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Integrated Circuit Systems, Inc.

ICS1893

Document Type: Data Sheet

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3.3-V 10Base-T/100Base-TX Integrated PHYceiver™

General

The ICS1893 is a low-power, physical-layer device (PHY) that supports the ISO/IEC 10Base-T and 100Base-TX Carrier-Sense Multiple Access/Collision Detection (CSMA/CD) Ethernet standards. The ICS1893 architecture is based on the ICS1892. The ICS1893 supports managed or unmanaged node, repeater, and switch applications.

The ICS1893 incorporates digital signal processing (DSP) in its Physical Medium Dependent (PMD) sublayer. As a result, it can transmit and receive data on unshielded twisted-pair (UTP) category 5 cables with attenuation in excess of 24 dB at 100 MHz. With this ICS-patented technology, the ICS1893 can virtually eliminate errors from killer packets.

The ICS1893 provides a Serial Management Interface for exchanging command and status information with a Station Management (STA) entity.

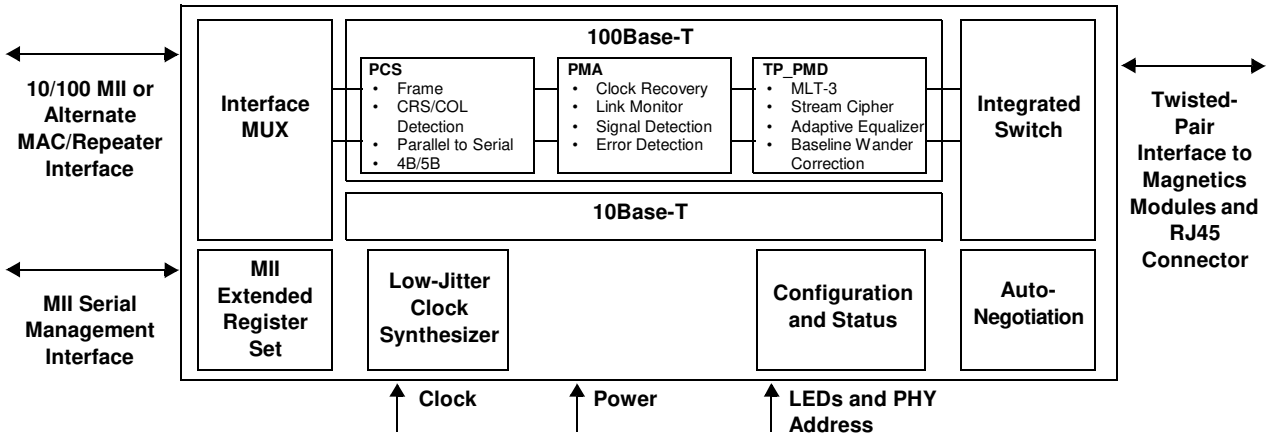
The ICS1893 Media Dependent Interface (MDI) can be configured to provide either half- or full-duplex operation at data rates of 10 MHz or 100 MHz. The MDI configuration can be established manually (with input pins or control register settings) or automatically (using the Auto-Negotiation features). When the ICS1893 Auto-Negotiation sublayer is enabled, it exchanges technology capability data with its remote link partner and automatically selects the highest-performance operating mode they have in common.

Features

- Supports category 5 cables with attenuation in excess of 24 dB at 100 MHz across a temperature range from -5° to +85° C
- DSP-based baseline wander correction to virtually eliminate killer packets across temperature range of from -5° to +85° C
- Low-power, 0.35-micron CMOS (typically 400 mW)
- Single 3.3-V power supply.
- Single-chip, fully integrated PHY provides PCS, PMA, PMD, and AUTONEG sublayers of IEEE standard
- 10Base-T and 100Base-TX IEEE 802.3 compliant
- Fully integrated, DSP-based PMD includes:
  - Adaptive equalization and baseline wander correction
  - Transmit wave shaping and stream cipher scrambler
  - MLT-3 encoder and NRZ/NRZI encoder
- Highly configurable design supports:
  - Node, repeater, and switch applications
  - Managed and unmanaged applications
  - 10M or 100M half- and full-duplex modes
  - Parallel detection
  - Auto-negotiation, with Next Page capabilities
- MAC/Repeater Interface can be configured as:
  - 10M or 100M Media Independent Interface
  - 100M Symbol Interface (bypasses the PCS)
  - 10M 7-wire Serial Interface
- Small Footprint 64-pin Thin Quad Flat Pack (TQFP)

NOTE: EOL for non-green parts to occur on 5/13/10 per PDN U-09-01.

