**.wko File Format (v28)**

**Document SVN revision “$Id$”**

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# Change Log

|  |  |  |
| --- | --- | --- |
| **Tracker** | **Date** | **Description** |
| 0.1 – 0.9 | July 2009 | * Initial Investigation prior to publishing |
| 0.10 | 1st Aug 2009 | * First version dropped into sourceforge files |
| 0.11 | 2nd Aug 2009 | * Completed “optional chart data” |
| 0.12 | 3rd Aug 2009 | * Device specific raw data bit width tables added for Powertap, SRM, Polar, Computrainer/Velotron, Garmin, iBike, Ergomo. * Started to decode the ‘marker’ flags (incomplete) |
| 0.13 | 4th Aug 2009 | * Completed analysis of available files for Powertap, SRM, Polar, Computrainer/Velotron, Garmin, iBike, Ergomo |
| 0.14 | 5th Aug 2009 | * Corrected some of the bit size tables after adapting extractit.c hack C code to implement against file corpus. |
| 0.15 | 7th Aug 2009 | * Fixed Polar from 4 to 1 bit marker * Fixed CT/Velotron from 4 to 1 bit marker * Fixed ibike GPS from 70 to 64 bits * Validated pause in recording bit size for all devices. * Raw data header added “Interval” flag bit * “Pause in recording” correctly interpreted as set interval and not a pause. Additionally noted null records used to denote a pause in recording. * Now accurately decodes all files except Garmin and manual entry workouts which have non-boolean record markers |
| 0.16 | 9th Aug 2009 | * Velotron altitude is 20 bits * 1bit marker on Garmin with smaller record structute * Start point on Garmin with 1 bit marker immediately after data size field in raw header. * Pause and Inc records. |
| 0.17 | 12th Aug 2009 | * 1bit marker on PT files with only H,S. Thanks to Vickie for the files to reproduce the error. * Garmin files always have 1 bit marker, altitude is 20 bits and distance is 22 bits, interval is set directly after 1st sample and header data not present for Garmin device. * GPS positioning decoding thanks to Seth and Vickie who provided the answer almost simultaneously. |
| 0.18 | 13th Aug 2009 | * 4bit marker value of 3 is a reset interval * Ergomo pause record is 39 bits long |
| 0.19 | 13th Aug 2009 | * 0x17 0x80 Another value for “data cache” in optional data * 0x0b 0x80 Another value for “empty data cache” * Device 0x00 (Manual Entry) Field sizing table |
| 0.20 | 13th Aug | * All device specific nonsense removed:   + 1 bit marker for all devices   + Altitude and Distance resolved |
| 0.21 | 26th Aug | * Device 0x12 Garmin 205 has a distance field of 22 bits |
| 0.22 | 10th September | * Added support for Device Type 0x16 – Cycleops 300PT |
| 0.23 | 2nd October | * Added new Optional charting data value 0x0d 0x80 |
| 0.24 | 4th October | * New optional charting data 0x0e 0x80 * New data cache value 0x1d 0x80 |
| 0.25 | 6th Jan 2010 | * Distribution Chart updated to include cached data and thus simplified the optional padding section |

# Introduction

The general structure of a .wko file is;

* Section 0 - File header – magic number and file version
* Section 1 – Workout data – workout settings and athlete data
* Section 2 – Graph Tab Data – graphs and ranges displayed on the workout graph tab
* Section 3 – Device Specific Data – token/value pairs related to the source device
* Section 4 – Charting settings and Cached Data
* Section 5 – Raw Data

The structure of this document reflects the structure of the .wko file.

This is a summary of my analysis of my own personal files and some of my friends files. It is almost certainly incorrect in many places. Feel free to send comments or feedback to the author at [liversedge@gmail.com](mailto:liversedge@gmail.com).

I hope you find the information useful, but it is supplied as-is and may or may not be factually correct. All efforts have been made to validate the contents against multiple files.

I am also developing a .WKO to .CSV file converter and have placed the source files and this document at <https://sourceforge.net/projects/wko2csv>. Feel free to download and use the utility, it isn’t incredibly stable, it is for my own personal use. If you find it useful then that’s great.

Since all my files are stored in v28 of the file format I have concentrated on analysing this version of the file format. Earlier versions will no doubt differ substantially (but hopefully later versions will not).

