NEC
ELECTRON DEVICE

MOS INTEGRATED CIRCUIT
μPD6901

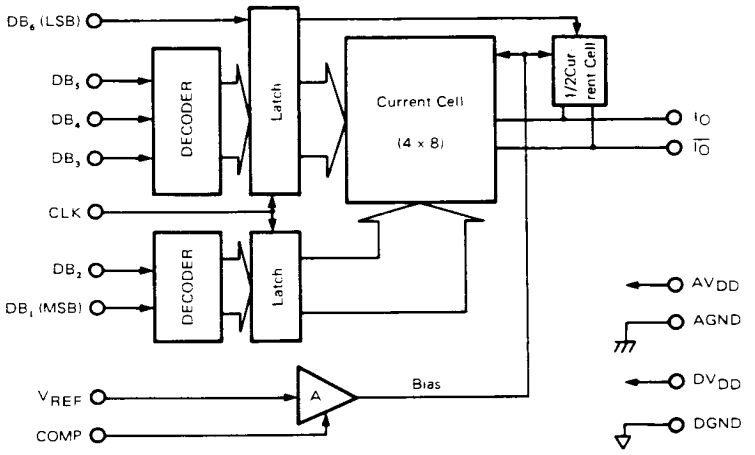
6 BIT D/A CONVERTER FOR VIDEO SIGNAL PROCESSING CMOS LSI

The μPD6901 is an 6 bit D/A converter for use in video applications. The high-speed CMOS processing technology and the matrix current cell method adopted for this CMOS device have enabled fast conversion rates to be achieved. Conversion rates of up to 20 Msps can be attained while operating at low power consumption, making this device ideal for a wide range of applications including digital TV systems and video systems. ★

FEATURES

- Resolution : 6 bits
- Conversion rate : 20 Mpsps
- Linearity : ±1/2 LSB MAX.
- Reference voltage : 2.0 V TYP.
- Power supply voltage : +5 V single
- Low power consumption (110 mW TYP.)
- TTL compatible (Digital inputs)
- 16 pin plastic DIP, and 16 pin plastic SOP (375 mil)

BLOCK DIAGRAM

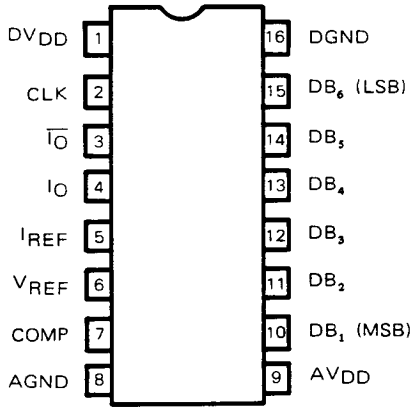


ORDERING INFORMATION

Ordering Name	Package
μPD6901C	16 pin plastic DIP (300 mil)
μPD6901G	16 pin plastic SOP (375 mil)

The ★ mark outside the columns denotes major points where revisions or additions are made in this edition.

CONNECTION DIAGRAM (Top View)



1	DV_{DD}	Digital power supply
2	CLK	Sampling clock input
3	$\overline{I_O}$	Complementary current output
4	I_O	Current output
5	I_{REF}	Full-scale current adjustment
6	V_{REF}	Reference voltage input
7	COMP	Amp compensation
8	AGND	Analog GND
9	AV_{DD}	Analog power supply
10	DB_1	Digital input (MSB)
11	DB_2	Digital input (2nd)
12	DB_3	Digital input (3rd)
13	DB_4	Digital input (4th)
14	DB_5	Digital input (5th)
15	DB_6	Digital input (LSB)
16	DGND	Digital GND

ABSOLUTE MAXIMUM RATINGS (T_a = 25 °C)

Power supply voltage	-0.3 to +7.0	V
Input terminal voltage	-0.3 to V_{DD} +0.3	V
Output terminal voltage	-0.3 to V_{DD} +0.3	V
Analog power supply voltage	DV_{DD}-0.3 to DV_{DD} +0.3	V
Analog GND voltage	DGND-0.3 to DGND+0.3	V
Operating temperature range	-20 to +75	°C
Storage temperature range	-40 to +125	°C

