Moxa DA Computers Linux Software User Manual

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www.moxa.com/products

Moxa DA Computers Linux Software User Manual

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1. Introduction

This Moxa DA computers Linux software user manual can help x86 Linux users to understand and navigate the usage of Linux utilities and standard Linux operating system on the DA computers.

Comprehensive information on topics such as Getting Started, x86 Linux SDK wizard, Peripheral Interface Operations, Basic Linux Concepts, and Troubleshooting are covered.

Supported Series

- DA-820E Series
- DA-820C Series
- DA-682C Series
- DA-681C Series
- DA-680 Series

2. Getting Started

The Getting Started section will introduce the Linux OS distribution installation instructions.

Linux OS Installation Instructions

Prepare bootable USB drive

At first, prepare a **USB storage drive**, download the Rufus to create bootable USB drive. Download the ISO image file and restore ISO image into USB storage drive.

Current Supported Distributions

- **Debian**
  - **Debian 11 (bullseye), Linux kernel 5.10**
  - **Debian 12 (bookworm), Linux kernel 6.1**
  - Official Debian installation guide
- **Ubuntu**
  - **Ubuntu 20.04 LTS (Focal Fossa), Linux kernel 5.4 (20.04.1), Linux kernel 5.15 (20.04.5), HWE kernel 5.15 or later version**
  - **Ubuntu 22.04 LTS (Jammy Jellyfish), Linux kernel 5.15 (22.04.3), Linux kernel 6.5 (22.04.4), HWE kernel 6.5 or later version**
  - Official Ubuntu installation guide
- **RedHat**
  - **RedHat 9, Linux kernel 5.14**
    - Official RedHat 9 download link
    - Official RedHat 9 installation guide
- **CentOS 7**
  - **CentOS 7.9, Linux kernel 3.10**
    - CentOS-7-x86_64-DVD-2009.iso download link

How to Enter BIOS Menu

Boot up device and press **F2** key from keyboard to enter BIOS menu, and select **boot from USB** from **UEFI mode**.

Then follow the distribution's official installation guide to finish OS installation procedure.

3. x86 Linux SDK Wizard

Introduction

The **Moxa x86 Linux SDK** enables the easy deployment on the Moxa x86 IPC platform. The SDK contains components for peripheral drivers, peripheral control tools and configuration files.

It also provides deployment features, such as build & installation log, dry-run, and self test on target model. User can download the Moxa x86 Linux SDK zip file from official product's website.

Below is the list of files:

- ***.tgz**: The tarball file of x86 Linux SDK Install Wizard
- **README.docx/README.md**: The user manual of x86 Linux SDK Install Wizard
- **sources_list**: The list of source code
- **build_info**: Build information

NOTE

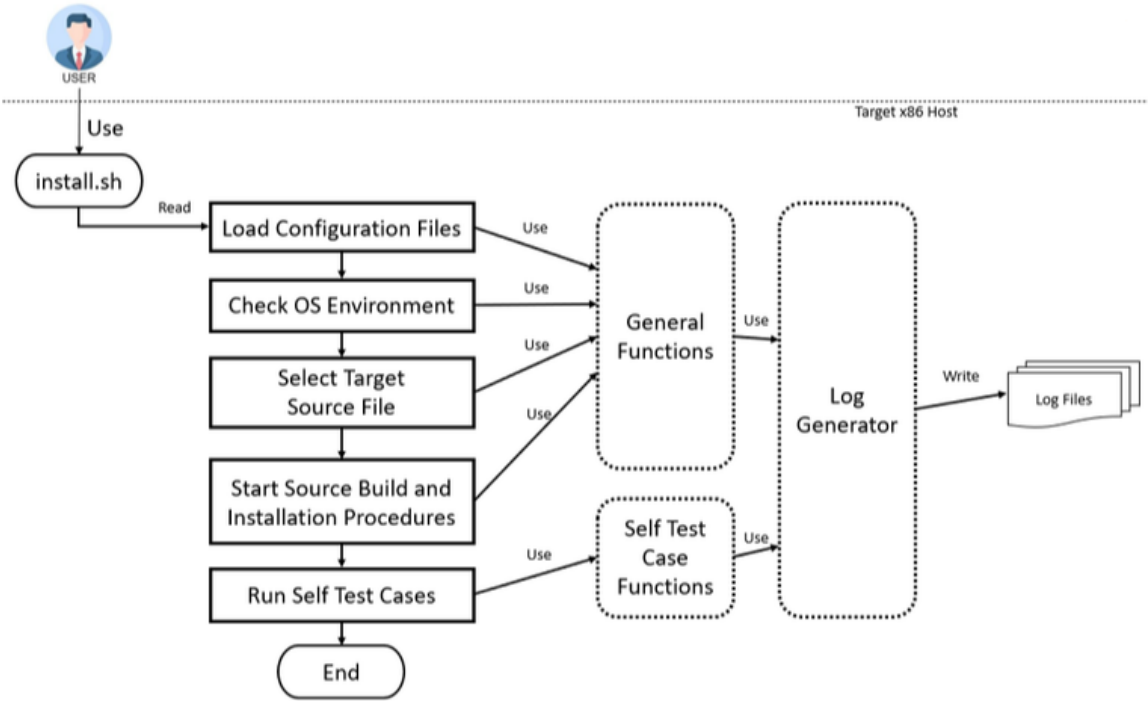
Please extract the **tgz** tarball file under Linux OS environment to avoid file permission issue.

DA Computers Supported

Series	Available SDK Version	Supported Linux Distributions
DA-820E	V1.2	Debian 12, Ubuntu 22.04 LTS, RedHat 9
DA-820C	V1.2	Debian 12, Ubuntu 22.04 LTS & HWE, RedHat 9, CentOS 7.9
DA-682C	V1.2	Debian 12, Ubuntu 22.04 LTS & HWE, RedHat 9, CentOS 7.9
DA-681C	V1.2	Debian 12, Ubuntu 22.04 LTS & HWE, RedHat 9, CentOS 7.9
DA-680	V1.2	Debian 12, Ubuntu 22.04 LTS & HWE, RedHat 9, CentOS 7.9

Software Flow Diagram

Software Diagram



User Interface

User Interface	Main Command	Sub Command	Option	Description
`install.sh`				Start to install all procedures (default)
			-y, --yes	Automatic yes to prompts
	-h, --help			Display the help menu
	-v, --version			Display the version information
	-s, --selftest			Run the self test cases
	--uninstall			Uninstall driver and tool
	--dry-run			It won't perform the installation, list available driver and tool only
			--force	Install driver and tool even if the version is the same or older (default is to install newer version)

Before Installing the Linux SDK

- Configure the **network settings** of your device before installing the Linux SDK
- To extract the tgz tarball file under Linux environment (e.g. tar xvf *.tar.gz)
- Run --dry-run option before installation, to check the target host device and environment are available
- Run --selftest option after installation, to check the status of drivers and tools

4. Peripheral Interface Operations

This guide is introduced the usage of **Moxa peripheral interface control utility**. These utilities should be installed after the x86 Linux SDK Wizard installation procedure.

