DP83TG720R-Q1 1000BASE-T1 Automotive Ethernet PHY

1 Features

- IEEE802.3bp 1000BASE-T1 compliant
- Open Alliance TC12 Interoperability and EMC compliant
  - Interoperability tested with OA/IEEE compliant PHYs
  - EMC immunity Class-IV compliant for UTP (unshielded twisted pair)
- Integrated LPF on MDI pins
- MAC Interface: RGMII
- Supported I/O voltages: 3.3V, 2.5V, and 1.8V
- Pin compatible with TI's 100BASE-T1 PHY
  - Single board design for 100BASE-T1 and 1000BASE-T1 with required BOM change
- Power savings features:
  - Standby and sleep
  - Local and remote wake-up
- Diagnostic tool kit
  - High accuracy temperature monitor
  - Voltage monitor
  - ESD event monitor
  - Data throughput calculator: inbuilt MAC packet generator, counter and error checker
  - Link quality monitoring
  - Cable open and short fault detection
  - Loopback modes
- 25MHz clock output source
- VQFN, wettable flank packaging
- AEC-Q100 Qualified
  - Inbuilt ESD protection : IEC61000-4-2 ESD : ±8 kV contact discharge
  - Device temperature grade 1: –40°C to +125°C ambient operating temperature

2 Applications

- Telematics control unit (TCU, TBOX)
- Gateway and Body Control Module (BCM)
- ADAS: LIDAR, RADAR, Front Camera

3 Description

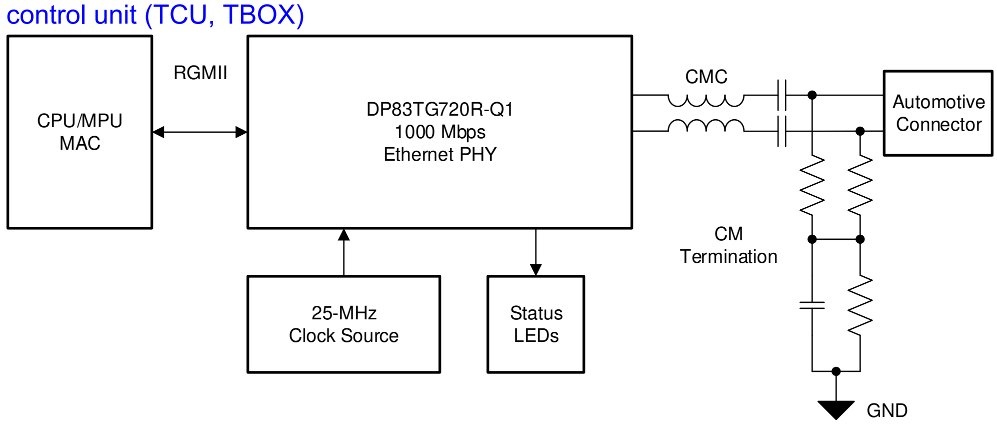
The DP83TG720R-Q1 device is an IEEE 802.3bp and Open Alliance compliant automotive Ethernet physical layer transceiver. The device provides all physical layer functions needed to transmit and receive data over unshielded/shielded single twisted-pair cables. The device supports RGMII for interfacing with a MAC.

DP83TG720 is compliant to Open Alliance EMC and interoperable specifications over unshielded twisted cable. DP83TG720 is front print compatible to TI's 100BASE-T1 PHY enabling design scalability with single board for both speeds. This device offers the Diagnostic Tool Kit, with an extensive list of real-time monitoring tools, debug tools and test modes. Within the tool kit is the first integrated electrostatic discharge (ESD) monitoring tool. The device is capable of counting ESD events on both the xMII and MDI as well as providing real-time monitoring through the use of a programmable interrupt. Additionally, the DP83TG720R-Q1 includes a data generator and checker tool to generate customizable MAC packets and check the errors on incoming packets. This enables system level datapath tests/optimizations without dependency on MAC.

Device Information

PART NUMBER	PACKAGE (1)	BODY SIZE (NOM) (2)
DP83TG720R-Q1	VQFN (36)	6.00mm × 6.00mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.
(2) The package size (length × width) is a nominal value and includes pins, where applicable.



Simplified Schematic

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4 Device Comparison Table

PART NUMBER	RGMII SUPPORT	SGMII SUPPORT	OPERATING TEMPERATURE
DP83TG720R-Q1	Yes	No	–40°C to 125°C
DP83TG720S-Q1	Yes	Yes	–40°C to 125°C

5 Pin Configuration and Functions

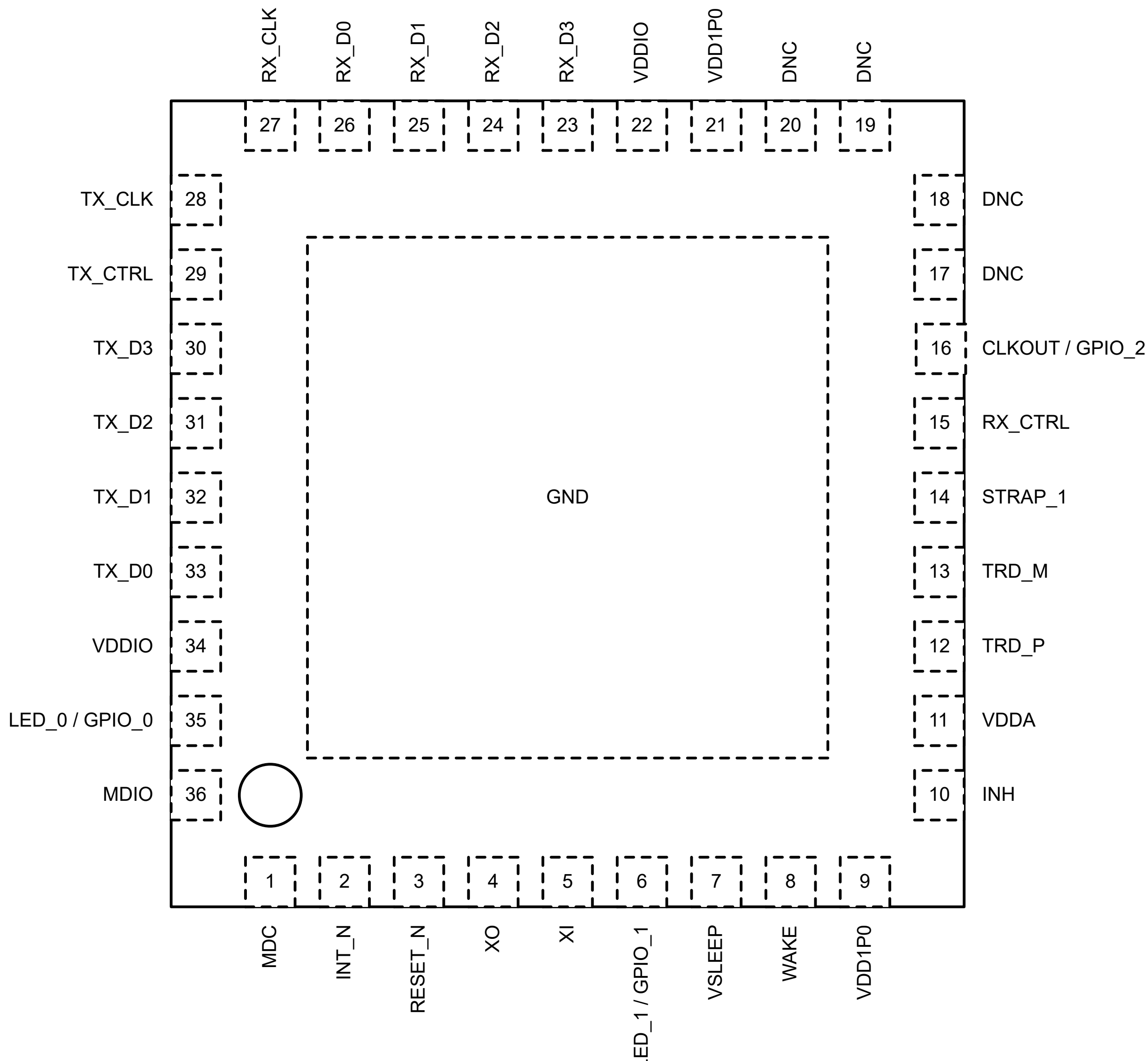

Figure 5-1. RHA Package
36-Pin VQFN
Top View

Pin Functions

Table 5-1. Pin Functions

PIN NAME	PIN NO.	STATE(1)	DESCRIPTION (2)
MAC INTERFACE			
RX_D3	23	S, PD, O	**Receive Data:** Symbols received on the cable are decoded and transmitted out of these pins synchronous to the rising edge of RX_CLK. Valid data is contained when RX_DV(decoded from RX_CTL) is asserted. A nibble, RX_D[3:0], is transmitted in RGMII mode.
RX_D2	24		
RX_D1	25		
RX_D0	26		
RX_CLK	27	O	**Receive Clock:** In RGMII mode, PHY provides this 125MHz clock to MAC.
RX_CTRL	15	S, PD, O	**RGMII Receive Control:** Receive control combines receive data valid indication and receive error indication into a single signal. RX_DV is presented on the rising edge of RX_CLK and RX_ER is presented on the falling edge of RX_CLK.
TX_CLK	28	I	**Transmit Clock:** In RGMII mode, MAC provides this 125MHz clock to PHY.
TX_CTRL	29	I	**RGMII Transmit Control:** Transmit control combines transmit enable and transmit error indication into a single signal. TX_EN is presented prior to the rising edge of TX_CLK; TX_ER is presented on the falling edge of TX_CLK.
TX_D3	30	I	**Transmit Data:** In RGMII mode, the transmit data nibble, TX_D[3:0], is received from the MAC .
TX_D2	31		
TX_D1	32		
TX_D0	33		
SERIAL MANAGEMENT INTERFACE			
MDC	1	I	**Management Data Clock:** Synchronous clock to the MDIO serial management input and output data.
MDIO	36	OD, IO	**Management Data Input/Output:** Bidirectional management data signal that is sourced by either the management station or the PHY. This pin requires an external pull-up resistor (recommended value = 2.2kΩ) .
CONTROL INTERFACE			
$\overline{\text{INT}}$	2	PU, OD, O	**Interrupt:** Active-LOW output, which is asserted LOW when an interrupt condition occurs. This pin has a weak internal pullup. Register access is necessary to enable various interrupt triggers. Once an interrupt event flag is set, register access is required to clear the interrupt event on this pin. This pin can be configured as an Active-HIGH output using register[0x0011]. To capture the interrupt source reliably, status from interrupt registers x12, x13, x18 is recommended to be read after interrupt is asserted on int_n pin.
$\overline{\text{RESET}}$	3	PU, I	**RESET:** Active-LOW input, which initializes or reinitializes the DP83TG720R-Q1. Asserting this pin LOW for at least 10µs forces a reset process to occur. All internal registers reinitialize to the default states as specified for each bit in the Register Map section. All bootstrap pins are resampled upon deassertion of reset.
INH	10	PMOS OD	**INH:** Active-HIGH PMOS open-drain output. When the PHY enters the sleep state, PHY releases the INH pin to allow an external pull-down resistor (recommended value = 10kΩ) to pull the line to ground. When in any other state, the INH pin drives a HIGH state to the VSLEEP rail.
WAKE	8	PD, I	**WAKE:** Active-HIGH (this pin works on VSLEEP domain) pulse on wake-up pin wakes up the PHY from the sleep state. For pulse width, refer to timing section. This pin can be directly tied to the VSLEEP rail when the sleep state is not used or left float.
STRP_1	14	I	**Strap 1:** This pin is for strapping PHY_AD bits.
CLOCK INTERFACE			
XI	5	I	**Reference Clock Input:** Reference clock 25MHz ±100ppm-tolerance crystal or oscillator input. The device supports either an external crystal resonator connected across pins XI and XO, or an external CMOS-level oscillator connected to pin XI only and XO left floating.
XO	4	O	**Reference Clock Output:** XO pin is used for crystal only. This pin is left floating when a CMOS-level oscillator is connected to XI.

Table 5-1. Pin Functions (continued)

PIN		STATE(1)	DESCRIPTION (2)
NAME	NO.		
LED/GPIO INTERFACE			
LED_0 / GPIO_0	35	S, PD, IO	**LED_0:** Link Status
LED_1 / GPIO_1	6	S, PD, IO	**LED_1:** Link Status and BLINK for TX/RX Activity
CLKOUT / GPIO_2	16	IO	**Clock Output:** 25MHz reference clock(buffered replication of XI) by default. If not used, clock output can be disabled by writing register 0x0453 = 0x0006.
MEDIUM DEPENDENT INTERFACE			
TRD_M	13	IO	**Differential Transmit and Receive:** Bidirectional differential signaling configured for 1000BASE-T1 operation, IEEE 802.3bp compliant.
TRD_P	12		
POWER AND GROUND CONNECTIONS			
VDDA3P3	11	SUPPLY	**Core Supply:** 3.3V. Refer to power supply recommendations for decoupling network.
VDDIO	22, 34	SUPPLY	**IO Supply:** 1.8V, 2.5V, or 3.3V. Refer to power supply recommendations for decoupling network.
VDD1P0	9, 21	SUPPLY	**Core Supply:** 1.0V. Refer to power supply recommendations for decoupling network.
VSLEEP	7	SUPPLY	**Sleep Supply:** 3.3V. Refer to power supply recommendations for decoupling network. This pin shall be tied to VDDA3P3 if sleep functionality is not used.
GROUND	DAP	GROUND	**Ground**
DO NOT CONNECT			
DNC	17, 18, 19, 20	DNC	**DNC:** Do Not Connect (test structures connected to these pins and must be kept floating to avoid damage or wrong mode entry of PHY)

(1) Type: I = Input
O = Output
IO = Input/Output
OD = Open Drain
PD = Internal Pulldown
PU = Internal Pullup
S = Strap: Configuration pin (all configuration pins have weak internal pullups or pulldowns)

(2) When pins are unused, follow the recommended connection requirements provided in the table above. The pins which do not have required termination can be left floating.

5.1 Pin States

Table 5-2. Pin States - RGMII

PIN NAME	POWER-UP / RESET			NORMAL OPERATION - RGMII		
	PIN STATE(1)	PULL TYPE	PULL VALUE (kΩ)	PIN STATE (1)	PULL TYPE	PULL VALUE (kΩ)
MDC	I	none	-	I	none	-
INT_N	I	PU	9	OD	PU	9
RESET_N	I	PU	9	I	PU	9
XO	O	none	-	O	none	-
XI	I	none	-	I	none	-
LED_1	I	PD	9	O	none	-
WAKE	I	PD	50	I	PD	50
STRP_1	I	PD	6.3	I	none	-
INH	PMOS,OD,O	none	-	PMOS OD, O	none	-
RX_CTRL	I	PD	6.3	O	none	-
CLKOUT/GPIO_2	O	none	-	O	none	-
RX_D3	I	PD	9	O	none	-
RX_D2	I	PD	9	O	none	-
RX_D1	I	PD	9	O	none	-
RX_D0	I	PD	9	O	none	-
RX_CLK	I	PD	9	O	none	-
TX_CLK	I	none	-	I	none	-
TX_CTRL	I	none	-	I	none	-
TX_D3	I	none	-	I	none	-
TX_D2	I	none	-	I	none	-
TX_D1	I	none	-	I	none	-
TX_D0	I	none	-	I	none	-
LED_0	I	PD	9	O	none	-
MDIO	I	none	-	IO	none	-

(1) Type: I = Input
O = Output
IO = Input/Output
OD = Open Drain
PD = Internal pulldown
PU = Internal pullup

Table 5-3. Pin States - Sleep and Isolate

PIN NAME	MAC ISOLATE			SLEEP		
	PIN STATE (1)	PULL TYPE	PULL VALUE (kΩ)	PIN STATE (1)	PULL TYPE	PULL VALUE (kΩ)
MDC	I	none	-	Float	none	-
INT_N	O	PU	9	Float	none	-
RESET_N	I	PU	9	Float	none	-
XO	O	none	-	Float	none	-
XI	I	none	-	Float	none	-
LED_1	O	none	-	Float	none	-
WAKE	I	PD	50	I	none	50
STRP_1	I	none	-	Float	none	-
INH	PMOS,OD,O	none	-	PMOS OD, O	none	-
RX_CTRL	I	PD	6.3	Float	none	-
CLKOUT/GPIO_2	O	none	-	Float	none	-
RX_D3	I	PD/none(2)	9	Float	none	-
RX_D2	I	PD/none(2)	9	Float	none	-
RX_D1	I	PD	9	Float	none	-
RX_D0	I	PD	9	Float	none	-
RX_CLK	I	PD	9	Float	none	-
TX_CLK	I	none	-	Float	none	-
TX_CTRL	I	none	-	Float	none	-
TX_D3	I	none	-	Float	none	-
TX_D2	I	none	-	Float	none	-
TX_D1	I	none	-	Float	none	-
TX_D0	I	none	-	Float	none	-
LED_0	O	none	-	Float	none	-
MDIO	IO	none	-	Float	none	-

(1) Type: I = Input
O = Output
IO = Input/Output
OD = Open Drain
PD = Internal pulldown
PU = Internal pullup
Hi-Z = High Impedence
Float = IO is not powered and hence pin is not biased by the PHY

(2) PD only for Rgmii's isolate mode.

Note

For sleep mode entry vdda, vddio and vdd1p0 are supposed to be powered-down. See figure Required Implementation of Sleep Mode for further details.

5.2 Pin Power Domain

Table 5-4. Pin Power Domain Table

Pin	RGMII Mode	SGMII Mode
MDC	VDDIO	VDDIO
INT_N	VDDIO	VDDIO
RESET_N	VDDIO	VDDIO
XI	VDDIO	VDDIO
XO	VDDIO	VDDIO
LED_1	VDDIO	VDDIO
WAKE	VSLEEP	VSLEEP
STRP_1	VDDIO	VDDIO
INH	VSLEEP	VSLEEP
RX_CTRL	VDDIO	VDDIO
CLKOUT/GPIO_2	VDDIO	VDDIO
RX_D3	VDDIO	VDDA
RX_D2	VDDIO	VDDA
RX_D1	VDDIO	VDDIO
RX_D0	VDDIO	VDDIO
RX_CLK	VDDIO	VDDIO
TX_CLK	VDDIO	VDDIO
TX_CTRL	VDDIO	VDDIO
TX_D3	VDDIO	VDDIO
TX_D2	VDDIO	VDDIO
TX_D1	VDDIO	VDDA
TX_D0	VDDIO	VDDA
LED_0	VDDIO	VDDIO
MDIO	VDDIO	VDDIO
TRD_P	VDDA	VDDA
TRD_M	VDDA	VDDA

6 Specifications

6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)[(1)]

		MIN	TYP	MAX	UNIT
Supply Voltage	VDDA3P3	-0.5		4	V
Supply Voltage	VDD1P0	-0.5		1.4	V
Supply Voltage	VDDIO (3.3V)	-0.5		4	V
Supply Voltage	VDDIO (2.5V)	-0.5		2.9	V
Supply Voltage	VDDIO (1.8V)	-0.5		2.2	V
Supply Voltage	V_{SLEEP}	-0.5		4	V
MDI Pins	TRD_M, TRD_P	-0.5		4	V
LVCMOS/ LVTTL Input Voltage	MDC, $\overline{\text{RESET}}$, XI, LED_1, STRP_1, RX_CTRL, CLKOUT, RX_D[3:0], TX_CLK, TX_CTRL, TX_D[3:0], LED_0, MDIO	-0.5		VDDIO + 0.3	V
LVCMOS/ LVTTL Input Voltage	WAKE	-0.5		V_{SLEEP} + 0.3	V
LVCMOS/ LVTTL Output Voltage	$\overline{\text{INT}}$, LED_1, RX_CTRL, CLKOUT, RX_D[3:0], RX_CLK, LED_0, MDIO	-0.5		VDDIO + 0.3	V
LVCMOS/ LVTTL Output Voltage	INH	-0.5		VSLEEP + 0.3	V
T_J	Junction Temperature			150	°C
T_{stg}	Storage temperature	-65		150	°C

(1) Stresses beyond those listed under *Absolute Maximum Rating* can cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Condition*. Exposure to absolute-maximum-rated conditions for extended periods can affect device reliability.

6.2 ESD Ratings

				VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per AEC Q100-002[(1)]	All pins	±2000	V
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per AEC Q100-002[(1)]	TRD_M, TRD_P	±8000	V
$V_{(ESD)}$	Electrostatic discharge	Charged device model (CDM), per AEC Q100-011	All pins	±500	V
$V_{(ESD)}$	Electrostatic discharge	IEC 61000-4-2 contact discharge	TRD_M, TRD_P	±8000	V

(1) AEC Q100-002 indicates that HBM stressing shall be in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

		MIN	NOM	MAX	UNIT
VDDIO	IO Supply Voltage, 1.8V operation	1.62	1.8	1.98	V
	IO Supply Voltage, 2.5V operation	2.25	2.5	2.75	
	IO Supply Voltage, 3.3V operation	2.97	3.3	3.63	
VDDA3P3	Core Supply Voltage, 3.3V	2.97	3.3	3.63	V
VDD1P0	Core Supply Voltage, 1.0V	0.95	1	1.1	V
V_{SLEEP}	Sleep Supply Voltage, 3.3V	2.97	3.3	3.63	V
T_A	Ambient temperature	–40		125	°C

6.4 Thermal Information

THERMAL METRIC(1)		DP83TG720	UNIT
		RHA (VQFN)	
		36 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	32.5	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	22.2	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	13.3	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	0.3	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	13.3	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	3.2	°C/W

(1) For more information about traditional and new thermal metrics, see the Semiconductor and IC Package Thermal Metrics application report.

6.5 Electrical Characteristics

Over operating free-air temperature range (unless otherwise noted)(1)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
DC CHARACTERISTICS						
XI						
V_{IH}	High-level Input Voltage		1.3			V
V_{IL}	Low-level Input Voltage				0.5	V
WAKE pin	WAKE pin	WAKE pin	WAKE pin	WAKE pin	WAKE pin	WAKE pin
V_{IH}	High-level Input Voltage	V_{SLEEP} = 3.3V ± 10%	2			V
V_{IL}	Low-level Input Voltage	V_{SLEEP} = 3.3V ± 10%			0.8	V
INH pin	INH pin	INH pin	INH pin	INH pin	INH pin	INH pin
V_{OH}	High-level Output Voltage	I_{OH} = -2mA, V_{SLEEP} = 3.3V ± 10%	2.4			V
3.3V VDDIO (2)						
V_{OH}	High-level Output Voltage	I_{OH} = -2mA, VDDIO = 3.3V ± 10%	2.4			V
V_{OL}	Low-level Output Voltage	I_{OL} = 2mA, VDDIO = 3.3V ± 10%			0.4	V
V_{IH}	High-level Input Voltage	VDDIO = 3.3V ± 10%	2			V
V_{IL}	Low-level Input Voltage	VDDIO = 3.3V ± 10%			0.8	V
2.5V VDDIO (2)						
V_{OH}	High-level Output Voltage	I_{OH} = -2mA, VDDIO = 2.5V ± 10%	2			V
V_{OL}	Low-level Output Voltage	I_{OL} = 2mA, VDDIO = 2.5V ± 10%			0.4	V
V_{IH}	High-level Input Voltage	VDDIO = 2.5V ± 10%	1.7			V

6.5 Electrical Characteristics (continued)

Over operating free-air temperature range (unless otherwise noted)(1)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{IL}	Low-level Input Voltage	VDDIO = 2.5V ± 10%			0.7	V
1.8V VDDIO (2)						
V_{OH}	High-level Output Voltage	I_{OH} = -2mA, VDDIO = 1.8V ± 10%	VDDIO – 0.45			V
V_{OL}	Low-level Output Voltage	I_{OL} = 2mA, VDDIO = 1.8V ± 10%			0.45	V
V_{IH}	High-level Input Voltage	VDDIO = 1.8V ± 10%	0.7 * VDDIO			V
V_{IL}	Low-level Input Voltage	VDDIO = 1.8V ± 10%			0.3 * VDDIO	V
I_{IH}	Input High Current (MDIO)	VIN = VCC, -40°C to 125°C	-5		5	μA
I_{IH}	Input High Current (RGMII Input pin,MDC)	VIN = VCC, -40°C to 125°C	-20		20	μA
I_{OZ}	Input High Current (MDIO)	VIN swept from 0V till VCC, -40°C to 125°C	-40		40	μA
I_{IL}	Input Low Current (RGMII Input pin, MDC, MDIO)	VIN = GND, -40°C to 125°C	-40		5	μA
I_{OZL}		INH			6	μA
I_{OZ}	Tri-state Output Current (5)	VIN swept from 0V till VCC, -40°C to 125°C	-40		10	μA
I_{OZ}	Tri-state Output Current (6)	VIN swept from 0V till VCC, -40°C to 125°C	-60		60	μA
C_{IN}	Input Capacitance	LVCMOS/LVTTL pins (3)			2	pF
C_{IN}	Input Capacitance	LVCMOS/LVTTL pins (4)			4	pF
		XI			1	pF
C_{OUT}	Output Capacitance	LVCMOS/LVTTL pins (3)			2	pF
C_{OUT}	Output Capacitance	LVCMOS/LVTTL pins (4)			4	pF
		XO			1	pF
$R_{pull-up}$	Integrated Pull-Up Resistance	$\overline{INT}$, $\overline{RESET}$	6.5	9	12.5	kΩ
$R_{pull-down}$	Integrated Pull-Down Resistance	STRP_1, RX_CTRL	4.725	6.3	7.875	kΩ
$R_{pull-down}$	Integrated Pull-Down Resistance	LED_1, RX_D[3:0], RX_CLK, LED_0	7.3	9	13	kΩ
		WAKE	35	50	62.5	kΩ
$R_{pull-down}$	Integrated Pull-Up Resistance when Active	INH		106		Ω
R_{series}	Integrated MAC Series Termination Resistor (Default)	RX_D[3:0], RX_CTRL, and RX_CLK	24	42	52	Ω
Rseries	Integrated MAC Series Terminatin Resistor (with register<0x0456> = 0x0148)	RX_D[3:0], RX_CTRL, and RX_CLK	30	52	65	Ω
Rseries	Integrated MAC Series Terminatin Resistor (with register<0x0456> = 0x0168)	RX_D[3:0], RX_CTRL, and RX_CLK	40	70	84	Ω
CURRENT CONSUMPTION, SLEEP MODE						
I_{SLEEP}	Sleep Supply Current	V_{SLEEP}		485	840	μA
CURRENT CONSUMPTION, RESET ASSERTED						
I_{DDIO}	IO Supply Current, VDDIO = 1.8V	VDDIO		4	9	mA
I_{DDIO}	IO Supply Current, VDDIO = 2.5V	VDDIO		5	12	mA
I_{DDIO}	IO Supply Current, VDDIO = 3.3V	VDDIO		6.5	15	mA
I_{DDA3P3}	Core Supply Current, 3.3V	VDDA3P3		5	8	mA

6.5 Electrical Characteristics (continued)

Over operating free-air temperature range (unless otherwise noted)(1)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{DD1P0}	Core Supply Current, 1.0V	VDD1P0		30	110	mA
CURRENT CONSUMPTION, STANDBY						
I_{DDIO}	IO Supply Current, VDDIO = 1.8V	VDDIO		4	11	mA
I_{DDIO}	IO Supply Current, VDDIO = 2.5V	VDDIO		6	13	mA
I_{DDIO}	IO Supply Current, VDDIO = 3.3V	VDDIO		8	15	mA
I_{DDA3P3}	Core Supply Current, 3.3V	VDDA3P3		16	18	mA
I_{DD1P0}	Core Supply Current, 1.0V	VDD1P0		33	112	mA
CURRENT CONSUMPTION, ACTIVE MODE, Voltage: +/- 10%, Traffic : 100%,Packet Size: 1518, Content : Random						
I_{DDIO}	IO Supply Current, VDDIO = 1.8V	RGMII		20	25	mA
I_{DDIO}	IO Supply Current, VDDIO = 2.5V	RGMII		26	30	mA
I_{DDIO}	IO Supply Current, VDDIO = 3.3V	RGMII		33	40	mA
I_{DDA3P3}	Core Supply Current, 3.3V	RGMII		85	89	mA
I_{DD1P0}	Core Supply Current, 1.0V	RGMII		177	250	mA
I_{SLEEP}	Sleep Supply Current	$V_{SLEEP = 3.3V +/- 10\%}$		1000	1500	μA
MDI CHARACTERISTICS						
V_{OD-MDI}	Output Differential Voltage	$R_{L(diff)}$ = 100 Ω			1.3	V
$R_{MDI-DIFF}$	Integrated Differential MDI Termination (Active State)	TRD_P, TRD_M		100		Ω
$R_{MDI-DIFF}$	Integrated Differential MDI Termination (Sleep State)	TRD_P, TRD_M		100		Ω
BOOTSTRAP DC CHARACTERISTICS						
2 level straps						
Vbsl_1v8	Bootstrap Threshold	Mode 1, VDDIO = 1.8V ± 10%, 2-level	0		0.35*VDDIO	V
Vbsh_1v8	Bootstrap Threshold	Mode 2, VDDIO = 1.8V ± 10%, 2-level	1.175		VDDIO	V
Vbsl_2v5	Bootstrap Threshold	Mode 1, VDDIO = 2.5V ± 10%, 2-level	0		0.7	V
Vbsh_2v5	Bootstrap Threshold	Mode 2, VDDIO = 2.5V ± 10%, 2-level	1.175		VDDIO	V
Vbsl_3v3	Bootstrap Threshold	Mode 1, VDDIO = 3.3V ± 10%, 2-level	0		0.7	V
Vbsh_3v3	Bootstrap Threshold	Mode 2, VDDIO = 3.3V ± 10%, 2-level	1.175		VDDIO	V
3 level straps						
V_{bs1_1V8}	Bootstrap Threshold	Mode 1, VDDIO = 1.8V ± 10%, 3-level	0		0.35 * VDDIO	V
V_{bs2_1V8}	Bootstrap Threshold	Mode 2, VDDIO = 1.8V ± 10%, 3-level	0.40 * VDDIO		0.75 * VDDIO	V
V_{bs3_1V8}	Bootstrap Threshold	Mode 3, VDDIO = 1.8V ± 10%, 3-level	0.84 * VDDIO		VDDIO	V
V_{bs1_2V5}	Bootstrap Threshold	Mode 1, VDDIO = 2.5V ± 10%, 3-level	0		0.19 * VDDIO	V
V_{bs2_2V5}	Bootstrap Threshold	Mode 2, VDDIO = 2.5V ± 10%, 3-level	0.27 * VDDIO		0.41 * VDDIO	V
V_{bs3_2V5}	Bootstrap Threshold	Mode 3, VDDIO = 2.5V ± 10%, 3-level	0.58 * VDDIO		VDDIO	V

6.5 Electrical Characteristics (continued)

Over operating free-air temperature range (unless otherwise noted)(1)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{bs1_3V3}	Bootstrap Threshold	Mode 1, VDDIO = 3.3V ± 10%, 3-level	0		0.18 * VDDIO	V
V_{bs2_3V3}	Bootstrap Threshold	Mode 2, VDDIO = 3.3V ± 10%, 3-level	0.22 * VDDIO		0.42 * VDDIO	V
V_{bs3_3V3}	Bootstrap Threshold	Mode 3, VDDIO = 3.3V ± 10%, 3-level	0.46 * VDDIO		VDDIO	V
Temperature Sensor						
	Temperature Sensor Resolution (LSB)	-40℃ to 125℃		1.5		℃
	Temperature Sensor Accuracy (Voltage and Temperature Variation on single part)	-40℃ to 125℃	-7.5		7.5	℃
	Temperature Sensor Accuracy (Voltage, Temperature and Part-to-Part variation)	-40℃ to 125℃	-21.5		20	℃
	Temperature Sensor Range		-40		140	℃
Voltage Sensor						
	VDDA3P3 Sensor Range		2.66	3.3	3.96	V
	VDDA3P3 Sensor Resolution (LSB)	-40℃ to 125℃		8.6		mV
	VDDA3P3 Sensor Accuracy (Voltage and Temperature Variation)	-40℃ to 125℃		8.6		mV
	VDDA3P3 Sensor Accuracy Part-to-Part	-40℃ to 125℃	-68.8		68.8	mV
	VDD1P0 Sensor Range		0.8		1.2	V
	VDD1P0 Sensor Resolution (LSB)	-40℃ to 125℃		2.8		mV
	VDD1P0 Sensor Accuracy (Voltage and Temperature Variation)	-40℃ to 125℃		2.8		mV
	VDD1P0 Sensor Accuracy Part-to-Part	-40℃ to 125℃	-22.4		22.4	mV
	VDDIO Sensor Range		1.44		3.8	V
	VDDIO Sensor Resolution (LSB)	-40℃ to 125℃		15.4		mV
	VDDIO Sensor Accuracy (Voltage and Temperature Variation)	-40℃ to 125℃		15.4		mV
	VDDIO Sensor Accuracy Part-to-Part	-40℃ to 125℃	-78		78	mV

(1) Verified by production test, characterization or design
(2) For pins: LED_1, STRP_1, RX_CTRL, CLKOUT, RX_D[3:0], RX_CLK, LED_0
(3) For pins: MDC, $\overline{\text{INT}}$, $\overline{\text{RESET}}$, LED_1, STRP_1, RX_CTRL, CLKOUT, RX_D0, RX_D1, RX_CLK, TX_CLK, TX_CTRL, TX_D2, TX_D3, LED_0, and MDIO
(4) For pins: TX_D0, TX_D1, RX_D2, and RX_D3
(5) For pins : LED_1, RX_D[3:0], RX_CLK, LED_0
(6) For pins : STRP_1 and RX_CTRL

6.6 Timing Requirements

(1)

PARAMETER		TEST CONDITIONS	MIN	NOM	MAX	UNIT
POWER-UP TIMING						
T5.1	VDDA3P3 Duration(2)	0% to 100% (+/- 10% VDDA3P3)	0.5		40	ms
T5.2	VDD1P0 Duration(2)	0% to 100% (+/- 10% VDD1P0)	0.1		40	ms
T5.2	VDDIO Duration(2)	VDDIO = 1.8V	0.1		40	ms
T5.2	VDDIO Duration(2)	VDDIO = 2.5V	0.1		40	ms

6.6 Timing Requirements (continued)

(1)

	PARAMETER	TEST CONDITIONS	MIN	NOM	MAX	UNIT
T5.2	VDDIO Duration(2)	VDDIO = 3.3V	0.1		40	ms
T5.2	$V_{SLEEP\ Duration}$ (2)	0% to 100% (+/- 10% V_{SLEEP})	0.1		40	ms
T5.3	Crystal stabilization-time post power-up (from last power rail ramp to 100%)			1500		µs
T5.4	Osillator stabilization-time post power-up (from last power rail ramp to 100%)(3)				20	ms
T5.5	Post power-up stabilization-time prior to MDC preamble for register access		65			ms
T5.6	Hardware configuration latch-in time from power-up				60	ms
T5.7	Hardware configuration pins transition to functional mode from latch-in completion				110	ns
T5.8	PAM3 IDLE Stream from power-up (Master Mode)				60	ms
RESET TIMING (RESET_N)						
T6.1	RESET pulse width		5			µs
T6.2	Post reset stabilization-time prior to MDC preamble for register access		1			ms
T6.3	Hardware configuration latch-in time from reset				2	µs
T6.4	Hardware configuration pins transition to functional mode from latch-in completion				1.5	µs
T6.5	PAM3 IDLE Stream from reset (Master Mode)				1500	µs
SMI TIMING						
T4.1	MDC to MDIO (Output) Delay Time (25 pF load)		0	6	10	ns
T4.2	MDIO (Input) to MDC Setup Time		10			ns
T4.3	MDIO (Input) to MDC Hold Time		10			ns
	MDC Frequency (25 pF load)			2.5	20	MHz
RECEIVE LATENCY TIMING						
	SSD symbol on MDI to Rising edge of RGMII RX_CLK with assertion of RX_CTRL				8	µs
	SSD symbol on MDI to Rising edge of RGMII RX_CLK with assertion of RX_CTRL (RS-FEC bypass mode)				400	ns
TRANSMIT LATENCY TIMING						
	RGMII Rising edge TX_CLK with assertion TX_CTRL to SSD symbol on MDI				0.8	µs
	RGMII Rising edge TX_CLK with assertion TX_CTRL to SSD symbol on MDI (RS-FEC bypass mode)				600	ns
25MHz OSCILLATOR REQUIREMENTS						
	Frequency (XI)			25		MHz
	Frequency Tolerance and Stability Over temperature and aging		–100		100	ppm
	Rise / Fall Time (10% - 90%)(6)				8	ns
	Jitter (RMS)	Integrated upto 5MHz			1	ps
	Duty Cycle		40	50	60	%
RGMII TIMING						
T_{setupR}	TX_D[3:0], TX_CTRL Setup to TX_CLK	on PHY pins	1	2		ns
T_{holdR}	TX_D[3:0], TX_CTRL Hold from TX_CLK (5)	on PHY pins	1	2		ns

6.6 Timing Requirements (continued)

(1)

PARAMETER		TEST CONDITIONS	MIN	NOM	MAX	UNIT
T_{skewT}	RX_D[3:0], RX_CTRL Delay from RX_CLK (Align Mode Enabled)	On PHY Pins	-500	0	500	ps
T_{skewT} (Shift)	RX_D[3:0], RX_CTRL Delay from RX_CLK (Shift Mode Enabled, default)(4)	On PHY Pins	2.190	2.650	2.970	ns
T_{cyc}	Clock Cycle Duration	RX_CLK	7.2	8	8.8	ns
T_{cyc}	Clock Cycle Duration	TX_CLK	7.2	8	8.8	ns
Duty_G	Duty Cycle	RX_CLK	45	50	55	%
Duty_G	Duty Cycle	TX_CLK	45	50	55	%
Tr	Rise Time (20% - 80%)	CL=Ctrace=5pF			0.75	ns
Tf	Fall Time (20% - 80%)	$C_{L=Ctrace}$ = 5pF			0.75	ns
RGMII RX Shift Mode Delays	DLL DLL_RX_DELAY_CTRL_SL=0(4)		0.330	0.650	0.970	ns
	DLL DLL_RX_DELAY_CTRL_SL=1(4)		0.580	0.900	1.220	ns
	DLL DLL_RX_DELAY_CTRL_SL=2(4)		0.830	1.150	1470	ns
	DLL DLL_RX_DELAY_CTRL_SL=3(4)		1.000	1.400	1.720	ns
	DLL DLL_RX_DELAY_CTRL_SL=4(4)		1.230	1.650	1.970	ns
	DLL DLL_RX_DELAY_CTRL_SL=5(4)		1.490	1.990	2.220	ns
	DLL DLL_RX_DELAY_CTRL_SL=6(4)		1.690	2.150	2.470	ns
	DLL DLL_RX_DELAY_CTRL_SL=7(4)		1.960	2.400	2.730	ns
	DLL DLL_RX_DELAY_CTRL_SL=8(4)		2.180	2.650	2.970	ns
	DLL DLL_RX_DELAY_CTRL_SL=9(4)		2.490	2.900	3.220	ns
RGMII Shift TX Mode Delays						
	DLL DLL_TX_DELAY_CTRL_SL=1(4) (7)		0.08	0.25	0.38	ns
	DLL DLL_TX_DELAY_CTRL_SL=2(4) (7)		0.27	0.49	0.67	ns
	DLL DLL_TX_DELAY_CTRL_SL=3(4) (7)		0.51	0.73	0.91	ns
	DLL DLL_TX_DELAY_CTRL_SL=4(4) (7)		0.75	0.97	1.15	ns
	DLL DLL_TX_DELAY_CTRL_SL=5(4) (7)		0.94	1.21	1.44	ns
	DLL DLL_TX_DELAY_CTRL_SL=6(4) (7)		1.18	1.45	1.68	ns
	DLL DLL_TX_DELAY_CTRL_SL=7(4) (7)		1.37	1.69	1.98	ns
	DLL DLL_TX_DELAY_CTRL_SL=8(4) (7)		1.61	1.93	2.22	ns
	DLL DLL_TX_DELAY_CTRL_SL=9(4) (7)		1.85	2.17	2.46	ns
	DLL DLL_TX_DELAY_CTRL_SL=10(4) (7)		2.04	2.42	2.75	ns
	DLL DLL_TX_DELAY_CTRL_SL=11(4) (7)		2.28	2.65	2.99	ns
	DLL DLL_TX_DELAY_CTRL_SL=12(4) (7)		2.52	2.9	3.23	ns
25MHz CRYSTAL REQUIREMENTS						
	Frequency			25		MHz
	Frequency Tolerance and Stability Over temperature and aging		–100		100	ppm
	Equivalent Series Resistance				100	Ω
OUTPUT CLOCK TIMING (CLKOUT)						
	Frequency			25		MHz
	Duty Cycle (With crystal attached)		45		55	%

6.6 Timing Requirements (continued)

(1)

PARAMETER		TEST CONDITIONS	MIN	NOM	MAX	UNIT
	Rise / Fall Time (10% - 90%)				2.5	ns
	Jitter (RMS) (Slave Mode, MAC Iinterface : SGMII)				5	ps
	Jitter (RMS) (Master Mode, MAC Iinterface : SGMII)				2.4	ps
	Jitter (RMS) (Slave Mode, MAC Interface : RGMII)				11	ps
	Jitter (RMS) (Master Mode, MAC Interface : RGMII)				15	ps
Sleep Entry and Wake-Up						
	WAKE LOW to Sleep Entry; INH Transition LOW	Normal Mode, MDI_Energy = FALSE sleep_en = TRUE		64	85	us
	sleep_en = True to Sleep Entry; INH Transition LOW (master mode)	Normal Mode, WAKE = LOW, MDI_Energy = FALSE		5	85	us
	sleep_en = True to Sleep Entry; INH Transition LOW (slave mode)	Normal Mode, WAKE = LOW, MDI_Energy = FALSE			5000	us
	MDI Energy Loss to Sleep Entry; INH Transition LOW	Normal Mode, WAKE = LOW, sleep_en = TRUE			5	ms
	Local Wake-Up Pulse Duration (on Wake pin)	Sleep Mode, WAKE pin	80			µs
	Send-S/Send-T pattern duration for wake up from MDI	Sleep Mode, Slave	1.25			ms
	Local Wake-Up; INH Transition HIGH	Sleep Mode, rising edge of WAKE pin to rising edge of INH			85	us
	Tolerable differential noise level on MDI for PHY to stay in sleep mode	Sleep Mode			200	mV pk-pk
	Link-partner's VOD for valid wake-up (for 5m cable)	Sleep Mode	840			mV pk-pk

(1) Verified by production test or characterization or design.
(2) No supply sequencing constraint across power rails
(3) In case OSC clock is delayed, additional reset is needed post Osc clock stablisation
(4) Refer register[0x0430] for programmability of RX and TX delay codes
(5) PHY provides internal delays on TX_CLK to TX_D[3:0] to add additional skew upto 2ns. Refer to register[0x0430] for programmability
(6) Max rise/fall time of 8ns is supported for duty cycle of 40% to 55%. Max rise/fall time of 6ns is supported for duty cycle of 40% to 60%
(7) Data for 1.8V VDDIO.

