

## 8-bit D/A Converter Supporting with I<sup>2</sup>C Bus

### Description

The CXA1315M/P is developed as a 5-channel 8-bit D/A converter supporting with I<sup>2</sup>C bus.

### Features

- Serial control through I<sup>2</sup>C bus
- 5-channel 8-bit D/A converter
- Built-in 4 general-purpose I/O ports (Digital I/O)
- I/O can be specified to respective ports independently
- Selection of 8 slave addresses possible through address select pins (3 pins)

### Applications

The IC, which cannot support I<sup>2</sup>C bus, can support it by connecting its control pin to the CXA1315M/P.

### Structure

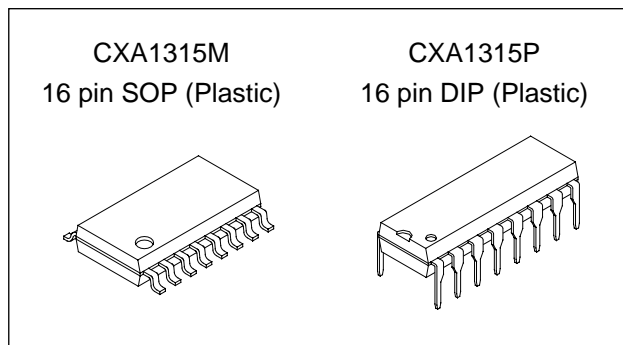
Bipolar silicon monolithic IC

### Absolute Maximum Ratings (T<sub>a</sub> = 25°C)

- |                               |                  |             |    |
|-------------------------------|------------------|-------------|----|
| • Supply voltage              | V <sub>CC</sub>  | 12          | V  |
| • Operating temperature       | T <sub>opr</sub> | -20 to +75  | °C |
| • Storage temperature         | T <sub>stg</sub> | -65 to +150 | °C |
| • Allowable power dissipation | P <sub>D</sub>   | 960         | mW |

### Operating Conditions

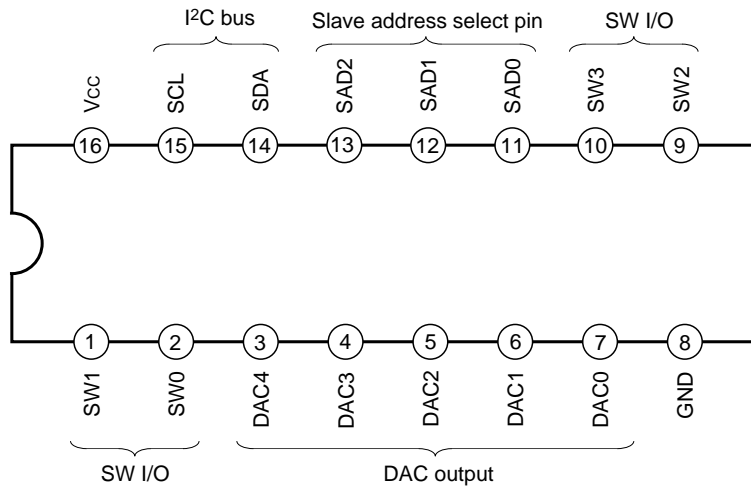
- |                         |                  |            |    |
|-------------------------|------------------|------------|----|
| • Supply voltage        | V <sub>CC</sub>  | 8.2 to 9.8 | V  |
| • Operating temperature | T <sub>opr</sub> | -20 to +75 | °C |



