

Magnetic precision has a name

Metrolab XML Record (.mxr) File Specification

PT2026 / MFC2046 / THM1176

Version 1.1

(Revision 1.0)

REVISION HISTORY

v. 1.0 r. 1.0	23.02.16 – ST	First release
v. 1.0 r. 1.1	25.02.16 – ST	Update of the « body » and « dataset » structures after PK review and recommendations.
v. 1.0 r. 1.2	23.08.16 - ST	Status item added to the PT2026 dataset.
v. 1.0 r. 1.3	23.10.17 - ST/SB	New dataset added to cope with the new types created for the MFCTool software.
v. 1.0 r. 1.4	16.01.18 - SB	In the dataset associated to the MFCTool, tag « measComment » has been added and the unit for stdDev has been modified to “ppm”.
v. 1.0 r. 1.5	29.01.18 - ST	In the dataset associated to the MFCTool, a tag called “tag” has been added.
v. 1.0 r. 1.6	29.10.18 - SB	Filename convention added. Description of the tags relative to the MFCTool have been updated.
v. 1.1 r. 1.0	22.07.19 - JT	English translation of the original French-written document.

Contents

1 Introduction 4
1.1 Tag versioning 4
1.2 Tag duplication 4
2 Filename convention 4
3 Common File Header 5
3.1 Body description 5
3.2 Body types 5
3.2.1 tMXR_BODY_PT2026 5
3.2.2 tMXR_BODY_MFCTOOL 5
3.2.3 tMXR_BODY_THM1176 6
4 Dataset contents 6
4.1 Dataset types 7
4.1.1 tMXR_DATASET_PT2026_MEASUREMENT 7
4.1.2 tMXR_DATASET_MFCTOOL_MAPPING 7
4.1.3 tMXR_DATASET_MFCTOOL_MEASUREMENT 9
4.1.4 tMXR_DATASET_THM1176_MEASUREMENT 11

1 Introduction

Metrolab XML record files, with file extension ".mxr.xml" have been developed to ensure all instruments developed by Metrolab Technology share a high level file format.

This file format, and specifically the part that describes the data container, is inspired by the file format standard HDF5 (Hierarchical Data Format, revision 5) which aims to store measurement data along other metadata. These metadata can be the measurement setup and parameters, any other information ensuring that the measurements conditions are clearly and exhaustively documented.

This format consists in several XML tags enabling a clear identification of the file, the instrument used for the measurements, the configuration parameters, the data collected and user's comments, if any.

1.1 Tag versioning

This procedure is meant to document every XML tags. For each XML tag a description is provided, and a version number is given, allowing traceability.

1.2 Tag duplication

In the description of the tags, the number in between the curly braces provides the number of times the tag can be replicated i.e. {1} signifies that the tag will appear only once, {0-n} means that the tag can be absent – as it may appear zero time – but you may have up to n times the same tag, encapsulating different contents.

2 Filename convention

Every filename must adhere to the following naming convention:

$$MODEL\_SERIALNUMBER\_DATE\_xxx.mxr.xml$$

With:

- MODEL = The standard 4-digit model number; i.e. 2046, 2026, 3045.
- SERIALNUMBER = The product serial number (usually 8-digits).
- DATE = File creation date using format: YYYY-MM-DD.
- xxx = Optional field, free for the user.
- .mxr.xml = standard Metrolab xml file extension for measurements.

Every field of the name must be separated with the « _ » (underscore) symbol.

Examples:

2046_00003109_2017-10-19.mxr.xml
3045_00004121_2016-02-13_Mapping.mxr.xml
1226_00080121_2018-01-01_Test.mxr.xml
2046_00020581_2018-01-10_Drift.mxr.xml

3 Common File Header

The header starting the XML file and common to every instruments and host software is the following.

```
<?xml version="1.0"?>
<MetrolabXmlRecord ver="1.0">
<header>
   <src>SourceOfThisFile</src>
   <datTim8601>YYYY-MM-DDTHH:MM:SS</datTim8601>
   <descr>DescriptionOfTheFile</descr>
</header>
<body type="BodyType" ver="x.y">
      BodyContent
</body>
</MetrolabXmlRecord>
```

It consists simply in a header and a body. The body is the important segment that contains the instrument reference number, its parametrization and all the recorded data.

header	{1}[1]	File header.
src	{1}	Name of the tool that created the file.
datTim8601	{1}	File creation date and time, according to standard ISO-8601.
descr	{1}	A short sentence describing the file content.
body	{1}	Body content, i.e. all the data that are recorded in the file, using the convention described below.

