OKI Semiconductor

This version: Sep. 1998
Previous version: Mar. 1996

MSM6411A

High speed and Simple 4-Bit Microcontroller

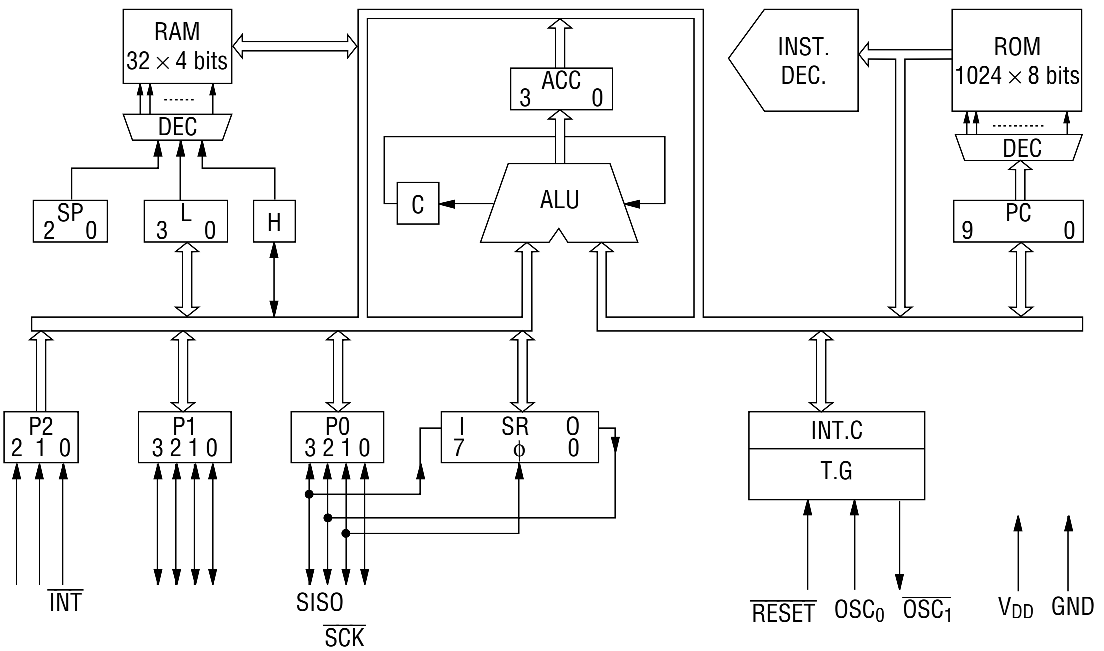
GENERAL DESCRIPTION

The MSM6411A, implemented in complementary metal-oxide semiconductor technology, is a low-power CMOS 4-bit microcontroller developed for smaller-scale control systems.

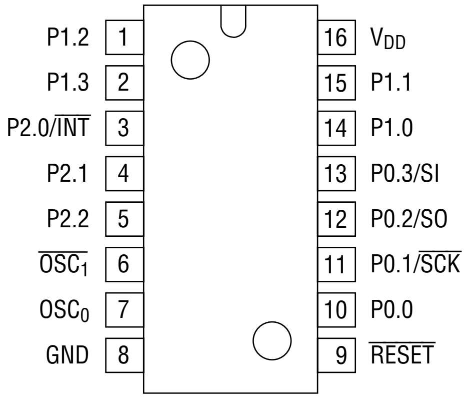
FEATURES

- ROM : 1024 words × 8 bits
- RAM : 32 words × 4 bits
- I/O port
  - Input-output port : 2 ports × 4 bits
  - Input port : 1 port × 3 bits
- 8-bit serial shift register
- 2 interrupt sources (1 external, 1 internal)
- 63 instructions
- Power-down features
- Minimum instruction execution time : 952 ns @ 4.2 MHz clock
- Single 5 V power supply
- Package:
  - 16-pin plastic DIP (DIP16-P-300-2.54) : (Product name : MSM6411A-××RS)
    ×× indicates a code number.

