Ultrasonic Pulse Transmission Tests: Datasets — Test Series 7, Reference Tests on Aluminium Cylinder

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Abstract

The test series was created in order to validate the stability and functionality of the test device and to create a data reference for metals (aluminium cylinder). The approach for the test series was to vary the parameters number-of-samples-recorded and pulse-voltage. This results in a two-dimensional test parameter grid. Tests were performed several times for each grid point (number-of-samples-recorded versus pulse-voltage) in order to receive statistical information about the stability of the test results. The material tested was an aluminium cylinder with a diameter of 50 millimetres and a height of 50 millimetres. The test method used was the ultrasonic pulse transmission method with combined compression- and shear wave measurements. All test data and metadata are summarized into datasets using GNU Octave's open binary file format.

1 Introduction

This document provides a technical description of the datasets of a series of ultrasonic pulse transmission tests (UPTT) performed in the course of the PhD thesis of the author of this document (see title page). This test series was performed to create a data reference for metals (aluminium cylinder). The test series design is based on the variation of two different parameters. The number-of-samples-recorded $N = [16k, 24k, 33k, 50k]$, the pulse-voltage $V = [400, 600, 800]$ Volts. The distance-between-actuator-and-sensor $D = [50]$ millimetres was kept constant and is identical to the height of the aluminium cylinder. This results in a two-dimensional parameter grid. For each grid point (N, V), tests were carried out several times to gain information about the stability of the tests. The result is a collection of 12 datasets containing the measurement data of the UPTT's. The test device used for the UPTT's is the FreshCon[1] device (developed at the University of Stuttgart, Germany). An elaborate description of test devices, the material and the test operation procedures is stored in the data set structure along with the measurement results. This record is published to allow other researchers to make use of it. In particular, those who have no access to the required laboratory facilities and test equipment. To allow others to make use of these datasets freely, an open license was chosen by the author (Creative Commons 4.0 Attribution, CC-BY-4.0).

2 Record content

The repository record consists of the following three files:

- **ts7_techdescr.pdf** contains the technical description (this file).
- **ts7_rawdata.tar.xz** contains the raw measurement data. This compressed TAR archive consists of a set of ZIP archives enlisted in table 8 in section **Appendix - Tables**. The content of the ZIP archives is described in section 3.
- **ts7_datasets.tar.xz** contains the datasets compiled from the raw measurement data. This compressed TAR archive consists of a set of binary files (*.oct, open GNU Octave binary format) enlisted in table 9 in section **Appendix - Tables**. The structure of the content of each data set is described in section 4 in detail.

Extracting data set files from compressed TAR archives: Under Linux the content of the compressed TAR archives can easily be extracted with the command line tool "tar"[2] on the "bash"[3] command prompt. On Microsoft Windows one may use "7zip"[4] instead.

```
$ tar -xf <filename>.tar.xz
```

Data integrity: To ensure the integrity of the files contained in the compressed TAR archives, the SHA256 checksum is also provided along with the files. See second column in tables 8 and 9 in section **Tables**. Check the integrity of a file with "sha256sum"[5] at the "bash" command prompt.

```
$ echo "<sha256_checksum> <filename>" > checkfile.txt
$ sha256sum --check checkfile.txt
```

File name convention, data set code: The variation of the test series parameters is also reflected in the file names. The file names are a concatenation of the test-series-id <T>, the distance-between-actuator-and-sensor <D> in millimetres, the number-of-samples-recorded (recording block size) <N> in kilo-samples and the pulse voltage <V> in Volts. Filename structure: **<T>_d<D>_b<N>_v<V>.oct**. As example, a test performed with $D = 50$ mm, $N = 16k$ samples and $V = 800$ Volts is stored in **ts7_d50_b16_v800.oct**. The name of the corresponding raw data archive is **ts7_d50_b16_v800.zip**.

3 Raw data archive structure

Each data set in the raw data archive **ts7_rawdata.tar.xz** is represented by a ZIP archive. The directories and files contained in the archive files are enlisted in table 1.

