

# ASSP

# AD/DA CONVERTER

## MB40166/MB40176

### 1-CHANNEL 6-BIT AD/DA CONVERTER WITH CLAMP CIRCUIT

The Fujitsu MB40166 and MB40176 are low power 6-bit AD/DA converter which is fabricated with Fujitsu Advanced Bipolar Technology. MB40166 and MB40176 have the same basic circuits and functions, with the only difference being that MB40166 has an independent analog input terminal for the A/D section and a clamp voltage output terminal, while MB40176 has an analog input in the A/D section internally connected with the clamp circuit.

Since both models contain a single-chip clamp circuit and a reference voltage circuit, they are ideal for video signal processing.

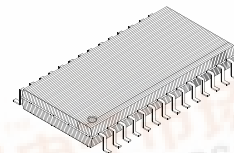
- Resolution :6 bits
- Linearity Error :±0.8% max.
- Maximum Conversion Rate :20 MSPS min.
- Analog Input Voltage Range :VREF to VCCA (MB40166)  
0 to 1.0 V (MB40176)
- Analog Output Voltage Range :VCC to VCC -1 V
- Digital I/O Level :TTL Level
- Power Supply Voltage :+5 V
- Power Dissipation:300 mW typ.
- Package

28pin Plastic FLAT Package (Suffix : -PF)  
28pin Plastic DIP Package (Suffix : -P)

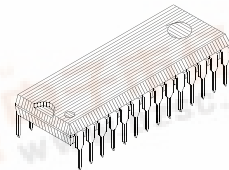
#### ABSOLUTE MAXIMUM RATINGS (see NOTE)

Rating	Symbol	Value	Unit
Power Supply Voltage	VCCA, VCCD	-0.5 to +7.0	V
Digital Input Voltage	VIND	-0.5 to +7.0	V
Analog Input Voltage	VINA	-0.5 to VCCA +0.5	V
Storage Temperature	TSTG	-55 to +125	°C

**NOTE:** Permanent device damage may occur if the above **Absolute Maximum Ratings** are exceeded. Functional operation should be restricted to the conditions as detailed in the operational sections of this data sheet. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.



PLASTIC PACKAGE  
FPT-28P-M01

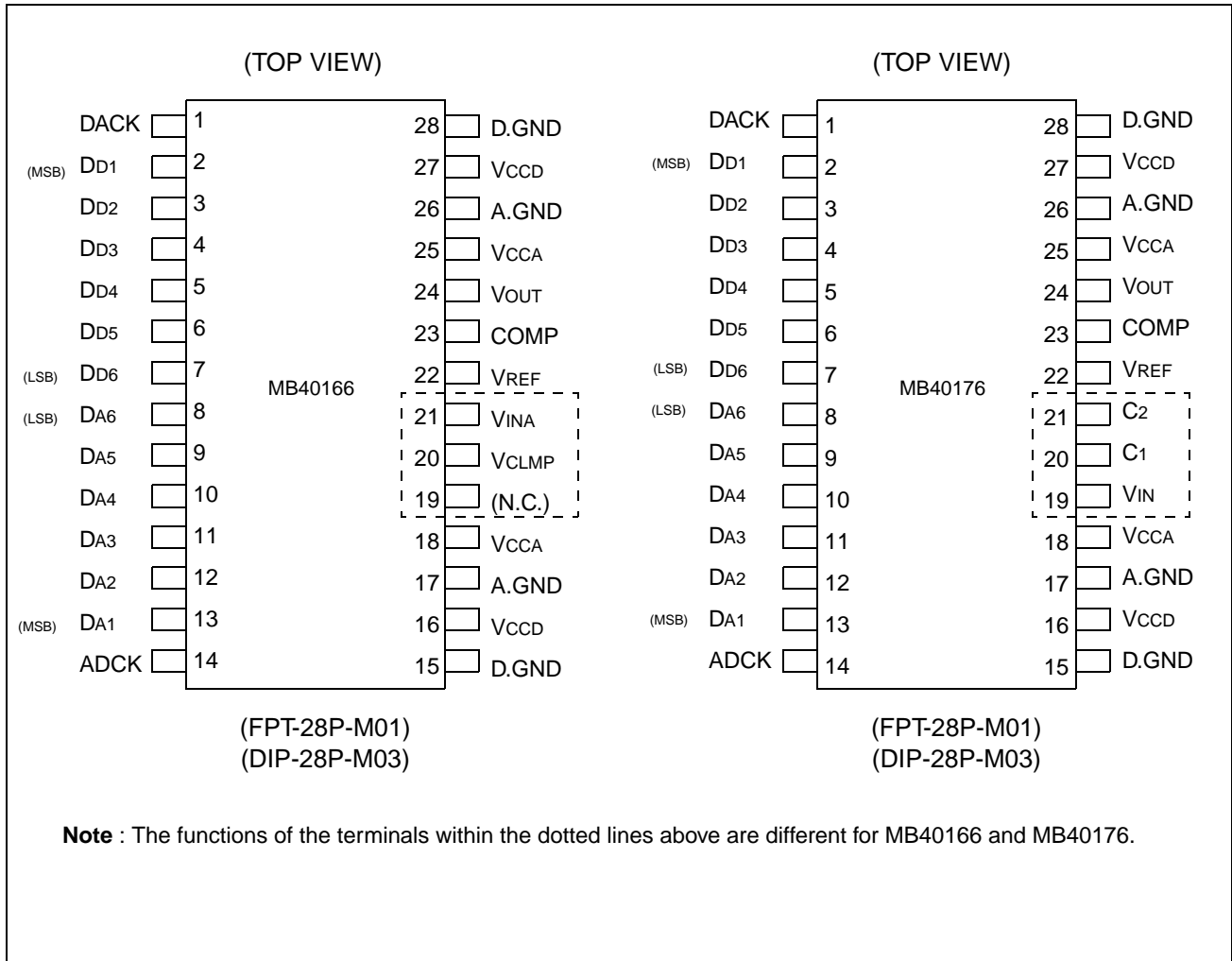


PLASTIC PACKAGE  
DIP-28P-M03

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields. However, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit.

