

GigaSOM gS01 Linux BSP

Linux BSP Guide

December 2019





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1 Introduction

1.1 Audience

This document is intended for software, hardware and system engineers who are planning to use the product, as well as anyone who wants to understand more about the product.

1.2 Contents of this document

This document describes how to download and install software tools for GigaSOM. It also gives short instructions for using particular system components in favor of customizing its behavior and development of drivers and applications.

2 Downloading and installing software

Compressed file you downloaded contains Exor_Mint_Package folder and Linux Mint installation file (linuxmint-19.1-cinnamon-64bit.iso). Before configuring using you should install Linux Mint on your GigaSOM.

2.1 Installing Linux Mint 19.1

Before Linux Mint installation please check if it is already installed on your GigaSOM. If yes, feel free to skip to caption 2.2 Installing updates and configuring Exor Mint.

Also if you see nothing but Mint Desktop Wallpaper, please see caption 3.2 LVDS display and then go back to 2.2.

First step is burning an ISO file to USB stick. When burning from Windows operating system you can use some utility for this purpose (e.g. Rufus - <https://rufus.ie/>).

When using some UNIX environment you can simply use the following terminal commands:

First you have to insert USB stick you will save your image on. Next step is to determine how your USB stick represented in system is. You should type:

```
$ sudo fdisk -l or $ lsblk
```

Your USB should be represented by something like /dev/sdb. If you have multiple hard disks already connected to your device it could also be /dev/sdc or /dev/sdd etc. After you've figure that your USB is, for example /dev/sdb, you should do the following:

```
$ sudo umount /dev/sdb*
$ sudo mkfs.ext4 /dev/sdb
$ sudo dd if=<path_to_iso>/linuxmint-19.1-cinnamon-64bit.iso of=/dev/sdb
```



The last command may take several minutes to execute without any visual feedback from the terminal. You can use another terminal window and type

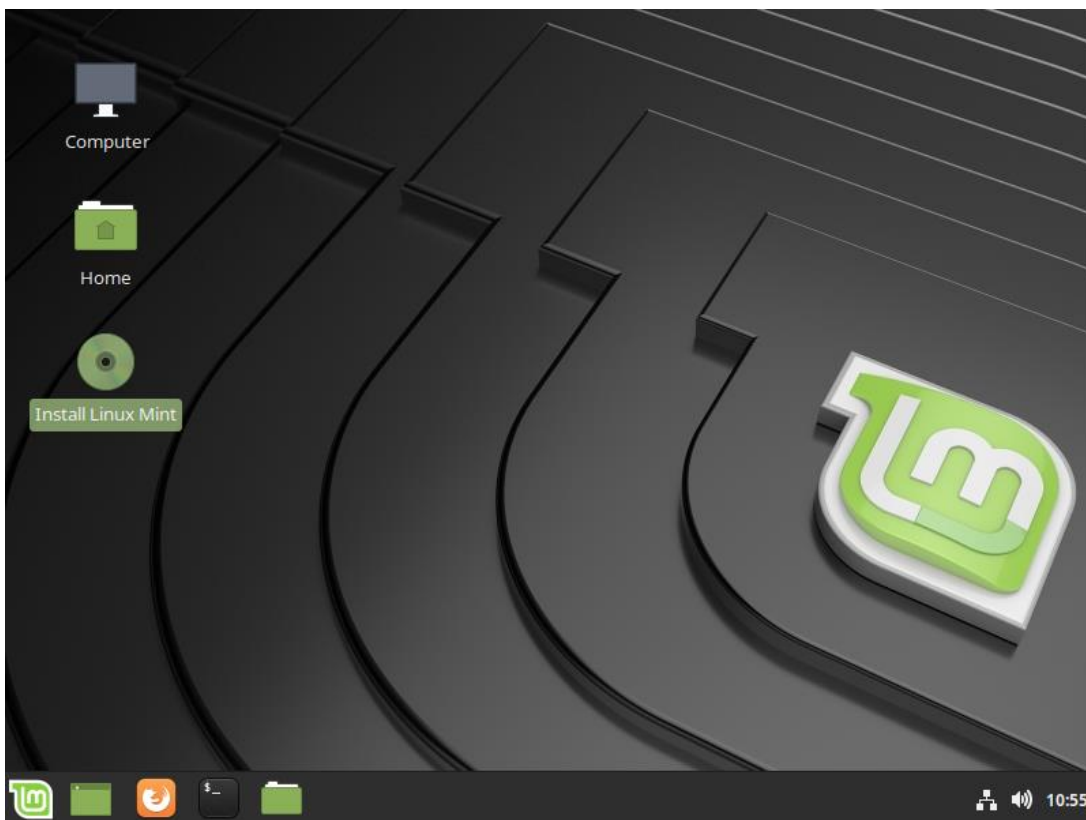
```
$ sudo kill -USR1 $(pgrep ^dd)
```

and you can see current result of dd command in its terminal window.

Now you have to plug in USB and turn GigaSOM on. Then you should enter BIOS on your GigaSOM by pressing Delete button while booting. In boot settings you should set booting from USB first. Then save this settings and exit.

If you are familiar with Linux Mint installation you can jump to section 2.2 Installing updates and configuring Exor Mint.

