30-2000 MHz Multi-band Body Wearable Antenna (MBWA)

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***Abstract*— A Multi-band Body Wearable Antenna (MBWA) has been designed to cover six communications bands: SINCGARS band (30 MHz-88 MHz), Air & Marine band (116 MHz–174 MHz), UHF band (225 MHz– 450 MHz), UHF-Public Safety band (450 MHz-512 MHz), UHF SATCOM band (225 MHz-318 MHz) and Soldier Radio Waveform (1-2 GHz). The MBWA can also be remoted from the radio and the soldier to enhance communications range in heavily forested or triple canopy jungle environments. A breadboard model has been developed and preliminary tests at WEO had fairly good results, reaching TRL-4.**

Keywords—Wearable antenna, broadband antenna, multi-band antenna, traveling wave antenna.

I. Introduction

During 1996-2006, the US Army sponsored research at WEO on body wearable antennas of the helmet and vest types for the ever-expanding communications bands [1]-[2]. Since 2010 WEO has been conducting IR&D on broadbanding antennas energized by the explosive growth of smartphones/tablets and their evolution from 4G to 5G. This paper presents preliminary results of a six-month effort sponsored by U.S. Army to develop a Multi-band Body Wearable Antenna (MBWA) that can operate efficiently in all six bands summarized in Table I, for radios fielded.

TABLE I. SIX FUNCTIONS (BANDS) REQUIRED FOR MBWA.

System served	Freq. (MHz)	Pol	Pattern	Sat/Ter	Tx/Rx
SINCGARS	30-88	LP	Omni	Terrestr	**Tx/Rx**
Air & Marine	116-174	LP	Omni	Terrestr	**Tx/Rx**
UHF Comm.	225-450	LP	Omni	Terrestr	**Tx/Rx**
UHF-Public Safety	450-512	LP	Omni	Terrestr	**Tx/Rx**
UHF SATCOM	225-318	RHCP	Hemisph	Satellite	**Tx/Rx**
L-Band (SRW)	1000-2000	LP	Omni	Terrestr	**Tx/Rx**

Additional requirements for this MBWA are: (1) has only one or two input/output connectors to the radio, (2) can be remoted from the radio and the soldier (i.e.: hoisted into a tree) to provide increased communications range in heavily forested or triple canopy jungle environments.

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II. Design Approach

The technical approach is based on the newest Traveling-Wave Antenna (TWA) technology [3]-[6]. The MBWA is divided into two parts, LP and RHCP, as follows:

(1) LP (linear polarization) MBWA: for omnidirectional terrestrial coverage over five frequency bands (essentially continuous);
(2) RHCP (right-hand circularly polarization) MBWA: for UHF SATCOM hemispherical coverage.

The MBWA has two input connectors: one for LP MBWA and the other for RHCP UHF SATCOM.

The MBWA has two modes of state: (1) Carrying and stowed, (2) Operating.

III. The MBWA Breadboard Model.

A. *LP MBWA for terrestrial coverage*

The LP MBWA is a utilitarian ensemble akin to the Swiss knife, hand axe, and ropes for the seasoned mountaineer. Fig. 1 shows the LP MBWA ensemble in a camouflage bag placed beside an Army handheld radio (AN/PRC-152) to show its size and shape. The LP MBWA, with a **total weight of about 1.5 Kg**, covers all five LP bands (30 to 2000 MHz) contiguously with omnidirectional pattern coverage.

Fig. 1. LP MBWA ensemble for omnidirectional coverage in a camouflage bag beside an Army multiband radio AN/PRC-152.

Fig. 2 displays the LP MBWA in operating state for LP terrestrial coverage. It is fully opened laying on the ground. Near the center is the TWA launcher, which is the prime mover of the LP MBWA ensemble and shown in more details in Fig. 3. There are eight (8) extended conducting wires which serve to create a "ground plane" (GP) of about 10 meters in diameter.

The TWA launcher is a two-stage mode-0 TWA based on [3]-[5]. For frequencies above 225 MHz, the TWA launcher alone is adequate to function as an LP MBWA.

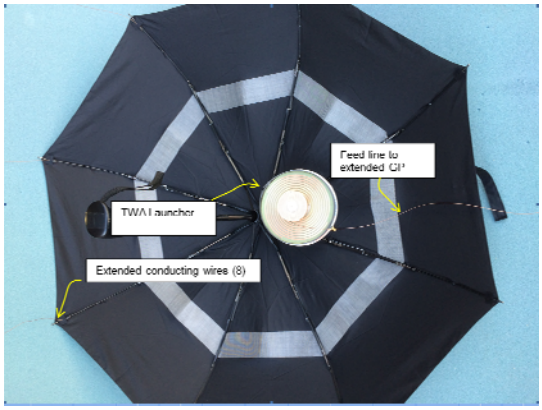

Fig. 2. LP MBWA ensemble in operation for 30-2000 MHz.

