OATo Technical Report nr. 141

EPICS 1.4 – EKPol Polarimeter Interactive Control Software:

An imaging polarimeter control software

Author: G. Capobianco

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Document Management

Date	Issue	Revision	Released by	Comments
2010-11-22	1.0	1	G. Capobianco	**OATo Technical Report nr. 141**

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List of Acronyms

CCD: Charge Coupled Device

CorMag: Coronal Magnetograph

C&DAQ: Control and Data Acquisition

EPICS: E-KPol Polarimeter Interactive Control Software

E-KPol: Eclipse Kcorona Polarimeter

GUI: Graphic User Interface

LC: Liquid Crystal

LCVR: Liquid Crystals Variable Retarder

LPT: Line Printer Terminal (parallel port)

OS: Operative System

PC: Personal Computer

PCI: Peripheral Component Interconnect

RAM: Random Access Memory

ROI: Region Of Interest

RS-232: Recommended Standard 232 (serial protocol)

USB: Universal Serial Bus

Software releases chronology

EPICS 1.4 released on date 2010-05-17

EPICS 1.3c released on date 2010-05-03

EPICS 1.3 released on date 2010-04-30

EPICS 1.2 released on date 2010-04-29

EPICS 1.0 released on date 2010-04-06

Abstract

Purpose of this report is to describe the last version (i.e. 1.4) of the EPICS software. EPICS, acronyms of E-KPol Polarimeter Interactive Control Software, is a software write in NI LabVIEW™ for the control and data acquisition (C&DAQ) of the E-KPol imaging polarimeter. This software requires NI LabVIEW 7.1 or later and is compatible with platform Windows 2000/NT. We have used this release for the E-KPol C&DAQ during the total solar eclipse of the July 11th 2010 in Tatakoto Atoll (French Polynesia). This software is based over the experience of the old software realized for the total solar eclipse of the March, 29th 2006.

Software objectives

The main objective of this software is the control of the devices that composes the E-KPol polarimeter instrument and the data acquisition. Two operative modes are provided: the manual control and a sequential mode C&DAQ that permits the user to run a script.

E-KPol instrument description

The E-KPol is composed by:

- a telescope (an achromatic doublet with 600mm of focal length);
- a telescope mount with computer guide;
- a LCVR-based polarimeter;
- a CCD detector (back illuminated camera).

More details are given in [Ref. 1] and [Ref. 2]. A description of the devices that we need to control and their electronic interfaces are listed on Table 1.

Device	Interface/Bus	Operations	Priority
LC-based polarimeter	Digital Controller/LPT	-Set/Read LC Temperature -Set LC Voltage	Mandatory
CCD Camera	PCI card	-Set ccd and DAQ parameters -Acquire frames	Mandatory
Telescope mount	RS-232	-Read pointing	Optional
Oscilloscope	USB	-Read voltage applied to LC	Optional

Table 1 – *List of devices and electronics interfaces (green background are for mandatory devices and red for optional)*

Using a PCI device, we need also use a control PC with this bus, usually not mounted on normal laptop. Then, we use a specific computer in order to control the E-KPol, a portable PC. A schematic view of the E-KPol instrument with all the electronics interfaces is shown in Figure 1.

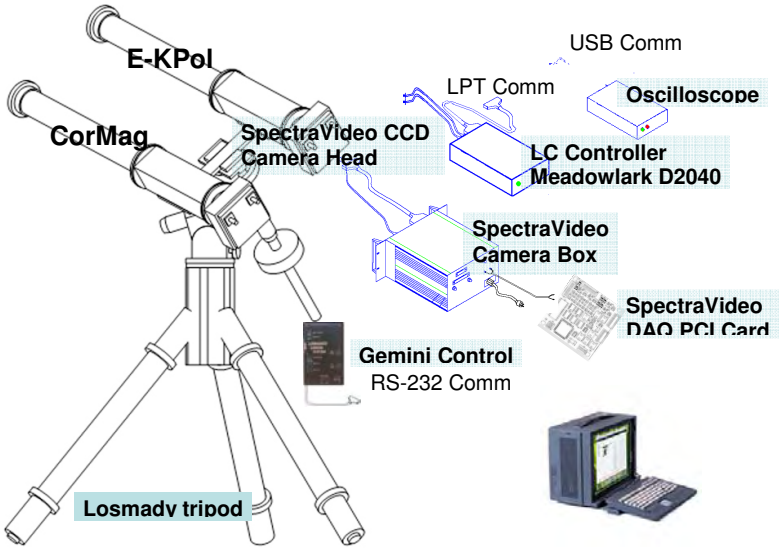


Figure 1 – *E-KPol and electronics interfaces (not in scale)*

The CorMag instrument (the second telescope in Figure 1) is not considered here.

Software installation

This software need the follow system requirements:

RAM: 256 MB;

OS: Windows 2000/NT;

Software: NI LabVIEW 7.1

BUS PCI;

LPT Port.

No software installation (except NI LabVIEW 7.1) is required. You just need to copy and paste the folder containing EPICS1.4.vi and all its subdir in the control PC.

GUI description

The main page of the EPICS software is shown in Figure 2.

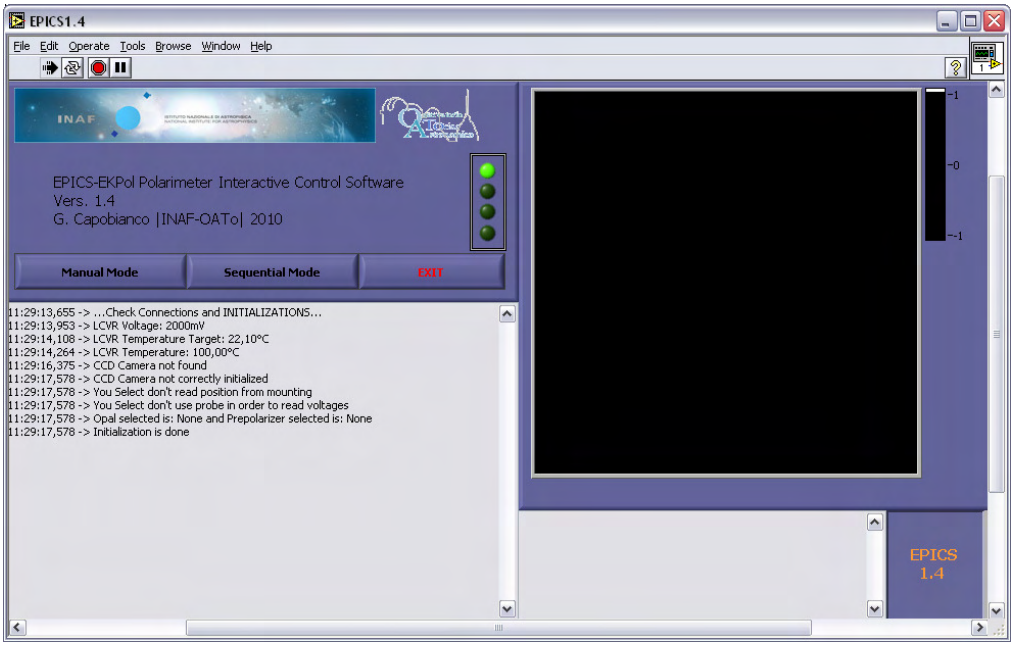


Figure 2 – *EPICS Software main page*

Running the software, a window appear that allow the user to set the initialization values for the devices, as shown in Figure 3.

