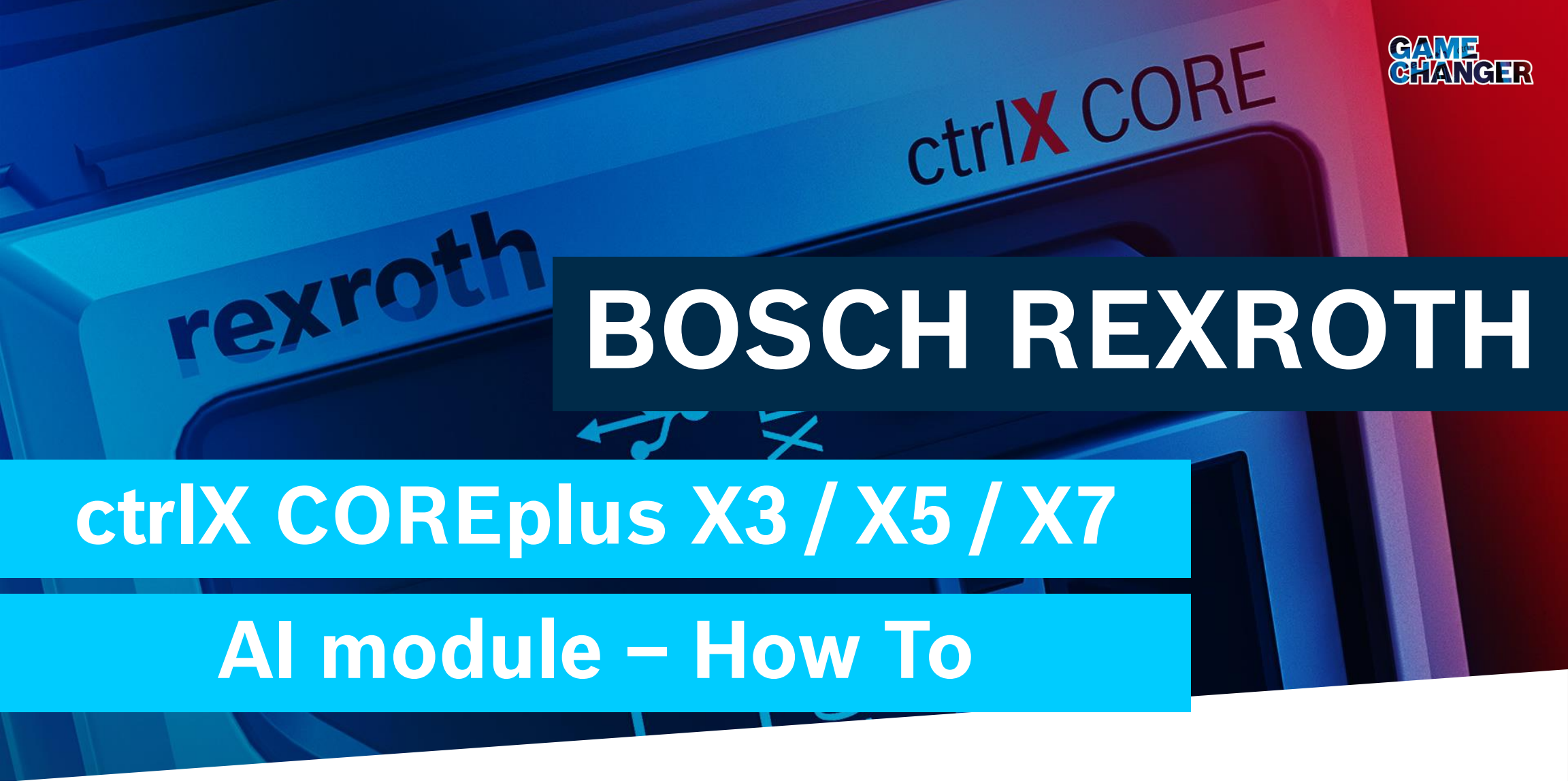

GAME CHANGER

BOSCH REXROTH

ctrlX COREplus X3 / X5 / X7

AI module – How To

DC-AE/PAG2 – 10.2025

GERMAN INNOVATION AWARD '20 WINNER

reddot winner 2020 industrial design

Der Deutsche Innovationspreis 2021

rexroth A Bosch Company

ctrlX COREplus X3/X5/X7 – AI-Module

Download Hailo Tools

- **HailoRT**
  - Device is Hailo 8
  - The HailoRT is the Run-time library with APIs which is required to connect the ctrlX device with Hailo AI extension.
  - Download the HailoRT from Hailo Developer Zone according to used ctrlX device architecture and ctrlX OS version:
    - hailort_4.15.0_arm64.deb => X3 with ctrlX OS 2.6
    - hailort_4.15.0_amd64.deb => for X5/X7 with ctrlX OS 2.6
    - hailort_4.19.0_arm64.deb => X3 with ctrlX OS 3.6
    - hailort_4.19.0_amd64.deb => for X5/X7 with ctrlX OS 3.6
    - NB: Search in all versions (in the developer Zone) for device Hailo 8/8L
  - The HailoRT need to be implemented in snap for installation on ctrlX device.

DC-AE/PAG2 – 10.2025

rexroth
A Bosch Company

ctrlX COREplus X3/X5/X7 – AI-Module

Snap creation with HailoRT

- **Snap creation with HailoRT (part of SDK)**
  - The Snapcraft.yaml need to be modified as in following application example:
    - In parts the HailoRT to be added with its version:

```
parts:
  hailo-integration-tool:
    plugin: nil
    stage-packages:
      - hailort:$SNAPCRAFT_TARGET_ARCH=4.15.0
      - libdw1:$SNAPCRAFT_TARGET_ARCH
```

    - In apps the hailortcli to be added with its plugs:

```
apps:
  hailortcli:
    command: usr/bin/hailortcli
    plugs:
      - hailo-0
      - system-observe
      - hardware-observe
```

    - On plugs the hailo module to be added:

```
plugs:
  hailo-0:
    interface: custom-device
    custom-device: ctrlx-hailo-0
```

    - In Layout the libhailort to be added:

```
layout:
  /usr/lib/libhailort.so.4.15.0:
    symlink: $SNAP/usr/lib/libhailort.so.4.15.0
```

ctrlX COREplus X3/X5/X7 – AI-Module

Scan for devices

- **System user access has to be requested (root access): see** “How to activate SSH communication in a ctrlX CORE“
- **Check connected PCIe devices**
  - ll /sys/bus/pci/devices/
  - Example:

```
rexroot@ctrlX-OS:~$ ll /sys/bus/pci/devices/
total 0
drwxr-xr-x 2 root root 0 Sep 23 09:27 ./
drwxr-xr-x 5 root root 0 Sep 23 09:27 ../
lrwxrwxrwx 1 root root 0 Sep 23 09:27 0000:00:00.0
lrwxrwxrwx 1 root root 0 Sep 23 09:27 0000:01:00.0
```

- **Check if AI extension is available via PCIe Vendor “0x1E60”**
  - cat /sys/bus/pci/devices/*/vendor
  - Example:

```
rexroot@ctrlX-OS:~$ cat /sys/bus/pci/devices/*/vendor
0x10ee
0x1e60
```

    - Note: Vendor found on second PCIe port so address is in this case 0000:01:00.0

DC-AE/PAG2 – 10.2025

ctrlX COREplus X3/X5/X7 – AI-Module

Scan for devices

- **Scan for Hailo Extension using HailoRT-CLI**
  - hailo-integrationtool.hailortcli scan
  - Example:

```
rexroot@ctrlX-OS:~$ hailo-integrationtool.hailortcli scan
HailoRT warning: Cannot create log file hailort.log! Please check the file ./hailort.log write permissions.
Hailo Devices:
[-] Device: 0000:01:00.0
```

    - Note: command “hailo-integrationtool.hailortcli” is depending to your created snap
    - Note: the warning is created due to missing write permissions (no warning when apply command as superuser “sudo”)

ctrlX COREplus X3/X5/X7 – AI-Module

Check FW and driver version

- **Check for HailoRT-CLI version**
  - hailo-integrationtool.hailortcli -v
  - Example:

```
rexroot@ctrlX-CORE:~$ hailo-integrationtool.hailortcli -v
HailoRT warning: Cannot create log file hailort.log! Please check the file ./hailort.log write permissions.
HailoRT-CLI version 4.15.0
```

