Interior Exploration Using Seismic Investigations, Geodesy, and Heat Transport (InSight) Mission

Insight Fluxgate Magnetometer (IFG)

PDS Archive

Software Interface Specification

Rev. 1.3

September 19, 2019

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Contents

1 Introduction

This software interface specification (SIS) describes the format and content of data acquired by the Insight Fluxgate Magnetometer (IFG) instrument for the Planetary Data System (PDS) data archive. It includes descriptions of the data products and associated metadata, and the archive format, content, and generation pipeline. This SIS describes raw, quick-look, and calibrated data products.

1.1 Document Change Log

Table 1: Document change log

Version	Change	Date	Affected portion
0.1	Initial draft	Sept 24, 2018	All
1.0	Updated discussions of calibration and data processing.	November 02, 2018	2.6, 3,4,5,Appendicies A and B
1.1	Significant update, responding to cruise data peer review comments, updates to the structure of the raw and partially processed data products, and the addition of the section on calibrated data	April 19, 2019	All
1.2	Updated to respond to Mars calibrated data peer review – lots of fairly minor edits	June 20, 2018	All
1.3	Additional peer review comment corrections; Reformatted sample labels	September 19, 2019	2.6.3, 4.4.3, 5.1.2, Appendix B, added section 4.5.8 Versions in file names

1.2 TBD Items

Table 2 lists items that are not yet finalized.

Table 2: List of TBD items

Item	Section(s)	Page(s)

1.3 Abbreviations

Table 3: Abbreviations and their meanings

Abbreviation	Meaning
AOBT	APSS Onboard Time
APSS	Auxiliary Payload Sensor Suite
ASCII	American Standard Code for Information Interchange
CNES	Centre National d'Etudes Spatiales
CODMAC	Committee on Data Management, Archiving, and Computing

Abbreviation	**Meaning**
EDR	Experiment Data Record
FEI	File Exchange Interface
FIR	Finite Impulse Response (filter)
FSW	Flight Software
GB	Gigabyte(s)
GEO	PDS Geosciences Node (Washington University, St. Louis, Missouri)
HP^3	Heat-Flow and Physical Properties Probe
ICC	Instrument Context Camera
ICD	Interface Control Document
IDA	Instrument Deployment Arm
IDC	Instrument Deployment Camera
IDS	Instrument Deployment System
IFG	Insight Fluxgate Magnetometer
IGPP	Institute of Geophysics and Planetary Physics
IOC	IFG Operation Center
IM	Information Model
ISO	International Standards Organization
JPL	Jet Propulsion Laboratory (Pasadena, CA)
LID	Logical Identifier
LIDVID	Versioned Logical Identifier
MB	Megabyte(s)
MD5	Message-Digest Algorithm 5
NAIF	Navigation and Ancillary Information Facility (JPL)
NASA	National Aeronautics and Space Administration
NSSDCA	National Space Science Data Coordinated Archive (GSFC)
PAE	Payload Ancillary Electronics
PDS	Planetary Data System
PDS4	Planetary Data System Version 4
RAD	Radiometer
RISE	Rotation and Interior Structure Experiment

Abbreviation	Meaning
SCLK	Spacecraft Clock
SEED	Standard for the Exchange of Earthquake Data
SEIS	Seismic Experiment for Investigating the Subsurface
SIS	Software Interface Specification
SISMOC	SEIS on Mars Operation Center
SP	Short Period
TBD	To Be Determined
TWINS	Temperature and Wind for InSight Subsystem
UCLA	University of California, Los Angeles
URN	Uniform Resource Name
UTC	Universal Time Coordinated
VBB	Very Broad Band
WU	Washington University in St. Louis
XML	eXtensible Markup Language

1.4 Glossary

Many of these definitions are taken from Appendix A of the PDS4 Concepts Document, pds.nasa.gov/pds4/doc/concepts. The reader is referred to that document for more information.

Archive – A place in which public records or historical documents are preserved; also the material preserved – often used in plural. The term may be capitalized when referring to all of PDS holdings – the PDS Archive.

Basic Product – The simplest product in PDS4; one or more data objects (and their description objects), which constitute (typically) a single observation, document, etc. The only PDS4 products that are *not* basic products are collection and bundle products.

Bundle Product – A list of related collections. For example, a bundle could list a collection of raw data obtained by an experiment during its mission lifetime, a collection of the calibration products associated with the experiment, and a collection of all documentation relevant to the first two collections.

Class – The set of attributes (including a name and identifier) which describes an item defined in the PDS Information Model. A class is generic – a template from which individual items may be constructed.

Collection Product – A list of closely related basic products of a single type (e.g. observational data, browse, documents, etc.). A collection is itself a product (because it is simply a list, with its label), but it is not a *basic* product.

Data Object – A generic term for an object that is described by a description object. Data objects include both digital and non-digital objects.

Description Object – An object that describes another object. As appropriate, it will have structural and descriptive components. In PDS4 a 'description object' is a digital object – a string of bits with a predefined structure.

Digital Object – An object which consists of real electronically stored (digital) data.

Identifier – A unique character string by which a product, object, or other entity may be identified and located. Identifiers can be global, in which case they are unique across all of PDS (and its federation partners). A local identifier must be unique within a label.

Label – The aggregation of one or more description objects such that the aggregation describes a single PDS product. In the PDS4 implementation, labels are constructed using XML.

Logical Identifier (**LID**) – An identifier which identifies the set of all versions of a product.

Versioned Logical Identifier (LIDVID) – The concatenation of a logical identifier with a version identifier, providing a unique identifier for each version of product.

Manifest - A list of contents.

Metadata – Data about data – for example, a 'description object' contains information (metadata) about an 'object.'

Object – A single instance of a class defined in the PDS Information Model.

PDS Information Model – The set of rules governing the structure and content of PDS metadata. While the Information Model (IM) has been implemented in XML for PDS4, the model itself is implementation independent.

Product – One or more tagged objects (digital, non-digital, or both) grouped together and having a single PDS-unique identifier. In the PDS4 implementation, the descriptions are combined into a single XML label. Although it may be possible to locate individual objects within PDS (and to find specific bit strings within digital objects), PDS4 defines 'products' to be the smallest granular unit of addressable data within its complete holdings.

Tagged Object – An entity categorized by the PDS Information Model, and described by a PDS label.

Registry – A data base that provides services for sharing content and metadata.

Repository – A place, room, or container where something is deposited or stored (often for safety).

XML – eXtensible Markup Language.

XML schema – The definition of an XML document, specifying required and optional XML elements, their order, and parent-child relationships.

2 Overview

2.1 Purpose and Scope

The purpose of this SIS (Software Interface Specification) document is to provide users of the IFG archive with a detailed description of the data products and how they are generated, along with a description of the PDS4 archive bundle, the structure in which the data products, documentation, and supporting material are stored. The users for whom this document is intended are the scientists who will analyze the data, including those associated with the project and those in the general planetary science community.

This SIS covers raw, quick-look, and calibrated data products generated by IFG that are archived in the Planetary Data System (PDS). In particular, these products consist of the science measurements downlinked from the IFG instrument that have been time-tagged and formatted into ASCII text tables with detached XML labels in a PDS4-compatible format.

The **IFG_Calibration_Description** document describes the details of the IFG calibration process, and the creation of the files that used during the data processing. This SIS document focuses on the data processing pipeline and the content and structure of the archive files. The calibration description document discusses the issues with the raw data and the methods by which some of them have been corrected, and describes several issues that currently remain uncorrected in the data.

2.2 SIS Contents

This SIS describes how the IFG instrument acquires data, and how the data are processed, formatted, labeled, and uniquely identified. The document discusses standards used in generating the data products and software that may be used to access the products. The data structure and organization are described in sufficient detail to enable a user to read and understand the data.

Appendices include a description of the file naming conventions used in the SEIS archive, and a list of cognizant persons involved in generating the archive.

2.3 Applicable Documents

[1] Planetary Data System Standards Reference, Version 1.11.0, October 1, 2018.

[2] Planetary Science Data Dictionary Document, Version 1.11.0.0, September 23, 2018.

[3] Planetary Data System (PDS) PDS4 Information Model Specification, Version 1.11.0.0, September 23, 2018.

[4] Data Providers' Handbook: Archiving Guide to the PDS4 Data Standards, Version 1.11.0, October 1, 2018.

[5] IFG Data Calibration Description, S. P. Joy, C. T. Russell, C. Johnson, April, 2019.

[6] PPI PDS4 Best Practice, J. N. Mafi, T. A. King, June, 2019.

[7] InSight Archive Generation, Validation, and Transfer Plan, Version 1.1, April 30, 2014.

[8] Banfield, D., Rodriguez-Manfredi, J.A., Russell, C.T. et al. Space Sci Rev (2019) 215: 4. https://doi.org/10.1007/s11214-018-0570-x

The PDS4 Documents [1] through [3] are subject to revision. The most recent versions may be found at pds.nasa.gov/pds4. The IFG PDS4 products specified in this SIS have been designed based on the versions current at the time, which are those listed above.

2.4 Audience

This document serves both as a Data Product SIS and an Archive SIS. It describes the format and content of IFG data products in detail, and the structure and content of the archive in which the data products, documentation, and supporting material are stored. This SIS is intended to be used both by the instrument teams in generating the archive, and by data users wishing to understand the format and content of the archive. Typically these individuals would include scientists, data analysts, and software engineers.

2.5 InSight Mission

InSight was launched on May 5, 2018 and placed a single geophysical lander on Mars on November 26, 2018, to study its deep interior. The Surface Phase consists of Deployment and Penetration, and Science Monitoring. It ends after one Mars year plus 40 sols.

The science payload comprises two experiments: the Seismic Experiment for Investigating the Subsurface (SEIS) and the Heat-Flow and Physical Properties Probe (HP^3). In addition, the Rotation and Interior Structure Experiment (RISE) will use the spacecraft X-band communication system to provide precise measurements of planetary rotation. SEIS and HP^3 were placed on the surface with an Instrument Deployment System (IDS) comprising an Instrument Deployment Arm (IDA), Instrument Deployment Camera (IDC), and Instrument Context Camera (ICC). There are also several supporting experiments. The Auxiliary Payload Sensor Subsystem (APSS) includes the pressure sensor, the magnetometer (IFG), and Temperature and Wind for InSight (TWINS) sensors and collects environmental data in support of SEIS. These data will be used by SEIS to reduce and analyze their data. The radiometer (RAD) will be used by the HP^3 team to measure surface temperature and thermal properties to support their data analysis.

2.6 IFG Instrument Description

The Insight Fluxgate (IFG) Magnetometer [7] built by UCLA produces 3 axis, 24bit, 20 samples per second data stream to measure the DC magnetic fields of +/-20,000nT, with measurements better than 0.1nT/√Hz from 0.1 to 1Hz on the Science Deck on the Insight Lander. The data are typically low-pass filtered before transmitting to Earth. After initial deployment, full rate data are only returned during short time intervals of scientific interest that have been selected by the science team. Continuous data were originally planned to be returned at a rate of 0.2Hz along with an "estaZ" channel that serves as a proxy for the high frequency variability in the band between 0.1 and 10 Hz. At the end of the commissioning phase it was decided that when sufficient downlink bandwidth was available, continuous data would be downlinked at 2 Hz, with the ESTA channel modified accordingly. The magnetometer consists of three matched elements, the precision fluxgate sensor, the interconnecting harness (2.5 m), and the electronics board. The magnetometer system has only one operational mode, "ON." Upon power application, the electronics synchronizes with the system clock, then provides continuous output data streams. No commanding is necessary.

The sensor is mounted on the bottom side, outside of the Insight Lander on the Science Deck, and the interconnecting harness is connected the sensor to the electronics. The connectors are labeled as J (male) and P (female) in Figure 1. The electronics fit inside the Auxiliary Payload Sensor System (APSS) and connect to the Payload Auxiliary Electronics (PAE), which provides power, timing, and collects the data.

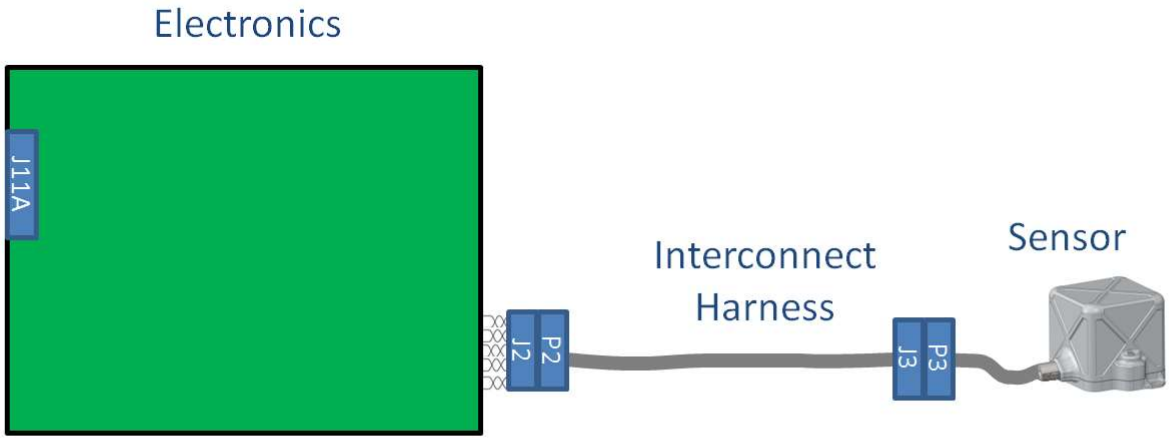

Figure 1: Overall block diagram of UCLA Magnetometer

2.6.1 Science Objectives

The prime scientific objective of the InSight mission is to determine the internal structure of Mars and its seismic activity. To guard against and possibly remove extraneous signals that are not associated with seismic sources, the InSight lander measures environmental conditions including magnetic signals in the passband of the seismometer. These magnetic signals can arise on the spacecraft and in the Mars ionosphere. During the pre-launch checkout period, the magnetometer on the InSight lander was tested in the laboratory to verify that it could detect signals expected from the Mars' ionosphere and determine what DC and AC magnetic fields may arise from the spacecraft. Based on these test data, the team expects to be able to distinguish the natural and spacecraft-associated DC and AC signals after landing successfully on the Martian surface.

Mars has a weak planetary magnetic field that is concentrated in magnetic "anomalies," crustal regions that became magnetized eons ago when Mars possessed an internal geomagnetic dynamo (Acuna et al., 1999, DOI: 10.1126/science.284.5415.790). The InSight landing site is in a region that satellite data show to be magnetized, albeit much less strongly than the southern highlands. Analysis of time variations in the magnetic field, specifically in the external field and the internal magnetic response to these might provide information on the interior electrical conductivity structure of Mars, including the core size. To calculate the magnetic field impressed on the ionosphere requires measurements in the solar wind or in the ionosphere with a spacecraft instrumented with plasma and field instruments such as those of MAVEN. At higher frequencies, the magnetometer might detect atmospheric phenomena at Mars, such as the transient electric currents associated with lightning and possibly electric currents associated with dust devils.

2.6.2 Calibration

This section describes the conversion of raw telemetry data number (DN) values into values in physical units (nT, ºC, V, etc.). The result of these various operations is a set of new numbers that are in physical units. After this conversion, the magnetic field vectors are still in a raw state in sensor axes coordinates. However, they are formatted properly for a true calibration that removes spacecraft fields, applies gain factors, and orthogonalizes the field components. After orthogonalization, the field vectors can be rotated into spacecraft and geophysical coordinates.

There is a dependency in the magnetometer data calibration on the temperature of the IFG electronics as well as on the sensor temperature.

Mag Temperature: This is the sensor head temperature. Calibration:

(1) st (ºC) = $9*10^{-5} * \mathbf{X}^2 - 0.576 * \mathbf{X} + 803.43$ where X is the raw value in DN

Electronics Temperature: This is the proximity electronics temperature, which affects the calibration. Calibration of this temperature:

(2) et (ºC) = $1/-7.3 * \mathbf{X} + 333.5$ where **X** is the raw value in DN

Mag X (called Mag Ch1 in Figure 2):

(3) MagX(nT) = ETGx(et)*STGx(st)***X**/145.6 + ETOx(et) + STOx(st)

where:

- **X** is the raw value of ch1 in DN
- STGx(st) = $1E{-}06*st^2 + 0.0004*st + 0.9916$, a function of the sensor temperature (st ºC).
- STOx(st) = $0.0002*st^2 - 0.0904*st + 1.2953$, also a function of the sensor temperature.
- ETGx(et) = $3E{-}07*et^2 - 7E{-}05*et + 1.0017$, a function of the electronics temperature (et ºC).
- ETOx(et) = $-0.0002*et^2 + 0.0073*et + 1.8809$, also a function of the electronics temperature.

Mag Y (called IFG_2 in Tables 11-13):

(4) MagY (nT) = ETGy(et)*STGy(st)***X**/141.4 + ETOy(et) + STOy(st)

where:

- **X** is the raw value of ch2 in DN
- $STGy(st) = 7E\text{-}07 * st^2 + 0.0003 * st + 0.991$, a function of the sensor temperature.
- $STOy(st) = -0.0003 * st^2 - 0.0073 * st + 1.75$, also a function of the sensor temperature.
- $ETGy(et) = 4E\text{-}07 * et^2 - 6E\text{-}05 * et + 1.0016$, a function of the electronics temperature.
- $ETOy(et) = 0.0005 * et^2 - 0.0275 * et - 0.1188$, also a function of the electronics temperature.

Mag Z (called IFG_3 in Tables 11-13):

(5) MagZ (nT) = ETGz(et)*STGz(st)***X**/141.7 + ETOz(et) + STOz(st)

where:

- **X** is the raw value of ch3 in DN
- $STGz(st) = 8E\text{-}07 * st^2 + 0.0002 * st + 0.9948$, a function of the sensor temperature.
- $STOz(st) = -0.0008 * st^2 - 0.1203 * st + 5.1656$, also a function of the sensor temperature.
- $ETGz(et) = 4E\text{-}07 * et^2 - 6E\text{-}05 * et + 1.0013$, a function of the electronics temperature.
- $ETOz(et) = 0.0009 * et^2 - 0.1085 * et - 3.0463$, also a function of the electronics temperature.

IFG calibration depends on both the electronics and sensor head temperature (st). The latter is a regular science channel in the PAE packet and in the output from the interface FSW, but the IFG electronics temperature (et) is only reported in an engineering packet at the start of a packet processing session, or nominally three times/day. Thus the electronics temperature data available will not be of very good resolution. However, the sensitivities of the scale factors to ET are very slight: the Z-axis is the most effected by temperature, and it varies by about 0.017% over the range -30C - +50C. In order to mitigate against the loss of the IFG sampled electronics temperature, the PAE temperature of the electronics housing box (PAE T-0014) is used as a proxy for the actual IFG electronics temperature. The actual data samples for PAE T-0014 are provided in the spacecraft engineering and ancillary data files that are included with the archive. The use of this proxy should further reduce the impact of the loss of the high-rate IFG electronics temperature measurements.

2.6.3 Magnetometer Zero Levels

Magnetometer zero levels were determined during ground testing after spacecraft integration is two separate tests using different methodology. The spacecraft field was measured by using a “swing” test (Nov. 2015) and a “gradiometer” test (Oct. 2017). In the swing test, the spacecraft was suspended on a cable and swung over a magnetometer that was placed beneath the swinging spacecraft. In the gradiometer test, many magnetometers were placed around the spacecraft at different distances and the field was measured. In both tests, fields that fell off with increasing distance from the spacecraft are attributed to the spacecraft. Both of these tests yielded similar but slightly different estimates of the spacecraft field. The swing test provides field estimates of (564, -515, 71) nT and the gradiometer test gave (534, -353, -18) nT. The average of the values from these two tests (549, -434, 26.5) nT in spacecraft coordinates is subtracted from the data.

2.6.4 Sample Timing

Upon power application, the IFG synchronizes with the system clock, and then provides continuous output data transmitted as vectors at the output cadence rate 20Hz. Each vector consists of a block of twelve bytes sent consecutively without a gap, other than the start bit at the beginning of each byte and stop bit at the end of each byte. The IFG team put considerable effort into accurately determining the precise timing offset of the magnetic field vector relative to the APSS Onboard Time (AOBT) time stamp but individual tests yielded different results. Eventually this effort was abandoned. The maximum timing offset observed in the tests conducted was less than 2ms, and this value should be considered the upper limit on the timing error. Since there is no clear determination of the time delays introduced internal to the IFG data processing, no timing adjustments are applied to the 20Hz data during routine data processing. Vectors are assigned Coordinated Universal Time (UTC) time values by converting the AOBT clock counts to SCLK values by using the AOBT_SCLK file that tabulates the offset between these two clocks. The relative drift rate between the two clock files is used to compute the offset AOBT-SCLK offset between samples. Once computed, the SCLK value is then converted to UTC using standard SPICE time conversion functions. Originally it was anticipated that the time conversion could be performed using the time correlation tool (TCT) provided by SEIS on Mars Operations Center (SISMOC). Unfortunately the IFG team was not able to incorporate this tool into their data processing pipeline.

