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POLE MOUNTED BI-DIRECTIONAL RF CONVERTER/AMPLIFIER

Background

The 2.4 GHz license-free radio band is widely used for Spread Spectrum Wireless Local Area Network (WLAN) applications. The most commonly used technology in the 2.4 GHz band are devices designed to comply with the IEEE 801.11 and 802.11b standards. These standards specify half-duplex operation in a Time Division Duplex (TDD) mode. In TDD, each radio can receive and transmit, but not at the same time. Two-way duplex communication takes place by sharing the airwaves based on time slots. One unit transmits and the other listens. Once the first unit goes off the air and switches to receive mode, the other unit is free to use the airwaves and send its data. If for some reason, two devices in communication with each other transmit at the same time, the data packets will be lost and will need to be retransmitted.

Most of these WLAN devices use the 802.11b standard. This standard defines fourteen Direct Sequence Spread Spectrum (DSSS) channels separated by five MHz, (i.e., 2412 MHz, 2517 MHz, 2422 MHz, etc.) only the first eleven of which can be used in the United States. Each channel occupies about 22 MHz of bandwidth. Therefore, at any one location (e.g., office, rooftop, or radio tower) a maximum of three 801.11b DSSS radio channels can be used – typically channels 1, 6 and 11. If channels too close to each other are used (e.g., channels 5 and 7), the sideband noise from the radiated spectrum from one transmitter will interfere with the reception of the remote client signals on other co-located radios. Thus, in most installations, no more then three 802.11b radio channels are used at any one location.

There are many manufacturers that make WLAN devices for this band and many millions of these devices have been sold worldwide. This has reduced the cost of these high-performance radio devices serving to expand their proliferation.

These WLAN devices were originally designed for indoor use to provide wireless connectivity to PCs and other devices. However, using external outdoor installations with these devices has enabled long-range outdoor applications. These devices have proliferated in recent years crowding the 2.4 GHz license-free radio band.

Also operating on this band are microwave ovens, cordless telephones, low-power video surveillance

Spread Spectrum radio devices to operate in the 5.8 GHz band thereby avoiding all the interference found on the 2.4 GHz band.

Brief Description of Drawings

Figure 1 shows a typical installation drawing with Converter Amplifier mounted near the antenna with coax cables connecting it to the DC Injector and radio transceiver

Figure 2 shows a simple block diagram illustrating how the Converter Amplifier module translates radio frequencies

Figure 3 shows the circuit elements found inside the bi-directional Converter Amplifier module

Figure 4 shows an alternate form of the Converter Amplifier where no DC Injector is required when the radio transceiver and antenna are all co-located.

Functional Description

Refer to Figure 1. In transmit mode, radio frequency (RF) signals generated in the radio device connected to Converter Amplifier **1** on 2.4 GHz band are converted to 5.8 GHz band. Likewise, when Converter Amplifier **1** is in the receive mode, received signals entering Converter Amplifier **1** in 5.8 GHz band are converted to 2.4 GHz band. Converter Amplifier **1** is a half-duplex device and automatically switches from receive to transmit mode. The device can be built to either up or down convert. In other words, the converted frequencies could be either higher or lower in frequency than the operating frequency of the radio it is connected to.

FIGURE 1

Figure 2 details the typical installation. Normally, antenna connector **21** is connected via coax cable **3** and external antenna **87** tuned to operate on to the 5.8 GHz band. In the receive mode, RF signals picked up by antenna **87** enter Converter Amplifier **1** at antenna connector **21**. They are then converted to 5.8 GHz band, amplified and fed out of Converter Amplifier **1** at radio connector **20** to DC (direct current) Power Injector **2**. The converted RF signal travels down coax cable **4** to DC Power Injector **2** through RF connector **72**. The signal then passes through DC Power Injector **2**, out RF connector **60** and to Transceiver Radio **6** thru the second coax cable **9** attached to Transceiver Radio **6**.

