either as the reference
Range	–180° to +360°
Resolution	Single-cycle 0.001° up to 10 kHz, decreasing to 1° >10 MHz. Resolution can be improved by using averaging (statistics)
Maximum Usable Frequency	160 MHz
Ancillary Measurements	Frequency (A) Va, Vb (in dB)

1 Other Available Readings do not have an accuracy specification.

Table 7: Other option capabilities

Characteristic	Description
Frequency Burst A, B, C (FCA3020/FCA3120)	Frequency and PRF of repetitive burst signals can be measured without external control signal and with selectable start arming delay.
Function	Frequency in burst (in Hz) PRF (in Hz)
Range	Input A, B, C: See Frequency Spec.
Minimum Burst Duration	Down to 40 ns
Minimun Pulses in Burst	Channel A or B: 3 (6 above 160 MHz) Channel C: 3 x prescaler factor
PRF Range:	0.5 Hz to 1 MHz
Start Delay	10 ns to 2 s, 10 ns resolution
Other Measurement:	PRF

Table 8: Software functions

Characteristic	Description
Statistics	
Measurements	Maximum, Minimum, Mean, ΔMax-Min, Standard Deviation and Allan Deviation
Display	Numeric, histogram, or trend plots
Sample Size	2 to 2 x 10^9 samples
Limit Qualifier	OFF or Capture values above/below/inside our outside limits
Measurement Pacing, Pacing Time Range	4 µs to 500 s
Auxiliary Functions; Trigger Hold-Off, Time Delay Range	20 ns to 2 s, 10 ns resolution
Auxiliary Functions; External Arming	Provides Start and Stop Arming

Table 8: Software functions (cont.)

Characteristic	Description
Modes	Start, Stop, Start and Stop Arming
Input Channels	A, B, or E (rear panel)
Maximum Repetition Rate for Arming Signal	Channel A, B: 160 MHz Channel E: 80 MHz
Start Time Delay Range	FCA3000 Series: 20 ns to 2 s, 10 ns resolution. MCA3000 Series: 10 ns to 2 s, 10 ns resolution
Mathematics Functions	(K*X+L)/M (K/X +L)/M Where: X is current reading K, L, and M are constants Constants set by keyboard or as frozen reference value (X_6)
Mathematics Functions; Stored Instrument Setups	20 (10 can be user protected) Instrument setups are saved/recalled from internal nonvolatile memory
Mathematics, Other Functions; Number of Displayed Digits	14 digits in numerical mode

Table 9: Power

Characteristic	Description
Line Power	100 – 240 V_{AC} ±10%, CAT II: 50 – 400 Hz ±10%: 40 W
Fuse Rating	No customer accessible fuse

Table 10: I/O connectors

Characteristic	Description
GPIB Interface	Included IEEE488.2 - 1987 Interface
Functions	All front panel accessible controls
Modes	Native Agilent 53131/132/181 command emulation. Timing and resolution not compatible
Interface Functions	SH1, AH1, T6, L4, SR1, RL1, DC1, DT1, E2
Measurement Rate, FCA3000 Series	To GPIB: 2000 readings/s block, 350 readings/s individual, 4000 readings/s talker only To Internal Memory: 250K readings/s Internal memory size: up to 750K readings
Measurement Rate, FCA30xx/MCA30xx	To GPIB: 13,900 readings/s block, 650 readings/s individual, 4000 readings/s talker only To Internal Memory: 250K readings/s, 100K readings/s with calibration on Internal memory size: Up to 3.9 M readings with calibration off
USB Interface	USB2.0, full speed
Classes	USBTMC USB488 subclass

Table 11: Display characteristics

Characteristic	Description
Display Type	Backlit LCD Graphics screen for menu control, numerical readout, and status information
Display Resolution	320 x 97 pixels

Table 12: Mechanical Characteristics

Characteristic	Description
Dimensions	
Width	210 mm (8.27 in)
Height	90 mm (3.54 in)
Depth	395 mm (15.55 in)
Weight	
Net	2.7 kg (5.8 lb)
Shipping	3.5 kg (7.5 lb)

Table 13: Environmental performance – Laboratory Products

Characteristic	Description
Temperature	Operating: +0 °C to +50 °C Nonoperating: -40 °C to +71 °C
Humidity	+10 °C to +30 °C (50 °F to 86 °F): 5% to 95% +30 °C to +40 °C (86 °F to 104 °F): 5% to 75% +40 °C to +50 °C (104 °F to 122 °F): 5% to 45%
Altitude (maximum)	Operating and nonoperating: 2000 m (6500 feet)

Performance Verification

This chapter contains performance verification procedures for the specifications marked with the ✓ symbol. The following equipment, or a suitable equivalent, is required to complete these procedures.

Table 14: Recommended Equipment

Equipment	Requirements	Example
Frequency Standard	■ Accuracy 5X better than the timebase being tested ■ Output Amplitude ≥0.5 V_{rms} (1.4 V_{p-p}) ■ $6{\times}10^{-11}$ required for the ultra high stability timebase	Spectracom/Pendulum 6689 Frequency Standard
Signal source (Function generator)	■ 1 channel at 200 MHz or better ■ Signal noise at 1 V output < –40 dBc ■ External reference input	Tektronix AFG3251 or AFG3252
Microwave signal source	■ 40 GHz operation ■ Frequency accuracy better than 1% ■ Amplitude accuracy better than 1.5 dB ■ Output range –50 dBm to +7 dBm	Gigatronics 2440C Signal Source with Option 18,and Option 26C
Digital multimeter	■ 1% measurement accuracy of resistance near 1 MΩ ■ 0.5% measurement accuracy on AC Volts at 10 mV	Tektronix DMM4020
Oscilloscope	■ 100 MHz Bandwidth, 5 mV/div and up	Tektronix DPO3012 Oscilloscope
Power meter	■ 40 GHz operation ■ VSWR < 1.37 at 40 GHz ■ Maximum power +7 dB ■ Minimum power –10 dB ■ 200 MHz to 40 GHz ■ Linearity Error < ±0.35 dB from –10 dBm to +10 dBm	R&S NRVS Power Meter with NRV-Z15 Sensor
Power splitter	■ DC to 40 GHz ■ Type K connector ■ Male input connection ■ Female output connections ■ Insertion loss < 8.5 dB at 40 GHz SWR < 2	Anritsu K241C
Adapter	■ SMA female to SMA female	Tektronix part number 015-1012-XX
Adapter	■ BNC to Banana Plug adapter	Tektronix part number 012-1450-XX
Adapter	■ Type N male to 2.92 male connector ■ 20 GHz operation	Fairview Microwave SM3140

Table 14: Recommended Equipment (cont.)