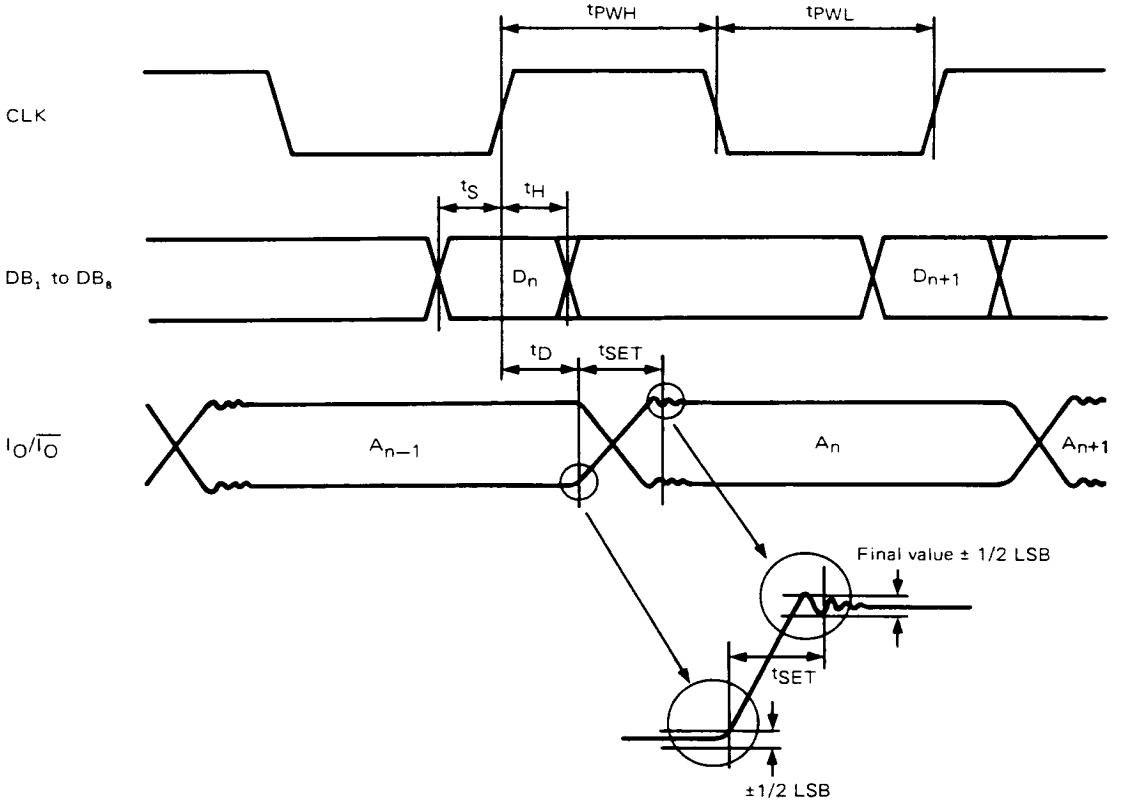
RECOMMENDED OPERATING CONDITIONS (T_a = -20 to +75 °C)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITION
Power supply voltage	V_{DD}	4.5	5.0	5.5	V	
Reference voltage	V_{REF}	1.8	2.0	2.2	V	
Reference resistance	R_{REF}		390		Ω	
Sampling clock	f_{samp}	DC		20	MHz	
Sampling clock low level pulse width	t_{PWL}	15			ns	
Sampling clock high level pulse width	t_{PWH}	15			ns	
Data set up time	t_S	20			ns	
Data hold time	t_H	10			ns	
Digital input high level	V_{IH}	2.7			V	
Digital input low level	V_{IL}			0.6	V	
Compensation capacity	C_{COMP}	0.01	1.0		μF	

