



82555 10/100 Mbps LAN Physical Layer Interface

Networking Silicon

Datasheet

Product Features

- Optimal integration for lower cost solutions
 - Integrated 10/100 Mbps single chip physical layer interface solution
 - Complete 10/100 Mbps MII compliance with MDI support
 - Full duplex operation in 10 Mbps and 100 Mbps modes
 - IEEE 802.3u Auto-Negotiation support for 10BASE-T half and full duplex, 100BASE-TX half and full duplex, and 100BASE-T4 configurations
 - Parallel detection algorithm for legacy support of non-Auto-Negotiation enabled link partner
 - Integrated 10BASE-T transceiver with built in transmit and receive filters
 - Glueless interface to T4-PHY for combination TX/T4 designs with single magnetics
 - Glueless support for 4 LEDs: activity, link, speed, and duplex
 - LED function mapping support via MDI
 - Low external component count
 - Single 25 MHz clock support for 10 Mbps and 100 Mbps (crystal or oscillator)
 - Single magnetics for 10 Mbps and 100 Mbps operation
 - QFP 100-pin package
- Performance enhancements
 - Flow control support for IEEE 802.3x Auto-Negotiation and Bay Technologies PHY Base* scheme
 - Adaptive Channel Equalizer for greater functionality over varying cable lengths
 - High tolerance to extreme noise conditions
 - Very low emissions
 - Jabber control circuitry to prevent data loss in 10 Mbps operation
 - Auto-polarity correction for 10BASE-T
 - Software compatible with 82557 drivers
- Repeater functionality
 - Repeater mode operation
 - Support for forced speed of 10 Mbps and 100 Mbps
 - Automatic carrier disconnect for IEEE 802.3u compliance
 - Auto-Negotiation enable/disable capability
 - Receive port enable function
 - Support for 32 configurable addresses
 - Narrow analog side (14 mm) for tight packing in repeater and switch designs

Notice:

Notice:

- Low power consumption
 - Typical total solution power including all resistors and magnetics:
 - 275 mA 100BASE-TX
 - 230 mA 10BASE-T
 - 250 mA Auto-Negotiation
 - 300 mA maximum total solution power in DTE (adapter) mode
 - Power-down of 10BASE-T/100BASE-TX sections when not in use
- Added modes for design, testing, and manufacturability
 - Test Access Port (TAP)
 - NAND Tree
 - Board Level Functional Test (BIST)
 - Programmable bypass for 4B/5B encoding/decoding and scrambler/descrambler
 - Diagnostic loopback mode

Revision History

Revision Date	Revision	Description
Jan. 1997	1.0	First external release of the preliminary datasheet
Apr. 1997	1.1	First release edition
Mar. 1998	2.0	General editing

Information in this document is provided in connection with Intel products. No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document. Except as provided in Intel's Terms and Conditions of Sale for such products, Intel assumes no liability whatsoever, and Intel disclaims any express or implied warranty, relating to sale and/or use of Intel products including liability or warranties relating to fitness for a particular purpose, merchantability, or infringement of any patent, copyright or other intellectual property right. Intel products are not intended for use in medical, life saving, or life sustaining applications.

Intel may make changes to specifications and product descriptions at any time, without notice.

Designers must not rely on the absence or characteristics of any features or instructions marked "reserved" or "undefined." Intel reserves these for future definition and shall have no responsibility whatsoever for conflicts or incompatibilities arising from future changes to them.

The 82555 10/100 Mbps LAN Physical Layer Interface may contain design defects or errors known as errata which may cause the product to deviate from published specifications. Current characterized errata are available on request.

Contact your local Intel sales office or your distributor to obtain the latest specifications and before placing your product order.

Copies of documents which have an ordering number and are referenced in this document, or other Intel literature, may be obtained from:

Intel Corporation
 P.O. Box 7641
 Mt. Prospect IL 60056-7641
 or call 1-800-879-4683.

Copyright © Intel Corporation, 1997

*Third-party brands and names are the property of their respective owners.

Contents

1.0	INTRODUCTION	1
1.1	Functional Overview	1
1.2	Compliance to Industry Standards	1
2.0	ARCHITECTURAL OVERVIEW	3
2.1	100 Mbps Mode	3
2.2	10 Mbps Mode	4
2.3	Media Independent Interface (MII)	5
3.0	PIN DEFINITIONS	7
3.1	Pin Types	8
3.2	Clock Pins	8
3.3	Twisted Pair Ethernet (TPE) Pins	8
3.4	Media Independent Interface (MII) Pins	8
3.5	Media Access Control/Repeater Interface Control Pins	9
3.6	LED Pins	10
3.7	External Bias Pins	10
3.8	Miscellaneous Control Pins	11
3.9	Power and Ground Pins	12
4.0	100BASE-TX ADAPTER MODE OPERATION	13
4.1	100BASE-TX Transmit Clock Generation	13
4.2	100BASE-TX Transmit Blocks	13
4.2.1	100BASE-TX 4B/5B Encoder	13
4.2.2	100BASE-TX Scrambler and MLT-3 Encoder	14
4.2.3	100BASE-TX Transmit Framing	15
4.2.4	Transmit Driver	16
4.3	100BASE-TX Receive Blocks	16
4.3.1	Adaptive Equalizer	17
4.3.2	Receive Clock and Data Recovery	17
4.3.3	MLT-3 Decoder, Descrambler, and Receive Digital Section	17
4.3.4	100BASE-TX Receive Framing	17
4.3.5	100BASE-TX Receive Error Detection and Reporting	17
4.4	100BASE-TX Collision Detection	17
4.5	100BASE-TX Link Integrity and Auto-Negotiation Solution	18
4.5.1	Link Integrity	18
4.5.2	Auto-Negotiation	18
4.5.3	Combination Tx/T4 Auto-Negotiation Solution	18
4.6	Auto 10/100 Mbps Speed Selection	19
4.7	Adapter Mode Addresses	19
5.0	10BASE-T FUNCTIONALITY IN ADAPTER MODE	21
5.1	10BASE-T Transmit Clock Generation	21
5.2	10BASE-T Transmit Blocks	21
5.2.1	10BASE-T Manchester Encoder	21
5.2.2	10BASE-T Driver and Filter	21
5.3	10BASE-T Receive Blocks	21
5.3.1	10BASE-T Manchester Decoder	21
5.3.2	10BASE-T Twisted Pair Ethernet (TPE) Receive Buffer and Filter	21

Contents

5.3.3	10BASE-T Error Detection and Reporting	22
5.4	10BASE-T Collision Detection.....	22
5.5	10BASE-T Link Integrity	22
5.6	10BASE-T Jabber Control Function	22
5.7	10BASE-T Full Duplex	23
6.0	REPEATER MODE	25
6.1	Special Repeater Features.....	25
6.2	Connectivity.....	25
7.0	MANAGEMENT DATA INTERFACE.....	27
7.1	MDI Frame Structure.....	27
7.2	MDI Registers.....	28
7.2.1	MDI Registers 0 - 7	28
7.2.2	MDI Registers 8 - 15.....	31
7.2.3	MDI Registers 16 - 31	31
8.0	AUTO-NEGOTIATION FUNCTIONALITY.....	35
8.1	Description	35
8.2	Parallel Detect and Auto-Negotiation	36
9.0	LED DESCRIPTIONS	39
10.0	RESET AND MISCELLANEOUS TEST MODES.....	41
10.1	Reset.....	41
10.2	Loopback.....	41
10.3	Scrambler Bypass	41
10.4	Test Port.....	41
11.0	ELECTRICAL SPECIFICATIONS AND TIMING PARAMETERS	43
11.1	Absolute Maximum Ratings	43
11.2	General Operating Conditions	43
11.3	DC Characteristics	43
11.3.1	MII DC Characteristics	43
11.3.2	10BASE-T Voltage/Current DC Characteristics	43
11.3.3	100BASE-TX Voltage/Current DC Characteristics	44
11.4	AC Characteristics.....	45
11.4.1	MII Clock Specifications.....	45
11.4.2	MII Timing Parameters	46
11.4.3	Repeater Mode Timing Parameters	47
11.4.4	Transmit Packet Timing Parameters	48
11.4.5	Squelch Test Timing Parameters	48
11.4.6	Jabber Timing Parameters	49
11.4.7	Receive Packet Timing Parameters	49
11.4.8	10BASE-T Normal Link Pulse (NLP) Timing Parameters	50
11.4.9	Auto-Negotiation Fast Link Pulse (FLP) Timing Parameters	50
11.4.10	Reset Timing Parameters	51
11.4.11	X1 Clock Specifications	51
11.4.12	100BASE-TX Transmitter AC Specification	52
12.0	82555 PACKAGE INFORMATION.....	53

1.0 Introduction

The 82555 is a highly integrated, physical layer interface solution designed for 10 and 100 Mbps Ethernet systems based on the IEEE 10BASE-T and 100BASE-TX specifications. 100BASE-TX is an IEEE 802.3 physical layer specification for use over two pairs of Category 5 unshielded twisted pair or Type 1 shielded twisted pair cable. 100BASE-TX defines a signaling scheme not only for 100 Mbps, but also provides CSMA/CD compatibility with the 10 Mbps IEEE 802.3 10BASE-T signaling standard.

1.1 Functional Overview

The 82555 is designed to work in two modes: Data Terminal Equipment (DTE) for adapters and repeater for hubs and switches. When configured to DTE (adapter) mode, the 82555 incorporates all active circuitry required to interface 10/100 Mbps Ethernet controllers and CSMA/CD MAC components to 10 Mbps and 100 Mbps networks. In this and other documents the 82555 may be referred to as the DTE, Physical Medium Device (PMD), or Physical Layer Medium (PLM). It supports a direct glueless interface to Intel components such as the 82557 Fast Ethernet controller. The 82555 also supports the Media Independent Interface (MII) signals as specified in the IEEE 802.3u standard. The figure below shows how the 82555 fits into a 10/100 Mbps Ethernet adapter design.

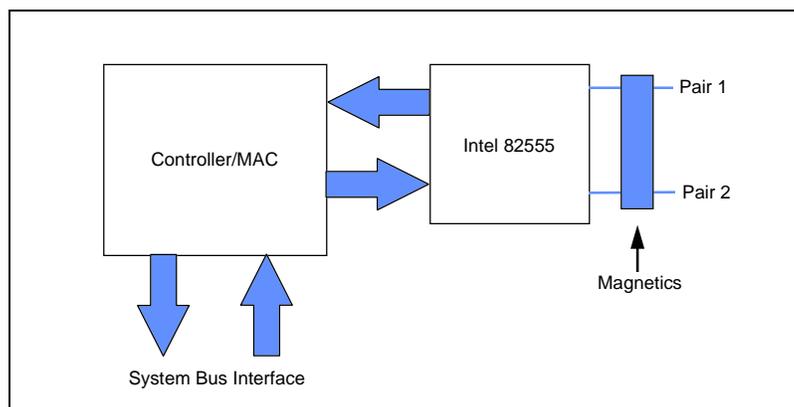


Figure 1. 82555 10/100 Mbps Ethernet Solution

When configured to repeater mode, the 82555 incorporates several features that allow it to function as a Class I or MII level repeater. [Section 6.0, “Repeater Mode” on page 25](#) describes the 82555 in a repeater type of application.

1.2 Compliance to Industry Standards

When operating in 100 Mbps mode, the 82555 complies with IEEE 802.3u 100BASE-TX specification. The PMD section with the related changes established in 802.3u 100BASE-TX complies with ANSI X3.263:1995 TP-PMD, Revision 2.2.

When operating in the 10 Mbps mode, the 82555 complies with the IEEE 802.3 10BASE-T specification.



The 82555 also complies with the IEEE 802.3u Auto-Negotiation and the IEEE 802.3x Full Duplex Flow Control sections. The MAC interface on the 82555 is a superset of the IEEE 802.3u Media Independent Interface (MII) standard.

2.0 Architectural Overview

The 82555 is an advanced combination of both digital and analog logic which combine to provide a functional stack between the Media Independent Interface (MII) and the wire through the magnetics. Figure 2 shows a general block diagram of the 82555 component.

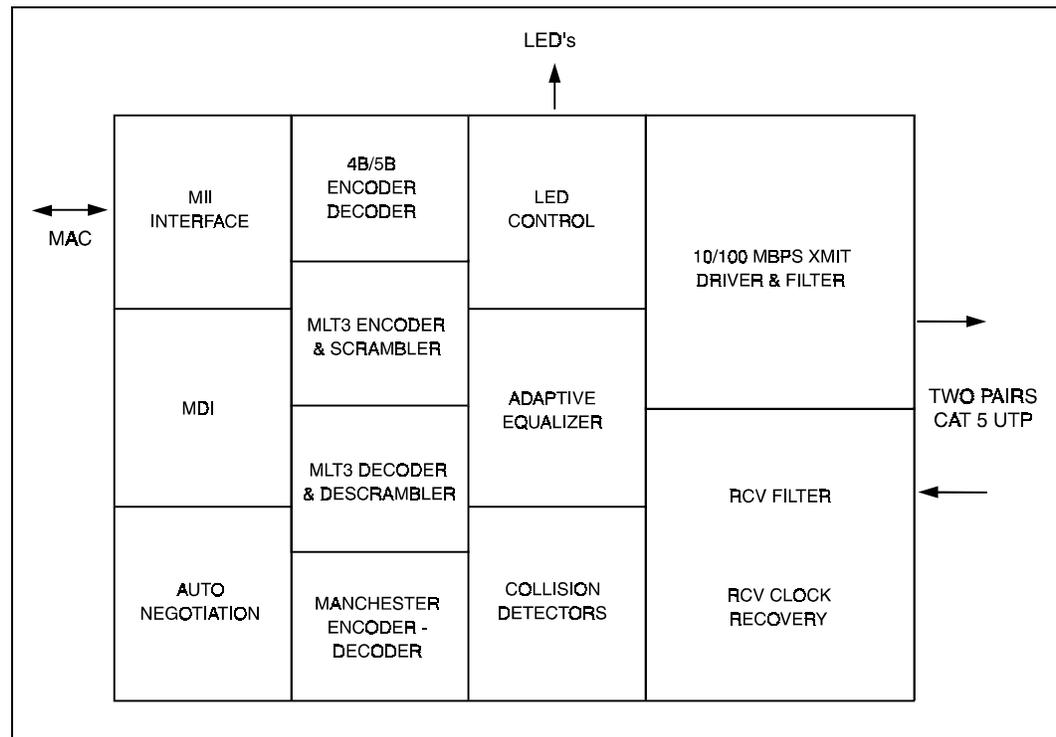


Figure 2. 82555 Simplified Block Diagram

2.1 100 Mbps Mode

In 100BASE-TX mode the 82555 digital subsection performs all signal processing of digital data obtained from the analog reception and the data to be driven into the analog transmit subsection. This includes 4B/5B encoding/decoding, scrambling/descrambling, carrier sense, collision detection, link detection, Auto-Negotiation, data validation, and providing MII to the Media Access Controller (MAC). The 82555 supports the IEEE defined MII as its MAC interface and expects the controller to drive the Management Data Input/Output and Management Data Clock signals to perform the management functions.

