To all our customers

Regarding the change of names mentioned in the document, such as Mitsubishi Electric and Mitsubishi XX, to Renesas Technology Corp.

The semiconductor operations of Hitachi and Mitsubishi Electric were transferred to Renesas Technology Corporation on April 1st 2003. These operations include microcomputer, logic, analog and discrete devices, and memory chips other than DRAMs (flash memory, SRAMs etc.) Accordingly, although Mitsubishi Electric, Mitsubishi Electric Corporation, Mitsubishi Semiconductors, and other Mitsubishi brand names are mentioned in the document, these names have in fact all been changed to Renesas Technology Corp. Thank you for your understanding. Except for our corporate trademark, logo and corporate statement, no changes whatsoever have been made to the contents of the document, and these changes do not constitute any alteration to the contents of the document itself.

Note : Mitsubishi Electric will continue the business operations of high frequency & optical devices and power devices.

Renesas Technology Corp.
Customer Support Dept.
April 1, 2003

M66011FP

SERIAL BUS CONTROLLER

DESCRIPTION

M66011 Semiconductor Integrated Circuit is a serial bus controller. It converts 2-byte parallel data that arrives from microcomputer into serial and outputs it to serial bus. It also converts serial data input from serial bus into parallel and outputs it to microcomputer.
The M66011 is used for the extension of microcomputer I/O ports and two-way communication with peripheral equipment connected with serial buses.

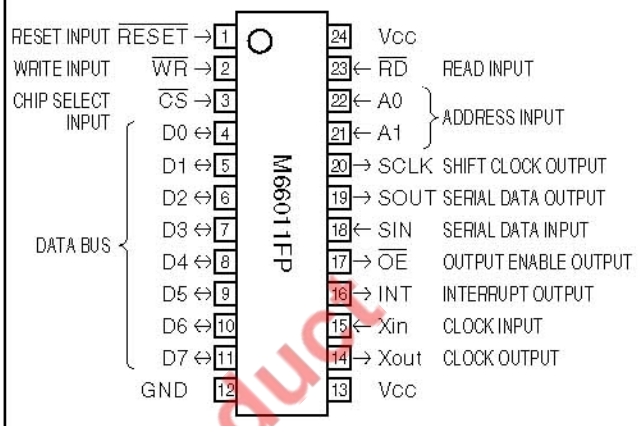
FEATURES

- Compatible with general-purpose 8-bit microprocessor busses
- TTL level input (one microcomputer side)
- Interrupt output
- Schmitt input ($\overline{\text{RESET}}$, $\overline{\text{CS}}$, SIN)
- Low power dissipation
- Wide operating temperature range (Ta = −20 to 75˚C)

APPLICATION

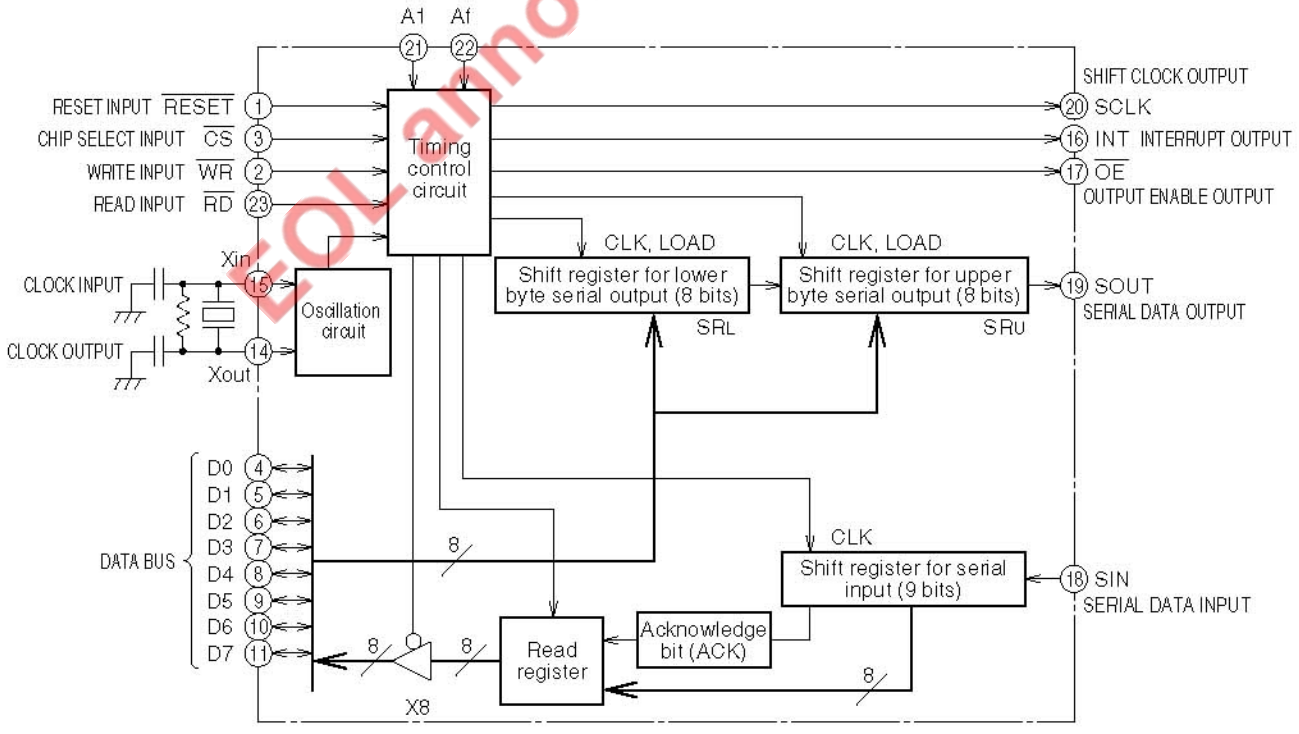
Microcomputer I/O port extension, etc.

