Technical Brief

Extended Temperature Support for Cyclone II, Cyclone III, and MAX II Devices

Attention: The extended industrial temperature support is no longer available for MAX II devices. Refer to KDB link: *Are MAX® II devices still offered in Extended Industrial Temperature grade?*.

Introduction

Semiconductor devices undergo at least two types of testing: device characterization and production testing. Device characterization is used to verify the performance of a semiconductor design and its physical implementation. Production testing is used to find manufacturing defects that randomly occur during the manufacture of all semiconductor devices. This technical brief describes these testing methods and the roles they play in supporting extended temperature Altera® Cyclone® II, Cyclone III, and MAX® II devices.

Testing

Device characterization is performed on a sample of devices to characterize performance and performance variations across process, voltage, and temperature ranges. Similar methods are used to characterize static power and how it varies across process, voltage, and different temperature ranges. Once device characterization has been performed, the operation of the device is well understood across a variety of operating conditions including commercial, industrial, and extended temperatures. Device characterization allows Altera to determine if a product can be utilized in commercial, industrial, and extended temperature conditions.

Production testing is used to identify manufacturing defects in devices prior to shipment to customers. There are two key stages for production testing: wafer sort and post device assembly (packaging). Wafer sort identifies good dies, which continue in the manufacturing process to device assembly. After assembly, additional testing is performed to verify device functionality and determine performance binning (speed and temperature grades).

Temperature Grades

Cyclone II, Cyclone III, and MAX II devices are available in three different temperature grades, each guaranteed to work within specifications at the specified temperature range, as shown in Table 1.

Table 1. Device Junction Temperature Ranges

Family	Commercial	Industrial	Extended *(1)*
Cyclone III	0°C to 85°C	-40°C to 100°C	-40°C to 125°C
Cyclone II	0°C to 85°C	-40°C to 100°C	-40°C to 125°C
MAX II	0°C to 85°C	-40°C to 100°C	-40°C to 125°C

Note:
(1) For automotive applications, please see Altera's automotive-grade devices for additional information.

Altera has characterized Cyclone II, Cyclone III, and MAX II devices across the commercial, industrial, and extended temperature ranges, and verified that they perform within our stringent specifications. However, note that while commercial-grade devices have been production tested and screened at commercial temperatures, and industrial-grade devices have been production tested and screened at industrial high-end temperatures, Altera does not perform production screening for extended temperature operation. Altera's extended temperature support is guaranteed by design plus characterization.

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Device Support

The device and package combinations shown in Table 2 support the extended temperature range.

Table 2. Extended Temperature Range Device Support

Family	Device	Package
Cyclone III	EP3C5	144-pin Enhanced quad flat pack (EQFP) 164-pin Micro FineLine BGA (MBGA) 256-pin FineLine BGA (FBGA) 256-pin Ultra FineLine BGA (UBGA)
	EP3C10	144-pin EQFP 164-pin MBGA 256-pin FBGA 256-pin UBGA
	EP3C16	144-pin EQFP 164-pin MBGA 240-pin plastic quad flat pack (PQFP) 256-pin FBGA 256-pin UBGA 484-pin FBGA 484-pin UBGA
	EP3C25	144-pin EQFP 240-pin PQFP 256-pin FBGA 256-pin UBGA 324-pin FBGA
	EP3C40	240-pin PQFP 324-pin FBGA 484-pin FBGA 484-pin UBGA 780-pin FBGA
	EP3C55	484-pin FBGA 484-pin UBGA 780-pin FBGA
	EP3C80	484-pin FBGA 484-pin UBGA 780-pin FBGA
	EP3C120	484-pin FBGA 780-pin FBGA
Cyclone II	EP2C5	144-pin thin quad flat pack (TQFP) 208-pin PQFP 256-pin FBGA
	EP2C8, EP2C8A	144-pin TQFP 208-pin PQFP 256-pin FBGA
	EP2C15	256-pin FBGA 484-pin FBGA
	EP2C20, EP2C20A	256-pin FBGA 484-pin FBGA
	EP2C35	484-pin UBGA 484-pin FBGA 672-pin FBGA
	EP2C50	484-pin UBGA 484-pin FBGA 672-pin FBGA
	EP2C70	672-pin FBGA 896-pin FBGA