User can check the status of utilities via running `./install.sh --selftest` command.

Utilities

Utilities Applicable Table

Available Models	Serial Port Utility	DIO Utility	PLED Utility	Relay Utility	Power Input Utility	USB Power Utility	HSR/PRP Utility	IRIG-B Utility	MCIM wrapper
DA-820E	✓	✓	✓	✓	✓	✓	✓	N/A	✓
DA-820C	✓	✓	✓	✓	✓	✓	✓	✓	✓
DA-682C	✓	✓	✓	✓	✓	✓	✓	N/A	✓
DA-681C	✓	✓	✓	✓	✓	✓	N/A	N/A	✓
DA-680	✓	✓	✓	✓	✓	N/A	N/A	✓	✓

Serial Port

The Moxa serial port mode control utility **mx-uart-ctl**, it is for getting and setting serial port's UART mode.

- Drivers dependency
  - moxa-it87-gpio-driver
  - moxa-it87-serial-driver
  - moxa-mxuport-driver
- Libraries Dependency
  - libgpiod

Usage of UART mode control

```
Usage:
                mx-uart-ctl -p <port_number> [-m <uart_mode>]

OPTIONS:
                -p <port_number>
                                Set target port.
                -m <uart_mode>
                                Set target port to uart_mode
                                0 --> set to RS-232 mode
                                1 --> set to RS-485-2W mode
                                2 --> set to RS-422 mode
                                3 --> set to RS-485-4W mode

Example:
                Get mode from port 0
                # mx-uart-ctl -p 0

                Set port 1 to RS232 mode
                # mx-uart-ctl -p 1 -m 0
```

Digital IO (DIO) Port

Moxa DIO port control tool **mx-dio-ctl** is for getting DI/DO and setting DO ports status (low/high).

- Drivers dependency
  - moxa-it87-gpio-driver
- Libraries dependency
  - libgpiod

Usage of DIO state control

```
Usage:
        mx-dio-ctl <-i|-o <#port number> [-s <#state>]>

OPTIONS:
        -i <#DIN port number>
        -o <#DOUT port number>
        -s <#state>
                Set state for target DOUT port
                0 --> LOW
                1 --> HIGH

Example:
        Get value from DIN port 0
        # mx-dio-ctl -i 0
        Get value from DOUT port 0
        # mx-dio-ctl -o 0

        Set DOUT port 0 value to LOW
        # mx-dio-ctl -o 0 -s 0
        Set DOUT port 0 value to HIGH
        # mx-dio-ctl -o 0 -s 1
```

Programmable LED Control

Moxa LED control tool **mx-led-ctl** is provided to control programmable LEDs light on/off

- Drivers dependency
  - moxa-it87-gpio-driver
  - moxa-gpio-pca953x-driver
- Libraries dependency
  - libgpiod

Usage of programmable LED control tool

```
Usage:
        mx-led-ctl -i <led_index> [on|off]

OPTIONS:
        -i <led_index>
                Set LED index.

Example:
        Get state from index 1
        # mx-led-ctl -i 1

        Set index 1 to on
        # mx-led-ctl -i 1 on
```

Relay Port State Control

Moxa relay port state control tool **mx-relay-ctl** is for getting and setting relay ports status (NO: Normal Open/NC: Normal Closed).

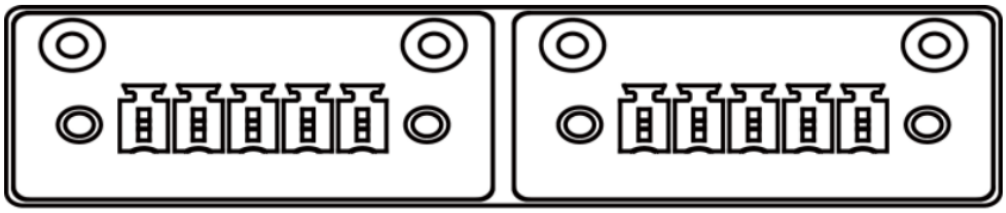
- Drivers dependency
  - moxa-it87-gpio-driver
- Libraries dependency
  - libgpiod

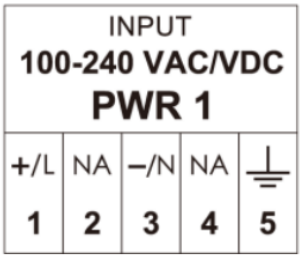
Usage of relay state control

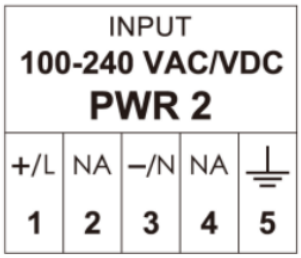
```
Usage:
                mx-relay-ctl -p <port_number> [-m <relay_mode>]

OPTIONS:
                -p <port_number>
                                Set target port.
                -m <relay_mode>
                                Set target port to relay_mode
                                0 --> set to NC (Normal Closed) mode
                                1 --> set to NO (Normal Open) mode

Example:
                Get mode from port 0
                # mx-relay-ctl -p 0

                Set port 0 to mode NC
                # mx-relay-ctl -p 0 -m 0

                Set port 0 to mode NO
                # mx-relay-ctl -p 0 -m 1
```

Power Input Port State

Moxa power input port state tool **mx-input-power-state** is for getting power input ports status (connected/disconnected):







- Drivers dependency
  - moxa-it87-gpio-driver
- Libraries dependency
  - libgpiod

Usage of power input port state tool

```
USAGE:
        mx-input-power-state -i <power_port>

OPTIONS:
        -i <power_port>
                Get power input port state <connected/disconnected>

EXAMPLE:
        Get power input port 0 state
        mx-input-power-state -i 0
```

USB Port Power State Control

Moxa USB port power state control tool **mx-usb-power-ctl** is for setting/getting USB ports (front/rear/internal) power state (off/on) control:

- Drivers dependency
  - moxa-it87-gpio-driver
- Libraries dependency
  - libgpiod

Usage of USB power port state control tool

```
USAGE:
        mx-usb-power-ctl -i <usb_port> [-s <state>]

OPTIONS:
        -i <usb_port>
                Get USB port power state
                        0: front
                        1: rear
                        2: internal

        -s <state>
                Set USB port power state
                        0: off
                        1: on

EXAMPLE:
        Get USB front port power state
        mx-usb-power-ctl -i 0

        Get USB rear port power state
        mx-usb-power-ctl -i 1

        Set USB front port power state to off
        mx-usb-power-ctl -i 0 -s 0

        Set USB internal port power state to on
        mx-usb-power-ctl -i 2 -s 1
```

HSR/PRP Utility

Moxa HSR/PRP card utility is based on SMBUS to query FPGA related register.

