ESA	ERS-1	Doc No.: ER-TN-ESA-RA-0008 Issue: 1.0 Date: 18.12.1990 Page: 0

RA Characterisation Data

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1 Introduction

This document can be regarded as a first issue of the long-awaited RA Characterisation Database. It contains values for all parameters which have been requested, except for some special cases which will be explained later. It contains many other parameters as well. For example it also contains all the parameters used in the LRDPF (and referred to in ER-RP-DSF-SY-0007) except for the parameters forseen to be updated frequently, such as the barometric pressure field (which will come from ECMWF).

However, this issue is in the form of hardcopy only, and must be transcribed to be useful. This is not a particularly practical distribution medium. It is far preferable to use an electronic method, of some sort. Such an approach will be proposed here. But first the data themselves.

2 The Data

The RA Characterisation Data are provided on the following pages, in Tables 2–1 to 2–4. Some words of explanation are needed.

- The unique means of identifying a parameter is the column "ID". Each parameter has an entry here and there are no duplicates. Whilst future updates may have a different order, or contain extra parameters, this field will not change. It should be used as the key.

- The field "PAF name" may contain errors, as the full list of PAF names is unknown.

- The "Symbol" field refers to the Data Chain document and to the Ground Processing document (FD). Unfortunately there are some inconsistencies in these uses of the symbols, even extending to sign convention and units. By using the "ID" field such inconsistencies should be avoided.

- The "Vector" field refers to the number of elements of the parameter. Normally these are single values, but sometimes there are tables. Normally such tables are one-dimensional, but there is at least one two-dimensional table. In such cases a cross-reference is provided.

- The values themselves are a mixture of measured values, nominal values and specified values. They should be taken together with the given tolerance values ("+/−"). These tolerances do not represent the ultimate accuracy achievable; rather they have been specified so that future (more accurate) updates should not differ from this version by more than the tolerance. In some cases though they are the ultimate tolerance.

  To reflect the situation during flight when only a single chain is in use, the tables contain only one entry. However since the A-chain and the B-chain have both been used during testing the values provided are not consistent with all data-sets. Similarly there are two sets of EGSE, which have both been used during testing.

A future issue will contain a single unified set of values together with a number of test data-sets known to be compatible.

- The "Units" should be self-explanatory, except that the symbol # refers to counts and bfr to base-frames — *ie* 50 pulses.
- The "Source" column is mainly for table maintenance, but also indicates when the value has been derived from other data in the table, or when the value is a nominal or specified value.

As mentioned above, some values are not provided. These are some of the auxiliary tables, which are still being refined (*eg* the AGC steps, where measurements have been made by three methods, which are currently being reconciled) or where they are not immediately relevant (*eg* the RSS test waveguide length differences — this is not needed because the PAF's currently have no way of knowing which set was in use at which time).

Some tables are provided. Table 2–5 and 2–6 show two orthogonal cuts through the antenna pattern. Table 2–7 shows the IF transfer function measured by the SPTR ice method and the preset tracking on noise method — the results are virtually identical.

3 The Proposed Approach

As is well known, there are a number of constraints in maintaining the RA Characterisation Database. It is probably not useful to reiterate all of them, but some relevant facts will be mentioned:

- Many of the parameters are inter-related by known equations. For example many timing and frequency parameters are related to the USO frequency measurement, and/or the chirp slope; SWH parameters are linked to the chirp slope *etc.* Some of these relationships are "hidden", in the sense that they depend on detailed knowledge of the way the altimeter works internally, or of the way certain parameters were measured.
- There is a strict requirement to maintain consistency between the inter-related values.
- A similar relationship exists for the errors or tolerances on values.
- The procedure to be followed when one or more parameters are updated is not particularly well defined. In any case the PAF's have determined that a historical record of previous values is probably needed.
- The set of values provided to the PAF's must be coherent with the values used by the FD chains, and there is in any case a similar task involved in maintaining the FD database.
- Whilst the formatting of data for the FD chains is fixed, and a split into static and dynamic values has been made, no equivalent definitions yet exist for the PAF's.