Figure 3 – *Initial settings window*

All the devices are initialized to these values. On the left side there are the LCVR parameters:

- The parallel port addresses (Data Register and Control Register) in hexadecimal;
- The LCVR temperature in °C;
- The Voltage in mV;
- And the delay between a write command and a read command in milliseconds.

On the right side there are the Camera Parameters:

- The board number;
- The exposure time in milliseconds;
- The binning of the two axes (X and Y);
- The default library name;
- The shutter control ([S]software, [O]open or [C]closed);
- The Single ROI option (if False no ROI is applied);
- If Single ROI is applied the coordinates of the ROI (Top, Bottom, Left and Right) in pixels.

In the bottom position there are:

- The Use probe option;
- The probe channel;
- The read pointing option;
- The COM port where mounting is connected;
- The Opal type and the Pre polarizer position if mounted;

These parameters can be saved in the configuration register and automatically updated the next time that the software will be open (“Save Parameters in Conf Register” button) and applied (“Apply” button). In right-bottom position there are also three status leds:

- The first one is “on” if no error are detected reading the configuration register;
- The second one is “on” if all the parameters are correctly read from the configuration register;
- The third one is “on” if the parameters are correctly write in the configuration register if this option has been selected.

The configuration register is the file Configuration .conf file in the directory home/Configuration.

An example of this file is the follow:

```
//This is a default parameters file for EPS1.0
//Please don't remove this file

//MLO D2040 Controller
//=====================
DataRegisterAddress=378;        //hex
ControlRegisterAddress=37A;     //hex
LCTemperature=22.1;             //°C
LCVoltage=2000;                 //mV
ReadWriteDelay=150;             //ms

//PixelVision CCd Camera
//=====================
CCDSettingsLib=OAToTestLib;     //LibraryName
BoardNumber=0;
ExposureTime=60;                //ms
XBinning=1;
YBinning=1;
ROIMode=N;                      //None(N) or Single(S)
ROITop=0;
ROIBottom=1023;
ROILeft=0;
ROIRight=1023;
```

```
Shutter=S;                      //Software(S),Open(O),Closed(C)

//Oscilloscope
//============
UseOscilloscope=F;              //True(T) or False(F)
ProbeChannel=A;

//Mounting Gemini
//===============
UseMounting=F;                  //True(T) or False(F)
MountingPort=COM2;

//Set-Up Parameters
//=================
Opal=None;                      //None or type
Prepol=None;                    //None or type
```

In the default library name are writing some values for the camera initialization. Is not useful change this values every time that the software is run. These files need an extension ".lb". An example is the follow:

```
//Please don't change this file
//Create a different lib file
//
CCDWidth=1024;
CCDHeight=1024;
FrameWidth=1024;
FrameHeight=1024;
PixelDept=16;
Timeout=80000;
Channels=1;
PROMPages=3;
CCDTemperature=230;
MasterClock=1000;
DiskingWait=31;
ParallelWait=495;
AfterExposureWait=258;
SerialWait=1;
FlushSerialWait=1;
//
//Author G. Capobianco INAF-OATo
//2010-05-03
```

The software need that with the same name there's also a registry file. In case of failure, the registry file is applied for the camera initialization.

After the choice of the parameters, clicking on Apply the program check if the selected devices are connected and initialize to the selected values these devices.

The green led are referred to correctly initialized LCVR Controller(1st led), CCD Camera (2nd led), Mount (3rd led) and Probe (4th led).

User can now select the Manual Mode or the Sequential Mode or Exit for stop the execution of the program .

Manual Mode

Selecting Manual Mode the user can control manually all the devices. Parameters that are changeable in this mode are:

- LCVR Voltage;
- LCVR Temperature;
- Camera Exposure Time;
- Camera Binning;
- Camera ROI;

- The coordinates of the ROI if enable;

A single click on the Apply button is required to set the new values.

The user can also acquire a single frame or a dark frame. If a Dark frame is acquired, the shutter need to be setted manually on Close position.

A screenshot of the Manual mode is reported in Figure 4.

