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Gravity Probe B Relativity Mission

Help for Using the TRE Support Systems (GSE Test Racks)

Simplified Instructions

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Using the TRE Support Systems

Here's **Help**

Following is a table of scale factors for converting TRE output slopes to photocurrents. The signals are normally digitized using the differential outputs of the TRE, however if you use a scope on the BNC connector at the test rack, it becomes a single ended measurement, and there is a factor of two difference in the scale factor. Recall that the TRE integrates the photocurrent, so the quantity to measure is the signal slope. Multiply the measured slope (volts/sec) by the appropriate scale factor from the table to get photocurrent in amperes.

Low gain mode is enabled by setting the control word to **1140h** for Engineering Unit TREs. The gain codes are entered as the two left hex digits of the BIAS command word. Use the same gain code value for each direction, as 44xxh or 77xxh.

For operating the test set, see **TRE Test Commands and the SQUID Software Program**. To find out about what the commands do, read **TRE Engineering Unit Control Parameters**. A table to help with temperature setting with the footer **LOCTEMP.XLS** relates hex values of the Dtemp register to focal plane temperatures.

A procedure for balancing the amplifiers, assuming the detectors are dark, is included: **Balancing the TRE Detector Modules**. Use this before going to low gain mode. In low gain mode, the clamp values will be much smaller than in normal mode. Adjust the amplifier gains based on the light level.

A list of Engineering Data Channel signal names and the hexadecimal control word command for selecting that channel is included as sheet eu chnls from HSECHNL.XLS with banner **TRE EU Engineering Data Channel Readout order**.

TRE Engineering Unit Scale Factors

Scale factor units are ampere-seconds per volt.

	Differential output			Single Ended Output	
Gain code	Normal	Lowgain		Normal	Lowgain
F	1.98E-16	3.96E-13	**F**	3.96E-16	7.93E-13
E	2.79E-16	5.58E-13	**E**	5.58E-16	1.12E-12
D	3.94E-16	7.89E-13	**D**	7.89E-16	1.58E-12
C	5.58E-16	1.12E-12	**C**	1.12E-15	2.23E-12
B	7.88E-16	1.58E-12	**B**	1.58E-15	3.15E-12
A	1.12E-15	2.24E-12	**A**	2.24E-15	4.47E-12
9	1.6E-15	3.19E-12	**9**	3.19E-15	6.38E-12
8	2.3E-15	4.59E-12	**8**	4.59E-15	9.19E-12
7	3.37E-15	6.75E-12	**7**	6.75E-15	1.35E-11
6	5.22E-15	1.04E-11	**6**	1.04E-14	2.09E-11
5	5.22E-15	1.04E-11	**5**	1.04E-14	2.09E-11
4	7.52E-15	1.50E-11	**4**	1.50E-14	3.01E-11
3	1.11E-14	2.21E-11	**3**	2.21E-14	4.42E-11
2	1.7E-14	3.39E-11	**2**	3.39E-14	6.79E-11
1	1.7E-14	3.39E-11	**1**	3.39E-14	6.79E-11
0	2.4E-14	4.80E-11	**0**	4.8E-14	9.60E-11

Scale factors are based on feedback capacitance values of 0.5 pF for normal mode and 1000pF for low gain mode. Gains used are based on measurements of engineering unit boards. Current estimates with the above should be accurate to better than ±4%.

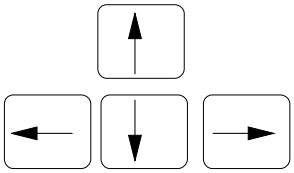
Note that gain codes 5 and 6 have the same scale factor, and gain code 1 and 2 also have the same scale factor. Scale factors for flight units will be different.

TRE Test Commands and the SQUID Software Program

The SQUID program runs on the TRE test rack and allows an interface between the operator and the Squid Readout Electronics emulator, and other test set control functions, such as recording data files of digitized TRE outputs. The program runs under DOS, and is based on sending a full set of commands to the Squid Readout Electronics. Only a limited set of its capability is used in the TRE test rack.

When the program is started, a set of default conditions are read from a data file that can be modified using a separate program, Setup.exe, found in the same directory as Squid.exe. A dot matrix graphic is displayed when Squid is started, and can be dismissed by pressing Enter to get to the first menu.

