

Technical Report

CONFIDENTIAL

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Annexen: 0

Cc : -

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Subject : USX test box software installation

In this document, the installation of the software needed to run the USX test box (016A005 00) is described. Matlab is used as programming language, however other programming languages like Delphi, C++ or Python could be used.

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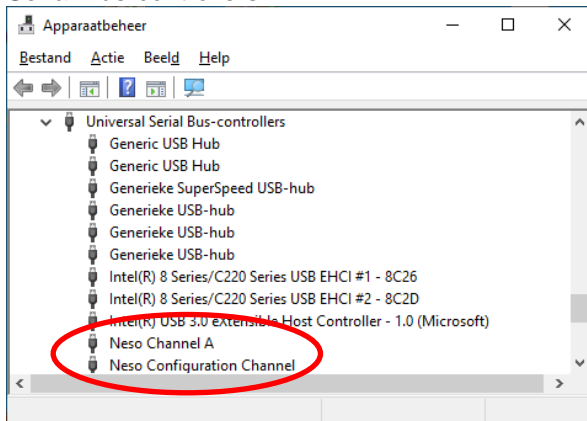
1. Software installation

The following software must be installed:

- Driver for Neso (<https://numato.com/product/neso-artix-7-fpga-development-board/> under "Downloads")
- FTDI-driver (<https://www.ftdichip.com/Drivers/D2XX.htm>, dpinst-amd64.exe)
- FT_Prog (https://www.ftdichip.com/Support/Utilities.htm#FT_PROG)
- Matlab 64-bit (2017b or higher) (<https://www.mathworks.com>)
- The driver files `asic_call_wrapper_dll64.dll` and `asic_call_wrapper_dll.h` are needed by Matlab (or the other programming language).

2. Driver for Neso

If the Neso driver is installed correctly, the Neso hardware should show up at the Device Manager under Universal Serial Bus-controllers:



3. FTDI-Driver / FT_Prog

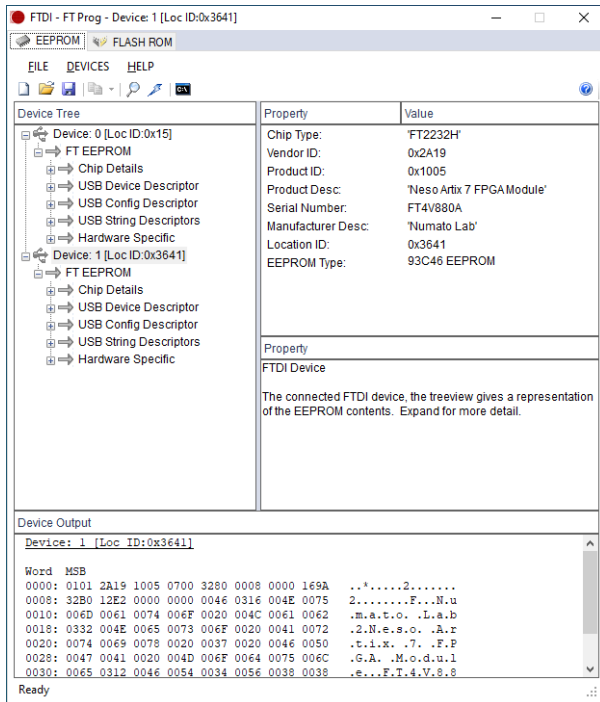
Start FT_Prog and press the magnifying glass. If the software is installed correctly. The value for "Product Desc" must be "ICE FPGA Testboard" or "Neso Artix 7 FPGA Module".

If the FTDI module does not have the correct name, the template must be applied by right clicking on the device and selecting "Apply template". For the testbox, "xxx_Testbox.xml" must be applied. For the handle board FPGA, "xxx_HandleBoard.xml" must be applied. The source code for these xml files is listed in Appendix A.

After applying the template, the FTDI device must be reprogrammed by clicking the lightning symbol ⚡.