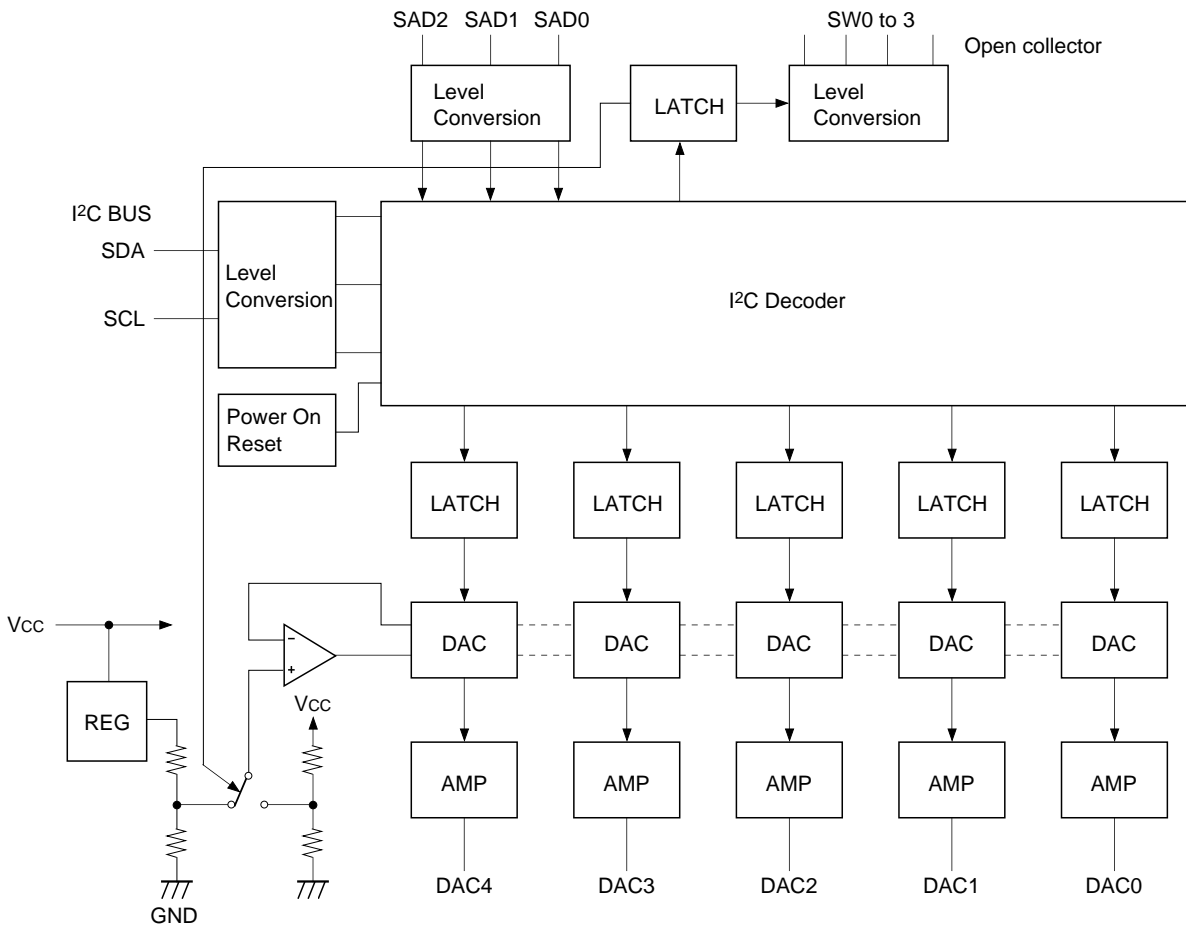
Purchase of Sony's I<sup>2</sup>C components conveys a license under the Philips I<sup>2</sup>C Patent Rights to use these components in an I<sup>2</sup>C system, provided that the system conforms to the I<sup>2</sup>C Standard Specifications as defined by Philips.

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Pin Configuration (Top View)



Block Diagram



Pin Description

No.	Symbol	Equivalent circuit	Description
1 2 9 10	SW1 SW0 SW2 SW3		I/O pin for genera-purpose I/O port $V_{ILmax}$ : 1.5V $V_{IHmin}$ : 3V $V_{OLmax}$ : 0.4V
14	SDA		SDA I/O pin for I <sup>2</sup> C bus
3 4 5 6 7	DAC4 DAC3 DAC2 DAC1 DAC0		D/A converter output pin
8	GND		GND pin
11 12 13	SAD0 SAD1 SAD2		Slave address input pin Input at positive logic $V_{ILmax}$ : 1.5V $V_{IHmin}$ : 3V
15	SCL		SCL input pin for I <sup>2</sup> C bus
16	Vcc		Power supply pin

Electrical Characteristics

(Ta = 25°C, Vcc = 9V)

No.	Item	Symbol	Test circuit	Test conditions	Min.	Typ.	Max.	Unit
1	Circuit current	Icc	1	DAC 0 to 4 = 127	8	11	15	mA

D/A Converter Block

2	Differential linearity	DLE	1	$\frac{V(\text{DAC0 to 4} = n + 1) - V(\text{DAC0 to 4} = N)}{V(\text{DAC0 to 4} = 191) - V(\text{DAC0 to 4} = 63)} \times 128 - 1$ n = 0 to 127	-1	0	+1.1	LSB
3	Minimum output voltage	Vmin	1	DAC 0 to 4 = 0	0.1	0.4	0.62	V
4	Maximum output voltage	Vmax	1	DAC 0 to 4 = 255	8.3	8.5	8.9	V
5	Output current	Iout	2	Current that can be flowed from Pins 3 to 7	-1		+1	mA
6	Output impedance	Zo	2	DAC 0 to 4 = 127, $\frac{V(-1\text{mA}) - V(1\text{mA})}{2\text{mA}}$	0	3	6	Ω
7	Repple rejection	Grip	3	DAC 0 to 4 = 127, REF = 0 Superimose 100Hz to Vcc, 1Vp-p	—	-60	-40	dB

