Temperatures and Wind Sensor for InSight (TWINS)

Pressure Sensor (PS)

PDS ARCHIVE SOFTWARE INTERFACE SPECIFICATION (SIS)

CAB-TWINS-SPC-0008
Issue 9

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1 INTRODUCTION

This software interface specification (SIS) describes the format and content of the TWINS and Pressure Sensor Planetary Data System (PDS) data archive. It includes descriptions of the data products and associated metadata, and the archive format, content, and generation pipeline.

1.1 DOCUMENT CHANGE LOG

Table 1: Document change log

Version	Change	Date	Affected portion
Issue 1	Initial document	12/04/2017	All
Issue 2	Atmospheres node corrections	12/20/2017	Sections 2.5, 2.6.1.2, 4.3, 5.
Issue 3	Peer review corrections	06/11/2018	Sections 1.3, 2.5, 2.6, 3.1, 3.2.2, 3.3, 4.4, 5, Appendix B
Issue 4	TWINS calibrated data merged into a single data product. Updates to Operational Flags and TWINS config data.	09/04/2018	Sections 4.1.3, 5.1.1.2, 5.1.1.3, 5.1.1.4
Issue 5	Added “validated flag” for wind data. Renamed frequency flag of ATS to “direct measurement”	03/21/2019	Sections 5.1.1.3, 5.1.1.4
Issue 6	Redefinition of data formats to separate continuous and event data into different data products. Temperatures in Kelvin.	04/26/2019	Sections 2.6.1.2, 2.6.2.1, 3.1, 4.1.3, 5.1
Issue 7	TWINS frequency columns changed to type ASCII_String to be able to contain more than one frequency.	05/08/2019	Section 5.1
Issue 8	Typos corrected		Section 5.1.2.4
Issue 9	Typos corrected. Table 11 renamed.		Sections 4.3, 5.1.2.2, 5.1.2.4

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 Subsystem
ASCII	American Standard Code for Information Interchange
ASIC	Application-Specific Integrated Circuit
Atmos	PDS Atmospheres Node (NMSU, Las Cruces, NM)
ATS	Air Temperature Sensor
CAB	Centro de AstroBiologia
CCSDS	Consultative Committee for Space Data Systems
CDR	Calibrated Data Record
CNES	Centre National d'Études Spatiales
CODMAC	Committee on Data Management, Archiving, and Computing
CSV	Comma-Separated Values
DTE	Direct To Earth
EDL	Entry Descent and Landing
EDR	Experiment Data Record
ERT	Earth Received Time
ESTA	Energy Short Term Average
FEI	File Exchange Interface
FIR	Finite Impulse Response
FOV	Field of View
FTP	File Transfer Protocol
GB	Gigabyte(s)
GEO	PDS Geosciences Node (Washington University, St. Louis, Missouri)
GSFC	Goddard Space Flight Center (Greenbelt, MD)
HK	Housekeeping
HP3	Heat Flow and Physical Properties Package
HTML	Hypertext Markup Language

Abbreviation	Meaning
ICC	Instrument Context Camera
ICD	Interface Control Document
IDA	Instrument Deployment Arm
IDC	Instrument Deployment Camera
IDS	Instrument Deployment System
IM	Information Model
IRIS	Incorporated Research Institutions for Seismology
ISO	International Standards Organization
JPL	Jet Propulsion Laboratory (Pasadena, CA)
LID	Logical Identifier
LIDVID	Versioned Logical Identifier
LMST	Local Mean Solar Time
LTST	Local True Solar Time
MAG	Magnetometer
MB	Megabyte(s)
MD5	Message-Digest Algorithm 5
MIPL	Multi-Mission Instrument Processing Laboratiry
NAIF	Navigation and Ancillary Information Facility (JPL)
NASA	National Aeronautics and Space Administration
NSSDC	National Space Science Data Center (GSFC)
PAE	Payload Auxiliary Electronics
PCB	Printed Circuit Board
PDS	Planetary Data System
PDS4	Planetary Data System Version 4
PPI	PDS Planetary Plasma Interactions Node (UCLA)
PRT	Platinum Resistance Thermometer
PS	Pressure Sensor
SIS	Software Interface Specification
RAD	Radiometer
RCT	Record Creation Time

Abbreviation	Meaning
RISE	Rotation and Interior Structure Experiment
RMS	Root Mean Square
SCET	Spacecraft Event Time
SCLK	Spacecraft Clock
SEED	Standard for the Exchange of Earthquake Data
SEIS	Seismic Experiment for Investigating the Subsurface
SFTP	Secure File Transfer Protocol
SIS	Software Interface Specification
SPICE	Spacecraft, Planet, Instrument, C-matrix, and Events (NAIF data format)
SPK	Spacecraft and Planetary Ephemeris Kernel (NAIF)
TBD	To Be Determined
TWINS	Temperature and Wind sensor for INSight
URN	Uniform Resource Name
UTC	Coordinated Universal Time
VID	Version Identifier
WS	Wind Sensor
WTS	Wind and Thermal Shield
WU	Washington University, 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 instrument during its mission lifetime, a collection of the calibration products associated with the instrument, 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) is to provide users of the TWINS (Temperature and Winds for InSight) and PS (Pressure Sensor) archive, both part of the InSight Auxiliary Payload Sensor Subsystem (APSS), 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 data products generated by both TWINS and Pressure Sensor and the higher level products derived from them that are intended to be archived in the Planetary Data System (PDS). These products are: TWINS raw, configuration, calibrated and modeled data, and Pressure Sensor raw and calibrated data.

2.2 SIS CONTENTS

This SIS describes how TWINS and PS instruments acquire 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 list of cognizant persons involved in generating the archive.

2.3 APPLICABLE DOCUMENTS

[1] Planetary Data System Standards Reference, Version 1.8.0, March 21, 2017.

[2] Planetary Science Data Dictionary Document, Version 1.8.0.8, March 10, 2017.

[3] Planetary Data System (PDS) PDS4 Information Model Specification, Version 1.8.0.0, March 10, 2017.

[4] InSight Archive Generation, Validation, and Transfer Plan, Revision A, August 16, 2017.

[5] APSS Science Team and PDS Atmospheres Node ICD (Interface Control Document), April 17, 2013.

The PDS4 Documents [1] through [3] are subject to revision. The most recent versions may be found at pds.nasa.gov/pds4. The TWINS and PS 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 TWINS and PS 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 will launch in May 2018 and will place a 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 main instruments: The Seismic Experiment for Interior Structure (SEIS) and the Heat-Flow and Physical Properties Probe (HP^3). In addition, the Rotation and Interior Structure Experiment (RISE) is not an instrument by itself, but will use the spacecraft X-band communication system to provide precise measurements of planetary rotation.

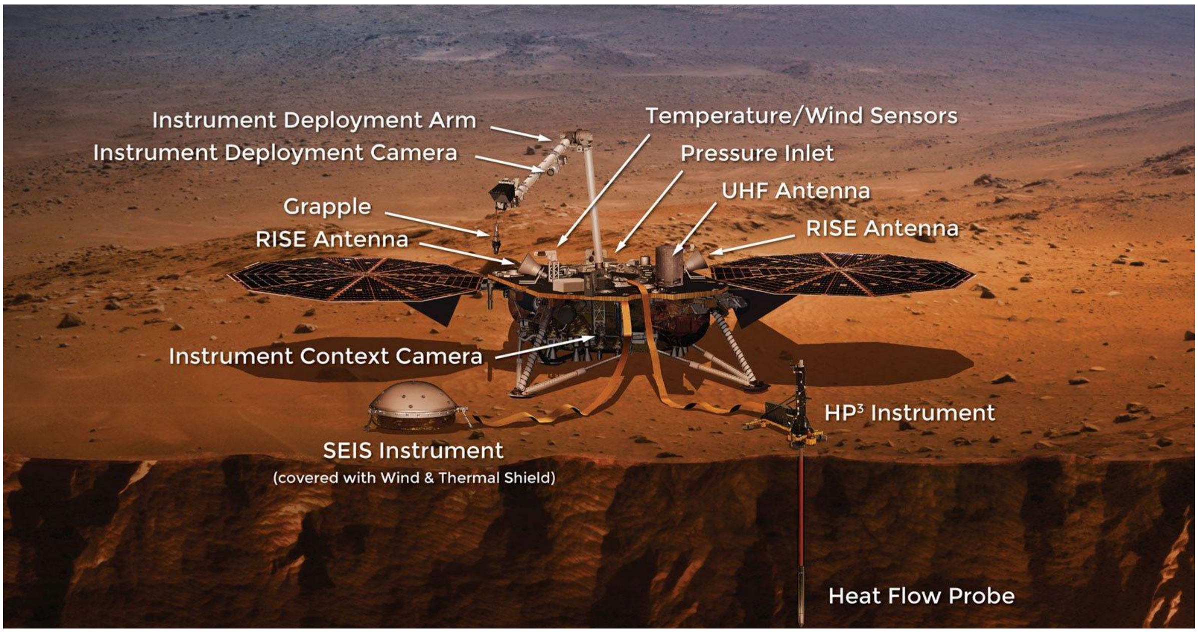

Figure 1 Insight Instruments

SEIS and HP^3 will be 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 instruments. Their primary purpose is to provide additional information to the main two, SEIS and HP^3, but they will also be used to do science of their own. One is the Auxiliary Payload Sensor Subsystem (APSS), which includes the pressure sensor, the magnetometer, and Temperature and Wind for InSight (TWINS) sensors. Its purpose is to collect environmental data in support of SEIS. These data will be used by SEIS to reduce and analyze their data. Other supporting instrument is the radiometer (RAD), which will be used by the HP^3 team to measure surface temperature and thermal properties to support their data analysis.

