



# **GWS-4006-17, GWS-4006-23 and GWS-4012-23 Users Guide**

---

June 9th 2016

Phone: 613-366-1768  
Email: [info@6harmonics.com](mailto:info@6harmonics.com)

Version 1.06



**Security Notice:** This document is confidential. The Intellectual Property Rights belong to 6Harmonics Inc.

GWS-4006-23 Users Guide .....	1
1 Revision History .....	3
2 FCC Regulatory Information .....	4
3 Part 15 TV Band Device Notice .....	5
4 Overview .....	8
5 Required Hardware and Software.....	9
7 System Block Diagram.....	10
9 System Setup/Configuration Flow Chart .....	11
10 Hardware Setup and Power Up .....	12
12 Configure PC IP Addresses .....	13
14 Assign new IP Address for GWS4006-23 .....	17
15 Configuring Radio BOX Operation Mode CAR/EAR .....	20
16 Configuring the Database Agent to allow the unit to register with the TVWS Database .....	22
17 Configuring RF Channels and TX Power to establish radio link.....	23
19 Start monitor tool on telnet shell to monitor the radio link .....	27
20 Link Performance Tuning.....	29
21 Troubleshooting .....	32



# 1 Revision History

Table 0 – Revision History

<b>Revisions</b>	<b>Author</b>	<b>Date</b>	<b>Status</b>	<b>Notes</b>
0.01	Dawen Zhang	Nov 20, 2015	Draft	Initial Draft
0.02	Steve Beaudin	Dec 2, 2015	Draft	Editorial Changes + database
1.00	Steve Beaudin	Dec 16,2015	Approved	Updated for higher power
1.01	Steve Beaudin	Dec 22,2015	Approved	Updated TX power values
1.02	Steve Beaudin	Feb 5, 2016	Approved	Added applicable model number table.
1.03	Steve Beaudin	Feb 19, 2016	Approved	Added Yagi antenna, plus approved antenna list.
1.04	Steve Beaudin	Feb 26th, 2016	Approved	Added TX Power vs. antenna gain.
1.05	Steve Beaudin	March 4th, 2016	Approved	Corrections to Section 4.4 as per request from CB.
1.06	Steve Beaudin	June 9th, 2016	Approved	Added section to explain which units can operate as CPEs and which as BTS.



## 2 Applicable Model Numbers

This users guide is applicable to the following products.

Model Number	FCCID	Max.TX Power	Channel Bandwidth	Peak Throughput (Mbps)
GWS-4006-17	2AASTGWS-4006-17	17 dBm	6 MHz	16.5 Mbps
GWS-4006-23	2AASTGWS-4006-23	23 dBm	6 MHz	16.5 Mbps
GWS-4012-23	2AASTGWS-4012-23	23 dBm	12 MHz	33.0 Mbps



### **3 FCC Regulatory Information**

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

### **4 Part 15 TV Band Device Notice**

This equipment has been tested and found to comply with the rules for TV bands devices, pursuant to part 15 of the FCC rules. These rules are designed to provide reasonable protection against harmful interference. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the manufacturer, dealer or an experienced radio/TV technician for help.

#### **4.1 Caution: Exposure to Radio Frequency Radiation.**

**4.2 To comply with FCC RF exposure compliance requirements, for fixed configurations, a separation distance of at least 40 cm must be maintained between the antenna of this device and all persons.**

**4.3 This device must not be co-located or operating in conjunction with any other antenna or transmitter.**



#### 4.4 Only the following components are approved for use with the radio.

- Power over Ethernet Mid-Span: PowerDsine™ 9001G-40/SP See pictures in Figure 1
- OMNI Antenna SL13319A, 2.5 dBi Gain, see pictures in Figure 2
- Sector Antenna SL12948A, 7 dBi Gain, see pictures in Figure 3
- GWS-4006-23 radio, see picture in Figure 4.
- You'll need to have RJ-45 Ethernet cables, RF cables, AC power cord and PCs to assist with the setup. See Figure 5 and 6.
- Sector Antenna SL14174A, 8dBi Yagi, no radome. See figure 6B.

Item	GWS-4006-17	GWS-4006-23	GWS-4012-23	Notes
SL13319 A, 2.5 dBi OMNI	x	x	x	At up to the maximum power of the module
SL12948A, 7dBi sector	x			At a maximum power of 17 dBm
SL14174A, 8dBi sector		x	x	At a maximum power of 17 dBm
PD 9001G-40/SP	x			40W injector
PD9501G/SP		x	x	75W injector

Table showing which antenna and POE Injectors are approved for use with each of the GWS-4000 radio modules. The x indicates the antenna or POE injector is approved for use with the radio module at the top of the column. A blank entry indicates the equipment is not approved for use with the module at the top of the column.

#### 4.4.1 Transmit Power vs. Antenna gain

##### 4.4.1.1 Setting Antenna Gain

During the initial configuration of the unit, the professional installer must use the "**setantennagain**" command to enter the gain in dBi, of the antenna being used with the unit. When the unit is shipped, this field is left blank and the unit will not transmit until a valid entry is provided.

##### 4.4.1.2 Transmit Power Reduction vs. Antenna Gain

For the GWS-4006-17, the unit can transmit at a maximum power of 17 dbm, using an antenna gain of 6dBi or less. For antenna gains greater than 6 dBi, the software will reduce the maximum permissible power by 1 dB for each additional dB of antenna gain above 6 dBi.

For the GWS-4006-23 and GWS-4012-23, the unit can transmit at a maximum power of 23 dBm, using an antenna gain of 2.5 dBi or less. For each dB above 2.5 dBi of antenna gain, the SW will reduce the maximum permissible power by 1 dB.

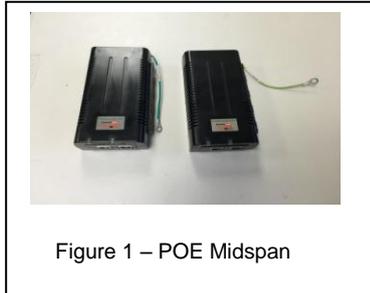


Figure 1 – POE Midspan

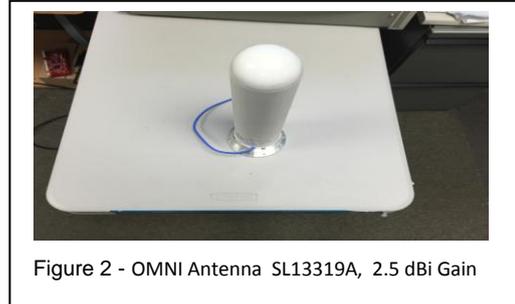


Figure 2 - OMNI Antenna SL13319A, 2.5 dBi Gain



Figure 3 – Sector Antenna SL12948A, 7 dBi Gain



Figure 4 – GWS4006-23 Radio

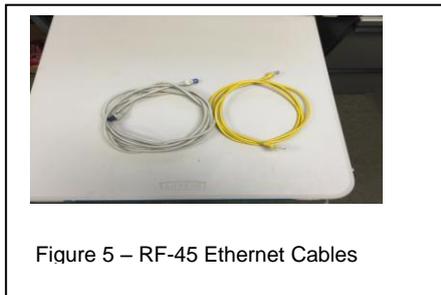


Figure 5 – RF-45 Ethernet Cables

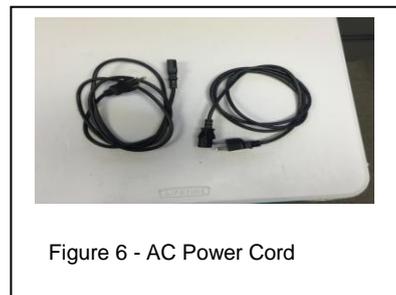


Figure 6 - AC Power Cord

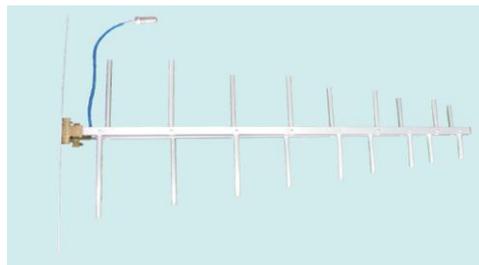


Figure 6B: SL14174A: 8dBi Yagi, no radome.



## 4.5 Approved Modes of Operation

The GWS-4000 series units can be used as either customer premise units (CPEs) or base stations (BTS) depending on the software configuration, and whether or not the database agent has been approved for use in that mode. Currently, the GWS-4006-17 has only been tested and certified for use as a CPE. The GWS-4006-23 and GWS-4012-23 have been certified and can be used as either a CPE or a BTS, subject to the customer having the appropriate software key.

The following table outlines the approved operating modes for each module type:

Model Number	CPE	BTS	Note
GWS-4006-17	Yes	No	Can only be used as a CPE
GWS-4006-23	Yes	Yes	Approved for both modes
GWS-4012-23	Yes	Yes	Approved for both modes. Note that this product can only be used where 2 contiguous channels are available. If the database does not provide a channel list which includes at least two contiguous channels, the module will not transmit.
GWS3000	Yes	Yes	The GWS3000 was the first product certified by 6Harmonics and is a single channel system. It has been certified for use as either a BTS or CPE and can interoperate with the GWS-4006-17 and GWS-4006-23. For more information on the GWS3000 please refer to that module's users guide.

**Table shows which units have been approved to operate as a CPE and which units have been approved to operate as a BTS. The database software operates differently depending on whether the unit has been configured as a BTS or CPE. To date, all units have been certified as BTS and CPE's with the exception of the GWS-4006-17 which has only been certified as a CPE.**

In addition, when the units are used as a network, the modules must be used as either a CPE or BTS and the CPE's must connect to the BTS using the UHF airwaves. The following modules can be used as CPE / BTS pairs.

Configuration #	Models used as BTS and CPE	Nodes
Config. 1	GWS3000 as BTS / GWS3000 as CPE	
Config. 2	GWS3000 as BTS / GWS-4006-17 as CPE	
Config. 3	GWS3000 as BTS / GWS-4006-23 as CPE	
Config. 4	GWS-4006-23 as BTS / GWS3000 as CPE	
Config. 5	GWS-4006-23 as BTS / GWS-4006-17 as CPE	
Config. 6	GWS-4006-23 as BTS / GWS-4006-23 as CPE	
Config. 7	GWS-4012-23 as BTS / GWS-4012-23 as CPE	12 MHz systems can only operate with other 12 MHz systems.

**Table shows which modules can be operated as a CPE/BTS pair.**

All 6 MHz systems are able to interoperate, as a BTS or CPE. The only exception to this rule is that the low power GWS-4006-17 has only been certified as a CPE, and as such it must connect to a GWS-4006-23 or GWS3000 as its BTS. All other modules, the GWS-4006-23, GWS-4012-23 and GWS3000 can be used as either a CPE or BTS. For the 12



MHz system, GWS-4012-23, this is currently the only available model number and as such they must be used as a pair where one or more GWS-4012-23 configured as CPE's connect to a GWS-4012-23 which has been configured as a BTS. Please note that a software key must be obtained from 6Harmonics to allow a CPE to be upgraded to a BTS.

