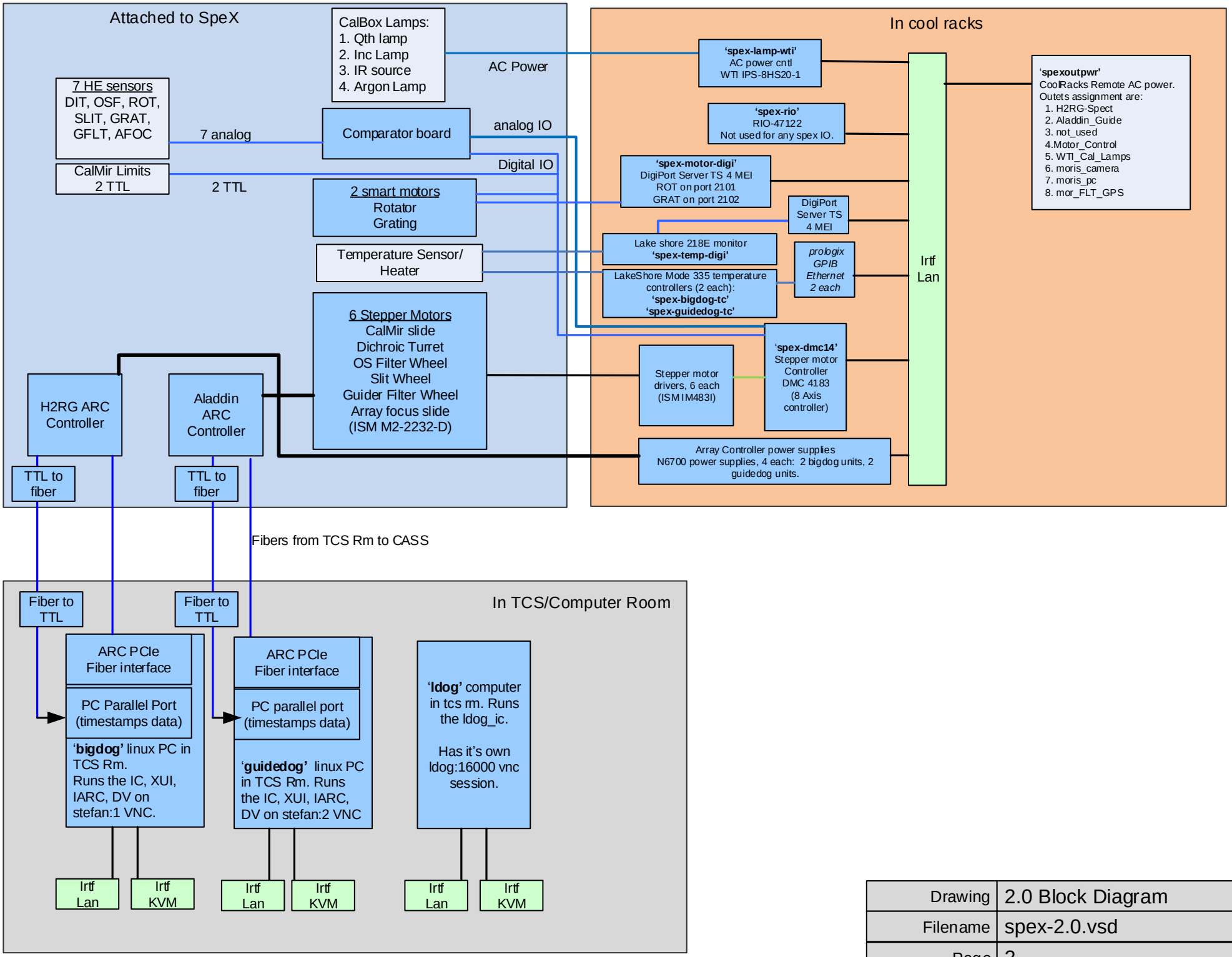
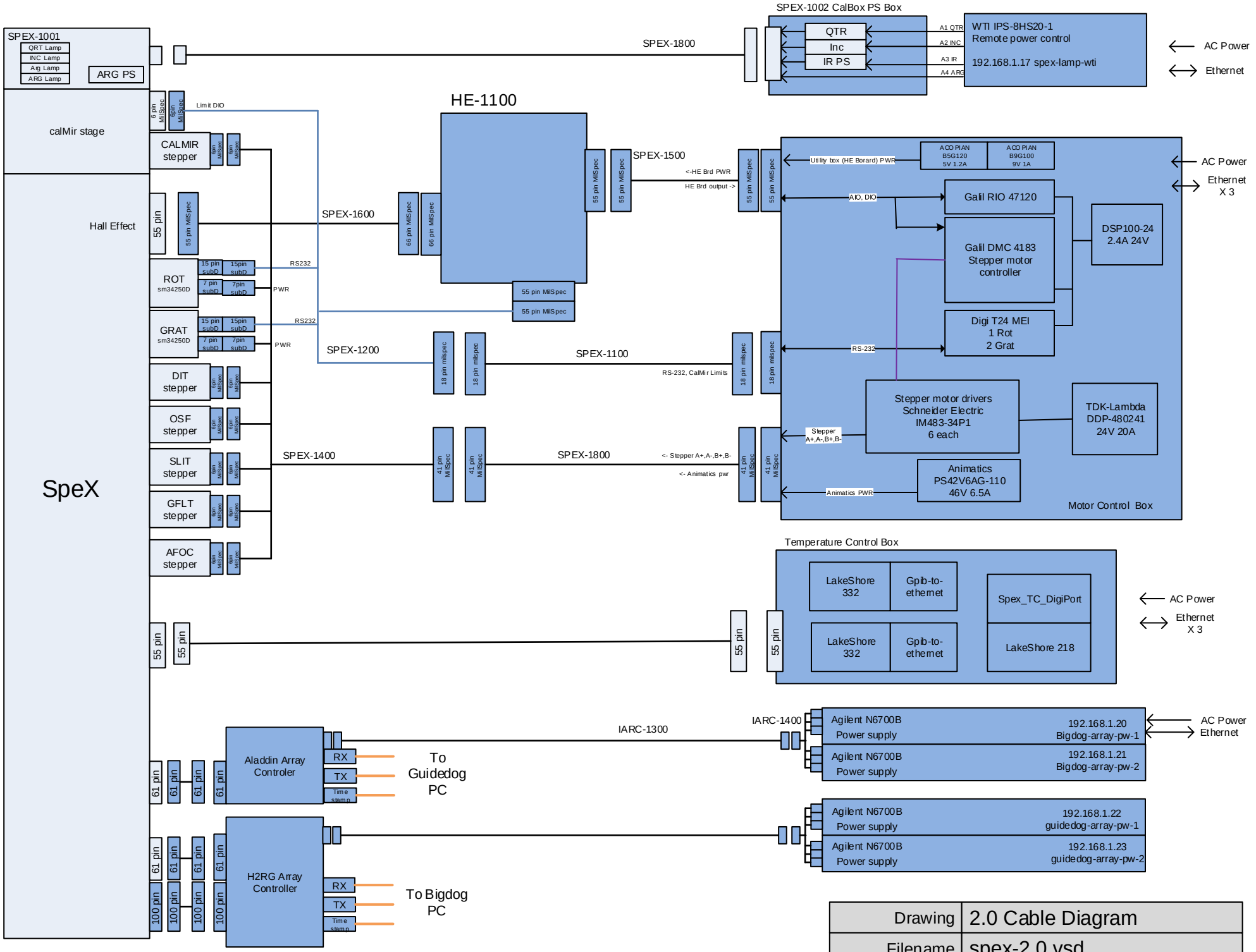
Table of Contents

SpeX 2.0 Title Page	1
2.0 Block Diagram	2
2.0 Cable Diagram	3
2.0 Array Cntr Block Diagram	4
IARC H2RG diagram	5
2.0 Software Overview	6
2.0 Software XUI/IC/LDog	7
User Accounts	8
Motor Summary	9
CalMir	10
DIT	11
OSF	12
ROT	13
SLIT	14
Slit AutoGuideBox	15
GRAT	16
GFLT	17
AFOC	18
Page-19	19
1.0 Block Diagram	20
1.0 cable diagram	21