6.7 Timing Diagrams

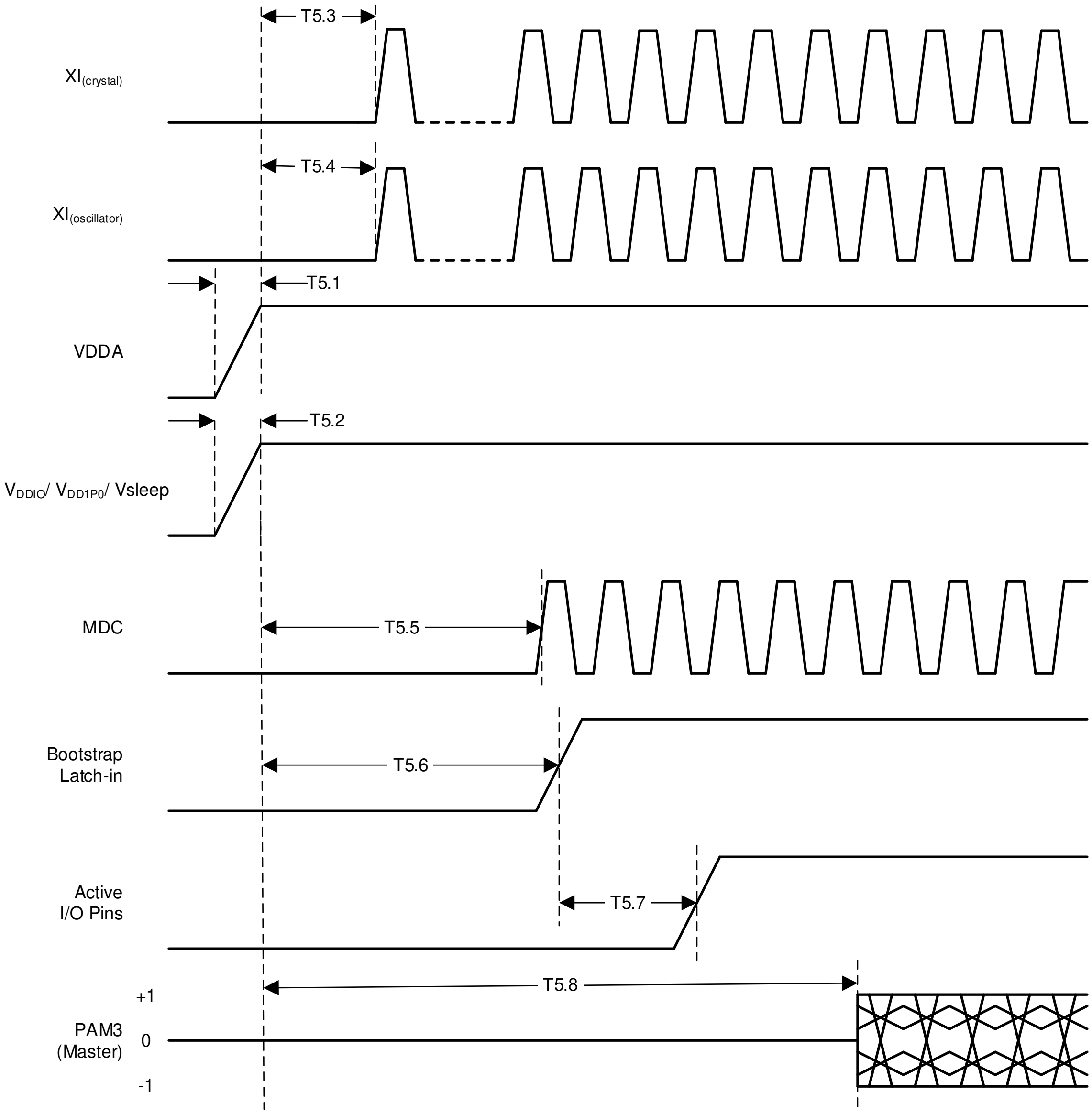

Figure 6-1. Power Up Timing

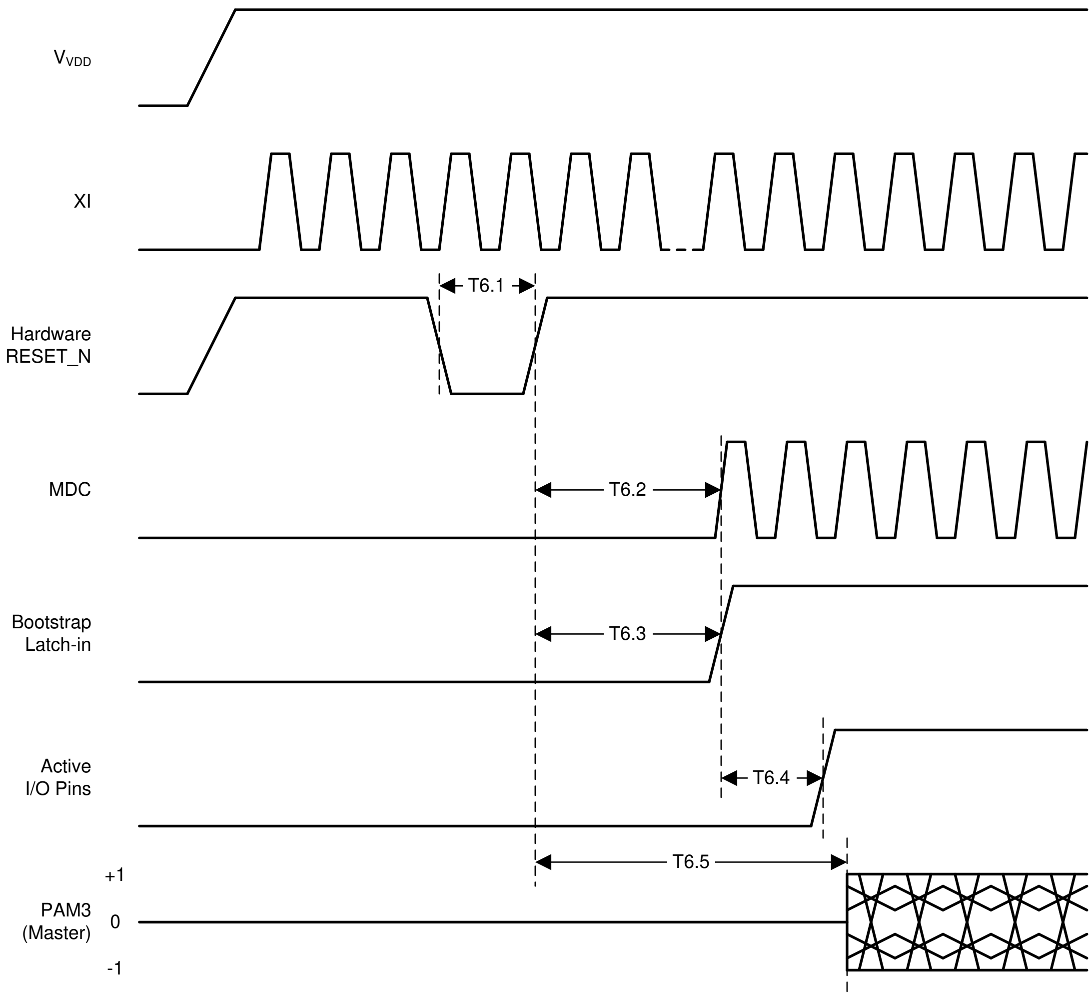

Figure 6-2. Reset Timing

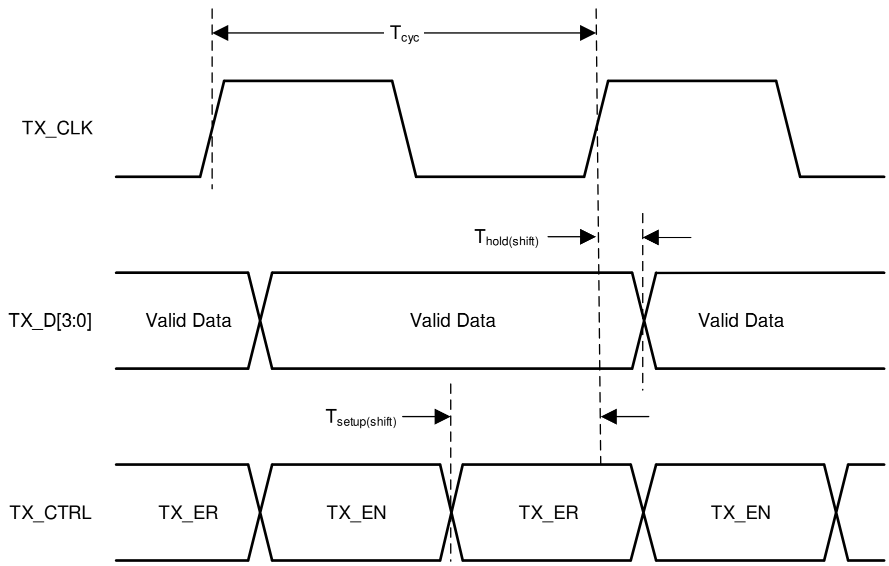

Figure 6-3. RGMII Transmit Timing (Internal Delay Enabled)

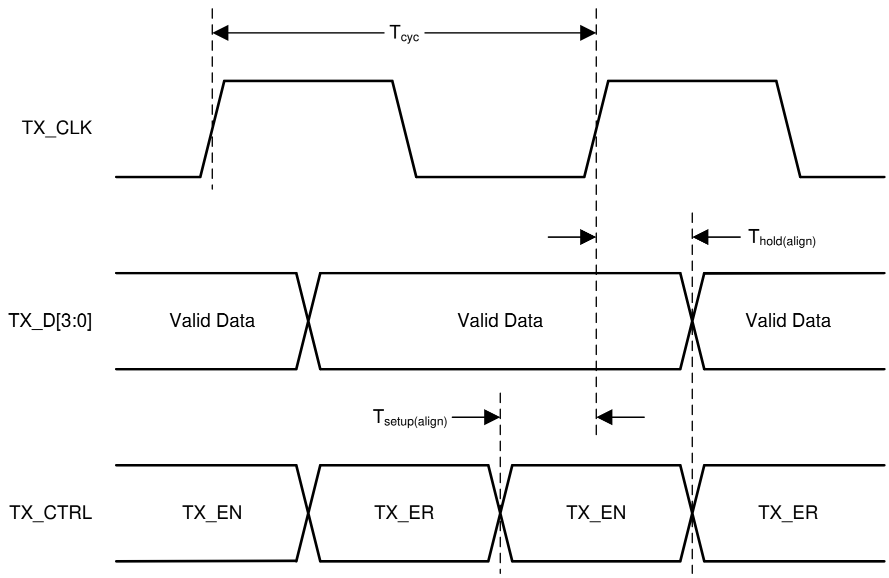

Figure 6-4. RGMII Transmit Timing (Internal Delay Disabled)

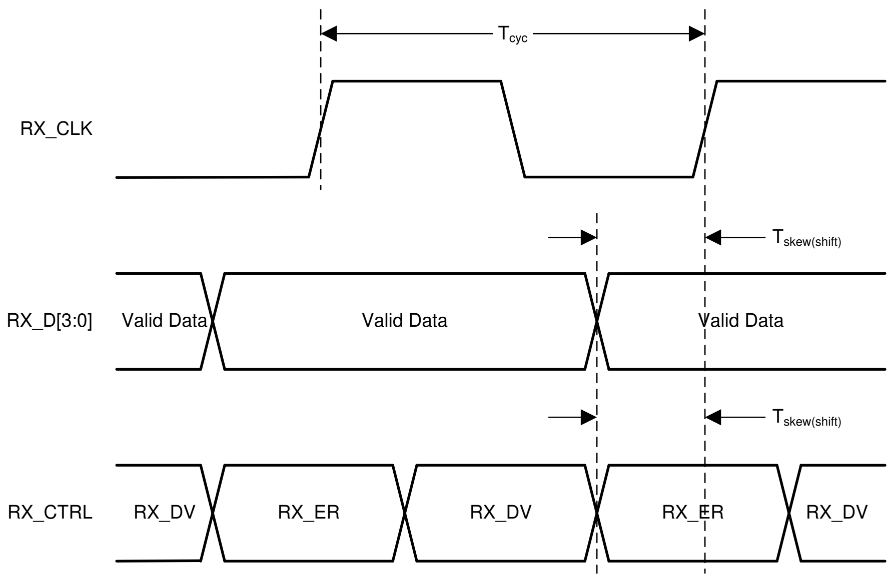

Figure 6-5. RGMII Receive Timing (Internal Delay Enabled)

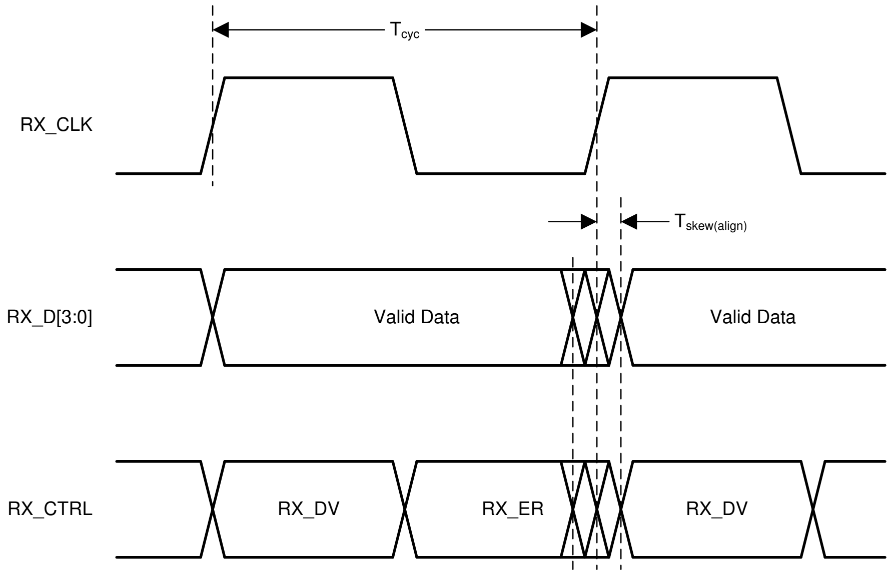

Figure 6-6. RGMII Receive Timing (Internal Delay Disabled)

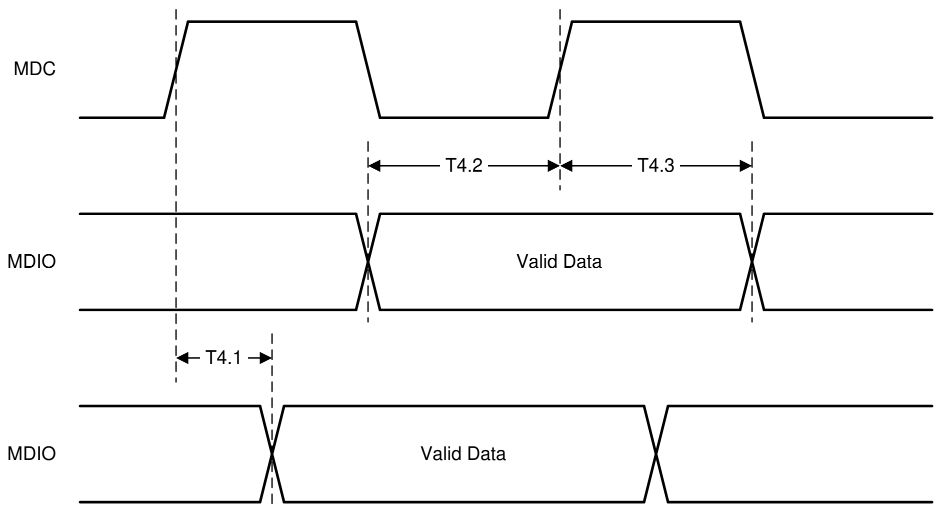

Figure 6-7. Serial Management Timing

6.8 LED Drive Characteristics

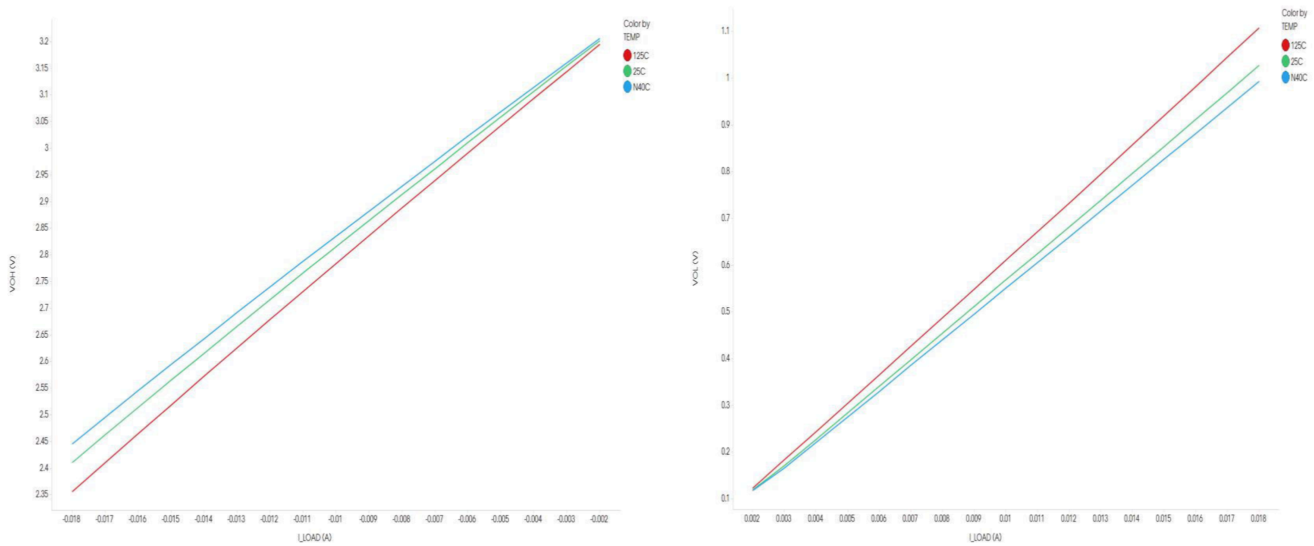

Figure 6-8. LED V vs I for 3.3V VDDIO

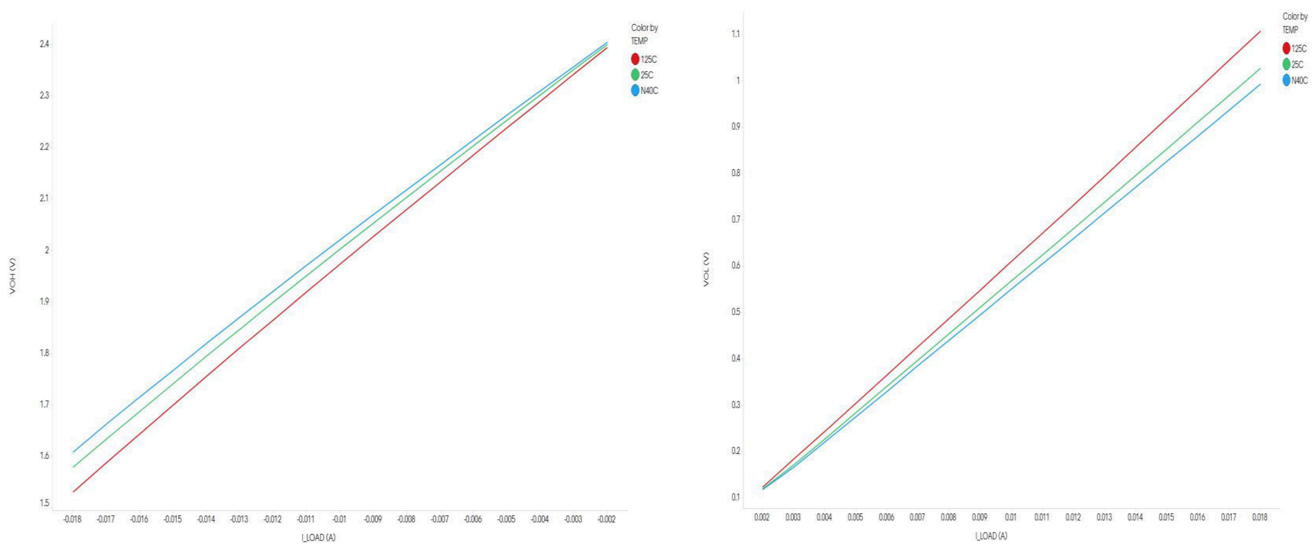

Figure 6-9. LED V vs I for 2.5V VDDIO

7 Detailed Description

7.1 Overview

The DP83TG720R-Q1 is a 1000BASE-T1 automotive Ethernet Physical Layer transceiver. It is IEEE 802.3bp compliant and AEC-Q100 qualified for automotive applications.

This device is specifically designed to operate at 1Gbps speed while meeting stringent automotive EMC requirements. The DP83TG720R-Q1 transmits PAM3 ternary symbols at 750-MBd over unshielded/shielded single-twisted pair cable. It is designed for RGMII support in a single 36-pin VQFN wettable flank package.

7.2 Functional Block Diagram

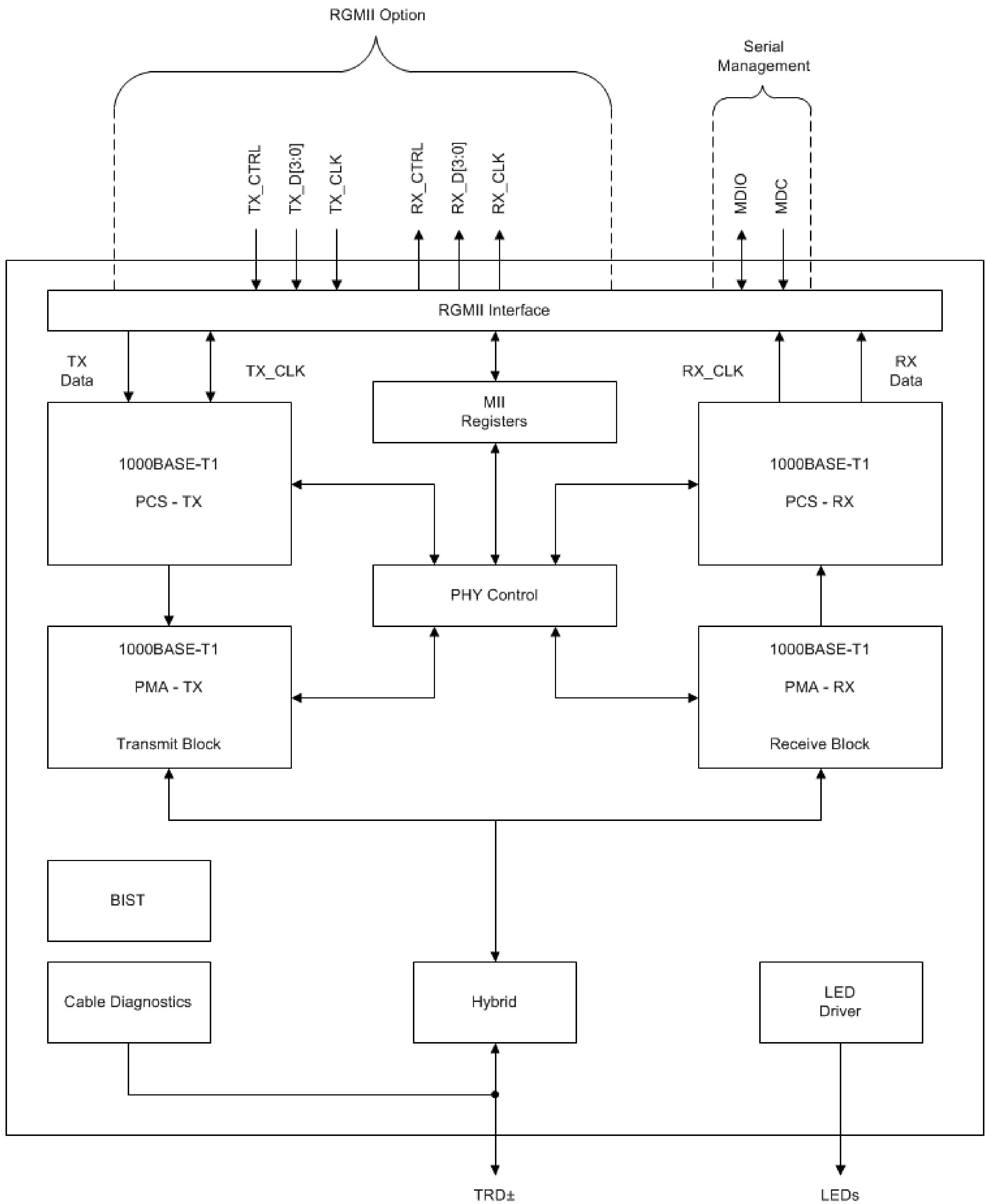

Figure 7-1. DP83TG720R-Q1 Functional Block Diagram

7.3 Feature Description

7.3.1 Diagnostic Tool Kit

The DP83TG720R-Q1 diagnostic tool kit provides mechanisms for monitoring normal operation, device-level debugging, system-level debugging, fault detection, and compliance testing. This tool kit includes a built-in self-test with PRBS data, various loopback modes, Signal Quality Indicator (SQI), Time Domain Reflectometry (TDR), voltage monitor, temperature monitor, electrostatic discharge monitor, and IEEE 802.3bp test modes.

7.3.1.1 Signal Quality Indicator

When the DP83TG720R-Q1 is active, the Signal Quality Indicator can be used to determine the quality of link based on SNR readings made by the device.

SQI is derived based on the calculated SNR value and is presented as 8 level indication, where level of 5 provides a BER better than 10^{-10}.

Note

Refer to *DP83TG720: Configuring for Open Alliance Specification Compliance* application note for details on using SQI register for Open Alliance TC12 SQI tests.

7.3.1.2 Time Domain Reflectometry

Time domain reflectometry helps detecting and estimating the location of OPEN and SHORT faults along a cable.

TDR is activated by setting bit[15] = 'b1 in the register[0x001E]. When TDR diagnostic process gets completed successfully, Bit[1:0] of register[0x001E] becomes 'b10. After this status change, TDR results can be read in the register of following table.

Table 7-1. TDR Result Registers : 0x030F

Register Bits	Description
[1:0]	• 01 = TDR Activation • 10 = TDR On • 00,11 = TDR Not Available
[3:2]	Reserved
[7:4]	• 0011 = Short • 0110 = Open • 0101 = Noise • 0111 = Cable OK • 1000 = Test in progress; initial value with TDR ON • 1101 = Test not possible (for example, noise, active link) • Other values are not valid
[13:8]	• Fault distance = Value in decimal of [13:8] • 'b111111 = Resolution not possible/out of distance
[15:14]	Reserved

Note

TDR must not be run if the link is already active. Running TDR on active line can make TDR fail and also can result in disruption of link.

Refer to *DP83TG720: Configuring for Open Alliance Specification Compliance* application note for detailed procedure of running TDR.

7.3.1.3 Built-In Self-Test For Datapath

The DP83TG720R-Q1 incorporates a data-path's Built-In-Self-Test (BIST) to check the PHY level and system level data-paths. BIST has following integrated features which make the system level data transfer tests (through-put etc) and diagnostics possible without relying on MAC or external data generator hardware/software.

1. Loopback modes
2. Data generator
   a. Customizable MAC packets generator.
   b. Transmitted packet counter.
   c. PRBS stream generator.
3. Data checker
   a. Received MAC packets error checker.
   b. Received packet counter: Counts total packets received and packets received with errors.
   c. PRBS lock and PRBS error checker.

7.3.1.3.1 Loopback Modes

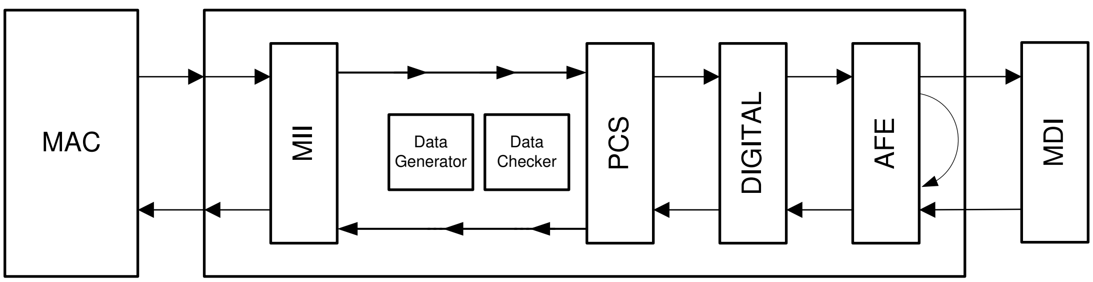

Figure 7-2. All Loopbacks

There are several loopback options within the DP83TG720R-Q1. Enabling different loopback modes enables/ bypass different data-paths according to system verification requirements. Different loopbacks can be enabled along-side following data generation options :

a. Inbuilt data-generator

b. External data-generator (on Ethernet cable or MAC side)

Following diagrams illustrate data-flow during different loopback options :

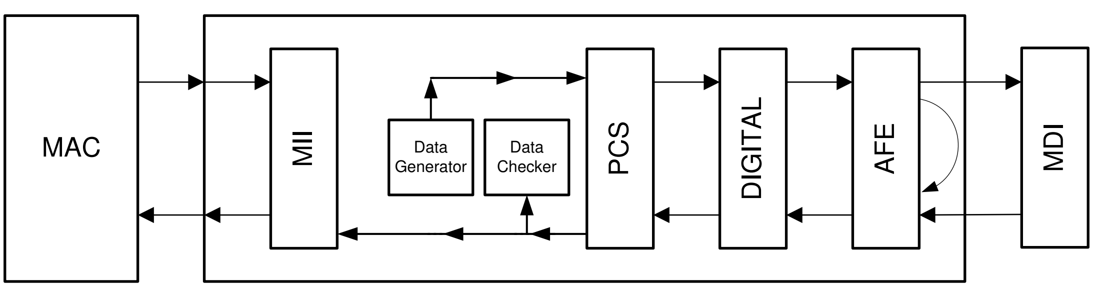

Figure 7-3. Analog Loopback With Inbuilt Data-Gen

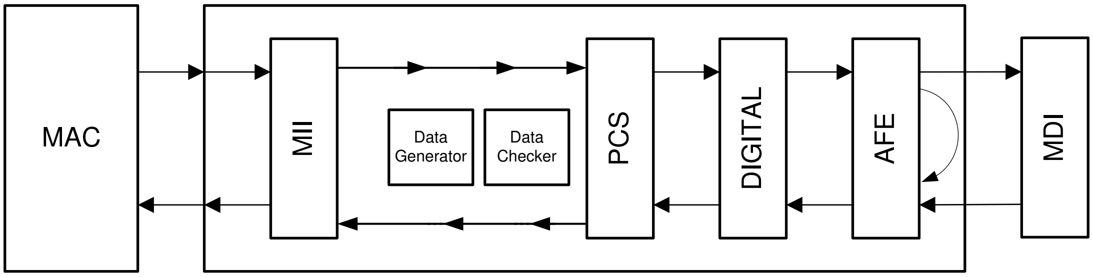

Figure 7-4. Analog Loopback With External Data-Gen

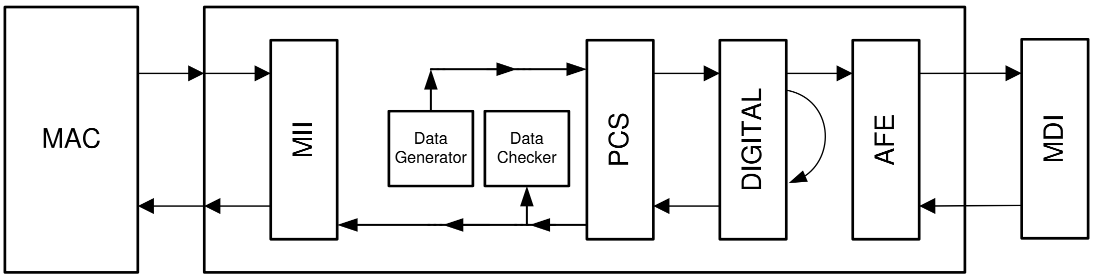

Figure 7-5. Digital Loopback With Inbuilt Data-Gen

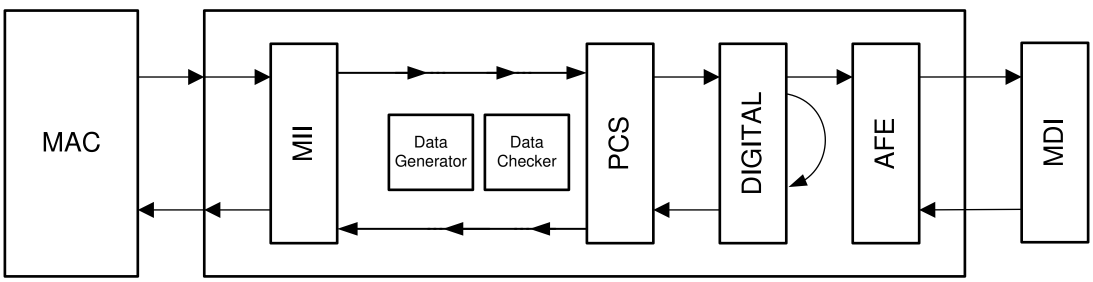

Figure 7-6. Digital Loopback With External Data-Gen

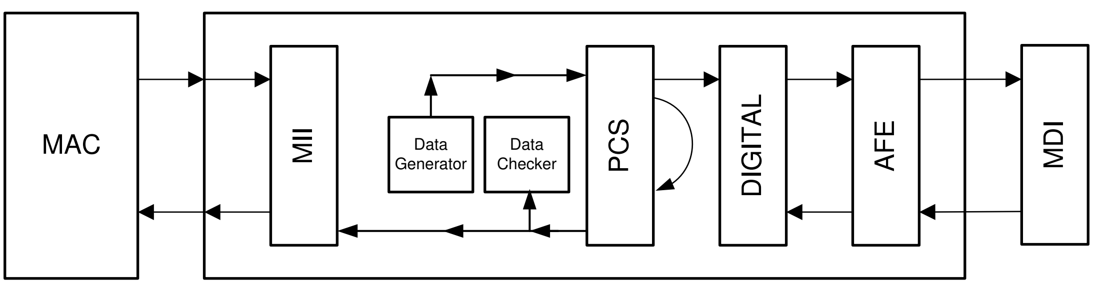

Figure 7-7. PCS Loopback With Inbuilt Data-Gen

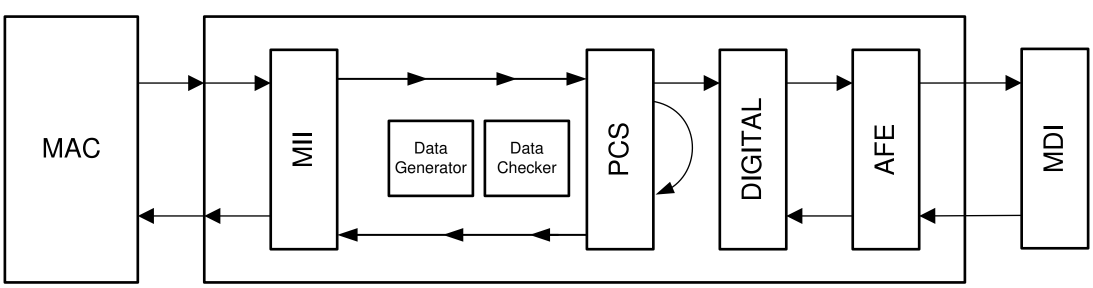

Figure 7-8. PCS Loopback With External Data-Gen

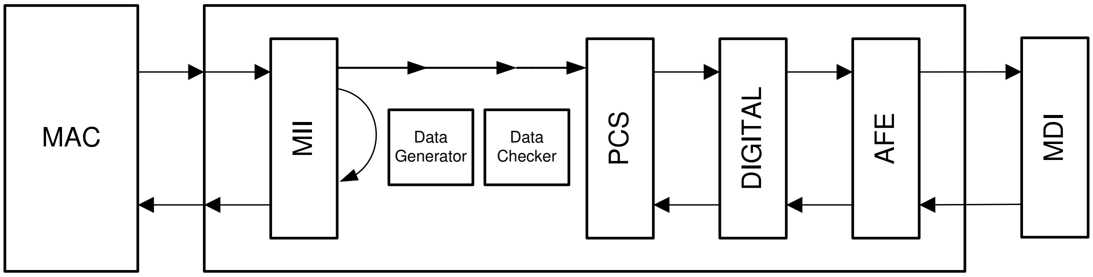

Figure 7-9. xMII Loopback With External Data-Gen

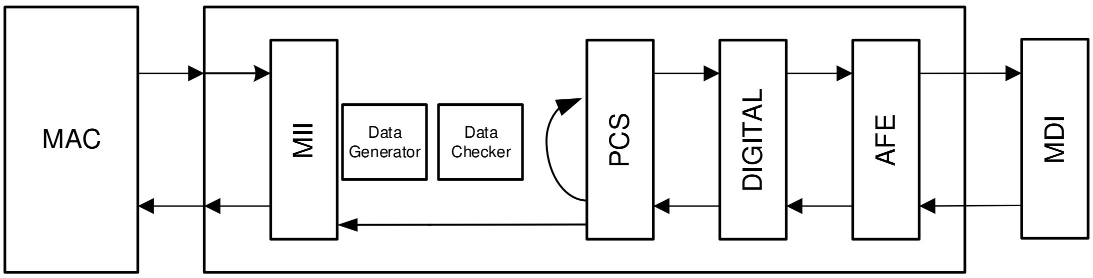

Figure 7-10. xMII Reverse Loopback With External Data-Gen

7.3.1.3.2 Data Generator

Data generator can be programmed to generate either user defined MAC packets or PRBS stream.

