Bitmask & Quality used on Cluster/EFW and MMS/FIELDS/EDP

Yuri Khotyaintsev
IRF-U

Bitmask usage

- We use a bit mask attached to all variables, e.g. V1

  - `V1.time [int64]`

  - `V1.data [float/double]`

  - `V1.bitmask [uint16]`

- Bitmask can be used to effectively filter/mask the data using `bitand()`

- Propagated to derived products, e.g. E12 = V1-V2 to use a combination of `V1.bitmask` and `V2.bitmask`.

MMS bits

Table 5. EDP bitmask values and corresponding Quality indicator.

Bit position	Hex value	Decimal value	Meaning if bit is set (1)	Corresponding Quality ind.
0	0x0001	1	Probe(-s) are disabled	0
1	0x0002	2	Probe(-s) have bad bias settings	1
2	0x0004	4	Probe(-s) are saturated	0
3	0x0008	8	Probe(-s) are saturated due to low density	1
4	0x0010	16	Probe(-s) are sweeping bias current	1
5	0x0020	32	SDP probe(-s) are in shadow from the ADP booms	1
6	0x0040	64	ASPOC is emitting non-zero current	2
7	0x0080	128	TBW (reserved for ADP processing)	TBW
8	0x0100	256	Asymmetric probe configuration (e.g. MMS4 after 2016-06-12)	2
9	0x0200	512	Maneuver is ongoing	1

Cluster bits

Bit	Decimal value	Meaning	E_quality <=	P_quality <=
0	1	Reset	0	1
1	2	Bad bias	0	1
2	4	Probe saturation	0	1
3	8	Low density saturation (-68V)	0	1
4	16	Sweep (collection and dump)	0	N/A
5	32	Burst dump	0	N/A
6	64	Non-standard operations (NS_OPS)	0	N/A
7	128	Manually set E_quality	N/A	N/A
8	256	Single probe pair (affects only Level 2 data)	1 (L2 only)	N/A
9	512	Asymmetric mode (p32 and p34, affects only Level 2 data)	2 (L2 only)	N/A
10	1024	Solar wind wake correction applied	3	N/A
11	2048	Lobe wake	1	N/A
12	4096	Plasmaspheric wake	1	N/A
13	8192	WHISPER operating	2	0
14	16384	Saturation due to high bias current	1	2
15	32768	Bias current DAC not responding correctly	2 (L2 only)	N/A
16	65536	Saturation due to probe shadow	1 (L2 only)	2

Non-standard operations database

```xml
<operation start="2002-05-08T08:31:00Z" dt="2280" c3="yes" plan="yes" sdesc="no_tm">
    <desc>WEC power cycled to clear up DWP memory latchup</desc>
    <res>
        <link href="ky020507a.txt">Keith 020507</link>
        <link href="sm020508a.txt">Silvano 020508</link>
    </res>
</operation>
<operation start="2002-05-12T03:53:57Z" dt="1800" c1="yes" c2="yes" c3="yes" c4="yes" plan="yes" sdesc="spec_bias">
    <desc>Bias test, running -70 nA to all spheres</desc>
    <res>
        <link href="aie020423a.txt">Anders 020423</link>
        <link href="aie020423b.txt">Anders 020423</link>
    </res>
</operation>
<operation start="2002-05-26T10:27:00Z" dt="54180" c3="yes" plan="yes" sdesc="spec_bias">
    <desc>Corrupted WEC TM triggered s/c to reset WEC 020526 10:27. EFW then operated with default settings (e.g. no
    <res>
        <link href="pal020527a.txt">Per-Arne 020527</link>
        <link href="sm020527a.txt">Silvano 020527</link>
    </res>
</operation>
<operation dt="2" plan="no" sdesc="bad_tm" start="2002-06-14T15:02:04Z" c4="yes">
    <desc>Single bad EFW TM packet</desc>
    <res><link href="pal060322a.txt">Per-Arne 060322</link></res>
</operation>
<operation dt="3120" plan="no" sdesc="bad_data" start="2002-06-19T09:42:00Z" c3="yes">
    <desc>Spacecraft manoeuvre contaminates data.</desc>
</operation>
<operation start="2002-06-29T05:05:00Z" dt="180" c4="yes" plan="no" sdesc="no_tm">
    <desc>EFW telemetry completely confused.</desc>
    <res>
        <link href="sm020704.txt">Silvano 020704</link>
        <link href="aie020704a.txt">Anders 020704</link>
        <link href="ky020710a.txt">Keith 020710</link>
    </res>
</operation>
```

https://cluster.irfu.se/efw/ops/ns_ops.html

Non-standard operations database

- **no_tm** = no telemetry at all (WEC off, missing data, etc)

- **bad_tm** = digital problems, like chopped up data

- **bad_data** = data formats OK, but data is crap for analog reasons, e.g. latched probes, strange guard voltage, hanging sweeps, ...

- **bad_lx** = LX data is bad, but HX data is OK

- **bad_hx** = HX data is bad, but LX data is OK

- **spec_bias** = commanded intervals with unusual bias, not accidents, setting guard to strange values etc which goes to bad_data

- **bad_bias** = intervals with accidental unusual bias

- **no_bm3** = No BM3 telemetry

- **no_p[1-4]** = No/bad data on probes [1-4]

- **no_p[12/32/34]** = No/bad data on probe pairs [12/32/34]

- **hxonly** = HXONLY sampling mode

- **no_10Hz_filt** = 10Hz filter is not operational

- **no_spin_fits** = No on-board spin fits

- **info** = informational only (no effect on CAA processing)

BIAS Bits

Bit	Decimal value	Meaning	Justification	Comment
		RPW +Z ANT PA in the line of sight of the HGA during TX ON.	The HGA TX may have an impact on the RPW science measurement quality when the ANT PA in the HGA light of sight	To be determinated by ROC from SPICE computation
		SPICE Heat Shield Door is open	SPICE HSD may have an impact on the RPW +Z ANT bending effect	Known from HSD_SPICE_OPEN E-FECS event
		LFR setting has changed before the end of the current data samples acquisition	According to LFR data acquisition mechanism and CDF structure, it can be impossible for some dataset (i.e., SWF) to take of a LFR setting change - performed via a command execution on-board - in a CDF record time window. Users need nevertheless to be warned when such LFR setting change occurred during a data sample acquisition.	Known from the reception of the TM_LFR_TC_EXE_SUCCESS {YIW00139} S1 TM that confirms the LFR setting change
		Possible SWA-PAS high voltage contamination	SWA-PAS unit may provoke noise on RPW measurements	Inclusion of this event into the bitmask is TBC (quantification of the impact is TBD)
		EMC QUIET window	SolO payload is in EMC QUIET mode	Known from EMC_MAND_QUIET E-FECS event
		EMC NOISY window	SolO payload is in EMC QUIET mode	Known from EMC_PREF_NOISY E-FECS event
		Spacecraft roll manœuvre	Indicate when the spacecraft perform rolls	Known from *_ROLL E-FECS event
		Thruster firings	Indicate when the plateform thruster firings happen	Known from TMC+WOL E-FECS event