

## Features

- 25MHz crystal or CMOS input
- Generates PCIe 1, 2, 3, 4 compliant clocks
- Four default configurations selected by hardware pins at reset:
  - Config0: 100MHz on output OC1 (CML format)
  - Config1: 100MHz on OC1, OC2 (CML)
  - Config2: 100MHz on OC1 (CML), OC2 (HSTL)
  - Config3: 100MHz on OC1, OC2 (CML) and 25MHz LVCMOS on OC3
- Per-output controls (using SPI or I2C interface)
  - Per-output enable/disable and glitchless start/stop (stop high or low)
  - Precise output alignment circuitry and per-output phase adjustment

## Ordering Information

ZL30281LDG1	32 Pin QFN	Trays
ZL30281LDF1	32 Pin QFN	Tape and Reel

Matte Tin

Package size: 5 x 5 mm

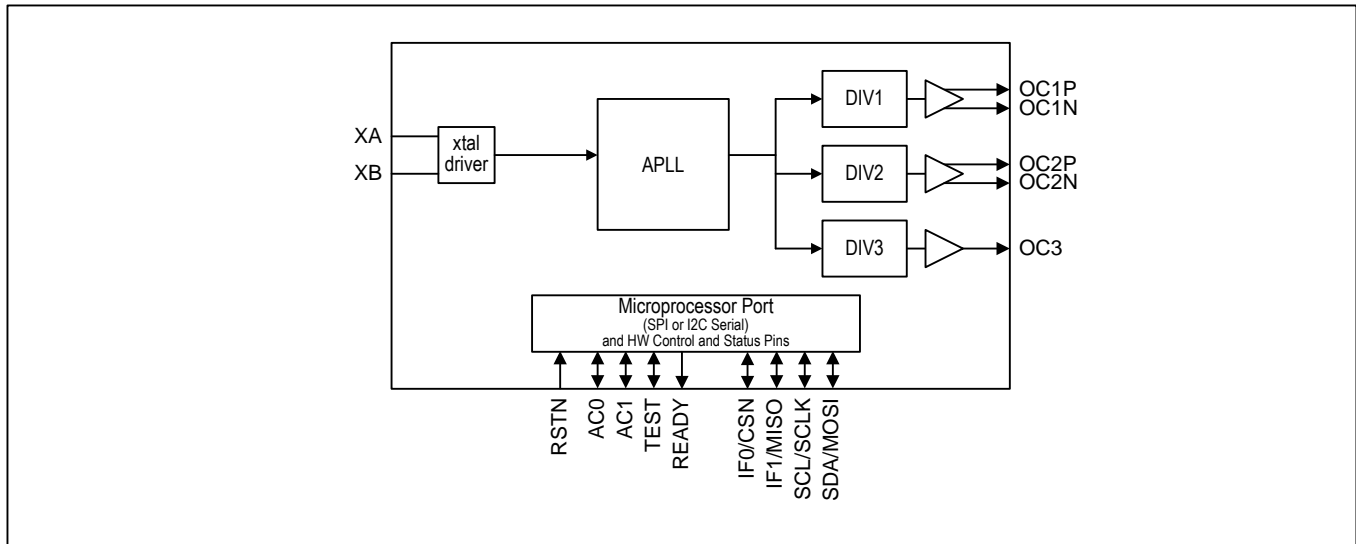
**-40°C to +85°C**

## General Features

- SPI or I<sup>2</sup>C processor Interface
- Tiny 5x5mm QFN package

## Applications

- PCIe Gen1 to Gen4 clock generation for PCIe storage systems, riser cards, JBOF, etc.



**Figure 1 - Functional Block Diagram**

## **Table of Contents**

<b>1. PIN DIAGRAM</b> .....	<b>4</b>
<b>2. PIN DESCRIPTIONS</b> .....	<b>4</b>
<b>3. FUNCTIONAL DESCRIPTION</b> .....	<b>6</b>
3.1 PIN-CONTROLLED AUTOMATIC CONFIGURATION AT RESET .....	6
3.2 LOCAL OSCILLATOR OR CRYSTAL .....	6
3.2.1 External Oscillator .....	6
3.2.2 External Crystal and On-Chip Driver Circuit .....	6
3.3 OUTPUT CLOCK CONFIGURATION.....	7
3.3.1 Output Signal Format, Voltage and Interfacing.....	7
3.3.2 Output Phase Adjustment and Phase Alignment.....	8
3.3.2.1 Phase Adjustment.....	8
3.3.2.2 Phase Alignment, Output-to-Output.....	8
3.3.3 Output Clock Start, Stop and High-Impedance.....	9
3.4 MICROPROCESSOR INTERFACE .....	9
3.4.1 SPI Slave .....	9
3.4.2 I <sup>2</sup> C Slave .....	11
3.5 RESET LOGIC .....	13
3.6 POWER-SUPPLY CONSIDERATIONS .....	13
<b>4. REGISTER DESCRIPTIONS</b> .....	<b>13</b>
4.1 REGISTER TYPES .....	13
4.1.1 Status Bits .....	13
4.1.2 Configuration Fields .....	13
4.2 REGISTER MAP .....	14
4.3 REGISTER DEFINITIONS .....	15
4.3.1 Global Configuration Registers .....	15
4.3.2 Status Registers.....	16
4.3.3 Output Clock Configuration Registers.....	19
<b>5. ELECTRICAL CHARACTERISTICS</b> .....	<b>22</b>
<b>6. PACKAGE AND THERMAL INFORMATION</b> .....	<b>28</b>
6.1 PACKAGE TOP MARK FORMAT .....	28
6.2 THERMAL SPECIFICATIONS .....	28
<b>7. MECHANICAL DRAWING</b> .....	<b>29</b>
<b>8. ACRONYMS AND ABBREVIATIONS</b> .....	<b>30</b>
<b>9. DATA SHEET REVISION HISTORY</b> .....	<b>30</b>

**List of Figures**

Figure 1 - Functional Block Diagram .....	1
Figure 2 - Pin Diagram.....	4
Figure 3 - Crystal Equivalent Circuit / Recommended Crystal Circuit.....	7
Figure 4 - SPI Read Transaction Functional Timing.....	11
Figure 5 - SPI Write Transaction Functional Timing.....	11
Figure 6 - I <sup>2</sup> C Read Transaction Functional Timing .....	12
Figure 7 - I <sup>2</sup> C Write Transaction Functional Timing.....	12
Figure 8 - Electrical Characteristics: CML Clock Outputs.....	24
Figure 9 - Example External Components for CML Output Signals .....	24
Figure 10 - Example External Components for HCSL Output Signals .....	25
Figure 11 - SPI Slave Interface Timing.....	26
Figure 12 - I <sup>2</sup> C Slave Interface Timing.....	27

**List of Tables**

Table 1 - Pin Descriptions.....	4
Table 2 - Crystal Selection Parameters .....	7
Table 3 - SPI Commands .....	10
Table 4 - Register Map .....	14
Table 5 - Recommended DC Operating Conditions .....	22
Table 6 - Electrical Characteristics: Supply Currents .....	22
Table 7 - Electrical Characteristics: Non-clock CMOS Pins .....	22
Table 8 - Electrical Characteristics: XA Clock Input .....	23
Table 9 - Electrical Characteristics: CML Clock Outputs.....	23
Table 10 - Electrical Characteristics: CMOS and HSTL (Class I) Clock Outputs.....	25
Table 11 - Electrical Characteristics: Typical Input-to-Output Clock Delay .....	25
Table 12 - Electrical Characteristics: Typical Output-to-Output Clock Delay .....	26
Table 13 - Electrical Characteristics: SPI Slave Interface Timing .....	26
Table 14 - Electrical Characteristics: I <sup>2</sup> C Slave Interface Timing .....	27
Table 15 - 5x5mm QFN Package Thermal Properties .....	28

## 1. Pin Diagram

The device is packaged in a 5x5mm 32-pin QFN.

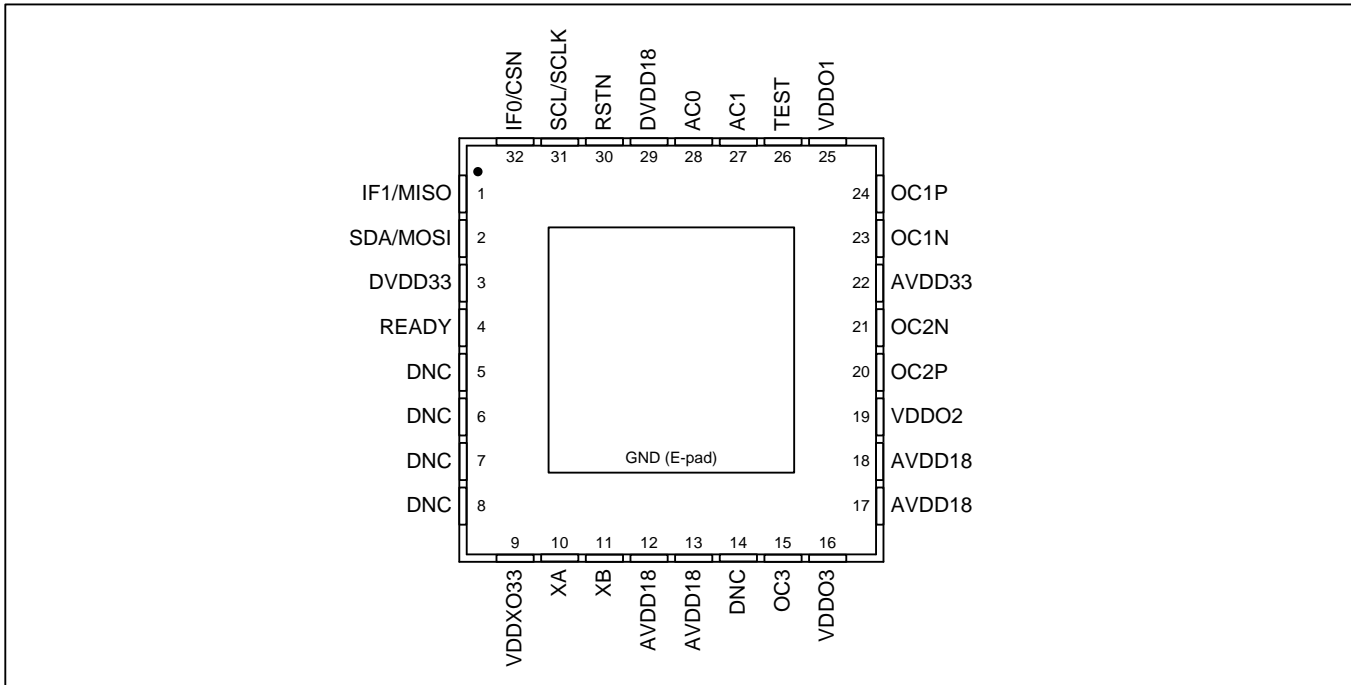


Figure 2 - Pin Diagram

## 2. Pin Descriptions

All device inputs and outputs are LVCMOS unless described otherwise. The Type column uses the following symbols: I – input, I<sub>PU</sub> – input with 50kΩ internal pullup resistor, O – output, A – analog, P – power supply pin. All SPI/I<sup>2</sup>C interface pins have Schmitt-trigger inputs and have output drivers that can be disabled (high impedance).