## **5 Overview**

This documentation provides a quick guide on how to setup and use the 6Harmonics's GWS-4006-23 Radios, and establish a radio link.

## **6 Required Hardware and Software**

To accomplish the setup, you'll need the following hardware and software:

- 6.1 Minimum of one GWS4006-23 radio and one GWS3006-20, see Figure 4
- 6.2 Two POEs for power supply, see Figure 1
- 6.3 Two antennas, see Figure 2
- 6.4 One PC with telnet supported
- 6.5 Four Ethernet RJ45 cables, see Figure 5
- 6.6 Two AC power cord and AC power outlet, See Figure 6



## 8 System Block Diagram

The typical minimal basic system setup for GWS4006-23 would consist of one CAR (Base Station) and one EAR (CPE) as shown in Figure 7. The CAR would behave like a BTS and connect to the internet, the EAR would connect to the CAR through the UHF air wave.

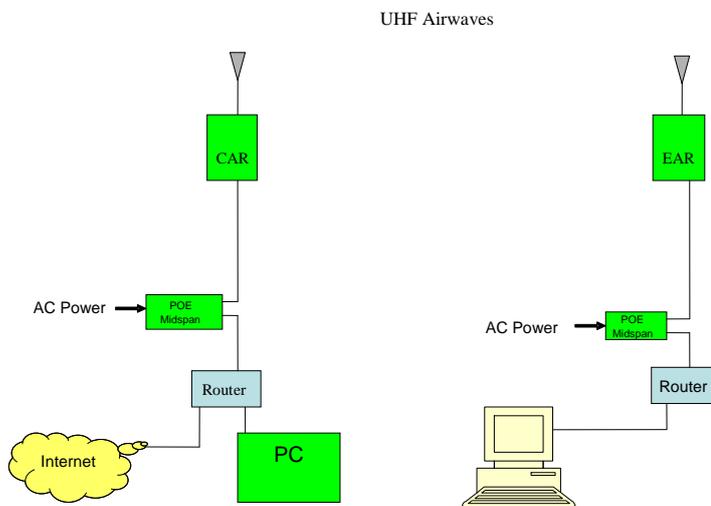
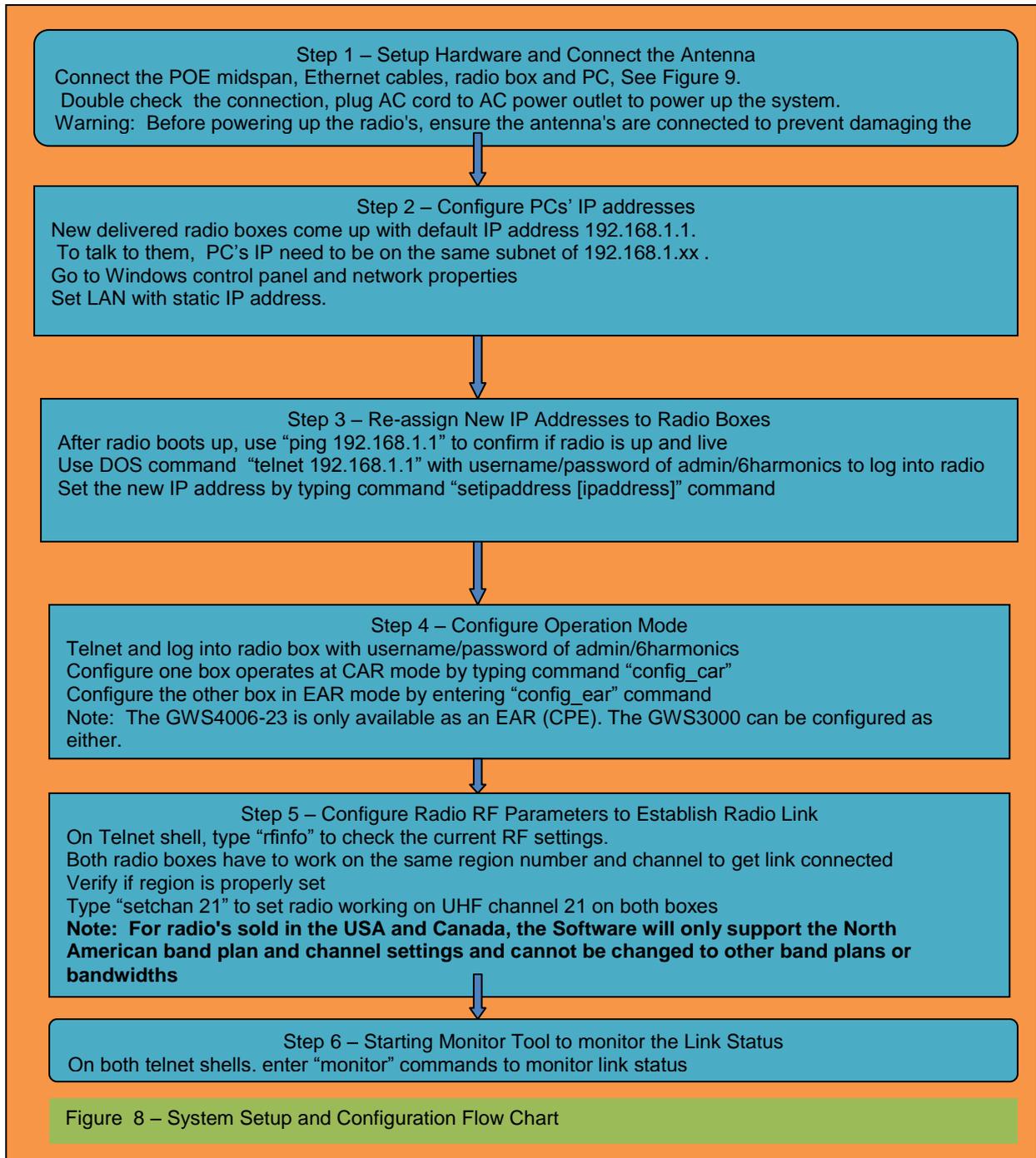


Figure 7 – System Block Diagram



## 10 System Setup/Configuration Flow Chart

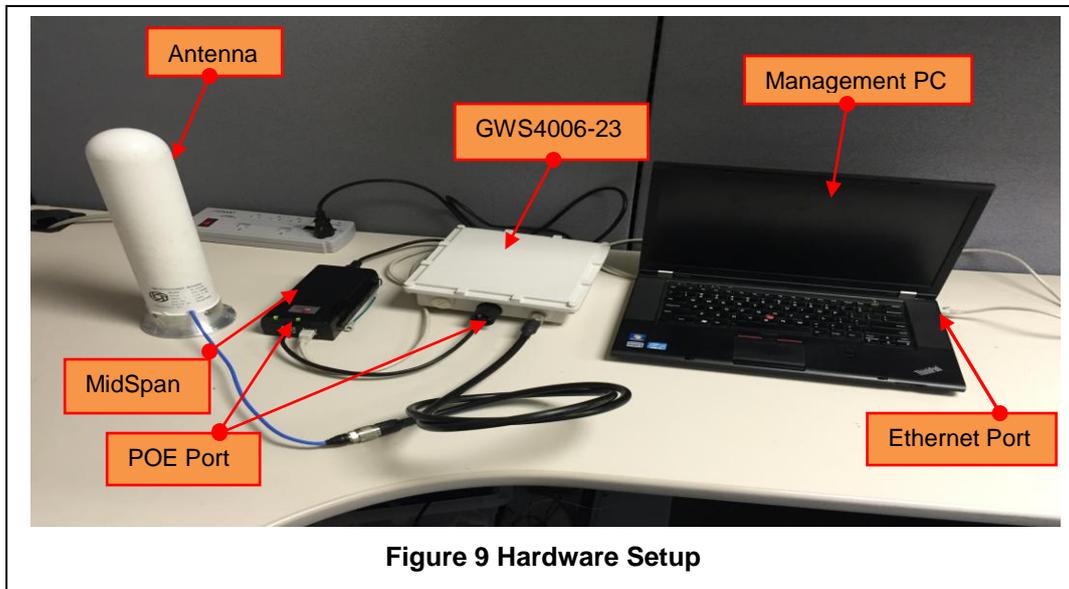
Figure 8 shows the system setup/configuration flow chart briefly. Please follow the steps in the flow chart to setup the system and establish a radio link. The detailed step by step instructions will be described later on.





## 11 Hardware Setup and Power Up

First connect Antenna, then connect midspan power out to box's RJ-45 connector, connect midspan data in to PC's Ethernet port, then connect AC cable to AC power outlet, Figure 9 shows one of the two setups.



For an actual deployment, the GWS4006-23 radio module would be located on the roof of a building, or on a pole or small tower along with the antenna. The POE Midspan would typically be in the home, or in a small weather proof utility box at the base of the pole or tower. A Cat5e cable will run from the POE midspan to the GWS4006-23 radio module. The maximum length of CAT5e cable which can be supported is 100m.

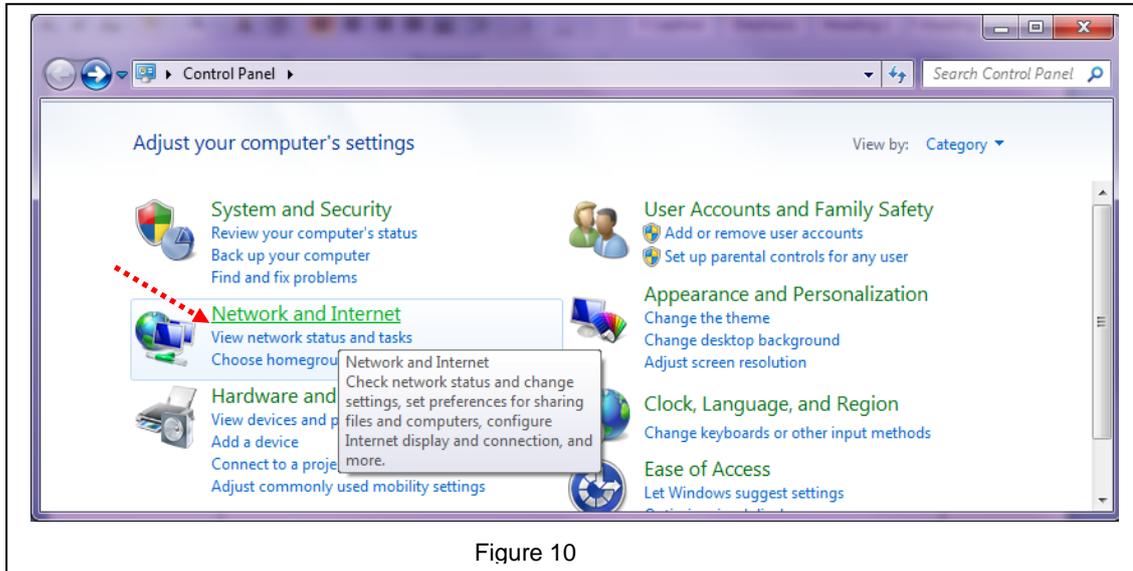
**Warning: Ensure an approved TVWS antenna, or RF load, is connected to the radio module antenna connector prior to powering up the unit. If the unit is powered up without an antenna or load, the power amplifier can be permanently damaged.**