3.1 Body description

Every "body" description is instrument specific. The "type" attribute of the body tag states to which specification the content of the body conforms to.

3.2 Body types

3.2.1 tMXR_BODY_PT2026

Describes the body structure specific to the measurements recorded using the host software that drives the PT2026, namely "Metrolab PT2026".

```
<body type="tMXR_BODY_PT2026" ver="1.0">
   <comment>Comment</comment>
   <instr>Model SerialNumber</instr>
   <dataset type="type" ver="x.y">DatasetContent</dataset>
</body>
```

comment	{1}[1]	User's comment.
instr	{1}	Instrument's model and serial number.
dataset	{0 - n}	Data set.

3.2.2 tMXR_BODY_MFCTOOL

Describes the body structure specific to the measurements recorded using MFCTool. This file is common to the MFC2046 and the MFC3045 systems (The port for this last instrument is under development).

```
<body type="tMXR_BODY_MFCTOOL" ver="1.0">
   <instrument>
```

```
      <muModel>Main Unit Model</muModel>
      <muSerialNumber>Main Unit Serial Number</muSerialNumber>
      <muCalibrationDate>Main unit calibration date</muCalibrationDate>
      <paModel>Probe-Array Model</paModel>
      <paSerialNumber>Probe-Array Serial Number</paSerialNumber>
      <paNormalizationDate>Probe-Array Normalization date</paNormalizationDate>
      <fmin>Minimum Probe-Array Frequency</fmin>
      <fmax>Maximum Probe-Array Frequency</fmax>
      <gyromagneticFactor>Probe-Array gyromagnetic Factor</gyromagneticFactor>
      <period>Acquisition period</period>
   </instrument>
   <dataset type="type" ver="x.y">DatasetContent</dataset>
</body>
```

instrument {1}[1] Provide all the details concerning the instrument and probe-array used to record the data.

Name	Units	Description
muModel	[-]	Main unit model.
muSerialNumber	[-]	Main unit serial number.
muCalibrationDate	[-]	Main unit calibration date.
paModel	[-]	Probe-array model.
paSerialNumber	[-]	Probe-array serial number.
paNormalizationDate	[-]	Probe-array normalization date.
Fmin	[MHz]	Probe-array minimum operating frequency.
Fmax	[MHz]	Probe-array maximum operating frequency.
gyromagneticFactor	[MHz/T]	Probe-array gyromagnetic factor.
Period	[sec]	Acquisition period of the NMR signal.

dataset {0 - n} See the chapter V for detailed description of the associated dataset.

3.2.3 tMXR_BODY_THM1176

Describes the body structure specific to the measurements recorded using the THM1176 application.

```
<body type="tMXR_BODY_THM1176" ver="1.0">
   <comment>Comment</comment>
   <instr>Model SerialNumber</instr>
   <dataset type="type" ver="x.y">DatasetContent</dataset>
</body>
```

comment {1}[1] User's comments.
instr {1} Instrument's model and serial number.
dataset {0 - n} See the chapter V for detailed description of the associated dataset. Quel chapter V???

4 Dataset contents

All measurements are stored in datasets. As stated in the introduction, the aim of the dataset is not only to contain the collected measurement but also to save with these measurements the experimental conditions. This includes the instrument type and serial number as well as the full probe description and the specific parametrization of the instrument. It can eventually include a comment from the user.

4.1 Dataset types

4.1.1 tMXR_DATASET_PT2026_MEASUREMENT

This dataset describes the measurement recorded using the PT2026 host software.

```
<dataset type="tMXR_DATASET_PT2026_MEASUREMENT" ver="1.0">
   <headings>Heading1 Heading2   …Headingn</headings>
   <parms>parm1=X  parm2=Y …parmn=Z</parms>
   <meas>Timestamp Flux sDev Uniformity Channel      Status
      Timestamp  Flux sDev Uniformity   Channel      Status
      Timestamp  Flux sDev Uniformity   Channel      Status</meas>
</dataset>
```

headings {1}[1] Column names.

parms {1} Parameters used to collect the data.