Following parameters of generated MAC packets can be configured (refer to registers<0x061B>,register<0x061A> and register<0x0624> for required configuration):

- Packet Length
- Inter-packet gap
- Defined number of packets to be sent or continuous transmission
- Packet data-type: Incremental/Fixed/PRBS
- Number of valid bytes per packet

7.3.1.3.3 Programming Datapath BIST

The following register settings enable different loopbacks, data generation and data checker procedures.

Table 7-2. Datapath BIST Programming

	Loopback Mode	To enable loopback mode	To enable data generator and checker: MAC packets	To check in-coming MAC packets status	To enable data generator and checker: PRBS stream	To check in-coming PRBS status: PRBS stream	Other care-abouts
1	Analog loopback	write : reg[0x0016]=0x0108 write : reg[0x0405]=0x2800	write : reg[0x0624]=0x55BF write : reg[0x0619]=0x1555	read : reg[0x063C] for (15:0) of total received packets count. read : reg[0x063D] for (31:16) of total received packets count. read : reg[0x063E] for Packets received with CRC errors	write : reg[0x0624]=0x55BF write : reg[0x0619]=0x0557	Step 1: write : reg[0x0620](1) = 1'b1 Step 2 : read : reg[0x0620] (7:0) = Number of error bytes received. read : reg[0x0620] (8) (1 indicates PRBS data is coming in and checker is locked)	Disconnect the cable/link-partner. Generated data will be going to MAC side, to disable MAC side : write : reg[0x0000]=0x0540
2	Digital loopback	write : reg[0x0016] = 0x0104 write : reg[0x0800][11]=1	write : reg[0x0624]=0x55BF write : reg[0x0619]=0x1555	read : reg[0x063C] = [15:0] of total received packets count. read : reg[0x063D]= [31:16] of total received packets count. read : reg<0x063E> -> Packets received with CRC errors	write : reg[0x0624]=0x55BF write : reg[0x0619]=0x0557	Step 1 : write : reg[0x0620][1] = 1'b1 Step 2 : read : reg[0x0620] [7:0] = Number of error bytes received. read : reg[0x0620] [8] (1 indicates PRBS data is coming in and checker is locked)	Generated data will be going to Cu cable side, to disable this transmission : write : reg[0x041F] = 0x1000 Generated data will be going to MAC side, to disable MAC side : write : reg[0x0000]=0x0540
3	PCS loopback	write : reg<0x0016> = 0x0101	write : reg[0x0624]=0x55BF write : reg[0x0619]=0x1555	read : reg[0x063C]= [15:0] of total received packets count. read : reg[0x063D]= [31:16] of total received packets count. read : reg[0x063E]= Packets received with CRC errors	write : reg[0x0624]=0x55BF write : reg[0x0619]=0x0557	Step 1 : write : reg[0x0620][1] = 1'b1 Step 2 : read : reg[0x0620] [7:0] = Number of error bytes received. read : reg[0x0620] [8] (1 indicates PRBS data is coming in and checker is locked)	Generated data will be going to Cu cable side, to disable this transmission : write : reg[0x041F] = 0x1000 Generated data will be going to MAC side, to disable MAC side : write : reg[0x0000]=0x0540

Table 7-2. Datapath BIST Programming (continued)

	Loopback Mode	To enable loopback mode	To enable data generator and checker: MAC packets	To check in-coming MAC packets status	To enable data generator and checker: PRBS stream	To check in-coming PRBS status: PRBS stream	Other care-abouts
4	RGMII loopback	write : reg<0x0000> = 0x4140	Data is generated externally at Rgmii TX pins Write : reg[0x0619]= 0x1004	Data can be verified at Rgmii RX pins. Packet errors can additionaly be checked internally by : read : reg[0x063C]= [15:0] of total received packets count. read : reg[0x063D] = [31:16] of total received packets count. read : reg[0x063E]= Packets received with CRC errors	Data is generated externally at Rgmii Tx pins.	Not applicable as data is external. PRBS stream checker works only with internal data generator.	Generated data will be going to Cu cable side, to disable this transmission : write : reg[0x041F] = 0x1000
5	SGMII loopback	write : reg[0x0000] = 0x4140	Data is generated externally at Sgmii TX pins Write : reg[0x0619] = 0x1114	Data can be verified at Sgmii RX pins. Packet errors can additionaly be checked internally by : read : reg[0x063C]= [15:0] of total received packets count. read : reg[0x063D] = [31:16] of total received packets count. read : reg[0x063E] = Packets received with CRC errors	Data is generated externally at Sgmii Tx pins.	Not applicable as data is external. PRBS stream checker works only with internal data generator.	Generated data will be going to Cu cable side, to disable this transmission : write : reg[0x041F] = 0x1000
6	RGMII Reverse loopback	write : reg[0x0016] = 0x0010	write : reg[0x0624]=0x55BF write : reg[0x0619]=0x1555	read : reg[0x063C] = [15:0] of total received packets count. read : reg[0x063D] = [31:16] of total received packets count. read : reg[0x063E] = Packets received with CRC errors	write : reg[0x0624]=0x55BF write : reg[0x0619]=0x0557	Step 1 : write : reg[0x0620][1] = 1'b1 Step 2 : read : reg[0x0620] [7:0] = Number of error bytes received. read : reg[0x0620] [8] (1 indicates PRBS data is coming in and checker is locked)	Generated data will be going to Cu cable side, to disable this transmission : write : reg[0x041F] = 0x1000

Table 7-2. Datapath BIST Programming (continued)

	Loopback Mode	To enable loopback mode	To enable data generator and checker: MAC packets	To check in-coming MAC packets status	To enable data generator and checker: PRBS stream	To check in-coming PRBS status: PRBS stream	Other care-abouts
7	SGMII Reverse loopback	write : reg[0x042C] = 0x0010	write : reg[0x0624]=0x55BF write : reg[0x0619]=0x1555	read : reg[0x063C] for [15:0] of total received packets count. read : reg[0x063D] for [31:16] of total received packets count. read : reg[0x063E] for Packets received with CRC errors	write : reg[0x0624]=0x55BF write : reg[0x0619]=0x0557	Step 1 : write : reg[0x0620][1] = 1'b1 Step 2 : read : reg[0x0620] [7:0] for Number of error bytes received. read : reg[0x0620] [8] (1 indicates PRBS data is coming in and checker is locked)	Generated data will be going to Cu cable side, to disable this transmission : write : reg[0x041F] = 0x1000

Note

Different MAC packet parameters can be further configured with register[0x061B] and register[0x0624]

7.3.1.4 Temperature and Voltage Sensing

Temperature sensor of PHY can be used to give the indication of the temperature of the system and reading can be taken on the fly by reading the temperature sensor output register.

Voltage sensor senses the voltage of all the supply pins: vdda, vddio and vdd1p0. Each pins active voltage can be sensed by reading the corresponding voltage sensor output register.

All sensors are always active and monitor state machine polls the value of each sensor periodically. Monitor state machine can be further programmed to give higher priority/sampling time to one sensor over another by using MONITOR_CTRL_3 register.

Following software sequence can be used to read out any sensor's output:

- Step1 : Program register[0x0467] = 0x6004 ; Initial configuration of monitors
- Step 2 : Program register [0x046A] = 0x00A6 and then register [0x046A]=0x00A3; Refresh the monitors
- Step 3 : Program register[0x0468] to select the corresponding sensor to be polled and read register [0x047B][14:7] for selected sensor's output code.
- Step 4 : Feed the values of read sensor's output code (in decimal) in following equations to get the sensor's output value in decimals. Refer to Sensor Select Table for required value of constants to be used in equations :
  – vdda_value = 3.3 + (vdda_output_code - vdda_output_mean_code)*slope_vdda_sensor
  – vdd1p0_value = 1.0 + (vdd1p0_output_code - vdd1p0_ouput_mean_code)*slope_vdd1p0_sensor
  – vddio_calculated = 3.3 + (vddio_ouput_code - vddio_output_mean_code)*slope_vddio_sensor
  – temperature_calculated = 25 + (temperature_output_code - temperature_output_mean_code)*slope_temperature_sensor

Table 7-3. Sensor Select Table

Register[0x0468]	Sensor Selected To Read-out
0x1920	VDDA Voltage Sensor
0x2920	VDD1P0 Voltage Sensor
0x3920	VDDIO Voltage Sensor
0x4920	Temperature Sensor

Table 7-4. Sensor's Constant Values

Constant	Value (in decimal)
vdda_output_mean_code	128
slope_vdda3p3_sensor	8.63014e-3
vdd1p0_output_mean_code	93
slope_vdd1p0_sensor	2.85714e-3
vddio_output_mean_code	224
slope_vddio_sensor	15.686e-3
temperature_output_mean_code	161
slope_temperature_sensor	1

Note

Accuracy of temperature sensor can be maximized (7.5degreeC), if customer can sample "temperature_output_code" at 25C and use it as "temperature_output_mean_code".

7.3.1.5 Electrostatic Discharge Sensing

Electrostatic discharge is a serious issue for electronic circuits and if not properly mitigated can create short-term issues (signal integrity, link drops, packet loss) as well as long-term reliability faults. The DP83TG720R-Q1 has robust integrated ESD circuitry and offers an ESD sensing architecture. ESD events can be detected on MDI pins for further analysis and debug.

The ESD sensing tool is useful for both prototyping and end-applications. Additionally, the DP83TG720R-Q1 provides an interrupt status flag; when an ESD event is logged in the register<0x0442>. Hardware and software resets are ignored by the ESDS register to prevent unwarranted clearing.

Table 7-5. ESD Sensing : Interrupt Setting and Count Reading

Function	Required Read/Write
Interrupt Enable	• Write register<0x0012>[3] = 1
ESD Event Counter	• Read register<0x0442>[14:9] • Value in decimal indicates the ESD strikes since power-up.

7.3.2 Compliance Test Modes

The six test modes for the DP83TG720R-Q1 are compliant to IEEE 802.3bp, Sub-clause 97.5.2. Supported test modes allow testing of the transmitter waveform Power Spectral Density (PSD) mask, distortion, MDI Master jitter, MDI Slave jitter, droop, transmitter frequency, frequency tolerance, BER monitoring, return loss, and mode conversion. Any of the three GPIOs can be used to output TX_TCLK for MDI Slave jitter measurement.

7.3.2.1 Test Mode 1

Test mode 1 tests the transmitter clock jitter when linked to a partner. In test mode 1, the DP83TG720R-Q1 PHYs are connected over link segment defined in section 97.6 within IEEE 802.3bp. TX_TCLK125 is a divided clock derived from TX_TCLK, which is one sixth the frequency.

7.3.2.2 Test Mode 2

Test mode 2 tests the transmitter MDI Master mode jitter. In test mode 2, the DP83TG720R-Q1 transmits a continuous pattern of three {+1} symbols followed by three {-1} symbols. The transmitted symbols are timed from the 750MHz source, which results in a 125MHz signal.

7.3.2.3 Test Mode 4

Test mode 4 tests the transmitter distortion. In test mode 4, the DP83TG720R-Q1 will transmit the sequence of symbols generated by Equation 1:

$$g(x) = 1 + x^9 + x^{11} \tag{1}$$

The bit sequences, x0n and x1n, are generated from combinations of the scrambler in accordance to and :

$$'x0_n = Scr_n[0] \tag{2}$$

$$x1_n = Scr_n[1] \wedge Scr_n[4] \tag{3}$$

$$x2_n = Scr_n[1] \wedge Scr_n[5] \tag{4}$$

Example streams of the 3-bit nibbles are shown in Table 7-6.

Table 7-6. Transmitter Test Mode 4 Symbol Mapping

x2n	x1n	x0n	T1n	T0n
0	0	0	-1	-1
0	0	1	0	-1
0	1	0	-1	0
0	1	1	-1	+1
1	0	0	+1	0
1	0	1	+1	-1
1	1	0	+1	+1
1	1	1	0	+1

7.3.2.4 Test Mode 5

Test mode 5 tests the transmitter PSD mask. In test mode 5, the DP83TG720R-Q1 will transmit normal Inter-Frame IDLE PAM3 symbols.

7.3.2.5 Test Mode 6

Test mode 6 tests the transmitter droop. In test mode 6, the DP83TG720R-Q1 transmits fifteen {+1} symbols followed by fifteen {-1} symbols with symbol transmission at 750MHz. This 25MHz pattern is repeated continuously until the test mode is disabled.

7.3.2.6 Test Mode 7

Test mode 7 enabled bit error rate measurement on a link segment. This mode uses zero data pattern on the MDI to check BER by comparing an expected zero data pattern to any non-zero bit received. Error checking is performed after FEC and 80B/81B decoding.

Table 7-7. Test Mode Register Setting

MMD	Register	Value	Test Mode
MMD1	0x0904	0x2000	Test Mode 1 : Tx_Tclk 125MHz is routed to clkout pin.
MMD1	0x0904	0x4000	Test Mode 2
MMD1	0x0904	0x8000	Test Mode 4 : Tx_Tclk 125MHz is routed to clkout pin.
MMD1F	0x0453	0x0019	
MMD1	0x0904	0xA000	Test Mode 5
MMD1	0x0904	0xC000	Test Mode 6
MMD1	0x0904	0xE000	Test Mode 7

7.4 Device Functional Modes

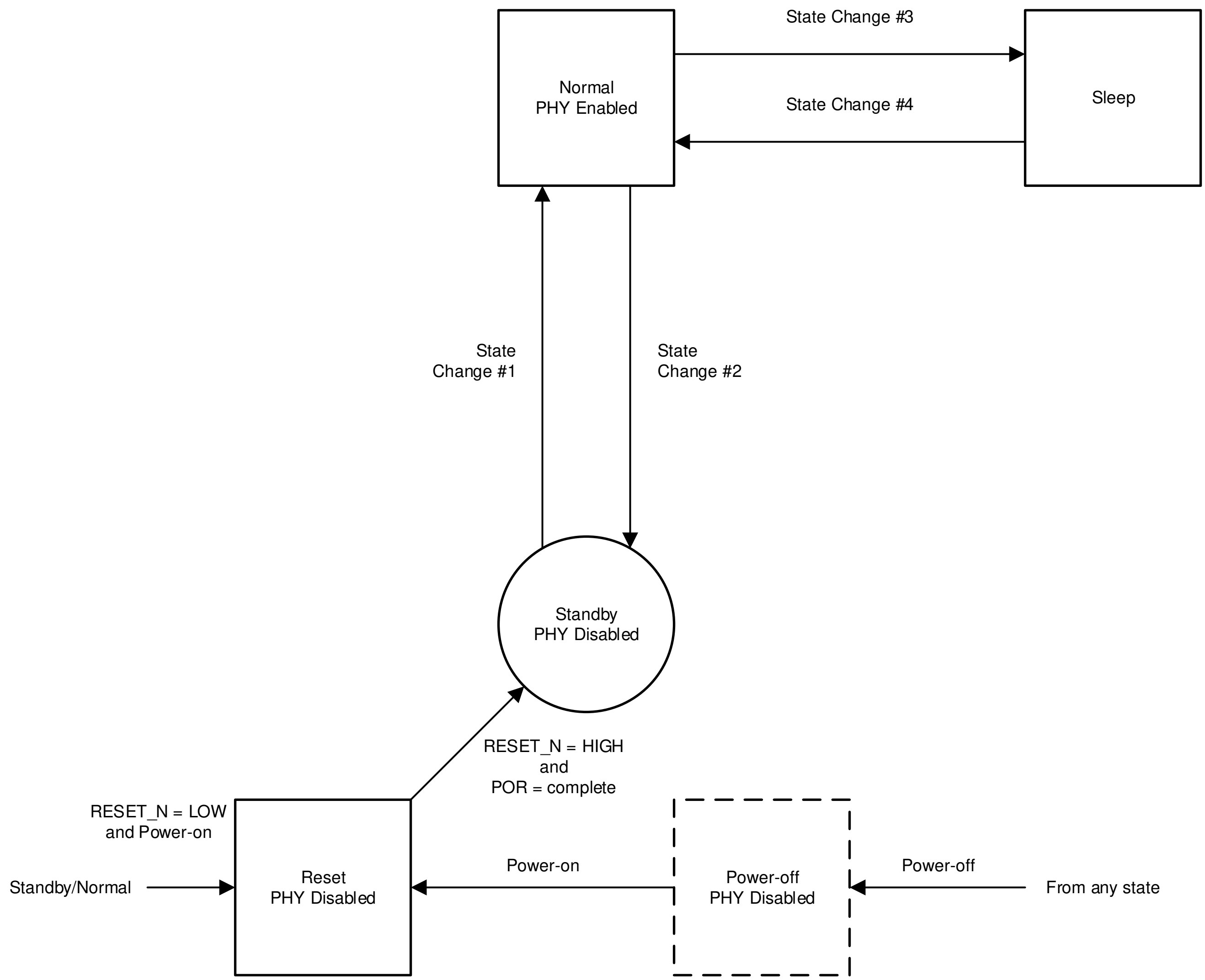

Figure 7-11. PHY Operation State Diagram

7.4.1 Power Down

When VDDA3P3 or VDDIO or VDD1P0 is below the POR threshold, the DP83TG720R-Q1 is in a power-down state. All digital IOs will remain in high impedance state and analog blocks are disabled. PMA termination is not present when in power-down.

7.4.2 Reset

Reset is activated upon power-up, when RESET_N is pulled LOW (for the minimum reset pulse time) or if hardware reset is initiated by setting bit[15] in the register[0x001F].

- Digital state machine restarts after reset and all the register settings are cleared to the boot-up state.
- 25MHz clock on clkout pin will remain active during reset state also.
- MDI/PMA will not have termination during reset state.

Note

Straps are re-latched only with pin reset and not by hardware reset through register (register [0x001F] = x8000.

7.4.3 Standby

The device (MDI Master mode or MDI Slave mode) automatically enters into standby post power-up and reset so long that the device is bootstrapped for managed operation.

In standby, all PHY functions are operational except for PCS and PMA blocks. Link establishment is not possible in standby and data cannot be transmitted or received. SMI functions are operational and register configurations are maintained.

If the device is configured for autonomous operation through bootstrap setting, the PHY automatically switches to normal operation once powered on and reset complete.

7.4.4 Normal

Normal mode can be entered from either autonomous or managed operation. When in autonomous operation, the PHY will automatically try to establish link with a valid Link Partner once powered on.

In managed operation, SMI access is required to allow the device to exit standby; commands issued through the SMI allow the device to exit standby and enables both the PCS and PMA blocks. All device features are operational in normal mode.

Autonomous operation can be enabled through SMI access by setting bit[6] in register 0x18B.

7.4.5 Sleep

Once in sleep mode, all PHY blocks are disabled except for energy detection. All register configurations are lost in sleep mode. No link can be established, data cannot be transmitted or received and SMI access is not available when in sleep mode.

To use sleep mode of PHY refer to implementation highlighted in following figure.

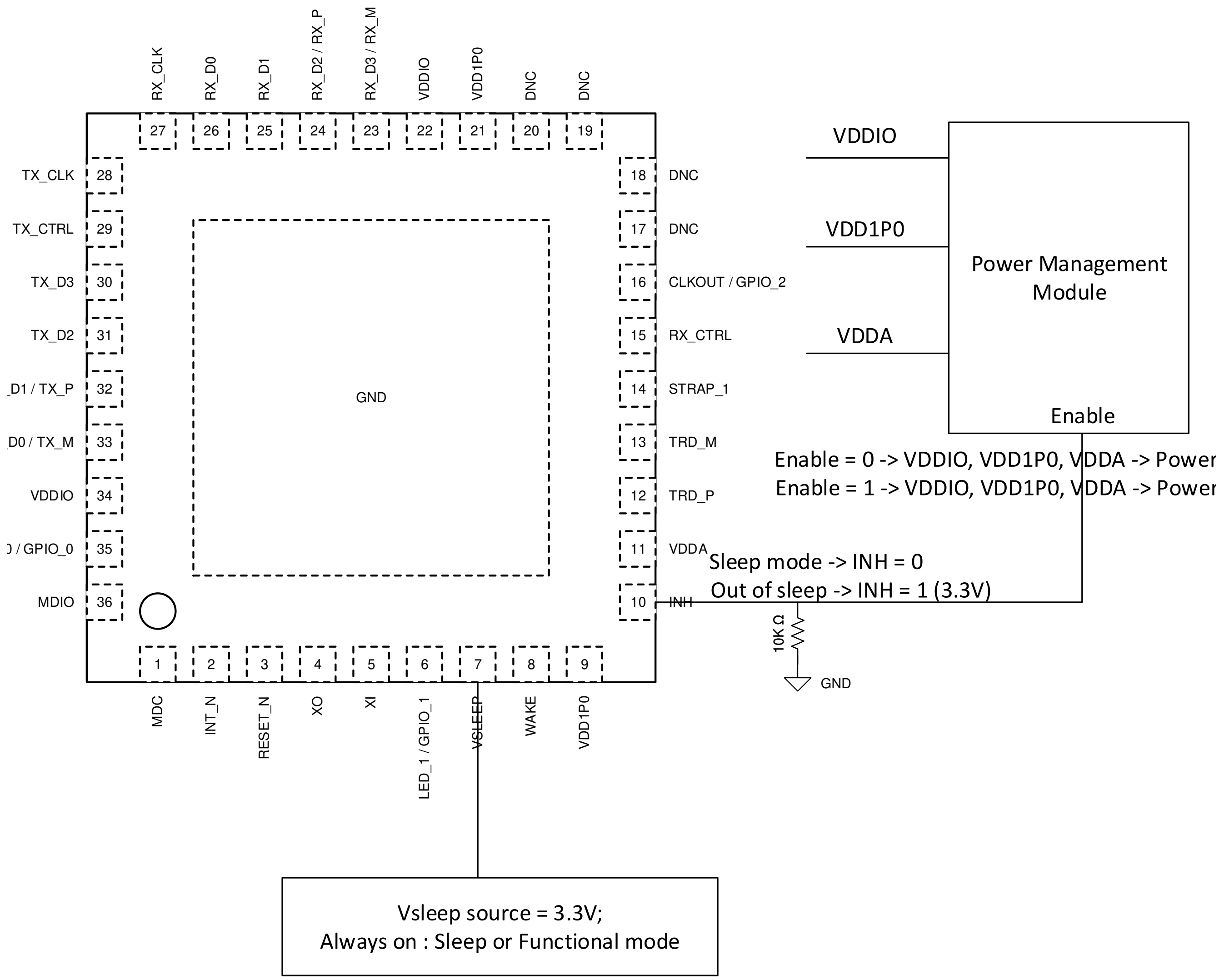

Figure 7-12. Required Implementation for Sleep Mode

Note

Phy does not go into sleep mode if supply sources are not disabled as per above figure.

7.4.6 State Transitions

7.4.6.1 State Transition #1 - Standby to Normal

Autonomous Operation: The PHY will automatically transition to Normal state upon POR completion.

Managed Operation: The PHY will transition to Normal state out of Standby only after writing register <0x018C> = 0x001.

7.4.6.2 State Transition #2 - Normal to Standby

The PHY can be forced back into Standby when in Normal state by writing register <0x018C> = 0x0010.

7.4.6.3 State Transition #3 - Normal to Sleep

Sleep state can be entered either locally (pin/register-write) or by remote link-partner.

Local sleep entry for Master mode phy :

- Step 1 : Write bit[7] = 'b1 of register[0x018B].
- Step 2 : Write reg0x042F = 0x0007, reg0x041E = 0x0100
- Step 3: Make "wake" pin low and hold it low for sleep mode.

Local sleep entry for Slave mode phy :

- Step 1 : Write bit[8] = 'b0 of register[0x018B] register.
- Step 2 : Write bit[7] = 'b1 of register[0x018B] register.
- Step 3 : Write reg0x042F = 0x0007, reg0x041E = 0x0100
- Step 4: Make "wake" pin low and hold it low for sleep mode.

Remote sleep entry for Master mode phy :

- Master can be put to sleep remotely by slave PHY provided the below instructions when the device is already linked-up with the link partner.
- Step 1: Write bit[8] = 'b1 of register [0x018B] register and bit[7] = 'b1 of register[0x018B] register.
- Step 2: Make "wake" pin low
- Step 3: Phy will go into sleep mode with loss of energy on Line

Remote sleep entry for Slave mode phy :

- Step 1 : Write bit[7] = 'b1 of register[0x018B] register.
- Step 2 : Make "wake" pin low.
- Step 3: Phy will go into sleep mode with loss of energy on line (when master will go quite : no data, no send-s).This can be achieved by putting link-partner in managed mode (where device is not allowed to start link-up sequence).

Note

Phy will go into sleep mode only if power supplies are disconnected using INH signal as shown in figure **Required Implementation for Sleep Mode**.

7.4.6.4 State Transition #4 - Sleep to Normal

Sleep state can be exited either locally (pin/register-write) or by remote link-partner.

Local Sleep Exit

Local sleep exit for Master mode PHY by :

- Making "wake" pin high (3.3V).

Local sleep exit for Slave mode PHY by :

- Making "wake" pin high (3.3V).

Remote Sleep Exit

Device can be made to exit the sleep mode by link-partner by either of the following :

1. Remote sleep exit using Send-S symbols from link-partner.
2. Remote sleep exit using Send-T symbols from link-partner

   Details of these procedures are in the following table :

Table 7-8. Remote Sleep Exit Procedures

Method	Device Mode	Procedure	Required Link-partner Cabability
Using Send-S	Master	Step 1 : Start IEEE defined Send-S pattern from link-partner for atleast 1.25ms. Step 2 : Put link-partner in the normal mode to start the link-up. Note : Link-partner with low VOD can limit the remote wake-up upto a maximum of 5m cable.	Link-partner needs to have a mode to send Send-S pattern on demand in Slave mode also. One possible way is : Step 1 : Put link-partner in master mode for atleast 1.25ms. Step 2 : Put link-partner in normal mode to start the link-up
	Slave	Step 1 : Start IEEE defined Send-S pattern from link-partner for atleast 1.25ms. Step 2 : Put link-partner in the normal mode to start the link-up. Note : Link-partner with low VOD can limit the remote wake-up upto a maximum of 5m cable. Note : To keep the slave mode DP83TG720 in sleep mode, link-partner can be put in managed mode (where device is not allowed to start link-up sequence).	Any IEEE compliant link-partner works, as master mode link-partner is supposed to send Send-S signals to start the link-up

Table 7-8. Remote Sleep Exit Procedures (continued)

Method	Device Mode	Procedure	Required Link-partner Cabability
Using Send-T	Master	Step 1 : Enable Send-T pattern on link-partner for atleast 1.25ms. Step 2 : Put link-partner in the normal mode to start the link-up.	Link-partner needs to have a mode to send Send-T pattern on demand. Swing during Send-T mode at pins of link-partner must be greater than 0.92V for remote wake-up over 15m cable. Link-partner with lower VOD can limit the remote wake-up to 5m cable. DP83T720 as link-partner can do the required with following steps : Step 1 : Enable Send-T pattern on DP83TG720 link-partner : write reg[0x0405]=0x7400; reg[0x0509]=0x4007 and reg[0x0576]=0x0500 Step 2 : After 100ms disable send-T pattern on DP83TG720 link-partner : write reg[0x0405]=x5800; reg[0x0509]=0x4005 and reg[0x0576]=0x0000
	Slave	Step 1 : Enable Send-T pattern on link-partner for atleast 1.25ms. Step 2 : Put link-partner in the normal mode to start the link-up.	Link-partner needs to have a mode to send Send-T pattern on demand. Swing during Send-T mode at pins of link-partner must be greater than 0.92V for remote wake-up over 15m cable. Link-partner with lower VOD can limit the remote wake-up to 5m cable. DP83T720 as link-partner can do the required with following steps : Step 1 : Enable Send-T pattern on DP83TG720 link-partner : write reg[0x0405]=0x7400; reg[0x0509]=0x4007 and reg[0x0576]=0x0500 Step 2 : After 100ms disable send-T pattern on DP83TG720 link-partner : write reg[0x0405]=x5800; reg[0x0509]=0x4005 and reg[0x0576]=0x0000

7.4.7 Media Dependent Interface

7.4.7.1 MDI Master and MDI Slave Configuration

MDI Master and MDI Slave are configured using either hardware bootstraps or through register access.

LED_0 controls the MDI Master and MDI Slave bootstrap configuration. By default, MDI Slave mode is configured because there is an internal pulldown resistor on LED_0 pin. If MDI Master mode configuration through hardware bootstrap is preferred, an external pullup resistor is required.

Additionally, bit[14] in the PMA_CTRL2 egister controls the MDI Master and MDI Slave configuration. When this bit is set, MDI Master mode is enabled.

7.4.7.2 Auto-Polarity Detection and Correction

During the link training process, the DP83TG720R-Q1 as MDI receiver is able to detect polarity reversal and automatically correct for the error. Both master and slave detects can do the required correction in the receiver polarity.

Auto-Polarity Correction cannot be disabled on DP83TG720R-Q1

7.4.8 MAC Interfaces

7.4.8.1 Reduced Gigabit Media Independent Interface

The DP83TG720R-Q1 also supports Reduced Gigabit Media Independent Interface (RGMII) as specified by RGMII version 2.0. RGMII is designed to reduce the number of pins required to connect MAC and PHY. To accomplish this goal, the control signals are multiplexed. Both rising and falling edges of the clock are used to sample the control signal pin on transmit and receive paths. For 1Gbps operation, RX_CLK and TX_CLK operate at 125MHz.

The RGMII signals are summarized in Table 7-9:

Table 7-9. RGMII Signals

FUNCTION	PINS
Data Signals	TX_D[3:0]
	RX_D[3:0]
Control Signals	TX_CTRL
	RX_CTRL
Clock Signals	TX_CLK
	RX_CLK

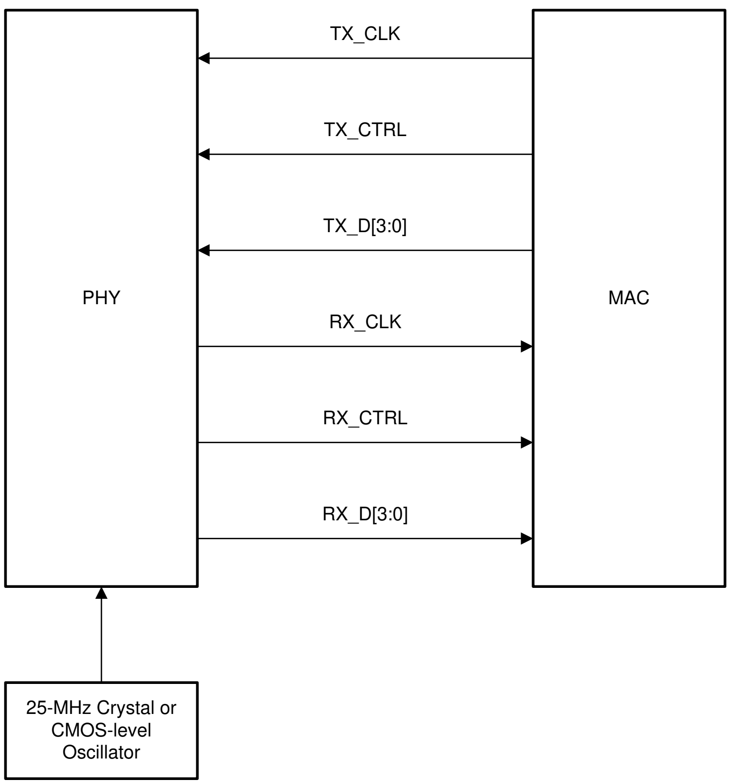

Figure 7-13. RGMII Connections

Table 7-10. RGMII Transmit Encoding

TX_CTRL (POSITIVE EDGE)	TX_CTRL (NEGATIVE EDGE)	TX_D[3:0]	DESCRIPTION
0	0	0000 through 1111	Normal Inter-Frame
0	1	0000 through 1111	Reserved
1	0	0000 through 1111	Normal Data Transmission
1	1	0000 through 1111	Transmit Error Propagation

Table 7-11. RGMII Receive Encoding

RX_CTRL (POSITIVE EDGE)	RX_CTRL (NEGATIVE EDGE)	RX_D[3:0]	DESCRIPTION
0	0	0000 through 1111	Normal Inter-Frame
0	1	0000 through 1101	Reserved
0	1	1110	False Carrier Indication
0	1	1111	Reserved
1	0	0000 through 1111	Normal Data Reception
1	1	0000 through 1111	Data Reception with Errors

The DP83TG720R-Q1 supports in-band status indication to help simplify link status detection. Inter-frame signals on RX_D[3:0] pins as specified in Table 7-12.

Table 7-12. RGMII In-Band Status

RX_CTRL	RX_D3	RX_D[2:1]	RX_D0
0 **Note:** In-band status is only valid when RX_CTRL is low	**Duplex Status:** 0 = Half-Duplex 1 = Full-Duplex	**RX_CLK Clock Speed:** 00 = 2.5MHz 01 = 25MHz 10 = 125MHz 11 = Reserved	**Link Status:** 0 = Link not established 1 = Valid link established

RGMII MAC Interface for Gigabit Ethernet has stringent timing requirements to meet system level performance. To meet these timing requirements and to operate with different MACs over RGMII, the following requirements must be taken into consideration when designing PCB. TI recommends to check board level signal integrity by using the DP83TG720 IBIS model.

RGMII-TX Requirements

- RGMII TX signals routed with controlled impedance of 50Ohm +/-15%.
- Max routing length limited to 5inches for better signal integrity performance.
- Figure 7-14 shows a RGMII interface requirements for TX* signals. MAC RGMII driver output impedance of 50Ohm+/-20%.
- Skew for all RGMII TX signals at TP2, in Figure 7-14, less than ±500ps.
- Signal Integrity at TP1 and TP2, in Figure 7-14, can be verified with IBIS model simulation, that the following requirements are met:
  – At TP2, signal meeting rise/fall time of 1ns (20-80%) of signal amplitude.
  – Rise/fall time is monotonic between VIH/VIL level at TP2.

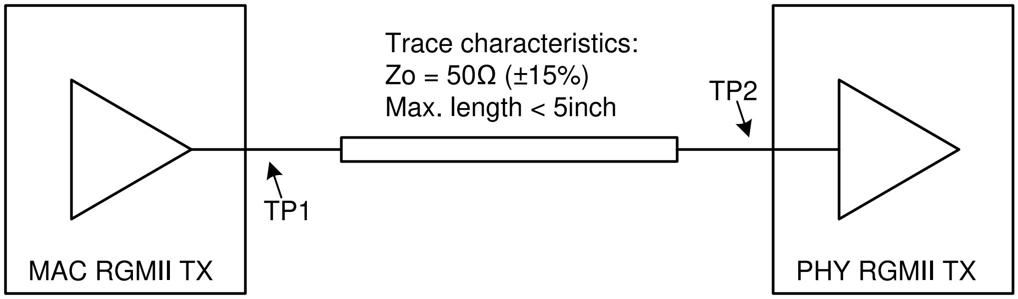

Figure 7-14. RGMII TX Requirements

RGMII-RX Requirements

- RGMII RX signals routed with controlled impedance of 50Ohm +/-15%.
- Max routing length limited to 5inch for better signal integrity performance.
- No damping resistors added at TP3/TP4, in Figure 7-15, as that can impact signal integrity of RX signals.
- Figure 7-15 shows a RGMII interface requirements for RX* signals. MAC RGMII driver output impedance is 50Ohm+/-20%.
- Signal Integrity at TP3 and TP4, in Figure 7-15, can be verified with IBIS model simulation, that the following requirements are met:
  - At TP4, signal meeting rise/fall time of 1ns (20-80%) of signal amplitude.
  - Rise/fall time is monotonic between VIH/VIL level at TP4.