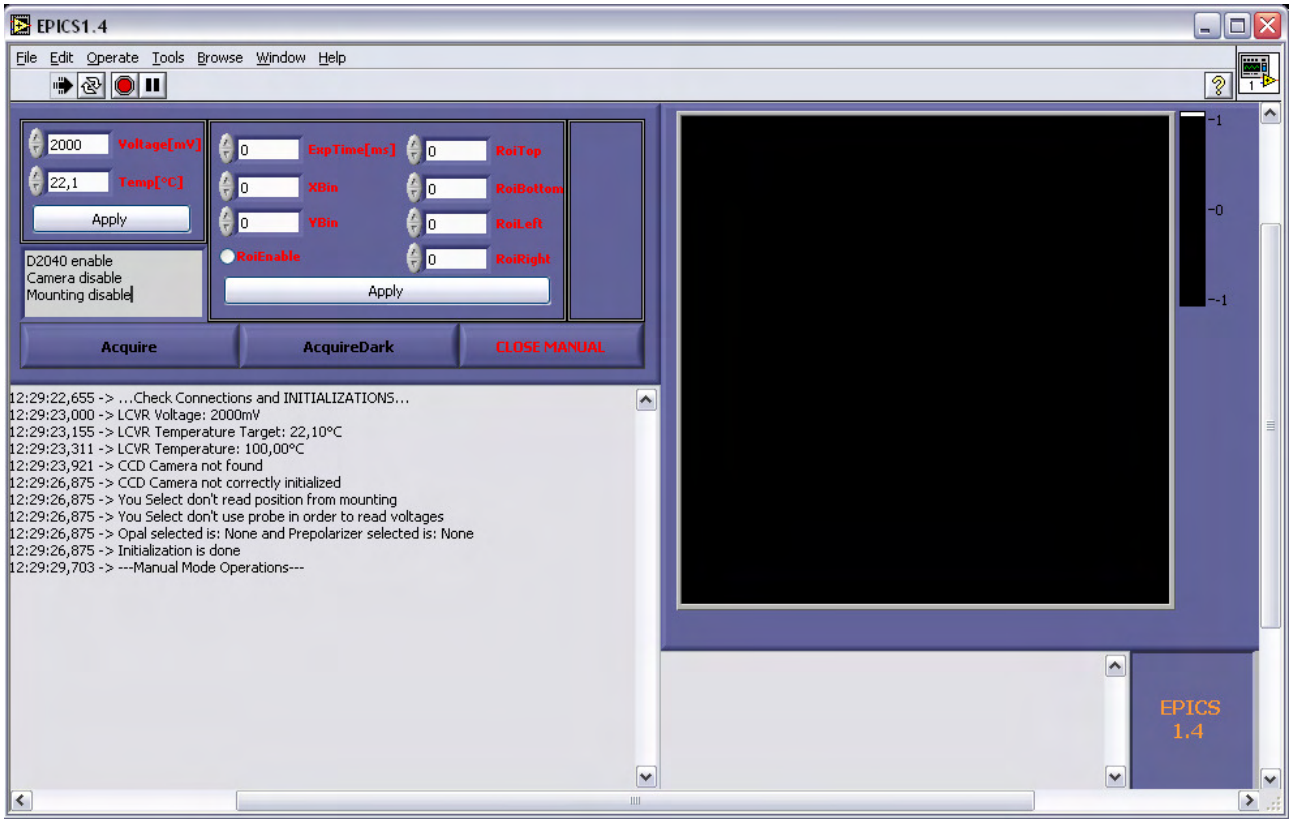


Figure 4 – *EPICS Manual Mode Operations screenshot*

The frame acquired is automatically saved in the folder:

[HOME]:/Data/[Dark]ImageYYYYMMDDHHmmSS.fits

- [HOME] is the path of the EPICS software;
- YYYY is the year;
- MM is the month;
- DD is the day;
- HH is the hour;
- mm the minutes;
- and SS the seconds.
- The sting “DARK” is add if the frame is acquired as Dark frame.

The frame is showed in the box in the right side and below is displayed the header. The description of the header is in the next session.

A monitor of the current values is automatically displayed. See Figure 5.

Figure 5 - *EPICS Software, Display of the current settings of the devices*

Sequential Mode

A screenshot of this mode is reported in Figure 6. The user need just to select the sequence file and click on the Load button. The software read this file and is ready for the data acquisition.

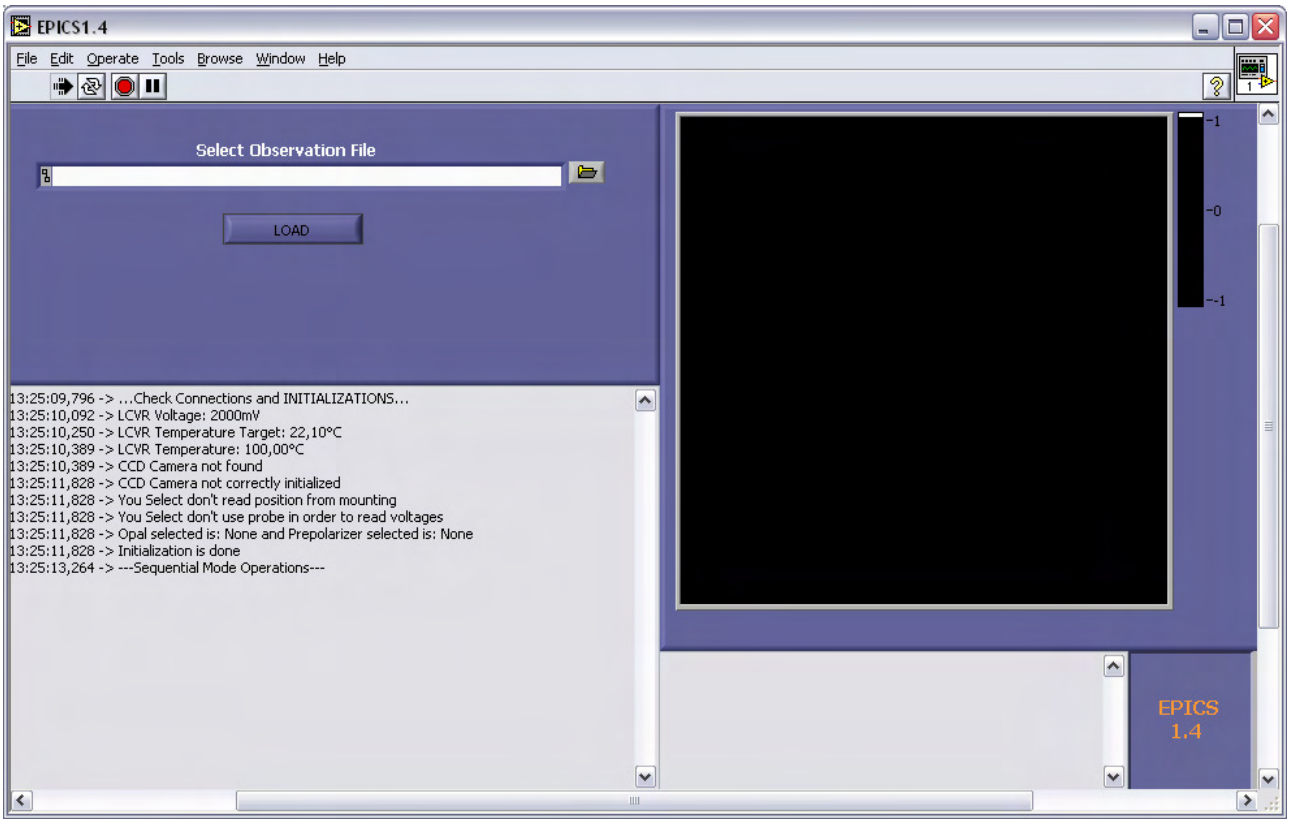


Figure 6 – *Screenshot of the sequential mode operations*

A window appear that show the temperature of the LCVR and a button to press for start the data acquisition. Also in this case the monitor of the current parameters appear.

The structure of the sequential file is the follow:

```
//Sequential Data Acquisition File
```

```
//
//LC Parameters
LC_VOLTAGES[0,1000,2000,3000] //mV
//Camera Parameters
EXPOSURE_TIMES[250,1000,4000] //ms
X_BINNING[1,1,1]
Y_BINNING[1,1,1]
ROI_MODE[N,N,N] //None(N) or Single(S)
ROI_TOP[0,0,0]
ROI_BOTTOM[1023,1023,1023]
ROI_LEFT[0,0,0]
ROI_RIGHT[1023,1023,1023]
//All the camera parameters arrays need
//to have the same dimension
```

For each set of values for the camera, the software acquire different frames applying all the LCVR voltages. During data acquisition, automatically appear a progress bar with the “STOP” button. All the frames acquired are showed in real time in the right window and below the frame is showed the header. Files are automatically saved in fits standard format using the same syntax of the manual mode. At the end of the data acquisition the software return to the main page (Figure 2).

