

---

# ***SmartFusion2, IGLOO2, and RTG4***

## ***Hard Multiplier Accumulator Configuration***



---

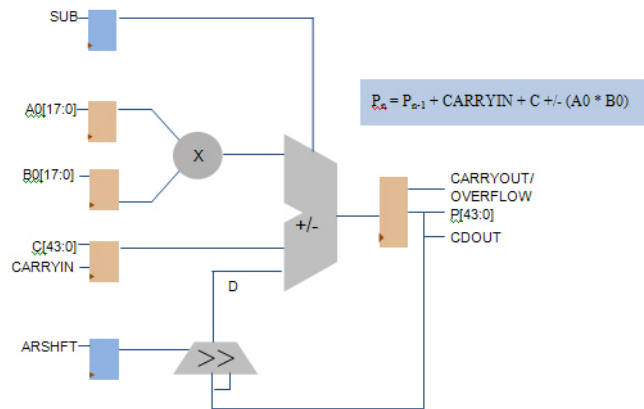
# Table of Contents

---

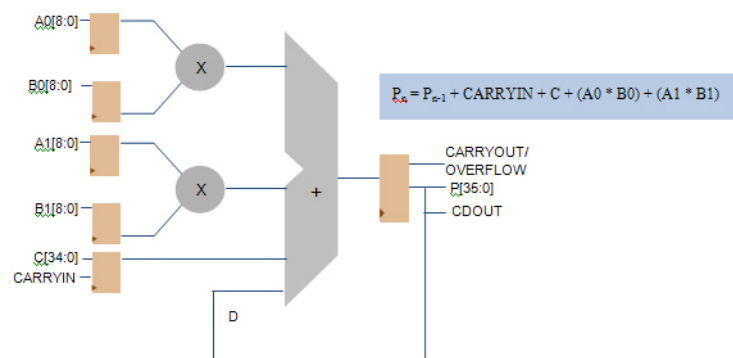
Introduction .....	3
Key Features .....	3
1 SmartDesign.....	5
2 Core Parameters .....	7
3 Port Description .....	10
A Product Support .....	14
Customer Service .....	14
Customer Technical Support Center .....	14
Technical Support .....	14
Website .....	14
Contacting the Customer Technical Support Center .....	14
ITAR Technical Support .....	15

## Introduction

The Hard Multiplier Accumulator for SmartFusion2, IGLOO2, and RTG4 supports normal (Figure 1) and dot product (Figure 2) multiplication. Blue registers indicate control signals; brown registers are for data.



**Figure 1 • Normal Multiplier Accumulator**



**Figure 2 • Dot Product Multiplier Accumulator**

## Key Features

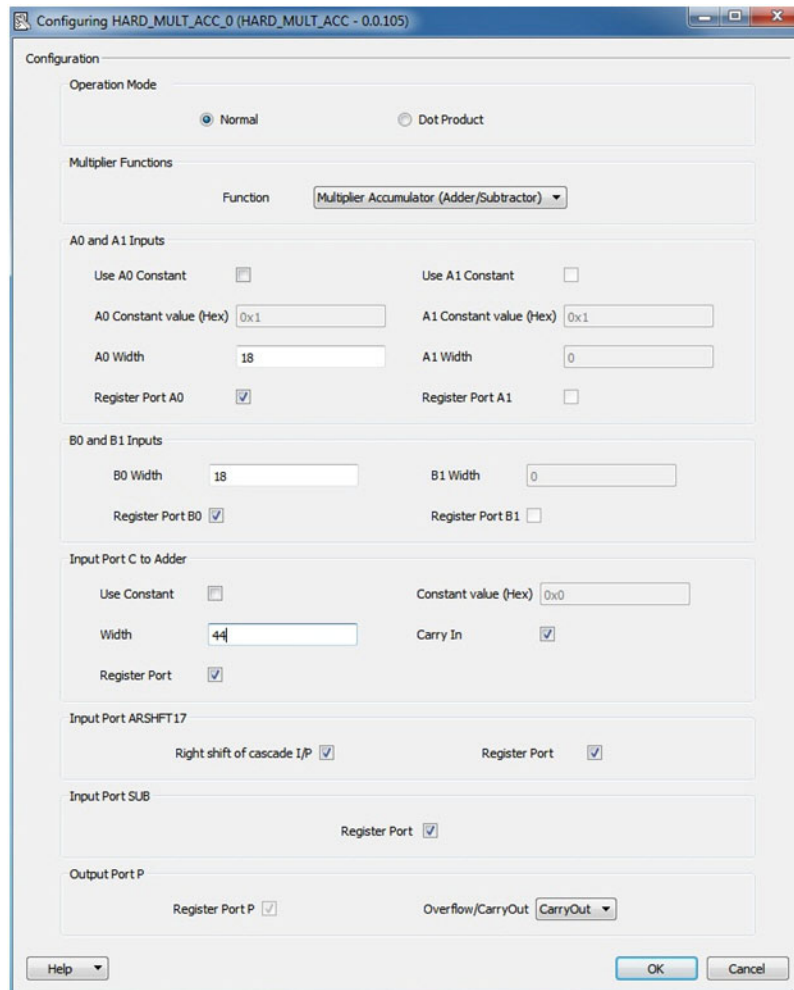
The Hard Multiplier Accumulator supports two operating modes: Normal and Dot Product.

- A structural netlist is generated in either Verilog or VHDL
- Individual inputs and outputs can be optionally registered with:
  - A common rising edge clock
  - Independent active-low asynchronous and synchronous clear controls
  - Independent active-high enable controls
- An additional cascade output CDOUT can be enabled. This is the sign-extended 44 bit copy of output P
- An additional Carry In input can be enabled

- An additional Carry Out or Overflow output can be enabled.
- Normal Mode Features:
  - Configurable operand widths for A0 and B0 between 2 and 18
  - Configurable operand width for C between 2 and 44
  - Optional assignment of operand A0 to an 18 bit two's complement constant
  - Optional assignment of operand C to a 44 bit two's complement constant
  - Option to select between Multiplier followed by Adder, Subtractor or dynamic AddSub
  - Optional Arithmetic Right Shift by 17 bits of the feedback input
- Dot Product Mode Features:
  - Configurable operand widths for A0, B0, A1, B1 between 2 and 9.
  - Configurable operand width for C between 2 and 35.
  - Optional assignment of operand A0 and A1 to a 9 bit two's complement constant
  - Optional assignment of Operand C to a 35 bit two's complement constant

# 1 – SmartDesign

The Hard Multiplier Accumulator for SmartFusion2, IGLOO2, and RTG4 is available for download from the Libero® SoC IP Catalog via the web repository. Once listed in the Catalog you can double-click the macro to configure it in SmartDesign. For information on using SmartDesign to configure, connect, and generate cores, see the Libero SoC online help.

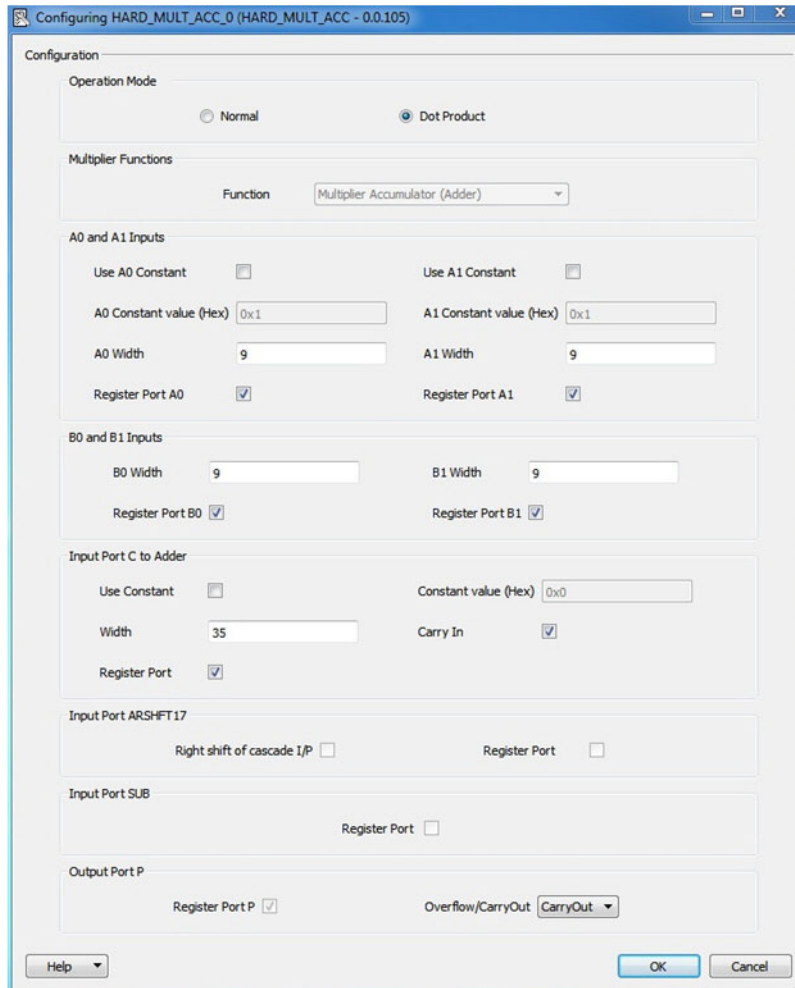


The image shows a configuration window titled "Configuring HARD\_MULT\_ACC\_0 (HARD\_MULT\_ACC - 0.0.105)". The window contains several sections for configuring the Hard Multiplier Accumulator in Normal Mode.

- Configuration**
  - Operation Mode:** Radio buttons for "Normal" (selected) and "Dot Product".
- Multiplier Functions**
  - Function:** A dropdown menu showing "Multiplier Accumulator (Adder/Subtractor)".
- A0 and A1 Inputs**
  - Use A0 Constant:** ☐ (unchecked)
  - A0 Constant value (Hex):**
  - A0 Width:**
  - Register Port A0:** ☒ (checked)
  - Use A1 Constant:** ☐ (unchecked)
  - A1 Constant value (Hex):**
  - A1 Width:**
  - Register Port A1:** ☐ (unchecked)
- B0 and B1 Inputs**
  - B0 Width:**
  - B1 Width:**
  - Register Port B0:** ☒ (checked)
  - Register Port B1:** ☐ (unchecked)
- Input Port C to Adder**
  - Use Constant:** ☐ (unchecked)
  - Constant value (Hex):**
  - Width:**
  - Carry In:** ☒ (checked)
  - Register Port:** ☒ (checked)
- Input Port ARSHIFT17**
  - Right shift of cascade I/P:** ☒ (checked)
  - Register Port:** ☒ (checked)
- Input Port SUB**
  - Register Port:** ☒ (checked)
- Output Port P**
  - Register Port P:** ☒ (checked)
  - Overflow/CarryOut:**

At the bottom of the window, there are buttons for "Help", "OK", and "Cancel".

**Figure 1-1 • Hard Multiplier Accumulator Configuration Options - Normal Mode**



Configuring HARD\_MULT\_ACC\_0 (HARD\_MULT\_ACC - 0.0.105)

Configuration

Operation Mode

☐ Normal ☒ Dot Product

Multiplier Functions

Function: Multiplier Accumulator (Adder)

A0 and A1 Inputs

Use A0 Constant ☐ Use A1 Constant ☐

A0 Constant value (Hex): 0x1 A1 Constant value (Hex): 0x1

A0 Width: 9 A1 Width: 9

Register Port A0 ☒ Register Port A1 ☒

B0 and B1 Inputs

B0 Width: 9 B1 Width: 9

Register Port B0 ☒ Register Port B1 ☒

Input Port C to Adder

Use Constant ☐ Constant value (Hex): 0x0

Width: 35 Carry In ☒

Register Port ☒

Input Port ARSHIFT 17

Right shift of cascade I/P ☐ Register Port ☐

Input Port SUB

Register Port ☐

Output Port P

Register Port P ☒ Overflow/CarryOut: CarryOut

Help OK Cancel

**Figure 1-2 • Hard Multiplier Accumulator Configuration Options - Dot Product Mode**

After configuring and generating the macro instance, you can simulate basic functionality. The macro can then be instantiated as a component of a larger design.

## 2 – Core Parameters

Table 2-1 lists the Normal mode Hard Multiplier Accumulator settings; Table 2-2 lists the Dot Product mode settings.

**Table 2-1 • Hard Multiplier Accumulator Normal Mode Configuration Description**

Name	Valid Range	Description
<b>Multiplier Functions</b>		
Function	Multiplier Accumulator (Adder) Multiplier Accumulator (Subtractor) Multiplier Accumulator (Adder/Subtractor)	The Multiplier Accumulator with Adder/Subtractor exposes the SUB control signal, which enables you to dynamically toggle between an add or subtract operation.
<b>Input Port A0</b>		
Use Constant		Sets input port A0 to constant
Constant Value (Hex)	$-2^{17}$ to $(2^{17} - 1)$	Two's complement value of A0, if A0 is constant. Values shorter than 18 bits are padded with zeros. Negative values must be a full 18 bits wide. For example, 0x1FFFF means +131071 ( $2^{17} - 1$ ), while 0x3FFFF means -1
Width	2 to 18	Width of input port A0; if shorter than 18 bits it is sign-extended. For example, if the width is 8, a value of 0x7F means +127 and a value of 0xFF means -1
Register Port		Registers input port A0 (if A0 is not set to constant)
<b>Input Port B0</b>		
Width	2 to 18	Width of input port B0; if shorter than 18 bits it is sign-extended. For example, if the width is 8, a value of 0x7F means +127 and a value of 0xFF means -1.
Register Port		Registers input port B0
<b>Input Port C</b>		
Use Constant		Sets input port C to constant
Constant Value (Hex)	$-2^{43}$ to $(2^{43} - 1)$	Two's complement value of C, if C is constant. Values shorter than 44 bits are padded with zeros. Negative values must be a full 44 bits wide.
Width	2 to 44	Width of input port C; if shorter than 44 bits it is sign-extended. For example, If the width is 8, a value of 0x7F means +127 and a value of 0xFF means -1.
Carry In		Carry in for C (if C is not set to constant)

**Table 2-1 • Hard Multiplier Accumulator Normal Mode Configuration Description (continued)**

Name	Valid Range	Description
Register Port		Registers input port C and Carry In (if C is not set to constant)
<b>Input Port ARSHFT17</b>		
Right Shift of Feedback Input		Feedback input is arithmetic right-shifted by 17 if selected
Register Port		Registers ARSHFT17 control signal
<b>Input Port SUB</b>		
Register Port		Registers control input port SUB when Multiplier Accumulator with Adder/Subtractor option is selected
<b>Output Port P</b>		
Register Port	Always Selected	Registers output port P, CDOUT and Overflow/CarryOut
Overflow/CarryOut	None, Overflow, CarryOut	Select the output port function to include in the module interface

**Table 2-2 • Hard Multiplier Accumulator Dot Product Mode Configuration Description**

Name	Valid Range	Description
<b>Input Port A0</b>		
Use Constant		Sets input port A0 to constant
Constant Value (Hex)	$-2^8$ to $(2^8 - 1)$	Two's complement value of A0, if A0 is constant. Values shorter than 9 bits are padded with zeros. Negative values must be a full 9 bits wide. For example, 0xFF means +255 ( $2^8 - 1$ ), while 0x1FF means -1
Width	2 to 9	Width of input port A0; if shorter than 9 bits it is sign-extended. For example, if the width is 8, a value of 0x7F means +127 and a value of 0xFF means -1.
Register Port		Registers input port A0 (if A0 is not set to constant)
<b>Input Port A1</b>		
Use Constant		Sets input port A1 to constant
Constant Value (Hex)	$-2^8$ to $(2^8 - 1)$	Two's complement value of A1, if A1 is constant. Values shorter than 9 bits are padded with zeros. Negative values must be a full 9 bits wide. For example, 0xFF means +255 ( $2^8 - 1$ ), while 0x1FF means -1
Width	2 to 9	Width of input port A1; if shorter than 9 bits it is sign-extended. For example, if the width is 8, a value of 0x7F means +127 and a value of 0xFF means -1.
Register Port		Registers input port A1 (if A1 is not set to constant)
<b>Input Port B0</b>		

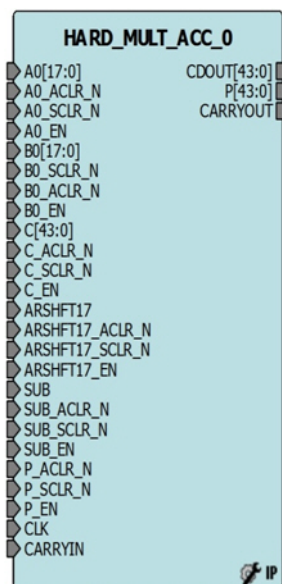


**Table 2-2 • Hard Multiplier Accumulator Dot Product Mode Configuration Description**

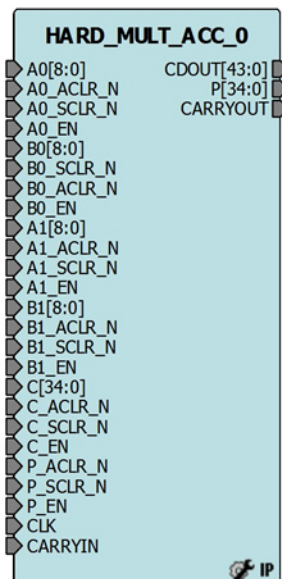
Name	Valid Range	Description
Width	2 to 9	Width of input port B0; if shorter than 9 bits it is sign-extended. For example, if the width is 8, a value of 0x7F means +127 and a value of 0xFF means -1.
Register Port		Registers input port B0
<b>Input Port B1</b>		
Width	2 to 9	Width of input port B1; if shorter than 9 bits it is sign-extended. For example, if the width is 8, a value of 0x7F means +127 and a value of 0xFF means -1.
Register Port		Registers input port B1
<b>Input Port C</b>		
Use Constant		Sets input port C to constant
Constant Value (Hex)	$-2^{35}$ to $(2^{35} - 1)$	Two's complement value of C, if C is constant. Values shorter than 35 bits are padded with zeros. Negative values must be a full 35 bits wide.
Width	2 to 35	Width of input port C; if shorter than 35 bits it is sign-extended. For example, if the width is 8, a value of 0x7F means +127 and a value of 0xFF means -1.
Carry In		Carry in for C (if C is not set to constant)
Register Port		Registers input port C and Carry In (if C is not set to constant)
<b>Output Port P</b>		
Register Port	Always selected	Registers output port P, CDOUT, and Overflow/CarryOut
Overflow/CarryOut	None, Overflow, CarryOut	Select the output port function to include in the module interface

## 3 – Port Description

The figures below display the Hard Multiplier Accumulator input and output ports for Normal mode (Figure 3-1) and Dot Product mode (Figure 3-2). Only a subset of the ports is used in any given Hard Multiplier Accumulator configuration.



**Figure 3-1 • Hard Multiplier Accumulator Ports, Normal Mode**



**Figure 3-2 • Hard Multiplier Accumulator Ports, Dot Product Mode**

Table 3-1 lists the Hard Multiplier Accumulator port signals for Normal mode.

**Table 3-1 • Hard Multiplier Accumulator Ports - Normal Mode**

Signal	Direction	Description
A0	Input	Input data A0, 2- 18 bits wide
B0	Input	Input data B0, 2- 18 bits wide
C	Input	Input data C, 2- 44 bits wide
CLK	Input	Input clock for all registers
A0_ACLR_N	Input	Asynchronous reset for data A0 registers
A0_SCLR_N	Input	Synchronous reset for data A0 registers
A0_EN	Input	Enable for data A0 registers
B0_ACLR_N	Input	Asynchronous reset for data B0 registers
B0_SCLR_N	Input	Synchronous reset for data B0 registers
B0_EN	Input	Enable for data B0 registers
C_ACLR_N	Input	Asynchronous reset for data C, Carry In registers
C_SCLR_N	Input	Synchronous reset for data C, Carry In registers
C_EN	Input	Enable for data C, Carry In registers
CARRYIN	Input	Carry In input for operand C
ARSHFT17_ACLR_N	Input	Asynchronous reset for ARSHF T17 register
ARSHFT17_SCLR_N	Input	Synchronous reset for ARSHF T17 register
ARSHFT17_EN	Input	Enable for ARSHFT17 register
SUB_ACLR_N	Input	Asynchronous reset for input control SUB registers
SUB_SCLR_N	Input	Synchronous reset for input control SUB registers
SUB_EN	Input	Enable for input control SUB registers
SUB	Input	Input control signal to select between add or subtract operation
P_ACLR_N	Input	Asynchronous reset for result P, CDOUT, Overflow/Carryout registers
P_SCLR_N	Input	Synchronous reset for result P, CDOUT, Overflow/Carryout registers
P_EN	Input	Enable for result P, CDOUT, Overflow/Carryout registers
P	Output	$P_n = P_{n-1} + \text{CARRYIN} + C + (A0 * B0)$ when SUB = 0 $P_n = P_{n-1} + \text{CARRYIN} + C - (A0 * B0)$ when SUB = 1
OVERFLOW	Output	When high, indicates that the result exceeded the width of output P. OVERFLOW = $(P[45] \wedge P[44]) \mid (P[44] \wedge P[43])$

**Table 3-1 • Hard Multiplier Accumulator Ports - Normal Mode (continued)**

Signal	Direction	Description
CARRYOUT	Output	This bit can be used to extend the adder in the fabric. $CARRYOUT = C[43] \wedge D[43] \wedge P[44]$
CDOUT	Output Cascade	Cascade output of result P. CDOUT is a copy of P, sign-extended to 44 bits. The entire bus must either be dangling or drive an entire CDIN of another MATH block in Normal mode.

Table 3-2 lists the Hard Multiplier Accumulator port signals for Dot Product mode.

**Table 3-2 • Hard Multiplier Accumulator Ports - Dot Product Mode**

Signal	Direction	Description
A0	Input	Input data A0, 2- 9 bits wide
B0	Input	Input data B0, 2- 9 bits wide
A1	Input	Input data A1, 2- 9 bits wide
B1	Input	Input data B1, 2- 9 bits wide
C	Input	Input data C, 2- 35 bits wide
CLK	Input	Input clock for all registers
A0_ACLR_N	Input	Asynchronous reset for data A0 registers
A0_SCLR_N	Input	Synchronous reset for data A0 registers
A0_EN	Input	Enable for data A0 registers
B0_ACLR_N	Input	Asynchronous reset for data B0 registers
B0_SCLR_N	Input	Synchronous reset for data B0 registers
B0_EN	Input	Enable for data B0 registers
A1_ACLR_N	Input	Asynchronous reset for data A1 registers
A1_SCLR_N	Input	Synchronous reset for data A1 registers
A1_EN	Input	Enable for data A1 registers
B1_ACLR_N	Input	Asynchronous reset for data B1 registers
B1_SCLR_N	Input	Synchronous reset for data B1 registers
B1_EN	Input	Enable for data B1 registers
C_ACLR_N	Input	Asynchronous reset for data C, Carry In registers
C_SCLR_N	Input	Synchronous reset for data C, Carry In registers
C_EN	Input	Enable for data C, Carry In registers
CARRYIN	Input	Carry In input for operand C
P_ACLR_N	Input	Asynchronous reset for result P, CDOUT, Overflow/Carryout registers

**Table 3-2 • Hard Multiplier Accumulator Ports - Dot Product Mode (continued)**

Signal	Direction	Description
P_SCLR_N	Input	Synchronous reset for result P, CDOUT, Overflow/Carryout registers
P_EN	Input	Enable for result P, CDOUT, Overflow/Carryout registers
P	Output	$P_n = P_{n-1} + \text{CARRYIN} + C + (A_0 * B_0) + (A_1 * B_1)$
OVERFLOW	Output	When high, indicates that the result exceeded the width of output P. $\text{OVERFLOW} = (P[36] \wedge P[35]) \mid (P[35] \wedge P[34])$
CARRYOUT	Output	This bit can be used to extend the adder in the fabric. $\text{CARRYOUT} = C[34] \wedge D[34] \wedge P[35]$
CDOUT	Output Cascade	Cascade output of result P. CDOUT is a sign-extended copy of P. The entire bus must either be dangling or drive an entire CDIN of another MATH block in Dot Product mode.

## A – Product Support

---

Microsemi SoC Products Group backs its products with various support services, including Customer Service, Customer Technical Support Center, a website, electronic mail, and worldwide sales offices. This appendix contains information about contacting Microsemi SoC Products Group and using these support services.

### Customer Service

Contact Customer Service for non-technical product support, such as product pricing, product upgrades, update information, order status, and authorization.

From North America, call 800.262.1060

From the rest of the world, call 650.318.4460

Fax, from anywhere in the world, 408.643.6913

### Customer Technical Support Center

Microsemi SoC Products Group staffs its Customer Technical Support Center with highly skilled engineers who can help answer your hardware, software, and design questions about Microsemi SoC Products. The Customer Technical Support Center spends a great deal of time creating application notes, answers to common design cycle questions, documentation of known issues, and various FAQs. So, before you contact us, please visit our online resources. It is very likely we have already answered your questions.

### Technical Support

Visit the Customer Support website ([www.microsemi.com/soc/support/search/default.aspx](http://www.microsemi.com/soc/support/search/default.aspx)) for more information and support. Many answers available on the searchable web resource include diagrams, illustrations, and links to other resources on the website.

### Website

You can browse a variety of technical and non-technical information on the SoC home page, at [www.microsemi.com/soc](http://www.microsemi.com/soc).

### Contacting the Customer Technical Support Center

Highly skilled engineers staff the Technical Support Center. The Technical Support Center can be contacted by email or through the Microsemi SoC Products Group website.

#### Email

You can communicate your technical questions to our email address and receive answers back by email, fax, or phone. Also, if you have design problems, you can email your design files to receive assistance. We constantly monitor the email account throughout the day. When sending your request to us, please be sure to include your full name, company name, and your contact information for efficient processing of your request.

The technical support email address is [soc\\_tech@microsemi.com](mailto:soc_tech@microsemi.com).

## My Cases

Microsemi SoC Products Group customers may submit and track technical cases online by going to [My Cases](#).

## Outside the U.S.

Customers needing assistance outside the US time zones can either contact technical support via email ([soc\\_tech@microsemi.com](mailto:soc_tech@microsemi.com)) or contact a local sales office. [Sales office listings](#) can be found at [www.microsemi.com/soc/company/contact/default.aspx](http://www.microsemi.com/soc/company/contact/default.aspx).

## ITAR Technical Support

For technical support on RH and RT FPGAs that are regulated by International Traffic in Arms Regulations (ITAR), contact us via [soc\\_tech\\_itar@microsemi.com](mailto:soc_tech_itar@microsemi.com). Alternatively, within [My Cases](#), select **Yes** in the ITAR drop-down list. For a complete list of ITAR-regulated Microsemi FPGAs, visit the [ITAR](#) web page.



**Microsemi**

**Microsemi Corporate Headquarters**  
One Enterprise, Aliso Viejo,  
CA 92656 USA

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

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

©2015 Microsemi Corporation. All rights reserved. Microsemi and the Microsemi logo are trademarks of Microsemi Corporation. All other trademarks and service marks are the property of their respective owners.

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

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