

## Semicustom Products

# UT0.6 $\mu$ CRH Commercial RadHard™ Gate Array Family

Data Sheet

May 2014

[www.aeroflex.com/RadHardASIC](http://www.aeroflex.com/RadHardASIC)



## FEATURES

- ❑ Multiple gate array sizes up to 500,000 usable equivalent gates
- ❑ Toggle rates up to 150 MHz
- ❑ Advanced 0.6 $\mu$  (0.5 $\mu$ L<sub>eff</sub>) radiation-tolerant silicon gate CMOS processed in a commercial fab
- ❑ Operating voltage of 5V and/or 3.3V
- ❑ QML Class Q & V compliant
- ❑ Designed specifically for high reliability applications
- ❑ Commercial RadHard™ for radiation-tolerant to 300 krad(Si) to meet space requirements and SEU-immune to less than 2.0E-10 errors/bit-day
- ❑ JTAG (IEEE 1149.1) boundary-scan supported
- ❑ Low noise package technology for high speed circuits
- ❑ Design support using Mentor Graphics® and Synopsys™ in VHDL or Verilog design languages on Sun® and Linux workstations
- ❑ Supports cold sparing for power down applications
- ❑ Supports voltage translation
  - 5V bus to 3.3V bus
  - 3.3V bus to 5V bus

## PRODUCT DESCRIPTION

The high-performance UT0.6 $\mu$ CRH gate array family features densities up to 500,000 equivalent gates and is available in MIL-PRF-38535 QML Q and V product assurance levels and is radiation-tolerant.

The Commercial RadHard™ silicon is fabricated at ON Semiconductor using a minimally invasive processing module, developed by Aeroflex, that enhances the total dose radiation hardness of the field and gate oxides while maintaining circuit density and reliability. In addition, for both greater transient radiation-hardness and latchup immunity, the Aeroflex 0.6 $\mu$  process is built on epitaxial substrate wafers.

Developed using Aeroflex's patented architectures, the UT0.6 $\mu$ CRH gate array family uses a highly efficient continuous column transistor architecture for the internal cell construction. Combined with state-of-the-art placement and routing tools, the utilization of available transistors is maximized using three levels of metal interconnect.

The UT0.6 $\mu$ CRH family of gate arrays is supported by an extensive cell library that includes SSI, MSI, and 54XX equivalent functions, as well as configurable RAM and cores. Aeroflex's core library includes the following functions:

- Intel 80C31® equivalent
- Intel 80C196® equivalent
- MIL-STD-1553 functions (BRCTM, RTI, RTMP)
- MIL-STD-1750 microprocessor
- RISC microcontroller
- Configurable RAM (SRAM, DPSRAM)
- USART (82C51)
- EDAC
- Aeroflex Gaisler

We offer Aeroflex Gaisler LEON3 and other IP which can be reviewed at [www.gaisler.com/CMS](http://www.gaisler.com/CMS)

**Table 1. Gate Densities**

| DEVICE PART NUMBERS | EQUIVALENT USABLE GATES <sup>1</sup> | SIGNAL I/O <sup>2</sup> | POWER & GROUND PADS <sup>3</sup> |
|---------------------|--------------------------------------|-------------------------|----------------------------------|
| UT06MRA010          | 10,000                               | 192                     | 48                               |
| UT06MRA025          | 25,000                               | 192                     | 48                               |
| UT06MRA050          | 50,000                               | 192                     | 48                               |
| UT06MRA075          | 75,000                               | 312                     | 72                               |
| UT06MRA100          | 100,000                              | 312                     | 72                               |
| UT06MRA150          | 150,000                              | 312                     | 72                               |
| UT06MRA200          | 200,000                              | 432                     | 96                               |
| UT06MRA250          | 250,000                              | 432                     | 96                               |
| UT06MRA300          | 300,000                              | 432                     | 96                               |
| UT06MRA350          | 350,000                              | 432                     | 96                               |
| UT06MRA400          | 400,000                              | 544                     | 144                              |
| UT06MRA450          | 450,000                              | 544                     | 144                              |
| UT06MRA500          | 500,000                              | 544                     | 144                              |

**Notes:**

1. Based on NAND2 equivalents. Actual usable gate count is design-dependent. Estimates reflect a mix of functions including RAM.

2. Includes five pins that may or may not be reserved for JTAG boundary-scan, depending on user requirements.

3. Reserved for dedicated  $V_{DD}/V_{SS}$  and  $V_{DDQ}/V_{SSQ}$ .

4. Aeroflex offers four die sizes: KD (280 mils), KC (407 mils), KB (535 mils), and KM (677 mils).

**Low-noise Device and Package Solutions**

The UT0.6 $\mu$ CRH array family's output drivers feature programmable slew rate control for minimizing noise and switching transients. This feature allows the user to optimize edge characteristics to match system requirements. Separate on-chip power and ground buses are provided for internal cells and output drivers which further isolate internal design circuitry from switching noise.

