Pulse Pattern Generator BPG30G-TERx8

Key Features

- **Pattern Generator for Bipolar Return-to-zero Pulses with 8 Output Channels**
- **Gap-Free Operation at Pulse Repetition Rates between 200 MHz and 15 GHz**
- **1 GBit Memory for User-programmable Patterns of Variable Length**
- **Word Repetition Function**
- **Independently Adjustable DC-Offset and Amplitudes of Positive and Negative Pulses for all Output Channels**
- **Separately Adjustable Dealy of $\pm 24\,ps$ for each Output Channel**
- **Integrated Clock Generator**
- **Other Customer-Specific Features on Demand**

The wide-band tuneable pattern generator BPG 30G-TER provides programmable ternary data signals consisting of positive and negative pulses and zeros. A clock signal between 200 Mhz and 15 Ghz is needed to provide the time base for operation. The generator is jitter-transparent and follows even abrupt frequency changes.

The internal clock generator has a wide frequency range from 200 MHz to 16 GHz with a resolution of exactly 1 mHz. An internal relay allows to switch between internal and external clock source.

The length of the user pattern is variable from 16 digits up to 536 870 912 digits and is repeated periodically. Each digit can be set to a positive pulse, a negative pulse or to zero.

The pattern memory can be split in 2, 4 or 8 parts to toggle synchronously between different waveforms. Two short user pattern of 16 digits and 128 digits length are programmable via the front panel.

The pattern generator provides complementary clock and 8 data outputs with programmable polarity. The output amplitude and duty-cycle of the positive and negative pulses of the ternary data signal as well as a DC-offset is independently adjustable for each data output.

An separately adjustable delay of $\pm 24\,ps$ and a resolution of 3 ps for each channel allows to compensate for cable delays and synchronize the outputs.

At the front panel several trigger signals, e.g. a divided clock signal and the word frame trigger signal, are available.

The instrument can be operated locally via the front panel or remotely controlled via its USB-interface. An easy-to-use graphical user interface is included in the supplied software and allows simple operation by mouse-clicking. Additionally self-programmed software may be used to control the instrument.

Clock Source

The clock source determines the time base for operation. All output signals are derived from it. The pattern generator is operated with a clock signal equal to the output data rate, i. e. with a clock signal of 20 GHz the instrument generates output pulses with a repetition rate of 20 GHz. There are two main clock sources:

Internal

The internal quartz controlled clock generator provides clock signals in the range from 200 MHz to 16 GHz with a resolution of exactly 1 mHz.

External

The clock signal connected to the instruments *Clock Input* is used as system clock. The clock input is jitter-transparent and the instrument follows even abrupt frequency changes of the externally attached signal. An internal relay allows to switch between internal and external clock source. All instrument modes are available in both internal and external clock mode.

10 MHz Reference Input

A 10 MHz reference clock signal can be applied to the reference clock input on the instruments rear panel. This clock signal is used as reference for all timing parameters.

10 MHz Reference Output

The 10 MHz reference clock output signal can be used to synchronize the time base of other instruments to the time base of the pattern generator.

Clock Output

The single-ended clock output provides a clock signal equal to the system clock signal. The CML output signal has an amplitude $400\,mV_{pp} \pm 50\,mV$ into 50 Ω.

Pattern

User Programmable Data

Arbitrary user pattern data up to a maximum length of 512 M Digit per channel can be generated. The pattern length can be set in steps of 128 digits. The programmed bit sequence is generated periodically. Additionally the pattern memory can be split in 2, 4 or 8 parts to toggle synchronously between different waveforms.

Data Format

Return to zero pulse format. The output signal returns to zero (low level) after each positive or negative bit and stays at low level for 0 bits.

Data Polarity

The polarity of each output signal can be independently set to normal or inverted. If the polarity is set to inverted the low and high level bits are interchanged.

Output Amplitudes

The amplitude of the positive and negative pulses of the ternary signal can be adjusted independently and for both data ouputs seperately. This means eight amplitude voltages can be independently set and changed:

- $V_{DataA1,+}$ and $V_{DataA1,-}$ define the amplitude of the positive and negative pulses respectively of the `Data A1` output signal
- $V_{DataA2,+}$ and $V_{DataA2,-}$ define the amplitude of the positive and negative pulses respectively of the `Data A2` output signal

  ⋮
- $V_{DataA8,+}$ and $V_{DataA8,-}$ define the amplitude of the positive and negative pulses respectively of the `Data A8` output signal

The adjustment range for all voltages is 200 mV to 500 mV (±10 % into 50 Ω).

