

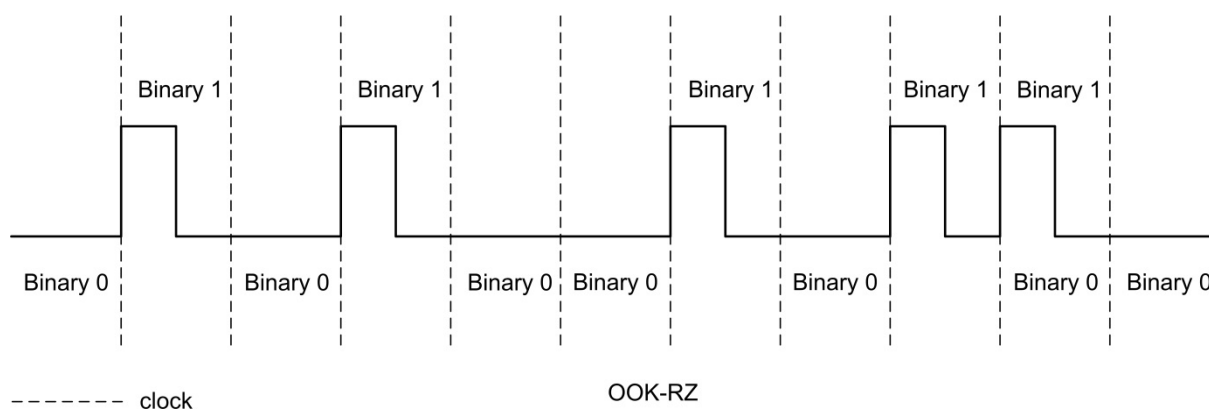
1. Assign the following modulation principle in the right-hand column to its name in the left-hand column.

AMI	phase of optical carrier is changed by π every bit regardless of the data traffic, no matter if it's 0 or 1
CSRZ	A binary 0 is encoded as absence of power during the bit interval (zero voltage), while a binary 1 is encoded alternately as a positive voltage or a negative voltage. A binary 1 is referred to as a mark
DPSK	A 180-degree carrier phase reversal preceding a chip shall characterize a binary 1. The absence of a preceding phase reversal shall denote a binary 0
DB	Pairs of bits are assigned a specific phase, as for example: 00 \rightarrow 45°, 01 \rightarrow 135°, 10 \rightarrow 315°, 11 \rightarrow 225°
DQPSK	A binary zero is represented by the absence of a laser pulse; binary 1s can be represented by a laser pulse with altered phase, based on the previous symbols in the following manner. Phase of a binary symbol is shifted by π if there is an odd number of binary 0 between two binary 1
QPSK	The pairs of bits correspond to a given phase shift from a reference (initial) phase, or, in other words, by 90° between the neighbouring symbols. The initial phase can be 0° or non-zero. 00 \rightarrow shift by 0° from the initial phase; 01 \rightarrow shift by 90° from the initial phase; 10 \rightarrow shift by 180° from the initial phase; 11 \rightarrow shift by 270° from the initial phase



2. Tick all the boxes, which refer to the main benefits of (D)QPSK modulations.

- ☒ symbol rate is 2x slower than the bit rate
- ☐ symbol rate is 2x faster than the bit rate
- ☒ robustness against polarization mode dispersion due to its longer symbol duration
- ☒ increased tolerance to chromatic dispersion
- ☒ narrow optical spectrum
- ☐ broad optical spectrum
- ☒ promising even for terabit transmission
- ☐ error detection
- ☐ error correction
- ☐ improved synchronization compared to DPSK and BPSK
- ☐ elimination of Far End Crosstalk

3. Which modulation principle is illustrated in the following figure?

OOK-RZ <input checked="" type="checkbox"/>	OOK-NRZ <input type="checkbox"/>	CSRZ <input type="checkbox"/>
QPSK <input type="checkbox"/>	PM-QPSK <input type="checkbox"/>	DPSK-RZ <input type="checkbox"/>



4. Write “intensity modulation”, “phase modulation”, “multi-carrier modulation” or “frequency modulation” next to the following modulation formats listed in the right-hand column.

Type of modulation format	Name of modulation format
frequency modulation	OFDM
intensity modulation	CSRZ
phase modulation	QPSK
multi-carrier modulation	DMT
intensity modulation	OOK
frequency modulation	VDMT
phase modulation	DPSK
intensity modulation	DB



5. Modulate the following binary data using OOK, CSRZ and DB modulation.

The data is 01001110.

Example:

Bit value	0		1	
Laser	ON/OFF	Phase/ phase shift	ON/OFF	Phase/ phase shift
OOK	OFF	-	ON	-
CSRZ	OFF	+90°	ON	+90°
DB	OFF	-	ON	+90°

Solution:

Bit value	0		1		0		0	
Laser	ON/OFF	Phase/ phase shift	ON/OFF	Phase/ phase shift	ON/OFF	Phase/ phase shift	ON/OFF	Phase/ phase shift
OOK	OFF	-	ON	-	OFF	-	OFF	-
CSRZ	OFF	+90°	ON	+90°	OFF	+90°	OFF	+90°
DB	OFF	-	ON	+90°	OFF	-	OFF	-

Bit value	1		1		1		0	
Laser	ON/OFF	Phase/ phase shift	ON/OFF	Phase/ phase shift	ON/OFF	Phase/ phase shift	ON/OFF	Phase/ phase shift
OOK	ON	-	ON	-	ON	-	OFF	-
CSRZ	ON	+90°	ON	+90°	ON	+90°	OFF	+90°
DB	ON	-	ON	-	ON	-	OFF	-

