

# **UDP-IP Demo Instruction**

Rev1.0 6-Jan-16

This document describes the instruction to run UDP-IP for transferring data between FPGA development board and PC through Gigabit Ethernet.

# 1 Environment Setup

As shown in Figure 1-1, to run UDP-IP demo, please prepare

- 1) FPGA Development board (AC701)
- 2) iMPACT ver 14.4 or later
- 3) Ethernet cable (Cat5e or Cat6) for network connection between FPGA Development board and PC
- 4) PC with Gigabit Ethernet support
- 5) micro USB cable for programming FPGA connecting between FPGA Development board and PC
- 6) "send\_udp\_client.exe" and "recv\_udp\_client.exe", provided by Design Gateway, which are test application on Windows PC



Figure 1-1 UDP-IP Demo Environment Setup on AC701



# 2 Demo description

The demo is designed by pure-hardware logic, so DIPSWs, push buttons, and LEDs are used to be user inputs and outputs on FPGA board.

#### 2.1 DIPSW

Bit1 and bit3 of DIPSW are used to set packet size for IP sending data and enable data verification for IP receiving data, like TOE2-IP demo. More details are described in Table 2-1.



Figure 2-1 DIPSW setting in the demo

DIPSW	OFF	ON				
Bit 1	Sending mode by using non-Jumbo frame	Sending mode by using Jumbo frame				
	(1472 bytes)	(8972 bytes)				
Bit 3	Receiving mode without data verification	Receiving mode with data verification				
Table 2-1 DIPSW setting definition						



# 2.2 LED

4 LEDs are used to show operation status of the demo such as IP in initialization, sending data, receiving data. More details of each LED description are shown in Table 2-2.



LED	ON	OFF	BLINK
0	IP is busy from initialization	IP is in Idle condition.	IP interrupt is found.
	or sending data.		
1	IP receives data.	No received data	Data verification is failed.
		available in IP.	
2	Sending mode in Jumbo	Sending mode in	Ethernet is not link-up. Please
	frame.	non-jumbo frame	check Ethernet cable.
3	User presses one of three	No push button is	N/A
	push buttons.	pressed.	
		Table 2-2   ED Definition	



#### 2.3 Push button

Three push buttons are used in the demo, i.e. West, Center, and East SW, as shown in Figure 2-3. The button is used to start IP initialization, data sending, and reset pattern verification. More details of each button are described as follows.



Figure 2-3 Push button setting in the demo

- StartSW (Center): After power-on system, user needs to press this SW to start IP initialization. User can start data sending or receiving test only after complete IP initialization.
- SendSW (West): Press this SW to start IP sending data to PC. Please confirm that BusyLED is OFF before pressing this SW.
- RxPattSW (East): Press this SW to reset start value of test pattern within data verification module. So, user needs to press this SW before re-run IP receiving data test with enable data verification.

Note:

- DIPSW setting must not be changed during operation.
- Before pressing StartSW, please confirm that LinkLED is not blinked to wait Ethernet PHY ready.
- Before pressing SendSW, please confirm that IP is in Idle state by monitoring BusyLED status.



# 3 PC Setup

Similar to TOE2-IP, please confirm network setting on TestPC that is correct setting before running the demo.

#### 3.1 IP Setting

Connect usina:	You can get IP settings assigned	automatically if your network supports
Intel(R) 82579V Gigabit Network Connection	this capability. Otherwise, you ne	eed to ask your network administrator
	tor the oppropriate a seconds.	
<u>C</u> onfigure	Obtain an IP address autor	atically
his connection uses the following items:	Use the following IP address	5:
Client for Microsoft Networks	IP address:	192 . 168 . 11 . 25
GOS Facket Scriedulet     Image: A starting for Microsoft Networks	Sybnet mask:	255 . 255 . 255 . 0
Internet Protocol Version 6 (TCP/IPv6)	Default gateway:	
Internet Protocol Version 4 (TCP/IPv4)		
✓ Link-Layer Topology Discovery Responder	Obtain DNS server address	automatically
	Use the following DNS served	er addresses:
Install Uninstall Properties	Preferred DNS server:	
Description	Alternate DNS server:	· · ·
Transmission Control Protocol/Internet Protocol. The default		
across diverse interconnected networks.	Validate settings upon exit	Ad <u>v</u> anced

Figure 3-1 IPv4 Setting

- Open Local Area Connection Properties of Ethernet test connection, as shown in left window of Figure 3-1.
- Select "TCP/IPv4" and then click Properties.
- Set IP address = 192.168.11.25, and Subnet mask = 255.255.255.0, as shown in right window of Figure 3-1.