In addition, Aeroflex offers advanced low-noise package technology with multi-layer, co-fired ceramic construction featuring built-in isolated power and ground planes (see Table 2). These planes provide lower overall resistance/inductance through pow-

er and ground paths which minimize voltage drops during periods of heavy switching. These isolated planes also help sustain supply voltage during dose rate events, thus preventing rail span collapse.

Flatpacks are available with up to 352 leads; PGAs are available with up to 299 pins and LGAs to 472 pins. Aeroflex's flatpacks feature a non-conductive tie bar that helps maintain lead integrity through test and handling operations. In addition to the packages listed in Table 2, Aeroflex offers custom package development and package tooling modification services for individual requirements.

**Table 2. Packages**

| <b>PACKAGE TYPE/<br/>LEADCOUNT<sup>1</sup></b> | <b>025</b> | <b>050</b> | <b>075</b> | <b>100</b> | <b>150</b> | <b>200</b> | <b>250</b> | <b>300</b> | <b>350</b> | <b>400</b> | <b>450</b> | <b>500</b> | <b>550</b> | <b>600</b> |
|--|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|
| <b>Flatpack</b>                                |            |            |            |            |            |            |            |            |            |            |            |            |            |            |
| 84   | X          | X          |            |            |            |            |            |            |            |            |            |            |            |            |
| 132  | X          | X          |            |            |            |            |            |            |            |            |            |            |            |            |
| 172  | X          | X          |            |            |            | X          | X          | X          | X          |            |            |            |            |            |
| 196  | X          | X          |            |            |            | X          | X          | X          | X          |            |            |            |            |            |
| 208  | X          | X          |            |            |            |            |            |            |            |            |            |            |            |            |
| 256  |            |            | X          | X          | X          | X          | X          | X          | X          | X          | X          | X          | X          | X          |
| 304  |            |            |            |            |            | X          | X          | X          | X          |            |            |            |            |            |
| 352  |            |            |            |            |            |            |            |            |            | X          | X          | X          | X          | X          |
| <b>PGA<sup>2</sup></b>                         |            |            |            |            |            |            |            |            |            |            |            |            |            |            |
| 299  |            |            |            |            |            | X          | X          | X          | X          |            |            |            |            |            |
| <b>LGA</b>                                     |            |            |            |            |            |            |            |            |            |            |            |            |            |            |
| 472  |            |            |            |            |            |            |            |            |            | X          | X          | X          | X          | X          |

**Notes:**

1. The number of device I/O pads available may be restricted by the selected package.
2. PGA packages have one additional non-connected index pin (i.e., 84 + 1 index pin = 85 total package pins for the 85 PGA).  
Contact Aeroflex for specific package drawings.

### Extensive Cell Library

The UT0.6 $\mu$ CRH family of gate arrays is supported by an extensive cell library that includes SSI, MSI, and 54XX-equivalent functions, as well as RAM and other library functions. User-selectable options for cell configurations include scan for all register elements, as well as output drive strength. Aeroflex's core library includes the following functions:

- Intel® 80C31 equivalent
- Intel® 80C196 equivalent
- MIL-STD-1553 functions (RTI)
- MIL-STD-1750 microprocessor
- Standard microprocessor peripheral functions
- Configurable RAM (SRAM, DPSRAM)
- RISC Microcontroller
- USART (82C51)
- EDAC
- Aeroflx Gaisler IP

Refer to Aeroflex's UT0.6 $\mu$ CRH Design Manual for complete cell listing and details.

### I/O Buffers

The UT0.6 $\mu$ CRH gate array family offers up to 544 signal I/O locations (note: device signal I/O availability is affected by package selection and pinout.) The I/O cells can be configured by the user to serve as input, output, bidirectional, three-state, or additional power and ground pads. Output drive options range from 2 to 12mA. To drive larger off-chip loads, output drivers may be combined in parallel to provide additional drive up to 24mA.

Other I/O buffer features and options include:

- Slew rate control
- Pull-up and pull-down resistors
- TTL, CMOS, and Schmitt levels
- Cold sparing
- Voltage translation
  - 5V bus to 3.3V bus
  - 3.3V bus to 5V bus

### JTAG Boundary-Scan

The UT0.6 $\mu$ CRH arrays provide for a test access port and boundary-scan that conforms to the IEEE Standard 1149.1 (JTAG). Some of the benefits of this capability are:

- Easy test of complex assembled printed circuit boards
- Gain access to and control of internal scan paths
- Initiation of Built-In Self Test

### Clock Driver Distribution

Aeroflex design tools provide methods for balanced clock distribution that maximize drive capability and minimize relative clock skew between clocked devices.

### Speed and Performance

Aeroflex specializes in high-performance circuits designed to operate in harsh military and radiation environments. Table 3 presents a sampling of typical cell delays.

Note that the propagation delay for a CMOS device is a function of its fanout loading, input slew, supply voltage, operating temperature, and processing radiation tolerance. In a radiation environment, additional performance variances must be considered. The UT0.6 $\mu$ CRH array family simulation models account for all of these effects to accurately determine circuit performance for its particular set of use conditions.

