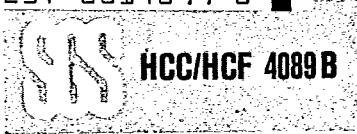


**COS/MOS
INTEGRATED
CIRCUIT**



41C 08913 DT-45-07

7929225 S G S SEMICONDUCTOR CORP

BINARY RATE MULTIPLIER

- CASCADABLE IN MULTIPLES OF 4-BITS
- SET TO "15" INPUT AND "15" DETECT OUTPUT
- QUIESCENT CURRENT SPECIFIED TO 20V FOR HCC DEVICE
- STANDARDIZED SYMMETRICAL OUTPUT CHARACTERISTICS
- INPUT CURRENT OF 100 nA AT 18V AND 25°C FOR HCC DEVICE
- 100% TESTED FOR QUIESCENT CURRENT
- MEETS ALL REQUIREMENTS OF JEDEC TENTATIVE STANDARD No. 13A, "STANDARD SPECIFICATIONS FOR DESCRIPTION OF "B" SERIES CMOS DEVICES"

The **HCC 4089B** (extended temperature range) and **HCF 4089B** (intermediate temperature range) are monolithic integrated circuit available in 16-lead dual in-line plastic or ceramic package, and ceramic flat package.

The **HCC/HCF 4089B** is a low-power 4-bit digital rate multiplier that provides an output pulse rate that is the clock-input-pulse rate multiplied by 1/16 times the binary input. For example, when the binary input number is 13, there will be 13 output pulses for every 16 input pulses.

The **HCC/HCF 4089B** has an internal synchronous 4-bit counter which, together with one of the four binary input bits, produces pulse trains as shown in timing diagram.

If more than one binary input bit is high, the resulting pulse train is a combination of the above separate pulse trains. This device may be used to perform arithmetic operations (add, subtract, divide, raise to a power), solve algebraic and differential equations, generate natural logarithms and trigonometric functions, A/D and D/A conversions, and frequency division.

ABSOLUTE MAXIMUM RATINGS

V_{DD}^*	Supply voltage: HCC types HCF types	-0.5 to 20 -0.5 to 18	V V
V_i	Input voltage	-0.5 to $V_{DD} + 0.5$	V
I_i	DC input current (any one input)	± 10	mA
P_{tot}	Total power dissipation (per package) Dissipation per output transistor for T_{op} = full package-temperature range	200 100	mW mW
T_{op}	Operating temperature: HCC types HCF types	-55 to 125 -40 to 85	°C °C
T_{stg}	Storage temperature	-65 to 150	°C

* All voltage values are referred to V_{SS} pin voltage

ORDERING NUMBERS:

HCC 4089 BD for dual in-line ceramic package
 HCC 4089 BF for dual in-line ceramic package, frit seal
 HCC 4089 BK for ceramic flat package
 HCF 4089 BE for dual in-line plastic package
 HCF 4089 BF for dual in-line ceramic package, frit seal

1331 E-06

339

2/82

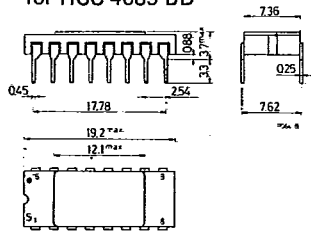
HCC/HCF 4089 B

41C 08914 DT-45-07

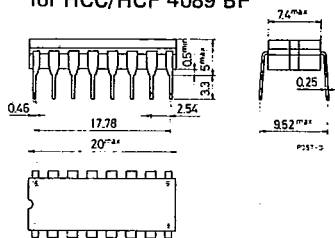
7929225 S G S SEMICONDUCTOR CORP

MECHANICAL DATA (dimensions in mm)

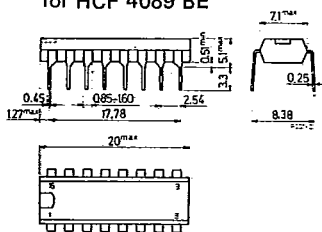
Dual in-line ceramic package for HCC 4089 BD



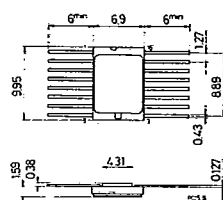
Dual in-line ceramic package for HCC/HCF 4089 BF



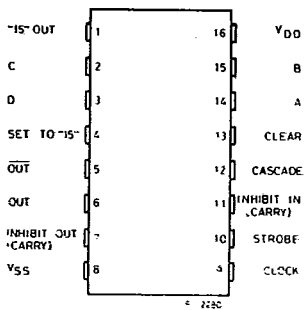
Dual in-line plastic package for HCF 4089 BE



