Qualcomm Technologies, Inc.

QCC744 and AR8032 Integration via EMAC Application Note

80-WL740-52 Rev. AB

Revision History

Revision	Date	Description
AA	July 2025	Initial release
AB	December 2025	Updated Slide 8 Block diagram

Contents

Introduction

- This document covers the following topics:
  - how to integrate QCC744 with AR8032
  - how to verify QCC744 Ethernet Media Access Controller (EMAC) peripheral
- The emac_basic example verifies the basic packet Tx and Rx functionality of the EMAC by conducting a loopback test of ARP packets through the connected external Ethernet PHY chip.
- The lwip_iperf example uses iperf to measure Ethernet speed.

Section 1

Hardware connections

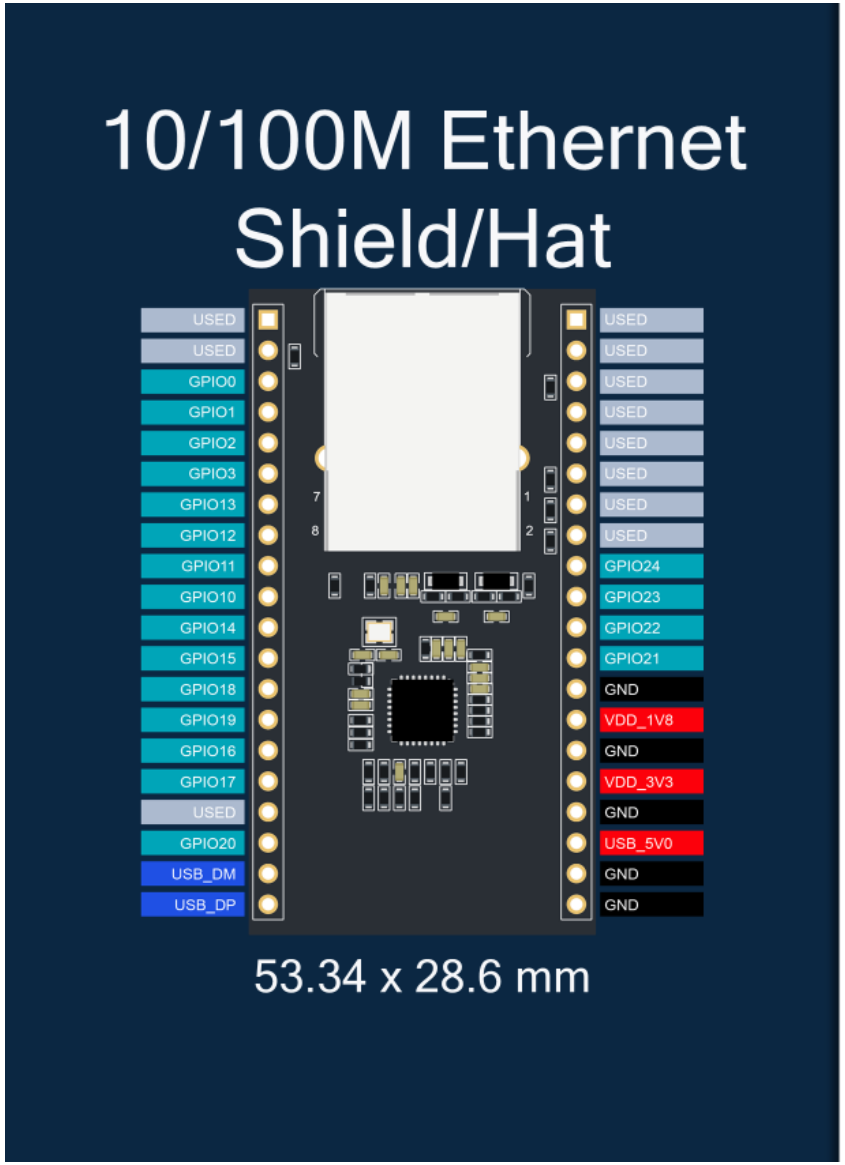
Pin mapping

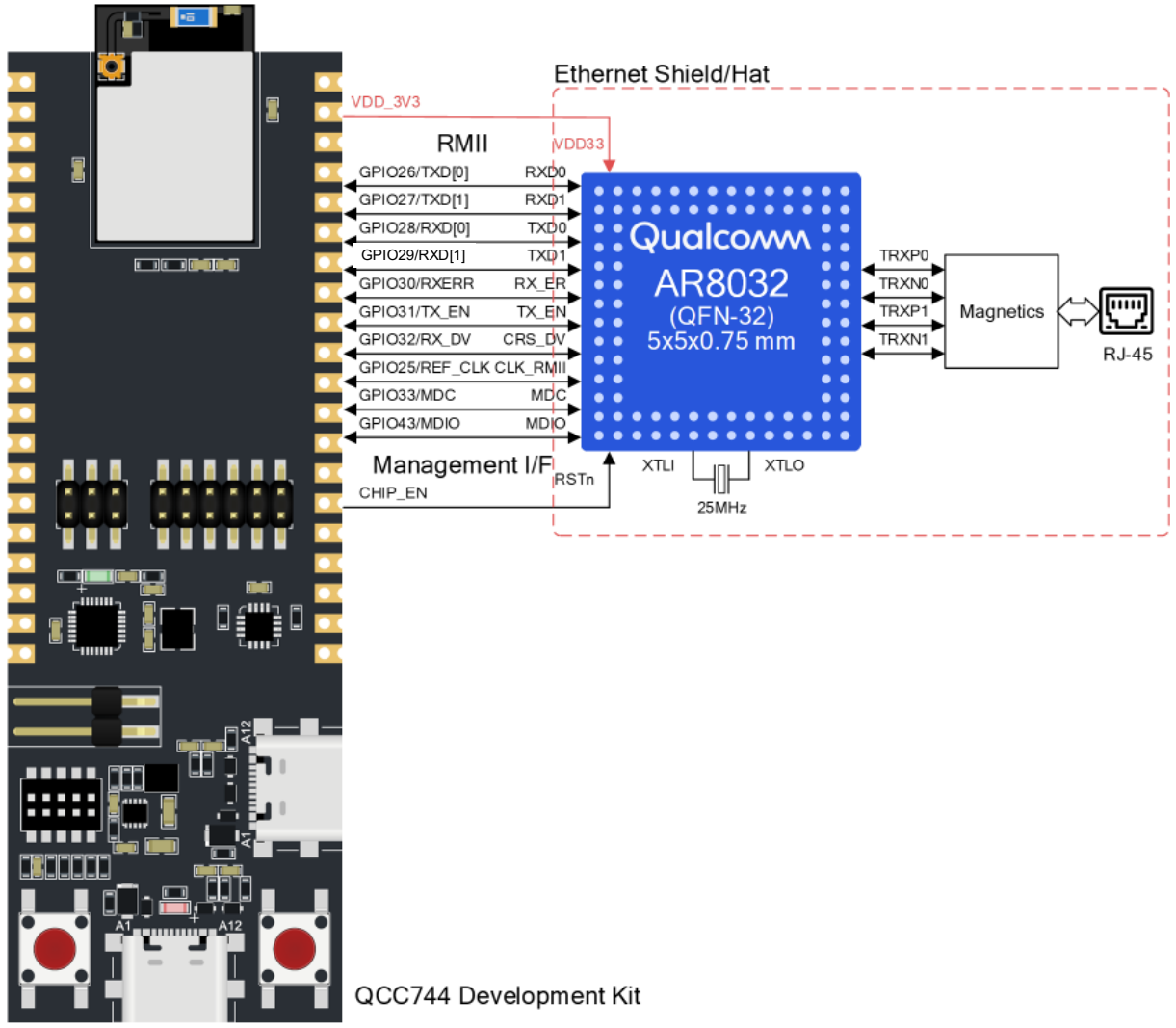
AR8032 pin number	AR8032 pin name	QCC744	RJ45-	Comments
1	VDD12_REG	-	-	-
2	VDD3	-	-	-
3	VDD25_REG	-	-	-
4	RX-	-	TD-	-
5	RX+	-	TD+	-
6	TX-	-	RD-	-
7	TX+	-	RD+	-
8	XO	-	-	NC
9	XI	GPIO25	-	Provision for either a 50 MHz crystal oscillator (OSC813500-SCO-B452) or a clock signal from the QCC744.
10	RSTn	GPIO24	-	-
11	MDIO	GPIO34	-	-
12	MDC	GPIO33	-	-
13	RXD3	-	-	Provision for a 22 Ω series resistor and a 10 kΩ pull-up to VDD25