SW, SAD Pins

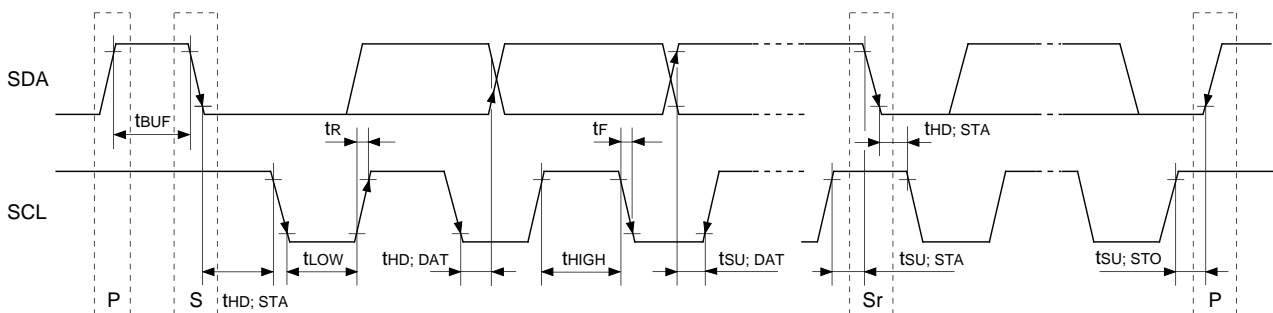
No.	Item	Symbol	Test circuit	Test conditions	Min.	Typ.	Max.	Unit
8	Low level input voltage	$V_{IL}$	4	Input voltage where ST0 to ST3 become "0"	—	—	1.5	V
8	High level input voltage	$V_{IH}$	4	Input voltage where ST0 to ST3 become "1"	3.0	—	—	V
9	Low level input current	$I_{IL}$	4	Input current when 0.4V is applied	-10	0	+10	$\mu$ A
10	High level input current	$I_{IH}$	4	Input current when 4.5V is applied	-10	0	+10	$\mu$ A
11	Low level input voltage	$V_{OL}$	5	SW 0 to 3 = 1, Output voltage when 1mA flows in	0	0.2	0.4	V

I<sup>2</sup>C Bus Block Items (SDA, SCL)

No.	Item	Symbol	Min.	Typ.	Max.	Unit
13	High level input voltage	$V_{IH}$	3.0	—	5.0	V
14	Low level input voltage	$V_{IL}$	0	—	1.5	V
15	High level input current	$I_{IH}$	—	—	10	$\mu$ A
16	Low level input current	$I_{IL}$	—	—	10	$\mu$ A
17	Low level output voltage, at 3mA flow to SDA (Pin 14)	$V_{OL}$	0	—	0.4	V
18	Maximum flowing current	$I_{OL}$	3	—	—	mA
19	Input capacitance	$C_i$	—	—	10	pF
20	Maximum clock frequency	$f_{SCL}$	0	—	100	kHz
21	Data change minimum waiting time	$t_{BUF}$	4.7	—	—	$\mu$ s
22	Data transfer start minimum waiting time	$t_{HD; STA}$	4.0	—	—	$\mu$ s
23	Low level clock pulse width	$t_{LOW}$	4.7	—	—	$\mu$ s
24	High level clock pulse width	$t_{HIGH}$	4.0	—	—	$\mu$ s
25	Minimum start preparation waiting time	$t_{SU; STA}$	4.7	—	—	$\mu$ s
26	Minimum data hold time	$t_{HD; DAT}$	5	—	—	$\mu$ s
27	Minimum data preparation time	$t_{SU; DAT}$	250	—	—	ns
28	Rise time	$t_R$	—	—	1	$\mu$ s
29	Fall time	$t_F$	—	—	300	ns
30	Minimum stop preparation waiting time	$t_{SU; STO}$	4.7	—	—	$\mu$ s

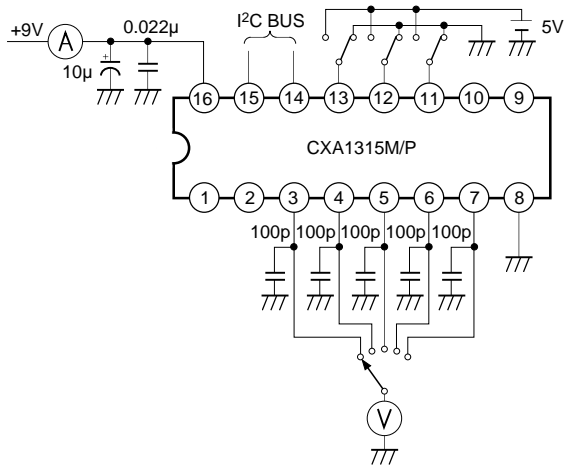
I<sup>2</sup>C bus load conditions: Pull-up resistance 4k $\Omega$  (Connected to +5V)  
 Load capacitance 200pF (Connected to GND)

