1 BIT INDUSTRIAL CONTROL UNIT

GENERAL DESCRIPT'ON

The MMC 4500 is a single bit, one-chip static CMOS processor. The industrial Control Unit (ICU) is design for the use in systems requiring decisions based on succesive single bit information. The control program is stored in an external ROM. With a program counter, output latches and input multiplexers, the ICU in a system, forms a stored program controller that replaces combinatorial logic. Applications include relay logic processing, serial data manipulation and control.

FEATURES

- 16 instructions
- Fully static operation
- Wide range of clock frequencies, typical 1 MHz operation at V_{DD} 5 V
- Executes one instruction per clock cycle
- Capable of driving one Low-Power Schottky load or two Low-Power TTL loads
- 3 to 18 V operation
- High noise immunity
- Low quiescent current

ABSOLUTE MAXIMUM RATINGS

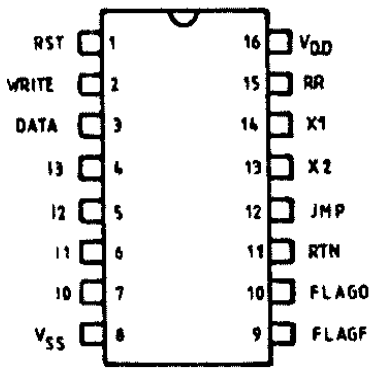
V_{DD}*	Supply voltage: G and H types	-0.5 to	20	V
	E and F types	-0.5 to	18	V
V_I	Input voltage	-0.5 to	V_{DD}+0.5	V
I_I	DC input current (any one input)		±10	mA
P_{tot}	Total power dissipation (per package)		200	mW
	Dissipation per output transistor for T_A = full package-temperature-range		100	mW
T_A	Operating temperature : G and H types	-55 to	125	°C
	E and F types	-40 to	85	°C
T_{stg}	Storage temperature	-65 to	150	°C

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

RECOMMENDED OPERATING CONDITIONS

V_{DD}*	Supply voltage: G and H types	3 to	18	V
	E and F types	3 to	15	V
V_I	Input voltage	0 to	V_{DD}	V
T_A	Operating temperature : G and H types	-55 to	125	°C
	E and F types	-40 to	85	°C

