

RAS

**MGSO System Requirements
Detailed Interface Design**

**SFOC-NAV-TRK-2-25
MGSO Tracking System
Interfaces
Archival Tracking Data File
Interface**

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SFOC-NAV-TRK-2-25***Section 1
Introduction******1.1 Purpose and Scope***

This module specifies the Archival Tracking Data File (ATDF) format of the radio metric data from the Deep Space Network (DSN). The content and format of the ATDFs generated by the Network Operations Control Center (NOCC) Navigation Subsystem (NAV) are defined herein.

1.2 Revision and Control

Revisions or changes to information contained in this module may be initiated in accordance with the procedures described in Section 1 of this document.

SFOC-NAV-TRK-2-25**Section 2
General Information****2.1 General Information**

Radio metric data are received by the NAV in the form of realtime NASCOM data blocks. These "packets" are processed to generate ATDFs. An ATDF contains all radio metric data received from the Deep Space Communications Complexes (DSCCs). These data include angles, doppler, range, differenced range versus integrated doppler (DRVID), programmed frequency data, uplink phase, pseudo-residuals, and validation data. An ATDF will contain data for a single spacecraft, for one or more stations, and for one or more passes or days.

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Section 3

Data Format

3.1 Data Format

The data on the ATDF are arranged as follows:

- (1) File Identification logical record (one only)
- (2) Transponder logical record (one only)
- (3) Tracking Data logical records (time ordered)
- (4) Software end-of-file mark (one only)
- (5) Hardware end-of-file mark (one only)

The logical record types are described in detail in Tables 3-1, 3-2, and 3-3.

The ATDF block (physical record) is 2016 32-bit words in length and consists of 28 72-word (2304-bit) logical records.

Note that several items of data have been split into two parts: a Sign Bits field and a Data item. For these items, the leftmost (sign) bit of the Data item has been left-extended to fill another item of information. For always non-negative items, the Sign Bits field will be zero; for items that may be positive, zero, or negative (provided as two's complement numbers), the Sign Bits field will be filled with zeros (non-negative) or ones (negative). The user may extract any specific Data item and sign-extend manually, or may use any portion of the Sign Bits field combined with the Data item to get a signed integer that will fill one word on the user's computer system. For example, a 22-Sign Bits/14-bit Data item pair may be taken as a 20-bit item to be ignored plus a 16-bit data item, or as a 4-bit item to be ignored plus a 32-bit data item, or as a single 36-bit item of data, etc. This is always true — whether the Sign Bits field is all zero-bits or all one-bits.

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Table 3-1. File Identification Logical Record

Item Number	Pack Format	Parameters Description
1	I32	Record Format = 8
2	I8	Reserved (set to 0)
3	I32	Record Type = 10
4	I12	File Creation Year modulo 1900
5	I16	File Creation Day-of-Year
6	I8	File Creation Hour
7	I12	File Creation Minute
8	I8	File Creation Second
9	I12	Reserved (set to 0)
10	I16	Spacecraft ID Number
11	I8	82 (= 'R')
12	I8	47 (= 'I')
13	I8	84 (= 'T')
14	I12	32 (= ' ')
15	I16	65 (= 'A')
16	I8	84 (= 'T')
17	I12	68 (= 'D')
18	I8	70 (= 'F')
19	I16	Reserved (set to 0)
20	I4	Not Used (set to 0)
21	I32	Not Used (set to 0)
thru 84	I32	Not Used (set to 0)

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Table 3-2. Transponder Logical Record

Item Number	Pack Format	Parameters Description
1	I32	Record Format = 8
2	I8	Reserved (set to 0)
3	I32	Record Type = 30
4	I12	File Start Year modulo 1900
5	I16	File Start Day-of-Year
6	I8	File Start Hour
7	I12	File Start Minute
8	I8	File Start Second
9	I12	Reserved (set to 0)
10	I16	Spacecraft ID Number
11	I8	Reserved (set to 0)
12	I8	Reserved (set to 0)
13	I8	Reserved (set to 0)
14	I12	File End Year modulo 1900
15	I16	File End Day-of-Year
16	I8	File End Hour
17	I12	File End Minute
18	I8	File End Second
19	I16	Reserved (set to 0)
20	I12	Sign Bits = 0
21	I24	Spacecraft Transponder Frequency (Hertz) - H/P†
22	I12	Sign Bits = 0
23	I24	Spacecraft Transponder Frequency (Hertz) - L/P†
24	I28	Not Used (set to 0)
25	I32	Not Used (set to 0)
thru		
85	I32	Not Used (set to 0)

