Keysight Technologies

RF & Universal Frequency Counter/Timers Migration, Comparison, and Differences Guide

53200A Series (53210A, 53220A, 53230A)
531xxA Series (53131A, 53132A, 53181A)

Application Note

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Introduction

The Keysight Technologies, Inc. 53131A, 53132A, 53181A (531xxA) RF and universal frequency counters have long established the industry standard for best-in-class frequency and time measurements.

The 53210A, 53220A, and 53230A (53200A Series) counters offer a replacement for the 531xxA family, providing even more capabilities in the speed and accuracy that only frequency counters can provide. The 53200A Series also provides new and advanced capabilities for a broader variety of applications.

This document compares key capabilities, and highlights those areas where there are differences and advancements of note between the products.

53131A, 53132A, and 53181A to 53200A Series Product Replacement Guide

Table 1. Product replacement guide

53131A, 53132A, and 53181A counters/timers	New 53200A Series counter/timers
If you use these models:	**Now order this:**
53181A 225 MHz RF counter (10 digits/s) 1 channel with optional 2nd microwave channel	53210A 350 MHz RF counter (10 digits/s) 1 channel with optional 2nd microwave channel
53131A 225 MHz universal counter (10 digits/s, 500 ps) 2 channels with optional 3rd microwave channel	53220A 350 MHz universal counter (12 digits/s, 100 ps) 2 channels with optional 3rd microwave channel
53132A 225 MHz universal counter (12 digits/s, 150 ps) 2 channels with optional 3rd microwave channel	53220A 350 MHz universal counter (12 digits/s, 100 ps) or 53230A 350 MHz universal counter (12 digits/s, 20 ps) 2 channels with optional 3rd microwave channel
Options	
If you use this option:	**Now order this:**
001 Medium stability time base	N/A - TCXO time base comes standard in base models
010 High stability time base	010 Ultra-high stability OCXO time base
012 Ultra-high stability oven time base (53132A only)	010 Ultra-high stability OCXO time base
015 Add 1.5 GHz channel (BNC) (53181A only)	106 Add 6 GHz CW channel (Type N)
030 Add 3 GHz channel (BNC)	106 Add 6 GHz CW channel (Type N)
050 Add 5 GHz channel (Type N)	106 Add 6 GHz CW channel (Type N)
124 Add 12.4 GHz channel (Type N)	115 Add 15 GHz CW channel (Type N)
060 Baseband rear input in parallel with front input	201 Add rear panel parallel input for baseband channel(s)
061 Baseband rear input in parallel with front input, microwave input rear only	201 Add rear panel parallel input for baseband channel(s) 203 Move microwave channel to rear (SMA)
062 Baseband rear input in parallel with front input, microwave input front only	201 Add rear panel parallel input for baseband channel(s) NOTE: Default for microwave channels (Option 106 and 115) is front.

Specification Comparison

There are many factors to consider when looking to replace reliable instruments such as the 531xxA Series of frequency counters. Table 2 outlines some of the compatible features shared by the 531xxA Series and the 53200A Series. A complete comparison can be made using the data sheets for the respective frequency counters. These documents can be found under the document tab at www.keysight.com/find/frequencycounters