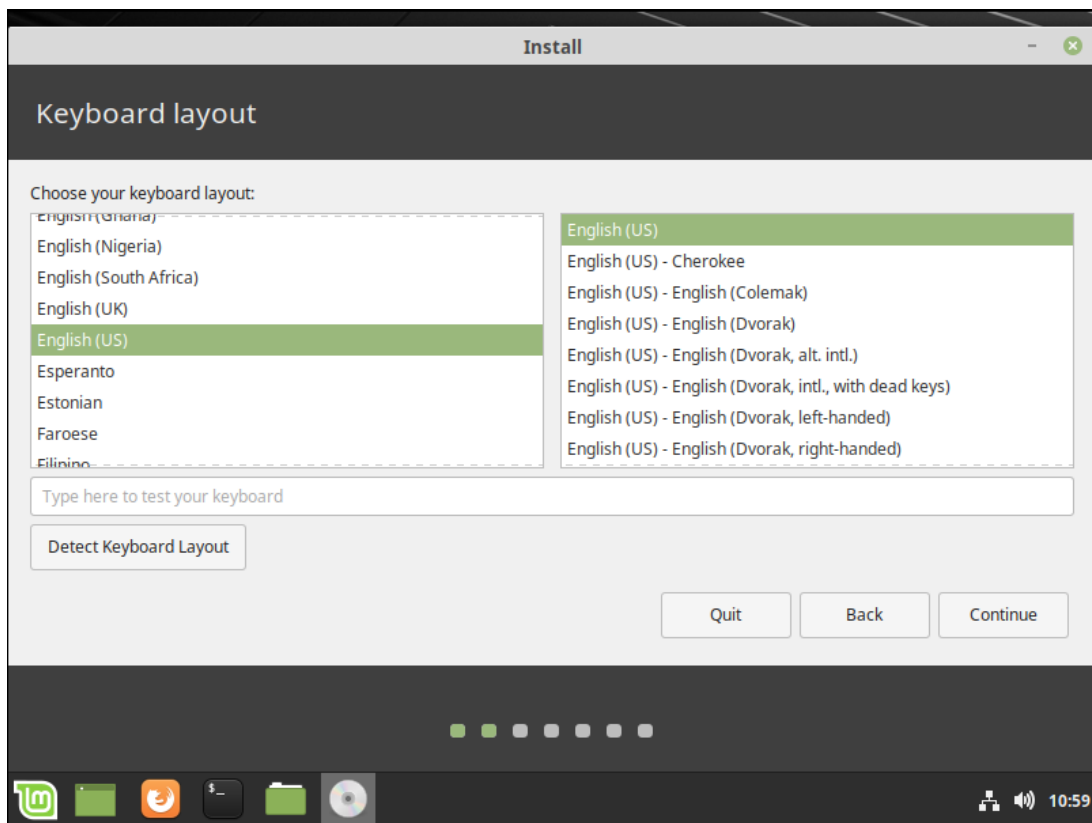
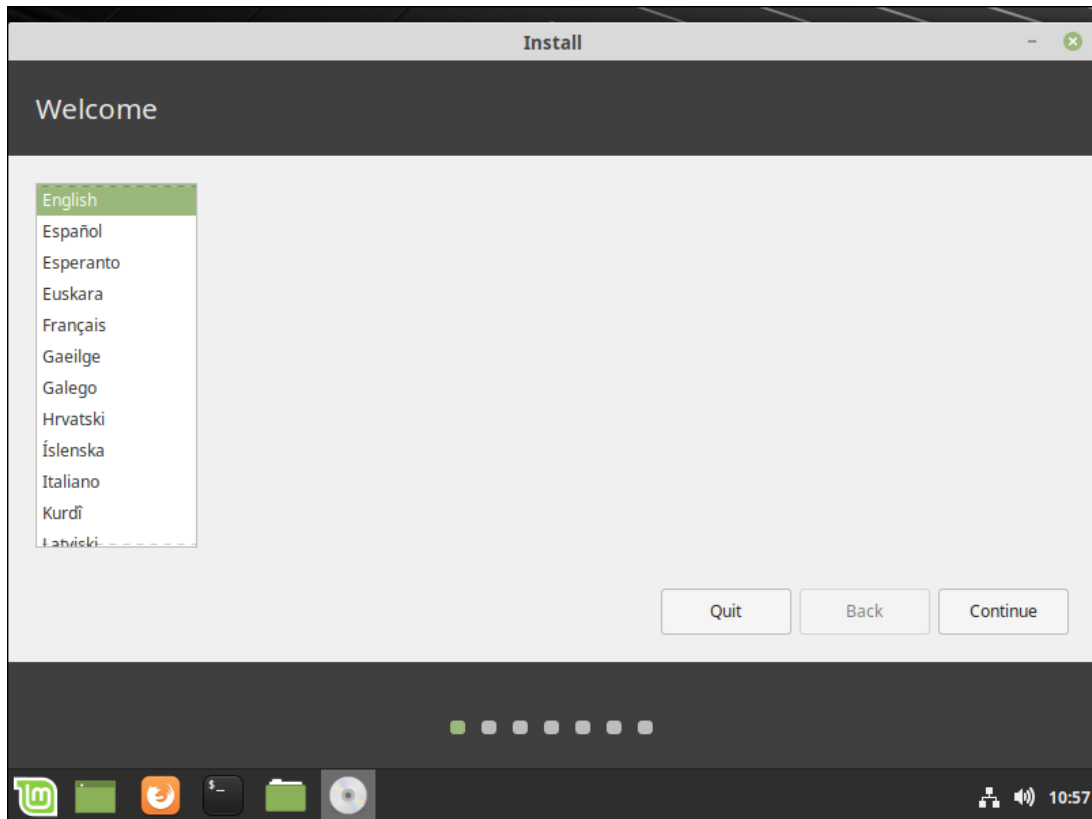
After few seconds Linux Mint will boot. This is the Live version of Linux Mint and it isn't installed on your system yet. So now double click on Install Linux Mint button on your desktop as you can see on the picture below. During installation your GigaSOM should be connected to Internet.

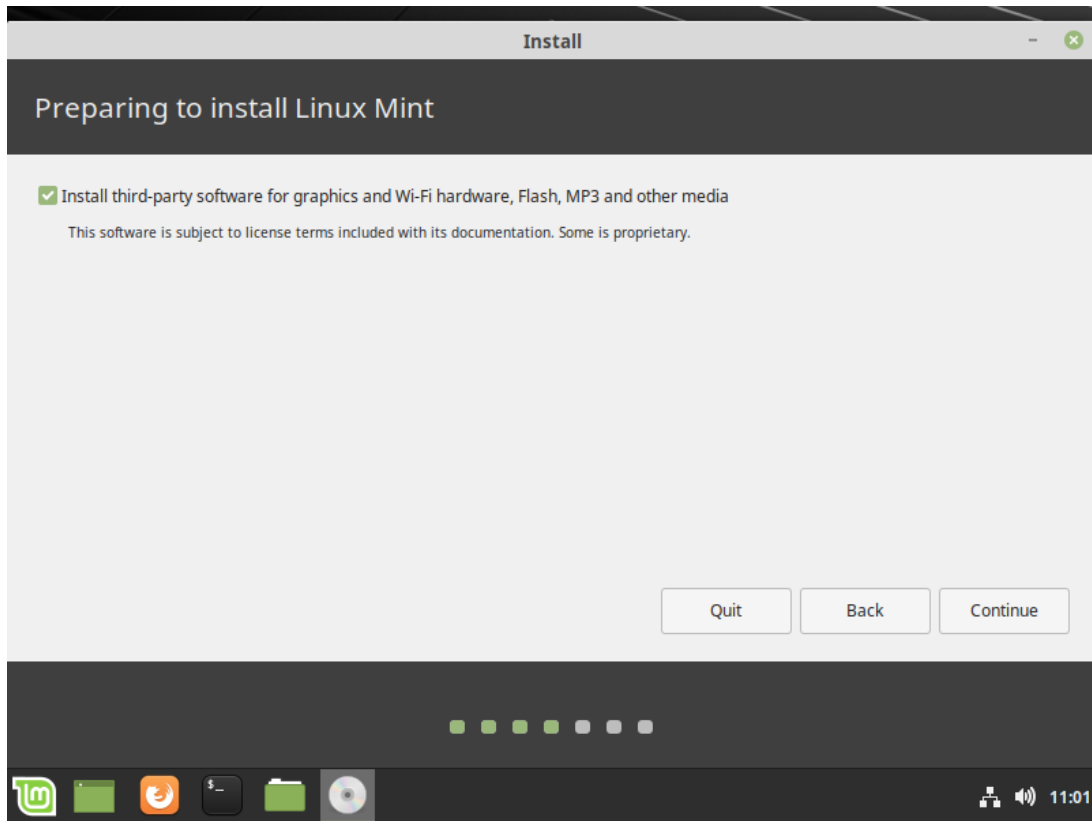


After you have done this the process of installation begins. Next you have to choose your language and keyboard layout as you can see on the next two images.