14	RXD2	-	-	Provision for a 22 Ω series resistor and a 10 kΩ pull-down to GND
15	RXD1	GPIO29	-	Provision for a 22 Ω series resistor and a 10 kΩ pull-up to VDD25
16	RXD0	GPIO28	-	Provision for a 22 Ω series resistor and either a 10 kΩ pull-up to VDD25 or a 10 kΩ pull-down to ground
17	VDD25	-	-	Due to the use of a switching regulator, connect pin 3 and pin 17 using a ferrite bead (PZ1005E700-R80TF) and a 0.1 µF capacitor.
18	RX_DV	GPIO32	-	Provision for a 22 Ω series resistor and a 10 kΩ pull-down to GND
19	RXC	-	-	Provision for a 10 kΩ pull-down to GND

Pin mapping (cont.)

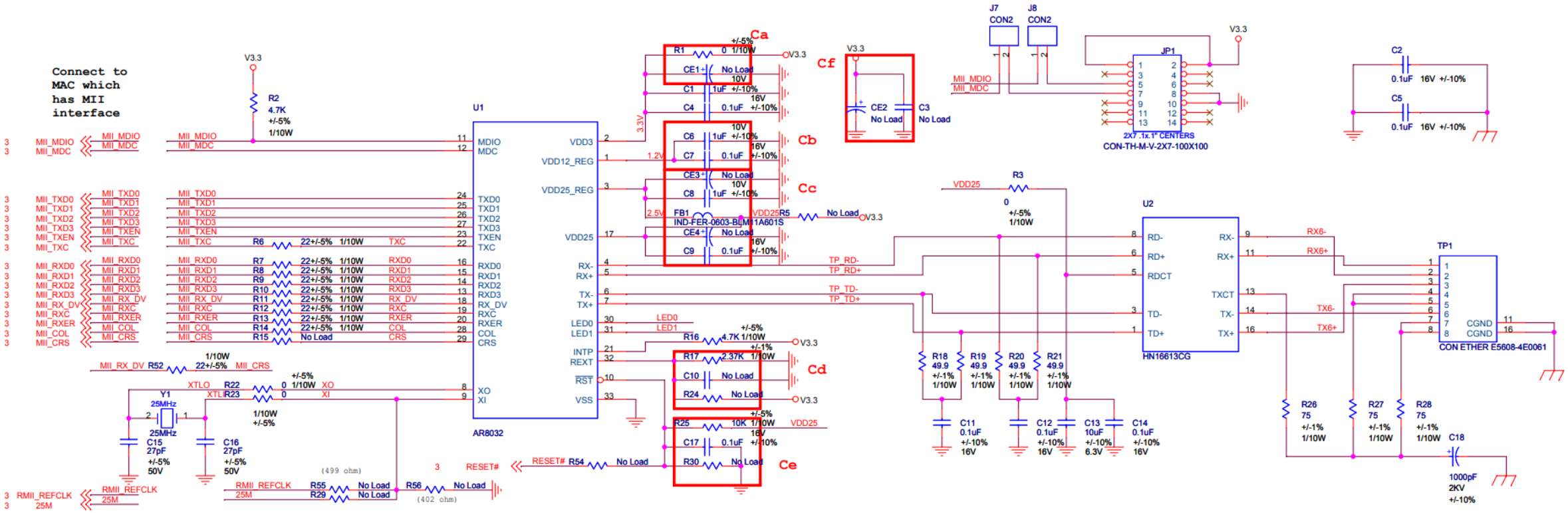
AR8032 pin number	AR8032 pin name	QCC744	RJ45	Comments
20	RXER	GPIO30	-	Provision for a 22 Ω series resistor
21	INTP	-	-	Provision for a 10 kΩ pull-up to VDD25
22	TXC	-	-	Provision for a 10 kΩ pull-up to VDD25
23	TXEN	GPIO31	-	-
24	TXD0	GPIO26	-	-
25	TXD1	GPIO27	-	-
26	TXD2	-	-	NC
27	TXD3	-	-	NC
28	COL	-	-	Provision for a 10 kΩ pull-up to VDD25
29	CRS	-	-	Provision for a 10 kΩ pull-down to GND
30	LED0	-	LEDY-	Provision for a 10 kΩ pull-up to VDD25
31	LED1	-	LEDY+	Provision for a 10 kΩ pull-up to VDD25
32	REXT	-	-	Provision for a 2.3 kΩ pull-down to GND
33	GPAD	-	-	Connect to GND

