

## Features

- 7.5 ns pin-to-pin logic delays on all pins
- $f_{CNT}$  to 125 MHz
- 108 macrocells with 2400 usable gates
- Up to 108 user I/O pins
- 5 V in-system programmable (ISP)
  - Endurance of 10,000 program/erase cycles
  - Program/erase over full commercial voltage and temperature range
- Enhanced pin-locking architecture
- Flexible 36V18 Function Block
  - 90 product terms drive any or all of 18 macrocells within Function Block
  - Global and product term clocks, output enables, set and reset signals
- Extensive IEEE Std 1149.1 boundary-scan (JTAG) support
- Programmable power reduction mode in each macrocell
- Slew rate control on individual outputs
- User programmable ground pin capability
- Extended pattern security features for design protection
- High-drive 24 mA outputs
- 3.3 V or 5 V I/O capability
- Advanced CMOS 5V FastFLASH technology
- Supports parallel programming of more than one XC9500 concurrently
- Available in 84-pin PLCC, 100-pin PQFP, 100-pin TQFP and 160-pin PQFP packages

## Description

The XC95108 is a high-performance CPLD providing advanced in-system programming and test capabilities for general purpose logic integration. It is comprised of six 36V18 Function Blocks, providing 2,400 usable gates with propagation delays of 7.5 ns. See [Figure 2](#) for the architecture overview.

## Power Management

Power dissipation can be reduced in the XC95108 by configuring macrocells to standard or low-power modes of operation. Unused macrocells are turned off to minimize power dissipation.

Operating current for each design can be approximated for specific operating conditions using the following equation:

$$I_{CC} \text{ (mA)} = MC_{HP} (1.7) + MC_{LP} (0.9) + MC (0.006 \text{ mA/MHz}) f$$

Where:

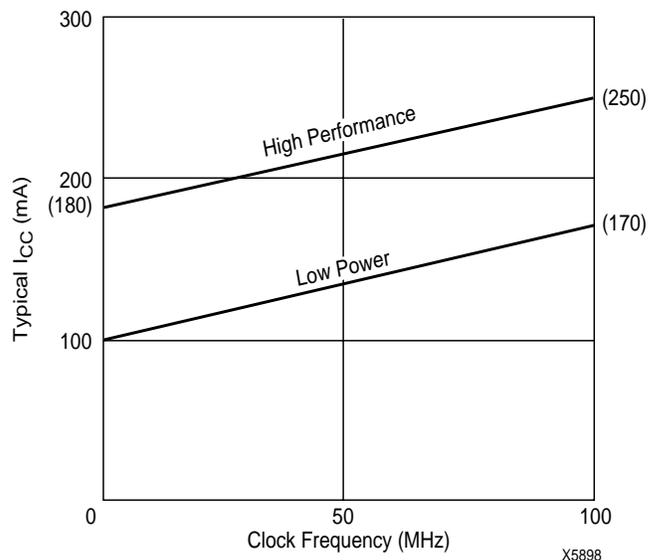
$MC_{HP}$  = Macrocells in high-performance mode