### Power Dissipation

Each internal gate or I/O driver has an average power consumption based on its switching frequency and capacitive loading. Radiation-tolerant processes exhibit power dissipation that is typical of CMOS processes. For a rigorous power estimating methodology, refer to the Aeroflex UT0.6 $\mu$ CRH Design Manual or consult with an Aeroflex Applications Engineer.

### Typical Power Dissipation

|                           |                           |
|---------------------------|---------------------------|
| 1.1 $\mu$ W/Gate-MHz@5.0V | 0.4 $\mu$ W/Gate-MHz@3.3V |
|---------------------------|---------------------------|

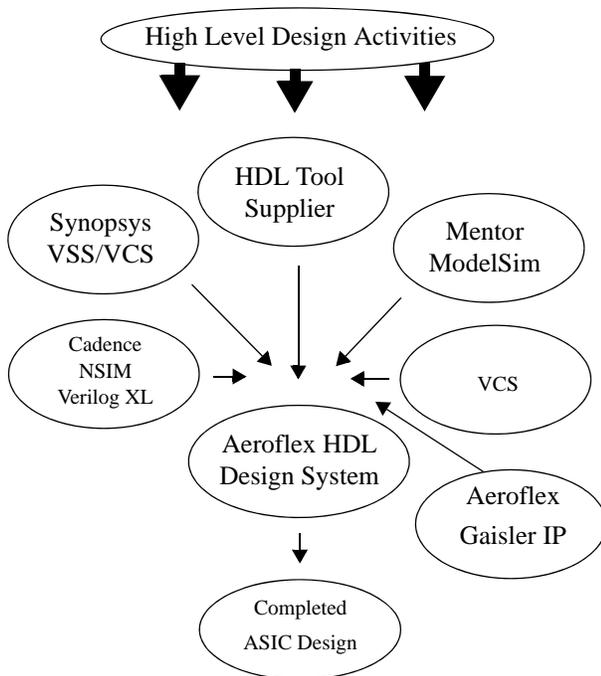
## ASIC DESIGN SOFTWARE

Using a combination of state-of-the-art third-party and proprietary design tools, Aeroflex delivers the CAE support and capability to handle complex, high-performance ASIC designs from design concept through design verification and test.

Aeroflex's flexible circuit creation methodology supports high level design by providing UT0.6 $\mu$ CRH libraries for Mentor Graphics and Synopsys synthesis tools. Design verification is performed in any VHDL or Verilog simulator or the Mentor Graphics environment, using Aeroflex's robust libraries. Aeroflex also supports Automatic Test Program Generation to improve design testing.

## Aeroflex HDL DESIGN SYSTEM

Aeroflex offers a Hardware Description Language (HDL) design system supporting VHDL and Verilog. Both the VHDL and Verilog libraries provide sign-off quality models and robust tools.



Aeroflex HDL Design Flow

The VHDL libraries are VITAL 3.0 compliant, and the Verilog libraries are OVI 1.0 compliant. With the library capabilities Aeroflex provides, you can use High Level Design methods to synthesize your design for simulation. Aeroflex also provides tools to verify that your HDL design will result in working ASIC devices.

Aeroflex's HDL design system lets you easily access Aeroflex's RadHard capabilities.

## ADVANTAGES OF THE AEROFLEX HDL DESIGN SYSTEM

- The Aeroflex HDL Design System gives you the freedom to use tools from Synopsys, Mentor Graphics, Cadence, and other vendors to help you synthesize and verify a design.
- Aeroflex's Logic Rules Checker and Tester Rules Checker allow you to verify partial or complete designs for compliance with Aeroflex design rules.
- Aeroflex HDL Design System accepts back-annotation of timing information through SDF.
- Your design stays entirely within the language in which you started (VHDL or Verilog) preventing conversion headaches.

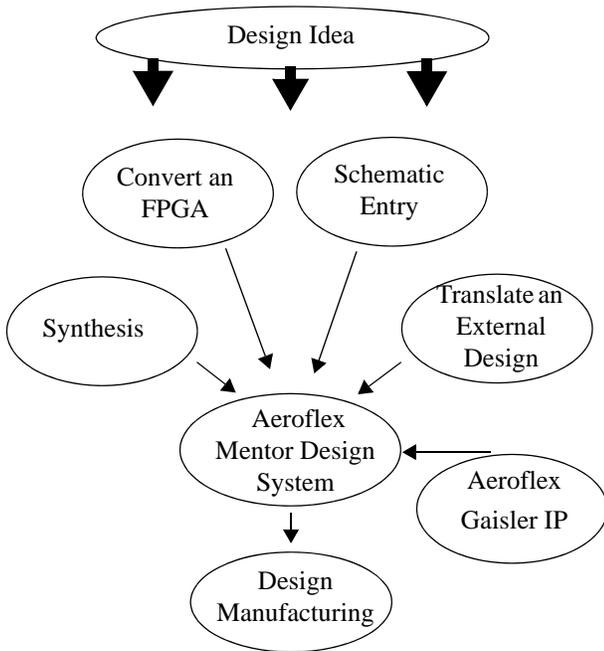
## XDT<sup>sm</sup> (eXternal Design Translation)

