Keysight Technologies
81133A and 81134A
3.35 GHz Pulse Pattern Generators

Data Sheet

Version 1.5

KEYSIGHT
TECHNOLOGIES

81133A and 81134A 3.35 GHz Pulse Pattern Generators

The need for pulse and pattern generation is fundamental to digital device characterization tasks. The ability to emulate the pulse and pattern conditions to which the device will encounter in its final application, is essential. This emulation should include both typical and worst case conditions. Accurate emulation requires superlative signal integrity and timing performance along with full control over parameters that allow specific worst case testing.

Setting Standards

The Keysight Technologies, Inc. 81133A and 81134A 3.35 GHz Pulse Pattern Generators provide programmable pulse periods from 15 MHz (66.6 ns) to 3.35 GHz (298.5 ps) on all channels. With frequency ranges this fast, the transition time performance becomes critical; the Keysight 81133A and 81134A perform at less than 60 ps transition. The Delay Control Input and the Variable Crossover Point functionalities allow fast and easy Signal Integrity measurements, including emulation of real world signals by adding jitter to clock or data signals or by distorting the 'eye' for eye diagram measurements.

Key Features

- Pulse, Data Pattern and PRBS generation from 15 MHz up to 3.35 GHz
- Data formats NRZ, RZ and R1
- 12 Mbit pattern memory per channel
- Low jitter, high accuracy
- Fast transition times
- PRBS generation from 25 -1...231 -1
- Delay control input for pre-defined jitter input
- Jitter emulation up to ± 250 ps
- Easy-to-use graphical user interface
- 50 mV to 2 Vpp output amplitude
- Differential outputs
- 1 or 2 channels

Connectors

Front panel connectors

All signal outputs and inputs are accessible at the front panel. These are:

- 2 (or 4) output connectors for the 1 (or 2) differential channel(s)
- Trigger output
- Clock input
- Start input
- 1 (or 2) delay control input(s) for the 1 (or 2) channel(s)

Rear panel connectors

Remote programming interfaces: GPIB, LAN, USB 2.0 (see also 'Additional Features')

Clock Source

Selecting the clock source determines the origin of the time base. All other timing parameters are derived from it.

There are two choices:

Internal

The Clock is derived from the internal oscillator.

External

The Clock is derived from the external input. The ext. frequency is measured once and is thereafter used to maintain the calculated frequency dependant values including the pulse width or phase if set to duty cycle mode or phase mode respectively.

External 10 MHz reference

A 10 MHz reference clock can be applied to the clock input. This clock is used as a reference for all timing parameters.

Direct mode (direct internal/ direct external)

The direct modes allow changes of frequency without dropouts in the range of 1:2. This can be used for applications, where dropouts would make a measurement impossible (e.g.: PLL frequency sweep, micro processor clock sweep). In both direct modes, the delay and deskew of all channels is set to zero (deskewed at the connectors) and can't be changed. Square mode, data mode (NRZ only) and PRBS mode (NRZ only) are available. In 'Direct External' mode the PLL is bypassed and the instrument exactly follows the externally attached frequency.

Frequency/Period

The main frequency is set for all channels. The frequency can also be set as period length. The frequency range is 15 Hz to 3.35 GHz, equal to 66.6µ to 298.5 ps period. The frequency range can also be further divided individually for each channel.

Available dividers are 1, 2, 4, 8, 16, 32, 64, 128.

Main Modes

Pulse pattern mode

In Pulse Pattern mode, each channel can be set independently to one of the channel modes described in 'Channel Modes'.

Burst mode

Burst mode enables the output of a burst consisting of data repeated n times followed by continuous zero data. It can be started either by:

- applying a signal at the start input.
- the start button.
- sending a command through the remote connections.

Repetitive burst mode

This command selects a repeated burst consisting of data repeated n times followed by a pause of p times zeros of the same length as the data before the data is repeated.

Channel Modes

The following channel modes are available, if the instrument main mode is set to pulse/pattern.

NOTE: The frequency of each channel can be optionally divided by 1, 2, 4, 8, 16, 32, 64, 128.

Square

Generates a square wave (clock) of fixed width (50% duty cycle)

Pulse

Generates pulses with selectable width or duty cycle.

Data

Generates data in either RZ, R1 or NRZ format. In RZ and R1 mode, the pulse width can be selected as either width or duty cycle.