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# General

Most texts are stored in the following formats[[1]](#footnote-1); (therefore, blank text fields are stored as a single null byte). I will refer to these types of text elements as VARTEXT for the rest of this document.

|  |  |  |
| --- | --- | --- |
| **Sub Field No.** | **Size Bytes** | **Value** |
| 1 | 1 | **Field Length < 255 characters**  0 indicates no text  255 indicates length in next two bytes  Text Length (8bit) |
| 2 | 2 | **[optional] Field Length > 255 characters**  Only set if #1 above is 255  Text length (little endian) |
| 3 | VARIABLE (set from field 1 or 2) | **Text**  ASCII Characters |

# Header Fields

|  |  |  |
| --- | --- | --- |
| **Field No.** | **Size Bytes** | **Field Description** |
| 1 | 4 | **File Magic Number**  W K O [sub]  0x57 0x4b 0x4f 0x1a |
| 2 | 4 | **File Format Version Number**  Previous versions seen include 12 and 7, one must assume that there are versions from 0 through the current of 28.  This document describes v28 of the file format ONLY, this is the current version in use, as at July 2009. |

# Workout Journal Tab

|  |  |  |
| --- | --- | --- |
| **Field No.** | **Size Bytes** | **Field Description** |
| 3 | 4 | **Workout Date**  Days since 01/01/1901 |
| 4 | VARTEXT | **Workout Goal** |
| 5 | VARTEXT | **Workout Notes** |
| 6 | VARTEXT | **Graphs**  P – Power  H – Heart Rate  C – Cadence  S – Speed  A – Altitude  D – Distance  G – GPS  T – Torque  W – Wind Speed  ^ - Hill Slope  + - Temperature |
| 7 | 4 | **Sport**  0x01 Swim  0x02 Bike  0x03 Run  0x04 Brick  0x05 Cross Train  0x06 Race  0x07 Day Off  0x08 Mountain Bike  0x09 Strength  0x0B XC Ski  0x0C Rowing  0x64 Other |
| 8 | VARTEXT | **Workout Code** |
| 9 | 4 | **Workout Duration**  1000ths of seconds |
| 10 | VARTEXT | **Last Name** |
| 11 | VARTEXT | **First Name** |
| 12 | 4 | **Workout Time of Day**  100ths of seconds since midnight |
| 13 | 4 | **Workout Distance**  Meters travelled |
| 14 | 4 | **Recording Interval**  In 1,000ths of a second  [note: some weirdness on 3 files with an interval of ff:ff:ff:f7] |
| 15 | 4 | **Athlete Max Heart Rate** |
| 16 | 4 | **Athlete Threshold Heart Rate** |
| 17 | 4 | **Athlete Threshold Power** |
| 18 | DOUBLE | **Athlete Threshold Pace**  Mins per kilometre expressed in fractions of a minute ie. 24:59 is 24.9833 |
| 19 | 4 | **Athlete Weight**  Weight in grams / 10 (little endian) ie. 100kg = 0x10 0x27 = 10,000 |
| 20 | 4 | **Wheel Circumference**  In millimetres (e.g. road bike 700C wheel is 2096mm). SRM Powercontrol and Ergomo files will set this value, but no value seen from Garmin or Powertap. |
| 21 | 4 | **Unknown**  Always 0x00 0x00 0x00 0x80 |
| 22 | 4 | **Unknown**  Always 1 |
| 23 | 4 | **Unknown**  Always 1 |
| 24 | 4 | **Unknown**  Not highly variable |
| 25 | 4 | **Unknown**  Not highly variable (but reflects field 24) |

# Graph Tab Data

|  |  |  |
| --- | --- | --- |
| **Field No.** | **Size Bytes** | **Field Description** |
| 26 | 4 | **Graph Tab – Active Range View (plus others unknown)**  On graph View Tab which range is active (first byte);  0x12 - Power  0x14 - Cadence  0x15 – Heart Rate  0x16 - Speed  0x17 – Pace  Others may be available (?). Note the remaining 3 bytes *are* used. |
| 27 | 4 | **Graph Tab – Active Chart View**  From Graph View Tab, which view is active;  0xc8 – Multiline chart view  0xc9 – Single line chart view  0xca – Raw Data aka 123 mode |
| 28 | 4 | **Device Type**  0x00 – Manual Entry  0x01 – Powertap  0x04 – SRM  0x05 – Polar  0x06 – Computrainer  0x11 – Ergomo  0x12 – Garmin Edge 205/305  0x13 – Garmin Edge 705  0x14 – iBike |
| 29 | 4 | **Unknown**  Always 0x04 0x00 0x00 0x00  Possibly indicates the sizeof(number) in use for the file (?) |

