Change Notice

Issue 1.0	30 April 2007	Original issue had non-operational channels with anomalous gain values
Issue 2.0	24 Feb 2009	Follows Sarah's injunction on the structure of calibration file derivation and now has proper values for all channels This note constitutes Version 0.1 release of the photometer JFET calibration files
Issue 2.1	23rd Mar 2009	Updated to include note on PTC gains now decided what to do about it

Reference Documents

RD1 Detectory Summary Spreadsheet SPIRE-RAL-TN-002783 v12.1

Scope

This note describes how the photometer JFET relative calibration data were obtained from a set of measurements made on the flight model JFETs and DCU in October 2006. This measurement is described below and cannot be repeated. The values obtained represent our best measurement of the end-to-end gain of the system in a realistic situation. The use of the gain data is subject to discussion, in this note I give the values as obtained. I attempt to follow the format requested by Sarah Leeks in her e-mail of 18 September 2009 – *vis.*

Documentation of Calibration Product Values

For each calibration product there needs to be a procedure that says how to derive the calibration data (including what algorithm should be used and any decisions and judgements to be made to get the data values) and also a note that says how each version of data were actually made (i.e. following the procedure version x using data from OBSID yyyyy, with script version www pipeline version zzz, etc ....).

The procedure only needs to be updated if the procedure changes.
However a new version of the note must accompany each delivery of (updated) data for a calibration file.
The note should reflect the full history of the calibration file (i.e. all releases, versions, editions etc in one document) with the most recent version at the start [note we will see how practical this turns out to be].

Also scripts used to get the values should be made available (possibly placed in CVS or more likely delivered with the data and the notes).

The purpose of the documentation is three fold:

1. *To enable someone else to be able to produce updated values (in case that the original person is not available).*
2. *To enable us to review and confirm that the values are what we want to use before a changed calibration file is released for use.*
3. *Also because we must be able to tell astronomers (and ourselves) how calibration data were made.*

Measurement Set up:

Warm JFETs connected to the FM warm electronics via RAL cryoharness.

No FPU present and bias fed directly to JFET inputs through test connectors and the FM backharness.

Electronics driven through standard instrument GSE and test scripts.

Measurements were taken as "standard loadcurves" (ILT_PERF_DAB_P) with fixed phase

Three bias frequencies were used namely 70, 130 and 189 Hz

At each frequency the phase was optimised:
70 Hz phase 163.76416
130 Hz phase 183.52880
189 Hz phase 196.23464

Note: Only the photometer channels were measured in this set up as the PTC membrane was not powered during the measurement. Therefore the PTC channel values are assumed to be nominal.

Datasets used
The data were exported into FITS format from the database *PFM4_Test* using the "Export" tool (*which version?*). The detector data were exported in raw format and the Housekeeping were converted using *err which version* of the calibration[1]. Three files are available for each frequency with the suffix PHOTF (DCU full photometer frame), PHOTOFF (photometer offset frame) and NHK (nominal housekeeping frame). The following suffixes are used for the three frequency measurements. All data files are available through the Test Team website.

70 Hz ILT_PERF_DAB_P_SinglePhase_300000F5_
130 Hz ILT_PERF_DAB_P_SinglePhase_300000F6_
189 Hz ILT_PERF_DAB_P_SinglePhase_300000F7_

Data Reduction:
Briefly: Bias converted to rms by dividing converted housekeeping values by sqrt(2). Gains applied as per DCU design description. No phase correction applied. Residual gain derived by first order (only) fit to data before saturation and extracting slope. See figure 1 for an example.

The data were reduced using IDL routines.

Results and validation:
The results for each array are summarised in figures 2,3 and 4. The are also given in handy ascii format at the end of the note. In the original measurements some channels were in operable due to faults in the harness. This is no longer the case in the satellite (see RD1) and these values have been "filled in" in the tables with the average values of near neighbours in the same JFET membrane.

As a cross check I looked at the value of the resistor during the warm functional checks (FUNC-DCU-13-PHOT_30011021_) and during an arbitrary cold load curve (ILT_PERF_DAB_P_SinglePhase_30011394_). The values returned using the same derivation procedure as for the gains were (in MΩ)

	EIDP	Warm	Cold
PSW	5.04986	4.94752	5.31180
PMW	5.36000	4.71816	5.06183
PLW	4.92089	4.84059	5.19588

[1] As the knowledge of what calibration and software version has been lost – I will redo the FITS derivation with the latest versions and report these in an update to this note.