ICS1893 Block Diagram



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Revision History

- The initial release of this document, Rev A, was dated August 5, 1999.
- Rev B was dated September 10, 1999. The following list also indicates what changes were made.
  - Page 1. Document status changes from ‘Preliminary’ to ‘Release’. Also, change to text in bullet that starts with “Low-power”.
  - Table of Contents reflect page renumbering.
  - Revision History
  - Chapter 3, “ICS1893 Enhanced Features”. Change to text in 1(a).
  - Section 7.4.1, “100Base-TX Operation: Stream Cipher Scrambler/Descrambler”. Added paragraph.
  - Section 8.6.4, “IEEE Reserved Bits (bits 4.12:10)”. New paragraph. (Subsequent paragraphs reflect renumbering.)
  - Chapter 9, “Pin Diagram, Listings, and Descriptions”. ICS1893 pin names have changes.
  - Table 10-1 reflects changes to ICS1893 pin names.
  - Table 10-2 reflects changes to ICS1893 pin names.
  - Section 10.4.1, “DC Operating Characteristics for Supply Current”. Changes to text and table reflect changes to ICS1893 pin names.
  - Section 10.4.2, “DC Operating Characteristics for TTL Inputs and Outputs”. Changes to text and table reflect changes to ICS1893 pin names.
  - Table 10-6. Changes to table values.
  - Table 10-7. Changes to table values.
  - Table 10-16. Changes to table values. Table title added.
  - Table 10-18. Changes to table values.
  - Section 10.5.13, “100M MII: Carrier Assertion/De-Assertion (Half-Duplex Transmission)”. Changes to table values and timing diagram.
  - Section 10.5.14, “10M MII: Carrier Assertion/De-Assertion (Half-Duplex Transmission)”. Changes to table values and timing diagram.
  - Table 10-24. Changes to table values. Also, the value that was previously ‘TBD’ is now determined.
  - Table 10-25. Changes to table values.
  - Table 10-26. Changes to table values.
  - Table 10-27. Changes to table values.
  - Table 10-28. Changes to table values.
  - Table 10-29. Changes to table values.
  - Chapter 11, “Physical Dimensions of ICS1893 Package”. Changes to text in bullets.

- This release of this document, Rev C, is dated May 22, 2000. Change bars indicate where all changes are made. (For an explanation of change bars, see the *Change Bar* note on this page.) The following list also indicates where changes occur.
  - Table of Contents reflect page renumbering.
  - Table 3-1 value xxx changes from 000011b to 000100b
  - Section 6.5, “Twisted-Pair Interface” text changes.
  - Section 6.5.1, “Twisted-Pair Transmitter Interface” and Section 6.5.2, “Twisted-Pair Receiver Interface” are two new sections with two new figures.
  - Section 6.6, “Clock Reference Interface” reflects deletion of references to crystal oscillator, as the ICS1893 does not work with a crystal. (Section 6.6.1 and Section 6.6.2 are deleted.)
  - Section 6.8, “Status Interface” has two new notes, Notes 5 and 6.
  - A new figure, Figure 6-3, follows Section 6.8, “Status Interface”.
  - Table 8-9 value changes from F420 to F441.
  - Section 8.5.2, “Manufacturer's Model Number (bits 3.9:4)” text changes.
  - Table 8-10 value changes from 0000 to 0001.
  - In the following areas, ICS1894 changes to ICS1893:
    - Section 8.13.1, “Remote Jabber Detect (bit 18.15)”
    - Table 9-5 RXCLK pin description.
    - Table 9-6 RXCLK pin description.
    - Table 9-8 NC pin description.
  - In the following sections, pin 54 changes from VDD_IO to VDD:
    - Section 9.1, “ICS1893 Pin Diagram”
    - Section 9.2, “ICS1893 Pin Listings”
    - Section 9.3.6, “Ground and Power Pins”
  - Table 9-4 text changes for the REF_IN and REF_OUT pin descriptions.
  - Table 9-7 text changes for the RXTRI pin descriptions.
  - Section 9.3.6, “Ground and Power Pins” adds the VSS ground pin, pin 22.
  - Section 10.3, “Recommended Component Values” text changes.
  - A new figure, Figure 10-1, follows Section 10.3, “Recommended Component Values”

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Change Bars

Change bars on subsequent ICS1893 data sheets indicate new documents posted to the web. (Change bars within a new version of a document also indicates changes to the document.)

Sample change bar

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Rev D, 8/11/09 - added EOL note to ordering information per PDN U-09-01

Chapter 1 Abbreviations and Acronyms

Table 1-1 lists and interprets the abbreviations and acronyms used throughout this data sheet.