Table 1 - Pin Descriptions

Pin #	Name	Type	Description
10 11	XA XB	A / I	<p><b>Crystal or Input Clock Pins</b>  <i>Crystal:</i> <a href="#">MCR1.XAB=01</a>. An on-chip crystal driver circuit is designed to work with an external crystal connected to the XA and XB pins. See section 3.2.2 for crystal characteristics and recommended external components.</p> <p><i>Input Clock:</i> <a href="#">MCR1.XAB=10</a>. An external local oscillator or clock signal can be connected to the XA pin. The XB pin must be left unconnected.</p>
24 23 20 21 15	OC1P OC1N OC2P OC2N OC3	O	<p><b>Output Clock Pins</b>                      CML, HSTL or CMOS. Programmable frequency and drive strength. See <a href="#">Table 9</a> and <a href="#">Figure 9</a> for electrical specifications and recommended external circuitry for interfacing to LVDS, LVPECL or CML input pins on neighboring devices.                      See <a href="#">Table 10</a> for electrical specifications for interfacing to CMOS and HSTL inputs on neighboring devices.                      See <a href="#">Figure 10</a> for recommended external circuitry for interfacing to HCSL inputs on neighboring devices.</p>

Pin #	Name	Type	Description
30	RSTN	I <sub>PU</sub>	<b>Reset (Active Low)</b> When this global asynchronous reset is pulled low, all internal circuitry is reset to default values. The device is held in reset as long as RSTN is low. See section 3.5.
28 27	AC0 AC1	I	<b>Auto-Configure [1:0]</b> On the rising edge of RSTN these pins specify the device configuration. See section 3.1.
26	TEST	I	<b>Factory Test</b> On the rising edge of RSTN the pin behaves as TEST. Factory test mode is enabled when TEST is high. For normal operation TEST must be low on the rising edge of RSTN.
4	READY	O	<b>PLL Lock</b> This pin indicates the state of the device after reset. 0=not ready, 1=ready.
32	IF0/CSN	I/O	<b>Interface Mode 0 / SPI Chip Select (Active Low)</b>  <i>Interface Mode:</i> On the rising edge of RSTN the pin behaves as IF0 and, together with IF1, specifies the interface mode for the device. See section 3.1.  <i>SPI Chip Select:</i> After reset this pin is CSN. An external SPI master must assert (low) CSN to access device registers.
31	SCL/SCLK	I/O	<b>I<sup>2</sup>C Clock / SPI Clock</b>  <i>I<sup>2</sup>C Clock:</i> When the device is configured as an I <sup>2</sup> C slave, an external I <sup>2</sup> C master must provide the I <sup>2</sup> C clock signal on the SCL pin.  <i>SPI Clock:</i> An external SPI master must provide the SPI clock signal on SCLK.
1	IF1/MISO	I/O	<b>Interface Mode 1 / SPI Master-In-Slave-Out</b>  <i>Interface Mode:</i> On the rising edge of RSTN the pin behaves as IF1 and, together with IF0, specifies the interface mode for the device. See section 3.1.  <i>SPI MISO:</i> After reset this pin is MISO. The device outputs data to an external SPI master on MISO during SPI read transactions
2	SDA/MOSI	I/O	<b>I<sup>2</sup>C Data / SPI Master-Out-Slave-In</b>  <i>I<sup>2</sup>C Data:</i> When the device is configured as an I <sup>2</sup> C slave, SDA is the bidirectional data line between the device and an external I <sup>2</sup> C master.  <i>SPI MOSI:</i> An external SPI master sends commands, addresses and data to the device on MOSI.
12 13 17 18	AVDD18	P	<b>Analog Power Supply. 1.8V ±5%.</b>
22	AVDD33	P	<b>Analog Power Supply. 3.3V ±5%.</b>
29	DVDD18	P	<b>Digital Power Supply. 1.8V ±5%.</b>
3	DVDD33	P	<b>Digital Power Supply. 3.3V ±5%.</b>
25	VDDO1	P	<b>Output OC1 Power Supply. 1.5V to 3.3V ±5%.</b>
19	VDDO2	P	<b>Output OC2 Power Supply. 1.5V to 3.3V ±5%.</b>
16	VDDO3	P	<b>Output OC3 Power Supply. 1.5V to 3.3V ±5%.</b>
9	VDDXO33	P	<b>Analog Power Supply for Crystal Driver Circuitry. 3.3V ±5%.</b>
5, 6, 7, 8, 14	DNC		<b>Do Not Connect.</b> Leave these pins floating.

Pin #	Name	Type	Description
E-pad	VSS	P	Ground. 0 Volts.

### 3. Functional Description

#### 3.1 Pin-Controlled Automatic Configuration at Reset

The device configuration is determined at reset (i.e. on the rising edge of RSTN) by the signal levels on five device pins: TEST, AC1, AC0, IF1/MISO and IF0/CSN. For each of these pins, the first name (TEST, AC1, AC0, IF1, IF0) indicates their function when they are sampled by the rising edge of the RSTN pin. The second name refers to their function after reset. The values of these pins are latched into the [CFGSR](#) register when RSTN goes high. To ensure the device properly samples the reset values of these pins, the following guidelines should be followed:

1. Any pullup or pulldown resistors used to set the value of these pins at reset should be 1kΩ.
2. RSTN must be asserted at least as long as specified in section [3.5](#).

The hardware configuration pins are grouped into three sets:

1. TEST - Manufacturing test mode
2. IF[1:0] – Microprocessor interface mode and I<sup>2</sup>C address
3. AC[1:0] – Auto-configuration

The TEST pin selects manufacturing test modes when TEST=1. Therefore TEST should be pulled low.

The IF[1:0] pins specify the processor interface mode and the I<sup>2</sup>C slave address. The AC[1:0] pins specify which of four device configurations to execute after reset.

IF1	IF0	Processor Interface
0	0	I <sup>2</sup> C, slave address 11011 00
0	1	I <sup>2</sup> C, slave address 11011 01
1	0	I <sup>2</sup> C, slave address 11011 10
1	1	SPI Slave

AC1	AC0	Auto Configuration
0	0	Config0: 100MHz on OC1 (CML signal format)
0	1	Config1: 100MHz on OC1 and OC2 (CML)
1	0	Config2: 100MHz on OC1 (CML) and OC2 (HSTL format)
1	1	Config3: 100MHz on OC1 and OC2 (CML) and 25MHz LVCMOS on OC3

All four configurations set up the part to use a 25MHz crystal on XA and XB as the input reference.

#### 3.2 Local Oscillator or Crystal

Section [3.2.1](#) describes how to connect an external oscillator and the required characteristics of the oscillator. Section [3.2.2](#) describes how to connect an external crystal to the on-chip crystal driver circuit and the required characteristics of the crystal.

##### 3.2.1 External Oscillator

A 25MHz signal from an external oscillator can be connected to the XA pin (XB must be left unconnected). To minimize jitter, the signal must be properly terminated and must have very short trace length. A poorly terminated single-ended signal can greatly increase output jitter, and long single-ended trace lengths are more susceptible to noise. When [MCR1.XAB=10](#), XA is enabled as a single-ended input.

The jitter on output clock signals depends on the phase noise and frequency of the external oscillator.

##### 3.2.2 External Crystal and On-Chip Driver Circuit

The on-chip crystal driver circuit is designed to work with a 25MHz fundamental mode, AT-cut crystal resonator. See [Table 2](#) for recommended crystal specifications. To enable the crystal driver, set [MCR1.XAB=01](#).

See Figure 3 for the crystal equivalent circuit and the recommended external capacitor connections. To achieve a crystal load ( $C_L$ ) of 10pF, an external 16pF ( $C_1$ ) is placed in parallel with the 4pF internal capacitance of the XA pin, and an external 16pF ( $C_2$ ) is placed in parallel with the 4pF internal capacitance of the XB pin. The crystal then sees a load of 20pF in series with 20pF, which is 10pF total load. Note that the 16pF capacitance include all capacitance on those nodes. If, for example, PCB trace capacitance between crystal pin and IC pin is 2pF then 14pF capacitors should be used to make 16pF total.

The crystal, traces, and two external capacitors should be placed on the board as close as possible to the XA and XB pins to reduce crosstalk of active signals into the oscillator. Also no active signals should be routed under the crystal circuitry.

Note: Crystals have temperature sensitivities that can cause frequency changes in response to ambient temperature changes. In applications where significant temperature changes are expected near the crystal, it is recommended that the crystal be covered with a thermal cap, or an external XO should be used instead.

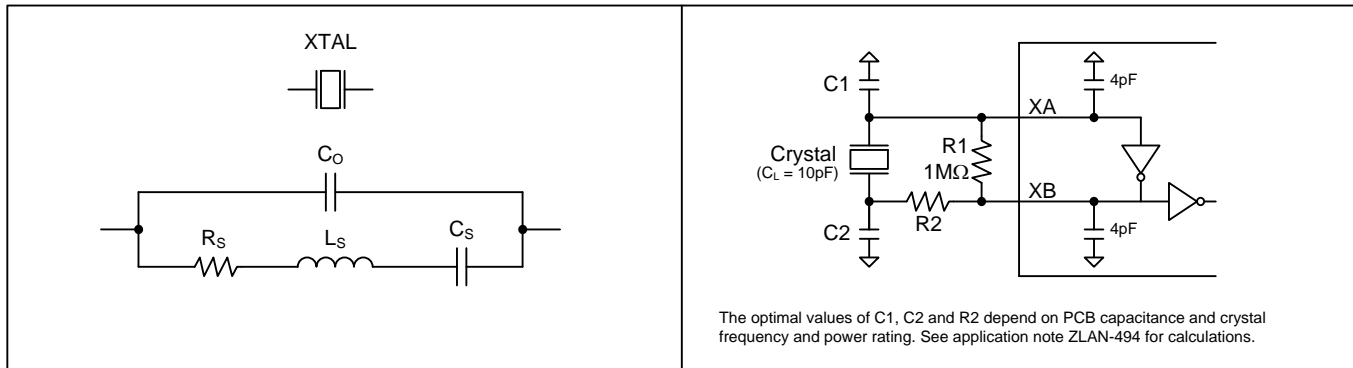


Figure 3 - Crystal Equivalent Circuit / Recommended Crystal Circuit

Table 2 - Crystal Selection Parameters

Parameter	Symbol	Min.	Typ.	Max.	Units
Crystal oscillation frequency <sup>1</sup>	$f_{osc}$		25		MHz
Shunt capacitance	$C_0$		2	5	pF
Load capacitance	$C_L$		10		pF
Equivalent series resistance (ESR) <sup>2</sup>	$f_{osc} < 40\text{MHz}$	$R_s$		60	$\Omega$
	$f_{osc} > 40\text{MHz}$	$R_s$		50	$\Omega$
Maximum crystal drive level		100			$\mu\text{W}$

Note 1: Higher frequencies give lower output jitter, all else being equal.

Note 2: These ESR limits are chosen to constrain crystal drive level to less than 100 $\mu\text{W}$ . If the crystal can tolerate a drive level greater than 100 $\mu\text{W}$  then proportionally higher ESR is acceptable.

Parameter	Symbol	Min.	Typ.	Max.	Units
Crystal Frequency Stability vs. Power Supply	$f_{VD}$		0.2	0.5	ppm per 10% $\Delta$ in VDD

### 3.3 Output Clock Configuration

The device has three output clock signal pairs. Each output has individual enable, start/stop and alignment controls. The outputs can be aligned relative to each other, and the phases of output signals can be adjusted dynamically with high resolution and infinite range.

#### 3.3.1 Output Signal Format, Voltage and Interfacing

The signal format of each output is determined by the configuration number specified by the AC[1:0] pins at device reset (see the AC[1:0] table in section 3.1). The clock to the output driver can be inverted by setting  $OCxCR2.POL=1$ . The CMOS/HSTL output driver can be set to any of four drive strengths using  $OCxCR2.DRIVE$ .