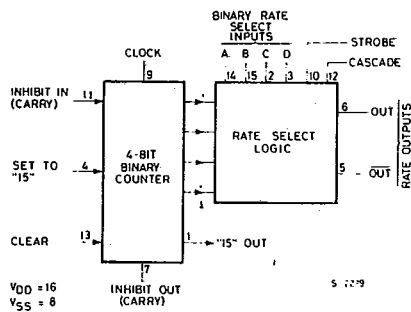
Ceramic flat package for HCC 4089 BK



CONNECTION DIAGRAM



FUNCTIONAL DIAGRAM



RECOMMENDED OPERATING CONDITIONS

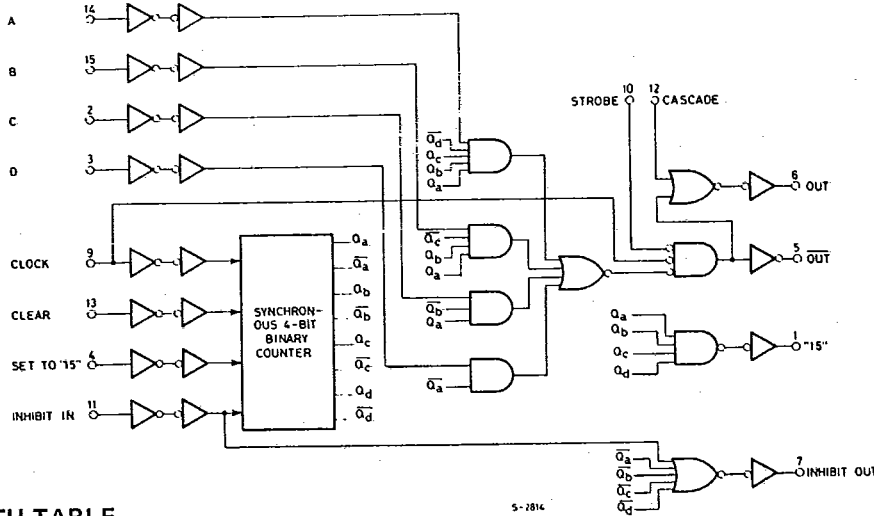
V_{DD}	Supply voltage: HCC types HCF types	3 to 18 V 3 to 15 V
V_I	Input voltage	0 to V_{DD} V
T_{op}	Operating temperature: HCC types HCF types	-55 to 125 °C -40 to 85 °C



41C 08915 DT-45-07

7929225 S G S SEMICONDUCTOR CORP

LOGIC DIAGRAM



5-2814

TRUTH TABLE

INPUTS										OUTPUTS			
Number of Pulses or Input Logic Level (0 = Low; 1 = High; X = Don't Care)										Number of Pulses or Output Logic Level (L = Low; H = High)			
D	C	B	A	CLK	INH IN	STR	CAS	CLR	SET	OUT	OUT	INH OUT	"15" OUT
0	0	0	0	16	0	0	0	0	0	L	H	1	1
0	0	0	1	16	0	0	0	0	0	1	1	1	1
0	0	1	0	16	0	0	0	0	0	2	2	1	1
0	0	1	1	16	0	0	0	0	0	3	3	1	1
0	1	0	0	16	0	0	0	0	0	4	4	1	1
0	1	0	1	16	0	0	0	0	0	5	5	1	1
0	1	1	0	16	0	0	0	0	0	6	6	1	1
0	1	1	1	16	0	0	0	0	0	7	7	1	1
1	0	0	0	16	0	0	0	0	0	8	8	1	1
1	0	0	1	16	0	0	0	0	0	9	9	1	1
1	0	1	0	16	0	0	0	0	0	10	10	1	1
1	0	1	1	16	0	0	0	0	0	11	11	1	1
1	1	0	0	16	0	0	0	0	0	12	12	1	1
1	1	0	1	16	0	0	0	0	0	13	13	1	1
1	1	1	0	16	0	0	0	0	0	14	14	1	1
1	1	1	1	16	0	0	0	0	0	15	15	1	1
X	X	X	X	16	1	0	0	0	0	●	●	H	●
X	X	X	X	16	0	1	0	0	0	L	H	1	1
X	X	X	X	16	0	0	1	0	0	H	*	1	1
1	X	X	X	16	0	0	0	1	0	16	16	H	L
0	X	X	X	16	0	0	0	1	0	L	H	H	L
X	X	X	X	16	0	0	0	0	1	L	H	L	H

* Output same as the first 16 lines of this truth table (depending on values of A, B, C, D).
 ● Depends on internal state of counter.