Block diagram

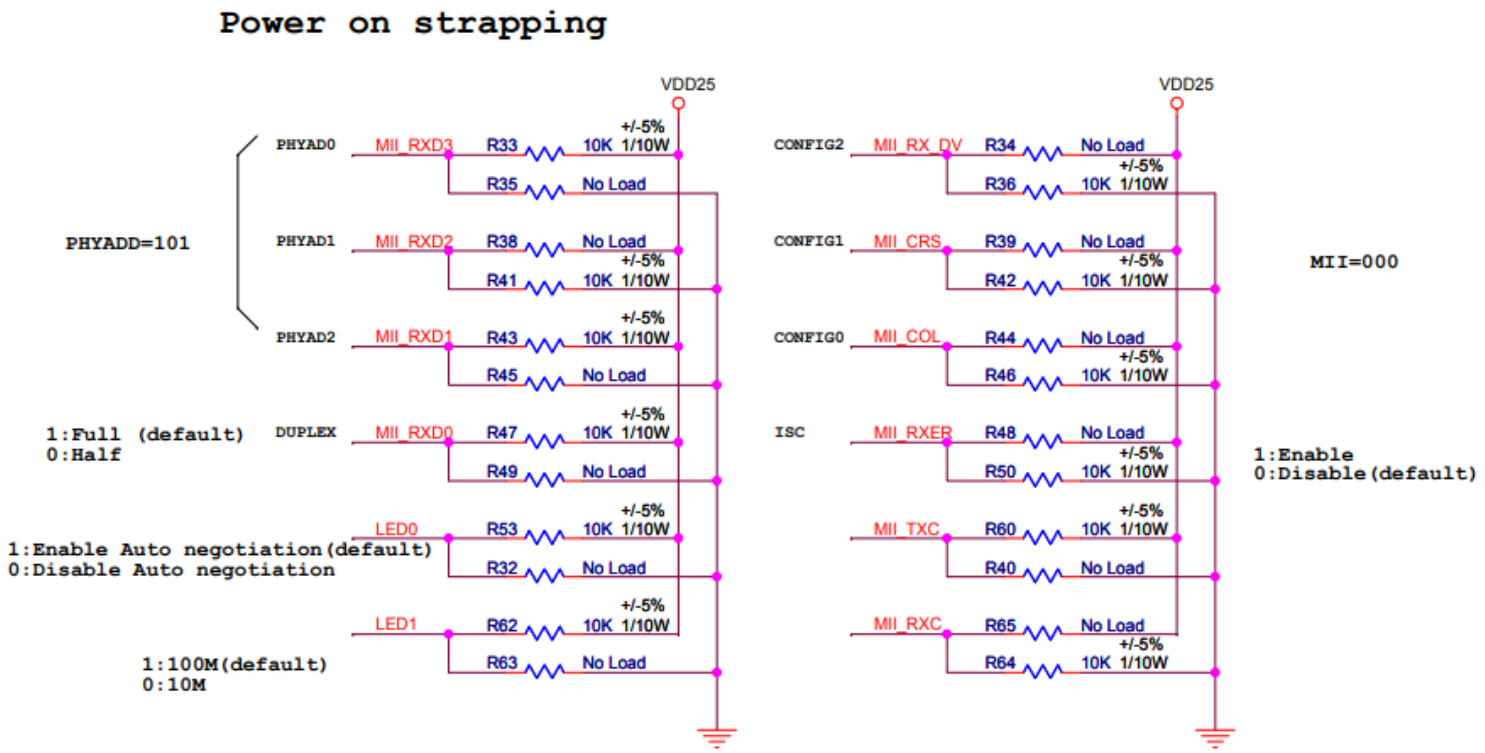




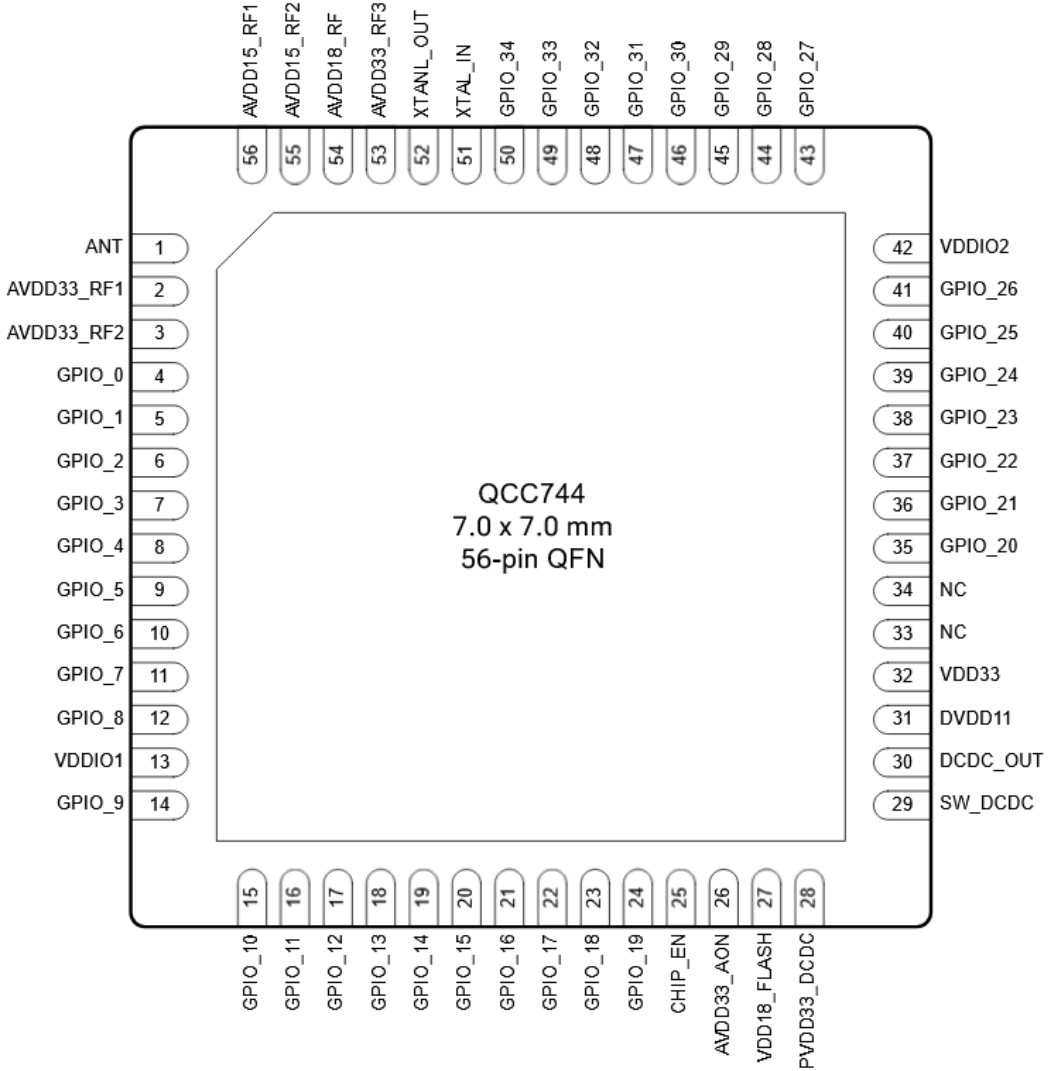
Schematic connections



Power-on strapping

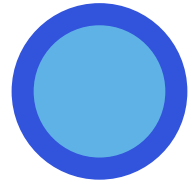


QCC744 pin assignments



QCC744 GPIO assignments

QCC744 GPIOs	Comments
GPIO0	Suggest to use a 100 kΩ pull-up resistor on the PCB
GPIO1	Suggest to use a 100 kΩ pull-up resistor on the PCB
GPIO2	Suggest to use a 100 kΩ pull-up resistor on the PCB
GPIO3	Suggest to use a 100 kΩ pull-up resistor on the PCB
GPIO4	Suggest to use a 10 kΩ pull-up resistor on the PCB
GPIO5	Suggest to use a 10 kΩ pull-up resistor on the PCB
GPIO6	Suggest to use a 10 kΩ pull-up resistor on the PCB
GPIO7	Suggest to use a 10 kΩ pull-up resistor on the PCB
GPIO8	Suggest to use a 10 kΩ pull-up resistor on the PCB
GPIO9	Suggest to use a 10 kΩ pull-up resistor on the PCB
GPIO10	Suggest to use a 100 kΩ pull-up resistor on the PCB
GPIO11	Suggest to use a 100 kΩ pull-up resistor on the PCB
GPIO12	Suggest to use a 100 kΩ pull-up resistor on the PCB
GPIO13	Suggest to use a 100 kΩ pull-up resistor on the PCB
GPIO14	Suggest to use a 100 kΩ pull-up resistor on the PCB
GPIO15	Suggest to use a 100 kΩ pull-up resistor on the PCB
GPIO16	Suggest to use a 100 kΩ pull-up resistor on the PCB
GPIO17	Floating
GPIO18	Suggest to use a 10 kΩ pull-up resistor on the PCB
GPIO19	Suggest to use a 10 kΩ pull-up resistor on the PCB
GPIO20	Suggest to use a 10 kΩ pull-up resistor on the PCB
GPIO21	Suggest to use a 10 kΩ pull-up resistor on the PCB
GPIO22	Suggest to use a 10 kΩ pull-up resistor on the PCB
GPIO23	Suggest to use a 10 kΩ pull-up resistor on the PCB