Equipment	Requirements	Example
Adapter	■ 2.92 mm male to N female ■ Low frequency requirement	Fairview Microwave SM3130
Adapter	■ Type N male to BNC female ■ 4 GHz	Fairview Microwave SM3510
Adapter (Qty 2)	■ 2.92 male to SMA female connector ■ 40 GHz operation	Fairview Microwave SM3285
Adapter (Qty 2)	■ 2.92 male to 2.92 male connector ■ 40 GHz operation	Fairview Microwave SM3242
Cable (Qty 2)	■ SMA male to BNC male	Tektronix part number 174-3998-XX
Cable (Qty 2)	■ Coaxial cable, BNC male to BNC male	Tektronix part number 012-0117-XX
Cable	■ Coaxial cable, BNC male to BNC female	Tektronix part number 012-0104-XX, 18 inch, or Pomona 4524-C-36, 36 inch
Cable	■ SMA male to SMA male cable	Tektronix part number 174-5401-XX
Cable	■ 1 m cable with 2.92 mm male and female connector	Huber & Sohner 84119347–SF102/115K/215K/1.0M
Termination	■ Coaxial BNC feedthrough terminator, 50 Ω, 2 W	Tektronix part number 011-0049-XX
Attenuator (Qty 2)	■ 50 Ω 10X attenuator, ±5% accuracy	Tektronix part number 011-0059-XX

These procedures cover all FCA3000, FCA3100, and MCA3000 series models. Please ignore checks that do not apply to the specific model that you are testing.

Photocopy the test record and use it to record the performance test results for your instrument.

As an alternative, you can access an Excel spreadsheet by clicking on the paperclip icon, at the left. This spreadsheet form of the test record will perform some of the necessary calculations for you.

1. Double-click on the paperclip icon, to the left.
2. Select **File > Save As** in the spreadsheet File menu, and save it to a convenient place on your desktop.
3. When you perform the Front End Characteristics procedure, enter the measured values on the yellow *Front End Characteristics* tab. Calculated values will automatically be added to the *Test Record* tab.

Test Record

Table 15: Test record

Instrument Model Number:	Certificate Number:
Instrument Serial Number:	Temperature:
Instrument Timebase Option:	RH %:
Date of Test:	Technician:

Instrument performance test	Minimum	Measured	Maximum
Input Impedance			
Channel A	47.5 Ω		52.5 Ω
Channel B	47.5 Ω		52.5 Ω
Front End Characteristics			
Channel A			
1X Noise (RMS)	0 mV		0.5 mV
1X Hysteresis Window	— —		30 mV
1X Trigger Level Uncertainty	–15 mV		15 mV
10X Noise (RMS)	0 mV		5 mV
10X Hysteresis Window	— —		300 mV
10X Trigger Level Uncertainty	–150 mV		150 mV
Channel B	— —		
1X Noise (RMS)	0 mV		0.5 mV
1X Hysteresis Window	— —		30 mV
1X Trigger Level Uncertainty	–15 mV		15 mV
10X Noise (RMS)	0 mV		5 mV
10X Hysteresis Window	— —		300 mV
10X Trigger Level Uncertainty	–150 mV		150 mV
Sensitivity, DC-400 MHz at 1X Attenuation			
Channel A			
10 Hz @ 15 mV_{RMS}	9.9 Hz		10.1 Hz
10 kHz @ 15 mV_{RMS}	9.9 kHz		10.1 kHz
200 MHz @ 15 mV_{RMS}	198 MHz		202 MHz
300 MHz @ 25 mV_{RMS}	297 MHz		303 MHz
400 MHz @ 25 mV_{RMS}	396 MHz		404 MHz
Channel B			
10 Hz @ 15 mV_{RMS}	9.9 Hz		10.1 Hz
10 kHz @ 15 mV_{RMS}	9.9 kHz		10.1 kHz
200 MHz @ 15 mV_{RMS}	198 MHz		202 MH

Instrument performance test	Minimum	Measured	Maximum
300 MHz @ 25 mV_{RMS}	297 MHz		303 MHz
400 MHz @ 25 mV_{RMS}	396 MHz		404 MHz
Timebase Accuracy			
FCA3X00 Series			
Std (7.00E^{-6})	0.9999930000		1.0000070000
Opt. MS (2.40E^{-7})	0.9999997600		1.0000002400
Opt. HS (6.00E^{-8})	0.9999999400		1.0000000600
MCA3X00 Series			
Std (2.40E^{-7})	0.9999997600		1.0000002400
Opt. HS (6.00E^{-8})	0.9999999400		1.0000000600
Opt. US (1.80E^{-8})	0.9999999820		1.0000000180
Quantization Error			
FCA3100 Series	— —		65 ps_{RMS}
FCA3000 Series	— —		100 ps_{RMS}
MCA3000 Series	— —		100 ps_{RMS}
External Reference Clock Frequency and Sensitivity			
0.999999 MHz	10.000005 MHz		10.000015 MHz
4.999995 MHz	10.000005 MHz		10.000015 MHz
9.999990 MHz	10.000005 MHz		10.000015 MHz
10 MHz Out Amplitude			
Output Amplitude	1.0 V		— —

Instrument performance test	Minimum	Measured	Maximum
Channel C (If Installed)			
Input Impedance			
FCA3003, FCA3103, MCA3040	–5.61 dB (0.524)		-1.84 dB (0.809)
FCA3020, FCA3120, MCA3027	–5.09 dB (0.556)		–2.19 dB (0.777)
Frequency Sensitivity			
FCA3X03			
100 MHz @ –21 dBm (~20 mV_{RMS})	100.0 MHz		100.0 MHz
300 MHz @ –27 dBm (~10 mV_{RMS})	300.0 MHz		300.0 MHz
2.5 GHz @ –21 dBm (~20 mV_{RMS})	2.500 GHz		2.500 GHz
3.0 GHz @ –15 dBm (~40 mV_{RMS})	3.000 GHz		3.000 GHz
FCA3X20			
250 MHz @ –21 dBm (~20 mV_{RMS})	250.0 MHz		250.0 MHz
500 MHz @ –21 dBm (~20 mV_{RMS})	500.0 MHz		500.0 MHz
18 GHz @ –27 dBm (~20 mV_{RMS})	18.00 GHz		18.00 GHz
20 GHz @ –21 dBm (~20 mV_{RMS})	20.00 GHz		20.00 GHz
MCA30XX			
300 MHz @ –33 dBm (~5 mV_{RMS})	300.0 MHz		300.0 MHz
18 GHz @ –33 dBm (~5 mV_{RMS})	18.00 GHz		18.00 GHz
20 GHz @ –29 dBm (~8 mV_{RMS})	20.00 GHz		20.00 GHz
27 GHz @ –27 dBm (~10 mV_{RMS})	27.00 GHz		27.00 GHz
40 GHz @ –23 dBm (~16 mV_{RMS})	40.00 GHz		40.00 GHz

Front End Characteristics Worksheet

The Front End Characteristics procedure requires several measurements, which are used to calculate the characteristics of the instrument. The calculations shown in this worksheet use the line references (Ref) to indicate which measured value to use in that calculation.

There is also a spreadsheet version of the test record, available from the paperclip icon on Page 2-2, which will perform the calculations automatically as the measured values are entered.

