

January 1994

## Binary Correlator

### Features

- This Circuit Is Processed In Accordance to MIL-STD-883 and Is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- Reconfigurable 256 Stage Binary Correlator
- 1-Bit Reference x 1, 2, 4, or 8-Bit Data
- Separate Control and Reference Interfaces
- Configurable for 1-D and 2-D Operation
- Double Buffered Mask and Reference
- Programmable Output Delay
- Cascadable
- Standard Microprocessor Interface

### Applications

- Radar/Sonar
- Spread Spectrum Communications
- Pattern/Character Recognition
- Error Correction Coding

### Ordering Information

PART NUMBER	TEMPERATURE RANGE	PACKAGE
HSP45256GM-20/883	-55°C to +125°C	85 Lead PGA
HSP45256GM-25/883	-55°C to +125°C	85 Lead PGA

### Description

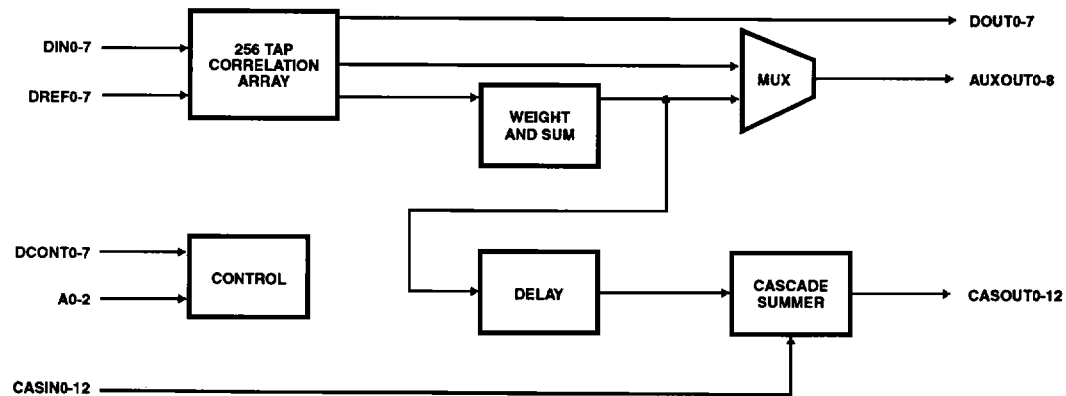
The Harris HSP45256 is a high-speed, 256 tap binary correlator. It can be configured to perform one- or two-dimensional correlations of selectable data precision and length. Multiple HSP45256's can be cascaded for increased correlation length. Unused taps can be masked out for reduced correlation length.

The correlation array consists of eight 32-tap stages. These may be cascaded internally to compare 1, 2, 4 or 8-bit input data with a 1-bit reference. Depending on the number of bits in the input data, the length of the correlation can be up to 256, 128, 64, or 32 taps. The HSP45256 can also be configured as two separate correlators with window sizes from 4 by 32 to 1 by 128 each. The mask register can be used to prevent any subset of the 256 bits from contributing to the correlation score.

The output of the correlation array (correlation score) feeds the weight and sum logic, which gives added flexibility to the data format. In addition, an offset register is provided so that a preprogrammed value can be added to the correlation score. This result is then passed through a user programmable delay stage to the cascade summer. The delay stage simplifies the cascading of multiple correlators by compensating for the latency of previous correlators.

The Binary Correlator is configured by writing a set of control registers via a standard microprocessor interface. To simplify operation, both the control and reference registers are double buffered. This allows the user to load new mask and reference data while the current correlation is in progress.

### Block Diagram



CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.  
Copyright © Harris Corporation 1994