†double precision variable $((H/P) \cdot 10^4 + (L/P) \cdot 10^3)$

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Table 3-3. Tracking Data Logical Records

Item Number	Pack Format	Data Units	Parameters Description
1	132	n/a	Record Format = 8
2	18	n/a	Reserved (set to 0)
3	132	n/a	Record Type = 90 (Low-Rate Data) = 91 (High-Rate Data)
4	112	n/a	Sample Year modulo 1900 Sample Day-of-Year Sample Hour Sample Minute Sample Second } Record Time Tag
5	116	n/a	
6	18	n/a	
7	18	n/a	
8	18	n/a	
9	120	n/a	Reserved (set to 0)
10	110	n/a	Receiving Station ID Number
11	18	n/a	Receiver/Downlink Frequency Band 0 = N/A or Ku-Band 1 = S-Band 2 = X-Band 3 = Ka-Band
12	16	n/a	Sample Data Type ID 1 = High-Rate Doppler 2 = Low-Rate Doppler 3 = Uplink Phase 4 = DRVID 5 = Range 6 = Ramp 7 = Mixed 8 = Allan Deviation or Smoothed Noise 11 = High-Rate Downlink Phase 12 = Low-Rate Downlink Phase
13	14	n/a	Doppler Channel Number

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Table 3-3. Tracking Data Logical Records (cont'd)

Item Number	Pack Format	Data Units	Parameters Description
14	14	n/a	Ground Mode 0 = Angles or Ramp or Uplink Phase 1 = 1-Way, Doppler or Mixed 2 = 2-Way, Doppler or Mixed 3 = 3-Way, Doppler or Mixed 4 = 3-Way Coherent, Doppler or Mixed 5 = 1-Way, Range or DRVID or Allan Deviation or Smoothed Noise 6 = 2-Way, Range or DRVID or Allan Deviation or Smoothed Noise 7 = 3-Way, Range or DRVID or Allan Deviation or Smoothed Noise
15	116	n/a	Spacecraft ID Number
16	18	n/a	Range Type 0 = No Range Data 1 = GSTDN (RE) 6 = PLOP or Pseudo-Noise (PRA) 7 = PLOP2 (SRA) 8 = MU2
17	18	n/a	Angle Type 0 = No Angle Data 1 = Azimuth/Elevation 2 = Hour Angle/Declination 3 = XY (where +X is East) 4 = XY (where +X is South)
18	18	n/a	DRVID Type 0 = No DRVID Data 6-8 = same as for Range Type
19	11	n/a	Doppler Good/Bad Indicator
20	S18	kHz	Doppler Bias
21	11	n/a	Angles Good/Bad Indicator
22	11	n/a	Frequency Level Indicator 0 = DCO level (22 MHz) 1 = sky level (GHz)
23	11	n/a	Simulation Synthesizer Indicator
24	11	n/a	Receiver Loop Lock Indicator

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Table 3-3. Tracking Data Logical Records (cont'd)

Item Number	Pack Format	Data Units	Parameters Description
25	I1	n/a	Transmitter On/Off Indicator
26	I6	n/a	Doppler Reference Receiver Type 2 = MFR 3 = Block III 4 = Block IV 5 = Block V 6 = DGT, single station 7 = DGT, arrayed 8 = FSP, arrayed
27	I6	n/a	Source Designation/Exciter Type 1 = 34m or 70m Subnet, Block III/IV Exciter 2 = 26m Subnet 3 = 11m (OVLBI) Subnet 4 = 34m or 70m Subnet, Block V Exciter
28	I4	n/a	No Process Flag and Cause 1 = before AOS/after LOS 2 = "frozen" Doppler counter 3 = illegal reference frequency
29	I32	0.01 seconds	Sample Interval
30	I24	10^{-6} counts	Doppler Count or Downlink Phase - H/P°
31	I24	10^{-6} counts	Doppler Count or Downlink Phase - I/P°
32	I24	10^{-6} counts	Doppler Count or Downlink Phase - L/P°
33	I24	10^{-6} (RU, ns)	Range - H/P°
34	I24	10^{-6} (RU, ns)	Range - I/P°
35	I24	10^{-6} (RU, ns)	Range - L/P°
			{ ns if Range Type (Item 18) is 1, otherwise units are RU
36	I8	n/a	Lowest (Last) Ranging Component
37	I28	2^{-32} cycles	Uplink Phase - part 1***
38	I24	2^{-32} cycles	Uplink Phase - part 2***
39	I24	2^{-32} cycles	Uplink Phase - part 3***
40	I24	2^{-32} cycles	Uplink Phase - part 4***
41	S24	.001 degrees	Angle 1 (Azimuth/Hour Angle/X)
42	S24	.001 degrees	Angle 2 (Elevation/Declination/Y)

