BD111/BD111T: Bidirectional Detectors for R26 Waveguide

General Description

BD111 and BD111T (Fig. 1 left) are bidirectional detectors that are intended for simultaneous sampling of the incident and reflected waves in high-power 2450 MHz industrial applications using the R26 (WR340) rectangular waveguide. BD111T includes a temperature sensor. These detectors combine the following components:

- Four-port directional coupler
- Attenuators
- Tunnel diode detectors
- Temperature sensor with analog output (BD111T only)

The detectors deliver well-scaled DC voltages approximately proportional to the power of the waves propagating in the forward and reverse directions in the main waveguide. The use of tunnel diodes provides improved temperature stability of the output voltages and a low video resistance for fast pulse rise/fall times.

The detector transfer curves are generally nonlinear and vary with temperature. A transfer curve of an "average detector" is presented in this datasheet.

Users can apply the output from the temperature sensor to their own software correction of the temperature dependence of the detector outputs.

The detector module is fastened to a parent waveguide by means of six M3 or similar-diameter screws after machining of appropriate holes in the waveguide wall. As an option, an assembly consisting of the module affixed to a precisely machined parent waveguide with the standard length 174 mm can be provided (Fig. 1 right).

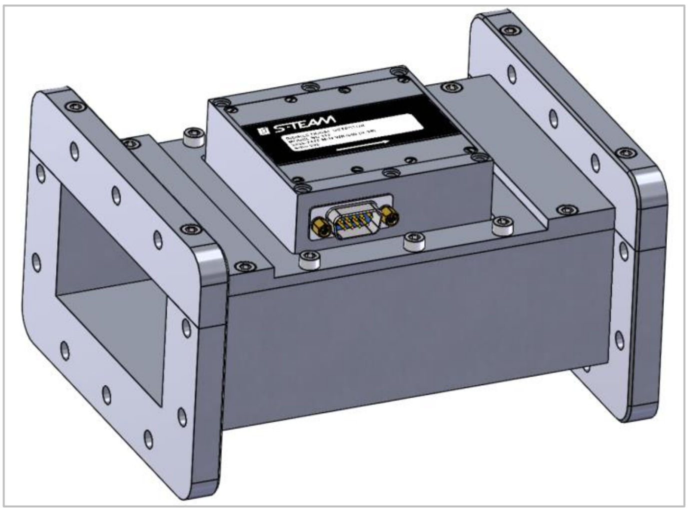

Fig. 1. Left: Bidirectional detector BD111/BD11T. Right: An assembly with a parent waveguide.

Specifications

Waveguide of destination	R26 (WR340)
Waveguide wall thickness	2 mm
Waveguide surface flatness required at BD interface	0.04 mm
Frequency range	2425 – 2475 MHz
Maximum working power	1 kW, 10 kW, 30 kW
Directivity	25 dB min
Output voltage polarity	Positive
Video resistance (typical)	225 Ω
Internal output capacitance	1000 pF
Statistical spread of output voltage	±1 dB (3-σ deviation)
Output voltage temperature variation (+5 °C to +65 °C)	< 0.5 dB
Connector	D-sub 9-pin male (D9m)
Dimensions (L x W x H)	73 mm × 80 mm × 29.5 mm
Mass	220 g
Operating temperature range	-10 °C to +65 °C
Storage temperature range	-20 °C to +80 °C

Pin Assignment

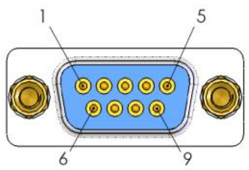

Fig. 2. D9m connector pin numbering.

Pin	Signal	Description
1	RFL	Reverse (reflected) signal: detector output
2		
3		
4	TSENS	Temperature sensor output
5		
6	FWD	Forward (incident) signal: detector output
7		
8	GND	Signal ground. Negative DC power supply input (0 V)
9	VPOS	Positive DC power supply input (+5 to +24 V)

Notes:

- RFL, FWD and TSENS outputs are referred to GND.
- The forward wave should propagate in the direction of the arrow on the nameplate.
- Unassigned pins are not connected.
- TSENS and VPOS are available only in BD111T.

