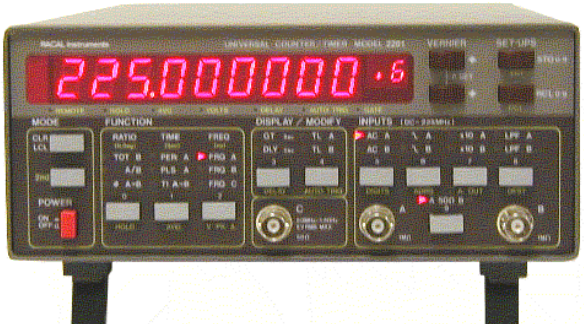
Racal Instruments
http://www.racalinstruments.com

PRODUCT INFORMATION

225 MHz Universal Counter/Timer Model 2201



- **225 MHz Frequency Measurement and 10 ps Averaged Time Interval Resolution**
- **Optional High-Stability Oscillator**
- **Optional Frequency Measurement to 1.3 GHz and OCXO**
- **Comprehensive Arming Capabilities and Trigger Control**
- **10 mV Trigger Resolution**
- **9 Automatic Measurements, Including Peak Signal Amplitude**

The Model 2201 is a high-performance, 2-channel, 225 MHz Universal Counter/Timer for applications from R&D benchtop to Automatic Test Equipment. The module offers nine automatic measurement functions and contains an optional 1.3 GHz third input available for RF requirements.

Brief Description
The 2201 offers nine automatic measurement functions:

- Frequency
- Period
- Time Interval
- Time Interval Delay
- Pulse Width
- Frequency Ratio Channel A to B
- Totalize
- Phase
- Peak Signal Voltage

High-Performance Trigger
The manual trigger mode is programmable from -5.1 V to + 5.1 V (-51 V to + 51 V in X10 mode) with an exceptional resolution of 10 mV (100 mV in X10 mode). An automatic trigger mode is also available covering the frequencies from 100 Hz to 150 MHz.

Automatic Attenuation Selection
Automatic trigger mode automatically switches attenuator settings if the input signal exceeds 5.1 Vpk-pk.

DVM Measurements
Automatic triggering establishes the peak voltages for setting trigger points. Users employ this feature to measure peak voltage levels.

Individual Channel Filtering
The 2201 contains an independent 100 kHz low-pass filter on each channel to reduce input stage sensitivity when making low-frequency measurements.

High-Stability Time Base
Users may improve stability by using an external clock or one of the two optional internal high stability time bases. The internal time base options are:

- TCXO: Standard
- OCXO: Option 11

Optional Analog Output
Option 08 (Analog Output) provides a high-accuracy source to drive devices like chart recorders. This option is especially useful in measuring and recording the aging and temperature stability of devices like oscillators and Voltage to Frequency (V-F) converters.

Flexible Gate Time and Delay Time Control
The Model 2201 allows fine control of gate-time and delay-time settings with 46 pre-defined times ranging from 100 µs to 10 seconds. In addition, gate or delay may be set to any value between 100 µs and 1000 seconds using an external input.

2201 SPECIFICATIONS

AUTOMATIC FUNCTIONS

Frequency
- Channels A & B: DC to 225 MHz
- Channel C (Option 41): 50 MHz to 1.3 GHz
- Accuracy: ± (Resolution ± Timebase Error × Freq)
- Resolution ≤ 10 MHz: (± LSD ± [1.4 x TrigError + 2ns] × Freq) /GateTime
- Resolution > 10 MHz: ± LSD
- LSD ≤ 10 MHz: (40ns / Gate Time) x Freq.
- LSD > 10 MHz: 4 / Gate Time)

Period A, Pulse Width A, Time Interval A to B
- Range: 10 ns to 10,000 s
- Accuracy: ± Resolution ± (TimebaseError × Time) ± TrigLevelTimingError± 2 ns
- Resolution: ±1 LSD ± StartTrigError ± StopTrigError
- LSD (Time < 100 s): 100 ns
- LSD (Time > 100 s): 5×10^{-9} × Time

Period A (Averaged)
- Range: 8 ns to 10 s
- Accuracy: ± Resolution ± TimebaseError x Period
- Resolution: ± 1 LSD ± (1.4 × TrigError + 2 ns) × Period / GateTime
- LSD: 40 ns × Period / GateTime
- Number of Periods Averaged: N =GateTime / Period

