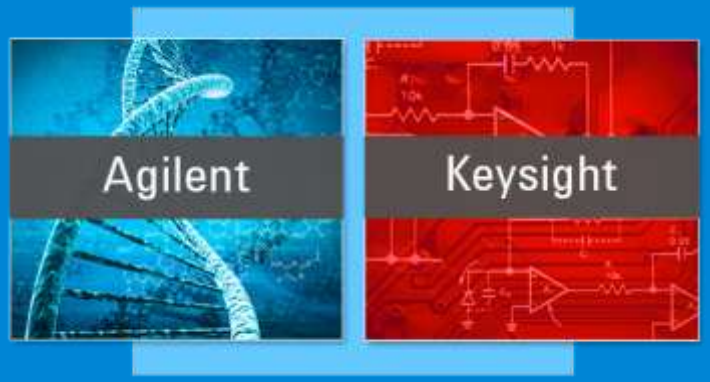
Function Generator Workshop: Accurate, Flexible Waveform Generation



A+ Hand-on Seminar

Marlo Manaloto,
Market Development Manager

Agenda

- Waveform Generator Basics
- Test Challenges with Hands On
  - Generating High Integrity Signals
  - Creating Differential Outputs
  - Sequencing Waveform Segments
  - Creating Long, Complex Waveforms
- Summary, BenchVue and Basic Instruments

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Pop Quiz

What was HP/Agilent/Keysight's first product ever made over 75 years ago?

The **HP 200A Audio Oscillator** sold to Walt Disney for the making of the movie "Fantasia"

This Audio Oscillator best equates to a modern day **Waveform Generator**.

1938 | 1940 | 1950 | 1960 | 1970 | 1980 | 1990 | 2000 | 2010 | 2014

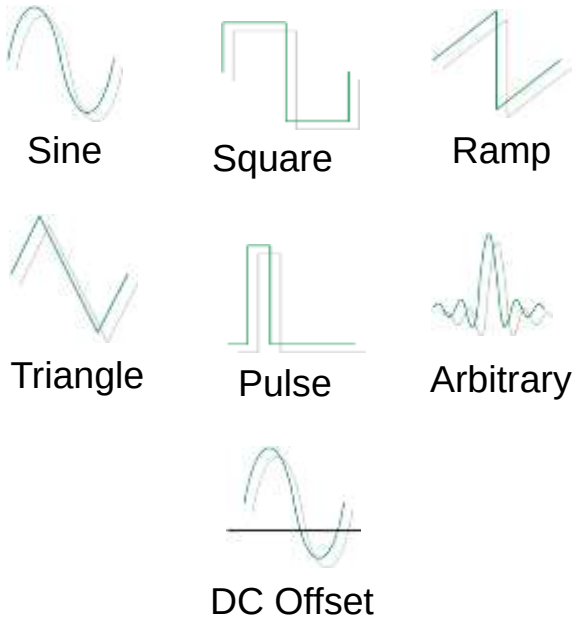
Waveform Generator Basics

Test, verify & characterize designs & products

- Apply signal
- Measure response of DUT

Utilize a variety of signals

- Sine, square, ramp, triangle
- AM, FM, PM, FSK, PWM
- Variable edge-time pulses
- Arbitrary waveforms



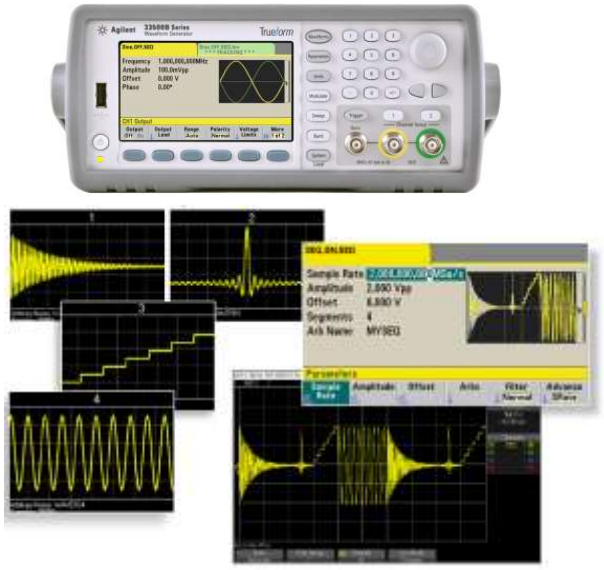
Instrumentation

Function Generator

- Standard functions
- Synthesized outputs (DDS), with built-in modulation capabilities

Waveform Generator

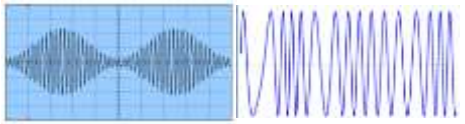
- All basic signals, plus…
- Enhanced sweep, plus…
- Unique built-in signal generation tools, plus…
- Multiple ways to download your application-specific waveforms



Other Types of Signal Generators

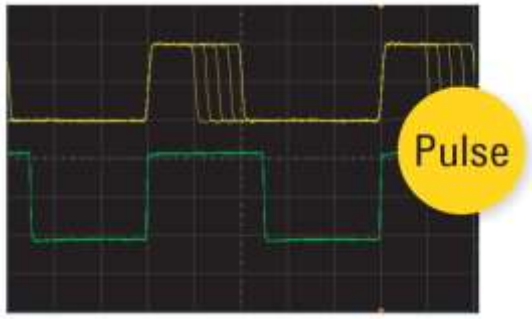
RF Signal Generator

- Analog Signal Generation
- RF and Microwave Frequencies
- Often need external modulation source

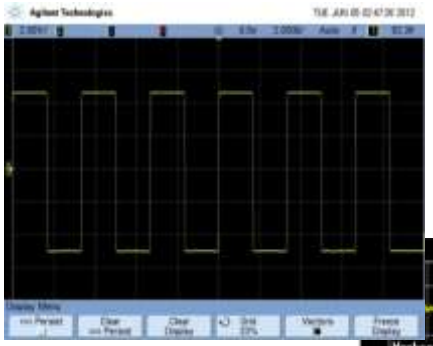


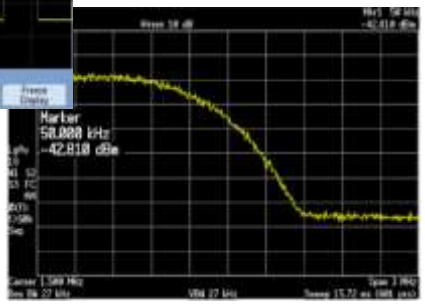
Pulse Generator

- Digital signal generation
- Can control rise-time, fall-time, phase
- Multiple outputs of serial data



Common Applications





Pulse Train Signals

- Clock Substitution
- Noise tolerance and jitter tolerance

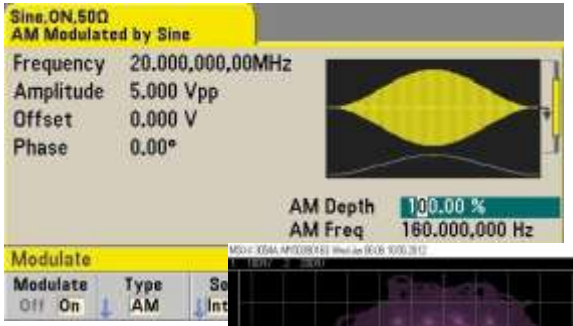
Arbitrary Waveforms

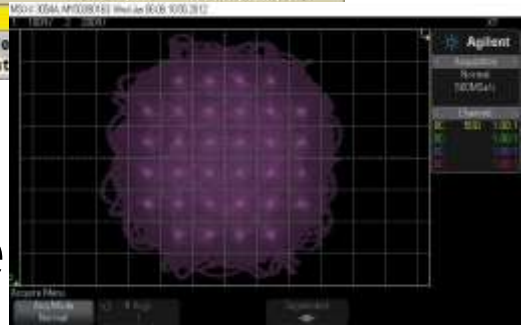
- Real-world signals

Amplifier Testing

- Sine and multi-tone for frequency response, distortion
- Square/Pulse for rise time, overshoot, delay
- Ramp/Triangle for linearity, clipping

Common Applications continued



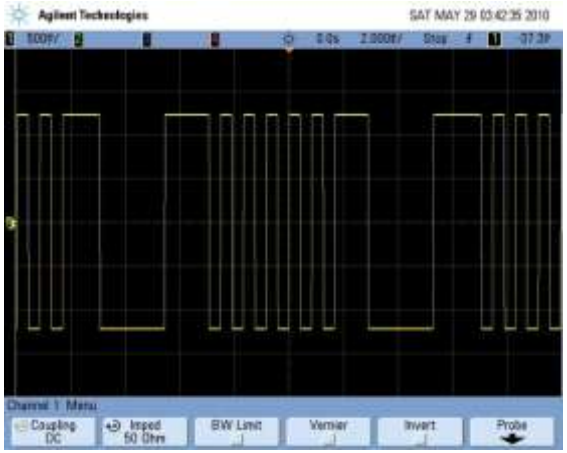


Modulation Source

- Provides AM, FM, PM, custom signals for RF generators
- Two channels for in-phase quadrature (IQ) modulation

PWM

- Motor drives, Class-D amplifiers
- Automotive sensors & actuators
- Switching power supplies



Generation Techniques
Direct Digital Synthesis (DDS)

Industry standard technology for function generators

- Low cost solution for the most common waveforms
- Output represents the phase of the waveform after look up table applied
- Can skip or repeat points in unpredictable ways depending on frequency

33120A

33210A
33220A
33250A

81150A

Generation Techniques
Point-per-Clock (PPC)

Used in high-end signal generators

- Higher cost, more complex for higher bandwidth
- Stores points in memory and read them out
- Requires low-noise variable-frequency clocks and filtering

M8190A

N6030A

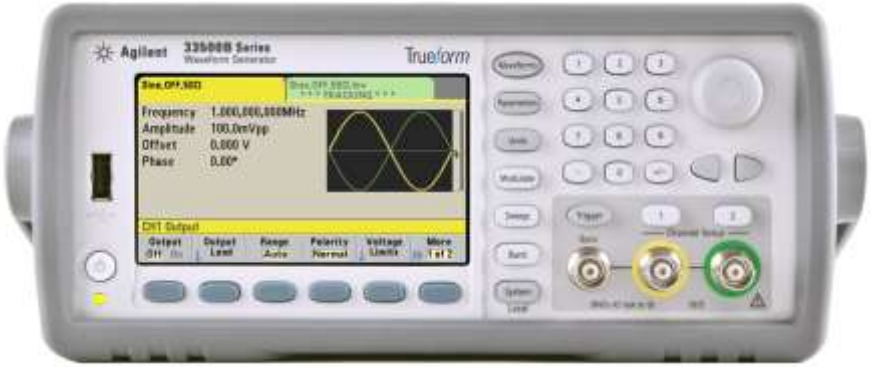
81180B

Generation Techniques
NEW True*form* Technology

The latest in waveform generation technology

- Provides the best of both DDS and PPC
- Advanced digital signal generation algorithms
- High end technology in a low cost instrument!