In routine operations, the spacecraft does not return magnetic fields vectors at the full 20Hz rate. Data are filtered by using one or more Finite Impulse Response (FIR) filters prior to down sampling the data to lower rates (10, 5, 4, 2, 0.5, and 0.2 Hz). Normally, only the 0.2Hz data are returned and these data are then analyzed to determine intervals when higher time resolution (usually 20 Hz or 2 Hz) data are required for detailed event analysis. Each FIR filter applied introduces a time delay in the output data. The delay associated with a given filter depends on the input data cadence (rate) and the number of coefficients (N) in filter applied. The FIR filter delay can be computed using equation 6.

(6) Delay (sec) = rate (sec) * (N+1)/2

There are three different FIR filters that can be applied to the data: div2, div4, and div5 which are used when down sampling the data by factors of two, four, or five respectively. Each filter has a different number of coefficients as shown in Table 4.

Table 4:Number of coefficients for each FIR filter

Filter Name	Coefficients	Comment
div2	121	Reduce cadence by a factor of two
div4	221	Reduce cadence by a factor of four
div5	241	Reduce cadence by a factor of five

On InSight, FIR filters are applied sequentially to the IFG data prior to down sampling the data with each filter contributing to the total time delay in the resulting data samples. In order to create the standard 0.2 Hz data, three filter steps are required. Initially, the data are reduced from the 20Hz cadence to the 4 Hz cadence after applying the “div5” filter that has 241 coefficients and the time delay introduced into resulting data is 6.05 seconds. Next, 1 Hz data are created from the 4 Hz data, by applying the “div4” filter. This process adds another 27.75 seconds of time delay to the 1Hz data. Finally, the “div5” filter is applied again before down sampling the 1Hz data to generate the 0.2 Hz data and this process introduces a further 121 seconds of time delay. Since the filters are applied successively, the delays introduced are cumulative. Table 5 summarizes the total time delay corrections applied to each of the different output cadences.

Table 5: Time Delay Correction in IFG data

Rate	Delay (seconds)	Comment
20 Hz	0	No time correction applied.
10 Hz	3.05	Correction required for div2 filter applied to 20Hz input.
5 Hz	5.55	Correction required for div4 filter applied to 20Hz input.
4 Hz	6.05	Correction required for div5 filter applied to 20Hz input.
2 Hz	21.30	Sum of div5 and div2 corrections when applied successively.
1 Hz	33.80	Sum of div5 and div4 corrections when applied successively.
0.5 Hz	94.80	Sum of div5, div4, div2 corrections when applied successively.
0.2 Hz	154.8	Sum of div5, div4, div5 corrections when applied successively.
0.01 Hz	6915	Filter delay introduced into IFG temperature data

Timing corrections are applied only to the UTC times associated with each IFG vector. The AOBT clock values assigned to each vector are unchanged from the values returned by the spacecraft.

The IFG sensor temperature data are filtered to an even lower data rate (0.01 Hz) and these data have very long filter delay time offsets.

3 IFG Data Products

3.1 Data Product Overview

The IFG data are organized by data processing level and include raw, partially processed, and calibrated magnetic field vectors. In addition, the spacecraft engineering and housekeeping data are included with the archive since some of these items might be used in the identification and removal of spacecraft magnetic interference during the calibration process.

3.2 Data Processing

This section describes the processing of IFG data products, their structure and organization, and their labeling.

3.2.1 Data Processing Levels

Data processing levels mentioned in this SIS refer to PDS4 processing levels. Table 6 provides a description of these levels along with the equivalent designations used in other systems.

Table 6: Data processing level definitions

PDS4 processing level	PDS4 processing level description	CODMAC Level (used in PDS3)	NASA Level (used in PDS3)
Raw	Original data from an experiment. If compression, reformatting, packetization, or other translation has been applied to facilitate data transmission or storage, those processes are reversed so that the archived data are in a PDS approved archive format. Often call EDRs (Experimental Data Records).	2	0
Partially Processed	Data that have been processed beyond the raw stage but which have not yet reached calibrated status. Some spacecraft or instrumental artifacts remain in the data.	3	1A
Calibrated	Data converted to physical units, which makes values independent of the experiment.	3	1B
Derived	Results that have been distilled from one or more calibrated data products (for example, maps, gravity or magnetic fields, or ring particle size distributions). Supplementary data, such as calibration tables or tables of viewing geometry, used to interpret observational data should also be classified as 'derived' data if not easily matched to one of the other three categories.	4+	2+

IFG data products described in this SIS are raw, partially calibrated, and calibrated. If any derived data products are created, they will be described in another SIS document or this document will be revised to include their description.

3.2.2 Data Product Generation

The IFG Operation Center at UCLA (IOC) has developed a data processing pipeline that reads in the raw ASCII, comma separated value (CSV) files that contain channelized data from the TWINS and IFG instruments and outputs raw and partially calibrated ASCII tables of magnetic field vectors.

3.2.3 Data Flow

Raw data are retrieved from the InSight File Exchange Interface (FEI) data storage system. The IFG and TWINS data are stored in the “twins_ops” folder of the FEI system. In addition, the raw APSS ancillary data are downloaded from the “seis_ancillary_data_gds_report” FEI folder. The ancillary data are likely to provide a window into the underlying state of the spacecraft that can be used in the identification and removal of spacecraft sources during the calibration process.

3.2.3.1 Ancillary Data

The ancillary data are tabulated first. Values from the various ancillary data channels are returned at different rates. The software that extracts these data initializes the output data structure setting all channels to the missing data value which is -1. As the software reads the raw data, it collects values of the various channels in the output data array until the spacecraft clock value updates. At this point it writes out a row of data in the output file. Channels that have not yet been populated with a spacecraft value retain the missing data value. Channel values are repeated in the output data file until a new value is received.

3.2.3.2 Raw Data

The first step is to read in the raw data extracted from FEI, and then reconstruct the magnetic field vectors from the channelized axes and sensor temperature data. The AOBT time tag associated with each channel record is used for this reconstruction. Once the data are again organized as a time-series of field vectors, the AOBT time tag is converted to UTC using the method previously described in section 2.6.4 (Sample Timing). The UTC time tag is then corrected for the FIR filter delays (2.6.4). As described in the section on IFG calibration, the conversion of the raw data to nanoTesla requires both sensor and electronics temperatures for every sample. The sensor temperature is included in the IFG data stream every 100 seconds. These data are linearly interpolated between samples to provide the required value for each sample. However, because of the very long FIR filter delay, the first sample is not available for several hours following the instrument power on or a PAE reset. During these time periods, a Mars local time model of the sensor temperature is used as a proxy for the required data. This model and its computation are described in detail in the IFG calibration document [5]. The IFG electronics temperature is only available a few times per day at the start of each spacecraft data processing session. These data are too sparse to be used directly for the instrument calibration. Fortunately, there is a temperature sensor affixed to the side of the PAE electronics box and its data are available more frequently, although not continuously. This sensor value is contained in the spacecraft engineering and ancillary data in channel T-0014. Data from this channel are fit with a running 3rd order polynomial and the polynomial fit values are used in the data calibration process. Again, this is described in much greater detail in the calibration document [5].

In addition, the raw IFG data have been found to be well correlated with the low frequency, diurnal variations in the fixed (E-0771, E-0791) and total (E-0772, E-0792) solar array currents are provided in the spacecraft engineering and ancillary data in channels listed. Unfortunately, these data are not provided continuously, nor at sufficient time resolution to be used directly in the decorrelation process. Mars local time dependent models of these current systems have been developed. These current systems also vary in UTC time, as additional systems were powered on, dust covered and uncovered the solar arrays, etc. The model values of the currents from these sources are included in the raw data file so that they can be used in the data processing pipeline. The detail of how these models are derived are included in the calibration document [5].

3.2.3.3 Partially Processed Data

The term partially processed data is intentionally vague in the PDS data dictionary so that it can be used to describe many different data sets with differing degrees of data processing. The term is used here to mean data that have been processed into physical units (nT) and that have been processed so as to remove as much of the low frequency variations in the data as possible that can be directly attributed to variations of temperature or current systems on the spacecraft. The primary purpose of the IFG is to provide a data set to the SEIS team that can be used to decorrelate the high frequency seismic signals from any high frequency variations in the local magnetic field. All high frequency variations remain in this dataset. In addition, it is anticipated that the high frequency fluctuations attributable to spacecraft sources, such as currents associated with heater cycling, will be most readily identifiable in the mechanical reference frame of the spacecraft while the IFG instrument frame is ideal for identifying instrumental artifacts. Accordingly, this dataset is provided in these two frames.

The first step in processing is to convert from engineering units to nanoTesla using the equations in section 2.6.2 (Calibration) using the temperature values that have been included in the raw data files. The next step is to subtract the spacecraft field. The average of the values from these two tests (549, -434, 26.5) nT in spacecraft coordinates is subtracted from the data. However, in order to make this correction properly, the spacecraft field values must first be transformed back into sensor coordinates. This requires both the sensor axes orthogonalization and the IFG to spacecraft frame transformation matrices. As built, the three axes of the sensor are not quite orthogonal. The orthogonalization matrix was determined during ground testing in 2014.

$$\text{Orthogonalization Matrix} \quad \begin{bmatrix} 0.9999338 & -0.0083392 & -0.0028278 \\ 0.0122568 & 0.9999740 & 0.0015478 \\ 0.0009358 & -0.0001125 & 0.9999976 \end{bmatrix}$$

After the axes data are orthogonal, the data can be rotated into spacecraft coordinates by applying a 57.9° rotation about axis 3 (z).

Sensor to Spacecraft Rotation Matrix $$\begin{bmatrix} \cos(57.9) & \sin(57.9) & 0 \\ -\sin(57.9) & \cos(57.9) & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

The actual mounting of the IFG sensor has several sources of uncertainty that are not considered in the transformation from sensor to spacecraft coordinates. The major source of uncertainty is how flush the deck inserts are with the S/C deck and is estimated to be ±0.10 degrees. This estimate is based on +0.005/-0.000 inch insert height uncertainty above the deck, and a 2.76" span between mounting bolts. Other contributing factors to the mounting uncertainty are insert orthogonality to the deck, and the S/C coordinate-defining fiducials with relation to the deck. These errors are expected to be less than ± 0.05° for the former and less than ±0.001° for the latter**. Errors associated with the landed spacecraft attitude (~1°) will be much larger than any of the sensor mounting or orthogonality errors.**

In practice, additional corrections are applied in the IFG frame before that data are transformed into spacecraft coordinates. Even after the IFG temperature corrections have been applied, there are large, low frequency variations in the field that are highly correlated with the temperatures, and with the various solar array currents. Data are initially processed to this level and then they are decorrelated with the temperatures and currents by using a linear least squares fitting process. The thermal characterization of the IFG is best at sensor temperatures above about -50 to -75 degrees Celsius and the solar array currents are not present after sundown. From these facts, we attempt to normalize the IFG data to the mean value observed at MLST = 20:00. This is generally a quiet time in the data. We found that the mean field over several weeks in December 2018 in IFG coordinates was (-1645, -500, -1045) nT. These values are subtracted from the data and then the residuals (dB_i) are fit as a linear function of the temperatures and solar array currents of the form:

$$dB_i = C_{0,i} + C_{1,i} * ST + C_{2,i} * ET + C_{3,i} * FSAC + C_{4,i} * TSAC$$

where the C are the constants determined by the fit, ST and ET are the sensor and electronics temperatures in the °C respectively, and FSAC and TSAC are the fixed and total solar array currents in Amps respectively. During the spacecraft commissioning, the spacecraft environment was changing frequently. We found that a set of coefficients could be used for only a few days to weeks. We are hopeful that the frequency at which new fits and models of the current systems used in the fitting process will decrease once commissioning is complete. In theory, after that time there should only be seasonal changes and those attributable to dust on the solar arrays. This process is described in much greater detail in the calibration document [5] and a table of the fit coefficients versus time is included in the IFG document collection.

After the offsets and fit field variations are removed from the data the IFG frame, the data are rotated into the spacecraft frame using the matrix provided above. Partially processed data are archived in sensor and spacecraft coordinates. Data are provided in ASCII tables with PDS4 labels. Partially processed data retain all of the high frequency spacecraft and environmental magnetic field sources that are observed by the IFG instrument. These data are likely to be most useful to the SEIS team for decorrelating the seismic data with fluctuations in the local magnetic field.

Cruise data are not processed beyond the partially processed level. No attempt will be made to remove the substantial residual spacecraft signatures from the cruise data, nor will they be provided in geophysically meaningful coordinates. Cruise data are acquired with the spacecraft stowed in the aeroshell that is discarded before deployment and magnetic sources associated with this transport device are not relevant to the main mission.

3.2.3.4 Calibrated Data

The calibrated dataset is derived from the partially processed dataset. These data differ from the partially processed data in that the team has attempted to identify and remove various high frequency artifacts that are found in the data, and the data are provided in a geophysical reference frame (lander local vertical, local horizontal = INSIGHT_LL) in addition to the spacecraft mechanical frame.

At the time of this writing, four types of high frequency interferences had been identified in the low resolution (0.2 Hz) filtered dataset. These include:

1. Single point data spikes in a single sensor, typically on the order of 3-5 nT;
2. Nearly square steps up down (3-10 nT) occurring simultaneously in multiple axes and returning to the baseline value in 10 – 50 minutes;
3. Nearly square steps up down (3-10 nT) occurring simultaneously in multiple axes and returning to the baseline value in 10 – 30 minutes, but with high frequency oscillations near the onset, termination, or both edges of the step;
4. Irregular steps and oscillations in all three axes, but largest and longest in the vertical component, that occur every day, sometime between 11:00 and 12:30 MLST and typically lasting for 30-50 minutes.

In addition, the high time resolution data show high frequency square wave variations that have a rapid onset and slow decay in amplitude that occurs in the morning hours (onset near 09:00 MLST) and lasting for several hours. We expect that as additional data are acquired and the team has had more time for analysis, that other interference types will be identified, and some of the existing types may be split into different types.

A data quality flag (dqf) is included in the calibrated data that gives the user information about which types of interference are present, and what, if anything has been done to correct the problem. This flag is a string of digits between zero and 5 where the location (offset) in the string defines the interference type and the value at that location indicates whether or not any action has been taken.

The dqf values for data quality are:

0. Good sample, no issue found
1. Issue identified and fully corrected in any/all components
2. Issue identified and partially corrected in all components
3. Issue identified and partially corrected in at least one component
4. Issue identified, no action taken
5. Sample not evaluated for data quality

The dqf values for data sources are:

0 Data value
1 Fit to available data values to fill in coverage gaps
2 Model – insufficient data reliably fill in gaps by fitting

Determining sources of spacecraft magnetic interference and techniques for their removal is expected to be a lengthy process, much longer than the time allowed for the initial archive deliveries. In order to meet the required schedule, data will be released with the best available calibration at the time of the first archive delivery. As the calibration is improved over time, data from the entire landed mission will be reprocessed and released with the updated calibration. This is likely to occur about once each year. Details of the interference removal process are **TBD** at this time. The output of the interference removal process is a calibrated data set provided as ASCII data tables and PDS4 labels.

3.3 Standards Used in Generating Data Products

IFG products and labels comply with Planetary Data System standards, including the PDS4 data model, as specified in applicable documents [1], [2] and [3].

3.3.1 Time Standards

The IFG data are time stamped with AOBT, UTC, and to Local Mean Solar Time (LMST). For the FIR filtered and down-sampled data, the UTC values are corrected for the filter delays as described in section 2.6.4. The corrected UTC values are then used to compute the LMST values assigned to each sample using SPICE. The AOBT values will be the uncorrected times assigned by the instrument.

3.3.2 Coordinate Systems

The IFG data are provided in multiple reference frames, depending on the data processing level. The raw data are provided in the non-orthogonal frame of the individual axes of the sensor. The partially processed data takes the raw data and applies the orthogonalization matrix to get the data into the IFG frame (SPICE name is INSIGHT_APSS_MAG). In addition, the partially processed data are rotated into the spacecraft mechanical frame (INSIGHT_LANDER). The calibrated data are provided in the spacecraft frame and in the landed local vertical, local horizontal coordinate system (INSIGHT_LL). In this frame, +Z points along local gravity vector, +X points towards local north, and +Y points towards local east. The transformation from the INSIGHT_LANDER frame to the INSIGHT_LL is assumed to be static and will be unless the landed spacecraft settles or shifts on the surface after landing. The transformation matrix between the two frames was computed using the WebGeocalc (https://wgc.jpl.nasa.gov:8443/webgeocalc/#NewCalculation) provided by the SPICE team using the following parameters:

Input time: 2019-02-28T00:00:00.000 UTC
Light propagation: None
Kernels input by manual selection:

INSIGHT/kernels/ck/insight_surf_ops_v1.bc
INSIGHT/kernels/fk/insight_v05.tf
INSIGHT/kernels/lsk/naif0012.tls
INSIGHT/kernels/sclk/NSY_SCLKSCET.00012.tsc
INSIGHT/kernels/spk/de430s.bsp
INSIGHT/kernels/spk/insight_ls_ops181206_iau2000_v1.bsp
INSIGHT/kernels/spk/mar097s.bsp
INSIGHT/kernels/fk/insight_tp_ops181206_iau2000_v1.tf

Which gives the resulting matrix:

0.99886589; -0.00622313; 0.04720395;
0.00862136; 0.99867298; -0.05077360;
-0.04682533; 0.05112297; 0.99759402.

3.3.3 Data Storage Conventions

All IFG archive data will be described in the PDS4 metadata as fixed column width ASCII tables with a one-line header that provides the column names.

3.4 Applicable Software

No software is provided with these data.

3.5 Backups and duplicates

The PPI Node of the PDS keeps two copies of each archive product. One copy is the primary online archive copy, another is a backup copy. Once the archive products are fully validated and approved for inclusion in the archive, a third copy of the archive is sent to the National Space Science Data Coordinated Archive (NSSDCA) for long-term preservation in a NASA-approved deep-storage facility. PPI may maintain additional copies of the archive products, either on or off-site as deemed necessary.

4 IFG Archive Organization, Identifiers and Naming Conventions

This section describes the basic organization of the IFG data archives under the PDS4 Information Model (IM) (Applicable Documents [1] and [3]), including the naming conventions used for the bundle, collection, and product unique identifiers.

4.1 Bundles

The highest level of organization for a PDS archive is the bundle. A bundle is a set of one or more related collections which may be of different types. A collection is a set of one or more related basic products which are all of the same type. Bundles and collections are logical structures, not necessarily tied to any physical directory structure or organization.

The InSight IFG archive is currently organized into two bundles (Cruise and Mars) as described in Table 7. The Cruise bundle contains raw and partially calibrated data. The Mars bundle will contain a calibrated data collection in addition to the two cruise data collections. If the IFG team determines that additional data collections are useful (derived data, etc.), these may either be added to the Mars bundle or a new bundle could be defined.

Table 7: IFG Bundles

Bundle Logical Identifier	PDS4 Processing Level	Description
urn:nasa:pds:insight-ifg-cruise	Raw, Partially Processed	IFG Cruise Bundle
urn:nasa:pds:insight-ifg-mars	Raw, Partially Processed, Calibrated	IFG Mars Bundle

4.2 Collections

Collections consist of basic products all of the same type. The IFG Bundles contain the collections listed in Table 8. The collections are described in section 4.5.

Table 8: Collections in the IFG Bundles

Collection Logical Identifier	Collection Type	Description
urn:nasa:pds:insight-ifg-cruise:document urn:nasa:pds:insight-ifg-mars:document	Document	Contains electronic documents including this SIS. Other documents that may be of interest to the user may be added later. Many of the documents in these collections will be secondary products, not physically stored with the data in the bundle(s).

urn:nasa:pds:insight-ifg-cruise:browse urn:nasa:pds:insight-ifg-mars:browse	Browse	Contains PNG plots of the IFG data for quick-look purposes
urn:nasa:pds:insight-ifg-cruise:data-sc-engineering urn:nasa:pds:insight-ifg-mars:data- sc-engineering	Ancillary Data	Spacecraft engineering and housekeeping data in fixed-width ASCII table format.
urn:nasa:pds:insight-ifg-cruise:data-ifg-raw urn:nasa:pds:insight-ifg-mars:data-ifg-raw	Raw Data	Raw data files in fixed-width ASCII table format.
urn:nasa:pds:insight-ifg-cruise:data-partially-processed urn:nasa:pds:insight-ifg-mars:data-partially-processed	Partially Processed Data	Partially processed data files in fixed-width ASCII table format.
urn:nasa:pds:insight-ifg-mars:data-ifg-calibrated	Calibrated Data	Calibrated data files in fixed-width ASCII table format.

