130 Recording Format

Specification

3.4.5

11/2/2012

This REF TEK manual provides technical information regarding the recording format for the Program for Array Seismic Studies of the Continental Lithosphere (PASSCAL) recording format, designed to store data acquired by field instruments.

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Revision History:

Rev	Date	Reason for change	Pages
	2012.05.22	**Modified EH/ET Filter Codes**	**Section 4.6.7**
	2011.03.11	**Modified for 3.3.0**	**All**
	2010.09.29	**Modified for 3.2.8**	**All**
	2010.06.24	**3.2.6 Update Format**	**All**
	2010.03.08	**Index added (3.2.2)**	**Section 5**
G	**2009.10.08**	**Improve DT description**	**Section 4.4**
	2009.06.04	**Updated for 3.0.0**	**All**
F	**2008.07.30**	**Converted to WORD format**	**All**
	2008.01.14	**Added Implement Time for FD**	**Pages 3-28**
	2009.06.19	**Updated Overscale Protection**	**Section 3.4**
E	**2006.09.12**	**Corrected EH and ET Tables**	**Section 3.5 and 3.6**
D	**2004.01.12**	**Updated Section 3**	**Section 3**
C	**2003.11.08**	**Added Vote Trigger**	**Section 3.3**
B	**2003.04.04**	**Added Auxiliary Data Parameter (AD)**	**Section 6.1**
A	**2003.01.03**	**Added 11/27/02 Command Update**	**All**
0.1	**2002.02.01**	**Initial release**	**All**

Related Manuals:

130-01/3 System Documents	**PDF file**
130-01 System Startup	130_startup_01.pdf
PFC_130 Users Guide	Pfc_130.pdf
Data Utilities Users Guide	130_utilities.pdf
Archive Utilities	arcutil.pdf
130 Theory of Operations	130_theory. pdf
iFSC Users Guide	iFSC.pdf
130 Command Reference	130_command.pdf
130 Recording Format	130_record.pdf
130-GPS Manual	130_gps. pdf
Optional Manuals	**PDF file**
RTPD Installation and Users Guide	RTPD.pdf
RT_View Users Guide	RTView.pdf
RTCC Command and Control Users Guide*	RTCC.pdf
130 RTCC Release Notes*	130_RTCCRN.pdf
RT_Display Users Guide*	RTDisplay.pdf
RTPMonitor Installation and Users Guide	RTPM.pdf
131A-02/3 3G Triaxial Accelerometer	131A023.pdf
131A-02/2 3G Biaxial Accelerometer	131A022.pdf
131A-01/3 4G Triaxial Accelerometer	131A013.pdf
131B-01/1 4G Unixial Accelerometer	131B011.pdf

CF Card Replacement:

Due to the large variability of CF cards available on the world market and the resulting problems with compatibility due to memory layout, signal structuring and power requirements, Refraction Technology cannot guarantee a CF card will work in a REFTEK data recorder unless it is sold through REFTEK itself. REFTEK ensures compatibility through communications with CF manufacturers and rigorous in-house testing. Some CF manufacturers refuse to provide adequate information or factory controls to ensure that the product being sold today is the same as the product sold earlier under the same part number. CF cards not purchased from REFTEK may work at one temperature but not at another, or may fail all together.

Software Version:

Current software and documentation is available on our web site. Some early units may require hardware modifications to use the latest software. Contact REF TEK if you have any queries on the compatibility of your unit(s) and the current software release.

Firmware Update:

To update firmware from the FTP site

1. Login to our FTP site at: ftp.reftek.com/pub as:

   User name: Anonymous

   Password: Your E-mail address

2. Find the 130 firmware at ftp.reftek.com/pub/130/cpu/prom.
3. Download the zip file of the most recently released firmware version.

Update firmware:

Updating firmware in a 130 DAS requires the presence of a firmware file on an installed Compact Flash device.

1. On power-up, the 130 checks the Compact Flash for the presence of 'main.s3' in the root directory.
2. If the 'main.s3' file is present on the Compact Flash, the 130:
   a) Reads the file.
   b) DELETES the file.
   c) Re-programs the internal flash memory.

Note: DO NOT DISTURB THE UNIT DURING THIS PROCESS.

Note: User parameters stored in SPROM using the WP command will be erased when a firmware update is performed.

Note: DAS power must be above 11.5V for a firmware update.

Follow these steps to update the firmware of a 130 DAS:

1. Unzip the 'main.s3' file from the downloaded zip file of the most recently released firmware.
2. Copy the desired firmware image to the root of the Compact Flash as 'main.s3' using a PC with a Compact Flash reader or ftp into the 130 DAS, with a Compact Flash installed, in binary mode.
3. With the Compact Flash with the main.s3 image installed in the 130 DAS, issue a reset command.

(a) If you are at the 130 DAS:

1. Issue a Reset command from a PDA running PFC_130 or disconnect and reconnect power to the unit.
2. Observe the LCD for the following messages:

READING DISK DO NOT DISTURB

WRITING FLASH DO NOT DISTURB

3. The 130 DAS resets and returns to normal messaging.

(b) If you are remotely connected to a 130 DAS via telemetry mode:

If you are connecting remotely by a TCP connection:

1. First connect
2. Discover the unit
3. Acquire status
4. Issue a reset command from the Status screen.
5. Delete the unit from the Station List screen.
6. Wait at least 5 minutes.
7. At the Connections screen (reconnect id using a TCP connection) issue a Station Discovery again to discover the 130 DAS station.

Note: DO NOT DISTURB THE UNIT until the start-up LCD message reappears.