Section 2

emac_basic

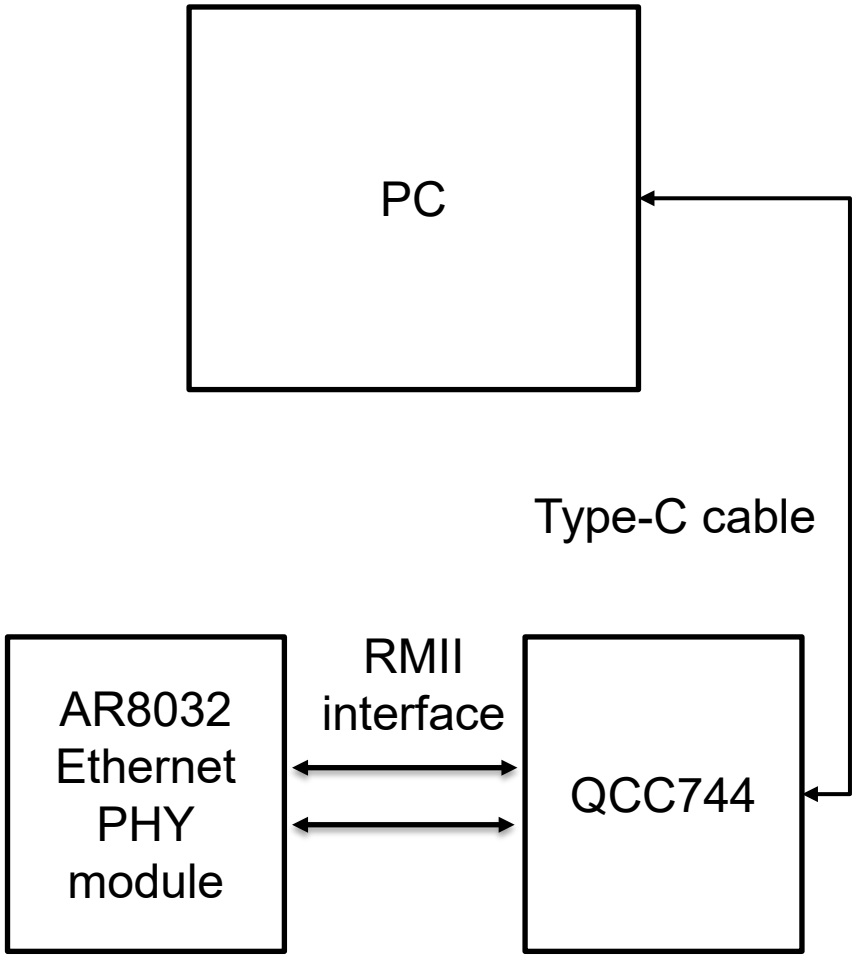
Test steps

This test validates the basic functionality of the EMAC on the QCC744 by performing a loopback test using ARP packets through the AR8032 Ethernet PHY.

Steps:

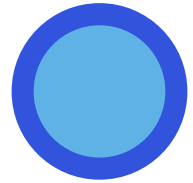
1. Flash the emac_basic build from the latest SDK onto the QCC744 board.
2. Connect the QCC744 to the AR8032 via the RMII interface.
3. Use a serial terminal (e.g., PuTTY) to monitor the output and verify packet transmission and reception.

Test setup


PC
Type-C cable
AR8032
Ethernet
PHY
module
RMII
interface
QCC744

Test output

```
Build:12:49:19,Feb 21 2025
Version of used components:
       Version: component_version_lhal: version-unknown-panic
       Version: component_version_sdk_2.0.64
Current chip device version: 1
======== flash cfg ========
flash size 0x00800000
jedec id     0x1760C4
mid              0xC4
iomode           0x04
clk delay        0x01
clk invert       0x01
read reg cmd0    0x05
read reg cmd1    0x35
write reg cmd0   0x01
write reg cmd1   0x31
qe write len     0x01
cread support    0x01
cread code       0xA0
burst wrap cmd   0x77
============================
dynamic memory init success, ocram heap size = 430 Kbyte, psram heap size = 4096 Kbyte
sig1:ffffffff
sig2:0000f32f
cgen1:9ffffffd
[I][MAIN] EMAC ARP Packet test!
[I][EPHY] eth phy scan success, phy_addr: 5, phy_id: 0x004DD023
[W][EPHY] drv_match falied, use General driver
[I][MAIN] eth_phy speed: 100M_FULL_DUPLEX
[I][MAIN] eth_phy loopback mode
[I][MAIN] eth_phy init done

[I][MAIN] TX: Speed: 74Mbps, valid_data_speed: 49Mbps
[I][MAIN]     success cnt:292434, error cnt:0, total size:12282228Byte
[I][MAIN]     push_cnt:292475, tx_db available:1
[I][MAIN] RX: Speed: 74Mbps, valid_data_speed: 74Mbps
[I][MAIN]     success cnt:292430, error cnt:0, total size:18715520Byte
[I][MAIN]     push_cnt:292430, rx_db available:1, busy cnt:0

[I][MAIN] TX: Speed: 74Mbps, valid_data_speed: 49Mbps
[I][MAIN]     success cnt:584750, error cnt:0, total size:24559500Byte
[I][MAIN]     push_cnt:584793, tx_db available:1
[I][MAIN] RX: Speed: 74Mbps, valid_data_speed: 74Mbps
[I][MAIN]     success cnt:584748, error cnt:0, total size:37423872Byte
[I][MAIN]     push_cnt:584748, rx_db available:1, busy cnt:0

[I][MAIN] TX: Speed: 74Mbps, valid_data_speed: 49Mbps
[I][MAIN]     success cnt:877070, error cnt:0, total size:36836940Byte
[I][MAIN]     push_cnt:877114, tx_db available:1
[I][MAIN] RX: Speed: 74Mbps, valid_data_speed: 74Mbps
[I][MAIN]     success cnt:877069, error cnt:0, total size:56132416Byte
[I][MAIN]     push_cnt:877069, rx_db available:1, busy cnt:0
```