Detector Correction Curve

A detector correction curve is the inverse of the transfer curve $V = f(P)$, where P is the power of a wave propagating in the waveguide in a given direction and V is the output voltage of the corresponding channel. The correction curve can serve, in particular in its mathematical form, for determining the input power from the output voltage. Fig. 3 shows a typical *normalized* correction curve for an ambient temperature of T_a = 25 °C, frequency 2450 MHz, and load resistance R_L = 33 kΩ, where P_{max} is the specified maximum working power.

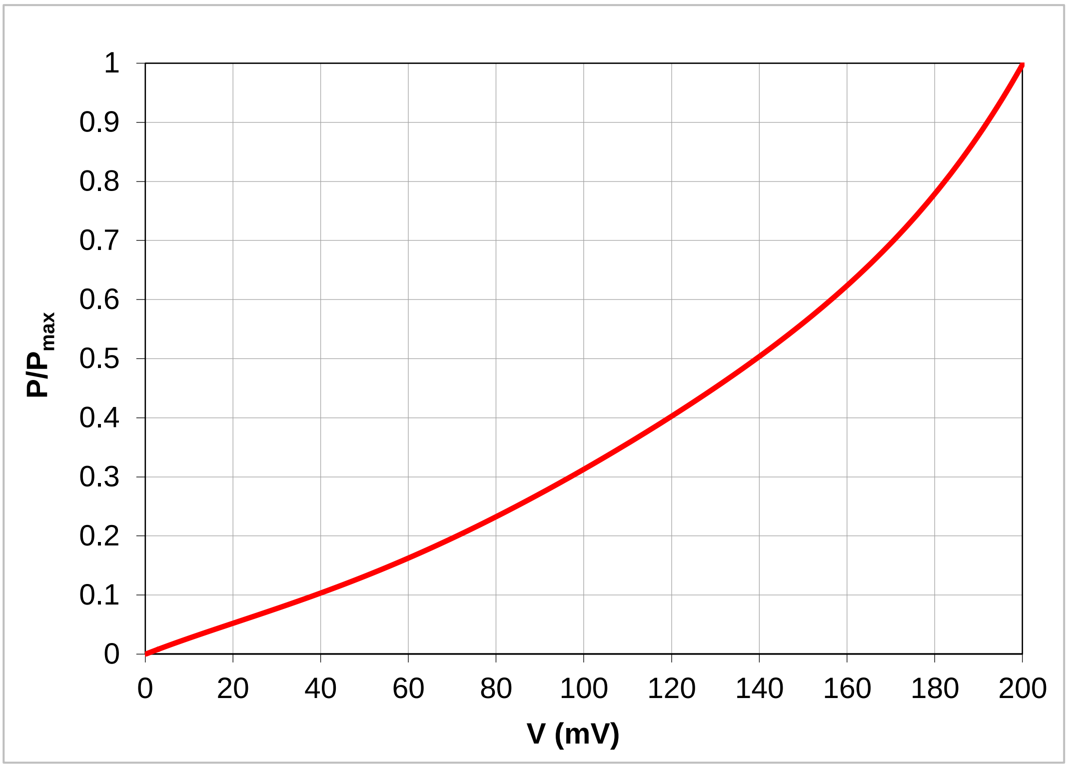

Fig. 3. Typical BD111/BD111T correction curve for both directions. P_{max} is the specified maximum working power.

The curve can be approximated by the polynomial

$$P/P_{max} = d_1 V + d_2 V^2 + d_3 V^3 + d_4 V^4 + d_5 V^5$$

where P is the input microwave power, P_{max} is the specified maximum working power (both in the same units), V is the output voltage in millivolts, and d_i are the coefficients listed in Tab. 1.

Tab. 1. Polynomial coefficients for BD111/BD111T correction curves.

Coefficient	Value
d_1	2.9131179E-03
d_2	-2.3462359E-05
d_3	5.0125511E-07
d_4	-3.2388504E-09
d_5	7.8936172E-12

Please be aware that the function is a statistical average based on an evaluation of a number of detectors, and generally depends on temperature. The behavior of individual detectors may vary.

