

# Philips Sensing Platform

SY1902 PSP Metrics Specification

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Approved

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## Document information

Info	Content
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Abstract	This document describes the metrics specification for PSP library.

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#### Revision history

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1.0	28-Jul-2021	JaWo	First version
1.1	25-Nov-2021	JaWo	Correct typo
	24-May-2022 07-Nov-2022	JaWo JaWo	Update Legal Information Update legal disclaimer, update date format
1.2	30 Jan 2023	JaWo	Renamed PPG-Red(middle) to PPG-Motion

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## 1 Introduction

### 1.1 Purpose & scope

This specification describes the Philips Sensing Platform (PSP) metrics, in particular their semantics and representation.

#### 1.1.1 Products and their supported metrics

The metrics specifications are adhered to by the PSP hardware and software products (as input and/or as output) and are also used for other purposes such as file format definitions.

NOTE: to know which metrics are supported by a given product, refer to the corresponding product specification. This will in general be a subset of the metrics in this specification. In other words, specific metrics in this specification only apply to certain products.

### 1.2 Syntax notation

This specification contains syntax descriptions. The following notation is used:

- Single bytes are represented between brackets '<>';
- Multiple-byte entities are represented in little endian, LSB through MSB. This is indicated with subscript postfixes attached to the logical unit, e.g. 'L' or '0' for LSB and 'H' or 'N-1' for MSB where subscript value N would equal the field length in bytes.

### 1.3 Definitions, acronyms & abbreviations

Abbreviation	Description
AFIB	Atrial fibrillation
Baro	Barometer
BPM	Beats Per Minute
Gyro	Gyroscope
LSB	Least Significant Byte
MSB	Most Significant Byte
PPG	Photo plethysmography measures the volumetric changes of the arteries caused by the pumping of the heart. From this measurement average heart rate and heart rate variability can be extracted.
PSP	Philips Sensing Platform
SpO2	Oxygen Saturation
UTC	Coordinated Universal Time

VO2Max	Maximal oxygen consumption
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1.4 References

Abbrev.	Title	Author(s)	Version

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## 2 Metrics specification

Metric data is represented as:

$\langle ID \rangle \langle N_L \rangle \langle N_H \rangle \langle IX \rangle \langle Q \rangle \langle V_0 \rangle \dots \langle V_{N-3} \rangle$

Where:

- ID : metric ID
- N : 2 bytes value representing the number N of remaining metric data bytes
- IX : Index, incremented at every metric value update
- Q : Quality indicator
- V : N-2 data bytes representing the metric Value(s)

Fields ID, N, IX and Q together constitute the preamble of the metric data.

The quality indicator Q denotes the reliability of the metric value(s). The valid quality range is defined as 0..4, where higher means more reliable, and:

- 0 denotes that the value is fully unreliable, i.e. the accompanying metric value(s) shall be ignored;
- 4 denotes the most reliable value that the metric source can provide.

Note that this definition implies that quality only has a meaning in the context of the source and of the metric itself. Quality values cannot be quantitatively compared among metrics, nor among metrics generated by the current version and previous or future versions of their source.

Table 1 lists the metrics, their update interval and their formats. If no update interval is listed, then the metric may be updated at arbitrary moments (asynchronous of others). Any metric data values that are not defined, shall be considered reserved.

Certain metrics are body position specific, rather than person-systemic. These metrics contain a body position field. Table 2 specifies the body position values.