Table 1-1. Abbreviations and Acronyms

Abbreviation / Acronym	Interpretation
4B/5B	4-Bit / 5-Bit Encoding/Decoding
ANSI	American National Standards Institute
CMOS	complimentary metal-oxide semiconductor
CSMA/CD	Carrier Sense Multiple Access with Collision Detection
CW	Command Override Write
DSP	digital signal processing
ESD	End-of-Stream Delimiter
FDDI	Fiber Distributed Data Interface
FLL	frequency-locked loop
FLP	Fast Link Pulse
IDL	A ‘dead’ time on the link following a 10Base-T packet, not to be confused with idle
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
ISO	International Standards Organization
LH	Latching High
LL	Latching Low
LMX	Latching Maximum
MAC	Media Access Control
Max.	maximum
Mbps	Megabits per second
MDI	Media Dependent Interface
MF	Management Frame
MII	Media Independent Interface
Min.	minimum
MLT-3	Multi-Level Transition Encoding (3 Levels)
N/A	Not Applicable
NLP	Normal Link Pulse
No.	Number
NRZ	Not Return to Zero
NRZI	Not Return to Zero, Invert on one
OSI	Open Systems Interconnection

Table 1-1. Abbreviations and Acronyms (*Continued*)

Abbreviation / Acronym	Interpretation
OUI	Organizationally Unique Identifier
PCS	Physical Coding sublayer
PHY	physical-layer device The ICS1893 is a physical-layer device, also referred to as a 'PHY' or 'PHYceiver'. (The ICS1890 is also a physical-layer device.)
PLL	phase-locked loop
PMA	Physical Medium Attachment
PMD	Physical Medium Dependent
ppm	parts per million
QFP	quad flat pack
RO	read only
R/W	read/write
R/W0	read/write zero
SC	self-clearing
SF	Special Functions
SFD	Start-of-Frame Delimiter
SI	Stream Interface, Serial Interface, or Symbol Interface. With reference to the MII/SI pin, the acronym 'SI' has multiple meanings. • Generically, SI means 'Stream Interface', and is documented as such in this data sheet. • However, when the MAC/Repeater Interface is configured for: – 10M operations, SI is an acronym for 'Serial Interface'. – 100M operations, SI is an acronym for 'Symbol Interface'.
SQE	Signal Quality Error
SSD	Start-of-Stream Delimiter
STA	Station Management Entity
STP	shielded twisted pair
TAF	Technology Ability Field
TP-PMD	Twisted-Pair Physical Layer Medium Dependent
Typ.	typical
UTP	unshielded twisted pair

Chapter 2 Conventions and Nomenclature

Table 2-1 lists and explains the conventions and nomenclature used throughout this data sheet.

Table 2-1. Conventions and Nomenclature

Item	Convention / Nomenclature
Bits	• A bit in a register is identified using the format 'register.bit'. For example, bit 0.15 is bit 15 of register 0. • When a colon is used with bits, it indicates the range of bits. For example, bits 1.15:11 are bits 15, 14, 13, 12, and 11 of register 1. • For a range of bits, the order is always from the most-significant bit to the least-significant bit.
Code groups	Within this table, see the item 'Symbols'
Colon (:)	Within this table, see these items: • 'Bits' • 'Pin (or signal) names'
Numbers	• As a default, all numbers use the decimal system (that is, base 10) unless followed by a lowercase letter. A string of numbers followed by a lowercase letter: – A 'b' represents a binary (base 2) number – An 'h' represents a hexadecimal (base 16) number – An 'o' represents an octal (base 8) number • All numerical references to registers use decimal notation (and not hexadecimal).
Pin (or signal) names	• All pin or signal names are provided in capital letters. • A pin name that includes a forward slash '/' is a multi-function, configuration pin. These pins provide the ability to select between two ICS1893 functions. The name provided: – Before the '/' indicates the pin name and function when the signal level on the pin is logic zero. – After the '/' indicates the pin name and function when the signal level on the pin is logic one. For example, the HW/SW pin selects between Hardware (HW) mode and Software (SW) mode. When the signal level on the HW/SW pin is logic: – Zero, the ICS1893 Hardware mode is selected. – One, the ICS1893 Software mode is selected. • An 'n' appended to the end of a pin name or signal name (such as RESETn) indicates an active-low operation. • When a colon is used with pin or signal names, it indicates a range. For example, TXD[3:0] represents pins/signals TXD3, TXD2, TXD1, and TXD0. • When pin name abbreviations are spelled out, words in parentheses indicate additional description that is not part of the pin name abbreviation.
Registers	• A bit in a register is identified using the format 'register.bit'. For example, bit 0.15 is bit 15 of register 0. • All numerical references to registers use decimal notation (and not hexadecimal). • When register name abbreviations are spelled out, words in parentheses indicate additional description that is not part of the register name abbreviation.

