LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY
- LIGO -
CALIFORNIA INSTITUTE OF TECHNOLOGY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Technical Note	LIGO-T1500062-v7	2019/03/03

Pcal End Station Power Sensors Responsivity Ratio Measurements Procedures and Log

N. Lecoeuche, S. Karki, R. Savage

California Institute of Technology
LIGO Project, MS 18-34
Pasadena, CA 91125
Phone (626) 395-2129
Fax (626) 304-9834
E-mail: info@ligo.caltech.edu

Massachusetts Institute of Technology
LIGO Project, Room NW22-295
Cambridge, MA 02139
Phone (617) 253-4824
Fax (617) 253-7014
E-mail: info@ligo.mit.edu

LIGO Hanford Observatory
Route 10, Mile Marker 2
Richland, WA 99352
Phone (509) 372-8106
Fax (509) 372-8137
E-mail: info@ligo.caltech.edu

LIGO Livingston Observatory
19100 LIGO Lane
Livingston, LA 70754
Phone (225) 686-3100
Fax (225) 686-7189
E-mail: info@ligo.caltech.edu

http://www.ligo.caltech.edu/

END STATION: ..... DATE: .....

PEOPLE DOING THE WORK: .....

Before (or after) going to the End Station

- Check the calibration of the Keithley Model 2100 voltmeter using the Martel Calibrated Voltage source (the same one that will be taken to the end station.
  - −4 V with Martel = ...-4.0001... V on Keithley 2100 DVM
  - −2 V with Martel = ...-2.0000... V on Keithley 2100 DVM
  - 0 V with Martel = ...-0.000122... V on Keithley 2100 DVM

Items to take to the end station for the measurements:

- Working Standard
- PD Satellite Box (blue box), D1300368
- Long (25') and short (6'-10') 9-pin D-sub cables
- BNC cable
- Martel calibrated voltage source and charger
- IR-only laser glasses

Before starting the measurements

- Disable excitations on the Pcal MEDM screen.
- Check that ETM is pointed properly. Check Pcal beam locations at the Rx sensor (photograph spot locations on white card).
- Open gpsclock
- Open StripTool and display the following sensor outputs. Always verify that signals are stable before recording time series.
  - (IFO):CAL-PCAL(END)_TX_PD_VOLTS_OUTMON
  - (IFO):CAL-PCAL(END)_RX_PD_VOLTS_OUTMON
  - (IFO):CAL-PCAL(END)_WS_PD_OUTMON
  - (IFO):CAL-PCAL(END)_OFS_PD_OUTMON

Calibration measurements and log

Preliminary measurements

Calibrate the Working standard channel

- Connect Martel Calibrated Voltage Source to INPUT 1 on the BNC to DB9 module. Note: use negative polarity.
- Record 15 seconds of data for each input voltage.
  - - 4 V = -3.996 volts and GPS Start Time 070 530
  - - 2 V = -1.998 volts and GPS Start Time 070 500
  - 0 V = -0.0001 volts and GPS Start Time 1240 070 475

Record Optical Follower Servo settings

- Offset: 3.70 volt
- Gain: 41.00 dB
- OFS PD: -3.686 volt

Record Working Standard temperature

- Measure sensor voltage at Interface Module WS PD MON BNC output ising a voltmeter. Between
  - GPS time: 1240070530 - 1240071070
  - WS PD MON: 2.582 volts
- Convert to degrees Celsius by dividing by 0.90909, multiplying by 100, and subtracting 273.15.
  - WS PD temperature: 10.87 deg. Celsius.
  - WS PD temperature: 51.56 deg. Farenheit.

Time Series Measurements

- Connect Pcal Blue Box PD MON output to INPUT 1 on the BNC to DB9 module.

Measurement 1:

- Block the OUTER beam with a razor blade dump in the Tx module.
- Place the WS in the INNER beam in the Tx module.

WS in the INNER beam in the Tx module.				
GPS Times		Readings from MEDM screen		
Start Time #1	1240 071 690	TxPD	2.545	volt
Duration	240 seconds	WSPD	-2.269	volt
End Time #1	072 130	OFSPD	-3.686	volt

Measurement 2:

- Move the block to the INNER beam in the Tx module.
- Move the WS to the OUTER beam in the Tx module.

WS in the OUTER beam in the Tx module.			
GPS Times		Readings from MEDM screen	
Start Time #2	" 072 250	TxPD	+2.546
Duration	240 seconds	WSPD	-2.274
End Time #2	" " 490	OFSPD	-3.686

Measurement 3:

- Leave the WS in the OUTER beam in the Tx module with the INNER beam blocked.
- Close the shutter in the Tx module.

WS in the OUTER beam in the Tx module. Shutter CLOSED.			
GPS Times		Readings from MEDM screen	
Start Time #3	072 535	TxPD	-0.0051
Duration	60 seconds	WSPD	-0.0005
End Time #3	072595	OFSPD	-0.01

Measurement 4:

- Leave the block in the INNER beam in the Tx module.
- Open the shutter in the Tx module.
- Replace the Rx sensor with the WS in the Rx module.

WS in the Rx module. INNER beam blocked in the Tx module.			
GPS Times		Readings from MEDM screen	
Start Time #4	073 000	TxPD	2.546
Duration	240 seconds	WSPD	-2.242
End Time #4	" 240	OFSPD	-3.686

Measurement 5: * Note: Rx module was not removed. WS module was moved b/w inner and outer beams

- Move the block to the OUTER beam in the Tx module.