## Graph Tab Chart Data

The structure below is repeated 16 times for each data channel (Power, Cadence, HR et al)

|  |  |  |
| --- | --- | --- |
| **Field No.** | **Size Bytes** | **Field Description** |
| 30-36 | 4 | **Fields 30-36 all 16 bit and unknown (highly invariant)**  Mostly believed to be chart config data (axis stepping, colors etc).  Note: It is highly likely that field 36 is padding to enable field 37 to be stored as a double across field 36 and 37 for pace charting data and possibly GPS data. |
| 37 | 4 | **Graph View Chart - Maximum Y-Axis**  For files with no power data set to 255 |
| 38 | 4 | **Graph View Chart – Show?**  0x01 0x00 0x00 0x00 – Chart Power  0x00 0x00 0x00 0x00– Do Not Chart Power |
| 39 | 4 | **Graph View Chart –Auto Scale ?**  0x01 0x00 0x00 0x00 – Yes Auto Scale  0x00 0x00 0x00 0x00 – No Auto Scale |
| 40 | 4 | **Graph View Chart – Auto Grid Lines ?**  0x01 0x00 0x00 0x00 – Yes Auto Grid Lines  0x00 0x00 0x00 0x00 – No Auto Grid Lines |
| 41 | 2 | **Graph View HR Chart - Number of Grid Lines**  Zero indicates no grid lines |
| 42 | 8 x #71 | **[Optional] Graph View Chart - Array of Grid Lines**  An array of field#71 size with each element being 8 bytes long;  1st 4 bytes are the grid line value  2nd 4 bytes are always 0x01 0x00 0x00 0x00 (probably padding)  In some cases, notably pace, the full 8 bytes are used to store a double. |

Each structure contains the graphing data for specific data channels;

1. Fields 30-42 – Heartrate
2. Fields 43-55 – Power
3. Fields 56-68 – Crank Torque
4. Fields 69-81 – Speed
5. Fields 82-94 – Cadence
6. Fields 95-107 – Unknown
7. Fields 108-120 – Unknown
8. Fields 121-133 – Distance
9. Fields 134-145 – Unknown
10. Fields 146-158 – Unknown
11. Fields 159-171 – Unknown
12. Fields 172-184 – Unknown
13. Fields 185-197 – Unknown
14. Fields 198-210 – Unknown
15. Fields 211-223 – Unknown
16. Fields 224-236 – Unknown

## Graph Ranges

The data ranges on the graph tab are stored next. Remember that the active view for the ranges is held in field #26.

|  |  |  |
| --- | --- | --- |
| **Field #** | **Size Bytes** | **Description** |
| 237 | 2 | **Number of Ranges**  The next section (fields 43-xx) are repeated for each range (either user defined or standard values), this field defines the size of that array. |

Each Range takes on the following structure;

|  |  |  |
| --- | --- | --- |
| **Field #** | **Size Bytes** | **Description** |
| 238 | 4 | **Unknown**  Appears to always be set to 5 |
| 239 | 4 | **Bit flags**  00000001 (1) –  00000010 (2) – **Duration Flag is Set (?)**  00000100 (4) - |
| 240 | 4 | **Unknown**  3 – User defined range  2 – System defined range  0 – Unsure (?) |
| 241 | VARTEXT | **User defined Range Description** |
| 242 | VARTEXT | **Standard Range Description** |
| 243 | 4 | **Show on Chart**  0x01 0x00 0x00 0x00 – Displayed on Chart  0x00 0x00 0x00 0x00 – Not Displayed on Chart |
| 244 | 4 | **Range Start**  Interval record no. Where range starts |
| 245 | 4 | **Range Ends**  Interval record no. Where range ends |
| 246 | 4 | **Unknown**  Appears to always be set to 0 |
| 247 | 4 | **Unknown**  Appears to always be set to 2 |
| 248 | 4 | **Range Duration**  In 1000ths of a second  (Only appears to be set on standard selections i.e. Peak 5s, 30s, 60min etc |

# Device Specific Data

Device specific information is related to the source device type (see field #28).

|  |  |  |
| --- | --- | --- |
| **Field #** | **Size Bytes** | **Description** |
| 249.0 | 2 | **Number of Device token pairs**  Defines the size of the subsequent array of token/value pairs. Zero obviously indicates no device token/value pairs. This varies per device but examples are given below. |
| 250 | Optional | **Token Value Pair**  #249 x VARTEXT token and VARTEXT value pair |