33500B and
NEW 33600A
Series



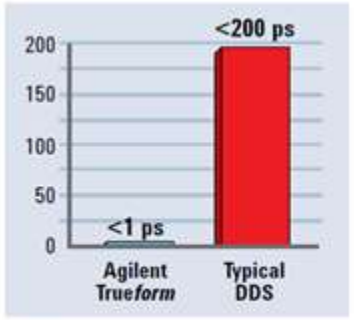
True*form* Benefits

Better signal fidelity

- No skipped points at higher frequencies
- Always anti-aliased – play at any rate

Lowest jitter

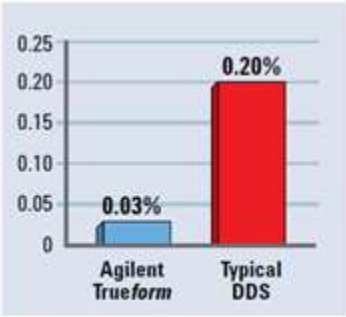
- DDS – typical is 200 picoseconds
- True*form* – <1 picosecond is 200x improvement



Jitter

Lower distortion

- Total harmonic distortion < 0.03%
- 5x improvement over DDS



Total harmonic distortion

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Lab Equipment

NEW 33622A 120 MHz 2-channel True*form* Waveform Generator (introduced March 4, 2014)

- 14-bit resolution, 1 GSa/s sample rate, 64M point memory per channel
- LAN, USB standard; GPIB optional

33250A 80 MHz 1-channel Waveform Generator

- 12-bit resolution, 200 MSa/s sample rate, 64k point arbitrary waveforms
- GPIB and RS-232 interfaces

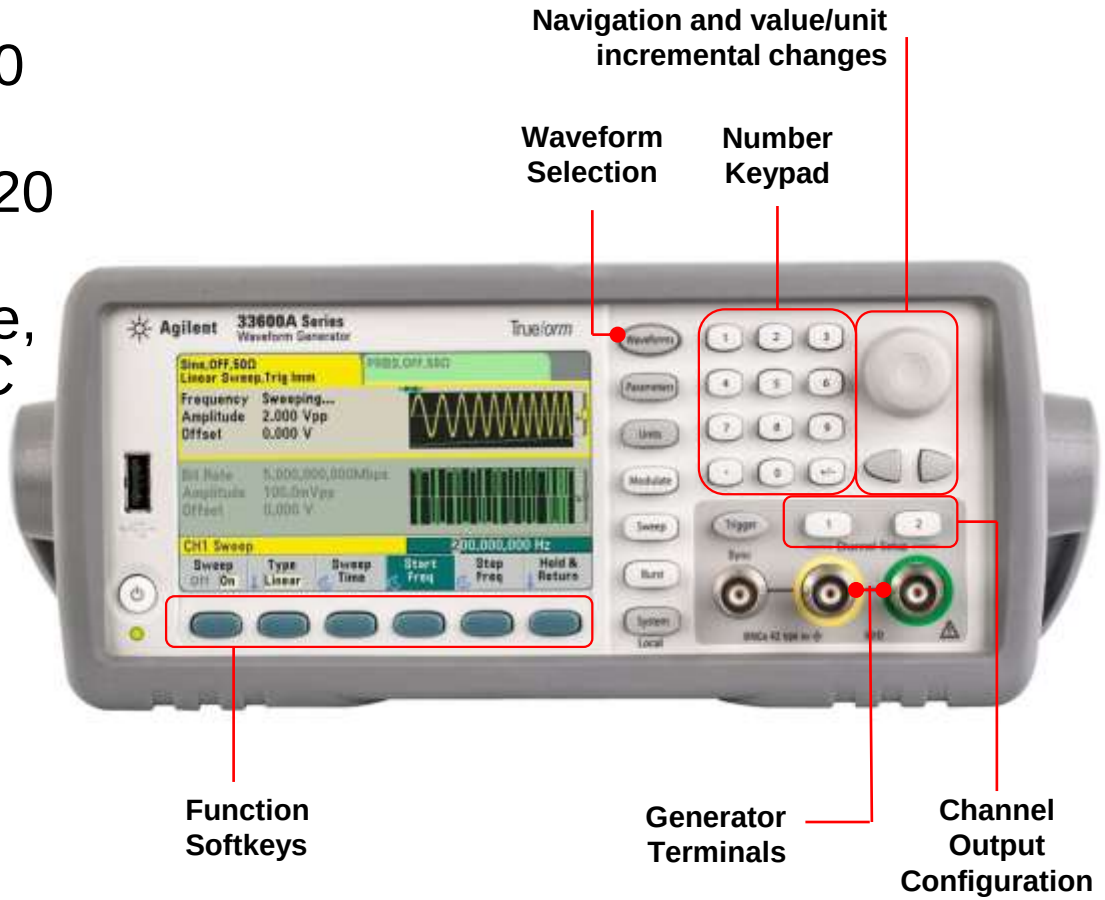
U1620A 200 MHz Handheld Oscilloscope

- 2 GSa/s sample rate, 2M point memory
- 3 viewing modes: indoor, outdoor, night vision

True*form* Waveform Generator Familiarization

12 **True*form*** Models:

- (8) 33500B series: 20 or 30 MHz
- (4) 33600A series: 80 or 120 MHz
- Sine, Square, Ramp, Pulse, Triangle, Noise, PRBS, DC functions standard
- 1M and 4M pt (16M and 64M optional) memory
- 14- and 16-bit resolution
- 1 GSa/s sample rate
- <1 ps jitter
- 0.03% THD
- Optional IQ player



Handheld Scope Familiarization

HH Scopes for Portability and Ruggedness:

- U1610A: 100 MHz
- U1620A: 200 MHz
- 2M pt memory
- 2 GSa/s sample rt
- 10,000 ct DMM
- 2 isolated CAT III, 600 V channels
- Data log to PC
- Indoor, outdoor, night vision modes

Lab 1: Generating High Integrity Signals

Typical Test Challenges:

- Reproduce an arb with designed glitches
- Run arbs at a fast frequency with the same signal from cycle to cycle
- Simulate a complex signal
- Need the best signal quality possible

How True*form* helps:

- **True*form*** waveform generators have the best signal integrity in the industry
  - Jitter at < 1 ps, High resolution at 14- and 16-bits
- Plays every point as designed without having to force fit a number of samples
- Output voltage with load settings
- None of the weaknesses of DDS (e.g., distorted signals and stretched points)

Lab 1: Generating High Integrity Signals

Lab Objective: Demonstrate the difference between DDS and **True*form*** arbitrary waveforms

Equipment:

- HH Scope
- 3 BNC cables
- 33600A
- 33250A

Lab 1: Setup

Using the 2 BNC cables, connect channel 1 of 33600A to channel 1 of the scope, and the 33250A output to channel 2 of the scope.

On the rear panel of 33600A and 33250A, connect the 10MHz out of 33600A to 10MHz in of the 33250A to ensure both the 33600A and 33250A have the same clock reference.

Cycle power on all instruments for default state or press **System** → **Set to Defaults** → and **Yes**.

Lab 1: Setting up the 33600A

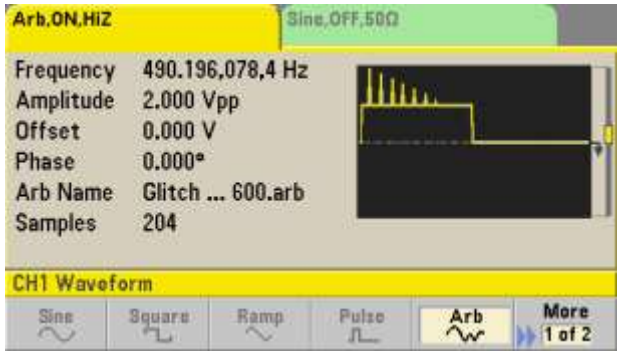
Bold: Front Panel Button
Blue Bold: Softkey
Italicize: comments

1. On 33600A unit, press **Waveform** → **Arb** → **Arbs** → **Select Arb**, browse the internal memory by scrolling the knob and select "GLITCH_DDS_33600.arb". Press **Select** to select the arb.
2. On the 33600A unit, press **Channel 1** → **Output Load** → **Set to High Z**. *The 33600A channel 1 will now be set for high Z output load to match the input impedance of the HH scope.*
3. On **Channel 1**, Press **Output** → On to turn on the output.