ID	PAF name	Symbol	Description	Vector	Value	+/−	Units	Updated	Source
F_15	f-15	f_{15}	15 MHz USO frequency	1	15.00000005	2e -08	MHz	8 Dec 90	ER-RP-DSF-SY-0030
F_15_REF	f-15 ref	f^o_{15}	Nominal 15 MHz USO frequency	1	15.00000000	-	MHz	8 Dec 90	nominal
F_80	f-80	f_{80}	80 MHz clock frequency	1	80.00000027	1.1e-7	MHz	8 Dec 90	derived
P_80	P80	P_{80}	80 MHz clock period	1	12.49999996	2e-8	ns	8 Dec 90	derived
P_80_REF	P80 ref	P^o_{80}	Nominal 80 MHz clock period	1	12.5	-	ns	8 Dec 90	nominal
F_PRF	f-PRF	f_{PRF}	PRF	1	1 019.991843	1.4e-6	Hz	8 Dec 90	derived
PRI	PRI	t_{PRI}	Pulse repetition interval	1	0.98040000	1.3e-9	s	14 Dec 90	derived
C_USO	C-USO	C_{USO}	USO factor	1	1.00000000	1.3e-9	-	8 Dec 90	derived
T	C-USO	T	USO clock period correcting factor	1	1	1.3e-9		14 Dec 90	derived
HEIGHT_ALFA		α	alpha filter coefficient, height cal	1	0.00314159	-	-	14 Dec 90	ORM/4521/IP/sml
HEIGHT_BETA		β	beta filter coefficient, height cal	1	9.8696e-6	-	-	14 Dec 90	ORM/4521/IP/sml
C	c	c	Speed of light	1	299 792 458	-	m/s	14 Dec 90	ER-RS-DSF-RA-0002
F	F	f_{TX}	Carrier frequency	1	13.7994e9	1e5	Hz	18 Dec 90	ER-LI-DSF-RA-0021
MU		μ	Chirp rate	1	-1.6536e13	1.2e11	Hz/s	18 Dec 90	ER-RP-AME-RA-0015
		ϵ_d	Default intl. cal. height error	1	0	-	-	14 Dec 90	derived
HEIGHT_XD		x_d	Default rate of change of cal correction	1	0	-	-	14 Dec 90	nominal
TAU_C_D		τ_{Cd}	Default smoothed intl. cal. height correction	1	163 577 856	-	TM	14 Dec 90	nominal
H_CAL		ΔH_{cal}	External calibration altitude correction	1	0	-	m	14 Dec 90	nominal
TAU_F_OFFSET		τ^F_{off}	Flight time offset value (5PRI)	1	25 700 597 760	33	TM	14 Dec 90	derived
EPS_TAU_G	epsilon-tau (g)	ϵ^G_τ	On-Ground Calibration Correction	32	29.8	0.1	ns	8 Dec 90	ER-DSF-2274/90
TAU_G_REF		τ^G_{ref}	On-Ground Calibration Correction	32	-2.98e-8	1e-10	s	8 Dec 90	ER-DSF-2274/90
E_RSS_T	E-RSS-T	ϵ^{RSS}_τ	RSS delay offset	1	40 376	200	ns	18 Dec 90	ER-RP-SAE-RA-0014
DEL_T	delta-t	δt	Test waveguide length difference	16	EGSE.dat		ns	8 Dec 90	
TAU_SC		τ_{sc}	Time delay scaling factor (nominal)	1	1.907348633e-13	-		14 Dec 90	nominal
K_DRY		K_{dry}	Pressure to height conversion factor	1	0.000232	1e-6	m/mb/10	14 Dec 90	ORM/4521/IP/sml
H_WET		ΔH_{wet}	Wet tropospheric height correction	1	0.1	-	m	14 Dec 90	ORM/4521/IP/sml