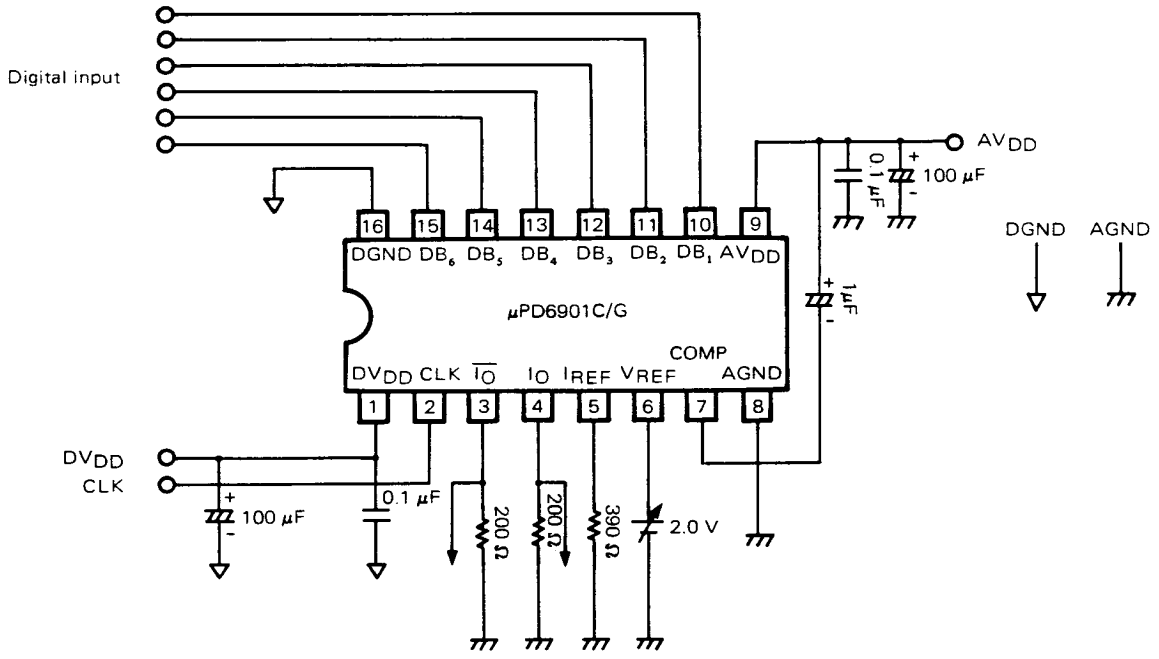
ELECTRICAL CHARACTERISTICS (T_a = -20 to +75 °C, V_{DD} = 5 V ± 0.5 V, f_{samp} = 20 MHz)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Power supply current	I_{DD}		22	50	mA	V_{DD} = 5.0 V
Resolution	RES		6		bit	
Non-linearity error	NL		±0.11	±0.5	LSB	T_a = 0 to 60°C, V_{DD} = 5 V ± 0.25 V
Differential non-linearity	DNL		±0.04	±0.5	LSB	T_a = 0 to 60°C, V_{DD} = 5 V ± 0.25 V
Output compliance	V_O	2.5	3.0		V	V_{DD} = 5.0 V
Analog output delay time	t_D		40		ns	
Settling time	t_{SET}		40		ns	
Full-scale current	I_{FS}	9	10	11	mA	V_{REF}=2.0 V, R_{REF}=390 Ω
Zero-scale offset current	I_{ZS}			20	μA	V_{REF}=2.0 V, R_{REF}=390 Ω
Digital input capacitance	C_{DI}		10	20	pF	
Digital input current	I_I			10	μA	

TIMING CHART



TEST CIRCUIT



PIN DESCRIPTIONS

DGND (Pin 16) Digital system ground
AGND (Pin 8) Analog system ground
DV_{DD} (Pin 1) Digital system power supply (+5 V)
AV_{DD} (Pin 9) Analog system power supply (+5 V)

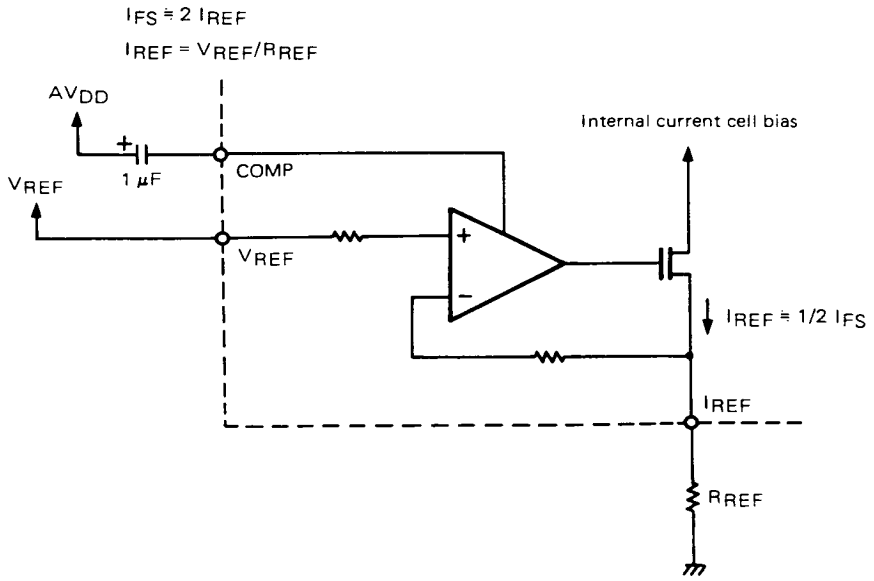
The digital system power supply and ground is isolated from the analog system power supply and ground in the IC as a precaution against noise. The ground and power supply lines are also isolated on the circuit boards, the analog ground being as wide as possible for better stability.