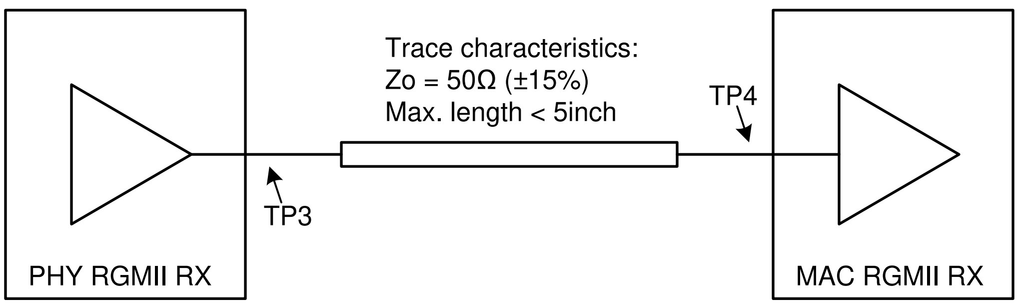

Figure 7-15. RGMII RX Requirements

Note

1. We recommend routing RGMII on buried traces to minimize EMC emissions.
2. Buried traces connected with via placement as close as possible to the PHY and MAC.

7.4.9 Serial Management Interface

The Serial Management Interface provides access to the DP83TG720R-Q1 internal register space for status information and configuration. The SMI is compatible with IEEE 802.3 clause 22. The implemented register set consists of the registers required by the IEEE 802.3 plus several others to provide additional visibility and controllability of the DP83TG720R-Q1.

The SMI includes the management clock (MDC) and the management input and output data pin (MDIO). MDC is sourced by the external management entity, also called Station (STA). MDC is not expected to be continuous, and can be turned off by the external management entity when the bus is idle.

MDIO is sourced by the external management entity and by the PHY. The data on the MDIO pin is latched on the rising edge of the MDC. MDIO pin requires a pullup resistor (2.2kΩ), which pulls MDIO high during IDLE and turnaround.

Up to 9 DP83TG720R-Q1 PHYs can share a common SMI bus. To distinguish between the PHYs, a 3-bit address is used. During power-up-reset, the DP83TG720R-Q1 latches the PHY_AD configuration pins to determine its address.

The management entity must not start an SMI transaction in the first cycle after power-up-reset. To maintain valid operation, the SMI bus must remain inactive at least one MDC cycle after hard reset is deasserted. In normal MDIO transactions, the register address is taken directly from the management-frame reg_addr field, thus allowing direct access to 32 16-bit registers (including those defined in IEEE 802.3 and vendor specific). The data field is used for both reading and writing. The Start code is indicated by a <01> pattern. This pattern makes sure that the MDIO line transitions from the default idle line state. Turnaround is defined as an idle bit time inserted between the Register Address field and the Data field. To avoid contention during a read transaction, no device can actively drive the MDIO signal during the first bit of turnaround. The addressed DP83TG720R-Q1 drives the MDIO with a zero for the second bit of turnaround and follows this with the required data.

For write transactions, the station-management entity writes data to the addressed DP83TG720R-Q1, thus eliminating the requirement for MDIO Turnaround. The turnaround time is filled by the management entity by inserting <10>.

Table 7-13. SMI Protocol Structure

SMI PROTOCOL	<idle> <start> <op code> <device address> <reg address> <turnaround> <data> <idle>
Read Operation	<idle><01><10><AAAAA><RRRRR><Z0><XXXX XXXX XXXX XXXX><idle>
Write Operation	<idle><01><01><AAAAA><RRRRR><10><XXXX XXXX XXXX XXXX><idle>

7.4.9.1 Direct Register Access

Direct register access can be used for the first 31 registers (0x0h through 0x1Fh).

7.4.9.2 Extended Register Space Access

The DP83TG720R-Q1 SMI function supports read and write access to the extended register set using registers REGCR (0x000Dh) and ADDAR (0x000Eh) and the MDIO Manageable Device (MMD) indirect method defined in IEEE 802.3ah Draft for Clause 22 for accessing the Clause 45 extended register set.

Note

Registers with addresses above 0x001F require indirect access. For indirect access, a sequence of register writes must be followed. The MMD value defines the Device Address (DEVAD) of the register set. The DEVAD must be configured in the register 0x000D (REGCR) bits [4:0] for indirect access

The DP83TG720R-Q1 supports 4 MMD device addresses. The 4 MMD register spaces are:

1. MMD1F (Vendor specific registers): DEVAD [4:0] = ‘11111’
2. MMD1 (IEEE 802.3az defined registers): DEVAD [4:0] = ‘00001’

3. MMD3 (IEEE 802.3az defined registers): DEVAD [4:0] = ‘00011’
4. MMD3 (IEEE 802.3az defined registers): DEVAD [4:0] = ‘00111’

Table 7-14. MMD Register Space Division

MMD Register Space	Register Address Range
MMD1F	0x000 - 0x0EFD
MMD1	0x1000 - 0x1904
MMD3	0x3000 - 0x390D
MMD7	0x7000 - 0x7200

Note

For MMD1/3/7, most significant nibble of the register address is used to denote the respective MMD space. This should be ignored during actual register access operation. For example to access register 0x1904 use 0x0904 as the register address and x01 as the MMD.

The following sections describe how to perform operations on the extended register set using register REGCR and ADDAR.

7.4.9.2.1 Write Operation (No Post Increment)

To write a register in the extened register set:

Instruction	Example: Set reg 0x0170 = 0C50
1. Write the value 0x001F (address function field = 00, DEVAD = 31) to register REGCR (0x0D).	Write register 0x0D to value 0x001F
2. Write the desired register address to register ADDAR (0x0E).	Write register 0x0E to value 0x0170
3. Write the value 0x401F (data, no post increment function field = 01, DEVAD = 31) to register REGCR.	Write register 0x0D to value 0x401F
4. Write the content of the desired extended register set register to register ADDAR.	Write register 0x0E to value 0x0C50

Subsequent writes to register ADDAR (step 4) continue to rewrite the register selected by the value in the address register.

Note

Steps (1) and (2) can be skipped if the address register was previously configured.

7.4.9.2.2 Read Operation (No Post Increment)

To read a register in the extended register set:

Instruction	Example: Read 0x0170
1. Write the value 0x001F (address function field = 00, DEVAD = 31) to register REGCR.	Write register 0x0D to value 0x001F
2. Write the desired register address to register ADDAR.	Write register 0x0E to value 0x0170
3. Write the value 0x401F (data, no post increment function field = 01, DEVAD = 31) to register REGCR.	Write register 0x0D to value 0x401F
4. Read the content of the desired extended register set register to register ADDAR.	Read register 0x0E

Subsequent reads from register ADDAR (step 4) continue reading the register selected by the value in the address register.

Note

Steps (1) and (2) can be skipped if the address register was previously configured.

7.4.9.2.3 Write Operation (Post Increment)

To write a register in the extended register set and automatically increment the address register to the next higher value following the write operation:

Instruction	Example: Set reg 0x0170 = 0C50 & reg 0x0171 = 0x0011
1. Write the value 0x001F (address function field = 00, DEVAD = 31) to register REGCR.	Write register 0x0D to value 0x001F
2. Write the register address from register ADDAR.	Write register 0x0E to value 0x0170
3. Write the value 0x801F (data, post increment on reads and writes function field = 10, DEVAD = 31) or the value 0xC01F (data, post increment on writes function field = 11. DEVAD = 31) to register REGCR.	Write register 0x0D to value 0x801F
4. Write the content of the desired extended register set register to register ADDAR.	Write register 0x0E to value 0x0C50
5. Subsequent writes to register ADDAR (step 4) writes the next higher addressed data register selected by the value of the address register; the address register is incremented after each access.	Write register 0x0E to value 0x0011

Step 4 Writes register 0x0170 to 0x0C50 and because post increment is enabled, Step 5 writes register 0x0171 to 0x0011.

7.4.9.2.4 Read Operation (Post Increment)

To read a register in the extended register set and automatically increment the address register to the next higher value following the read operation:

Instruction	Example: Read register 0x0170 & 0x0171
1. Write the value 0x001F (address function field = 00, DEVAD = 31) to register REGCR.	Write register 0x0D to value 0x001F
2. Write the desired register address to register ADDAR.	Write register 0x0E to value 0x0170
3. Write the value 0x801F (data, post increment on reads and writes function field = 10, DEVAD = 31) to register REGCR.	Write register 0x0D to value 0x801F
4. Read the content of the desired extended register set register to register ADDAR.	Read register 0x0E
5. Subsequent reads to register ADDAR (step 4) reads the next higher addressed data register selected by the value of the address register; the address register is incremented after each access.	Read register 0x0E

Step 4 Reads register 0x0170 and because post increment is enabled, Step 5 reads register 0x0171.

7.5 Programming

7.5.1 Strap Configuration

The DP83TG720R-Q1 uses functional pins as strap options to place the device into specific modes of operation. The values of these pins are sampled at power up and hardware reset (through either the RESET_N pin or register access). The strap pins support 2-levels and 3-levels, which are described in greater detail below. Configuration of the device is done through strapping or through serial management interface.

Note

- Strap pins are functional pins after reset is deasserted and must not be connected directly to VCC or GND.
- Pull up strap resistors are sufficient to enter different strap modes.
- Pull down strap resistor can have application for LED pin straps. Refer to LED Configuration section.

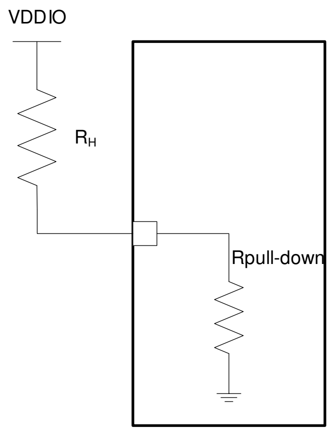

Figure 7-16. Strap Circuit

Table 7-15. Recommended 3-level Strap Resistor Ratios

MODE	Recommended RH (kΩ) [1] for VDDIO = 3.3V	Recommended RH (kΩ) [2] for VDDIO = 2.5V	Recommended RH (kΩ) [1] for VDDIO = 1.8V
1	OPEN	OPEN	OPEN
2	13	12	4
3	4.5	2	0.8

1. 10% resistor accuracy
2. 1% resistor accuracy

Table 7-16. Recommended 2-level Strap Resistor

MODE	Recommended RH (kΩ) [1 2]
1	OPEN
2	2.49

1. 10% resistor accuracy
2. To gain more margin in customer application for 1.8V VDDIO, either 2.1K+/-10% pull-up can be used or resistor accuracy of 2.49K resistor can be limited to 1%.

The following table describes the DP83TG720R-Q1 configuration bootstraps:

Table 7-17. 2-level Bootstraps

PIN NAME	PIN NO.	STRAP MODE	STRAP FUNCTION	DESCRIPTION
RX_D0	26	1 (default)	MAC[0] = 0	MAC Interface Selection [0]. Refer to Table 7-18 for full description.
		2	MAC[0] = 1	
RX_D1	25	1 (default)	MAC[1] = 0	MAC Interface Selection [1]. Refer to Table 7-18 for full description.
		2	MAC[1] = 1	
RX_D2	24	1 (default)	MAC[2] = 0	MAC Interface Selection [2]. Refer to Table 7-18 for full description.
		2	MAC[2] = 1	
LED_0	35	1 (default)	MS = 0	MDI Master Slave Select. MS = 0 Slave MS = 1 Master
		2	MS = 1	
LED_1	6	1 (default)	$\overline{\text{AUTO}}$ = 0	Autonomous Disable $\overline{\text{AUTO}}$ = 0 Autonomous $\overline{\text{AUTO}}$ = 1 Managed
		2	$\overline{\text{AUTO}}$ = 1	

Table 7-18. MAC Interface Selection Bootstraps

MAC[2]	MAC[1]	MAC[0]	DESCRIPTION
0	0	0	RESERVED
0	0	1	RESERVED
0	1	0	RESERVED
0	1	1	RESERVED
1	0	0	RGMII (Align Mode)
1	0	1	RGMII (TX Shift Mode)
1	1	0	RGMII (TX and RX Shift Mode)
1	1	1	RGMII (RX Shift Mode)

Table 7-19. 3-Level Bootstrap: PHY Address

PHY_AD[3:0]	RX_CTRL STRAP MODE	STRP_1 STRAP MODE	DESCRIPTION
0000	1	1	PHY Address: 0x0000 (0)
0001	-	-	RESERVED
0010	-	-	RESERVED
0011	-	-	RESERVED
0100	2	1	PHY Address: 0x0004 (4)
0101	3	1	PHY Address: 0x0005 (5)
0110	-	-	RESERVED
0111	-	-	RESERVED
1000	1	2	PHY Address: 0x0008 (8)
1001	-	-	RESERVED
1010	1	3	PHY Address: 0x000A (10)
1011	-	-	RESERVED
1100	2	2	PHY Address: 0x000C (12)
1101	3	2	PHY Address: 0x000D (13)
1110	2	3	PHY Address: 0x000E (14)
1111	3	3	PHY Address: 0x000F (15)

7.5.2 LED Configuration

The DP83TG720R-Q1 supports up to three configurable Light Emitting Diode (LED) pins: LED_0, LED_1, and LED_2 (CLKOUT). Several functions can be multiplexed onto the LEDs for different modes of operation. LED operations are selected using registers 0x0450 and 0x0451.

Note

CLKOUT has 25MHz clock output as default. If required, it can be configured to LED2 using register 0x0453.

Because the LED output pins are also used as strap pins, external components required for strapping and the user must consider the LED usage to avoid contention. Specifically, when the LED outputs are used to drive LEDs directly, the active state of each output driver is dependent on the logic level sampled by the corresponding input upon power up or hardware reset.

Figure 7-17 shows the two proper ways of connecting LEDs directly to the DP83TG720R-Q1.

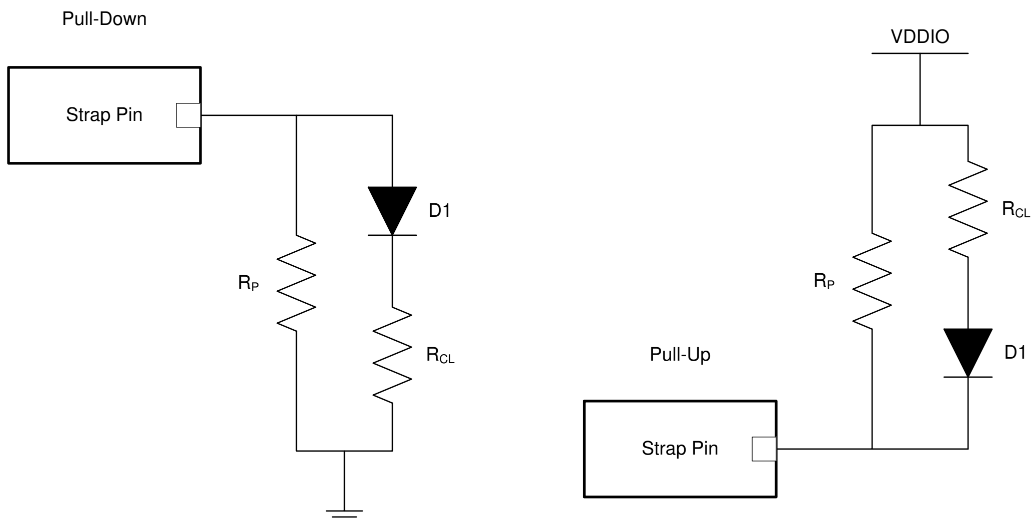

Figure 7-17. Example Strap Connections

7.5.3 PHY Address Configuration

The DP83TG720R-Q1 can be set to respond to any of 9 possible PHY addresses through bootstrap pins. The PHY address is latched into the device upon power-up or hardware reset. Each DP83TG720R-Q1 or port sharing PHY on the serial management bus in the system must have a unique PHY address. The DP83TG720R-Q1 supports PHY address as described in Table 7-19.

By default, the DP83TG720R-Q1 will latch to a PHY address of 0 ([0000]). This address can be changed by adding pullup resistors to bootstrap pins found in Table 7-17.

7.6 Register Maps

7.6.1 Register Access Summary

There are two different methods for accessing registers within the field. Direct register access method is only allowed for the first 31 registers (0x0h through 0x1Fh) of MMD1F register space. Registers beyond 0x1Fh must be accessed by use of the Indirect Method (Extended Register Space) described in *Section 7.4.9.2*.

Table 7-20. MMD Register Space Division

MMD REGISTER SPACE	REGISTER ADDRESS RANGE
MMD1F	0x000 - 0x0EFD
MMD1	0x1000 - 0x1904
MMD3	0x3000 - 0x390D
MMD7	0x7000 - 0x7200

Table 7-21. Register Access Summary

REGISTER FIELD	REGISTER ACCESS METHODS
0x0h through 0x1Fh	Direct Access
	Indirect Access, MMD1F = '11111' **Example:** to read register 0x17h in MMD1F field with no post increment Step 1) write 0x1Fh to register 0xDh Step 2) write 0x17h to register 0xEh Step 3) write 0x401Fh to register 0xDh Step 4) read register 0xEh
MMD1F Field 0x20h - 0xFFFh	Indirect Access, MMD1F = '11111' **Example:** to read register 0x462h in MMD1F field with no post increment Step 1) write 0x1Fh to register 0xDh Step 2) write 0x462h to register 0xEh Step 3) write 0x401Fh to register 0xDh Step 4) read register 0xEh
MMD1 Field 0x0000h - 0x0FFFh	Indirect Access, MMD1 = '00001' **Example:** to read register 0x7h in MMD1 field with no post increment Step 1) write 0x1h to register 0xDh Step 2) write 0x7h to register 0xEh Step 3) write 0x4001h to register 0xDh Step 4) read register 0xEh

7.6.2 DP83TG720 Registers

Table 7-22 lists the memory-mapped registers for the DP83TG720 registers. All register offset addresses not listed in Table 7-22 should be considered as reserved locations and the register contents should not be modified.

Table 7-22. DP83TG720 Registers

Offset	Acronym	Register Name	Section
0h	BMCR		Section 7.6.2.1
1h	BMSR		Section 7.6.2.2
2h	PHYID1		Section 7.6.2.3
3h	PHYID2		Section 7.6.2.4
Dh	REGCR		Section 7.6.2.5
Eh	ADDAR		Section 7.6.2.6
10h	MII_REG_10		Section 7.6.2.7
11h	MII_REG_11		Section 7.6.2.8
12h	MII_REG_12		Section 7.6.2.9
13h	MII_REG_13		Section 7.6.2.10
16h	MII_REG_16		Section 7.6.2.11
18h	MII_REG_18		Section 7.6.2.12
19h	MII_REG_19		Section 7.6.2.13
1Eh	MII_REG_1E		Section 7.6.2.14
1Fh	MII_REG_1F		Section 7.6.2.15
180h	LSR		Section 7.6.2.16
18Bh	LPS_CFG2		Section 7.6.2.17
18Ch	LPS_CFG3		Section 7.6.2.18
18Eh	LPS_STATUS		Section 7.6.2.19
30Fh	TDR_TC12		Section 7.6.2.20
405h	A2D_REG_05		Section 7.6.2.21
41Eh	A2D_REG_30		Section 7.6.2.22
428h	A2D_REG_40		Section 7.6.2.23
429h	A2D_REG_41		Section 7.6.2.24
42Ch	A2D_REG_44		Section 7.6.2.25
42Fh	A2D_REG_47		Section 7.6.2.26
430h	A2D_REG_48		Section 7.6.2.27
442h	A2D_REG_66		Section 7.6.2.28
450h	LEDS_CFG_1		Section 7.6.2.29
451h	LEDS_CFG_2		Section 7.6.2.30
452h	IO_MUX_CFG_1		Section 7.6.2.31
453h	IO_MUX_CFG_2		Section 7.6.2.32
456h	IO_CONTROL_3		Section 7.6.2.33
45Dh	SOR_VECTOR_1		Section 7.6.2.34
45Eh	SOR_VECTOR_2		Section 7.6.2.35
468h	MONITOR_CTRL2		Section 7.6.2.36
46Ah	MONITOR_CTRL4		Section 7.6.2.37
47Bh	MONITOR_STAT1		Section 7.6.2.38
510h	RS_DECODER		Section 7.6.2.39
52Bh	TRAINING_RX_STATUS_7		Section 7.6.2.40
543h	LINK_QUAL_1		Section 7.6.2.41
544h	LINK_QUAL_2		Section 7.6.2.42

Table 7-22. DP83TG720 Registers (continued)

Offset	Acronym	Register Name	Section
545h	LINK_DOWN_LATCH_STAT		Section 7.6.2.43
547h	LINK_QUAL_3		Section 7.6.2.44
548h	LINK_QUAL_4		Section 7.6.2.45
552h	RS_DECODER_FRAME_STAT_2		Section 7.6.2.46
553h	RS_DECODER_FRAME_STAT_3		Section 7.6.2.47
600h	RGMII_CTRL		Section 7.6.2.48
601h	RGMII_FIFO_STATUS		Section 7.6.2.49
602h	RGMII_DELAY_CTRL		Section 7.6.2.50
608h	SGMII_CTRL_1		Section 7.6.2.51
60Ah	SGMII_STATUS		Section 7.6.2.52
60Ch	SGMII_CTRL_2		Section 7.6.2.53
60Dh	SGMII_FIFO_STATUS		Section 7.6.2.54
618h	PRBS_STATUS_1		Section 7.6.2.55
619h	PRBS_CTRL_1		Section 7.6.2.56
61Ah	PRBS_CTRL_2		Section 7.6.2.57
61Bh	PRBS_CTRL_3		Section 7.6.2.58
61Ch	PRBS_STATUS_2		Section 7.6.2.59
61Dh	PRBS_STATUS_3		Section 7.6.2.60
61Eh	PRBS_STATUS_4		Section 7.6.2.61
620h	PRBS_STATUS_6		Section 7.6.2.62
622h	PRBS_STATUS_8		Section 7.6.2.63
623h	PRBS_STATUS_9		Section 7.6.2.64
624h	PRBS_CTRL_4		Section 7.6.2.65
625h	PRBS_CTRL_5		Section 7.6.2.66
626h	PRBS_CTRL_6		Section 7.6.2.67
627h	PRBS_CTRL_7		Section 7.6.2.68
628h	PRBS_CTRL_8		Section 7.6.2.69
629h	PRBS_CTRL_9		Section 7.6.2.70
62Ah	PRBS_CTRL_10		Section 7.6.2.71
638h	CRC_STATUS		Section 7.6.2.72
639h	PKT_STAT_1		Section 7.6.2.73
63Ah	PKT_STAT_2		Section 7.6.2.74
63Bh	PKT_STAT_3		Section 7.6.2.75
63Ch	PKT_STAT_4		Section 7.6.2.76
63Dh	PKT_STAT_5		Section 7.6.2.77
63Eh	PKT_STAT_6		Section 7.6.2.78
871h	SQI_REG_1		Section 7.6.2.79
874h	DSP_REG_74		Section 7.6.2.80
875h	DSP_REG_75		Section 7.6.2.81
1000h	PMA_PMD_CONTROL_1		Section 7.6.2.82
1007h	PMA_PMD_CONTROL_2		Section 7.6.2.83
1009h	PMA_PMD_TRANSMIT_DISABLE		Section 7.6.2.84
100Bh	PMA_PMD_EXTENDED_ABILITY2		Section 7.6.2.85

Table 7-22. DP83TG720 Registers (continued)

Offset	Acronym	Register Name	Section
1012h	PMA_PMD_EXTENDED_ABILITY		Section 7.6.2.86
1834h	PMA_PMD_CONTROL		Section 7.6.2.87
1900h	PMA_CONTROL		Section 7.6.2.88
1901h	PMA_STATUS		Section 7.6.2.89
1902h	TRAINING		Section 7.6.2.90
1903h	LP_TRAINING		Section 7.6.2.91
1904h	TEST_MODE_CONTROL		Section 7.6.2.92
3900h	PCS_CONTROL		Section 7.6.2.93
3901h	PCS_STATUS		Section 7.6.2.94
3902h	PCS_STATUS_2		Section 7.6.2.95
3904h	OAM_TRANSMIT		Section 7.6.2.96
3905h	OAM_TX_MESSAGE_1		Section 7.6.2.97
3906h	OAM_TX_MESSAGE_2		Section 7.6.2.98
3907h	OAM_TX_MESSAGE_3		Section 7.6.2.99
3908h	OAM_TX_MESSAGE_4		Section 7.6.2.100
3909h	OAM_RECEIVE		Section 7.6.2.101
390Ah	OAM_RX_MESSAGE_1		Section 7.6.2.102
390Bh	OAM_RX_MESSAGE_2		Section 7.6.2.103
390Ch	OAM_RX_MESSAGE_3		Section 7.6.2.104
390Dh	OAM_RX_MESSAGE_4		Section 7.6.2.105
7200h	AN_CFG		Section 7.6.2.106

Complex bit access types are encoded to fit into small table cells. Table 7-23 shows the codes that are used for access types in this section.

Table 7-23. DP83TG720 Access Type Codes

Access Type	Code	Description
Read Type		
R	R	Read
Write Type		
W	W	Write
W0C	W 0C	Write 0 to clear
W0S	W 0S	Write 0 to set
WMC	W	Write
WMC,0	W	Write
WMC,1	W	Write
WSC	W	Write
WSC,0	W	Write
Reset or Default Value		
-n		Value after reset or the default value

7.6.2.1 BMCR Register (Offset = 0h) [Reset = 0140h]

BMCR is shown in Figure 7-18 and described in Table 7-24.

Return to the Summary Table.

Figure 7-18. BMCR Register

15	14	13	12	11	10	9	8
mii_reset	loopback	RESERVED	RESERVED	power_down	isolate	RESERVED	RESERVED
R/WMC-0h	R/W-0h	R-0h	R-0h	R/W-0h	R/W-0h	R-0h	R-0h

7	6	5	4	3	2	1	0
RESERVED	speed_sel_msb	RESERVED	RESERVED				
R-0h	R-1h	R-0h	R-0h				

Table 7-24. BMCR Register Field Descriptions

Bit	Field	Type	Reset	Description
15	mii_reset	R/WMC	0h	1b = Digital in reset and all MII regs (0x0 - 0xF) reset to default 0b = No reset
14	loopback	R/W	0h	1b = MII loopback 0b = No MII loopback
13	RESERVED	R	0h	Reserved
12	RESERVED	R	0h	Reserved
11	power_down	R/W	0h	1b = Power down via register or pin 0b = Normal mode
10	isolate	R/W	0h	1b = MAC isolate mode (No output to MAC from the PHY) 0b = Normal Mode
9	RESERVED	R	0h	Reserved
8	RESERVED	R	0h	Reserved
7	RESERVED	R	0h	Reserved
6	speed_sel_msb	R	1h	0b= Reserved 1b= 1000 Mb/s
5	RESERVED	R	0h	Reserved
4-0	RESERVED	R	0h	Reserved

7.6.2.2 BMSR Register (Offset = 1h) [Reset = 0141h]

BMSR is shown in Figure 7-19 and described in Table 7-25.

Return to the Summary Table.

Figure 7-19. BMSR Register

15	14	13	12	11	10	9	8
RESERVED	RESERVED	RESERVED	RESERVED	RESERVED	RESERVED	RESERVED	extended_status
R-0h	R-0h	R-0h	R-0h	R-0h	R-0h	R-0h	R-1h
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
unidirectional_ability	preamble_supression	aneg_complete	remote_fault	aneg_ability	link_status	jabber_detect	extended_capability
R-0h	R-1h	R-0h	R/W0C-0h	R-0h	R/W0S-0h	R/W0C-0h	R-1h

Table 7-25. BMSR Register Field Descriptions

Bit	Field	Type	Reset	Description
15	RESERVED	R	0h	Reserved
14	RESERVED	R	0h	Reserved
13	RESERVED	R	0h	Reserved
12	RESERVED	R	0h	Reserved
11	RESERVED	R	0h	Reserved
10	RESERVED	R	0h	Reserved
9	RESERVED	R	0h	Reserved
8	extended_status	R	1h	1b = Extended status information in Register 15 0b = No extended status information in Register 15
7	unidirectional_ability	R	0h	Reserved
6	preamble_supression	R	1h	1b = PHY accepts management frames with preamble suppressed. 0b = PHY does not accept management frames with preamble suppressed
5	aneg_complete	R	0h	Reserved
4	remote_fault	R/W0C	0h	Reserved
3	aneg_ability	R	0h	Reserved
2	link_status	R/W0S	0h	1b = link is up 0b = link down
1	jabber_detect	R/W0C	0h	Reserved
0	extended_capability	R	1h	1b = extended register capabilities 0b = basic register set capabilities only

7.6.2.3 PHYID1 Register (Offset = 2h) [Reset = 2000h]

PHYID1 is shown in Figure 7-20 and described in Table 7-26.

Return to the Summary Table.

Figure 7-20. PHYID1 Register

15	14	13	12	11	10	9	8
oui_21_16							
R-2000h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
oui_21_16							
R-2000h							

Table 7-26. PHYID1 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	oui_21_16	R	2000h	Unique identifier for the part

7.6.2.4 PHYID2 Register (Offset = 3h) [Reset = A284h]

PHYID2 is shown in Figure 7-21 and described in Table 7-27.

Return to the Summary Table.

Figure 7-21. PHYID2 Register

15	14	13	12	11	10	9	8
oui_5_0						model_number	
R-28h						R-28h	
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
model_number				rev_number			
R-28h				R-4h			

Table 7-27. PHYID2 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-10	oui_5_0	R	28h	Unique identifier for the part
9-4	model_number	R	28h	Unique identifier for the part
3-0	rev_number	R	4h	Unique identifier for the part

7.6.2.5 REGCR Register (Offset = Dh) [Reset = 0000h]

REGCR is shown in Figure 7-22 and described in Table 7-28.

Return to the Summary Table.

Figure 7-22. REGCR Register

15	14	13	12	11	10	9	8
Extended Register Command		RESERVED					
R/W-0h		R-0h					
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED			DEVAD				
R-0h			R/W-0h				

Table 7-28. REGCR Register Field Descriptions

Bit	Field	Type	Reset	Description
15-14	Extended Register Command	R/W	0h	00b = Address 01b = Data, no post increment 10b = Data, post increment on read and write 11b = Data, post increment on write only
13-5	RESERVED	R	0h	Reserved
4-0	DEVAD	R/W	0h	MMD field for indirect register access

7.6.2.6 ADDAR Register (Offset = Eh) [Reset = 0000h]

ADDAR is shown in Figure 7-23 and described in Table 7-29.

Return to the Summary Table.

Figure 7-23. ADDAR Register

15	14	13	12	11	10	9	8
Address/Data							
R/W-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Address/Data							
R/W-0h							

Table 7-29. ADDAR Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	Address/Data	R/W	0h	Address Data field for indirect register access

7.6.2.7 MII_REG_10 Register (Offset = 10h) [Reset = 0004h]

MII_REG_10 is shown in Figure 7-24 and described in Table 7-30.

Return to the Summary Table.

Figure 7-24. MII_REG_10 Register

15	14	13	12	11	10	9	8
RESERVED					RESERVED	descr_lock_bit	RESERVED
R-0h					R-0h	R/W0S-0h	R-0h
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
mii_int_bit	RESERVED			mii_loopback	duplex_mode_env	RESERVED	link_status_bit
R-0h	R-0h			R-0h	R-1h	R-0h	R-0h

Table 7-30. MII_REG_10 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-11	RESERVED	R	0h	Reserved
10	RESERVED	R	0h	Reserved
9	descr_lock_bit	R/W0S	0h	1b = Descrambler is locked 0b = Descrmabler is unlocked atleast once
8	RESERVED	R	0h	Reserved
7	mii_int_bit	R	0h	1b = Interrupt pin had been set 0b = Interrupts pin not set Cleared on Read
6-4	RESERVED	R	0h	Reserved
3	mii_loopback	R	0h	1b = MII loopback 0b = No MII loopback
2	duplex_mode_env	R	1h	1b = Full duplex 0b = Half duplex
1	RESERVED	R	0h	Reserved
0	link_status_bit	R	0h	1b = link is up 0b = link had been down

7.6.2.8 MII_REG_11 Register (Offset = 11h) [Reset = 000Bh]

MII_REG_11 is shown in Figure 7-25 and described in Table 7-31.

Return to the Summary Table.

Figure 7-25. MII_REG_11 Register

15	14	13	12	11	10	9	8
RESERVED	RESERVED	RESERVED		RESERVED	RESERVED	RESERVED	RESERVED
R-0h	R-0h	R-0h		R-0h	R-0h	R-0h	R-0h
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED	RESERVED	RESERVED		int_polarity	force_interrupt	int_en	RESERVED
R-0h	R-0h	R-0h		R/W-1h	R/W-0h	R/W-1h	R-0h

Table 7-31. MII_REG_11 Register Field Descriptions

Bit	Field	Type	Reset	Description
15	RESERVED	R	0h	Reserved
14	RESERVED	R	0h	Reserved
13-12	RESERVED	R	0h	Reserved
11	RESERVED	R	0h	Reserved
10	RESERVED	R	0h	Reserved
9	RESERVED	R	0h	Reserved
8	RESERVED	R	0h	Reserved
7	RESERVED	R	0h	Reserved
6	RESERVED	R	0h	Reserved
5-4	RESERVED	R	0h	Reserved
3	int_polarity	R/W	1h	1b = Active low 0b = Active high
2	force_interrupt	R/W	0h	1b = Force interrupt pin 0b = Do not force interrupt pin
1	int_en	R/W	1h	1b = Enable interrupts 0b = Disable interrupts
0	RESERVED	R	0h	Reserved

7.6.2.9 MII_REG_12 Register (Offset = 12h) [Reset = 0000h]

MII_REG_12 is shown in Figure 7-26 and described in Table 7-32.

Return to the Summary Table.

Figure 7-26. MII_REG_12 Register

15	14	13	12	11	10	9	8
RESERVED	energy_det_int	link_int	RESERVED	esd_int	ms_train_done_int	RESERVED	RESERVED
R-0h	R-0h	R-0h	R-0h	R-0h	R-0h	R-0h	R-0h
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED	energy_det_int_en	link_int_en	RESERVED	esd_int_en	ms_train_done_int_en	RESERVED	RESERVED
R-0h	R/W-0h	R/W-0h	R-0h	R/W-0h	R/W-0h	R-0h	R-0h

Table 7-32. MII_REG_12 Register Field Descriptions

Bit	Field	Type	Reset	Description
15	RESERVED	R	0h	Reserved
14	energy_det_int	R	0h	Energy det change interrupt status
13	link_int	R	0h	Link status change interrupt status
12	RESERVED	R	0h	Reserved
11	esd_int	R	0h	ESD fault detected interrupt status
10	ms_train_done_int	R	0h	Training done interrupt status
9	RESERVED	R	0h	Reserved
8	RESERVED	R	0h	Reserved
7	RESERVED	R	0h	Reserved
6	energy_det_int_en	R/W	0h	Energy det change interrupt enable
5	link_int_en	R/W	0h	Link status change interrupt enable
4	RESERVED	R	0h	Reserved
3	esd_int_en	R/W	0h	ESD fault detected interrupt enable
2	ms_train_done_int_en	R/W	0h	Training done interrupt enable
1	RESERVED	R	0h	Reserved
0	RESERVED	R	0h	Reserved

7.6.2.10 MII_REG_13 Register (Offset = 13h) [Reset = 0000h]

MII_REG_13 is shown in Figure 7-27 and described in Table 7-33.

Return to the Summary Table.

Figure 7-27. MII_REG_13 Register

15	14	13	12	11	10	9	8
under_volt_int	over_volt_int	RESERVED	RESERVED	over_temp_int	RESERVED	pol_change_int	RESERVED
R-0h	R-0h	R-0h	R-0h	R-0h	R-0h	R-0h	R-0h
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
under_volt_int_en	over_volt_int_en	RESERVED	RESERVED	over_temp_int_en	RESERVED	pol_change_int_en	RESERVED
R/W-0h	R/W-0h	R-0h	R-0h	R/W-0h	R-0h	R/W-0h	R-0h

Table 7-33. MII_REG_13 Register Field Descriptions

Bit	Field	Type	Reset	Description
15	under_volt_int	R	0h	Under volt interrupt status
14	over_volt_int	R	0h	Over volt interrupt status
13	RESERVED	R	0h	Reserved
12	RESERVED	R	0h	Reserved
11	over_temp_int	R	0h	Over temp interrupt status
10	RESERVED	R	0h	Reserved
9	pol_change_int	R	0h	Data polarity change interrupt status
8	RESERVED	R	0h	Reserved
7	under_volt_int_en	R/W	0h	Under volt interrupt enable
6	over_volt_int_en	R/W	0h	Over volt interrupt enable
5	RESERVED	R	0h	Reserved
4	RESERVED	R	0h	Reserved
3	over_temp_int_en	R/W	0h	Over temp interrupt enable
2	RESERVED	R	0h	Reserved
1	pol_change_int_en	R/W	0h	Data Polarity change interrupt enable
0	RESERVED	R	0h	Reserved

7.6.2.11 MII_REG_16 Register (Offset = 16h) [Reset = 0000h]

MII_REG_16 is shown in Figure 7-28 and described in Table 7-34.

Return to the Summary Table.

Figure 7-28. MII_REG_16 Register

15	14	13	12	11	10	9	8
RESERVED					RESERVED	RESERVED	core_pwr_mode
R-0h					R-0h	R-0h	R-0h
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED	loopback_mode						
R-0h	R/W-0h						

Table 7-34. MII_REG_16 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-11	RESERVED	R	0h	Reserved
10	RESERVED	R	0h	Reserved
9	RESERVED	R	0h	Reserved
8	core_pwr_mode	R	0h	1b = Core is is normal power mode 0b = Core is in power down or sleep mode
7	RESERVED	R	0h	Reserved
6-0	loopback_mode	R/W	0h	000001b = PCS loop 000010b = RS loop 000100b = Digital loop 001000B = Analog loop 010000b = Reverse loop

7.6.2.12 MII_REG_18 Register (Offset = 18h) [Reset = 0008h]

MII_REG_18 is shown in Figure 7-29 and described in Table 7-35.

