6. Test Methods

6.1. Sleep1 Current Measurement

6.1.1. Test Setup

Keithley 2001 series current meter to get accurate data.

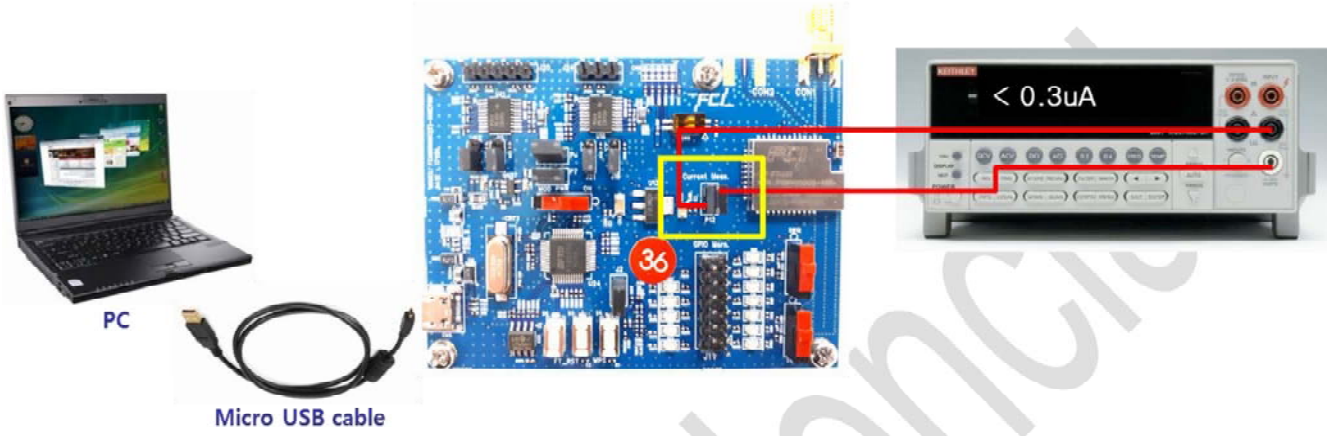

Figure 5.Sleep1 Current Measurement Environment

6.1.2. Test Procedure

1) Connect a USB cable from PC to EVB Micro USB port and connect a wired cable from the test point in the yellow box to the current meter (Keithley 2001)
2) Set the Power S/W (SW13) to ON and Set the PWR_KEY (SW2) to Low status

Switch-ON (default)

RTC Power off

3) Measure sleep1 current on the current meter. It would be lower than 0.3uA

6.2. Sleep3 Current Measurement

6.2.1. Test Setup

Keysight N6705 power analyzer to measure average current and low current at deep power sleep mode.

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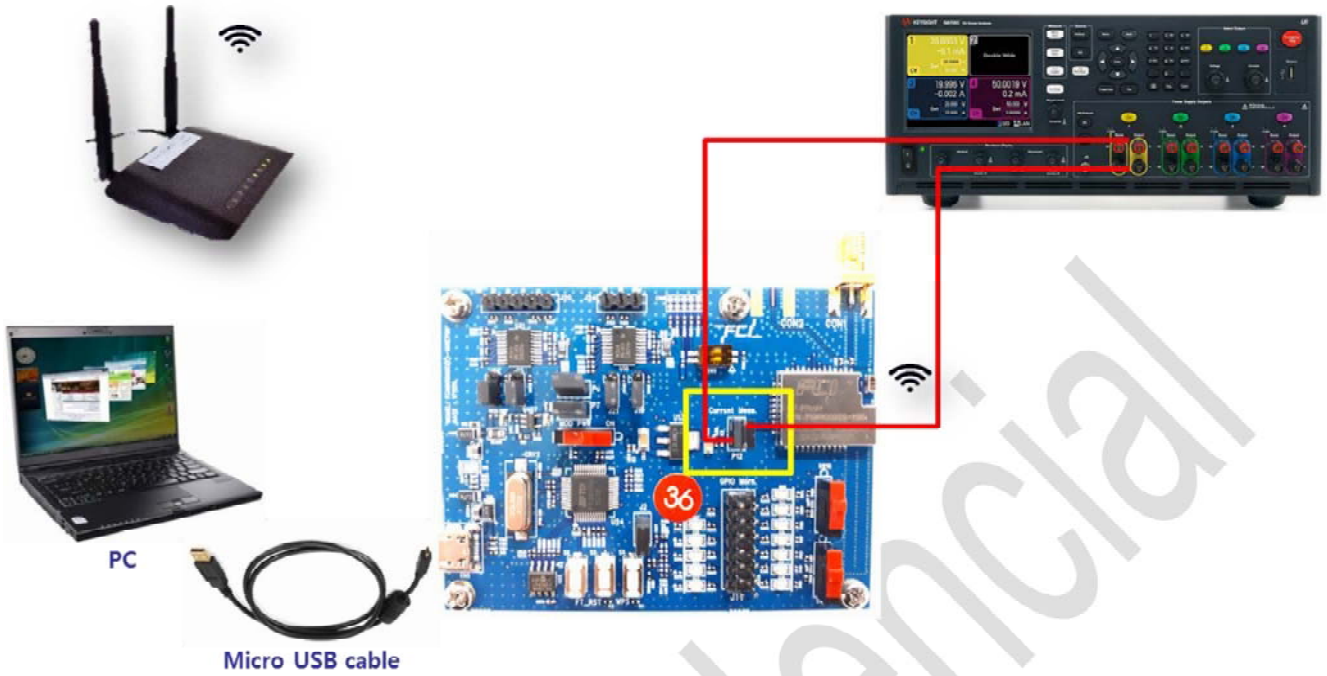

