

## Radiation Hardened Dual 4-Input NAND Gate

September 1995

### Features

- 3 Micron Radiation Hardened SOS CMOS
- Total Dose 200K RAD (Si)
- SEP Effective LET No Upsets:  $>100 \text{ MEV-cm}^2/\text{mg}$
- Single Event Upset (SEU) Immunity  $< 2 \times 10^{-9} \text{ Errors/Bit-Day (Typ)}$
- Dose Rate Survivability:  $>1 \times 10^{12} \text{ RAD (Si)/s}$
- Dose Rate Upset  $>10^{10} \text{ RAD (Si)/s}$  20ns Pulse
- Latch-Up Free Under Any Conditions
- Military Temperature Range:  $-55^\circ\text{C}$  to  $+125^\circ\text{C}$
- Significant Power Reduction Compared to LSTTL ICs
- DC Operating Voltage Range: 4.5V to 5.5V
- LSTTL Input Compatibility
  - $V_{IL} = 0.8V \text{ Max}$
  - $V_{IH} = V_{CC}/2 \text{ Min}$
- Input Current Levels  $I_i \leq 5\mu\text{A}$  at  $V_{OL}$ ,  $V_{OH}$

### Description

The Intersil HCTS20MS is a Radiation Hardened Dual 4-Input NAND Gate. A low on any input forces the output to a High state.

The HCTS20MS 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 HCTS20MS is supplied in a 14 lead Ceramic flatpack (K suffix) or a SBDIP Package (D suffix).

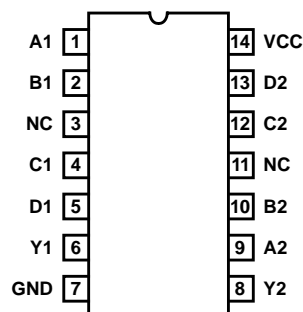
### Ordering Information

PART NUMBER	TEMPERATURE RANGE	SCREENING LEVEL	PACKAGE
HCTS20DMSR	$-55^\circ\text{C}$ to $+125^\circ\text{C}$	Intersil Class S Equivalent	14 Lead SBDIP
HCTS20KMSR	$-55^\circ\text{C}$ to $+125^\circ\text{C}$	Intersil Class S Equivalent	14 Lead Ceramic Flatpack
HCTS20D/ Sample	$+25^\circ\text{C}$	Sample	14 Lead SBDIP
HCTS20K/ Sample	$+25^\circ\text{C}$	Sample	14 Lead Ceramic Flatpack
HCTS20HMSR	$+25^\circ\text{C}$	Die	Die

### Pinouts

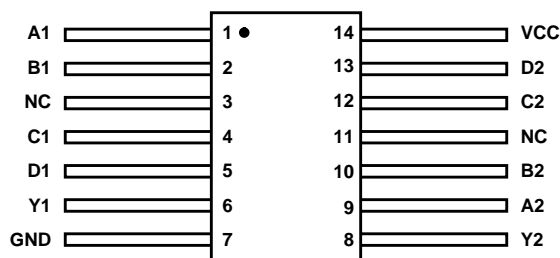
14 LEAD CERAMIC DUAL-IN-LINE METAL SEAL  
PACKAGE (SBDIP) MIL-STD-183S CDIP2-T14