# MB40166/MB40176

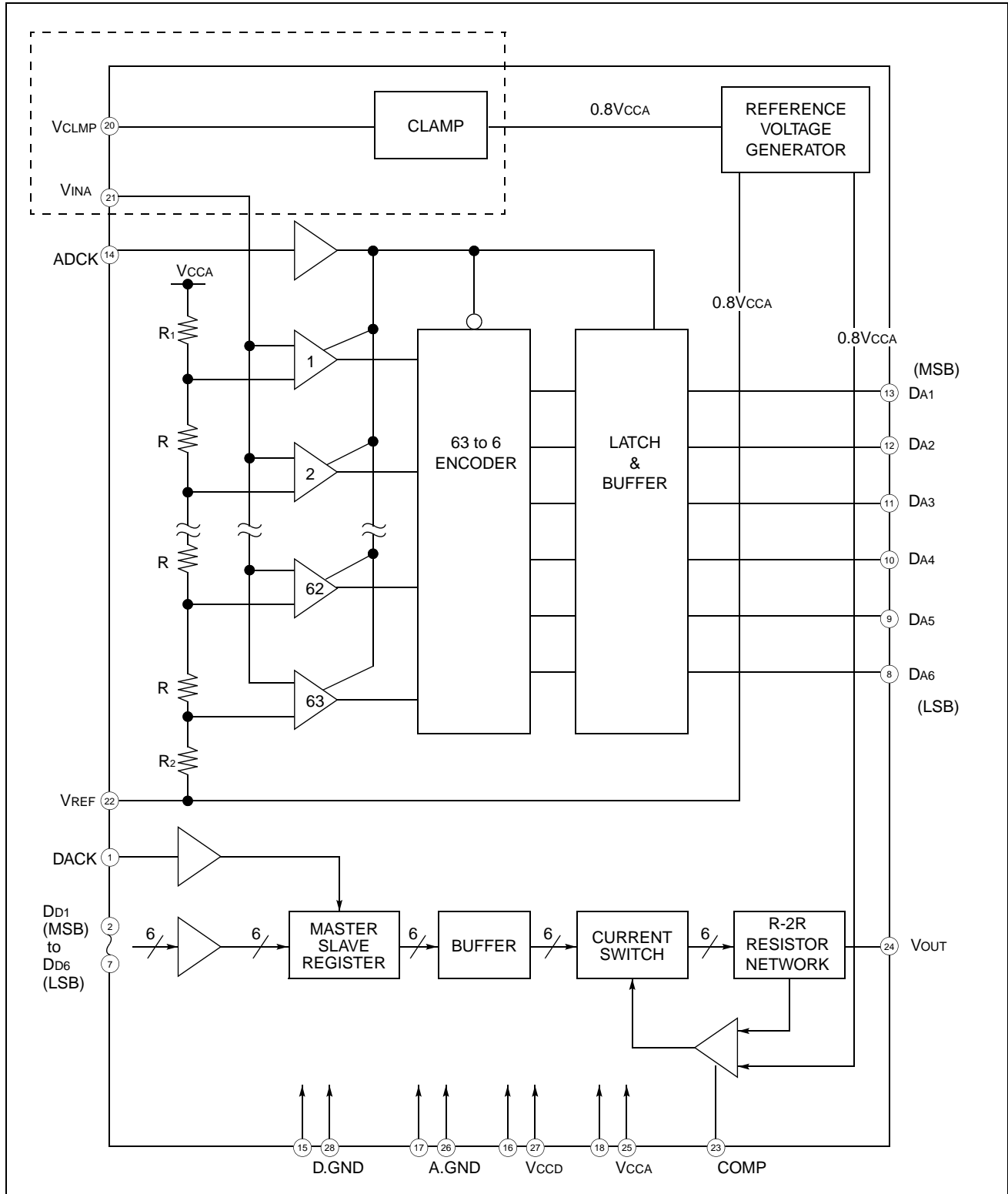
## ■ PIN ASSIGNMENT



# MB40166/MB40176

## ■ BLOCK DIAGRAM

### • MB40166

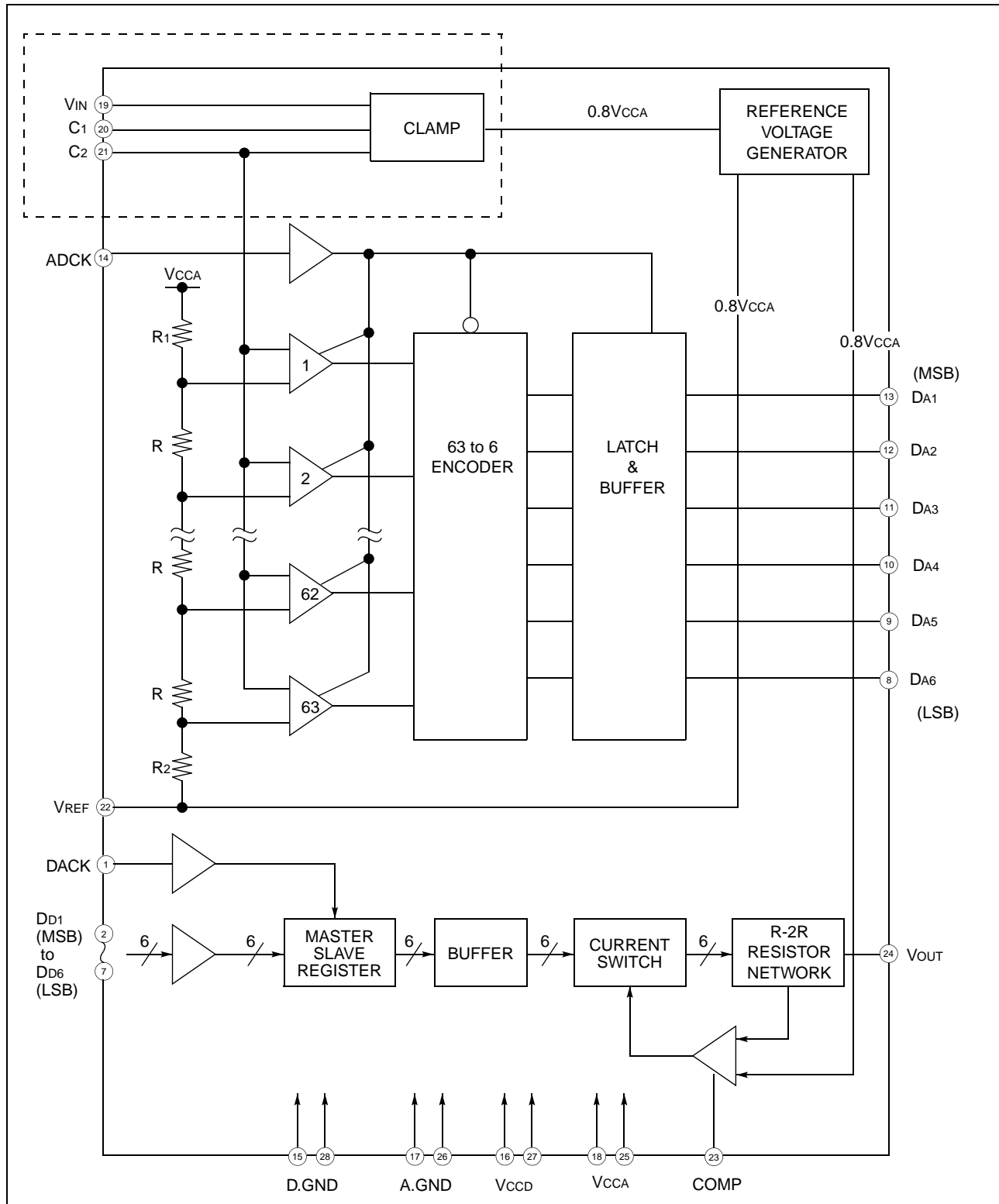


**Note :** The circuits within the dotted lines above are different for MB40166 and MB40176.

# MB40166/MB40176

## ■ BLOCK DIAGRAM (Continued)

- MB40176



**Note :** The circuits within the dotted lines above are different for MB40166 and MB40176.

# MB40166/MB40176

## ■ PIN DESCRIPTIONS

Section	Pin No.		Symbol	I/O	Function
	40166	40176			
A/D	21	–	VINA	I	Analog signal input.
	–	19	VIN	I	
	22		VREF	O	Reference voltage output. Reference voltage divided by the resistors, with the output voltage set to 0.8 x VCCA (V).
	8 to 13		DA1 to DA6	O	Digital signal outputs. (DA1: MSB, DA6: LSB)
	20	–	VCLMP	O	Clamp voltage output.
	–	20	C1	–	Clamp capacitor is connected between these pins.
	–	21	C2	–	
	14		ADCK	I	A/D conversion clock input.
D/A	24		VOUT	O	Analog signal output.
	2 to 7		DD1 to DD6	I	Digital signal input. (DD1: MSB, DD6: LSB)
	23		COMP	–	Phase compensation capacitor is connected. Insert a capacitor of 1 μF or more between this pin and A.GND.
	1		DACK	I	D/A conversion clock input.
Common	18, 25		VCCA	–	Power supply for analog circuit. (+5 V)
	16, 27		VCCD	–	Power supply for digital circuit. (+5 V)
	17, 26		A.GND	–	Ground for analog circuit. (0 V)
	15, 28		D.GND	–	Ground for digital circuit. (0 V)
Other	19	–	(N.C.)	–	No connection.

# MB40166/MB40176

## ■ RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Value			Unit	Remarks
		Min	Typ	Max		
Power Supply Voltage	VCCA, VCCD	4.75	5.00	5.25	V	
Analog Input Voltage	VINA	VREF	–	VCCA	V	MB40166
	VIN	0	–	1	V	MB40176
Digital High-level Input Voltage	VIHD	2.0	–		V	
Digital Low-level Input Voltage	VILD	–	–	0.8	V	
Clock Frequency	fCLK	–	–	20	MHz	
Clock Pulse Width at High Level	tw <sup>+</sup>	20	–	–	ns	
Clock Pulse Width at Low Level	tw <sup>-</sup>	20	–	–	ns	
Set-up Time	ts	12.5	–	–	ns	
Hold Time	th	7.5	–	–	ns	
Phase Compensation Capacitance	C <sub>COMP</sub>	1.0	–	–	μF	
Clamp Capacitance	C <sub>CLAMP</sub>	1.0	–	–	μF	
Reference Voltage Capacitance	C <sub>VREF</sub>	1.0	–	–	μF	
Operating Temperature	T <sub>a</sub>	0	–	70	°C	

## ■ ELECTRICAL CHARACTERISTICS

### ANALOG CIRCUIT DC CHARACTERISTICS

(VCCA=VCCD=5V±5%, Ta=0 to 70°C)

Parameter	Symbol	Condition	Value			Unit	Remarks
			Min	Typ	Max		
Resolution	–		–	–	6	Bits	
Linearity Error	LE	DC	–	–	±0.8	%	
Analog High Level Input Current	I <sub>IHA</sub>	V <sub>INA</sub> = V <sub>CCA</sub>	–	8.5	25	μA	MB40166
Analog Low Level Input Current	I <sub>IILA</sub>	V <sub>INA</sub> = V <sub>REF</sub>	–	7.5	23	μA	MB40166
Equivalent resistance for Analog Input	R <sub>INA</sub>	$\frac{V_{CCA} - V_{REF}}{I_{IHA} - I_{IILA}}$	400	–	–	kΩ	MB40166
Analog Input Current	I <sub>IN</sub>		-400	–	–	μA	MB40176
Reference Voltage	V <sub>REF</sub> *		3.9	4.0	4.1	V	
Clamp Voltage	V <sub>CLMP</sub>		–	V <sub>REF</sub>	–	V	
Full-Scale Output Voltage	V <sub>OFS</sub>		–	V <sub>CCA</sub>	–	V	
Zero-Scale Output Voltage	V <sub>OZS</sub>		–	V <sub>REF</sub>	–	V	
Output Resistance	R <sub>O</sub>		–	240	–	Ω	
Power Supply Current	I <sub>CC</sub>		–	60*	90	mA	

Note : \*VCCA=VCCD=5.0V

# MB40166/MB40176

## ■ ELECTRICAL CHARACTERISTICS (Continued)

### DIGITAL CIRCUIT DC CHARACTERISTICS

(VCCA=VCCD=5V±5%, Ta=0°C to 70°C)

Parameter	Symbol	Condition	Value			Unit
			Min	Typ	Max	
Digital High-level Output Voltage	VOHD	I <sub>OH</sub> =-400 μA	2.7	–	–	V
Digital Low-level Output Voltage	VOLD	I <sub>OL</sub> =1.6mA	–	–	0.4	V
Digital High-level Input Voltage	VIHD		2.0	–	–	V
Digital Low-level Input Voltage	VILD		–	–	0.8	V
Digital High-level Input Current	IIHD		–	–	20	μA
Digital Low-level Input Current	IILD		-100	–	–	μA