HCC/HCF 4089B

41C 08916 DT-45-07

7929225 S G S SEMICONDUCTOR CORP
 STATIC ELECTRICAL CHARACTERISTICS (over recommended operating conditions)

Parameter		Test conditions				Values						Unit	
		V _I (V)	V _O (V)	I _O (μA)	V _{DD} (V)	T _{Low} *		25°C			T _{High} *		
						Min.	Max.	Min.	Typ.	Max.	Min.		Max.
I _L Quiescent current	HCC types	0/ 5			5		5		0.04	5		150	μA
		0/10			10		10		0.04	10		300	
		0/15			15		20		0.04	20		600	
		0/20			20		100		0.08	100		3000	
	HCF types	0/ 5			5		20		0.04	20		150	
		0/10			10		40		0.04	40		300	
		0/15			15		80		0.04	80		600	
V _{OH} Output high voltage	0/ 5		< 1	5	4.95		4.95			4.95		V	
	0/10		< 1	10	9.95		9.95			9.95		V	
	0/15		< 1	15	14.95		14.95			14.95		V	
V _{OL} Output low voltage	5/0		< 1	5		0.05			0.05		0.05	V	
	10/0		< 1	10		0.05			0.05		0.05	V	
	15/0		< 1	15		0.05			0.05		0.05	V	
V _{IH} Input high voltage		0.5/4.5	< 1	5	3.5		3.5			3.5		V	
		1/9	< 1	10	7		7			7		V	
		1.5/13.5	< 1	15	11		11			11		V	
V _{IL} Input low voltage		4.5/0.5	< 1	5		1.5			1.5		1.5	V	
		9/1	< 1	10		3			3		3	V	
		13.5/1.5	< 1	15		4			4		4	V	
I _{OH} Output drive current	HCC types	0/ 5	2.5		5	-2		-1.6	-3.2		-1.15	mA	
		0/ 5	4.6		5	-0.64		-0.51	-1		-0.36		
		0/10	9.5		10	-1.6		-1.3	-2.6		-0.9		
		0/15	13.5		15	-4.2		-3.4	-6.8		-2.4		
	HCF types	0/ 5	2.5		5	-1.53		-1.36	-3.2		-1.1		
		0/ 5	4.6		5	-0.52		-0.44	-1		-0.36		
		0/10	9.5		10	-1.3		-1.1	-2.6		-0.9		
I _{OL} Output sink current	HCC types	0/ 5	0.4		5	0.64		0.51	1		0.36	mA	
		0/10	0.5		10	1.6		1.3	2.6		0.9		
		0/15	1.5		15	4.2		3.4	6.8		2.4		
	HCF types	0/ 5	0.4		5	0.52		0.44	1		0.36		
		0/10	0.5		10	1.3		1.1	2.6		0.9		
		0/15	1.5		15	3.6		3.0	6.8		2.4		
I _{IH} , I _{IL} Input leakage current	HCC types	0/18	Any input	18		±0.1		±10 ⁻⁵	±0.1		± 1	μA	
	HCF types	0/15		15		±0.3		±10 ⁻⁵	±0.3		± 1		
C _I Input capacitance			Any input					5	7.5			pF	

* T_{Low} = -55°C for HCC device; -40°C for HCF device.
 * T_{High} = +125°C for HCC device; +85°C for HCF device.
 The Noise Margin for both "1" and "0" level is: 1V min. with V_{DD} = 5V
 2V min. with V_{DD} = 10V
 2.5V min. with V_{DD} = 15V



HCC/HCF 4089B

41C 08917 DT-45.07

7929225 S G S SEMICONDUCTOR CORP

DYNAMIC ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^{\circ}\text{C}$, $C_L = 50 \text{ pF}$, $R_L = 200 \text{ k}\Omega$,
typical temperature coefficient for all V_{DD} values is $0.3\%/^{\circ}\text{C}$, all input rise and fall times = 20 ns)

