Første steg V2.10.0~pre0~refs-pull-3178-merge~b75a7eaf36, 09 Oct 2023

Innhold

LinuxCNC-laget

Denne håndboken er under utvikling. Hvis du kan bidra med skriving, redigering eller grafisk utforming ta kontakt med et medlem av skribentgruppen eller abonner på og send epost til emc-users@lists.sourc

Kapittel 1

About LinuxCNC

1.1 Programvaren

- LinuxCNC (Tidligere kjent som ”Enhanced Machine Control - EMC”) er et programvaresystem for datastyring av maskinverktøy som fresemaskiner og dreiebenker, roboter (som Puma og Scara) samt andre datastyrte maskiner opp til 9 akser.
- LinuxCNC er fri programvare med åpen kildekode. Gjeldende versjoner av LinuxCNC er i sin helhet lisensiert under GNU General Public License og Lesser GNU General Public License (GPL og LGPL).
- LinuxCNC tilbyr:
  - enkelt å gjøre seg kjent med og teste uten installasjon med en kjørbar CD,
  - enkel installasjon fra den kjørbare CD-en,
  - enkelt å bruke grafiske oppsettassistenter for å raskt lage oppsett spesifikk for maskinen,
  - direkte tilgjengelig som en vanlig pakke i de siste utgavene av Debian (fra og med Bookworm) og Ubuntu (fra og med Kinetic Kudu),
  - et grafisk brukergrensesnitt (til og med flere grensesnitt å velge blant),
  - et grafisk verktøy for å lage grafiske grensesnitt (Glade),
  - en tolker for *G-kode* (maskinverktøyprogrammeringsspråket RS-274),
  - a realtime motion planning system with look-ahead,
  - styring av lavnivå maskinelektronikk som sensorer og motorkontrollere,
  - an easy to use *breadboard* layer for quickly creating a unique configuration for your machine,
  - en programvare-PLA programmerbar med PLA-diagram.
- LinuxCNC tilbyr ikke funksjoner for tegning (DAK - dataassistert konstruksjon) eller å lage G-kode fra tegninger (DAP - dataassistert produksjon).
- LinuxCNC kan bevege opp til 9 akser samtidig og støtter en rekke grensesnitt.
- Kontrolleren kan håndere ekte servoer (analog eller PWM) med lukket tilbakemeldingssløyfe i LinuxCNC-programvaren på datamaskinen, eller åpen sløyfe med trinnservoer eller steppermotorer.
- Motion control features include: cutter radius and length compensation, path deviation limited to a specified tolerance, lathe threading, synchronized axis motion, adaptive feedrate, operator feed override, and constant velocity control.
- Støtte for ikke-kartesiske bevegelsessystemer tilbys via tilpassede kinematikk-moduler. Tilgjengelige arkitekturer inkluderer heksapoder (Stewardplatformer og lignende konsepter) og systemer med roterende ledd som kan beveges slik som PUMA- eller SCARE-roboter.
- LinuxCNC kjører på Linux med sanntidsutvidelser.

1.2 Operativsystemet

LinuxCNC er tilgjengelig som pakker klare til bruk for Ubuntu- og Debian-distribusjonene.

1.3 Getting Help

1.3.1 IRC

IRC står for Internet Relay Chat. Det er en direkte forbindelse til andre LinuxCNC-brukere. IRC-kanalen for LinuxCNC er #linuxcnc på libera.chat.

Den enkleste måten å komme på IRC er å bruke den innebygde nettleserklienten fra libera.

Litt IRC-etikette

- Still spesifikke spørsmål… Unngå spørsmål som «Kan noen hjelpe meg?».
- Hvis du er helt ny med alt dette, tenk gjennom spørsmålet ditt før du skriver det ned. Sikre at du oppgir nok informasjon til at det er mulig å forstå og svare på spørsmålet ditt.
- Ha litt tålmodighet når du venter på et svar. Noen ganger tar det litt tid å formulere et svar, eller alle kan være opptatt med å jobbe eller noe annet.
- Sett opp IRC-kontoen din med ditt unike navn slik at folk kan vite hvem du er. Hvis du bruker en javaklient, bruk det samme brukernavnet hver gang du logger inn. Dette hjelper folk å huske hvem du er samt at mange vil huske tidligere diskusjoner, noe som sparer tid for alle parter.

Fildeling

Den vanligste måten å dele filer på IRC er å laste opp filen til en av følgende eller tilsvarende tjenester og lime inn lenken:

- *For tekst*: https://pastebin.com/, https://gist.github.com/, https://0bin.net/, https://paste.debian.net/-
- *For bilder*: https://imagebin.org/, https://imgur.com/, https://bayimg.com/
- *For filer*: https://filedropper.com/, https://filefactory.com/, https://1fichier.com/

1.3.2 Epostlister

En epostliste på Internett er en måte å legge ut spørsmål som alle på den listen kan se og svare på når det passer dem. Du får større eksponering for dine spørsmål på en epostliste enn på IRC, men det kan ta lengre tid å få svar. Kort sagt så sender du en epost til listen og får enten daglige oppsummeringer eller individuelle svar tilbake, alt etter hvordan du har satt opp kontoen din.

Du kan abonnere på epostlisten emc-users via https://lists.sourceforge.net/lists/listinfo/emc-users.

1.3.3 Nettsideforum

En kan finne et nettsideforum på https://forum.linuxcnc.org/ eller ved å følge lenken på toppen av hjemmesiden https://linuxcnc.org/.

Dette er ganske aktivt, men demografien heller mer mot brukere enn epostlisten. Hvis du vil sikre at meldingen din blir sett av utviklerne, så bør en foretrekke epostlisten.

1.3.4 LinuxCNC-wiki

Et wikinettsted er et brukervedlikeholdt nettsted der enhver kan legge til eller endre.

Det brukervedlikeholdte LinuxCNC-wikinettstedet inneholder en overflod av informasjon og tips på https://wiki.linuxcnc.org/.

1.3.5 Feilrapporter

Rapporter feil til LinuxCNC github feilhåndtering.

Kapittel 2

System Requirements

2.1 Minimumskrav

Minimumssystemet for å kjøre LinuxCNC og Debian/Ubuntu kan variere avhengig av konkret bruk. Steppersystemer trenger generelt raskere tråder for å lage stegpulser enn servosystemer. Du kan bruke den kjørbare CD-en for å teste programvaren før du permanent installerer det på en datamaskin. Husk at tallene fra Latency Test er viktigere enn prosessorhastigheten for å lage steg med programvare Mer informasjon om Latency Test er tilgjengelig her. I tillegg trenger LinuxCNC å kjøre på et operativsystem som bruker en endre kjerne, se kjerne- og versjonskrav.

Mer informasjon finner du på wikisiden for LinuxCNC: Maskinvarekrav

LinuxCNC og Debian Linux bør kjøre rimelig greit på en datamaskin med følgende minimumsmaskinvarespesifikasjon. Disse tallene er ikke absolutte minimum, men gir rimelig ytelse for de fleste stegmotorsystemer.

