

DIGIBOARD

Multifunctional photocurrent amplifier board



GENERAL FEATURES



Description of the Digiboard

Although the UV photodiodes of sglux provide high sensitivity an additional amplifier is required in most applications of photodiodes. This is especially true in the ultraviolet wavelength range because of the very small photocurrents.

To support your application development we provide this amplifier board based on our successful Multiboard. The Digiboard offers an analog transimpedance channel with adjustable Schmitt-Trigger (ST) and a Current-to-Frequency converter (CFC) channel.

The frequency output of the CFC simplifies the measurement of photocurrents over a wide dynamic range in microcontroller based designs because only one digital pin/counter can be used to record photocurrents.

FEATURES

- wide single supply voltage range 5.0 V to 18.0 V with surge and polarity protection
- low power consumption (< 50 mW @ 5 V)
- analog transimpedance amplifier channel with:
 - o adjustable gain in the range 10^5 - 10^7 V/A with fine tuning option
 - o Schmitt-Trigger stage with adjustable switching point and adjustable hysteresis
 - o LED showing state of Schmitt-Trigger output for simple adjustment
- Current-to-Frequency converter with:
 - o 2 measurement ranges giving high dynamic range
 - o standard CMOS compatible frequency output

Important Notice

Please consider any possible action to protect the sensitive devices on the board against electrostatic discharge (ESD). Not to do so voids warranty.

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▶ GETTING STARTED

Power Supply

This board requires a single DC voltage supply from 5 V to 18 V to be connected as shown in figure 1. In general a simple filtered DC source is sufficient.

For ultra low noise and high gain measurements we recommend using batteries or carefully selected power supply units.

The board is protected against wrong polarity of the power supply.

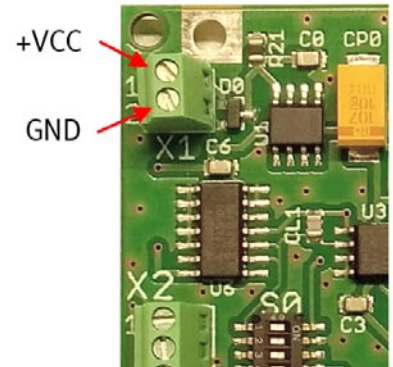


Fig. 1: power supply

Current-to-Frequency Converter

The input and output connections for this function are shown in the figure below. The anode of the photodiode must be connected to the input terminal and the cathode to GND.

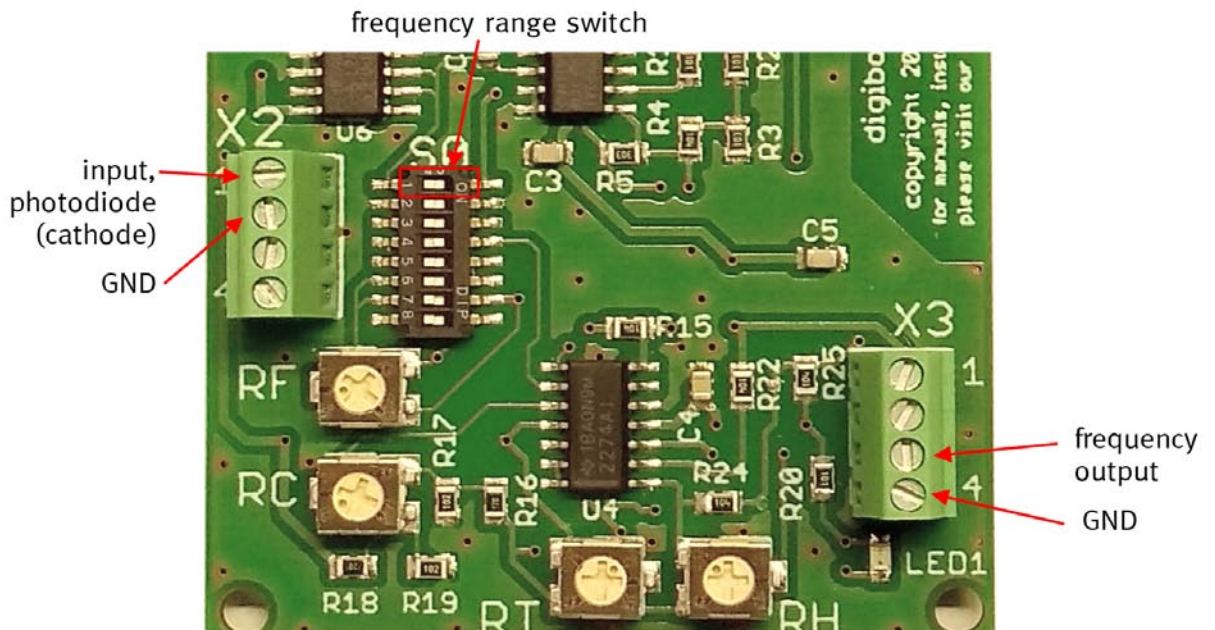


Fig. 2: Current-to-Frequency Converter input, output and switches

If there appears no pulse signal on the output the polarity of the photodiode may be wrong. Also check that your equipment is able of recognising pulses as short as 1 μ s.

