# DC/DC High Voltage Modules dBC-Series

LASER COMPONENTS

## DESCRIPTION


The dBC series (dBC = digital bias controller) of miniature high voltage modules has been specially designed for avalanche photodiode (APD) operation. 3 versions are offered: The dBC-120-3x delivers a precisely controlled voltage in the range 1 – 120 V from a 3 V input voltage. This version is designed for use with InGaAs-APDs as well as very fast Si-PIN-photodiodes. The dBC-220-3x provides an output voltage range of 1 – 220 V, also from a 3 V supply, and is the ideal choice for most silicon APDs. Larger area APDs requiring higher voltages benefit from the dBC-380-5x which supplies up to 380 V from a 5 V input voltage. All three versions share a compact housing design with dimensions 21 mm x 21 mm x 8.3 mm.

The modules have integrated temperature compensation circuitry allowing both discrete APDs as well as APD modules with built-in temperature sensors to be controlled. An integrated current limiter ensures that the APD is protected against overexposure. The output voltage may be regulated using either an analog control voltage or voltage divider, or via the digital interface provided (SPI or RS-232). Suitable temperature sensors include silicon diodes or any sensor in the 2 – 10 kOhm range (at 25°C).

## FEATURES

- Output voltage up to 380 V
- Temperature compensation
- High precision
- High stability
- Short-circuit proof
- Very low ripple
- Compact package
- Optional SPI or RS232 interface

## APPLICATIONS

- Avalanche photodiodes
- PIN photodiodes
- Light sources
- Piezo elements



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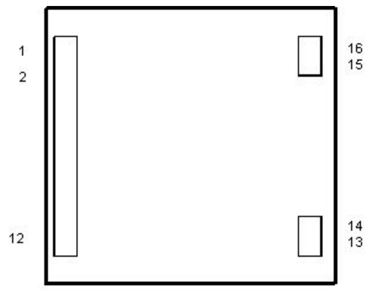
## TECHNICAL SPECIFICATIONS

| Part number | dBC-120-3x | dBC-220-3x | dBC-380-5x |
|---|---|---|---|
| Operating voltage | 2.8 … 12.5 V | 2.8 … 12.5 V | 4.8 … 12.5 V |
| Output voltage | 1 … 120 V | 1 … 220 V | 1 … 380 V |
| Output adjust | 0 … +2.2 VDC | 0 … +2.2 VDC | 0 … +2.2 VDC |
| TK adjust | 0 … +2.2 VDC | 0 … +2.2 VDC | 0 … +2.2 VDC |
| Temperature sensor * (default) | Si diode | Si diode | Si diode |
| Output current | max. 0.45 mA | max. 0.45 mA | 0.3 mA @380 V<br>max. 0.9 mA @ short-circuit |
| Operating temperature | -10°C … + 50°C | -10°C … + 50°C | -10°C … + 50°C |
| Dimensions | 21 x 21 x 8.3 mm | 21 x 21 x 8.3 mm | 21 x 21 x 8.3 mm |
| Weight | 10 g | 10 g | 10 g |

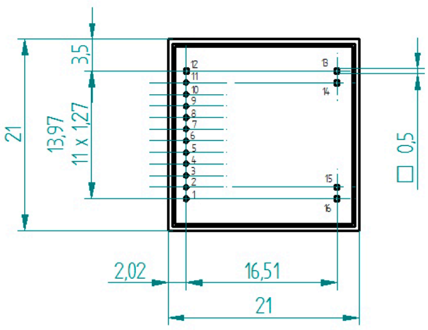
* other sensors may also be used

## PIN CONFIGURATION

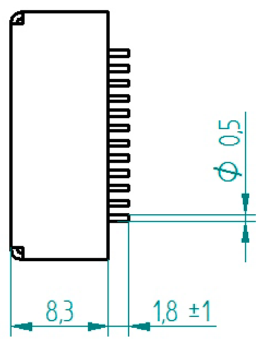
| Pin | Function | Absolute max. rating |
|---|---|---|
| 1 | $V_{in}$ / Operating voltage | [-0.3..15] $V_{dc}$ |
| 2 | RS232: RxD *<br>SPI: NSS | [-0.3..5.5] V |
| 3 | RS232: TxD *<br>SPI: MOSI | [-0.3..5.5] V |
| 4 | SPI: MISO | [-0.3..5.5] V |
| 5 | SPI: SCLK | [-0.3..5.5] V |
| 6 | Constant current source for temp. sensor<br>IREF | [-0.3..5.5] V<br>max. 2 mA<br>default = 1 mA |
| 7 | TK adjust<br>A_TK | [-0.3..5.5] V |
| 8 | Output adjust<br>A_ADJ | [-0.3..5.5] V |
| 9 | Temp. sensor | [-0.3..5.5] V |
| 10 | Reset and prog. interface<br>C2CK / Reset | [-0.3..5.5] V |
| 11 | Prog. interface<br>C2D | [-0.3..5.5] V |
| 12 | GND | GND |
| 13/14 | HV | Output max. 400 V |
| 15/16 | GND | GND |



