FUJITSU SEMICONDUCTOR
DATA SHEET

DS04-28500-5E

ASSP

AD/DA CONVERTER

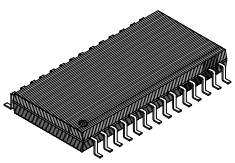
MB40166/MB40176

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

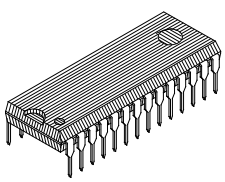
The Fujitsu MB40166 and MB40176 are low power 6-bit AD/DA converter which is fabricated with Fujitsu Advanced Bipolar Technology. MB40166 and MB40176 have the same basic circuits and functions, with the only difference being that MB40166 has an independent analog input terminal for the A/D section and 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 :V_{REF} to V_{CCA} (MB40166)
  0 to 1.0 V (MB40176)
- Analog Output Voltage Range :V_{CC} to V_{CC} -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)

28 pin, Plastic SOP
(FPT-28P-M01)



28 pin, Plastic SH-DIP
(DIP-28P-M03)



ABSOLUTE MAXIMUM RATINGS (see NOTE)

Parameter	Symbol	Rating	Unit
Power Supply Voltage	V_{CCA}, V_{CCD}	-0.5 to +7.0	V
Digital Input Voltage	V_{IND}	-0.5 to +7.0	V
Analog Input Voltage	V_{INA}	-0.5 to V_{CCA} +0.5	V
Storage Temperature	T_{STG}	-55 to +125	°C

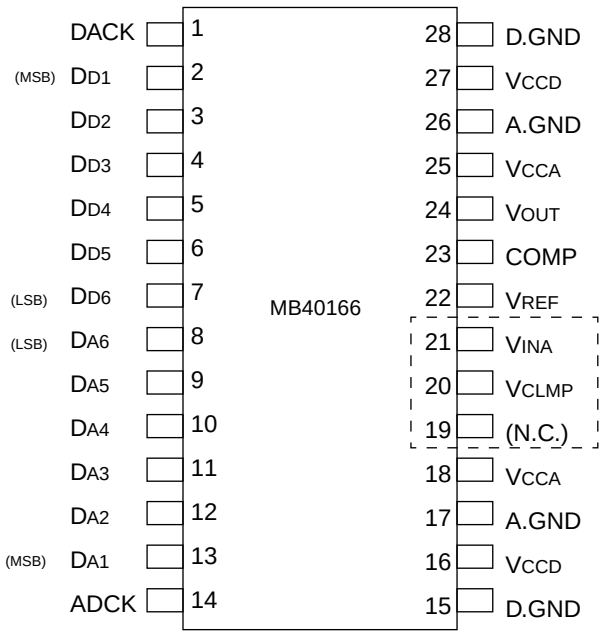
NOTE: Permanent device damage may occur if the above **Absolute Maximum Ratings** are exceeded. Functional operation should be restricted to the conditions as detailed in the operational sections of this data sheet. Exposure to absolute maximum rating conditions for extended periods may affect device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

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.

MB40166/40176

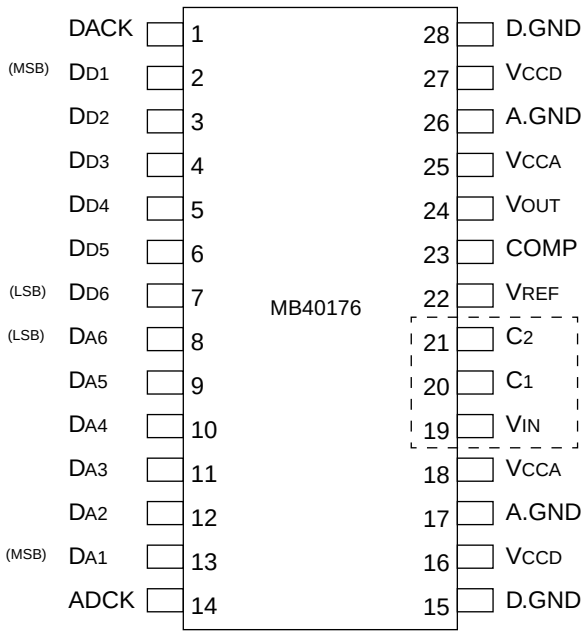
■ PIN ASSIGNMENT

(TOP VIEW)



(FPT-28P-M01)
(DIP-28P-M03)

(TOP VIEW)

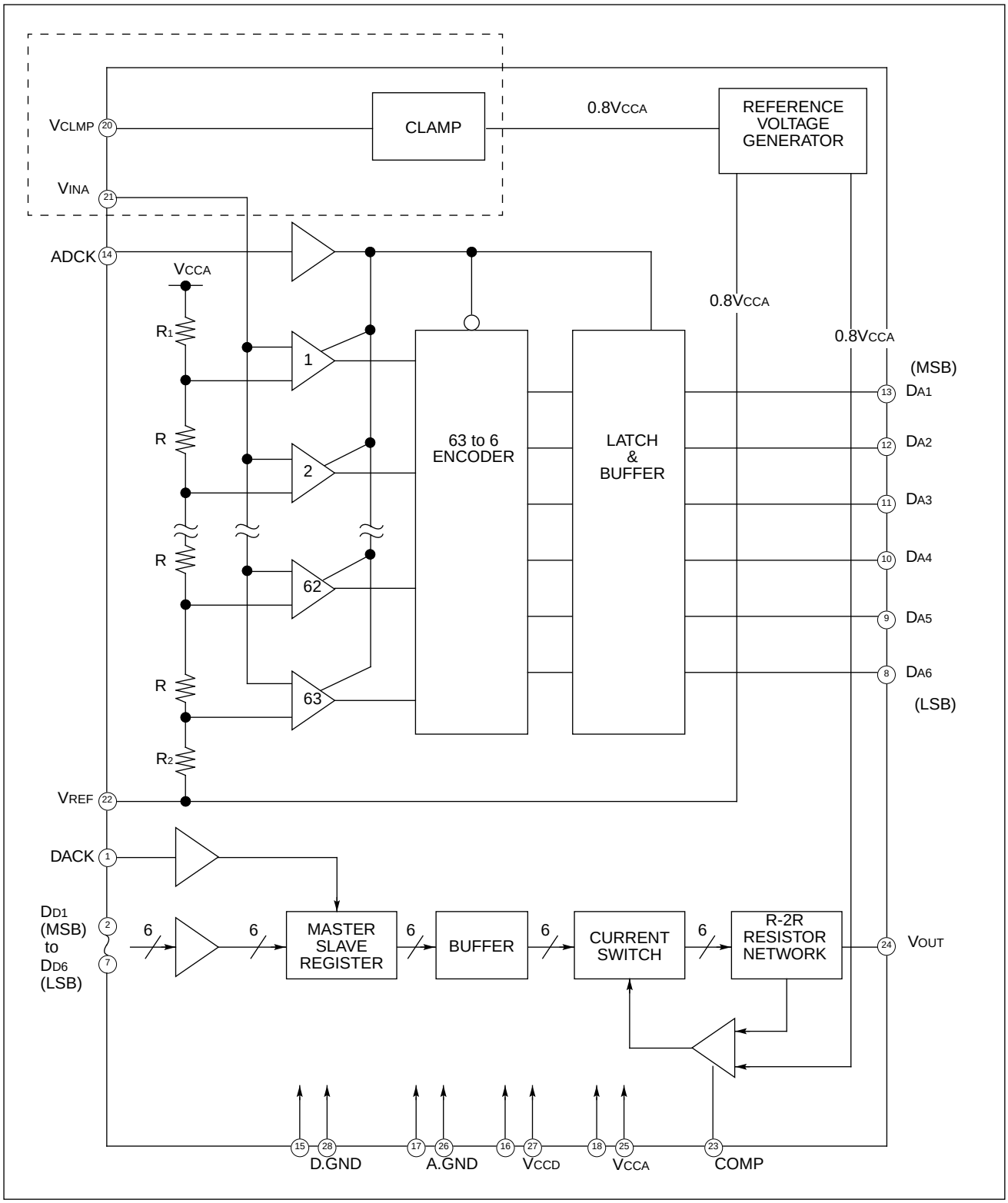


(FPT-28P-M01)
(DIP-28P-M03)

Note : The functions of the terminals within the dotted lines above are different for MB40166 and MB40176.