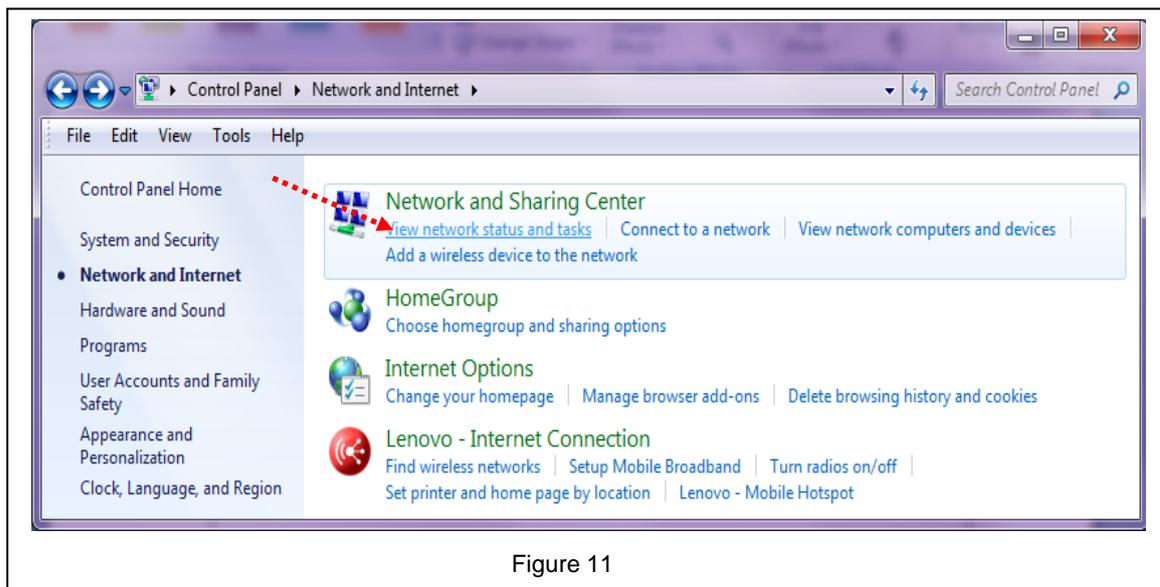
## 13 Configure PC IP Addresses

All the new deliveries come with default IP address 192.168.1.1. To log onto the radio, the PC must be configured on the same subnet of 192.168.1.xx. Below is an example of how to configure the IP settings on a windows based computer.

### 13.1 Go to control panel/ and double click “Network and internet” menu, see Figure 10



### 13.2 After double clicking the Network and Internet menu, you’ll get a new window as Figure 11. Then double click View network status and Tasks option.





**13.3** After click View network status and task, you'll see new window as Figure 12. Then double click

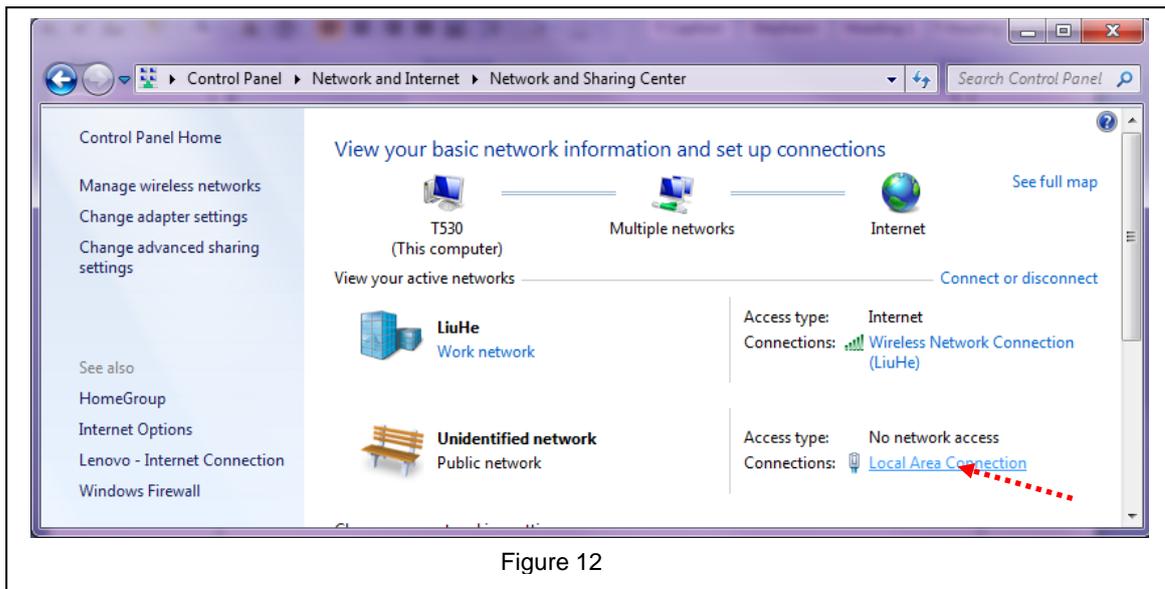


Figure 12

**13.4** After click “Local Area Connection”, new window appears as Figure 7, then click “Properties” button to enter properties window. See Figure 13.

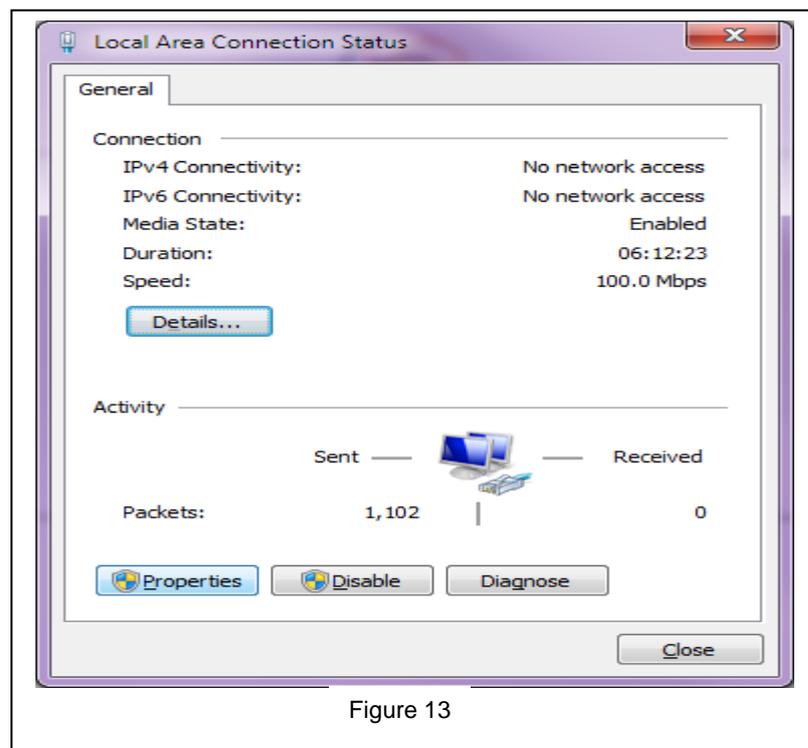


Figure 13



13.5 In the Properties window, highlight Internet Protocol Version 4(TCP/IPv4) (see Figure 8)

13.6 Then click Properties to enter new window as Figure 14.

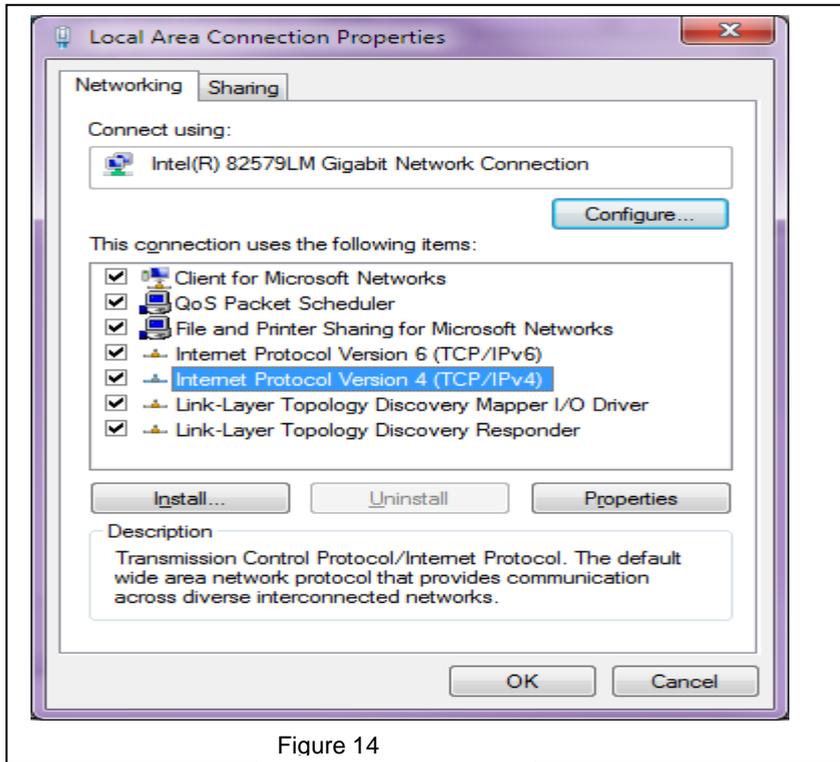


Figure 14

13.7 After entering Internet Protocol Window, select “Use The following IP Address” to specify your PC IP Address. Here for example it is 192.168.1.188 and subnet mask is 255.255.255.0. Then Click OK/close/close to close all the windows opened. See Figure 15.