Usage

```
[root@localhost moxa]# mxhsrprpd -h
Usage:
        -h: Show this information.
        -B: Run daemon in the background
        -b: SMBUS device, default is /dev/i2c-0
        -t: HSR/PRP Status update period. Default is 3 second.
        -m: configure to prp or hsr mode, default is prp mode.
                The argurement is [index]:[mode]
                [index] range from 0~7.
                [mode] 0 is prp, mode 1 is hsr.
                Ex: Set card 0 to hsr mode, card 1 to prp mode.
                root@Moxa:~# mxhsrprpd -t 2 -m 0:1,1:0
        -s: configure fiber speed, default is auto detect mode.
                The argurement is [index]:[speed]
                [index] range from 0~7.
                [speed] 0 is 100M, 1 is 1000M. (default fiber speed is 1000M)
                Ex: Set card 0 fiber speed to 100M, card 1 fiber speed to
1000M.
                root@Moxa:~# mxhsrprpd -t 2 -s 0:0,1:1
```

Add systemd service to use (if needed)

edit /lib/systemd/system/mx_hsrprp.service

```
[Unit]
Description=Moxa HSR-PRP daemon service

[Service]
Type=oneshot
ExecStart=/usr/sbin/mx_hsrprp start
ExecStop=/usr/sbin/mx_hsrprp stop
RemainAfterExit=yes

[Install]
WantedBy=multi-user.target
```

then enable service.

```
systemctl enable mx_hsrprp.service
```

IRIG-B Utility

Utility for controlling DA-IRIG-B expansion module Compile and install the IRIG-B time sync daemon.

Usage

```
[root@localhost moxa]# ServiceSyncTime -h
Found the IRIG-B module, Hardware ID = 7
IRIG-B time sync daemon.
Usage: ServiceSyncTime -t [signal type] -I -i [Time sync interval] -s [Time
Source] -p [Parity check mode] -B
   -t - [signal type]
        0 - TTL
        1 - DIFF
        default value is 1
   -I - Inverse the input signal
   -s - [Time Source] The sync source from FREERUN(Internal RTC), Fiber or
IRIG-B port
        0 - FREERUN(Internal RTC) module
        1 - Fiber port
        2 - IRIG-B port
        default value is 2
   -i - [Time sync interval] The time interval in seconds to sync the IRIG-B
time into system time.
        1 ~ 86400 Time sync interval. Default is 10 second.
   -p - [Parity check mode] Set the parity bit
        0: EVEN
        1: ODD
        2: NONE
        default value is 0
   -B - Run daemon in the background
Usage example: Enable to sync time from IRIG-B Port 1, in TTL signal type every
10 seconds. The input signals is not inverse.
root@Moxa:~# ServiceSyncTime -t 0 -i 10
```

Use systemd service step by step

1. Disable NTP service

> **WARNING**
>
> NTP service affects IRIG-B service time syncing.

- Disable service

```
timedatectl set-ntp false
```

- Make sure NTP service is inactive

```
timedatectl status
               Local time: Mon 2023-02-13 02:27:54 PST
           Universal time: Mon 2023-02-13 10:27:54 UTC
                 RTC time: Mon 2023-02-13 10:27:54
                Time zone: America/Los_Angeles (PST, -0800)
System clock synchronized: yes
              NTP service: inactive
          RTC in local TZ: no
```

2. Config IRIG-B time sync service
   - Edit /usr/sbin/mx_irigb.sh to config service options MX_IRIGB_SERVICESYNCTIME_OPTS.

> **NOTE**
>
> For more details about options, run the **`ServiceSyncTime -h`** command.

```
...
# The time sync daemon default configure wtih
#   -t 1 - Sync time in DIFF signal format
#   -i 10 - The time interval in 10 seconds to sync the IRIG-B time into
system time.
#   -B - Run daemon in the background
#
MX_IRIGB_SERVICESYNCTIME_OPTS="-t 1 -i 10 -B"
...
```

3. Start IRIG-B time sync service
   - Create and edit systemd service file /lib/systemd/system/mx_irigb.service

```
[Unit]
Description=Moxa DA-IRIG-B daemon service

[Service]
Type=oneshot
ExecStart=/usr/sbin/mx_irigb.sh start
ExecStop=/usr/sbin/mx_irigb.sh stop
RemainAfterExit=yes

[Install]
WantedBy=multi-user.target
```

   - Launch service

```
$ systemctl daemon-reload
$ systemctl enable mx_irigb.service
Created symlink /etc/systemd/system/multi-

user.target.wants/mx_irigb.service →

/lib/systemd/system/mx_irigb.service.
$ systemctl start mx_irigb.service
$ systemctl status mx_irigb.service
● mx_irigb.service - Moxa DA-IRIG-B daemon service
     Loaded: loaded (/lib/systemd/system/mx_irigb.service; enabled;
vendor preset: enabled)
     Active: active (exited) since Tue 2023-02-14 01:48:29 PST; 5s ago
    Process: 8322 ExecStart=/usr/sbin/mx_irigb.sh start (code=exited,
status=0/SUCCESS)
   Main PID: 8322 (code=exited, status=0/SUCCESS)
        CPU: 9ms

Feb 14 01:48:29 moxa systemd[1]: Starting Moxa DA-IRIG-B daemon
service...
Feb 14 01:48:29 moxa systemd[1]: Finished Moxa DA-IRIG-B daemon service.
```

MCIM wrapper

MCIM wrapper means Moxa Computer Interface Manager (MCIM) shell script based wrapper. It's provide users with commands similar to MCIM when operating peripherals.