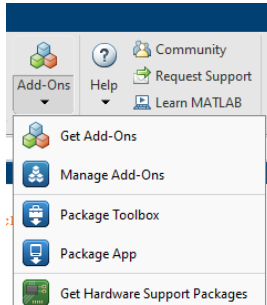
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4. Matlab

After installation of the software, the MinGW compiler for Matlab needs to be installed:



Search for “MATLAB Support for MinGW-w64 C/C++ Compiler” and install this add-on. This add-on only works for versions 2017b and above.

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5. USX driver

The driver files `asic_call_wrapper_dll64.dll` and `asic_call_wrapper_dll.h` must be copied into a search path of Matlab. The path could be added by clicking "Set Path" -> "Add Folder".

The two attached script `InitializeAsic.m` and the attached class `asic.m` could be used to run the driver in Matlab. The code is listed in Appendix B.

After running `InitializeAsic.m`, the Test box should be recognized and initialized. The warnings (orange) while starting the driver can be ignored.

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A. FTDI templates

A.1. 20201124_Testbox.xml

```
<?xml version="1.0" encoding="utf-16"?>
<FT_EEPROM>
  <Chip_Details>
    <Type>FT232H</Type>
  </Chip_Details>
  <USB_Device_Descriptor>
    <VID_PID>2</VID_PID>
    <idVendor>2A19</idVendor>
    <idProduct>1005</idProduct>
    <bcdUSB>USB 2.0</bcdUSB>
  </USB_Device_Descriptor>
  <USB_Config_Descriptor>
    <bmAttributes>
      <RemoteWakeupEnabled>>false</RemoteWakeupEnabled>
      <SelfPowered>>false</SelfPowered>
      <BusPowered>>true</BusPowered>
    </bmAttributes>
    <IOpullDown>>false</IOpullDown>
    <MaxPower>100</MaxPower>
  </USB_Config_Descriptor>
  <USB_String_Descriptors>
    <Manufacturer>Numato Lab</Manufacturer>
    <Product_Description>Neso Artix 7 FPGA Module</Product_Description>
    <SerialNumber_Enabled>>true</SerialNumber_Enabled>
    <SerialNumber />
    <SerialNumberPrefix>FT</SerialNumberPrefix>
    <SerialNumber_AutoGenerate>>true</SerialNumber_AutoGenerate>
  </USB_String_Descriptors>
  <Hardware_Specific>
    <Suspend_DBUS7>>false</Suspend_DBUS7>
    <TPRDRV>0</TPRDRV>
    <Port_A>
      <Hardware>
        <UART>>false</UART>
        <_245FIFO>>true</_245FIFO>
        <CPUFIFO>>false</CPUFIFO>
        <OPTO>>false</OPTO>
      </Hardware>
      <Driver>
        <VCP>>false</VCP>
        <D2XX>>true</D2XX>
      </Driver>
    </Port_A>
    <Port_B>
      <Hardware>
        <UART>>false</UART>
        <_245FIFO>>true</_245FIFO>
        <CPUFIFO>>false</CPUFIFO>
        <OPTO>>false</OPTO>
      </Hardware>
      <Driver>
        <VCP>>false</VCP>
        <D2XX>>true</D2XX>
      </Driver>
    </Port_B>
  </IO_Pins>
  <Group_AL>
    <SlowSlew>>false</SlowSlew>
    <Schmitt>>false</Schmitt>
    <Drive>4mA</Drive>
  </Group_AL>
  <Group_AH>
```

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```
<SlowSlew>false</SlowSlew>
<Schmitt>false</Schmitt>
<Drive>4mA</Drive>
</Group_AH>
<Group_BL>
  <SlowSlew>false</SlowSlew>
  <Schmitt>false</Schmitt>
  <Drive>4mA</Drive>
</Group_BL>
<Group_BH>
  <SlowSlew>false</SlowSlew>
  <Schmitt>false</Schmitt>
  <Drive>4mA</Drive>
</Group_BH>
</IO_Pins>
</Hardware_Specific>
</FT_EEPROM>
```

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A.2. 20201124_HandleBoard.xml