Table 2-1. Conventions and Nomenclature (*Continued*)

Item	Convention / Nomenclature
Signal references	• When referring to signals, the terms: – 'FALSE', 'low', or 'zero' represent signals that are logic zero. – 'TRUE', 'high', or 'one' represent signals that are logic one. • Chapter 10, "DC and AC Operating Conditions" defines the electrical specifications for 'logic zero' and 'logic one' signals.
Symbols	• In this data sheet, code group names are referred to as 'symbols' and they are shown between '/' (slashes). For example, the symbol /J/ represents the first half of the Start-of-Stream Delimiter (SSD1). • Symbol sequences are shown in succession. For example, /I/J/K/ represents an IDLE followed by the SSD.
Terms: 'set', 'active', 'asserted',	The terms 'set', 'active', and 'asserted' are synonymous. They do not necessarily infer logic one. (For example, an active-low signal can be set to logic zero.)
Terms: 'cleared', 'de-asserted', 'inactive'	The terms 'cleared', 'inactive', and 'de-asserted' are synonymous. They do not necessarily infer logic zero.
Terms: 'twisted-pair receiver'	In reference to the ICS1893, the term 'Twisted-Pair Receiver' refers to the set of Twisted-Pair Receive output pins (TP_RXP and TP_RXN).
Terms: 'twisted-pair transmitter'	In reference to the ICS1893, the term 'Twisted-Pair Transmitter' refers to the set of Twisted-Pair Transmit output pins (TP_TXP and TP_TXN).

Chapter 3 ICS1893 Enhanced Features

The ICS1893 is an enhanced version of the ICS1890. In contrast to the ICS1890, the ICS1893 offers significant improvements in both performance and features while maintaining backward compatibility. The specific differences between these devices are listed below.

1. The ICS1893 employs an advanced digital signal processing (DSP) architecture that improves the 100Base-TX Receiver performance beyond that of any other PHY in the market. Specifically:
   a. The ICS1893 DSP-based, adaptive equalization process allows the ICS1893 to accommodate a maximum cable attenuation/insertion loss in excess of 24 dB, which is nearly equivalent to the attenuation loss of a 100-meter Category 5 cable.
   b. The ICS1893 DSP-based, baseline-wander correction process eliminates killer packets.
2. The analog 10Base-T Receive Phase-Locked Loop (PLL) of the ICS1890 is replaced with a digital PLL in the ICS1893, thereby resulting in lower jitter and improved stability.
3. The ICS1890 Frequency-Locked Loop (FLL) that is part of the 100Base-TX Clock and Data Recovery circuitry is replaced with a digital FLL in the ICS1893, also resulting in lower jitter and improved stability.
4. The ICS1893 transmit circuits are improved in contrast to the ICS1890, resulting in a decrease in the magnitude of the 10Base-T harmonic content generated during transmission. (See ISO/IEC 8802-3: 1993 clause 8.3.1.3.)
5. The ICS1893 supports the Auto-Negotiation Next Page functions described in IEEE Std 802.3u-1995 clause 28.2.3.4.
6. The ICS1893 supports Management Frame (MF) Preamble Suppression.
7. The ICS1893 provides the Remote Jabber capability.
8. The ICS1893 has an improved version of the ICS1890 10Base-T Squelch operation.
9. The ICS1893 “seeds” (that is, initializes) the Transmit Stream Cipher Shift register by using the ICS1893 PHY address from Table 8-16, which minimizes crosstalk and noise in repeater applications.
10. The ICS1893 offers an automatic 10Base-T power-down mode.
11. The enhanced features of the ICS1893 required some modifications to the ICS1890 Management Registers. However, the ICS1893 Management Registers are backward-compatible with the ICS1890 Management Registers. Table 3-1 summarizes the differences between the ICS1890 and the ICS1893 Management Registers.

Table 3-1. Summary of Differences between ICS1890 and ICS1893 Registers

Register. Bit(s)	ICS1890		ICS1893	
	Function	**Default**	**Function**	**Default**
1.6	Reserved	0b (always)	Management Frame Preamble Suppression	0b
3.9:4	Model Number	000010b	Model Number	000100b
3.3:0	Revision Number	0011b	Revision Number	0000b
6.2	Next Page Able	0b (always)	Next Page Able	1b
7.15:0	Not applicable (N/A)	N/A	Auto-Negotiate Next Page Transmit Register	2001h
8.15:0	N/A	N/A	Auto-Negotiate Next Page Link Partner Ability	0000h
9.15:0 through 15.15:0	IEEE reserved.	0000h	IEEE reserved. **Note:** Although the default value is changed, this response more accurately reflects an MDIO access to registers 9–15.	FFFFh
18.15	Reserved	0b	Remote Jabber	0b
19.1	Reserved	0b	Automatic 10Base-T Power Down	1b
20.15:0 through 31.15:0	N/A	N/A	ICS test registers. (There is no claim of backward compatibility for these registers.)	See specific registers and bits.