Parameter		Test conditions	Values			Unit	
			V_{DD} (V)	Min.	Typ.		Max.
t_{PHL} , t_{PLH}	Propagation delay time	Clock to $\overline{\text{out}}$	5		110	220	ns
			10		55	110	
			15		45	90	
	Clock or strobe to out	5		150	300	ns	
		10		75	150		
		15		60	120		
	Clock to inhibit high level to low level	5		360	720	ns	
		10		160	320		
		15		110	220		
	Low level to high level	5		250	500	ns	
		10		100	200		
		15		75	150		
	Clear to out	5		380	760	ns	
		10		175	350		
		15		130	260		
	Clock to "g" or "15" out	5		300	600	ns	
		10		125	250		
		15		90	180		
	Cascade to out	5		90	180	ns	
		10		45	90		
		15		35	70		
	Inhibit in to inhibit out	5		160	320	ns	
		10		75	150		
		15		55	110		
Set to out	5		330	660	ns		
	10		150	300			
	15		110	220			
t_{THL} , t_{TLH}	Transition time	5		100	200	ns	
		10		50	100		
		15		40	80		
f_{CL}	Maximum clock frequency	5	1.2	2.4		MHz	
		10	2.5	5			
		15	3.5	7			
t_w	Clock pulse width	5	330	165		ns	
		10	170	85			
		15	100	50			
t_r , t_f	Clock rise or fall time	5			15	μs	
		10			15		
		15			15		
t_w	Set or clear pulse width	5	160	80		ns	
		10	90	45			
		15	60	30			

HCC/HCF 4089B

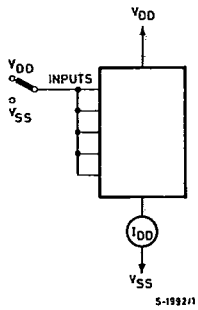
7929225 S G S SEMICONDUCTOR CORP .41C 08918 DT-45-07

DYNAMIC ELECTRICAL CHARACTERISTICS (continued)

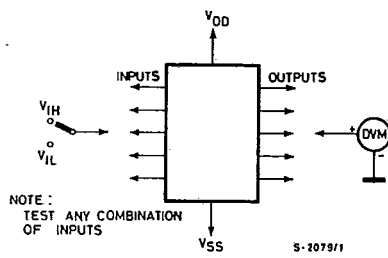
Parameter	Test conditions	Values			Unit
		V _{DD} (V)	Min.	Typ.	
t _{setup} Inhibit input setup time, high level to low level		5	100	50	ns
		10	40	20	
		15	20	10	
t _R Inhibit, input removal time		5	240	120	ns
		10	130	65	
		15	110	55	
t _R Minimum set removal time		5	150	75	ns
		10	80	40	
		15	50	25	
t _R Clear removal time		5	60	30	ns
		10	40	20	
		15	30	15	

TEST CIRCUIT

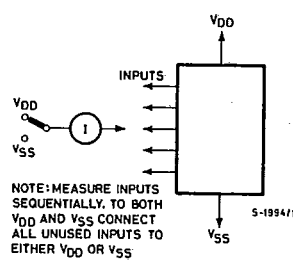
Quiescent device current



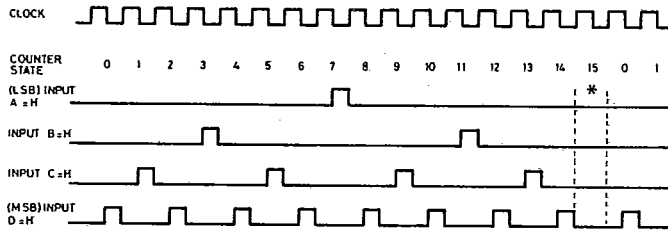
Noise immunity



Input leakage current

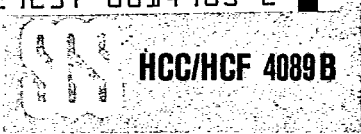


TIMING DIAGRAM



* AN OUTPUT BIT MAY BE FILLED IN THIS COUNTER STATE BY A LESS SIGNIFICANT HCC-HCF4089B CASCADED IN THE ADD MODE

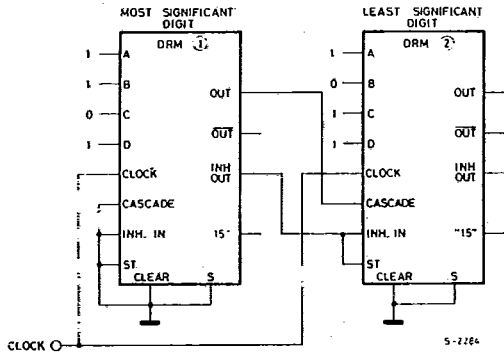
S-2287



7929225 S G S SEMICONDUCTOR CORP
APPLICATION NOTES

For words of more than 4 bits, HCC/HCF 4089B devices may be cascaded in two different modes: an Add mode and a Multiply mode.