PIN CONFIGURATION (TOP VIEW)



Outline 24P2N-B

BLOCK DIAGRAM



FUNCTION

M66011 integrated circuit is a serial bus controller. It is equipped with two 8-bit shift registers used to convert parallel input data into serial for output, as well as with one 9-bit shift register used to convert serial input data into parallel for output.
This IC receives and sends 8-bit parallel in communication with microcomputer. In communication with serial bus, it outputs 16-bit data and receives 9-bit data.

Serial data input/output uses four signal lines: shift clock output SCLK, serial data output SOUT, serial data input SIN and output enable output $\overline{OE}$.
Serial data is output synchronously with shift clock fall edges, while input of serial data is synchronous with shift clock rise edges.
Serial communication data consists of one prefixed acknowledge bit and 8 data bits.

PIN DESCRIPTIONS

Pin	Name	Input/Output	Functions
$\overline{RESET}$	Reset input	Input	"L" level: M66011 is reset to initial state.
$\overline{CS}$	Chip select input	Input	"L" level: M66011 becomes accessible.
$\overline{WR}$	Write input	Input	"L" level: 8-bit parallel data is input from data bus and written on M66011.
$\overline{RD}$	Read input	Input	"L" level: Serial-input 8-bit data or internal status data is output in parallel to data bus.
D0~D7	Data bus	Input/Output	Bi-directional 8-bit bus buffer. Used for communication with microcomputer (data write and read).
SCLK	Shift clock output	Output	Outputs clock to serial bus. Active ("H") status normally.
SOUT	Serial date output	Output	Outputs serial data to serial bus. Active ("H") status normally.
SIN	Serial data input	Input	Inputs serial data from serial bus.
$\overline{OE}$	Output enable output	Output	"L" when serial data communication is executed. Active ("H") otherwise.
INT	Interrupt output	Output	Outputs interrupt command signal to microcomputer when serial data communication is finished.
A0, A1	Address input	Input	Selects register on which data is written during write operation. Designates data to be read during read operation.
X_{in}	Clock input	Input	Connected to ceramic resonator, generates M66011 activation clock and SCLK output clock. If clock is input from outside, use pin X_{in} and keep pin X_{out} open.
X_{out}	Clock output	Output	
V_{CC}	Positive supply pin	—	Connected positive supply (5V).
GND	Grounding pin	—	Used for grounding (0V).

OPERATION

1. Write operation

(1) Serial output data setting

The M66011 has two built-in 8-bit shift registers. They are used to set serial output data.

When the address setting is (A1, A0) = (0, 1), 8-bit data on data bus is written on the upper byte serial output shift register (SR_U). When the address setting is (A1, A0) = (0, 0), the data is written on the lower byte serial output shift register (SR_L). In either case, data write starts when $\overline{WR}$ is on the "L" level.

(2) Status register setting

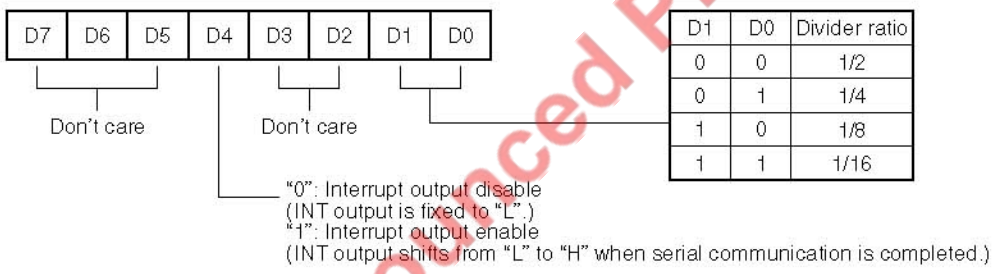
When the address setting is (A1, A0) = (1, 1), written data becomes the setting of status register in M66011. (Refer to the table below.)

Write Operation Basic Functions (Note 1)

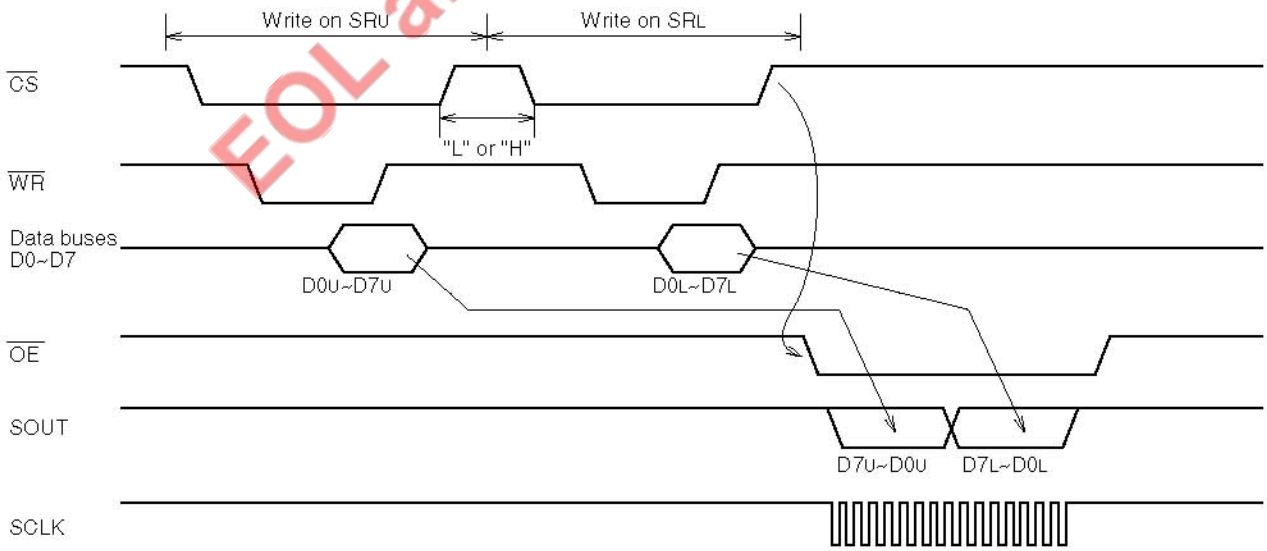
$\overline{CS}$	A1	A0	$\overline{RD}$	$\overline{WR}$	Functions
0	0	0	1	0	• Lower byte serial output shift register ← Data bus data
0	0	1	1	0	• Upper byte serial output shift register ← Data bus data
0	1	1	1	0	• Shift clock divider ratio register • Interrupt output control register ← (Note 2) Data bus data