Note:

1. There are new registers and bits. For example:
   a. Registers 7 and 8 are new (that is, the ICS1890 does not have these registers).
   b. Registers 20 through 31 are new ICS test registers.
2. For some bits (such as the model number and revision number bits), the default values are changed.

Chapter 4 Overview of the ICS1893

The ICS1893 is a stream processor. During data transmission, it accepts sequential nibbles from its MAC (Media Access Control)/Repeater Interface, converts them into a serial bit stream, encodes them, and transmits them over the medium through an external isolation transformer. When receiving data, the ICS1893 converts and decodes a serial bit stream (acquired from an isolation transformer that interfaces with the medium) into sequential nibbles. It subsequently presents these nibbles to its MAC/Repeater Interface.

The ICS1893 implements the OSI model's physical layer, consisting of the following, as defined by the ISO/IEC 8802-3 standard:

- Physical Coding sublayer (PCS)
- Physical Medium Attachment sublayer (PMA)
- Physical Medium Dependent sublayer (PMD)
- Auto-Negotiation sublayer

The ICS1893 is transparent to the next layer of the OSI model, the link layer. The link layer has two sublayers: the Logical Link Control sublayer and the MAC sublayer. The ICS1893 can interface directly to the MAC and offers multiple, configurable modes of operation. Alternately, this configurable interface can be connected to a repeater, which extends the physical layer of the OSI model.

The ICS1893 transmits framed packets acquired from its MAC/Repeater Interface and receives encapsulated packets from another PHY, which it translates and presents to its MAC/Repeater Interface.

Note: As per the ISO/IEC standard, the ICS1893 does not affect, nor is it affected by, the underlying structure of the MAC/repeater frame it is conveying.

4.1 100Base-TX Operation

During 100Base-TX data transmission, the ICS1893 accepts packets from a MAC/repeater and inserts Start-of-Stream Delimiters (SSDs) and End-of-Stream Delimiters (ESDs) into the data stream. The ICS1893 encapsulates each MAC/repeater frame, including the preamble, with an SSD and an ESD. As per the ISO/IEC Standard, the ICS1893 replaces the first octet of each MAC preamble with an SSD and appends an ESD to the end of each MAC/repeater frame.

When receiving data from the medium, the ICS1893 removes each SSD and replaces it with the pre-defined preamble pattern before presenting the nibbles to its MAC/Repeater Interface. When the ICS1893 encounters an ESD in the received data stream, signifying the end of the frame, it ends the presentation of nibbles to its MAC/Repeater Interface. Therefore, the local MAC/repeater receives an unaltered copy of the transmitted frame sent by the remote MAC/repeater.

During periods when MAC frames are being neither transmitted nor received, the ICS1893 signals and detects the IDLE condition on the Link Segment. In the 100Base-TX mode, the ICS1893 transmit channel sends a continuous stream of scrambled ones to signify the IDLE condition. Similarly, the ICS1893 receive channel continually monitors its data stream and looks for a pattern of scrambled ones. The results of this signaling and monitoring provide the ICS1893 with the means to establish the integrity of the Link Segment between itself and its remote link partner and inform its Station Management Entity (STA) of the link status.

For 100M data transmission, the ICS1893 MAC/Repeater Interface can be configured to provide either a 100M Media Independent Interface (MII) or a 100M Symbol Interface. With the Symbol Interface configuration, the data stream bypasses the ICS1893 Physical Coding sublayer (PCS). In addition:

1. The ICS1893 shifts the responsibility of performing the 4B/5B translation to the MAC/repeater. As a result, the requirement is for a 5-bit data path between the MAC/repeater and the ICS1893.
2. The latency through the ICS1893 is reduced. (The ICS1893 provides this 100M Symbol Interface primarily for repeater applications for which latency is a critical performance parameter.)

4.2 10Base-T Operation

During 10Base-T data transmission, the ICS1893 inserts only the IDL delimiter into the data stream. The ICS1893 appends the IDL delimiter to the end of each MAC frame. However, since the 10Base-T preamble already has a Start-of-Frame delimiter (SFD), it is not required that the ICS1893 insert an SSD-like delimiter.

When receiving data from the medium (such as a twisted-pair cable), the ICS1893 uses the preamble to synchronize its receive clock. When the ICS1893 receive clock establishes lock, it presents the preamble nibbles to its MAC/Repeater Interface. The 10M MAC/Repeater Interface can be configured as either a 10M MII, a 10M Serial Interface, or a Link Pulse Interface.

In 10M operations, during periods when MAC frames are being neither transmitted nor received, the ICS1893 signals and detects Normal Link Pulses. This action allows the integrity of the Link Segment with the remote link partner to be established and then reported to the ICS1893's STA.