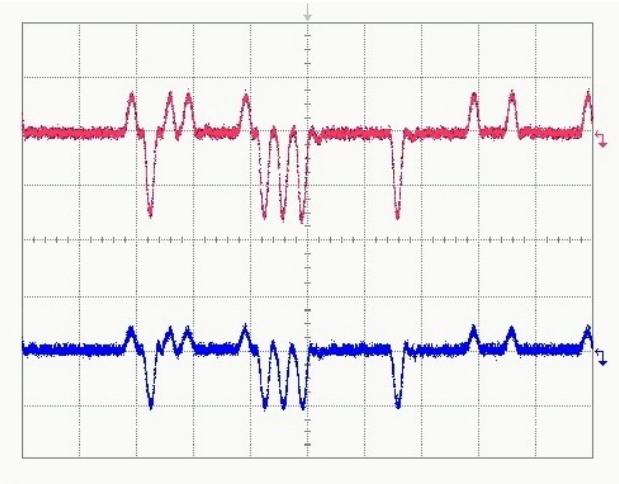


Figure 1: Output Pattern with four different Amplitude Settings

Offset

A DC-offset between 0 V and +500 mV can be added to the output signal. The DC-offset can be set independently for the *Data A1*, *Data A2*, ... *Data A8* outputs.

Duty Cycle

The duty cycle of the positive and negative RZ output pulses can be adjusted to optimize the output pulse shape.

Word Repetition

For the long user pattern a word repetition function is available that allows to generate patterns with a repetition rate below 1 Hz at the maximum pulse repetition rate of 20 GHz.
The word repetition is selectable between 1 (no repetition) and 32, i. e. each 128 digits long word of the pattern memory is repeated 32-times. Additionally it is possible to repeat fractional words of 32 and 64 digits length.

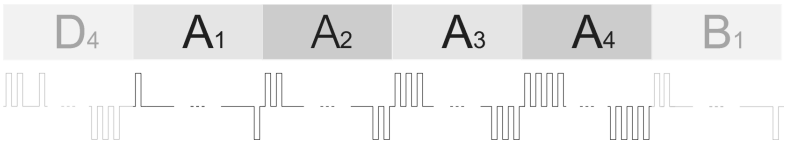
Word Fraction		Word Repetition
1	(≙128 Digit)	1, 2, 3, ..., 32
2	(≙ 64 Digit)	2, 4, 6, ..., 64
4	(≙ 32 Digit)	4, 8, 12, ..., 128

Table 1: Word Fraction and Word Repetition Factors

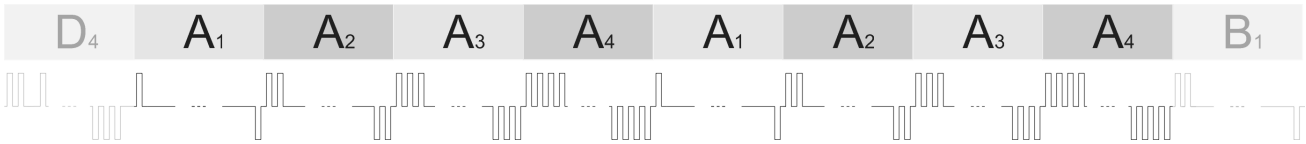
During normal operation (Word Repetition = 1 und Word Fraction = 1) the words of the programmed pattern are generated successively in the generator and repeated periodically when the pattern end is reached.

Figure 2: Pattern consisting of 4 words A, B, C and D of each 128 digits length

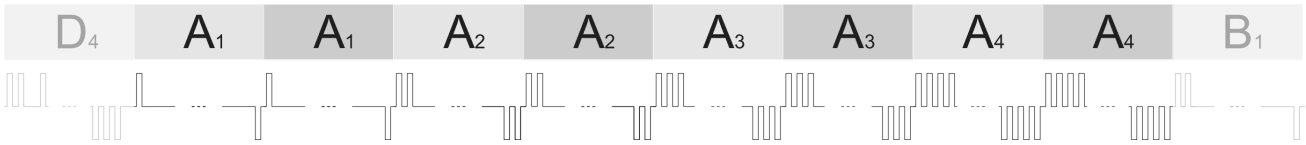
The *Word Repetition* and *Word Fraction* functions allow to extend the length of the generated pattern by repeatedly generating the words or fractional words of the programmed pattern according to the selected repetition factors. The following figures illustrate this at the example of a 128 digits long word $A = A_1|A_2|A_3|A_4$ in a pattern consisting of the 4 words A, B, C and D.