BLOCK DIAGRAM



PIN CONFIGURATION (TOP VIEW)



16-Pin Plastic DIP

PIN DESCRIPTIONS

Pin	Symbol	Type	Description	During reset
10 11 12 13	P0.0 P0.1/$\overline{SCK}$ P0.2/SO P0.3/SI	I/O	4-bit input-output port. P0.1 to P0.3 are used as both input-output ports and shift register pins.	"1"
14 15 1 2	P1.0 P1.1 P1.2 P1.3	I/O	4-bit input-output port.	"1"
3 4 5	P2.0/$\overline{INT}$ P2.1 P2.2	I	3-bit input port with latch. P2.0 is used as both input port and $\overline{INT}$ input pin (falling edge trigger input).	Latch is reset. ("0")
7	OSC_0	I	System clock input pin.	Clocked in
6	$\overline{OSC_1}$	0	System clock output pin. This pin and OSC_0 pin make up the oscillator circuit.	—
9	$\overline{RESET}$	I	Input pin for system reset.	—
16	V_{DD}	I	Power supply voltage pin.	—
8	GND	I	Ground pin.	—

INSTRUCTION LIST

	Mnemonic	Code	Byte	Cycle	Description
Load, Push, Pop, Exchange	LAI n	90-9F	1	1	A←n
	LLI n	80-8F	1	1	L←n
	LHLI nn	15nn	2	2	HL←nn
	LAL	21	1	1	A←L
	LLA	2D	1	1	L←A
	LAM	38	1	1	A←M
	LMA	2F	1	1	M←A
	LAMD mm	10mm	2	2	A←Md
	LMAD mm	11mm	2	2	Md←A
	LMSR	3E5A	2	2	M(w)←SR
	LSRM	3E52	2	2	SR←M(w)
	PUSH	1C	1	3	ST←C, A, H, L, SP←SP – 1
	POP	1D	1	3	C, A, H, L←ST, SP←SP + 1
	X	28	1	1	A←M
Increment and Decrement	INL	31	1	1	L←L + 1, SKIP IF L = "0"
	INH	32	1	1	H←H + 1, SKIP IF H = "0"
	INM	33	1	1	M←M + 1, SKIP IF M = "0"
	INMD mm	12mm	2	2	Md←Md – 1, SKIP IF Md = "0"
	DCL	35	1	1	L←L – 1, SKIP IF L = "F"
	DCH	36	1	1	H←H – 1
	DCM	37	1	1	M←M – 1, SKIP IF M = "F"
Arithmetic	ADS	02	1	1	A←A + M, SKIP IF Cy = "1"
	ADC	03	1	1	C, A←C + A + M
	AIS n	3E4n	2	2	A←A + n, SKIP IF Cy = "1"
	DAS	0A	1	1	A←A + 10
	AND	0D	1	1	A←A∧M
	EOR	04	1	1	A←A∀M
	CMA	0B	1	1	A←$\overline{A}$
	CAM	16	1	1	SKIP IF A = M
	SC	07	1	1	C←"1"
	RC	08	1	1	C←"0"
	TC	09	1	1	SKIP IF C = "1"
	RAL	0E	1	1	A C←3←2←1←0←

INSTRUCTION LIST (continued)