Chapter 5 Operating Modes Overview

The ICS1893 operating modes and interfaces are configurable with one of two methods. The HW/SW (hardware/software) pin determines which method the ICS1893 is to use, either its hardware pins or its register bits. When the HW/SW bit is logic zero the ICS1893 is in hardware mode. In hardware mode, the hardware pins have priority over the internal registers for establishing the configuration settings of the ICS1893. When the HW/SW bit is logic one the ICS1893 is in software mode. In software mode, the internal register bits have priority over the hardware pins for establishing the configuration settings of the ICS1893. The register bits are typically controlled from software.

The ICS1893 register bits are accessible through a standard MII (Media Independent Interface) Serial Management Port. Even when the ICS1893 MAC/Repeater Interface is not supporting the standard MII Data Interface, access to the Serial Management Port is provided (that is, operation of the Serial Management Port is independent of the MAC/Repeater Interface configuration).

The ICS1893 provides a number of configuration functions to support a variety of operations. For example, the MAC/Repeater Interface can be configured to operate as a 10M MII, a 100M MII, a 100M Symbol Interface, a 10M Serial Interface, or a Link Pulse Interface. The protocol on the Medium Dependent Interface (MDI) can be configured to support either 10M or 100M operations in either half-duplex or full-duplex modes.

The ICS1893 is fully compliant with the ISO/IEC 8802-3 standard, as it pertains to both 10Base-T and 100Base-TX operations. The feature-rich ICS1893 allows easy migration from 10-Mbps to 100-Mbps operations as well as from systems that require support of both 10M and 100M links.

This chapter is an overview of the following ICS1893 modes of operation:

5.1 Reset Operations

This section first discusses reset operations in general and then specific ways in which the ICS1893 can be configured for various reset options.

5.1.1 General Reset Operations

The following reset operations apply to all the specific ways in which the ICS1893 can be reset, which are discussed in Section 5.1.2, “Specific Reset Operations”.

5.1.1.1 Entering Reset

When the ICS1893 enters a reset condition (either through hardware, power-on reset, or software), it does the following:

1. Isolates the MAC/Repeater Interface input pins
2. Drives all MAC/Repeater Interface output pins low
3. Tri-states the signals on its Twisted-Pair Transmit pins (TP_TXP and TP_TXN)
4. Initializes all its internal modules and state machines to their default states
5. Enters the power-down state
6. Initializes all internal latching low (LL), latching high (LH), and latching maximum (LMX) Management Register bits to their default values

5.1.1.2 Exiting Reset

When the ICS1893 exits a reset condition, it does the following:

1. Exits the power-down state
2. Latches the Serial Management Port Address of the ICS1893 into the Extended Control Register, bits 16.10:6. [See Section 8.11.3, “PHY Address (bits 16.10:6)”.]
3. Enables all its internal modules and state machines
4. Sets all Management Register bits to either (1) their default values or (2) the values specified by their associated ICS1893 input pins, as determined by the HW/SW pin
5. Enables the Twisted-Pair Transmit pins (TP_TXP and TP_TXN)
6. Resynchronizes both its Transmit and Receive Phase-Locked Loops, which provide its transmit clock (TXCLK) and receive clock (RXCLK)
7. Releases all MAC/Repeater Interface pins, which takes a maximum of 640 ns after the reset condition is removed

5.1.1.3 Hot Insertion

As with the ICS189X products, the ICS1893 reset design supports ‘hot insertion’ of its MII. (That is, the ICS1893 can connect its MAC/Repeater Interface to a MAC/repeater while power is already applied to the MAC/repeater.)

5.1.2 Specific Reset Operations

This section discusses the following specific ways that the ICS1893 can be reset:

- Hardware reset (using the RESETn pin)
- Power-on reset (applying power to the ICS1893)
- Software reset (using Control Register bit 0.15)

Note: At the completion of a reset (either hardware, power-on, or software), the ICS1893 sets all registers to their default values.

5.1.2.1 Hardware Reset

Entering Hardware Reset

Holding the active-low RESETn pin low for a minimum of five REF_IN clock cycles initiates a hardware reset (that is, the ICS1893 enters the reset state). During reset, the ICS1893 executes the steps listed in Section 5.1.1.1, “Entering Reset”.

Exiting Hardware Reset

After the signal on the RESETn pin transitions from a low to a high state, the ICS1893 completes in 640 ns (that is, in 16 REF_IN clocks) steps 1 through 5, listed in Section 5.1.1.2, “Exiting Reset”. After the first five steps are completed, the Serial Management Port is ready for normal operations, but this action does not signify the end of the reset cycle. The reset cycle completes when the transmit clock (TXCLK) and receive clock (RXCLK) are available, which is typically 53 ms after the RESETn pin goes high. [For details on this transition, see Section 10.5.18, “Reset: Hardware Reset and Power-Down”.]