Lab 1: Setting up the 33600A

Bold: Front Panel Button
Blue Bold: Softkey
Italicize: comments

4. Press **Waveform** → **Arb** → **Filter**, and select **Normal** filter. *The 33600A has multiple filters, and Normal filter is similar to the one used in 33250A.*
5. Press **Units** → **Arb rate** and choose **Freq**. *The factory default unit is arb rate. By changing the unit to frequency we can edit the frequency of the arb waveform directly without additional steps of calculating the equivalent frequency of the given sample rate.*



Lab 1: Setting up the 33250A

Bold: Front Panel Button
Blue Bold: Softkey
Italicize: comments

6. On the 33250A unit, press **ARB** → **Select Wform** → **Stored Wform** → **Arb Mem 1** (named GLITCH) → **SELECT ARB** to output the arbitrary waveform
7. Set the output load to high Z by pressing **Utility** → **Output Setup** and **High Z** to match the input impedance of the HH Scope
8. Press **Output** to turn the output on

Lab 1: Setting Parameters

Bold: Front Panel Button
Blue Bold: Softkey
Italicize: comments

9. Set the frequency to 1 kHz and amplitude to 200 mVpp in both 33600A and 33250A
   a. On the 33600A, select **Parameters**→**Arb Freq**. Use the number pad to key in **1** followed by **kHz**. Select **Amplitude**→ Use the number pad to key in **200** **mVpp**
   b. On the 33250A, select **Arb** and use the number pad to key in **1** followed by **kHz**. Select **Ampl** → Use the number pad to key in **200** **mVpp**

Lab 1: Viewing the waveforms

10. On the oscilloscope, press **Autoscale**.
    a. Adjust the vertical positions of the signals by using the **Up** and **Down** arrows above Ch 1 Vertical and Ch 2 Vertical in order to see both signals. Change the range to be 1 volts/div. for each channel.
11. Set the frequency on both units to 1 MHz and observe the waveforms appear on the scope
    a. **Autoscale** then adjust the vertical positions of the signals by using the Up and Down arrows above Ch 1 Vertical and Ch 2 Vertical in order to see both signals. Change the range to be 1 volts/div. for each channel.

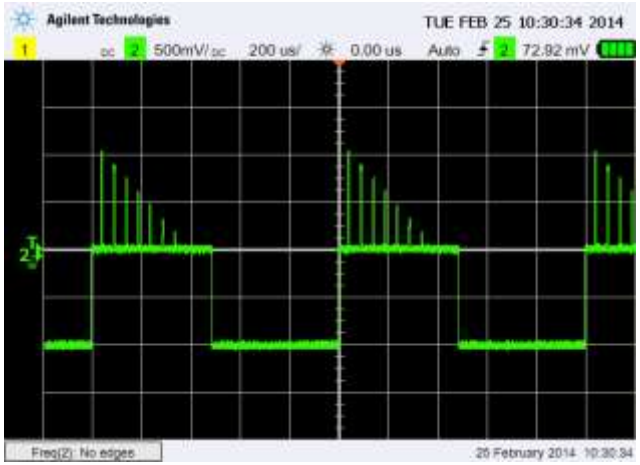
Lab 1: Trueform vs DDS

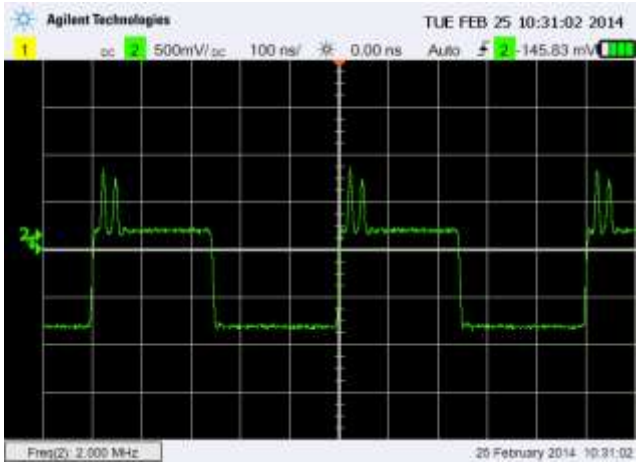
12. Increase the frequency up to 4MHz in 1 MHz steps by using the knob or the keypad
13. Unplug Channel 1 from the 33600A.
14. Now go back to 1 kHz on the 33250A. Press **Autoscale**. The waveform looks good now.

Lab 1: DDS Glitches

o) Go back to 2 MHz on 33250A. Press **Autoscale**. The output should be missing a glitch or two.

p) Go back to 1 kHz (**Autoscale**)**,** then back to 2 Mhz (**Autoscale**). *The output is now missing a different set of glitches.*





Lab 1: Reflection

How did the DDS based generator result differ from the **True*form*** based generator?

- DDS skipped points, **True*form*** did not

Was the DDS based generator predictable?

- No

Note: Randomly skipping points at higher frequencies is a known flaw with DDS generators. DDS technology works fine for the majority of function generator applications.

Lab 2: Creating Differential Outputs

Typical Test Challenges:

- Simulate an IC Output
- Simulate balanced twisted pair outputs
- Biomedical signal simulation
- Generate Low-Voltage, Differential Signaling (LVDS) stimulus signal

How True*form* helps:

- Dual channels, Floating outputs up to 42 V
- Frequency or amplitude coupling
- Identical or inverted signals between two channels
- 1 mVpp to 10 Vpp outputs

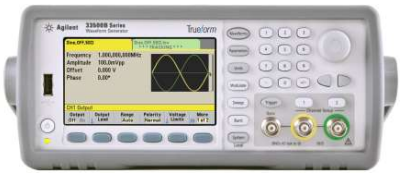
Lab 2: Creating Differential Outputs

Lab Objective: Demonstrate how to create differential signals with modern 2-channel waveform generators

Why Differential Signals?: better resistance to EMC, less noise

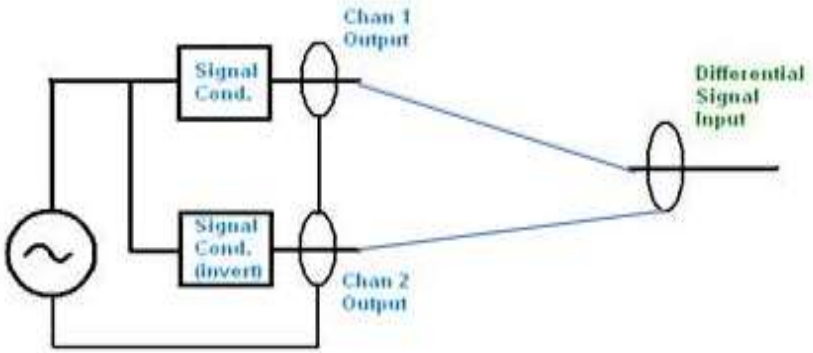
Equipment:

- 33600A
- HH Scope
- 1 custom differential signal cable



Lab 2: Differential Cable

2 signal outputs combined to be positive and low signal



<u>33600A Channel 1:</u>

- Positive or ‘+’ signal
- Connected to BNC center

<u>33600A Channel 2:</u>

- Inverted signal, low or ‘-’ signal after combined
- Connected to BNC outer shell

Lab 2: Setup

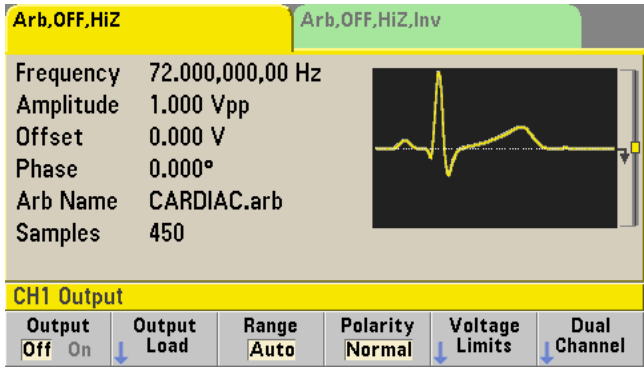
- Unplug the Charger from the HH scope.
- Set the 33600A to factory default settings by pressing **System** → **Set to Defaults** → and **Yes**. On the HH Scope. Turn off ch 2 by pressing **Scope**, **Ch 2**, ch 2 on to toggle on or off.
- Unplug all BNC cables from the HH Scope.
- Connect the differential cable between 33600A (channel 1 to the yellow connector and channel 2 to the green connector) to channel 1 of the scope.

Lab 2: Load the Waveform

1. On the 33600A unit, press **Channel 1** → **Output Load** → **Set to High Z**. *The 33600A channel 1 will now be set for high Z output load to match the input impedance of the HH scope.*
2. Load the cardiac arb waveform from memory by pressing **Waveforms** → **Arb** → **Arbs** → **Select Arb** → then select the “CARDIAC.arb” from the BuiltIn folder. Use the knob and arrow keys to navigate through the file structure and press **Select** to output the selected waveform file.

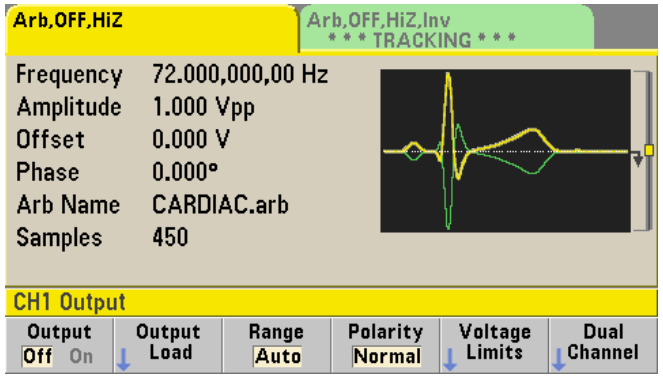
Lab 2: Set the Parameters

3. Press **Units** → **Arb rate** and choose "**Freq**". *The factory default unit is Arb Rate, and by changing the unit to frequency we can edit the frequency of the arb waveform easily without additional steps of calculating the equivalent frequency using the given sample rate.*
4. Press **Parameters** → **Arb Freq**. Use the number pad to key in **72** followed by **Hz** to set the frequency for channel 1.
5. Press **Parameters** → **Amplitude**. Use the number pad to key in **1** followed by **Vpp**.



