Building an 18 Port Switch Using Two TNETX3100 Desktop ThunderSWITCH Devices

APPLICATION REPORT: SDNA019A

Networking Business Unit
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TEXAS INSTRUMENTS

TRADEMARKS

Contents

Figures

Tables

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Abstract

This application report explains how to connect two Texas Instruments (TI™) TNETX3100 Desktop ThunderSWITCH™ devices to build an 18 port Desktop ThunderSWITCH. This configuration allows the Ethernet switch designer to double the number of ports in a design without increasing overall system complexity.

The Desktop ThunderSWITCH enables the OEM to support a modular design in either an 8/2 or 16/2 managed or unmanaged configuration. In the unmanaged configuration, the Desktop ThunderSWITCH and External Address Look-up Engine (EALE) support auto-configuration using EEPROMs.

Optionally, the OEM can replace the EEPROMs with a CPU for a managed configuration supporting Simple Network Management Protocol (SNMP) and remote monitoring (RMON).

This application report contains block and interconnection diagrams with a corresponding bill of materials for the configuration of two Desktop ThunderSWITCH devices. Throughput test results for the 18 port configuration are included.

Product Support

World Wide Web

Our World Wide Web site at

www.ti.com/sc/docs/network/nbuhome.htm

contains the most up to date product information, revisions, and additions. New users must register with TI&ME at www.ti.com before they can access the data sheet archive. TI&ME allows users to build custom information pages and receive new product updates automatically via email.

Email

For technical issues or clarification on switching products, please send a detailed email to:

networks@micro.ti.com

Questions receive prompt attention and are usually answered within one business day.

Introduction

The TNETX3100 Desktop ThunderSWITCH is an Ethernet switch on a chip. The Desktop ThunderSWITCH fully integrates a high performance switching engine with network management extensions and 10 Ethernet media access controllers (MAC) on a single piece of silicon.

Each Desktop ThunderSWITCH device includes two 100 Mbps ports. One port interconnects two Desktop ThunderSWITCH devices. The Desktop ThunderSWITCH supports modular designs in either an 8/2 (8 10-Mbps ports and 2 100-Mbps ports) or 16/2 (16 10-Mbps ports and 2 100-Mbps ports) managed or unmanaged configuration.

The 16/2 Desktop ThunderSWITCH configuration allows the port density to increase from 10 to 18 ports with minimal glue logic (see Figure 1). The External Address Lookup-Engine, optional CPU, and SNMP interfaces enable the collection of Remote Monitoring (RMON), SNMP, and Ethernet statistics.