Notation Conventions

The following notation conventions are used throughout REF TEK documentation:

Notation	Description
ASCII	Indicates the entry conforms to the American Standard Code for Information Interchange definition of character (text) information.
Binary	Indicates the entry is a raw, numeric value.
Hex	Indicates hexadecimal notation. This is used with both ASCII characters (0 – 9, A – F) and numeric values.
BCD	Indicates the entry is a numeric value where each four bits represents a decimal digit.
FPn	Indicates the entry is the ASCII representation of a floating-point number with n places following the decimal point.
<n>	Indicates a single 8-bit byte. When the contents are numeric, it indicates a hexadecimal numeric value; i.e. <84> represents hexadecimal 84 (132 decimal). When the contents are capital letters, it represents a named ASCII control character; i.e. <SP> represents a space character, <CR> represents a carriage return character and <LF> represents a line feed character.
MSB	Most Significant Byte of a multi-byte value.
MSbit	Most Significant Bit of a binary number.
LSB	Least Significant Byte of a multi-byte value.
LSbit	Least Significant Bit (bit 0) of a binary number.
YYYY	Year as a 4-digit number
DDD	Day of year
HH	Hour of day in 24-hour format
MM	Minutes of hour
SS	Seconds of minute
TTT	Thousandths of a second (milliseconds)
IIII	Unit ID number

n, nS	nano, nanoSecond; 10-9 = 0.000000001
u, uS	micro, microSecond; 10-6 = 0.000001
m, mS	milli, milliSecond; 10-3 = 0.001
K, KHz	Kilo, KiloHertz; 103 = 1,000
M, MHz	Mega, MegaHertz; 106 = 1,000,000
G, GHz	Giga, GigaHertz; 109 = 1,000,000,000
Kb, KB	Kilobit, KiloByte; 210 = 1,024
Mb, MB	Megabit, MegaByte; 220 = 1,048,576
Gb, GB	Gigabit, GigaByte; 230 = 1,073,741,824

REF TEK Support and update notifications

As a valued user of REF TEK equipment we would like to provide the best support possible by keeping you up to date with our product updates. If you would like to be notified of any REF TEK product updates please spend a couple of minutes to register with the REF TEK customer support team.

To register enter your company information through the Register link on our website fill at http://support.reftek.com .

Our support team will send you a unique Username and Password allowing secured access to all product documentation and software sold to you company.

Once we register your contact we will only send necessary notifications via email. The same notifications will be shown on our website http://support.reftek.com notification page

Thanks,

Your REF TEK support team

Contents

1 About This Manual

This document contains technical information regarding the recording format for the Program for Array Seismic Studies of the Continental Lithosphere (PASSCAL) recording format. It includes a separate section for each of the following topics:

- Information storage
- Notation conventions
- Packet Header description
- Packet descriptions
- Special packets

The PASSCAL recording format was designed to store data acquired by field instruments manufactured to the PASSCAL specification. In general, the PASSCAL specification requires that each recording stand alone with respect to the sample rate, start time, and data format. Furthermore, it was a goal of the specification that additional types of recordings could be added to the format specification without having to reformat previous recordings.

The REF TEK 130 series DAS units record data in this format. DAS units record data into 1,024-byte packets and store them in RAM. Without altering the format, the DAS units write the packets to disk and/or transmit them over a telemetry link.

This recording format lets users convert data to other formats, including SEG-Y (Society of Exploration Geophysicists), SUDS (Seismic Unified Data System), and ASCII formats. Example C language conversion programs are available from Refraction Technology, Inc. or IRIS (Incorporated Research Institutions for Seismology).

1.1 Software Version

The information in this manual is accurate for products that use software of any version from that shown on the cover to the version of software you received with your DAS unit(s).

1.2 Document Version

The document version is shown by the date on the front cover (the 'save' date). The save date is also shown on the bottom of each text page; it may be later than the front cover date if editorial and/or other corrections were made.

If you have any concerns on the applicability of this manual to your particular DAS unit(s), please contact Refraction Technology, Inc. Our address and phone numbers are shown on the inside cover of this document.

2 Information Storage

The REF TEK 130 Data Acquisition Systems (DAS units) store information in RAM in packets of 1,024 bytes each. Each packet contains a 16-byte header followed by 1,008 bytes allocated according to the packet type. The first two bytes of the header indicate the packet type.

The REF TEK 130 DAS can write these packets to files on its disk, to its serial communications port or to its network communications port. When data storage has been directed to one of the telemetry ports, each packet is transmitted on a first-in/first-out basis.

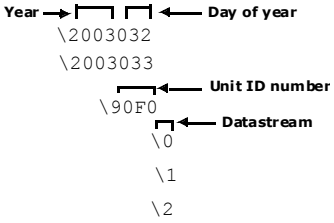
2.1 Disk Recording

Information packets stored in RAM may be written to files on the internal disk drive. The disk drive is formatted using the FAT-32 file system with long file name support. Each DAS event is written to a separate file. The State of Health packets and the parameter packets are written to a common State of Health file.

2.1.1 Disk Directory Structure

Files are distributed in subdirectories in the same manner as a REF TEK data archive. This creates subdirectories by date, Unit ID and data stream; \YYYYDDD\IIII\S.

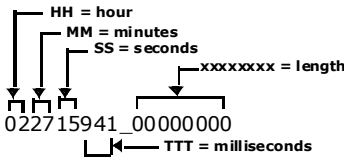
The State of Health log is recorded as datastream 0. For example:



2.1.2 File Names

Files are named in the same manner as a REF TEK data archive. Each event file name includes the time of the first sample of the event and the length of the event in hexadecimal milliseconds. If the length in milliseconds is zero, the event is incomplete.

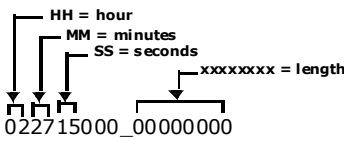
For example:



2.1.3 State of Health files (SOH)

The State of Health file is named in a similar manner but based on the time of the first entry into the file.

For example:



3 Packet Header Description

3.1 Packet Header Description

The REF TEK 130 DAS units store information in packets of 1,024 bytes each. Each packet starts with a 16-byte header. The remaining 1,008 bytes are allocated differently for each packet type. The header has the following form:

Offset	Field	No. of Bytes	Format
0	Packet Type	2	ASCII characters
2	Experiment Number	1	2-digit BCD 0-99
3	Year	1	2-digit BCD 0-99
4	Unit ID Number	2	4-digit Hexadecimal 0-FFFF
6	Time	6	BCD DDDHHMMSSTTT
12	Byte Count	2	4-digit BCD
14	Packet Sequence	2	4-digit BCD 0-9999

3.1.1 Packet Type

The first two bytes of a packet are an ASCII code designating the type of information in the packet. The codes are as follows:

Type	Description
AD	Auxiliary Data Parameter Packet
CD	Calibration Parameter Packet
DS	Data Stream Parameter Packet
DT	Data Packet
EH	Event Header Packet
ET	Event Trailer Packet
OM	Operating Mode Parameter Packet
SH	State-Of-Health Packet
SC	Station/Channel Parameter Packet

3.1.2 Experiment Number

The experiment number field is a two-digit decimal number that is rarely used. While currently filled with the experiment number from the Station Parameters, it may be reallocated at a later date.