Pulse A, Time Interval A to B (Averaged)
- Range (Pulse Width A): 5 ns to 10 s
- Range (T.I. A to B): 0 ns to 10 s
- Accuracy: ± (Resolution ± TrigError) / $\sqrt{N}$± TimebaseError x Time ± 2ns
- Resolution: ± 1 LSD
- LSD: 50 ns /$\sqrt{N}$
- Dead Time Stop to Start (Min.): 20 ns
- Number of Samples Averaged: N =GateTime × FreqA

Phase A to B (Averaged)
- Phase Range: 0 to 360° × (1 – 20 ns ×FreqA)
- Frequency Range: 0.1 Hz to 25 MHz
- Accuracy: ± Resolution ± 2 ns x FreqA x 360° ± (TrigError x FreqA x 360°) /$\sqrt{N}$
- Resolution: ± 1 LSD
- LSD: 25 ns x 360° x (1+ $\sqrt{N}$)/ GateTime or 0.01°, whichever is greater
- Number of Cycles Averaged: N=GateTime x FreqA
- Minimum Amplitude: 100 mVrms sine wave

Time Interval Delay
(Delays Start of Time Interval Measurements.)
- Range (Internal): 100 µs to 10 s
- Range (External): 100 µs to 10,000 s

Frequency Ratio
(Channel A to Channel B)
- Channel A Range: 0.1 Hz to 225 MHz
- Channel B Range: 0.1 Hz to 125 MHz
- Accuracy & Resolution: ± (LSD ± TrigErrorB x Ratio) / GateTime
- LSD: 4 × Ratio / (FreqA × GateTime)

Totalize (Channel B by Channel A)
- Frequency Range: 0 to 100 MHz
- Events: 0 to 10^{16}-1
- Start/Stop Control: Channel A
- Accuracy: ± (PulseRepRateB × TrigError A) / TotalCountsB
- Resolution: 1 LSD
- LSD: 1 count
- Dead Time (Stop to Start): 20 ns

Peak Signal (Maxima or Minima)
- Frequency Range: 40 Hz to 10 MHz
- Dynamic Range: 280 mVpk-pk to 51 Vpk-pk
- Accuracy: ± Resolution ± (10% of Vpk-pk) ± 35m V
- Resolution: 10 mV (× Atten)

INPUT CHARACTERISTICS

(Input Channels A and B)

Frequency Range (DC Coupling)
- DC to 225 MHz

Frequency Range (AC Coupling)
- 1 MΩ: 30 Hz to 225 MHz
- 50 Ω: 1 MHz to 225 MHz

Low-Pass Filter (Selectable)
- 100 kHz BW, nominal

Selectable Input Features
- Impedance: 50 Ω or 1 MΩ
- Coupling: AC or DC
- Attenuation: ×1 or ×10
- Trigger Slope: + or –

Sensitivity (Sine Wave, ×1 Atten)
- < 100 MHz: 35 mVrms
- < 225 MHz: 50 mVrms

Sensitivity (Pulse, 5 ns Width, ×1 Atten)100 mVpk-pk

Dynamic Range (x1 Atten.)
- < 100 MHz: 34 dB (100 mVpk-pk to 5 Vpk-pk)
- < 225 MHz: 24 dB (150m Vpk-pk to 2.5Vpk-pk)

Damage Level (AC or DC)
- 50 Ω: 5 Vrms
- 1 MΩ, DC to 2 kHz (× Atten): 200 V (DC + peak AC)
- 1 MΩ, 2 kHz (× Atten) to 100 kHz: 4 x 10^5 Vrms . Hz x Atten/Freq
- 1 MΩ, > 100 kHz: 5 Vrms (× Atten)

INPUT CHARACTERISTICS

(Option 41: Input Channel C)

Frequency Range
50 MHz to 1.3 GHz

Input Impedance
50 Ω, nominal

Coupling
AC

Sensitivity (Sine Wave)
≤ 1.0 GHz: 25 mVrms
≤ 1.3 GHz: 50 mVrms

Dynamic Range
≤ 1.0 GHz: (25 mV to 1 Vrms) 32 dB
≤ 1.3 GHz: (50 mV to 1 Vrms) 26 dB

Damage Level
DC to 100 kHz: 15 V (DC + peak AC)
100 kHz to 1.3 GHz: 5 Vrms

GATE AND DELAY TIME

Modes
Internal Gate: Programmable
External Gate: Rear Panel BNC (except TI, PW, and Totalize)
Internal Delay: Programmable (TI only)
External Gate: Rear Panel BNC (TI only)

Internal Range (Gate & Delay)
100 µs to 10 s or one period of the input

Internal Resolution (Gate & Delay)
≤ 1 ms: 100 µs
≤ 10 ms: 1 ms
≤ 100 ms: 10 ms
≤ 1 s: 100 ms
≤ 10 s: 1 s

External Gate Time Range
100 µs to 1000 s

External Delay Range
100 µs to 1000 s

External Gate Delay
< 10 µs

10 MHz TIMEBASE CHARACTERISTICS

Standard TCXO
Aging Rate: 0.1 ppm/month
Temperature Stability: 1 ppm, 0° C to 40° C
Line Voltage: 0.1 ppm, 10% change (short term)

Optional OCXO (Option 11)
Accuracy: 0.01 ppm
Temperature Stability: 0.1 ppm, 0° C to 60° C
Aging Rate: 0.1 ppm/year
Warm-up Time: 0.1 ppm in 3 min.