## Example Token/Value Pairs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Field #** | **Size Bytes** | | **GARMIN** | |
| 250.1 | VARTEXT | | GarminProductID token | |
| 250.2 | VARTEXT | | GarminProductID | |
| 250.3 | VARTEXT | | GarminDeviceName token | |
| 250.4 | VARTEXT | | GarminDeviceName | |
| 250.5 | VARTEXT | | GarminUnitID token | |
| 250.6 | VARTEXT | | GarminUnitID | |
| **Field #** | **Size Bytes** | | **ERGOMO** | |
| 250.1 | VARTEXT | | ERGOMOWheel token | |
| 250.2 | VARTEXT | | Wheel | |
| 250.3 | VARTEXT | | ERGOMOComment token | |
| 250.4 | VARTEXT | | Comment | |
| 250.5 | VARTEXT | | ERGOMO Temperature token | |
| 250.6 | VARTEXT | | Temperature | |
| 250.7 | VARTEXT | | ERGOMO KFactor token | |
| 250.8 | VARTEXT | | KFactor | |
| **Field #** | | **Size Bytes** | | **SRM** |
| 250.1 | | VARTEXT | | SRMRate token |
| 250.2 | | VARTEXT | | SRM Rate (1.00) |
| 250.3 | | VARTEXT | | SRMOffset token |
| 250.4 | | VARTEXT | | Offset |
| 250.5 | | VARTEXT | | SRMInitials |
| 250.6 | | VARTEXT | | Initials |
| 250.7 | | VARTEXT | | SRMComment token |
| 250.8 | | VARTEXT | | Comment |
| 250.9 | | VARTEXT | | SRMSlope token |
| 250.10 | | VARTEXT | | Slope |

# Journal Tab Chart Data

The configuration of the different charts are stored in this section. It is worth noting that the charts are spread across multiple perspectives and athlete specific zones are NOT available within the workout file.

|  |  |  |
| --- | --- | --- |
| **Field #** | **Size Bytes** | **Description** |
| 251 | 2 | **Number of Charts**  Defines how many charts are used within all perspectives within the workout file. A minimum value of 4 (you will always have a workout settings, workout goals, workout notes and workout summary chart, regardless of perspective).  There appears to be no maximum value. |

From this point onwards there are repeated blocks of either configuration settings for chart types or chart structures which include both settings and data.

## Repeated Segment

|  |  |  |
| --- | --- | --- |
| **Field #** | **Size Bytes** | **Description** |
| 252 | 4 | **Segment Type**  0xFF 0xFF 0x01 0x00 – Config Block  0x02 0x00 0x00 0x00 – Perspective  0x03 0x00 0x00 0x00 – Chart / Chart Cache |
| 253 | VARIABLE | **Segment Data**  Either Config, Perspective of Chart Data (see below) |

## Config Block

|  |  |  |
| --- | --- | --- |
| **Field #** | **Size Bytes** | **Description** |
| 253.1 | 2 | **Type Token Length**  Length in bytes of the segment type token |
| 253.2 | TEXT | **Type Token**  Although not null terminated, nor stored as a VARTEXT this token is always present as string with length defined in field #253.  Please Note: it is *NOT* null terminated.  Configuration Blocks (and associated number of configuration bytes)   * CrideGoalConfig (8) * CRideSettingsConfig (4) * CrideSummaryConfig (0) * CrideNotesConfig (0) * CdistributionChartConfig (??) * CmeanMaxChartConfig (??)   Data Caches   * CdistributionChartCache * CmeanMaxChartCache |
| 253.4 | 4 | **Perspective Segment Identifier**  Always 0x02 0x00 0x00 0x00 |
| 253.5 | VARTEXT | **Perspective Name**  Standard values include ‘My Journal Charts’, ‘Cycling’, ‘Running’, ‘Swimming’, ‘Weight Loss’ although the user can create and delete their own. |
| 253.6 | VARIABLE | **Configuration Bytes**   * 8 bytes for CrideNotesConfig * 8 bytes for CrideGoalConfig * 8 bytes for CrideSummaryConfig * 4 bytes for CRideSettingsConfig * 0 bytes for CdistributionChartConfig * 0 bytes for CmeanMaxChartConfig   **Cache Bytes**   * See Distribution Chart Cache Below for CDistributionChartCache * See MeanMaxChartCache Below for CMeanMaxChartCache   Note: The chart configuration bytes are exactly the same for for all workout files |