Return to the Summary Table.

Figure 7-29. MII_REG_18 Register

15	14	13	12	11	10	9	8
ack_received_int	tx_valid_clr_int	RESERVED	RESERVED	por_done_int	RESERVED	RESERVED	RESERVED
R-0h	R-0h	R-0h	R-0h	R-0h	R-0h	R-0h	R-0h
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
ack_received_int_en	tx_valid_clr_int_en	RESERVED	RESERVED	por_done_int_en	RESERVED	RESERVED	RESERVED
R/W-0h	R/W-0h	R-0h	R-0h	R/W-1h	R-0h	R-0h	R-0h

Table 7-35. MII_REG_18 Register Field Descriptions

Bit	Field	Type	Reset	Description
15	ack_received_int	R	0h	Ack received interrupt status (OAM)
14	tx_valid_clr_int	R	0h	mr_tx_valid clear interrupt status (OAM)
13	RESERVED	R	0h	Reserved
12	RESERVED	R	0h	Reserved
11	por_done_int	R	0h	POR done interrupt status
10	RESERVED	R	0h	Reserved
9	RESERVED	R	0h	Reserved
8	RESERVED	R	0h	Reserved
7	ack_received_int_en	R/W	0h	Ack received interrupt enable (OAM)
6	tx_valid_clr_int_en	R/W	0h	mr_tx_valid clear interrupt enable (OAM)
5	RESERVED	R	0h	Reserved
4	RESERVED	R	0h	Reserved
3	por_done_int_en	R/W	1h	POR done interrupt enable
2	RESERVED	R	0h	Reserved
1	RESERVED	R	0h	Reserved
0	RESERVED	R	0h	Reserved

7.6.2.13 MII_REG_19 Register (Offset = 19h) [Reset = 00XXh]

MII_REG_19 is shown in Figure 7-30 and described in Table 7-36.

Return to the Summary Table.

Figure 7-30. MII_REG_19 Register

15	14	13	12	11	10	9	8
RESERVED					RESERVED	RESERVED	
R-0h					R-0h	R-0h	
7	6	5	4	3	2	1	0
RESERVED			SOR_PHYADDR				
R-0h			R-Xh				

Table 7-36. MII_REG_19 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-11	RESERVED	R	0h	Reserved
10	RESERVED	R	0h	Reserved
9-5	RESERVED	R	0h	Reserved
4-0	SOR_PHYADDR	R	X	PHY ADDRESS latched from strap

7.6.2.14 MII_REG_1E Register (Offset = 1Eh) [Reset = 0000h]

MII_REG_1E is shown in Figure 7-31 and described in Table 7-37.

Return to the Summary Table.

Figure 7-31. MII_REG_1E Register

15	14	13	12	11	10	9	8
tdr_start	cfg_tdr_auto_run	RESERVED					
R/WMC-0h	R/W-0h	R-0h					
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED						tdr_done	tdr_fail
R-0h						R-0h	R-0h

Table 7-37. MII_REG_1E Register Field Descriptions

Bit	Field	Type	Reset	Description
15	tdr_start	R/WMC	0h	1b = TDR start Bit is cleared after TDR run is complete
14	cfg_tdr_auto_run	R/W	0h	1b = TDR start automatically on link down 0b = TDR start manually using 0x1E[15]
13-2	RESERVED	R	0h	Reserved
1	tdr_done	R	0h	TDR done status 1b = TDR done 0b = TDR on-going or not initiated
0	tdr_fail	R	0h	When tdr_done status is 1, this bit inidicates if TDR ran successfully 1b = TDR run failed 0b = TDR ran successfully

7.6.2.15 MII_REG_1F Register (Offset = 1Fh) [Reset = 0000h]

MII_REG_1F is shown in Figure 7-32 and described in Table 7-38.

Return to the Summary Table.

Figure 7-32. MII_REG_1F Register

15	14	13	12	11	10	9	8
sw_global_reset	digital_reset	RESERVED	RESERVED				
R/WMC-0h	R/WMC-0h	R-0h	R-0h				
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED	RESERVED	RESERVED	RESERVED				
R-0h	R-0h	R-0h	R-0h				

Table 7-38. MII_REG_1F Register Field Descriptions

Bit	Field	Type	Reset	Description
15	sw_global_reset	R/WMC	0h	Hardware reset - Reset digital + register file This bit is self clearing
14	digital_reset	R/WMC	0h	Soft reset - Reset only digital core This bit is self clearing
13	RESERVED	R	0h	Reserved
12-8	RESERVED	R	0h	Reserved
7	RESERVED	R	0h	Reserved
6	RESERVED	R	0h	Reserved
5	RESERVED	R	0h	Reserved
4-0	RESERVED	R	0h	Reserved

7.6.2.16 LSR Register (Offset = 180h) [Reset = 0000h]

LSR is shown in Figure 7-33 and described in Table 7-39.

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Figure 7-33. LSR Register

15	14	13	12	11	10	9	8
link_up	link_down	phy_ctrl_send_data	link_status	RESERVED			
R-0h	R-0h	R-0h	R-0h	R-0h			
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED	RESERVED	RESERVED	RESERVED	channel_ok	descr_sync	loc_rcvr_status	rem_rcvr_status
R-0h	R-0h	R-0h	R-0h	R-0h	R-0h	R-0h	R-0h

Table 7-39. LSR Register Field Descriptions

Bit	Field	Type	Reset	Description
15	link_up	R	0h	Link up as defined by CnS
14	link_down	R	0h	Link down as defined by CnS
13	phy_ctrl_send_data	R	0h	Phy control in send data status
12	link_status	R	0h	IEEE defined Live Link status
11-8	RESERVED	R	0h	Reserved
7	RESERVED	R	0h	Reserved
6	RESERVED	R	0h	Reserved
5	RESERVED	R	0h	Reserved
4	RESERVED	R	0h	Reserved
3	channel_ok	R	0h	channel okay status
2	descr_sync	R	0h	Descrambler lock status
1	loc_rcvr_status	R	0h	Local receiver status
0	rem_rcvr_status	R	0h	Remote receiver status

7.6.2.17 LPS_CFG2 Register (Offset = 18Bh) [Reset = 0000h]

LPS_CFG2 is shown in Figure 7-34 and described in Table 7-40.

Return to the Summary Table.

Figure 7-34. LPS_CFG2 Register

15	14	13	12	11	10	9	8
RESERVED							ed_en
R-0h							R/W-0h
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
sleep_en	cfg_auto_mode_en_strap	RESERVED	RESERVED	RESERVED	RESERVED	RESERVED	RESERVED
R/W-0h	R/WMC,1-0h	R-0h	R-0h	R-0h	R-0h	R-0h	R-0h

Table 7-40. LPS_CFG2 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-9	RESERVED	R	0h	Reserved
8	ed_en	R/W	0h	1b = Enable energy detection on MDI 0b = Disable energy detection on MDI
7	sleep_en	R/W	0h	1b = Allow PHY to enter sleep 0b = Do not allow PHY to enter sleep
6	cfg_auto_mode_en_strap	R/WMC,1	0h	LPS autonomous mode enable 1b = PHY enters normal mode on power up 0b = PHY enters standby mode on power up
5	RESERVED	R	0h	Reserved
4	RESERVED	R	0h	Reserved
3	RESERVED	R	0h	Reserved
2	RESERVED	R	0h	Reserved
1	RESERVED	R	0h	Reserved
0	RESERVED	R	0h	Reserved

7.6.2.18 LPS_CFG3 Register (Offset = 18Ch) [Reset = 0000h]

LPS_CFG3 is shown in Figure 7-35 and described in Table 7-41.

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Figure 7-35. LPS_CFG3 Register

15	14	13	12	11	10	9	8
RESERVED							
R-0h							

7	6	5	4	3	2	1	0
RESERVED	RESERVED	RESERVED	cfg_lps_pwr_mode_4	RESERVED	RESERVED	RESERVED	cfg_lps_pwr_mode_0
R-0h	R-0h	R-0h	R/WMC,0-0h	R-0h	R-0h	R-0h	R/WMC,0-0h

Table 7-41. LPS_CFG3 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-8	RESERVED	R	0h	Reserved
7	RESERVED	R	0h	Reserved
6	RESERVED	R	0h	Reserved
5	RESERVED	R	0h	Reserved
4	cfg_lps_pwr_mode_4	R/WMC,0	0h	Set to enter standby mode
3	RESERVED	R	0h	Reserved
2	RESERVED	R	0h	Reserved
1	RESERVED	R	0h	Reserved
0	cfg_lps_pwr_mode_0	R/WMC,0	0h	Set to enter normal mode

7.6.2.19 LPS_STATUS Register (Offset = 18Eh) [Reset = 0000h]

LPS_STATUS is shown in Figure 7-36 and described in Table 7-42.

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Figure 7-36. LPS_STATUS Register

<table>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td></tr>
<tr><td colspan="8">RESERVED</td></tr>
<tr><td colspan="8">R-0h</td></tr>
<tr><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>RESERVED</td><td colspan="7">status_lps_st</td></tr>
<tr><td>R-0h</td><td colspan="7">R-0h</td></tr>
</table>

Table 7-42. LPS_STATUS Register Field Descriptions

Bit	Field	Type	Reset	Description
15-7	RESERVED	R	0h	Reserved
6-0	status_lps_st	R	0h	Observe LPS state : 0x2 = Standby mode 0x4 = Normal mode

7.6.2.20 TDR_TC12 Register (Offset = 30Fh) [Reset = 0000h]

TDR_TC12 is shown in Figure 7-37 and described in Table 7-43.

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Figure 7-37. TDR_TC12 Register

15	14	13	12	11	10	9	8
RESERVED		fault_loc					
R-0h		R-0h					
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
tdr_state				RESERVED		tdr_activation	
R-0h				R-0h		R-0h	

Table 7-43. TDR_TC12 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-14	RESERVED	R	0h	Reserved
13-8	fault_loc	R	0h	See TC12
7-4	tdr_state	R	0h	See TC12
3-2	RESERVED	R	0h	Reserved
1-0	tdr_activation	R	0h	See TC12

7.6.2.21 A2D_REG_05 Register (Offset = 405h) [Reset = 6400h]

A2D_REG_05 is shown in Figure 7-38 and described in Table 7-44.

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Figure 7-38. A2D_REG_05 Register

15	14	13	12	11	10	9	8
ld_bias_1p0v_sl						RESERVED	
R/W-19h						R-0h	
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED							
R-0h							

Table 7-44. A2D_REG_05 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-10	ld_bias_1p0v_sl	R/W	19h	Bits to control the DAC current of LD and hence the swing. 001010b = 400mV 001011b = 440mV 001100b = 480mV 001101b = 520mV 001110b = 560mV 001111b = 600mV 010000b = 640mV 010001b = 680mV 010010b = 720mV 010011b = 760mV 010100b = 800mV 010101b = 840mV 010110b = 880mV 010111b = 920mV 011000b = 960mV 011001b = 1000mV 011010b = 1040mV 011011b = 1080mV 011100b = 1120mV 011101b = 1160mV 011110b = 1200mV
9-0	RESERVED	R	0h	Reserved

7.6.2.22 A2D_REG_30 Register (Offset = 41Eh) [Reset = 0000h]

A2D_REG_30 is shown in Figure 7-39 and described in Table 7-45.

Return to the Summary Table.

Figure 7-39. A2D_REG_30 Register

15	14	13	12	11	10	9	8
RESERVED							spare_in_2_fromdig_sl_force_en
R-0h							R/W-0h
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED	RESERVED	RESERVED	RESERVED	RESERVED			
R-0h	R-0h	R-0h	R-0h	R-0h			

Table 7-45. A2D_REG_30 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-9	RESERVED	R	0h	Reserved
8	spare_in_2_fromdig_sl_force_en	R/W	0h	Force control enable for Reg0x042F
7	RESERVED	R	0h	Reserved
6	RESERVED	R	0h	Reserved
5	RESERVED	R	0h	Reserved
4	RESERVED	R	0h	Reserved
3-0	RESERVED	R	0h	Reserved

7.6.2.23 A2D_REG_40 Register (Offset = 428h) [Reset = 6002h]

A2D_REG_40 is shown in Figure 7-40 and described in Table 7-46.

Return to the Summary Table.

Figure 7-40. A2D_REG_40 Register

15	14	13	12	11	10	9	8
RESERVED	SGMII_TESTMODE		RESERVED	SGMII_SOP_SON_SLEW_CTRL	RESERVED	RESERVED	
R-0h	R/W-3h		R-0h	R/W-0h	R-0h	R-0h	

7	6	5	4	3	2	1	0
RESERVED	RESERVED						RESERVED
R-0h	R-0h						R-0h

Table 7-46. A2D_REG_40 Register Field Descriptions

Bit	Field	Type	Reset	Description
15	RESERVED	R	0h	Reserved
14-13	SGMII_TESTMODE	R/W	3h	00b = 1000mV Sgmii output swing 01b = 1260mV Sgmii output swing 10b = 900mV Sgmii output swing 11b = 720mV Sgmii output swing
12	RESERVED	R	0h	Reserved
11	SGMII_SOP_SON_SLEW_CTRL	R/W	0h	0b =Default output rise/fall time 1b = Slow output rise/fall time
10	RESERVED	R	0h	Reserved
9-8	RESERVED	R	0h	Reserved
7	RESERVED	R	0h	Reserved
6-1	RESERVED	R	0h	Reserved
0	RESERVED	R	0h	Reserved

7.6.2.24 A2D_REG_41 Register (Offset = 429h) [Reset = 0030h]

A2D_REG_41 is shown in Figure 7-41 and described in Table 7-47.

Return to the Summary Table.

Figure 7-41. A2D_REG_41 Register

15	14	13	12	11	10	9	8
RESERVED					RESERVED	RESERVED	RESERVED
R-0h					R-0h	R-0h	R-0h
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED						SGMII_IO_LOOPBACK_EN	RESERVED
R-0h						R/W-0h	R-0h

Table 7-47. A2D_REG_41 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-11	RESERVED	R	0h	Reserved
10	RESERVED	R	0h	Reserved
9	RESERVED	R	0h	Reserved
8	RESERVED	R	0h	Reserved
7-2	RESERVED	R	0h	Reserved
1	SGMII_IO_LOOPBACK_EN	R/W	0h	1b = Connects RX and TX signals internally to provide internal loopback option without external components.
0	RESERVED	R	0h	Reserved

7.6.2.25 A2D_REG_44 Register (Offset = 42Ch) [Reset = 0000h]

A2D_REG_44 is shown in Figure 7-42 and described in Table 7-48.

Return to the Summary Table.

Figure 7-42. A2D_REG_44 Register

15	14	13	12	11	10	9	8
RESERVED	RESERVED	RESERVED	RESERVED	RESERVED	RESERVED	RESERVED	RESERVED
R-0h	R-0h	R-0h	R-0h	R-0h	R-0h	R-0h	R-0h
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED	RESERVED	RESERVED	SGMII_DIG_LOOPBACK_EN	RESERVED			RESERVED
R-0h	R-0h	R-0h	R/W-0h	R-0h			R-0h

Table 7-48. A2D_REG_44 Register Field Descriptions

Bit	Field	Type	Reset	Description
15	RESERVED	R	0h	Reserved
14	RESERVED	R	0h	Reserved
13	RESERVED	R	0h	Reserved
12	RESERVED	R	0h	Reserved
11	RESERVED	R	0h	Reserved
10	RESERVED	R	0h	Reserved
9	RESERVED	R	0h	Reserved
8	RESERVED	R	0h	Reserved
7	RESERVED	R	0h	Reserved
6	RESERVED	R	0h	Reserved
5	RESERVED	R	0h	Reserved
4	SGMII_DIG_LOOPBACK_EN	R/W	0h	1b = Loops back TX data to RX before the IO
3-1	RESERVED	R	0h	Reserved
0	RESERVED	R	0h	Reserved

7.6.2.26 A2D_REG_47 Register (Offset = 42Fh) [Reset = 0000h]

A2D_REG_47 is shown in Figure 7-43 and described in Table 7-49.

Return to the Summary Table.

Figure 7-43. A2D_REG_47 Register

15	14	13	12	11	10	9	8
RESERVED							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED				RESERVED	spare_in_2_fromdig_sl_2	spare_in_2_fromdig_sl_1	spare_in_2_fromdig_sl_0
R-0h				R-0h	R/W-0h	R/W-0h	R/W-0h

Table 7-49. A2D_REG_47 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-4	RESERVED	R	0h	Reserved
3	RESERVED	R	0h	Reserved
2	spare_in_2_fromdig_sl_2	R/W	0h	energy lost indication force control value
1	spare_in_2_fromdig_sl_1	R/W	0h	energy lost detector enable force control value
0	spare_in_2_fromdig_sl_0	R/W	0h	[0] - sleep enable force control value Force control enable is controlled by reg0x041E[8]

7.6.2.27 A2D_REG_48 Register (Offset = 430h) [Reset = 0960h]

A2D_REG_48 is shown in Figure 7-44 and described in Table 7-50.

Return to the Summary Table.

Figure 7-44. A2D_REG_48 Register

15	14	13	12	11	10	9	8
RESERVED	RESERVED	RESERVED	RESERVED	DLL_TX_DELAY_CTRL_SL			
R-0h	R-0h	R-0h	R-0h	R/W-9h			
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
DLL_RX_DELAY_CTRL_SL				RESERVED			
R/W-6h				R-0h			

Table 7-50. A2D_REG_48 Register Field Descriptions

Bit	Field	Type	Reset	Description
15	RESERVED	R	0h	Reserved
14	RESERVED	R	0h	Reserved
13	RESERVED	R	0h	Reserved
12	RESERVED	R	0h	Reserved
11-8	DLL_TX_DELAY_CTRL_SL	R/W	9h	Refer to electrical specification for delay vs code information.
7-4	DLL_RX_DELAY_CTRL_SL	R/W	6h	Refer to electrical specification for delay vs code information.
3-0	RESERVED	R	0h	Reserved

7.6.2.28 A2D_REG_66 Register (Offset = 442h) [Reset = 0000h]

A2D_REG_66 is shown in Figure 7-45 and described in Table 7-51.

Return to the Summary Table.

Figure 7-45. A2D_REG_66 Register

15	14	13	12	11	10	9	8
RESERVED	esd_event_count						RESERVED
R-0h	R-0h						R-0h
7	6	5	4	3	2	1	0
RESERVED			RESERVED	RESERVED			
R-0h			R-0h	R-0h			

Table 7-51. A2D_REG_66 Register Field Descriptions

Bit	Field	Type	Reset	Description
15	RESERVED	R	0h	Reserved
14-9	esd_event_count	R	0h	Number gives the number of esd events on the copper channel
8	RESERVED	R	0h	Reserved
7-5	RESERVED	R	0h	Reserved
4	RESERVED	R	0h	Reserved
3-0	RESERVED	R	0h	Reserved

7.6.2.29 LEDS_CFG_1 Register (Offset = 450h) [Reset = 2610h]

LEDS_CFG_1 is shown in Figure 7-46 and described in Table 7-52.

Return to the Summary Table.

Figure 7-46. LEDS_CFG_1 Register

15	14	13	12	11	10	9	8
RESERVED	leds_bypass_stretching	leds_blink_rate		led_2_option			
R-0h	R/W-0h	R/W-2h		R/W-6h			
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
led_1_option				led_0_option			
R/W-1h				R/W-0h			

Table 7-52. LEDS_CFG_1 Register Field Descriptions

Bit	Field	Type	Reset	Description
15	RESERVED	R	0h	Reserved
14	leds_bypass_stretching	R/W	0h	Bypass LED Signal Stretch
13-12	leds_blink_rate	R/W	2h	Blink Rate for the LED - 00b = 20Hz (50mSec) 01b = 10Hz (100mSec) 10b = 5Hz (200mSec) 11b = 2Hz (500mSec)
11-8	led_2_option	R/W	6h	0000b = link OK 0001b = link OK + blink on TX/RX activity 0010b = link OK + blink on TX activity 0011b = link OK + blink on RX activity 0100b = link OK + 100Base-T1 Master 0101b = link OK + 100Base-T1 Slave 0110b = TX/RX activity with stretch option 0111b = Reserved 1000b = Reserved 1001b = Link lost (remains on until register 0x1 is read) 1010b = PRBS error latch until cleared by 0x620(1) 1011b = XMII TX/RX Error with stretch option
7-4	led_1_option	R/W	1h	0000b = link OK 0001b = link OK + blink on TX/RX activity 0010b = link OK + blink on TX activity 0011b = link OK + blink on RX activity 0100b = link OK + 100Base-T1 Master 0101b = link OK + 100Base-T1 Slave 0110b = TX/RX activity with stretch option 0111b = Reserved 1000b = Reserved 1001b = Link lost (remains on until register 0x1 is read) 1010b = PRBS error (latch until cleared by 0x620(1) 1011b = XMII TX/RX Error with stretch option
3-0	led_0_option	R/W	0h	0000b = link OK 0001b = link OK + blink on TX/RX activity 0010b = link OK + blink on TX activity 0011b = link OK + blink on RX activity 0100b = link OK + 100Base-T1 Master 0101b = link OK + 100Base-T1 Slave 0110b = TX/RX activity with stretch option 0111b = Reserved 1000b = Reserved 1001b = Link lost (remains on until register 0x1 is read) 1010b = PRBS error (latch until cleared by 0x620(1) 1011b = XMII TX/RX Error with stretch option

7.6.2.30 LEDS_CFG_2 Register (Offset = 451h) [Reset = 0000h]

LEDS_CFG_2 is shown in Figure 7-47 and described in Table 7-53.

Return to the Summary Table.

Figure 7-47. LEDS_CFG_2 Register

15	14	13	12	11	10	9	8
RESERVED		RESERVED				XXXX	RESERVED
R-0h		R-0h					R-0h
7	6	5	4	3	2	1	0
RESERVED	RESERVED	RESERVED	RESERVED	led_1_polarity	RESERVED	RESERVED	led_0_polarity
R-0h	R-0h	R-0h	R-0h	R/W-0h	R-0h	R-0h	R/W-0h

Table 7-53. LEDS_CFG_2 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-14	RESERVED	R	0h	Reserved
13-10	RESERVED	R	0h	Reserved
11-9	cfg_ieee_compl_sel	R/W	0h	Observe IEEE Compliance signals in LED_0_GPIO_0, when LED_0_GPIO_CTRL= 'h5 as follows - 000b = loc_rcvr_status 001b = rem_rcvr_status 010b = loc_snr_margin 011b = rem_phy_ready 100b = pma_watchdog_status 101b = link_sync_link_control
8	RESERVED	R	0h	Reserved
7	RESERVED	R	0h	Reserved
6	RESERVED	R	0h	Reserved
5	RESERVED	R	0h	Reserved
4	RESERVED	R	0h	Reserved
3	led_1_polarity	R/W	0h	LED_1 polarity
2	RESERVED	R	0h	Reserved
1	RESERVED	R	0h	Reserved
0	led_0_polarity	R/W	0h	LED_0 polarity

7.6.2.31 IO_MUX_CFG_1 Register (Offset = 452h) [Reset = 0000h]

IO_MUX_CFG_1 is shown in Figure 7-48 and described in Table 7-54.

Return to the Summary Table.

Figure 7-48. IO_MUX_CFG_1 Register

15	14	13	12	11	10	9	8
RESERVED		RESERVED			led_1_gpio_ctrl		
R-0h		R-0h			R/W-0h		
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED		RESERVED			led_0_gpio_ctrl		
R-0h		R-0h			R/W-0h		

Table 7-54. IO_MUX_CFG_1 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-14	RESERVED	R	0h	Reserved
13-11	RESERVED	R	0h	Reserved
10-8	led_1_gpio_ctrl	R/W	0h	Controls the output of LED_1 IO - 000b = LED_1 (default: link OK + blink on TX/RX activity) 001b = Reserved 010b = RGMII data match indication 011b = Under-Voltage indication 100b = Interrupt 101b = IEEE compliance signals 110b = constant 0 111b = constant 1
7-6	RESERVED	R	0h	Reserved
5-3	RESERVED	R	0h	Reserved
2-0	led_0_gpio_ctrl	R/W	0h	Controls the output of LED_0 IO: 000b = LED_0 (default: LINK) 001b = Reserved 010b = RGMII data match indication 011b = Under-Voltage indication 100b = Interrupt 101b = IEEE compliance signals (see 0x451[11:9]) 110b = constant 0 111b = constant 1

7.6.2.32 IO_MUX_CFG_2 Register (Offset = 453h) [Reset = 0001h]

IO_MUX_CFG_2 is shown in Figure 7-49 and described in Table 7-55.

Return to the Summary Table.

Figure 7-49. IO_MUX_CFG_2 Register

15	14	13	12	11	10	9	8
RESERVED							
R-0h							
7	6	5	4	3	2	1	0
RESERVED		clk_o_clk_source			clk_o_gpio_ctrl		
R-0h		R/W-0h			R/W-1h		

Table 7-55. IO_MUX_CFG_2 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-6	RESERVED	R	0h	Reserved
5-3	clk_o_clk_source	R/W	0h	Clock Observable in CLK_O pin - 000b = xi_osc_25m_1p0v_dl (25MHz crystal output - from analog) 001b = Reserved 010b = Reserved 011b = 125MHz clock 100b = 125MHz clock 101b = Reserved 110b = Reserved 111b = Reserved
2-0	clk_o_gpio_ctrl	R/W	1h	Controls the output of CLK_O IO - 000b = LED_2 (default: TX/RX activity with stretch option(LED_2_OPTION=0x6) 001b = Clock out (see 0x453[5:3]) 010b = RGMII data match indication 011b = Under-Voltage indication 100b = constant 0 101b = constant 0 110b = constant 0 111b = constant 1

7.6.2.33 IO_CONTROL_3 Register (Offset = 456h) [Reset = 0108h]

IO_CONTROL_3 is shown in Figure 7-50 and described in Table 7-56.

Return to the Summary Table.

Figure 7-50. IO_CONTROL_3 Register

15	14	13	12	11	10	9	8
RESERVED						cfg_mac_rx_impedance	
R-0h						R/W-8h	
7	6	5	4	3	2	1	0
cfg_mac_rx_impedance			RESERVED				
R/W-8h			R-0h				

Table 7-56. IO_CONTROL_3 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-10	RESERVED	R	0h	Reserved
9-5	cfg_mac_rx_impedance	R/W	8h	Slew Rate Control for RGMII pads - 01010b = Medium Slew (OA tr/tf compliant, max tr/tf = 1ns) 01011b = Slowest Slew (For low emissions, max tr/tf = 1.2ns) 01000b = Default mode (rgmii tr/tf compliant, max tr/tf=750ps)
4-0	RESERVED	R	0h	Reserved

7.6.2.34 SOR_VECTOR_1 Register (Offset = 45Dh) [Reset = 0000h]

SOR_VECTOR_1 is shown in Figure 7-51 and described in Table 7-57.

Return to the Summary Table.

Strap Status Register:
This register has information on modes selected based on straps. Any override of mode using other registers will not be reflected in this register

Figure 7-51. SOR_VECTOR_1 Register

15	14	13	12	11	10	9	8
RGMII_TX_SHIFT	RGMII_RX_SHIFT	SGMII_EN	RGMII_EN	RESERVED			MAC_MODE
R-0h	R-0h	R-0h	R-0h	R-0h			R-0h

7	6	5	4	3	2	1	0
MAC_MODE		MAS/SLV	PHY_AD				
R-0h		R-0h	R-0h				

Table 7-57. SOR_VECTOR_1 Register Field Descriptions

Bit	Field	Type	Reset	Description
15	RGMII_TX_SHIFT	R	0h	0x0 = TX shift disbaled 0x1 = TX shift enabled
14	RGMII_RX_SHIFT	R	0h	0x0 = RX shift disabled 0x1 = RX shift enabled
13	SGMII_EN	R	0h	0x0 = SGMII disabled 0x1 = SGMII enabled
12	RGMII_EN	R	0h	0x0 = RGMII disabled 0x1 = RGMII enabled
11-9	RESERVED	R	0h	Reserved
8-6	MAC_MODE	R	0h	0x0 = SGMII 0x1 = Reserved 0x2 = Reserved 0x3 = Reserved 0x4 = RGMII align 0x5 = RGMII TX shift 0x6 = RGMII TX and RX shift 0x7 = RGMII RX shift
5	MAS/SLV	R	0h	0x0 = Slave 0x1 = Master
4-0	PHY_AD	R	0h	0x0 = PHY address 0 0x4 = PHY address 4 0x5 = PHY address 5 0x8 = PHY address 8 0xA = PHY address A 0xC = PHY address C 0xD = PHY address D 0xE = PHY address E 0xF = PHY address F

7.6.2.35 SOR_VECTOR_2 Register (Offset = 45Eh) [Reset = 0000h]

SOR_VECTOR_2 is shown in Figure 7-52 and described in Table 7-58.

Return to the Summary Table.

Strap Status Register:
This register has information on modes selected based on straps. Any override of mode using other registers will not be reflected in this register

Figure 7-52. SOR_VECTOR_2 Register

15	14	13	12	11	10	9	8
RESERVED							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED							AUTO/ MANAGED
R-0h							R-0h

Table 7-58. SOR_VECTOR_2 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-1	RESERVED	R	0h	Reserved
0	AUTO/MANAGED	R	0h	0x0 = Autonomous mode enabled 0x1 = Managed mode enabled

7.6.2.36 MONITOR_CTRL2 Register (Offset = 468h) [Reset = 0920h]

MONITOR_CTRL2 is shown in Figure 7-53 and described in Table 7-59.

Return to the Summary Table.

Figure 7-53. MONITOR_CTRL2 Register

15	14	13	12	11	10	9	8
RESERVED	cfg_rd_data			RESERVED			RESERVED
R-0h	R/W-0h			R-0h			R-0h

7	6	5	4	3	2	1	0
RESERVED		RESERVED			RESERVED		
R-0h		R-0h			R-0h		

Table 7-59. MONITOR_CTRL2 Register Field Descriptions

Bit	Field	Type	Reset	Description
15	RESERVED	R	0h	Reserved
14-12	cfg_rd_data	R/W	0h	Sensor select for read-out: 001b = VDDA 010b = VDD1P0 011b = VDDIO 100b = Temperature
11-9	RESERVED	R	0h	Reserved
8-6	RESERVED	R	0h	Reserved
5-3	RESERVED	R	0h	Reserved
2-0	RESERVED	R	0h	Reserved

7.6.2.37 MONITOR_CTRL4 Register (Offset = 46Ah) [Reset = 0094h]

MONITOR_CTRL4 is shown in Figure 7-54 and described in Table 7-60.

Return to the Summary Table.

Figure 7-54. MONITOR_CTRL4 Register

15	14	13	12	11	10	9	8
RESERVED							RESERVED
R-0h							R-0h
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED	RESERVED	RESERVED		RESERVED	cfg_reset	periodic	start
R-0h	R-0h	R-0h		R-0h	R/W-1h	R/W-0h	R/WSC-0h

Table 7-60. MONITOR_CTRL4 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-9	RESERVED	R	0h	Reserved
8	RESERVED	R	0h	Reserved
7	RESERVED	R	0h	Reserved
6	RESERVED	R	0h	Reserved
5-4	RESERVED	R	0h	Reserved
3	RESERVED	R	0h	Reserved
2	cfg_reset	R/W	1h	0b = Enable the monitor 1b = Monitor is held in reset state At any point of time, if the signal is changed to 1, the module abruptly goes to reset state
1	periodic	R/W	0h	0b = Monitor is enabled only when start is set for one iteration 1b = Monitor is enabled for periodic iteration
0	start	R/WSC	0h	Start indication for sensor monitor FSM, self clearing

7.6.2.38 MONITOR_STAT1 Register (Offset = 47Bh) [Reset = 0000h]

MONITOR_STAT1 is shown in Figure 7-55 and described in Table 7-61.

Return to the Summary Table.

Figure 7-55. MONITOR_STAT1 Register

15	14	13	12	11	10	9	8
stat_rd_data							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
stat_rd_data							
R-0h							

Table 7-61. MONITOR_STAT1 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	stat_rd_data	R	0h	Read sensor data

7.6.2.39 RS_DECODER Register (Offset = 510h) [Reset = 2D50h]

RS_DECODER is shown in Figure 7-56 and described in Table 7-62.

Return to the Summary Table.

Figure 7-56. RS_DECODER Register

15	14	13	12	11	10	9	8
cfg_rs_decoder_bypass	RESERVED	RESERVED					
R/W-0h	R-0h	R-0h					
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED							RESERVED
R-0h							R-0h

Table 7-62. RS_DECODER Register Field Descriptions

Bit	Field	Type	Reset	Description
15	cfg_rs_decoder_bypass	R/W	0h	Bypass RS decoder 0h = RS decoder in use 1h = Bypass RS decoder
14	RESERVED	R	0h	Reserved
13-8	RESERVED	R	0h	Reserved
7-1	RESERVED	R	0h	Reserved
0	RESERVED	R	0h	Reserved

7.6.2.40 TRAINING_RX_STATUS_7 Register (Offset = 52Bh) [Reset = 0000h]

TRAINING_RX_STATUS_7 is shown in Figure 7-57 and described in Table 7-63.

Return to the Summary Table.

Figure 7-57. TRAINING_RX_STATUS_7 Register

15	14	13	12	11	10	9	8
RESERVED			rx_rvrs_pol	RESERVED			
R-0h			R-0h	R-0h			
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED				RESERVED			
R-0h				R-0h			

Table 7-63. TRAINING_RX_STATUS_7 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-13	RESERVED	R	0h	Reserved
12	rx_rvrs_pol	R	0h	Received polarity 0h = Polarity decoded from received is not inverted 1h = Polarity decoded from receiver is inverted
11-8	RESERVED	R	0h	Reserved
7-4	RESERVED	R	0h	Reserved
3-0	RESERVED	R	0h	Reserved

7.6.2.41 LINK_QUAL_1 Register (Offset = 543h) [Reset = 0000h]

LINK_QUAL_1 is shown in Figure 7-58 and described in Table 7-64.

Return to the Summary Table.

Figure 7-58. LINK_QUAL_1 Register

15	14	13	12	11	10	9	8
RESERVED							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
link_training_time							
R-0h							

Table 7-64. LINK_QUAL_1 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-8	RESERVED	R	0h	Reserved
7-0	link_training_time	R	0h	Link training time in ms (TC12)

7.6.2.42 LINK_QUAL_2 Register (Offset = 544h) [Reset = 0000h]

LINK_QUAL_2 is shown in Figure 7-59 and described in Table 7-65.

Return to the Summary Table.

Figure 7-59. LINK_QUAL_2 Register

15	14	13	12	11	10	9	8
remote_receiver_time							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
local_receiver_time							
R-0h							

Table 7-65. LINK_QUAL_2 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-8	remote_receiver_time	R	0h	Remote receiver time in ms (TC12)
7-0	local_receiver_time	R	0h	Local receiver time in ms (TC12)

7.6.2.43 LINK_DOWN_LATCH_STAT Register (Offset = 545h) [Reset = 0000h]

LINK_DOWN_LATCH_STAT is shown in Figure 7-60 and described in Table 7-66.

Return to the Summary Table.

Figure 7-60. LINK_DOWN_LATCH_STAT Register

15	14	13	12	11	10	9	8
RESERVED							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED		channel_ok_ll	link_fail_inhibit_lh	send_s_sigdet_lh	hi_rfer_lh	block_lock_ll	pma_watchdog_ll
R-0h		R/W0C-0h	R/W0C-0h	R/W0C-0h	R/W0C-0h	R/W0S-0h	R/W0S-0h

Table 7-66. LINK_DOWN_LATCH_STAT Register Field Descriptions

Bit	Field	Type	Reset	Description
15-6	RESERVED	R	0h	Reserved
5	channel_ok_ll	R/W0C	0h	1b = Channel ok was never de-asserted 0b = Channel ok was de-asserted
4	link_fail_inhibit_lh	R/W0C	0h	1b = Link fail inhibit assertion was reported 0b = Link fail inhibit assertion was never reported
3	send_s_sigdet_lh	R/W0C	0h	1b = Send s sigdet assertion was reported 0b = Send s sigdet assertion was never reported
2	hi_rfer_lh	R/W0C	0h	1b = High ri rfer assertion was reported 0b = High ri rfer assertion was never reported
1	block_lock_ll	R/W0S	0h	1b = Block lock de-assertion was never reported 0b = Block lock de-assertion was never reported
0	pma_watchdog_ll	R/W0S	0h	1b = Low pma watchdog was never reported 0b = Low pma watchdof was reported

7.6.2.44 LINK_QUAL_3 Register (Offset = 547h) [Reset = 0000h]

LINK_QUAL_3 is shown in Figure 7-61 and described in Table 7-67.

Return to the Summary Table.

Figure 7-61. LINK_QUAL_3 Register

15	14	13	12	11	10	9	8
link_loss_cnt						link_fail_cnt	
R-0h						R-0h	
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
link_fail_cnt							
R-0h							

Table 7-67. LINK_QUAL_3 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-10	link_loss_cnt	R	0h	Link loss count since last power cycle (TC12)
9-0	link_fail_cnt	R	0h	Link fail without link loss count since last power cycle (TC12)

7.6.2.45 LINK_QUAL_4 Register (Offset = 548h) [Reset = 0000h]

LINK_QUAL_4 is shown in Figure 7-62 and described in Table 7-68.

Return to the Summary Table.

Figure 7-62. LINK_QUAL_4 Register

15	14	13	12	11	10	9	8
RESERVED							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED							comm_ready
R-0h							R-0h

Table 7-68. LINK_QUAL_4 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-1	RESERVED	R	0h	Reserved
0	comm_ready	R	0h	Communication ready status (TC12)

7.6.2.46 RS_DECODER_FRAME_STAT_2 Register (Offset = 552h) [Reset = 0000h]

RS_DECODER_FRAME_STAT_2 is shown in Figure 7-63 and described in Table 7-69.

Return to the Summary Table.

Figure 7-63. RS_DECODER_FRAME_STAT_2 Register

15	14	13	12	11	10	9	8
rs_dec_uncorr_frame_cnt							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
rs_dec_uncorr_frame_cnt							
R-0h							

Table 7-69. RS_DECODER_FRAME_STAT_2 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	rs_dec_uncorr_frame_cnt	R	0h	No of uncorrectable RS frames received at RS decoder, clear on read, saturates

7.6.2.47 RS_DECODER_FRAME_STAT_3 Register (Offset = 553h) [Reset = 0000h]

RS_DECODER_FRAME_STAT_3 is shown in Figure 7-64 and described in Table 7-70.

Return to the Summary Table.