■ BLOCK DIAGRAM

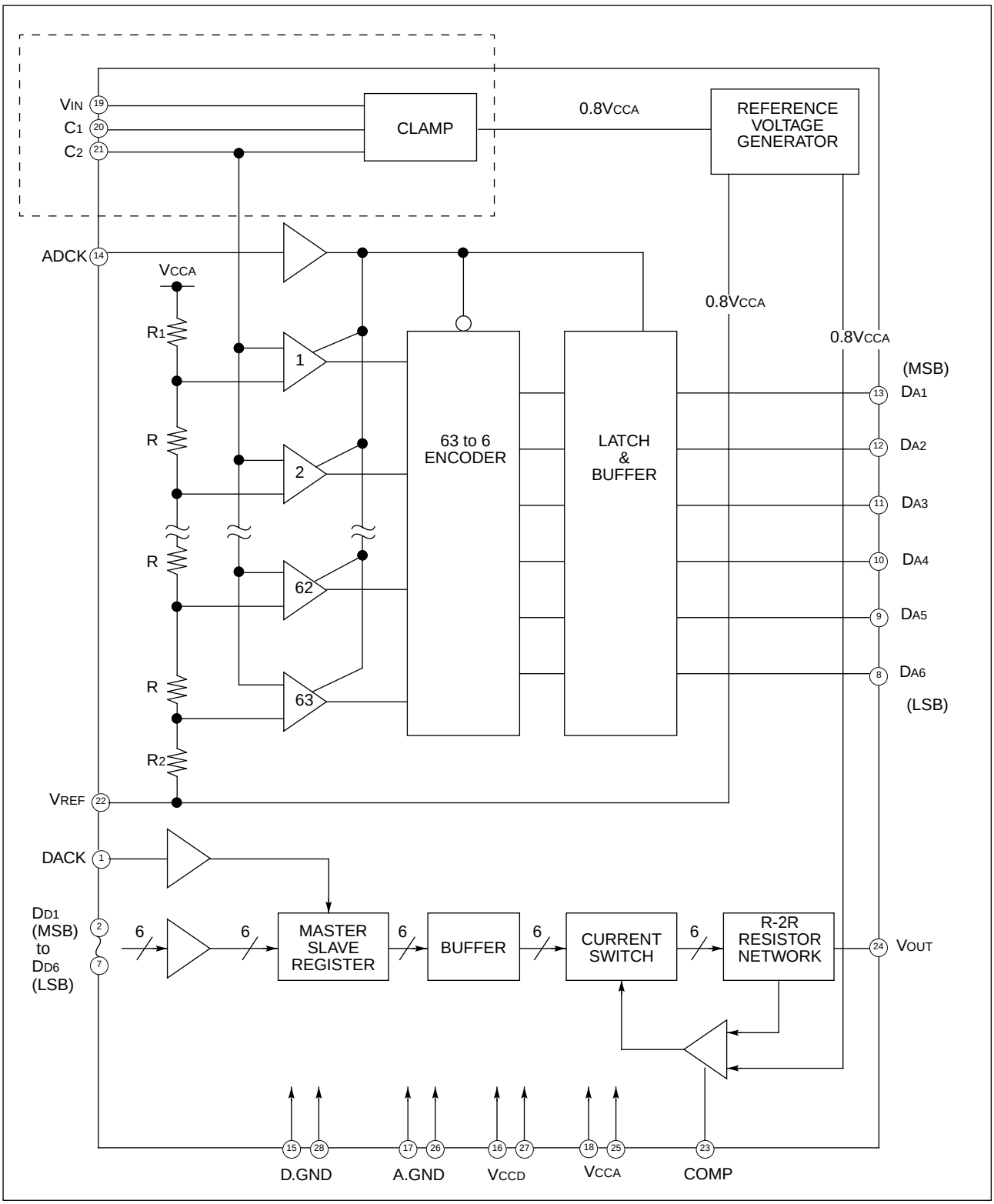
- **MB40166**



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

■ BLOCK DIAGRAM (Continued)

- **MB40176**



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

■ PIN DESCRIPTIONS

Section	Pin No.		Symbol	I/O	Function
	40166	40176			
A/D	21	–	V_{INA}	I	Analog signal input.
	–	19	V_{IN}	I	
	22		V_{REF}	O	Reference voltage output. Reference voltage divided by the resistors, with the output voltage set to 0.8 x V_{CCA} (V).
	8 to 13		D_{A1} to D_{A6}	O	Digital signal outputs. (D_{A1}: MSB, D_{A6}: LSB)
	20	–	V_{CLMP}	O	Clamp voltage output.
	–	20	C_1	–	Clamp capacitor is connected between these pins.
	–	21	C_2	–	
	14		ADCK	I	A/D conversion clock input.
D/A	24		V_{OUT}	O	Analog signal output.
	2 to 7		D_{D1} to D_{D6}	I	Digital signal input. (D_{D1}: MSB, D_{D6}: 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		V_{CCA}	–	Power supply for analog circuit. (+5 V)
	16, 27		V_{CCD}	–	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.

■ RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Value			Unit	Remarks
		Min	Typ	Max		
Power Supply Voltage	V_{CCA}, V_{CCD}	4.75	5.00	5.25	V	
Analog Input Voltage	V_{INA}	V_{REF}	–	V_{CCA}	V	MB40166
	V_{IN}	0	–	1	V	MB40176
Digital High-level Input Voltage	V_{IHD}	2.0	–		V	
Digital Low-level Input Voltage	V_{ILD}	–	–	0.8	V	
Clock Frequency	f_{CLK}	–	–	20	MHz	
Clock Pulse Width at High Level	t_{W^+}	20	–	–	ns	
Clock Pulse Width at Low Level	t_{W^-}	20	–	–	ns	
Set-up Time	t_S	12.5	–	–	ns	
Hold Time	t_H	7.5	–	–	ns	
Phase Compensation Capacitance	C_{COMP}	1.0	–	–	µF	
Clamp Capacitance	C_{CLAMP}	1.0	–	–	µF	
Reference Voltage Capacitance	C_{VREF}	1.0	–	–	µF	
Operating Temperature	Ta	0	–	70	°C	

■ ELECTRICAL CHARACTERISTICS

ANALOG CIRCUIT DC CHARACTERISTICS

(V_{CCA}=V_{CCD}=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_{IHA}	$V_{INA} = V_{CCA}$	–	8.5	25	µA	MB40166
Analog Low Level Input Current	I_{ILA}	$V_{INA} = V_{REF}$	–	7.5	23	µA	MB40166
Equivalent resistance for Analog Input	R_{INA}	$\frac{V_{CCA} - V_{REF}}{I_{IHA} - I_{ILA}}$	400	–	–	kΩ	MB40166
Analog Input Current	I_{IN}		-400	–	–	µA	MB40176
Reference Voltage	V_{REF}*		3.9	4.0	4.1	V	
Clamp Voltage	V_{CLMP}		–	V_{REF}	–	V	
Full-Scale Output Voltage	V_{OFS}		–	V_{CCA}	–	V	
Zero-Scale Output Voltage	V_{OZS}		–	V_{REF}	–	V	
Output Resistance	R_O		–	240	–	Ω	
Power Supply Current	I_{CC}		–	60*	90	mA	

Note : *V_{CCA}=V_{CCD}=5.0V

■ ELECTRICAL CHARACTERISTICS (Continued)

DIGITAL CIRCUIT DC CHARACTERISTICS

(V_{CCA}=V_{CCD}=5V±5%, Ta=0°C to 70°C)

Parameter	Symbol	Condition	Value			Unit
			Min	Typ	Max	
Digital High-level Output Voltage	V_{OHD}	I_{OH}=-400 µA	2.7	–	–	V
Digital Low-level Output Voltage	V_{OLD}	I_{OL}=1.6mA	–	–	0.4	V
Digital High-level Input Voltage	V_{IHD}		2.0	–	–	V
Digital Low-level Input Voltage	V_{ILD}		–	–	0.8	V
Digital High-level Input Current	I_{IHD}		–	–	20	µA
Digital Low-level Input Current	I_{ILD}		-100	–	–	µA