#### 3.2 Speed and Frame Setting

	You have made changes to the properties of this connection.
Ponnect using:	If you proceed your changes will be lost. Do you wish to proceed?
Configure  This connection uses the following items:  Client for Microsoft Networks  Client for Microsoft Networks  Client for Microsoft Networks  A Internet Protocol Version 6 (TCP/IPv6)  A Internet Protocol Version 4 (TCP/IPv4)  A Link-Layer Topology Discovery Mapper I/D Driver  A Link-Layer Topology Discovery Responder	Yes No
Install Uninstall Properties	

Figure 3-2 Network Configure

- On Local Area Connection Properties window, click "Configure", as shown in Figure 3-2.
- On Advance tab, Jumbo Packet = 9014 Bytes to enable jumbo frame, as shown in Figure 3-3.

Teaming	VLAN	s Drive	er D	etails
General	Link Speed	Advanced	Power Mana	gement
ettings: Gigabit Master Interrupt Mode Large Send Of Large Send Of Locally Admini	Advanced Ada Slave Mode ration ffload (IPv4) ffload (IPv6) stered Address Event	pter Settings	ue: )14 Bytes	-
Performance (	Options	<b>T</b>	Use <u>D</u> efault	
Jumbo Packet Enables Jum where large additional lat CPU utilizatio Jumbo Packet are approxim	bo Packet capab packets make up ency can be tolen in and improve w ets are larger tha nately 1.5k in size te: Changing this	lity for TCP/IP pack to the majority of tra- rated, Jumbo Pack ire efficiency. In standard Etherne setting may cause	kets. In situations affic and ets can reduce et frames, which a a momentary	3 A
los:	s of connectivity.	- 18 - T		•

Figure 3-3 Jumbo Frame Setting



- On Link Speed tab, select "1.0 Gbps Full Duplex" for running Gigabit transfer test, as shown in left window of Figure 3-4.
- On Advance tab, Settings=Interrupt Moderation and Value= "Enabled", as shown in right window of Figure 3-4.