Figure 7-64. RS_DECODER_FRAME_STAT_3 Register

15	14	13	12	11	10	9	8
rs_dec_err_frame_cnt							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
rs_dec_err_frame_cnt							
R-0h							

Table 7-70. RS_DECODER_FRAME_STAT_3 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	rs_dec_err_frame_cnt	R	0h	No of erroreous RS frames received at RS decoder, clear on read, saturates

7.6.2.48 RGMII_CTRL Register (Offset = 600h) [Reset = 0120h]

RGMII_CTRL is shown in Figure 7-65 and described in Table 7-71.

Return to the Summary Table.

Figure 7-65. RGMII_CTRL Register

<table>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td></tr>
<tr><td colspan="6">RESERVED</td><td colspan="2">rgmii_rx_half_full_th</td></tr>
<tr><td colspan="6">R-0h</td><td colspan="2">R/W-2h</td></tr>
<tr><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>rgmii_rx_half_full_th</td><td colspan="3">rgmii_tx_half_full_th</td><td>rgmii_tx_if_en</td><td>invert_rgmii_txd</td><td>invert_rgmii_rxd</td><td>RESERVED</td></tr>
<tr><td>R/W-2h</td><td colspan="3">R/W-2h</td><td>R/W-0h</td><td>R/W-0h</td><td>R/W-0h</td><td>R-0h</td></tr>
</table>

Table 7-71. RGMII_CTRL Register Field Descriptions

Bit	Field	Type	Reset	Description
15-10	RESERVED	R	0h	Reserved
9-7	rgmii_rx_half_full_th	R/W	2h	RGMII RX sync FIFO half full threshold
6-4	rgmii_tx_half_full_th	R/W	2h	RGMII TX sync FIFO half full threshold
3	rgmii_tx_if_en	R/W	0h	RGMII enable bit Default from strap 0h = RGMII disable 1h = RGMII enable
2	invert_rgmii_txd	R/W	0h	Invert RGMII Tx wire order - full swap [3:0] to [0:3] 0h = Keep RGMII Tx wire order same 1h = Invert RGMII Tx wire order
1	invert_rgmii_rxd	R/W	0h	Invert RGMII Rx wire order - full swap [3:0] to [0:3] 0h = Keep RGMII Rx wire order same 1h = Invert RGMII Rx wire order
0	RESERVED	R	0h	Reserved

7.6.2.49 RGMII_FIFO_STATUS Register (Offset = 601h) [Reset = 0000h]

RGMII_FIFO_STATUS is shown in Figure 7-66 and described in Table 7-72.

Return to the Summary Table.

Figure 7-66. RGMII_FIFO_STATUS Register

15	14	13	12	11	10	9	8
RESERVED							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED				rgmii_rx_af_full_err	rgmii_rx_af_empty_err	rgmii_tx_af_full_err	rgmii_tx_af_empty_err
R-0h				R/W0C-0h	R/W0C-0h	R/W0C-0h	R/W0C-0h

Table 7-72. RGMII_FIFO_STATUS Register Field Descriptions

Bit	Field	Type	Reset	Description
15-4	RESERVED	R	0h	Reserved
3	rgmii_rx_af_full_err	R/W0C	0h	RGMII RX fifo full error 0h = No empty fifo error 1h = RGMII TX full error has been indicated
2	rgmii_rx_af_empty_err	R/W0C	0h	RGMII RX fifo empty error 0h = No empty fifo error 1h = RGMII RX empty error has been indicated
1	rgmii_tx_af_full_err	R/W0C	0h	RGMII TX fifo full error 0h = No empty fifo error 1h = RGMII TX full error has been indicated
0	rgmii_tx_af_empty_err	R/W0C	0h	RGMII TX fifo empty error 0h = No empty fifo error 1h = RGMII TX empty error has been indicated

7.6.2.50 RGMII_DELAY_CTRL Register (Offset = 602h) [Reset = 0000h]

RGMII_DELAY_CTRL is shown in Figure 7-67 and described in Table 7-73.

Return to the Summary Table.

Figure 7-67. RGMII_DELAY_CTRL Register

15	14	13	12	11	10	9	8
RESERVED							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED						rx_clk_sel	tx_clk_sel
R-0h						R/W-0h	R/W-0h

Table 7-73. RGMII_DELAY_CTRL Register Field Descriptions

Bit	Field	Type	Reset	Description
15-2	RESERVED	R	0h	Reserved
1	rx_clk_sel	R/W	0h	In RGMII mode, Enable or disable the internal delay for RXD wrt RX_CLK (use this mode when RGMII_RX_CLK and RGMII_RXD are aligned). The delay magnitude can be configured by programming register 0x430[7:4] 0h = clock and data are aligned 1h = clock is delayed relative to RGMII_RX data
0	tx_clk_sel	R/W	0h	In RGMII mode, Enable or disable the internal delay for TXD wrt TX_CLK (use this mode when RGMII_TX_CLK and RGMII_TXD are aligned). The delay magnitude can be configured by programming register 0x430[11:8] 0h = clock and data are aligned 1h = clock is internally delayed

7.6.2.51 SGMII_CTRL_1 Register (Offset = 608h) [Reset = 007Bh]

SGMII_CTRL_1 is shown in Figure 7-68 and described in Table 7-74.

Return to the Summary Table.

SGMII Register: Available only on DP83TG720S-Q1

Figure 7-68. SGMII_CTRL_1 Register

15	14	13	12	11	10	9	8
sgmii_tx_err_dis	cfg_align_idx_force	cfg_align_idx_value				cfg_sgmii_en	cfg_sgmii_rx_pol_invert
R/W-0h	R/W-0h	R/W-0h				R/W-0h	R/W-0h
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
cfg_sgmii_tx_pol_invert	RESERVED		RESERVED	RESERVED	sgmii_autoneg_timer		mr_an_enable
R/W-0h	R-0h		R-0h	R-0h	R/W-1h		R/W-1h

Table 7-74. SGMII_CTRL_1 Register Field Descriptions

Bit	Field	Type	Reset	Description
15	sgmii_tx_err_dis	R/W	0h	1 = Disable SGMII TX Error indication 0 = Enable SGMII TX Error indication
14	cfg_align_idx_force	R/W	0h	Force word boundray index selection
13-10	cfg_align_idx_value	R/W	0h	when cfg_align_idx_force = 1 This value set the iword boundray index
9	cfg_sgmii_en	R/W	0h	SGMII enable bit Default from strap 0h = SGMII disable 1h = SGMII enable
8	cfg_sgmii_rx_pol_invert	R/W	0h	SGMII RX bus invert polarity 0h = Polarity not inverted 1h = SGMII RX bus invert polarity
7	cfg_sgmii_tx_pol_invert	R/W	0h	SGMII TX bus invert polarity 0h = Polarity not inverted 1h = SGMII TX bus invert polarity
6-5	RESERVED	R	0h	Reserved
4	RESERVED	R	0h	Reserved
3	RESERVED	R	0h	Reserved
2-1	sgmii_autoneg_timer	R/W	1h	Selects duration of SGMII Auto-Negotiation timer: 00: 1.6ms 01: 2us 10: 800us 11: 11ms
0	mr_an_enable	R/W	1h	1 = Enable SGMII Auto-Negotaition 0 = Disable SGMII Auto-Negotiation

7.6.2.52 SGMII_STATUS Register (Offset = 60Ah) [Reset = 0000h]

SGMII_STATUS is shown in Figure 7-69 and described in Table 7-75.

Return to the Summary Table.

SGMII Register: Available only on DP83TG720S-Q1

Figure 7-69. SGMII_STATUS Register

15	14	13	12	11	10	9	8
RESERVED			sgmii_page_received	link_status_1000bx	mr_an_complete	cfg_align_en	cfg_sync_status
R-0h			R-0h	R-0h	R-0h	R-0h	R-0h
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
cfg_align_idx				cfg_state			
R-0h				R-0h			

Table 7-75. SGMII_STATUS Register Field Descriptions

Bit	Field	Type	Reset	Description
15-13	RESERVED	R	0h	Reserved
12	sgmii_page_received	R	0h	Indicates that a new auto neg page was received 0h = No new auto neg page received 1h = A new auto neg page received
11	link_status_1000bx	R	0h	sgmii link status 0h = SGMII link down 1h = SGMII link up
10	mr_an_complete	R	0h	sgmii autoneg complete indication 0h = SGMII autoneg not completed 1h = SGMII autoneg completed
9	cfg_align_en	R	0h	word boundary FSM - align indication
8	cfg_sync_status	R	0h	word boundary FSM - sync status indication 0h = sync not achieved 1h = sync achieved
7-4	cfg_align_idx	R	0h	word boundary index selection
3-0	cfg_state	R	0h	word boundary FSM state

7.6.2.53 SGMII_CTRL_2 Register (Offset = 60Ch) [Reset = 001Bh]

SGMII_CTRL_2 is shown in Figure 7-70 and described in Table 7-76.

Return to the Summary Table.

SGMII Register: Available only on DP83TG720S-Q1

Figure 7-70. SGMII_CTRL_2 Register

15	14	13	12	11	10	9	8
RESERVED							RESERVED
R-0h							R-0h

7	6	5	4	3	2	1	0
RESERVED	mr_restart_an	tx_half_full_th			rx_half_full_th		
R-0h	R/WSC,0-0h	R/W-3h			R/W-3h		

Table 7-76. SGMII_CTRL_2 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-9	RESERVED	R	0h	Reserved
8	RESERVED	R	0h	Reserved
7	RESERVED	R	0h	Reserved
6	mr_restart_an	R/WSC,0	0h	Restart sgmii autonegotiation
5-3	tx_half_full_th	R/W	3h	SGMII TX sync FIFO half full threshold
2-0	rx_half_full_th	R/W	3h	SGMII RX sync FIFO half full threshold

7.6.2.54 SGMII_FIFO_STATUS Register (Offset = 60Dh) [Reset = 0000h]

SGMII_FIFO_STATUS is shown in Figure 7-71 and described in Table 7-77.

Return to the Summary Table.

SGMII Register: Available only on DP83TG720S-Q1

Figure 7-71. SGMII_FIFO_STATUS Register

15	14	13	12	11	10	9	8
RESERVED							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED				sgmii_rx_af_full_err	sgmii_rx_af_empty_err	sgmii_tx_af_full_err	sgmii_tx_af_empty_err
R-0h				R/W0C-0h	R/W0C-0h	R/W0C-0h	R/W0C-0h

Table 7-77. SGMII_FIFO_STATUS Register Field Descriptions

Bit	Field	Type	Reset	Description
15-4	RESERVED	R	0h	Reserved
3	sgmii_rx_af_full_err	R/W0C	0h	SGMII RX fifo full error 0h = No error indication 1h = SGMII RX fifo full error has been indicated
2	sgmii_rx_af_empty_err	R/W0C	0h	SGMII RX fifo empty error 0h = No error indication 1h = SGMII RX fifo empty error has been indicated
1	sgmii_tx_af_full_err	R/W0C	0h	SGMII TX fifo full error 0h = No error indication 1h = SGMII TX fifo full error has been indicated
0	sgmii_tx_af_empty_err	R/W0C	0h	SGMII TX fifo empty error 0h = No error indication 1h = SGMII TX fifo empty error has been indicated

7.6.2.55 PRBS_STATUS_1 Register (Offset = 618h) [Reset = 0000h]

PRBS_STATUS_1 is shown in Figure 7-72 and described in Table 7-78.

Return to the Summary Table.

Figure 7-72. PRBS_STATUS_1 Register

15	14	13	12	11	10	9	8
RESERVED							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
prbs_err_ov_cnt							
R-0h							

Table 7-78. PRBS_STATUS_1 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-8	RESERVED	R	0h	Reserved
7-0	prbs_err_ov_cnt	R	0h	Holds number of error counter overflow that received by the PRBS checker. Value in this register is locked when write is done to register prbs_status_6 bit[0] or bit[1]. Counter stops on 0xFF. Note: when PRBS counters work in single mode, overflow counter is not active

7.6.2.56 PRBS_CTRL_1 Register (Offset = 619h) [Reset = 0574h]

PRBS_CTRL_1 is shown in Figure 7-73 and described in Table 7-79.

Return to the Summary Table.

Figure 7-73. PRBS_CTRL_1 Register

<table>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td></tr>
<tr><td colspan="2">RESERVED</td><td>RESERVED</td><td>send_pkt</td><td>RESERVED</td><td colspan="3">cfg_prbs_chk_sel</td></tr>
<tr><td colspan="2">R-0h</td><td>R-0h</td><td>R/WMC,0-0h</td><td>R-0h</td><td colspan="3">R/W-5h</td></tr>
<tr><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>RESERVED</td><td colspan="3">cfg_prbs_gen_sel</td><td>cfg_prbs_cnt_mode</td><td>cfg_prbs_chk_enable</td><td>cfg_pkt_gen_prbs</td><td>pkt_gen_en</td></tr>
<tr><td>R-0h</td><td colspan="3">R/W-7h</td><td>R/W-0h</td><td>R/W-1h</td><td>R/W-0h</td><td>R/W-0h</td></tr>
</table>

Table 7-79. PRBS_CTRL_1 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-14	RESERVED	R	0h	Reserved
13	RESERVED	R	0h	Reserved
12	send_pkt	R/WMC,0	0h	Enables generating MAC packet with fix/incremental data w CRC (pkt_gen_en has to be set and cfg_pkt_gen_prbs has to be clear) Cleared automatically when pkt_done is set 0h = Stop MAC packet 1h = Transmit MAC packet w CRC
11	RESERVED	R	0h	Reserved
10-8	cfg_prbs_chk_sel	R/W	5h	000 : Checker receives from RGMII TX 001 : Checker receives SGMII TX 101 : Checker receives from Cu RX
7	RESERVED	R	0h	Reserved
6-4	cfg_prbs_gen_sel	R/W	7h	000 : PRBS transmits to RGMII RX 001 : PRBS transmits to SGMII RX 101 : PRBS transmits to Cu TX
3	cfg_prbs_cnt_mode	R/W	0h	1 = Continuous mode, when one of the PRBS counters reaches max value, pulse is generated and counter starts counting from zero again 0 = Single mode, When one of the PRBS counters reaches max value, PRBS checker stops counting.
2	cfg_prbs_chk_enable	R/W	1h	Enable PRBS checker xbar (to receive data) To be enabled for counters in 0x63C, 0x63D, 0x63E to work 0h = Disable PRBS checker 1h = Enable PRBS checker
1	cfg_pkt_gen_prbs	R/W	0h	If set: (1) When pkt_gen_en is set, PRBS packets are generated continuously (3) When pkt_gen_en is cleared, PRBS RX checker is still enabled If cleared: (1) When pkt_gen_en is set, non - PRBS packet is generated (3) When pkt_gen_en is cleared, PRBS RX checker is disabled as well 0h = Stop PRBS packet 1h = Transmit PRBS packet
0	pkt_gen_en	R/W	0h	1 = Enable packet/PRBS generator 0 = Disable packet/PRBS generator

7.6.2.57 PRBS_CTRL_2 Register (Offset = 61Ah) [Reset = 05DCh]

PRBS_CTRL_2 is shown in Figure 7-74 and described in Table 7-80.

Return to the Summary Table.

Figure 7-74. PRBS_CTRL_2 Register

15	14	13	12	11	10	9	8
cfg_pkt_len_prbs							
R/W-5DCh							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
cfg_pkt_len_prbs							
R/W-5DCh							

Table 7-80. PRBS_CTRL_2 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	cfg_pkt_len_prbs	R/W	5DCh	Length (in bytes) of PRBS packets and MAC packets w CRC

7.6.2.58 PRBS_CTRL_3 Register (Offset = 61Bh) [Reset = 007Dh]

PRBS_CTRL_3 is shown in Figure 7-75 and described in Table 7-81.

Return to the Summary Table.

Figure 7-75. PRBS_CTRL_3 Register

15	14	13	12	11	10	9	8
RESERVED							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
cfg_ipg_len							
R/W-7Dh							

Table 7-81. PRBS_CTRL_3 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-8	RESERVED	R	0h	Reserved
7-0	cfg_ipg_len	R/W	7Dh	Inter-packet gap (in bytes) between packets

7.6.2.59 PRBS_STATUS_2 Register (Offset = 61Ch) [Reset = 0000h]

PRBS_STATUS_2 is shown in Figure 7-76 and described in Table 7-82.

Return to the Summary Table.

Figure 7-76. PRBS_STATUS_2 Register

15	14	13	12	11	10	9	8
prbs_byte_cnt							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
prbs_byte_cnt							
R-0h							

Table 7-82. PRBS_STATUS_2 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	prbs_byte_cnt	R	0h	Holds number of total bytes that received by the PRBS checker. Value in this register is locked when write is done to register prbs_status_6 bit[0] or bit[1]. When PRBS Count Mode set to zero, count stops on 0xFFFF

7.6.2.60 PRBS_STATUS_3 Register (Offset = 61Dh) [Reset = 0000h]

PRBS_STATUS_3 is shown in Figure 7-77 and described in Table 7-83.

Return to the Summary Table.

Figure 7-77. PRBS_STATUS_3 Register

15	14	13	12	11	10	9	8
prbs_pkt_cnt_15_0							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
prbs_pkt_cnt_15_0							
R-0h							

Table 7-83. PRBS_STATUS_3 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	prbs_pkt_cnt_15_0	R	0h	Bits [15:0] of number of total packets received by the PRBS checker Value in this register is locked when write is done to register prbs_status_6 bit[0] or bit[1]. When PRBS Count Mode set to zero, count stops on 0xFFFFFFFF

7.6.2.61 PRBS_STATUS_4 Register (Offset = 61Eh) [Reset = 0000h]

PRBS_STATUS_4 is shown in Figure 7-78 and described in Table 7-84.

Return to the Summary Table.

Figure 7-78. PRBS_STATUS_4 Register

15	14	13	12	11	10	9	8
prbs_pkt_cnt_31_16							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
prbs_pkt_cnt_31_16							
R-0h							

Table 7-84. PRBS_STATUS_4 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	prbs_pkt_cnt_31_16	R	0h	Bits [31:16] of number of total packets received by the PRBS checker Value in this register is locked when write is done to register prbs_status_6 bit[0] or bit[1]. When PRBS Count Mode set to zero, count stops on 0xFFFFFFFF

7.6.2.62 PRBS_STATUS_6 Register (Offset = 620h) [Reset = 0000h]

PRBS_STATUS_6 is shown in Figure 7-79 and described in Table 7-85.

Return to the Summary Table.

Figure 7-79. PRBS_STATUS_6 Register

15	14	13	12	11	10	9	8
RESERVED			pkt_done	pkt_gen_busy	prbs_pkt_ov	prbs_byte_ov	prbs_lock
R-0h			R-0h	R-0h	R-0h	R-0h	R-0h

7	6	5	4	3	2	1	0
prbs_err_cnt							
R-0h							

Table 7-85. PRBS_STATUS_6 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-13	RESERVED	R	0h	Reserved
12	pkt_done	R	0h	Set when all MAC packets w CRC are transmitted 0h = MAC packet transmission in progress 1h = MAC packets transmission completed
11	pkt_gen_busy	R	0h	1 = Packet generator is in process 0 = Packet generator is not in process
10	prbs_pkt_ov	R	0h	If set, packet counter reached overflow Overflow is cleared when PRBS counters are cleared - done by setting bit #1 of prbs_status_6 0h = No overflow 1h = Packet counter overflow
9	prbs_byte_ov	R	0h	If set, bytes counter reached overflow Overflow is cleared when PRBS counters are cleared - done by setting bit #1of prbs_status_6 0h = No overflow 1h = byte counter overflow
8	prbs_lock	R	0h	1 = PRBS checker is locked sync) on received byte stream 0 = PRBS checker is not locked 0h = PRBS checker is not locked 1h = PRBS checker is locked sync) on received byte stream
7-0	prbs_err_cnt	R	0h	Holds number of errored bits received by the PRBS checker Value in this register is locked when write is done to bit[0] or bit[1] When PRBS Count Mode set to zero, count stops on 0xFF Notes: Writing bit 0 generates a lock signal for the PRBS counters. Writing bit 1 generates a lock and clear signal for the PRBS counters

7.6.2.63 PRBS_STATUS_8 Register (Offset = 622h) [Reset = 0000h]

PRBS_STATUS_8 is shown in Figure 7-80 and described in Table 7-86.

Return to the Summary Table.

Figure 7-80. PRBS_STATUS_8 Register

15	14	13	12	11	10	9	8
pkt_err_cnt_15_0							
R-0h							
7	6	5	4	3	2	1	0
pkt_err_cnt_15_0							
R-0h							

Table 7-86. PRBS_STATUS_8 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	pkt_err_cnt_15_0	R	0h	Bits [15:0] of number of total packets with error received by the PRBS checker Value in this register is locked when write is done to register prbs_status_6 bit[0] or bit[1]. When PRBS Count Mode set to zero, count stops on 0xFFFFFFFF

7.6.2.64 PRBS_STATUS_9 Register (Offset = 623h) [Reset = 0000h]

PRBS_STATUS_9 is shown in Figure 7-81 and described in Table 7-87.

Return to the Summary Table.

Figure 7-81. PRBS_STATUS_9 Register

15	14	13	12	11	10	9	8
pkt_err_cnt_31_16							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
pkt_err_cnt_31_16							
R-0h							

Table 7-87. PRBS_STATUS_9 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	pkt_err_cnt_31_16	R	0h	Bits [31:16] of number of total packets with error received by the PRBS checker Value in this register is locked when write is done to register prbs_status_6 bit[0] or bit[1]. When PRBS Count Mode set to zero, count stops on 0xFFFFFFFF

7.6.2.65 PRBS_CTRL_4 Register (Offset = 624h) [Reset = 5511h]

PRBS_CTRL_4 is shown in Figure 7-82 and described in Table 7-88.

Return to the Summary Table.

Figure 7-82. PRBS_CTRL_4 Register

15	14	13	12	11	10	9	8
cfg_pkt_data							
R/W-55h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
cfg_pkt_mode		cfg_pattern_vld_bytes			cfg_pkt_cnt		
R/W-0h		R/W-2h			R/W-1h		

Table 7-88. PRBS_CTRL_4 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-8	cfg_pkt_data	R/W	55h	Fixed data to be sent in Fix data mode
7-6	cfg_pkt_mode	R/W	0h	0h = Incremental 1h = Fixed 2h = PRBS 3h = PRBS
5-3	cfg_pattern_vld_bytes	R/W	2h	Number of bytes of valid pattern in packet (Max - 6) 0h = 0 bytes 1h = 1 bytes 2h = 2 bytes 3h = 3 bytes 4h = 4 bytes 5h = 5 bytes 6h = 6 bytes 7h = 6 bytes
2-0	cfg_pkt_cnt	R/W	1h	000b = 1 packet 001b = 10 packets 010b = 100 packets 011b = 1000 packets 100b = 10000 packets 101b = 100000 packets 110b = 1000000 packets 111b = Continuous packets

7.6.2.66 PRBS_CTRL_5 Register (Offset = 625h) [Reset = 0000h]

PRBS_CTRL_5 is shown in Figure 7-83 and described in Table 7-89.

Return to the Summary Table.

Figure 7-83. PRBS_CTRL_5 Register

15	14	13	12	11	10	9	8
pattern_15_0							
R/W-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
pattern_15_0							
R/W-0h							

Table 7-89. PRBS_CTRL_5 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	pattern_15_0	R/W	0h	Bits 15:0 of pattern

7.6.2.67 PRBS_CTRL_6 Register (Offset = 626h) [Reset = 0000h]

PRBS_CTRL_6 is shown in Figure 7-84 and described in Table 7-90.

Return to the Summary Table.

Figure 7-84. PRBS_CTRL_6 Register

15	14	13	12	11	10	9	8
pattern_31_16							
R/W-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
pattern_31_16							
R/W-0h							

Table 7-90. PRBS_CTRL_6 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	pattern_31_16	R/W	0h	Bits 31:16 of pattern

7.6.2.68 PRBS_CTRL_7 Register (Offset = 627h) [Reset = 0000h]

PRBS_CTRL_7 is shown in Figure 7-85 and described in Table 7-91.

Return to the Summary Table.

Figure 7-85. PRBS_CTRL_7 Register

15	14	13	12	11	10	9	8
pattern_47_32							
R/W-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
pattern_47_32							
R/W-0h							

Table 7-91. PRBS_CTRL_7 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	pattern_47_32	R/W	0h	Bits 47:32 of pattern

7.6.2.69 PRBS_CTRL_8 Register (Offset = 628h) [Reset = 0000h]

PRBS_CTRL_8 is shown in Figure 7-86 and described in Table 7-92.

Return to the Summary Table.

Figure 7-86. PRBS_CTRL_8 Register

15	14	13	12	11	10	9	8
pmatch_data_15_0							
R/W-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
pmatch_data_15_0							
R/W-0h							

Table 7-92. PRBS_CTRL_8 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	pmatch_data_15_0	R/W	0h	Bits 15:0 of Perfect Match Data - used for DA (destination address) match

7.6.2.70 PRBS_CTRL_9 Register (Offset = 629h) [Reset = 0000h]

PRBS_CTRL_9 is shown in Figure 7-87 and described in Table 7-93.

Return to the Summary Table.

Figure 7-87. PRBS_CTRL_9 Register

15	14	13	12	11	10	9	8
pmatch_data_31_16							
R/W-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
pmatch_data_31_16							
R/W-0h							

Table 7-93. PRBS_CTRL_9 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	pmatch_data_31_16	R/W	0h	Bits 31:16 of Perfect Match Data - used for DA (destination address) match

7.6.2.71 PRBS_CTRL_10 Register (Offset = 62Ah) [Reset = 0000h]

PRBS_CTRL_10 is shown in Figure 7-88 and described in Table 7-94.

Return to the Summary Table.

Figure 7-88. PRBS_CTRL_10 Register

15	14	13	12	11	10	9	8
pmatch_data_47_32							
R/W-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
pmatch_data_47_32							
R/W-0h							

Table 7-94. PRBS_CTRL_10 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	pmatch_data_47_32	R/W	0h	Bits 47:32 of Perfect Match Data - used for DA (destination address) match

7.6.2.72 CRC_STATUS Register (Offset = 638h) [Reset = 0000h]

CRC_STATUS is shown in Figure 7-89 and described in Table 7-95.

Return to the Summary Table.

Figure 7-89. CRC_STATUS Register

15	14	13	12	11	10	9	8
RESERVED							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED						rx_bad_crc	tx_bad_crc
R-0h						R-0h	R-0h

Table 7-95. CRC_STATUS Register Field Descriptions

Bit	Field	Type	Reset	Description
15-2	RESERVED	R	0h	Reserved
1	rx_bad_crc	R	0h	CRC error indication in packet received on Cu RX 0h = No CRC error 1h = CRC error
0	tx_bad_crc	R	0h	CRC error indication in packet transmitted on Cu TX 0h = No CRC error 1h = CRC error

7.6.2.73 PKT_STAT_1 Register (Offset = 639h) [Reset = 0000h]

PKT_STAT_1 is shown in Figure 7-90 and described in Table 7-96.

Return to the Summary Table.

Figure 7-90. PKT_STAT_1 Register

15	14	13	12	11	10	9	8
tx_pkt_cnt_15_0							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
tx_pkt_cnt_15_0							
R-0h							

Table 7-96. PKT_STAT_1 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	tx_pkt_cnt_15_0	R	0h	Lower 16 bits of Tx packet counter Note : Register is cleared when 0x639, 0x63A, 0x63B are read in sequence

7.6.2.74 PKT_STAT_2 Register (Offset = 63Ah) [Reset = 0000h]

PKT_STAT_2 is shown in Figure 7-91 and described in Table 7-97.

Return to the Summary Table.

Figure 7-91. PKT_STAT_2 Register

15	14	13	12	11	10	9	8
tx_pkt_cnt_31_16							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
tx_pkt_cnt_31_16							
R-0h							

Table 7-97. PKT_STAT_2 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	tx_pkt_cnt_31_16	R	0h	Upper 16 bits of Tx packet counter Note : Register is cleared when 0x639, 0x63A, 0x63B are read in sequence

7.6.2.75 PKT_STAT_3 Register (Offset = 63Bh) [Reset = 0000h]

PKT_STAT_3 is shown in Figure 7-92 and described in Table 7-98.

Return to the Summary Table.

Figure 7-92. PKT_STAT_3 Register

15	14	13	12	11	10	9	8
tx_err_pkt_cnt							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
tx_err_pkt_cnt							
R-0h							

Table 7-98. PKT_STAT_3 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	tx_err_pkt_cnt	R	0h	Tx packet w error (CRC error) counter Note : Register is cleared when 0x639, 0x63A, 0x63B are read in sequence

7.6.2.76 PKT_STAT_4 Register (Offset = 63Ch) [Reset = 0000h]

PKT_STAT_4 is shown in Figure 7-93 and described in Table 7-99.

Return to the Summary Table.

Figure 7-93. PKT_STAT_4 Register

15	14	13	12	11	10	9	8
rx_pkt_cnt_15_0							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
rx_pkt_cnt_15_0							
R-0h							

Table 7-99. PKT_STAT_4 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	rx_pkt_cnt_15_0	R	0h	Lower 16 bits of Rx packet counter Note : Register is cleared when 0x63C, 0x63D, 0x63E are read in sequence

7.6.2.77 PKT_STAT_5 Register (Offset = 63Dh) [Reset = 0000h]

PKT_STAT_5 is shown in Figure 7-94 and described in Table 7-100.

Return to the Summary Table.

Figure 7-94. PKT_STAT_5 Register

15	14	13	12	11	10	9	8
rx_pkt_cnt_31_16							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
rx_pkt_cnt_31_16							
R-0h							

Table 7-100. PKT_STAT_5 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	rx_pkt_cnt_31_16	R	0h	Upper 16 bits of Rx packet counter Note : Register is cleared when 0x63C, 0x63D, 0x63E are read in sequence

7.6.2.78 PKT_STAT_6 Register (Offset = 63Eh) [Reset = 0000h]

PKT_STAT_6 is shown in Figure 7-95 and described in Table 7-101.

Return to the Summary Table.

Figure 7-95. PKT_STAT_6 Register

15	14	13	12	11	10	9	8
rx_err_pkt_cnt							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
rx_err_pkt_cnt							
R-0h							

Table 7-101. PKT_STAT_6 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	rx_err_pkt_cnt	R	0h	Rx packet w error (CRC error) counter Note : Register is cleared when 0x63C, 0x63D, 0x63E are read in sequence

7.6.2.79 SQI_REG_1 Register (Offset = 871h) [Reset = 0000h]

SQI_REG_1 is shown in Figure 7-96 and described in Table 7-102.

Return to the Summary Table.

Figure 7-96. SQI_REG_1 Register

15	14	13	12	11	10	9	8
RESERVED							
R-0h							

7	6	5	4	3	2	1	0
worst_sqi_out			RESERVED	sqi_out			RESERVED
R-0h			R-0h	R-0h			R-0h

Table 7-102. SQI_REG_1 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-8	RESERVED	R	0h	Reserved
7-5	worst_sqi_out	R	0h	3 bit Worst SQI since last read (see SQI mapping above) Cleared on Read
4	RESERVED	R	0h	Reserved
3-1	sqi_out	R	0h	3 bit SQI - (mse here refers to Mean Square Error 0x875[9:0]) 0b000 = MSE > 102 0b001 = 81 < MSE ≤102 0b010 = 65 < MSE ≤ 81 0b011 = 51 < MSE ≤ 65 0b100 = 41 < MSE ≤ 51 0b101 = 32 < MSE ≤ 41 0b110 = 25 < MSE ≤ 32 0b111 = MSE ≤ 25
0	RESERVED	R	0h	Reserved

7.6.2.80 DSP_REG_74 Register (Offset = 874h) [Reset = 0000h]

DSP_REG_74 is shown in Figure 7-97 and described in Table 7-103.

Return to the Summary Table.

Figure 7-97. DSP_REG_74 Register

15	14	13	12	11	10	9	8
worst_peak_mse_out							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
peak_mse_out							
R-0h							

Table 7-103. DSP_REG_74 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-8	worst_peak_mse_out	R	0h	Worst peak mse out since last read as per TC12 (see peak mse mapping above) Cleared on Read
7-0	peak_mse_out	R	0h	Peak mse as per TC12 - This value is 0.0625*averaged squared slicer error(max val = 0.015625). To get actual squared slicer error divide this value by 248.

7.6.2.81 DSP_REG_75 Register (Offset = 875h) [Reset = 0000h]

DSP_REG_75 is shown in Figure 7-98 and described in Table 7-104.

Return to the Summary Table.

Figure 7-98. DSP_REG_75 Register

15	14	13	12	11	10	9	8
RESERVED				RESERVED		mse_lock	
R-0h				R-0h		R-0h	
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
mse_lock							
R-0h							

Table 7-104. DSP_REG_75 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-12	RESERVED	R	0h	Reserved
11-10	RESERVED	R	0h	Reserved
9-0	mse_lock	R	0h	10 bit mse used for SQI mapping. (mse = mean square error at the receiver)

7.6.2.82 PMA_PMD_CONTROL_1 Register (Offset = 1000h) [Reset = 0000h]

PMA_PMD_CONTROL_1 is shown in Figure 7-99 and described in Table 7-105.

Return to the Summary Table.

First nibble (0x1) in the register address is to indicate MMD register space. For register access, ignore the first nibble.

Figure 7-99. PMA_PMD_CONTROL_1 Register

15	14	13	12	11	10	9	8
pma_reset_2	RESERVED			RESERVED	RESERVED		
R-0h	R-0h			R-0h	R-0h		

7	6	5	4	3	2	1	0
RESERVED							
R-0h							

Table 7-105. PMA_PMD_CONTROL_1 Register Field Descriptions

Bit	Field	Type	Reset	Description
15	pma_reset_2	R	0h	1 = PMA/PMD reset 0 = Normal operation Note - RW bit, self clearing
14-12	RESERVED	R	0h	Reserved
11	RESERVED	R	0h	Reserved
10-0	RESERVED	R	0h	Reserved

7.6.2.83 PMA_PMD_CONTROL_2 Register (Offset = 1007h) [Reset = 003Dh]

PMA_PMD_CONTROL_2 is shown in Figure 7-100 and described in Table 7-106.

Return to the Summary Table.

First nibble (0x1) in the register address is to indicate MMD register space. For register access, ignore the first nibble.

Figure 7-100. PMA_PMD_CONTROL_2 Register

15	14	13	12	11	10	9	8
RESERVED							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED		cfg_pma_type_selection					
R-0h		R/W-3Dh					

Table 7-106. PMA_PMD_CONTROL_2 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-6	RESERVED	R	0h	Reserved
5-0	cfg_pma_type_selection	R/W	3Dh	BASE-T1 type selection for device 3Dh = BASE-T1 type selection for device

7.6.2.84 PMA_PMD_TRANSMIT_DISABLE Register (Offset = 1009h) [Reset = 0000h]

PMA_PMD_TRANSMIT_DISABLE is shown in Figure 7-101 and described in Table 7-107.

Return to the Summary Table.

First nibble (0x1) in the register address is to indicate MMD register space. For register access, ignore the first nibble.

Figure 7-101. PMA_PMD_TRANSMIT_DISABLE Register

15	14	13	12	11	10	9	8
RESERVED							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED							cfg_transmit_disable_2
R-0h							R-0h

Table 7-107. PMA_PMD_TRANSMIT_DISABLE Register Field Descriptions

Bit	Field	Type	Reset	Description
15-1	RESERVED	R	0h	Reserved
0	cfg_transmit_disable_2	R	0h	1 = Transmit disable 0 = Normal operation Note - RW bit

7.6.2.85 PMA_PMD_EXTENDED_ABILITY2 Register (Offset = 100Bh) [Reset = 0800h]

PMA_PMD_EXTENDED_ABILITY2 is shown in Figure 7-102 and described in Table 7-108.

Return to the Summary Table.

First nibble (0x1) in the register address is to indicate MMD register space. For register access, ignore the first nibble.

Figure 7-102. PMA_PMD_EXTENDED_ABILITY2 Register

15	14	13	12	11	10	9	8
RESERVED				base_t1_extended_abilities	RESERVED		
R-0h				R-1h	R-0h		
7	6	5	4	3	2	1	0
RESERVED							
R-0h							

Table 7-108. PMA_PMD_EXTENDED_ABILITY2 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-12	RESERVED	R	0h	Reserved
11	base_t1_extended_abilities	R	1h	1 = PMA/PMD has BASE-T1 extended abilities listed in register 1.18 0 = PMA/PMD does not have BASE-T1 extended abilities
10-0	RESERVED	R	0h	Reserved

7.6.2.86 PMA_PMD_EXTENDED_ABILITY Register (Offset = 1012h) [Reset = 0002h]

PMA_PMD_EXTENDED_ABILITY is shown in Figure 7-103 and described in Table 7-109.

Return to the Summary Table.

First nibble (0x1) in the register address is to indicate MMD register space. For register access, ignore the first nibble.

Figure 7-103. PMA_PMD_EXTENDED_ABILITY Register

15	14	13	12	11	10	9	8
RESERVED							
R-0h							

7	6	5	4	3	2	1	0
RESERVED						mr_1000_base_t1_ability	mr_100_base_t1_ability
R-0h						R-1h	R-0h

Table 7-109. PMA_PMD_EXTENDED_ABILITY Register Field Descriptions

Bit	Field	Type	Reset	Description
15-2	RESERVED	R	0h	Reserved
1	mr_1000_base_t1_ability	R	1h	1 = PMA/PMD is able to perform 1000BASE-T1 0 = PMA/PMD is not able to perform 1000BASE-T1
0	mr_100_base_t1_ability	R	0h	1 = PMA/PMD is able to perform 100BASE-T1 0 = PMA/PMD is not able to perform 100BASE-T1

7.6.2.87 PMA_PMD_CONTROL Register (Offset = 1834h) [Reset = 8001h]

PMA_PMD_CONTROL is shown in Figure 7-104 and described in Table 7-110.

Return to the Summary Table.

First nibble (0x1) in the register address is to indicate MMD register space. For register access, ignore the first nibble.

Figure 7-104. PMA_PMD_CONTROL Register

15	14	13	12	11	10	9	8
RESERVED	cfg_master_slave_val	RESERVED					
R-0h	R/W-0h	R-0h					

7	6	5	4	3	2	1	0
RESERVED				RESERVED			
R-0h				R-0h			

Table 7-110. PMA_PMD_CONTROL Register Field Descriptions

Bit	Field	Type	Reset	Description
15	RESERVED	R	0h	Reserved
14	cfg_master_slave_val	R/W	0h	1 = Configure PHY as MASTER 0 = Configure PHY as SLAVE
13-4	RESERVED	R	0h	Reserved
3-0	RESERVED	R	0h	Reserved

7.6.2.88 PMA_CONTROL Register (Offset = 1900h) [Reset = 0000h]

PMA_CONTROL is shown in Figure 7-105 and described in Table 7-111.

