

UNCLASSIFIED WITH SPECIAL HANDLING**SECURITY SUMMARY & SPECIAL HANDLING REQUIREMENTS**

It is your responsibility to ensure that each page of this application is marked in accordance with the procedures in your security manual. The following summaries are provided for that purpose.

APPLICATION TITLE: (U) Sand Flea Ground Robot
OVERALL CLASSIFICATION: UNCLASSIFIED
SPECIAL HANDLING: B - Releasable to soil country and NATO; otherwise, not releasable outside the US Government IAW Section 552(b)(1) of Title 5 of the US Code.

DERIVATIVE CLASSIFICATION(S):
ORIGINAL CLASSIFICATION AUTHORITY:
REASON(S) FOR CLASSIFICATION:
DECLASSIFICATION INSTRUCTIONS:
DECLASSIFICATION DATE:
DECLASSIFICATION EVENT:
DOWNGRADING CLASSIFICATION:
DOWNGRADING DATE:

SECTION	STARTING PAGE #	CLASSIFICATION
DOD GENERAL INFORMATION	1	UNCLASSIFIED
TRANSMITTER EQUIPMENT CHARACTERISTICS #1	3	UNCLASSIFIED
RECEIVER EQUIPMENT CHARACTERISTICS #1	4	UNCLASSIFIED
RECEIVER EQUIPMENT CHARACTERISTICS #2	5	UNCLASSIFIED
ANTENNA EQUIPMENT CHARACTERISTICS #1	6	UNCLASSIFIED
ANTENNA EQUIPMENT CHARACTERISTICS #2	7	UNCLASSIFIED
ANTENNA EQUIPMENT CHARACTERISTICS #3	8	UNCLASSIFIED
NTIA GENERAL INFORMATION	9	UNCLASSIFIED

UNCLASSIFIED WITH SPECIAL HANDLING

APPLICATION FOR EQUIPMENT FREQUENCY ALLOCATION		CLASSIFICATION UNCLASSIFIED WITH SPECIAL HANDLING	DATE 22 May 2012	
			Page 1 of 10	
DOD GENERAL INFORMATION				
TO	DISA DSO / Army Spectrum Management Office ATTN: Plans Branch P.O. Box 549 Ft. Meade, MD 20755-0549		FROM	U.S. Army, Rapid Equipping Force (REF) 10236 Burbeck Road Ft. Belvoir, VA 22060-5852
1. APPLICATION TITLE (U) Sand Flea Ground Robot				
2. SYSTEM NOMENCLATURE (U) Boston Dynamics "Sand Flea" Ground Robot *(See Remarks)				
3. STAGE OF ALLOCATION (U) ☐ a. STAGE 1 CONCEPTUAL ☐ b. STAGE 2 EXPERIMENTAL ☒ c. STAGE 3 DEVELOPMENTAL ☐ d. STAGE 4 OPERATIONAL				
4. FREQUENCY REQUIREMENTS *(See Remarks)				
a. FREQUENCY(IES) (U)		b. EMISSION DESIGNATORS (U)		
2.32 GHz - 2.37 GHz		280KF1D (Hopping)		
1575.42 MHz		24M0G7X (Non-Hopping)		
5. TARGET STARTING DATE FOR SUBSEQUENT STAGES				
a. STAGE 2 (U) NA		b. STAGE 3 (U) NA		c. STAGE 4 (U) 1 MAR 2013
6. EXTENT OF USE (U) Intermittent (4 to 12 hours daily)				
7. GEOGRAPHICAL AREA FOR				
a. STAGE 2 (U) NA				
b. STAGE 3 (U) Aberdeen Proving Ground, Maryland Yuma Proving Ground, Arizona				
c. STAGE 4 (U) Deployment in CENTCOM theater. Locations are classified. Aberdeen Proving Ground, Maryland Yuma Proving Ground, Arizona Deployment TBD.				
8. NUMBER OF UNITS				
a. STAGE 2 (U) NA		b. STAGE 3 (U) 7		c. STAGE 4 (U) 7
9. NUMBER OF UNITS OPERATING SIMULTANEOUSLY IN THE SAME ENVIRONMENT (U) 7				
10. OTHER J/F 12 APPLICATION ID(S) TO BE			11. IS THERE ANY OPERATIONAL REQUIREMENT AS DESCRIBED IN THE INSTRUCTIONS FOR PARAGRAPH 11?	
a. SUPERSEDED (U) NA			(U) ☐ a. YES ☐ b. NO ☒ c. NAVAIL	
b. RELATED (U) NA				