Topview



Bottomview



Sideview

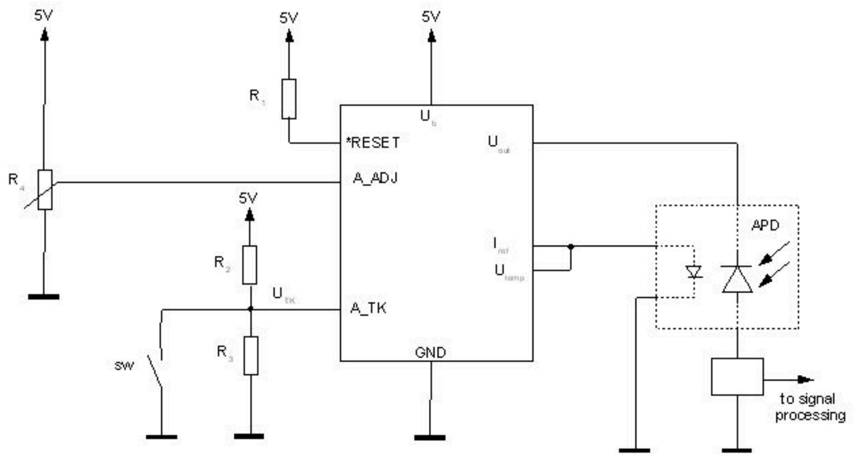
* Dual use pin: either RS232 or SPI interface
  Pin 10/11: Programming interface (required for firmware updates)

**SPI connection description:**

| | | |
|---|---|---|
| MOSI | -> | Master Out, Slave In |
| MISO | -> | Master In, Slave Out |
| SCLK | -> | Serial Clock |
| NSS | -> | used in Multimaster Mode |

## OPERATIONAL MODES

### Analog Mode




**Function:**

$V_{out} = (V_{A\_ADJ} * Gain) + (V_{TK} * d_{Temp})$

$d_{Temp} = Temp - 25°C$ (Temperature difference)

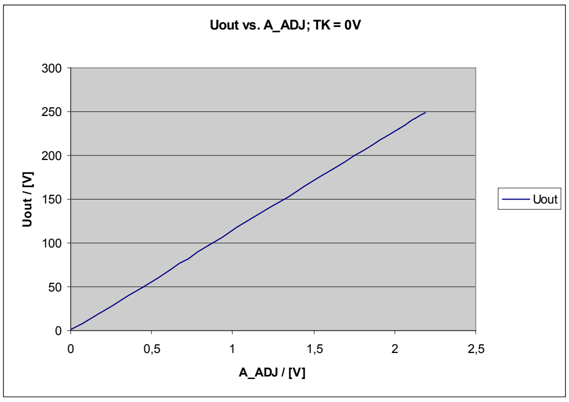
| dBC-xxx | Gain |
|---|---|
| 380-5x | 215 ± 2 |
| 220-3x | 114 ± 2 |
| 120-3x | 60 ± 2 |

Setup:

„SW" closed, or $V_{TK} = 0V$.

$V_{out} = (V_{A\_ADJ} * Gain)$ corresponds to $V_{out}$ at 25°C

**Note: For operation without temperature compensation, A_TK must be connected to GND.**




Example: dBC-220-3x



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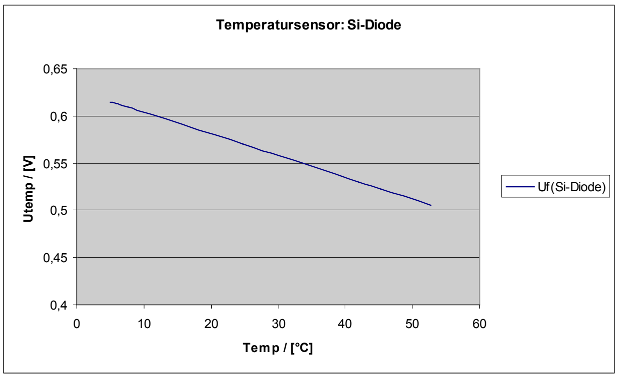
Temperature measurement ($I_{ref}/V_{temp}$):