Each output has its own power supply pin to allow CMOS or HSTL signal swing from 1.5V to 3.3V for glueless interfacing to neighboring components. If OC2 is HSTL format (Config2) then a 1.8V VDDO2 voltage can be used to as shown in [Figure 10](#) to get a signal compatible with HCSL receivers. Note that CML outputs must have a power supply voltage of 3.3V.

The CML outputs can be easily interfaced to LVDS, LVPECL, CML, HCSL, HSTL and other differential inputs on neighboring ICs using a few external passive components. See [Figure 9](#) for examples.

### 3.3.2 Output Phase Adjustment and Phase Alignment

The device has flexible, high-resolution tools for managing the phases of the output clocks relative to one another. The key register fields for this are found in the [PACR1](#) global configuration register and the per-output [OCxPH](#) register. Resolution is one period of the 600MHz APLL clock, i.e. 1.667ns.

#### 3.3.2.1 Phase Adjustment

A phase adjustment is a phase change for an output relative to that output's most recent phase. To cause the device to perform phase adjustment of an output clock, set [PACR1.MODE=1](#), set [OCxCR1.PHEN=1](#) to enable the output for phase adjustment, and write the phase adjustment amount to the output's [OCxPH](#) register. Then an arm/trigger methodology is used to cause the phase adjustment to happen.

The arm step tells the device that it is enabled to perform the phase adjustment when it sees the trigger stimulus. The arm signal is a 0-to-1 transition of the [PACR1.ARM](#) bit. The trigger signal a 0-to-1 transition of the [PACR1.TRIG](#) bit. Any combination of outputs can be phase adjusted by the same trigger, and each output can be adjusted by a different amount. Only outputs with [OCxCR1.PHEN=1](#) and [OCxPH.PHADJ≠0](#) have their phases adjusted.

There are a few constraints on the range of possible phase adjustments. The largest negative phase adjustment is 2 APLL periods, which is  $2 * 1.667ns = 3.333ns$ . The largest positive phase adjustment is 6 APLL periods, which is  $6 * 1.667ns = 10ns$ .

An armed phase adjustment can be canceled before the trigger occurs by setting the [PACR1.RST](#) bit.

The [PASR](#) register has real-time status bits indicating whether a phase adjustment is armed and waiting for a trigger (ARMED bit) or in progress (BUSY bit). It also has a latched status bit (ADJL bit) to indicate the adjustment has completed.

**Example:** +1.0 APLL period phase adjustment for output OC1:

```

OC1CR1.PHEN=1      (Enable phase adjust on OC1)
OC1PH.PHADJ=0000010 (Specify +1.0 APLL period phase adjustment, i.e. 1.667ns)
PACR1.MODE=1      (Phase adjustment mode)
PACR1.RST=1       (reset phase adjust/align state machine)
PACR1.ARM=1       (arm for phase adjust)
PACR1.TRIG=1      (trigger the phase adjust: add +1.0 UI to output phase)
repeat the next two writes as needed:
PACR1.ARM=1 .TRIG=0 (arm again; clearing the TRIG bit is required)
PACR1.TRIG=1      (trigger again: add +1.0 APLL period to output phase again)

```

#### 3.3.2.2 Phase Alignment, Output-to-Output

A phase alignment is a special case of phase adjustment where the dividers for all participating outputs are reset just before the phase adjustment occurs.

To avoid glitches (i.e. "runt pulses") on the output clock it is possible to manually stop the output(s), before triggering the phase alignment, and then restart the output(s) after the alignment (See section [3.3.3](#)).



When aligning outputs, it is important to note that, by default, the phase of outputs configured as HSTL format is opposite that of CML outputs. For example, consider the case where OC1 is 100MHz CML format and OC2 is 100MHz HSTL format. When OC1 and OC2 are aligned then OC2N is high when OC1P is high. The polarity bit `OCxCR2.POL` can be used to change this as needed.

Contact Microsemi Timing Applications Support for help with alignment scenarios that don't meet the rules listed above.

**Example:** OC1-to-OC2 alignment (+3.5 APLL cycle offset):

```

OC1CR1.PHEN=1      (Enable phase adjust on OC1)
OC2CR1.PHEN=1      (Enable phase adjust on OC2)
OC1PH.PHADJ=00000000 (0.0UI)
OC2PH.PHADJ=00000111 (+3.5UI)
PACR1.MODE=0       (Phase alignment mode)
PACR1.RST=1        (reset phase adjust/align state machine)
PACR1.ARM=1        (arm for phase alignment)
PACR1.TRIG=1       (trigger the phase alignment)
    
```

### 3.3.3 Output Clock Start, Stop and High-Impedance

Output clocks can be stopped high or low. One use for this behavior is to ensure “glitchless” output clock operation while the output is reconfigured or phase aligned with some other signal.

Each output has an `OCxSTOP` register with fields to control this behavior. The `OCxSTOP.MODE` field specifies whether the output clock signal stops high, stops low, or does not stop. The `OCxSTOP.SRC` field specifies the source of the stop signal. Options include the `OCxSTOP.STOP` bit and the arming of a phase adjustment (which is indicated by `PASR.ARMED`).

When the stop mode is Stop High (`OCxSTOP.MODE=01`) and the stop signal is asserted, the output clock is stopped after the next rising edge of the output clock. When the stop mode is Stop Low (`OCxSTOP.MODE=10`) and the stop signal is asserted, the output clock is stopped after the next falling edge of the output clock. Internally the clock signal continues to toggle while the output is stopped. When the stop signal is deasserted, the output clock resumes on the opposite edge that it stopped on.

When `OCxCR2.POL=1` the output stops on the opposite polarity that is specified by the `OCxSTOP.MODE` field.

When `OCxCR2.STOPDIS=1` the output driver is disabled (high impedance) while the output clock is stopped.

Each output has a status register (`OCxSR`) with several stop/start status bits. The `STOPD` bit is a real-time status bit indicating stopped or not stopped. The `STOPL` bit is a latched status bit that is set when the output clock has stopped. The `STARTL` bit is a latched status bit that is set when the output clock has started.

## 3.4 Microprocessor Interface

The device can communicate over a SPI interface or an I<sup>2</sup>C interface.

In SPI mode the device can only be configured as a SPI slave to a processor master. The device is always a slave on the I<sup>2</sup>C bus.

Section 3.1 describes reset pin settings required to configure the device for these interfaces.

### 3.4.1 SPI Slave

The device can present a SPI slave port on the CSN, SCLK, MOSI, and MISO pins. SPI is a widely used master/slave bus protocol that allows a master and one or more slaves to communicate over a serial bus. SPI masters are typically microprocessors, ASICs or FPGAs. Data transfers are always initiated by the master, which also generates the SCLK signal. The device receives serial data on the MOSI (Master Out Slave In) pin and

transmits serial data on the MISO (Master In Slave Out) pin. MISO is high impedance except when the device is transmitting data to the bus master.

**Bit Order.** The register address and all data bytes are transmitted most significant bit first on both MOSI and MISO.

**Clock Polarity and Phase.** The device latches data on MOSI on the rising edge of SCLK and updates data on MISO on the falling edge of SCLK. SCLK does not have to toggle between accesses, i.e., when CSN is high.

**Device Selection.** Each SPI device has its own chip-select line. To select the device, the bus master drives its CSN pin low.

**Command and Address.** After driving CSN low, the bus master transmits an 8-bit command followed by a 16-bit register address. The available commands are shown below.

**Table 3 - SPI Commands**

Command	Hex	Bit Order, Left to Right
Write	0x02	0000 0010
Read	0x03	0000 0011

**Read Transactions.** After driving CSN low, the bus master transmits the read command followed by the 16-bit address. The device then responds with the requested data byte on MISO, increments its address counter, and prefetches the next data byte. If the bus master continues to demand data, the device continues to provide the data on MISO, increment its address counter, and prefetch the following byte. The read transaction is completed when the bus master drives CSN high. See [Figure 4](#).

**Write Transactions.** After driving CSN low, the bus master transmits the write command followed by the 16-bit register address followed by the first data byte to be written. The device receives the first data byte on MOSI, writes it to the specified register, increments its internal address register, and prepares to receive the next data byte. If the master continues to transmit, the device continues to write the data received and increment its address counter. The write transaction is completed when the bus master drives CSN high. See [Figure 5](#).

**Early Termination of Bus Transactions.** The bus master can terminate SPI bus transactions at any time by pulling CSN high. In response to early terminations, the device resets its SPI interface logic and waits for the start of the next transaction. If a write transaction is terminated prior to the SCLK edge that latches the least significant bit of a data byte, the data byte is not written.

**Design Option: Wiring MOSI and MISO Together.** Because communication between the bus master and the device is half-duplex, the MOSI and MISO pins can be wired together externally to reduce wire count. To support this option, the bus master must not drive the MOSI/MISO line when the device is transmitting.

**AC Timing.** See [Table 13](#) and [Figure 11](#) for AC timing specifications for the SPI interface.

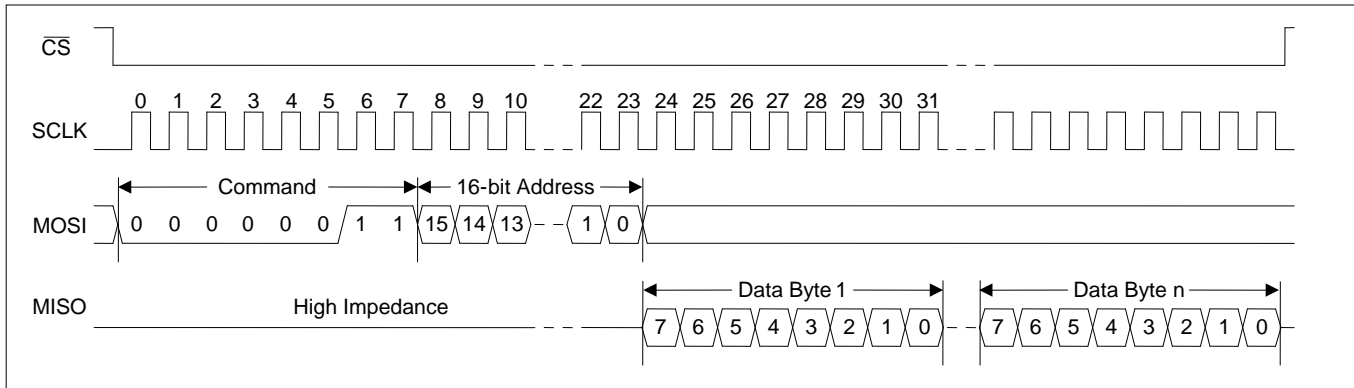


Figure 4 - SPI Read Transaction Functional Timing

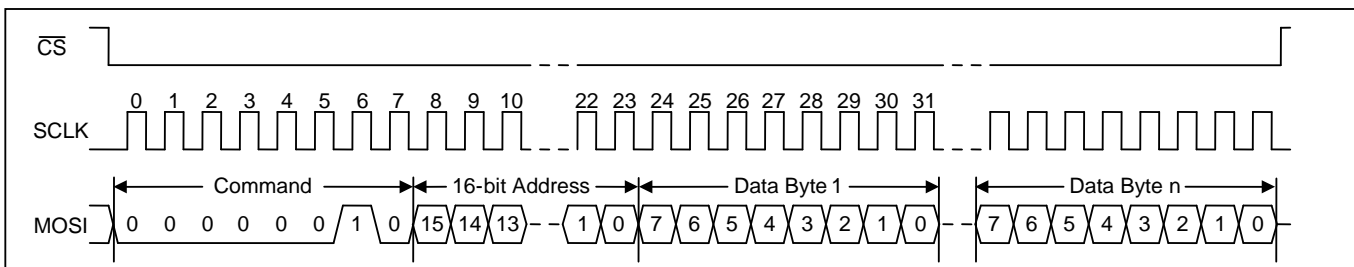


Figure 5 - SPI Write Transaction Functional Timing

### 3.4.2 I<sup>2</sup>C Slave

The device can present a fast-mode (400kbit/s) I<sup>2</sup>C slave port on the SCL and SDA pins. I<sup>2</sup>C is a widely used master/slave bus protocol that allows one or more masters and one or more slaves to communicate over a two-wire serial bus. I<sup>2</sup>C masters are typically microprocessors, ASICs or FPGAs. Data transfers are always initiated by the master, which also generates the SCL signal. The device is compliant with version 2.1 of the I<sup>2</sup>C specification.