Table 2. Key specification differences

Specification	Keysight 531xxA Series (53181A, 53131A, 53132A)	Keysight 53200A Series (53210A, 53220A, 53230A)
Frequency bandwidth	225 MHz, 1.5 (53181A only), 3, 5, 12.4 GHz	350 MHz, 6, 15 GHz
Frequency resolution	10 digits/s (53181A, 53131A) 12 digits/s (53132A)	10 digits/s (53210A) 12 digits/s (53220A, 53230A)
Time interval resolution (single-shot resolution)	500 ps (53131A) 150 ps (53132A)	100 ps (53220A) 20 ps (53230A)
Memory	None	1 M reading internal memory USB flash
Speed	Transactional: 200 readings/s Readings to memory: N/A Timestamp: N/A	Transactional: 350 to 400 readings/s Readings to memory: – Frequency: up to 75,000 readings/s – Time interval: up to 90,000 readings/s Timestamp: up to 1 M readings/s
Timebase	XO (standard in all models) 3 OCXO options	TCXO (standard in all models) 1 OCXO option
Interfaces	GPIB, RS232 (print only)	LXI-C/LAN, USB, GPIB
Display and analysis	Vacuum florescent display Math and limit operations	Color graphical display Full integrated math, limits, statistics, graphs
Rack mount dimensions	212.6 mm (W) x 88.5 mm (H) x 348.3 mm (D) (2U x ½ width)	212.8 mm (W) x 88.3 mm (H) x 272.3 mm (D) (2U x ½ width)

Compatibility

There are many factors to consider when looking to replace reliable instruments such as the 531xxA Series of frequency counters. Table 3 outline some of the common features between the 531xxA Series and the 53200A Series.

Table 3. Compatibility summary

Attribute	Details
Functions and ranges	53200A Series is a superset of the 531xxA Series capabilities
Timebase	53200A Series comes standard with a timebase that is of equivalent performance to Option 001 on the 531xxA model counters
Measurement accuracy and resolution	53200A Series' specifications are equivalent or better with few exceptions
SCPI compatibility	We have taken extra care to ensure the 53200A Series works with SCPI programs that were written for the Keysight 531xxA Series while using the compatibility mode
Mechanical size	Height and width dimensions are the same
Accessories	Rack mount kits are compatible with both products
Manufacturing	Both counters are produced to the same rigorous quality standards and manufacturing process controls
Keysight service and support	Our international team is available to help you calibrate your counter or answer any questions about either instrument

Physical and Measurement Differences

There are also some differences and feature enhancements between the two series of counters as summarized in Table 4.

Table 4. Key attribute differences between the 531xxA Series and 53200A Series

Attribute	531xxA Series	53200A Series
Interface ports	GPIB and RS-232 printer	LAN, GPIB, and USB
Length	348.3 mm	272.3 mm
Connector location		Positions are different
Calibration		Uses different calibration procedures with different default password
Bandwidth	225 MHz (base channel)	350 MHz
Optional microwave channels	4 channels: 1.5, 3, 5, and 12.5 GHz	2 channels: 6 and 15 GHz
Connectors	Optional microwave channel: BNC	Optional microwave channel: N-type Rear option: SMA
Specification calculations		Different method used
Specification values	012 timebase option is slightly better than the OCXO option on the 53200A Series	Typically equal to or exceed 531xxA Series
Limit out capabilities	Provided via RS-232 hardware	Provided by software

Measurement Considerations and Improvements

To augment the data provided in earlier tables, the following sections discuss measurement considerations and improvements in greater detail.

Time interval resolution and accuracy

One of the key advances the 53200A Series provides is its industry-leading timing specifications. This measurement is often represented through a single shot specification. Single-shot timing represents how well the counter can resolve an event in time. It is most often associated with time interval measurements, but every counter measurement is a result of timing and accurate placement of the edge. So, the better the single-shot timing of a frequency counter, the better overall measurement performance of the counter. The single shot resolution for the 531xxA Series (53132A) is 150 ps, versus 20 ps for the 53200A Series (53230A).

Memory and measurement reading speed

There are several ways to consider the measurement speed on frequency counters; two of which are:

- Single measurement reading throughput: the time to take a single measurement and transfer from volatile reading memory over the I/O bus
- Block reading throughput: the time to take blocks of measurements into memory and when complete, transfer from volatile reading memory over the I/O bus

Typically, single measurement throughput is slower than block measurement throughput due to I/O processing/transfer overhead. The 531xxA frequency counters are single reading counters with no internal memory. In most applications, up to 200 readings per second is the typical single measurement reading speed on 531xxA counters. Depending on the I/O interface chosen (USB, LAN or GPIB), the single measurement throughput on the 53200A Series counters can have an optimized throughput of approximately 400 readings per second.

