

Radiation Hardened Hex Inverting Schmitt Trigger

December 1992

Features

- 3 Micron Radiation Hardened SOS CMOS
- Total Dose 200K or 1 Mega-RAD (SI)
- Dose Rate Upset $>10^{10}$ RAD(SI)/s 20ns Pulse
- Cosmic Ray Upset Rate 2×10^{-9} Errors/Bit Day
- Latch-Up Free Under Any Conditions
- Military Temperature Range: -55°C to $+125^{\circ}\text{C}$
- Significant Power Reduction Compared to LSTTL ICs
- DC Operating Voltage Range: 4.5V to 5.5V
- LSTTL Input Compatibility
 - $V_{IL} = 0.8V$ Max
 - $V_{IH} = V_{CC}/2$ Min
- Input Current Levels $I_i \leq 5\mu\text{A}$ @ V_{OL}, V_{OH}

Description

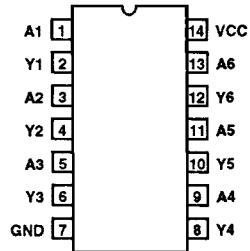
The Harris HCTS14MS is a Radiation Hardened HEX Inverting with Schmitt trigger inputs.

The HCTS14MS utilizes advanced CMOS/SOS technology to achieve high-speed operation. This device is a member of radiation hardened, high-speed, CMOS/SOS Logic Family.

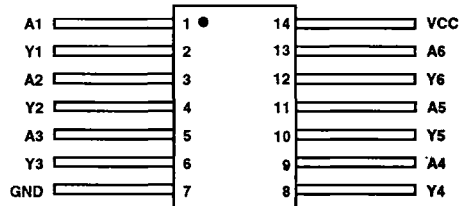
The HCTS14MS is supplied in a 14 lead Weld Seal Ceramic flatpack (K suffix) or a Weld Seal Ceramic Dual-In-Line Package (D suffix).

Pinouts

14 PIN CERAMIC DUAL-IN-LINE
CASE OUTLINE D-1, CONFIGURATION 3, LEAD FINISH C
TOP VIEW



14 PIN CERAMIC FLAT PACK
CASE OUTLINE F-2A, CONFIGURATION 2, LEAD FINISH C
TOP VIEW



Truth Table

| INPUTS A_n | OUTPUTS Y_n |
|-----------------|------------------|
| L | H |
| H | L |

NOTE: L = Logic Level Low, H = Logic level High

Functional Diagram



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Specifications HCTS14MS

Absolute Maximum Ratings

| | |
|---|--------------------|
| Supply Voltage | -0.5V to +7.0V |
| Input Voltage Range, All Inputs | -0.5V to VCC +0.5V |
| DC Input Current, Any One Input | ±10mA |
| DC Drain Current, Any One Output (All Voltage Reference to the VSS Terminal) | ±25mA |
| Storage Temperature Range (TSTG) | -65°C to +150°C |
| Lead Temperature (Soldering 10sec) | +265°C |
| Junction Temperature (TJ) | +175°C |
| ESD Classification | Class 1 |

Reliability Information

| | | |
|---------------------------------------|----------------------------|---------------|
| Thermal Impedance | θ_{ja} | θ_{jc} |
| Weld Seal DiC | 75°C/W | 16°C/W |
| Weld Seal Flat Pack | 64°C/W | 12°C/W |
| Power Dissipation per Package (PD) | 1W | |
| For T _A = -55°C to +100°C | Derate Linearly at 13mW/°C | |
| For T _A = +100°C to +125°C | | |

CAUTION: As with all semiconductors, stress listed under "Absolute Maximum Ratings" may be applied to devices (one at a time) without resulting in permanent damage. This is a stress rating only. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. The conditions listed under "Electrical Performance Characteristics" are the only conditions recommended for satisfactory device operation.