TOP VIEW

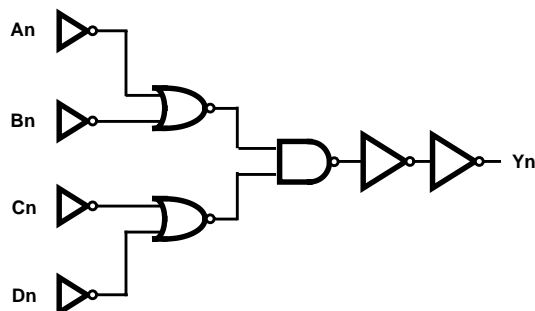


14 LEAD CERAMIC METAL SEAL FLATPACK PACKAGE  
(FLATPACK) MIL-STD-183S CDFP3-F14

TOP VIEW



### Functional Diagram



TRUTH TABLE

INPUTS				OUTPUTS
An	Bn	Cn	Dn	Yn
L	X	X	X	H
X	L	X	X	H
X	X	L	X	H
X	X	X	L	H
H	H	H	H	L

NOTE: L = Logic Level Low, H = Logic level High, X = Don't Care

# Specifications HCTS20MS

## 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 . . . . . ±10mA  
 DC Drain Current, Any One Output . . . . . ±25mA  
 (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  $\theta_{JA}$   $\theta_{JC}$   
 SBDIP Package . . . . . 74°C/W 24°C/W  
 Ceramic Flatpack Package . . . . . 116°C/W 30°C/W  
 Maximum Package Power Dissipation at +125°C Ambient  
 SBDIP Package . . . . . 0.68W  
 Ceramic Flatpack Package . . . . . 0.43W  
 If device power exceeds package dissipation capability, provide heat sinking or derate linearly at the following rate:  
 SBDIP Package . . . . . 13.5mW/°C  
 Ceramic Flatpack Package . . . . . 8.6mW/°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 Rise and Fall Times at 4.5V VCC (TR, TF) . . . . . 100ns/V 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 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	µA
			2, 3	+125°C, -55°C	-	±5.0	µA
Noise Immunity Functional Test	FN	VCC = 4.5V, VIH = 2.25V, VIL = 0.80V (Note 2)	7, 8A, 8B	+25°C, +125°C, -55°C	-	-	-

### NOTES:

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

## Specifications HCTS20MS

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

PARAMETER	SYMBOL	(NOTES 1, 2) CONDITIONS	GROUP A SUB- GROUPS	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Input to Output	TPHL	VCC = 4.5V	9	+25°C	2	18	ns
			10, 11	+125°C, -55°C	2	20	ns
	TPLH	VCC = 4.5V	9	+25°C	2	20	ns
			10, 11	+125°C, -55°C	2	22	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	-	60	pF
			1	+125°C, -55°C	-	120	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, $V_{IN} = \text{VCC or GND}$	+25°C	-	0.2	mA
Output Current (Sink)	IOL	VCC = 4.5V, $V_{IN} = \text{VCC or GND}$ , $V_{OUT} = 0.4\text{V}$	+25°C	4.0	-	mA
Output Current (Source)	IOH	VCC = 4.5V, $V_{IN} = \text{VCC or GND}$ , $V_{OUT} = \text{VCC} - 0.4\text{V}$	+25°C	-4.0	-	mA
Output Voltage Low	VOL	VCC = 4.5V and 5.5V, $V_{IH} = \text{VCC}/2\text{V}$ , $V_{IL} = 0.80\text{V RAD}$ , $I_{OL} = 50\mu\text{A}$	+25°C	-	0.1	V
Output Voltage High	VOH	VCC = 4.5V and 5.5V, $V_{IH} = \text{VCC}/2\text{V}$ , $V_{IL} = 0.8\text{V}$ , $I_{OH} = -50\mu\text{A}$	+25°C	VCC -0.1	-	V
Input Leakage Current	IIN	VCC = 5.5V, $V_{IN} = \text{VCC or GND}$	+25°C	-	$\pm 5$	$\mu\text{A}$
Noise Immunity Functional Test	FN	VCC = 4.5V, $V_{IH} = 2.25\text{V}$ , $V_{IL} = 0.8\text{V}$ , (Note 3)	+25°C	-	-	V
Input to Output	TPHL	VCC = 4.5V	+25°C	2	20	ns
	TPLH	VCC = 4.5V	+25°C	2	22	ns

**NOTES:**

1. All voltages referenced to device GND.
2. AC measurements assume  $R_L = 500\Omega$ ,  $C_L = 50\text{pF}$ , Input  $t_r = t_f = 3\text{ns}$ ,  $V_{IL} = \text{GND}$ ,  $V_{IH} = 3\text{V}$ .
3. For functional tests  $V_O \geq 4.0\text{V}$  is recognized as a logic "1", and  $V_O \leq 0.5\text{V}$  is recognized as a logic "0".

## Specifications HCTS20MS

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

PARAMETER	GROUP B SUBGROUP	DELTA LIMIT
ICC	5	3μA
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.

**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.

## Specifications HCTS20MS

**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)					
3, 6, 8, 11	1, 2, 4, 5, 7, 9, 10, 12, 13	-	14	-	-
STATIC BURN-IN II TEST CONNECTIONS (Note 1)					
3, 6, 8, 11	7	-	1, 2, 4, 5, 9, 10, 12, 13, 14	-	-
DYNAMIC BURN-IN TEST CONNECTIONS (Note 2)					
-	7	3, 6, 8, 11	14	1, 2, 4, 5, 9, 10, 12, 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
3, 6, 8, 11	7	1, 2, 4, 5, 9, 10, 12, 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/wafer 0 failures.