```
<?xml version="1.0" encoding="utf-16"?>
<FT_EEPROM>
  <Chip_Details>
    <Type>FT2232H</Type>
  </Chip_Details>
  <USB_Device_Descriptor>
    <VID_PID>0</VID_PID>
    <idVendor>0403</idVendor>
    <idProduct>6010</idProduct>
    <bcdUSB>USB 2.0</bcdUSB>
  </USB_Device_Descriptor>
  <USB_Config_Descriptor>
    <bmAttributes>
      <RemoteWakeupEnabled>>false</RemoteWakeupEnabled>
      <SelfPowered>>false</SelfPowered>
      <BusPowered>>true</BusPowered>
    </bmAttributes>
    <IOpullDown>>false</IOpullDown>
    <MaxPower>100</MaxPower>
  </USB_Config_Descriptor>
  <USB_String_Descriptors>
    <Manufacturer>Oldelft</Manufacturer>
    <Product_Description>195F081 03</Product_Description>
    <SerialNumber_Enabled>>true</SerialNumber_Enabled>
    <SerialNumber />
    <SerialNumberPrefix>FT</SerialNumberPrefix>
    <SerialNumber_AutoGenerate>>true</SerialNumber_AutoGenerate>
  </USB_String_Descriptors>
  <Hardware_Specific>
    <Suspend_DBUS7>>false</Suspend_DBUS7>
    <TPRDRV>0</TPRDRV>
    <Port_A>
      <Hardware>
        <UART>>false</UART>
        <_245FIFO>>true</_245FIFO>
        <CPUFIFO>>false</CPUFIFO>
        <OPTO>>false</OPTO>
      </Hardware>
      <Driver>
        <VCP>>false</VCP>
        <D2XX>>true</D2XX>
      </Driver>
    </Port_A>
    <Port_B>
      <Hardware>
        <UART>>false</UART>
        <_245FIFO>>true</_245FIFO>
        <CPUFIFO>>false</CPUFIFO>
        <OPTO>>false</OPTO>
      </Hardware>
      <Driver>
        <VCP>>false</VCP>
        <D2XX>>true</D2XX>
      </Driver>
    </Port_B>
  </IO_Pins>
  <Group_AL>
    <SlowSlew>>false</SlowSlew>
    <Schmitt>>false</Schmitt>
    <Drive>4mA</Drive>
  </Group_AL>
  <Group_AH>
    <SlowSlew>>false</SlowSlew>
    <Schmitt>>false</Schmitt>
    <Drive>4mA</Drive>
  </Group_AH>
</FT_EEPROM>
```

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```
</Group_AH>
<Group_BL>
  <SlowSlew>false</SlowSlew>
  <Schmitt>false</Schmitt>
  <Drive>4mA</Drive>
</Group_BL>
<Group_BH>
  <SlowSlew>false</SlowSlew>
  <Schmitt>false</Schmitt>
  <Drive>4mA</Drive>
</Group_BH>
</IO_Pins>
</Hardware_Specific>
</FT_EEPROM>
```