The I<sup>2</sup>C interface on the device is a protocol translator from external I<sup>2</sup>C transactions to internal SPI transactions. This explains the slightly increased protocol complexity described in the paragraphs that follow.

**Read Transactions.** The bus master first does an I<sup>2</sup>C write to the device. In this transaction three bytes are written: the SPI Read command (see Table 3), the upper byte of the register address, and the lower byte of the register address. The bus master then does an I<sup>2</sup>C read. During each acknowledge (A) bit the device fetches data from the read address and then increments the read address. The device then transmits the data to the bus master during the next 8 SCL cycles. The bus master terminates the read with a not-acknowledge (NA) followed by a STOP condition (P). See Figure 6. Note: If the I<sup>2</sup>C write is separated in time from the I<sup>2</sup>C read by other I<sup>2</sup>C transactions then the device only outputs the data value from the first address and repeats that same data value after each acknowledge (A) generated by the bus master.

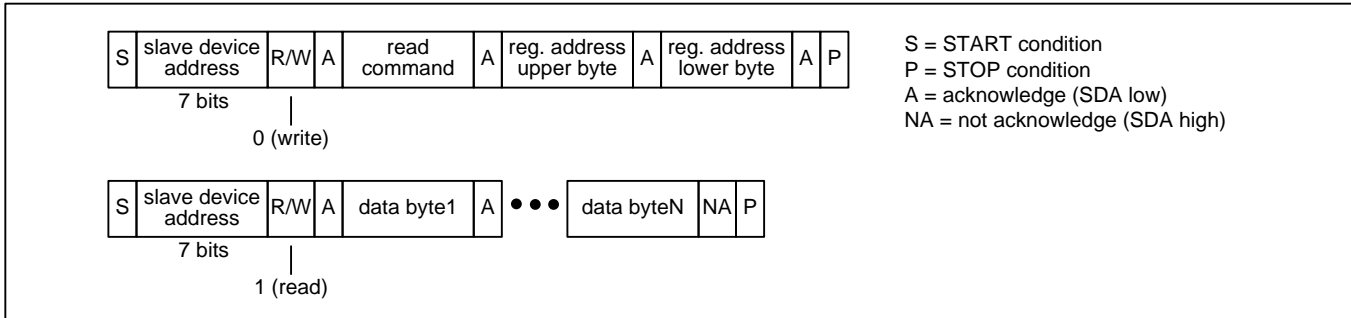
**Write Transactions.** The bus master does an I<sup>2</sup>C write to the device. The first three bytes of this transaction are the SPI Write command (see Table 3), the upper byte of the register address, and the lower byte of the register address. Subsequent bytes are data bytes to be written. After each data byte is received, the device writes the byte to the write address and then increments the write address. The bus master terminates the write with a STOP condition (P). See Figure 7.

**I<sup>2</sup>C Features Not Supported by the Device.** The I<sup>2</sup>C specification has several optional features that are not supported by the device. These are: 3.4Mbit/s high-speed mode (Hs-mode), 10-bit device addressing, general call address, software reset, and device ID. The device does not hold SCL low to force the master to wait.

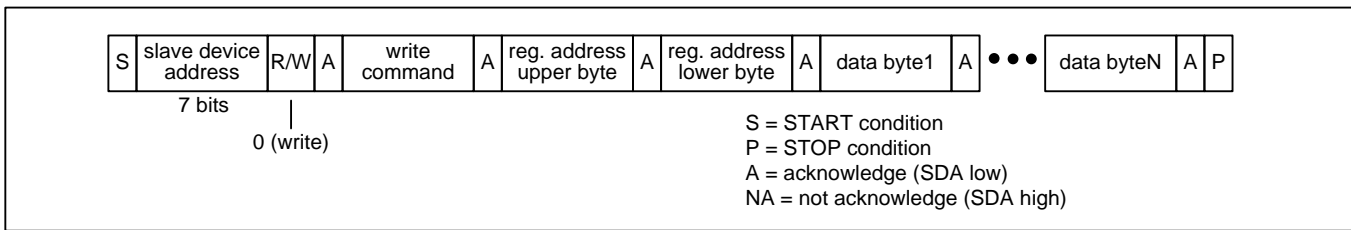
**I<sup>2</sup>C Slave Address.** The device’s 7-bit slave address can be pin-configured for any of three values. These values are show in the table in section 3.1.

**Bit Order.** The I<sup>2</sup>C specification requires device address, register address and all data bytes to be transmitted most significant bit first on the SDA signal.

Note: as required by the I<sup>2</sup>C specification, when power is removed from the device, the SDA and SCL pins are left floating so they don’t obstruct the bus lines.



**Figure 6 - I<sup>2</sup>C Read Transaction Functional Timing**



**Figure 7 - I<sup>2</sup>C Write Transaction Functional Timing**

Note: In Figure 6 and Figure 7, a STOP condition (P) immediately followed by a START condition (S) can be replaced by a repeated START condition (Sr) as described in the I<sup>2</sup>C specification.

### 3.5 Reset Logic

The device has two reset controls: the RSTN pin and the RST bit in [MCR1](#). The RSTN pin asynchronously resets the entire device. When the RSTN pin is low all internal registers are reset to their default values. **The RSTN pin must have one rising edge after power-up.** At initial power-up reset should be asserted for at least 1 $\mu$ s. During operation, the RSTN assertion time can be as short as 1 $\mu$ s with one important exception:

Consider the IF1/MISO pin: If (1) the pin could be an output driving high when RSTN is asserted, and (2) an external pulldown resistor is used to set the at-reset value of the pin, then RSTN should be asserted for 100 milliseconds.

The [MCR1](#).RST bit resets the entire device (except for the microprocessor interface and the RST bit itself), but when the RST bit is active, the register fields with pin-programmed defaults do not latch their values from, or based on, the corresponding input pins. Instead these fields are reset to the default values that were latched when the RSTN pin was last active.

**Important:** System software must wait at least 100 $\mu$ s after RSTN is deasserted and wait for [GLOBISR.READY=1](#) before configuring the device.

### 3.6 Power-Supply Considerations

Due to the multi-power-supply nature of the device, some I/Os have parasitic diodes between a <3.3V supply and a 3.3V supply. When ramping power supplies up or down, care must be taken to avoid forward-biasing these diodes because it could cause latchup. Two methods are available to prevent this. The first method is to place a Schottky diode external to the device between the <3.3V supply and the 3.3V supply to force the 3.3V supply to be within one parasitic diode drop of the <3.3V supply. The second method is to ramp up the 3.3V supply first and then ramp up the <3.3V supply. In some applications VDDOx power supply pins can be at other voltages, such as 2.5V or 1.5V. In these applications the general solution is to ramp up the supplies in order from highest nominal to lowest nominal voltage.

## 4. Register Descriptions

The device has an overall address range from 000h to 1FFh. [Table 4](#) shows the register map. In each register, bit 7 is the MSb and bit 0 is the LSb. Register addresses not listed and bits marked “—” are reserved and must be written with 0. Writing other values to these registers may put the device in a factory test mode resulting in undefined operation. Bits labeled “0” or “1” must be written with that value for proper operation. Register fields with underlined names are read-only fields; writes to these fields have no effect. All other fields are read-write. Register fields are described in detail in the register descriptions that follow [Table 4](#).

### 4.1 Register Types

#### 4.1.1 Status Bits

The device has two types of status bits. Real-time status bits are read-only and indicate the state of a signal at the time it is read. Latched status bits are set when a signal changes state (low-to-high, high-to-low, or both, depending on the bit) and cleared when written with a logic 1 value. Writing a 0 has no effect. Status bits marked “—” are reserved and must be ignored.

#### 4.1.2 Configuration Fields

Configuration fields are read-write. During reset, each configuration field reverts to the default value shown in the register definition. Configuration register bits marked “—” are reserved and must be written with 0.

## 4.2 Register Map

**Table 4 - Register Map**

ADDR	REGISTER	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0	
<b>Global Configuration Registers</b>										
09	MCR1	RST	—	—	—	—	—	XAB[1:0]		
1B	PACR1	RST	TRIG	ARM	—	—	—	—	MODE	
<b>Status Registers</b>										
30	ID1	IDU[7:0]								
31	ID2	IDL[3:0]				REV[3:0]				
40	CFGSR	TEST	XOFAIL	—	—	IF[1:0]		AC[1:0]		
43	GLOBISR	READY	—	—	—	—	—	—	—	
48	APLLSR	—	—	ALK2L	ALK2	—	—	ALKL	ALK	
4D	PASR	—	—	—	—	—	ADJL	BUSY	ARMED	
53	OC1SR	—	—	—	—	STARTL	—	STOPL	STOPD	
54	OC2SR	—	—	—	—	STARTL	—	STOPL	STOPD	
55	OC3SR	—	—	—	—	STARTL	—	STOPL	STOPD	
<b>Output Clock Configuration Registers</b>										
<b>OC1 Registers</b>										
200	OC1CR1	PHEN	—	—	—	—	—	—	—	
201	OC1CR2	—	POL	DRIVE[1:0]		STOPDIS	—	—	—	
207	OC1PH	PHADJ[7:0]								
208	OC1STOP	STOP	—	SRC[3:0]				MODE[1:0]		
<b>OC2 Registers</b>										
210	OC2CR1	PHEN	—	—	—	—	—	—	—	
211	OC2CR2	—	POL	DRIVE[1:0]		STOPDIS	—	—	—	
217	OC2PH	PHADJ[7:0]								
218	OC2STOP	STOP	—	SRC[3:0]				MODE[1:0]		
<b>OC3 Registers</b>										
220	OC3CR1	PHEN	—	—	—	—	—	—	—	
221	OC3CR2	—	POL	DRIVE[1:0]		STOPDIS	—	—	—	
227	OC3PH	PHADJ[7:0]								
228	OC3STOP	STOP	—	SRC[3:0]				MODE[1:0]		

## 4.3 Register Definitions

### 4.3.1 Global Configuration Registers

**Register Name:** MCR1  
**Register Description:** Master Configuration Register 1  
**Register Address:** 09h

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
<b>Name</b>	RST	—	—	—	—	—	XAB[1:0]	
<b>Default</b>	0	0	0	0	0	0	0	1

**Bit 7: Device Reset (RST).** When this bit is high the entire device is held in reset, and all register fields, except the RST bit itself, are reset to their default states. When RST is high, the register fields with pin-programmed defaults do not latch their values from the corresponding input pins. Instead these fields are reset to the default values that were latched from the pins when the RSTN pin was last active. See section 3.5.