L	C	Path	Type	Description
0	1	<datasetcode>	directory	data set directory
1	1	projinfo.txt	plain text file	metadata and information about additional tests
1	1	Channel 1	directory	compression wave measurement data
2	1	../measurements.txt	plain text file	list of signal filenames and recording timestamp
2	1	../settings.txt	plain text file	device and measurement settings
2	N	../tst<num>.dat	plain text files	signal data of compression wave measurements
1	1	Channel 2	directory	shear wave measurement data
2	1	../measurements.txt	plain text file	list of signal filenames and recording timestamp
2	1	../settings.txt	plain text file	device and measurement settings
2	N	../tst<num>.dat	plain text files	signal data of shear wave measurements

Table 1: Raw data directory- and file structure (ZIP archives). L . . . directory level; C . . . cardinality.

4 Data set binary file structure

Each data set in the data set archive **ts7_datasets.tar.xz** is represented by a OCT file (<filename>.oct). They were generated from raw data consisting of plain text files (see also 3). Therefore, GNU Octave 6.2.0[6] command scripts were used. The result of the conversion process are datasets available in GNU Octave's open binary file format. The data in the datasets is organized in a C-like hierarchical data structure. That structure consists of several structural levels. The top structural level serves to classify the data according to individual thematic areas. The metadata and data of the measurement results are stored in the lower structure levels. To be able to display the data and metadata as simply as possible, sub-structures are used, which are referred to here as "atomic elements" and represent the lowest structural level of the data. There are three defined types of atomic elements: the atomic reference element (ARE), the atomic attribute element (AAE) and the atomic data element (ADE). All atomic elements consist of simple structure fields that hold the data.

4.1 Atomic elements

Atomic reference element (ARE): Atomic reference elements are used to link objects to each other. This is to avoid copies of recurring content (e.g. for a specimen used in several subsidiary tests). They consist of a set of fields enlisted in table 2.

Field	Description	Data type
obj	object type (always "ARE")	string
ver	version number [major, minor]	uint16
t	tag, a descriptive name	string
i	referenced id	uint, [uint]
r	referenced object name	{string}
d	description	string

Table 2: Field list of atomic reference elements (ARE)

Atomic attribute element (AAE): Atomic attribute elements are used to store text only (e.g. additional description of the parent data structure). They consist of a set of fields enlisted in table 3.

Field	Description	Data type
obj	object type (always "AAE")	string
ver	version number [Major, Minor]	[uint16]
t	tag, a descriptive name	string
v	value, text	string, {string}
d	description	string

Table 3: Field list of atomic attribute elements (AAE)

Atomic data element (AAE): Atomic data elements are used to store values in combination with value type and physical unit (e.g. measurement data). They consist of a set of fields enlisted in table 4. The value type enumerators stored in field “vt” are enlisted in table 6 in section **Appendix - Tables**.

Field	Description	Data type
obj	object type (always "ADE")	string
ver	version number [Major, Minor]	[uint16]
t	tag, a descriptive name	string
vt	value type enumerator	string
v	value of given value type	depends on value type
u	unit	string
d	description	string

Table 4: Field list of atomic data elements (ADE)

4.2 Data set structure hierarchy

The hierarchy of the data structure consists of top-level substructures containing various atomic elements or other lower-level substructures (e.g. ds.tst, test collection). A list of main substructures is shown in table 5. A more detailed description of the structure hierarchy is shown in table 7 in section **Appendix - Tables**.