WS in the Rx module. OUTER beam blocked in the Tx module.			
GPS Times 498		Readings from MEDM screen	
Start Time #5	073 ~~295~~	TxPD	2.546
Duration	240 seconds	WSPD	-2.238
End Time #5	" 730	OFSPD	-3.686

subsubsection*Measurement 6:

- CLOSE the shutter in the Tx module.

WS in the Rx module. Shutter CLOSED in the Tx module.			
GPS Times		Readings from MEDM screen	
Start Time #6	074 110	TxPD	0.015
Duration	60 seconds	WSPD	-0.0001
End Time #6	074 170	OFSPD	-0.009

Measurement 7:

#1

- OPEN the shutter in the Tx module.
- Leave the beam block in the OUTER beam in the Tx module.
- Replace the WS with the Rx sensor in the Rx module.

OUTER beam blocked in the Tx module. Rx sensor in the Rx module.			
GPS Times		Readings from MEDM screen	
Start Time #7	1240071070	TxPD	2.545
Duration	240 seconds	RxPD	1.615
End Time #7	071310	OFSPD	-3.685

Measurement 8:

- Move the beam block to the INNER beam in the Tx module.

INNER beam blocked in the Tx module. Rx sensor in the Rx module.			
GPS Times		Readings from MEDM screen	
Start Time #8	071345	TxPD	2.544
Duration	240 seconds	RxPD	1.618
End Time #8	071585	OFSPD	-3.686

Measurement 9:

- CLOSE the shutter in the Tx module.

Shutter CLOSED in the Tx module. Inner beam blocked.			
GPS Times		Readings from MEDM screen	
Start Time #9	071610	TxPD	0.005
Duration	60 seconds	RxPD	-0.0003
End Time #9	071670	OFSPD	-001

When measurements are finished.

- Remove the beam block from the INNER beam in the Tx module.
- OPEN shutter in the Tx module.
- Set shutter control to Remote on interface module.
- Re-enable excitations on the Pcal MEDM screen (if applicable).
- Check that ETM is pointed properly. Check Pcal beam locations at the Rx sensor (photograph spot locations on white card).

- Analyze the data and upload results to the SVN.
- Make aLog entry, append image of beam spots at the Rx module, add pointer to measurements results in the SVN.

Data Retrieval and Ratio calculations

Data Acquisition, Plots and Report

1. Make sure the SVN directory
   `/ligo/svncommon/CalSVN/aligocalibration/trunk/Projects/PhotonCalibrator/scripts/pcalEndstation`
   is installed in the machine where you are trying to do the calibration calculation. A description of the Photon Calibrator SVN directory structure and instructions for checking out the whole Pcal repository can be found in `LIGO-T1500095`.

2. Execute the command `svn update` to make sure you have the latest version of the scripts.

3. Execute the command `kinit albert.einstein@LIGO.ORG` to establish connection to the external data server. This will be required for obtaining data later.

4. Open the `parametersforScript01.m` script in Matlab.

   (a) Enter the appropriate calibration date, location and GPS times.

   (b) Make sure the `workingcopy_location` has the appropriate path to the `PhotonCalibrator` directory,
   e.g. `/ligo/svncommon/CalSVN/aligocalibration/trunk/Projects/PhotonCalibrator/`

5. Run `Script01_pcaldateandtime.m` in Matlab.

   (a) It will create a folder named `DYYYYMMDD` in the appropriate directory, e.g. `/ligo/svncommon/CalSVN/aligocalibration/trunk/Projects/PhotonCalibrator/measurements/LHO_EndY`

   (b) It also creates a matlab file named `DYYYYMMDD_time.m` in this folder; it contains the GPS time information.

6. Open the `parametersforScript02.m` script in Matlab.

   (a) Enter the appropriate calibration date and location (interferometer and end station). This is typically the same as for first parameter file.

   (b) Again, make sure the `workingcopy_location` path is correct.

7. Run `Script02_pcalDataandResults.m` in Matlab.

   (a) This will fetch the data from the server and write it as .txt files in the folder.

   (b) It also generates plots of the ratios and saves the plots to the same folder, in addition to displaying them on the screen. Make sure the plots are satisfactory before closing them.

   (c) It will generate files, `DYYYYMMDD_Ratio.mat` and `DYYYYMMDD_Results.mat`, that contain the calibration results.

8. In the Matlab command window run the following command.
   `pcalPublishReport('ifo_arm', 'outputFilename')` where

(a) `ifo_arm` = `LHOX`, `LHOY`, `LLOX` or `LLOY`.

(b) `outputFilename` is
- `''` (quotes with an empty string will return the default .pdf filename)
- `XXXXX.pdf` with `XXXXX` being the desired .pdf output filename

Commit the new files to the SVN

1. In the terminal window, execute the following commands (Refer to T1500095 for details) from the `.../PhotonCalibrator/measurements/end_station` folder (Refer to T1500095 for details.)
   - `svn add DYYYYMMDD`
   - `svn commit -m "message, e.g. person committing files"`
   - `svn update`
2. Also make sure that the changes made to the scripts in the `pcalEndstation` folder are committed to the svn in a similar manner.

DCC Update

1. Upload the generated report to the T-document filecard in the DCC as a new version.
2. Update the `LIGO-T1500622` filecard by adding a link¡ under the proper interferometer and end station¡ to the new `DYYYYMMDD` folder in the SVN repository.

trends document located at:
PhotonCalibrator/trends/endstation

The default is like LHO_PD_trend.pdf