First Menu--The first menu offers five options: Commands, View, Disk, Global, and Quit. The current selection is highlighted, and alternative selections are made by use of the left or right arrow keys on the keyboard. When the appropriate option is highlighted, press Enter to get to a sub-menu.



Commands provides a sub-menu for selecting a subsystem to which command values might be entered. Further description will come later.

View allows selecting alternative sub-unit displays. Probably not required for TRE tests.

Disk allows controlling the generation of disk file length and recording frequency. Allows starting and stopping the data recording.

Global allows setting certain flags that control what portions of the SRE would be active.

Quit allows exiting the program if you really mean it.

For the TRE tests, first select Global and press Enter. Four options are allowed in the global menu. Depress the down arrow key twice to select "**All A side commands are to be: Enabled**" with Enabled highlighted, and press Enter. Then press ESC to leave that menu and return to the First Menu.

Select Commands using the left or right arrow keys, and press Enter. The Commands choices are:

```
0 TRE X            4 SRE SQUID 1/3
1 TRE Y            5 SRE SQUID 2/4
2 SRE DAS/CAL      6 SRE POWER
3 SRE BRACKET
```

Selections are highlighted, and the arrow keys may be used to change the selection, or the leading number can be entered to select an option. Only 0 and 1 are of interest for the TRE testing. For board test only, select TRE X and then press Enter. The Box level tests will require use of both TRE X and TRE Y.

The TRE (X or Y) menus are the same, allowing six different commands to be sent to the selected axis.

```
Control    DTemp      Heat       Clamp      Bias       Offsets
```

A command name will be highlighted. Selection of the name is changed using the Page Up or Page Down key. Once the desired selection is achieved, press Enter.

The selected field then allows the command to be enabled or disabled, and if it is enabled, data values may be entered as Hexadecimal, decimal, or binary numbers. Move to the desired choice using the arrow keys until the desired option is highlighted. Most of the TRE Test Plan data will be entered as Hexadecimal values. Enter values using 0 through 9 and a through f keys. The entry is not case sensitive. Each character is entered at the right hand column, with the remaining characters shifted left. When the proper value has been keyed in, press Enter to transfer the number to the register.

Additional entries can be made to the same selection, or another command option may be selected. Leave the menu by pressing the ESC key.

If it is desired to record a sample of the analog to digital converted outputs, go to the main menu, select Disk and press Enter. If the file mode options are acceptable, press Enter to either enable or disable the disk file writing. File naming is automatic based on the time of the decade to the nearest second determined from the internal computer clock. Press ESC to leave the disk menu. Alternative command values can be entered while a disk operation is in progress by returning to the Commands menu.

Shortcuts are available for changing some of the data values in the hexadecimal data entry menu. The 4 character value can be incremented or decremented by use of the + or - keys. A particular character in the 4 character may be selectively increased or decreased by a combination of either shift or Ctrl and a function key F1 through F4. The left most character is selected by F1, the

second character by F2, the third by F3 and the right character by F4. Hold Shift to increment or Ctrl to decrement, and then press the appropriate function key.
Carries and borrows happen in this mode. This feature is useful in changing commands for split fields such as Clamp, Bias, and Offsets, where the high bytes control one action and the low byte a different action.

When finished, stop any Disk logging, and go to the First menu and select Quit. Press Enter, and then Y to answer the "Do you really want to Quit?" question.

Turn out the lights, and lock the door.