- 700 MHz x86 prosessor (anbefalt 1.2 GHz x86 prosessor) eller Raspberry Pi 4 eller bedre.
- LinuxCNC 2.8 og senere fra den kjørbare CD-en forventer et system som håndterer 64-bit.
- 512 MB med RAM, 4 GB med grafisk brukergrensesnitt for å unngå overraskelser
- Ingen harddisk for kjørbar CD, 8 GB eller mer for permanent installasjon
- Grafikkort som kan levere oppløsning på minst 1024x768, og som ikke bruker de godseide driverne til NVidia eller ATI fglrx. Moderne innbakte grafikkbrikker ser generelt ut til å være OK.
- Internett-forbindelse (ikke strengt nødvendig, men veldig nyttig for oppdateringer og for å kommunisere med LinuxCNC-fellesskapet)

Minimumskravene for maskinvare endres etter hvert som Linuxdistribusjonene utvikler seg, så sjekk Debian-nettstedet for detaljer om den kjørbare CD-en som du bruker. Eldre maskinvare fungere bedre med eldre versjoner av den kjørbare CD-en hvis det finnes.

If you plan not to rely on the distribution of readily executable programs (”binaries”) and/or aim at contributing to the source tree of LinuxCNC, then there is a good chance you want a second computer to perform the compilation. Even though LinuxCNC and your developments could likely be executed at the same time with respect to disk space, RAM and even CPU speed, a machine that is busy will have worse latencies, so you are unlikely to compile your source tree and produce chips at the same time.

2.2 Kjerne- og versjonskrav

LinuxCNC krever en kjerne tilpasset for sanntidsbruk for å kontrollere ekte maskinvare. Derimot kan den kjøre på en vanlig kjerne i simuleringsmodus når formålet er å sjekke G-kode, teste oppsettfiler og lære systemet å kjenne. For bruk med disse kjerneversjonene så distribueres to utgaver av LinuxCNC. Pakkenavnene er «linuxcnc» og «linuxcnc-uspace».

Sanntidskjernevalgene er preempt-rt, RTAI og Xenomai.

Du kan finne kjerneversjonen for ditt system med kommandoen:

```
uname -a
```

Hvis du ser (som over) `-rt` i kjernenavnet så kjører du en «preemt-rt»-kjerne og bør installere «uspace»-utgaven av LinuxCNC. Du bør også installere denne for simulert oppsett på ikkesanntidskjerner.

Hvis du ser `-rtai-` i kjernenavnet så kjører du med RTAI-sanntidssystem. Se under om hvilken LinuxCNC-versjon å installere.

2.2.1 «Preemt-RT» med «linuxcnc-uspace»-pakke

Preempt-RT er det nyeste av sanntidssystemene, og også den versjonen som er nærmest offisiell kjerne. Preempt-RT-kjerner er tilgjengelige som forhåndsbygde pakker fra hovedpakkedepotene. Søkeordet «PREEMPT_RT» finner dem, og de kan lastes ned og installeres som enhver annen pakke. Preempt-RT vil vanligvis ha best driverstøtte og er eneste valg for systemer som bruker Mesa ethernet-tilkoblede maskindriverkort. Vanligvis har preempt-rt størst forsinkelse blant de tilgjengelige systemene, men det finnes unntak.

2.2.2 RTAI med «linuxcnc»-pakke

RTAI har vært hovedaktøren i LinuxCNC-distribusjoner i mange år. Den vil vanligvis gi best sanntidsytelse når det gjelder kort forsinkelse, men kan ha dårligere støtte for ekstrautstyr og dårligere skjermoppløsning. En RTAI-kjerne er tilgjengelig fra LinuxCNC-pakkedepotet. Hvis du installerer fra kjørbart/installerings-avtrykk, så finner du bytte av kjerne og LinuxCNC-variant beskrevet i [Installing-RTAI].

2.2.3 Xenomai med «linuxcnc-uspace»-pakke

Zenomai er også støttet, men du må finne eller bygge kjernen og bygge LinuxCNC fra kildekode for å ta det i bruk.

2.2.4 RTAI med *linuxcnc-uspace*-pakke

Det er også mulig a kjøre LinuxCNC med RTAI i brukerlandmodus. Som med Xenomai må du bygge fra kildekode for å gjøre dette.

2.3 Problematisk maskinvare

2.3.1 Bærbare

Bærbare er generelt ikke egnet for programvarebasert steggenerering i sanntid. Igjen vil en lengre kjøring av Latency Test gi deg kunnskapen du trenger for å vurdere egnethet.

2.3.2 Skjermkort

Hvis installasjonen din dukker opp med skjermoppløsning på 800 x 600, så har Debian mest sannsynlig ikke kjent igjen skjermkortet eller skjermen din. En kan noen ganger jobbe seg rundt dette ved å installere drivere eller lage / endre på Xorg.conf-filer.

Kapittel 3

Skaffe LinuxCNC

This section describes the recommended way to download and make a fresh install of LinuxCNC. There are also Alternate Install Methods for the adventurous. If you have an existing install that you want to upgrade, go to the Updating LinuxCNC section instead.

Merk
To operate machinery LinuxCNC requires a special kernel with real-time extensions. There are three possibilities here: preempt-rt, RTAI or Xenomai. In addition there are two versions of LinuxCNC which work with these kernels. See the table below for details. However for code testing and simulation it is possible to run the `linuxcnc-uspace` application on a stock kernel of the distribution.

Fresh installs of LinuxCNC are most easily created using the Live/Install Image. This is a hybrid ISO filesystem image that can be written to a USB storage device or a DVD and used to boot a computer. At boot time you will be given a choice of booting the ”Live” system (to run LinuxCNC without making any permanent changes to your computer) or booting the Installer (to install LinuxCNC and its operating system onto your computer’s hard drive).

Rammen for prosessen ser slik ut:

1. Last ned kjørtbart/installeringsavtrykk.
2. Skriv avtrykket til en USB-lagringsenhet eller DVD.
3. Start opp det kjørbare systemet for å teste ut LinuxCNC.
4. Start opp installasjonen for å installere LinuxCNC.

3.1 Last ned avtrykket

This section describes some methods for downloading the Live/Install image.

3.1.1 Normal nedlasting

Software for LinuxCNC to download is presented on the project’s Downloads page. Most users will aim for the disk image for Intel/AMD PCs, the URL will resemble https://www.linuxcnc.org/iso/linuxcnc_2.9.2-amd64.hybrid.iso.

For the Raspberry Pi, multiple images are provided to address differences between the RPi4 and RPi5.

Merk
Do not use the regular Raspbian distribution for LinuxCNC that may have shipped with your RPi starter kit - that will not have the real-time kernel and you cannot migrate from Raspbian to Debian's kernel image.

3.1.2 Last ned med zsync

zsync is a download application that efficiently resumes interrupted downloads and efficiently transfers large files with small modifications (if you have an older local copy). Use zsync if you have trouble downloading the image using the Normal Download method.

zsync i Linux

1. Installer zsync med Synaptic eller, ved å kjøre følgende i en terminal

```
sudo apt-get install zsync
```

2. Kjør så denne kommandoen for å laste ned iso-en til din datamaskin

```
zsync https://www.linuxcnc.org/iso/linuxcnc_2.9.2-amd64.hybrid.iso
```

zsync på Windows Det finnes en Windows-utgave av zsync. Den virker som et konsoll-program og kan lastes ned fra https://www.assembla.com/spaces/zsync-windows/documents .