In 100BASE-TX mode, the analog subsection of the 82555 performs two functions:

- Transmit: The 82555 converts a digital 125 Mbps stream into MLT-3 format and drives it through the transmit differential pair onto the physical medium.

- Receive: The 82555 takes receive analog MLT-3 data from the receive differential pair and converts it into a digital 125 Mbps stream, recovering both clock and data signals.

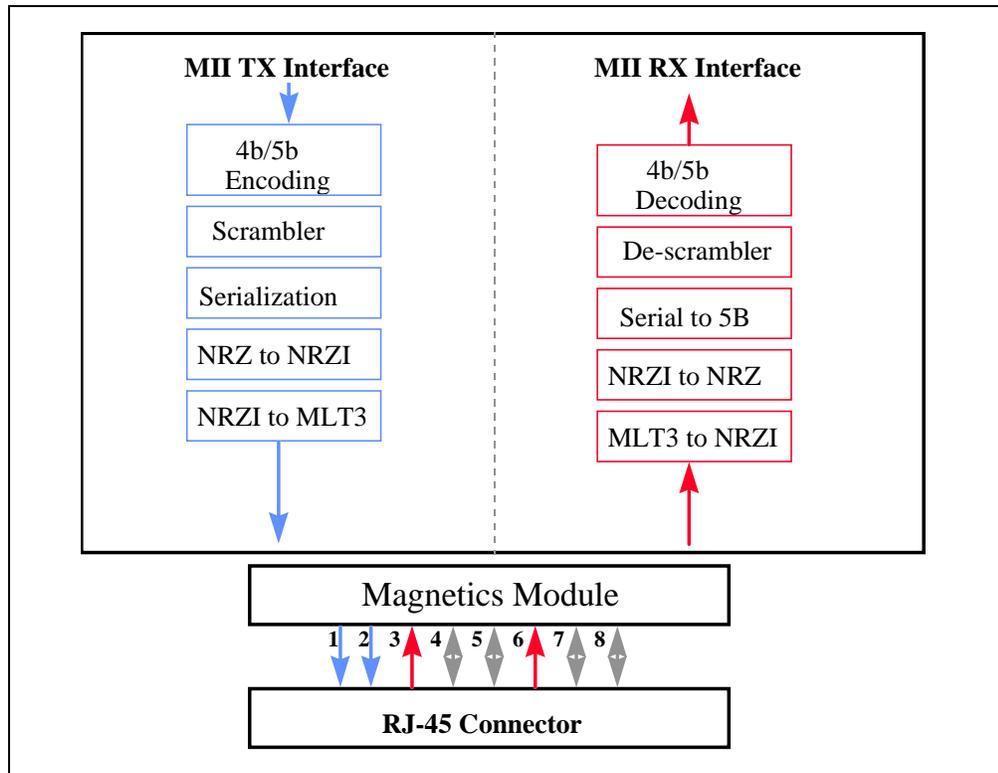


Figure 3. 82555 Analog Logic

2.2 10 Mbps Mode

The 82555 operation in 10BASE-T mode is similar to the 82555 operation in 100BASE-TX mode. Manchester encoding and decoding is used instead of 4B/5B encoding/decoding and scrambling/descrambling. In addition, the Transmit Clock and Receive Clock (MII clock signals) provide 2.5 MHz instead of 25 MHz.

The 82555 provides a glueless interface to Intel components such as the 82557 Fast Ethernet Controller, as well as any MII compatible device. Figure 4 shows a schematic-level diagram of the 82557 Fast Ethernet controller implementation connected to the 82555 using the MII interface.

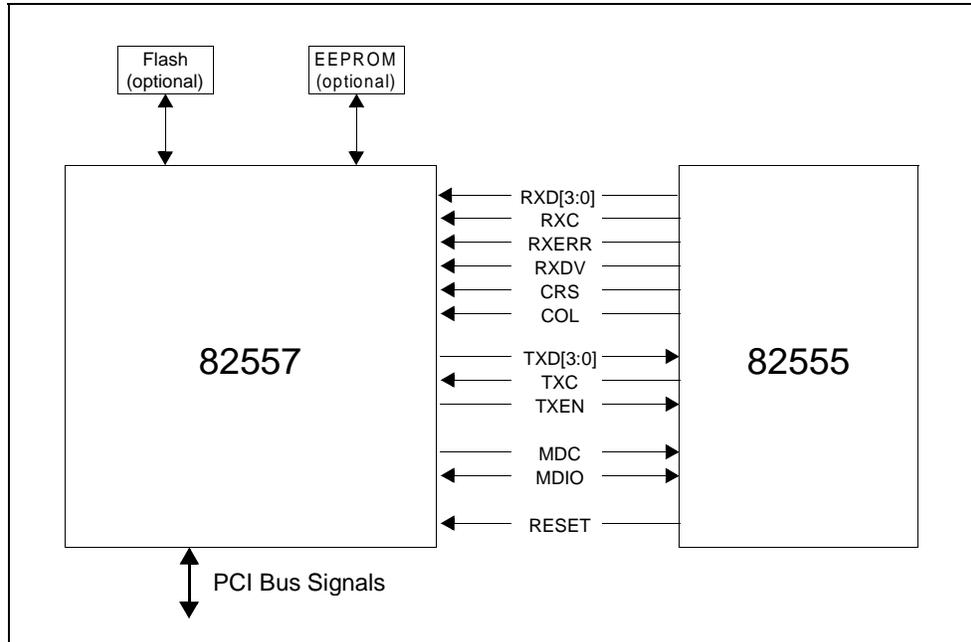


Figure 4. Intel 82557/82555 Solution

2.3 Media Independent Interface (MII)

The 82555 supports the Media Independent Interface (MII) as its primary interface to the MAC. The MII Interface is summarized in Table 1.

Table 1. 82555 MII

Signal Name	Description	Direction	Clock Reference	MII Signal Supported by the 82555?
TXC	Transmit Clock	From 82555 (adapter mode only)	--	Yes
TXD[3:0]	Transmit Data	From MAC	TXC	Yes
TXEN	Transmit Enable	From MAC	TXC	Yes
COL	Collision Detect	From 82555	Asynchronous	Yes
CRS	Carrier Sense	From 82555	Asynchronous	Yes
RXC	Receive Clock	From 82555	--	Yes
RXD[3:0]	Receive Data	From 82555	RXC	Yes
RXDV	Receive Data Valid	From 82555	RXC	Yes
RXERR	Receive Error	From 82555	RXC	Yes
MDC	Management Data Clock	From manager	--	Yes
MDIO	Management Data Input/Output	From manager	MDC	Yes



Table 1. 82555 MII

Signal Name	Description	Direction	Clock Reference	MI I Signal Supported by the 82555?
TXERR	Transmit Error (repeater mode only)	From RIC	TXC	Yes

3.0 Pin Definitions

All active digital pins are defined to have transistor-to-transistor logic voltage levels except the X1 and X2 crystal signals. The transmit differential and receive differential pins are specified as analog outputs and inputs, respectively.

The figure below show the pin locations on the 82555 component. The following subsections describe the pin functions.

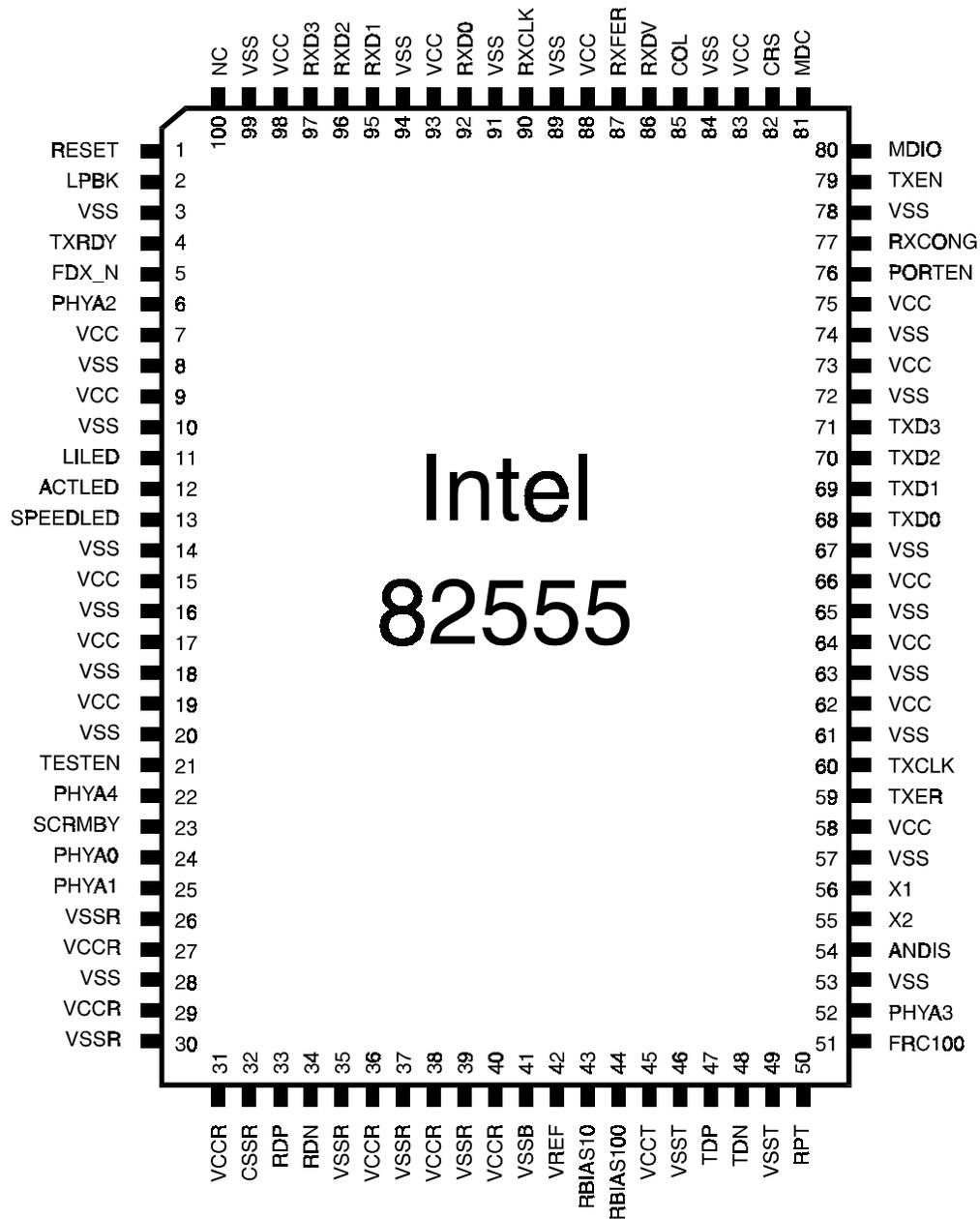


Figure 5. 82555 Pin Numbers and Labels

Pin allocation is based on a 100-lead quad flat package. All pin locations are based on printed circuit board layout and other design constraints.

3.1 Pin Types

Pin Type	Description
I	This type of pin is an input pin to the 82555.
O	This type of pin is an output pin from the 82555.
I/O	This type of pin is both an input and output pin for the 82555.
B	This pin is used as a bias pin. The bias pin is either pulled up or down with a resistor. The bias pin may also be used as an external voltage reference.

3.2 Clock Pins

Symbol	Pin	Type	Name and Function
X1	56	I	Crystal Input One. X1 and X2 can be driven by an external 25 MHz crystal. Otherwise, X1 may be driven by an external MOS level 25 MHz oscillator when X2 is left floating. (The crystal should have a tolerance of 50 PPM or better.)
X2	55	O	Crystal Output Two. X1 and X2 can be driven by an external 25 MHz crystal. Otherwise, X1 may be driven by an external MOS level 25 MHz oscillator when this pin is left floating.

3.3 Twisted Pair Ethernet (TPE) Pins

Symbol	Pin	Type	Name and Function
TDP TDN	47 48	O	Transmit Differential Pair. These pins send the serial bitstream for transmission on an unshielded twisted pair (UTP) cable. The current-driven differential driver can be two-level (10BASE-T or Manchester) or three-level (100BASE-TX or MLT-3) signals depending on the operating mode. These signals interface directly with an isolation transformer.
RDP RDN	33 34	I	Receive Differential Pair. These pins receive the serial bitstream from the isolation transformer. The bitstream can be two-level (10BASE-T or manchester) or three-level (100BASE-TX or MLT-3) signals depending on the operating mode.

3.4 Media Independent Interface (MII) Pins

Symbol	Pin	Type	Name and Function
RXD3 RXD2 RXD1 RXD0	97 96 95 92	O	Receive Data. In 100 Mbps and 10 Mbps mode, data is transferred across these four lines one nibble at a time.

