ATA Cooled, Antonio Feed
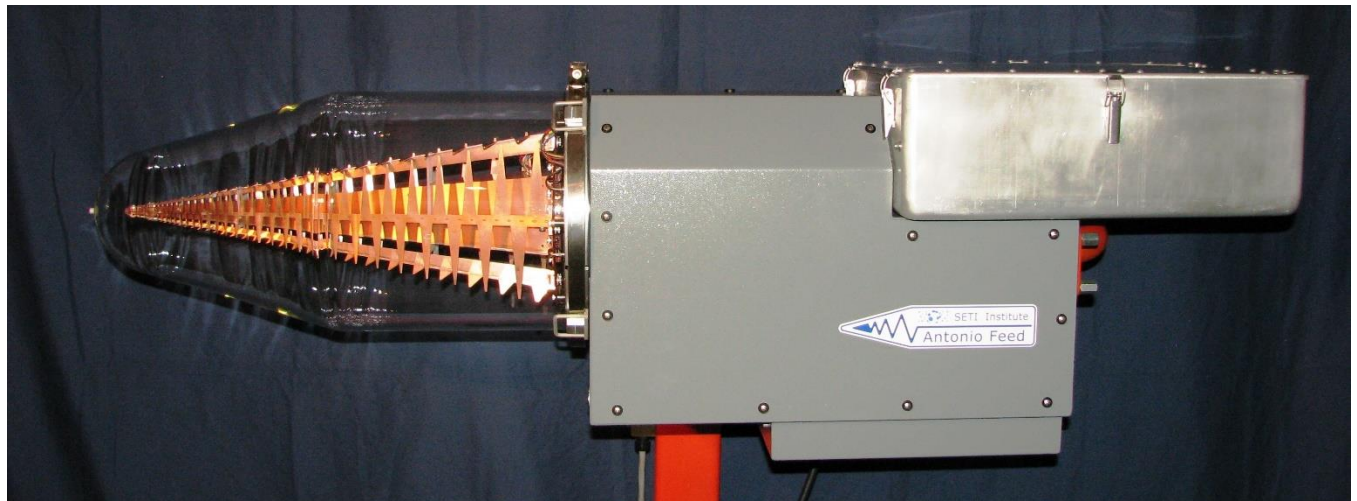# Control Commands Manual
Matt Fleming, Minex Engineering, Ver 06
Other related files may be stored in folder "Testing".

Version	Date	Comment	Initials
Version 5a	2018-11-05	Released. (still preliminary)	MCF
Version 06	2019-03-17	Slightly improved.	MCF

Table of Contents

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Introduction:

These instructions should be read along with the following documents:
      ATA Cooled Feed Manual Operation and Installation.
      ATA Cooled Feed Development History.

There are 3 discrete control boards in the Feed Housing.   They are: Feed Control, Vacuum Control & Cooler Control. There is also 1 control board in the Pax Box, but that is unrelated to this discussion. The Feed Control Board, designed by Rob Ackermann, coordinates all functions in the feed housing. It communicates with the Rim Box via RS-232, 19200 N 8 1. The Feed Control Board has a set of commands for monitor and control of devices in the feed, such as fan speed, temperature monitoring, etc. The board also passes several commands through to the Sunpower Cooler Control and the Pfeiffer Vacuum Control. Several tables of commands are shown in the pages that follow, one for each board.

The following notes apply.
- All commands are delivered to the Feed Control Board, but some are passed through to other controllers.
- No commands are identical among controllers. (Ackermann, Pfeiffer, Sunpower)
- All commands to the Cooler Control Board are in upper case. (Sunpower)
- All commands to the Vacuum Control Board begin with lowercase p. (Pfeiffer)
- On a functional terminal screen, after command entry, the response will appear on the next line below.
- We are now using the Feed Control Board relay to act as a thermostat input to the Cooler Control, 2019-02.
- More cooler commands are listed in the separate Sunpower controller manual. (version 06)
- More vacuum commands are listed in the separate Pfeiffer controller manual. (version etc ?)
- On some commands a 0 before the decimal may be needed.   (not sure if this is still true)
- Colors used in this document have meaning and are intended to indicate the type of attention needed.

Examples of typical commands used on the 3 control boards			
Item	Command	Response	Description (direct to Feed Control Board)(always lower case)
1	setfanpwm 30	ok	Ackermann commands take any form except those of pass thru.
2	p316	22	Pfeifer commands begin with a lower case p and are passed thru.
3	TC	65	Sunpower commands are upper case and are passed thru.

Rob Ackermann has written a Data Logging Program in python. It is used on a laptop at the command prompt. It opens a terminal program communicating with the feed via RS-232. One can also open a terminal program and type in commands directly.
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ATA Cooled Feed Image and Diagram:
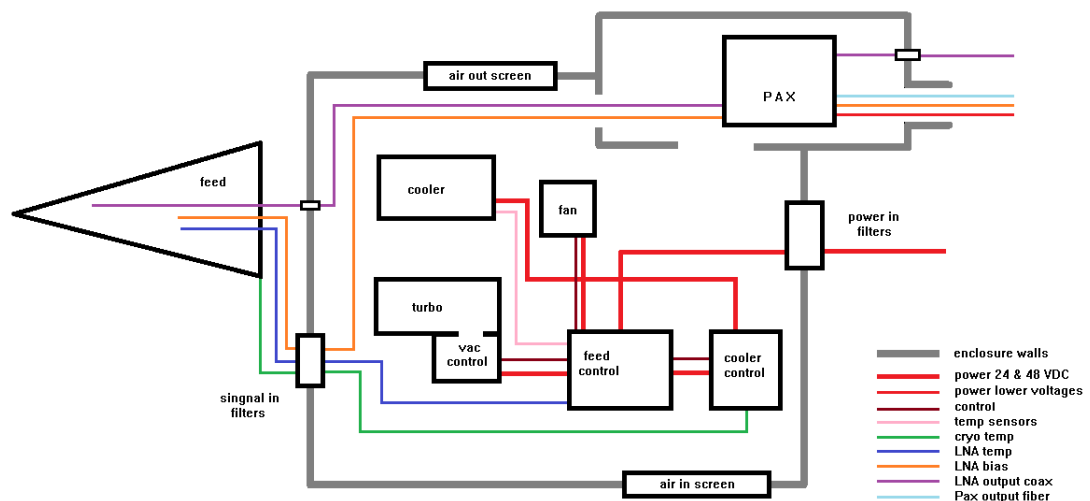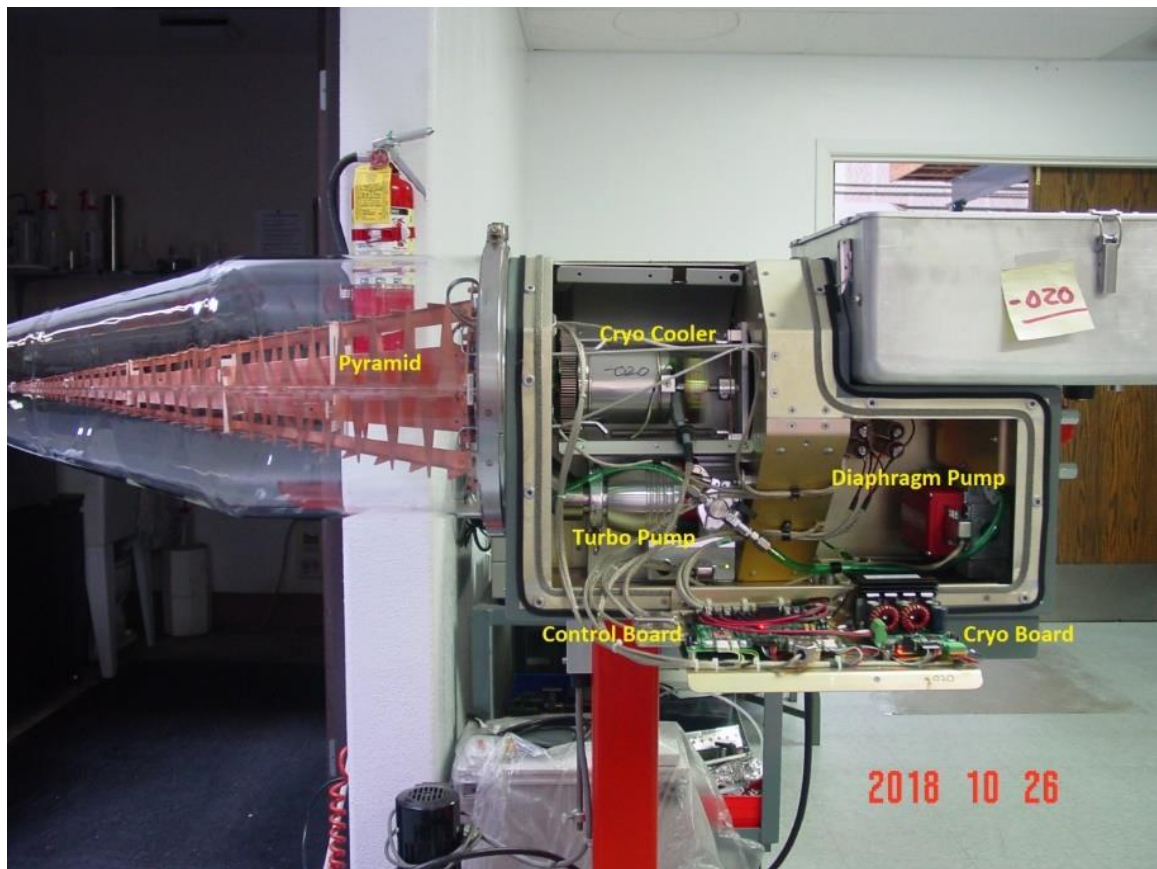
Feed Control Board Commands:

Feed Control Board Commands		(Ackermann, direct) (via RS-232 19,200 N 8 1)	
Item	Command	Response	Description (direct to Feed Control Board)(always lower case)
1	help	big list	Display a list of supported commands. (feed control only)
2	help commands		Display a list of all commands.
3	help gt	specific	Example: how to get help with the "gt" command.
4	getfanpwm	25	Display fan power. (% on time) (pulse width modulation)
5	setfanpwm 30	OK	Set new fan power. (% on time) (or "setfanpwm auto" for temp reg)
6	getfanspeed	2420	Display current fan speed. (rpm) (3000 rpm max speed)
7	getcryoattemp	regulating	Display Cooler State, at setpoint temp. (yes, no) (cooler pin 4)(5V=yes)
8	gettemp a0	28.1	Display temperature, on control board. (°C) (near ambient)
9	gettemp a1	27.8	Display temperature, Outside air. (°C) (lower vent from amb)
10	gettemp a2	27.8	Display temperature, PAX air. (°C) (PAX case exit air)
11	gettemp a3	27.1	Display temperature, Exhaust air. (°C) (to amb) (a4 not used)
12	gettemp a5	26.5	Display temperature, Cooler rejection. (°C) (near to fins)
13	gettemp a6	25.5	Display temperature, Cooler housing. (°C) (back of housing)(70 C max)
14	gt a6 -f		Options use "gt" abbreviation or " -f" gives value in (°F)
15	getdiode or gd	68.0	Display LNA temperature. (Kelvin) (uses equation to calculate) (T = -67792 X3 + 1661 X2 - 1794.7 X + 899.38 from excel)(Lakeshore 41 or 67 ?)
16	gd -v	0.527	Display LNA diode voltage. (_-v gives)(volts x.xxx)
17	getvac or gv	1.2 E-05	Display vacuum gauge. (mbar)(equation)(if gauge is present) (p = 10^(1.667xU-d) (U volts) (d = 11.33 for mbar) Similar to p340 when using Pfeifer DCU. (1 atm = 1.013 E+3 mbar) also message "under range" "over range" "sensor error"
18	gv -v		Display vacuum gauge voltage. (5 volts = 1.0E-3)
19	getaccel	table	Display accelerometer data in a 3 x 4 matrix. since last call. (g) 3 rows, X, Y, Z, and 4 columns, min, mean, stddev, max. 1 sec running avg.
2	getaccel -d x 100	string	Dump samples, x axis, 100 count. (1 to 400) (400 / second)
21	getrelay	0	Display relay state
22	setrelay 1		Set Relay, 1 = closed, 0 = Open. (future use)(maybe gauge)
23	getfeedstartmode	string	Displays manual or auto.
24	setfeedstartmode	OK	manual or auto. (if auto selected, use reset to start auto program)
25	getcryoattemp	Y –or- N	Display Y for regulating or N for not regulating.
26	get24v	23.9	Display 24 VDC actual measured.
27	get48v		Display 48 VDC actual measured. (not connected)
28	getversion		Display current firmware version.
29	reset		Resets the program. (this will take 1 minute, then 1 minute to fix all com)
30			
31	bootloader		Don't know this one.
32	stty –or- rimbox		Don't know this one.
33	ls –or- dir	list	Display the contents of a directory. (example: "dir")
34	cat –or- type	text	Display the contents of a file. (example: "type log.txt")
35	minex –or- ht –or- hyperterminal		From the command prompt in the correct directory of a laptop.

Do not allow cooler temperatures "a6" to exceed 70 to 75 C.

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Vacuum Control Commands:

Vacuum Control TC-110 Commands   (Pfeiffer, passed through Feed Control Board) (prefix p) (RS-485 9,600 N 8 1)
--------   Initial programmed Settings are Shown in Column 2 -------   Other Options Shown in Column Last ----------

Item	Command	Response	Description (always lower case ?)
1	p009=1	111111	**Set acknowledge error.** 1 = acknowledge, (data type 0 for true false) note: Allows station start if p010=1 but stopped due to fault, maybe p010=0 first.

2	p010=0	000000	**Set pumping station.** turbo & diaphragm. (takes 8 to 10 min to wind down)
			   0 = off. (setting is preserved at power down and applied at next power up)
			   1 = on. (clears error)(starts Diaphragm, starts Turbo if p023=1)

3	p023=1	111111	**Set turbo on / off.** for turbo motor only. (not the same as Station On) 0 = off. (technically 000000) & 1 = on. (technically 111111)(but 0 & 1 work)

4	p024=000	000	**Set D pump speed high / low.** Set Cfg D01, Output, ,
			   0 = Rot speed switch point. (see p701, turbo at 90%)
			   9 = always 0, MVP-006 pin 8 = open, high speed, 3000 rpm.
			   10 = always 1, MVP-006 pin 8 = 24 VDC, low speed 1000 rpm. (seasoned)
			   13 = follow backing mode. (see p025)(MVP-006 DIP Sw 2 set to off)
			       note for 13, Control is equal to p010 and p025. (111111 and 001)

5	p025=001	001	**Set D pump intermittent.** backing pump.
			   0 = continuous. (uses p024=9 or p024=10)
			   1 = intermittent. (assumes p024=13) (uses settings p710 & p711)
			   2 = delayed switch-on. (not used for our process)

6	p035=003	003	**Set D pump on / off / backing.** Set Cfg Acc A1, Accessory , ,
			   3 = backing pump.
			   6 = always 0, MVP pin 3/10 = open, diaphragm pump off.
			   7 = always 1, MVP pin 3/10 = 24 VDC, diaphragm pump on.

7	p027=001	001	Set gas load. 1 = light gas.
8	p700=000120	000120	Set value run-up time. (min) (1 to 120)(maybe need shorter)
9	p701=000090	000090	Rotation speed switchpoint 1. (% turbo full speed,) (used by p024)
10	p707=010000	010000	Set value in rotation speed setting mode. (% full speed 100.00 = 90,000 rpm)
11	p708=070	070	Set value power consumption. (% full power, 100% = 110w unit, 90w at p316)
12	p710=000014	000014	Set point diaphragm intermittent on. (motor off) (watts)(based on p316)
13	p711=000024	000024	Set point diaphragm intermittent off. (motor on) (watts)(based on p316)

Vacuum Control TC-110 Commands related to DCU 002 (only relevant for Pfeiffer hand held unit attached)			
	p794=001	7	001	Set extended parameter set. (0 = basic, 1 = extended set, like p710 etc)
	p738=PKR2xx	4		Set type of gauge. (PKR251 Combined Pirani & Cold Cathode)(DCU page 8)
	p340	7	1.2 E-4	Display pressure from gauge. (mbar)(only Pfeiffer DCU) (p738 gauge type)

Data Type. ("T" in the table above)		
Type 0	for true false,	000000 or 111111.
Type 1	positive 6 place integer	000000 to 999999
Type 2	positive 6 place integer,	001571 is 15.71 , decimal 2nd & 3rd place.
Type 4	symbol chain 6 places	TC_400
Type 7	positive 3 place integer.	000 to 999

Note: ECU indicator LED lights mean the following:	
Green flashing	= power on.
Green Solid	= station on.
Yellow Solid	= Warning. (usually wrn117)
Red solid	= Malfunction. (usually err117)
Note: To extend life, delay p023=1 until 1.2 E+1 mbar.	