### SWITCHING CHARACTERISTICS

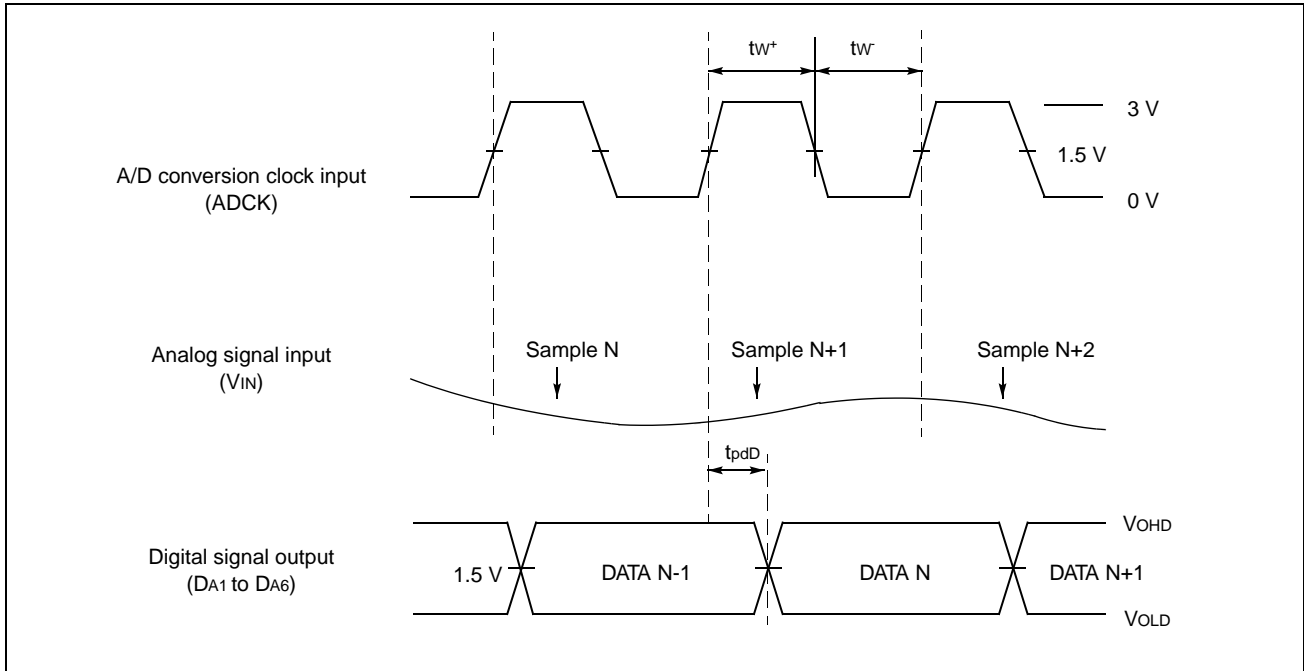
(VCCA=VCCD=5V±5%, Ta=0°C to 70°C)

Parameter	Symbol	Condition	Value			Unit
			Min	Typ	Max	
Maximum Conversion Rate	F <sub>S</sub>		20	–	–	MSPS
Digital Output Delay Time	t <sub>PDD</sub>		8	15	30	ns
Analog Output Delay Time	t <sub>PDA</sub>		–	13	–	ns
Analog Output Rise Time	t <sub>r</sub>		–	15	–	ns
Analog Output Fall Time	t <sub>f</sub>		–	15	–	ns