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The measurement range can be selected by switch 1 as shown in the following table. You can calculate the output frequency by multiplying the photocurrent with the given conversion factor.

switch 1	mode	conversion factor
1 = OFF	high frequency / low current	$\sim 3.3 \times 10^9 \text{ Hz / A}$
1 = ON	low frequency / high current	$\sim 3.0 \times 10^8 \text{ Hz / A}$

In both ranges the useful frequencies reach from 0.1 Hz up to about 40 kHz giving a dynamic range of 112 dB. Above 40 kHz the linearity error increases as shown in figure 3 due to the influence of the fixed output pulse duration on the total integration cycle length.

In programmable systems the linearity error can be corrected by using a matched lookup table. In this case frequencies up to 500 kHz can be used and thus the total dynamic range increases by two orders of magnitude.

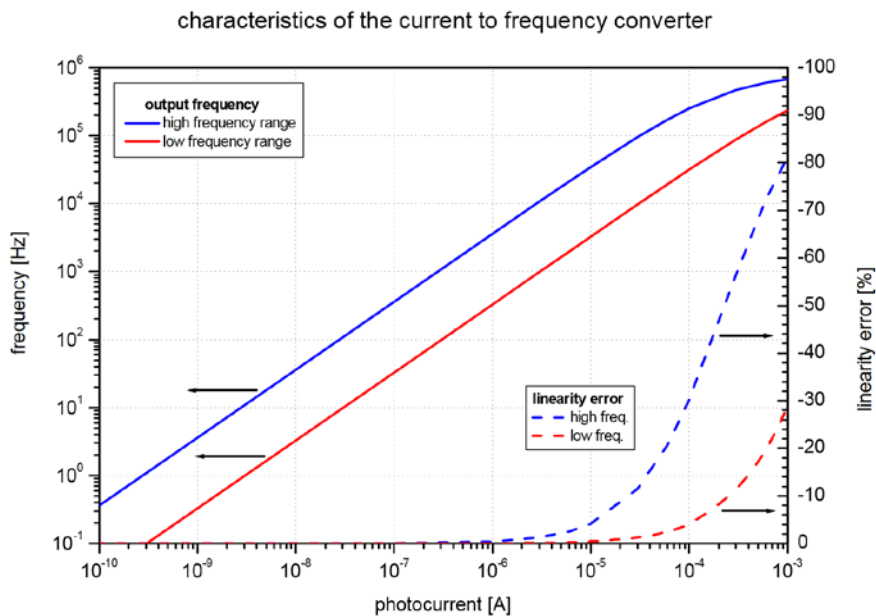


Fig. 3: CFC performance

Hint: If you require different conversion factors the integration capacitors CL1 and CL2 have to be changed. CL1 is active if switch 1 is opened. Closing switch 1 puts both capacitors in parallel and the active integration capacitance equals their sum. We are happy to assist you with that or to deliver boards adapted to your application.

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ANALOG AMPLIFIER CHANNEL

Amplifier stage

This channel is completely independent of the CFC and works fully bipolar. Please refer to figure 4 for the appropriate connections and controls. If you connect the anode of the photodiode to the input pin the output voltage is negative and vice versa.