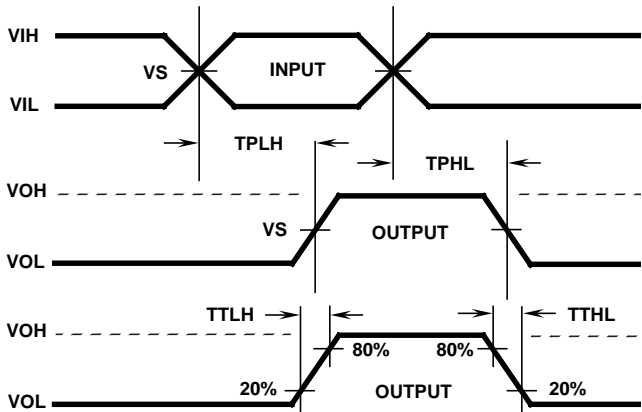
**Intersil Space Level Product Flow - 'MS'**

Wafer Lot Acceptance (All Lots) Method 5007 (Includes SEM)	100% Interim Electrical Test 1 (T1)
GAMMA Radiation Verification (Each Wafer) Method 1019, 4 Samples/Wafer, 0 Rejects	100% Delta Calculation (T0-T1)
100% Nondestructive Bond Pull, Method 2023	100% Static Burn-In 2, Condition A or B, 24 hrs. min., +125°C min., Method 1015
Sample - Wire Bond Pull Monitor, Method 2011	100% Interim Electrical Test 2 (T2)
Sample - Die Shear Monitor, Method 2019 or 2027	100% Delta Calculation (T0-T2)
100% Internal Visual Inspection, Method 2010, Condition A	100% PDA 1, Method 5004 (Notes 1 and 2)
100% Temperature Cycle, Method 1010, Condition C, 10 Cycles	100% Dynamic Burn-In, Condition D, 240 hrs., +125°C or Equivalent, Method 1015
100% Constant Acceleration, Method 2001, Condition per Method 5004	100% Interim Electrical Test 3 (T3)
100% PIND, Method 2020, Condition A	100% Delta Calculation (T0-T3)
100% External Visual	100% PDA 2, Method 5004 (Note 2)
100% Serialization	100% Final Electrical Test
100% Initial Electrical Test (T0)	100% Fine/Gross Leak, Method 1014
100% Static Burn-In 1, Condition A or B, 24 hrs. min., +125°C min., Method 1015	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:**

- Failures from Interim electrical test 1 and 2 are combined for determining PDA 1.
- 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.
- Radiographic (X-Ray) inspection may be performed at any point after serialization as allowed by Method 5004.
- Alternate Group A testing may be performed as allowed by MIL-STD-883, Method 5005.
- 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.

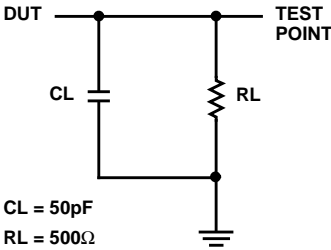
AC Timing Diagrams



AC VOLTAGE LEVELS

PARAMETER	HCTS	UNITS
VCC	4.50	V
$V_{IH}$	3.00	V
$V_S$	1.30	V
$V_{IL}$	0	V
GND	0	V

AC Load Circuit



## HCTS20MS

### Die Characteristics

#### DIE DIMENSIONS:

2.20 x 2.24(mm)