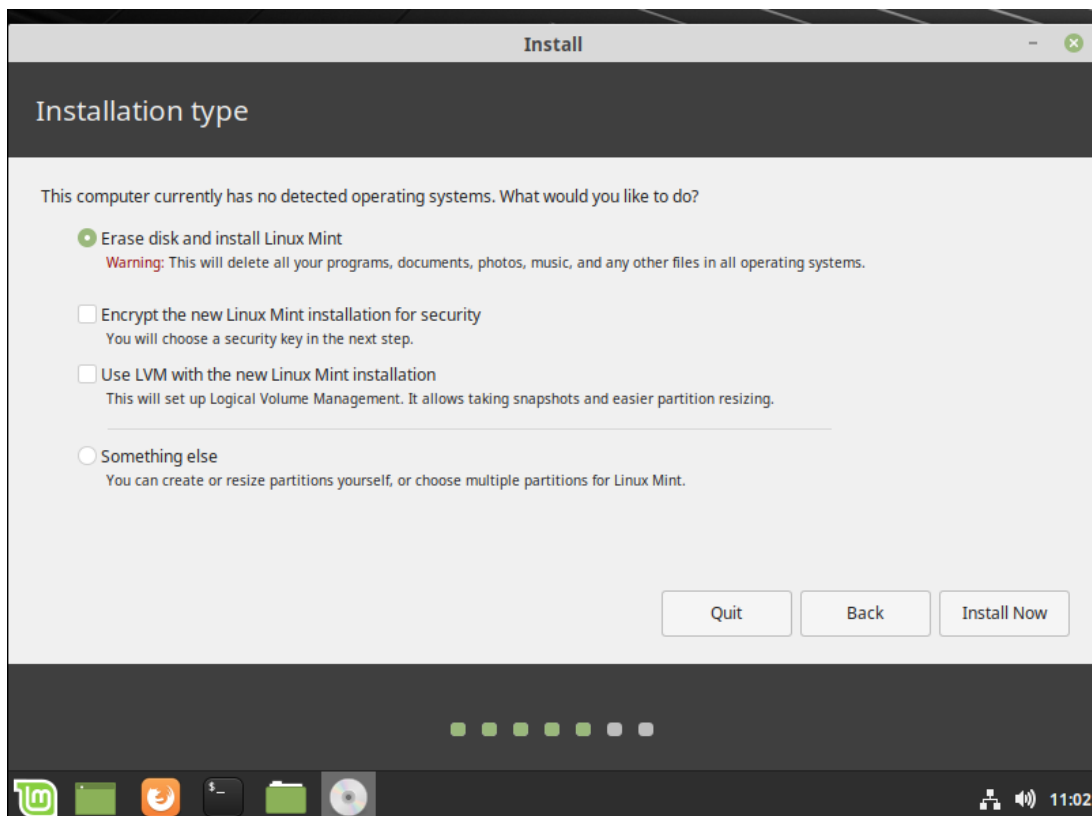
After that you will be asked if you want to install third-party software for graphics and some hardware and media. This you can either check or leave blank. If you leave it blank and if you need it in any time, you can simply type the following command and third-party software will be installed.

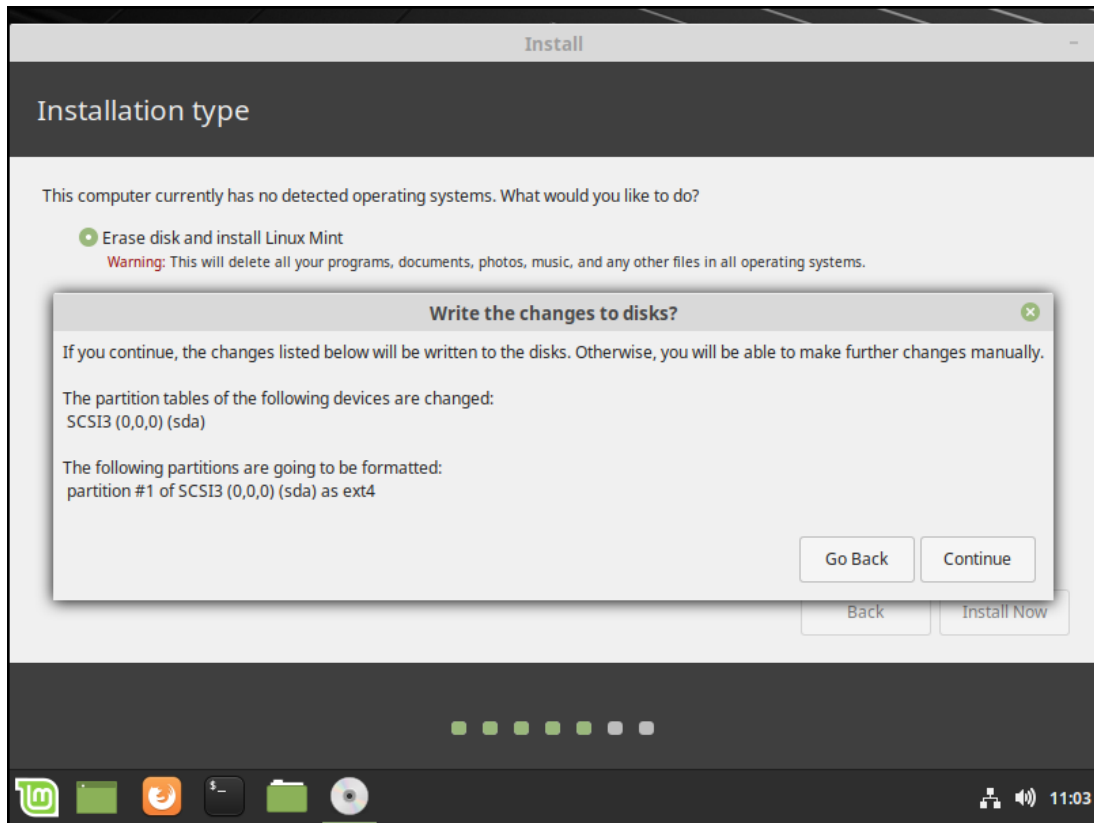
```
$ sudo apt-get install mint-meta-codecs
```



