Feed Control Commands and Functions
2015-05-03, Ver 3a

Other related files may be stored in folder "Testing".

Contents:

Introduction:

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. Three 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 may have mislabeled or forgotten some commands.
- More cooler commands are listed in the separate Sunpower controller manual. (version etc ?)
- 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.

Example of typical commands used on the 3 control boards

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

Color code used in command tables

Color	Meaning in this document.
	Please make changes to this command. (Rob Ackermann)
	Please add this command. (Rob Ackermann)
	This value is worth monitoring. (in general)
	This feature might be useful. (discuss with Rob Ackermann)

Rob Ackernann 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

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	getfanpwm	25	Display fan power. (% on time) (pulse width modulation)
3	setfanpwm 30	ok	Set new fan power. (% on time) (check operation with new fan)
4	getfanspeed	2420	Display current fan speed. (rpm) (modify for new fan)
5	getcryoattemp	regulating	Display Cooler State, at setpoint temp. (yes, no) (cooler pin 4)(5V=yes)
6	gettemp a0	21.1	Display temperature, on control board. (°C xx.x) (near ambient)
7	gettemp a1	38.3	Display temperature, Outside air. (°C xx.x) (lower vent from amb)
8	gettemp a2		Display temperature, PAX air. (°C xx.x) (PAX case exit air)
9	gettemp a3		Display temperature, Exhaust air. (°C xx.x) (to amb) (a4 not used)
10	gettemp a5		Display temperature, Cooler rejection. (°C xx.x) (near to fins)
11	gettemp a6		Display temperature, Cooler housing. (°C xx.x) (back of housing)
12	gd -v	0.527	Display LNA diode voltage. (_-v gives)(volts x.xxx) (maybe getdiode ?)
13	gd	68.0	Display LNA temperature. (Kelvin xx.x) (uses equation to calculate) (T = -67792 X3 + 1661 X2 - 1794.7 X + 899.38 from excel)
14	gv	1.2 E-5	Display vacuum gauge. (change to mbar)(equation)(if gauge is present) (p = 10^(1.667xU-d) (U volts) (d = 11.33 for mbar) (5 volts = 1.0E-3) Similar to p340 when using Pfeifer DCU.
15	getaccel	?	Display accelerometer data. ???
16	setgauge 1		Set gauge power, 1 = on, 0 = off. (to increase gauge life)(relay ?)
17	setrelay 1		Set Relay, 1 = closed, 0 = Open. (future use)(mabe gauge)
18	setcoolmode 1		Set cooler start mode, 0 = none, 1 = apply delayed start per "setcoolstart".
19	setcoolstart 90		Set cooler start condition. (time, vac, turbo ?) (SSTOP=1 at power on)
20	setmaxreject 60		Set cooler rejection limit. (C)
21	getcoolerstate		Display has Control board shut down cooler. ????
22	setperiodm 120		Set period M for monitor ratios on diaphragm pump & other items. (min)
23	setperiodh 24		Set time for period H. (hours) (used in getmax etc maybe)
24	getdphr	60%	Display ratio diaphram pump high speed per last M minutes. (%)
25	getdplr	60%	Display ratio diaphram pump low speed per last M minutes. (%)
26	gettimeon	55	Display time power has been on. (days)(since last power off recovery)
27	gettimecool	42	Display time cooling has been < 200 Kelvin. (days) (setbadcool 200 ??)
28	gettimevac turbo	45	Display time vacuum has been < 1 E-2. (days) ? (setlbadvac ???)
29	getmaxgd	150	Display maximum LNA temp over period H hours. (K)
30	getmaxgv	8.2 E-4	Display maximum vac pressure over period H hours. (mbar)
31	getmaxtp	60	Display maximum turbo power over period H hours. (watts)
32	getmaxcp	224	Display maximum cooler power over period H hours. (watts)
33	getmaxa1	22.6	Display max ambient outside air inlet temp a1. (C)

Maybe there should just be a getmaxstring with % time or getoverstring that sends most common monitored items.

~

Vacuum Control Board Commands				(Pfeiffer, passed through Feed Control Board) (prefix p) (RS-485 9,600 N 8 1)
Item	Command	T	Response	Description (always lower case ?)
1	p009=111111	0		Set acknowledge error, 1 = acknowledge, (data type 0 for true false)
2	p010=000000	0		Set pumping station, turbo & diaphragm. 0 = off. (setting is preserved at power down and applied at next power up) 1 = on. (Also acknowledges or clears error)
3	p023=000000	0		Set turbo on/off, for turbo motor only. (not the same as Station on/off) 0 = off. (technically 000000) & 1 = on. (technically 111111)(but 0 & 1 work)
4	p024=009	7		Set Cfg D01, Output, Diaphragm Pump speed, 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)
5	p025=001	7		Set operation mode 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	p027=001	7		1 = light gas.
7	p035=003	7		Set Cfg Acc A1, Accessory , Diaphragm pump on, 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.
8	p700=000120	1		Set value run-up time. (min) (1 to 120)
9	p710=000014	1		Set point diaphragm intermittent on. (watts)(based on turbo power p316)
10	p711=000024	1		Set point diaphragm intermittent off. (watts)(based on turbo power p316)
11	p304	0	0	Display Excess Temp Electronics. (0 = no, 1 = yes)
12	p305	0	0	Display Excess Temp Turbo. (0 = no, 1 = yes)
13	p310	2	1.83	Display Turbo current consumption. (amps) (000183 = 1.83)
14	p311	1	85	Display Station operation (hours)(0 to 65535)
15	p315	1	1500	Display Turbo speed, nominal. (Hz) (1500 Hz = 90,000 rpm)(x6)
16	p316	1	22	Display Turbo power consumption. (watts)(77 max)(14 good)
17	p326	1	34	Display Electronics control board temperature. (°C xx.x) (tenths ?)
18	p330	1	35	Display Turbo bottom temperature. (°C xx.x) (tenths ?)
19	p342	1	39	Display Turbo bearing temperature. (°C xx.x) (tenths ?)
20	p346	1	31	Display Turbo motor temperature. (°C xx.x) (tenths ?)
21	p398	1	90030	Display Turbo speed, actual. (rpm)(90,000 max nominal)

