# TN-037C. Flash Memory Management

**General.** The RBSP-EFW IDPU contains a 32 GB memory to store up to 40+ days of data at relatively high speed, giving scientists on the ground a chance to view the low-resolution survey data and request playbacks of high-resolution data. Properly managing the memories involves coordination between the IDPU FSW, the SOC and the scientists.

**IDPU FSW requirements**. The IDPU FSW shall

1. Power separate sections of Flash, so will have to work-around unpowered sections;
2. Identify bad blocks of memory, so will have to handle bad blocks automatically; read and write failures will cause Event messages (APID 268);
3. Utilize a chip-level memory map (64 elements) from virtual to physical addresses (the Flash Memory Map, or FMM);
4. Reference the memory in 262,144 blocks, each containing 128 Kbytes;
5. Buffer up selected packets of sensor data in SDRAM, and simultaneously record the evaluation of conditions “B1\_EVALMAX” using on-board trigger functions;
6. As 128 KB blocks are finished, compare B1\_EVALMAX to B1\_THRESH. If EVALMAX>THRESH, it will transfer the 128 KB Block from SDRAM to the Flash memory, recording at the recording pointer “B1\_RECPTR” and incrementing the pointer; when the pointer hits the end of Flash, it will reset to the beginning;
7. Maintain the BadBlockIndicator (BBI) and EraseCountIndicator (ECI) on each 128 KB block, and provide this information in housekeeping;
8. Be able to dump either part or all of the Flash memory status information (the BBI, ECI and MET) for each block if commanded to do so (APID\_240);
9. Transfer 128KB blocks from Flash to SDRAM, using a ground-provided list of up to 128 playback starting points with 4-block resolution, and lengths in units of 128 KB blocks. Once in SDRAM, the data will be compressed and telemetered;.
10. Telemeter the following at 0.5Hz (APID263):

|  |  |
| --- | --- |
| **Mnemonic** | **Description** |
| B1\_RECPTR | Recording Pointer |
| B1\_RECBBI | Recording Bad Block Indicator |
| B1\_RECECI | Recording Erase Count |
| B1\_PLAYPTR | Playback Pointer |
| B1\_PLAYCTR | Playback Count Remaining |
| B1\_PLAYREQ | Playback Request Index (in bytes) |
| B1\_EVALMAX | Evaluation of Conditions |
| B1\_THRESH | Threshold for Recording to Flash |

**GSE Requirements**. The GSE shall:

1. Provide a script that can be utilized for wear-leveling writes to flash memory. When invoked, this script will use the number of days since 1970, mod 64 modules, to set the flash write pointer to the starting address of the respective flash memory module.

**SOC requirements**. For each RBSP flight unit, the SOC shall

1. Maintain a master copy of the 64-byte Flash Memory Map (FMM);
   1. The master copy of FMM includes both FLASHSIZE and FMAP.
   2. The master copy reflects the expected state of FMM in FSW.
   3. Changes to the master copy shall be reflected by a change to EFW\_CONFIG (TBR).
2. Verify the FMM in housekeeping on a regular basis;
   1. Verification consists of:
      1. Periodic (weekly initially, with decreasing cadence as warranted by on-orbit experience) downlink of FSW copy of FMM.
      2. Comparision of downlinked copy to master copy.
      3. Prompting of EFW OPS team to upload master copy to FSW if discrepancies found.
      4. Flag to EFW OPS team to diagnose source of discrepancies if discrepancies found.
3. Update the FMM when large areas of memory have errors or power problems indicated by the Flash Event messages;
   1. Maintain database of Flash Event Messages (FEMs), with most recent crop of FEMs passed to EFW OPS team after each downlink pass and processing session
4. Maintain 262,144-element tables of BBI and ECI in the SOC FLASH database; as the B1\_RECPTR increments through Flash, record the BBI and ECI values into the SOC FLASH database;
5. Using the SOC FLASH database, detect errors in BBI and ECI, such as an invalid BBI value (valid BBIs are: FF good, FE 1 strike, FC 2 strikes, F8 3 strikes (considered bad and not usable), 00 factory marked bad), or ECI count either going downward or increasing sharply; Prompt EFW OPS to command a TBD corrective action;
6. Maintain one 262,144-element table of TIME in the SOC FLASH database, recording the TIME in MET when the block at B1\_RECPTR was written;
7. Compare the BBI 262,144-element table to a reference table for each flight unit;
   1. The reference table shall be generated from a FLASH Table of Contents (TOC) dump.
   2. A TOC dump shall occur periodically (initially weekly, with decreasing cadence as warranted by on-orbit experience).
8. Read the APID 240 Flash Diagnostic data and compare to the reference table;
9. Maintain one 262,144-element table of B1\_EVALMAX, recording the evaluation of data when the block at B1\_RECPTR was written;
10. Calculate using ground-processed survey data, the Quality Factor for that MET;
11. Plot the Quality Factor, EVALMAX for the entire Flash Memory;
12. Indicate the top N peaks in Quality or EVALMAX where N is up to 64;
13. Indicate the sections already selected for playback;
14. Indicate on the plot where the RECPTR is currently and where RECPTR will be in three days (the time it takes to get commands up); this area is doomed to be overwritten and no playback selections should use this memory;
15. Automatically generate new playback request list, with default durations, assuring that PLAYREQ plus the new additions will not exceed 63 maximum;
16. Allow scientist approval, additions and deletions;
17. Transfer the playback request list to the spacecraft MOC;
18. Verify B1\_PLAYPTR to match a request in the playback request list; when the playback completes, the SOC can check that the data was played back;
19. Calculate Playback rates to determine how many playbacks we can ask for and/or how long each one can be. One can use the rate at which PLAYPTR moves.



Figure 28-1. Flash Memory Map

**EFW Science Team Requirements:** The lead scientist overseeing the data on the SOC, sometimes referred to as the SOC-Jock or TOHBAN, shall:

1. Plot the survey data for both spacecraft within a few days;
2. Identify interesting regions to play back;
3. Verify that playback requests are being checked off;
4. Determine if formulas for Quality Factor and EVALMAX need modification;
5. Coordinate with other investigations on Burst collections;
6. Determine if THRESH is too high or low;
7. Plot playback Flash data;
8. Write lots of scientific papers;
9. Get Nobel;
10. Thank all the little people who helped.

**REVISION HISTORY:**

* Rev A, PRH, ancient past.
  + Initial version.
* Rev B, ???, 2009?
  + Updates and detailing.
* Rev C, John Bonnell and Michael Ludlam, UCB SSL, 7 March 2012.
  + Detailing of SOC FLASH management and B1 playback requirements.
  + Added BBI details.