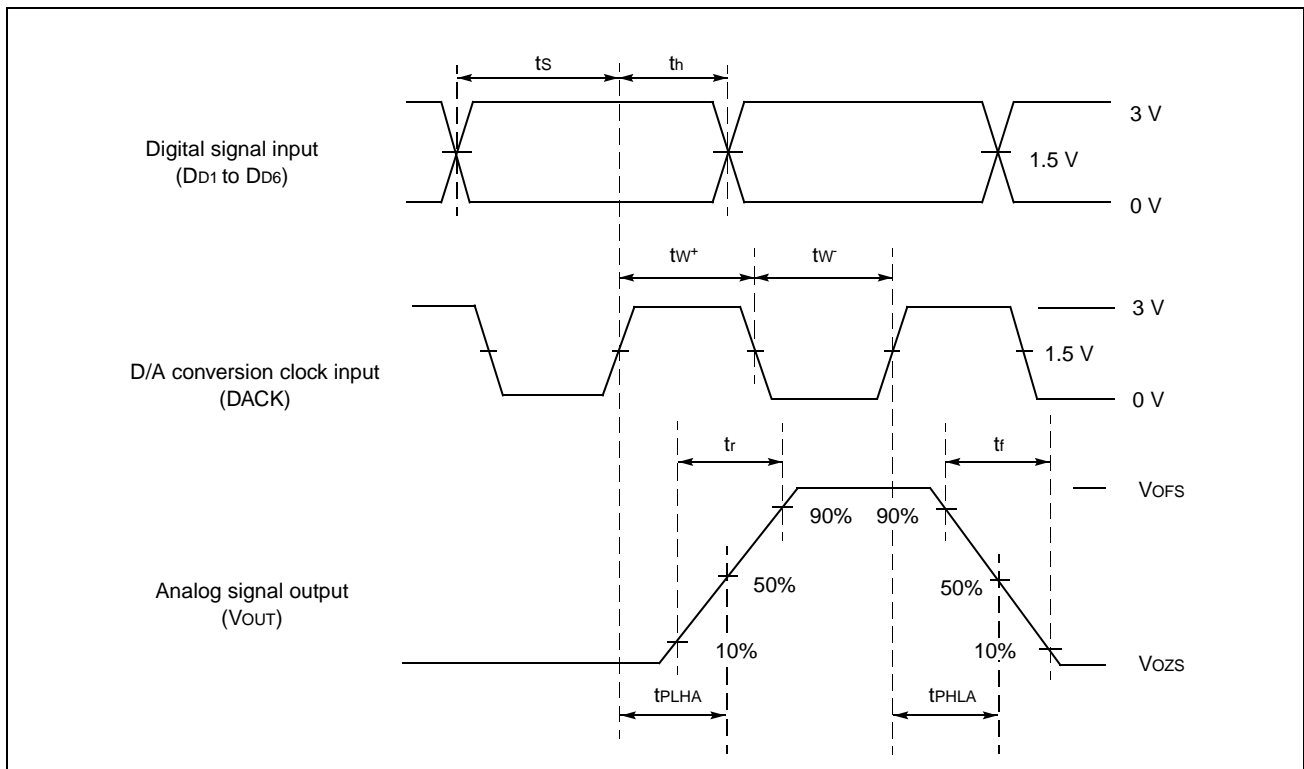
# MB40166/MB40176

## ■ TIMING CHART

### 1. Timing Chart for A/D Conversion

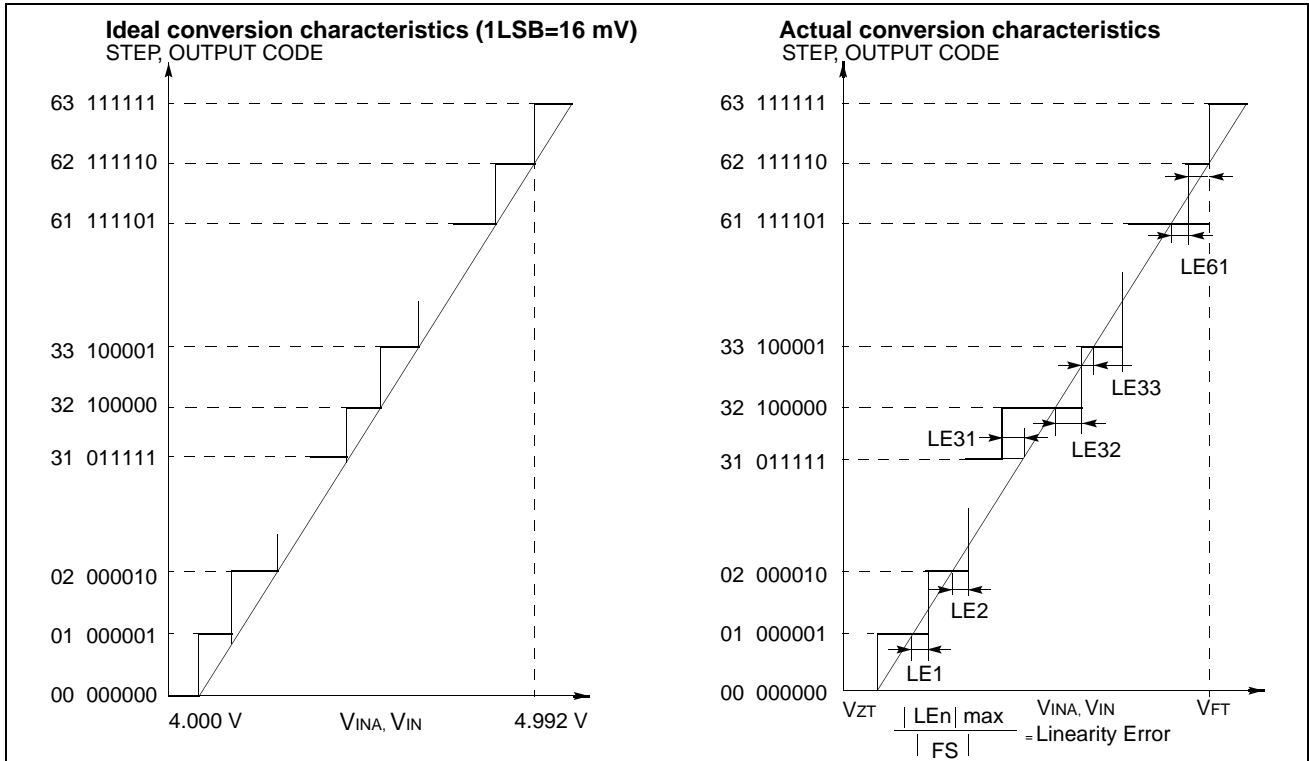


### 2. Timing Chart for D/A Conversion

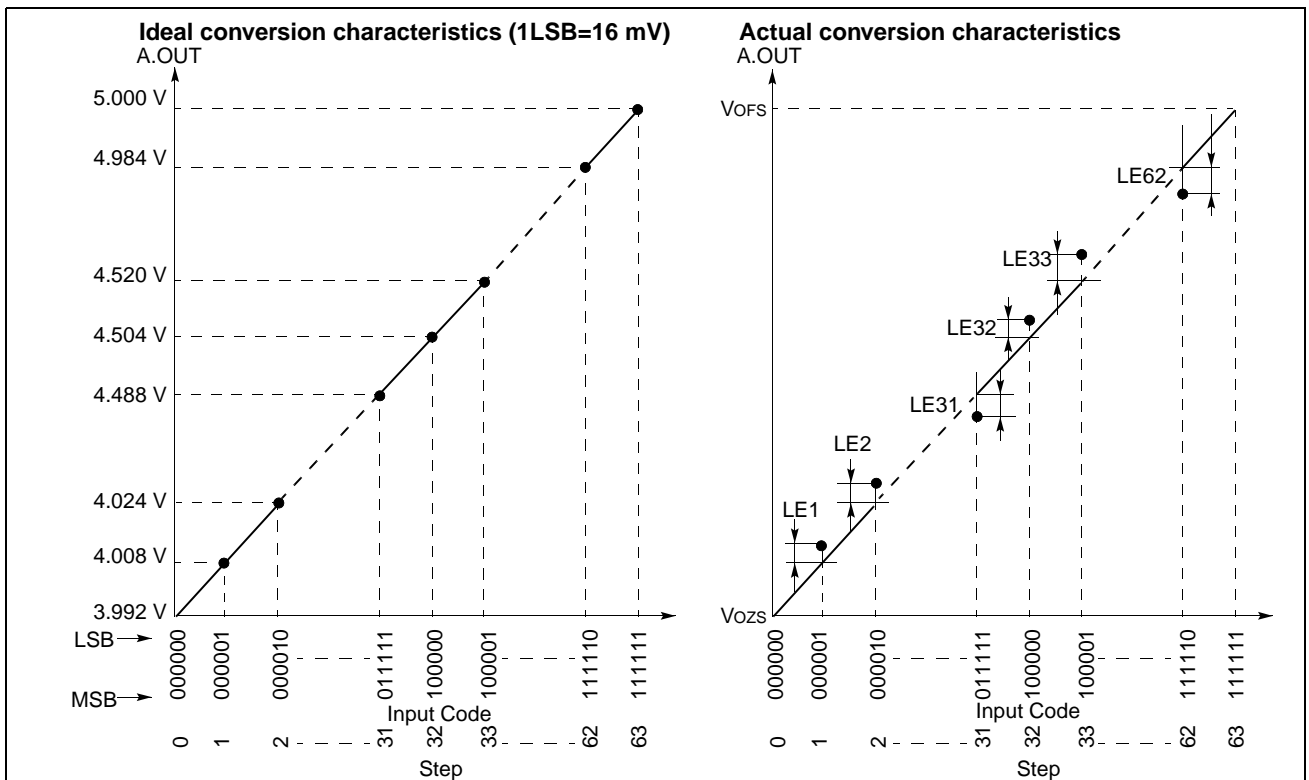




## ■ A/D CONVERSION CHARACTERISTICS



## ■ D/A CONVERSION CHARACTERISTICS



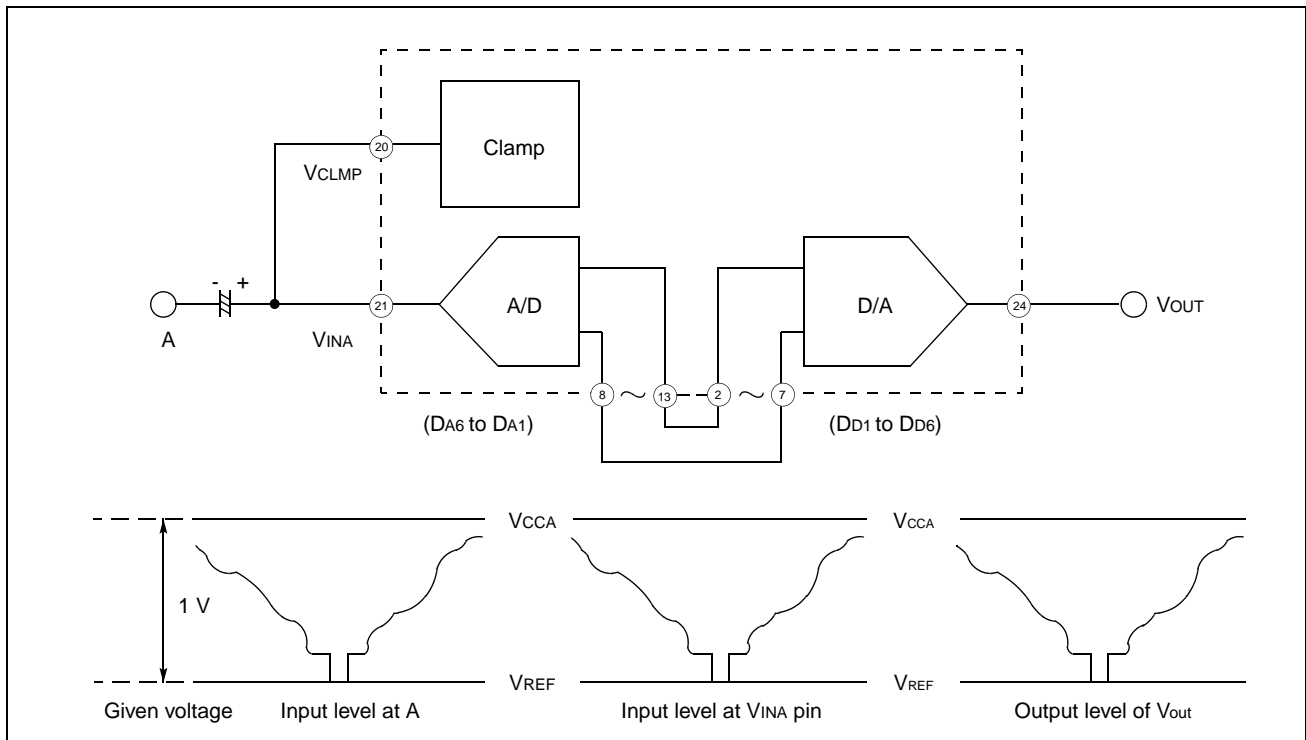
# MB40166/MB40176

## FUNCTIONAL DESCRIPTIONS CLAMP CIRCUIT

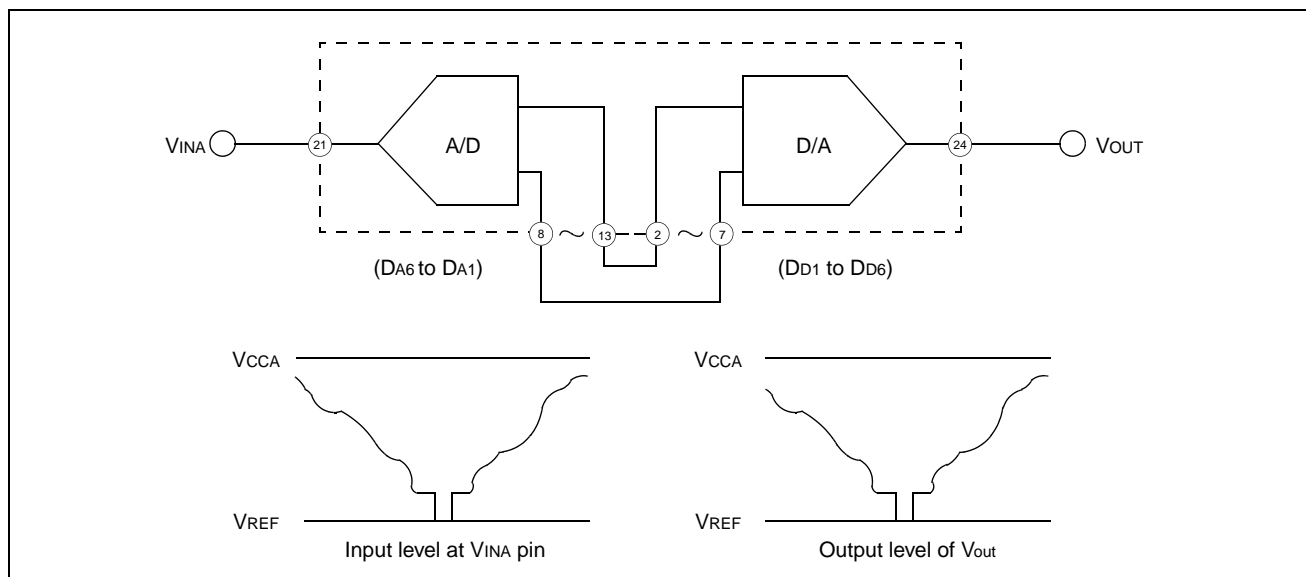
The clamp circuit contained in MB40166/MB40176 is a peak detector type, in which the top of the sync of the composite sync signal is clamped.  
Clamp voltage is common to the reference voltage ( $0.8 \times V_{CC}$ ) of A/D and D/A circuits.