Data Type. (Column "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

Vacuum Control Board Commands related to DCU 002				
	p794=001	7		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 from Pfeiffer DCU) (p738 gauge type)

Notes on ECU indicator lights:
Green flashing, power on | Green solid, station on | Yellow solid, warning | Red solid, malfunction

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 SSTOPM=1 *	1	Set Soft Stop Mode. (0 = stop via SSTOP , 1 = stop via pin 5)
2	SET SSTOP=1 *	1	Set Soft Stop. (0 = restart motor, 1 = stop motor)
3	SET MAX=210 *	210	Set Max user defined power. (watts) Not PWOUT. Factory < 240.
4	SET MIN=100 *	80	Set Min user defined power. (watts) Not PWOUT. Factory > 70.
5	SET PID=2 *	002.00	Set control to temperature mode. (0 = power, 2 = temp)
6	SET TTARGET=65 *	065.00	Set cold-head temp target to number. (Kelvin) (risk if below 60)
7	SET PWOUT=200 *	200.00	Set power target to number. (watts) (while in PID mode 0)
8	TC	65 (065.00)	Display Temperature Coldhead. (Kelvin xx.x) (risk if below 60)
9	P	210	Display current power. (watts)
10	E	120 70 120	Max allowable power. (watts) (varies with cold, usually 240) Min allowable power. (watts) (never less than 70) Current power. (watts) (usually < 240 during regulation)
11	SHOW MX	80 210	Display Min & Max. (watts)
12	STATE	list	Display status list of 14 commanded states. (see manual)
13	RESET=F	RESETTING	Resets all parameters to factory default.
14	ERROR	 000 001 000 010 000 100 001 000 010 000 100 000 100 001	Display error messages. (both LEDs are flashing repeatedly) 1 LED Flash, Over Current 2 LED Flashes, Jumper Error 3 LED Flashes, Serial Error (Baud 4800, None, Data 8, Stop 1) 4 LED Flashes, Non-volatile Memory Error 5 LED Flashes, Watchdog Error. 6 LED Flashes, Temperature Sensor Error. 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 load. Needs 100 cu-ft/min air. achieve 1.0E-4 or better vacuum.
	LED on Red	Unit in cool down mode, above Set Point Temp.
	LED on Green	Unit regulating within 0.5 Kelvin of Set Point Temp. (pin 4 high)
	Inhibit motor on/off	see feed control board relay. (maybe)(pin 10 at 5 VDC to pin 5 soft stop)

~

Feed Control Program:

When power is applied to the feed, 3 control boards become energized: Feed Control, Pump Control, Cooler Control.
Each of these probably has some initialization process and then attempts to establish communication.

It should be assumed that the feed operation was terminated without warning by a cut in 24 and or 48 VDC.
Questions: How long has the unit been off? What is the vacuum condition? What is the cold condition?
Some variables are changed by loading a new program and some are changed by input via RS-232 com.

Assume that pump restart will occur with command, not with power up. (not sure if this is best ??)
Assume that cooler restart will occur with command only. (only if 24 VDC & Feed Control Program is running)

When power is applied the feed control program begins, goes through some initialization steps, taking X seconds.
Establish communication with pump control & cooler control.
Set fan for 100%.
Set cooler off or disable or inhibit.
Determine date & time ?? (not sure if this is possible)
Action based on time ?? (not sure what this might be, just put it in here)
Read the LNA temperature and or Cold Head temperature. (not sure how used, maybe initial mode or resume mode)

Set Turbo on. (just in case it was set to off for some reason, will not start until station on, maybe not needed)
Set pump station on. (diaphragm will start at high speed, turbo will start, run up time will start)

If turbo power is < 20 watts, set cooler restart or enable. (evaluate every 1 minute)(maybe user input)

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.
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.

Possible initial startup routine:

The diaphragm pump is started and run for X minutes.
The turbo pump is started.
The turbo power is monitored.
Turbo is turned off. (pump down or resume ??)

