

Radiation Hardened Inverting 3-to-8 Line Decoder/Demultiplexer

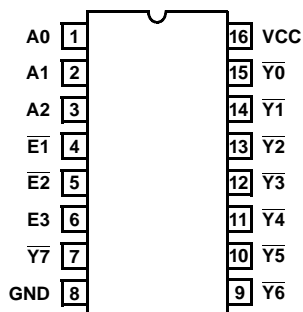
The Intersil HCTS138MS is a Radiation Hardened 3-to-8 line Decoder/Demultiplexer. The outputs are active in the low state. Two active low and one active high enables ($\overline{E1}$, $\overline{E2}$, $E3$) are provided. If the device is enabled, the binary inputs ($A0$, $A1$, $A2$) determine which one of the eight normally high outputs will go to a low logic level.

The HCTS138MS utilizes advanced CMOS/SOS technology to achieve high-speed operation. This device is a member of radiation hardened, high-speed, CMOS/SOS Logic Family.

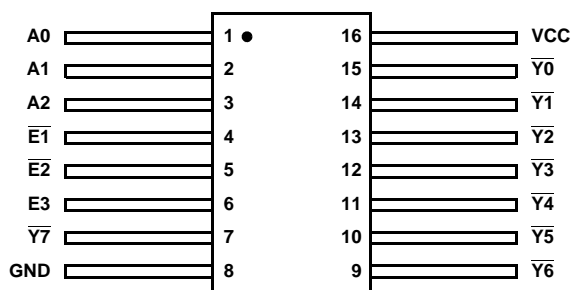
The HCTS138MS is supplied in a 16 lead Ceramic flatpack (K suffix) or a SBDIP Package (D suffix).

Pinouts

**16 LEAD CERAMIC DUAL-IN-LINE
METAL SEAL PACKAGE (SBDIP)
MIL-STD-1835 CDIP2-T16
TOP VIEW**



**16 LEAD CERAMIC METAL SEAL
FLATPACK PACKAGE (FLATPACK)
MIL-STD-1835 CDFP4-F16
TOP VIEW**



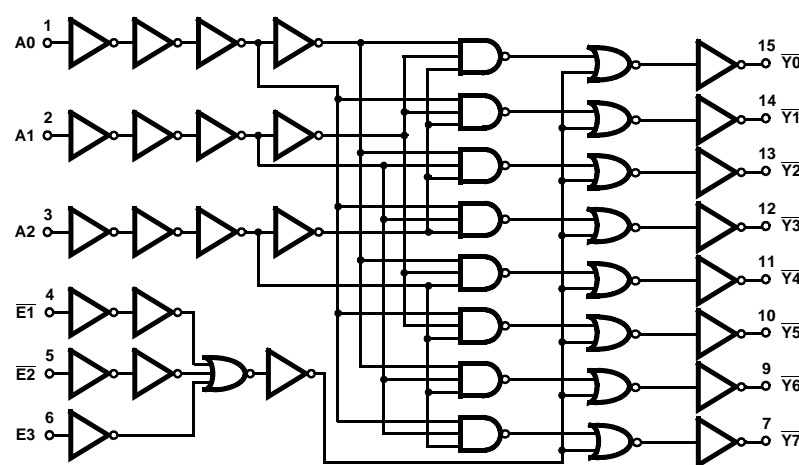
Features

- 3 Micron Radiation Hardened SOS CMOS
- Total Dose 200K RAD (Si)
- SEP Effective LET No Upsets: >100 MEV-cm²/mg
- Single Event Upset (SEU) Immunity < 2 x 10⁻⁹ Errors/Bit-Day (Typ)
- Latch-Up Free Under Any Conditions
- Fanout (Over Temperature Range)
 - Bus Driver Outputs - 15 LSTTL Loads
- Military Temperature Range: -55°C to +125°C
- Significant Power Reduction Compared to LSTTL ICs
- DC Operating Voltage Range: 4.5V to 5.5V
- LSTTL Input Compatibility
 - VIL = 0.8V Max
 - VIH = VCC/2 Min
- Input Current Levels $I_i \leq 5\mu A$ at VOL, VOH