2.6 TWINS AND PRESSURE SENSOR DESCRIPTION

TWINS and the Pressure Sensor are part of the InSight Auxiliary Payload Sensor Subsystem (APSS). This subsystem is in charge of collecting environmental data in support of the SEIS instrument (also onboard the InSight lander), as well as of providing helpful data for the safe deployment of the hardware to the Martian surface. Data from both TWINS and PS will be used by SEIS to reduce and decorrelate atmospheric effects from seismic signals.

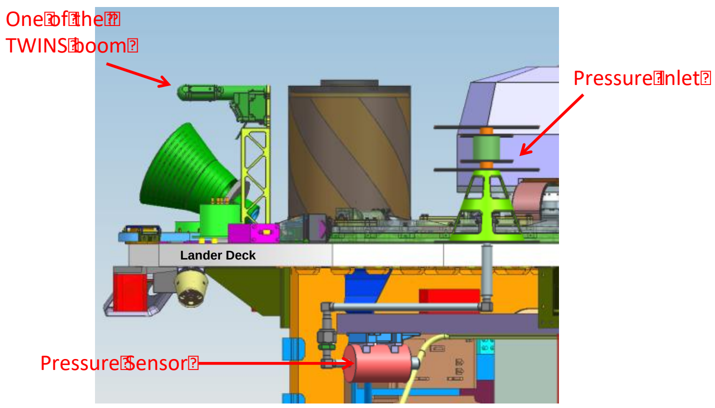

Figure 2 Location of TWINS and PS on the lander deck

2.6.1 TWINS

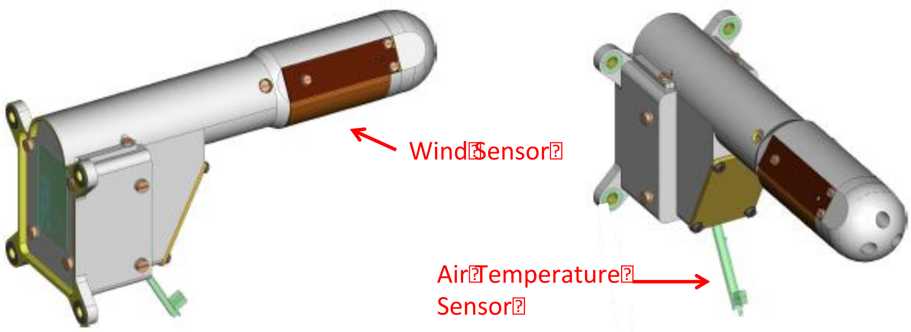

Figure 3 TWINS Booms

TWINS (Temperature and Wind for InSight) comprises two identical booms arrayed with wind and temperature sensors (Figure 3), placed on diametrically opposite sides of the lander deck, one pointing in the -Y lander axis direction and the other in the +Y direction, as shown in Figure 4. Booms are approximately 1.4m above the ground level, 200mm above the lander top deck, horizontally placed, and in parallel to each other.

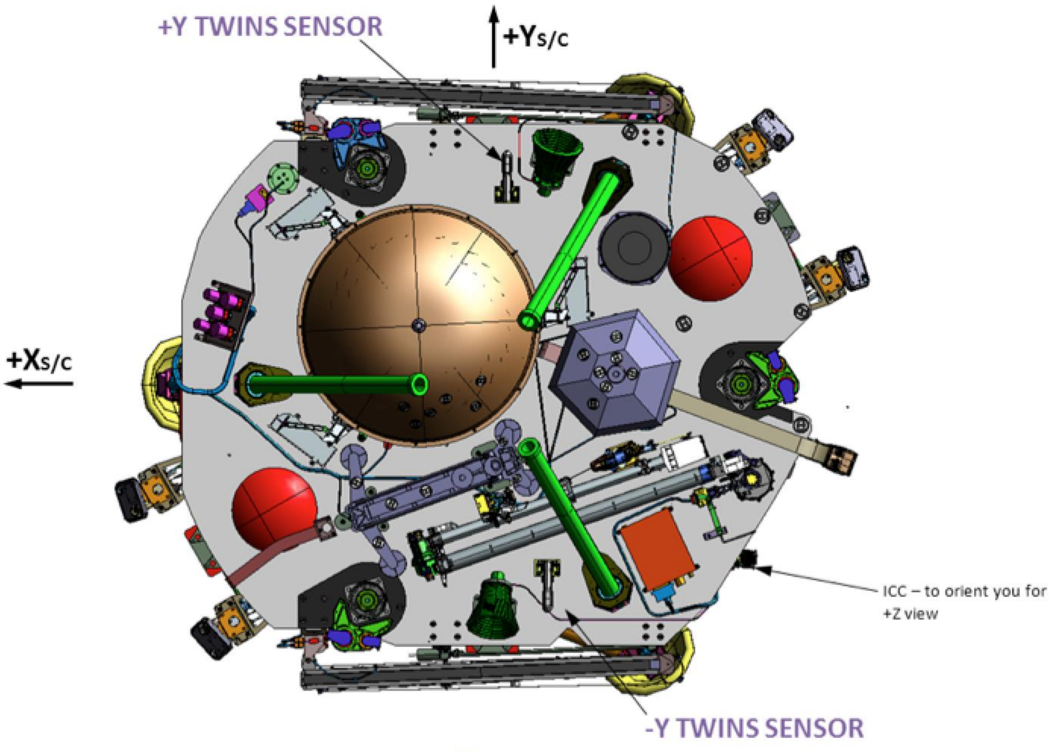

Figure 4 TWINS Booms layout

This layout is intended to minimize the effects and perturbations in the wind flow induced by the other elements in the lander top deck, by ensuring that at least one of them will record clean wind data for any given wind direction.

Each boom has three sensor boards attached to its surface (colored brown in Figure 3). Each board acts as a bi-dimensional anemometer that contains on its surface four hot film dices. The dices are heated and exposed to the airflow, and a fifth cold die is used for reference.

The two-dimensional wind speed and direction in each board is calculated by combining measurements of the four hot dices. The three-dimensional wind speed and direction is calculated by combining the readings of the three boards and by using a calibration lookup table covering all possible directions and speeds. In this way, TWINS will be able to determine, by ground analysis of measurements, the wind at the mounting height of the wind sensor when it exceeds 5.5 m/s ± 1.5 m/s, at a sampling rate of 1Hz.

Additionally, a sensor extending below each boom provides air temperature measurements. The Air Temperature Sensor (ATS) is a small rod made of a low thermal conductivity material that obliquely comes out of the bottom of each boom. Each rod has three Platinum Resistance Thermometer, or PRTs, at its base, tip, and intermediate positions. Their readings are combined and processed to provide the temperature of the fluid around the instrument, despite the thermal contamination from the boom. TWINS will be able to measure the atmospheric temperature greater than -106 C and less than +4 C with an accuracy of 6 C at a sampling rate of 1 Hz.

2.6.1.1 TWINS Electronics

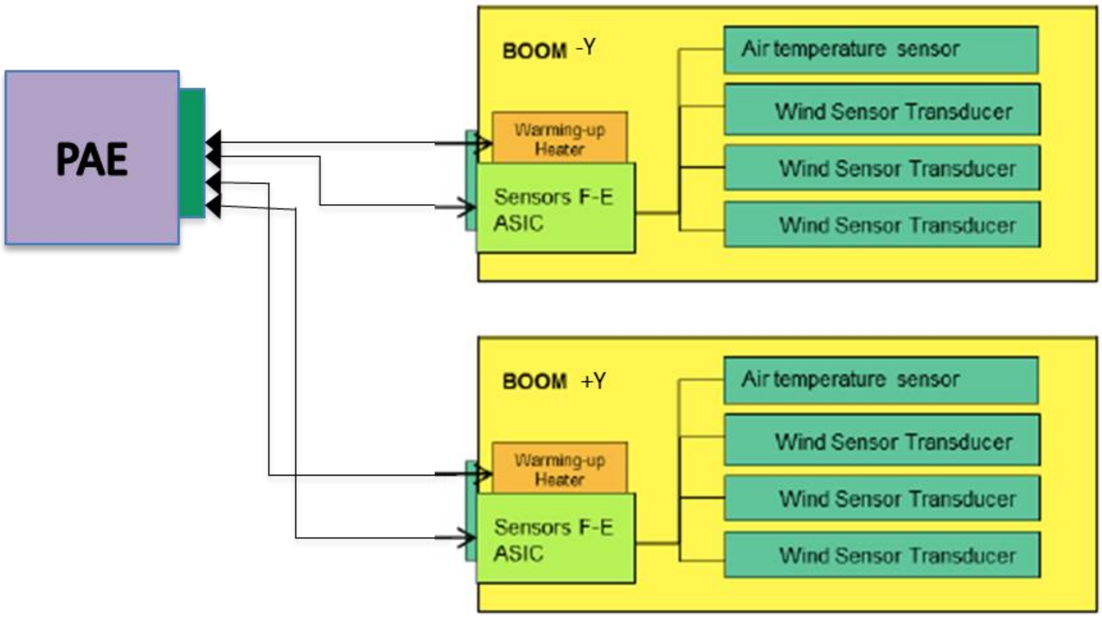

Figure 5 TWINS Block diagram

Two front-end ASICs, one per boom, process all the received analog inputs from the transducers and send the data to the boom controller via a serial communication link. The boom controller is called the Payload Auxiliary Electronics (PAE) and it is managed by JPL as part of the overall APSS instrument where TWINS is integrated.

The front-end ASICs are furnished with a heater to be able to warm-up the ASICs to any given operational temperature, as far as needed, by means of a heater power line. That power line is to be regulated externally in base to an ASIC temperature thermistor read-out also provided in the interface. The target operational temperature is called heater setpoint and is configured from the ground.