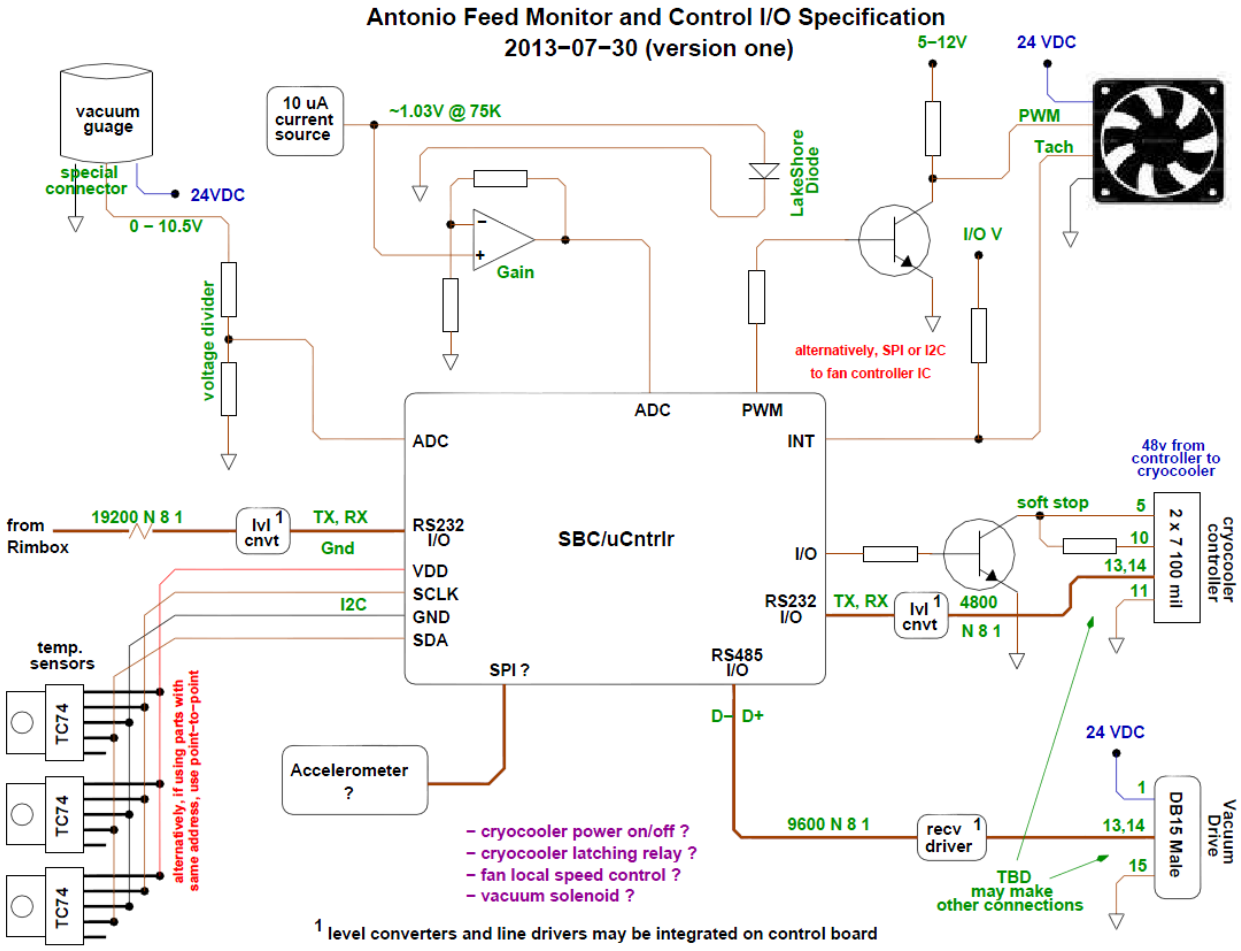
~

Data Logging Program:

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.

Is it possible for the user to input a value for the interval between data gathering? Can it be changed several times during a logging session?

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)


Antonio Feed Monitor and Control I/O Specification
2013−07−30 (version one)
vacuum guage
special connector
24VDC
0 − 10.5V
voltage divider
10 uA current source
~1.03V @ 75K
Gain
LakeShore Diode
5−12V
24 VDC
PWM
Tach
I/O V
alternatively, SPI or I2C to fan controller IC
ADC
PWM
ADC
INT
SBC/uCntrlr
from Rimbox
19200 N 8 1
lvl cnvt 1
TX, RX
Gnd
RS232 I/O
VDD
SCLK
GND
SDA
I2C
SPI ?
I/O
RS232 I/O
TX, RX
lvl cnvt 1
4800
N 8 1
RS485 I/O
D− D+
48v from controller to cryocooler
soft stop
5
10
13,14
11
2 x 7 100 mil
cryocooler controller
temp. sensors
TC74
TC74
TC74
alternatively, if using parts with same address, use point−to−point
Accelerometer ?
− cryocooler power on/off ?
− cryocooler latching relay ?
− fan local speed control ?
− vacuum solenoid ?
9600 N 8 1
recv driver 1
24 VDC
1
13,14
15
DB15 Male
Vacuum Drive
TBD may make other connections
1 level converters and line drivers may be integrated on control board