3.1.3 Kontroller avtrykket

(Dette steget er ikke nødvendig hvis du bruker zsync)

1. Etter nedlasting, kontroller sjekksummen til avtrykket for å sikre dets integritet.

```
md5sum linuxcnc-2.9.2-amd64.iso
```

or

```
sha256sum linuxcnc-2.9.2-amd64.iso
```

1. Sammenlign deretter disse sjekksummene

```
amd64 (PC)
md5sum: 1815aceaac0e7861747aa34d61846e79
sha256sum: 08b3f59233e47c91cf1c9a85c41df48542c97b134efefa7446d3060c9a3e644b
arm64 (Pi)
md5sum: 4547e8a72433efb033f0a5cf166a5cd2
sha256sum: ff3ba9b8dfb93baf1e2232746655f8521a606bc0fab91bffc04ba74cc3be6bf0
```

Kontroller md5sum på Windows eller Mac Windows and Mac OS X do not come with an md5sum program, but there are alternatives. More information can be found at: How To MD5SUM

3.2 Skriv avtrykket til en startbar enhet

The LinuxCNC Live/Install ISO Image is a hybrid ISO image which can be written directly to a USB storage device (flash drive) or a DVD and used to boot a computer. The image is too large to fit on a CD.

3.2.1 Raspberry Pi-avtrykk

The Raspberry Pi image is a complete SD card image and should be written to an SD card with the Raspberry Pi Imager App.

3.2.2 AMD-64 (x86-64, PC) Image using GUI tools

Download and install Balena Etcher from https://etcher.balena.io/#download-etcher (Linux, Windows, Mac) and write the downloaded image to a USB drive.

If your image fails to boot then please also try Rufus. It looks more complicated but seems to be more compatible with various BIOSes.

3.2.3 Kommandolinje - Linux

1. Koble til en USB-lagringsenhet (for eksempel en flashdisk eller minnepinne).
2. Finn enhetsfilen som tilsvarer USB-flashdisken. Denne informasjonen kan finnes ved å se på utskriften fra å kjøre `dmesg` etter å ha koblet til enheten. `/proc/partitions` kan også være nyttig.
3. Bruk `dd`-kommandoen til å skrive avtrykket til din USB-lagringsenhet. For eksempel, hvis din lagringsenhet dukket opp som `/dev/sde, bruk denne kommandoen:

```
dd if=linuxcnc_2.9.2-amd64.hybrid.iso of=/dev/sde
```

3.2.4 Kommandolinje - MacOS

1. Open a terminal and type

```
diskutil list
```

2. Insert the USB and note the name of the new disk that appears, e.g. /dev/disk5.
3. Unmount the USB. The number found above should be substituted in place of the N.

```
diskutil unmountDisk /dev/diskN
```

4. Transfer the data with dd, as for Linux above. Note that the disk name has an added ”r” at the beginning.

```
sudo dd if=/linuxcnc_2.9.2-amd64.hybrid.iso of=/dev/rdiskN bs=1m
```

5. Note that this may take a long time to complete and there will be no feedback during the process.

Writing the image to a DVD in Linux

1. Insert a blank DVD into your burner. A *CD/DVD Creator* or *Choose Disc Type* window will pop up. Close this, as we will not be using it.
2. Browse to the downloaded image in the file browser.
3. Right click on the ISO image file and choose Write to Disc.
4. Select the write speed. It is recommended that you write at the lowest possible speed.
5. Start the burning process.

6. If a *choose a file name for the disc image* window pops up, just pick OK.

Writing the image to a DVD in Windows

1. Download and install Infra Recorder, a free and open source image burning program: https://infrarecord
   .
2. Insert a blank CD in the drive and select Do nothing or Cancel if an auto-run dialog pops up.
3. Open Infra Recorder, and select the *Actions* menu, then *Burn image*.

Writing the image to a DVD in Mac OSX

1. Download the .iso file
2. Right-click on the file in the Finder window and select ”Burn to disc”. (The option to burn to disc will only appear if the machine has an optical drive fitted or connected.)

3.3 LinuxCNC-testing

With the USB storage device plugged in or the DVD in the DVD drive, shut down the computer then turn the computer back on. This will boot the computer from the Live/Install Image and choose the Live boot option.

Merk
If the system does not boot from the DVD or USB stick, it may be necessary to change the boot order in the PC BIOS.

Once the computer has booted up you can try out LinuxCNC without installing it. You can not create custom configurations or modify most system settings in a Live session, but you can (and should) run the latency test.

To try out LinuxCNC: from the Applications/CNC menu pick LinuxCNC. A dialog box will open from which you can choose one of many sample configurations. At this point it only really makes sense to pick a ”sim” configuration. Some of the sample configurations include onscreen 3D simulated machines, look for ”Vismach” to see these.

To see if your computer is suitable for software step pulse generation run the Latency Test as shown here.

At the time of writing the Live Image is only available with the preempt-rt kernel and a matching LinuxCNC. On some hardware this might not offer good enough latency. There is an experimental version available using the RTAI realtime kernel which will often give better latency.

3.4 Installing LinuxCNC

To install LinuxCNC from the Live CD select *Install (Graphical)* at bootup.

3.5 Updates to LinuxCNC

With the normal install the Update Manager will notify you of updates to LinuxCNC when you go on line and allow you to easily upgrade with no Linux knowledge needed. It is OK to upgrade everything except the operating system when asked to.

Advarsel
Do not upgrade the operating system to a new version if prompted to do so. You should accept OS *updates* however, especially security updates.

3.6 Install Problems

In rare cases you might have to reset the BIOS to default settings if during the Live CD install it cannot recognize the hard drive during the boot up.

3.7 Alternate Install Methods

The easiest, preferred way to install LinuxCNC is to use the Live/Install Image as described above. That method is as simple and reliable as we can make it, and is suitable for novice users and experienced users alike. However, this will typically replace any existing operating system. If you have files on the target PC that you want to keep, then use one of the methods described in this section.

In addition, for experienced users who are familiar with Debian system administration (finding install images, manipulating apt sources, changing kernel flavors, etc), new installs are supported on following platforms: (”amd64” means ”64-bit”, and is not specific to AMD processors, it will run on any 64-bit x86 system)

Distribusjon	Arkitektur	Kjerne	Pakkenavn	Typisk bruk
Debian Bookworm	amd64 & arm64	preempt-rt	linuxcnc-uspace	maskinstyring og simulering
Debian Bookworm	amd64	RTAI	linuxcnc	machine control
Debian Bullseye	amd64	preempt-rt	linuxcnc-uspace	maskinstyring og simulering
Debian Buster	amd64 & arm64	preempt-rt	linuxcnc-uspace	maskinstyring og simulering
Debian Buster	amd64	RTAI	linuxcnc	machine control
Any	Any	Vanlig	linuxcnc-uspace	simulation ONLY

Merk
LinuxCNC v2.9 is not supported on Debian 9 or older.

Preempt-RT kernels The Preempt-rt kernels are available for Debian from the regular debian.org archive. The package is called `linux-image-rt-*`. Simply install the package in the same way as any other package from the Synaptic Package manager or with apt-get at the command-line.

RTAI Kernels The RTAI kernels are available for download from the linuxcnc.org debian archive. The apt source is:

- Debian Bookworm: `deb https://linuxcnc.org bookworm base`
- Debian Bullseye: `deb https://linuxcnc.org bullseye base`
- Debian Buster: `deb https://linuxcnc.org buster base`

LinuxCNC and the RTAI kernel are now only available for 64-bit OSes but there are very few surviving systems that can not run a 64-bit OS.

3.7.1 Installing on Debian Bookworm (with Preempt-RT kernel)

1. Install Debian Bookworm (Debian 12), amd64 version. You can download the installer here: https://www.debian.org/distrib/
2. After burning the iso and booting up if you don't want Gnome desktop select *Advanced Options > Alternative desktop environments* and pick the one you like. Then select *Install* or *Graphical Install*.

   Advarsel
   Do not enter a root password, if you do sudo is disabled and you won't be able to complete the following steps.