Operating Conditions

| | | | |
|--|-----------------|--------------------------|--------------|
| Supply Voltage (VCC) | +4.5V to +5.5V | Input Low Voltage (VIL) | 0.0V to 0.8V |
| Input Rise and Fall Times at 4.5V VCC (TR, TF) | Unlimited | Input High Voltage (VIH) | VCC/2 to VCC |
| Operating Temperature Range (T _A) | -55°C to +125°C | | |

TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS

| PARAMETERS | SYMBOL | (NOTE 1) CONDITIONS | GROUP A SUB- GROUPS | TEMPERATURE | LIMITS | | UNITS |
|-----------------------------------|--------|---|---------------------------|----------------------|-------------|-----|-------|
| | | | | | MIN | MAX | |
| Quiescent Current | ICC | VCC = 5.5V, VIN = VCC or GND | 1 | +25°C | - | 10 | μA |
| | | | 2, 3 | +125°C, -55°C | - | 200 | μA |
| Output Current (Sink) | IOL | VCC = 4.5V, VIH = 4.5V, VOUT = 0.4V, VIL = 0V | 1 | +25°C | 4.8 | - | mA |
| | | | 2, 3 | +125°C, -55°C | 4.0 | - | mA |
| Output Current (Source) | IOH | VCC = 4.5V, VIH = 4.5V, VOUT = VCC - 0.4V, VIL = 0V | 1 | +25°C | -4.8 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -4.0 | - | mA |
| Output Voltage Low | VOL | VCC = 4.5V, VIH = 2.25V, IOL = 50μA, VIL = 0.8V | 1, 2, 3 | +25°C, +125°C, -55°C | - | 0.1 | V |
| | | VCC = 5.5V, VIH = 2.75V, IOL = 50μA, VIL = 0.8V | 1, 2, 3 | +25°C, +125°C, -55°C | - | 0.1 | V |
| Output Voltage High | VOH | VCC = 4.5V, VIH = 2.25V, IOH = -50μA, VIL = 0.8V | 1, 2, 3 | +25°C, +125°C, -55°C | VCC -0.1 | - | V |
| | | VCC = 5.5V, VIH = 2.75V, IOH = -50μA, VIL = 0.8V | 1, 2, 3 | +25°C, +125°C, -55°C | VCC -0.1 | - | V |
| Input Leakage Current | IIN | VCC = 5.5V, VIN = VCC or GND | 1 | +25°C | -0.5 | 0.5 | μA |
| | | | 2, 3 | +125°C, -55°C | -5.0 | 5.0 | μA |
| Noise Immunity Functional Test | FN | VCC = 4.5V, VIH = 2.25V, VIL = 0.8V | 7, 8A, 8B | +25°C, +125°C, -55°C | 4.0 | 0.5 | V |

NOTE:

- All voltages reference to device GND.
- For functional tests VO ≥ 4.0V is recognized as a logic "1", and VO ≤ 0.5V is recognized as a logic "0".

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TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS

| PARAMETER | SYMBOL | (NOTES 1, 2) CONDITIONS | GROUP A SUB- GROUPS | TEMPERATURE | LIMITS | | UNITS |
|--------------------|--------|-------------------------------------|---------------------------|---------------|--------|------|-------|
| | | | | | MIN | MAX | |
| Propagation Delay | TPHL | VCC = 4.5V, VIH = 3.0V, VIL = 0V | 9 | +25°C | 2 | 19 | ns |
| | | | 10, 11 | +125°C, -55°C | 2 | 21 | ns |
| | TPLH | VCC = 4.5V, VIH = 3.0V, VIL = 0V | 9 | +25°C | 2 | 25 | ns |
| | | | 10, 11 | +125°C, -55°C | 2 | 26 | ns |
| Input Switch Point | VT+ | VCC = 4.5V | 9 | +25°C | 0.5 | 2.25 | V |
| | | | 10, 11 | +125°C, -55°C | 0.5 | 2.25 | V |
| | VT- | VCC = 4.5V | 9 | +25°C | 0.5 | 2.25 | V |
| | | | 10, 11 | +125°C, -55°C | 0.5 | 2.25 | V |
| | VH | VCC = 4.5V | 9 | +25°C | 0.1 | 1.40 | V |
| | | | 10, 11 | +125°C, -55°C | 0.1 | 1.40 | V |

NOTES:

1. All voltages referenced to device GND.
2. AC measurements assume RL = 500Ω, CL = 50pF, Input TR = TF = 3ns, VIL = GND, VIH = 3V.