Typical Directivity

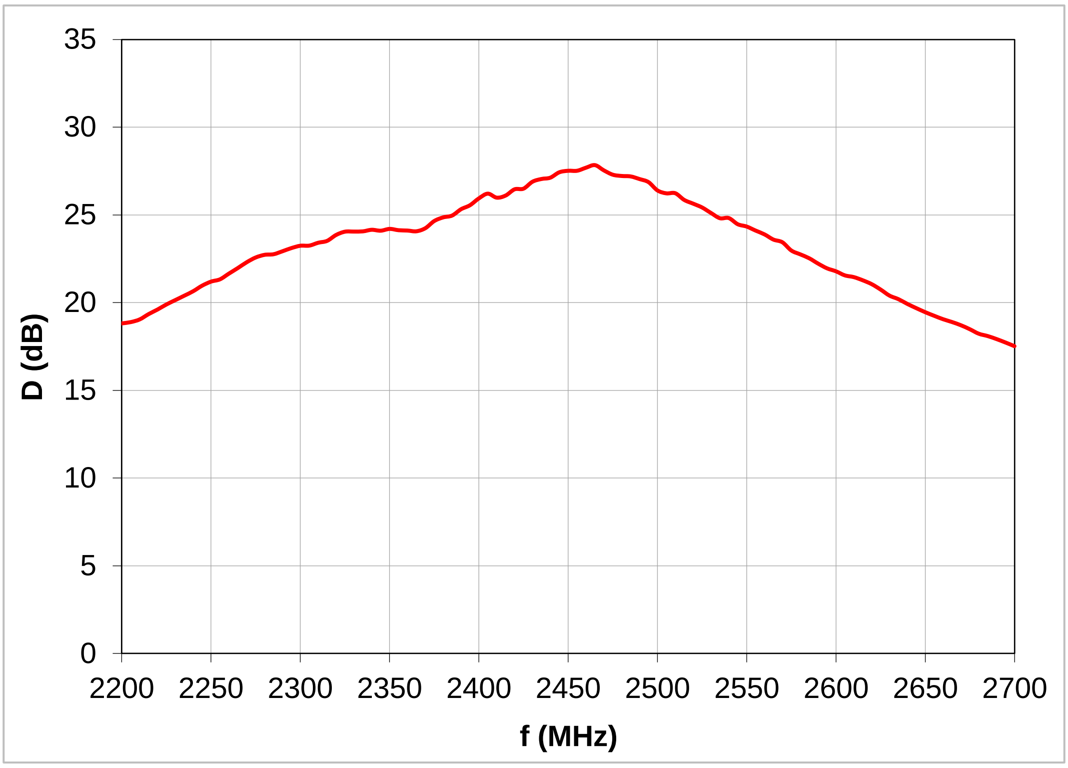

Fig. 4. Typical BD111 directivity (both directions).