Section 3

lwip_iperf

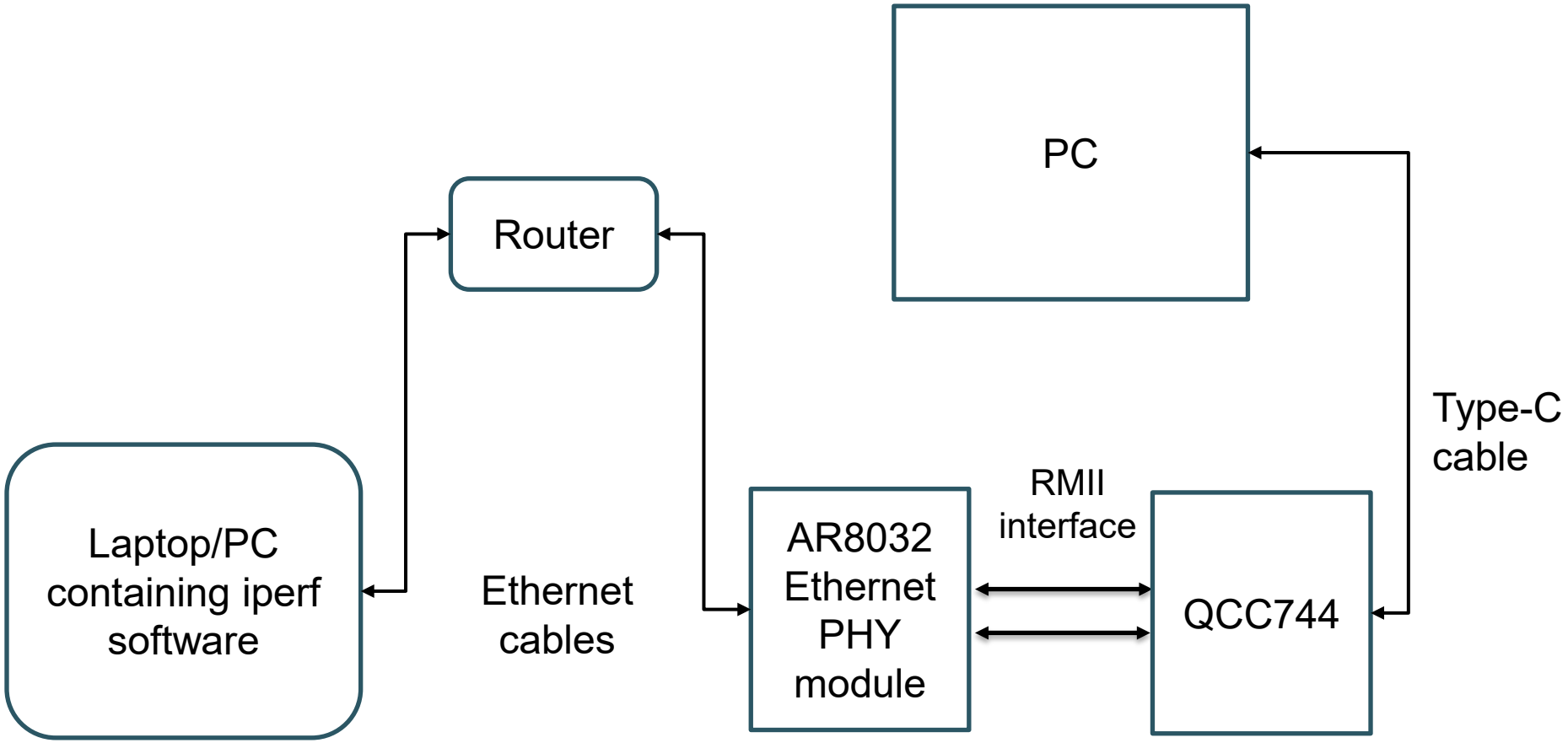
Test steps

This test measures Ethernet throughput using the iperf tool, providing insights into the performance of the QCC744's EMAC interface.

Steps:

1. Flash the lwip_iperf build from the latest SDK onto the QCC744 board.
2. Establish an Ethernet connection between the AR8032 module and a router.
3. Connect a PC or laptop running iperf to the same network.
4. Use the lwip_emac_info command to retrieve EMAC diagnostics.
5. Perform the following tests:
   - TCP Receive (Rx): Device as server, PC as client.
   - TCP Transmit (Tx): PC as server, device as client.
   - UDP Receive (Rx): Device as server, PC as client.
   - UDP Transmit (Tx): PC as server, device as client.

Test setup


PC
Router
Laptop/PC containing iperf software
Ethernet cables
AR8032 Ethernet PHY module
RMII interface
QCC744
Type-C cable

Run iperf tests

- After the software is flashed and Ethernet connection is established between the Ethernet PHY module and the router, the system generates logs like the following:

```
=========================
dynamic memory init success, ocram heap size = 343 Kbyte, psram heap size = 4096 Kbyte
sig1:ffffffff
sig2:0000f32f
cgen1:9fffffd
EMAC lwip iperf test case !
[I][MAIN] Create app_start task.
[I][MAIN] Start Scheduler.
[I][MAIN] app_start_task Run...
qcc74x />[I][MAIN] Shell Ready...
[I][MAIN] lwip statck init
[I][MAIN] netif config
[I][EPHY] eth phy scan success, phy_addr: 5, phy_id: 0x004DD023
[W][EPHY] drv_match falied, use General driver
[I][LWIP_EMAC] [OS] Starting emac rx task...
[I][MAIN] app_start_task Delete...
[I][MAIN] lwip_status_update_task Run...
[W][LWIP_EMAC] Lwip Eth Emac LinkUp !!!
[I][LWIP_EMAC] eth_phy speed: 100M_FULL_DUPLEX
[I][LWIP_EMAC] State: Looking for DHCP server ...
 IP:192.168.0.102
 MASK: 255.255.255.0
 Gateway: 192.168.0.1
[I][LWIP_EMAC] IP address assigned by a DHCP server: 192.168.0.102
```

Use diagnostic commands

- Use the lwip_emac_info command to retrieve relevant information about the EMAC.

```
qcc74x />lwip_emac_info
[I][LWIP_EMAC] TX: success cnt:7, error cnt:0, total size:910Byte
[I][LWIP_EMAC]     push_cnt:7, tx_db available:64, tx_bd_ptr:7
[I][LWIP_EMAC] RX: success cnt:5, error cnt:0, total size:1380Byte
[I][LWIP_EMAC]     push_cnt:15, rx_db available:54, rx_bd_ptr:5, busy cnt:0
```