Symbol	Pin	Type	Name and Function
RXC	90	O	Receive Clock. The Receive Clock may be either 25 MHz or 2.5 MHz depending on the 82555's operating speed (25 MHz for 100 Mbps and 2.5 MHz for 10 Mbps). The Receive Clock is recovered directly from incoming data and is continuous into the Media Access Controller (MAC). Thus, it must be resynchronized in 10 Mbps mode at the start of each incoming packet.
RXDV	86	O	Receive Data Valid. This signal indicates that the incoming data on the RSC[3:0] pins are valid.
RXERR	87	O	Receive Error. The RXERR signal indicates to the 82555 that an error has occurred during frame reception.
TXD3 TXD2 TXD1 TXD0	71 70 69 68	I	Transmit Data. In 100 Mbps and 10 Mbps mode, data is transferred across these four lines one nibble at a time.
TXC	60	I/O	Transmit Clock. The Transmit Clock may be either 25 MHz or 2.5 MHz depending on the 82555's operating speed (25 MHz for 100 Mbps and 2.5 MHz for 10 Mbps). The Transmit Clock outputs a continuous clock into the MAC that is generated directly from the external clock source in DTE (adapter) mode. In repeater mode, the TXC is an input signal operating at either 25 MHz or 2.5 MHz depending on the operating speed, which is typically clocked by a receiver interface device.
TXEN	79	I	Transmit Enable. The Transmit Enable signal indicates to the 82555 that valid data is present on the TXD[3:0] pins.
TXERR	59	I	Transmit Error. The TXERR signal indicates to the 82555 that an error has occurred during transmissions of a frame.
CRS	82	O	Carrier Sense. The Carrier Sense signal indicates to the 82555 that traffic is present on the link. CRS is an asynchronous output signal.
COL	85	O	Collision Detect. The Collision Detect signal operates in half duplex mode and indicates to the 82555 that a collision has occurred on the link. COL is an asynchronous output signal to the controller.
MDIO	80	I/O	Management Data Input/Output. The MDIO signal is a bidirectional data pin for the Management Data Interface (MDI).
MDC	81	II	Management Data Clock. The MDC signal functions as a clock reference for the MDIO signal. MDC should operate at a maximum frequency of 2.5 MHz

3.5 Media Access Control/Repeater Interface Control Pins

Symbol	Pin	Type	Name and Function
RXCONG	77	I	Receive Congestion. If the following conditions exist, the RXCONG is an active high and indicates an overrun on the controller receive side: <ul style="list-style-type: none"> • Full duplex PHY Base (Bay Technologies) flow control DTE (adapter) mode • Full duplex signal (FDX_N) is high • Full duplex technology is active through Auto-Negotiation
PORTEN	76	I	Port Enable. In repeater mode when the PORTEN signal is low, the following signals will be tri-stated: RXD[3:0], RXC, RXDV, and RXERR.

Symbol	Pin	Type	Name and Function
TXRDY (TOUT)	4	O	This pin is multiplexed and can be used for one of the following: Transmit Ready. If full duplex and PHY Base (Bay Technologies) flow control modes are enabled, the TXRDY signal enables transmission while it is asserted. TOUT. When the Test Enable signal is activated, this signal functions as the Test Output port.
FDX_N	5	I/O	Full Duplex. In DTE (adapter) mode, this active low output signal reports the result of the duplex configuration to the MAC. This pin can also operate as the LED driver and will be an active low for all technologies. In repeater mode, this signal is used for Auto-Negotiation advertisement to the 82555's link partner and activates the PHY Base (Bay Technologies) flow control if 100BASE-TX full duplex is the highest common technology between the 82555 and its link partner.

3.6 LED Pins

Symbol	Pin	Type	Name and Function
ACTLED	12	O	Activity LED. This signal indicates either transmit or receive activity. When activity is present, the ACTLED is on. When no activity is present, the ACTLED is off.
LILED	11	O	Link Integrity LED. This signal indicates the link integrity. If a valid link is present in either 10 Mbps or 100 Mbps, the LILED is on; and if an invalid link is present, LILED is off. For a combination design board, the LILED should be connected to the TX technology LED.
SPEED-LED	13	O	Speed LED This signal is used to indicate the speed of operation. For 100 Mbps, the SPEEDLED will be on; and for 10 Mbps, the SPEEDLED will be off.

3.7 External Bias Pins

Symbol	Pin	Type	Name and Function
RBIAS100	44	B	Bias Reference Resistor 100. A 634 Ω resistor should be connected from this pin to ground.
RBIAS10	43	B	Bias Reference Resistor 10. A 768 Ω resistor should be connected from this pin to ground.
PD1	42	I	Pull Down One. A 10 K Ω resistor should be connected from this pin to ground.
PD2	100	I	Pull Down One. A 1 K Ω resistor should be connected from this pin to ground.

Note: The resistor values described for the external bias pins are only recommended values and may require to be fine tuned for various designs.

3.8 Miscellaneous Control Pins

Symbol	Pin	Type	Name and Function
RESET	1	I	Reset. The Reset signal is active high and resets the 82555. A reset pulse width of at least 1 μ s should be used.
FRC100 (MACTYP)	51	I	This pin is multiplexed and can be used for one of the following: Force 100/10 Mbps. In repeater mode, this pin configures the repeater to either 100 Mbps (active high) or to 10 Mbps (active low). MAC Type. In DTE (adapter) full duplex mode, if this input signal is high, the 82555 drives 82557 mode. If this input signal is low, the 82555 drives a generic MII MAC mode.
PHYA4 (TIN)	22	I	This pin is multiplexed and can be used for one of the following: PHY Address 4. In repeater mode, this signal represents the fifth bit for address port configuration. TIN. If the Test Enable signal is active, this signal is used as the Test Input data.
PHYA3 (SLVTRI)	52	I/O	This pin is multiplexed and can be used for one of the following: PHY Address 3. In repeater mode, this signal represents the fourth bit for address port configuration. Slave Tri-state. In DTE (adapter) mode, this output operates in conjunction with the T4 Advanced signal. When both are active, the slave PHY is inactive and tri-states all its outputs.
PHYA2 (LISTAT)	6	I	This pin is multiplexed and can be used for one of the following: PHY Address 2. In repeater mode, this signal represents the third bit for address port configuration. Link Status. In DTE (adapter) mode, if T4 Advance is active, the LISTAT_N signal is active low and the slave PHY link is valid.
PHYA1 (TEXEC)	25	I	This pin is multiplexed and can be used for one of the following: PHY Address 1. In repeater mode, this signal represents the second bit for address port configuration. Test Execute. If Test Enable is asserted, this signal acts as the test execution command indicating that the pin 22 is being used as the Test Input pin.
PHYA0 (TCK)	24	I	This pin is multiplexed and can be used for one of the following: PHY Address 0. In repeater mode, this signal represents the first bit for address port configuration. Test Clock. If Test Enable is asserted, this signal acts as the Test Clock signal.
ANDIS (T4ADV)	54	I	This pin is multiplexed and can be used for one of the following: Auto-Negotiation Disable. In repeater mode, the Auto-Negotiation operates for management reasons. If this input signal is high, the Auto-Negotiation operation will be disabled. T4ADV. In DTE (adapter) mode, this pin enables the combo mode. This allows the LISTAT and SLVTRI pins to be used as interface to the slave PHY.
SCRMBY	23	I	Scrambler/Descrambler Bypass. If SCRMBY is high, the scrambler/descrambler of TP-PMD will be bypassed.
LPBK	2	I	Loopback. When the LPBK signal is high, the 82555 will perform a diagnostic loopback function.
RPT	50	I	Repeater. When the RPT signal is high, the 82555 functions in repeater mode. When this signal is low, the 82555 runs in DTE (adapter) mode.
TESTEN	21	I	Test. If the TESTEN signal is high, the 82555 enables the test ports.

3.9 Power and Ground Pins

Symbol	Pin	Type	Name and Function
VCC	7, 9, 15, 17, 19, 27, 29, 31, 36, 38, 40, 45, 58, 62, 64, 66, 73, 75, 83, 88, 93, 98	I	Power: +5 V \pm 5%
VSS	3, 8, 10, 14, 16, 18, 20, 26, 28, 30, 32, 35, 37, 39, 41, 46, 49, 53, 57, 61, 63, 65, 67, 72, 74, 78, 84, 89, 91, 94, 99	I	Ground: 0 V

4.0 100BASE-TX Adapter Mode Operation

4.1 100BASE-TX Transmit Clock Generation

A 25 MHz crystal or a 25 MHz oscillator is used to drive the 82555's X1 and X2 pins. The 82555 derives its internal transmit digital clocks from this crystal or oscillator input. The Transmit Clock signal is a derivative of the 25 MHz internal clock. The accuracy of the external crystal or oscillator must be $\pm 0.0005\%$ (50 PPM).

4.2 100BASE-TX Transmit Blocks

The transmit subsection of the 82555 accepts nibble-wide data on the TXD[3:0] lines when TXEN is asserted (high). The transmit subsection passes data unconditionally to the 4B/5B encoder as long as TXEN is active.

The 4B/5B encoder accepts nibble-wide data (4 bits) from the MAC and compiles it into 5-bit-wide parallel symbols. These symbols are scrambled and serialized into a 125 Mbps bit stream, converted by the analog transmit driver into a MLT-3 waveform format, and transmitted onto the Unshielded Twisted Pair (UTP) or Shielded Twisted Pair (STP) wire.

4.2.1 100BASE-TX 4B/5B Encoder

The 4B/5B encoder complies with the IEEE 802.3u 100BASE-TX standard. Four bits are encoded according to the transmit 4B/5B lookup table. The lookup table matches a 5-bit code to each 4-bit code.

The table below illustrates the 4B/5B encoding scheme associated with the given symbol.

Table 2. 4B/5B Encoder

Symbol	5B Symbol Code	4B Nibble Code
0	11110	0000
1	01001	0001
2	10100	0010
3	10101	0011
4	01010	0100
5	01011	0101
6	01110	0110
7	01111	0111
8	10010	1000
9	10011	1001
A	10110	1010
B	10111	1011
C	11010	1100
D	11011	1101

Table 2. 4B/5B Encoder

Symbol	5B Symbol Code	4B Nibble Code
E	11100	1110
F	11101	1111
I	11111	Inter Packet Idle Symbol (No 4B)
J	11000	1st Start of Packet Symbol 0101
K	10001	2nd Start of Packet Symbol 0101
T	01101	1st End of Packet Symbol
R	00111	2nd End of Packet Symbol and Flow Control
V	00000	INVALID
V	00001	INVALID
V	00010	INVALID
V	00011	INVALID
H	00100	INVALID
V	00101	INVALID
V	00110	INVALID
V	01000	INVALID
V	01100	INVALID
V	10000	Flow Control S
V	11001	INVALID

4.2.2 100BASE-TX Scrambler and MLT-3 Encoder

Data is scrambled in 100BASE-TX in order to reduce electromagnetic emissions during long transmissions of high-frequency data codes. The scrambler logic accepts 5 bits from the 4B/5B encoder block and presents the scrambled data to the MLT-3 encoder. The 82555 implements the 11-bit stream cipher scrambler as adopted by the ANSI XT3T9.5 committee for UTP operation. The cipher equation used is:

$$X[n] = X[n-11] + X[n-9] \pmod{2}$$

The MLT-3 encoder receives the scrambled Non-Return to Zero (NRZ) data stream from the scrambler and encodes the stream into MLT-3 for presentation to the driver. MLT-3 is similar to NRZI coding, but three levels are output instead of two. There are three output levels: positive, negative and zero. When an NRZ “0” arrives at the input of the encoder, the last output level is

maintained (either positive, negative or zero). When an NRZ “1” arrives at the input of the encoder, the output steps to the next level. The order of steps is negative-zero-positive-zero which continues periodically. The figure below illustrates this process.

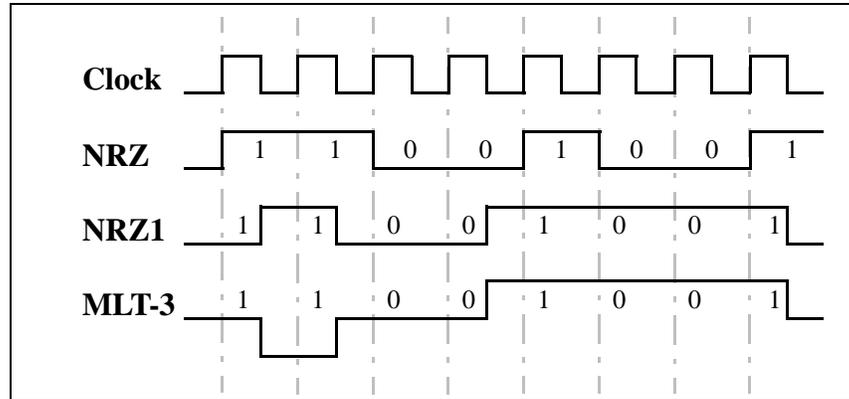


Figure 6. NRZ to MLT-3 Encoding Diagram

4.2.3 100BASE-TX Transmit Framing

The 82555 does not differentiate between the fields of the MAC frame containing preamble, start of frame delimiter, data and Cyclic Redundancy Check (CRC). When TXEN is asserted, the 82555 accepts data on the MII TXD[3:0] lines, encodes it, and sends it out onto the wire. The 82555 encodes the first byte of the preamble as the “JK” symbol, encodes all other pieces of data according to the 4B/5B lookup table, and adds the “TR” code after the end of the packet (de-assertion of TXEN). The 82555 scrambles and serializes the data into a 125 Mbps stream, encodes it as MLT-3, and drives it onto the wire. If TXERR is asserted during transmission of valid data, the 82555 transmits an invalid “H” symbol.

4.2.4 Transmit Driver

The transmit differential lines are implemented with a digital slope controlled current driver that meets the TP-PMD specifications. Current is sunk from the isolation transformer by the transmit differential pins. The conceptual transmit differential waveform for 100 Mbps is illustrated in the following figure.