Dimensional Drawing

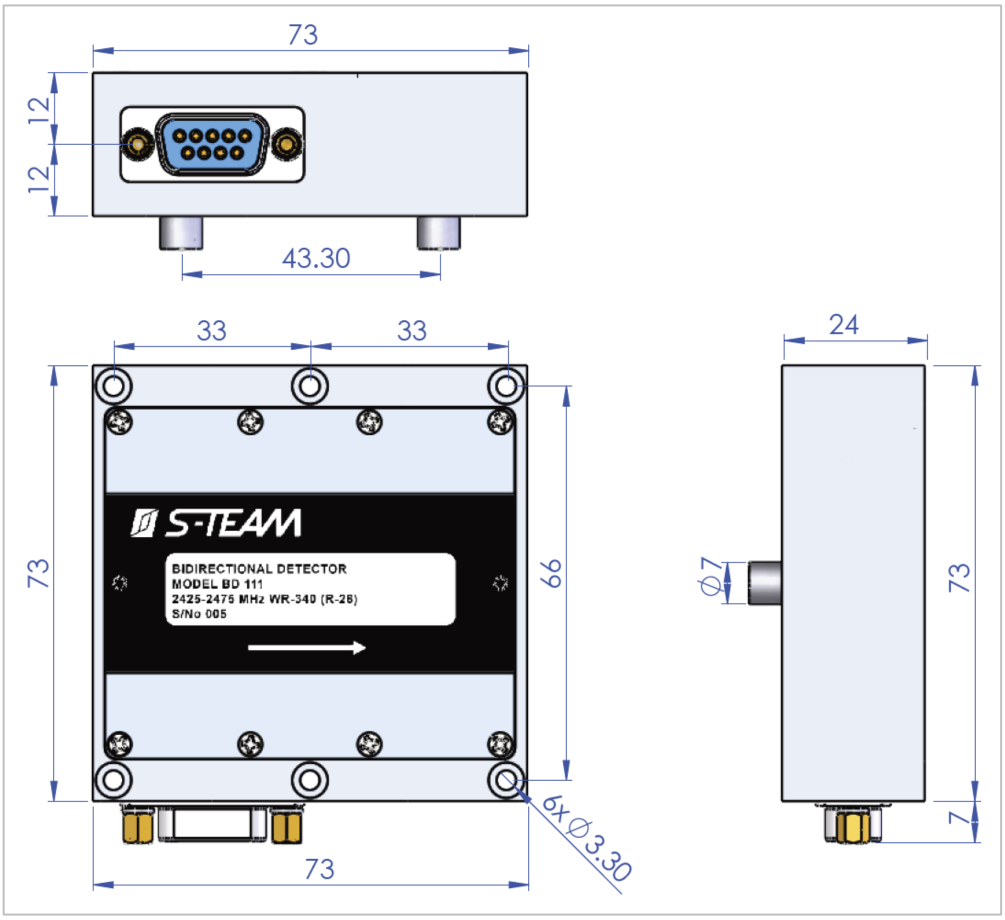

Fig. 5. Basic BD111/BD111T dimensions. All dimensions are in millimeters. The probe protrusion is 5.5 mm.

Waveguide Machining Template

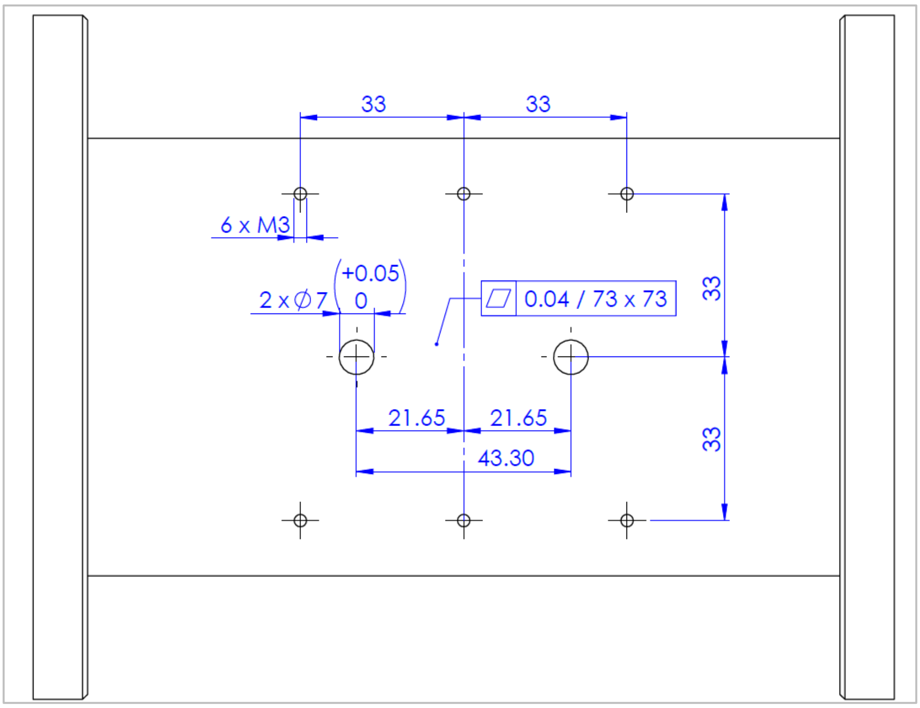

Fig. 6. Waveguide machining template. All dimensions are in millimeters. The pattern is centered about the waveguide axis. The waveguide wall thickness **must be 2 mm**. Suggested are M3 x 25 screws (stainless or galvanized steel).

Important Note

Complying with the specified waveguide wall thickness and flatness of its surface interfacing with the detector is essential in order to achieve the specified measurement accuracy. The slope of the coupling factor as a function of the wall thickness is about -6 dB/mm (increasing the wall thickness decreases the output power readings).

If the wall thickness differs from the specified figure but is known, one can apply a user-defined correction based on the above slope. Nevertheless, the wall thickness should not deviate from the specification by more than ±0.3 mm, as otherwise BD directivity will deteriorate.