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B. Matlab code

B.1. asic.m

```
% Asic class - adapted
% Arjan Flikweert 2020-11-20

classdef asic <handle
    properties (SetAccess=public)
        driverString='asic_call_wrapper_dll64';
        fpgaName=[]; % Name of the FPGA board
        driverVersion=''; % Driver version, e.g. 'build 1234'
        asicDriverNumber=0; % Driver number, e.g. 1234
        fpgaVersion=''; % FPGA version string
        fpgaHardwareID=''; % Hardware ID of the FPGA
        serialNumber=-1*ones(1,4,'int32'); % Hardware ID of ASICs
        nAsics=int32(0); % Number of ASICs
        clockSpeed=''; % clock speed of ASIC
        strOutPtr=[];
        strOutPtrSize=0;
    end

    methods
        function delete(asc) % Destructor
            if libisloaded(asc.driverString)
                unloadlibrary(asc.driverString);
            end
        end
    end

    methods (Static=true) % static methods do not perform operations and thus do not need an instance

        function s = saveobj(asc)
            end

        function asc = loadobj(s) % needs to be executed if obj is loaded from disk
            end

        function s=GetErrorCode(status)
            nBits=24;
            if ischar(status)
                status=str2double(status);
            end
            binValue=dec2bin(status,nBits);
            s='';

            errorCodes={'ERRORCODE_FAILED','ERRORCODE_PARAM','ERRORCODE_PARAMSET','ERRORCODE_STATUS','ERRORCODE_USB_INIT','ERRORCODE_U
            SB_RECEIVE','ERRORCODE_USB_SEND','ERRORCODE_NOT_IMPLEMENTED',...
                'ERRORCODE_CRC','ERRORCODE_FPGA','ERRORCODE_SWINTERNAL (Digilent)',' ',' ',' ',' ',' ','...

            'ASIC_ERRORFLAG_UNKNOWN_CMD','ASIC_ERRORFLAG_VALIDERROR','ASIC_ERRORFLAG_CHKSUMERROR','ASIC_ERRORFLAG_BUSY',' ',' ','ASIC_ER
            RORFLAG_LOCKED','ASIC_ERRORFLAG_EXTERNAL'};
            for iBit=1:nBits
                if binValue(nBits-(iBit-1))=='1'
                    s=[s,sprintf('%s\n',errorCodes{iBit})];
                end
            end
            if s(end)==char(10)
                s=s(1:end-1); % Remove last EOL
            end
        end
    end % methods Static=true

    methods (Static=false) % dynamic methods perform operations and thus need an instance of this class
        function LoadAsicLibrary(asc)
            % Load ASIC DLL file
            try
                if ~libisloaded(asc.driverString)
                    if ~exist([asc.driverString,'.m'],'file') % Create proto if not existing --> this is MUCH faster for
loading the next time
                        loadlibrary([asc.driverString,'.dll'],'asic_call_wrapper_dll.h','mfilename',asc.driverString); %
_proto
                    else

```

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```
if strcmp(asc.driverString,'asic_call_wrapper_dll64')
    loadlibrary([asc.driverString,'.dll'],@asic_call_wrapper_dll64); % use proto .m file for
faster loading
else
    loadlibrary([asc.driverString,'.dll'],@asic_call_wrapper_dll32); % use proto .m file for
faster loading
end
end
catch
    fprintf('Error loading ASIC DLL.\n');
end
end

function asc=asic
    % Construct object "asic"
    %
    % addpath('dll_output'); % Please put in the path to the driver + header file in here
    asc.LoadAsicLibrary;
end

function [outStr,status]=Parse(asc,inStr,strOutSize)
    % Parse ASIC command to DLL
    %
    % INPUT:
    %   inStr (string)           : command to execute. If empty and
    %   strOutSize (double)      : size of outStr (default=50k)
    % OUTPUT:
    %   outStr (string)          : answer from DLL
    %   status (string)          : status string from DLL

    if ~exist('strOutSize','var') || isempty(strOutSize) || strOutSize==0
        strOutSize=1024*50; % Reserve 50k
    end

    if asc.strOutPtrSize~=strOutSize % Create ptr, otherwise reuse ptr
        asc.strOutPtr= libpointer('cstring',repmat(' ',1,strOutSize));
        asc.strOutPtrSize=strOutSize;
    end

    if ~isempty(inStr)
        [status,~,outStr]=calllib(asc.driverString,'asic_call_parse',libpointer('cstring',inStr),asc.strOutPtr);
    else
        status=[];
    end

    if status && isempty(strfind(outStr,'Available commands')) % DLL error detected
        fprintf(2,'DLL error %0.f:\n',status);
        fprintf(2,[asic.GetErrorcode(status),'\n']);
        fprintf('   inStr: %s\n   outStr: %s\n',inStr,outStr);
    end
    if status && ~isempty(strfind(outStr,'Available commands')) % DLL error detected
        ind=strfind(inStr,':');
        if isempty(ind); ind=length(inStr)+1; end
        fprintf(2,'DLL command not found: %s\n',inStr(1:ind-1));
    end
end

function OpenAsic(asc,fpgaName)
    % Initialize driver and FPGA. Initialize ASIC.
    %
    % INPUT:
    %   fpgaName (string)        : name of FPGA

    if ~exist('fpgaName','var') || isempty(fpgaName); fpgaName='ICE FPGA Testbox A;'; end
    asc.clockSpeed='100';

    asc.LoadAsicLibrary; % if not loaded: load it again
    asc.fpgaName=fpgaName;
    asc.driverVersion='';
    asc.fpgaVersion='';
    asc.serialNumber=-1*ones(1,4,'int32');