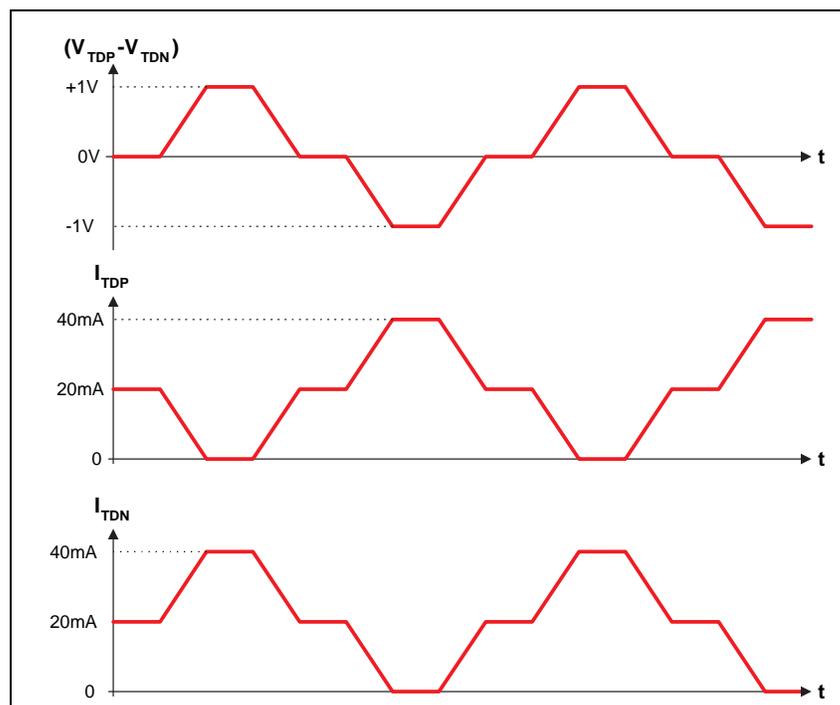


Figure 7. Conceptual Transmit Differential Waveform

The magnetics module that is external to the 82555 converts I_{TDP} and I_{TDN} to $2.0 V_{pp}$, as required by the TP-PMD specification. The same magnetics used for 100BASE-TX mode should also work in 10BASE-T mode. The following is a list of current magnetics modules available from several vendors:

Table 3. Magnetics Modules

Vendor	Model/Type	100BASE-TX	10BASE-T
Delta	LF8200A	Yes	Yes
Pulse Engineering	PE-68515	Yes	Yes
Pulse Engineering	H1012	Yes	Yes

4.3 100BASE-TX Receive Blocks

The receive subsection of the 82555 accepts 100BASE-TX MLT-3 data on the receive differential pair. Due to the advanced digital signal processing design techniques employed, the 82555 will accurately receive valid data from Category 5 (CAT5) UTP and Type 1 STP cable of length well in excess of 100 meters.

4.3.1 Adaptive Equalizer

The distorted MLT-3 signal at the end of the wire is restored by the equalizer. The equalizer performs adaptation based on the shape of the received signal, equalizing the signal to meet superior Data Dependent Jitter performance.

4.3.2 Receive Clock and Data Recovery

The clock recovery circuit uses advanced digital signal processing technology to compensate for various signal jitter causes. The circuit recovers the 125 MHz clock and data and presents the data to the MLT-3 decoder.

4.3.3 MLT-3 Decoder, Descrambler, and Receive Digital Section

The 82555 first decodes the MLT-3 data; afterwards, the descrambler reproduces the 5B symbols originated in the transmitter. The descrambling is based on synchronization to the transmit 11-bit Linear Feedback Shift Register (LFSR) during idle. The data is decoded at the 4B/5B decoder. Once the 4B symbols are obtained, the 82555 outputs the receive data to the CSMA unit.

4.3.4 100BASE-TX Receive Framing

The 82555 does not differentiate between the fields of the MAC frame containing preamble, start of frame delimiter, data and CRC. During 100 Mbps reception, the 82555 differentiates between the idle condition ("L" symbols on the wire) and the preamble or start of frame delimiter. When two non-consecutive bits are 0b within 10 bits (125 Mbps 5B data coding) the 82555 immediately asserts the CRS signal. When the "JK" symbols ("11000, 10001") are fully recognized, the 82555 asserts the RXDV signal and provides the data received on the MII RXD[3:0] to the Receive Clock. If the "JK" symbol is not recognized ("false carrier sense"), the CRS signal is immediately de-asserted and RXERR is asserted. Otherwise, the valid data is passed through the MII until the 82555 finds the "TR" ("01101, 00111") and idle symbols in order to de-assert TXDV and CRS.

4.3.5 100BASE-TX Receive Error Detection and Reporting

In 100BASE-TX mode, the 82555 can detect errors in receive data in a number of ways. Any of the following conditions is considered an error:

- Link integrity fails in the middle of frame reception.
- The start of stream delimiter "JK" symbol is not fully detected after idle.
- An invalid symbol is detected at the 4B/5B decoder.
- Idle is detected in the middle of a frame (before "TR" is detected).

When any of the above error conditions occurs, the 82555 immediately asserts the Receive Error signal to the MAC. The RXERR signal is asserted as long as the receive error condition persists on the receive pair.

4.4 100BASE-TX Collision Detection

100BASE-TX collisions in half duplex mode only are detected similarly to 10BASE-T collision detection, via simultaneous transmission and reception.

4.5 100BASE-TX Link Integrity and Auto-Negotiation Solution

The 82555's Auto-Negotiation function automatically configures the device to the technology, media, and speed to operate with its link partner. Auto-Negotiation is widely described in IEEE specification 802.3u, Clause 28. The 82555 supports 10BASE-T half duplex, 10BASE-T full duplex, 100BASE-TX half duplex, and 100BASE-TX full duplex.

The 82555 has two Physical Medium Attachment (PMA) technologies with its link integrity function, 10BASE-T and 100BASE-TX. The 82555 also has a special interface defined between itself and a PHY-T4 in order to implement an Auto-Negotiation combination card.

4.5.1 Link Integrity

In 100BASE-TX, the link integrity function is determined by a stable signal status coming from the TP-PMD block. Signal status is asserted when the PMD detects breaking squelch energy and the right bit error rate according to the ANSI specification.

4.5.2 Auto-Negotiation

The 82555 fully supports IEEE 802.3u, Clause 28. In DTE (adapter) mode, the technology, 10BASE-T or 100BASE-TX, is determined by the Auto-Negotiation result. In repeater mode only, this function can be disabled by pin configuration. If the T4ADV pin is active, the Auto-Negotiation function will advertise and negotiate T4 technology.

Speed and duplex auto-select are functions of Auto-Negotiation. However, these parameters may be manually configured via the MII management interface (MDI registers).

4.5.3 Combination Tx/T4 Auto-Negotiation Solution

The Auto-Negotiation function is available in both the 82555 and a PHY-T4. For these PHYs to operate together, some arbitration at the PMA level is required and the Auto-Negotiation function of one of the PHYs must be disabled. For this purpose, the 82555 is defined as the master; and the PHY-T4, the slave. In combination mode, only the 82555's Auto-Negotiation function is enabled (the PHY-T4's Auto-Negotiation is disabled).

In a combination board, a PHY-T4 is used only to support 100BASE-T4 operation and the 82555 is used to support 100BASE-TX full or half duplex and 10BASE-T full or half duplex as determined by the Auto-Negotiation or Parallel Detection function.

Combination mode is available only in DTE (adapter) mode with the following pin interface:

- **T4ADV** (pin 54): Enables T4 technology in a PHY-TX Auto-Negotiation system.
- **SLVTRI** (pin 52): Disables the PHY-T4. The PHY-T4 is enabled only if the T4 technology has been detected by Auto-Negotiation or Parallel Detection.
- **LISTAT** (pin 6): Indicates valid link on the PHY-T4. When SLVTRI is de-asserted, the PHY-T4 should be active.

The figure below illustrates an 82557/82555/PHY-T4 solution in a block diagram.

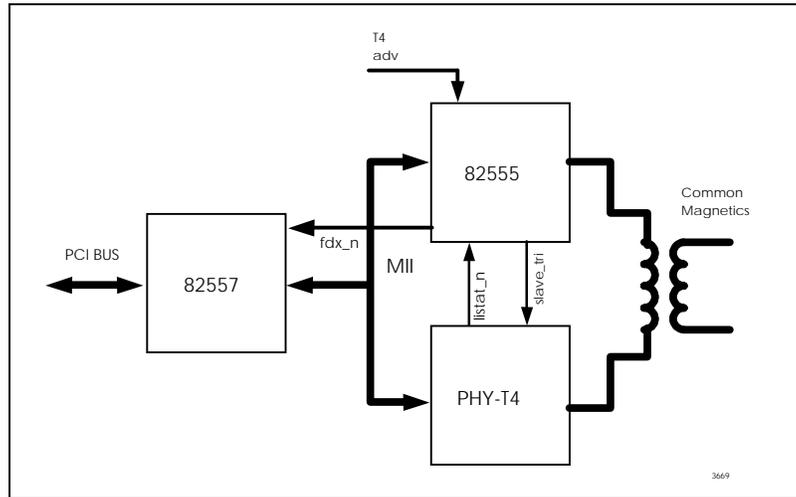


Figure 8. Combination Card Example

4.6 Auto 10/100 Mbps Speed Selection

The MAC may either allow the 82555 to automatically select its operating speed or force the 82555 into 10 Mbps or 100 Mbps mode. The Management Data Interface (MDI) can control the 82555 speed mode.

The 82555 autoselect function determines the operation speed of the media based on the link integrity pulses it receives. If no Fast Link Pulses (FLPs) are detected and Normal Link Pulses (NLPs) are detected, the 82555 defaults to 10 Mbps operation. If the 82555 detects a speed change, it dynamically changes its transmit clock and receive clock frequencies to the appropriate value. This change takes a maximum of five milliseconds.

4.7 Adapter Mode Addresses

In DTE (adapter) mode, the 82555 supports addresses 0, 1, 2, and 3 through the pins PHYA1 and PHYA0. Four addresses are sufficient in the case of a combination adapter having three PHYs. For switch applications, the T4ADV signal should be de-asserted to allow all 32 addresses to be available in repeater mode.



5.0 10BASE-T Functionality in Adapter Mode

5.1 10BASE-T Transmit Clock Generation

The 20 MHz and 10 MHz clocks needed for 10BASE-T are synthesized from the external 25 MHz crystal or oscillator. The 82555 provides the transmit clock and receive clock to the MAC at 2.5 MHz.

5.2 10BASE-T Transmit Blocks

5.2.1 10BASE-T Manchester Encoder

After the 2.5 MHz clocked data is serialized in a 10 Mbps serial stream, the 20 MHz clock performs the Manchester encoding. The Manchester code always has a mid-bit transition. If the value is 1b then the transition is from low to high. If the value is 0b then the transition is from high to low. The boundary transition occurs only when the data changes from bit to bit. For example, if the value is 10b, then the change is from high to low; if 01b, then the change is from low to high.

5.2.2 10BASE-T Driver and Filter

Since 10BASE-T and 100BASE-TX have different filtration needs, both filters are implemented inside the chip. This allows the two technologies to share the same magnetics. The 82555 supports both technologies through one pair of transmit differential pins and by externally sharing the same magnetics.

In 10 Mbps mode, the 82555 begins transmitting the serial Manchester bit stream within 3 bit times (300 nanoseconds) after the MAC asserts TXEN. In 10 Mbps mode the line drivers use a pre-distortion algorithm to improve jitter tolerance. The line drivers reduce their drive level during the second half of “wide” (100 ns) Manchester pulses and maintain a full drive level during all narrow (50 ns) pulses and the first half of the wide pulses. This reduces line overcharging during wide pulses, a major source of jitter.

5.3 10BASE-T Receive Blocks

5.3.1 10BASE-T Manchester Decoder

The 82555 performs Manchester decoding and timing recovery when in 10 Mbps mode. The Manchester encoded data stream is decoded from the receive differential pair to separate Receive Clock and Receive Data lines from the differential signal. This data is transferred to the controller at 2.5 MHz/nibble through the MII. The high-performance circuitry of the 82555 exceeds the IEEE 802.3 jitter requirements.

5.3.2 10BASE-T Twisted Pair Ethernet (TPE) Receive Buffer and Filter

In 10 Mbps mode, data is expected to be received on the receive differential pair after passing through isolation transformers. The filter is implemented inside the 82555 for supporting single magnetics that are shared with the 100BASE-TX side. The input differential voltage range for the

Twisted Pair Ethernet (TPE) receiver is greater than 585 mV and less than 3.1 V. The TPE receive buffer distinguishes valid receive data, link test pulses, and the idle condition, according to the requirements of the 10BASE-T standard.

The following line activity is determined to be inactive and is rejected:

- Differential pulses of peak magnitude less than 300 mV.
- Continuous sinusoids with a differential amplitude less than $6.2 V_{pp}$ and frequency less than 2 MHz.
- Sine waves of a single cycle duration starting with 0° or 180° phase that have a differential amplitude less than $6.2 V_{pp}$ and a frequency of at least 2 MHz and not more than 16 MHz. These single-cycle sine waves are discarded only if they are preceded by 4 bit times (400 nanoseconds) of silence.

All other activity is determined to be either data, link test pulses, Auto-Negotiation fast link pulses, or the idle condition. When activity is detected, the carrier sense signal is asserted to the MAC.

5.3.3 10BASE-T Error Detection and Reporting

In 10 Mbps mode, the 82555 can detect errors in the receive data. The following condition is considered an error:

The receive pair's voltage level drops to the idle state during reception before the end-of-frame bit is detected (250 nanoseconds without mid-bit transitions).

5.4 10BASE-T Collision Detection

Collision detection in 10 Mbps mode is indicated by simultaneous transmission and reception. If the 82555 detects this condition, it asserts a collision indication to the controller.

5.5 10BASE-T Link Integrity

The link integrity in 10 Mbps works with link pulses. The 82555 senses and differentiates those link pulses from fast link pulses and from 100BASE-TX idles. In the first and last case, the 82555 activates parallel detection of the respective technology; and in the second case, Auto-Negotiation. The 10 Mbps link pulses or normal link pulses are driven in the transmit differential pair line but are 100 ns wide and have levels from 0 V to 5 V. The link beat pulse is also used to determine if the receive pair polarity is reversed. If it is, the polarity is corrected internally.

5.6 10BASE-T Jabber Control Function

The 82555 contains a jabber control function that inhibits transmission after a specified time window when enabled. In 10 Mbps mode, the jabber timer is set to a value between 26.2 ms and 39 ms. If the 82555 detects continuous transmission that is greater than this time period, it prevents further transmissions from onto the wire until it detects that the MAC transmit enable signal has been inactive for at least 314 ms.

5.7 10BASE-T Full Duplex

The 82555 supports 10 Mbps full duplex by disabling the collision function, the squelch test, and the carrier sense transmit function. This allows the 82555 to transmit and receive simultaneously, achieving up to 20 Mbps of network bandwidth. The configuration can be achieved through Auto-Negotiation. Full duplex should only be used in point-to-point connections (no shared media). Flow control is always disabled.

6.0 Repeater Mode

The 82555 has a complete set of repeater features making it the ideal PHY for Class 1 (MII) repeater designs. The 82555 works in repeater mode when the RPT signal (pin 50) is high. The FRC100 signal (pin 51) determines which type of repeater is supported, either 100BASE-TX or 10BASE-T.

