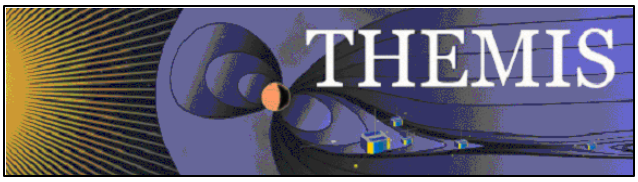

THEMIS
FIELDS L1 Data files Variable Name Definition

THM-SOC-105
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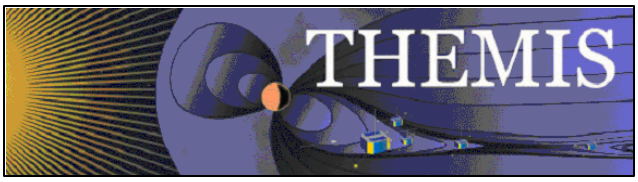

Document Revision Record

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-	2006-09-11	Draft	-
-	2006-09-18	Signature Version	
-	2006-09-22	Added 405 in APID table	
-	2006-09-29	Lowercase variable names, Added “tha_eff_ac” flag	Signatories

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Identifier	Description

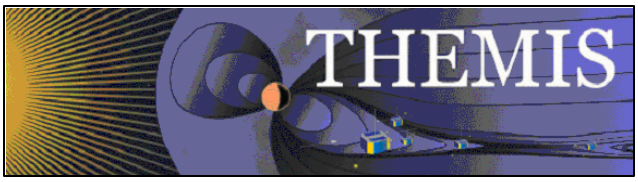


Table of Contents

1. Introduction

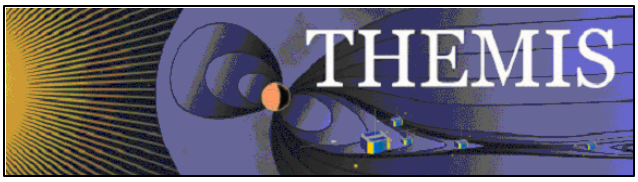
1.1 Purpose and Scope.

THEMIS data are transmitted to the ground as Virtual Channel (VC), APplication Identifier (APID) packets, each containing packets of a specific instrument data type from a specific IDPU instrument APID. Time-ordering of individual APID packet files, time-tagging, decompression of the IDPU post-recording compression, a small re-arrangement of quantities and possible trivial processing of raw quantities results in L0 file data. These files (herein termed APID_L0DAT.pkt) contain APID data in daily files. The APIDs are described in: thm_fsw_003_ctm_v4.013.xls (and previous versions), and are also listed below:

THEMIS IDPU APPLICATION IDENTIFIERS

APID(Hex)	Description of Packet
405	IDPU FGM CAL DATA
410	IDPU SPIN FIT PACKET (EFI & FGM)
411	spare
412	spare
440	DIGITAL FIELDS BOARD FILTERS
441	DIGITAL FIELDS BOARD Fast Survey (A) V1-V6
442	DIGITAL FIELDS BOARD Fast Survey (B) V1-V6
443	DIGITAL FIELDS BOARD Fast Survey E12DC, E34DC, E56DC at 2 to 256 Hz
444	DIGITAL FIELDS BOARD Fast Survey SCM1, SCM2, SCM3 at 2 to 256 Hz
445	DIGITAL FIELDS BOARD Particle Burst (A) V1-V6 at 2 to 256 Hz
446	DIGITAL FIELDS BOARD Particle Burst (B) V1-V6 at 2 to 256 Hz
447	DIGITAL FIELDS BOARD Particle Burst E12DC, E34DC, E56DC at 2 to 256 Hz
448	DIGITAL FIELDS BOARD Particle Burst SCM1, SCM2, SCM3 at 2 to 256 Hz
449	DIGITAL FIELDS BOARD Wave Burst (A) V1-V6 at 512 to 8192 Hz
44A	DIGITAL FIELDS BOARD Wave Burst (B) V1-V6 at 512 to 8192 Hz
44B	DIGITAL FIELDS BOARD Wave Burst E12DC, E34DC, E56DC at 512 to 16384 Hz
44C	DIGITAL FIELDS BOARD Wave Burst SCM1, SCM2, SCM3 at 512 to 16384 Hz
44D	DIGITAL FIELDS BOARD Particle Burst Spectra 1 to 4 16-64 pts @1/4-8 Hz
44E	DIGITAL FIELDS BOARD Wave Burst Spectra 1 to 4 16-64 pts @1/4-8 Hz
44F	spare
450	spare
451	Trigger Data
452	SST Engineering Data
453	ESA and SST Moments [212 bytes/spin]
454	iESA_FDF Survey Ion Angle*Energies
455	iESA_RDF Survey Ion Angle*Energies
456	iESA_FDF Burst Ion Angle*Energies
457	eESA_FDF Survey Electron Angle*Energies
458	eESA_RDF Survey Electron Angle*Energies
459	eESA_FDF Burst Electron Angle*Energies
45A	iSST_FDF Survey Ion Angle*Energies
45B	iSST_RDF Survey Ion Angle*Energies
45C	iSST_FDF Burst Ion Angle*Energies
45D	eSST_FDF Survey Electron Angle*Energies
45E	eSST_RDF Survey Electron Angle*Energies
45F	eSST_FDF Burst Electron Angle*Energies
460	FGM LOW RATE DATA (TML)
461	FGM HIGH RATE DATA (TMH)

THEMIS Level 1 probe data (herein termed L1DAT.cdf), shall be CDF files containing the above L0 data, in principle as close to their L0 format as feasible, but with addition of metadata and time stamps that facilitate interpretation and access by the scientific community. It is anticipated that L1 files will originally



contain data stemming from their individual APID files, but will eventually be merged into a single daily multi-instrument file, containing all the science APIDs for a single probe.

Generation of physical quantities from such L1DAT.cdf files shall proceed, in principle, by use of two additional files and a piece of code: A calibration file (herein termed CAL.cdf), a probe STATE file (herein termed STATE.cdf) and a piece of IDL code that reads the three files, calibrates and transforms the data into the proper coordinate system and produces physical quantities.

The purpose of this document is to define the EFI, SCM and FGM instrument L1 data file quantities and names. The overarching principle is to create short and unique mnemonics that facilitate easy understanding of the data quantities they carry, while preserving, if possible, the efficiency (and compactness) of the L0 and APID data representation.

1.2 Applicable Documents.

1.	THM_SYS_012_PDMP	THEMIS Project Data Management Plan
2.	THM_SOC_101_TIME	THEMIS TIME Definition
3.	THM_SOC_108_GMAG_L1_VARNAMES	THEMIS GMAG Variable Name Def's
4.	THM_SOC_109_ASI_L1_VARNAMES	THEMIS ASI Variable Name Definitions
5.	THM_SOC_110_COORDINATES	THEMIS Coordinate Systems Definitions
6.	THM_SOC_111_SUNSENSPROC	THEMIS SUN SENSOR Science Processing
7.	THM_SOC_112_ATTPAIPROC	THEMIS Science ATT & Inertia Determ.
8.	THM_SOC_113_FGM_CALPROC	THEMIS FGM CAL File and Processing
9.	THM_SOC_114_SCM_CALPROC	THEMIS SCM CAL File and Processing
10.	THM_SOC_115_EFI_CALPROC	THEMIS EFI CAL File and Processing
11.	THM_SOC_116_ESA_CALPROC	THEMIS ESA CAL File and Processing
12.	THM_SOC_117_SST_CALPROC	THEMIS SST CAL File and Processing
13.	THM_SOC_117_ASI_CALPROC	THEMIS ASI CAL File and Processing

2. General L1DAT File Variable Naming Conventions

2.1 Construct of FIELDS VARNAMES: th[a-e]_xxyY; th[a-e]_xxy_zz

Following an overall principle of naming THEMIS variables using more general to less general descriptors, separated by the underscore character "_", the EFI, SCM and FGM Variables shall be named: th[a-e]_xxx, where a-e is the probe letter – identifier, and "xxx" is the unique, descriptive quantity identifier. This construct works well with data from all fields instruments, and when further specificity is required in order to ensure optimal file size, such as in the number of spectral quantities, additional descriptors _yy are utilized.