Through Aeroflex's XDT services, customers can convert an existing non-Aeroflex design to Aeroflex's processes. The XDT tool is particularly useful for converting an FPGA to an Aeroflex radiation-tolerant gate array. The XDT translation tools convert industry standard netlist formats and vendor libraries to Aeroflex formats and libraries. Industry standard netlist formats supported by Aeroflex include:

- VHDL
- Verilog HDL<sup>TM</sup>
- FPGA source files (Actel, Altera, Xilinx)
- EDIF
- Third-party netlists supported by Synopsys

## AEROFLEX MENTOR GRAPHICS DESIGN SYSTEM

The Aeroflex Mentor Graphics Design System software is fully integrated into the Mentor Graphics design environment, making it familiar and easy to use. Aeroflex tools support Mentor functions such as cross-highlighting, graphical menus, and design navigation.



Aeroflex Mentor Graphics Design Flow

After creating a design in the Mentor Graphics environment, you can easily verify the design for electrical rules compliance with the Aeroflex Logic Rules Checker. Testability can be verified with the Aeroflex Tester Rules Checker. Both of these tools are fully integrated into the Mentor Graphics Environment.

When you have completed all design activities, Aeroflex's Design Transfer tool captures all the required files and prepares them for easy transfer to Aeroflex. Aeroflex uses this data to convert your design into a packaged and tested device.

## ADVANTAGES OF THE AEROFLEX MENTOR DESIGN SYSTEM

- Aeroflex customers have successfully used the Aeroflex Mentor Graphics Design System for over a decade.
- Aeroflex's Logic and Tester Rules Checker tools allow you to verify partial or complete designs for compliance with Aeroflex manufacturing practices and procedures.
- The Design System accepts pre-and post-layout timing information to ensure your design results in devices that meet your specifications.
- The Design System supports Leonardo, and database transfer between Synopsys and Mentor.
- The Design System supports powerful Mentor Graphics ATPG capabilities.

## TOOLS SUPPORTED BY AEROFLEX

Aeroflex supports libraries for:

- Mentor Graphics
- ModelSim
- Tessent
- Synopsys
- Design Compiler
- PrimeTime
- Formality
- TetraMax
- VITAL-compliant VHDL Tools
- OVI-compliant Verilog Tools

## TRAINING AND SUPPORT

Aeroflex personnel conduct training classes tailored to meet individual needs. These classes can address a wide mix of engineering backgrounds and specific customer concerns. Applications assistance is also available through all phases of ASIC Design.

**Table 3. Typical Cell Delays**

| CELL                  | OUTPUT TRANSITION | PROPAGATION DELAY <sup>1</sup> |                        |
|-----------------------|-------------------|--------------------------------|------------------------|
|                       |                   | V <sub>DD</sub> = 5.0V         | V <sub>DD</sub> = 3.3V |
| <b>Internal Gates</b> |                   |                                |                        |
| INV1, Inverter        | HL                | .15                            | .16                    |
|                       | LH                | .23                            | .29                    |
| INV4, Inverter 4X     | HL                | .06                            | .07                    |
|                       | LH                | .10                            | .16                    |
| NAND2, 2-Input NAND   | HL                | .19                            | .25                    |
|                       | LH                | .22                            | .33                    |
| NOR2, 2-Input NOR     | HL                | .16                            | .22                    |
|                       | LH                | .32                            | .45                    |
| DFF - CLK to Q        | HL                | .81                            | 1.12                   |
|                       | LH                | .76                            | 1.06                   |
|                       | HL                | .75                            | 1.05                   |
|                       | LH                | .61                            | .85                    |
| <b>Output Buffers</b> |                   |                                |                        |
| OC5050N4, CMOS        | HL                | 3.85                           | 2.15                   |
|                       | LH                | 4.66                           | 3.76                   |
| OT5050N4, TTL, 4mA    | HL                | 5.58                           | 5.49                   |
|                       | LH                | 2.52                           | 2.93                   |
| OT5050N12, TTL, 12mA  | HL                | 2.42                           |                        |
|                       | LH                | 1.29                           |                        |
| <b>Input Buffers</b>  |                   |                                |                        |
| IC5050, CMOS          | HL                | .81                            | 1.07                   |
|                       | LH                | 1.16                           | 1.18                   |
| IT5050, TTL           | HL                | 1.39                           | 1.12                   |
|                       | LH                | 1.16                           | 1.30                   |

**Note:**

1. All specifications in ns (typical). Output load capacitance is 50pF. Fanout loading for input buffers and gates is the equivalent of two gate input loads.

## PHYSICAL DESIGN

Using three layers of metal interconnect, Aeroflex achieves optimized layouts that maximize speed of critical nets, overall chip performance, and design density up to 500,000 equivalent gates.

### Test Capability

Aeroflex supports all phases of test development from test stimulus generation through high-speed production test. This support includes ATPG, fault simulation, and fault grading. Scan design options are available on all UT0.6μCRH storage elements. Automatic test program development capabilities handle large vector sets for use with Aeroflex's Teradyne Tiger tester supporting high-speed testing (up to 1.2GHz with pin multiplexing).

