HA17008RP/RFP

8-Bit Multiplying Digital to Analog Converter

HITACHI

ADE-204-060 (Z)
Rev. 0
Dec. 2000

Description

The HA17008R series are 8-bit monolithic D/A converters which have built in, a reference current amplifier, an R-2R ladder resistor, and 8 high speed current switches.

By setting the reference voltage and resistance, the maximum output current can be freely varied in response to the application.

The reference current is distributed to the current value for each bit by the R-2R ladder resistor, and the maximum output current is 255/256 of the reference current. For example, if the input reference current is 2.0 mA, then the maximum available output current is 1.992 mA.

Applications for the HA17008R are wide ranging, and include CRT displays, stepping motor control, programmable power supplies, audio equipment, and attenuators.

Features

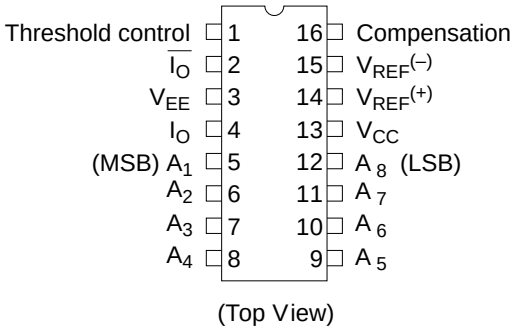
- Linearity of ±0.19% (±1/2 LSB) guaranteed.
- The settling time is short, 85 ns (typ), enabling rapid conversions.
- Low power dissipation has been reduced: 135 mW typ.
- Compatible with TTL and CMOS logic.
- The standard supply voltage is V_{CC} = +15.0 V, V_{EE} = –15.0 V.
- A wide output voltage range can be provided. From –10 V to +18 V.

Ordering Information

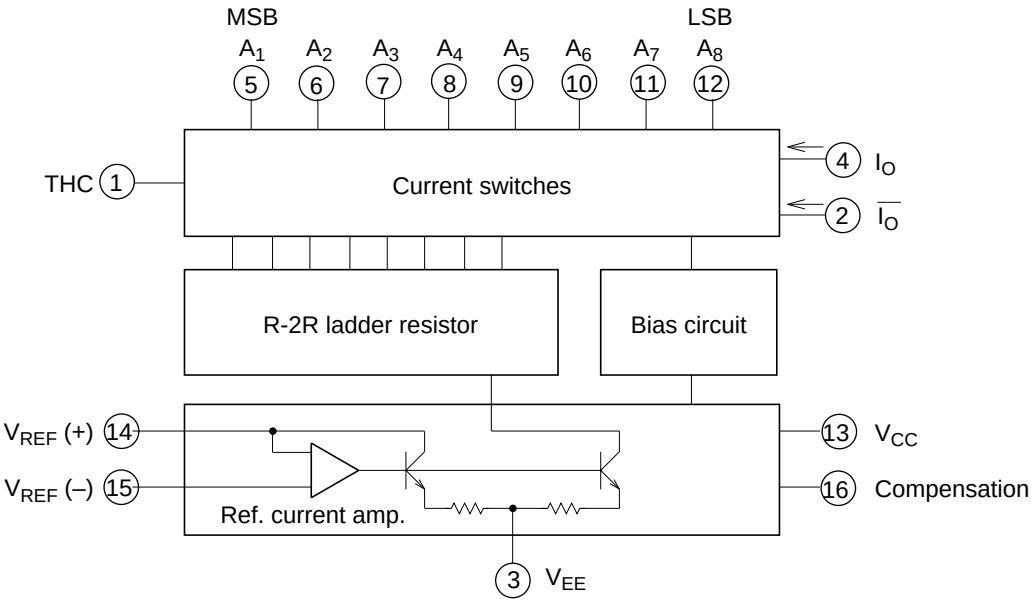
Type No.	Package
HA17008RP	DP-16
HA17008RFP	FP-16DA

Hitachi semiconductor

Pin Arrangement



Block Diagram



Functions

Reference differential amplifier and phase compensation

The reference amplifier is a circuit which converts the reference voltage applied to pin 14 through the external resistor R_{14} from a voltage to a current. The converted current is supplied to each bit by a current mirror and the ladder resistor. Note that this should be used with the polarity of the current flowing in to pin 14. The reference voltage source provides all of the current flowing into pin 14.

Also, even removing the resistor R_{15} will have a minimal influence on precision and temperature drift.