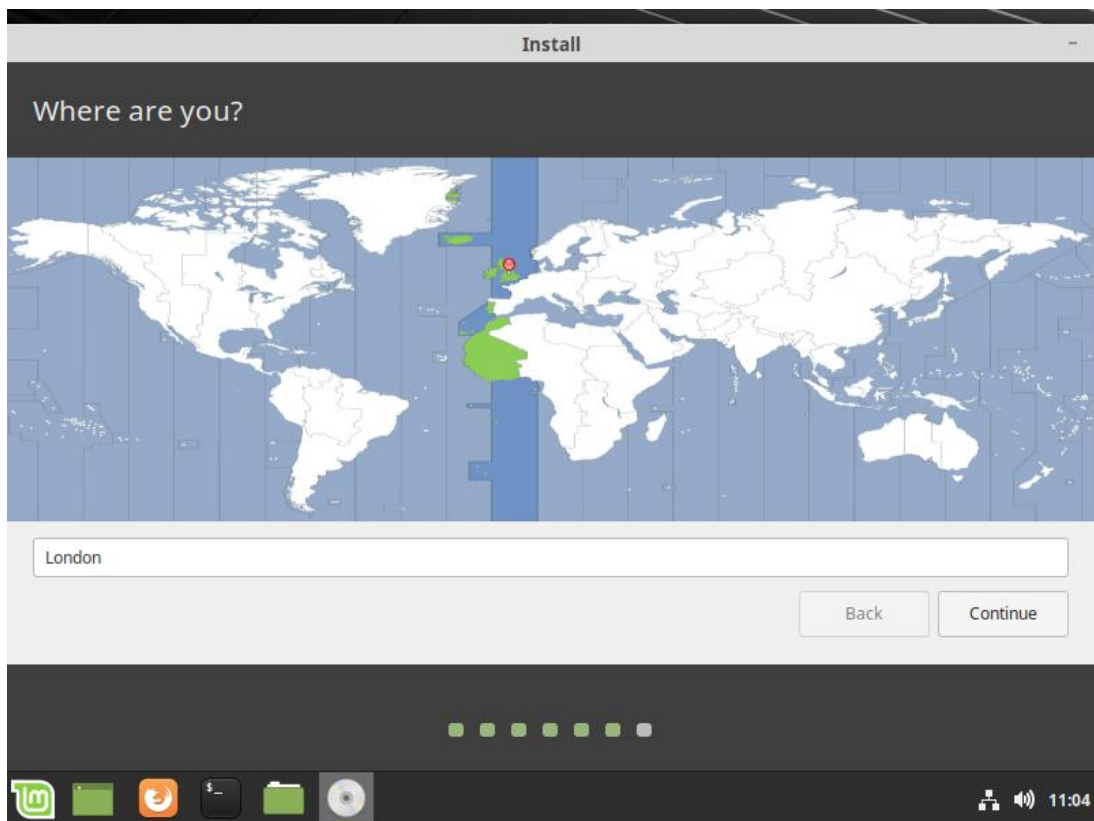


The next thing you will be asked is to choose hard drive you will install Mint on. There is no other options in the following picture because we only have one drive. After choosing to erase disk and install Linux Mint click on the Install Now button in the lower right corner. On the popup window simply press Continue.



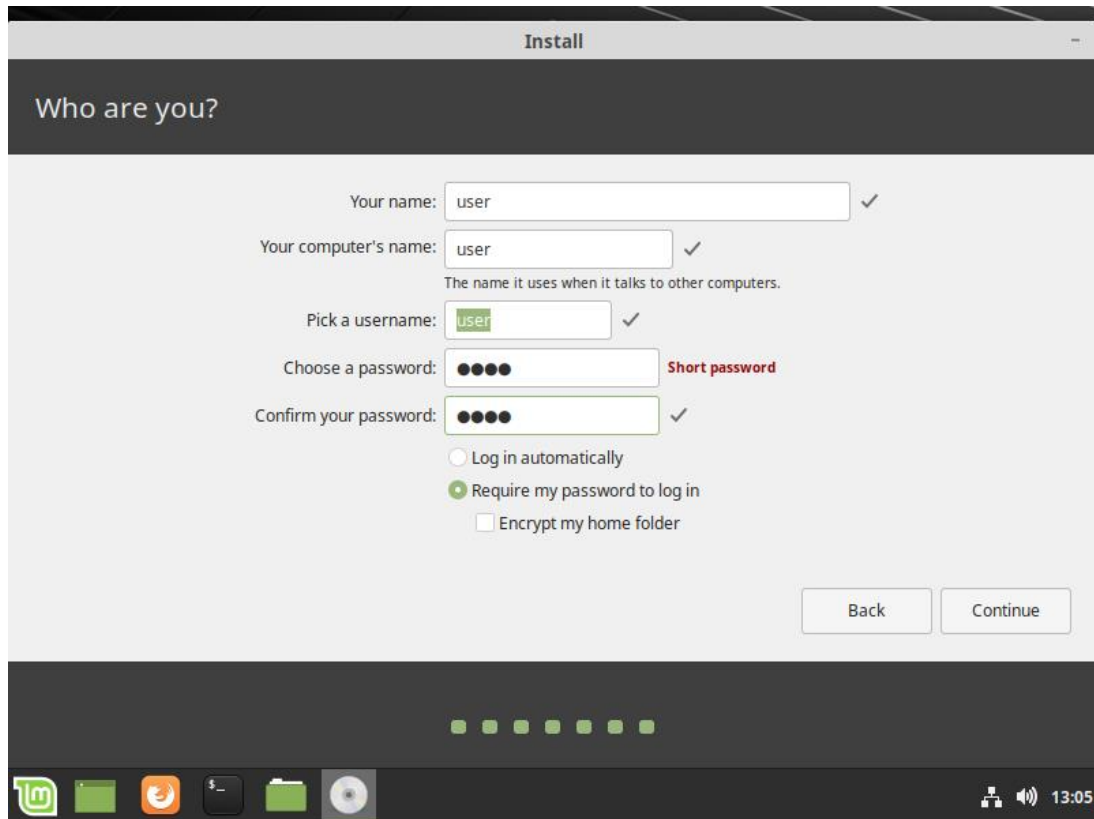


Next set your approximate location.

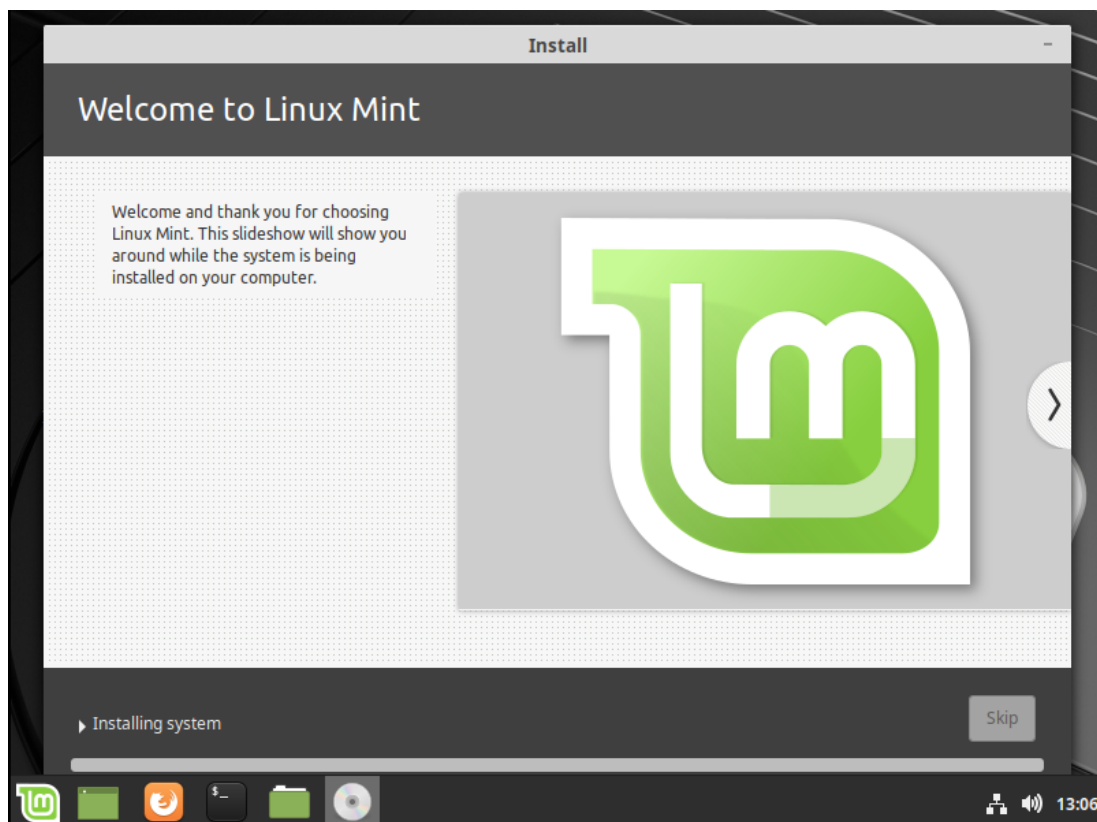




The last thing you will be asked is your personal info and password. Enter the following and click Continue.