Usage

```
 The Moxa Computer Interface Manager (MCIM) is a tool designed to simplify
 user control of peripherals. The design of MCIM aims to enhance
 operational efficiency, enabling users to conveniently handle tasks
 related to peripheral devices.
Usage:
  mx-interface-mgmt [command]

Available Commands:
  cellular     Manages the cellular modem
  dio          Manages digital inputs and outputs for external devices
  led          Manages LED indicators
  relay        Manages the relay mode
  serialport   Manages the serial port
  input_power  Manages the power input state
  usb_power    Manages the usb power state

Flags:
  -h, --help      help for mx-interface-mgmt

Use "mx-interface-mgmt [command] --help" for more information about a command.
```

Usage (cellular wrapper)

```
Usage:
  mx-interface-mgmt cellular <NAME> <COMMAND> [ARG]

Available Commands:
  Get the power state of a cellular
    $ mx-interface-mgmt cellular <cellular_name> get_power
  Set the power state of a cellular
    $ mx-interface-mgmt cellular <cellular_name> set_power <power_state>
  Get the SIM slot of a cellular
    $ mx-interface-mgmt cellular <cellular_name> get_sim_slot
  Set the SIM slot of a cellular
    $ mx-interface-mgmt cellular <cellular_name> set_sim_slot <sim_slot>

Arguments:
  cellular_name: The slot number of cellular (e.g. 1|2)
  power_state: on|off
  sim_slot: 1|2
```

Usage (dio wrapper)

```
Usage:
  mx-interface-mgmt dio <NAME> <COMMAND> [ARG]

Available Commands:
  Get the state of a dio
    $ mx-interface-mgmt dio <dio_name> get_state
  Set the state of a dio
    $ mx-interface-mgmt dio <dio_name> set_state <dio_state>

Arguments:

  dio_name: The name of dio (e.g. DI0、DO0)

  dio_state: 0(low)|1(high)
```

Usage (led wrapper)

```
Usage:
  mx-interface-mgmt led <NAME> <COMMAND> [ARG]

Available Commands:
  Get the state of a LED
    $ mx-interface-mgmt led <led_name> get_state
  Set the state of a LED
    $ mx-interface-mgmt led <led_name> set_state <led_state>

Arguments:
  led_name: The number of LED (e.g. 0, 1, 2, ......)
  led_state: on|off
```

Usage (relay wrapper)

```
Usage:
  mx-interface-mgmt relay <NAME> <COMMAND> [ARG]

Available Commands:
  Get the mode of a relay
    $ mx-interface-mgmt relay <relay_name> get_mode
  Set the mode of a relay
    $ mx-interface-mgmt relay <relay_name> set_mode <relay_mode>

Arguments:
  relay_name: The number of relay (e.g. 0, 1, 2, ......)
  relay_mode: 0|1
              0 --> set to NC (Normal Closed) mode
              1 --> set to NO (Normal Open) mode
```

Usage (input_power wrapper)

```
Usage:
  mx-interface-mgmt input_power <NAME> <COMMAND> [ARG]

Available Commands:
  Get the state of a input_power
    $ mx-interface-mgmt input_power <input_power_name> get_state

Arguments:
  input_power_name: The number of input_power (e.g. 0, 1, 2, ......)
```

Usage (usb_power wrapper)

```
Usage:
  mx-interface-mgmt usb_power <NAME> <COMMAND> [ARG]

Available Commands:
  Get the usb power state of a port
    $ mx-interface-mgmt usb_power <usb_port> get_state
  Set the usb power state of a port
    $ mx-interface-mgmt usb_power <usb_port> set_state <state>

Arguments:
  usb_port: Get USB port power state
                        0: front
                        1: rear
                        2: internal
  state: Set USB port power state
                        0: off
                        1: on
```

Usage (serialport wrapper)

```
Usage:
  mx-interface-mgmt serialport <NAME> <COMMAND> [ARG]

Available Commands:
  Get the interface of a serial port
    $ mx-interface-mgmt serialport <serialport_name> get_interface
  Set the interface of a serial port
    $ mx-interface-mgmt serialport <serialport_name> set_interface
<serial_interface>

Arguments:
  serialport_name: The number of serial port (e.g. 0, 1, 2, ......)
  serial_interface:
                0 --> set to RS-232 mode
                1 --> set to RS-485-2W mode
                2 --> set to RS-422 mode
                3 --> set to RS-485-4W mode
```

Drivers

Drivers Applicable Table

Available Models	it87_gpio	it87_serial	it87_wdt	mxu11x0	gpio-pca953x	hid-ft260	irigb	i915 (backport)
DA-820E	✓	✓	✓	N/A	*[1]	*[2]	N/A	*[3]
DA-820C	✓	✓	✓	N/A	*[1]	*[2]	✓	N/A
DA-682C	✓	✓	✓	N/A	*[1]	*[2]	N/A	N/A
DA-681C	✓	N/A	✓	N/A	*[1]	N/A	N/A	N/A
DA-680	✓	N/A	✓	✓	N/A	N/A	✓	N/A

*[1]: Debian 11, Debian 12, RHEL 9, CentOS 7.9
*[2]: RHEL 9, CentOS 7.9
*[3]: Ubuntu 22.04 LTS

moxa-it87-gpio-driver

The purpose of moxa-it87-gpio-driver is controlling GPIO interface for IT87xx Super I/O chips, based on Linux kernel drivers/gpio/gpio-it87.c, removed label for Moxa utilities' compatibility and fix-up some issues.

Kernel module information

```
root@moxa-ElkhartLake-U:/home/moxa# modinfo gpio_it87
filename:       /lib/modules/5.19.0-50-generic/kernel/drivers/gpio/gpio-it87.ko
version:        1.5.0
license:        GPL
description:    GPIO interface for IT87xx Super I/O chips
author:         Diego Elio Pettenò <flameeyes@flameeyes.eu>
srcversion:     BF1E1DA11ED46916F0525B3
depends:
retpoline:      Y
name:           gpio_it87
vermagic:       5.19.0-50-generic SMP preempt mod_unload modversions
parm:           force_id:Override the detected device ID (ushort)
```

Once the **gpio_it87** driver has been probed, the gpiochip interfaces /sys/class/gpio/gpiochip* and /sys/class/gpio/gpio* are created by the driver.

E.g.

```
# cat /sys/class/gpio/gpiochip698/label
gpio_it87
# cat /sys/class/gpio/gpio699/value
0
```

Thus, by read/write the gpio value, user can get/set the super IO gpio value.

NOTE

If the Linux kernel version ≥ 5.x, default uses the **libgpiod** to set/get set/get gpio value.

Alternatively, for Linux kernel version ≤ 3.x, default uses the **sys class gpio** to set/get gpio value.

moxa-it87-serial-driver

IT87xx Super I/O chips support six standard serial ports and **RS485 automatic direction control (ADDC)**. This driver provide an interface under misc device for controlling serial register.