Drawing	SpeX 2.0 Title Page
Filename	spex-2.0.vsd
Page	1

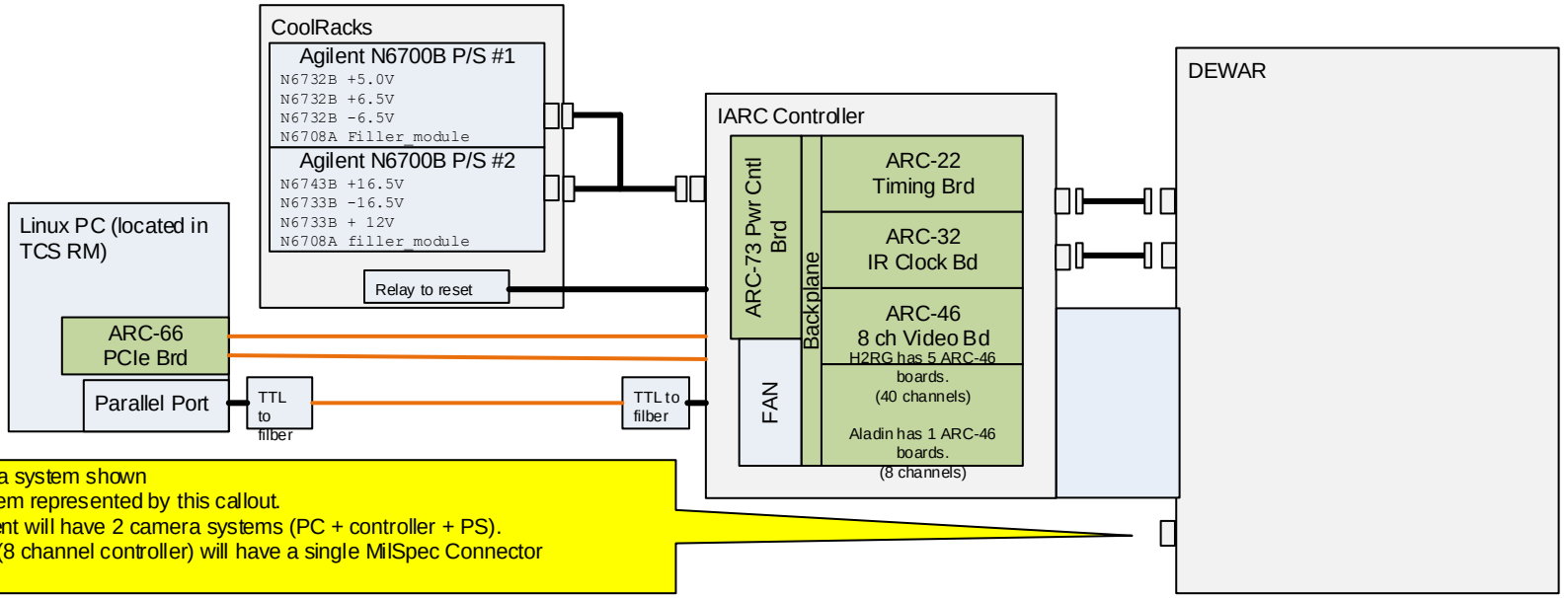


Drawing	2.0 Block Diagram
Filename	spex-2.0.vsd
Page	2

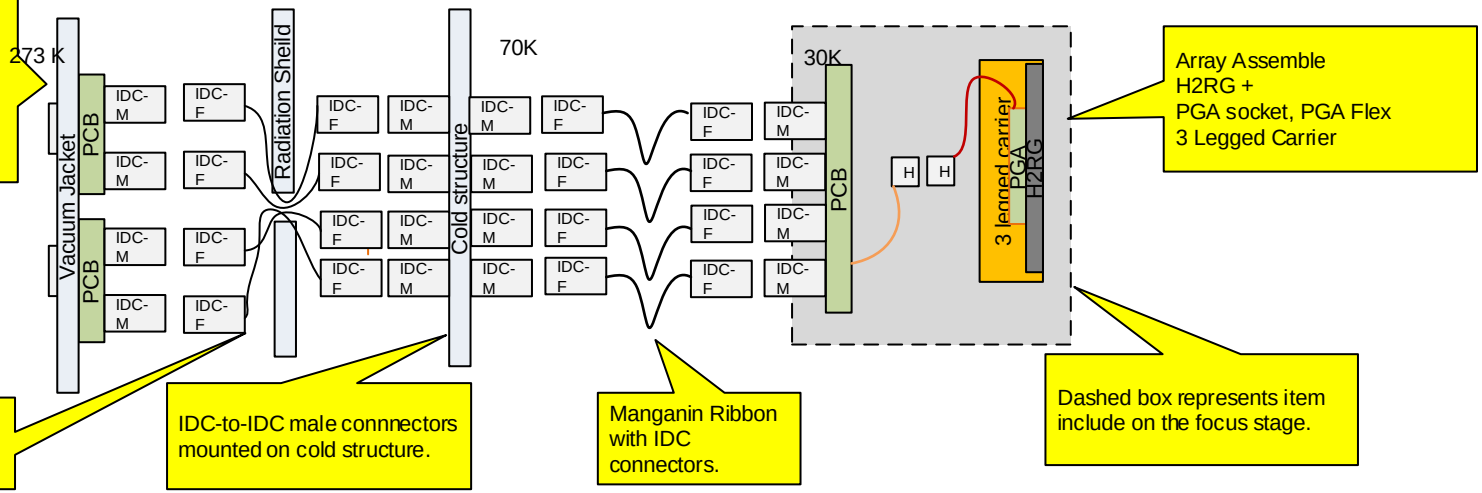


Based on EW google docs drawing:
https://docs.google.com/drawings/d/1M_lYA1YIQgE1bSQKpC8oeTdTGstZauQxcjNFWqR9234/edit

Drawing	2.0 Cable Diagram
Filename	spex-2.0.vsd
Page	3



MILSpec-to-IDC PCB Assembly is mounted on non-removable panel area of the Vacuum Jacket. H2RG has:
61pin MilSpec (MS3340H24C61P-0037)
100pin MilSpec (231-100-H0ZL23-34CN)

