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PTO/SB/16 (09-04)

Approved for use through 07/31/2008. OMB 0651-0032

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This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

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Additional inventors are being named on the ONE separately numbered sheets attached hereto

**TITLE OF THE INVENTION (500 characters max):**  
**CLOSED LOOP MIMO SYSTEMS AND METHODS**

Direct all correspondence to: **CORRESPONDENCE ADDRESS**

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**ENCLOSED APPLICATION PARTS (check all that apply)**

Specification Number of Pages 12

CD(s), Number of CDs \_\_\_\_\_

Drawing(s) Number of Sheets 31

Other (specify) \_\_\_\_\_

Application Data Sheet. See 37 CFR 1.76

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Yes, the name of the U.S. Government agency and the Government contract number are: \_\_\_\_\_

FILING FEE Amount (\$) 200.00

SIGNATURE John D. Crane Date January 10, 2005

TYPED or PRINTED NAME JOHN D. CRANE REGISTRATION NO. 25,231  
 (if appropriate)

TELEPHONE 972-685-8442 Docket Number: 17546ROUS01P

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**Additional Page**

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First Named Inventor	TONG, WEN	Docket Number	17546ROUS01P
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## CLOSED LOOP MIMO SYSTEMS AND METHODS

### Field of the Invention

This invention generally relates to the field of wireless communications. More specifically the inventions relate to closed loop MIMO systems and methods.

### Background of the Invention

Known ways to facilitate wireless closed-loop MIMO communications include broadband closed-loop MIMO and narrowband closed-loop MIMO as shown in Figure 1. Broadband closed-loop MIMO includes many sub-bands. Each of these sub-bands require MIMO channel feedback. As a result the feedback resources required for broadband closed-loop MIMO can become quite large. Narrowband closed-loop MIMO, by comparison, includes one or a few sub-bands which results in smaller feedback resources being required. Broadband and narrowband MIMO, therefore, have different applications. As will be apparent to one skilled in the art of MIMO communications, MIMO channel information feedback may be used for performing beam-forming.

In narrowband MIMO environments sounding can be achieved by compressing the channel matrix information and feeding it back via a highly protected feedback channel such as CQICH. In broadband MIMO environments, however, use of the CQICH is not efficient for sounding.

A need exists for an improved system and method for providing wireless closed-loop MIMO communications.

### Summary of the Invention

It is an object of the invention to provide a closed-loop MIMO system and method that uses pilot signals to perform channel sounding.

It is an object of the invention to provide a closed-loop MIMO system and method including round trip channel sounding. In accordance with one embodiment of the invention the system and method are applied to the downlink channel. In accordance with another embodiment of the invention the system and method are applied to the uplink channel. In accordance with an embodiment of the invention the system and method are applied to both the downlink and uplink channels.

It is an object of the invention to provide a closed-loop MIMO system and method that enables a basestation to estimate the downlink or uplink channels. In accordance with an embodiment of the invention that basestation may estimate both the downlink and uplink channels.

It is an object of the invention to provide a closed-loop MIMO system and method that enables a basestation to separate the downlink or uplink channels. In accordance with an embodiment of the invention the basestation may separate the downlink and uplink channels.

It is an object of the invention to provide a closed-loop MIMO system and method including a sounding pilot arrangement.

It is an object of the invention to provide a closed-loop MIMO system and method for facilitating broad-band beam-forming.

It is an object of the invention to provide a closed-loop MIMO system and method where broad-band sounding can be performed in the frequency domain.

It is an object of the invention to provide a closed-loop MIMO system and method that enables a mobile subscriber station to send a sounding symbol and insert transponder pilot samples received from the downlink channel therein.

It is an object of the invention to provide a closed-loop MIMO system and method that is applicable to time division duplexing.

It is an object of the invention to provide a closed-loop MIMO system and method that is applicable to frequency division duplexing.

It is an object of the invention to provide a closed-loop MIMO system and method that allows calibration of the transmit and receive RF chains

### **Detailed Description of Embodiments of the Invention**

The following describes embodiments of broad-band closed loop MIMO systems and methods for use in accordance with the IEEE 802.16(e) and IEEE 802.11(n) standards which standards which are hereby incorporated by reference. The broader inventions set out in the summary and claims are not limited in this regard, however, and may be applicable to other wireless environments including those operating in accordance with the 3GPP and 3GPP2 standards.

Figure 2 shows broad-band closed loop MIMO communications in terms of time and frequency in accordance with an embodiment of the invention.

Figure 3 shows a schematic diagram of a closed-loop MIMO architecture in accordance with an embodiment of the invention including round trip pilot relay channel sounding.

Figure 4 shows a down link pilot, uplink pilot, pre-code pilot, transponder pilot construction for a SISO arrangement. As depicted therein the following set of pilots may be used for the sounding pilots: downlink pilot; uplink pilot; pre-code pilot; and

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