Pulse Pattern Generator BPG 30G-TER

Key Features

- **Pulse Pattern Generator for Bipolar Return-To-Zero Pulses with 2 Data Outputs**
- **Gap-Free Operation at Pulse Repetition Rates between 200 MHz and 15 GHz**
- **512 MBit Memory for User Programmable Patterns of Variable Length**
- **Word Repetition Function**
- **Independently Adjustable DC-Offset and Amplitude Control of Positive and Negative Pulses for both Data Outputs**
- **Operation via Front Panel or USB-Interface**
- **Optionally Available:**
  - **Internal Clock Generator**
  - **Extended Pattern Memory of 1 GBit**
  - **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. An external 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 length of the user pattern is variable from 16 digits up to 268 435 456 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 or 4 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 2 data outputs with programmable polarity. The output amplitude of the positive and negative pulses of the ternary data signal as well as a DC-offset is independently adjustable for both data 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 SCPI commands 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 15 GHz the instrument generates output pulses with a repetition rate of 15 GHz. There are two main clock sources:

Internal

The internal quartz controlled clock generator provides clock signals in the range from 200 MHz to15 GHz with a resoltion 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. 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 differential clock outputs provide a clock signal equal to the system clock signal. The CML output signal has an amplitude $500\,mV_{pp} \pm 100\,mV$ into $50\,\Omega$.

Pattern

User Programmable Data

Arbitrary user pattern data up to a maximum length of 256 M Digit 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 or 4 parts to toggle synchronously between different waveforms. Optionally the pattern generator is available with an extended pattern memory of 512 M Digit.

RZ

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 signals 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 four 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

The adjustment range for all four voltages is 0.2 V to 0.5 V (±10 % into 50 Ω).

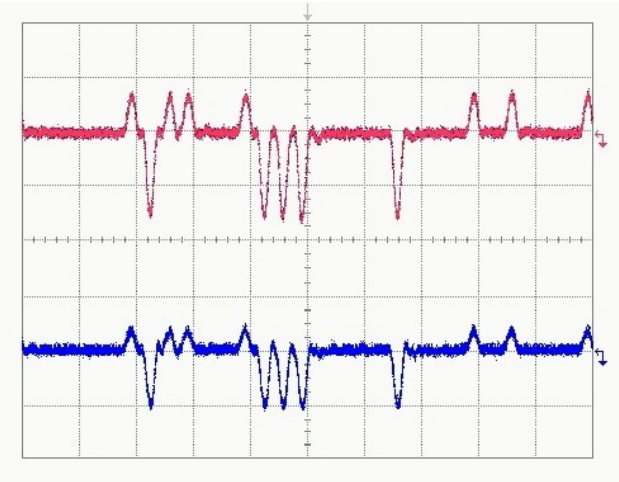


Figure 1: Output Pattern with four different Amplitude Settings

Offset

A DC-offset between 0 V and +1 V can be added to the output signal. The DC-offset can be set independently for the *Data A1* and *Data A2* outputs.

Duty Cycle

The duty cycle of the 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 15 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.

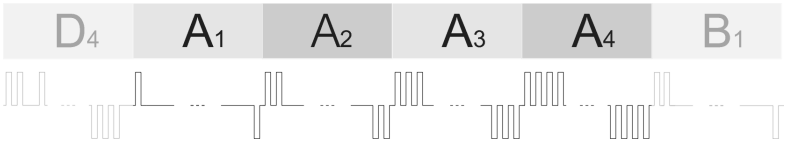
Word Fraction	Word Repetition
1 (≙128 Digit)	1, 2, 3, . . . , 32
2 (≙ 64 Digit)	2, 4, 6, . . . , 64
4 (≙ 32 Digit)	2, 4, 8, 12, . . . , 128