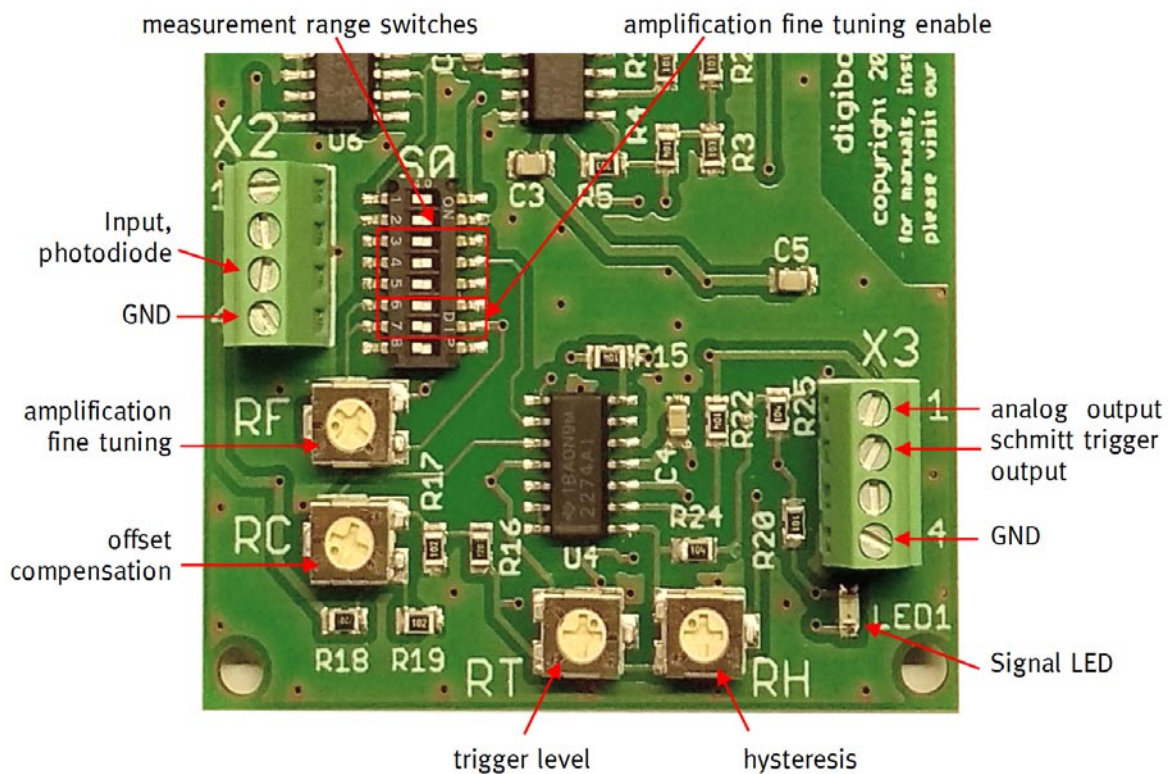


Fig. 4: Analog amplifier channel: input, output, potentiometers and switches

For basic operation close (ON) one of the switches 3, 4, 5 and both switches 6 and 7.

The amplification can be selected as follows:

switches 3, 4, 5	amplification
3 = ON 4 = OFF 5 = OFF	10^7 V/A
3 = OFF 4 = ON 5 = OFF	10^6 V/A
3 = OFF 4 = OFF 5 = ON	10^5 V/A

To activate amplification fine tuning you must open both switches 6 and 7 (OFF). Now you can adjust the total amplification with potentiometer “RF” by a factor in the range from 0.5 to 1.5.

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switches 6, 7	amplification fine tuning
6 = OFF 7 = OFF	enabled
6 = ON 7 = ON	disabled

Note: switches 6 and 7 must be explicitly both on or both off! Any other setting will produce a malfunction (but no damage).

Example: You choose 10^6 V/A and fine tuning. Now with “RF” you can trim the amplification in the range from 5×10^5 V/A to 1.5×10^6 V/A.

The maximum analog output voltage is approx. ± 3.0 V and the output current must not exceed 1 mA. Please note that the amplifier is fast enough to resolve intensity modulation of the doubled mains frequency as normally found when using fluorescent lamps.

The input offset can be compensated following this procedure:

1. select amplification with switches 3, 4, 5
2. connect the (darkened) photodiode to the input (Fig. 4)
3. switch power supply on
4. adjust ‘RC’ potentiometer until the analog output voltage is zero

Schmitt-Trigger

The analog output voltage is internally connected to the Schmitt-Trigger. The switching point can be adjusted by potentiometer “RT” within the range +3 V (left stop) to -3 V (right stop).

The hysteresis is adjustable by potentiometer “RH” from 0.05 V (left stop) to approx. 1.5 V (center position). Most of the time it is useful to start with a small hysteresis setting. Too large hysteresis setting may impose unexpected behaviour.

The logical state of the Schmitt-Trigger output is displayed by the red LED. The LED is on if the Schmitt-Trigger output is logically HIGH (~ 3 V).

Special feature:

- if the analog output voltage is positive: the Schmitt-Trigger output goes HIGH if the analog output voltage exceeds the switching point.
- if the analog output voltage is negative: the Schmitt-Trigger output goes LOW if the analog output voltage exceeds the switching point.