Table 16: Front End Characteristics Worksheet

Ref	Name	Measurement Step or Calculation	Value		Units	Copy into Test Record
Measure:						
A	Terminator Only	Step 6			V	
B	First Attenuator	Step 7			V	
C	Second Attenuator	Step 8			V	
			Channel A	Channel B		
D	1X Trigger Level Uncertainty	Step 14			mV	X
E	1X Just Triggers	Step 15			V	
F	10X Trigger Level Uncertainty	Step 18			mV	X
G	10X Just Triggers	Step 18			V	
H	10X Just Becomes Inaccurate	Step 21			V	
I	1X Just Becomes Inaccurate	Step 26			V	
Calculate:						
J	10X Attenuator Correction	A/B			na	
K	100X Attenuator Correction	A/C			na	
L	1X Pk-Pk Noise	((I – E) / K) × 500			mV	
M	10X Pk-Pk Noise	((H – G) / J) × 500			mV	
N	1X noise (RMS)	L / 2 / 3.1			mV	X
O	1X Hysteresis Window	(((I + E) / 2) / K) × 1000			mV	X
P	10X Noise (RMS)	M / 2 / 3.1			mV	X
Q	10X Hysteresis Window	(((H + G) / 2) / J) × 1000			mV	X

Instrument Calibration Procedures

Run the Internals Calibration procedure before running a Performance Verification, or whenever the ambient air temperature of the instrument changes by more than 5 °C (9 °F).

CAUTION. *The FCA/MCA3X00 Series instrument can be damaged by trying to run calibration procedures without the correct test equipment, setup, and procedure. To avoid damage to the FCA/MCA3X00 Series instrument, do NOT attempt to perform the Timebase Calibration, Voltage Calibration, or Power Calibration procedures.*

Instrument Warmup Requirements

All FCA/MCA3X00 Series models require a 48 hour warm-up period, except FCA models with a Standard Timebase. FCA models with a Standard Timebase only require a 20 minute warm-up.

Internals Calibration

Equipment

No equipment is required.

Procedure

1. Disconnect all cables and inputs from the FCA/MCA3X00 Series instrument.
2. Power on the FCA/MCA3X00 Series instrument for a minimum of 20 minutes. (See page 24, *Instrument Warmup Requirements*.)
3. Push **User Opt -> Calibrate -> 62951413 -> Enter**.
4. Push **Internals**.

NOTE. *Only push Internals. Do not select any other calibration program available at this point, only Internals. Doing so may void your traceability.*

---

5. Push **Start Calib**.
6. The FCA/MCA3X00 Series instrument displays the Frequency A measurement screen when the calibration is done.

Reset the Instrument

After performing any procedure on an FCA/MCA3X00 Series instrument, it is a good idea to reset the instrument to the factory defaults, to return the instrument to a known state:

- Push the **User Opt** button, and then select **Save Recall** > **Setup** > **Recall Setup** > **Default**.

Performance Verification

This procedure tests the FCA/MCA3X00 Series instrument, to verify that it meets all of the guaranteed specifications.

NOTE. *Before starting the Performance Verification procedures, look at the serial number sticker on the back of the FCA/MCA3X00 Series instrument to see which timebase the instrument has; Std., Opt. MS, Opt. HS or Opt. US. Note the timebase type on the test record.*

Instrument Warmup Requirements

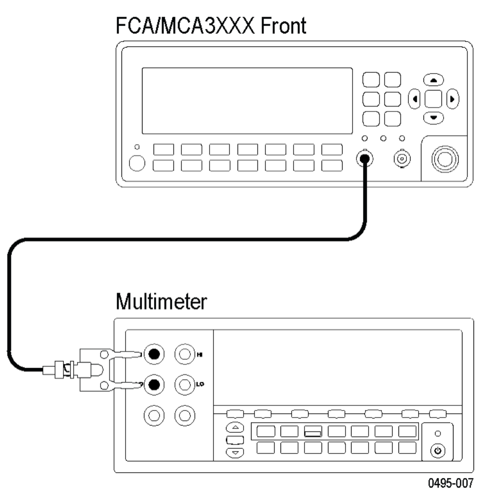
All FCA/MCA3X00 Series models require a 48 hour warm-up period, except FCA models with a Standard Timebase. FCA models with a Standard Timebase only require a 20 minute warm-up.

Channel A and B Input Resistance

Equipment:

- Digital Multimeter
- Coaxial cable, BNC male to BNC male
- BNC to Banana Plug adapter

Equipment Setup



Procedure

1. Connect the equipment as shown.
2. Power on the instruments for at least 20 minutes. (See page 24, *Instrument Warmup Requirements*.)

3. Set the Digital Multimeter to measure resistance in an autorange mode. On a Tektronix DMM4020:
   a. Push the **Ω** button (if necessary, push again to get to 2X4Wire mode, not 4Wire mode).
   b. Push the **RANGE** button to select **Auto Range** (if not already selected).
4. On the Tektronix FCA/MCA3X00 Series instrument under test:
   a. Push **Input A**.
   b. Set the input coupling to **DC**.
   c. Set the input impedance to **50 Ω**.
   d. Set the input attenuator to **1X**.
5. Record the measured Channel A input resistance in the test record.
6. Move the Coaxial cable from Input A to Input B on the FCA/MCA3X00 Series instrument.
7. On the Tektronix FCA/MCA3X00 Series instrument under test:
   a. Push **Input B**.
   b. Set the input coupling to **DC**.
   c. Set the input impedance to **50 Ω**.
   d. Set the input attenuator to **1X**.
8. Record the measured Channel B input resistance in the test record.

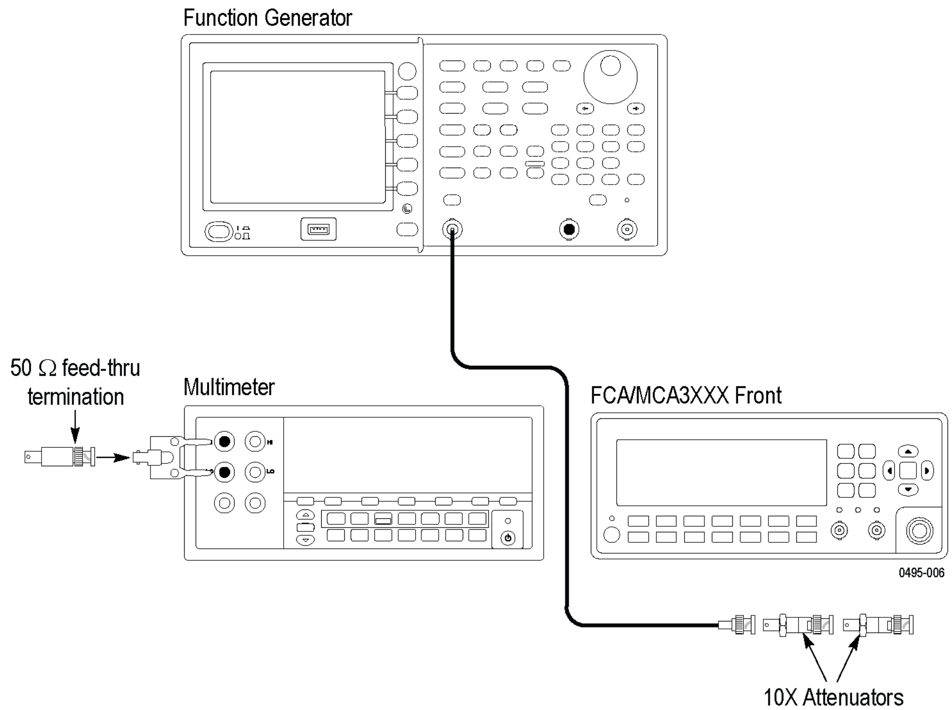
Front End Characteristics

This procedure checks the hysteresis band at 1X, and RMS noise. It also verifies trigger level uncertainty and 10X attenuator scale factor.