Figure 1. Unmanaged 16/2 Switch Block Diagram

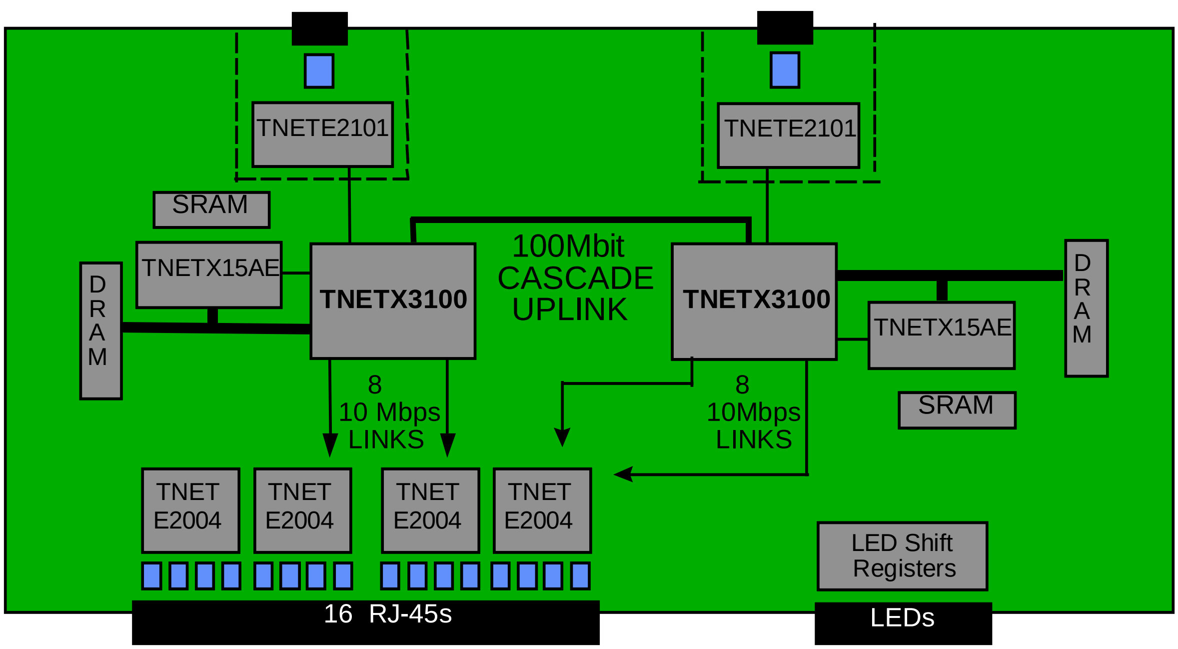


Table 1 shows the bill of materials for the unmanaged 16/2 switch.

Table 1. Bill of Materials for the Unmanaged 16/2 Switch

Device	Part Number	Vendor	Qty
Desktop ThunderSWITCH	TNETX3100PGC	Texas Instruments	2
Quad 10 Mbps PHY	TNETE2004PBE	Texas Instruments	4
External Address Lookup Engine	TNETX315AEPGE	Texas Instruments	2
1M x 16 – 60 ns EDO DRAM (Packet Memory)	TMS486169-60	Texas Instruments	2
10/100 Mbps PHY	TNETE2101PZ	Texas Instruments	2
3.3 V Voltage Regulator	TL7705ACD	Texas Instruments	1
Miscellaneous Logic	SN74LSXX	Texas Instruments	x
64K x 16 – 15 ns SRAM (Supports 1K Addresses)	KM6164002J-20	Samsung	2
EEPROM	24C02	Atmel, Xicor	4
PWB		Compuroute	1
Power Supply	UP0651S-01	International Power Sources, Inc	1
Quad RJ45 Connectors	558524-1	Amp	4
Single RJ45 Connector	558344-1	Amp	2
20 MHz Oscillator	HSM93-20MHZ	Connor-Winfield	1
50 MHz Oscillator	HSM93-50MHz	Connor-Winfield	1
Quad 10 Mbps Transformers	TD22-3506G1	Halo, Belfuse	4
10/100 Mbps Transformers	TG46-S010NX	Halo, Belfuse	2
Enclosure			1
Miscellaneous LEDs, Capacitors, Resistors, Screws			x