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS

| PARAMETER | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS | | UNITS |
|----------------------------------|--------------|---|-------|-------------|------------|-----|-------|
| | | | | | MIN | MAX | |
| Capacitance Power Dissipation | CPD | VCC = 5.0V, VIH = 5.0V, VIL = 0.0V, f = 1MHz | 1 | +25°C | Typical 17 | | pF |
| | | | 1 | +125°C | Typical 19 | | pF |
| Input Capacitance | CIN | VCC = 5.0V, VIH = 5.0V, VIL = 0.0V, f = 1MHz | 1 | +25°C | - | 10 | pF |
| | | | 1 | +125°C | - | 10 | pF |
| Output Transition Time | TTHL TTLH | VCC = 4.5V, VIH = 4.5V, VIL = 0.0V | 1 | +25°C | 1 | 15 | ns |
| | | | 1 | +125°C | 1 | 22 | ns |

NOTES:

1. The parameters listed in Table 3 are controlled via design or process parameters. Min and Max Limits are guaranteed but not directly tested. These parameters are characterized upon initial design release and upon design changes which affect these characteristics.

TABLE 4. DC POST RADIATION ELECTRICAL PERFORMANCE CHARACTERISTICS

| PARAMETERS | SYMBOL | (NOTES 1, 2) CONDITIONS | TEMP- ERATURE | 200K RAD LIMITS | | 1M RAD LIMITS | | UNITS |
|----------------------------|--------|---|------------------|--------------------|-----|------------------|-----|-------|
| | | | | MIN | MAX | MIN | MAX | |
| Quiescent Current | ICC | VCC = 5.5V, VIN = VCC or GND | +25°C | - | 0.2 | - | 1.0 | mA |
| Output Current (Sink) | IOL | VCC = 4.5V, VIN = VCC or GND, VOUT = 0.4V | +25°C | 4.0 | - | 4.0 | - | mA |
| Output Current (Source) | IOH | VCC = 4.5V, VIN = VCC or GND, VOUT = VCC - 0.4V | +25°C | -4.0 | - | -4.0 | - | mA |
| Output Voltage Low | VOL | VCC = 4.5V and 5.5V, VIH = VCC/2, VIL = 0.8V at 200K RAD, VIL = 0.3V at 1M RAD, IOL = 50μA | +25°C | - | 0.1 | - | 0.1 | V |

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TABLE 4. DC POST RADIATION ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)

| PARAMETERS | SYMBOL | (NOTES 1, 2) CONDITIONS | TEMP- ERATURE | 200K RAD LIMITS | | 1M RAD LIMITS | | UNITS |
|-----------------------------------|--------|--|------------------|--------------------|---------|------------------|---------|---------|
| | | | | MIN | MAX | MIN | MAX | |
| Output Voltage High | VOH | VCC = 4.5V and 5.5V, VIH = VCC/2, VIL = 0.8V at 200K RAD, VIL = 0.3V at 1M RAD, IOH = -50 μ A | +25 $^{\circ}$ C | VCC -0.1 | - | VCC -0.1 | - | V |
| Input Leakage Current | IIN | VCC = 5.5V, VIN = VCC or GND | +25 $^{\circ}$ C | - | \pm 5 | - | \pm 5 | μ A |
| Noise Immunity Functional Test | FN | VCC = 4.5V, VIH = 2.25V, VIL = 0.8V at 200K RAD, VIL = 0.3V at 1M RAD (Note 3) | +25 $^{\circ}$ C | - | - | - | - | - |
| Propagation Delay | TPHL | VCC = 4.5V | +25 $^{\circ}$ C | 2 | 21 | 2 | 37 | ns |
| | TPLH | VCC = 4.5V | +25 $^{\circ}$ C | 2 | 31 | 2 | 49 | ns |
| Input Switch Point | VT+ | VCC = 4.5 | +25 $^{\circ}$ C | 0.40 | 2.25 | 0.30 | 2.25 | V |
| | VT- | VCC = 4.5 | +25 $^{\circ}$ C | 0.40 | 2.25 | 0.30 | 2.25 | V |
| | VH | VCC = 4.5 | +25 $^{\circ}$ C | 0.10 | 1.40 | 0.10 | 1.40 | V |