DOWNGRADING INSTRUCTIONS	
	CLASSIFICATION UNCLASSIFIED WITH SPECIAL HANDLING

DOD GENERAL INFORMATION**12. NAMES AND TELEPHONE NUMBERS****a. PROGRAM MANAGER (U)**

NAME Gary Frost, Chief, Technology
Management Division
COMMERCIAL 703-704-9497
DSN NA
EMAIL garland.frost@conus.army.mil

b. PROJECT ENGINEER (U)

NAME Gary Frost
COMMERCIAL 703-704-9497
DSN NA
EMAIL garland.frost@conus.army.mil

13. REMARKS

(U) Item 2:
The "Sand Flea" ground robot contains a GPS receiver and a radio modem.
The Sand Flea ground robot communicates with an Operator Control Unit (OCU) which uses the same model radio modem as the robot.

This application is for the entire system:
one each GPS Receiver (in robot)
two MicroHard radio modems (one in robot, one in OCU)

(U) Item 4:
1. The MicroHard IPnDDL2350 radio modem is a new product. Exact details and specifications for this model were not available at the time of this application. Details from a similar MicroHard radio modem are provided here. After details are released any variations from those entered at this time will be updated.

2. GPS receiver: This uses L1 GPS frequency.

(U) Other Contacts:
MAJ Paul Bushey
AEC, APG, MD 21005
Phone: 931-338-0093 email: paul.bushey@us.army.mil

Mr. Miles S. Thompson (Technical Onsite Contact)
GTRI-Aerospace, Transportation and Advanced Systems Laboratory
7220 Richardson Rd, SE
Smyrna, GA 30080
Phone: 404-407-7837 email: miles.thompson@gtri.gatech.edu

Mr. David A. Price (Technical Contact--composed form)
GTRI-Aerospace, Transportation and Advanced Systems Laboratory
7220 Richardson Rd, SE
Smyrna, GA 30080
Phone: 404-407-7105 email: dave.price@gtri.gatech.edu

Mr. Christian Weagle
Robotician
Boston Dynamics
78 Fourth Ave
Waltham, MA 02451
Phone: 617-868-5600 email: cweagle@bostondynamics.com

Dr. Ai-Ping Hu
GTRI-Aerospace, Transportation and Advanced Systems Laboratory
FPT Division
Atlanta, GA 30332
Phone: 404-407-8815 email: ai-ping.hu@gtri.gatech.edu

(U) DOD General Information Remarks:
The "Sand Flea" ground robot may be operated singly or with other similar robots.
In the case of multiple robot use, different RF channels and hopping schemes can be selected to provide frequency de-confliction between robots.

TRANSMITTER EQUIPMENT CHARACTERISTICS**1. NOMENCLATURE, MANUFACTURER'S MODEL NO.**

(U) RF Modem, Model IPnDDL2350 *(See Remarks)

2. MANUFACTURER'S NAME

(U) Microhard Systems, Inc.

3. TRANSMITTER INSTALLATION (U)

inside a ground robot; inside an Operator Control Unit (OCU)

4. TRANSMITTER TYPE

(U) Spread Spectrum Communications

5. TUNING RANGE (U)

2.32 GHz - 2.37 GHz

6. METHOD OF TUNING

(U) PLL Synthesizer *(See Remarks)

7. RF CHANNELING CAPABILITY (U) 2.32 to 2.37 GHz with less than 100 Hz increments**8. EMISSION DESIGNATOR (U)** 280KF1D**12. EMISSION BANDWIDTH (U)****a. -3 dB****b. -20 dB****c. -40 dB****d. -60 dB****e. OC-BW**☐

Calculated

☒

Measured

150 kHz

280 kHz

540 kHz

1100 kHz

290 kHz

13. MAXIMUM BIT RATE (U)

12 Mbps

14. MODULATION TECHNIQUES AND CODING (U)

Modulation is CPFSK.

