1 PRODUCT OVERVIEW

KS88-SERIES MICROCONTROLLES

Samsung's KS88 series of 8-bit single-chip CMOS microcontrollers offers a fast and efficient CPU, a wide range of integrated peripherals, and various mask-programmable ROM sizes. Among the major CPU features are:

— Efficient register-oriented architecture

— Selectable CPU clock sources

— Idle and Stop power-down mode release by interrupt

— Built-in basic timer with watchdog function

A sophisticated interrupt structure recognizes up to eight interrupt levels. Each level can have one or more interrupt sources and vectors. Fast interrupt processing (within a minimum of six CPU clocks) can be assigned to specific interrupt levels.

KS88C2148/P2148 MICROCONTROLLER

The KS88C2148/P2148 single-chip CMOS microcontroller is fabricated using the highly advanced CMOS process, based on Samsung's newest CPU architecture.

The KS88C2148 is a microcontroller with a 48-Kbyte mask-programmable ROM embedded.

The KS88P2148 is a microcontroller with a 48-Kbyte one-time-programmable ROM embedded.

Using a proven modular design approach, Samsung engineers have successfully developed the KS88C2148/P2148 by integrating the following peripheral modules with the powerful SAM8 core:

— Six programmable I/O ports, including five 8-bit ports and one 7-bit port, for a total of 47 pins.

— Twelve bit-programmable pins for external interrupts.

— One 8-bit basic timer for oscillation stabilization and watchdog functions (system reset).

— One 8-bit timer/counter and one 16-bit timer/counter with selectable operating modes.

— Watch timer for real time.

— 4-input A/D converter

— Serial I/O interface

The KS88C2148/P2148 is versatile microcontroller for cordless phone, pager, etc. They are currently available in 80-pin TQFP and 80-pin QFP package.

OTP

The KS88P2148 is an OTP (One Time Programmable) version of the KS88C2148 microcontroller. The KS88P2148 microcontroller has an on-chip 48-Kbyte one-time-programmable EPROM instead of a masked ROM. The KS88P2148 is comparable to the KS88C2148, both in function and in pin configuration.

FEATURES

CPU

- SAM8 CPU core

Memory

- Data memory: 1040-byte of internal register file (Excluding LCD RAM)
- Program memory: 48-Kbyte internal program memory (ROM)

External Interface

- 64-Kbyte external data memory area

Instruction Execution Time

- 750 ns at 8 MHz (minimum, Main oscillator)
- 183 μs at 32,768 Hz (minimum, Sub oscillator)

Interrupts

- 7 interrupt levels and 19 interrupt sources
- 19 vectors
- Fast interrupt processing feature (for one selected interrupt level)

I/O Ports

- Five 8-bit I/O ports (P0-P4) and one 7-bit I/O port (P5) for a total of 47 bit-programmable pins

8-Bit Basic Timer

- One programmable 8-bit basic timer (BT) for oscillation stabilization control or watchdog timer (software reset) function

Watch Timer

- Time internal generation: 3.91 ms, 0.5 s at 32,768 Hz
- Four frequency outputs to BUZ pin
- Clock source generation for LCD

Timers and Timer/Counters

- One 8-bit timer/counter (Timer 0) with three operating modes: Interval, Capture, and PWM
- One 16-bit timer/counter (Timer 1) with two 8-bit timer/counter modes

LCD Controller/Driver

- UP to 32 segment pins
- 3, 4, and 8 common selectable
- Choice of duty cycle
- All dots can be switched on/off
- Internal resistor circuit for LCD bias

Serial Port

- One synchronous SIO

A/D Converter

- 8-bit conversion resolution × 4 channel
- 34 μs conversion time(4 MHz CPU clock, fxx/4)

Oscillation Sources

- Crystal, ceramic, or RC for main system clock
- Crystal or external oscillator for subsystem clock
- Main system clock frequency: 8 MHz
- Subsystem clock frequency: 32.768 kHz

Power-Down Modes

- Main idle mode (only CPU clock stops)
- Sub idle mode
- Stop mode (main/sub system oscillation stops)

Operating Temperature Range

- – 40°C to + 85°C

Operating Voltage Range

- 2.0 V to 5.5 V at 32 kHz (sub clock)-6 MHz (main clock)
- 2.2 V to 5.5 V at 8 MHz

Package Type

- 80-pin TQFP, 80-pin QFP

BLOCK DIAGRAM

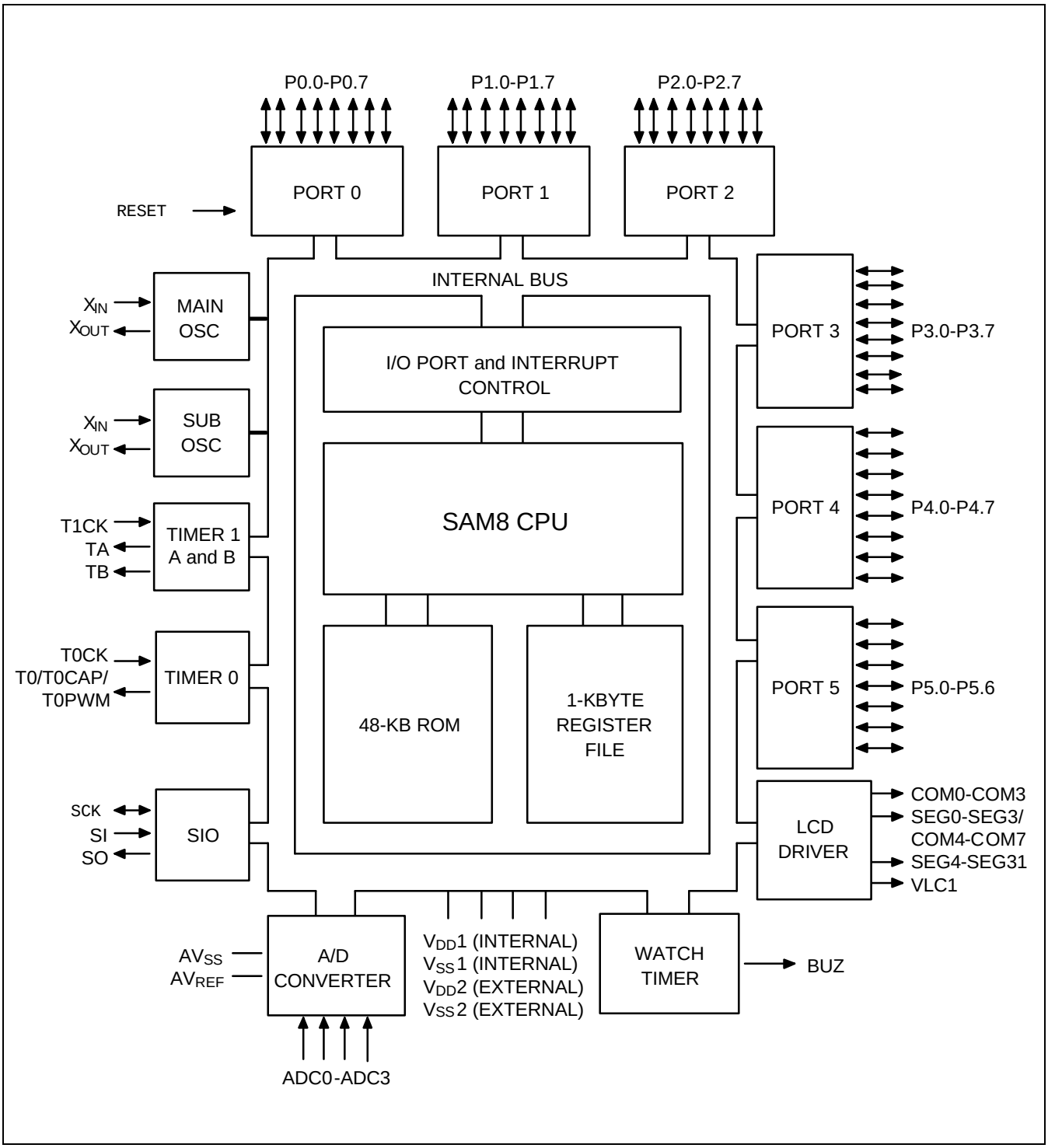


Figure 1-1. KS88C2148 Simplified Block Diagram

PIN ASSIGNMENTS

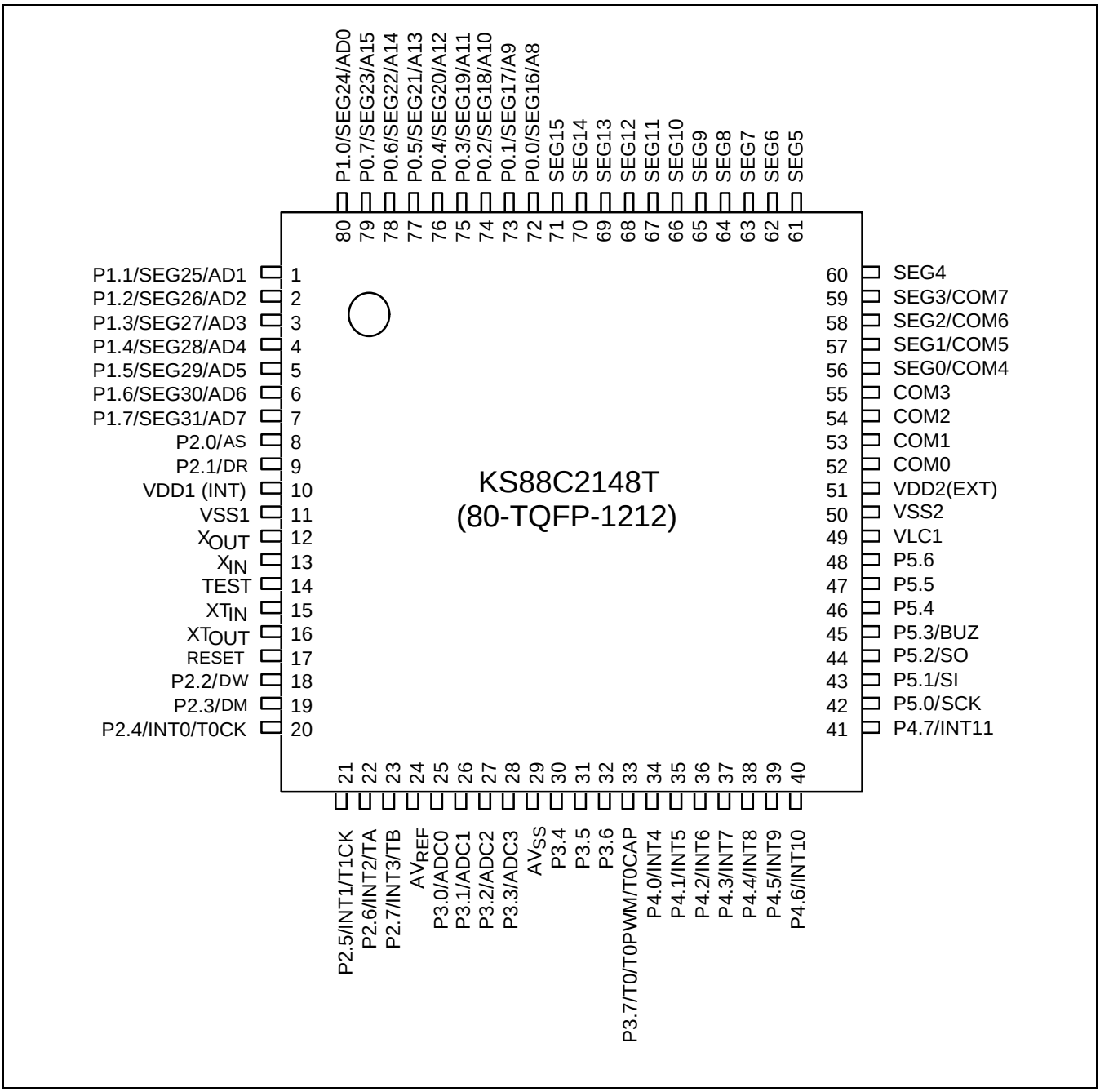


Figure 1-2. KS88C2148 Pin Assignments (80TQFP)

PIN ASSIGNMENTS (Continued)