To preserve an appropriate value of the phase margin, it is necessary to increase the value of the phase compensation capacitance as R_{14} is increased. For example, if R_{14} is 1 k , 2.5 k , or

5 k , the minimum capacitances should be 15 pF, 37 pF, and 75 pF, respectively. The capacitor is connected to V_{EE}. If high impedance is required in the reference current source, connect R_{14} to ground and connect R_{15} to the negative reference voltage. (Refer figure 2.) If a DC reference voltage is used, a bypass capacitor should be inserted in the reference voltage source to reduce compounded hum and noise. We cannot recommend the use of noisy 5 V logic power supplies. When a logic control 5 V power supply of good stability is used for the reference supply, connect a resistor to the reference supply and connect a 0.1 µF capacitor between the reference supply and the resistor contact.

When pin 14 is controlled by a high impedance such as a fixed current supply, phase compensation will not be possible with the above method. Therefore, provide adequate phase compensation in the frequency band of the fixed current supply.

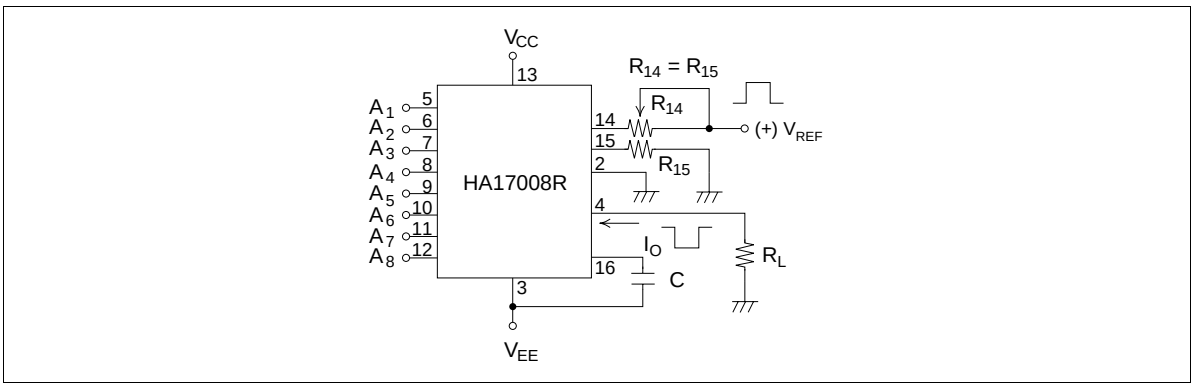


Figure 1 Positive Reference Potential Application Example

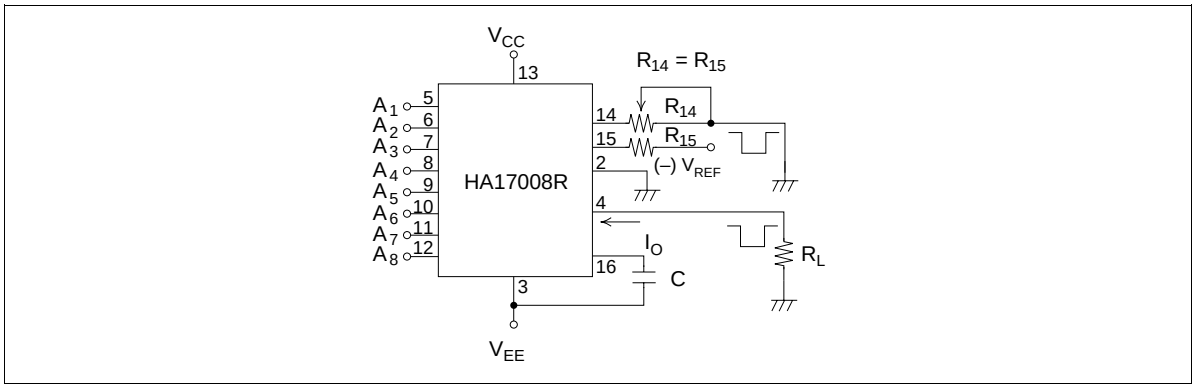


Figure 2 Negative Reference Potential Application Example

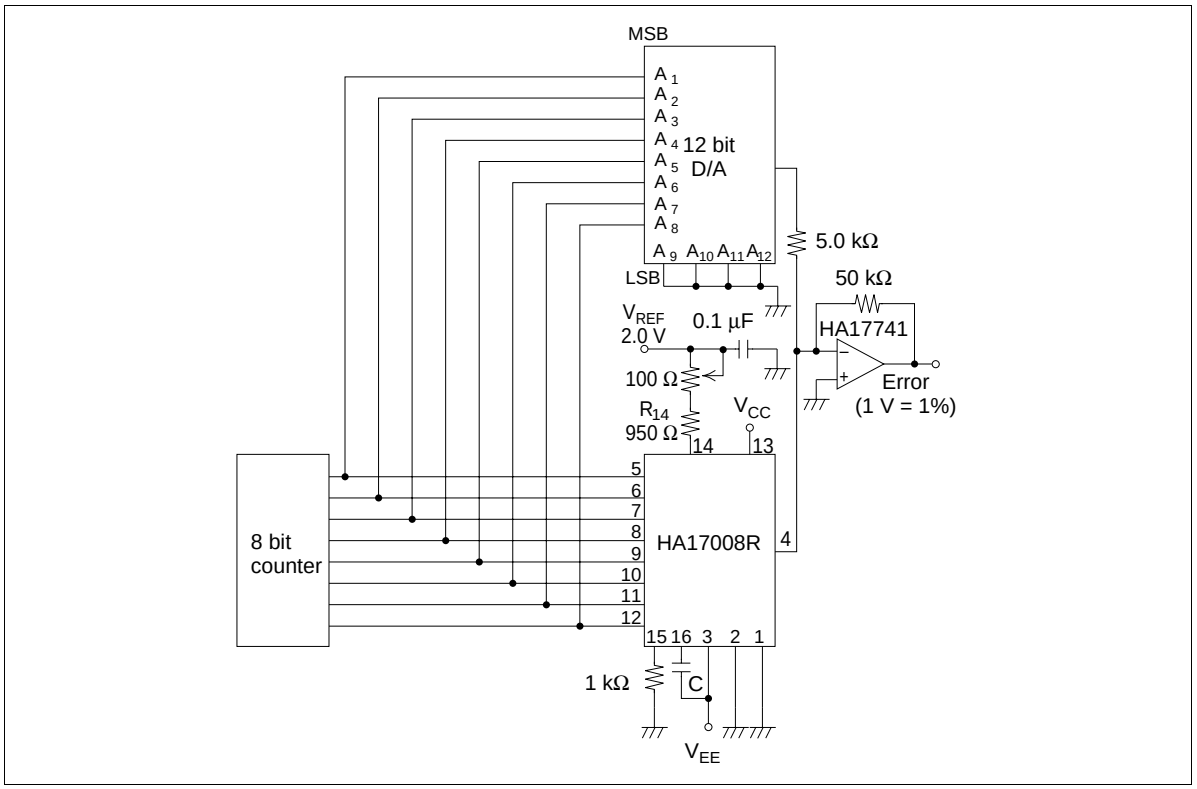


Figure 3 Non Linearity Measurement Circuit

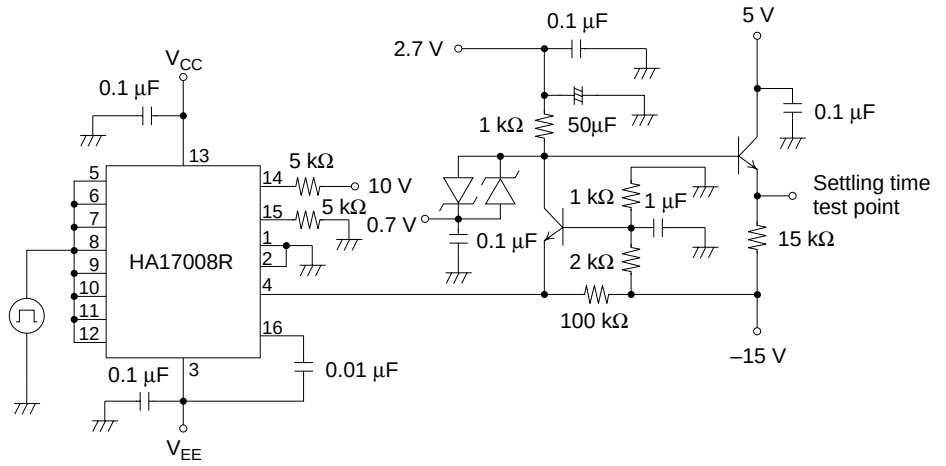
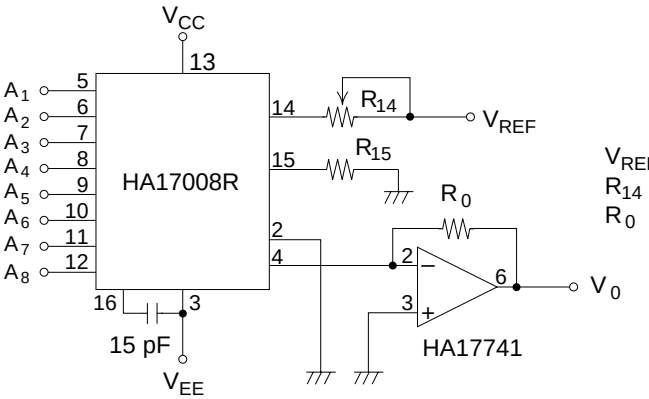