Hardware Configuration

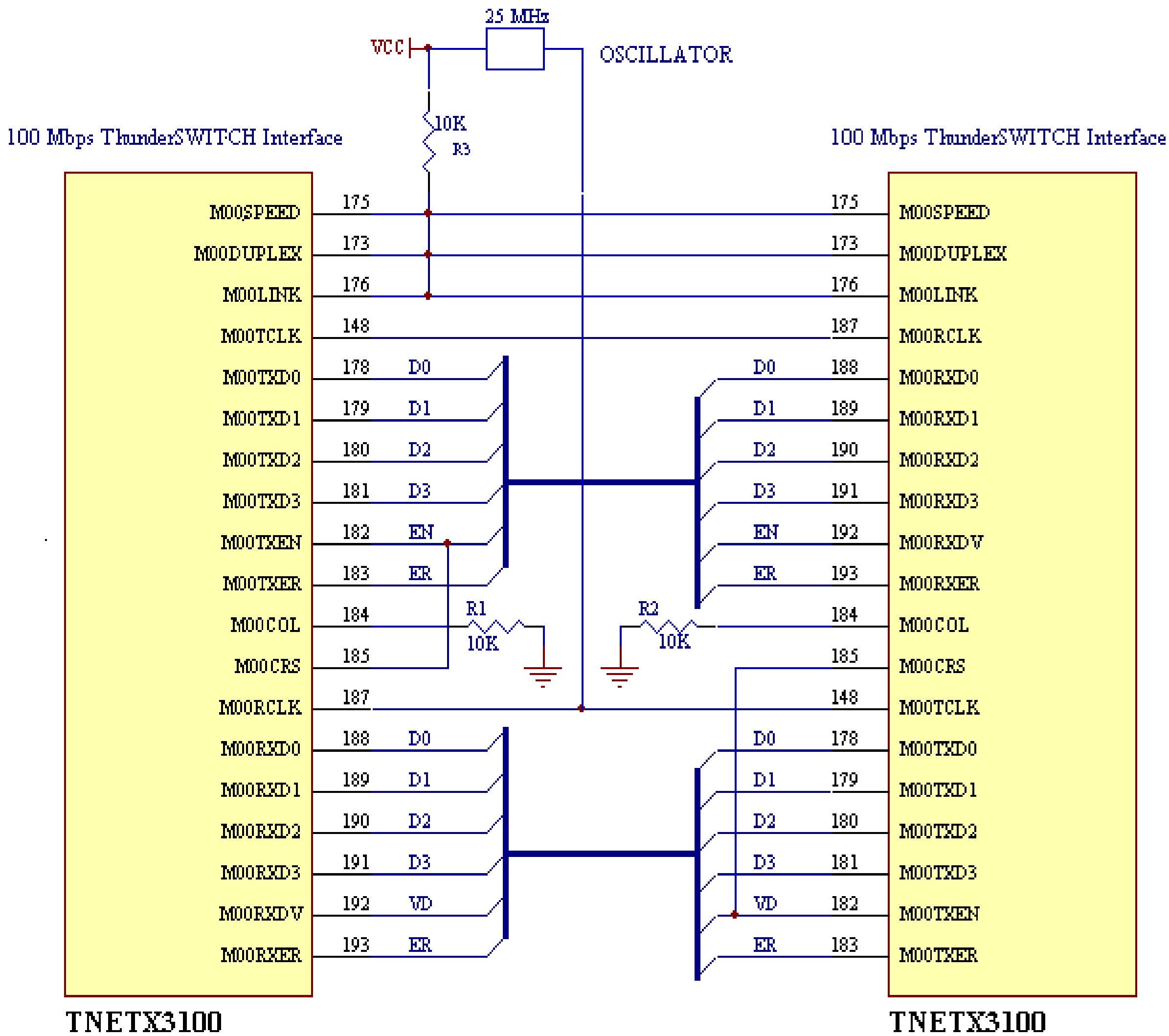
Figure 2 shows two Desktop ThunderSWITCH devices interconnected through port 00 in a 16/2 port configuration. In this configuration, port 00 provides a 100 Mbps, nibble-wide interface.

The connected interface operates at a bandwidth of 100 Mbps. No internal modifications are needed to build this configuration. If a packet size of more than 100 Mb is sent through this interface, there will be a packet loss.

NOTE:

The TNETX3100 Desktop ThunderSWITCH flow control feature only effects the ports in the Half-Duplex mode. The connection link between the two switches does not support flow control because it is set to perform at Full Duplex. Hence, it may drop packets when utilized at more than 100 Mbps bandwidth.

