



Unified Status Packets

Advanced State-of-Health Information

Specification

Part No. SWA-RFC-UNIS

Designed and manufactured by
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1 Introduction

At present, the DM24 supports three types of status packet: textual information, typically sent around every 15 minutes or so; CD status packets, a packed binary format sent every second; and DSS status packets, structured textual packets sent every minute (or on a user-defined interval more recently).

The CD status and DSS status packets have been introduced to try and solve issues encountered in CD1.x (Continuous Data, CTBTO's preferred realtime transfer protocol) and DSS (data subscription system, initially developed at Quanterra and used by KIGAM) data transfer protocols, both of which require some form of realtime state of health information to be made available to the receiver.

The aim of the unified status packets is to combine all of the information used by CD1.x and DSS (and also the information that can be expressed in SEED volumes) into a single, extensible packet type that is programmatically easy to deal with. This will allow us to leave the existing status packet generation alone and deprecate DSS/CD status in favour of the new packet type.

1.1 Requirements

Requirements come from two places: users wishing to know the state of health (SOH) information of the digitiser, and programs which need data/clock quality information to make decisions. SOH information often needs to be encoded: many realtime data transfer systems have explicit SOH fields which need to be filled, and there are pure-SOH systems (e.g. seisnetwatch), so textual status is not sufficient for this purpose.

Although some (if not most) of the data quality information could be determined by analysis of the data itself, combined with some sort of parser for the textual status packets, this analysis is complex and error-prone. Some of the systems required to perform this analysis have low latency requirements, low power consumption, and little in the way of resources. It therefore seems best to simply

package the actual data quality information itself (which the digitiser can unambiguously determine) and present it as a block of metadata along with the samples themselves.

The following sections contain items that need to be reported, along with a discussion of where the requirement originated. Some of the information that can be represented in SEED volumes may not be available to digitisers, or may not be relevant — this can simply be noted as such and left out of the implementation. Some of the information is not required by any particular protocol but seems sensible to export.

Data quality information should be emitted in a GCF block with a special stream ID (perhaps ending 01 or similar), and can be archived along with waveform data. It should be emitted every second, so that processing applications can retain as little state as possible. This implies that we should use a fairly efficient packed binary format in order to avoid saturating the serial link.

Clock Status

We can report whether or not the clock is currently locked. If it is, we can report our measured drift from the source; if not, our estimate of the worst-case drift. We can also report the clock source: GPS, stream sync, NTP, etc. Finally, the time of the last lock should be reported.

This is used in SEED and CD1.1. The DSS server will also discard data with clock differential too large, or data from a system that has never been synced. CD1.1 and DSS require us to estimate clock drift when the clock is unlocked. What we are after here is the magnitude of the worst case drift. If we know the ppm of the crystal and the time elapsed since last sync, we should be able to estimate the worst-case drift.

GPS Receiver Status

We report the status (no comms, no fix, 2D, 3D) and the last reported location (latitude, longitude and elevation).

The GPS status is used in CD1.1. The location is used in SEED and DSS. If we have never had a fix, the location should be left blank. Otherwise, even if the fix has been lost, it should be the location of the last fix.

Channel Quality Flags

We report on things such as whether the FIR filter is still charging, whether clipping has occurred, etc.

This information is represented in both the CD1.x status subframe and in SEED volumes. It is also used by DSS to determine if the data should be used for strong motion calculation or discarded.

2 Unified Status Packet Format

This packet is a GCF block with a stream ID ending with '01'. The other header details are the same as a normal ('00') status packet, i.e. 0 sample rate and the number of samples field (which corresponds to the number of tag/data words in the unified status packet) is multiplied by 4 to give the number of bytes.

In order to make the packet expandable/future-proof, we use a tag system. Each status packet consists of an arbitrary number of records. Each record has an identifying tag (32-bit) and an arbitrary number of data words (each word is 32-bit). The lower 8 bits of the tag are used to indicate the number of following data words (00000000=1, 00000001=2, ..., 11111111=256).

2.1 Clock Status

31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0																															
Tag: 0x000000																								Words: 0x01							
L						Src	Differential																								
Last lock day												Last lock second																			

2 data words. Tag 0x000000 01.

Data word 1

bit 31 clock locked (i.e. GPS control on, stream sync on, etc.)

bits 24–26 current clock source

000	internal RTC
001	GPS
010	stream sync

- 011 NTP
- 100 accurate clock module

bits 0–23 clock differential (in μs), 2’s complement, 0x800000 if never locked or greater than the maximum (8.388607s). Estimated if clock not locked; otherwise measured.

Data word 2

Time of last sync to GPS/etc., in GCF time format (this will be 0 if never synced/locked or NOW if clock is locked).

2.2 GPS Receiver Status

31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0								
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; text-align: center; padding: 5px;">Tag: 0x000001</td> <td style="width: 50%; text-align: center; padding: 5px;">Words</td> </tr> <tr> <td style="padding: 5px;"></td> <td style="padding: 5px;"> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; text-align: center; padding: 5px;">Format</td> <td style="width: 50%; text-align: center; padding: 5px;">GPS fix</td> </tr> </table> </td> </tr> <tr> <td colspan="2" style="text-align: center; padding: 5px;">GPS Location, variable length</td> </tr> </table>	Tag: 0x000001	Words		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; text-align: center; padding: 5px;">Format</td> <td style="width: 50%; text-align: center; padding: 5px;">GPS fix</td> </tr> </table>	Format	GPS fix	GPS Location, variable length	
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Format	GPS fix							
GPS Location, variable length								

Variable length. Tag 0x000001 nn

Data word 1

bits 4–7 location format

- 0000 DM24mk3 (“5121.6655,N,00109.8456,W,00113,M”, 32 bytes)
- 0001 Degrees/m (“+51.216655-001.098456+000113.000”, 32 bytes)

bits 0–3 GPS fix status

- 0000 powered off
- 0001 no comms
- 0010 no fix
- 0011 2D fix
- 0100 3D fix

Data words 2–(n+1)

Location from last fix in specified format, unused bytes set to ASCII NUL (0). If we have never had a fix, this field can be omitted altogether (remember to change the number of words in the tag header), or can be blank (filled with ASCII NUL).

2.3 Channel Quality Flags

31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

Tag: 0x0001	I	Channel	Words: 0x00
			Flags

1 data word. Tag 0x0001yy 00. yy is channel (top bit set if instrument 1):

00	channel '0' of instrument 0
01	channel '1' of instrument 0
...	
0A	channel 'A' of instrument 0
...	
23	channel 'Z' of instrument 0
80	channel '0' of instrument 1
...	
A3	channel 'Z' of instrument 1

Data word 1

bit 11	FIR filter charging
bit 10	missing or padded data
bit 9	spikes
bit 8	glitches (missing samples?)
bit 7	amplifier saturated

bit 6	(unused)
bit 5	(unused)
bit 4	analogue input shorted
bit 3	calibration underway
bit 2	digitiser clipping
bit 1	zeroed data
bit 0	dead sensor channel