Pulse Pattern Generator BPG 2x40G-TER

Key Features

- **Pulse Pattern Generator for Bipolar Return-To-Zero Pulses**
- **Two Independently Programmable Data Channels with two Outputs per Channel**
- **Gap-Free Operation at Pulse Repetition Rates between 200 MHz and 20 GHz**
- **2x1024 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 all Data Outputs**
- **Operation via Front Panel or USB-Interface**
- **Internal Clock Generator**

The wide-band tuneable pattern generator BPG 2x40G-TER provides programmable ternary data signals consisting of positive and negative pulses and zeros.

The internal clock generator or an externally applied clock signal between 200 MHz and 20 GHz determines the time base for operation.

The BPG 2x40G-TER has two independently programmable data channels with two data outputs per channel. 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 of each channel 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 a clock and two data outputs per channel with programmable polarity. The output amplitude of the positive and negative pulses of the ternary data signal is independently adjustable for all data outputs.

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

The instrument is 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 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 20 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 $400\,mV_{pp} \pm 100\,mV$ 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 = 1 word. 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 after each positive or negative digit.

Data Polarity

The polarity of each output signals can be independently set to *positive* or *negative*. If the polarity is set to *negative* the positive and negative digits 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
- $V_{DataB1,+}$ and $V_{DataB1,-}$ define the amplitude of the positive and negative pulses respectively of the `Data B1` output signal
- $V_{DataB2,+}$ and $V_{DataB2,-}$ define the amplitude of the positive and negative pulses respectively of the `Data B2` output signal

The adjustment range for all voltages is 150 mV to 280 mV (±10 % into 50 Ω).

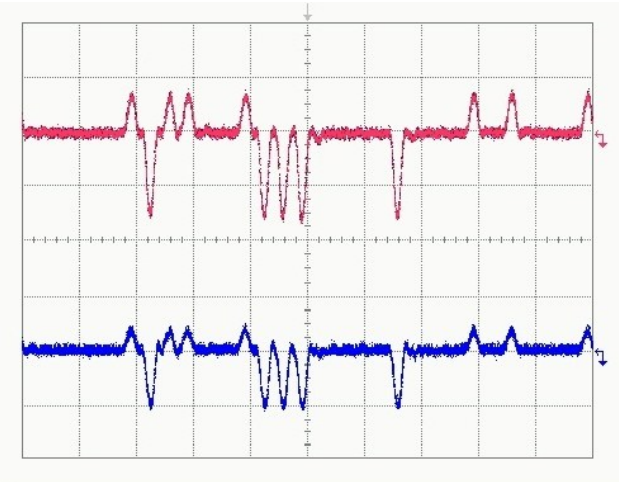


Figure 1: Output Pattern with four different Amplitude Settings

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.

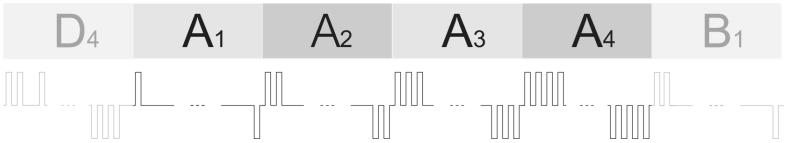
Word Fraction	Word Repetition
1 (≙128 Digit)	1, 2, 3, . . . , 32
2 (≙ 64 Digit)	2, 4, 6, . . . , 64
4 (≙ 32 Digit)	4, 8, 12, . . . , 128

Table 1: Word Fraction and Word Repetition Factors

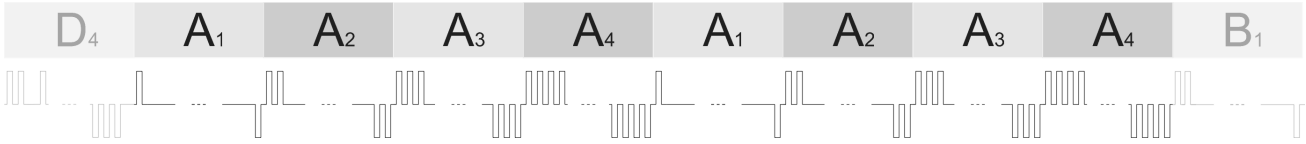
During normal operation (Word Repetition = 1 und Word Fraction = 1) the words of the programmed pattern are generated successively in the generator and repeated periodically when the pattern end is reached.

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

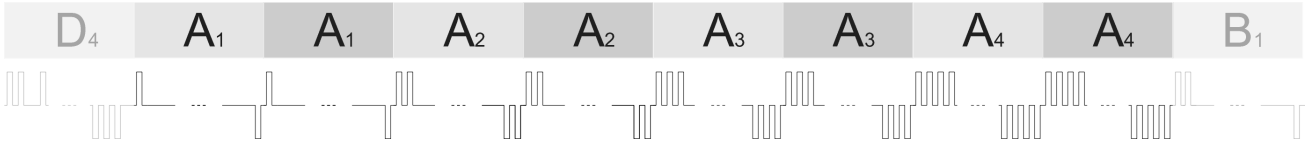
The *Word Repetition* and *Word Fraction* functions allow to extend the length of the generated pattern by repeatedly generating the words or fractional words of the programmed pattern according to the selected repetition factors. The following figures illustrate this at the example of a 128 digits long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

Bit Delay

The bit shift functionality allows to delay the data channels independently by n bits ($0 \leq n \leq 2^{36} - 1$) relative to the trigger signal.