### Unparalleled Quality and Reliability

Aeroflex is dedicated to meeting the stringent performance requirements of aerospace and defense systems suppliers. Aeroflex maintains the highest level of quality and reliability through our Quality Management Program under MIL-PRF-38535 and ISO-9001. In 1988, we were the first gate array manufacturer to achieve QPL certification and qualification of our technology families. Our product assurance program has kept pace with the demands of certification and qualification.

Our quality management plan includes the following activities and initiatives.

- Quality improvement plan
- Failure analysis program
- SPC plan
- Corrective action plan
- Change control program
- Standard Evaluation Circuit (SEC) and Technology Characterization Vehicle (TCV) assessment program
- Certification and qualification program

Because of numerous product variations permitted with customer specific designs, much of the reliability testing is performed using a Standard Evaluation Circuit (SEC) and Technology Characterization Vehicle (TCV). The TCV utilizes test structures to evaluate hot carrier aging, electromigration, and time dependent test samples for reliability testing. Data from the wafer-level testing can provide rapid feedback to the fabrication process, as well as establish the reliability performance of the product before it is packaged and shipped.

### Radiation Tolerance

Aeroflex incorporates radiation-tolerance techniques in process design, design rules, array design, power distribution, and library element design. All key radiation-tolerance process parameters are controlled and monitored using statistical methods and in-line testing.

| PARAMETER                 | RADIATION TOLERANCE                          | NOTES |
|---------------------------|--|-------|
| Total dose                | 1.0E <sup>5</sup> rad(SiO <sub>2</sub> )     | 1     |
|                           | 3.0E <sup>5</sup> rad(SiO <sub>2</sub> )     | 2     |
| Dose rate upset           | 1.0E <sup>8</sup> rad(Si)/sec                | 3     |
| Dose rate survivability   | 1.0E <sup>11</sup> rad(Si)/sec               | 4     |
| SEU                       | <2.0E <sup>-10</sup> errors per cell-day     | 4, 5  |
| Projected neutron fluence | 1.0E <sup>14</sup> n/sq cm                   |       |
| Latchup                   | Latchup-immune over specified use conditions |       |

#### Notes:

1. Total dose Co-60 testing is in accordance with MIL-STD-883, Method 1019. Data sheet electrical characteristics guaranteed to 1.0E<sup>5</sup> rads(SiO<sub>2</sub>). All post-radiation values measured at 25°C.
2. Total dose Co-60 testing is in accordance with MIL-STD-883, Method 1019 at dose rates <1 rad(SiO<sub>2</sub>)/s.
3. Short pulse 20ns FWHM (full width, half maximum).
4. Is design dependent; SEU limit based on standard evaluation circuit at 4.5V worst case condition.
5. SEU-hard flip-flop cell. Non-hard flip-flop typical is 4E<sup>-8</sup>.

## ABSOLUTE MAXIMUM RATINGS <sup>1</sup>

(Referenced to  $V_{SS}$ )

| SYMBOL    | PARAMETER                          | LIMITS                  |
|-----------|------------------------------------|-------------------------|
| $V_{DD}$  | DC supply voltage                  | -0.3 to 6.0V            |
| $V_{IO}$  | Voltage on any pin                 | -0.3V to $V_{DD} + 0.3$ |
| $T_{STG}$ | Storage temperature                | -65 to +150°C           |
| $T_J$     | Maximum junction temperature       | +175°C                  |
| $I_{LU}$  | Latchup immunity                   | $\pm 150$ mA            |
| $I_I$     | DC input current                   | $\pm 10$ mA             |
| $T_{LS}$  | Lead temperature (soldering 5 sec) | +300°C                  |

### Note:

1. Stresses outside the listed absolute maximum ratings may cause permanent damage to the device. This is a stress rating only, and functional operation of the device at these or any other conditions beyond limits indicated in the operational sections of this specification is not recommended. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## RECOMMENDED OPERATING CONDITIONS

| SYMBOL   | PARAMETER               | LIMITS         |
|----------|-------------------------|----------------|
| $V_{DD}$ | Positive supply voltage | 3.0 to 5.5V    |
| $T_C$    | Case temperature range  | -55 to +125C   |
| $V_{IN}$ | DC input voltage        | 0V to $V_{DD}$ |

### 5V DC ELECTRICAL CHARACTERISTICS

( $V_{DD} = 5.0V \pm 10\%$ ;  $-55^{\circ}C < T_C < +125^{\circ}C$ )<sup>1,2</sup>