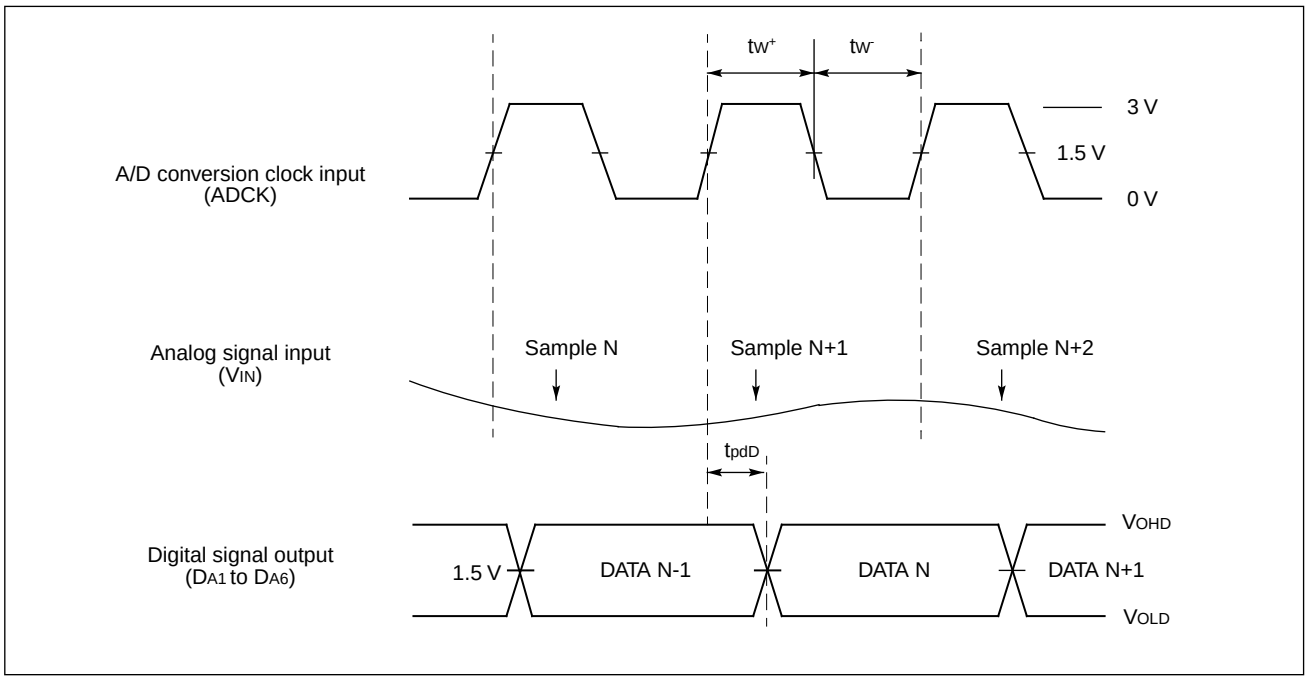
SWITCHING CHARACTERISTICS

(V_{CCA}=V_{CCD}=5V±5%, Ta=0°C to 70°C)

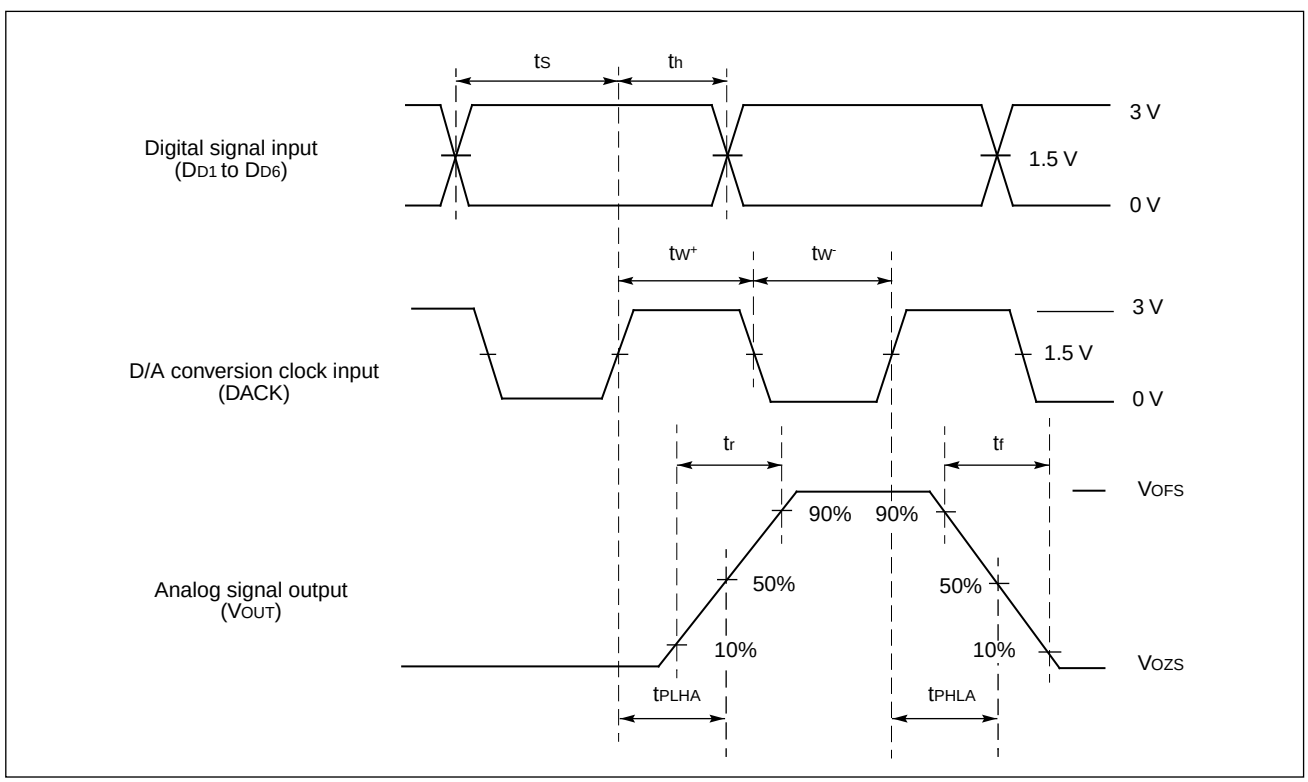
Parameter	Symbol	Condition	Value			Unit
			Min	Typ	Max	
Maximum Conversion Rate	F_S		20	–	–	MSPS
Digital Output Delay Time	t_{PDD}		8	15	30	ns
Analog Output Delay Time	t_{PDA}		–	13	–	ns
Analog Output Rise Time	t_r		–	15	–	ns
Analog Output Fall Time	t_f		–	15	–	ns