3.1.3 Year

The year field includes the last two decimal digits of the year that the first information in the packet was recorded.

3.1.4 Unit ID Number

The Unit ID Number field identifies which REF TEK DAS unit recorded the packet. The Unit ID number is set at the factory. The Unit ID numbers for REF TEK 130 DAS units range from 9001 to FFFF.

3.1.5 Time

The time field for each packet includes the following information:

- Day of the year
- Hour of the day (24-hour day)
- Minute of the hour
- Second of the minute
- Tenths, hundredths, and thousandths of the second (milliseconds) of the first entry

For data packets, this time is the time of the first sample in the packet. For Event Header (EH) and Event Trailer (ET) packets, it is the trigger time. For parameter packets, it is the time the parameters were implemented. For State-of-Health (SH) packets, it is the time the packet was created.

3.1.6 Byte Count

The Byte Count field indicates the number of valid bytes contained in the packet, starting with the first byte of the 1,024-byte packet. It ranges from 24 to 1024.

3.1.7 Packet Sequence Number

The Packet Sequence field is incremented for each packet of an event. Each event is sequenced separately. The State of Health Log and parameter packets are sequenced together. Their sequence begins at zero each time the user clears RAM or initializes the DAS. If the sequence number reaches 9999, it rolls over to zero.

4 Packet Description

This section provides detailed technical specifications for packets recorded using the REF TEK 130 DAS, including:

- AD - Auxiliary Data Parameter Packet
- CD - Calibration Parameter Packet
- DS - Data Stream Parameter Packet
- DT - Data Packet
- EH - Event Header Packet
- ET - Event Trailer Packet
- FD - Filter Description Packet
- OM - Operating Mode Parameter Packet
- SC - Station/Channel Parameter Packet
- SH - State-Of-Health Packet

4.1 Auxiliary Data parameter packet (AD)

The Auxiliary Data parameter packet contains the auxiliary channel recording parameters.

Offset	Description	No. of Bytes	Format
0	Packet Header	16	Type AD
16	Marker	2	ASCII digits: 99
18	Channels	16	ASCII characters: Each byte by position corresponds to a channel. A <SP> disables a channel while a character enables a channel.
34	Sample Period	8	ASCII integer: seconds between samples
42	Data Format	2	ASCII digits: 16
44	Record length	8	ASCII integer : seconds
52	Recording Destination	4	ASCII characters: Each byte represents a recording destination; RAM, Disk, Ethernet and Serial. A <SP> disables a destination while a character enables it.
56	Reserved	950	ASCII character: <SP>
1008	Implement Time	16	ASCII time of implement: YYYYDDDHHMMSSTTT

4.2 Calibration parameter packet (CD)

The Calibration parameter packet contains the Calibration parameters. Bytes 17 – 82 (offsets 16 – 81) are defined for the REF TEK 72A series DAS and are not filled in by the REF TEK 130 DAS. Bytes 131 - 306 are defined for the REK TEK 130 DAS and are not filled in by the 72A DAS.

Offset	Description	No. of Bytes	Format
0	Packet Header	16	Type CD
16	72A Calibration	114	See below
130	130 Sensor Auto-center	64	4 structures as defined below
194	130 Sensor Calibration Signal	112	4 structures as defined below
306	130 Sensor Calibration Sequence	538	4 structures as defined below
538	Reserved	164	ASCII character: <SP>
1008	Implement Time	16	ASCII time of implement: YYYYDDDHHMMSSTTT

4.2.1 72A Calibration Information

The following fields are filled in by a REF TEK 72A DAS.

Offset	Description	No. Of Bytes	Format
16	Start Time	14	ASCII digits: YYYYDDDHHMMSS
30	Repeat Interval	8	ASCII digits: DDHHMMSS
38	# of Intervals	4	ASCII integer
42	Length	8	ASCII digits: FP 3 (seconds)
50	Step On/Off	4	ASCII characters: ON or OFF
54	Step Period	8	ASCII digits: FP 3 (seconds)
62	Step Size	8	ASCII digits: FP 3 (seconds)
70	Step Amplitude	8	ASCII digits: FP 3 (volts)
78	Step Output	4	ASCII characters: COIL or AMPL
82	Reserved	48	ASCII character: <SP>

4.2.2 130 Sensor Auto-Center Information

The following fields are filled in by a REF TEK 130 DAS.

Offset	Description	No. of Bytes	Format
0	Sensor	1	ASCII integer: 1 – 4
1	Enable	1	ASCII character: <SP> = disable, else = enable
2	Reading Interval	4	ASCII integer: 10 or 100 (seconds)
6	Cycle Interval	2	ASCII integer: hours between cycles, 0 = disable
8	Level	4	ASCII digits: 0.1 – 9.9 volts
12	Attempts	2	ASCII integer: max attempts per cycle
14	Attempt Interval	2	ASCII integer: minutes between attempts

4.2.3 130 Sensor Calibration Signal Information

The following fields are filled in by a REF TEK 130 DAS.

Offset	Description	No. of Bytes	Format
0	Sensor	1	ASCII digit: 1 - 4
1	Enable	1	ASCII character: <SP> = disable, else = enable
2	Reserved	2	ASCII character: <SP>
4	Duration	4	ASCII digits: 1 – 500 seconds
8	Amplitude	4	ASCII digits: FP 2: 0.01 – 3.75 volts
12	Signal	4	ASCII characters: STEP, SINE, NOIS
16	Step interval	4	ASCII digits: 1 – 250 seconds
20	Step width	4	ASCII digits: 1 – 250 seconds
24	Sine Frequency	4	ASCII digits: 1, 2, 4, 5, 8, 10, 20, 25, 40, 50 or 100 Hz

4.2.4 130 Sensor Calibration Sequence Information

The following fields are filled in by a REF TEK 130 DAS.