| SYMBOL     | PARAMETER  | CONDITION  | MIN   | TYP | MAX  | UNIT    |
|------------|--|--|---|-----|--|---------|
| $V_{IL}^3$ | Low-level input voltage<br>TTL inputs<br>CMOS  | $V_{DD} = 4.5V$ and $5.5V$   |   |     | 0.8<br>.3 $V_{DD}$                               | V       |
| $V_{IH}^3$ | High-level input voltage<br>TTL inputs<br>CMOS   | $V_{DD} = 4.5V$ and $5.5V$   | 2.2<br>.7 $V_{DD}$  |     |  | V       |
| $V_{T+}^3$ | Schmitt Trigger, positive going threshold  | $V_{DD} = 4.5V$ and $5.5V$   |   |     | .24<br>7 $V_{DD}$                                | V       |
| $V_{T-}^3$ | Schmitt Trigger, negative going threshold  | $V_{DD} = 4.5V$ and $5.5V$   | 0.9<br>.3 $V_{DD}$  |     |  | V       |
| $V_H^4$    | Schmitt Trigger, typical range of hysteresis   |  | 0.4<br>0.6  |     |  | V       |
| $I_{IN}$   | Input leakage current<br>TTL, CMOS, and Schmitt inputs<br>Inputs with pull-down resistors<br>Inputs with pull-down resistors<br>Inputs with pull-up resistors<br>Inputs with pull-up resistors<br>Cold Spare Inputs - Normal Mode<br><br>Cold Spare Inputs - Cold Spare Mode | $V_{DD} = 5.5V$<br>$V_{IN} = V_{DD}$ and $V_{SS}$<br>$V_{IN} = V_{DD}$<br>$V_{IN} = V_{SS}$<br>$V_{IN} = V_{SS}$<br>$V_{IN} = V_{DD}$<br>$V_{IN} = 0$ to $5.5V$<br><br>$V_{DD} = V_{SS} = 0V$<br>$V_{IN} = V$ and $5.5V$ | -1<br>+20<br>-5<br>-225<br>-5<br>-5   |     | 1<br>+225<br>+5<br>-20<br>+5<br>+5               | $\mu A$ |
| $V_{OL}$   | Low-level output voltage<br>TTL 2.0mA buffer<br>TTL 4.0mA buffer<br>TTL 8.0mA buffer<br>TTL 12.0mA buffer *<br>CMOS outputs<br>CMOS outputs (optional)<br>CMOS outputs (cold spare)  | $V_{DD} = 4.5V$<br>$I_{OL} = 2.0mA$<br>$I_{OL} = 4.0mA$<br>$I_{OL} = 8.0mA$<br>$I_{OL} = 12.0mA$<br>$I_{OL} = 1.0\mu A$<br>$I_{OL} = 100\mu A$<br>$I_{OL} = 100\mu A$  |   |     | 0.4<br>0.4<br>0.4<br>0.4<br>0.05<br>0.25<br>0.25 | V       |
| $V_{OH}$   | High-level output voltage<br>TTL 2.0mA buffer<br>TTL 4.0mA buffer<br>TTL 8.0mA buffer<br>TTL 12.0mA buffer *<br>CMOS outputs<br>CMOS outputs (optional)<br>CMOS outputs (cold spare)   | $V_{DD} = 4.5V$<br>$I_{OH} = -2.0mA$<br>$I_{OH} = -4.0mA$<br>$I_{OH} = -8.0mA$<br>$I_{OH} = -12.0mA$<br>$I_{OH} = -1.0\mu A$<br>$I_{OH} = -100\mu A$<br>$I_{OH} = -100\mu A$   | 2.4<br>2.4<br>2.4<br>2.4<br>$V_{DD}-0.05$<br>$V_{DD}-0.35$<br>$V_{DD}-0.35$ |     |  | V       |

| SYMBOL                 | PARAMETER                             | CONDITION                                       | MIN  | TYP | MAX              | UNIT    |    |
|------------------------|---------------------------------------|---|------|-----|------------------|---------|----|
| $I_{OZ}$               | Three-state output leakage current    | $V_{DD} = 5.5V$                                 |      |     |                  | $\mu A$ |    |
|                        | TTL 2.0mA buffer                      |   | -5   |     | 5                |         |    |
|                        | TTL 4.0mA buffer, CMOS                |   | -10  |     | 10               |         |    |
|                        | TTL 8.0mA buffer                      |   | -20  |     | 20               |         |    |
|                        | TTL 12.0mA buffer *                   |   | -30  |     | 30               |         |    |
|                        | Cold Spare Inputs - normal mode       | $V_O = 0V$ and $5.5V$                           | -5   |     | -5               |         |    |
|                        | Cold Spare Inputs - cold spare mode   | $V_{DD} = V_{SS} = 0$<br>$V_{DD} = 0$ to $5.5V$ | -5   |     | -5               |         |    |
| $I_{OS}^{4,5}$         | Short-circuit output current          | $V_O = 0V$ and $5.5V$                           |      |     |                  | mA      |    |
|                        | TTL 2.0mA buffer                      |   | -50  |     | 50               |         |    |
|                        | TTL 4.0mA buffer, CMOS                |   | -100 |     | 100              |         |    |
|                        | TTL 8.0mA buffer                      |   | -200 |     | 200              |         |    |
|                        | TTL 12.0mA buffer *                   |   | -300 |     | 300              |         |    |
| $I_{DDQ}$              | Quiescent Supply Current <sup>6</sup> | $V_{DD} = 5.5V$                                 |      |     |                  | $\mu A$ |    |
|                        | Group A subgroups 1,3                 | 200K gates<br>400K gates<br>500K gates          |      |     | 50<br>100<br>180 |         |    |
|                        | Group A subgroup 2                    | $V_{DD} = 5.5V$                                 |      |     |                  | mA      |    |
|                        |                                       | 200K gates<br>400K gates<br>500K gates          |      |     | 1<br>2<br>3      |         |    |
|                        | Group A, subgroup 1                   | $V_{DD} = 5.5V$                                 |      |     |                  | mA      |    |
|                        | RHA Designator: M, D, P, L, R,F       | 200K gates<br>400K gates<br>500K gates          |      |     | 4<br>8<br>12     |         |    |
|                        | $C_{IN}^7$                            | Input capacitance                               |      |     |                  | 23      | pF |
|                        | $C_{OUT}^7$                           | Output capacitance                              |      |     |                  |         | pF |
|                        |                                       | TTL 2.0mA buffer                                |      |     |                  | 22      |    |
| TTL 4.0mA buffer, CMOS |                                       |   |      |     | 26               |         |    |
| TTL 8.0mA buffer       |                                       |   |      |     | 26               |         |    |
| TTL 12.0mA buffer *    |                                       |   |      |     | 26               |         |    |
| $C_{IO}^7$             | Bidirect I/O capacitance              |   |      |     |                  | pF      |    |
|                        | TTL 4.0mA buffer, CMOS                |   |      |     | 24               |         |    |
|                        | TTL 8.0mA buffer                      |   |      |     | 26               |         |    |
|                        | TTL 12.0mA buffer *                   |   |      |     | 26               |         |    |