4.3 Products

A PDS product consists of one or more digital objects and an accompanying PDS label file. PDS labels provide identification and description information for labeled objects. The PDS label includes a Logical Identifier (LID) by which any PDS labeled product is uniquely identified throughout all PDS archives. PDS4 labels are XML-formatted ASCII files.

4.4 Logical Identifiers

Every product in PDS is assigned an identifier which allows it to be uniquely identified across the system. This identifier is referred to as a Logical Identifier or LID. A LIDVID (Versioned Logical Identifier) includes product version information, and allows different versions of a specific product to be referenced uniquely. A product's LID and VID are defined as separate attributes in the product label. LIDs and VIDs are assigned by PDS and are formed according to the conventions described in sections 4.4.2 and 4.4.3 below. The uniqueness of a product's LIDVID may be verified using the PDS Registry and Harvest tools. More information on LIDs and VIDs may be found in section 6d of the PDS Standards Reference [1] and in chapter 5 of the Data Providers' Handbook [4].

4.4.1 File Naming Conventions

For nominal science operations, a single file is created per sol for each data rate returned. Usually this will be just the 0.2 Hz rate data. However, higher rate data (1, 2, 4, 10, or 20 Hz) from selected time intervals will occasionally be returned when downlink resources and science priorities permit.

The filename convention for IFG data is

ifg_level_SOLssss_startdatetime_stopdatetime_rate_vers.tab, where:

- ifg is literal and indicates that the data are from the IFG instrument;

- level is the data processing level and can be one of raw, pcal, or cal;

- SOL is literal

- ssss is the SOL number

- startdatetime is the Earth UTC start date and time of the data file in the format YYYYMMDDThhmmss where “YYYY” is the 4 digit year, “MM” is the month, “DD” is the day, ”T” is literal and is used to separate date and time, “hh” is the hour of day, “mm” is the minute of hour, and “ss” is the second of minute;

- stopdatetime is the Earth UTC stop date and time of the data file in the same format as the startdatetime field;

- rate is the IFG data rate and may be one of pt2Hz, 1Hz, 2Hz, 4Hz, 10Hz, or 20Hz;

- vers is the IFG file version number (v01 – v99)

- “.tab” is literal and denotes that the data are stored in an ASCII table.

Note: The file naming convention for IFG browse data follows the convention for the data files except that the file extension is “.png” rather than “.tab”. The start/stop date/times are those of the plots rather than the data. The plots typically extend a bit beyond the data in both directions.

The filename convention for spacecraft engineering data is

ancil_SOLssss_startdatetime_stopdatetime_vers.tab, where:

- “ancil” is literal and identifies that data as ancillary;

- SOL is literal

- ssss is the SOL number

- startdatetime is the Earth UTC start date and time of the data file in the format YYYYDDDThhmmss where “YYYY” is the 4 digit year, “DDD” is the day of year where Jan 01 = 001, ”T” is literal and is used to separate date and time, “hh” is the hour of day, “mm” is the minute of hour, and “ss” is the second of minute;

- stopdatetime is the Earth UTC stop date and time of the data file in the same format as the startdatetime field;

- vers is the IFG file version number (v01 – v99)

- “.tab” is literal and denotes that the data are stored in an ASCII table.

4.4.2 LID Formation

LIDs take the form of a Uniform Resource Name (URN). LIDs are restricted to ASCII lower case letters, digits, dash, underscore, and period. Colons are also used, but only to separate prescribed components of the LID. Within one of these prescribed components dash, underscore, or period are used as separators. LIDs are limited in length to 255 characters.

InSight IFG LIDs are formed according to the following conventions:

- Bundle LIDs are formed by appending a bundle specific ID to the PDS base ID:

  urn:nasa:pds:<bundle ID>

  Example: urn:nasa:pds:insight-ifg-mars

  The bundle ID must be unique across all bundles archived with the PDS.

- Collection LIDs are formed by appending a collection specific ID to the collection's parent bundle LID:

  urn:nasa:pds:<bundle ID>:<collection ID>

  Example: urn:nasa:pds:insight-ifg-mars:data-ifg-raw

  Since the collection LID is based on the bundle LID, which is unique across PDS, the only additional condition is that the collection ID must be unique across the bundle. Collection IDs correspond to the collection type (e.g. "browse", "data", "document", etc.). Additional descriptive information may be appended to the collection type (e.g. "data-ifg-raw", "data-ifg-calibrated", etc.) to insure that multiple collections of the same type within a single bundle have unique LIDs.

- Basic product LIDs are formed by appending a product-specific ID to the product's parent collection LID:

  urn:nasa:pds:<bundle ID>:<collection ID>:<product ID>

  Example: urn:nasa:pds:insight-ifg-cruise:data-ifg-raw: ifg-raw-sol0054-20190120t174229-20190121t182158-pt2hz-v01

  Since the product LID is based on the collection LID, which is unique across PDS, the only additional condition is that the product ID must be unique across the collection. For IFG data products, the product LID is nearly the same as the data file name without the extension. The changes are that the underscores and "dot" in the file name have been converted to dashes and the uppercase "SOL", "T" and "H" in the SOL, time and rate elements have been replaced with lowercase "sol", "t" or "h". Uppercase letters are not allowed in the PDS4 LID and the underscores are replaced with dashes in order to conform to the PDS-PPI "best practices" for LID formation. See section 4.5 below for examples of IFG data product LIDs.

4.4.3 VID Formation

Product Version IDs consist of major and minor components separated by a "." (M.n). Both components of the VID are integer values. The major component is initialized to a value of "1", and the minor component is initialized to a value of "0". The minor component resets to "0" when the major component is incremented. The first time a file (basic product) is publicly released, it has version 1.0. Updates to the metadata associated with a product causes a minor version update (v1.1). Updates to the data (document, etc.) that are described by the metadata cause the major element of the version number to increment, resetting the minor version (2.0). PDS collections follow similar versioning rules. If members are added to a collection, such as a new data release in an active mission, the minor component of the version is incremented. However, if the structure/content of the collection members changes (i.e. redelivery of previously released products), then the major version is updated. The PDS Standards Reference [1] specifies rules for incrementing major and minor components.

4.5 Data Collections

4.5.1 IFG Raw Data Collections

The IFG raw data, regardless of the sample rate, are included in the raw data collection. Data are separated into data files by date and sample rate. The data file granularity is one file per SOL.

4.5.2 IFG Partially Processed Data Collections

The IFG partially processed data are directly linked to the raw data. This collection contains one file for each raw data file.

4.5.3 IFG Calibrated Data Collection

The IFG calibrated data are also directly linked to the raw data. This collection contains one file for each raw data file in the Mars bundle. This collection is not included in the IFG cruise data bundle.

4.5.4 Ancillary Data Collections

The ancillary data collection contains spacecraft engineering and housekeeping data files. Ancillary data files are only provided when IFG science data are being acquired.

4.5.5 IFG Browse Collections

PNG plots are provided for each of the partially processed (cruise bundle) or calibrated (Mars bundle) data files. These plots are included in a browse data collection. Each plot file is described by a PDS label that identifies the primary data file used to create the plot.

4.5.6 IFG Document Collections

The IFG documents will be physically included in the document collection of the Mars data bundle and remotely referenced in the document collection of the cruise data bundle. Using the PDS4 terminology, these documents will be primary members of the document collection in the Mars bundle and secondary members in the document collection for the cruise bundle. In PDS4, only a single version of a document is allowed, but the document can be remotely referenced any number of times. Documents from the InSight document bundle (an archive of documents that apply to multiple experiments, such as those that describe the mission and spacecraft) will also be remotely referenced as secondary members of the IFG document collections.

4.5.7 Other Collections

Many PDS4 bundles contain a variety of other collections such as “schema” or “context” that are not normally included on bundles at the PPI Node of the PDS. These archives are built according to the best practices of the PPI Node

4.5.8 Versions in File Names

PDS assigns a version to each product in the archive as discussed in Section 4.5.3 VID Formation. However, the version number that the IFG team assigns to the files that are provided internally and then archived reflects the version of the data processing pipeline used to create the data. MAG and spacecraft engineering data have separated data processing pipelines. The latter hasn’t changed and is, and likely always be, version v01. The MAG data processing pipeline has gone through several versions which are described below.

4.5.8.1 MAG pipeline version v01

Initial version, mostly used to process cruise data and data shortly after landing. This version assumed that AOBT=SCLK for UTC time conversion. In addition, since sensor and electronics temperature values were sparse or unavailable, models of these temperature variations were developed and used for calibration.

4.5.8.2 MAG pipeline version v02

UTC time tags correctly computed by properly accounting for the AOBT drift relative to SCLK. Removal of the diurnal variations in the data correlated with solar array fixed and total currents was added. Models of temperature and current variations were replaced by polynomial fits to these values in order to track temporal variations in the MLST signatures.

4.5.8.3 MAG pipeline version v03

An error in the time tag associated with the MAG sensor temperature values was discovered and corrected. This error most strongly affected data acquired between about 06:30 and 09:30 MLST when the temperature was rising quickly.

4.5.8.4 MAG pipeline version v04

An initial version of a data spike and square-wave step removal process was added to the calibration procedure of the 0.2 Hz data in spacecraft coordinates. These features remain in the partially processed data. The difference between the values of (Bx_SC, By_SC, and Bz_SC) in the calibrated versus partially processed data is the correction that has been applied.

5 IFG Data Product Formats

Data that comprise the IFG data archive are formatted in accordance with PDS specifications (see Applicable Documents [1], [2] and [3]. This section provides details on the formats used for each of the products included in the archive.

5.1 Data Product Formats

The following sections describe the structures of the various IFG data files.

5.1.1 Raw Data File Structures

The IFG raw data files contain the IFG data returned from the spacecraft as data numbers, organized as a set of time-tagged and time-ordered data. The filtered and down-sampled data have three more columns (estaZ, IFGT_DN, SensorT) than the full 20Hz data. The structure of the raw data files are given in Tables 9 and 10.

Table 9: IFG Raw 20 Hz Data File Structure

Column Name	Type	Units	Start Byte	Bytes	Description
SCET_UTC	ASCII_ Date_ Time_ YMD	N/A	1	23	Sample S/C event time UTC in YYYY-MM-DDThh:mm:ss.sss format
AOBT	ASCII_ Real	N/A	25	14	PPS onboard time (AOBT) value of sample. This is the spacecraft clock time used by the APSS instruments.
frequency	ASCII_ Real	Hz	40	8	IFG sample frequency (Hz) – column headings in the data tables use "freq" to fit in the allowed space
conf	ASCII_ Integer	N/A	49	4	Configuration table number used to define onboard processing including IFG down-sampling rate and the computation of the estimated parameters.
off	ASCII_ Integer	N/A	54	4	Sample offset within the downlink packet (samples 1 - 1024).
IFG1_DN	ASCII_ Integer	N/A	59	8	IFG axis 1 value in data numbers.
IFG2_DN	ASCII_ Integer	N/A	68	8	IFG axis 2 value in data numbers.
IFG3_DN	ASCII_ Integer	N/A	77	8	IFG axis 3 value in data numbers.
MLST	ASCII_ Real	hours	86	8	Mars local time represented as decimal hours (0 - 24)
HR_Angle	ASCII_ Real	deg	95	8	Solar hour angle in degrees (0-360) with 0 at noon and 90 at dusk.

Column Name	Type	Units	Start Byte	Bytes	Description
modelET	ASCII_ Real	deg	104	8	The actual IFG electronics temperature (ET) is only available a few times per SOL. Since a value is required for every IFG vector for calibration purposes, a spline fit to the PAE temperature T-0014 is used as a proxy. T-0014 is sometimes available every minute or so, but is only infrequently returned at night. The observed values of T-0014 are spline fit to produce data set that is sampled at 5 minute resolution or better and then the values between those samples are derived by linear interpolation. This value is given in units of degrees Celsius.
modelST	ASCII_ Real	deg	113	8	Since the value of the actual IFG sensor temperature is not available in the high rate data, a model value of the sensor temperature derived from low rate data [deg C] is used for the calibration.
modelSA	ASCII_ Real	A	122	8	MLST and UTC dependent model of the fixed solar array current [A] derived from the values of the E-0771 from selected time intervals. Actual data values are sparsely sampled.
ModSACT	ASCII_ Real	A	131	8	MLST and UTC dependent model of the solar array current [A] total (SACT) derived from the sum of E-0772 and E-0772 from selected time intervals. Actual data values are sparsely sampled.

Table 10: IFG Raw Down-sampled Data (0.2, 2.0, and 10 Hz) File Structure

Column Name	Type	Units	Start Byte	Bytes	Description
SCET_UTC	ASCII_ Date_ Time_ YMD	N/A	1	23	Sample S/C event time UTC in YYYY-MM-DDThh:mm:ss.sss format
AOBT	ASCII_ Real	N/A	25	14	PPS onboard time (AOBT) value of sample. This is the spacecraft clock time used by the APSS instruments.
frequency	ASCII_ Real	Hz	40	8	IFG sample frequency (Hz)
conf	ASCII_ Integer	N/A	49	4	Configuration table number used to define onboard processing including IFG down-sampling rate and the computation of the estimated parameters.
off	ASCII_ Integer	N/A	54	4	Sample offset within the downlink packet (samples 1 - 1024).
IFG1_DN	ASCII_ Integer	N/A	59	8	IFG axis 1 value in data numbers.
IFG2_DN	ASCII_ Integer	N/A	68	8	IFG axis 2 value in data numbers.
IFG3_DN	ASCII_ Integer	N/A	77	8	IFG axis 3 value in data numbers.

Column Name	**Type**	**Units**	**Start Byte**	**Bytes**	**Description**
estaZ	ASCII_ Integer	N/A	86	8	Estimated IFG parameter. The meaning of this value depends on the configuration table used. In the projection configuration the value is the sum of constants (1, 2, 3) times the corresponding IFG axes values. In the norm configuration, the value is the square-root of the sum of constants (1, 2, 3) times the square of the corresponding IFG axes values.
IFGT_DN	ASCII_ Integer	N/A	95	8	IFG sensor temperature value in data numbers.
MLST	ASCII_ Real	hours	104	8	Mars local time represented as decimal hours (0 - 24)
HR_Angle	ASCII_ Real	Deg	113	8	Solar hour angle in degrees (0-360) with 0 at noon and 90 at dusk.
SensorT	ASCII_ Real	Deg C	122	8	IFG sensor temperature [deg C] computed from the value of IFGT_DN in order to provide a comparison with the model sensor temperature.
ModelET	ASCII_ Real	Deg C	131	8	The actual IFG electronics temperature (ET) is only available a few times per SOL. Since a value is required for every IFG vector for calibration purposes, a spline fit to the PAE temperature T-0014 is used as a proxy. T-0014 is sometimes available every minute or so, but is only infrequently returned at night. The observed values of T-0014 are spline fit to produce data set that is sampled at 5 minute resolution or better and then the values between those samples are derived by linear interpolation. This value is given in units of degrees Celsius.
ModelST	ASCII_ Real	Deg C	140	8	Value of the actual IFG sensor temperature [SensorT] when available, otherwise a MLST and UTC dependent model of the IFG sensor temperature [deg C] derived from the measured values from selected time intervals is provided. The FIR filter applied to the temperature data is longer than the one applied to the MAG data so there is a roughly two hour gap in the temperature data whenever the IFG powers on (i.e. following a spacecraft safing or PAE reset). The value in this column is used for the MAG calibration since it is available for all samples.
ModelSA	ASCII_ Real	A	149	8	MLST and UTC dependent model of the fixed solar array current [A] derived from the values of the E-0771 from selected time intervals.
ModSACT	ASCII_ Real	A	158	8	MLST and UTC dependent model of the solar array current [A] total (SACT) derived from the sum of E-0772 and E-0772 from selected time intervals.

5.1.2 Partially Processed Data File Structure

The IFG partially processed data files contain the IFG data returned from the spacecraft with the temperature dependent gains and offsets applied and the estimated zero levels removed. Once the individual axes data are converted to nanoTesla, they are orthogonalized (sensor coordinates) and rotated into spacecraft coordinates.

Table 11: IFG Partially Processed Down-sampled Data (0.2 Hz) File Structure (Cruise)

Column Name	Type	Units	Start Byte	Bytes	Description
SCET_UTC	ASCII_ Date_ Time_ YMD	N/A	1	23	Sample S/C event time UTC in YYYY-MM-DDThh:mm:ss.sss format
AOBT	ASCII_ Real	N/A	26	14	APSS onboard time (AOBT) value of sample. This is the spacecraft clock time used by the APSS instruments.
IFG_1	ASCII_ Real	nT	41	9	IFG axis 1 data in nT with offsets and MLST variations subtracted
IFG_2	ASCII_ Real	nT	51	9	IFG axis 2 data in nT with offsets and MLST variations subtracted
IFG_3	ASCII_ Real	nT	61	9	IFG axis 3 data in nT with offsets and MLST variations subtracted
Bx_SC	ASCII_ Real	nT	71	9	B field component in the spacecraft coordinate X direction in nT.
By_SC	ASCII_ Real	nT	81	9	B field component in the spacecraft coordinate Y direction in nT.
Bz_SC	ASCII_ Real	nT	91	9	B field component in the spacecraft coordinate Z direction in nT.
|B|	ASCII_ Real	nT	101	9	Field magnitude equals sqrt($Bx^2 + By^2 + Bz^2$)
SenTemp	ASCII_ Real	Deg C	111	9	Measured sensor temperature in degrees C
estElcTmp	ASCII_ Real	Deg C	121	9	Estimated electronics temperature in degrees C

Table 12: IFG Partially Processed High Resolution (20Hz) Data File Structure (Mars)

Column Name	Type	Units	Start Byte	Bytes	Description
SCET_UTC	ASCII_ Date_ Time_ YMD	N/A	1	23	Sample S/C event time UTC in YYYY-MM-DDThh:mm:ss.sss format
AOBT	ASCII_ Real	N/A	26	14	APSS onboard time (AOBT) value of sample. This is the spacecraft clock time used by the APSS instruments.
IFG_1	ASCII_ Real	nT	41	9	IFG axis 1 data in nT with offsets and MLST variations subtracted
IFG_2	ASCII_ Real	nT	51	9	IFG axis 2 data in nT with offsets and MLST variations subtracted
IFG_3	ASCII_ Real	nT	61	9	IFG axis 3 data in nT with offsets and MLST variations subtracted
Bx_SC	ASCII_ Real	nT	71	9	Spacecraft mechanical coordinate system Bx component in nT. This frame is called the INSIGHT Lander Frame in SPICE and is described in the insight_v02.tf file as: FRAME_INSIGHT_LANDER = -189001, FRAME_-189001_NAME = INSIGHT_LANDER.
By_SC	ASCII_ Real	nT	81	9	Spacecraft mechanical coordinate system By component in nT
Bz_SC	ASCII_ Real	nT	91	9	Spacecraft mechanical coordinate system Bz component in nT
MLST	ASCII_ Real	hours	101	9	Mars local time represented as decimal hours (0 - 24)
HR_Angle	ASCII_ Real	deg	111	9	Solar hour angle in degrees (0-360) with 0 at noon and 90 at dusk.
modelET	ASCII_ Real	Deg C	121	9	The actual IFG electronics temperature (ET) is only available a few times per SOL. Since a value is required for every IFG vector for calibration purposes, a spline fit to the PAE temperature T-0014 is used as a proxy. T-0014 is sometimes available every minute or so, but is only infrequently returned at night. The observed values of T-0014 are spline fit to produce data set that is sampled at 5 minute resolution or better and then the values between those samples are derived by linear interpolation. This value is given in units of degrees Celsius. See the IFG calibration document for additional details.
modelST	ASCII_ Real	Deg C	131	9	Since the value of the actual IFG sensor temperature is not available in the high rate data, a model value of the sensor temperature derived from low rate data [deg C] is used for the calibration.
modelSA	ASCII_ Real	A	141	9	MLST and UTC dependent model of the fixed solar array current [A] derived from the values of the E-0771 from selected time intervals. Actual data values are sparsely sampled.
ModSACT	ASCII_ Real	A	151	9	MLST and UTC dependent model of the solar array current [A] total (SACT) derived from the sum of E-0772 and E-0772 from selected time intervals. See the IFG calibration document for additional details.