Kernel module information

```
root@moxa-ElkhartLake-U:/home/moxa# modinfo it87_serial
filename:       /lib/modules/5.19.0-50-generic/kernel/drivers/misc/it87_serial.ko
version:        1.4.1
license:        GPL
author:         Remus Wu <remusty.wu@moxa.com>
description:    Serial Port Register Control for IT8786 Super I/O chips
softdep:        pre: it87
srcversion:     DF70894844D938C398F1E94
depends:
retpoline:      Y
name:           it87_serial
vermagic:       5.19.0-50-generic SMP preempt mod_unload modversions
parm:           force_id:Override the detected device ID (ushort)
```

Once the **it87_serial** driver has been probed, the /sys/class/misc/it87_serial/serial[p] interface are created by the driver.

E.g.

```
# cat /sys/class/gpio/gpiochip698/label
gpio_it87
# cat /sys/class/gpio/gpio699/value
0
```

Thus, by read/write the gpio value, user can get/set the super IO gpio value.

NOTE

IT87xx Super I/O chips support six standard serial ports and **RS485 automatic direction control (ADDC)**. This driver provide an interface under misc. device for controlling serial register.

moxa-it87-wdt-driver

Watchdog timer driver for ITE IT87xx environment control. The moxa-it87-wdt-driver is based on Linux kernel drivers/watchdog/it87_wdt.c driver, and add kernel parameters to support Moxa platform's hardware design.

Kernel module information

```
root@moxa-ElkhartLake-U:/home/moxa# modinfo it87_wdt
filename:       /lib/modules/5.19.0-50-generic/kernel/drivers/watchdog/it87_wdt.ko
version:        1.5.0
license:        GPL
description:    Hardware Watchdog Device Driver for IT87xx EC-LPC I/O
author:         Oliver Schuster
srcversion:     539E4978F03512C150A3753
depends:
retpoline:      Y
name:           it87_wdt
vermagic:       5.19.0-50-generic SMP preempt mod_unload modversions
parm:           timeout:Watchdog timeout in seconds, default=60 (int)
parm:           testmode:Watchdog test mode (1 = no reboot), default=0 (int)
parm:           nowayout:Watchdog cannot be stopped once started, default=0 (bool)
parm:           krst:Watchdog enable KRST reset output, default=1 (bool)
parm:           ldn_reset:Set SIO LDN back to 01h when init and update_timeout, default=0 (bool)
parm:           force_id:Override the detected device ID (ushort)
```

The watchdog device node /dev/watchdog0 is created by it87_wdt driver.

The x86 Linux SDK Wizard will default setup the watchdog daemon configuration file /etc/watchdog.conf and enable service for specific Linux distributions.

Default timeout of watchdog device is 60 seconds (maximum is 65535 seconds). If you want to change timeout value, you need to edit watchdog daemon config file /etc/watchdog.conf

e.g. watchdog timeout for 300 second:

```
watchdog-timeout = 300
```

moxa-mxu11x0-driver

The purpose of moxa-mxu11x0-driver is Moxa UPort 11x0 USB to Serial Hub driver. The driver can be used in the Linux kernel with the usbcore and usbserial modules.

Kernel module information

```
root@moxa:/home/moxa# modinfo mxu11x0
filename:       /lib/modules/6.1.0-21-amd64/misc/mxu11x0.ko
license:        GPL
version:        6.0
description:    MOXA UPort 11x0 USB to Serial Hub Driver
author:         Jason Chen
srcversion:     69A9036218C1FF04D109D71
alias:          usb:v0451p3410d*dc*dsc*dp*ic*isc*ip*in*
alias:          usb:v110Ap7001d*dc*dsc*dp*ic*isc*ip*in*
alias:          usb:v110Ap3001d*dc*dsc*dp*ic*isc*ip*in*
alias:          usb:v110Ap1131d*dc*dsc*dp*ic*isc*ip*in*
alias:          usb:v110Ap1151d*dc*dsc*dp*ic*isc*ip*in*
alias:          usb:v110Ap1150d*dc*dsc*dp*ic*isc*ip*in*
alias:          usb:v110Ap1130d*dc*dsc*dp*ic*isc*ip*in*
alias:          usb:v110Ap1110d*dc*dsc*dp*ic*isc*ip*in*
alias:          usb:v110Ap1110d*dc*dsc*dp*ic*isc*ip*in*
alias:          usb:v110Ap1130d*dc*dsc*dp*ic*isc*ip*in*
alias:          usb:v110Ap1150d*dc*dsc*dp*ic*isc*ip*in*
alias:          usb:v110Ap1151d*dc*dsc*dp*ic*isc*ip*in*
alias:          usb:v110Ap1131d*dc*dsc*dp*ic*isc*ip*in*
alias:          usb:v110Ap3001d*dc*dsc*dp*ic*isc*ip*in*
alias:          usb:v110Ap7001d*dc*dsc*dp*ic*isc*ip*in*
alias:          usb:v0451p3410d*dc*dsc*dp*ic*isc*ip*in*
depends:        usbserial,usbcore
retpoline:      Y
name:           mxu11x0
vermagic:       6.1.0-21-amd64 SMP preempt mod_unload modversions
```

The device name for each serial port is /dev/ttyUSBxx which xx is a sequence number maintained by USB subsystem.

The mxu11x0 UART mode selection has been imported into **mx-uart-ctl** utility.

moxa-gpio-pca953x-driver

This driver is for PCA953x 4/8/16/24/40 bit I/O ports control.

Kernel module information

```
root@moxa-imoxa-0000000:/home/moxa# modinfo gpio-pca953x
filename:       /lib/modules/5.10.0-cip-rt-moxa-tigerlake/kernel/drivers/gpio/gpio-pca953x.ko
license:        GPL
description:    GPIO expander driver for PCA953x
author:         eric miao <eric.miao@marvell.com>
alias:          i2c:xra1202
alias:          i2c:tca9554
alias:          i2c:tca9539
alias:          i2c:tca6424
alias:          i2c:tca6416
alias:          i2c:tca6408
alias:          i2c:pca6107
alias:          i2c:max7318
```

Once the gpio-pca953x driver has been probed, and bind with USB to i2c bridge (e.g. FT260 or CP2112), the gpiochip interface /sys/class/gpio/gpiochip* and /sys/class/gpio/gpio* are created by driver.

The example refers to moxa-it87-gpio-driver section.

moxa-hid-ft260-driver

This driver is for USB to SMBus master bridge driver on FT260.

Kernel module information

```
[root@localhost moxa]# modinfo hid_ft260
filename:       /lib/modules/5.14.0-162.6.1.el9_1.x86_64/kernel/drivers/hid/hid-ft260.ko
license:        GPL v2
author:         Michael Zaidman <michael.zaidman@gmail.com>
description:    FTDI FT260 USB HID to I2C host bridge
rhelversion:    9.1
srcversion:     087AA8C0DB968178D54C0A8
alias:          hid:b0003g*v00000403p00006030
depends:
retpoline:      Y
name:           hid_ft260
vermagic:       5.14.0-162.6.1.el9_1.x86_64 SMP preempt mod_unload modversions
parm:           debug:Toggle FT260 debugging messages (int)
```

Add Udev Rules to Rebind FT260 Device

To avoid the ft260 hid device is pre-bind to hid-generic subsystem, add udev rules to re-bind to ft260 driver.