Ordering Information

| PART NUMBER | TEMP RANGE | SCREENING LEVEL | PACKAGE |
|-------------|-----------------|-----------------------------|--------------------------|
| HCTS138DMSR | -55°C to +125°C | Intersil Class S Equivalent | 16 Lead SBDIP |
| HCTS138KMSR | -55°C to +125°C | Intersil Class S Equivalent | 16 Lead Ceramic Flatpack |
| HCTS138HMSR | +25°C | Die | Die |

Functional Diagram



TRUTH TABLE

| INPUTS | | | | | | OUTPUTS | | | | | | | |
|--------|-----------------|-----------------|----|----|----|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| ENABLE | | | | | | | | | | | | | |
| E3 | $\overline{E2}$ | $\overline{E1}$ | A2 | A1 | A0 | $\overline{Y0}$ | $\overline{Y1}$ | $\overline{Y2}$ | $\overline{Y3}$ | $\overline{Y4}$ | $\overline{Y5}$ | $\overline{Y6}$ | $\overline{Y7}$ |
| X | X | H | X | X | X | H | H | H | H | H | H | H | H |
| L | X | X | X | X | X | H | H | H | H | H | H | H | H |
| X | H | X | X | X | X | H | H | H | H | H | H | H | H |
| H | L | L | L | L | L | L | H | H | H | H | H | H | H |
| H | L | L | L | L | H | H | L | H | H | H | H | H | H |
| H | L | L | L | H | L | H | H | L | H | H | H | H | H |
| H | L | L | L | H | H | H | H | H | L | H | H | H | H |
| H | L | L | H | L | L | H | H | H | H | L | H | H | H |
| H | L | L | H | L | H | H | H | H | H | H | L | H | H |
| H | L | L | H | H | L | H | H | H | H | H | H | L | H |
| H | L | L | H | H | H | H | H | H | H | H | H | H | L |

H = High Level, L = Low Level, X = Don't Care

Specifications HCTS138MS

Absolute Maximum Ratings

Supply Voltage (VCC) -0.5V to +7.0V
 Input Voltage Range, All Inputs -0.5V to VCC +0.5V
 DC Input Current, Any One Input $\pm 10\text{mA}$
 DC Drain Current, Any One Output $\pm 25\text{mA}$
 (All Voltage Reference to the VSS Terminal)
 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 Resistance θ_{JA} θ_{JC}
 SBDIP Package 73°C/W 24°C/W
 Ceramic Flatpack Package 114°C/W 29°C/W
 Maximum Package Power Dissipation at +125°C Ambient
 SBDIP Package 0.68W
 Ceramic Flatpack Package 0.44W
 If device power exceeds package dissipation capability, provide heat sinking or derate linearly at the following rate:
 SBDIP Package 13.7mW/°C
 Ceramic Flatpack Package 8.8mW/°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 +4.5V to +5.5V
 Input Rise and Fall Times at VCC = 4.5V (TR, TF) 500ns Max
 Operating Temperature Range (TA) -55°C to +125°C

