

## **SMEI Instrument Commanding Protocol**

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## 1. Introduction

The purpose of this document is to provide an overview of the commanding strategy and available commands for the SMEI data handling unit (DHU). Detailed command formats are given in the 'SMEI Instrument Commanding Specification (SMEI/BU/SPE/002).

This document does not cover mechanisms for transmission of SMEI telemetry to the spacecraft.

## 2. Commanding Overview

The SMEI instrument has a number of discrete modes of operation. In each mode, only a subset of the available commands are permitted. This provides a measure of protection from software and commanding errors by requiring a multiple command sequence to be sent.

<i>Mode Name</i>	<i>MNEMONIC</i>	<i>Description</i>
COLD START	CS	Used during the boot sequence before applying software patches to the system software.
SAFE	SAFE	Used during emergencies. Entering this mode attempts to close the shutters and reduce SMEI power requirements to a minimum.
CONFIGURE / STANDBY	CONF	Used to select observing and instrument configurations.
OBSERVING	OBS	Data acquisition mode. Camera images are only taken in this mode.
PATCHING	PATCH	Non-volatile storage update mode. Permits the use of commands to modify data in the E <sup>2</sup> PROM.

Table 1. Primary Instrument Modes

Commands to the SMEI DHU are supplied over a redundant MILSPEC-1553 bus. All the command blocks are structured with the same two word header, containing the command number, a sequence number, and the command checksum (CRC). The command blocks are all thirty two words in length, and spare words are filled with zeros. This document does not consider the 1553 command words.

SMEI has three sub-addresses for different types of commands from the spacecraft. Sub-address 4 is used for standard commands. These are routine commands to change the instrument configuration, start observations and so forth.

Sub-address 5 is used during spacecraft emergencies to shutdown SMEI rapidly.

Sub-address 6 is used for supplying SMEI with time and attitude information.

## 3. Command Summary

The table here summarises the available standard commands (set via S/A 4), and shows which modes each command is available in. A brief description of each command is also given.

<i>COMMAND</i>	<i>AVAILABLE MODES</i>					<i>Description</i>
	<i>CS</i>	<i>SAFE</i>	<i>CONF</i>	<i>OBS</i>	<i>PATCH</i>	
SM_ENBL_SAFE	Y		Y	Y	Y	Enable safe mode
SM_GOTO_SAFE	Y		Y	Y	Y	Enter safe mode
SM_ENBL_PTCH	Y		Y			Enable patch mode
SM_GOTO_PTCH	Y		Y			Enter patch mode
SM_GOTO_CONF				Y	Y	Enter configuration mode
SM_GOTO_OBS			Y			Enter observing mode
SM_DHU_COLD	Y					Continue boot sequence
SM_PATCH_UPL					Y	Upload patch data

<b>COMMAND</b>	<b>AVAILABLE MODES</b>					<b>Description</b>
	<b>CS</b>	<b>SAFE</b>	<b>CONF</b>	<b>OBS</b>	<b>PATCH</b>	
SM_PATCH_CMT					Y	Write patch data to E <sup>2</sup> PROM
SM_PATCH_DEA					Y	Deactivate a code patch
SM_PATCH_ACT					Y	Activate a code patch
SM_THERM_CTRL			Y			Set-up camera thermal control
SM_1_PWR_ON			Y			Switch on camera power relay
SM_1_ICE_OFF			Y			Switch off de-ice heater
SM_1_ICE_ON			Y			Switch on de-ice heater
SM_1_HOP_EN			Y			Enable HOP activation command
SM_1_HOP_TEST			Y			Run a HOP continuity test
SM_1_HOP_ACT			Y			Active the HOP
SM_1_CONF			Y			Load a predefined configuration
SM_1_DYN_CONF			Y			Load a dynamic configuration
SM_1_MOTOR			Y			Change the shutter position
SM_2_PWR_ON			Y			Switch on camera power relay
SM_2_ICE_OFF			Y			Switch off de-ice heater
SM_2_ICE_ON			Y			Switch on de-ice heater
SM_2_HOP_EN			Y			Enable HOP activation command
SM_2_HOP_TEST			Y			Run a HOP continuity test
SM_2_HOP_ACT			Y			Active the HOP
SM_2_CONF			Y			Load a predefined configuration
SM_2_DYN_CONF			Y			Load a dynamic configuration
SM_2_MOTOR			Y			Change the shutter position
SM_3_PWR_ON			Y			Switch on camera power relay
SM_3_ICE_OFF			Y			Switch off de-ice heater
SM_3_ICE_ON			Y			Switch on de-ice heater
SM_3_HOP_EN			Y			Enable HOP activation command
SM_3_HOP_TEST			Y			Run a HOP continuity test
SM_3_HOP_ACT			Y			Active the HOP
SM_3_CONF			Y			Load a predefined configuration
SM_3_DYN_CONF			Y			Load a dynamic configuration
SM_3_MOTOR			Y			Change the shutter position

