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Technical Report

CONFIDENTIAL

To : Michiel Baas

Franc van den Adel

Boris Lippe

Cc : -

From: A. Flikweert Tel.: 959

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.

Annexen:

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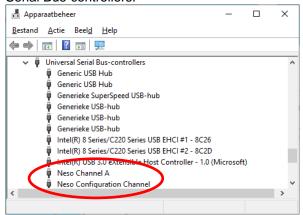
1. Software installation

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".

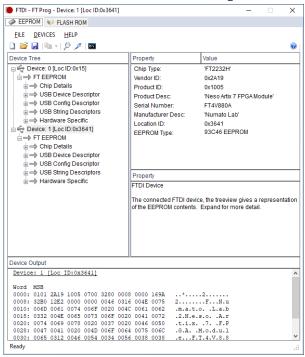
If the FTDI module does not have the correct name, the template must be applied by right clicking on the device and selecting "Apply template". For the testbox, "xxx_Testbox.xml" must be applied. For the handle board FPGA, "xxx_HandleBoard.xml" must be applied. The source code for these xml files is 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>FT2232H</Type>
  </Chip Details>
  <USB Device Descriptor>
    <VID PID>2</VID PID>
    <idVendor>2A19</idVendor>
    <idProduct>1005</idProduct>
    <br/>
<bcdUSB>USB 2.0</bcdUSB>
  </USB_Device_Descriptor>
  <USB_Config_Descriptor>
    <bmAttributes>
      <RemoteWakeupEnabled>false</RemoteWakeupEnabled>
      <SelfPowered>false</SelfPowered>
      <BusPowered>true
    </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 > \overline{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
       <_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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```
<Schmitt>false</Schmitt>
        <Drive>4mA</Drive>
      </Group AH>
      <Group BL>
       <SlowSlew>false</SlowSlew>
        <Schmitt>false</Schmitt>
       <Drive>4mA</prive>
      </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>
    \langle VID PID \rangle \overline{0} \langle VID PID \rangle
    <idVendor>0403</idVendor>
    <idProduct>6010</idProduct>
    <br/>
<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>trueAutoGenerate>
  </USB String Descriptors>
  <hardware Specific>
    <Suspend DBUS7>false</Suspend DBUS7>
    < TPRDRV > 0 < / TPRDRV >
    <Port A>
      <Hardware>
        <UART>false</UART>
        < 245FIFO>true</ 245FIFO>
        <PUFIFO>false</PUFIFO>
        <OPTO>false</OPTO>
      </Hardware>
      <Driver>
        <VCP>false</VCP>
        <D2XX>true</D2XX>
      </Driver>
   </Port_A>
   <Port B>
     <Hardware>
       <UART>false
        <_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</prive>
      </Group AL>
      <Group AH>
       <SlowSlew>false</SlowSlew>
        <Schmitt>false</Schmitt>
        <Drive>4mA</Drive>
```

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B. Matlab code

B.1. asic.m

```
% Asic class - adapted
% Arjan Flikweert 2020-11-20
classdef asic <handle</pre>
    properties (SetAccess=public)
       driverString='asic_call_wrapper_dl164';
                                  % Name of the FPGA board
       fpgaName=[];
                              % Name of the FPGA board
% Driver version, e.g. 'build 1234'
% Driver number, e.g. 1234
% FPGA version string
       driverVersion='';
       asicDriverNumber=0;
       fpgaVersion='';
fpgaHardwareID='';
       % clock speed of ASIC
       clockSpeed='';
       strOutPtr=[];
       strOutPtrSize=0;
    methods
        function delete(asc) % Destructor
            if libisloaded(asc.driverString)
                 unloadlibrary(asc.driverString);
            end
    methods (Static=true) % static methods do not perform operations and thus do not need an instance
        function s = saveobj(asc)
        function asc = loadobj(s) % needs to be executed if obj is loaded from disk
        function s=GetErrorCode(status)
            nBits=24;
                 status=str2double(status);
            binValue=dec2bin(status, nBits);
            s='';
errorCodes={'ERRORCODE_FAILED','ERRORCODE_PARAM','ERRORCODE_PARAMSET','ERRORCODE_STATUS','ERRORCODE_USB_INIT','ERRORCODE_USB_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
                 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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```
loadlibrary([asc.driverString,'.dll'],@asic call wrapper dll64); % use proto .m file for
faster loading
                             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
        function asc=asic
            % Construct object "asic"
              addpath('dll output'); % Please put in the path to the driver + header file in here
        function [outStr,status]=Parse(asc,inStr,strOutSize)
            % Parse ASIC command to DLL
                                         : command to execute. If empty and
: size of outStr (default=50k)
                inStr (string)
                strOutSize (double)
            % 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
            if asc.strOutPtrSize~=strOutSize % Create ptr, otherwise reuse ptr
                 asc.strOutPtr= libpointer('cstring',repmat(' ',1,strOutSize));
                 asc.strOutPtrSize=strOutSize;
            if ~isempty(inStr)
                [status,~,outStr]=calllib(asc.driverString,'asic_call_parse',libpointer('cstring',inStr),asc.strOutPtr);
                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);
            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
        function OpenAsic(asc,fpgaName)
            \mbox{\ensuremath{\$}} Initialize driver and FGPA. Initialize ASIC.
                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;*');
```

if strcmp(asc.driverString,'asic_call_wrapper_dl164')

end



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```
if ~isempty(strfind(strOut,'FAILED'))
                           return; % Testbox not found
                  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
                   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);
         % Reading of FPGA/ASIC information
          function ReadSerial(asc,strOut)
                   \mbox{\ensuremath{\$}} Read serial number from ASIC
                  % strOut (string)
                                                                                : Output string of DLL InitializeAsic command
                   for i=1:4
                            \verb|ind=strf| ind(strOut, sprintf('SerialNumber[%g]', i-1)); % find this serial number is a simple of the strong s
                            ind1=strfind(strOut(ind+16:end),','); % find next serial number
                            if ~isemptv(ind1)
                                     ind1=ind1(1);
                                     asc.serialNumber(i)=int32(str2double(strOut(ind+16:ind+16+ind1-2)));
                                     asc.serialNumber(i)=int32(str2double(strOut(ind+16:end)));
                                     break; % this is the last one --> rest is zero
                  if i<4</pre>
                            asc.serialNumber(i+1:4)=int32(-1);
                  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 % METHODS
```



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Technical Report

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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