$MC_{LP}$  = Macrocells in low-power mode

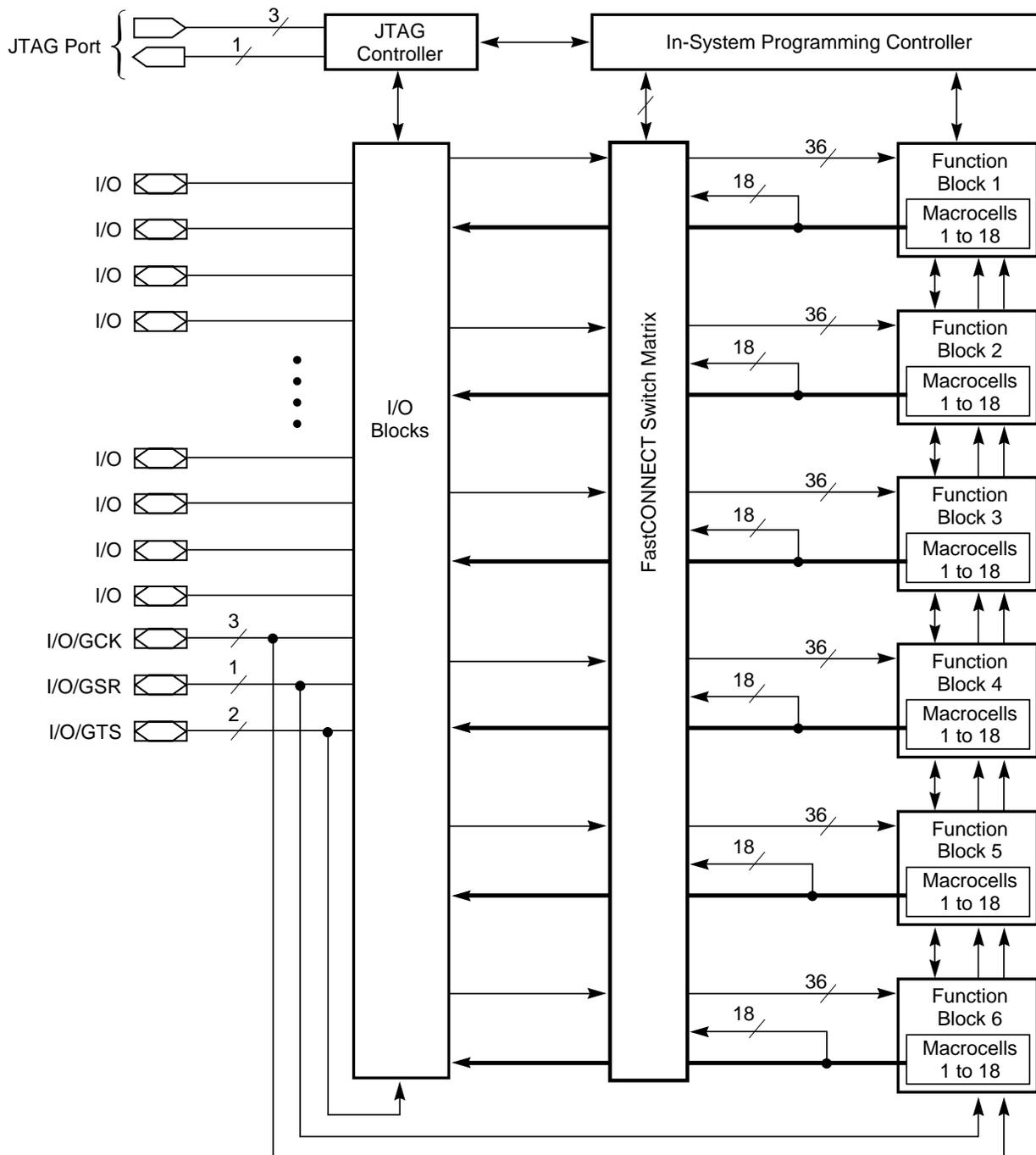
$MC$  = Total number of macrocells used

$f$  = Clock frequency (MHz)

[Figure 1](#) shows a typical calculation for the XC95108 device.



**Figure 1: Typical I<sub>CC</sub> vs. Frequency for XC95108**



X5897

**Figure 2: XC95108 Architecture**

**Note:** Function Block outputs (indicated by the bold line) drive the I/O Blocks directly

## Absolute Maximum Ratings

Symbol	Parameter	Value	Units
$V_{CC}$	Supply voltage relative to GND	-0.5 to 7.0	V
$V_{IN}$	DC input voltage relative to GND	-0.5 to $V_{CC} + 0.5$	V
$V_{TS}$	Voltage applied to 3-state output with respect to GND	-0.5 to $V_{CC} + 0.5$	V
$T_{STG}$	Storage temperature	-65 to +150	°C
$T_{SOL}$	Max soldering temperature (10 s @ 1/16 in = 1.5 mm)	+260	°C

**Warning:** Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those listed under Recommended Operating Conditions is not implied. Exposure to Absolute Maximum Rating conditions for extended periods of time may affect device reliability.