Figure 2. Desktop ThunderSWITCH 16/2 Port Configuration



Layout Considerations for Clock Skew

Observe the following rules to eliminate clock skew on the 16/2 interconnected configuration:

- Keep all signal traces as short as possible to minimize crosstalk.
- Keep all interconnecting signal traces the same length to eliminate propagation delay.
- Decouple the analog supply (AVcc) pins from the digital supply (Vcc) pins using an inductor or ferrite bead. This can be accomplished by one of the following methods:
  - Connect the AVcc pins together and use a single inductor/ferrite bead to connect them to the digital supply plane.
  - Connect the AVcc pins for the clock recovery block together and use an inductor/ferrite bead to connect them to the digital supply plane. Connect the AVcc pins for the clock generation block together and use a second inductor/ferrite bead to connect them to the digital supply plane.
  - Connect each AVcc pin to the digital supply plane using an inductor or ferrite bead and a 0.1 µF bypass capacitor.
- Use low-inductance bypass capacitors (such as 0.1 µF surface mount devices) to reduce Vcc noise due to output switching.

NOTE:

The recommended bypass approach is one bypass capacitor for each AVcc pin and one bypass capacitor for every two Vcc pins.

Test Results for the Development Platform

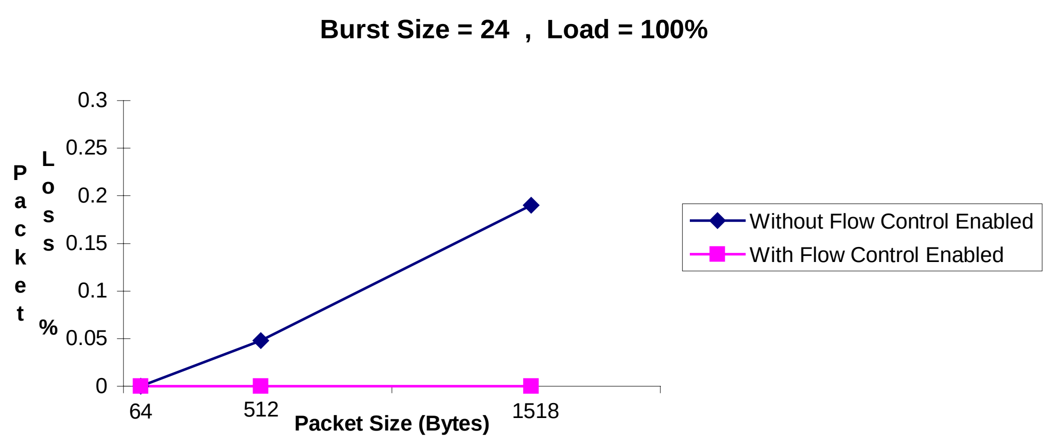
This section describes the following throughput tests used to verify the cascade mode configuration for the development platform:

- XSTREAM™
- Latency
- Packet loss

XSTREAM Test

The XSTREAM test generates multidirectional streams of traffic between 18 Ethernet ports. Each port is assigned a specific number of MAC addresses. This test determines whether any packets are lost through the cross-stream traffic. Figure 3 shows the frame loss test results for the interconnected configuration of two Desktop ThunderSWITCH devices with and without flow control enabled.

Figure 3. XSTREAM Test Results for 18 10-Mbps Ports (with and without Flow Control Enabled)



In this test, each port is assigned one MAC address. All ports run with a bandwidth of 10 Mbps and in the Half Duplex mode. During the first part of the test, three different frame sizes are used (64, 512, and 1518 bytes) to run a burst size of 24 frames. A 100 percent load is utilized during each test.

Flow control is enabled for the second part of the test. All other parameters are the same. Both tests run for 10 seconds. Figure 3 clearly shows that enabling flow control eliminates frame loss on all ports.

Latency Test

The latency test effectively gauges the efficiency of the switch. Low latency switches can provide improved quality for asynchronous data applications, which is essential for time-sensitive traffic such as voice and video.

The latency test measures the time it takes for the frame to leave the transmitter port and arrive at the receiver port. The test is conducted in two different settings:

- ❑ Store and Forward mode
- ❑ Cut Through mode

In the Store and Forward mode, all frames are received and temporarily stored in a buffer. Once the end-of-frame is received, the whole frame is forwarded. In the Cut Through mode, each frame received by the switch is forwarded to the designated address.