TWINS booms are controlled via several configuration registers (ASIC Registers). They are, in general, used to enable/disable functions (temperature or wind acquisitions), to configure the internal analogue acquisition chain (multiplexer, filter, ADC and amplifier gains) to define several operational engineering parameters (band gap reference level and compensation resistor parameters), for configuring the wind sensor heating and measurement currents and for supporting internal ASIC development and characterization tests. The configuration (these configuration registers) shall be uploaded to the booms after each boom power on.

2.6.1.2 TWINS operation

TWINS operation is designed around two main phases:

1. Deployment phase.

2. Science monitoring phase.

During deployment phase, TWINS aim is to provide data regarding wind, with the objective of assessing when to deploy instruments. During that phase, it is expected that both booms will be used at the same time, although this will depend on available resources (such as power and bandwidth). Data from both booms will be used on ground to retrieve wind speed and direction, as well as air temperature.

During science monitoring phase, after all instruments (SEIS, HP3) are deployed, only one boom will be used at a time. A selection of which boom is operative (measuring) will be done in accordance to where the wind flows come from, **highly determined by the time of the Martian day** (among other factors). The boom selection pattern will be commanded once per week, based on past observations and predictive models.

In both phases, continuous logging is the main driver for TWINS operation, based on the Payload Auxiliary Electronics' capability of measuring uninterruptedly and autonomously from the lander computers. Available transmission bandwidth per sol will dictate what portion of the recorded data can be downloaded to Earth. Two retrieval modes are defined: continuous mode and event retrieval mode.

In continuous mode, only selected, low frequency data are sent. How the data are selected depends on each sensor or instrument. For all TWINS data, only one sample every M is sent to Earth. This process is called decimation. For nominal operations, M is set to 10. Since TWINS has a sampling rate of 1Hz, this makes an effective frequency of 0.1Hz. Additional M values will be defined depending on available bandwidth during the mission.

TWINS ATS mid-rod and extreme-rod sensors also record one sample every M, but instead of storing the raw value, an average and standard deviation of the last N samples (where N is defined to 7) is computed on board and stored with the rest of the measurements. There are no plans to change the value of N through the mission, as it is stable enough and would not provide additional information.

In event retrieval mode, a limited time-range of the high frequency data is downloaded. This will be done when continuous mode data reveal interesting events.

Event retrieval is very dependent of available downlink bandwidth, and most of the data is expected to be in continuous mode. Table 4 summarizes downlink modes.

Table 4 TWINS Downlink Modes

Downlink Mode	Wind speed data retrieval	Air Temperature data retrieval	Additional
Continuous	1/M Hz	N samples average and standard deviation at 1/M Hz	M = decimation rate = 20, 10, 2, 1 N = average window = 7
Event/Full	1 Hz, 0.5Hz, 0.2Hz	1Hz, 0.5Hz, 0.2Hz	

2.6.2 Pressure Sensor

The PS is a pressure transducer manufactured by TAVIS Corporation (Figure 6.a), located in the lander body, and connected to the ambient atmosphere with an inlet on the lander top deck (Figure 2). The inlet is specifically designed to minimize the effects of wind on the pressure measurement, with a design similar to the “Quad-Disc” design developed for single inlet microbarometric measurements terrestrially (Nishiyama & Bedard, 1991) (Figure 6.b). Before deployment, the WTS (Wind & Thermal Shield) will cover the Quad-Disc inlet for the PS, which will likely increase the Pressure Sensor’s sensitivity to winds, but not invalidate the results entirely (i.e., likely <1Pa for 7m/s winds).

Quad-Disc inlets under terrestrial conditions reduce wind effects (dynamic pressure) on pressure measurements to 1% to 0.01%, depending on the Reynolds number of the flow (worse at high Reynolds number). On Mars, the Reynolds number will be about 2 orders of magnitude smaller, so the Quad-disc should reduce wind dynamic pressure effects down to of order 0.0001% (i.e., <1mPa for 1000 Pa ambient pressure), however experimental studies haven’t been able to empirically confirm this level of performance due to the very difficult nature of such a measurement.

The inlet tubing between the atmosphere and the pressure sensor itself produces a response time (or alternatively a cutoff frequency) for the instrument. For perturbations shorter than this time, the sensor’s response will be reduced. The cutoff frequency due to the inlet plumbing of the pressure sensor is roughly 6 Hz. There is also a first-order electrical low pass filter on the sensor output with a cutoff frequency of about 3 Hz. The sensor is read by an Analog to Digital Converter on the PAE at 500 Hz, which is then averaged down to a 20 Hz data stream. The two cutoff frequencies in the system provide adequate anti-aliasing filtering for the 10 Hz Nyquist frequency of the fundamental data rate of the pressure sensor.

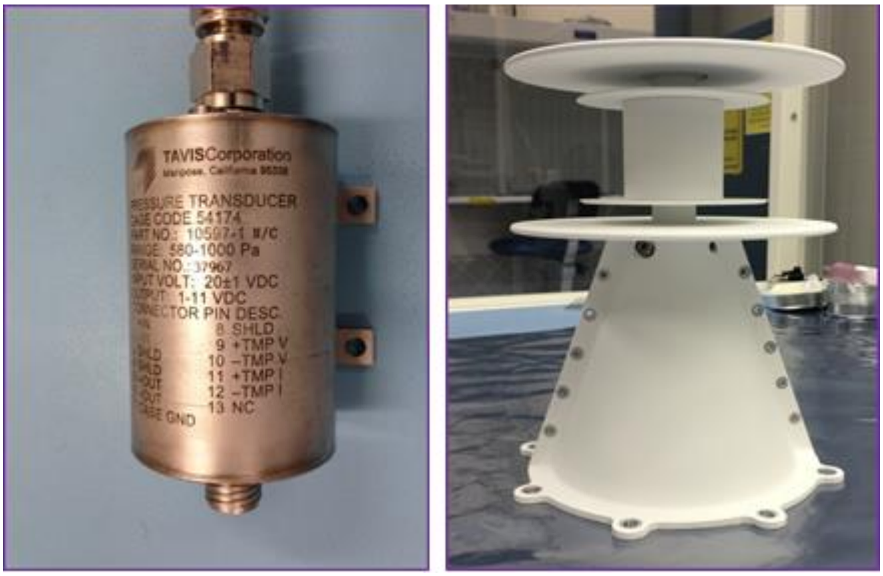

Figure 6-(a) The Tavis Pressure Sensor (PS). (b) The Quad-Disc pressure sensor inlet

The sensor itself is designed to produce valid output between pressures of about 560 Pa and 1000 Pa, which are expected to be the extreme pressures that will be experienced at the InSight landing site (based on VL1 and MSL data and MOLA altitudes of the landing ellipse). The actual calibration is temperature dependent so the ultimate range possible for the instrument will depend on the thermal environment realized. The sensor is specifically designed to minimize noise, with a typical RMS of about 10 mPa on any particular reading. The instrument requirements defined a noise spectrum that was demonstrated to have been met in the pre-flight testing of the flight sensor.

Placing the transducer within the body of the lander allows it to remain in a relatively controlled thermal environment, minimizing temperature effects corrupting the pressure measurement. Nevertheless, the pressure sensor also includes a temperature sensor near the sensor's active element. This is required to accurately calibrate the sensor voltage readings to actual ambient environmental pressures.

2.6.2.1 Pressure Sensor operation

The pressure sensor is designed to operate constantly throughout the mission, only being turned off in case of low power availability. Because the pressure decorrelation is crucial to interpreting the seismic signals, pressure data are needed at all times of the mission. The native sampling rate on board the lander is 20 Hz, although downlink budgets preclude returning all of these data to Earth. Instead, on-board processing will downsample this to a lower sampling rate continuous data stream, as well as other processed versions of the full signal to indicate energy in the pressure signal at frequencies above the continuously downlinked sampling rate. For the nominal downlink case (continuous mode, ~38 Mbits/Sol), the pressure sensor will return continuous data downsampled to 2 Hz, and its temperature sensor will be downsampled to 0.2 Hz. Onboard processing will also produce the RMS of a high-pass version of the pressure signal above 1 Hz, which will be downsampled to 0.5 Hz. This is called ESTA (Energy Short Term Average). This latter signal is expected to be indicative of high frequency pressure variations above that resolved in the continuous pressure data, to focus attention for downlink of the full sampling rate data in an "event". There will be a certain amount of the downlink budget allocated to "events" which will be special times in the mission where anomalous signals are detected in the pressure (or seismic or wind or magnetic) data sets, and full temporal resolution data sets are desired. In this case, a higher rate data set from the pressure sensor will be downlinked.

Pressure Sensor continuous and event modes data rates may change during the mission. Table 5 summarizes rates defined at the writing of this document.

Table 5 Pressure Downlink Modes

Downlink Mode	Pressure data retrieval	Temperature data retrieval	Additional
Continuous	2Hz, 10Hz	0.2Hz	RMS of >1Hz @0.5 Hz or 1Hz
Event	10Hz, 5Hz, 4Hz	10Hz, 5Hz, 4Hz, 2Hz, 1Hz, 0.5Hz	
Full	20Hz	20Hz	

3 TWINS AND PRESSURE SENSOR DATA PRODUCTS

3.1 DATA PRODUCT OVERVIEW

TWINS/PS data consist of clusters of data records in a time-series. Both raw observations and calibrated data are provided. In addition to that, estimations on wind and air temperature free of perturbation from the lander (modeled data) may also be included and improved during the mission, depending on data availability and analysis. Raw data are measured in counts (except for configuration registers, which contain register values directly), while calibrated and modeled data products contain wind, air temperature and pressure in standard units (meters/second, Kelvin and Pascals). Each data product contains one sol of observations. All data products are CSV files (Comma Separated Value) in ASCII format. Continuous and event data are stored in separate files.