    - Note: command “hailo-integrationtool.hailortcli” is depending to your created snap
    - Note: the warning is created due to missing write permissions (no warning when apply command as superuser “sudo”)
- **Check for driver version in used Kernel of Linux system**
  - cat /sys/bus/pci/devices/0000\:01\:00.0/driver/module/version
  - Example:

```
rexroot@ctrlX-CORE:~$ cat /sys/bus/pci/devices/0000\:01\:00.0/driver/module/version
4.15.0
```

    - Note: PCI address of previous scanned device to be used

- **Note: Driver version in kernel has to match to used HailoRT-CLI version otherwise no access to module!**

ctrlX COREplus X3/X5/X7 – AI-Module

Check Module FW version

- **Check for FW version on Hailo module**
  - sudo hailo-integrationtool.hailortcli fw-control identify
  - Example:

```
rexroot@ctrlX-CORE:~$ sudo hailo-integrationtool.hailortcli fw-control identify
Executing on device: 0000:01:00.0
Identifying board
Control Protocol Version: 2
Firmware Version: 4.15.0 (release,app,extended context switch buffer)
Logger Version: 0
Board Name: Hailo-8
Device Architecture: HAILO8
Serial Number: HLLWM2B225101603
Part Number: HM218B1C2FAE
Product Name: HAILO-8 AI ACC M.2 M KEY MODULE EXT TEMP
```

    - Note: command “hailo-integrationtool.hailortcli” is depending to your created snap
    - Note: command can only be applied as superuser (“sudo”)

- **Note: The FW version of the module is implemented in Linux driver and will automatically be updated on Hailo module when newer version of HailoRT applied.**

rexroth
A Bosch Company

ctrlX COREplus X3/X5/X7 – AI-Module

Run .hef File

- **Run .hef File to perform operations on Hailo module**
  - sudo hailo-integrationtool.hailortcli run ./96.hef –measure-temp –measure-current –t 10
  - Example:

```
rexroot@ctrlX-CORE:~$ sudo hailo-integrationtool.hailortcli run ./96.hef --measure-temp --measure-current -t 10
Running streaming inference (./96.hef):
  Transform data: true
    Type:      auto
    Quantized: true
[HailoRT] [warning] Using the overcurrent protection dvm for power measurement will disable the overcurrent protection.
If only taking one measurement, the protection will resume automatically.
If doing continuous measurement, to enable overcurrent protection again you have to stop the power measurement on this dvm.
Network 96/96: 100% | 405 | FPS: 40.44 | ETA: 00:00:00
> Inference result:
 Network group: 96
    Frames count: 405
    FPS: 40.44
    Send Rate: 876.64 Mbit/s
    Recv Rate: 876.64 Mbit/s

  Device: 0000:01:00.0
    Minimum current consumption: 1978.53 mA
    Average current consumption: 2105.16 mA
    Maximum current consumption: 2130.02 mA
    Minimum chip temperature: 44.2717C
    Average chip temperature: 53.2409C
    Maximum chip temperature: 56.9436C
```

    - Note: command “hailo-integrationtool.hailortcli” is depending to your created snap
    - Note: command can only be applied as superuser (“sudo”)
    - The 96.hef is an example file from Hailo which creates defined load.
      - “—measure-temp” => readout the temperature of the module
      - “—measure-current” => readout the current value of the module
      - “-t 10” => defines test time of 10sec

rexroth
A Bosch Company

ctrlX COREplus X3/X5/X7 – AI-Module

Read Temperature configuration

- **Readout configured temperature thresholds of Hailo module**
  - sudo hailo-integrationtool.hailortcli fw-config read
  - Example:

```
rexroot@ctrlX-CORE:~$ sudo hailo-integrationtool.hailortcli fw-config read
Executing on device: 0000:01:00.0
{
    "system": {
        "name": "Hailo-8",
        "temperature_throttling_enable": true,
        "temperature_orange_threshold": 116,
        "temperature_orange_hysteresis_threshold": 110,
        "temperature_red_threshold": 116,
        "temperature_red_hysteresis_threshold": 110,
        "temperature_parameters_source": {
            "value": "USER CONFIG VALUES"
        }
    }
}
```

  - Note: command “hailo-integrationtool.hailortcli” is depending to your created snap
  - Note: command can only be applied as superuser (“sudo”)
  - There are 2 different temperature zones defined which in defined ambient temperature range for ctrlX devices never should be reached.

rexroth
A Bosch Company