HASP Payload Specification and Integration Plan

Payload Title: Single Event Effect Detector

Payload Class: Small Large (circle one)

Payload ID: 2012-04

Institution: Montana State University

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Submit Date: 06/22/2012

I. Mechanical Specifications:

A. Measured weight of the payload (not including payload plate)

i. Payload weight estimate: 1.7-kg.

ii. See Appendix I Figure 1 for detailed weight budgets.

B. Provide a mechanical drawing detailing the major components of your payload and specifically how your payload is attached to the payload mounting plate

i. Appendix I Figures 2-3 provide mechanical drawings of the payload.

C. If you are flying anything that is potentially hazardous to HASP or the ground crew before or after launch, please supply all documentation provided with the hazardous components (i.e. pressurized containers, radioactive material, projectiles, rockets…)

i. Payload contains no hazardous materials.

D. Other relevant mechanical information

i. No other information at this time.

II. Power Specifications:

A. Measured current draw at 30 VDC

i. Current draw estimate: 228-mA.

ii. Payload current draw is depicted in Appendix I Figure 4.

iii. Current draw at 30 VDC will be measured at integration, if necessary, to demonstrate satisfaction of requirements.

B. If HASP is providing power to your payload, provide a power system wiring diagram starting from pins on the student payload interface plate EDAC 516 connector through your power conversion to the voltages required by your subsystems.
   i. Power system wiring diagram included in Appendix I Figure 5.

C. Other relevant power information
   i. No other relevant power information at this time.

III. Downlink Telemetry Specifications:

A. Serial data downlink format: Stream Packetized (circle one)

B. Approximate serial downlink rate (in bits per second)
   i. Nominal: 851 bytes per minute – 113.5 bps @ 1200 baud.
   ii. Maximum: 893 bytes per minute – 119.1 bps @ 1200 baud

C. Specify your serial data record including record length and information contained in each record byte.
   i. Nominal record length: 851 bytes, maximum record length: 893 bytes. Length may vary based on event-driven system response and issued payload commands. See Appendix I Figure 6 for details telemetry packet details.

D. Number of analog channels being used:
   i. No analog channels used.

E. If analog channels are being used, what are they being used for?
   i. N/A

F. Number of discrete lines being used:
   i. No discrete lines used.

G. If discrete lines are being used what are they being used for?
   i. N/A

H. Are there any on-board transmitters? If so, list the frequencies being used and the transmitted power.
   i. No on-board transmitters.

I. Other relevant downlink telemetry information.
   i. No other downlink telemetry information at this time.

IV. Uplink Commanding Specifications:

A. Command uplink capability required: Yes No (circle one)

B. If so, will commands be uplinked in regular intervals: Yes No (circle one)

C. How many commands do you expect to uplink during the flight (can be an absolute number or a rate, i.e. *n commands per hour*)

   i. One command early in ascent to verify correct power-up and operation

   ii. Other commands only on as-needed basis during flight. (No commands during nominal operation)

D. Provide a table of all of the commands that you will be uplinking to your payload

   i. Table of all payload commands included in Appendix I Figure 7.

E. Are there any on-board receivers? If so, list the frequencies being used.

   i. No on-board receivers.

F. Other relevant uplink commanding information.

   i. No other relevant uplink command information at this time.

V. Integration and Logistics

A. Date and Time of your arrival for integration:

   i. 0800 July 30, 2012

B. Approximate amount of time required for integration:

   i. Aiming for a plug-and-play integration, but wish to reserve 1-2 hours for testing and troubleshooting if necessary.

C. Name of the integration team leader:

   i. Raymond Weber

D. Email address of the integration team leader:

   i. raymond.weber@msu.montana.edu

E. List **ALL** integration participants (first and last names) who will be present for integration with their email addresses:

   i. Justin Hogan, justin.hogan@msu.montana.edu

   ii. Raymond Weber, raymond.weber@msu.montana.edu

F. Define a successful integration of your payload:

   i. Payload weight ≤ 3kg

   ii. Current @ 30 VDC ≤ 0.5A

   iii. Nominal system start-up after power on

   iv. Payload telemetry packet arrival is verified

   v. Payload response to each available command is verified

vi. Payload demonstrates proper operation under thermal and vacuum testing.