Table 13: IFG Partially Processed Down-sampled Data (0.2, 2, 10 Hz) File Structure (Mars)

Column Name	Type	Units	Start Byte	Bytes	Description
SCET_UTC	ASCII_Date_Time_YMD	N/A	1	23	Sample S/C event time UTC in YYYY-MM-DDThh:mm:ss.sss format
AOBT	ASCII_Real	N/A	26	14	APSS onboard time (AOBT) value of sample. This is the spacecraft clock time used by the APSS instruments.
IFG_1	ASCII_Real	nT	41	9	IFG axis 1 data in nT with offsets and MLST variations subtracted
IFG_2	ASCII_Real	nT	51	9	IFG axis 2 data in nT with offsets and MLST variations subtracted
IFG_3	ASCII_Real	nT	61	9	IFG axis 3 data in nT with offsets and MLST variations subtracted
Bx_SC	ASCII_Real	nT	71	9	Spacecraft mechanical coordinate system Bx component in nT. This frame is called the INSIGHT Lander Frame in SPICE and is described in the insight_v02.tf file as: FRAME_INSIGHT_LANDER = -189001, FRAME_-189001_NAME = INSIGHT_LANDER.
By_SC	ASCII_Real	nT	81	9	Spacecraft mechanical coordinate system By component in nT
Bz_SC	ASCII_Real	nT	91	9	Spacecraft mechanical coordinate system Bz component in nT
MLST	ASCII_Real	hours	101	9	Mars local time represented as decimal hours (0 - 24)
HR_Angle	ASCII_Real	deg	111	9	Solar hour angle in degrees (0-360) with 0 at noon and 90 at dusk.
modelET	ASCII_Real	Deg C	131	9	The actual IFG electronics temperature (ET) is only available a few times per SOL. Since a value is required for every IFG vector for calibration purposes, a spline fit to the PAE temperature T-0014 is used as a proxy. T-0014 is sometimes available every minute or so, but is only infrequently returned at night. The observed values of T-0014 are spline fit to produce data set that is sampled at 5 minute resolution or better and then the values between those samples are derived by linear interpolation. This value is given in units of degrees Celsius. See the IFG calibration document for additional details.
modelST	ASCII_Real	Deg C	121	9	Value of the actual IFG sensor temperature [SensorT] when available, otherwise a MLST and UTC dependent model of the IFG sensor temperature [deg C] derived from the measured values from selected time intervals is provided. The FIR filter applied to the temperature data is longer than the one applied to the MAG data so there is a roughly two hour gap in the temperature data whenever the IFG powers on (i.e. following a spacecraft safing or PAE reset). The value in this column is used for the MAG calibration since it is available for all samples. See the IFG calibration document for additional details.

Column Name	Type	Units	Start Byte	Bytes	Description
modelSA	ASCII_ Real	A	141	9	MLST and UTC dependent model of the fixed solar array current [A] derived from the values of the E-0771 from selected time intervals. Actual data values are sparsely sampled.
ModSACT	ASCII_ Real	A	151	9	MLST and UTC dependent model of the solar array current [A] total (SACT) derived from the sum of E-0772 and E-0772 from selected time intervals. See the IFG calibration document for additional details.

Note, the Mars data do not have the same structure as the cruise data. After landing, it was determined that additional columns would need to be included to model spacecraft currents and instrument temperatures. Actual temperature data are not always available and the temperature is highly variable.

5.1.3 Calibrated Data File Structure

The IFG calibrated data files contain the best estimates of the actual field values at the surface of Mars. All identified sources of spacecraft interference have been removed to the best of the current ability of the IFG team. Each record contains a data quality flag that both indicates the IFG team assessment of the quality of that vector, a list of interference corrections applied to the data, and a list of interference signatures that remain but have yet to be characterized well enough to be removed from the data. The data are provided in units of nanoTesla in INSIGHT_LL coordinates (see section 3.3.2 for details). The structure of the calibrated data is given in Table 14.

Table 14: IFG Calibrated Data File Structure (for all data rates)

Column Name	Type	Units	Start Byte	Bytes	Description
SCET_UTC	ASCII_ Date_ Time_ YMD	N/A	1	23	Sample S/C event time UTC in YYYY-MM-DDThh:mm:ss.sss format
MLST	ASCII_ Real	N/A	25	9	Mars local time represented as decimal hours (0 - 24)
HR_Angle	ASCII_ Real	deg	35	9	Solar hour angle in degrees (0-360) with 0 at noon and 90 at dusk.
Bx_SC	ASCII_ Real	nT	45	9	B field component in the spacecraft X direction in nT.
By_SC	ASCII_ Real	nT	55	9	B field component in the spacecraft Y direction in nT.
Bz_SC	ASCII_ Real	nT	65	9	B field component in the spacecraft Z direction in nT.

Column Name	Type	Units	Start Byte	Bytes	Description
B_north	ASCII_ Real	nT	75	9	B_north (+X) field component [nT] in the Landed Local Vertical, Local Horizontal Coordinate System. In this frame, +Z points along local gravity vector, +X points towards local North, and +Y points east. This frame is called the INSIGHT_LL Frame in SPICE and is described in the insight_v02.tf file as: FRAME_INSIGHT_LL = -189003, FRAME_-189003_NAME = INSIGHT_LL.
B_east	ASCII_ Real	nT	85	9	The B_east (+Y) field component [nT] in the INSIGHT_LL frame.
B_down	ASCII_ Real	nT	95	9	The B_down (+Z) field component [nT] in the INSIGHT_LL frame.
dqf	ASCII_ String	N/A	105	14	Data quality flag – a string of 14 characters (numbers) that define the data quality and contamination associated with this field vector. In addition, some items describe the source of the temperature or current values used in the data processing. Starting from the right (least significant), an increasing one character for each item: 1. Overall data quality assessment 2. Source of sensor temperature data 3. Source of electronics temperature data 4. Source of fixed solar array current 5. Source of total solar array current 6. Not used at this time 7. Not used at this time 8. Single point data spike at least one component 9. Square wave step in one or more components 10. Square wave step in one or more components with fluctuations or the leading or trailing edge, or both 11. Irregular steps, ramps, and other structures occurring between 11 and 12.5 hours MLST 12. “33” hour steps in IFG1_DN beginning in April 2019 13. Not used at this time 14. Not used at this time Data Source values: 0 Data value 1 Fit to data value to fill in coverage gaps 2 Model Data Quality Values: 0. Good sample, no issue found 1. Issue identified and fully corrected in any/all components 2. Issue identified and partially corrected in all components 3. Issue identified and partially corrected in at least one component 4. Issue identified, no action taken 5. Sample not evaluated for data quality

5.1.4 Ancillary Data File Structure

Table 14 describes the structure and content of the spacecraft engineering and housekeeping data. These data are provided in physical units (amps, Volts, degrees Celsius, etc.). Individual channel values repeat until the next value is received. Values are set to -1 until the first value is received.

Table 15: Ancillary Data File Structure

Column Name	Type	Units	Start Byte	Bytes	Description
SCLK	ASCII_ Real	N/A	1	14	Spacecraft clock counter. The fractional portion of the SCLK value (0-255) are the 8 most significant bits of the 16 bit value (nominally 1/256 of a second).
SCET_UTC	ASCII_ Date_ Time_ DOY	N/A	16	21	Sample S/C event time UTC in YYYY-DDDThh:mm:ss.sss format
ERT_UTC	ASCII_ Date_ Time_ DOY	N/A	38	24	Sample Earth receive time UTC in YYYY-MM-DDThh:mm:ss.ssssss format
SOL/MLST	ASCII_ String	N/A	63	21	Sample SOL and Mars local solar time (SOL-xxxxMhh:mm:ss.sss)
E-0114	ASCII_ Real	Volts	85	8	PDDU AAC (analog acquisition card) AIV (analog input voltage) channel 14. Bus voltage monitor 1A signal.
E-0126	ASCII_ Real	Volts	94	8	PDDU AAC (analog acquisition card) AIV (analog input voltage) channel 26. Bus voltage monitor 2A signal.
E-0606	ASCII_ Real	amps	103	8	DDU AAC (analog acquisition card) OFC (off card) 00 channel 06. USM 1 (universal switch module 1) upstream switch DPC 0 (discrete power controller 0) current. Corresponds to C-0606
E-0607	ASCII_ Real	amps	112	8	DDU AAC (analog acquisition card) OFC (off card) 00 channel 07. USM 1 (universal switch module 1) upstream switch DPC 1 (discrete power controller 1) current. Corresponds to C-0607
E-0608	ASCII_ Real	amps	121	8	DDU AAC (analog acquisition card) OFC (off card) 00 channel 08. USM 1 (universal switch module 1) upstream switch DPC 2 (discrete power controller 2) current. Corresponds to C-0608 (USM1usD2Ccio)
E-0609	ASCII_ Real	amps	130	8	DDU AAC (analog acquisition card) OFC (off card) 00 channel 09. USM 1 (universal switch module 1) upstream switch DPC 3 (discrete power controller 3) current. Corresponds to C-0609
E-0610	ASCII_ Real	amps	139	8	DDU AAC (analog acquisition card) OFC (off card) 00 channel 10. USM 1 (universal switch module 1) upstream switch DPC 4 (discrete power controller 4) current. Corresponds to C-0610 (USM1usD4Ccio)

Column Name	Type	Units	Start Byte	Bytes	Description
E-0611	ASCII_ Real	amps	148	8	DDU AAC (analog acquisition card) OFC (off card) 00 channel 11. USM 1 (universal switch module 1) upstream switch DPC 5 (discrete power controller 5) current. Corresponds to C-0611 (USM1usD5Ccio)
E-0623	ASCII_ Real	amps	157	8	PDDU AAC (analog acquisition card) OFC (off card) 01 channel 03. USM 1 (universal switch module 1) upstream switch latching switch current. Corresponds to C-0623 (USM1usLTCcio).
E-0624	ASCII_ Real	amps	166	8	PDDU AAC (analog acquisition card) OFC (off card) 01 channel 04. USM 1 (universal switch module 1) upstream switch latching switch current. Corresponds to C-0624 (USM1usLCCcio).
E-0625	ASCII_ Real	amps	175	8	PDDU AAC (analog acquisition card) OFC (off card) 01 channel 05. USM 1 (universal switch module 1) upstream switch latching switch current. Corresponds to C-0625 (USM1usHCCcio).
E-0646	ASCII_ Real	amps	184	8	PDDU AAC (analog acquisition card) OFC (off card) 02 channel 06. USM 2 (universal switch module 2) upstream switch DPC 0 (discrete power controller 0) current. Corresponds to C-0646 (USM2usD0Ccio).
E-0647	ASCII_ Real	amps	193	8	PDDU AAC (analog acquisition card) OFC (off card) 02 channel 07. USM 2 (universal switch module 2) upstream switch DPC 1 (discrete power controller 1) current. Corresponds to C-0647 (USM2usD1Ccio).
E-0648	ASCII_ Real	amps	202	8	PDDU AAC (analog acquisition card) OFC (off card) 02 channel 08. USM 2 (universal switch module 2) upstream switch DPC 2 (discrete power controller 2) current. Corresponds to C-0648 (USM2usD2Ccio).
E-0649	ASCII_ Real	amps	211	8	PDDU AAC (analog acquisition card) OFC (off card) 02 channel 09. USM 2 (universal switch module 2) upstream switch DPC 3 (discrete power controller 3) current. Corresponds to C-0649 (USM2usD3Ccio).
E-0650	ASCII_ Real	amps	220	8	PDDU AAC (analog acquisition card) OFC (off card) 02 channel 10. USM 2 (universal switch module 2) upstream switch DPC 4 (discrete power controller 4) current. Corresponds to C-0650 (USM2usD4Ccio).
E-0651	ASCII_ Real	amps	229	8	PDDU AAC (analog acquisition card) OFC (off card) 02 channel 11. USM 2 (universal switch module 2) upstream switch DPC 5 (discrete power controller 5) current. Corresponds to C-0651 (USM2usD5Ccio).
E-0663	ASCII_ Real	amps	238	8	PDDU AAC (analog acquisition card) OFC (off card) 03 channel 03. USM 2 (universal switch module 2) upstream switch latching switch current. Corresponds to C-0663 (USM2usLTCcio).
E-0664	ASCII_ Real	amps	247	8	PDDU AAC (analog acquisition card) OFC (off card) 03 channel 04. USM 2 (universal switch module 2) upstream switch low current switch current. Corresponds to C-0664 (USM2usLCCcio).

Column Name	Type	Units	Start Byte	Bytes	Description
E-0665	ASCII_ Real	amps	256	8	PDDU AAC (analog acquisition card) OFC (off card) 03 channel 05. USM 2 (universal switch module 2) upstream switch high current switch current. Corresponds to C-0665 (USM2usHCCcio).
E-0686	ASCII_ Real	amps	265	8	PDDU AAC (analog acquisition card) OFC (off card) 04 channel 06. USM 3 (universal switch module 3) upstream switch DPC 0 (discrete power controller 0) current. Corresponds to C-0686 (USM2usD0Ccio).
E-0687	ASCII_ Real	amps	274	8	PDDU AAC (analog acquisition card) OFC (off card) 04 channel 07. USM 3 (universal switch module 3) upstream switch DPC 1 (discrete power controller 1) current. Corresponds to C-0687 (USM2usD1Ccio).
E-0688	ASCII_ Real	amps	283	8	PDDU AAC (analog acquisition card) OFC (off card) 04 channel 08. USM 3 (universal switch module 3) upstream switch DPC 2 (discrete power controller 2) current. Corresponds to C-0688 (USM2usD2Ccio).
E-0689	ASCII_ Real	amps	292	8	PDDU AAC (analog acquisition card) OFC (off card) 04 channel 09. USM 3 (universal switch module 3) upstream switch DPC 3 (discrete power controller 3) current. Corresponds to C-0689 (USM2usD3Ccio).
E-0690	ASCII_ Real	amps	301	8	PDDU AAC (analog acquisition card) OFC (off card) 04 channel 10. USM 3 (universal switch module 3) upstream switch DPC 4 (discrete power controller 4) current. Corresponds to C-0690 (USM2usD4Ccio).
E-0691	ASCII_ Real	amps	310	8	PDDU AAC (analog acquisition card) OFC (off card) 04 channel 11. USM 3 (universal switch module 3) upstream switch DPC 5 (discrete power controller 5) current. Corresponds to C-0691 (USM2usD5Ccio).
E-0703	ASCII_ Real	amps	319	8	PDDU AAC (analog acquisition card) OFC (off card) 05 channel 03. USM 3 (universal switch module 3) upstream switch latching switch current. Corresponds to C-0703 (USM3usLTCcio).
E-0704	ASCII_ Real	amps	328	8	PDDU AAC (analog acquisition card) OFC (off card) 05 channel 04. USM 3 (universal switch module 3) upstream switch low current switch current. Corresponds to C-0704 (USM3usLCCcio).
E-0705	ASCII_ Real	amps	337	8	PDDU AAC (analog acquisition card) OFC (off card) 05 channel 05. USM 3 (universal switch module 3) upstream switch high current switch current. Corresponds to C-0705 (USM3usHCCcio).
E-0726	ASCII_ Real	amps	346	8	PDDU AAC (analog acquisition card) OFC (off card) 06 channel 06. USM 4 (universal switch module 4) upstream switch DPC 0 (discrete power controller 0) current. Corresponds to C-0726 (USM4usD0Ccio).
E-0727	ASCII_ Real	amps	355	8	PDDU AAC (analog acquisition card) OFC (off card) 06 channel 07. USM 4 (universal switch module 4) upstream switch DPC 1 (discrete power controller 1) current. Corresponds to C-0727 (USM4usD1Ccio).

Column Name	Type	Units	Start Byte	Bytes	Description
E-0728	ASCII_ Real	amps	364	8	PDDU AAC (analog acquisition card) OFC (off card) 06 channel 08. USM 4 (universal switch module 4) upstream switch DPC 2 (discrete power controller 2) current. Corresponds to C-0728 (USM4usD2Ccio).
E-0729	ASCII_ Real	amps	373	8	PDDU AAC (analog acquisition card) OFC (off card) 06 channel 09. USM 4 (universal switch module 4) upstream switch DPC 3 (discrete power controller 3) current. Corresponds to C-0729 (USM4usD3Ccio).
E-0730	ASCII_ Real	amps	382	8	PDDU AAC (analog acquisition card) OFC (off card) 06 channel 10. USM 4 (universal switch module 4) upstream switch DPC 4 (discrete power controller 4) current. Corresponds to C-0730 (USM4usD4Ccio).
E-0731	ASCII_ Real	amps	391	8	PDDU AAC (analog acquisition card) OFC (off card) 06 channel 11. USM 4 (universal switch module 4) upstream switch DPC 5 (discrete power controller 5) current. Corresponds to C-0731 (USM4usD5Ccio).
E-0743	ASCII_ Real	amps	400	8	PDDU AAC (analog acquisition card) OFC (off card) 07 channel 03. USM 4 (universal switch module 4) upstream switch latching switch current. Corresponds to C-0743 (USM4usLTCcio).
E-0744	ASCII_ Real	amps	409	8	PDDU AAC (analog acquisition card) OFC (off card) 07 channel 04. USM 4 (universal switch module 4) upstream switch low switch current. Corresponds to C-0744 (USM4usLCCcio).
E-0745	ASCII_ Real	amps	418	8	PDDU AAC (analog acquisition card) OFC (off card) 07 channel 05. USM 4 (universal switch module 4) upstream switch high switch current. Corresponds to C-0745 (USM4usHCCcio).
E-0769	ASCII_ Real	Volts	427	8	PDDU AAC (analog acquisition card) OFC (off card) 08 channel 09. This channel is used for the SABC_1 VBATT signal. Corresponds to C-0769 (Sabc1VBAcio).
E-0770	ASCII_ Real	amps	436	8	PDDU AAC (analog acquisition card) OFC (off card) 08 channel 10. This channel is used for the SABC_1 IBATT signal. Corresponds to C-0770 (Sabc1IBAcio).
E-0771	ASCII_ Real	amps	445	8	PDDU AAC (analog acquisition card) OFC (off card) 08 channel 11. This channel is used for the SABC_1 solar array current signal. Corresponds to C-0771.
E-0772	ASCII_ Real	amps	454	8	PDDU AAC (analog acquisition card) OFC (off card) 08 channel 12. This channel is used for the SABC_1 solar array current signal.
E-0789	ASCII_ Real	Volts	463	8	PDDU AAC (analog acquisition card) OFC (off card) 09 channel 09. This channel is used for the SABC_2 VBATT signal. Corresponds to C-0789 (Sabc2VBAcio).
E-0790	ASCII_ Real	amps	472	8	PDDU AAC (analog acquisition card) OFC (off card) 09 channel 10. This channel is used for the SABC_2 IBATT signal. Corresponds to C-0790 (Sabc2IBAcio).
E-0791	ASCII_ Real	amps	481	8	PDDU AAC (analog acquisition card) OFC (off card) 09 channel 11. This channel is used for the SABC_2 solar array current signal. Corresponds to C-0791,

Column Name	Type	Units	Start Byte	Bytes	Description
E-0792	ASCII_ Real	amps	490	8	PDDU AAC (analog acquisition card) OFC (off card) 09 channel 12. This channel is used for the SABC_2 solar array current signal.
G-0036	ASCII_ Real	amps	499	8	Total Solar Array Current (ground computed channel).
G-1715	ASCII_ Real	N/A	508	8	The state of the telecom SDST 1 X band exciter (0=off, 1=on).
T-0003	ASCII_ Real	deg C	517	8	PDDU AAC (analog acquisition card) AIP (analog input passive) channel 03. Landed solar array -Y temperature 1.
T-0004	ASCII_ Real	deg C	526	8	PDDU AAC (analog acquisition card) AIP (analog input passive) channel 04. Landed solar array -Y temperature 1.
T-0007	ASCII_ Real	deg C	535	8	PDDU AAC (analog acquisition card) AIP (analog input passive) channel 07. SEIS Ebox temperature.
T-0009	ASCII_ Real	deg C	544	8	PDDU AAC (analog acquisition card) AIP (analog input passive) channel 09. SEIS sensor temperature 1.
T-0010	ASCII_ Real	deg C	553	8	PDDU AAC (analog acquisition card) AIP (analog input passive) channel 10. HP3 BEE temperature.
T-0014	ASCII_ Real	deg C	562	8	PDDU AAC (analog acquisition card) AIP (analog input passive) channel 14. PAE temperature.
T-0015	ASCII_ Real	deg C	571	8	PDDU AAC (analog acquisition card) AIP (analog input passive) channel 15. Science deck temperature.
T-0018	ASCII_ Real	deg C	580	8	PDDU AAC (analog acquisition card) AIP (analog input passive) channel 18. Landed solar array -Y temperature 2.
T-0019	ASCII_ Real	deg C	589	8	PDDU AAC (analog acquisition card) AIP (analog input passive) channel 19. Landed solar array +Y temperature 2.
T-0021	ASCII_ Real	deg C	598	8	PDDU AAC (analog acquisition card) AIP (analog input passive) channel 21. SEIS frangibolt 1 temperature. Corresponds to C-0021 (SeisFb1Tcio).
T-0022	ASCII_ Real	deg C	607	8	PDDU AAC (analog acquisition card) AIP (analog input passive) channel 22. TWINS +Y temperature.
T-0027	ASCII_ Real	deg C	616	8	PDDU AAC (analog acquisition card) AIP (analog input passive) channel 27. PEB temperature.
T-0036	ASCII_ Real	deg C	625	8	PDDU AAC (analog acquisition card) AIP (analog input passive) channel 36. 330 FT (fuel tank) fuel temperature 3. Corresponds to C-0036 (FT330F_T3cio).
T-0037	ASCII_ Real	deg C	634	8	PDDU AAC (analog acquisition card) AIP (analog input passive) channel 37. Descent REM lines temperature 5. Corresponds to C-0037 (DeRemL_T5cio).
T-0039	ASCII_ Real	deg C	643	8	PDDU AAC (analog acquisition card) AIP (analog input passive) channel 39. HP3 frangibolt 1 temperature. Corresponds to C-0039 (Hp3Fb1Tcio).
T-0042	ASCII_ Real	deg C	652	8	PDDU AAC (analog acquisition card) AIP (analog input passive) channel 42. SEIS TB frangibolt temperature. Corresponds to C-0042 (SeisTbFbTcio).
T-0045	ASCII_ Real	deg C	661	8	PDDU AAC (analog acquisition card) AIP (analog input passive) channel 45. MAG sensor temperature.