Figure 6.Sleep3 Current Measurement Environment

6.2.2. Test Procedure

1) Connect USB cable from PC to EVB Micro USB port and connect wired cable from test point in yellow box to N6705 output port.
2) Set the Power S/W (SW13) to ON and Set PWR_KEY (SW2) to High status.

Switch-ON (default)

RTC Power off

3) Perform DPM Mode setting procedure.
4) Set N6705 power analyzer to proper setup for measurement and check deep sleep current and average current during DPM mode operation.

6.3. Current Measurement with IAR I-scope

6.3.1. Test Setup

This chapter explains how to measure current consumption of the FCM9000S with IAR I-jet and I-scope. Before current measurement, shunt resistors need to be placed in series between the power measurement header pins (refer to Figure 1). The value of the shunt resistors would be 0.33 Ohm to measure up to 300mA. The value is adjustable if it is small enough not to drop voltage but 0.33 Ohm is our recommendation.

$$R = V/I = 0.1\ V/0.3\ A = 0.33\ Ohm$$

Note : The shunt resistors should be removed to measure the current with other equipment (e.g. Keysight).

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Connect IAR I-jet and IAR I-scope to the FCM9000S EVB as described in Figure 7. Connect the two differential current measurement leads(marked I+ and I-) to the power measurement header pins on the FCM9000S EVB.

