

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

Data Sheet



Figure 1: 81134A

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 simulate the pulse and pattern conditions that the device will encounter in its final application, is essential. These device tests should include both typical and worst case conditions. Accurate measurements and tests require leading-edge signal integrity and timing performance along with full control over all signal parameters in order to enable worst case tests.

Setting Standards

The Agilent 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 wide, the transition time performance becomes critical; the Agilent 81133A and 81134A perform at less than 60 ps transition. With a RMS jitter of 1.5 ps (typ), the best signal quality is assured. The Delay Control Input and the Variable Crossover Point functionalities allow fast and easy Signal Integrity measurements, including generation of real world-like signals by adding jitter to clock or data signals or by distorting the signal 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 $2^5 - 1$ to $2^{31} - 1$
- Delay control input for pre-defined jitter injection
- Jitter emulation up to ± 250 ps
- Easy-to-use graphical user interface
- 50 mV_{pp} to 2 V_{pp} output amplitude
- Differential outputs
- 1 or 2 channels



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Connectors

81133A - Front Panel Connectors

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

- 2 Output Connectors for the differential channel
- Trigger Output
- Clock Input
- Start Input
- 1 Delay Control Input

81134A - Front Panel Connectors

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

- 4 Output Connectors for the 2 differential channels
- Trigger Output
- Clock Input
- Start Input
- 2 Delay Control Inputs for both of the output channels

Rear Panel Connectors

Remote control 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 YIG oscillator.

External

The Clock is derived from the external input. The external 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 prevent measurement with reliable results (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 MHz to 3.35 GHz, equal to 66.6 ns 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

Generates a selectable PRBS (Pseudo Random Bit 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.
- a 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

The pulse width can be set as:

- an absolute value in nano seconds or pico seconds. In absolute mode, the pulse width stays constant when the frequency or period is changed.
- a 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 switches to the high level 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 switches to the low level 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.

Pattern

Two types of patterns are available:

Data

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

PRBS

Pre-defined PRBS of 2^5-1 to $2^{31}-1$ can be set up 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 convenient 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 Enabled/Disabled

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

Store/Recall

Allows permanent storage of instrument settings, including all signal parameters and data settings. Data patterns up to 8 kBit 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 restores them on the next power-on.

For data patterns with more than 8 kBit length, it is recommended to use the PC-based Pattern Management Tool.

Auxiliary Channels

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

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 ($n = 1, 2, 3, 4, 5, 6, 7 \dots 2^{31}-1$).

- Trigger on data

A single trigger pulse occurs on the start of the repetitive data pattern.

Inputs

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

Jitter Injection

With the Delay Control Input a delay to the instrument's output signals can easily be added. As the added delay is only dependent on the

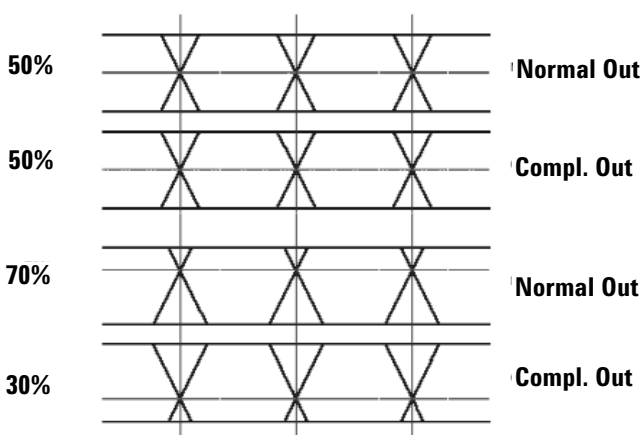


Figure 2: Variable Crossover

attached voltage, any form of delay - including jitter - can be emulated. Up to a frequency of 200 MHz, the delay added to the output by the voltage attached at the Delay Control input is a linear function.

The maximum delay depends on the sensitivity selected and is either +/- 25ps or +/- 250 ps.

Variable Crossover

For each channel, the crossover of the NRZ signal in PRBS or data mode can be adjusted. This is used to artificially close the eye pattern by simulating signal 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.

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.

PC-based Pattern Management Tool

With the new PC-based Pattern Management Tool, it is very easy to manage and edit patterns to be generated with the 81133A and 81134A. The Pattern Management Tool includes a Pattern Editor that can quickly define and modify any pattern up to 12 MBit length. In addition, the Pattern Management Tool is able to save an unlimited amount of different patterns on a computer and easily upload and download them to or from the instruments, via one of the remote interfaces, including GPIB, LAN and USB 2.0. The Pattern Management Tool is especially recommended when working with patterns longer than 8 kBit, as the 81133A and 81134A can only save patterns up to this length, as well as the front panel only provides access to patterns up to 8 kBit.