I<sup>2</sup>C Bus Control Signal

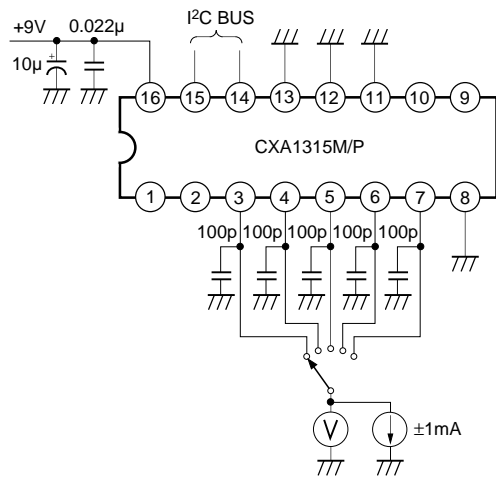


Electrical Characteristics Measurement Circuit

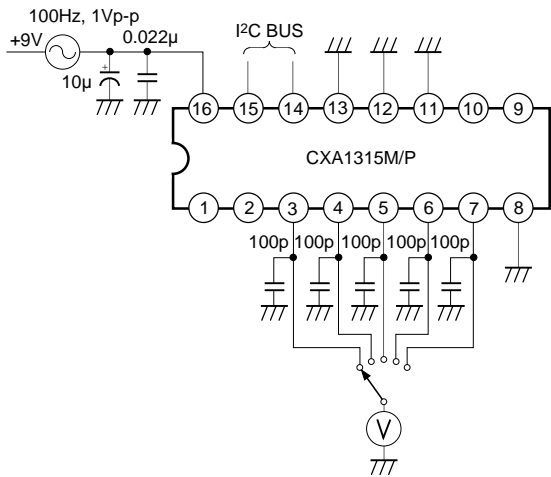
Measurement Circuit 1



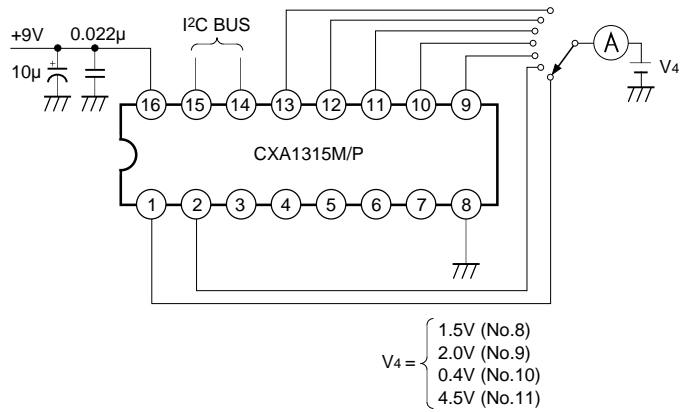
Measurement Circuit 2



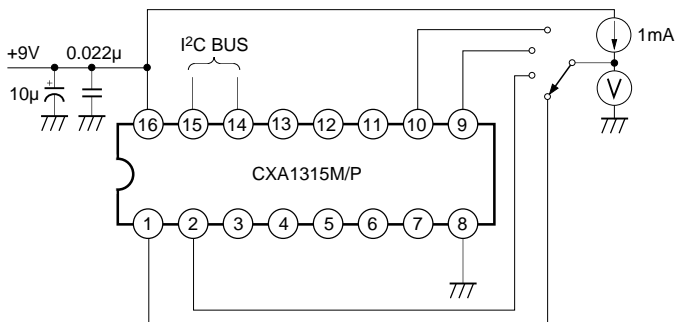
Measurement Circuit 3



Measurement Circuit 4

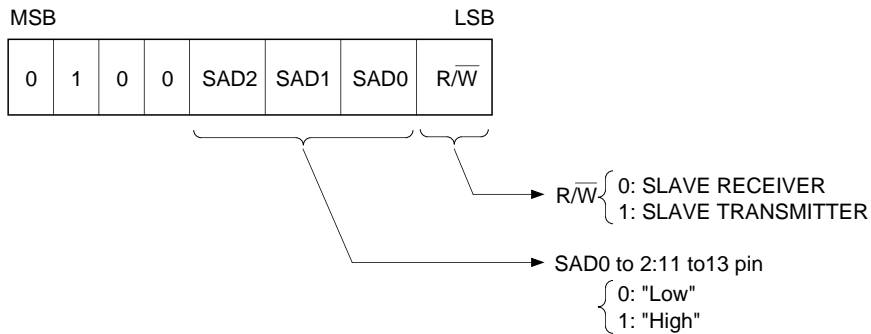


Measurement Circuit 5



**Definition of I<sup>2</sup>C Bus Register**

**<Slave address>**



**<Register table>**

- With the IC reset all registers are reset to "0"
- \*: Not defined
- x: Don't care
- Sub address is auto incremented
- It can be used as a 6-bit D/A converter by setting the lower two bits of DAC0 to 4 registers to "0", but take care that the max. voltage of DA output will lower about 100mV compared with the use of 8 bits.