Diode Temperature, Kelvin	Diode Voltage	control voltage	DTemp command HEX	Single end engineering data volts
10	1.40304	7.01521	0B39	4.2109
15	1.28238	6.41190	0A42	3.8488
20	1.16172	5.80859	094B	3.4867
25	1.13273	5.66364	0910	3.3997
30	1.10374	5.51869	08D4	3.3126
32	1.10047	5.50233	08CE	3.3028
34	1.09719	5.48597	08C7	3.2930
36	1.09392	5.46961	08C0	3.2832
38	1.09065	5.45325	08BA	3.2734
40	1.08738	5.43689	08B3	3.2635
42	1.08418	5.42088	08AC	3.2539
44	1.08098	5.40488	08A6	3.2443
46	1.07777	5.38887	089F	3.2347
48	1.07457	5.37287	0899	3.2251
50	1.07137	5.35687	0892	3.2155
52	1.06821	5.34107	088C	3.2060
54	1.06505	5.32527	0885	3.1965
56	1.06189	5.30947	087F	3.1871
58	1.05873	5.29367	0878	3.1776
60	1.05557	5.27787	0872	3.1681
62	1.05235	5.26177	086B	3.1584
64	1.04913	5.24567	0865	3.1488
66	1.04592	5.22958	085E	3.1391
68	1.04270	5.21348	0857	3.1294
70	1.03948	5.19739	0851	3.1198
72	1.03614	5.18071	084A	3.1098
74	1.03281	5.16403	0843	3.0998
76	1.02947	5.14735	083C	3.0898
78	1.02614	5.13068	0836	3.0797
80	1.02280	5.11400	082F	3.0697
82	1.01937	5.09685	0828	3.0594
84	1.01594	5.07970	0821	3.0491
86	1.01251	5.06255	081A	3.0388
88	1.00908	5.04540	0813	3.0286
90	1.00565	5.02826	080C	3.0183
92	1.00211	5.01054	0804	3.0076
94	0.99856	4.99282	07FD	2.9970
96	0.99502	4.97511	07F6	2.9864
98	0.99148	4.95739	07EF	2.9757
100	0.98794	4.93968	07E7	2.9651
102	0.98428	4.92138	07E0	2.9541
104	0.98062	4.90308	07D8	2.9431
110	0.96964	4.84818	07C2	2.9102
120	0.95076	4.75378	079B	2.8535
150	0.89110	4.45552	0721	2.6745
200	0.78434	3.92169	0646	2.3540

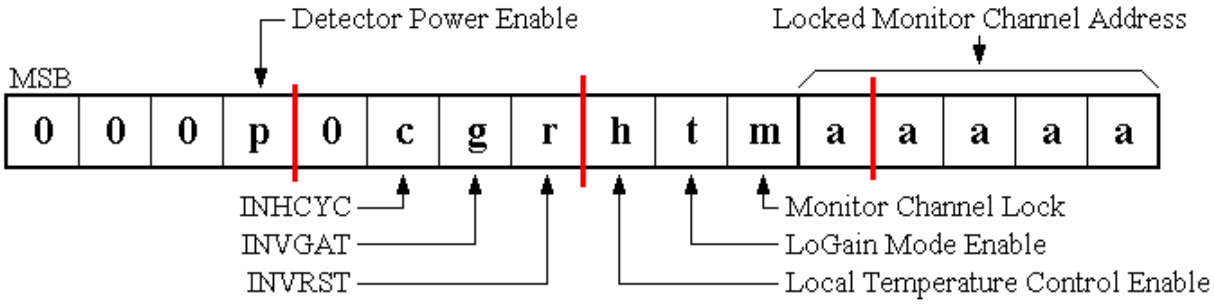
from LOCTEMP.XLS

TRE Engineering Unit Control Parameters

PBIAS is changed to BIAS
SBIAS is changed to OFFSETS

Command Parameter	**Parameter Description**
CONTROL	TRE axis CONTROL bit field (11 bits)
DTEMP	TRE axis Detector Temperature Setpoint value (12 bits)
HEAT	TRE axis Detector Heater value (12 bits)
CLAMP	TRE axis Detector Clamp Voltage values (2 x 8 bits)
PBIAS (BIAS)	TRE axis Gain values (2 x 4 bits) & Pri. Photo-Diode Bias (5 bits)
SBIAS (OFFSETS)	TRE axis Reference Offset values (2 x 8 bits)

CONTROL is a bit field which specifies the TRE axis operating state. The bitwise definition is as follows:



Bits **aaaaa** specify the locked monitor channel address. (Engineering data channel signal)
Bit **m** locks the monitor to channel address '**aaaaa**': 0 = rotating monitor, 1 = locked monitor.
Bit **t** enables low gain mode: 0 = disable, 1 = enable. (Also set **r** for low gain operation., EU only.)
Bit **h** enables local closed loop temperature control: 0 = local open loop control, 1 = local closed loop control.
Bits **r**, **g**, & **c** control the various diagnostic modes. Normal operating mode is all three bits cleared (0).
Bit **p** turns on power to the (cold area) detector circuitry: 0 = off, 1 = powered.
The remaining bits are not used, and should be cleared (0).

DTEMP is a 12-bit binary value, Detector Temperature Control Setpoint. High order 4 bits are ignored.