PRBS

Outputs a selectable PRBS (Pseudo Random Binary Sequence) polynomial of either RZ, R1 or NRZ format. In RZ and R1 mode, the pulse width can be selected as either width or duty cycle.

Timing

Delay

The delay can be set:

- as an absolute value in nano seconds or pico seconds. The delay remains unchanged as the frequency or the period is modified.
- as phase (degrees relative to period). The phase remains unchanged as the frequency or the period is modified.

Deskew

The deskew adjustment allows for the compensation of e.g. cable delays. Deskew adjustment is not available in Direct Mode. In this case, all channels are factory deskewed at the front panel connectors.

Width

There are two ways to set the pulse width:

- as absolute value in nano seconds or pico seconds. In absolute mode, the pulse width stays constant when the frequency or period is changed.
- as duty cycle (percentage of period). In duty cycle mode, the duty cycle stays constant when the frequency or period is changed.

NOTE: Width adjustment is not available if data mode is set to NRZ.

Pulse Format

RZ

Return to zero pulse format. On 0 bit patterns, the signal remains at the low level. On 1 bit patterns, the signal goes high and back to the low level after the time specified by the pulse width or the duty cycle parameter.

R1

Return to one pulse format. On 1 bit patterns, the signal remains at the high level. On 0 bit patterns, the signal goes low and back to the high level after the time specified by the pulse width or the duty cycle parameter.

NRZ

Non-return to zero pulse format. The signal remains at the low level or high level according to the bit level of the pattern for the entire period.

NOTE: The pulse format selection is only available when operating the instrument in the data/pattern modes.

Variable Crossover

For each channel, the cross over of the NRZ signal in PRBS or data mode can be adjusted. This is used to artificially close the eye pattern simulating distortion. Figure 1 shows the normal and complement output with cross over point set to 50% and 70% respectively.

NOTE: Variable Crossover feature is available in NRZ mode only.

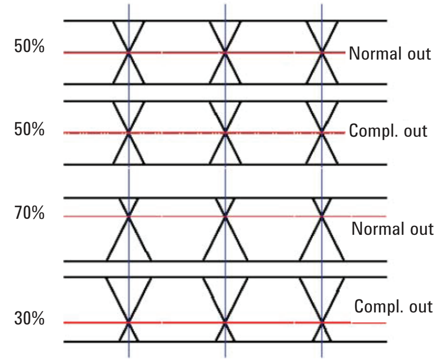

Figure 1. Variable crossover

Pattern

There are two types of patterns available:

Data

Arbitrary data up to the maximum available memory per channel can be setup as pattern data.

PRBS

Predefined PRBS of 25-1 to 231-1 can be setup as pattern data.

Data Polarity

In pattern mode the polarity of the data can be set to either normal or inverted. When set to inverted, a logical ‘1’ will become a logical ‘0’ at the output and vice versa.

Levels

Pre-defined levels

Pre-defined levels allow the easy setup of the channels for commonly used logic families. These are: ECL, ECLGND, LVT, LVPCL and LVDS.

Custom levels

Levels can be set to custom values in either of two ways:
- low level and high level
- amplitude and offset

Level protection

Output levels can be limited to a user defined range to protect the device under test. Level protection can be switched on and off.

Level polarity

Level polarity can be set to either normal or inverted. Set to inverted, the low level and the high level values are interchanged.

Outputs enable/disable

Outputs can be switched on and off independently for each channel and for each normal/complement connector.

Auxiliary Channels

Outputs

Trigger output

The trigger output can be enabled or disabled. The levels of the trigger output can be set as high level or low level pair.

The trigger output can be set to one of the following modes:
- Trigger on clock The frequency of the trigger output is identical to the system frequency. It can be further divided by n (n= 1, 2, 3, 4, 5, 6, 7...231-1).
- Trigger on data One Trigger pulse occurs on the first part of the repetitive data pattern.

Inputs

NOTE: The built-in input and output terminations eliminate the need for external bias networks and prevent a degrading of the input/output sensitivity

Clock input

The clock input can be 'AC' or 'DC' terminated. The 'DC' termination voltage can be set. See also 'Clock Source - external'.

Start input

The start input can be used to start the instrument. After being armed, the instrument waits for the selected edge of the applied signal.

