MFM DISK-DRIVE EMULATOR
Get started Manual for the DE10-Nano board

Version Beta V010

Instructions for loading & flashing DE0-Nano_SoC board running the MFM disk emulator on it

Requirement : Up and running FPGA-SoC_Linux on a SoC/HPS board, like the DE10-Nano
Reference : DE10-Nano_User_manual.pdf
Further information on my homepage, pdp11gy.com and on de10-nano.terasic.com/cd

We recommend to download and install the Unix kernel

de10_nano_linux_console

Details in the manual Getting Started Guide

Jumper settings

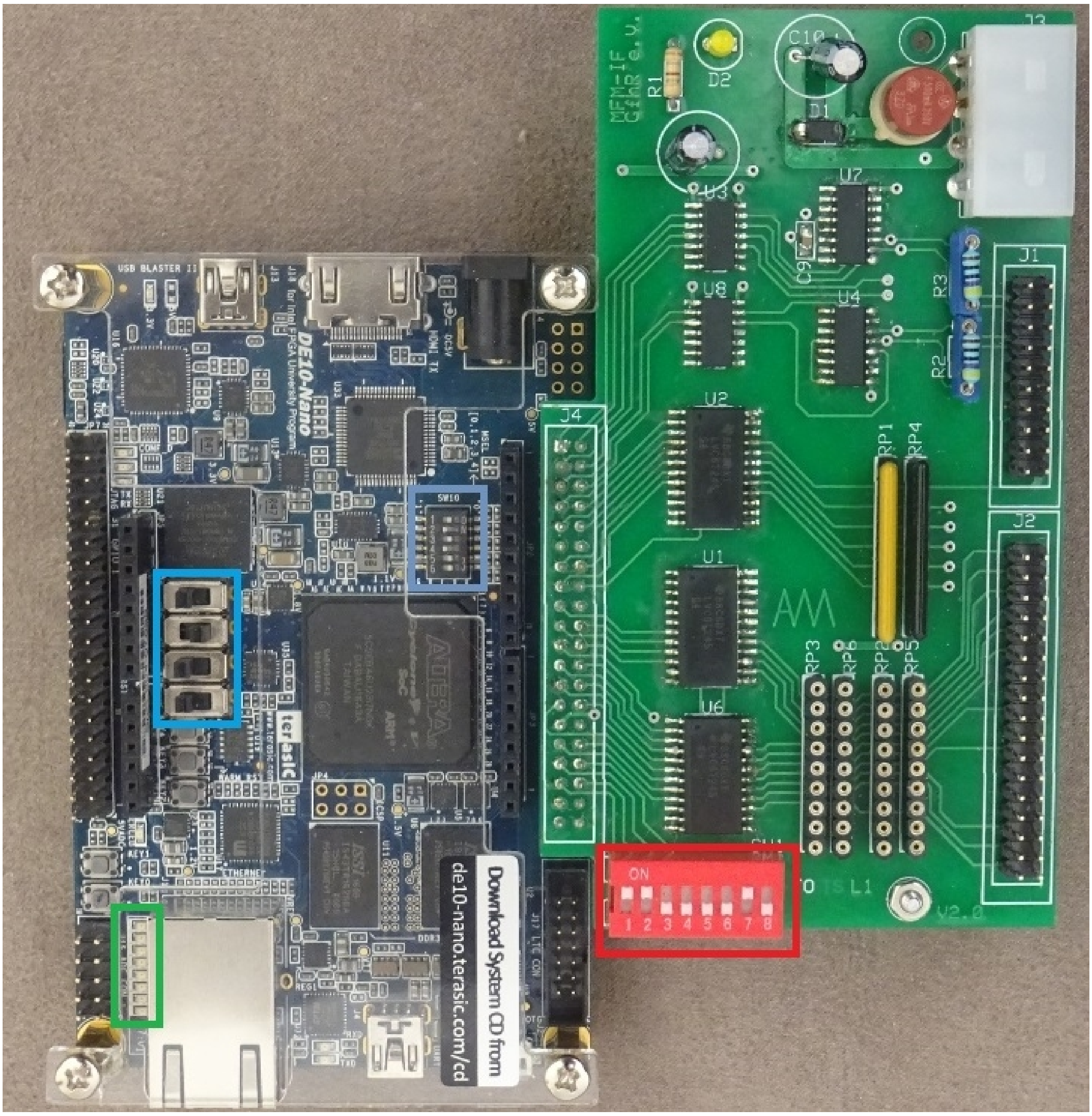
DE10-Nano: The four slide switches (page 26, User_manual): Only switch 0 is used: ON=Clone-Mode OFF=EMULATOR Mode
Button 2 and 3 : Reconfigure and Reset/Restart
De0-Nano-SoC DIP switch (SW10) configuration, see page 12 @ User_manuel

