Small Lunar Payload Users Guide

- Any part or all of the small Lunar payload guide is subject to change. NASA reserves the right to select none
- All teams will have to quantify if (or how much) they can meet of the specifications detailed below.

Lunar landing time frame: Lunar mid-morning

Mission lifetime: Lunar mid-morning to Lunar noon, stretch goal of extended mission of 3 lunar days (Note: power may not be available)

Payload Requirements:

Mechanical

1. Interface Drawing, JPL drawing number10353889 is the controlling document and supersedes in case of a contradiction with this document
2. Maximum exterior static envelope, with the exception of the interface connector: 100mm x 100mm x 50mm MAX
3. Mass 0.4Kg Max
4. Mounting interface pattern and keep out zones per Interface Drawing
5. Acceptable threads per Interface Drawing
6. No requirement on Center of Gravity location within envelope
7. Interface connector Airborn R-series Part Number: RM212-030-1XX-5500 or RM252-030-3XX-5500
8. Interface connector location per Interface Drawing

Dynamic

1. Assembly will experience approximately 100g static acceleration in the three principal axes (X, Y, Z) of the spacecraft reference frame specified by the Interface Drawing. Note: this requirement may be updated for specific missions and specific launch vehicles
2. Maximum dynamic envelope: surfaces shall exceed the maximum static envelope by 0.8mm MAX in the load cases of Dynamic-1 assuming fixed or RBE2 condition between four mounting interface points applied to contact areas of 10mm outer diameter MAX as specified in the Interface Drawing
3. Acoustic: Acoustic testing requirements to be released at a later time
4. Shock: Shock testing requirements to be released at a later time

Thermal Environment

Pre-launch: 0 °C to +27 °C Integration and launch facilities will be climate controlled

Launch: -60 °C to +27 °C The integrated spacecraft is encapsulated in an environmentally controlled payload fairing

Cruise: -60 °C to +100 °C: Colder environment for objects in shadow and hotter for objects in direct sunlight

Lunar Orbit: -120 °C to +100 C: Colder environment for objects in shadow and hotter for objects in direct sunlight

Lunar surface: -30 °C to +80 °C. Colder environment for objects in shadow and hotter for objects in direct sunlight. This range is relevant for the nominal lunar surface operation duration and does not include lunar night

1. Average radiative boundary conditions normal to faces of envelope, per the spacecraft reference frame in the Interface Drawing:
    a. +X: -Z half of face view of outer space, +Z half of face view of surface at 120°C
    b. –X: Spacecraft surface at 80°C
    c. +Y: Spacecraft surface at 80°C
    d. –Y: Spacecraft surface at 80°C
    e. +Z: Surface at 120°C
    f. –Z: Spacecraft surface at 80°C
2. Conductive boundary condition: .01W/K total conductance at bolted interface across four contact areas of 14mm outer diameter (154mm^2) MAX, as specified in the Interface Drawing.
3. Temperature range at bolted interface -55°C to +120°C,
4. Coefficient of thermal expansion at spacecraft side of bolted interface 20-25ppm/C.

Note: Corresponding thermal environments of the payload depend on mounting location and sunlight during the mission. NASA will work with the customer to develop payload specific environments for relevant system testing prior to payload integration.

Materials & Processes

1. Material Total Mass Loss (TML) 1% MAX
2. Material Collected Volatile Condensable Material (CVCM) 0.1% MAX
3. The following materials are forbidden: Pure beryllium, cadmium, mercury, zinc, and radioactive materials. Note: exceptions can be made in special circumstances by agreement with program office.
4. Pure tin mitigation: Tin of greater than 90% purity must be mitigated for tin whiskers by either alloying with other materials or by encapsulation.
5. No dangerous stored energy is allowed at time of launch. This includes charged batteries and supercapacitors, sealed pressure vessels (high and low pressure), and reactive chemicals. Note: exceptions can be made in special circumstances by agreement with program office.
6. Interface threads free from paint, anodize, or other non-conductive coatings
7. Interface threads to spacecraft must be conductively tied to Payload chassis ground

8. For galvanic matching to spacecraft, Interfacing bearing surfaces to spacecraft must be chemfilm, bare aluminum, electroless nickel, gold, anodize, stainless steel, titanium, or tiodize

Environmental:

1. The hosting spacecraft is not responsible for sealing payloads from the environment. For surface missions the payload is responsible their own dust mitigation, if necessary
2. The payload will experience a pressure differential during launch. It is recommended that payloads incorporate dedicated vent holes to prevent structural damage to the assembly due to launch pressure differential. If HEPA or other dust filter material is used to protect the assembly vent paths, the material will limit the venting rate. Upon request the hosting spacecraft can provide launch specific pressure profiles and provide guidance for venting both with and without filter materials.
3. Internal and External metallic elements with surface area greater than 3 cm^2, or wires longer than 25cm shall have resistance to chassis ground of <100 MOhm at all times. Condition verified by measurement in air.
4. Primary payload electrical return and payload chassis ground at mounting interface will be tied to Spacecraft primary return and chassis ground with a maximum resistance of 2.5mohm.
5. Probability of solid-particle and/or meteoroid impact during cruise, landing, surface operations is mission specific and will be provided to payloads upon mission selection.
6. Total Ionizing Dose (TID) is expected to be low. Maximum TID is 6 krad assuming 2.54mm aluminum shielding and a mission length of 1 year.
7. The payload should be tolerant to single event effects due to Solar Proton Flux, Solar Heavy Ion Flux, Galactic Cosmic Ray Proton Flux, and Galactic Cosmic Ray Heavy Ion Flux.

Electromagnetic Interference/Electromagnetic Compatibility (EMI/EMC)

1. The hosting spacecraft transmits on 900MHz and 2.4GHz frequencies. The payload shall accept all interference from the hosting spacecraft on these frequencies. Note: vent holes and connectors can serve as apertures for electromagnetic radiation.
2. Conducted Emissions (CE), Conducted Susceptibility (CS), Radiated Emissions (RE), and Radiated Susceptibility (RS) testing for payload will be completed by the hosting program as an integrated system with the hosting spacecraft. Test conditions TBD.

Power:

1. Power will be inhibited to hosting spacecraft and payload during launch, cruise, and landing
2. Payload will be unpowered during critical spacecraft operations, including mobility

Lunar Surface

3. Electrical Pinout per Interface Drawing
4. Hosting spacecraft will provide current limited and switched access to primary bus:
    a. 6-8V
    b. 8V, 1A MAX, 50ms MAX
    c. 4W, 0.5A continuous

5. Hosting spacecraft will provide current limited and switched regulated secondary rails:
    a. 3.3V, 100mA MAX
    b. 5V, 100mA MAX
6. Hosting spacecraft will provide primary bus return and tie all grounds and returns to primary bus return.
7. Payload must be tolerant to immediate, unanticipated power loss

Data:

1. Electrical Pinout per Interface Drawing
2. The following General Purpose Input/Output (GPIO) pins will be provided
    a. Pulse Per Second (PPS) from spacecraft to payload (Output)
    b. Interrupt from payload to spacecraft (Input)
    c. Heartbeat from payload to spacecraft (Input)
    d. Comm Disable from spacecraft to payload (Output)
    e. Soft Reset from spacecraft to payload (Output)
    f. Reprogram/Reflash Firmware Enable from spacecraft to payload (Output)
    g. 1 spare Output from spacecraft to payload (Output)
    h. 1 spare Input from payload to spacecraft (Input)
3. The spacecraft will provide an asynchronous UART TX/RX at 115 kbaud per second
4. The spacecraft will provide one SPI master at 1Mbits/s
5. The payload can query the following telemetry from the spacecraft, format TBD:
    a. 6 axis IMU data
    b. UTC timestamp or equivalent global timestamp
    c. Bulk temperature data
    d. Odometry
    e. Estimated position and orientation

Software:

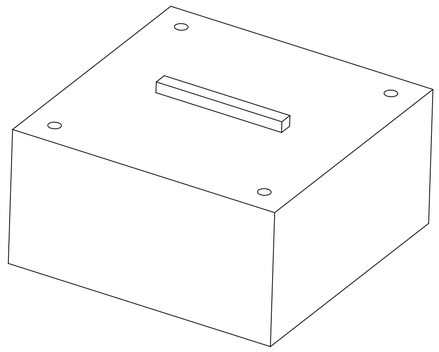
1. Software interface protocol TBD
2. Electrical waveform TBD

Operational restrictions:

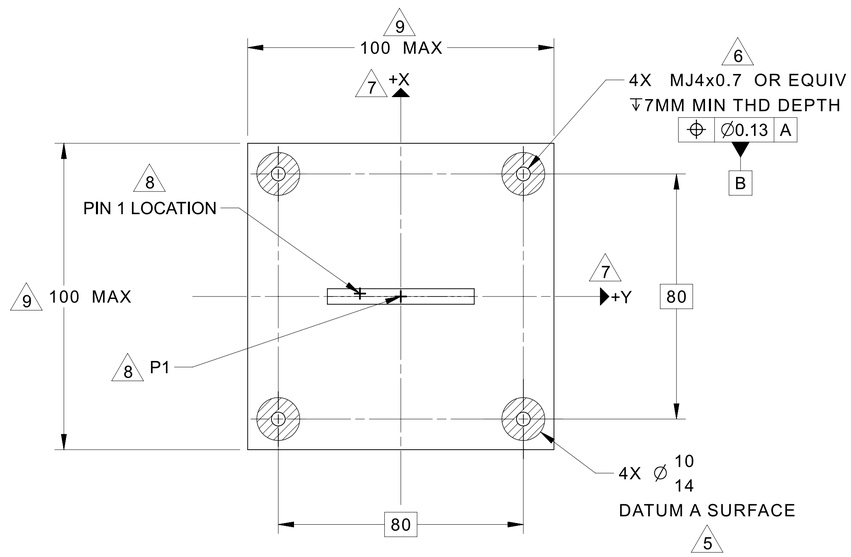
1. Maximum continuous data rate from payload to spacecraft is limited by downlink to hosting mission and will be approximately 1-2 kb/s
2. Received data is limited by lander capability and mission life. Data will not be stored by the hosting spacecraft or lander, and any data not received at the end of the mission will be lost.
3. For surface operations, nominal clearance from payload to surface approximately 6.5cm
4. For surface operations, hosting spacecraft can deliver front face of payload within 5cm of target of interest taller than 6.5cm
5. Deployables can be allowed by agreement with program office
6. Telecom is not allowed directly from payload. All communication will transmit through hosting spacecraft
7. Mission range from lander 1km, assuming maximum Zigbee telecom range

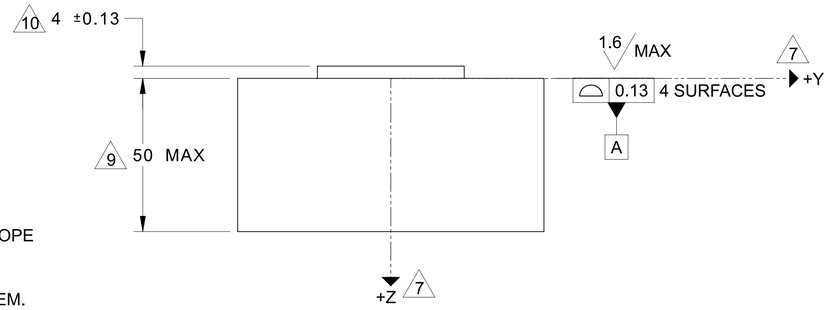
8. Hosting spacecraft will soft reset payload if no heartbeat is received for 5 continuous seconds
9. Hosting spacecraft will power cycle payload if 5 consecutive soft resets fail
10. Hosting spacecraft will turn off payload permanently if 2 consecutive power cycles fail.
11. Payload pointing and sensor exposure: +X face of payload may be exposed to direct, normal sunlight. +Z face of payload may be exposed to direct sunlight at a maximum continuous elevation of 30 degrees and a maximum instantaneous angle of 45 degrees during driving events.
12. Elevation of normal vector to +Z face:
    a. 10 - 20 degrees nominal at rest
    b. -10 – 30 degrees nominal during driving on regolith
    c. -45 – 45 degrees during terrain navigation

REVISION HISTORY						
REV	ZONE	DESCRIPTION	CAT	DWN	ENGR	SEE JPL DATA MANAGEMENT SYSTEM FOR APPROVAL SIGNATURES AND DATES
B	-	CHANGED EXPORT CONTROL MARKING TO NOT EXPORT CONTROLLED	II	JR	JR	



REFERENCE VIEW
SCALE NONE





8 TABLE 1: PAYLOAD CONNECTOR P1 PINOUT		
PIN NUMBER	SIGNAL DESCRIPTION	SIGNAL REFERENCE DESIGNATOR
1	BUS POWER	BUS
2	NO CONNECT	NC
3	5V	5V
4	NO CONNECT	NC
5	NO CONNECT	NC
6	POWER RETURN	RTN
7	PULSE PER SECOND	PPS
8	INTERRUPT	INT
9	SOFT RESET	RST
10	SPARE INPUT	SPARE_IN
11	NO CONNECT	NC
12	UART TRANSMIT	UART TX
13	POWER RETURN	RTN
14	SERIAL CLOCK	SCLK
15	MASTER INPUT SLAVE OUTPUT	MISO
16	BUS POWER	BUS
17	NO CONNECT	NC
18	NO CONNECT	NC
19	3.3V	3.3V
20	NO CONNECT	NC
21	POWER RETURN	RTN
22	COMM DISABLE	COMD
23	HEARTBEAT	HRT
24	FIRMWARE REPROGRAM/ REFLASH ENABLE	F_EN
25	SPARE OUTPUT	SPARE_OUT
26	NO CONNECT	NC
27	UART RECEIVE	UART RX
28	POWER RETURN	RTN
29	MASTER OUTPUT SLAVE INPUT	MOSI
30	SLAVE SELECT	SS