0 = Normal operation

1 = Reset

Note: For proper sequencing of internal logic, write MCR1 to clear the MCSEL1, MCSEL and ROSCD bits first (without changing the value of the RST bit) then perform a second write to set the RST bit.

(Note: on rev A devices (ID2.REV=0) do not set this bit to 1.)

**Bits 1 to 0: XA/XB Pin Mode (XAB[1:0]).** This field specifies the behavior of the XA and XB pins. See section 3.2.

00 = Crystal driver and input disabled / powered down

01 = Crystal driver and input enabled on XA/XB

10 = XA enabled as single-ended input for external oscillator signal; XB must be left floating

11 = {unused value}

**Register Name:** PACR1  
**Register Description:** Phase Adjust Configuration Register 1  
**Register Address:** 1Bh

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
<b>Name</b>	RST	TRIG	ARM	—	—	—	—	MODE
<b>Default</b>	0	0	0	0	0	0	0	0

**Bit 7: Phase Adjustment Reset Bit (RST).** This bit is used to reset the phase adjustment state machine. This is used to abort the phase adjustment after arming but before the trigger occurs. Resetting puts the state machine back to waiting for an arm signal. This bit is self-clearing. See section 3.3.2.

1 = Reset a phase adjustment event in progress, self clearing

**Bit 6: Phase Adjustment Trigger Bit (TRIG).** This bit is used to trigger the phase adjustment event after the phase adjustment has been armed. This bit is self-clearing and must be written again to cause another trigger. The ARM bit must be set first then the TRIG bit can be set in a subsequent register write to initiate a trigger event. See section 3.3.2.

1 = Trigger a phase adjustment, self clearing

**Bit 5: Phase Adjustment Arm Bit (ARM).** Setting this bit to 1 while PASR.ARMED=0 arms the phase adjustment. Writing a 0 to this bit has no effect. Changing the value of this bit from 0 to 1 while PASR.ARMED=1 has no effect. See section 3.3.2.

1 = Arm the phase adjustment, self clearing

**Bit 0: Phase Adjust/Alignment Mode (MODE).** This field sets the mode of the phase change. In output phase alignment mode, the device aligns all participating outputs and then adjusts the phase of each participating output

as specified in the **OCxPH** register. In output phase *adjustment* mode the device does align the outputs and therefore causes each participating output to have the phase adjustment specified in the **OCxPH** register relative to that output's previous phase. See section 3.3.2.

0 = Phase alignment mode

1 = Phase adjustment mode

### 4.3.2 Status Registers

**Register Name:** ID1  
**Register Description:** Device Identification Register, MSB  
**Register Address:** 30h

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
<b>Name</b>	IDU[7:0]							
<b>Default</b>	0	0	0	1	1	0	0	1

**Bits 7 to 0: Device ID Upper (IDU[7:0]).** This field is the upper eight bits of the device ID.

**Register Name:** ID2  
**Register Description:** Device Identification Register, LSB and Revision  
**Register Address:** 31h

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
<b>Name</b>	IDL[3:0]				REV[3:0]			
<b>Default</b>	0	0	0	1	0	0	0	1

**Bits 7 to 4: Device ID Lower (IDL[3:0]).** This field is the lower four bits of the device ID.

**Bits 3 to 0: Device Revision (REV[3:0]).** These bits are the device hardware revision starting at 0.

**Register Name:** CFGSR  
**Register Description:** Configuration Status Register  
**Register Address:** 40h

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
<b>Name</b>	TEST	XOFAIL	—	—	IF[1:0]		AC[1:0]	
<b>Default</b>	see below	0	0	0	see below	see below	see below	see below

**Bit 7: Test Mode (TEST).** This read-only bit is the latched state of the TEST pin when the RSTN pin transitions high. For proper operation it should be 0. See section 3.1.

**Bit 6: XO Fail (XOFAIL).** This read-only bit is set when the external oscillator signal on the XA pin fails or when the crystal connected to the XA/XB pins fails to oscillate.

**Bits 3 to 2: Interface Mode (IF[1:0]).** These read-only bits are the latched state of the IF1/MISO and IF0/CSN pins when the RSTN pin transitions high. See section 3.1.

**Bits 1 to 0: Auto-Configuration (AC[1:0]).** These read-only bits are the latched state of the AC1 and AC0 pins when the RSTN pin transitions high. See section 3.1.



**Register Name:** GLOBISR  
**Register Description:** Global Functions Status Register  
**Register Address:** 43h

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
<b>Name</b>	READY	—	—	—	—	—	—	—
<b>Default</b>	see below	0	0	0	0	0	0	0

**Bit 7: Device Ready (READY).** This bit indicates the status of the device after reset. It is cleared when the device is reset and set when the device is ready for operation.

**Register Name:** APLLSR  
**Register Description:** APLL Status Register  
**Register Address:** 48h

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
<b>Name</b>	—	—	ALK2L	ALK2	—	—	ALKL	ALK
<b>Default</b>	0	0	0	0	0	0	0	0

**Bit 5: APLL Lock 2 Latched Status (ALK2L).** This latched status bit is set to 1 when the ALK2 status bit changes state (set or cleared). ALK2L is cleared when written with a 1.

**Bit 4: APLL Lock Status 2 (ALK2).** This real-time status bit provides one type of APLL lock status. System software should consider the APLL locked when ALK (bit 0) is set to 1 AND ALK2=1.

**Bit 1: APLL Lock Latched Status (ALKL).** This latched status bit is set to 1 when the ALK status bit changes state (set or cleared). ALKL is cleared when written with a 1.

**Bit 0: APLL Lock Status (ALK).** This real-time status bit indicates one type of APLL lock status. System software should consider the APLL locked when ALK=1 AND ALK2 (bit 4) is set to 1.

0 = Not locked

1 = Locked

**Register Name:** PASR  
**Register Description:** Phase Adjust Status Register  
**Register Address:** 4Dh

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
<b>Name</b>	—	—	—	—	—	ADJL	BUSY	ARMED
<b>Default</b>	1	0	0	0	0	1	0	0

**Bit 2: Phase Adjustment Finished (ADJL).** This latched status bit is set when the output phase adjustment is completed for all participating outputs. Writing a 1 to this bit clears it. See section 3.3.2.

- 0 = Output phase adjustment has not completed
- 1 = Output phase adjustment has completed

**Bit 1: Phase Adjustment Busy (BUSY).** This bit is a real time status that indicates that the output phase adjustment has been triggered and is in progress on the participating outputs. See section 3.3.2.

- 0 = Output phase adjustment is not in progress
- 1 = Output phase adjustment is in progress

**Bit 0: Phase Adjustment Armed (ARMED).** This bit is a real time status that indicates that the output phase adjustment is armed and waiting for a trigger. It is cleared when the trigger event occurs. See section 3.3.2.

- 0 = Output phase adjustment is not armed
- 1 = Output phase adjustment is armed

**Register Name:** OCxSR  
**Register Description:** Output Clock x Status Register  
**Register Address:** OC1: 53h, OC2: 54h, OC3: 55h

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
<b>Name</b>	—	—	—	—	STARTL	—	STOPL	STOPD
<b>Default</b>	0	0	0	0	0	0	see note	see note

**Bit 3: (STARTL).** This latched status bit is set when the output clock signal has been started after being stopped. Writing a 1 to this bit clears it. See section 3.3.3.

- 0 = Output clock signal has not resumed from being stopped
- 1 = Output clock signal has resumed from being stopped

**Bit 1: (STOPL).** This latched status bit is set when the output clock signal has been stopped. Writing a 1 to this bit clears it. See section 3.3.3.

- 0 = Output clock signal has not stopped
- 1 = Output clock signal has stopped

**Bit 0: (STOPD).** This real-time status bit is high when the output clock signal is stopped and low when the output clock is not stopped. See section 3.3.3.

- 0 = Output clock signal is not stopped
- 1 = Output clock signal is stopped

**Note:** STOPL and STOPD are controlled by logic that does not have a clock at reset. Therefore their reset values are indeterminate. They will become 0 when the output clock path is configured and one of the high-speed clocks from the APLL is connected to the logic.

### 4.3.3 Output Clock Configuration Registers

**Register Name:** OCxCR1  
**Register Description:** Output Clock x Configuration Register 1  
**Register Address:** OC1: 200h, OC2: 210h, OC3: 220h

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
<b>Name</b>	PHEN	—	—	—	—	—	—	—
<b>Default</b>	see below	0	0	0	0	1	0	1

**Bit 7: Phase Adjust Enable (PHEN).** This bit enables this output to participate in phase adjustment/alignment. See section 3.3.2.

- 0 = Phase adjustment/alignment disabled for this output
- 1 = Phase adjustment/alignment enabled for this output

PHEN default value:

	OC1	OC2	OC3
Config0	1	0	0
Config1	1	1	0
Config2	1	1	0
Config3	1	1	1

**Register Name:** OCxCR2  
**Register Description:** Output Clock x Configuration Register 2  
**Register Address:** OC1: 201h, OC2: 211h, OC3: 221h

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
<b>Name</b>	—	POL	DRIVE[1:0]	STOPDIS	—	—	—	—
<b>Default</b>	0	see below	see below	0	varies over config and output #			

**Bit 6: Clock Path Polarity (POL).** The clock path to the output is inverted when this bit set. The default value for this bit is 1 for OC2 in config2; otherwise the default value is 0. See section 3.3.1.

**Bits 5 to 4: CMOS/HSTL Output Drive Strength (DRIVE[1:0]).** The CMOS/HSTL output drivers have four equal sections that can be enabled or disabled to achieve four different drive strengths from 1x to 4x. When the output power supply VDDOx is 3.3V or 2.5V, the user should start with 1x and only increase drive strength if the output is highly loaded and signal transition time is unacceptable. When VDDOx is 1.8V or 1.5V the user should start with 4x and only decrease drive strength if the output signal has unacceptable overshoot. See section 3.3.1. This field only applies in Config2 for OC2 (HSTL) and in Config3 for OC3 (CMOS). Otherwise it is ignored. The default value is 01 for OC2 in Config2; otherwise it is 00.

- 00 = 1x
- 01 = 2x
- 10 = 3x
- 11 = 4x

**Bit 3: Stop Disable (STOPDIS).** This bit causes the output to become disabled (high impedance) while the output clock is stopped. See section 3.3.3.

- 0 = Do not disable the output while stopped
- 1 = Disable the output while stopped

**Register Name:** OCxPH  
**Register Description:** Output Clock x Phase Adjust Register  
**Register Address:** OC1: 207h, OC2: 217h, OC3: 227h

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
<b>Name</b>	PHADJ[7:0]							
<b>Default</b>	See below							

**Bits 7 to 0: Phase Adjust Value (PHADJ[7:0]).** When `OCxCR1.PHEN=1`, this field specifies the phase adjustment of the output clock during a phase adjustment event. When `OCxCR1.PHEN=0`, this field is ignored. The specified phase adjustment occurs once during a phase adjustment event. The format of the field is 2's-complement with the LSB being one half of an APLL output clock period. See section [3.3.2](#).

```

00000000 = 0.0 UI
00000001 = +0.5 UI
00000010 = +1.0 UI
00000011 = +1.5 UI
...
01111110 = +63.0 UI
01111111 = +63.5 UI
10000000 = -64.0 UI
10000001 = -63.5 UI
...
11111101 = -1.5 UI
11111110 = -1.0 UI
11111111 = -0.5 UI
    
```

Default value:

	OC1	OC2	OC3
Config0	0	0	0
Config1	0	0	0
Config2	2	0	0
Config3	2	2	0

**Register Name:** OCxSTOP  
**Register Description:** Output Clock x Start Stop Register  
**Register Address:** OC1: 208h, OC2: 218h, OC3: 228h

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
<b>Name</b>	STOP	—	SRC[3:0]			MODE[1:0]		
<b>Default</b>	0	0	0	0	0	0	0	0

**Bit 7: Output Clock Stop (STOP).** When SRC=0000, this bit is used to stop the output clock high or low. The output stays stopped while this bit is high. See section 3.3.3.