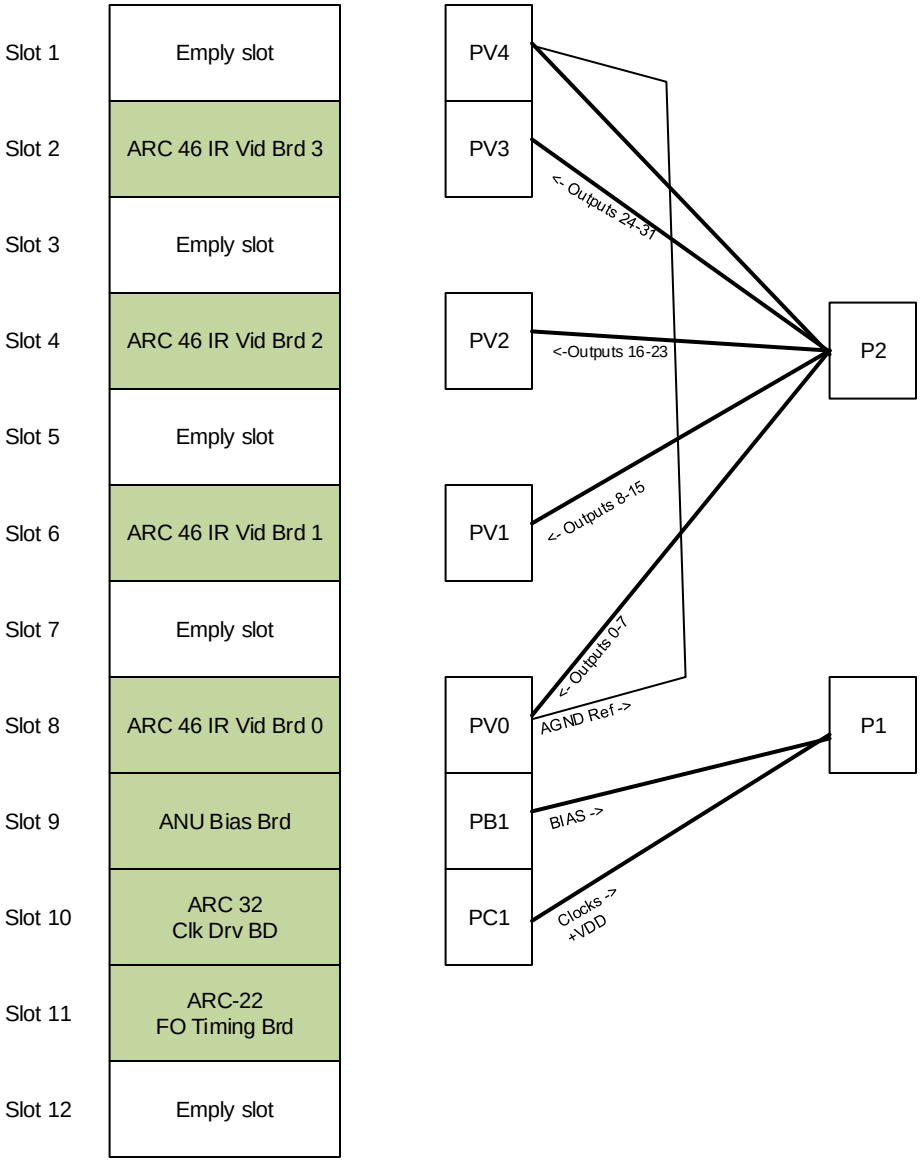


H2RG Internal Dewar Cabling Block Diagram

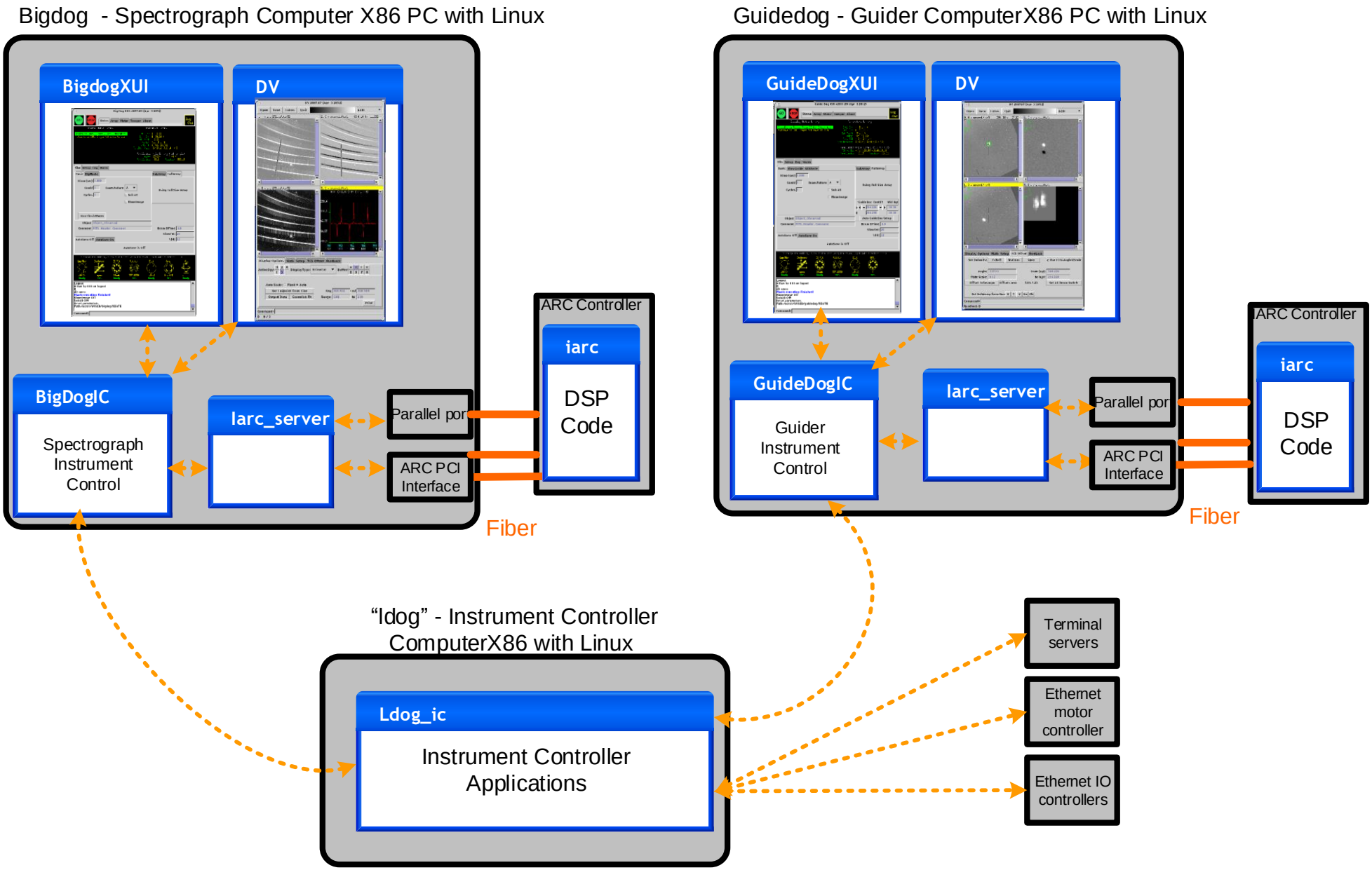
Aladdin Internal Dewar Cabling Block Diagram

Drawing	2.0 Array Cntr Block Diagram
Filename	spex-2.0.vsd
Page	4

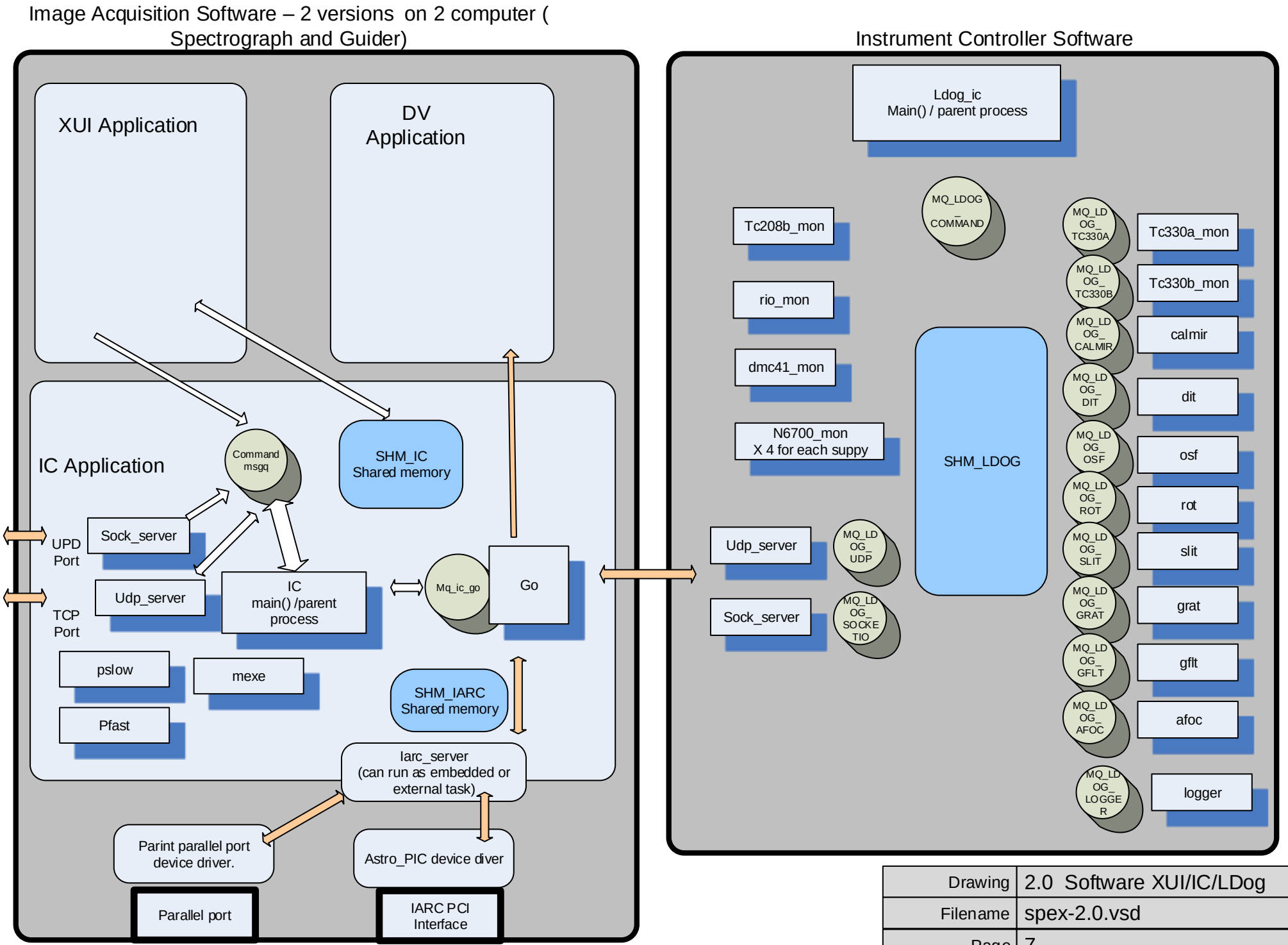
Ref: IARC Design Spreadsheet
https://docs.google.com/spreadsheet/ccc?key=0AgDomi_LyO2MdGo1QURjWmd3eUg4TmZOYnJNQkpWUFE#gid=28



Drawing	IARC H2RG diagram
Filename	spex-2.0.vsd
Page	5



Drawing	2.0 Software Overview
Filename	spex-2.0.vsd
Page	6



Drawing	2.0 Software XUI/IC/LDog
Filename	spex-2.0.vsd
Page	7

User Accounts for SpeX

spex – host the spex web site. Used by support scientist to provide documentation on spex to observers.

Bigdog – user account to run the bigdog software. Bigdog is the spectrograph camera software. It normally runs inside the VNC stefan:1

Guidedog – user account to run the guidedog software. Guidedog is the imager/guider camera software. It normally runs inside the VNC stefan:2

Ldog – user account to run the ldog software. Ldog is the instrument controller (motor, temperature controlers, etc).ldog create it own VNC server, ldog:16000, where the ldog_ic application runs.

s2 – user account for spex programmer. Source code, development documentation is store here. Also has the sim/ directory to run spex in simulation mode.

The original spex (sparc/vme/redstar) was build from 1994-2000, and used at the IRTF from May 2000 to Aug 31, 2013. This Spex 1.0 bigdog, guidedog user accounts were rename as oldbigdog, oldguidedog.spex has the old 1.0 source code In /home/src/spex/. There was no ldog account, littledog was an embedded PC running inside of coolracks.

Bigdog Account

The bigdog account runs the spectragraph software. The user bigdog should login to the bigdog computer.
Important directies in bigdog:

```
/home/bigdog/
   |-- current/   - The current version of bigdog.
   |-- old/       - order binaries are archived here.
   |-- dev/       - A test or development binaries.
   |-- macro/     - bigdog macros.
   |-- include/   = include files. (so we con't use /usr/local).
   |-- lib/       - lib for bigdog (so we don't used /usr/local).
   |-- src/       - source dirctory. Should be soft lins to /home/s2.
   |-- tools/     - contains iarc's dsp compiler.
   |-- bin/       - user scripts, like startic, etc.
```

GuideDog Account

The guidedog account runs the imager/guider software. The user guidedog should use the guidedog computer.
Guidedog is similar to bigdog. It has the same directories with the same purposes.

ldog Account

The ldog (littledog) account runs the ldog_ic software on the ldog computer. Important directories in the account are:

```
/home/ldog/
   |-- current/   - The current version of bigdog.
   |-- old/       - order binaries are archived here.
   |-- dev/       - A test or development binaries.
   |-- src/       - source dirctory. Should be soft lins to /home/s2.
   |-- bin/       - user scripts, like startic, etc.
```

s2 Account

The s2 account is used by the spex program for development and testing. This account has the source code, documentation, and the sim/ binaries..