(a) Word Repetition=1, Word Fraction=1



(b) Word Repetition=2, Word Fraction=1



(c) Word Repetition=2, Word Fraction=4

Figure 3: *Word Fraction* and *Word Repetition* in a pattern consisting of the words A, B, C and D

Delay

The generator provides different ways to shift and time-align the data signals at the instruments outputs.

Bit Delay

The bit shift functionality allows to delay the data signal by n bits ($0 \leq n \leq 2^{36}$) relative to the trigger signal.

Output Delay

Additionally the output delay function allows to delay each output signal independently by $\pm 24\,ps$ with a resolution of 3 ps.

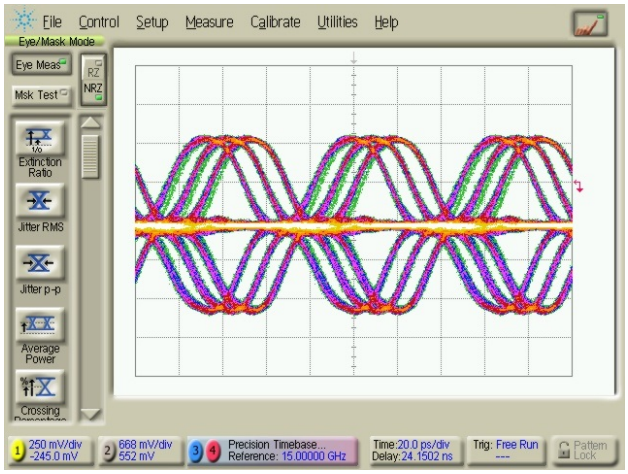


Figure 4: Pulse pattern delayed in steps of 9 ps

Jitter Insertion

When the external clock input is used the pattern generator follows exactly the externally connected frequency. By modulating the external clock source jitter-modulated data signals can be generated.

Trigger Signals

Trigger Output

The trigger output provides a divided clock signal (Bit Rate)/8 or a pattern synchronous trigger signal (word-frame trigger signal).

Front Panel Controls

The instrument has no front panel controls. The device current device parameter settings are displayed on the front panel LCD.

Graphical User Interface

The graphical user interface allows to change all device settings and program the user pattern by simple mouse-clicking. The last settings are automatically saved when power is turned off.

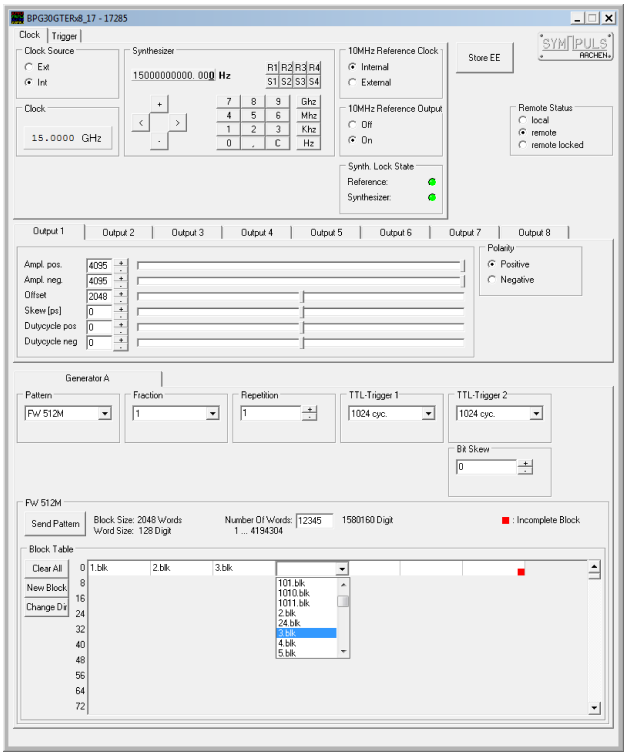


Figure 5: Graphical User Interface of the Operating Software

SCPI Remote Control

The pattern generator can be remotely controlled via SCPI commands, a standardized instruction set for controlling and programming measurement instruments. The SCPI commands are transfered to the instrument in ASCII text format and may be generated using any programming language and development environment.

Options

GPIB IEEE-488.2 Interface

In addition to its USB interface the pattern generator is available with a GPIB interface. The active interface can be selected in the instruments setup menu.