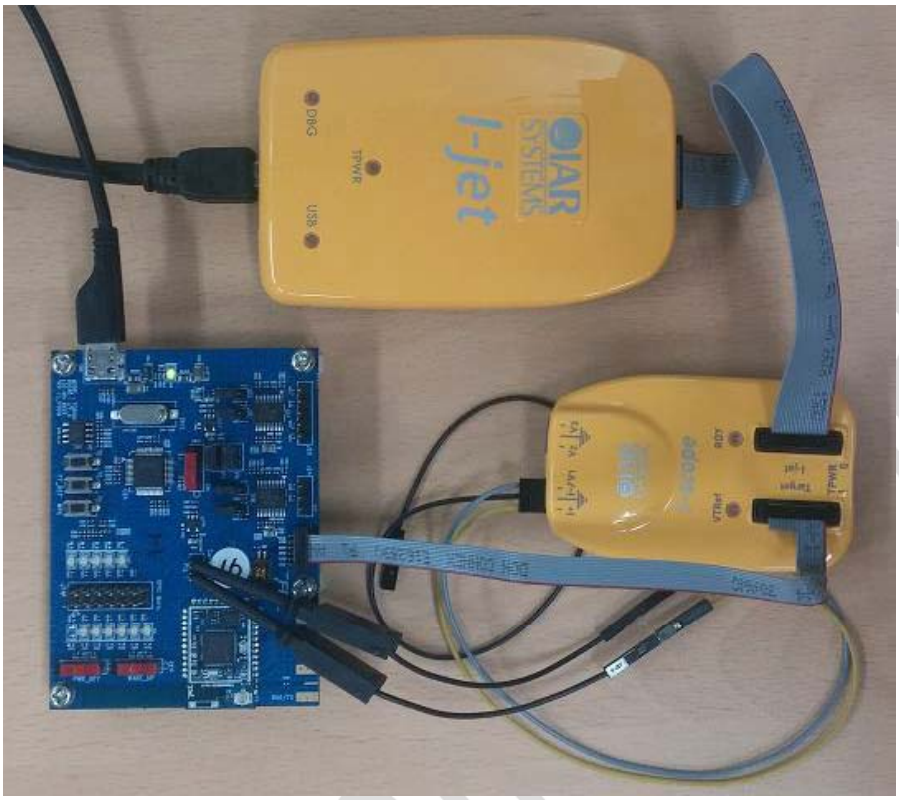

Figure 7. Current Measurement Environment with IAR I-scope

6.3.2. Test Procedure

1) Run IAR Workbench.
2) Menu > File > Open > Workspace. Open the FCM9000S SDK workspace.
3) Menu > Project > Project Download and debug.
4) Menu > I-jet/JTAGjet > Power Log Setup. Change "Shunt" value to 0.3 Ohm (as same as added to the power measurement header pins).

Power Log Setup

Sampling Frequency Max [Hz]: 200000 Wanted [Hz]: 10000 Actual [Hz]: 23437

ID	Name	Shunt [Ohm]	Threshold	Unit	Action
I	I	0.300	0	mA	Log All
V1	V1	--	0	mV	Log All
V2	V2	--	0	mV	Log All
V3	V3	--	0	mV	Log All

5) Menu > I-jet/JTAGjet > Power Log. Enable power log function through the context menu.

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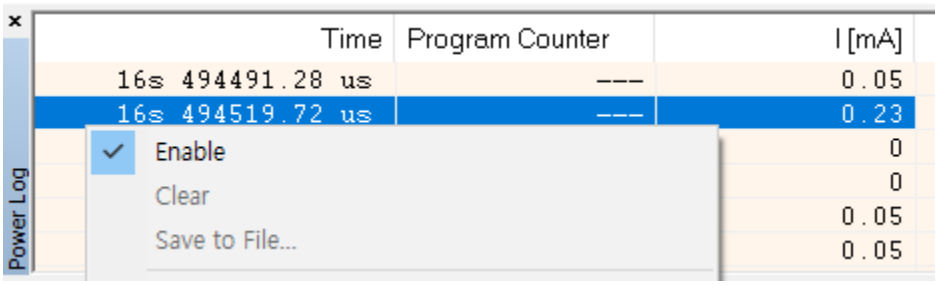
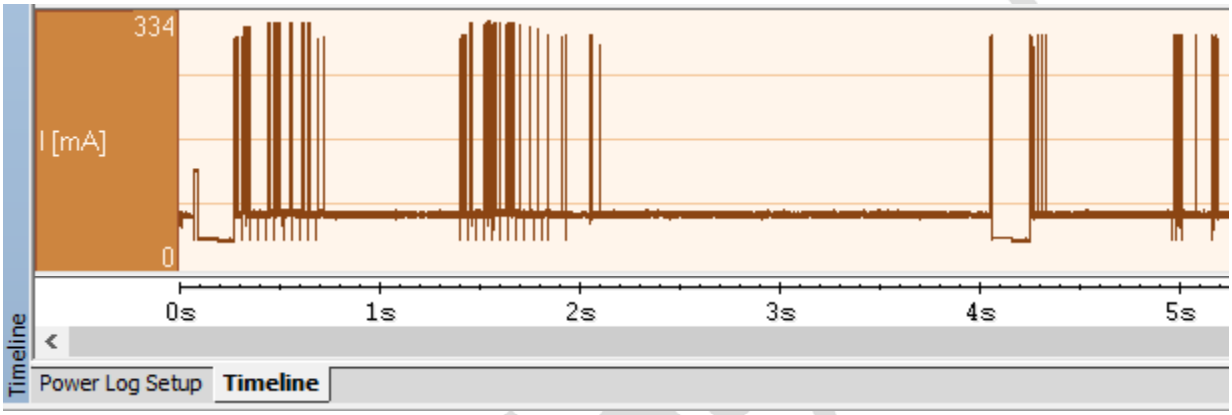


6) Menu > I-jet/JTAGjet > Timeline.