Note 1: Figure "0" indicates "L" level, while "1" indicates "H" level.

Note 2:



D1	D0	Divider ratio
0	0	1/2
0	1	1/4
1	0	1/8
1	1	1/16



Write Operation Basic Timing (Serial Output Data Setting)

2. Read operation

When a read access arrives, M66011 outputs data in parallel to data bus. The data output at this moment may be serial input data, or data on internal status resister.

When a read access arrives when the address setting is (A1, A0) = (1, 0), 8-bits of 9-bit serial input data, excluding the acknowledge bit, is output to data bus While $\overline{RD}$ is "L".

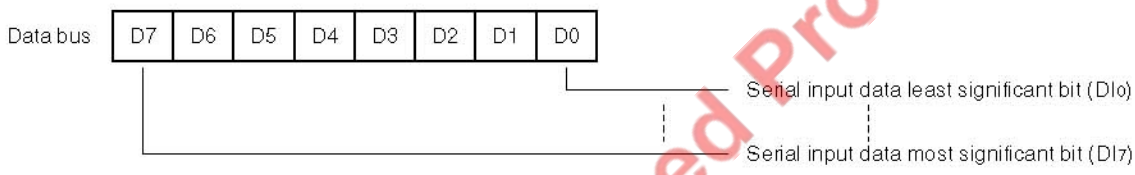
When a read access arrives when the address setting is (A1, A0) =(1, 1), interrupt control register, busy flag, serial-input acknowledge bit and clock dividing ratio register are output to data bus while $\overline{RD}$ is "L".

Read Operation Basic Function

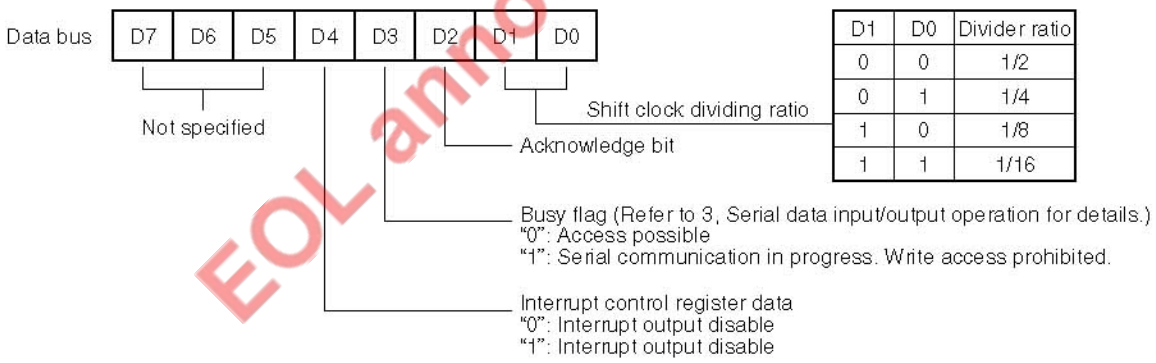
$\overline{CS}$	A1	A0	$\overline{RD}$	$\overline{WR}$	Functions
0	1	0	0	1	Date bus ← Serial input shift register
0	1	1	0	1	Data bus ← Status register

Read Output Data Details

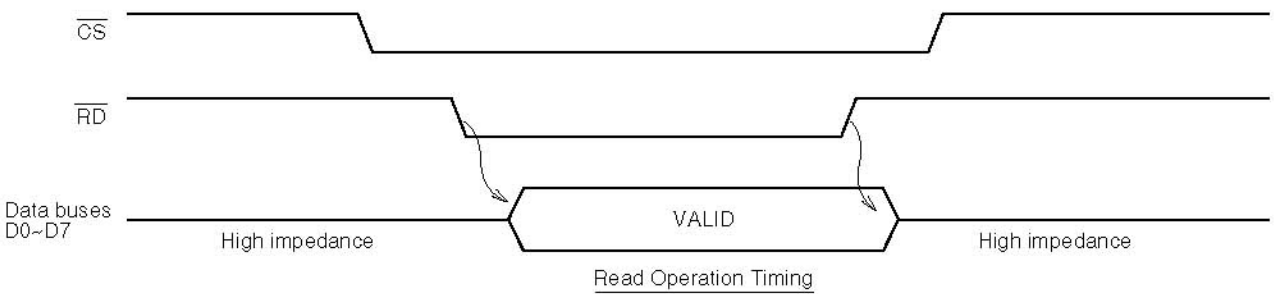
(1)When (A1, A0) is (1, 0):



(2)When (A1, A0) is (1, 1):



D1	D0	Divider ratio
0	0	1/2
0	1	1/4
1	0	1/8
1	1	1/16



Read Operation Timing

3. Serial data input/output operation

A cycle of 16-bit serial output data setting and serial data communication starts with a write access given by microcomputer to transmission shift registers in M66011.

M66011 has two 8-bit shift registers, on for upper byte (SR_U), the other for lower byte (SR_L). If the $\overline{CS}$ status rises from "L" to "H" after a write access is given to SR_L, serial data communication is started. SR_U 8-bit data and SR_L, 8-bit data are output in series in this order. Output of each data starts from its most significant bit.

At the $\overline{CS}$ rise edge, busy flag in M66011 is set, and $\overline{OE}$ output shifts from "H" to "L". Shift clock SCLK and serial data SOUT are then output.

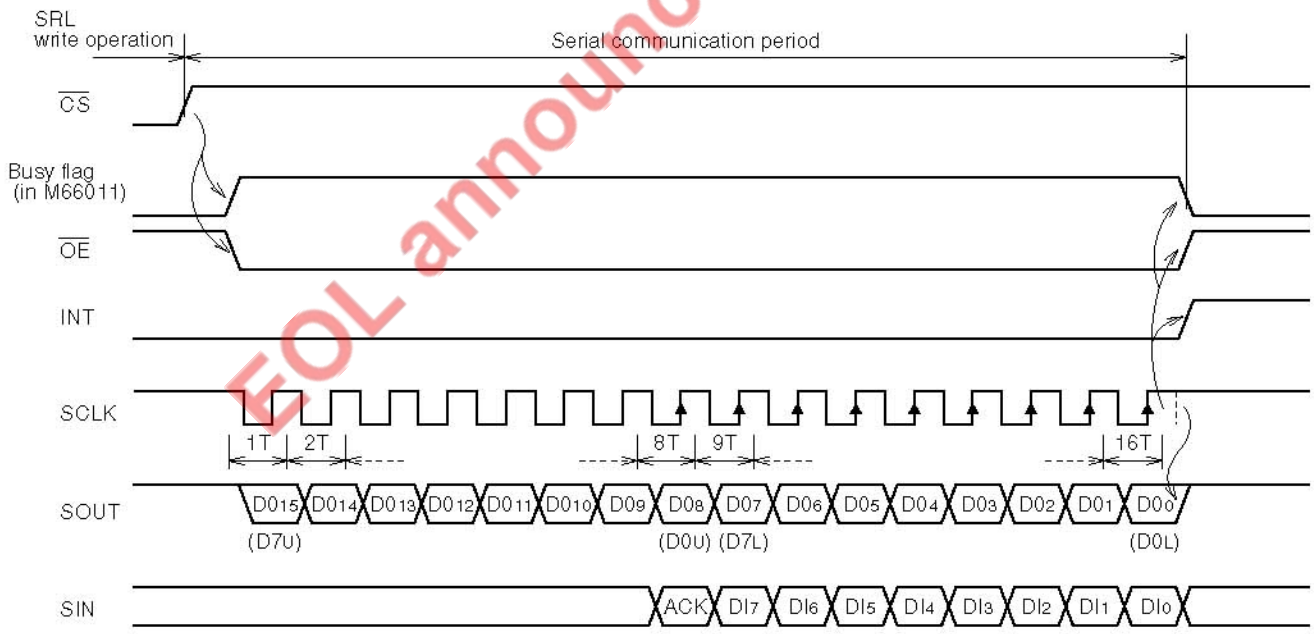
At SCLK fall edges, serial output shift register executes shifting operation, and data on shift register is output in series from pin SOUT. Serial input data from pin SIN is taken into input shift register at SCLK 8T thru 16T rise edges. However, data taken in at 8T rise edge is processed as acknowledge bit, while data taken in at 9T thru 16T rise edges are processed as data bits.

After the SCLK 16T rise edge, the status of SOUT and $\overline{OE}$ shifts to "H" after one bit's delay of SCLK, and busy flag is reset. When interrupt output is being set to enable, INT output is set.

(Remarks)

(1) If $\overline{CS}$ rises after write operation is executed on SR_L only and not on SR_U, SR_U data is unstable.

(2) When write operations executed on SR_L, M66011 becomes ready for start of serial communication and stands by for detection of $\overline{CS}$ rise. However, if a read access is given after data is written on SR_L while $\overline{CS}$ is maintained on "L" level, this standby status is canceled. To resume serial communication in this case, rewrite data on SR_L and raise $\overline{CS}$.



Serial Communication Timing Chart

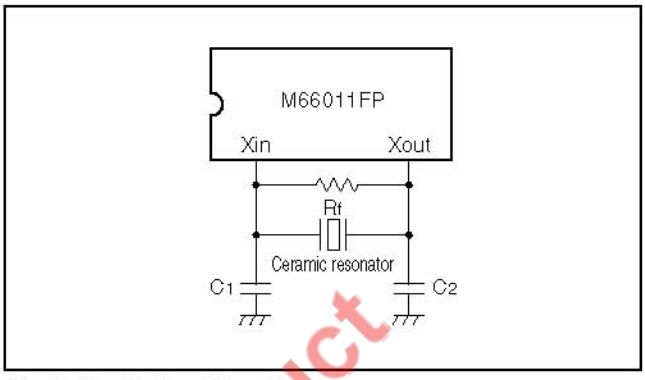
4. Shift clock output
Shift clock output pin (SCLK) outputs clock pulses generated by ceramic resonator oscillation circuit connected between pins X_{in} and X_{out}, or divided clock pulses input via pin X_{in} from external clock. The dividing ratio can be selected from among 1/2, 1/4, 1/8 and 1/16.

5. Interrupt output
When interrupt output control register is set to "1" (interrupt output enable), the status of this output shifts from "L" to "H" at the end of a serial communication cycle, and an interrupt command is given to microcomputer. Interrupt output "H" is reset when read accessed.
When interrupt output control register is set to "0" (interrupt output disable), the status of this output is retained on the "L" level.

6. Conditions when reset
If "L" is input to $\overline{\text{RESET}}$, M66011 are put under the conditions as specified below:

Pin name	Status
$\overline{\text{OE}}$, SCLK and SOUT outputs	Active ("H")
Internal busy flag	Reset ("L")
Acknowledge bit register	Set ("H")
INT output	Disable (continuous "L" output)
Divider ratio	1/2

7. Oscillation circuit
An example of circuit connection and circuit constants are given below for the case where a ceramic resonator is used.



Clock Oscillation Circuit

Maker	Ceramic resonator	Frequency (MHz)	C1 (pF)	C2 (pF)	Rf (MΩ)
Murata Mfg.	CSA4.00MG040	4.0	100	100	1.0
	CST4.00MGW040	4.0	100 (built-in)	100 (built-in)	1.0
	CSA8.00MT	8.0	30	30	1.0
	CSA8.00MTW	8.0	30 (built-in)	30 (built-in)	1.0

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Ratings	Unit
V_{CC}	supply voltage	−0.5 ~ +7.0	V
V_I	Input voltage	−0.5 ~ V_{CC} + 0.5	V
V_O	Output voltage	−0.5 ~ V_{CC} + 0.5	V
P_d	Power dissipation	500	mW
T_{stg}	Storage temperature	−60 ~ 150	°C

RECOMMENDED OPERATIONAL CONDITIONS

Symbol	Parameter	Limits			Unit
		Min.	Typ.	Max.	
V_{CC}	Supply voltage	4.5	5.0	5.5	V
V_I	Input voltage	0		V_{CC}	V
V_O	Output voltage	0		V_{CC}	V
T_{opr}	Operating temperature	−20		75	°C

ELECTRICAL CHARACTERISTICS (Ta = −20 ~ 75°C, V_{CC} = 5V ± 10% and GND = 0V unless otherwise noted)

Symbol	Parameter		Test conditions	Limits			Unit
				Min.	Typ.	Max.	
V_{IH}	"H" input voltage	$\overline{WR}$, $\overline{RD}$, A0, A1, D0~D7		2.0			V
V_{IL}	"L" input voltage					0.8	V
V_{IH}	"H" input voltage	Xin		V_{CC}×0.8			V
V_{IL}	"L" input voltage					V_{CC}×0.2	V
V_{T+}	Positive threshold voltage	$\overline{RESET}$, $\overline{CS}$, SIN				2.4	V
V_{T-}	Negative threshold voltage			0.7			V
V_h	Hysteresis width				0.6		V
V_{OH}	"H" output voltage	D0~D7, SCLK, INT, SOUT, $\overline{OE}$	I_{OH}=−4mA	V_{CC}−0.8			V
V_{OL}	"L" output voltage		I_{OL}=4mA			0.4	V
I_I	Input leak current		V_I=0~V_{CC}			±10	µA
I_{OZ}	Output leak current in off state	D0~D7	V_O=0~V_{CC}			±10	µA
I_{CC}	Quiescent supply current		V_I=V_{CC}, GND output open			200	µA
CI/O	Input/output pin capacitance	D0~D7				20	pF

Note 3: Standard value measuring conditions: Ta = 25°C and V_{CC} =5V

TIMING CONDITIONS (Ta = −20 ~ 75°C, Vcc = 5V ± 10%, GND = 0V)

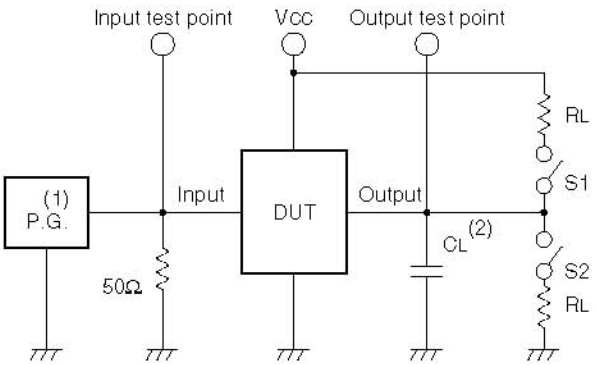
Symbol	Parameter	Test conditions	Limits			Unit
			Min.	Typ.	Max.	
$t_{c(\phi)}$	Clock cycle		120		520	ns
$t_{WH(\phi)}$	Clock "H" pulse width			$t_{c(\phi)}/2$		ns
$t_{WL(\phi)}$	Clock "L" pulse width			$t_{c(\phi)}/2$		ns
$t_{r(\phi)}$	Clock rise time				20	ns
$t_{f(\phi)}$	Clock fall time				20	ns
$t_{W(\overline{R})}$	Read pulse width		100			ns
$t_{W(\overline{W})}$	Write pulse width		100			ns
$t_{su(\overline{CS}\text{-}\overline{R})}$	Chip select setup time before read		0			ns
$t_{su(A\text{-}\overline{R})}$	Address setup time before read		0			ns
$t_{su(\overline{CS}\text{-}\overline{W})}$	Chip select setup time before write		0			ns
$t_{su(A\text{-}\overline{W})}$	Address setup time before write		0			ns
$t_{su(D\text{-}\overline{W})}$	Data setup time before write		40			ns
$t_{h(\overline{R}\text{-}\overline{CS})}$	Chip select hold time after read		0			ns
$t_{h(\overline{R}\text{-}A)}$	Address hold time after read		0			ns
$t_{h(\overline{W}\text{-}\overline{CS})}$	Chip select hold time after write		0			ns
$t_{h(\overline{W}\text{-}A)}$	Address hold time after write		0			ns
$t_{h(\overline{W}\text{-}D)}$	Data hold time after write		0			ns
$t_{su(SI\text{-}CK)}$	Serial data setup time		100			ns
$t_{h(CK\text{-}SI)}$	Serial data hold time		100			ns
t_{BUSY}	Internal processing time after write				$5t_{c(\phi)}$	ns
$t_{WH(\overline{CS})}$	Chip select "H" time at serial communication start up		$5t_{c(\phi)}$			ns