Equipment:

- Function Generator
- Digital Multimeter
- Coaxial Cable, BNC male to BNC male
- 50 Ω 10X (20 dB) Attenuator (Qty 2)
- 50 Ω Feed Through Terminator
- BNC to Banana Plug adapter

Equipment Setup



Worksheet

This procedure uses a worksheet, as several of the characteristics must be calculated. The worksheet is located directly after the Test Record.(See Table 16 on page 22.) As an alternative, there is a spreadsheet version of the Test Record, available from a link on page 2-2, which will perform these calculations for you.

Procedure

During this procedure you will add and remove 10X attenuators to the signal path. When more than one attenuator is connected they may be referred to as an attenuator stack.

1. Connect the equipment as shown. Connect the 50 Ω feedthrough terminator to the BNC-to-Banana Plug adapter, and attach them to the Multimeter.
2. Power on the instruments for at least 20 minutes.(See page 24, *Instrument Warmup Requirements*.)
3. Set the Function Generator to produce a 1 V DC output. Use the following steps to set a Tektronix AFG3251:
   a. Push the **More** function button.
   b. Push the **More Waveform** side menu button.
   c. Push **DC**.
   d. Push the **Top Menu** panel button.
   e. Push the **Amplitude/Level Menu** side menu button.

f. Push **Offset**.

g. Adjust the offset voltage to **1 V**.

h. Push the Output **ON** button to turn on the signal output. (The button glows green.)

4. Set the Multimeter to measure DC volts, autoranging.

5. Connect the Function Generator output to the feedthrough terminator and BNC-to-Banana Plug adapter on the Multimeter.

6. Enter the measured *Terminator Only* value in the test record. This value should be approximately 1 V.

NOTE. *As you add and remove attenuators in this procedure, make sure to keep them in the same sequence relative to one another and to the cable. When you first remove an attenuator, whether you remove the one closest to the cable or the one closest to the DUT, make sure to add/remove that same attenuator in that same position for the rest of the procedure. If necessary, label the attenuators to maintain the order.*

---

7. Add the first 10X attenuator between the feedthrough terminator and the coaxial cable, and enter the measured *First Attenuator* value in the test record. The value should be approximately 100 mV.

8. Add the second 10X attenuator between the feedthrough terminator and the coaxial cable, and enter the *Second Attenuator* measured value in the test record. The value should be approximately 10 mV.

9. Set the Function Generator to generate a 100 Hz, 1 V_{pp} signal. On an AFG3251, use these steps:

a. Push the **Sine** function button.

b. Push the **Frequency/Period** side menu button.

c. Push the **Frequency** side menu button.

d. Use the keypad and side menu buttons to enter **100 Hz**.

e. Push the **Top Menu** panel button.

f. Push the **Amplitude/Level Menu** side menu button.

g. Push **Offset**.

h. Use the keypad and side menu buttons to set the offset voltage to **0 mV**.

i. Push the **Amplitude** side menu button.

j. Use the keypad and side menu buttons to set the amplitude to **1 V_{pp}**.

k. Use the arrow buttons below the control knob to position the control cursor to the 10 mV unit of the amplitude value so that the knob changes the output amplitude in 10 mV increments.

l. Push the Output **ON** button to turn on the signal output.

10. Move the cable and attenuator stack from the feedthrough terminator on the voltmeter to the Channel A input on the FCA/MCA3X00 Series instrument. Both 10X attenuators are installed. (Do not include the 50 Ω feedthrough termination.)

11. On the Tektronix FCA/MCA3X00 Series instrument:

a. Push the **Meas** button and select **Freq > Freq > A**.

b. Push the **Settings** button, select **Meas Time**, enter **20 ms**, and then push the **Save/Exit** button to return to the main screen.

c. Push **Input A** and make the following selections:

d. Set the input coupling to **DC**.

e. Set the input impedance to **50 Ω**.

f. Set the input attenuator to **1X**.

g. Set the Trigger mode to **Man**.

h. Push the **Trig** menu button, enter **0 V**, and push the **Save/Exit** button to return to the main screen.

i. Push the **Analyze** button until you see the Numerical Analysis display, shown here:

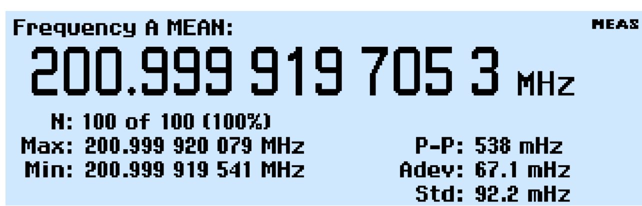


Figure 1: Numerical Analysis display

Note that this display has the standard deviation readout (shown as **Std:**) in the lower right corner of the screen.

j. Make sure that **Hold/Run** is set to **Run** (**Meas** appears in the upper right segment of the screen).

12. If the instrument is still triggering (the Trig LED is flashing), slowly decrease the Function Generator output level until the FCA/MCA3X00 Series instrument stops counting.

NOTE. *When adjusting the signal amplitude, if you hear a relay click in the generator there will be a few cycles of incorrect data, which must be ignored. Wait several seconds before proceeding.*

---

13. On the Function Generator, increase the output level in 10 mV increments until the **Gate** LED begins to flash. This can be an intermittent flash, it does not have to be regular.
14. On the Tektronix FCA/MCA3X00 Series instrument, push **Input A > Trig** and adjust the trigger level to read the highest possible frequency. Enter the adjusted trigger level from the FCA/MCA3X00 Series instrument into the test record as *1X Trigger Level Uncertainty at 0 V*.
15. On the Function Generator, reduce the signal output level until the Tektronix FCA/MCA3X00 Series instrument does not trigger (the Trig LED stops flashing). Then slowly increase the Function Generator output to find the minimum amplitude to cause the unit to count. This does not have to be an accurate count, you are just finding the point the counter just starts to trigger, on noise. Enter the Function Generator amplitude in the test report as *1X Just Triggers*.
16. On the Tektronix FCA/MCA3X00 Series instrument, push the **Input A** button and set the input attenuation to **10X**.
17. Disconnect the cable and attenuator stack from the Tektronix FCA/MCA3X00 Series instrument, remove one of the external 10X Attenuators, and reconnect the cable and remaining attenuator to the Tektronix FCA/MCA3X00 Series instrument.

NOTE. *As you go through this procedure you will be told to remove or add an attenuator from/to the attenuator stack.* ***Always*** *remove/replace the same attenuator when you do this.*

---

18. Repeat Steps 12 through 15, and enter the values in the test report as *10X Trigger Level Uncertainty* and *Just Triggers (10X)*.
19. Push the **Input A** button to return to the Numerical Analysis screen (shows **Std**).
20. Set the Function Generator signal amplitude to 3.0 Vpp.
21. Slowly decrease the Function Generator amplitude until the counter accuracy is affected; that is, when the Std Deviation at least doubles (watch for a sudden shift from mHz to Hz, as well as watching the numbers), or when the

frequency readout becomes noticeably incorrect. You should wait for two or three sample periods after changing the amplitude before taking the reading.