**Notes:**

\* Contact Aeroflex prior to usage.

1. These devices are capable of being configured and support dual voltage: 3.3V and/or 5.0V bus, 2.5V core/3.3V or 5.0V core/5.0V bus. The supply voltage range shall be specified in the AID.
2. Devices are supplied to this drawing will meet all levels M, D, P, L, R and F of irradiation. However, this device is only tested at the "R" and "F" level. Pre and Post irradiation values are identical unless otherwise specified in Table 1. When performing post irradiation electrical measurements for any RHA level,  $T_A = +25^\circ C$ .

3. Functional tests are conducted in accordance with MIL-STD-883 with the following input test conditions:  $V_{IH} = V_{IH(min)} + 20\%$ ,  $- 0\%$ ;  
 $V_{IL} = V_{IL(max)} + 0\%$ ,  $- 50\%$ , as specified herein, for TTL, CMOS, or Schmitt compatible inputs. Devices may be tested using any input voltage within the above specified range, but are guaranteed to  $V_{IH(min)}$  and  $V_{IL(max)}$ .
4. Supplied as a design limit but not guaranteed or tested.
5. Not more than one output may be shorted at a time for maximum duration of one second.
6. All inputs with internal pull-ups should be left floating. All other inputs should be tied high or low.
7. Capacitance measured for initial qualification and when design changes may affect the value. Capacitance is measured between the designated terminal and  $V_{SS}$  at frequency of 1MHz @0V and a signal amplitude of  $\leq 50\text{mV RMS}$ .

### 3V DC ELECTRICAL CHARACTERISTICS

( $V_{DD} = 3.3V \pm .3V$ ;  $-55^{\circ}C < T_C < +125^{\circ}C$ )<sup>1,2</sup>