ID [hex]	Metric	Update interval [s]	Metric value data <bytes>	Description [unit]
03	Age	-	<A>	The age of the person A : Age [year] Range 0..120.
04	Profile	-	<Y <sub>L</sub> > <Y <sub>H</sub> > <M> <D> <S> <H>	Time-invariant properties of the person, fixed at birth Y : Year of birth Range {0; 1900..2100}; value 0 means unspecified M : Month of birth Range 0..12; value 0 means unspecified D : Day of birth Range 0..31; value 0 means unspecified S : Sex 0 : unspecified 1 : male 2 : female H : Handedness 0 : unspecified 1 : right-handed 2 : left-handed

ID [hex]	Metric	Update interval [s]	Metric value data <bytes>	Description [unit]
				3 : mixed-handed  The date of birth fields shall either all be specified or all be unspecified.
05	Height	-	<H>	The height of the person H : Height [cm] Range 0..255; value 0 means unspecified.
06	Weight	-	<W <sub>L</sub> > <W <sub>H</sub> >	The weight of the person W : Weight [hg] Range 0..2000; value 0 means unspecified  E.g. W=741 represents 74.1 kg
09	Sleep Preference	-	<I>	Information about the person in relation to his/her sleep I : Has intention to sleep 0 : unspecified 1 : yes 2 : no
1E	Time	1	<U <sub>0</sub> > ... <U <sub>3</sub> > <TZ*> <DST*>	The time U : Time [UTC] in seconds since January 1, 1970 (Unix/Posix time, also known as 'epoch time'). Range 0..2 <sup>32</sup> -1.  TZ : (*optional) Time Zone definition to represent time difference in 15 minutes increments between local standard time and UTC. Range [-48 .. +56] equals to -12:00 hour to +14:00 hour  DST : (*optional) Daylight Saving Time offset in 15 minutes increments. Valid values: 0, 2, 4, 8  If <TZ> is specified also <DST> must be defined and vice versa.  E.g. U = 1449056584 = 0x565ED948 (U <sub>0</sub> =0x48, U <sub>1</sub> =0xD9, U <sub>2</sub> =0x5E, U <sub>3</sub> =0x56) corresponds to: Wed, 02 Dec 2015 11:43:04 GMT. An online converter can be found at <a href="http://www.epochconverter.com">www.epochconverter.com</a> .  Local time is defined as UTC + TZ + DST. If TZ and DST are not defined, it represents the UTC time.
20	Heart Rate	1	<HR>	The heart rate of the person HR : Heart Rate [BPM] Range 30..220.
21	Resting Heart Rate	3600	<RHR>	The resting heart rate of the person RHR : Resting Heart Rate [BPM] Range 30..120.

ID [hex]	Metric	Update interval [s]	Metric value data <bytes>	Description [unit]
22	Skin Proximity	1	<P>	The proximity to the skin of the person P : Proximity 0 : on-skin 254 : off-skin 255 : unspecified
23	Active Energy Expenditure	1	<E <sub>L</sub> > <E <sub>H</sub> >	The energy expenditure due to physical activity of the person E : Energy Expenditure [kcal/h] Range 0..1200.
24	Speed	1	<SP>	The motion speed of the person SP : Speed [0.1m/s] Range 0..150.  E.g. SP=40 represents 4.0 m/s = 14.4 km/h
25	Cadence	1	<C>	The motion cadence of the person C : Cadence of the motion [min <sup>-1</sup> ] Range 20..120.
26	Activity Type	1	<AT>	The type of activity the person is performing AT : Activity Type 0: unspecified 1: other 2: walk 4: run 6: cycle 7: rest
27	Heart Beat Time Stamp	1	<M> <BPI> <Q <sub>0</sub> > <T <sub>0,0</sub> > <T <sub>1,0</sub> > <T <sub>2,0</sub> > <T <sub>3,0</sub> > <E <sub>L,0</sub> > <E <sub>H,0</sub> > <TY <sub>0</sub> > ... <Q <sub>M-1</sub> > <T <sub>0,M-1</sub> > <T <sub>1,M-1</sub> > <T <sub>2,M-1</sub> > <T <sub>3,M-1</sub> > <E <sub>L,M-1</sub> > <E <sub>H,M-1</sub> > <TY <sub>M-1</sub> >	The heart beats of the person at the specified body position M : number of heart beats (0..5) BPI : Body position index (Table 2) For all heart beats $i = 0..M-1$ :  Q <sub>i</sub> : quality (0..4) T <sub>i</sub> : time [ms]; range 0..2 <sup>32</sup> -1 E <sub>i</sub> : reserved TY <sub>i</sub> : type: 0: normal beat in sequence 255: last beat in sequence  Heart Beats are reported in sequence. The sequence of heart beats may also be temporarily interrupted when no beats could be detected e.g. due to motion influences. This is signaled by the heart beat type. The time between two consecutive heart beats in a sequence can be determined by subtracting their times (modulo 2 <sup>32</sup> ).  Note that this metric has an individual quality Q <sub>i</sub> per heart beat, in addition to the overall quality of the metric.