### MB40166

#### (1) Providing a clamp circuit

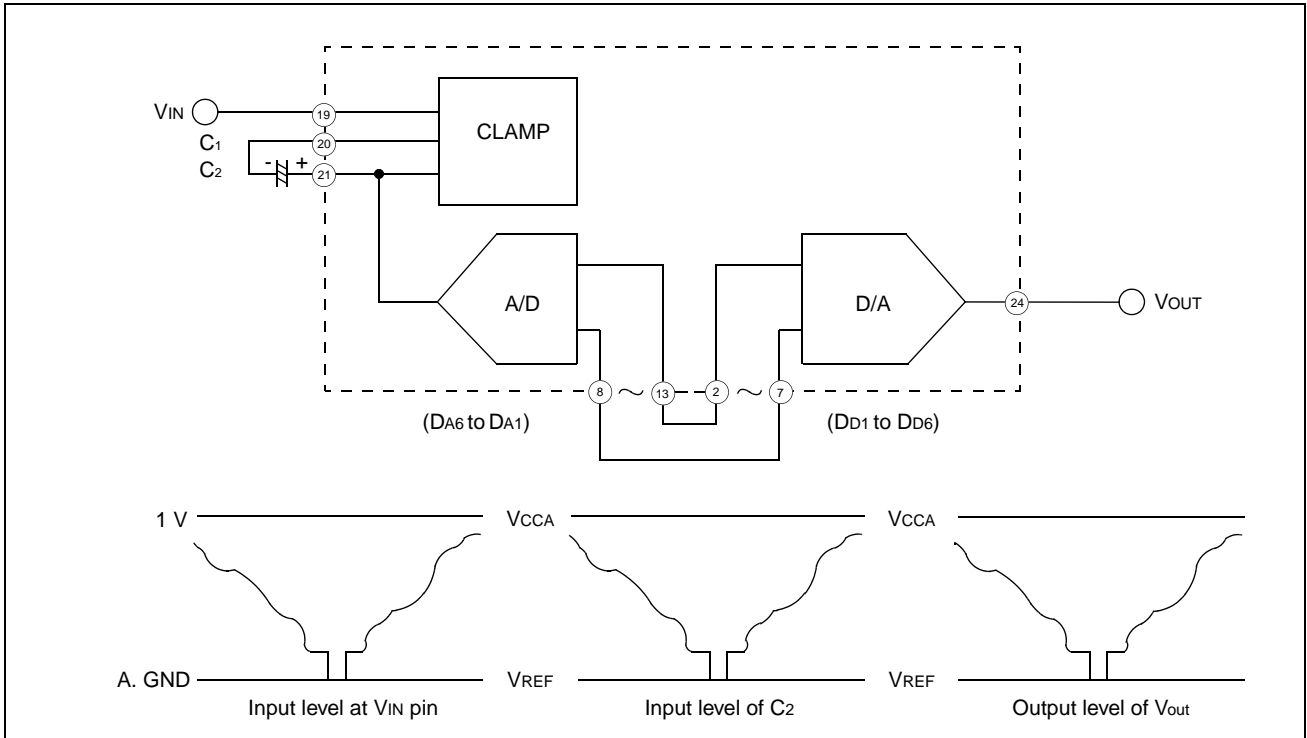


#### (2) Directly feeding the signal at the VINA pin



# MB40166/MB40176

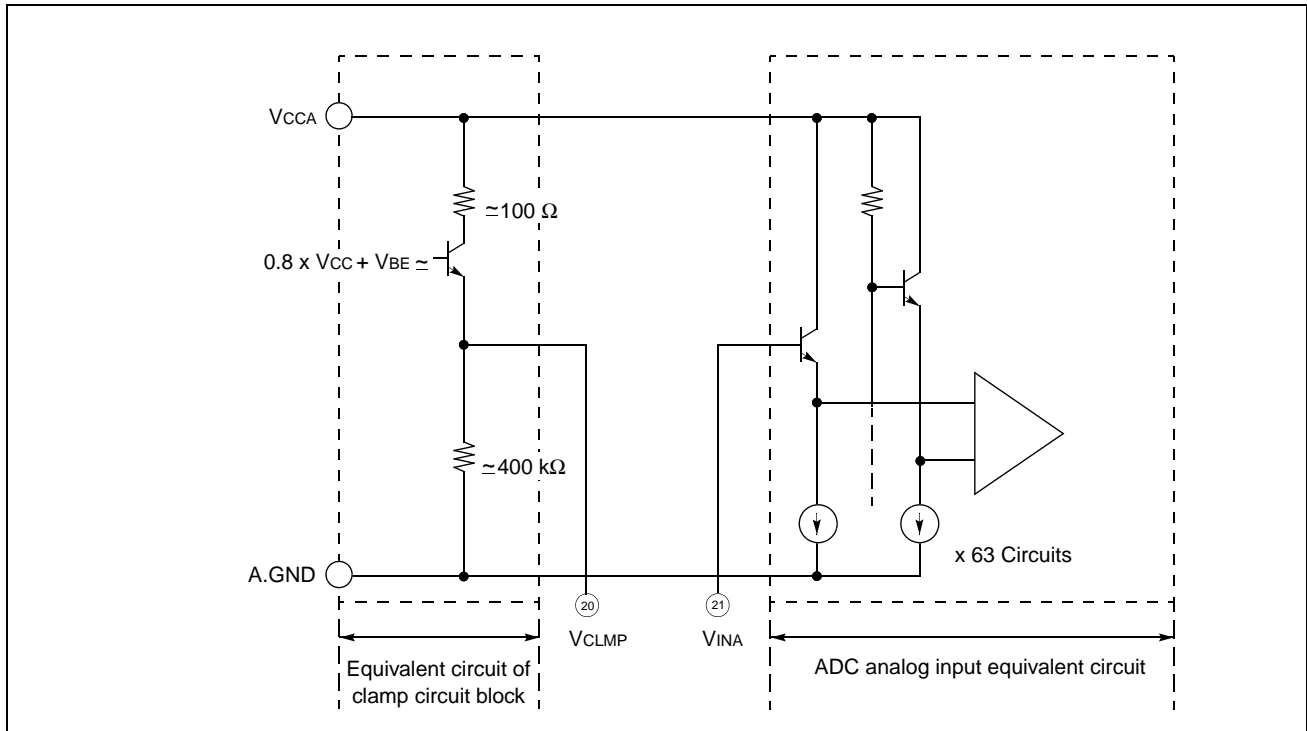
- MB40176



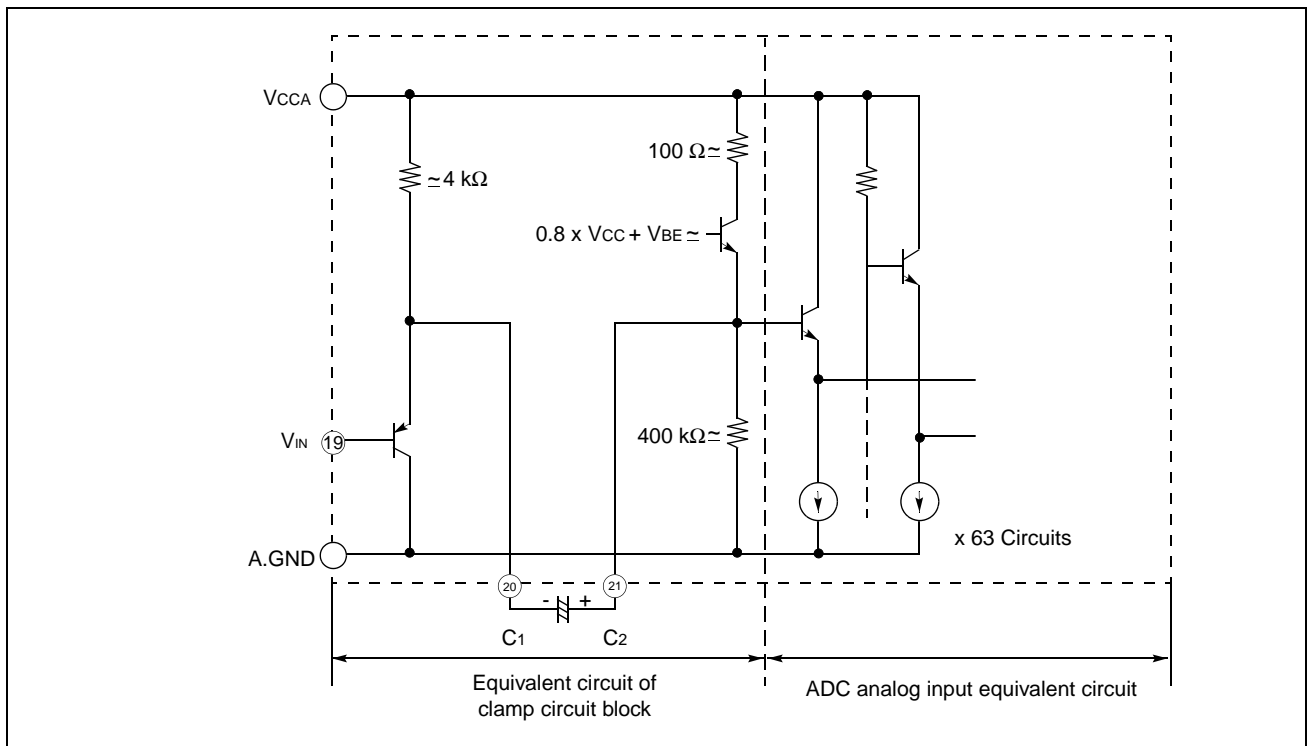
# MB40166/MB40176

## ■ ANALOG INPUT EQUIVALENT CIRCUIT

### • MB40166



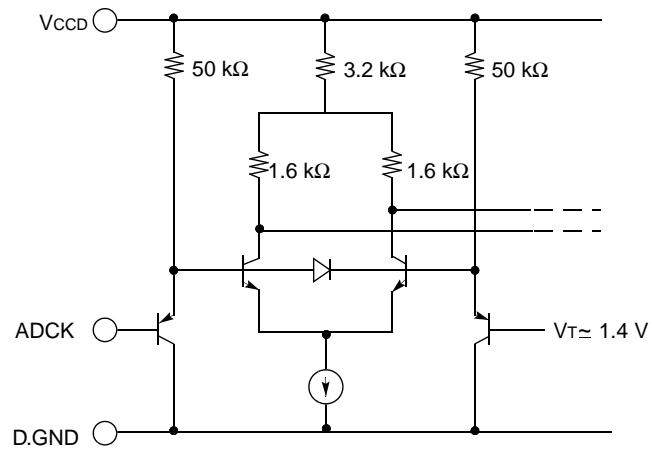
### • MB40176



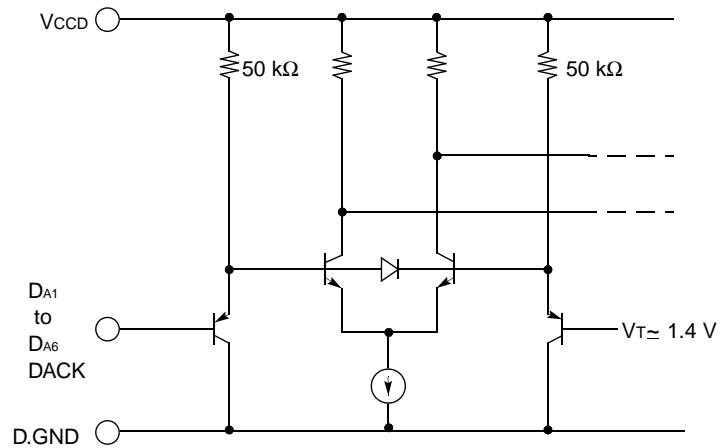
## ■ DIGITAL INPUT EQUIVALENT CIRCUITS

- MB40166/MB40176