## Distribution Chart Cache

|  |  |  |
| --- | --- | --- |
| **Field #** | **Size Bytes** | **Description** |
| 253.7 | 4 | **Unknown (0x02 00 00 00)** |
| 253.8 | 4 | **Unknown (0x01 00 00 00)** |
| 253.11 | 338 | **Cache Data**  Always 338 bytes of data. |
| 253.12 | PAD | **Optional Charting Data** |

## Mean Maximal Chart Cache

|  |  |  |
| --- | --- | --- |
| **Field #** | **Size Bytes** | **Description** |
| 253.1 | 20 | **Unknown**  Unknown cached data |
| 253.2 | 4 | **Size of first data block**  Number of 8 byte values (doubles) in first data block |
| 253.3 | VAR | **First Data block**  Size is 253.2 times 8 |
| 253.4 | 28 | **Unknown**  Further cache data |
| 253.5 | 4 | **Size of second data block**  Number of 8 byte values (doubles) in second data block |
| 253.6 | VAR | **Second Data block**  Size is 253.5 times 8 |
| 253.5 | 2 | **Number of mean max structures that follow**  The number of meanmax structures that follow typically E9 (233) for power. |
| 253.6 | VAR | **Mean Max Structures**  Generally either 1 (which is a short 4 byte structure) or 233 of them as defined by field 253.5. If the set is truncated due to a sequence number of zero then the chart data ends here and the fields below (253.7 onwards) are not present. |
| 253.7 | 12 | **[Optional] Preamble to 2nd Section**  If the sequence above completed then there will be 12 bytes of data which seem to always be 0x59 0x02 0x00 0x00 0x00 0x00  0x00 0x00 0x00 0x00 0x00 0x00 |
| 253.8 | 2 | **[Optional] Number of mean max structures that follow**  Almost always 0xe9 0x00 (233). |
| 253.9 | VAR | **[Optional] 2nd Set of Mean Max Structures**  The set never appears to be truncated and has 253.8 members. |
| 252.10 | 24 | **[Optional] Unknown**  24 final bytes of data related to the mean max chart. |
| 253.7 | VAR | **Optional Charting Data** |

## Perspective Block

|  |  |  |
| --- | --- | --- |
| **Field #** | **Size Bytes** | **Description** |
| 253.1 | VARTEXT | **Perspective Name**  Standard values include ‘My Journal Charts’, ‘Cycling’, ‘Running’, ‘Swimming’, ‘Weight Loss’ although the user can create and delete their own |

## Chart Block

|  |  |  |
| --- | --- | --- |
| **Field #** | **Size Bytes** | **Description** |
| 253.1 | VARTEXT | **Chart Title**  Text used at the top of the chart. |
| 253.2 | 32 | **General Chart Configuration**  32 bytes of chart config settings common to all chart types (?)   |  |  | | --- | --- | | **Byte** | **Meaning** | | 1-2 | Always 0x5c 0x02 | | 3-12 | Unknown | | 13 | **Chart Size**  0xbc – Small  0xbd – Medium  0xbe – Large  0xbf – Full | | 14-16 | Unknown | | 17-32 | Unknown | |
| 253.3 | 4 | **Chart Type**  There are only chart types usable within a workout (Periodic and PMC charts are only available on the Athlete Home Tab), one assumes that other chart types are available across WKO given the non-contiguous values used to identify chart type.  0x02 – Distribution Chart  0x0c – Mean Maximal Chart |

## Distribution Chart

The format of the remaining fields for a distribution chart are;