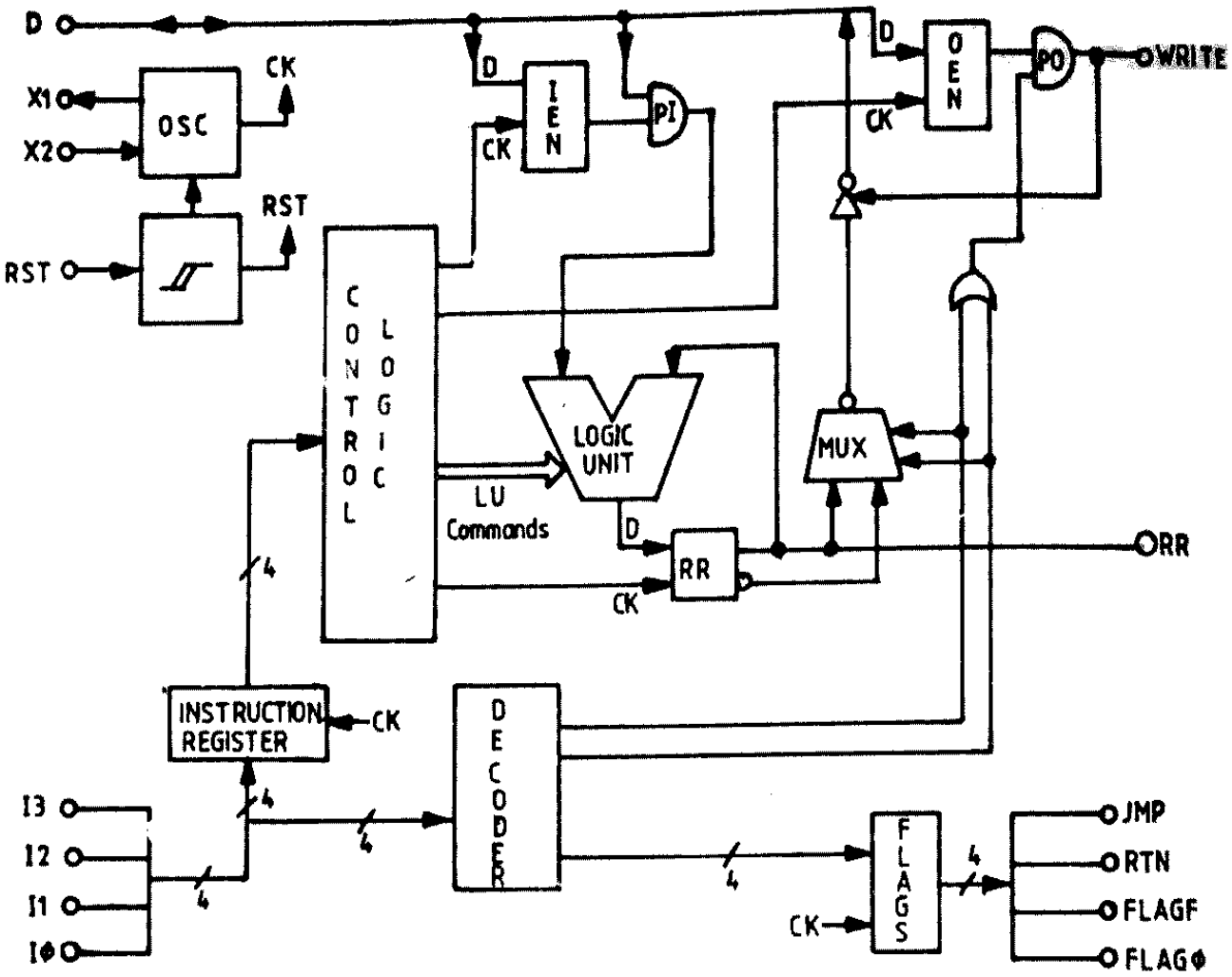
CONNECTION DIAGRAM



PIN FUNCTION

Pin No.	Function	Symbol
1	Chip Reset	RST
2	Write Pulse	WRITE
3	Data In/Out	DATA
4	MSB Instruction Word	I3
5	Bit 2 Instruction Word	I2
6	Bit 1 Instruction Word	I1
7	LSB Instruction Word	I0
8	Ground	V_{SS}
9	Flag on NOPF	FLAGF
10	Flag on NOPO	FLAGO
11	Subroutine Return Flag	RTN
12	Jump Instruction Flag	JMP
13	Oscillator Input	X2
14	Oscillator Output	X1
15	Result Register	RR
16	Positive Supply	V_{DD}