Vacuum Control TC-110		Values to Monitor, Thresholds, Warnings & Errors. (See page 46 Pfeiffer Manual)

Item	Monitor	Returns	
10	p303	wrn117	Display error messages, (also use p360 to p369 for history)
11	p304	0	Display Excess Temp Electronics. (0 = no, 1 = yes)
12	p305	0	Display Excess Temp Turbo. (0 = no, 1 = yes)
13	p310	000183	Display Turbo current consumption. (amps) (000183 = 1.83) (data T2)
14	p311	85	Display Station operation (hours)(0 to 65535)
15	p315	001500	Display Turbo speed, nominal. (Hz) (1500 Hz = 90,000 rpm)(x6)
16	p316	000022	Display Turbo power consumption. (watts)(77 max)(14 good)
17	p326	000034	Display Electronics control board temperature. (°C xx.x) (tenths ?)
18	p330	000035	Display Turbo bottom temperature. (°C) (most sensitive to fan)
19	p342	000039	Display Turbo bearing temperature. (°C) (no tenths from Pfeiffer)
20	p346	000042	Display Turbo motor temperature. (°C) (error 117) (100 is hot)
21	P360	Err006	Display Error History, position 1. (p361 gives position 2, p362 gives position 3, etc)
22	p398	90016	Display Turbo speed, actual. (rpm)(90,000 nom)(90,600 bad, reset p023)

Item	Monitor	Warning	Value	Error	Value	Description see page 57 manual.
	p701			Err006		Run-up time error. (Err also called malfunction)
	p326	Wrn044	80	Err044	85	Excess Temp Electronics general, (°C)(better cooling)
	p346	Wrn045	115	Err045	120	Excess Temp Motor. (°C)
	p330	Wrn117	55	Err117	60	Excess Temp Pump bottom. (°C) (most common sensitive)
		Wrn118		Err118		Excess Temp Electronics Power Stage. (°C)
	p342	Wrn119	55	Err119	60	Excess Temp Bearing. (°C)
						Warning value will issue a warning, yellow LED.
						Error value will change operation or shutdown sys, red LED.

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Cryo Cooler Control Commands:

Cooler Control Board Commands		(Sunpower, passed thru Feed Control Board) (via RS-232 4,800 N 8 1)	
Item	Command	Response	Description (always upper case ?)
1	SET TSTATM=1	001.00	How to use thermostat, 0 = disable , 1 = use IO input 3. (via relay)
2	TSTAT		Display status of thermostat, If M=1
3	SET SSTOPM=1 *	0 change?	Set Soft Stop Mode. (0 = stop via SSTOP , 1 = stop via pin 5)
4	SET SSTOP=1 *	1	Set Soft Stop. (0 = restart motor, 1 = stop motor)
5	SET MAX=210 *	210	Set Max user defined power. (watts) Not PWOUT. Factory < 240.
6	SET MIN=100 *	80	Set Min user defined power. (watts) Not PWOUT. Factory > 70.
7	SET PID=2 *	002.00	Set control to temperature mode. (0 = power, 2 = temp)
8	SET TTARGET=65 *	065.00	Set cold-head temp target to number. (Kelvin) (risk if below 60)
9	SET PWOUT=200 *	200.00	Set power target to number. (watts) (while in PID mode 0)
10	TC	65 (065.00)	Display Temperature Coldhead. (Kelvin) (risk if below 60)
11	P	210	Display current power. (watts)
12	E	240	Max allowable power. (watts) (varies with cold, usually 240)
		70	Min allowable power. (watts) (never less than 70)
		120	Current power. (watts) (usually < 240 during regulation)
13	SHOW MX	80	Display Min & Max. (watts)
		210	
14	STATE	list	Display status list of 14 commanded states. (see manual)
15	RESET=F	RESETTING	Resets all parameters to factory default.
16	ERROR		Display error messages. (both LEDs are flashing repeatedly)
	Over Current	000 001	Red & Grn LED Flash 1 time, then pause then repeat.
	Jumper error	000 010	Red & Grn LED Flash 2 times, then pause then repeat.
	Serial Error	000 100	Red & Grn LED Flash 3 times. (Baud 4800, None, Data 8, Stop 1)
	Memory Error	001 000	Red & Grn LED Flash 4 times. (Non-volatile Memory)
	Watchdog Error	010 000	Red & Grn LED Flash 5 times.
	Temp Sensor Error	100 000	Red & Grn LED Flash 6 times, (coldhead, test sensor at connector)
		100 001	Multiple Errors, Over Current & Cold Temp Sensor.

*1 To display current value for most commands, type the command without " =number".
   Example: SET TTARGET   displays   065.00 (note space between SET and TTARGET)
*2 PID means proportional, integral, differential, a control method.

Cryo Cooler Notes		
	Operation	Cooler should start within 11 seconds of power on for SSTOP=0.
	Conditions	Needs 48 VDC +/- ? Needs 6 watts minimum thermal load.
		Needs 100 cu-ft/min air. Cools best with vacuum better than 1.0E-4 mbar.
	Red LED on	Unit in cool down mode, above Set Point Temp.
	Grn LED on	Unit regulating within 0.5 Kelvin of Set Point Temp. (pin 4 high)
	Inhibit motor on/off	see feed control board relay. (maybe)(pin 3 or 10 at 5 VDC to pin 5 soft stop)
		Do not operate without at least 100 cfm airflow. That means 24 VDC must be present.
		Do not allow cooler temperatures to exceed 70 to 75C. The motor winding bobbin will degrade or melt.
		Do not allow TC below 65 Kelvin. The unit may backdrive when power is removed. This action may damage the unit. It is an audible knocking sound. Repower the unit and set temperature higher before removing power. Feed -004 seems to do this easily, so it has TTARGET set to 70 Kelvin.

Favorite Control Commands & Setups:

Feed Control Initial Setup:

Item	Command	Response	Description (always lower case ?)
1	p010=0	000000	Set pumping station, 0 = off. (also clears errors ?)
2	p023=0	000000	Set turbo on / off, 0 = off.
3	p024=000	000	Set D pump speed high / low, 000 high to low at Rot speed switch point.
4	p025=000	000	Set D pump intermittent, 000 cont, 001 int. (1 no longer used, see p710 p711)
5	p035=003	003	Set D pump 007 on, 006 off, 003 backing pump mode.
6	p027=001	001	Set gas load. 1 = light gas.
7	p700=000020	000020	Set value run-up time. (min) (1 to 120)(maybe need shorter)
8	p701=000090	000090	Rotation speed switchpoint 1. (% turbo full speed,)(90%)(used by p024)
9	p707=010000	010000	Set value in rotation speed setting mode. (% full speed 100.00 = 90,000 rpm)
10	p708=070	070	Set value power level. (% full power, 100% = 110w unit, 90w at motor p316)
11	p710=000014	000014	Set point diaphragm intermittent on. (motor off) (watts)(based on p316)
12	p711=000024	000024	Set point diaphragm intermittent off. (motor on) (watts)(based on p316)
21	SET SSTOPM=0	0	Set Soft Stop Mode, 0 for software SSTOP. (1 = stop via pin 5 for future use)
22	SET SSTOP=1	1	Set Soft Stop, 1 for stop motor.
23	SET PID=2	002.00	Set control, 2 for temperature mode.
24	SET TTARGET=65	065.00	Set cold-head temp target, 65 Kelvin.
31	getfeedstartmode	auto	

Vacuum Control TC-110   The preferred Start Up Routine:

Time (min)	Cmd	Value	Vacuum (mbar)	Description
assume	p010= p023= p025= p035=	0 001 001 003		Set pumping station, off. (maybe p009=1 clear errors) Set T pump for start with station on. (T = Turbo) Set D pump intermittent on. (no longer used)(was set at 90 min mark) Set D pump power. (backing pump) (usually does not change)
setup	p023= p024= p025=	001 009 000	1.0 atm	Set T pump off. Set D pump speed high. (runs for 60 to 80 minutes) Set D pump Intermittent off (Continuous) (or set 001 now not later)
00	p010=	1	1.0 atm	Set pumping station on. (D pump high speed if p024=000 & p035=003)
08			7.0 E+2	Gauge begins to read a value between 9.0 & 4.0 E+2. (if available)
40			1.2 E+1	Typical vacuum at this time. (might be able to start turbo here)
60	p023=	1	3.0 E+0	Set T pump on. (begin run up time ?) (only works if p010=1)
64			1.0 E -5	Turbo run up complete. (usually 4 to 6 minutes) (12 watts at 75 min)
80	p024=	000		Set D pump speed low. (using turbo rotation speed switch)
90	p025=	001	?.0E -5	Set D pump intermittent on. (optional depending on conditions)

Vacuum Control TC-110   Some Popular Manual Modes:

Item	Cmd	Manual D Fast	Manual D Slow	Normal D Int	Description
	P009=	1	1	1	Set acknowledge current errors (1 clear errors if present)
	P700=	120	120	120	Set run time as desired in minutes, 120 max.
	P708=	070			50% 54 watts, 70% = 76 w, 100% =107 w, might get hot.
	p024=	009	010	000	Set Diaphragm Pump speed, (009 independent of p010)
	p025=	000	000	001	Set operation mode backing pump.
	p035=	007	007	003	Set Cfg Acc A1, Diaphragm pump, 007 on, 006 off, 003 backing.
	p010=	1		1	Set pumping station, turbo & diaphragm. (1 start station)
	p023=	1		1	Set turbo on/off, turbo motor only. (1 start independently)
	P346	watch			Display motor temp.
	P398	watch			Display motor speed.

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Feed Control Program and Auto start:

The "Feed Control Program" resides on the Feed Control Board inside the Feed Housing. In general when power is applied to the feed, 3 control boards become energized: Feed Control, Vacuum Control, Cooler Control. Each of these probably has some initialization process and then attempts to establish communication. The Feed Control Program will initially set certain parameters on other controllers and will use whatever commands were last set. As always it will pass through all entered commands to the appropriate controller at any time.

At startup or after a power cycle or after a reset command. The" Feed Control Program" will take about 2 minutes to initialize. It is best not to enter commands during this period. When the Control Program becomes active it first checks the stored "getfeedstartmode" value.   If set to "auto" it will execute a sub program called the "Auto Start Program". We have to assume that the feed operation was terminated without warning by a loss of the 24 and or the 48 VDC for some unknown period of time.

The Auto Start Program will have to address 2 questions: What is the vacuum condition and what is the cold condition? Based on various sensor readings the Auto Start Program will execute the necessary commands to bring the feed to proper operation. The Auto Start Program may operate for 2 hours before ending in a successful condition or a failed condition. In either case the Feed Control Program will still be active and ready to process any entered commands. If commands are entered during the execution of the Start Program, I am not sure how the Start Program reacts. If you enter "setautostartmode manual", I am not sure it will end the Start Program, but I know the next time the board is power cycled or reset it will not execute the Auto Start Program again.

If "setautostartmode auto" has been entered, the Auto Start Program will not execute until the power is cycled or the "reset" command is entered. If the "reset" command is used please wait 2 minutes before entering any commands.

The Control Program should always be left with "setfeedstartmode auto". In the future the Control Program should use SET SSTOPM=1 allowing the Feed control board to enable the Cooler Control via pin 5. This will provide protection if 24 VDC & fan fails.

In order to shut down the Cooler when 24 VDC has failed, the Cooler Control, IO input 3, for thermostat has been routed through the relay on the main Feed Control Board.

Fan speed can be manually set "setfanpwm 90" or allow computer to temperature regulate via "setfanpwm auto".

How to run the auto start program :

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At a terminal accessing the feed control board type the following:

setfeedstartmode auto        ( restart may be required to lock in this mode )
OK
reset
reset in one minute...                          ( response )
Antonio Feed Monitor and Control Firmware 3.12 ( response )(this line will be copied over )

Note: When the reset process is complete the fan will cycle to high speed then back down.
Then wait one additional minute for the program to establish full communication with other
boards before requesting actions.

setfeedstartmode manual     ( no restart required to begin this mode ?? )( see page X )


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Description of Start Program for Various Conditions:

Operation for (vacuum poor and feed is warm > 250 K)

Power has just been applied or program is reset and the timer set to zero.
The Diaphragm Pump will start and run at high speed.
The Turbo Pump will start. (vacuum is poor, so expect a long struggle to reach high speed)
At the 15 minute mark, the turbo has probably not reached full speed.
The Turbo pump will shut down. (to avoid overheating and unnecessary ware)
The diaphragm pump will continue at high speed for an additional 45 minutes.
At the 60 minute mark, the Turbo will start again.
The Turbo pump will probably find a better vacuum, reach full speed & the diaphragm pump will go to low speed.
At the 75 min mark, the Turbo power will be tested for less than 20 watts, indicating a very good vacuum.
The Cooler will start, assuming it passed the above test. (if test fails then turbo will stop and wait again)
Start up program is complete.

Operation for (vacuum good and feed is warm > 250 K)

Power has just been applied or program is reset and the timer set to zero.
The Diaphragm Pump will start and run at high speed.
The Turbo Pump will start. (vacuum is good, so expect a short time to reach high speed)
The Turbo Pump will reach full speed & the diaphragm pump will go to low speed.
At the 15 min mark, the Turbo power will be tested for less than 20 watts, indicating a very good vacuum.
The Cooler will start, assuming it passed the above test. (if test fails then turbo will stop and wait again)
Start up program is complete

Operation for (vacuum good and feed is cold < 250 K)

Power has just been applied or program is reset and the timer set to zero.
The Diaphragm Pump will start and run at high speed.
The Cooler will start. (this happens because the LNA temperature is already cold < 250 K)
The Turbo Pump will start. (vacuum is good, so expect a short time to reach high speed)
The Turbo Pump will reach full speed & the diaphragm pump will go to low speed.
At the 15 min mark, the Turbo power will be tested for less than 20 watts, indicating a very good vacuum.
The Cooler will continue. (if the Turbo power test fails then turbo will stop and program gives error)
Start up program is complete.

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Proposed Startup Program Routine: (actual routine may differ)

Allow vac system & cooler to self start or continue as previously programmed. (see question above)
setfanpwm=100
start thermal management program. ⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⟶
Set Timer = 0   Initialize & start timer, (minutes)
p009=1   Acknowledge error. (not sure about this one, I think it is needed)(maybe same as p010=0)
p010=0   Set Pumping station Off.   (maybe pause for a moment)
p700=000020   Set Turbo runup time to 20 minutes. (not sure needed)
p023=1   Set Turbo Pump to On. (it will start when Pumping Station Starts p010=1)
p024=000   Set D Pump to High Speed for < 90% Turbo and Low for > 90% Turbo Rotation Speed Set Point.
p025=000   Set D Pump Intermittent to Off.   (we might want to turn this on much later)
p035=003   Set D Pump On/Off/Backing to Backing.
p010=1   Set Pumping Station On. (D pump will start)
If getdiode < 250 Then setsoftstop 0 Set Cooler On, Lift Soft Stop condition, or SET SSTOP=0. (preserve cold)
p023=1   Set T Pump On. (Turbo Vac 15 minute Attempt)(Test vacuum pressure)
Timer   Wait 15 minutes.
If p316 < 20 Then setsoftstop 0 Set Cooler On, Lift Soft Stop, goto Continue. (passed Vac test) ⎯⎯⎯⟶
p023=0   Set T Pump Off. (wait for D pump to lower pressure)
setcryostop 1   Set Cooler Off. Impose Soft Stop. (feed should not be cooled further)
If getdiode < 250 Then Error (this feed has poor vacuum and is cold, maybe ice issues) ⎯⎯⎯⎯⟶
Timer   Wait 45 minutes. (one time thru is 60 min two times thru is 120 min)
Goto   (loop up to Turbo Vac 15 minute Test)(maybe cycle counter, maybe 4 X max)
Continue

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Other commands you may wish to send after feed is well established.
p025=001   Set D Pump Intermittent On. (we may want to do this after some number of hours / days)
p700=000008   Set Turbo runup time to 8 minutes. (needed? would force shut down if wake with no control)

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Notes on fan speeds:

Power (pwm)	Speed (rpm)	theoretical 3000 rpm max
20	1168	
30	1586	half speed
40	1945	
50	2235	
55	2339	
60	2428	
65	2526	
70	2652	
75	2817	
80	2945	full speed
100	2950	

cryo-reject 48C and housing A6 60C
Fan speed can be manually set "setfanpwm 90" or allow computer to temperature regulate via "setfanpwm auto".