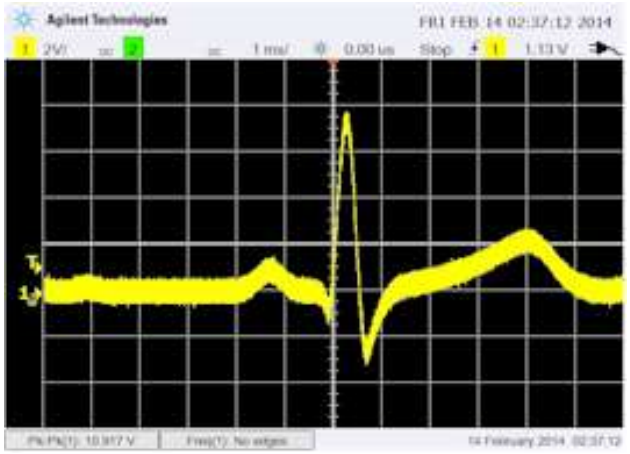
Lab 2: Results

6. Press **Channel 1** → **Dual Channel** → **Tracking** → select **Inverted** → then **Done**. *Channel 2 will now output the inverse of the channel 1 signal.*
7. On both **Channel 1** and **Channel 2** of the 33600A, Press **Output** → On to turn on the outputs
8. View the waveform by pressing **Autoscale** on the scope



Lab 2: View on the Scope

9. Press **Scope** → **Channel 1** → **Probe setting** → **Probe <**ratio**>**. Keep pressing **Probe <**ratio**>** until it's set to "1:1"
10. Press **Trigger** →**Trig. Mode <**setting**>** to turn the trigger to "Normal"
11. Press **Trigger** → **Trig. Setting** → **Level <**level**>** → move the arrow to 1 V
12. *Try using the oscilloscope to measure Vpk-pk. You will see the Vpk-pk as 2 Vpp.*

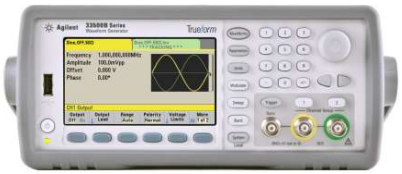


Lab 2b: Multi-Channel Synchronization

Lab Objective: Simulate a general synchronization between two signals within modern 2-channel waveform generators

Equipment:

- 33600A
- HH Scope
- 2 BNC cables



Lab 2b: Setup

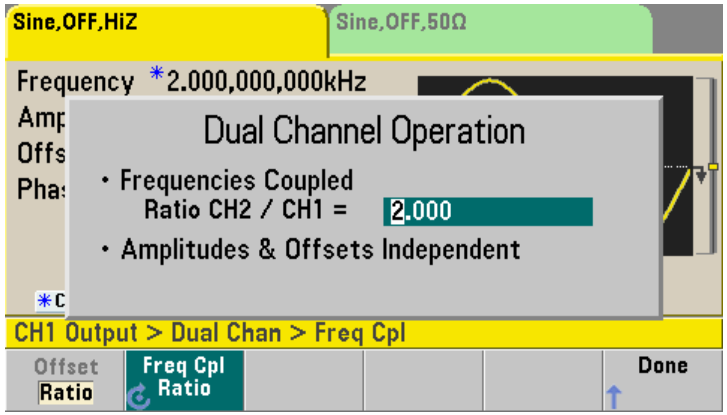
- Using the 2 BNC cables, connect channel 1 of 33600A to channel 1 of the scope, and channel 2 of 33600A to channel 2 of the scope.
- Set the 33600A to factory default settings by pressing **System** → **Set to Defaults** → and **Yes**.

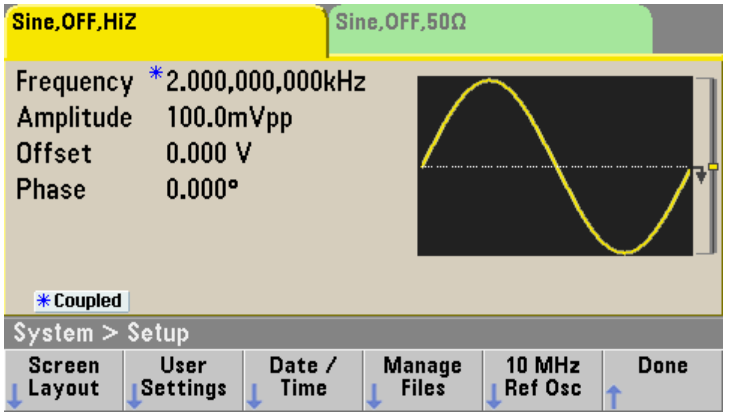
Lab 2b: Setting up Channel 1

1. Press **Channel 1** → **Output Load** → **Set to High Z** to match with the input impedance of HH Scope.
2. Press **Waveforms** → **Sine** to output a sine wave.
3. Set the frequency to **2 kHz** and amplitude to **100 mVpp** in the **Parameters** menu.

Lab 2b: Coupling Frequency

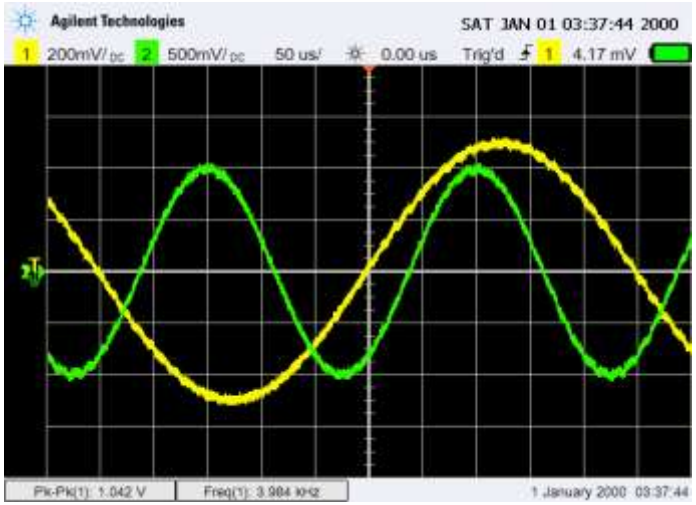
4. On **Channel 1**, select **Dual Channel** → F**requency Coupling** → **On**.
5. Press **Freq Cpl Settings** → **Freq Cpl Ratio** and to set the ratio to 2 (channel 2 is twice the frequency of channel 1). *You may notice an asterisk (*) next to Frequency to indicate the setting is coupled*
6. Press **Done** twice to return to the Output menu.





Lab 2b: Channel 2 Setup and Sync

7. Press **Channel 2** → **Output Load** → **Set to High Z** to match with the input impedance of HH Scope.
8. On both **Channel 1** and **Channel 2**, Press **Output** → **On** to turn on the outputs.
9. View the waveforms by pressing **Autoscale** on the scope.
10. To increase signal stability, press **Trigger** → **Trig. Settings** → **Source <**src**>** until it's set to "Ch1"

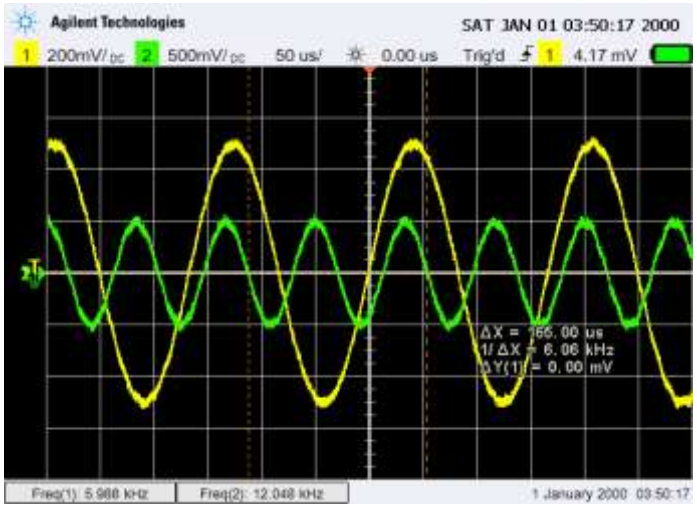


Lab 2b: Frequency Coupling

11. Using the oscilloscope to measure frequencies of channel 1 and channel 2. You will see the frequency of channel 1 as 2 kHz, and frequency of channel 2 as 4 kHz.
    a. Press **Clear Measurements**
    b. Press **Measure** → **Source <>** to change between channels 1 and 2
    c. Press **Select <**parameter**>** → select **“**Freq”
    d. Press **Measure <Frequency>** to display frequency measurements

Lab 2b: Changing the Frequency

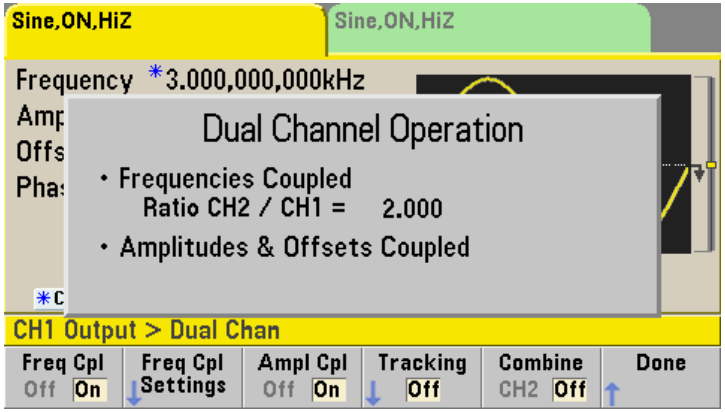
12. On the 33600A, change the frequency of channel 1 in the **Parameters** menu and watch the frequency of both channels change accordingly in which channel 2 will always have twice the frequency of channel 1.

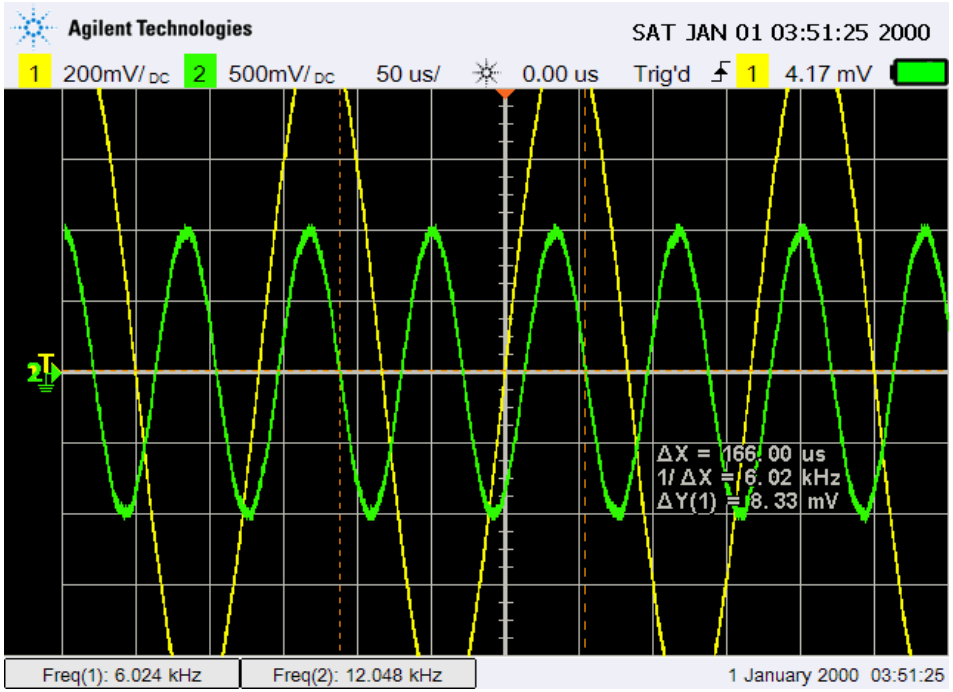


Lab 2b: Amplitude Coupling

13. Repeat for amplitude, by going to **Channel 1→Dual Channel** and turn on the **Ampl Cpl**.
14. Change the amplitude of channel 1 in the **Parameters** menu and watch the amplitude for both channels. You will see the amplitudes are coupled and change accordingly.
15. You may also sync the phase of both channels by accessing the **Parameters → Phase→ Sync Internal**. With this, the phases are aligned on both channels.