Figure 4 Settling Time Test Circuit

Operation Example

- **Current to voltage converter using an op-amp**



V_{REF} = +2 V_{DC}
R_{14} = R_{15} = 1.0 kΩ
R_0 = 5.0 kΩ

Logical output V_0

$$V_0 = \frac{V_{REF}}{R_{14}} (R_0) \left(\frac{A_1}{2} + \frac{A_2}{4} + \frac{A_3}{8} + \frac{A_4}{16} + \frac{A_5}{32} + \frac{A_6}{64} + \frac{A_7}{128} + \frac{A_8}{256} \right)$$

When V_{REF}, R_{14}, and R_0 are determined, the output voltage becomes 9.961 V in case of all-high input bits.

$$V_0 = \frac{2\ V}{1\ k\Omega} (5\ k\Omega) \left(\frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} + \frac{1}{32} + \frac{1}{64} + \frac{1}{128} + \frac{1}{256} \right)$$

Absolute Maximum Ratings (Ta = 25°C)

Item	Symbol	Rating	Unit
Power supply voltage	V_{CC}	+18	V
	V_{EE}	–18	V
Digital input voltage	V_5 to V_{12}	V_{EE} to V_{EE} + 36 V	V
Reference current	I_{14}	5	mA
Reference amplifier input voltage range	V_{REF}	V_{CC} to V_{EE}	V
Power dissipation	P_T	500*[1]	mW
Operating temperature	Topr	–20 to +75	°C
Storage temperature	Tstg	–55 to +125	°C

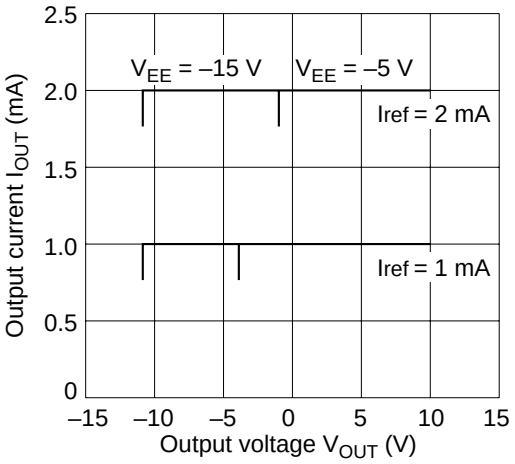
Note: 1. This is the allowable value up to Ta = 65°C for HA17008RP. Derate by 8.3mW/°C above that temperature.
In case of HA17008RFP, see notes on SOP Package usage in Reliability section.

Electrical Characteristics (V_{CC} = 15 V, V_{EE} = –15 V, I_{REF} = 2 mA, V_{THC} = 0 V, Ta = 25°C)

