Stratix II GX Embedded Gigabit Ethernet MAC / PHY

User's Guide
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User's Guide
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1 Design Kit Installation

1.1 Platform Specific JAVA Runtime Installation

To be able to run the MAC Design Kit delivery and configuration tool, a Java runtime must be present on the system. The design kit needs the Java Runtime Environment Version 1.2.x (JRE1.2) or later.

To determine if and which Java version is installed on your system, open a Shell and type "java -version". If you get errors then the runtime is not installed. If the version is lower than 1.3.x a newer package must be installed.

A platform specific package (The runtime standard edition 1.3, JRE 1.3, is sufficient) can be downloaded from the Sum Microsystems WEB site:

http://java.sun.com/j2se

To install the runtime environment, follow the instructions included in the download package:

- Windows platform: Execute the self-extracting archive.
- Solaris/Linux: Extract the package in a directory and add the bin directory to the PATH environment variable.

1.2 Design Kit Installation

A single executable Java delivery and configuration utility, common to all platforms, is provided, ethpack.jar. The utility generates all the required design files as well as the required scripts for simulation and implementation.

After unzipping the distribution in any directory¹, the Java application can be started immediately:

- Windows users:
  1. Double-click on the ethpack.jar file found in the distribution top directory

- UNIX (Solaris/Linux) users:
  1. Goto the installation directory: $> cd <installation directory>
  2. Execute the Java application: $> java -jar ethpack.jar

¹ Use the extract feature of your unzip tool. Avoid using drag&drop as it does not preserve the directory structure.
2 Design Flow

The different steps of the Embedded Gigabit Ethernet MAC-PHY Design are:

- Core generation
- RTL Simulation
- Synthesis
- Implementation using Quartus II
- Gate-Level Simulation – Not available with Evaluation License

The design kit provides scripts for ease of use, fast design and verification / implementation turn-around.

The tools primarily supported are:

- Simulation: Modelsim Version 5.7a or higher
- Synthesis: Altera Quartus II V5.1 or higher
- Implementation: Altera Quartus II V5.1 or higher
3 Generating the MAC/PHY Core

3.1 Overview

After the Core configuration utility is installed, start the utility and when the panel is available:

1. Select the Core options on the panel
2. Press the “Generate HDL” button.
3. A new window appears prompting you for a key. Type LbNH-sC79 and press “Enter”.
4. A new window appears which can be used to navigate through the file system to select an existing directory or create a new working directory. After pressing the "open" button finally creates the database.

Figure 1: Design Flow Overview
3.2 Core Configuration Options

The Core is fully configurable and a user friendly GUI is provided to simplify configuration. To optimize the core for the intended application environment, several options are available which can be modified before the actual database is generated as described before.

![Figure 2: MAC Core Configuration Panel]
Table 1: Core Configuration Options

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>The Core is optimized for Altera Stratix II GX devices.</td>
</tr>
<tr>
<td>Maximum Frame Length</td>
<td>Maximum Frame Length. Defines a 14-Bit maximum frame length used by the MAC receive logic to check frames.</td>
</tr>
<tr>
<td>Pause Frame Quanta</td>
<td>Receive Pause Quanta. 16-Bit value sets, in increment of 512 Ethernet bit times, the pause quanta used in each Pause Frame sent to the remote Ethernet device.</td>
</tr>
<tr>
<td>Enable Promiscuous Receive Mode</td>
<td>When selected, all frames are received without Unicast address filtering.</td>
</tr>
<tr>
<td>Insert MAC Address on Transmit</td>
<td>If select the MAC overwrites the source MAC address with the MAC set on the Core signal mac_addr. If disabled, the source MAC address received from the transmit application transmitted is not modified by the MAC.</td>
</tr>
</tbody>
</table>

3.3 Design Kit Database

Table 2: Design Kit Directory Structure

<table>
<thead>
<tr>
<th>Directory</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>models</td>
<td>Ethernet Frame generator and monitor models.</td>
</tr>
<tr>
<td>quartus</td>
<td>Contains the netlist for Altera Stratix implementation and a script to control the Altera Quartus design software.</td>
</tr>
<tr>
<td>simulation</td>
<td>Scripts to configure and execute RTL and Gate-Level Simulation as well the ModelSim integrated TestBuilder.</td>
</tr>
<tr>
<td>source</td>
<td>Encrypted VHDL design source files, testbench and configuration files.</td>
</tr>
</tbody>
</table>

3.4 Simulation Environment

A complete testbench is provided (File testbench.vhd in directory source/testbench/vhdl) which implements the Core together with a simulation control state machine and the following drivers and monitors.

- **GMII Ethernet Frame Generator**: Configurable Ethernet Gigabit Ethernet frame generator with GMII interface.
- **GMII Ethernet Frame Monitor**: Gigabit Ethernet frame monitor with GMII interface.
- **Ethernet Frame Generator (FIFO mode)**: Configurable Ethernet frame generator simulating a user application connected to the MAC transmit FIFO interface.
- **Ethernet Monitor (FIFO mode)**: Ethernet frame checker simulating a user application connected to the MAC receive FIFO interface.
- **PCS**: 1000Base-X PCS function that decodes / encodes data from / to the MAC / PHY Core and controls the Auto-Negotiation process within the testbench.
3.5 Running Simulation Using Modelsim SE

Overview

To simplify the evaluation process and to allow designers to quickly generate custom simulation scenarios, a graphical utility (Testbuilder) is provided. Testbuilder operates as a Modelsim plugin, which is used to set simulation options, compile the complete design and run the simulation process.

To start Testbuilder in the Modelsim command window:

1. Change to Modelsim working directory
   
   ```
   cd <Design Kit Root>/simulation
   ```

2. Run the Modelsim macro
   
   ```
   do testbuilder.do
   ```
Important note:

The system variable QUARTUS_ROOTDIR should be set to the Quartus software installation directory so that the Altera libraries can be linked during RTL or Gate level simulations.

Testbuilder Options

A single VHDL configuration file configures the Testbench:

- `source/package/vhdl/mtip_sim_pack.vhd`

The file can be modified to implement different simulation scenarios. To ease the configuration, a graphical tool, `TestBuilder` is provided that modifies the configuration file. `TestBuilder` is a TCL/TK extension written for the ModelSim Simulator, which is fully integrated in the ModelSim framework.
Table 3: Simulation Options

<table>
<thead>
<tr>
<th>Option</th>
<th>Unit</th>
<th>Description</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Frames in RX path</td>
<td>Frames</td>
<td>Sets the number of frames that are generated by the Ethernet frame Generator connected to the Receive PHY interface. If set to 0, a Serdes loopback test is performed with the Core pin loop_ena set to '1'.</td>
<td>5</td>
</tr>
<tr>
<td>Number of Frames in TX path</td>
<td>Frames</td>
<td>Sets the number of frames that are generated by the frame Generator connected to the Core transmit FIFO interface.</td>
<td>5</td>
</tr>
<tr>
<td>IPG in RX path</td>
<td>Bytes</td>
<td>Sets the inter-packet gap (IGP) used by the Ethernet Frame generator when generating frames to the RX PHY interface.</td>
<td>12</td>
</tr>
<tr>
<td>Length of first frame</td>
<td>Bytes</td>
<td>Defines the payload length of the first frame generated by the Ethernet and FIFO models.</td>
<td>100</td>
</tr>
<tr>
<td>Feature</td>
<td>Type</td>
<td>Description</td>
<td>Value</td>
</tr>
<tr>
<td>---------</td>
<td>------</td>
<td>-------------</td>
<td>-------</td>
</tr>
<tr>
<td>Frame length increment</td>
<td>Bytes</td>
<td>Frame payload length increment. During simulation frames are generated starting from &quot;length of first frame&quot; incrementing with each frame generated.</td>
<td>1</td>
</tr>
<tr>
<td>Generated Frames max. payload length</td>
<td>Bytes</td>
<td>Defines the payload maximum length used by the Ethernet Generator models. This value specifies the wrap around for the frame length of generated frames. I.e. if the frame length increment would exceed this value it wraps around to zero. Can be used to test frame length error detection, when set to any value larger than the MAC length configuration.</td>
<td>1500</td>
</tr>
<tr>
<td>Enable Padding of Frames in RX Path</td>
<td>Boolean</td>
<td>If enabled, RX PHY Generator model generated frames are padded to 64 octets in length (normal mode). If disabled, no padding occurs and erroneous frames will be sent to the MAC RX.</td>
<td>True</td>
</tr>
<tr>
<td>Enable VLAN frames for all tests</td>
<td>Boolean</td>
<td>If enabled, all frames sent/received will be VLAN type of frames</td>
<td>False</td>
</tr>
<tr>
<td>Stop RX FIFO read after</td>
<td>Frames</td>
<td>Inhibits the Testbench RX FIFO monitor reading the RX FIFO, after this amount of frames has been sent to the RX. Can be used to test Flow-Control behaviour. If more frames are received, the FIFO will get filled. When the threshold level is reached, a Pause-Frame will be generated by the MAC TX. If set to 0, the RX FIFO read is never paused.</td>
<td>0</td>
</tr>
<tr>
<td>Restart RX FIFO read after</td>
<td>RX FIFO clocks</td>
<td>Number of clock cycles, the RX FIFO should not be read after it has been stopped. Only relevant if the previous configuration (read stop) was set to a non-null value. After this number of RX FIFO clock cycles, the RX FIFO will be emptied again.</td>
<td>10</td>
</tr>
<tr>
<td>Generate Frames with Errors on Transmit FIFO Interface</td>
<td>Boolean</td>
<td>Enable Transmit Error Generation the Core Transmit Interface. When selected, the transmit FIFO signal ( ff_{tx\ err} ) is asserted with ( ff_{tx\ eop} ) to signal an Error. When disabled, the FIFO error is signalled, ( ff_{tx\ err} ) is never set to '1'.</td>
<td>False</td>
</tr>
<tr>
<td>Testbench reacts on Pause Frames</td>
<td>Boolean</td>
<td>If enabled (true) the Testbench will stop the RX (PHY) Frame generator, if the MAC sends a Pause Frame. This simulates a usual flow-control chain correctly. If disabled (False) Pause Frames sent by the MAC are ignored by the Testbench and the RX (PHY) Frame generator will never pause. This can be used to test the MACs FIFO overflow behavior. This option has no effect, if loopback mode is enabled (i.e. Frame generation in RX path is set 0).</td>
<td>True</td>
</tr>
</tbody>
</table>
Force Xoff Frame Generation at (clocks) | Integer | XOFF Pause Frame Generation. Set the time for to generate a XOFF Frame with the Core command pin xoff_gen. When set to 0, XOFF Frame generation is disabled. | 0

Force Xon Frame Generation at (clocks) | Integer | XON Pause Frame Generation. Set the time for to generate a XON Frame with the Core command pin xon_gen. When set to 0, XON Frame generation is disabled. | 0

Table 4: MAC Configuration Options

<table>
<thead>
<tr>
<th>Option</th>
<th>Unit</th>
<th>Description</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAC CONFIG: Transmit FIFO Section Empty Threshold</td>
<td>Integer</td>
<td>Set the Transmit FIFO Section empty threshold to any value between 0 and 63 (Maximum memory depth).</td>
<td>16</td>
</tr>
<tr>
<td>MAC CONFIG: Transmit FIFO Section Full Threshold</td>
<td>Integer</td>
<td>Set the Transmit FIFO Section full threshold to any value between 0 and 63 (Maximum memory depth).</td>
<td>16</td>
</tr>
<tr>
<td>MAC CONFIG: Receive FIFO Section Empty Threshold</td>
<td>Integer</td>
<td>Set the Receive FIFO Section empty threshold to any value between 0 and 63 (Maximum memory depth).</td>
<td>0</td>
</tr>
<tr>
<td>MAC CONFIG: Receive FIFO Section Full Threshold</td>
<td>Integer</td>
<td>Set the Receive FIFO Section full threshold to any value between 0 and 63 (Maximum memory depth).</td>
<td>16</td>
</tr>
<tr>
<td>MAC CONFIG: Enable Auto-Negotiation</td>
<td>Boolean</td>
<td>Enable Auto-Negotiation. When selected, the Core performs auto-negotiation to check the link with the Link Partner before simulation starts. After simulation, the Auto-Negotiation is restarted with the Core signal an_enable set to '0'. When disabled, non Auto-Negotiation is performed.</td>
<td>True</td>
</tr>
<tr>
<td>MAC CONFIG: Ignore Pause Frames</td>
<td>Boolean</td>
<td>Ignore Pause Frames. When enabled, received Pause Frames are ignored, when disable, Pause Frames are decoded.</td>
<td>False</td>
</tr>
<tr>
<td>MAC CONFIG: Remove Frame Padding</td>
<td>Boolean</td>
<td>Enable Receive Padding Remove. When enabled, Frames are provided on the Client Interface without padding, when disabled, Frames are provided on the Client Interface with padding.</td>
<td>True</td>
</tr>
<tr>
<td>MAC CONFIG: Forward CRC</td>
<td>Boolean</td>
<td>Enable CRC Forwarding. When selected, CRC is passed transparently from the Transmit Client Interface to line and, is preserved on the Received Client Interface.</td>
<td>False</td>
</tr>
<tr>
<td>MAC CONFIG: Transmit IPG Length</td>
<td>Integer</td>
<td>Transmit Inter-Packet Gap. Defined, in Bytes, the IPG between transmitted Frames.</td>
<td>12</td>
</tr>
</tbody>
</table>
Table 5: Testbuilder Simulation Control

<table>
<thead>
<tr>
<th>Testbuilder Panel Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compile Database before Simulation (VHDL)</td>
<td>When enabled, the Core simulation database is refreshed with the Core configuration options. The option must be enabled at least once after a new Core database was generated.</td>
</tr>
<tr>
<td>Run Simulation Only</td>
<td>When selected, starts the RTL simulation with all the options defined in the Testbuilder panel ignored (Previous configuration used).</td>
</tr>
<tr>
<td>Configure and Start Simulation</td>
<td>When selected, the options defined on the Testbuilder panel are saved before the RTL simulation is performed.</td>
</tr>
<tr>
<td>Run Gate-Level</td>
<td>When selected, the options defined on the Testbuilder panel are saved before the Gate level simulation is performed.</td>
</tr>
</tbody>
</table>

When running a simulation, a set of waveforms is displayed; error and information messages are issued in the Modelsim standard output.

3.6 Running Simulation Using Modelsim PE or Modelsim AE

Overview

Modifying the file mtip_sim_pack.vhd located in the directory source/package/vhdl creates a custom simulation scenario. The Core files and dependencies are available in the file comp.do (In Directory simulation), the testbench file and simulation models files are listed in the file sim.do. The files comp.do and sim.do should be modified and adapted with the simulator command.

Once a scenario has been created, the following steps should be followed:

1. Change to the simulation directory.
2. Compile the Core database:
   - do comp.do
3. Compile the Simulation database and run simulation:
   - do sim.do

Simulation Options

The simulation is controlled and is configured with a set of parameters set in the file mtip_sim_pack.vhd.

Table 6: Simulation Options

<table>
<thead>
<tr>
<th>Option</th>
<th>Unit</th>
<th>Description</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>TB_RXFRAMES</td>
<td>Frames</td>
<td>Sets the number of frames that are generated by the Ethernet frame Generator connected to the Receive PHY interface. If set to 0, a Serdes loopback test is performed with the Core pin loop_ena set to '1'.</td>
<td>5</td>
</tr>
</tbody>
</table>
### TB_TXFRAMES
- **Type**: Frames
- **Description**: Sets the number of frames that are generated by the frame Generator connected to the Core transmit FIFO interface.
- **Value**: 5

### TB_RXIPG
- **Type**: Bytes
- **Description**: Sets the inter-packet gap (IGP) used by the Ethernet Frame generator when generating frames to the RX PHY interface.
- **Value**: 12

### TB_LENSTART
- **Type**: Bytes
- **Description**: Defines the payload length of the first frame generated by the Ethernet and FIFO models.
- **Value**: 100

### TB_LENSTEP
- **Type**: Bytes
- **Description**: Frame payload length increment. During simulation frames are generated starting from "length of first frame" incrementing with each frame generated.
- **Value**: 1

### TB_LENMAX
- **Type**: Bytes
- **Description**: Defines the payload maximum length used by the Ethernet Generator models. This value specifies the wrap around for the frame length of generated frames. I.e. if the frame length increment would exceed this value it wraps around to zero. Can be used to test frame length error detection, when set to any value larger than the MAC length configuration.
- **Value**: 1500

### TB_ENA_PADDING
- **Type**: Boolean
- **Description**: If enabled, RX PHY Generator model generated frames are padded to 64 octets in length (normal mode). If disabled, no padding occurs and erroneous frames will be sent to the MAC RX.
- **Value**: True

### TB_ENA_VLAN
- **Type**: Boolean
- **Description**: If enabled, all frames sent/received will be VLAN type of frames.
- **Value**: False

### TB_STOPREAD
- **Type**: Frames
- **Description**: Inhibits the Testbench RX FIFO monitor reading the RX FIFO, after this amount of frames has been sent to the RX. Can be used to test Flow-Control behaviour. If more frames are received, the FIFO will get filled. When the threshold level is reached, a Pause-Frame will be generated by the MAC TX. If set to 0, the RX FIFO read is never paused.
- **Value**: 0

### TB_HOLDREAD
- **Type**: RX FIFO clocks
- **Description**: Number of clock cycles, the RX FIFO should not be read after it has been stopped. Only relevant if the previous configuration (read stop) was set to a non-null value. After this number of RX FIFO clock cycles, the RX FIFO will be emptied again.
- **Value**: 10

### TB_TX_FF_ERR
- **Type**: Boolean
- **Description**: Enable Transmit Error Generation the Core Transmit Interface. When selected, the transmit FIFO signal `ff_tx_err` is asserted with `ff_tx_eop` to signal an Error. When disabled, the FIFO error is signalled, `ff_tx_err` is never set to '1'.
- **Value**: False

### TB_PAUSECONTROL
- **Type**: Boolean
- **Description**: If enabled (true) the Testbench will stop the RX (PHY) Frame generator, if the MAC sends a
- **Value**: True
Pause Frame. This simulates a usual flow-control chain correctly. If disabled (False) Pause Frames sent by the MAC are ignored by the Testbench and the RX (PHY) Frame generator will never pause. This can be used to test the MACs FIFO overflow behavior. This option has no effect, if loopback mode is enabled (i.e. Frame generation in RX path is set 0).

<table>
<thead>
<tr>
<th>Option</th>
<th>Unit</th>
<th>Description</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>TB_TRIGGERXOFF</td>
<td>Integer</td>
<td>XOFF Pause Frame Generation. Set the time for to generate a XOFF Frame with the Core command pin xoff_gen. When set to 0, XOFF Frame generation is disabled.</td>
<td>0</td>
</tr>
<tr>
<td>TB_TRIGGERXON</td>
<td>Integer</td>
<td>XON Pause Frame Generation. Set the time for to generate a XON Frame with the Core command pin xon_gen. When set to 0, XON Frame generation is disabled.</td>
<td>0</td>
</tr>
</tbody>
</table>

### Table 7: MAC Configuration Options

<table>
<thead>
<tr>
<th>Option</th>
<th>Unit</th>
<th>Description</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>TX_FIFO_SE</td>
<td>Integer</td>
<td>Set the Transmit FIFO Section empty threshold to any value between 0 and 63 (Maximum memory depth).</td>
<td>16</td>
</tr>
<tr>
<td>TX_FIFO_SF</td>
<td>Integer</td>
<td>Set the Transmit FIFO Section full threshold to any value between 0 and 63 (Maximum memory depth).</td>
<td>16</td>
</tr>
<tr>
<td>RX_FIFO_SE</td>
<td>Integer</td>
<td>Set the Receive FIFO Section empty threshold to any value between 0 and 63 (Maximum memory depth).</td>
<td>0</td>
</tr>
<tr>
<td>RX_FIFO_SF</td>
<td>Integer</td>
<td>Set the Receive FIFO Section full threshold to any value between 0 and 63 (Maximum memory depth).</td>
<td>16</td>
</tr>
<tr>
<td>TB_ENA_AUTONEG</td>
<td>Boolean</td>
<td>Enable Auto-Negotiation. When selected, the Core performs auto-negotiation to check the link with the Link Partner before simulation starts. After simulation, the Auto-Negotiation is restarted with the Core signal an_enable set to '0'. When disabled, non Auto-Negotiation is performed.</td>
<td>True</td>
</tr>
<tr>
<td>TB_IGNORE_PAUSE</td>
<td>Boolean</td>
<td>Ignore Pause Frames. When enabled, received Pause Frames are ignored, when disable, Pause Frames are decoded.</td>
<td>False</td>
</tr>
<tr>
<td>TB_PAD_ENA</td>
<td>Boolean</td>
<td>Enable Receive Padding Remove. When enabled, Frames are provided on the Client Interface without padding, when disabled, Frames are provided on the Client Interface with padding.</td>
<td>True</td>
</tr>
</tbody>
</table>
TB_CRC_FWD | Boolean | Enable CRC Forwarding. When selected, CRC is passed transparently from the Transmit Client Interface to line and, is preserved on the Received Client Interface. | False
---|---|---|---
TB_IPG_LEN | Integer | Transmit Inter-Packet Gap. Defined, in Bytes, the IPG between transmitted Frames. | 12