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Table 3-3. Tracking Data Logical Records (cont'd)

Item Number	Pack Format	Data Units	Parameters Description
43	I32	10^6 Hertz	Doppler Reference/Receiver Frequency - H/P**
44	I32	10^6 Hertz	Doppler Reference/Receiver Frequency - L/P**
45	S32	.01 RU	DAVID
46	I24	10^6 counts	No. 2 H/R Doppler or Downlink Phase (H/P*)
47	I24	10^6 counts	No. 2 H/R Doppler or Downlink Phase (I/P*)
48	I24	10^6 counts seconds 10^{-17} 10^{-6}	No. 2 H/R Doppler or Downlink Phase (L/P*) or Round Trip Light Time or 0.1-second Allan Deviation or 0.1-second Smoothed Noise
49	I24	10^6 counts	No. 3 H/R Doppler or Downlink Phase (H/P*)
50	I24	10^6 counts	No. 3 H/R Doppler or Downlink Phase (I/P*)
51	I24	10^6 counts seconds 10^{-17} 10^{-6}	No. 3 H/R Doppler or Downlink Phase (L/P*) or Time of Range Acquisition or 1-second Allan Deviation or 1-second Smoothed Noise
52	I24	10^6 counts	No. 4 H/R Doppler or Downlink Phase (H/P*)
53	I24	10^6 counts	No. 4 H/R Doppler or Downlink Phase (I/P*)
54	I24	10^6 counts seconds 10^{-17} 10^{-6}	No. 4 H/R Doppler or Downlink Phase (L/P*) or T1 Integration Time Constant or 10-second Allan Deviation or 10-second Smoothed Noise
55	I24	10^6 counts	No. 5 H/R Doppler or Downlink Phase (H/P*)
56	I24	10^6 counts	No. 5 H/R Doppler or Downlink Phase (I/P*)
57	I24	10^6 counts seconds 10^{-17} 10^{-6}	No. 5 H/R Doppler or Downlink Phase (L/P*) or T2 Integration Time Constant or 100-second Allan Deviation or 100-second Smoothed Noise
58	I24	10^6 counts	No. 6 H/R Doppler or Downlink Phase (H/P*)
59	I24	10^6 counts	No. 6 H/R Doppler or Downlink Phase (I/P*)

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Table 3-3. Tracking Data Logical Records (cont'd)