Fits Files Header

The header of the files is the follow:

```
SIMPLE  =                    T/Conform to FITS Standard
BITPIX  =                  -32/Number of bits per pixel
NAXIS   =                    2/Number of axes in the image
NAXIS1  =                 1024/Length of the first axis (columns)
NAXIS2  =                 1024/Length of the second axis (rows)
FILENAME='1Image20100711184545'/Name of the fits file
OBSEQ   =                    1/Sequential number of EKPol data acquisition (single session of automatic mode)
EXPTIME =               250,00/Exposure time in milliseconds  (CCD Camera exposure time)
LCVOLT  =                 4500/LCVR Voltage in mV
LCTEMP  =                30,74/LCVR Temperature in °C
DATEOBS =          '2010/07/11'/Date of the start of exposure
TIMEOBS =            '18:45:41'/Time of the start of exposure
DATETIME= '2010/07/11 18:45:45'/Date/Time of file generation
XBINNING=                    1/Binning along X axis
YBINNING=                    1/Binning along Y axis
PREPOL  =               'None'/Position of prepolarizer
OPAL    =               'None'/Opal type
DECLIN  =               'None'/declination of  pointing (ddd.mm.ss) (read from the mount)
RA      =               'None'/RA of  pointing (ddd.mm.ss) (read from the mount)
END
```

File Format

Files are automatically saved in fits format. The dimensions of the frames are 1024x1024 pixels. The depth is of 16 bit, but for the correct interpretation is set to -32 (see BITPIX keyword in the header). Each file need 4MB of disk space.

Log File

Closing the application, a log file is automatically created. The filename have the same structure of the data filename, with a string “ECSLog-“ before date/time. The file extension is “.log”.

Conclusions

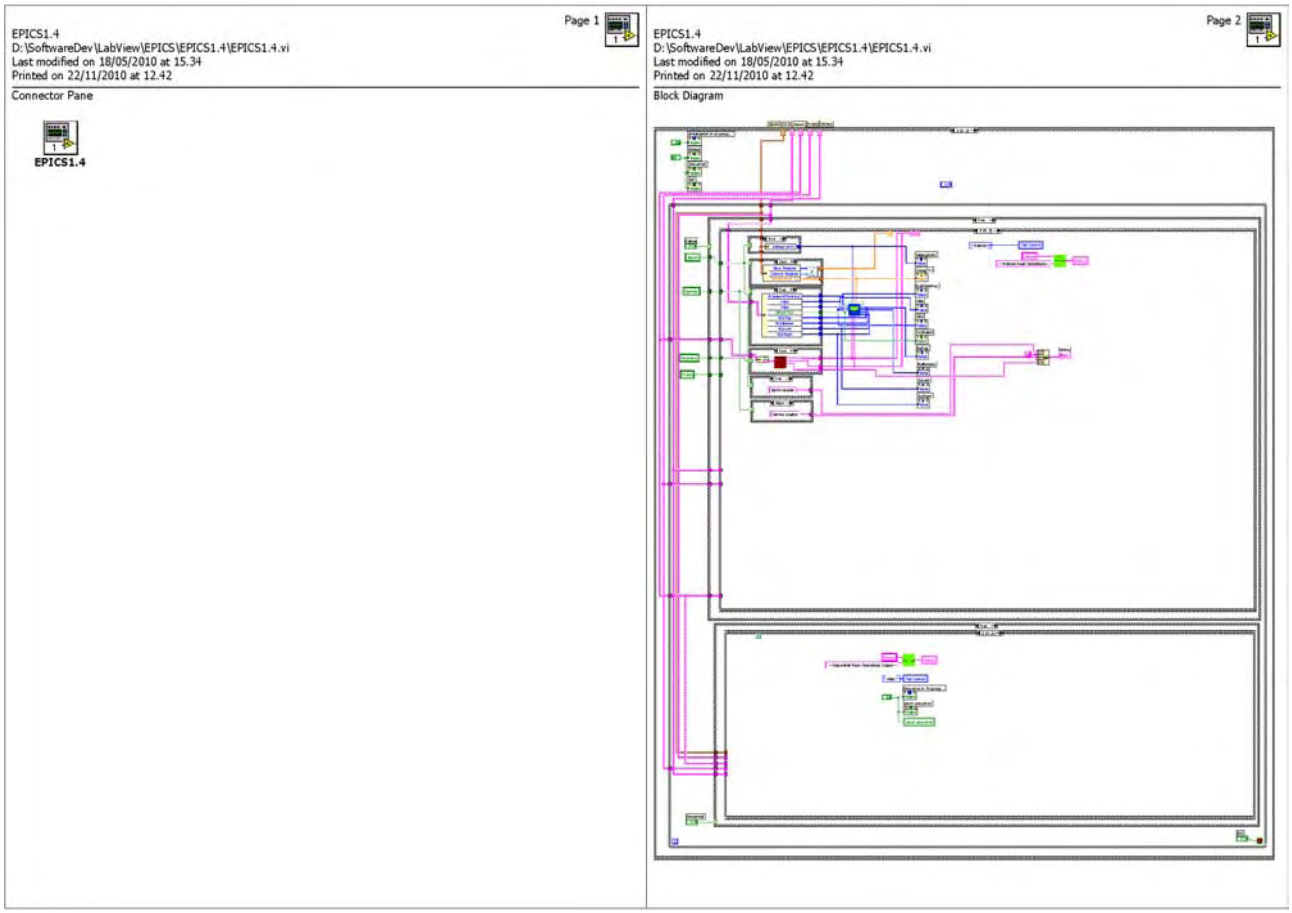
This software has been successfully used during the total solar eclipse of July 11th 2010, and for the pre and post calibration measurements of the E-KPol instrument. The software require at list 7MB of free disk space and 256 MB of RAM.