L	C	Path	Description
0	1	ds	structure root
1	1	ds.meta_ser	test series metadata
1	1	ds.meta_set	data set metadata
1	N	ds.loc	geo-location information, GPS coordinates
1	1	ds.lic	license information
1	N	ds.aut	author information
1	N	ds.dev	test device information
1	N	ds.mat	test material information
1	N	ds.spm	test specimen information, specimen I and II
1	1	ds.tst	test collection
2	1	ds.tst.s02	solid specimen density, specimen I
2	1	ds.tst.s03	solid specimen density, specimen II
2	1	ds.tst.s04	ultrasonic measurement distance, specimen I
2	1	ds.tst.s05	ultrasonic measurement distance, specimen II
2	1	ds.tst.s06	ultrasonic pulse transmission test (compression wave), specimen I
2	1	ds.tst.s07	ultrasonic pulse transmission test (shear wave), specimen II
2	1	ds.tst.s09	environment temperature

Table 5: Main substructures. L . . . hierarchy level; C . . . cardinality.

4.3 Accessing items of the hierarchical data structure

To access the data and metadata in the hierarchical data structure, the file need to be loaded into memory first. Then, the structure handling commands of GNU Octave can be used to access single items. To illustrate the process, some typical application examples using the GNU Octave command line interface are given below.

Load data set: Load data set and store the result in variable `ds`.

```
octave: >>> ds = load('/path/to/dataset/file.oct', 'dataset').dataset;
```

Accessing items: The following commands store the signal data of all compression wave signals in variable `s1` and all shear wave signals in variable `s2`. All other elements can be accessed in the same way. A detailed list of available structure elements is shown in table 7 in section **Appendix - Tables**.

```
octave: >>> s1 = ds.tst.s06.d13.v;
octave: >>> s2 = ds.tst.s07.d13.v;
```

References

[1] Smartmote. *Smartmote - FreshCon*. July 14, 2023. URL: `http://www.smartmote.de/joomla/de/produkte/~ultraschall/9-produkte/19-neptun-webservices-5`.

[2] die.net. *tar(1) - Linux man page*. July 14, 2023. URL: `https://linux.die.net/man/1/tar`.

[3] die.net. *bash(1) - Linux man page*. July 14, 2023. URL: `https://linux.die.net/man/1/bash`.

[4] www.7 zip.org. *7zip download*. July 14, 2023. URL: `https://www.7-zip.org/download.html`.

[5] die.net. *sha256sum(1) - Linux man page*. July 14, 2023. URL: `https://linux.die.net/man/1/sha256sum`.

[6] John W. Eaton et.al. *GNU Octave - Scientific Programming Language*. July 14, 2023. URL: `https://octave.org/`.

Appendix - Tables

Data type	Description
string	character array, character = 8 bit
string_arr	1D cell array (vector) of strings
string_mat	2D cell array (matrix) of string
boolean	unsigned integer, 8 bit
boolean_arr	1D array (vector) of type boolean
boolean_mat	2D array (matrix) of type boolean
uint	unsigned integer
uint_arr	1D array (vector) of type uint
uint_mat	2D array (matrix) of type uint
int	signed integer
int_arr	1D array (vector) of type int
int_mat	2D array (matrix) of type int
single	single precision floating point number, 32 bit
single_arr	1D array (vector) of type single
single_mat	2D array (matrix) of type single
double	double precision floating point value, 64 bit
double_arr	1D array (vector) of type double
double_mat	2D array (matrix) of type double

Table 6: Value types for atomic data elements (ADE)

Table 7: Detailed overview of the hierarchical structure of the datasets (*.oct files).