Table 2. Standard Command Summary

In addition to the standard commands, SMEI recognises a spacecraft emergency command (set via S/A 5), and attempts to make safe the SMEI instrument, and to reduce power consumption to a minimum. This command does not require an enable.

<b>COMMAND</b>	<b>AVAILABLE MODES</b>					<b>Description</b>
	<b>CS</b>	<b>SAFE</b>	<b>CONF</b>	<b>OBS</b>	<b>PATCH</b>	
SM_EMERG_SAFE	Y		Y	Y	Y	Emergency safe mode

Table 3. Emergency Safe Mode

The final command recognised by SMEI contains time and attitude data sent via S/A 6.

<b>COMMAND</b>	<b>AVAILABLE MODES</b>					<b>Description</b>
	<b>CS</b>	<b>SAFE</b>	<b>CONF</b>	<b>OBS</b>	<b>PATCH</b>	
SM_SC_ATT			Y	Y	Y	Provide time and attitude data

Table 4. Time and Attitude Data

## 4. Detailed Command Descriptions

This section provides details of the parameters taken by each command. A number of the commands are per camera. To reduce the duplication in this section, we replace '1', '2' and '3' with the generic identifier 'x'.

### 4.1 SM\_ENBL\_SAFE

This command is used to enable the SM\_GOTO\_SAFE command. It acts as protection from accidentally shutting down the instrument.

### 4.2 SM\_GOTO\_SAFE

This command puts SMEI into safe mode, in preparation for being switched off by the spacecraft. It is only performed if the preceding command is SM\_ENBL\_SAFE, and they are issued within 60 seconds.

### 4.3 SM\_ENBL\_PTCH

This command is used to enable the SM\_GOTO\_PTCH command. It acts as protection from accidentally entering the E<sup>2</sup>PROM update mode.

### 4.4 SM\_GOTO\_PTCH

This command puts SMEI into patch mode. It is only performed if the preceding command is SM\_ENBL\_PTCH, and they are issued within 60 seconds.

### 4.5 SM\_GOTO\_CONF

This command puts SMEI into configuration mode. This mode is used to change observing parameters.

### 4.6 SM\_GOTO\_OBS

This command puts SMEI into observation mode. The camera configurations set in configuration mode are used to configure the CCD electronics, and images acquisition is started.

### 4.7 SM\_DHU\_COLD

This command finishes the SMEI boot process and enters configuration mode. The boot process pauses in cold start mode before the system software has any patches applied to it from the E<sup>2</sup>PROM. This allows recovery from a corrupted E<sup>2</sup>PROM image.

### 4.8 SM\_PATCH\_UPL

This command supplies 28 words of binary patch data to SMEI. The 28 words are written into an 8 kiloword buffer at the commanded offset. Issuing this command repeatedly permits a complete patch to be uploaded before it is committed to the E<sup>2</sup>PROM using the SM\_PATCH\_CMT command.

