Open Source Automation Development Lab (OSADL) eG

The OSADL Latency Measurement Box

www.osadl.org
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Getting started with the OSADL Latency Measurement Box

General hardware features

- CPU PowerPC 750FX @ 600MHz
- 512 kB on-chip L2 cache
- 64 MB SDRAM on SODIMM
- One 10/100 Mb/s network interface (10BaseT / 100BaseTX)
- Two serial channels
- Embedded Linux BSP support
- 16 MB (optionally 32 MB) Flash EPROM
- Two TTL/OPTO output trigger channels
- Four TTL/OPTO input ports
- Four measurement indicator LEDs
- One RS232 interface at Min-D connector (U-Boot)
- One RS232 interface onboard (for debug purposes)
- One RS485 channel, opto-decoupled
- + 6.3 V supply voltage

Front view

8-pin connector (pin 1 on the left)

<table>
<thead>
<tr>
<th>Pin</th>
<th>Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>pin1</td>
<td>GND</td>
</tr>
<tr>
<td>pin2</td>
<td>GND</td>
</tr>
<tr>
<td>pin3</td>
<td>TRIG1_TTL</td>
</tr>
<tr>
<td>pin4</td>
<td>TRIG2_TTL</td>
</tr>
<tr>
<td>pin5</td>
<td>IN1_TTL</td>
</tr>
<tr>
<td>pin6</td>
<td>IN2_TTL</td>
</tr>
<tr>
<td>pin7</td>
<td>IN3_TTL</td>
</tr>
<tr>
<td>pin8</td>
<td>IN4_TTL</td>
</tr>
</tbody>
</table>
12-pin connector (pin 1 on the left)

<table>
<thead>
<tr>
<th>Pin</th>
<th>Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>pin 1</td>
<td>GND_EXT</td>
</tr>
<tr>
<td>pin 2</td>
<td>GND_EXT</td>
</tr>
<tr>
<td>pin 3</td>
<td>TRIG1</td>
</tr>
<tr>
<td>pin 4</td>
<td>TRIG2</td>
</tr>
<tr>
<td>pin 5</td>
<td>IN4+</td>
</tr>
<tr>
<td>pin 6</td>
<td>IN4-</td>
</tr>
<tr>
<td>pin 7</td>
<td>IN3+</td>
</tr>
<tr>
<td>pin 8</td>
<td>IN3-</td>
</tr>
<tr>
<td>pin 9</td>
<td>IN2+</td>
</tr>
<tr>
<td>pin 10</td>
<td>IN2-</td>
</tr>
<tr>
<td>pin 11</td>
<td>IN1+</td>
</tr>
<tr>
<td>pin 12</td>
<td>IN1-</td>
</tr>
</tbody>
</table>

Back view

![Back view image](image_url)
Path flow of interrupt execution

External event, e.g. from a light barrier

Scheduling of user-space application

Gate Latency

3

CPU IRQ

3

Interrupt Service Routine

9

Scheduling, Context Switch

15

Total Latency or Preemption Latency

30

Example measurement set-up
Standard U-Boot environment of the user FEPROM

The system needs a proper network configuration. Connect the RS232 port (lower 9 pin DSUB female) to a serial terminal with a 1-to-1 cable.

The default port configuration is:

9600 baud, 8N1, no handshake

The network parameters can be configured via BOOTP, DHCP or manually, e.g.:

-> setenv serverip 192.168.2.100
-> setenv ipaddr 192.168.2.105
-> setenv gatewayip 192.168.2.1
-> setenv netmask 255.255.255.0

An optional NTP Server IP can also be configured (SIMS 550 has no RTC).

-> setenv ntpserverip 129.69.1.153

The following must be entered as a single line string. The backslash before a semicolon prevents the command from being executed immediately.

-> setenv bootcmd fsload 1000000 osadl_t.img\; setenv bootargs console=ttyS0
   root=/dev/ram rootfstype=tmpfs ip=\$(ipaddr):\$(serverip):\$(gatewayip):
   \$(netmask):\$(hostname):eth0:none:\$(ntpserverip):\; bootm

After power on U-Boot starts with an autoboot delay of 5 seconds.

Login into the system

After Linux has finished booting from the flash file, the system is waiting for login. Two users are configured: ’root' and ’osadl'.

1. user=root, password=osadl
2. user=osadl, password=osadl

A user can login at the serial RS232 port (9600 baud, 8N1, no HS) or via ssh.