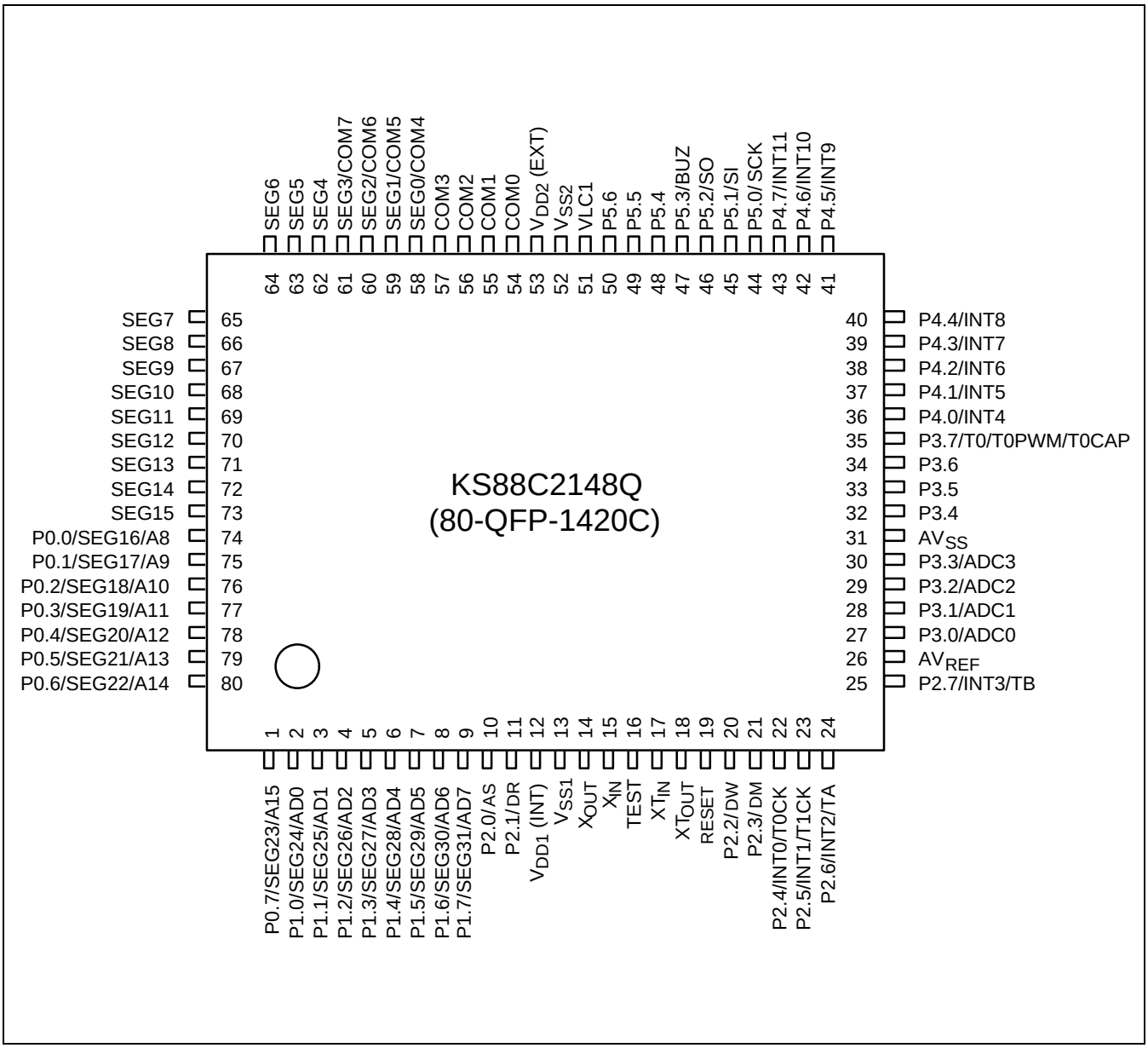


Figure 1-3. KS88C2148 Pin Assignments (80QFP)

PIN DESCRIPTIONS

Table 1-1. KS88C2148 Pin Descriptions

Pin Names	Pin Type	Pin Description	Circuit Type	Pin Numbers (note)	Share Pins
P0.0-P0.7	I/O	4-bit-programmable I/O port. Pull-up resistors and open-drain outputs are software assignable. Pull-up resistors are automatically disabled for output pins. Configurable as LCD segments/ external interface address and data lines	H-32	72-79 (74-80, 1)	SEG16/A8 – SEG23/A15
P1.0-1.7	I/O	4-bit-programmable I/O port. Pull-up resistors and open-drain outputs are software assignable. Pull-up resistors are automatically disabled for output pins. Configurable as LCD segments/ external interface address and data lines	H-32	80, 1-7 (2-9)	SEG24/AD0 – SEG31/AD7
P2.0 P2.1 P2.2 P2.3 P2.4 P2.5 P2.6 P2.7	I/O	1-bit-programmable I/O port. Pull-up resistors are software assignable, and automatically disabled for output pins. P2.0-P2.3 can alternately be used as external interface lines. P2.4-P2.7 are configurable as alternate functions or external interrupts at falling edge with noise filters.	D-4	8 (10) 9 (11) 18 (20) 19 (21) 20 (22) 21 (23) 22 (24) 23 (25)	AS DR DW DM INT0/T0CK INT1/T1CK INT2/TA INT3/TB
P3.0-P3.3 P3.4-P3.6 P3.7	I/O	1-bit-programmable I/O port. Pull-up resistors are software assignable, and automatically disabled for output pins. P3.0-P3.3 can alternately be used as ADC. P3.7 is configurable as an alternate function.	F-16 D-4 D-4	25-28 (27-30) 30-32 (32-34) 33 (35)	ADC0-ADC3 T0/T0PWM/ T0CAP
P4.0–P4.7	I/O	1-bit-programmable I/O port. Pull-up resistors and open-drain outputs are software assignable. Pull-up resistors are automatically disabled for output pins. P4.0-P4.7 are configurable as external interrupts at a selectable edge with noise filters.	E-4	34-41 (36-43)	INT4-INT11
P5.0 P5.1 P5.2 P5.3 P5.4-P5.6	I/O	1-bit-programmable I/O port. Pull-up resistors are software assignable, and automatically disabled for output pins. P5.0-P5.3 are configurable as alternate functions. If SCK and SI are used as input, these pins have noise filters.	D-4	42 (44) 43 (45) 44 (46) 45 (47) 46-48 (48-50)	SCK SI SO BUZ

NOTE: Parentheses indicate pin number for 80-QFP package.

Table 1-1. KS88C2148 Pin Descriptions (Continued)

Pin Names	Pin Type	Pin Description	Circuit Type	Pin Numbers (note)	Share Pins
$V_{SS}1$, $V_{DD}1$	–	Power input pins for internal power block	–	10, 11 (12, 13)	–
X_{OUT}, X_{IN}	–	Main oscillator pins	–	12, 13 (14, 15)	–
TEST	–	Chip test input pin Hold GND when the device is operating	–	14 (16)	–
XT_{IN}, XT_{OUT}	–	Sub oscillator pins for sub-system clock	–	15,16 (17,18)	–
RESET	I	RESET signal input pin. Schmitt trigger input with internal pull-up resistor.	B	17 (19)	–
INT0-INT3	I/O	External interrupts input with noise filter.	D-4	20-23 (22-25)	P2.4–P2.7
T0CK	I/O	8Bit Timer 0 external clock input.	D-4	20 (22)	P2.4
T1CK	I/O	Timer 1/A external clock input.	D-4	21 (23)	P2.5
TA	I/O	Timer 1/A clock output	D-4	22 (24)	P2.6
TB	I/O	Timer B clock output	D-4	23 (25)	P2.7
T0	I/O	Timer 0 clock output	D-4	33 (35)	P3.7
T0PWM	I/O	Timer 0 PWM output	D-4	33 (35)	P3.7
T0CAP	I/O	Timer 0 capture input	D-4	33 (35)	P3.7
ADC0-ADC3	I/O	Analog input pins for A/D converts module	F-16	25-28 (27-30)	P3.0–P3.3
AV_{REF}, AV_{SS}	–	A/D converter reference voltage and ground	–	24, 29 (26, 31)	–
INT4-INT11	I/O	External interrupts input with noise filter.	E-4	34-41 (36-43)	P4.0–P4.7
BUZ	I/O	Buzzer signal output	D-4	45 (47)	P5.3
SCK, SI, SO	I/O	Serial clock, serial data input, serial data output	D-4	42-44 (44-46)	P5.0–P5.2
$V_{LC}1$	–	LCD bias voltage input pins	–	49 (51)	–
$V_{SS}2$, $V_{DD}2$	–	Power input pins for external power block	–	50, 51 (52, 53)	–
COM0-COM3	O	LCD Common signal output	H-30	52-55 (54-57)	–
SEG0-SEG3 (COM4-COM7)	O	LCD Common or Segment signal output	H-31	56-59 (58-61)	–
SEG4-SEG15	O	LCD segment signal output	H-29	60-71 (62-73)	–

NOTE: Parentheses indicate pin number for 80-QFP package.

Table 1-1. KS88C2148 Pin Descriptions (Concluded)

Pin Names	Pin Type	Pin Description	Circuit Type	Pin Numbers	Share Pins
SEG16-SEG23	I/O	LCD segment signal output	H-32	72-79 (74-80, 1)	P0.0-P0.7
SEG24-SEG31	I/O	LCD segment signal output	H-32	80, 1-7(2-9)	P1.0-P1.7
A8-A15	I/O	External interface address lines	H-32	72-79(74-80, 1)	P0.0-P0.7
AD0-AD7	I/O	External interface address/data lines	H-32	80, 1-7(2-9)	P1.0-P1.7
AS	I/O	Address strobe	D-4	8 (10)	P2.0
DR	I/O	Data read	D-4	9 (11)	P2.1
DW	I/O	Data write	D-4	18 (20)	P2.2
DM	I/O	Data memory select	D-4	19 (21)	P2.3

NOTE: Parentheses indicate pin number for 80-QFP package.