Column Name	Type	Units	Start Byte	Bytes	Description
T-0046	ASCII_ Real	deg C	670	8	PDDU AAC (analog acquisition card) AIP (analog input passive) channel 46. Pressure sensor electronics temperature.
T-0048	ASCII_ Real	deg C	679	8	PDDU AAC (analog acquisition card) AIP (analog input passive) channel 48. SEIS frangibolt 3 temperature. Corresponds to C-0048 (SeisFb3Tcio).
T-0049	ASCII_ Real	deg C	688	8	PDDU AAC (analog acquisition card) AIP (analog input passive) channel 49. HP3 frangibolt 2 temperature. Corresponds to C-0049 (Hp3Fb2Tcio).
T-0052	ASCII_ Real	deg C	697	8	PDDU AAC (analog acquisition card) AIP (analog input passive) channel 52. SSPA 3 internal temperature.
T-0202	ASCII_ Real	deg C	706	8	CDH AAC (analog acquisition card) AIP (analog input passive) channel 02. Thermal enclosure temperature 1.
T-0216	ASCII_ Real	deg C	715	8	CDH AAC (analog acquisition card) AIP (analog input passive) channel 16. Thermal enclosure temperature 2.
T-0229	ASCII_ Real	deg C	724	8	CDH AAC (analog acquisition card) AIP (analog input passive) channel 29. 150 FT (fuel tank) ullage temperature 1. Corresponds to C-0229 (FT150U_T1cio).
T-0230	ASCII_ Real	deg C	733	8	CDH AAC (analog acquisition card) AIP (analog input passive) channel 30. 330 FT (fuel tank) ullage temperature 1. Corresponds to C-0230 (FT330U_T1cio).
V-3518	ASCII_ Real	N/A	742	8	Indicates whether science processing is OK.
V-3531	ASCII_ Real	N/A	751	8	Indicates whether the spacecraft is in an active UHF session.
V-3644	ASCII_ Real	N/A	760	8	Written by IDA software and is available for use by IDA and interoperability sequences/blocks. Indicates the Cartesian Target X coordinate.
V-3645	ASCII_ Real	N/A	769	8	Written by IDA software and is available for use by IDA and interoperability sequences/blocks. Indicates the Cartesian Target Y coordinate.
V-3646	ASCII_ Real	N/A	778	8	Written by IDA software and is available for use by IDA and interoperability sequences/blocks. Indicates the Cartesian Target Z coordinate.

5.2 Document Product Formats

Documents in this archive are provided as PDF/A (www.pdfa.org/download/pdfa-in-a-nutshell) or as plain ASCII text if no special formatting is required. Figures that accompany documents are embedded in the PDF/A.

5.3 PDS Labels

Each IFG product is accompanied by a PDS4 label. PDS4 labels are ASCII text files written in the eXtensible Markup Language (XML). Product labels are detached from the files they describe (with the exception of the Product_Bundle label). There is one label for every product. A PDS4 label file usually has the same name as the data product it describes, but always with the extension ".xml".

Documents are also considered products, and have PDS4 labels just as basic observational data products do. For the InSight mission, the structure and content of PDS labels will conform to the PDS master schema and schematron based upon the PDS Information Model [3]. By use of an XML editor the schema and schematron may be used to validate the structure and content of the product labels. In brief, the schema is the XML model that PDS4 labels must follow, and the schematron is a set of validation rules that are applied to PDS4 labels.

The PDS master schema and schematron documents are produced, managed, and supplied to InSight by the PDS. In addition to these documents, the InSight mission has produced additional XML schema and schematron files which govern the products in this archive. These documents contain attribute and parameter definitions specific to the InSight mission.

Appendix A Support Staff and Cognizant Persons

Table 16: Archive Support Staff

IFG Team		
Name	**Affiliation**	**Email**
Christopher Russell	UCLA – IFG principal investigator	ctrussell@igpp.ucla.edu
Steven Joy	UCLA – programmer/archivist	sjoy@igpp.ucla.edu
PDS Planetary Plasma Interactions Node		
Name	**Affiliation**	**Email**
Raymond Walker, manager	UCLA	rwalker@igpp.ucla.edu
Joseph Mafi	UCLA	jmafi@igpp.ucla.edu

Appendix B Example Data Product Labels

This section provides examples of product labels for the various data types described in this document. The content of actual IFG data product labels may vary from these examples.

PDS4 Label for an IFG Raw 20Hz Mars Data Product

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-model href="https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1B00.sch"
   schematypens="http://purl.oclc.org/dsdl/schematron"?>
<?xml-model
href="https://pds.nasa.gov/pds4/mission/insight/v1/PDS4_INSIGHT_1B00_1840.sch"
     schematypens="http://purl.oclc.org/dsdl/schematron"?>
<Product_Observational
   xmlns="http://pds.nasa.gov/pds4/pds/v1"
   xmlns:insight="http://pds.nasa.gov/pds4/mission/insight/v1"
   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
   xsi:schemaLocation="http://pds.nasa.gov/pds4/pds/v1
   https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1B00.xsd

   http://pds.nasa.gov/pds4/mission/insight/v1
   https://pds.nasa.gov/pds4/mission/insight/v1/PDS4_INSIGHT_1B00_1840.xsd">
  <Identification_Area>
    <logical_identifier>urn:nasa:pds:insight-ifg-mars:data-ifg-raw:ifg-raw-sol0019-
20181215t183410-20181216t191045-20hz-v01</logical_identifier>
    <version_id>1.0</version_id>
    <title>2018-12-15T18:34 to 2018-12-16T19:10 IFG Magnetometer Mars Raw High-Res
Data</title>
    <information_model_version>1.11.0.0</information_model_version>
    <product_class>Product_Observational</product_class>
    <Citation_Information>
      <author_list>Russell, C. T.; Joy, S. P.</author_list>
      <publication_year>2019</publication_year>
      <keyword>mag</keyword>
      <description>
        InSight high time resolution (20Hz) raw IFG magnetic field data
        acquired between 2018-12-15T18:34 and 2018-12-16T19:10 on the surface of Mars.
      </description>
    </Citation_Information>
    <Modification_History>
      <Modification_Detail>
        <modification_date>2019-04-16</modification_date>
        <version_id>1.0</version_id>
        <description>Initial Version</description>
      </Modification_Detail>
    </Modification_History>
  </Identification_Area>
```

```
  <Observation_Area>
    <Time_Coordinates>
      <start_date_time>2018-12-15T18:34:10Z</start_date_time>
      <stop_date_time>2018-12-16T19:10:45Z</stop_date_time>
    </Time_Coordinates>
    <Primary_Result_Summary>
      <purpose>Science</purpose>
      <processing_level>Raw</processing_level>
      <description>
        These are raw data from the IFG sensor axes in data numbers.
      </description>
      <Science_Facets>
        <discipline_name>Fields</discipline_name>
        <facet1>Magnetic</facet1>
        <facet2>Background</facet2>
      </Science_Facets>
    </Primary_Result_Summary>
    <Investigation_Area>
      <name>InSight</name>
      <type>Mission</type>
      <Internal_Reference>
        <lid_reference>urn:nasa:pds:context:investigation:mission.insight</lid_reference>
        <reference_type>data_to_investigation</reference_type>
      </Internal_Reference>
    </Investigation_Area>
    <Observing_System>
      <Observing_System_Component>
        <name>InSight</name>
        <type>Spacecraft</type>
        <Internal_Reference>

<lid_reference>urn:nasa:pds:context:instrument_host:spacecraft.insight</lid_reference>
          <reference_type>is_instrument_host</reference_type>
        </Internal_Reference>
      </Observing_System_Component>
      <Observing_System_Component>
        <name>InSight Fluxgate Magnetometer</name>
        <type>Instrument</type>
        <Internal_Reference>
          <lid_reference>urn:nasa:pds:context:instrument:apss-ifg.insight</lid_reference>
          <reference_type>is_instrument</reference_type>
        </Internal_Reference>
      </Observing_System_Component>
    </Observing_System>
    <Target_Identification>
      <name>Mars</name>
```

```
            <type>Planet</type>
            <Internal_Reference>
                <lid_reference>urn:nasa:pds:context:target:planet.mars</lid_reference>
                <reference_type>data_to_target</reference_type>
            </Internal_Reference>
        </Target_Identification>
        <Mission_Area>
            <insight:Observation_Information>
                <insight:release_number>0001</insight:release_number>
                <insight:mission_phase_name>SURFACE MISSION</insight:mission_phase_name>
                 <insight:sol_number>0001</insight:sol_number>
<insight:spacecraft_clock_start_count>598170839</insight:spacecraft_clock_start_count>

<insight:spacecraft_clock_stop_count>598259438</insight:spacecraft_clock_stop_count>

<insight:spacecraft_clock_count_partition>1</insight:spacecraft_clock_count_partition>
<insight:sol_number>0001</insight:sol_number>
            </insight:Observation_Information>
        </Mission_Area>
    </Observation_Area>
    <Reference_List>
        <Internal_Reference>
            <lid_reference>urn:nasa:pds:insight_documents:document_mission</lid_reference>
            <reference_type>data_to_document</reference_type>
        </Internal_Reference>
        <Internal_Reference>
            <lid_reference>urn:nasa:pds:insight-ifg-mars:document:insight-ifg-sis</lid_reference>
            <reference_type>data_to_document</reference_type>
            <comment>
               This document describes the IFG data processing and the structure
               of the various data files in this archive.
            </comment>
        </Internal_Reference>
        <Internal_Reference>
            <lid_reference>urn:nasa:pds:insight-ifg-mars:data-sc-engineering:ancil-sol0019-
2018350t020049-2018351t024455-v01</lid_reference>
            <reference_type>data_to_associate</reference_type>
            <comment>Spacecraft engineering data acquired during the IFG data interval</comment>
        </Internal_Reference>
        <External_Reference>
            <doi>https://doi.org/10.1007/s11214-018-0570-x</doi>
            <reference_text>
                Banfield, D., Rodriguez-Manfredi, J.A., Russell, C.T. et al. Space Sci Rev (2019) 215:
4.
                https://doi.org/10.1007/s11214-018-0570-x
            </reference_text>
```

```xml
      <description>Published instrument paper</description>
    </External_Reference>
  </Reference_List>
  <File_Area_Observational>
    <File>
<file_name>ifg_raw_SOL0019_20181215T183410_20181216T191045_20Hz_v01.tab</file_name>
      <creation_date_time>2019-04-16</creation_date_time>
      <file_size unit="byte">142034060</file_size>
      <records>1014529</records>
      <md5_checksum>0aa9e89dc03551242403915690b6f0ee</md5_checksum>
    </File>
    <Header>
      <offset unit="byte">0</offset>
      <object_length unit="byte">131</object_length>
      <parsing_standard_id>PDS DSV 1</parsing_standard_id>
      <description>First row of the file contains column names</description>
    </Header>
    <Table_Character>
      <offset unit="byte">131</offset>
      <records>1014528</records>
      <record_delimiter>Carriage-Return Line-Feed</record_delimiter>
      <Record_Character>
        <fields>14</fields>
        <groups>0</groups>
        <record_length unit="byte">131</record_length>
        <Field_Character>
          <name>SCET_UTC</name>
          <field_number>1</field_number>
          <field_location unit="byte">1</field_location>
          <data_type>ASCII_Date_Time_YMD</data_type>
          <field_length unit="byte">23</field_length>
          <description>Sample S/C event time UTC in YYYY-MM-DDThh:mm:ss.sss format</description>
        </Field_Character>
        <Field_Character>
          <name>AOBT</name>
          <field_number>2</field_number>
          <field_location unit="byte">25</field_location>
          <data_type>ASCII_Real</data_type>
          <field_length unit="byte">14</field_length>
          <field_format>%14.3f</field_format>
          <description>
            APSS onboard time (AOBT) value of sample. This is the spacecraft
            clock time used by the APSS instruments.
```

```
          </description>
        </Field_Character>
        <Field_Character>
          <name>frequency</name>
          <field_number>3</field_number>
          <field_location unit="byte">40</field_location>
          <data_type>ASCII_Real</data_type>
          <field_length unit="byte">8</field_length>
          <field_format>%8.5f</field_format>
          <unit>Hz</unit>
          <description>IFG sample frequency [Hz]</description>
        </Field_Character>
        <Field_Character>
          <name>conf</name>
          <field_number>4</field_number>
          <field_location unit="byte">49</field_location>
          <data_type>ASCII_Integer</data_type>
          <field_length unit="byte">4</field_length>
          <field_format>%4d</field_format>
          <description>
            Configuration table number used to define onboard
            processing including IFG down-sampling rate and the
            computation of the estimated parameters.
          </description>
        </Field_Character>
        <Field_Character>
          <name>off</name>
          <field_number>5</field_number>
          <field_location unit="byte">54</field_location>
          <data_type>ASCII_Integer</data_type>
          <field_length unit="byte">4</field_length>
          <field_format>%4d</field_format>
          <description>Sample offset within the downlink packet (samples 1 -
1024).</description>
        </Field_Character>
        <Field_Character>
          <name>IFG1_DN</name>
          <field_number>6</field_number>
          <field_location unit="byte">59</field_location>
          <data_type>ASCII_Integer</data_type>
          <field_length unit="byte">8</field_length>
          <field_format>%8d</field_format>
          <description>IFG axis 1 value in data numbers.</description>
        </Field_Character>
        <Field_Character>
          <name>IFG2_DN</name>
```

```
        <field_number>7</field_number>
        <field_location unit="byte">68</field_location>
        <data_type>ASCII_Integer</data_type>
        <field_length unit="byte">8</field_length>
        <field_format>%8d</field_format>
        <description>IFG axis 2 value in data numbers.</description>
      </Field_Character>
      <Field_Character>
        <name>IFG3_DN</name>
        <field_number>8</field_number>
        <field_location unit="byte">77</field_location>
        <data_type>ASCII_Integer</data_type>
        <field_length unit="byte">8</field_length>
        <field_format>%8d</field_format>
        <description>IFG axis 3 value in data numbers.</description>
      </Field_Character>
      <Field_Character>
        <name>MLST</name>
        <field_number>9</field_number>
        <field_location unit="byte">86</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">8</field_length>
        <field_format>%8.3f</field_format>
        <unit>Hour</unit>
            <description> Mars local time represented as decimal hours (0 -
24)</description>
      </Field_Character>
      <Field_Character>
        <name>HR_Angle</name>
        <field_number>10</field_number>
        <field_location unit="byte">95</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">8</field_length>
        <field_format>%8.3f</field_format>
        <unit>Degree</unit>
        <description>Solar hour angle in degrees (0-360)</description>
      </Field_Character>
      <Field_Character>
        <name>modelET</name>
        <field_number>11</field_number>
        <field_location unit="byte">104</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">8</field_length>
        <field_format>%8.3f</field_format>
        <unit>Degree</unit>
        <description>
```

```
      The actual IFG electronics temperature (ET) is only available a few times
      per SOL. Since a value is required for every IFG vector for calibration
      purposes, a spline fit to the PAE temperature T-0014 is used as a
      proxy. T-0014 is sometimes available every minute or so, but is only
      infrequently returned at night. The observed values of T-0014 are spline
      fit to produce data set that is sampled at 5 minute resolution or better
      and then the values between those samples are derived by linear interpolation.
      This value is given in units of degrees Celsius.
    </description>
  </Field_Character>
  <Field_Character>
    <name>modelST</name>
    <field_number>12</field_number>
    <field_location unit="byte">113</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">8</field_length>
    <field_format>%8.3f</field_format>
    <unit>Degree</unit>
    <description>
      Since the value of the actual IFG sensor temperature is not available in the high rate
      data, a model value of the sensor temperature derived from low rate data [deg C]
      is used for the calibration.
    </description>
  </Field_Character>
  <Field_Character>
    <name>modelSA</name>
    <field_number>13</field_number>
    <field_location unit="byte">122</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">8</field_length>
    <field_format>%8.3f</field_format>
    <unit>mA</unit>
    <description>
      MLST and UTC dependent model of the fixed solar array current [mA]
      derived from the values of the E-0771 from selected time intervals.
      Actual data values are sparsely sampled.
    </description>
  </Field_Character>
  <Field_Character>
    <name>ModSACT</name>
    <field_number>14</field_number>
    <field_location unit="byte">131</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">8</field_length>
    <field_format>%8.3f</field_format>
    <unit>mA</unit>
```