Path	Type	Tag	Description
ds	struct_dataset	—	**structure root**
ds.meta_ser	struct_metaser	—	**substructure**
ds.meta_ser.r01	ARE	author	author reference
ds.meta_ser.r02	ARE	license	license reference
ds.meta_ser.d01	ADE	series_id	test series id
ds.meta_ser.a01	AAE	series_code	test series code
ds.meta_ser.a02	AAE	series_name	test series name
ds.meta_ser.a03	AAE	description	test series description
ds.meta_ser.a04	AAE	abstract	test series abstract
ds.meta_ser.a05	AAE	context	test series context
ds.meta_ser.a06	AAE	date_start	test series start date
ds.meta_ser.a07	AAE	date_end	test series end date
ds.meta_set	struct_metaset	—	**substructure**
ds.meta_set.r01	ARE	author	author reference
ds.meta_set.r02	ARE	series	test series reference
ds.meta_set.r03	ARE	location	location reference
ds.meta_set.r04	ARE	license	license reference
ds.meta_set.d01	ADE	dataset_id	data set id
ds.meta_set.a01	AAE	dataset_code	data set code
ds.meta_set.a02	AAE	dataset_name	data set name
ds.meta_set.a03	AAE	description	description, general
ds.meta_set.a04	AAE	description_abstract	description, abstract
ds.meta_set.a05	AAE	description_methods	description, methods
ds.meta_set.a06	AAE	description_tableofcontents	description, tableofcontents
ds.meta_set.a07	AAE	created_by	data set creator name
ds.meta_set.a08	AAE	collected_by	data set collector name
ds.meta_set.a09	AAE	copyrighted_by	data set copyrighter name
ds.meta_set.a10	AAE	date_created	date created

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Path	Type	Tag	Description
ds.meta_set.a11	AAE	date_collected	date collected
ds.meta_set.a12	AAE	date_copyrighted	date copyrighted
ds.meta_set.a13	AAE	size	data set size, number of files
ds.meta_set.a14	AAE	format	data set file format
ds.meta_set.a15	AAE	version	data set version
ds.meta_set.a16	AAE	context	data set context
ds.meta_set.a17	AAE	rawdata_directory	data set rawdata directory
ds.meta_set.a18	AAE	rawdata_archive	data set rawdata archive
ds.loc	struct_loc	—	**substructure array**
ds.loc.d01	ADE	location_id	location id
ds.loc.d02	ADE	geolocation	geo location, latitude, longitude
ds.loc.a01	AAE	country	country
ds.loc.a02	AAE	state_province	state or province
ds.loc.a03	AAE	city	city
ds.loc.a04	AAE	zipcode	zip code, postal code
ds.loc.a05	AAE	street	street name
ds.loc.a06	AAE	housenumber	house number
ds.loc.a07	AAE	description	location description
ds.lic	struct_lic	—	**substructure**
ds.lic.r01	ARE	author	author reference
ds.lic.d01	ADE	license_id	license id
ds.lic.a01	AAE	license_code	license code
ds.lic.a02	AAE	rightsholder	rights holder
ds.lic.a03	AAE	rights	rights description, e.g. Creative Commons Attribution 4.0 International
ds.lic.a04	AAE	rights_uri	rights URI, e.g. https://spdx.org/licenses/CC-BY-4.0.html
ds.lic.a05	AAE	rights_identifier_scheme	rights identifier scheme, e.g. SPDX
ds.lic.a06	AAE	rights_identifier_scheme_uri	rights identifier scheme URI, e.g. https://spdx.org/licenses/
ds.lic.a07	AAE	license_description	license description
ds.lic.a08	AAE	spdx_icon	license icon (spdx)
ds.lic.a09	AAE	spdx_id	license id (spdx)

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Path	Type	Tag	Description
ds.aut	struct_aut	—	**substructure**
ds.aut.d01	ADE	author_id	author id
ds.aut.a01	AAE	name	full name
ds.aut.a02	AAE	givenname	given name, first name
ds.aut.a03	AAE	familyname	family name, surname
ds.aut.a04	AAE	initials	initials
ds.aut.a05	AAE	title_pfx	title before the name (prefix)
ds.aut.a06	AAE	title_sfx	title behind the name (suffix)
ds.aut.a07	AAE	organization	organization name
ds.aut.a08	AAE	department	department name
ds.aut.a09	AAE	role	role in organization/department
ds.aut.a10	AAE	country	country
ds.aut.a11	AAE	state_province	state or province
ds.aut.a12	AAE	city	city name
ds.aut.a13	AAE	zipcode	zip code, postal code
ds.aut.a14	AAE	street	street name
ds.aut.a15	AAE	email	email address
ds.aut.a16	AAE	name_identifier_type	name identifier type, e.g. ORCID
ds.aut.a17	AAE	name_identifier_type_uri	name identifier type uri, e.g. https://orcid.org/
ds.aut.a18	AAE	name_identifier	name identifier, e.g. ORCID id
ds.aut.a19	AAE	description	author description
ds.dev	struct_dev	—	**substructure array**
ds.dev.d01	ADE	device_id	device id
ds.dev.a01	AAE	name	device name
ds.dev.a02	AAE	vendor	vendor name
ds.dev.a03	AAE	product	product name
ds.dev.a04	AAE	category	device category
ds.dev.a05	AAE	usage	device usage
ds.dev.a06	AAE	description	device description
ds.dev.s01	ADE	data_array	device properties