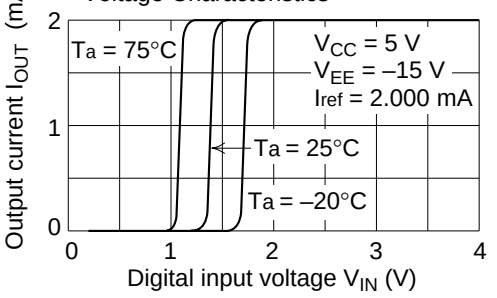
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Nonlinearity	NL	—	—	±0.19	%FS	
Settling time (±1/2 LSB)	t_S	—	85	150	ns	All bits OFF to ON
Propagation delay time	t_{PLH}, t_{PHL}	—	35	60	ns	
Full scale current temperature dependence	T_{CIFS}	—	±10	±50	ppm/°C	
Digital input level	V_{IH}	2	—	—	V	
	V_{IL}	—	—	0.8	V	
Digital input current (MSB)	I_{IH}	—	0.002	10	µA	V_{IH} = 5 V
	I_{IL}	–10	–2	—	µA	V_{IL} = 0.8 V
Reference input bias current	I_{15}	–3	–1	—	µA	
Output current range	I_{F5R}	0	2	2.1	mA	V_{EE} = –5 V
		0	2	4.2	mA	V_{EE} = –8 to –18 V
Full scale output current	I_{FS}	1.94	1.99	2.04	mA	Vref = 10 V, R_{14}, R_{15} = 5 kΩ
Zero scale output current	I_Z	—	0	2	µA	All Bits Low
Output voltage range	V_{OC}	–10	—	+18	V	$\Delta I_{FS} \leq$ 1/2 LSB
Reference current slew rate	dI/dt	4	8	—	mA/µs	$R_{REF} \leq 200\Omega$, C_C = 0pf
Power supply current	I_{CC}	—	1.8	3.8	mA	V_{CC} = 5 V, I_{REF} = 1 mA,
	I_{EE}	–5.8	–3.7	—	mA	V_{EE} = –5 V
	I_{CC}	—	1.9	3.8	mA	V_{CC} = 5 V, I_{REF} = 2 mA,
	I_{EE}	–7.8	–5.8	—	mA	V_{EE} = –15 V
	I_{CC}	—	2.1	3.8	mA	V_{CC} = 15 V, I_{REF} = 2 mA,
	I_{EE}	–7.8	–5.9	—	mA	V_{EE} = –15 V
Power supply voltage	V_{CC}	4.5	15	18	V	I_{REF} = 1 mA
	V_{EE}	–18	–15	–4.5	V	
Differential full scale output current difference	I_{FSS}	–8	±1	+8	µA	$I_{FS4} - I_{FS2}$
Digital input voltage range	V_{IS}	–10	—	+18	V	V_{THR} = –10 to +13.5 V
Threshold voltage range	V_{THR}	–10	0	13.5	V	$V_{THR} \cong V_{THC}$ +1.3 V
Power supply voltage dependence	$P_{SS}I_{FS}$+	–100	—	100	ppmFS/%V	V_{CC} = –4.5 to –18 V, I_{REF} = 1 mA
	$P_{SS}I_{FS}$–	–100	—	100	ppmFS/%V	V_{EE} = –4.5 to –18V, I_{REF} = 1 mA

Standard Characteristics Curves

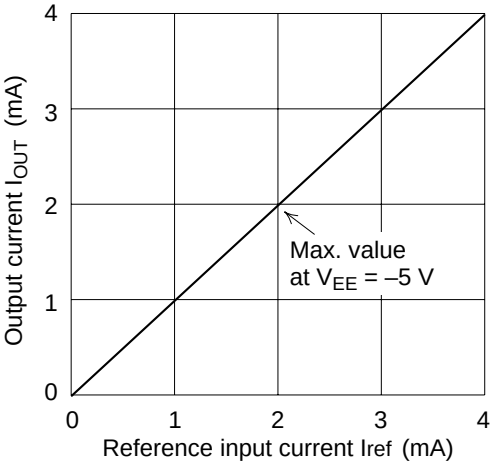
Output Current vs. Output Voltage Characteristics



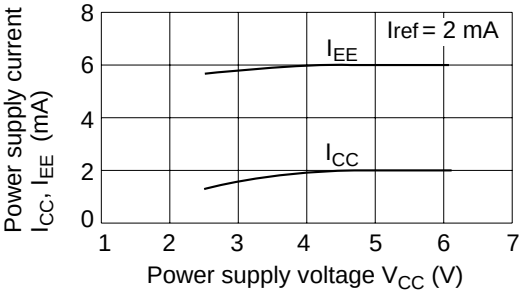
Output Current vs. Digital Input Voltage Characteristics



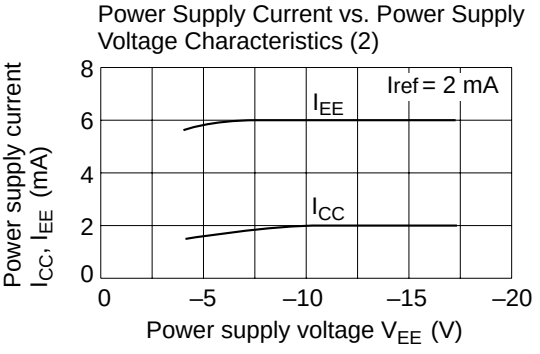
Output Current vs. Reference Input Current Characteristics



Power Supply Current vs. Power Supply Voltage Characteristics (1)