ID [hex]	Metric	Update interval [s]	Metric value data <bytes>	Description [unit]
28	VO2Max	60	<VOM>	The maximum oxygen uptake of the person VOM : VO2Max [ml/kg/min] Range 10..100.
29	Fitness Index	60	<FI>	The percentile rank of the person's VO2Max relative to population of similar age and gender FI : Fitness Index [%] Range 0..100 (= lowest fitness..highest fitness)
2A	Respiration Rate	1	<RR>	The respiration rate of the person RR : Respiration Rate [0.25 breaths/min] Range 20..180  Range corresponds to 5..45 breaths/min. E.g. RR=44 represents 11 breaths/min
2B	Acceleration	See field AF	<BPI> <AF> <X <sub>0,L</sub> > <X <sub>0,H</sub> > <Y <sub>0,L</sub> > <Y <sub>0,H</sub> > <Z <sub>0,L</sub> > <Z <sub>0,H</sub> > ... <X <sub>M-1,L</sub> > <X <sub>M-1,H</sub> > <Y <sub>M-1,L</sub> > <Y <sub>M-1,H</sub> > <Z <sub>M-1,L</sub> > <Z <sub>M-1,H</sub> >	The 3D acceleration of the person at the specified body position BPI: Body position index (Table 2) AF: Acceleration sample format (Table 3) X <sub>i</sub> : Acceleration along X axis Y <sub>i</sub> : Acceleration along Y axis Z <sub>i</sub> : Acceleration along Z axis  The sample format specifies the sample width, i.e. how many MSBs of the two-byte X, Y and Z values are valid.
2D	Low power Heart Rate	60	<LHR>	The heart rate of the person LHR : Low power Heart Rate [BPM] Range 30..220.  The Low power Heart Rate is the short-term heart rate, but represented periodically at each update interval.
2E	Activity Count	1	<BPI> <AC <sub>L</sub> > <AC <sub>H</sub> >	The activity count of the person at the specified body position BPI : Body position index (Table 2) AC : Activity Count [arbitrary unit] Range 0..65535.
2F	Private Data	60	<D <sub>0</sub> > <D <sub>1</sub> > ... <D <sub>NB-2</sub> > <D <sub>NB-1</sub> >	Private data, suited for subsequent metric extraction  D <sub>i</sub> : Data byte Range 0x00..0xFF.  Number of bytes NB may range from 0 to 300.