Parameters:
- Threshold (voltage)
- Edge (rising/falling)
- Termination voltage

Store/Recall

Allows permanent storage of instrument settings, including all signal parameters and data settings. Data patterns up to 8K bit length are also stored. The instrument provides memory for 9 different settings.

In addition, the 81133A and 81134A stores the current settings at shutdown and restored them on next power-on.

For data patterns with more than 8K Bit length, it is recommended to use the special PC-based pattern editor.

Overprogramming

Many parameters can be programmed to values that exceed the specified ranges.

Specifications

Specifications describe the instrument's warranted performance. Non-warranted values are described as typical. All specifications apply after a 30 min warm-up with 50 Ohm source/load resistance. All specifications are valid from 0 to 55 °C ambient temperature if not stated otherwise.

Internal clock generation	
Period range	298.5 ps - 66.6 ns
Period resolution	6 digits, 0.001 ps best case
Frequency range	15 MHz - 3.35 GHz
Frequency resolution	1 Hz
Accuracy	50 ppm
Jitter	
Random jitter (clock mode)	< 4 ps RMS typical [1,2]
Total jitter (data mode)	< 40 ps pp[1,3]
	(30 ps typical for frequencies <= 3 GHz)

1. Measured on a 86100 Infiniium DCA-J Wideband Oscilloscope by using the Enhanced Jitter Analysis Software
2. Clock pattern
3. PRBS 2^7-1, BER 10^{-12}

Transition Times

The transition times can be modified by the 'Pulse Performance' selector:

Mode	Description	Typical transition times
Fast	Provides faster rise and fall times 60 to 75 ps	
Normal	Standard setting with guaranteed specifications	70 to 80 ps
Smooth	Provides slower rise and fall times and smoother edges	80 to 120 ps

Human Interface

The graphical user interface enables the user to operate the instrument as simply as possible. All parameters are displayed on a color coordinated display. The instrument setup is intuitive. All important parameters can be easily accessed and modified with numeric keys, cursor keys or the twist and push button. A content sensitive online help enables users to set up their test configurations quickly and easily.

Channel output timing	
Number of channels	1, (81133A), 2 (81134A)
Transition times	(10 % to 90 %) < 90 ps
Transition times	(20 % to 80 %) < 60 ps
Delay variation	–5 ns to 230 ns
Delay resolution	1 ps
Delay accuracy	± 20 ps
Phase	–6000 to +279000°
Phase resolution	0.01°, or 1 ps
Skew between differential outputs	< 20 ps nominal
Maximum skew range	± 10 ns,
Width range	100 ps to (period - 100 ps)
Width resolution	1 ps
Width accuracy	± 40 ps
Duty cycle range	0.15 - 99.85%
Duty cycle resolution	0.002%, or 1 ps
Divide by	1, 2, 4, 8, 16, 32, 64, 128

NOTE: Timing specifications are valid after auto calibration with a maximum temperature variation of ±10 °C.

Channel output levels	
Amplitude	50 mV to 2.00 V
Level window	–2.00 to +3.00 V
Level resolution	10 mV
Level accuracy	2% of setting ±20 mV
Amplitude accuracy	2% ± 20 mV
Settling time	1 ns
Overshoot, ringing	< 10 % ± 10 mV differential outputs
Impedance	50 Ohm nominal
Variable crossover	30 to 70% typical
Maximum external termination voltage	–2.00 to +3.00 V
Short circuit current	–80 mA <= I_{sc} <= 120 mA nominal
Limit	High and low levels into 50 Ohm can be limited.
Normal/complement	Selectable
Disable	Yes (relay)

Pulse Pattern and Data Functionality

The 81133A and 81134A can generate an 8 KBit digital pattern in NRZ, RZ and R1 mode. Furthermore, the 81133A and 81134A can provide a hardware generated pseudo random binary sequence (PRBS) from $2^5 - 1$ to $2^{31} - 1$.

Jitter Emulation (Delay Control Input)

Full control over the signal quality of pulse and data signals provides the Delay Control Input. With an external modulation source (e.g. Keysight 33250A) the amount and shape of signal jitter can be varied for stress tests or to emulate real world signals. The external source for jitter modulation is applied to this input. Jitter modulation can be turned on and off individually for each channel. Either one of two fixed sensitivities can be selected ± 25 ps or ± 250 ps resulting in a total of 50 ps or 500 ps. The amplitude of the modulated jitter is set by the voltage level of the signal applied to the Delay Control Input. The Variable Crossover Point feature provides additional control over the signal quality.