The reading throughput potential is substantially different when block reading capabilities are considered. With the built-in memory of 1 million readings on the 53200A Series counters, speeds increases to tens of thousands of readings per second. Again, the I/O interface chosen impacts the amount of overhead on the overall throughput capabilities. The 53200A Series data sheet outlines typical reading speeds by model (literature number 5990-6283EN).

Timebase comparisons

Table 5 describes and compares the timebases available with each series of counters. Typically, most timebases are compared based on their aging specification — either one month or one year. The 53200A Series comes standard with a timebase that is of equivalent performance to the Option 001 on the 531xxA model counters. There is one 53200A Series timebase option: Option 010 Ultra-high stability time base. Although both 53200A Series Option 010 and 531xxA Option 012 are ultra-high stability time bases, Option 012 has the better aging performance of the two.

Table 5. Comparison of timebases

Timebase	531xxA Series				53200A Series	
	Standard XO	Option 001 medium oven	Option 010 high oven	Option 012 (53132A only ultra-high oven)	Standard TCXO	Option 010 ultra-high stability OCXO
Aging						
24-hour, TCAL ± 1 °C		40 ppb (4×10^{-8})	0.5 ppb (5×10^{-10})	0.1 ppb 0.2 (1×10^{-10})		± 0.3 ppb (3×10^{-10})
30-day, TCAL ± 5 °C	0.3 ppm (3×10^{-7})	0.2 ppm (2×10^{-7})	15 ppb (1.5×10^{-8})	3 ppb (3×10^{-9})	± 0.2 ppm (2×10^{-7})	± 10 ppb (10×10^{-9})
1-year, TCAL ± 5 °C				20 ppb (2×10^{-8})	± 1 ppm (1×10^{-6})	± 50 ppb (50×10^{-9})
Temperature (typical)						
0 to 55 °C relative to 25 °C	5 ppm (5×10^{-6})	0.2 ppm (2×10^{-7})	2.5 ppb (2.5×10^{-9})	2.5 ppb (2.5×10^{-9})	± 1 ppm (1×10^{-6})	± 5 ppb (5×10^{-9})
TCAL ± 5 °C					± 0.5 ppm (5×10^{-7})	± 0.5 ppb (5×10^{-10})

53200A Series Option 010 is available on all models and has accuracy between that of 531xxA Options 010 (available on all models) and 012 (only available on the 53132A).

Like the 531xxA counters, the 53200A Series also accepts an external reference (1, 5, or 10 MHz) if higher timebase stability is required. Additionally, the 53200A Series offers an internal lithium ion battery pack and charger (Option 300) if use requires disconnecting the counter from power while maintaining timebase stability.

Connectivity and interfaces

The standard I/O connectivity on the 531xxA counters is GPIB. RS-232 is also available as a talk-only interface for printer support and can be set as a hardware limit out indicator to flag when a measurement drifts out of limits.

The 53200A Series offers 10/100/1000 LAN/LXI-C (Sockets and VXI-11 protocol), USB 2.0, and GPIB connectivity (Figure 1). If RS-232 output and hardware limit out capability is desired, it needs to be replicated via software control.

Figure 1. 53200A Series rear panel

Programming Compatibility and Differences

The new 53200A Series counters have a built-in emulation mode that enables the Keysight 531xxA Standard Commands for Programmable Instruments (SCPI) command set to be used with a 53200A Series counter. With 531xxA Series compatibility mode selected, all programming is through the counter's remote interface (LAN, USB, GPIB). The counter display responds according to the remote commands received. When in emulation mode, you get 53200A Series precision and measurement accuracy. The emulation mode is a SCPI language substitution (commands and syntax operation) to enable you to use existing programs. Note: Pressing any front panel key while in 531xxA compatibility mode returns the counter to 53200A Series mode.