- 0 = Do not stop the output clock
- 1 = Stop the output clock

**Bits 5 to 2: Output Clock Stop Source (SRC[3:0]).** This field specifies the source of the stop signal. See section 3.3.3.

- 0000 = STOP bit
- 0001 = The arming of a phase adjustment (signal stopped when PASR.ARMED is asserted; signal started when PASR.ADJL is asserted)
- 0010 to 1111 = {unused values}

**Bits 1 to 0: Output Clock Stop Mode (MODE[1:0]).** This field selects the mode of the start-stop function. See section 3.3.3.

- 00 = Never stop
- 01 = Stop High: stop after rising edge of output clock, start after falling edge of output clock
- 10 = Stop Low: stop after falling edge of output clock, start after rising edge of output clock
- 11 = {unused value}

The following table shows which pin(s) stop high or low as specified above for each output signal format:

Signal Format	Pin that Stops As Specified
CML	OCxP
HSTL	OCxN
Two CMOS, OCxP in phase with OCxN	OCxP and OCxN
One CMOS, OCxN enabled	OCxN
One CMOS, OCxP enabled	OCxP
Two CMOS, OCxP inverted vs. OCxN	OCxN

Notes:

- The highest priority condition for an output is when it is stopped and OCxCR2.STOPDIS=1. When this condition occurs both OCxP and OCxN become high-impedance regardless of the state of the control bits mentioned below.
- When the above situation does not apply, OCxCR2.POL=1 changes Stop High to Stop Low and vice versa.

## 5. Electrical Characteristics

### Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Units
Supply voltage, nominal 1.8V	VDD18	-0.3	1.98	V
Supply voltage, nominal 3.3V	VDD33	-0.3	3.63	V
Supply voltage, VDDOx (x=1,2,3)	VDDOx	-0.3	3.63	V
Voltage on XA, any OCxP/N pin	VANAPIN	-0.3	3.63	V
Voltage on any digital I/O pin	VDIGPIN	-0.3	5.5	V
Storage Temperature Range	T <sub>ST</sub>	-55	+125	°C

\* Exceeding these values may cause permanent damage. Functional operation under these conditions is not implied.

\* Voltages are with respect to ground (VSS) unless otherwise stated.

**Note 1:** The typical values listed in the tables of Section 5 are not production tested.

**Note 2:** Specifications to -40°C and 85°C are guaranteed by design or characterization and not production tested.

**Table 5 - Recommended DC Operating Conditions**

Parameter	Symbol	Min.	Typ.	Max.	Units
Supply voltage, nominal 1.8V	VDD18	1.71	1.8	1.89	V
Supply voltage, nominal 3.3V	VDD33	3.135	3.3	3.465	V
Supply voltage, VDDOx (x=1,2,3)	VDDOx	1.425	1.5	1.575	V
		1.71	1.8	1.89	
		2.375	2.5	2.625	
		3.135	3.3	3.465	
Operating temperature	T <sub>A</sub>	-40		+85	°C

**Table 6 - Electrical Characteristics: Supply Currents**

Characteristics	Symbol	Min.	Typ. <sup>1</sup>	Max	Units	Notes
Total current, all 1.8V supply pins, Config 0	I <sub>DD18</sub>		93		mA	
Total current, all 3.3V supply pins, Config 0	I <sub>DD33</sub>		115		mA	
Total current, all 1.8V supply pins, Config 1	I <sub>DD18</sub>		131		mA	
Total current, all 3.3V supply pins, Config 1	I <sub>DD33</sub>		132		mA	
Total current, all 1.8V supply pins, Config 2	I <sub>DD18</sub>		123		mA	
Total current, all 3.3V supply pins, Config 2	I <sub>DD33</sub>		131		mA	
Total current, all 1.8V supply pins, Config 3	I <sub>DD18</sub>		161		mA	
Total current, all 3.3V supply pins, Config 3	I <sub>DD33</sub>		167		mA	

**Note 1:** Typical values measured at 1.80V and 3.30V supply voltages and 25°C ambient temperature.

**Table 7 - Electrical Characteristics: Non-clock CMOS Pins**

Characteristics	Symbol	Min.	Typ.	Max.	Units	Notes
Input high voltage, SCL and SDA	V <sub>IH</sub>	0.7 x VDD33			V	
Input low voltage, SCL and SDA	V <sub>IL</sub>			0.3 x VDD33	V	
Input high voltage, all other digital inputs	V <sub>IH</sub>	2.0			V	
Input low voltage, all other digital inputs	V <sub>IL</sub>			0.8	V	
Input leakage current, RSTN pin	I <sub>ILPU</sub>	-85		10	μA	Note 1
Input leakage current, all digital inputs	I <sub>IL</sub>	-10		10	μA	Note 1
Input capacitance	C <sub>IN</sub>		3	10	pF	
Input capacitance, SCL/SCLK, SDA/MOSI	C <sub>IN</sub>		3	11	pF	
Input hysteresis, SCL and SDA in I <sup>2</sup> C Bus Mode		0.05*			mV	

Characteristics	Symbol	Min.	Typ.	Max.	Units	Notes
		VDD33				
Output leakage (when high impedance)	$I_{LO}$	-10		10	$\mu\text{A}$	Note 1
Output high voltage	$V_{OH}$	2.4			V	$I_o = -3.0\text{mA}$
Output low voltage	$V_{OL}$			0.4	V	$I_o = 3.0\text{mA}$

**Note 1:**  $0\text{V} < V_{IN} < \text{VDD33}$  for all other digital inputs.

**Note 2:**  $V_{OH}$  does not apply for SCL and SDA in I<sup>2</sup>C interface mode since they are open drain.

**Table 8 - Electrical Characteristics: XA Clock Input**

This table covers the case when there is no external crystal connected and an external oscillator or clock signal is connected to the XA pin.

Characteristics	Symbol	Min.	Typ.	Max.	Units	Notes
Input high voltage, XA	$V_{IH}$	1.2			V	
Input low voltage, XA	$V_{IL}$			0.8	V	
Input frequency on XA pin	$f_{IN}$		25		MHz	
Input leakage current	$I_{IL}$	-10		10	$\mu\text{A}$	
Input duty cycle		40		60	%	

**Table 9 - Electrical Characteristics: CML Clock Outputs**

$V_{ODDx} = 3.3\text{V} \pm 5\%$  for CML operation.

Characteristics	Symbol	Min.	Typ.	Max.	Units	Notes
Output frequency	$f_{OCML}$		100		MHz	
Output high voltage, single-ended, OCxP or OCxN	$V_{OH,S}$		$V_{DDOx} - 0.2$		V	AC coupled to 50 $\Omega$ termination
Output low voltage, single-ended, OCxP or OCxN	$V_{OL,S}$		$V_{DDOx} - 0.6$		V	
Output common mode voltage	$V_{CM,S}$		$V_{DDOx} - 0.4$		V	
Output differential voltage	$ V_{OD,S} $	320	400	500	mV	
Output differential voltage, peak-to-peak	$ V_{OD,S,PP} $	640	800	1000	mV <sub>P-P</sub>	
Difference in Magnitude of Differential Voltage for Complementary States	$V_{DOS}$			50	mV	
Output Rise/Fall Time	$t_R, t_F$		150		ps	20%-80%
Output Duty Cycle		45	50	55	%	
Output Impedance	$R_{OUT}$		50		$\Omega$	Single Ended, to $V_{DDOx}$
Mismatch in a pair	$\Delta R_{OUT}$			10	%	

**Note 1:** The differential CML outputs can easily be interfaced to LVDS, LVPECL, CML and other differential inputs on neighboring ICs using a few external passive components. See [Figure 9](#) for details.