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 253.4 | 4 | **Distribution Chart Configuration**  16 longs (64 bytes) of Unknown Config settings common to Distribution Charts  The 6th number seems to flag the non-presence of field 253.7   |  |  | | --- | --- | | **Byte** | **Meaning** | | 1-4 | **Type**  0x2c 01 00 00 – Bar Chart  0x2d 01 00 00 – Pie Chart | | 5-8 | **Channel**  00 – Power  01 – Heart Rate  02 – Cadence  03 – Speed  04 – Hub Torque  05 – Altitude  08 – Normalised Power  09 – Crank Torque  0C – Normalised Graded Pace | | 9-12 | **Percentage or Absolute**  0x58 02 – Percentage  0x59 03 - Absolute | | 13-16 | **Unknown**  04 (4) | | 17-20 | **Units**  Units to display on Chart  01 – BPM  02 - %Max HR  03 - %LTHR  04 – Watts  05 – Watts per Kilogram  06 – Watts per LB  0A – KM/H  ...  18 – Minutes per Mile  and so on. | | 21-24 | **ONE, TWO, ZERO Flag**  It does not appear to do anything on distribution charts, or at least the file structure does not appear to change. | | 25-32 | **Conversion Factor**  By default (unset) it is a double of value ‘1.00’. It could also be set to the rider weight in LBS when the unit is W/LB on the power channel. Assumed it changes alongside the units selector. | | 33-36 | **Bin mode**  0xF4 01 00 00 (500) - Automatic  0xF5 01 00 00 (501) - Manual  0xF6 01 00 00 (502) - Zones | | 37-40 | **Include Zeros**  0x01 00 00 00 – Include Zeroes  0x00 00 00 00 – Do not include zeros | | 41-44 | **Unknown**  00 00 00 00 | | 45-48 | **Lower Limit**  Float to set lower limit when using manual bins | | 49-52 | **Unknown**  00 00 00 00 | | 53-56 | **Upper Limit**  Float to set upper limit when using for manual bins | | 57-60 | **Unknown**  00 00 00 00 | | 61-64 | **Increments**  4 byte floatIncremental units | |
| 253.5 | 2 | **Number of Bars on a Distribution Chart**  A count of how many bar settings follow |
| 253.6 | VARIABLE | **Bar Descriptions**  Repeated #253.5 times;  4 byte Number - Counter  VARTEXT – Axis Label  VARTEXT – Alternate (hover) label  8 byte double – Axis Label as a floating point number |
| 253.7 | VAR | **Optional Data** |
| 253.71 | 2 | Cached Data Flag  If this 2 byte field is set to 1 (0x01 0x00) then a chart data cache exists, any other value means that no further data is present. |
| 253.72 | 4 | Usually 0x00 0x00 |
| 253.73 | 2 | **Cache Marker**  If this value is NOT 0xffff then a data cache will follow, if it is 0xffff then it represents the start of the next segment and should not be skipped over. Typically it will contain a value like 0x09 0x80 |
| 253.74 | 4 | Usually 0x02 0x00 0x00 0x00 |
| 253.75 | 4 | Usually 0x01 0x00 0x00 0x00 |
| 253.76 | DOUBLE | **Unknown**  Can have many values, 8 byte double |
| 253.77 | 2 | **Cache Size**  A 2 byte short with a count of the number of cached values that follow, this is typically the same as the bins for the distrbution chart, i.e. if there are 7 zones 1,2,3,4,5a,5b,5c then this field will contain 0x07 0x00 |
| 253.78 | VARIABLE | **The field above contains a count of the number of double (8byte) values to be found in this field.** |

## Mean Maximal Chart

The format of the remaining fields for a chart of type mean maximal are as follows;

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 253.4 | 28 | **Mean Maximal Chart Type Specific Configuration**   |  |  | | --- | --- | | **Byte** | **Meaning** | | 1-4 | Scale  00 – Linear  01 – Logarithmic | | 5-8 | Channel  00 – Power  01 – Heart Rate  02 – Cadence  03 – Speed  04 – Hub Torque  05 – Altitude  08 – Normalised Power  09 – Crank Torque  0C – Normalised Graded Pace | | 9-12 | Unknown 04 00 00 00 | | 13-16 | **Units**  01 – BPM  02 - %Max HR  03 - %LTHR  04 – Watts  05 – Watts per Kilogram  06 – Watts per LB  ...  18 – Minutes per Mile  and so on. | | 17-20 | **ONE, TWO, ZERO Flag**  Zero seems to indicate that 2nd conversion factor is not present  One seems to indicate that 2nd conversion factor is present but not used  Two seems to indicate that 2nd conversion factor is present and used | | 21-28 | **Conversion Factor**  8 byte double conversion factor (only set for specific units) | | 29-32 | **Second conversion factor**  4 byte long conversion factor | |
| 253.5 | 2 | **Number of mean max structures that follow**  The number of meanmax structures that follow typically E9 (233) for power.  If it is zero then there is no more data AT ALL for this chart.  If it is one then there will almost certainly be a partial mean max structure below (re: 253.7 being zero). |
| 253.6 | VAR | **Mean Max Structures**  Generally either 1 (which is a short 4 byte structure) or 233 of them as defined by field 253.5. If the set is truncated due to a sequence number of zero then the chart data ends here and the fields below (253.7 onwards) are not present. |
| 253.7 | 12 | **[Optional] Preamble to 2nd Section**  If the sequence above completed then there will be 12 bytes of data which seem to always be 0x59 0x02 0x00 0x00 0x00 0x00  0x00 0x00 0x00 0x00 0x00 0x00 |
| 253.8 | 2 | **[Optional] Number of mean max structures that follow**  Almost always 0xe9 0x00 (233). |
| 253.9 | VAR | **[Optional] 2nd Set of Mean Max Structures**  The set never appears to be truncated and has 253.8 members. |
| 252.10 | 24 | **[Optional] Unknown**  24 final bytes of data related to the mean max chart. |
| 253.7 | VAR | **Optional Charting Data** |