TCP Rx

Device as Server

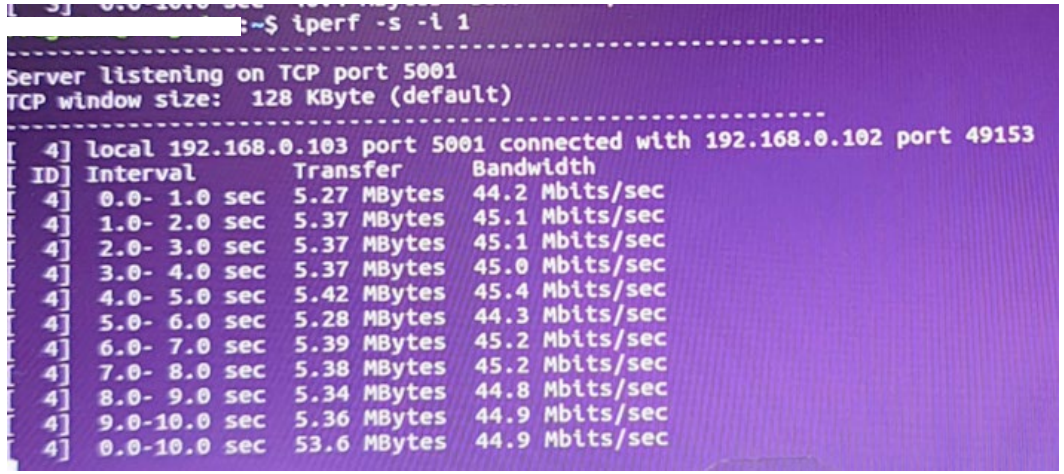
```
qcc74x />iperf -s -i 1
[iperf] Socket created
------------------------------------------------------------
Server listening on TCP port 5001
------------------------------------------------------------
qcc74x />[iperf] accept: 192.168.0.103,37904

[ ID] Interval       Transfer     Bandwidth
[  0]  0.0- 1.0 sec  4.83 MByte  38.65 Mbits/sec
[  0]  1.0- 2.0 sec  4.80 MByte  38.44 Mbits/sec
[  0]  2.0- 3.0 sec  4.92 MByte  39.34 Mbits/sec
[  0]  3.0- 4.0 sec  4.79 MByte  38.33 Mbits/sec
[  0]  4.0- 5.0 sec  4.85 MByte  38.78 Mbits/sec
[  0]  5.0- 6.0 sec  4.97 MByte  39.77 Mbits/sec
[  0]  6.0- 7.0 sec  4.82 MByte  38.59 Mbits/sec
[  0]  7.0- 8.0 sec  4.90 MByte  39.21 Mbits/sec
[  0]  8.0- 9.0 sec  4.87 MByte  38.99 Mbits/sec
[  0]  9.0-10.0 sec  4.82 MByte  38.54 Mbits/sec
[  0]  0.0-10.0 sec  48.58 MByte  38.86 Mbits/sec
[iperf] TCP Socket server is closed.
iperf exit
```

PC as Client

```
~$ iperf -c 192.168.0.102 -i 1 -t 10
------------------------------------------------------------
Client connecting to 192.168.0.102, TCP port 5001
TCP window size: 85.0 KByte (default)
------------------------------------------------------------
[  3] local 192.168.0.103 port 37904 connected with 192.168.0.102 port 5001
[ ID] Interval       Transfer     Bandwidth
[  3]  0.0- 1.0 sec  4.75 MBytes  39.8 Mbits/sec
[  3]  1.0- 2.0 sec  4.62 MBytes  38.8 Mbits/sec
[  3]  2.0- 3.0 sec  4.62 MBytes  38.8 Mbits/sec
[  3]  3.0- 4.0 sec  4.62 MBytes  38.8 Mbits/sec
[  3]  4.0- 5.0 sec  4.50 MBytes  37.7 Mbits/sec
[  3]  5.0- 6.0 sec  4.88 MBytes  40.9 Mbits/sec
[  3]  6.0- 7.0 sec  4.50 MBytes  37.7 Mbits/sec
[  3]  7.0- 8.0 sec  4.75 MBytes  39.8 Mbits/sec
[  3]  8.0- 9.0 sec  4.62 MBytes  38.8 Mbits/sec
[  3]  9.0-10.0 sec  4.50 MBytes  37.7 Mbits/sec
[  3]  0.0-10.0 sec  46.4 MBytes  38.9 Mbits/sec
```

TCP Tx

PC as Server



Device as Client

```
qcc74x />iperf -c 192.168.0.103 -i 1 -t 10
------------------------------------------------------------
Client connecting to 192.168.0.103, TCP port 5001
------------------------------------------------------------
qcc74x />[iperf] Successfully connected
[ ID] Interval       Transfer     Bandwidth
[  0]  0.0- 1.0 sec  5.52 MByte  44.17 Mbits/sec
[  0]  1.0- 2.0 sec  5.63 MByte  45.06 Mbits/sec
[  0]  2.0- 3.0 sec  5.64 MByte  45.15 Mbits/sec
[  0]  3.0- 4.0 sec  5.63 MByte  45.06 Mbits/sec
[  0]  4.0- 5.0 sec  5.69 MByte  45.51 Mbits/sec
[  0]  5.0- 6.0 sec  5.54 MByte  44.34 Mbits/sec
[  0]  6.0- 7.0 sec  5.66 MByte  45.29 Mbits/sec
[  0]  7.0- 8.0 sec  5.66 MByte  45.25 Mbits/sec
[  0]  8.0- 9.0 sec  5.61 MByte  44.89 Mbits/sec
[  0]  9.0-10.0 sec  5.62 MByte  44.99 Mbits/sec
[  0]  0.0-10.0 sec  56.21 MByte  44.97 Mbits/sec
[iperf] TCP Socket client is closed.
iperf exit
```

UDP Rx

- In UDP Rx test, server and client data rates don’t match because UDP is a protocol without ACK. The client tries its best to send data and doesn't care whether the peer has enough buffer to receive. This is typically observed when the client is a PC with high-speed network interface (for example 1000M Ethernet) while the QCC74X embeds a 100M PHY only. In this case, you can change -b 300M to -b 100M to lower the client throughput.