G. List all expected integration steps:

i. If required, measure weight of payload to demonstrate satisfaction of weight requirements.

ii. Attach payload to mounting plate and attach connectors

iii. If required, measure payload current draw to demonstrate satisfaction of power requirements.

iv. Observe proper payload operation by monitoring the downlink stream.

v. Issue all available commands and observe response in downlink stream.

vi. Power down payload

H. List all checks that will determine a successful integration:

i. Measured weight ≤ 3kg

ii. Measured current @ 30 VDC ≤ 0.5A

iii. Check telemetry to verify proper power-on sequence

iv. Check telemetry to verify proper telemetry packet contents and transmission frequency.

v. Check telemetry to verify proper response to each command.

vi. Verify local memory storage contents to ensure proper local archival.

vii. Demonstrate proper operation during thermal and pressure testing.

I. List any additional LSU personnel support needed for a successful integration other than directly related to the HASP integration (i.e. lifting, moving equipment, hotel information/arrangements, any special delivery needs…):

i. No additional personnel support anticipated at this time.

J. List any LSU supplied equipment that may be needed for a successful integration:

i. Anticipate use of standard lab measurement equipment including:

1. Oscilloscope
2. Multimeter (Ohmmeter, Voltmeter, Ammeter)
3. Payload attachment tools (Philips screwdriver, hex drivers)

ii. If not already available on-site, we can arrange to bring this equipment.

APPENDIX I
PAYLOAD FIGURES

MSU RTC PAYLOAD_04 WEIGHT SUMMARY						
CIRCUIT CARD ASSEMBLY						
Part Name	**Part Number**	**Quantity**	**Weight/Piece (g)**	**Total Weight (g)**	**Description**	**Notes**
POWER CCA	U1MSUA1	1	139.7424	139.7424	Estimated weight based on POWER CCA components	
EXPERIMENT CCA	U1MSUA2	0	0	0	No separate experiment CCA to be used on	Experiment CCA reserved for future use
FPGA CCA	U1MSUA3	1	128.4543	128.4543	Estimated weight based on FPGA CCA components	
SENSOR_2 CCA	U1MSUA4	1	89.811	89.811	Measured weight of SENSOR CCA with radiation sensor	
SENSOR_1 CCA	U1MSUA5	1	89.811	89.811	Measured weight of SENSOR CCA with radiation sensor	
			CCA STACK TOTAL:	447.8187		
MECHANICAL						
Part Name	**Part Number**	**Quantity**	**Weight (g)**	**Total Weight (g)**	**Description**	**Manufacturer/Notes**
Mechanical Components	U1MSU_ENC	1	1230.134	1230.134	Includes all mounting hardware	Estimate based on material datasheets
			MECHANICAL TOTAL:	1230.134		
ELECTRICAL						
Part Name	**Part Number**	**Quantity**	**Weight (g)**	**Total Weight (g)**	**Description**	**Manufacturer/Notes**
Electrical Components		1	40	40	Includes all system-level electrical hardware	
			ELECTRICAL TOTAL:	40		
			PAYLOAD WEIGHT ESTIMATE:	1717.9527		