Parameter name	Description
units	[-] – units used for the current dataset.
…	**TBD, future extension.**

meas {0 – n} Measurements in TSV format.

measurement name	Description
Timestamp	Local timestamp associated with the current measurement.
Flux	Magnetic field density.
sDev	1-σ deviation of the measurement. The standard deviation is computed according to the selected measurement averaging mode – None, exponential, moving, block averaging -.
Uniformity	Magnetic field density uniformity. Express the ratio between T2* measured and T2 stored in the probe.
Channel	Instrument channel on which the measurement was made.
Status	Current status associated with the measurement, expressed in hexadecimal.

4.1.2 tMXR_DATASET_MFCTOOL_MAPPING

This dataset describes how a measurement is recorded when using the MFCTool host software in mapping mode.

```
<dataset type="tMXR_DATASET_MFCTOOL_MAPPING" ver="1.0" scenario="FieldMapping" >
   <comment>Comment</comment>
   <parameters>
      <fieldUnit>Field_Unit</fieldUnit>
      <nbChannels>Channels_Number</nbChannels>
      <averaging>Averaging</averaging>
      <centralFreq>Central_Frequency</centralFreq>
      <centralFreqTol>Central_freq_tol_ppm</centralFreqTol>
      <minimalPeriod>Minimal_period</minimalPeriod>
      <nbMeasurementsDriftCalc>Drift_number</nbMeasurementsDriftCalc>
      <channels>chan1 chan2 ... chanN</channels>
```

```
      <positionsCount>position count</positionsCount>
      <angleIncrement>angle increment</angleIncrement>
      <repeatFirstPosition>repeat first position</repeatFirstPosition>
   </parameters>
   <measurements>
      <measurement index="n">
         <timestamp>timestamp</timestamp>
         <angle units="deg">angle_value</angle>
         <freq units="MHz">freq1 freq2 ... freqN</freq>
         <stdDev units="ppm">stdDev1 stdDev2 ... stdDevN</stdDev>
         <nbValid>nbValid1 nbValid2 ... nbValidN</nbValid>
         <stats>
            <average units="MHz">Average_stat</average>
            <min units="MHz" probe="1">Min_stat</min>
            <max units="MHz" probe="24">Max_stat</max>
            <stdDev units="ppm">stdDev_stat</stdDev>
         </stats>
      </measurement>
   </measurements>
</dataset>
```

comment {1}[1] User's comment for the dataset.

parameters {1} Parameters used to gather this set of measurements:

Parameter name	Units	Description
fieldUnit	[-]	Magnetic field density unit.
nbChans	[-]	Number of channels in use.
averaging	[-]	Measurement number used during the averaging process.
centralFreq	[MHz]	Central frequency.
centralFreqTol	[ppm]	Relative tolerance of the central frequency.
minimalPeriod	[ms]	Minimum period of the NMR measurement.
nbMeasurementsDriftCalc	[-]	Measurement number used to compute the slope.
channels	[-]	Measurement channel list.
positionsCount	[-]	Angular position count for this measurement set.
angleIncrement	[deg]	Angle increment.
repeatFirstPosition	[-]	State whereas the dataset duplicates the first measurement at the end or not. Useful for drift cancellation.

measurement {0 – n} Measurement block. The « index » attribute state the position / angle at which the measurement was taken.

Measurement name	Units	Description
timestamp	[ms]	Timestamp associated to the first measurement of the block. All other data are (allegedly) sampled at the minimalPeriod rate.
angle	Specified in the heading "units" attributes	Probe-array angular value for the current set of measurements.
freq	Specified in the heading "units" attributes	Average of all frequencies measured. This list follows the order stated in the field « channels » allowing the user to reconciliate

		the measurement to the measuring head number (and position).
stdDev	Specified in the heading "units" attributes	1-σ standard deviation for the measured frequencies. The ordering of these value is identical to the one used for the frequencies.
nbValid	[-]	Number of valid measurements for each channel. The ordering of these values is identical to the one used for the frequencies.
stats	[-]	Statistics for the current measurement bloc.

The "stats" subtype is specified as follow:

Nom	Units	Description
average	Specified in the heading "units" attributes	Average of all measurements made during the current acquisition frame.
min	Specified in the heading "units" attributes	Minimum value found during the current acquisition frame.
max	Specified in the heading "units" attributes	Maximum value found during the current acquisition frame.
stdDev	Specified in the heading "units" attributes. Always set to [ppm]	1-σ standard deviation for the current acquisition frame. This deviation is computed over the whole measurement bloc using the following equation: (max(measurements) – min(measurements)) / mean(measurements) x 1e6.