10. P1 CONNECTOR MATING PLANE.

9. MAXIMUM STATIC ENVELOPE. ADDITIONAL DYNAMIC ENVELOPE BEYOND STATIC ENVELOPE PER INTERFACE DOCUMENT.

8. P1 CONNECTOR MOUNTING LOCATION ALIGNED WITH SPACECRAFT COORDINATE SYSTEM. P1 CONNECTOR PART NUMBER PER INTERFACE DOCUMENT. PINOUT PER TABLE 1.

7. SPACECRAFT COORDINATE SYSTEM. ORIGIN DEFINED BY DATUM A (MOUNTING SURFACE) AND DATUM B (MOUNTING THREAD HOLE CENTERS).

6. ACCEPTABLE MOUNTING/INTERFACE THREADS:
A) THREADS OF ALUMINUM 7075-T7351 OR STRONGER
B) THREADED KEENSERT P/N KNCM4x0.7 OR EQUIVALENT
C) THREADED HELICOIL P/N MA3279-104 OR EQUIVALENT

5. SPACECRAFT MOUNTING/BEARING INTERFACE SURFACE.
EXTERIOR FINISH FOR MOUNTING/BEARING SURFACES PER INTERFACE DOCUMENT.

4. PERMANENTLY MARK CONNECTOR REFERENCE DESIGNATOR ON EXTERIOR OF ASSEMBLY ADJACENT TO CONNECTOR PER JPL SPECIFICATION DocID: 35256 OR EQUIVALENT.

3. THE FINAL MASS PROPERTIES SHALL BE DOCUMENTED ON THE MASS PROPERTIES REPORTING FORM PROVIDED AT HRCR/DELIVERY. FINAL REPORTED MEASURED MASS SHALL BE WITHIN +/-5 GRAMS. THE MOMENTS AND PRODUCTS OF INERTIA REPORTED SHALL BE ABOUT THE CENTER OF MASS AND WITH RESPECT TO THE COORDINATE FRAME SHOWN AT THE CENTER OF MASS.

2. PERMANENTLY MARK EXTERIOR OF ASSEMBLY WITH PROJECT NAME, PART NUMBER, SERIAL NUMBER, REFERENCE DESIGNATOR, PART NAME, MANUFACTURER'S CAGE NUMBER, AND MANUFACTURER'S PART NUMBER IN AREA INDICATED PER MIL-STD-130.

1. THIS IS THE INTERFACE DRAWING FOR THE COMMON LUNAR PAYLOAD. PAYLOADS SHALL MEET THE REQUIREMENTS OF THIS INTERFACE DRAWING AND THE PAYLOAD INTERFACE DOCUMENT, JPL DOCUMENT NUMBER TBD.

NOTES: UNLESS OTHERWISE SPECIFIED

INTERFACE DRAWING

THIS DOCUMENT HAS BEEN REVIEWED AND DETERMINED NOT TO CONTAIN EXPORT CONTROLLED TECHNICAL DATA.

MATERIAL

METRIC

THIRD ANGLE PROJECTION

NEXT ASSEMBLY | USED ON

APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MILLIMETERS

LINEAR TOLERANCES:

0-6	±0.1
OVER 6-30	±0.2
OVER 30-120	±0.3
OVER 120-315	±0.5
OVER 315-1000	±0.8
OVER 1000	±1.2

ANGULAR TOLERANCES: ±0.5°

SURFACE ROUGHNESS (MICROMETERS)

DO NOT SCALE DRAWING
INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5-2009
INTERPRET DWG PER ASME Y14.100

CONTRACT NO

DWN	J. RAVICH
ENGR	J. RAVICH

SEE JPL DATA MANAGEMENT SYSTEM FOR APPROVAL SIGNATURES AND DATES

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CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CA 91109

TITLE
COMMON LUNAR PAYLOAD

SIZE	DAI	DWG NO	REV
A1	23835	10353889	B
SCALE: 1/1		SHEET 1 OF 1	

REV 05/2018

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DBASE NAME: 10353889