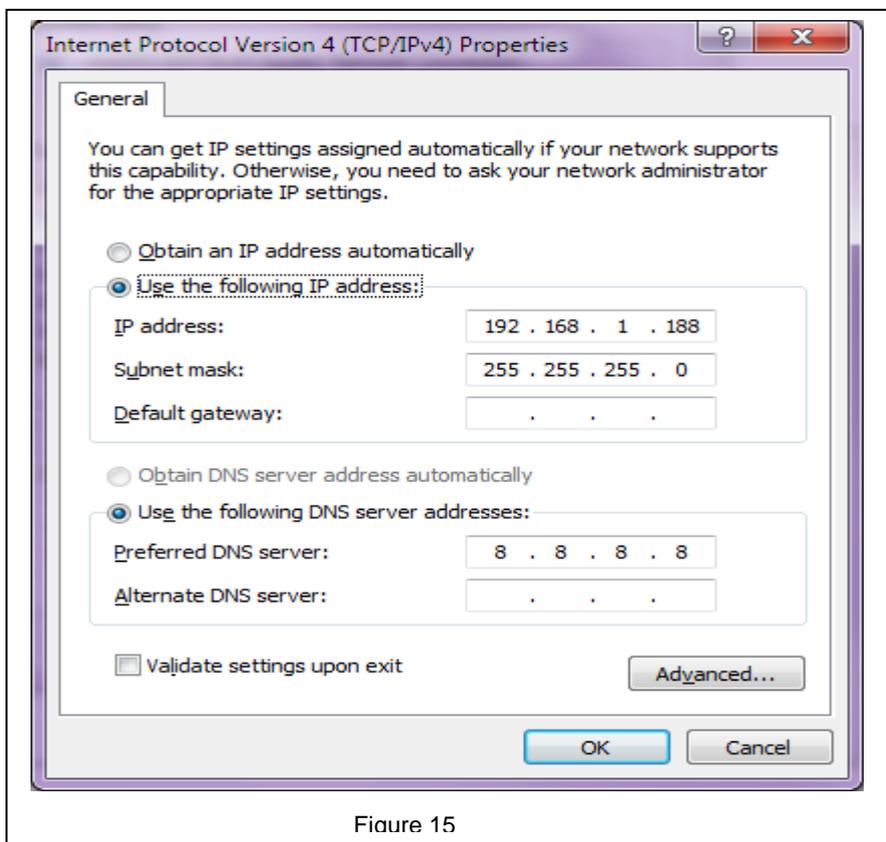


Figure 15



13.8 After Closing out all windows, go to DOS prompt and type “ipconfig” to see if new IP address is properly assigned, see Figure 16.

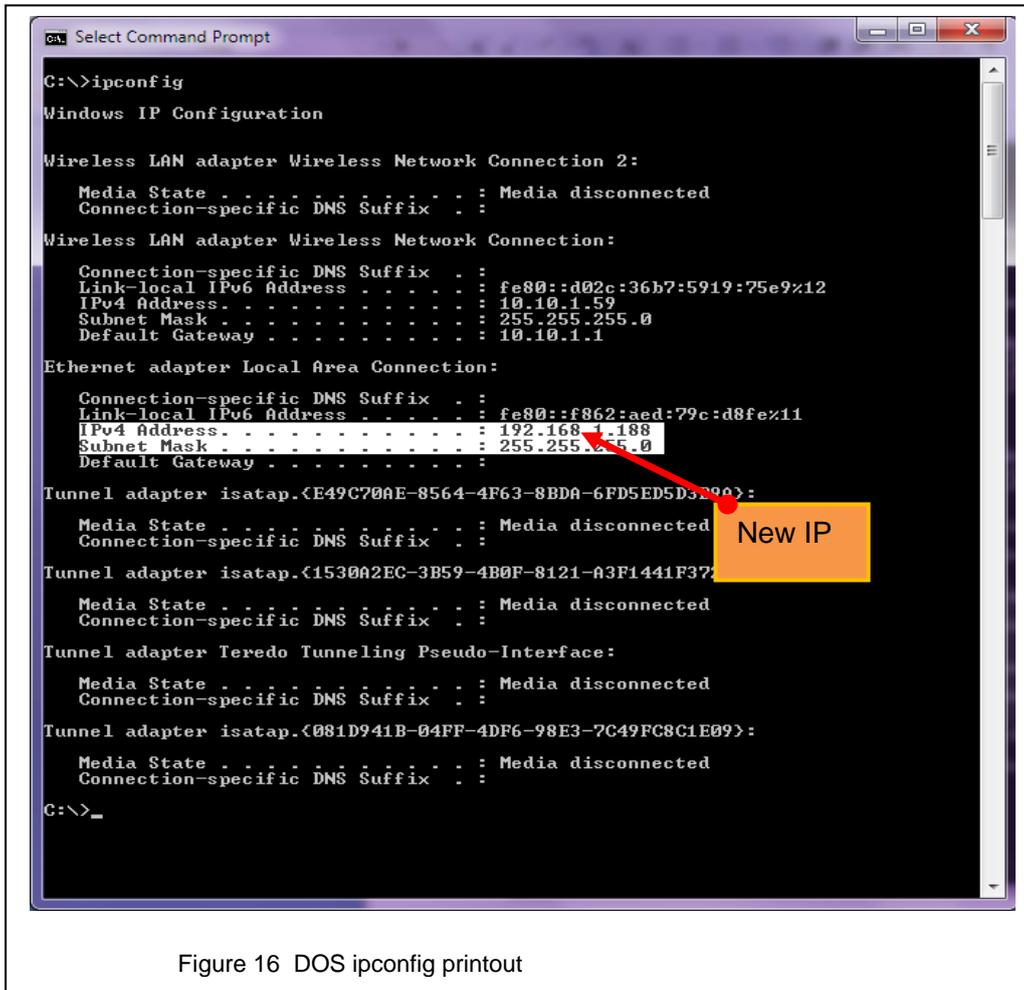


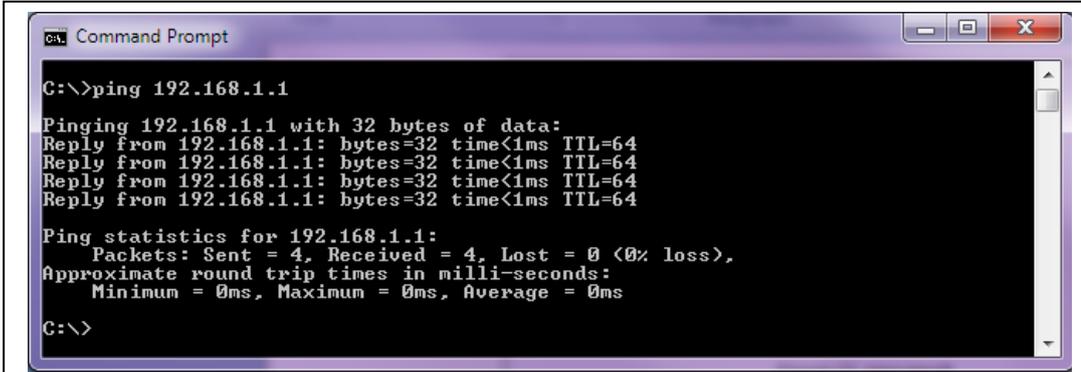
Figure 16 DOS ipconfig printout



## 15 Assign new IP Address for GWS4006-23

After configuring PC IP on the same subnet of 192.168.1.xx, you should be able to communicate with the radio box after booting up.

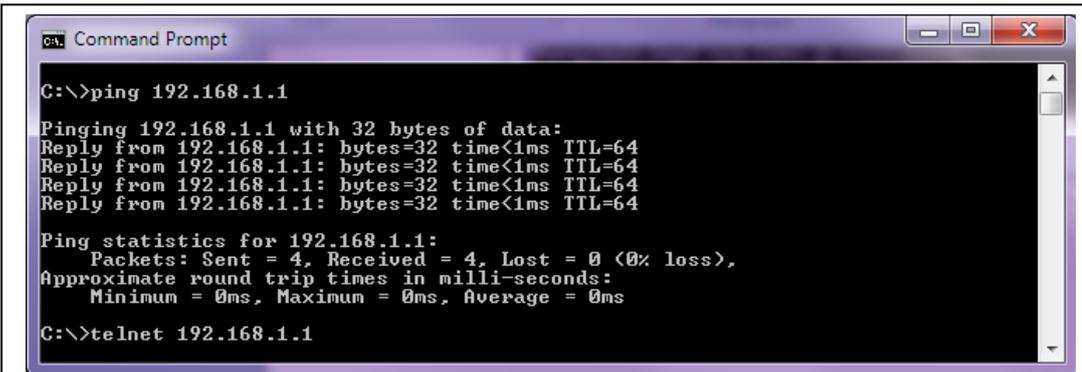
- 15.1 First ping to see if PC can talk to box, see figure 17. If you get ping reply from box IP of 192.168.1.1, that means the radio box is up, connections are good, all ready to go to next step.



```
ca: Command Prompt
C:\>ping 192.168.1.1
Pinging 192.168.1.1 with 32 bytes of data:
Reply from 192.168.1.1: bytes=32 time<1ms TTL=64
Ping statistics for 192.168.1.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms
C:\>
```

Figure 17 ping result

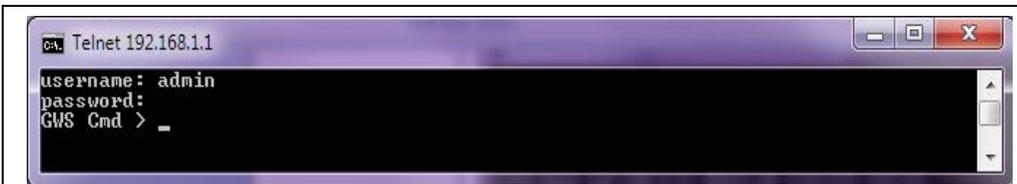
- 15.2 Now radio box is up, and PC is able to talk to the radio, we can telnet on to the radio to assign a new IP address. To simplify the setup in this example, we will assign it as 192.168.1.23 for one box and 192.168.1.24 for the other. First type “telnet 192.168.1.1” command on DOS prompt and enter. See Figure 18.



```
ca: Command Prompt
C:\>ping 192.168.1.1
Pinging 192.168.1.1 with 32 bytes of data:
Reply from 192.168.1.1: bytes=32 time<1ms TTL=64
Ping statistics for 192.168.1.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms
C:\>telnet 192.168.1.1
```

Figure 18 - Telnet to radio box

- 15.3 Following the enter key of “telnet 192.168.1.1” command, new window with log in prompt will show up, enter “admin” as user name and with password of “6harmonics” to log in. See Figure 19



```
ca: Telnet 192.168.1.1
username: admin
password:
GWS Cmd > _
```