**Pin Description**

SYMBOL	PIN NUMBER	TYPE	DESCRIPTION
V <sub>CC</sub>	D2, G9, K2		The +5V power supply pin
GND	A10, B1, D10, J10, L2		Ground.
DIN0-7	D1, E1-E3, F2, F3, G1, G3	I	The DIN0-7 bus consists of eight single data input pins. The assignment of the active pins is determined by the configuration. Data is loaded synchronous to the rising edge of CLK. DIN0 is the LSB.
DOUT0-7	E9-E11, F9-F11, G10, G11	O	The DOUT0-7 bus is the data output of the correlation array. The format of the output is dependent on the window configuration and bit weighting. DOUT0 is the LSB.
CLK	C1	I	System clock. Positive edge triggered.
CASIN0-12	A1-A6, B2-B5, C2, C5, C6	I	CASIN0-12 allows multiple correlators to be cascaded by connecting CASOUT0-12 of one correlator to CASIN0-12 of another. The CASIN bus is added internally to the correlation score to form CASOUT. CASIN0 is the LSB.
CASOUT0-12	A7-A9, A11, B6-B11, C10, C11, D11	O	CASOUT0-12 is the output correlation score. This value is the delayed sum of all the 256 taps of one chip and CASIN0-12. When the part is configured to act as two independent correlators, CASOUT0-8 represents the correlation score for the first correlator while the second correlation score is available on the AUXOUT0-8 bus. In this configuration, the cascading feature is no longer an option. CASOUT0 is the LSB.
OEC#	C7	I	OEC# is the output enable for CASOUT0-12. When OEC# is high, the output is three-stated. Processing is not interrupted by this pin. (Active low.)
TXFR#	L3	I	TXFR# is a synchronous clock enable signal that allows the loading of the reference and mask inputs from the preload register to the correlation array. Data is transferred on the rising edge of CLK while TXFR# is low. (Active low.)
DREF0-7	F1, G2, H1, H2, J1, J2, K1, L1	I	DREF0-7 is an 8-bit wide data reference input. This is the input data bus used to load the reference data. RLOAD# going active initiates the loading of the reference registers. This input bus is used to load the reference registers of the correlation array. The manner in which the reference data is loaded is determined by the window configuration. If the window configuration is 1 x 256, the reference bits are loaded one at a time over DREF7. When the HSP45256 is configured as an 8 x 32 array, the data is loaded into all stages in parallel. In this case, DREF7 is the reference data for the first stage and DREF0 is the reference data for the eighth stage. The contents of the reference data registers are not affected by changing the window configuration. DREF0 is the LSB.
RLOAD#	K3	I	RLOAD# enables loading of the reference registers. Data on DREF0-7 is loaded into the preload registers on the rising edge of RLOAD#. This data is transferred into the correlation array by TXFR#. (Active low.)
DCONT0-7	J6, J7, K6, K7, L5-L8	I	DCONT0-7 is the control data input, which is used to load the mask bit for each tap as well as the configuration registers. The mask data is sequentially loaded into the eight stages in the same manner as the reference data. DCONT0 is the LSB.
CLOAD#	K4	I	CLOAD# enables the loading of the data on DCONT0-7. The destination of this data is controlled by A0-2. (Active low.)
A0-2	J5, K5, L4	I	A0-2 is a 3-bit address that determines what function will be performed when CLOAD# is active. This address bus is set up with respect to the rising edge of the load signal, CLOAD#. A0 is the LSB.
AUXOUT0-8	H10, H11, J11, K9-K11, L9-L11	O	AUXOUT0-8 is a 9-bit bus that provides either the data reference output or the 9-bit correlation score of the second correlator, depending on the configuration. When the user programs the chip to be two separate correlators, the score of the second correlator is output on this bus. When the user has programmed the chip to be one correlator, AUXOUT0-7 represents the reference data out, with the state of AUXOUT0-8 undefined. AUXOUT0 is the LSB.
OEA#	K8	I	The OEA# signal is the output enable for the AUXOUT0-8 output. When OEA# is high, the output is disabled. Processing is not interrupted by this pin. (Active low.)
Index Pin	C3		Used for orienting pin in socket or printed circuit board. Must be left as a no connect in circuit.