PIN CIRCUITS

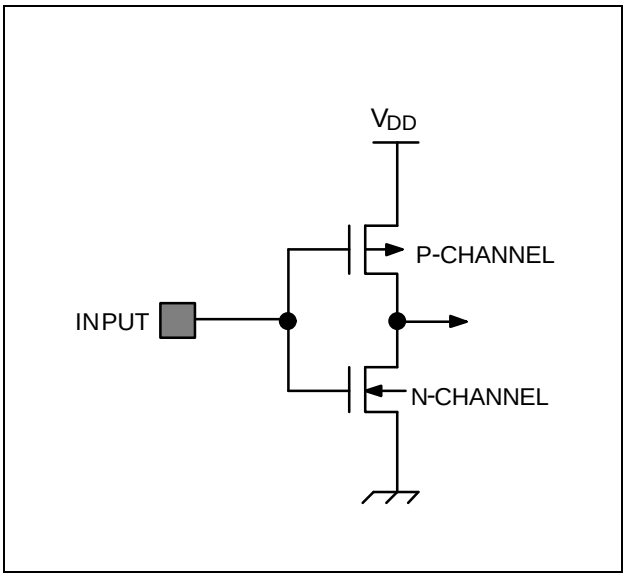


Figure 1-4. Pin Circuit Type A

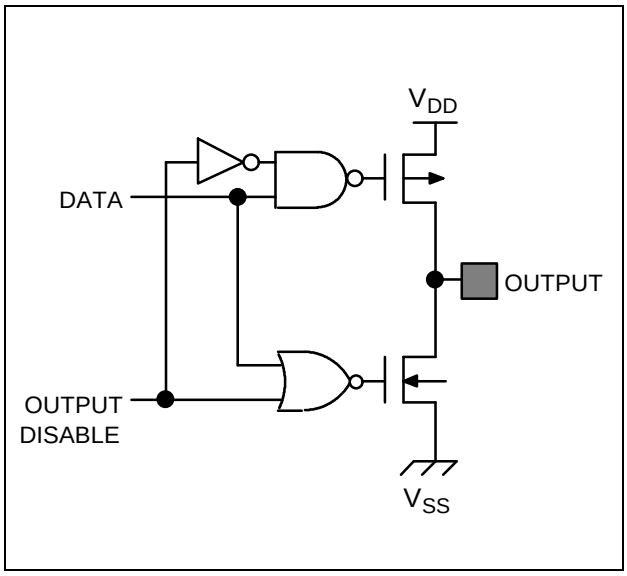


Figure 1-6. Pin Circuit Type C

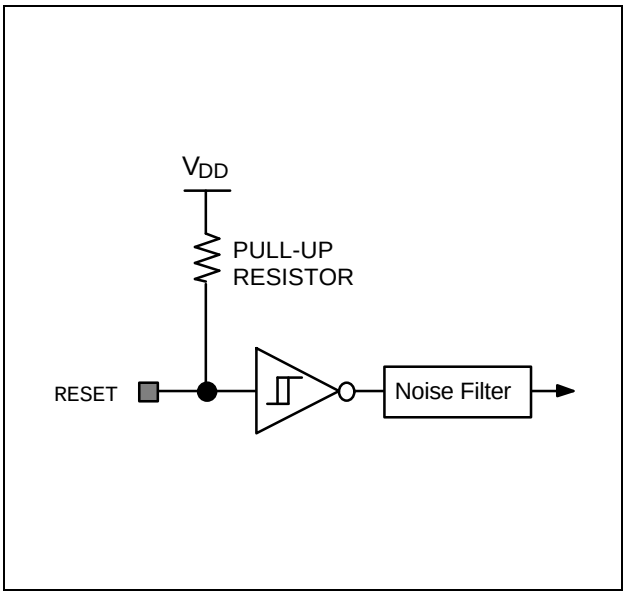


Figure 1-5. Pin Circuit Type B

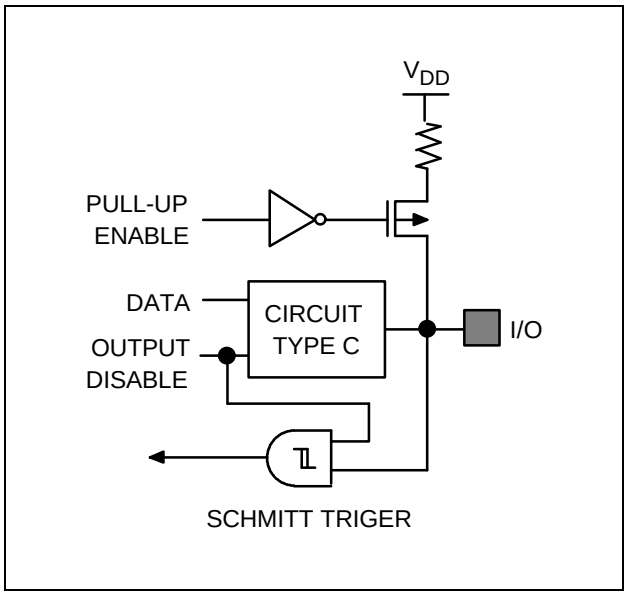


Figure 1-7. Pin Circuit Type D-4

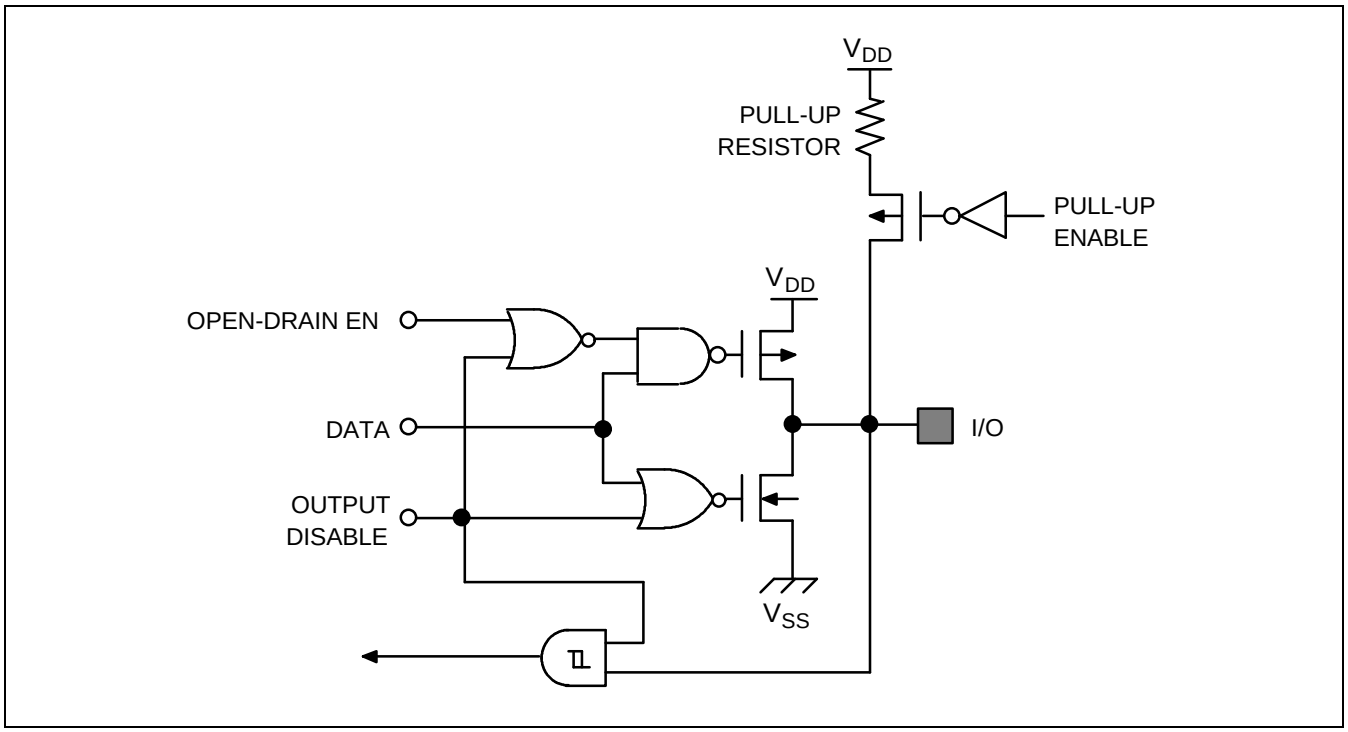


Figure 1-8. Pin Circuit Type E-4

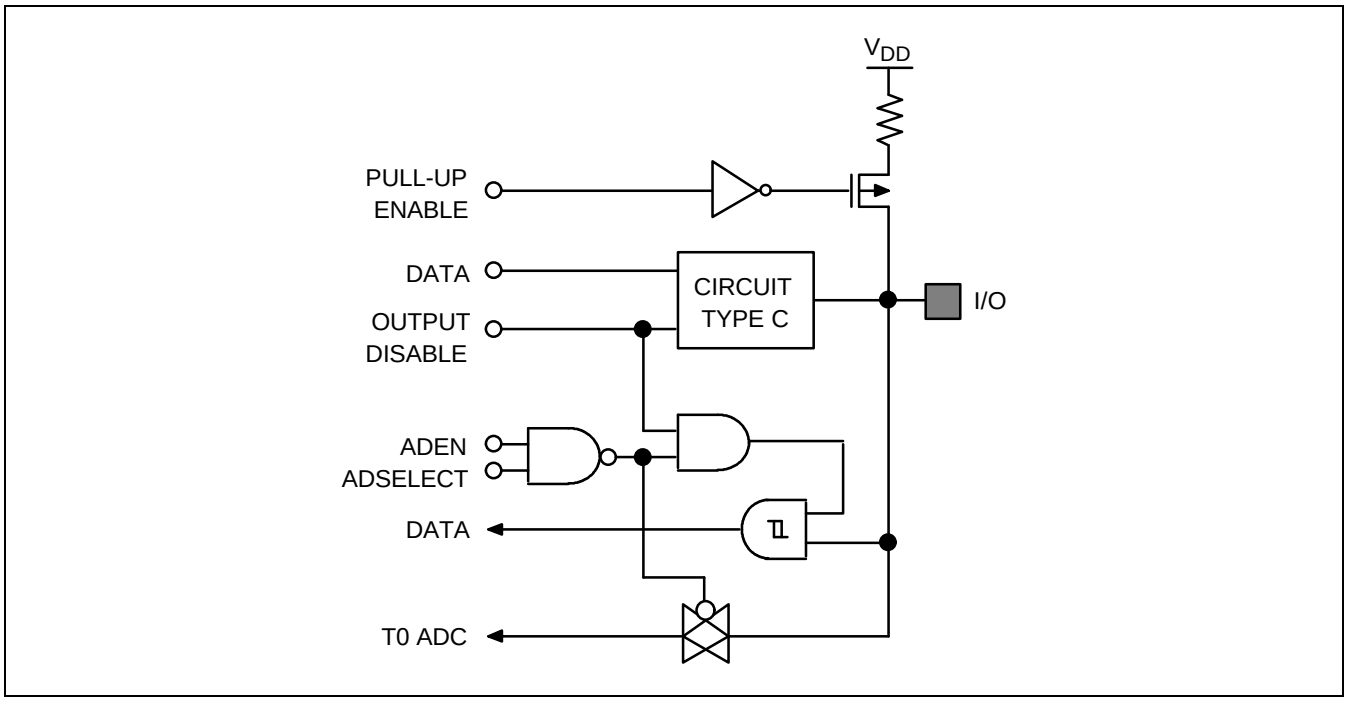


Figure 1-9. Pin Circuit Type F-16

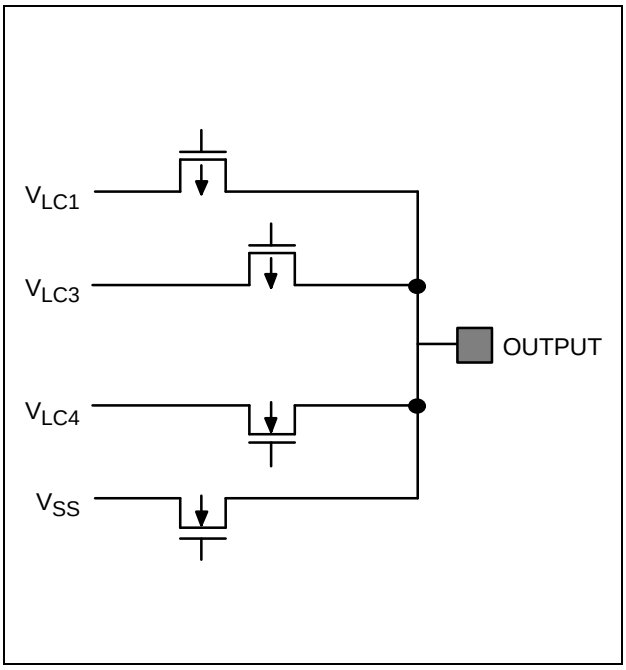


Figure 1-10. Pin Circuit Type H-29

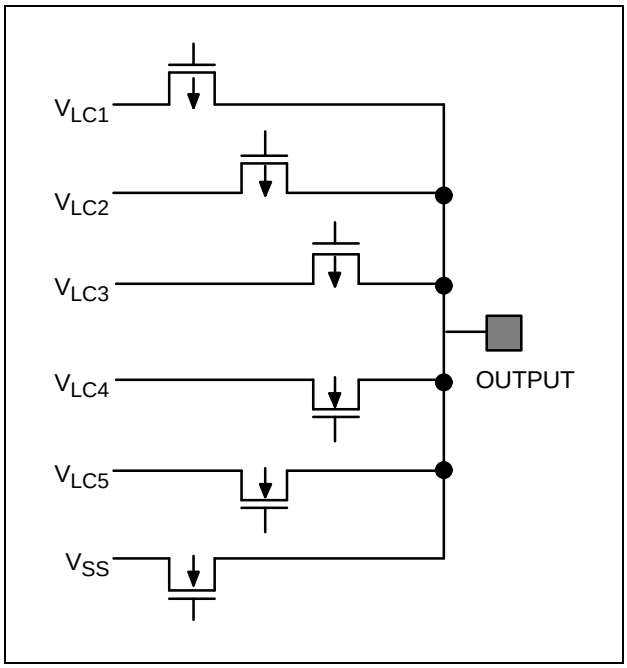


Figure 1-12. Pin Circuit Type H-31

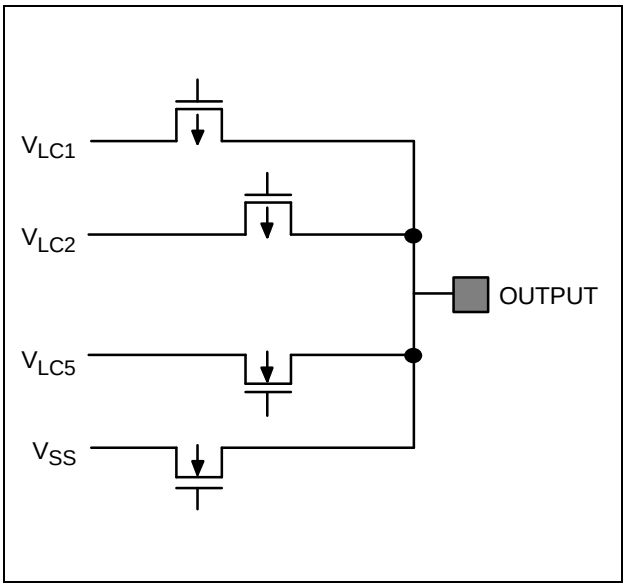


Figure 1-11. Pin Circuit Type H-30

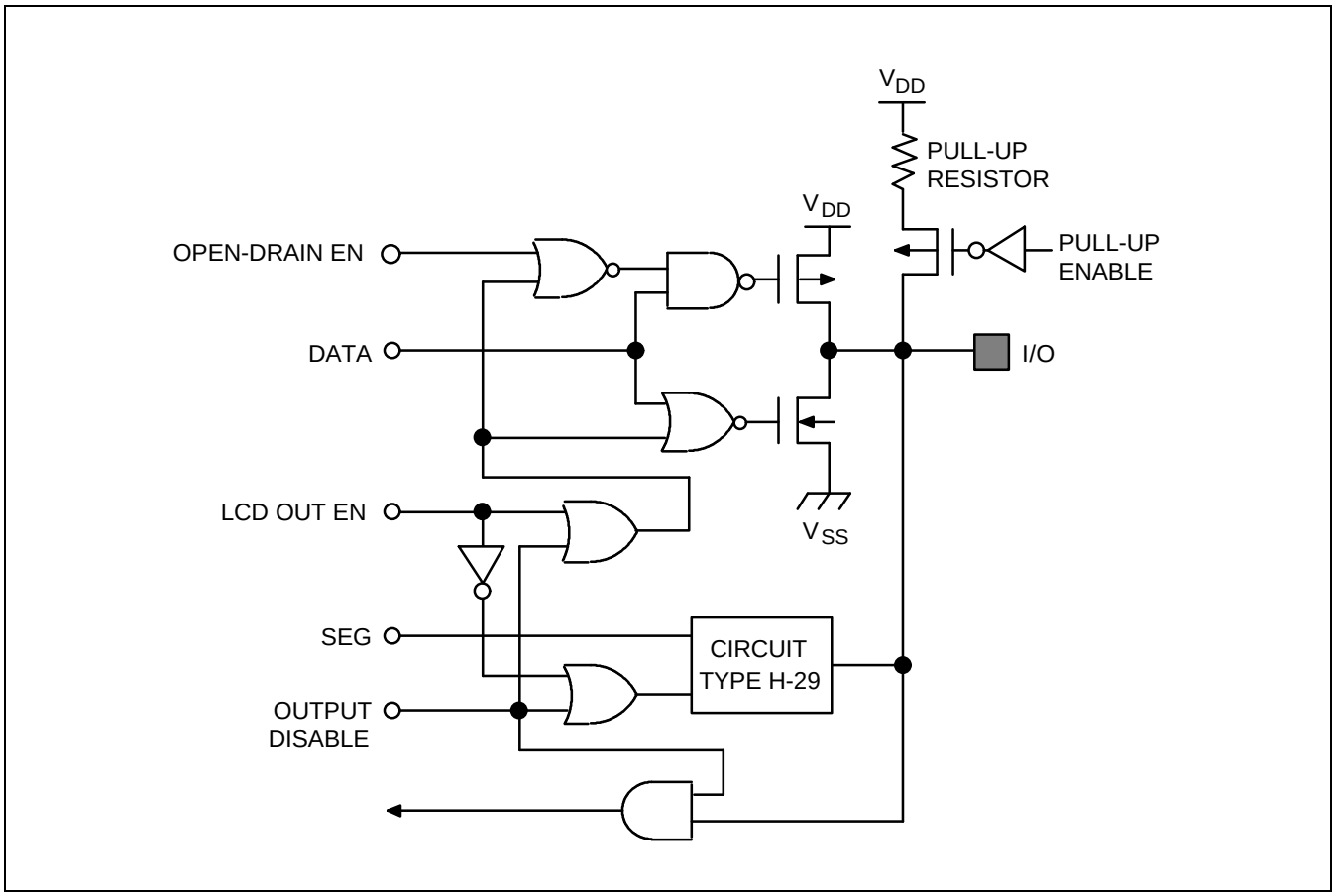


Figure 1-13. Pin Circuit Type H-32

17 ELECTRICAL DATA

OVERVIEW

In this section, KS88C2148 electrical characteristics are presented in tables and graphs. The information is arranged in the following order:

— Absolute maximum ratings
— D.C. electrical characteristics
— Data retention supply voltage in Stop mode
— Stop mode release timing when initiated by an external interrupt
— Stop mode release timing when initiated by a Reset
— I/O capacitance
— A.C. electrical characteristics
— A/D converter electrical characteristics
— Input timing for external interrupts (P4, P2.4-P2.7)
— Input timing for RESET
ó Serial data transfer timing
— Oscillation characteristics
— Oscillation stabilization time
— Operating voltage range

Table 17-1. Absolute Maximum Ratings

(T_A = 25°C)

Parameter	Symbol	Conditions	Rating	Unit
Supply voltage	V_{DD}	–	– 0.3 to + 6.5	V
Input voltage	V_{IN}	All I/O ports	– 0.3 to V_{DD} + 0.3	V
Output voltage	V_O	–	– 0.3 to V_{DD} + 0.3	V
Output current High	I_{OH}	One I/O port active	– 18	mA
		All I/O ports active	– 60	
Output current Low	I_{OL}	One I/O port active	+ 30 (peak value)	mA
			+ 15 (note)	
		Ports 0, 1, 2, and 3	+ 100 (peak value)	
			+ 60 (note)	
		Ports 4 and 5	+ 100 (peak value)	
			+ 60 (note)	
Operating temperature	T_A	–	– 40 to + 85	°C
Storage temperature	T_{STG}	–	– 65 to + 150	°C

NOTE: The values for Output Current Low (I_{OL}) are calculated as Peak Value $\times \sqrt{\text{Duty}}$.

Table 17-2. D.C. Electrical Characteristics

(T_A = – 40°C to + 85°C, V_{DD} = 2.0 V to 5.5 V)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Operating Voltage	V_{DD}	f_{OSC} = 8 MHz (Instruction clock = 1.33 MHz)	2.2	–	5.5	V
		f_{OSC} = 6 MHz (Instruction clock = 1 MHz)	2.0			
Input High voltage	V_{IH1}	P0 and P1	0.7 V_{DD}	–	V_{DD}	V
	V_{IH2}	RESET, P2, P3, P4, and P5	0.8 V_{DD}		V_{DD}	
	V_{IH3}	X_{IN}, XT_{IN}	V_{DD} – 0.1		V_{DD}	
Input Low voltage	V_{IL1}	P0 and P1	0	–	0.3 V_{DD}	
	V_{IL2}	RESET, P2, P3, P4, and P5			0.2 V_{DD}	
	V_{IL3}	X_{IN}, XT_{IN}			0.1	
Output High voltage	V_{OH}	V_{DD} = 3 V; I_{OH} = – 200 µA All output pins	V_{DD} – 1.0	–	–	
Output Low voltage	V_{OL}	V_{DD} = 3 V; I_{OL}= 1 mA All output pins	–	0.4	1.0	
Input High leakage current	I_{LIH1}	V_{IN} = V_{DD} All input pins except those specified below for I_{LIH2}	–	–	1	µA