Table 1: Word Fraction and Word Repetition Factors

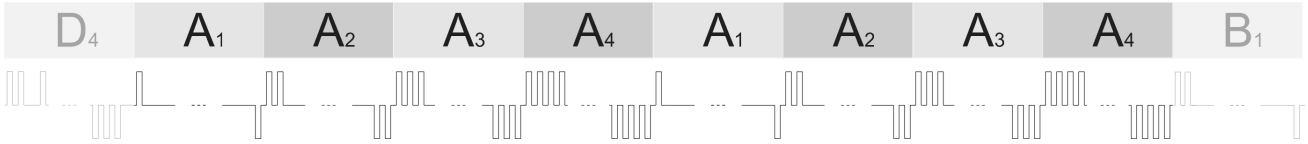
During normal operation (Word Repetition = 1 und Word Fraction = 1) the words of the programmed pattern are generated successively in the generator and repeated periodically when the pattern end is reached.

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

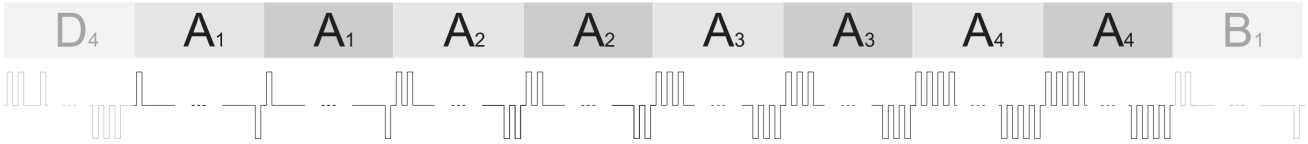
The *Word Repetition* and *Word Fraction* functions allow to extend the length of the generated pattern by repeatedly generating the words or fractional words of the programmed pattern according to the selected repetition factors. The following figures illustrate this at the example of a 128 digits long 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

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

All instrument settings can be changed using the buttons on the front panel. The device parameters are accessible through an intuitive menu structure that is displayed on the 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.

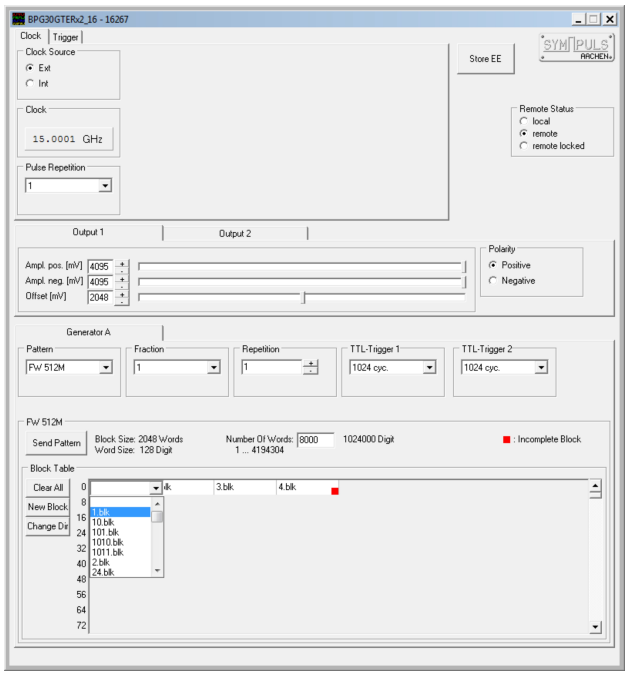


Figure 4: Graphical User Interface of the Operating Software

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

Internal Clock Generator

The internal synthesizer generates clock signals between 200 MHz and 15 GHz with a resolution of exactly 1 mHz. An internal relay allows to switch between internal and external clock source. The 10 MHz reference input and output make it possible to synchronize the pulse pattern generator to external timing references or other instruments in the measurement setup.

Extended Pattern Memory

The extended pattern memory of 1 GBit allows to generate user patterns of 536 870 912 digits length.

Bit Shift

The bit shift functionality allows to delay the output signal by n bits ($0 \leq n \leq 2^{36}$) to compensate for cable delays.