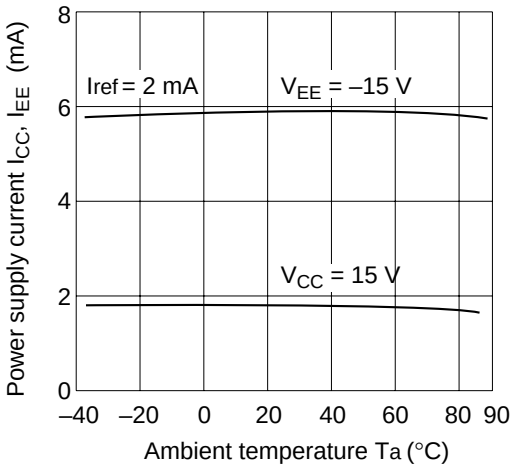


Power Supply Current vs. Power Supply Voltage Characteristics (2)

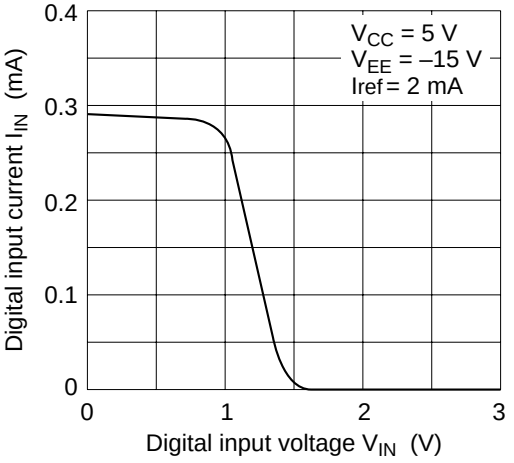


Standard Characteristics Curves (cont)

Power Supply Current vs. Ambient Temperature Characteristics

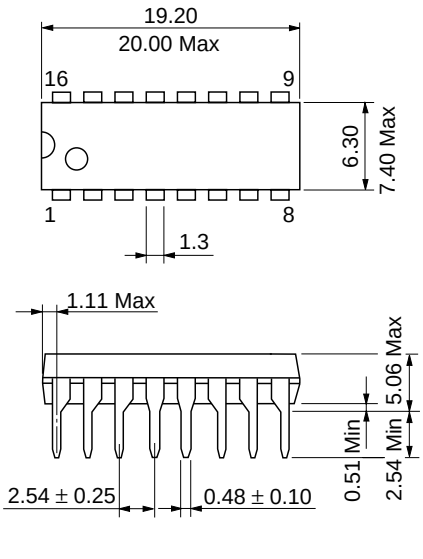


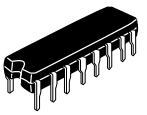
Digital Input Current vs. Digital Input Voltage Characteristics



Package Dimensions

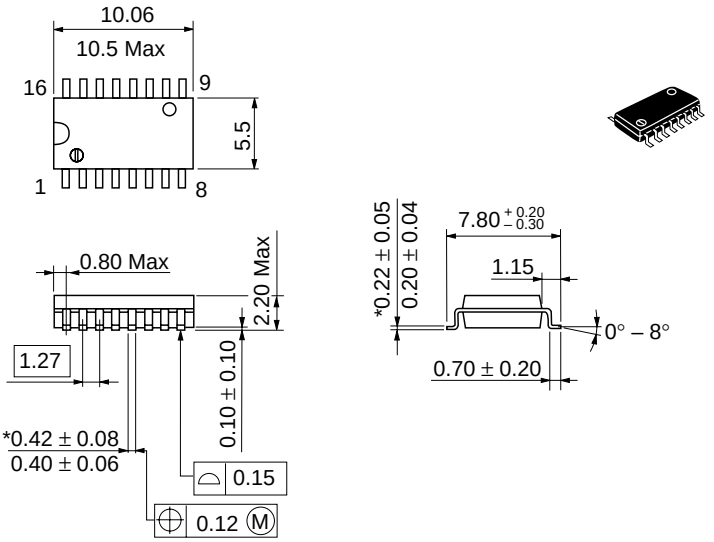
Unit: mm





Hitachi Code	DP-16
JEDEC	Conforms
EIAJ	Conforms
Mass (reference value)	1.07 g

Unit: mm



Hitachi Code	FP-16DA
JEDEC	—
EIAJ	Conforms
Mass (reference value)	0.24 g

*Dimension including the plating thickness
Base material dimension

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