Lab 2b: Results





Lab 2: Reflection

How can you synchronize both channels on a **True*form*** Waveform Generator?

- Frequency coupling by ratio or offset, Amplitude coupling, tracking identical and inverted, combination

Lab 3: Sequencing Waveform Segments

Typical Test Challenges:

- Change one segment of an arbitrary signal without redesigning the whole signal
- Reuse your proven signal designs but put them together in a different order
- Have a signal continuously playing until an event starts another signal
- Sweeping an arbitrary waveform through different frequencies

How True*form* helps:

- Arbitrary waveform sequencing and triggering
- 1 GSa/s, Deep waveform memory
- Change amplitude, sample rate and filter settings with arb metadata
- Easy drag and drop file system

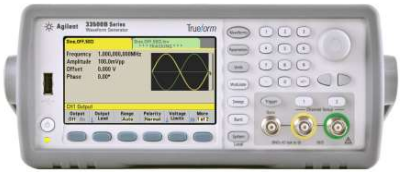
Lab 3: Sequencing Waveform Segments

Lab Objective:

Demonstrate the flexibility of sequencing waveforms

Equipment:

- 33600A
- 1 BNC cable
- HH Scope



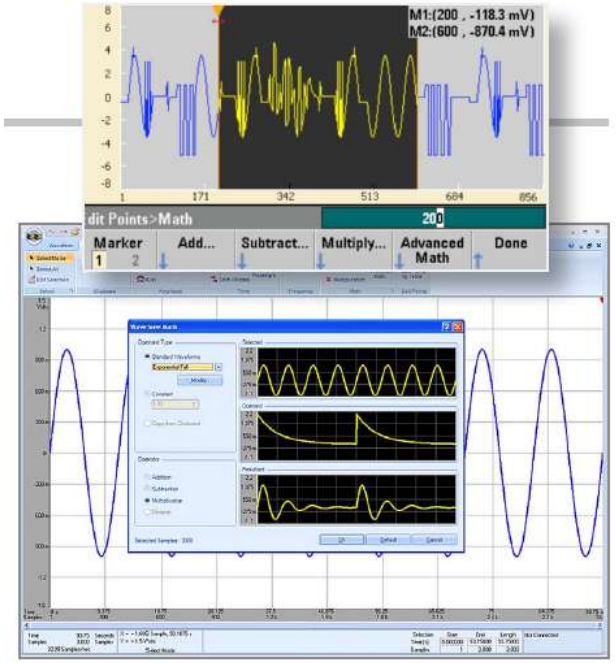
Lab 3: Setup

- Using the BNC cable, connect channel 1 of 33600A to channel 1 of the scope. (Disconnect channel 2 on both ends)
- Set the 33600A to factory default settings by pressing **System** → **Set to Defaults** → and **Yes**.

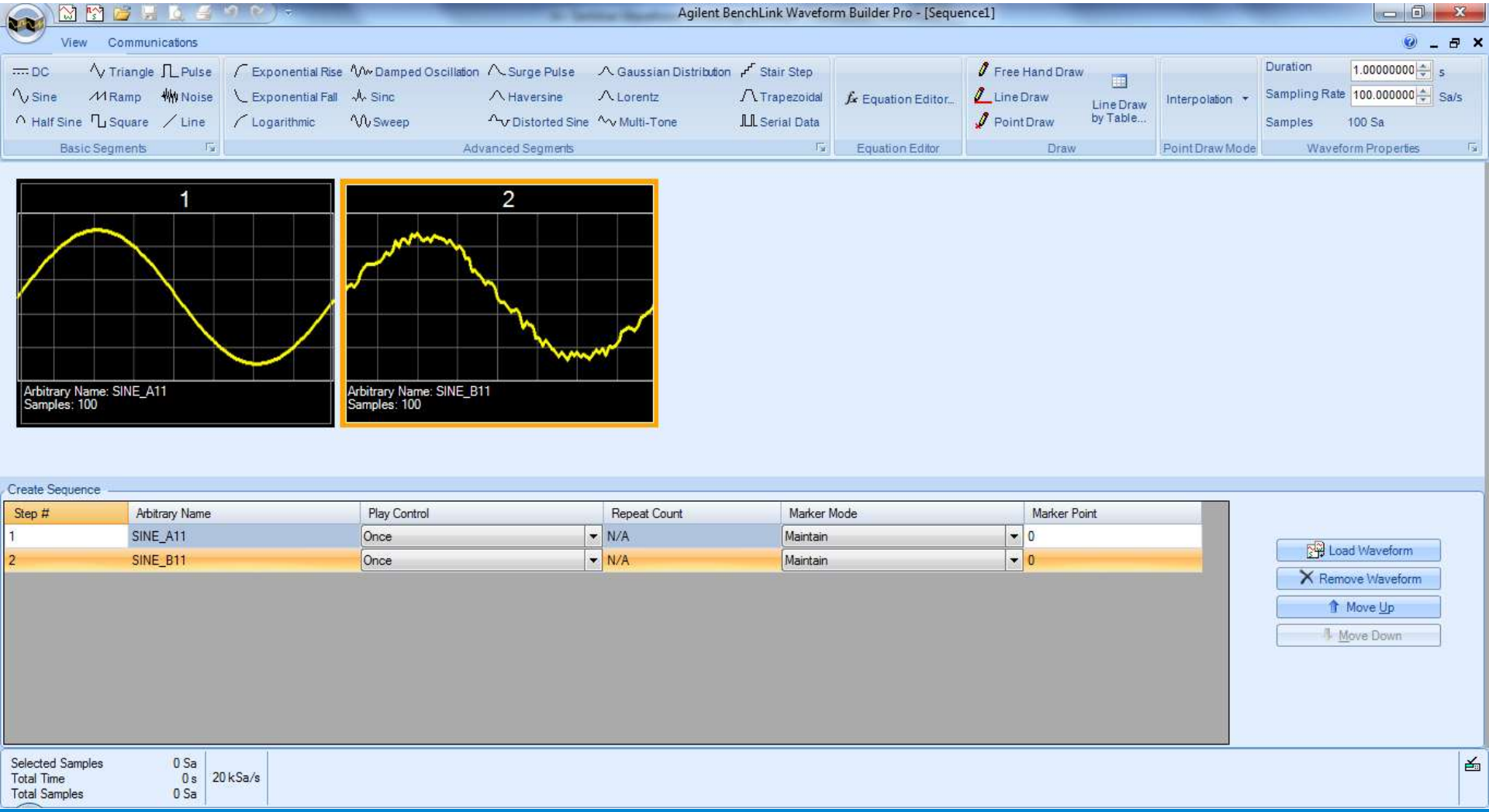
Lab 3: Using BenchLink Waveform Builder

We used 33503A BenchLink Waveform Builder Pro to create the sequence file

- Create and edit complex waveforms
  - Equation editor, waveform math
  - Drawing tools
  - Function library, sequencer, filters
  - Sequencing



BenchLink Waveform Builder Example

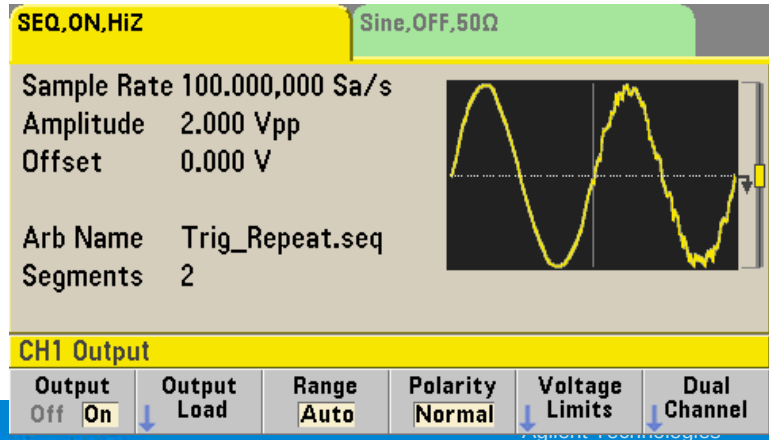


Lab 3: 33600A Setup

1. Press **Channel 1** → **Output Load** → **Set to High Z**. The 33600A channel 1 will now be set for high Z output load to match the input impedance of the HH scope.
2. Load the sequence waveform to channel 1 by pressing **Waveforms**→**Arb**→**Arbs**→**Select Arb**, browse the internal memory, and select "Trig_Repeat.seq" in the SEQ folder. Use the knob and arrow keys to navigate through the file structure and press **Select** to output the selected sequence file.

