ANSI/CTA Standard

Definitions and Characteristics for Wearable Sleep Monitors

ANSI/CTA/NSF-2052.1

September 2016
NOTICE

Consumer Technology Association (CTA)™ Standards, Bulletins and other technical publications are designed to serve the public interest through eliminating misunderstandings between manufacturers and purchasers, facilitating interchangeability and improvement of products, and assisting the purchaser in selecting and obtaining with minimum delay the proper product for his particular need. Existence of such Standards, Bulletins and other technical publications shall not in any respect preclude any member or nonmember of the Consumer Technology Association from manufacturing or selling products not conforming to such Standards, Bulletins or other technical publications, nor shall the existence of such Standards, Bulletins and other technical publications preclude their voluntary use by those other than Consumer Technology Association members, whether the standard is to be used either domestically or internationally.

Standards, Bulletins and other technical publications are adopted by the Consumer Technology Association in accordance with the American National Standards Institute (ANSI) patent policy. By such action, the Consumer Technology Association does not assume any liability to any patent owner, nor does it assume any obligation whatever to parties adopting the Standard, Bulletin or other technical publication.

This document does not purport to address all safety problems associated with its use or all applicable regulatory requirements. It is the responsibility of the user of this document to establish appropriate safety and health practices and to determine the applicability of regulatory limitations before its use.

This document is copyrighted by the Consumer Technology Association (CTA)™ and the National Sleep Foundation (NSF) and may not be reproduced, in whole or part, without written permission. Federal copyright law prohibits unauthorized reproduction of this document by any means. Organizations may obtain permission to reproduce a limited number of copies by entering into a license agreement. Requests to reproduce text, data, charts, figures or other material should be made to the Consumer Technology Association (CTA)™ and the National Sleep Foundation (NSF).

(Formulated under the cognizance of the CTA R6.4 Health & Fitness Technology Subcommittee.)

Published by
©CONSUMER TECHNOLOGY ASSOCIATION 2016
Technology & Standards Department
www.cta.tech

All rights reserved
FOREWORD

This standard was developed by the Consumer Technology Association’s R6.4 Health & Fitness Technology Subcommittee.
CONTENTS

1. Scope and Disclaimer .......................................................................................................................... 6
   Table 1 - Sleep Terminology Categorization ...................................................................................... 6

2. References ............................................................................................................................................... 8
   2.1 Informative References .................................................................................................................. 8
   2.2 Compliance Notation ..................................................................................................................... 8
   2.3 Definitions ....................................................................................................................................... 8
   2.4 Symbols and Abbreviations ........................................................................................................... 8