■ TIMING CHART

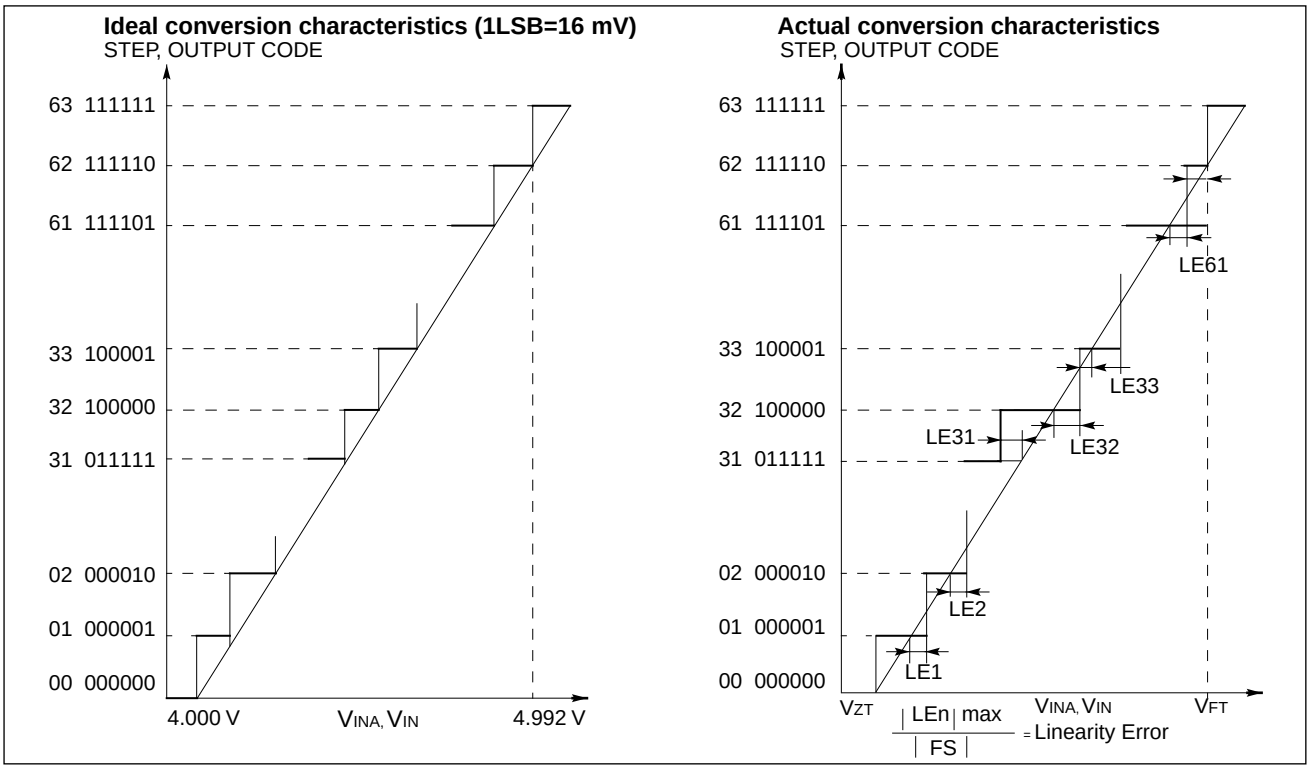
1. Timing Chart for A/D Conversion



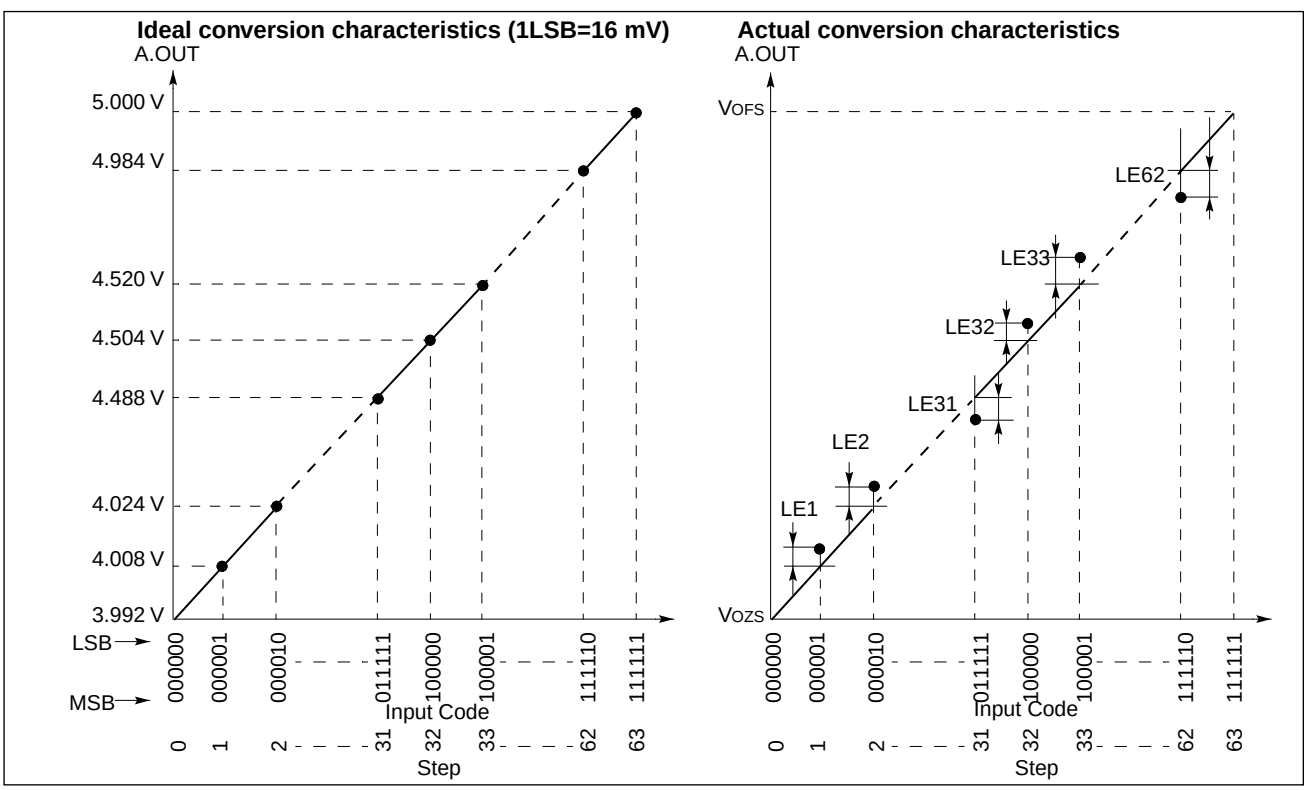
2. Timing Chart for D/A Conversion



■ A/D CONVERSION CHARACTERISTICS



■ D/A CONVERSION CHARACTERISTICS

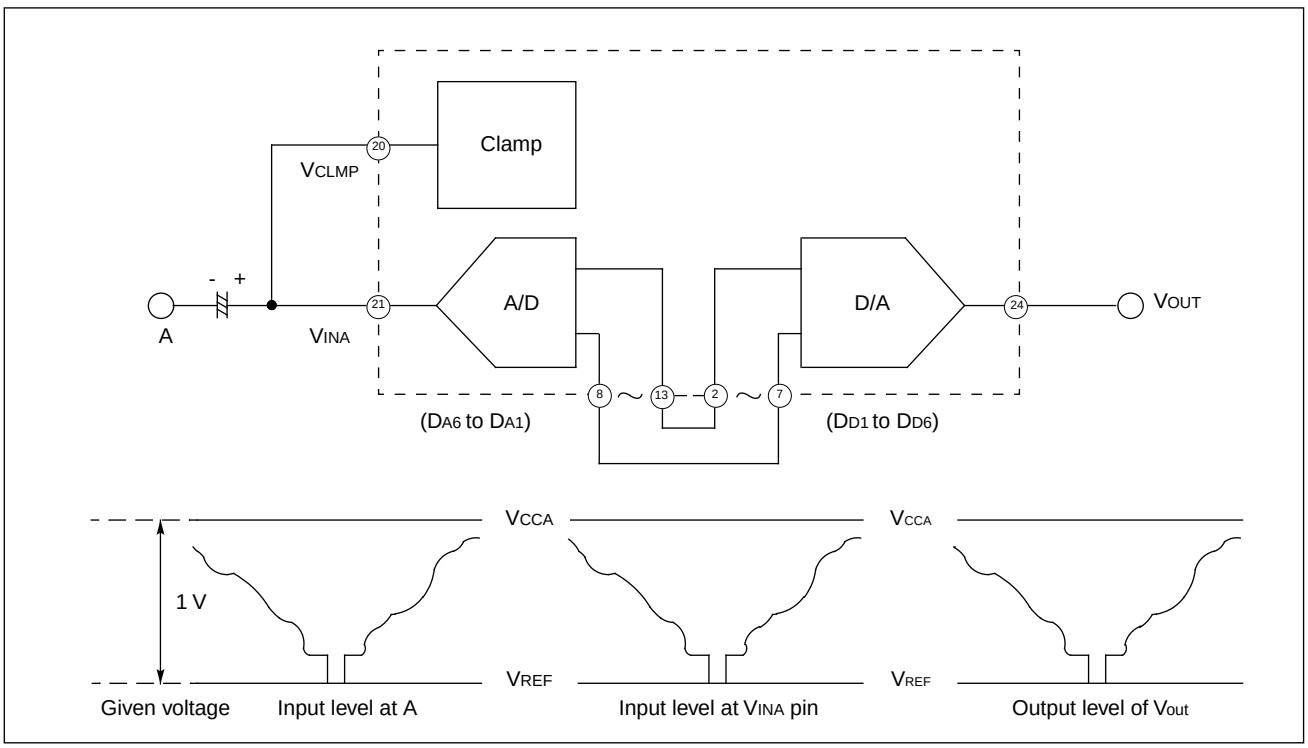


■ FUNCTIONAL DESCRIPTIONS CLAMP CIRCUIT

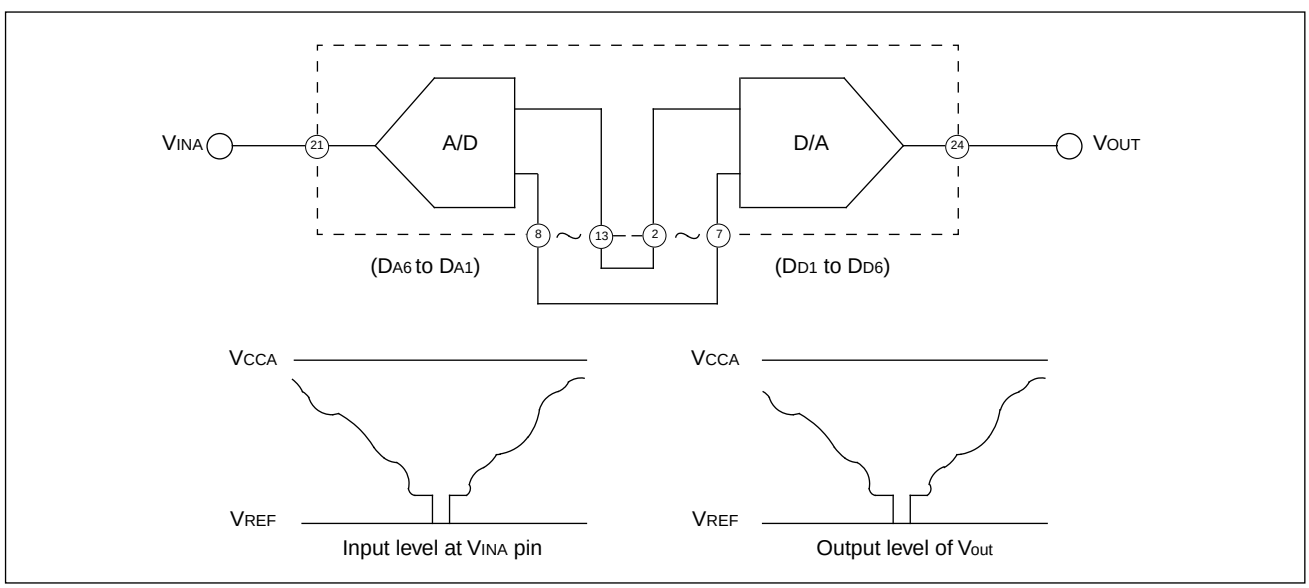
The clamp circuit contained in MB40166/MB40176 is a peak detector type, in which the top of the sync of the composite sync signal is clamped.
Clamp voltage is common to the reference voltage (0.8 x V_{CC}) of A/D and D/A circuits.