Figure 1: Payload Weight Budget

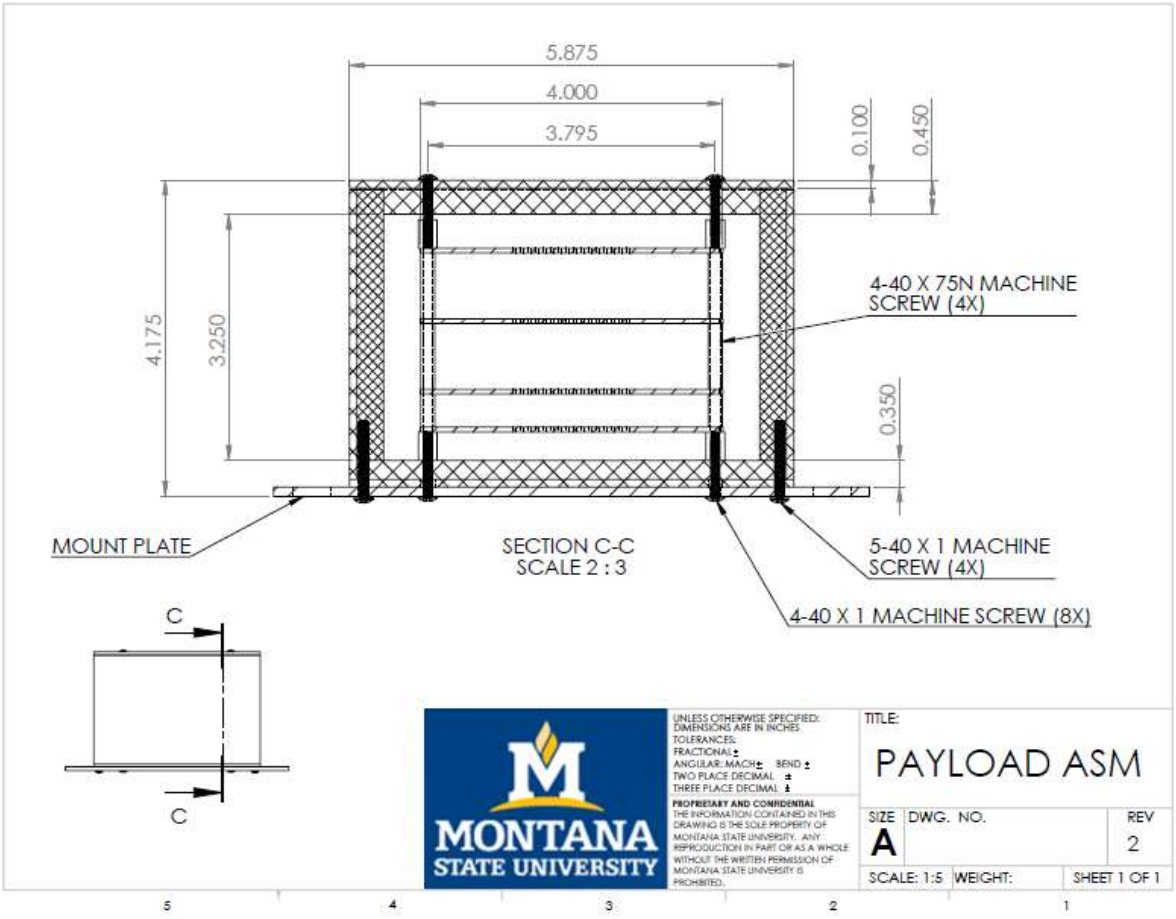

Figure 2: Payload Mechanical Drawing

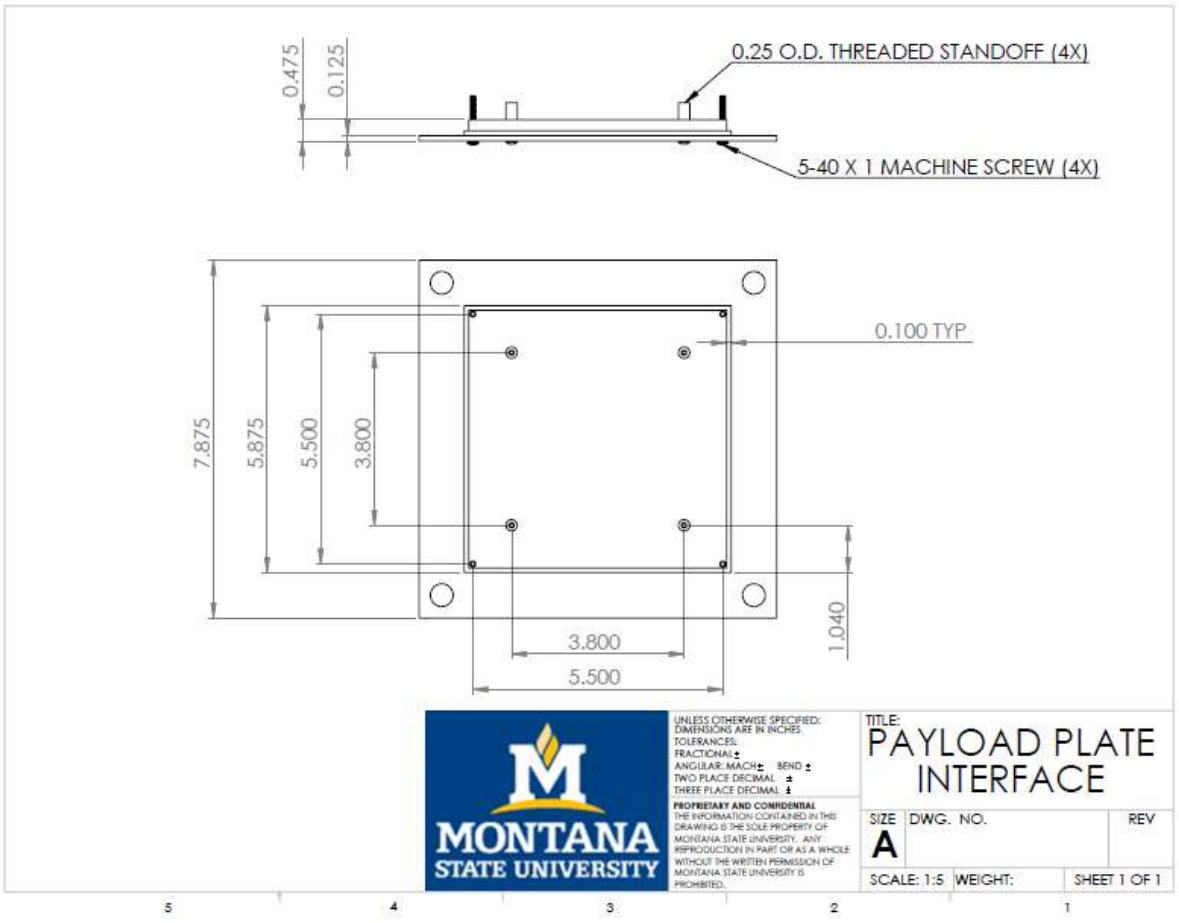

Figure 3: Payload Mounting Interface

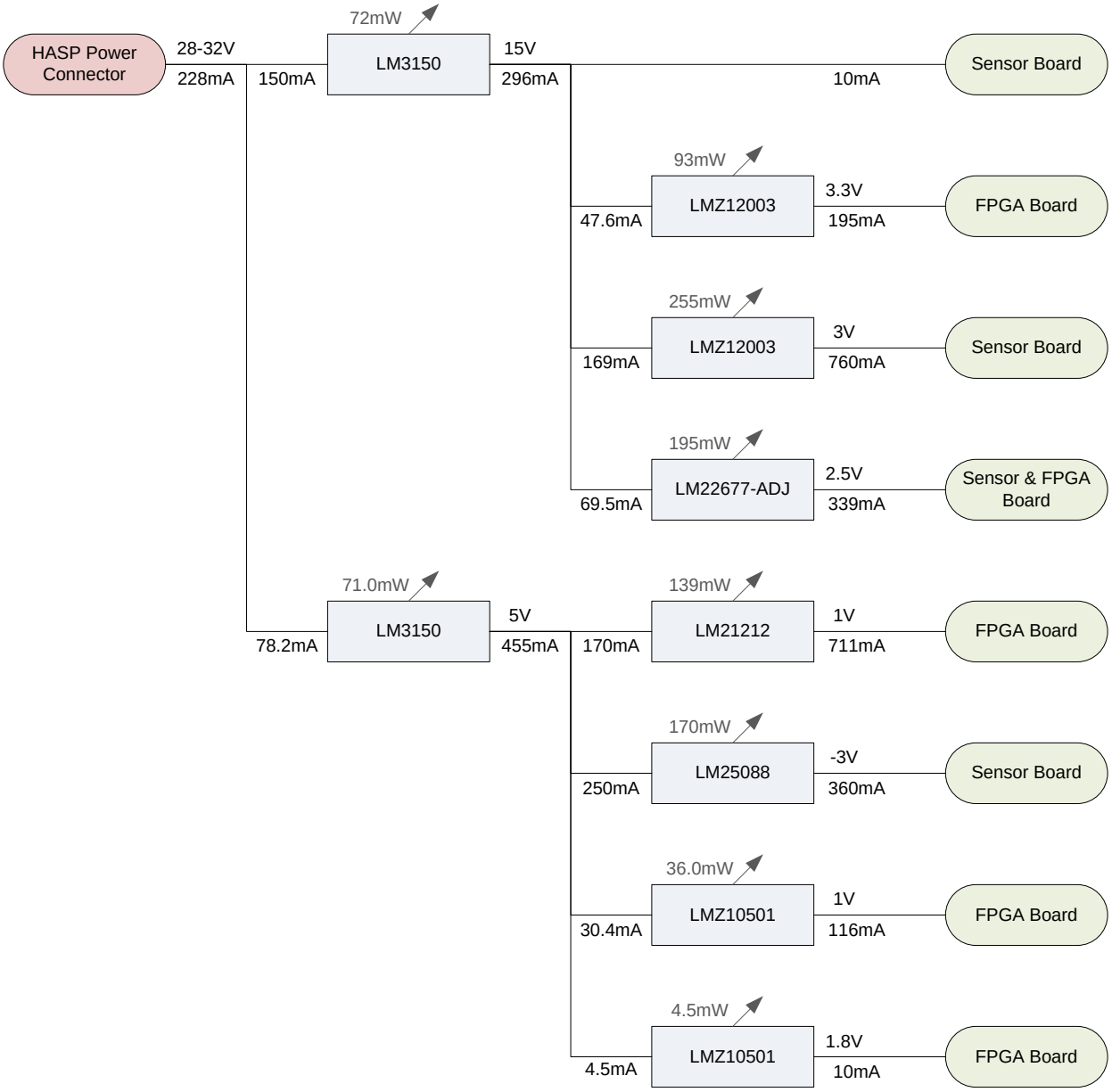

Figure 4: Payload Power Conversion Chart

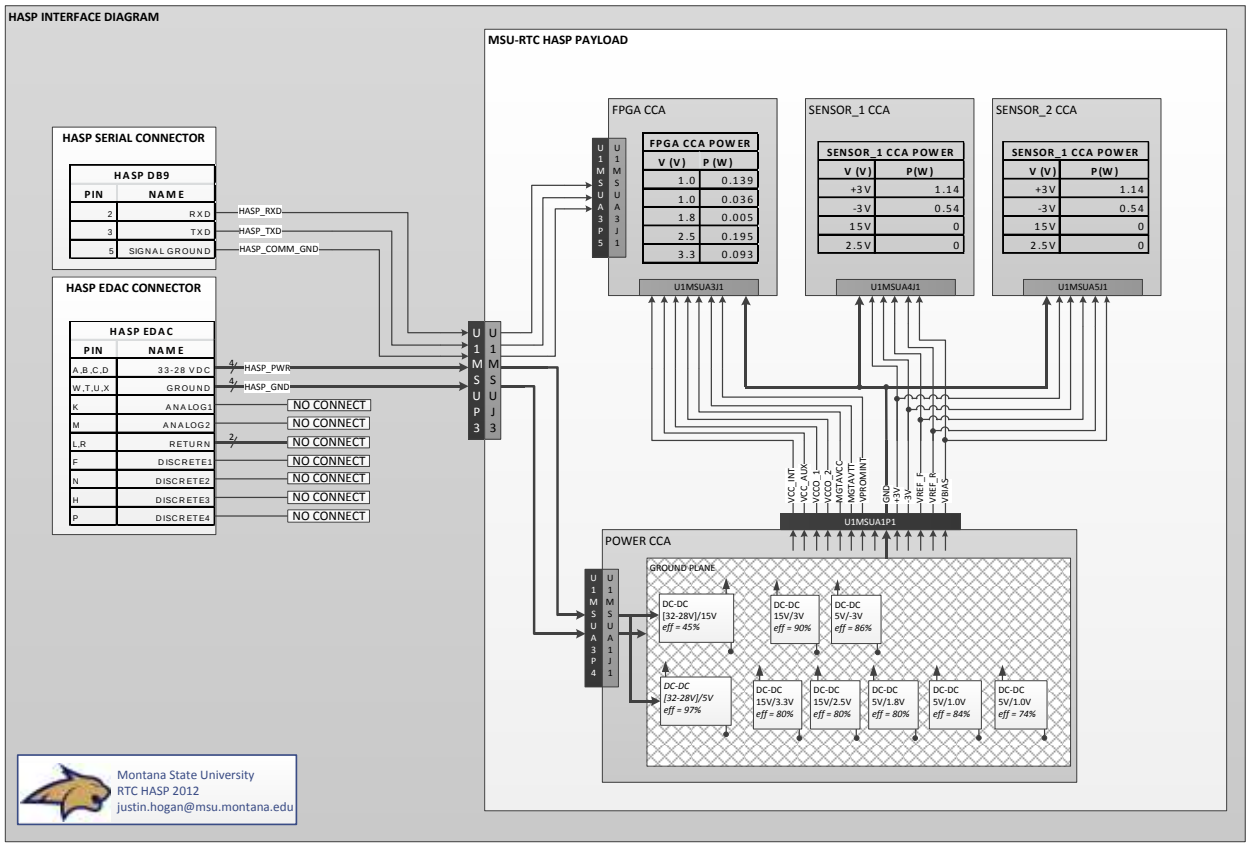

Figure 5: Payload Power Wiring Diagram

MSU RTC PAYLOAD_04 TELEMETRY FORMAT														
PACKET NAME	PACKET NUMBER	PACKET CONTENTS												
		B0	B1	B2:B5	B6:B9	B10:B11	B12	B13	B14	B15	B16	B17:755		
TLM_NUM_STRIKES	01		0x01	-- -- -- --	-- -- -- --	0x03 0x00	--	CUMULATIVE STRIKE COUNTS PER TILE						