Offset	Description	No. of Bytes	Format
0	Sequence	1	ASCII digit: 1
1	Enable	1	ASCII character: non-<SP>
2	Reserved	2	ASCII <SP>
4	Start Time	14	ASCII digits: YYYYDDDHHMMSS
18	Interval	8	ASCII digits: DDHHMMSS
26	Count	2	ASCII integer
28	Record Length	8	ASCII integer seconds
36	Sensor	4	ASCII
40	Reserved	18	ASCII <SP>

4.3 Data Stream parameter packet (DS)

Each Data Stream parameter packet contains parameters for up to four data streams.

Offset	Description	No. of Bytes	Format
0	Packet Header	16	Type DS
16	Data Stream Info	920	Four streams as described in the following section
936	Reserved	72	ASCII character: <SP>
1008	Implement Time	16	ASCII time of implement: YYYYDDDHHMMSSTTT

4.3.1 Data Stream Information

Offset	Description	No. of Bytes	Format
0	Data Stream #	2	ASCII integer
2	Data Stream Name	16	ASCII characters
18	Recording Destination	4	ASCII characters: Each byte represents a recording destination; RAM, Disk, Ethernet and Serial. A <SP> disables a destination while a character enables it.
22	Reserved	4	ASCII character: <SP>
26	Channels Included	16	ASCII characters: Each byte by position corresponds to a channel. A <SP> disables a channel while a character enables a channel.
42	Sample Rate	4	ASCII integer (samples per second)
46	Data Format	2	ASCII characters: 16, 32, or C0
48	Reserved	16	ASCII character: <SP>
64	Trigger Type	4	ASCII characters: EVT, TIM, LEV, CON, RAD, EXT, CRS
68	Trigger Description	162	Format depends on type of trigger as described below.

4.3.2 Continuous Trigger Info (Trigger type = CON)

Offset	Description	No. of Bytes	Format
0	Record Length	8	ASCII digits: FP 3 (seconds)
8	Start Time	14	ASCII: YYYYDDDHHMMSS
22	Reserved	140	ASCII: <SP>

4.3.3 Cross-Stream Trigger Info (Trigger type = CRS)

Offset	Description	No. of Bytes	Format
0	Trigger Stream No	2	ASCII integer
2	Pretrigger Length	8	ASCII digits: FP 3 (seconds)
10	Record Length	8	ASCII digits: FP 3 (seconds)
18	Reserved	144	ASCII character: <SP>

4.3.4 Event Trigger Information (Trigger type = EVT)

Offset	Description	No. of Bytes	Format
0	Trigger Channels	16	Non-space for included channel, position dependent (byte one for channel one, byte two for channel two, etc.); REFTEK user interfaces use an ASCII digit (lower digit of channel number)
16	Minimum Channels	2	ASCII integer
18	Trigger Window	8	ASCII digits: FP 3 (seconds)
26	Pretrigger Length	8	ASCII digits: FP 3 (seconds)
34	Post-trigger Length	8	ASCII digits: FP 3 (seconds)
42	Record Length	8	ASCII digits: FP 3 (seconds)
50	Reserved	8	ASCII: <SP>
58	STA Length	8	ASCII digits: FP 3 (seconds)
66	LTA Length	8	ASCII digits: FP 3 (seconds)
74	Mean Removal	8	ASCII digits: FP 2
82	Trigger Ratio	8	ASCII digits: FP 3 (seconds)
90	De-trigger Ratio	8	ASCII digits: FP 2
98	LTA Hold	4	ASCII characters: ON or OFF
102	Low Pass Corner Freq.	4	ASCII digits: FP 1 (Hz): OFF, 0, 12
106	High Pass Corner Freq.	4	ASCII digits: FP 1 (Hz): OFF, 0, 0.1, 2
110	Reserved	52	ASCII character: <SP>

4.3.5 External Trigger Information (Trigger type = EXT)

Offset	Description	No. of Bytes	Format
0	Pretrigger Length	8	ASCII digits: FP 3 (seconds)
8	Record Length	8	ASCII digits: FP 3 (seconds)
16	Reserved	146	ASCII: <SP>

4.3.6 Level Trigger Information (Trigger type = LEV)

Offset	Description	No. of Bytes	Format
0	Level	8	ASCII: Gn.nnnn FP4 Mnnn.nn FP2 %nn 1 – 99 Hxxxxxxx hex Integer Else Integer
8	Pretrigger Length	8	ASCII digits: FP 3 (seconds)
16	Record Length	8	ASCII digits: FP 3 (seconds)
24	Low Pass Corner Freq.	4	ASCII digits: FP 1 (Hz): OFF, 0, 12
28	High Pass Corner Freq.	4	ASCII digits: FP 1 (Hz): OFF, 0, 0.1, 2
32	Reserved	130	ASCII character: <SP>

4.3.7 Time Trigger Information (Trigger type = TIM)

Offset	Description	No. of Bytes	Format
0	Start Time	14	ASCII digits: YYYYDDDHHMMSS
14	Repeat Interval	8	ASCII digits: DDHHMMSS
22	No. of Intervals	4	ASCII integer
26	Reserved	8	ASCII: <SP>
34	Record Length	8	ASCII digits: FP 3 (seconds)
42	Reserved	120	ASCII character: <SP>

4.3.8 Time List Trigger (Trigger type = TML)

Offset	Description	No. of Bytes	Format
0	Start Time	14	ASCII digits: YYYYDDDHHMMSS
14	Start Time	14	ASCII digits: YYYYDDDHHMMSS
28	Start Time	14	ASCII digits: YYYYDDDHHMMSS
42	Start Time	14	ASCII digits: YYYYDDDHHMMSS
56	Start Time	14	ASCII digits: YYYYDDDHHMMSS
70	Start Time	14	ASCII digits: YYYYDDDHHMMSS
84	Start Time	14	ASCII digits: YYYYDDDHHMMSS
98	Start Time	14	ASCII digits: YYYYDDDHHMMSS
112	Start Time	14	ASCII digits: YYYYDDDHHMMSS
126	Start Time	14	ASCII digits: YYYYDDDHHMMSS
140	Start Time	14	ASCII digits: YYYYDDDHHMMSS
154	Record Length	8	ASCII digits: FP 3 (seconds)