- **MB40166**

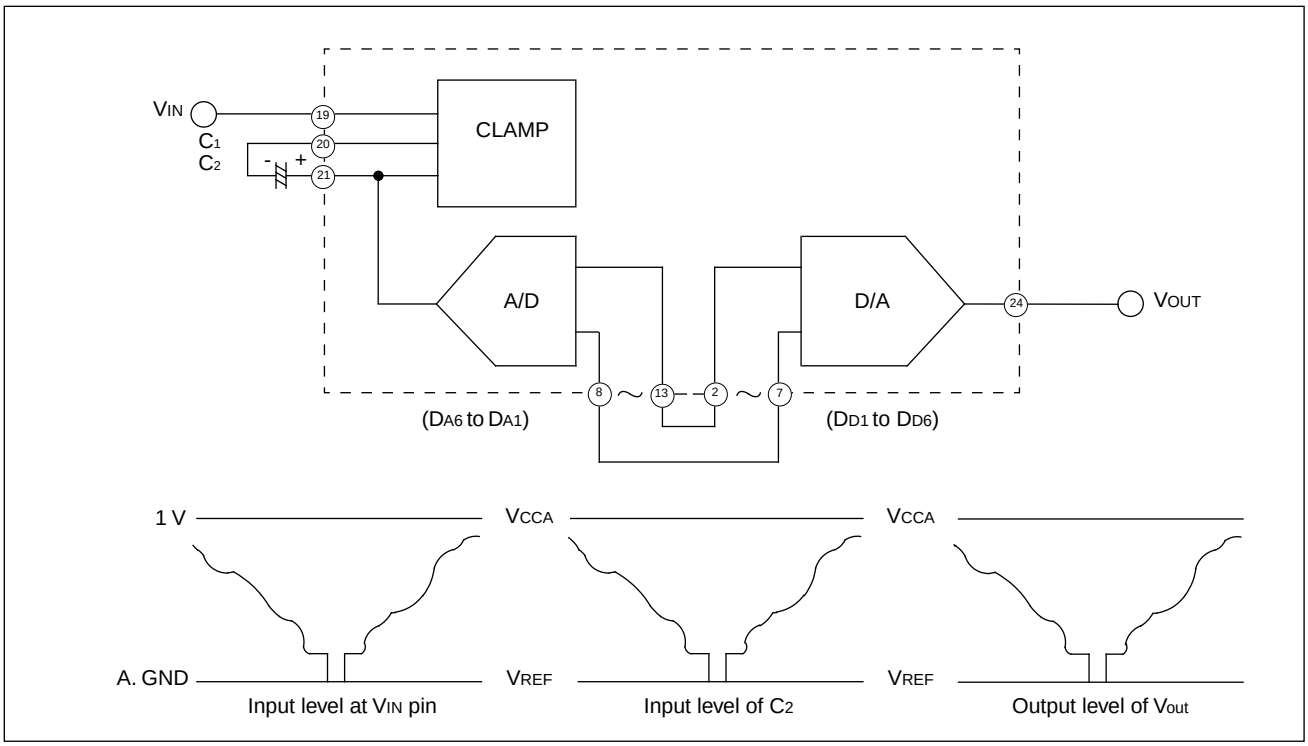
(1) Providing a clamp circuit



(2) Directly feeding the signal at the V_{INA} pin

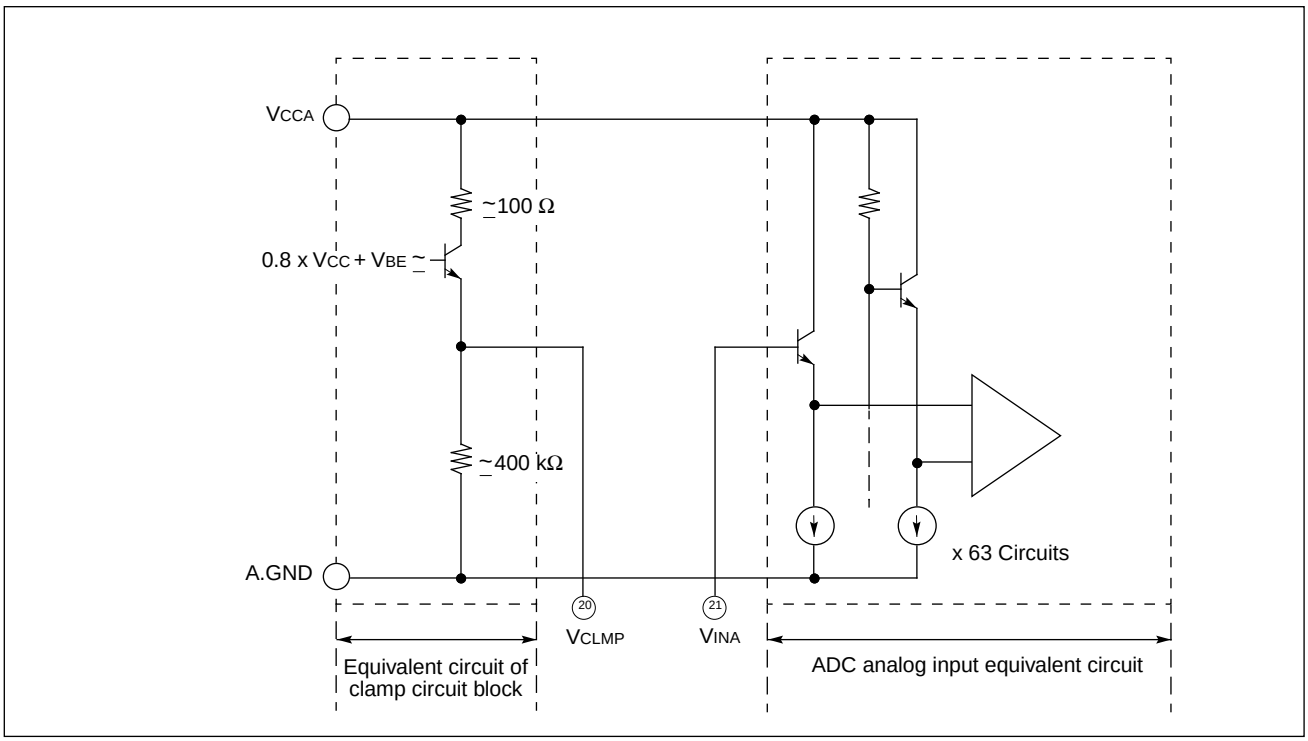


- **MB40176**

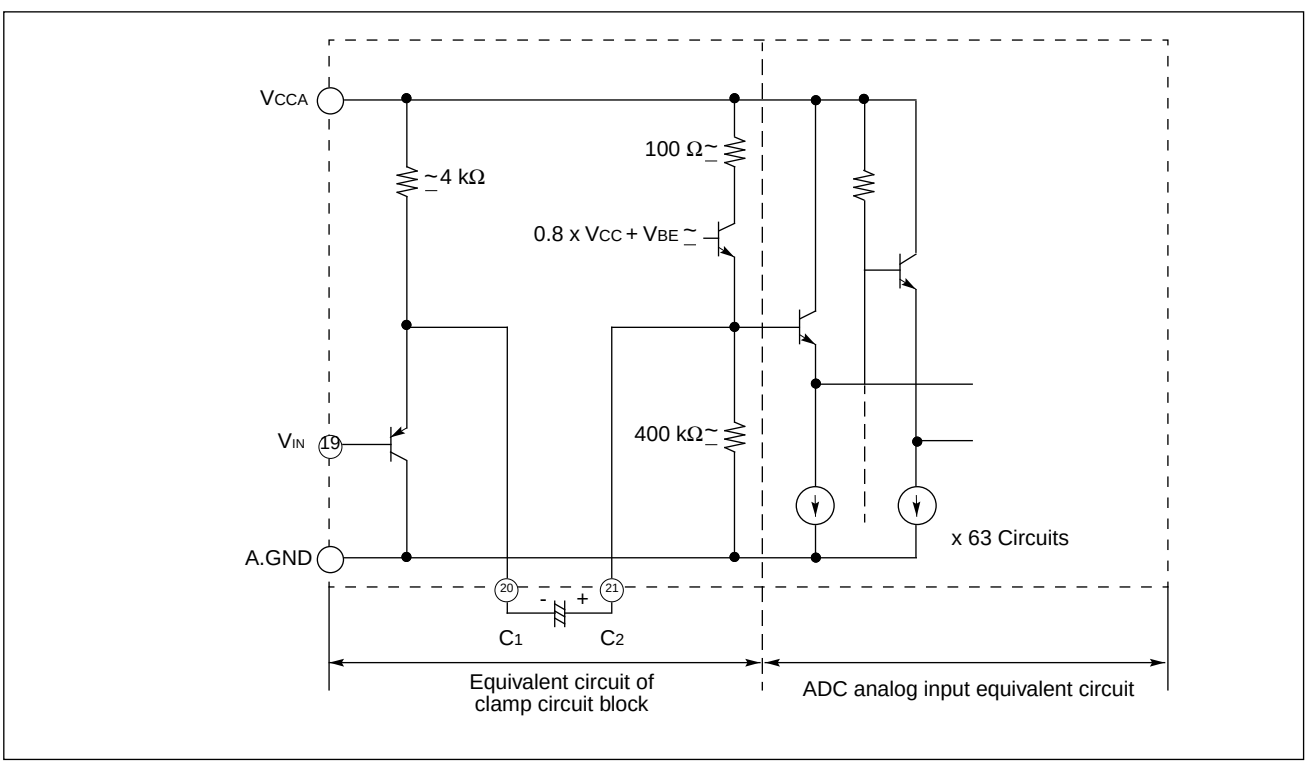

VIN
C1
C2
19
20
21
CLAMP
A/D
D/A
24
VOUT
8
13
2
7
(DA6 to DA1)
(DD1 to DD6)
1 V
A. GND
Input level at VIN pin
VCCA
VREF
Input level of C2
VCCA
VREF