This section lists those areas where 531xxA Series users might find differences in operation when using a 53200A Series counter. These differences are few, but documented in order to make it easier to verify programs.

Measurement Tip

Enabling compatibility mode

Compatibility mode on the 53210A/53220A/53230A counters is enabled using the following key sequence or SCPI command:

53210A:
Utility > System Setup > User Settings > SCPI Lang
SYSTem:LANGuage "53181A"

53220A/53230A:
Utility > System Setup > User Settings > SCPI Lang
SYSTem:LANGuage "53132A"

When enabled, the product will return the ID of the counter it is emulating.

With 531xxA Series' compatibility mode selected, all programming is through the counter's remote interface (LAN, USB, GPIB). The counter display responds according to the remote commands received. Pressing any front panel key while in 531xxA Series compatibility mode returns the counter to 53200A Series mode as prompted. Setting or changing to either mode requires the instrument to be restarted. Setting the compatibility mode programmatically causes an immediate reboot of the instrument.

When the 531xxA compatibility mode has been selected, most SCPI commands should execute semantically the same as the SCPI commands described in the Keysight 53181A and 53131A/132A 225 MHz Universal Counter Programming Guides available in the library section of each the product's web pages found at **www.keysight.com/find/frequencycounters.**

CALCulate subsystem

The 531xxA CALCulate1:IMMediate, CALCulate1: IMMediate:AUTO, CALCulate2: IMMediate, and CALCulate2: IMMediate:AUTO commands, which allowed recalculation of old measurements, are not supported.

Measurement instructions

The 531xxA READ?, FETCh?, and MEASure? commands returned a variable-length ASCII string whose number of digits depended on the actual measurement resolution. The 53200A Series will always return 15 digits.

The 531xxA READ:<function>? and FETch:<function>? commands do not allow data conversion from one function to another. <function> must match the currently-configured measurement function.

SENSe Subsytem—Trigger events

Hysteresis
The 53200A Series hardware has only two input hysteresis levels, compared to three on the 531xxA counters.

For 53131A/132A:
Sending the 53131A/132A SENSe:EVENt{1|2}:HYSTeresis 50 or 100 command enables noise rejection (INPut{1|2}:NREJect ON) in the 53220A/230A; SENSe:EVENt{1|2}:HYSTeresis 0 disables noise rejection.

For 53181A:
Sending the 53181A SENSe:EVENt:HYSTeresis 50 or 100 command enables noise rejection (INPut:NREJect ON) in the 53210A; SENSe:EVENt:HYSTeresis 0 disables noise rejection.

Reference levels for pulse width and duty cycle

The 53131A/132A allows you to set different reference levels for the rising and falling edges for pulse width and duty cycle measurements using the SENSe:EVENt{1|2}:LEVel subsystem commands. The 53220A/230A uses the same reference level for both edges. If you require different references levels for the two edges, you can accomplish this by using the time interval measurement function instead of pulse width or duty cycle.

The 53131A/132A models allowed the lower and upper reference values for rise and fall time measurements to be in different units (percent vs. voltage). The 53220A/230A models require the same units for both reference values (both must be percent, or both must be voltage).

Gate time resolution

The 53131A/53132A has different resolutions for long and short gate times and delays for the following commands:

CONFigure:TOTalize:TIMed
MEASure:TOTalize:TIMed?
SENSe:FREQuency:ARM:STOP:TIMer
SENSe:TINTerval:ARM:STOP:TIMer
SENSe:TINTerval:ARM:ESTOP:LAYer1:TIMer
SENSe:TOTalize:ARM:STOP:TIMe

The resolution for gate time and delay does not change based on value on the 53220A/230A models.

The 53181A has different resolutions for long and short gate times for the SENSe:FREQuency:ARM:STOP:TIMer command. The 53210A has the same, or better resolution regardless of the gate time.