Item Number	Pack Format	Data Units	Parameters Description
60	I24	10 ⁻⁶ counts seconds 10 ⁻¹⁷ 10 ⁻⁶	No. 6 H/R Doppler or Downlink Phase (L/P*) or T3 Integration Time Constant or 1000-second Allan Deviation or 200-second Smoothed Noise
61	I24	10 ⁻⁶ counts	No. 7 H/R Doppler or Downlink Phase (H/P*)
62	I24	10 ⁻⁶ counts	No. 7 H/R Doppler or Downlink Phase (I/P*)
63	S24	10 ⁻⁶ counts .001 volts 10 ⁻⁶	No. 7 H/R Doppler or Downlink Phase (L/P*) or Reference (0-degree) Correlation Voltage or 600-second Smoothed Noise
64	I24	10 ⁻⁶ counts	No. 8 H/R Doppler or Downlink Phase (H/P*)
65	I24	10 ⁻⁶ counts	No. 8 H/R Doppler or Downlink Phase (I/P*)
66	S24	10 ⁻⁶ counts .001 volts	No. 8 H/R Doppler or Downlink Phase (L/P*) or Quadrature (90-degree) Correlation Voltage
67	I24	10 ⁻⁶ counts	No. 9 H/R Doppler or Downlink Phase (H/P*)
68	I24	10 ⁻⁶ counts	No. 9 H/R Doppler or Downlink Phase (I/P*)
69	S24	10 ⁻⁶ counts dB	No. 9 H/R Doppler or Downlink Phase (L/P*) or Carrier Suppression
70	I24	10 ⁻⁶ counts	No. 10 H/R Doppler or Downlink Phase (H/P*)
71	I24	10 ⁻⁶ counts	No. 10 H/R Doppler or Downlink Phase (I/P*)
72	I24	10 ⁻⁶ counts n/a	No. 10 H/R Doppler or Downlink Phase (L/P*) or Highest (First) Ranging Component
73	S4	n/a	Sign Bits for next item
74	S32	.001 Hertz	Doppler Pseudo-Residual
75	S4	n/a	Sign Bits for next item
76	S32	.001 (RU or ns)	Range Pseudo-Residual
77	S18	.001 degrees	Angle 1 Pseudo-Residual
78	S18	.001 degrees	Angle 2 Pseudo-Residual

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Table 3-3. Tracking Data Logical Records (cont'd)

Item Number	Pack Format	Data Units	Parameters Description
79	18	n/a	Exciter/Uplink Frequency Band 0 = Ku-Band, or N/A, or S-Band TRK-2-14 1 = S-Band 2 = X-Band 3 = Ka-Band 7 = S-Band TRK-2-20
80	14	n/a	Angle Mode 0 = Auto Track 1 = Manual Aided 2 = Computer 3 = Sidereal 4 = Brake
81	12	n/a	Conscan Mode 0 = Conscan Off 1 = Closed Loop 2 = Open Loop
82	11	n/a	Angle 1 Pseudo-Residual Tolerance
83	11	n/a	Angle 2 Pseudo-Residual Tolerance
84	11	n/a	Doppler Pseudo-Residual Tolerance
85	11	n/a	Doppler Noise Tolerance
86	18	percent	Percentage of Data Used for Allan Deviation
87	110	cycles	Total Slipped Cycles During Count
88	S18	.001 Hertz	Doppler Noise
89	S18	.01 dBm	Received Signal Strength
90	124	nanoseconds	Exciter Station Delay
91	124	nanoseconds	Receiver Station Delay
92	11	n/a	Range Modulation On/Off
93	11	n/a	Prime Ranging Channel
94	11	n/a	Pipelining On/Off
95	11	n/a	Chopper Frequency On/Off
96	11	n/a	Range Good/Bad Indicator
97	11	n/a	Range Calibration Tolerance

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Table 3-3, Tracking Data Logical Records (cont'd)

Item Number	Pack Format	Data Units	Parameters Description
98	I1	n/a	Range Configuration Change
99	I1	n/a	Range Pseudo-Residual Tolerance
100	I1	n/a	Pseudo DRVID Tolerance
101	I4	n/a	Amplifier Type
102	I1	n/a	Transmitter Low Power Indicator
103	I10	kilowatts	Transmitter Power
104	I24	.01 RU	Ranging Equipment Delay
105	S12	.1 dB	Range or DRVID Power/Noise Ratio
106	S4	n/a	Sign Bits for next item
107	S32	.001 Hertz .001 degrees	Average Doppler Pseudo-Residual or OVLBI Train Axis Angle
108	S4	n/a	Sign Bits for next item
109	S32	.01 RU 10^{-14}	Pseudo DRVID or Delta Frequency/Frequency (1/P ²)
110	I4	n/a	Sign Bits = 0
111	I32	10^{-14}	Delta Frequency/Frequency (1/P ²)
112	S22	.01 ns	Z-Correction
113	I14	nanoseconds	Spacecraft Delay
114	I23	.01 RU	Range or DRVID Noise
115	I1	n/a n/a	DRVID Good/Bad indicator or Ranging Assembly Status
116	I1	n/a	Range or DRVID Noise Tolerance
117	I1	n/a	Range or DRVID Power/Noise Tolerance
118	I10	n/a	Number of Post Acquisition DRVID Points