	Mnemonic	Code	Byte	Cycle	Description
Bit manipulation	TAB n2	54-57	1	1	SKIP IF [A bit n2] = "1"
	TMB n2	58-5B	1	1	SKIP IF [M bit n2] = "1"
	RMB n2	68-6B	1	1	[M bit n2]←"0"
	SMB n2	78-7B	1	1	[M bit n2]←"1"
	TPBD p•n2	3D p0 to 3	2	2	SKIP IF [Pp bit n2] = "1"
	RPBD p•n2	3D p4 to 7	2	2	[Pp bit n2]←"0"
	SPBD p•n2	3D p8 to B	2	2	[Pp bit n2]←"1"
Interrupt	MEI	3E60	2	2	MEIF←"1"
	MDI	3E61	2	2	MEIF←"0"
	EICT	3DCB	2	2	EICTF←"1"
	EIEX	3DC8	2	2	EIEXF←"1"
	DICT	3DC7	2	2	EICTF←"0"
	DIEX	3DC4	2	2	EIEXF←"0"
	TICT	3DC3	2	2	SKIP IF EICTF = "1"
	TIEX	3DC0	2	2	SKIP IF EIEXF = "1"
	TQEX	3D20	2	2	SKIP IF IRQEX = "1"
	TQSR	3DD3	2	2	SKIP IF IRQSR = "1"
	RQEX	3D24	2	2	IRQEX←"0"
	RQSR	3DD7	2	2	IRQSR←"0"
Shift register	ESR	3DBA	2	2	SRF←"1"
	DSR	3DB6	2	2	SRF←"0"
	TSR	3DB2	2	2	SKIP IF SRF = "1"
Branch	JCP a_6	C0 to FF	1	1	PC←a_6
	JP a_{10}	40 to 43 00 to FF	2	2	PC←a_{10}
	CAL a_{10}	A0 to A3 00 to FF	2	4	ST←PC + 2, PC←a_{10}, SP←SP - 1
Input/ output	RT	IE	1	4	PC←ST, SP←SP + 1
	IPD p	3DpD	2	2	A←Pp
	OPD p	3DpC	2	2	Pp←A
CPU control	STOP	3DB9	2	2	STOP CLOCK
	NOP	00	1	1	NO OPERATION

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Condition	Rating	Unit
Power Supply Voltage	V_{DD}	Ta = 25°C	–0.3 to +7	V
Input Voltage	V_I		–0.3 to V_{DD}	V
Output Voltage	V_O		–0.3 to V_{DD}	V
Power Dissipation	P_D	Ta = 25°C per package	200 max.	mW
		Ta = 25°C per output	50 max.	mW
Storage Temperature	T_{STG}	—	–55 to +150	°C

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Condition	Range	Unit
Power Supply Voltage	V_{DD}	$f_{OSC} \leq 1$ MHz	3 to 6	V
		$f_{OSC} \leq 4.2$ MHz	4.5 to 5.5	V
Data-Hold Voltage	V_{DDH}	$f_{OSC} \leq 0$ Hz	2 to 6	V
Operating Temperature	T_{op}	—	–40 to +85	°C
Fan Out	N	MOS load	15	—
		TTL load	1	

ELECTRICAL CHARACTERISTICS

DC Characteristics

(V_{DD} = 5 V ±10%, Ta = –40 to +85°C)

Parameter		Symbol	Condition	Min.	Typ.	Max.	Unit
"H" Input Voltage	*1,*2	V_{IH}	—	2.4	—	V_{DD}	V
"H" Input Voltage	*3,*4	V_{IH}	—	3.6	—	V_{DD}	V
"L" Input Voltage		V_{IL}	—	–0.3	—	+0.8	V
"H" Output Voltage	*1,*5	V_{OH}	I_O = –15 µA	4.2	—	—	V
"L" Output Voltage	*1	V_{OL}	I_O = 1.6 mA	—	—	0.4	V
"L" Output Voltage	*5	V_{OL}	I_O = 15 µA	—	—	0.4	V
Input Current	*3	I_{IH}/I_{IL}	$V_I = V_{DD}$/0 V	—	—	15/–15	µA
Input Current	*2,*4	I_{IH}/I_{IL}	$V_I = V_{DD}$/0 V	—	—	1/–30	µA
"H" Output Current	*1	I_{OH}	V_O = 2.4 V	–0.1	—	—	mA
"H" Output Current	*1	I_{OH}	V_O = 0.4 V	—	—	–1.2	mA
Input Capacitance		C_I	f = 1 MHz, Ta = 25°C	—	5	—	pF
Output Capacitance		C_O		—	7	—	
Power Supply Current (In Stop Mode)		I_{DDS}	V_{DD} = 2 V, no load, Ta = 25°C	—	0.2	5	µA
			No load	—	1	100	µA
Power Supply Current		I_{DD}	Crystal oscillation, no load, 4.2 MHz	—	6	12	mA