Table 2–1: RA Characterisation Data

ID	PAF name	Symbol	Description	Vector	Value	+/−	Units	Updated	Source
B_I	B (i)	B^i	Chirp bandwidth (ice)	1	83.84368	2	MHz	8 Dec 90	derived
B_O	B (o)	B^o	Chirp bandwidth (ocean)	1	337.3344	2	MHz	8 Dec 90	derived
TP_I	Tp (i)	T^i	Chirp duration (ice)	1	20.39	0.03	μs	8 Dec 90	ER-RP-AME-RA-0015
TP_O	Tp (o)	T^o	Chirp duration (ocean)	1	20.40	0.03	μs	8 Dec 90	ER-RP-AME-RA-0015
MU_I	mu (i)	μ^i	Chirp rate (ice)	1	-4.112	0.1	MHz/μs	8 Dec 90	ER-RP-AME-RA-0015
MU_O	mu (o)	μ^o	Chirp rate (ocean)	1	-16.536	0.12	MHz/μs	8 Dec 90	ER-RP-AME-RA-0015
TAU_I	tau (i)	τ^i	Effective compressed pulse length (ice)	1	16.2	0.4	ns	18 Dec 90	ER-DSF-2274/90
TAU_O	tau (o)	τ^o	Effective compressed pulse length (ocean)	1	4.54	0.1	ns	18 Dec 90	ER-DSF-2274/90
TAU_C_I	tau-c (i)	τ_c^i	Nominal pulse length (ice)	1	11.93	0.28	ns	8 Dec 90	derived
TAU_C_O	tau-c (o)	τ_c^o	Nominal pulse length (ocean)	1	2.96	0.02	ns	8 Dec 90	derived
G_0	G(0)		Antenna power gain	1	42.05	0.1	dB	18 Dec 90	XEE/209.90/RT
P_0	P-0	P_o	TX power (at antenna flange)	1	56	5	W	18 Dec 90	ER-RP-DSF-SY-0008
HK_15_16	HK15/16		HPA TM conversion curve	50	HK1516.dat	-	#/W	8 Dec 90	
HK_33_34	HK33/34		MWRX TM conversion curve	50	HK3334.dat	-	#/deg	8 Dec 90	
HK_13_14	HK13/14		SAW TM conversion curve	50	HK1314.dat	-	#/deg	8 Dec 90	
DT	dt	dt	Datation bias	1	0	0.2	ms	8 Dec 90	
TDELTA		TDELTA	Half window size around packet time interval	1	409.6	-	1/2048 s	14 Dec 90	ORM/4521/IP/sml
N_0		N_0	Minimum number of ocean mode blocks	1	10	-	-	14 Dec 90	ORM/4521/IP/sml
N_PRI		N_{PRI}	number of pulses from datation instant to TX of 1st pulse in block 10	1	495	-	-	14 Dec 90	ORM/4521/IP/sml
T_H		T_H	offset to the time the mid pulse is on the ground	1	0.003103538	4e-12	s	14 Dec 90	ORM/4521/IP/sml
TINT		TINT	Time interval between 2 consequtive source packets	1	2 007.04	-	1/2048 s	14 Dec 90	ORM/4521/IP/sml

Table 2–2: RA Characterisation Data (continued)