Data generation		
Memory depth	8 Kbit per channel/12 Mbit extended memory	
Data format	RZ/NRZ/R1	
PRBS	**2^n-1 , n = 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 23, 31**	
PRBS	**Polynomial**	**Comment**
2^5-1	$X^5 + X^4 + X^2 + X^1 + 1$	
2^6-1	$X^6 + X^5 + X^3 + X^2 + 1$	ITU-T V.29
2^7-1	$X^7 + X^6 + 1$	
2^8-1	$X^8 + X^7 + X^3 + X^2 + 1$	
2^9-1	$X^9 + X^5 + 1$	CCITT 0.153/ITU-T V.52
2^{10}-1	$X^{10} + X^7 + 1$	CCITT 0.152/ITU-T 0.152
2^{11}-1	$X^{11} + X^{19} + 1$	
2^{12}-1	$X^{12} + X^9 + X^8 + X^5 + 1$	
2^{13}-1	$X^{13} + X^{12} + X^{10} + X^9 + 1$	
2^{14}-1	$X^{14} + X^{13} + X^{10} + X^9 + 1$	
2^{15}-1	$X^{15} + X^{14} + 1$	CCITT 0.151/ITU-T 0.151
2^{23}-1	$X^{23} + X^{18} + 1$	CCITT 0.151/ITU-T 0.151
2^{31}-1	$X^{31} + X^{28} + 1$	

Trigger output	
Amplitude	50 mV to 2.00 V
Level window	–2.00 V . . +3.00 V
Resolution	10 mV
Format fixed duty cycle	50% nominal
Maximum external voltage	–2.00 V . . +3.00 V
Transition times (20% to 80% of amplitude)	< 100 ps (< 70 ps typical)
Minimum output frequency	15 MHz/divider factor
Mode clock clock divided by 1,2,3, . .	2^{31}-1 or trigger on bit 0 of data
Disable	Yes (relay)
Delay control input	
Interface	dc-coupled
Impedance	50 Ohm nominal
Input levels for full modulation range	±500 mV
Max input levels	±2.5 V
Delay modulation range	±250 ps, ±25 ps, selectable
Modulation frequency	0 Hz - 200 MHz

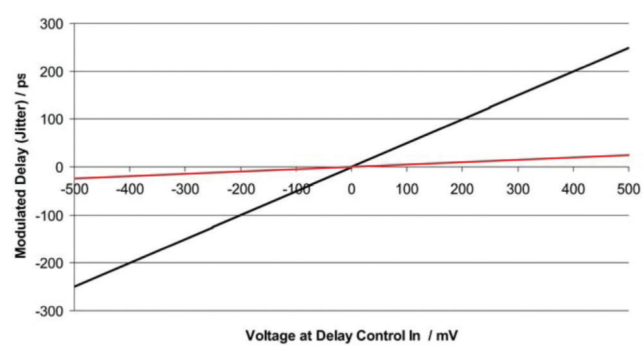

Figure 2. Modulated Delay (Jitter) vs Voltage Level at Delay-Control-Input for ±250 ps and ±25 ps settings