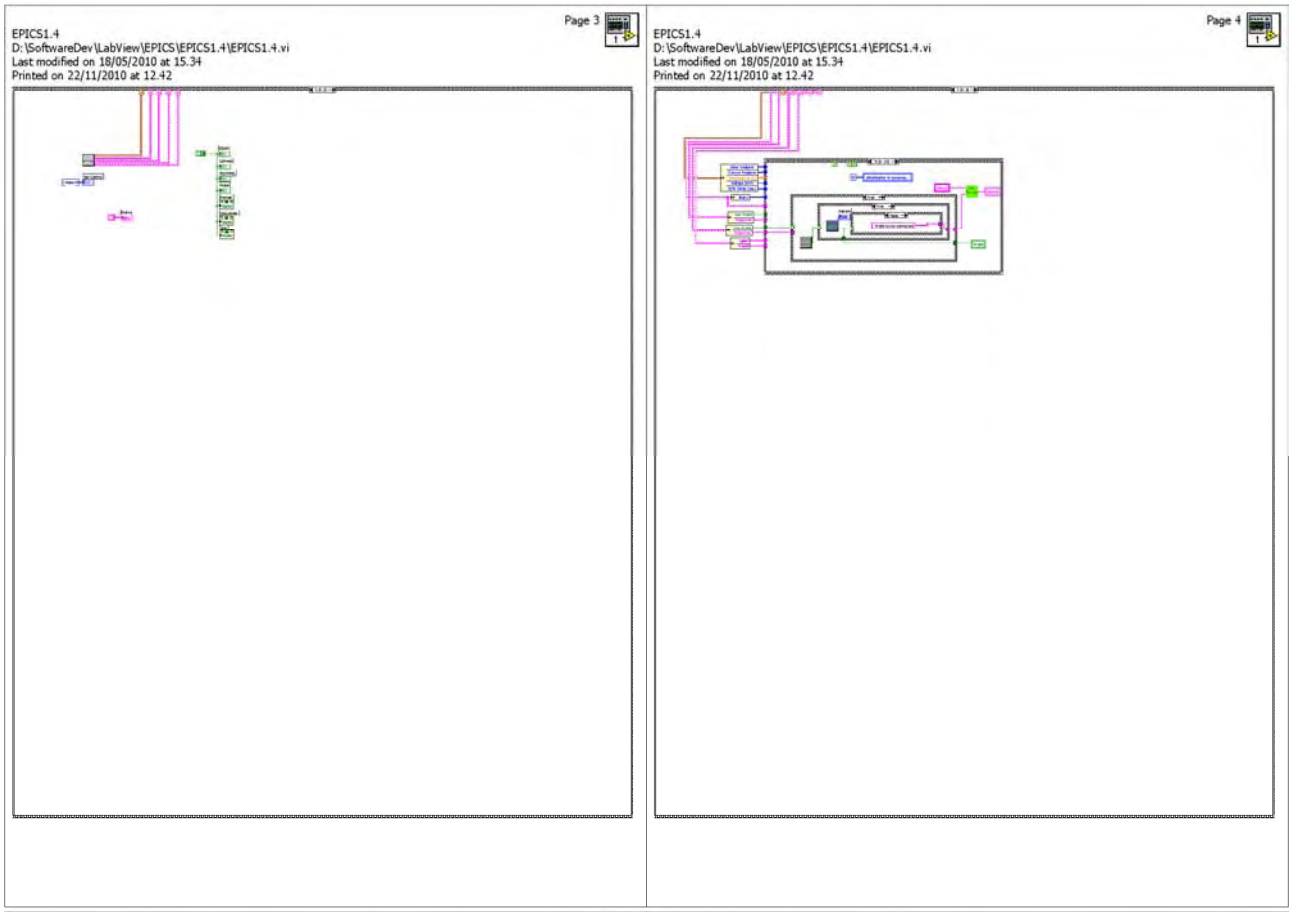
References

Ref. 1 Zangrilli et al. - Proceedings of the International Symposium on Solar Physics and Solar Eclipses (SPSE-2006), pp. 37-45 (2006)

Ref. 2 Zangrilli et al. - Proceedings of the SPIE, Volume 7438, pp. 74380W1-74380W-10 (2009)

Appendix A – Source Code




Page 3
EPICS1.4
D:\SoftwareDev\LabView\EPICS\EPICS1.4\EPICS1.4.vi
Last modified on 18/05/2010 at 15.34
Printed on 22/11/2010 at 12.42