    % Initialize driver -----
    [strOut,value1]=asc.Parse(['InitializeDriver:USB:',fpgaName]);
    if value1==2 % Retry A
        [strOut,value1]=asc.Parse('InitializeDriver:USB:ICE FPGA Testbox A;');
    end
end
```

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```

end
if ~isempty(strfind(strOut, 'FAILED'))
    return; % Testbox not found
end
fprintf(['\n', strOut, '\n']);
s=asc.Parse('DriverVersion');
asc.driverVersion=s(22:end);
ind=strfind(asc.driverVersion, 'Build');
asc.asicDriverNumber=sscanf(asc.driverVersion(ind+6:end), '%g');

% Initialize ASIC -----
[ strOut, value2]=asc.Parse(['InitializeAsic:', asc.clockSpeed]);
fprintf([strOut, '\n']);
if isempty(strfind(strOut, 'FAILED'))
    return; % ASIC not found
end
ind=strfind(strOut, ' Asics found');
asc.nAsics=int32(sscanf(strOut(ind-1:ind-1), '%g'));

% Read ASIC serial, DLL version and FPGA pars -----
asc.ReadSerial(strOut);
asc.ReadFpgaPars;

% Enable HVP
asc.Parse('ChangeInterface:0,0,0,2');
asc.Parse('ChangeInterface:0,0,0,3');
pause(1);
end

```

```

% -----
% Reading of FPGA/ASIC information

function ReadSerial(asc, strOut)
% Read serial number from ASIC
%
% INPUT:
%   strOut (string)           : Output string of DLL InitializeAsic command

for i=1:4
    ind=strfind(strOut, sprintf('SerialNumber[%g]', i-1)); % find this serial number
    indl=strfind(strOut(ind+16:end), ','); % find next serial number
    if ~isempty(indl)
        indl=indl(1);
        asc.serialNumber(i)=int32(str2double(strOut(ind+16:ind+16+indl-2)));
    else
        asc.serialNumber(i)=int32(str2double(strOut(ind+16:end)));
        break; % this is the last one --> rest is zero
    end
end
if i<4
    asc.serialNumber(i+1:4)=int32(-1);
end
end

function ReadFpgaPars(asc)
% Read FPGA parameters:
%   FPGAVersion
%   FPGAHardwareID
%   FPGADescription
%   miniMatrixFlag
% These are stored in asc object

s=asc.Parse('FPGAVersion');
asc.fpgaVersion=s(20:end);
s=asc.Parse('FPGAHardwareID');
asc.fpgaHardwareID=s(35:end);
s=asc.Parse('FPGADescription');
asc.fpgaName=s(24:end);

end

end % METHODS
end

```

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B.2. InitializeAsic.m

```
handles.asc=asic;
handles.asc.OpenAsic('ICE FPGA Testboard A;');
% handles.asc.OpenAsic('Neso Artix 7 FPGA Module A;');

% Setup
% handles.asc.Parse('SetParam:Setup,DisableLED:1'); % Disable LEDs later on, since it causes distortion on acoustic signal
handles.asc.Parse('SetParam:Setup,EnableTrigger:1');
handles.asc.Parse('SetParam:Setup,ExecuteTriggerOnce:0');
handles.asc.Parse('SetParam:ConfigCore,RxAlwaysEn:1');

% Firing
delaysTxStr=[repmat('0,',1,1023),'0'];
delaysRxStr=[repmat('14,',1,15),'14'];
handles.asc.Parse(['FireAsicReceive:0,0:',delaysTxStr,':',delaysRxStr]);
```

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