## Specifications HSP45256/883

### Absolute Maximum Ratings

Supply Voltage .....	+8.0V
Input, Output or I/O Voltage .....	GND-0.5V to $V_{CC}+0.5V$
Storage Temperature Range .....	-65°C to +150°C
Junction Temperature .....	+175°C
Lead Temperature (Soldering 10s) .....	+300°C
ESD Classification .....	Class 1

### Reliability Information

Thermal Resistance .....	$\theta_{JA}$	$\theta_{JC}$
Ceramic PGA Package .....	36°C/W	10°C/W
Maximum Package Power Dissipation at +125°C .....	1.39W	
Ceramic PGA Package .....	1.39W	
Gate Count .....	13,000 Gates	

**CAUTION:** Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

### Operating Conditions

Operating Voltage Range .....	+4.5V to +5.5V	Operating Temperature Range .....	-55°C to +125°C
-------------------------------	----------------	-----------------------------------	-----------------

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Guaranteed and 100% Tested

PARAMETER	SYMBOL	CONDITIONS	GROUP A SUB- GROUPS	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Logical One Input Voltage	$V_{IH}$	$V_{CC} = 5.5V$	1,2,3	$-55^{\circ} \leq T_A \leq +125^{\circ}C$	2.2	-	V
Logical Zero Input Voltage	$V_{IL}$	$V_{CC} = 4.5V$	1,2,3	$-55^{\circ} \leq T_A \leq +125^{\circ}C$	-	0.8	V
Logical One Input Voltage Clock	$V_{IHC}$	$V_{CC} = 5.5V$	1,2,3	$-55^{\circ} \leq T_A \leq +125^{\circ}C$	3.0	-	V
Logical Zero Input Voltage Clock	$V_{ILC}$	$V_{CC} = 4.5V$	1,2,3	$-55^{\circ} \leq T_A \leq +125^{\circ}C$	-	0.8	V
Output HIGH Voltage	$V_{OH}$	$I_{OH} = -400\mu A$ $V_{CC} = 4.5V$ (Note 1)	1,2,3	$-55^{\circ} \leq T_A \leq +125^{\circ}C$	2.6	-	V
Output LOW Voltage	$V_{OL}$	$I_{OL} = +2.0mA$ $V_{CC} = 4.5V$ (Note 1)	1,2,3	$-55^{\circ} \leq T_A \leq +125^{\circ}C$	-	0.4	V
Input Leakage Current	$I_I$	$V_{IN} = V_{CC}$ or GND $V_{CC} = 5.5V$	1,2,3	$-55^{\circ} \leq T_A \leq +125^{\circ}C$	-10	+10	$\mu A$
Output Leakage Current	$I_O$	$V_{IN} = V_{CC}$ or GND $V_{CC} = 5.5V$	1,2,3	$-55^{\circ} \leq T_A \leq +125^{\circ}C$	-10	+10	$\mu A$
Standby Power Supply Current	$I_{CCSB}$	$V_{IN} = V_{CC}$ or GND $V_{CC} = 5.5V$ , Outputs Open	1,2,3	$-55^{\circ} \leq T_A \leq +125^{\circ}C$	-	500	$\mu A$
Operating Power Supply Current	$I_{CCOP}$	$f = 20$ MHz, $V_{IN} = V_{CC}$ or GND, $V_{CC} = 5.5V$ (Note 2)	1,2,3	$-55^{\circ} \leq T_A \leq +125^{\circ}C$	-	140	mA
Functional Test	FT	(Note 3)	7,8	$-55^{\circ} \leq T_A \leq +125^{\circ}C$	-	-	-

**NOTES:**

1. Interchanging of force and sense conditions is permitted.
2. Operating Supply Current is proportional to frequency, typical rating is 7mA/MHz.
3. Tested as follows:  $f = 1$  MHz,  $V_{IH}$ (clock inputs) = 3.4V,  $V_{IH}$  (all other inputs) = 2.6V,  $V_{IL} = 0.4V$ ,  $V_{OH} \geq 1.5V$ , and  $V_{OL} \leq 1.5V$ .