TLM_STRIKE_INFO	02		0x02	-- -- -- --	-- -- -- --	0x00 0x02	--	SEN1_X:SEN1_Y	SEN2_X:SEN2_Y					
TLM_ACTIVE	03		0x03	-- -- -- --	-- -- -- --	0x00 0x02	--	ACTIVE_0:ACTIVE_1	ACTIVE_2:**NULL**					
TLM_SCRUB_FAULTS	04		0x04	-- -- -- --	-- -- -- --	0x00 0x04	--	SCRUB_CNT	SCRUB_CNT	SCRUB_CNT	SCRUB_CNT			
TLM_VOTE_FAULTS	05		0x05	-- -- -- --	-- -- -- --	0x00 0x04	--	VOTER_CNT	VOTER_CNT	VOTER_CNT	VOTER_CNT			
TLM_TEMP	06		0x06	-- -- -- --	-- -- -- --	0x00 0x02	--	CTRL_JUNC_TEMP	MAIN_JUNC_TEMP					
TLM_VOLT	07		0x07	-- -- -- --	-- -- -- --		--	CTRL_VCC3V3	CTRL_VCCINT	CTRL_VCCAUX				
TLM_ECHO	08		0x08	-- -- -- --	-- -- -- --	0x00 0x01	--	ACKD_CMD_NUM						