Enter the results in the test report as *10X Just Becomes Inaccurate* .

NOTE. *When adjusting the signal amplitude, if you hear a relay click in the generator there will be a few cycles of incorrect data, which must be ignored. Wait several seconds before proceeding.*

---

22. Disconnect the cable to the Tektronix FCA/MCA3X00 Series instrument, replace the external 10X Attenuator removed in Step 17, and reconnect the cable to the Tektronix FCA/MCA3X00 Series instrument.

23. On the Tektronix FCA/MCA3X00 Series instrument, push the **Input A** button and set the input attenuation to **1X**.

24. Reset the Trigger value to that noted in step 14, the *1X Trigger Level Uncertainty at 0 V* value.

25. Push the **Save/Exit** button to save the change and return to the Numerical Analysis display.

26. Repeat steps 20 and 21, entering the result in the test record as *1X Just Becomes Inaccurate*.

27. Move the input cable and attenuator stack to the Channel B input.

28. Repeat steps 9 through 26 for Channel B.

29. Now that the measurements have been made, perform the calculations shown at the bottom of the *Front End Characteristics Worksheet*. The letters in the calculations show which reference (Ref) line to use.

If you are using the spreadsheet version of the test record, these calculations are done for you as you enter the measurement results.

Sensitivity, DC–400 MHz at 1X Attenuation

This procedure verifies the 1X Attenuation path sensitivity over the frequency range.

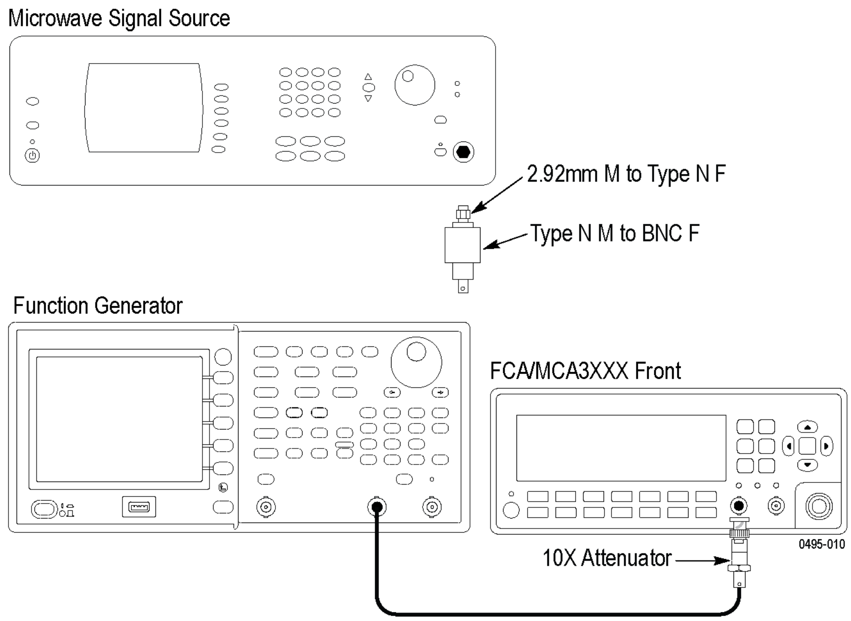
Equipment:

- Microwave Signal Generator
- Function Generator
- 10X Attenuator
- Coaxial Cable, BNC male to BNC male

- Adapter, 2.92 mm male to N female [1]
- Adapter, Type N male to BNC female [1]

1 Use adapters appropriate for your test equipment and cables.

Equipment Setup



Procedure

1. Power on the instruments.
2. Wait at least 20 minutes. (See page 24, *Instrument Warmup Requirements*.)
3. Connect the Function Generator output through a 10X Attenuator to Channel A on the Tektronix FCA/MCA3X00 Series instrument.
4. Set the Function Generator to produce a 10 Hz sinewave at 150 mV_{RMS} (424.2 $mV_{p\text{-}p}$). Follow these steps to set a Tektronix AFG3251:
   a. Push the **Sine** function button.
   b. Push the **Frequency/Period** menu button.
   c. Push the **Frequency** menu button.
   d. Use the keypad and menu buttons to set the output frequency to **10 Hz**.
   e. Push the **Top Menu** button.
   f. Push the **Amplitude/Level** menu button.
   g. Push the **–More-** side menu button.
   h. Push the **Units** side menu button, and then push the **Vrms** side menu button.

i. Push the **–More-** side menu button.

j. Push the **Amplitude** menu button.

k. Use the keypad and menu buttons to set the output level to **150 mV$_{RMS}$** (424.2 mV$_{p-p}$).

l. Push the Output **ON** button to turn on the signal (On button glows green).

5. On the Tektronix FCA/MCA3X00 Series instrument:

   a. Push the **Meas** button and select **Freq > Freq > A**.

   b. Push the **Settings** button, select **Meas Time**, enter **20 ms**, and then push the **Save/Exit** button to return to the main screen.

   c. Push the **Input A** button.

   d. Set the input coupling to **DC**.

   e. Set the input impedance to **50 Ω**.

   f. Set the input attenuator to **1X**.

   g. Set the Trigger mode to **Man**.

   h. Push the **Trig** menu button, enter **0 V**, and then push the **Save/Exit** button to return to the main screen.

   i. Push the **Analyze** button as many times as needed, until you see the Numerical Analysis display. (See Figure 1.)

6. On the Function Generator, at each of the following frequencies, verify that the Tektronix FCA/MCA3X00 Series instrument is counting, and that the count is accurate. Enter the frequency in the test record.

   - 10 Hz
   - 10 kHz
   - 200 MHz

7. On the Function Generator, push the Output **ON** button to turn off the output signal (button goes from green to unlit).

8. On the Tektronix FCA/MCA3X00 Series instrument, disconnect the cable and attenuator from Channel A and connect them to Channel B.

9. Repeat steps 4 through 7. Substitute Channel B for the instructions in steps 5 a and 5 c.

10. Set the Microwave Signal Generator output to **Off**, set the output amplitude to **0 dBm**, and then set the output frequency to **300 MHz**.