SWITCHING CHARACTERISTICS (Ta = −20 ~ 75°C, Vcc = 5V ± 10%, GND = 0V)

Symbol	Parameter		Test conditions	Limits			Unit
				Min.	Typ.	Max.	
$t_{PZH(\overline{R}\text{-}D)}$ $t_{PZL(\overline{R}\text{-}D)}$	Data output enable time after read		CL=150pF RL=2KΩ (Note 4)			80	ns
$t_{PHZ(\overline{R}\text{-}D)}$ $t_{PLZ(\overline{R}\text{-}D)}$	Data output disable time after read			5		50	ns
t_{PLH}, t_{PHL}	Serial output propagation delay time	SCLK-SOUT				60	ns
		$\overline{OE}$-SCLK		$t_{c(\phi)}+20$			ns
		SCLK-$\overline{OE}$			$\frac{n \cdot t_{c(\phi)}}{2}$		ns

n: Divider ratio

NOTE 4: TEST CIRCUIT

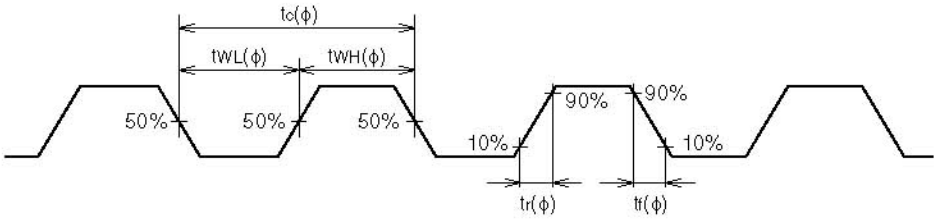


Symbol	S1	S2
$t_{PZH(\overline{R}\text{-}D)}$	Open	Closed
$t_{PZL(\overline{R}\text{-}D)}$	Closed	Open
$t_{PHZ(\overline{R}\text{-}D)}$	Open	Closed
$t_{PLZ(\overline{R}\text{-}D)}$	Closed	Open
t_{PLH}, t_{PHL}	Open	Open

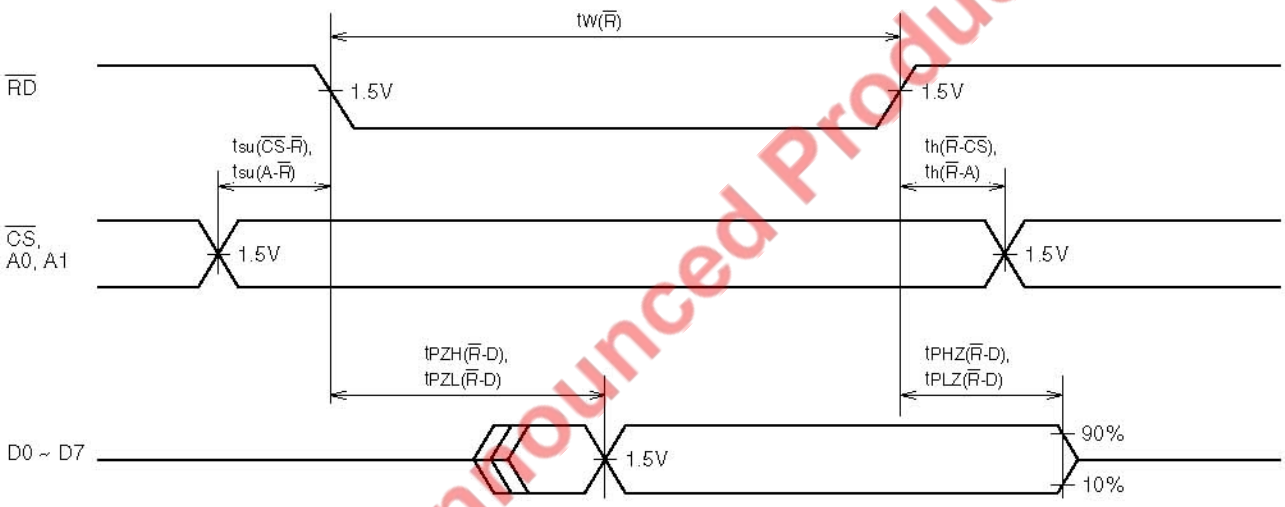
(1) Pulse generator (PG) characteristics: t_r=t_f=6ns, Z_o=50Ω
(2) Capacitance C_L includes connection floating capacitance and probe input capacitance.

TIMING CHARTS

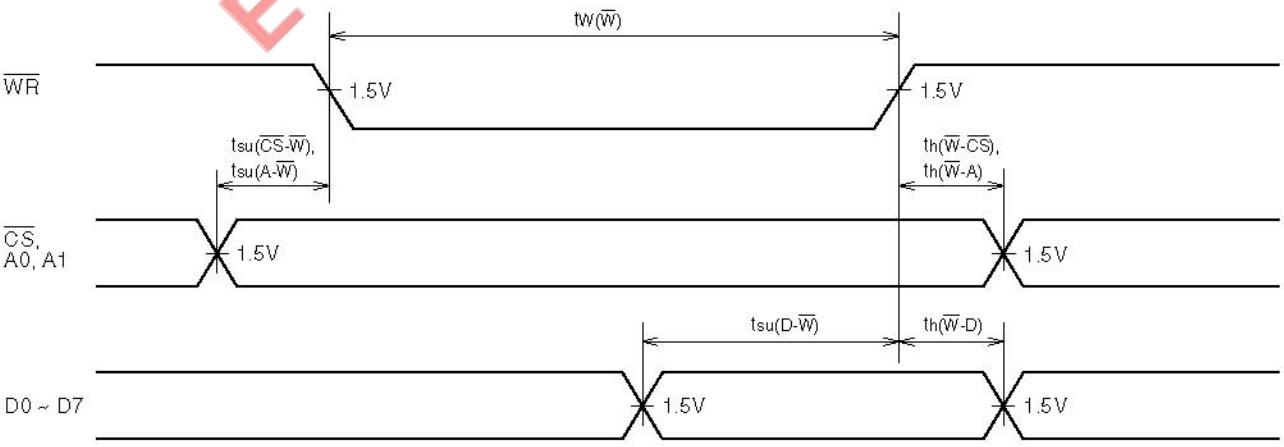
Clock timing



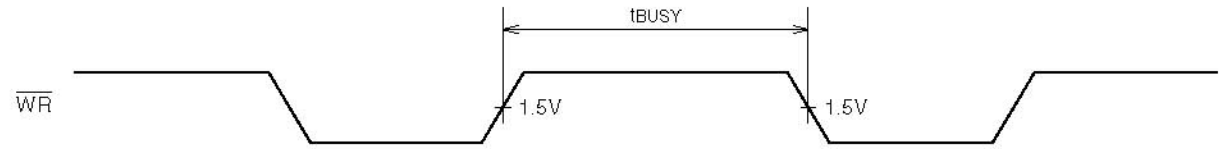
Read operation timing



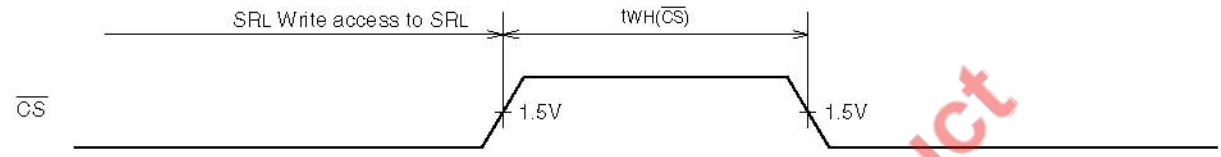
Write operation timing



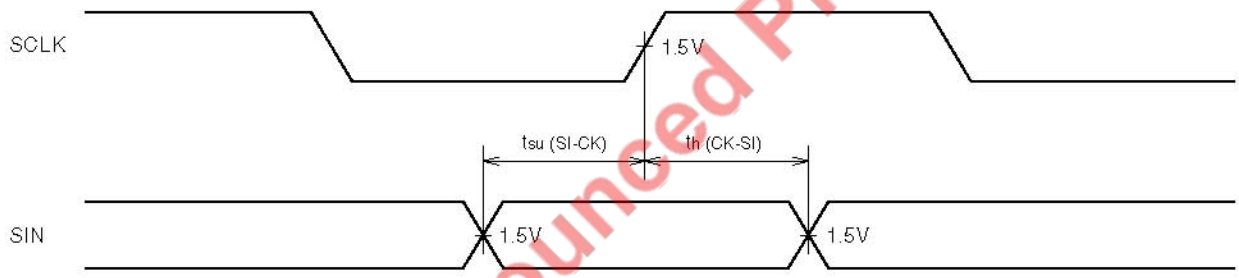
Write operation internal processing time