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Control Items to Monitor:

The following list of commands are very useful for establishing the current state of the feed hardware. Each command will return data, so some pause between each request may be necessary.

Item	Command	Response	Description (always upper case ?)

Suggested Sensors to Monitor			
Item	Command	Response	Description (always upper case ?)
1	TC	65.0	Display Temperature Coldhead. (Kelvin) (risk if below 60)
2	gd	72.9	Display LNA temperature. (Kelvin)
3	P	213.8	Display current power. (watts) (SHOW MX to display max & min)
4	p398	90016	Display Turbo speed, actual. (rpm)(90,600 bad, reset p023)
5	p316	000019	Display Turbo power consumption. (watts)(77 max)(14 good)
6	p326	000040	Display Electronics control board temperature. (°C)
7	p330	000033	Display Turbo bottom temperature. (°C) (most sensitive to fan)
8	p342	000035	Display Turbo bearing temperature. (°C) (no tenths from Pfeiffer)
9	p346	000042	Display Turbo motor temperature. (°C) (55 gives error 117)
10	gt a0	24.0	Display temperature, on control board. (°C) (near ambient)
11	gt a1	22.1	Display temperature, Outside air. (°C) (lower vent from amb)
12	gt a2	21.8	Display temperature, PAX air. (°C) (PAX case exit air)
13	gt a3	26.7	Display temperature, Exhaust air. (°C) (to amb) (a4 not used)
14	gt a5	41.1	Display temperature, Cooler rejection. (°C) (near to fins)
15	gt a6	47.8	Display temperature, Cooler housing. (°C)(back side)(70 C max)
16	getfanspeed	2256	Display fan speed. (rpm)
17	get24v	23.9	Display 24 VDC actual measured.
18	get48v	47.9	Display 48 VDC actual measured. (not all feeds connected)
19	P360	Err006	Display Error History, position 1. (p361 gives position 2, etc.)

Suggested Settings to Monitor		(list not complete)	
	getversion	3.12	Display current firmware version.
	getfeedstartmode	auto	Displays manual or auto.
	p035	003	Display D pump, 007 on, 006 off, 003 backing pump mode.
	SET SSTOPM	0	Set Soft Stop Mode. (0 = stop via SSTOP , 1 = stop via pin 5)
	SET SSTOP	1	Set Soft Stop. (0 = restart motor, 1 = stop motor)
	SET PID	002.00	Set control to temperature mode. (0 = power, 2 = temp)
	SET TTARGET	065.00	Set cold-head temp target to number. (Kelvin) (risk if below 60)
	SET PWOUT	200.00	Set power target to number. (watts) (while in PID mode 0)
	SHOW MX	70 240	Display Min & Max. (watts)
	STATE	list	Display status list of 14 commanded states. (see manual)
	ERROR		Display error messages. (both LEDs are flashing repeatedly)
	Over Current	000 001	Red & Grn LED Flash 1 time, then pause then repeat.
	Jumper error	000 010	Red & Grn LED Flash 2 times, then pause then repeat.
	Serial Error	000 100	Red & Grn LED Flash 3 times. (Baud 4800, None, Data 8, Stop 1)
	Memory Error	001 000	Red & Grn LED Flash 4 times. (Non-volatile Memory)
	Watchdog Error	010 000	Red & Grn LED Flash 5 times.
	Temp Sensor Error	100 000	Red & Grn LED Flash 6 times, (coldhead, test sensor at connector)
		100 001	Multiple Errors, Over Current & Cold Temp Sensor.

~

Data Logging Program used at Minex:

The output of the desired Data Logging Program would look similar to the table shown below. The program is designed for use in the assembly and testing lab. It is written in python and is used on a laptop and a terminal program communicating with the feed via RS-232. The data filename is generated using the date & time from the computer. For example a filename would appear as follows. 2015-05-07-15-07-26-antonio-feed-status-log.txt. The file is a space delimited TXT file and will contain 2 lines of header information followed by lines of data as shown in the table below. The file will record the header only once but the display will re print the header every 10 rows of data. When the program starts it will display the headings shown and a first line of data. It will display a line of data every 3 minutes. After 10 lines are displayed a line of headings will be displayed.

The program starts with a data line every 3 minutes.
The " < " character will decrease the time interval between data lines down to 10 seconds.
The " > " character will increase time. (10 sec, 20 sec, 30 sec, 1 min, 2min, 3 min)
The " ? " character will give a data line right away.

Time	Temp Coldhead (K)	Temp LNA (K)	Vac (mbar)	Turbo (rpm)	Turbo (amps)	Turbo (watts)	Temp Electronics (C)	Temp bottom (C)	Temp bearing (C)	Temp motor (C)	Temp Control Board (C)	Temp outside air inlet (C)	Temp pax air exit (C)	Temp exhaust air exit (C)	Temp cooler rejection (C)	Temp cooler housing (C)	Fan speed (%)	Power current (watts)	Power max allowed (watts)	Power min allowed (watts)
Time	TC	gd	gv	p398	p310	p316	p326	p330	p342	p346	gettemp a0	gettemp a1	gettemp a2	gettemp a3	gettemp a5	gettemp a6	getfanpwm	E (or P)	E (or MX)	E (or MX)

~

Feed Control Board Help Command Examples:

```
help

SYNOPSIS
        help [topic]

DESCRIPTION
shows help information for Antonio feed control board internal commands.  Cryo and vacuum
controller commands, which pass through the control board, are documented elsewhere.

Commands beginning with a lowercase p and three numbers (e.g., "p316") are routed to the
vacuum controller.
Uppercase commands (e.g., "TC") are routed to the cryo controller.

EXAMPLES
      list all available internal commands: help commands
      show help information for getvacuum command: help getvacuum

help commands

setfanpwm                               getcryoattemp
getfanpwm                               getfeedstartmode
getfanrpm -or- getfanspeed              setfeedstartmode
gettemp -or- gt
getvacuum -or- gv
getdiode -or- gd
setcryostartmode
getaccel                                getrelay
setrelay                                bootloader
minex -or- hyperterminal -or- ht        reset
ls -or- dir                             stty -or- rimbox
cat -or- type                           getversion
get24v                                  get48v


help getvacuum
SYNOPSIS
    getvac [options] gv [options]

DESCRIPTION
    get Pfeiffer vacuum gauge reading in millibar units.  May also return
    "underrange," "overrange," or "sensor error" (see manual).

    -v  return measured voltage (don't convert to millibar)

EXAMPLES
    get vacuum gauge reading converted to millibar units: getvac
    get measured vacuum gauge voltage: getvac -v
```

How to Connect to Feed Control via the Rim Box:

```
From ant2e linux command line:

telnet rimbox 1518
```

The above, will open a connection to the rimbox RS-232 port over which you can talk to the feed controller board. Just like telnet'ing to other boards, you can hit "control-C e " to close the connection.

```
   ~
```

Troubleshooting and Diagnostics (incomplete)