PMW warm value looks anomalous here (12% deviation from EIDP?) otherwise the values are within 2-6% of expected. Why there is a variation at all is a good question perhaps? A quick check with another cold loadcurve showed that there is no variation from day to day.

Conclusions:

Basically the results are as expected for the JFET gain – nominal ~0.96 – with some small variation from membrane to membrane and channel to channel. There is a slight, no more than 2-3%, overall gain variation with frequency. This is possibly due to one of the following causes: the phase not being set absolutely precisely for each frequency; a variation in the gain of the JFETs with frequency or a variation in the bias output with frequency. It is hard to tell which is the culprit. The comparison with the fixed resistor is a little strange but (apart from PMW warm measurement) the reported value is always within 6% of the expectation. Final conclusion is that the default absolute gains for the DCU are certainly correct to within 6% absolute and probably better than this. We can take the measured values per channel as relative channel to channel gain variation. We can either normalise them or use them directly as the JFET gain – especially if the bias frequency is selected to be one of those where the measurement was made.

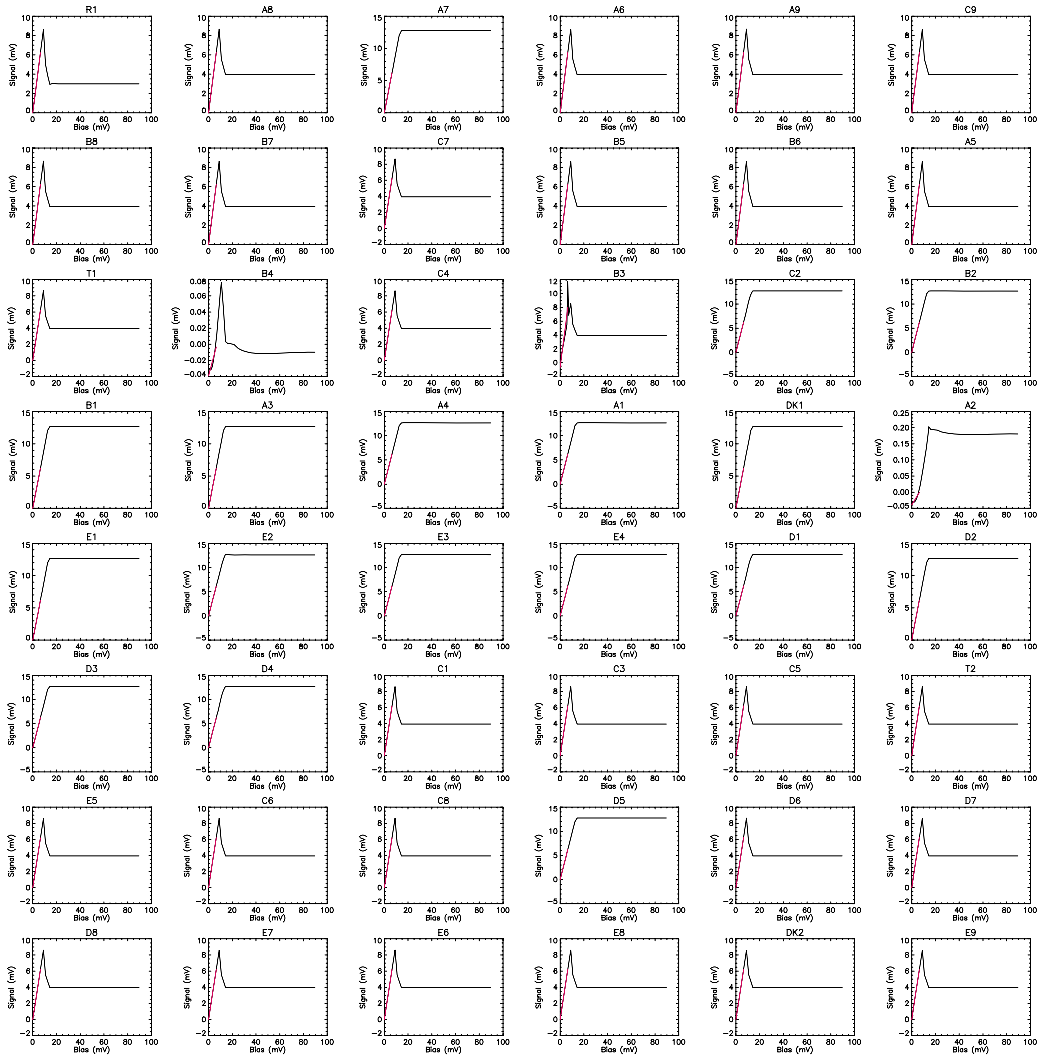

Figure 1: Example of slope fitting for gain determination. This is for PLW. The black line is the measured voltage versus applied bias after gain correction and addition of offsets; the red line is a first order fit to the data. The slope of the fit is taken as the residual gain.