4.3.9 Vote Trigger (Trigger type = VOT)

Offset	Description	No. of Bytes	Format
0	Pre-trigger length	8	ASCII digits: FP 3 (seconds)
8	Post-trigger length	8	ASCII digits: FP 3 (seconds)
16	Record length	8	ASCII digits: FP 3 (seconds)
24	Level Units	1	ASCII characters: G Gs M m Gs % percent of full-scale H Hex counts Else Integer counts
25	Reserved	3	ASCII spaces
28	Trigger Channels	6	ASCII digit: Each byte indicates a channel (1 – G represents 1 - 16), allowing up to 6 channels to be specified.
34	Trigger channel votes	6	ASCII digit: Each byte indicates the number of votes, 1 – 9, for the corresponding channel specified by the channels field.
40	Trigger channel level	6 * 8	ASCII digits: Trigger level for each corresponding channel: Gs FP4 mGs FP2 % Integer 1 – 99 Hex Hexadecimal Counts Integer
88	Trigger minimum votes	2	ASCII integer: 1 - 99
90	Trigger window	8	ASCII digits: FP 3 (seconds)
98	De-trigger channel votes	6	ASCII digit: Each byte indicates the number of votes, 1 – 9, for the corresponding channel specified by the channels field.
104	De-trigger channel level	6 * 8	ASCII digits: De-trigger level for each corresponding channel: Gs FP 4 % Integer 1 – 99 Counts Integer
152	De-trigger minimum votes	2	ASCII integer: 1 - 99
154	Low Pass Corner Freq.	4	ASCII digits: FP 1 (Hz): OFF, 0, 12
158	High Pass Corner Freq.	4	ASCII digits: FP 1 (Hz): OFF, 0, 0.1, 2

4.4 Data packet (DT)

The Data packets contain the actual ADC data. These packets have an 8-byte extended header in addition to the standard 16-byte packet header.

Offset	Description	No. of Bytes	Format
0	Packet Header	16	Type DT
16	Event #	2	4-digit BCD
18	Data Stream #	1	2-digit BCD
19	Channel #	1	2-digit BCD
20	No. of Samples	2	4-digit BCD
22	Flags	1	8 bit-flags
23	Data Format	1	2-digit BCD (16, 32, 33, C0, C1, C2, C3)
24	Sample Data	1000	As described in next two subsections

4.4.1 Extended Header Fields

Event Number

The Event Number field increments for each new event the DAS records. It rolls over to zero once it reaches 9999.

Datastream Number

The Datastream Number field indicates which datastream generated the packet contents. This field is zero-based instead of 1-based, meaning that 1 must be added to this number to associate it with the data stream numbers presented to the user in the user interface.

Channel Number

The Channel Number field indicates which input channel generated the packet contents. This field is zero-based instead of 1-based, meaning that 1 must be added to this number to associate it with the channel numbers presented to the user in the user interface.

Sample Count

The Sample Count Field indicates the number of samples in the packet. A compressed packet may contain up to 892 samples. An uncompressed packet may contain up to 250 samples.

Flags

The Flags field contains bit flags that provide additional information about binary data.

Bit	Description
7 (msb)	Calibration signal enabled during packet
6	Overscaled data detected during packet
5	Stacked data in packet
4	ST Command Trigger Event
3	Unused
2	2nd EH/ET flag
1	Last data packet of event (excluding EH/ET packets)
0 (lsb)	First data packet of event (excluding EH/ET packets)

Format

The Format field indicates the format of the payload section of the packet. The following formats have been defined:

Field Value	Description
16h	Binary 16-bit data (MSB – LSB)
32h	Binary 32-bit data (MSB – LSB)
33h	Binary 32-bit data (MSB – LSB) with overscale flag
C0h	Binary Compressed data
C1h	Binary Compressed data with overscale flag
C2h	Binary Highly-Compressed data
C3h	Binary Highly-Compressed data with overscale flag

Note: Overscale detection is only available for specific hardware and firmware combinations. When overscale detection is active the data format will be 33, C1 or C3 instead of 32, C0 or C2. Overscale flags are not available for 16-bit data.

Note: The overscale flag bit is any bit from bit 29 to bit 31 (Counting the LSB as bit 1 of the uncompressed data sample). Bit 32 is the data sign bit and is never affected.

4.4.2 Uncompressed Data Format (16, 32 or 33)

The maximum number of samples that can be stored in an uncompressed data packet is 500 samples in 16-bit format or 250 samples in 32-bit format.

Offset	Description	No. of Bytes	Format
24	Sample Data	1000	Binary (2's-compliment); 16-bit or 32-bit with MSB first and LSB last.

4.4.3 Compressed Data Format (C0 or C1)

A 40-byte reserved area follows the extended packet header so that the data bytes start on a 64-byte boundary. The remainder of the packet is divided into 15 data frames of 64 bytes each.

Offset	Description	No. of Bytes	Format
24	Filler	40	ASCII characters: <SP>
64	Data Frame 0-14	960	Compressed data frames

Each data frame is divided into 16 four-byte sequences. The first four-byte sequence of each data frame contains 16 two-bit codes which describe the format of each corresponding four-byte sequence in the frame. A bit code of 00 indicates the corresponding four-byte sequence is non-data or a special entry. A bit code of 01 indicates the corresponding four-byte sequence contains four 1-byte differences. A bit code of 10 indicates two 2-byte differences. A bit code of 11 indicates one 4-byte difference. The following table summarizes the compression codes:

Primary Code	Contents of 4-byte sequence
00	Special or non-data entry
01	Four 8-bit differences
10	Two 16-bit differences
11	One 32-bit differences

For all data frames, the first two-bit code is always 00 since it corresponds to the four-byte sequence containing the codes. In the first data frame, the 2nd and 3rd codes are also 00. These correspond to the start/stop values for the entire block. A sample value is obtained from each difference by adding the difference to the previous sample value. The start value equals the stop value of the previous block for the same channel of an event plus the first difference in the current block. For the first block of a given channel for an event, the start value equals the first difference. The stop value equals the last sample value from that block. The maximum number of samples that can be stored in a compressed data packet is 892.