## Recommended Operation Conditions<sup>1</sup>

Symbol	Parameter	Min	Max	Units
$V_{CCINT}$	Supply voltage for internal logic and input buffer	4.75 (4.5)	5.25 (5.5)	V
$V_{CCIO}$	Supply voltage for output drivers for 5 V operation	4.75 (4.5)	5.25 (5.5)	V
	Supply voltage for output drivers for 3.3 V operation	3.0	3.6	V
$V_{IL}$	Low-level input voltage	0	0.80	V
$V_{IH}$	High-level input voltage	2.0	$V_{CCINT} + 0.5$	V
$V_O$	Output voltage	0	$V_{CCIO}$	V

**Note:** 1. Numbers in parenthesis are for industrial-temperature range versions.

## Endurance Characteristics

Symbol	Parameter	Min	Max	Units
$t_{DR}$	Data Retention	20	-	Years
$N_{PE}$	Program/Erase Cycles	10,000	-	Cycles

## DC Characteristics Over Recommended Operating Conditions

Symbol	Parameter	Test Conditions	Min	Max	Units
V <sub>OH</sub>	Output high voltage for 5 V operation	I <sub>OH</sub> = -4.0 mA V <sub>CC</sub> = Min	2.4		V
	Output high voltage for 3.3 V operation	I <sub>OH</sub> = -3.2 mA V <sub>CC</sub> = Min	2.4		V
V <sub>OL</sub>	Output low voltage for 5 V operation	I <sub>OL</sub> = 24 mA V <sub>CC</sub> = Min		0.5	V
	Output low voltage for 3.3 V operation	I <sub>OL</sub> = 10 mA V <sub>CC</sub> = Min		0.4	V
I <sub>IL</sub>	Input leakage current	V <sub>CC</sub> = Max V <sub>IN</sub> = GND or V <sub>CC</sub>		±10.0	μA
I <sub>IH</sub>	I/O high-Z leakage current	V <sub>CC</sub> = Max V <sub>IN</sub> = GND or V <sub>CC</sub>		±10.0	μA
C <sub>IN</sub>	I/O capacitance	V <sub>IN</sub> = GND f = 1.0 MHz		10.0	pF
I <sub>CC</sub>	Operating Supply Current (low power mode, active)	V <sub>I</sub> = GND, No load f = 1.0 MHz	100 (Typ)		ma

## AC Characteristics

Symbol	Parameter	XC95108-7		XC95108-10		XC95108-15		XC95108-20		Units
		Min	Max	Min	Max	Min	Max	Min	Max	
t <sub>PD</sub>	I/O to output valid		7.5		10.0		15.0		20.0	ns
t <sub>SU</sub>	I/O setup time before GCK	4.5		6.0		8.0		10.0		ns
t <sub>H</sub>	I/O hold time after GCK	0.0		0.0		0.0		0.0		ns
t <sub>CO</sub>	GCK to output valid		4.5		6.0		8.0		10.0	ns
f <sub>CNT</sub> <sup>1</sup>	16-bit counter frequency	125.0		111.1		95.2		83.3		MHz
f <sub>SYSTEM</sub> <sup>2</sup>	Multiple FB internal operating frequency	83.3		66.7		55.6		50.0		MHz
t <sub>PSU</sub>	I/O setup time before p-term clock input	0.5		2.0		4.0		4.0		ns
t <sub>PH</sub>	I/O hold time after p-term clock input	4.0		4.0		4.0		6.0		ns
t <sub>PCO</sub>	P-term clock to output valid		8.5		10.0		12.0		16.0	ns
t <sub>OE</sub>	GTS to output valid		5.5		6.0		11.0		16.0	ns
t <sub>OD</sub>	GTS to output disable		5.5		6.0		11.0		16.0	ns
t <sub>POE</sub>	Product term OE to output enabled		9.5		10.0		14.0		18.0	ns
t <sub>POD</sub>	Product term OE to output disabled		9.5		10.0		14.0		18.0	ns
t <sub>WLH</sub>	GCK pulse width (High or Low)	4.0		4.5		5.5		5.5		ns

**Note:** 1. f<sub>CNT</sub> is the fastest 16-bit counter frequency available, using the local feedback when applicable.

f<sub>CNT</sub> is also the Export Control Maximum flip-flop toggle rate, f<sub>TOG</sub>.