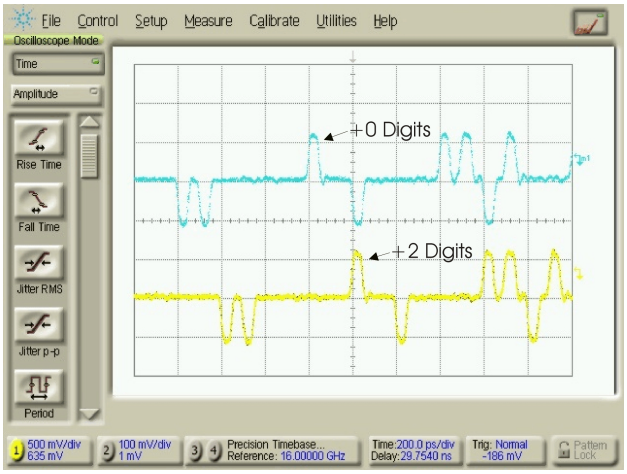


Figure 5: Example of a pulse pattern delayed by 2 bits

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

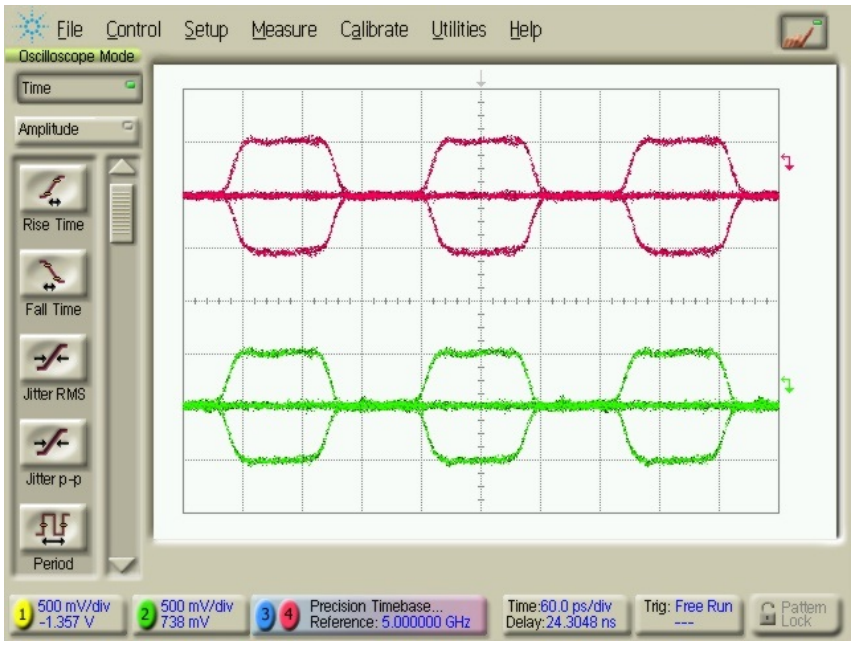
Bipolar Pattern Generator BPG 30G-TER	
External Clock	
Frequency Range	200 MHz ... 15 GHz, gap-free
Each clock cycle represents one positive or negative RZ pulse, the pulse width equals half the clock period.	
Clock Input	200 MHz ... 15 GHz
Impedance	$R_i = 50\,\Omega$, $\lvert r\rvert < 0,2$
Input Amplitude	$U_i = 0.5 \ldots 1\,V_{pp}$
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	1. 16-digit pulse pattern (programmable via front panel) 2. 128-digit pulse patten (programmable via front panel) 3. Pulse pattern of length $128 * m$ digit ($m = 3, 4, \ldots, 2^{21}$) (=max. 268.435.456 ternary coded digits) 4. Pulse pattern consisting of two parts, each of length $128 * m$ digit ($m = 3, 4, \ldots, 2^{20}$), synchronously selectable 5. Pulse pattern consisting of four parts, each of length $128 * m$ digit ($m = 3, 4, \ldots, 2^{19}$), synchronously selectable All patterns are programmable and selectable via the USB-interface. The programmed patterns should have approximately the same number of positive and negative pulses
Pattern Memory	536 870 912 bits (= 268 435 456 digits)
Programmable Pattern Length	$128 * m$ digits, ($m = 1, 2, \ldots, 2^{21}$)
Data Outputs	1. Data A1, 2.92 mm connector 50 Ω 2. Data A2, 2.92 mm connector 50 Ω Ternary data code -V / 0 / +V Four amplitude voltages $V_{DataA1,+}$, $V_{DataA1,-}$ and $V_{DataA2,+}$, $V_{DataA2,-}$ independently adjustable in the range of 0.2 to 0.5 V (±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 Polarity reversible (positive and negative pulses interchanged)
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

