2118 BNC-TTL / 2128 SMA-TTL

Features

- 8 channels.

- Input and output capable.

- Galvanically isolated.

- 3ns minimum pulse width.

- BNC or SMA connectors.

Applications

- Photon counting.

- External equipment trigger.

- Optical shutter control.

Figure 1: Simplified Block Diagram

General Description

The 2118 BNC-TTL card is a 8hp EEM module, while the 2128 SMA-TTL card is a 4hp EEM module. Both TTL cards add general-purpose digital I/O capabilities to carrier cards such as 1124 Kasli and 1125 Kasli-SoC.

Each card provides two banks of four digital channels each, with BNC (2118) or SMA (2128) 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.
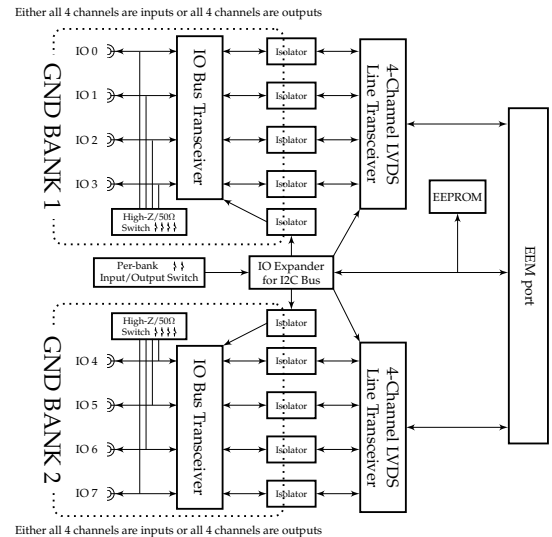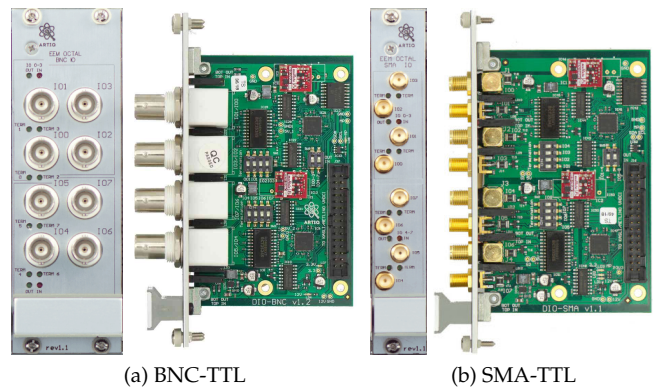

(a) BNC-TTL   (b) SMA-TTL

Figure 2: BNC-TTL/SMA-TTL Card photos

Electrical Specifications

All specifications are in $0°C \leq T_A \leq 70°C$ unless otherwise noted. Specifications are based on the bus transceivers IC (SN74BCT25245DW[1]) and the isolator IC (SI8651BB-B-IS1[2]).

Table 1: Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
High-level input voltage[1]	V_{IH}	2			V	
Low-level input voltage[1]	V_{IL}			0.8	V	
Input clamp current[1]	I_{OH}			-18	mA	termination disabled
High-level output current[1]	I_{OH}			-160	mA	
Low-level output current[1]	I_{OL}			376	mA	

Table 2: Electrical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
High-level output voltage[1]	V_{OH}	2			V	I_{OH}=-160mA
		2.7			V	I_{OH}=-6mA
Low-level output voltage[1]	V_{OL}		0.42	0.55	V	I_{OL}=188mA
				0.7	V	I_{OL}=376mA
Pulse width distortion[2]	PWD		0.2	4.5	ns	
Peak jitter[2]	$T_{JIT(PK)}$		350		ps	

Front Panel Drawings

Figure 3: 2128 SMA-TTL front panel drawings.

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[1]https://www.ti.com/lit/ds/symlink/sn74bct25245.pdf
[2]https://www.skyworksinc.com/-/media/Skyworks/SL/documents/public/data-sheets/si865x-datasheet.pdf

Configuring IO Direction & Termination

The termination and IO direction can be configured by switches. The per-channel termination and per-bank IO direction switches are found at the middle-left and middle-right of both cards respectively.

Termination switches selects the termination of each channel, between high impedence (OFF) and 50Ω (ON).

IO direction switches partly decides the IO direction of each bank.

- Closed switch (ON)
  Fix the corresponding bank to output. The direction cannot be changed by I^{2}C.
- Opened switch (OFF)
  Leave the direction configurable by I^{2}C.

(a) BNC-TTL   (b) SMA-TTL
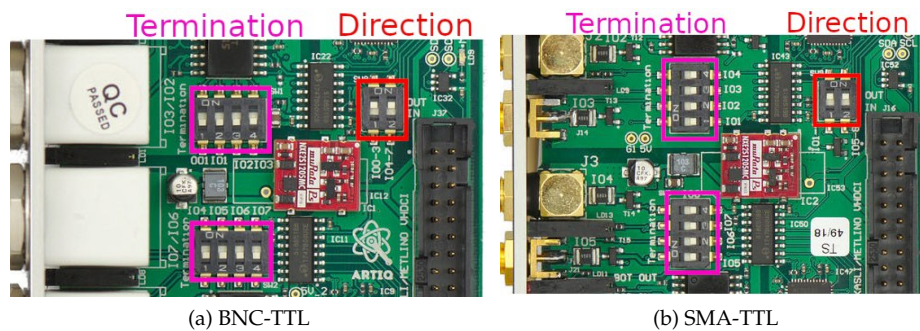
Figure 4: Position of switches

Example ARTIQ code

The sections below demonstrate simple usage scenarios of the 2118 BNC-TTL/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 gateware 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 gateware and hardware.

```python
@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.

```python
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 gateware and hardware.

```python
@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 gateware counter is enabled on the TTL channel, it can typically count up to 125 million events per second:

```python
@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.

```python
@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 2118 BNC-TTL/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.