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Path	Type	Tag	Description
ds.mat	struct_mat	—	**substructure array**
ds.mat.d01	ADE	material_id	material id
ds.mat.a01	AAE	name	material name
ds.mat.a02	AAE	vendor	vendor name
ds.mat.a03	AAE	product	product name
ds.mat.a04	AAE	category	material category
ds.mat.a05	AAE	description	material description
ds.mat.a06	AAE	storage_place	material storage place
ds.mat.a07	AAE	storage_condition	material storage condition
ds.mat.s01	ADE	data_array	array contains 4 elements
ds.spm	struct_spm_ref	—	**substructure array**
ds.spm.r01	ARE	author	author reference
ds.spm.r02	ARE	material	material reference
ds.spm.r03	ARE	device	device reference
ds.spm.r04	ARE	location	location reference
ds.spm.d01	ADE	specimen_id	specimen id
ds.spm.d02	ADE	datetime	date and time, seconds since epoch (UTC)
ds.spm.a01	AAE	specimen_code	specimen code
ds.spm.a02	AAE	operator	operator name
ds.spm.a03	AAE	procedure	procedure description
ds.spm.a04	AAE	description	general description
ds.tst	struct_test	—	**substructure**
ds.tst.s02	struct_test_ssd2	—	**substructure**
ds.tst.s02.r01	ARE	author	author reference
ds.tst.s02.r02	ARE	specimen	specimen reference
ds.tst.s02.r03	ARE	device	device reference
ds.tst.s02.r04	ARE	location	location reference
ds.tst.s02.d01	ADE	datetime	date and time, seconds since epoch (UTC)
ds.tst.s02.d02	ADE	specimen_weight	specimen weight, measurement result
ds.tst.s02.d03	ADE	specimen_diameter	specimen diameter, diameter of cylinder

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Path	Type	Tag	Description
ds.tst.s02.d04	ADE	specimen_length	specimen length, length of cylinder
ds.tst.s02.d07	ADE	specimen_volume	specimen volume, calculated value
ds.tst.s02.d08	ADE	specimen_density	specimen density, calculated value
ds.tst.s02.a01	AAE	testname	test name
ds.tst.s02.a02	AAE	operator	operator name
ds.tst.s02.a03	AAE	procedure	procedure description
ds.tst.s02.a04	AAE	calculation	calculation description, formula
ds.tst.s02.a05	AAE	description	general description
ds.tst.s03	struct_test_ssd2	—	**substructure**
ds.tst.s03.r01	ARE	author	author reference
ds.tst.s03.r02	ARE	specimen	specimen reference
ds.tst.s03.r03	ARE	device	device reference
ds.tst.s03.r04	ARE	location	location reference
ds.tst.s03.d01	ADE	datetime	date and time, seconds since epoch (UTC)
ds.tst.s03.d02	ADE	specimen_weight	specimen weight, measurement result
ds.tst.s03.d03	ADE	specimen_diameter	specimen diameter, diameter of cylinder
ds.tst.s03.d04	ADE	specimen_length	specimen length, length of cylinder
ds.tst.s03.d07	ADE	specimen_volume	specimen volume, calculated value
ds.tst.s03.d08	ADE	specimen_density	specimen density, calculated value
ds.tst.s03.a01	AAE	testname	test name
ds.tst.s03.a02	AAE	operator	operator name
ds.tst.s03.a03	AAE	procedure	procedure description
ds.tst.s03.a04	AAE	calculation	calculation description, formula
ds.tst.s03.a05	AAE	description	general description
ds.tst.s04	struct_test_umd2	—	**substructure**
ds.tst.s04.r01	ARE	author	author reference
ds.tst.s04.r02	ARE	specimen	specimen reference
ds.tst.s04.r03	ARE	device	device reference
ds.tst.s04.r04	ARE	location	location reference
ds.tst.s04.d01	ADE	datetime	date and time, seconds since epoch (UTC)