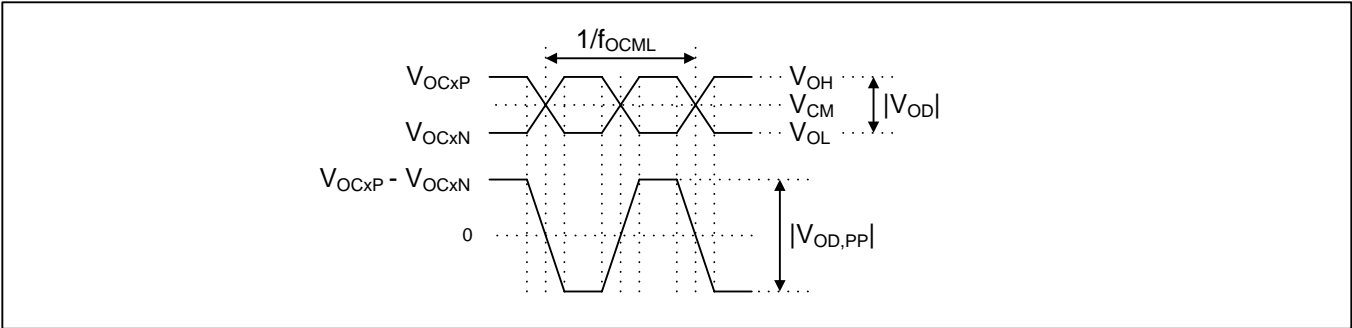


Figure 8 - Electrical Characteristics: CML Clock Outputs

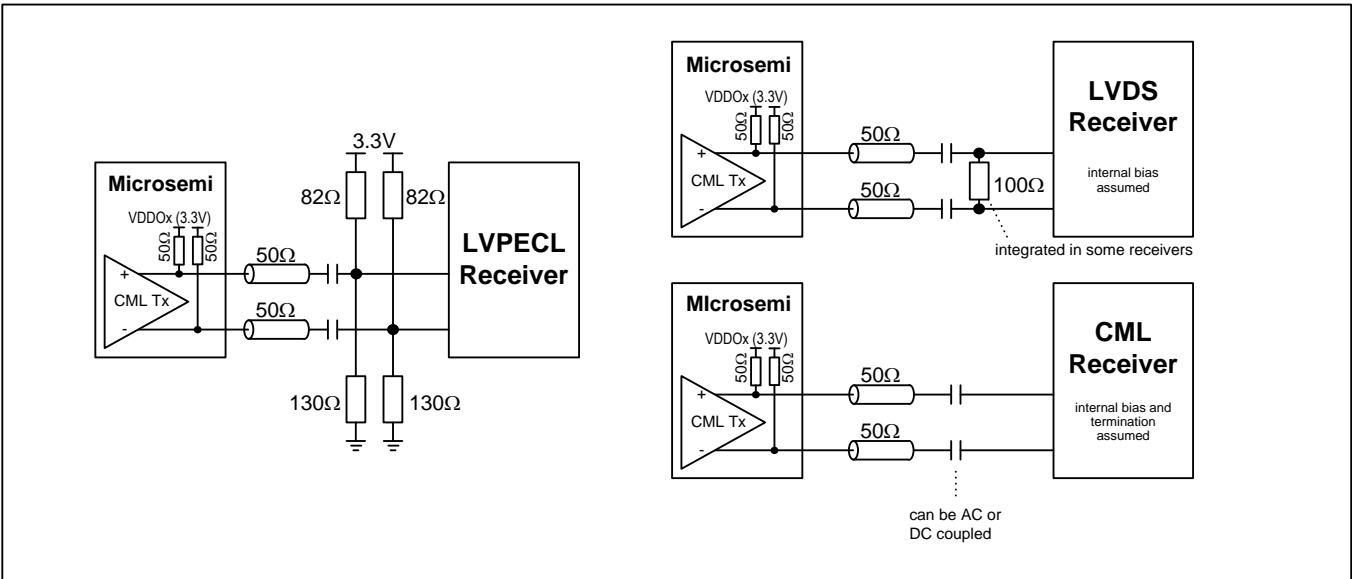


Figure 9 - Example External Components for CML Output Signals



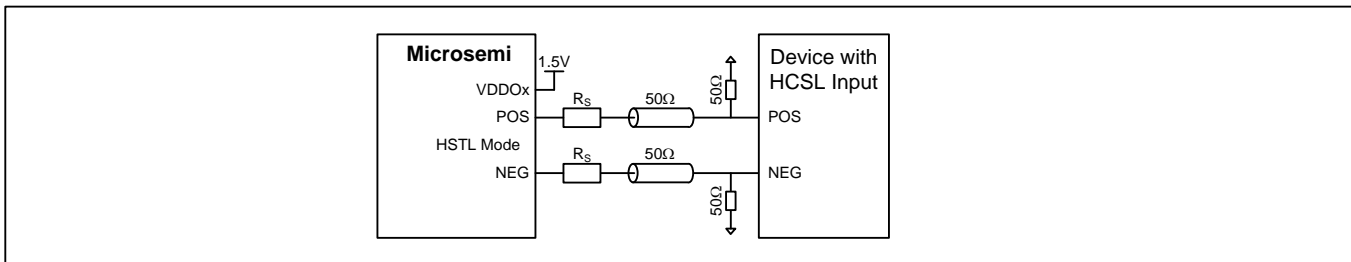
**Table 10 - Electrical Characteristics: CMOS and HSTL (Class I) Clock Outputs**

Characteristics	Symbol	Min.	Typ.	Max.	Units	Notes
Output frequency	$f_{OCMOS}$	25			MHz	
Output high voltage	$V_{OH}$	$V_{DDOx} - 0.4$		$V_{DDOx}$	V	Notes 2, 3
Output low voltage	$V_{OL}$	0		0.4	V	Notes 2, 3
Output rise/fall time, $V_{CCOx}=1.8V$ , $OCxCR2.DRIVE=4x$	$t_R, t_F$		0.4		ns	2pF load
Output rise/fall time, $V_{CCOx}=1.8V$ , $OCxCR2.DRIVE=4x$			1.2		ns	15pF load
Output rise/fall time, $V_{CCOx}=3.3V$ , $OCxCR2.DRIVE=1x$			0.7		ns	2pF load
Output rise/fall time, $V_{CCOx}=3.3V$ , $OCxCR2.DRIVE=1x$			2.2		ns	15pF load
Output duty cycle		45	50	55	%	Note 4
Output duty cycle		42	50	58	%	Notes 5, 6
Output duty cycle, OCxNEG single-ended			50		%	Note 5
Output duty cycle, OCxPOS single-ended			46		%	Note 5
Output current when output disabled			10		$\mu A$	

- Note 1:** Measured with a series resistor of 33 $\Omega$  and a 5pF load capacitance unless otherwise specified.
- Note 2:** For HSTL Class I,  $V_{OH}$  and  $V_{OL}$  apply for both unterminated loads and for symmetrically terminated loads, i.e. 50 $\Omega$  to  $V_{DDOx}/2$ .
- Note 3:** For  $V_{DDOx}=3.3V$  and  $OCxCR2.DRIVE=1x$ ,  $I_o=4mA$ . For  $V_{DDOx}=1.5V$  and  $OCxCR2.DRIVE=4x$ ,  $I_o=8mA$ .
- Note 4:**  $V_{DDOx} \geq 1.8V$ .
- Note 5:**  $V_{DDOx} < 1.8V$ .
- Note 6:** Measured differentially.

**Interfacing to HCSL Components**

In Config2, output OC2 is HSTL mode. HSTL mode with  $V_{DDO2}=1.8V$  can provide an HCSL-compatible signal ( $V_{OH}$  typ. 0.75V) to a neighboring component when configured as shown in Figure 10 below. The resistor  $R_S$  should be 20 $\Omega$ .



**Figure 10 - Example External Components for HCSL Output Signals**

**Table 11 - Electrical Characteristics: Typical Input-to-Output Clock Delay**

Mode	Delay, Input Clock Edge to Output Clock Edge
All Modes	Non-deterministic but constant as long as the APLL remains locked and output clock phases are not adjusted as described in section 3.3.2.1.

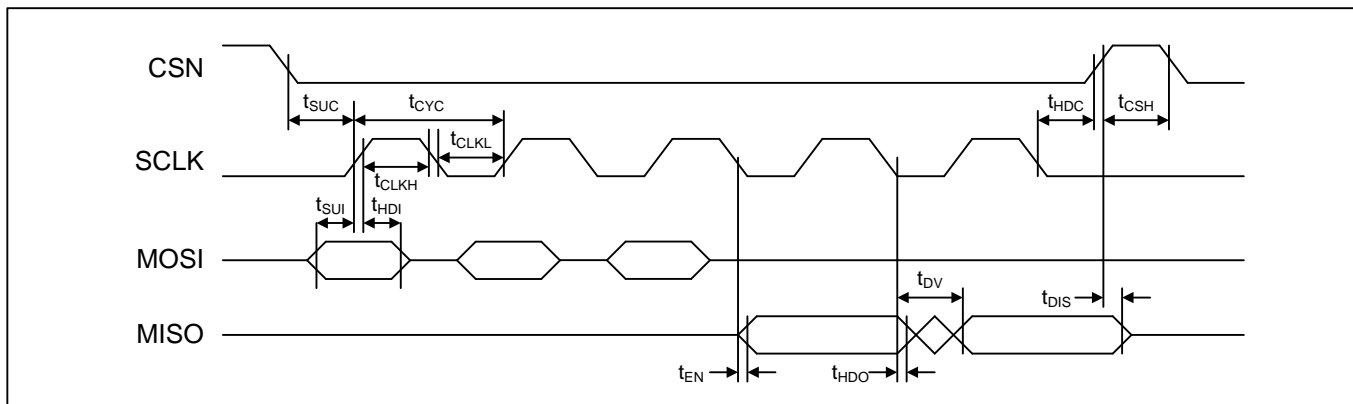
**Table 12 - Electrical Characteristics: Typical Output-to-Output Clock Delay**

Mode	Delay, Output Clock Edge to Output Clock Edge
All Modes	<100ps Requires phase adjustment and phase alignment capability described in section 3.3.2.

**Table 13 - Electrical Characteristics: SPI Slave Interface Timing**

Characteristics (Notes 1 to 3)	Symbol	Min.	Typ.	Max.	Units	Notes
SCLK frequency	$f_{BUS}$			10	MHz	
SCLK cycle time	$t_{CYC}$	100			ns	
CSN setup to first SCLK edge	$t_{SUC}$	50			ns	
CSN hold time after last SCLK edge	$t_{HDC}$	50			ns	
CSN high time	$t_{CSH}$	50			ns	
SCLK high time	$t_{CLKH}$	40			ns	
SCLK low time	$t_{CLKL}$	40			ns	
MOSI data setup time	$t_{SUI}$	10			ns	
MOSI data hold time	$t_{HDI}$	10			ns	
MISO enable time from SCLK edge	$t_{EN}$	0			ns	
MISO disable time from CSN high	$t_{DIS}$			80	ns	
MISO data valid time	$t_{DV}$			40	ns	
MISO data hold time from SCLK edge	$t_{HDO}$	0			ns	
CSN, MOSI input rise time, fall time	$t_R, t_F$			10	ns	

- Note 1:** All timing is specified with 100pF load on all SPI pins.
- Note 2:** All parameters in this table are guaranteed by design or characterization.
- Note 3:** See timing diagram in [Figure 11](#).

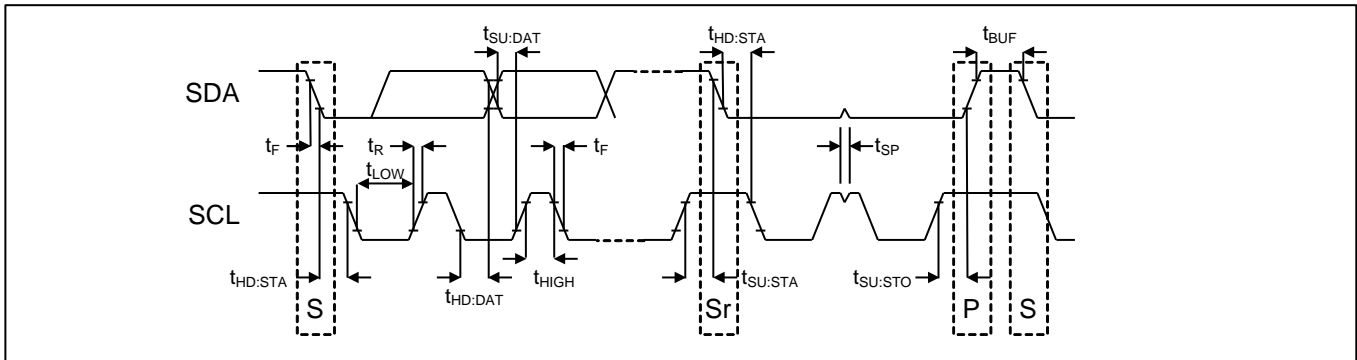


**Figure 11 - SPI Slave Interface Timing**

**Table 14 - Electrical Characteristics: I<sup>2</sup>C Slave Interface Timing**

Characteristics	Symbol	Min.	Typ.	Max.	Units	Notes
SCL clock frequency	f <sub>SCL</sub>			400	kHz	
Hold time, START condition	t <sub>HD:STA</sub>	0.6			μs	
Low time, SCL	t <sub>LOW</sub>	1.3			μs	
High time, SCL	t <sub>HIGH</sub>	0.6			μs	
Setup time, START condition	t <sub>SU:STA</sub>	0.6			μs	
Data hold time	t <sub>HD:DAT</sub>	0		0.9	μs	Notes 2 and 3
Data setup time	t <sub>SU:DAT</sub>	100			ns	
Rise time	t <sub>R</sub>				ns	Note 4
Fall time	t <sub>F</sub>	20 + 0.1C <sub>b</sub>		300	ns	C <sub>b</sub> is cap. of one bus line
Setup time, STOP condition	t <sub>SU:STO</sub>	0.6			μs	
Bus free time between STOP/START	t <sub>BUF</sub>	1.3			μs	
Pulse width of spikes which must be suppressed by the input filter	t <sub>SP</sub>	0		50	ns	

- Note 1:** The timing parameters in this table are specifically for 400kbps Fast Mode. Fast Mode devices are downward-compatible with 100kbps Standard Mode I<sup>2</sup>C bus timing. All parameters in this table are guaranteed by design or characterization. All values referred to V<sub>IHmin</sub> and V<sub>ILmax</sub> levels (see Table 7).
- Note 2:** The device internally provides a hold time of at least 300ns for the SDA signal (referred to the V<sub>IHmin</sub> of the SCL signal) to bridge the undefined region of the falling edge of SCL. Other devices must provide this hold time as well per the I<sup>2</sup>C specification.
- Note 3:** The I<sup>2</sup>C specification indicates that the maximum t<sub>HD:DAT</sub> spec only has to be met if the device does not stretch the low period (t<sub>LOW</sub>) of the SCL signal. The device does not stretch the low period of the SCL signal.
- Note 4:** Determined by choice of pull-up resistor.