Output level of Vout

■ ANALOG INPUT EQUIVALENT CIRCUIT

- **MB40166**



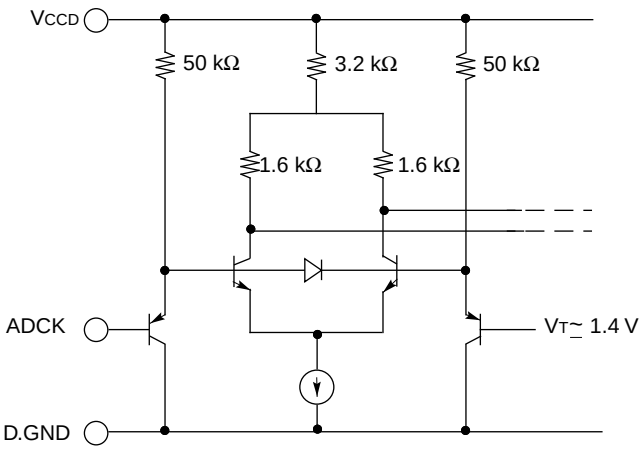
- **MB40176**



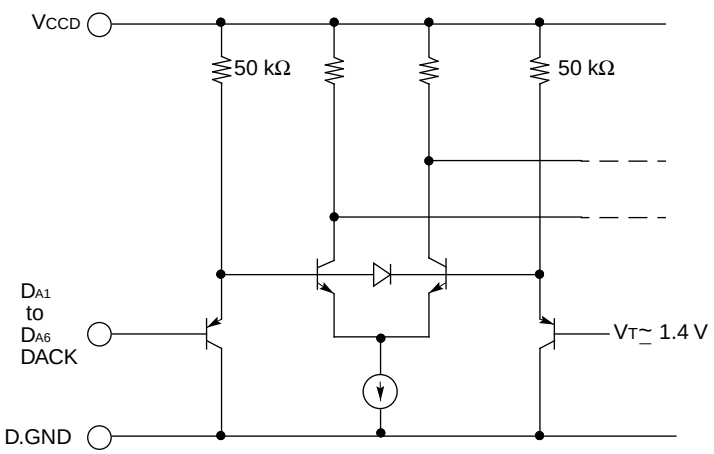
■ DIGITAL INPUT EQUIVALENT CIRCUITS

- **MB40166/MB40176**

Digital input equivalent circuit of A/D converter block



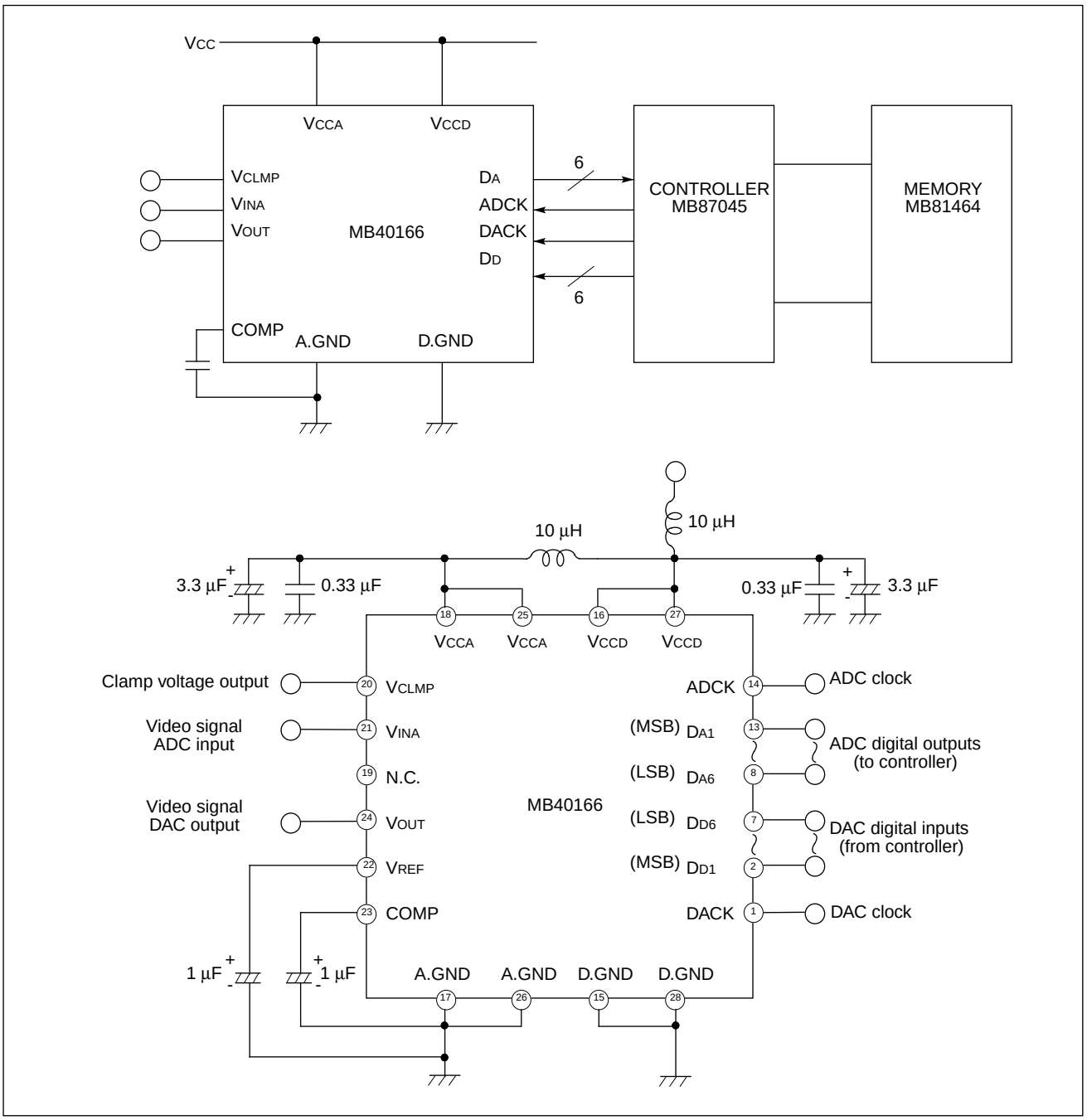
Digital input equivalent circuit of D/A converter block



