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Mariner Mars 1969 Spacecraft Clock Correlation: the basis for NAIF SPICE SCLK Kernels

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1   Introduction

The Mariner Mars 1969 Mission (NASA, 1969) had two spacecraft, Mariner 6 and Mariner 7. Each spacecraft carried a narrow and a wide angle camera (Danielson and Montgomery, 1971, Reindfleisch, *et. al.*, 1971) that were mounted on two degree-of-freedom scan platforms to point the cameras at Mars during Mars approach and flyby. About 200 approach and flyby images of Mars were taken by the narrow and wide angle cameras (Leighton, *et. al.*, 1969, Leighton, *et. al.*, 1971, Collins, 1971). The NASA Science Missions Directorate, Planetary Science Division, under it Planetary Data Archive Restoration and Technology (PDART) Program, is restoring these images in Planetary Data System PDS4 data formats and creating their associated ancillary engineering data as NAIF SPICE Kernels (Acton, 1996, Acton, *et. al.*, 2017). The complete set of SPICE kernels were created that are listed in the SPICE meta-kernel *mariner69_v02.tm*, making the use of the Mariner 69 kernels collection much easier.

The Mariner Mars 1969 NAIF SPICE Kernel collection includes Spacecraft Trajectory S Kernels (Duxbury and Jacobson, 2017)

mr6_690721_690810_ssd_v10.bsp and

mr7_690726_690815_ssd_v10.bsp,

Instrument I Kernels (Duxbury, 2017)

mr6_na_tcd_v10.ti and

mr7_na_tcd_v10.ti,

Narrow Angle Camera Pointing and Spacecraft Attitude C Kernels (Duxbury and Semenov, 2017)

mr6_na_690729_690730_tcd_v10.bc,

*mr7_na_*690802_690804*_tcd_v*10*.bc*,

*mr6_sc_*690729_690730*_tcd_v*10*.bc* and

mr7_sc_690802_690804_tcd_v10.bc,

Spacecraft Frames F Kernels (Duxbury and Semenov, 2017b)

mr6_v10.tf and

mr7_v10.tf

and Spacecraft Clock Correlations Kernels

m6_fict.tsc and

m7_fict.tsc

described here. The NAIF SPICE spacecraft and camera ID numbers for Mariner Mars 1969 are listed in Table 1.

Unfortunately the Mariner 6 and 7 spacecraft did not have clocks that were correlated with Earth clocks using the ground receipt times of telemetered spacecraft clock ticks as modern spacecraft do. Therefore ficticious Spacecraft Clock Correlation SCLK Kernels *mr6_v10.tf* and *mr7_v10.tf* were created as these are needed to extract attitude/pointing data from the C Kernels. These fictional kernels are described below.

2   SCLK Kernel Paramerters

The SCLK Kernel implementation of fictitious spacecraft clock times used to give time tags to the attitude / pointing data at image times (taken from Campbell, 1969) in the Mariner Mars 1969 C Kernels uses a simple counter of milliseconds since each spacecraft launch. Mariner 6 was launched on 1969 February 25 01:29:02 (UTC) and Mariner 7 was launched on 1969 March 27, 22:22:00 (UTC). Spacecraft SCLK Kernels use the Dynamical Barycentric Time (TDB) system; therefore the UTC launch dates need to be converted to TDB.

The TDB associated with the launch date of Mariner 6 is:

[mgl2:/toolkit_64/exe]tduxbury% chronos -setup /kernels/gen/lsk/naif0012.tls -from utc -to et -format 'YYYY-MON-DD-HR:MN:SC.###### ::RND' -time 1969 February 25, 01:29:02

1969-FEB-25-01:29:43.185325 (ET/SCET)

The primary data for the Mariner 6 SCLK Kernel (*m6_fict.tsc*) is then:

SCLK_KERNEL_ID   = (@17-MAR-2017)

SCLK_DATA_TYPE_530   = (1)

SCLK01_TIME_SYSTEM_530   = (2)

SCLK01_N_FIELDS_530   = (2)

SCLK01_MODULI_530   = (10000000000 1000)

SCLK01_OFFSETS_530   = (0 0)

SCLK01_OUTPUT_DELIM_530 = (1)

SCLK_PARTITION_START_530 = (0.0000000000000E+00)

SCLK_PARTITION_END_530   = (1.00000000E+14)

SCLK01_COEFFICIENTS_530   = (0.00000000E+00

                                                 @1969-FEB-25-01:29:43.185325
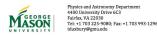
                                                 1)

The TDB associated with the launch date of Mariner 7 is:

[mgl2:/toolkit_64/exe]tduxbury% chronos -setup /Users/tduxbury/kernels/naif0012.tls -from utc -to et -format 'YYYY-MON-DD-HR:MN:SC.###### ::RND' -time 1969 March 27, 22:22:00

1969-MAR-27-22:22:41.185647 (ET/SCET)

The primary data for the Mariner 7 SCLK Kernel (*m7_fict.tsc*) is then

SCLK_KERNEL_ID   = (@17-MAR-2017)

SCLK_DATA_TYPE_531   = (1)

SCLK01_TIME_SYSTEM_531   = (2)

SCLK01_N_FIELDS_531   = (2)

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SCLK01_MODULI_531   = (10000000000 1000)

SCLK01_OFFSETS_531   = (0 0)

SCLK01_OUTPUT_DELIM_531 = (1)

SCLK_PARTITION_START_531 = (0.0000000000000E+00)

SCLK_PARTITION_END_531   = (1.00000000E+14)

SCLK01_COEFFICIENTS_531   = (0.00000000E+00

        @1969-MAR-27-22:22:41.185647

        1)

These Mariner 6 and 7 SCLK kernels are valid for all Far and Near Emncounter, Narrow and Wide Angle camera images.

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Table 1: Mariner Mars 1969 SPICE Spacecraft and Camera Identification Numbers

S/C	S/C (S & SCLK) Kernels	S/C (C, F & I) Kernels	Narrow Angle Camera	Wide Angle Camera
Mariner 6	-530	-530000	-530101	-530102
Mariner 7	-531	-531000	-531101	-531102