External reference signals

The 53181A and 53131A can automatically adapt to external reference signals of 1 MHz, 5 MHz, or 10 MHz. The 53132A only accepts 10 MHz signals. The SENSe:ROSCillator: EXTernal:FREQuency? query measures and returns which frequency was present. The 53200A Series accepts 1 MHz, 5 MHz, or 10 MHz, but you need to specify via the SENSe :ROSCillator:EXTernal:FREQuency command which frequency is present. This command form is available in 53181A/53131A/53132A compatibility mode; the query form returns the programmed value, not a measured value.

The 53181A/53131A/53132A SENSe:ROSCillator:EXTernal:CHECk command controls whether the instrument detects and reports errors if the external reference signal is not present at the end of a measurement. The 53200A Series will always detect this condition and report errors. The 531xxA command is accepted by the 53200A Series, but has no effect on the instrument.

SCPI macros

The 531xxA SCPI macro capability is not supported in the 53200A Series, including the *DMC, *EMC, *EMC?, *GMC?, *LMC?, *PMC, MEMory:DELete:MACRo, and MEMory:FREE:MACRo? commands.

RS-232 commands

The 53200A Series does not include an RS-232 port, and does not support hard copy output. The associated HCOPy:CONTinuous and SYStem:COMMunicate:SERial subsystem SCPI commands of the 531xxA Series 53131A/132A are accepted by the 53200A Series, but have no effect on the instrument.

Diagnostics and calibration

Due to significant hardware differences between the 53200A Series and the 531xxA counters, the calibration procedure and some of the CALibration subsystem commands are different. The 531xxA DIAGnostic subsystem commands are not supported.

Front panel operation

Given the complete redesign of the front panel, the 531xxA SYSTem:KEY and SYSTem:KEY:LOG? commands, which simulate the pressing of a front-panel key, are not supported.

Input protection

When 50 Ω input impedance is selected, the 531xxA and the 53200A Series specifications limit the input voltage to 5 Vrms to prevent damage to the input termination resistor. If higher voltage is present, 53200A Series will automatically switch the input impedance to 1 MΩ to prevent damage; the 531xxA counters do not have this protection capability. If the automatic protection is triggered on the 53200A Series, you will need to send the 53131A/132A INPut{1|2}:IMPedance SCPI command to reset the input impedance to 50 Ω (on 53181A: INPut:IMPedance).

Additional 53200A Series Enhancements

In addition to differences noted previously, there are additional enhancements made to the 53200A Series that provide capabilities unavailable in Keysight legacy frequency counters. These attributes enhance the usability and efficiency of the 53200A Series.

User interface

The 53200A Series frequency counters offer an intuitive user interface with a large color graphical display.
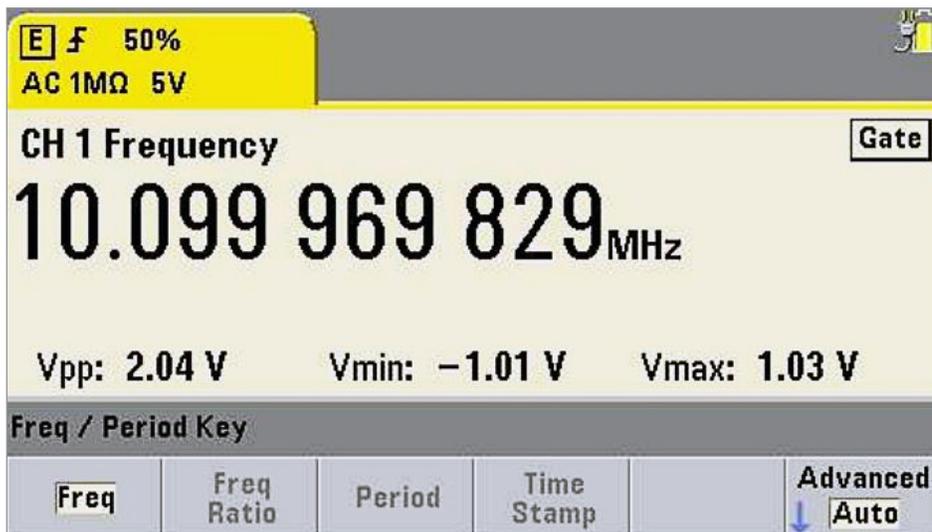