Digital input equivalent circuit of A/D converter block



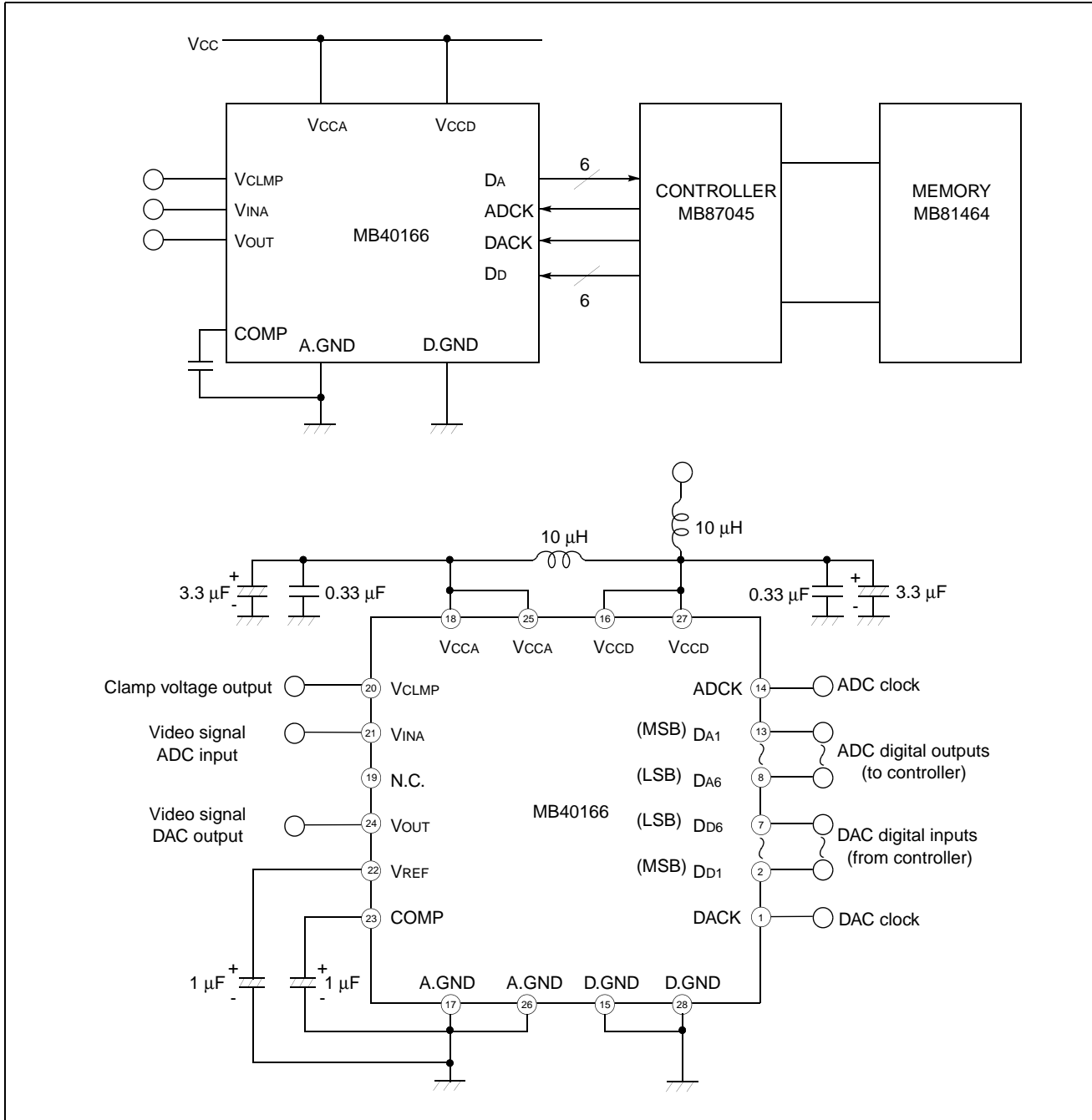
Digital input equivalent circuit of D/A converter block



# MB40166/MB40176

## ■ TYPICAL CONNECTION EXAMPLE

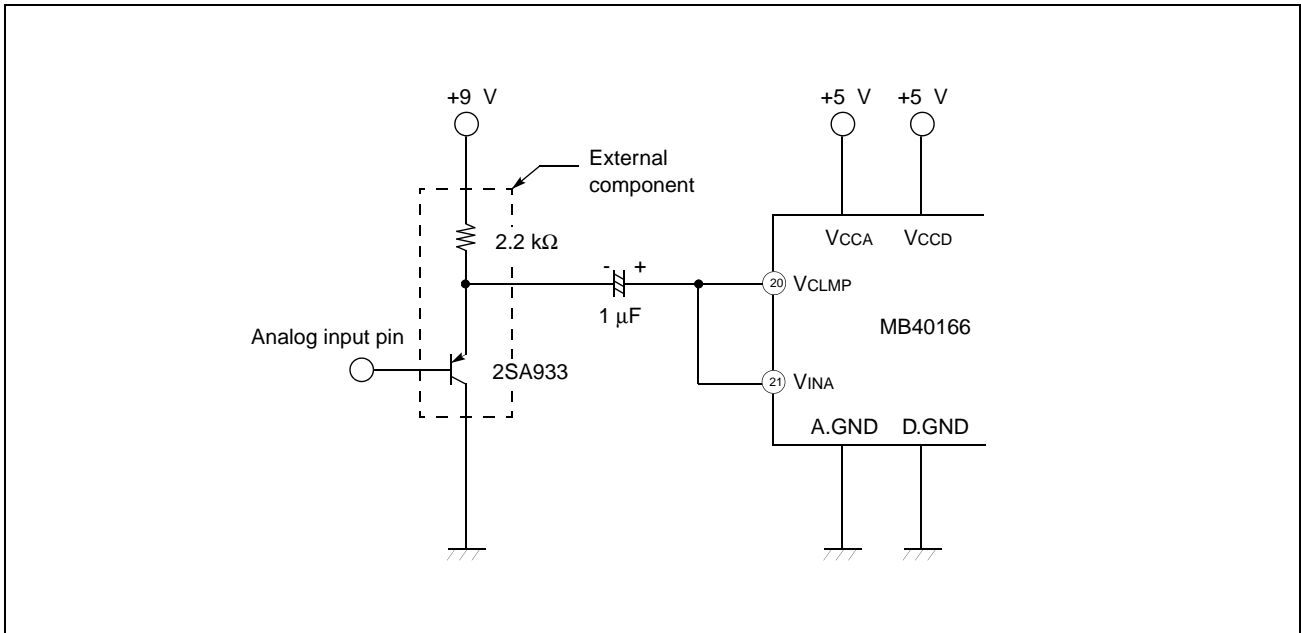
- MB40166



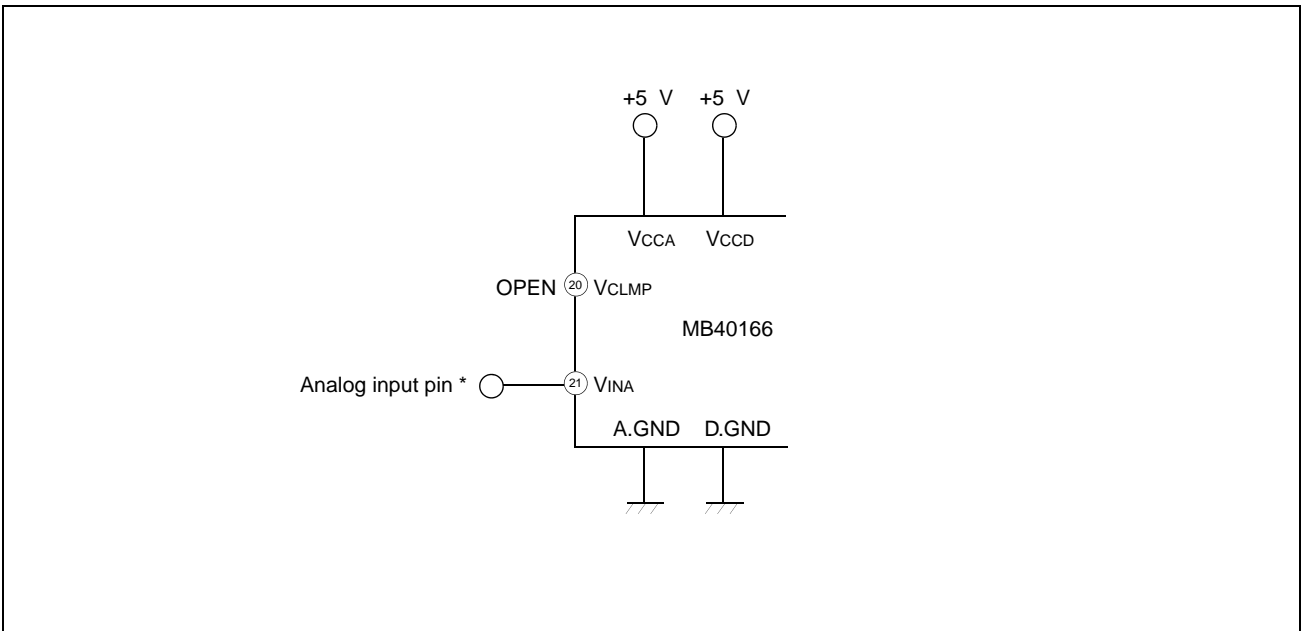
**Note :** If the clamp circuit is used, connect VINA with VCLMP.  
 If the clamp circuit is not used, do not connect VINA with VCLMP.