15. MAXIMUM MODULATION FREQUENCY (U) 116 kHz**17. DEVIATION RATIO (U)** 2**18. PULSE CHARACTERISTICS****a. RATE****b. WIDTH****c. RISE TIME****d. FALL TIME****e. COMP RATIO**

(U)

(U)

(U)

(U)

(U)

NA

NA

NA

NA

NA

19. POWER**a. MEAN (U)** 1 W**b. PEP (U)** 1 W**9. FREQUENCY TOLERANCE (U)** 3 ppm**10. FILTER EMPLOYED**(U) ☒ a. YES ☐ b. NO *(See Remarks)**11. SPREAD SPECTRUM**(U) ☒ a. YES ☐ b. NO**16. PRE-EMPHASIS**(U) ☐ a. YES ☒ b. NO**20. OUTPUT DEVICE**

(U) HBT

22. SPURIOUS LEVEL

(U) -60 dB

21. HARMONIC LEVEL**a. 2nd (U)** -54 dB**b. 3rd (U)** -54 dB**c. OTHER (U)** -60 dB**23. FCC TYPE ACCEPTANCE NO.**

(U) NA

24. REMARKS

(U) Item 1:

RF Modem, Model IPnDDL2350, manufacturer: Microhard Systems, Inc.

(U) Item 6:

This radio can be used in a fixed frequency mode or a frequency hopping mode where 50 frequencies can be programmed into the radio in less than 100 Hz resolution between 2.32 to 2.37 GHz.

(U) Item 10:

NA

CLASSIFICATION UNCLASSIFIED WITH SPECIAL HANDLING				Page 4 of 10	
RECEIVER EQUIPMENT CHARACTERISTICS					
1. NOMENCLATURE, MANUFACTURER'S MODEL NO. (U) Radio Modem, IPnDDL2350			2. MANUFACTURER'S NAME (U) Microhard Systems, Inc.		
3. RECEIVER INSTALLATION (U) inside a ground robot; inside an Operator Control Unit (OCU) Receiver is integral to the IPnDDL2350 which also includes the companion transmitter, enabling two-way communication.			4. RECEIVER TYPE (U) Dual Conversion Superheterodyne		
5. TUNING RANGE (U) 2.32 GHz - 2.37 GHz			6. METHOD OF TUNING (U) PLL Synthesizer		
7. RF CHANNELING CAPABILITY (U) 2.32 to 2.37 GHz with under 100 Hz increments			8. EMISSION DESIGNATORS (U) 280KF1D		
9. FREQUENCY TOLERANCE (U) 3 ppm			11. RF SELECTIVITY ☐ Calculated ☒ Measured		
10. IF SELECTIVITY	1st (U)	2nd (U)	3rd (U)	a. -3 dB (U) 400 kHz b. -20 dB (U) 600 kHz c. -60 dB (U) 2.4 MHz d. Preselection Type (U) Front end LC filter	
a. -3 dB	1.15 MHz	280 kHz	NA		
b. -20 dB	3.40 MHz	650 kHz	NA		
c. -60 dB	16 MHz	1.25 MHz	NA		
12. IF FREQUENCY a. 1st (U) 110.6 MHz b. 2nd (U) 10.7 MHz c. 3rd (U) NA			13. MAXIMUM POST DETECTION FREQUENCY (U) 87 kHz		
			14. MINIMUM POST DETECTION FREQUENCY (U) 58 kHz		
15. OSCILLATOR TUNED	1st (U)	2nd (U)	3rd (U)	17. SENSITIVITY	
a. ABOVE TUNED FREQUENCY		X	NA	a. SENSITIVITY (U) -108 dBm	
b. BELOW TUNED FREQUENCY			NA	b. CRITERIA (U) 10E-4 BER	
c. EITHER ABOVE OR BELOW THE FREQUENCY	X		NA	c. NOISE FIG (U) 5 dB	
16. MAXIMUM BIT RATE (U) 230.4 kbps			d. NOISE TEMP (U) NA		
18. DE-EMPHASIS (U) ☐ a. YES ☒ b. NO			19. IMAGE REJECTION (U) 50 dB		
			20. SPURIOUS REJECTION (U) 60 dB		
21. REMARKS 					

