



ARL-TN-1149 • FEB 2023



Minimal Set of Signal Metadata Format (SigMF) Keys for RF Test Data Sets Using the Advanced Electronic Warfare Laboratory (AEWL)

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REPORT DOCUMENTATION PAGE

1. REPORT DATE		2. REPORT TYPE		3. DATES COVERED	
February 2023		Technical Note		START DATE	END DATE
				1 October 2021	30 September 2022
4. TITLE AND SUBTITLE					
Minimal Set of Signal Metadata Format (SigMF) Keys for RF Test Data Sets Using the Advanced Electronic Warfare Laboratory (AEWL)					
5a. CONTRACT NUMBER		5b. GRANT NUMBER		5c. PROGRAM ELEMENT NUMBER	
5d. PROJECT NUMBER		5e. TASK NUMBER		5f. WORK UNIT NUMBER	
6. AUTHOR(S)					
Marius Necsoiu, Kenneth I Ranney, Dannielle Tadas, Andre C Magill, Neal Tesny, and William J Diehl					
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)				8. PERFORMING ORGANIZATION REPORT NUMBER	
DEVCOM Army Research Laboratory ATTN: FCDD-RLA-LD Adelphi, MD 20783-1138				ARL-TN-1149	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)			10. SPONSOR/MONITOR'S ACRONYM(S)	11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT					
Approved for public release: distribution unlimited.					
13. SUPPLEMENTARY NOTES					
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14. ABSTRACT					
A minimal set of Signal Metadata Format (SigMF) metadata keys are recommended by the US Army Combat Capabilities Development Command Army Research Laboratory to be used in conjunction with the Advanced Electronic Warfare Laboratory. The SigMF metadata keys are described, and an example usage is given.					
15. SUBJECT TERMS					
Electromagnetic Spectrum Sciences, SigMF, AEWL, RFML, metadata					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT		18. NUMBER OF PAGES
a. REPORT	b. ABSTRACT	c. THIS PAGE	UU		12
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED			
19a. NAME OF RESPONSIBLE PERSON				19b. PHONE NUMBER (Include area code)	
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STANDARD FORM 298 (REV. 5/2020)

Prescribed by ANSI Std. Z39.18

Contents

List of Figures	iv
List of Tables	iv
1. Introduction	1
2. SigMF Metadata Keys	1
2.1 Global Segment	1
2.2 Captures Segment	2
2.3 Annotations Segment	2
3. SigMF Example	3
4. References	4
List of Symbols, Abbreviations, and Acronyms	5
Distribution List	6

List of Figures

Fig. 1	Example usage of the SigMF metadata keys for a stored data set.....	3
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List of Tables

Table 1	Global segment objects	2
Table 2	Captures segment objects.....	2
Table 3	Annotations segment objects	3

1. Introduction

The US Army Combat Capabilities Development Command (DEVCOM) Army Research Laboratory (ARL) recommends a minimal set of Signal Metadata Format (SigMF) metadata keys when using the Advanced Electronic Warfare Laboratory (AEWL), a complex hardware-in-the-loop system used to evaluate and improve modern and future radio systems. This minimal set is based on the SigMF format described by GitHub/GNURadio Signal Metadata Format Specification (Hilburn et al. 2018) and could be used in developing RF machine learning data sets.

The purpose of the key set is to provide a generally accepted format for storage of RF-related data sets that will allow data to be exchanged and used more readily by the scientific community. An extended set of metadata keys is also available (see ARL-TN-1151).

2. SigMF Metadata Keys

2.1 Global Segment

Table 1 lists the keys specified in the `core` namespace defined in the SigMF Specification v1.0.0 (<https://github.com/gnuradio/SigMF/blob/sigmf-v1.x/sigmf-spec.md>) and used in the **global** segment object.

The legend is as follows:

Keys in **green** are listed as “required” by the SigMF Format Specification. Keys in **blue** are listed as “not required” by the SigMF Format Specification but are used in documenting the ARL RF data sets.