	I_{LIH2}	V_{IN} = V_{DD} X_{IN}, X_{OUT}, XT_{IN}, and XT_{OUT}			20	
Input Low leakage current	I_{LIL1}	V_{IN} = 0 V All input pins except those specified below for I_{LIL2} and RESET	–	–	– 1	
	I_{LIL2}	V_{IN} = 0 V X_{IN}, X_{OUT}, XT_{IN}, and XT_{OUT}			– 20	
Output High leakage current	I_{LOH}	V_{OUT} = V_{DD} All output pins	–	–	1	
Output Low leakage current	I_{LOL}	V_{OUT} = 0 V All output pins	–	–	– 1	
$\|V_{DD}–COMi\|$ voltage drop (i = 0–7)	V_{DC}	V_{DD} = 2.7 V to 5.5 V – 15 µA per common pin	–	–	120	mV
$\|V_{DD}–SEGx\|$ voltage drop (x = 0–31)	V_{DS}	V_{LCD} = 2.7 V to 5.5 V – 15 µA per segment pin	–	–	120	

Table 17-2. D.C. Electrical Characteristics (Continued)

(T_A = – 40°C to + 85°C, V_{DD} = 2.0 V to 5.5 V)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
V_{LC2} output voltage	V_{LC2}	V_{DD} = 2.7 V to 5.5 V LCD clock = 0 Hz V_{LC1} = V_{DD}		0.8 V_{DD} – 0.15	0.8 V_{DD}	0.8 V_{DD} + 0.15	V
V_{LC3} output voltage	V_{LC3}			0.6 V_{DD} – 0.15	0.6 V_{DD}	0.6 V_{DD} + 0.15	
V_{LC4} output voltage	V_{LC4}			0.4 V_{DD} – 0.15	0.4 V_{DD}	0.4 V_{DD} + 0.15	
V_{LC5} output voltage	V_{LC5}			0.2 V_{DD} – 0.15	0.2 V_{DD}	0.2 V_{DD} + 0.15	
Pull-up resistors	R_{L1}	V_{IN} = 0 V; T_A = 25°C V_{DD} = 3.0 ± 10%; Ports 0–5		30	80	200	kΩ
	R_{L2}	V_{IN} = 0 V; T_A = 25°C V_{DD} = 3.0 ± 10% RESET only		200	450	800	
LCD voltage dividing resistor	R_{LCD}	V_{LCD} = 2.7 V to 5.5 V T_A = 25 °C		45	65	80	kΩ
Supply current (note)	I_{DD1}	Run mode; V_{DD}=5.0V±10% Crystal oscillator C1 = C2 = 22 pF	6.0 MHz	–	6.0	12	mA
			4.19 MHz		4.5	9.0	
		V_{DD} = 3.0 V ± 10%	6.0 MHz		2.9	5.8	
			4.19 MHz		2.0	4.0	
	I_{DD2}	Idle mode; V_{DD}=5.0V± 0% Crystal oscillator C1 = C2 = 22 pF	6.0 MHz		1.3	2.6	
			4.19 MHz		1.2	2.4	
		V_{DD} = 3.0 V ± 10%	6.0 MHz		0.6	1.2	
			4.19 MHz		0.4	0.8	
	I_{DD3}	Run mode; V_{DD} = 3.0 V ± 10% 32 kHz crystal oscillator			20	40	µA
	I_{DD4}	Idle mode; V_{DD} = 3.0 V ± 10% 32 kHz crystal oscillator			7	14	
	I_{DD5}	Stop mode; V_{DD} = 5.0 V ± 10%			0.5	3	
		Stop mode; V_{DD} = 3.0 V ± 10%			0.3	2	

NOTES:

1. Supply current does not include current drawn through internal pull-up resistors, LCD voltage dividing resistors, and ADC.
2. I_{DD1} and I_{DD2} include power consumption for subsystem clock oscillation.
3. I_{DD3} and I_{DD4} are current when main system clock oscillation stops and the subsystem clock is used.
4. I_{DD5} is current when main system clock and subsystem clock oscillation stops.

Table 17-3. Data Retention Supply Voltage in Stop Mode

(T_A = – 40 °C to + 85 °C)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Data retention supply voltage	V_{DDDR}	–	2.2	–	3.4	V
Data retention supply current	I_{DDDR}	V_{DDDR} = 1.0 V Stop mode	–	–	1	µA
Oscillator stabilization wait time	t_{WAIT}	Released by RESET	–	2^{16}/fx (1)	–	ms
		Released by interrupt	–	(2)	–	

NOTES:
1. fx is the main oscillator frequency.
2. The duration of the oscillation stabilization time (t_{WAIT}) when it is released by an interrupt is determined by the setting in the basic timer control register, BTCON.