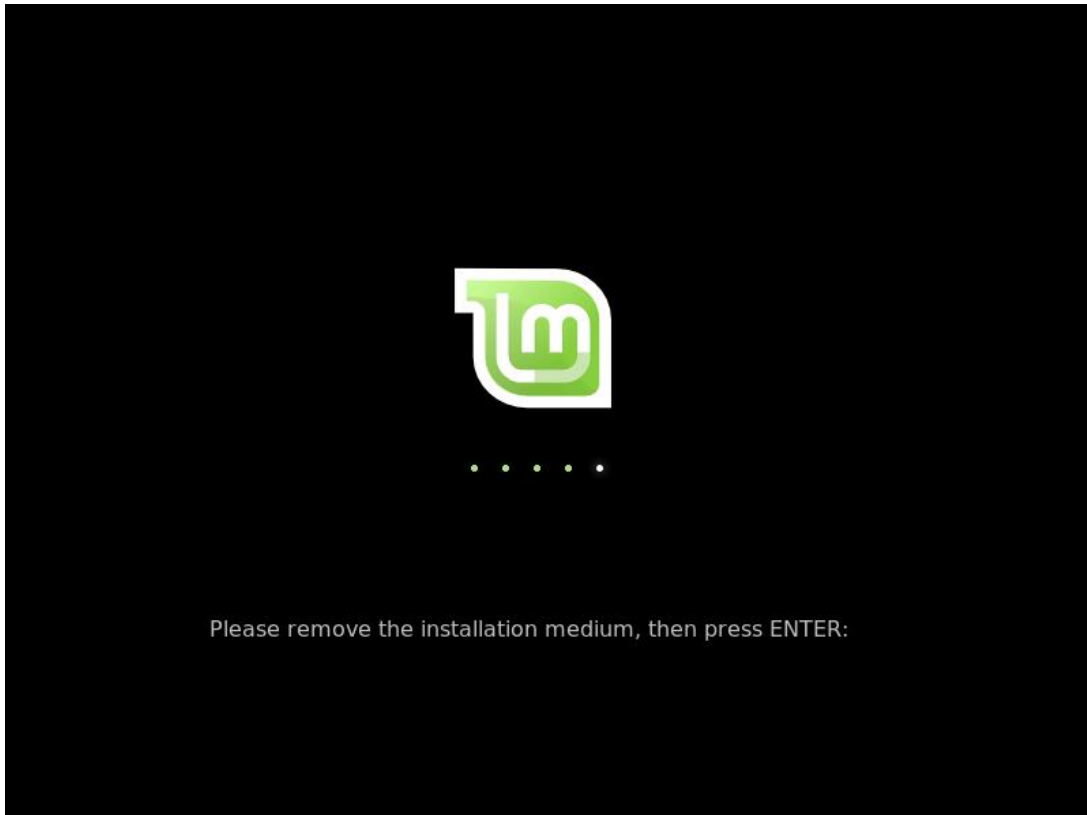


Now wait for few minutes and let your Mint install.





After the installation is done, a popup will ask if you would like to restart computer. Please press Restart Now button. While restarting, please remove the installation USB.



2.2 Installing updates and configuring Exor Mint.

When the system is ready you have to install updates. Open terminal by pressing Ctrl + Alt + T on your keyboard or open it by clicking terminal button on the Start Bar. Enter the following commands:

```
$ sudo apt-get update
$ sudo apt-get upgrade
```