External Frequency Standard Input
Rear Panel BNC

TRIGGERING CHARACTERISTICS

General (Manual or Autotrigger)
Range: ±5 V (× Atten), programmable
Accuracy: ± 3% of TrigLevel ± 35 mV (× Atten)
Resolution: 10 mV (× Atten)

Trigger-Level Outputs
Accuracy: ± 50 mV ± 5% of TrigLevel

Auto Trigger
Range (DC & 1 MΩ, AC): 100 Hz to 150 MHz (Usable to 225 MHz)
Range (50 Ω, AC): 1 MHz to 150 MHz (Usable to 225 MHz)
Minimum Amplitude: 100 mVrms (280 mVpk-pk)

Auto Attenuation
Mode: Automatically enabled in Autotrigger mode, peak > ±5.1 V or when the difference between maximum and minimum peaks exceeds 5.1 V.

External Arming
Operation: Arms the instrument when set to HOLD mode
Trigger Delay: < 50 µs
Minimum Pulse Width: 10 µs

PANEL I/O

Front Inputs
Channel A: BNC, 50 Ω or 1 MΩ
Channel B: BNC, 50 Ω or 1 MΩ
Channel C (Option 41): BNC, 50 Ω

Front Inputs
External Arm/Gate/Delay: BNC, 1 kΩ
External Frequency Standard: BNC, 10 MHz, TTL

Rear Outputs
Frequency Standard: BNC, 10 MHz, > 2 V
Trigger Level Outputs: Terminals, 1 kΩ

OPTIONAL FEATURES

Option 08: Analog Output
Range: 0 to 9.99 V
Tracking: Any 3 consecutive digits
Normal: Output proportional to Digits
Offset: Offset added to output
Offset Range: 0-9 V, 1 V resolution
Accuracy and Nonlinearity: ±2 mV
Output Impedance: 1 kΩ
Settling Time: 1 ms after measurement end

Option 11: OCXO 10 MHz Reference
Front Panel Output: BNC
Specifications: Per Timebase Specification

Option 41: 1.3 GHz Input C
Frequency Range: 50 MHz to 1.3 GHz
Specifications: Per Input Characteristics

Option 60A: Rack Mount Kit
For 19" Rack Mounting

GPIB INTERFACE DATA

Programmable Features
All front panel controls except POWER switch

IEEE 488.1 Support
Multiline: DCL, LLO, SDC, GET, GTL, UNT, UNL, SPE, SPD
Uniline: IFC, REN, EOI, SRQ, ATN
Interface: SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0, E1

Data Formatting
Measurements (with prefix): 18 ASCII characters plus terminator
Measurements (without prefix): 14 ASCII characters plus terminator
Gate/Delay Time & Trigger Level (with prefix): 9 ASCII characters plus terminator
Gate/Delay Time & Trigger Level (without prefix): 5 ASCII characters plus terminator

Address Selection
Via front panel control, address is stored in a non-volatile memory.

GENERAL

Display Rate
Normal: 4 Readings/second
Fast: 27 Readings/second

Display
Digits: 9 for mantissa, 2 for exponent
Gate: LED lights when gate is open

Non-Volatile Setups
Including: Trigger levels, gate/delay time, input conditioning and measurement rate
Storage Life: 5 years

Drivers
LabVIEW, LabWindows/CVI

Power Requirements
115/230 V_{rms} ±10%, 48-63 Hz, 40 W max

Voltage Range Selection
Rear panel switch

Accessories Furnished
Power Cord, User's Manual, Drivers

ENVIRONMENTAL

Temperature
Operating: 0° C to 40° C, 0 to 80% RH
Storage: -25° C to 65° C

Warm-up
1 hour to rated accuracy and stability

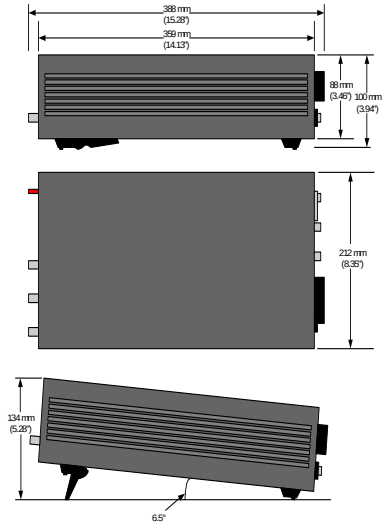
Weight
8.8 lbs. (4 kg)