```
                <description>
                    MLST and UTC dependent model of the solar array current [mA] total (SACT)
                    derived from the sum of E-0772 and E-0772 from selected time intervals.
                    Actual data values are sparsely sampled.
                </description>
            </Field_Character>
        </Record_Character>
    </Table_Character>
  </File_Area_Observational>
</Product_Observational>
```

PDS4 Label for an IFG Raw 0.2Hz Mars Data Product

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-model href="https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1B00.sch"
    schematypens="http://purl.oclc.org/dsdl/schematron"?>
<?xml-model
href="https://pds.nasa.gov/pds4/mission/insight/v1/PDS4_INSIGHT_1B00_1840.sch"
      schematypens="http://purl.oclc.org/dsdl/schematron"?>
<Product_Observational
    xmlns="http://pds.nasa.gov/pds4/pds/v1"
    xmlns:insight="http://pds.nasa.gov/pds4/mission/insight/v1"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://pds.nasa.gov/pds4/pds/v1
    https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1B00.xsd

    http://pds.nasa.gov/pds4/mission/insight/v1
    https://pds.nasa.gov/pds4/mission/insight/v1/PDS4_INSIGHT_1B00_1840.xsd">
  <Identification_Area>
      <logical_identifier>urn:nasa:pds:insight-ifg-mars:data-ifg-raw:ifg-raw-sol0019-
20181215t183053-20181216t191042-pt2hz-v01</logical_identifier>
      <version_id>1.0</version_id>
      <title>2018-12-15T18:30 to 2018-12-16T19:10 IFG Magnetometer Mars Raw Filtered (0.2
Hz) Data </title>
      <information_model_version>1.11.0.0</information_model_version>
      <product_class>Product_Observational</product_class>
      <Citation_Information>
          <author_list>Russell, C. T.; Joy, S. P.</author_list>
          <publication_year>2019</publication_year>
          <keyword>mag</keyword>
          <description>
                    InSight low time resolution (0.2 Hz) raw IFG magnetic field data
                    acquired between 2018-12-15T18:30 and 2018-12-16T19:10 on the surface of
Mars.
          </description>
      </Citation_Information>
```

```
    <Modification_History>
      <Modification_Detail>
        <modification_date>2019-04-16</modification_date>
        <version_id>1.0</version_id>
        <description>Initial Version</description>
      </Modification_Detail>
    </Modification_History>
  </Identification_Area>
  <Observation_Area>
    <Time_Coordinates>
      <start_date_time>2018-12-15T18:30:53Z</start_date_time>
      <stop_date_time>2018-12-16T19:10:42Z</stop_date_time>
      </Time_Coordinates>
    <Primary_Result_Summary>
      <purpose>Science</purpose>
      <processing_level>Raw</processing_level>
      <description>
        These are raw data from the IFG sensor axes in data numbers.
      </description>
      <Science_Facets>
        <discipline_name>Fields</discipline_name>
        <facet1>Magnetic</facet1>
        <facet2>Background</facet2>
      </Science_Facets>
    </Primary_Result_Summary>
    <Investigation_Area>
      <name>InSight</name>
      <type>Mission</type>
      <Internal_Reference>
        <lid_reference>urn:nasa:pds:context:investigation:mission.insight</lid_reference>
        <reference_type>data_to_investigation</reference_type>
      </Internal_Reference>
    </Investigation_Area>
    <Observing_System>
      <Observing_System_Component>
        <name>InSight</name>
        <type>Spacecraft</type>
        <Internal_Reference>

<lid_reference>urn:nasa:pds:context:instrument_host:spacecraft.insight</lid_reference>
          <reference_type>is_instrument_host</reference_type>
        </Internal_Reference>
      </Observing_System_Component>
      <Observing_System_Component>
        <name>InSight Fluxgate Magnetometer</name>
        <type>Instrument</type>
```

```
        <Internal_Reference>
          <lid_reference>urn:nasa:pds:context:instrument:apss-ifg.insight</lid_reference>
          <reference_type>is_instrument</reference_type>
        </Internal_Reference>
      </Observing_System_Component>
    </Observing_System>
    <Target_Identification>
      <name>Mars</name>
      <type>Planet</type>
      <Internal_Reference>
        <lid_reference>urn:nasa:pds:context:target:planet.mars</lid_reference>
        <reference_type>data_to_target</reference_type>
      </Internal_Reference>
    </Target_Identification>

    <Mission_Area>
      <insight:Observation_Information>
        <insight:release_number>0001</insight:release_number>
        <insight:mission_phase_name>SURFACE MISSION</insight:mission_phase_name>

<insight:spacecraft_clock_start_count>598170790</insight:spacecraft_clock_start_count>

<insight:spacecraft_clock_stop_count>598259580</insight:spacecraft_clock_stop_count>

<insight:spacecraft_clock_count_partition>1</insight:spacecraft_clock_count_partition>
<insight:sol_number>0001</insight:sol_number>
      </insight:Observation_Information>
    </Mission_Area>
  </Observation_Area>
  <Reference_List>
    <Internal_Reference>
      <lid_reference>urn:nasa:pds:insight_documents:document_mission</lid_reference>
      <reference_type>data_to_document</reference_type>
    </Internal_Reference>
    <Internal_Reference>
      <lid_reference>urn:nasa:pds:insight-ifg-mars:document:insight-ifg-sis</lid_reference>
      <reference_type>data_to_document</reference_type>
      <comment>
        This document describes the IFG data processing and the structure
        of the various data files in this archive.
      </comment>
    </Internal_Reference>
    <Internal_Reference>
      <lid_reference>urn:nasa:pds:insight-ifg-mars:data-sc-engineering:ancil-sol0019-
2018350t020049-2018351t024455-v01</lid_reference>
      <reference_type>data_to_associate</reference_type>
```

```
      <comment>Spacecraft engineering and housekeeping data acquired during the IFG data
interval</comment>
    </Internal_Reference>
    <External_Reference>
      <doi>https://doi.org/10.1007/s11214-018-0570-x</doi>
      <reference_text>
        Banfield, D., Rodriguez-Manfredi, J.A., Russell, C.T. et al. Space Sci Rev (2019) 215:
4.
        https://doi.org/10.1007/s11214-018-0570-x
      </reference_text>
      <description>Published instrument paper</description>
    </External_Reference>
  </Reference_List>
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          <field_length unit="byte">23</field_length>
          <description>Sample S/C event time UTC in YYYY-MM-DDThh:mm:ss.sss
format</description>
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```

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   <field_length unit="byte">14</field_length>
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   <description>
      APSS onboard time (AOBT) value of sample. This is the spacecraft
      clock time used by the APSS instruments.
   </description>
</Field_Character>
<Field_Character>
   <name>frequency</name>
   <field_number>3</field_number>
   <field_location unit="byte">39</field_location>
   <data_type>ASCII_Real</data_type>
   <field_length unit="byte">8</field_length>
   <field_format>%8.5f</field_format>
   <unit>Hz</unit>
   <description>IFG sample frequency [Hz]</description>
</Field_Character>
<Field_Character>
   <name>conf</name>
   <field_number>4</field_number>
   <field_location unit="byte">47</field_location>
   <data_type>ASCII_Integer</data_type>
   <field_length unit="byte">4</field_length>
   <field_format>%4d</field_format>
   <description>
     Configuration table number used to define onboard
     processing including IFG down-sampling rate and the
     computation of the estimated parameters.
   </description>
</Field_Character>
<Field_Character>
   <name>off</name>
   <field_number>5</field_number>
   <field_location unit="byte">52</field_location>
   <data_type>ASCII_Integer</data_type>
   <field_length unit="byte">4</field_length>
   <field_format>%4d</field_format>
   <description>Sample offset within the downlink packet (samples 1 -
1024).</description>
</Field_Character>
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```

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   <field_length unit="byte">8</field_length>
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   <description>IFG axis 1 value in data numbers.</description>
   <Special_Constants>
      <missing_constant>9999999</missing_constant>
   </Special_Constants>
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   <name>IFG2_DN</name>
   <field_number>7</field_number>
   <field_location unit="byte">66</field_location>
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   <field_length unit="byte">8</field_length>
   <field_format>%8d</field_format>
   <description>IFG axis 2 value in data numbers.</description>
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   <name>IFG3_DN</name>
   <field_number>8</field_number>
   <field_location unit="byte">75</field_location>
   <data_type>ASCII_Integer</data_type>
   <field_length unit="byte">8</field_length>
   <field_format>%8d</field_format>
   <description>IFG axis 3 value in data numbers.</description>
</Field_Character>
<Field_Character>
   <name>estaZ</name>
   <field_number>9</field_number>
   <field_location unit="byte">84</field_location>
   <data_type>ASCII_Integer</data_type>
   <field_length unit="byte">8</field_length>
   <field_format>%8d</field_format>
   <description>
     Estimated IFG parameter. The meaning of this value depends
     on the configuration table used. In the projection configuration
     the value is the sum of constants (1,2,3) times the corresponding
     IFG axes values. In the norm configuration, the value is the
     square-root of the sum of constants (1,2,3) times the square
     of the corresponding IFG axes values.
```

```
  </description>
  <Special_Constants>
    <missing_constant>9999999</missing_constant>
  </Special_Constants>
</Field_Character>
<Field_Character>
  <name>IFGT_DN</name>
  <field_number>10</field_number>
  <field_location unit="byte">93</field_location>
  <data_type>ASCII_Integer</data_type>
  <field_length unit="byte">8</field_length>
  <field_format>%8d</field_format>
  <description>IFG sensor temperature value in data numbers.</description>
  <Special_Constants>
    <missing_constant>9999999</missing_constant>
  </Special_Constants>
</Field_Character>
<Field_Character>
  <name>MLST</name>
  <field_number>11</field_number>
  <field_location unit="byte">102</field_location>
  <data_type>ASCII_Real</data_type>
  <field_length unit="byte">8</field_length>
  <field_format>%8.3f</field_format>
  <unit>hour</unit>
  <description>Mars local time represented as decimal hours (0 - 24)</description>
</Field_Character>
<Field_Character>
  <name>SHA</name>
  <field_number>12</field_number>
  <field_location unit="byte">111</field_location>
  <data_type>ASCII_Real</data_type>
  <field_length unit="byte">8</field_length>
  <field_format>%8.3f</field_format>
  <unit>degree</unit>
  <description>Solar hour angle in degrees (0-360)</description>
</Field_Character>
<Field_Character>
  <name>SensorT</name>
  <field_number>13</field_number>
  <field_location unit="byte">120</field_location>
  <data_type>ASCII_Real</data_type>
  <field_length unit="byte">8</field_length>
  <field_format>%8.3f</field_format>
  <unit>degree</unit>
  <description>
```

```
              IFG sensor temperature [deg C] computed from the value
              of IFGT_DN in order to provide a comparison with the
              model sensor temperature.
           </description>
        </Field_Character>
        <Field_Character>
           <name>ModelET</name>
           <field_number>14</field_number>
           <field_location unit="byte">129</field_location>
           <data_type>ASCII_Real</data_type>
           <field_length unit="byte">8</field_length>
           <field_format>%8.3f</field_format>
           <unit>degree</unit>
           <description>
              The actual IFG electronics temperature (ET) is only available a few times
              per SOL. Since a value is required for every IFG vector for calibration
              purposes, a spline fit to the PAE temperature T-0014 is used as a
              proxy. T-0014 is sometimes available every minute or so, but is only
              infrequently returned at night. The observed values of T-0014 are spline
              fit to produce data set that is sampled at 5 minute resolution or better
              and then the values between those samples are derived by linear interpolation.
              This value is given in units of degrees Celsius.
           </description>
        </Field_Character>
        <Field_Character>
           <name>ModelST</name>
           <field_number>15</field_number>
           <field_location unit="byte">138</field_location>
           <data_type>ASCII_Real</data_type>
           <field_length unit="byte">8</field_length>
           <field_format>%8.3f</field_format>
           <unit>degree</unit>
           <description>
              Value of the actual IFG sensor temperature [SensorT] when available,
              otherwise a MLST and UTC dependent model of the IFG sensor temperature [deg
C]

              derived from the measured values from selected time intervals is
              provided. The FIR filter applied to the temperature data is longer
              than the one applied to the MAG data so there is a roughly two
              hour gap in the temperature data whenever the IFG powers on (i.e.
              following a spacecraft safing or PAE reset). The value in this column
              is used for the MAG calibration since it is available for all samples.
           </description>
        </Field_Character>
        <Field_Character>
           <name>ModelSA</name>
```

```
          <field_number>16</field_number>
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          <field_format>%8.3f</field_format>
          <unit>mA</unit>
          <description>
            MLST and UTC dependent model of the fixed solar array current [mA]
            derived from the values of the E-0771 from selected time intervals.
          </description>
        </Field_Character>
        <Field_Character>
          <name>ModSACT</name>
          <field_number>17</field_number>
          <field_location unit="byte">156</field_location>
          <data_type>ASCII_Real</data_type>
          <field_length unit="byte">8</field_length>
          <field_format>%8.3f</field_format>
          <unit>mA</unit>
          <description>
            MLST and UTC dependent model of the solar array current [mA] total (SACT)
            derived from the sum of E-0772 and E-0772 from selected time intervals.
          </description>
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PDS4 Label for an IFG Partially Processed Mars 20 Hz Data Product

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    schematypens="http://purl.oclc.org/dsdl/schematron"?>
<?xml-model
href="https://pds.nasa.gov/pds4/mission/insight/v1/PDS4_INSIGHT_1B00_1840.sch"
       schematypens="http://purl.oclc.org/dsdl/schematron"?>
<Product_Observational
    xmlns="http://pds.nasa.gov/pds4/pds/v1"
    xmlns:insight="http://pds.nasa.gov/pds4/mission/insight/v1"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://pds.nasa.gov/pds4/pds/v1
    https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1B00.xsd

    http://pds.nasa.gov/pds4/mission/insight/v1
    https://pds.nasa.gov/pds4/mission/insight/v1/PDS4_INSIGHT_1B00_1840.xsd">
   <Identification_Area>
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sol0019-20181215t183410-20181216t191045-20hz-v01</logical_identifier>
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      <title>2018-12-15T18:34 to 2018-12-16T19:10 IFG Magnetometer Mars Partially Processed
High-Res Data</title>
      <information_model_version>1.11.0.0</information_model_version>
      <product_class>Product_Observational</product_class>
      <Citation_Information>
         <author_list>Russell, C. T.; Joy, S. P.</author_list>
         <publication_year>2019</publication_year>
         <keyword>mag</keyword>
         <description>A
            InSight high time resolution (20Hz) partially processed IFG magnetic field data
            acquired between 2018-12-15T18:34 and 2018-12-16T19:10 on the surface of Mars.
         </description>
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        These data have been converted to physical units and have
        been corrected for temperature variations in the sensor
        gains and zero-levels. Substantial spacecraft sources
        remain in the data uncorrected.
      </description>
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        <facet2>Background</facet2>
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<insight:spacecraft_clock_stop_count>598259438</insight:spacecraft_clock_stop_count>

<insight:spacecraft_clock_count_partition>1</insight:spacecraft_clock_count_partition>
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2018350t020049-2018351t024455-v01</lid_reference>
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    </Internal_Reference>
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      <reference_type>data_to_document</reference_type>
      <comment>
        This document describes the IFG data processing and the structure
        of the various data files in this archive.
      </comment>
    </Internal_Reference>
    <External_Reference>
      <doi>https://doi.org/10.1007/s11214-018-0570-x</doi>
      <reference_text>
        Banfield, D., Rodriguez-Manfredi, J.A., Russell, C.T. et al. Space Sci Rev (2019) 215:
4.
        https://doi.org/10.1007/s11214-018-0570-x
      </reference_text>
      <description>Published instrument paper</description>
    </External_Reference>
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20181215t183410-20181216t191045-20hz-v01::1.0</lidvid_reference>
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      <comment>Raw data used in processing</comment>
    </Source_Product_Internal>
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          <field_length unit="byte">23</field_length>
          <description>sample S/C event time UTC in YYYY-MM-DDThh:mm:ss.sss format</description>
        </Field_Character>
        <Field_Character>
          <name>AOBT</name>
          <field_number>2</field_number>
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          <data_type>ASCII_Real</data_type>
          <field_length unit="byte">15</field_length>
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          <description>
            APSS onboard time (AOBT) value of sample. This is the spacecraft
```

```
          clock time used by the APSS instruments.
        </description>
      </Field_Character>
      <Field_Character>
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        <unit>nT</unit>
        <description>IFG axis 1 data in nT with offsets and MLST variations
subtracted</description>
      </Field_Character>
      <Field_Character>
         <name>IFG_2</name>
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        <field_location unit="byte">51</field_location>
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        <field_length unit="byte">9</field_length>
        <field_format>%9.3f</field_format>
        <unit>nT</unit>
        <description>IFG axis 2 data in nT with offsets and MLST variations
subtracted</description>
      </Field_Character>
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        <name>IFG_3</name>
        <field_number>5</field_number>
        <field_location unit="byte">61</field_location>
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        <field_length unit="byte">9</field_length>
        <field_format>%9.3f</field_format>
        <unit>nT</unit>
        <description>IFG axis 3 data in nT with with offsets and MLST variations
subtracted</description>
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        <field_number>6</field_number>
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        <unit>nT</unit>
        <description>i
          Spacecraft mechanical coordinate system Bx component in nT.
```

```
                This frame is called the INSIGHT Lander Frame in SPICE and
                is described in the insight_v02.tf file as:
                FRAME_INSIGHT_LANDER = -189001, FRAME_-189001_NAME =
INSIGHT_LANDER.
              </description>
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              <unit>nT</unit>
              <description>Spacecraft mechanical coordinate system By component in
nT</description>
          </Field_Character>
          <Field_Character>
              <name>Bz_SC</name>
              <field_number>8</field_number>
              <field_location unit="byte">91</field_location>
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              <field_length unit="byte">9</field_length>
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              <unit>nT</unit>
              <description>Spacecraft mechanical coordinate system Bz component in nT
</description>
          </Field_Character>
          <Field_Character>
              <name>MLST</name>
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              <field_location unit="byte">101</field_location>
              <data_type>ASCII_Real</data_type>
              <field_length unit="byte">9</field_length>
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              <unit>Hour</unit>
              <description>Mars local time represented as decimal hours (0 - 24)</description>
          </Field_Character>
          <Field_Character>
              <name>HR_Angle</name>
              <field_number>10</field_number>
              <field_location unit="byte">111</field_location>
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              <field_length unit="byte">9</field_length>
              <field_format>%9.3f</field_format>
              <unit>Degree</unit>
```

```
               <description>Solar hour angle in degrees (0-360)</description>
            </Field_Character>
            <Field_Character>
               <name>modelET</name>
               <field_number>11</field_number>
               <field_location unit="byte">121</field_location>
               <data_type>ASCII_Real</data_type>
               <field_length unit="byte">9</field_length>
               <field_format>%9.3f</field_format>
               <unit>Degree</unit>
               <description>
                  The actual IFG electronics temperature (ET) is only available a few times
                  per SOL. Since a value is required for every IFG vector for calibration
                  purposes, a spline fit to the PAE temperature T-0014 is used as a
                  proxy. T-0014 is sometimes available every minute or so, but is only
                  infrequently returned at night. The observed values of T-0014 are spline
                  fit to produce data set that is sampled at 5 minute resolution or better
                  and then the values between those samples are derived by linear interpolation.
                  This value is given in units of degrees Celsius.
                  See the IFG calibration document for additional details.
               </description>
            </Field_Character>
            <Field_Character>
               <name>modelST</name>
               <field_number>12</field_number>
               <field_location unit="byte">131</field_location>
               <data_type>ASCII_Real</data_type>
               <field_length unit="byte">9</field_length>
               <field_format>%9.3f</field_format>
               <unit>Degree</unit>
               <description>
                 Since the value of the actual IFG sensor temperature is not available in the high
                 rate data, a model value of the sensor temperature derived from low rate data [deg
C]
                 is used for the calibration.
               </description>
            </Field_Character>
            <Field_Character>
               <name>modelSA</name>
               <field_number>13</field_number>
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               <unit>mA</unit>
               <description>
```

```
            MLST and UTC dependent model of the fixed solar array current [mA]
            derived from the values of the E-0771 from selected time intervals.
            Actual data values are sparsely sampled.
          </description>
        </Field_Character>
        <Field_Character>
          <name>ModSACT</name>
          <field_number>14</field_number>
          <field_location unit="byte">151</field_location>
          <data_type>ASCII_Real</data_type>
          <field_length unit="byte">9</field_length>
          <field_format>%9.3f</field_format>
          <unit>mA</unit>
          <description>
            MLST and UTC dependent model of the solar array current [mA] total (SACT)
            derived from the sum of E-0772 and E-0772 from selected time intervals.
            See the IFG calibration document for additional details.
          </description>
        </Field_Character>
      </Record_Character>
    </Table_Character>
  </File_Area_Observational>
</Product_Observational>
```

PDS4 Label for an IFG Partially Processed Mars 0.2 Hz Data Product

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-model href="https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1B00.sch"
    schematypens="http://purl.oclc.org/dsdl/schematron"?>
<?xml-model
href="https://pds.nasa.gov/pds4/mission/insight/v1/PDS4_INSIGHT_1B00_1840.sch"
       schematypens="http://purl.oclc.org/dsdl/schematron"?>
<Product_Observational
    xmlns="http://pds.nasa.gov/pds4/pds/v1"
    xmlns:insight="http://pds.nasa.gov/pds4/mission/insight/v1"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://pds.nasa.gov/pds4/pds/v1
    https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1B00.xsd

    http://pds.nasa.gov/pds4/mission/insight/v1
    https://pds.nasa.gov/pds4/mission/insight/v1/PDS4_INSIGHT_1B00_1840.xsd">
   <Identification_Area>
      <logical_identifier>urn:nasa:pds:insight-ifg-mars:data-ifg-partially-processed:ifg-pcal-
sol0019-20181215t183053-20181216t191042-pt2hz-v01</logical_identifier>
      <version_id>1.0</version_id>
      <title>2018-12-15T18:30 to 2018-12-16T19:10 IFG Magnetometer Mars Filtered (0.2 Hz)
Data</title>
      <information_model_version>1.11.0.0</information_model_version>
      <product_class>Product_Observational</product_class>
      <Citation_Information>
         <author_list>Russell, C. T.; Joy, S. P.</author_list>
         <publication_year>2019</publication_year>
         <keyword>mag</keyword>
         <description>
            InSight low time resolution (0.2 Hz) partially calibrated IFG magnetic
            field data from 2018-12-15T18:30 to 2018-12-16T19:10 acquired
            on the surface of Mars.
         </description>
      </Citation_Information>
      <Modification_History>
         <Modification_Detail>
            <modification_date>2019-04-17</modification_date>
            <version_id>1.0</version_id>
            <description>Initial Version</description>
         </Modification_Detail>
      </Modification_History>
   </Identification_Area>
   <Observation_Area>
      <Time_Coordinates>
         <start_date_time>2018-12-15T18:30:53Z</start_date_time>
```

```
      <stop_date_time>2018-12-16T19:10:42Z</stop_date_time>
    </Time_Coordinates>
    <Primary_Result_Summary>
      <purpose>Science</purpose>
      <processing_level>Partially Processed</processing_level>
      <description>
        Data were filtered and resampled to the low resolution onboard the spacecraft
        before downlink. The data have been converted to physical
        units and have been corrected for temperature variations in the
        sensor gains and zero-levels. Substantial spacecraft sources
        remain in the data uncorrected.
      </description>
      <Science_Facets>
        <discipline_name>Fields</discipline_name>
        <facet1>Magnetic</facet1>
        <facet2>Background</facet2>
      </Science_Facets>
    </Primary_Result_Summary>
    <Investigation_Area>
      <name>InSight</name>
      <type>Mission</type>
      <Internal_Reference>
        <lid_reference>urn:nasa:pds:context:investigation:mission.insight</lid_reference>
        <reference_type>data_to_investigation</reference_type>
      </Internal_Reference>
    </Investigation_Area>
    <Observing_System>
      <Observing_System_Component>
        <name>InSight</name>
        <type>Spacecraft</type>
        <Internal_Reference>

<lid_reference>urn:nasa:pds:context:instrument_host:spacecraft.insight</lid_reference>
          <reference_type>is_instrument_host</reference_type>
        </Internal_Reference>
      </Observing_System_Component>
      <Observing_System_Component>
        <name>InSight Fluxgate Magnetometer</name>
        <type>Instrument</type>
        <Internal_Reference>
          <lid_reference>urn:nasa:pds:context:instrument:apss-ifg.insight</lid_reference>
          <reference_type>is_instrument</reference_type>
        </Internal_Reference>
      </Observing_System_Component>
    </Observing_System>
    <Target_Identification>
```