Important directories in the account are:

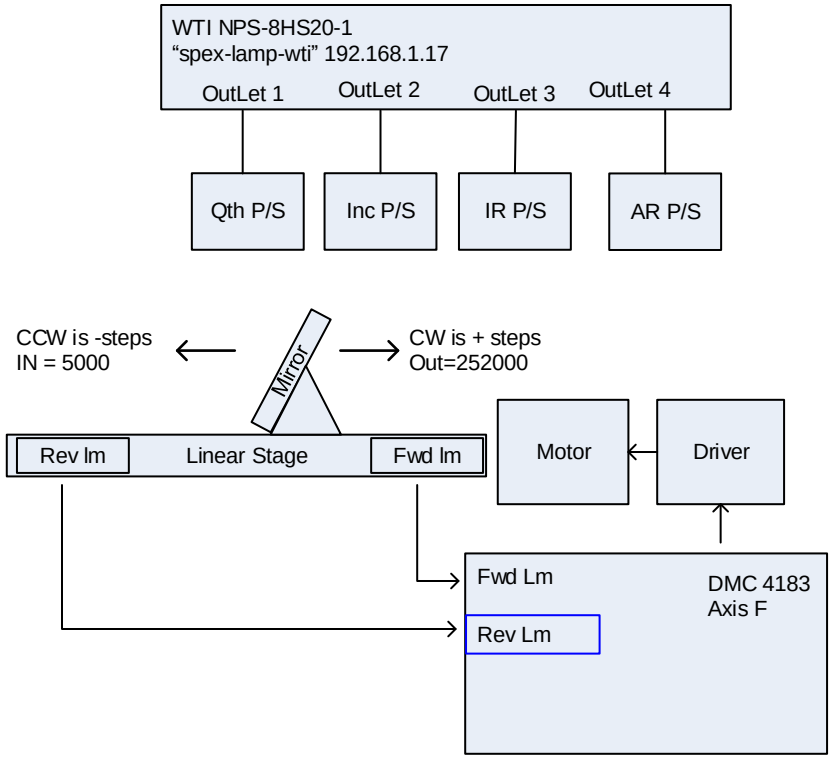
```
/home/s2/
   |-- current/   - The current version of bigdog.
   |-- old/       - order binaries are archived here.
   |-- dev/       - A test or development binaries.
   |-- src/       - source dirctory. Should be soft lins to /home/s2.
   |-- bin/       - user scripts, like startic, etc.
```

Drawing	User Accounts
Filename	spex-2.0.vsd
Page	8

	Motor							Device					Summ					
NAME	Motor Type	Model	Motor Vel	Steps/sec	Step/rot	RPM	Dir for +Steps	Type	Gear 1:x	Total Steps	Measure Size	Full Travel (sec)	Neg Lm	Pos Lm	Hm	A/D	DMC41A XIS	
calmir	Stepper	M-222-6.0D	50000	50000	6400	468.8	CW	linear			259412	5.19	1	1			F	
dit	Stepper	M-222-6.0D	3000	3000	6400	28.1	CCW	detent wh	40	256000	256000	85.33		1	1	1	A	
OSF	Stepper	M-222-6.0D	10000	10000	6400	93.8	CCW	detent wh	100	640000	640000	64.00		1	1	1	B	
SLIT	Stepper	M-222-6.0D	3000	3000	6400	28.1	CCW	detent wh	60	384000	384000	128.00		1	1	1	C	
GFLT	Stepper	M-222-6.0D	10000	10000	6400	93.8	CCW	detent wh	100	640000	640000	64.00		1	1	1	D	
AFOC	Stepper	M-222-6.0D	5000	5000	6400	46.9	CCW	linear			605000	121.00	1	1		1	E	
ROT	Smart MT	SM34205D	80000	9765.625	8000	73.2	CCW	wheel	180	1440000	720000	73.73			1	1		
GRAT	Smart Mt	SM34205D	80000	9765.625	8000	73.2	CCW	Wheel	180	1440000	720000	73.73			1	1		
													2	6	6	7		

Drawing	Motor Summary
Filename	spex-2.0.vsd
Page	9

Calibration Mirror and Lamp Power Control (CALMIR)



Stepper motor drives a linear stage to position the calibration mirror Out or In of the beam. To initailize we drive the stage to the REV limit, and set the position to 0.

Position the stage OUT Or IN using the step position in the table.
When the motor is idle, the power to the stepper driver should be OFF.

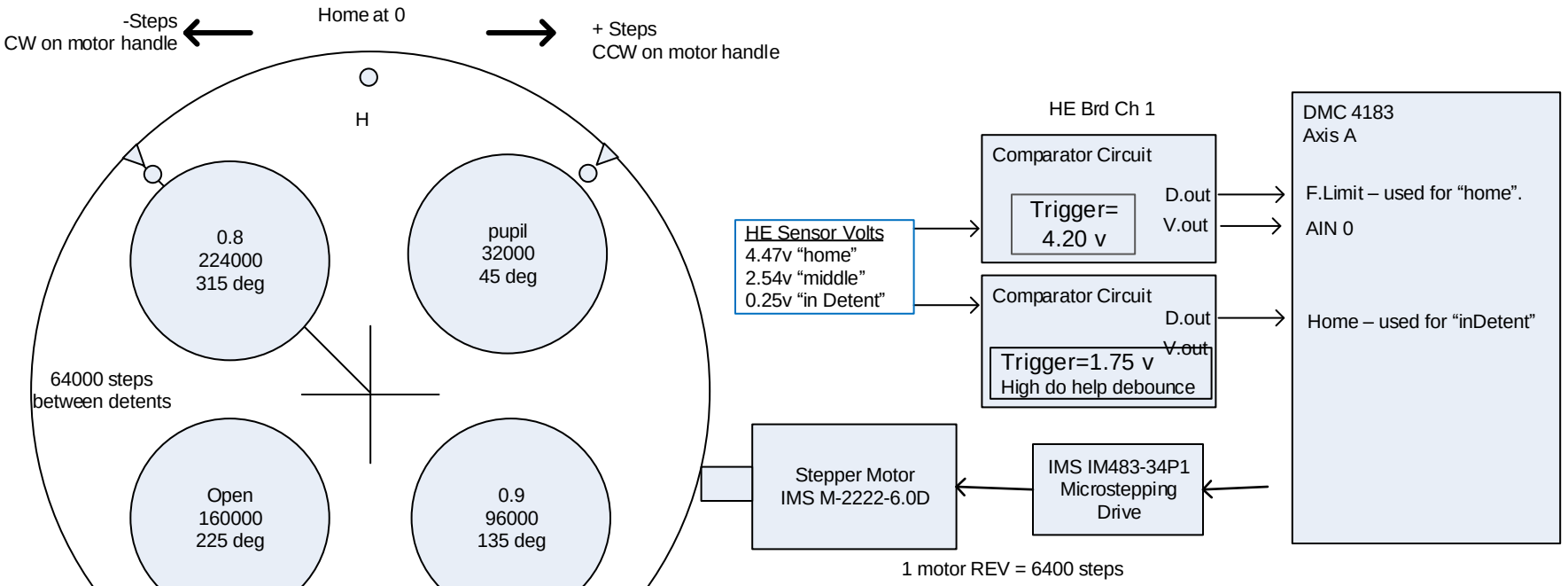
A WTI unit is used to control the A/C power supplies to turn off/on the 4 calibration lamps.

Motor shaft has 6400 steps/revolution

Position of mirror	Green LED	RED LED
Limits on JBOX	~256866	0
Out/In positions	out=252000	in=5000

Drawing	CalMir
Filename	spex-2.0.vsd
Page	10

Dichroic Wheel (DIT)



The Dichroic Wheel is also know as DIT.

The DIT is a detent wheel. The detents provide reproducible positioning for each position. An HE sensor senses the home and indetent magnets. A single magnet defines the home position. A each detent, a magnets with reverse polarity are installed. Two comparator circuit are used to provide a "home" and "indetent" signal..

To initialize we drive the wheel forward until the Forward limit is triggered. This defines the home position.

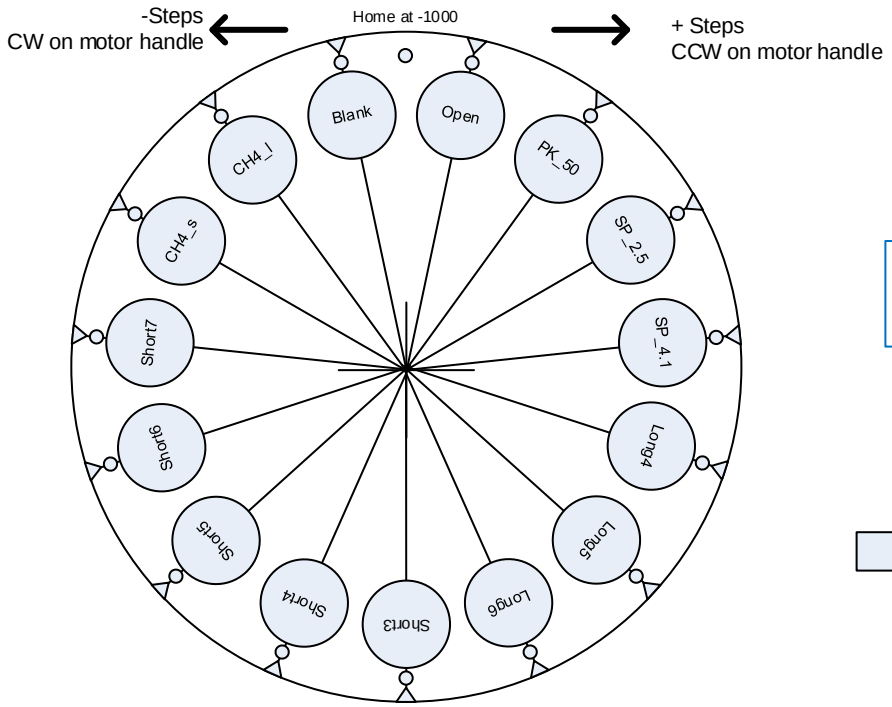
To move to a detented position, we use the (default) detent_center() or detent_moveto() algorithms.