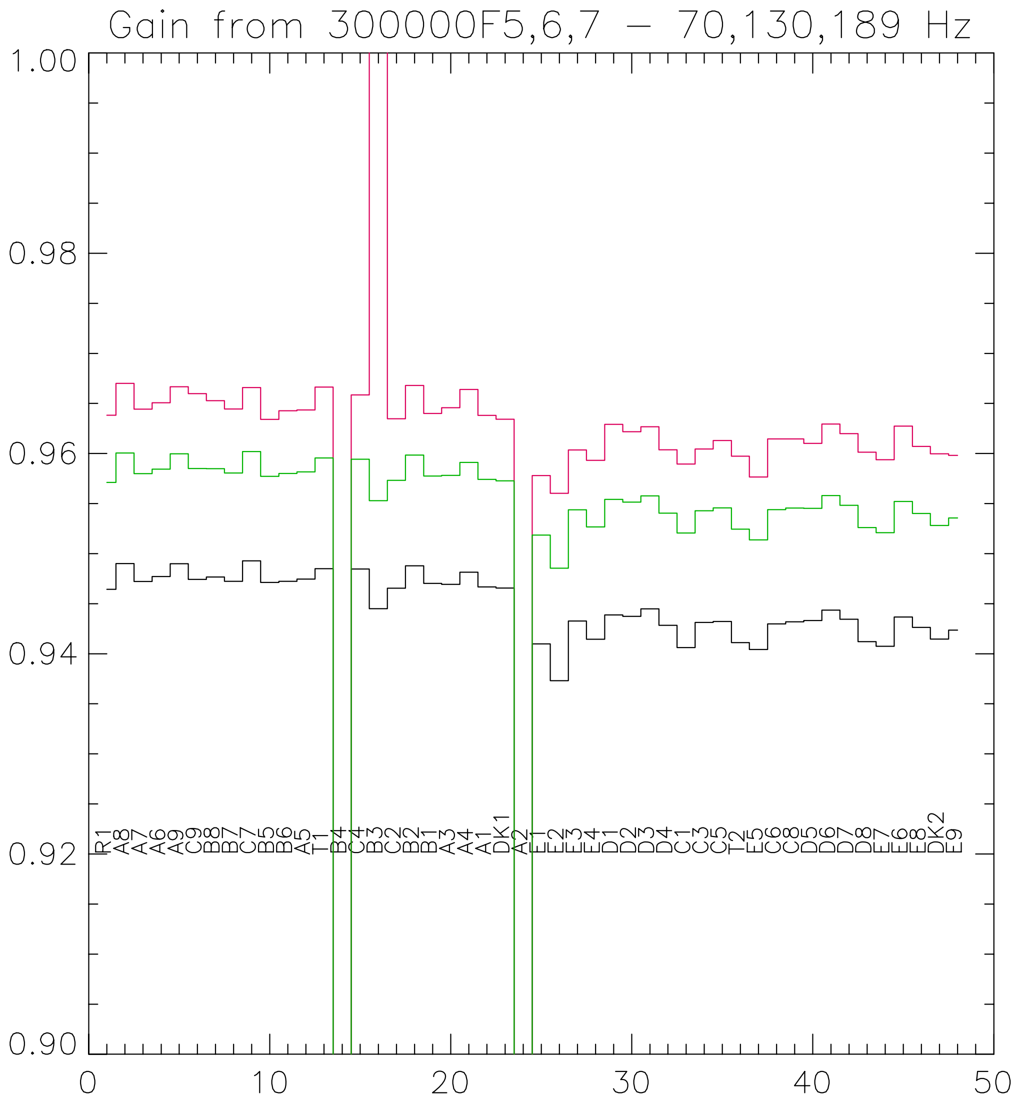

Figure 2: PLW JFET gains at 70 (red) 130 (green) and 189 Hz (black) versus channel number.