Edit /etc/udev/rules.d/11-ft260-pca9535.rules

```
ACTION=="add", KERNEL=="0003:0403:6030.*", SUBSYSTEM=="hid",
DRIVERS=="hid-generic", \
RUN+="/bin/bash -c 'echo $kernel > /sys/bus/hid/drivers/hid-generic/unbind'", \
RUN+="/bin/bash -c 'echo $kernel > /sys/bus/hid/drivers/ft260/bind'"
```

moxa-irigb-driver

The IRIG-B driver is for Moxa embedded compute for controlling the IRIG-B device.

Kernel module information

```
[root@localhost moxa]# modinfo moxa_irigb
filename:       /lib/modules/5.14.0-162.6.1.el9_1.x86_64/kernel/drivers/misc/moxa_irigb.ko
version:        1.3.0
description:    IRIG-B module device driver
author:         jared.wu@moxa.com
license:        Proprietary
rhelversion:    9.1
srcversion:     897C12BC0A9368430DEEBF0
depends:
retpoline:      Y
name:           moxa_irigb
vermagic:       5.14.0-162.6.1.el9_1.x86_64 SMP preempt mod_unload modversions
```

The IRIG-B driver is depends on IRIG-B Utility.

intel-gpu-i915-backports

Intel® Graphics Driver Backports for Linux® OS (intel-gpu-i915-backports)

Contains the backported kernel module source code of intel GPUs on various OS distributions and LTS Kernels.

Kernel module information

```
root@moxa:/home/moxa# modinfo i915
filename:       /lib/modules/5.15.0-119-generic/updates/dkms/i915.ko
license:        GPL and additional rights
description:    Intel Graphics
version:        backported to 5.15.0-119 from (b434e44e14397) using backports I915_23.8.20_PSB_230810.22
author:         Intel Corporation
author:         Tungsten Graphics, Inc.
import_ns:      INTEL_VSEC
firmware:       i915/mtl_gsc_102.0.0.7366.bin
firmware:       i915/skl_huc_2.0.0.bin
firmware:       i915/bxt_huc_2.0.0.bin
firmware:       i915/kbl_huc_4.0.0.bin
firmware:       i915/glk_huc_4.0.0.bin
firmware:       i915/kbl_huc_4.0.0.bin
```

Use lspci -v to check i915 driver is in use

```
root@moxa:/home/moxa# lspci -v
00:00.0 Host bridge: Intel Corporation Device a706
        Subsystem: Intel Corporation Device 7270
        Flags: bus master, fast devsel, latency 0
        Capabilities: [e0] Vendor Specific Information: Len=14 <?>

00:02.0 VGA compatible controller: Intel Corporation Device a720 (rev 04) (prog-if 00 [VGA controller])
        Subsystem: Intel Corporation Device a720
        Flags: bus master, fast devsel, latency 0, IRQ 166
        Memory at 6004000000 (64-bit, non-prefetchable) [size=16M]
        Memory at 4000000000 (64-bit, prefetchable) [size=256M]
        I/O ports at 5000 [size=64]
        Expansion ROM at 000c0000 [virtual] [disabled] [size=128K]
        Capabilities: [40] Vendor Specific Information: Len=0c <?>
        Capabilities: [70] Express Root Complex Integrated Endpoint, MSI 00
        Capabilities: [ac] MSI: Enable+ Count=1/1 Maskable+ 64bit-
        Capabilities: [d0] Power Management version 2
        Capabilities: [100] Process Address Space ID (PASID)
        Capabilities: [200] Address Translation Service (ATS)
        Capabilities: [300] Page Request Interface (PRI)
        Capabilities: [320] Single Root I/O Virtualization (SR-IOV)
        Kernel driver in use: i915
        Kernel modules: i915
```

Libraries

libgpiod

libgpiod - C library and tools for interacting with the **Linux GPIO character device** (gpiod stands for GPIO device).

Since **Linux kernel 4.8** the GPIO sysfs interface is deprecated. User space should use the character device instead. This library encapsulates the ioctl calls and data structures behind a straightforward API.

The new character device interface guarantees all allocated resources are freed after closing the device file descriptor and adds several new features that are not present in the obsolete sysfs interface.

One device file per gpiochip

- /dev/gpiochip0, /dev/gpiochip1, …, /dev/gpiochipX

Usage

```
There are currently six command-line tools available:

* gpiodetect - list all gpiochips present on the system, their names, labels
               and number of GPIO lines

* gpioinfo   - list all lines of specified gpiochips, their names, consumers,
               direction, active state and additional flags

* gpioget    - read values of specified GPIO lines

* gpioset    - set values of specified GPIO lines, potentially keep the lines
               exported and wait until timeout, user input or signal

* gpiofind   - find the gpiochip name and line offset given the line name

* gpiomon    - wait for events on GPIO lines, specify which events to watch,
               how many events to process before exiting or if the events
               should be reported to the console
```

E.g.

```
# Read the value of a single GPIO line.
$ gpioget gpiochip1 23
0

# Read two values at the same time. Set the active state of the lines to low.
$ gpioget --active-low gpiochip1 23 24
1 1

# Set the value of a single line, then exit immediately.
# This is useful for floating pins.
$ gpioset gpiochip1 23=1
```

5. Basic Linux Concepts

The section introduces basic Linux concepts, like x86 secure boot, IO interfaces, TPM2 module, SD card slot mounting, Linux PTP (IEEE 1588), etc.

To provide skills and basic information for newcomers to learn more about Linux.

Secure Boot

The **UEFI Secure Boot** is a security feature that has been widely adopted in modern computer systems, especially those running Windows and some Linux distributions.

Its primary purpose is to ensure the integrity and authenticity of the operating system and bootloader during the system boot process, protecting the system against boot-time malware and other unauthorized software.

Secure Boot Purpose

Secure Boot is designed to prevent the loading of malicious software, such as rootkits and bootkits, during the boot process.

It does this by ensuring that only trusted and digitally **signed** bootloaders and OS kernels are executed.

Thus, if user loads **unsigned** bootloaders and OS kernels on target Linux distributions when UEFI secure boot has been enabled on BIOS menu, the boot process or kernel modules should be failed due to unauthorized policy.