11. Disconnect the cable from the Function Generator and connect it to the adapter on the Microwave Signal Generator.

12. Set the Microwave Signal Generator output to **On**.

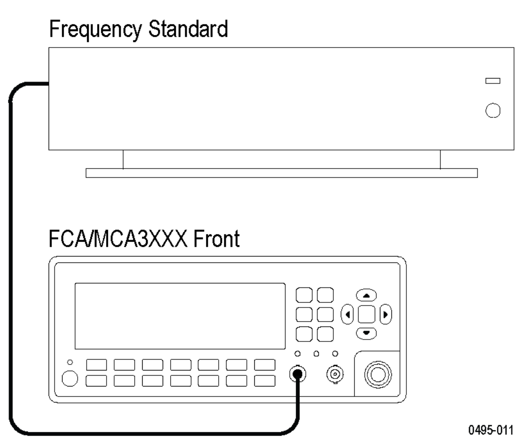
13. Enter the Frequency shown on the Tektronix FCA/MCA3X00 Series instrument as *Channel B 300 MHz sensitivity* in the test record.
14. Set the Microwave Signal Generator to **400 MHz**.
15. Enter the Frequency shown on the Tektronix FCA/MCA3X00 Series instrument as *Channel B 400 MHz sensitivity* in the test record.
16. On the Microwave Signal source, set the output to **Off**.
17. On the Tektronix FCA/MCA3X00 Series instrument:
    a. Disconnect the cable from Channel B and connect it to Channel A.
    b. Push the **Meas** button and select **Freq** > **Freq** > **A**.
18. On the Microwave Signal source, set the output to **On**.
19. Enter the Frequency shown on the Tektronix FCA/MCA3X00 Series instrument as *Channel A 400 MHz sensitivity* in the test record.
20. Set the Microwave Signal source to **300 MHz**.
21. Enter the Frequency shown on the Tektronix FCA/MCA3X00 Series instrument as *Channel A 300 MHz sensitivity* in the test record.
22. On the Microwave Signal source, set the output to **Off**.

Timebase Accuracy

Equipment:

- Frequency Standard
- Coaxial cable, BNC male to BNC male

Equipment Setup



Procedure

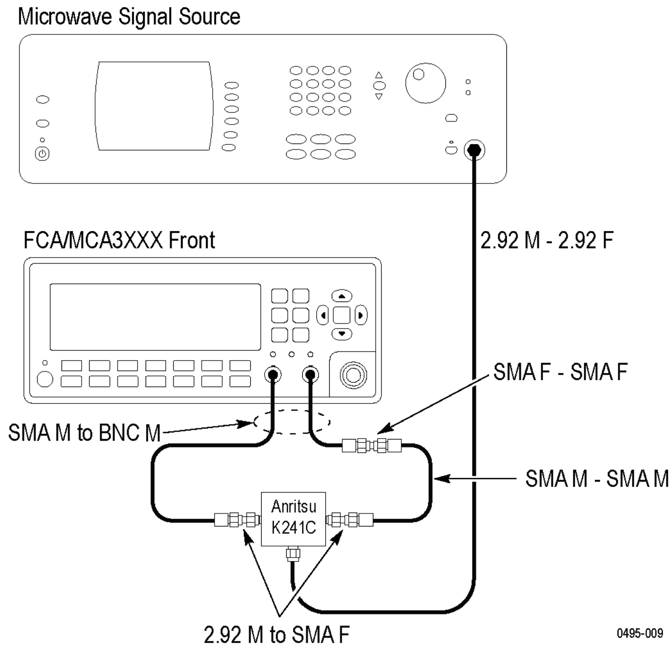
1. Power on the instruments for at least 20 minutes. (See page 24, *Instrument Warmup Requirements*.) The frequency standard should never be turned off but, if it has been, check the manufacturers instructions for its proper warm-up period.
2. Connect the Frequency Standard 10 MHz output to Input A on the Tektronix FCA/MCA3X00 Series instrument.
3. Set the Tektronix FCA/MCA3X00 Series instrument:
   - **a.** Push the **Meas** button and select **Freq > Freq > A**.
   - **b.** Push the **Settings** button, select **Meas Time**, enter **1 s**, and push the **Save/Exit** button to return to the main screen.
   - **c.** Push the **Input A** button.
   - **d.** Set the input coupling to **DC**.
   - **e.** Set the input impedance to **50 Ω**.
   - **f.** Set the input attenuator to **1X**.
   - **g.** Set the Trigger mode to **Man**.
   - **h.** Push the **Trig** menu button, enter **0 V**, and push the **Save/Exit** button to return to the main screen.
   - **i.** Push the **Value** button.
   - **j.** Push the **Hold/Run** button to set the instrument in **Hold** mode.
   - **k.** Using a calculator, calculate <reading>/<timebase nominal value> to get the error as a ratio.
   - **l.** Record the frequency error ratio in the test record in the appropriate location depending upon the installed instrument timebase option (Std, or Option MS, HS, or US).

Quantization Error

Equipment:

- Microwave Signal Generator
- Type K male to female cable
- Power Splitter, Type K connectors
- 2.92 male to SMA female connectors (Qty 2)
- SMA male to BNC male cables (Qty 2)
- SMA male to SMA male cable
- SMA female to SMA female adapter

Equipment Setup



Procedure

1. Connect the equipment as shown.
2. Power on the instruments. Wait at least 20 minutes.
3. On the Microwave Signal Generator:
   a. Set the Output to **OFF**.
   b. Set the frequency to **300 MHz**.
   c. Set the output level to at least **+10 dBm**, not to exceed **+13 dBm (2.8 V_{p-p})**.
   d. Turn the Output **On**.
4. On the Tektronix FCA/MCA3X00 Series instrument:
   a. Push the **Meas** button and select **Time > Time Interval > A to B**.
   b. Push the **Settings** button, select **Meas Time**, enter **20 ms**, and push the **Save/Exit** button to return to the main screen.
   c. Push the **Input A** button.
   d. Set the input coupling to **DC**.
   e. Set slope to **Falling**.
   f. Set the input impedance to **50 Ω**.
   g. Set the input attenuator to **1X**.
   h. Set the Trigger mode to **Man**.

i. Push the **Trig** menu button, enter **0.0 V**, and push the **Save/Exit** button to return to the main screen.

j. Push the **Input B** button.

k. Repeat steps d through i to set the Input B parameters.

l. Push the **Value** button.

5. On the Tektronix FCA/MCA3X00 Series instrument:

a. Push the **Hold/Run** button to put the FCA/MCA3X00 Series instrument into Hold mode.

b. Push the **Value** button. This runs a single acquisition and returns to Hold mode.

c. Enter the time interval measurement value in the table below.

1.	**6.**
2.	**7.**
3.	**8.**
4.	**9.**
5.	**10.**

e. Repeat parts b and c nine times, for a total of 10 entries in the table above.

f. Add all values together, and divide by 10 to get the mean (A1). For each measurement, put into the A2 table the value (measurement - MEAN). For each measurement in the A2 table, Put into the A3 table the value A3=A2^2. Sum all of the A3 values together and take the square root (Quantization error)