CLASSIFICATION UNCLASSIFIED WITH SPECIAL HANDLING				Page 5 of 10	
RECEIVER EQUIPMENT CHARACTERISTICS					
1. NOMENCLATURE, MANUFACTURER'S MODEL NO. (U) GPS Receiver *(See Remarks)			2. MANUFACTURER'S NAME (U) Microstrain		
3. RECEIVER INSTALLATION (U) inside the "Sand Flea" ground robot			4. RECEIVER TYPE (U) Dual Conversion Superheterodyne		
5. TUNING RANGE (U) 1575.42 MHz			6. METHOD OF TUNING (U) Fixed Crystal		
7. RF CHANNELING CAPABILITY (U) NA			8. EMISSION DESIGNATORS (U) 24M0G7X		
9. FREQUENCY TOLERANCE (U) 0.001 ppm			11. RF SELECTIVITY ☐ Calculated ☒ Measured		
10. IF SELECTIVITY	1st (U)	2nd (U)	3rd (U)	a. -3 dB (U) 32 MHz b. -20 dB (U) 70 MHz c. -60 dB (U) 140 MHz d. Preselection Type (U) SAW filter	
a. -3 dB	26 MHz	24 MHz	NA		
b. -20 dB	35 MHz	30 MHz	NA		
c. -60 dB	50 MHz	33 MHz	NA		
12. IF FREQUENCY a. 1st (U) 175.42 MHz b. 2nd (U) 35.42 MHz c. 3rd (U) NA				13. MAXIMUM POST DETECTION FREQUENCY (U) 24 MHz	
				14. MINIMUM POST DETECTION FREQUENCY (U) 2.0 MHz	
15. OSCILLATOR TUNED	1st (U)	2nd (U)	3rd (U)	17. SENSITIVITY	
a. ABOVE TUNED FREQUENCY		X	NA	a. SENSITIVITY (U) -130 dBm	
b. BELOW TUNED FREQUENCY			NA	b. CRITERIA (U) C/noise 38 dB-Hz	
c. EITHER ABOVE OR BELOW THE FREQUENCY	X		NA	c. NOISE FIG (U) 5 dB	
16. MAXIMUM BIT RATE (U) 50 bps				d. NOISE TEMP (U) 600 Kelvin	
18. DE-EMPHASIS (U) ☐ a. YES ☒ b. NO				19. IMAGE REJECTION (U) 60 dB	
				20. SPURIOUS REJECTION (U) 60 dB	
21. REMARKS (U) Item 1: This receiver is integral to the Microstrain Inertial Measurement Unit (IMU) Model No. 3DM-GX3-35) (U) Receiver Remarks: Item 15. Max Bit Rate: The GPS signal is a spread-spectrum structure with a chipping rate of 10.23 MHz. The carrier at L1 (1575.42 MHz) is modulated with a 50 bit/second Navigation message data stream. Item 17b. Criteria: L1 C/A code modulated signal of -130 dBm at RF input will produce an output carrier-to-noise value of 38 dB-Hz.					

ANTENNA EQUIPMENT CHARACTERISTICS

1. (U) ☐ a. TRANSMITTING ☐ b. RECEIVING ☒ c. TRANSMITTING AND RECEIVING
*(See Remarks)

2. NOMENCLATURE, MANUFACTURER'S MODEL NO.

(U) Antenna, comms *(See Remarks)

3. MANUFACTURER'S NAME

(U) Georgia Tech Research Institute

5. TYPE

(U) Patch

4. FREQUENCY RANGE (U)

2.32 GHz - 2.36 GHz

6. POLARIZATION (U)

Vertical linear

8. GAIN

a. MAIN BEAM (U) 1.0 dBi

b. 1st MAJOR SIDE LOBE

(1) 1st Side Lobe: (U) NA

(2) Angular Position: (U) NA

9. BEAMWIDTH

a. HORIZONTAL: (U) 360 degrees

b. VERTICAL: (U) 60 degrees

7. SCAN CHARACTERISTICS

a. TYPE (U) fixed

b. VERTICAL SCAN (U) Fixed (No Scan)

(1) Max Elev (U) NA

(2) Min Elev (U) NA

(3) Scan Rate (U) NA

c. HORIZONTAL SCAN (U) Fixed (No Scan)

(1) Sector Scanned (U) NA

(2) Scan Rate (U) NA

d. SECTOR BLANKING (U) ☐ (1) YES ☒ (2) NO

10. REMARKS

(U) Item 1:

The RF modem uses a common antenna for two-way communication. The antenna is separate from the IPnDDL2350 radio modem.