Operating System Support

User can be considered to refer to the following website links for more UEFI secure boot information.

- Debian Secure Boot
- Ubuntu Secure Boot
- RedHat Secure Boot

Linux PTP (IEEE 1588)

The **Precision Time Protocol (PTP)** s a protocol used to synchronize clocks throughout a computer network. PTP provides higher precision and faster synchronization than NTP even without hardware support. With hardware support, sub-microsecond accuracy can be expected.

Whereas NTP is intended for WAN use, PTP is designed for LAN environments and makes use of UDP multicast.

Available LAN chip

- Intel I210 (driver: ibg)
- Intel I219 (driver: e1000e)

Debian Linuxptp package

Linuxptp package is an implementation of the Precision Time Protocol (PTP) according to IEEE standard 1588 for Debian Linux. Features include:

1. Support for hardware and software time stamping via the Linux SO_TIMESTAMPING socket option.
2. Support for the Linux PTP Hardware Clock (PHC) subsystem by using the clock_gettime family of calls, including the new clock_adjtimex system call
3. Implementation of **Boundary Clock (BC)** and **Ordinary Clock (OC)**
4. Transport over UDP/IPv4, UDP/IPv6, and raw Ethernet (Layer 2)
5. Support for IEEE 802.1AS-2011 in the role of end station

Debian phc2sys program

phc2sys is a program which synchronizes two or more clocks in the system. Typically, it is used to synchronize the system clock to a PTP hardware clock (PHC), which itself is synchronized by the ptp4l(8) program. See manpage for more information.

- Prerequisite
  - Install **Debian 11** or later version
  - Install **Linuxptp** package: apt update && apt install linuxptp
  - Stop and disable systemd time sync daemon service to avoid some unexpected operations: systemctl stop systemd-timesyncd && systemctl disable systemd-timesyncd

Example for Linux PTP setting up

Ordinary Clock (OC) Mode

Set as **OC master** mode: Layer 2, P2P mode, peer delay mechanism

```
# Assume A side interface device is 'enp4s0'
ip link set dev enp4s0 up
ptp4l -m -2 -P -i enp4s0
```

Set as **OC slave** mode: Layer 2, P2P mode, peer delay mechanism

```
# Assume B side interface device is 'enp5s0'
ip link set dev enp5s0 up
ptp4l -m -2 -P -s -i enp5s0
# or with log: ptp4l -m -2 -s -P -i enp5s0 2>&1 | tee $(date +%Y%m%d%H%M%S.log)

# use phc2sys to sync sys clock for 10Hz
phc2sys -a -m -r -R 10
```

Boundary Clock (BC) Mode

Set as **BC mode** host

- clock_type Specifies the kind of PTP clock. Valid values are "OC" for ordinary clock, "BC" for boundary clock, "P2P_TC" for peer to peer transparent clock, and "E2E_TC" for end to end transparent clock. An multi-port ordinary clock will automatically be configured as a boundary clock. The default is "OC".
- boundary_clock_jbod When running as a **boundary clock** (that is, when more than one network interface is configured), ptp4l performs a sanity check to make sure that all of the ports share the same hardware clock device. This option allows ptp4l to work as a boundary clock using "just a bunch of devices" that are not synchronized to each other. For this mode, the collection of clocks must be synchronized by an external program, for example phc2sys(8) in "automatic" mode. The default is 0 (disabled).

Example for BC mode

```
# For example, edit config file 'bc.cfg'
# and assume 'enp12s0' and 'enp4s0' are connected network interface
[global]
sanity_freq_limit        0
step_threshold           0.000002
tx_timestamp_timeout     10
logMinPdelayReqInterval  0
logSyncInterval          0
logAnnounceInterval      0
announceReceiptTimeout   3
syncReceiptTimeout       2
twoStepFlag              1
summary_interval         0
clock_type               BC
priority1                128
priority2                127
delay_mechanism          P2P

[enp12s0]
boundary_clock_jbod          1
network_transport            L2
fault_reset_interval         0

[enp4s0]
boundary_clock_jbod          1
network_transport            L2
fault_reset_interval         0

# run the ptp4l procedure
ip link set dev enp12s0 up
ip link set dev enp4s0 up
ptp4l -m -f bc.cfg

# use phc2sys to sync sys clock for 10Hz
phc2sys -a -m -r -R 10
```

On OC **Grandmaster**

```
# assume interface is enp5s0
ip link set dev enp5s0 up
ptp4l -2 -m -P -i enp5s0
```

On OC **Slave**

```
# assume interface is enp4s0
ip link set dev enp4s0 up
ptp4l -2 -m -s -P -i enp4s0
# with log: ptp4l -2 -m -s -P -i enp4s0 2>&1 | tee $(date +%Y%m%d%H%M%S.log)
```

Transparent Clock (TC) Mode

Set TC mode host

```
# For example, edit config file 'tc.cfg'
# and assume 'enp12s0' and 'enp4s0' are connected network interface
[global]
priority1               254
priority2               253
free_running            1
freq_est_interval       3
tc_spanning_tree        1
clock_type              P2P_TC
network_transport       L2
delay_mechanism         P2P

[enp12s0]
egressLatency           0
ingressLatency          0
delay_mechanism         P2P
network_transport       L2

[enp4s0]
egressLatency           0
ingressLatency          0
delay_mechanism         P2P
network_transport       L2

# run the ptp4l procedure
ip link set dev enp12s0 up
ip link set dev enp4s0 up
ptp4l -m -f tc.cfg

# use phc2sys to sync sys clock between master & slave for 10Hz
# -c Specify the slave clock by device (e.g. /dev/ptp1) or interface (e.g.
eth1)
# -s Specify the master clock by device (e.g. /dev/ptp0) or interface (e.g.
eth0)
phc2sys -s enp12s0 -c enp4s0 -O 0 -R 10 -m
```

As OC Grandmaster

```
# assume interface is enp5s0
ip link set dev enp5s0 up
ptp4l -2 -m -P -i enp5s0
```

As OC Slave

```
# assume interface is enp4s0
ip link set dev enp4s0 up
ptp4l -2 -m -s -P -i enp4s0

# use phc2sys to sync sys clock for 10Hz on slve
phc2sys -a -m -r -R 10
```

6. Troubleshooting

The troubleshooting section provides fundamental skills for system logging, debugging, the debug of Moxa x86 SDK Wizard and issues tracing.

How to Print Kernel Message from Linux Environment

The dmesg command is used to display the kernel ring buffer, which contains messages related to the kernel and hardware events.

It's a useful tool for troubleshooting hardware-related issues, monitoring system-level events and diagnosing hardware issues.