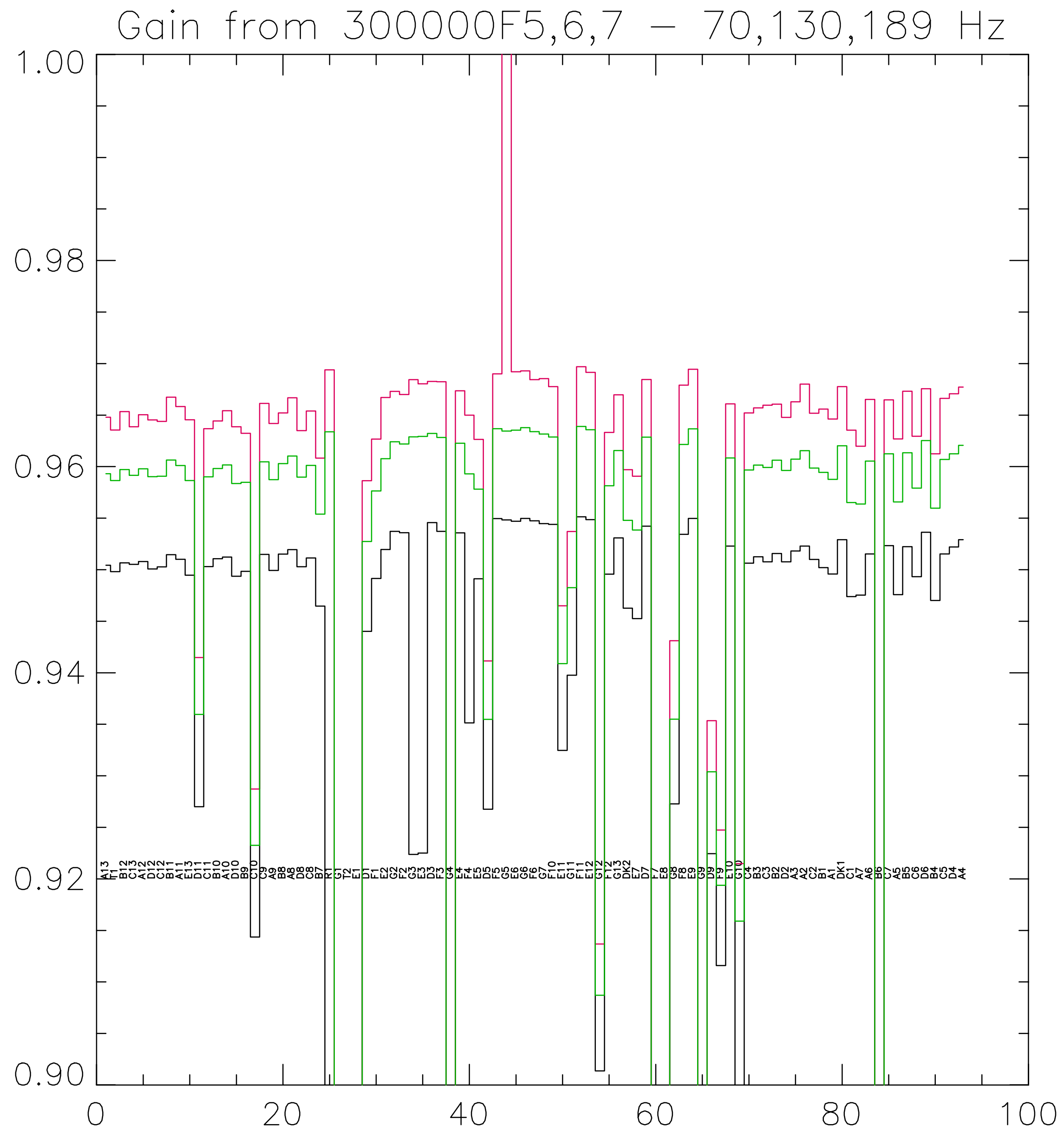

Figure 3: PMW JFET gains at 70 (red) 130 (green) and 189 Hz (black) versus channel number.