**Control Register**

Sub address	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
x x x x x 0 0 0	REF	*	*	*	SW3	SW2	SW1	SW0
x x x x x 0 0 1	DAC0 (8)							
x x x x x 0 1 0	DAC1 (8)							
x x x x x 0 1 1	DAC2 (8)							
x x x x x 1 0 0	DAC3 (8)							
x x x x x 1 0 1	DAC4 (8)							

**Status Register**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PONRES	0	0	0	ST3	ST2	ST1	ST0

<Registers> In brackets ( ) number of bits

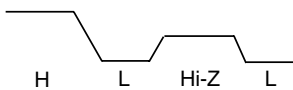
- REF (1): Switches D/A converter reference voltage
  - 0: Standardizes the inner regulator
  - 1: Standardizes voltage resistance divided from Vcc
  
- SW0 to 3 (1): Selects ON/OFF of Pins 1, 2, 9 and 10  
(Each pin is the open collector output of NPN transistor)
  - 0: OFF
  - 1: ON
  
- DAC0 to 4 (8): Digital data input register of D/A converter
  - 0: Output voltage turns to minimum
  - 255: Output voltage turns to maximum
  
- PONRES (1): Detects POWER ON RESET
  - 0: Master passes from the bus and is reset to "0" after having read this status
  - 1: Sets to "1" when power supply is turned on or when there has been a power dip
  
- ST0 to 3 (1): Detects and registers the voltage condition of Pins 1, 2, 9 and 10
  - 0: 1.5V and below
  - 1: 3.0V and above

**Note)** SW0 to 3 effective during "0"

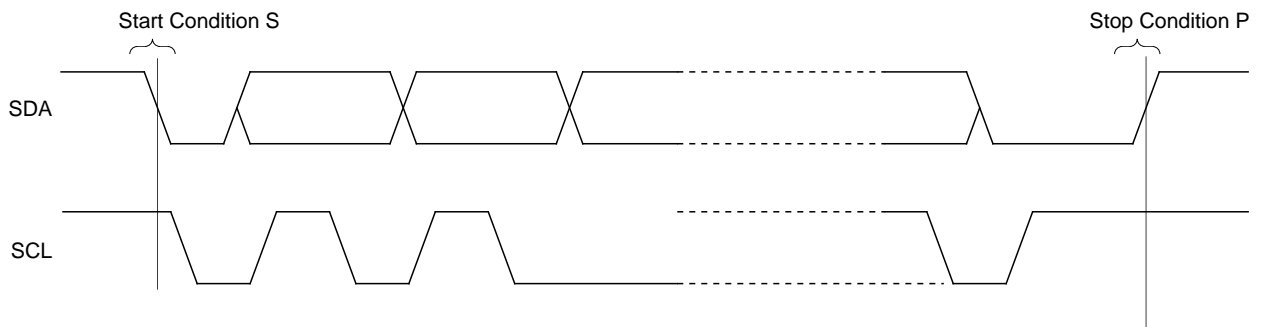
**I<sup>2</sup>C Bus Signal**

There are 2 signals in I<sup>2</sup>C bus. SDA (Serial Data) and SCL (Serial Clock).  
SDA is double-way.

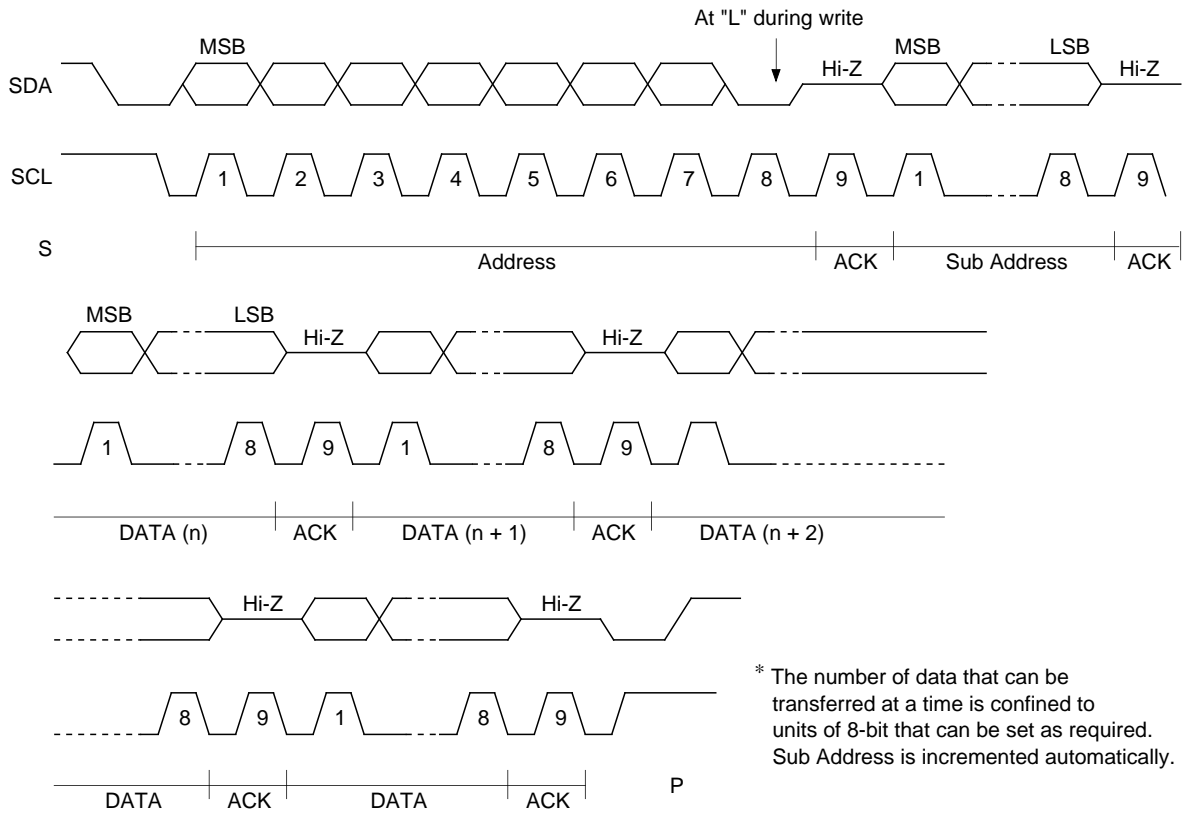
- As SDA is bidirectional it has 3 state outputs, H, L and Hi-Z.