To avoid problems with manufacturing precision waveguide components, one can order a calibrated assembly consisting of a BD module fixed to a parent waveguide. The standard waveguide length is 174 mm.

Wiring Examples

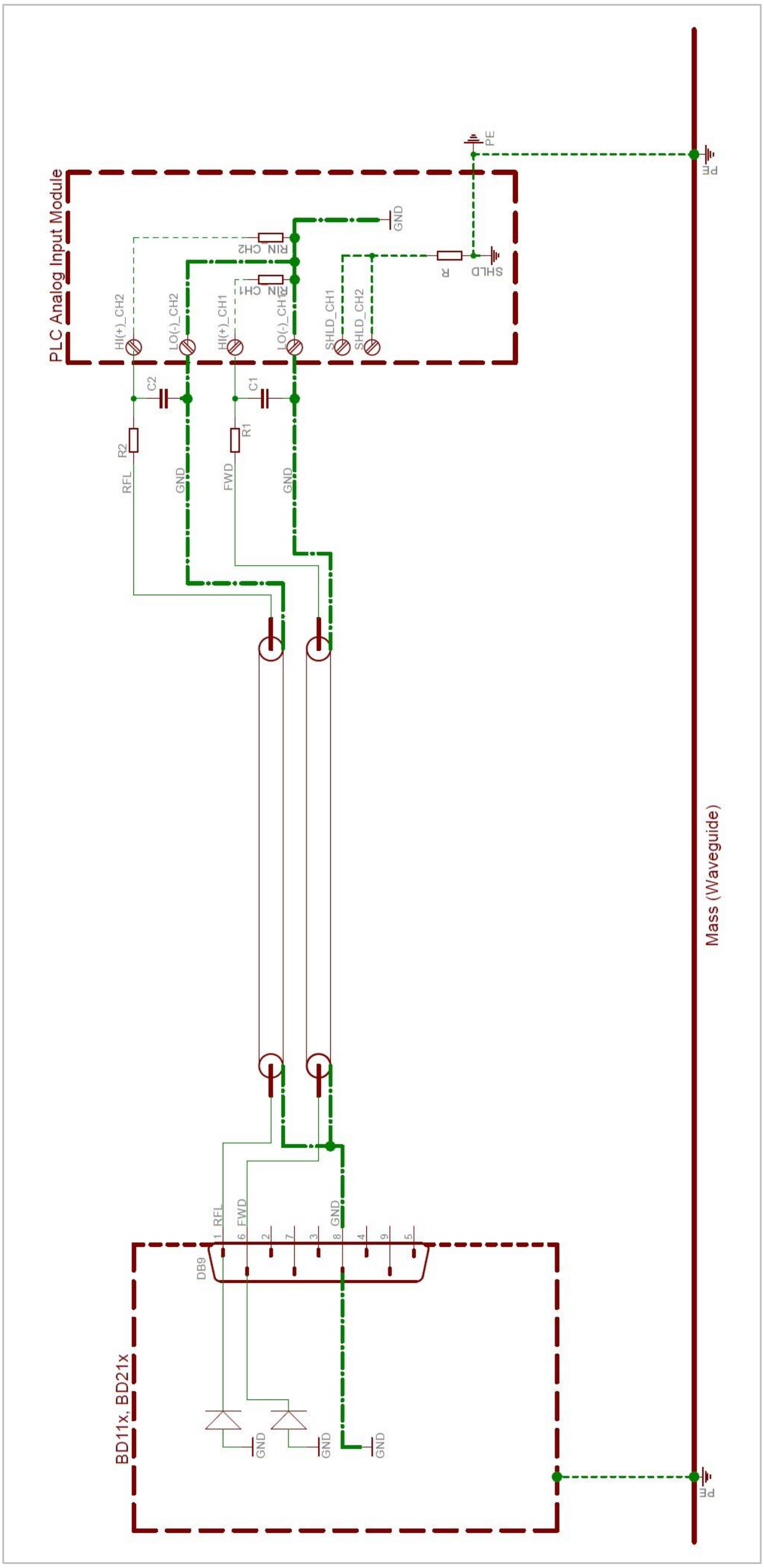

Fig. 7. Example of BD111 – PLC connection.