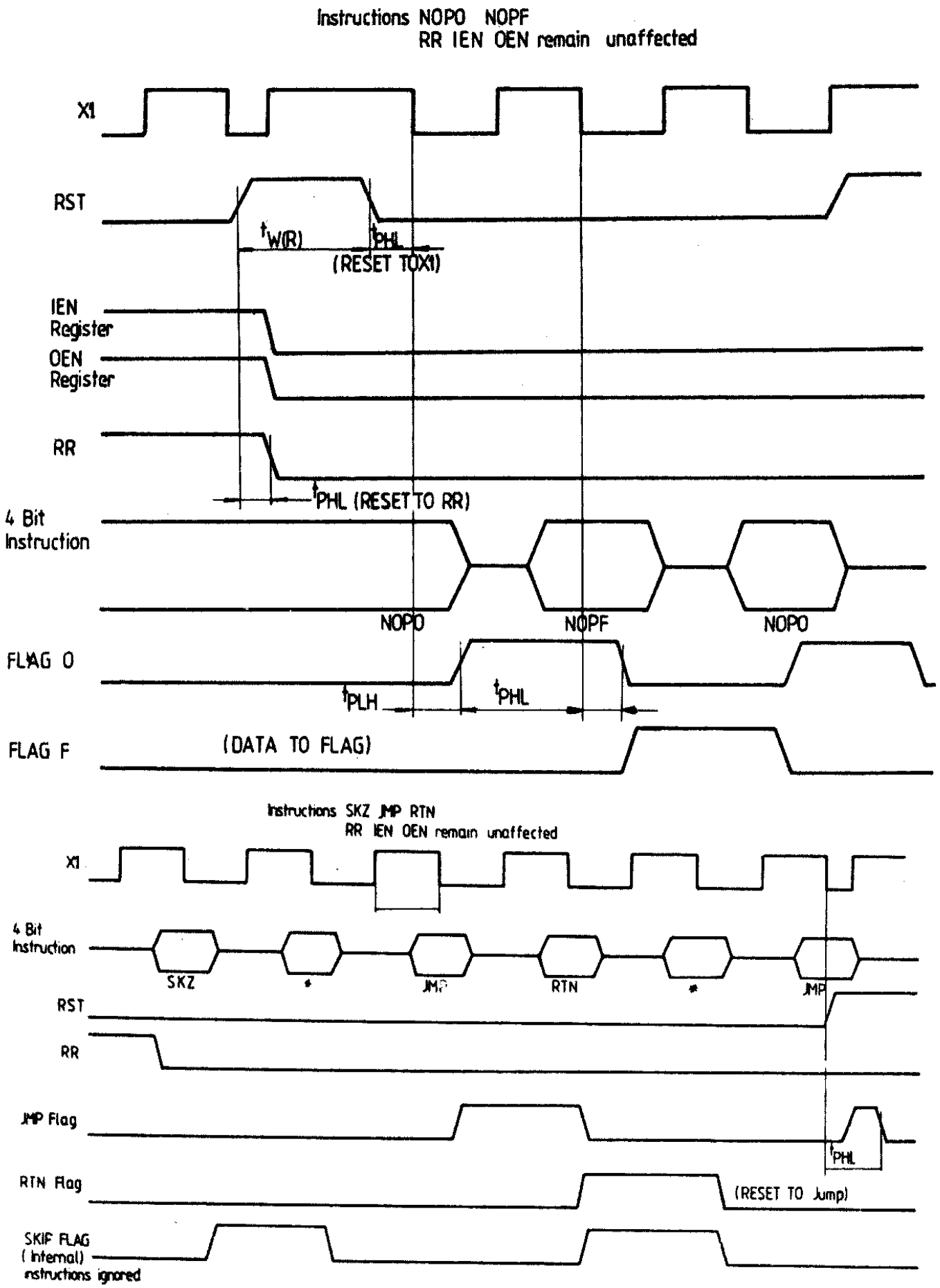
BLOCK DIAGRAM



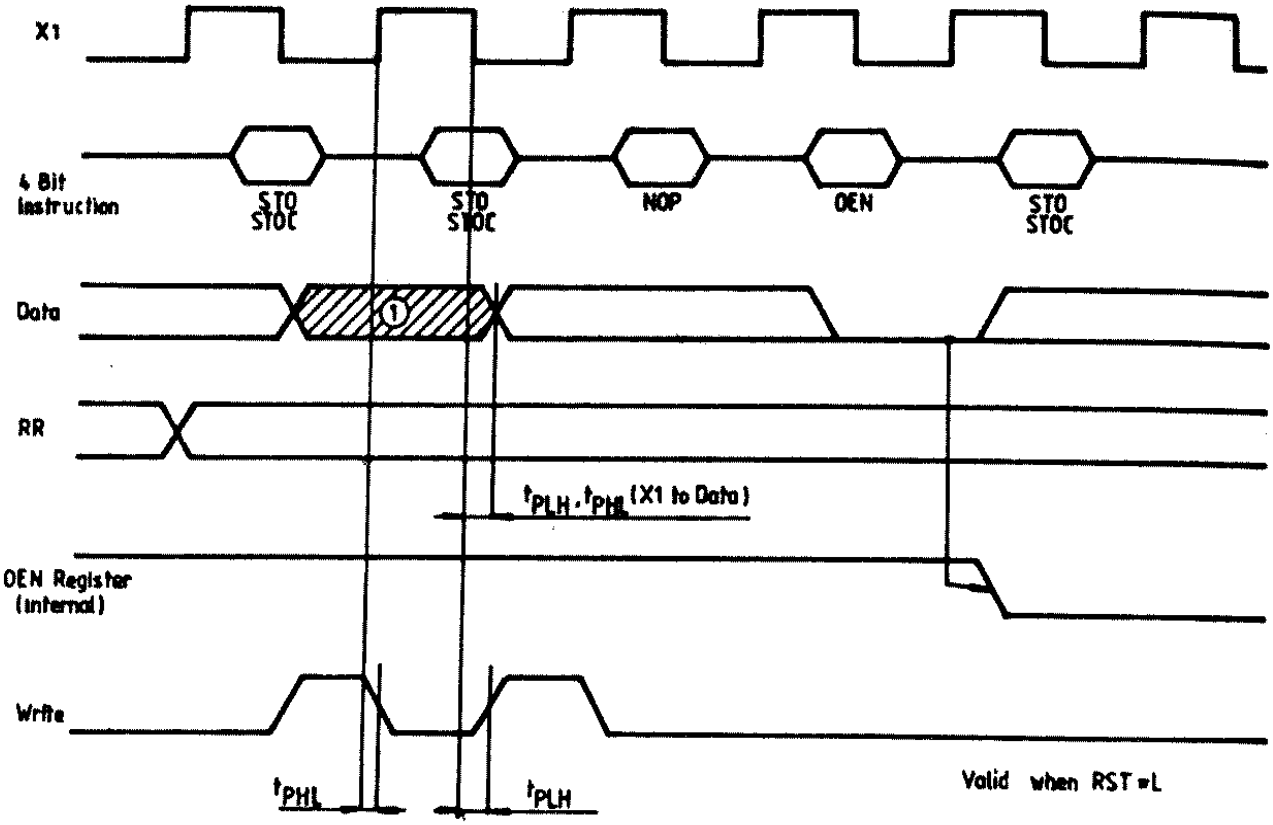
MMC 4500 - INSTRUCTION SET

Instruction	Code	Mnemonic	Action
0	0000	NOPO	No Change in registers; RR ← RR, FLAGO ← ⎍
1	0001	LD	Load result register;RR ← DATA
2	0010	LDC	Load complement; RR ← $\overline{DATA}$
3	0011	AND	Logical AND; RR ← RR * DATA
4	0100	ANDC	Logical AND with complement; RR ← RR * $\overline{DATA}$
5	0101	OR	Logical OR, RR ← RR + DATA
6	0110	ORC	Logical OR with complement; RR ← RR + $\overline{DATA}$
7	0111	XNOR	Exclusiv NOR, if RR = DATA, RR ← 1
8	1000	STO	Store; DATA → RR, WRITE → ⎍
9	1001	STOC	Store complement, DATA → RR, WRITE ← ⎍
10	1010	IEN	Input enable, IEN Register ← DATA
11	1011	OEN	Output enable; OER Register ← DATA
12	1100	JMP	Jump, JMP Flag → ⎍
13	1101	RTN	Return, RTN Flag → ⎍ [illegible]
14	1110	SKZ	Skip next instruction if RR = 0
15	1111	NOPF	No change in registers, RR ← RR, FLAGF → ⎍