6.1 Special Repeater Features

Special features of the 82555 repeater mode operation include:

- Fully IEEE compliant with automatic carrier disconnect.
The 82555 will disconnect when it receives false carrier detects. Either a long series of valid idle symbols or a valid “JK” pair will cause it to reconnect.
- Narrow 14 mm analog side that enables tight packing of multiple PHYs, which is ideal for 8, 12, 18, 24, or even 32 port repeater designs.
- Very low emissions and high noise immunity.
- 32 configurable addresses through five address lines.
- Auto-Negotiation disable function.
In repeater mode, the Auto-Negotiation function is not used for configuration purposes. When Auto-Negotiation is enabled in repeater mode, the MII management will be able to obtain data from the MDI Auto-Negotiation register about the remote partner. This is a feature for hub management allowing a 10/100 Mbps repeater design to automatically detect whether or not it can operate at 100 Mbps. If the ANDIS signal is de-asserted, the Auto-Negotiation feature will be disabled.
- Forced 10 Mbps or 100 Mbps operation (allows for a 10/100 repeater design).
- Receive port enable function.
The PORTEN signal is a glueless interface to the Repeater Interface Controller (RIC). When the PORTEN signal is low, all receive signals are tri-stated, except CRS and COL.
- 26-bit PHY budget for round trip.
The total PHY bit budget is 8 bits from the MII to the wire and 18 bits from the wire to the MII.
- Static 2.5 MHz (10BASE-T) or 25 MHz (100BASE-TX) clock input for repeater designs (issued by RIC).
The 82555 clock source is fixed between Resets. There is one input, either 2.5 MHz or 25 MHz, as indicated by the level at the FRC100 pin. All clocks have a common source generation so that PPM is 0 between them (X1, 2.5 MHz and 25 MHz).
- DTE (adapter) features not available in repeater mode: full duplex, flow control, and the combination Auto-Negotiation interface for T4.

6.2 Connectivity

A 25 MHz buffered oscillator can provide the clock to all of the 82555 devices. A 2.5 MHz (10 Mbps) or a 25 MHz (100 Mbps) signal is required to clock the RIC and the TXC signal in the PHYs. TXD[3:0], TXERR, RXC, RXD[3:0], RXDV, and RXERR are single-bus (shortened) for all

PHYs connected to the RIC. Signals TXEN, CRS, and PORTEN are connected from each of the 82555 devices to the specified RIC pin. The figure below illustrates an example of multiple 82555s connected to a 25 MHz (or 2.5 MHz) oscillator.

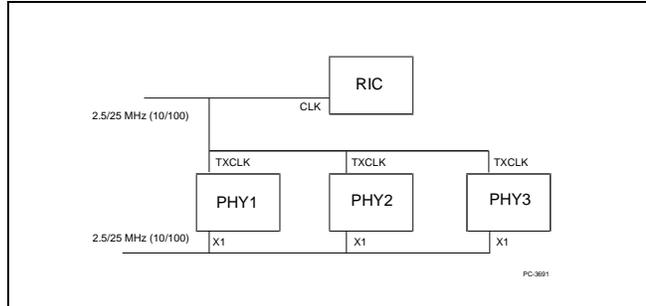


Figure 9. Clock Signal Example

7.0 Management Data Interface

The 82555 provides status and accepts management information through the Management Data Interface (MDI). This is accomplished through read and write operations to various registers in accordance with the IEEE 802.3u MII specification.

7.1 MDI Frame Structure

Data read from or written to a particular register is called a management frame and is sent serially over the MDIO pin synchronously to the MDC signal. Read and write cycles are viewed from the perspective of the controller. Thus, the controller always drives the start, opcode, PHY address, and register address onto the MDIO pin. For read cycles, the controller drives the transition bits and data onto the MDIO pin; for write cycles, to the 82555. The controller drives addresses and data on the falling edge of the MDC signal, and the 82555 latches the data on the rising edge of the MDC signal. The following list defines protocol terms:

PREAMBLE	At the beginning of each transaction, the controller send a sequence of 32 contiguous logic one bits on the MDIO pin with corresponding cycles on the MDC pin for synchronization by the 82555.
ST	This field contains the value of 01b indicating the start of a frame.
OP	This is a 2-bit field containing one of the following two operation codes: 10b (read) or 01b (write).
PHYAD	This field is a 5-bit address of the 82555 device that provides support for 32 unique PHY addresses. The controller drives the value written into the PHYAD portion of the MDI register in this field.
REGAD	This field is a 5-bit address of a specific register within the 82555. This provides support for 32 unique registers. The desired register address is specified by the value written to the MDI register.
TA	This field contains a 2-bit value specifying the period during a read cycle that no device may actively drive the MDIO signal. During a read transaction, the 82555 should not drive the MDIO signal in the first bit time; however, it will drive a 0b in the second bit time. During a write transaction, the controller drives the pattern of 10b to fill this time.
DATA	This field contains 16 bits of data driven by the 82555 on a read transaction or by the controller on a write transactions. This data is either control or status parameters passed between the controller and the 82555.
IDLE	During the idle state, the MDIO signal is in a high impedance state. The MDIO driver is disabled, and the 82555 will pull the MDIO signal high to a logic 1.

The 82555 address can be configured to four 0 through 3 in DTE (adapter) mode and 0 through 31 in repeater mode. A special functions for switches allows 32 addresses to exist in repeater mode. The management frame structure is as follows:

Transition	ST	OP	PHYAD	REGAD	TA	DATA
READ	<01>	<10>	<AAAAA>	<RRRRR>	<X0>	16 bits
WRITE	<01>	<01>	<AAAAA>	<RRRRR>	<10>	16 bits

7.2 MDI Registers

MDI registers are described in the following subsections and the acronyms mentioned in the registers are defined as follows:

- SC - Self Cleared.
- RO -Read Only.
- P- External pin affects 82555 register content.
- LL - Latch Low.
- LH - Latch High.

7.2.1 MDI Registers 0 - 7

7.2.1.1 Register 0: Control Register Bit Definitions

Bit(s)	Name	Description	Default	R/W
15	Reset	This bit sets the status and control register of the 82555 to their default states and is self-clearing. The PHY returns a value of 1b until the reset process has completed and accepts a read or write transaction. 1 = PHY Reset 0 = Normal operation	0	RW SC
14	Loopback	This bit enables loopback of transmit data nibbles from the TXD[3:0] signals to the receive data path. The 82555's receive circuitry is isolated from the network. Note that this may cause the descrambler to lose synchronization and produce 560 nanoseconds of "dead time." Note also that the loopback configuration bit takes priority over the Loopback MDI bit. 1 = Loopback enabled 0 = Loopback disabled (normal operation)	0	RW P
13	Speed Selection	This bit controls speed when Auto-Negotiation is disabled and is valid on read when Auto-Negotiation is disabled. 1 = 100 Mbps 0 = 10 Mbps	1	RW P
12	Auto-Negotiation Enable	This bit enables Auto-Negotiation. Bits 13 and 8, Speed Selection and Duplex Mode, respectively, are ignored when Auto-Negotiation is enabled. 1 = Auto-Negotiation enabled 0 = Auto-Negotiation disabled	1	RW

Bit(s)	Name	Description	Default	R/W
11	Power-Down	This bit sets the 82555 into a low power mode. 1 = Power-down enabled 0 = Power-down disabled (normal operation)	0	RW
10	Isolate	This bit allows the 82555 to electrically isolate the Media Independent Interface. When the MII is isolated, the 82555 does not respond to TXD[3:0], TXEN, and TXERR input signals. Also, the 82555 presents high impedance on its TXC, RXC, RXDV, RXERR, RXD[3:0], COL, and CRS output signals. In the TX mode, the 82555 responds to management transactions. 1 = Electrically isolate MII 0 = Normal operation	0	RW
9	Restart Auto-Negotiation	This bit restarts the Auto-Negotiation process and is self-clearing. 1 = Restart Auto-Negotiation process 0 = Normal operation	0	RW SC
8	Duplex Mode	This bit controls the duplex mode when Auto-Negotiation is disabled. If the 82555 reports that it is only able to operate in one duplex mode, the value of this bit shall correspond to the mode which the 82555 can operate. When the 82555 is placed in Loopback mode, the behavior of the PHY shall not be affected by the status of this bit, bit 8. 1 = Full Duplex 0 = Half Duplex	0	RW
7	Collision Test	This bit will force a collision in response to the assertion of the transmit enable signal. 1 = Force COL 0 = Do not force COL	0	RW
6:0	Reserved	These bits are reserved and should be set to 0000000b.	0	RW

7.2.1.2 Register 1: Status Register Bit Definitions

Bit(s)	Name	Description	Default	R/W
15	100BASE-T4	1 = 82555 able to perform 100BASE-T4 0 = 82555 not able to perform 100BASE-T4	--	RO P
14	100BASE-TX Full Duplex	1 = 82555 able to perform full duplex 100BASE-TX 0 = 82555 not able to perform full duplex in repeater mode	--	RO P
13	100 Mbps Half Duplex	1 = 82555 able to perform half duplex 100BASE-TX 0 = 82555 not able to perform 100BASE-TX	--	RO P
12	10 Mbps Full Duplex	1 = 82555 able to operate at 10 Mbps in full duplex mode 0 = 82555 not able to operate in full duplex mode in 10BASE-T	--	RO P
11	10 Mbps Half Duplex	1 = 82555 able to operate at 10 Mbps in half duplex mode 0 = 82555 not able to operate in 10BASE-T	--	RO P
10:7	Reserved	These bits are reserved and should be set to 0000b.	0	RO

Bit(s)	Name	Description	Default	R/W
6	Management Frames Preamble Suppression	1 = 82555 will accept management frames with preamble suppressed 0 = 82555 will not accept management frames with preamble suppressed	--	RO
5	Auto-Negotiation Complete	1 = Auto-Negotiation process completed 0 = Auto-Negotiation process has not completed	0	RO
4	Remote Fault	1 = Remote fault condition detected 0 = No remote fault condition detected	0	RO P
3	Auto-Negotiation Ability	1 = 82555 is able to perform Auto-Negotiation 0 = 82555 is in repeater mode and Auto-Negotiation Disable pin is high	1	RO
2	Link Status	1 = Valid link has been established 0 = Invalid link detected	0	RO LL SC
1	Jabber Detect	1 = Jabber condition detected 0 = No jabber condition detected	0	RO LH SC
0	Extended Capability	1 = Extended register capabilities enabled 0 = No extended register capabilities	1	RO

7.2.1.3 Register 2: 82555 Identifier Register Bit Definitions

Bit(s)	Name	Description	Default	R/W
15:0	82555 ID (high byte)	Value: 02A8H	--	RO

7.2.1.4 Register 3: 82555 Identifier Register Bit Definitions

Bit(s)	Name	Description	Default	R/W
15:0	82555 ID (low byte)	Value: 0150H	--	RO

7.2.1.5 Register 4: Auto-Negotiation Advertisement Register Bit Definitions

Bit(s)	Name	Description	Default	R/W
15	Next Page	Constant 0 = Transmitting primary capability data page	--	RO
14	Reserved	This bit is reserved and should be set to 0b.	0	RO
13	Remote Fault	1 = Indicate link partner's remote fault 0 = No remote fault	0	RW
12:5	Technology Ability Field	Technology Ability Field is an 8-bit field containing information indicating supported technologies specific to the selector field value.	--	RW
4:0	Selector Field	The Selector Field is a 5-bit field identifying the type of message to be sent via Auto-Negotiation. This field is read only in the 82555 and contains a value of 00001b, IEEE Standard 802.3.	00001	RO

7.2.1.6 Register 5: Auto-Negotiation Link Partner Ability Register Bit Definitions

Bit(s)	Name	Description	Default	R/W
15	Next Page	This bit reflects the 82555's link partner's Auto-Negotiation ability.	--	RO
14	Acknowledge	This bit is used to indicate that the 82555 has successfully received its link partner's Auto-Negotiation advertising ability.	--	RO
13	Remote Fault	This bit reflects the 82555's link partner's Auto-Negotiation ability.	--	RO
12:5	Technology Ability Field	This bit reflects the 82555's link partner's Auto-Negotiation ability.	--	RO
4:0	Selector Field	This bit reflects the 82555's link partner's Auto-Negotiation ability.	--	RO

7.2.1.7 Register 6: Auto-Negotiation Expansion Register Bit Definitions

Bit(s)	Name	Description	Default	R/W
15:5	Reserved	These bits are reserved and should be set to a constant 0.	0	RO
4	Parallel Detection Fault	1 = Fault detected via parallel detection (multiple link fault occurred) 0 = No fault detected via parallel detection This bit will self-clear on read	0	RO SC LH
3	Link Partner Next page Able	1 = Link Partner is Next Page able 0 = Link Partner is not Next Page able	0	RO
2	Next Page Able	1 = Local drive is Next Page able 0 = Local drive is not Next Page able	0	RO
1	Page Received	1 = New Page received 0 = New Page not received This bit will self-clear on read.	0	RO SC LH
0	Link Partner Auto-Negotiation Able	1 = Link Partner is Auto-Negotiation able 0 = Link Partner is not Auto-Negotiation able	0	RO

7.2.2 MDI Registers 8 - 15

Registers eight through fifteen are reserved for IEEE.

7.2.3 MDI Registers 16 - 31

Register numbers 16, 17, 20, 21, 22, 23, 24, 25, and 27 are described in the following subsections.