3. Definitions, Indicators, and Calculations ................................................................................................. 9
   A - General Terms Describing the Temporal Surrounding a Sleep Episode ........................................ 9
      A.1 (Elemental): TIB End Time ........................................................................................................... 9
      A.2 (Elemental): TATS End Time ....................................................................................................... 9
      A.3 (Elemental): TIB Start Time ........................................................................................................ 9
      A.4 (Elemental): TATS Start Time .................................................................................................... 9
      A.5 (Derived) Total TATS Duration ............................................................................................... 10
      A.6 (Derived) Total TIB Duration .................................................................................................... 10
   B. General Terms Describing Basic Features of Wakefulness and Sleep ........................................... 10
      B.1 (Elemental): Awake ................................................................................................................ 10
      B.2 (Elemental): Asleep ............................................................................................................... 10
      B.3 (Elemental): Awakening from Sleep ......................................................................................... 10
      B.4 (Elemental): Brief Awakening ............................................................................................... 11
      B.5 (Elemental): Brief Moment of Sleep (Dozing) ......................................................................... 11
      B.6 (Derived): Total sleep period duration (TSPD) ........................................................................ 11
      B.7 (Derived): Total sleep time (TST) ............................................................................................ 11
      B.8 (Derived): Sleep maintenance percentage ............................................................................ 11
      B.9 (Derived): Total wakefulness duration .................................................................................. 11
      B.10 (Derived): Wakefulness duration after initial sleep onset .................................................... 11
      B.11 (Derived): Number of awakenings ....................................................................................... 11
      B.12 (Derived): Number of brief awakenings ............................................................................ 12
      B.13 (Derived): Awakening rate per hour ................................................................................... 12
      B.14 (Derived): Sleep fragmentation rate ................................................................................... 12
      B.15 (Derived): Number of dozing episodes ............................................................................... 12
   C. Terms Derived from Basic Features of Wakefulness and Sleep As They Relate to the Sleep Episode and Temporal Surround .................................................................................. 12
      C.1 (Elemental): Initial Sleep Onset Time ...................................................................................... 12
      C.2 (Elemental): Final Awakening Time ....................................................................................... 12
      C.3 (Derived): Latency to sleep onset .......................................................................................... 12
      C.4 (Derived): Latency to arising .............................................................................................. 13
      C.5 (Derived): Sleep efficiency percentage ................................................................................. 13
   D. Specific Terms Describing Processes Occurring During Sleep Based on Polysomnography ........... 13
      D.1 (Elemental): REM Sleep ........................................................................................................ 13
      D.2 (Elemental): N1 .................................................................................................................. 13
      D.3 (Elemental): N2 .................................................................................................................. 13
      D.4 (Elemental): N3 .................................................................................................................. 13
      D.5 (Elemental): CNS Arousal .................................................................................................. 14
      D.6 (Derived): Number of CNS arousals .................................................................................... 14
      D.7 (Derived): CNS arousal rate per hour .................................................................................. 14
      D.8 (Derived): REM sleep duration, percentage, and latency from sleep onset ........................... 14
      D.9 (Derived): N1 Sleep duration, percentage, and latency from sleep onset ............................... 14
      D.10 (Derived): N2 Sleep duration, percentage, and latency from sleep onset ............................. 14
      D.11 (Derived): N3 Sleep duration, percentage, and latency from sleep onset ............................. 14
   E. Alternate terms for subdividing sleep into different processes ....................................................... 15
E.1 (Elemental): Dream sleep ................................................................. 15
E.2 (Elemental): Core Sleep .............................................................. 15
E.3 (Elemental): Sound Sleep ............................................................ 15
E.4 (Elemental): Restless Sleep ......................................................... 15
E.5 (Derived): Total dream sleep (Duration and Percentage) ................. 16
E.6 (Derived): Total core sleep (Duration and Percentage) .................. 16
E.7 (Derived): Total sound Sleep (Duration and Percentage) ............... 16
E.8 (Derived): Total restless Sleep (Duration and Percentage) ............... 16
F. Terms used to describe the sleep-wake cycle over time periods exceeding 7 days ........ 16
   F.1 (Elemental): Circadian Amplitude ............................................. 16
   F.2 (Elemental): Circadian Period length (tau) ............................ 16
   F.3 (Elemental): Circadian Phase (phi) ........................................... 16
   F.4 (Derived): Relative duration of the active period compared to the dormant period........ 17
Definitions and Characteristics for Wearable Sleep Monitors

1. Scope and Disclaimer

This voluntary standard defines terms used to describe sleep and indicates, where appropriate, the functionality necessary in a consumer sleep measuring device to measure those characteristics. This standard provides definitions of sleep features terminology recommended for wearable sleep monitoring consumer products. This standard does not provide operational definitions for terminology used for medical devices. Furthermore, it is acknowledged that not all compliant products will include features to meet every sleep feature, but the ones that it does claim such will meet the respective requirements.

Terminology covered in this document falls into six general categories (A-F) as shown on the Table 1.

<table>
<thead>
<tr>
<th>Terminology Category</th>
<th>Elemental Measure</th>
<th>Derived Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>C</strong> Terms derived from basic features of wakefulness, sleep as they relate to the sleep episode and its surround</td>
<td>1. Initial sleep onset time 2. Final awakening time</td>
<td>3. Latency to sleep onset 4. Latency to arising 5. Sleep efficiency %</td>
</tr>
<tr>
<td><strong>E</strong> Alternate terms for subdividing sleep into different processes</td>
<td>1. Dream sleep 2. Core Sleep 3. Sound Sleep 4. Restless Sleep</td>
<td>Duration and percentage for each of the following: 5. Dream sleep 6. Core sleep 7. Sound Sleep 8. Restless sleep % of TST</td>
</tr>
</tbody>
</table>