Table 2. Extended Temperature Range Device Support

Family	Device	Package
MAX II	EPM240	100-pin TQFP 100-pin FBGA 100-pin MBGA
	EPM570	100-pin TQFP 144-pin TQFP 100-pin FBGA 256-pin FBGA 100-pin MBGA 256-pin MBGA
	EPM1270	144-pin TQFP 256-pin FBGA 256-pin MBGA
	EPM2210	256-pin FBGA 324-pin FBGA
MAX IIG	EPM240G	100-pin TQFP 100-pin FBGA 100-pin MBGA
	EPM570G	100-pin TQFP 144-pin TQFP 100-pin FPGA 256-pin FBGA 100-pin MBGA
	EPM1270G	144-pin TQFP 256-pin FBGA 256-pin MBGA
	EPM2210G	256-pin FBGA 324-pin FBGA

Extended Temperature Support

For extended temperature operation for Cyclone II and MAX II devices, Altera supports the use of industrial-grade devices without compiling to a slower speed grade (i.e., without de-rating). The timing model in Quartus® II software compensates the timing difference between the extended temperature operation and industrial temperature operation for Cyclone II and MAX II devices.

For extended temperature operation for Cyclone III devices, Altera supports the use of industrial-grade devices with de-rating. Customers wishing to use Cyclone III devices over the extended temperature range must compile their designs in Quartus using the -8 timing model.

Table 3 shows the target device, which must be selected in the Quartus II software for timing simulations along with the corresponding industrial device that should be ordered. For extended temperature static power, the Quartus PowerPlay Early Power Estimator should be used.

Table 3. Extended Temperature Range Device Software Selection

Family	Device Selected in Software	Device Ordered and Shipped
Cyclone III	EP3C5E144C8	EP3C5E144I7 or EP3C5E144I7N
	EP3C5M164C8	EP3C5M164I7N
	EP3C5F256C8	EP3C5F256I7 or EP3C5F256I7N
	EP3C5U256C8	EP3C5U256I7 or EP3C5U256I7N
	EP3C10E144C8	EP3C10E144I7 or EP3C10E144I7N
	EP3C10M164C8	EP3C10M164I7N
	EP3C10F256C8	EP3C10F256I7 or EP3C10F256I7N
	EP3C10U256C8	EP3C10U256I7 or EP3C10U256I7N
	EP3C16E144C8	EP3C16E144I7 or EP3C16E144I7N
	EP3C16M164C8	EP3C16M164I7N
	EP3C16F256C8	EP3C16F256I7 or EP3C16F256I7N
	EP3C16U256C8	EP3C16U256I7 or EP3C16U256I7N
	EP3C16F484C8	EP3C16F484I7 or EP3C16F484I7N
	EP3C16U484C8	EP3C16U484I7 or EP3C16U484I7N
	EP3C25E144C8	EP3C25E144I7 or EP3C25E144I7N
	EP3C25F256C8	EP3C25F256I7 or EP3C25F256I7N
	EP3C25U256C8	EP3C25U256I7 or EP3C25U256I7N
	EP3C25F324C8	EP3C25F324I7 or EP3C25F324I7N
	EP3C40F324C8	EP3C40F324I7 or EP3C40F324I7N
	EP3C40F484C8	EP3C40F484I7 or EP3C40F484I7N
	EP3C40U484C8	EP3C40U484I7 or EP3C40U484I7N
	EP3C40F780C8	EP3C40F780I7 or EP3C40F780I7N
	EP3C55F484C8	EP3C55F484I7 or EP3C55F484I7N
	EP3C55U484C8	EP3C55U484I7 or EP3C55U484I7N
	EP3C55F780C8	EP3C55F780I7 or EP3C55F780I7N
	EP3C80F484C8	EP3C80F484I7 or EP3C80F484I7N
	EP3C80U484C8	EP3C80U484I7 or EP3C80U484I7N
	EP3C80F780C8	EP3C80F780I7 or EP3C80F780I7N
	EP3C120F484C8	EP3C120F484I7 or EP3C120F484I7N
	EP3C120F780C8	EP3C120F780I7 or EP3C120F780I7N