Table 6 shows a summary of TWINS/PS Data Products. Details can be found in Section 5.1.

Table 6 TWINS/PS Data Products

Instrument	Product	Processing level
TWINS	TWINS continuous raw science data	Raw
TWINS	TWINS event raw science data	Raw
TWINS	TWINS configuration registers	Raw
TWINS	Continuous wind speed/direction and air temperature at each sensor location (one per boom)	Calibrated
TWINS	Wind speed/direction and air temperature events	Calibrated
TWINS	Model-estimated wind speed/direction and air temperature	Derived
TWINS	Model-estimated wind speed/direction and air temperature events	Derived
Pressure Sensor	Continuous pressure raw data	Raw
Pressure Sensor	Pressure raw data events	Raw
Pressure Sensor	Continuous pressure calibrated data	Calibrated
Pressure Sensor	Pressure calibrated data events	Calibrated

3.2 DATA PROCESSING

This section describes the processing of TWINS/PS data products, their structure and organization, and their labeling.

3.2.1 Data Processing Level

Data processing levels mentioned in this SIS refer to the PDS4 processing level described in Table 7.

Table 7: Data processing level definitions

PDS4 processing level	PDS4 processing level description	CODMAC Level (used in PDS3)	NASA Level (used in PDS3)
n/a	Telemetry data with instrument data embedded. PDS does not archive telemetry data.	1	0
Raw	Original data from an instrument. 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	1A
Partially Processed	Data that have been processed beyond the raw stage but which have not yet reached calibrated status. These and more highly processed products are often called RDRs (Reduced Data Records).	3	1A
Calibrated	Data converted to physical units, which makes values independent of the instrument.	4	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+

TWINS and PS data products described in this SIS belong to raw and calibrated processing levels.

3.2.2 Data Product Generation

Both raw and calibrated data products are generated by the TWINS team at CAB.

TWINS and PS raw data products are generated using pre-processed raw data products provided by the Multimission Image Processing Laboratory (MIPL) team at JPL. Those pre-processed products are generated from telemetry using software called TWINS telemproc, and will be provided per downlink satellite pass, removing duplicates and correcting errors. CAB merges these products to create one single sol raw data product from multiple downlink passes. Observations are re-ordered based on AOBT when necessary. Older or partial products are replaced by newer and more complete versions. Newer versions will always contain the old data, plus any new data. Data in two's complement are converted to positive/negative values.

Telemetry data comes time tagged with AOBT, but raw data products have several time references: AOBT, SCLK, LTST, LMST and UTC. To get all of them, a conversion from AOBT to SCLK is done first, using time correlation files and software provided by CNES. Afterwards, SCLK is converted to LTST, LMST and UTC using SPICE data provided by NAIF.

TWINS configuration data products are created using binary CCSDS packets provided by MIPL. Binary data are converted to ASCII and time ordered.

TWINS and PS calibrated data are generated using raw data products, calibration parameters, SPICE data from NAIF and other ancillary data from the lander. TWINS derived data are generated using calibrated data.

3.2.3 Data Flow

This section describes only those portions of the InSight data flow that are directly connected to TWINS/PS archiving. A full description of InSight data flow is provided in the InSight Archive Generation, Validation, and Transfer Plan [4].

Telemetry first arrives at JPL, where the MIPL converts CCSDS packets to pre-raw data products and place them into FEI. TWINS science team at CAB will retrieve those data and create raw, calibrated and derived data products, which will all be placed back into FEI, for distribution to the Pressure Sensor science team at Cornell and the rest of the mission team. TWINS calibrated and derived data products will also be sent to CNES via a SFTP server, for integration into mini-SEED format and delivery to Incorporated Research Institutions for Seismology (IRIS) and to GEOSCOPE (geoscope.ipgp.fr).

The TWINS team generates PDS4 labels for all the data products, assembles the data and documentation into TWINS/PS archive bundles, and delivers the bundles to the PDS Atmospheres Node. Deliveries take place according to the release schedule agreed upon by the InSight Project and PDS and specified in the InSight Archive Plan. The Atmospheres Node validates the bundles for PDS4 compliance and for compliance with this SIS document, and makes them available to the public online.

Note that since FEI is used only during the life of the mission, the PDS archives are the official version of all data products.

3.3 STANDARDS USED IN GENERATING DATA PRODUCTS

TWINS/PS 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 following time standards and conventions are used throughout this document, as well as the InSight project for planning activities and identification of events.

Table 8 Time Standards

Time Format	Definition
AOBT	APSS onboard time. It is a 48-bit counter, where the 32 most significant bits are seconds and the 16 least significant bits are milliseconds.
SCET	Spacecraft event time. This is the time when an event occurred on-board the spacecraft, in UTC. It is usually derived from SCLK.
SCLK	Spacecraft Clock. This is an on-board 48-bit counter, in which the 32 most significant bits are seconds.
ERT	Earth Received Time. This is the time when the first bit of the packet containing the current data was received at the Deep Space (DSN) station. Recorded in UTC format.
Local Solar Time	Local Solar Time. LST is simply a measure of angles between landing (sub-spacecraft) and actual (for Local True Solar Time) or mean (for Local Mean Solar Time) sub-solar meridians on the surface of a body expressed as a "24 hour" local clock.*****
RCT	Record Creation Time. This is the time when the first telemetry packet, containing a given data set was created on the ground. Recorded in UTC format.

Local True Solar Time	Local True Solar Time. LTST is the local solar time expressed by the number of local solar days (SOLs) from a landing date and using a "24-hour" clock readout within the current local solar day (HR:MN:SC); LST is a true local solar time computed using positions of the Sun and the landing site from SPICE kernels specified in CHRONOS setup file*****. LTST sub-second precision is not provided by SPICE and hence not available in the data.
	
	LTST examples:
	`00012 12:00:01`
	`00132 01:22:32`
	`00002 09:00:00`

Local Mean Solar Time	Local Mean Solar Time. It is a local solar time computed by counting mean Martian seconds since a reference epoch corresponding to the LMST midnight on the day of landing and converting this count to the number of mean local solar days (SOLs) and hour-minutes-seconds-fraction of a "24-hour" clock (HR:MN:SC.TMSEC)***.**

	For TWINS/PS LMST has the format "nnnnnMhh:mm:ss.sss", where nnnnn is the sol number. LMST examples:
	`00064M08:03:03.350`
	`00001M21:01:34.432`
	`00123M14:02:43.123`

UTC	Universal Time Coordinated. It is the system of time keeping that gives a name to each instant of time of the International Atomic Time system.
	
	The format used for UTC in metadata labels is YYYY-MM-DDThh:mm:ss.fffZ. The format used for UTC within the data is YYYY-DOYThh:mm:ss.fffZ. UTC examples:
	`2019-012T12:00:00.000Z`
	`2020-182T23:32:34.020Z`
	`2020-01-17T14:05:24.384Z`

SOL	Solar Day Number. This is the number of complete solar days on Mars since landing. The landing day therefore is SOL zero.

(*) definition from http://naif.jpl.nasa.gov/misc/chronos_nsyt_ug.html

The PDS label for TWINS/PS data products uses keywords containing time values, such as start time, stop time, start spacecraft clock count, and stop spacecraft clock count. Each time value standard is defined according to the keyword definition.

3.3.2 Coordinate Systems

Different coordinate systems, or frames, are defined within the project to refer to the position and orientation of the Lander, its structures and science instruments. Different frames are defined for cruise, EDL and surface operations. Here, only Lander surface operations frames are referred (the complete frame definitions can be found at the NAIF web site: http://naif.jpl.nasa.gov/pub/naif/INSIGHT/kernels/fk/insight_v00.tf). Note that the Y axis completes the right-handed rule over the X and Z axis. That makes it point east or west depending on the direction of the other two axis for a given frame.

Table 9 Reference Frames

Coordinate System	***Origin***	***Orientation***
Topocentric frame	At InSight landing site	+Z normal outward at the landing site +X local North +Y local west
Local Vertical, Local Horizontal (LL) frame	Fixed with respect to the landed spacecraft	+Z points along local gravity vector (downwards) +X local North +Y local East
Lander frame	Centered on the launch vehicle separation plane (TBD millimeters above the lander deck)	+Z normal to launch vehicle interface plane (pointing down) +X pointed towards foot of deployed lander 0 degree leg (points away from the deck center toward the deck side opposite to the arm)

		+Y completes the right-handed frame and points along solar array axis of symmetry

3.3.3 Data Storage Conventions

TWINS/PS data products are composed of a detached file with PDS label and a data file.

The detached PDS labels are stored as XML. Label keywords will provide necessary information to determine the size and organization of the records.

The data file is stored as an ASCII table with variable width columns separated by commas. This format is commonly known as Comma Separated Value (CSV) format, and is described in RFC 4180 (http://tools.ietf.org/html/rfc4180). The first line contains column names. Each line is terminated by ASCII carriage-return and line-feed characters.

3.4 APPLICABLE SOFTWARE

Both TWINS and PS data products can be loaded into any software that can interpret ASCII CSV (Comma Separated Value) files, such as spreadsheet programs, and use them to display plots or any other kind of data analysis.

3.5 BACKUPS AND DUPLICATES

The Atmospheres Node 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 Center (NSSDC) for long-term preservation in a NASA-approved deep-storage facility. The Atmospheres Node may maintain additional copies of the archive products, either on or off-site as deemed necessary.

4 TWINS AND PS ARCHIVE ORGANIZATION, IDENTIFIERS AND NAMING CONVENTIONS

This section describes the basic organization of the TWINS/PS data archive 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 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 the following sections. The uniqueness of a product's LIDVID may be verified using the PDS Registry and Harvest tools.