HEAT is interpreted differently based on the state of the Local Temperature Control Enable bit, **h**, in CONTROL.
Under local temp. control (**h**=1), the 3 least sig. bits of HEAT select the servo update rate. Other bits are ignored.
Under remote temp. control (**h**=0), HEAT is a 12-bit binary value, Detector Heater. High order bits are ignored.

CLAMP high order byte is an 8-bit binary value, Positive Detector Clamp Level Command.
CLAMP low order byte is an 8-bit binary value, Negative Detector Clamp Level Command.

BIAS high order byte is two 4-bit binary values, Negative Gain (bits 12-15) and Positive Gain (bits 8-11).
BIAS low order byte is an 5-bit binary value, Photo-Diode Bias Command. Bits 5-7 are ignored, EU only)

OFFSETS high order byte is an 8-bit binary value, Positive Reference Offset Command.
OFFSETS low order byte is an 8-bit binary value, Negative Reference Offset Command.

Balancing the TRE Detector Modules

Get the device to the operating temperature. If using closed loop control the third hex digit in the control word is an 8, xx8x, if using LN_2 cooling, this digit should be a zero, xx0x.

Set the Clamp word to 0000h. Set the OFFSET command to FFFFh. Set the BIAS to 0000h. Turn on the detectors in the balancing mode, CONTROL = 15x0h. The input stages will be severely unbalanced, with the Reference currents nearly zero and the Signal currents high. The Feedback points will be at a large positive level, as will the normal signal outputs.

Begin decrementing the most significant nibble of the OFFSET command until the Plus Feedback point goes negative, and then increment it one value. Do this for the Negative direction by decrementing the third most significant nibble of the OFFSET command until the Negative Feedback point goes negative and then increment one value. Now refine the balance by decrementing the second or fourth nibbles until the corresponding feedback point goes negative, and then increment one value. This procedure ends with approximately equal currents in the Reference and Signal Transimpedance amplifier outputs, and with a positive level at the feedback points.

Set the CONTROL word for normal operation, 10x0h. Do not change the OFFSET values. Increase the first or third nibble of the CLAMP command until the signal output goes negative, and then decrement the value once. Increase the gain of the outputs by setting the BIAS to 8800h. Increment the second or fourth nibble of the CLAMP command until the outputs levels are as close to zero as possible. Increase the gain further by setting BIAS to CC00h. Adjust the CLAMP value to achieve the output level closest to zero volts. Then stop.

Revised TRE Engineering Data Channel Readout order			
Channel Address		**TRE (New) Signal Name**	**TRE (Old) Signal Name**
decimal	control word	(Flight Units)	(Engineering Units)
0	xx20h	ground	ground
1	xx21h	+ Reference TIA voltage	+ Reference TIA voltage
2	xx22h	+ Signal TIA voltage	+ Signal TIA voltage
3	xx23h	+ Direction Clamp voltage	+ Direction Clamp voltage
4	xx24h	+ Direction Feedback Point	+ Direction Feedback Point
5	xx25h	- Reference TIA voltage	- Reference TIA voltage
6	xx26h	- Signal TIA voltage	- Signal TIA voltage
7	xx27h	- Direction Clamp voltage	- Direction Clamp voltage
8	xx28h	- Direction Feedback Point	- Direction Feedback Point
9	xx29h	Silicon Diode Voltage	Silicon Diode Voltage
10	xx2Ah	Box Temperature voltage	Box Temperature voltage
11	xx2Bh	Heater voltage	Heater voltage
12	xx2Ch	Temperature Command DAC voltage	Temperature Command DAC voltage
13	xx2Dh	Temperature Servo error voltage	Temperature Servo error voltage
14	xx2Eh	+12V Supply voltage	+12V Supply voltage
15	xx2Fh	+5V Power voltage	ground
16	xx30h	ground	-12V Supply voltage
17	xx31h	Reference -4V voltage	+5V Power voltage
18	xx32h	Reference -10V voltage	Diode Bias voltage
19	xx33h	-12V Supply voltage	Reference +5V voltage
20	xx34h	Reset Drive Level voltage	Reference -4V voltage
21	xx35h	Reference +0.5 V voltage	Reference -10V voltage
22	xx36h	Diode Bias voltage	Reset Drive Level voltage
23	xx37h	Reference +5V voltage	Reference +0.5 V voltage
24	xx38h	SRC1V	ground
25	xx39h	SRC2V	ground
26	xx3Ah	ground	ground
27	xx3Bh	ground	ground