Lab 3: Setting the Parameters

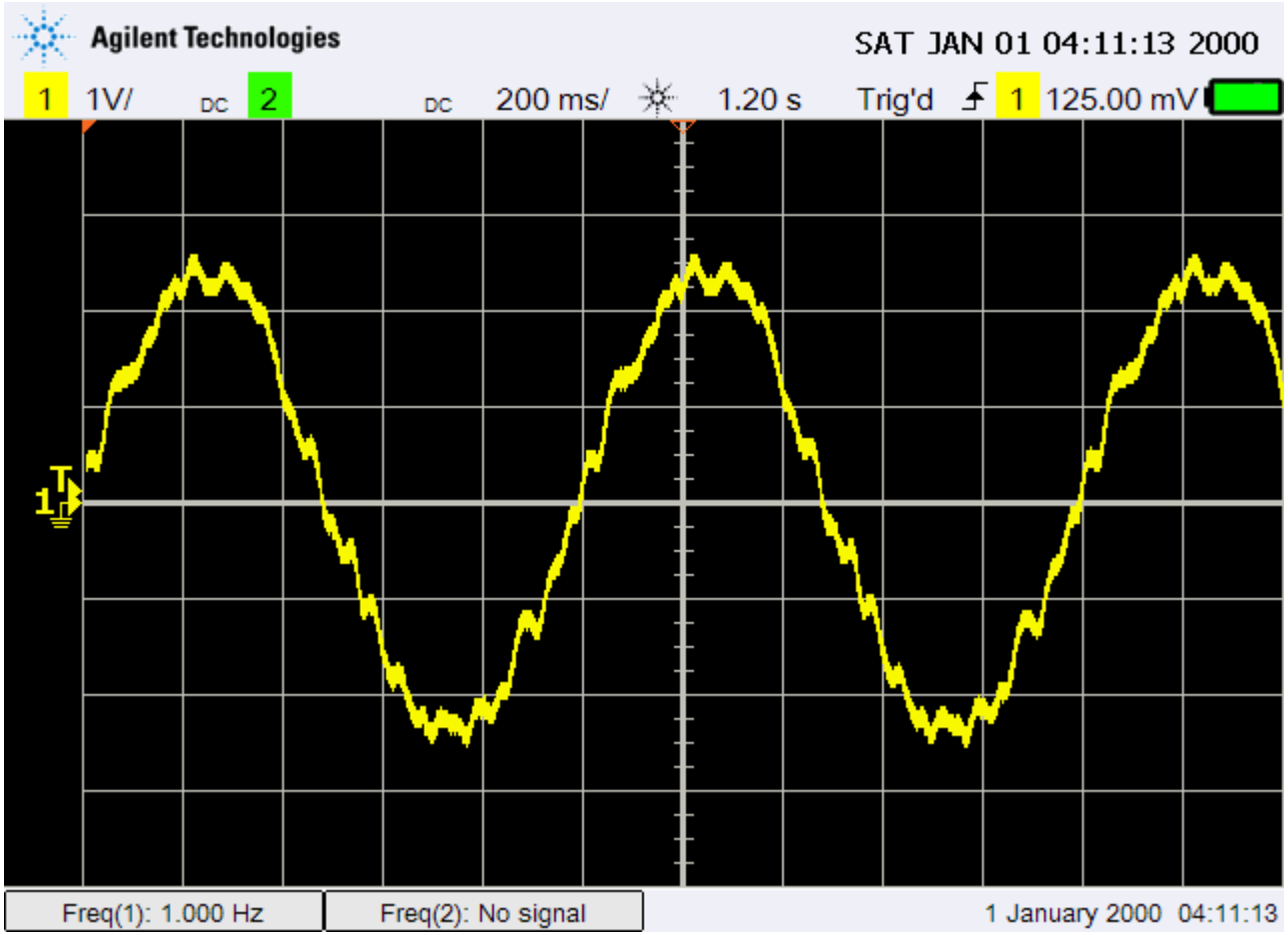
3. Press **Parameters** → **Sample rate**, and use the number pad to key in **100** followed by **Sa/s**
4. Set Pk-Pk voltage to 500 mV on the 33600A
   a. Press **Parameters** → **Amplitude**. Then key in **500** followed by **mV**
5. Press **Trigger** → **Source** → **Manual** to use manual triggering
6. Press **Channel 1** → **Output** → **On** to turn on the output.



Lab 3: Viewing on the Scope

7. On the oscilloscope, set the vertical scale to 1V/div, and horizontal scale to 200ms/division and change the horizontal time delay to 1.2 seconds. Use the position keys above the CH 1 Vertical label to center the signal on the screen if not done already.
8. Press **Trigger** on the 33600A to move to the next part of the sequence. *Observe the waveform display on the scope and notice the noisy cycles every time the trigger is pressed.*

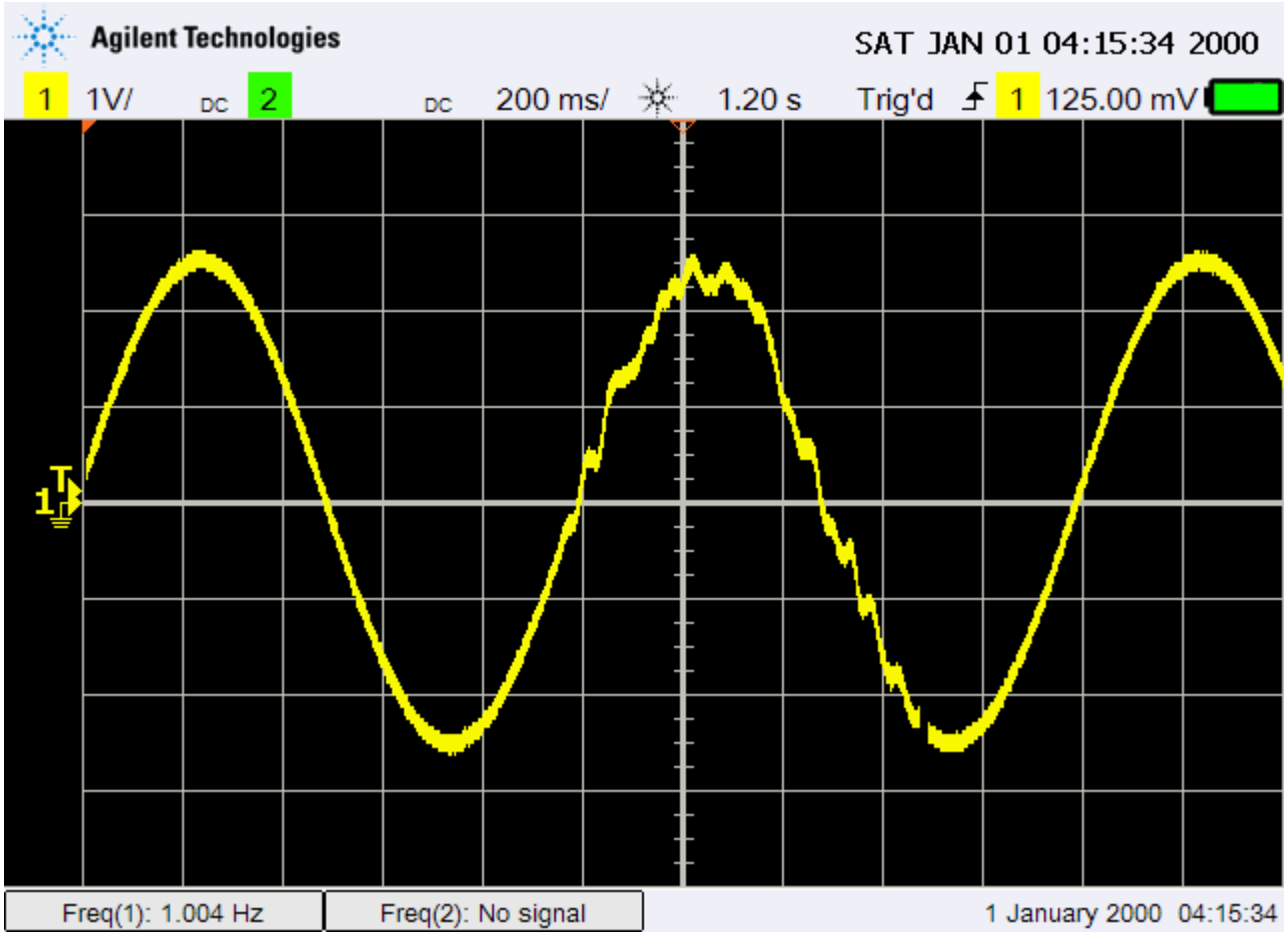
Lab 3: Trig_Repeat.seq Results



Lab 3: Changing the Sequence

9. Load the new sequence waveform to channel 1 by pressing **Waveforms**→**Arb**→**Arbs**→**Select Arb**, browse the internal memory, and select "Trig_Hold.seq" in the SEQ folder. Use the knob and arrow keys to navigate through the file structure and press **Select** to output the selected sequence file.
10. Set Pk-Pk voltage to 500mV on the 33600A
11. The new sequence will continue to output the noisy sine until the trigger is pressed.

Lab 3: Trig_Hold.seq Results



Lab 3: Reflections

What are the benefits of sequencing waveforms?

- Re-order signals, change portions of waveform, sweep through different frequencies, greater flexibility and efficiency in waveform generation

Lab 4: Creating Long, Complex Waveforms

Typical Test Challenges :

- Long Signals that are non-repeating
- Simple signals that need a lot of time resolution
- Simulating a digital data protocol
- Simulating a digitally modulated carrier

How True*form* helps:

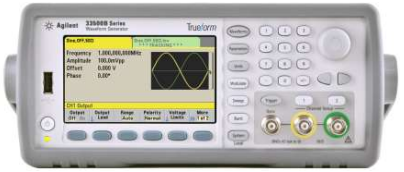
- Deep waveform memory
- 1 GSa/s arb sampling rate
- **True*form*** waveform generator accuracy
- Ample onboard memory to store all of your waveforms

Lab 4: Creating Long, Complex Waveforms

Lab Objective: Highlight deeper waveform memory for complex signals

Equipment:

- 33600A
- Custom Speaker assembly



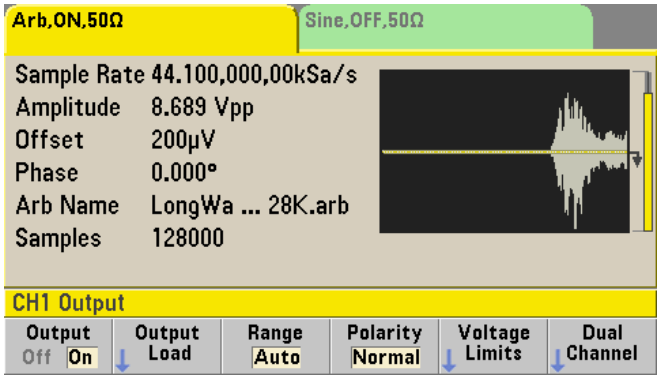
Lab 4: Setup

- Power the custom speaker assembly and connect the BNC cables to channels 1 and 2 of the 33600A.
- Set the 33600A to factory default settings by pressing **System** → **Set to Defaults** → and **Yes**.