2. f<sub>SYSTEM</sub> is the internal operating frequency for general purpose system designs spanning multiple FBs.

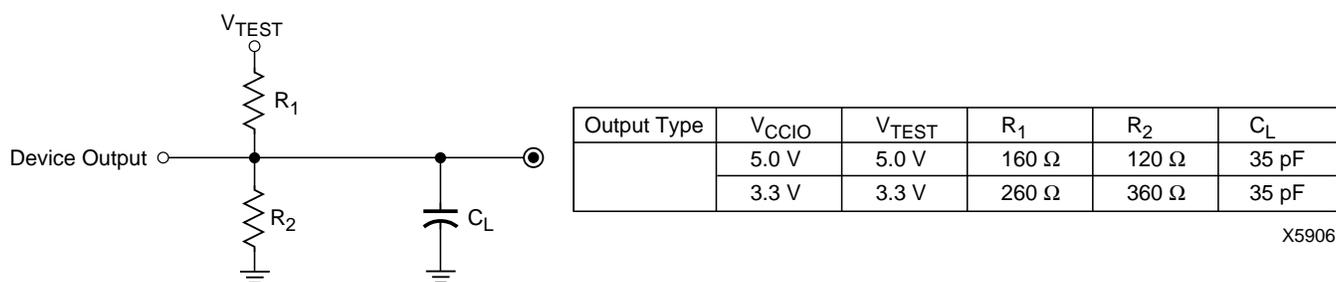


Figure 3: AC Load Circuit

## Internal Timing Parameters

Symbol	Parameter	XC95108-7		XC95108-10		XC95108-15		XC95108-20		Units
		Min	Max	Min	Max	Min	Max	Min	Max	
<b>Buffer Delays</b>										
t <sub>IN</sub>	Input buffer delay		2.5		3.5		4.5		6.5	ns
t <sub>GCK</sub>	GCK buffer delay		1.5		2.5		3.0		3.0	ns
t <sub>GSR</sub>	GSR buffer delay		4.5		6.0		7.5		9.5	ns
t <sub>GTS</sub>	GTS buffer delay		5.5		6.0		11.0		16.0	ns
t <sub>OUT</sub>	Output buffer delay		2.5		3.0		4.5		6.5	ns
t <sub>EN</sub>	Output buffer enable/disable delay		0.0		0.0		0.0		0.0	ns
<b>Product Term Control Delays</b>										
t <sub>PTCK</sub>	Product term clock delay		3.0		3.0		2.5		2.5	ns
t <sub>PTSR</sub>	Product term set/reset delay		2.0		2.5		3.0		3.0	ns
t <sub>PTTS</sub>	Product term 3-state delay		4.5		3.5		5.0		5.0	ns
<b>Internal Register and Combinatorial delays</b>										
t <sub>PDI</sub>	Combinatorial logic propagation delay		0.5		1.0		3.0		4.0	ns
t <sub>SUI</sub>	Register setup time	1.5		2.5		3.5		3.5		ns
t <sub>HI</sub>	Register hold time	3.0		3.5		4.5		6.5		ns
t <sub>COI</sub>	Register clock to output valid time		0.5		0.5		0.5		0.5	ns
t <sub>AOI</sub>	Register async. S/R to output delay		6.5		7.0		8.0		8.0	ns
t <sub>RAI</sub>	Register async. S/R recovery before clock	7.5		10.0		10.0		10.0		ns
t <sub>LOGI</sub>	Internal logic delay		2.0		2.5		3.0		3.0	ns
t <sub>LOGILP</sub>	Internal low power logic delay		10.0		11.0		11.5		11.5	ns
<b>Feedback Delays</b>										
t <sub>F</sub>	FastCONNECT matrix feedback delay		8.0		9.5		11.0		13.0	ns
t <sub>LF</sub>	Function Block local feedback delay		4.0		3.5		3.5		5.0	ns
<b>Time Adders</b>										
t <sub>PTA</sub> <sup>3</sup>	Incremental Product Term Allocator delay		1.0		1.0		1.0		1.5	ns
t <sub>SLEW</sub>	Slew-rate limited delay		4.0		4.5		5.0		5.5	ns