3. Run the following in a terminal to bring the machine up to date with the latest packages.

   ```
   sudo apt-get update
   sudo apt-get dist-upgrade
   ```

   Merk
   It is possible to download a version of LinuxCNC directly from Debian but this will install an old pre-release version, and is not recommended at this time.

4. Install the Preempt-RT kernel and modules

   ```
   sudo apt-get install linux-image-rt-amd64
   ```

5. Re-boot, and select the Linux 6.1.0-10-rt-amd64 kernel. The exact kernel version might be different, look for the "-rt" suffix. This might be hidden in the "Advanced options for Debian Bookworm" sub-menu in Grub. When you log in, verify that `PREEMPT RT` is reported by the following command.

   ```
   uname -v
   ```

6. Open Applications Menu > System > Synaptic Package Manager search for *linux-image* and right click on the original non-rt and select *Mark for Complete Removal*. Reboot. This is to force the system to boot from the RT kernel. If you prefer to retain both kernels then the other kernels need not be deleted, but grub boot configuration changes will be needed beyond the scope of this document.
7. Add the LinuxCNC Archive Signing Key to your apt keyring by downloading [the LinuxCNC installer script](https://www.linuxcnc.org/linuxcnc-install.sh). You will need to make the script executable to run it:

   ```
   chmod +x linuxcnc-install.sh
   ```

   Then you can run the installer:

   ```
   sudo ./linuxcnc-install.sh
   ```

3.7.2 Installing on Debian Bookworm (with experimental RTAI kernel)

1. This kernel and LinuxCNC version can be installed on top of the Live DVD install, or alternatively on a fresh Install of Debian Bookworm 64-bit as described above.
2. You can add the LinuxCNC archive signing key and repository information by downloading and running the installer script as described above. If an RTAI kernel is detected it will stop before installing any packages.
3. Update the package list from linuxcnc.org

```
sudo apt-get update
```

4. Install the new realtime kernel, RTAI and the RTAI-version of LinuxCNC.

```
sudo apt-get install linuxcnc
```

Reboot the machine, ensuring that the system boots from the new 5.4.258-rtai kernel.

3.7.3 Installing on Raspbian 12

Don’t do that. The latencies are too bad with the default kernel and the PREEMPT_RT (the RT is important) kernel of Debian does not boot on the Pi (as of 1/2024). Please refer to the .iso images provided online on the regular LinuCNC download page. You can create them yourself following the scripts provided online.

Kapittel 4

Running LinuxCNC

4.1 LinuxCNC-oppstart

After installation, LinuxCNC starts just like any other Linux program: run it from the terminal by issuing the command *linuxcnc*, or select it in the *Applications -> CNC* menu.

4.2 Configuration Launcher

When starting LinuxCNC (from the CNC menu or from the command line without specifying an INI file) the Configuration Selector dialog starts.

The Configuration Selector dialog allows the user to pick one of their existing configurations (My Configurations) or select a new one (from the Sample Configurations) to be copied to their home directory. Copied configurations will appear under My Configurations on the next invocation of the Configuration Selector.

The Configuration Selector offers a selection of configurations organized:

- *My Configurations* - User configurations located in linuxcnc/configs in your home directory.
- *Sample Configurations* - Sample configurations, when selected, are copied to linuxcnc/configs. Once a sample configuration was copied to your local directory, the launcher will offer it as *My Configurations*. The names under which these local configurations are presented correspond to the names of the directories within the configs/ directory:
  - *sim* - Configurations that include simulated hardware. These can be used for testing or learning how LinuxCNC works.
  - *by_interface* - Configurations organized by GUI.
  - *by_machine* - Oppsett organisert etter maskin.
  - *apps* - Applications that do not require starting linuxcnc but may be useful for testing or trying applications like PyVCP or GladeVCP.
  - *attic* - Obsolete or historical configurations.

The sim configurations are often the most useful starting point for new users and are organized around supported GUIs:

- *axis* - Keyboard and Mouse GUI
- *craftsman* - Touch Screen GUI (no longer maintained ???)

- *gmoccapy* - Touch Screen GUI
- *gscreen* - Touch Screen GUI
- *pyvcp_demo* - Python Virtual Control Panel
- *qtaxis* - Touch Screen GUI, axis lookalike
- *qtdragon* - Touch Screen GUI
- *qtdragon_hd* - Touch Screen GUI, high definition
- *qtplasmac* - Touch Screen GUI, for plasma tables
- *qttouchy* - Touch Screen GUI
- *tklinuxcnc* - Keyboard and Mouse GUI (no longer maintained)
- *touchy* - Touch Screen GUI
- *woodpecker* - Touch Screen GUI

A GUI configuration directory may contain subdirectories with configurations that illustrate special situations or the embedding of other applications.

The *by_interface* configurations are organized around common, supported interfaces like:

- general mechatronics
- mesa
- parport
- pico
- pluto
- servotogo
- vigilant
- vitalsystems

Related hardware may be required to use these configurations as starting points for a system.

by_machine-oppsett er organisert rundt komplette kjente systemer som:

- boss
- cooltool
- scortbot erIII
- sherline
- smithy
- tormach

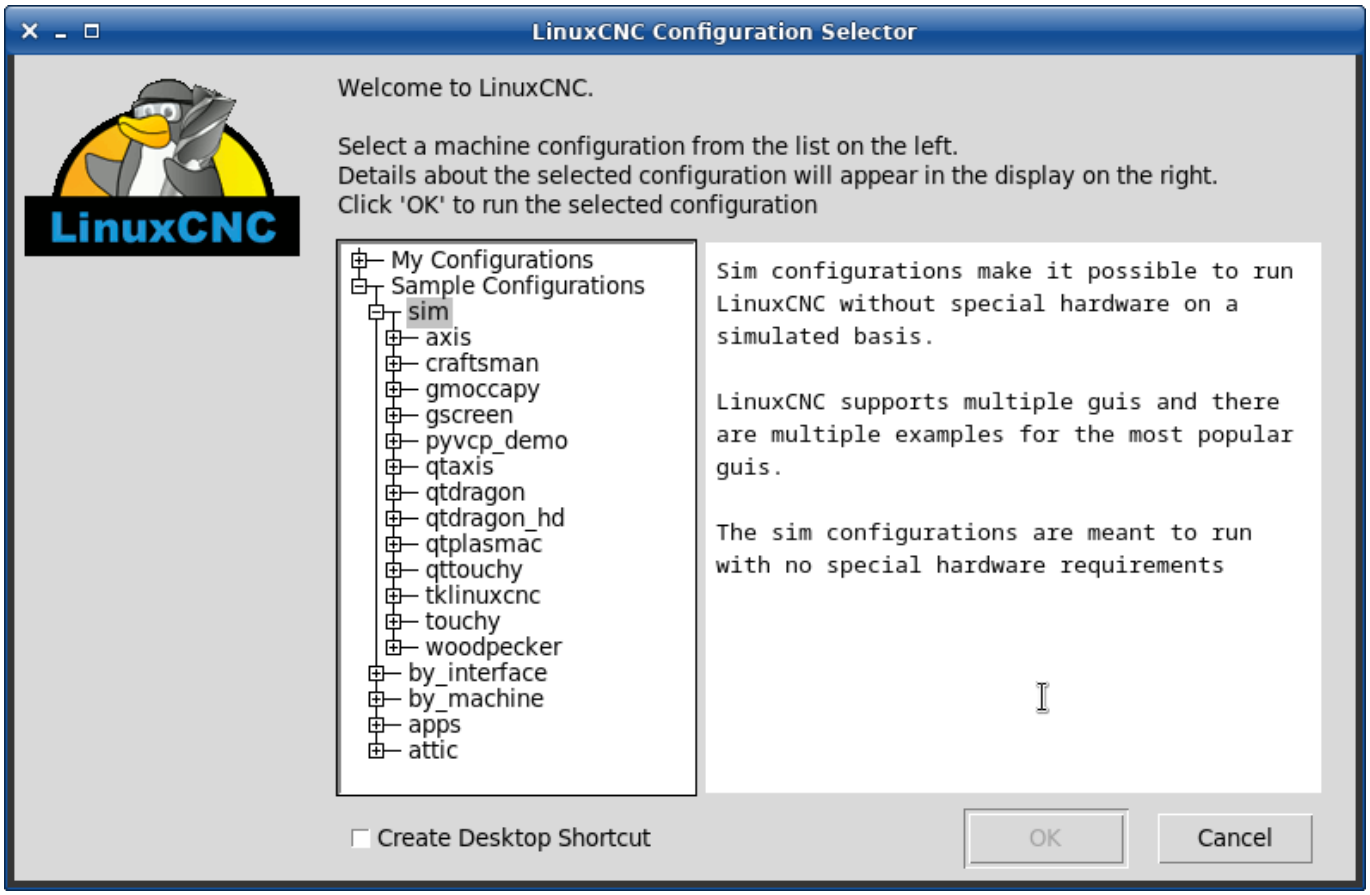
A complete system may be required to use these configurations.