When Transceiver Radio **6** goes into the transmit mode, RF energy from radio **6** travels the same path. The signal passes from radio **6** through coax cable **9** in RF connector **60** to DC Power Injector **2** on through coax cable **4** to Converter Amplifier **1** through radio connector **20**. The signal is then converted to 5.8 GHz band, amplified and fed out of Converter Amplifier **1** at antenna connector **21** to external antenna **87** via coax cable **3**.

DC Power Injector **2** serves the primary purpose of injecting DC power onto coax cable **4** to power the electronics in Converter Amplifier **1**. Additionally, DC Power Injector **2** offers lightning and power surge protection as well as LEDs to show the operational status of the system.

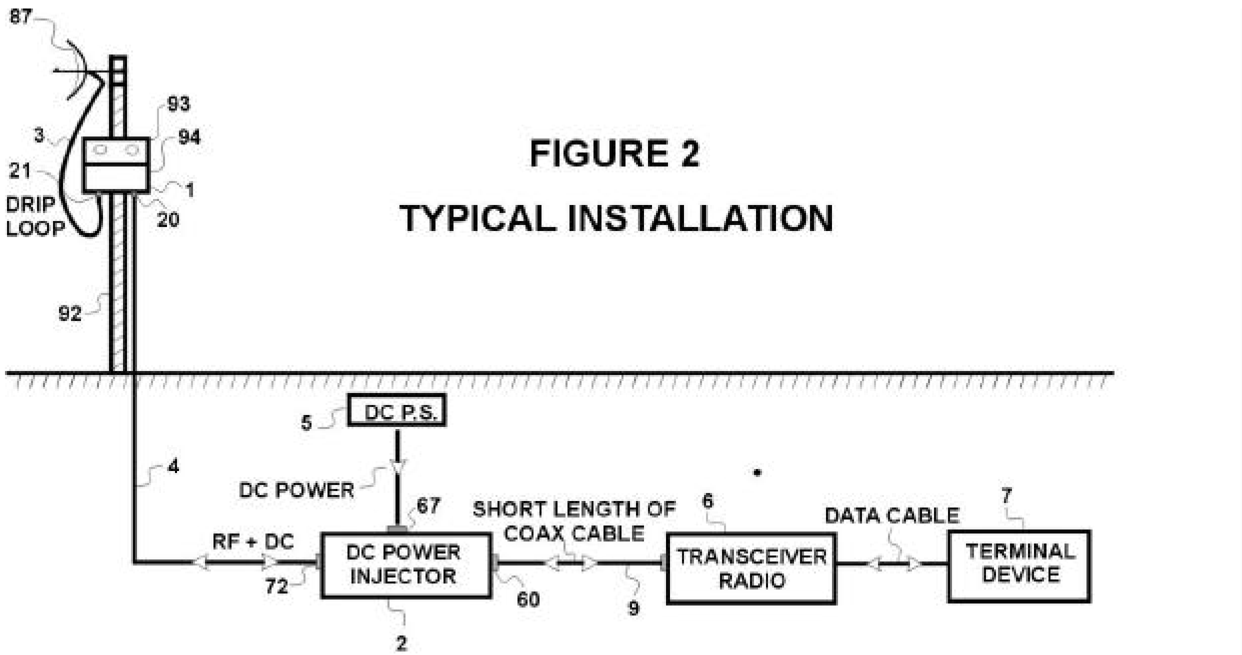

FIGURE 2

TYPICAL INSTALLATION

Figure 3 shows the circuit components inside Converter Amplifier **1.** In the receive mode, the received RF signal enters Converter Amplifier **1** at antenna connector **21**. The signal is filtered by 5.8 GHz band by Bandpass Filter **36** via electronic switch **35** and proceeds into noise amplifier (LNA) **30**. This signal is fed into receive RF Mixer **29** where it is mixed with the signal from Local Oscillator (LO) **31**. The resulting signal is converted or translated to RF 2.4 GHz band and fed though 2.4 GHz band Bandpass Filter **27**. The signal is then passed through input switch **24** and to radio connector **20** where it is ultimately presented to Transceiver Radio **6** from the transmission coax cable **4**, through DC Power Injector **2** and along coax cable **9**.