4.1.3 tMXR_DATASET_MFCTOOL_MEASUREMENT

This dataset describes how a measurement is recorded when using the MFCTool host software in every mode but the mapping one (see previous chapter).

```
<dataset type="tMXR_DATASET_MFCTOOL_MEASUREMENT" ver="1.0" scenario="Advanced">
   <comment>Comment</comment>
   <parameters>
      <fieldUnit>Field_Unit</fieldUnit>
      <nbChannels>Channels_Number</nbChannels>
      <averaging>Averaging</averaging>
      <centralFreq>Central_Frequency</centralFreq>
      <centralFreqTol>Central_freq_tol_ppm</centralFreqTol>
      <minimalPeriod>Minimal_period</minimalPeriod>
      <nbMeasurementsDriftCalc>Drift_number</nbMeasurementsDriftCalc>
      <channels>chan1 chan2 ... chanN</channels>
   </parameters>
   <headings>
      <col index="1" units="MHz">NMR Field [MHz]</col>
      <col index="2" units="ppm">Standard Deviation [ppm]</col>
      <col index="3"            >No.Valid Acquisitions</col>
      <col index="4" units="ppm/h">Slope [ppm/h]</col>
   </headings>
   <measurements>
      <measurement index="1">
         <timestamp>3135628</timestamp>
         <data>63.8842459;0.020;5;nan
            63.8842709;0.034;5;nan
```

```
            63.8849228;0.033;5;nan
            63.8851033;0.049;5;nan
            63.8848449;0.029;5;nan
            63.8852153;0.069;5;nan
            63.8853260;0.028;5;nan
            63.8851997;0.019;5;nan
            63.8843322;0.042;5;nan
            63.8845087;0.006;5;nan
            63.8844367;0.030;5;nan
            63.8837469;0.022;5;nan
            63.8838097;0.039;5;nan
            63.8845073;0.019;5;nan
            63.8844596;0.023;5;nan
            63.8843189;0.036;5;nan
            63.8852914;0.035;5;nan
            63.8853930;0.009;5;nan
            63.8851339;0.019;5;nan
            63.8848558;0.038;5;nan
            63.8852745;0.019;5;nan
            63.8848307;0.013;5;nan
            63.8842997;0.022;5;nan
            63.8844367;0.020;5;nan</data>
        </measurement>
    </measurements>
</dataset>
```

Comment {1}[1] User's comments.

Parameters {1} Parameter list for this dataset according to the following table.

Parameter name	Description	
fieldUnit	[-]	Magnetic field density unit.
nbChans	[-]	Number of channels in use.
averaging	[-]	Measurement number used during the averaging process.
centralFreq	[MHz]	Central frequency.
centralFreqTol	[ppm]	Central frequency tolerance.
minimalPeriod	[ms]	Minimum period of the NMR measurement.
nbMeasurementsDriftCalc	[-]	Measurement number used to compute the slope.
channels	[-]	Measurement channel list.

Headings {1} Content description for each column of the measurement set. The "index" attribute states which column is described and the "unit" attribute states in which unit the associated data was recorded.

Measurement {0 – n} Measurement block. Each measurement is indexed (field "index"). The content of this tag is described in the following table.

Nom	Units	Description
timestamp	[ms]	Timestamp associated to the first measurement of the block. All other data are (allegedly) sampled at the minimalPeriod rate.
data	Specified in the heading "units" attributes	Measurement data for the current block. Each line represents measurement made on a specific channel in the order stated in the field "channels" of this record. For each channel, measurements are stored in column using the type as described in the "heading" field and

	are semicolumn separated.

4.1.4 tMXR_DATASET_THM1176_MEASUREMENT

This dataset describes how a measurement is recorded when using the THM1176 host software.

```
<dataset type="tMXR_DATASET_THM1176_MEASUREMENT" ver="1.0">
   <headings>Heading1 Heading2   …Headingn</headings>
   <parms>parm1=X  parm2=Y …parmn=Z</parms>
   <meas>
      <temp>Temperature</temp>
      <flux>Timestamp B  Bx By Bz
      Timestamp  B  Bx By Bz
      Timestamp  B  Bx By Bz</flux>
   </meas>
</dataset>
```

headings	{1}[1]	Column name.
parms	{1}	List all parameters that are recorded in this dataset with their associated values.
meas	{0 – n}	Measurement block number.
temp	{1}	Temperature recorded for the current dataset.
flux	{1}	Magnetic flux density for each axis, including the magnitude. Each line in TSV format is prefixed by a local timestamp.

NOTES

[1] Read paragraph Tag duplication