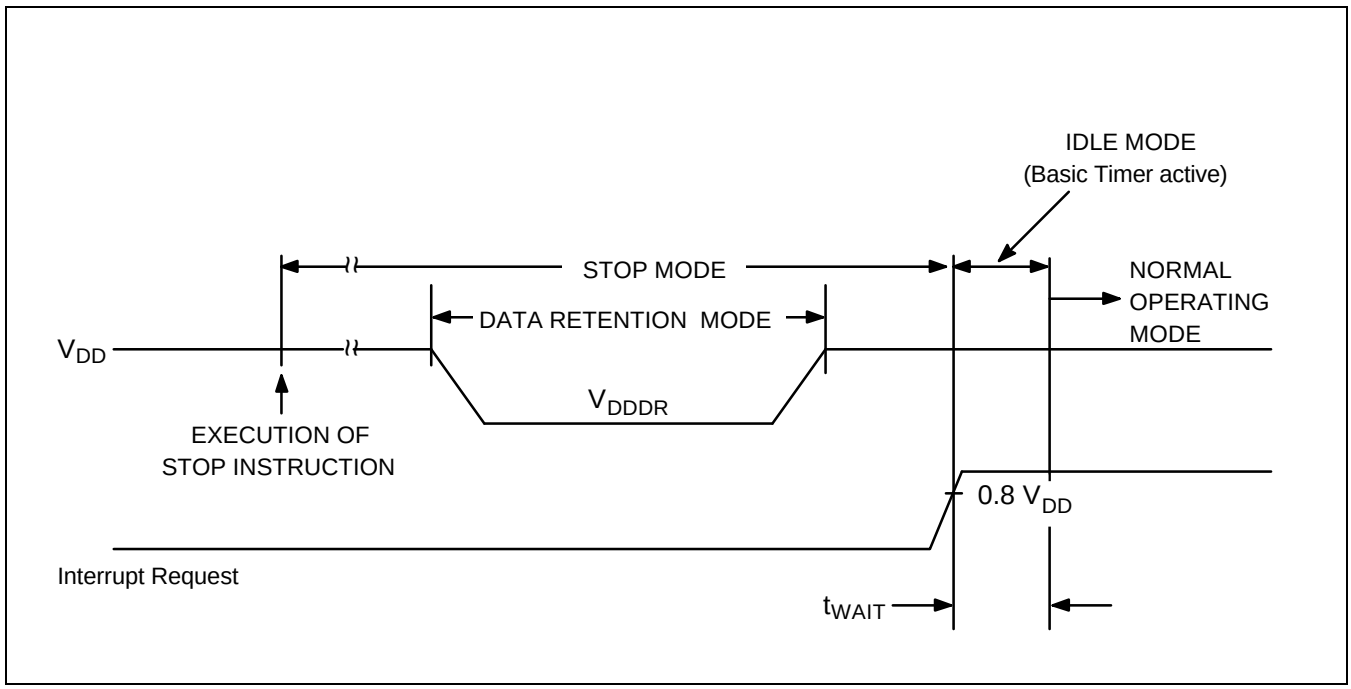


Figure 17-1. Stop Mode Release Timing When Initiated by an External Interrupt

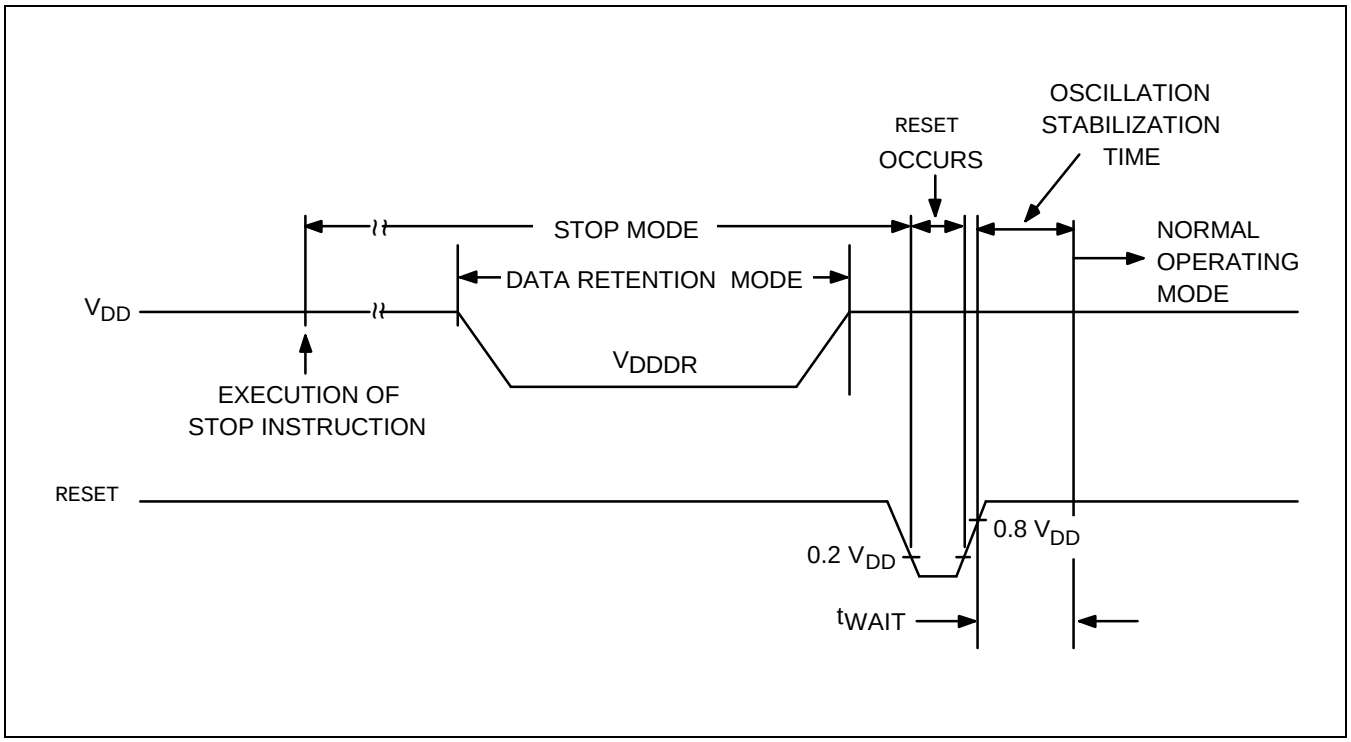


Figure 17-2. Stop Mode Release Timing When Initiated by a RESET

Table 17-4. Input/Output Capacitance

(T_A = – 25°C, V_{DD} = 0 V)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Input capacitance	C_{IN}	f = 1 MHz; unmeasured pins are connected to V_{SS}	–	–	10	pF
Output capacitance	C_{OUT}					
I/O capacitance	C_{IO}					

Table 17-5. A.C. Electrical Characteristics

(T_A = – 40°C to + 85°C, V_{DD} = 2.0 V to 5.5 V)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
SCK cycle time	t_{KCY}	External SCK source	1,000	–	–	ns
		Internal SCK source	1,000			
SCK high, low width	t_{KH}, t_{KL}	External SCK source	500			
		Internal SCK source	t_{KCY}/2–50			
SI setup time to SCK high	t_{SIK}	External SCK source	250			
		Internal SCK source	250			
SI hold time to SCK high	t_{KSI}	External SCK source	400			
		Internal SCK source	400			
Output delay for SCK to SO	t_{KSO}	External SCK source	–	–	300	ns
		Internal SCK source			250	
Interrupt input, high, low width	t_{INTH}, t_{INTL}	All interrupt V_{DD} = 3 V	500	700	–	ns
RESET input low width	t_{RSL}	Input V_{DD} = 3 V	2,000	–	–	

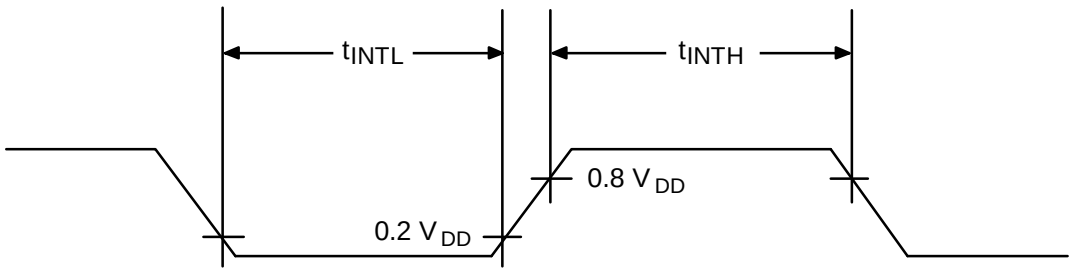
Table 17-6. A/D Converter Electrical Characteristics

(T_A = – 40°C to + 85°C, V_{DD} = 2.7 V to 5.5 V, V_{SS} = 0 V)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Resolution			–	8	–	bit
Total accuracy		V_{DD} = 5.12 V AV_{REF} = 5.12 V AV_{SS} = 0 V	–	–	± 2	LSB
Conversion time (1)	t_{CON}	8 bit conversion 34 x n/fxx (2), n=1,4,8,16	17	–	170	µs
Analog input voltage	V_{IAN}	–	AV_{SS}	–	AV_{REF}	V
Analog input impedance	R_{AN}	–	2	1,000	–	MΩ
Analog reference voltage	AV_{REF}	–	2.5	–	V_{DD}	V
Analog ground	AV_{SS}	–	V_{SS}	–	V_{SS} + 0.3	V
Analog input current	I_{ADIN}	AV_{REF} = V_{DD} = 5V	–	–	10	µA

NOTES:

1. "Conversion time" is the time required from the moment a conversion operation starts until it ends.
2. fxx is a selected system clock for peripheral hardware.



NOTE: The unit t_{CPU} means one CPU clock period.

Figure 17-3. Input Timing for External Interrupts

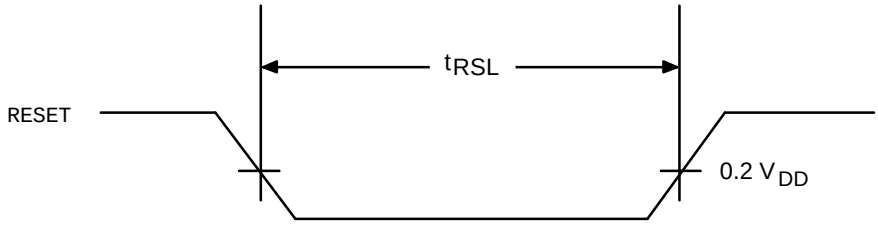


Figure 17-4. Input Timing for RESET

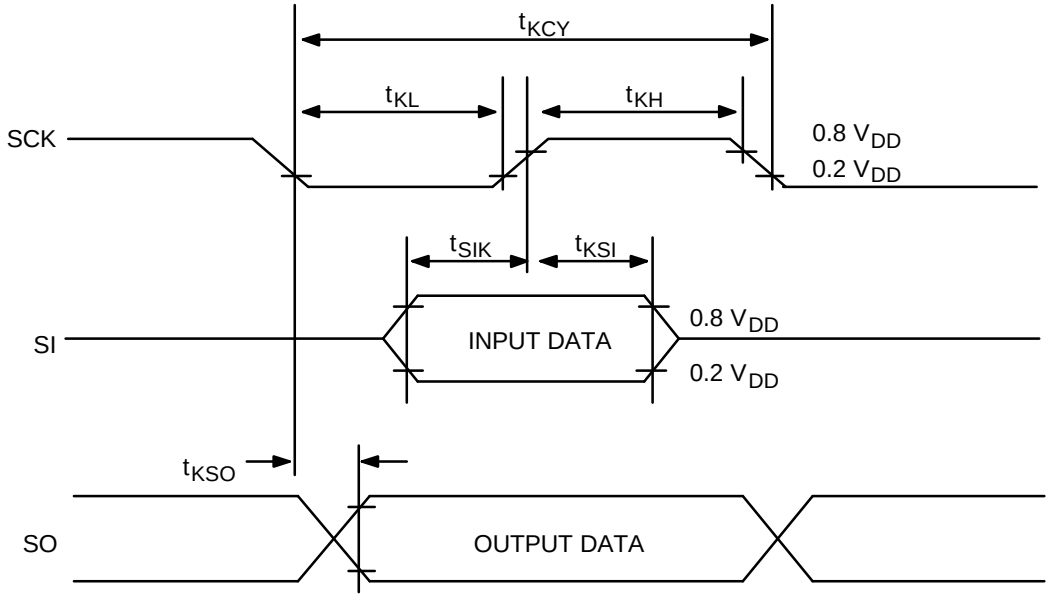


Figure 17-5. Serial Data Transfer Timing

Table 17-7. Main System Oscillation Characteristics

(T_A = – 40°C + 85°C)