The *apps items* are typically either:

1. utilities that don’t require starting linuxcnc
2. demonstrations of applications that can be used with linuxcnc

- info - creates a file with system information that may be useful for problem diagnosis.
- gladevcp - Example GladeVCP applications.
- halrun - Starts halrun in an terminal.
- latency - Applications to investigate latency
  - latency-histogram-1 - histogram for single servo thread
  - latency-histogram - histogram
  - latency-test - standard test
  - latency-plot - stripchart
- parport - Applications to test parport.
- pyvcp - Example pyvcp applications.
- xhc-hb04 - Applications to test an xhc-hb04 USB wireless MPG

Merk
Under the Apps directory, only applications that are usefully modified by the user are offered for copying to the user's directory.



Figur 4.1: LinuxCNC Configuration Selector

Click any of the listed configurations to display specific information about it. Double-click a configuration or click OK to start the configuration.

Select *Create Desktop Shortcut* and then click *OK* to add an icon on the Ubuntu desktop to directly launch this configuration without showing the Configuration Selector screen.

When you select a configuration from the Sample Configurations section, it will automatically place a copy of that config in the ~/linuxcnc/configs directory.

4.3 Next steps in configuration

After finding the sample configuration that uses the same interface hardware as your machine (or a simulator configuration), and saving a copy to your home directory, you can customize it according to the details of your machine. Refer to the Integrator Manual for topics on configuration.

4.4 Simulator Configurations

All configurations listed under Sample Configurations/sim are intended to run on any computer. No specific hardware is required and real-time support is not needed.

These configurations are useful for studying individual capabilities or options. The sim configurations are organized according to the graphical user interface used in the demonstration. The directory for axis contains the most choices and subdirectories because it is the most tested GUI. The capabilities demonstrated with any specific GUI may be available in other GUIs as well.

4.5 Oppsettressurser

The Configuration Selector copies all files needed for a configuration to a new subdirectory of ~/linuxcnc/configs (equivalently: /home/username/linuxcnc/configs). Each created directory will include at least one INI file (iniflename.ini) that is used to describe a specific configuration.

File resources within the copied directory will typically include one or more INI file (filename.ini) for related configurations and a tool table file (toolfilename.tbl). Additionally, resources may include HAL files (filename.hal, filename.tcl), a README file for describing the directory, and configuration specific information in a text file named after a specific configuration (inifilename.txt). That latter two files are displayed when using the Configuration Selector.

The supplied sample configurations may specify the parameter HALFILE (filename.hal) in the configuration INI file that are not present in the copied directory because they are found in the system HAL file library. These files can be copied to the user configuration directory and altered as required by the user for modification or test. Since the user configuration directory is searched first when finding HAL files, local modifications will then prevail.

The Configuration selector makes a symbolic link in the user configuration directory (named hallib) that points to the system HAL file library. This link simplifies copying a library file. For example, to copy the library core_sim.hal file in order to make local modifications:

```
cd ~/linuxcnc/configs/name_of_configuration
cp hallib/core_sim.hal core_sim.hal
```

Kapittel 5

Updating LinuxCNC

Oppdatering av LinuxCNC til en ny mindre oppdatering (med andre ord, en ny versjon i samme stabile serie, for eksempel fra 2.9.1 til 2.9.2) er en automatisk prosess hvis din PC er koblet til Internett. Du vil se en oppdateringsmelding etter en liten oppdatering sammen med andre programvareoppdateringer. Hvis du ikke har en Internett-forbindelse for PC-en din, se oppdatering uten nettverk.

5.1 Oppgradering til den nye versjonen

Dette avsnittet beskriver hvordan oppgradere LinuxCNC fra versjon 2.8.x til en 2.9.y-versjon. Den antar at du har en eksisterende 2.8-installasjon som du ønsker å oppdatere.

For å oppgradere LinuxCNC fra en versjon eldre enn 2.8 så må du først oppgradere din gamle installasjon til 2.8 og så følge disse instruksjonene for å oppgradere til den nye versjonen.

Hvis du ikke har en gammel versjon av LinuxCNC å oppgradere så er det bedre tjent med å installere en ny versjon som beskrevet i avsnittet Skaffe LinuxCNC.

I tillegg, hvis du kjører Ubuntu Precise eller Debian Wheezy så er det absolutt verdt å vurdere å ta en sikkerhetskopi av «linuxcnc»-mappen til flyttbart medie og gjennomføre en installasjon fra bunnen av med nyere OS og LinuxCNC-versjon, da disse utgivelsene nådde sin levetid i henholdsvis 2017 og 2018. Hvis du kjører Ubuntu Lucid så må du dette, da Lucid ikke lenger støttes av LinuxCNC (den nådde sin levetid i 2013).

For å oppgradere hovedversjoner som 2.8 til 2.9 når du har en nettforbindelse på maskinen, så må du koble ut de gamle linuxcnc.org-apt-kildene i filen /etc/apt/sources.list og legge til en ny linuxcnc.org-apt-kilde for 2.9 for så å oppgradere LinuxCNC.

Detaljene avhenger av hvilken platform du kjører på. Åpne en terminal, skriv så `lsb_release -ic` for å finne informasjon om dette:

```
lsb_release -ic
Distributor ID: Debian
Codename:       Buster
```

Du bør kjøre på Debian Buster, Bullseye eller Bookworm eller Ubuntu 20.04 ”Focal Fossa” eller nyere. LinuxCNC 2.9.y kjører ikke på eldre distribusjoner enn disse.

Du må også sjekke hvilken sanntidskjerne som brukes:

```
uname -r
6.1.0-10-rt-amd64
```

Hvis du ser (som over) `-rt` i kjernenavnet så kjører du en «preemt-rt»-kjerne og bør installere «uspace»-utgaven av LinuxCNC. Du bør også installere denne for simulert oppsett på ikkesanntidskjerner.