Starting the latency measurement application

The OSADL Latency Measurement Box has two independent channels for latency measurements. The I/O connectors are located on the front panel, see front view on page 3.

Each channel has one output trigger signal. This trigger signal can either have TTL or OPTO level. A channel can measure one or two input signals.

Channel 0 (/dev/sims_lt0) input configurations

1. [IN1_TTL] or [IN1+/IN1-] for one input signal
2. [IN1_TTL, IN2_TTL] or [IN1+/IN1-, IN2+/IN2-] for two input signals
Channel 1 (/dev/sims_lt1) input configurations

1. [IN3_TTL] or [IN3+/IN3-] for one input signal
2. [IN3_TTL, IN4_TTL] or [IN3+/IN3-, IN4+/IN4-] for two input signals

The latency measurement application is called 'lthisto'.

# lthisto

Usage: lthisto [DEVICE] [OPTIONS]
Build latency time histogram (output pulse to response) on '/dev/sims_lt0' and '/dev/sims_lt1'.

-O -- use OPTO input port instead of TTL (=default) inputs
-B -- summarize both input ports instead of first input only (=default)
-n -- use negative edge for trigger input instead of positiv (=default)
-b -- use both (neg/pos) edges for trigger input instead of positiv (=default)
-v -- time to measure starts the falling edge output instead of rising (=default)
-r runtime -- set program runtime (measurement time) in seconds (default: 10)
-t timeout -- set program timeout value in microseconds (default: 1000)
-h high time -- set trigger output high time value in microseconds (default: 100)
-l low time -- set trigger output low time value in microseconds (default: 100)
-H values -- set count for histogram entries (default: 1000)
-f filename -- set output filename of measurement on input 1/3 (default: lt0-0.txt/lt1-0.txt)
-F filename -- set output filename of measurement on input 2/4 (default: lt0-1.txt/lt1-1.txt)

The result output file first reports the measurement configuration. This is followed by the histogram values. The latter are continuously listed with a resolution of 1 µs, e.g.

# lthisto /dev/sims_lt0 -B -b -h 10 -l 10
......

# cat lt0-0.txt
#
# Date: Thu Jan 1 03:43:51 1970
#
# Runtime parameter:
# ---------------------
# Measurement time: 10 seconds
# Device: /dev/sims_lt0
# Input port(s): OPTO
# Number of inputs: 1
# Trigger input on: all edges
# Measurement starts at: rising edge
# Wait input timeout: 10000 microseconds
# Signal out high time: 100 microseconds
# Signal out low time: 100 microseconds
# Histogram entries: 1000
#
0 <-- response after 1 µs

Starting the latency measurement application
0 0 0
0 0 0 0 0
0 <- response after 5 µs
0 0 0
0 0 76 <- response after 11 µs
2238 8800
20027 <- peak after 14 µs
18433 430
25
14
16
15
12
21
38
47
6
1
0
3
4
0
1
0
1
2
0
1

.....
0 <- response after 1000 µs or timeout reached

Getting the measurement results

The OSADL Latency Measurement Box includes a Web server and an FTP daemon. The Web server offers two demo files. Please make a backup of the files and adjust the network address in the file in use.

OSADL.sh - A script to get the measurement results via ftp and to convert the text files into jpg images.

osadl.html - A simple Web page to display the measurement results in a browser.

Please note: Running the script OSADL.sh requires the gnuplot utility to be installed on the Linux host computer.
Update of the Linux image

The application Linux image is stored as a file in a JFFS on /dev/mtdblock2. After the Linux system has been started, this partition is mounted as /flash.

A network connection is required to update the Linux image. The new image can be transferred via NFS or using the scp utility, e.g.

```
# mkdir /nfs
# mount 192.168.2.100:/nfsroot/nfs -o nolock,noac,mountvers=2
# cp /nfs/osadl_t.img /flash
```

At U-Boot Prompt:

```
=> ls
  Scanning JFFS2 FS: . done.
  -rw-r--r-- 4185443 Thu Jan 01 00:06:42 1970 sims.img
=> fsload 1000000 osadl_t.img
### JFFS2 loading 'osadl_t.img' to 0x1000000
### JFFS2 load complete: 4081058 bytes loaded to 0x1000000
```

Manufacturer information, authors and support

The OSADL Latency Measurement Box was developed by ELTEC Elektronik AG, Mainz, Germany. This documentation was written by Frank Gottschling, ELTEC, and Carsten Emde, OSADL.

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Please send support requests to OSADL (info@osadl.org).