BPG 30G-TER	
Trigger Outputs	
Clock Outputs	1. Clock, CML: $0\,V/-0.5\,V \pm 0.2\,V$ 2. /Clock, CML: $0\,V/-0.5\,V \pm 0.2\,V$ DC-coupled, $50\,\Omega$ SMA
Trigger Outputs	1. CML: $0\,V/-0.4\,V$ into $50\,\Omega$ 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), Trigger frequency according to the choosen pattern, pulse width selectable: 1024, 2048, 3072 or 4096 clock periods 3. TTL Word Frame Trigger 2: $0\,V/3\,V$ SMA (on rear panel), Trigger frequency according to the choosen pattern, 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 135 x 435 mm
Weight	approx. 12 kg
Power Supply	110 V-120 V/60 Hz/150 VA or 220 V-240 V/50 Hz/150 VA
Optionally Available	
Option 1: Internal Clock Generator	
Internal or External Clock Selectable	
Frequency Range	200 MHz to 15 GHz
Resolution	1 mHz
Reference	10 MHz Reference Clock Input and Output
Option 2: Extended Pattern Memory	
Pattern Memory	1 GBit (=536 870 912 digits)
Option 3: GPIB IEEE-488.2 Interface	
Interface	GPIB IEEE-488.2
Data Transfer Rate	up to 1.5 MByte/s

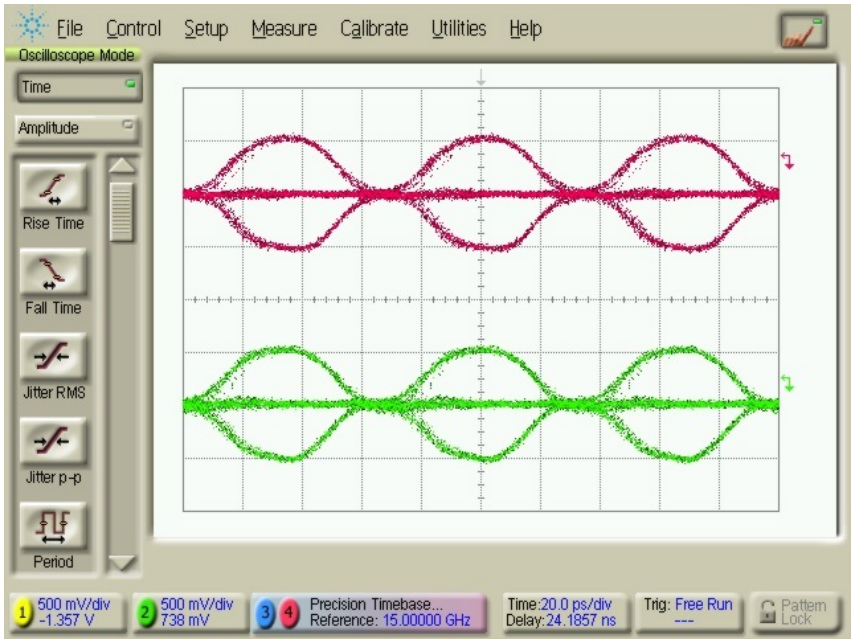
Output Signals

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



Differential Outputs at 5 GHz Clock Rate



Differential Outputs at 15 GHz Clock Rate

Ordering Information

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Included in delivery:

- BPG 30G-TER
- 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.