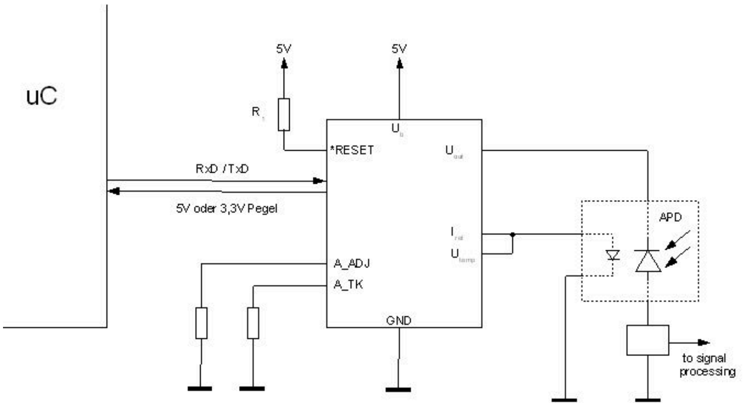
$I_{ref}$ : constant current source (default 1mA)
$V_{temp}$ : forward voltage Si diode or temperature sensor




Other temperature sensors with the following parameters may also be used.
($I_{ref}$ max. = 2 mA ($V_{temp}$ max = 2.2 V); default 1mA; current source resolution: 12-Bit)

### Remote control

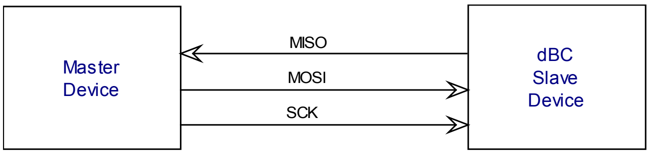
Circuit example: RS232 interface:




Serial interface setup: 8-Bit; 9600 Bd, no parity, no handshake

Circuit example: SPI-interface

3-wire single master and slave mode



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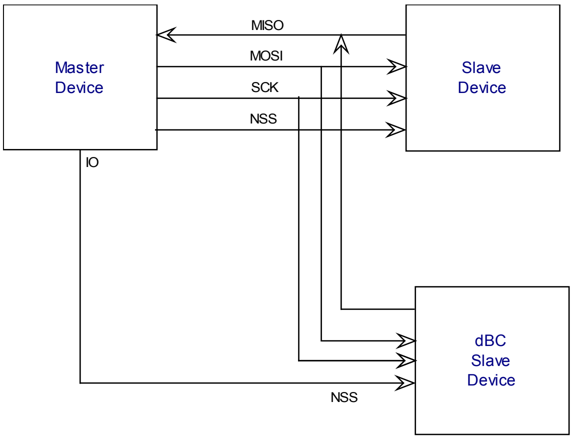
Optional: 4-wire single master and slave




## INTERFACE FUNCTIONS

| Function | RS232 command | SPI command (2x 8 Bit see timing) | Response: | Description |
|---|---|---|---|---|
| $V_{out}$ @25°C | U_xxxx | Hi-Byte = 1000 yyyy<br>Low-Byte = yyyy yyyy | Hi-Byte = 1000 yyyy<br>Low-Byte = yyyy yyyy | Output voltage at 25°C and TK = 0 mV<br>(e.g. APD data sheet value) |
| TK value | T_xxxx | Hi-Byte = 0100 yyyy<br>Low-Byte = yyyy yyyy | Hi-Byte = 0100 yyyy<br>Low-Byte = yyyy yyyy | Temperature compensation value [mV]<br>( $V_{out}$ @25°C + Temp*TK ) |
| TEMP ? | T_? | Hi-Byte = 0010 yyyy<br>Low-Byte = yyyy yyyy | Hi-Byte = 0010 yyyy<br>Low-Byte = yyyy yyyy | Temp. sensor readout<br>(12-bit ADC value) |
| HV ? | V_? | Hi-Byte = 0001 yyyy<br>Low-Byte = yyyy yyyy | Hi-Byte = 0001 yyyy<br>Low-Byte = yyyy yyyy | HV readout<br>(12-bit ADC value) |
| Module ON/OFF | M_1<br><br>M_0 | Hi-Byte = 1001 yyyy<br>Low-Byte = yyyy yyyy<br><br>Hi-Byte = 1010 yyyy<br>Low-Byte = yyyy yyyy | Hi-Byte = 1001 0000 (0x90)<br>Low-Byte = yyyy yyyy (0x90)<br><br>Hi-Byte = 1010 yyyy (0xA0)<br>Low-Byte = yyyy yyyy (0xA0) | Output voltage on/off |
| Remote-Mode ON/OFF | R_1<br><br>R_0 | Hi-Byte = 1011 yyyy<br>Low-Byte = yyyy yyyy<br><br>Hi-Byte = 1100 yyyy<br>Low-Byte = yyyy yyyy | Hi-Byte = 1011 0000 (0xA0)<br>Low-Byte = 1011 0000 (0xC0)<br><br>Hi-Byte = 1100 0000 (0xC0)<br>Low-Byte = 1000 0000 (0xC0) | Switching:<br>Remote mode ↔ analog mode |
| SPI-Error | | | Hi-Byte = 1111 0000 (0xF0)<br>Low-Byte = 1111 0000 (0xF0) | |
| Data out ON<br><br>OFF | D_1<br><br>„ESC" | | | Continuous readout<br>TK [mV]<br>HV [0,1 * V]<br>Temperature [0,1 * °C] |
| Help | H ? | | Function table | |