4.1.1 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 TWINS/PS LIDs are formed according to the following conventions:

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

  urn:nasa:pds:<bundle ID>

  Example: urn:nasa:pds:insight_twins

  The bundle ID must be unique across all products 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_twins:data_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-raw", "data-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: urn:nasa:pds:insight_twins:data_raw:<product_id>

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. TWINS/PS product IDs are set to be the same as the data file name without the extension and the version number. See section 4.4 below for examples of TWINS/PS data product LIDs.

4.1.2 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 PDS Standards Reference [1] specifies rules for incrementing major and minor components.

4.1.3 File Naming Convention

TWINS/PS data products are named according to the following conventions:

<Instrument>_<Type>_<Sol>_ <Version>.csv

Where:

<Instrument>: may be "twins" or "ps".
<Type>: may be "raw", "config", "calib", "model" (in the case of continuous data), or rawevent, calibevent or modelevent (in the case of event data).
<Sol>: this is the sol in which the observations were taken. Always a four-digit number.
<Version>: product version number. Two digits.

Example filenames are "twins_raw_0023_01.csv", "twins_config_0123_03.csv", "ps_calib_0043_01.csv".

4.2 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 complete InSight TWINS/PS archive is organized into the bundles described in Table 10.

Table 10: TWINS/PS Bundles

Bundle Logical Identifier	Description
urn:nasa:pds:insight_twins	TWINS raw and calibrated data
urn:nasa:pds:insight_ps	Pressure Sensor raw and calibrated data

4.3 COLLECTIONS

Collections consist of basic products of the same type. The TWINS/PS Data Bundles contains the collections listed in Table 11. These are described in section 5.1.

Table 11: Collections in the TWINS and Pressure Data Bundles

Collection Logical Identifier	Collection Type	Description
urn:nasa:pds:insight_twins:data_raw	Data	TWINS raw data and configuration registers
urn:nasa:pds:insight_twins:data_calibrated	Data	TWINS calibrated data
urn:nasa:pds:insight_twins:data_derived	Data	TWINS derived data
urn:nasa:pds:insight_twins:document	Document	TWINS bundle documentation
urn:nasa:pds:insight_twins:xml_schema	XML_Schema	Contains XML schemas and related products which may be used for generating and validating PDS4 labels in this bundle.
urn:nasa:pds:insight_twins:context	Context	List of objects relevant to the mission and the instrument.

Collection Logical Identifier	Collection Type	Description
urn:nasa:pds:insight_ps:data_raw	Data	Pressure raw data
urn:nasa:pds:insight_ps:data_calibrated	Data	Pressure calibrated data
urn:nasa:pds:insight_ps:document	Document	Pressure bundle documentation
urn:nasa:pds:insight_ps:xml_schema	XML_Schema	Contains XML schemas and related products which may be used for generating and validating PDS4 labels in this bundle.
urn:nasa:pds:insight_ps:context	Context	List of objects relevant to the mission and the instrument.

4.4 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.

The tables below give examples of LIDs for data products in TWINS/PS collections (note that TWINS raw and TWINS config are in the same collection and hence share the LID prefix).

In these examples, <product_id> is the file name of the data product minus the version number and the extension.

Table 12: Examples of TWINS Data LIDs

Data Product Type	LID
TWINS raw	urn:nasa:pds:insight_twins:data_raw:<product_id>
TWINS config	
TWINS calibrated	urn:nasa:pds:insight_twins:data_calibrated:<product_id>
TWINS model	urn:nasa:pds:insight_twins:data_derived:<product_id>

Table 13: Examples of PS Data LIDs

Data Product Type	LID
Pressure raw	urn:nasa:pds:insight_ps:data_raw <product_id>
Pressure calibrated	urn:nasa:pds:insight_ps:data_calibrated:<product_id>

4.5 INSIGHT DOCUMENT BUNDLE AND COLLECTIONS

Documents are also considered products by PDS, and have LIDs, VIDs and PDS4 labels just as data products do. The InSight archives include an InSight Document Bundle, which consists of collections of documents relevant to the mission itself and all the science experiments. The document_apss collection will contain references to the documentation in the TWINS/PS bundles.

Table 14: Collections in the InSight Document Bundle

Collection Logical Identifier	Description
urn:nasa:pds:insight_documents:document_mission	InSight mission, spacecraft and lander descriptions
urn:nasa:pds:insight_documents:document_apss	APSS SIS, instrument description, and other relevant documents
urn:nasa:pds:insight_documents:document_camera	Camera SIS, instrument description, and other relevant documents
urn:nasa:pds:insight_documents:document_hp3rad	HP^3/RAD SIS, instrument description, and other relevant documents
urn:nasa:pds:insight_documents:document_ida	IDA SIS, instrument description, and other relevant documents

urn:nasa:pds:insight_documents:document_mag	MAG SIS, instrument description, and other relevant documents
urn:nasa:pds:insight_documents:document_rise	RISE SIS, instrument description, and other relevant documents
urn:nasa:pds:insight_documents:document_seis	SEIS SIS, instrument description, and other relevant documents
urn:nasa:pds:insight_documents:document_spice	SPICE relevant documents

Documents in the InSight Document Collections are assigned LIDs based on file names such that they are unique identifiers.

5 TWINS/PS ARCHIVE PRODUCT FORMATS

Data that comprise the TWINS/PS 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

This section describes the format and record structure of each of the data file types. All of them share the following commonalities described below:

All TWINS/PS data products are stored as ASCII tables in CSV format. The first line contains the names of the columns. Each line, including the last, is delimited by an ASCII carriage-return line-feed pair (<CR><LF>).

Data are time ordered. Five time references are provided: AOBT, SCLK, LMST, LTST and UTC (as defined in section 3.3.1). Each data product contains one sol of measurements. New versions of the same data products are generated if new data arrive for their corresponding sol.

Even though TWINS and PS have 1 Hz and 20 Hz sampling rate respectively, not all data downloaded and stored on data products have that frequency. It depends on download mode (as explained in sections 2.6.1.2 and 2.6.2.1). Since it may change during the same sol, this means that time deltas between lines are not constant through each file/sol. Downlink mode can be inferred by looking at the time difference between adjacent records. Any time difference higher than the sampling rate for each sensor should be considered a gap in the data. A “frequency” column is also provided in some cases: one for continuous calibrated pressure data, one for air temperature data, and another for wind data. In the case of air temperature and wind, the frequency column applies to all the columns related to those sensors for any given time tag.

TWINS sensors “frequency” columns may contain multiple frequencies separated by a slash “/”, if more than one data set were retrieved at the same time tag but at different frequencies. This is because in the case of TWINS a measurement at any particular time tag will have the same value regardless of the frequency at which it is downlinked to the ground. However, for pressure, that column contains only a single value, since in continuous retrieval pressure is not taken at more than one frequency at the same time.

Data retrieved in continuous mode are stored into separate files than those retrieved in event mode.

Data types of each column are defined using PDS data types (as defined in applicable document [1]). Values of hardware configuration or status registers are defined as strings containing hexadecimal integers using the notation “0x<hex_value>”.

TWINS calibrated and derived data include a column type named operational flags. These columns are strings of ones and zeroes representing different factors that describe the conditions in which the measurements were taken. For each factor, a ‘1’ means that it was optimal (and hence the data are of higher quality) and a ‘0’ that it was not. Confidence in the measured data will be bigger the higher the number of ‘1’ in the code. The character 'X' may be present in some codes for factors whose value is not known at the time of the data generation.

5.1.1 TWINS Data Products

There are four types of data products for TWINS: three raw, two calibrated and two derived.

5.1.1.1 TWINS raw continuous

This data product contains TWINS raw science data downloaded from the spacecraft in continuous mode. This includes Air Temperature Sensor PT1000 raw values, Wind Sensor counters and temperatures, and ASIC temperature. Data originally stored on board as two's complement have been converted to positive/negative values.

As explained in Section 2.6.1.2, in continuous mode only one sample every M (M defined to 10 at the beginning of the mission) will be recorded. The M value can be inferred by looking at the time difference between adjacent records. In addition, a frequency column is provided for wind channel and another one for air temperature channels, one per boom.

In continuous mode, and for mid-rod and extreme-rod air temperature PT1000 sensors, the recorded value is an average and a standard deviation using a window of N samples (N defined to 7). This window starts at the time in which the decimation process selects the rest of the data, each M samples. This means that the actual averages and standard deviations are obtained N seconds after the rest of the samples. For convenience, the data products contain all values aligned at the same time tags.

Air Temperature data for which the average and standard deviations are calculated have three columns: one for the raw value, for modes in which a single sample was retrieved, and two others with the average and standard deviations. Depending on the downlink mode used to retrieve the data, the appropriate column will contain the value and the other(s) will be empty.