Channel Delay

The channel delay function delays data channel B relative to channel A by $\pm 25\,ps$ with a resolution of 0.1 ps.

Output Delay

Additionally the output delay function allows to delay each output signal independently by $\pm 15\,ps$ with a resolution of 0.1 ps.

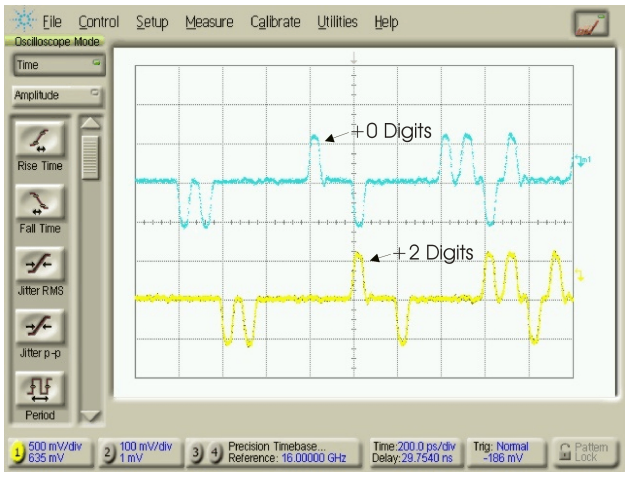


Figure 4: Example of a pulse pattern delayed by 2 digits

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 (wordframe trigger).

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.

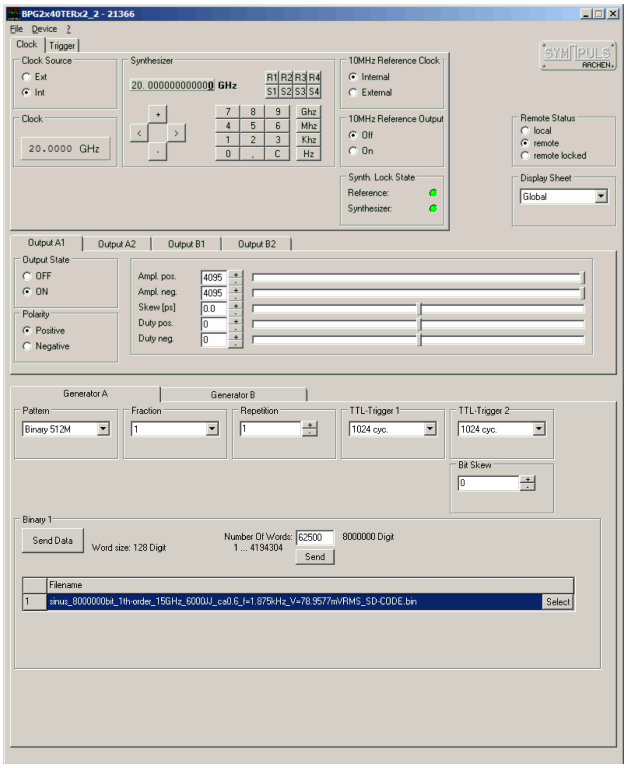


Figure 5: Graphical User Interface of the Operating Software

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.