```
         <name>Mars</name>
         <type>Planet</type>
         <Internal_Reference>
            <lid_reference>urn:nasa:pds:context:target:planet.mars</lid_reference>
            <reference_type>data_to_target</reference_type>
         </Internal_Reference>
      </Target_Identification>
      <Mission_Area>
         <insight:Observation_Information>
            <insight:release_number>0001</insight:release_number>
            <insight:mission_phase_name>SURFACE MISSION</insight:mission_phase_name>

<insight:spacecraft_clock_start_count>598170790</insight:spacecraft_clock_start_count>

<insight:spacecraft_clock_stop_count>598259580</insight:spacecraft_clock_stop_count>

<insight:spacecraft_clock_count_partition>1</insight:spacecraft_clock_count_partition>
<insight:sol_number>0001</insight:sol_number>
         </insight:Observation_Information>
      </Mission_Area>
   </Observation_Area>
   <Reference_List>
      <Internal_Reference>
         <lid_reference>urn:nasa:pds:insight-ifg-mars:data-sc-engineering:ancil-sol0019-
2018350t020049-2018351t024455-v01</lid_reference>
         <reference_type>data_to_associate</reference_type>
         <comment>Spacecraft engineering data acquired during the IFG data file time
period.</comment>
      </Internal_Reference>
      <Internal_Reference>
         <lid_reference>urn:nasa:pds:insight-ifg-mars:browse:ifg-cal-sol0019-20181215t183053-
20181216t191042-pt2hz-v01</lid_reference>
         <reference_type>data_to_browse</reference_type>
         <comment>PNG plot of the partially calibrated IFG data in this file.</comment>
      </Internal_Reference>
      <Internal_Reference>
         <lid_reference>urn:nasa:pds:insight-ifg-mars:document:insight-ifg-sis</lid_reference>
         <reference_type>data_to_document</reference_type>
         <comment>
           This document describes the IFG data processing and the structure
           of the various data files in this archive.
         </comment>
      </Internal_Reference>
      <External_Reference>
         <doi>https://doi.org/10.1007/s11214-018-0570-x</doi>
         <reference_text>
```

```
        Banfield, D., Rodriguez-Manfredi, J.A., Russell, C.T. et al. Space Sci Rev (2019) 215:
4.
        https://doi.org/10.1007/s11214-018-0570-x
      </reference_text>
      <description>Published instrument paper</description>
    </External_Reference>
    <Source_Product_Internal>
      <lidvid_reference>urn:nasa:pds:insight-ifg-mars:data-ifg-raw:ifg-raw-sol0019-
20181215t183053-20181216t191042-pt2hz-v01::1.0</lidvid_reference>
      <reference_type>data_to_raw_source_product</reference_type>
      <comment>Raw data used in processing</comment>
    </Source_Product_Internal>
  </Reference_List>
  <File_Area_Observational>
    <File>

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ame>
      <creation_date_time>2019-04-17</creation_date_time>
      <file_size unit="byte">2859360</file_size>
      <records>17760</records>
      <md5_checksum>7787102fcfe85fbf001707f0168e2613</md5_checksum>
    </File>
    <Header>
      <offset unit="byte">0</offset>
      <object_length unit="byte">161</object_length>
      <parsing_standard_id>PDS DSV 1</parsing_standard_id>
      <description>First row of the file contains column names</description>
    </Header>
    <Table_Character>
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      <records>17759</records>
      <record_delimiter>Carriage-Return Line-Feed</record_delimiter>
      <Record_Character>
        <fields>14</fields>
        <groups>0</groups>
        <record_length unit="byte">161</record_length>
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          <name>SCET_UTC</name>
          <field_number>1</field_number>
          <field_location unit="byte">1</field_location>
          <data_type>ASCII_Date_Time_YMD</data_type>
          <field_length unit="byte">23</field_length>
          <description>sample S/C event time UTC in YYYY-MM-DDThh:mm:ss.sss
format</description>
        </Field_Character>
```

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            <Field_Character>
              <name>AOBT</name>
              <field_number>2</field_number>
              <field_location unit="byte">26</field_location>
              <data_type>ASCII_Real</data_type>
              <field_length unit="byte">15</field_length>
              <field_format>%15.3f</field_format>
              <description>
                APSS onboard time (AOBT) value of sample. This is the spacecraft
                clock time used by the APSS instruments.
              </description>
            </Field_Character>
            <Field_Character>
              <name>IFG_1</name>
              <field_number>3</field_number>
              <field_location unit="byte">41</field_location>
              <data_type>ASCII_Real</data_type>
              <field_length unit="byte">9</field_length>
              <field_format>%9.3f</field_format>
              <unit>nT</unit>
              <description>IFG axis 1 data in nT with offsets and MLST variations
subtracted</description>
              <Special_Constants>
                <missing_constant>9999.999</missing_constant>
              </Special_Constants>
            </Field_Character>
            <Field_Character>
              <name>IFG_2</name>
              <field_number>4</field_number>
              <field_location unit="byte">51</field_location>
              <data_type>ASCII_Real</data_type>
              <field_length unit="byte">9</field_length>
              <field_format>%9.3f</field_format>
              <unit>nT</unit>
              <description>IFG axis 2 data in nT with offsets and MLST variations
subtracted</description>
              <Special_Constants>
                <missing_constant>9999.999</missing_constant>
              </Special_Constants>
            </Field_Character>
            <Field_Character>
              <name>IFG_3</name>
              <field_number>5</field_number>
              <field_location unit="byte">61</field_location>
              <data_type>ASCII_Real</data_type>
              <field_length unit="byte">9</field_length>
```

```
          <field_format>%9.3f</field_format>
          <unit>nT</unit>
          <description>IFG axis 3 data in nT with offsets and MLST variations
subtracted</description>
          <Special_Constants>
            <missing_constant>9999.999</missing_constant>
          </Special_Constants>
        </Field_Character>
        <Field_Character>
          <name>Bx_SC</name>
          <field_number>6</field_number>
          <field_location unit="byte">71</field_location>
          <data_type>ASCII_Real</data_type>
          <field_length unit="byte">9</field_length>
          <field_format>%9.3f</field_format>
          <unit>nT</unit>
          <description>i
            Spacecraft mechanical coordinate system Bx component in nT.
            This frame is called the INSIGHT Lander Frame in SPICE and
            is described in the insight_v02.tf file as:
            FRAME_INSIGHT_LANDER = -189001, FRAME_-189001_NAME =
INSIGHT_LANDER.
          </description>
          <Special_Constants>
            <missing_constant>9999.999</missing_constant>
          </Special_Constants>
        </Field_Character>
        <Field_Character>
          <name>By_SC</name>
          <field_number>7</field_number>
          <field_location unit="byte">81</field_location>
          <data_type>ASCII_Real</data_type>
          <field_length unit="byte">9</field_length>
          <field_format>%9.3f</field_format>
          <unit>nT</unit>
          <description>Spacecraft mechanical coordinate system By component in
nT</description>
          <Special_Constants>
            <missing_constant>9999.999</missing_constant>
          </Special_Constants>
        </Field_Character>
        <Field_Character>
          <name>Bz_SC</name>
          <field_number>8</field_number>
          <field_location unit="byte">91</field_location>
          <data_type>ASCII_Real</data_type>
```

```
          <field_length unit="byte">9</field_length>
          <field_format>%9.3f</field_format>
          <unit>nT</unit>
          <description>Spacecraft mechanical coordinate system Bz component in nT
</description>
          <Special_Constants>
            <missing_constant>9999.999</missing_constant>
          </Special_Constants>
        </Field_Character>
        <Field_Character>
          <name>MLST</name>
          <field_number>9</field_number>
          <field_location unit="byte">101</field_location>
          <data_type>ASCII_Real</data_type>
          <field_length unit="byte">9</field_length>
          <field_format>%9.3f</field_format>
          <unit>Hour</unit>
          <description>Mars local solar time in decimal hours (0-24)</description>
        </Field_Character>
        <Field_Character>
          <name>hr_angle</name>
          <field_number>10</field_number>
          <field_location unit="byte">111</field_location>
          <data_type>ASCII_Real</data_type>
          <field_length unit="byte">9</field_length>
          <field_format>%9.3f</field_format>
          <unit>Degree</unit>
          <description>Solar hour angle in degrees (0-360)</description>
        </Field_Character>
        <Field_Character>
          <name>modelST</name>
          <field_number>11</field_number>
          <field_location unit="byte">121</field_location>
          <data_type>ASCII_Real</data_type>
          <field_length unit="byte">9</field_length>
          <field_format>%9.3f</field_format>
          <unit>Degree</unit>
          <description>
            Value of the actual IFG sensor temperature [SensorT] when available,
            otherwise a MLST and UTC dependent model of the IFG sensor temperature [deg
C]
            derived from the measured values from selected time intervals is
            provided. The FIR filter applied to the temperature data is longer
            than the one applied to the MAG data so there is a roughly two
            hour gap in the temperature data whenever the IFG powers on (i.e.
            following a spacecraft safing or PAE reset). The value in this column
```

```
       is used for the MAG calibration since it is available for all samples.
       See the IFG calibration document for additional details.
    </description>
</Field_Character>
 <Field_Character>
    <name>modelET</name>
    <field_number>12</field_number>
    <field_location unit="byte">131</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">9</field_length>
    <field_format>%9.3f</field_format>
    <unit>Degree</unit>
    <description>
       The actual IFG electronics temperature (ET) is only available a few times
       per SOL. Since a value is required for every IFG vector for calibration
       purposes, a spline fit to the PAE temperature T-0014 is used as a
       proxy. T-0014 is sometimes available every minute or so, but is only
       infrequently returned at night. The observed values of T-0014 are spline
       fit to produce data set that is sampled at 5 minute resolution or better
       and then the values between those samples are derived by linear interpolation.
       This value is given in units of degrees Celsius.
       See the IFG calibration document for additional details.
    </description>
</Field_Character>
 <Field_Character>
    <name>modelSA</name>
    <field_number>13</field_number>
    <field_location unit="byte">141</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">9</field_length>
    <field_format>%9.3f</field_format>
    <unit>mA</unit>
    <description>
       MLST and UTC dependent model of the fixed solar array current [mA]
       derived from the values of the E-0771 from selected time intervals.
       See the IFG calibration document for additional details.
    </description>
</Field_Character>
 <Field_Character>
    <name>ModSACT</name>
    <field_number>14</field_number>
    <field_location unit="byte">151</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">9</field_length>
    <field_format>%9.3f</field_format>
    <unit>mA</unit>
```

```
          <description>
            MLST and UTC dependent model of the solar array current [mA] total (SACT)
            derived from the sum of E-0772 and E-0772 from selected time intervals.
            See the IFG calibration document for additional details.
          </description>
        </Field_Character>
      </Record_Character>
    </Table_Character>
  </File_Area_Observational>
</Product_Observational>
```

PDS4 Label for an IFG Calibrated Mars Data Product

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-model href="https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1B00.sch"
    schematypens="http://purl.oclc.org/dsdl/schematron"?>
<?xml-model
href="https://pds.nasa.gov/pds4/mission/insight/v1/PDS4_INSIGHT_1B00_1840.sch"
       schematypens="http://purl.oclc.org/dsdl/schematron"?>
<Product_Observational
    xmlns="http://pds.nasa.gov/pds4/pds/v1"
    xmlns:insight="http://pds.nasa.gov/pds4/mission/insight/v1"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://pds.nasa.gov/pds4/pds/v1
    https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1B00.xsd

    http://pds.nasa.gov/pds4/mission/insight/v1
    https://pds.nasa.gov/pds4/mission/insight/v1/PDS4_INSIGHT_1B00_1840.xsd">
   <Identification_Area>
      <logical_identifier>urn:nasa:pds:insight-ifg-mars:data-ifg-calibrated:ifg-cal-sol0019-
20181215t183410-20181216t191045-20hz-v01</logical_identifier>
      <version_id>1.0</version_id>
      <title>2018-12-15T18:34 to 2018-12-16T19:10 IFG Magnetometer Mars high resolution (20
Hz) Data</title>
      <information_model_version>1.11.0.0</information_model_version>
      <product_class>Product_Observational</product_class>
      <Citation_Information>
         <author_list>Russell, C. T.; Joy, S. P.</author_list>
         <publication_year>2019</publication_year>
         <keyword>mag</keyword>
         <description>
            InSight high time resolution (20 Hz) calibrated IFG magnetic
            field data from 2018-12-15T18:34 to 2018-12-16T19:10 acquired
            on the surface of Mars.
         </description>
      </Citation_Information>
      <Modification_History>
         <Modification_Detail>
            <modification_date>2019-04-18</modification_date>
            <version_id>1.0</version_id>
            <description>Initial Version</description>
         </Modification_Detail>
      </Modification_History>
   </Identification_Area>
   <Observation_Area>
      <Time_Coordinates>
         <start_date_time>2018-12-15T18:34:10Z</start_date_time>
```

```
      <stop_date_time>2018-12-16T19:10:45Z</stop_date_time>
    </Time_Coordinates>
    <Primary_Result_Summary>
      <purpose>Science</purpose>
      <processing_level>Calibrated</processing_level>
      <description>
        The data have been converted to physical
        units and have been corrected for temperature variations in the
        sensor gains and zero-levels. Substantial spacecraft sources
        remain in the data uncorrected.
      </description>
      <Science_Facets>
        <discipline_name>Fields</discipline_name>
        <facet1>Magnetic</facet1>
        <facet2>Background</facet2>
      </Science_Facets>
    </Primary_Result_Summary>
    <Investigation_Area>
      <name>InSight</name>
      <type>Mission</type>
      <Internal_Reference>
        <lid_reference>urn:nasa:pds:context:investigation:mission.insight</lid_reference>
        <reference_type>data_to_investigation</reference_type>
      </Internal_Reference>
    </Investigation_Area>
    <Observing_System>
      <Observing_System_Component>
        <name>InSight</name>
        <type>Spacecraft</type>
        <Internal_Reference>

<lid_reference>urn:nasa:pds:context:instrument_host:spacecraft.insight</lid_reference>
          <reference_type>is_instrument_host</reference_type>
        </Internal_Reference>
      </Observing_System_Component>
      <Observing_System_Component>
        <name>InSight Fluxgate Magnetometer</name>
        <type>Instrument</type>
        <Internal_Reference>
          <lid_reference>urn:nasa:pds:context:instrument:apss-ifg.insight</lid_reference>
          <reference_type>is_instrument</reference_type>
        </Internal_Reference>
      </Observing_System_Component>
    </Observing_System>
    <Target_Identification>
      <name>Mars</name>
```

```
      <type>Planet</type>
      <Internal_Reference>
        <lid_reference>urn:nasa:pds:context:target:planet.mars</lid_reference>
        <reference_type>data_to_target</reference_type>
      </Internal_Reference>
    </Target_Identification>
    <Mission_Area>
      <insight:Observation_Information>
        <insight:release_number>0001</insight:release_number>
        <insight:mission_phase_name>SURFACE MISSION</insight:mission_phase_name>
      </insight:Observation_Information>
    </Mission_Area>
  </Observation_Area>
  <Reference_List>
    <Internal_Reference>
      <lid_reference>urn:nasa:pds:insight-ifg-mars:document:insight-ifg-sis</lid_reference>
      <reference_type>data_to_document</reference_type>
      <comment>
       This document describes the IFG data processing and the structure
       of the various data files in this archive.
      </comment>
    </Internal_Reference>
    <External_Reference>
      <doi>https://doi.org/10.1007/s11214-018-0570-x</doi>
      <reference_text>
        Banfield, D., Rodriguez-Manfredi, J.A., Russell, C.T. et al. Space Sci Rev (2019) 215:
4.
        https://doi.org/10.1007/s11214-018-0570-x
      </reference_text>
      <description>Published instrument paper</description>
    </External_Reference>
    <Source_Product_Internal>
      <lidvid_reference>urn:nasa:pds:insight-ifg-mars:data-ifg-raw:ifg-raw-sol0019-
20181215t183410-20181216t191045-20hz-v01::1.0</lidvid_reference>
      <reference_type>data_to_raw_source_product</reference_type>
      <comment>Raw data used in processing</comment>
    </Source_Product_Internal>
  </Reference_List>
  <File_Area_Observational>
    <File>

<file_name>ifg_cal_SOL0019_20181215T183410_20181216T191045_20Hz_v01.tab</file_na
me>
      <creation_date_time>2019-04-18</creation_date_time>
      <file_size unit="byte">112612718</file_size>
      <records>1014529</records>
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        <object_length unit="byte">109</object_length>
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        <description>First row of the file contains column names</description>
      </Header>
      <Table_Character>
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        <records>1014528</records>
        <record_delimiter>Carriage-Return Line-Feed</record_delimiter>
        <Record_Character>
          <fields>9</fields>
          <groups>0</groups>
          <record_length unit="byte">109</record_length>
          <Field_Character>
            <name>SCET_UTC</name>
            <field_number>1</field_number>
            <field_location unit="byte">1</field_location>
            <data_type>ASCII_Date_Time_YMD</data_type>
            <field_length unit="byte">23</field_length>
            <description>sample S/C event time UTC in YYYY-MM-DDThh:mm:ss.sss
format</description>
          </Field_Character>
          <Field_Character>
            <name>MLST</name>
            <field_number>2</field_number>
            <field_location unit="byte">25</field_location>
            <data_type>ASCII_Real</data_type>
            <field_length unit="byte">9</field_length>
            <field_format>%9.3f</field_format>
            <description>Mars local time represented as decimal hours (0 - 24)</description>
          </Field_Character>
          <Field_Character>
            <name>Bx_SC</name>
            <field_number>3</field_number>
            <field_location unit="byte">35</field_location>
            <data_type>ASCII_Real</data_type>
            <field_length unit="byte">9</field_length>
            <field_format>%9.3f</field_format>
            <unit>nT</unit>
            <description>
              Spacecraft mechanical coordinate system Bx component in nT.
              This frame is called the INSIGHT Lander Frame in SPICE and
              is described in the insight_v02.tf file as:
```

```xml
          FRAME_INSIGHT_LANDER = -189001, FRAME_-189001_NAME = INSIGHT_LANDER.
        </description>
        <Special_Constants>
          <missing_constant>9999.999</missing_constant>
        </Special_Constants>
      </Field_Character>
      <Field_Character>
        <name>By_SC</name>
        <field_number>4</field_number>
        <field_location unit="byte">45</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">9</field_length>
        <field_format>%9.3f</field_format>
        <unit>nT</unit>
        <description>Spacecraft mechanical coordinate system By component in nT</description>
        <Special_Constants>
          <missing_constant>9999.999</missing_constant>
        </Special_Constants>
      </Field_Character>
      <Field_Character>
        <name>Bz_SC</name>
        <field_number>5</field_number>
        <field_location unit="byte">55</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">9</field_length>
        <field_format>%9.3f</field_format>
        <unit>nT</unit>
        <description>Spacecraft mechanical coordinate system Bz component in nT</description>
        <Special_Constants>
          <missing_constant>9999.999</missing_constant>
        </Special_Constants>
      </Field_Character>
      <Field_Character>
        <name>B_north</name>
        <field_number>6</field_number>
        <field_location unit="byte">65</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">9</field_length>
        <field_format>%9.3f</field_format>
        <unit>nT</unit>
        <description>
          B_north (+X) field component [nT] in the Landed Local Vertical, Local Horizontal Coordinate System.
```

```
                    In this frame, +Z points along local gravity vector, +X points towards local North,
and +Y points east.
                    This frame is called the INSIGHT_LL Frame in SPICE and is described in the
insight_v02.tf file as:
                    FRAME_INSIGHT_LL = -189003, FRAME_-189003_NAME = INSIGHT_LL.
                </description>
                <Special_Constants>
                  <missing_constant>9999.999</missing_constant>
                </Special_Constants>
            </Field_Character>
            <Field_Character>
                <name>B_east</name>
                <field_number>7</field_number>
                <field_location unit="byte">75</field_location>
                <data_type>ASCII_Real</data_type>
                <field_length unit="byte">9</field_length>
                <field_format>%9.3f</field_format>
                <unit>nT</unit>
                <description>The B_east (+Y) field component [nT] in the INSIGHT_LL
frame.</description>
                <Special_Constants>
                  <missing_constant>9999.999</missing_constant>
                </Special_Constants>
            </Field_Character>
            <Field_Character>
                <name>B_down</name>
                <field_number>8</field_number>
                <field_location unit="byte">85</field_location>
                <data_type>ASCII_Real</data_type>
                <field_length unit="byte">9</field_length>
                <field_format>%9.3f</field_format>
                <unit>nT</unit>
                <description>The B_down (+Z) field component [nT] in the INSIGHT_LL
frame.</description>
                <Special_Constants>
                  <missing_constant>9999.999</missing_constant>
                </Special_Constants>
            </Field_Character>
            <Field_Character>
                <name>dqf</name>
                <field_number>9</field_number>
                <field_location unit="byte">95</field_location>
                <data_type>ASCII_String</data_type>
                <field_length unit="byte">14</field_length>
                <field_format>%14s</field_format>
           </Field_Character>
```