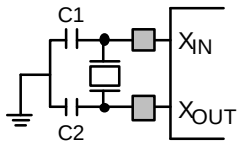
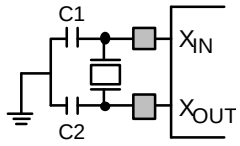
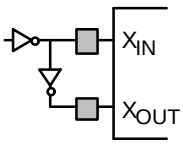
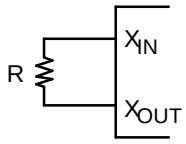
Oscillator	Clock Circuit	Parameter	Condition (V_{DD})	Min	Typ	Max	Unit
Crystal		Main oscillation frequency	2.2 V-5.5 V	0.4	–	8	MHz
			2.0 V-5.5 V	0.4	–	6	
Ceramic		Main oscillation frequency	2.2 V-5.5 V	0.4	–	8	
			2.0 V-5.5 V	0.4	–	6	
External clock		X_{IN} input frequency	2.2 V-5.5 V	0.4	–	8	
			2.0 V-5.5 V	0.4	–	6	
RC		Frequency	3.0 V	0.4	–	2	

Table 17-8. Subsystem Oscillation Characteristics

(T_A = – 40°C + 85°C)

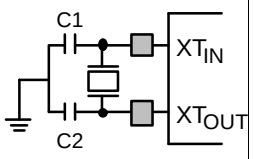
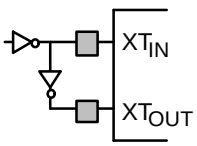
Oscillator	Clock Circuit	Parameter	Condition (V_{DD})	Min	Typ	Max	Unit
Crystal		Sub oscillation frequency	2.0 V-5.5 V	32	32.768	35	kHz
External clock		XT_{IN} input frequency	2.0 V-5.5 V	32	–	500	kHz

Table 17-9. Main Oscillation Stabilization Time

(T_A = – 40°C + 85°C, V_{DD} = 2.0 V to 5.5 V)

Oscillator	Test Condition	Min	Typ	Max	Unit
Crystal	fx > 400 kHz	–	–	20	ms
Ceramic	Oscillation stabilization occurs when V_{DD} is equal to the minimum oscillator voltage range.	–	–	10	ms
External clock	X_{IN} input High and Low width (t_{XH}, t_{XL})	25	–	500	ns

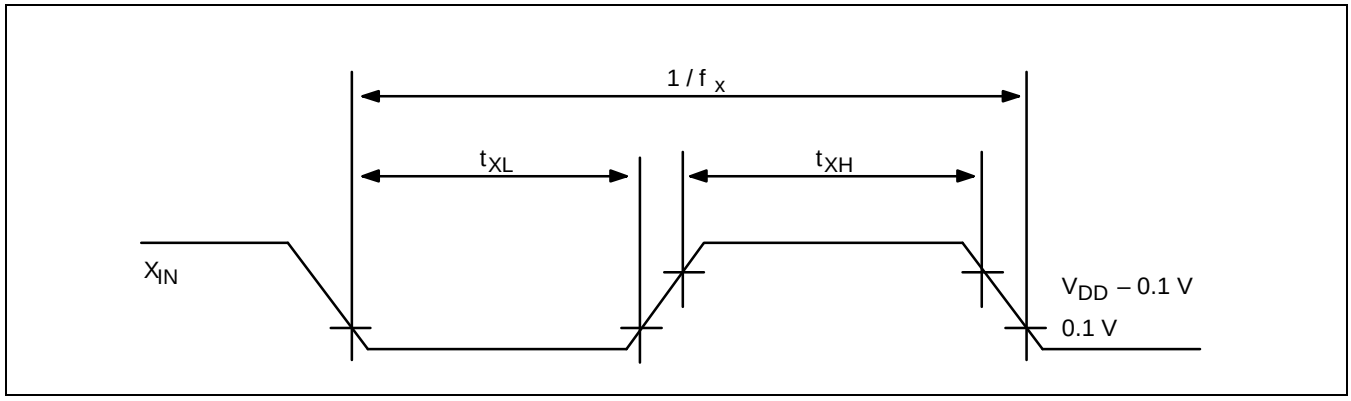


Figure 17-6. Clock Timing Measurement at X_{IN}

Table 17-10. Sub Oscillation Stabilization Time

(T_A = – 40°C + 85°C, V_{DD} = 2.0 V to 5.5 V)

Oscillator	Test Condition	Min	Typ	Max	Unit
Crystal	–	–	–	10	s
External clock	XT_{IN} input High and Low width (t_{XH}, t_{XL})	1	–	18	µs

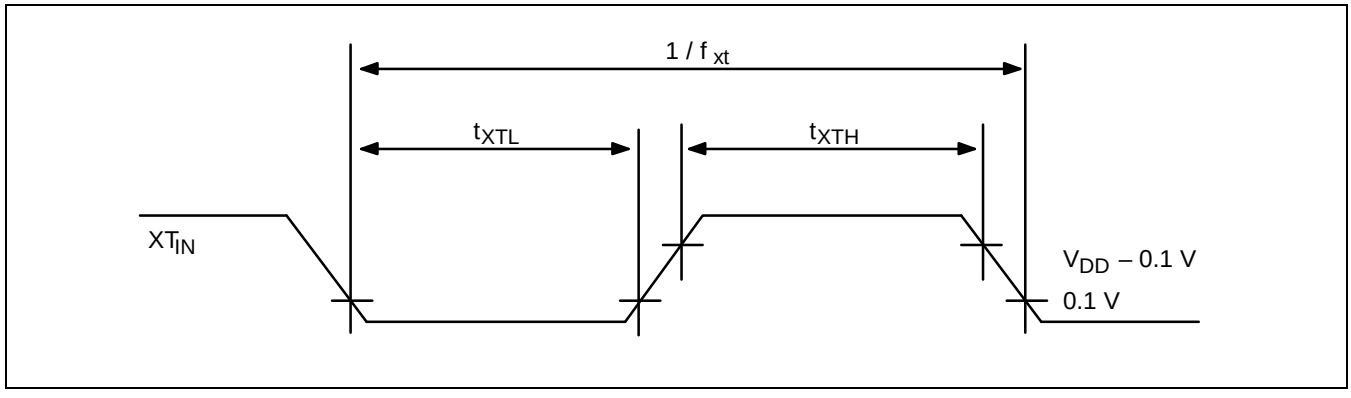


Figure 17-7. Clock Timing Measurement at XT_{IN}

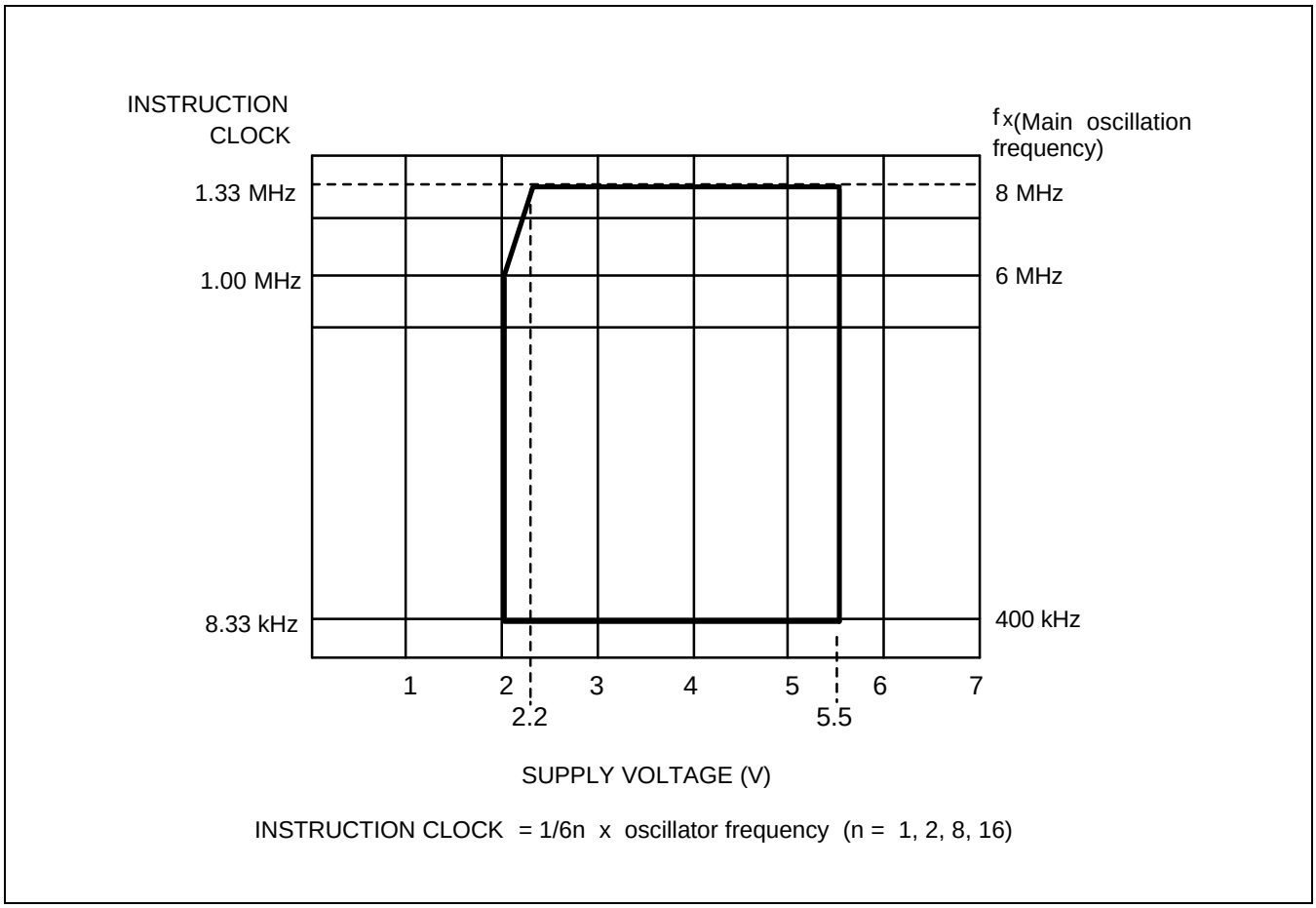
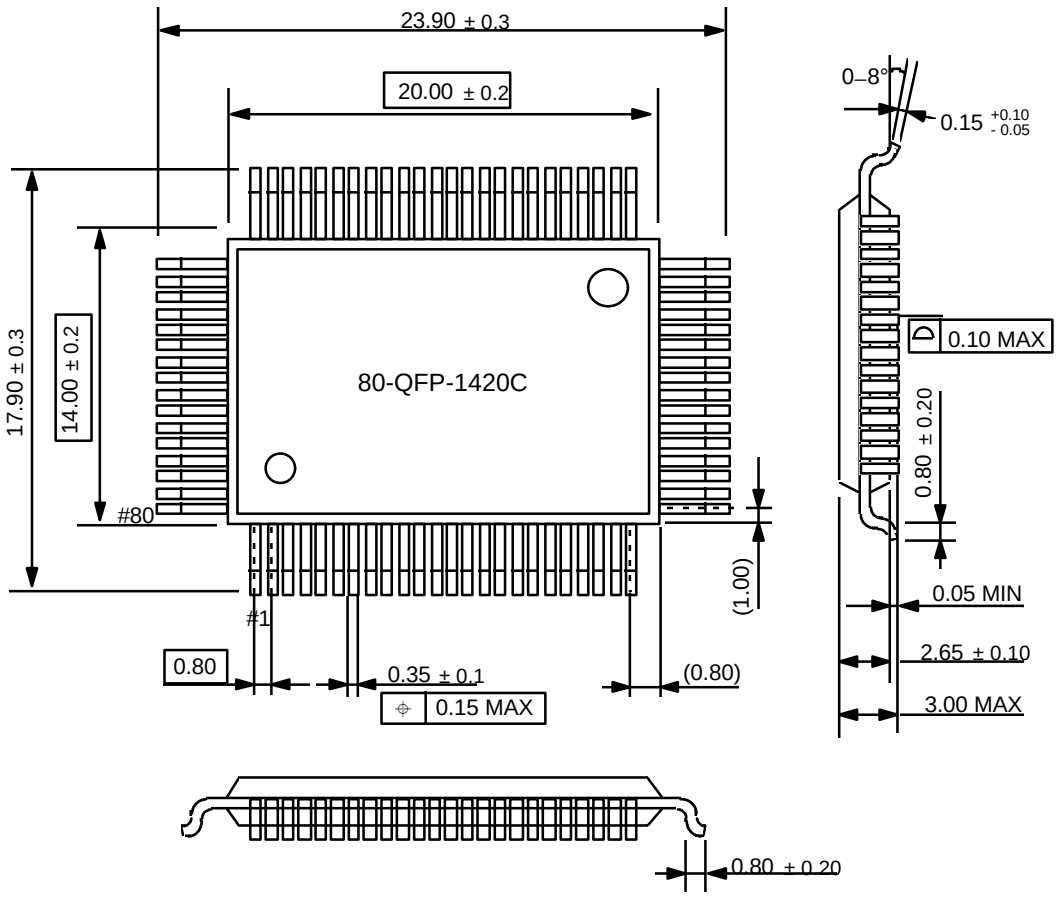