Seneral       Link Speed       Advanced       Power Management         Ink       Speed and Duplex Settings       Intel(R) PROSet Version: 17.2.154.0         Link Status       • Speed:       1.0Gbps/Full Duplex (EEE Capable)         Speed and Duplex:	Teaming	VLANs	Driver	Details		Teaming	VLANs_	D	river	Details
Link Speed and Duplex Settings         Intel(R) PROSet Version: 17.2.154.0         Link Status         Speed:       1.0Gbps/Full Duplex (EEE Capable)         seed and Duplex:         D Gbps Full Duplex         Lidentify Adapter         D Gbps Full Duplex         Lidentify Adapter         D Gbps Full Duplex         Lidentify Adapter         D Gaps Full Duplex Setting. By default, Intel® adapters are set to automatically detect and negotiate speed and duplex settings.         If the adapter fails to connect, you can set the speed and duplex setting.         EEE Enabled: Displays "EEE Enabled" if this device has negotiated an Energy Efficient Ethernet link with its link partner.         Temperature: Displays temperature state if the adapter has a termacedure system performance.         Vertice Changing this settion may cause a momentary of the settion may cause a momentary	General	Link Speed	Advanced	Power Manageme	int	General	Link Speed	Advanced	Pow	er Manageme
Speed: 1.0Gbps/Full Duplex (EEE Capable) Seed and Duplex: Diagnostics Diagnostics Useped and Duplex • Diagnostics Identify Adapter Speed and Duplex Setting. By default, Intel® adapters are set to automatically detect and negotiate speed and duplex settings. If the adapter fails to connect, you can set the speed and duplex settings. EEE Enabled: Displays "EEE Enabled" if this device has negotiated an Energy Efficient Ethernet link with its link partner. Temperature: Displays temperature state if the adapter has a temperature state if the adapter has a temperature state of the link partner. With a dapter to moderate interrupt are is low er, and the result is better system performance. When you enable hterrupt Moderation, the interrupt rate is low er, and the result is better system performance. WDTE Changing this setting may cause a promentary.	Link Status	Link Speed and I Intel(R) PROSet 1	Duplex Settings Version: 17.2.154.	0		(intel)	Advanced Adap	ter Settings		
Speed and Duplex:       Diagnostics         0 Gbps Full Duplex       Diagnostics         Identify Adapter       Jumbo Packet         Large Send Offload (IPv4)       Large Send Offload (IPv6)         Locally Administered Address       Log Link State Event         Performance Options       Use Default         Interrupt Moderation       Allow s the adapter to moderate interrupts.         When a packet arrives, the adapter generates an interrupt, which allow s the driver to handle the packet. At greater link speeds, more interrupts are created, and CPU utilization also increases. This results in poor system performance. When you enable hiterrupt Moderation, the interrupt rate is low er, and the result is better system performance.         Year       NOTE Changing this settion may cause a promentary.	Speed:	1.0Gbps/Fi	ull Duplex (EEE C	apable)		Settings:		1	(alue:	
Diagnostics Diagno	need and Dun	lev.				Gigabit Maste	r Slave Mode	-	Enabled	
Speed and Duplex Setting. By default, Intel® adapters are set to automatically detect and negotiate speed and duplex settings. If the adapter fails to connect, you can set the speed and duplex settings to match those of the link partner. EEE Enabled: Displays "EEE Enabled" if this device has negotiated an Energy Efficient Ethernet link with its link partner. Temperature: Displays temperature state if the adapter has a temperature sector.	.0 Gbps Full D	Juplex		Diagnostics		Jumbo Packe Large Send 0 Large Send 0 Locally Admin	t ffload (IPv4) ffload (IPv6) istered Address	H		
Speed and Duplex Setting. By default, Intel® adapters are set to automatically detect and negotiate speed and duplex settings. If the adapter fails to connect, you can set the speed and duplex settings. If the adapter fails to connect, you can set the speed and duplex settings. If the adapter fails to connect, you can set the speed and duplex settings. If the adapter fails to connect, you can set the speed and duplex settings. If the adapter fails to connect, you can set the speed and duplex settings to match those of the link partner. If the adapter fails to connect, you can set the speed and duplex settings. If the adapter fails to connect, you can set the speed and duplex settings to match the speed and the spe				lentily Drahter		Log Link Stat Performance	e Event Options	-	Use	<u>D</u> efault
Allow s the adapter to moderate interrupts. Allow s the adapter generates an interrupt, which allow s the driver to handle the packet. At greater link speeds, more interrupts are created, and CPU utilization also increases. This results in poor system performance. When you enable interrupt Moderation, the interrupt rate is low er, and the result is better system performance.	Speed and I	Duplex Setting.	By default, Intel®	adapters are set	^	Interrupt Mod	eration			
EEE Enabled: Displays "EEE Enabled" if this device has negotiated an Energy Efficient Ethernet link with its link partner. Temperature: Displays temperature state if the adapter has a temperature sector Temperature sector Temperature: Displays temperature state if the adapter has a temperature sector Temperature sec	If the adapter settings to ma	fails to connect, and heg atch those of the l	you can set the s ink partner.	peed and duplex	E	Allows the a	adapter to moderate ket arrives, the ada	e interrupts. apter generate	s an interru	ipt,
Temperature: Displays temperature state if the adapter has a temperature appear. This results in poor system performance. When you enable interrupt Moderation, the interrupt rate is low er, and the result is better system performance.	EEE Enabled negotiated an	I: Displays "EEE Er Energy Efficient I	abled" if this dev Ethernet link with	ice has its link partner.		speeds, mo	e interrupts are cri	eated, and CP	U utilization	aiso =
	Temperature i	re: Displays tempe	erature state if the	e adapter has a	-	increases. 1 enable Intern result is bet	This results in poor rupt Moderation, the ter system perform	system perfo e interrupt rate ance. setting may ca	mance. Wh is low er, a	and the

Figure 3-4 Link speed and Jumbo frame setup

- For Intel LAN controller, Performance Options in "Advanced" tab should be set for better performance as shown in Figure 3-5. "Interrupt Moderation Rate" in "Performance Options" windows must be set to "Off".