Insert by-pass capacitors of about 0.01 μF and 47 μF between the analog power line and analog ground, and also between the digital power line and digital ground. These capacitors should be connected as close as possible, to the μPD6901C pins. Supply the digital system power from the analog power line through the low path filter to prevent from luch up.

I_{REF} (Pin 5) Full-scale current adjustment pin
V_{REF} (Pin 6) Reference voltage input pin

These pins are used in adjustment of the analog output current (full-scale current).

The analog output current (full-scale current I_{FS}) is set by the reference voltage V_{REF} and the reference resistance R_{REF} connected between the I_{REF} pin and analog ground.



The recommended reference voltage and reference resistance values are V_{REF} = 2.0 V and R_{REF} = 390 Ω respectively. The output analog current I_{FS} in this case will be 10 mA. Also connect by-pass capacitors of about 0.01 μF and 47 μF between the V_{REF} pin and GND in the same way as the by-pass capacitors connected to the power pins.

COMP (Pin 7) Phase compensation capacitor connection

A capacitor for phase compensation of the internal amplifier is connected to this pin. Connect a 1.0 μF capacitor between this pin and analog V_{DD}.

DB_1 to DB_6 (Pins 10 thru 15) Digital data input pins

DB_1 to DB_6 are the 6 bit digital data input pins. The code format is binary, and the input voltage level is TTL compatible.

Digital input code						Analog output current
DB_1 (MSB)	DB_2	DB_3	DB_4	DB_5	DB_6 (LSB)	
0	0	0	0	0	0	0 note
0	0	0	0	0	1	1/64 I_{FS}
⋮	⋮	⋮	⋮	⋮	⋮	⋮
1	1	1	1	0	1	61/64 I_{FS}
1	1	1	1	1	0	62/64 I_{FS}
1	1	1	1	1	1	63/64 I_{FS}

Note: Excluding offset current

Digital data (DB_1 to DB_6) is latched by the rising edge of the sampling clock, and converted to corresponding analog outputs.

CLK (Pin 2) Sampling clock input pin

Digital data is latched by the rising edge of the clock signal applied to the sampling clock input pin, and is subsequently converted to analog outputs. The maximum clock frequency is 20 MHz.

I_O (Pin 4) Analog signal output pin

$\overline{I_O}$ (Pin 3) Analog signal complementary output pin

These two pins are current output pins. The full-scale output current is determined by the reference resistance R_{REF} and reference voltage V_{REF}.

$$I_{FS} = I_O + \overline{I_O} = 2\,V_{REF}/R_{REF}$$

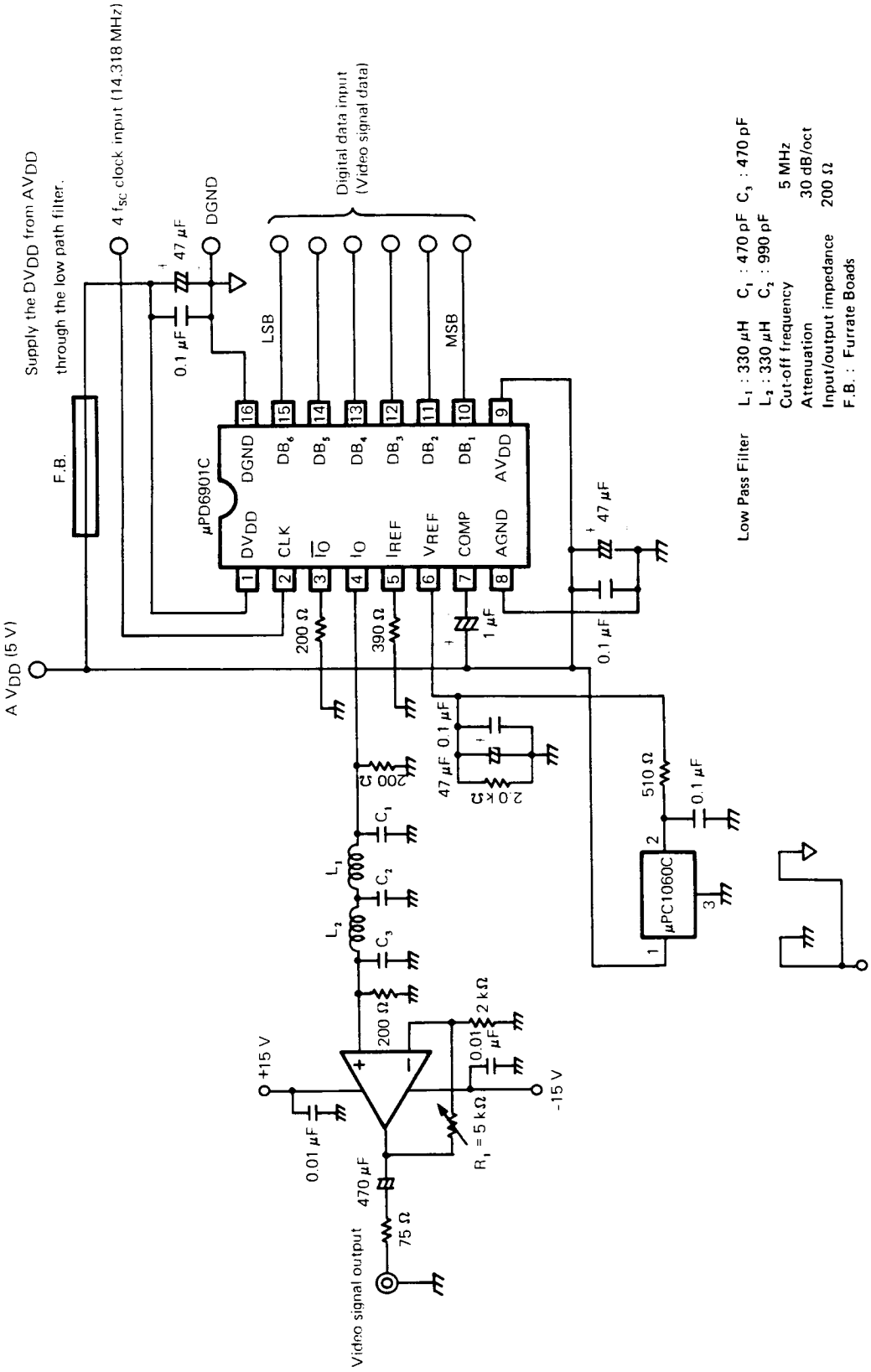
$\overline{I_O}$ is the complementary output pin of I_O. The added output current from the I_O and $\overline{I_O}$ pins becomes the full-scale current in accordance with the above equation. Analog output current can be easily converted to an analog output voltage by connecting a resistance between the I_O or $\overline{I_O}$ pin and analog ground. In this case resistances must also be connected to the I_O and $\overline{I_O}$ pins.

Example of an Application Circuit

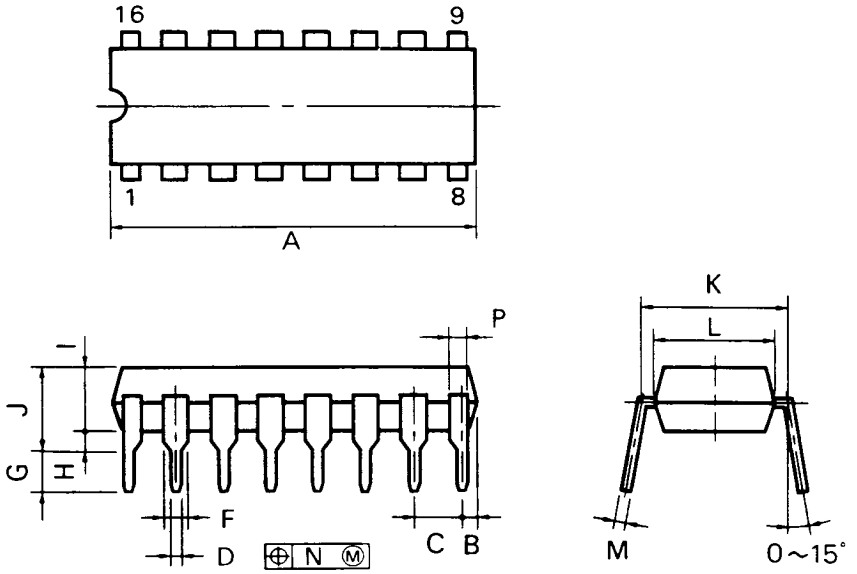
This example shows D/A conversion of video signal (NTSC) digital data at a conversion rate of four times the subcarrier frequency ($4\,f_{SC}$) to obtain the video output signal.