Technical Specifications

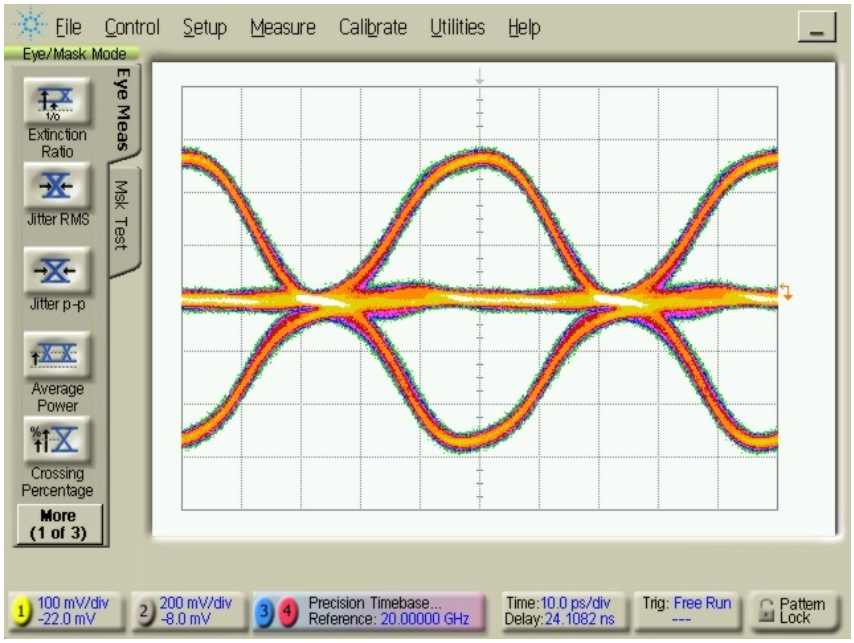
Bipolar Pattern Generator BPG 2x40G-TER	
External Clock	
Frequency Range	200 MHz ... 20 GHz, gap-free
Each clock cycle represents one positive or negative RZ pulse, the pulse width equals half the clock period.	
Clock Input	200 MHz ... 20 GHz
Impedance	$R_i = 50\,\Omega$, $\lvert r\rvert < 0,2$
Input 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 ... 20 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. 536 870 912 ternary coded digits)
Subpatterns	1. Pulse pattern consisting of two parts, each of length $128 * m$ digit $(m = 1, 2, \ldots, 2^{21})$, synchronously selectable 2. Pulse pattern consisting of four parts, each of length $128 * m$ digit $(m = 1, 2, \ldots, 2^{20})$, synchronously selectable 3. 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) per channel
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 3. Data B1, 2.92 mm connector 50 Ω 4. Data B2, 2.92 mm connector 50 Ω Ternary data code -V / 0 / +V All amplitude voltages $V_{DataA1,+}$, $V_{DataA1,-}$, $V_{DataA2,+}$, $V_{DataA2,-}$, $V_{DataB1,+}$, $V_{DataB1,-}$ and $V_{DataB2,+}$, $V_{DataB2,-}$ independently adjustable in the range of 150 mV to 280 mV (±10% into 50 Ω) Rise-/Falltime < 14 ps (20/80%) Jitter (rms) < 2 ps Independently adjustable delay of $\pm 15\,ps$ for each output channel Polarity reversible (positive and negative pulses interchanged)

BPG 2x40G-TER	
Delay	Channels A and B can be shifted independently by n bits, $0 \leq n < 2^{36}$, relative to the trigger output. Analogue delay of $\pm 25\,ps$ between the generator channels.
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 Outputs	1. Clock, CML: $0\,V/-0.4\,V \pm 0.1\,V$ DC-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 2. TTL Word Frame Trigger 3: $0\,V/3\,V$ SMA (on rear panel), Synchronous to Channel B, pulse width selectable. 1024, 2048, 3072 or 4096 clock periods 3. TTL Word Frame Trigger 4: $0\,V/3\,V$ SMA (on rear panel), Synchronous to Channel B, pulse width selectable: 1024, 2048, 3072 or 4096 clock periods
General Information	
Interface	USB-port, max. data transmission rate 10 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
Internal Clock Generator	
Internal or External Clock Selectable	
Frequency Range	200 MHz to 20 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

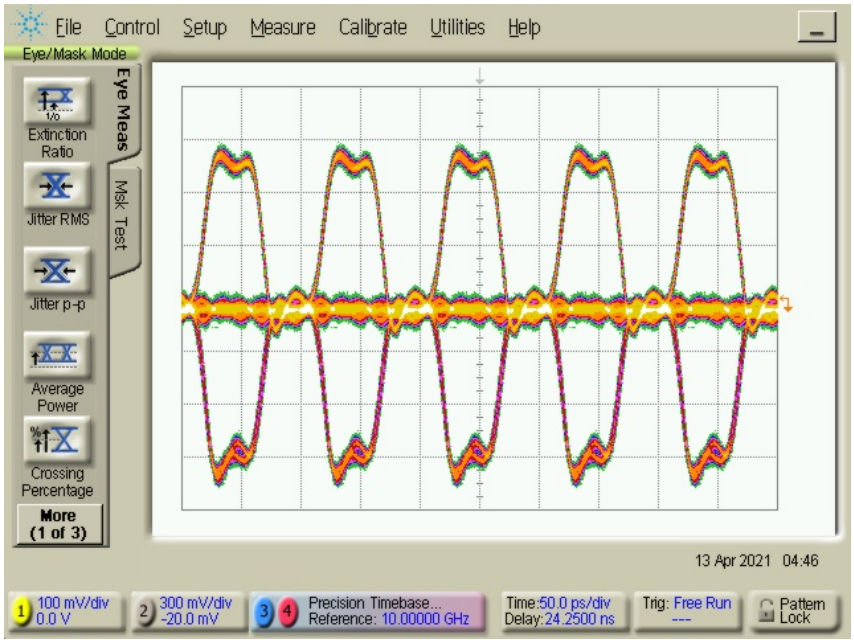
Output Signals

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 20 GHz Clock Rate



Ternary Output at 10 GHz Clock Rate

Ordering Information

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

Included in delivery:

- BPG 2x40G-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.