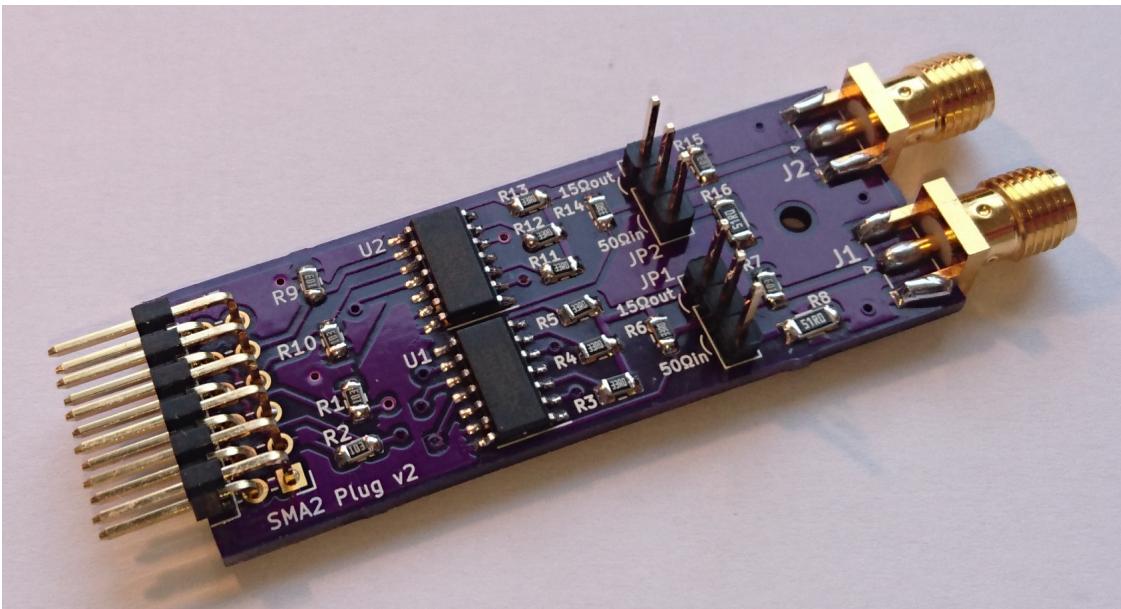


# SMA2 Plug v2 User Manual



## Overview

The *SMA2 Plug* provides an easy way to connect digital TTL signals to an FPGA board via coaxial cables.

One side of the module has two SMA connectors which can each be used either as digital input or as digital output. The other side of the module has a 2x6 pin header which can be plugged into an FPGA board.

The module converts the TTL input level of each SMA connector into a matching IN signal for the FPGA. The module also expects two output signals from the FPGA for each SMA connector: OE (output enable) to enable or disable the output function, and OUT to determine whether the output (if enabled) produces a logic high or logic low level.

### Features:

- ▶ Two SMA connectors for external digital signals, separately configurable as input or output.
- ▶ Useful for connecting TTL control signals or trigger signals to external equipment.
- ▶ Signal rate up to 100 Mbit/s.
- ▶ Input impedance 10 kOhm or 50 Ohm, configurable via jumper.
- ▶ Output 3.3 Volt with 50 Ohm output impedance into high impedance load, or 2.5 Volt with low output impedance into 50 Ohm load, configurable via jumper.
- ▶ Compatible with Digilent Pmod specification.

See <https://github.com/jorisvr/hw-sma-plug> for schematics and design files.

## Connectors

Label	Type	Description
J1	SMA	Digital input/output channel 1
J2	SMA	Digital input/output channel 2
J3	2x6 pin header	Connection to FPGA board

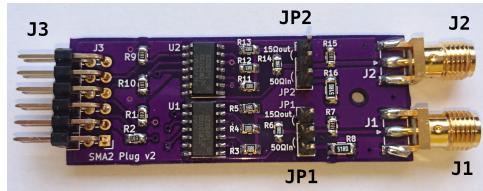


Table 1: Connectors

Connector J3 is compatible with the Digilent Pmod specification v1.2.0 (see <https://reference.digilentinc.com/reference/pmod/start>). This means the module will work when plugged into a dual-row Pmod connector as present on many Digilent FPGA boards.

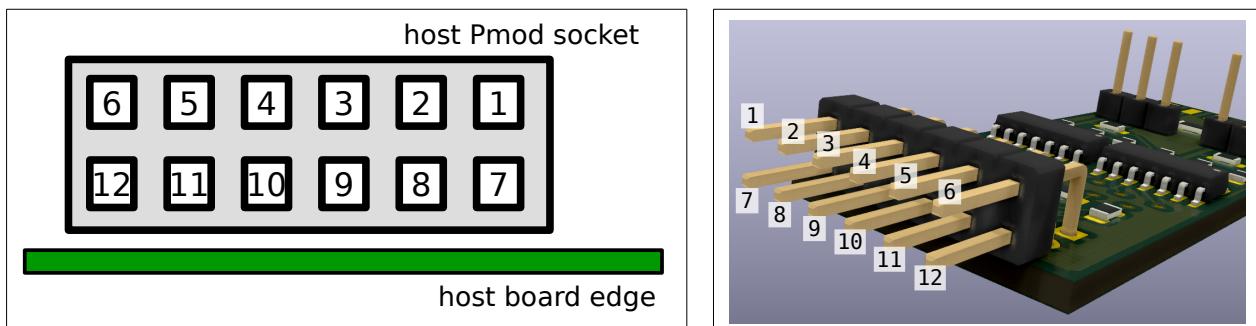


Figure 1: Pin numbers of Pmod connector on host FPGA board and SMA Plug module

The pin functions of connector J3 match Pmod interface type 1A (GPIO). The pin assignments are as follows:

Pin nr	Name	In/out	Function
1	IN2	FPGA input	Input signal from J2.
2	OUT2	FPGA output	Output signal for J2.
3	OE2	FPGA output	High to enable output via J2; low to disable output via J2.
4			not connected
5	GND		0 V ground
6	3V3		+3.3 V power supply from FPGA board
7	IN1	FPGA input	Input signal from J1.
8	OUT1	FPGA output	Output signal for J1.
9	OE1	FPGA output	High to enable output via J1; low to disable output via J1.
10			not connected
11	GND		0 V ground
12	3V3		+3.3 V power supply from FPGA board

Table 2: Connector J3 pin assignments

Note: These pin number assignments are based on the Digilent Pmod specification. The schematic of the SMA2 Plug v2 uses different pin numbers internally.

## Jumpers

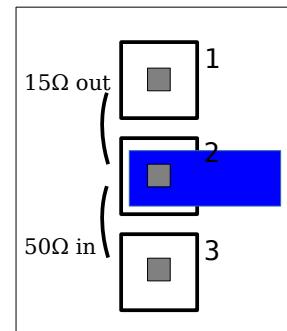
Each of the two SMA ports has a 3-pin jumper which is used to choose between 3 modes of operation for that port. The jumper settings are as follows:

### Jumper not connected

This is the best setting to use in most cases.

The input function receives a TTL signal from an external device. The SMA Plug input has  $10\text{ k}\Omega$  termination. The external device is expected to provide  $50\ \Omega$  source termination to avoid reflections in the cable.

The output function drives a 3.3 V TTL signal to an external device with high input impedance. The output has  $50\ \Omega$  series termination to avoid reflections in the coax cable. The external device must have high input impedance (at least  $500\ \Omega$ ) to ensure that the output meets the TTL threshold.



Input function:  $10\text{ k}\Omega$  input impedance.

Input threshold: logic low level max 0.8 V, logic high level min 2.0 V.

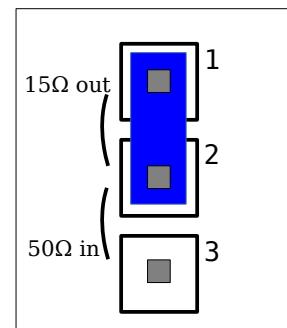
Output function:  $50\ \Omega$  output resistance.

Output levels: 0.0 V to 3.2 V into high-impedance load.

### Jumper connected from pin 1 to pin 2

This mode is suitable for driving a 2.5 V TTL output signal to an external device with  $50\ \Omega$  input impedance.

The jumper reduces the output resistance of the SMA Plug to  $15\ \Omega$  to make it strong enough to drive a  $50\ \Omega$  load. This only works well if the coax cable ends in  $50\ \Omega$  termination at the external device, otherwise reflections may occur.



Input function:  $10\text{ k}\Omega$  input impedance.

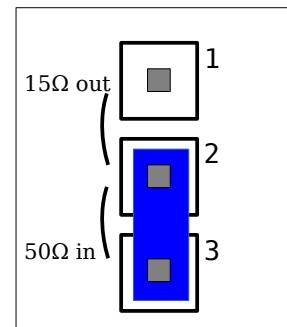
Input threshold: logic low level max 0.8 V, logic high level min 2.0 V.

Output function:  $15\ \Omega$  output resistance.

Output levels: 0.0 V to 2.5 V into  $50\ \Omega$  load.

### Jumper connected from pin 2 to pin 3

This mode is suitable for TTL input from an external device which is designed to drive a  $50\ \Omega$  load. The jumper connects a  $50\ \Omega$  load resistor between the SMA port and ground to terminate the coax cable.



In this mode the input voltage must stay below 3.6 V to prevent overheating of the load resistor.

Input function:  $50\ \Omega$  input impedance.

Input threshold: logic low level max 0.8 V, logic high level min 2.0 V.

Output function: not usable (keep OEn = '0').

# Specifications

## Physical specifications

Board dimensions:	54.4 x 20.4 mm
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## Damage limits

Input voltage limits:	minimum	-0.5 V
	maximum (10 kΩ input impedance)	+5.5 V
	maximum (50 Ω input impedance)	+3.6 V
Output load:	minimum load resistance	30 Ω

Exceeding these limits may damage the SMA Plug.

Short-circuiting the SMA connector with output enabled may damage the SMA Plug.

## Voltage levels

Input thresholds:	logic low level, maximum input voltage	0.8 V
	logic high level, minimum input voltage	2.0 V
Output levels: (typical)	logic low output level	0.0 V
	logic high output level (50 Ω output resistance, > 1 kΩ load)	3.2 V
	logic high output level (15 Ω output resistance, 50 Ω load)	2.5 V

## Power consumption

Supply current: (typical)	both outputs disabled	1 mA
	both outputs enabled, logic high output, 15 Ω output resistance, 50 Ω load	100 mA

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Source location: <https://github.com/jorisvr/hw-sma-plug>