ID [hex]	Metric	Update interval [s]	Metric value data <bytes>	Description [unit]
30	Sleep Stages	-	<ST <sub>0</sub> > <ST <sub>1</sub> > <ST <sub>2</sub> > <ST <sub>3</sub> > <ET <sub>0</sub> > <ET <sub>1</sub> > <ET <sub>2</sub> > <ET <sub>3</sub> > <SS> <ES> <SHQ> <SHR> <EL> <M <sub>L</sub> > <M <sub>H</sub> > <SQ <sub>0</sub> > <ST <sub>0</sub> > ... <SQ <sub>M-1</sub> > <ST <sub>M-1</sub> >	The Sleep Stages metric is a report containing among others the start and end time of the sleep sessions and all detected sleep stages.  ST: Session start time [UTC] ET: Session end time [UTC] SS: Start source: 0: automatic 1: sleep preference ES: End source: 0: automatic 1: sleep preference 2: end of stream SHQ: Sleeping heart rate quality Range 0..4 SHR: Sleeping heart rate [BPM] Range 30..120 EL: Epoch length [s] 30: only value currently supported M: Number of epochs Range 0..1920  For all epochs $i = 0..M-1$ : SQ <sub>i</sub> : Sleep stage quality for epoch $i$ Range 0..4 ST <sub>i</sub> : Sleep stage for epoch $i$ 0: Unspecified 1: Deep Sleep 2: Light Sleep 3: REM Sleep 4: Awake
34	Compressed Acceleration	See field AF	<BPI> <AF> <B <sub>0</sub> > <B <sub>1</sub> > ... <B <sub>N-2</sub> > <B <sub>N-1</sub> >	The 3D acceleration of the person at the specified body position, compressed to minimize data rate BPI: Body position index (Table 2) AF: Acceleration sample format B <sub>i</sub> : Data byte Range 0x00..0xFF.  Number of bytes N may range from 0 to 180. The compression scheme is proprietary.
35	Compressed PPG	See field PF	<BPI> <PF> <B <sub>0</sub> > <B <sub>1</sub> > ... <B <sub>N-2</sub> > <B <sub>N-1</sub> >	The green PPG (relative blood volume) of the person at the specified body position, compressed to minimize data rate BPI: Body position index (Table 2) PF: PPG sample format B <sub>i</sub> : Data byte Range 0x00..0xFF.  Number of bytes N may range from 0 to 80. The compression scheme is proprietary.

ID [hex]	Metric	Update interval [s]	Metric value data <bytes>	Description [unit]
3B	Heart Rhythm Type	30	<D> <T>	<p>The Heart Rhythm Type of the person for a 1 minute time window. The time between subsequent time windows equals 30 seconds (i.e. 50% overlap between subsequent windows).</p> <p>D: Delay (time elapsed) between end of the time window and the time that the heart rhythm type could be determined [seconds]. In non-real-time contexts, this field may be ignored.</p> <p>T: Heart rhythm type            0: Other            1: Atrial fibrillation (AFIB)            255: Unspecified</p>
3C	Low Power Active Energy Expenditure	60	<E <sub>L</sub> > <E <sub>H</sub> >	<p>The energy expenditure due to physical activity of the person            E : Energy Expenditure [kcal/h]            Range 0..1200.</p> <p>The Low Power Active Energy Expenditure is the short-term energy expenditure, but represented periodically at each update interval.</p>
3D	Skin Conductance	See field SF	<BPI> <SF> <S <sub>0,0</sub> > <S <sub>0,1</sub> > <S <sub>0,2</sub> > ... <S <sub>M-1,0</sub> > <S <sub>M-1,1</sub> > <S <sub>M-1,2</sub> >	<p>The skin conductance of the person at the specified body position            BPI: Body position index (Table 2)            SF: Skin Conductance sample format (Table 5)            S<sub>i</sub> : Skin Conductance</p> <p>The sample format specifies the sample width, i.e. how many MSBs of the three-byte values are valid.</p>
3E	Stress Level Skin Conductance	1	<SL <sub>L</sub> > <SL <sub>H</sub> >	<p>Stress level that is measured based on skin conductance            SL : Stress Level            Range: 0 .. 1000 (arbitrary unit)</p> <p>A percentage value between 0 and 1000 that describes the stress level.</p>