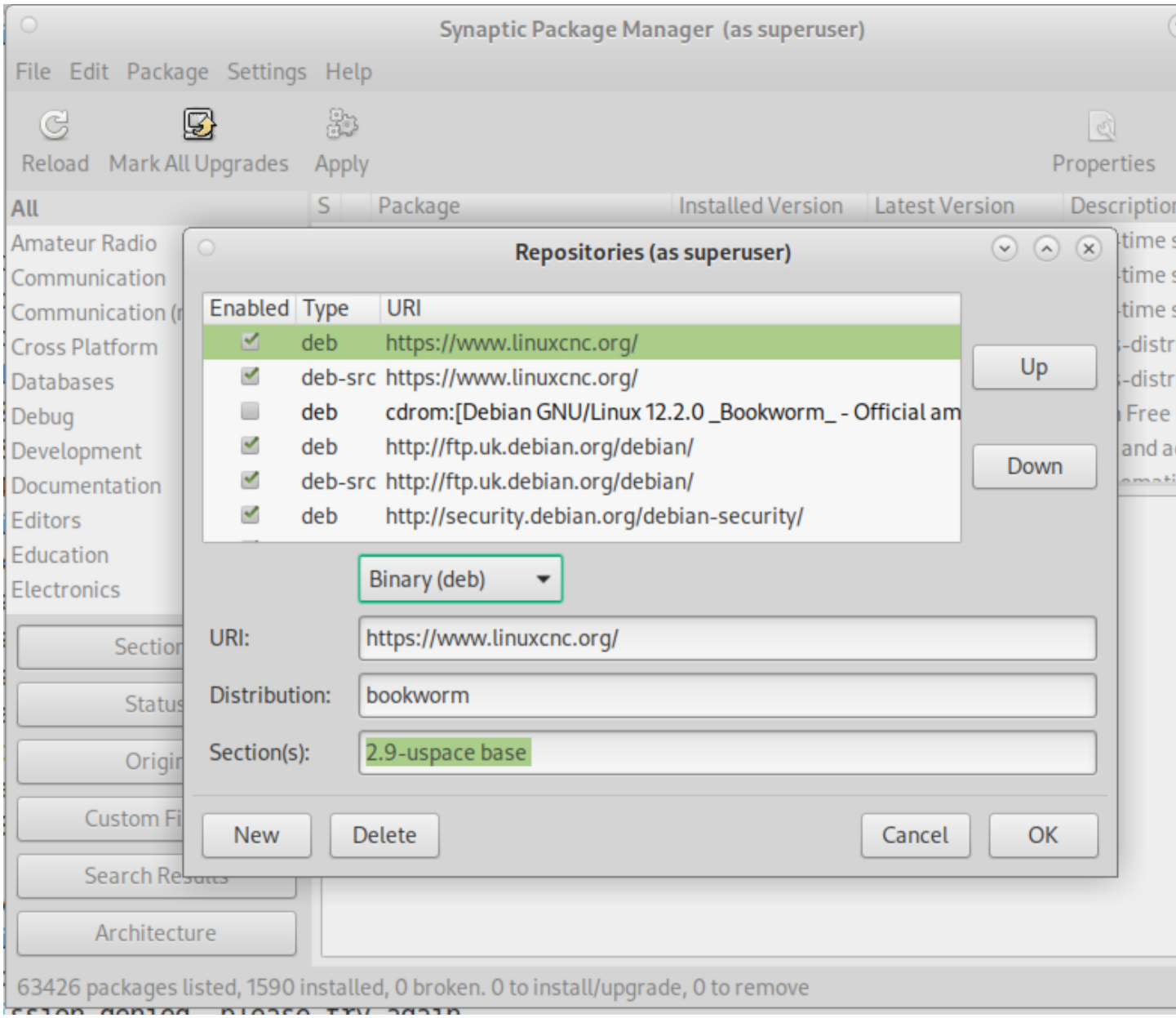
If you see `-rtai-` in the kernel name then you are running RTAI realtime. See below for the LinuxCNC version to install. RTAI packages are available for Bookworm and Buster but not currently for Bullseye.

5.1.1 Apt-kildeoppsett

- Åpne `Software Sources`-vinduet. Prosessen for å gjøre dette varierer litt på de tre støttede platformene:
  - Debian:
    * Klikk på `Applications Menu`, deretter `System`, så `Synaptic Package Manager`.
    * Klikk på `Oppsett`-menyen i Synaptic, klikk så på `Repositories` for å åpne `Software Sources`-vinduet.
  - Ubuntu Precise:
    * Click on the `Dash Home` icon in the top left.
    * In the `Search` field, type "software", then click on the `Ubuntu Software Center` icon.
    * In the Ubuntu Software Center window, click on the `Edit` menu, then click on `Software Sources...` to open the `Software Sources` window.
  - Ubuntu Lucid:
    * Click the `System` menu, then `Administration`, then `Synaptic Package Manager`.
    * In Synaptic, click on the `Settings` menu, then click on `Repositories` to open the `Software Sources` window.
- In the `Software Sources` window, select the `Other Software` tab.
- Delete or un-check all the old linuxcnc.org entries (leave all non-linuxcnc.org lines as they are).
- Click the `Add` button and add a new apt line. The line will be slightly different on the different platforms:

Tabell 5.1: Tabular overview on variants of the Operating System and the corresponding configuration of the repository. The configuration can be performed in the GUI of the package manager or in the file /etc/apt/sources.list.

OS / Sanntidsversjon	**Depot**
Debian Buster - preempt	`deb https://linuxcnc.org buster base 2.9-uspace`
Debian Buster - RTAI	`deb https://linuxcnc.org buster base 2.9-rt`
Debian Bullseye - preempt	`deb https://linuxcnc.org bullseye base 2.9-uspace`
Debian Bookworm - preempt	`deb https://linuxcnc.org bookworm base 2.9-uspace`
Debian Bookworm - RTAI	`deb https://linuxcnc.org bookworm base 2.9-rt`



Figur 5.1: Figur med et skjermbilde av depotoppsettet til pakkebestyreren Synaptic.

- Click `Add Source`, then `Close` in the Software Sources window. If it pops up a window informing you that the information about available software is out-of-date, click the `Reload` button.

5.1.2 Upgrading to the new version

Now your computer knows where to get the new version of the software, next we need to install it.

Igjen så er prosessen annerledes avhengig av platformen din.

5.1.2.1 Debian Buster, Bullseye og Bookworm

Debian uses the Synaptic Package Manager.

- Open Synaptic using the instructions in Setting apt sources above.
- Click the `Reload` button.
- Use the Search function to search for `linuxcnc`.
- The package is called ”linuxcnc” for RTAI kernels and ”linuxcnc-uspace” for preempt-rt.
- Click the check box to mark the new linuxcnc and linuxcnc-doc-* packages for upgrade. The package manager may select a number of additional packages to be installed, to satisfy dependencies that the new linuxcnc package has.
- Click the `Apply` button, and let your computer install the new package. The old linuxcnc package will be automatically upgraded to the new one.

5.1.3 Ubuntu

- Click on the `Dash Home` icon in the top left.
- In the `Search` field, type ”update”, then click on the `Update Manager` icon.
- Click the `Check` button to fetch the list of packages available.
- Click the `Install Updates` button to install the new versions of all packages.

5.2 Updating without Network

To update without a network connection you need to download the .deb then install it with dpkg. The .debs can be found in https://linuxcnc.org/dists/ .

You have to drill down from the above link to find the correct deb for your installation. Open a terminal and type in *lsb_release -ic* to find the release name of your OS.

```
> lsb_release -ic
Distributor ID: Debian
Codename:       bullseye
```

Pick the OS from the list then pick the major version you want like 2.9-rt for RTAI or 2.9-rtpreempt or 2.9-uspace for preempt-rt.