7.2.3.1 Register 16: 82555 Status and Control Register Bit Definitions

Bit(s)	Name	Description	Default	R/W
15	Flow Control	This bit enables PHY Base (Bay Technologies) flow control. 1 = Enable PHY Base flow control 0 = Disable PHY Base flow control	0	RW
14	Reserved	These bits are reserved and should be set to 0b	0	RW
13	Carrier Sense Disconnect Control	This bit enables the disconnect function. 1 = Disconnect function enabled (default in DTE) 0 = Disconnect function disabled (default in repeater)	0 (DTE) 1 (Rptr)	RW
12	Transmit Flow Control Disable	This bit enables Transmit Flow Control 1 = Transmit Flow Control enabled 0 = Transmit Flow Control disabled	0	RW
11	Receive De-Serializer In-Sync Indication	This bit indicates status of the 100BASE-TX Receive De-Serializer In-Sync.	--	RO
10	100BASE-TX Power-Down	This bit indicates the power state of 100BASE-TX 82555. 1 = Power-down 0 = Normal operation	--	RO
9	10BASE-T Power-Down	This bit indicates the power state of 10BASE-TX 82555. 1 = Power-Down 0 = Normal operation	--	RO
8	Polarity	This bit indicates 10BASE-T polarity. 1 = Reverse polarity 0 = Normal polarity	--	RO
7:3	Reserved	These bits are reserved and should be set to a constant 0.	00000	RO
2	T4	This bit indicates the Auto-Negotiation result. 1 = 100BASE-T4 0 = No 100BASE-T4	--	RO
1	Speed	This bit indicates the Auto-Negotiation result. 1 = 100 Mbps 0 = 10 Mbps	--	RO
0	Duplex Mode	This bit indicates the Auto-Negotiation result. 1 = Full Duplex 0 = Half Duplex	--	RO

7.2.3.2 Register 17: 82555 Special Control Bit Definitions

Bit(s)	Name	Description	Default	R/W
15	Scrambler Bypass	1 = By-pass Scrambler 0 = Normal operations	0	RW
14	By-pass 4B/5B	1 = 4 bit to 5 bit by-pass 0 = Normal operation	0	RW

Bit(s)	Name	Description	Default	R/W
13	Force Transmit H-Pattern	1 = Force transmit H-pattern 0 = Normal operation	0	RW
12	Force 34 Transmit Pattern	1 = Force 34 transmit pattern 0 = Normal operation	0	RW
11	Good Link	1 = 100BASE-TX link good 0 = Normal operation	0	RW
10	Reserved	This bit is reserved and should be set to 0b.	0	RW
9	Transmit Carrier Sense Disable	1 = Transmit Carrier Sense disabled 0 = Transmit Carrier Sense enabled	0	RW
8	Disable Dynamic Power-Down	1 = Dynamic Power-Down disabled 0 = Dynamic Power-Down enabled (normal)	0	RW
7	Auto-Negotiation Loopback	1 = Auto-Negotiation loopback 0 = Auto-Negotiation normal mode	0	RW
6	MDI Tri-State	1 = MDI Tri-state (transmit driver tri-states) 0 = Normal operation	0	RW
5	Filter By-pass	1 = By-pass filter 0 = Normal filter operation	0	RW
4	Auto Polarity Disable	1 = Auto Polarity disabled 0 = Normal polarity operation	0	RW
3	Squelch Disable	1 = 10BASE-T squelch test disable 0 = Normal squelch operation	0	RW
2	Extended Squelch	1 = 10BASE-T Extended Squelch control enabled 0 = 10BASE-T Extended Squelch control disabled	--	RW
1	Link Integrity Disable	1 = Link disabled 0 = Normal Link Integrity operation	0	RW
0	Jabber Function Disable	1 = Jabber disabled 0 = Normal Jabber operation	0	RW

7.2.3.3 Register 20: 100BASE-TX Receive Disconnect Counter Bit Definitions

Bit(s)	Name	Description	Default	R/W
15:0	Disconnect Event	This field contains a 16-bit counter that increments for each disconnect event. The counter stops when full (and does not roll over) and self-clears on read In repeater mode, a frame that starts without "JK" is a disconnect event.	--	RO SC

7.2.3.4 Register 21: 100BASE-TX Receive Error Frame Counter Bit Definitions

Bit(s)	Name	Description	Default	R/W
15:0	Receive Error Frame	This field contains a 16-bit counter that increments once per frame for any receive error condition (such as a symbol error or premature end of frame) in that frame. The counter stops when full (and does not roll over) and self-clears on read.	--	RO SC

7.2.3.5 Register 22: Receive Symbol Error Counter Bit Definitions

Bit(s)	Name	Description	Default	R/W
15:0	Symbol Error Counter	This field contains a 16-bit counter that increments for each symbol error. The counter stops when full (and does not roll over) and self-clears on read. In a frame with a bad symbol, each sequential six bad symbols count as one.	--	RO SC

7.2.3.6 Register 23: 100BASE-TX Receive Premature End of Frame Error Counter Bit Definitions

Bit(s)	Name	Description	Default	R/W
15:0	Premature End of Frame	This field contains a 16-bit counter that increments for each premature end of frame event. The counter stops when full (and does not roll over) and self-clears on read. A frame without a "TR" at the end is considered a premature end of frame event.	--	RO SC

7.2.3.7 Register 24: 10BASE-T Receive End of Frame Error Counter Bit Definitions

Bit(s)	Name	Description	Default	R/W
15:0	End of Frame Counter	This is a 16-bit counter that increments for each end of frame error event. The counter stops when full (and does not roll over) and self-clears on read.	--	RO SC

7.2.3.8 Register 25: 10BASE-T Transmit Jabber Detect Counter Bit Definitions

Bit(s)	Name	Description	Default	R/W
15:0	Jabber Detect Counter	This is a 16-bit counter that increments for each jabber detection event. The counter stops when full (and does not roll over) and self-clears on read.	--	RO SC

7.2.3.9 Register 27: 82555 Special Control Bit Definitions

Bit(s)	Name	Description	Default	R/W																											
15:3	Reserved	These bits are reserved and should be set to 0b.	0	RW																											
2:0	LED Switch Control	<table border="0"> <tr> <td>Value</td> <td>ACTLED</td> <td>LILED</td> </tr> <tr> <td>000</td> <td>Activity</td> <td>Link</td> </tr> <tr> <td>001</td> <td>Speed</td> <td>Collision</td> </tr> <tr> <td>010</td> <td>Speed</td> <td>Link</td> </tr> <tr> <td>011</td> <td>Activity</td> <td>Collision</td> </tr> <tr> <td>100</td> <td>Off</td> <td>Off</td> </tr> <tr> <td>101</td> <td>Off</td> <td>On</td> </tr> <tr> <td>110</td> <td>On</td> <td>Off</td> </tr> <tr> <td>111</td> <td>On</td> <td>On</td> </tr> </table>	Value	ACTLED	LILED	000	Activity	Link	001	Speed	Collision	010	Speed	Link	011	Activity	Collision	100	Off	Off	101	Off	On	110	On	Off	111	On	On	000	RW
Value	ACTLED	LILED																													
000	Activity	Link																													
001	Speed	Collision																													
010	Speed	Link																													
011	Activity	Collision																													
100	Off	Off																													
101	Off	On																													
110	On	Off																													
111	On	On																													

8.0 Auto-Negotiation Functionality

The 82555 supports Auto-Negotiation. Auto-Negotiation is a scheme of auto-configuration designed to manage interoperability in multifunctional LAN environments. It allows two stations with “N” different modes of communication to establish a common mode of operation. At power-up, Auto-Negotiation automatically establishes a link that takes advantage of an Auto-Negotiation capable device. An Auto-Negotiation capable device can detect and automatically configure its port to take maximum advantage of common modes of operation without user intervention or prior knowledge by either station. The possible common modes of operation are: 100BASE-TX, 100BASE-TX Full Duplex, 100BASE-T4, 10BASE-T, and 10BASE-T Full Duplex.

8.1 Description

Auto-Negotiation selects the fastest operating mode (in other words, the highest common denominator) available to hardware at both ends of the cable. A PHY’s capability is encoded by bursts of link pulses called Fast Link Pulses (FLPs). Connection is established by FLP exchange and handshake during link initialization time. Once the link is established by this handshake, the native link pulse scheme resumes (that is, 10BASE-T or 100BASE-TX link pulses). A reset or management renegotiate command (through the MDI interface) will restart the process. To enable Auto-Negotiation, bit 12 of the MDI Control Register must be set. If the 82555 cannot perform Auto-Negotiation, it will set this bit to 0b and determine the speed using Parallel Detection.

The 82555 supports four technologies: 100BASE-Tx Full and Half Duplex and 10BASE-T Full and Half Duplex. Since only one technology can be used at a time (after every renegotiate command), a prioritization scheme must be used to ensure that the highest common denominator ability is chosen. Table 4 lists the technology ability field bit assignments. Each bit in this table is set according to what the PHY is capable of supporting. In the case of the 82555, bits 0, 1, 2, and 3 are set. Table 5 lists the priority of each of the technologies.

Table 4. Technology Ability Field Bit Assignments

Bit Setting	Technology
0	10BASE-T Half Duplex
1	10BASE-T Full Duplex
2	100BASE-T Half Duplex
3	100BASE-T Full Duplex
4	100BASE-T4
5	Pause (Flow Control)
6	Reserved
7	Reserved

Table 5. Technology Priority

Priority	Technology
1	100BASE-TX Full Duplex
2	100BASE-T4
3	100BASE-TX Half Duplex

Table 5. Technology Priority

Priority	Technology
4	10BASE-T Full Duplex
5	10BASE-T Half Duplex

To detect the correct technology, the two register fields should be ANDed together to obtain the highest common denominator. This value should then be used to map into a priority resolution table used by the MAC driver to use the appropriate technology.

The following is an outline of the Auto-Negotiation process:

1. Receive 3 consecutive, matching code words
2. Set Acknowledge bit in transmit code word
3. Receive 3 consecutive, matching code words with Acknowledge bit set
4. Transmit 6 to 8 more code words with Acknowledge bit set
5. Determine operating mode via the priority table
6. Receive FLP from the link partner and record FLP in the MII register

8.2 Parallel Detect and Auto-Negotiation

The 82555 automatically determines the speed of the link either by using Parallel Detect or Auto-Negotiation. Upon a reset, a link status fail, or a negotiate/re negotiate command, the 82555 inserts a long delay during which no link pulses are transmitted. This period, known as Force_Fail, insures that the 82555's link partner has gone into a Link Fail state before Auto-Negotiation or Parallel Detection begins. Thus, both sides (the 82555 and the 82555's link partner) will perform Auto-

Negotiation or Parallel Detection with no data packets being transmitted. Connection is then established either by FLP exchange or Parallel Detection. The 82555 will look for both FLPs and link integrity pulses. The following diagram illustrates this process.

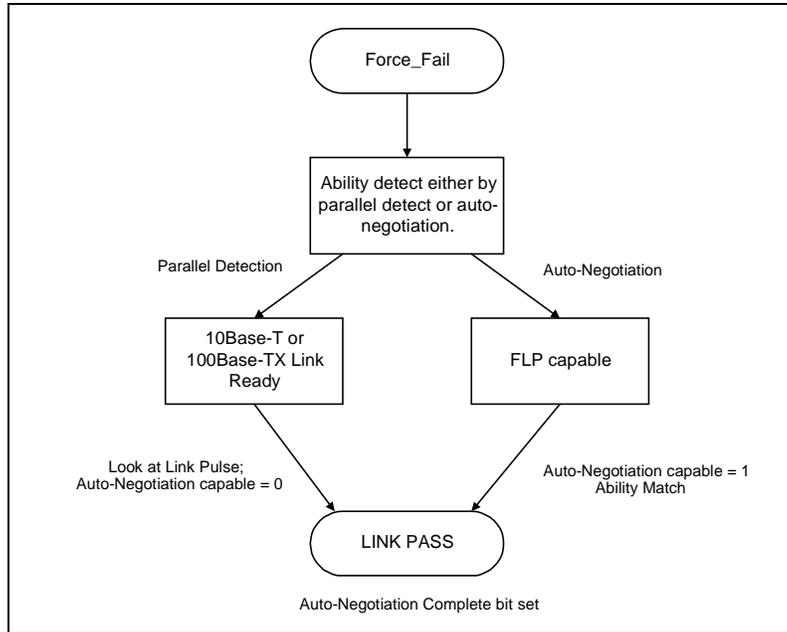


Figure 10. Auto-Negotiation and Parallel Detect

9.0 LED Descriptions

The 82555 supports four LED pins to indicate link status, network activity and network speed.

- **Link:** This LED is off (logic high) until a valid link has been detected. After a valid link has been detected, the LED will remain on (active-low).
- **Activity:** This LED is on (active-low) when activity is detected on the wire. In DTE (adapter) mode, this LED is on during transmit and receive when the 82555 is not in loopback mode. In repeater mode, this LED is on only during receive when the 82555 is not in loopback mode.
- **Speed:** This LED will be on if a 100BASE-TX link is detected and off if a 10BASE-T link is detected. If the link fails while in Auto-Negotiation, this LED will keep the last valid link state. If 100BASE-TX link is forced this LED will be on, regardless of the link status. This LED will be off if the 10BASE-T link is forced, regardless of the link status.
- **Full Duplex:** The FDX_N signal can operate as a LED if it is enabled. It indicates full duplex link for either 100BASE-TX or 10 BASE-T technology.

MDI register 27 in [Section 7.2.3.9, “Register 27: 82555 Special Control Bit Definitions”](#) on [page 34](#) details the information for LED function mapping and support enhancements.

10.0 Reset and Miscellaneous Test Modes

10.1 Reset

When the 82555 RESET signal is asserted (high), all internal circuits are reset. TXC and RXC should run continuously even though RESET is active. The 82555 may also be reset through the MDI reset bit.

10.2 Loopback

When the loopback pin is being driven high, the 82555 executes a loopback diagnostics operation. This mode can also be accessed through the MDI registers.

10.3 Scrambler Bypass

When the Scrambler Bypass pin is active, the 82555 bypasses the scrambler/descrambler. This mode can also be accessed through the MDI registers.

10.4 Test Port

When the TESTEN pin is high, the test pins provide a test access port for the 82555. In test mode, the 82555 will default to address 1. The 82555 has a simple Test Access Port (TAP) from which all the test modes are selected and test instructions are operated. The TAP is controlled by a simple mechanism and handshake. Activation of all test modes requires simple hardware. The TAP signals connected to the 82555 blocks and periphery control the 82555's mode of operation to allow simple testing and internal built-in self testing.

The test instruction are shifted into the Test Instruction Shift Register (TISR) through the TIN pin. The TIN pin is sampled on the rising edge of the TCK input signal. The instruction is transferred from the TISR to the Test Instruction Register (TIR) when TESTEN is sampled high on the rising edge of TCK. As a general rule, all the TAP input and output pins are activated by the rising edge of TCK. If TCK is a constant clock signal, then TESTEN must be 1 clock pulse width.