Lab 4: Setup Channel 1

1. Press **Channel 1** → **Output Load** → Set to **50 Ohm**.
2. On channel 1 of the 33600A, press **Waveforms** → **Arb** → **Arbs** → **Select Arb**, and open the file "longwaveform_128k.arb". Use the knob and arrow keys to navigate through the file structure and press **Select** to output the selected waveform file. *This will output an audio arb to channel 1 .*
3. Press **Channel 1** → **Output** to turn on the output.

Lab 4: Playing the Waveform



4. [instructor] On channel 1 of the 33600A, press **Waveforms** → **Arb** → **Arbs** → **Select Arb**, and open the file “longwaveform.arb” to output a long audio arb to channel 1 . Use the knob and arrow keys to navigate through the file structure and press **Select** to output the selected waveform file.

Lab 4: Changing the Frequency

4. Press **Units**→**Arb rate** and choose "**Freq**". *The factory default unit is Arb Rate, and by changing the unit to frequency we can edit the frequency of the arb waveform easily without additional steps of calculating the equivalent frequency using the given sample rate.*
5. Press **Parameters** → **Arb Freq**. Use the knob to change the frequency at which the song plays.

Lab 4: Reflection

How are **True*form*** Waveform Generators able to help create long, complex arbitrary waveforms?

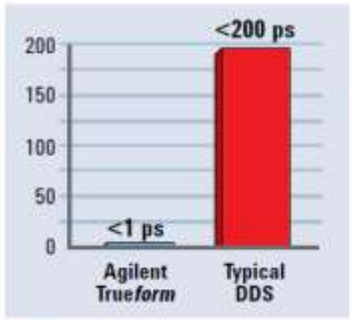
- Large memory (4M points standard, 64M optional)
- 1 GSa/s sample rate
- High accuracy signals with **True*form*** technology

Agenda

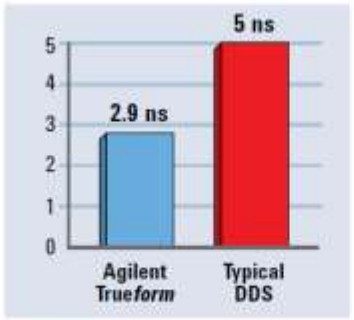
- Waveform Generator Basics
- Test Challenges with Hands On
  - Generating High Integrity Signals
  - Creating Differential Outputs
  - Sequencing Waveform Segments
  - Creating Long, Complex Waveforms
- Summary, BenchVue and Basic Instruments

True*form* vs DDS

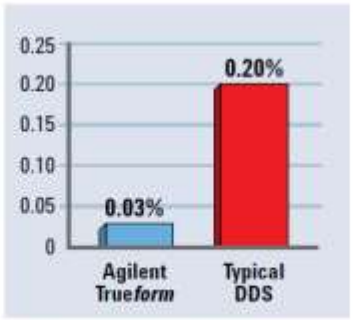
	DDS: Traditional 100 MHz Waveform Generator	True*form:* Agilent 80 and 120 MHz Waveform Generator	Improvement
Edge jitter	<200 ps	**<1 ps**	200x better
Custom waveform replication	Skips waveform points	**100% point coverage**	Exact waveform replication
Total harmonic distortion	0.2%	**0.03%**	5x better
Anti-alias filtering	Must provide externally	**Always anti-aliased**	No anti-aliasing artifacts
Sequenced arb	Not possible	**Standard**	Easily create complex waveform sequences



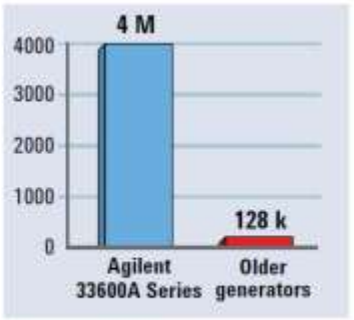
Jitter



Risetime



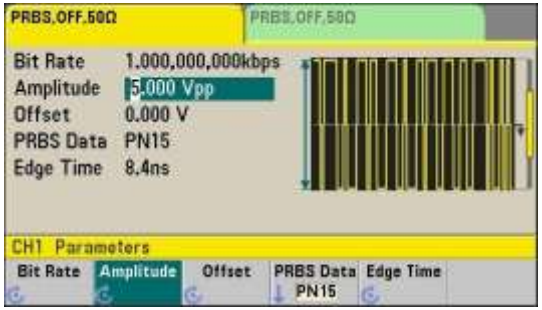
Total harmonic distortion



Standard memory

33600A Series Summary

- 4 models: 80 or 120 MHz, 1 or 2 channel
- **True*form*** technology
- $4000 - $7000
- Special signals:
  - PRBS function
  - Variable bandwidth noise
  - Sum modulation
  - Low voltage signals to 1 mVpp



- 33500B 20 and 30 MHz Series **True*form*** Waveform Generators also available ($1650 - $3250)

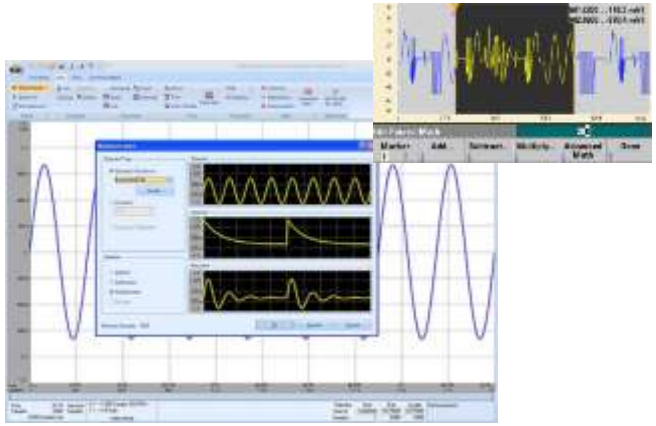
33600A Promotion

Receive a FREE 33503A BenchLink Waveform Builder Pro software license (a $750 value) with a purchase of any of the NEW 33600A Series **True*form*** Waveform Generators

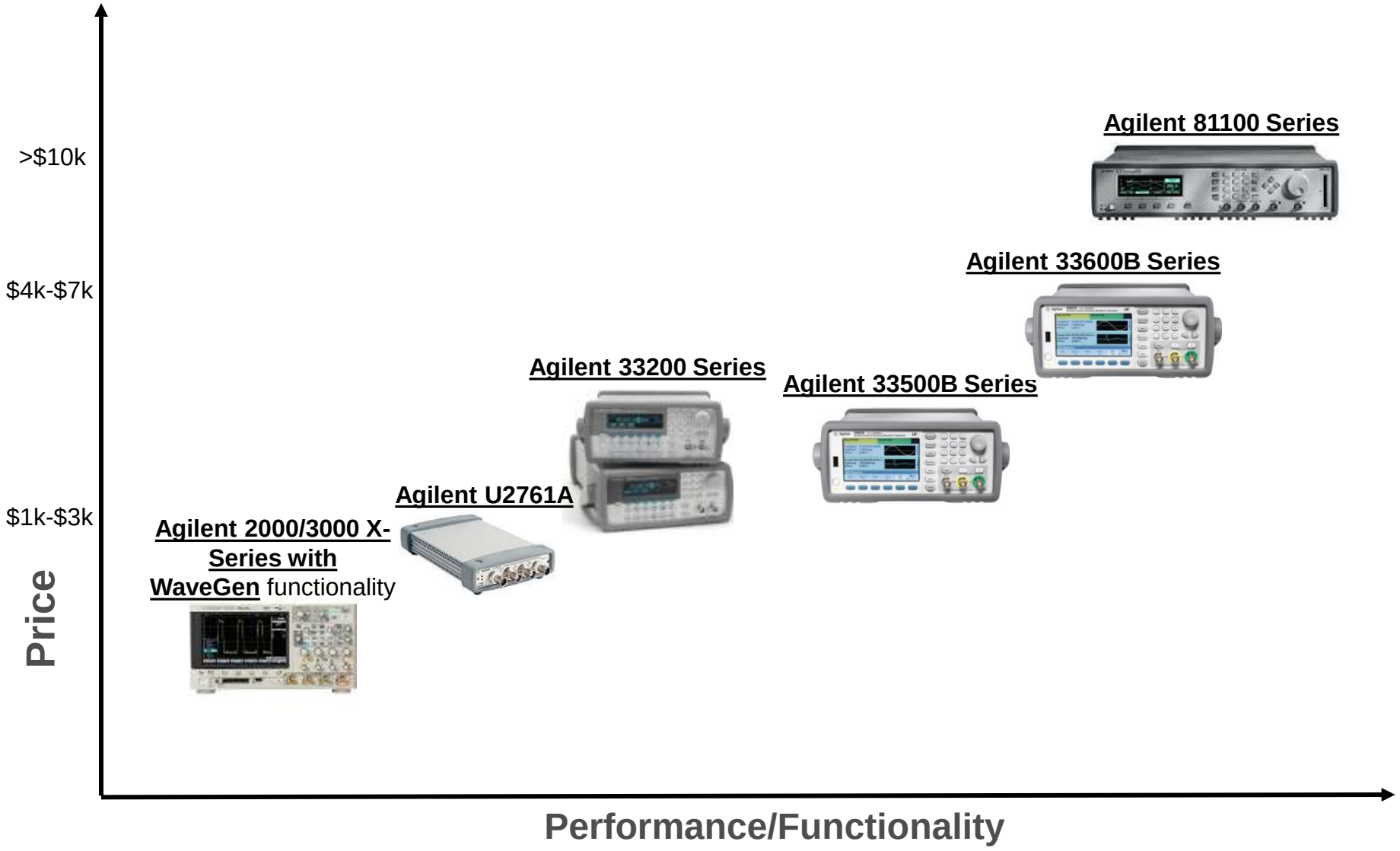
- 33611A, 33612A, 33621A, 33622A

No promotion code needed. Customers register at www.agilent.com/find/33600promo

Begins:
Mar 4, 2014
Ends:
Aug 31, 2014



Agilent Waveform Generator Positioning



BenchVue and Waveform Generators

BenchVue Software Supported Instruments

Digital multimeters (7)	Function generators (13)	DC power supplies (18)	Signal analyzers (16)	Oscilloscopes (98)
34401A	33210A	E3631A	PSA E444x	MSO/DSO-X 2000 Series (12)
34405A	33220A	E3632A	ESA E440x	MSO/DSO-X 3000 Series (18)
34410A	33250A	E3633A	PXA N9030A	MSO/DSO-X 4000 Series (16)
34411A	33521A	E3634A	MXA N9020A	MSO/DSO 6000 Series (16)
34450A	33522A	E3640A	CXA E9000A	DSO/MSO 7000 Series (28)
34460A	33509B	E3641A	EXA N9010A	DSO/MSO 9000 Series (8)
34461A	33510B	E3642A	N93xx Series	
	33511B	E3643A		
	33512B	E3644A		
	33519B	E3645A		
	33520B	E3646A		
	33521B	E3647A		
	33522B	E3648A		
	33611A	E3649A		
	33612A	N6700A/B		
	33621A	N6701A		
	33622A	N6702A		
		N6705B		