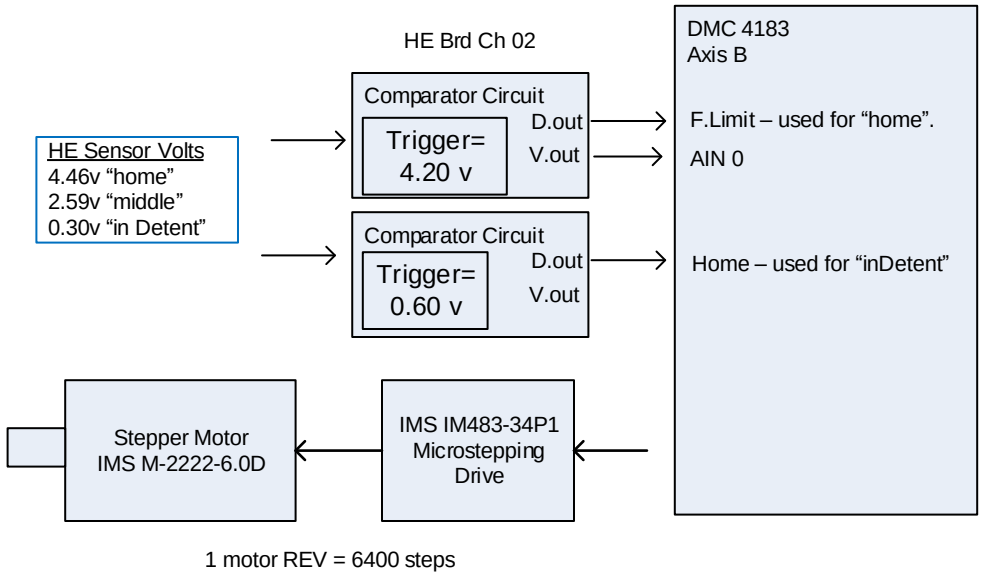
When the motor is idle, the power to the stepper driver should be OFF.

	Step/Rev=	256000		
Menu Inx	**Short Name**	**Long Name**	**Angle**	**Step Pos**
0	pupil	Pupil Viewer	45	32000
1	0.9	0.9 (Rf:0.47-0.92,Tx:0.92-6)	135	96000
2	Open	Open	225	160000
3	0.8	0.8, Rf:0.42-0.8 Tx:0.80-6.0	315	224000

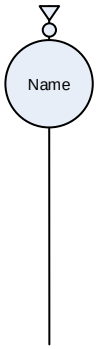
Drawing	DIT
Filename	spex-2.0.vsd
Page	11

Order Sorter Wheel (OSF)





1 motor REV = 6400 steps



	Steps/Rev =	640000		
Menu I	Short Name	Long Name	Angle	Step Pos
0	Open	Open	12	21333
1	PK_50	PK_50 - Pass < 2.5 um	36	64000
2	SP_2.5	SP_2.5 - Pass < 2.5 um	60	106667
3	SP_4.1	SP_4.1 - Pass < 4.1	84	149333
4	Long4	Long4 4.40 - 6.00 um	108	192000
5	Long5	Long5 3.59 - 4.14	132	234667
6	Long6	Long6 3.13 - 3.53 um	156	277333
7	Short3	Short3 1.92 - 2.52 um	180	320000
8	Short4	Short4 1.47 - 1.80 um	204	362667
9	Short5	Short5 1.17 - 1.37um	228	405333
10	Short6	Short6 1.03 - 1.17um	252	448000
11	Short7	Short7 0.91 - 1.00um	276	490667
12	CH4_s	CH4_s 1.58um 6%	300	533333
13	CH4_l	CH4_l 1.69um 6%	324	576000
14	Blank	Blank - Closed	348	618667

The Order Sorter Wheell is also know as OSF.

The OSF is a 15 position detent wheel. The detents provide reproducible positioning for each position. An HE sensor senses the home and indetent magnets. A single magnet defines the home position. A each detent, a magnets with reverse polarity are installed. Two comparator circuit are used to provide a "home" and "indetent" signal..

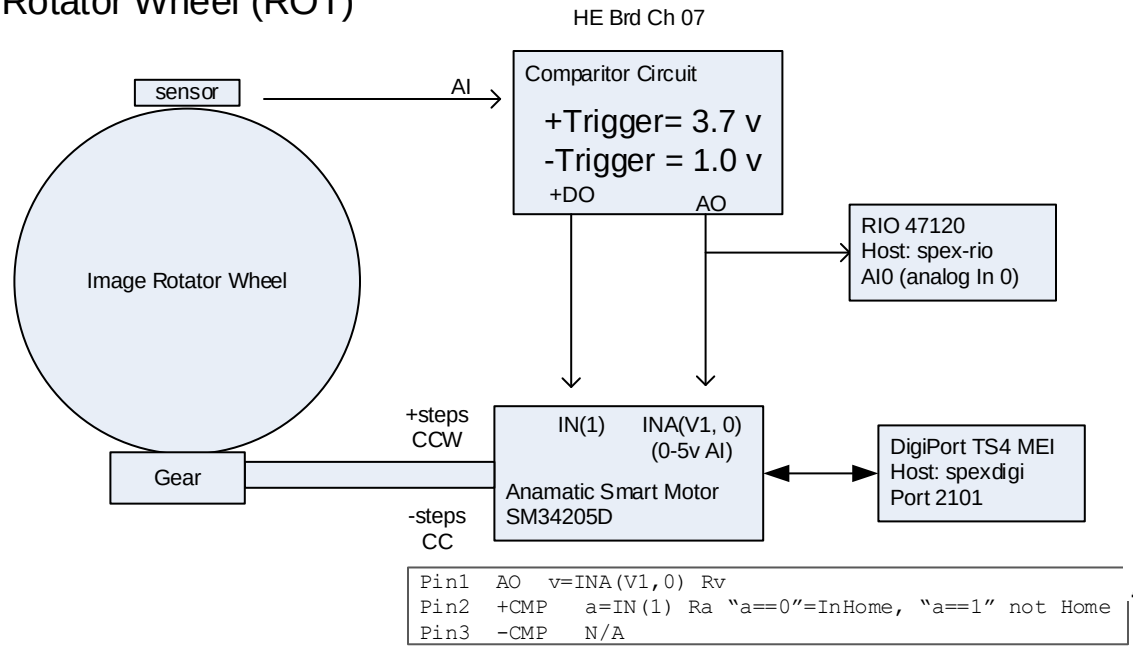
To initialize we drive the wheel forward until the Forward limit is triggered. This defines the home position.

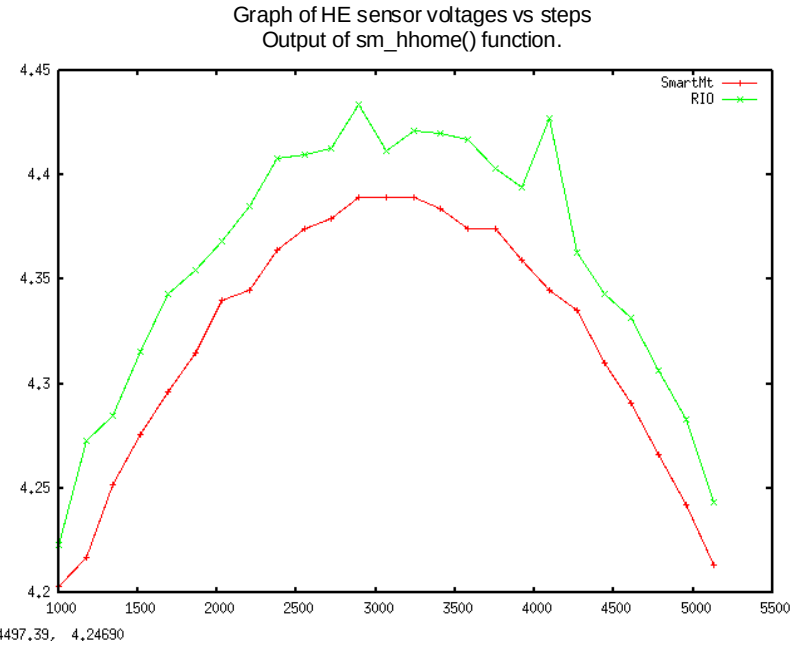
To move to a detented position, we use the (default) detent_center() or detent_moveto() algorithms.

When the motor is idle, the power to the stepper driver should be OFF.

Drawing	OSF
Filename	spex-2.0.vsd
Page	12

Rotator Wheel (ROT)