Note:

1. The MAC/Repeater Interface is not available for use until the TXCLK and RXCLK are valid.
2. The Control Register bit 0.15 does not represent the status of a hardware reset. It is a self-clearing bit that is used to initiate a software reset.

5.1.2.2 Power-On Reset

Entering Power-On Reset

When power is applied to the ICS1893, it waits until the potential between VDD and VSS achieves a minimum voltage before entering reset and executing the steps listed in Section 5.1.1.1, “Entering Reset”. After entering reset from a power-on condition, the ICS1893 remains in reset for approximately 20 µs. (For details on this transition, see Section 10.5.17, “Reset: Power-On Reset”.)

Exiting Power-On Reset

The ICS1893 automatically exits reset and performs the same steps as for a hardware reset. (See Section 5.1.1.2, “Exiting Reset”.)

Note: The only difference between a hardware reset and a power-on reset is that during a power-on reset, the ICS1893 isolates its RESETn input pin. All other functionality is the same. As with a hardware reset, Control Register bit 0.15 does not represent the status of a power-on reset.

5.1.2.3 Software Reset

Entering Software Reset

Initiation of a software reset occurs when a management entity writes a logic one to Control Register bit 0.15. When this write occurs, the ICS1893 enters the reset state for two REF_IN clock cycles.

Note: Entering a software reset is nearly identical to entering a hardware reset or a power-on reset, except that during a software-initiated reset, the ICS1893 does not enter the power-down state.

Exiting Software Reset

At the completion of a reset (either hardware, power-on, or software), the ICS1893 sets all registers to their default values. This action automatically clears (that is, sets equal to logic zero) Control Register bit 0.15, the software reset bit. Therefore, for a software reset (only), bit 0.15 is a self-clearing bit that indicates the completion of the reset process.

Note:

1. The RESETn pin is active low but Control Register bit 0.15 is active high.
2. Exiting a software reset is nearly identical to exiting a hardware reset or a power-on reset, except that upon exiting a software-initiated reset, the ICS1893 does not re-latch its Serial Management Port Address into the Extended Control Register. [For information on the Serial Management Port Address, see Section 8.11.3, “PHY Address (bits 16.10:6)”.]
3. The Control Register bit 0.15 does not represent the status of a hardware reset. It is a self-clearing bit that is used to initiate a software reset. During a hardware or power-on reset, Control Register bit 0.15 does not get set to logic one. As a result, this bit 0.15 cannot be used to indicate the completion of the reset process for hardware or power-on resets.

5.2 Power-Down Operations

The ICS1893 enters the power-down state whenever either (1) the RESETn pin is low or (2) Control Register bit 0.11 (the Power-Down bit) is logic one. In the power-down state, the ICS1893 disables all internal functions and drives all MAC/Repeater Interface output pins to logic zero except for those that support the MII Serial Management Port. In addition, the ICS1893 tri-states its Twisted-Pair Transmit pins (TP_TXP and TP_TXN) to achieve an additional reduction in power.

There is one significant difference between entering the power-down state by setting Control Register bit 0.11 as opposed to entering the power-down state during a reset. When the ICS1893 enters the power-down state:

- By setting Control Register bit 0.11, the ICS1893 maintains the value of all Management Register bits except for the latching low (LL), latching high (LH), and latching maximum (LMX) status bits. Instead, these LL, LH, and LMX Management Register bits are re-initialized to their default values.
- During a reset, the ICS1893 sets all of its Management Register bits to their default values. It does not maintain the state of any Management Register bit.

For more information on power-down operations, see the following:

- Section 8.14, “Register 19: Extended Control Register 2”
- Section 10.4, “DC Operating Characteristics”, which has tables that specify the ICS1893 power consumption while in the power-down state

5.3 Automatic Power-Saving Operations

The ICS1893 has power-saving features that automatically minimize its total power consumption while it is operating. Table 5-1 lists the ICS1893 automatic power-saving features for the various modes.

Table 5-1. Automatic Power-Saving Features, 10Base-T and 100Base-TX Modes

Power-Saving Feature	Mode for ICS1893	
	10Base-T Mode	**100Base-TX Mode**
Disable Internal Modules	In 10Base-T mode, the ICS1893 disables all its internal 100Base-TX modules.	In 100Base-TX mode, the ICS1893 disables all its internal 10Base-T modules.
STA Control of Automatic Power-Saving Features	When an STA sets the state of the ICS1893 Extended Control Register 2, bit 19.0 to logic: • Zero, the 100Base-TX modules always remain enabled, even during 10Base-T operations. • One, the ICS1893 automatically disables 100Base-TX modules while the ICS1893 is operating in 10Base-T mode.	When an STA sets the state of the ICS1893 Extended Control Register 2, bit 19.1 to logic: • Zero, the 10Base-T modules always remain enabled, even during 100Base-TX operations. • One, the ICS1893 automatically disables 10Base-T modules while the ICS1893 is operating in 100Base-TX mode.

