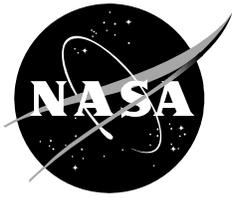


NASA/TM-2010-216117



# Heart Rate Sensor Technology Recommendations White Paper

*Duncan Atchison  
Lockheed Martin  
Houston, Texas*

*Lesley Lee  
Wyle  
Houston, Texas*

*The Constellation EVA Space Medicine Working Group  
NASA Lyndon B. Johnson Space Center  
Houston, Texas*

National Aeronautics and  
Space Administration

Johnson Space Center  
Houston, TX 77058

---

March 2010

## NASA STI Program ... in Profile

Since its founding, NASA has been dedicated to the advancement of aeronautics and space science. The NASA scientific and technical information (STI) program plays a key part in helping NASA maintain this important role.

The NASA STI program operates under the auspices of the Agency Chief Information Officer. It collects, organizes, provides for archiving, and disseminates NASA's STI. The NASA STI program provides access to the NASA Aeronautics and Space Database and its public interface, the NASA Technical Report Server, thus providing one of the largest collections of aeronautical and space science STI in the world. Results are published in both non-NASA channels and by NASA in the NASA STI Report Series, which includes the following report types:

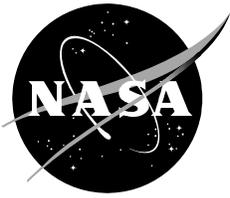
- **TECHNICAL PUBLICATION.** Reports of completed research or a major significant phase of research that present the results of NASA Programs and include extensive data or theoretical analysis. Includes compilations of significant scientific and technical data and information deemed to be of continuing reference value. NASA counterpart of peer-reviewed formal professional papers but has less stringent limitations on manuscript length and extent of graphic presentations.
- **TECHNICAL MEMORANDUM.** Scientific and technical findings that are preliminary or of specialized interest, e.g., quick release reports, working papers, and bibliographies that contain minimal annotation. Does not contain extensive analysis.
- **CONTRACTOR REPORT.** Scientific and technical findings by NASA-sponsored contractors and grantees.

- **CONFERENCE PUBLICATION.** Collected papers from scientific and technical conferences, symposia, seminars, or other meetings sponsored or co-sponsored by NASA.
- **SPECIAL PUBLICATION.** Scientific, technical, or historical information from NASA programs, projects, and missions, often concerned with subjects having substantial public interest.
- **TECHNICAL TRANSLATION.** English-language translations of foreign scientific and technical material pertinent to NASA's mission.

Specialized services also include creating custom thesauri, building customized databases, and organizing and publishing research results.

For more information about the NASA STI program, see the following:

- Access the NASA STI program home page at <http://www.sti.nasa.gov>
- E-mail your question via the Internet to [help@sti.nasa.gov](mailto:help@sti.nasa.gov)
- Fax your question to the NASA STI Help Desk at 443-757-5803
- Phone the NASA STI Help Desk at 443-757-5802
- Write to:  
NASA STI Help Desk  
NASA Center for AeroSpace Information  
7115 Standard Drive  
Hanover, MD 21076-1320



# Heart Rate Sensor Technology Recommendations White Paper

*Duncan Atchison  
Lockheed Martin  
Houston, Texas*

*Lesley Lee  
Wyle  
Houston, Texas*

*The Constellation EVA Space Medicine Working Group  
NASA Lyndon B. Johnson Space Center  
Houston, Texas*

National Aeronautics and  
Space Administration

Johnson Space Center  
Houston, TX 77058

Available from:

NASA Center for AeroSpace Information  
7115 Standard Drive  
Hanover, MD 21076-1320  
Phone: 301-621-0390 or  
Fax: 301-621-0134

National Technical Information Service  
5285 Port Royal Road  
Springfield, VA 22161  
703-605-6000

This report is also available in electronic form at <http://ston.jsc.nasa.gov/collections/TRS/>



REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.				
1. AGENCY USE ONLY (Leave Blank)	2. REPORT DATE March 2010	3. REPORT TYPE AND DATES COVERED Technical Memorandum		
4. TITLE AND SUBTITLE Heart Rate Sensor Technology Recommendations White Paper			5. FUNDING NUMBERS	
6. AUTHOR(S) Ducan Atchison*; Lesley Lee**; The Constellation EVA Space Medicine Working Group***				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) *Lockheed Martin, Houston; **Wyle, Houston; ***Lyndon B. Johnson Space Center, Houston			8. PERFORMING ORGANIZATION REPORT NUMBERS S-1062	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) National Aeronautics and Space Administration Washington, DC 20546-0001			10. SPONSORING/MONITORING AGENCY REPORT NUMBER TM-2010-216117	
11. SUPPLEMENTARY NOTES *NASA Johnson Space Center				
12a. DISTRIBUTION/AVAILABILITY STATEMENT Classified/Limited Available from the NASA Center for AeroSpace Information (CASI) 7115 Standard Drive Hanover, MD 21076-1320 Category: 54			12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words)  This paper presents results of preliminary engineering evaluations of various heart rate (HR) sensors and recommends technologies for further evaluation by the extravehicular activity (EVA) suit contractor. It focuses on sensor type, location, and implementation, allowing quick and easy don/doff while providing the best chance for meeting HR performance requirements. Included are lessons learned from previous market studies and testing at the National Center for Human Performance, Ames Research Center, Johnson Space Center, and Glenn Research Center, and during Small Business Innovation Research studies. While many studies were originally performed on electrocardiogram systems, many applicable lessons can be taken for HR sensor performance – assuming the more accurate the R-wave captured, the more accurate the HR calculation. Although this paper addresses sensor selection, it is important to note that overall performance is tied to the entire system's configuration. Artifact rejection and return of signal quality after motion artifact depends on interaction of the signal conditioning/pulse detection circuitry and the electrodes themselves. Cables and connectors can be a considerable source of noise. Many commercial off-the-shelf systems mentioned in this paper have proprietary systems for noise and motion artifact reduction; this too will need to be considered by the EVA suit contractor.				
14. SUBJECT TERMS heart rate; sensors, bioinstrumentation; extravehicular activity; electrocardiography; space suits			15. NUMBER OF PAGES 26	16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT Limited	



---