TLM_CTRL_START	09		0x09	-- -- -- --	-- -- -- --		--	CTRL_START_CODE						
TLM_MAIN_START	10		0x0A	-- -- -- --	-- -- -- --		--	MAIN_START_CODE						
TLM_SHTDN	11		0x0B	-- -- -- --	-- -- -- --	0x00 0x01	--	SHTDN_CODE						

BYTE NUMBER	BYTE NAME	BYTE DESCRIPTION
B0	SYNC BYTE PATTERN	Unique bit pattern unlikely to occur in data to signify beginning of telemetry packet
B1	PACKET TYPE INDICATO	Packet type identifier
B2	TIME STAMP(0:7)	Macro time stamp (seconds since 01 JAN 1970)
B3	TIME STAMP(8:15)	Macro time stamp (seconds since 01 JAN 1970)
B4	TIME STAMP(16:23)	Macro time stamp (seconds since 01 JAN 1970)
B5	TIME STAMP(24:31)	Macro time stamp (seconds since 01 JAN 1970)
B6	TIME STAMP(0:7)	Micro time stamp (nanoseconds since last second)
B7	TIME STAMP(8:15)	Micro time stamp (nanoseconds since last second)
B8	TIME STAMP(16:23)	Micro time stamp (nanoseconds since last second)
B9	TIME STAMP(24:31)	Micro time stamp (nanoseconds since last second)
B10	RECORD SIZE(15:8)	Number of data bytes contained in the data packet (1 to 65536)
B11	RECORD SIZE(7:0)	Number of data bytes contained in the data packet (1 to 65536)
B12	CHECKSUM	Least significant byte of record checksum
B13:B(RECORD SIZE)	PACKET DATA	Packet data contents