Device as Server

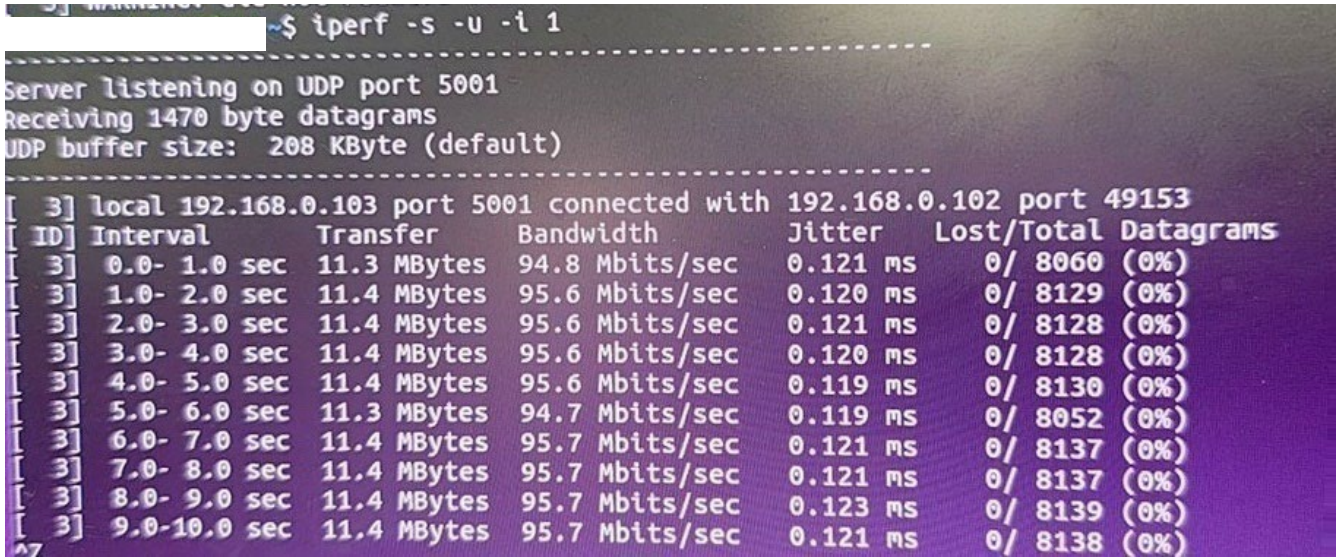
```
qcc74x />iperf -s -u -i 1
[iperf] Socket created
[iperf] Socket bound, port 35091
------------------------------------------------------------
Server listening on UDP port 5001
------------------------------------------------------------
qcc74x />[ ID] Interval       Transfer     Bandwidth
[  0]  0.0- 1.0 sec  3.26 MByte  26.11 Mbits/sec
[  0]  1.0- 2.0 sec  3.24 MByte  25.94 Mbits/sec
[  0]  2.0- 3.0 sec  3.38 MByte  27.00 Mbits/sec
[  0]  3.0- 4.0 sec  3.36 MByte  26.91 Mbits/sec
[  0]  4.0- 5.0 sec  3.38 MByte  27.05 Mbits/sec
[  0]  5.0- 6.0 sec  3.45 MByte  27.64 Mbits/sec
[  0]  6.0- 7.0 sec  3.31 MByte  26.50 Mbits/sec
[  0]  7.0- 8.0 sec  3.45 MByte  27.61 Mbits/sec
[  0]  8.0- 9.0 sec  3.62 MByte  28.94 Mbits/sec
[  0]  9.0-10.0 sec  3.33 MByte  26.64 Mbits/sec
[  0]  0.0-10.0 sec  33.79 MByte  27.03 Mbits/sec
[iperf] Udp socket server is closed.
iperf exit
```

PC as Client

```
[  3] WARNING: did not receive ack of last datagram after 3 tries.
$ iperf -u -c 192.168.0.102 -i 1 -t 10 -b 300M
------------------------------------------------------------
Client connecting to 192.168.0.102, UDP port 5001
Sending 1470 byte datagrams
UDP buffer size:  208 KByte (default)
------------------------------------------------------------
[  3] local 192.168.0.103 port 33605 connected with 192.168.0.102 port 5001
[ ID] Interval       Transfer     Bandwidth
[  3]  0.0- 1.0 sec  11.5 MBytes  96.4 Mbits/sec
[  3]  1.0- 2.0 sec  11.3 MBytes  95.1 Mbits/sec
[  3]  2.0- 3.0 sec  11.4 MBytes  95.2 Mbits/sec
[  3]  3.0- 4.0 sec  11.4 MBytes  95.5 Mbits/sec
[  3]  4.0- 5.0 sec  11.4 MBytes  95.5 Mbits/sec
[  3]  5.0- 6.0 sec  11.4 MBytes  95.2 Mbits/sec
[  3]  6.0- 7.0 sec  11.4 MBytes  95.4 Mbits/sec
[  3]  7.0- 8.0 sec  11.4 MBytes  95.5 Mbits/sec
[  3]  8.0- 9.0 sec  11.3 MBytes  94.9 Mbits/sec
[  3]  9.0-10.0 sec  11.4 MBytes  95.3 Mbits/sec
[  3]  0.0-10.0 sec   114 MBytes  95.4 Mbits/sec
[  3] Sent 81133 datagrams
read failed: Connection refused
[  3] WARNING: did not receive ack of last datagram after 3 tries.
```

UDP Tx

PC as Server



Device as Client

```
qcc74x />iperf -u -c 192.168.0.103 -i 1 -t 10 -b 300M
[iperf] Socket created, sending to 1728096448:5001
[ ID] Interval       Transfer     Bandwidth
------------------------------------------------------------
Client connecting to 192.168.0.103, UDP port 5001
Sending 0 byte datagrams
------------------------------------------------------------
qcc74x />[  0]  0.0- 1.0 sec  11.95 MByte  95.57 Mbits/sec
[  0]  1.0- 2.0 sec  11.95 MByte  95.56 Mbits/sec
[  0]  2.0- 3.0 sec  11.95 MByte  95.59 Mbits/sec
[  0]  3.0- 4.0 sec  11.95 MByte  95.59 Mbits/sec
[  0]  4.0- 5.0 sec  11.95 MByte  95.59 Mbits/sec
[  0]  5.0- 6.0 sec  11.95 MByte  95.60 Mbits/sec
[  0]  6.0- 7.0 sec  11.95 MByte  95.59 Mbits/sec
[  0]  7.0- 8.0 sec  11.95 MByte  95.59 Mbits/sec
[  0]  8.0- 9.0 sec  11.95 MByte  95.59 Mbits/sec
[  0]  9.0-10.0 sec  11.95 MByte  95.59 Mbits/sec
[  0]  0.0-10.0 sec  119.48 MByte  95.58 Mbits/sec
[iperf] UDP Socket client is closed
iperf exit
```

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