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Path	Type	Tag	Description
ds.tst.s04.d04	ADE	specimen_thickness	distance between actuator and sensor
ds.tst.s04.a01	AAE	testname	test name
ds.tst.s04.a02	AAE	operator	operator name
ds.tst.s04.a03	AAE	procedure	procedure description
ds.tst.s04.a04	AAE	calculation	calculation description, formula
ds.tst.s04.a05	AAE	description	general description
ds.tst.s05	struct_test_umd2	—	**substructure**
ds.tst.s05.r01	ARE	author	author reference
ds.tst.s05.r02	ARE	specimen	specimen reference
ds.tst.s05.r03	ARE	device	device reference
ds.tst.s05.r04	ARE	location	location reference
ds.tst.s05.d01	ADE	datetime	date and time, seconds since epoch (UTC)
ds.tst.s05.d04	ADE	specimen_thickness	distance between actuator and sensor
ds.tst.s05.a01	AAE	testname	test name
ds.tst.s05.a02	AAE	operator	operator name
ds.tst.s05.a03	AAE	procedure	procedure description
ds.tst.s05.a04	AAE	calculation	calculation description, formula
ds.tst.s05.a05	AAE	description	general description
ds.tst.s06	struct_test_utt	—	**substructure**
ds.tst.s06.r01	ARE	author	author reference
ds.tst.s06.r02	ARE	specimen	specimen reference
ds.tst.s06.r03	ARE	device	device reference
ds.tst.s06.r04	ARE	location	location reference
ds.tst.s06.d01	ADE	datetime	date and time, seconds since epoch (UTC)
ds.tst.s06.d02	ADE	zerotime	time span between adding water to cement and test start
ds.tst.s06.d03	ADE	interval_steps	number of interval steps, number of measurements
ds.tst.s06.d04	ADE	interval_length	interval length, time span between measurements
ds.tst.s06.d05	ADE	pulse_voltage	device setting, pulse generator voltage
ds.tst.s06.d06	ADE	pulse_width	device setting, pulse generator pulse width
ds.tst.s06.d07	ADE	sampling_rate	device setting, oscilloscope sampling rate

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Path	Type	Tag	Description
ds.tst.s06.d08	ADE	recorded_block_size	recording block size, number of recorded samples
ds.tst.s06.d09	ADE	num_init_samples	number of initial samples before trigger point
ds.tst.s06.d10	ADE	num_signals	number of recorded signals
ds.tst.s06.d11	ADE	sig_maturity	signal/specimen maturity array [num_signals x 1]
ds.tst.s06.d12	ADE	sig_times	signal sample time array [num_samples x 1]
ds.tst.s06.d13	ADE	sig_magnitudes	signal magnitude matrix [num_samples x num_signals]
ds.tst.s06.a01	AAE	testname	test name
ds.tst.s06.a02	AAE	operator	operator name
ds.tst.s06.a03	AAE	procedure	procedure description
ds.tst.s06.a04	AAE	calculation	calculation description, formula
ds.tst.s06.a05	AAE	description	general description
ds.tst.s06.a06	AAE	ss_filepath	settings file path, full qualified path
ds.tst.s06.a07	AAE	ss_filename	settings file name
ds.tst.s06.a08	AAE	ss_filehash	settings file hash, sha-256
ds.tst.s06.a09	AAE	mm_filepath	measurements file path, full qualified path
ds.tst.s06.a10	AAE	mm_filename	measurements file name
ds.tst.s06.a11	AAE	mm_filehash	measurements file hash, sha-256
ds.tst.s06.a12	AAE	data_dirpath	signal data directory path, full qualified path
ds.tst.s06.a13	AAE	data_filepath	signal data file path list, full qualified paths num_signals x 1
ds.tst.s06.a14	AAE	data_filename	signal data file name list num_signals x 1
ds.tst.s06.a15	AAE	data_filehash	signal data file hash list, sha-256 num_signals x 1
ds.tst.s07	struct_test_utt	—	**substructure**
ds.tst.s07.r01	ARE	author	author reference
ds.tst.s07.r02	ARE	specimen	specimen reference
ds.tst.s07.r03	ARE	device	device reference
ds.tst.s07.r04	ARE	location	location reference
ds.tst.s07.d01	ADE	datetime	date and time, seconds since epoch (UTC)
ds.tst.s07.d02	ADE	zerotime	time span between adding water to cement and test start
ds.tst.s07.d03	ADE	interval_steps	number of interval steps, number of measurements
ds.tst.s07.d04	ADE	interval_length	interval length, time span between measurements