LNA Temperature running high…………

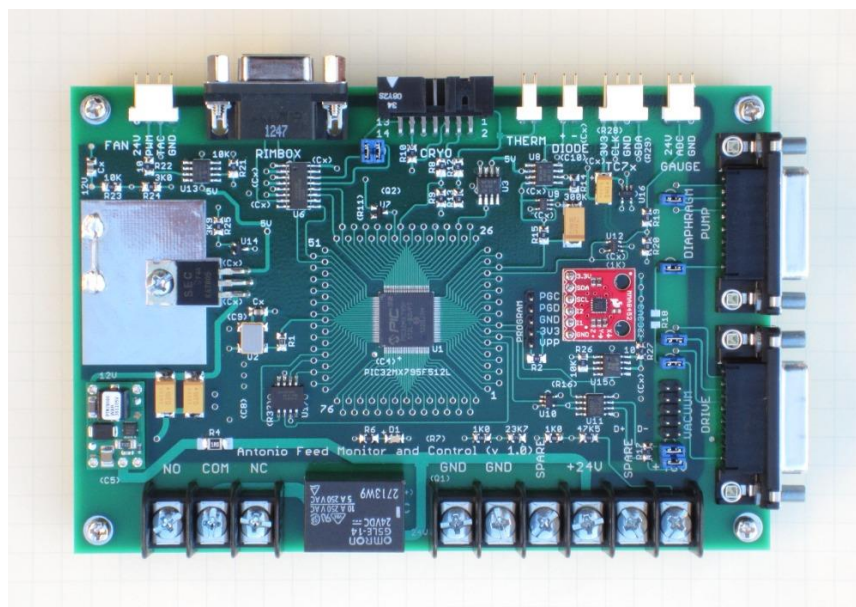Component Temperatures running high………..
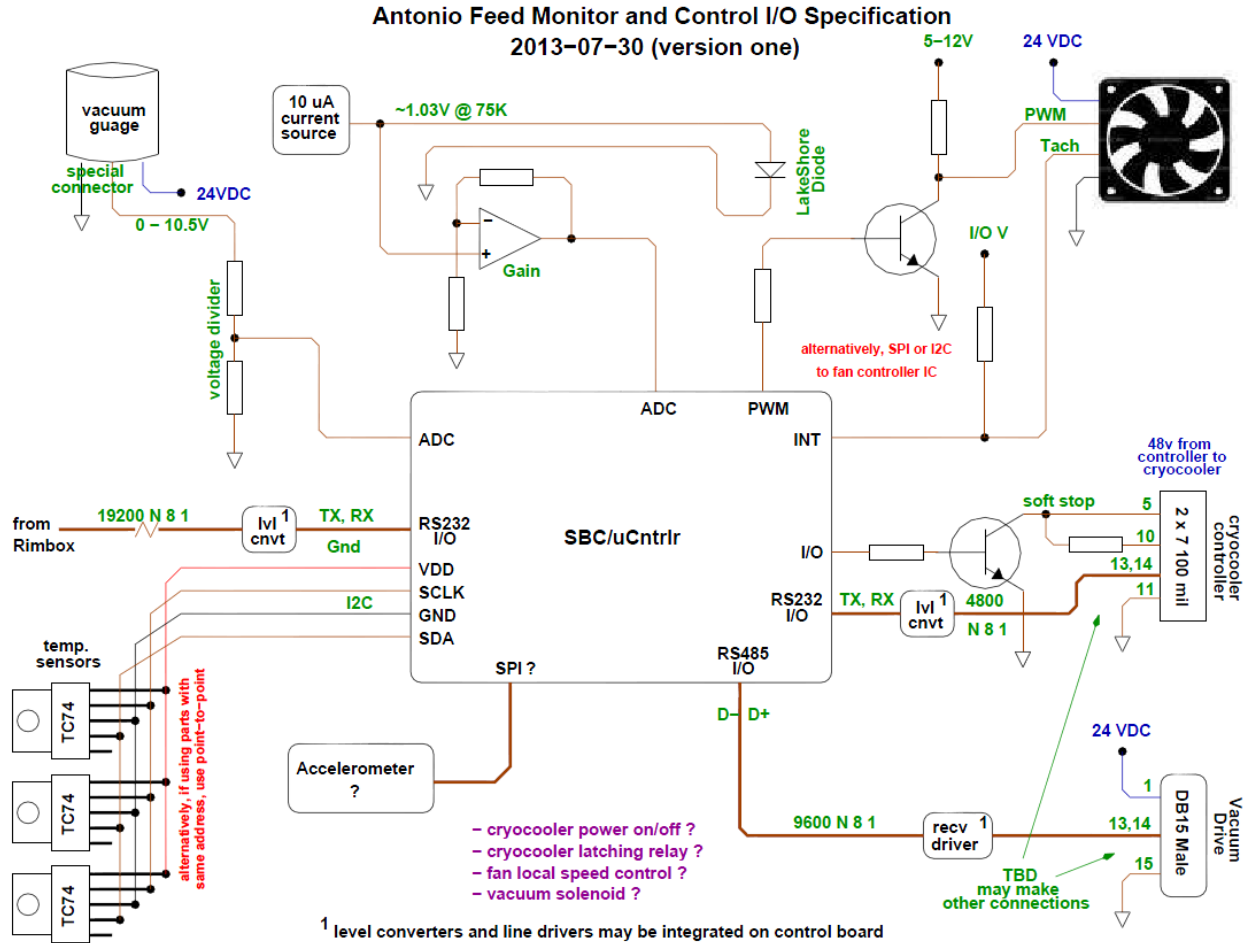
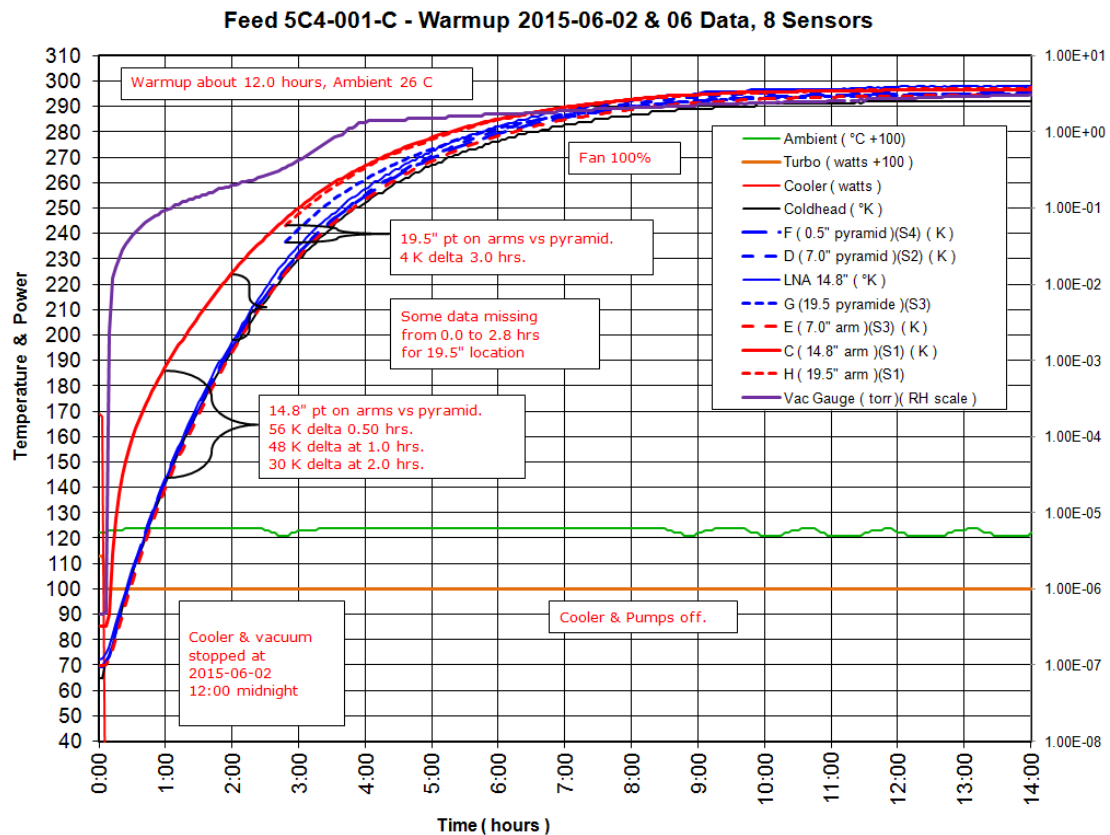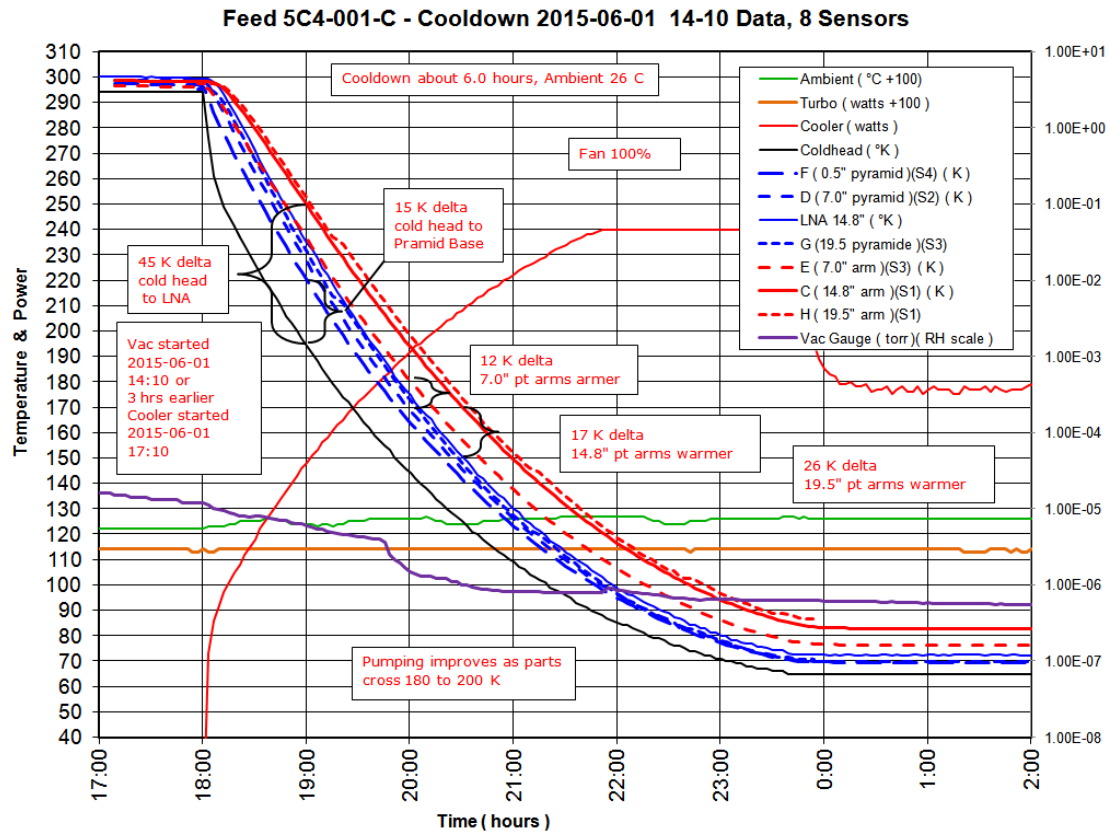Ice on glass dome……