Figure 2. Input settings such as trigger threshold, input impedance, and input range can be easily viewed from the front panel
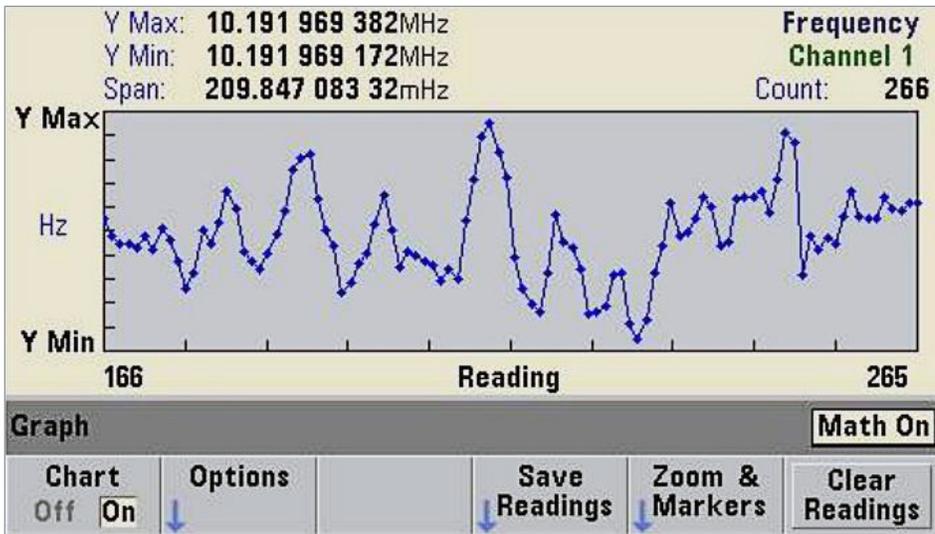
Figure 3. Graphics functions compute and display histograms and trend charts of real time measurement data
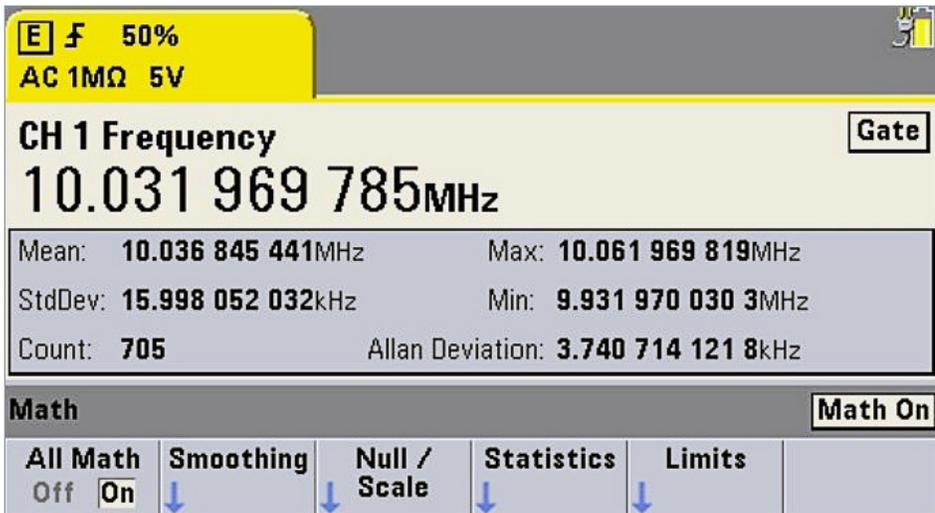