```
            </Record_Character>
        </Table_Character>
    </File_Area_Observational>
</Product_Observational>
```

PDS4 Label for an Ancillary Data Product

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-model href="https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1B00.sch"
   schematypens="http://purl.oclc.org/dsdl/schematron"?>
<?xml-model href="http://pds.nasa.gov/pds4/mission/insight/v1/PDS4_INSIGHT_1600.sch"
  schematypens="http://purl.oclc.org/dsdl/schematron"?>
<Product_Observational xmlns="http://pds.nasa.gov/pds4/pds/v1"
   xmlns:pds="http://pds.nasa.gov/pds4/pds/v1"
   xmlns:insight="http://pds.nasa.gov/pds4/mission/insight/v1"
   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
   xsi:schemaLocation="
   http://pds.nasa.gov/pds4/pds/v1
   https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1B00.xsd

   http://pds.nasa.gov/pds4/mission/insight/v1
   https://pds.nasa.gov/pds4/mission/insight/v1/PDS4_INSIGHT_1600.xsd">
   <Identification_Area>
      <logical_identifier>urn:nasa:pds:insight-ifg-cruise:data-sc-engineering:ancil-2018196t220009-2018197t214842</logical_identifier>
      <version_id>1.0</version_id>
      <title>2018-07-15T22:00 to 2018-07-16T21:48 InSight IFG Magnetometer Cruise Ancillary Data</title>
      <information_model_version>1.11.0.0</information_model_version>
      <product_class>Product_Observational</product_class>
      <Citation_Information>
         <author_list>Russell, C. T.; Joy, S. P.</author_list>
         <publication_year>2018</publication_year>
         <keyword>housekeeping</keyword>
         <description>Spacecraft engineering parameters including various currents, voltages, temperatures, etc.</description>
      </Citation_Information>
      <Modification_History>
         <Modification_Detail>
            <modification_date>2018-10-24</modification_date>
            <version_id>1.0</version_id>
            <description>Initial Version</description>
         </Modification_Detail>
      </Modification_History>
   </Identification_Area>
   <Observation_Area>
       <Time_Coordinates>
         <start_date_time>2018-07-15T22:00:09Z</start_date_time>
         <stop_date_time>2018-07-16T21:48:12Z</stop_date_time>
      </Time_Coordinates>
      <Primary_Result_Summary>
```

```
      <purpose>Engineering</purpose>
      <processing_level>Partially Processed</processing_level>
    </Primary_Result_Summary>
    <Investigation_Area>
      <name>InSight Mars Lander Mission</name>
      <type>Mission</type>
      <Internal_Reference>
        <lid_reference>urn:nasa:pds:context:investigation:mission.insight</lid_reference>
        <reference_type>data_to_investigation</reference_type>
      </Internal_Reference>
    </Investigation_Area>
    <Observing_System>
      <Observing_System_Component>
        <name>InSight Mars Lander Spacecraft</name>
        <type>Spacecraft</type>
        <Internal_Reference>

<lid_reference>urn:nasa:pds:context:instrument_host:spacecraft.insight</lid_reference>
          <reference_type>is_instrument_host</reference_type>
        </Internal_Reference>
      </Observing_System_Component>
    </Observing_System>
    <Target_Identification>
      <name>Solar Wind</name>
      <type>Plasma Stream</type>
      <Internal_Reference>
        <lid_reference>urn:nasa:pds:context:target:plasma_stream.solar_wind</lid_reference>
        <reference_type>data_to_target</reference_type>
      </Internal_Reference>
    </Target_Identification>
    <Mission_Area>
      <insight:Observation_Information>
        <insight:mission_phase_name>CRUISE</insight:mission_phase_name>

<insight:spacecraft_clock_start_count>0584964004.141</insight:spacecraft_clock_start_count>

<insight:spacecraft_clock_stop_count>0585049687.070</insight:spacecraft_clock_stop_count>
      </insight:Observation_Information>
    </Mission_Area>
  </Observation_Area>
  <File_Area_Observational>
    <File>
      <file_name>ancil_2018196T220009_2018197T214842.tab</file_name>
      <creation_date_time>2018-10-24</creation_date_time>
      <file_size unit="byte">2109947</file_size>
      <records>2681</records>
```

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      <md5_checksum>a4455bcfac3adc7d11d052aa44c39816</md5_checksum>
    </File>
   <Header>
     <offset unit="byte">0</offset>
     <object_length unit="byte">787</object_length>
     <parsing_standard_id>PDS DSV 1</parsing_standard_id>
     <description>First row of the file contains column names</description>
   </Header>
    <Table_Character>
      <offset unit="byte">787</offset>
      <records>2680</records>
      <record_delimiter>Carriage-Return Line-Feed</record_delimiter>
      <Record_Character>
        <fields>82</fields>
        <groups>0</groups>
        <record_length unit="byte">785</record_length>
        <Field_Character>
          <name>SCLK</name>
          <field_number>1</field_number>
          <field_location unit="byte">1</field_location>
          <data_type>ASCII_Real</data_type>
          <field_length unit="byte">14</field_length>
          <field_format>%14.3f</field_format>
          <description>Spacecraft clock counter</description>
        </Field_Character>
        <Field_Character>
          <name>SCET_UTC</name>
          <field_number>2</field_number>
          <field_location unit="byte">16</field_location>
          <data_type>ASCII_Date_Time_DOY_UTC</data_type>
          <field_length unit="byte">21</field_length>
          <description>Sample S/C event time UTC in YYYY-DDDThh:mm:ss.sss
format</description>
        </Field_Character>
        <Field_Character>
          <name>ERT_UTC</name>
          <field_number>3</field_number>
          <field_location unit="byte">38</field_location>
          <data_type>ASCII_Date_Time_DOY_UTC</data_type>
          <field_length unit="byte">24</field_length>
          <description>Sample Earth receive time UTC in YYYY-DDDThh:mm:ss.ssssss
format</description>
        </Field_Character>
        <Field_Character>
          <name>SOL/MLST</name>
          <field_number>4</field_number>
```

```
          <field_location unit="byte">63</field_location>
          <data_type>ASCII_String</data_type>
          <field_length unit="byte">21</field_length>
          <description>Sample SOL and Mars local solar time (SOL-
xxxxMhh:mm:ss.sss)</description>
        </Field_Character>
        <Field_Character>
          <name>E-0114</name>
          <field_number>5</field_number>
          <field_location unit="byte">85</field_location>
          <data_type>ASCII_Real</data_type>
          <field_length unit="byte">8</field_length>
          <field_format>%8.3f</field_format>
          <unit>Volts</unit>
          <description>PDDU AAC (analog acquisition card) AIV (analog input voltage)
channel 14.  Bus voltage monitor 1A signal.</description>
          <Special_Constants>
            <missing_constant>-1.000</missing_constant>
          </Special_Constants>
        </Field_Character>
        <Field_Character>
          <name>E-0126</name>
          <field_number>6</field_number>
          <field_location unit="byte">94</field_location>
          <data_type>ASCII_Real</data_type>
          <field_length unit="byte">8</field_length>
          <field_format>%8.3f</field_format>
          <unit>Volts</unit>
          <description>PDDU AAC (analog acquisition card) AIV (analog input voltage)
channel 26.  Bus voltage monitor 2A signal.</description>
          <Special_Constants>
            <missing_constant>-1.000</missing_constant>
          </Special_Constants>
        </Field_Character>
        <Field_Character>
          <name>E-0606</name>
          <field_number>7</field_number>
          <field_location unit="byte">103</field_location>
          <data_type>ASCII_Real</data_type>
          <field_length unit="byte">8</field_length>
          <field_format>%8.3f</field_format>
          <unit>Amps</unit>
          <description>PDDU AAC (analog acquisition card) OFC (off card) 00 channel 06.
USM 1
            (universal switch module 1) upstream switch DPC 0 (discrete power controller 0)
current.  Corresponds to C-0606 </description>
```

```
  <Special_Constants>
    <missing_constant>-1.000</missing_constant>
  </Special_Constants>
</Field_Character>
<Field_Character>
  <name>E-0607</name>
  <field_number>8</field_number>
  <field_location unit="byte">112</field_location>
  <data_type>ASCII_Real</data_type>
  <field_length unit="byte">8</field_length>
  <field_format>%8.3f</field_format>
  <unit>Amps</unit>
  <description>PDDU AAC (analog acquisition card) OFC (off card)
    00 channel 07.  USM 1 (universal switch module 1) upstream
    switch DPC 1 (discrete power controller 1) current.
    Corresponds to C-0607 </description>
  <Special_Constants>
    <missing_constant>-1.000</missing_constant>
  </Special_Constants>
</Field_Character>
<Field_Character>
  <name>E-0608</name>
  <field_number>9</field_number>
  <field_location unit="byte">121</field_location>
  <data_type>ASCII_Real</data_type>
  <field_length unit="byte">8</field_length>
  <field_format>%8.3f</field_format>
  <unit>Amps</unit>
  <description>PDDU AAC (analog acquisition card) OFC (off card) 00 channel 08.
    USM 1 (universal switch module 1) upstream switch DPC 2 (discrete power
    controller 2) current.  Corresponds to C-0608 (USM1usD2Ccio).
  </description>
  <Special_Constants>
    <missing_constant>-1.000</missing_constant>
  </Special_Constants>
</Field_Character>
<Field_Character>
  <name>E-0609</name>
  <field_number>10</field_number>
  <field_location unit="byte">130</field_location>
  <data_type>ASCII_Real</data_type>
  <field_length unit="byte">8</field_length>
  <field_format>%8.3f</field_format>
  <unit>Amps</unit>
  <description>PDDU AAC (analog acquisition card)
    OFC (off card) 00 channel 09.  USM 1 (universal switch module 1) upstream switch
```

```
            DPC 3 (discrete power controller 3) current.  Corresponds to C-0609 </description>
          <Special_Constants>
            <missing_constant>-1.000</missing_constant>
          </Special_Constants>
        </Field_Character>
        <Field_Character>
          <name>E-0610</name>
          <field_number>11</field_number>
          <field_location unit="byte">139</field_location>
          <data_type>ASCII_Real</data_type>
          <field_length unit="byte">8</field_length>
          <field_format>%8.3f</field_format>
          <unit>Amps</unit>
          <description>PDDU AAC (analog acquisition card) OFC (off card) 00 channel 10.
            USM 1 (universal switch module 1) upstream switch DPC 4 (discrete power
controller 4) current.
            Corresponds to C-0610 (USM1usD4Ccio).</description>
          <Special_Constants>
            <missing_constant>-1.000</missing_constant>
          </Special_Constants>
        </Field_Character>
        <Field_Character>
          <name>E-0611</name>
          <field_number>12</field_number>
          <field_location unit="byte">148</field_location>
          <data_type>ASCII_Real</data_type>
          <field_length unit="byte">8</field_length>
          <field_format>%8.3f</field_format>
          <unit>Amps</unit>
          <description>PDDU AAC (analog acquisition card) OFC (off card) 00 channel 11.
            USM 1 (universal switch module 1) upstream switch DPC 5 (discrete power
controller 5) current.
            Corresponds to C-0611 (USM1usD5Ccio).</description>
          <Special_Constants>
            <missing_constant>-1.000</missing_constant>
          </Special_Constants>
        </Field_Character>
        <Field_Character>
          <name>E-0623</name>
          <field_number>13</field_number>
          <field_location unit="byte">157</field_location>
          <data_type>ASCII_Real</data_type>
          <field_length unit="byte">8</field_length>
          <field_format>%8.3f</field_format>
          <unit>Amps</unit>
          <description>PDDU AAC (analog acquisition card) OFC (off card) 01 channel 03.
```

```
    USM 1 (universal switch module 1) upstream switch latching switch current.
    Corresponds to C-0623 (USM1usLTCcio).</description>
  <Special_Constants>
    <missing_constant>-1.000</missing_constant>
  </Special_Constants>
</Field_Character>
<Field_Character>
  <name>E-0624</name>
  <field_number>14</field_number>
  <field_location unit="byte">166</field_location>
  <data_type>ASCII_Real</data_type>
  <field_length unit="byte">8</field_length>
  <field_format>%8.3f</field_format>
  <unit>Amps</unit>
  <description>PDDU AAC (analog acquisition card) OFC (off card) 01 channel 04.
    USM 1 (universal switch module 1) upstream switch low current switch current.
    Corresponds to C-0624 (USM1usLCCcio).</description>
  <Special_Constants>
    <missing_constant>-1.000</missing_constant>
  </Special_Constants>
</Field_Character>
<Field_Character>
  <name>E-0625</name>
  <field_number>15</field_number>
  <field_location unit="byte">175</field_location>
  <data_type>ASCII_Real</data_type>
  <field_length unit="byte">8</field_length>
  <field_format>%8.3f</field_format>
  <unit>Amps</unit>
  <description>PDDU AAC (analog acquisition card) OFC (off card) 01 channel 05.
    USM 1 (universal switch module 1) upstream switch high current switch current.
    Corresponds to C-0625 (USM1usHCCcio).</description>
  <Special_Constants>
    <missing_constant>-1.000</missing_constant>
  </Special_Constants>
</Field_Character>
<Field_Character>
  <name>E-0646</name>
  <field_number>16</field_number>
  <field_location unit="byte">184</field_location>
  <data_type>ASCII_Real</data_type>
  <field_length unit="byte">8</field_length>
  <field_format>%8.3f</field_format>
  <unit>Amps</unit>
  <description>PDDU AAC (analog acquisition card) OFC (off card) 02 channel 06.
```

```
            USM 2 (universal switch module 2) upstream switch DPC 0 (discrete power
controller 0) current.
            Corresponds to C-0646 (USM2usD0Ccio).</description>
          <Special_Constants>
            <missing_constant>-1.000</missing_constant>
          </Special_Constants>
        </Field_Character>
        <Field_Character>
          <name>E-0647</name>
          <field_number>17</field_number>
          <field_location unit="byte">193</field_location>
          <data_type>ASCII_Real</data_type>
          <field_length unit="byte">8</field_length>
          <field_format>%8.3f</field_format>
          <unit>Amps</unit>
          <description>PDDU AAC (analog acquisition card) OFC (off card) 02 channel 07.
            USM 2 (universal switch module 2) upstream switch DPC 1 (discrete power
controller 1) current.
            Corresponds to C-0647 (USM2usD1Ccio).</description>
          <Special_Constants>
            <missing_constant>-1.000</missing_constant>
          </Special_Constants>
        </Field_Character>
        <Field_Character>
          <name>E-0648</name>
          <field_number>18</field_number>
          <field_location unit="byte">202</field_location>
          <data_type>ASCII_Real</data_type>
          <field_length unit="byte">8</field_length>
          <field_format>%8.3f</field_format>
          <unit>Amps</unit>
            <description>PDDU AAC (analog acquisition card) OFC (off card) 02 channel 08.
              USM 2 (universal switch module 2) upstream switch DPC 2 (discrete power
controller 2) current.
              Corresponds to C-0648 (USM2usD2Ccio).</description>
          <Special_Constants>
            <missing_constant>-1.000</missing_constant>
          </Special_Constants>
        </Field_Character>
        <Field_Character>
          <name>E-0649</name>
          <field_number>19</field_number>
          <field_location unit="byte">211</field_location>
          <data_type>ASCII_Real</data_type>
          <field_length unit="byte">8</field_length>
          <field_format>%8.3f</field_format>
```

```
          <unit>Amps</unit>
          <description>PDDU AAC (analog acquisition card) OFC (off card) 02 channel 09.
            USM 2 (universal switch module 2) upstream switch DPC 3 (discrete power
controller 3) current.
            Corresponds to C-0649 (USM2usD3Ccio).</description>
          <Special_Constants>
            <missing_constant>-1.000</missing_constant>
          </Special_Constants>
        </Field_Character>
        <Field_Character>
          <name>E-0650</name>
          <field_number>20</field_number>
          <field_location unit="byte">220</field_location>
          <data_type>ASCII_Real</data_type>
          <field_length unit="byte">8</field_length>
          <field_format>%8.3f</field_format>
          <unit>Amps</unit>
          <description>PDDU AAC (analog acquisition card) OFC (off card) 02 channel 10.
            USM 2 (universal switch module 2) upstream switch DPC 4 (discrete power
controller 4) current.
            Corresponds to C-0650 (USM2usD4Ccio).</description>
          <Special_Constants>
            <missing_constant>-1.000</missing_constant>
          </Special_Constants>
        </Field_Character>
        <Field_Character>
          <name>E-0651</name>
          <field_number>21</field_number>
          <field_location unit="byte">229</field_location>
          <data_type>ASCII_Real</data_type>
          <field_length unit="byte">8</field_length>
          <field_format>%8.3f</field_format>
          <unit>Amps</unit>
          <description>PDDU AAC (analog acquisition card) OFC (off card) 02 channel 11.
            USM 2 (universal switch module 2) upstream switch DPC 5 (discrete power
controller 5) current.
            Corresponds to C-0651 (USM2usD5Ccio).</description>
          <Special_Constants>
            <missing_constant>-1.000</missing_constant>
          </Special_Constants>
        </Field_Character>
        <Field_Character>
          <name>E-0663</name>
          <field_number>22</field_number>
          <field_location unit="byte">238</field_location>
          <data_type>ASCII_Real</data_type>
```

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  <field_length unit="byte">8</field_length>
  <field_format>%8.3f</field_format>
  <unit>Amps</unit>
  <description>PDDU AAC (analog acquisition card) OFC (off card) 03 channel 03.
    USM 2 (universal switch module 2) upstream switch latching switch current.
    Corresponds to C-0663 (USM2usLTCcio).</description>
  <Special_Constants>
    <missing_constant>-1.000</missing_constant>
  </Special_Constants>
</Field_Character>
<Field_Character>
  <name>E-0664</name>
  <field_number>23</field_number>
  <field_location unit="byte">247</field_location>
  <data_type>ASCII_Real</data_type>
  <field_length unit="byte">8</field_length>
  <field_format>%8.3f</field_format>
  <unit>Amps</unit>
  <description>PDDU AAC (analog acquisition card) OFC (off card) 03 channel 04.
    USM 2 (universal switch module 2) upstream switch low current switch current.
    Corresponds to C-0664 (USM2usLCCcio).</description>
  <Special_Constants>
    <missing_constant>-1.000</missing_constant>
  </Special_Constants>
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    Corresponds to C-0665 (USM2usHCCcio).</description>
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          <unit>Amps</unit>
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controller 0) current.
            Corresponds to C-0686 (USM2usD0Ccio).</description>
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controller 1) current.
            Corresponds to C-0687 (USM2usD1Ccio).</description>
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controller 2) current.
            Corresponds to C-0688 (USM2usD2Ccio).</description>
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controller 3) current.
              Corresponds to C-0689 (USM2usD3Ccio).</description>
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controller 4) current.
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controller 5) current.
              Corresponds to C-0691 (USM2usD5Ccio).</description>
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controller 0) current.
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controller 1) current.
        Corresponds to C-0727 (USM4usD1Ccio).</description>
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controller 2) current.
        Corresponds to C-0728 (USM4usD2Ccio).</description>
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controller 3) current.
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controller 4) current.
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controller 5) current.
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      Corresponds to C-0745 (USM4usHCCcio).</description>
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signal.
            Corresponds to C-0769 (Sabc1VBAcio).</description>
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            This channel is used for the SABC_1 IBATT signal.  Corresponds to C-0770
(Sabc1IBAcio).</description>
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            This channel is used for the SABC_1 solar array current signal.</description>
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            This channel is used for the SABC_2 VBATT signal.  Corresponds to C-0789
(Sabc2VBAcio).</description>
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(Sabc2IBAcio).</description>
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channel 03.
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channel 04.
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channel 09.
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channel 10.  HP3 BEE temperature.</description>
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channel 18.  Landed solar array -Y temperature 2.</description>
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channel 19.  Landed solar array +Y temperature 2.</description>
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(SeisFb1Tcio).</description>
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channel 22.  TWINS +Y temperature.</description>
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channel 27.  PEB temperature.</description>
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channel 36.
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(FT330F_T3cio).</description>
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channel 37.
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(DeRemL_T5cio).</description>
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channel 39.
            HP3 frangibolt 1 temperature.  Corresponds to C-0039
(Hp3Fb1Tcio).</description>
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channel 42.
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(SeisTbFbTcio).</description>
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channel 45.
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channel 46.
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channel 48.
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(SeisFb3Tcio).</description>
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channel 49.
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(Hp3Fb2Tcio).</description>
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channel 52.
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02.  Thermal enclosure temperature 1.</description>
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16.  Thermal enclosure temperature 2.</description>
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29.
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(FT150U_T1cio).</description>
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(FT330U_T1cio).</description>
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