Turbo Pump Current running high………….

Cryo Cooler Current running high……..

Cryo Cooler Vibration extreme……….

Diaphragm pump noisy, means that pump rotational bearings are degrading and failure will occur sooner than later. It does not necessarily mean the pumping performance is degraded. Diaphragm pump performance can degrade if chambers get overloaded with condensed water or water vapor. These pumps sometimes struggle with water vapor more than other pump designs. This issue can be improved by opening the input of the pump to the atmosphere or clean gas for a good flow rate through the pump to carry away water.

## Feed Control Board Diagram and Photo:

Appendix A   Typical Performance Charts (page 1)

Feed 5C4-001-C - Cooldown 2015-06-01 14-10 Data, 8 Sensors

Cooldown about 6.0 hours, Ambient 26 C

Fan 100%

15 K delta
cold head to
Pramid Base

45 K delta
cold head
to LNA

12 K delta
7.0" pt arms armer

Vac started
2015-06-01
14:10 or
3 hrs earlier
Cooler started
2015-06-01
17:10

17 K delta
14.8" pt arms warmer

26 K delta
19.5" pt arms warmer

Pumping improves as parts
cross 180 to 200 K

Legend:
- Ambient (°C +100)
- Turbo (watts +100)
- Cooler (watts)
- Coldhead (°K)
- F (0.5" pyramid)(S4) (K)
- D (7.0" pyramid)(S2) (K)
- LNA 14.8" (°K)
- G (19.5 pyramide)(S3)
- E (7.0" arm)(S3) (K)
- C (14.8" arm)(S1) (K)
- H (19.5" arm)(S1)
- Vac Gauge (torr)(RH scale)

Temperature & Power

Time (hours)

Feed 5C4-001-C - Warmup 2015-06-02 & 06 Data, 8 Sensors

Warmup about 12.0 hours, Ambient 26 C

Fan 100%

19.5" pt on arms vs pyramid.
4 K delta 3.0 hrs.

Some data missing
from 0.0 to 2.8 hrs
for 19.5" location

14.8" pt on arms vs pyramid.
56 K delta 0.50 hrs.
48 K delta at 1.0 hrs.
30 K delta at 2.0 hrs.

Cooler & Pumps off.

Cooler & vacuum
stopped at
2015-06-02
12:00 midnight

Legend:
- Ambient (°C +100)
- Turbo (watts +100)
- Cooler (watts)
- Coldhead (°K)
- F (0.5" pyramid)(S4) (K)
- D (7.0" pyramid)(S2) (K)
- LNA 14.8" (°K)
- G (19.5 pyramide)(S3)
- E (7.0" arm)(S3) (K)
- C (14.8" arm)(S1) (K)
- H (19.5" arm)(S1)
- Vac Gauge (torr)(RH scale)

Temperature & Power

Time (hours)

Appendix A   (page 2)

Feed 5C4-003-A - Pumpdown 2015-07-28 11:36:24
Start Turbo Pump 60 minutes after Diaphragm Pump
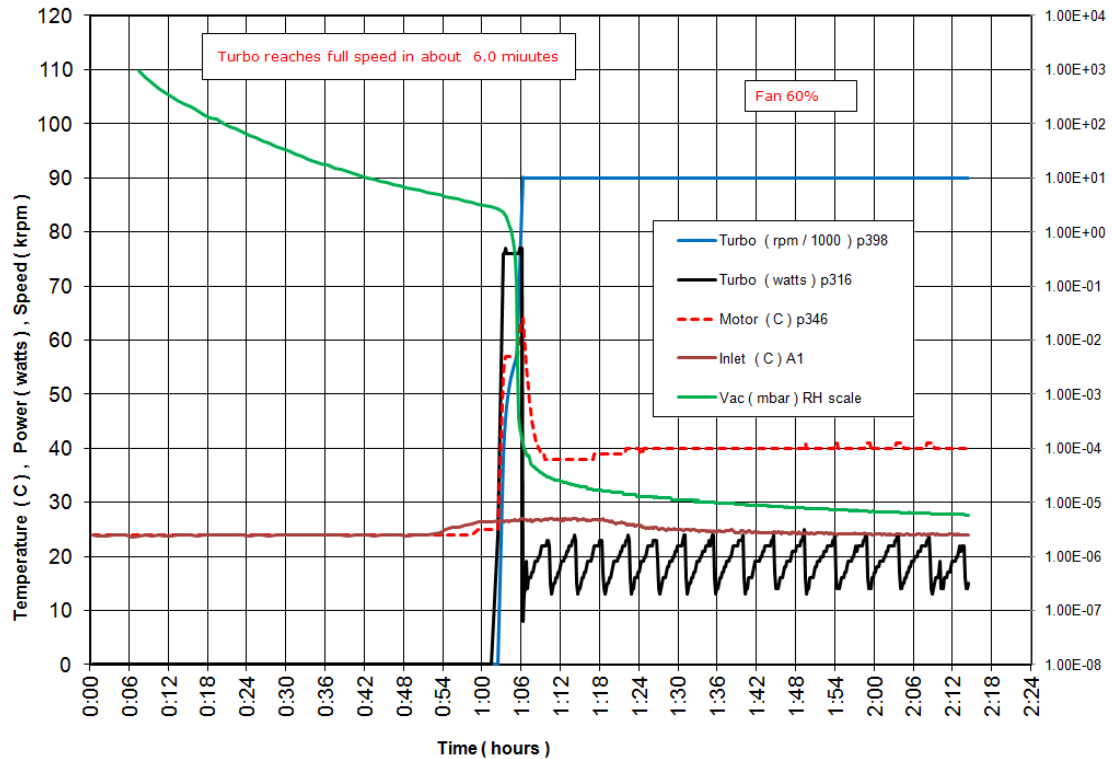
Feed 5C4-003-A - Pumpdown 2015-07-28 09:33:52
Start Turbo Pump same time as Diaphragm Pump.
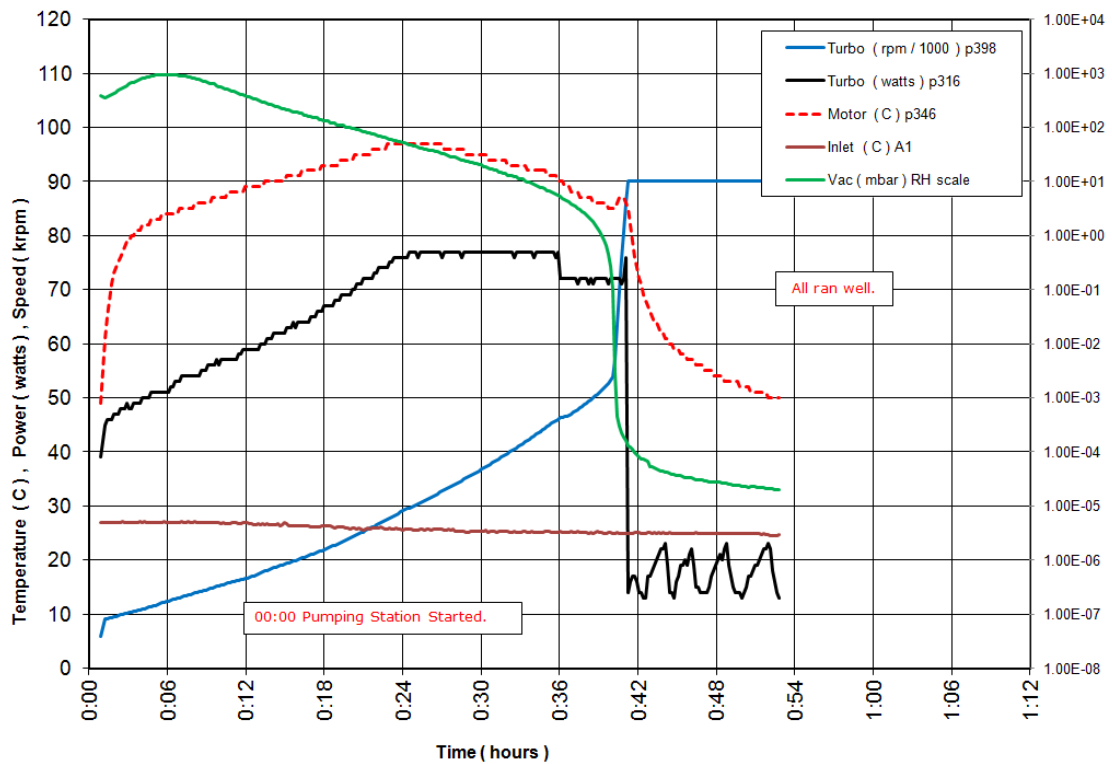
Appendix B   Improvements Needed   (page 1)