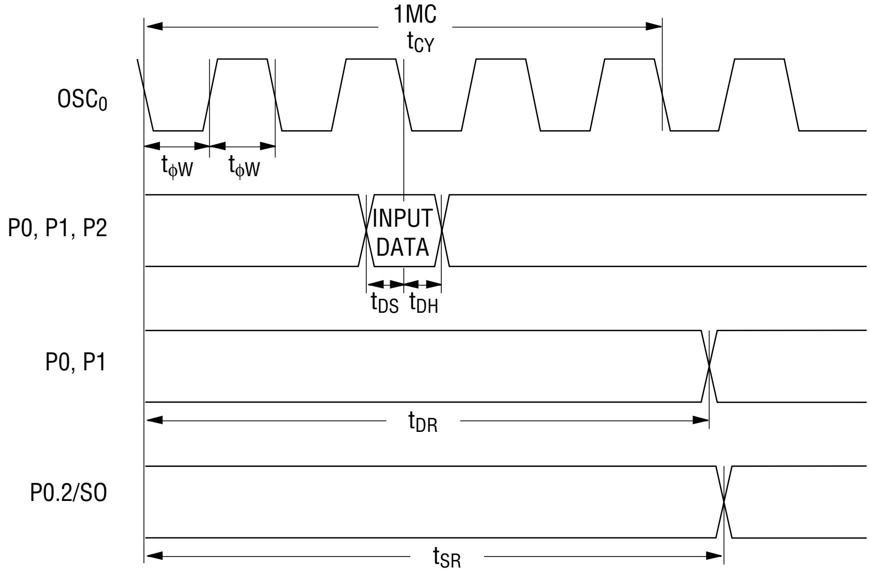
*1 Applied to P0 and P1
*2 Applied to P2
*3 Applied to OSC_0
*4 Applied to $\overline{RESET}$
*5 Applied to $\overline{OSC_1}$