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Path	Type	Tag	Description
ds.tst.s07.d05	ADE	pulse_voltage	device setting, pulse generator voltage
ds.tst.s07.d06	ADE	pulse_width	device setting, pulse generator pulse width
ds.tst.s07.d07	ADE	sampling_rate	device setting, oscilloscope sampling rate
ds.tst.s07.d08	ADE	recorded_block_size	recording block size, number of recorded samples
ds.tst.s07.d09	ADE	num_init_samples	number of initial samples before trigger point
ds.tst.s07.d10	ADE	num_signals	number of recorded signals
ds.tst.s07.d11	ADE	sig_maturity	signal/specimen maturity array [num_signals x 1]
ds.tst.s07.d12	ADE	sig_times	signal sample time array [num_samples x 1]
ds.tst.s07.d13	ADE	sig_magnitudes	signal magnitude matrix [num_samples x num_signals]
ds.tst.s07.a01	AAE	testname	test name
ds.tst.s07.a02	AAE	operator	operator name
ds.tst.s07.a03	AAE	procedure	procedure description
ds.tst.s07.a04	AAE	calculation	calculation description, formula
ds.tst.s07.a05	AAE	description	general description
ds.tst.s07.a06	AAE	ss_filepath	settings file path, full qualified path
ds.tst.s07.a07	AAE	ss_filename	settings file name
ds.tst.s07.a08	AAE	ss_filehash	settings file hash, sha-256
ds.tst.s07.a09	AAE	mm_filepath	measurements file path, full qualified path
ds.tst.s07.a10	AAE	mm_filename	measurements file name
ds.tst.s07.a11	AAE	mm_filehash	measurements file hash, sha-256
ds.tst.s07.a12	AAE	data_dirpath	signal data directory path, full qualified path
ds.tst.s07.a13	AAE	data_filepath	signal data file path list, full qualified paths num_signals x 1
ds.tst.s07.a14	AAE	data_filename	signal data file name list num_signals x 1
ds.tst.s07.a15	AAE	data_filehash	signal data file hash list, sha-256 num_signals x 1
ds.tst.s09	struct_test_env2	—	**substructure**
ds.tst.s09.r01	ARE	author	author reference
ds.tst.s09.r02	ARE	device	device reference
ds.tst.s09.r03	ARE	location	location reference
ds.tst.s09.d01	ADE	datetime	date and time, seconds since epoch (UTC)
ds.tst.s09.d02	ADE	temperature	environment temperature at test start

Continued on next page

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Path	Type	Tag	Description
ds.tst.s09.d03	ADE	humidity	environment humidity at test start
ds.tst.s09.a01	AAE	testname	test name
ds.tst.s09.a02	AAE	operator	operator name
ds.tst.s09.a03	AAE	procedure	procedure description
ds.tst.s09.a04	AAE	calculation	calculation description, formula
ds.tst.s09.a05	AAE	description	general description

Table 8: Raw data archive listing (content of **ts7_rawdata.tar.xz**).