7

SPECIAL  
FUNCTION

## Specifications HSP45256/883

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Guaranteed and 100% Tested

PARAMETER	SYMBOL	(NOTE 1) CONDITIONS	GROUP A SUB- GROUPS	TEMPERATURE	-25 (25.6MHz)		-20 (20MHz)		UNITS
					MIN	MAX	MIN	MAX	
CLK Period	T <sub>CP</sub>		9, 10, 11	-55° ≤ T <sub>A</sub> ≤ +125°C	39	-	50	-	ns
CLK High	T <sub>CH</sub>		9, 10, 11	-55° ≤ T <sub>A</sub> ≤ +125°C	15	-	20	-	ns
CLK Low	T <sub>CL</sub>		9, 10, 11	-55° ≤ T <sub>A</sub> ≤ +125°C	15	-	20	-	ns
CLOAD# Cycle Time	T <sub>CLC</sub>		9, 10, 11	-55° ≤ T <sub>A</sub> ≤ +125°C	39	-	50	-	ns
CLOAD# High	T <sub>CLH</sub>		9, 10, 11	-55° ≤ T <sub>A</sub> ≤ +125°C	15	-	20	-	ns
CLOAD# Low	T <sub>CLL</sub>		9, 10, 11	-55° ≤ T <sub>A</sub> ≤ +125°C	15	-	20	-	ns
RLOAD# Cycle Time	T <sub>RLC</sub>		9, 10, 11	-55° ≤ T <sub>A</sub> ≤ +125°C	39	-	50	-	ns
RLOAD# High	T <sub>RLH</sub>		9, 10, 11	-55° ≤ T <sub>A</sub> ≤ +125°C	15	-	20	-	ns
RLOAD# Low	T <sub>RLL</sub>		9, 10, 11	-55° ≤ T <sub>A</sub> ≤ +125°C	15	-	20	-	ns
Set-up Time; DIN to CLK High	T <sub>DS</sub>		9, 10, 11	-55° ≤ T <sub>A</sub> ≤ +125°C	13	-	15	-	ns
Hold Time; DIN to CLK High	T <sub>DH</sub>		9, 10, 11	-55° ≤ T <sub>A</sub> ≤ +125°C	1	-	1	-	ns
Set-up Time; DREF to RLOAD High	T <sub>RS</sub>		9, 10, 11	-55° ≤ T <sub>A</sub> ≤ +125°C	14	-	15	-	ns
Hold Time; DREF to RLOAD High	T <sub>RH</sub>		9, 10, 11	-55° ≤ T <sub>A</sub> ≤ +125°C	1	-	1	-	ns
DCONT Set up Time	T <sub>DCS</sub>		9, 10, 11	-55° ≤ T <sub>A</sub> ≤ +125°C	13	-	15	-	ns
DCONT Hold Time	T <sub>DCH</sub>		9, 10, 11	-55° ≤ T <sub>A</sub> ≤ +125°C	1	-	1	-	ns
Address Set up Time	T <sub>AS</sub>		9, 10, 11	-55° ≤ T <sub>A</sub> ≤ +125°C	13	-	15	-	ns
Address Hold Time	T <sub>AH</sub>		9, 10, 11	-55° ≤ T <sub>A</sub> ≤ +125°C	1	-	1	-	ns
TXFR# Set up Time	T <sub>TS</sub>		9, 10, 11	-55° ≤ T <sub>A</sub> ≤ +125°C	13	-	15	-	ns
TXFR# Hold Time	T <sub>TH</sub>		9, 10, 11	-55° ≤ T <sub>A</sub> ≤ +125°C	1	-	1	-	ns
CLK to Output Delay DO <sub>OUT</sub> , AUX <sub>OUT</sub> , CAS <sub>OUT</sub>	T <sub>DO</sub>		9, 10, 11	-55° ≤ T <sub>A</sub> ≤ +125°C	-	20	-	25	ns
Output Enable Time	T <sub>OE</sub>	Note 2	9, 10, 11	-55° ≤ T <sub>A</sub> ≤ +125°C	-	20	-	20	ns
TXFR# High to CLK Low	T <sub>THCL</sub>	Note 3	9, 10, 11	-55° ≤ T <sub>A</sub> ≤ +125°C	3	-	4	-	ns
CLK Low to RLOAD#, CLOAD# High	T <sub>CLLH</sub>	Note 3	9, 10, 11	-55° ≤ T <sub>A</sub> ≤ +125°C	1	-	1	-	ns

**NOTES:**

1. AC testing is performed as follows: V<sub>CC</sub> = 4.5V and 5.5V. Input levels (CLK Input) 4.0V and 0V; Input levels (all other inputs) 3.0V and 0V; Timing reference levels (CLK) 2.0V; All others 1.5V. Output load per test load circuit with C<sub>L</sub> = 40pF. Output transition is measured at V<sub>OH</sub> ≥ 1.5V and V<sub>OL</sub> ≤ 1.5V.
2. Transition is measured at ±200mV from steady state voltage, Output loading per test load circuit, C<sub>L</sub> = 40pF.
3. Applicable only when TXFR# and RLOAD# or CLOAD# are active on the same cycle of CLK.