Input Low Voltage (VIL) 0.0V to 0.8V
 Input High Voltage (VIH) VCC/2 to VCC

TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS

| PARAMETER | SYMBOL | (NOTE 1) CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS | | UNITS |
|--------------------------------|--------|--|----------------------|----------------------|----------|-----------|---------------|
| | | | | | MIN | MAX | |
| Quiescent Current | ICC | VCC = 5.5V, VIN = VCC or GND | 1 | +25°C | - | 40 | μA |
| | | | 2, 3 | +125°C, -55°C | - | 750 | μA |
| Output Current (Sink) | IOL | VCC = 4.5V, VIH = 4.5V, VOUT = 0.4V, VIL = 0V | 1 | +25°C | 7.2 | - | mA |
| | | | 2, 3 | +125°C, -55°C | 6.0 | - | mA |
| Output Current (Source) | IOH | VCC = 4.5V, VIH = 4.5V, VOUT = VCC -0.4V, VIL = 0V | 1 | +25°C | -7.2 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -6.0 | - | mA |
| Output Voltage Low | VOL | VCC = 4.5V, VIH = 2.25V, IOL = 50 μA , VIL = 0.8V | 1, 2, 3 | +25°C, +125°C, -55°C | - | 0.1 | V |
| | | VCC = 5.5V, VIH = 2.75V, IOL = 50 μA , 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 = -50 μA , VIL = 0.8V | 1, 2, 3 | +25°C, +125°C, -55°C | VCC -0.1 | - | V |
| | | VCC = 5.5V, VIH = 2.75V, IOH = -50 μA , 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 | μA |
| | | | 2, 3 | +125°C, -55°C | - | ± 5.0 | μA |
| Noise Immunity Functional Test | FN | VCC = 4.5V, VIH = 2.25V, VIL = 0.8V, (Note 2) | 7, 8A, 8B | +25°C, +125°C, -55°C | - | - | - |

NOTES:

1. All voltages reference to device GND.
2. For functional tests $VO \geq 4.0\text{V}$ is recognized as a logic "1", and $VO \leq 0.5\text{V}$ is recognized as a logic "0".

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TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS

| PARAMETER | SYMBOL | (NOTES 1, 2) CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS | | UNITS |
|-------------------|--------|----------------------------|----------------------|---------------|--------|-----|-------|
| | | | | | MIN | MAX | |
| Address to Output | TPLH | VCC = 4.5V | 9 | +25°C | 2 | 25 | ns |
| | | | 10, 11 | +125°C, -55°C | 2 | 30 | ns |
| | TPHL | VCC = 4.5V | 9 | +25°C | 2 | 28 | ns |
| | | | 10, 11 | +125°C, -55°C | 2 | 39 | ns |
| Enable to Output | TPLH | VCC = 4.5V | 9 | +25°C | 2 | 26 | ns |
| | | | 10, 11 | +125°C, -55°C | 2 | 31 | ns |
| | TPHL | VCC = 4.5V | 9 | +25°C | 2 | 26 | ns |
| | | | 10, 11 | +125°C, -55°C | 2 | 34 | ns |

NOTES:

1. All voltages referenced to device GND.
2. AC measurements assume $R_L = 500\Omega$, $C_L = 50\text{pF}$, Input $T_R = T_F = 3\text{ns}$, $V_{IL} = \text{GND}$, $V_{IH} = 3\text{V}$.

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS

| PARAMETER | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS | | UNITS |
|-------------------------------|--------------|-------------------------------|-------|---------------|--------|-----|-------|
| | | | | | MIN | MAX | |
| Capacitance Power Dissipation | CPD | VCC = 5.0V, $f = 1\text{MHz}$ | 1 | +25°C | - | 89 | pF |
| | | | 1 | +125°C, -55°C | - | 102 | pF |
| Input Capacitance | CIN | VCC = 5.0V, $f = 1\text{MHz}$ | 1 | +25°C | - | 10 | pF |
| | | | 1 | +125°C, -55°C | - | 10 | pF |
| Output Transition Time | TTHL TTLH | VCC = 4.5V | 1 | +25°C | - | 15 | ns |
| | | | 1 | +125°C, -55°C | - | 22 | ns |

NOTE:

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

| PARAMETER | SYMBOL | (NOTES 1, 2) CONDITIONS | TEMPERATURE | 200K RAD LIMITS | | UNITS |
|-------------------------|--------|--|-------------|--------------------|------|-------|
| | | | | MIN | MAX | |
| Quiescent Current | ICC | VCC = 5.5V, VIN = VCC or GND | +25°C | - | 0.75 | mA |
| Output Current (Sink) | IOL | VCC = 4.5V, VIN = VCC or GND, VOUT = 0.4V | +25°C | 6.0 | - | mA |
| Output Current (Source) | IOH | VCC = 4.5V, VIN = VCC or GND, VOUT = VCC - 0.4V | +25°C | -6.0 | - | mA |