Interface-board: 8 switches **:**

Switch 1: ON: LED Debug info OFF=Pattern
Switch 2 : Debug Mode ON/OFF
Switch 3-4: Unit number
Switch 5-8 : drive typ:

0-0-0-1	=	ST506
0-0-1-0	=	ST412
0-1-0-0	=	ST 225

Overview:



LED's : 0 = **heartbeat LED** (schould be blinking)

1 = CLONE Mode, 2 = CLONE-Mode STEP

3 = Interface enable 4 = Index-Pulse

5 = EMULATOR-Mode : Write

6 = EMULATOR-Mode : STEP

7 = EMULATOR Mode

Quick Start:

The firmware can be loaded in 3 different ways.

1) New: In the current version now works "**Load FPGA from Linux**". To load the firmware another software is used, see
https://github.com/nhasbun/de10nano_fpga_linux_config
This software was taken over unchanged, only the Makefile was modified and the executable file is called loadrbf.
As a pure user, I recommend this method because there is no additional software required like Quartus.
Here are the steps to load the firmware and start the MFM emulator:
- Suppose you are in Folder MFM `root@socfpga:~/MFM`
- First, copy the file "soc_mfm_beta.zip" to the DE0-Nano-SoC board, for example, using scp or winscp. Unpack the zip file and navigate to folder soc_mfm_beta.

unzip soc_mfm_beta.zip
cd soc_mfm_beta
cd MFM
chmod 777 *
The loadrbf program is using the filename fpga_config_file.rbf but the RL emulator is using the file RL_EMULATOR_SoC.rbf . Use a link to get the issue fixed as follow:
ln -s ../FW/MFM_EMULATOR_SoC.rbf fpga_config_file.rbf

That’s all !

Directory listing:

```
root@socfpga:~/MFM/soc_mfm_beta/MFM# ls -l
total 76
lrwxrwxrwx 1 root root    26 Jun 18 15:33 fpga_config_file.rbf ->
../FW/MFM_EMULATOR_SoC.rbf
-rwxrwxrwx 1 root root  7486 Jun 18 15:32 hps_0.h
-rwxrwxrwx 1 root root 13795 Jun 18 15:32 loadrbf
-rwxrwxrwx 1 root root 27135 Jun 18 15:32 mfmemulator
-rwxrwxrwx 1 root root 21067 Jun 18 15:32 read_save-cylinder
root@socfpga:~/MFM/soc_mfm_beta/MFM#
```

Now you can start the **A**)firmware loader and then the **B**)RL emulator or **C**) the read/test program, read and save one cylinder/track:

A) root@socfpga:~/socv2_2/RL# **./loadrbf**
B) root@socfpga:~/socv2_2/RL# **./rlemulator**
C) root@socfpga:~/socv2_2/RL# **./readc**

loadrbf program output:

```
******************************************************
MSEL Pin Config..... 0xa
FPGA State.......... Powered Off
cfgwdth Register.... 0x1
cdratio Register.... 0x0
axicfgen Register... 0x0
Nconfig pull reg.... 0x0
CONF DONE........... 0x0
Ctrl.en?............ 0x0
******************************************************
Turning FPGA Off.
Setting cdratio with 0x3.
Turning FPGA On.
Loading rbf file.
EOF reached.
******************************************************
MSEL Pin Config..... 0xa
FPGA State.......... User Phase
cfgwdth Register.... 0x1
cdratio Register.... 0x3
axicfgen Register... 0x0
Nconfig pull reg.... 0x0
CONF DONE........... 0x0
Ctrl.en?............ 0x0
******************************************************
root@socfpga:~/socv2_2/RL#
```

Now, the heartbeat LED on the interface board should be blinking

mfmemulator program output:

< not yet ready >

In the Linux world you can now do smart things, like:
alias mfm='./loadrbf;sleep 2;./mfmemulator'

If you type now mfm, the firmware will be loaded and then the mfm emulator is starting.

There are **2** more ways to load the firmware to the DE10 Nano board. However, you need additional software , Quartus, Version 16.1. The DE10-Nano board is pre-configured with the Angstrom Linux - Kernel (DE10_Nano_LXDE).
the default installed Linux is not able to run with a EPCS configuration.
I recommend to use the de10_nano_linux_console.img which can be very easy installed with disk-imager like win32diskimager. More details in the Getting_Started_Guide.pdf. The images and all documentation can be downloaded from www.de10-nano.terasic.com/cd .

