

2128 SMA-TTL

Features

- 8 channels.
- Input and output capable.
- Galvanically isolated.
- 3ns minimum pulse width.
- SMA connectors.

Applications

- Photon counting.
- External equipment trigger.
- Optical shutter control.

General Description

The 2128 SMA-TTL card is a 4hp EEM module part of the ARTIQ Sinara family. It adds general-purpose digital I/O capabilities to carrier cards such as 1124 Kasli and 1125 Kasli-SoC.

It provides two banks of four digital channels each, with SMA connectors. Each bank has individual ground isolation. The direction (input or output) of each bank can be selected using DIP switches. Each channel supports 50Ω terminations individually controllable using DIP switches. Outputs tolerate short circuits indefinitely. The card support a minimum pulse width of 3ns.

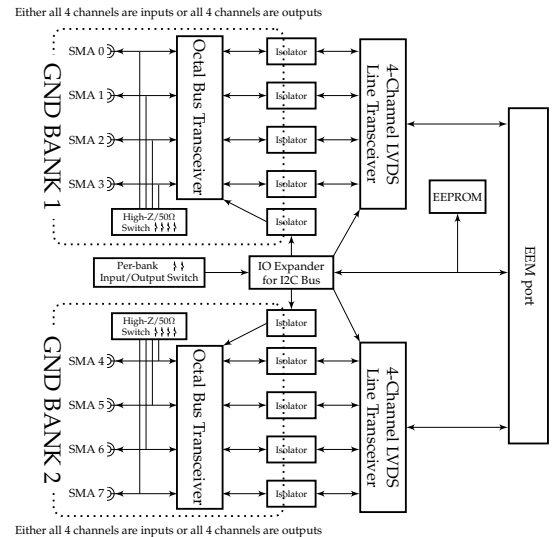


Figure 1: Simplified Block Diagram

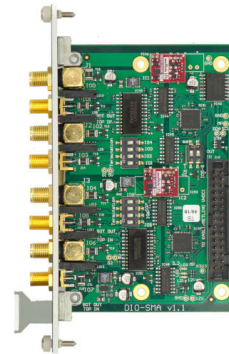


Figure 2: SMA-TTL Card photo

Electrical Specifications

All specifications are in $0^{\circ}\text{C} \leq T_A \leq 70^{\circ}\text{C}$ unless otherwise noted.

Table 1: Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
High-level input voltage	V_{IH}	2			V	
Low-level input voltage	V_{IL}			0.8	V	
Input clamp current	I_{OH}			-18	mA	termination disabled
High-level output current	I_{OH}			-160	mA	
Low-level output current	I_{OL}			376	mA	

Table 2: Electrical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
High-level output voltage	V_{OH}	2			V	$I_{OH}=-160\text{mA}$
		2.7			V	$I_{OH}=-6\text{mA}$
Low-level output voltage	V_{OL}		0.42	0.55	V	$I_{OL}=188\text{mA}$
				0.7	V	$I_{OL}=376\text{mA}$
Pulse width distortion	PWD		0.2	4.5	ns	
Peak jitter	$T_{JIT(PK)}$		350		ps	

Example ARTIQ code

The sections below demonstrate simple usage scenarios of the 2128 SMA-TTL card with the ARTIQ control system. They do not exhaustively demonstrate all the features of the ARTIQ system. The full documentation for the ARTIQ software and gateway is available at <https://m-labs.hk>.

Timing accuracy in the examples below is well under 1 nanosecond thanks to the ARTIQ RTIO system.

One pulse per second

The channel should be configured as output in both the gateway and hardware.

```
@kernel
def run(self):
    self.core.reset()
    while True:
        self.ttl0.pulse(500*ms)
        delay(500*ms)
```

Morse code

This example demonstrates some basic algorithmic features of the ARTIQ-Python language.

```
def prepare(self):
    # As of ARTIQ-6, the ARTIQ compiler has limited string handling
    # capabilities, so we pass a list of integers instead.
    message = ".- .-. - .. --.-"
    self.commands = [{"": 1, "-": 2, " ": 3}[c] for c in message]

@kernel
def run(self):
    self.core.reset()
    for cmd in self.commands:
        if cmd == 1:
            self.led.pulse(100*ms)
            delay(100*ms)
        if cmd == 2:
            self.led.pulse(300*ms)
            delay(100*ms)
        if cmd == 3:
            delay(700*ms)
```

Counting rising edges in a 1ms window

The channel should be configured as input in both the gateway and hardware.

```
@kernel
def run(self):
    self.core.reset()
    gate_end_mu = self.ttl0.gate_rising(1*ms)
    counts = self.ttl0.count()
    print(counts)
```

This example code uses the software counter, which has a maximum count rate of approximately 1 million events per second. If the gateway counter is enabled on the TTL channel, it can typically count up to 125 million events per second:

```
@kernel
def run(self):
    self.core.reset()
    self.edgecounter0.gate_rising(1*ms)
    counts = self.edgecounter0.fetch_count()
    print(counts)
```

Responding to an external trigger

One channel needs to be configured as input, and the other as output.

```
@kernel
def run(self):
    self.core.reset()
    self.ttlin.gate_rising(5*ms)
    timestamp_mu = self.ttlin.timestamp_mu()
    at_mu(timestamp_mu + self.core.seconds_to_mu(10*ms))
    self.ttlout.pulse(1*us)
```

Ordering Information

To order, please visit <https://m-labs.hk> and select the 2128 SMA-TTL in the ARTIQ Sinara crate configuration tool. The card may also be ordered separately by writing to <mailto:sales@m-labs.hk>.

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