Figure 19 – telnet login window



#### 15.4 Now that you can log onto the radio, type “h” to display all the available commands, see Figure 20.

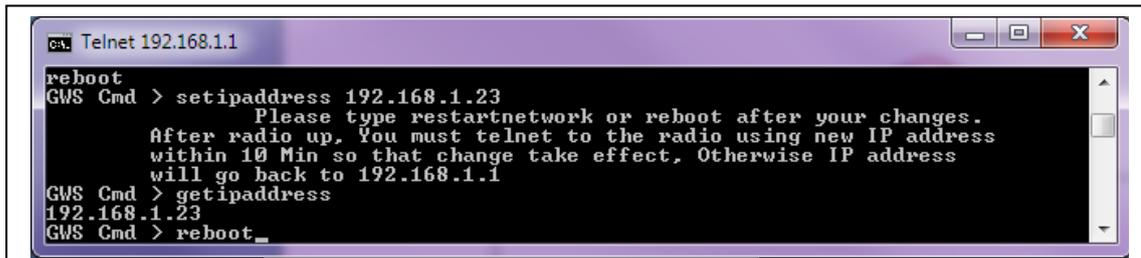
From Figure 20, you’ll see there are some highlighted commands for networks IP, mask and gateway setup and inquiry.

```
GWS Cmd > h
Support Commands:
h or --help
monitor
setchan xx
getchan
settxpwr xx
gettxpwr
setrxgain xx
getrxgain
u /*tx power up 0.5dBm*/
d /*tx power down 0.5 dBm*/
cu /*tx ppwer up 5 dBm*/
cd /*tx power down 5 dBm*/
setrxatten x xx
setagcmode x
rfinfo
setinstaller
getinstaller
getchanlist
setsubchanlist
getsubchanlist
txoff
setuser xxx
setpwd xxx
txresume
setregion x
setchanlist xx xx ...
settxatten xx
showregistration
setipaddress xxx.xxx.xxx.xxx
setnetworkmask xxx.xxx.xxx.xxx
setgateway xxx.xxx.xxx.xxx
getipaddress
getnetworkmask
getgateway
getproto
restartnetwork
configbackup
configrestore
configfactoryrestore
config_ear
config_car
getgwsmode
version
reboot
GWS Cmd >
```

Figure 20 – help commands printout



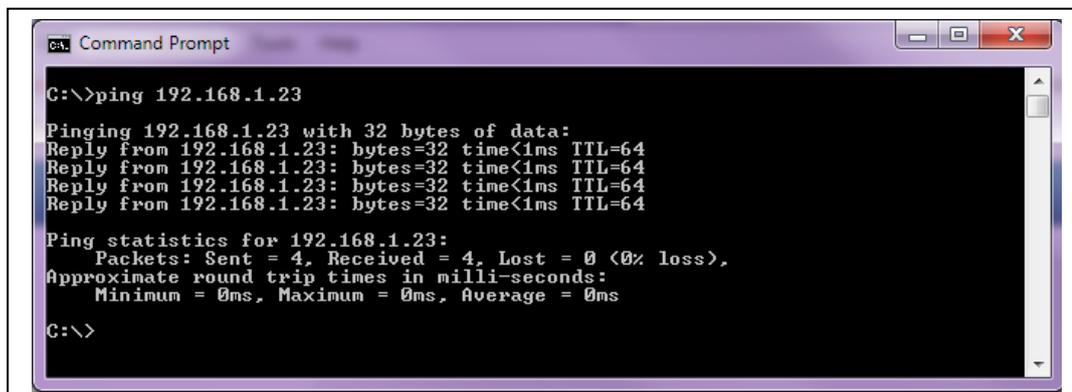
- 15.5 Now lets use the “setipaddress” command to assign new ip address of 192.168.1.23 to the box. Then use getipaddress to verify if the ip is set properly. See Figure 21.



```
GA: Telnet 192.168.1.1
reboot
GWS Cmd > setipaddress 192.168.1.23
Please type restartnetwork or reboot after your changes.
After radio up, You must telnet to the radio using new IP address
within 10 Min so that change take effect, Otherwise IP address
will go back to 192.168.1.1
GWS Cmd > getipaddress
192.168.1.23
GWS Cmd > reboot_
```

Figure 21 – assign and verify IP address

- 15.6 To make the new IP take effect, you’ll need to reboot the box again. So type reboot command to reboot the box (see Figure 21). After 1~2 minutes power up, go to DOS prompt ping new IP to see if box is up, see Figure 22. Ping reply shows new IP are assigned properly and can go to next step now.



```
GA: Command Prompt
C:\>ping 192.168.1.23
Pinging 192.168.1.23 with 32 bytes of data:
Reply from 192.168.1.23: bytes=32 time<1ms TTL=64

Ping statistics for 192.168.1.23:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>
```

Figure 22 – Ping new assigned IP

- 15.7 Repeat steps a~f to assign IP address 192.168.1.24 for the other radio box

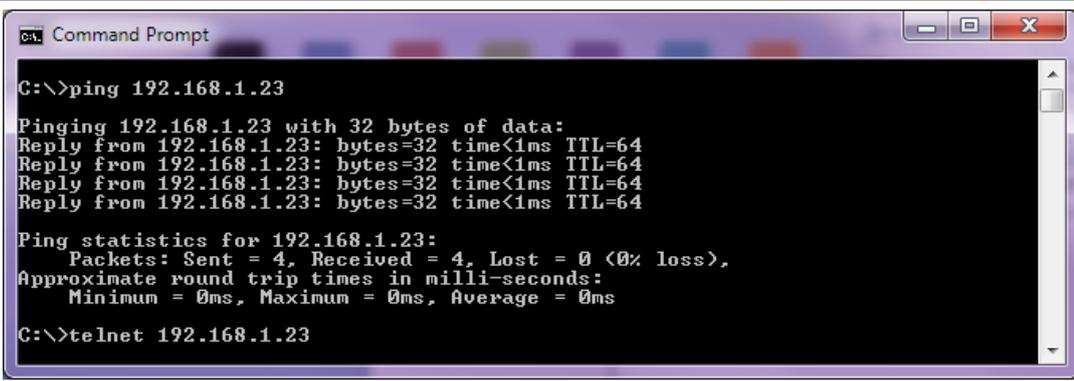


## 16 Configuring Radio BOX Operation Mode CAR/EAR

Now that all IP addresses are set, we can go to configure the operating mode of boxes. There are two modes to choose: CAR or EAR. The CAR mode just behaves like a BTS and EAR behaves like a CPE.

*Note: For the current software release, the GWS4000 is only being provided as an EAR (CPE). The GWS4000 must communicate with a GWS3000 module which has been configured as a CAR (BTS). The GWS3000 module can be configured as either an EAR or CAR using the procedure outlined below.*

### 16.1 First ping to see if the box is alive, then telnet into the box as shown in Figure 23



```
C:\>ping 192.168.1.23

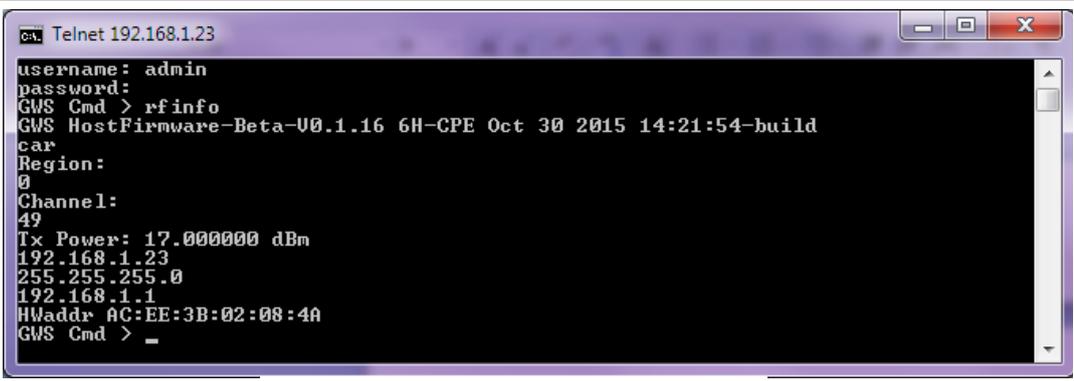
Pinging 192.168.1.23 with 32 bytes of data:
Reply from 192.168.1.23: bytes=32 time<1ms TTL=64

Ping statistics for 192.168.1.23:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>telnet 192.168.1.23
```

Figure 23 – ping and telnet into box

### 16.2 Use “admin/6harmonics” to log on to box, then type “rfinfo” to see the current operating mode, see Figure 24. From the output of “rfinfo”, we can see the box is configured in “CAR” mode, which is the default mode from delivery.

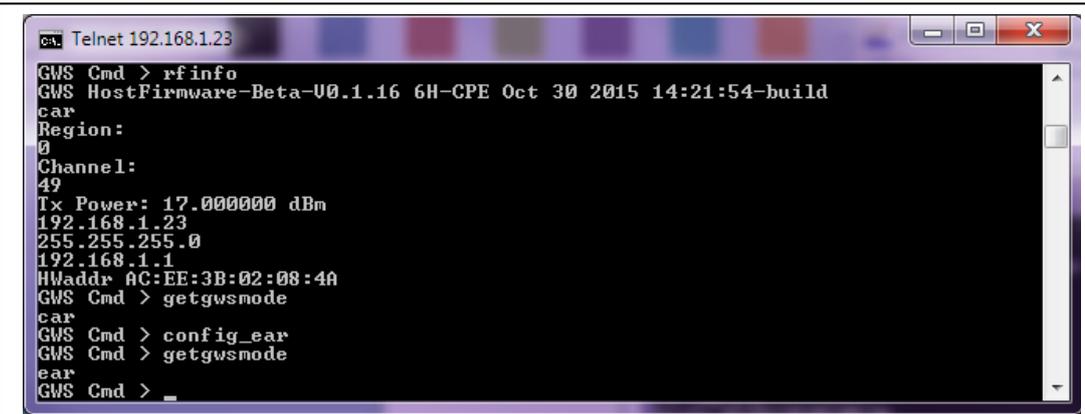


```
Telnet 192.168.1.23
username: admin
password:
GWS Cmd > rfinfo
GWS HostFirmware-Beta-U0.1.16 6H-CPE Oct 30 2015 14:21:54-build
car
Region:
0
Channel:
49
Tx Power: 17.000000 dBm
192.168.1.23
255.255.255.0
192.168.1.1
HWaddr AC:EE:3B:02:08:4A
GWS Cmd > _
```

Figure 24 – login and rfinfo printout



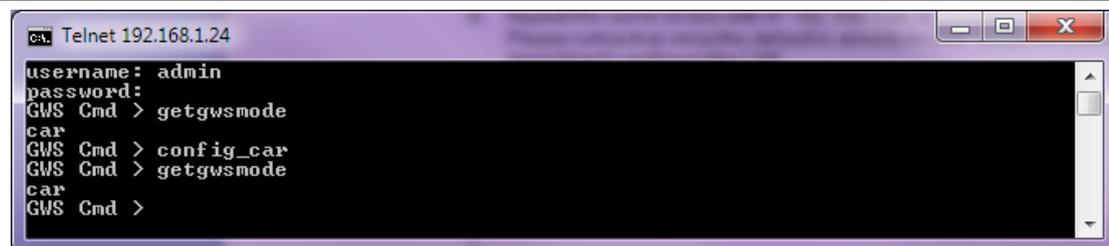
**16.3** We are going to configure this box to operate as “EAR” Mode by using “`config_ear`” command. Type “`config_ear`” and enter, and then use “`getgwsmode`” to confirm if new mode is set. See figure 25.