6.4. Iperf Test

FCM9000S provides iperf command to measure packet trasfer performance. The iperf command with no option or "-h" option shows the usage.

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```
[PRADA] iperf
Usage: iperf -I [WLAN0|WLAN1] [-s|-c host][options]
       iperf [-h] [-v]

Client/Server:
       -I      Interface [WLAN0|WLAN1]
       -u      use UDP rather than TCP
       -p, #   server port to listen on/connect to
       -w, #   TCP window size (4 ~ 64K)
       -d      finsh service
               ex) iperf -d -c -u : udp clinet
                   iperf -d -c    : tcp clinet
                   iperf -d -u    : udp server
                   iperf -d       : tcp server

Server specific:
       -s      run in server mode
       -T  #   Rx Time Out Min:1 sec. 'F' Forever

Client specific:
       -c      <host>   run in client mode, connecting to <host>
       -t  #   time in seconds to transmit for (default 10 secs)
       -l  #   UDP PacketSize option (default 1470, IPv6 1448)
       -n  #   UDP Tx packet number
       -S  #   WMM TOS option
               [224|192]
               [184|160|152|144|136]
               [112|96|0]
               [88|72|56|40|32]
       -P, #   Pair Index (0,1,2)
               (default Max, Step 1~100 Mbps)
       -O      use Main Packet Pool