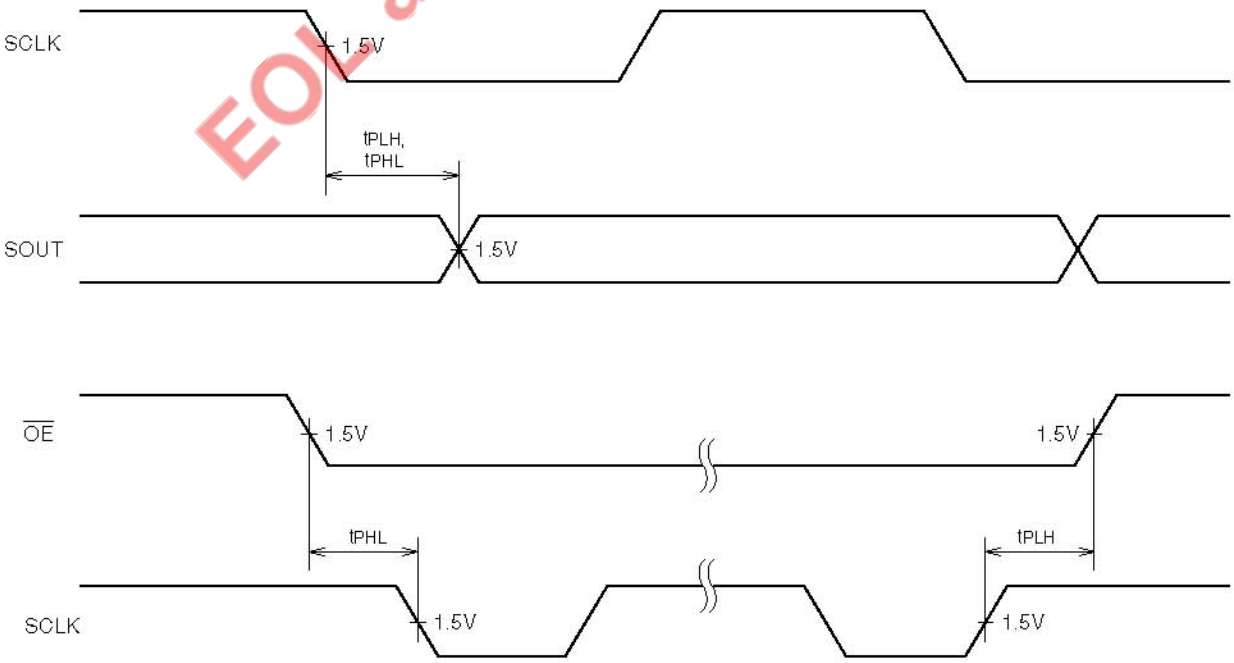
Serial input communication start timing



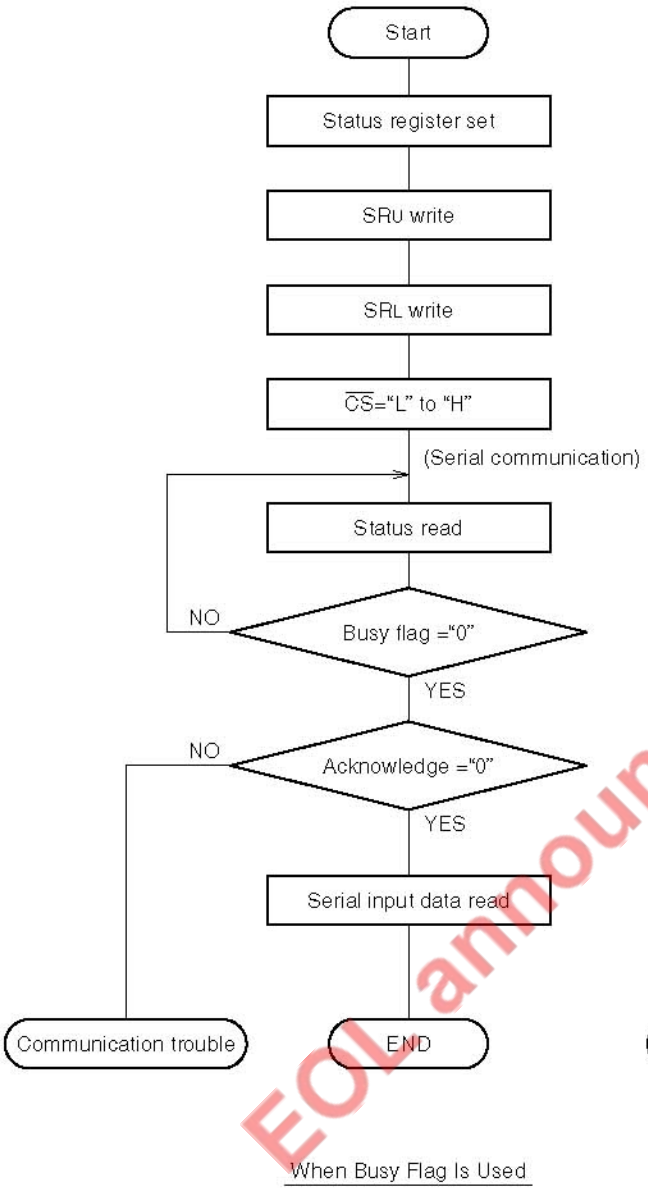
Serial input operation



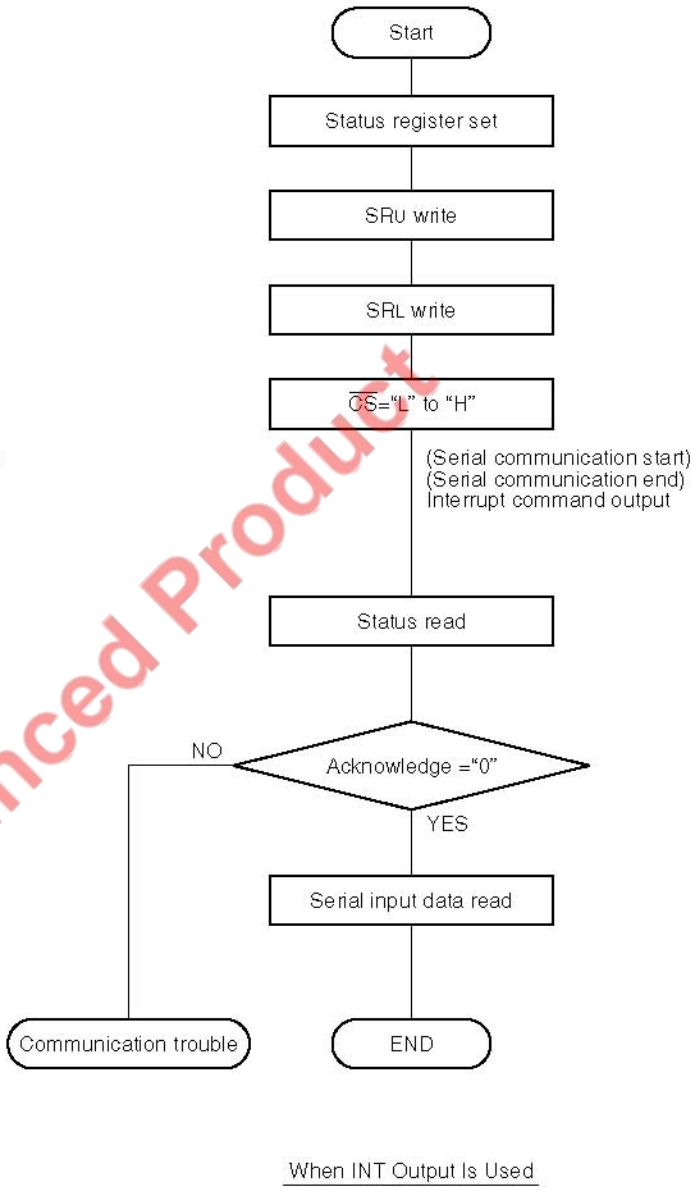
Serial output operation



Operation Flow Chart



When Busy Flag Is Used



When INT Output Is Used

APPLICATION EXAMPLE