## Specifications HSP45256/883

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

PARAMETER	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	-25		-20		UNITS
					MIN	MAX	MIN	MAX	
Input Capacitance	$C_{IN}$	VCC = Open, f=1 MHz All measurements are referenced to device GND.	1	$-55^{\circ} \leq T_A \leq +125^{\circ}C$	-	10	-	10	pF
Output Capacitance	$C_{OUT}$		1	$-55^{\circ} \leq T_A \leq +125^{\circ}C$	-	10	-	10	pF
Output Disable Time	$T_{OD}$		1, 2	$-55^{\circ} \leq T_A \leq +125^{\circ}C$	-	20	-	20	ns
Output Rise Time	$T_R$	From 0.8V to 2.0V	1, 2	$-55^{\circ} \leq T_A \leq +125^{\circ}C$	-	8	-	8	ns
Output Fall Time	$T_F$	From 2.0V to 0.8V	1, 2	$-55^{\circ} \leq T_A \leq +125^{\circ}C$	-	8	-	8	ns

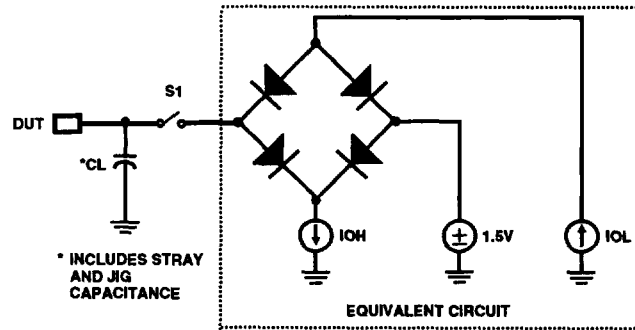
**NOTES:**

1. The parameters in Table 3 are controlled via design or process parameters and not directly tested. Characterized upon Initial design and after major process and/or design changes.
2. Loading is as specified in the test load circuit with  $C_L = 40pF$ .

**TABLE 4. APPLICABLE SUBGROUPS**

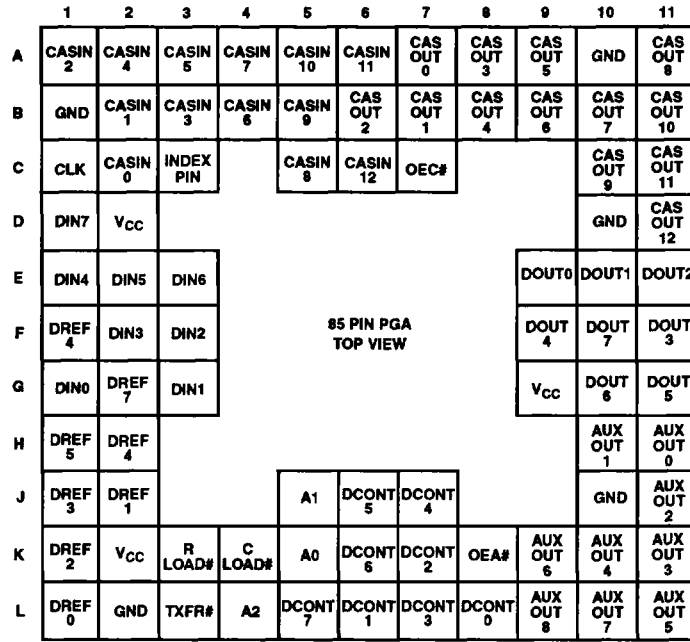
CONFORMANCE GROUPS	METHOD	SUBGROUPS
Initial Test	100%/5004	-
Interim Test	100%/5004	-
PDA	100%	1
Final Test	100%	2, 3, 8A, 8B, 10, 11
Group A	-	1, 2, 3, 7, 8A, 8B, 9, 10, 11
Groups C and D	Samples/5005	1, 7, 9