Miscellaneous:
       -h      print this message
       -v      print version
[PRADA]
```

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6.4.1. Test Setup

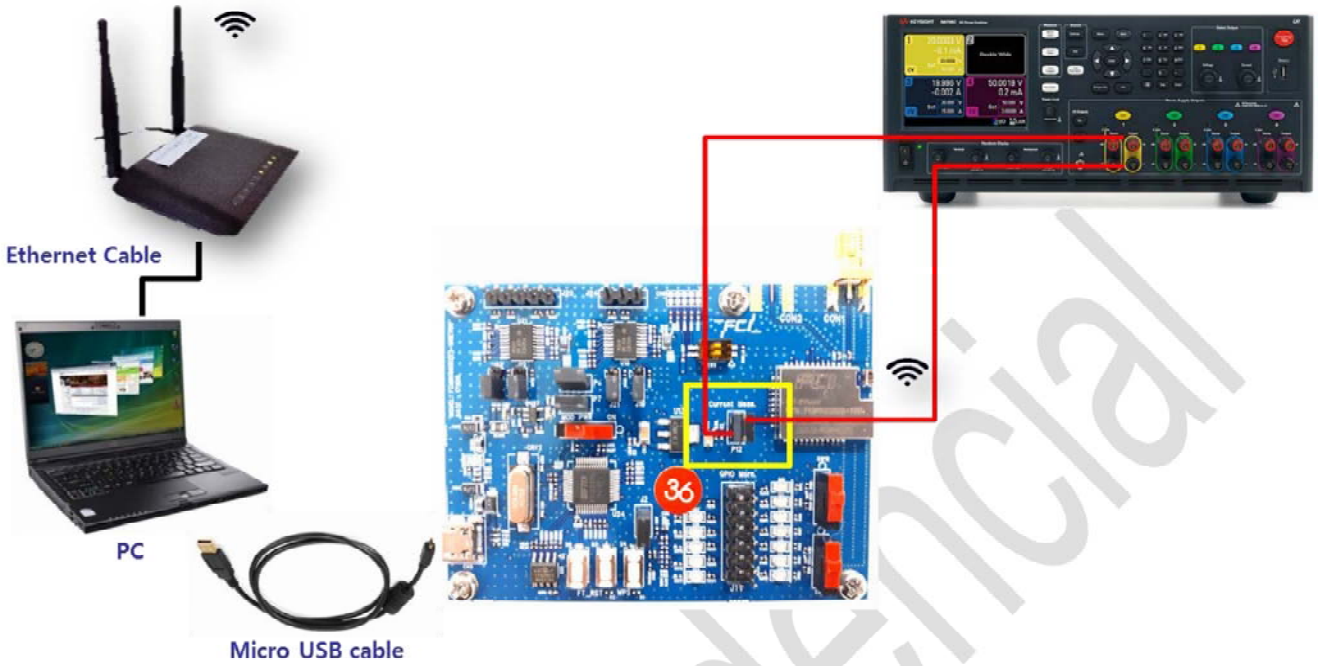

Figure 8. Iperf Test Environment

5) Prepare the iperf tool on your PC. If you don't have the iperf tool you can download the software from the web (https://iperf.fr/iperf-download.php)
6) Iperf Version 2.0.5 is recommend.

6.4.2. Test Procedure (Client Mode)

1) Connect your PC to the AP.
2) Check the IP address of your PC (10.0.1.3, IP address would be different depending on home AP setting)

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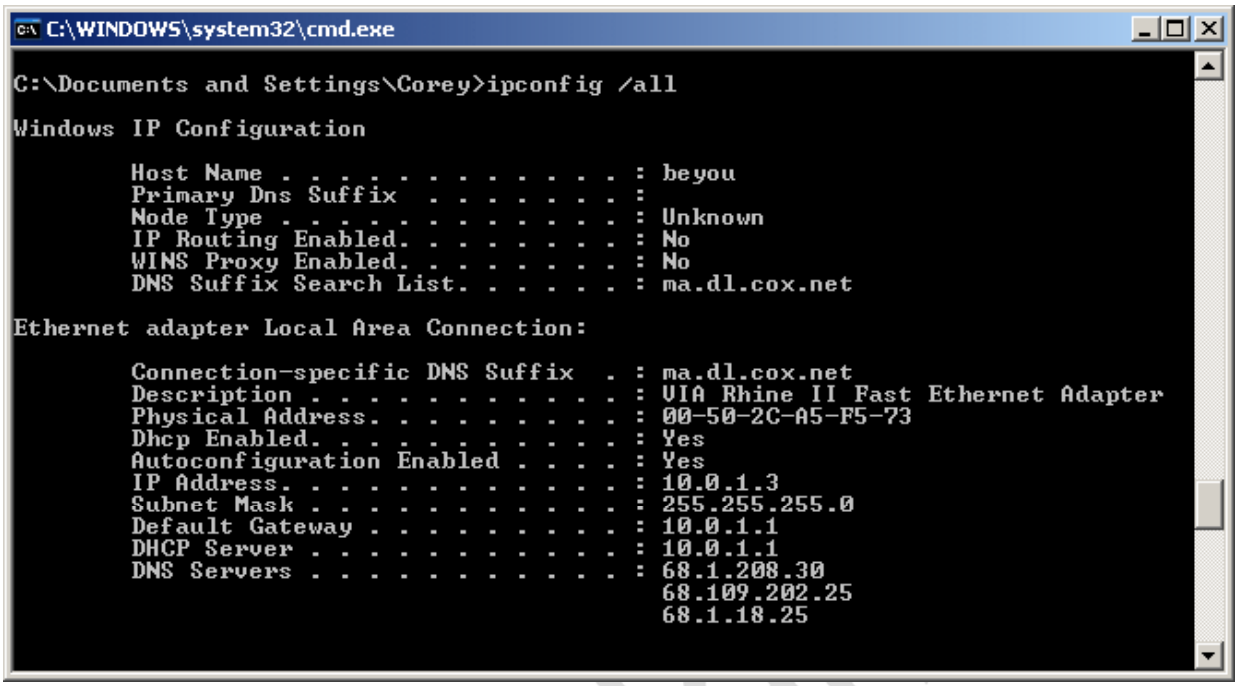
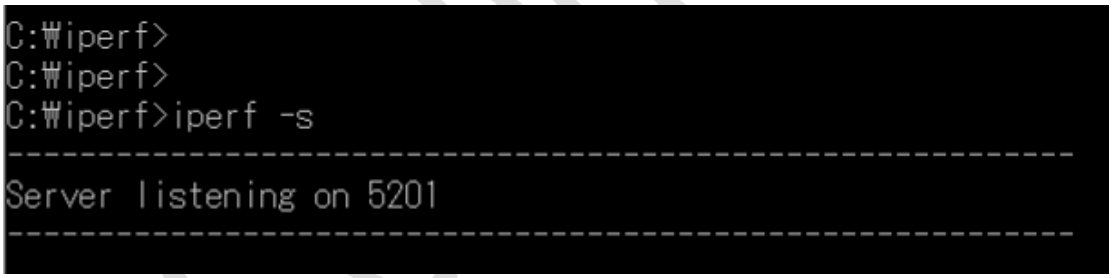
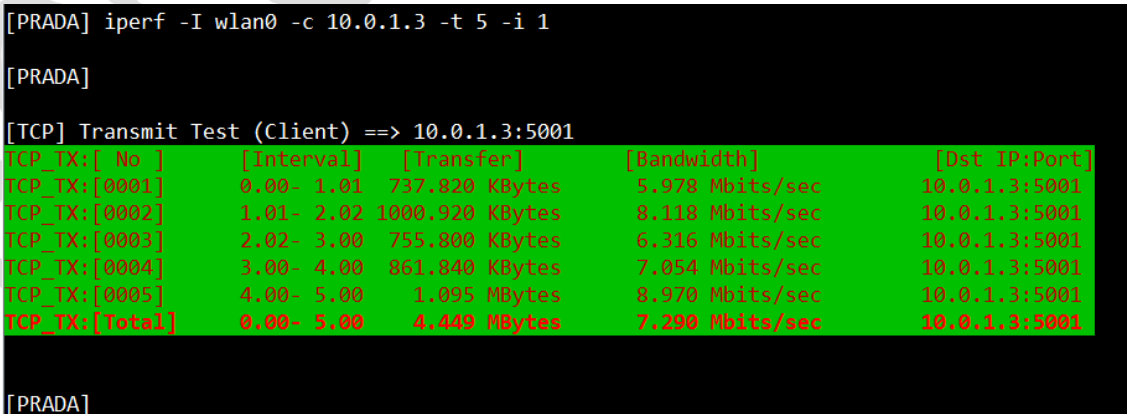


3) Prepare FCM9000S as Station mode without DPM.
4) Run iperf server on your PC.



5) Run iperf client on the FCM9000S

"Iperf –I wlan0 –c 10.0.1.3 –t 5 –I 1"



6.4.3. Test Procedure (Server Mode)

1) Connect your PC to the AP.
2) Check the IP address of FCM9000S (10.0.1.1, IP address would be different depending on home AP setting)

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```
-- DHCP Client WLAN0: SEL
-- DHCP Client WLAN0: REQ
-- DHCP Client WLAN0: BOUND
        Assigned addr   : 10.0.1.2
              netmask   : 255.255.255.0
              gateway   : 10.0.1.1
              DNS addr  : 10.0.1.1

        DHCP Server IP  : 10.0.1.1
        Lease Time      : 24h 00m 00s
        Renewal Time    : 12h 00m 00s

[PRADA]
```