| SYMBOL     | PARAMETER  | CONDITION  | MIN  | TYP | MAX                                       | UNIT    |
|------------|--|--|--|-----|---|---------|
| $V_{IL}^3$ | Low-level input voltage<br>CMOS  | $V_{DD} = 3.0V$ and $3.6V$   |  |     | 0.8<br>.3 $V_{DD}$                        | V       |
| $V_{IH}^3$ | High-level input voltage<br>CMOS   | $V_{DD} = 3.0V$ and $3.6V$   | 2.4<br>.7 $V_{DD}$   |     |   | V       |
| $V_{T+}^3$ | Schmitt Trigger, positive going threshold  | $V_{DD} = 3.0V$ and $3.6V$   |  |     | .7 $V_{DD}$                               | V       |
| $V_{T-}^3$ | Schmitt Trigger, negative going threshold  | $V_{DD} = 3.0V$ and $3.6V$   | .3 $V_{DD}$  |     |   | V       |
| $V_H^4$    | Schmitt Trigger, typical range of hysteresis   |  | .6   |     |   | V       |
| $I_{IN}$   | Input leakage current<br>TTL, CMOS, and Schmitt inputs<br>Inputs with pull-down resistors<br>Inputs with pull-down resistors<br>Inputs with pull-up resistors<br>Inputs with pull-up resistors<br>Cold Spare Inputs - normal mode<br><br>Cold Spare Inputs - cold spare mode | $V_{DD} = 3.6V$<br>$V_{IN} = V_{DD}$ and $V_{SS}$<br>$V_{IN} = V_{DD}$<br>$V_{IN} = V_{SS}$<br>$V_{IN} = V_{SS}$<br>$V_{IN} = V_{DD}$<br>$V_{IN} = 0$ to $3.6V$<br><br>$V_{DD} = V_{SS} = 0V$<br>$V_{IN} = V$ and $3.6V$ | -1<br>+10<br>-5<br>-225<br>-5<br>-5                                  |     | 1<br>+225<br>+5<br>-10<br>+5<br>+5        | $\mu A$ |
| $V_{OL}$   | Low-level output voltage<br>TTL 2.0mA buffer<br>TTL 4.0mA buffer<br>TTL 8.0mA buffer<br>CMOS outputs<br>CMOS outputs (optional)<br>CMOS outputs (cold spare)   | $V_{DD} = 3.0V$<br>$I_{OL} = 2.0mA$<br>$I_{OL} = 4.0mA$<br>$I_{OL} = 8.0mA$<br>$I_{OL} = 1.0\mu A$<br>$I_{OL} = 100\mu A$<br>$I_{OL} = 100\mu A$   |  |     | 0.4<br>0.4<br>0.4<br>0.05<br>0.25<br>0.25 | V       |
| $V_{OH}$   | High-level output voltage<br>TTL 2.0mA buffer<br>TTL 4.0mA buffer, CMOS<br>TTL 8.0mA buffer<br>CMOS outputs<br>CMOS outputs (optional)<br>CMOS outputs (cold spare)  | $V_{DD} = 3.0V$<br>$I_{OH} = 2.0mA$<br>$I_{OH} = 2.0mA$<br>$I_{OH} = 8.0mA$<br>$I_{OH} = 1.0\mu A$<br>$I_{OH} = 100\mu A$<br>$I_{OH} = 100\mu A$   | 2.4<br>2.4<br>2.4<br>$V_{DD}-0.05$<br>$V_{DD}-0.35$<br>$V_{DD}-0.35$ |     |   | V       |

| SYMBOL                         | PARAMETER  | CONDITION  | MIN  | TYP | MAX | UNIT |
|--------------------------------|--|--|------|-----|-----|------|
| I <sub>OZ</sub>                | Three-state output leakage current                             | V <sub>DD</sub> = 3.6V                               |      |     |     | μA   |
|                                | CMOS   | V <sub>O</sub> = V <sub>DD</sub> and V <sub>SS</sub> | -20  |     | 20  |      |
|                                | Cold Spare Inputs - normal mode                                | V <sub>DD</sub> = V <sub>SS</sub> = 0V               | -5   |     | 5   |      |
|                                | Cold Spare Inputs - cold spare mode                            | V <sub>O</sub> = 0V and 3.6V                         | -5   |     | 5   |      |
| I <sub>OS</sub> <sup>4,5</sup> | Short-circuit output current <sup>5</sup><br>CMOS, LVTTTL      | V <sub>O</sub> = V <sub>DD</sub> and V <sub>SS</sub> | -200 |     | 200 | mA   |
| I <sub>DDQ</sub>               | Quiescent Supply Current <sup>6</sup><br>Group A subgroups 1,3 | V <sub>DD</sub> = 5.5V                               |      |     |     | μA   |
|                                |  | 200K gates   |      |     | 50  |      |
|                                |  | 400K gates   |      |     | 100 |      |
|                                | Group A subgroup 2   | V <sub>DD</sub> = 5.5V                               |      |     |     | mA   |
|                                |  | 200K gates   |      |     | 1   |      |
|                                |  | 400K gates   |      |     | 2   |      |
|                                | Group A, subgroup 1<br>RHA designator: M, D, P, L, R           | V <sub>DD</sub> = 5.5V                               |      |     |     | mA   |
|                                |  | 200K gates   |      |     | 4   |      |
|                                |  | 400K gates   |      |     | 8   |      |
| C <sub>IN</sub> <sup>7</sup>   | Input capacitance  |  |      |     | 23  | pF   |
|                                |  |  |      |     |     |      |
| C <sub>OUT</sub> <sup>7</sup>  | Output capacitance<br>CMOS                                     |  |      |     | 26  | pF   |
|                                |  |  |      |     |     |      |
| C <sub>IO</sub> <sup>7</sup>   | Bidirect I/O capacitance<br>CMOS                               |  |      |     | 26  | pF   |

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3. Functional tests are conducted in accordance with MIL-STD-883 with the following input test conditions: V<sub>IH</sub> = V<sub>IH</sub>(min) + 20%, - 0%; V<sub>IL</sub> = V<sub>IL</sub>(max) + 0%, - 50%, as specified herein, for TTL, CMOS, or Schmitt compatible inputs. Devices may be tested using any input voltage within the above specified range, but are guaranteed to V<sub>IH</sub>(min) and V<sub>IL</sub>(max).
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7. Capacitance measured for initial qualification and when design changes may affect the value. Capacitance is measured between the designated terminal and V<sub>SS</sub> at frequency of 1MHz @0V and a signal amplitude of ≤50mV RMS.

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## *Aeroflex Colorado Springs - Datasheet Definition*

Advanced Datasheet - Product In Development

Preliminary Datasheet - Shipping Prototype

Datasheet - Shipping QML & Reduced HiRel

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