**Figure 12 - I<sup>2</sup>C Slave Interface Timing**

## 6. Package and Thermal Information

### 6.1 Package Top Mark Format

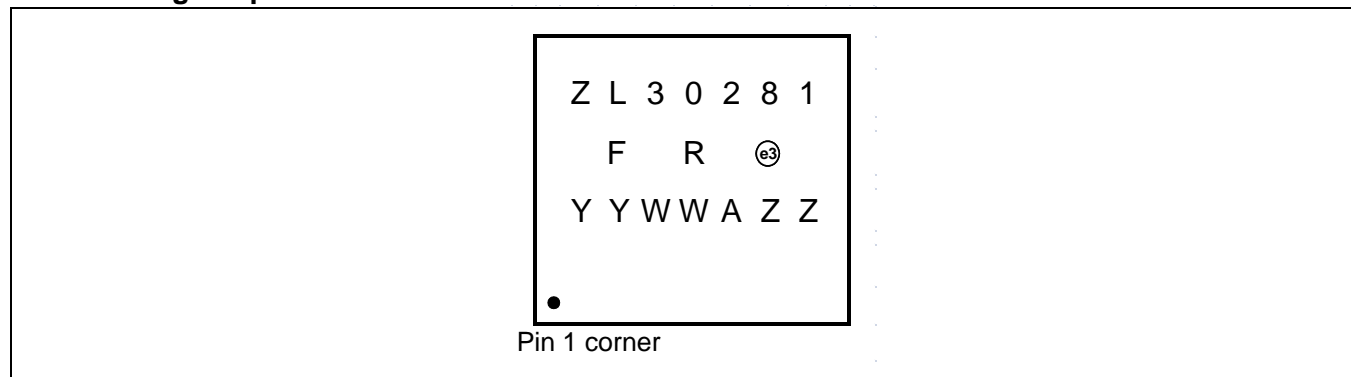


Figure 13 - Device Top Mark

Table 15 – Package Top Mark Legend

Line	Characters	Description
1	ZL30169	Part Number
2	F	Fab Code
2	R	Product Revision Code
2	e3	Denotes Pb-Free Package
3	YY	Last Two Digits of the Year of Encapsulation
3	WW	Work Week of Assembly
3	A	Assembly Location Code
3	ZZ	Assembly Lot Sequence

### 6.2 Thermal Specifications

Table 16 - 5x5mm QFN Package Thermal Properties

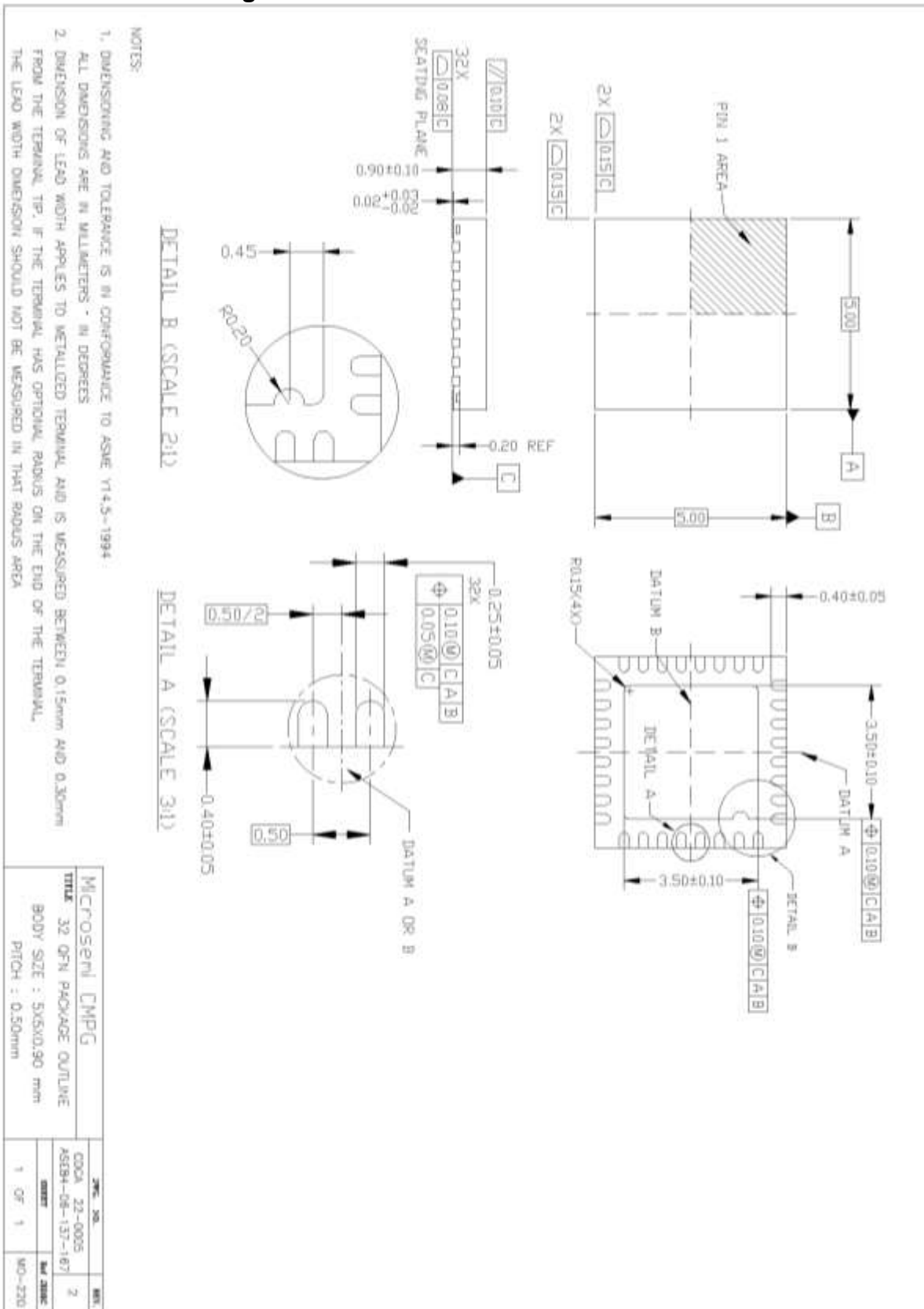
PARAMETER	SYMBOL	CONDITIONS	VALUE	UNITS
Maximum Ambient Temperature	$T_A$		85	°C
Maximum Junction Temperature	$T_{JMAX}$		125	°C
Junction to Ambient Thermal Resistance (Note 1)	$\theta_{JA}$	still air	29.6	°C/W
		1m/s airflow	23.3	
		2.5m/s airflow	20.6	
Junction to Board Thermal Resistance	$\theta_{JB}$		9.8	°C/W
Junction to Case Thermal Resistance	$\theta_{JC}$		17.5	°C/W
Junction to Pad Thermal Resistance (Note 2)	$\theta_{JP}$	Still air	3.4	°C/W
Junction to Top-Center Thermal Characterization Parameter	$\psi_{JT}$	Still air	0.2	°C/W

**Note 1:** Theta-JA ( $\theta_{JA}$ ) is the thermal resistance from junction to ambient when the package is mounted on an 4-layer JEDEC standard test board and dissipating maximum power.

**Note 2:** Theta-JP ( $\theta_{JP}$ ) is the thermal resistance from junction to the center exposed pad on the bottom of the package.

**Note 3:** For all numbers in the table, the exposed pad is connected to the ground plane with a 5x5 array of thermal vias; via diameter 0.33mm; via pitch 0.76mm.

**7. Mechanical Drawing**



## 8. Acronyms and Abbreviations

APLL	analog phase locked loop
CML	current mode logic
GbE	gigabit Ethernet
HCSL	high-speed current steering logic
HSTL	high-speed transceiver logic
I/O	input/output
LVDS	low-voltage differential signal
LVPECL	low-voltage positive emitter-coupled logic
PFD	phase/frequency detector
PLL	phase locked loop
pk-pk	peak-to-peak
RMS	root-mean-square
RO	read-only
R/W	read/write
UI	unit interval
UI <sub>PP</sub> or UI <sub>P-P</sub>	unit interval, peak to peak
XO	crystal oscillator

## 9. Data Sheet Revision History

Revision	Description
02-Aug-2017	First full draft
07-Aug-2017	Edited section 3.3 to remove concepts that don't apply to ZL30281.
08-Aug-2017	Deleted Figure 8 which does not apply to ZL30281. Deleted note 1 from Table 10 and renumbered remaining notes.
09-Aug-2017	Below Table 10, simplified Interfacing to HCSL components to apply only to OC2 in Config2 with VDDO2=1.8V. Made similar edits to section 3.3.1. In OCxCR2 add text to say when this DRIVE field applies and how default value varies over config # and output #.
21-Sep-2017	Added IDD numbers in Table 6. Removed Preliminary from page headers.
10-May-2018	In section 6 added package top mark format.
13-Jun-2018	On page 1 changed wording to indicate PCIe 1-4 compliance.



Microsemi Corporate Headquarters  
One Enterprise  
Aliso Viejo, CA 92656 USA

**Within the USA:** +1 (800) 713-4113  
**Outside the USA:** +1 (949) 380-6100  
**Sales:** +1 (949) 380-6136  
**Fax:** +1 (949) 215-4996

**E-mail:** [sales.support@microsemi.com](mailto:sales.support@microsemi.com)

©2018 Microsemi Corporation. All rights reserved. Microsemi and the Microsemi logo are trademarks of Microsemi Corporation. All other trademarks and service marks are the property of their respective owners.

Microsemi Corporation (Nasdaq: MSCC) offers a comprehensive portfolio of semiconductor and system solutions for communications, defense & security, aerospace and industrial markets. Products include high-performance and radiation-hardened analog mixed-signal integrated circuits, FPGAs, SoCs and ASICs; power management products; timing and synchronization devices and precise time solutions, setting the world's standard for time; voice processing devices; RF solutions; discrete components; security technologies and scalable anti-tamper products; Power-over-Ethernet ICs and midspans; as well as custom design capabilities and services. Microsemi is headquartered in Aliso Viejo, Calif., and has approximately 3,400 employees globally. Learn more at [www.microsemi.com](http://www.microsemi.com).

---

Microsemi makes no warranty, representation, or guarantee regarding the information contained herein or the suitability of its products and services for any particular purpose, nor does Microsemi assume any liability whatsoever arising out of the application or use of any product or circuit. The products sold hereunder and any other products sold by Microsemi have been subject to limited testing and should not be used in conjunction with mission-critical equipment or applications. Any performance specifications are believed to be reliable but are not verified, and Buyer must conduct and complete all performance and other testing of the products, alone and together with, or installed in, any end-products. Buyer shall not rely on any data and performance specifications or parameters provided by Microsemi. It is the Buyer's responsibility to independently determine suitability of any products and to test and verify the same. The information provided by Microsemi hereunder is provided "as is, where is" and with all faults, and the entire risk associated with such information is entirely with the Buyer. Microsemi does not grant, explicitly or implicitly, to any party any patent rights, licenses, or any other IP rights, whether with regard to such information itself or anything described by such information. Information provided in this document is proprietary to Microsemi, and Microsemi reserves the right to make any changes to the information in this document or to any products and services at any time without notice.