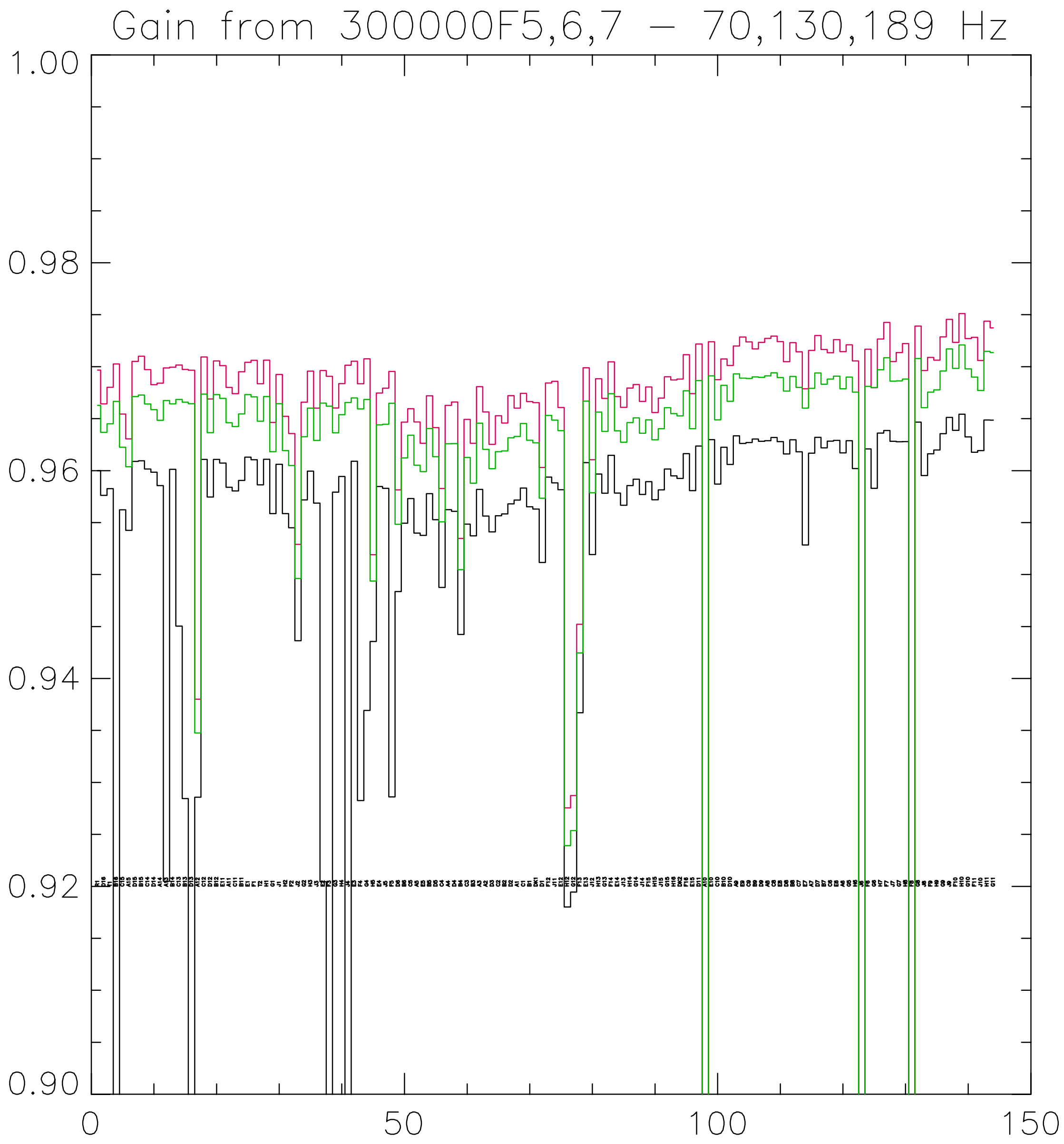

Figure 4: PSW JFET gains at 70 (red) 130 (green) and 189 Hz (black) versus channel number.