Figure 17-8. Operating Voltage Range

18 MECHANICAL DATA

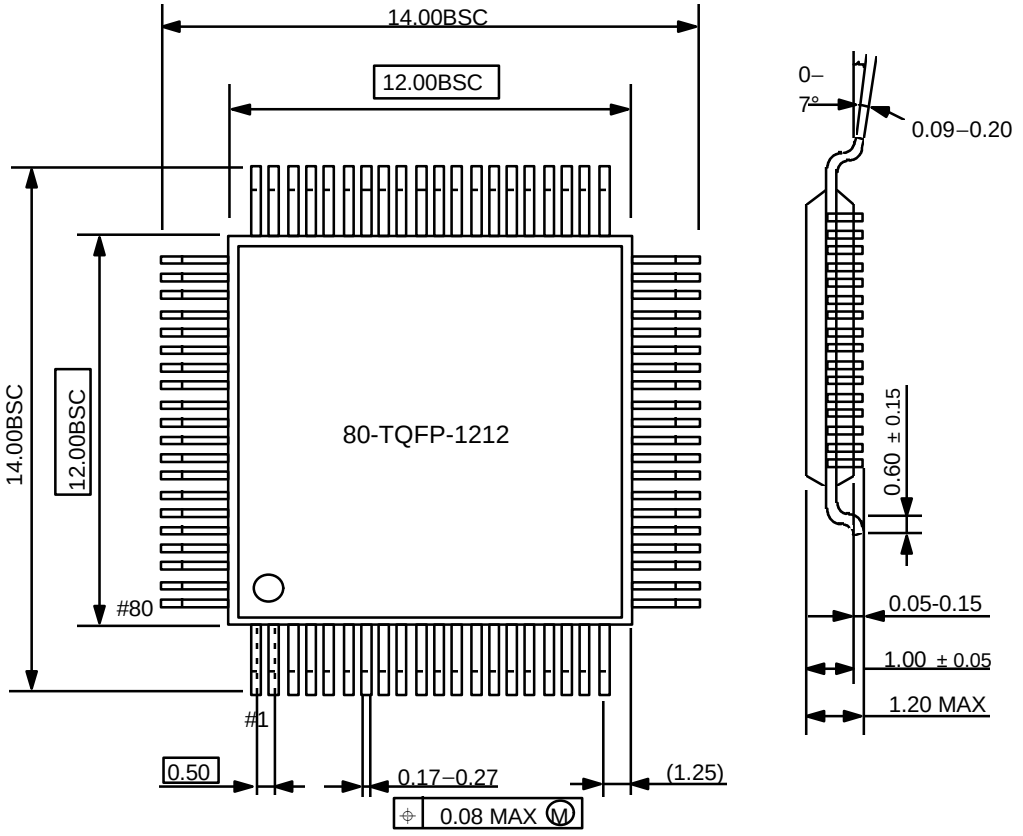
OVERVIEW

The KS88C2148 microcontroller is currently available in 80-pin QFP and TQFP package.



NOTE: Dimensions are in millimeters.

Figure 18-1. 80-Pin QFP Package Demensions



NOTE: Dimensions are in millimeters.

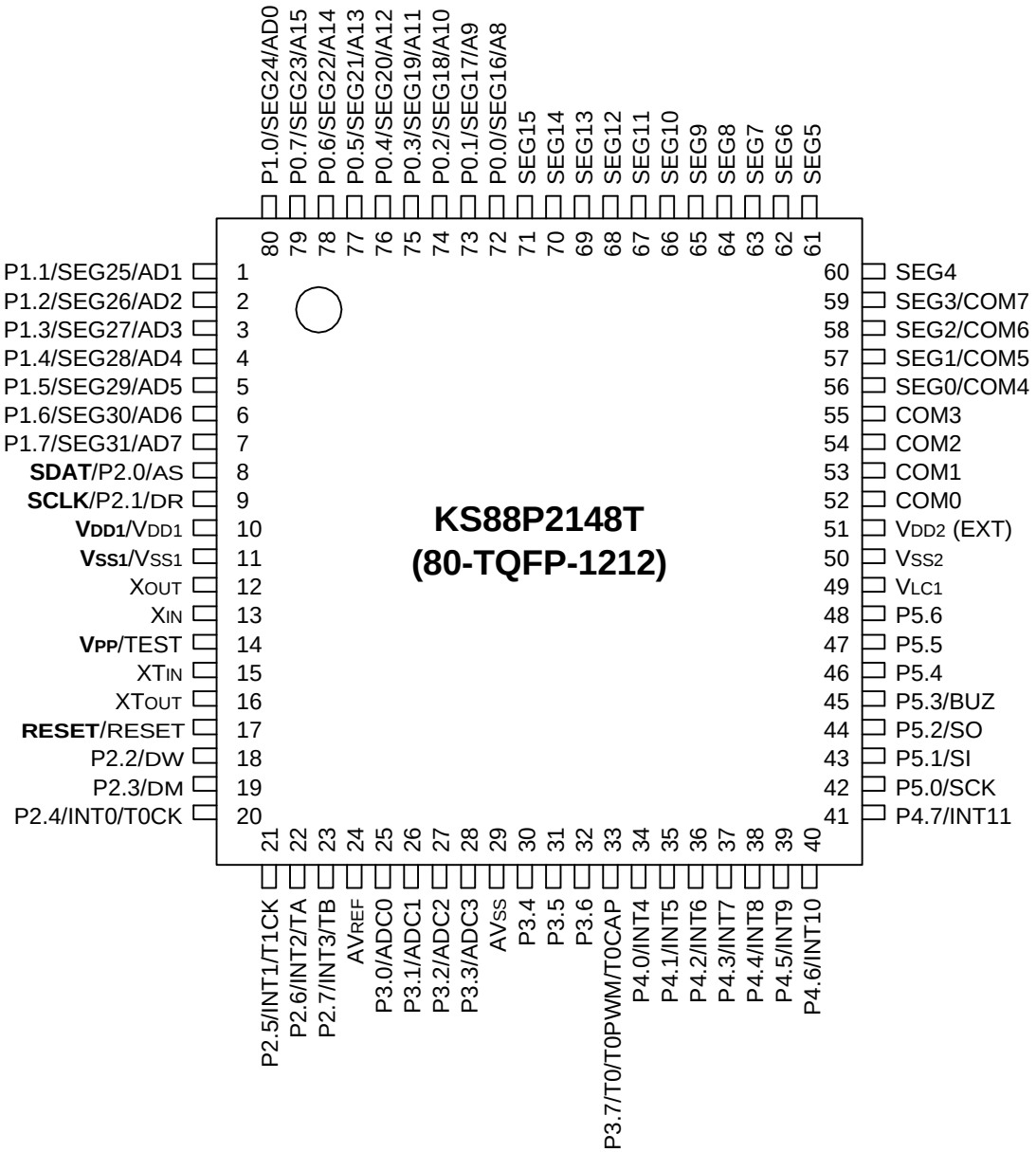
Figure 18-2. 80-Pin TQFP Package Demensions

20 KS88P2148 OTP

OVERVIEW

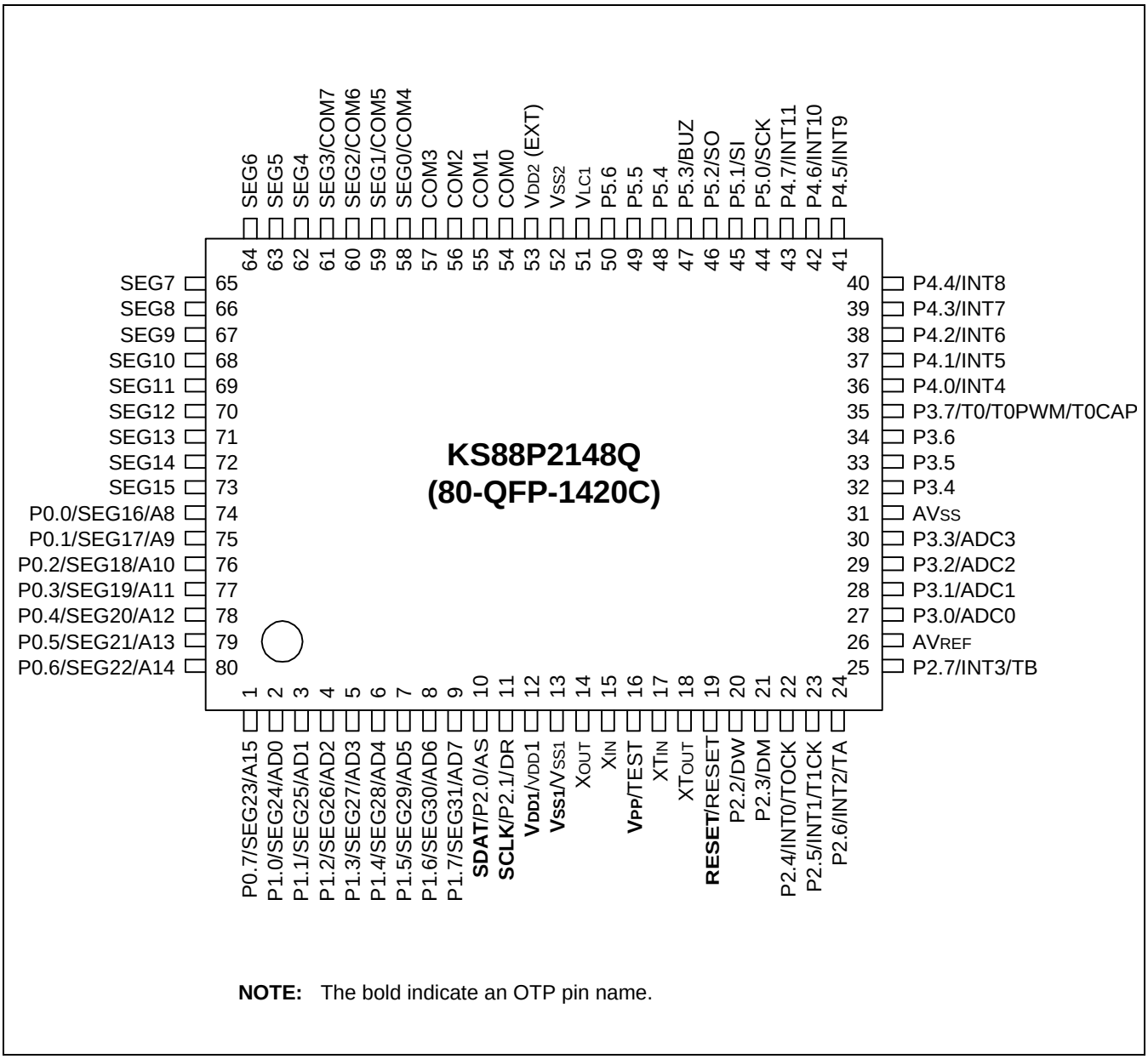
The KS88P2148 single-chip CMOS microcontroller is the OTP (One Time Programmable) version of the KS88C2148 microcontroller. It has an on-chip OTP ROM instead of a masked ROM. The EPROM is accessed by serial data format.