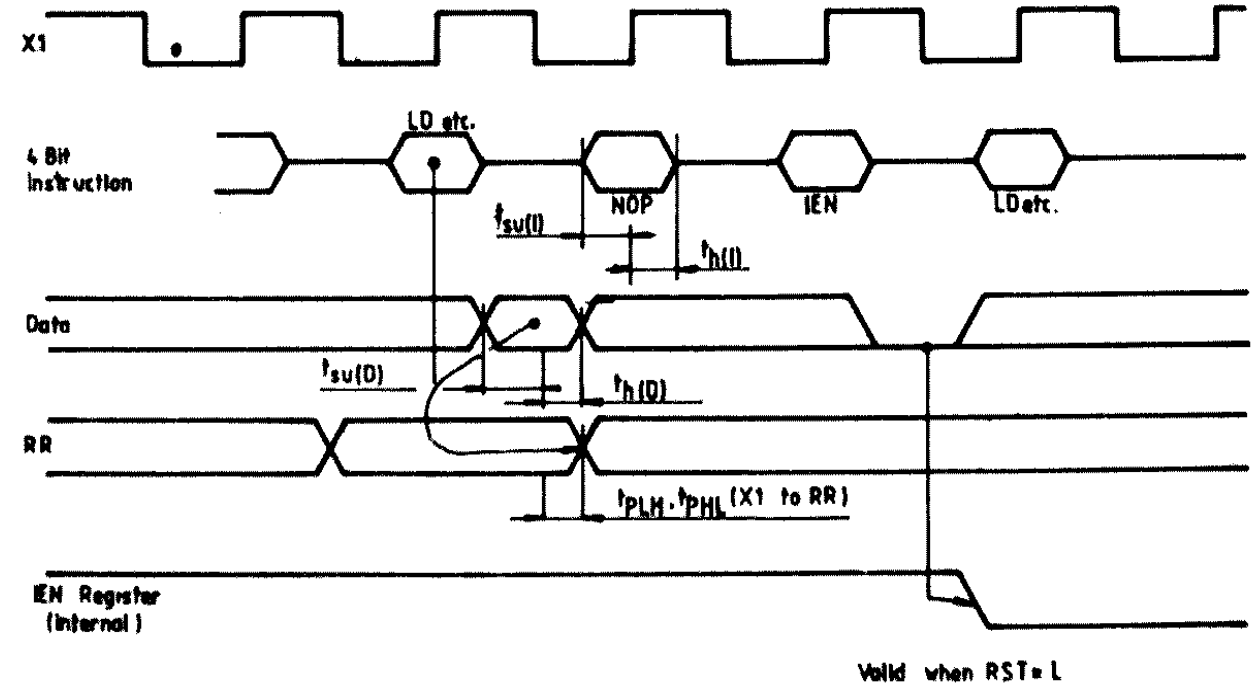
TIMING DIAGRAM



TIMING DIAGRAM



NOTE: 1. Valid output data



STATIC ELECTRICAL CHARACTERISTICS

(over recommended operating conditions)

PARAMETER		TEST CONDITIONS V_I (V)	V_O (V)	I_O (μA)	V_{DD} (V)	VALUES T^*_{LOW} min.	T^*_{LOW} max.	25°C min.	25°C typ	25°C max.	T^*_{HIGH} min.	T^*_{HIGH} max.	UNIT
I_L —Quiescent current	G, H types	0/ 5			5		5		0.04	5		150	
		0/10			10		10		0.04	10		300	
		0/15			15		20		0.04	20		600	
		0/20			20		100		0.08	100		3000	μA
	E, F 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		
		0/10		< 1	10	9.95		9.95			9.95		V
		0/15		< 1	15	14.95		14.95			14.95		
V_{OL} —Output low voltage		5 /0		< 1	5		0.05			0.05		0.05	
		10/0		< 1	10		0.05			0.05		0.05	V
		15/0		< 1	15		0.05			0.05		0.05	
V_{IH} —Input high voltage			0.5/4.5	< 1	5	3.5		3.5			3.5		
			1/9	< 1	10	7		7			7		V
			1.5/13.5	< 1	15	11		11			11		
V_{IL} —Input low voltage			4.5/0.5	< 1	5		1.5			1.5		1.5	
			9/1	< 1	10		3			3		3	V
			13.5/1.5	< 1	15		4			4		4	
V_{IH} Input High Voltage (I3,I2,I1,I0, Pins			0.5/4.5	< 1	5	2.5		2.5	2.2		2.5		
			1/9	< 1	10	6		6	3.1		6		V
			1.5/13.5	< 1	15	15		10	4.3		10		
V_{IL} Input Low Voltage (I3,I2,I1,I0, Pins)			4.5/0.5	< 1	5		0.8		1.1	0.8		0.8	
			9/1	< 1	10		1.6		2.2	1.6		1.6	V
			13.5/1.5	< 1	15		2.4		3.4	2.4		2.4	
I_{OH} —Output drive current	G, H types	0/ 5	2.5		5	−2		−1.6	−3.2		−1.15		
		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		mA
	E, F 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		
		0/15	13.5		15	−3.6		−3.0	−6.8		−2.4		
I_{OL} —Output sink current	G, H types	0/ 5	0.4		5	0.64		0.51	1		0.36		
		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		mA
	E, F 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_{OH} Output drive Current (DATA, WRITE Pins) All types		0/ 5	4.6		5	−1.2		−1.0	−2.0		−0.7		
		0/10	9.5		10	−3.6		−3.0	−6.0		−2.1		mA
		0/15	13.5		15	−7.2		−6.0	−12.0		−4.2		
I_{OL} Output Sink Current (DATA, Write Pins) All types		0/ 5	0.4		5	1.9		1.6	3.2		1.1		
		0/10	0.5		10	3.6		3.0	6.0		2.1		mA
		0/15	7.2		15	6.0		6.0	12.0		4.2		