A1 Value _______________

A2 Value

1	6
2	7
3	8
4	9
5	10

A3 Value

1	6
2	7
3	8
4	9
5	10

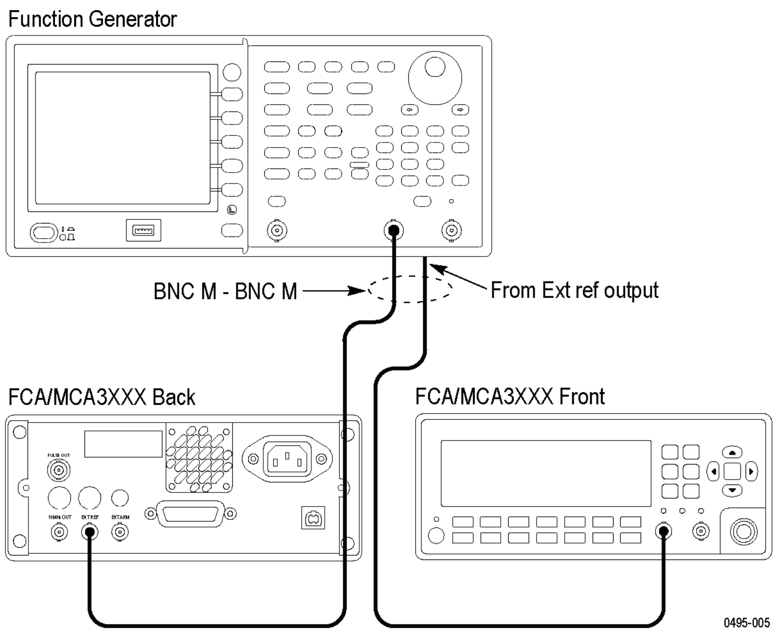
Quantization error _______________

External Reference Clock Frequency and Sensitivity

Equipment:

- Function Generator
- BNC male to BNC male 50 Ω cable (24 inches) (Qty 2)

Equipment Setup



Procedure

1. Connect the equipment as shown.
2. Power on the instruments. Wait at least 20 minutes.

NOTE. *To ensure that the external timebase is being used, the frequency is intentionally offset. If the measured value does not agree with the expected value shown in the procedure, the signal applied to the DUT External Reference input may not be adequate.*

---

3. Set the Function Generator to produce a 0.999999 MHz sine wave at 0.25 V_{p-p}. On an AFG3251, use these steps:
   a. Push the **Sine** function button.
   b. Push the **Frequency/Period** menu button.
   c. Push the **Frequency** menu button.
   d. Use the keypad and menu buttons to set the output frequency to **0.999999 MHz**.

   e. Push the **Top Menu** button.
   f. Push the **Amplitude/Level** menu button.
   g. Push the **Amplitude** menu button.
   h. Use the keypad and menu buttons to set the output level to **0.25 Vpp**.
   i. Push the **Top Menu** button.
   j. Push the Output **ON** button to turn on the signal (On button turns green).

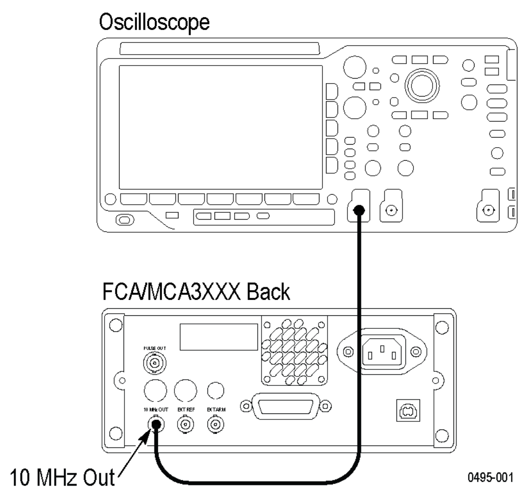
4. On the Tektronix FCA/MCA3X00 Series instrument:
   a. Push the **Meas** button and select **Freq > Freq > A**.
   b. Push the **Settings** button, select **Meas Time**, enter **20 ms**, and then push the **Save/Exit** button to return to the main screen.
   c. Push the **Input A** button.
   d. Set the input coupling to **DC**.
   e. Set the input impedance to **1 MΩ**.
   f. Set the input attenuator to **10X**.
   g. Set the Trigger mode to **Man**.
   h. Push the **Trig** menu button, enter **1.4 V**, and then push the **Save/Exit** button to return to the previous screen.
   i. Verify that Filter is set to **Off**.
   j. Push the **Settings** button, select **Timebase Ref**, and then select **Ext**.
   k. Push the **Save/Exit** button.
5. Push the **Analyze** button to display the Numeric Analysis screen (with Std in lower right corner). (See Figure 1 on page 28.)
6. Enter measured frequency in the test report. (It should be close to 10.000010 MHz.)
7. Change the Function Generator frequency to 4.999995 MHz.
8. Enter measured frequency in the test report. (It should be close to 10.000010 MHz.)
9. Change the Function Generator frequency to 9.999990 MHz.
10. Enter measured frequency in the test report. (It should be close to 10.000010 MHz.)
11. Set the FCA/MCA3000 Series instrument to the factory defaults; push **User Opt > SaveRecall > Setup > Recall Setup > Default**.

10 MHz Out Amplitude

Equipment:

- Oscilloscope
- BNC male to BNC male Cable (24 inches)

Setup



Procedure

1. Connect the as shown.
2. Power on the instruments. Wait at least 20 minutes.
3. Set the Oscilloscope:
   a. Set channel 1 to **50 Ω** input, **500 mV/div**, and **DC coupled**.
   b. Set the timebase to **40 nS/div**.
   c. Adjust the trigger for a stable display.
4. Verify that the signal amplitude on the oscilloscope is ≥1 V_{RMS} (≥2.828 V_{P-P}). Enter this amplitude in the test record.
5. Verify that the output frequency is approximately 10 MHz. At 40 nS/Div two complete sine waves should have a duration of 5 divisions.

   Note that this frequency measurement is not sufficient to assure accuracy of the timebase, since the oscilloscope's timebase is less accurate than the counter. However, it provides confidence that the output is actually 10 MHz.

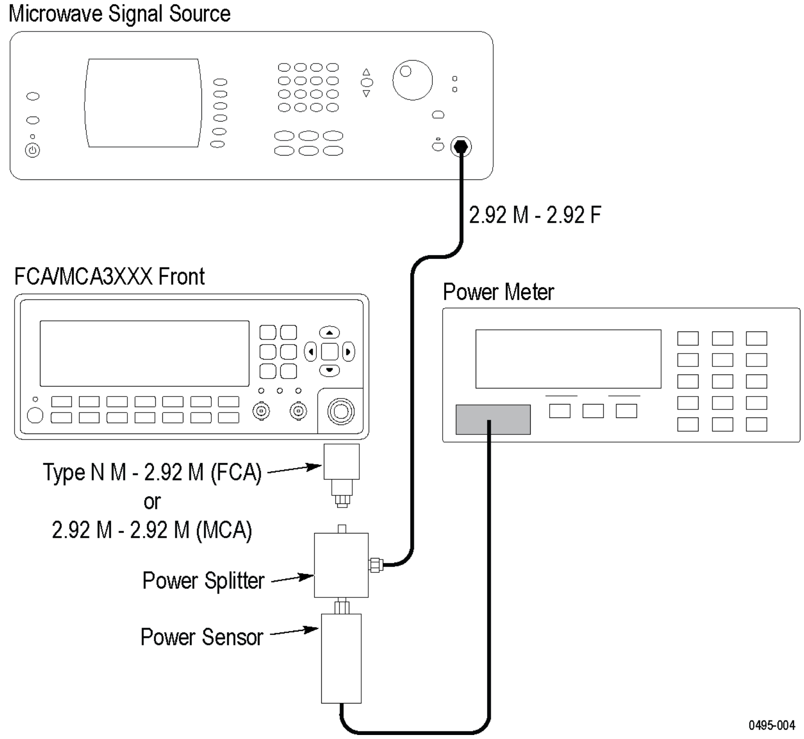
Channel C (if installed) Input Impedance

Equipment:

- Microwave Signal Source
- Power Meter with sensor

- Power Splitter
- 1m cable with 2.92 mm male and female connectors
- Type N male to 2.92 male adapter (FCA3X00 Series)
- 2.92 male to 2.92 male adapter (MCA3000 Series)

Setup



1 If installed.

Procedure

1. Connect the as shown:
   - **FCA3100 Series instruments:** Attach the type N to 2.92 mm adapter to the FCA3100 Series instrument. Do ***not*** connect the power splitter to it for the initial steps in the procedure. The power splitter is connected to the adapter in Step 5.