Technical Specifications

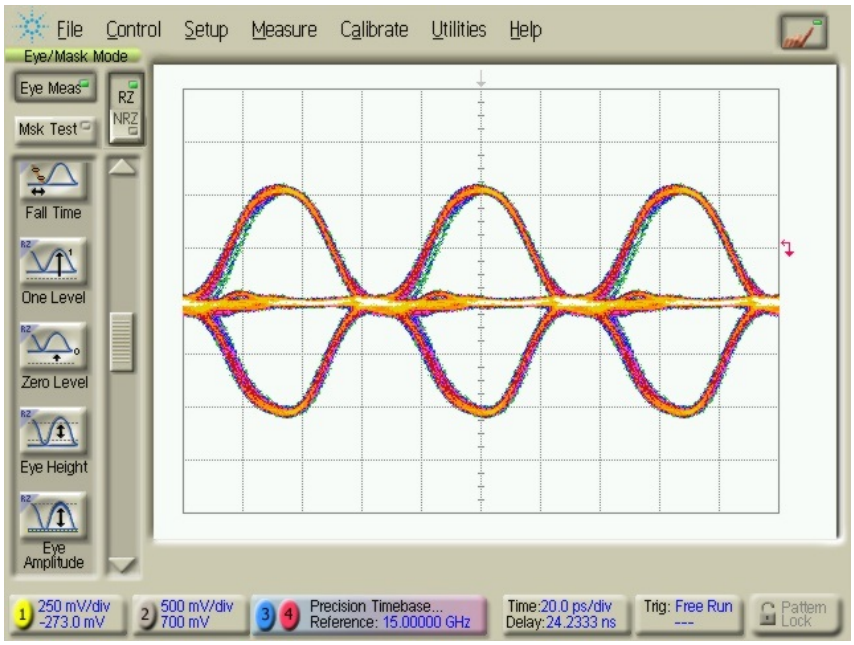
Bipolar Pattern Generator BPG 30G-TERx8	
External Clock	
Frequency Range	200 MHz ... 15 GHz, gap-free
Each clock cycle represents one positive or negative RZ pulse, the pulse width equals half the clock period.	
Clock Input	200 MHz ... 15 GHz
Impedance	$R_i = 50\,\Omega$, $\lvert r\rvert < 0,2$
Input Amplitude	$U_i = 0.5 \ldots 1\,V_{pp}$
Connector	50 Ω SMA
Frequency Counter	6-digit frequency display
Pattern Generation	
Data Format	Bipolar Return-to-zero pulses
Pulse Repetition Rate	According to Input Clock, 200 MHz ... 15 GHz
Programmable Patterns	All patterns separately programmable for data channels A and B: 1. 16-digit pulse pattern 2. 128-digit pulse patten 3. Pulse pattern of length $128 * m$ digit $(m = 1, 2, \ldots, 2^{22})$ (=max. 268.435.456 ternary coded digits) 4. Pulse pattern consisting of two parts, each of length $128 * m$ digit $(m = 1, 2, \ldots, 2^{21})$, synchronously selectable 5. Pulse pattern consisting of four parts, each of length $128 * m$ digit $(m = 1, 2, \ldots, 2^{20})$, synchronously selectable 6. Pulse pattern consisting of eight parts, each of length $128 * m$ digit $(m = 1, 2, \ldots, 2^{19})$, synchronously selectable The programmed patterns should have approximately the same number of positive and negative pulses
Pattern Memory	1 073 741 824 bits (= 536 870 912 digits)
Programmable Pattern Length	$128 * m$ digits, $(m = 1, 2, \ldots, 2^{22})$
Data Outputs	1. Data A1, 2.92 mm connector 50 Ω 2. Data A2, 2.92 mm connector 50 Ω ... 2. Data A8, 2.92 mm connector 50 Ω Ternary data code -V / 0 / +V All amplitude voltages $V_{DataA1,+}$, $V_{DataA1,-}$, $V_{DataA2,+}$, $V_{DataA2,-}$, ..., $V_{DataA8,+}$, $V_{DataA8,-}$ independently adjustable in the range of 200 mV to 500 mV (±10% into 50 Ω) Rise-/Falltime < 20 ps (20/80%) Jitter (pp) < 10 ps Separate DC-Offset regulation for all data outputs for zero-potential adjustment Ajustable delay of $\pm 24\,ps$ with a resolution of 3 ps for each output channel Polarity reversible (positive and negative pulses interchanged)