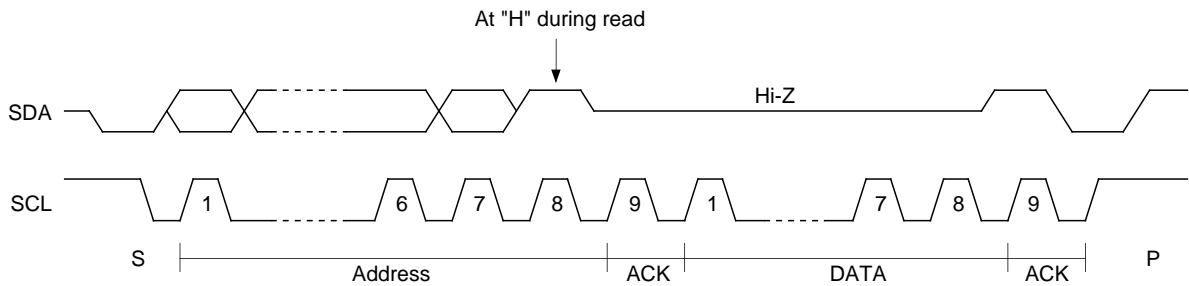
- I<sup>2</sup>C transfer begins with Start Condition and ends with Stop Condition.



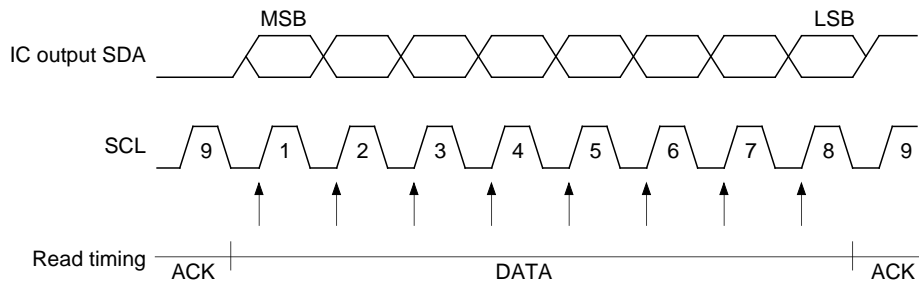
• I<sup>2</sup>C data write (Write from I<sup>2</sup>C controller to IC)



• I<sup>2</sup>C data read (Read from IC to I<sup>2</sup>C controller)



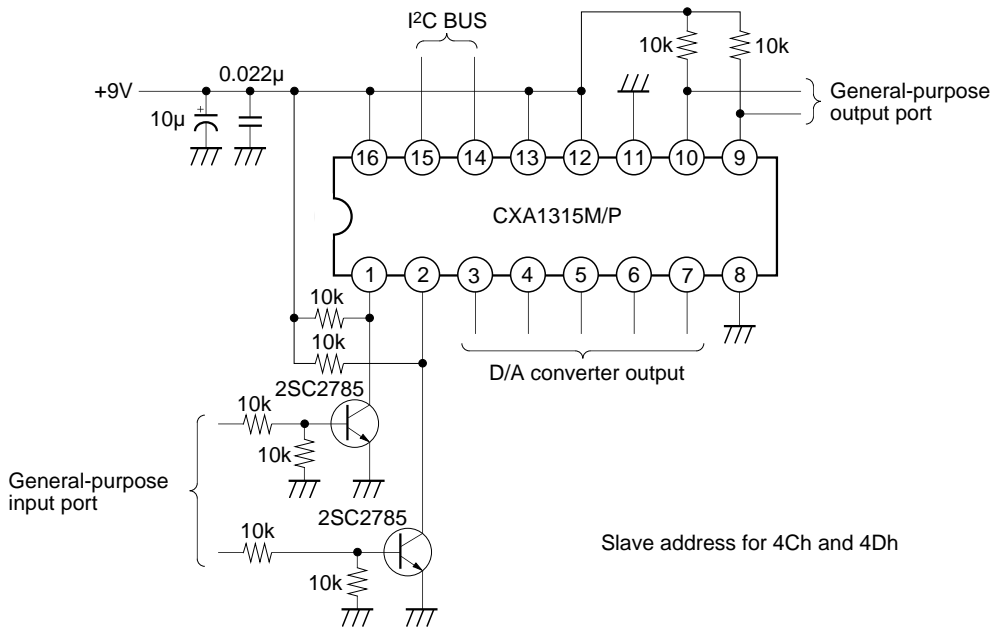
• Read timing



\* Data read is performed with SCL rise.