Table 1 Global segment objects

Name	Type	Description
datatype	String	The format of the stored samples in the data set file. Its value must be a valid SigMF data set format type string.
sample_rate	Double	The sample rate of the signal in samples per second.
version	String	The version of the SigMF specification used to create the metadata file.
sha512	String	The SHA512 hash of the data set file associated with the SigMF file.
offset	uint	The index number of the first sample in the data set. This value defaults to zero. Typically used when a recording is split over multiple files.
description	String	A text description of the SigMF recording.
author	String	The author's name (and optionally email address).
recorder	String	The name of the software used to make this SigMF recording.
hw	String	A text description of the hardware used to make the recording.
extensions	Object	A list of extensions used by this recording.

2.2 Captures Segment

Table 2 lists the names are specified in the core namespace defined in the SigMF Specification v1.0.0 (<https://github.com/gnuradio/SigMF/blob/sigmf-v1.x/sigmf-spec.md>) and used in **captures** segment objects.

Table 2 Captures segment objects

Name	Type	Description
sample_start	uint	The sample index in the data set file at which this segment takes effect.
frequency	Double	The center frequency of the signal in hertz.
datetime	String	An ISO-8601 (2023) string indicating the time stamp of the sample index specified by <code>sample_start</code> .

2.3 Annotations Segment

The following names (Table 3) are specified in the core namespace defined in the SigMF Specification v1.0.0 (<https://github.com/gnuradio/SigMF/blob/sigmf-v1.x/sigmf-spec.md>) and used in **annotations** segment objects.

Table 3 Annotations segment objects

Name	Type	Description
sample_start	uint	The sample index at which this segment takes effect.
sample_count	uint	The number of samples that this segment applies to.
freq_lower_edge	Double	The frequency (hertz) of the lower edge of the feature described by this annotation.
freq_upper_edge	Double	The frequency (hertz) of the upper edge of the feature described by this annotation.
comment	String	A human-readable comment.

3. SigMF Example

Figure 1 shows an example of a sigmf-meta file created using the AEWL (Tadas et al. 2021). The figure shows the content of the metadata file associated with an in-phase/quadrature (IQ) signal. The global, captures, and annotations segments are shown with the objects describing the data set.

```

1  {
2    "global":{
3      "core:datatype": "cf32_le",
4      "core:version": "0.0.2",
5      "core:sample_rate": 50000000.000,
6      "core:offset": 0,
7      "core:description": "AEWL test dataset, NumberSamples=175000000, AcqBW= 40MHz,
8      MeasBW=165MHz, Length:3.5s.",
9      "core:sha512": "e87a795deee6490b8585079c12dfe68d6d68fbeb64c2226c051fd15e860fee8f1762d37c9efdf288d
10     d77991854fc4dea9b7b9fbd74f92dc61d5755e1727f80f2",
11     "core:author": "John Doe john.m.doe.civ@mail.mil)",
12     "core:recorder": "Notepad++",
13     "core:hw": "Tektronix RSA6100, SpecMon26B, Serial #B000000, FirmwareVersion 1.0.00",
14     "core:extensions":{
15       "arl-awl": "not_required",
16     }
17   },
18   "captures": [
19     {
20       "core:sample_start": 0,
21       "core:frequency": 1680000000,
22       "core:datetime": "2020-01-24T20:33:51.232Z"
23     }
24   ],
25   "annotations": [
26     {
27       "core:sample_start": 0,
28       "core:sample_count": 14379264,
29       "core:comment": "Block containing 7189632 IQ samples"
30     }
31   ]
32 }

```

Fig. 1 Example usage of the SigMF metadata keys for a stored data set

4. References

Hilburn B, West N, O'Shea T, Roy T. SigMF: the signal metadata format. Proceedings of the GNU Radio Conference. 2018 Sep;3(1).

ISO 8601. Date and time format. International Organization for Standardization [accessed 2023 Feb 2]. <https://www.iso.org/iso-8601-date-and-time-format.html>.

Tadas D, Tesny N, Magill A, Necsoiu M, Dietlein C. Multi-emitter scenario emulation in a hardware in the loop environment. Presented at the MSS Virtual Tri-Service Radar Symposium; 2021 Nov 15–19.

List of Symbols, Abbreviations, and Acronyms

AEWL	Advanced Electronic Warfare Laboratory
ARL	Army Research Laboratory
DEVCOM	US Army Combat Capabilities Development Command
IQ	in-phase/quadrature
RF	radio frequency
SigMF	Signal Metadata Format
uint	unsigned integer

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