#### METALLIZATION:

Type: SiAl

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

#### GLASSIVATION:

Type:  $\text{SiO}_2$

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

#### WORST CASE CURRENT DENSITY:

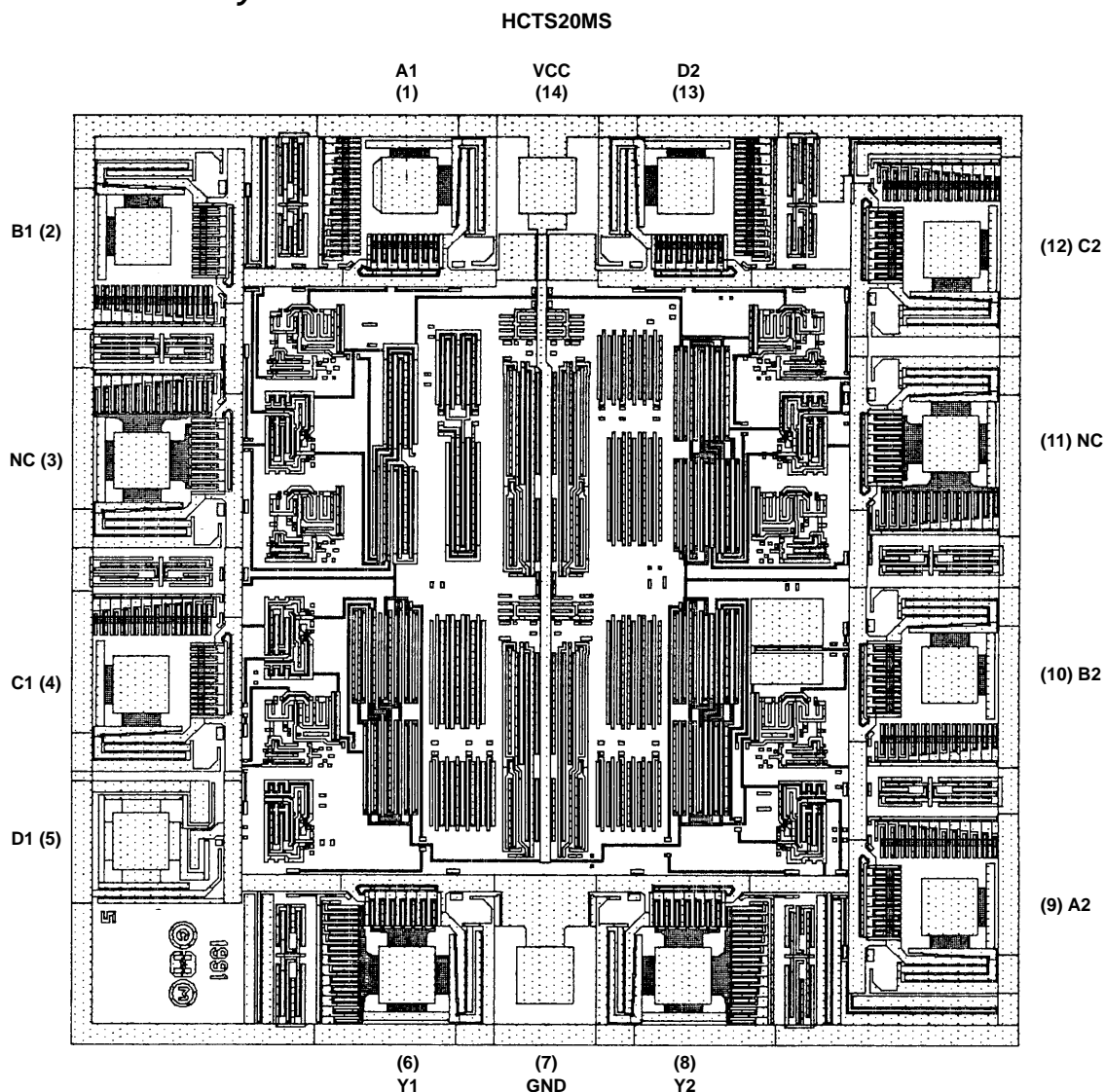
$<2.0 \times 10^5 \text{A/cm}^2$

#### BOND PAD SIZE:

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

4 mils 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 HCTS20 is TA14426A.



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## **Sales Office Headquarters**

### **NORTH AMERICA**

Intersil Corporation  
P. O. Box 883, Mail Stop 53-204  
Melbourne, FL 32902  
TEL: (407) 724-7000  
FAX: (407) 724-7240

### **EUROPE**

Intersil SA  
Mercure Center  
100, Rue de la Fusee  
1130 Brussels, Belgium  
TEL: (32) 2.724.2111  
FAX: (32) 2.724.22.05

### **ASIA**

Intersil (Taiwan) Ltd.  
Taiwan Limited  
7F-6, No. 101 Fu Hsing North Road  
Taipei, Taiwan  
Republic of China  
TEL: (886) 2 2716 9310  
FAX: (886) 2 2715 3029