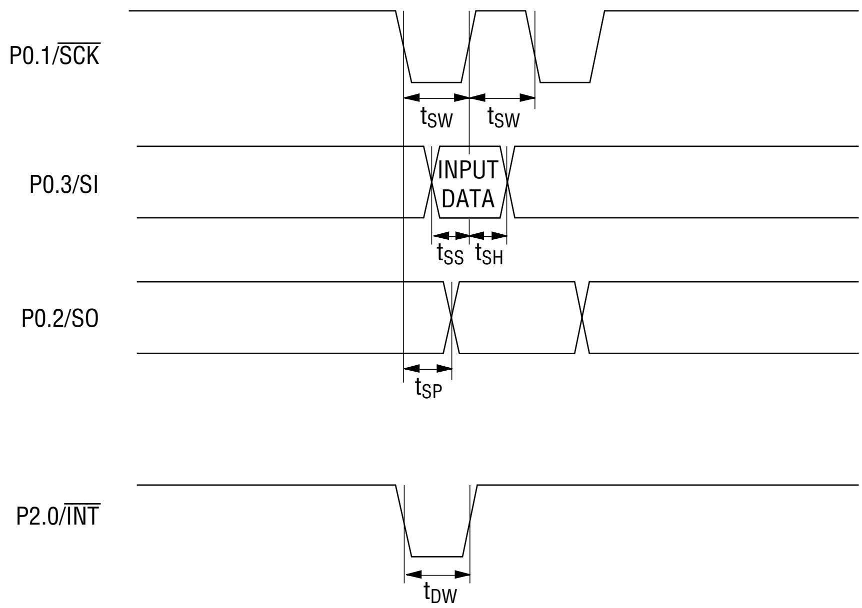
AC Characteristics

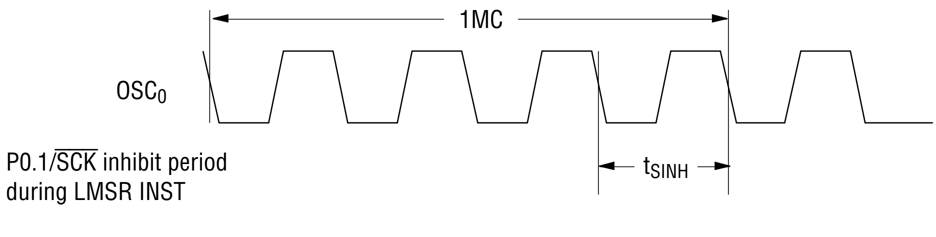
(V_{DD} = 5 V ±10%, Ta = –40 to +85°C)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Clock (OSC_0) Pulse Width	$t_{\phi W}$	—	119	—	—	ns
Cycle Time	t_{CY}	—	952	—	—	ns
Input Data Setup Time	t_{DS}	—	120	—	—	ns
Input Data Hold Time	t_{DH}	—	120	—	—	ns
Input Data/Input Clock Pulse Width	t_{DW}	—	120	—	—	ns
SR Clock Pulse Width	t_{SW}	—	$t_{\phi W}$	—	—	ns
SR Data Setup Time	t_{SS}	—	120	—	—	ns
SR Data Hold Time	t_{SH}	—	120	—	—	ns
Data Delay Time	t_{DR}	C_L = 15 pF	—	—	t_{CY} + 300	ns
PORT Clock SR Data Delay Time	t_{SR}	C_L = 15 pF	—	—	t_{CY} + 480	ns
External Clock SR Data Delay Time	t_{SP}	C_L = 15 pF	—	—	360	ns
SR Clock Invalid Time	t_{SINH}	—	2/8 t_{CY}	—	—	ns

Timing Diagrams

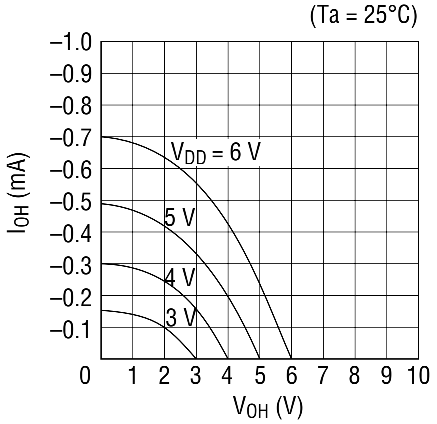




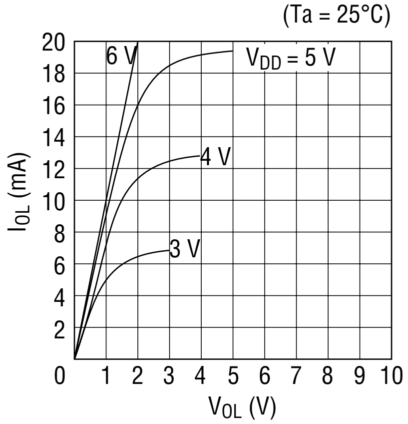


Operating Characteristics

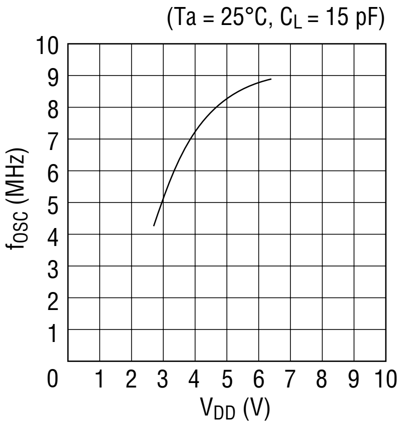
Current (I_{OH}) vs. Voltage (V_{OH}) for High State Output