A terminal window titled 'cs: Telnet 192.168.1.23' showing the following commands and output:

```
GWS Cmd > rfinfo
GWS HostFirmware-Beta-U0.1.16 6H-CPE Oct 30 2015 14:21:54-build
car
Region:
0
Channel:
49
Tx Power: 17.000000 dBm
192.168.1.23
255.255.255.0
192.168.1.1
HWaddr AC:EE:3B:02:08:4A
GWS Cmd > getgwsmode
car
GWS Cmd > config_ear
GWS Cmd > getgwsmode
ear
GWS Cmd > _
```

Figure 25– configure OP mode as “EAR”

**16.4** Repeat the same on box with IP 192.168.1.24, to configure it in “CAR” mode. See Figure 26. Please notice that since the default is already in CAR mode, for practice reason, we just do it one more time to configure the CAR.

A terminal window titled 'cs: Telnet 192.168.1.24' showing the following commands and output:

```
username: admin
password:
GWS Cmd > getgwsmode
car
GWS Cmd > config_car
GWS Cmd > getgwsmode
car
GWS Cmd >
```

Figure 26 – configure Box in “CAR” mode



## 17 Configuring the Database Agent to allow the unit to register with the TVWS Database

In the US and Canada, the operation of TVWS devices is only permitted with an approved TVWS database. Prior to registration, the IP parameters of the BTS and or CPE must be configured to allow the radio to communicate through the router on your network (see Section 14), and access the TVWS database.

### 17.1.1 Database Configuration

1. On Work Station 1, under Telnet, one can configure the Database parameters for CPE by following commands.
2. Type “**setlatitude xx.xxx**” and “**setlongitude xx.xxx**” to set the latitude and longitude of the CPE location (assuming BTS is none database access).  
Example: “setlatitude 28”, “setlongitude -81”. Check with “getlatitude”, “getlongitude” commands.
3. Type “**setantennaheight 30**” to set antenna height to 30 meters. Check with “getantennaheight” command.
4. The operator is able to use the following commands to set the operator personal information:
  - “**setowner XXX**” –to set the owner
  - “**setcontactname XXX**” –to set the contact name
  - “**setcontactaddress XXX**” –to set the contact address
  - “**setcontactcity XXX**” –to set the contact city
  - “**setcontactstate XXX**” –to set the contact state
  - “**setcontactzipcode XXX**” –to set the contact zip code
  - “**setcontactcountry XXX**” –to set the contact country
  - “**setcontactemail XXX**” –to set the contact email
  - “**setcontacttelephone XXX**” –to set the contact telephone

Operator can type the paired “getXXX” commands to check the information settings. Example “getcontactname” etc.

For convenience, the “**showregistration**” command can be used to display all the registration information. A similar set of commands are supported on the GWS3000 BTS.

*Note: The latitude and longitude coordinates must be precise to within 100m. Coordinates can be obtained from a GPS receiver or Google Maps.*

5. Type “**reboot**” to reboot the CPE.
6. Login via **Telnet** again.

### 17.1.2 OPERATION with TVWS Database

1. CPE can start to run white space agent automatically in background after reboot.



2. Login again via Telnet. Type **“monitor”** in Telnet shell to monitor the RF status of CPE.
3. The operator can start a new Telnet session window to issue commands on GWS shell while monitor keeps running.
4. The operator should be able to observe the following status through monitor:
  - CPE starts to scan the full channel list and try to connect to a BTS.
  - If connected, CPE would query the database through radio link with BTS.
  - If query successfully, CPE will operate on the valid channel. The monitor will display channel list expire time and the time left to re-query database for CPE. If unsuccessful, CPE will restart to scan the channel list after 50 sec.
5. The operator can use **“setchan XX”** to set CPE to a desired channel directly during scanning if the BTS channel is known already.
6. If the operator wants to change the database parameters, such as location, contact name and antenna height. After typing **“setXXX”** command, **“restartwsagentear”** needs to be issued to restart agent and apply the changes.
7. **“rfinfo”** can be used to check the entire RF information.
8. **“h”** can be used to show more commands usage.

Note: The GWS3000 BTS must also be registered with the TVWS database. The following commands will operate with the BTS as well. The key difference is that when the unit is configured as a CAR (BTS) it will not scan for BTS beacons, but rather the operator must configure the BTS to one of the channels which have been provided by the TVWS database.

## **18 Configuring RF Channels and TX Power to establish radio link**

**18.1 Telnet and log into the radio box, use the following commands. ==.**

**18.2 Use “rfinfo” command to print out the current RF settings (region, channel, TX power) and the other status**

**18.3 Use “setchan [channel\_no]” to set UHF channel to establish channel**

After registration, if the operator attempts to set the unit to a channel number which is not included as a valid channel list from the TVWS database, the SW will reject the command and respond "Not a Valid Channel."

Prior to registration, the CPE will initiate a blind scan of all channels as it searches for a BTS beacon. If the operator knows the channel on which a nearby BTS is transmitting, they can use the "setchan xx" command to set the CPE to that channel. The CPE will perform a blind scan of this channel, and will only attempt to connect if it detects a beacon. If the connection is successful, the CPE will remain on the channel and attempt to register with the TVWS database for 1 minute.



- If registration is successful and the channel is included in the valid channel list provided by the TVWS database, the CPE will remain connected to the BTS.
- If the channel is not included in the valid channel list provided by the TVWS database, the CPE will drop the connection and initiate a blind scan of all channels provided by the TVWS database to search for a BTS on an approved channel.

**18.4 Use “settxpwr [power\_value]” to set the TX power level in dbm, here we are putting two box very close 100m, so we put the TX power very low at 7dbm in order to avoid saturation. For the GWS4006-23, the maximum power is 23 dBm and the minimum power is 7 dBm.**

Note: In some of the screen shots below, TX powers as low as 1 dBm are shown. These examples are for the GWS-4006-17 which is designed to operate at lower powers and has a minimum power setting of 1 dBm and a maximum power of 17 dB. The GWS-4006-23 and GWS4012-23 have a minimum power setting of 7 dBm and a maximum power setting of 23 dBm.

#### **Maximum TX Power vs. Antenna Gain:**

During the initial configuration the user must configure the antenna gain of the system using the "**setantennagain xx**" command. The unit will not transmit until the "**setantennagain**" command has been used by the professional installer to enter a valid value. For detail on how the Software will adjust the Maximum Permissible transmit power for different antenna gains, please see **section 4.4**.

#### **18.4.1 TX Power Control is mandated by the FCC and Industry Canada**

- The unit operating as the BTS should be set to the minimum power necessary to reach the furthest CPE with an RSS of -75 dBm. In many cases the BTS will be set to the maximum permitted power. Since the BTS operates in a Point to Multipoint configuration, its power must be set to reach the furthest CPE with an acceptable SNR.
- The individual CPE Transmit Power should be adjusted such that the RSSI at the BTS is -75 dBm. If the RSSI is above -75 dBm, drop the TX power of the CPE. If the RSSI is lower than -75 dBm, set the CPE to maximum power permitted based on the model number and gain of the antenna being used.



**18.5 Use “rfinfo” to double check if RF settings are properly set, both CAR and EAR should work on the same region number and channel number. For units sold in the USA or Canada, the region will always read "region 0" and cannot be changed by the user.**

Figure 27 shows how to configure and setup channels and TX power on CAR

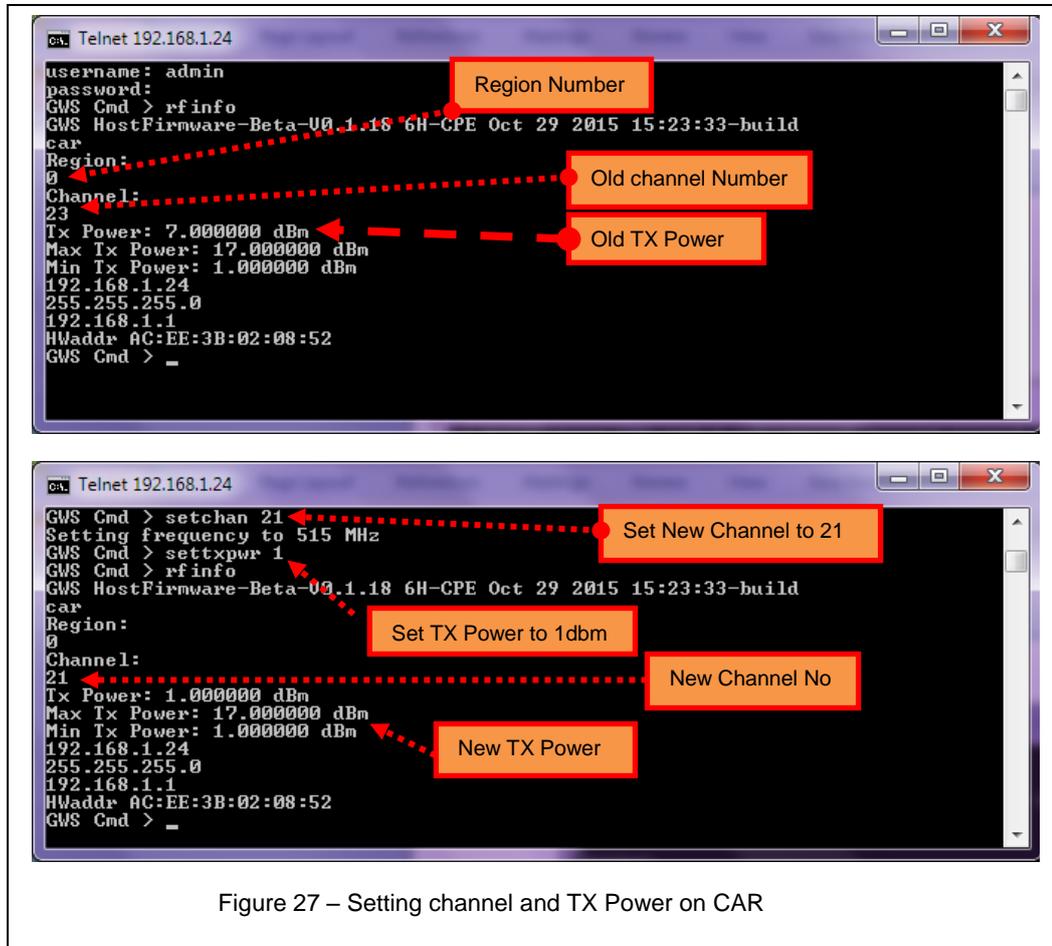


Figure 27 – Setting channel and TX Power on CAR



## 19.1 Figure 28 shows the setup on EAR

```

c:\ Telnet 192.168.1.23
username: admin
password:
GWS Cmd > rfinfo
GWS HostFirmware-Beta-U0.1.16 6H-CPE Oct 30 2015 14:21:54-build
ear
Region:
0
Channel:
23
Tx Power: 5.000000 dBm
192.168.1.23
255.255.255.0
192.168.1.1
HWaddr AC:EE:3B:02:08:4A
GWS Cmd >

c:\ Telnet 192.168.1.23
GWS Cmd > setchan 21
Setting frequency to 515 MHz
GWS Cmd > settxpr 3
GWS Cmd > rfinfo
GWS HostFirmware-Beta-U0.1.16 6H-CPE Oct 30 2015 14:21:54-build
ear
Region:
0
Channel:
21
Tx Power: 3.000000 dBm
192.168.1.23
255.255.255.0
192.168.1.1
HWaddr AC:EE:3B:02:08:4A
GWS Cmd > _

```

Figure 28 – Setting channel and TX Power on EAR



## 20 Start monitor tool on telnet shell to monitor the radio link

Now that both CAR and EAR are working on the same region number 0 , UHF channel 18 and proper TX Power to cover the distance, the radio link should be established. You can start the monitor tools on both CAR and EAR's telnet shell to monitor the link status.

