



# ZL40255 SmartBuffer™

## 3-Output Programmable Fanout Buffer with Multi-Format I/O and Dividers

Data Sheet

April 2018

### Features

- **Four Input Clocks**
  - One crystal/CMOS input
  - Two differential/CMOS inputs
  - One single-ended/CMOS input
  - Any input frequency up to 1035MHz (up to 300MHz for CMOS)
  - Clock selection by pin or register control
- **Up to 3 Differential Outputs (Up to 6 CMOS)**
  - Output frequencies are any integer divisor up to  $2^{32}$  of the input frequency (CMOS 250MHz max)
  - Each output has independent dividers
  - Low additive jitter <200fs RMS (12kHz-20MHz, for input frequencies  $\geq 100$ MHz)
  - Outputs are CML or 2xCMOS, can interface to LVDS, LVPECL, HSTL, SSTL and HCSL
  - In 2xCMOS mode, the P and N pins can be different frequencies (e.g. 125MHz and 25MHz)\*
  - Per-output supply pin with CMOS output voltages from 1.5V to 3.3V
  - Precise output alignment circuitry and per-output phase adjustment\*
  - Per-output enable/disable and glitchless start/stop (stop high or low)\*

Ordering Information		
ZL40255LDG1	32 Pin QFN	Trays
ZL40255LDF1	32 Pin QFN	Tape and Reel
Matte Tin		
Package size: 5 x 5 mm		
<b>-40°C to +85°C</b>		

### General Features

- Automatic self-configuration at power-up from internal EEPROM; up to four configurations, pin-selectable
- Crystal interface for frequency synthesis up to 60MHz
- Four general-purpose I/O pins, each with many status and control options
- SPI or I<sup>2</sup>C processor Interface
- Tiny 5x5mm QFN package

### Applications

- Frequency synthesis up to 60MHz
- Fanout up to 1035MHz
- Format conversion, frequency division, and skew adjustment in a wide variety of equipment types

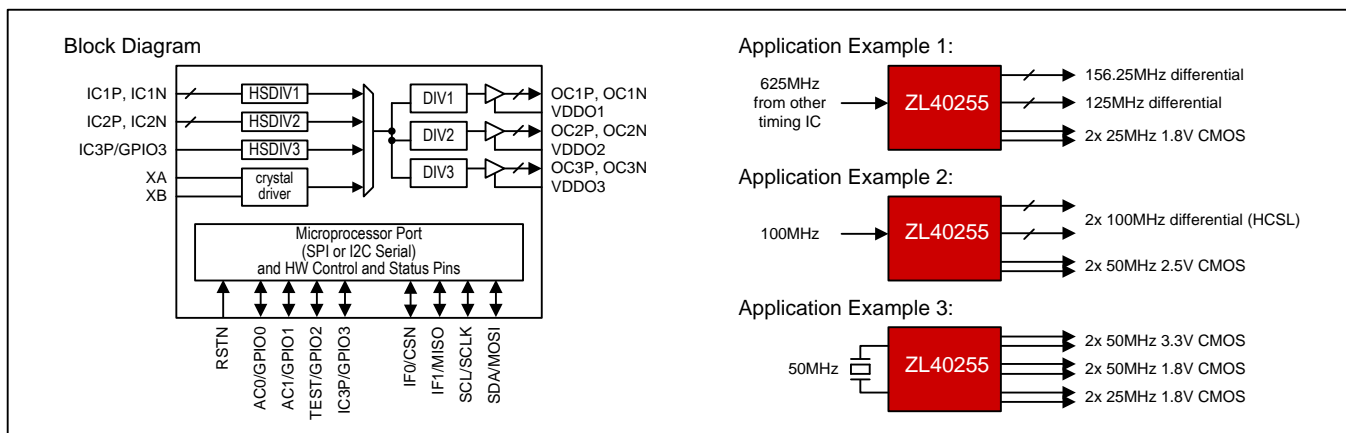


Figure 1 - Functional Block Diagram and Application Examples

\* Some features require a higher-frequency input clock and enabling the output dividers.

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### 1. Pin Diagram

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

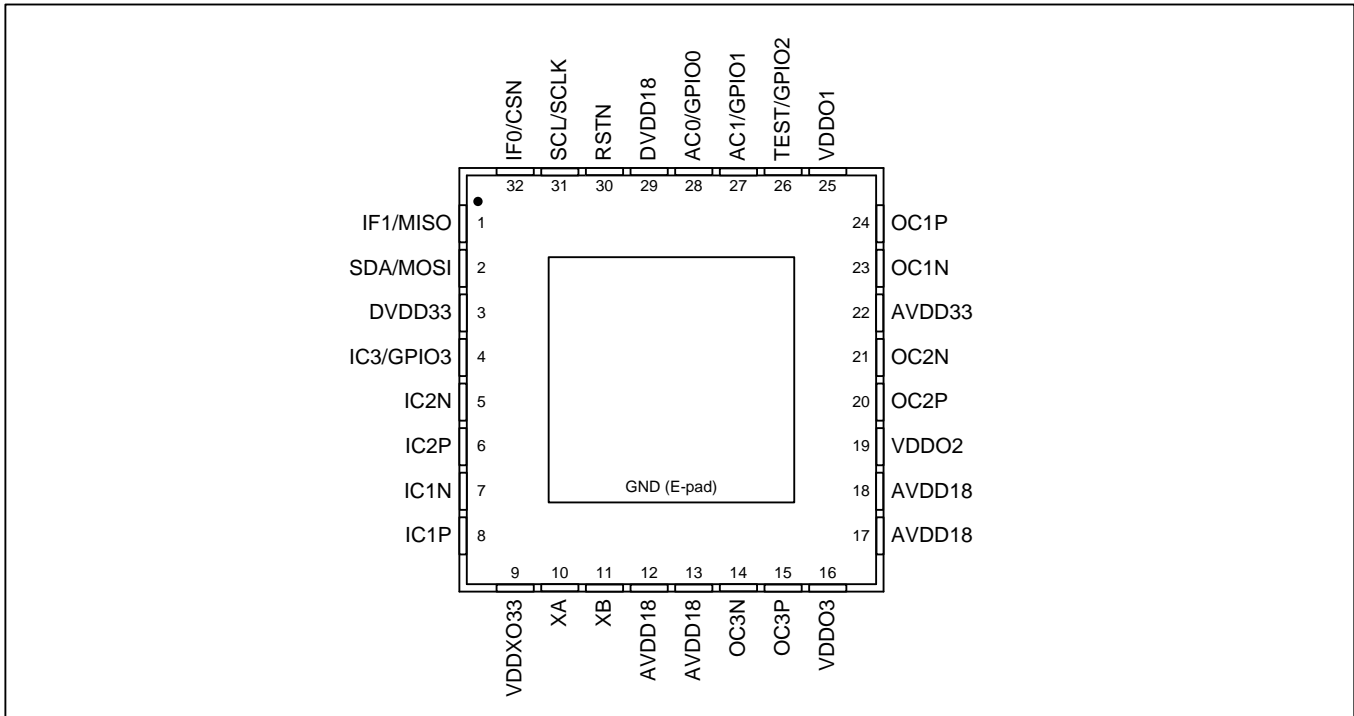


Figure 2 - Pin Diagram

## 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 GPIO and 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
8 7 6 5 4	IC1P IC1N IC2P IC2N IC3P/GPIO3	I I I I I/O	<p><b>Input Clock Pins</b> Differential or Single-ended signal format. Programmable frequency.</p> <p><i>Differential:</i> See <a href="#">Table 9</a> for electrical specifications, and see <a href="#">Figure 13</a> for recommended external circuitry for interfacing these differential inputs to LVDS, LVPECL, CML or HSCL output pins on neighboring devices.</p> <p><i>Single-ended:</i> For input signal amplitude &gt;2.5V, connect the signal directly to ICxP pin. For input signal amplitude ≤2.5V, AC-coupling the signal to ICxP is recommended. Connect the N pin to a capacitor (0.1μF or 0.01μF) to VSS. As shown in <a href="#">Figure 13</a>, the ICxP and ICxN pins are internally biased to approximately 1.3V. Treat the ICxN pin as a sensitive node; minimize stubs; do not connect to anything else including other ICxN pins.</p> <p><i>Unused:</i> Set ICEN.ICxEN=0. The ICxP and ICxN pins can be left floating.</p> <p>Note that the IC3N pin is not bonded out. A differential signal can be connected to IC3P by AC-coupling the POS trace to IC3P and terminating the signal on the driver side of the coupling cap. If not needed as an input clock pin, IC3P can behave as general-purpose I/O pin GPIO3, which is configured by <a href="#">GPIOCR2</a>. Its state is indicated in <a href="#">GPIOSR</a>.</p>
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 <a href="#">3.3</a> 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 14	OC1P OC1N OC2P OC2N OC3P OC3N	O	<p><b>Output Clock Pins</b> CML, HSTL or 1 or 2 CMOS. Programmable frequency and drive strength. See <a href="#">Table 10</a> and <a href="#">Figure 15</a> for electrical specifications and recommended external circuitry for interfacing to LVDS, LVPECL or CML input pins on neighboring devices.</p> <p>See <a href="#">Table 11</a> for electrical specifications for interfacing to CMOS and HSTL inputs on neighboring devices.</p> <p>See <a href="#">Figure 16</a> for recommended external circuitry for interfacing to HCSL inputs on neighboring devices.</p>
30	RSTN	I <sub>PU</sub>	<p><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 <a href="#">3.9</a>.</p>

Table 1 - Pin Descriptions (continued)

Pin #	Name	Type	Description
28 27	AC0/GPIO0 AC1/GPIO1	I/O	<p><b>Auto-Configure [1:0] / General Purpose I/O 0 and 1</b></p> <p><i>Auto Configure:</i> On the rising edge of RSTN these pins behave as AC[1:0] and specify one of the configurations stored in EEPROM. See section 3.2.</p> <p><i>General-Purpose I/O:</i> After reset these pins are GPIO0 and GPIO1. <a href="#">GPIOCR1</a> configures the pins. Their states are indicated in <a href="#">GPIOSR</a>.</p>
26	TEST/GPIO2	I/O	<p><b>Factory Test / General Purpose I/O 2</b></p> <p><i>Factory Test:</i> 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.</p> <p><i>General-Purpose I/O:</i> After reset this pin is GPIO2. <a href="#">GPIOCR2</a> configures the pin. Its state is indicated in <a href="#">GPIOSR</a>.</p>
32	IF0/CSN	I/O	<p><b>Interface Mode 0 / SPI Chip Select (Active Low)</b></p> <p><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 3.2.</p> <p><i>SPI Chip Select:</i> After reset this pin is CSN. When the device is configured as a SPI slave, an external SPI master must assert (low) CSN to access device registers.</p>
31	SCL/SCLK	I/O	<p><b>I<sup>2</sup>C Clock / SPI Clock</b></p> <p><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. Note that I<sup>2</sup>C requires an external pullup resistor on this signal. See the I<sup>2</sup>C specification for details.</p> <p><i>SPI Clock:</i> When the device is configured as a SPI slave, an external SPI master must provide the SPI clock signal on SCLK.</p>
1	IF1/MISO	I/O	<p><b>Interface Mode 1 / SPI Master-In-Slave-Out</b></p> <p><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 3.2.</p> <p><i>SPI MISO:</i> After reset this pin is MISO. When the device is configured as a SPI slave, the device outputs data to an external SPI master on MISO during SPI read transactions.</p>
2	SDA/MOSI	I/O	<p><b>I<sup>2</sup>C Data / SPI Master-Out-Slave-In</b></p> <p><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. Note that I<sup>2</sup>C requires an external pullup resistor on this signal. See the I<sup>2</sup>C specification for details.</p> <p><i>SPI MOSI:</i> When the device is configured as a SPI slave, an external SPI master sends commands, addresses and data to the device on MOSI.</p>
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>

Pin #	Name	Type	Description
25	VDDO1	P	<b>Output OC1 Power Supply.</b> 1.5V to 3.3V $\pm 5\%$ .
19	VDDO2	P	<b>Output OC2 Power Supply.</b> 1.5V to 3.3V $\pm 5\%$ .
16	VDDO3	P	<b>Output OC3 Power Supply.</b> 1.5V to 3.3V $\pm 5\%$ .
9	VDDXO33	P	<b>Analog Power Supply for Crystal Driver Circuitry.</b> 3.3V $\pm 5\%$ .
E-pad	VSS	P	<b>Ground.</b> 0 Volts.

### 3. Functional Description

#### 3.1 Device Identification

The 12-bit read-only ID field and the 4-bit revision field are found in the [ID1](#) and [ID2](#) registers. Contact the factory to interpret the revision value and determine the latest revision.

#### 3.2 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/GPIO2, AC1/GPIO1, AC0/GPIO0, 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 1k $\Omega$ .
2. RSTN must be asserted at least as long as specified in section [3.9](#).

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 from EEPROM

The TEST pin selects manufacturing test modes when TEST=1 (the AC[1:0] pins specify the test mode). TEST=1 and AC[1:0]=00 configures the part so that production SPI EEPROM programmers can program the internal EEPROM (see section [3.11.2](#)).

The IF[1:0] pins specify the processor interface mode and the I<sup>2</sup>C slave address.

IF1	IF0	Processor Interface
0	0	I <sup>2</sup> C, slave address 10110 00
0	1	I <sup>2</sup> C, slave address 10110 01
1	0	I <sup>2</sup> C, slave address 10110 10
1	1	SPI Slave

The AC[1:0] pins specify which of four device configurations in the EEPROM to execute after reset.

AC1	AC0	Auto Configuration
0	0	Configuration 0
0	1	Configuration 1
1	0	Configuration 2
1	1	Configuration 3

For more information about auto-configuration from EEPROM see section [3.11.1](#).

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

The on-chip crystal driver circuit is designed to work with a 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 is placed in parallel with the 4pF internal capacitance of the XA pin, and an external 16pF 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 values in [Figure 3](#) 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 or TCXO should be used instead.

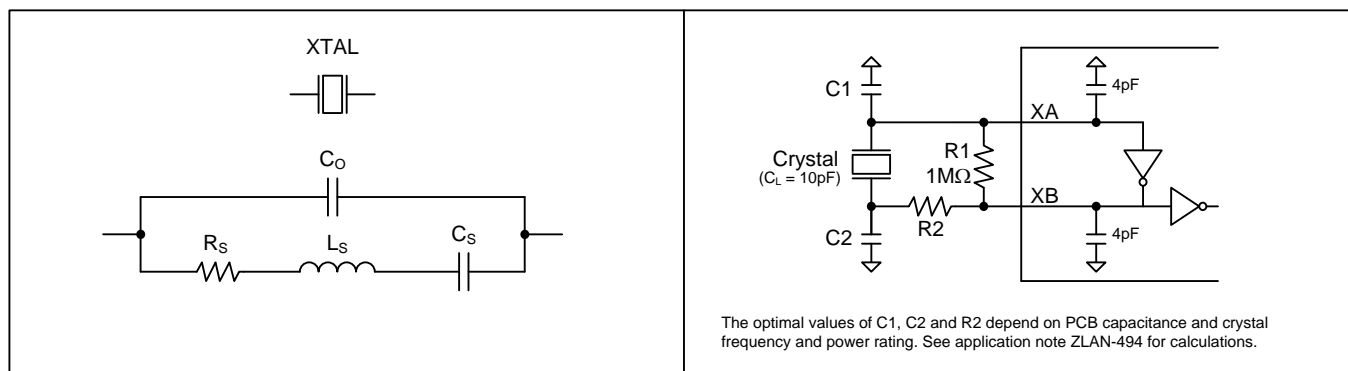


Figure 3 - Crystal Equivalent Circuit / Recommended Crystal Circuit

Table 2 - Crystal Selection Parameters

Parameter	Symbol	Min.	Typ.	Max.	Units
Crystal oscillation frequency <sup>1</sup>	$f_{osc}$	25		60	MHz
Shunt capacitance	$C_o$		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.

### 3.4 Input Signal Format Configuration

Input clocks IC1, IC2 and IC3 are enabled by setting the enable bits in the `ICEN` register. The power consumed by a differential receiver is shown in [Table 6](#). The electrical specifications for these inputs are listed in [Table 9](#). Each input clock can be configured to accept nearly any differential signal format by using the proper set of external components (see [Figure 13](#)). To configure these differential inputs to accept single-ended CMOS signals, connect the single-ended signal to the ICxP pin, and connect the ICxN pin to a capacitor (0.1 $\mu\text{F}$  or 0.01 $\mu\text{F}$ ) to VSS. Each ICxP and ICxN pin is internally biased to approximately 1.3V. If an input is not used, both ICxP and ICxN pins can be left floating. Note that the IC3N pin is not present. A differential signal can be connected to IC3P by AC-coupling



the POS trace to IC3P and terminating the signal on the driver side of the coupling cap. If not needed as an input clock pin, IC3P can behave as general-purpose I/O pin GPIO3.

### 3.5 Input Selection

The input to the device can be controlled by a GPIO pin or by the [SRCCR3.INMUX](#) register field. When [SRCCR3.EXTSW=0](#), the [SRCCR3.INMUX](#) register field controls the input mux.

When [SRCCR3.EXTSW=1](#), a GPIO pin controls the input mux. When the GPIO pin is low, the mux selects the input specified by [SRCCR3.INMUX](#). When the GPIO pin is high, the mux selects the input specified by [SRCCR3.ALTMUX](#). [MCR2.EXTSS](#) specifies which GPIO pin controls this behavior.

The polarity of an ICx input signal can be inverted by setting [ICxCR1.POL](#).

Input clock frequencies above 850MHz must be divided by 2 using the input high-speed dividers configured by [ICxCR1.HSDIV](#).

### 3.6 Output Clock Configuration

The device has three output clock signal pairs. Each output has individual divider, enable and signal format controls. In CMOS mode each signal pair can become two CMOS outputs, allowing the device to have up to six output clock signals. Also in CMOS mode, the OCxN pin can have an additional divider allowing the OCxN frequency to be an integer divisor of the OCxP frequency (example: OC3P 125MHz and OC3N 25MHz). The outputs can be aligned relative to each other and relative to an input signal, and the phases of output signals can be adjusted dynamically with high resolution and infinite range.

#### 3.6.1 Output Enable, Signal Format, Voltage and Interfacing

To use an output, the output driver must be enabled by setting [OCxCR2.OCSF≠0](#), and the per-output dividers must be enabled by setting the appropriate bit in the [OCEN](#) register. The per-output dividers include the medium-speed divider, the low-speed divider and the associated phase adjustment/alignment circuitry and start/stop logic.

Using the [OCxCR2.OCSF](#) register field, each output pair can be disabled or configured as a CML output, an HSTL output, or one or two CMOS outputs. When an output is disabled it is high impedance, and the output driver is in a low-power state. In CMOS mode, the OCxN pin can be disabled, in phase or inverted vs. the OCxP pin. In CML mode the normal 800mV  $V_{OD}$  differential voltage is available as well as a half-swing 400mV  $V_{OD}$ . All of these options are specified by [OCxCR2.OCSF](#). 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 OCSF is set to HSTL mode then a 1.5V power supply voltage should be used to get a standards-compliant HSTL output. Note that differential (CML) outputs must have a power supply of 3.3V.

The differential 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 15](#) for examples.

#### 3.6.2 Output Frequency Configuration

Each output has two output dividers, a 7-bit medium-speed divider ([OCxCR1.MSDIV](#)) and a 25-bit low-speed output divider (LSDIV field in the [OCxDIV](#) registers). These dividers are in series, medium-speed divider first then output divider. These dividers produce signals with 50% duty cycle for all divider values including odd numbers. The low-speed divider can only be used if the medium-speed divider is used (i.e. [OCxCR1.MSDIV>0](#)). The maximum input frequency to the medium-speed divider is 850MHz. The maximum input frequency to the low-speed divider is 425MHz.

Since each output has its own independent dividers, the device can output families of related frequencies that have an input frequency as a common multiple. For example, for Ethernet clocks, a 625MHz input clock can be divided by four for one output to get 156.25MHz, divided by five for another output to get 125MHz, and divided by 25 for another output to get 25MHz. Similarly, for SDH/SONET clocks, a 622.08MHz input clock can be divided by 4 to get 155.52MHz, by 8 to get 77.76MHz, by 16 to get 38.88MHz or by 32 to get 19.44MHz.

### Two Different Frequencies in 2xCMOS Mode

When an output is in 2xCMOS mode it can be configured to have the frequency of the OCxN clock be an integer divisor of the frequency of the OCxP clock. Examples of where this can be useful:

- 125MHz on OCxP and 25MHz on OCxN for Ethernet applications
- 77.76MHz on OCxP and 19.44MHz on OCxN for SONET/SDH applications
- 25MHz on OCxP and 1Hz (i.e. 1PPS) on OCxN for telecom applications with Synchronous Ethernet and IEEE1588 timing

An output can be configured to operate like this by setting the LSDIV value in the [OCxDIV](#) registers to  $\text{OCxP\_freq} / \text{OCxN\_freq} - 1$  and setting [OCxCR3.LSSEL=0](#) and [OCxCR3.NEGLSD=1](#). Here are some notes about this dual-frequency configuration option:

- In this mode only the medium speed divider is used to create the OCxP frequency. The low-speed divider is then used to divide the OCxP frequency down to the OCxN frequency. This means that the lowest OCxP frequency is the input high-speed divider frequency divided by 128.
- An additional constraint is that the medium-speed divider must be configured to divide by 6 or more (i.e. must have [OCxCR1.MSDIV \$\geq\$ 5](#)).

### 3.6.3 Output Duty Cycle Adjustment

For output frequencies less than or equal to 141.666MHz, the duty cycle of the output clock can be modified using the [OCxDC.OCDC](#) register field. This behavior is only available when  $\text{MSDIV} > 0$  and  $\text{LSDIV} > 1$ . When  $\text{OCDC} = 0$  the output clock is 50%. Otherwise the clock signal is a pulse with a width of OCDC number of MSDIV output clock periods. The range of OCDC can create pulse widths of 1 to 255 MSDIV output clock periods. When [OCxCR2.POL=0](#), the pulse is high and the signal is low the remainder of the cycle. When  $\text{POL}=1$ , the pulse is low and the signal is high the remainder of the cycle.

Note that duty cycle adjustment is done in the low-speed divider. Therefore when [OCxCR3.LSSEL=0](#) the duty cycle of the output is not affected. Also, when a CMOS output is configured with [OCxCR3.LSSEL=0](#) and [OCxCR3.NEGLSD=1](#), the OCxN pin has duty cycle adjustment but the OCxP pin does not. This allows a higher-speed 50% duty cycle clock signal to be output on the OCxP pin and a lower-speed frame/phase/time pulse (e.g. 2kHz, 8kHz or 1PPS) to be output on the OCxN pin at the same time.

An output configured for CMOS or HSTL signal format should not be configured to have a duty cycle with high time shorter than 2ns or low time shorter than 2ns.

### 3.6.4 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](#) and [PACR2](#) global configuration registers and the per-output [OCxPH](#) register.

Phase alignment and phase adjustment are done in the medium-speed dividers. Resolution is 0.5 periods (also known as unit intervals or UI) of the input clock after the high-speed divider. For example, for an input frequency of 800MHz, resolution is 625ps.

### 3.6.4.1 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 source of the arm signal is specified by **PACR2.ARMSRC**. Options include the 0-to-1 transition of the **PACR1.ARM** bit or a transition on one of the GPIO pins.

The source of the trigger signal is specified by **PACR2.TRGSRC**. Options include 0-to-1 transition of the **PACR1.TRIG** bit or a transition on one of the GPIO pins. The trigger signal can be inverted by setting **PACR1.TINV**. With **TINV=1**, the same GPIO signal can arm on one edge and trigger on the opposite edge.

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. These have to do with the output's medium-speed divider value.

- 1) Phase adjustment is not available unless **OCxCR1.MSDIV>0**.
- 2) The largest negative phase adjustment magnitude in input HSDIV periods is:  
 If **OCxCR1.MSDIV** is odd:  $(OCxCR1.MSDIV - 1) / 2$   
 If **OCxCR1.MSDIV** is even:  $(OCxCR1.MSDIV - 2) / 2$
- 3) The largest positive phase adjustment in input HSDIV periods is:  
 If **OCxCR1.MSDIV** is odd:  $(127 - OCxCR1.MSDIV) / 2$   
 If **OCxCR1.MSDIV** is even:  $(128 - OCxCR1.MSDIV) / 2$

The implications of constraints 2) and 3) are shown in this table:

<b>OCxCR1.MSDIV</b>	<b>Largest Negative Phase Adjust, HSDIV periods</b>	<b>Largest Positive Phase Adjust, HSDIV periods</b>	<b>Notes</b>
1 or 2	0	63	no negative adjustment
3 or 4	1	62	
5 or 6	2	61	
...	...	...	
123 or 124	61	2	
125 or 126	62	1	
127	63	0	no positive adjustment

During a phase adjustment the MSDIV output period is changed for one period. The MSDIV output signal during that period will have longer high time (unless inverted) during a positive phase adjustment and shorter high time (unless inverted) during a negative phase adjustment. With negative phase adjustments care must be taken to shorten the high time of the output clock signal to be too short for the components that receive the clock. There are several possible ways to avoid this issue including: (1) using small negative adjustments such as  $-0.5UI$  repeatedly instead of one larger negative adjustment, (2) using positive adjustments to "wrap around" to the desired negative adjustment, or (3) holding the components that receive the clock in reset during the phase adjustment.

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).

**Example:** +1.0 HSDIV period phase adjustment for output OC1 using ARM and TRIG register bits:

`OC1CR1.PHEN=1` (Enable phase adjust on OC1)  
`OC1PH.PHADJ=00000010` (Specify +1.0 HSDIV period phase adjustment)  
`PACR1.MODE=1` (Phase adjustment mode)  
`PACR2.ARMSRC=0001` (arm signal is `PACR1.ARM` bit)  
`PACR2.TRGSRC=0000` (trigger signal is `PACR1.TRIG` bit)  
`PACR1.RST=1` (reset phase adjust/align state machine after changing ARMSRC)  
`PACR1.ARM=1` (arm for phase adjust)  
`PACR1.TRIG=1` (do the phase adjust: add +1.0 UI to output phase)  
 repeat the next two writes as needed:  
`PACR1.ARM=1 .TRIG=0` (clear the trigger bit and arm again)  
`PACR1.TRIG=1` (add +1.0 UI to output phase again)

### 3.6.4.2 Phase Alignment, Output-to-Output

A phase alignment is a special case of phase adjustment where the MSDIV and LSDIV dividers for all participating outputs are reset just before the phase adjustment occurs. For output-to-output alignment the trigger can be the `PACR1.TRIG` bit.

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 3.6.5).

When aligning outputs, it is important to note that, by default, the phase of outputs configured as HSTL format or “two CMOS, OCxP inverted vs. OCxN” 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.

There are several rules when alignment is enabled for multiple outputs:

- All participating outputs must come from the same high-speed divider
- All outputs that use both medium-speed and low-speed divider must have the same MSDIV value, the same LSDIV value and PHADJ=0. Subsequent phase adjustment(s) can be used to move the output(s) to other phase(s).
- All outputs that only use medium-speed divider can have PHADJ values smaller than the period of the highest output frequency among them.
- When some outputs use only medium-speed divider and other outputs use both medium-speed and low-speed divider, all MSDIV values must be the same, and those output using low-speed divider must have PHADJ=0.

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 HSDIV UI 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)  
`PACR2.ARMSRC=0001` (arm signal is `PACR1.ARM` bit)  
`PACR2.TRGSRC=0000` (trigger signal is `PACR1.TRIG` bit)  
`PACR1.RST=1` (reset phase adjust/align state machine after changing ARMSRC, TRGSRC)  
`PACR1.ARM=1` (arm for phase alignment)  
`PACR1.TRIG=1` (trigger phase alignment)  
`PACR1.TRIG=0` (clear trigger bit)

### 3.6.5 Output Clock Start and Stop

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, assertion of one of the GPIO pins, 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. Low-speed output clocks can take long intervals before being stopped after the stop signal goes active. For example, a 1 Hz output could take up to 1 second to stop.

**OCxCR1.MSDIV** must be > 0 for this function to operate since **MSDIV=0** bypasses the start-stop circuits. Note that when **OCxCR3.NEGLSD=1** the start-stop logic is bypassed for the OCxN pin, and OCxN may not start/stop without glitches.

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.

### 3.7 Microprocessor Interface

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

Section 3.2 describes reset pin settings required to configure the device for these interfaces.

#### 3.7.1 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 Enable	0x06	0000 0110
Write	0x02	0000 0010
Read	0x03	0000 0011
Read Status	0x05	0000 0101

**Read Transactions.** The device registers are accessible when **EESEL**=0. The internal EEPROM memory is accessible when **EESEL**=1. 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](#).

**Register Write Transactions.** The device registers are accessible when **EESEL**=0. 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 6](#).

**EEPROM Writes** The EEPROM memory is accessible when **EESEL**=1. After driving CSN low, the bus master transmits the write enable command and then drives CSN high to set the internal write enable latch. The bus master then drives CSN low again and transmits the write command followed by the 16-bit address followed by the first data byte to be written. The device first copies the page to be written from EEPROM to its page buffer. The device then receives the first data byte on MOSI, writes it to its page buffer, 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 to its page buffer and continues to increment its address counter. The address counter rolls over at the 32-byte page boundary (i.e. when the five least-significant address bits are 11111). When the bus master



drives CSN high, the device transfers the data in the page buffer to the appropriate page in the EEPROM memory. See [Figure 5](#) and [Figure 6](#).

**EEPROM Read Status.** After the bus master drives CSN high to end an EEPROM write command, the EEPROM memory is not accessible for up to 5ms while the data is transferred from the page buffer. To determine when this transfer is complete, the bus master can use the Read Status command. After driving CSN low, the bus master transmits the Read Status command. The device then responds with the status byte on MISO. In this byte, the least significant bit is set to 1 if the transfer is still in progress and 0 if the transfer has completed.

**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 register 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. If an EEPROM write transaction is terminated prior to the SCLK edge that latches the least significant bit of a data byte, none of the bytes in that write transaction are 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 17](#) for AC timing specifications for the SPI interface.

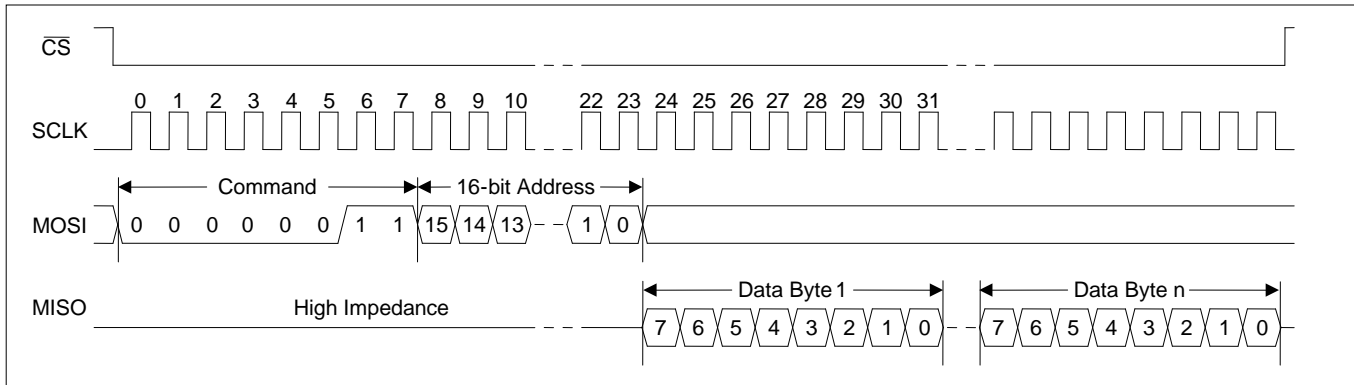


Figure 4 - SPI Read Transaction Functional Timing

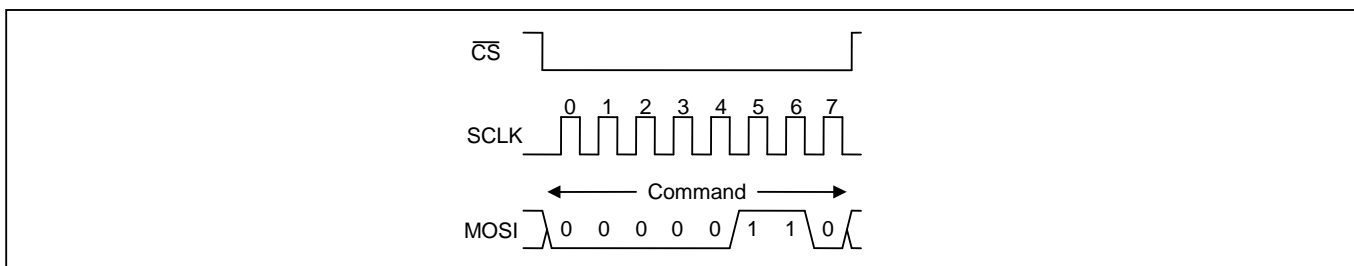


Figure 5 - SPI Write Enable Transaction Functional Timing

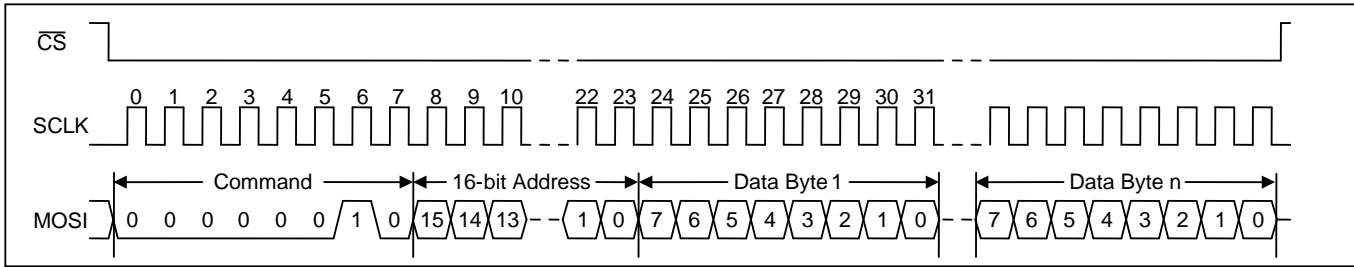


Figure 6 - SPI Write Transaction Functional Timing

### 3.7.2 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 device registers are accessible when  $EESEL=0$ . The internal EEPROM memory is accessible when  $EESEL=1$ . 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 7. 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.

**Register Write Transactions.** The device registers are accessible when  $EESEL=0$ . 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 8.

**EEPROM Writes.** The EEPROM memory is accessible when  $EESEL=1$ . The bus master first does an I<sup>2</sup>C write to transmit the SPI Write Enable command (see Table 3) to the device. The bus master then does an I<sup>2</sup>C write to transmit data to the device as described in the Register Write Transactions paragraph above. See Figure 9.

**EEPROM Read Status.** The bus master first does an I<sup>2</sup>C write to transmit the SPI Read Status command (see Table 3) to the device. The bus master then does an I<sup>2</sup>C read to get the status byte. In this byte, the least significant bit is set to 1 if the transfer is still in progress and 0 if the transfer has completed. See Figure 10.

**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 3.2.

**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.

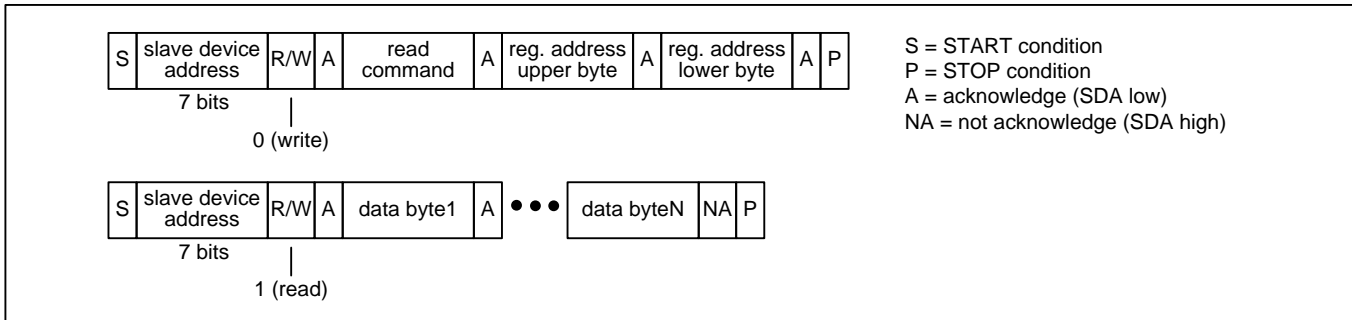


Figure 7 – I<sup>2</sup>C Read Transaction Functional Timing

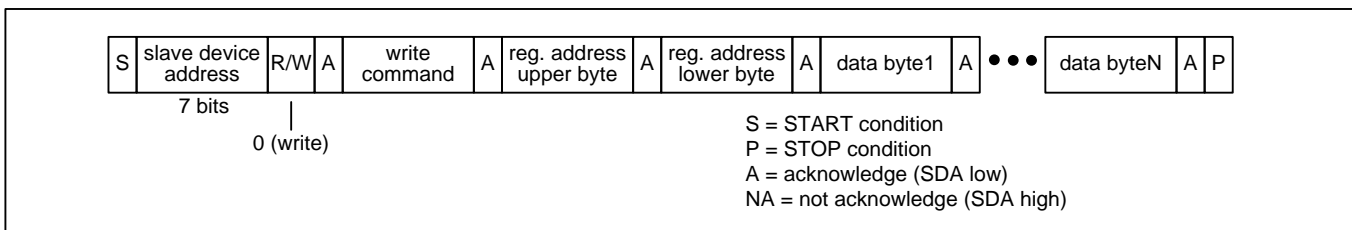


Figure 8 – I<sup>2</sup>C Register Write Transaction Functional Timing

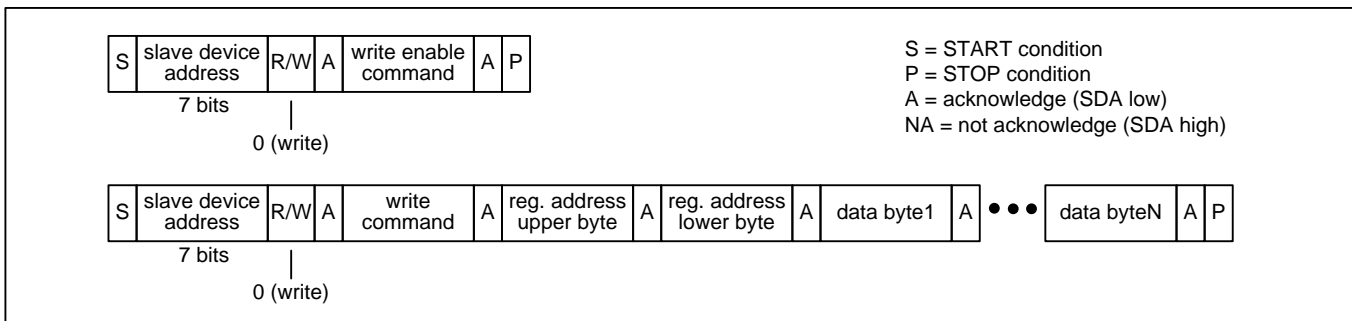


Figure 9 – I<sup>2</sup>C EEPROM Write Transaction Functional Timing

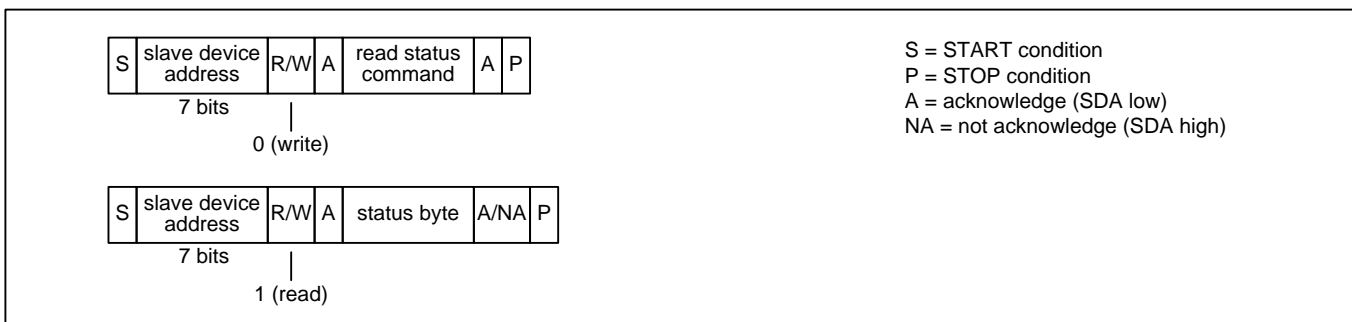


Figure 10 – I<sup>2</sup>C EEPROM Read Status Transaction Functional Timing

Note: In Figure 7 through Figure 10, 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.

### 3.8 Interrupt Logic

Any of the GPIO pins can be configured as an interrupt-request output by setting the appropriate GPIOxC field in the GPIOCR registers to one of the status output options (01xx) and configuring the appropriate GPIOxSS register to follow the INTSR.INT bit. If system software is written to poll rather than receive interrupt requests, then software can read the INTSR.INT bit first to determine if any interrupt requests are active in the device.

Many of the latched status bits in the device can be the source of an interrupt request if their corresponding interrupt enable bits are set. The device's interrupt logic is shown in Figure 11. See the register map (Table 4) and the status register descriptions in section 4.3.2 for descriptions of the register bits shown in the figure.

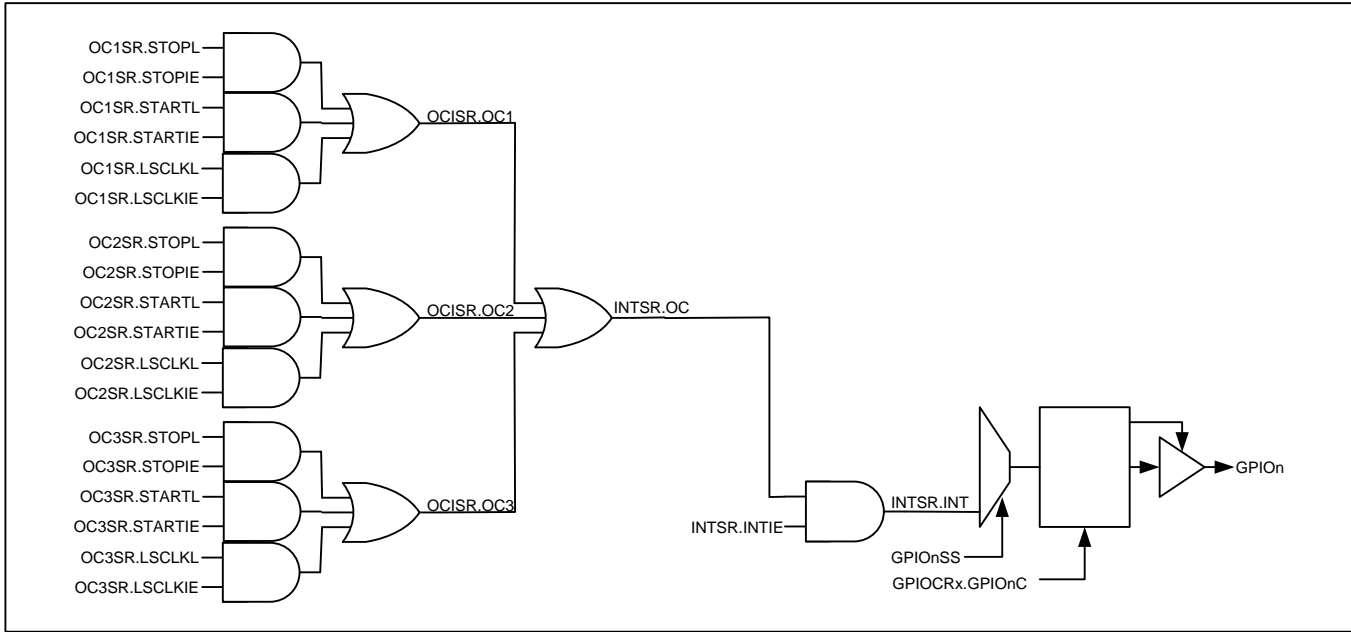


Figure 11 – Interrupt Structure

### 3.9 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 be asserted once after power-up.** At initial power-up reset should be asserted for at least 1µs. During operation, the RSTN assertion time can be as short as 1µs with one important exception:

Consider each of these four pins: AC0/GPIO0, AC1/GPIO1, TEST/GPIO2 and IF1/MISO. 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 100µs after RSTN is deasserted and wait for GLOBISR.BCDONE=1 before configuring the device.

### 3.10 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.

### 3.11 Auto-Configuration from EEPROM

#### 3.11.1 Factory-Default Device Configurations

As shipped from Microsemi, the device auto-configures at reset as follows:

- IC1 and IC2 receivers enabled and input high-speed dividers set to 1 (don't divide). `ICEN=0x03`.
- External switching mode enabled with the GPIO3 pin as the control signal switching between between IC1 (GPIO3=0) and IC2 (GPIO3=1). `MCR2=0x60`, `SRCCR3=0x51`.
- OC1, OC2 and OC3 medium-speed and low-speed dividers enabled and set to 1 (don't divide). `OCEN=0x07`.
- OC1, OC2 and OC3 signal format specified at reset by the AC[1:0] pins as shown in the table below

AC1	AC0	OC1, OC2, OC3 Output Configuration	OCxCR2 (0x201,0x211,0x221)
0	0	3 full-swing CML outputs	0x01
0	1	3 HCSL outputs (apply 1.8V to all VDDO pins)	0x17
1	0	6 CMOS outputs (apply 3.3V or 2.5V to all VDDO pins)	0x04
1	1	Disabled	0x00

- Write `SRCCR1=0x02` to set bit 2 to 1 and write `OC1CR3=0x40` to set bit 6 to 1 as required.

#### 3.11.2 Direct EEPROM Write Mode

To simplify writing the internal EEPROM during manufacturing, the device has a test mode known as direct EEPROM write mode. The device enters this mode when `TEST=1` and `AC[1:0]=00` on the rising edge of `RSTN`. In this mode the EEPROM memory is mapped into the address map and can be written as needed to store configuration scripts in the device. Device registers are not accessible in this mode. The device exits this mode when `TEST=0` on the rising edge of `RSTN`. Note: the device drives the `MISO` pin continually during this mode. Therefore this mode cannot be used when `MOSI` and `MISO` are tied together (as described in the *Design Option: Wiring MOSI and MISO Together* paragraph in section 3.7.1).

### 3.12 Power Supply Decoupling and Layout Recommendations

Application Note ZLAN-594 describes recommended power supply decoupling and layout practices.

## 4. Register Descriptions

The device has an overall address range from 000h to 6FFh. 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. When set, some latched status bits can cause an interrupt request if enabled to do so by corresponding interrupt enable bits. 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.

### 4.1.3 Bank-Switched Registers

The [EESEL](#) register is a bank-select control field that maps the device registers into the memory map at address 0x1 and above when EESEL=0 and maps the EEPROM memory into the memory map at address 0x1 and above when EESEL=1. The EESEL register itself is always in the memory map at address 0x0 for both EESEL=0 and EESEL=1.

## 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>									
00h	<a href="#">EESEL</a>	—	—	—	—	—	—	—	EESEL
09	<a href="#">MCR1</a>	RST	—	—	—	—	—	XAB[1:0]	
0A	<a href="#">MCR2</a>	—	EXTSS[1:0]		—	—	—	—	—
0C	<a href="#">ICEN</a>	—	—	—	—	—	IC3EN	IC2EN	IC1EN
0D	<a href="#">OCEN</a>	—	—	—	—	—	OC3EN	OC2EN	OC1EN
0E	<a href="#">GPIOCR1</a>	GPIO1C[3:0]				GPIO0C[3:0]			
0F	<a href="#">GPIOCR2</a>	GPIO3C[3:0]				GPIO2C[3:0]			
12	<a href="#">GPIO0SS</a>	REG[4:0]				BIT[2:0]			
13	<a href="#">GPIO1SS</a>	REG[4:0]				BIT[2:0]			
14	<a href="#">GPIO2SS</a>	REG[4:0]				BIT[2:0]			
15	<a href="#">GPIO3SS</a>	REG[4:0]				BIT[2:0]			
1B	<a href="#">PACR1</a>	RST	TRIG	ARM	—	—	—	TINV	MODE
1C	<a href="#">PACR2</a>	ARMSRC[3:0]				TRGSRC[3:0]			
<b>Status Registers</b>									
30	<a href="#">ID1</a>	IDU[7:0]							
31	<a href="#">ID2</a>	IDL[3:0]				REV[3:0]			
40	<a href="#">CFGSR</a>	<u>TEST</u>	—	—	—	IF[1:0]		AC[1:0]	
41	<a href="#">GPIOSR</a>	—	—	—	—	<u>GPIO3</u>	<u>GPIO2</u>	<u>GPIO1</u>	<u>GPIO0</u>
42	<a href="#">INTSR</a>	—	—	<u>OC</u>	—	—	—	INTIE	<u>INT</u>
43	<a href="#">GLOBISR</a>	<u>BCDONE</u>	—	—	—	—	—	—	—
45	<a href="#">OCISR</a>	—	—	—	—	—	<u>OC3</u>	<u>OC2</u>	<u>OC1</u>

ADDR	REGISTER	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
4D	PASR	—	—	—	—	—	—	BUSY	ARMED
53	OC1SR	LSCLKIE	LSCLKL	LSCLK	STARTIE	STARTL	STOPIE	STOPL	STOPD
54	OC2SR	LSCLKIE	LSCLKL	LSCLK	STARTIE	STARTL	STOPIE	STOPL	STOPD
55	OC3SR	LSCLKIE	LSCLKL	LSCLK	STARTIE	STARTL	STOPIE	STOPL	STOPD
<b>Source Selection Configuration Registers</b>									
100	SRCCR1	—	—	—	—	—	—	1	—
102	SRCCR3	—	EXTSW	ALTMUX[2:0]			INMUX[2:0]		
<b>Output Clock Configuration Registers</b>									
<b>OC1 Registers</b>									
200	OC1CR1	PHEN	MSDIV[6:0]						
201	OC1CR2	—	POL	DRIVE[1:0]		STOPDIS	OCSF[2:0]		
202	OC1CR3	SRLSEN	1	NEGLSD	LSSEL	—	—	—	LSDIV[24]
203	OC1DIV1	LSDIV[7:0]							
204	OC1DIV2	LSDIV[15:8]							
205	OC1DIV3	LSDIV[23:16]							
206	OC1DC	OCDC[7:0]							
207	OC1PH	PHADJ[7:0]							
208	OC1STOP	STOP	—	SRC[3:0]				MODE[1:0]	
<b>OC2 Registers</b>									
210	OC2CR1	same as OC1 registers							
...	...								
218	OC2STOP								
<b>OC3 Registers</b>									
220	OC3CR1	same as OC1 registers							
...	...								
228	OC3STOP								
<b>Input Clock Configuration</b>									
300	IC1CR1	—	POL	—	—	—	—	HSDIV[1:0]	
320	IC2CR1	—	POL	—	—	—	—	HSDIV[1:0]	
340	IC3CR1	—	POL	—	—	—	—	HSDIV[1:0]	

## 4.3 Register Definitions

### 4.3.1 Global Configuration Registers

**Register Name:** EESEL  
**Register Description:** EEPROM Memory Selection Register  
**Register Address:** 00h

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

**Bit 0: EEPROM Memory Select (EESEL).** This bit is a bank-select that specifies whether device register space or EEPROM memory is mapped into addresses 0x1 and above. See sections 3.7 and 4.1.3. Note that this bit is write-only; the value read is not reliable.

- 0 = Device registers
- 1 = EEPROM memory

**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	0

**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 3.9.

- 0 = Normal operation
- 1 = Reset

**Bits 1 to 0: XA/XB Pin Mode (XAB[1:0]).** This field specifies the behavior of the XA and XB pins. See section 3.3.

- 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:** MCR2  
**Register Description:** Master Configuration Register 2  
**Register Address:** 0Ah

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

**Bits 6 to 5: External Switch Source Select (EXTSS[1:0]).** This field selects the GPIO source for the external switch control signal. It is only valid when [SRCR3.EXTSW=1](#). See section [3.5](#).

00 = GPIO0  
 01 = GPIO1  
 10 = GPIO2  
 11 = GPIO3

**Register Name:** ICEN  
**Register Description:** Input Clock Enable Register  
**Register Address:** 0Ch

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
<b>Name</b>	—	—	—	—	—	IC3EN	IC2EN	IC1EN
<b>Default</b>	0	0	0	0	0	0	0	0

**Bit 2: Input Clock 3 Enable (IC3EN).** This bit enables and disables the input clock 3 differential receiver and input dividers. See section [3.4](#).

0 = Disabled  
 1 = Enabled

**Bit 1: Input Clock 2 Enable (IC2EN).** This bit enables and disables the input clock 2 differential receiver and input dividers. See section [3.4](#).

0 = Disabled  
 1 = Enabled

**Bit 0: Input Clock 1 Enable (IC1EN).** This bit enables and disables the input clock 1 differential receiver and input dividers. See section [3.4](#).

0 = Disabled  
 1 = Enabled

**Register Name:** OCEN  
**Register Description:** Output Clock Enable Register  
**Register Address:** 0Dh

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
<b>Name</b>	—	—	—	—	—	OC3EN	OC2EN	OC1EN
<b>Default</b>	0	0	0	0	0	0	0	0

**Bit 2: Output Clock 3 Enable (OC3EN).** This bit enables and disables the output clock 3 drivers, output dividers, phase adjustment/alignment circuitry and start/stop circuitry. See section [3.6.1](#).

0 = Disabled  
 1 = Enabled

**Bit 1: Output Clock 2 Enable (OC2EN).** This bit enables and disables the output clock 2 drivers, output dividers, phase adjustment/alignment circuitry and start/stop circuitry. See section 3.6.1.

0 = Disabled  
1 = Enabled

**Bit 0: Output Clock 1 Enable (OC1EN).** This bit enables and disables the output clock 1 drivers, output dividers, phase adjustment/alignment circuitry and start/stop circuitry. See section 3.6.1.

0 = Disabled  
1 = Enabled

**Register Name:** GPIOCR1  
**Register Description:** GPIO Configuration Register 1  
**Register Address:** 0Eh

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Name	GPIO1C[3:0]				GPIO0C[3:0]			
Default	0	0	0	0	0	0	0	0

**Bits 7 to 4: GPIO1 Configuration (GPIO1C[3:0]).** This field configures the GPIO1 pin as a general-purpose input, a general-purpose output driving low or high, or a status output. The current state of the pin can be read from [GPIOSR.GPIO1](#). When GPIO1 is a status output, the [GPIO1SS](#) register specifies which status bit is output.

0000 = General-purpose input  
0001 = General-purpose input - inverted polarity  
0010 = General-purpose output driving low  
0011 = General-purpose output driving high  
0100 = Status output – non-inverted polarity  
0101 = Status output - inverted polarity of the status bit it follows  
0110 = Status output – 0 drives low, 1 high impedance  
0111 = Status output – 0 high impedance, 1 drives low  
1000 to 1111 = {unused values}

**Bits 3 to 0: GPIO0 Configuration (GPIO0C[3:0]).** This field configures the GPIO0 pin as a general-purpose input, a general-purpose output driving low or high, or a status output. The current state of the pin can be read from [GPIOSR.GPIO0](#). When GPIO0 is a status output, the [GPIO0SS](#) register specifies which status bit is output.

0000 = General-purpose input  
0001 = General-purpose input - inverted polarity  
0010 = General-purpose output driving low  
0011 = General-purpose output driving high  
0100 = Status output – non-inverted polarity  
0101 = Status output - inverted polarity of the status bit it follows  
0110 = Status output – 0 drives low, 1 high impedance  
0111 = Status output – 0 high impedance, 1 drives low  
1000 to 1111 = {unused values}

**Register Name:** GPIOCR2  
**Register Description:** GPIO Configuration Register 2  
**Register Address:** 0Fh

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Name	GPIO3C[3:0]				GPIO2C[3:0]			
Default	0	0	0	0	0	0	0	0

These fields are identical to those in [GPIOCR1](#) except they control GPIO2 and GPIO3.



**Register Name:** GPIO0SS  
**Register Description:** GPIO0 Status Select Register  
**Register Address:** 12h

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Name	REG[4:0]					BIT[2:0]		
Default	0	0	0	0	0	0	0	0

**Bits 7 to 3: Status Register (REG[4:0]).** When [GPIOCR1.GPIO0C=01xx](#), this field specifies the register of the status bit that GPIO0 will follow while the BIT field below specifies the status bit within the register. Setting the combination of this field and the BIT field below to point to a bit that isn't implemented as a real-time or latched status register bit results in GPIO0 being driven low. The address of the status bit that GPIO0 follows is 0x40 + REG[4:0]

**Bits 2 to 0: Status Bit (BIT[2:0]).** When [GPIOCR1.GPIO0C=01xx](#), the REG field above specifies the register of the status bit that GPIO0 will follow while this field specifies the status bit within the register. Setting the combination of the REG field and this field to point to a bit that isn't implemented as a real-time or latched status register bit results in GPIO1 being driven low. 000=bit 0 of the register. 111=bit 7 of the register.

Note: The device does not allow the GPIO status register bits in [GPIOSR](#) to be followed by a GPIO.

**Register Name:** GPIO1SS  
**Register Description:** GPIO1 Status Select Register  
**Register Address:** 13h

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Name	REG[4:0]					BIT[2:0]		
Default	0	0	0	0	0	0	0	0

These fields are identical to those in [GPIO0SS](#) except they control GPIO1.

**Register Name:** GPIO2SS  
**Register Description:** GPIO2 Status Select Register  
**Register Address:** 14h

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Name	REG[4:0]					BIT[2:0]		
Default	0	0	0	0	0	0	0	0

These fields are identical to those in [GPIO0SS](#) except they control GPIO2.

**Register Name:** GPIO3SS  
**Register Description:** GPIO3 Status Select Register  
**Register Address:** 15h

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Name	REG[4:0]					BIT[2:0]		
Default	0	0	0	0	0	0	0	0

These fields are identical to those in [GPIO0SS](#) except they control GPIO3.

**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	—	—	—	TINV	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 3.6.4.

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 when [PACR2.TRGSRC=0000](#) and the phase adjustment has been armed. This bit may self-clear (return to 0) in some configurations, but system software should not depend on self-clearing behavior and should always set it back to 0 before retriggering. When the ARM bit and TRIG bit are selected as the sources for arming and triggering, respectively, 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 3.6.4.

0→1 = Trigger a phase adjustment

**Bit 5: Phase Adjustment Arm Bit (ARM).** When [PACR2.ARMSRC=0001](#), 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 3.6.4.

1 = Arm the phase adjustment, self clearing

**Bit 1: Phase Adjustment Trigger Invert (TINV).** This bit specifies the polarity of the trigger signal. See section 3.6.4.

0 = Trigger signal normal polarity

1 = Trigger signal inverted

**Bit 0: Phase Adjust/Alignment Mode (MODE).** This field sets the mode of the phase change. In output phase *alignment* mode, the device resets the MSDIV and LSDIV dividers for all participating outputs so that they are all aligned and then adjusts the phase of each participating output as specified in the [OCxPH](#) register. In output phase *adjustment* mode the device does not reset the MSDIV and LSDIV dividers 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 3.6.4.

0 = Phase alignment mode

1 = Phase adjustment mode

**Register Name:** PACR2  
**Register Description:** Phase Adjust Configuration Register 2  
**Register Address:** 1Ch

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

**Bits 7 to 4: Output Phase Adjustment Arm Source (ARMSRC[3:0]).** This field selects the source of the phase adjustment arming signal. See section 3.6.4.

- 0000 = Always armed (see Note)
- 0001 = PACR1.ARM bit (one-shot)
- 0010 to 0111 = {unused values}
- 1000 = GPIO0 transition (see note below)
- 1001 = GPIO1 transition
- 1010 = GPIO2 transition
- 1011 = GPIO3 transition
- 1100 to 1111 = {unused values}

Note: When using always armed, any change to the PACR1 or PACR2 registers or any change to the OCxCR1.PHEN bits must be followed by a reset of the phase adjustment state machine (set PACR1.RST=1).

**Bits 3 to 0: Output Phase Adjustment Trigger Source (TRGSRC[3:0]).** This field selects the source of the phase adjustment trigger signal. The phase adjustment must be armed or the trigger signal is ignored. The trigger source transition initiates the phase adjustment event. See section 3.6.4.

- 0000 = PACR1.TRIG bit
- 0001 to 0111 = {unused values}
- 1000 = GPIO0 transition (see note below)
- 1001 = GPIO1 transition
- 1010 = GPIO2 transition
- 1011 = GPIO3 transition
- 1100 to 1111 = {unused values}

**Note:** In both fields above the GPIO transitions are 0-to-1 when GPIOCR1.GPIOxC=0000 and 1-to-0 when GPIOCR1.GPIOxC=0001.

### 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
Name	IDU[7:0]							
Default	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
Name	IDL[3:0]				REV[3:0]			
Default	1	1	0	0	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	—	—	—	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/GPIO2 pin when the RSTN pin transitions high. For proper operation it should be 0. See section 3.2.

**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 3.2.

**Bits 1 to 0: Auto-Configuration (AC[1:0]).** These read-only bits are the latched state of the AC1/GPIO1 and AC0/GPIO0 pins when the RSTN pin transitions high. See section 3.2.

**Register Name:** GPIOSR  
**Register Description:** GPIO Status Register  
**Register Address:** 41h

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
<b>Name</b>	—	—	—	—	<u>GPIO3</u>	<u>GPIO2</u>	<u>GPIO1</u>	<u>GPIO0</u>
<b>Default</b>	0	0	0	0	0	0	0	0

**Bit 3: GPIO3 State (GPIO3).** This real-time status bit indicates the current state of the GPIO3 pin, not influenced by any inversion that may be specified by [GPIOCR2.GPIO3C](#).

0 = low  
 1 = high

**Bit 2: GPIO2 State (GPIO2).** This real-time status bit indicates the current state of the GPIO2 pin, not influenced by inversion that may be specified by [GPIOCR2.GPIO2C](#).

0 = low  
 1 = high

**Bit 1: GPIO1 State (GPIO1).** This real-time status bit indicates the current state of the GPIO1 pin, not influenced by inversion that may be specified by [GPIOCR1.GPIO1C](#).

0 = low  
 1 = high

**Bit 0: GPIO0 State (GPIO0).** This real-time status bit indicates the current state of the GPIO0 pin, not influenced by inversion that may be specified by [GPIOCR1.GPIO0C](#).

0 = low  
 1 = high

**Register Name:** INTSR  
**Register Description:** Interrupt Status Register  
**Register Address:** 42h

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
<b>Name</b>	—	—	OC	—	—	—	INTIE	INT
<b>Default</b>	0	0	0	0	0	0	0	0

**Bit 5: Output Clock Interrupt Status (OC).** This read-only bit is set if any of the output clock interrupt status bits are set in the [OCISR](#) register. See section [3.8](#).

**Bit 1: Interrupt Enable Bit (INTIE).** This is the global interrupt enable bit. When this bit is 0 all interrupt sources are prevented from setting the INT global interrupt status bit (below). See section [3.8](#).

0 = Interrupts are disabled at the global level

1 = Interrupts are enabled at the global level

**Bit 0: Interrupt Status (INT).** This read-only bit is set when any of bits 7:2 in this [INTSR](#) register are set and the INTIE bit is set. This bit can cause an interrupt request when set by configuring one of the GPIO pins to follow it. See section [3.8](#).

0 = No interrupt

1 = An unmasked interrupt source is active

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

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

**Bit 7: Boot Controller Done (BCDONE).** This bit indicates the status of the on-chip boot controller, which performs auto-configuration from EEPROM. It is cleared when the device is reset and set after the boot controller finishes auto-configuration of the device. See section [3.11](#).

**Register Name:** OCISR  
**Register Description:** Output Clock Interrupt Status Register  
**Register Address:** 45h

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
<b>Name</b>	—	—	—	—	—	<u>OC3</u>	<u>OC2</u>	<u>OC1</u>
<b>Default</b>	0	0	0	0	0	0	0	0

**Bit 2: Output Clock 3 Interrupt Status (OC3).** This bit indicates the current status of the interrupt sources for OC3. It is set when any latched status bit in the [OC3SR](#) register is set and the associated interrupt enable bit is also set. See section [3.8](#).

**Bit 1: Output Clock 2 Interrupt Status (OC2).** This bit indicates the current status of the interrupt sources for OC2. It is set when any latched status bit in the [OC2SR](#) register is set and the associated interrupt enable bit is also set. See section [3.8](#).

**Bit 0: Output Clock 1 Interrupt Status (OC1).** This bit indicates the current status of the interrupt sources for OC1. It is set when any latched status bit in the [OC1SR](#) register is set and the associated interrupt enable bit is also set. See section [3.8](#).

**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>	—	—	—	—	—	—	<u>BUSY</u>	<u>ARMED</u>
<b>Default</b>	1	0	0	0	0	1	0	0

**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 [3.6.4](#).

- 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 [3.6.4](#).

- 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>	LSCLKIE	LSCLKL	LSCLK	STARTIE	STARTL	STOPIE	STOPL	STOPD
<b>Default</b>	0	0	0	0	0	0	see note	see note

**Bit 7: (LSCLKIE).** This bit enables the LSCLKL latched status bit to send an interrupt request into device's interrupt logic.

- 0 = Interrupt is disabled
- 1 = Interrupt is enabled

**Bit 6: (LSCLKL).** This latched status bit is set when the low-speed divider output clock transitions low-to-high. Writing a 1 to this bit clears it.

- 0 = Low speed output clock has not transitioned low to high
- 1 = Low speed output clock has transitioned low to high

**Bit 5: (LSCLK).** This real-time status bit follows the level of the low-speed divider output clock when the [OCxCR3.SRLSEN](#) bit is set.

- 0 = LSCLK is high
- 1 = LSCLK is low

**Bit 4: (STARTIE).** This bit enables the STARTL latched status bit to send an interrupt request into device's interrupt logic.

- 0 = Interrupt is disabled
- 1 = Interrupt is enabled

**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 [3.6.5](#).

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

**Bit 2: (STOPIE).** This bit enables the STOPL latched status bit to send an interrupt request into device's interrupt logic.

- 0 = Interrupt is disabled
- 1 = Interrupt is enabled

**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 [3.6.5](#).

- 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 [3.6.5](#).

- 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 an input clock is connected to the logic.



### 4.3.3 Source Selection Configuration Registers

**Register Name:** SRCCR1  
**Register Description:** Source Selection Configuration Register 1  
**Register Address:** 100h

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Name	—	—	—	—	—	—	1	—
Default	0	0	0	0	0	0	0	0

**Bit 1:** This bit must be set to 1 for proper operation.

**Register Name:** SRCCR3  
**Register Description:** Source Selection Configuration Register 3  
**Register Address:** 102h

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Name	—	EXTSW	ALTMUX[2:0]			INMUX[2:0]		
Default	0	0	0	0	0	0	0	0

**Bit 6: External Switching Mode (EXTSW).** This bit enables external reference switching mode. In this mode, if the selected GPIO signal is low the input mux is controlled by [SRCCR3.INMUX](#). If the selected GPIO signal is high the input mux is controlled by [SRCCR3.ALTMUX](#). [MCR2.EXTSS](#) specifies which GPIO pin controls this behavior. See section [3.5](#)

**Bits 5 to 3: Alternate Mux Control (ALTMUX[2:0]).** When [SRCCR3.EXTSW](#)=0 this field is ignored. When [SRCCR3.EXTSW](#)=1 and the selected GPIO signal is high, this field controls the input mux. See section [3.5](#).

000 = Crystal driver circuit if crystal is connected, otherwise XA input  
 001 = IC1 input  
 010 = IC2 input  
 011 = IC3 input  
 100-111 = {unused values}

**Bits 2 to 0: Input Mux Control (INMUX[2:0]).** By default this field controls the input mux. When [SRCCR3.EXTSW](#)=1 and the selected GPIO signal is high, this field is ignored, and the input clock source is specified by [SRCCR3.ALTMUX](#). See section [3.5](#).

000 = Crystal driver circuit if crystal is connected, otherwise XA input  
 001 = IC1 input  
 010 = IC2 input  
 011 = IC3 input  
 100-111 = {unused values}

### 4.3.4 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	MSDIV[6:0]						
<b>Default</b>	0	0	0	0	0	0	0	0

**Bit 7: Phase Adjust Enable (PHEN).** This bit enables this output to participate in phase adjustment/alignment. See section 3.6.4.

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

**Bits 6 to 0: Medium-Speed Divider Value (MSDIV[6:0]).** This field specifies the setting for the output clock's medium-speed divider. The divisor is MSDIV+1. Note that if MSDIV is not set to 0 (bypass) then MSDIV must be set to a value that causes the output clock of the medium-speed divider to be 425MHz or less. When MSDIV=0, the medium-speed divider, phase adjust, low-speed divider, start/stop and output duty cycle adjustment circuits are bypassed and the high-frequency clock signal is directly sent to the output driver. See section 3.6.2.

**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	OCSF[2:0]		
<b>Default</b>	0	0	0	0	0	0	0	0

**Bit 6: Clock Path Polarity (POL).** The clock path to the CML, HSTL and CMOS outputs is inverted when this bit set. This does not invert the LSDIV path to the CMOS OCxN pin if that path is enabled. See section 3.6.1.

**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 3.6.1.

- 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 3.6.5.

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

**Bits 2 to 0: Output Clock Signal Format (OCSF[2:0]).** Note that `OCEN.OCxEN=0` forces the output driver to be high-impedance regardless of the value of the OCSF register field. See section 3.6.1.

- 000 = Disabled (high-impedance, low power mode)
- 001 = CML, standard swing ( $V_{OD} = 800mV_{P-P}$  typical)
- 010 = CML, narrow swing ( $V_{OD} = 400mV_{P-P}$  typical)
- 011 = HSTL (Set `OCxCR2.DRIVE=11` (4x) to meet JESD8-6)
- 100 = Two CMOS: OCxP in phase with OCxN
- 101 = One CMOS: OCxP high impedance, OCxN enabled
- 110 = One CMOS: OCxP enabled, OCxN high impedance
- 111 = Two CMOS: OCxP inverted vs. OCxN

**Register Name:** OCxCR3  
**Register Description:** Output Clock x Configuration Register 3  
**Register Address:** OC1: 202h, OC2: 212h, OC3: 222h

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
<b>Name</b>	SRLSEN	1	NEGLSD	LSSEL	—	—	—	LSDIV[24]
<b>Default</b>	0	0	0	0	0	0	0	0

**Bit 7 Enable LSDIV Statuses (SRLSEN).** This bit enables the `OCxSR.LSCLK` real-time status bit and its associated latched status bit `OCxSR.LSCLKL`.

- 0 = LSCLK status bit is not enabled (low)
- 1 = LSCLK status bit is enabled

**Bit 6: This bit must be set to 1 for proper operation.**

**Bit 5: OCxN Low Speed Divider (NEGLSD).** This bit selects the source of the clock on the OCxN pin in CMOS mode. See section 3.6.2.

- 0 = Same as OCxP
- 1 = Output of the LSDIV divider

Note: NEGLSD should only be set to one in two-CMOS mode (`OCxCR2.OCSF=100` or `111`) and when `OCxCR2.POL=0`.

**Bit 4: LSDIV Select (LSSEL).** This bit selects the source of the output clock. When the MSDIV divider is selected (`LSSEL=0`) the LSDIV divider output can be independently selected as the source for the OCxN pin (in CMOS output mode) or monitored by the `OCxSR.LSCLK` status bit. This bit is only valid when `OCxCR1.MSDIV > 0`. See section 3.6.2.

- 0 = The output clock is sourced from the MSDIV divider.
- 1 = The output clock is sourced from the LSDIV divider.

**Bit 0: Low-Speed Divider Value (LSDIV[24]).** See the `OCxDIV1` register description.

**Register Name:** OCxDIV1  
**Register Description:** Output Clock x Divider Register 1  
**Register Address:** OC1: 203h, OC2: 213h, OC3: 223h

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Name	LSDIV[7:0]							
Default	0	0	0	0	0	0	0	0

**Bits 7 to 0: Low-Speed Divider Value (LSDIV[7:0]).** The full 25-bit LSDIV[24:0] field spans this register, [OCxDIV2](#), [OCxDIV3](#), and bit 0 of [OCxCR3](#). LSDIV is an unsigned integer. The frequency of the clock from the medium-speed divider is divided by LSDIV+1. The [OCxCR3](#).LSSEL and NEGLSD bits control when the output of the low-speed divider is present on the OCxP and OCxN output pins. [OCxCR1](#).MSDIV must be > 0 for the low-speed divider to operate. See section [3.6.2](#).

**Register Name:** OCxDIV2  
**Register Description:** Output Clock x Divider Register 2  
**Register Address:** OC1: 204h, OC2: 214h, OC3: 224h

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Name	LSDIV[15:8]							
Default	0	0	0	0	0	0	0	0

**Bits 7 to 0: Low-Speed Divider Value (LSDIV[15:8]).** See the [OCxDIV1](#) register description.

**Register Name:** OCxDIV3  
**Register Description:** Output Clock x Divider Register 3  
**Register Address:** OC1: 205h, OC2: 215h, OC3: 225h

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Name	LSDIV[23:16]							
Default	0	0	0	0	0	0	0	0

**Bits 7 to 0: Low-Speed Divider Value (LSDIV[23:16]).** See the [OCxDIV1](#) register description.

**Register Name:** OCxDC  
**Register Description:** Output Clock x Duty Cycle Register  
**Register Address:** OC1: 206h, OC2: 216h, OC3: 226h

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Name	OCDC[7:0]							
Default	0	0	0	0	0	0	0	0

**Bits 7 to 0: Output Clock Duty Cycle (OCDC[7:0]).** This field controls the output clock signal duty cycle when MSDIV>0 and LSDIV>1. When OCDC = 0 the output clock is 50%. Otherwise the clock signal is a pulse with a width of OCDC number of MSDIV output clock periods. The range of OCDC can create pulse widths from 1 to 255 MSDIV output clock periods. When [OCxCR2](#).POL=0, the pulse is high and the signal is low the remainder of the cycle. When POL=1, the pulse is low and the signal is high the remainder of the cycle. See section [3.6.3](#).

**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>	0	0	0	0	0	0	0	0

**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 input HSDIV clock period. Positive values move the signal later in time (to the right on a scope). See section 3.6.4.

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

**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 3.6.5.

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 3.6.5.

0000 = STOP bit  
 0001 = The arming of a phase adjustment (signal stopped when `PASR.ARMED` is asserted; signal started when `PASR.BUSY` is cleared)  
 0010 to 0111 = {unused values}  
 1000 = GPIO0  
 1001 = GPIO1  
 1010 = GPIO2  
 1011 = GPIO3  
 1100 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 3.6.5.

- 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	OCxCR2.OCSF	Pin that Stops As Specified
CML	001 or 010	OCxP
HSTL	011	OCxN
Two CMOS, OCxP in phase with OCxN	100	OCxP and OCxN
One CMOS, OCxN enabled	101	OCxN
One CMOS, OCxP enabled	110	OCxP
Two CMOS, OCxP inverted vs. OCxN	111	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 output is not stopped or when OCxCR2.STOPDIS=0, OCxCR3.NEGLSD=1 causes the OCxN pin to follow the output clock of the low-speed divider uninverted regardless of the signal format, regardless of the state of OCxCR2.POL, and regardless of whether the output is stopped.
- When the above situations do not apply, OCxCR2.POL=1 changes Stop High to Stop Low and vice versa.

### 4.3.5 Input Clock Configuration Registers

**Register Name:** ICxCR1  
**Register Description:** Input Clock x Configuration Register 1  
**Register Address:** IC1: 300h, IC2: 320h, IC3: 340h

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

**Bit 6: Locking Polarity (POL).** This field specifies the polarity of the input clock that is passed to the output clock pins. See section 3.5.

- 0 = Normal
- 1 = Inverted

**Bits 1 to 0: Input Clock High-Speed Divider (HSDIV[1:0]).** This field specifies the divide value for the input clock high-speed divider. See section 3.5.

- 00 = Divide by 1
- 01 = Divide by 2
- 10 = Divide by 4
- 11 = Divide by 8

## 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 ICxP/N, 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 power, one input and three normal-swing CML outputs enabled, XA/XB disabled	P <sub>DISS</sub>		0.385		W	
Config 0 total current, all 1.8V supply pins	I <sub>DD18</sub>		122		mA	Note 2
Config 0 total current, all 3.3V supply pins	I <sub>DD33</sub>		57		mA	Note 2
Config 1 total current, all 1.8V supply pins	I <sub>DD18</sub>		136		mA	Note 2
Config 1 total current, all 3.3V supply pins	I <sub>DD33</sub>		5		mA	Note 2
Config 2 total current, all 1.8V supply pins	I <sub>DD18</sub>		101		mA	Note 2
Config 2 total current, all 3.3V supply pins	I <sub>DD33</sub>		47		mA	Note 2
Config 3 total current, all 1.8V supply pins	I <sub>DD18</sub>		96		mA	Note 2
Config 3 total current, all 3.3V supply pins	I <sub>DD33</sub>		5		mA	Note 2
3.3V supply current change from enabling or disabling the crystal driver circuit	ΔI <sub>DD33XTAL</sub>		16		mA	
1.8V supply current from enabling/disabling per-output mux and dividers using OCEN.OCxEN bit	ΔI <sub>DD18ODIV</sub>		28		mA	
1.8V supply current change from enabling or disabling a CML output, standard swing	ΔI <sub>DD18CML</sub>		10		mA	
3.3V supply current change from enabling or disabling a CML output, standard swing	ΔI <sub>DD33CML</sub>		17		mA	
1.8V supply current change from enabling or disabling a CML output, narrow swing	ΔI <sub>DD18CMLN</sub>		10		mA	
3.3V supply current change from enabling or disabling a CML output, narrow swing	ΔI <sub>DD33CMLN</sub>		9		mA	
1.8V supply current change from enabling or disabling a pair of single-ended outputs	ΔI <sub>DD18CMOS</sub>		2		mA	
VDDOx supply current change from enabling or disabling a pair of single-ended outputs	ΔI <sub>DD33CMOS</sub>		16		mA	Note 3

Characteristics	Symbol	Min.	Typ. <sup>1</sup>	Max	Units	Notes
1.8V supply current change from enabling or disabling an input clock	$\Delta I_{DD18IN}$		13		mA	

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

**Note 2:** IC1 enabled and 125MHz. IC2, IC3, XA and crystal driver circuit disabled. All outputs enabled and 125MHz with signal format as specified in section 3.11.1 for the configuration chosen. VDDOx=1.8V for HCSL signal format, 3.3V otherwise. HCSL outputs terminated 50Ω to ground. CMOS outputs terminated 1MΩ to ground.

**Note 3:** VDDOx=3.3V, 1x drive strength, f<sub>o</sub>=250MHz, 2pF load

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

Characteristics	Symbol	Min.	Typ.	Max.	Units	Notes
Input high voltage, SCL and SDA	$V_{IH}$	0.7 x VDD33			V	
Input low voltage, SCL and SDA	$V_{IL}$			0.3 x VDD33	V	
Input high voltage, all other digital inputs	$V_{IH}$	2.0			V	
Input low voltage, all other digital inputs	$V_{IL}$			0.8	V	
Input leakage current, RSTN pin	$I_{ILPU}$	-85		10	μA	Note 1
Input leakage current, GPIO3/IC3P pin	$I_{ILGP3}$	-20		20	μA	Note 1
Input leakage current, all other digital inputs	$I_{IL}$	-10		10	μA	Note 1
Input capacitance	$C_{IN}$		3	10	pF	
Input capacitance, SCL/SCLK, SDA/MOSI	$C_{IN}$		3	11	pF	
Input hysteresis, SCL and SDA in I <sup>2</sup> C Bus Mode		0.05* VDD33			mV	
Output leakage (when high impedance)	$I_{LO}$	-10		10	μA	Note 1
Output high voltage	$V_{OH}$	2.4			V	I <sub>o</sub> = -3.0mA
Output low voltage	$V_{OL}$			0.4	V	I <sub>o</sub> = 3.0mA

**Note 1:** 0V < V<sub>IN</sub> < VDD33 for all other digital inputs.

**Note 2:** VOH does not apply for SCL and SDA in I2C 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.

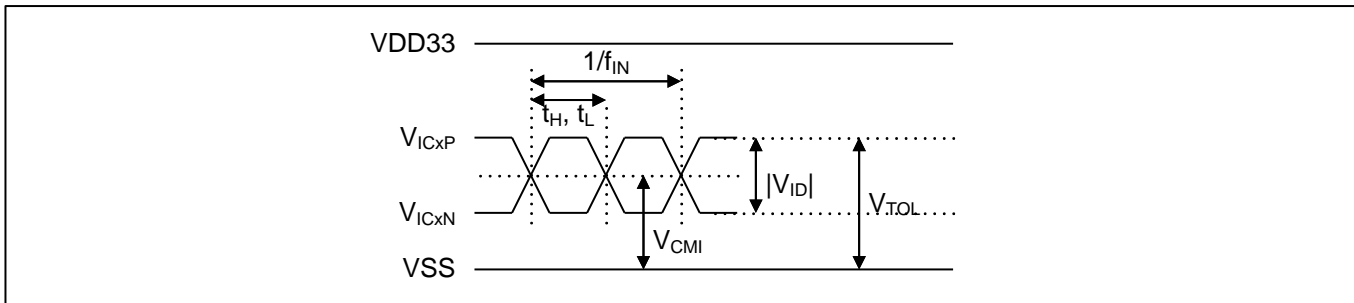
Characteristics	Symbol	Min.	Typ.	Max.	Units	Notes
Input high voltage, XA	$V_{IH}$	1.2			V	
Input low voltage, XA	$V_{IL}$			0.8	V	
Input frequency on XA pin	f <sub>IN</sub>			156.25	MHz	
Input leakage current	$I_{IL}$	-10		10	μA	
Input duty cycle		40		60	%	



**Table 9 - Electrical Characteristics: Clock Inputs, ICxP/N**

Characteristics	Symbol	Min.	Typ.	Max.	Units	Notes
Input voltage tolerance (each pin, single-ended)	$V_{TOL}$	0		VDD33	V	Note 1
Input differential voltage	$ V_{ID} $	0.1		1.4	V	Note 2
Input DC bias voltage (internally biased)	$V_{CMI}$		1.3		V	
Input frequency, ICx pins	$f_{IN}$	9.72		1035	MHz	Differential
		9.72		300	MHz	Single-ended
Minimum input clock high, low time, $f_{IN} \leq 250\text{MHz}$	$t_H, t_L$		smaller of 3ns or $0.3 \times 1 / f_{IN}$		ns	
Minimum input clock high, low time, $f_{IN} > 250\text{MHz}$	$t_H, t_L$	0.4			ns	Note 5
Input resistance, single-ended to VDD18, ICxP or ICxN	$R_{INVDD18}$		50		$k\Omega$	
Input resistance, single-ended to VSS, ICxP or ICxN	$R_{INVSS}$		80		$k\Omega$	

- Note 1:** The device can tolerate voltages as specified in  $V_{TOL}$  w.r.t. VSS on its ICxP and ICxN pins without being damaged. For differential input signals, proper operation of the input circuitry is only guaranteed when the other specifications in this table, including  $|V_{ID}|$ , are met.
- Note 2:** For inputs IC1P/N and IC2P/N  $V_{ID} = V_{ICxP} - V_{ICxN}$ . For input IC3P,  $V_{ID} = V_{IC3P} - V_{CMI}$ . The max  $V_{ID}$  spec only applies when a differential signal is applied on ICxP/N; it does not apply when a single-ended signal is applied on ICxP.
- Note 3: Differential signals.** The differential inputs can easily be interfaced to neighboring ICs driving LVDS, LVPECL, CML, HCSL, HSTL or other differential signal formats using a few external passive components. In general, Microsemi recommends terminating the signal with the termination/load recommended in the neighboring component's data sheet and then AC-coupling the signal into the ICxP/ICxN pins. See [Figure 13](#) for details. To connect a differential signal to IC3, AC-couple one side of the signal to IC3P and AC-couple the other side to VSS. For DC-coupling, treat the input as 1.8V CML.
- Note 4: Single-ended signals** can be connected to ICxP pins. Signals with amplitude greater than 2.5V must be DC-coupled. For signals with amplitudes less than 2.5V Microsemi recommends AC-coupling but DC-coupling can also be used. When a single-ended signal is connected to ICxP, ICxN should be connected to a capacitor (0.1 $\mu$ F or 0.01 $\mu$ F) to VSS.
- Note 5:** The input high-speed divider must be used to divide the frequency by 2 or more.


**Figure 12 - Electrical Characteristics: Clock Inputs**

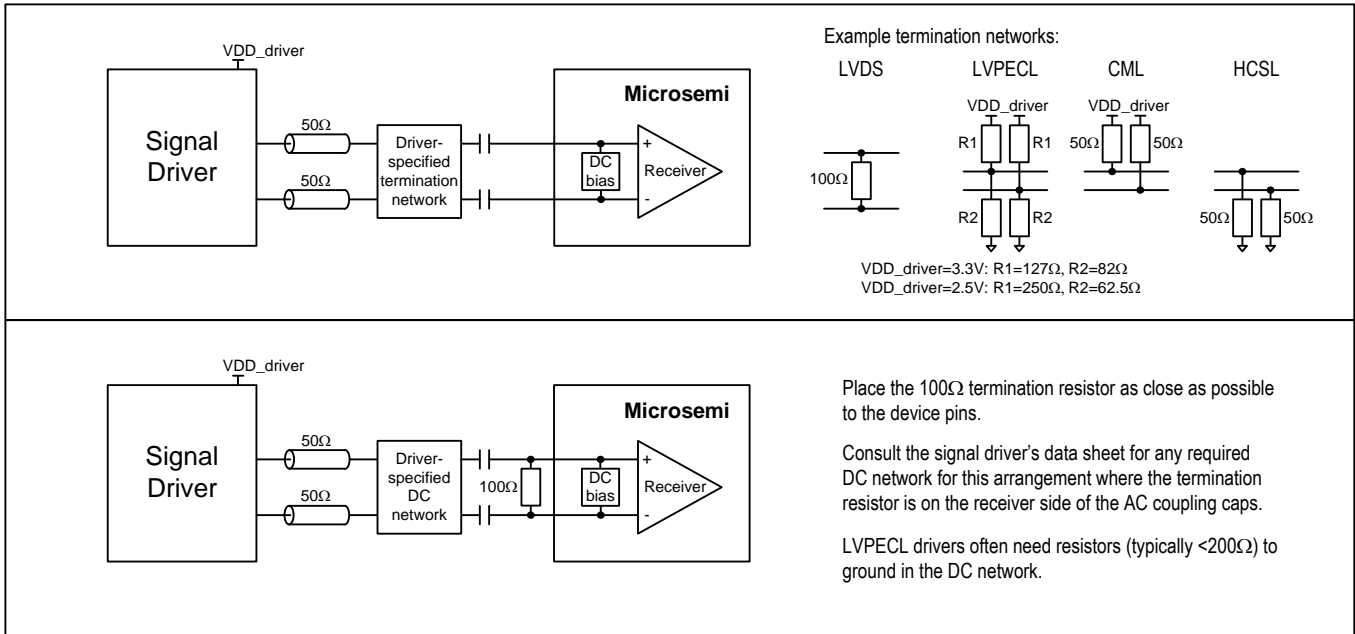


Figure 13 - Example External Components for Differential Input Signals

Table 10 - Electrical Characteristics: CML Clock Outputs

VODDx = 3.3V±5% for CML operation.

Characteristics	Symbol	Min.	Typ.	Max.	Units	Notes
Output frequency	$f_{OCML}$			1035	MHz	
Output frequency from medium-speed divider	$f_{OCML,MSDIV}$			425	MHz	
Output high voltage, single-ended, OCxP or OCxN	$V_{OH,S}$		VDDOx - 0.2		V	Standard Swing (OCxCR2.OCSF=1), AC coupled to 50Ω termination
Output low voltage, single-ended, OCxP or OCxN	$V_{OL,S}$		VDDOx - 0.6		V	
Output common mode voltage	$V_{CM,S}$		VDDOx - 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>	
Output high voltage, single-ended, OCxP or OCxN	$V_{OH,N}$		VDDOx - 0.1		V	Narrow Swing (half the power) (OCxCR2.OCSF=2), AC coupled to 50Ω termination
Output low voltage, single-ended, OCxP or OCxN	$V_{OL,N}$		VDDOx - 0.3		V	
Output common mode voltage	$V_{CM,N}$		VDDOx - 0.2		V	
Output differential voltage	$ V_{OD,N} $	160	200	250	mV	
Output differential voltage, peak-to-peak	$ V_{OD,N,PP} $	320	400	500	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		Ω	Single Ended, to VDDOx
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 15 for details.

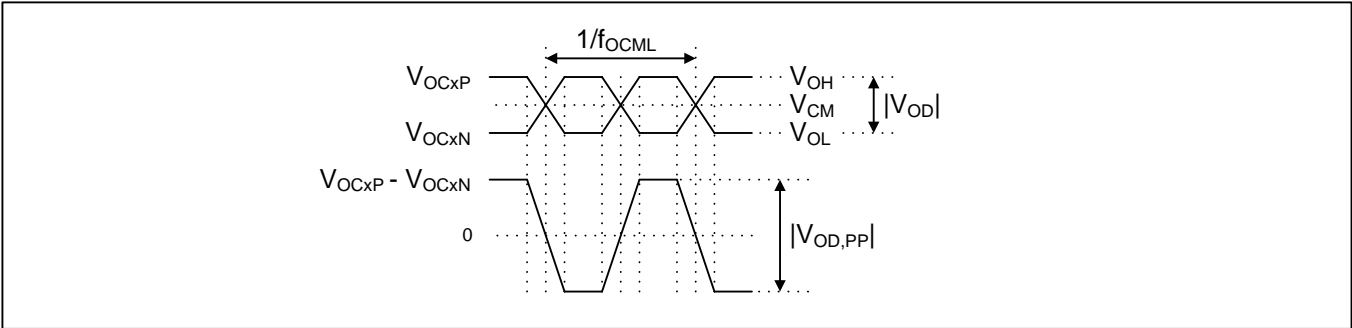


Figure 14 - Electrical Characteristics: CML Clock Outputs

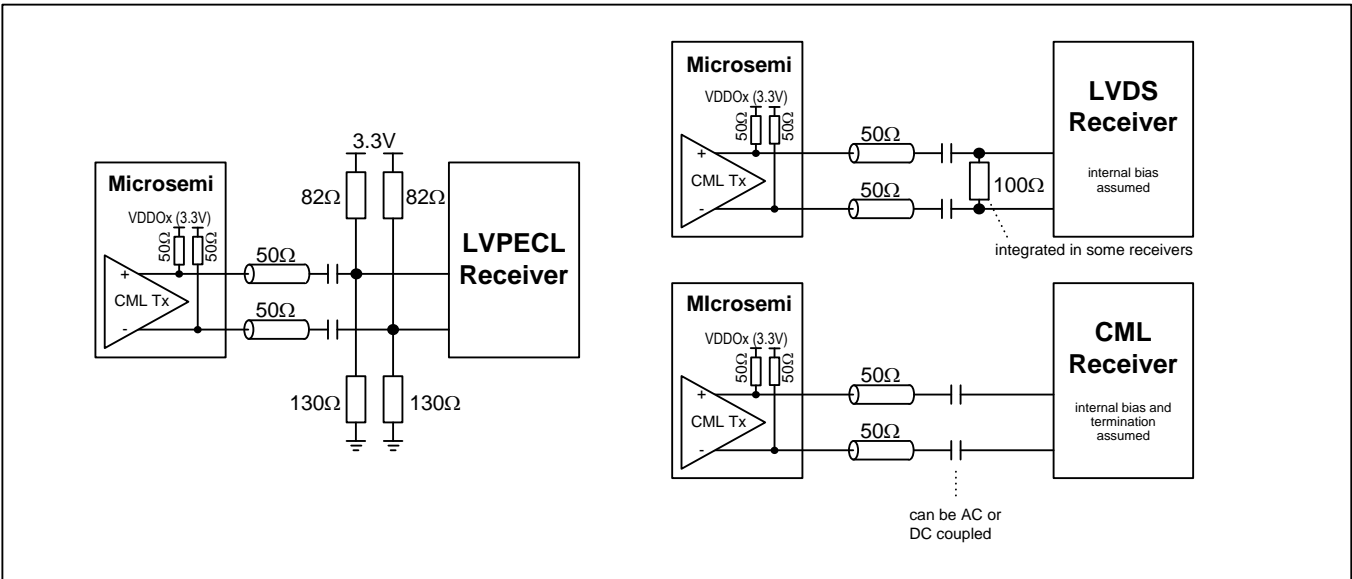


Figure 15 – Example External Components for CML Output Signals

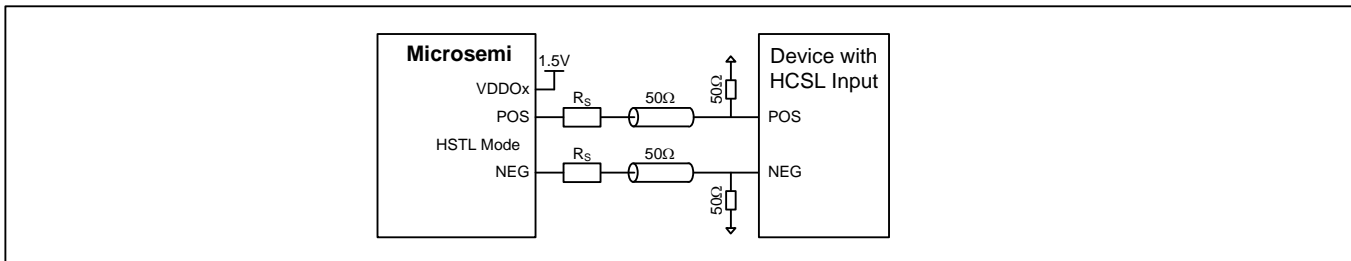
**Table 11 - Electrical Characteristics: CMOS and HSTL (Class I) Clock Outputs**

Characteristics	Symbol	Min.	Typ.	Max.	Units	Notes
Output frequency	$f_{OCMOS}$	$\ll 1\text{Hz}$		250	MHz	Note 1
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, $V_{CCOx}=1.8\text{V}$ , $OCxCR2.DRIVE=4x$	$t_R, t_F$		0.4		ns	2pF load
Output rise/fall time, $V_{CCOx}=1.8\text{V}$ , $OCxCR2.DRIVE=4x$			1.2		ns	15pF load
Output rise/fall time, $V_{CCOx}=3.3\text{V}$ , $OCxCR2.DRIVE=1x$			0.7		ns	2pF load
Output rise/fall time, $V_{CCOx}=3.3\text{V}$ , $OCxCR2.DRIVE=1x$			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		$\mu\text{A}$	$OCxCR2.OCSF=0$

- Note 1:** Minimum output frequency is a function of input frequency and device divider values and is guaranteed by design.
- 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  $V_{DDOx}=3.3\text{V}$  and  $OCxCR2.DRIVE=1x$ ,  $I_o=4\text{mA}$ . For  $V_{DDOx}=1.5\text{V}$  and  $OCxCR2.DRIVE=4x$ ,  $I_o=8\text{mA}$ .
- Note 4:** Output clock frequency  $\leq 160\text{MHz}$  or  $V_{DDOx} \geq 1.8\text{V}$ .
- Note 5:** Output clock frequency  $> 160\text{MHz}$  and  $V_{DDOx} < 1.8\text{V}$ .
- Note 6:** Measured differentially.

**Interfacing to HCSL Components**

Outputs in HSTL mode with  $V_{DDOx}=1.5\text{V}$  or  $V_{DDOx}=1.8\text{V}$  can provide an HCSL signal ( $V_{OH}$  typ.  $0.75\text{V}$ ) to a neighboring component when configured as shown in Figure 16 below. For  $V_{DDOx}=1.5\text{V}$  the value of  $R_S$  should be set to  $30\Omega$  and  $OCxCR2.DRIVE$  should be set to  $4x$ . For  $V_{DDOx}=1.8\text{V}$  the value of  $R_S$  should be set to  $20\Omega$  and  $OCxCR2.DRIVE$  should be set to  $2x$ .



**Figure 16 – Example External Components for HCSL Output Signals**

**Table 12 - Electrical Characteristics: Jitter and Skew Specifications**

Characteristics		Min.	Typ.	Max.	Units	Notes
Additive Jitter	100MHz		178		ps RMS	12kHz-20MHz, Notes 1, 4
	125MHz		151			
	200MHz		114			
	400MHz		88			
	800MHz		60			
	1035MHz		51			
Input-to-Output Propagation Delay, CML outputs			1.6		ns	Notes 3
Input-to-Output Propagation Delay, CMOS/HSTL outputs			3.9		ns	Notes 3
Output-to-Output Skew			<75		ps	Note 2
Output Phase Jitter, 50MHz crystal, 50MHz output			0.284		ps RMS	Notes 5, 6
Output Period Jitter, 50MHz crystal, 50MHz output			8.3		ps pk-pk	N=10000, Note 6
Output Cycle-to-Cycle Jitter, 50MHz crystal, 50MHz output			7.7		ps pk	N=10000, Note 6

**Note 1:** Output frequency = input frequency, full-swing CML output signal format.

**Note 2:** Only applies for outputs that have the same signal format, VDDO voltage, drive strength and load/termination. Also, this skew spec doesn't apply to OCxN when an output pair is configured with `OCxCR3NEGLSD=1`.