4.4.4 Highly-Compressed Data Format (C2 or C3)

A 40-byte reserved area follows the extended packet header so that the data bytes start on a 64-byte boundary. The remainder of the packet is divided into 15 data frames of 64 bytes each.

Offset	Description	No. of Bytes	Format
24	Filler	40	ASCII characters: <SP>
64	Data Frame 0-14	960	Compressed data frames

Each data frame is divided into 16 four-byte sequences. The first four-byte sequence of each data frame contains 16 two-bit codes which describe the format of each corresponding four-byte sequence in the frame. A bit code of 00 indicates the corresponding four-byte sequence is non-data or a special entry. A bit code of 01 indicates the corresponding four-byte sequence contains four 1-byte differences. A bit code of 10 or 11 indicates a secondary two-bit code is located in the four-byte sequence itself. The following table summarizes the compression codes:

Primary Code	Secondary Code	Contents of 4-byte sequence
00	-	Special or non-data entry
01	-	Four 8-bit differences
10	00	Invalid
10	01	One 30-bit difference
10	10	Two 15-bit differences
10	11	Three 10-bit differences
11	00	Five 6-bit differences
11	01	Six 5-bit differences
11	10	Seven 4-bit differences
11	11	Invalid

For all data frames, the first two-bit code is always 00 since it corresponds to the four-byte sequence containing the codes. In the first data frame, the 2nd and 3rd codes are also 00. These correspond to the start/stop values for the entire block. A sample value is obtained from each difference by adding the difference to the previous sample value. The start value equals the stop value of the previous block for the same channel of an event plus the first difference in the current block. For the first block of a given channel for an event, the start value equals the first difference. The stop value equals the last sample value from that block. The maximum number of samples that can be stored in a highly compressed data packet is 1561.

4.5 Event Header packet (EH)

The Event Header packet signals the start of a new event. It has the same 8-byte extended header found in data packets, but the channel, sample count and flags fields are not used. The Event Header packet and the Event Trailer packet are identical in structure, but the detrigger and last sample times are only recorded in the Event Trailer packet.

Offset	Description	No. of Bytes	Format
0	Packet Header	16	Type EH
16	Event #	2	4-digit BCD
18	DataStream #	1	2-digit BCD
19	Reserved	3	Binary: 0
22	Flags	1	Binary: Bit 2: 0 = chn 1-16, 1 = 17-32
23	Data Format	1	2-digit BCD (16, 32, 33, C0, C1, C2, C3)
24	Trigger Time Message	33	ASCII characters
57	Time Source	1	ASCII characters: See 4.6.1 below.
58	Time Quality	1	ASCII characters: See 4.6.2 below.
59	Station Name Ext	1	ASCII character: 5th character of station name
60	Station Name	4	ASCII character: first 4 characters of station name from the Station Parameters
64	Stream Name	16	Stream name from the Datastream Parameters
80	Reserved	8	ASCII character: <SP>
88	Sample Rate	4	ASCII integer (samples / second)
92	Trigger Type	4	ASCII characters: CON, CRS, EVT, EXT, LEV, TIM, TML, VOT
96	Trigger Time	16	ASCII digits: YYYYDDDHHMMSSTTT
112	First Sample Time	16	ASCII digits: YYYYDDDHHMMSSTTT
128	Detrigger Time	16	ASCII character: <SP>
144	Last Sample Time	16	ASCII character: <SP>
160	Channel Adjusted Nominal Bit Weights	128 (8 * 16)	ASCII characters: volts/count (for upper 16-bits of the data) in FP with units (mV, mV, etc.); 16 channels with 8 bytes per channel, first 8 bytes is channel one, etc.; <SP>s if channel is not included in this data stream.
288	Channel True Bit Weights	128 (8 * 16)	ASCII characters: volts/count of the LSBit of the data; 16 channels with 8 bytes per channel, first 8 bytes is channel one, etc.; <SP>s if channel is not included in this data stream.
416	Channel Gain	16	ASCII character per channel: See 4.6.3 below.
432	Channel A/D Resolution	16	ASCII character per channel: See 4.6.4 below.
448	Channel FSA	16	ASCII character per channel: See 4.6.5 below.
464	Channel Code	64 (4 *16)	ASCII characters: See the SEED manual Appendix A.
528	Channel Sensor FSA	16	ASCII character per channel: See 4.6.5 below.
Offset	**Description**	**No. of**	**Format**

Bytes			
544	Channel Sensor VPU	96 (6 *16)	ASCII digits: FP3 volts per measurement unit
640	Channel Sensor Units	16	ASCII character per channel: see 4.6.6 below.
656	Station Channel Number	48 (3 * 16)	ASCII digits: 1-999, 3 bytes each for 16 channels
704	Reserved	156	ASCII character: <SP>
860	Total Installed Channels	2	ASCII digits: Total installed channels.
862	Station Comment	40	ASCII character: station comment from Station Parameters
902	Digital Filter List	16	ASCII characters: Each byte specifies the filter used for the corresponding filter stage. See 4.6.7 below
918	Position	26	ASCII characters: Latitude Longitude Altitude C DDMM.MMMCDDDMM.MMM +/-MMMMM
944	Ref Tek 120	80	Reserved for REF TEK 120: see 0 below

4.6 Event Trailer packet (ET)

The Event Trailer packet signals the end of an event. It has the same 8-byte extended header found in data packets, but the channel, sample count and flags fields are not used. The Event Trailer packet and the Event Header packet are identical in structure, but the detrigger and last sample times are only recorded in the Event Trailer packet.