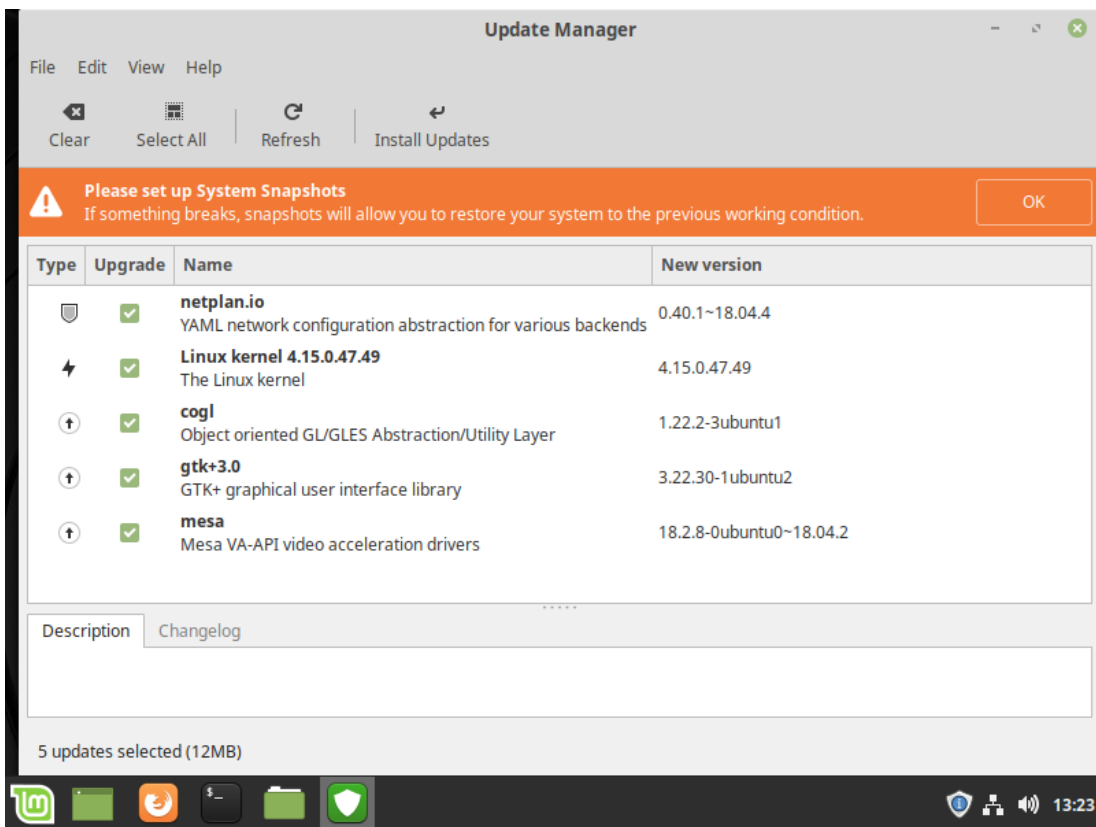
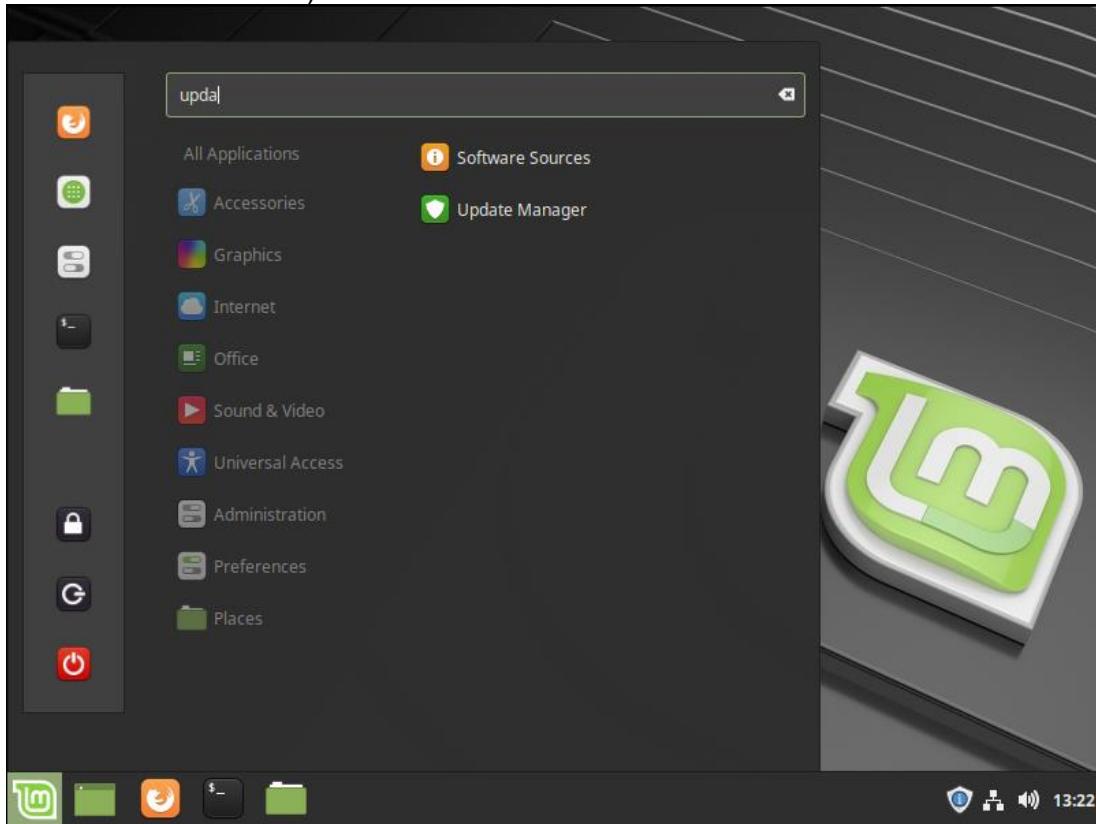
The second one should last few minutes. In some recent versions it may fail with gconf2 error. This should be solved using following commands:

```
$ sudo dpkg --configure -a
$ sudo apt-get autoremove
$ sudo apt-get upgrade
```

After this is done click on the Start Menu and find Update Manager as show on the image below. After clicking OK button on the Welcome window, click Install Updates button above. On the popup window click OK and your update should start. It will also take a few minutes.



When it is done, you have to configure Exor Mint using run.sh script. The script will change system graphic appearance, as well as add some important contents to kernel and BIOS (such as drivers and ACPI content).





Save Exor_Mint_Package.zip to GigaSOM and extract it. In this example Exor_Mint_Package is saved in the Desktop folder.

Again, open terminal and navigate into Exor_Mint_Package directory.

```
$ pwd # shows current location
$ cd ~/Desktop/Exor_Mint_Package # add your path if it is different
$ ls # lists directory contents
```

Before installing Exor_Mint_Package you should set MAC addresses for FPGA TSE MACs in case you are using reference design with two PCIe Ethernet ports. Those instructions you can find in GigaSOM MAC address setup Guide document or use following commands:

```
$ sudo sh run.sh -mac 00:aa:bb:cc:dd:ee 00:aa:bb:cc:dd:ff
```

MAC1 is MAC address for tse0 (J23) and MAC2 is address for tse1 (J24). Both MACs should be as in the following example:

```
$ sudo sh run.sh -mac 00:aa:bb:cc:dd:ee 00:aa:bb:cc:dd:ff
```

Every Ethernet port on GigaSOM should have its own sticker with unique MAC address. Please use every MAC address within its port.

In Exor_Mint_Package folder type

```
$ sudo sh run.sh -all
$ sudo sh run.sh -all -lvds # in case you use LVDS display
```

then enter your password and wait until script is done. When it is done type

```
$ reboot
```

to make all changes work.

Another options for script are

```
$ sudo sh run.sh -drivers # for driver update, needed in case of kernel update
$ sudo sh run.sh -acpi # for ACPI only
$ sudo sh run.sh -lvds # for LVDS screen
```

3 Instructions for using supported Apollo Lake interfaces

In the following text we will describe Linux BSP functions that are currently supported and some basic use instructions will be provided.



3.1 GPIO

On the carrier board there are two general-purpose input/output pins. They can be found on J22 header. In the following text bash commands for changing GPIO pins directions and values are shown. Table 1 shows J22 pin locations and number of GPIO pin you must use in given bash commands.

```
$ cd /sys/class/gpio
$ echo NO_OF_THE_PIN > export
$ echo out > gpioNO_OF_THE_PIN/direction
```

or

```
$ echo out > gpioNO_OF_THE_PIN/direction # input is default direction
$ echo 1 > gpioNO_OF_THE_PIN/value
```

or

```
$ echo 0 > gpioNO_OF_THE_PIN/value # 0 is default value
```

Table 1 GPIO configuration

GPIO	Pin on J22	NO_OF_THE_PIN
SOC_GPIO_3	6	437
SOC_GPIO_4	8	436

3.2 LVDS display

In GigaSOM revision A LVDS display is used as a primary display. It's a problem when you don't use LVDS display and on your HDMI or DisplayPort screen you can only see desktop background. You have to disable LVDS display.

To do this first click with your mouse somewhere on the screen you can see. Then press Super (Windows or) key on your keyboard, type Display and press Enter (you don't see what you are typing – this is all right). Display window should appear. Then just turn off first screen and apply this settings.

The issue is solved in revision B.

3.3 USB3.0 Type A, USB 3.0 micro AB, USB2.0 header, USB2.0 type A

There are four USB connectors on the carrier board. All of them can simply be used by inserting the corresponding USB media in their connectors. The exception is USB2.0 header for which you should use an adapter or connect it somehow different.



3.4 SD Card

SD Card reader can be used by simply inserting Micro SD Card in its slot. After insertion, the SD Card should be immediately visible in /media/user.