Return to the Summary Table.

First nibble (0x1) in the register address is to indicate MMD register space. For register access, ignore the first nibble.

Figure 7-105. PMA_CONTROL Register

15	14	13	12	11	10	9	8
pma_reset	cfg_transmit_disable	RESERVED		RESERVED	RESERVED		
R-0h	R-0h	R-0h		R-0h	R-0h		
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED							
R-0h							

Table 7-111. PMA_CONTROL Register Field Descriptions

Bit	Field	Type	Reset	Description
15	pma_reset	R	0h	1 = PMA/PMD reset 0 = Normal operation Note - RW bit, self clearing
14	cfg_transmit_disable	R	0h	1 = Transmit disable 0 = Normal operation Note - RW bit
13-12	RESERVED	R	0h	Reserved
11	RESERVED	R	0h	Reserved
10-0	RESERVED	R	0h	Reserved

7.6.2.89 PMA_STATUS Register (Offset = 1901h) [Reset = 0900h]

PMA_STATUS is shown in Figure 7-106 and described in Table 7-112.

Return to the Summary Table.

First nibble (0x1) in the register address is to indicate MMD register space. For register access, ignore the first nibble.

Figure 7-106. PMA_STATUS Register

15	14	13	12	11	10	9	8
RESERVED				oam_ability	eee_ability	receive_fault_ability	low_power_ability
R-0h				R-1h	R-0h	R-0h	R-1h
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED					receive_polarity	receive_fault	pma_receive_link_status_ll
R-0h					R-0h	R-0h	R/W0S-0h

Table 7-112. PMA_STATUS Register Field Descriptions

Bit	Field	Type	Reset	Description
15-12	RESERVED	R	0h	Reserved
11	oam_ability	R	1h	1 = PHY has 1000BASE-T1 OAM ability 0 = PHY does not have 1000BASE-T1 OAM ability
10	eee_ability	R	0h	1 = PHY has EEE ability 0 = PHY does not have EEE ability
9	receive_fault_ability	R	0h	1 = PMA/PMD has the ability to detect a fault condition on the receive path 0 = PMA/PMD does not have the ability to detect a fault condition on the receive path
8	low_power_ability	R	1h	1 = PMA/PMD has low-power ability 0 = PMA/PMD does not have low-power ability
7-3	RESERVED	R	0h	Reserved
2	receive_polarity	R	0h	1 = Receive polarity is reversed 0 = Receive polarity is not reversed
1	receive_fault	R	0h	1 = Fault condition detected 0 = Fault condition not detected
0	pma_receive_link_status_ll	R/W0S	0h	1 = PMA/PMD receive link up 0 = PMA/PMD receive link down

7.6.2.90 TRAINING Register (Offset = 1902h) [Reset = 0002h]

TRAINING is shown in Figure 7-107 and described in Table 7-113.

Return to the Summary Table.

First nibble (0x1) in the register address is to indicate MMD register space. For register access, ignore the first nibble.

Figure 7-107. TRAINING Register

15	14	13	12	11	10	9	8
RESERVED					cfg_training_user_fld		
R-0h					R/W-0h		

7	6	5	4	3	2	1	0
cfg_training_user_fld				RESERVED		cfg_oam_en	cfg_eee_en
R/W-0h				R-0h		R/W-1h	R/W-0h

Table 7-113. TRAINING Register Field Descriptions

Bit	Field	Type	Reset	Description
15-11	RESERVED	R	0h	Reserved
10-4	cfg_training_user_fld	R/W	0h	7-bit user defined field to send to the link partner
3-2	RESERVED	R	0h	Reserved
1	cfg_oam_en	R/W	1h	1 = 1000BASE-T1 OAM ability advertised to link partner 0 = 1000BASE-T1 OAM ability not advertised to link partner
0	cfg_eee_en	R/W	0h	1 = EEE ability advertised to link partner 0 = EEE ability not advertised to link partner

7.6.2.91 LP_TRAINING Register (Offset = 1903h) [Reset = 0000h]

LP_TRAINING is shown in Figure 7-108 and described in Table 7-114.

Return to the Summary Table.

First nibble (0x1) in the register address is to indicate MMD register space. For register access, ignore the first nibble.

Figure 7-108. LP_TRAINING Register

15	14	13	12	11	10	9	8
RESERVED					lp_training_user_fld		
R-0h					R-0h		
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
lp_training_user_fld				RESERVED		lp_oam_adv	lp_eee_adv
R-0h				R-0h		R-0h	R-0h

Table 7-114. LP_TRAINING Register Field Descriptions

Bit	Field	Type	Reset	Description
15-11	RESERVED	R	0h	Reserved
10-4	lp_training_user_fld	R	0h	7-bit user defined field received from the link partner
3-2	RESERVED	R	0h	Reserved
1	lp_oam_adv	R	0h	1 = Link partner has 1000BASE-T1 OAM ability 0 = Link partner does not have 1000BASE-T1 OAM ability
0	lp_eee_adv	R	0h	1 = Link partner has EEE ability 0 = Link partner does not have EEE ability

7.6.2.92 TEST_MODE_CONTROL Register (Offset = 1904h) [Reset = 0000h]

TEST_MODE_CONTROL is shown in Figure 7-109 and described in Table 7-115.

Return to the Summary Table.

First nibble (0x1) in the register address is to indicate MMD register space. For register access, ignore the first nibble.

Figure 7-109. TEST_MODE_CONTROL Register

15	14	13	12	11	10	9	8
cfg_test_mode			RESERVED				
R/W-0h			R-0h				
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED							
R-0h							

Table 7-115. TEST_MODE_CONTROL Register Field Descriptions

Bit	Field	Type	Reset	Description
15-13	cfg_test_mode	R/W	0h	111 = Test mode 7 110 = Test mode 6 101 = Test mode 5 100 = Test mode 4 011 = Reserved 010 = Test mode 2 001 = Test mode 1 000 = Normal (non-test) operation
12-0	RESERVED	R	0h	Reserved

7.6.2.93 PCS_CONTROL Register (Offset = 3900h) [Reset = 0000h]

PCS_CONTROL is shown in Figure 7-110 and described in Table 7-116.

Return to the Summary Table.

First nibble (0x3) in the register address is to indicate MMD register space. For register access, ignore the first nibble.

Figure 7-110. PCS_CONTROL Register

15	14	13	12	11	10	9	8
pcs_reset	RESERVED	RESERVED					
R-0h	R-0h	R-0h					
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED							
R-0h							

Table 7-116. PCS_CONTROL Register Field Descriptions

Bit	Field	Type	Reset	Description
15	pcs_reset	R	0h	Note - RW bit, self clear bit 0h = Normal operation 1h = PCS reset
14	RESERVED	R	0h	Reserved
13-0	RESERVED	R	0h	Reserved

7.6.2.94 PCS_STATUS Register (Offset = 3901h) [Reset = 0000h]

PCS_STATUS is shown in Figure 7-111 and described in Table 7-117.

Return to the Summary Table.

First nibble (0x3) in the register address is to indicate MMD register space. For register access, ignore the first nibble.

Figure 7-111. PCS_STATUS Register

15	14	13	12	11	10	9	8
RESERVED				RESERVED	RESERVED	RESERVED	RESERVED
R-0h				R-0h	R-0h	R-0h	R-0h
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
pcs_fault	RESERVED				pcs_receive_link_status_ll	RESERVED	
R-0h	R-0h				R/W0S-0h	R-0h	

Table 7-117. PCS_STATUS Register Field Descriptions

Bit	Field	Type	Reset	Description
15-12	RESERVED	R	0h	Reserved
11	RESERVED	R	0h	Reserved
10	RESERVED	R	0h	Reserved
9	RESERVED	R	0h	Reserved
8	RESERVED	R	0h	Reserved
7	pcs_fault	R	0h	0h = No fault condition detected 1h = Fault condition detected
6-3	RESERVED	R	0h	Reserved
2	pcs_receive_link_status_ll	R/W0S	0h	0h = PCS receive link down 1h = PCS receive link up
1-0	RESERVED	R	0h	Reserved

7.6.2.95 PCS_STATUS_2 Register (Offset = 3902h) [Reset = 0000h]

PCS_STATUS_2 is shown in Figure 7-112 and described in Table 7-118.

Return to the Summary Table.

First nibble (0x3) in the register address is to indicate MMD register space. For register access, ignore the first nibble.

Figure 7-112. PCS_STATUS_2 Register

15	14	13	12	11	10	9	8
RESERVED					pcs_receive_link_status	hi_rfer	block_lock
R-0h					R-0h	R-0h	R-0h
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
hi_rfer_lh	block_lock_ll	RESERVED					
R/W0C-0h	R/W0S-0h	R-0h					

Table 7-118. PCS_STATUS_2 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-11	RESERVED	R	0h	Reserved
10	pcs_receive_link_status	R	0h	0h = PCS receive link down 1h = PCS receive link up
9	hi_rfer	R	0h	0h = PCS not reporting a high BER 1h = PCS reporting a high BER
8	block_lock	R	0h	0h = PCS not locked to received blocks 1h = PCS locked to received blocks
7	hi_rfer_lh	R/W0C	0h	0h = PCS has not reported a high BER 1h = PCS has reported a high BER
6	block_lock_ll	R/W0S	0h	0h = PCS does not have block lock 1h = PCS has block lock
5-0	RESERVED	R	0h	Reserved

7.6.2.96 OAM_TRANSMIT Register (Offset = 3904h) [Reset = 0000h]

OAM_TRANSMIT is shown in Figure 7-113 and described in Table 7-119.

Return to the Summary Table.

First nibble (0x3) in the register address is to indicate MMD register space. For register access, ignore the first nibble.

Figure 7-113. OAM_TRANSMIT Register

15	14	13	12	11	10	9	8
mr_tx_valid	mr_tx_toggle	mr_tx_received	mr_tx_received_toggle	mr_tx_message_num			
R/WMC,0-0h	R-0h	R-0h	R-0h	R/W-0h			
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED				mr_rx_ping	mr_tx_ping	mr_tx_snr	
R-0h				R-0h	R/W-0h	R-0h	

Table 7-119. OAM_TRANSMIT Register Field Descriptions

Bit	Field	Type	Reset	Description
15	mr_tx_valid	R/WMC,0	0h	This bit is used to indicate message data in registers 3.2308.11:8, 3.2309, 3.2310, 3.2311, and 3.2312 are valid and ready to be loaded. This bit shall self-clear when registers are loaded by the state machine. 1 = Message data in registers are valid 0 = Message data in registers are not valid
14	mr_tx_toggle	R	0h	Toggle value to be transmitted with message. This bit is set by the state machine and cannot be overridden by the user.
13	mr_tx_received	R	0h	This bit shall self clear on read. 1 = 1000BASE-T1 OAM message received by link partner 0 = 1000BASE-T1 OAM message not received by link partner
12	mr_tx_received_toggle	R	0h	Toggle value of message that was received by link partner
11-8	mr_tx_message_num	R/W	0h	User-defined message number to send
7-4	RESERVED	R	0h	Reserved
3	mr_rx_ping	R	0h	Received PingTx value from latest good 1000BASE-T1 OAM frame received
2	mr_tx_ping	R/W	0h	Ping value to send to link partner
1-0	mr_tx_snr	R	0h	00 = PHY link is failing and shall drop link and relink within 2ms to 4ms after the end of the current 1000BASE-T1 OAM frame. 01 = LPI refresh is insufficient to maintain PHY SNR. Request link partner to exit LPI and send idles (used only when EEE is enabled). 10 = PHY SNR is marginal. 11 = PHY SNR is good.

7.6.2.97 OAM_TX_MESSAGE_1 Register (Offset = 3905h) [Reset = 0000h]

OAM_TX_MESSAGE_1 is shown in Figure 7-114 and described in Table 7-120.

Return to the Summary Table.

First nibble (0x3) in the register address is to indicate MMD register space. For register access, ignore the first nibble.

Figure 7-114. OAM_TX_MESSAGE_1 Register

15	14	13	12	11	10	9	8
mr_tx_message_15_0							
R/W-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
mr_tx_message_15_0							
R/W-0h							

Table 7-120. OAM_TX_MESSAGE_1 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	mr_tx_message_15_0	R/W	0h	Message octet 1/0. LSB transmitted first.

7.6.2.98 OAM_TX_MESSAGE_2 Register (Offset = 3906h) [Reset = 0000h]

OAM_TX_MESSAGE_2 is shown in Figure 7-115 and described in Table 7-121.

Return to the Summary Table.

First nibble (0x3) in the register address is to indicate MMD register space. For register access, ignore the first nibble.

Figure 7-115. OAM_TX_MESSAGE_2 Register

15	14	13	12	11	10	9	8
mr_tx_message_31_16							
R/W-0h							
7	6	5	4	3	2	1	0
mr_tx_message_31_16							
R/W-0h							

Table 7-121. OAM_TX_MESSAGE_2 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	mr_tx_message_31_16	R/W	0h	Message octet 3/2. LSB transmitted first.

7.6.2.99 OAM_TX_MESSAGE_3 Register (Offset = 3907h) [Reset = 0000h]

OAM_TX_MESSAGE_3 is shown in Figure 7-116 and described in Table 7-122.

Return to the Summary Table.

First nibble (0x3) in the register address is to indicate MMD register space. For register access, ignore the first nibble.

Figure 7-116. OAM_TX_MESSAGE_3 Register

15	14	13	12	11	10	9	8
mr_tx_message_47_32							
R/W-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
mr_tx_message_47_32							
R/W-0h							

Table 7-122. OAM_TX_MESSAGE_3 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	mr_tx_message_47_32	R/W	0h	Message octet 5/4. LSB transmitted first.

7.6.2.100 OAM_TX_MESSAGE_4 Register (Offset = 3908h) [Reset = 0000h]

OAM_TX_MESSAGE_4 is shown in Figure 7-117 and described in Table 7-123.

Return to the Summary Table.

First nibble (0x3) in the register address is to indicate MMD register space. For register access, ignore the first nibble.

Figure 7-117. OAM_TX_MESSAGE_4 Register

15	14	13	12	11	10	9	8
mr_tx_message_63_48							
R/W-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
mr_tx_message_63_48							
R/W-0h							

Table 7-123. OAM_TX_MESSAGE_4 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	mr_tx_message_63_48	R/W	0h	Message octet 7/6. LSB transmitted first.

7.6.2.101 OAM_RECEIVE Register (Offset = 3909h) [Reset = 0000h]

OAM_RECEIVE is shown in Figure 7-118 and described in Table 7-124.

Return to the Summary Table.

First nibble (0x3) in the register address is to indicate MMD register space. For register access, ignore the first nibble.

Figure 7-118. OAM_RECEIVE Register

15	14	13	12	11	10	9	8
mr_rx_lp_valid	mr_rx_lp_toggle	RESERVED		mr_rx_lp_message_num			
R-0h	R-0h	R-0h		R-0h			

7	6	5	4	3	2	1	0
RESERVED						mr_rx_lp_SNR	
R-0h						R-0h	

Table 7-124. OAM_RECEIVE Register Field Descriptions

Bit	Field	Type	Reset	Description
15	mr_rx_lp_valid	R	0h	This bit is used to indicate message data in registers 3.2313.11:8, 3.2314, 3.2315, 3.2316, and 3.2317 are stored and ready to be read. This bit shall self clear when register 3.2317 is read. 0h = Message data in registers are not valid 1h = Message data in registers are valid
14	mr_rx_lp_toggle	R	0h	Toggle value received with message Note - 0x3 added in [15:12] to differentiate
13-12	RESERVED	R	0h	Reserved
11-8	mr_rx_lp_message_num	R	0h	Message number from link partner Note - 0x3 added in [15:12] to differentiate
7-2	RESERVED	R	0h	Reserved
1-0	mr_rx_lp_SNR	R	0h	00 = Link partner link is failing and shall drop link and relink within 2ms to 4ms after the end of the current 1000BASE-T1 OAM frame. 01 = LPI refresh is insufficient to maintain link partner SNR. Link partner requests local device to exit LPI and send idles (used only when EEE is enabled). 10 = Link partner SNR is marginal. 11 = Link partner SNR is good

7.6.2.102 OAM_RX_MESSAGE_1 Register (Offset = 390Ah) [Reset = 0000h]

OAM_RX_MESSAGE_1 is shown in Figure 7-119 and described in Table 7-125.

Return to the Summary Table.

First nibble (0x3) in the register address is to indicate MMD register space. For register access, ignore the first nibble.

Figure 7-119. OAM_RX_MESSAGE_1 Register

15	14	13	12	11	10	9	8
mr_rx_lp_message_15_0							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
mr_rx_lp_message_15_0							
R-0h							

Table 7-125. OAM_RX_MESSAGE_1 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	mr_rx_lp_message_15_0	R	0h	Message octet 1/0. LSB transmitted first.

7.6.2.103 OAM_RX_MESSAGE_2 Register (Offset = 390Bh) [Reset = 0000h]

OAM_RX_MESSAGE_2 is shown in Figure 7-120 and described in Table 7-126.

Return to the Summary Table.

First nibble (0x3) in the register address is to indicate MMD register space. For register access, ignore the first nibble.

Figure 7-120. OAM_RX_MESSAGE_2 Register

15	14	13	12	11	10	9	8
mr_rx_lp_message_31_16							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
mr_rx_lp_message_31_16							
R-0h							

Table 7-126. OAM_RX_MESSAGE_2 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	mr_rx_lp_message_31_16	R	0h	Message octet 3/2. LSB transmitted first.

7.6.2.104 OAM_RX_MESSAGE_3 Register (Offset = 390Ch) [Reset = 0000h]

OAM_RX_MESSAGE_3 is shown in Figure 7-121 and described in Table 7-127.

Return to the Summary Table.

First nibble (0x3) in the register address is to indicate MMD register space. For register access, ignore the first nibble.

Figure 7-121. OAM_RX_MESSAGE_3 Register

15	14	13	12	11	10	9	8
mr_rx_lp_message_47_32							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
mr_rx_lp_message_47_32							
R-0h							

Table 7-127. OAM_RX_MESSAGE_3 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	mr_rx_lp_message_47_32	R	0h	Message octet 5/4. LSB transmitted first.

7.6.2.105 OAM_RX_MESSAGE_4 Register (Offset = 390Dh) [Reset = 0000h]

OAM_RX_MESSAGE_4 is shown in Figure 7-122 and described in Table 7-128.

Return to the Summary Table.

First nibble (0x3) in the register address is to indicate MMD register space. For register access, ignore the first nibble.

Figure 7-122. OAM_RX_MESSAGE_4 Register

15	14	13	12	11	10	9	8
mr_rx_lp_message_63_48							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
mr_rx_lp_message_63_48							
R-0h							

Table 7-128. OAM_RX_MESSAGE_4 Register Field Descriptions

Bit	Field	Type	Reset	Description
15-0	mr_rx_lp_message_63_48	R	0h	Message octet 7/6. LSB transmitted first.

7.6.2.106 AN_CFG Register (Offset = 7200h) [Reset = 0000h]

AN_CFG is shown in Figure 7-123 and described in Table 7-129.

Return to the Summary Table.

First nibble (0x7) in the register address is to indicate MMD register space. For register access, ignore the first nibble.

Figure 7-123. AN_CFG Register

15	14	13	12	11	10	9	8
RESERVED							
R-0h							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RESERVED							mr_main_reset
R-0h							R/WSC-0h

Table 7-129. AN_CFG Register Field Descriptions

Bit	Field	Type	Reset	Description
15-1	RESERVED	R	0h	Reserved
0	mr_main_reset	R/WSC	0h	1 = Reset link sync/autoneg Note - RW bit

8 Application and Implementation

Note

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes, as well as validating and testing their design implementation to confirm system functionality.

8.1 Application Information

The DP83TG720R-Q1 is a single-port 1-Gbps Automotive Ethernet PHY. It supports IEEE 802.3bp and allows for connections to an Ethernet MAC through RGMII. When using the device for Ethernet applications, it is necessary to meet certain requirements for normal operation. The following subsections are intended to assist in appropriate component selection and required connections.

8.2 Typical Applications

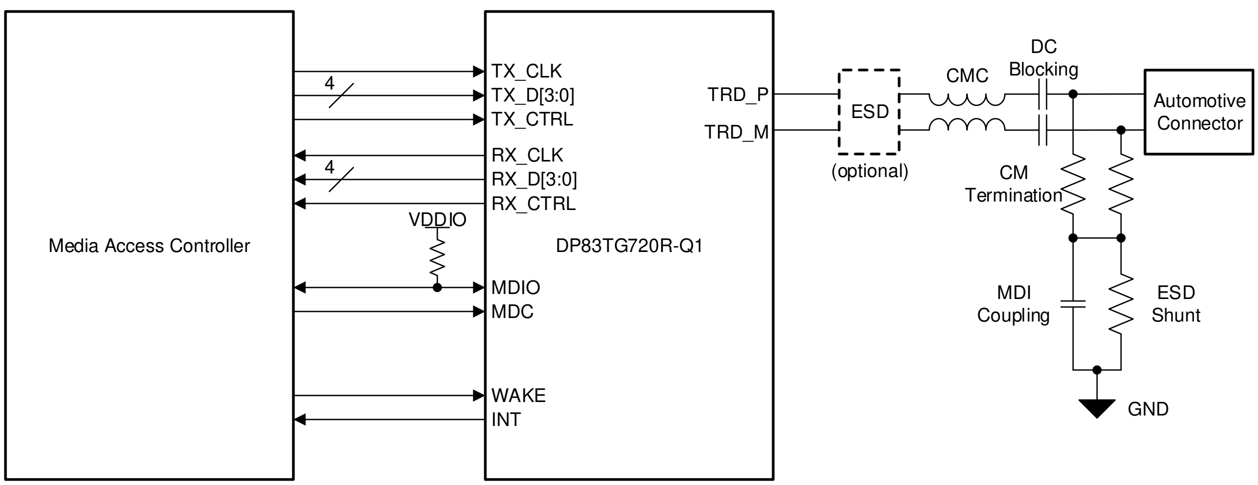


Figure 8-1. Typical Application (RGMII)

Table 8-1. Recommended Components for MDI Network

Design Parameter	Value
DC Blocking Capacitors 1	0.1µF
Common-Mode Choke	Murata :DLW32MH101XT2
Common Mode Termination Resistors 1 2	1kΩ
MDI Coupling Capacitor	4.7nF
ESD Shunt	100kΩ

1. 1% tolerance components are recommended for margins over spec of return loss and mode conversion.
2. CM termination resistor's size higher than 0805 helps in increasing ESD margin.

8.2.1 Design Requirements

For these typical applications, use the following as input parameters:

Table 8-2. Design Parameters

DESIGN PARAMETER	EXAMPLE VALUE
V_{DDIO}	1.8V, 2.5V, or 3.3V
De-Coupling Capacitors V_{DDIO} (pin 34)	10nF, 100nF
De-Coupling Capacitors V_{DDIO} (pin 22)	10nF, 100nF, 2.2uF

Table 8-2. Design Parameters (continued)

DESIGN PARAMETER	EXAMPLE VALUE
Combined Ferrite Bead for VDDIO	BLM18HE102SN1
V_{DDA}	3.3V
De-Coupling Capacitors V_{DDA} (pin 11)	10nF, 100nF, 2.2uF
Ferrite Bead for V_{DDA}	BLM18KG601SH1
V_{DD1p0}	1V
De-Coupling Capacitors V_{DD1P0} (pin 9)	10nF, 100nF, 2.2uF
De-Coupling Capacitors V_{DDA} (pin 21)	10nF, 100nF, 2.2uF
Combined Ferrite Bead for V_{DD1P0}	BLM18KG601SH1
V_{sleep}	3.3V
DC Blocking Capacitors (1)	0.1µF
Common-Mode Choke	Murata :DLW32MH101XT2
Common Mode Termination Resistors(1) (2)	1kΩ
MDI Coupling Capacitor	4.7nF
ESD Shunt	100kΩ
Reference Clock	25MHz

(1) 1% tolerance components are recommended to improve return loss and mode conversion measurements. CM termination resistor's size higher than 0805 helps in increasing ESD margin.
(2) CM termination resistor's size higher than 0805 helps in increasing ESD margin.

8.3 Power Supply Recommendations

The DP83TG720R-Q1 is capable of operating with a wide range of IO supply voltages (3.3V, 2.5V, or 1.8V). No power supply sequencing is required. The recommended power supply de-coupling network is shown in following figure :

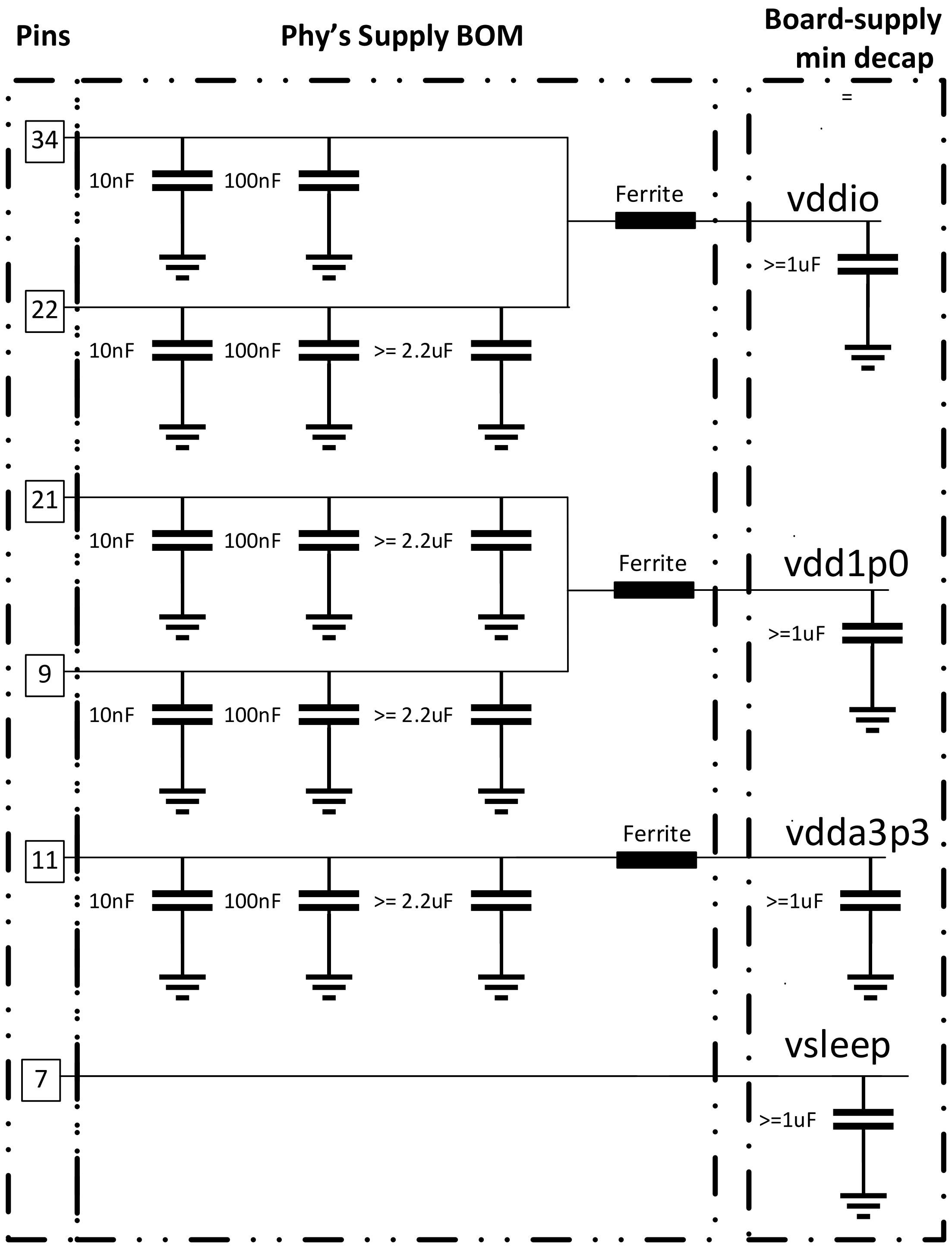


Figure 8-2. Recommended Supply De-Coupling Network (if sleep mode is used in the application)

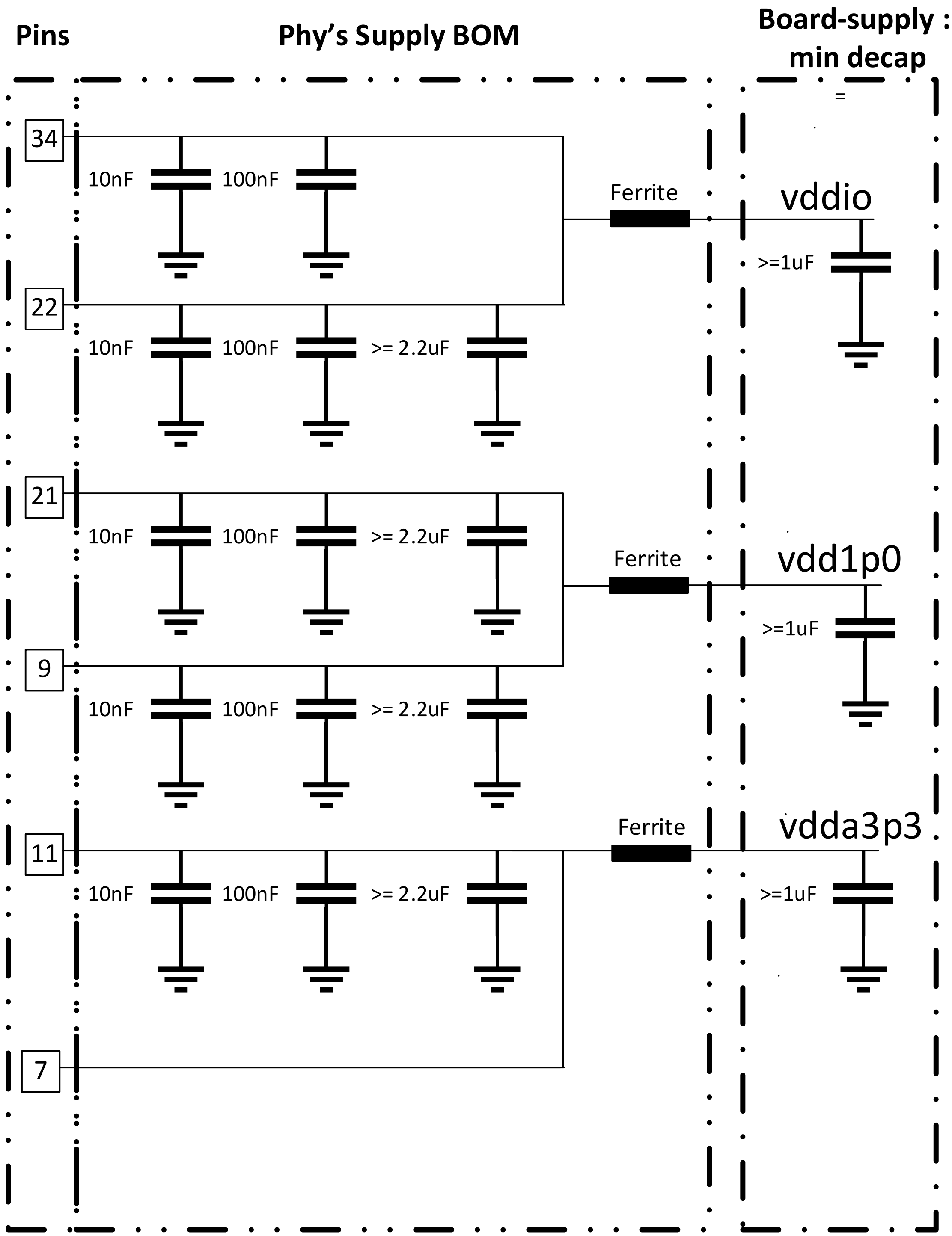


Figure 8-3. Recommended Supply De-Coupling Network (if sleep mode is not used in application)

Table 8-3. Recommended Components for Power Network

Design Parameter	Value
V_{DDIO}	1.8V, 2.5V, or 3.3V
De-Coupling Capacitors V_{DDIO} (pin 34)	10nF, 100nF
De-Coupling Capacitors V_{DDIO} (pin 22)	10nF, 100nF, 2.2uF
Combined Ferrite Bead for VDDIO	BLM18HE102SN1

Table 8-3. Recommended Components for Power Network (continued)

Design Parameter	Value
V_{DDA}	3.3V
De-Coupling Capacitors V_{DDA} (pin 11)	10nF, 100nF, 2.2uF
Ferrite Bead for V_{DDA}	BLM18KG601SH1
V_{DD1p0}	1V
De-Coupling Capacitors V_{DD1P0} (pin 9)	10nF, 100nF, 2.2uF
De-Coupling Capacitors V_{DDA} (pin 21)	10nF, 100nF, 2.2uF
Combined Ferrite Bead for V_{DD1P0}	BLM18KG601SH1
V_{sleep}	3.3V

Note

For recommendation on LDOs for VDD1p0 and Vsleep, please refer to the *DP83TC811, DP83TG730 Rollover Document* application report.

8.4 Compatibility with TI's 100BT1 PHY

Following table shows pin comparison between DP83TC811 and DP83TG720. Pins highlighted in bold need attention while designing a common board for both 100BT1 and 1000BT1 PHY. 100BT1 and 1000BT1 PHY's different BOM requirements can also be taken care by a common board.

Details and recommendation for common board design can be found in *DP83TC811, DP83TG720 Rollover Document* application report.

Table 8-4. Pin Comparison Table

Pin No.	DP83TC811	DP83TG720
1	MDC	MDC
2	INT_N	INT_N
3	RESET_N	RESET_N
4	XO	XO
5	XI	XI
6	LED_1	LED_1
7	**EN**	**VSLEEP**
8	**WAKE**	**WAKE**
9	**DNC**	**VDD1P0**
10	**INH**	**INH**
11	VDDA	VDDA
12	TRD_P	TRD_P
13	TRD_M	TRD_M
14	RX_ER	STRP1
15	RX_DV	RX_CTRL
16	CLKOUT	CLKOUT
17	**TCK**	**DNC**
18	**TDO**	**DNC**
19	**TMS**	**DNC**
20	**TCK**	**DNC**
21	**DNC**	**VDD1P0**
22	VDDIO	VDDIO
23	RX_D3	RX_D3
24	RX_D2	RX_D2

Table 8-4. Pin Comparison Table (continued)

Pin No.	DP83TC811	DP83TG720
25	RX_D1	RX_D1
26	RX_D0	RX_D0
27	RX_CLK	RX_CLK
28	TXCLK	TXCLK
29	TX_EN	TX_CTRL
30	TX_D3	TX_D3
31	TX_D2	TX_D2
32	TX_D1	TX_D1
33	TX_D0	TX_D0
34	**TX_ER**	**VDDIO**
35	LED_0	LED_0
36	MDIO	MDIO

8.5 Layout

8.5.1 Layout Guidelines

8.5.1.1 Signal Traces

PCB traces are lossy and long traces can degrade signal quality. Traces must be kept short as possible. Unless mentioned otherwise, all signal traces must be 50Ω, single-ended impedance. Differential traces must be 50Ω single-ended and 100Ω differential. Impedance discontinuities cause reflections leading to emissions and signal integrity issues. Stubs must be avoided on all signal traces, especially differential signal pairs.

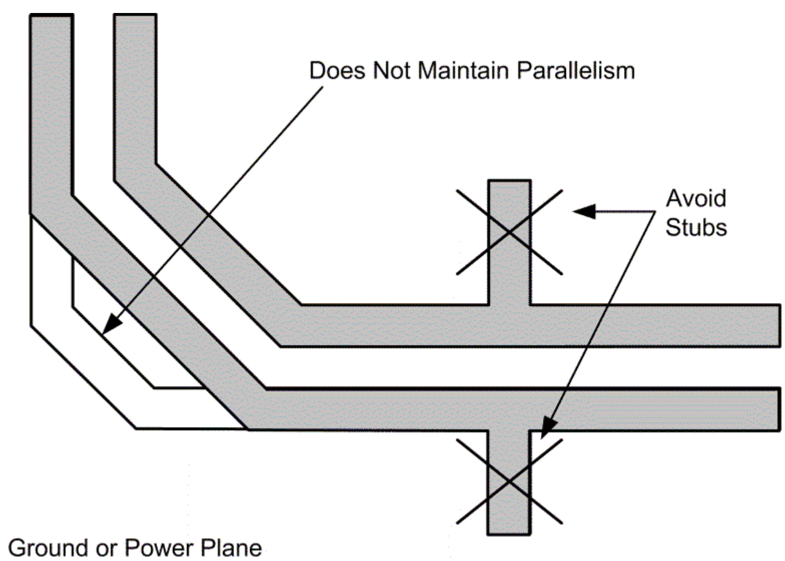


Figure 8-4. Differential Signal Trace Routing

Within the differential pairs, trace lengths must be run parallel to each other and matched in length. Matched lengths minimize delay differences, avoiding an increase in common mode noise and emissions. Length matching is also important for MAC interface connections. All transmit signal traces must be length matched to each other and all receive signal traces must be length matched to each other.

Avoid crossover or vias on signal path traces. Vias present impedance discontinuities and be minimized when possible. Route trace pairs on the same layer. Avoid signals on different layers crossing each other without at least one return path plane between them. Differential pairs must always have a constant coupling distance between them. For convenience and efficiency, TI recommends routing critical signals first (that is, MDI differential pairs, reference clock, and MAC IF traces).

8.5.1.2 Return Path

A general best practice is to have a solid return path beneath all signal traces. This return path can be a continuous ground or DC power plane. Reducing the width of the return path can potentially affect the impedance of the signal trace. This effect is more prominent when the width of the return path is comparable to the width of the signal trace. Breaks in return path between the signal traces must be avoided. A signal crossing a split plane causes unpredictable return path currents and impacts signal quality and result in emissions issues.

