

HardCopy II Military Temperature Range Support

Introduction

As part of Altera’s initiative to provide enhanced commercial off-the-shelf (COTS) devices for military applications, the temperature range for the HardCopy® II device family has been extended to enable operation across the military temperature range (-55°C to 125°C). This allows military programs to benefit from new technology and economies of scale by using commercially available HardCopy II structured ASICs.

HardCopy II structured ASICs are extremely robust devices capable of operating across a wide temperature range with excellent reliability characteristics. This technical brief describes Altera’s support for HardCopy II military temperature range operation with appropriate background information. It also explains how to utilize HardCopy II devices across military temperature range operation, along with any limitations in operation that affect the HardCopy II datasheet specifications.

Military Temperature Support

Military temperature operation requires additional timing margin over industrial temperature operation to compensate for the potentially increased variation of f_{MAX} across temperature. For the Stratix® II FPGA prototype devices, the increased timing margin is achieved by compiling the design using an industrial I4 part and setting the temperature range from -55°C to 125°C in the Quartus II software. The Quartus II software provides separate timing models at 125°C for slow corner and -55°C for fast corner. For the HardCopy II companion devices, the design process is simplified through the introduction of new “M” part numbers. By selecting a HardCopy II companion device with the “M” part number (see [Table 1](#)), the Quartus II software uses the appropriate timing models for -55°C and 125°C to ensure that the constraints of military temperature range operation are met.

Table 1. HardCopy II Military Temperature Device Support

HardCopy II Device	Military Temp Support
HC210WF484M (1)	Yes
HC210F484M	Yes
HC220F672M	Yes
HC220F780M	Yes
HC230F1020M	Yes
HC240F1020M	Yes
HC240F1508M	Yes

Note:

(1) This device is in a wire bond package.

Software Support

Military temperature support for HardCopy II devices is provided beginning with Quartus II software version 7.2. The military temperature range support design flow is the same as that for commercial and industrial devices. Use the software’s HardCopy II Advisor to help guide you through the flow to ensure the design is ready for submission to Altera’s HardCopy Design Center. In addition, follow the guidelines outlined in TB-086: Stratix II Military Temperature Range Support when designing for the Stratix II FPGA prototype. Select the industrial I4 speed grade device and set the low and high operating temperature conditions to -55°C and 125°C, respectively. When choosing the HardCopy II companion device for migration, select the HardCopy II device with the “M” part number as listed in [Table 1](#). This sets the default operating temperature conditions to -55°C and 125°C. To constrain these temperatures, select them in the settings menu.

Note that the two largest Stratix II FPGA devices, EP2S130 and EP2S180, do not support military temperature range operation. However, they can be migrated to HardCopy II companion devices that do operate at military temperature range. For these two Stratix II devices, select the industrial I4 speed grade as described above. The operating temperature conditions default to the industrial temperature range of -40°C to 100°C. During the migration to the HardCopy II companion device, select the device with the “M” part number, which sets the default operating temperature range from -55°C to 125°C.

Limitations to Datasheet Specifications

This section describes the limitations to the HardCopy II datasheet specifications when operating HardCopy II devices at military temperature range. Characterization results show that HardCopy II device operation across the military temperature range is bounded by the industrial grade of the datasheet specifications and any relevant errata, except where noted below. In addition, the limitations for Stratix II military temperature operation generally apply to HardCopy II military temperature operation.

- Worst-case standby power at 125°C is about 1.8X of the worst-case standby power at 100°C, therefore careful power analysis and thermal management is required. For military temperature static power, the HardCopy II PowerPlay Early Power Estimator or PowerPlay Power Analyzer version 7.2 or later should be used.
- Delay-locked loop (DLL) frequency range is bounded by the minimum DLL frequencies listed in [Table 2](#).

Table 2. Minimum DLL Frequencies

Mode	Frequency
Frequency Mode 0	120 MHz
Frequency Mode 1	170 MHz
Frequency Mode 2	220 MHz
Frequency Mode 3	270 MHz

- Non-calibrated on-chip termination (OCT) is bounded to +/-40% for series resistance
- Hot-socketing DC limit is raised to 350 μ A
- I/O F_{MAX} is 15% less than the industrial specifications for all I/O standards
 - Note that the HardCopy II industrial specifications for I/O F_{MAX} will be included in the next revision of the datasheet. Because the HardCopy II industrial I/O F_{MAX} specifications are equivalent to the Stratix II C5 specifications, please refer to the Stratix II datasheet at this time.
- LVDS I/O 2.5V minimum V_{OCM} is 1.1V, minimum V_{OD} is 240mV
- Phase-locked loop (PLL) switchover operates between 0°C and 100°C

PLL Settings

Starting with version 7.2, the Quartus II software fully supports military temperature range operation for PLL. The compiler implements PLL settings with certain restrictions to ensure the PLL operates correctly across the military temperature range.

The altpll MegaWizard® also supports military temperature range operation. When creating a custom altpll megafunction for the Stratix II FPGA prototype, you can indicate military temperature range operation by checking the “Use military temperature range devices only” box on page 3. When creating a custom altpll megafunction for the HardCopy II companion device, the military temperature range operation is the default, provided a device with an “M” part number is selected first.

For your reference, the following are the PLL setting restrictions for military temperature range operation:

- M counter must be between 3 and 19, and:
 - For M = 3 or 4, I_{CP} must be $\geq 36 \mu A$
 - For M = 5 or 6, I_{CP} must be $\geq 52 \mu A$
 - For M = 7, I_{CP} must be $\geq 57 \mu A$
 - For M = 8 or 9, I_{CP} must be $\geq 72 \mu A$
 - For M = 10, I_{CP} must be $\geq 77 \mu A$
 - For M = 11 or 12, I_{CP} must be $\geq 92 \mu A$
 - For M = 13 or 14, I_{CP} must be $\geq 110 \mu A$
 - For M = 15, I_{CP} must be $\geq 114 \mu A$
 - For M = 16, I_{CP} must be $\geq 127 \mu A$
 - For M = 17, I_{CP} must be $\geq 131 \mu A$
 - For M = 18 or 19, I_{CP} must be $\geq 144 \mu A$
- The phase frequency detector (PFD) input frequency must be greater than or equal to 25 MHz and greater than eight times (8X) the bandwidth of the PLL.
 - PFD input frequency is defined as PLL input frequency (f_{IN}) divided by the N counter.

In general, these PLL restrictions have the following effects:

- Reduced input/output frequency combinations available (due to limited M counter choices)
- Reduced PLL bandwidth range (due to limited charge pump current choices)
 - Lower bandwidths are more difficult to achieve

Conclusion

These guidelines have been determined through additional characterization of HardCopy II devices on samples of production silicon across military temperature ranges (125°C and -55°C). While characterizations demonstrate correct operation across military temperatures by design, production testing of industrial grade devices for military temperature range operation is performed at 100°C.

Further Information

- Detailed characterization reports are available to qualified customers. Contact your local sales representative for access to these reports:
www.altera.com/corporate/contact/con-index.html
- TB-086: Stratix II Military Temperature Range Support Technical Brief:
www.altera.com/literature/tb/tb-086.pdf
- HardCopy II PowerPlay Early Power Estimator:
www.altera.com/support/devices/estimator/pow-powerplay.html



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