3) Prepare FCM9000S as Station mode without DPM.
4) Run Iperf server on terminal.

```
[PRADA]
[PRADA] iperf -I wlan0 -s

iPerf Server(TCP): Ready

[PRADA]
```

5) Run Iperf client on the PC.

"Iperf –c 10.0.1.2 –t 5 –I 1"

```
C:¥iperf>iperf -c 10.0.1.2 -t 5 -i 1
------------------------------------------------------------
Client connecting to 10.0.1.2, TCP port 5001
TCP window size:  208 KByte (default)
------------------------------------------------------------
[  3] local 10.0.1.3 port 53895 connected with 10.0.1.2 port 5001
[ ID] Interval       Transfer     Bandwidth
[  3]  0.0- 1.0 sec  1.88 MBytes  15.7 Mbits/sec
[  3]  1.0- 2.0 sec  1.75 MBytes  14.7 Mbits/sec
[  3]  2.0- 3.0 sec  1.50 MBytes  12.6 Mbits/sec
[  3]  3.0- 4.0 sec  1.75 MBytes  14.7 Mbits/sec
[  3]  4.0- 5.0 sec  1.38 MBytes  11.5 Mbits/sec
[  3]  0.0- 5.1 sec  8.25 MBytes  13.6 Mbits/sec

C:¥iperf>_
```

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7. REGULATORY APPROVAL

7.1. Federal Communication Commission Interference Statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. 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. However, there is no guarantee that interference will not occur in a particular installation. 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 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 dealer or an experienced radio/TV technician for help

FCC Caution:

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

Radiation Exposure Statement:

This device is intended only for OEM integrators under the following conditions:

1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and the maximum antenna gain allowed for use with this device is 2.5 dBi.
2) The transmitter module may not be co-located with any other transmitter or antenna.