5.4 Auto-Negotiation Operations

The ICS1893 has an Auto-Negotiation sublayer and provides both an input pin, ANSEL (Auto-Negotiation Select) and a Control Register bit (bit 0.12) to determine whether its Auto-Negotiation sublayer is enabled or disabled. The ICS1893 HW/SW input pin exclusively selects whether the ANSEL pin (which is used for the hardware mode) or Control Register bit 0.12 (which is used for the software mode) controls its Auto-Negotiation sublayer.

When enabled, the ICS1893 Auto-Negotiation sublayer exchanges technology capability data with its remote link partner and automatically selects the highest-performance operating mode it has in common with its remote link partner. For example, if the ICS1893 supports 100Base-TX and 10Base-T modes – but its link partner supports 100Base-TX and 100Base-T4 modes – the two devices automatically select 100Base-TX as the highest-performance common operating mode. For details regarding initialization and control of the auto-negotiation process, see Section 7.2, “Functional Block: Auto-Negotiation”.

5.5 100Base-TX Operations

The ICS1893 100Base-TX mode provides 100Base-TX physical layer (PHY) services as defined in the ISO/IEC 8802-3 standard. In the 100Base-TX mode, the ICS1893 is a 100M translator between a MAC/repeater and the physical transmission medium. As such, the ICS1893 has two interfaces, both of which are fully configurable: one to the MAC/repeater and one to the Link Segment. In 100Base-TX mode, the ICS1893 provides the following functions:

- Data conversion from both parallel-to-serial and serial-to-parallel formats
- Data encoding/decoding (4B/5B, NRZ/NRZI, and MLT-3)
- Data scrambling/descrambling
- Data transmission/reception over a twisted-pair medium

To accurately transmit and receive data, the ICS1893 employs DSP-based wave shaping, adaptive equalization, and baseline wander correction. In addition, in 100Base-TX mode, the ICS1893 provides a variety of control and status means to assist with Link Segment management. For more information on 100Base-TX, see Section 7.4, “Functional Block: 100Base-TX TP-PMD Operations”.

5.6 10Base-T Operations

The ICS1893 10Base-T mode provides 10Base-T physical layer (PHY) services as defined in the ISO/IEC 8802-3 standard. In the 10Base-T mode, the ICS1893 is a 10M translator between a MAC/repeater and the physical transmission medium. As such, the ICS1893 has two interfaces, both of which are fully configurable: one to the MAC/repeater and one to the Link Segment. In 10Base-T mode, the ICS1893 provides the following functions:

- Data conversion from both parallel-to-serial and serial-to-parallel formats
- Manchester data encoding/decoding
- Data transmission/reception over a twisted-pair medium

In addition, in 10Base-T mode, the ICS1893 provides a variety of control and status means to assist with Link Segment management. For more information on 10Base-T, see Section 7.5, “Functional Block: 10Base-T Operations”.

5.7 Half-Duplex and Full-Duplex Operations

The ICS1893 supports half-duplex and full-duplex operations for both 10Base-T and 100Base-TX applications. Full-duplex operation allows simultaneous transmission and reception of data, which effectively doubles the Link Segment throughput to either 20 Mbps (for 10Base-T operations) or 200 Mbps (for 100Base-TX operations).

As per the ISO/IEC standard, full-duplex operations differ slightly from half-duplex operations. These differences are necessary, as during full-duplex operations a PHY actively uses both its transmit and receive data paths simultaneously.

- In 10Base-T full-duplex operations, the ICS1893 disables its loopback function (that is, it does not automatically loop back data from its transmitter to its receiver) and disables its SQE Test function.
- In both 10Base-T and 100Base-TX full-duplex operations, the ICS1893 asserts its CRS signal only in response to receive activity while its COL signal always remains inactive.

For more information on half-duplex and full-duplex operations, see the following sections:

- Section 8.2, “Register 0: Control Register”
- Section 8.2.8, “Duplex Mode (bit 0.8)”
- Section 8.3, “Register 1: Status Register”
- Section 8.6, “Register 4: Auto-Negotiation Register”

Chapter 6 Interface Overviews

The ICS1893 MAC/Repeater Interface is fully configurable, thereby allowing it to accommodate many different applications.

This chapter includes overviews of the following MAC/repeater-to-PHY interfaces: