1 PRODUCT OVERVIEW

SAM87RI PRODUCT FAMILY

Samsung's SAM88RCRI family of 8-bit single-chip CMOS microcontrollers offer fast and efficient CPU, a wide range of integrated peripherals, and support OTP device.

A dual address/data bus architecture and bit- or nibble-configurable I/O ports provide a flexible programming environment for applications with varied memory and I/O requirements. Timer/counters with selectable operating modes are included to support real-time operations.

S3C9664 MICROCONTROLLER

The S3C9664 microcontroller with USB function can be used in a wide range of general purpose applications. It is especially suitable for joystick, game pad controller or mouse and is available in 20-pin DIP, 24-pin SDIP and 20, 24-pin SOP. The S3C9664 single-chip 8-bit microcontroller is fabricated using an advanced CMOS process. It is built around the powerful SAM88RCRI CPU core.

Stop and Idle power-down modes were implemented to reduce power consumption. To increase on-chip register space, the size of the internal register file was logically expanded. The S3C9664 has 4 K bytes of program memory on-chip, and 208 bytes of RAM including 16 bytes of working register. Using the SAM88RCRI design approach, the following peripherals were integrated with the SAM88RCRI core:

— Two configurable I/O ports (14 I/O pins on 20 pin package, 18 I/O pins on 24pin package)
— Analog-to-digital converter with six input channel and 10-bit resolution
— One 8-bit basic timer for watchdog function
— One 8 bit timer/counter with three operating modes (Timer 0)
— One 8 bit timer (Timer 1)

OTP

The S3C9664 microcontroller is also available in OTP (One Time Programmable) version, S3P9664. S3P9664 microcontroller has an on-chip 4 K byte one-time-programmable EPROM instead of masked ROM.
The S3P9664 is compatible to S3C9664, both in function and in pin configuration.

FEATURES

CPU

- SAM88RCRI CPU core

Memory

- 4-K byte internal program memory
- 208-byte general purpose register area
- 16 bytes of working register

Instruction Set

- 41 instructions
- IDLE and STOP instructions added for power-down modes

Instruction Execution Time

- 0.66 µs at 6 MHz f_{OSC}

Interrupts

- 28 interrupt sources and one vector (24 pins)
- 24 interrupt sources and one vector (20 pin)
- One interrupt level

General I/O

- Three I/O ports (total 18 I/O pins at 24 SOP/SDIP)
- Three I/O ports (total 14 I/O pins at 20 SOP/DIP)

Timer/Counter

- One 8-bit basic timer for watchdog function
- One 8 bit timer/counter with three operating modes(Match, capture, PWM)
- One 8-bit Timer

USB

- Compatible to USB low speed (1.5 Mbps) device 1.1 specification.
- Serial bus interface engine (SIE)
  - — Packet decoding/generation
  - — CRC generation and checking
  - — NRZI encoding/decoding and bit-stuffing
- Two 8-byte receive/transmit USB buffer

A/D Converter

- Six analog input pins
- 10-bit conversion resolution

Low Voltage Reset

- Low voltage reset
- Power on Reset

Sub Oscillator

- Internal RC sub oscillator
- Auto interrupt wake-up

Oscillator Frequency

- 6 MHz crystal/ceramic oscillator
- External clock source (6 MHz)

Operating Temperature Range

- – 40°C to + 85°C

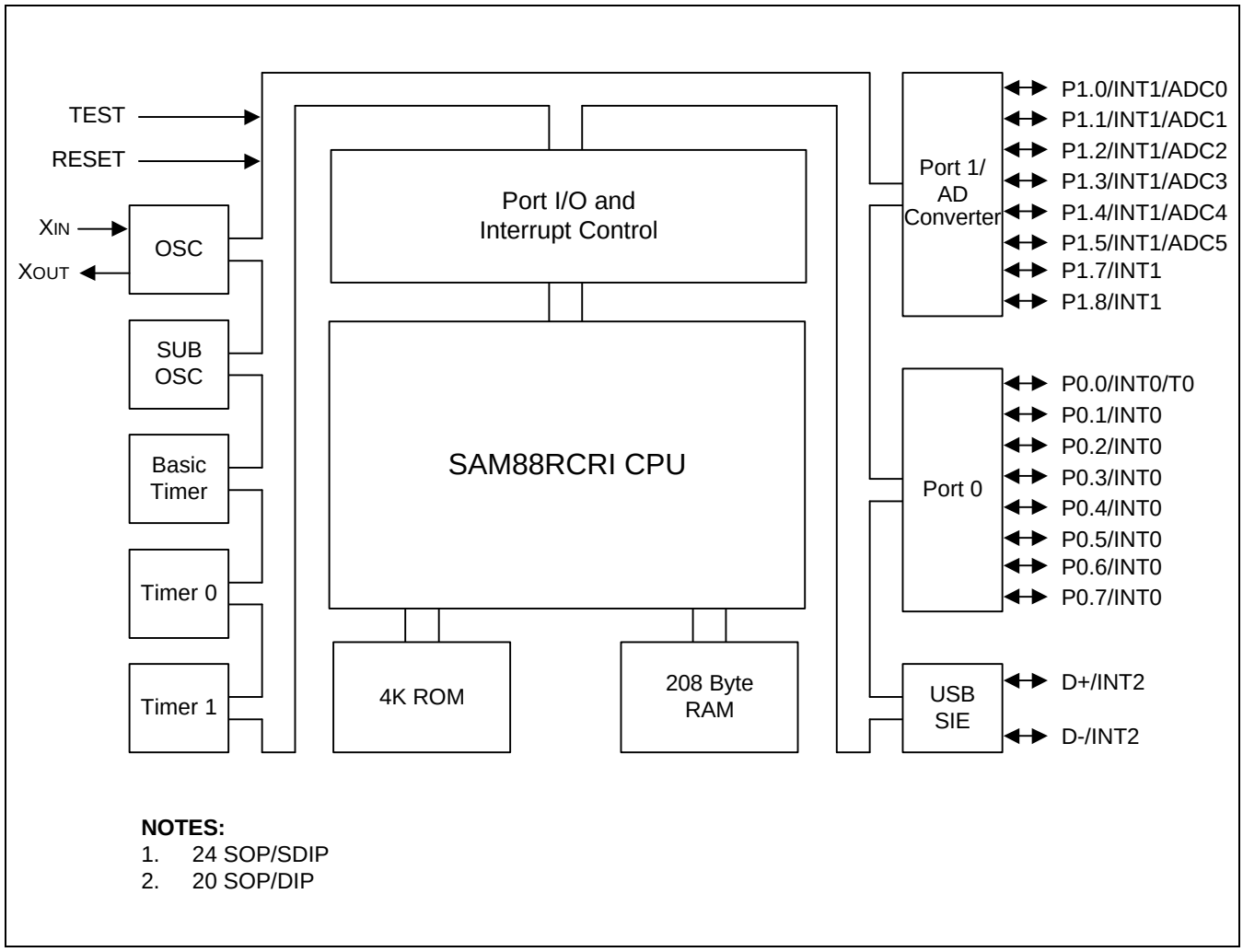
Operating Voltage Range

- 4.0 V to 5.25 V

Package Types

- 24-pin SOP/SDIP
- 20-pin SOP/DIP

BLOCK DIAGRAM



NOTES:
1. 24 SOP/SDIP
2. 20 SOP/DIP

Figure 1-1. Block Diagram

PIN ASSIGNMENTS

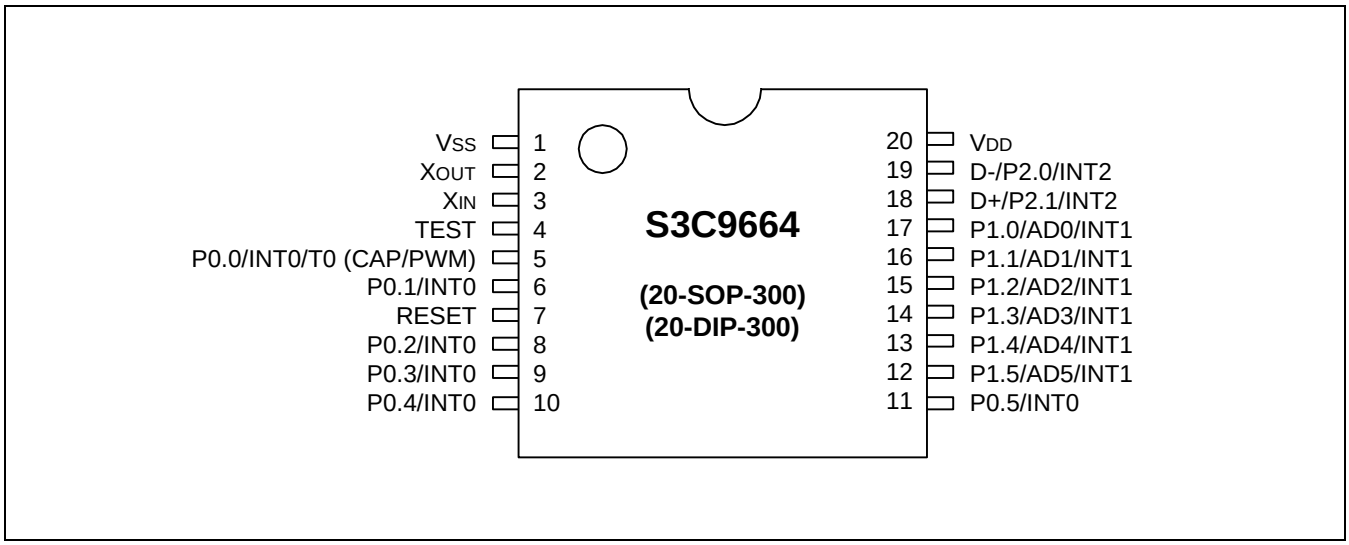


Figure 1-2. Pin Assignment (20 Pin)

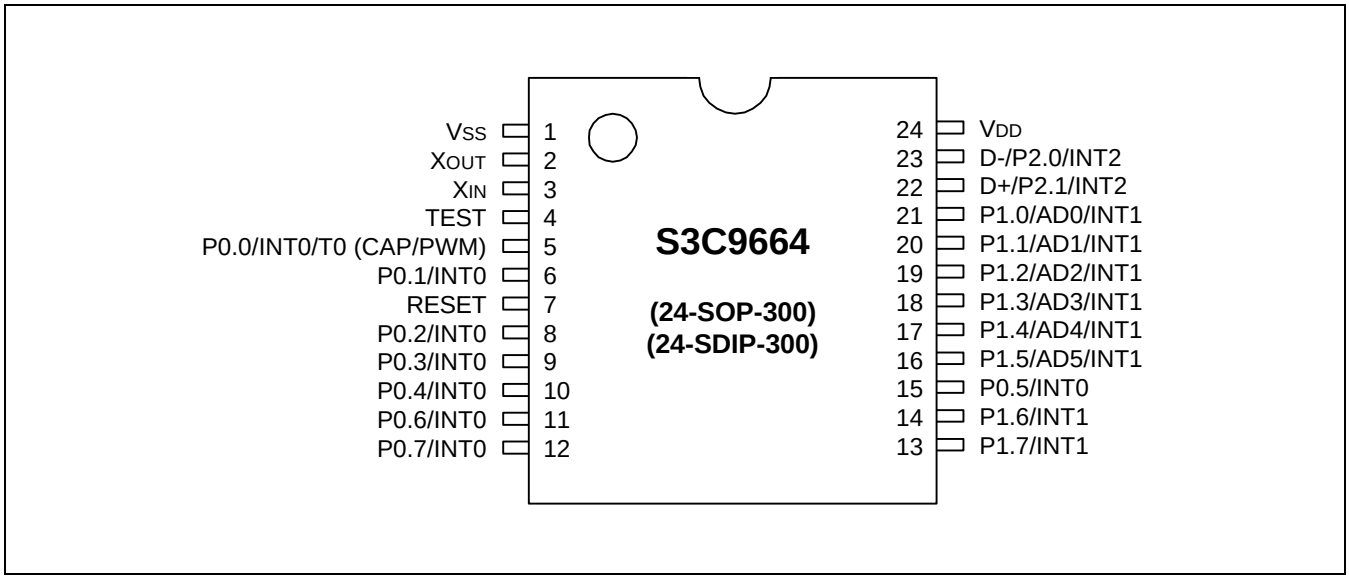


Figure 1-3. Pin Assignment (24 Pin)

Table 1-1. Pin Descriptions

Pin Name	In/Out	Pin Description	Pin Type	Pin Numbers	Share Pins
P0.0–P0.7	I/O	Bit-programmable I/O port for Schmitt trigger input , push-pull output and N-Ch open drain output. Pull-up/ pull-down resistors are assignable by software. Port1 pins can also be used as external interrupt.	G	5,6,8–11 (5,6,8–12,15)	T0, INT0
P1.0-P1.5	I/O	Bit-programmable I/O port for Schmitt trigger input, Schmitt trigger input with pull-up and N-Ch open drain output. Port1 pins can also be used as A/D converter Channel.	F	12–17 (16–21)	AD0–5 INT1
P1.6-P1.7	I/O	Bit-programmable I/O port for Schmitt trigger input , Schmitt trigger input with pull-up and N-Ch open drain output and Push-pull output.	E	(13–14)	INT1
P2.0/D– – P2.1/D+	I/O	Bit-programmable I/O port for Schmitt trigger input , Schmitt trigger input with pull-up and N-Ch open drain output and Push-pull output. Port 2 can be individually configured as external interrupt inputs. Also it can be configured as an USB ports	E	18–19 (22–23)	INT2
X_{IN}, X_{OUT}	–	Crystal/ceramic oscillator signal for system clock.	–	2–3 (2–3)	–
RESET	I	System reset signal input pin.	B	7 (7)	–
TEST	I	Test signal input pin(for factory use only; muse be connected to V_{SS})	–	4 (4)	–
V_{DD} ,V_{SS}	–	Voltage input pin and ground	–	1,20 (1,24)	–
T0	I/O	Timer 0 capture input or PWM output pin	G	6 (6)	P0.0
INT0	I	External interrupt input	G	5,6,8–11 (5,6,8–12,15)	P0.0–P0.7
INT1	I	External interrupt input	F,E	12–17 (13–14, 16–21)	P1.0–P1.7
INT2	I	External interrupt input	E	18–19	P2.0–P2.1
AD0–AD5	I	A/D converter input	F	12–17 (16–21)	P1.0–P1.5

NOTE: Pin numbers show in parentheses "( )" are for the 24-pin package

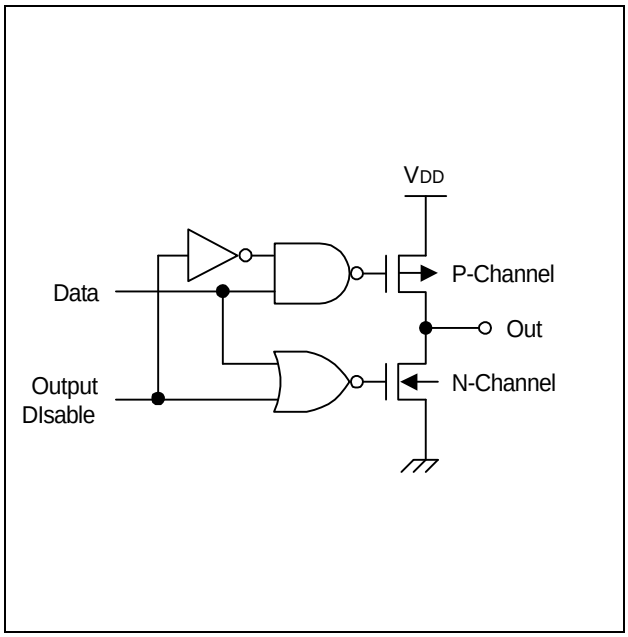


Figure 1-4. Pin Circuit Type C

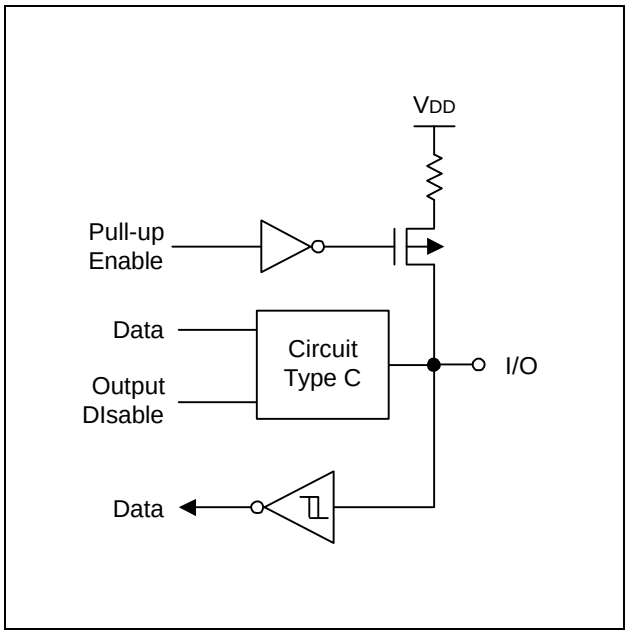


Figure 1-5. Pin Circuit Type D

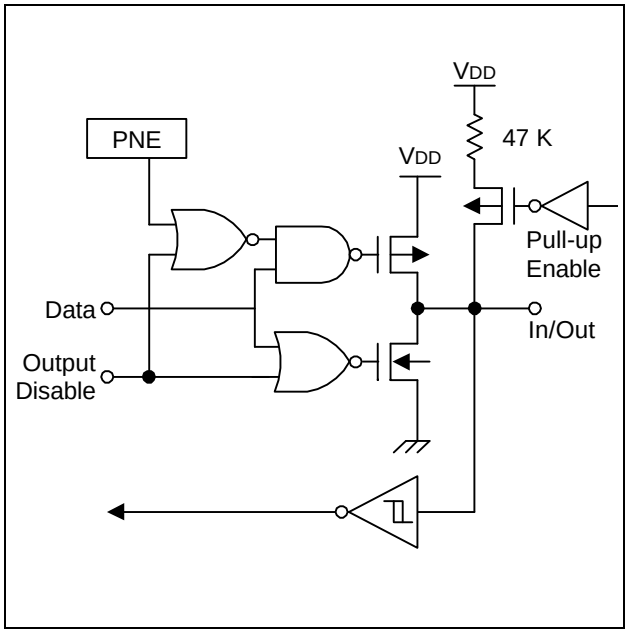


Figure 1-6. Pin Circuit Type E

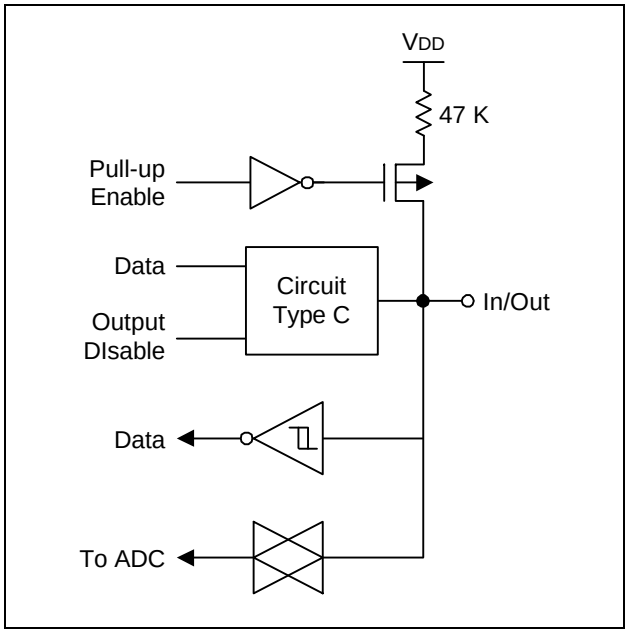


Figure 1-7. Pin Circuit Type F

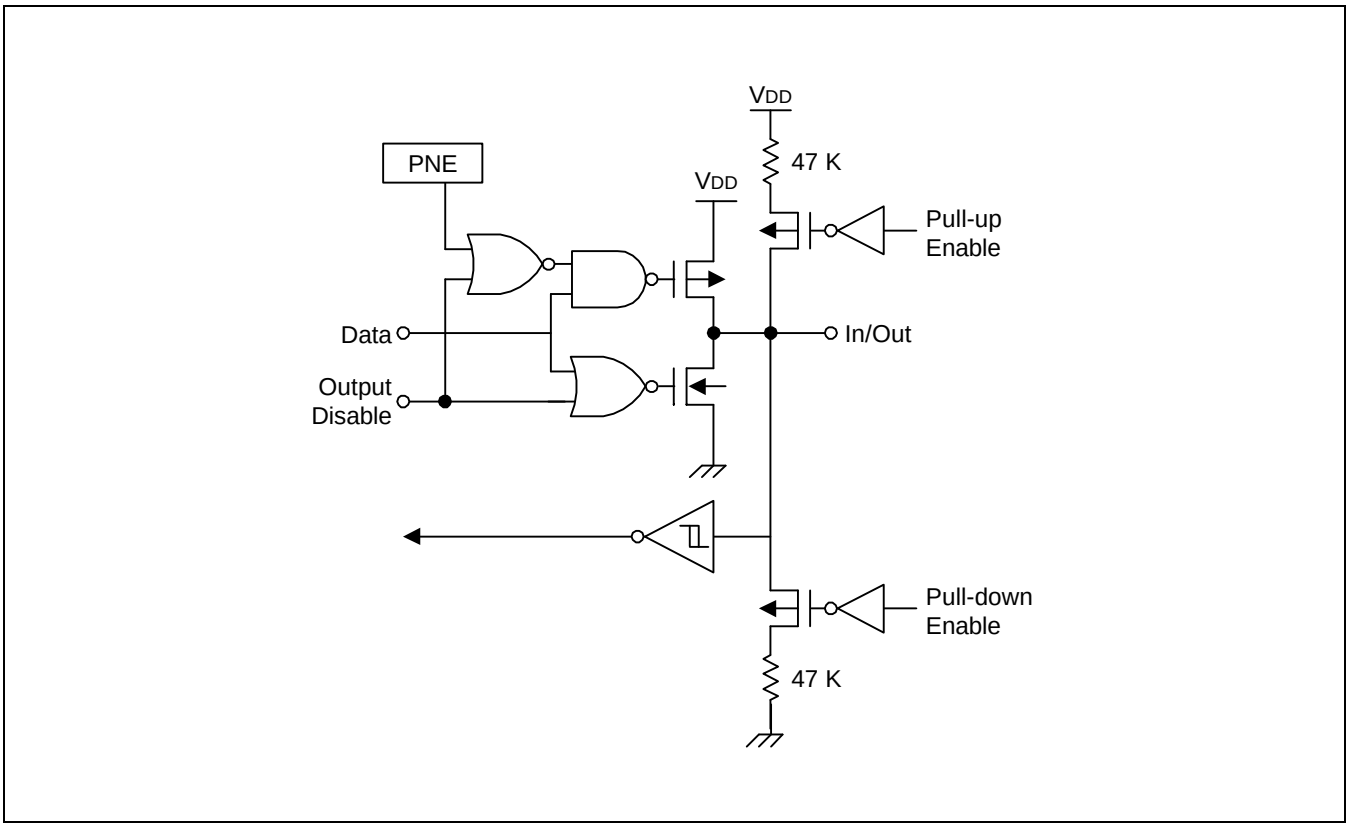


Figure 1-8. Pin Circuit Type G

16 ELECTRICAL DATA

OVERVIEW

In this section, the following S3C9664 electrical characteristics are presented in tables and graphs:

— Absolute maximum ratings
— D.C. electrical characteristics
— I/O capacitance
— A.C. electrical characteristics
— Oscillator characteristics
— Operating voltage range
— Oscillation stabilization time
— Clock timing measurement points at X_{IN}
— Data retention supply voltage in Stop mode
— Stop mode release timing when initiated by a RESET
— Stop mode release timing when initiated by an external interrupt
— Characteristic curves
— AD Converter Electrical Characteristics

Table 16-1. 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_I	All ports	– 0.3 to V_{DD} + 0.3	V
Output voltage	V_O	All output ports	– 0.3 to V_{DD} + 0.3	V
Output current high	I_{OH}	One I/O pin active	– 18	mA
		All I/O pins active	– 60	
Output current low	I_{OL}	One I/O pin active	+ 30	mA
		Total pin current for ports 0, 1, 2	+ 100	
Operating temperature	T_A	–	0 to + 85	°C
Storage temperature	T_{STG}	–	– 60 to + 150	

Table 16-2. D.C. Electrical Characteristics

(T_A = – 40°C to + 85°C, V_{DD} = 4.0 V to 5.25 V)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Input highvoltage	V_{IH1}	All input pins except V_{IH2}, D+, D–	0.8 V_{DD}	–	V_{DD}	V
	V_{IH2}	X_{IN}	V_{DD} – 0.5		V_{DD}	
Input low voltage	V_{IL1}	All input pins except V_{IL2}, D+, D–	–	–	0.2 V_{DD}	
	V_{IL2}	X_{IN}	–	–	0.4	
Output high voltage	V_{OH}	V_{DD} = 4.0 V – 5.25 V I_{OH} = – 200 mA All output ports except D+, D–	V_{DD} – 1.0	–	–	
Output low voltage	V_{OL}	V_{DD} = 4.0 V – 5.25 V I_{OL} = 2 mA All output ports except D+, D–	–	–	0.4	
Input high leakage current	I_{LIH1}	V_{IN} = V_{DD} All inputs except I_{LIH2} except D+, D–, X_{OUT}	–	–	3	µA
	I_{LIH2}	V_{IN} = V_{DD}, X_{IN}	–	–	20	
Input low leakage current	I_{LIL1}	V_{IN} = 0 V All inputs except I_{LIL2} except D+, D–, X_{OUT}	–	–	– 3	
	I_{LIL2}	V_{IN} = 0 V, X_{IN}	–	–	– 20	
Output high leakage current	I_{LOH}	V_{OUT} = V_{DD} All output pins except D+, D–	–	–	3	
Output low leakage current	I_{LOL}	V_{OUT} = 0 V All output pins except D+, D– X_{OUT}	–	–	– 3	
Pull-up resistors	R_{L1}	V_{IN} = 0 V, V_{DD} = 5.0 V, Port 0, Port 1,Port2	25	50	100	KΩ
	R_{L2}	V_{IN} = 0 V, V_{DD} = 5.0 V, RESET only	100	220	400	
Pull-down resistors	R_{L3}	V_{IN} = 0 V, V_{DD} = 5.0 V, Port 0	25	50	100	KΩ
Supply current	I_{DD1}	Normal operation mode, V_{DD} = 5 V ± 10 %, 6 MHz, CPU clock	–	6.5	15	mA
	I_{DD2}	IDLE mode V_{DD} = 5 V ± 10 %, 6 MHz, CPU clock	–	4	8	
	I_{DD3}	Stop mode, oscillator stop V_{DD} = 5 V ± 10 %,	–	150	300	µA

NOTES:
1. Supply current does not include current drawn through internal pull-up resistors or external output current load.
2. This parameter is guaranteed, but not tested (include D+, D–).
3. Only in 4.0 V to 5.25 V, D+ and D– satisfy the USB spec 1.1.

Table 16-3. Input/Output Capacitance

(T_A = 0°C to + 85°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}	expect X_{IN}, X_{OUT}				
XI/XO capacitance	C_{XI}, C_{XO}	X_{IN}, X_{OUT}			33	

Table 16-4. A.C. Electrical Characteristics

(T_A = – 40°C to + 85°C, V_{DD} = 4.0 V to 5.25 V)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Noise filter	t_{NF1H}, t_{NF1L}	P1 (RC delay)	100	–	200	ns

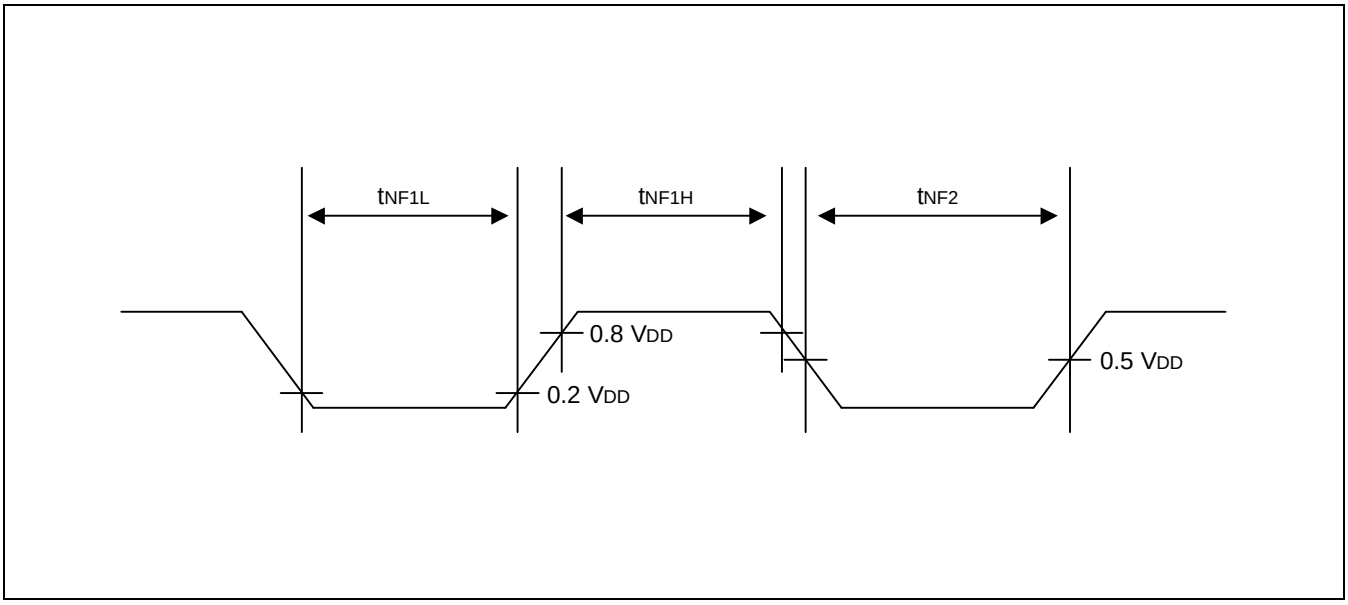


Figure 16-1. Input Timing for External Interrupts

Table 16-5. Oscillator Characteristics

(T_A = 0°C + 85°C)

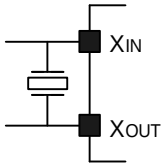
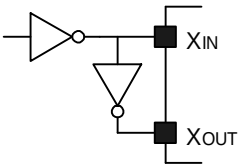
Oscillator	Clock Circuit	Test Condition	Min	Typ	Max	Unit
Main crystal Main ceramic (f_{OSC})		Oscillation frequency V_{DD} = 4.0 V – 5.25 V	–	6.0	–	MHz
External clock		Oscillation frequency V_{DD} = 4.0 V – 5.25 V	–	6.0	–	

Table 16-6. Oscillation Stabilization Time

(T_A = 0°C + 85°C, V_{DD} = 4.0 V to 5.25 V)

Oscillator	Test Condition	Min	Typ	Max	Unit
Main crystal	V_{DD} = 4.0 V to 5.25 V, f_{OSC} > 6.0 MHz	–	–	10	ms
Main ceramic	(Oscillation stabilization occurs when V_{DD} is equal to the minimum oscillator voltage range.)				
Oscillator stabilization wait time	t_{WAIT} stop mode release time by a reset	–	$2^{16}/f_{OSC}$	–	
	t_{WAIT} stop mode release time by an interrupt	–	–	–	

NOTE: The oscillator stabilization wait time, t_{WAIT}, when it is released by an interrupt, is determined by the setting in the basic timer control register, BTCON.

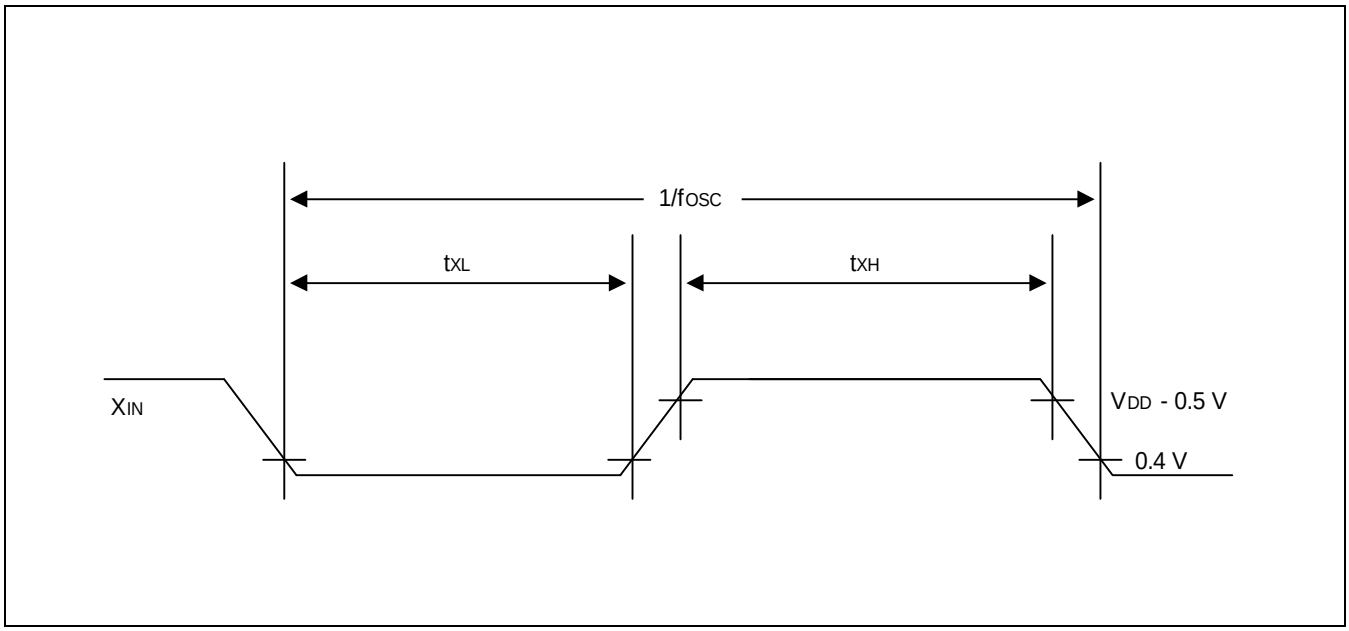


Figure 16-2. Clock Timing Measurement Points at X_{IN}

Table 16-7. Data Retention Supply Voltage in Stop Mode

(T_A = 0°C to + 70°C)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Data retention supply voltage	V_{DDDR}	Stop mode	2.0	–	6	V
Data retention supply current	I_{DDDR}	Stop mode; V_{DDDR} = 2.0 V	–	–	5	µA

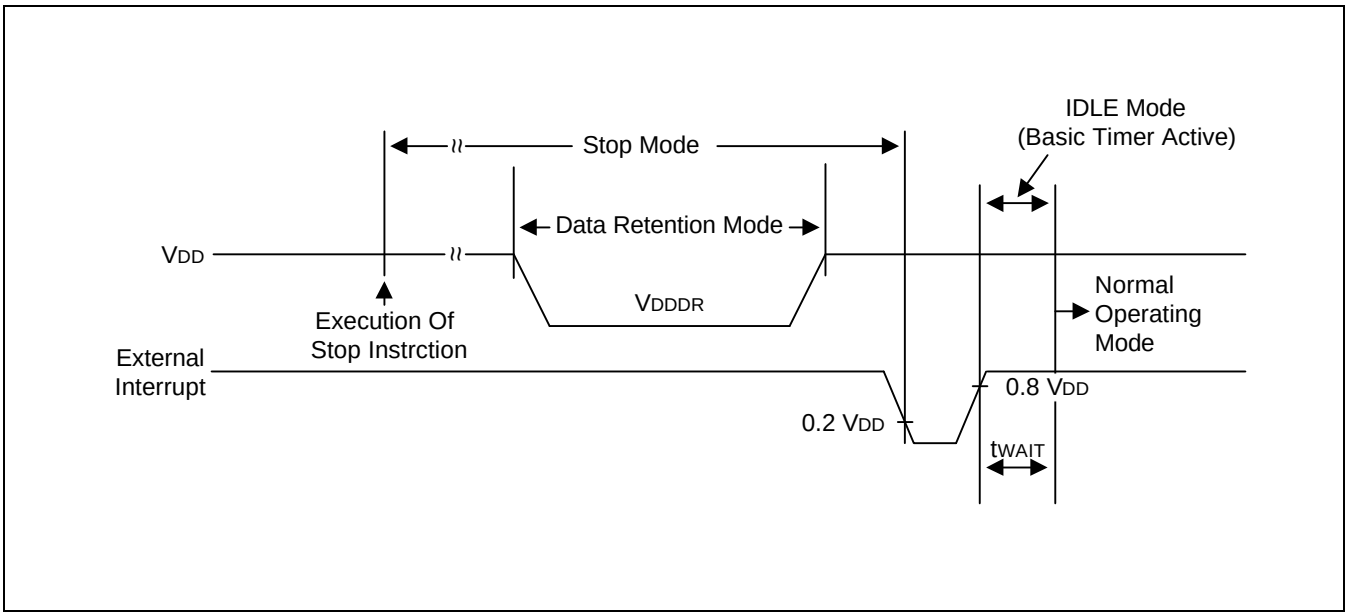


Figure 16-3. Stop Mode Release Timing When Initiated by an External Interrupt

Table 16-8. Low Speed Source Electrical Characteristics (USB)

(T_A = 0°C to + 85°C, Voltage Regulator Output V_{33OUT} = 2.8 V to 3.5 V, typ 3,3 V)

Parameter	Symbol	Conditions	Min	Max	Unit
Transition Time:					
Rise Time	Tr	CL = 200 pF	75	–	ns
		CL = 650 pF	–	300	
Fall Time	Tf	CL = 200 pF	75	–	
		CL = 650 pF	–	300	
Rise/Fall Time Matching	Trfm	(Tr/Tf) CL = 50 pF	80	125	%
Output Signal Crossover Voltage	Vcrs	CL = 50 pF	1.3	2.0	V
Output Voltage Regulator Built-in	V_{33OUT}	V_{DD} = 4.0–5.25 V	2.8	3.6	V

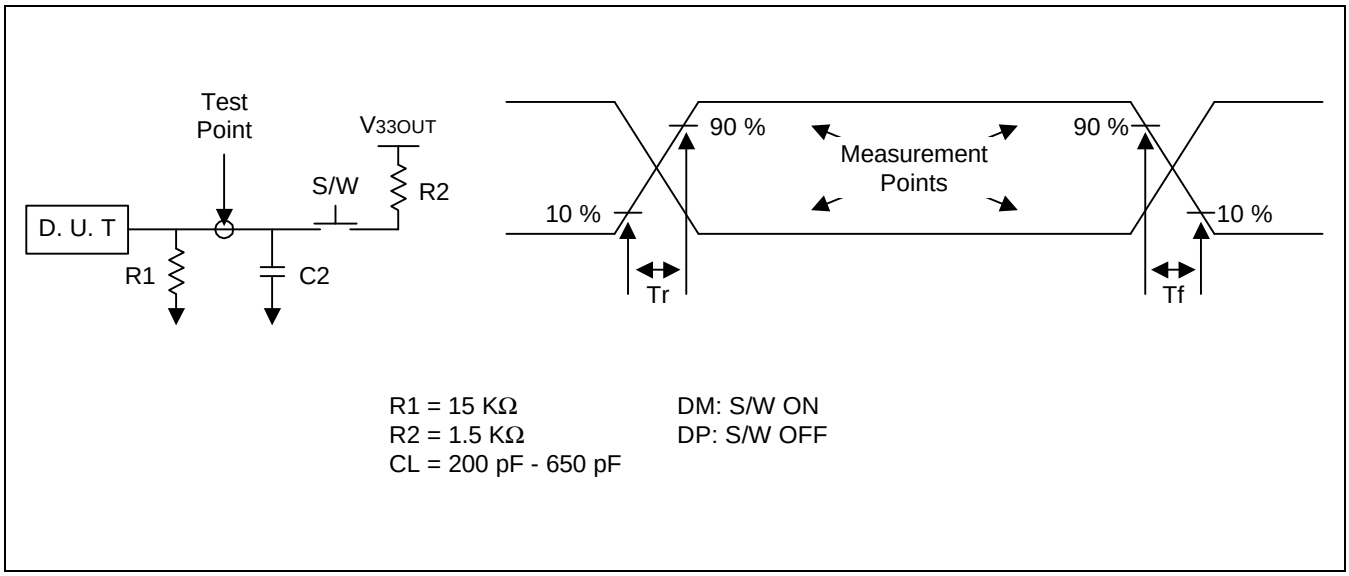


Figure 16-4. USB Data Signal Rise and Fall Time

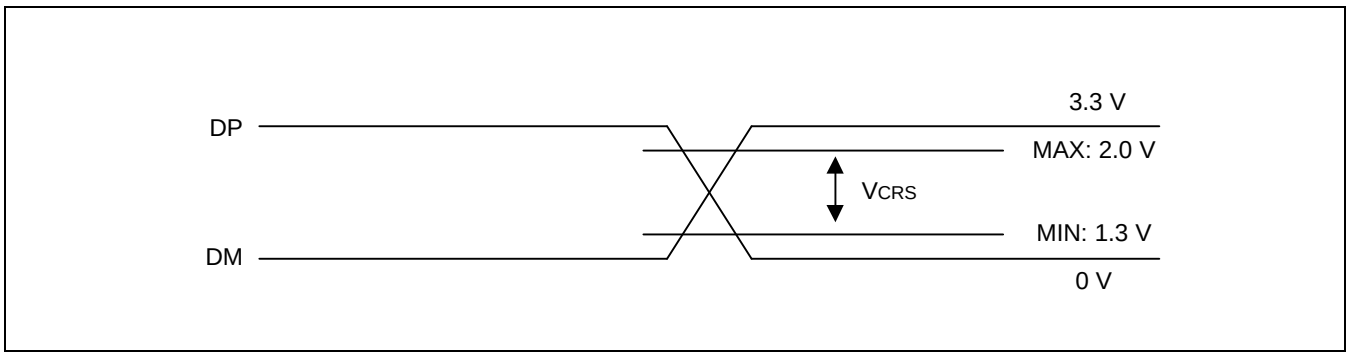


Figure 16-5. USB Output Signal Crossover Point Voltage

Table 16-9. A/D Converter Electrical Characteristics

(T_A = – 40°C to + 85°C, V_{DD} = 4.2 V to 5.25 V, V_{SS} = 0 V) S3C9664/P9664: 10-bit ADC

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Total accuracy		V_{DD} = 5.12 V CPU clock = 10 MHz V_{DD} = 5.12 V V_{SS} = 0 V	–	–	± 3	LSB
Integral linearity error	ILE	–		–	± 2	
Differential linearity error	DLE	–		–	± 1	
Offset error of top	EOT	–		– 1	± 3	
Offset error of bottom	EOB	–		– 1	± 2	
Conversion time(1)	t_{CON}	fcpu = 10 MHz	–	50x4/ f_{OSC}	–	µs
Analog input voltage	V_{IAN}	–	V_{SS}	–	V_{DD}	V
Analog input impedance	R_{AN}	–	2	–	–	MΩ
Analog input current	I_{ADIN}	V_{DD} = 5 V	–	–	10	µA
ADC block current(2)	I_{ADC}	V_{DD} = 5 V	–	1	3	mA
		V_{DD} = 5 V Power down mode	–	100	500	nA

NOTES:

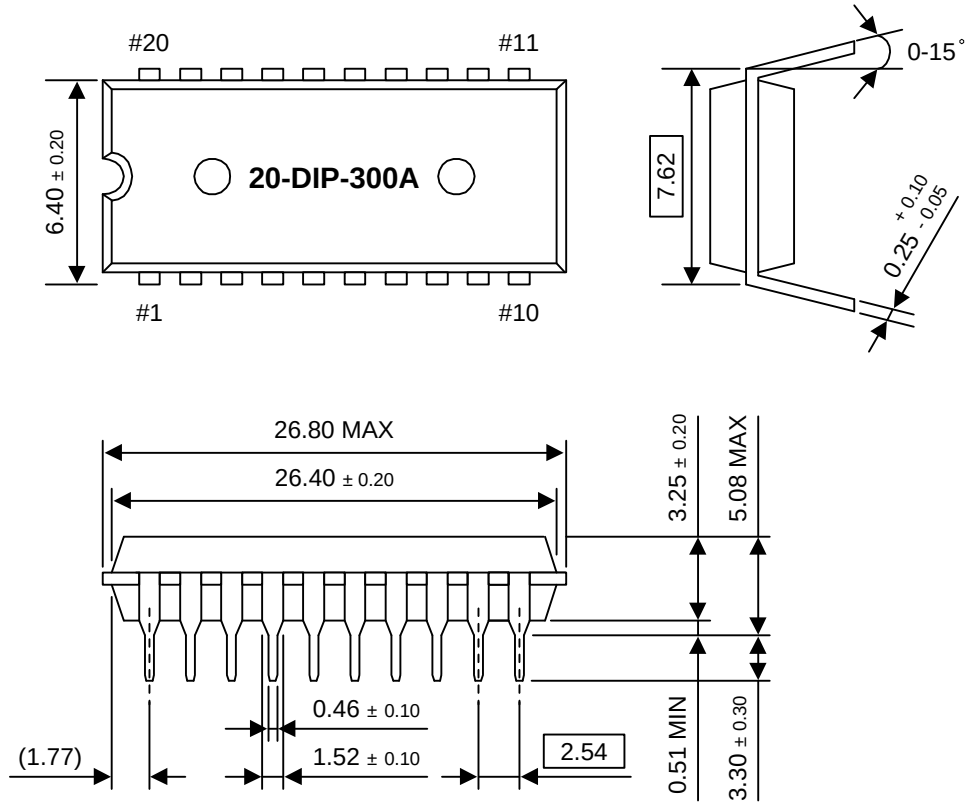
1. 'Conversion time' is the time required from the moment a conversion operation starts until it ends.
2. I_{ADC} is operating current during A/D conversion.

17 MECHANICAL DATA

OVERVIEW

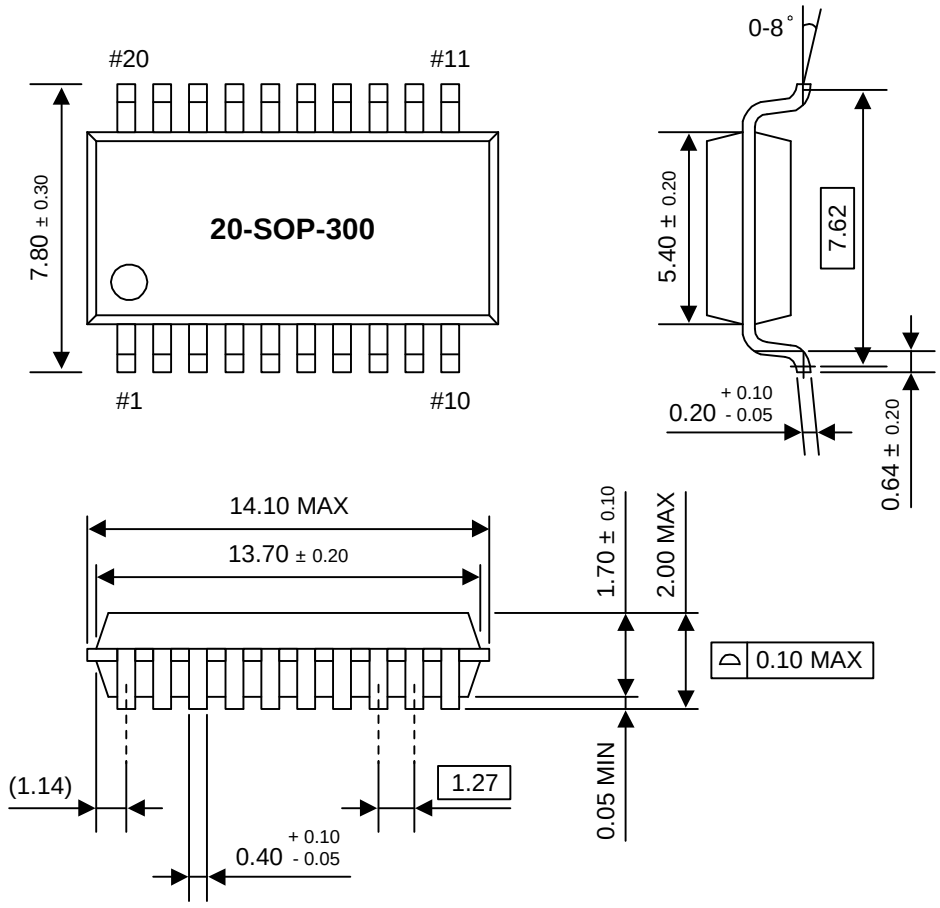
This section contains the following information about the device package:

— Package dimensions in millimeters
— Pad diagram



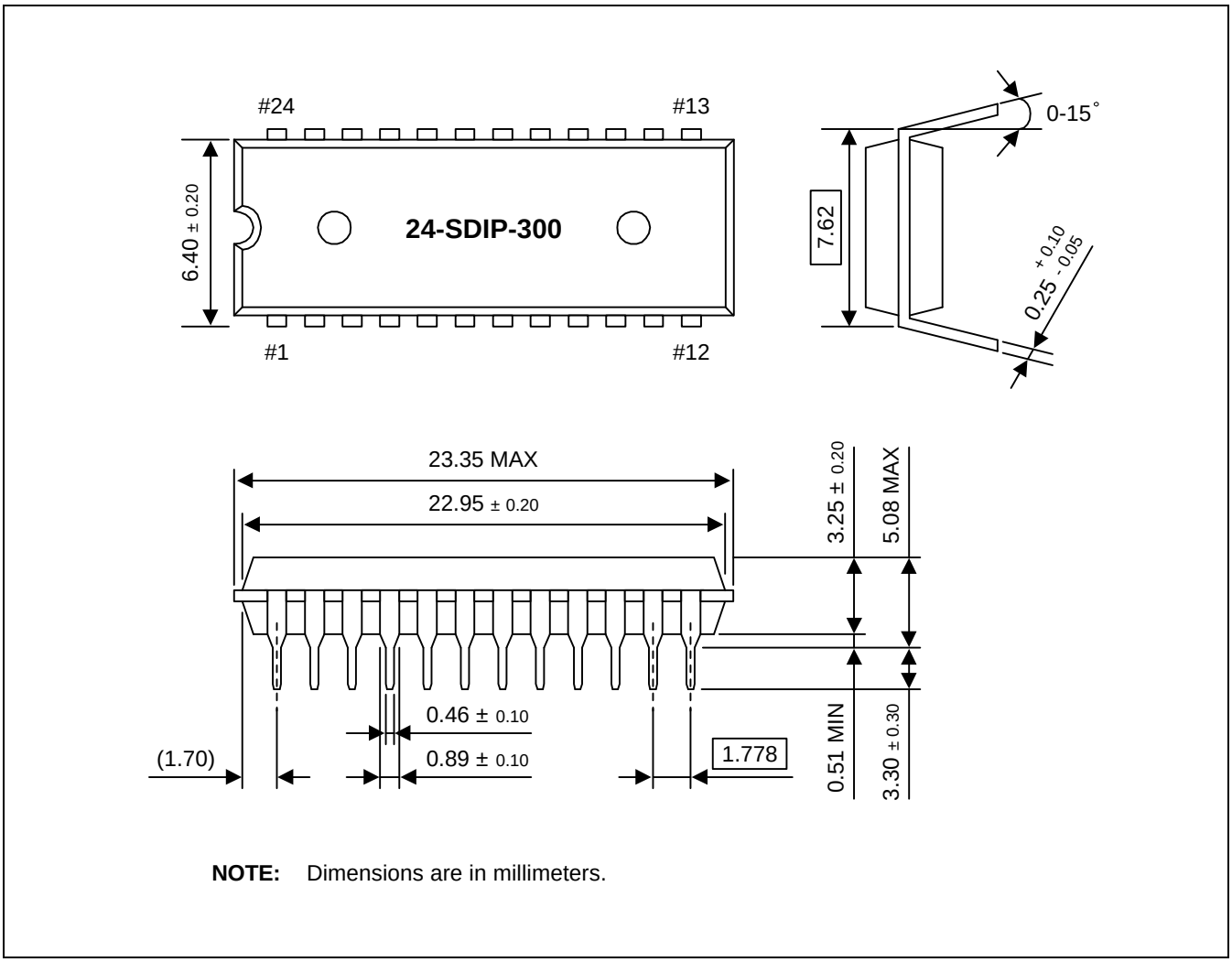
NOTE: Dimensions are in millimeters.

Figure 17-1. 20-DIP-300A Package Dimensions



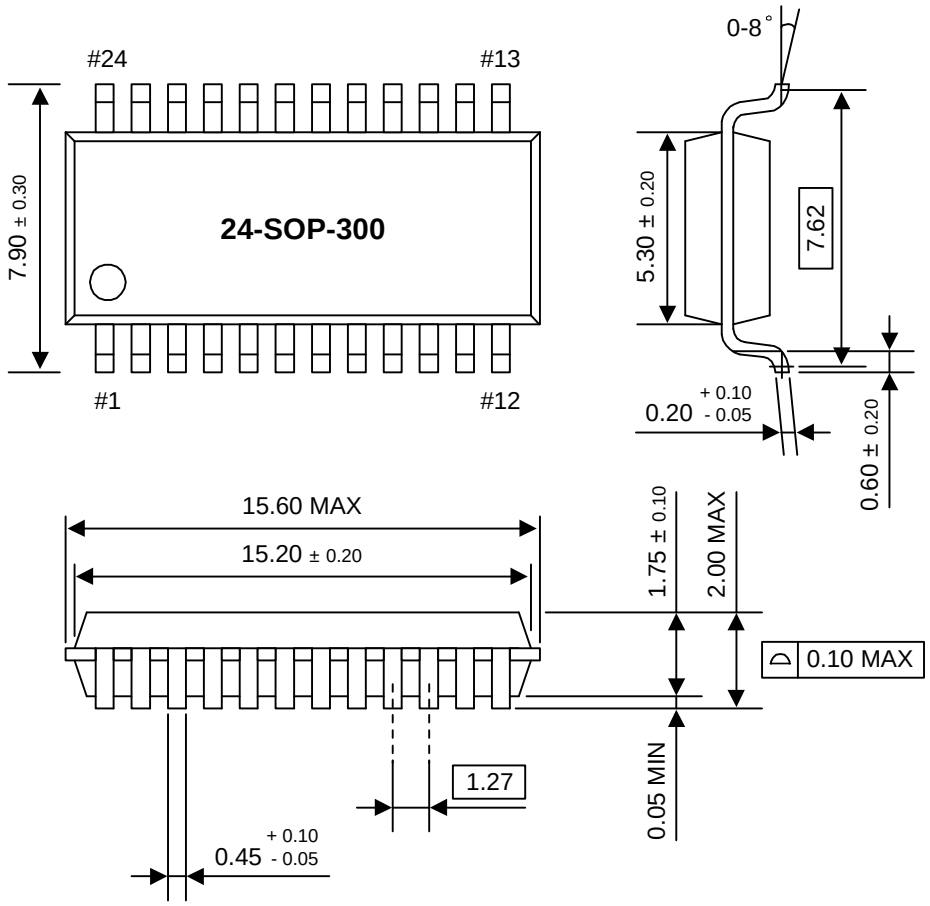
NOTE: Dimensions are in millimeters.

Figure 17-2. 20-SOP-300 Package Dimensions



NOTE: Dimensions are in millimeters.

Figure 17-3. 24-SDIP-300 Package Dimensions



NOTE: Dimensions are in millimeters.

Figure 17-4. 24-SOP-300 Package Dimensions

18 S3P9664 OTP

OVERVIEW

The S3C9664 single-chip CMOS microcontroller is the OTP (One Time Programmable) version of the S3C9664 microcontroller. It has an on-chip OTP ROM instead of masked ROM. The EPROM is accessed by serial data format.

The S3P9664 is fully compatible with the S3C9664, both in function and in pin configuration. Because of its simple programming requirements, the S3P9664 is ideal for use as an evaluation chip for the S3C9664.

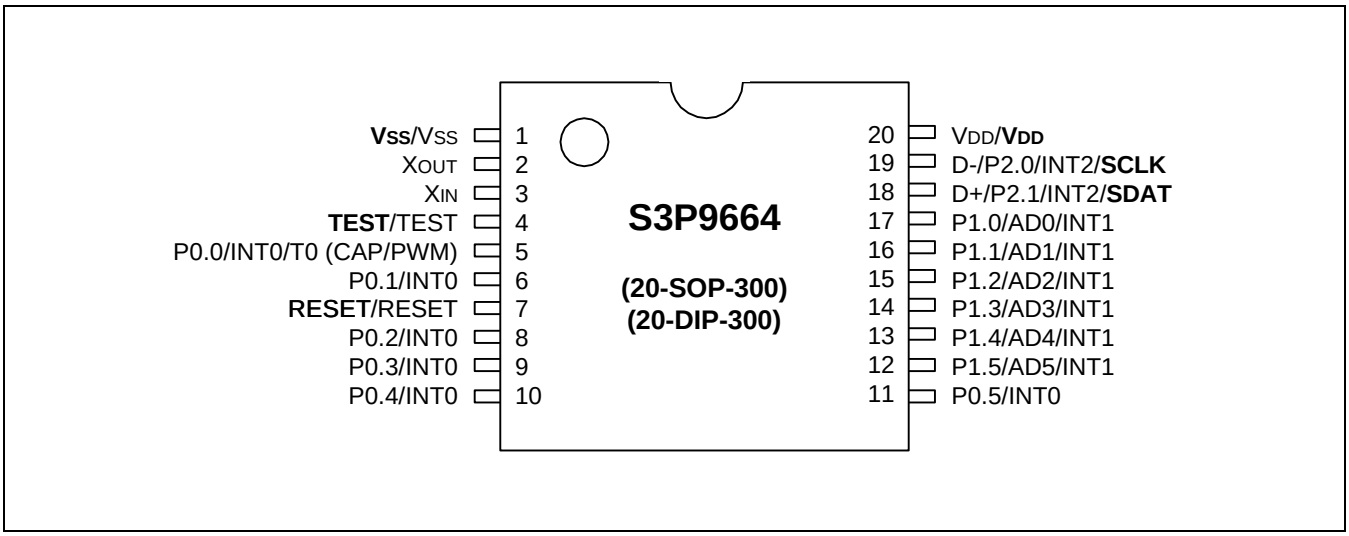


Figure 18-1. S3P9664 Pin Assignments (20-Pin Package)

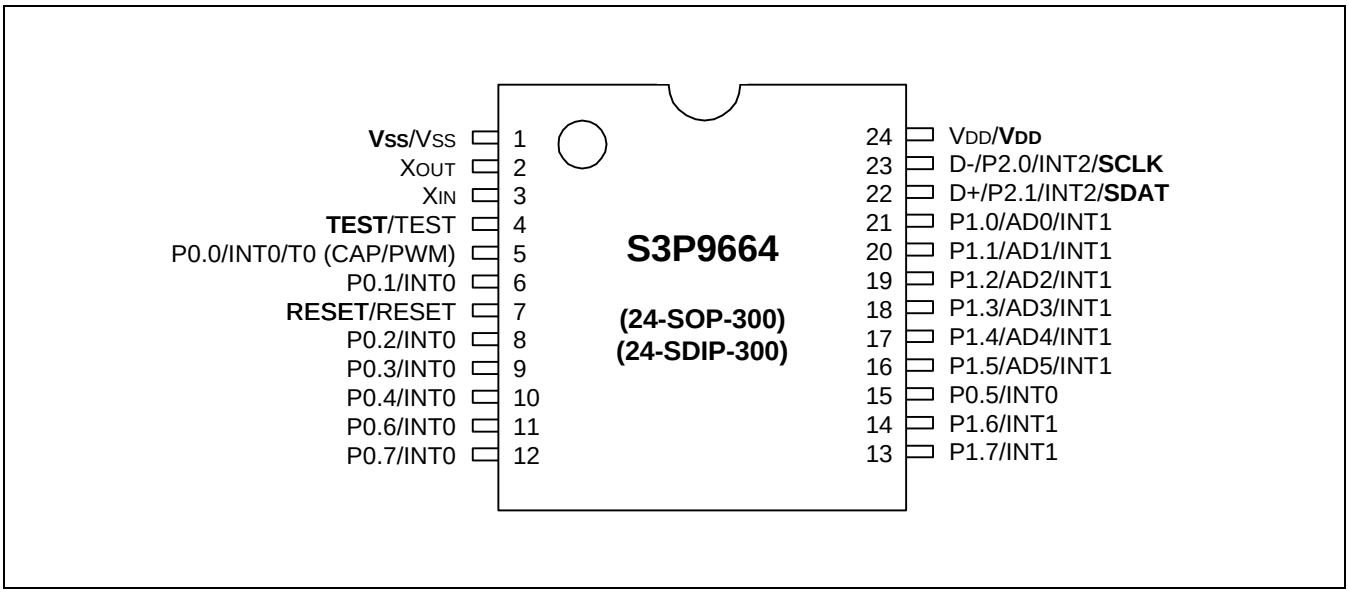


Figure 18-2. S3P9664 Pin Assignments (24-Pin Package)

Table 18-1. Descriptions of Pins Used to Read/Write the EPROM

Main Chip Pin Name	During Programming			
	Pin Name	Pin No. (24 DIP)	I/O	Function
P1.0	SDAT	23	I/O	Serial Data Pin (Output when reading, Input when writing) Input and Push-pull Output Port can be assigned
P1.1	SCLK	22	I/O	Serial Clock Pin (Input Only Pin)
TEST	V_{PP} (TEST)	5	I	0V : OTP write and test mode 5V : Operating mode
RESET	RESET	8	I	Chip Initialization and EPROM Cell Writing Power Supply Pin (Indicates OTP Mode Entering) When writing 12.5V is applied and when reading.
V_{DD}/V_{SS}	V_{DD}/V_{SS}	24/1	I	Logic Power Supply Pin.

Table 18-2. Comparison of S3P9664 and S3C9664 Features

Characteristic	S3P9664	S3C9664
Program Memory	4 K byte EPROM	4 K byte mask ROM
Operating Voltage (V_{DD})	4.0 V to 5.25 V	4.0 V to 5.25 V
OTP Programming Mode	V_{DD} = 5 V, V_{PP} (RESET) =12.5V	
Pin Configuration	20 SOP/20 DIP/24 SOP/24 SDIP	20 SOP/20 DIP/24 SOP/24SDIP
EPROM Programmability	User Program 1 time	Programmed at the factory