As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

IMPORTANT NOTE:

In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

End Product Labeling:

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with

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the following: "**Contains FCC ID: 2AMRF-FCM9000S**". The grantee's FCC ID can be used only when all FCC compliance requirements are met

Manual Information To the End User:

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module. The end user manual shall include all required regulatory information/warning as show in this manual.

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7.2. Industry Canada Statement

This Class B digital apparatus complies with Canadian ICES-003.
Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.

The County Code Selection feature is disabled for products marketed in the US/ Canada.
La fonction de sélection de l'indicatif du pays est désactivée pour les produits commercialisés aux États-Unis et au Canada.

Radiation Exposure Statement:
This equipment complies with IC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

Déclaration d'exposition aux radiations:
Cet équipement est conforme aux limites d'exposition aux rayonnements IC établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de 20 cm de distance entre la source de rayonnement et votre corps.

This device is intended only for OEM integrators under the following conditions: (For module device use)

1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and
2) The transmitter module may not be co-located with any other transmitter or antenna

As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

Cet appareil est conçu uniquement pour les intégrateurs OEM dans les conditions suivantes: (Pour utilisation de dispositif module)

1) L'antenne doit êoit installle de telle sorte qu'une distance de 20 cm est respectte entre l'antenne et les utilisateurs, et
2) Le module ée modul peut ne pas êne coo pas pa avec un autre éutre un ou antenne.

Tant que les 2 conditions ci-dessus sont remplies, des essais supplémentaires sur l'émetteur ne seront pas nécessaires. Toutefois, l'intégrateur OEM est toujours responsable des essais sur son produit final pour toutes exigences de conformité supplémentaires requis pour ce module installé.

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IMPORTANT NOTE:

In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the Canada authorization is no longer considered valid and the IC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate Canada authorization.

NOTE IMPORTANTE:

Dans le cas où ces conditions ne peuvent être satisfaites (par exemple pour certaines configurations d'ordinateur portable ou de certaines co-localisation avec un autre émetteur), l'autorisation du Canada n'est plus considéré comme valide et l'ID IC ne peut pas être utilisé sur le produit final. Dans ces circonstances, l'intégrateur OEM sera chargé de réévaluer le produit final (y compris l'émetteur) et l'obtention d'une autorisation distincte au Canada.

End Product Labeling:

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: "Contains IC: 22972-FCM9000S".

Plaque signalétique du produit final:

Ce module émetteur est autorisé uniquement pour une utilisation dans un dispositif où l'antenne peut être installée de telle sorte qu'une distance de 20cm peut être maintenue entre l'antenne et les utilisateurs. Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante: "Contient des IC: 22972-FCM9000S".

Manual Information To the End User:

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.
The end user manual shall include all required regulatory information/warning as show in this manual.

Manuel d'information à l'utilisateur final:

L'intégrateur OEM doit être conscient de ne pas fournir des informations à l'utilisateur final quant à la façon d'installer ou de supprimer ce module RF dans le manuel de l'utilisateur du produit final qui intègre ce module.
Le manuel de l'utilisateur final doit inclure toutes les informations réglementaires requises et avertissements comme indiqué dans ce manuel.

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Detachable Antenna Usage:

Detachable Antenna usageThis radio transmitter (IC: 22972-FCM9000S) has been approved by Industry Canada to operate with the antenna type listed below with maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with the device.

Utilisation détachable de l'antenne:

Le présent émetteur radio (IC: 22972-FCM9000S) a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal. Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

Brand	Model	Ant type	Antenna gain	Connector
Partron	SDBTPTR3015	Chip	1.99	N/A
TELLESTAR	TE-2450TO-03-105	External	2.5	u. FL connector

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