BPG 30G-TERx8	
Word Repetition	Repetition function for the $128/n$ digits ($n \in \{1, 2, 4\}$) long fractional words of the programmed pattern, repetition factors: 1*n, 2*n, 3*n, ..., 32*n
Trigger Outputs	
Clock Output	1. Clock, 400 $mV_{pp} \pm 50\,mV$ AC-coupled, 50 Ω SMA
Trigger Outputs	1. CML: $0\,V/-0.4\,V$ into 50 Ω SMA Clock/8 or Word Frame Trigger selectable, Pulse width: 64 clock periods 2. TTL Word Frame Trigger 1: $0\,V/3\,V$ SMA (on rear panel), Synchronous to Channel A, pulse width selectable. 1024, 2048, 3072 or 4096 clock periods 3. TTL Word Frame Trigger 2: $0\,V/3\,V$ SMA (on rear panel), Synchronous to Channel A, pulse width selectable. 1024, 2048, 3072 or 4096 clock periods
General Information	
Interface	USB-port, max. data transmission rate 8 MByte/s
Software	Graphical User Interface for operation and pattern programming
Dimensions	19" Desktop W x H x D = 462 x 185 x 480 mm
Weight	approx. 12 kg
Power Supply	110 V-120 V/60 Hz/150 VA or 220 V-240 V/50 Hz/150 VA
Internal Clock Generator	
Internal or External Clock Selectable	
Frequency Range	200 MHz to 16 GHz
Resolution	1 mHz
10 MHz Reference Input	$U_i = 1\,V_{pp} \ldots 3\,V_{pp}$
10 MHz Reference Output	1.5 Vpp, 50 Ω SMA, AC-coupled
Optionally Available	
Option 1: GPIB IEEE-488.2 Interface	
Interface	GPIB IEEE-488.2
Data Transfer Rate	up to 1.5 MByte/s

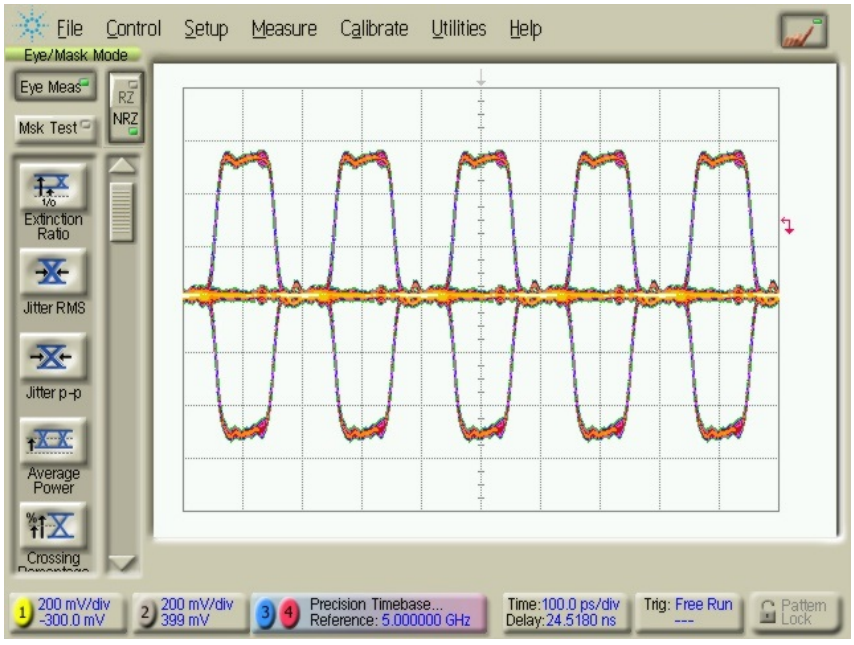
Output Signals

All oscillograms in this section were taken using the Agilent 86100B sampling oscilloscope and the sampling modules 86118A (70 GHz cut-off frequency) and 86107A.

Typical Output Waveforms



Ternary Output at 15 GHz Clock Rate



Ternary Output at 5 GHz Clock Rate

Ordering Information

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Email: mail@sympuls-aachen.de
Internet: www.sympuls-aachen.de

Included in delivery:

- BPG30G-TERx8
- 115/230 V Mains, User Manual, USB Cable Set
- CD-ROM with Device Driver and Operating Software

The instrument is produced by SYMPULS in Germany.
We offer a reliable service and 24 month warranty.