Figure 4. Built-in statistics, math, and limit functions are readily available
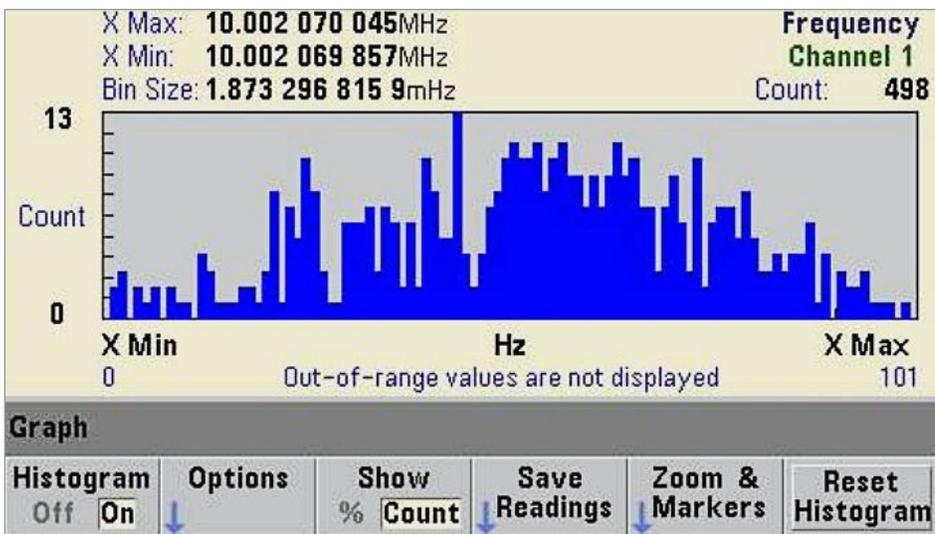

Figure 5. The front panel datalogging function enables logging and analysis of up to one million readings. Front panel USB flash memory access makes storing measurement results and analyzing via your PC fast and simple

Additional 53200A Series capabilities

The 53230A model also provides new measurement capabilities:

– Continuous, gap-free measurements for true Allan Deviation computations. In this mode, all samples are taken within a single gate open/gate close sequence and computed back-to-back. There is no gap between readings that otherwise occurs with the per sample gate open/gate close sequence
– Time stamp measurements to record events (edges) as they occur on the counter input channels. Timestamp measurement speed is up to one million samples per second
– Microwave burst/pulse measurements are available on optional channel 3 with the pulse/burst measurement software (Option 150). Measurements include: Burst carrier frequency, pulse repetition interval (PRI), pulse repetition frequency (PRF), positive (on) width, and negative (off) width

More Information

For additional specifications on the new 53200A Series Frequency Counter/Timers, please refer to: Keysight 53200A Series RF/Universal Counter/Timers, Data Sheet, literature number 5990-6283EN[1].

View video demonstrations of the new 53200A Series frequency counter features and applications: **www.keysight.com/find/53200videos**

For additional details and product literature on Keysight frequency counters, please visit: **www.keysight.com/find/counters**
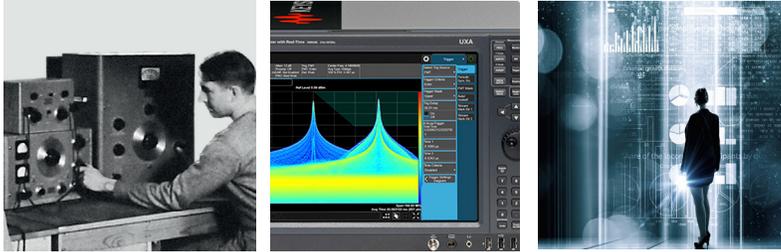
For additional 53131A, 53132A, 53181A frequency counter migration information, please visit: **www.keysight.com/find/nextgencounters**

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1. Specifications listed in the 53200A Series datasheet are ISO 17025-compliant. Note that 53131A, 53132A and 53181A specifications are not ISO-17025 compliant.

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