Twins raw data columns can be found in Table 15

Table 15 TWINS Raw Data Columns

System	#	Column	Data Type	Description
Time References	1	AOBT	ASCII_Real	APSS Onboard Time
	2	SCLK	ASCII_Real	Spacecraft Clock
	3	LMST	ASCII_String	Local Mean Solar Time
	4	LTST	ASCII_String	Local True Solar Time
	5	UTC	ASCII_Date_Time_DOY_UTC	Coordinated Universal Time
BOOM -Y	6	BMY_2L_TEMP_1	ASCII_Integer	WS transducer 1 PCB temperature PT-1000 PRT
	7	BMY_2L_TEMP_2	ASCII_Integer	WS transducer 2 PCB temperature PT-1000 PRT
	8	BMY_2L_TEMP_3	ASCII_Integer	WS transducer 3

				PCB temperature PT-1000 PRT
	9	BMY_2L_TEMP_4	ASCII_Integer	ATS-mid-rod temperature: PT-1000 PRT sensor located at an intermediate position in the ATS rod
	10	BMY_2L_TEMP_4_AVERAGE	ASCII_Integer	ATS-mid-rod temperature average of the last N samples
	11	BMY_2L_TEMP_4_STD	ASCII_Integer	ATS-mid-rod temperature standard deviation of the last N samples
	12	BMY_2L_TEMP_5	ASCII_Integer	Boom Housing Temp: PT-1000 PRT located at the Boom housing near the base of the ATS rod
	13	BMY_2L_TEMP_6	ASCII_Integer	Calibration resistor: 1K ohm
	14	BMY_AIR_TEMP	ASCII_Integer	ATS-rod-extreme temperature: PT-1000 PRT located at ATS extreme
	15	BMY_AIR_TEMP_AVERAGE	ASCII_Integer	ATS-rod-extreme temperature average of the last N samples
	16	BMY_AIR_TEMP_STD	ASCII_Integer	ATS-rod-extreme temperature standard deviation of the last N samples
	17	BMY_WD_REF_OUT_1	ASCII_Integer	WS transducer 1 cold die temperature
	18	BMY_WD_REF_OUT_2	ASCII_Integer	WS transducer 2 cold die temperature
	19	BMY_WD_REF_OUT_3	ASCII_Integer	WS transducer 3 cold die temperature
	20	BMY_WD_OUT_1	ASCII_Integer	Number of counts measured for WS channel 1
	21	BMY_WD_OUT_2	ASCII_Integer	Number of counts measured for WS channel 2
	22	BMY_WD_OUT_3	ASCII_Integer	Number of counts measured for WS channel 3

	23	BMY_WD_OUT_4	ASCII_Integer	Number of counts measured for WS channel 4
	24	BMY_WD_OUT_5	ASCII_Integer	Number of counts measured for WS channel 5
	25	BMY_WD_OUT_6	ASCII_Integer	Number of counts measured for WS channel 6
	26	BMY_WD_OUT_7	ASCII_Integer	Number of counts measured for WS channel 7
	27	BMY_WD_OUT_8	ASCII_Integer	Number of counts measured for WS channel 8
	28	BMY_WD_OUT_9	ASCII_Integer	Number of counts measured for WS channel 9
	29	BMY_WD_OUT_10	ASCII_Integer	Number of counts measured for WS channel 10
	30	BMY_WD_OUT_11	ASCII_Integer	Number of counts measured for WS channel 11
	31	BMY_WD_OUT_12	ASCII_Integer	Number of counts measured for WS channel 12
	32	BMY_ASIC_TEMP	ASCII_Integer	ASIC temperature
	33	BMY_AIR_TEMP_FREQUENCY	ASCII_String	Air temperature channels frequency or frequencies
	34	BMY_WIND_FREQUENCY	ASCII_String	Wind channels frequency or frequencies
BOOM +Y	35	BPY_2L_TEMP_1	ASCII_Integer	WS transducer 1 PCB temperature PT-1000 PRT
	36	BPY_2L_TEMP_2	ASCII_Integer	WS transducer 2 PCB temperature PT-1000 PRT
	37	BPY_2L_TEMP_3	ASCII_Integer	WS transducer 3 PCB temperature PT-1000 PRT
	38	BPY_2L_TEMP_4	ASCII_Integer	Calibration resistor: 1K ohm
	39	BPY_2L_TEMP_5	ASCII_Integer	ATS-mid-rod temperature: PT-1000 PRT sensor located at a intermediate position in the ATS rod
	40	BPY_2L_TEMP_5_AVERAGE	ASCII_Integer	ATS-mid-rod temperature average of the last N samples
	41	BPY_2L_TEMP_5_STD	ASCII_Integer	ATS-mid-rod temperature

				standard deviation of the last N samples
	42	BPY_2L_TEMP_6	ASCII_Integer	Boom Housing Temp: PT-1000 PRT located at the Boom housing near the base of the ATS rod
	43	BPY_AIR_TEMP	ASCII_Integer	ATS-rod-extreme temperature: PT-1000 PRT located at ATS extreme
	44	BPY_AIR_TEMP_AVERAGE	ASCII_Integer	ATS-rod-extreme temperature average of the last N samples
	45	BPY_AIR_TEMP_STD	ASCII_Integer	ATS-rod-extreme temperature standard deviation of the last N samples
	46	BPY_WD_REF_OUT_1	ASCII_Integer	WS transducer 1 cold die temperature
	47	BPY_WD_REF_OUT_2	ASCII_Integer	WS transducer 2 cold die temperature
	48	BPY_WD_REF_OUT_3	ASCII_Integer	WS transducer 3 cold die temperature
	49	BPY_WD_OUT_1	ASCII_Integer	Number of counts measured for WS channel 1
	50	BPY_WD_OUT_2	ASCII_Integer	Number of counts measured for WS channel 2
	51	BPY_WD_OUT_3	ASCII_Integer	Number of counts measured for WS channel 3
	52	BPY_WD_OUT_4	ASCII_Integer	Number of counts measured for WS channel 4
	53	BPY_WD_OUT_5	ASCII_Integer	Number of counts measured for WS channel 5
	54	BPY_WD_OUT_6	ASCII_Integer	Number of counts measured for WS channel 6
	55	BPY_WD_OUT_7	ASCII_Integer	Number of counts measured for WS channel 7
	56	BPY_WD_OUT_8	ASCII_Integer	Number of counts measured for WS channel 8
	57	BPY_WD_OUT_9	ASCII_Integer	Number of counts measured for WS channel 9

	58	BPY_WD_OUT_10	ASCII_Integer	Number of counts measured for WS channel 10
	59	BPY_WD_OUT_11	ASCII_Integer	Number of counts measured for WS channel 11
	60	BPY_WD_OUT_12	ASCII_Integer	Number of counts measured for WS channel 12
	61	BPY_ASIC_TEMP	ASCII_Integer	ASIC temperature
	62	BPY_AIR_TEMP_FREQUENCY	ASCII_String	Air temperature channels frequency or frequencies
	63	BPY_WIND_FREQUENCY	ASCII_String	Wind channels frequency or frequencies

5.1.1.2 TWINS raw event

Event raw data are retrieved at a higher frequency that continuous data for the same time interval. In the case of TWINS, this is nominally 1Hz, but other rates are available. As in the case of continuous data, the frequency can be obtained by looking at the time deltas between consecutive records, for the same boom or by using the provided frequency columns.

The columns included in TWINS event raw data products are the same as those in TWINS continuous raw data products and are defined in Table 15.

5.1.1.3 TWINS config

A TWINS config data product contains the value of the TWINS ASICs configuration registers, which are needed to generate calibrated data products.

The initial values of those registers are commanded from earth. Some of them (namely, IX current configuration registers) are updated onboard by the PAE depending on temperature conditions. A record of these registers is created each time they change.

Since the registers updated onboard automatically correspond to one of several predefined sets (one per temperature range), two columns (BMY_WIND_CONF_TABLE and BPY_WIND_CONF_TABLE) show the name assigned to the set used. If the set cannot be identified because several correspondences are available for the same register values, all the possible names are shown separated by a slash (“/”).

To generate calibrated products, the last recorded known configuration for a given time is used.

Columns for this data product are in Table 16.

Table 16 TWINS Config Columns

System	#	Column	Data Type	Description
Time References	1	AOBT	ASCII_Real	APSS Onboard Time
	2	SCLK	ASCII_Real	Spacecraft Clock

	3	LMST	ASCII_String	Local Mean Solar Time
	4	LTST	ASCII_String	Local True Solar Time
	5	UTC	ASCII_Date_Time_DOY_UTC	Coordinated Universal Time
BOOM -Y	6	BMY_WIND_ CONF_TABLE	ASCII_String	Boom -Y wind configuration table that corresponds to this register set
	7	BMY_GENERAL_CFG	ASCII_String (hex)	General Configuration Register
	8	BMY_A/D_CONVERTER_CFG	ASCII_String (hex)	A/D Converter Configuration Register
	9	BMY_MISCELLANEOUS_CFG	ASCII_String (hex)	Miscellaneous Config. Register
	10	BMY_IR_COND_2	ASCII_String (hex)	IR_COND 2 Configuration Register
	11	BMY_IR_COND_3	ASCII_String (hex)	IR_COND 3 Configuration Register
	12	BMY_IR_COND_4	ASCII_String (hex)	IR_COND 4 Configuration Register
	13	BMY_WD_CFG	ASCII_String (hex)	WD_CFG Configuration Register
	14	BMY_WD_IX_1	ASCII_String (hex)	WD IX _1 Current Configuration Register
	15	BMY_WD_IX_2	ASCII_String (hex)	WD IX _2 Current Configuration Register
	16	BMY_WD_IX_3	ASCII_String (hex)	WD IX _3 Current Configuration Register
	17	BMY_WD_IX_4	ASCII_String (hex)	WD IX _4 Current Configuration Register
	18	BMY_WD_IX_5	ASCII_String (hex)	WD IX _5 Current Configuration Register
	19	BMY_WD_IX_6	ASCII_String (hex)	WD IX _6 Current Configuration Register
	20	BMY_WD_IX_7	ASCII_String (hex)	WD IX _7 Current Configuration Register
	21	BMY_WD_IX_8	ASCII_String (hex)	WD IX _8 Current Configuration Register
	22	BMY_WD_IX_9	ASCII_String (hex)	WD IX _9 Current Configuration Register
	23	BMY_WD_IX_10	ASCII_String (hex)	WD IX _10 Current Configuration Register
	24	BMY_WD_IX_11	ASCII_String (hex)	WD IX _11 Current Configuration Register
	25	BMY_WD_IX_12	ASCII_String (hex)	WD IX _12 Current Configuration Register
	26	BMY_BAND_CFG	ASCII_String (hex)	ASIC Band Gap Configuration Register
	27	BMY_TST_CFG	ASCII_String (hex)	ASIC Test Configuration Register
	28	BMY_STATUS	ASCII_String (hex)	ASIC Status Register
	29	BMY_A/D_OFFSET_REG2	ASCII_Integer	ASIC A/D Offset register 2
	30	BMY_A/D_OFFSET_REG1	ASCII_Integer	ASIC A/D Offset register 1
BOOM +Y	31	BPY_WIND_CONF_TABLE	ASCII_String	Boom +Y wind configuration table that corresponds to this register set
	32	BPY_GENERAL_CFG	ASCII_String (hex)	General Configuration Register
	33	BPY_A/D_CONVERTER_CFG	ASCII_String (hex)	A/D Converter Configuration Register
	34	BPY_MISCELLANEOUS_CFG	ASCII_String (hex)	Miscellaneous Config. Register
	35	BPY_IR_COND_2	ASCII_String (hex)	IR_COND 2 Configuration Register
	36	BPY_IR_COND_3	ASCII_String (hex)	IR_COND 3 Configuration