2.2 FIELDS Packet HEADERs: th[a-e]_xxy_hed; th[a-e]_xxy_zz_hed

Packet header information and packet time (but not packet data) shall be included in the L1 files. Such headers shall be named by appending the 3 letters "hed" to the variable name, e.g., "th[a-e]_xxy_hed", or "th[a-e]_xxx_zz_hed".

3. Specific FIELDS Quantities

A map of valid EFI, SCM and FGM variable names and the corresponding APIDs is shown below. Blanks are non-existent variable names since there is no data product corresponding to that "xxy" combination. The _fit varname does not conform to the "_xxy" breakdown.

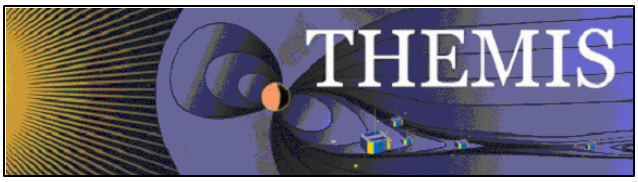


Table 1. EFI variable names: mnemonics and association with APIDs

		_xxy	_xxs	_xxf	_xxp	_xxw
Spin Fits	**E&B spin fits**	**_fit**	_fit=410			
Spectra	**Filter Bank**	**_fby**	_fby=440, y∈{1,2,h}			
	DFB Fast Fourier	**_ffy**			_ffp=44d	_ffw=44e
Waveforms	**Voltage A**	**_vay**		_vaf=441	_vap=445	_vaw=449
	Voltage B	**_vby**		_vbf=442	_vbp=446	_vbw=44A
	Electric Field	**_efy**		_eff=443	_efp=447	_efw=44B
	Search Coil	**_scy**		_scf=444	_scp=448	_scw=44C
	Flux Gate	**_fgy**	fge=405; fgl=460; fgh=461			

3.1 Spin Fits (APID 410): _fit

Spin fits of electric and magnetic field shall be contained within quantity: _fit, a 2x5 element R*4 array, as shown in Table 2. This is a 2 dimensional quantity of size 2x5, where _fit.dat(0,*) is E-field information and _fit.dat(1,*) is B-field information.

The information on the code used for the fits shall be contained within quantity _fit_code, a 1dimensional, 2 element, BYTE array, as shown in Table 2.

The number of points in the fits shall be contained in quantity _fit_npts, a 1dimensional, 2 element, BYTE array, as shown in Table 2.

Table 2. Map of the _FIT quantities

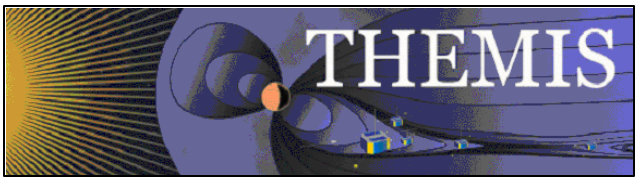
	101000x1: Fit Code, A1 for V12, A3 for V34, B1 for FGM-X, B2 for FGM-Y, BYTE	xxnnnnnn Integer N, 0-32, BYTE	Real * 4				
Use	Code	N_points	A	B	C	Sigma	Z Avg
NAME	**_fit_code (2)**	**_fit_npts(2)**	**_fit (2x5)**				
E	_fit_code (0)	_fit_npts (0)	(0,0)	(0,1)	(0,2)	(0,3)	(0,4)
B	_fit_code (1)	_fit_npts (1)	(1,0)	(1,1)	(1,2)	(1,3)	(1,4)

3.2 Spectra (APIDs 440, 44D, 44E)

Electric and magnetic field spectral information can be produced either as filter bank quantities (FB, APID=440) or as Fast Fourier transformed spectra within the DFB (FF, APID=44D during particle bursts, APID=44E during wave bursts). Spectra from various voltages, electric or search coil magnetic field quantities, or their dot or cross products to the ambient unit magnetic field shall be denoted with variable names: _xxy, where xx∈{fb, ff} and Y∈{s,f,p,w} for {Slow Survey, Fast Survey, Particle Burst, Wave Burst}. The actual quantity being transformed into spectra (e.g.,V1, E12, EdotB, SCMX) is less important and need not be reflected in the variable name – information regarding that choice is carried internally into the CDFs in the packet header.