## Mean Max Structure

|  |  |  |
| --- | --- | --- |
|  | 4 | **Sequence ID**  If this is zero then there are no more structures. And the rest of the structure is not present. |
|  | 4 | **Unknown** |
|  | 4 | **1000th of second interval**  The interval to show on the chart in 100ths of a second |
|  | 4 | **Unknown** |
|  | 8 | **Value shown on chart**  The value to show on the chart for this interval |
|  | 4 | **Unknown** |
|  | 4 | **Unknown** |

## Optional Charting Data

After some chart structures additional data is sometimes, but not always, stored. This can prove particularly challenging to manage since the specific conditions that cause the data to be present are not known. Further, the meaning and purpose of the data is not known.

Since my goal is to recover my personal data from the .wko files I have not investigated this further than necessary, although it is worth noting that the extensive coverage of the chart configuration data is as a result of investigations to identify the conditions that result in this ‘optional charting data’.

The optional data is an artefact of the MFC persistent object format. This section now reflects the constants being used by these routines (previous releases of the document outlined variable data that has now been identified as distribution chart data caches, and present in most WKO files).

The following patterns have been observed where optional data is present

|  |  |  |
| --- | --- | --- |
| **Value** | **Followed by** | **Followed by** |
| 0x07 0x80  0x0a 0x80  0x0b 0x80  0x0c 0x80  0x0d 0x80  0x0e 0x80  0x0f 0x80  0x10 0x80  0x11 0x80  0x12 0x80  0x13 0x80 | **No further data**  marks end of optional data |  |
| 0x00 0x00 0x00 0x00 | **No further data**  Marks end of optional data |  |

If the table above is confusing please see the function optpad() and optpad2() in the source files at <http://www.sourceforge.net/projects/wko2csv>.

# Raw Data

## Raw Data Header

There are no preceding padding bytes or markers the raw data header follows immediately after the last chart, which is often a [CRideSummaryConfig] block, but can be another chart if the user has modified the default WKO charts setup.

|  |  |  |
| --- | --- | --- |
| **Field No.** | **Size Bytes** | **Description** |
| R.1 | 2 | **Number of Records**  16 bit short which equates to the number of packed data records that make up the raw data header. If there is more than 0xfffe records this field will be set to 0xffff and followed by a 4 byte long. |
| R.1x | 4 | **[Optional] Number of Records**  32 bit longwhich equates to the number of recordings and only stored when the previous field is set to FFFF |
| R.2 | 2 | **Number of Bytes**  16 bit short which equates to the total number of bytes used to store the raw data fields. If the number of bytes is greater than 0xFFFE this value will be set to 0xFFFF and followed by a 4 byte long describing the number of bytes.  It appears to be ‘out by one’ record. For example, a file with 744 records which are 6 bytes long would equate to 4464 bytes. Whereas this field would record 4470 bytes (hence ‘out by one’ record). |
| R.2x | 4 | **[Optional] Number of Bytes**  32 bit longwhich equates to the total number of bytes used to store the raw data fields and only stored when the previous field is set to FFFF. |
| R.3 | 1 BIT  15 BITS | **[Optional] Device Flag**  Only non-zero for Garmin data which starts at this point.  **Record Interval**  For non-garmin devices the remaining 15 bits of this short define the recording interval when the 1bit flag is not set.  Fields R.3/4/5/6 are not present for Garmin devices. |
| R.4 | 2 | **[Optional] Unknown**  Not present if 1bit flag is set |
| R.5 | 1 | **[Optional] Unknown**  Not present if 1bit flag is set |
| R.6 | 3 bits | **[Optional] Unknown**  Three bits of data prior to first record – i.e. the data starts from bit 4 of this byte. |

## Graph Data Bitstream

Each graph is packed bitwise into a bitstream in the same sequence as the GRAPHS string (see above). Although there is no byte swapping the data is big-endian (left to right), so you need reverse them as you read them in i.e. a HR of 78 BPM is stored as 01110010 and not 01001110[[2]](#footnote-2).

Where the minimum is negative the field is ‘signed’ and uses the topmost bit to indicate negative values and is also two’s complemented (ie all bits are reversed). Note that the maximum value may be used to denote absence of value e.g. HR of 256 is shown as a data dropout in the graphs.