3.5 HDMI, DisplayPort

Both HDMI and DisplayPort can be simply used by connecting those two interfaces with the display monitor. If you are using display monitor with built-in speakers you could also hear sound.

3.6 LPDDR4

LPDDR4 is used as a system RAM. (4*2048 MB = 8 GB)

3.7 M.2 type B PCIe

M.2 type B PCIe was tested using 240 GB PCIe SSD. Writing speed was approximately 300 MB/s.

3.8 M.2 type B SATA

M.2 type B SATA was tested using 120 GB SATA SSD. Writing speed was approximately 100 MB/s.

3.9 M.2 type E

Type E slot has many interfaces. They cannot be all tested at once, but we have dedicated procedures for each one.

3.9.1 PCIe

To test PCIe interface we use Intel's 7265 wifi & bluetooth module. Linux Mint already contains all the required drivers. To query Linux whether it sees the module on PCIe bus:

```
$ lspci -nn
```

'lspci' response should, among other, contain following line:

```
05:00.0 Network controller [0280]: Intel Corporation Wireless 7265 [8086:095a] (rev 48)
```

To check which wifi network are available locally:

```
$ iwlist wlp5s0 scan
```

To connect to an unprotected network named 'Redmi':

```
$ sudo iwconfig wlp5s0 essid Redmi
```

If you get immediately disconnected, try:

```
$ systemctl disable wpa_supplicant
```

To get IP address using DHCP from 'Redmi' access point device:



```
$ sudo dhclient wlp5s0
```

Now you can use the wifi connection.

3.9.2 USB

To test USB interface we use Intel's 7265 wifi & bluetooth module; wifi is on PCIe and bluetooth is on USB. To query Linux whether it sees the module on the USB bus:

```
$ lsusb
```

'lsusb' response should, among other, contain following line:

```
Bus 001 Device 004: ID 8087:0a2a Intel Corp.
```

The easy way to verify bluetooth is working is to install Bluetooth Manager:

```
$ sudo apt-get install blueman
```

Start the application, pair with a phone or other device and verify that communication works.

3.9.3 SDIO

To test SDIO interface we use Laird's ST60-2230C wifi & bluetooth module. Drivers for the interface should be compiled by the Exor Linux script. To load the drivers:

```
$ sudo su
$ rmmod mwifiex_sdio
$ rmmod mwifiex
$ rmmod cfg80211
$ insmod compat/compat.ko
$ insmod net/wireless/cfg80211.ko
$ insmod net/mac80211/mac80211.ko
$ insmod drivers/net/wireless/laird/lrdmwl/lrdmwl.ko
$ insmod drivers/net/wireless/laird/lrdmwl/lrdmwl_sdio.ko
```

If loading lrdmwl_sdio.ko fails, try disconnecting the power supply to the device to force reboot of the wifi module, then powering it up again.

To verify wifi interface has started:

```
$ ip link
```

... should, among other, contain following output:

```
3: wlan0: <BROADCAST,MULTICAST> mtu 1500 qdisc noop state DOWN mode DEFAULT group default
qlen 1000
    link/ether c0:ee:40:42:0c:c4 brd ff:ff:ff:ff:ff:ff
```

Use start menu – Preferences – Network, Wi-Fi section, to connect to a desired network.

3.9.4 UART

(Note: to compile bluetooth drivers, use 'make defconfig-bluetooth' instead of 'defconfig-lrdmwl'.)



To test UART interface we use Laird's ST60-2230C wifi & bluetooth module. To load the drivers, first follow the steps for loading SDIO drivers, because firmware for the module that SDIO driver loads initializes both wifi and bluetooth functionality.

To load cryptography module needed by bluetooth drivers:

```
$ insmod /lib/modules/4.15.0-70-generic/kernel/crypto/ecdh_generic.ko
```

Load bluetooth drivers:

```
$ insmod net/bluetooth/bluetooth.ko
$ insmod drivers/bluetooth/hci_uart.ko
```

Initialize bluetooth engine:

```
$ hciattach /dev/ttyS5 any 3000000 1
$ hciconfig
```

If everything went well, 'hciconfig' should print out something like:

```
hci0:  Type: Primary  Bus: UART
      BD Address: C0:EE:40:42:0C:C7  ACL MTU: 1021:7  SCO MTU: 120:6
      UP RUNNING PSCAN ISCAN
      RX bytes:921 acl:0 sco:0 events:70 errors:0
      TX bytes:5469 acl:0 sco:0 commands:70 errors:0
```

Now you can use Bluetooth Manager or other related software to verify bluetooth functionality.

3.9.5 I2C

To be done.

3.9.6 I2S

To be done; possibly not feasible due to missing Apollo Lake support for generic I2S codecs.

3.10 SPI Flash

SPI flash is used for programming FPGA. It can be accessed from PC using JTAG and also from GigaSOM processor. It is ruled by mux.

Default mux state (0) is using JTAG as a programming media. When you want to use processor, you have to set mux select line to 1. This can be made by setting GPIO 458 value 1. (For detailed instructions see 3.1)

After GPIO 458 changing, you have to remove and add drivers again. This can be done using following commands.

```
$ sudo rmmod m25p80
$ sudo rmmod spi-nor
$ sudo modprobe spi-nor
$ sudo modprobe m25p80
```

Or you can simply run `spi_flash.sh` script which does everything for you (including GPIO change).



```
$ sudo sh Exor_Mint_Package/Programs/spi-flash/spi_flash.sh
```

If the flash is properly installed, it should be seen as a /dev/mtdX device*.

For using SPI flash you have to install mtd-utils. This can simply be done by typing the following command in terminal. (You already have it installed if you used Exor_Mint_Package)

```
$ sudo apt-get install mtd-utils
```

For information about connected flash type command:

```
$ mtdinfo -a
```

For erasing flash from a to b address line enter following command:

```
$ sudo flash_erase /dev/mtdX a b
```

And if you would like to erase the entire flash memory, instead of a and b type 0 0:

```
$ sudo flash_erase /dev/mtdX 0 0
```

For writing into the flash simply use the following command:

```
$ sudo flashcp -v PATH_TO_FILE /dev/mtdX
```

For FPGA programming use .rpd file and write it into flash using one of the following commands. They include setting GPIO pin for resetting FPGA.
For gS01 revision A use 436 as GPIO_PIN. For gS01 revision B use 441.

```
$ sudo su
$ echo GPIO_PIN > /sys/class/gpio/export
$ echo out > /sys/class/gpio/gpioGPIO_PIN/direction
$ echo 1 > /sys/class/gpio/gpioGPIO_PIN/value
$ flashcp -v -f PATH_TO_FILE /dev/mtdX (or flashcp_fpga -v -f PATH_TO_FILE /dev/mtdX)
$ echo 0 > /sys/class/gpio/gpioGPIO_PIN/value
```

And the last thing to do is to reboot Linux using command:

```
$ reboot
```

Reading from the flash is possible using dd command:

```
$ sudo dd if=/dev/mtdX of=output_file bs=1k count=100
```



(bs means how many bytes you read and write at a time. The default value is 512. Count is a number of input blocks you would like to copy. So in the upper example you would copy 100 kB of data.)