This Appendix stores some ideas about maintenance routines. (not implemented)

Possible Thermal Control Routine:
Determine current programmed fan speed lower limit Y. (Y for user input of user defined value)
If cooler rejection temp is > X and $T_2/T_1 > 1$, increased fan speed by X%.
If cooler case temp > X and $T_2/T_1 > 1$, increased fan speed by X%.
If pump electronics temp > X and $T_2/T_1 > 1$, increased fan speed by X%.
If none of the above is true, reduce fan speed by X %, until low speed limit Y is reached.
(evaluate every 10 sec ??)

If cooler rejection temp exceeds X, turn off cooler and wait X minutes.
If cooler case temp exceeds X, turn off cooler and wait X minutes.
If the above is executed 3 times, stop attempts and send error message.

Other Maintenance Monitoring:
If acceleration exceeds X, send error.
If gauge has been on for more than X hours, turn off.   (relay)

Record data log for period Y in local memory.   (this would give some data to laptop without use of main lab data)
Update most recent maximums or extremes.   (when did it occur ?)
Update fraction of time over period Y that data value exceeded Y.

LNA Temperature Troubleshooting:
Cold Head Temperature strange while LNA Temperature is consistent:
If TC = 400K, the RTD sensor most likely has a broken wire or open circuit.
If TC = 35K then the RTD sensor most likely has a short to ground.
If TC = variable numbers over a short time scale, the RTD may have an cracked wire vibrating at 60Hz.
If TC = Incorrect value the RTD may have a vibrating rub spot where insulation is worn through and grounding.
If TC = variable numbers over a longer time scale, the sensor maybe loose or cooler malfunctioning, check P or E.

 ~

Appendix B   (page 2)

Other Important Ideas to Implement:

Disable cooler under the following conditions: (avoid icing and major vibration, hammering, from vacuum loss)

> If 24 VDC is not present. Idea: use SET SSTOPM =1, allow pin 5 control, run = pin 5 open or low, stop = pin 5 high to 5V from onboard isolated pin 10 or 12, use relay or IO on Feed Control Board, wiring Feed Board to Cooler Board in existing?

If vacuum is not present. Idea: turbo control status

If air flow is not present. Idea: use temp sensor on cooler, use rpm sensor on fan, hard wire switch to Cooler Control.

Physically move the clamp on Cooler End Pin so it will not hit the cross bar at zero vacuum.

====================================

Controller Connector Wiring Information
Pin Numbering for I/O connector and RS-232 connections on CryoTel® Controller
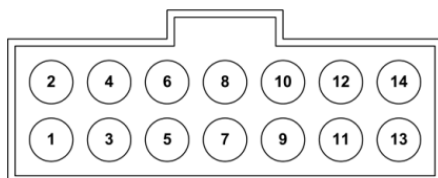
Pin Number	Function
1	Digital Out 1
2	Digital Out 2
3	Digital Out 3
4	Digital Out 4 (AT Temperature)
5	Digital Input 1 (Soft Stop)
6	Digital Input 2
7	Digital Input 3 (Thermostat)
8	Digital Input 4
9	Isolated I/O GND
10	Onboard Isolated 5V
11	Isolated I/O GND
12	Onboard Isolated 5V
13	RS-232 RX (Input)
14	RS-232 TX (Output)

Figure 16: I/O connector
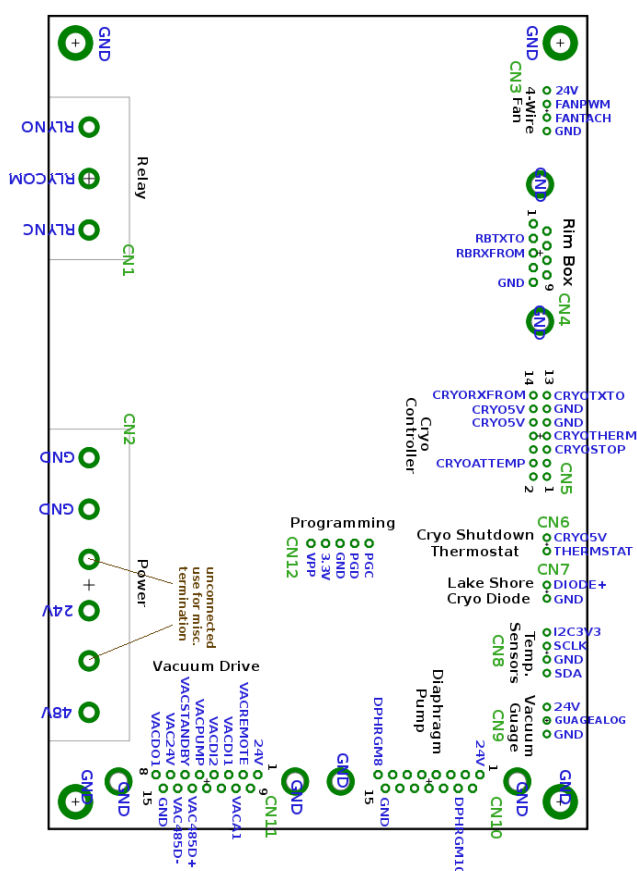
```
SET SSTOPM =1
001.00
```

d) When in Soft Stop Mode 1, setting Digital Input 1 high will shut down the cryocooler. Setting it low or leaving it disconnected will allow the cryocooler to run. The Onboard Isolated 5V (I/O connector pin 10 or pin 12) can be used to set Digital Input 1 high.

e) The soft stop function will slowly ramp down the cooler before shut down to minimize shutdown vibration.