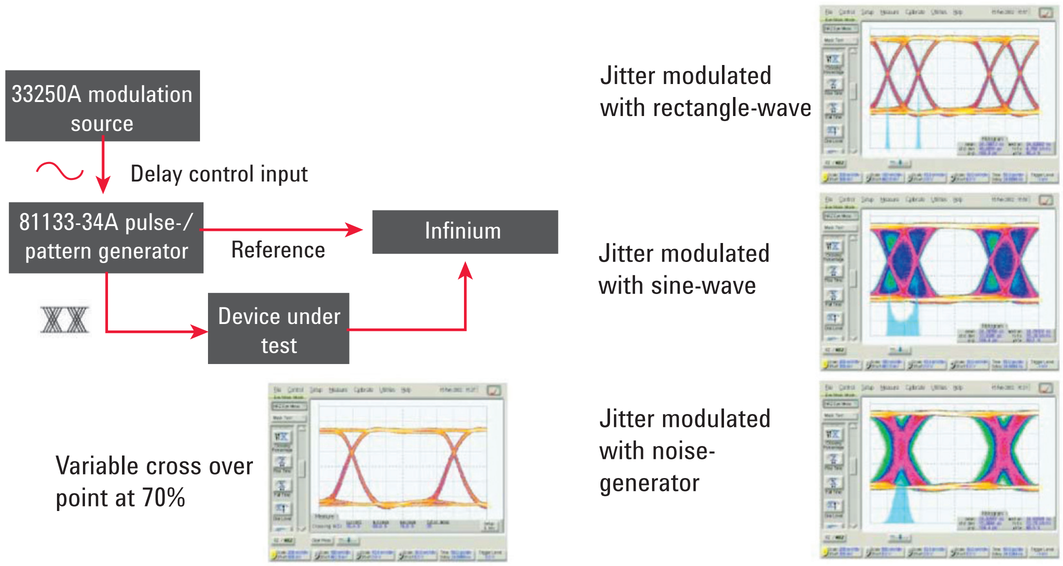

Figure 3.

Clock input	
Interface	ac-coupled with optional dc termination
Impedance	50 Ohm
Termination voltage	–2.0 V...+3.0 V
Minimum amplitude	300 mV, tr < 3 ns, 50% duty cycle; sine: 6 dBm
Maximum amplitude	3 Vpp, ± 5 Vdc
Frequency measurement	Yes
Period range	299 ps...66.6 ns
Period resolution	6 digits, 0.001 ps best case
Frequency range	15 MHz...3.35 GHz
Measurement resolution	100 kHz
Measurement accuracy	50 ppm
Propagation delay	
Clock input to trigger output 8.4 ns nominal, fixed	
Trigger output to channel output 32 ns nominal variable	
Additional features	
Remote interfaces	SCPI over GPIB, LAN and USB
Store/recall registers (Non volatile memory)	9 complete settings can be saved. The last settings are saved when power is turned off.

Start input	
Modes	Start [1]
Interface	dc-coupled
Impedance	50 Ohm nominal
Termination voltage	–2.0 V...3.0 V
Transitions	< 1 ns
Threshold	–1.8 to +4 V
Max. level window	–2 to +5 V

1. No fixed latency between assertion of start signal and start of output signal

General information	
Operating temperature	0 to +55 °C
Storage temperature	–40 to +70 °C
Humidity	95% R.H. (0 to +40 °C)
Warm up	30 Minutes
EMC	Class A
Power	100V to 240V AC nom.; 200 VA max.; 47 Hz to 63 Hz
Net weight	14.8 kg (32.6 lbs)
Shipping weight	19 kg (41.9 lbs)
Dimensions	145 x 426 x 553 (mm) 5.7 x 16.75 x 21.75 (in)
Recalibration period	3 years recommended

Ordering Information

Keysight 81133A	3.35 GHz 1-channel pulse/pattern generator
Keysight 81134A	3.35 GHz 2-channel pulse/pattern generator

Options

Keysight 8113xA-UK6	Commercial Calibration Certificate with Test Data
Keysight 8113xA-1CP	Rackmount and Handle Kit
Keysight 1494-0059	Rack Slide Kit
Keysight N4871A	Cable Kit: SMA matched pair, tt=50 ps (Recommended for high performance and differential applications)

Accessories

Keysight 15435A	Transition Time Converter 150 ps
Keysight 15432B	Transition Time Converter 250 ps
Keysight 15433B	Transition Time Converter 500 ps
Keysight 15434B	Transition Time Converter 1000 ps
Keysight 15438A	Transition Time Converter 2000 ps

Complimentary products

DSO 91xxxA/DCA-X	1/20 GHz
DSO 90604A/90804A	6/8 GHz
DSO 90404A	4 GHz

Warranty and service

3 years Return-to-Keysight (standard with every order)

5 years Return-to-Keysight

Related literature	Publication number
Pulse Pattern and Function Arbitrary Generators and Arbitrary Waveform Generator, Brochure	5980-0489E
Keysight 81100 Family Pulse Pattern, Data Sheet	5980-1215E
Generating and Measuring Jitter, Application Note	5988-9411EN
Keysight 81133A/ 81134A Extended Pattern Memory, Product Fact Sheet	5988-9591EN

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