## ■ TYPICAL CONNECTION EXAMPLE (continued)

(1) Internal clamp circuit is used.



(2) Internal clamp circuit is not used.

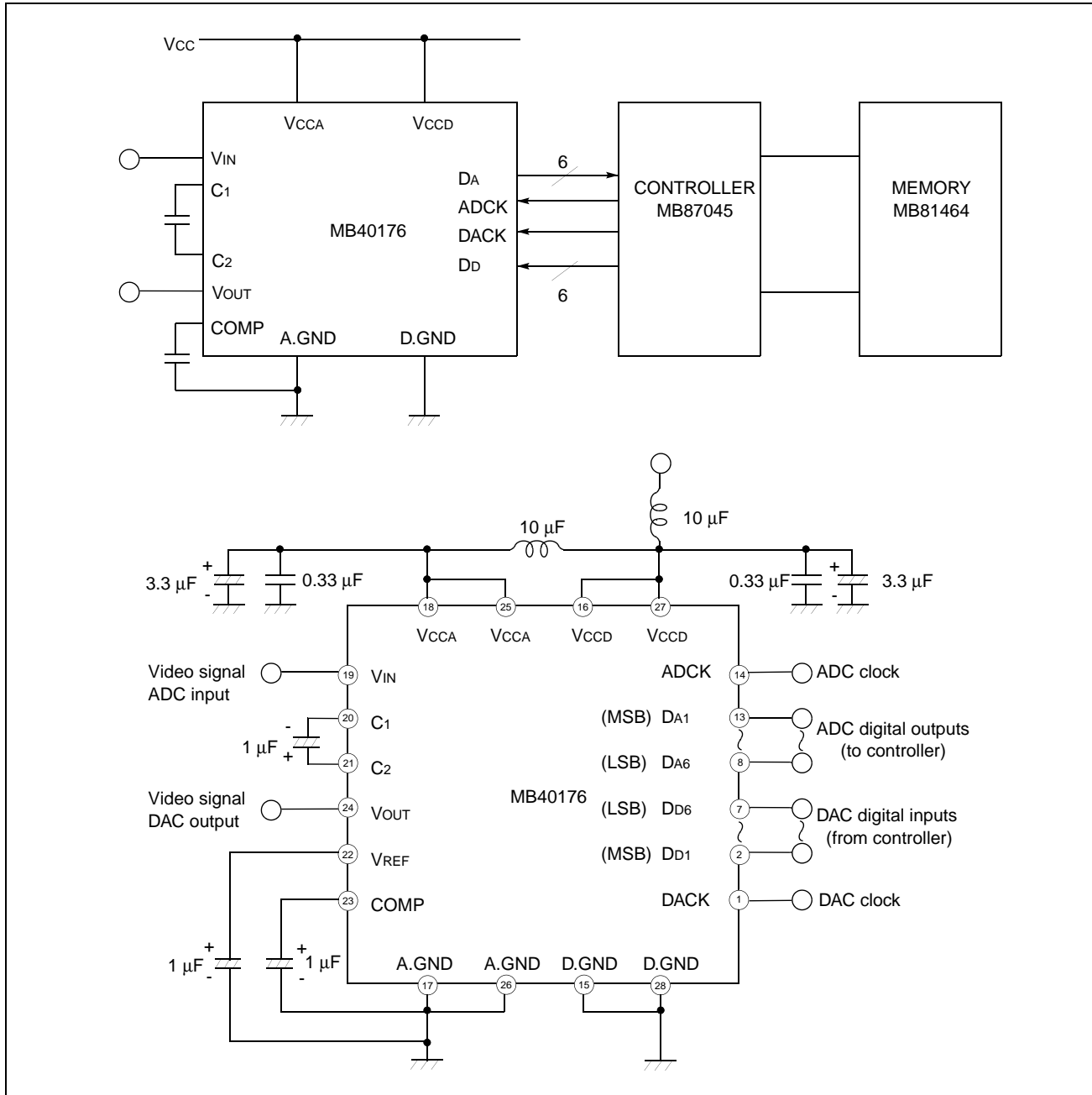


\*: Input voltage range for the analog input pin is  $V_{REF}$  up to  $V_{CCA}$ .

# MB40166/MB40176

## ■ TYPICAL CONNECTION EXAMPLE (continued)

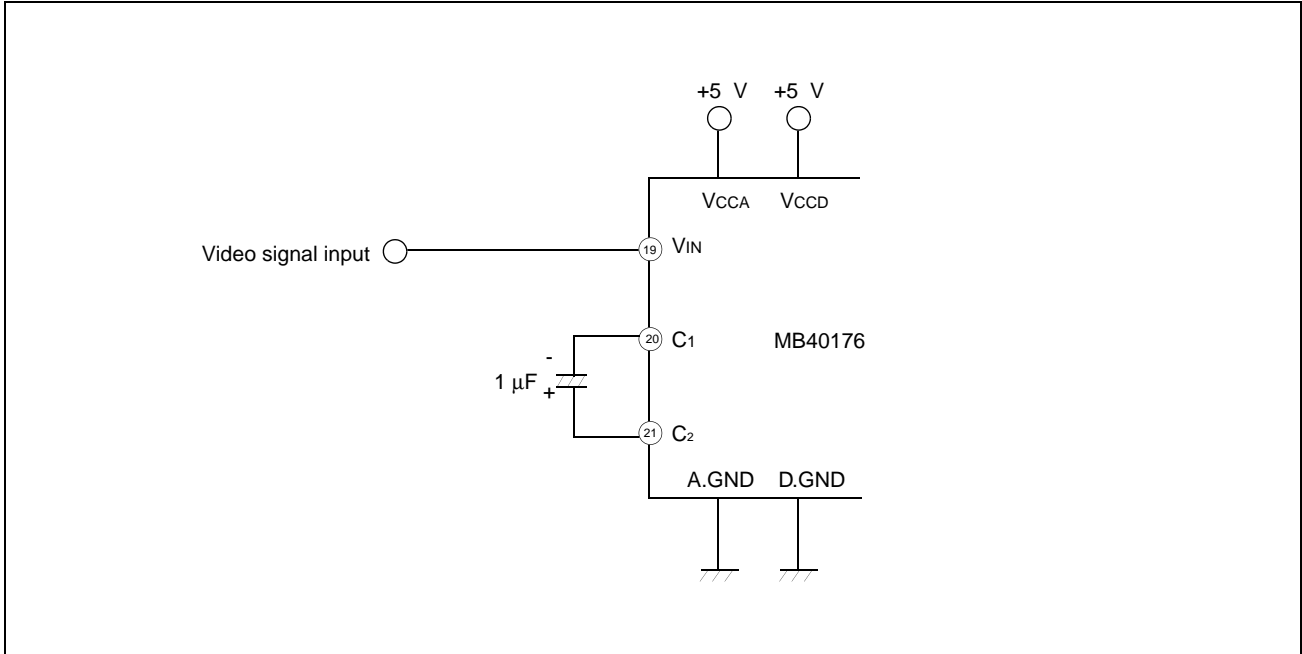
- MB40176





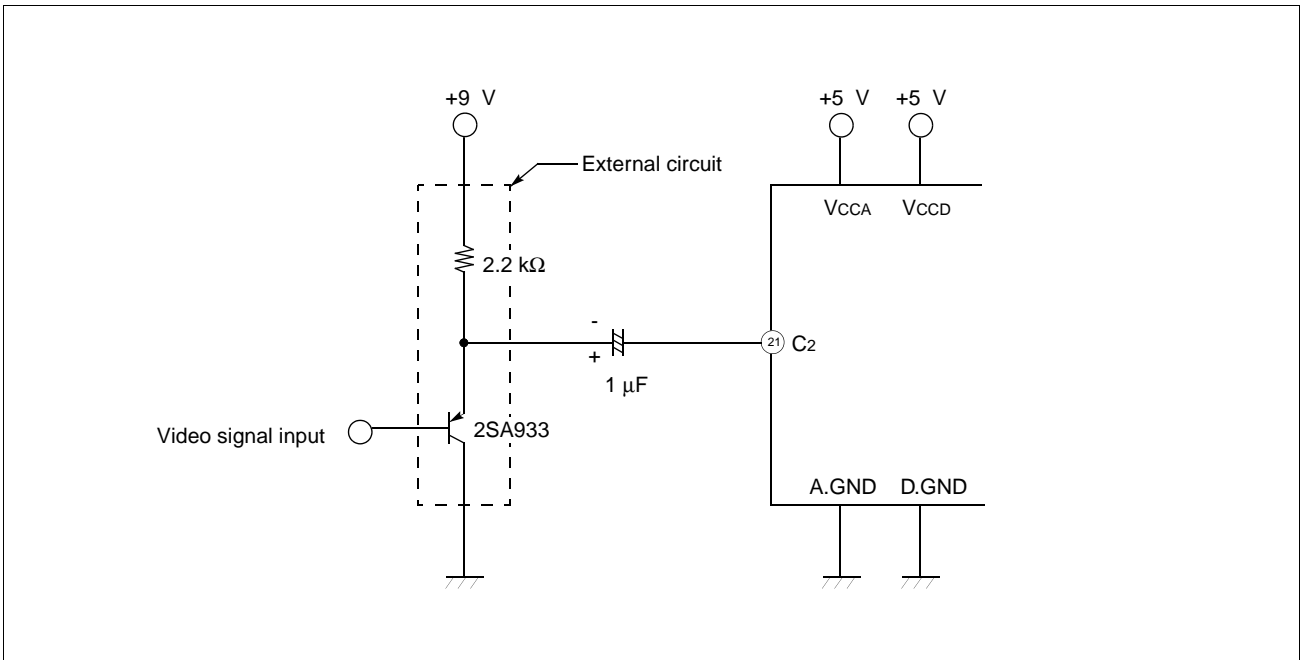
## ■ TYPICAL CONNECTION EXAMPLE (continued)

1.ON-CHIP Input PNP Transistor is utilized.