To simply view the kernel ring buffer, run the following command: *dmesg*

You can save the output of dmesg to a file for further analysis. For instance, to save the log to a file named kernel.log, use the following command:

```
# save kernel message to log
dmesg >kernel.log

# or simply to save the error and warninglevel log:
dmesg --level=err,warn > kernel_err_warn.log
```

How to Collect Systems Logs from Linux Environment

The following procedure describes the collecting of log files. Log files in the /var/log directory.

Archive and compress all log files and put them in /tmp

```
tar czvf /tmp/varlog.tar.gz /var/log/*.log.*
```

The output file /tmp/varlog.tar.gz can be transferred for debugging usage.

How to Get Installation Logs from Moxa x86 Linux SDK Install Wizard

Moxa x86 Linux SDK provides **self-test** for diagnosing the status of drivers and tools after installation. To simply see the log, run the following command:

```
./install.sh --selftest
```

Then the self test cases will check the SDK status and print on terminal, for example:

```
[info] Product Name: RKPA110
[info] OS Name: Ubuntu
[info] OS Version: 22.04
[info] Kernel Info: Linux moxa-ElkhartLake-U 5.19.0-50-generic #50-Ubuntu SMP PREEMPT_DYNAMIC Mon Jul 10 18:24:29 UTC 2023 x86_64 x86_64 x86_64 GNU/Linux
[info] >>> Execute hook script "self-test.sh".
[info] ------------------------------------------------------------------------
[info]  Name                          Installed      Status         Version
[info] ========================================================================
[info]  moxa-it87-gpio-driver                                       5.2+1.5.0-1
[info]  - gpio_it87                   Yes            Loaded
[info]  moxa-it87-wdt-driver                                        5.2+1.5.0-1
[info]  - it87_wdt                    Yes            Loaded
[info]  - watchdog service            Yes            Active
[info]  moxa-it87-serial-driver                                     1.4.1+u2
[info]  - it87_serial                 Yes            Loaded
[info]  moxa-mxuport-driver                                         5.1.1_build_23080316
[info]  - mxuport                     Yes            Loaded
[info]  moxa-x86-control-tools                                      1.8.1
[info]  - mx-uart-ctl                 Yes            10 ports
[info]  - mx-dio-ctl                  Yes            8 DI / 8 DO
[info] ------------------------------------------------------------------------
[info] <<< Execute hook script "self-test.sh" done.
```

For further, the log of installation is also created on Moxa_x86_Linux_Install_Wizard_<version>_Build_<build_date>/install.log

User can consider to view the log file and check issues.

How to Get Hardware Information on a Host

IOS exports the hardware information on to a **DMI** (Desktop Management Interface) table.

Linux **dmidecode** is a tool for dumping a computer DMI (some say **SMBIOS**) table contents in a human-readable format. This table contains a description of the system's hardware components, as well as other useful pieces of information such as serial numbers and BIOS revision.

Install dmidecode Package

- Ubuntu/Debian: sudo apt-get install dmidecode
- RHEL: sudo yum install dmidecode

Example

[Get model name and hardware version]

The Option 1 (or Option 2) displays the 16 bytes information, for example: RKP A110000091

RKP A110000091 means

- PCBA name = RKP
- PCBA number = A110
- PCBA serial = 0
- PCBA type = 00
- PCBA hw version = 091 (v0.91)

How to get information from dmitable

```
# dmidecode -t 12
Handle 0x0021, DMI type 12, 5 bytes
System Configuration Options
        Option 1:   RKP A110000091
        Option 2:
        Option 3:
...
```

BYTE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Define	PCBA Nmae (Eng					PCBA Name (Number					Serial	Type		PCBA version		
Example : UC-8580 Main board PCBA : 1.0a	UC					8580					0	00		10a		

[Get current BIOS version]

```
# dmidecode -t bios
BIOS Information
        Vendor: INSYDE Corp.
        Version: V1.0.0S04
        Release Date: 05/15/2023
        Address: 0xE0000
        Runtime Size: 128 kB
        ROM Size: 10 MB
...
```

[Get memory and processor hardware information]

```
# dmidecode -t memory
Physical Memory Array
        Location: System Board Or Motherboard
        Use: System Memory
        Error Correction Type: None
        Maximum Capacity: 16 GB
        Error Information Handle: Not Provided
        Number Of Devices: 2
...
# sudo dmidecode -t processor
Processor Information
        Socket Designation: U3E1
        Type: Central Processor
        Family: Other
        Manufacturer: Intel(R) Corporation
        ID: 61 06 09 00 FF FB EB BF
        Version: Intel Atom(R) x6425E Processor @ 2.00GHz
        Voltage: 1.1 V
        External Clock: 100 MHz
...
```

7. Appendix

The License/Commercial-Use of Linux Distributions

A Linux distribution is a version of the Linux operating system that includes the Linux kernel, system utilities, libraries, and additional software and applications. Linux distributions are created by various organizations, communities, and individuals, each tailoring the operating system to meet specific needs and preferences.

Linux distribution include:

Debian

Debian is a free and open-source operating system, and its intellectual property rights policy is based on a commitment to free software principles. Debian adheres to a set of guidelines and policies outlined in the Debian Free Software Guidelines (DFSG). The DFSG defines the criteria that software must meet to be considered "free" in the context of Debian.

Commercial use:

Free redistribution.

The license of a Debian component **may not restrict** any party from selling or giving away the software as a component of an aggregate software distribution containing programs from several different sources. The license may not require a royalty or other fee for such sale.

https://wiki.debian.org/DebianFreeSoftwareGuidelines

https://www.debian.org/trademark

https://wiki.debian.org/ProposedTrademarkPolicy

Ubuntu

Ubuntu is built by Canonical and the Ubuntu community. We share access rights owned by Canonical with the Ubuntu community for the purposes of discussion, development and advocacy. We recognize that most of the open source discussion and development areas are for non-commercial purposes and we therefore allow the use of Canonical IP in this context, as long as there is no commercial use and that the Canonical IP is used in accordance with this IP Rights Policy.

You can modify Ubuntu for **personal** or **internal commercial** use.

You can **redistribute** Ubuntu, but only where there has been **no modification** to it.

For more Canonical's intellectual property rights policy:

https://ubuntu.com/legal/intellectual-property-policy

Red Hat Enterprise Linux (RHEL)

Red Hat Enterprise Linux (RHEL) is a **commercial** Linux distribution provided by Red Hat, Inc. It is designed for enterprise environments and comes with a subscription-based pricing model.

https://www.redhat.com/en/store/linux-platforms

https://www.redhat.com/en/about/trademark-guidelines-and-policies

https://www.redhat.com/en/about/terms-use

CentOS

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