### 20.1 Figure 29 shows monitor window on CAR

From Figure 24 we can get the following information:

- RSSI: -58 dBm - Noise Floor: -99 dBm - SNR: 41
- RX Speed: 14.0 Mbps - RX MCS: 6
- TX Speed: 4.0 MBps - TX MCS: 2
- Region: 0 - Channel: 21 - TX Power: 1dbm
- Connection: connected to EAR who has MAC AC:EE:3B:02:08:3A

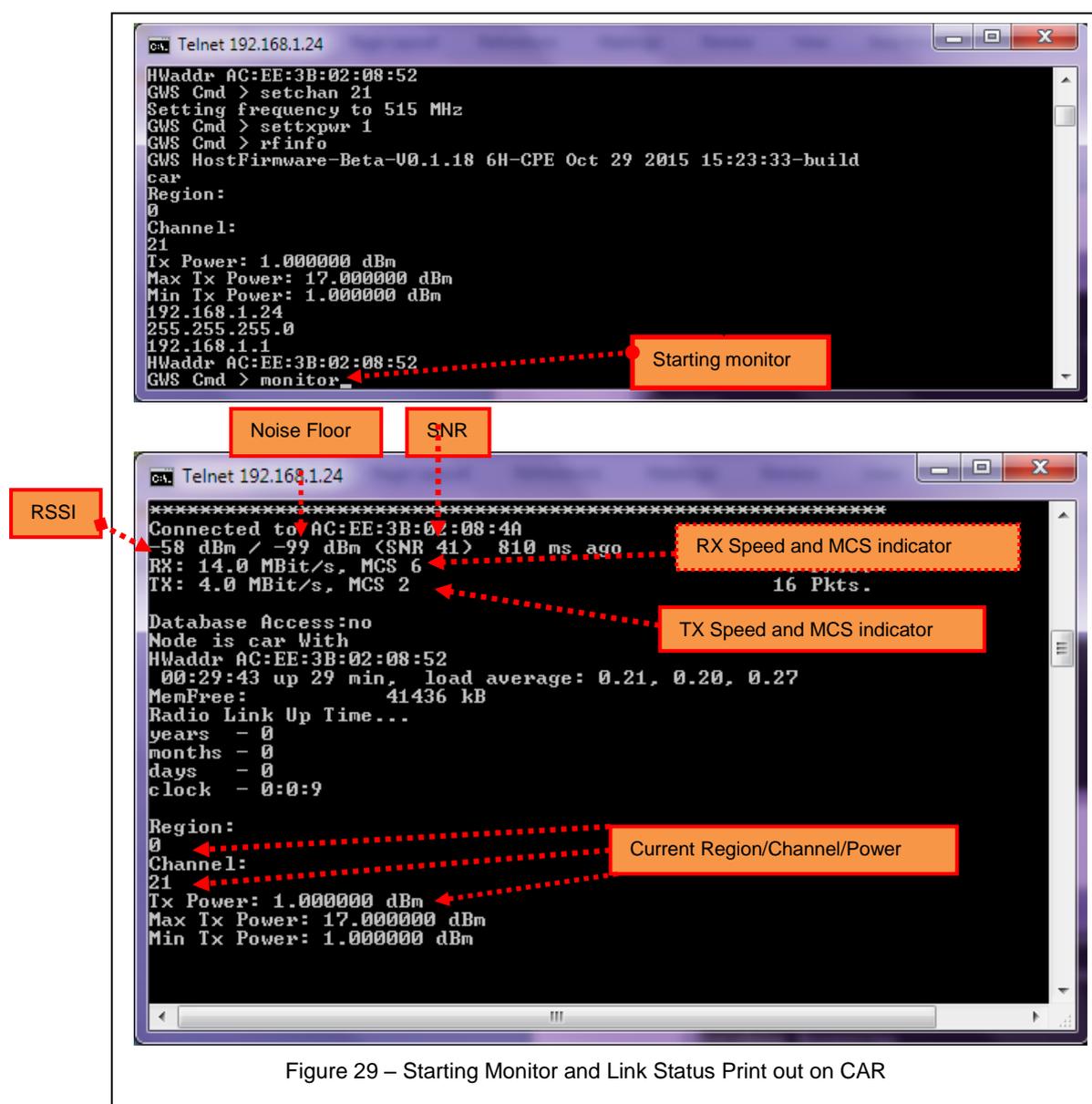


Figure 29 – Starting Monitor and Link Status Print out on CAR



## 20.2 Figure 30 shows monitor window on EAR

From Figure 25 we can get the following information:

- RSSI: -51 dBm - Noise Floor: -98 dBm - SNR: 47
- RX Speed: 4.0 Mbps - RX MCS: 2
- TX Speed: 6.0 MBps - TX MCS: 3
- Region: 0 - Channel: 21 - TX Power: 3dbm
- Connection: connected to CAR who has MAC AC:EE:3B:02:08:52

```
cx Telnet 192.168.1.23
GWS Cmd > setchan 21
Setting frequency to 515 MHz
GWS Cmd > settxprw 3
GWS Cmd > rfinfo
GWS HostFirmware-Beta-U0.1.16 6H-CPE Oct 30 2015 14:21:54-build
ear
Region:
0
Channel:
21
Tx Power: 3.000000 dBm
192.168.1.23
255.255.255.0
192.168.1.1
HWaddr AC:EE:3B:02:08:4A
GWS Cmd > monitor_

cx Telnet 192.168.1.23
*****
Connected to AC:EE:3B:02:08:52
-51 dBm / -98 dBm (SNR 47) 4680 ms ago
RX: 4.0 MBit/s, MCS 2          1556 Pkts.
TX: 6.0 MBit/s, MCS 3          18 Pkts.

Database Access:no
Node is ear With
HWaddr AC:EE:3B:02:08:4A
00:18:39 up 18 min, load average: 0.14, 0.27, 0.29
MemFree: 41768 kB
Radio Link Up Time...
years - 0
months - 0
days - 0
clock - 0:1:10

Region:
0
Channel:
21
Tx Power: 3.000000 dBm
```

Figure 30 – Starting Monitor Tool and Link Status Print Out on EAR



## 21 Link Performance Tuning

After the link has been established, you may need to tune the link balance to get optimal performance:

- 21.1 If the TX power of the BTS is too strong, the signal may saturate the receiver of the receiving node and link performance will be degraded. Figure 31 shows a link with too strong power. In this case, you'll need to lower down the TX Power to get RSSI below -60dbm and above -75 dbm.
- 21.2 Sometime link signal may be too weak, let's RSSI is below -80dbm, then you may need to increase the TX Power if possible so that RSSI is above -75dbm.
- 21.3 Other cases are one side RSSI is too high, the other side RSSI is too weak, then you need to tweak the TX power to balance the link RSSI to optimal performance.

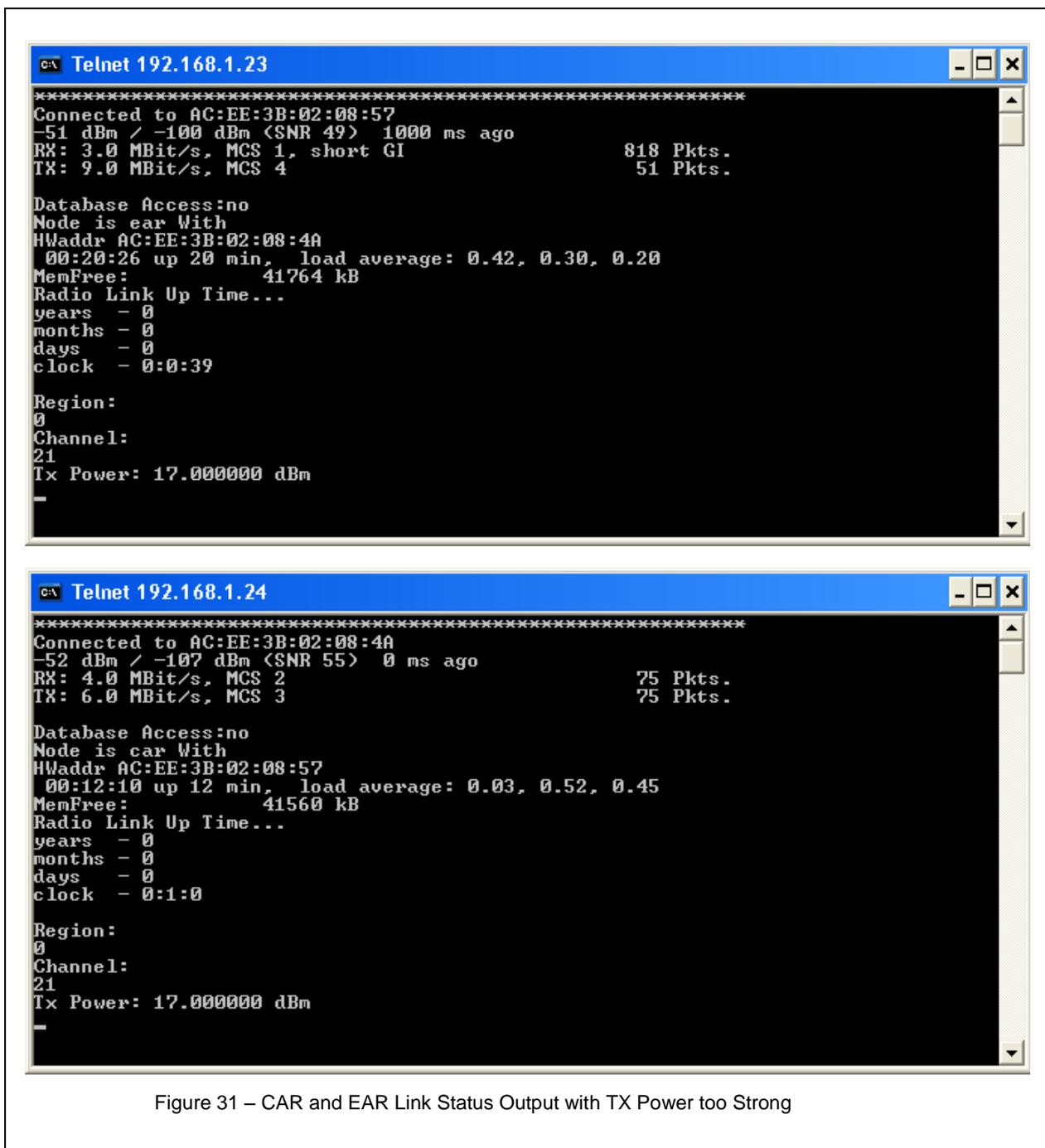


Figure 31 – CAR and EAR Link Status Output with TX Power too Strong



21.4 Figure 32 shows an example of lowering down TX power to tune link balance and performance. You gradually lower down the TX Power and wait a minute to see the RSSI and MCS feedback. The RSSI should go down and MCS should go up. You stop when the RSSI fallen between -60 dbm ~ -75dbm with a MCS at 6~7.