When the TIR receives a new instruction, the instruction is decoded into control signals and synchronized to the 10 MHz clock. These control signals set the 82555 blocks into various test modes. In order to achieve stable synchronization between the clock signal (X1) and the TCK signal, the TCK input signal frequency should be less than or equal to half of the clock input signal frequency.

The TOUT pin is controlled by different sources according to the active test instruction. The TOUT signal is activated by the falling edge of TCK. The TAP must be reset during power-up. Otherwise, the 82555 can wake-up during high-Z mode or NAND Test, which can be harmful to the board. The TAP should be reset only with a hardware reset input pin and not with software reset. The TOUT control logic selects the TISR output in all tests, except burn-in test modes.

Table 6. Test Instruction Coding

Number	Code	Test Instruction	Select Input to TOUT
1	00000	Idle	TISR D4out
2	00001	Reserved	TISR D4out
3	00010	High-Z	High-Z
4	00011	NAND Test	TISR D4out

11.0 Electrical Specifications and Timing Parameters

11.1 Absolute Maximum Ratings

Symbol	Parameter Description	Min	Typ	Max	Units
T_C	Case temperature under bias	0		85	C
T_S	Storage temperature	-65		140	C
V_{SUP}	Supply voltage	-0.5		7.0	V
V_{OA}^a	All output voltages	-0.5		7.0	V
V_{OTD}	Transmit Data Output Voltage	-0.5		8.0	V
V_{IA}	All input voltages	-1.0		6.0	V

a. Stresses above the listed under absolute maximum ratings may cause permanent damage to the device. This is a stress rating only and functional operations of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

11.2 General Operating Conditions

Symbol	Parameter Description	Min	Typ	Max	Units
V_{CC}	Supply voltage	4.75		5.25	V
T_C	Case temperature	0		85	C

11.3 DC Characteristics

11.3.1 MII DC Characteristics

Symbol	Parameter Description	Condition	Min	Typ	Max	Units
V_{IL}	Input low voltage (TTL)		0		0.8	V
V_{IH}	Input high voltage (TTL)		2.0			V
V_{OL}	Output low voltage	$I_{out} = 4 \text{ mA}$			0.45	V
V_{OH}	Output high voltage	$I_{out} = -4 \text{ mA}$	2.4			V
I_{IL}	Input low leakage current	$0 < V_{in} < V_{CC}$			± 15	μA
C_{IN}^a	Input capacitance				10	pF

a. This parameter is only characterized, not tested. It is valid for digital pins only.

11.3.2 10BASE-T Voltage/Current DC Characteristics

Symbol	Parameter Description	Condition	Min	Typ	Max	Units
R_{ID10}^a	Input differential resistance	DC and $V_{RDP} = (V_{CC}/2) + 0.5 \text{ V}$	10			$\text{K}\Omega$

Symbol	Parameter Description	Condition	Min	Typ	Max	Units
V_{IDA10}	Input differential accept voltage	$5 \text{ MHz} \leq f \leq 10 \text{ MHz}$	± 585		± 3100	mV _P
V_{IDR10}	Input differential reject voltage	$5 \text{ MHz} \leq f \leq 10 \text{ MHz}$			± 300	mV _P
V_{ICM10}	Input common mode voltage			$V_{CC}/2$		V
V_{OD10}	Output differential voltage	$R_L = 100 \Omega^b$ $R_{BIAS10} = 768 \Omega$	± 2.2		± 2.8	V
I_{CCT10}^c	Line driver supply	$R_{BIAS10} = 768 \Omega$		110		mA
I_{CC10}^d	Current on all V_{CC} pins			120		mA
$I_{CCT10TOT}$	Total supply current			230		mA
L_{ILA10}^e	Leakage on analog pins				20	mA

- a. This value is measured across the receive differential pins, RDP and RDN.
b. R_L is the resistive load across the receive differential pins, RDP and RDN.
c. Transmitter current is measured with a 1:1 transformer on the center tap.
d. Current is measured on all V_{CC} pins at $V_{CC} = 5.25 \text{ V}$.
e. The analog pins are: TDP, TDN, RDP, RDN, RBIAS10, and RBIAS100.

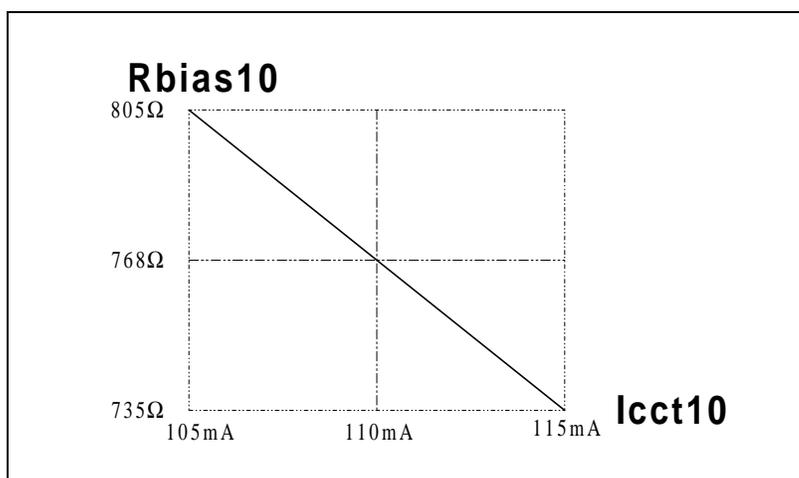


Figure 11. RBIAS10 Resistance versus I_{CCT10}

11.3.3 100BASE-TX Voltage/Current DC Characteristics

Symbol	Parameter Description	Condition	Min	Typ	Max	Units
R_{ID100}	Input differential resistance	DC $V_{RDP} = (V_{CC}/2) + 0.5 \text{ V}$ $V_{RDN} = (V_{CC}/2) - 0.5 \text{ V}$	10			K Ω
V_{IDA100}	Input differential accept voltage		± 500			mV _P
V_{IDR100}	Input differential reject voltage		± 100			mV _P
V_{ICM100}	Input common mode voltage			$V_{CC}/2$		V
V_{OD100}^a	Output differential voltage	$R_{BIAS100} = 634 \Omega$	± 0.95	± 1.00	± 1.05	V _P
I_{CCT100}^b	Line driver supply	$R_{BIAS100} = 634 \Omega$		40		mA

Symbol	Parameter Description	Condition	Min	Typ	Max	Units
I_{CC100}^c	Current on all V_{CC} pins			235		mA
$I_{CCT100TOT}$	Total supply current			275		mA

- a. Transmitter current is measured with a 1:1 transformer on the center tap.
- b. Transmitter current is measured with a 1:1 transformer on the center tap.
- c. Current is measured on all V_{CC} pins at $V_{CC} = 5.25$ V.

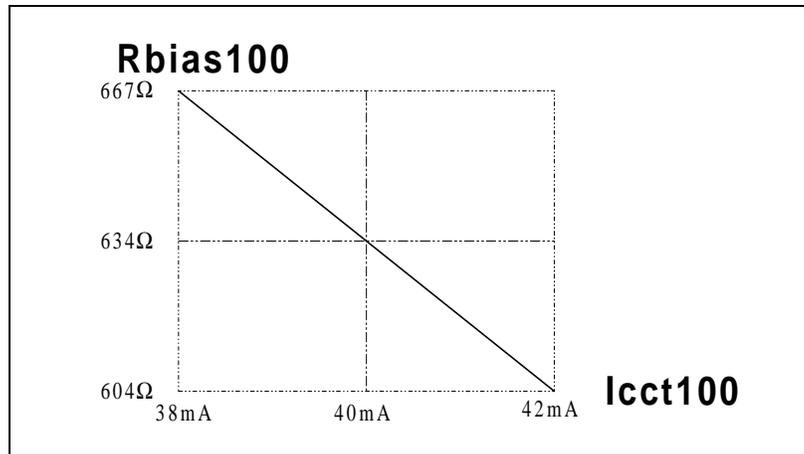


Figure 12. RBIAS100 Resistance versus I_{CC100}

11.4 AC Characteristics

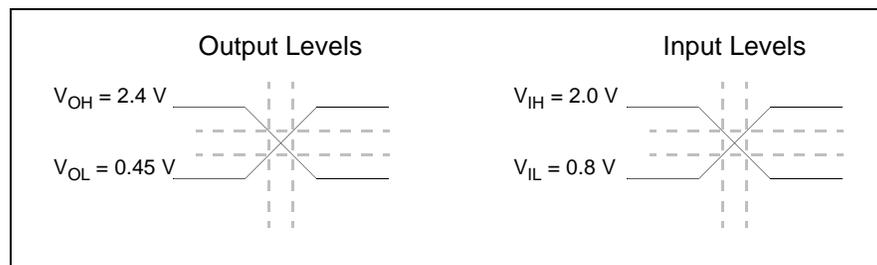


Figure 13. AC Testing Level Conditions

11.4.1 MII Clock Specifications

	Symbol	Parameter	Conditions	Min	Typ	Max	Units
T1	T_{P100}	TXC/RXC period	100 Mbps		40		ns
T2	T_{P10}	TXC/RXC period	10 Mbps		400		ns
T3	T_{PMDC}	MDC clock period		400			ns
T4	T_{TXDC}	TXC duty cycle		35		65	%
T5	T_{RXDC}	RXC duty cycle		35		65	%
T6	T_{MDC}	MDC duty cycle		35		65	%

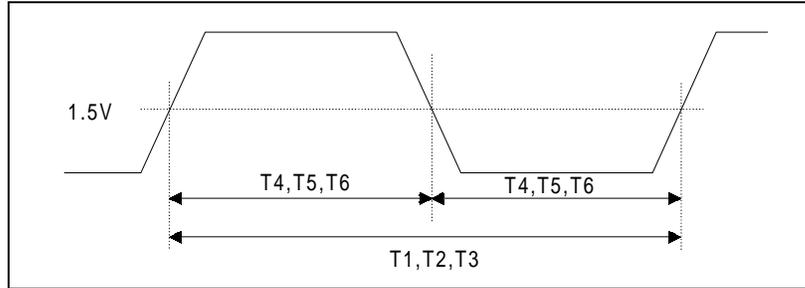


Figure 14. MII Clocks AC Timing

11.4.2 MII Timing Parameters

	Symbol	Parameter	Conditions	Min	Typ	Max	Units
T7	T_{TXDV}	TXD[3:0], TXEN, TXERR setup from the rising edge of TXC		15		25	ns
T8	T_{TXH}	TXD[3:0], TXEN, TXERR hold time after the rising edge of TXC		0			ns
T9	T_{RXSU}	RXD[3:0], RXDV, RXERR valid before the rising edge of RXC		10			ns
T10	T_{RXH}	RXD[3:0], RXDV, RXERR hold time after the rising edge of RXC		10			ns
T11	T_{MSU}	MDIO setup time to the rising edge of MDC	MDIO input	10			ns
T12	T_{MH}	MDIO hold time from the rising edge of MDC	MDIO input	10			ns
T13	T_{MV}	MDIO valid from the rising edge of MDC	MDIO output	300			ns

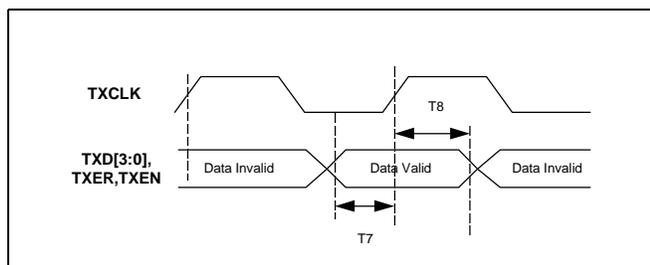


Figure 15. MII Transmit Timing Parameters

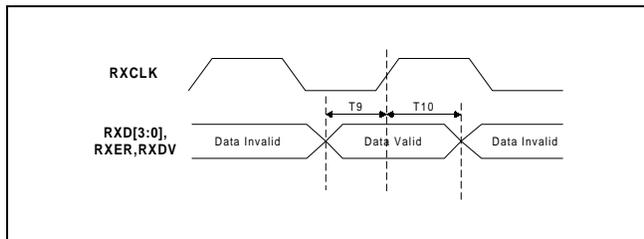


Figure 16. MII Receive Timing Parameters

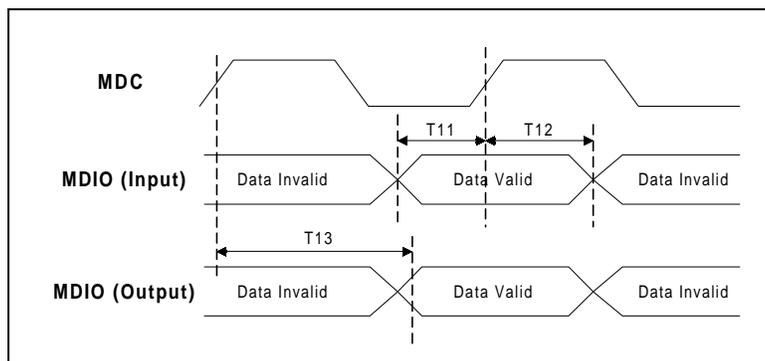


Figure 17. MII Timing Parameters: MDC/MDIO

11.4.3 Repeater Mode Timing Parameters

	Symbol	Parameter	Conditions	Min	Typ	Max	Units
T14	T_{RDRV}	PORTEN assertion to RXD[3:0], RXDV, and RXERR (RXC driven)		1.5		2.5	RXC clocks
T15	T_{RTST}	PORTEN de-assertion to RXD[3:0], RXDV, and RXERR (RXC tri-stated) ^a		1.5		2.5	RXC clocks

a. RXC, RXDV, and RXERR are tri-stated only after they have been driven low (0).