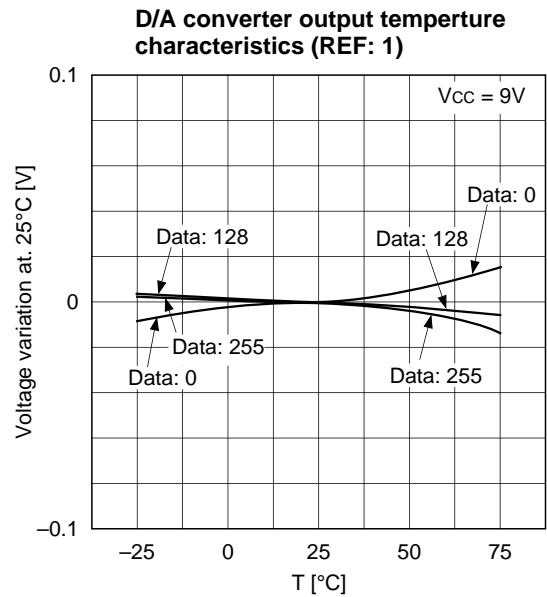
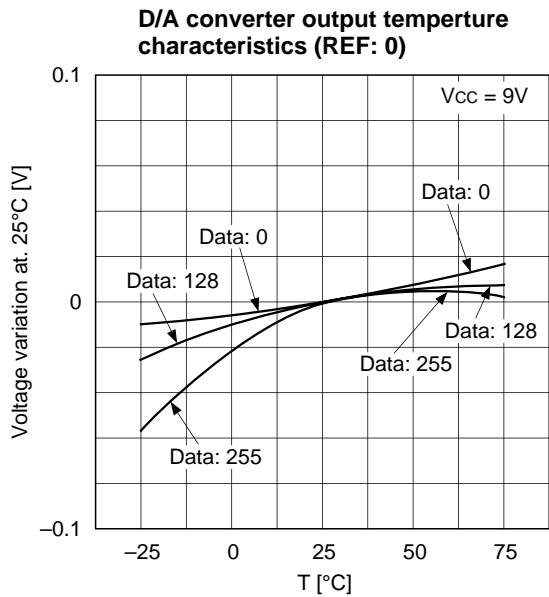


Application Circuit



Application circuits shown are typical examples illustrating the operation of the devices. Sony cannot assume responsibility for any problems arising out of the use of these circuits or for any infringement of third party patent and other right due to same.

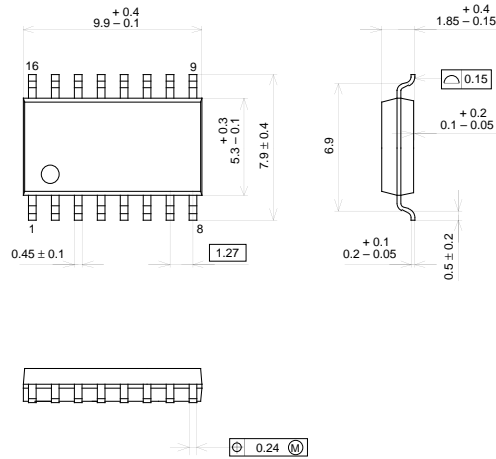
Characteristics Diagram



Package Outline Unit: mm

CXA1315M

16PIN SOP (PLASTIC)

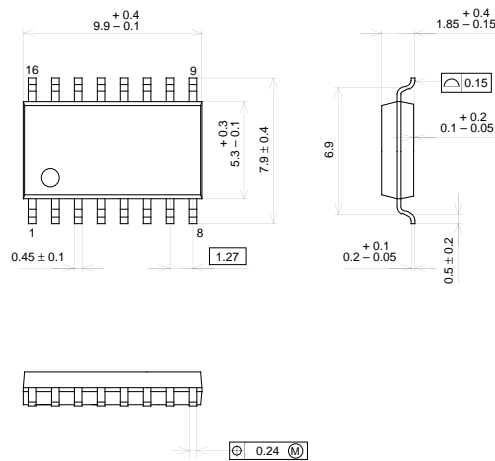


SONY CODE	SOP-16P-L01
EIAJ CODE	SOP016-P-0300
JEDEC CODE	

PACKAGE STRUCTURE

PACKAGE MATERIAL	EPOXY RESIN
LEAD TREATMENT	SOLDER PLATING
LEAD MATERIAL	COPPER ALLOY
PACKAGE MASS	0.2g

16PIN SOP (PLASTIC)