NOTES:

1. All voltages referenced to device GND.
2. AC measurements assume RL = 500 Ω , CL = 50pF, Input TR = TF = 3ns, VIL = GND, VIH = VCC.
3. For functional tests VO \geq 4.0V is recognized as a logic "1", and VO \leq 0.5V is recognized as a logic "0".

TABLE 5. BURN-IN AND OPERATING LIFE TEST, DELTA PARAMETERS (+25 $^{\circ}$ C)

| PARAMETER | GROUP B SUBGROUP | DELTA LIMIT |
|-----------|---------------------|----------------|
| ICC | 5 | 3 μ A |
| IOL/IOH | 5 | -15% of 0 Hour |

TABLE 6. APPLICABLE SUBGROUPS

| CONFORMANCE GROUPS | | METHOD | GROUP A SUBGROUPS | READ AND RECORD |
|--------------------------------|--------------|-------------|---------------------------------------|------------------------------|
| Initial Test (Preburn-In) | | 100%/5004 | 1, 7, 9 | ICC, IOL/H |
| Interim Test I (Postburn-In) | | 100%/5004 | 1, 7, 9 | ICC, IOL/H |
| Interim Test II (Postburn-In) | | 100%/5004 | 1, 7, 9 | ICC, IOL/H |
| PDA | | 100%/5004 | 1, 7, 9, Deltas | |
| Interim Test III (Postburn-In) | | 100%/5004 | 1, 7, 9 | ICC, IOL/H |
| PDA | | 100%/5004 | 1, 7, 9, Deltas | |
| Final Test | | 100%/5004 | 2, 3, 8A, 8B, 10, 11 | |
| Group A (Note 1) | | Sample/5005 | 1, 2, 3, 7, 8A, 8B, 9, 10, 11 | |
| Group B | Subgroup B-5 | Sample/5005 | 1, 2, 3, 7, 8A, 8B, 9, 10, 11, Deltas | Subgroups 1, 2, 3, 9, 10, 11 |
| | Subgroup B-6 | Sample/5005 | 1, 7, 9 | |
| Group D | | Sample/5005 | 1, 2, 3, 7, 8A, 8B, 9, 10, 11 | |

NOTE:

1. Alternate group A inspection in accordance with method 5005 of MIL-STD-883 may be exercised.

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TABLE 7. TOTAL DOSE IRRADIATION

| CONFORMANCE GROUPS | METHOD | TEST | | READ AND RECORD | |
|--------------------|--------|---------|----------|-----------------|------------------|
| | | PRE RAD | POST RAD | PRE RAD | POST RAD |
| Group E Subgroup 2 | 5005 | 1, 7, 9 | Table 4 | 1, 9 | Table 4 (Note 1) |

NOTE:

1. Except FN test which will be performed 100% Go/No-Go.

TABLE 8. STATIC AND DYNAMIC BURN-IN TEST CONNECTIONS

| OPEN | GROUND | 1/2 VCC = 3V ± 0.5V | VCC = 6V ± 0.5V | OSCILLATOR | |
|---|-----------------------|---------------------|------------------------|--------------------|-------|
| | | | | 50kHz | 25kHz |
| STATIC BURN-IN I TEST CONNECTIONS | | | | | |
| 2, 4, 6, 8, 10, 12 | 1, 3, 5, 7, 9, 11, 13 | - | 14 | - | - |
| STATIC BURN-IN II TEST CONNECTIONS | | | | | |
| 2, 4, 6, 8, 10, 12 | 7 | - | 1, 3, 5, 9, 11, 13, 14 | - | - |
| DYNAMIC BURN-IN TEST CONNECTIONS | | | | | |
| - | 7 | 2, 4, 6, 8, 10, 12 | 14 | 1, 3, 5, 9, 11, 13 | - |

NOTES:

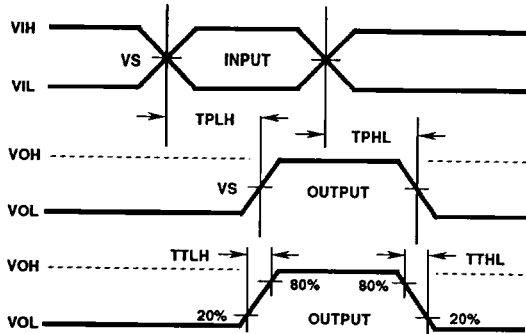
1. Each pin except VCC and GND will have a resistor of 10kΩ ± 5% for static burn-in
2. Each pin except VCC and GND will have a resistor of 1kΩ ± 5% for dynamic burn-in

TABLE 9. IRRADIATION TEST CONNECTIONS

| OPEN | GROUND | VCC = 5V ± 0.5V |
|--------------------|--------|------------------------|
| 2, 4, 6, 8, 10, 12 | 7 | 1, 3, 5, 9, 11, 13, 14 |

NOTE: Each pin except VCC and GND will have a resistor of 47KΩ ± 5% for irradiation testing. Group E, Subgroup 2, sample size is 4 dice/water 0 failures.

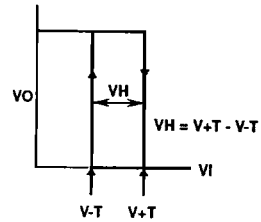
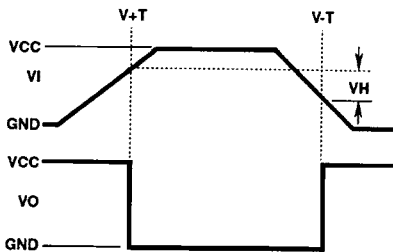
AC Timing Diagrams



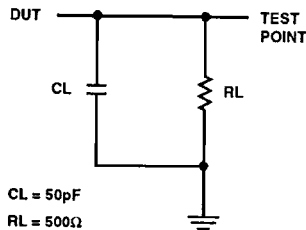
AC VOLTAGE LEVELS

| PARAMETER | HCTS | UNITS |
|-----------|------|-------|
| VCC | 4.50 | V |
| VIH | 3.0 | V |
| VS | 1.3 | V |
| VIL | 0 | V |
| GND | 0 | V |

Hysteresis Definition, Characteristic, and Test Setup



AC Load Circuit



HCTS14MS

Die Characteristics

DIE DIMENSIONS:

87 x 88 mils
2.20 x 2.24mm

METALLIZATION:

Type: SiAl
Metal Thickness: $11k\text{\AA} \pm 1k\text{\AA}$

GLASSIVATION:

Type: SiO_2
Thickness: $13k\text{\AA} \pm -2.6k\text{\AA}$

DIE ATTACH:

Material: Silver Epoxy

WORST CASE CURRENT DENSITY:

$<2.0 \times 10^5 \text{A/cm}^2$

BOND PAD SIZE:

$100\mu\text{m} \times 100\mu\text{m}$
4 x 4 mils

Metallization Mask Layout