Dimensions
3.43" H x 8.27" W x 15.35" D

Workmanship Standards
Conforms to IPC-A-610D

EMC (Council Directive 89/336/EEC)
EN55011, Group 1, Class A
EN50082-1, IEC 801-2,3,4

Safety (Low-Voltage Directive 73/23/EEC)
IEC1010-1, UL3111-1, CSA 22.2 #1010



DEFINITIONS OF TERMS

LSD:
Unit value of least significant digit, rounded as follows: 1 to < 5 Hz -> 1 Hz, 5 ns to 10 ns > 10 ns, etc.

Trigger Error (TrigError)**:**

$$\frac{\sqrt{(e_i^2 + e_n^2)}}{S_i}$$

where,

e_i is the rms noise voltage of the counter's input channel (250µV, typical)

e_n is the rms noise voltage of the input signal in a 225MHz bandwidth

S_i is the input slew rate at the trigger point

TimebaseError (TimeBaseError)**:**
Maximum fractional frequency change in the timebase due to all errors, e.g., aging, temp., line voltage, etc.

Trigger-Level Timing Error (TrigLevelTimingError):

$$\frac{18\ mV}{S_{i\ @\ start}} - \frac{18\ mV}{S_{i\ @\ stop}}$$

External Arming Trigger Delay:
Delay from the positive going slope of the gating signal to the internal gate open signal.

External Gate Delay:
Delay from the positive going slope of the gating signal to the internal gate open signal.

Dead Time:
Minimum time between measurement which the counter is busy processing and the next measurement. During dead time, the counter will not respond to any input transition.

ORDERING INFORMATION		
Model	**Description**	**Part Number**
2201	225 MHz Universal Counter/Timer (GPIB, TCXO)	407743-000
2201 w/ Option 11	225 MHz Universal Counter/Timer (GPIB, OCXO)	407743-001
2201 w/ Option 8	225 MHz Universal Counter/Timer (GPIB, TCXO, Analog Output)	407743-010
2201 w/ Option 8 and 11	225 MHz Universal Counter/Timer (GPIB, OCXO, Analog Output)	407743-011
2201 w/ Option 41	1.3 GHz Universal Counter/Timer (GPIB, TCXO)	407743-100
2201 w/ Option 41 and 11	1.3 GHz Universal Counter/Timer (GPIB, OCXO)	407743-101
2201 w/ Option 41 and 8	1.3 GHz Universal Counter/Timer (GPIB, TCXO, Analog Output)	407743-110
2201 w/ Option 41, 8, and 11	1.3 GHz Universal Counter/Timer (GPIB, OCXO, Analog Output)	407743-111
Option 60A	19" Rack Mounting Kit	407745

CE The CE Mark indicates that the product has completed and passed rigorous testing in the area of RF Emissions, Immunity to Electromagnetic Disturbances and complies with European electrical safety standards.

Racal Instruments, Inc., 4 Goodyear St., Irvine, CA 92618-2002. Tel: (800) RACAL-ATE, (800) 722-2528, (949) 859-8999; FAX: (949) 859-7139
Racal Instruments Ltd., 480 Bath Road, Slough, Berkshire, SL1 6BE, United Kingdom. Tel: +44 (0) 1628 604455; FAX: +44 (0) 1628 662017
Racal Systems Electronique S.A., 18 Avenue Dutartre, 78150 LeChesnay, France. Tel: +33 (1) 3923 2222; FAX: +33 (1) 3923 2225
Racal Systems Elettronica Srl, Strada 2-Palazzo C4, 20090 Milanofiori Assago, Milan, Italy. Tel: +39 (0)2 5750 1796; FAX +39 (0)2 5750 1828
Racal Instruments GmbH, Technologiepark Bergisch Gladbach, Friedrich-Ebert-Strasse, D-51429 Bergisch Gladbach, Germany. Tel: +49 2204 8442 00; FAX: +49 2204 8442 19
Racal Australia Pty Ltd., 3 Powells Road, Brookvale, NSW 2100, Australia. Tel: +612 9936 7000; FAX: +612 9936 7036