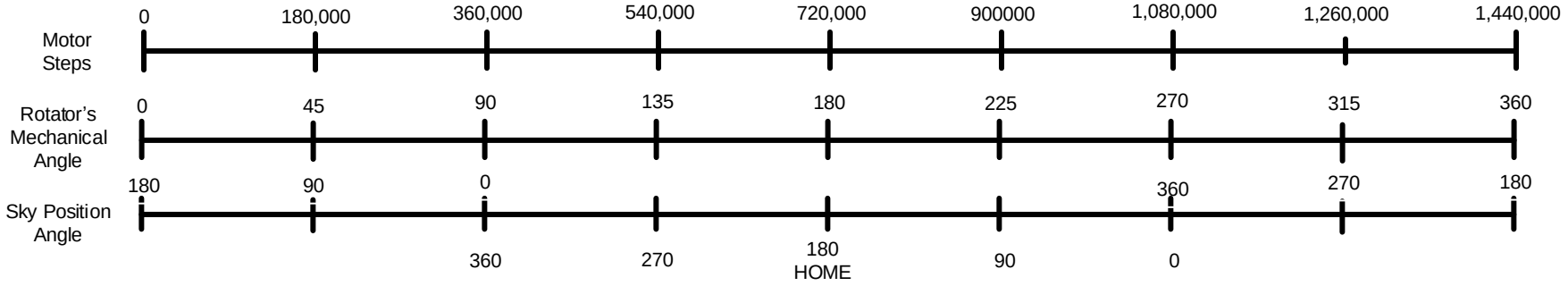




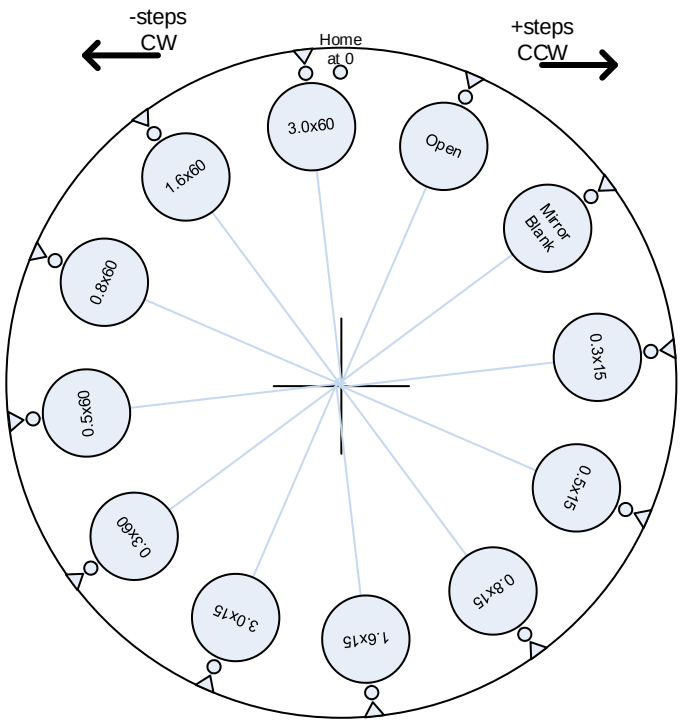
The Rotator is a continuous wheel Mechanism.
Methods for describing the rotator's position.

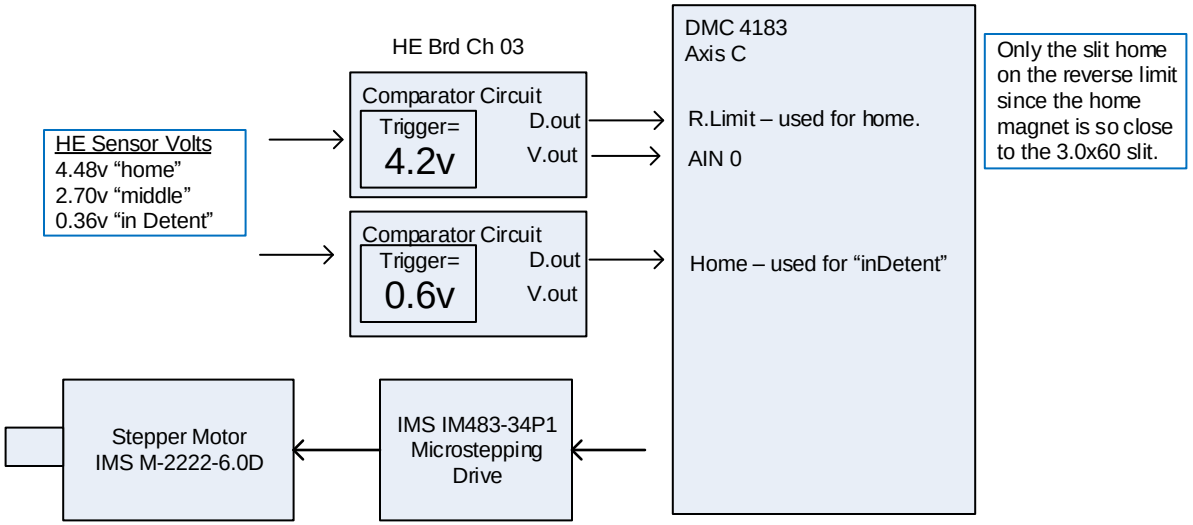
Motor Steps – The rotator is controlled using a stepper motor. The mechanism has a step range of 0 to 1,440,000.
Rotator Angle – The rotator angle is simple mapping of degrees (0 to 360) to the motor steps (0 to 1,440,000).
Position Angle – The position angle describes the orientation of the slit to the sky image. 0 degrees, the slit is vertical (North on Top). Positive angles rotator the slit clockwise. Negative angles rotate the slit counter-clockwise.

This diagram illustrates the relationship between theses position.



SLIT Wheel (SLIT)





Steps/Rev =	384000			

Menu	Short Name	Long Name	Angle	Step Pos
0	Open	Open	23.4375	25000
1	Mirror	Mirror/Blank	53.4375	57000
2	0.3x15	0.3x15 arcsec	83.4375	89000
3	0.5x15	0.5x15 arcsec	113.4375	121000
4	0.8x15	0.8x15 arcsec	143.4375	153000
5	1.6x15	1.6x15 arcsec	173.4375	185000
6	3.0x15	3.0x15 arcsec	203.4375	217000
7	0.3x60	0.3x60 arcsec	233.4375	249000
8	0.5x60	0.5x60 arcsec	263.4375	281000
9	0.8x60	0.8x60 arcsec	293.4375	313000
10	1.6x60	1.6x60 arcsec	323.4375	345000
11	3.0x60	3.0x60 arcsec	353.4375	377000

The Slit Wheel is also know as SLIT.

The SLIT is a detent wheel. The detents provide reproducible positioning for each position. An HE sensor senses the home and indetent magnets. A single magnet defines the home position. A each detent, a magnets with reverse polarity are installed. Two comparator circuit are used to provide a "home" and "indetent" signal..

To initialize we drive the wheel forward until the Forward limit is triggered. This defines the home position.

To move to a detented position, we use the (default) detent_cente() or detent_moveto() algorithms.

When the motor is idle, the power to the stepper driver should be OFF.

Drawing	SLIT
Filename	spex-2.0.vsd
Page	14

AutoGuide Box Values for Slit Positions					
	CenterX	CenterY	Box Size	Upper-Left X	Upper-Left Y
0.3x15"	249	209	30	234	194
	249	272	30	234	257
0.5x15"	245	210	30	230	195
	245	273	30	230	258
0.8x15"	246	214	30	231	199
	246	277	30	231	262
1.6x15"	246	210	32	230	194
	246	273	32	230	257
3.0x15"	245	212	45	222.5	189.5
	245	275	45	222.5	252.5
0.3x60"	247	212	30	232	197
	247	275	30	232	260
0.5x60"	245	212	30	230	197
	245	275	30	230	260
0.8x60"	243	212	30	228	197
	243	275	30	228	260
1.6x60"	245	212	32	229	196
	245	275	32	229	259
3.0x60"	244	212	45	221.5	189.5
	244	275	45	221.5	252.5

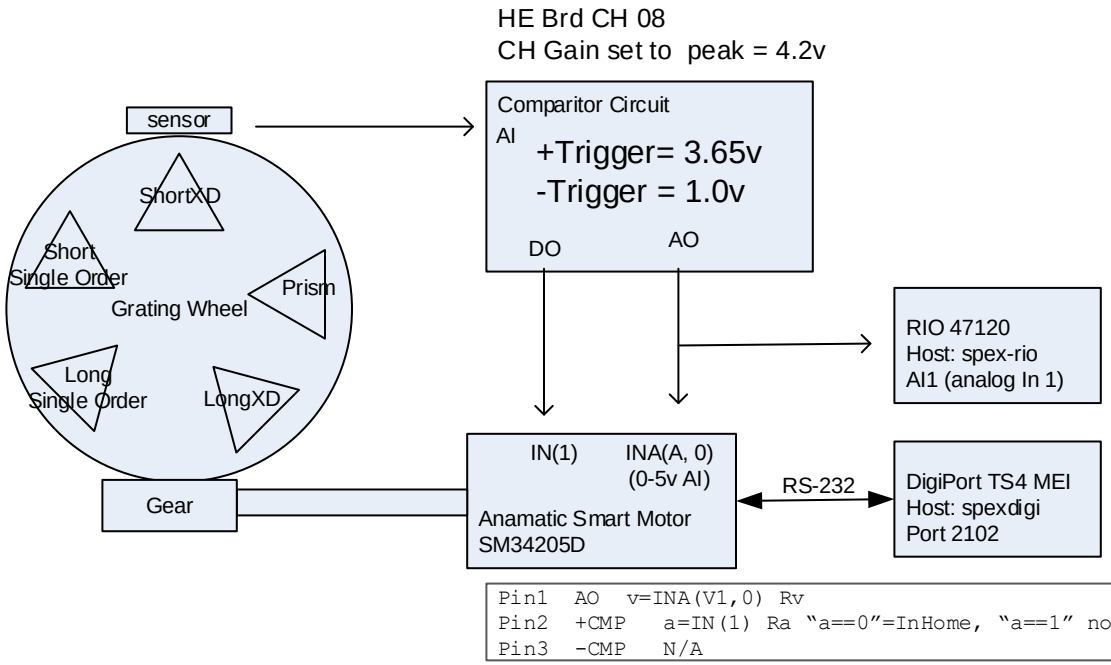
Note:

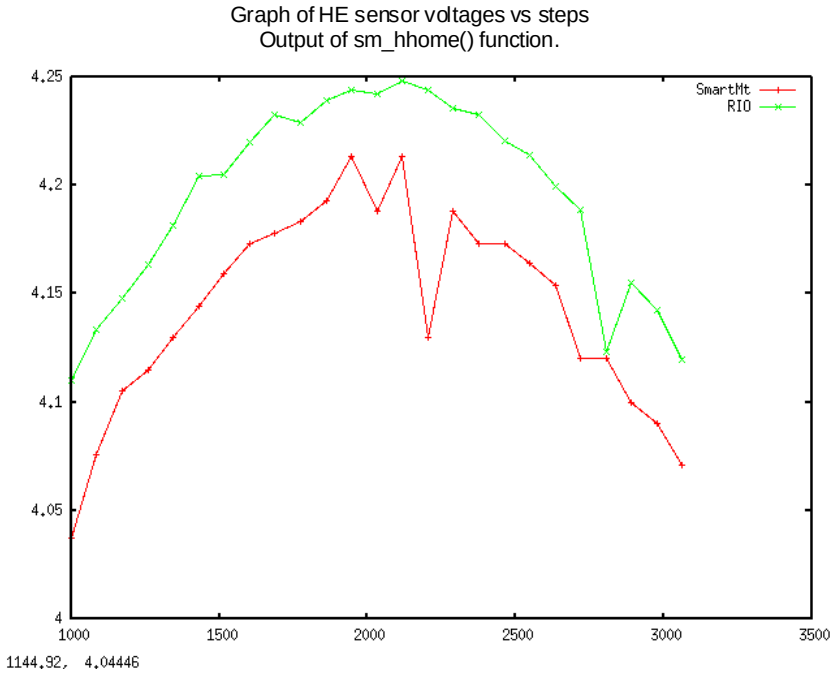
The spex software defines the autoguide boxes in the the ic/command.c file do_autoguidebox_setup().