Next pick the type of computer you have: binary-amd64 for any 64-bit x86, binary-i386 for 32 bit, binary-armhf (32bit) or binary-arm64 (64bit) for Raspberry Pi.

Next pick the version you want from the bottom of the list like *linuxcnc-uspace_2.9.2_amd64.deb* (choose the latest by date). Download the deb and copy it to your home directory. You can rename the file to something a bit shorter with the file manager like *linuxcnc_2.9.2.deb* then open a terminal and install it with the package manager with this command:

```
sudo dpkg -i linuxcnc_2.9.2.deb
```

5.3 Oppdatering av oppsettfiler for 2.9

5.3.1 Stricter handling of pluggable interpreters

If you just run regular G-code and you don’t know what a pluggable interpreter is, then this section does not affect you.

A seldom-used feature of LinuxCNC is support for pluggable interpreters, controlled by the undocumented `[TASK]INTERPRETER` INI setting.

Versions of LinuxCNC before 2.9.0 used to handle an incorrect `[TASK]INTERPRETER` setting by automatically falling back to using the default G-code interpreter.

Since 2.9.0, an incorrect `[TASK]INTERPRETER` value will cause LinuxCNC to refuse to start up. Fix this condition by deleting the `[TASK]INTERPRETER` setting from your INI file, so that LinuxCNC will use the default G-code interpreter.

5.3.2 Canterp

If you just run regular G-code and you don't use the `canterp` pluggable interpreter, then this section does not affect you.

In the extremely unlikely event that you are using `canterp`, know that the module has moved from `/usr/lib/libcanterp.so` to `/usr/lib/linuxcnc/canterp.so`, and the `[TASK]INTERPRETER` setting correspondingly needs to change from `libcanterp.so` to `canterp.so`.

5.4 Updating Configuration Files (for 2.9.y)

No changes should be necessary to configuration files when moving from 2.8.x to 2.9.y.

5.4.1 Spindle limits in the INI

It is now possible to add settings to the [SPINDLE] section of the INI file

MAX_FORWARD_VELOCITY = 20000 The maximum spindle speed (in RPM)

MIN_FORWARD_VELOCITY = 3000 The minimum spindle speed (in RPM)

MAX_REVERSE_VELOCITY = 20000 This setting will default to MAX_FORWARD_VELOCITY if omitted.

MIN_REVERSE_VELOCITY = 3000` This setting is equivalent to MIN_FORWARD_VELOCITY but for reverse spindle rotation. It will default to the MIN_FORWARD_VELOCITY if omitted.

INCREMENT = 200 Sets the step size for spindle speed increment / decrement commands. This can have a different value for each spindle. This setting is effective with AXIS and Touchy but note that some control screens may handle things differently.

HOME_SEARCH_VELOCITY = 100 - Accepted but currently does nothing

HOME_SEQUENCE = 0 - Aksepteres men gjør for tiden ingen ting

5.5 Nye HAL-komponenter

5.5.1 Ikke-sanntid

mdro mqtt-publisher pi500_vfd pmx485-test qtplasmac-materials sim-torch svd-ps_vfd

5.5.2 Sanntid

anglejog div2 enum filter_kalman flipflop hal_parport homecomp limit_axis mesa_uart millturn scaled_s32_sums tof ton

5.6 Nye drivere

Et rammeverk for å kontrollere ModBus-enheter med serieporter på mange Mesakort har blitt introdusert. http://linuxcnc.org/docs/2.9/html/drivers/mesa_modbus.html

En ny GPIO-driver for enhver GPIO som støttes av gpiod-biblioteket er nå med: http://linuxcnc.org/-docs/2.9/html/drivers/hal_gpio.html

Kapittel 6

Glossary

A listing of terms and what they mean. Some terms have a general meaning and several additional meanings for users, installers, and developers.

Acme Screw
A type of lead-screw that uses an Acme thread form. Acme threads have somewhat lower friction and wear than simple triangular threads, but ball-screws are lower yet. Most manual machine tools use acme lead-screws.

Axis
One of the computer controlled movable parts of the machine. For a typical vertical mill, the table is the X axis, the saddle is the Y axis, and the quill or knee is the Z axis. Angular axes like rotary tables are referred to as A, B, and C. Additional linear axes relative to the tool are called U, V, and W respectively.

AXIS(GUI)
One of the Graphical User Interfaces available to users of LinuxCNC. It features the modern use of menus and mouse buttons while automating and hiding some of the more traditional LinuxCNC controls. It is the only open-source interface that displays the entire tool path as soon as a file is opened.

GMOCCAPY (GUI)
A Graphical User Interfaces available to users of LinuxCNC. It features the use and feel of an industrial control and can be used with touch screen, mouse and keyboard. It support embedded tabs and hal driven user messages, it offers a lot of hal beens to be controlled with hardware. GMOCCAPY is highly customizable.

Backlash
The amount of ”play” or lost motion that occurs when direction is reversed in a lead screw. or other mechanical motion driving system. It can result from nuts that are loose on leadscrews, slippage in belts, cable slack, ”wind-up” in rotary couplings, and other places where the mechanical system is not ”tight”. Backlash will result in inaccurate motion, or in the case of motion caused by external forces (think cutting tool pulling on the work piece) the result can be broken cutting tools. This can happen because of the sudden increase in chip load on the cutter as the work piece is pulled across the backlash distance by the cutting tool.

Backlash Compensation
Any technique that attempts to reduce the effect of backlash without actually removing it from the mechanical system. This is typically done in software in the controller. This can correct the final resting place of the part in motion but fails to solve problems related to direction changes while in motion (think circular interpolation) and motion that is caused when external forces (think cutting tool pulling on the work piece) are the source of the motion.

Ball Screw
A type of lead-screw that uses small hardened steel balls between the nut and screw to reduce friction. Ball-screws have very low friction and backlash, but are usually quite expensive.

Ball Nut
A special nut designed for use with a ball-screw. It contains an internal passage to re-circulate the balls from one end of the screw to the other.

CNC
Computer Numerical Control. The general term used to refer to computer control of machinery. Instead of a human operator turning cranks to move a cutting tool, CNC uses a computer and motors to move the tool, based on a part program.

Comp
A tool used to build, compile and install LinuxCNC HAL components.

Configuration(n)
A directory containing a set of configuration files. Custom configurations are normally saved in the users home/linuxcnc/configs directory. These files include LinuxCNC's traditional INI file and HAL files. A configuration may also contain several general files that describe tools, parameters, and NML connections.

Configuration(v)
The task of setting up LinuxCNC so that it matches the hardware on a machine tool.

Coordinate Measuring Machine
A Coordinate Measuring Machine is used to make many accurate measurements on parts. These machines can be used to create CAD data for parts where no drawings can be found, when a hand-made prototype needs to be digitized for moldmaking, or to check the accuracy of machined or molded parts.

Display units
The linear and angular units used for onscreen display.

Digitalavleser
A Digital Read Out is a system of position-measuring devices attached to the slides of a machine tool, which are connected to a numeric display showing the current location of the tool with respect to some reference position. DROs are very popular on hand-operated machine tools because they measure the true tool position without backlash, even if the machine has very loose Acme screws. Some DROs use linear quadrature encoders to pick up position information from the machine, and some use methods similar to a resolver which keeps rolling over.

EDM
EDM is a method of removing metal in hard or difficult to machine or tough metals, or where rotating tools would not be able to produce the desired shape in a cost-effective manner. An excellent example is rectangular punch dies, where sharp internal corners are desired. Milling operations can not give sharp internal corners with finite diameter tools. A *wire* EDM machine can make internal corners with a radius only slightly larger than the wire's radius. A *sinker* EDM can make internal corners with a radius only slightly larger than the radius on the corner of the sinking electrode.