Figure 6: Payload Telemetry Packet Description

MSU RTC PAYLOAD_04 COMMAND FORMAT											
COMMAND NAME	COMMAND NUMBER	COMMAND CONTENTS							PACKET	CHECKSUM	BITS
		B1	B2	B3	B4	B5	B6	B7			
CMD_CTRL_RST	01	0x01	0x02	0x4-	0x01	0x03	0x0D	0x0A	01024-01030D0A		56
CMD_CTRL_CFG	02	0x01	0x02	0x4-	0x02	0x03	0x0D	0x0A	01024-02030D0A		56
CMD_MAIN_CFG	03	0x01	0x02	0x4-	0x03	0x03	0x0D	0x0A	01024-03030D0A		56
CMD_STRIKES	04	0x01	0x02	0x4-	0x04	0x03	0x0D	0x0A	01024-04030D0A		56
CMD_SCRUB_FAULTS	05	0x01	0x02	0x4-	0x05	0x03	0x0D	0x0A	01024-05030D0A		56
CMD_VOTE_FAULTS	06	0x01	0x02	0x4-	0x06	0x03	0x0D	0x0A	01024-06030D0A		56
CMD_ACTIVE	07	0x01	0x02	0x4-	0x07	0x03	0x0D	0x0A	01024-07030D0A		56
CMD_HEALTH	08	0x01	0x02	0x4-	0x08	0x03	0x0D	0x0A	01024-08030D0A		56
CMD_SHTDN	09	0x01	0x02	0x4-	0x09	0x03	0x0D	0x0A	01024-09030D0A		56
CMD_TILE_MUTE	10	0x01	0x02	0x4-	0x--	0x03	0x0D	0x0A	01024---030D0A		56

Command Number	Command	Command Description	Payload Response
01	CMD_CTRL_RST	Reset the CTRL microblaze	TLM_ECHO, TLM_CTRL_START
02	CMD_CTRL_CFG	Reconfigure entire system (reconfig CTRL FPGA)	TLM_ECHO, TLM_STRIKES, TLM_SCRUB_FAULTS, TLM_VOTE_FAULTS, TLM_CTRL_START, TLM_MAIN_START
03	CMD_MAIN_CFG	Reconfig main FPGA only	TLM_ECHO, TLM_MAIN_START
04	CMD_STRIKES	Tell us total strikes since power on	TLM_ECHO, TLM_STRIKES
05	CMD_SCRUB_FAULTS	Tell us how many faults detected by readback scrubber	TLM_ECHO, TLM_SCRUB_FAULTS
06	CMD_VOTE_FAULTS	Tell us how many faults detected by TMR voter	TLM_ECHO, TLM_VOTE_FAULTS
07	CMD_ACTIVE	Tell us which tiles are currently active	TLM_ECHO, TLM_ACTIVE
08	CMD_HEALTH	Tell us core voltages and junction temperature	TLM_ECHO, TLM_VOLT, TLM_TEMP, TLM_CTRL_START, TLM_MAIN_START
09	CMD_SHTDN	Send command to shutdown the payload	TLM_ECHO, TLM_VOLT, TLM_TEMP, TLM_STRIKES, TLM_SCRUB_FAULTS, TLM_VOTE_FAULTS
10	CMD_TILE_MUTE	Send command to stop monitoring a faulty radiation sensor channel	TLM_ECHO

Packet Number	Telemetry	Telemetry Packet Description
01	TLM_NUM_STRIKES	Send the cumulative strike information
02	TLM_STRIKE_INFO	Send the strike location information (sensor1 pos, sensor2 pos)
03	TLM_ACTIVE	Send the active tile locations
04	TLM_SCRUB_FAULTS	Send the number of configuration faults found by the scrubber
05	TLM_VOTE_FAULTS	Contains the number of faults detected by the voter portion of the TMR
06	TLM_TEMP	Contains the junction temperature for the CTRL FPGA
07	TLM_VOLT	Contains the internal voltages of the CTRL FPGA
08	TLM_ECHO	Contains an echo of the most recently received command
09	TLM_CTRL_START	Contains a message indicating proper start-up of the system following power-up, reset, or reconfiguration
10	TLM_MAIN_START	Contains a message indicating proper configuration and start-up of the Main FPGA
11	TLM_HEART	Contains a message indicating that the system is operating nominally in the absence of strikes
12	TLM_SHTDN	Contains a message indicating the system autonomously entered a shutdown mode

Figure 7: Payload Command List