   MCA3000 Series instruments: Attach the 2.92 mm male to 2.92 mm male adapter to the MCA3000 Series instrument. Do ***not*** connect the power splitter to it for the initial steps in the procedure. The power splitter is connected to the adapter in Step 5.
2. Power on the instruments. Wait at least 20 minutes. (See page 24, *Instrument Warmup Requirements*.)
3. Set the Microwave signal source to output **+7 dBm** at **500 MHz**.

4. Set the Power Meter to measure power at roughly **+1 dBm** relative to the input that it currently is receiving. Use these steps to set a Rohde & Schwarz NRVS Power Meter:

   a. Push **W<->dBm** twice, to display dBm.

   b. Verify that the signal is approximately +1 dBm, and log the result in the test record as *Relative*, under Input Impedance.

   c. Push **Unit**.

   d. Push **REL**, under the display.

   e. Push **ΔdB** under the display.

   f. Press **STO** under the display.

5. Connect the power splitter to the adapter on the Tektronix FCA3100 or MCA3000 Series instrument.

NOTE. *If the specified adapter is not available, it is important that the splitter port attached to the Tektronix FCA3100/MCA3000 Series instrument has no adapters attached. The goal is to have the minimum possible load on that port of the splitter for the first measurement. Load capacitance should be minimized. Adapters present an unterminated stub.*

NOTE. *The length between the Type N port and the splitter must be minimized. Any cable length between the splitter and the Tektronix FCA3100/MCA3000 Series instrument is likely to cause unexpected errors during the second measurement.*

---

6. Enter the relative power measured by the power meter, with the splitter connected to the Tektronix FCA3100/MCA3000, in the Test Report:

   - FCA3003, FCA3103, MCA3040: Between -5.61 dB (.524) and -1.84 dB (.809) to assure a VSWR of 2.5.
   - FCA3020, FCA3120, MCA3027: Between -5.09 dB (.556) and -2.19 dB (.777) for a VSWR of 2.0.
   - VSWR of 1:1 is at a ratio of -3.52 dB (.667).

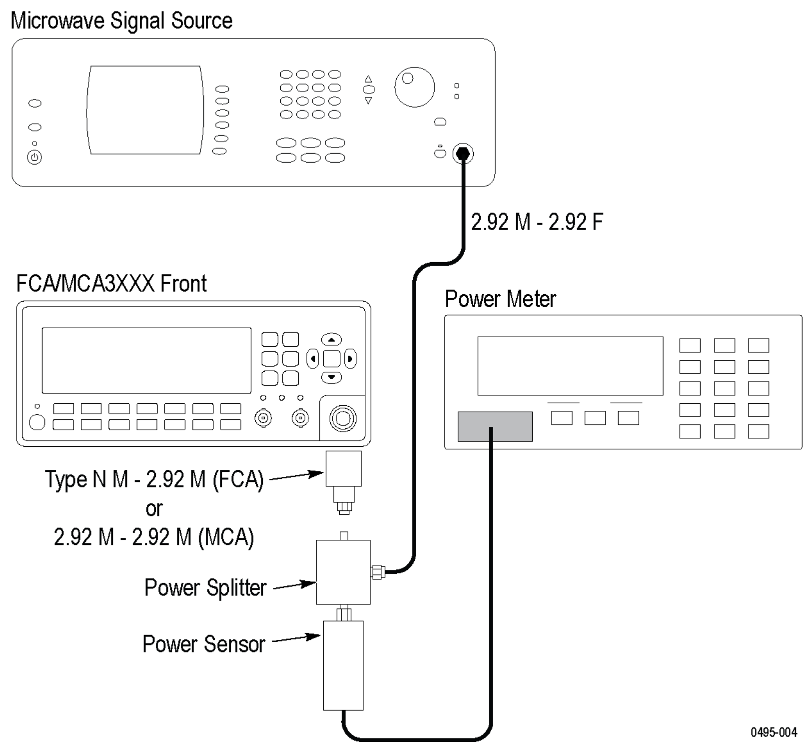
Channel C (if installed) Frequency Sensitivity

Equipment:

- Microwave Signal Source
- Power Meter with sensor
- 1 m cable with 2.92 mm male and female connectors.

- Type N male to 2.92 mm male adapter (FCA3100 Series)
- 2.92 mm male to 2.92 mm male adapter (MCA3000 Series)

Setup



Procedure

1. Connect the as shown. This is the same setup as the preceding step.
2. Power on the instruments. Wait at least 20 minutes. (See page 24, *Instrument Warmup Requirements*.)
3. On the Tektronix FCA/MCA3000 Series instrument, push the **Meas** button and select **Freq** > **Freq** > **C**.
4. Set the Microwave Signal Generator to output the first frequency listed below, for the Tektronix FCA/MCA3000 Series instrument being tested.
5. Adjust the Microwave Signal Generator output so that the Power Meter shows the amplitude listed for the frequency setting made in Step 4.
6. Enter **Pass** in the test record if the first four significant digits of the Tektronix FCA/MCA3000 Series frequency readout match the microwave signal generator's frequency. Enter **Fail** if the frequency readouts do not agree. Digits after the first 4 most significant do not matter.
7. Repeat steps 4 through 6 for the remaining frequencies shown for the instrument being tested.

Frequency	Amplitude
FCA3X03	
100 MHz	–21 dBm (~20 mV_{RMS})
300 MHz	–27 dBm (~10 mV_{RMS})
2.5 GHz	–21 dBm (~20 mV_{RMS})
3.0 GHz	–15 dBm (~40 mV_{RMS})
FCA3X20	
250 MHz	–21 dBm (~20 mV_{RMS})
500 MHz	–21 dBm (~20 mV_{RMS})
18 GHz	–27 dBm (~10 mV_{RMS})
20 GHz	–21 dBm (~20 mV_{RMS})
MCA30XX	
300 MHz	–33 dBm (~5 mV_{RMS})
18 GHz	–33 dBm (~5 mV_{RMS})
20 GHz	–29 dBm (~8 mV_{RMS})
27 GHz	–27 dBm (~10 mV_{RMS})
40 GHz	–23 dBm (~16 mV_{RMS})

Push the **User Opt** button, and then select **Save Recall** > **Recall Setup** > **Default** to return the instrument to the factory default settings.

• ***This completes the Performance Verification procedure*** •