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

| PARAMETER | SYMBOL | (NOTES 1, 2) CONDITIONS | TEMPERATURE | 200K RAD LIMITS | | UNITS |
|-----------------------------------|--------|--|-------------|--------------------|-----|-------|
| | | | | MIN | MAX | |
| Output Voltage Low | VOL | VCC = 4.5V and 5.5V, VIH = VCC/2, VIL = 0.8V at 200K RAD, IOL = 50μA | +25°C | - | 0.1 | V |
| Output Voltage High | VOH | VCC = 4.5V and 5.5V, VIH = VCC/2, VIL = 0.8V at 200K RAD, IOH = -50μA | +25°C | VCC -0.1 | - | V |
| Input Leakage Current | IIN | VCC = 5.5V, VIN = VCC or GND | +25°C | - | ±5 | μA |
| Noise Immunity Functional Test | FN | VCC = 4.5V, VIH = 2.25V, VIL = 0.8V, (Note 3) | +25°C | - | - | - |
| Address to Output | TPLH | VCC = 4.5V | +25°C | 2 | 30 | ns |
| | TPHL | VCC = 4.5V | +25°C | 2 | 39 | ns |
| Enable to Output | TPLH | VCC = 4.5V | +25°C | 2 | 31 | ns |
| | TPHL | VCC = 4.5V | +25°C | 2 | 34 | ns |

NOTES:

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

TABLE 5. BURN-IN AND OPERATING LIFE TEST, DELTA PARAMETERS (+25°C)

| PARAMETER | GROUP B SUBGROUP | DELTA LIMIT |
|-----------|---------------------|----------------|
| ICC | 5 | 12μA |
| 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, 7, 9 | |

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 (Note 1) | | | | | |
| 7, 9 - 15 | 1 - 6, 8 | | 16 | | |
| STATIC BURN-IN II TEST CONNECTIONS (Note 1) | | | | | |
| 7, 9 - 15 | 8 | - | 1 - 6, 16 | - | - |
| DYNAMIC BURN-IN TEST CONNECTIONS (Note 2) | | | | | |
| - | 4, 5, 8 | 7, 9 - 15 | 3, 6, 16 | 2 | 1 |

NOTES:

1. Each pin except VCC and GND will have a resistor of $10K\Omega \pm 5\%$ for static burn-in
2. Each pin except VCC and GND will have a resistor of $680\Omega \pm 5\%$ for dynamic burn-in

TABLE 9. IRRADIATION TEST CONNECTIONS

| OPEN | GROUND | VCC = 5V ± 0.5V |
|-----------|--------|-----------------|
| 7, 9 - 15 | 8 | 1 - 6, 16 |

NOTE: Each pin except VCC and GND will have a resistor of $47K\Omega \pm 5\%$ for irradiation testing.
Group E, Subgroup 2, sample size is 4 dice/wafer 0 failures.

Intersil Space Level Product Flow - 'MS'

Wafer Lot Acceptance (All Lots) Method 5007
(Includes SEM)

GAMMA Radiation Verification (Each Wafer) Method 1019,
4 Samples/Wafer, 0 Rejects

100% Nondestructive Bond Pull, Method 2023

Sample - Wire Bond Pull Monitor, Method 2011

Sample - Die Shear Monitor, Method 2019 or 2027

100% Internal Visual Inspection, Method 2010, Condition A

100% Temperature Cycle, Method 1010, Condition C,
10 Cycles

100% Constant Acceleration, Method 2001, Condition per
Method 5004

100% PIND, Method 2020, Condition A

100% External Visual

100% Serialization

100% Initial Electrical Test (T0)

100% Static Burn-In 1, Condition A or B, 24 hrs. min.,
+125°C min., Method 1015

100% Interim Electrical Test 1 (T1)

100% Delta Calculation (T0-T1)

