2245 LVDS-TTL

Features

- 16 LVDS channels.

- Input and output capable.

- No galvanic isolation.

- High speed and low jitter.

- RJ45 connectors.

Applications

- Photon counting.

- External equipment trigger.

- Optical shutter control.

- Serial communication to remote devices.

General Description

The 2245 LVDS-TTL card is a 4hp EEM module. It adds general-purpose digital I/O capabilities to carrier cards such as 1124 Kasli and 1125 Kasli-SoC.

Each card provides sixteen digital channels each, controlled through 2 EEM connectors. Each EEM connector controls eight channels independently. Single EEM operation is possible. Each RJ45 connector exposes four digital channels in the LVDS format. The direction (input or output) of each channel can be selected using DIP switches. Outputs are intended to drive 100Ω loads, inputs are 100Ω terminated. This card can achieve higher speed and lower jitter than the isolated 2118/2128 BNC/SMA-TTL cards. Only shielded Ethernet Cat-6 cables should be connected.
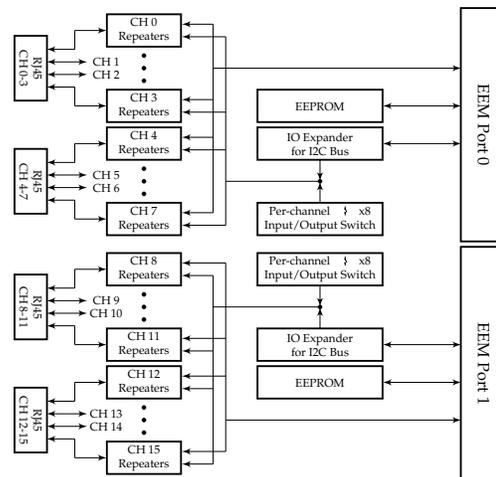

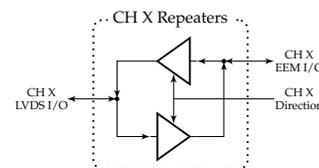**Figure 1: Simplified Block Diagram**

Figure 2: Detailed diagram for channel repeaters

Figure 3: LVDS-TTL Card photo

Electrical Specifications

Information in this section is based on the datasheet of the repeaters IC (FIN1101K8X[1]).

The Absolute Maximum Ratings are those values beyond which damage to the device may occur. Other specifications should be met without exception.

Table 1: Absolute Maximum Ratings

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
LVDS DC input voltage	V_{IN}	-0.5		4.6	V	
LVDS DC output voltage	V_{OUT}	-0.5		4.6	V	
Continuous Short Circuit Current	I_{OSD}		10		mA	

Table 2: Recommended Input Voltage

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Magnitude of differential input	$|V_{ID}|$	0.1		3.3	V	
Common mode input	V_{IC}	$|V_{ID}|/2$		$3.3 - |V_{ID}|/2$	V	

The recommended operating temperature is $-40°C \leq T_A \leq 85°C$.

All specifications are in the recommended operating temperature range unless otherwise noted. All typical values of DC specifications are at $T_A = 25°C$.

Table 3: DC Specifications

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Differential input threshold HIGH	V_{TH}			100	mV	
Differential input threshold LOW	V_{TL}	-100			mV	
Output differntiual Voltage	V_{OD}	250	330	450	mV	With 100Ω load.
$|V_{OD}|$ change (LOW-to-HIGH)	ΔV_{OD}			25	mV	With 100Ω load.
Offset voltage	V_{OS}	1.125	1.23	1.375	V	With 100Ω load.
$|V_{OS}|$ change (LOW-to-HIGH)	ΔV_{OS}			25	mV	With 100Ω load.
Short circuit output current	I_{OS}		±3.4	±6	mA	
Input current	I_{IN}			±20	μA	Recommended Input Voltage

[1]https://www.onsemi.com/pdf/datasheet/fin1101-d.pdf

All typical values of AC specifications are at $T_A = 25°C$, $V_{ID} = 300mV$, $V_{IC} = 1.3V$ unless otherwise specified.

Table 4: AC Specifications

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Differential Output Rise Time (20% to 80%)	t_{TLHD}	0.29	0.40	0.58	ns	duty Cycle = 50%.
Differential Output Fall Time (80% to 20%)	t_{THLD}	0.29	0.40	0.58	ns	
Pulse width distortion	PWD		0.01	0.2	ns	
LVDS data jitter, deterministic	t_{DJ}		85	125	ps	$PRBS = 2^{23} - 1$ 800 Mbps
LVDS clock jitter, random (RMS)	t_{RJ}		2.1	3.5	ps	400 MHz clock

Configuring IO Direction & Termination

The IO direction can be configured by switches, which are found at the top of the card.

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

- Closed switch (ON)
  Fix the corresponding channel to output. The direction cannot be changed by I²C.

- Opened switch (OFF)
  Leave the direction configurable by I²C.

Figure 4: Position of switches

Example ARTIQ code

The sections below demonstrate simple usage scenarios of the 2245 LVDS-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 2245 LVDS-TTL in the ARTIQ Sinara crate configuration tool. The card may also be ordered separately by writing to mailto:sales@m-labs.hk.