This antenna is a conformal patch antenna attached to the ground robot.

(U) Item 2:

the antenna is an experimental patch antenna developed by GTRI

CLASSIFICATION UNCLASSIFIED WITH SPECIAL HANDLING	Page 7 of 10
ANTENNA EQUIPMENT CHARACTERISTICS	
1. (U) ☐ a. TRANSMITTING ☐ b. RECEIVING ☒ c. TRANSMITTING AND RECEIVING *(See Remarks)	
2. NOMENCLATURE, MANUFACTURER'S MODEL NO. (U) Dipole Antenna, ANT-2.4-CW-HWR-SMA *(See Remarks)	
3. MANUFACTURER'S NAME (U) Antenna Factor	5. TYPE (U) Dipole
4. FREQUENCY RANGE (U) 2.3 GHz - 2.6 GHz	6. POLARIZATION (U) Vertical linear
8. GAIN a. MAIN BEAM (U) 2.1 dBi b. 1st MAJOR SIDE LOBE (1) 1st Side Lobe: (U) NA (2) Angular Position: (U) NA	7. SCAN CHARACTERISTICS a. TYPE (U) fixed b. VERTICAL SCAN (U) Fixed (No Scan) (1) Max Elev (U) NA (2) Min Elev (U) NA (3) Scan Rate (U) NA c. HORIZONTAL SCAN (U) Fixed (No Scan) *(See Remarks) (1) Sector Scanned (U) 90 degrees (2) Scan Rate (U) NA d. SECTOR BLANKING (U) ☐ (1) YES ☒ (2) NO
9. BEAMWIDTH a. HORIZONTAL: (U) 360 degrees b. VERTICAL: (U) 60 degrees	
10. REMARKS (U) Item 1: This antenna is located on the Operator Control Unit (OCU) (U) Item 2: This is a center-fed dipole antenna to be used on the OCU. (U) Item 7c: the antenna features a flexible joint at its base allowing the antenna to be oriented within a 90 deg range	

CLASSIFICATION UNCLASSIFIED WITH SPECIAL HANDLING	Page 8 of 10
ANTENNA EQUIPMENT CHARACTERISTICS	
1. (U) ☐ a. TRANSMITTING ☒ b. RECEIVING ☐ c. TRANSMITTING AND RECEIVING *(See Remarks)	
2. NOMENCLATURE, MANUFACTURER'S MODEL NO. (U) GPS Antenna, Model SGP.25c	
3. MANUFACTURER'S NAME (U) Taoglas Limited	5. TYPE (U) Patch
4. FREQUENCY RANGE (U) 1575.42 MHz *(See Remarks)	6. POLARIZATION (U) Right-hand circular
8. GAIN a. MAIN BEAM (U) 4 dBi b. 1st MAJOR SIDE LOBE (1) 1st Side Lobe: (U) NA (2) Angular Position: (U) NA	7. SCAN CHARACTERISTICS a. TYPE (U) fixed b. VERTICAL SCAN (U) Fixed (No Scan) (1) Max Elev (U) NA (2) Min Elev (U) NA (3) Scan Rate (U) NA c. HORIZONTAL SCAN (U) Fixed (No Scan) (1) Sector Scanned (U) NA (2) Scan Rate (U) NA d. SECTOR BLANKING (U) ☐ (1) YES ☒ (2) NO
9. BEAMWIDTH a. HORIZONTAL: (U) 180 degrees b. VERTICAL: (U) 60 degrees	
10. REMARKS (U) Item 1: This is a GPS antenna used with the MicroHard RF modem (U) Item 4: This antenna is for L1 band GPS only	