### 3.7 Design Implementation with Quartus II

Two TCL script `quartus.tcl` is provided in the design kit directory `quartus`, which performs the following actions:

1. Create project
2. Build database
3. Set timing constraints
4. Set I/O Fast Register constraint on fast I/O signals
5. Run Quartus fitter
6. Reports design timing and timing violations
7. Generates VHO VHDL gate level netlist and SDO timing file used during Gate level simulation

The TCL script can run from the Quartus II graphical interface or in batch mode.

- **Graphical Mode:**
  1. In Quartus II TCL console Change to Quartus working directory
     
     `cd <Design Kit Root>/quartus`
  2. Run the design TCL script

     `source quartus.tcl`

### 3.8 VQM Netlist Generation

After you obtain a core license from Altera, a VQM netlist of the Core can be generated with the Quartus II software. The VQM netlist can be used to integrate the Core in a customer design.

To create the VQM netlist:

1. Analyze and Synthesize the Core
2. Generate the VQM Netlist
The VQM Netlist (embedded_gige_mac_phy.vqm) is created in the directory quartus/atom_netlists.

Note: Without the free license from Altera, the VQM netlist cannot be generated and an error message will appear. You can disregard this message as it will not prevent you from running RTL simulation.

3.9 Full Timing Gate Level Simulation

The gate level verification is performed using Quartus II VHDL output files (Structural VHDL and SDF timing files) in the directory quartus/simulation.

To run the gate level simulation with Modelsim, use as described in chapters “3.5” and following. A gate level simulation when the Testbuilder simulation option “Run Gate-Level” is used.

With a Modelsim PE or Modelsim AE, run the script gate.do:

- do gate.do
4 Contact

Altera

For the most up-to-date information about Altera products, go to the Altera world-wide web site at www.altera.com. For technical support on this product, go to www.altera.com/mysupport. For additional information about Altera products, consult the sources shown below.

<table>
<thead>
<tr>
<th>Information Type</th>
<th>USA &amp; Canada</th>
<th>All Other Locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical support</td>
<td><a href="http://www.altera.com/mysupport">www.altera.com/mysupport</a></td>
<td><a href="http://www.altera.com/mysupport">www.altera.com/mysupport</a></td>
</tr>
<tr>
<td></td>
<td>(800) 800-EPLD (3753) (7:00 a.m. to 5:00 p.m. Pacific Time)</td>
<td>+1 408-544-8767 7:00 a.m. to 5:00 p.m. (GMT –8:00) Pacific Time</td>
</tr>
<tr>
<td>Product literature</td>
<td><a href="http://www.altera.com">www.altera.com</a></td>
<td><a href="http://www.altera.com">www.altera.com</a></td>
</tr>
<tr>
<td>Altera literature services</td>
<td><a href="mailto:literature@altera.com">literature@altera.com</a></td>
<td><a href="mailto:literature@altera.com">literature@altera.com</a></td>
</tr>
<tr>
<td>Non-technical customer</td>
<td>(800) 767-3753</td>
<td>+1 408-544-7000 7:00 a.m. to 5:00 p.m. (GMT –8:00) Pacific Time</td>
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<td>service</td>
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<td>FTP site</td>
<td>ftp.altera.com</td>
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