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_{OH} 3—state output	G, H types	0/18	0/18		18		±0.4		$±10^{-4}$	±0.4		±12	μA
	E, F types	0/15	0/15		15		±1.0		$±10^{-4}$	±1.0		±7.5	
I_{in} Input Current (RST Pin)					15	25			150			250	μA
I_{IH} I_{IL} Input leakage current	G, H types	0/18	Any input		18		±0.1		$±10^{-5}$	±0.1		±1	μA
	E, F types	0/15			15		±0.3		$±10^{-5}$	±0.3		±1	
C_I —Input capacitance			Any input						5	7.5			pF
C_{in} Input Capacitance (DATA Pin)									15				pF
I^* Total Supply Current at on External Load Capacitance (CL) on All outputs					5	$I_T=(1.5\mu A/kHz)xf+I_L$							μA
					10	$I_T=(3.0\mu A/kHz)xf+I_L$							
					15	$I_T=(4.5\mu Ak/Hz)xf+I_L$							

* The formulas given are for the typical characteristics only at 25°C

* T_{LOW} = −55°C for G, H devices; −40°C for E, F devices.
* T_{HIGH} = +125°C for G, H devices; +85°C for E, F devices.

The Noise Margin for both "1" and "0" level is:

1 V min. with V_{DD} = 5 V
2 V min. with V_{DD} = 10 V
2.5 V min. with V_{DD} = 15 V

DYNAMIC ELECTRICAL CHARACTERISTICS

(T_A=25°C; C_L=50pF for JMP, X1, RR, FLAGO, FLAGF; C_L=130pF+1TTL load for DATA and WRITE R_L=200K; all inputs rise and fall times=20 ns).

CHARACTERISTICS	SYMBOL	V_{DD}	VALUES Min.	Typ.	Max.	UNITS
Propagation delay Time X1 to RR	t_{dR}	5	—	250	500	ns
		10	—	125	250	
		15	—	100	200	
X1 to FLAG F, FLAG O RTN, JMP	t_{dF}	5	—	200	400	
		10	—	100	200	
		15	—	85	170	
X1 to WRITE	t_{dW}	5	—	225	450	
		10	—	125	250	
		15	—	100	200	
X1 to DATA	t_{dD}	5	—	250	500	
		10	—	120	240	
		15	—	100	200	
RST to RR	t_{dRRR}	5	—	250	500	
		10	—	125	250	
		15	—	100	200	
RST to X1	t_{dRX}	5	—	450	Note 1	
		10	—	200		
		15	—	150		
RST to FLAG F, FLAG O, RTN, JMP	t_{dRF}	5	—	400	800	
		10	—	200	400	
		15	—	150	300	
RST to WRITE, DATA	t_{dRW}	5	—	450	900	
		10	—	225	450	
		15	—	175	350	
Clock Pulse Width, X1	$t_{W(c1)}$	5	400	200	—	ns
		10	200	100	—	
		15	180	90	—	
Reset Pulse Width, RST	$t_{W(R)}$	5	500	250	—	ns
		10	250	125	—	
		15	200	100	—	
Setup time, instruction	$t_{SU(I)}$	5	400	200	—	ns
		10	250	125	—	
		15	180	90	—	
Data	$t_{SU(D)}$	5	200	100	—	
		10	100	50	—	
		15	80	40	—	
Hold Time Instruction	$t_{h(I)}$	5	100	0	—	ns
		10	50	0	—	
		15	50	0	—	
Data	$t_{h(D)}$	5	200	100	—	
		10	100	50	—	
		15	100	50	—	

Note 1 Maximum reset Delay may extend to one half clock period
Data tabelled "Typ" is not to be used for design purposes but is intended as an indication of the IC potential performance

TYPICAL APPLICATIONS