ID [hex]	Metric	Update interval [s]	Metric value data <bytes>	Description [unit]
3F	Cognitive Zone	60	<CZ> <PCZ> <PCZT> <CZH> <CC <sub>0</sub> > <CC <sub>1</sub> > <CC <sub>2</sub> >	CZ: Cognitive zone Enumerated value, please see below.  PCZ: Predictive Cognitive Zone Enumerated value, please see below.  PCZT: Predictive Cognitive Zone Transition Time [mins]  CZH: Cognitive Zone in One Hour Enumerated value, please see below.  CC: Cortisol Contribution [arbitrary unit]  Cognitive zone, Predicted Cognitive Zone and Cognitive Zone in One Hour can be one of the following values: 0: Undefined 1: Under Stimulated 2: Balanced 3: Over Stimulated
40	Stress Level Heart Rate	1	<SL <sub>L</sub> > <SL <sub>H</sub> >	Heart Rate derived Stress parameters of a person SL : Stress Level [arbitrary unit] Range: 0..1000 (arbitrary unit)
41	SpO2	1	<OX>	The blood oxygen saturation level of a person OX : Oxygen level [%] Range 0..100
42	Fall Occurrence	1	<FD>	Fall Detection of a person FD : Fall Detection 0 : no fall detected 1 : fall detected
79	Angular Rotational Velocity/Gyro	See field GF	<BPI> <GF> <X <sub>0,L</sub> > <X <sub>0,H</sub> > <Y <sub>0,L</sub> > <Y <sub>0,H</sub> > <Z <sub>0,L</sub> > <Z <sub>0,H</sub> > ... <X <sub>M-1,L</sub> > <X <sub>M-1,H</sub> > <Y <sub>M-1,L</sub> > <Y <sub>M-1,H</sub> > <Z <sub>M-1,L</sub> > <Z <sub>M-1,H</sub> >	The 3D angular rotational velocity (gyro) of the person at the specified body position BPI: Body position index (Table 2) GF: Gyro sample format (Table 6) X <sub>i</sub> : angular velocity along X axis Y <sub>i</sub> : angular velocity along Y axis Z <sub>i</sub> : angular velocity along Z axis  The sample format specifies the sample width, i.e. how many MSBs of the two-byte X, Y and Z values are valid.
7A	Pressure/Baro	See field BF	<BPI> <BF> <B <sub>0,L</sub> > <B <sub>0,H</sub> > ... <B <sub>M-1,L</sub> > <B <sub>M-1,H</sub> >	The pressure (barometer) of the person at the specified body position BPI: Body position index ((Table 2) BF: Pressure/Baro sample format (Table 7) B <sub>i</sub> : Pressure  The sample format specifies the sample width, i.e. how many MSBs of the two-byte values are valid.

ID [hex]	Metric	Update interval [s]	Metric value data <bytes>	Description [unit]
7B	PPG-Infrared	See field PF	<BPI> <PF> <SI> <OFS> <EXP> <L <sub>0</sub> > ... <L <sub>3</sub> > <G <sub>0</sub> > ... <G <sub>3</sub> > <P <sub>0,L</sub> > <P <sub>0,H</sub> > ... <P <sub>M-1,L</sub> > <P <sub>M-1,H</sub> >	<p>The PPG (relative blood volume) of the person at the specified body position</p> <p>BPI : Body position index (Table 2)</p> <p>PF: PPG sample format (Table 4) ( only 0x60 supported )</p> <p>SI: Stream locations identifier* bit7 - bit4: Led bit3 - bit0: Photodiode</p> <p>OFS: PPG Offset bit7 – bit0: Offset</p> <p>EXP# (optional): PPG Exponent + PPG Offset extension bit7 - bit4: Offset bit11 – bit8 bit3 - bit0: Exponent</p> <p>L<sub>i</sub>: Relative LED power [%] for each quarter of samples (M/4) 0..100: power</p> <p>G<sub>i</sub>: Relative ADC gain used to obtain P<sub>i</sub> for each quarter of samples (M/4) 0: gain factor 1x 1: gain factor 2x 2: gain factor 4x 3: gain factor 8x</p> <p>P<sub>i</sub> : Relative PPG level (16 bit unsigned), translated into 32 bit unsigned:  <math>(P_i \ll \text{Exponent}) + (\text{Offset} * 32768) = \text{absolute PPG level} * \text{relative ADC gain factor}</math></p> <p>The relative LED power is in relation to the maximum (100%) power that the PPG source supports. 0% means 'LED fully off'.</p> <p>The ADC gain minimum is assumed 1x. Gain steps are in factor of 2.</p> <p>* : Location(led/pd) is specified according to the position of the numbers of an analog clock(1..12) reference to center point. If more than one LED/PD stream, they can be distinguished by using different stream location identifiers.</p> <p># : If &lt;EXP&gt; is not used then Exponent (bit3 – bit0 in EXP) = 0. Also, if propagated PPG is enabled, &lt;EXP&gt; field is removed at output.</p> <p>Remarks: Offset and Exponent are still not yet supported.</p>
7C	PPG-Red			Same as metric 7B
7D	PPG-Motion			Same as metric 7B led position is n/a and set to 0