2) Load .sof file(NOT permanent)

- De0-Nano-SoC DIP switch (SW10) to default configuration, see page 12 @ User_manual
- unzip the file "`soc_mfm_beta.zip`"
- Start Quartus Lite Version 16.1
- Make sure, your USB connection to the DE10-Nano is working.
- Follow the instruction in the DE10-Nano_User_manual at page 15 and load the **MFM_EMULATOR_SoC.sof** file.
- After download , the heartbeat LED schould be blinking.

3) Permanent (EPCS): Required: Quartus Lite Version 16.1

- De0-Nano-SoC DIP switch (SW10) to EPCS configuration, see page 12 @ User_manual
- unzip the file "`soc_mfm_beta.zip`"
- Start Quartus Lite Version 16.1
- Make sure, your USB connection to the DE10-Nano is working.
- Follow the instruction in the DE10-Nano_User_manual at page 112 and flash the DE10-Nano board with the fil **MFM_EMULATOR_SoC.jic** from folder /flash.
- After repowering the DE10-Nano board, the heartbeat LED schould be blinking.

Folders:

FW: Contains the RL_EMULATOR_SoC.jic file for flashing the FW into the EPCS and the RL_EMULATOR_SoC.rbf for loading the FW in the FPGA.
The .cof file are configuration files if you want to convert the .sof file to .jic or .rbf by yourself.

MFM: Contains the binary runable MFM-emulator file: mfmemulator

Some personal information:
I also use a Raspberry Pi 3 (model B) connected via network to the DE10-Nano board. I use the Raspberry for development purposes with a graphical interface. I can compile the programs like SIMH emulators and copy it to the DE10-Nano board, because it is binary compatible. That's so great and there is still a lot of room for further additional applications.

Instructions: Rebuild the MFM-emulator running on DE10-Nano board.

Firmware:
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Use Quartus V16.1 and open the Project RL_emulator.qpf
After compiling the Project, use the the MAKE_jic.cof and MAKE_rbf.cof file to build the .jic and .rbf files.

Programming environment:
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It was difficult to make everything runable because many things in the documentation and in the examples were not correct. Here is a step by step explamation to rebuild the MFM-emulator if necessary or if you want to design some add-on application.

- Download and install **Quartus Version 16.1.**
- Download and install Intel **SoCEDSPro Version 16.1**

Fix Problems:
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*1 : error You must define soc_cv_av or soc_a10 before compiling with HwLibs
Go to intelFPGA/16.1/embedded/ip/altera/hps/altera_hps/hwlib/include
Copy all .h files in the folder soc_cv_av and soc_a10

*2 : generate_hps_qsys_header.sh : PATH is not set correct: correct as following:

```
#!/bin/sh
PATH=/cygdrive/C/altera_lite/16.1/quartus/sopc_builder/bin:$PATH
sopc-create-header-files \
"$PWD/RL_system.sopcinfo" \
--single hps_0.h \
--module hps_0
```

*3: Modify the makefiles, here the MFM-emulator cylinder-read make file

```
software/MFM/Makefile     //  mfmemulator
software/read/Makefile    //  readc
```

mfmemulator makefile:

```
#
TARGET = mfmemulator
ALT_DEVICE_FAMILY ?= soc_cv_av
ALT_DEVICE_FAMILY ?= soc_a10
#
CROSS_COMPILE = arm-linux-gnueabihf-
#CFLAGS = -static -g -Wall  -I$
{SOCEDS_DEST_ROOT}/ip/altera/hps/altera_hps/hwlib/include
CFLAGS = -g -Wall  -I$
{SOCEDS_DEST_ROOT}/ip/altera/hps/altera_hps/hwlib/include/$
{ALT_DEVICE_FAMILY} -Dsoc_cv_av -Dsoc_a10
LDFLAGS =  -g -Wall
CC = $(CROSS_COMPILE)gcc
ARCH= arm


build: $(TARGET)
$(TARGET): main.o
	$(CC) $(LDFLAGS)   $^ -o $@
%.o : %.c
	$(CC) $(CFLAGS) -c $< -o $@

.PHONY: clean
clean:
	rm -f $(TARGET) *.a *.o *~
```

For comments and questions, please contact me.
INFO@pdp11gy.com

References:
http://www.pdp11gy.com
https://github.com/pdp11gy/SoC-HPS-based-MFM-disk-emulator
https://github.com/pdp11gy/SoC-HPS-based-RL-disk-emulator
https://github.com/pdp11gy/DEC-RL02-RL01-disk-emulator
http://www.pdp11gy.com/sddoneE.html