### 4.9 SM\_PATCH\_CMT

This command copies the commanded portion of the patch buffer to the given location in the E<sup>2</sup>PROM. It is used after a patch has been uploaded by SM\_PATCH\_UPL to commit the change to the non-volatile store.

#### **4.10 SM\_PATCH\_DEA**

This command deactivates an uploaded software patch. Software patches are committed to a special region in the E<sup>2</sup>PROM which is reserved for this purpose. This patch sets a flag to ignore a particular patch in the region.

#### **4.11 SM\_PATCH\_ACT**

This command activates an uploaded software patch. Software patches are committed to a special region in the E<sup>2</sup>PROM which is reserved for this purpose.

#### **4.12 SM\_THERM\_CTRL**

This command sets the control temperatures for the three camera cold fingers. It also sets the maximum number of heaters that are permitted to be active at any given point in time. This allows active control of the cold finger temperature to prevent thermal cycling of the cold finger to CCD bonding material.

#### **4.13 SM\_x\_PWR\_ON**

This command switches on the power relay for a camera. This enables power to the secondary switching facilities in the DHU, and does not switch on the cameras directly. There is no corresponding off command to avoid a single point failure.

#### **4.14 SM\_x\_ICE\_OFF**

This command switches off a de-icing heater override. Note that the active temperature control settings configured using SM\_THERM\_CTRL have precedence over this command.

#### **4.15 SM\_x\_ICE\_ON**

This command enables a de-icing heater for the specified amount of time. The target temperature for the cold finger is also specified, and if the temperature is below that specified, the heater is switched on. Note that this command overrides the global thermal control specified in SM\_THERM\_CTRL.

#### **4.16 SM\_x\_HOP\_EN**

This command enables the SM\_x\_HOP\_ACT command. This serves as protection against accidental activation of the HOP. Note that the camera relay must also be in the ON position for the HOP to be fired.

#### **4.17 SM\_x\_HOP\_TEST**

This command is used to test the continuity of the HOP firing circuitry. It switches on the HOP briefly, and allows the instrument power monitor to register the increase in current while the HOP is powered. This command requires that the camera power relay is in the ON position. It does not require SM\_x\_HOP\_EN to have been sent, as a single erroneous transmission of this command will not cause the hop to fire.

#### **4.18 SM\_x\_HOP\_ACT**

This command activates the HOP for the specified duration. It is only performed if the SM\_x\_HOP\_EN command was the previous command, and that both are issued within 60 seconds. Note that the camera power relay must be in the ON position for power to be supplied to the HOP.

#### **4.19 SM\_x\_CONF**

This command selects a predefined observation configuration for the camera. It copies the relevant table from the E<sup>2</sup>PROM.

#### **4.20 SM\_x\_DYN\_CONF**

This command sets the observation configuration for the camera to the uploaded data supplied. This allows test or infrequently used configurations to be configured 'on the fly', without requiring changes to the E<sup>2</sup>PROM.

#### **4.21 SM\_x\_MOTOR**

This command can be used to manually test the filter wheel stepper motor. The supplied parameters indicate which of the four coils to energise, and the duration. Note that the camera power relay must be in the ON position for power to be switched.

#### **4.22 SM\_EMERG\_SAFE**

This command is issued during emergency conditions. On receipt, SMEI immediately switches off the three camera, and attempts to sequentially close the shutters for the three cameras. Note that SMEI does not protect this command. It's format is defined in Section C of the Interface Control Document.

#### **4.23 SM\_SC\_ATT**

This command provides the time and attitude solution data to SMEI. The format is defined in Section C of the Interface Control Document.

### **5. References**

SMEI Instrument Command Specification

SMEI/BU/SPE/002

SMEI Instrument Telemetry Specification

SMEI/BU/SPE/003

Coriolis Interface Control Document

CDRL NO. 004