File name	SHA256 checksum
ts7_d50_b16_v400.zip	bc57861d194701516f6fae48912ac4644aca97dbb00ebfb6b7f987c0777eea96
ts7_d50_b16_v600.zip	249f2255d3795a73a4294267d7aa177a050cfe913df605b7b4bcd96cf2ca246e
ts7_d50_b16_v800.zip	4620dfd7b899efe333743b32967792b1cddee5d0e8279708f6d4eb76f8838a38
ts7_d50_b24_v400.zip	784107f5e84a8b09be9314cf071cb71013a3f59ba547ed1d7aba5e23d49c7d7f
ts7_d50_b24_v600.zip	eb7ecb9de55edb70cc62ea67668659fdd848f4007a23d664da802e8f979316c8
ts7_d50_b24_v800.zip	9ea58ea4db291cf9877e54d76d050a448c1a2575eccc95ac9ffb7ab13466c804
ts7_d50_b33_v400.zip	17db4fbcd6990714371487f6bf709832dbacb10f7e9c9119fe14894f0a43e894
ts7_d50_b33_v600.zip	bb62da3af83efc4a9f6fe7f105468d848a2ac084c73ea1d9fd1bed377826633d
ts7_d50_b33_v800.zip	1bdeb035d68623204c4b67bc1793d75b736a6fbc7daa485ba36e7ad9537ab292
ts7_d50_b50_v400.zip	15c2e63b6e4b2fd162672b05accd3b944694529b35815b696f2e8aa0caab5f70
ts7_d50_b50_v600.zip	0b4196d0a9bd47860ab6799417e6a0e063e40b6f4e4c7574455c75e19355fd86
ts7_d50_b50_v800.zip	ff5a228aff7c54fb3df45b35280bc37b553bc5cc115d06f4f2e17ed0feacbf8f

Table 9: Data set file listing (content of **ts7_datasets.tar.xz**).

File name	SHA256 checksum
ts7_d50_b16_v400.oct	6b97bd964f8472f801b2d0fe1067396e895f1260c045431994a642e5b9e571c7
ts7_d50_b16_v600.oct	301039902f6c5ab7fcb76d8d4aa53095c2ea9e6b0a206ef2016ea396a5a850aa
ts7_d50_b16_v800.oct	cd2c09377e24a5df0915563314f17e6e5945fe794ef49ff173250662eda8f811
ts7_d50_b24_v400.oct	8077b75af6e2e4bf4a21d58f1272c52061c337dcd78e42b4d187c5a9fbf1ef56
ts7_d50_b24_v600.oct	2ef908a62256c86d0105aa0308f4ffb9d4472d5cf0e674f9ff5cb4e988d33777
ts7_d50_b24_v800.oct	63b5efa3edf93294f2ac815c5b35cf0a2bda1b69258a265f969c5ccb72cfd814
ts7_d50_b33_v400.oct	0e38e4b3a64e6a035ab41ab66d5650348b9644eb21f05a7cb33af487c9dd60b3
ts7_d50_b33_v600.oct	5061730402f8caf6b562b29a5333df86b36c4af7c6c4469a33fd3172ffee4a94
ts7_d50_b33_v800.oct	b520198042c5614664b3d5ef8084a4e66b1e75ab3e1227abfe85097f7dbaa82a
ts7_d50_b50_v400.oct	17620b05b7198e1a589cf3a7a70e38baecb76cb8095b9ef75da2e12e698f4f07
ts7_d50_b50_v600.oct	723e8033c0cc8bf1c5d8dffa7ec1b2ae76f0db7a67cfebcb698c28ea8b607fc9
ts7_d50_b50_v800.oct	757837b13bd2d804d5df305bf26805594457f683b83932fb62cfd424c33dde54