ID	PAF name	Symbol	Description	Vector	Value	+/−	Units	Updated	Source
X_RA_S	x-RA	x^S_{RA}	x position of RA antenna in S-Frame	1	-3 786.4	1.5	mm	9 Dec 90	ER-TN-DSF-SY-1275
Y_RA_S	y-RA	y^S_{RA}	y position of RA antenna in S-Frame	1	-570	1.2	mm	9 Dec 90	ER-TN-DSF-SY-1275
Z_RA_S	z-RA	z^S_{RA}	z position of RA antenna in S-Frame	1	-1 149.7	0.2	mm	9 Dec 90	ER-TN-DSF-SY-1275
X_CG_S	x-CG	x^S_{CG}	x position of Centre of Gravity in S-Frame	1	-1 813.3	10.0	mm	9 Dec 90	ER-RP-DSF-SY-0030
Y_CG_S	y-CG	y^S_{CG}	y position of Centre of Gravity in S-Frame	1	11.6	11.0	mm	9 Dec 90	ER-RP-DSF-SY-0030
Z_CG_S	z-CG	z^S_{CG}	z position of Centre of Gravity in S-Frame	1	10.2	12.0	mm	9 Dec 90	ER-RP-DSF-SY-0030
X_LR_S	x-LRR	x^S_{LRR}	x position of LRR in S-Frame	1	-2 850.4	1.0	mm	9 Dec 90	ER-TN-DSF-SY-1275
Y_LR_S	y-LRR	y^S_{LRR}	y position of LRR in S-Frame	1	-700	0.9	mm	9 Dec 90	ER-TN-DSF-SY-1275
Z_LR_S	z-LRR	z^S_{LRR}	z position of LRR in S-Frame	1	-950	0.9	mm	9 Dec 90	ER-TN-DSF-SY-1275
X_PR_S	x-PRARE	x^S_{PRARE}	x position of PRARE in S-Frame	1	-467	0.9	mm	9 Dec 90	ER-TN-DSF-SY-1275
Y_PR_S	y-PRARE	y^S_{PRARE}	y position of PRARE in S-Frame	1	714	0.9	mm	9 Dec 90	ER-TN-DSF-SY-1275
Z_PR_S	z-PRARE	z^S_{PRARE}	z position of PRARE in S-Frame	1	-975	0.6	mm	9 Dec 90	ER-TN-DSF-SY-1275
LOOP_CAL_K1		κ_1	Time delay reference value, height cal	1	3.12e-5	-	s	14 Dec 90	nominal
LOOP_CAL_K4	k-4	k_1	AGC calibration constant	1	945	500	-	8 Dec 90	ER-PL-SES-RA-0004
LOOP_CAL_KF		κ_f	Conversion factor from FFT to time	1	2.96e-9	2e-11	-	14 Dec 90	derived
RX_INIT	RX init	RX_{init}	Initial position of SPTR signal	1	2 496	-	-	8 Dec 90	nominal
ANT_BW	bw	θ_{bw}	Antenna beamwidth	1	1.340	0.007	deg	18 Dec 90	XEE/209.90/RT
GAMMA	Gamma	γ	Antenna aperture	1	0.0003771	1e-6	-	18 Dec 90	ER-DSF-2274/90
SIGMA_P	sigma-p	σ_p	SWH calculation constant	1	1.9295	0.04	ns	18 Dec 90	ER-DSF-2274/90
T_Z	Tz	T_z	SWH calculation constant	1	1.035	0.02	-	8 Dec 90	ER-DS-SES-RA-0001
K1	k1	κ_1	SWH calculation constant (includes TM conversion, via Pref)	1	12 451	1 030	m	14 Dec 90	derived
K2	k2	κ_2	SWH calculation constant	1	0.084	0.003	m**2	14 Dec 90	derived

Table 2–3: RA Characterisation Data (continued)

ID	PAF name	Symbol	Description	Vector	Value	+/−	Units	Updated	Source
T_W_H		$t_{w,h}$	Warning threshold height	1	0.1	-	m	14 Dec 90	nominal
T_W_PP		$t_{w,pp}$	Warning threshold peakiness	1	1.5	-	-	14 Dec 90	nominal
TH_W_SWH		$t_{w,SWH}$	Warning threshold SWH	1	1	-	m	14 Dec 90	nominal
T_W_V		$t_{w,v}$	Warning threshold windspeed	1	0.1	-	-	14 Dec 90	nominal
G_ANT	G(ant)		Antenna pattern	2×51	ANT.dat	0.1	dB	18 Dec 90	XEE/209.90/RT
G_IF	G(IF)		IF transfer function	64	IF.dat	1	-	8 Dec 90	ER-DSF-2274/90
T_PRE	T-preset		Nominal Preset duration	1	1 300	-	bfr	18 Dec 90	ER-DSF-2274/90
BG_CORR	BG-Corr		Pre-launch bin gain correction	64	IF.dat	0.1		8 Dec 90	ER-DSF-2274/90
L_AL_I	L-alias (i)		Range window alias lower limit (ice)	1	4	-	-	8 Dec 90	nominal
L_AL_O	L-alias (o)		Range window alias lower limit (ocean)	1	4	-	-	8 Dec 90	nominal
U_AL_I	U-alias (i)		Range window alias upper limit (ice)	1	60	-	-	8 Dec 90	nominal
U_AL_O	U-alias (o)		Range window alias upper limit (ocean)	1	60	-	-	8 Dec 90	nominal
A_G_REF_I	A-G-REF (i)		AGC Tabulated values (ice)	64	AGC.dat	0.1	dB	8 Dec 90	
A_G_REF	A-G-REF (o)	A^{G}_{ref}	AGC tabulated values (ocean)	64	-22.80	0.1	dB	8 Dec 90	
P_V	PV	P_V	AGC telemetry scaling factor	1	0.015625	-	-	8 Dec 90	nominal
AGC_ALFA		α	Alpha filter coefficient AGC cal	1	0.00314159	-	-	14 Dec 90	nominal
AGC_BETA		β	Beta filter coefficient AGC cal	1	9.8696e-6	-	-	14 Dec 90	nominal
AGC_EPS_D		ϵ_d	Default intl.cal. AGC error	1	0	-	-	14 Dec 90	nominal
AGC_XD		x_d	Default rate of change of cal. correction	1	0	-	-	14 Dec 90	nominal
A_C_D		$A_{C,d}$	Default smoothed intl.cal. AGC correction	1	0	-	-	14 Dec 90	nominal
P1278	P1278	P_{1278}	Gain difference TX/RX path / cal path	1	-95.92	0.5	dB	18 Dec 90	ER-DSF-2274/90
PREF_0	Pref-0	P^{o}_{ref}	Power reference standard value	1	7.5	-	-	8 Dec 90	nominal
PREF	Pref	P_{ref}	Power reference value (in TM)	1	240	-	-	8 Dec 90	nominal
H_REF	H-ref	H_{REF}	Reference satellite altitude	1	800 000.00	-	m	8 Dec 90	nominal
E_S0_G	E-S0-G	$\epsilon^{G}_{\sigma^o}$	sigma-zero ground calibration	1	22.80	0.1	dB	8 Dec 90	