**Note:** 3. t<sub>PTA</sub> is multiplied by the span of the function as defined in the family data sheet.

# XC95108 In-System Programmable CPLD

## XC95108 I/O Pins

Function Block	Macrocell	PC84	PQ100	TQ100	PQ160	BScan Order	Notes	Function Block	Macrocell	PC84	PQ100	TQ100	PQ160	BScan Order	Notes
1	1	–	–	–	25	321		3	1	–	–	–	45	213	
1	2	1	15	13	21	318		3	2	14	31	29	47	210	
1	3	2	16	14	22	315		3	3	15	32	30	49	207	
1	4	–	21	19	29	312		3	4	–	36	34	57	204	
1	5	3	17	15	23	309		3	5	17	34	32	54	201	
1	6	4	18	16	24	306		3	6	18	35	33	56	198	
1	7	–	–	–	27	303		3	7	–	–	–	50	195	
1	8	5	19	17	26	300		3	8	19	37	35	58	192	
1	9	6	20	18	28	297		3	9	20	38	36	59	189	
1	10	–	26	24	36	294		3	10	–	45	43	69	186	
1	11	7	22	20	30	291		3	11	21	39	37	60	183	
1	12	9	24	22	33	288	[1]	3	12	23	41	39	62	180	
1	13	–	–	–	34	285		3	13	–	–	–	52	177	
1	14	10	25	23	35	282	[1]	3	14	24	42	40	63	174	
1	15	11	27	25	37	279		3	15	25	43	41	64	171	
1	16	12	29	27	42	276	[1]	3	16	26	44	42	68	168	
1	17	13	30	28	44	273		3	17	31	51	49	77	165	
1	18	–	–	–	43	270		3	18	–	–	–	74	162	
2	1	–	–	–	158	267		4	1	–	–	–	123	159	
2	2	71	98	96	154	264		4	2	57	83	81	134	156	
2	3	72	99	97	156	261		4	3	58	84	82	135	153	
2	4	–	4	2	4	258		4	4	–	82	80	133	150	
2	5	74	1	99	159	255	[1]	4	5	61	87	85	138	147	
2	6	75	3	1	2	252		4	6	62	88	86	139	144	
2	7	–	–	–	9	249		4	7	–	–	–	128	141	
2	8	76	5	3	6	246	[1]	4	8	63	89	87	140	138	
2	9	77	6	4	8	243	[1]	4	9	65	91	89	142	135	
2	10	–	9	7	12	240		4	10	–	–	–	147	132	
2	11	79	8	6	11	237		4	11	66	92	90	143	129	
2	12	80	10	8	13	234		4	12	67	93	91	144	126	
2	13	–	–	–	14	231		4	13	–	–	–	153	123	
2	14	81	11	9	15	228		4	14	68	95	93	146	120	
2	15	82	12	10	17	225		4	15	69	96	94	148	117	
2	16	83	13	11	18	222		4	16	–	94	92	145	114	
2	17	84	14	12	19	219		4	17	70	97	95	152	111	
2	18	–	–	–	16	216		4	18	–	–	–	155	108	

Notes: [1] Global control pin

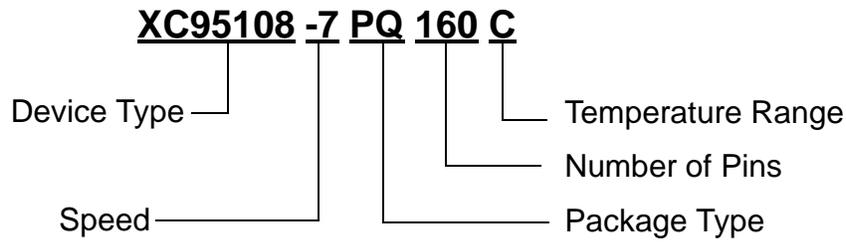
XC95108 I/O Pins (continued)