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Table 3-3. Tracking Data Logical Records (cont'd)

Item Number	Pack Format	Data Units	Parameters Description
119	I8	n/a n/a	Ramp Controller Indicator 0 = POCA 1 = DCO 4 = Block-V Exciter or Cause of Allan Deviation Report Generation 0 = 1000-second report 1 = Doppler mode change 2 = IDLE mode 3 = radio science smoothed noise
120	S32	10^{-4} Hz/sec	Programmed Frequency Ramp Rate - H/P**
121	S32	10^{-4} Hz/sec 2^{-12} dB seconds	Programmed Frequency Ramp Rate - L/P** or Received Signal Strength or Ranging Transmitter Coder In-Phase Time Offset (seconds before sample time tag)
122	I4	n/a	Sign Bits = 0
123	I32	10^{-4} Hz n/a	Programmed Ramp Start Frequency - H/P** or Numerator for Spacecraft Turnaround Ratio
124	I4	n/a	Sign Bits = 0
125	I32	10^{-4} Hz n/a	Programmed Ramp Start Frequency - L/P** or Denominator for Spacecraft Turnaround Ratio
126	I1	n/a	Exciter Frequency Changed Flag
127	I1	n/a	Receiver Loop Lock Changed Flag
128	I1	n/a	Receiver Frequency Changed Flag
129	I1	n/a	Transmitter On/Off Changed Flag
130	I1	n/a	Station Delay(s) Changed Flag
131	I1	n/a	Ramp Rate/Frequency Changed Flag
132	I1	n/a	Ground Mode Changed Flag
133	I1	n/a	Highest/Lowest Ranging Component Changed Flag
134	I1	n/a	Sample Year Changed Flag
135	I1	n/a	Z-Correction Changed Flag
136	I1	n/a	Ramp Record Added Flag

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Table 3-3. Tracking Data Logical Records (cont'd)

Item Number	Pack Format	Data Units	Parameters Description
137	I1	n/a	Doppler Good/Bad Indicator Changed Flag
138	I1	n/a	Range Good/Bad Indicator Changed Flag
139	I1	n/a	Angles Good/Bad Indicator Changed Flag
140	I28	10^6 Hertz	Transmitter/Exciter Frequency - H/P**
141	I30	10^6 Hertz	Transmitter/Exciter Frequency - L/P**
142	I32	n/a	0 (not currently used)
143	I32	n/a	0 (not currently used)
144	I32	n/a	0 (not currently used)
145	I32	n/a	0 (not currently used)
146	I32	n/a	0 (not currently used)
147	I32	n/a	0 (not currently used)
148	I32	n/a	0 (not currently used)
149	I32	n/a	0 (not currently used)
150	I32	n/a	0 (not currently used)

* double precision variable = $[(H/P) \cdot 10^6 + (I/P) \cdot 10^1 + (L/P) \cdot 10^{-6}]$ if Doppler, downlink phase, or range

** double precision variable = $[(I/P) \cdot 10^{-7} + (L/P) \cdot 10^{-14}]$ if delta frequency/frequency
 = $[(H/P) \cdot 10^3 + (L/P) \cdot 10^{-6}]$ if ramp frequency, reference frequency, or ramp rate

*** quadruple precision phase = $[(\text{part } 1) \cdot 2^{40} + (\text{part } 2) \cdot 2^{16} + (\text{part } 3) \cdot 2^8 + (\text{part } 4) \cdot 2^{32}]$ if uplink phase

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Section 4

Explanatory Notes

4.1 Explanatory Notes

- (1) Each data type will consist of one or more parameter fields of which the first 32 bits will be a data type format indicator. The parameter field pack format conventions used herein are as follows:

Cx = ASCII character string, x bits in length, 8 bits per character

Ix = unsigned integer, x bits in length

Sx = signed integer, x bits in length, two's complement

Bx = BCD character string, x bits in length, 4 bits per character

- (2) Most data parameters will be provided as binary integers; two's complement will be used for all fields that may have negative values.
- (3) Items not applying to a record data type are set to zero for that record.
- (4) Single-bit status parameters will be set to one (1) for no, bad, off, out of tolerance, etc.; and will be set to zero (0) for yes, good, on, in tolerance, etc.