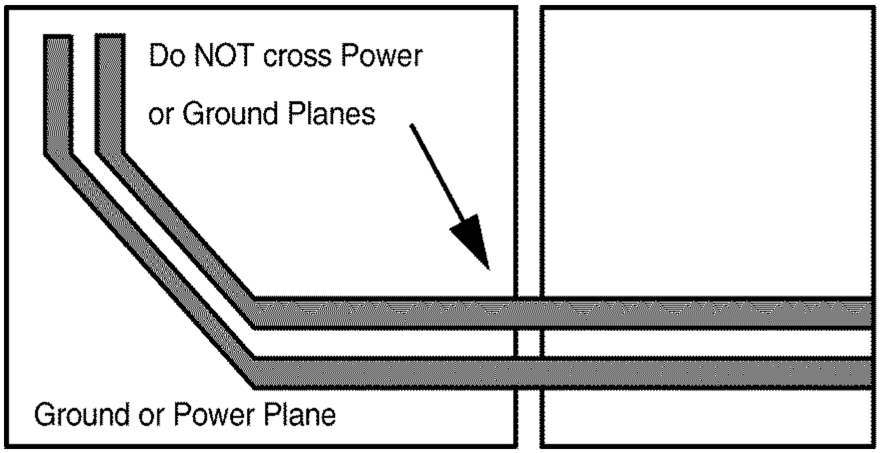


Figure 8-5. Power and Ground Plane Breaks

8.5.1.3 Physical Medium Attachment

There must be no metal running beneath the common-mode choke. CMCs can inject noise into metal beneath them, which can affect the emissions and immunity performance of the system. Because the DP83TG720R-Q1 is a voltage mode line driver, no external termination resistors are required. The ESD shunt and MDI coupling capacitor must be connected to ground. Select common mode termination resistors that are 1% tolerance or better to improve differential coupling.

8.5.1.4 Metal Pour

All metal pours that are not signals or power must be tied to ground. There must be no floating metal in the system, and there must be no metal between differential traces.

8.5.1.5 PCB Layer Stacking

To meet signal integrity and performance requirements, minimum four-layer PCB is recommended. However, a six-layer PCB and above should be used when possible.

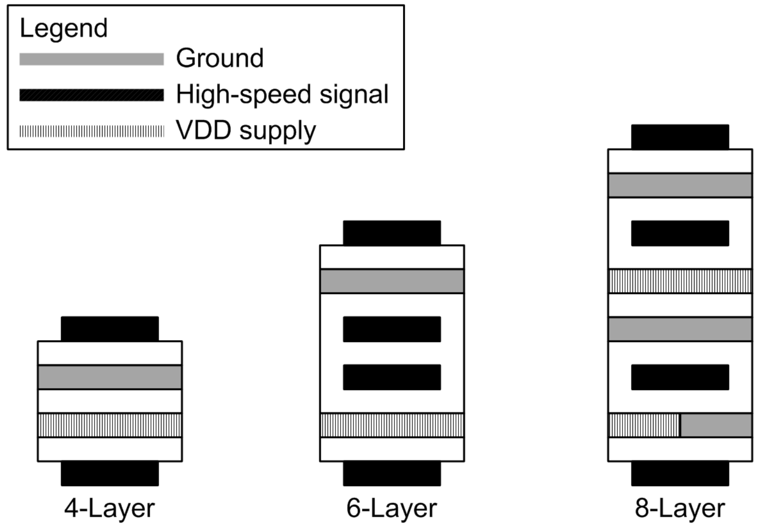


Figure 8-6. Recommended PCB Layer Stack-Up

9 Device and Documentation Support

Note

TI is transitioning to use more inclusive terminology. Some language may be different than what you would expect to see for certain technology areas.

9.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Notifications* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

9.2 Support Resources

TI E2E™ support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

Linked content is provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

9.3 Trademarks

TI E2E™ is a trademark of Texas Instruments.
All trademarks are the property of their respective owners.

9.4 Electrostatic Discharge Caution

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

9.5 Glossary

TI Glossary — This glossary lists and explains terms, acronyms, and definitions.

10 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision C (November 2022) to Revision D (April 2025) — **Page**

- Changed the order of register 0x619 and 0x624 writes 29
- Changed the parameter 'slope_temperature_sensor'........ 32
- Added a statement that Auto-Polarity Correction can't be disabled on DP83TG720-Q1........ 42
- Simplified the description of Serial Management Interface for ease of readability........ 46
- Changed LED_0 pin number from 1 to 35 in Table 7-18........ 49
- Removed unused register fields from the register map........ 53

Changes from Revision B (March 2021) to Revision C (November 2022) — **Page**

- Updated the Pin state of strap_1 to input only. 4
- Edited the INH pin in power/reset to PMOS, OD, O in Pin States table. Updated abbreviations........ 6
- Added the Pin Power Domain Table........ 8
- SQI section updated to indicate improved number of SQI levels with updated computation method........ 24
- Updated the link for the TDR application note........ 24
- Updated the step of local and remote sleep entry........ 39

- CM resistor packaging recommendation 0805 163

Changes from Revision A (February 2021) to Revision B (March 2021) **Page**

- IOZ, 2 level boot-strap's Mode 2 threshold and Rpull-down min/max data sheet limits updated to give more margin to customer application 9
- Min/Max values of rgmii DLL_TX_DELAY, sleep mode timing parameters, latency parameters, reset mode power, standby mode power and sleep mode power added 9
- Changed Integrated Pull-Down Resistance from 4.5kΩ to 4.725kΩ 9
- Further details added to remote sleep exit procedure 39
- Note added for more margins for 1.8V two level straps 49
- Updated Power Supply Recommendation Note 164

Changes from Revision * (December 2020) to Revision A (February 2021) **Page**

- Updated the Pull-down resistor value of rx_cntrl and strp_1 pins in the pin-state tables. Changed from 6 K to 6.3 K to match value in the Specifications section 4
- SQI section updated to meet OA requirements 24
- Strap circuit diagram updated to remove external pull-down 49

11 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left navigation.

11.1 Package Option Addendum

11.1.1 Packaging Information

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish(4)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking(5) (6)
PDP83TG720SWCSTQ1	EARLY SAMPLE	VQFN	RHA	36	250	RoHS	NiPdAu	MSL3-260C	-40 to 125	
DP83TG720RWRHATQ1	ACTIVE	VQFN	RHA	36	250	RoHS	NiPdAu	MSL3-260C	-40 to 125	720R
DP83TG720RWRHARQ1	ACTIVE	VQFN	RHA	36	2500	RoHS	NiPdAu	MSL3-260C	-40 to 125	720R

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PRE_PROD Unannounced device, not in production, not available for mass market, nor on the web, samples not available.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

(5) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device

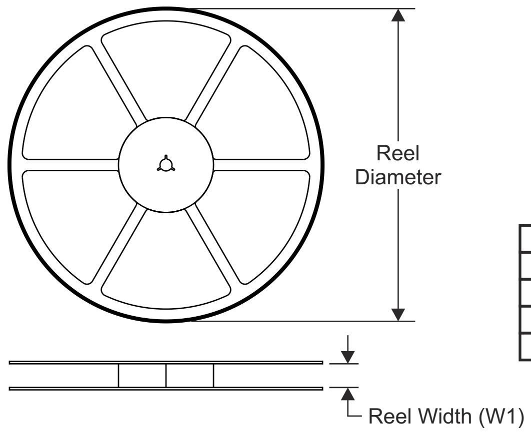
(6) Multiple Device markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

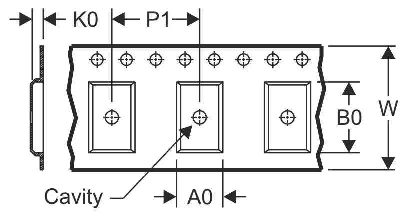
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

11.1.2 Tape and Reel Information

REEL DIMENSIONS

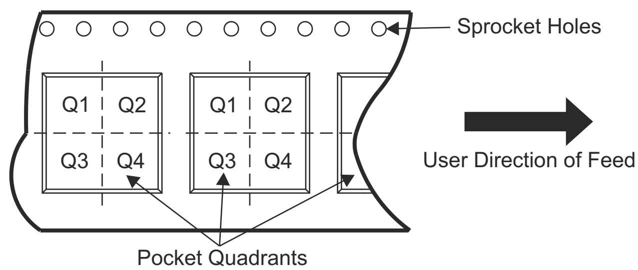


TAPE DIMENSIONS



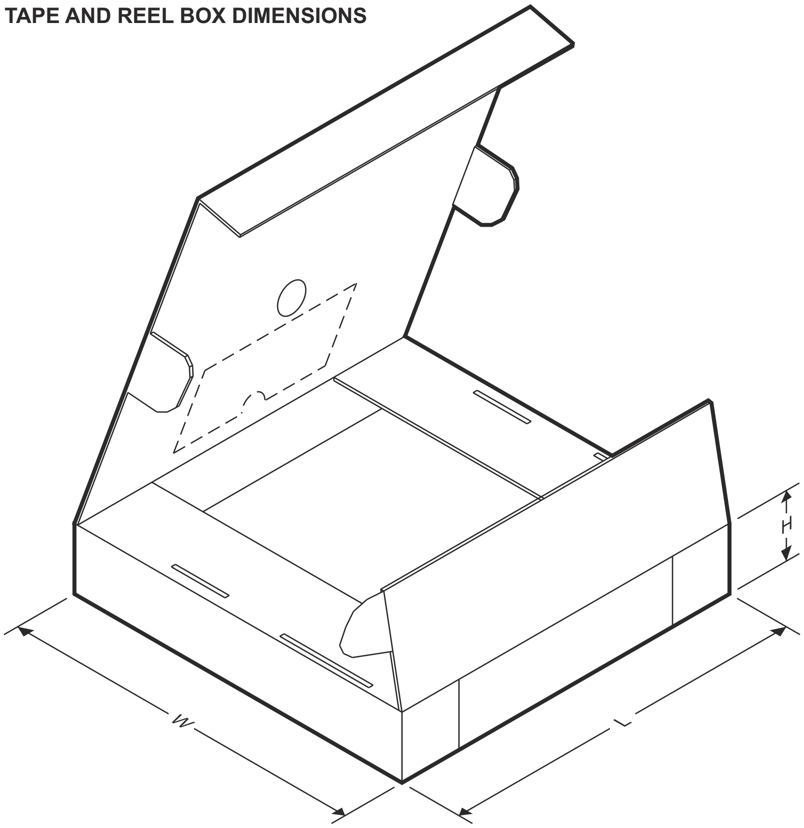
A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
PDP83TG720SWCSTQ1	VQFN	RHA	36	250	Call TI	Call TI	Call TI	Call TI	Call TI	Call TI	Call TI	Call TI
DP83TG720RWRHATQ1	VQFN	RHA	36	250	180	16.4	6.3	6.3	1.1	12	16	Q2
DP83TG720RWRHARQ1	VQFN	RHA	36	2500	330	16.4	6.3	6.3	1.1	12	16	Q2

TAPE AND REEL BOX DIMENSIONS



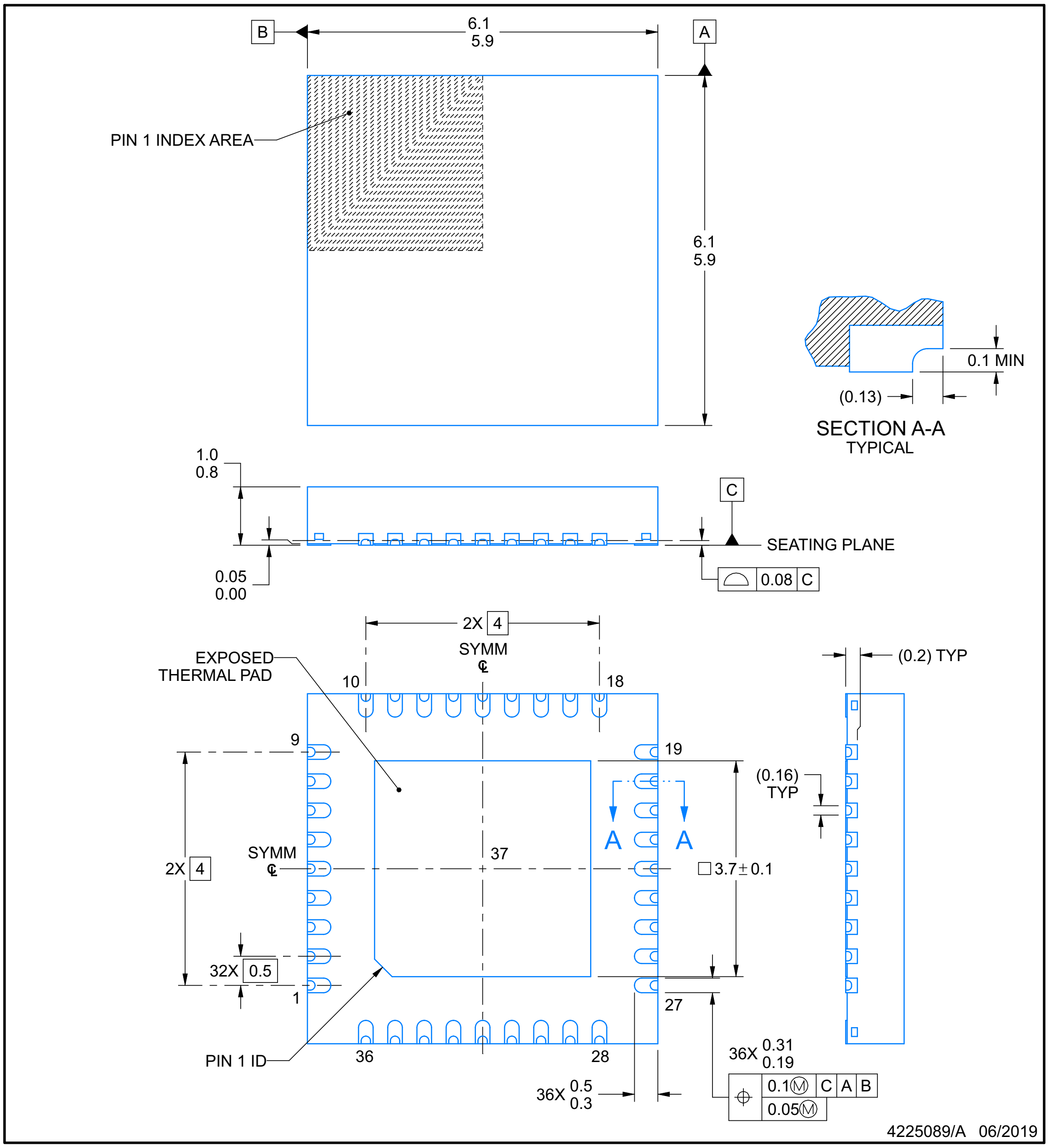
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
DP83TG720RWRHATQ1	VQFN	RHA	36	250	210	185	35
DP83TG720RWRHARQ1	VQFN	RHA	36	2500	367	367	35

PACKAGE OUTLINE

RHA0036A

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



NOTES:

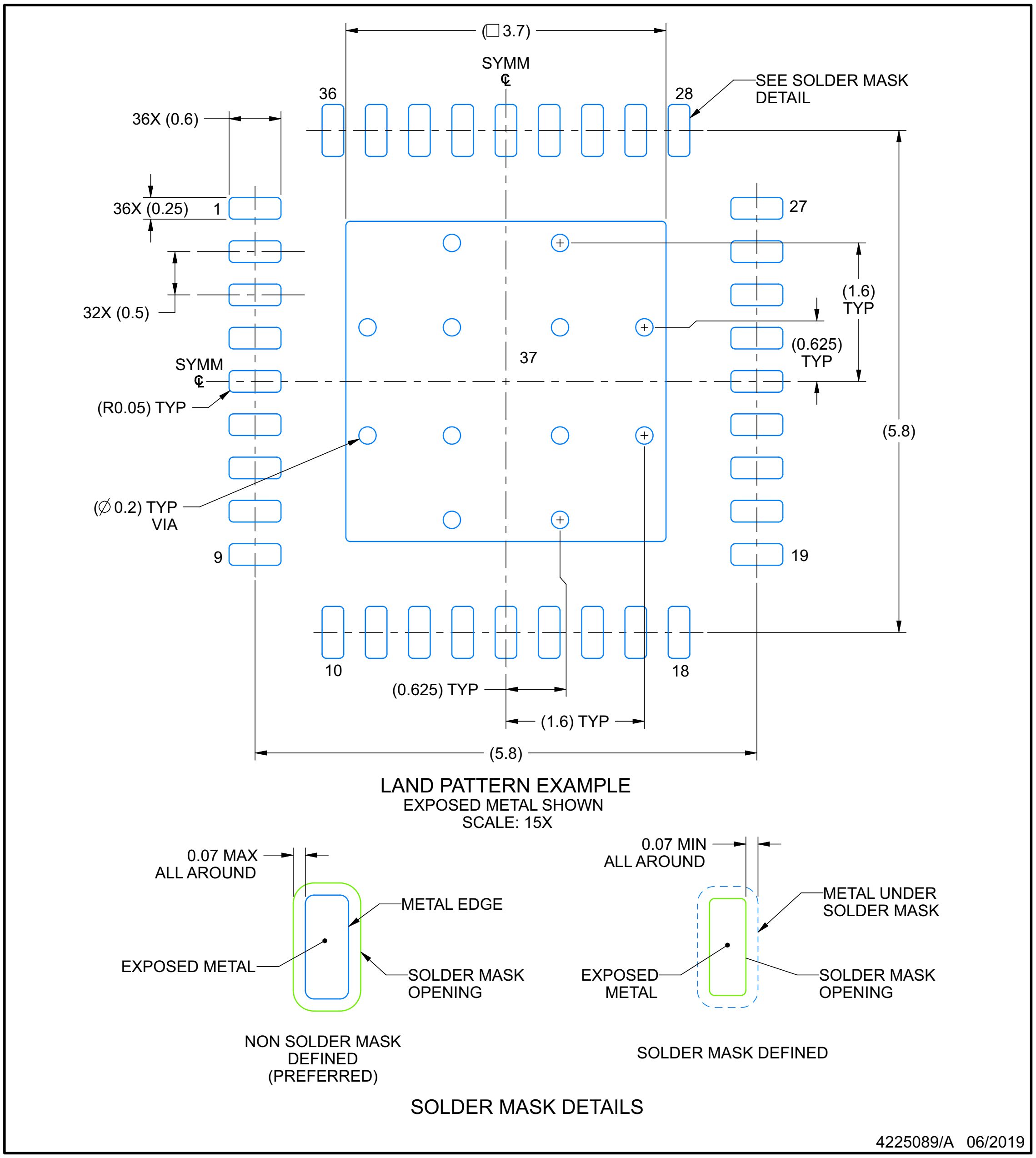
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

EXAMPLE BOARD LAYOUT

RHA0036A

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



NOTES: (continued)

4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

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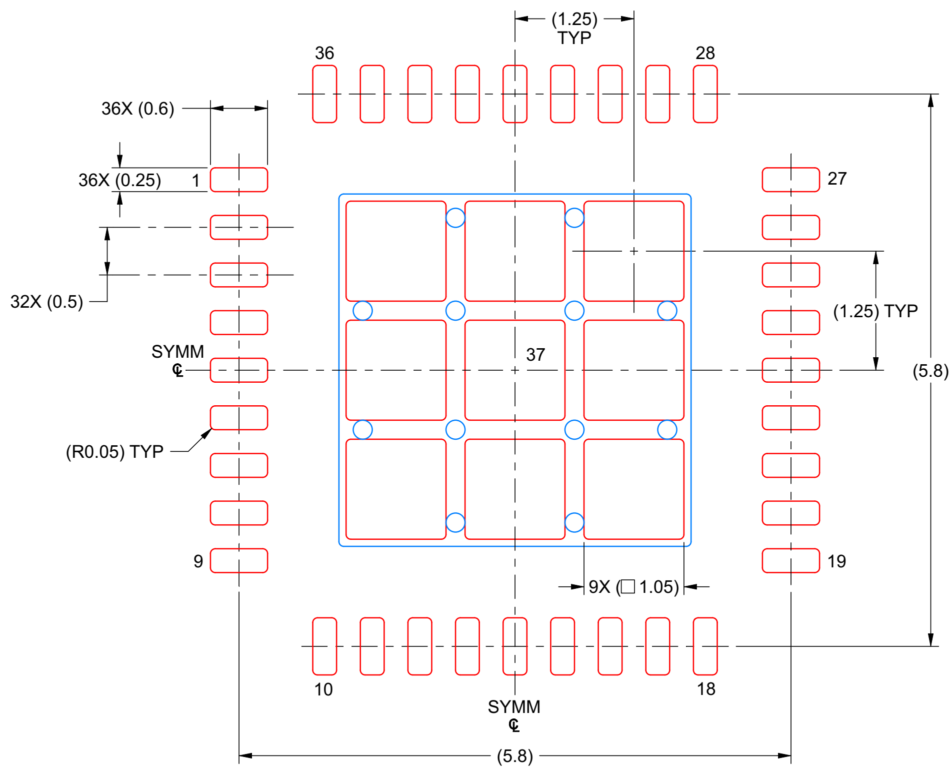
EXAMPLE STENCIL DESIGN

RHA0036A

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



SOLDER PASTE EXAMPLE
BASED ON 0.125 MM THICK STENCIL
SCALE: 15X

EXPOSED PAD 37
72% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE

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NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

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PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
DP83TG720RWRHARQ1	Active	Production	VQFN (RHA) | 36	2500 | LARGE T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 125	720R
DP83TG720RWRHARQ1.A	Active	Production	VQFN (RHA) | 36	2500 | LARGE T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 125	720R
DP83TG720RWRHATQ1	Active	Production	VQFN (RHA) | 36	250 | SMALL T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 125	720R
DP83TG720RWRHATQ1.A	Active	Production	VQFN (RHA) | 36	250 | SMALL T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 125	720R

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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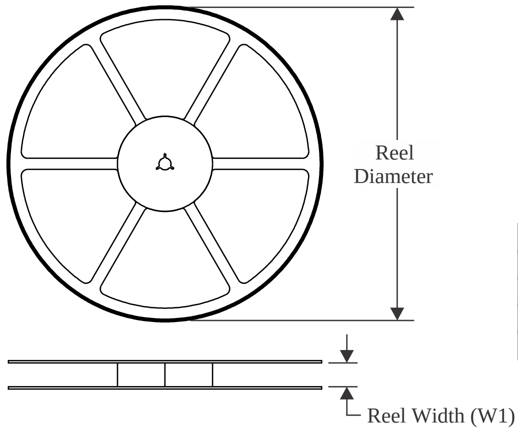
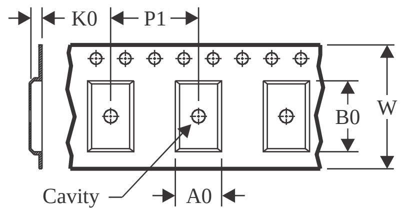
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

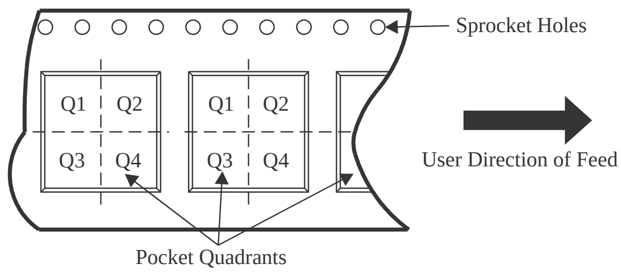


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

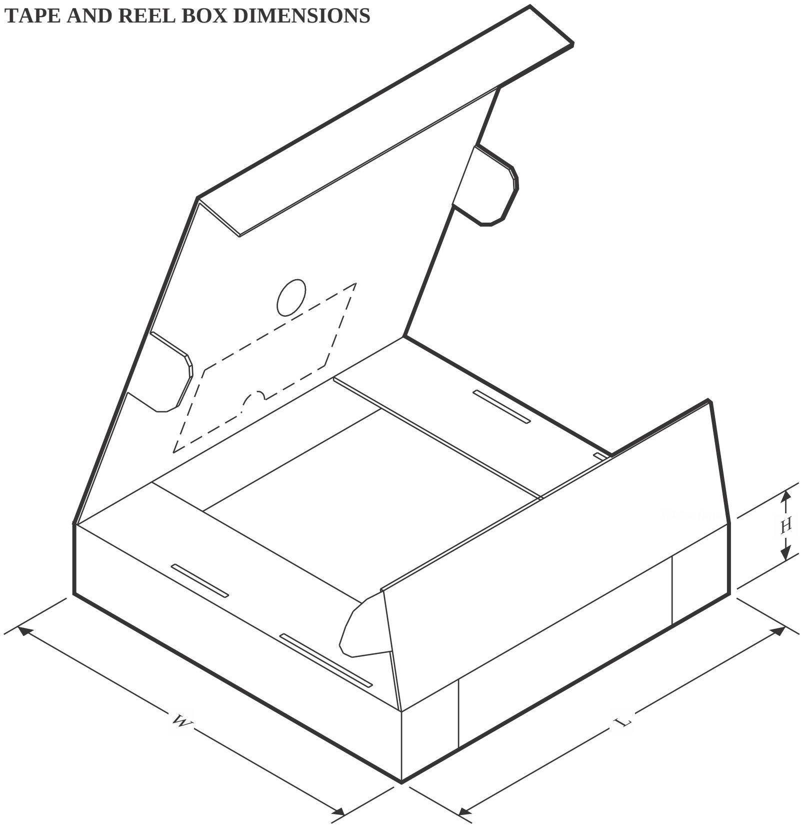
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
DP83TG720RWRHARQ1	VQFN	RHA	36	2500	330.0	16.4	6.3	6.3	1.1	12.0	16.0	Q2
DP83TG720RWRHATQ1	VQFN	RHA	36	250	180.0	16.4	6.3	6.3	1.1	12.0	16.0	Q2

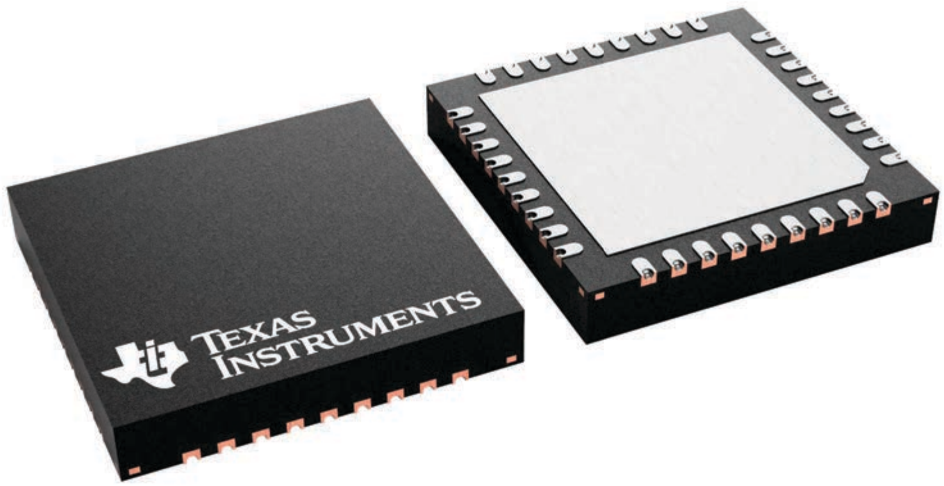
TAPE AND REEL BOX DIMENSIONS

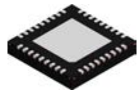


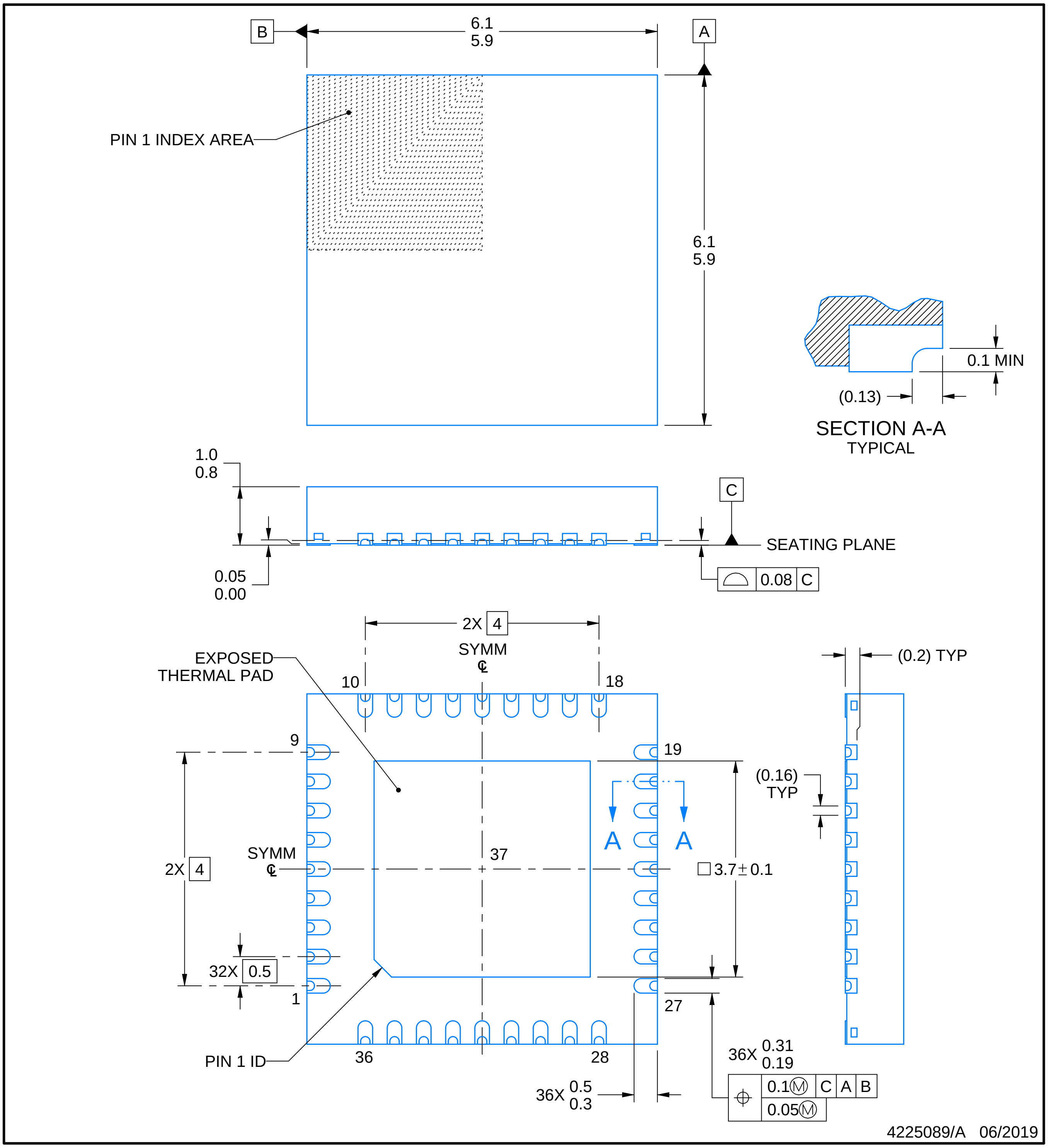
*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
DP83TG720RWRHARQ1	VQFN	RHA	36	2500	367.0	367.0	35.0
DP83TG720RWRHATQ1	VQFN	RHA	36	250	210.0	185.0	35.0

This image is a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.







NOTES:

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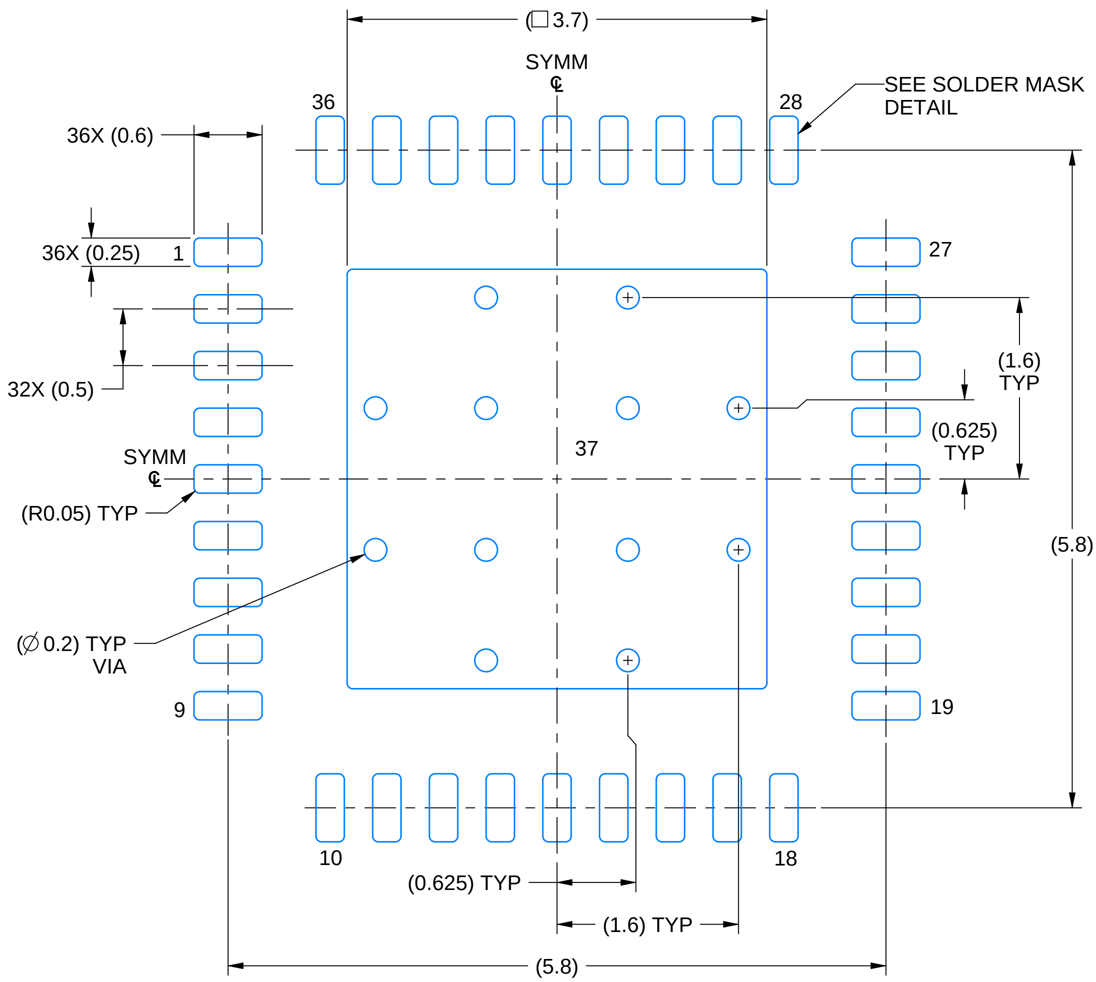
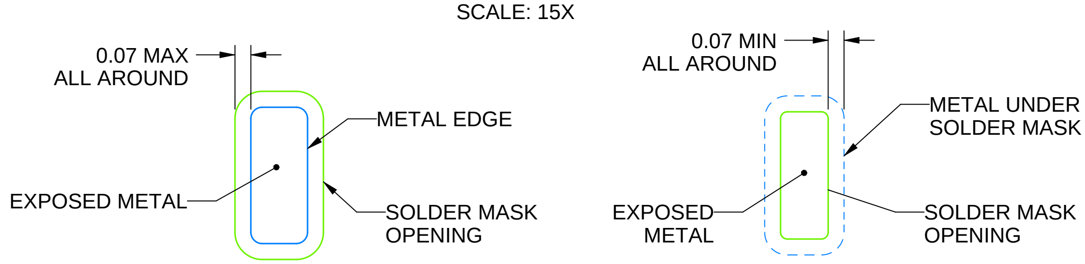
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 15X



NON SOLDER MASK DEFINED (PREFERRED)

SOLDER MASK DEFINED

SOLDER MASK DETAILS

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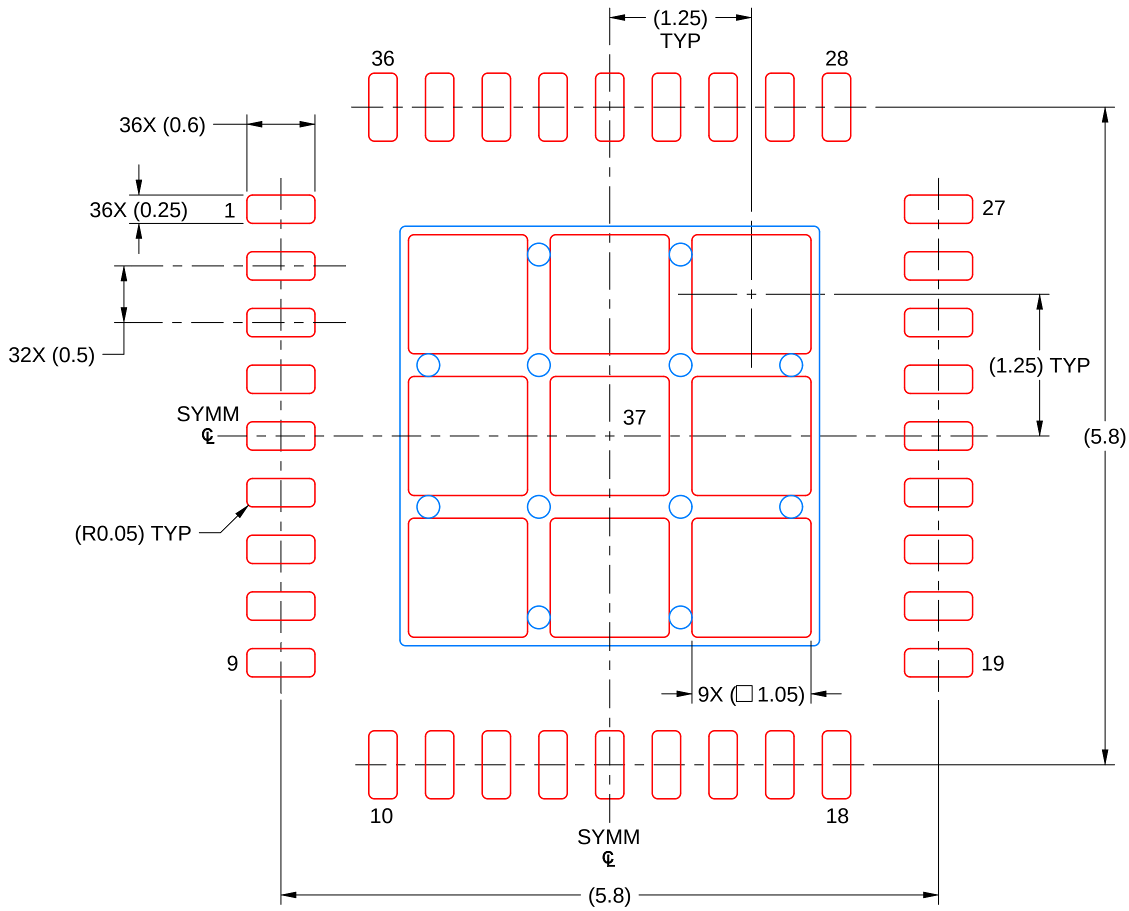
NOTES: (continued)

4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.



SOLDER PASTE EXAMPLE
BASED ON 0.125 MM THICK STENCIL
SCALE: 15X

EXPOSED PAD 37
72% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE

4225089/A 06/2019

NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.