# EDU33210 Series
# 20 MHz Function/Arbitrary Waveform Generators

## EDU33210 Series Function/Arbitrary Waveform Generators

The Keysight EDU33210 Series function/arbitrary waveform generators offer the standard signals and features you expect — such as modulation, sweep, and burst. It also provides features that give you the capabilities and flexibility you need to get your job done quickly, no matter how complex. An intuitive, information-packed front-panel interface enables you to easily recall where you left off when your attention is focused elsewhere. And that is just the beginning.

## Features

- Use the signature 7-inch color display for a simultaneous parameter set up, signal viewing, and editing
- Get six built-in modulation types and 17 popular waveforms to simulate typical applications for testing
- Acquire 16-bit arbitrary waveform capability with memory up to 8 M samples per channel
- Begin using the USB and LAN IO interface for remote connectivity
- Receive Keysight's PathWave BenchVue software to enable PC control



**Keysight EDU33211A**
20 MHz, single-channel function/arbitrary waveform generator

**Keysight EDU33212A**
20 MHz, dual-channel function/arbitrary waveform generator

# Simple set up and operation

The 7-inch wide video graphics array (WVGA) color display gives you both the waveform setting and other parameters in one view. The EDU33212A 20 MHz dual-channel function/arbitrary waveform generator can simultaneously display both channels' waveform information. Color-coded keypads along with display and output connectors help you prevent set up and connection errors.

The EDU33210 Series 20 MHz function/arbitrary waveform generators ship standard with USB and LAN connectivity, making it easy for remote access and control. It supports operation using standard commands for programmable instruments (SCPI) language, interchangeable virtual instruments (IVI) driver, web browser, or Keysight's Pathwave BenchVue software.

The EDU33210 Series 20 MHz function/arbitrary waveform generators feature a built-in USB memory port enabling you to store setup parameters with a USB flash drive. This feature maximizes efficiency when you need to restore the same setup into all the function/arbitrary waveform generators in your lab. It also enables you to load the arbitrary waveform signal to the function generator quickly.

# Modulation and built-in waveforms

The EDU33210 Series 20 MHz function/arbitrary waveform generators has 17 built-in arbitrary waveforms. It comes with common waveforms — sine, square, ramp, triangle, pulse, PRBS, DC, and Gaussian noise; see Figures 1 and 2. It has specialty waveforms such as cardiac, exponential fall, exponential rise, Gaussian pulse, haversine, Lorentz, D-Lorentz, negative ramp, and sinc; see Figures 3 and 4. The six built-in modulations are AM, FM, phase modulation (PM), frequency-shift keying (FSK), binary phase shift keying (BPSK), and pulse width modulation (PWM).

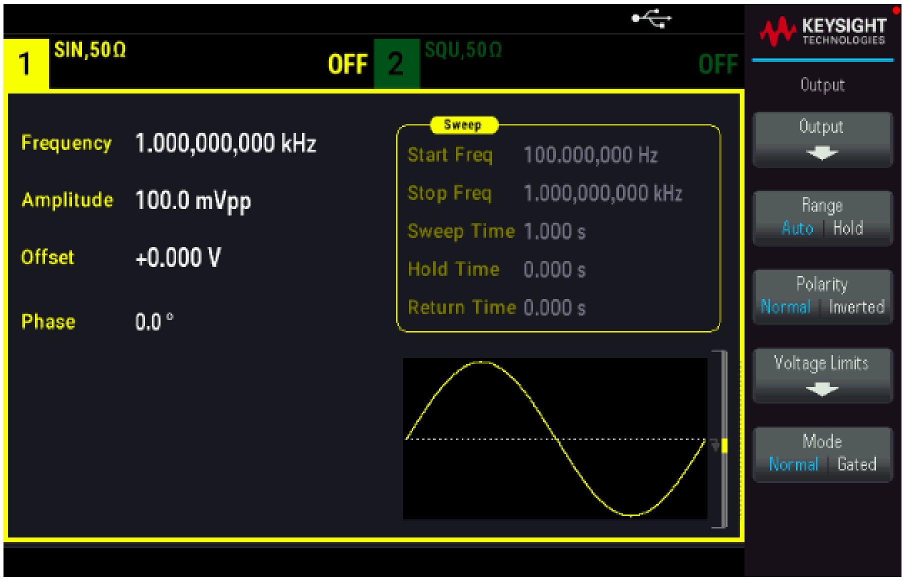


**Figure 1.** Standard since wave and setting


**Figure 2.** Dual-screen display of standard sine and square wave

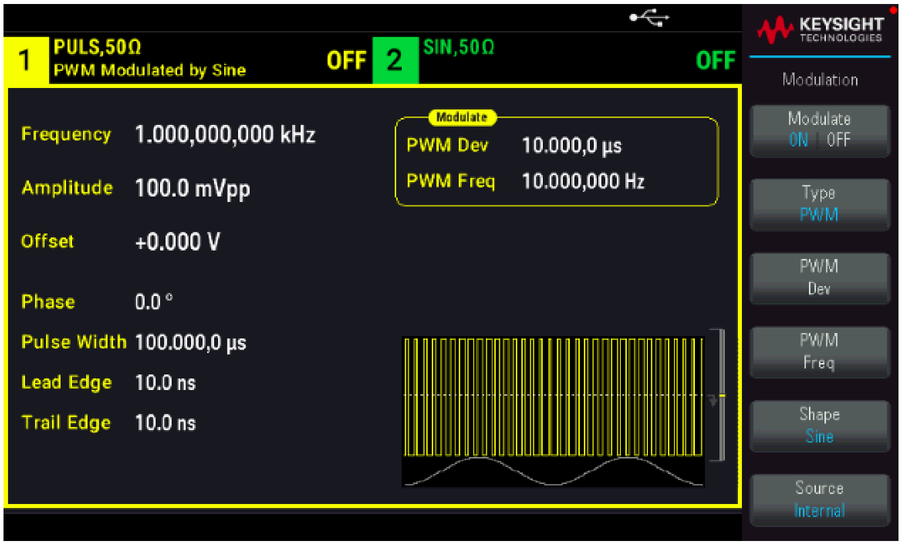


**Figure 3.** PWM modulated with standard sine wave

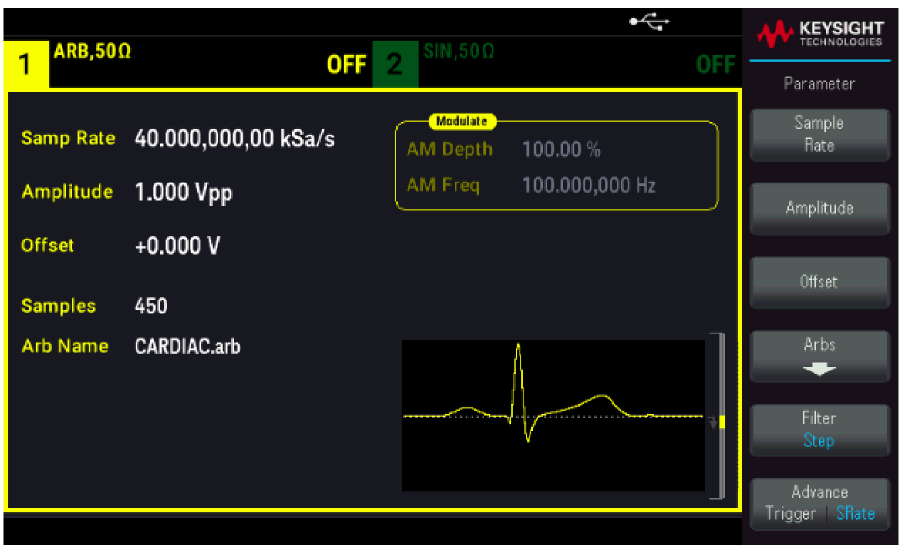


**Figure 4.** Cardiac specialty waveform

# Signal Integrity: Outputting the Signals You Expect

If your generator is introducing spurious signals or harmonics, you will have a challenging time producing reliable designs. To be successful, you need to test with clean, precise, low-noise signals. The EDU33210 Series function/arbitrary waveform generators has the highest signal fidelity, so you can generate the exact waveforms you need for your most challenging measurements. You can be confident you are seeing your design's characteristics and not your waveform generator's measurements.

# Arbitrary Waveform with Deep Memory

Are you looking to test your design with long, complex waveforms with a variety of anomalies? The EDU33210 Series function/arbitrary waveform generators come standard with up to 8 M samples per channel deep memory at a maximum of 1 M sample per waveform, providing sufficient memory to overcome your test challenges.

# Intuitive front panel


| Label | Description |
|---|---|
| 1 | 7-inch WVGA display |
| 2 | Function keys |
| 3 | Soft keys |
| 4 | Numeric keypad |
| 5 | Knob and cursor arrows |
| 6 | Output connectors, set up, and on / off buttons |
| 7 | Sync / trigger output connector |
| 8 | External triggering / gate / FSK / burst connector |
| 9 | CAL connector |
| 10 | USB port |
| 11 | Power switch |

# PathWave BenchVue Software

As Figures 5 and 6 show, PathWave BenchVue software for the PC makes it simple to connect and control your function generators. You can now quickly move past the test development phase and access results faster with just a few clicks.

- Intuitive point and click user interface
- Select and easily configure the waveform identified
- Load custom arbitrary waveforms from files


**Figure 5.** Select and configure your required waveform

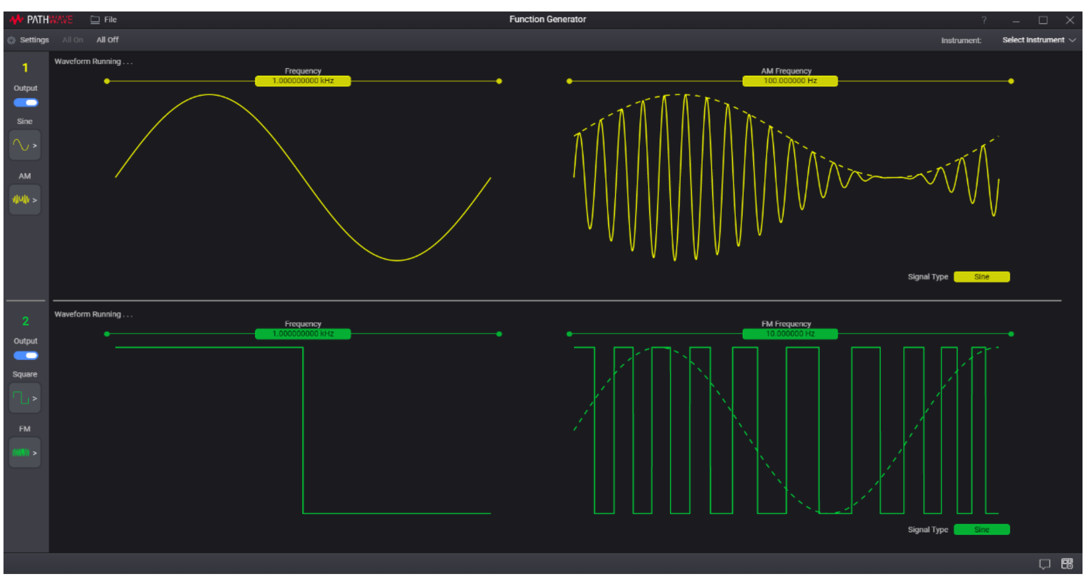


**Figure 6.** Setting the modulation waveform

# Characteristics

Unless otherwise stated, all specifications are using a 50 Ω resistive load, and the automatic amplitude range selection is enabled.

## Instrument

| **Models and options** | | |
|---|---|---|
| Model number | EDU33211A | EDU33212A |
| Maximum frequency | 20 MHz | |
| Number of channels | 1 | 2 |
| **Models and options** | | |
| Standard | Sine, square, ramp, pulse, triangle, Gaussian noise, pseudorandom binary sequence (PRBS), DC | |
| Built-in arbitrary | Cardiac, exponential fall, exponential rise, Gaussian pulse, haversine, Lorentz, D-Lorentz, negative ramp, sinc | |
| User-defined arbitrary | Up to 8 MSa per channel; with up to 1 MSa per waveform | |
| **Operating modes and modulation types** | | |
| Operating modes | Continuous, modulate, frequency sweep, gated burst | |
| Modulation types | Amplitude modulation (AM), frequency modulation (FM), phase modulation (PM), frequency shift keying (FSK), binary phase shift keying (BPSK), pulse width modulation (PWM) | |

# Waveform

| **Sine** | |
|---|---|
| Frequency range | 1 µHz to 20 MHz, 1 µHz resolution |
| Amplitude flatness (specification) [1,2,3] (relative to 1 kHz) | 1 $V_{pp}$ < = $V_{out}$ < = 10 $V_{pp}$ (50 Ohm load)<br>$f_{OUT}$ < = 100 KHz: ±0.1 dB<br>100 KHz < $f_{OUT}$ < = 5 MHz: ±0.15 dB<br>5 MHz < $f_{OUT}$ < = 20 MHz: ±0.3 dB |
| Harmonic distortion (typical) [1,3] | 1 $V_{pp}$ < = $V_{out}$ < = 10 $V_{pp}$ (50 Ohm load)<br>$f_{OUT}$ < = 100 KHz: -60 dBc<br>100 KHz < $f_{OUT}$ < = 1 MHz: -50 dBc<br>1 MHz < $f_{OUT}$ < = 20 MHz: -40 dBc |
| THD (typical) [1] | $f_{OUT}$ = 10 Hz to 20 kHz: < 0.075% |
| Non-harmonic spurious (typical) [1,3,4] | $f_{OUT}$ ≤ 2 MHz: < -70 dBc<br>$f_{OUT}$ > 2 MHz: < -70 dBc + 20 dB/decade |
| Phase noise (SSB) (typical) [5] | 10 kHz offset: -105 dBc/Hz |
| **Sine (for 25 MHz, enabled by 332BW1U or 332BW2U optional upgrade)** | |
| Amplitude flatness (typical) (relative to 1 kHz) | 20 MHz < $f_{OUT}$ < = 25 MHz: ±0.3 dB |
| Harmonic distortion (typical) [1,3] | 20 MHz < $f_{OUT}$ < = 25 MHz: -40 dBc |
| **Square and pulse** | |
| Frequency ranges | 1 µHz to 10 MHz, 1 µHz resolution |
| Rise and fall times (nominal) | Square at 8.4 ns, fixed<br>Pulse at 8.4 ns to 1 µs, independently variable, 100 ps resolution |
| Overshoot (typical) | ≤ 3% |
| Duty cycle [6] | 0.01% to 99.99%, 0.01% resolution |
| Pulse width | 16 ns minimum (adjustable with 100 ps resolution) |
| Jitter (rms) (measured) [7] | ≤ 5 MHz: 2 ppm of the period + 100 ps<br>> 5 MHz: 100 ps |
| **Ramp and triangle** | |
| Frequency range | 1 µHz to 200 kHz, 1 µHz resolution |
| Ramp symmetry | 0% to 100%, 0.1% resolution, (0% is negative ramp, 100% is positive ramp, 50% is triangle) |
| Linearity (typical) | ≤ 0.1% from 5% to 95% of the signal amplitude ($V_{out}$ ≥ 1 $V_{pp}$) |

1 DC offset set to zero
2 Add 1/10 of the specification per °C for operation at temperatures below 18 °C or above 28 °C
3 Auto range "ON"
4 At low amplitude, the non-harmonic spurious level is -100 dBm (typical)
5 Measured with a Keysight N9030B PXA X-Series signal analyzer
6 Subject to pulse width limits
7 Measured with a Keysight N9030B PXA X-Series signal analyzer

| Gaussian noise | |
|---|---|
| Variable bandwidth | 1 MHz to 20 MHz |
| Crest factor (nominal) | 4.6 |
| Repetition period | > 50 years |
| **Pseudorandom binary sequence (PRBS)** | |
| Bit rate | 1 Mbps to 50 Mbps, 1 Mbps resolution |
| Sequence length | 2 m - 1, m = 7, 9, 11, 15, 20, 23 |
| Rise and fall times | 8.4 ns to 1 µS, independently variable, 100 ps resolution |
| **Arbitrary waveforms** | |
| Waveform length | 8 Sa to 8 MSa per channel (maximum up to 1 MSa per waveform) |
| Sample rate | 1 µSa/s to 250 MSa/s, 1 µSa/s resolution |
| Voltage resolution | 16 bits |
| **General** | |
| Connector | Front-panel BNC, shell connected to chassis; all inputs and output BNC connectors are chassis referenced |
| Function | On, off, or inverted |
| Output impedance (nominal) | 50 Ω |
| Isolation | Connector shells for channel output(s), sync, and modulation "in" are connected. |
| Overload protection | Output turns off automatically when an overload is applied; the instrument will tolerate a short circuit to ground indefinitely |
| **Amplitude** | |
| Range [1] | 1 $mV_{pp}$ to 10 $V_{pp}$ into 50 Ω, 4-digit resolution |
| | 2 $mV_{pp}$ to 20 $V_{pp}$ into open circuit, 4-digit resolution |
| Units | $V_{pp}$, $V_{rms}$, or dBm |
| Accuracy (at 1 kHz sine) (specification) [2,3] | ± (2% of setting in $V_{pp}$) ± (1 $mV_{pp}$) |
| Accuracy (at 1 kHz Sine) (typical) [3] | ± (1% of setting in $V_{pp}$) ± (1 $mV_{pp}$) |
| Voltage limit function | User-definable maximum and minimum voltage limits |
| **DC offset** | |
| Range [4] | ± (5 VDC minus peak AC) into 50 Ω, 4-digit resolution |
| | ± (10 VDC minus peak AC) into open circuit, 4-digit resolution |
| Units | VDC |
| Accuracy (specification) [2,3] | ± (1% of offset setting) ± (1% of amplitude in $V_{pp}$) ± (5 mV) |
| **Frequency accuracy (spec)** | |
| Standard frequency reference | ± (1 ppm of setting + 15 pHz), 1 year, 23 ºC ± 5 ºC |
| | ± (2 ppm of setting + 15 pHz), 1 year, 0 ºC to 55 ºC |

1 Maximum amplitude is less at high frequency for specific waveforms
2 Add 1/10 of the specification per °C for operation at temperatures below 18 °C or above 28 °C
3 Auto range "ON"
4 Output noise is typically 20 dB lower when DC and peak AC are < 320 mV and 50 Ω or 640 mV into open circuits

# Modulation, burst, and sweep

| Amplitude modulation (AM) | |
|---|---|
| Source | Internal only |
| Carrier waveform | Sine, square, ramp, arb |
| Modulating waveform | Sine, square, ramp, noise, arb |
| Depth [1,2] | 0% to 120%, 0.01% resolution |
| **Frequency modulation (FM) [3]** | |
| Source | Internal only |
| Carrier waveform | Sine, square, ramp, arb |
| Modulating waveform | Sine, square, ramp, noise, arb |
| Deviation | 1 µHz to 15 MHz, 1 µHz resolution |
| **Phase modulation (PM)** | |
| Source | Internal only |
| Carrier waveform | Sine, square, ramp, arb |
| Modulating waveform | Sine, square, ramp, noise, arb |
| Modulation frequency | 2 MHz to 1 MHz |
| Deviation | 0º to 360º, 0.1º resolution |
| **Frequency-shift key Modulation (FSK) [4]** | |
| Source | Internal or external connector |
| Rate | ≤ 1 MHz |
| **Binary Phase-Shift Key modulation (BPSK)** | |
| Source | Internal or external connector |
| Phase shift | 0º to 360º, 0.1º resolution |
| Rate | ≤ 1 MHz |
| **Pulse Width Modulation (PWM)** | |
| Source | Internal, external connector |
| Carrier waveform | Pulse |
| Modulating waveform | Sine, square, ramp, noise, arb |
| Deviation 5 | 0% to 100% of pulse width, 0.01% resolution |

1 Add 1/10 of the specification per °C for operation at temperatures below 18 °C or above 28 °C
2 Subject to amplitude limits
3 All frequency changes are phase continuous
4 Auto range "ON"
5 Subject to pulse width limits

**Burst characteristics** [1]

| | |
|---|---|
| Type | Counted or gated |
| Counted burst operation | Each trigger event causes the instrument to produce from 1 to $10^8$ or an infinite number of waveform cycles |
| Gated burst operation | Instrument produces waveforms while the trigger is in the "on" state. For Gaussian noise, waveform generation stops immediately when the trigger is in the "off" state; all other waveforms stop after the completion of a cycle; more than one cycle might elapse before generation stops |
| Start/stop phase [2] | -360° to +360°, 0.1° resolution |
| Trigger source | Internal timer or rear-panel connector |
| Marker | Indicated by the trailing edge of the sync pulse; adjustable to any cycle of the burst |

**Sweep characteristics** [3]

| | |
|---|---|
| Type | Linear, logarithmic, or list (up to 128 user-defined frequencies) |
| Operation | Characterization of linear and logarithmic sweeps occur by a sweep time during which the frequency changes smoothly from start to stop; a hold time during which the frequency stays at the stop frequency; and a return time during which the frequency changes smoothly from stop to start |
| Direction | Up (start frequency < stop frequency) or down (start frequency > stop frequency) |

**Sweep time**

| | |
|---|---|
| Linear | 1 millisecond to 3,600 seconds, 1 ms resolution |
| | 3,601 seconds to 250,000 seconds, 1 second resolution |
| Logarithmic | 1 millisecond to 500 seconds, 1 ms resolution |
| Hold time | 0 to 3,600 seconds, 1 ms resolution |
| Return time | 0 to 3,600 seconds, 1 ms resolution |
| Trigger source [4,5] | Immediate (continuous), external (rear-panel connector), manual (front-panel button), bus or internal timer |

1 Counted burst is not available for Gaussian noise
2 Limited to arbitrary waveforms that are < 1 million points; phase resolution limited by the number of points in arbitrary waveforms < 3,600 points
3 All frequency changes are phase continuous
4 External trigger only for sweep time > 8,000 seconds
5 Measured with a square or pulse waveform, edge time set to minimum, and trigger delay set to zero. Trigger latency is generally greater for other instrument settings. For some waveforms, trigger latency is a function of the output frequency

# Two-channel characteristics — EDU33212A only

| Standard | |
|---|---|
| Operating modes | Independent, coupled parameter(s), combined (Channels 1 and 2); equal (Channel 1 = Channel 2) or differential (Ch 1 = -Ch 2) |
| Parameter coupling | None, frequency (ratio or difference) and / or amplitude and DC offset |
| Relative phase | 0° to 360°, 0.1° resolution |
| Channel-to-channel skew (typical); both channels configured identically | < 0.8 ns |
| Crosstalk (typical) | < -75 dB |

# Sync out/trigger out

| General | |
|---|---|
| Connector | Front BNC, chassis-referenced; functions as an output |
| Minimum output high voltage | Minimum 1.3 V |
| Maximum output low voltage | Maximum 0.1 V |

# External trigger input/gate; input/burst; input/FSK input

| General | |
|---|---|
| Connector | Front BNC, chassis-referenced; functions as input |
| Polarity | Positive or negative slope |
| Maximum rate | 1 MHz |
| **Input** | |
| Minimum input high voltage | 2.2 V |
| Maximum input low voltage | 0.6 V |
| Minimum pulse width | 16 ns |
| Variable trigger delay | 0 to 1,000 s; 4 ns resolution |
| Latency (typical) [1] | < 160 ns with trigger delay set to zero |
| Jitter | < 2.5 ns, rms |

1. Only apply to 1 kHz and above

# Memory

| Instrument state | |
|---|---|
| Store / recall | User-defined instrument states with user-defined names in the file system |
| Power-on state | Default settings or state at power-off, selectable |
| **USB file system** | |
| Front-panel port | USB 2.0 high-speed mass storage class (MSC) device |
| Capability | Read or write instrument configuration settings, instrument states, arbitrary waveform |
| Speed (nominal) | 10 MB/s |