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 °C to 55 °C ambient temperature if not stated otherwise.

Table 1: 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

Table 2: Jitter

Random Jitter (Clock Mode)	<4 ps RMS (1.5ps typical)
Total Jitter (Data Mode)	<5 ps RMS (2ps typical) (<30 ps pp (12ps typical))

Table 3: 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.

Table 4: Transition Times

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

Transition Times

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

Table 5: Channel Output Levels

Amplitude	50 mV to 2.00 V
Level Window	-2.00 V 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 V 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)

Table 6: 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 (< 60 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)

Table 7: Clock Input

Interface	ac-coupled with optional dc termination
Impedance	50 Ohm
Termination Voltage	-2.0 V . . +3.0 V
Minimum Swing	300 mV, tr < 3 ns, 50% duty cycle, sine: 0 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

Table 8: 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 V to +4 V
Max. Level Window	- 2 V to +5 V

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

Table 9: Propagation Delay

Clock Input to trigger output	8.4 ns nominal, fixed
Trigger Output to channel output	32 ns nominal variable

Pulse Pattern and Data Functionality

The 81133A and 81134A can generate a 12 MBit digital pattern in NRZ, RZ and R1 mode. Pattern with up to 8 kBit can be edited directly from the front panel. Patterns with more than 8 kBit can only be programmed via the remote interfaces. The PC-based Pattern Management tool includes a Pattern Editor which allows easy programming of any pattern, as well as convenient management of many patterns on any Windows®-based computer. The patterns can be uploaded using any of the available remote interfaces. 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. Agilent 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 $\pm 25\text{ps}$ or $\pm 250\text{ps}$ resulting in a total of 50ps or 500ps .

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.

Table 10: Data Generation

Memory Depth	12 MBit per channel, 8 kBit accessible from front panel
Data Format	RZ / NRZ / R1
Granularity of Data Pattern Length	32 Bit up to 8 kBit 128 Bit from 8 kBit to 12 MBit

Table 11: PRBS Generation Capabilities

PRBS	$2^n - 1, n = 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 23, 31$	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	$X^{11} + X^9 + 1$	
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	$X^{31} + X^{28} + 1$	

Table 12: Delay Control Input

Interface	dc-coupled
Impedance	50 Ohm nominal
Input Levels For Full Modulation Range	$\pm 500\text{ mV}$
Max Input Levels	$\pm 2.5\text{ V}$
Delay Modulation Range	$\pm 250\text{ ps}, \pm 25\text{ ps}, \text{selectable}$
Modulation Frequency	0 Hz - 200 MHz

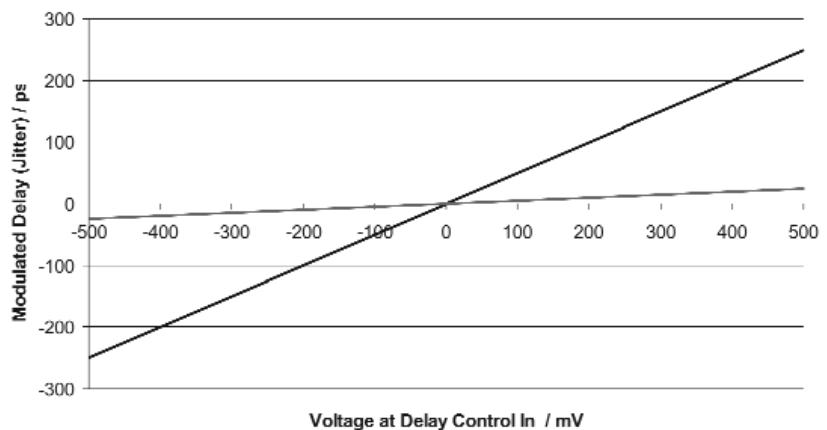


Figure 3: Modulated Delay (Jitter) vs Voltage Level at Delay-Control-Input for $\pm 250\text{ps}$ and $\pm 25\text{ps}$ settings