Table 2–4: RA Characterisation Data (continued)

```
ERS-1 Radar Altimeter Antenna

  File = RADALT01.REP
  Function = VV
    POLAR = 0 deg
    FREQUENCY = 13.8 GHz
    AZIMUTH = -0 towards 0 deg
```

Pointer	Abcissa	Logarithmic (dB)
126	-2.5000000	-40.986618
127	-2.3999996	-37.420982
128	-2.3000002	-35.140209
129	-2.1999998	-33.756294
130	-2.0999994	-33.410732
131	-2.0000000	-33.843067
132	-1.8999996	-34.007324
133	-1.8000002	-31.209305
134	-1.6999998	-26.599018
135	-1.5999994	-22.035240
136	-1.5000000	-18.587620
137	-1.3999996	-15.616457
138	-1.3000002	-13.088411
139	-1.1999998	-10.700119
140	-1.0999994	-8.9714165
141	-1.0000000	-7.2669926
142	-0.89999962	-5.7072506
143	-0.80000019	-4.4425926
144	-0.69999981	-3.3636169
145	-0.59999943	-2.4807873
146	-0.50000000	-1.7179413
147	-0.39999962	-1.0936031
148	-0.30000019	-0.62175751
149	-0.19999981	-0.26079750
150	-0.99999428E-01	-0.61742783E-01
151	0.00000000E+00	0.34332275E-04
152	0.10000038	-0.62736511E-01
153	0.19999981	-0.26694298
154	0.30000019	-0.59000969
155	0.40000057	-1.0455666
156	0.50000000	-1.6501579
157	0.60000038	-2.3888817
158	0.69999981	-3.2424316
159	0.80000019	-4.2572556
160	0.90000057	-5.5550823
161	1.0000000	-6.9661274
162	1.1000004	-8.5475178
163	1.2000008	-10.380657
164	1.3000011	-12.421085
165	1.3999996	-15.022085
166	1.5000000	-17.650570
167	1.6000004	-20.599953
168	1.7000008	-24.115128
169	1.8000011	-27.881428
170	1.8999996	-31.890381
171	2.0000000	-34.502052
172	2.1000004	-35.565853
173	2.2000008	-35.318802
174	2.3000011	-34.170258
175	2.3999996	-32.591026
176	2.5000000	-31.076214

Table 2–5: RA Antenna Pattern (0°)

ERS-1 Radar Altimeter Antenna

File = RADALT01.REP
Function = VV
POLAR = 90 deg
FREQUENCY = 13.8 GHz
AZIMUTH = -5 towards 5 deg