3.2.1 Filter banks (440): _fby; y∈{1,2,h}

Filter bank data variables shall be denoted as: _fby where y is one of {1,2,h} all time varying, one-dimensional, byte arrays. _fb1 and _fb2 are six-element arrays containing the filter bank data, and fbh is a two-element array containing HF Peak and HF Average as its elements. Time shall be denoted as _FB_TIME. The header for all shall be denoted as _fb_hed and its time _fb_hed_time.



3.2.2 Digital Fields Board Fast Fourier Transforms (44D, 44E): _ffy_nf

FFT data variables shall be denoted as: _ffp_nf for particle burst (44D) and _ffw_nf for wave burst (44E), where nf ∈ {16, 32, 64} is the number of frequencies. The variable shall be a N x NF array, where N=0 represents SPEC1, N=1 represents SPEC2, etc. Time shall be denoted as _ffp_nf_time and header information as _ffp_nf_hed with the corresponding time of the header being _ffp_nf_hed_time

Note: Header information from both data products _ffp and _ffw is required to interpret spectra from either _ffp or _ffw spectral quantities.

3.3 EFI, SCM Waveforms (APIDs 441 - 44C): _xxy, xx Î {va, vb, ef, sc} ; y Î {f,p,w}

Voltage, electric field and search coil magnetic field and fluxgate magnetic field time series data can be produced by the DFB. In particular APIDs 444, 448 and 44C come from the SCM instrument and the others from the EFI instrument. Products differ by the selected DFB processor source (A,B), DFB quantity (V, E12, EX, SCMX, SCMdotB) and filtering applied (AC coupled or DC coupled). The primary principle of the naming selection, which is denoted in **Table 1** as _xxy, where xx∈ {va, vb, ef, sc} and y∈{f,p,w}, is the premise that the user does not care which particular electric or magnetic field quantity or filtering method is being used to decide if they will use the data for specific event analysis – they use what they get. Information on quantity and filtering needed to interpret the data shall be contained within the header information.

The prefix th[a-e]_xxy fully defines all quantities above, except for dot and cross product (diagnostic) wave-burst waveform quantities, which may appear (infrequently) in I&T and possibly commissioning or science data, and convenience mode flags such as AC or DC coupled signal state. Those quantities for EFI and SCM shall be represented as a 1-dimensional multi-element variable: e.g.,_dq for “derived quantities” in “tha_scw_dq” means the SCMdotB and SCMcrossB channels, or as a 0-dimensional variable: e.g., _ac for the AC/DC state of the EFI waveforms in “tha_eff_ac” and similar quantities. This quantity will only be present whenever those values are available in the raw telemetry.

3.4 FGM waveforms (APIDs 405, 460, 461): _fge, _fgl, _fgh

Fluxgate magnetic field time series data can be produced as TML (460) and TMH (461) by the FluxGate Electronics board and routed by the Digital Signal Processing board. Telemetry-High (TMH) data are also taken by decimating CAL near perigee at higher data rate (8S/s typical) in order to determine science attitude. L1 data have been expanded from 3bytes to 4bytes, but range information is retained in the header.

Decimated Engineering (VC0 or VC1 - produced) TMH data shall be contained in _fge, a 1dim, 3element Real*4 array.

TML data (4-129 S/s) shall be contained within _fgl, a 1dim, 3element, Real*4 array.

TMH data (128S/s) shall be contained within quantity _fgh, a 1dim, 3element, Real*4 array.