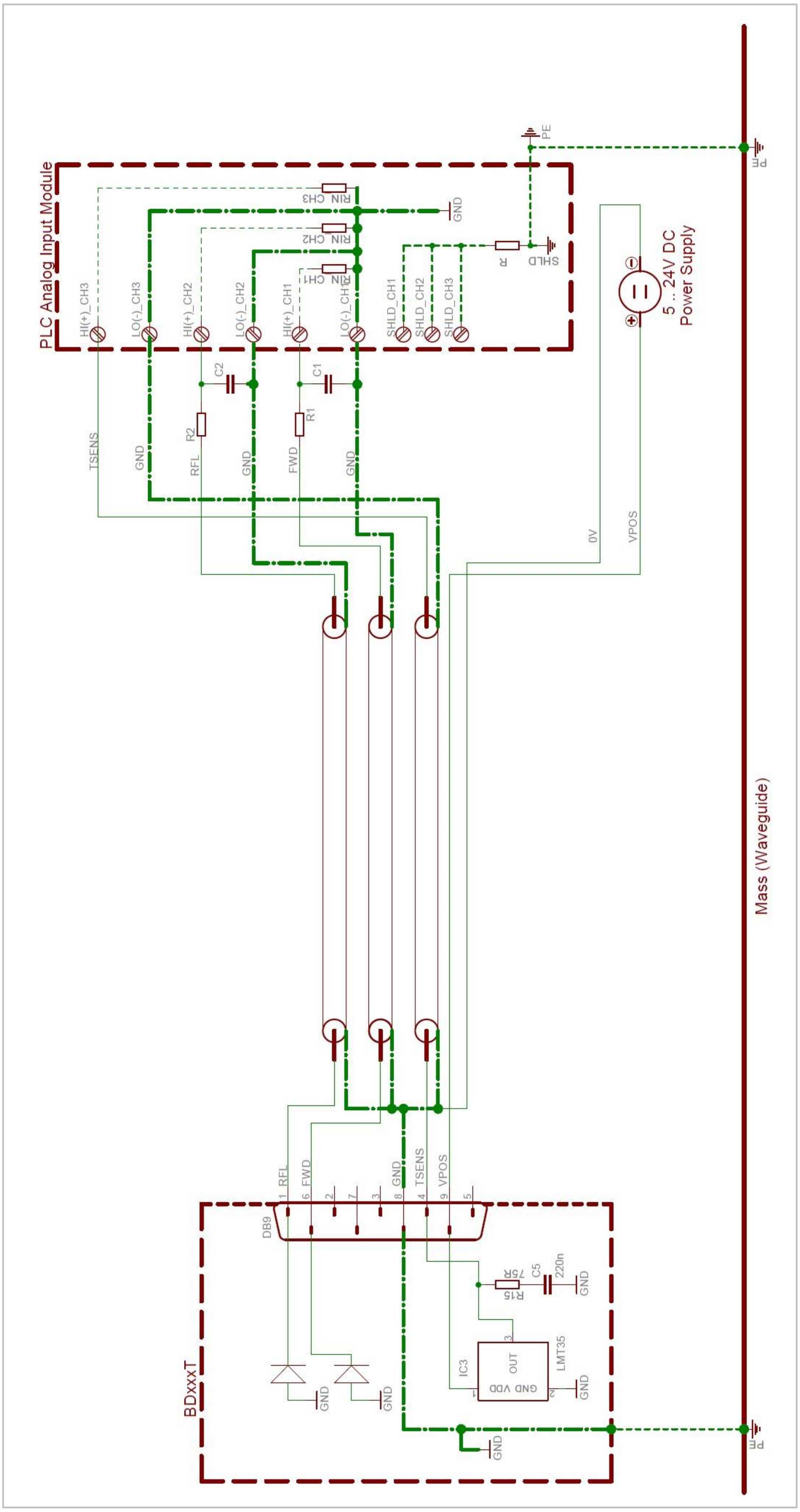

Fig. 8. Example of BD111T – PLC connection.

Time Constant

The internal output time constant of BD111 is set to approximately 0.26 μs (3-dB cutoff frequency of about 620 kHz). To improve interference immunity in CW applications, the time constant can be increased by an optional external RC filter as indicated in the wiring diagram (R1, C1 and R2, C2). The filters, if applied, should be placed as close to the PLC inputs as possible.