EMC
The Enhanced Machine Controller. Initially a NIST project. Renamed to LinuxCNC in 2012.

EMCIO
The module within LinuxCNC that handles general purpose I/O, unrelated to the actual motion of the axes.

EMCMOT
The module within LinuxCNC that handles the actual motion of the cutting tool. It runs as a real-time program and directly controls the motors.

Encoder
A device to measure position. Usually a mechanical-optical device, which outputs a quadrature signal. The signal can be counted by special hardware, or directly by the parport with LinuxCNC.

Feed
Relatively slow, controlled motion of the tool used when making a cut.

Feed rate
The speed at which a cutting motion occurs. In auto or MDI mode, feed rate is commanded using an F word. F10 would mean ten machine units per minute.

Feedback
A method (e.g., quadrature encoder signals) by which LinuxCNC receives information about the position of motors.

Feedrate Override
A manual, operator controlled change in the rate at which the tool moves while cutting. Often used to allow the operator to adjust for tools that are a little dull, or anything else that requires the feed rate to be ”tweaked”.

Flyttall
Et tall som har et desimalkomma. (12,300) Kjent som float i HAL.

G-code
The generic term used to refer to the most common part programming language. There are several dialects of G-code, LinuxCNC uses RS274/NGC.

GUI
Graphical User Interface.

General
A type of interface that allows communications between a computer and a human (in most cases) via the manipulation of icons and other elements (widgets) on a computer screen.

LinuxCNC
An application that presents a graphical screen to the machine operator allowing manipulation of the machine and the corresponding controlling program.

HAL
Hardware Abstraction Layer. At the highest level, it is simply a way to allow a number of building blocks to be loaded and interconnected to assemble a complex system. Many of the building blocks are drivers for hardware devices. However, HAL can do more than just configure hardware drivers.

Home
A specific location in the machine’s work envelope that is used to make sure the computer and the actual machine both agree on the tool position.

INI file
A text file that contains most of the information that configures LinuxCNC for a particular machine.

Instance
One can have an instance of a class or a particular object. The instance is the actual object created at runtime. In programmer jargon, the ”Lassie” object is an instance of the ”Dog” class.

Joint Coordinates
These specify the angles between the individual joints of the machine. See also Kinematics

Jog
Manually moving an axis of a machine. Jogging either moves the axis a fixed amount for each key-press, or moves the axis at a constant speed as long as you hold down the key. In manual mode, jog speed can be set from the graphical interface.

kernel-space
Code running inside the kernel, as opposed to code running in userspace. Some realtime systems (like RTAI) run realtime code in the kernel and non-realtime code in userspace, while other realtime systems (like Preempt-RT) run both realtime and non-realtime code in userspace.

Kinematics
The position relationship between world coordinates and joint coordinates of a machine. There are two types of kinematics. Forward kinematics is used to calculate world coordinates from joint coordinates. Inverse kinematics is used for exactly the opposite purpose. Note that kinematics does not take into account, the forces, moments etc. on the machine. It is for positioning only.

Lead-screw
An screw that is rotated by a motor to move a table or other part of a machine. Lead-screws are usually either ball-screws or acme screws, although conventional triangular threaded screws may be used where accuracy and long life are not as important as low cost.

Machine units
The linear and angular units used for machine configuration. These units are specified and used in the INI file. HAL pins and parameters are also generally in machine units.

MDI
Manual Data Input. This is a mode of operation where the controller executes single lines of G-code as they are typed by the operator.

NIST
National Institute of Standards and Technology. An agency of the Department of Commerce in the United States.

NML
Neutral Message Language provides a mechanism for handling multiple types of messages in the same buffer as well as simplifying the interface for encoding and decoding buffers in neutral format and the configuration mechanism.

Offsets
An arbitrary amount, added to the value of something to make it equal to some desired value. For example, G-code programs are often written around some convenient point, such as X0, Y0. Fixture offsets can be used to shift the actual execution point of that G-code program to properly fit the true location of the vice and jaws. Tool offsets can be used to shift the ”uncorrected” length of a tool to equal that tool’s actual length.

Part Program
A description of a part, in a language that the controller can understand. For LinuxCNC, that language is RS-274/NGC, commonly known as G-code.

Program Units
The linear and angular units used in a part program. The linear program units do not have to be the same as the linear machine units. See G20 and G21 for more information. The angular program units are always measured in degrees.

Python
General-purpose, very high-level programming language. Used in LinuxCNC for the Axis GUI, the StepConf configuration tool, and several G-code programming scripts.

Rapid
Fast, possibly less precise motion of the tool, commonly used to move between cuts. If the tool meets the workpiece or the fixturing during a rapid, it is probably a bad thing!

Rapid rate
The speed at which a rapid motion occurs. In auto or MDI mode, rapid rate is usually the maximum speed of the machine. It is often desirable to limit the rapid rate when testing a G-code program for the first time.

Real-time
Software that is intended to meet very strict timing deadlines. On Linux, in order to meet these requirements it is necessary to install a realtime kernel such as RTAI or Preempt-RT, and build the LinuxCNC software to run in the special real-time environment. Realtime software can run in the kernel or in userspace, depending on the facilities offered by the system.

RTAI
Real Time Application Interface, see https://www.rtai.org/, the real-time extensions for Linux that LinuxCNC can use to achieve real-time performance.

RTLINUX
See https://en.wikipedia.org/wiki/RTLinux, an older real-time extension for Linux that LinuxCNC used to use to achieve real-time performance. Obsolete, replaced by RTAI.

RTAPI
A portable interface to real-time operating systems including RTAI and POSIX pthreads with realtime extensions.

RS-274/NGC
The formal name for the language used by LinuxCNC part programs.

Servo Motor
Generally, any motor that is used with error-sensing feedback to correct the position of an actuator. Also, a motor which is specially-designed to provide improved performance in such applications.

Servo Loop
A control loop used to control position or velocity of an motor equipped with a feedback device.

Signed Integer
A whole number that can have a positive or negative sign. In HAL it is usually a s32, but could be also a s64.

Spindel
The part of a machine tool that spins to do the cutting. On a mill or drill, the spindle holds the cutting tool. On a lathe, the spindle holds the workpiece.

Spindle Speed Override
A manual, operator controlled change in the rate at which the tool rotates while cutting. Often used to allow the operator to adjust for chatter caused by the cutter's teeth. Spindle Speed Override assumes that the LinuxCNC software has been configured to control spindle speed.

StepConf
An LinuxCNC configuration wizard. It is able to handle many step-and-direction motion command based machines. It writes a full configuration after the user answers a few questions about the computer and machine that LinuxCNC is to run on.

Stepper Motor
A type of motor that turns in fixed steps. By counting steps, it is possible to determine how far the motor has turned. If the load exceeds the torque capability of the motor, it will skip one or more steps, causing position errors.

TASK
The module within LinuxCNC that coordinates the overall execution and interprets the part program.

Tcl/Tk
A scripting language and graphical widget toolkit with which several of LinuxCNCs GUIs and selection wizards were written.

Traverse Move
A move in a straight line from the start point to the end point.

Enheter
See ”Machine Units”, ”Display Units”, or ”Program Units”.

Unsigned Integer
A whole number that has no sign. In HAL it is usually a u32 but could be also a u64.

World Coordinates
This is the absolute frame of reference. It gives coordinates in terms of a fixed reference frame that is attached to some point (generally the base) of the machine tool.

Kapittel 7

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