BenchVue: Function Generators

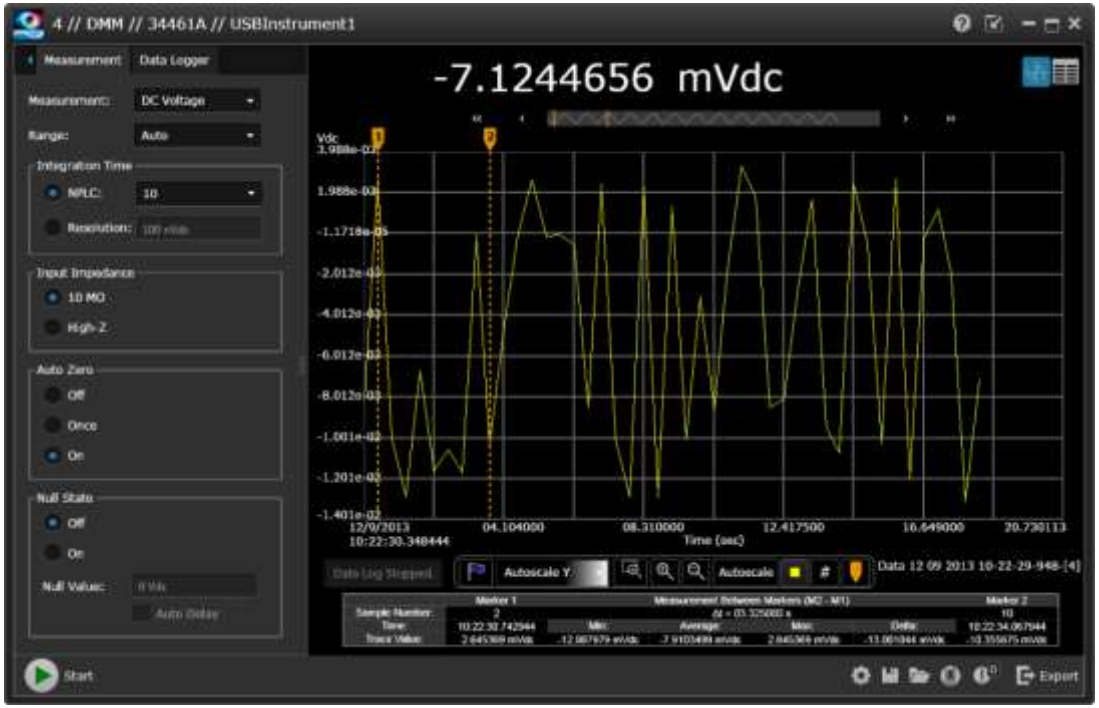
Supported Functionality

- Waveform selection
- Instrument configuration
- Exporting
  - Instrument properties
- Save/recall instrument state

Supported Instruments:

- 33210A, 33220A, 33250A, 33521A, 33522A, 33509B, 33510B, 33511B, 33512B, 33519B, 33520B, 33521B, 33522B, 33611A, 33612A, 33621A,33622A

BenchVue: Digital Multimeters



Supported Functionality

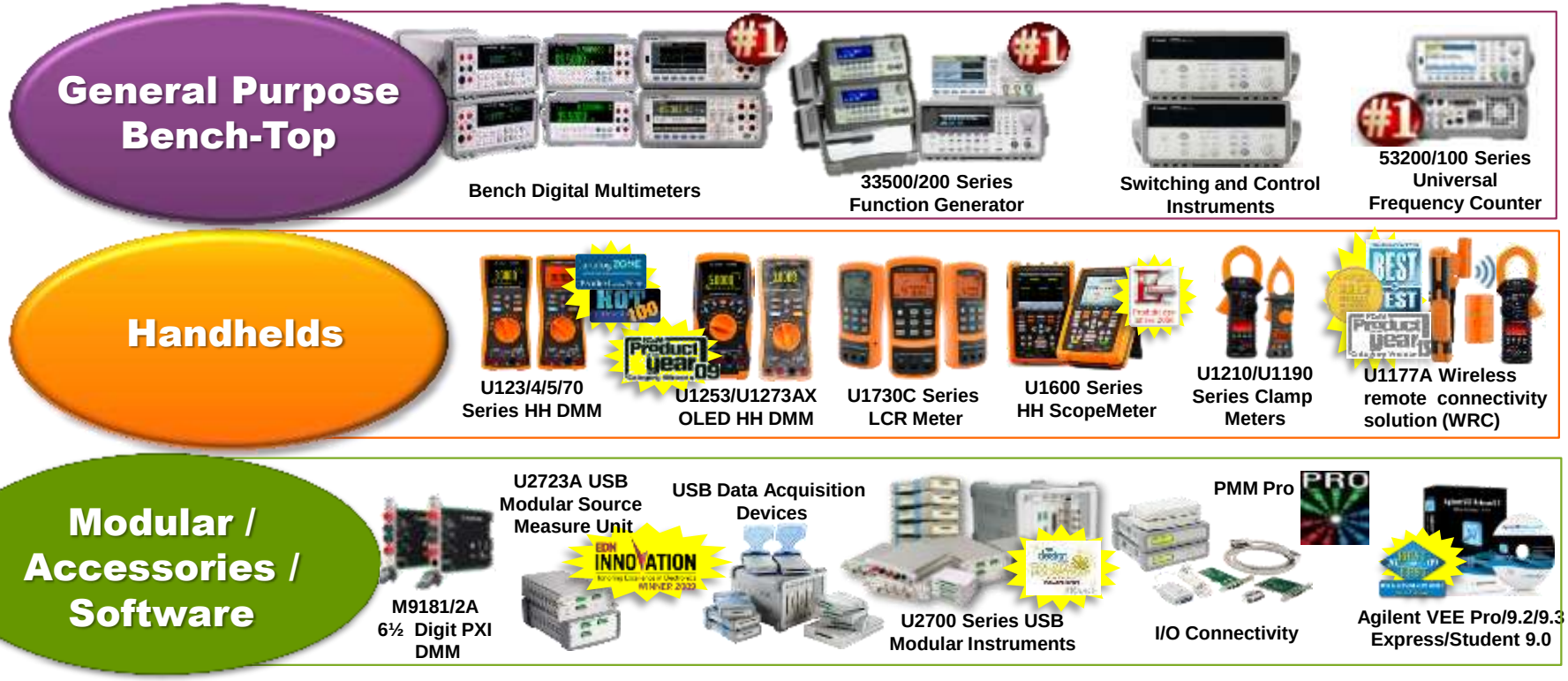
- Measurement configuration
- Visualization & annotation
- Data Logging
- Exporting
  - Screen shots
  - Data
- Save/recall instrument state
- BenchVue Mobile (iOS)

Supported Instruments:

- 34401A, 34405A, 34410A, 34411A, 34450A, 34460A, 34461A

Basic Instruments from Agilent

Be sure to check out the demo table for more Agilent instruments!



Thank You!

Unlocking Measurement Insights for 75 Years

BACKUP SLIDES

Equipment Pre-Setup Checklist

33622A (33600A on front panel):

- Turn on state is set to Defaults
- Files preloaded via thumb drive:
  - “Glitch_DDS_33600.arb” to internal
  - “longwaveform_128k.arb” to internal
  - SEQ folder to internal
    - “Sine_A.barb”, “Sine_B.barb”, “Trig_Hold.seq”, “Trig_Repeat.seq”

33250A:

- Turn on state is set to Defaults
- File preloaded via BLWB:
  - “Glitch_DDS_33250A.arb” to ArbMem1 as “GLITCH”

True*form* Waveform Generators

(8) 33500B Series True*form* Waveform Generators for value price points

- Choose between 20 or 30 MHz
- Choose between 1 or 2 channel
- Choose Arbitrary waveform capability (1M or 16M optional) or none
- Software upgradeable for bandwidth, arb, arb memory, IQ player
- $1650 - $3250

(4) 33600A Series True*form* Waveform Generators for higher bandwidth

- Choose between 80 or 120 MHz
- Choose between 1 or 2 channel
- Arbitrary waveforms on all models (4M points or 64M optional)
- Software upgradeable for bandwidth, arb memory, IQ player
- $4000 - $7000

BenchVue vs BenchLink

- BenchVue: setup, view, and integrate different benchtop instruments
  - No arbitrary waveform editing capabilities
- BenchLink: Waveform Builder Pro creates and edits arbitrary waveforms
  - Built-in functions with adjustable parameters, equation editor, drawing tools using points and lines, sequencing

	BenchVue 1.0	Benchlink Waveform Builder Pro	Benchlink Data Logger Pro
Targeted Customer Application	Measurement visibility and short data capture (<1 hr) for your bench, screen shots & instrument state	Custom waveform creation for your arbitrary waveforms	Long duration data logging and conditional actions based on measurements
Instrument Support	Limited DMMs, Function Generators, Power Supplies, Spectrum Analyzers, Scopes	Agilent Function Generators, Oscilloscopes	Agilent 34970A, 34972A, 34980A
Cost	$0	$750	$1000