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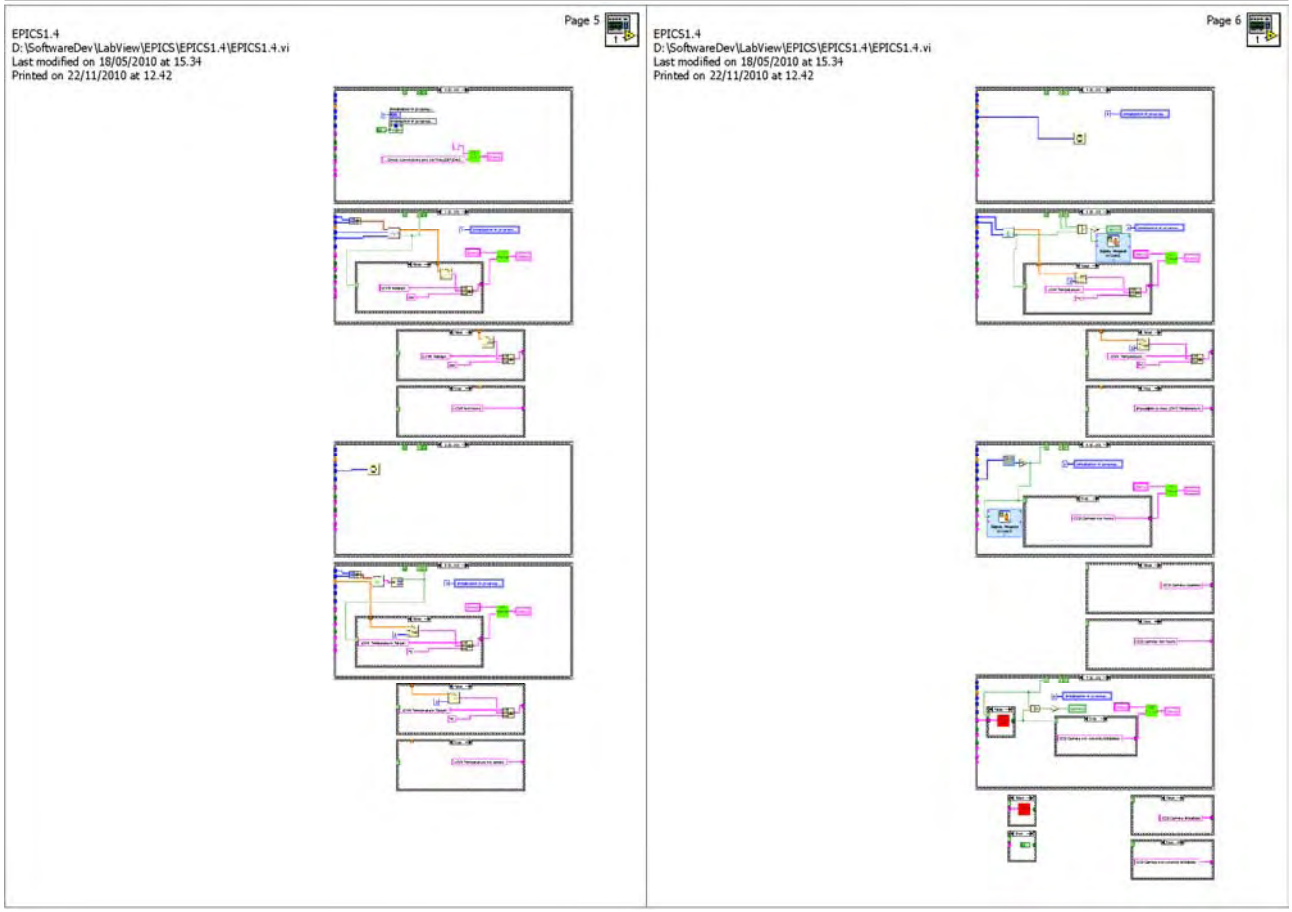
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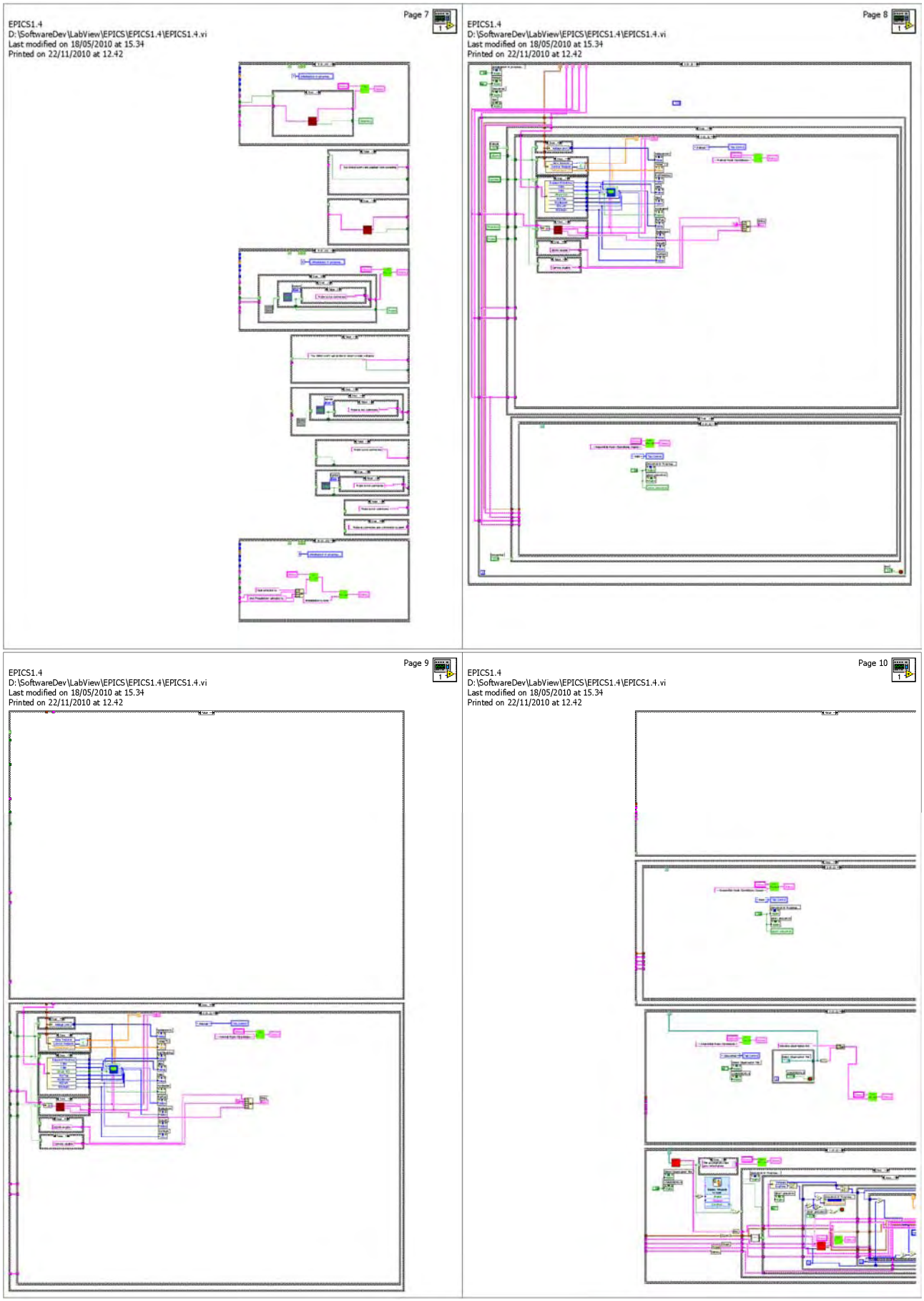
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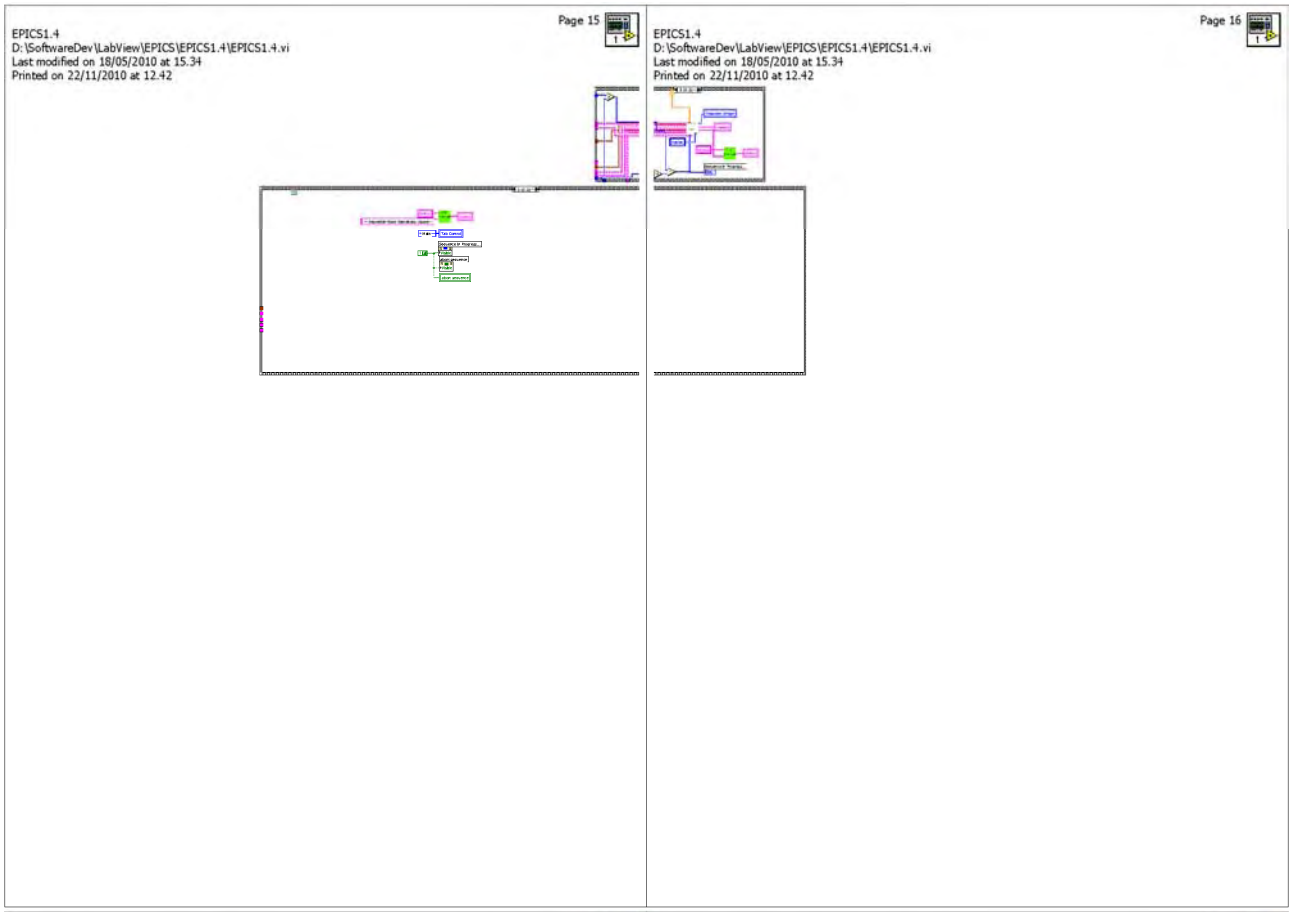
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EPICS1.4