MB40166/40176

■ TYPICAL CONNECTION EXAMPLE

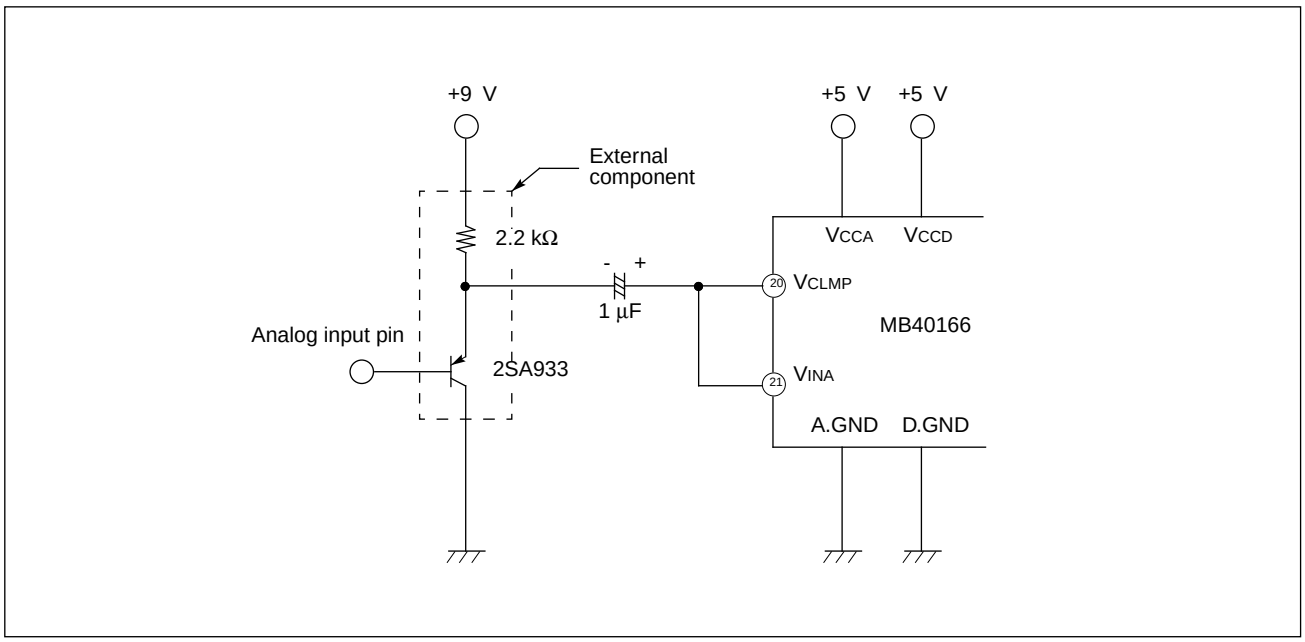
- **MB40166**



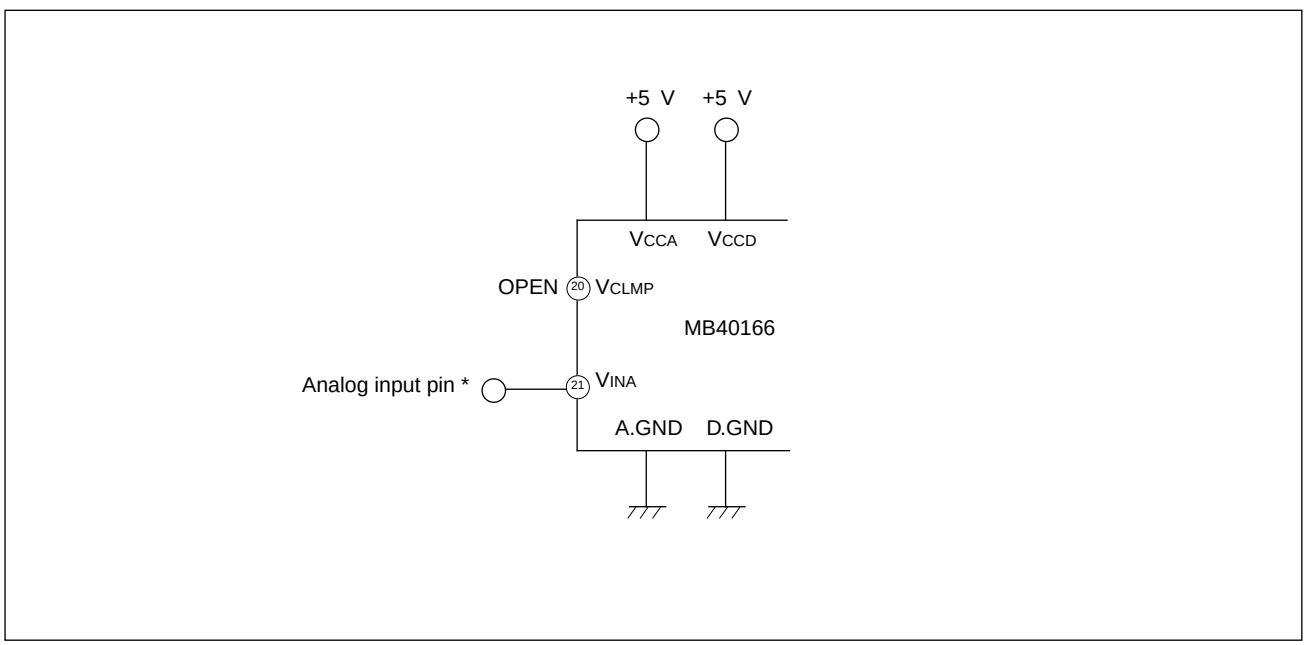
Note : If the clamp circuit is used, connect VINA with VCLMP.
If the clamp circuit is not used, do not connect VINA with VCLMP.

■ TYPICAL CONNECTION EXAMPLE (continued)

(1) Internal clamp circuit is used.



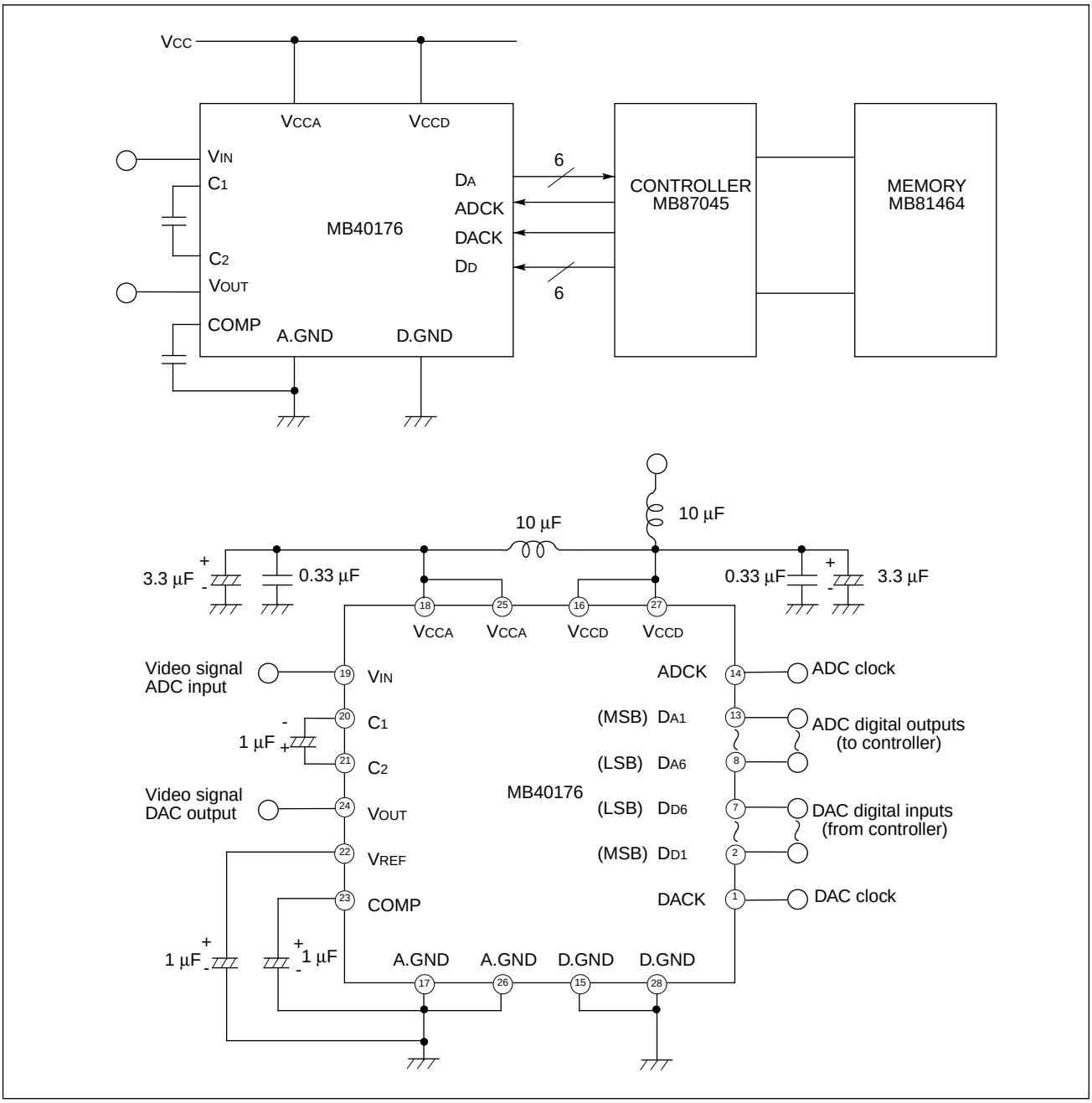
(2)Internal clamp circuit is not used.