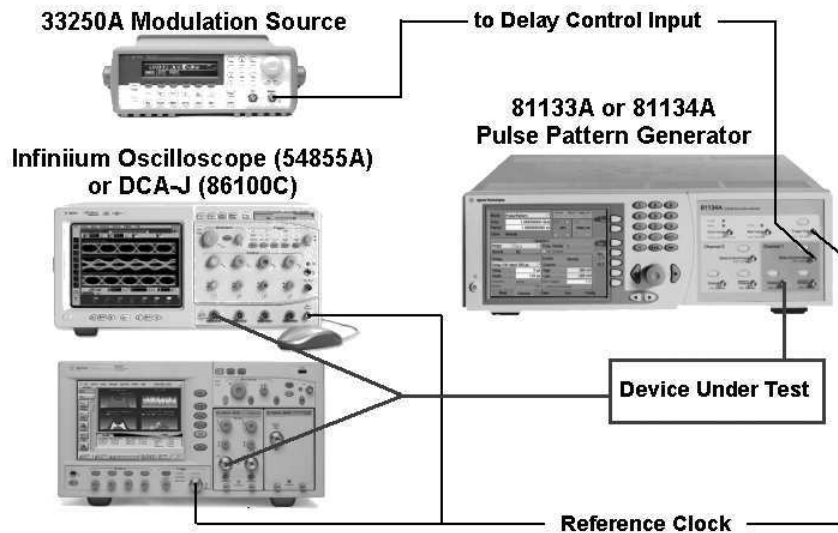


Figure 4: Jitter Emulation Test Setup

Table 13: Additional Features

Remote Interfaces	SCPI over GPIB, LAN and USB 2.0
Store/Recall Registers	9 complete settings can be saved. The last settings (Non Volatile Memory) are saved when power is turned off.

Table 14: General Information

Operating Temperature	0°C to +55°C
Storage Temperature	-40°C to +70°C
Humidity	95% R.H. (0°C 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 mm x 426 mm x 553 mm (5.7 in x 16.75 in x 21.75 in)
Recalibration Period	3 years recommended

Ordering Information

Agilent 81133A 3.35 GHz 1-channel Pulse Pattern Generator
Agilent 81134A 3.35 GHz 2-channel Pulse Pattern Generator

Options

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

Accessories

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

Complementary Products

The 6 GHz **Infiniium 54855A** real time oscilloscope combined with the InfiniiMax 1134A 7 GHz differential and single-ended active probes deliver the highest performance end-to-end measurement system available. With the 20 GSa/s sample rate on each channel, and its E2681A EZJIT Jitter Analysis Software, the 54855A is ideal for making signal integrity and jitter measurements for PCI Express, Serial ATA, Gigabit Ethernet, Fibre Channel and other high speed serial bus standards.

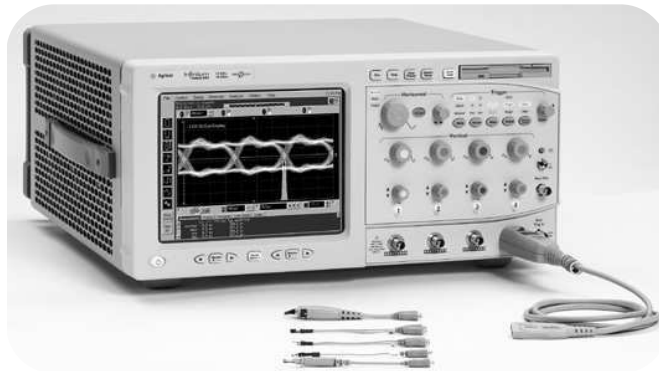


Figure 5: Agilent 54855A 6 GHz Infiniium Oscilloscope

The **86100C Digital Communications Analyzer** with Jitter Analysis is a sampling oscilloscope with up to 80 GHz Bandwidth. With its unique one-button Jitter Separation and Analysis, the 81600C is ideal for fast and precise signal integrity measurements.



Figure 6: Agilent 86100C DCA-J

Related Agilent Literature

Pub No.

- Agilent Family of Pulse/Pattern Generators, Brochure 5980-0489E
- Agilent 81100 Family Pulse/Pattern, Product Overview 5980-1215E
- Agilent 3.3GHz Pulse-/Pattern Generators, Photocard 5988-5935EN
- Generating/Measuring Jitter with the Agilent 81134A Pulse/Pattern Generator & 54855A Infiniium Scope, Product Note 5988-9411EN
- Agilent 81133A/81134A 12 Mbit Extended Pattern Memory, Product Note 5988-9591EN

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Printed in Germany April 27th 2004
5988-5549EN

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