Figure 4 and Figure 5 illustrate the latency test results in each mode for different frame sizes (64, 512, and 1518 bytes).

Figure 4. Latency Test Results for Desktop ThunderSWITCH Efficiency (Cut Through Mode)

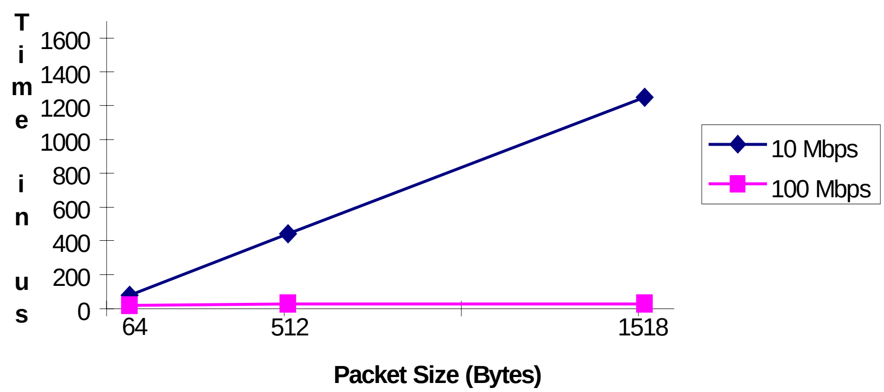
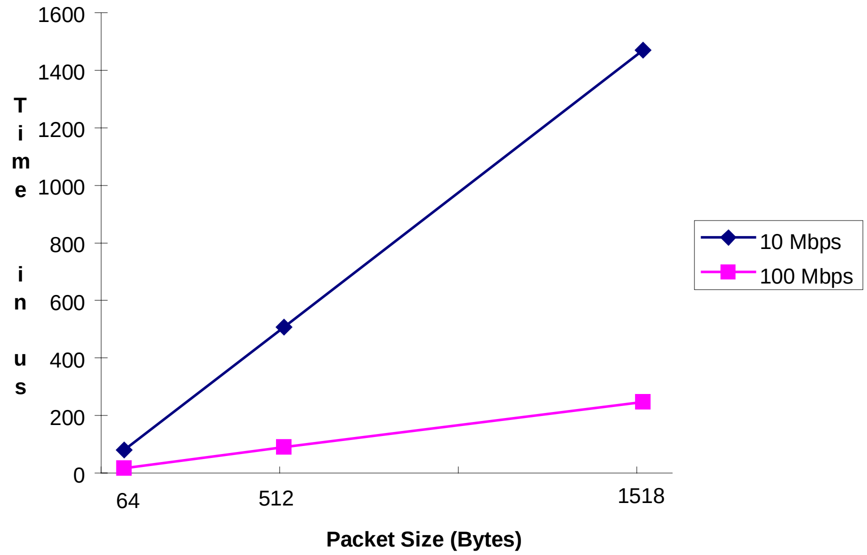


Figure 5. Latency Test Results for Desktop ThunderSWITCH Efficiency (Store and Forward) Mode



Packet Loss Test

The packet loss test is another measure of switch efficiency. Frame packets of different sizes are sent one way through the uplink interface. The packet loss test measures the percentage of frames lost through the traffic.

Each port is assigned one MAC address. The test is run without flow control enabled. Three different frame sizes (64, 512, and 1518 bytes) are sent through the uplink interface at 100 percent load for 10 seconds. Figure 6 shows the test configuration and port labeling.