Function Block	Macrocell	PC84	PQ100	TQ100	PQ160	BScan Order	Notes	Function Block	Macrocell	PC84	PQ100	TQ100	PQ160	BScan Order	Notes
5	1	–	–	–	76	105		6	1	–	–	–	91	51	
5	2	32	52	50	79	102		6	2	45	67	65	103	48	
5	3	33	54	52	82	99		6	3	46	68	66	104	45	
5	4	–	48	46	72	96		6	4	–	75	73	116	42	
5	5	34	55	53	86	93		6	5	47	69	67	106	39	
5	6	35	56	54	88	90		6	6	48	70	68	108	36	
5	7	–	–	–	78	87		6	7	–	–	–	105	33	
5	8	36	57	55	90	84		6	8	50	72	70	111	30	
5	9	37	58	56	92	81		6	9	51	73	71	113	27	
5	10	–	–	–	84	78		6	10	–	–	–	107	24	
5	11	39	60	58	95	75		6	11	52	74	72	115	21	
5	12	40	62	60	97	72		6	12	53	76	74	117	18	
5	13	–	–	–	87	69		6	13	–	–	–	112	15	
5	14	41	63	61	98	66		6	14	54	78	76	122	12	
5	15	43	65	63	101	63		6	15	55	79	77	124	9	
5	16	–	61	59	96	60		6	16	–	81	79	129	6	
5	17	44	66	64	102	57		6	17	56	80	78	126	3	
5	18	–	–	–	89	54		6	18	–	–	–	114	0	

XC95108 Global, JTAG and Power Pins

Pin Type	PC84	PQ100	TQ100	PQ160
I/O/GCK1	9	24	22	33
I/O/GCK2	10	25	23	35
I/O/GCK3	12	29	27	42
I/O/GTS1	76	5	3	6
I/O/GTS2	77	6	4	8
I/O/GSR	74	1	99	159
TCK	30	50	48	75
TDI	28	47	45	71
TDO	59	85	83	136
TMS	29	49	47	73
V <sub>CCINT</sub> 5 V	38,73,78	7,59,100	5,57,98	10,46,94,157
V <sub>CCIO</sub> 3.3 V/5 V	22,64	28,40,53,90	26,38,51,88	1,41,61,81,121,141
GND	8,16,27,42,49,60	2,23,33,46,64,71,77,86	100,21,31,44,62,69,75,84	20,31,40,51,70,80,99
GND	–	–	–	100,110,120,127,137
GND	–	–	–	160
No connects	–	–	–	3,5,7,32,38,39,48,53,55,6 5,66,67,83,85,93,109, 118,119,125,130,131, 132,149,150,151

## Ordering Information



### Speed Options

- 20 20 ns pin-to-pin delay
- 15 15 ns pin-to-pin delay
- 10 10 ns pin-to-pin delay
- 7 7 ns pin-to-pin delay

### Packaging Options

- PC84 84-Pin Plastic Leaded Chip Carrier (PLCC)
- PQ100 100-Pin Plastic Quad Flat Pack (PQFP)
- TQ100 100-Pin Very Thin Quad Flat Pack (TQFP)
- PQ160 160-Pin Plastic Quad Flat Pack (PQFP)

### Temperature Options

- C Commercial 0°C to +70°C
- I Industrial -40°C to +85°C

## Component Availability

Pins		84	100		160
Type		Plastic PLCC	Plastic PQFP	Plastic TQFP	Plastic PQFP
Code		PC84	PQ100	TQ100	PQ160
<b>XC95108</b>	-20	C(I)	C(I)	C(I)	C(I)
	-15	C(I)	C(I)	C(I)	C(I)
	-10	C(I)	C(I)	C(I)	C(I)
	-7	C(I)	C(I)	C(I)	C(I)

C = Commercial = 0° to +70°C I = Industrial = -40° to +85°C

## Revision Control

Date	Revision
12/04/98	Update AC Characteristics and Internal Parameters