The KS88P2148 is fully compatible with the KS88C2148, both in function and in pin configuration. Because of its simple programming requirements, the KS88P2148 is ideal as an evaluation chip for the KS88C2148.



NOTE: The bold indicate an OTP pin name.

Figure 20-1. KS88P2148 Pin Assignments (80-TQFP Package)



NOTE: The bold indicate an OTP pin name.

Figure 20-2. KS88P2148 Pin Assignments (80-QFP Package)

Table 20-1. Descriptions of Pins Used to Read/Write the EPROM

Main Chip	During Programming			
Pin Name	Pin Name	Pin No.	I/O	Function
P2.0	SDAT	8 (10)	I/O	Serial data pin. Output port when reading and input port when writing. Can be assigned as a Input/push-pull output port.
P2.1	SCLK	9 (11)	I/O	Serial clock pin. Input only pin.
V_{PP}	TEST	14 (16)	I	Power supply pin for EPROM cell writing (indicates that OTP enters into the writing mode). When 12.5 V is applied, OTP is in writing mode and when 5 V is applied, OTP is in reading mode. (Option)
RESET	RESET	17 (19)	I	Chip Initialization
V_{DD1}/V_{SS1}	V_{DD1}/V_{SS1}	10 (12)/11 (13)	–	Logic power supply pin. V_{DD} should be tied to +5 V during programming.

NOTE: ( ) means 80 QFP package.

Table 20-2. Comparison of KS88P2148 and KS88C2148 Features

Characteristic	KS88P2148	KS88C2148
Program Memory	48-Kbyte EPROM	48-Kbyte mask ROM
Operating Voltage (V_{DD})	2.0 V to 5.5 V	2.0 V to 5.5 V
OTP Programming Mode	V_{DD} = 5 V, V_{PP} (TEST) = 12.5 V	
Pin Configuration	80 QFP/80 TQFP	80 QFP/80 TQFP
EPROM Programmability	User Program 1 time	Programmed at the factory

OPERATING MODE CHARACTERISTICS

When 12.5 V is supplied to the V_{PP} (TEST) pin of the KS88P2148, the EPROM programming mode is entered. The operating mode (read, write, or read protection) is selected according to the input signals to the pins listed in Table 20-3 below.

Table 20-3. Operating Mode Selection Criteria

V_{DD}	V_{PP} (TEST)	REG/ MEM	ADDRESS (A15-A0)	R/W	MODE
5 V	5 V	0	0000H	1	EPROM read
	12.5 V	0	0000H	0	EPROM program
	12.5 V	0	0000H	1	EPROM verify
	12.5 V	1	0E3FH	0	EPROM read protection

NOTE: "0" means Low level; "1" means High level.

Table 20-4. D.C. Electrical Characteristics

(T_A = – 40°C to + 85°C, V_{DD} = 2.0 V to 5.5 V)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Operating Voltage	V_{DD}	f_{OSC} = 8 MHz (Instruction clock = 1.33 MHz)	2.2	–	5.5	V
		f_{OSC} = 6 MHz (Instruction clock = 1 MHz)	2.0			
Input High voltage	V_{IH1}	P0 and P1	0.7 V_{DD}	–	V_{DD}	V
	V_{IH2}	RESET, P2, P3, P4, and P5	0.8 V_{DD}		V_{DD}	
	V_{IH3}	X_{IN}, XT_{IN}	V_{DD} – 0.1		V_{DD}	
Input Low voltage	V_{IL1}	P0 and P1	0	–	0.3 V_{DD}	
	V_{IL2}	RESET, P2, P3, P4, and P5			0.2 V_{DD}	
	V_{IL3}	X_{IN}, XT_{IN}			0.1	
Output High voltage	V_{OH}	V_{DD} = 3 V; I_{OH} = – 200 µA All output pins	V_{DD} – 1.0	–	–	
Output Low voltage	V_{OL}	V_{DD} = 3 V; I_{OL}= 1 mA All output pins	–	0.4	1.0	
Input High leakage current	I_{LIH1}	V_{IN} = V_{DD} All input pins except those specified below for I_{LIH2}	–	–	1	µA
	I_{LIH2}	V_{IN} = V_{DD} X_{IN}, X_{OUT}, XT_{IN}, and XT_{OUT}			20	
Input Low leakage current	I_{LIL1}	V_{IN} = 0 V All input pins except those specified below for I_{LIL2} and RESET	–	–	– 1	
	I_{LIL2}	V_{IN} = 0 V X_{IN}, X_{OUT}, XT_{IN}, and XT_{OUT}			– 20	
Output High leakage current	I_{LOH}	V_{OUT} = V_{DD} All output pins	–	–	1	
Output Low leakage current	I_{LOL}	V_{OUT} = 0 V All output pins	–	–	– 1	
$\lvert V_{DD-COMi} \rvert$ voltage drop (i = 0-7)	V_{DC}	V_{DD} = 2.7 V to 5.5 V – 15 µA per common pin	–	–	120	mV
$\lvert V_{DD-SEGx} \rvert$ voltage drop (x = 0-31)	V_{DS}	V_{LCD} = 2.7 V to 5.5 V – 15 µA per segment pin	–	–	120	

Table 20-4. D.C. Electrical Characteristics (Continued)

(T_A = – 40°C to + 85°C, V_{DD} = 2.0 V to 5.5 V)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
V_{LC2} output voltage	V_{LC2}	V_{DD} = 2.7 V to 5.5 V LCD clock = 0 Hz		0.8 V_{DD} – 0.15	0.8 V_{DD}	0.8 V_{DD} + 0.15	V
V_{LC3} output voltage	V_{LC3}	V_{LC1} = V_{DD}		0.6 V_{DD} – 0.15	0.6 V_{DD}	0.6 V_{DD} + 0.15	
V_{LC4} output voltage	V_{LC4}			0.4 V_{DD} – 0.15	0.4 V_{DD}	0.4 V_{DD} + 0.15	
V_{LC5} output voltage	V_{LC5}			0.2 V_{DD} – 0.15	0.2 V_{DD}	0.2 V_{DD} + 0.15	
Pull-up resistors	R_{L1}	V_{IN} = 0 V; T_A = 25°C V_{DD} = 3.0 ± 10%; Ports 0–5		30	80	200	kΩ
	R_{L2}	V_{IN} = 0 V; T_A = 25°C V_{DD} = 3.0 ± 10% RESET only		300	500	800	
LCD voltage dividing resistor	R_{LCD}	V_{LCD} = 2.7 V to 5.5 V T_A = 25 °C		45	65	80	kΩ
Supply current (note)	I_{DD1}	Run mode; V_{DD}=5.0V±10%	6.0 MHz	–	6.0	12	mA
		Crystal oscillator C1 = C2 = 22 pF	4.19 MHz		4.5	9.0	
		V_{DD} = 3.0 V ± 10%	6.0 MHz		2.9	5.8	
			4.19 MHz		2.0	4.0	
	I_{DD2}	Idle mode; V_{DD}=5.0V± 0%	6.0 MHz		1.3	2.6	
		Crystal oscillator C1 = C2 = 22 pF	4.19 MHz		1.2	2.4	
		V_{DD} = 3.0 V ± 10%	6.0 MHz		0.6	1.2	
			4.19 MHz		0.4	0.8	
	I_{DD3}	Run mode; V_{DD} = 3.0 V ± 10% 32 kHz crystal oscillator			20	40	µA
	I_{DD4}	Idle mode; V_{DD} = 3.0 V ± 10% 32 kHz crystal oscillator			7	14	
	I_{DD5}	Stop mode; V_{DD} = 5.0 V ± 10%			0.5	3	
		Stop mode; V_{DD} = 3.0 V ± 10%			0.3	2	

NOTES:
1. Supply current does not include current drawn through internal pull-up resistors, LCD voltage dividing resistors, and ADC.
2. I_{DD1} and I_{DD2} include power consumption for subsystem clock oscillation.
3. I_{DD3} and I_{DD4} are current when main system clock oscillation stops and the subsystem clock is used.
4. I_{DD5} is current when main system clock and subsystem clock oscillation stops.

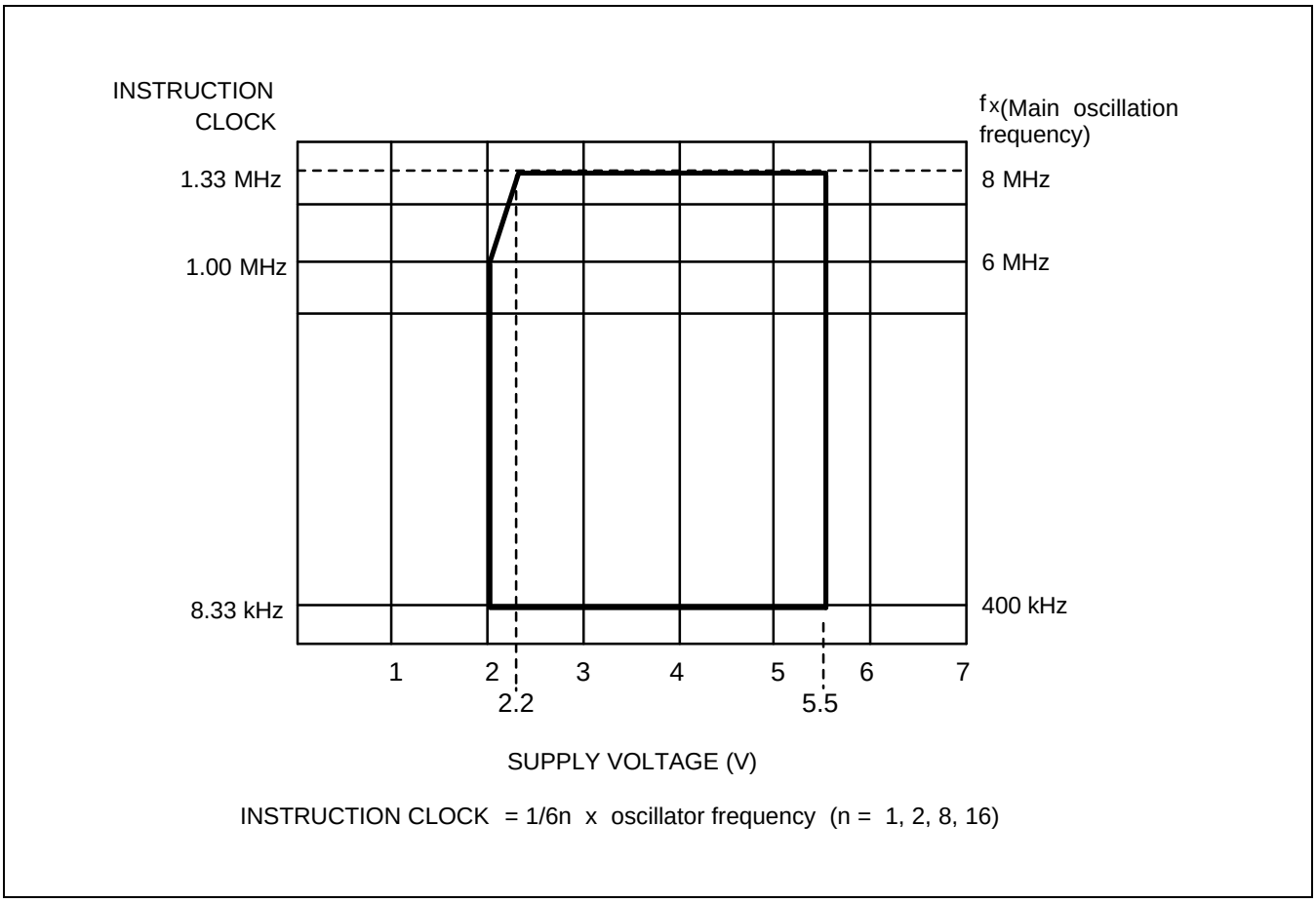


Figure 20-3. Operating Voltage Range

NOTES