*To determine which mtdX device you should use, please type the following commands:

```
$ cd /sys/bus/spi/devices/spi-PRP0001\:\XX/mtd/mtdX/device/  
$ cat modalias
```

By the output you can see type of current mtdX device.

3.11 SPI FRAM

SPI FRAM is another mtd device. To writing into and reading from it you can use the following command:

```
$ cd /dev/  
$ sudo su  
$ echo "Text you would like to enter" > mtdX # writing into FRAM  
$ cat mtdX # reading from FRAM
```

Determination which mtdX device is FRAM is same as for SPI Flash.

3.12 eMMC

eMMC is used as a 60 GB system memory. Writing speed was 60 MB/s.

3.13 Serial EEPROM

For writing in serial EEPROM and reading from it you should use the following commands.

```
$ cd /sys/bus/i2c/devices/i2c-INT3499:00  
$ sudo su  
$ echo "string you want to enter in eeprom" > eeprom # if you want to enter some string  
in eeprom  
$ cat eeprom # see eeprom output on stdout  
$ sudo dd if=path_to_file of=eeprom # writing a file to eeprom  
$ sudo dd if=eeprom of=path_to_file # writing from eeprom to file
```

3.14 Temperature and relative humidity sensor

Temperature sensor HTU21D can be accessed by the following commands:

```
$ cd /sys/bus/i2c/devices/i2c-PRP0001\:\XX/iio\:device0/subsystem/devices/iio\:device
```



```
$ ls
$ cat in_temp_input # raw temperature info*
$ cat in_humidityrelative_input # raw humidity info*
```

*See HTU1D datasheet for temperature and relative humidity calculation.

3.15 SIM card

Insert a SIM card into slot J18. Insert an LTE modem into slot J17. The board was verified with:

- Croatian A1 network SIM card
- Huawei ME906s-158 M.2 EU LTE modem (USB)
- 2JF0624P Flexible Polymer Internal Antenna

Install i2c-tools package, if it's not already installed, by using the following command:

```
$ sudo apt-get install i2c-tools
```

To turn on the modem, we need to use IC28, I2C extender PCA6408 on I2C bus 4. I2C extender responds on address 0x21. Verify that it's there (some Linux distribution may enumerate I2C busses differently, so you might need to try different busses to find the extender):

```
$ sudo i2cdetect -y -r 4
```

Device "21" should be visible in the output printout of i2cdetect.
Set port 0 of I2C extender to output mode:

```
$ sudo i2cset -y 4 0x21 0x03 0xFE b
```

Set output port 0 to high value to turn the modem on:

```
$ sudo i2cset -y 4 0x21 0x01 0x01 b
```

Wait a couple of seconds and modem should be detected by Linux:

```
$ lsusb
```

'lsusb' command should show, among other devices, the modem:

```
Bus 001 Device 006: ID 12d1:15c1 Huawei Technologies Co., Ltd.
```

To install modem software for Linux Mint, use the following command:

```
$ sudo apt-get install modem-manager-gui
```

Open the Modem Manager GUI application from the start menu, create a new connection (optionally adjust connection settings as needed, as some defaults may not be appropriate) and activate the connection. You are now connected to the Internet over the modem, and you can also send and receive SMS messages.

3.16 DSUB 9 UART

To test RS-232 functionality of the J12 port:

- Set Gigasom's GPIO 448 to 0, to activate RS-232 mode.
- Set Gigasom's switch S2 to position CPU/RST on; 485/422 switch doesn't matter.
- Connect UNT40 or equivalent adapter to port J12.



- Connect an active serial-USB converter/cable to the UNT40 adapter. If using the Connective Peripherals' EasySYNC ES-U-3001-MB converter, set DIP switches to positions off, on, on, on.
- Connect the USB cable from the serial-USB converter to a PC.

To test RS-422 functionality:

- Set Gigasom's GPIO 448 to 1, to activate RS-422/485 mode.
- Set Gigasom's switch S2 to position CPU/RST on; 485/422 off.
- Connect appropriate wiring adapter to port J12. There should be a 120 ohms termination resistor on both sides, or only on Gigasom's side if the converter has internal termination.
- Connect an active converter/cable to the wiring adapter. If using the ES-U-3001-MB converter, set DIP switches to positions on, on, on, on. If the wiring adapter contains only a termination resistor on Gigasom's side, activate internal termination by using jumper 5-6.
- Connect the USB cable to a PC.

To test RS-485 functionality:

- Set Gigasom's GPIO 448 to 1, to activate RS-422/485 mode.
- Set Gigasom's switch S2 to position CPU/RST on; 485/422 on.
- Connect appropriate wiring adapter to port J12. There should be a 120 ohms termination resistor on both sides, or only on Gigasom's side if the converter has internal termination.
- Connect an active converter/cable to the wiring adapter. If using the ES-U-3001-MB converter, set DIP switches to positions on, off, on, on. If the wiring adapter contains only a termination resistor on Gigasom's side, activate internal termination by using jumper 5-6.
- Connect the USB cable to a PC.

UART Type	GPIO 448 (see chapter 3.1)	S2: CPU/RST	S2: 485/422
RS-232	0	ON	N/A
RS-422	1	ON	OFF
RS-485	1	ON	ON

On the PC, start Teraterm or equivalent serial communication utility and connect to the serial/USB port on the PC. Set communication parameters to 115200 baud, 8 bit data, 1 stop bit, no parity, no flow control. To send some data to Gigasom, just type, or send a text file. The received data will appear automatically.

On the Gigasom, initialize the serial port by entering commands:

```
$ sudo su
$ stty -F /dev/ttySX 115200
```

To send some data to PC, enter a command like:

```
$ echo Schwarzenegger > /dev/ttySX
```

To receive data, enter a command:

```
$ cat /dev/ttySX
```

UART Type	Device location
RS-232/422/485	/dev/ttyS4
USB UART	/dev/ttyS6



4 Instructions for using FPGA interfaces

In the following text we will describe Cyclone 10 functions that are currently supported and some basic use instructions will be provided.

FPGA design can be programmed both using Quartus Programmer and Apollo Lake. When using Quartus Programmer via JTAG you should use .jic or .pof files for write design into flash and .sof file when programming without flash.

When using Apollo Lake you should use .rpd file and follow instructions from chapter 3.8 SPI Flash.

4.1 PCIe memory test

First step is programming FPGA using one of the methods mentioned above. Use design for PCIe memory test.

Second step is inserting altera_tse module. This can be done using the following commands. First it is important to navigate to directory that contains source code or .ko driver.

```
$ make # if you are generating driver from sources
$ sudo insmod altera_tse.ko
```

If insmod does not work, you should probably remove altera_cvp driver by typing:

```
$ sudo rmmod altera_cvp
```

and try insmod command again.

After you have inserted module, you should check latest kernel messages.

```
$ dmesg
```

or

```
$ dmesg | tail
```

If PCIe probe was successful you should see the message “memory test end success”.

4.2 1 Gb Ethernet

First step is programming FPGA with design for 1 Gb Ethernet. The design can be tested using loopback. Using python script on PC you generate Ethernet message and send it to FPGA. Using Wireshark you can check if the message returned. If so, Ethernet is working properly.