				Register
	37	BPY_IR_COND_4	ASCII_String (hex)	IR_COND 4 Configuration Register
	38	BPY_WD_CFG	ASCII_String (hex)	WD_CFG Configuration Register
	39	BPY_WD_IX_1	ASCII_String (hex)	WD IX _1 Current Configuration Register
	40	BPY_WD_IX_2	ASCII_String (hex)	WD IX _2 Current Configuration Register
	41	BPY_WD_IX_3	ASCII_String (hex)	WD IX _3 Current Configuration Register
	42	BPY_WD_IX_4	ASCII_String (hex)	WD IX _4 Current Configuration Register
	43	BPY_WD_IX_5	ASCII_String (hex)	WD IX _5 Current Configuration Register
	44	BPY_WD_IX_6	ASCII_String (hex)	WD IX _6 Current Configuration Register
	45	BPY_WD_IX_7	ASCII_String (hex)	WD IX _7 Current Configuration Register
	46	BPY_WD_IX_8	ASCII_String (hex)	WD IX _8 Current Configuration Register
	47	BPY_WD_IX_9	ASCII_String (hex)	WD IX _9 Current Configuration Register
	48	BPY_WD_IX_10	ASCII_String (hex)	WD IX _10 Current Configuration Register
	49	BPY_WD_IX_11	ASCII_String (hex)	WD IX _11 Current Configuration Register
	50	BPY_WD_IX_12	ASCII_String (hex)	WD IX _12 Current Configuration Register
	51	BPY_BAND_CFG	ASCII_String (hex)	ASIC Band Gap Configuration Register
	52	BPY_TST_CFG	ASCII_String (hex)	ASIC Test Configuration Register
	53	BPY_STATUS	ASCII_String (hex)	ASIC Status Register
	54	BPY_A/D_OFFSET_REG2	ASCII_Integer	ASIC A/D Offset register 2
	55	BPY_A/D_OFFSET_REG1	ASCII_Integer	ASIC A/D Offset register 1

5.1.1.4 TWINS calibrated continuous

Twins calibrated continuous files contain wind local to each boom and the temperature measured by each individual sensor in the Air Temperature Sensor rod, retrieved in continuous mode. Wind is provided as two speed components, horizontal and vertical (defined by the local gravity), both in meters/second, and a direction. Temperatures are given in Kelvin.

Continuous calibrated data are generated using TWINS continuous raw data products, continuous calibrated pressure data and lander ancillary data. Their accuracy depends on several factors specified in the operational flags.

Under some wind conditions, calibrated wind direction and/or speed cannot be calculated. This causes their corresponding columns to be empty, even when there are no gaps in the data. This can be checked by comparing with the twins raw data products. The WIND_FREQUENCY column for the boom(s) in which this happens will not be empty, which will only happen if there is a data gap.

TWIS calibrated data format is specified in Table 17. Operational flags used for calibrated data are specified in
Table 18 and Table 19.

Table 17 TWINS Calibrated Data Columns

System	#	Column	Data Type	Description
Time References	1	AOBT	ASCII_Real	APSS Onboard Time
	2	SCLK	ASCII_Real	Spacecraft Clock
	3	LMST	ASCII_String	Local Mean Solar Time
	4	LTST	ASCII_String	Local True Solar Time
	5	UTC	ASCII_Date_Time_DOY_UTC	Coordinated Universal Time
BOOM –Y Wind	6	BMY_HORIZONTAL_WIND_SPEED	ASCII_Real	Wind horizontal speed, in meters/second
	7	BMY_VERTICAL_WIND_SPEED	ASCII_Real	Wind vertical speed, in meters/second
	8	BMY_WIND_DIRECTION	ASCII_Real	Wind direction
	9	BMY_WIND_FREQUENCY	ASCII_String	Wind data frequency or frequencies
	10	BMY_WS_OPERATIONAL_FLAGS	ASCII_String	Wind Sensor operational flags
BOOM –Y Air Temperature	11	BMY_BASE_ROD_TEMP	ASCII_Real	Temperature at the boom housing near the base of the ATS rod, in Kelvin
	12	BMY_MID_ROD_TEMP	ASCII_Real	Temperature at an intermediate position in the ATS rod, in Kelvin
	13	BMY_TIP_ROD_TEMP	ASCII_Real	Temperature at the tip of the ATS rod, in Kelvin
	14	BMY_AIR_TEMP_FREQUENCY	ASCII_String	Temperature data frequency or frequencies
	15	BMY_AIR_TEMP_OPERATIONAL_FLAGS	ASCII_String	Air Temperature Sensor operational flags
BOOM +Y Wind	16	BPY_HORIZONTAL_WIND_SPEED	ASCII_Real	Wind horizontal speed, in meters/second
	17	BPY_VERTICAL_WIND_SPEED	ASCII_Real	Wind vertical speed, in meters/second
	18	BPY_WIND_DIRECTION	ASCII_Real	Wind direction
	19	BPY_WIND_FREQUENCY	ASCII_String	Wind data frequency or frequencies
	20	BPY_WS_OPERATIONAL_FLAGS	ASCII_String	Wind Sensor operational flags
BOOM +Y Air Temperature	21	BPY_BASE_ROD_TEMP	ASCII_Real	Temperature at the boom housing near the base of the ATS rod, in Kelvin
	22	BPY_MID_ROD_TEMP	ASCII_Real	Temperature at an intermediate position in the ATS rod, in Kelvin
	23	BPY_TIP_ROD_TEMP	ASCII_Real	Temperature at the tip of the ATS rod, in Kelvin
	24	BPY_AIR_TEMP_FREQUENCY	ASCII_String	Temperature data frequency or

				frequencies
	25	BPY_AIR_TEMP_OPERATIONAL_FLAGS	ASCII_String	Air Temperature Sensor operational flags

Table 18 Wind Sensor Calibrated Data Operational Flags

Flag	Factor	Values	Description
0	ASIC temperature	0 = out of operational range 1 = in operational range	If ASIC temperature is out of its operational range, the ASIC won't work properly, and neither the Wind Sensor.
1	Frequency	0 = low rate (less than 1Hz) 1 = high rate (1 Hz)	When only low rate data are available, wind data cannot be determined reliably.
2	Front wind	0 = wind not coming from the front of the boom or boom off 1 = wind coming from the front of the boom	Wind accuracy is less reliable when wind is coming from the rear of the boom.

Table 19 Air Temperature Sensor Calibrated Data Operational Flags

Flag	Factor	Values	Description
0	ASIC temperature	0 = out of operational range 1 = in operational range	If ASIC temperature is out of its operational range, the ASIC won't work properly, and neither the ATS.
1	Direct measurement	0 = temperatures calculated using proxies (averages) 1 = temperatures calculated using direct measurements	If 0, any of the temperatures were calculated using proxies, such as averages, instead of direct measurements.
2	Affected by lander thermal plume	0 = affected 1 = not affected	A value of 0 means ATS is contaminated by the lander's thermal plume. If 1, ATS is outside thermal plume, which depends on the wind speed and direction.
3	Accuracy	0 = accuracy higher 6ºC or low frequency data 1 = accuracy less than 6ºC	If 1, the row contains high accuracy data. Error less than 6 degrees can only be achieved when 1 Hz data are available.

5.1.1.5 TWINS calibrated event

TWINS calibrated event data products contain calibrated data calculated using TWINS event raw data products. They have the same format and rules as specified for TWINS continuous calibrated data.

5.1.1.6 TWINS modeled continuous

TWINS modeled data includes an estimation of wind data in the absence of perturbation from the lander (in the same components as in calibrated data), as well as the local air temperature in the vicinity of each boom (in Kelvin), after applying a model that integrates the three rod air temperatures to estimate the temperature of the fluid around the instrument, free of thermal contamination from the boom. These data products are calculated using TWINS continuous calibrated data as the starting point.