PLW JFET Gain versus Channel

Chan	70 Hz	130Hz	189 Hz	
R1	0.963823	0.957106	0.946430	
A8	0.967006	0.960047	0.948999	
A7	0.964439	0.957997	0.947228	
A6	0.965074	0.958440	0.947720	
A9	0.966671	0.959980	0.948990	
C9	0.965987	0.958503	0.947432	
B8	0.965280	0.958498	0.947672	
B7	0.964449	0.958060	0.947234	
C7	0.966583	0.960193	0.949279	
B5	0.963405	0.957715	0.947130	
B6	0.964272	0.958001	0.947237	
A5	0.964346	0.958164	0.947463	
T1	0.966633	0.959566	0.948499	
B4	0.966	0.959	0.948	**:Inoperable channel all values interpolated**
C4	0.965858	0.959429	0.948467	
B3	0.965	0.955295	0.944495	**:Odd value at 70 Hz – value interpolated**
C2	0.963473	0.957327	0.946543	
B2	0.966800	0.959841	0.948786	
B1	0.963993	0.957756	0.947025	
A3	0.964576	0.957813	0.946931	
A4	0.966400	0.959106	0.948141	
A1	0.963814	0.957416	0.946670	
DK1	0.963415	0.957271	0.9465578	
A2	0.963	0.957	0.946	**Inoperable channel all values interpolated**
E1	0.957806	0.951848	0.940983	
E2	0.956032	0.948545	0.937317	
E3	0.960357	0.954380	0.943274	
E4	0.959328	0.952660	0.941445	
D1	0.962919	0.955422	0.943883	
D2	0.962182	0.955152	0.943743	
D3	0.962672	0.955765	0.944480	
D4	0.960373	0.954043	0.942842	
C1	0.958948	0.952056	0.940622	
C3	0.960445	0.954281	0.943117	
C5	0.961304	0.954570	0.943222	
T2	0.959724	0.952455	0.941105	
E5	0.957652	0.951372	0.940420	
C6	0.961450	0.954405	0.942977	
C8	0.961451	0.954552	0.943190	
D5	0.961009	0.954515	0.943321	
D6	0.962938	0.955806	0.944361	
D7	0.961991	0.954827	0.943451	
D8	0.960134	0.952599	0.941205	
E7	0.959375	0.952083	0.940740	
E6	0.962739	0.955214	0.943668	
E8	0.960714	0.954008	0.942629	
DK2	0.959971	0.952812	0.9414675	
E9	0.959821	0.953570	0.942371	

PMW JFET Gain versus Channel

Chan	70 Hz	130 Hz	189 Hz	
A13	0.964795	0.959312	0.950434	
T1	0.963550	0.958653	0.949820	
B12	0.965344	0.959719	0.950672	
C13	0.963876	0.959155	0.950523	
A12	0.965037	0.959800	0.950795	
D12	0.964528	0.959032	0.950072	
C12	0.964389	0.959065	0.950278	
B11	0.966732	0.960635	0.951461	
A11	0.965829	0.960113	0.951012	
E13	0.964547	0.958658	0.949475	
D11	0.941484	0.935952	0.927010	
C11	0.963684	0.959014	0.950304	
B10	0.964430	0.959815	0.951071	
A10	0.965426	0.960169	0.951223	
D10	0.963864	0.958358	0.949370	
B9	0.963240	0.958471	0.949843	
C10	0.928729	0.923259	0.914357	
C9	0.966133	0.960467	0.951477	
A9	0.964187	0.958738	0.949923	
B8	0.965205	0.960290	0.951517	
A8	0.966679	0.961028	0.951950	
D8	0.963504	0.958985	0.950281	
C8	0.965400	0.960123	0.951132	
B7	0.960831	0.955390	0.946466	
R1	0.969395	0.963378	0.890225	
G1	0.969	0.963	0.944	**:Inoperable channel All values interpolated**
T2	0.969	0.963	0.944	**:Inoperable channel All values interpolated**
E1	0.969	0.963	0.944	**:Inoperable channel All values interpolated**
D1	0.958637	0.952747	0.944016	
F1	0.962675	0.957646	0.949146	
E2	0.966707	0.960770	0.951955	
G2	0.967297	0.962419	0.953727	
F2	0.967000	0.962200	0.953586	
G3	0.968446	0.962895	0.922382	
E3	0.968034	0.962927	0.922507	
D3	0.968264	0.963219	0.954569	
F3	0.968236	0.962830	0.953716	
G4	0.968	0.963	0.953	**:Inoperable channel All values interpolated**
E4	0.967365	0.962274	0.953581	
F4	0.964999	0.959305	0.935137	
E5	0.962652	0.957817	0.949128	
D5	0.941142	0.935477	0.926765	
F5	0.969004	0.963684	0.954963	
G5	0.969	0.963453	0.954824	**:Odd value at 70 Hz – value interpolated**
E6	0.969202	0.963535	0.954706	
G6	0.969289	0.963790	0.954977	
F6	0.968448	0.963389	0.954745	
G7	0.968547	0.963165	0.954464	
F10	0.967761	0.962879	0.954395	
E11	0.946503	0.940895	0.932465	
G11	0.953715	0.948264	0.939769	
F11	0.969688	0.963897	0.955127	
E12	0.969144	0.963580	0.954860	
G12	0.913682	0.908713	0.901373	
F12	0.963323	0.958148	0.949566	
G13	0.966972	0.961567	0.953085	
DK2	0.959696	0.954784	0.946262	
E7	0.959064	0.953855	0.945262	
D7	0.968461	0.962870	0.954216	
F7	0.968	0.963	0.953	**:Inoperable channel All values interpolated**
E8	0.891568	0.887566	0.881205	
G8	0.943106	0.935504	0.927282	
F8	0.967900	0.962154	0.953440	
E9	0.969442	0.963672	0.954973	
G9	0.968	0.963	0.953	**:Inoperable channel All values interpolated**