**Note 3:** CMOS/HSTL outputs unloaded, differential outputs with 100Ω differential termination (CML) or 50Ω single-ended to ground (HCSL).

**Note 4:** Tested with input clock slew rate of 3V/ns.

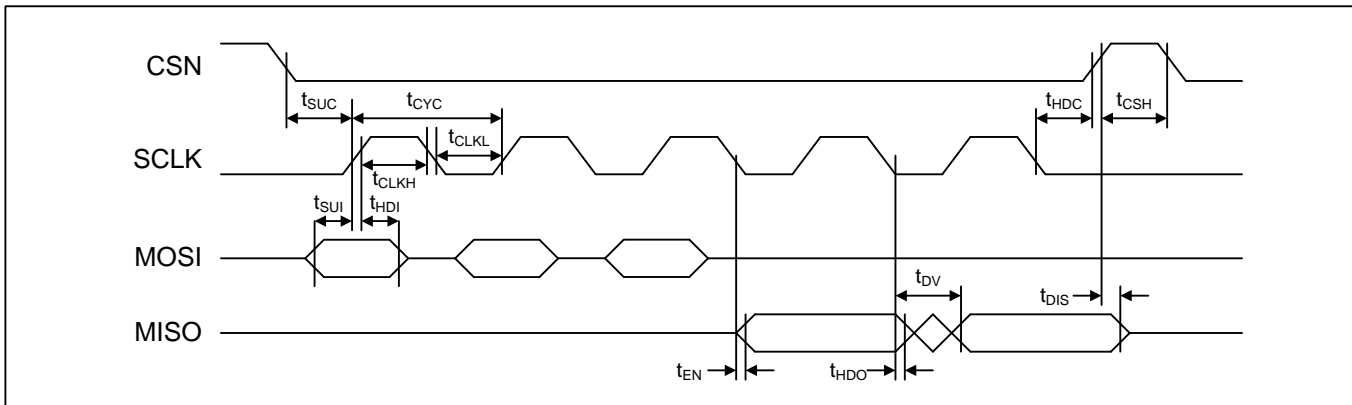
**Note 5:** Jitter calculated from integrated phase noise from 12kHz to 20MHz.

**Note 6:** Tested with 50MHz crystal TXC 7M50070021.

**Table 13 - Electrical Characteristics: SPI Slave Interface Timing, Device Registers**

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 17](#).



**Figure 17 - SPI Slave Interface Timing**

**Table 14 - Electrical Characteristics: SPI Slave Interface Timing, Internal EEPROM**

Characteristics (Notes 1 to 4)	Symbol	Min.	Typ.	Max.	Units	Notes
SCLK frequency	$f_{\text{BUS}}$			10	MHz	
SCLK cycle time	$t_{\text{CYC}}$	100			ns	
CSN setup to first SCLK edge	$t_{\text{SUC}}$	50			ns	
CSN hold time after last SCLK edge	$t_{\text{HDC}}$	51			ns	
CSN high time	$t_{\text{CSH}}$	51			ns	
SCLK high time	$t_{\text{CLKH}}$	41			ns	
SCLK low time	$t_{\text{CLKL}}$	41			ns	
MOSI data setup time	$t_{\text{SUI}}$	11			ns	
MOSI data hold time	$t_{\text{HDI}}$	11			ns	
MISO enable time from SCLK edge	$t_{\text{EN}}$	0			ns	
MISO disable time from CSN high	$t_{\text{DIS}}$			90	ns	
MISO data valid time	$t_{\text{DV}}$			60	ns	
MISO data hold time from SCLK edge	$t_{\text{HDO}}$	0			ns	
CSN, MOSI input rise time, fall time	$t_{\text{R}}, t_{\text{F}}$			10	ns	

**Note 1:** This timing applies (a) when  $\text{EESEL}=1$  and (b) in direct EEPROM write mode (see section 3.11.2).

**Note 2:** All timing is specified with 100pF load on all SPI pins.

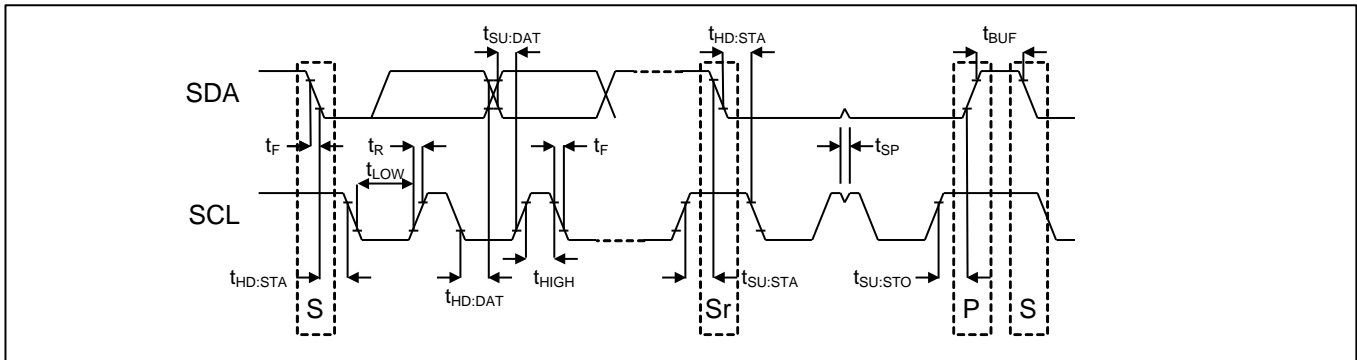
**Note 3:** All parameters in this table are guaranteed by design or characterization.

**Note 4:** See timing diagram in Figure 17.

**Table 15 - 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.

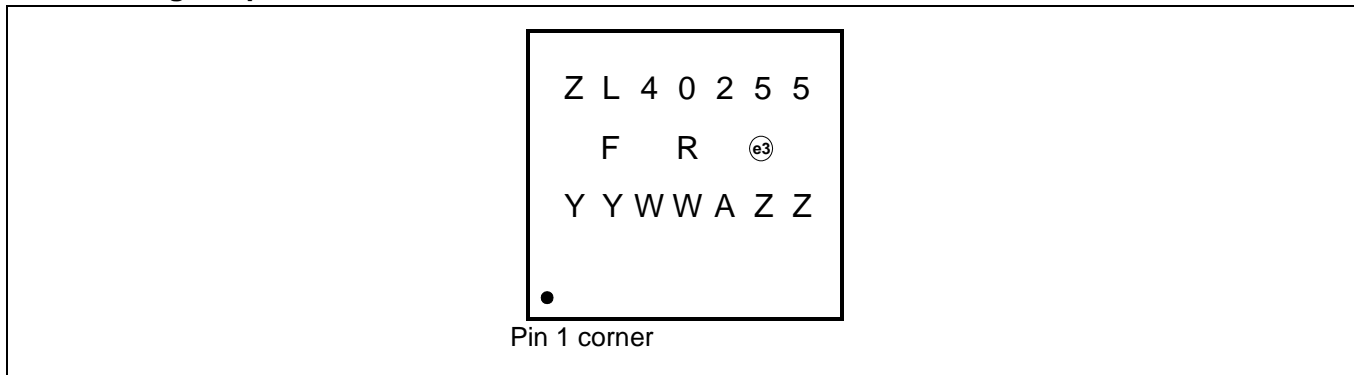


**Figure 18 - I<sup>2</sup>C Slave Interface Timing**



## 6. Package and Thermal Information

### 6.1 Package Top Mark Format



**Figure 19 - Device Top Mark**

**Table 16 – Package Top Mark Legend**

Line	Characters	Description
1	ZL40255	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 17 - 5x5mm QFN Package Thermal Properties**

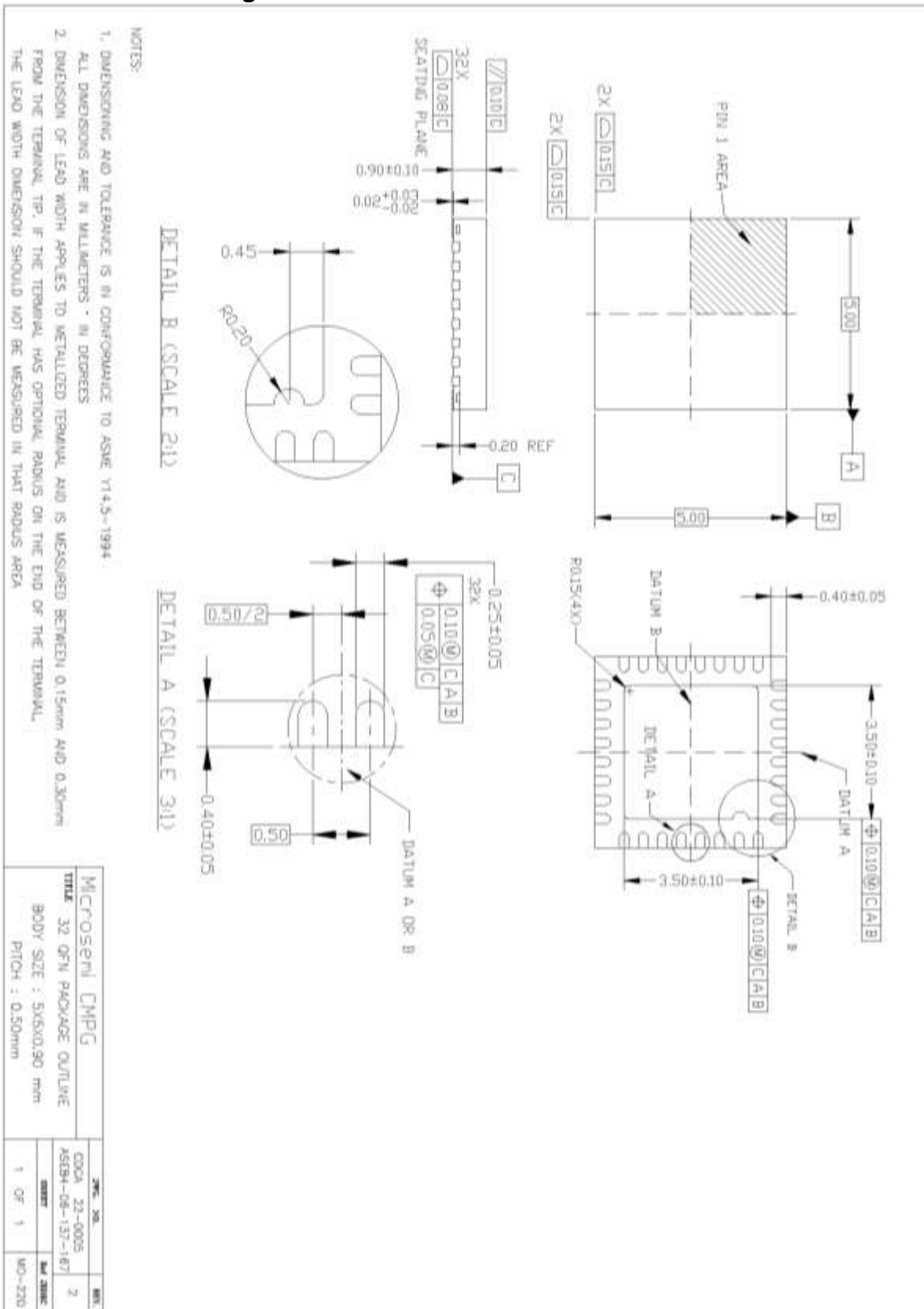
PARAMETER	SYMBOL	CONDITIONS	VALUE	UNITS
Maximum Ambient Temperature	$T_A$		85	°C
Maximum Junction Temperature	$T_{JMAX}$		125	°C
Junction to Ambient Thermal Resistance (Note 1)	$\theta_{JA}$	still air	29.6	°C/W
		1m/s airflow	23.3	
		2.5m/s airflow	20.6	
Junction to Board Thermal Resistance	$\theta_{JB}$		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

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
ppb	parts per billion
ppm	parts per million
pk-pk	peak-to-peak
RMS	root-mean-square
RO	read-only
R/W	read/write
TCXO	temperature-compensated crystal oscillator
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
09-Mar-2016	First general release
11-Mar-2016	In section 3.12 corrected ZLAN number to 594.
19-Apr-2016	<p>Corrected Figure 2 to have square corners rather than chamfered corners to match the mechanical drawing in section 7.</p> <p>Added Note 3 to Table 17.</p> <p>In Table 9 changed <math>t_{H}</math>, <math>t_{L}</math> specs for <math>f_{IN} &gt; 250\text{MHz}</math> from <math>0.4/f_{IN}</math> typical to 0.4ns min and added Note 5.</p> <p>In section 3.7.2 in the Read Transactions paragraph added a note describing the case where the I<sup>2</sup>C write is separated in time from the I<sup>2</sup>C read.</p>
17-Apr-2018	<p>Deleted section 3.11.2 and renumbered section 3.11.3 as new section 3.11.2.</p> <p>In Table 10 deleted Note 2.</p> <p>Deleted Figure 20 and in Table 16 deleted the CCID and WP rows.</p> <p>All of the above were copied over from other documentation but do not apply for this product.</p> <p>In section 3.6.2.second paragraph added maximum input frequency sentences for the medium-speed and low-speed dividers.</p> <p>In section 4 changed the end of the address range from 0x1FF to 0x6FF to include test registers.</p> <p>In the EESEL register description, added a note that the EESEL bit is write-only.</p> <p>In Table 1, in the SCL/SCLK and SDA/MOSI pin descriptions added notes indicating the need for an external pullup resistor for I<sup>2</sup>C operation and referring the reader to the I<sup>2</sup>C specification for details.</p> <p>In OCxPH register description, indicated that positive values represent later in time.</p>