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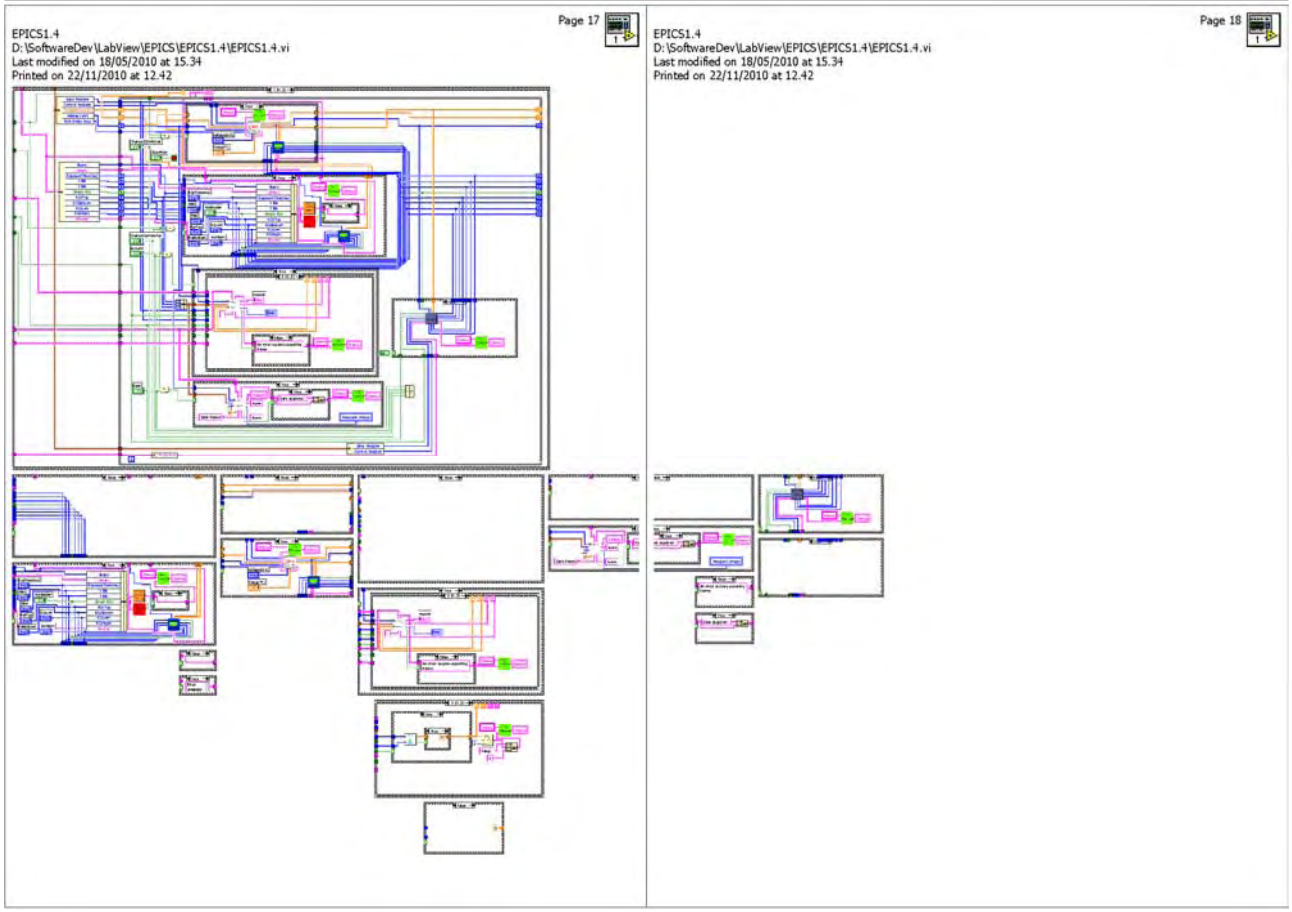
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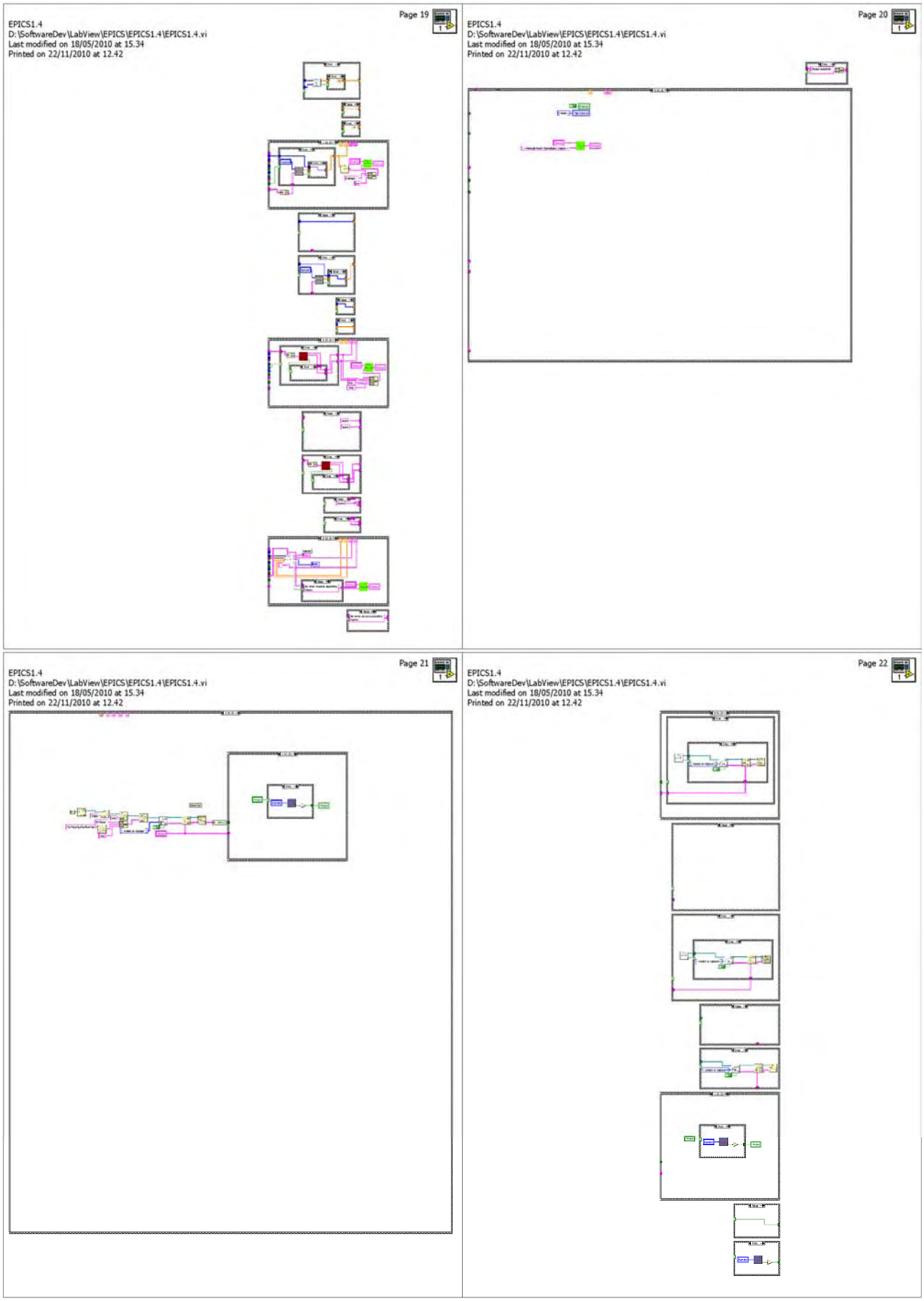
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List of SubVIs and Express VIs with Configuration Information