Offset	Description	No. of Bytes	Format
0	Packet Header	16	Type EH
16	Event #	2	4-digit BCD
18	DataStream #	1	2-digit BCD
19	Reserved	3	Binary: 0
22	Flags	1	Binary: Bit 2: 0 = chn 1-16, 1 = 17-32
23	Data Format	1	2-digit BCD (16, 32, 33, C0, C1, C2, C3)
24	Trigger Time Message	33	ASCII characters
57	Time Source	1	ASCII characters: See 4.6.1 below.
58	Time Quality	1	ASCII characters: See 4.6.2 below.
59	Station Name Ext	1	ASCII character: 5th character of station name
60	Station Name	4	ASCII character: first 4 characters of station name from the Station Parameters
64	Stream Name	16	Stream name from the Datastream Parameters
80	Reserved	8	ASCII character: <SP>
88	Sample Rate	4	ASCII integer (samples / second)
92	Trigger Type	4	ASCII characters: CON, CRS, EVT, EXT, LEV, TIM, TML, VOT
96	Trigger Time	16	ASCII digits: YYYYDDDHHMMSSTTT
112	First Sample Time	16	ASCII digits: YYYYDDDHHMMSSTTT
128	Detrigger Time	16	ASCII character: YYYYDDDHHMMSSTTT
144	Last Sample Time	16	ASCII character: YYYYDDDHHMMSSTTT
160	Channel Adjusted Nominal Bit Weights	128 (8 * 16)	ASCII characters: volts/count (for upper 16-bits of the data) in FP with units (mV, mV, etc.); 16 channels with 8 bytes per channel, first 8 bytes is channel one, etc.; <SP>s if channel is not included in this data stream.
288	Channel True Bit Weights	128 (8 * 16)	ASCII characters: volts/count of the LSBit of the data; 16 channels with 8 bytes per channel, first 8 bytes is channel one, etc.; <SP>s if channel is not included in this data stream.
416	Channel Gain	16	ASCII character per channel: See 4.6.3 below.
432	Channel A/D Resolution	16	ASCII character per channel: See 4.6.4 below.
448	Channel FSA	16	ASCII character per channel: See 4.6.5 below.
464	Channel Code	64 (4 *16)	ASCII characters: See the SEED manual Appendix A.
528	Channel Sensor FSA	16	ASCII character per channel: See 4.6.6 below.
Offset	**Description**	**No. of**	**Format**

Bytes			
544	Channel Sensor VPU	96 (6 *16)	ASCII digits: FP3 volts per measurement unit
640	Channel Sensor Units	16	ASCII character per channel: see 4.6.6 below.
656	Station Channel Number	48 (3 * 16)	ASCII digits: 1-999, 3 bytes each for 16 channels
704	Reserved	156	ASCII character: <SP>
860	Total Installed Channels	2	ASCII digits: Total installed channels.
862	Station Comment	40	ASCII character: station comment from Station Parameters
902	Digital Filter List	16	ASCII characters: Each byte specifies the filter used for the corresponding filter stage. See 4.6.7 below
918	Position	26	ASCII characters: Latitude Longitude Altitude C DDMM.MMMCDDDMM.MMM +/-MMMMM
944	Ref Tek 120	80	Reserved for Ref Tek 120: see 0 below

4.6.1 EH/ET Time Source Codes

Code	Description
<SP>	Unknown
1	Internal
2	GPS

4.6.2 EH/ET Time Quality Codes

Code	Description
<SP>	Unknown
?	Never achieved PLL
0 - 9	Days since PLL

4.6.3 EH/ET Channel Gain Codes

Code	Description
<SP>	Unknown
1	x1
2	x8
3	x32
4	x128
5	x512
6	x2048
7	x8192
8	x100
A	12 dB
B	24 dB
C	36 dB
D	48 dB
E	60 dB
F	x2
G	x4
H	x16
I	x64
J	x256

4.6.4 EH/ET Channel A/D Resolution Codes

Code	Description
<SP>	Unknown
1	8-bit
2	16-bit
3	24-bit
4	32-bit
A	10-bit
B	11-bit
C	12-bit

4.6.5 EH/ET Channel, Sensor Full Scale Analog Codes

Code	Description
<SP>	Unknown
1	+/- 3.75 V
2	+/- 5.0 V
3	+/- 10.0 V
4	+/- 20.0 V
R	0-3.34 V
T	0-512 Kelvin
V	0-20.875

4.6.6 EH/ET Sensor Units Codes

Code	Description
<SP>	Unknown
A	M/S**2
D	M
G	G
V	M/S
T	OK Temp
P	Voltage

4.6.7 EH/ET Filter Codes

Code	Description
<SP>	No Information
0	Ref Tek soft 2:1
1	Ref Tek soft 4:1
2	Ref Tek soft 5:1
3	Ref Tek hard 2:1
4	Ref Tek hard 4:1
5	Ref Tek hard 5:1
A	CS5322 input 8:1
B	CS5322 filter 2:1
C	CS5322 output 2:1
D	Fir Stage 1 Decimate by 2
E	Fir Stage 2 Decimate by 2
F	Fir Stage 3 Decimate by 4
G	Fir Stage 4 Decimate by 2
H^n	Sinc Filter H^n $H = 2$ n = power
M	163.84K
N	81.92K
O	Undefined
P	409.6K
Q	819.2K
R	1024.0K
S	8.192K
T	40.96K
U	204.8K
V	512.0K
W	4.096K
X	20.48K
Y	102.4K
Z	256.0K

4.6.8 REF TEK 120 Information

Offset	Description	No. of Bytes	Format
944	Event Length	10	ASCII digits:
954	Overscale Count	6	ASCII digits: 0 - 65536
960	Firmware Version	8	ASCII characters
968	Transmitter Frequency	8	ASCII fraction
976	Transmitter Identifier	8	ASCII characters
984	Transmitter Site	8	ASCII characters
992	DAU Sensor ID	8	ASCII characters
1000	DAU Sensor Site	8	ASCII characters
1008	Analog Filter; CH 1-4	4	ASCII character: A-D
1012	DAU Propagation Delay	4	ASCII digits: 1 – 9999 (clock ticks; 1/12.888MHz)
1016	DAU Data Channel	2	ASCII digits: 1 - 99
1018	DAU Data Channel Pos	4	ASCII digits: 1 - 100
1022	Analog Filter; CH 5-6	2	ASCII character : A-D

4.7 Filter Description packet (FD)

Offset	Description	No. of Bytes	Format
0	Packet Header	16	Type FD
16	Filter Info	992	See below
1008	Implement Time	16	ASCII Time of Implement YYYYDDDHHMMSSTTT

Each Filter Description packet can contain more than one filter block. Each filter block starts on a 4-byte boundary and contains an 8-byte header followed by the filter coefficients. If a filter block does not end on a 4-byte boundary, it is padded with zeros to the next 4-byte boundary.