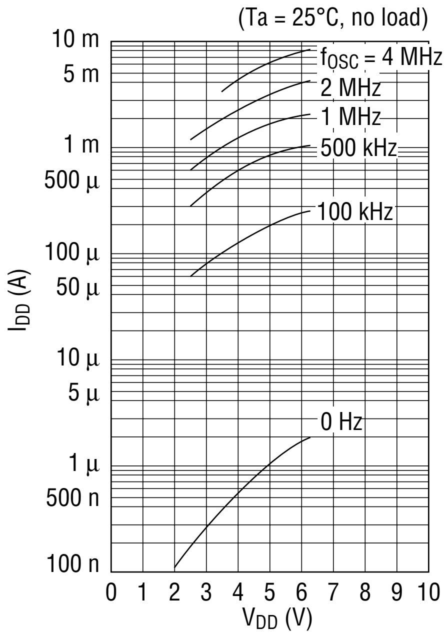
Current (I_{OL}) vs. Voltage (V_{OL}) for Low State Output



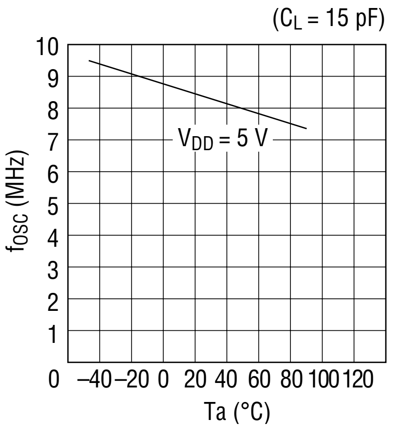
Maximum Clock Frequency (f_{OSC}) vs. Supply Voltage (V_{DD})



Supply Current (I_{DD}) vs. Supply Voltage (V_{DD})



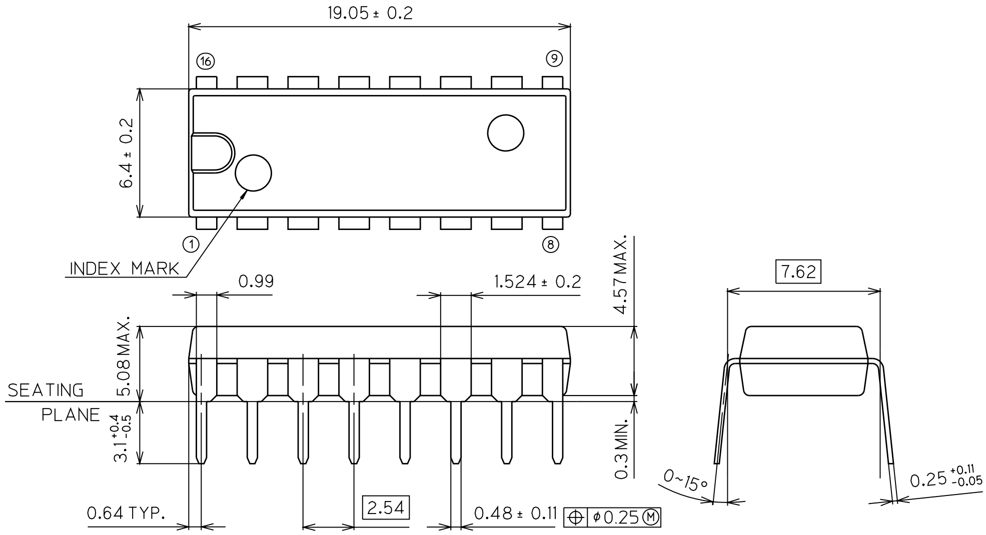
Maximum Clock Frequency (f_{OSC}) vs. Temperature (Ta)



PACKAGE DIMENSIONS

(Unit : mm)

DIP16-P-300-2.54



Package material	Epoxy resin
Lead frame material	42 alloy
Pin treatment	Solder plating
Solder plate thickness	5 μm or more
Package weight (g)	0.99 TYP.