RS232 command: „_" = space
SPI command: 4 bit function + 12 bit data (yyyy yyyy yyyy)

**Application examples**

1. Temperature compensation with Si diode as sensor:

APD data sheet values e.g. gain = 100; $V_{opt}$ = 200 V; TK = 0.5 V/°C

Input following values:
$V_{out}$ @25°C: 200 V
TK value: 0.5 V

The module automatically adjusts the high voltage in accordance with the measured temperature.



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2. Temperature compensation with any sensor:

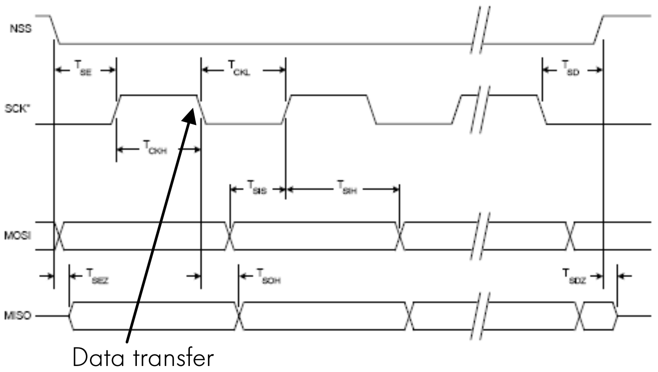
APD data sheet values e.g. gain = 100; $V_{opt}$ = 200 V; TK = 0.5 V/°C

TEMP ?: Reads out the measured temperature and calculates the correct HV value
$V_{out}$ @25°C: Corresponding to measured temperature
TK value: 0 V

Default temperature measurement configuration:

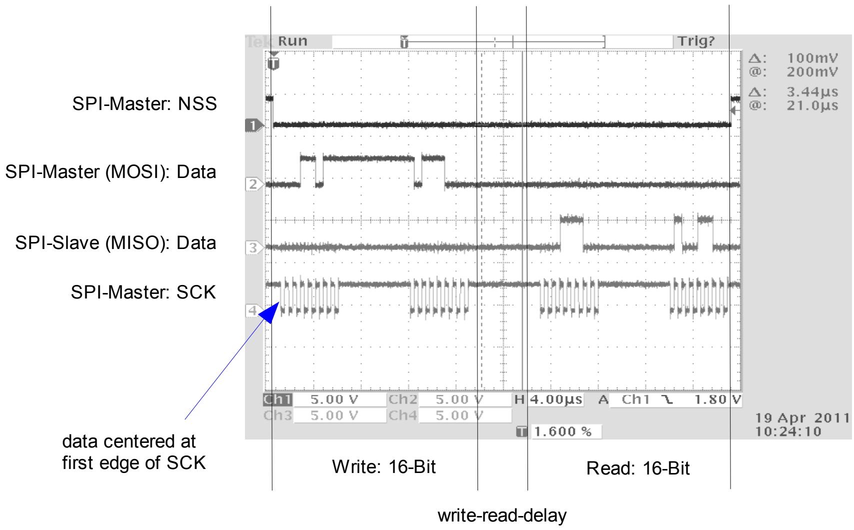
Iref = 1mA; Vtemp max = 2.2 V; Vtemp resolution: 12-Bit

## TIMING DIAGRAM: DBC IN SLAVE MODE




| | |
|---|---|
| Write-read-delay | > 3.3 µs |
| $T_{CKH}$ / $T_{CKL}$ | > 80 ns |
| $T_{SE}$ / $T_{SD}$ | > 380 ns |

## SPI-TIMING: WRITE READ




16 bits must be written and read out. The dBC module evaluates 4 data blocks. In the first two 8-bit blocks the data are read out, in the following blocks the dBC answers with 16-bit data. The 3.3 µs write-read-delay is required to allow the microprocessor to evaluate the write data.