Offset	Description	No. of Bytes	Format
0	Filter Block count	1	Integer: Number of additional filter blocks in this packet
1	Filter ID	1	ASCII character: base 36 filter code (see EH/ET Filter Codes)
2	Filter Decimation	1	Integer
3	Filter Scalar	1	Integer: power of 2 scalar (i.e. 4 means 2^4 = 16)
4	Filter Coefficient count	1	Integer (unsigned): number of coefficients in this filter (0 = 256)
5	Packet Coefficient count	1	Integer (unsigned): number of coefficients in this packet (<= 248)
6	Coefficient Packet count	1	Integer: number of packets for this filter
7	Coefficient Format	1	2-digit BCD: 16, 32
8	Coefficients	<=248	Integer: 2's compliment with MSB first and LSB last.

The Filter Block count indicates how many filter blocks follow this one in the same packet. Zero indicates the last filter block in the packet. If non-zero, the start of next filter block is ((4 * count) + 8) bytes from the current filter block.

The Filter ID is a base-36 ASCII code that corresponds to the ASCII filter codes stored in the EH/ET packets.

The Filter Decimation indicates the decimation of the filter.

The Filter Scalar indicates the scalar that must be applied to the filter to return it to its original form. The coefficients in the REF TEK filters were all less than 1 and were scaled to allow integer arithmetic within the unit. The Filter Scalar is the power of 2 by which the coefficients were originally scaled.

The Filter Coefficient Count indicates the total number of coefficients in the filter.

The Packet Coefficient Count indicates how many coefficients are in this filter block. Multiplying this number by the size of each coefficient and adding 8 gives the offset from this filter block to the next filter block.

The Coefficient Packet Count is only used when a filter contains more than 248 32-bit coefficients and a second Filter Description packet is needed to complete the filter. A non-zero count indicates the number of additional Filter Description packets that are needed to complete this filter.

The Coefficient Format indicates the data format of the coefficients. A BCD value of 16 indicates 16-bit (2-byte) coefficients and a BCD value of 32 indicates 32-bit (4-byte) coefficients.

4.8 Operating Mode parameter packet (OM)

Offset	Description	No. of Bytes	Format
0	Packet Header	16	Type OM
16	72A Power State	2	ASCII characters: SL or CP
18	Recording Mode	2	ASCII characters: RM, SC or SR
20	Disk Reserved	4	ASCII character: <SP>
24	Auto-dump on ET	1	ASCII character: Y (yes/enable) or N (no/disable)
25	Disk Reserved	1	ASCII character: <SP>
26	Auto-dump Threshold	2	ASCII integer: percent of RAM
28	72A Power-down Delay	4	ASCII integer: seconds
32	Disk Wrap	1	ASCII character: Y (yes/enable) or N (no/disable)
33	Disk Reserved	1	ASCII character: <SP>
34	72A Disk Power	1	ASCII character: T (toggle) or O (always on)
35	72A Terminator Power	1	ASCII character: T (toggle) or O (always on)
36	Disk Retry	1	ASCII digit: days
37	Disk Reserved	11	ASCII character: <SP>
48	72A Wake up Reserved	2	ASCII character: <SP>
50	72A Wake up Start Time	12	ASCII digits: YYYYDDDHHMM
62	72A Wake up Duration	6	ASCII digits: DDHHMM
68	72A Wake up Repeat Interval	6	ASCII digits: DDHHMM
74	72A Wake up Number of Intervals	2	ASCII integer
76	72A Wake up Reserved	484	ASCII character: <SP>
560	Reserved	448	ASCII character: <SP>
1008	Implement Time	16	ASCII time of implement: YYYYDDDHHMMSSTTT

4.9 Station/Channel parameter packet (SC)

Offset	Description	No. of Bytes	Format
0	Packet Header	16	Type SC
16	Experiment Number	2	ASCII integer
18	Experiment Name	24	ASCII characters
42	Experiment Comment	40	ASCII characters
82	Station Number	4	ASCII integer
86	Station Name	24	ASCII characters
110	Station Comment	40	ASCII characters
150	DAS Model	12	ASCII characters
162	DAS Serial #	12	ASCII integer
174	Experiment Start	14	ASCII digits: YYYYDDDHHMMSS
188	Time Clock Type	4	ASCII characters
192	Time Clock S/N	10	ASCII characters
202	Channel Information	730	Up to five channels per packet as described in the following subsection
932	Reserved	76	ASCII character: <SP>
1008	Implement Time	16	ASCII time of implement: YYYYDDDHHMMSSTTT

4.9.1 Channel Information

Offset	Description	No. of Bytes	Format
0	Channel #	2	ASCII integer
2	Channel Name	10	ASCII characters
12	Azimuth	10	ASCII characters
22	Inclination	10	ASCII characters
32	X Coordinate	10	ASCII characters
42	Y Coordinate	10	ASCII characters
52	Z Coordinate	10	ASCII characters
62	Unit type for X, Y	4	ASCII characters
66	Unit type for Z	4	ASCII characters
70	Preamp Gain	4	ASCII characters
74	Sensor Model	12	ASCII characters
86	Sensor Serial #	12	ASCII characters
98	Comments	40	ASCII characters
138	Adjusted Nominal Bit weight	8	ASCII characters: volts/count (for upper 16-bits of the data) in FP with units (mV, uV, etc.); 16 channels with 8 bytes per channel, first 8 bytes is channel one, etc.; <SP>s if channel is not included in this data stream.

4.10 State-of-Health packet (SH)

Offset	Description	No. of Bytes	Format
0	Packet Header	16	Type SH
16	Reserved	8	ASCII character: <SP>
24	Information	1000	ASCII characters: Entries contain a time tag in the form DDD:HH:MM:SS followed by a <SP>, the entry, and a <CR><LF>. The time tag is the time the entry was made into the packet. It is the approximate time of occurrence for the entry. Entries provide information on conditions that affect the performance of the unit.

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