**Note :** Input impedance of  $V_{IN}$  input pin (19) is about  $20\text{ k}\Omega$ , please pay attention to output impedance of signal source.

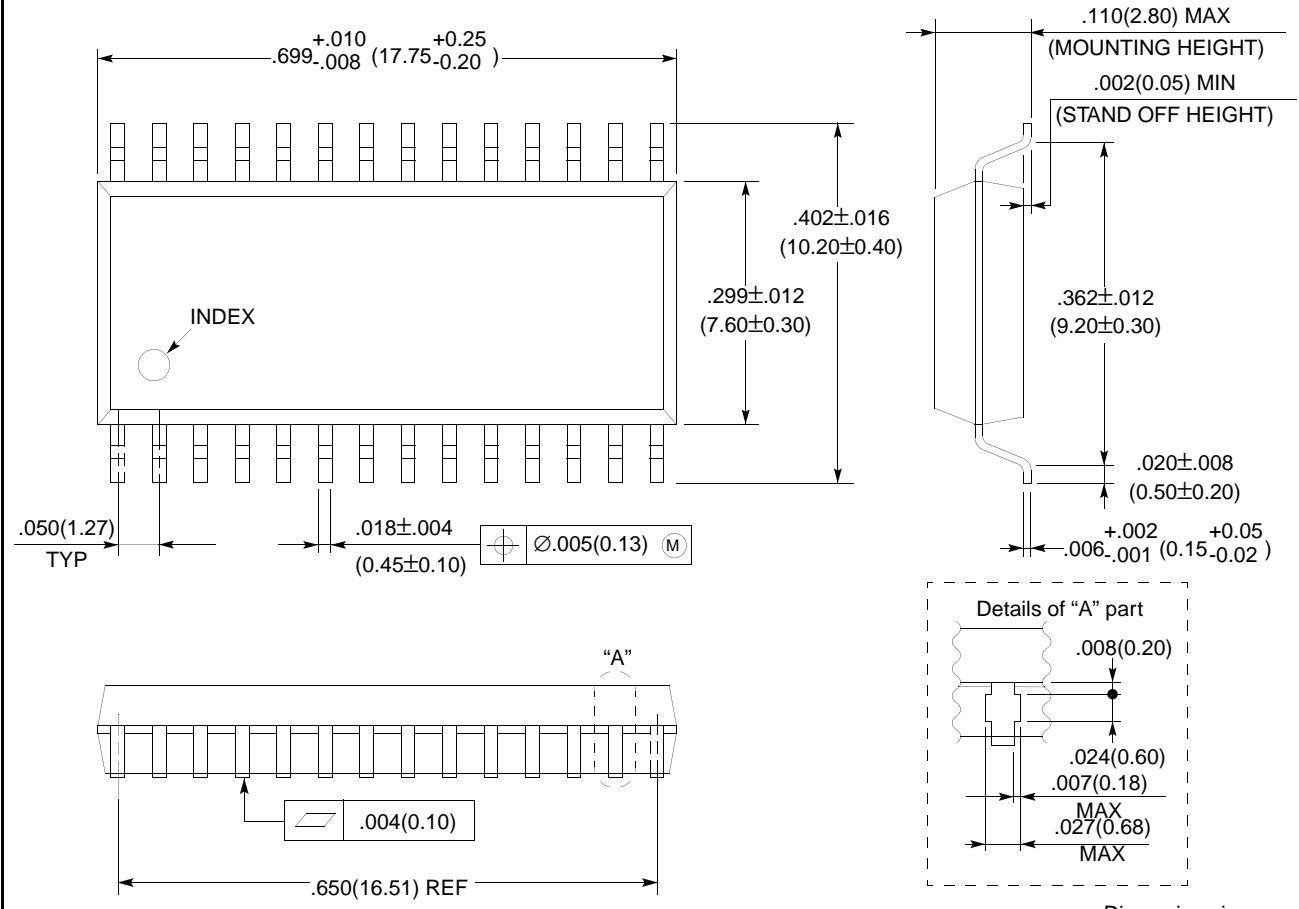
2. Input PNP Transistor of Clamp Circuit is put externally.



**Note :** Both  $V_{IN}$  (19) and C (20) are connected with  $V_{CCA}$ .

# MB40166/MB40176

## 28-LEAD PLASTIC FLAT PACKAGE (CASE No.: FPT-28P-M01)

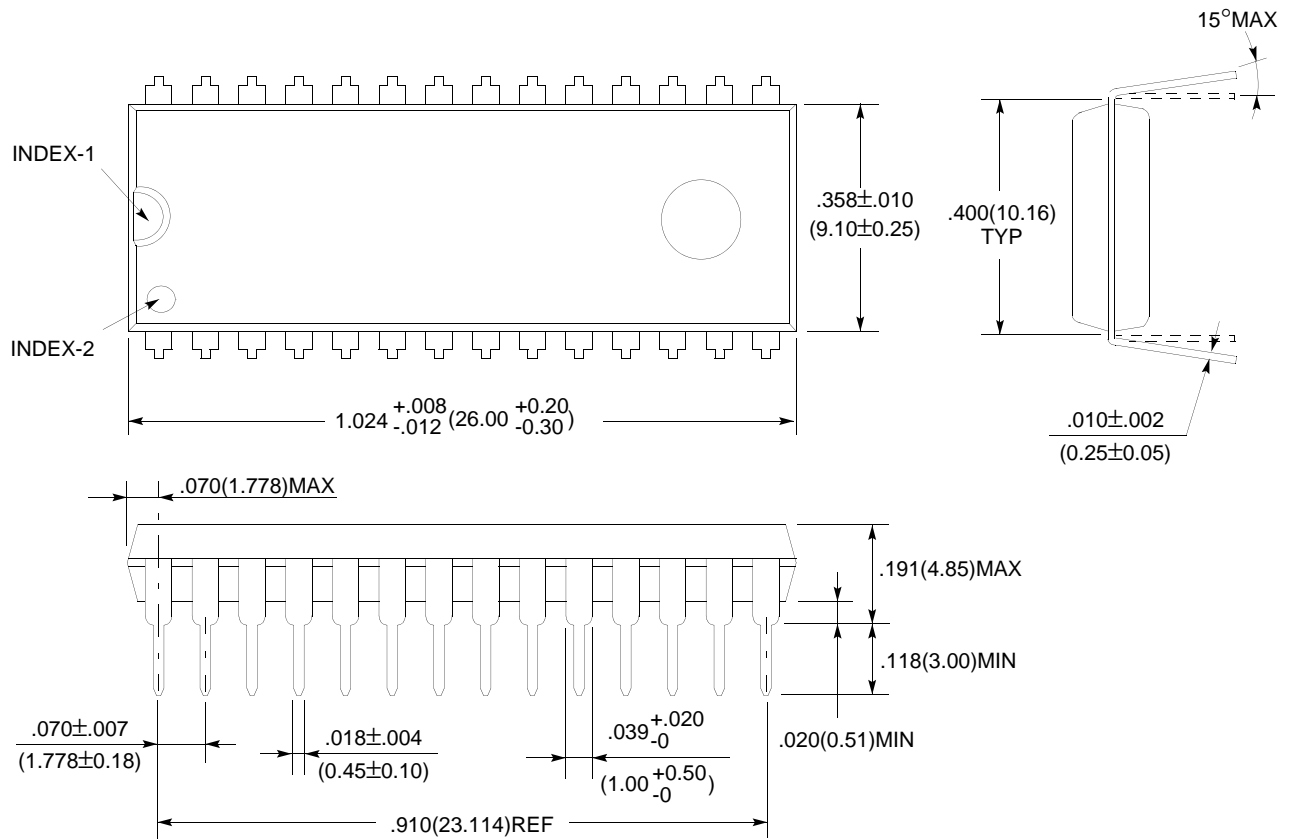


©1994 FUJITSU LIMITED F28005S-5C

Dimensions in inches (millimeters)

# MB40166/MB40176

## 28-LEAD PLASTIC DUAL IN-LINE PACKAGE (CASE No.: DIP-28P-M03)



©1994 FUJITSU LIMITED D28012S-3C

Dimensions in  
inches (millimeters)

# MB40166/MB40176

## FUJITSU LIMITED

*For further information please contact:*

### **Japan**

FUJITSU LIMITED  
Corporate Global Business Support Division  
Electronic Devices  
KAWASAKI PLANT, 1015, Kamikodanaka  
Nakahara-ku, Kawasaki-shi  
Kanagawa 211, Japan  
Tel: (044) 754-3753  
Fax: (044) 754-3329

### **North and South America**

FUJITSU MICROELECTRONICS, INC.  
Semiconductor Division  
3545 North First Street  
San Jose, CA 95134-1804, U.S.A.  
Tel: (408) 922-9000  
Fax: (408) 432-9044/9045

### **Europe**

FUJITSU MIKROELEKTRONIK GmbH  
Am Siebenstein 6-10  
63303 Dreieich-Buchsschlag  
Germany  
Tel: (06103) 690-0  
Fax: (06103) 690-122

### **Asia Pacific**

FUJITSU MICROELECTRONICS ASIA PTE. LIMITED  
No. 51 Bras Basah Road,  
Plaza By The Park,  
#06-04 to #06-07  
Singapore 189554  
Tel: 336-1600  
Fax: 336-1609

All Rights Reserved.

Circuit diagrams utilizing Fujitsu products are included as a means of illustrating typical semiconductor applications. Complete information sufficient for construction purposes is not necessarily given.

The information contained in this document has been carefully checked and is believed to be reliable. However, Fujitsu assumes no responsibility for inaccuracies.

The information contained in this document does not convey any license under the copyrights, patent rights or trademarks claimed and owned by Fujitsu.

Fujitsu reserves the right to change products or specifications without notice.

No part of this publication may be copied or reproduced in any form or by any means, or transferred to any third party without prior written consent of Fujitsu.

The information contained in this document are not intended for use with equipments which require extremely high reliability such as aerospace equipments, undersea repeaters, nuclear control systems or medical equipments for life support.