The code uses Upper-Left XY.

This table provides an eazy CenterXY to Upper-Letf XY translation.

Grating Wheel (GRAT)

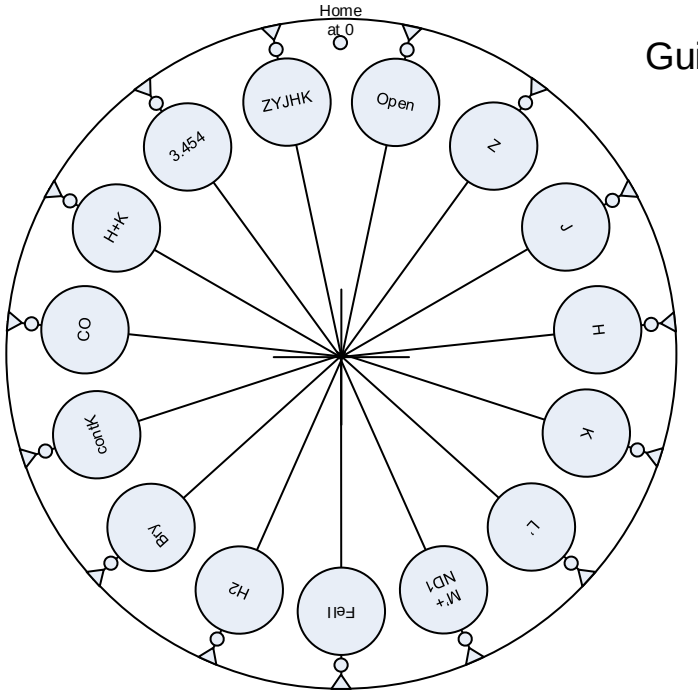


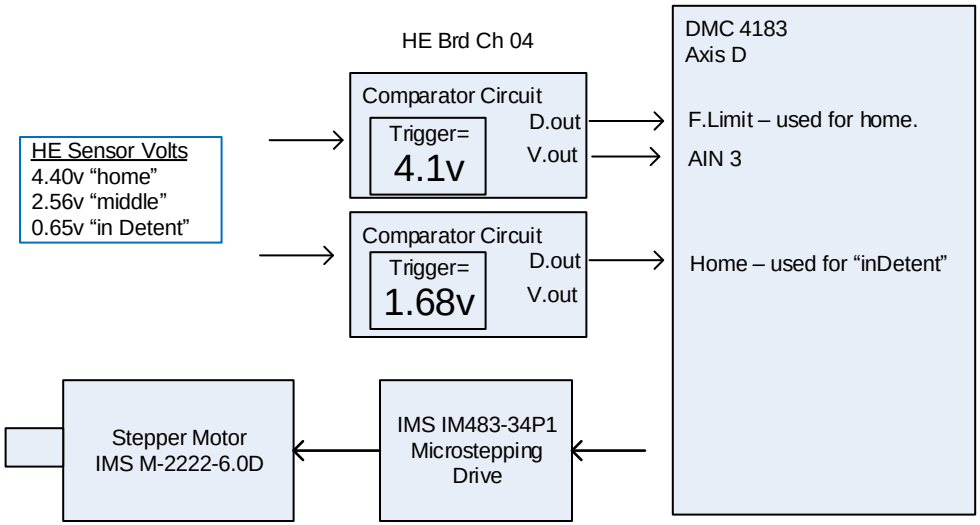


The Grating is a continuous wheel mechanism.

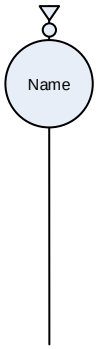
Step/Rev =	1440000				
Short Name	Long Name		Angle	Step Position	Desired Focus
ShortXD	ShortXD	0.70-2.55 um	0.43	1700	25000
Prism	Prism	0.70-2.6 um	90.20	360800	0
LXD_long	LXD_long	1.98-5.3 um	155.88	623500	10000
LXD_shor	LXD_short	1.65-4.2 um	156.93	627700	10000
SO_long	Single Order Long	3.1-5.3 um	238.50	954000	0
SO_short	Single Order Short	0.9-2.5 um	303.53	1214100	-50000

Guider Filter (GFLT) Wheel





	Steps/Rev =	640000		
Menu Ir	Short Name	Long Name	Angle	Step Pos
0	Open	Open	12	21333
1	Z	Z 0.95 - 1.11 um	36	64000
2	J	J 1.164 - 1.326 um	60	106667
3	H	H 1.487 - 1.783 um	84	149333
4	K	K 2.027 - 2.363 um	108	192000
5	L'	L' 3.424 - 4.124 um	132	234667
6	5.1	5.1um 0.5% - must block with OSF L	156	277333
7	FeII	FeII 1.644 um 1.5% - Cross with blo	180	320000
8	H2	H2 v=1-0 s(1) 2.122 1.5%	204	362667
9	Bry	Bry 2.166 um 1.5%	228	405333
10	contK	cont-K 2.26 um 1.5%	252	448000
11	CO+ND2	CO (2-0bh) 2.294 1.5% + ND 2.0	276	490667
12	H+K	H+K notch	300	533333
13	3.417	3.417um 0.5%	324	576000
14	ZYJHK	ZYJHK - Pass < 2.5 um	348	618667



The Guider Filter Wheel, GFLT, is a 15 position detent wheel. The detents provide reproducible positioning for each position. An HE sensor senses the home and indetent magnets. A single magnet defines the home position. At each detent, a magnets with reverse polarity is installed. Two comparator circuit are used to provide a "home" and "indetent" signal..

To initialize we drive the wheel forward until the Forward limit is triggered. This defines the home position.

To move to a detented position, we use the detent_moveto() algorithms.

When the motor is idle, the power to the stepper driver should be OFF.

Drawing	GFLT
Filename	spex-2.0.vsd
Page	17

Array Focus Mechanism (AFOC)

There are 6500 steps per motor revolution.
1 revolution of the axis = 50 microns of linear travel.

Several Nth degree polynomial equations are used to convert between HE Sensors voltage output and the motor position counts. The y = f(x) represents a Nth degree polynomial fit.

Data and fit documented in src/spex/ldog/afoc_fit/

The equations are:

$$y = a + xb + x^2c + x^3d + x^4e + \ldots$$

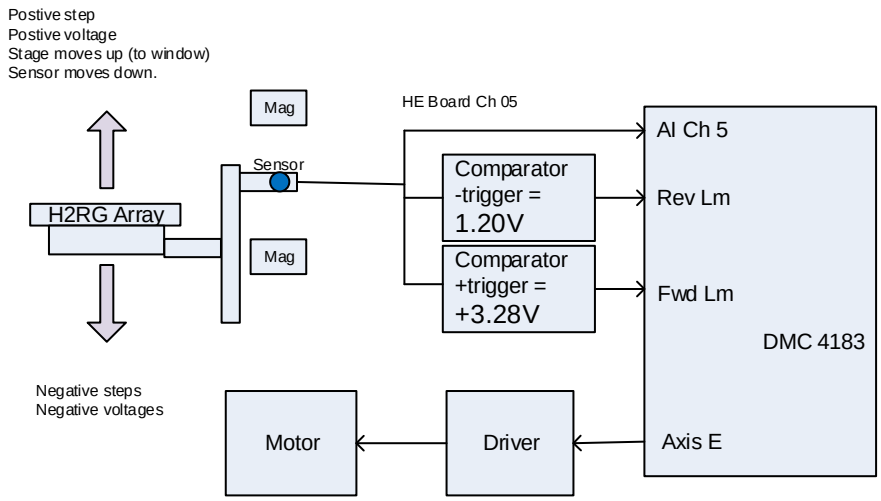
NEG Steps to Voltage Coeff
- a = 2.4561558
- b = 2.6225302e-06
- c = -3.0148264e-12
- d = -3.5663117e-18
- e = -7.8737030e-23