Teaming	VLANs	Driver	Details	
ral	Link Speed	Advanced	Power Management	Performance Options
tel	Advanced Adapt	er Settinas		
	CORNERS CONTRA	a (1999) (1997) (1997)		Settings: Value:
				Adaptive Inter-Frame Spacing Off
				Flow Control
220				Receive Buffers
5.				Transmit Buffers
ipt Model	ration	^ L	Properties	Use <u>D</u> efa
Send Off	fload (IPv4) fload (IPv6)	11		Interrupt Moderation Rate
ally Adminis	tered Address			This sets the rate at which the controller moderates or delay
Link State	Event			generation of interrupts making it possible to optimize network
rity & VLAN	Alabet Alar	-		throughput and CPU utilization. The Adaptive setting adjusts
omance ()	otione			interrupt rates dynamically depending on traffic type and net
official Ce O	puvia			system performance in certain configurations
rformance	e adapter to use s	etungs mat can i	nprove adapter	Without interrupt moderation, CPU utilization increases at biol
				data rates because the system must handle a larger number
				QK
				<u>(</u>
			-	
			610	



# 4 How to run demo

#### 4.1 Initialization

Before running IP sending and receiving data test, please follow below steps to setup and initialize test system.

- Connect micro USB cable from FPGA development board to PC and connect power supply to FPGA board.
- Connect Ethernet cable between FPGA development board and PC.
- Set up network setting on PC, following Topic 3.
- Power on FPGA development board.
- Open iMPACT and download "udpiptest\_ac701.bit" to FPGA development board, as shown in Figure 4-1.





- Monitor LED2 status on FPGA development board that should change from BLINK to be ON/OFF status following DIPSW1 setting.

<u>Note:</u> If LED2 still be BLINK, please check Ethernet cable connection between FPGA and PC.



Blink -> ON/OFF

Figure 4-2 LED status after programming bit file and ethernet can linkup

 Press StartSW at Center-SW to start IP initialization process. LED0 will change from ON to OFF after IP initialization complete, as shown in Figure 4-3.

<u>Note:</u> If LED0 is not ON and change to BLINK status instead, please check that IP address on PC is correct or Ethernet cable is in good status.

To re-initialize system, user needs to press CPU RESET button, wait until LED2 changing from BLINK to ON/OFF, and press StartSW again.



# ON -> OFF

Figure 4-3 LED status after press StartSW and IP initialization complete

Now system is ready to run IP sending data and receiving data. More details are described in the next topic.

Note: Transfer performance on the demo depends on Test PC specification.



## 4.2 IP Sending Data Test

Hardware logic designs to support two different packet sizes to show performance when running non-jumbo frame and jumbo frame size. Hardware setting and parameter input of test application should be matched. More details about each mode are described as follows.

- 4.2.1 Non-Jumbo frame mode
  - Set DIPSW[1] = OFF and confirm that LED2 status is OFF.
  - Open "command prompt" on PC, and run "recv\_udp\_client" test application by using command as shown in Figure 4-4.

<u>Note:</u> This demo fixes IP address, port number, and received size. So, please do not change any value without HDL code modification.



- Confirm that IP is in Idle condition by monitoring LED0 = OFF. Then, press SendSW at West-SW to start data sending from FPGA.
- LED0 will change to ON status, as shown in Figure 4-5. LED0 will be OFF after all data are transferred completely.



# Non-jumbo frame

Figure 4-5 LED status during running "recv\_udp\_client" with non-jumbo frame



 During receiving data, test application will display total received byte on the console every second. Finally, it will show total dropped packet, and performance as shown in Figure 4-6. <u>Note:</u> Total performance output from test application will include delay time from running "recv\_udp\_client" to pressing SendSW, so user should press SendSW immediately after running "recv\_udp\_client" for output performance accuracy.