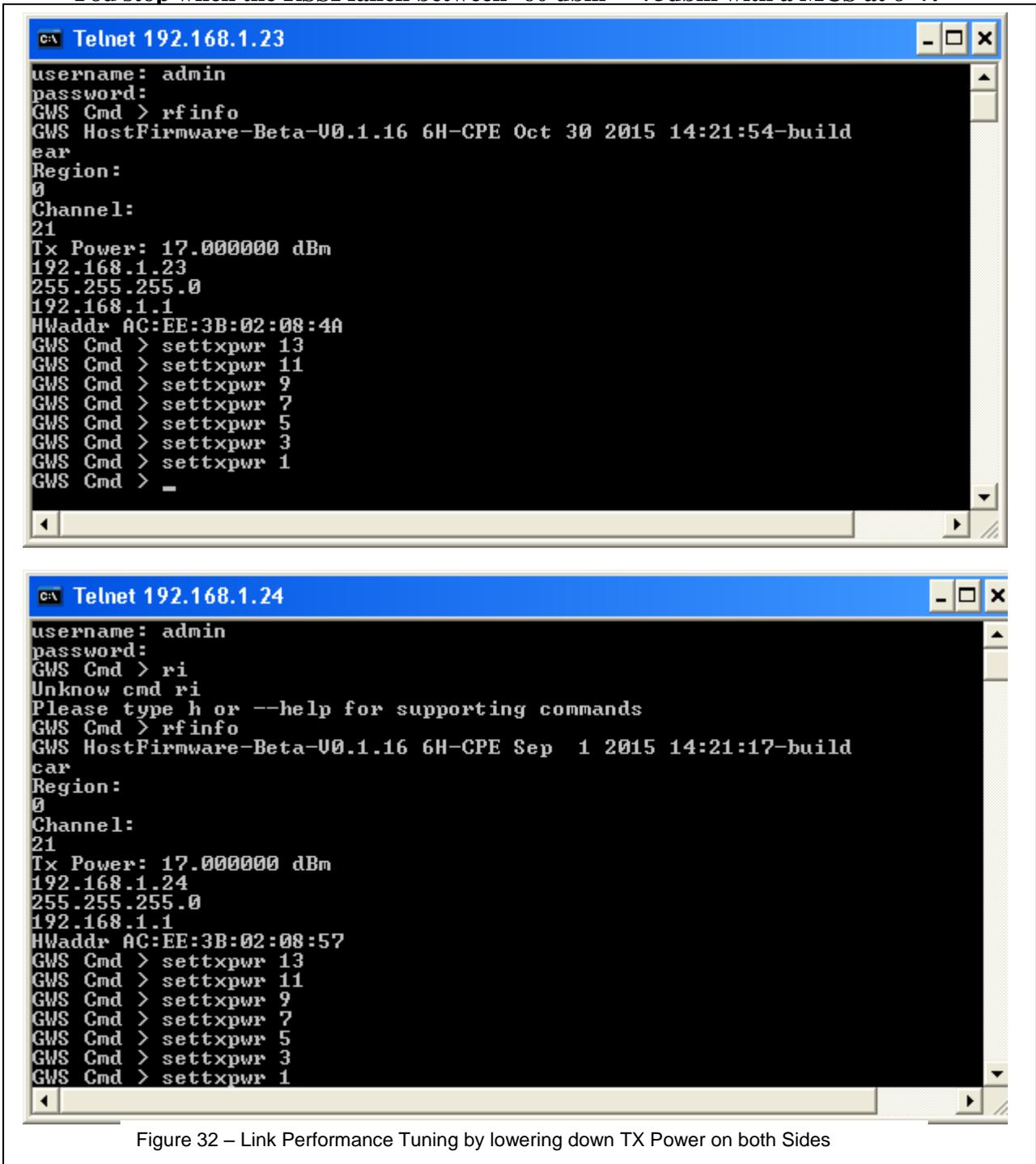


Figure 32 – Link Performance Tuning by lowering down TX Power on both Sides



21.5 Figure 33 shows after fine tuning, both CAR and EAR have very good link performance with MCS at 7.

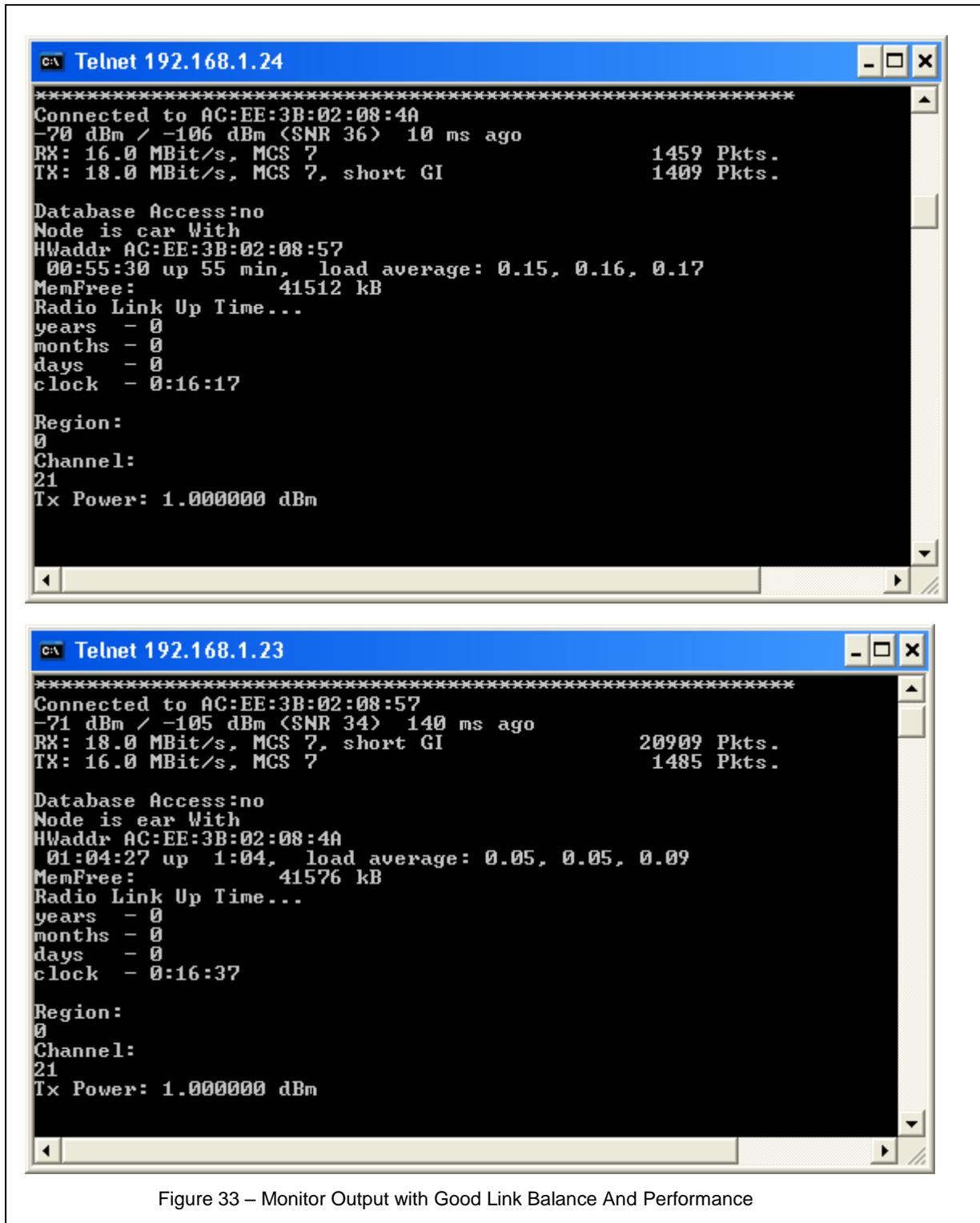


Figure 33 – Monitor Output with Good Link Balance And Performance



## 22 Troubleshooting

Table 1 shows some troubleshooting tips to help resolve some issues often seen during setup

Table 1 - Troubleshooting

Symptoms	Possible Cause	Actions	Details
Ping 192.168.1.1 timeout	POE cables or power cord are not properly connected	Check to see if both POE LEDs are on.	AC LED not on – AC power cord not plugged
			POUT LED not on – POE Ethernet cable not connected to BOX RJ-45 connector.
		Check to see if PC Link LED is on and blinking	PC Ethernet cable not properly connected
	PC IP Address not on the same subnet of 192.168.1.xx	On DOS prompt, use ipconfig command to check if PC IP is properly configured	Go back to network properties to reconfigure static IP
Cannot ping box with new IP after re-configure box's IP	New IP may not take effect	Reset the box	Power down/up to reboot the box
		Try to ping with old IP	Try to ping and log in with old IP, then reconfigure IP
Cannot establish radio link	Does TX/RX on	Does monitor show radio READY?	If status shows radio not ready, try to turn tx on by typing "txon" on telnet shell.
	Does both CAR and EAR working on the same RF settings	Use monitor to check the RF settings	Checking region number, channel number to see if they are same
	Signal too Strong	Lower TX Power	Lowering TX Power by log into telnet shell, and adjust power by using "settxpwr" command
	Signal too weak	Increase TX Power	Increasing TX Power by log into telnet shell, and adjust power by using "settxpwr" command
	Interference – the current channel has strong interference or not clean	Change to different channel	Change to different channel in telnet shell
Link Performance not good	Link not balanced, signal too weak or strong	Adjusting TX power	Increasing or lowering TX power to adjust RSSI and MCS to a good range of -60dbm ~ -75dbm
BTS or CPE is showing "No Valid Channel List"	The registration info is incomplete, or the BTS or CPE cannot reach the database	Double check registration info. Ensure the nodes can reach the database.	