Figure 6. Packet Loss Test Configuration

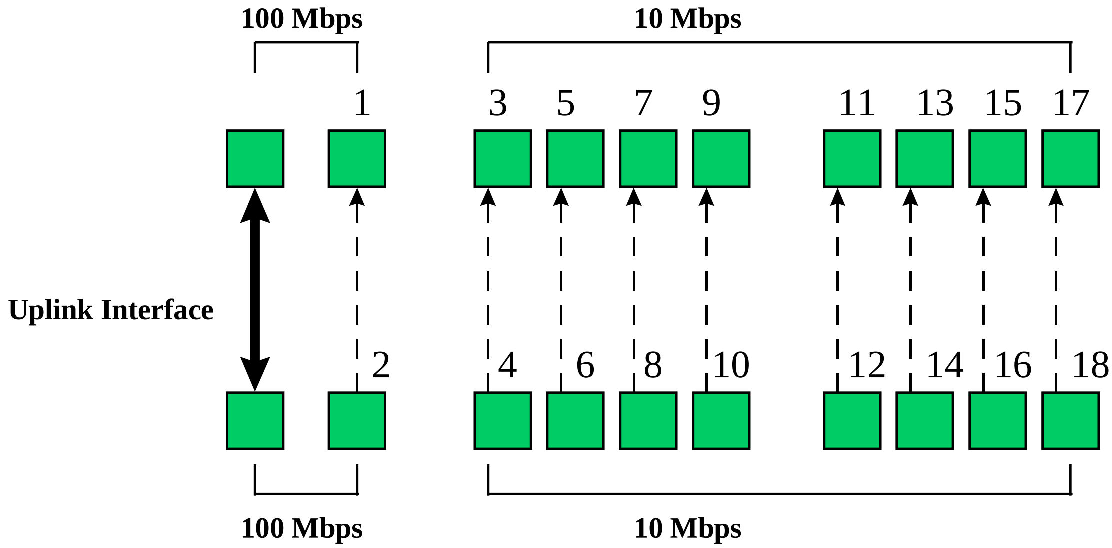


Table 2 shows the packet loss test results for two connected Desktop ThunderSWITCH devices. In this case, ports 1 through 18 are operating in Half Duplex mode with a speed of 10 Mbps. Flow control is not enabled for this test.

Table 2. Packet Loss Test Results for Desktop ThunderSWITCH Efficiency (Without Flow Control Enabled)

Packet Size (Bytes)	**64**	**512**	**1518**
2 to 1	0.00	0.00	0.00
4 to 3	0.00	0.00	0.00
6 to 5	0.00	0.00	0.00
8 to 7	0.00	0.00	0.00
10 to 9	0.00	0.00	0.00
12 to 11	0.00	0.00	0.00
14 to 13	0.00	0.00	0.00
16 to 15	0.00	0.00	0.00
18 to 17	0.00	0.00	0.00

A worst-case scenario is simulated for two interconnected Desktop ThunderSWITCH devices. In this case, ports 1 and 2 are in 100 Mbps. Ports 3 through 18 are in 10 Mbps. All ports, except the uplink interface, are set to the Half Duplex mode. Flow control is enabled on the TNETX3100. Table 3 shows the percentage of dropped frames.

Table 3. Packet Loss Test Results for Desktop ThunderSWITCH Efficiency (with Flow Control Enabled) – Worst-Case Scenario

Packet Size (Bytes)	**64**	**512**	**1518**
2 to 1	0.00	0.00	0.00
4 to 3	0.00	0.00	0.00
6 to 5	0.00	0.00	0.00
8 to 7	0.00	0.00	0.00
10 to 9	0.00	0.00	0.00
12 to 11	0.00	0.00	0.00
14 to 13	0.00	0.00	0.00
16 to 15	0.00	0.00	0.00
18 to 17	0.00	0.00	0.00

Enabling the flow control on the TNETX3100 eliminates frame loss when all ports are in the Half Duplex mode. The results shown in Table 3 clearly show the high performance of the Desktop ThunderSWITCH when operated under worst-case conditions.

Summary

Connecting two Desktop ThunderSWITCH devices is a simple way to increase the port density of an existing Ethernet switching design without increasing complexity. This configuration allows the Ethernet switch designer to double the number of ports in a design without increasing overall system complexity.

The 16/2 configuration increases port density from 8 to 16 ports and can be verified using the XSTREAM, latency, and packet loss throughput tests outlined in this application report.