Each record is preceded by a 1bit marker that is used to indicate what follows either a record to set the interval in 100ths of a second or a data sample, structured in the same sequence as the GRAPHS string.

## Field Sizing

The table below lists all field sizes in bits

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Graph Letter** | **Value** | **Units** | **Multiplier** | **Minimum** | **Maximum** | **Bits** |
| **N/A** | **Marker** | **N/A** | **N/A** | **0** | **15** | **1** |
| **N/A** | **Pause** | **N/A** | **N/A** | **0** | **0** | **39/42\*** |
| **P** | **Power** | **Watts** | **1** | **0** | **4096** | **12** |
| **H** | **HR** | **BPM** | **1** | **0** | **256** | **8** |
| **C** | **Cadence** | **RPM** | **1** | **0** | **256** | **8** |
| **S** | **Speed** | **Km/h** | **0.10** | **0** | **2048** | **11** |
| **A** | **Altitude** | **Meters** | **0.1** | **-52179** | **52678** | **20** |
| **T** | **Hub Torque** | **NM** | **0.10** | **0** | **2048** | **11** |
| **D** | **Distance** | **Meters** | **0.005** | **0** | **524,287** | **19/22\*** |
| **G** | **GPS position**  **Lat Long** | **Degrees** | **180 / 2^31** | **-90**  **-180** | **+90**  **+180** | **32 + 32 signed int** |
| **W** | **Wind Speed** | **Km/h** | **0.10** | **0** | **2048** | **11** |
| **+** | **Temperature** | **Celsius** | **1** | **-127** | **+127** | **8** |
| **^** | **Hill Slope** | **%** | **1** | **-524287** | **+524287** | **20** |

PLEASE NOTE: The distance field varies by device;

* 19 bits – Device types: 0x04 0x05 0x06 0x11 0x19 0x1a
* 22 bits – Device types: 0x00 0x01 0x12 0x13 0x14 0x16

PLEASE NOTE: The pause size varies by device;

* 39 bits – Device type: 0x14
* 42 bits – All other devices

As an example, a Powertap typically provides the following graphs: PHCSTD. A single record in the bitstream this will be encoded as shown below;

|  |  |  |
| --- | --- | --- |
| **GRAPH** | **Value** | **As encoded in the bitstream (Note the bit order)** |
| M | 8 | 0001 |
| P | 101 w | 101001100000 |
| H | 89 bpm | 10011010 |
| C | 77 rpm | 10110010 |
| S | 30.0 kph | 00110100100 |
| T | 1.7 nm | 10001000000 |
| D | 0.004 km | 0000010011000000000 |

## Recording Flag ‘aka Marker’

The recording flag is either 1 or 4 bits of data that precede the structure that follows and can have the following values, please note I have re-ordered the bits to reflect the value after it is unpacked from the bitstream. So, for example in the sequence 0001 in the bitstream is shown as 1000 (8).

**For a 1 bit Marker**

|  |  |  |
| --- | --- | --- |
| **Marker Flags** | **Following Bits** | **Description** |
| 0 (0) | 42 | **Set interval record**  NOTE! For ibike files there are 39 not 42 bits of data.  The first 32 bits is the period in 1000ths of a second that should be used for the interval value from this point onwards.  It is often followed by a full record structure, which is set to the maximum values and – this is to indicate a pause in recording. After this record there is always a second entry to reset the interval value back to the normal value.  For some reason Velotron files spew out lots and lots of these. |
| 1 (1) | VAR | **Absolute Recording**  The normal structure follows (as indicated by the GRAPHS flag) |

## Footer Record

|  |  |  |
| --- | --- | --- |
| **Field No.** | **Size Bytes** | **Description** |
| R.7 | 1 | **Unknown**  Zero byte following last data record – see R.5 above – is this a counter of some kind? |
| R.8 | 10 | **Unknown** |
| R.9 | VARTEXT | **Currently Active Perspective**  Perspective in use when viewing this workout |
| R.10 | 8 | **Unknown**  E.g. 01 00 00 00 00 00 00 00 |

1. Although the configuration enumeration tokens CRideGoalConfig et al are stored as a 2 byte length field followed by a text field (see section 4). [↑](#footnote-ref-1)
2. Read my code particularly the function get\_bits() to see how this is implemented. I may have described this incorrectly since I still get confused between endian storage and register bit ordering (!) [↑](#footnote-ref-2)