Table 20 TWINS Modeled Data Columns

System	#	Column	Data Type	Description
Time References	1	AOBT	ASCII_Real	APSS Onboard Time
	2	SCLK	ASCII_Real	Spacecraft Clock
	3	LMST	ASCII_String	Local Mean Solar Time
	4	LTST	ASCII_String	Local True Solar Time
	5	UTC	ASCII_Date_Time_DOY_UTC	Coordinated Universal Time
Wind	6	HORIZONTAL_WIND_SPEED	ASCII_Real	Wind horizontal speed, in meters/second
	7	VERTICAL_WIND_SPEED	ASCII_Real	Wind vertical speed, in meters/second
	8	WIND_DIRECTION	ASCII_Real	Wind direction
	9	WIND_FREQUENCY	ASCII_String	Wind data frequency or frequencies
	10	WS_OPERATIONAL_FLAGS	ASCII_String	Wind Sensor operational flags
Air Temperature	11	BMY_ AIR_TEMP	ASCII_Real	Local Air Temperature at boom -Y, in Kelvin
	12	BMY_AIR_TEMP_FREQUENCY	ASCII_String	Air Temperature data frequency or frequencies
	13	BMY_AIR_TEMP_OPERATIONAL_FLAGS	ASCII_String	Boom –Y Air Temperature Sensor operational flags
	14	BPY_ AIR_TEMP	ASCII_Real	Local Air Temperature at boom +Y, in Kelvin
	15	BPY_AIR_TEMP_FREQUENCY	ASCII_String	Air Temperature data frequency or frequencies
	16	BPY_AIR_TEMP_OPERATIONAL_FLAGS	ASCII_String	Boom +Y Air Temperature Sensor operational flags

Table 21 Wind Sensor Model Data Operational Flags

Flag	Factor	Values	Description
0	ASIC temperature	0 = out of operational range 1 = in operational range	If ASIC temperature is out of its operational range, the ASIC won't work properly, and neither the Wind Sensor.
1	Frequency	0 = low rate (less than 1Hz) 1 = high rate (1 Hz)	When only low rate data are available, wind data cannot be determined reliably.
2	Boom -Y on	0 = boom -Y is off 1 = boom -Y is on	Wind accuracy is less reliable when only one boom is active, and wind is coming from the rear of that boom. Data are more accurate
3	Boom +Y on	0 = boom +Y is off 1 = boom +Y is on	
4	Front wind boom -Y	0 = wind not coming from the front of boom -Y or boom -Y off	

		1 = wind coming from the front of boom –Y	when both booms are used, since they will cover a wider range of optimal wind directions.
5	Front wind boom +Y	0 = wind not coming from the front of boom +Y or boom +Y off 1 = wind coming from the front of boom +Y	

Table 22 Air Temperature Sensor Model Data Operational Flags

Flag	Factor	Values	Description
0	ASIC temperature	0 = out of operational range 1 = in operational range	If ASIC temperature is out of its operational range, the ASIC won't work properly, and neither the ATS.
1	Direct measurement	0 = temperature calculated using proxies (such as averages) 1 = temperature calculated using direct measurements	If 0, the temperatures was calculated using proxies, such as averages, instead of direct measurements.
2	Affected by lander thermal plume	0 = affected 1 = not affected	A value of 0 means ATS is contaminated by the lander's thermal plume. If 1, ATS is outside thermal plume, which depends on the wind speed and direction.
3	Accuracy	0 = accuracy higher 6ºC or low frequency data	If 1, the row contains high accuracy data. Error less than 6 degrees can only be achieved when 1 Hz data are available.

5.1.1.7 TWINS modeled event

These data products have the same type of information and format as TWINS continuous modeled data, but they use TWINS event calibrated data products as the source of processing, instead of continuous calibrated data.

5.1.2 Pressure Sensor Products

5.1.2.1 Pressure raw continuous

Pressure raw data will go through several filters before being downlinked from the spacecraft, depending on bandwidth availability or interesting events (downlink modes, see section 2.6.2). Those filters will usually be a series of FIR filters that will reduce sampling frequency. The result of those calculations will come down to Earth as a channel. Channels selected for downlink will depend on downlink mode, either continuous or event. Pressure continuous raw data files have a column for each possible continuous channel. Only one pressure and pressure temperature channel will be enabled for a particular time frame. The rest of the columns will be empty.

Since new sets of filters may be used during the mission, Pressure raw data products may incorporate new columns in the future.

In addition to pressure and pressure temperature, the ESTA (introduced in section 2.6.2) is included. ESTA is calculated onboard, and its purpose is to help to determine if there are data interesting to request event data retrieval, by giving insight into any high frequency signals above 1Hz (such as turbulence level, infra-sounds). For that, a high pass FIR filter is first applied to raw pressure data to extract only high frequencies of the signal, and to remove any low frequency component (including average pressure value). Then, a root mean square is computed over a 2s window, that should give the square root of the pressure signal energy in the pass band of the filter average over the 2s window.

Table 23 Pressure Raw Data Columns

System	#	Column	Data Type	Description
Time References	1	AOBT	ASCII_Real	APSS Onboard Time
	2	SCLK	ASCII_Real	Spacecraft Clock
	3	LMST	ASCII_String	Local Mean Solar Time
	4	LTST	ASCII_String	Local True Solar Time
	5	UTC	ASCII_Date_Time_DOY_UTC	Coordinated Universal Time
Pressure	6	P_2Hz	ASCII_Integer	Pressure 2Hz
	7	P_10Hz	ASCII_Integer	Pressure 10Hz
	8	P_20Hz	ASCII_Integer	Pressure Raw 20Hz
	9	P_TEMP_pt2Hz	ASCII_Integer	Pressure Temperature 0.2Hz
	10	P_TEMP_20Hz	ASCII_Integer	Pressure Temperature 20Hz
	11	P_ESTA_pt5Hz	ASCII_Integer	Pressure ESTA at 0.5Hz

5.1.2.2 Pressure raw event

Pressure event raw data products are defined in a similar way to pressure event raw data products, but containing only columns for each possible channel usable for event retrieval. Contrary to pressure continuous data, multiple pressure and pressure temperature channels may be enabled for any given time frame.

System	#	Column	Data Type	Description
Time References	1	AOBT	ASCII_Real	APSS Onboard Time
	2	SCLK	ASCII_Real	Spacecraft Clock
	3	LMST	ASCII_String	Local Mean Solar Time
	4	LTST	ASCII_String	Local True Solar Time
	5	UTC	ASCII_Date_Time_DOY_UTC	Coordinated Universal Time
Pressure	6	P_4Hz	ASCII_Integer	Pressure 4Hz
	7	P_5Hz	ASCII_Integer	Pressure 5Hz
	8	P_10Hz	ASCII_Integer	Pressure 10Hz
	9	P_20Hz	ASCII_Integer	Pressure Raw 20Hz
	10	P_TEMP_pt5Hz	ASCII_Integer	Pressure Temperature 0.5Hz
	11	P_TEMP_1Hz	ASCII_Integer	Pressure Temperature 1Hz
	12	P_TEMP_2Hz	ASCII_Integer	Pressure Temperature 2Hz
	13	P_TEMP_4Hz	ASCII_Integer	Pressure Temperature 4Hz
	14	P_TEMP_5Hz	ASCII_Integer	Pressure Temperature 5Hz
	15	P_TEMP_10Hz	ASCII_Integer	Pressure Temperature 10Hz
	16	P_TEMP_20Hz	ASCII_Integer	Pressure Temperature Raw 20Hz

5.1.2.3 Pressure calibrated continuous

This data product provides calibrated pressure (in Pascals) in addition to the calibrated value of its temperature (in Kelvin). These two magnitudes are calculated using the enabled ones for any given time interval in the Pressure continuous raw data products.

Table 24 Pressure Calibrated Data Columns

System	#	Column	Data Type	Description
Time References	1	AOBT	ASCII_Real	APSS Onboard Time

	2	SCLK	ASCII_Real	Spacecraft Clock
	3	LMST	ASCII_String	Local Mean Solar Time
	4	LTST	ASCII_String	Local True Solar Time
	5	UTC	ASCII_Date_Time_DOY_UTC	Coordinated Universal Time
Pressure	6	PRESSURE	ASCII_Real	Pressure in Pascals
	7	PRESSURE_FREQUENCY	ASCII_Real	Pressure data frequency
	8	PRESSURE_TEMP	ASCII_Real	Pressure Sensor temperature in Kelvin
	9	PRESSURE_TEMP_FREQUENCY	ASCII_REal	Pressure Sensor temperature data frequency

5.1.2.4 Pressure calibrated event

Pressure event calibrated data products contain calibrated pressure and pressure temperatures for all available frequencies in Pressure event raw data products.

System	#	Column	Data Type	Description
Time References	1	AOBT	ASCII_Real	APSS Onboard Time
	2	SCLK	ASCII_Real	Spacecraft Clock
	3	LMST	ASCII_String	Local Mean Solar Time
	4	LTST	ASCII_String	Local True Solar Time
	5	UTC	ASCII_Date_Time_DOY_UTC	Coordinated Universal Time
Pressure	6	P_4Hz	ASCII_Real	Pressure 4Hz
	7	P_5Hz	ASCII_Real	Pressure 5Hz
	8	P_10Hz	ASCII_Real	Pressure 10Hz
	9	P_20Hz	ASCII_Real	Pressure 20Hz
	10	P_TEMP_pt5Hz	ASCII_Real	Pressure Temperature 0.5Hz
	11	P_TEMP_1Hz	ASCII_Real	Pressure Temperature 1Hz
	12	P_TEMP_2Hz	ASCII_Real	Pressure Temperature 2Hz
	13	P_TEMP_4Hz	ASCII_Real	Pressure Temperature 4Hz
	14	P_TEMP_5Hz	ASCII_Real	Pressure Temperature 5Hz
	15	P_TEMP_10Hz	ASCII_Real	Pressure Temperature 10Hz
	16	P_TEMP_20Hz	ASCII_Real	Pressure Temperature 20Hz

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 may be provided as TIFF, GIF, JPEG, or PNG files.

5.3 PDS LABELS

Each TWINS/PS 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 product, however, may consist of one or more data objects. The data objects of a given product may all reside in a single file, or they may be stored in multiple separate files, in which case the PDS4 label points to all the files. A PDS4 label file usually has the same name as the data product it describes, but always with the extension ".xml".

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 documents which govern the products in this archive. These documents contain attribute and parameter definitions specific to the InSight mission. A list of the XML documents associated with this archive is provided provided at http://pds.nasa.gov/pds4/schema/released/.

Appendix A Support staff and cognizant persons

Table 25: Archive support staff

TWINS/PS Team		
Name	**Affiliation**	**Email**
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