The analog output signal is passed via a low-pass filter (LPF) to a video amplifier to be amplified prior to output.

APPLICATION CIRCUIT



16PIN PLASTIC DIP (300 mil)



P16C-100-300B

NOTES

1) Each lead centerline is located within 0.25 mm (0.01 inch) of its true position (T.P.) at maximum material condition.

2) Item "K" to center of leads when formed parallel.

ITEM	MILLIMETERS	INCHES
A	20.32 MAX.	0.800 MAX.
B	1.27 MAX.	0.050 MAX.
C	2.54 (T.P.)	0.100 (T.P.)
D	$0.50^{\pm 0.10}$	$0.020^{-0.004}_{-0.005}$
F	1.1 MIN.	0.043 MIN.
G	$3.5^{\pm 0.3}$	$0.138^{\pm 0.012}$
H	0.51 MIN.	0.020 MIN.
I	4.31 MAX.	0.170 MAX.
J	5.08 MAX.	0.200 MAX.
K	7.62 (T.P.)	0.300 (T.P.)
L	6.5	0.256
M	$0.25^{-0.10}_{-0.05}$	$0.010^{-0.004}_{-0.003}$
N	0.25	0.01
P	1.1 MIN.	0.043 MIN.

16 PIN PLASTIC SOP (375 mil)

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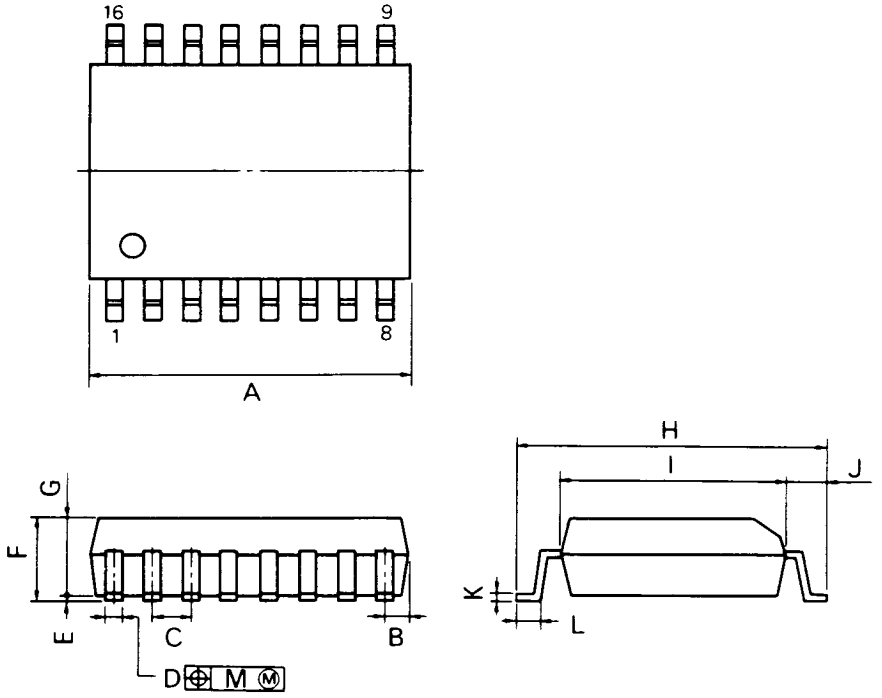

P16GM-50-375B

NOTE

Each lead centerline is located within 0.12 mm (0.005 inch) of its true position (T.P.) at maximum material condition.

ITEM	MILLIMETERS	INCHES
A	10.46 MAX.	0.412 MAX.
B	0.78 MAX.	0.031 MAX.
C	1.27 (T.P.)	0.050 (T.P.)
D	$0.40^{+0.10}_{-0.05}$	$0.016^{+0.004}_{-0.003}$
E	0.1 ± 0.1	0.004 ± 0.004
F	2.9 MAX.	0.115 MAX.
G	2.50	0.098
H	10.3 ± 0.3	$0.406^{+0.012}_{-0.013}$
I	7.2	0.283
J	1.6	0.063
K	$0.15^{+0.10}_{-0.05}$	$0.006^{+0.004}_{-0.002}$
L	0.8 ± 0.2	$0.031^{+0.009}_{-0.008}$
M	0.12	0.005