Two HCC/HCF 4089B's cascaded in the "Add" mode with a preset number of 189.

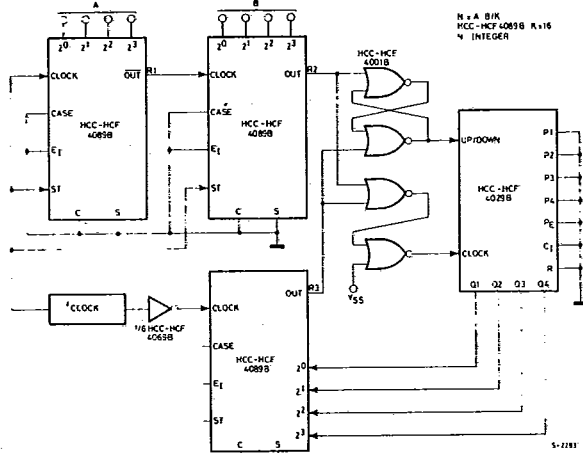


Nota:

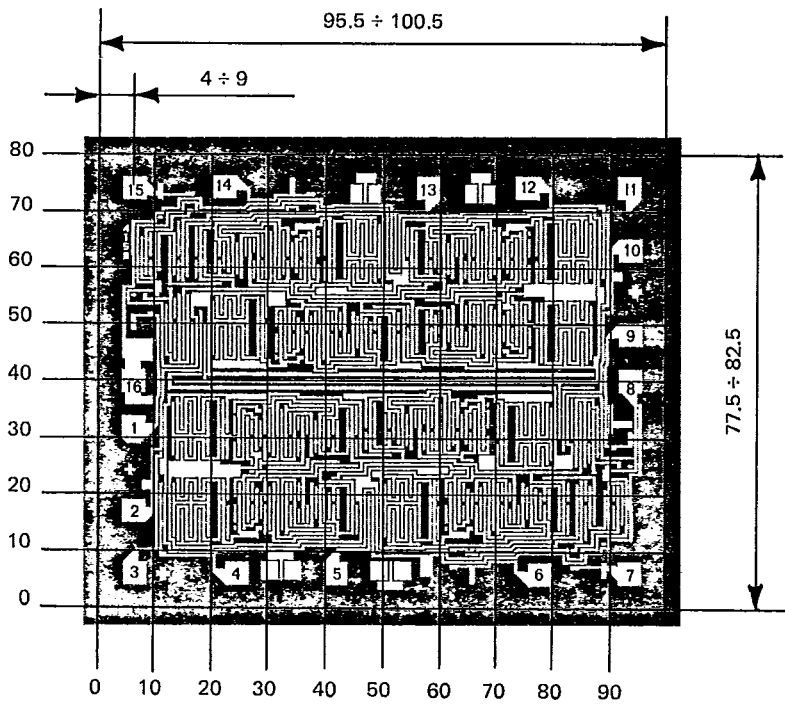
In the Add mode some of the gaps left by the more significant unit at the count of 15 are filled in by the less significant units. For example, when two units are cascaded in the Add mode and programmed to 11 and 13, respectively, the more significant unit will have 11 output pulses for every 16 input pulses and the other unit will have 13 output pulses for every 256 input pulses for a total of

$$\frac{11}{16} + \frac{13}{256} = \frac{189}{256}$$

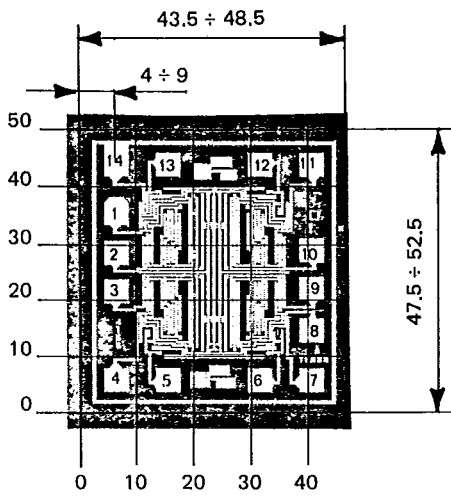
Two HCC/HCF 4089B's cascaded in the Multiply mode for Multiplication of two variables A and B with loop circuit control.



When the loop stabilises rate $R_2 = \text{rate } R_3$, thus $f_{\text{clock}} \left(\frac{A}{16} \cdot \frac{B}{16} \right) = f_{\text{clock}} \left(\frac{1}{16} \cdot \frac{N}{16} \right)$ therefore $N = A \cdot B$.



4015B



4016B