D9	0.935344	0.930394	0.922454	
F9	0.924749	0.919380	0.911588	
E10	0.966084	0.960846	0.952300	
G10	0.921479	0.915897	0.677865	
C4	0.965211	0.959681	0.950644	
B3	0.965701	0.960157	0.951260	
C3	0.965968	0.959923	0.950769	
B2	0.966059	0.960628	0.951577	
D2	0.964783	0.959630	0.950761	
A3	0.966296	0.960733	0.951816	
A2	0.968014	0.961553	0.952291	
C2	0.965183	0.959865	0.950998	
B1	0.965588	0.959434	0.950200	
A1	0.964626	0.958762	0.949582	
DK1	0.967768	0.962022	0.952908	
C1	0.963542	0.956521	0.947398	
A7	0.961984	0.956375	0.947533	
A6	0.966522	0.960537	0.951537	
B6	0.966	0.961	0.952	:**Inoperable channel All values interpolated**
C7	0.966477	0.961246	0.952333	
A5	0.962690	0.956571	0.947584	
B5	0.967316	0.961354	0.952244	
C6	0.962953	0.957907	0.949319	
D6	0.967566	0.962528	0.953635	
B4	0.961243	0.955976	0.947015	
C5	0.966631	0.960699	0.951537	
D4	0.967070	0.961239	0.952207	
A4	0.967728	0.962066	0.952911	

PTC JFET Gain versus Channel

All taken as nominal as not measured. Included here as in natural readout order for the PHOT frame

70 Hz	130Hz	189 Hz	
P1	0.96	0.96	0.96
P2	0.96	0.96	0.96
P3	0.96	0.96	0.96

PSW JFET Gain versus Channel

Chan	70 Hz	130 Hz	189 Hz
R1	0.969681	0.966282	0.959973
D16	0.966425	0.963690	0.957631
T1	0.968021	0.964498	0.958267
B16	0.970253	0.966660	0.863046
C15	0.965442	0.962253	0.956230
A15	0.963050	0.960371	0.954252
D15	0.970512	0.967118	0.960882
B15	0.971019	0.967274	0.960950
C14	0.969729	0.966411	0.960152
D14	0.968268	0.965871	0.959853
A14	0.968408	0.964845	0.958559
A13	0.969879	0.966750	0.920487
B14	0.969952	0.966427	0.960119
C13	0.970161	0.966850	0.945039
B13	0.969735	0.966596	0.928444
D13	0.969658	0.966442	0.895592
A12	0.938018	0.934758	0.928582
C12	0.970940	0.967357	0.961069
D12	0.966895	0.963662	0.957465
B12	0.970561	0.967316	0.961076
E11	0.970106	0.966949	0.960720
A11	0.968009	0.964608	0.958394
C11	0.967399	0.964238	0.958043
B11	0.969512	0.965460	0.959050
E1	0.970424	0.967308	0.961294
F1	0.970607	0.967092	0.961046
T2	0.968352	0.964764	0.958628
H1	0.970618	0.967130	0.961089
G1	0.964640	0.961825	0.955858
J1	0.969245	0.966447	0.960607
H2	0.965219	0.961926	0.955871
F2	0.963572	0.960495	0.954506
J2	0.952909	0.949619	0.943636
G2	0.966576	0.963251	0.957186
H3	0.969578	0.966015	0.959941
J3	0.966008	0.962901	0.956873
E2	0.969629	0.966492	0.920447
F3	0.969070	0.966205	0.887530
G3	0.966020	0.963637	0.957921
H4	0.968372	0.965388	0.959429
J4	0.970152	0.966560	0.895831
E3	0.970520	0.967000	0.960911
F4	0.968353	0.965943	0.928249
G4	0.970752	0.966855	0.936925
H5	0.951901	0.949380	0.943557
E4	0.967463	0.964401	0.958466
J5	0.967930	0.964463	0.958299
F5	0.969553	0.966488	0.928598
D6	0.958146	0.954837	0.948358
B6	0.964669	0.961222	0.954935
C5	0.965954	0.963405	0.957319
A5	0.964681	0.960513	0.953997
E5	0.962637	0.959908	0.953766
B5	0.967195	0.964048	0.957784
D5	0.964133	0.961343	0.955283
C4	0.958281	0.955080	0.948759
A4	0.966277	0.962594	0.956248
D4	0.966606	0.962601	0.956086
B4	0.953482	0.950481	0.944243
C3	0.964931	0.961260	0.954857
B3	0.962636	0.958796	0.953722
A3	0.968082	0.964565	0.958193
A2	0.965645	0.962048	0.955633
D3	0.962529	0.960185	0.954110
C2	0.965277	0.961831	0.955665