SONY CODE	SOP-16P-L01
EIAJ CODE	SOP016-P-0300
JEDEC CODE	

PACKAGE STRUCTURE

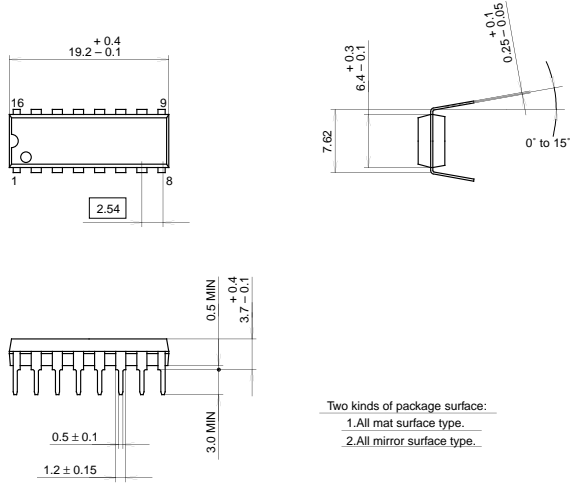
PACKAGE MATERIAL	EPOXY RESIN
LEAD TREATMENT	SOLDER PLATING
LEAD MATERIAL	COPPER ALLOY
PACKAGE MASS	0.2g

LEAD PLATING SPECIFICATIONS

ITEM	SPEC.
LEAD MATERIAL	COPPER ALLOY
SOLDER COMPOSITION	Sn-Bi Bi:1-4wt%
PLATING THICKNESS	5-18μm

Package Outline Unit: mm  
CXA1315P

16PIN DIP (PLASTIC)

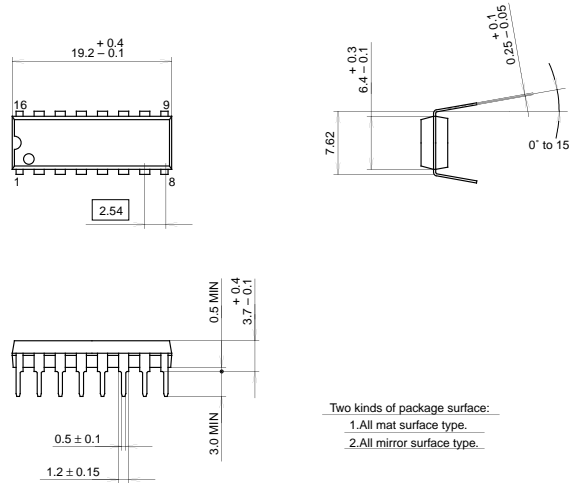


PACKAGE STRUCTURE

SONY CODE	DIP-16P-01
EIAJ CODE	DIP016-P-0300
JEDEC CODE	Similar to MO-001-AE

PACKAGE MATERIAL	EPOXY RESIN
LEAD TREATMENT	SOLDER PLATING
LEAD MATERIAL	COPPER ALLOY
PACKAGE MASS	1.0 g

16PIN DIP (PLASTIC)



PACKAGE STRUCTURE

SONY CODE	DIP-16P-01
EIAJ CODE	DIP016-P-0300
JEDEC CODE	Similar to MO-001-AE

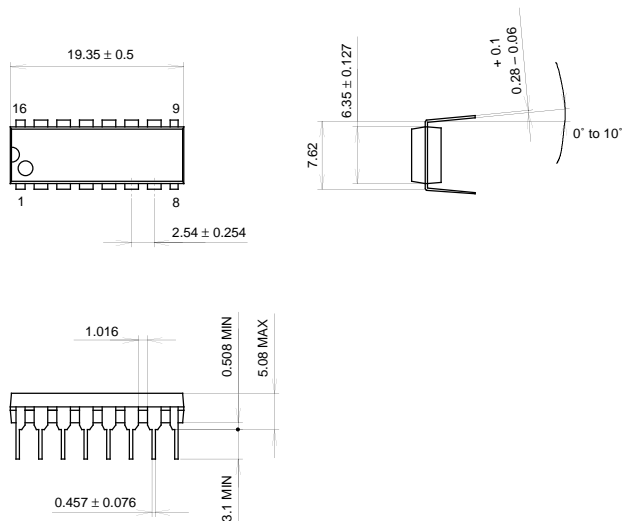
PACKAGE MATERIAL	EPOXY RESIN
LEAD TREATMENT	SOLDER PLATING
LEAD MATERIAL	COPPER ALLOY
PACKAGE MASS	1.0 g

LEAD PLATING SPECIFICATIONS

ITEM	SPEC.
LEAD MATERIAL	COPPER ALLOY
SOLDER COMPOSITION	Sn-Bi Bi:1-4wt%
PLATING THICKNESS	5-18µm

Package Outline Unit: mm  
CXA1315P

16PIN DIP (PLASTIC) 300mil



PACKAGE STRUCTURE

SONY CODE	DIP-16P-191
EIAJ CODE	DIP016-P-0300-AU
JEDEC CODE	MS-001-AA

PACKAGE MATERIAL	EPOXY RESIN
LEAD TREATMENT	SOLDER PLATING
LEAD MATERIAL	COPPER
PACKAGE MASS	1.0g