**Test Load Circuit**



SWITCH S1 OPEN FOR  $I_{CCSB}$  AND  $I_{CCOP}$  TEST

**Burn-In Circuits**



PGA PIN	PIN NAME	BURN-IN SIGNAL	PGA PIN	PIN NAME	BURN-IN SIGNAL	PGA PIN	PIN NAME	BURN-IN SIGNAL	PGA PIN	PIN NAME	BURN-IN SIGNAL
A1	CASIN2	F3	B11	CASOUT10	V <sub>CC</sub> /2	F9	DOUT4	V <sub>CC</sub> /2	K2	V <sub>CC</sub>	V <sub>CC</sub>
A2	CASIN4	F5	C1	CLK	F0	F10	DOUT7	V <sub>CC</sub> /2	K3	RLOAD#	F3
A3	CASIN5	F6	C2	CASIN0	F1	F11	DOUT3	V <sub>CC</sub> /2	K4	CLOAD#	F3
A4	CASIN7	F1	C5	CASIN8	F2	G1	DIN0	F1	K5	A0	F9
A5	CASIN10	F4	C6	CASIN12	F6	G2	DREF7	F8	K6	DCONT6	F7
A6	CASIN11	F5	C7	OE#	F11	G3	DIN1	F2	K7	DCONT2	F6
A7	CASOUT0	V <sub>CC</sub> /2	C10	CASOUT9	V <sub>CC</sub> /2	G9	V <sub>CC</sub>	V <sub>CC</sub>	K8	OE#	F11
A8	CASOUT3	V <sub>CC</sub> /2	C11	CASOUT11	V <sub>CC</sub> /2	G10	DOUT6	V <sub>CC</sub> /2	K9	AUXOUT6	V <sub>CC</sub> /2
A9	CASOUT5	V <sub>CC</sub> /2	D1	DIN7	F8	G11	DOUT5	V <sub>CC</sub> /2	K10	AUXOUT4	V <sub>CC</sub> /2
A10	GND	GND	D2	V <sub>CC</sub>	V <sub>CC</sub>	H1	DREF5	F6	K11	AUXOUT3	V <sub>CC</sub> /2
A11	CASOUT8	V <sub>CC</sub> /2	D10	GND	GND	H2	DREF4	F8	L1	DREF0	F4
B1	GND	GND	D11	CASOUT12	V <sub>CC</sub> /2	H10	AUXOUT1	V <sub>CC</sub> /2	L2	GND	GND
B2	CASIN1	F2	E1	DIN4	F5	H11	AUXOUT0	V <sub>CC</sub> /2	L3	TXFR#	F2
B3	CASIN3	F4	E2	DIN5	F6	J1	DREF3	F7	L4	A2	F11
B4	CASIN6	F7	E3	DIN6	F7	J2	DREF1	F5	L5	DCONT7	F8
B5	CASIN9	F3	E9	DOUT0	V <sub>CC</sub> /2	J5	A1	F10	L6	DCONT1	F5
B6	CASOUT2	V <sub>CC</sub> /2	E10	DOUT1	V <sub>CC</sub> /2	J6	DCONT5	F6	L7	DCONT3	F7
B7	CASOUT1	V <sub>CC</sub> /2	E11	DOUT2	V <sub>CC</sub> /2	J7	DCONT4	F8	L8	DCONT0	F4
B8	CASOUT4	V <sub>CC</sub> /2	F1	DREF6	F7	J10	GND	GND	L9	AUXOUT8	V <sub>CC</sub> /2
B9	CASOUT6	V <sub>CC</sub> /2	F2	DIN3	F4	J11	AUXOUT2	V <sub>CC</sub> /2	L10	AUXOUT7	V <sub>CC</sub> /2
B10	CASOUT7	V <sub>CC</sub> /2	F3	DIN2	F3	K1	DREF2	F6	L11	AUXOUT5	V <sub>CC</sub> /2

NOTES:

- V<sub>CC</sub>/2 (2.7V ±10%) used for outputs only.
- 47kΩ (±20%) resistor connected to all pins except V<sub>CC</sub> and GND.
- V<sub>CC</sub> = 5.5 ± 0.5V.
- 0.1μF (min) capacitor between V<sub>CC</sub> and GND per position.
- FO = 100kHz ± 10%, F1 = FO/2, F2 = F1/2 ... F11 = F10/2, 40 - 60% Duty Cycle.
- Input Voltage Limits: V<sub>IL</sub> = 0.8V max, V<sub>IH</sub> = 4.5 ± 10%.