100% Static Burn-In 2, Condition A or B, 24 hrs. min.,
+125°C min., Method 1015

100% Interim Electrical Test 2 (T2)

100% Delta Calculation (T0-T2)

100% PDA 1, Method 5004 (Notes 1 and 2)

100% Dynamic Burn-In, Condition D, 240 hrs., +125°C or
Equivalent, Method 1015

100% Interim Electrical Test 3 (T3)

100% Delta Calculation (T0-T3)

100% PDA 2, Method 5004 (Note 2)

100% Final Electrical Test

100% Fine/Gross Leak, Method 1014

100% Radiographic, Method 2012 (Note 3)

100% External Visual, Method 2009

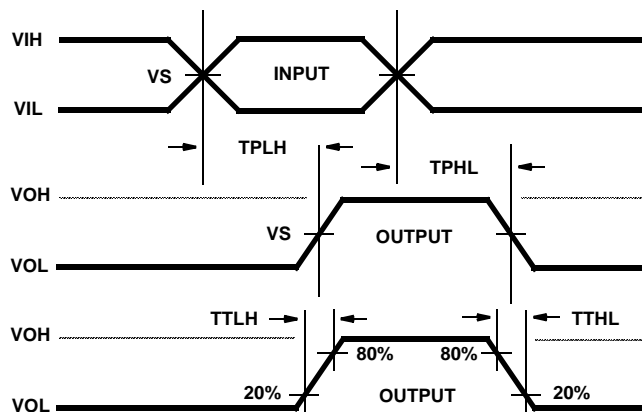
Sample - Group A, Method 5005 (Note 4)

100% Data Package Generation (Note 5)

NOTES:

1. Failures from Interim electrical test 1 and 2 are combined for determining PDA 1.
2. Failures from subgroup 1, 7, 9 and deltas are used for calculating PDA. The maximum allowable PDA = 5% with no more than 3% of the failures from subgroup 7.
3. Radiographic (X-Ray) inspection may be performed at any point after serialization as allowed by Method 5004.
4. Alternate Group A testing may be performed as allowed by MIL-STD-883, Method 5005.
5. Data Package Contents:
 - Cover Sheet (Intersil Name and/or Logo, P.O. Number, Customer Part Number, Lot Date Code, Intersil Part Number, Lot Number, Quantity).
 - Wafer Lot Acceptance Report (Method 5007). Includes reproductions of SEM photos with percent of step coverage.
 - GAMMA Radiation Report. Contains Cover page, disposition, Rad Dose, Lot Number, Test Package used, Specification Numbers, Test equipment, etc. Radiation Read and Record data on file at Intersil.
 - X-Ray report and film. Includes penetrometer measurements.
 - Screening, Electrical, and Group A attributes (Screening attributes begin after package seal).
 - Lot Serial Number Sheet (Good units serial number and lot number).
 - Variables Data (All Delta operations). Data is identified by serial number. Data header includes lot number and date of test.
 - The Certificate of Conformance is a part of the shipping invoice and is not part of the Data Book. The Certificate of Conformance is signed by an authorized Quality Representative.

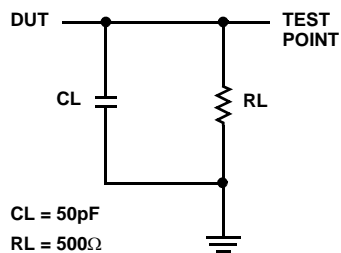
AC Timing Diagrams



AC VOLTAGE LEVELS

| PARAMETER | HCTS | UNITS |
|-----------|------|-------|
| VCC | 4.50 | V |
| VIH | 3.00 | V |
| VS | 1.30 | V |
| VIL | 0 | V |
| GND | 0 | V |

AC Load Circuit



Die Characteristics

DIE DIMENSIONS:

85 x 101 mils

METALLIZATION:

Type: SiAl

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

GLASSIVATION:

Type: SiO_2

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

WORST CASE CURRENT DENSITY:

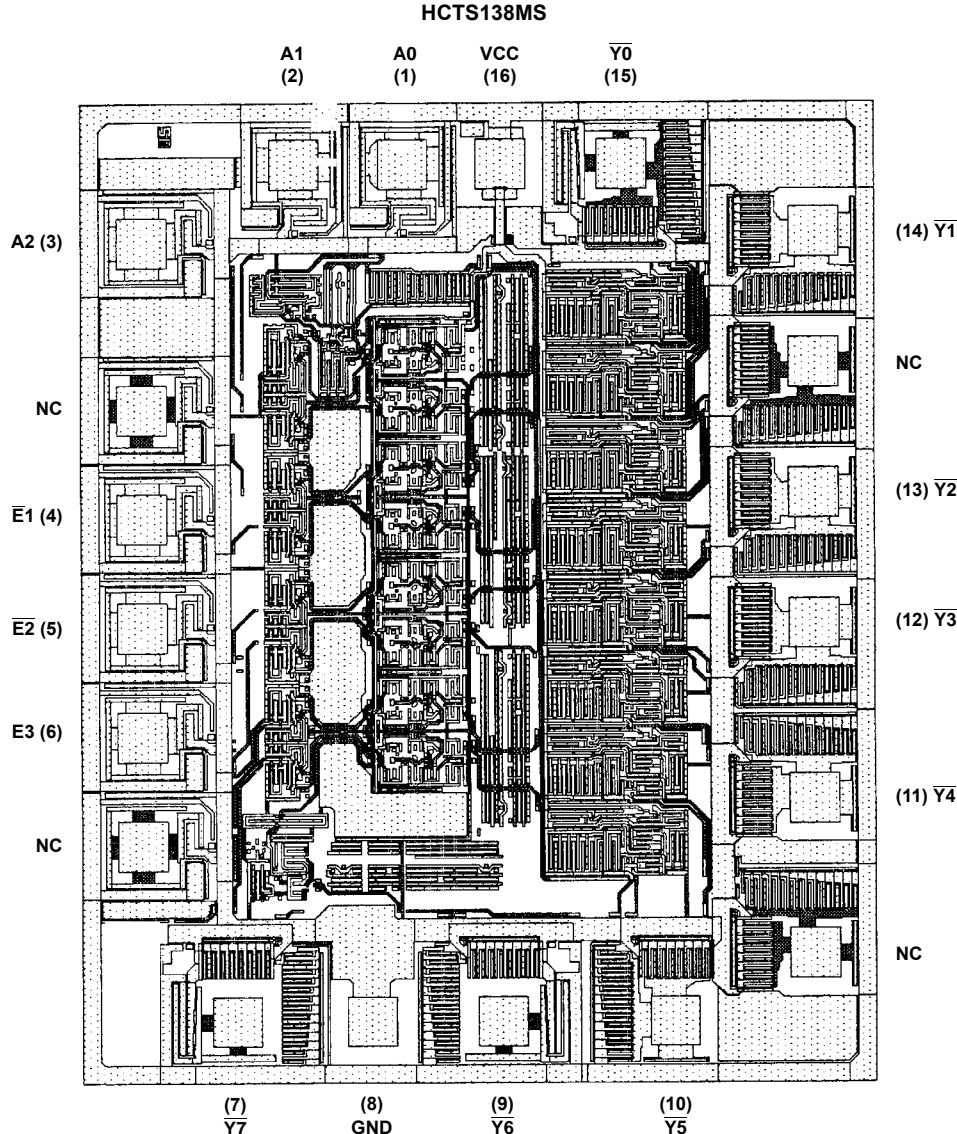
$<2.0 \times 10^5 \text{A/cm}^2$

BOND PAD SIZE:

$100\mu\text{m} \times 100\mu\text{m}$

4 x 4 mils

Metallization Mask Layout



NOTE: The die diagram is a generic plot from a similar HCS device. It is intended to indicate approximate die size and bond pad location. The mask series for the HCTS138 is TA14461A.

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