When Transceiver Radio **6** is operated in the transmit mode, the RF energy enters Converter Amplifier **1** at the radio connector **20**. The Power Sense circuitry switches the converter module from receive to transmit mode. The transmit signal in 2.4 GHz band from Transceiver Radio **6** passes through input switch **24** through attenuator pad **32**. Attenuator pad **32** reduces the transmit signal to a level suitable for the input of transmit mixer **33** and sets the transmit gain of the amplifier. This signal is combined with the output of LO **31** and converted to 5.8 GHz band. It is then amplified to the desired power level by power amplifier **34**. The signal then passes through output switch **35** and 5.8 GHz band pass Filter **36** to antenna connector **21** and antenna **87** shown in Figure 1.

The DC voltage to power Converter Amplifier **1** is picked off radio connector **20** through an inductor and fed to power supply **26** to power the circuitry in the converter module.

FIGURE 3
CONVERTER AMPLIFIER BLOCK DIAGRAM

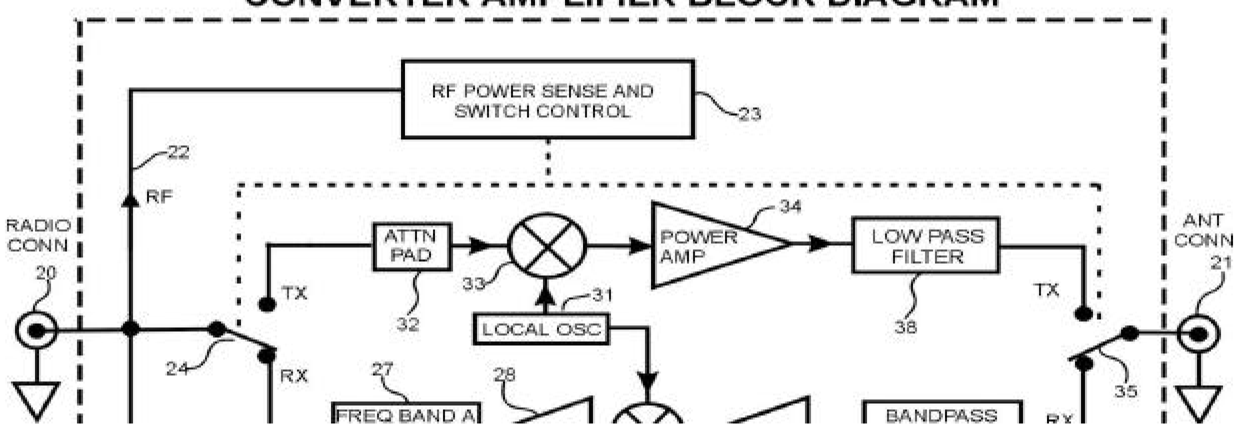

Figure 4 illustrates an alternate form of the Converter Amplifier **80** that has its DC Power **88** applied directly to it without the use of a DC power injector. This version is used when Converter Amplifier **80** is located very close to radio transceiver **83**. Typically, Converter Amplifier **80** and radio transceiver **83** would both be located in outdoor enclosure **86**. This configuration precludes the need for a DC injector. In this case, coax cable **85** that runs from antenna **84** to the Converter Amplifier **80** is short. Also, the coax cable **81** connecting the Converter **80** to the radio transceiver **83** is very short. To compensate for the small signal loss on the short jumper cable **81** between the radio transceiver **83** and the converter **80**, this version of the converter amplifier would have 4 dB less transmit power gain. This is implemented by increasing the value of attenuator pad **32** shown on Figure 3 at time of manufacture.

FIGURE 4
CONVERTER WITH NO DC INJECTOR