**Metal Topology**

**DIE DIMENSIONS:**

254 x 214 x 19 ± 1mils

**METALLIZATION:**

Type: Si - Al or Si-Al-Cu  
Thickness: 8kÅ

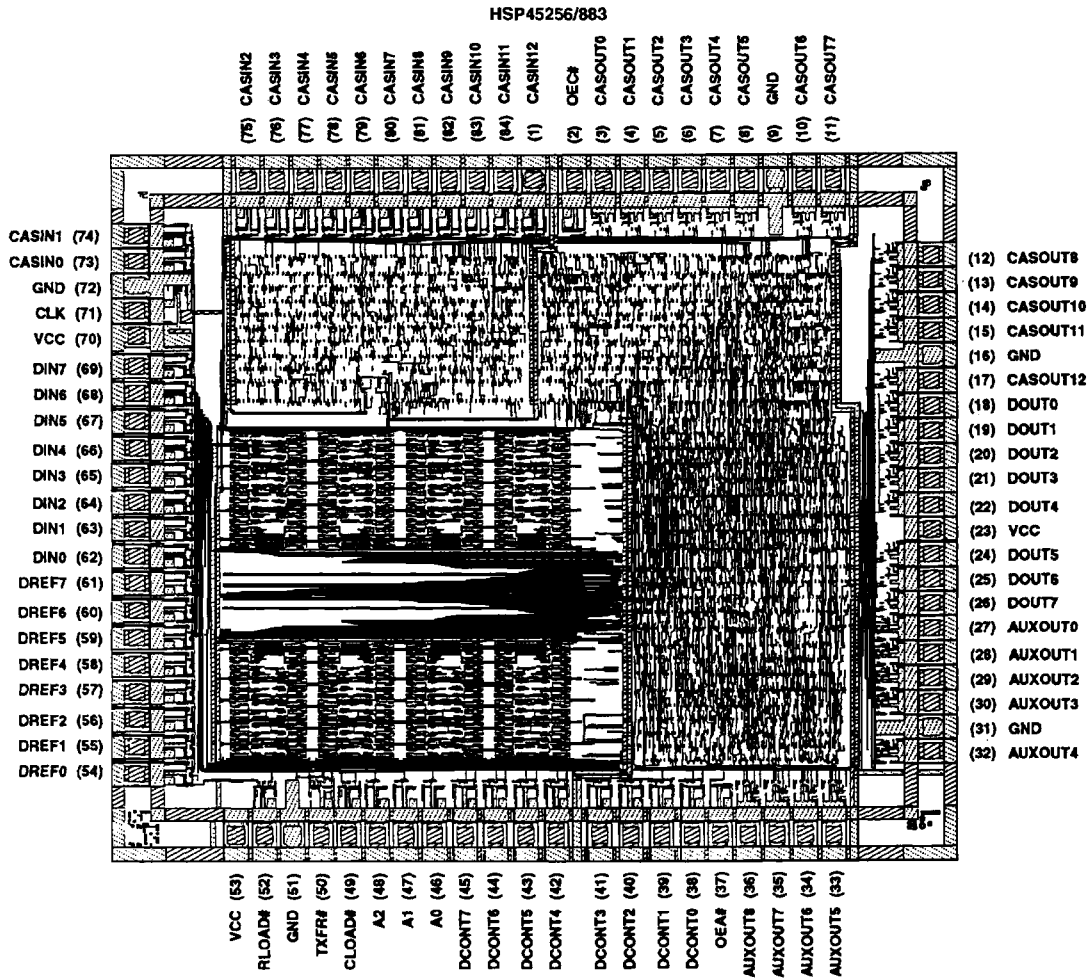
**GLASSIVATION:**

Type: Nitrox  
Thickness: 10kÅ

**WORST CASE CURRENT DENSITY:**

0.96 x 10<sup>5</sup> A/cm<sup>2</sup>

**Metallization Mask Layout**



7

SPECIAL  
FUNCTION