# General characteristics

| USB file system | |
|---|---|
| LXI-C (rev1.5) | 10/100Base-T (sockets and VXI-11 protocols); USB 2.0 (USB-TMC488 protocol) |
| Web user interface | Remote operation and monitoring |
| Programming language | SCPI-1999, IEEE-488.2 |
| Real-time clock / calendar battery | CR-2032 coin type, replaceable, > 5-year life (typical) |
| **Mechanical** | |
| Size (nominal) | 314 mm W x 130 mm H x 165 mm D (12.36 in W x 5.12 in H x 6.50 in D) |
| Weight (nominal) | 3.1 kg (6.8 lbs.) |
| **Environmental** | |
| Storage temperature | -40 °C to 70 °C |
| Warm-up time | 1 hour |
| Operating environment | Indoor use, installation category II for AC input; pollution degree 2 |
| Operating temperature | 0 °C to 55 °C |
| Operating humidity | Up to 80% RH at 40 °C non-condensing |
| Altitude | Up to 3,000 meters (9842.5 ft) |

| Regulatory | |
| --- | --- |
| Electromagnetic compatibility | Compliant with EMC directive (2014/30/EU)<br>IEC 61326-1/EN 61326-1 Group 1 Class A<br>Canada: ICES/NMB-001<br>Australia / New Zealand: AS/NZS CISPR 11<br>South Korea: KC mark<br>(South Korean Class A EMC declaration:<br>Information to the user:<br>This equipment has been conformity assessed for use in business environments. In a residential environment, this equipment may cause radio interference.) |
| Safety | IEC 61010-1 / EN 61010-1<br>USA: ANSI/UL Std. No. 61010-1<br>Canada: CAN/CSA-C22.2 No.61010-1 |
| Acoustic noise | Sound pressure level (1 m free field) (nominal) 31 dB(A) at ambient ≤ 28 °C |
| **Line power** | |
| Line voltage | 100 to 240 V, 50 / 60 Hz; 100 to 120 V, 50 / 60 Hz |
| Power consumption | < 45 W |

# Definitions

## Specification (spec)

The specification refers to the warranted performance of a calibrated instrument stored for a minimum of two hours within the operating temperature range of 0 to 55 ºC and after a one-hour warm-up period. Measurement and calibration uncertainties comply with ISO-17025 methods. Data published in this document are specifications as indicated.

## Typical (typ)

The characteristic performance that 80% or more manufactured instruments will meet. Warranty for this is not available and does not include measurement or calibration uncertainty, and is valid only at approximately 23 ºC (room temperature).

## Nominal (nom)

Nominal represents the mean or average characteristic performance, or the value of an attribute determined by design such as a connector type, physical dimension, or operating speed. Warranty for this data is not available, and the measurement is at approximately 23 ºC (room temperature).

## Measured (meas)

Measured is an attribute taken during product development to communicate expected performance. Warranty for this data is not available, and the measurement is at approximately 23 ºC (room temperature).

# Ordering Information

## EDU33210 Series function/arbitrary waveform generators

| | |
|---|---|
| EDU33211A | Waveform generator, 20 MHz, 1-channel |
| EDU33212A | Waveform generator, 20 MHz, 2-channel |

## Standard shipped accessory

AC power cord (based on destination country)

## Optional upgrade model

| | |
|---|---|
| 332BW1U | 25-MHz Bandwidth Upgrade for 1-Channel EDU33210 Series Waveform Generator |
| 332BW2U | 25-MHz Bandwidth Upgrade for 2-Channel EDU33210 Series Waveform Generator |

## Optional accessory

| | |
|---|---|
| EDU190A | Instrument stacking kit (to use with other education series instruments) |

## Other education series products

| | |
|---|---|
| EDU34450A | Digital multimeter, 5.5 digit |
| EDU36311A | 90 W DC power supply, triple-output, 6 V, 5 A, and 2x 30 V, 1 A, LAN, USB |
| EDUX1052A | Keysight InfiniiVision 1000 X-Series oscilloscope, 50 MHz, analog channels |
| EDUX1052G | InfiniiVision 1000 X-Series oscilloscope, 50 MHz, two analog channels, with a built-in waveform generator |



Keysight enables innovators to push the boundaries of engineering by quickly solving design, emulation, and test challenges to create the best product experiences. Start your innovation journey at www.keysight.com.