ManualParametersManager.vi
D:\SoftwareDev\LabView\EPICS\EPICS1.4\SubVI\General\ManualParametersManager.vi

LogManager.vi
D:\SoftwareDev\LabView\EPICS\EPICS1.4\SubVI\General\LogManager.vi

LCVRTemp_single.vi
D:\SoftwareDev\LabView\EPICS\EPICS1.4\SubVI\D2040\LCVRTemp_single.vi

LCVRTemperatureRead.vi
D:\SoftwareDev\LabView\EPICS\EPICS1.4\SubVI\D2040\LCVRTemperatureRead.vi

pvInitCapture.vi
D:\SoftwareDev\LabView\EPICS\EPICS1.4\SubVI\PixelVision\PixelVisionCameraSettings.llb\pvInitCapture.vi

ParameterMonitor.vi
D:\SoftwareDev\LabView\EPICS\EPICS1.4\SubVI\General\ParameterMonitor.vi

D2040ManualChangeParam.vi
D:\SoftwareDev\LabView\EPICS\EPICS1.4\SubVI\D2040\D2040ManualChangeParam.vi

CameraParameterStringOut.vi
D:\SoftwareDev\LabView\EPICS\EPICS1.4\SubVI\PixelVision\CameraParameterStringOut.vi

DAQandSAVEFITSseq.vi
D:\SoftwareDev\LabView\EPICS\EPICS1.4\SubVI\DataIO\DAQandSAVEFITSseq.vi

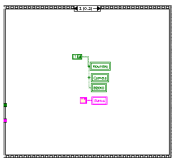
StatusRefresh.vi
D:\SoftwareDev\LabView\EPICS\EPICS1.4\SubVI\General\StatusRefresh.vi

ReadSeqFile.vi
D:\SoftwareDev\LabView\EPICS\EPICS1.4\SubVI\DataIO\ReadSeqFile.vi

Display Message to User
Display Message to User
Displays a standard dialog box that contains an alert or a message for users.

This Express VI is configured as follows:

Message:



Display Message to User2
Display Message to User
Displays a standard dialog box that contains an alert or a message for users.

This Express VI is configured as follows:

Message:

Display Message to User3
Display Message to User
Displays a standard dialog box that contains an alert or a message for users.

This Express VI is configured as follows:

Message:

WaitForSeq.vi
D:\SoftwareDev\LabView\EPICS\EPICS1.4\SubVI\General\WaitForSeq.vi

Initialization0.1.vi
D:\SoftwareDev\LabView\EPICS\EPICS1.4\SubVI\PixelVision\Initialization0.1.vi

CameraInit1.vi
D:\SoftwareDev\LabView\EPICS\EPICS1.4\SubVI\Seq\CameraInit1.vi

LCRVoltApply.vi
D:\SoftwareDev\LabView\EPICS\EPICS1.4\SubVI\D2040\LCRVoltApply.vi

LCRChangeVolt.vi
D:\SoftwareDev\LabView\EPICS\EPICS1.4\SubVI\Seq\LCRChangeVolt.vi

DAQandSAVEFITSvi.vi
D:\SoftwareDev\LabView\EPICS\EPICS1.4\SubVI\DataIO\DAQandSAVEFITSvi.vi

Open/Create/Replace File.vi
C:\Programmi\National Instruments\LabVIEW 7.1\vi.lib\Utility\file.llb\Open/Create/Replace File.vi

SaveLogFile.vi
D:\SoftwareDev\LabView\EPICS\EPICS1.4\SubVI\DataIO\SaveLogFile.vi

ProbeConn.vi
D:\SoftwareDev\LabView\EPICS\EPICS1.4\SubVI\Probe\ProbeConn.vi

ProbeOpen.vi
D:\SoftwareDev\LabView\EPICS\EPICS1.4\SubVI\Probe\ProbeOpen.vi

GeminiTestCommunication.vi
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GeminiReadRAandDec.vi
D:\SoftwareDev\LabView\EPICS\EPICS1.4\SubVI\Gemini\GeminiReadRAandDec.vi

ProbeDAQ.vi
D:\SoftwareDev\LabView\EPICS\EPICS1.4\SubVI\Probe\ProbeDAQ.vi

ProbeClose.vi
D:\SoftwareDev\LabView\EPICS\EPICS1.4\SubVI\Probe\ProbeClose.vi