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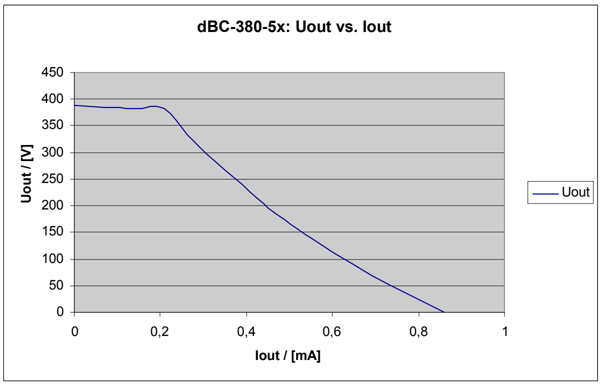
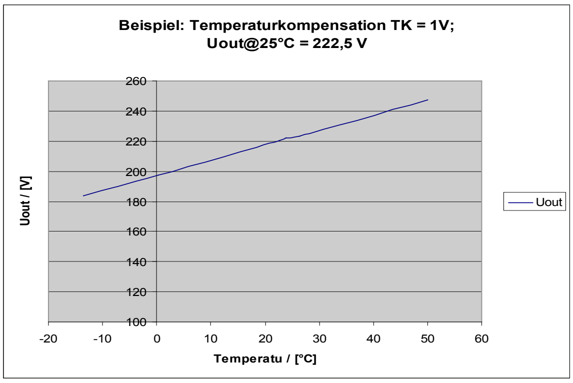
## DIAGRAMS

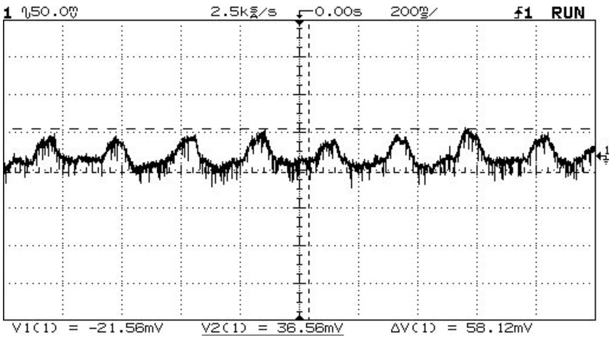



Current limiting curve for dBC-380-5x




Example: temperature compensation

Noise and Ripple




Measured ripple for dBC-380-5x at Vout = 370 Vdc
Ripple: ca. 1.6 E-4



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## ORDERING INFORMATION

**d B C** - [ ][ ][ ] - [ ][ ]

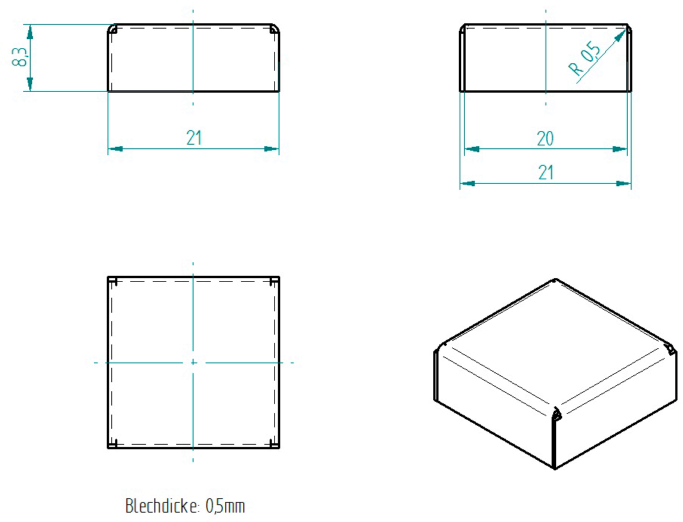
| Output voltage |
|---|
| 120 = 1 ... 120 V<br>220 = 1 ... 220 V<br>380 = 1 ... 380 V |

| Operating voltage* |
|---|
| 3 = 2,8 ... 12,5 V<br>5 = 4,8 ... 12,5 V |

| Interface |
|---|
| R = RS 232 |
| S = SPI |

* 3 for dBC-120 und dBC-220
5 for dBC-380

## DIMENSIONS




Dimensions ca. 21 x 21 x 10 mm

## ACCESSORIES

A suitable Evaluation Board dBC-EVA-Board is available upon request.

07/11 / V4 / SB / lce/ dbc-series_e.doc



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