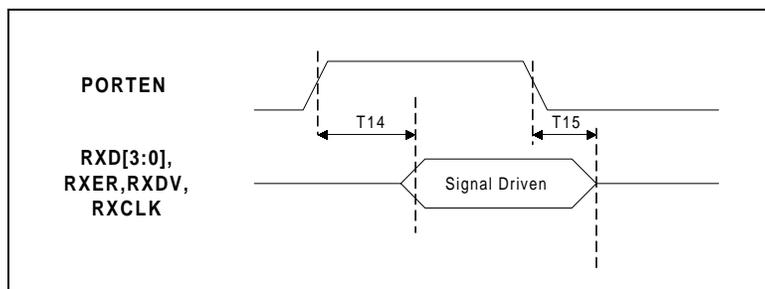


Figure 18. PORT Enable Timing

11.4.4 Transmit Packet Timing Parameters

	Symbol	Parameter	Conditions	Min	Typ	Max	Units
T15	T_{XEN_ST}	TXC on first TXEN active to start of frame	100 Mbps	10		12	bits
T15a	T_{XEN_ST}	TXC on first TXEN active to start of frame	10 Mbps	3.5		5	bits
T16	T_{XEN_CRSH}	TXC on first TXEN active to rising edge of CRS	100 Mbps			4	bits
T16a	T_{XEN_CRSH}	TXC on first TXEN active to rising edge of CRS	10 Mbps			1.5	bits
T17	T_{XEN_END}	TXC on first TXEN inactive to end of frame	100 Mbps			17	bits
T17a	T_{XEN_END}	TXC on first TXEN inactive to end of frame	10 Mbps			5	bits
T18	T_{XEN_CRSL}	TXC on first TXEN inactive to falling edge of CRS	100 Mbps			11	bits
T18a	T_{XEN_CRSL}	TXC on first TXEN inactive to falling edge of CRS	10 Mbps			6	bits
T19	T_{EOF}	End of frame high time	10 Mbps	250		350	ns

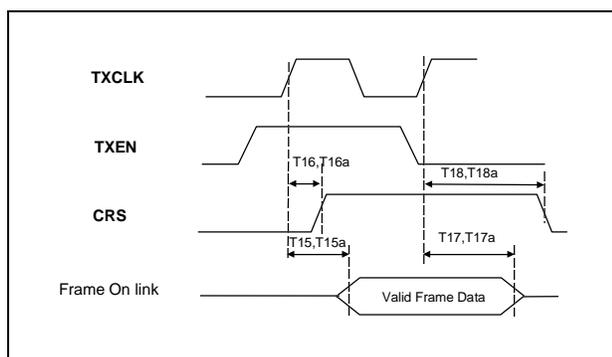


Figure 19. Transmit Frame Timing Parameters

11.4.5 Squelch Test Timing Parameters

	Symbol	Parameter	Conditions	Min	Typ	Max	Units
T20	T_{SQE_DEL}	Collision detect heartbeat delay	10 Mbps	7		8	bits
T21	T_{SQE_DUR}	Collision detect heartbeat duration	10 Mbps	9		11	bits

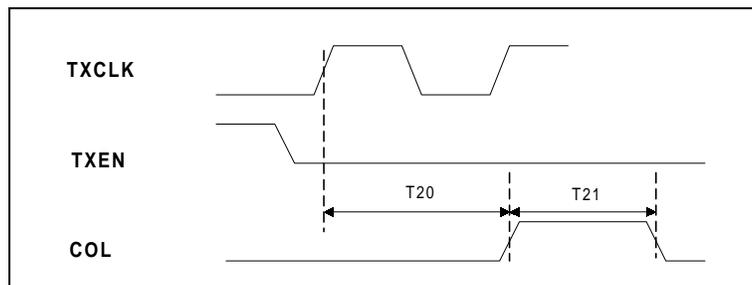


Figure 20. Squelch Test Timing Parameters

11.4.6 Jabber Timing Parameters

	Symbol	Parameter	Conditions	Min	Typ	Max	Units
T22	$T_{\text{JAB_ON}}$	Jabber turn-on delay (TXEN asserted to end of transmit frame)	10 Mbps		26		ms
T23	$T_{\text{JAB_OFF}}$	Jabber turn-off delay (TXEN deasserted to falling edge of COL)	10 Mbps		410		ms

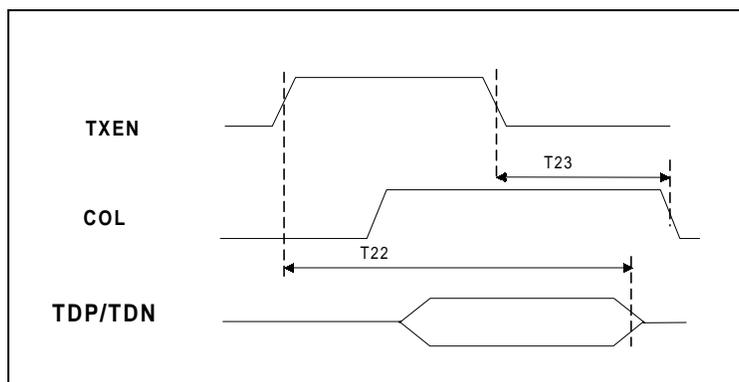


Figure 21. Jabber Timing Parameters

11.4.7 Receive Packet Timing Parameters

	Symbol	Parameter	Conditions	Min	Typ	Max	Units
T24	$T_{\text{R_CRSH}}$	Start of receive frame to rising edge of CRS	100 Mbps	11		13	bits
T24a	$T_{\text{R_CRSH}}$	Start of receive frame to rising edge of CRS	10 Mbps	3		5	bits
T25	$T_{\text{R_RXDVH}}$	Start of receive frame to rising edge of RXDV	100 Mbps			15	bits
T25a	$T_{\text{R_RXDVH}}$	Start of receive frame to rising edge of RXDV	10 Mbps			22	bits
T26	$T_{\text{R_CRSL}}$	End of receive frame to falling edge of CRS	100 Mbps	14		16	bits

	Symbol	Parameter	Conditions	Min	Typ	Max	Units
T26a	T_{R_CRSL}	End of receive frame to falling edge of CRS	10 Mbps			4.5	bits
T27	T_{R_RXDVL}	End of receive frame to falling edge of RXDV	100 Mbps			12	bits
T27a	T_{R_RXDVL}	End of receive frame to falling edge of RXDV	10 Mbps			4	bits

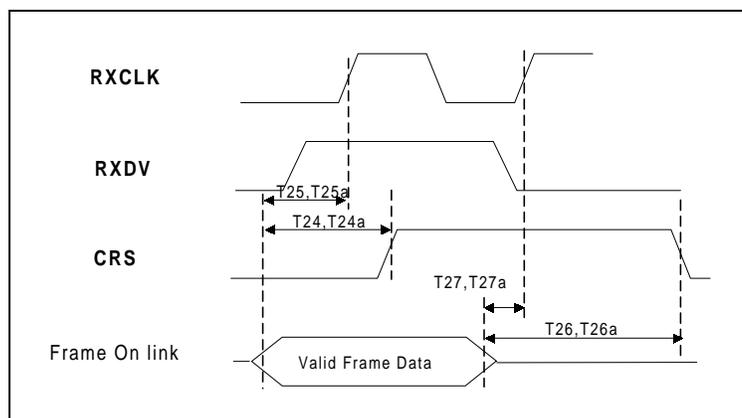


Figure 22. Receive Packet Timing Parameters

11.4.8 10BASE-T Normal Link Pulse (NLP) Timing Parameters

	Symbol	Parameter	Conditions	Min	Typ	Max	Units
T28	T_{NLP_WID}	NLP width	10 Mbps		100		ns
T29	T_{NLP_PER}	NLP period	10 Mbps	8		24	ms

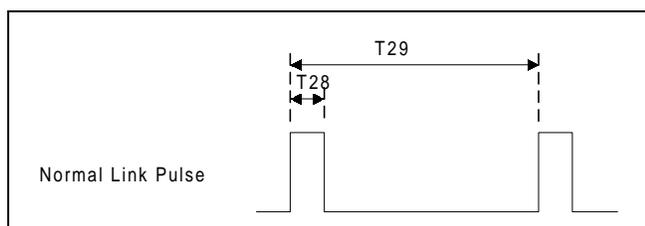


Figure 23. Normal Link Pulse Timing Parameters

11.4.9 Auto-Negotiation Fast Link Pulse (FLP) Timing Parameters

	Symbol	Parameter	Conditions	Min	Typ	Max	Units
T30	T_{FLP_WID}	FLP width (clock/data)			100		ns
T31	$T_{FLP_CLK_CLK}$	Clock pulse to clock pulse period		111	125	139	μ s
T32	$T_{FLP_CLK_DAT}$	Clock pulse to data pulse period		55.5	62.5	69.5	μ s

	Symbol	Parameter	Conditions	Min	Typ	Max	Units
T33	$T_{FLP_BUR_NUM}$	Number of pulses in one burst		17		33	
T34	$T_{FLP_BUR_WID}$	FLP Burst width			2		ms
T35	$T_{FLP_BUR_PER}$	FLP burst period		8		24	ms

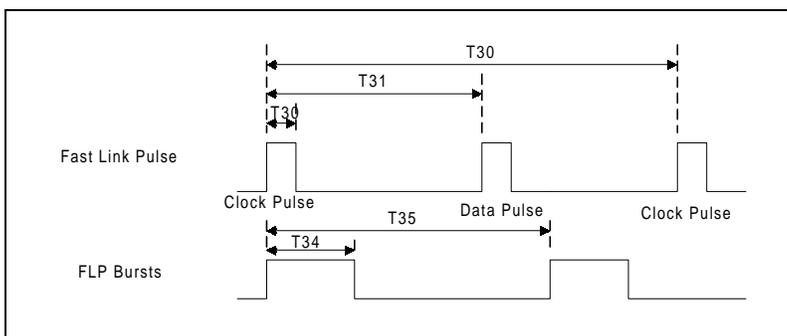


Figure 24. Fast Link Pulse Timing Parameters

11.4.10 Reset Timing Parameters

	Symbol	Parameter	Conditions	Min	Typ	Max	Units
T36	T_{RST_WID}	Reset pulse width		500			ns
T37	T_{PUP_RST}	Power-up to falling edge of reset		500			μ s

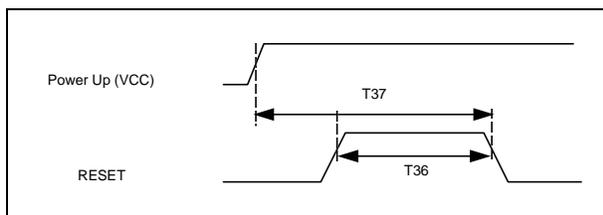


Figure 25. Reset Timing Parameters

11.4.11 X1 Clock Specifications

	Symbol	Parameter	Conditions	Min	Typ	Max	Units
T38	T_{X1_DC}	X1 duty cycle		40		60	%
T39	T_{X1_PR}	X1 period	± 50 PPM		40		ns

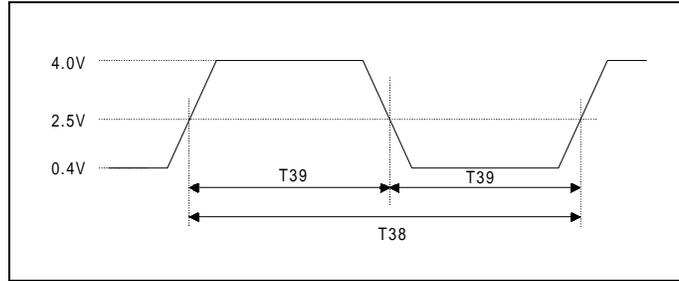


Figure 26. X1 Clock Specifications

11.4.12 100BASE-TX Transmitter AC Specification

	Symbol	Parameter	Conditions	Min	Typ	Max	Units
T40	T_{JIT}	TDP/TDN differential output peak jitter	HLS data		300	700	ps

12.0 82555 Package Information

This section provides the physical packaging information for the 82555. The 82555 is an 100-pin plastic Quad Flat Pack (QFP) device. Package attributes are provided in [Table 7](#) and the dimensions are shown in [Figure 27](#).

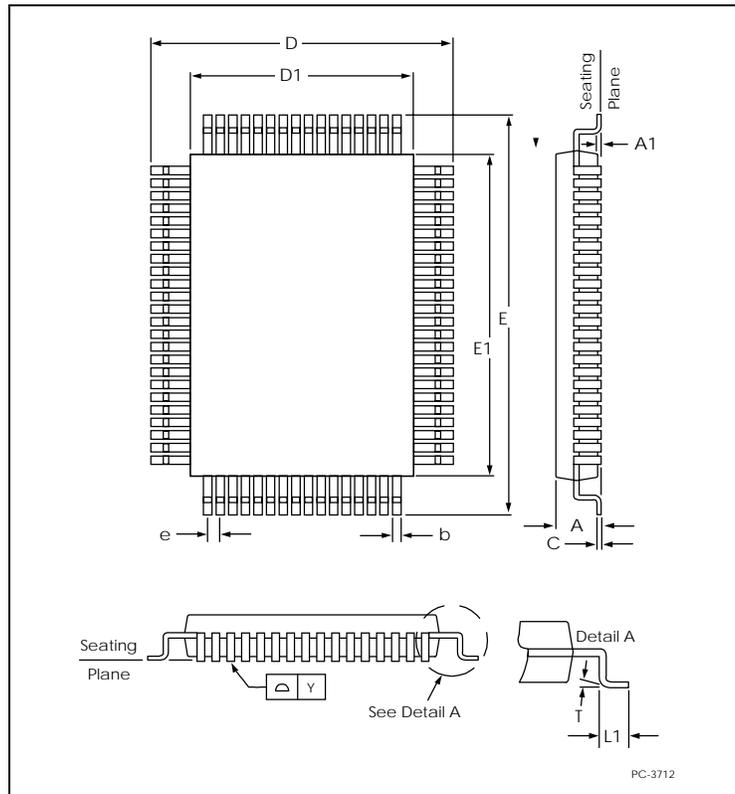


Figure 27. Dimension Diagram for the 82555 QFP

Table 7. Dimensions for the 82555 QFP

Symbol	Description	Min	Norm	Max
N	Lead Count	-	100	-
A	Overall Height	-	-	3.15
A1	Stand Off	0.05	-	0.40
b	Lead Width	0.20	0.30	0.40
c	Lead Thickness	0.10	0.15	0.20
D	Terminal Dimension	17.5	17.9	18.3
D1	Package Body	-	14.0	-
E	Terminal Dimension	23.5	23.9	24.3
E1	Package Body	-	20.0	-
e1	Lead Pitch	0.53	0.65	0.77
L1	Foot Length	0.60	0.80	1.00

Table 7. Dimensions for the 82555 QFP

Symbol	Description	Min	Norm	Max
T	Lead Angle	0.0	-	10.0
Y	Coplanarity	-	-	0.10