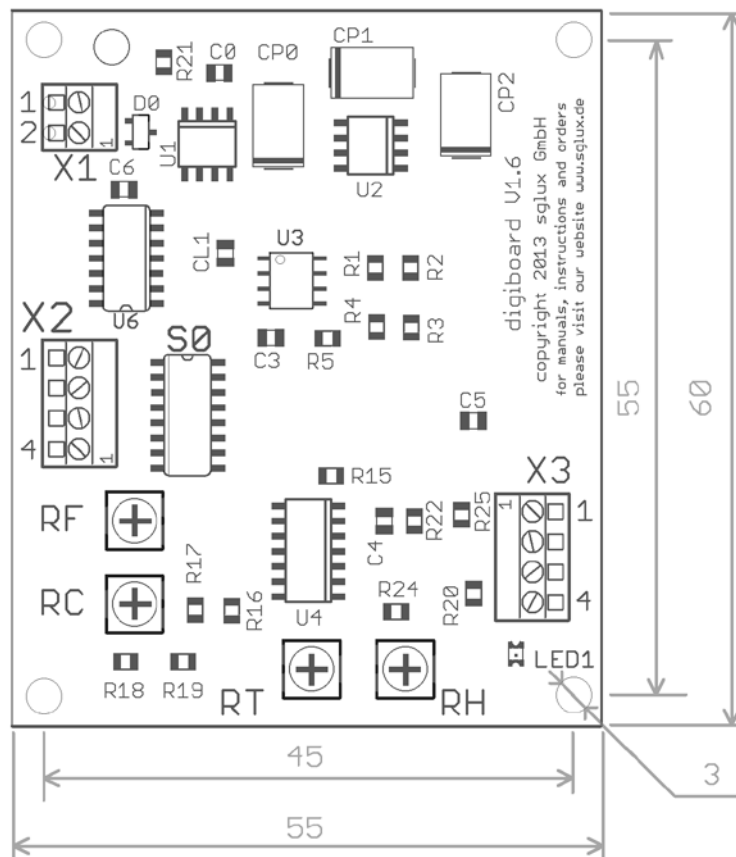
This way it is possible to realise exceedance or underrun of a limit value by inverting the polarity of the photodiode!

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PHYSICAL DIMENSIONS

All dimensions are shown in millimeters.



ABSOLUTE MAXIMUM RATINGS

Exceeding these limits may decrease lifetime or destroy the board or parts of it immediately.

Parameter	Value
Operating temperature	0 to +70°C (non condensing)
Storage temperature	-25 to +85°C (non condensing)
Supply voltage	18 V
Output current (digital output)	0.5 mA
Output current (analog output)	10 mA

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ELECTRICAL CHARACTERISTICS

(at 25°C unless otherwise noted, jumper settings)

General

Parameter	Unit	min	Value typ	max
Supply voltage	V	5	12	18
Power dissipation (at 5 V supply voltage, depends on load and switching frequency)	mW		50	

Analog channel

Parameter	Unit	min	Value typ	max
Fixed transimpedance gain (gain setting by switches 3, 4, 5)				
low	V / A	0.98×10^5	10^5	1.02×10^5
medium		0.98×10^6	10^6	1.02×10^6
high		0.95×10^7	10^7	1.05×10^7
Amplification fine tuning		0.7 - 1.3	0.5 - 1.5	0.3 - 1.7
Input current	μA			± 30
Maximum output voltage (in both polarities)	V	± 2.6	± 2.9	± 3.3
Output offset voltage (with compensation)	mV		$< \pm 5$	± 10
Cutoff frequency (low pass filter)	Hz		120	160

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Digital channel

Parameter	Unit	min	Value typ	max
Frequency and Schmitt-Trigger output output voltage LOW output voltage HIGH	V	0 2.8	0.05 3.1	0.1 3.3
Frequency output pulse length FWHM (levels above)	μs	1	1.2	2
Input current	A	$\sim 10^{-10}$		$\sim 10^{-4}$
Conversion rate low frequency mode high frequency mode	Hz / A	2.8×10^8 3.1×10^9	3.0×10^8 3.3×10^9	3.2×10^8 3.5×10^9
Conversion rate temperature dependence	1 / K		$\pm 3 \times 10^{-5}$	
Linearity error @ 10 kHz @ 40 kHz @ 100 kHz	%		1 5.2 12	

Further reading:

Our digiboard resembles a discreet implementation of a switched integrator circuit in continuous running mode. For further reading about the basic principles and application of switched integrator circuits please refer to these documents:

Appnote AB-048: <http://www.ti.com/lit/pdf/sboa029>

Datasheet ACF2101: <http://www.ti.com/lit/gpn/acf2101>