Table 3. Extended Temperature Range Device Software Selection

Family	Device Selected in Software	Device Ordered and Shipped
Cyclone II	EP2C5T144I8	EP2C5T144I8 or EP2C5T144I8N
	EP2C5Q208I8	EP2C5Q208I8 or EP2C5Q208I8N
	EP2C5F256I8	EP2C5F256I8 or EP2C5F256I8N
	EP2C8T144I8	EP2C8T144I8 or EP2C8T144I8N
	EP2C8Q208I8	EP2C8Q208I8 or EP2C8Q208I8N
	EP2C8F256I8	EP2C8F256I8 or EP2C8F256I8N
	EP2C8AF256I8	EP2C8AF256I8N
	EP2C15AF256I8	EP2C15AF256I8N
	EP2C15AF484I8	EP2C15AF484I8N
	EP2C20F256I8	EP2C20F256I8 or EP2C20F256I8N
	EP2C20F484I8	EP2C20F484I8 or EP2C20F484I8N
	EP2C20AF484I8	EP2C20AF484I8N
	EP2C35F484I8	EP2C35F484I8 or EP2C35F484I8N
	EP2C35U484I8	EP2C35U484I8 or EP2C35U484I8N
	EP2C35F672I8	EP2C35F672I8 or EP2C35F672I8N
	EP2C50F484I8	EP2C50F484I8 or EP2C50F484I8N
	EP2C50U484I8	EP2C50U484I8 or EP2C50U484I8N
	EP2C50F672I8	EP2C50F672I8 or EP2C50F672I8N
	EP2C70F672I8	EP2C70F672I8 or EP2C70F672I8N
	EP2C70F896I8	EP2C70F896I8 or EP2C70F896I8N
MAX II	EPM240T100I5	EPM240T100I5 or EPM240T100I5N
	EPM240F100I5	EPM240F100I5N or EPM240F100I5NN
	EPM240M100I5	EPM240M100I5N
	EPM570T100I5	EPM570T100I5 or EPM570T100I5N
	EPM570T144I5	EPM570T144I5 or EPM570T144I5N
	EPM570F100I5	EPM570F100I5N
	EPM570M100I5	EPM570M100I5N
	EPM570F256I5	EPM570F256I5 or EPM570F256I5N
	EPM570M256I5	EPM570M256I5N
	EPM1270T144I5	EPM1270T144I5 or EPM1270T144I5N
	EPM1270F256I5	EPM1270F256I5 or EPM1270F256I5N
	EPM1270M256I5	EPM1270M256I5N
	EPM2210F256I5	EPM2210F256I5 or EPM2210F256I5N
	EPM2210F324I5	EPM2210F324I5 or EPM2210F324I5N

Table 3. Extended Temperature Range Device Software Selection

Family	Device Selected in Software	Device Ordered and Shipped
MAX IIG	EPM240GT100I5	EPM240GT100I5 or EPM240GT100I5N
	EPM240GF100I5	EPM240GF100I5N
	EPM240GM100I5	EPM240GM100I5N
	EPM570GT100I5	EPM570GT100I5 or EPM570GT100I5N
	EPM570GF100I5	EPM570GF100I5N
	EPM570GT144I5	EPM570GT144I5 or EPM570GT144I5N
	EPM570GF256I5	EPM570GF256I5 or EPM570GF256I5N
	EPM570GM256I5	EPM570GM256I5N
	EPM1270GT144I5	EPM1270GT144I5 or EPM1270GT144I5N
	EPM1270GF256I5	EPM1270GF256I5 or EPM1270GF256I5N
	EPM1270GM256I5	EPM1270GM256I5N
	EPM2210GF256I5	EPM2210GF256I5 or EPM2210GF256I5N
	EPM2210GF324I5	EPM2210GF324I5 or EPM2210GF324I5N

Conclusion

Altera supports extended temperature range Cyclone II, Cyclone III, and MAX II devices, thereby enabling customers to target their designs for communications, military, and industrial applications. For automotive applications, please see Altera's automotive-grade devices for additional information.

Additional Resources

■ Certain extended temperature specifications for Cyclone II are different from the specification for industrial grade devices. Refer to the *DC Characteristics and Timing Specifications* chapter of the *Cyclone II Handbook* for further information on Cyclone II extended temperature offerings:
www.altera.com/literature/lit-cyc2.jsp

■ Certain specifications for the MAX II family are different for extended temperature grade devices. Refer to the *DC and Switching Characteristics* chapter of the *MAX II Handbook* for further information before designing with extended temperature devices:
www.altera.com/literature/lit-max2.jsp

■ Altera's automotive-grade devices:
www.altera.com/end-markets/auto/devices/aut-devices.html