B2	0.964587	0.961897	0.955835	
D2	0.967221	0.963165	0.956801	
A1	0.966016	0.963284	0.957171	
C1	0.967434	0.964527	0.958321	
B1	0.966646	0.962917	0.956529	
DK1	0.966536	0.962680	0.956299	
D1	0.960302	0.957341	0.951166	
F12	0.968427	0.965305	0.959375	
J11	0.968588	0.964859	0.958821	
E12	0.966081	0.963848	0.958166	
H12	0.927559	0.923918	0.918025	
G12	0.928742	0.925365	0.919455	
F13	0.945218	0.942459	0.936705	
E13	0.969902	0.966694	0.960776	
J12	0.961052	0.957869	0.951918	
H13	0.968849	0.965629	0.959673	
G13	0.966951	0.963774	0.957830	
F14	0.970466	0.967404	0.961473	
E14	0.967121	0.963835	0.957841	
J13	0.966093	0.962730	0.956664	
H14	0.967951	0.964618	0.958567	
G14	0.968287	0.965074	0.959176	
J14	0.966655	0.963599	0.957704	
F15	0.968046	0.964884	0.958935	
H15	0.965595	0.962971	0.957188	
J15	0.966987	0.964035	0.958148	
G15	0.969037	0.966059	0.960147	
H16	0.968719	0.965488	0.959503	
DK2	0.968815	0.965265	0.959237	
F16	0.971151	0.967681	0.961630	
E15	0.967408	0.964040	0.958073	
D11	0.972181	0.968669	0.962362	
A10	0.972	0.968	0.962	:**Inoperable channel All values interpolated**
E10	0.972404	0.969119	0.962980	
C10	0.968753	0.964888	0.958708	
B10	0.970738	0.968212	0.962245	
D10	0.970124	0.966671	0.960593	
A9	0.971986	0.969313	0.963351	
E9	0.972860	0.968903	0.962612	
C9	0.972388	0.968877	0.962698	
B9	0.971713	0.969016	0.963044	
D9	0.972339	0.968969	0.962817	
A8	0.972721	0.969121	0.962880	
C8	0.972940	0.969411	0.963184	
E8	0.972417	0.968961	0.962790	
D8	0.970484	0.967653	0.961599	
B8	0.972320	0.969067	0.962968	
C7	0.971440	0.967998	0.961814	
E7	0.967875	0.966006	0.952849	
A7	0.971568	0.967921	0.961687	
D7	0.972993	0.969398	0.963197	
B7	0.971650	0.968309	0.962186	
C6	0.971348	0.968811	0.962841	
E6	0.972604	0.969090	0.962901	
A6	0.971449	0.967868	0.961710	
G5	0.972115	0.969004	0.962884	
H6	0.970557	0.967557	0.960197	
J6	0.970	0.967	0.962	:**Inoperable channel All values interpolated**
F6	0.971682	0.968108	0.962085	
G6	0.967976	0.967987	0.958291	
H7	0.972668	0.969709	0.963607	
F7	0.974254	0.970866	0.963863	
J7	0.970491	0.968603	0.962821	
G7	0.971355	0.968646	0.962781	
H8	0.972223	0.968817	0.962796	
F8	0.972	0.969	0.963	:**Inoperable channel All values interpolated**
G8	0.973908	0.970782	0.964673	
J8	0.969631	0.966063	0.959529	
F9	0.970890	0.967556	0.961614	

H9	0.970626	0.967773	0.961984
G9	0.972868	0.969592	0.963551
J9	0.974554	0.971710	0.965112
F10	0.972347	0.969841	0.963879
H10	0.975106	0.972085	0.965425
G10	0.972714	0.969793	0.963239
F11	0.972827	0.969007	0.961767
J10	0.970592	0.967716	0.961920
H11	0.974378	0.971478	0.964873
G11	0.973726	0.971370	0.964862