Figure 4-6 Output performance when running "recv\_udp\_client" with non-jumbo frame

 As shown in Figure 4-7, if packet dropped is found, "Drop Expect" message will be displayed on the console. Final result will show total dropped packet, and test application will be ended by 0.5 sec timeout. "[WARNING] Timeout" message will be displayed when test application is exit from timeout condition.





#### 4.2.2 Jumbo frame mode

- Set DIPSW[1] = ON and confirm that LED2 status is ON.
- Open "command prompt" on PC, and run "recv\_udp\_client" test application by using command as shown in Figure 4-8. Parameter inputs are same as non-jumbo frame except packet size which is set to 8972 instead of 1472.



- Demo steps are same as non-jumbo frame mode. Please follow the step described in non-jumbo frame mode.
- As shown in Figure 4-10, test performance when using jumbo frame will be better than non-jumbo frame.









Figure 4-10 Output performance when running "recv\_udp\_client" with jumbo frame



## 4.3 IP Receiving Data Test

Hardware logic designs to support enable/disable data verification module. Disable is used when test application sends dummy data to FPGA for higher performance. Enable is used when test application sends increment data to FPGA to check data valid. More details of each mode are described as follows.

- 4.3.1 Disable verification mode
  - Set DIPSW[3] = OFF to disable data verification.
  - Open "command prompt" on PC, and run "send\_udp\_client" test application by following command

>> send\_udp\_client <FPGA IP address> <FPGA port number> <PC port number> <numbers of 8kbyte packet > <mode>

- Similar to sending application, IP address and port number cannot change without HDL code modification.
- User can set numbers of 8kbyte packet which is valid from 1- 524287. Total transfer size will be calculated by numbers of packet x 8 x 1024 byte. So, maximum transfer size is 524287x8x1024 byte
- Mode: '0'- All '0' pattern are sent for high performance.



- After running test application, LED[1] status will change from OFF to ON as shown in Figure 4-12.



Figure 4-12 LED status during running "send\_udp\_client"



- Test application displays "..." during transferring packet. Time usage with performance will be displayed when complete data transfer, as shown in Figure 4-13.

Administrator: Command Prompt	
000 Start Send Check 000 Server: 192.168.11.42, 4000, Send_Cnt: 524287, <mark>Send_Vrf</mark> [INFO] Sending Package	: DIS Dummy data
[INFO] Spend 37.22 Second(s) for sending 4095 MByte(s) [INFO] Sending Data Rate: 110.04 MByte(s)/Sec	Performance Result
D:\SW>	
	-

Figure 4-13 Test performance of "send\_udp\_client" when disable verification

- 4.3.2 Enable Verification mode
  - Set DIPSW[3] = ON to enable data verification.
  - Press RxPattSW at West-SW to reset test pattern for data verification.
  - Open "command prompt" on PC, and run "send\_udp\_client" test application by setting mode = 1 to generate 32-bit increment data. The example command is shown in Figure 4-14.



Figure 4-14 Example "send\_udp\_client" command when enable verification

Administrator: Command Prompt	
000 Start Send Check 000 Server: 192.168.11.42, 4000, Send_Cnt: 524287, Send_Urf	: EN 32-bit Inc data
[[NFO] Spend 38.66 Second(s) for sending 4095 MByte(s) [[NFO] Sending Data Rate: 105.96 MByte(s)/Sec	Performance Result
D:\SW>	-

Figure 4-15 Test performance of "send\_udp\_client" when enable verification

- LED2 will blink if any error data is detected from Verification module.

D•G

 $dg\_udpip\_instruction\_xilinx\_en.doc$ 

#### 4.4 Run two applications

In the demo, sending and receiving data test use different port number on PC, so user can run both tests at the same time. When running two applications at the same time, it will take much resource on PC. So, performance may be reduced for receiving data test and packet dropped may be much found for sending data test.

The example command and LED status during run both tests at the same time are shown in Figure 4-16 and Figure 4-17.



Figure 4-16 Run recv\_udp\_client and send\_udp\_client at the same time





# 5 Revision History

Revision	Date	Description
1.0	6-Jan-16	Initial version release