Pointer	Abcissa	Logarithmic (dB)
126	-2.5000000	-37.184330
127	-2.3999996	-35.605587
128	-2.3000002	-34.596676
129	-2.1999998	-34.353432
130	-2.0999994	-35.157421
131	-2.0000000	-37.366184
132	-1.8999996	-36.995979
133	-1.8000002	-31.161552
134	-1.6999998	-25.664204
135	-1.5999994	-21.152290
136	-1.5000000	-17.754211
137	-1.3999996	-14.980631
138	-1.3000002	-12.524015
139	-1.1999998	-10.398897
140	-1.0999994	-8.4378929
141	-1.0000000	-6.9480190
142	-0.89999962	-5.4229984
143	-0.80000019	-4.2072926
144	-0.69999981	-3.1479645
145	-0.59999943	-2.3160725
146	-0.50000000	-1.5969887
147	-0.39999962	-1.0035095
148	-0.30000019	-0.52066612
149	-0.19999981	-0.21652603
150	-0.99999428E-01	-0.44580460E-01
151	0.00000000E+00	-0.21934509E-04
152	0.10000038	-0.89807510E-01
153	0.19999981	-0.30325890
154	0.30000019	-0.64082146
155	0.40000057	-1.1001263
156	0.50000000	-1.7091389
157	0.60000038	-2.4534321
158	0.69999981	-3.3241386
159	0.80000019	-4.4162521
160	0.90000057	-5.5179157
161	1.0000000	-7.0676575
162	1.1000004	-8.6546669
163	1.2000008	-10.488934
164	1.3000011	-12.601738
165	1.3999996	-15.237846
166	1.5000000	-17.977951
167	1.6000004	-21.183174
168	1.7000008	-25.130543
169	1.8000011	-30.018269
170	1.8999996	-35.927448
171	2.0000000	-38.724442
172	2.1000004	-38.175106
173	2.2000008	-37.697330
174	2.3000011	-38.402527
175	2.3999996	-40.020157
176	2.5000000	-42.345314

Table 2–6: RA Antenna Pattern (90°)

RA FM A-chain, TV test phase TV09, MWRX temp=14.6°C SO310T175032000:

FFT sample	SPTR amplitude linear
3	1246.875
4	1280.438
5	1303.969
6	1289.625
7	1255.406
8	1242.000
9	1230.875
10	1212.812
11	1215.656
12	1239.031
13	1235.281
14	1206.281
15	1209.062
16	1205.312
17	1195.031
18	1202.281
19	1222.594
20	1213.250
21	1186.000
22	1185.750
23	1174.125
24	1145.406
25	1134.594
26	1142.188
27	1142.875
28	1133.969
29	1152.219
30	1148.312
31	1122.688
32	1144.156
33	1134.500
34	1132.156
35	1126.062
36	1129.312
37	1128.688
38	1118.250
39	1092.812
40	1080.469
41	1090.719
42	1085.688
43	1081.156
44	1105.719
45	1114.094
46	1096.406
47	1100.844
48	1095.938
49	1086.250
50	1081.562
51	1105.156
52	1109.344
53	1089.938
54	1087.000
55	1081.906
56	1063.000
57	1062.781

Table 2–7: IF Transfer Function

- The full set of RA characterisation data is rather small, and is not expected to be updated frequently.

In view of these and other factors it has been found convenient to maintain the characterisation data using a spreadsheet program. In this way inter-related values are automatically connected and links to other files may be maintained. This linking facility can alleviate the problem of maintaining parameters of different dimensions in the same structure. It has also been possible, by using cross-file lookup facitities, to maintain a "verification" spreadsheet, in which the coherency of the given parameters, equations and known data-sets can be ensured.

The logical approach to the distribution of the data, therefore, is to provide the complete set of spreadsheet files on floppy disk whenever it is necessary to update one or more parameters. This has the following advantages:

- Coherency of parameters is always ensured.
- The date of the files, or of the disk itself, provide the applicability date for the parameter-set, while the "Update" field in the files themselves provides the change information.
- The historical record is automatically created, by archiving of the floppy disks.
- Users may extract the data in any format or order they wish, by manipulating the spreadsheet.

The spreadsheet format proposed is that of Microsoft Excell. This software is well-known and exists at least on PC-type and Macintosh computers. This choice is not based on a particularly rigourous selection; the spreadsheet available on the ERS-1 VAX Cluster (2020) is not sufficiently flexible, and the choice among the personal computer spreadsheets has been driven simply by availability.