ID [hex]	Metric	Update interval [s]	Metric value data <bytes>	Description [unit]
7E	PPG-Green(middle)			Same as metric 7B led position is n/a and set to 0
7F	PPG-Ambient			Same as metric 7B All led powers are per definition 0 led position is n/a and set to 0

Table 1 - Metrics and their data formats

Index	Body position
0	Unspecified
1	Left wrist
2	Right wrist
3	Unspecified wrist

Table 2 – Body positions<sup>1</sup>

Sample format AF [hex]	Sample rate Fs [Hz]	Update interval U [s]	Samples per update M = Fs * U	Range [g]	Width [MSBs]	Resolution [g]
FF	128	1/16	8	+/-8	12	1/256
6E	32	1	32	+/-8	13	1/512
70	50	1	50	+/-32	16	1/1024

Table 3 – Acceleration sample formats

Sample format PF [hex]	Effective sample rate Fs [Hz]	Update interval U [s]	Samples per update M = Fs * U
7F	32	1/16	2
60	32	1	32

Table 4 – PPG sample formats

Sample format SF [hex]	Sample rate Fs [Hz]	Update interval U [s]	Samples per update M = Fs * U	Range [mS]	Width [MSBs]	Resolution [nS]
01	25	1	25	0...1.677	24	0.1

Table 5 – Skin Conductance sample formats

Sample format GF [hex]	Sample rate Fs [Hz]	Update interval U [s]	Samples per update M = Fs * U	Range [dps]	Width [MSBs]	Resolution [dps]
01	50	1	50	+/- 2000	16	0.061

Table 6 – Gyro sample formats

Sample format BF [hex]	Sample rate Fs [Hz]	Update interval U [s]	Samples per update M = Fs * U	Range [Pa]	Width [MSBs]	Resolution [Pa]
01	4	1	4	70000...135535	16	1

Table 7 – Pressure/Baro sample formats

<sup>1</sup> Body position means the wearing location of the device. It can be left, right or unspecified wrist. In future, it may extend to cover other position on body, like chest, foot etc.

## 3 Metrics examples

The following examples illustrate the metrics representation. All byte values are expressed in hexadecimal.

### Heart Rate (0x20)

Binary: 20 03 00 01 03 5A

Meaning:

- 0x20 : Metric ID of Heart Rate
- 0x03 0x00 : 0x0003. Metric value size is 3 bytes
- 0x01 : IX.
- 0x03 : Q. Quality of the metric value
- 0x5A : Metric value

Summary: Heart Rate now is 90 Beats Per Minute (BPM) with quality level 3 and index 1.

### Skin Proximity (0x22)

Binary: 22 03 00 06 04 00

Meaning:

- 0x22 : Metric ID of Skin Proximity
- 0x03 0x00 : 0x0003. Metric value size is 3 bytes
- 0x06 : IX.
- 0x04 : Q. Quality of the metric value
- 0x00 : Metric value

Summary: Skin Proximity now is 0 (on skin) with quality level 4 and index 6.

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