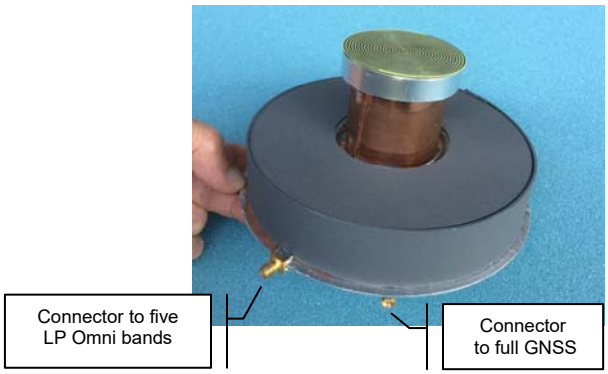

Fig. 3. The TWA Launcher as the prime mover of the LP MBWA ensemble.

For remoting from the radio and the soldier (i.e.: hoisted into a tree) to provide increased communications range in heavily forested or triple canopy jungle environments, one can raise the 1.5-Kg LP MBWA with a small roped gear.

B. RHCP MBWA

The RHCP MBWA for UHF SATCOM is a mode-1 2-D TWA. It is carried in a separate camouflage bag not shown here, with a total weight of about 0.7 Kg. Covering 225 MHz–450 MHz, the current model is 64 cm in diameter, but weighs only 0.5 Kg. It can be modified to a foldable configuration of about the same weight but small enough to be contained in a bag about 64cm×30cm×15cm in size.

IV. Preliminary Test Results

All performance tests were carried out with the MBWA in the transmit. At frequencies above 100 MHz, conventional antenna tests was conducted in WEO's anechoic chamber. The SWR and gain patterns for LP MBWA were fairly good for the three high bands, and marginal for the Air & Marine band.

For the 30-88 MHz SINCGARS band, though low SWR is a necessary condition for good performance, yet it could be misleading. Therefore, at SINCGARS band "field tests" were employed for performance demonstration.

An Anritsu 37347C Vector Network Analyzer was used as the transmitter feeding the LP MBWA, the signal strength at a far-field location in a distant separate room in the same building was measured on an Anritsu 2601B Spectrum Analyzer via a standard-gain dipole antenna EMCO model 3121C. The relative performance of LP MBWA is obtained by comparing that of a 1.24-m Thales Whip Blade Antenna for 30-90 MHz and the 0.343-m whip of AN/PRC-152 multiband handheld Radio above 90 MHz. As can be seen in Table II, the LP MBWA performed as well as the 1.24-m Thales Whip.

TABLE II. Measured Relative Signal Strength for MBWA.

Measured Relative Signal Strength
WEO MBWA VS. Thales 1.24 Meter Whip Antenna

	P_{WEO} (WEO MBWA)	P_{Thales} (Thales 1.24 Meter Whip)		P_{WEO}/P_{Thales} (WBWA/Thales)
40 MHz	-45 dB	VP	-42 dB	-3 dB
		HP	-48 dB	3 dB
	HP only	45˚ angle	-56 dB	11 dB
50 MHz	-51 dB	VP	-52 dB	1 dB
		HP	-52 dB	1 dB
	HP only	45˚ angle	-55 dB	4 dB
60 MHz	-48 dB	VP	-50 dB	2 dB
		HP	-52 dB	4 dB
	HP only	45˚ angle	-62 dB	14 dB
70 MHz	-51 dB	VP	-50 dB	-1 dB
		HP	-47 dB	-4 dB
	HP only	45˚ angle	-48 dB	-3 dB
80 MHz	-62 dB	VP	-66 dB	4 dB
		HP	-63 dB	1 dB
	HP only	45˚ angle	-68 dB	6 dB
90 MHz	-82 dB	VP	-80 dB	-2 dB
		HP	-76 dB	-6 dB
	HP only	45˚ angle	-75 dB	-7 dB

The RHCP MBWA was tested in WEO anechoic chamber with fair results.

V. Conclusions

A breadboard model for MBWA has been developed and tested successfully at WEO, reaching TRL (Technology Readiness Level) 4. The MBWA covers six communications bands quite well, ranging from 30 MHz to 2 GHz.

References

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