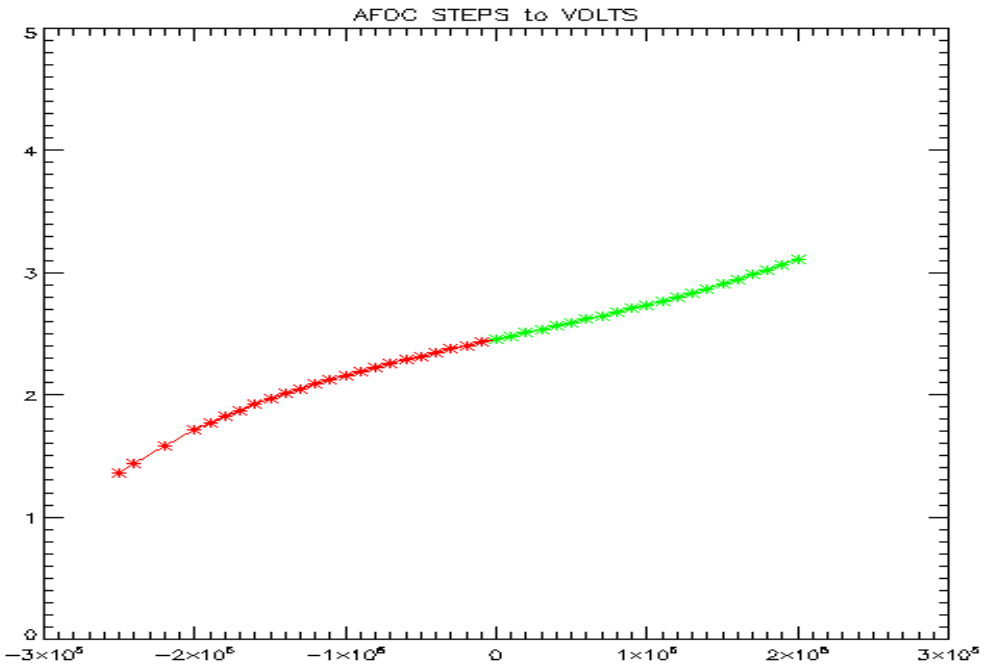
POS Steps to Voltage Coeff
- a = 2.4550567
- b = 2.6298539e-06
- c = 1.0336774e-12
- d = 4.8733233e-18
- e = 3.1596328e-23

NEG Volts to Steps
- a = -870428.07
- b = 1198416.7
- c = -918526.42
- d = 323556.58
- e = -36435.731

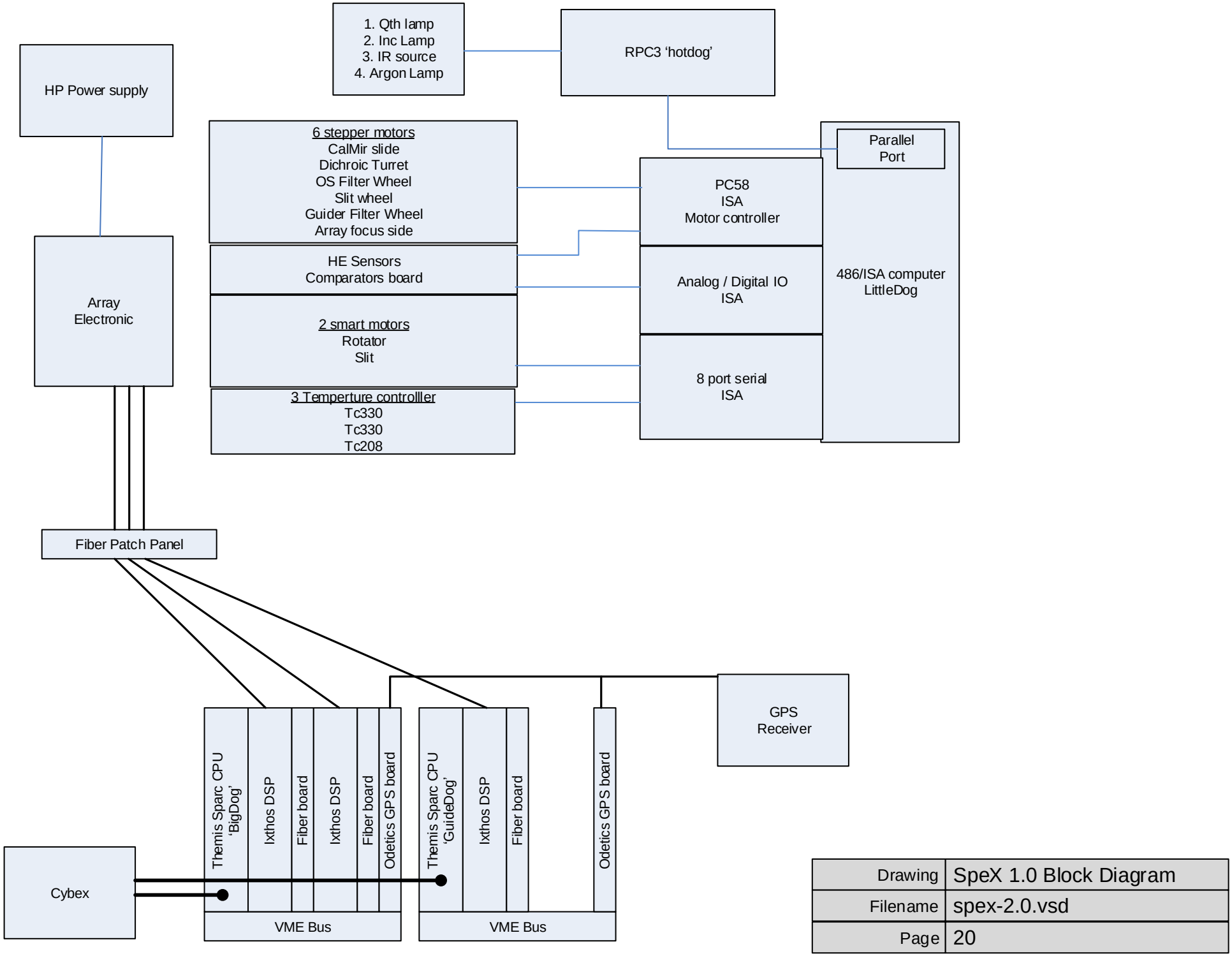
POS Volts to Steps
- a = 6370113.9
- b = -10522098.
- c = 6013895.8
- d = -1446830.1
- e = 127282.28

	volts at trigger	approx step pos
-Trigger	1.20	-271453
+Trigger	3.28	234492
ZERO POS VOLTS	2.455	

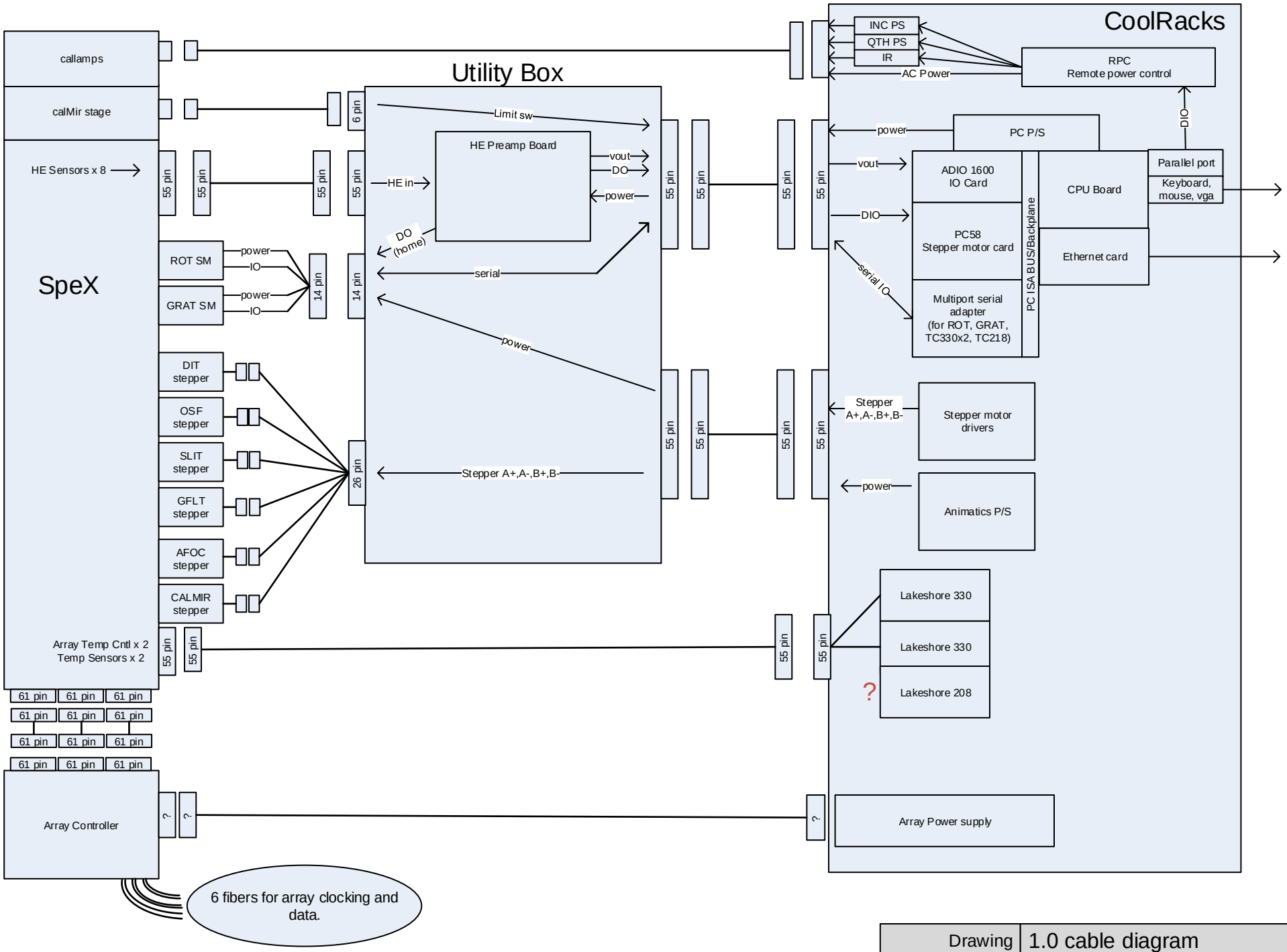




Drawing	AFOC
Filename	spex-2.0.vsd
Page	18



Drawing	SpeX 1.0 Block Diagram
Filename	spex-2.0.vsd
Page	20



Drawing	1.0 cable diagram
Filename	spex-2.0.vsd
Page	21