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

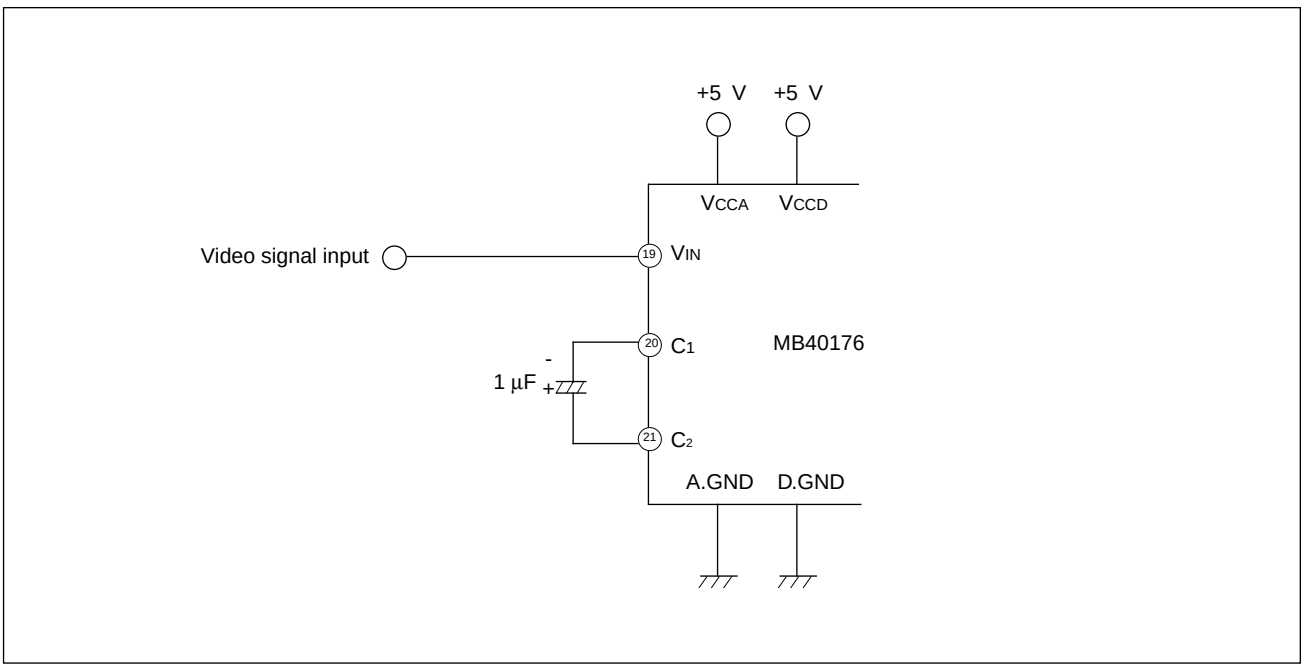
■ TYPICAL CONNECTION EXAMPLE (continued)

- **MB40176**



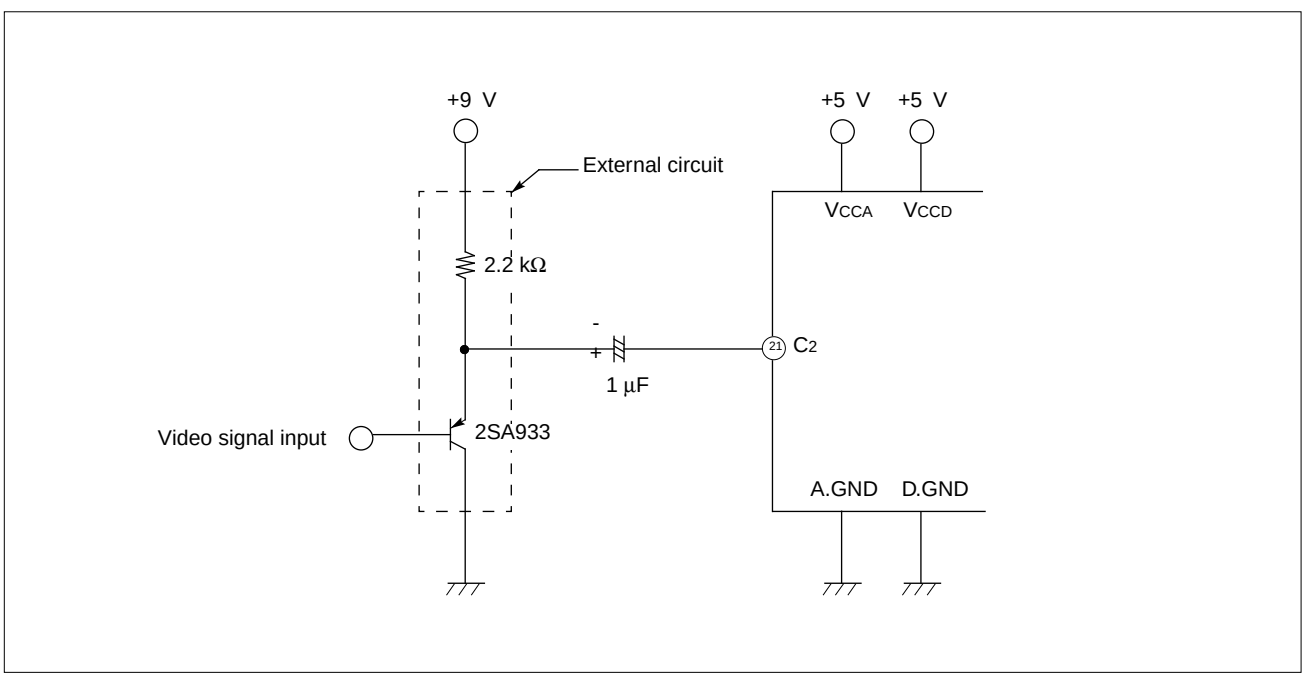
■ TYPICAL CONNECTION EXAMPLE (continued)

1.ON-CHIP Input PNP Transistor is utilized.



Note : Input impedance of V_{IN} input pin (19) is about 20 kΩ, please pay attention to output impedance of signal source.

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

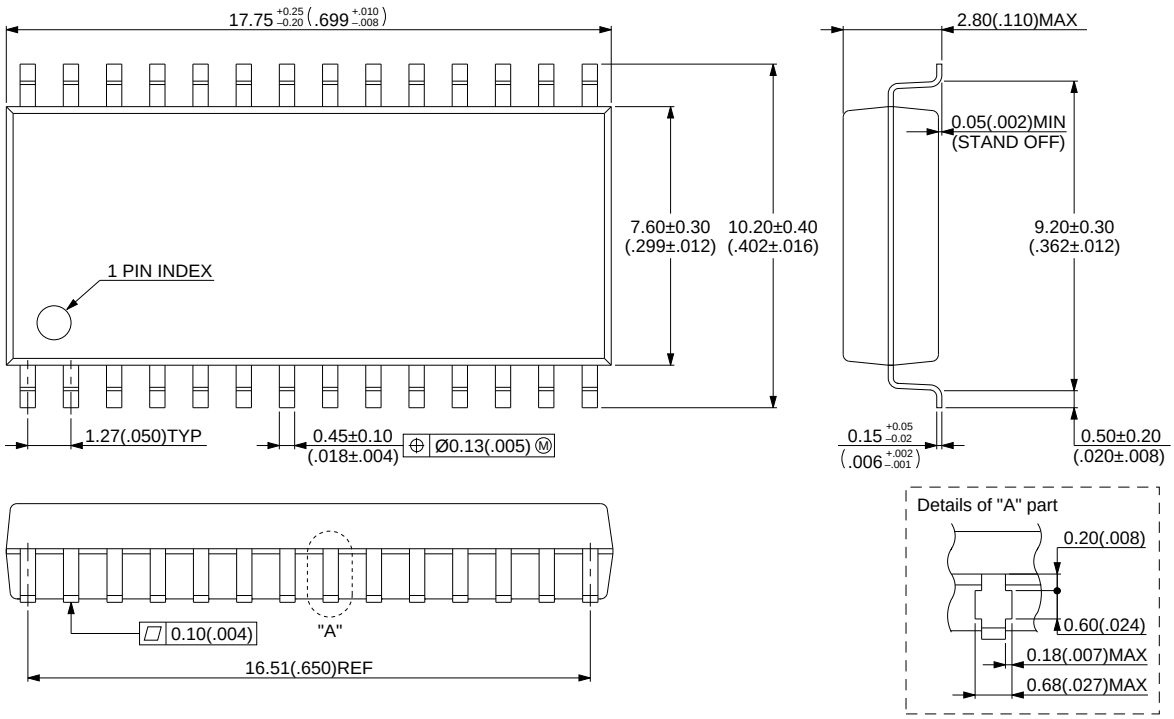


Note : Both V_{IN} (19) and C (20) are connected with V_{CCA}.

MB40166/40176

■ PACKAGE DIMENSIONS

28 pin, Plastic SOP
(FPT-28P-M01)



Dimensions in mm (inches).

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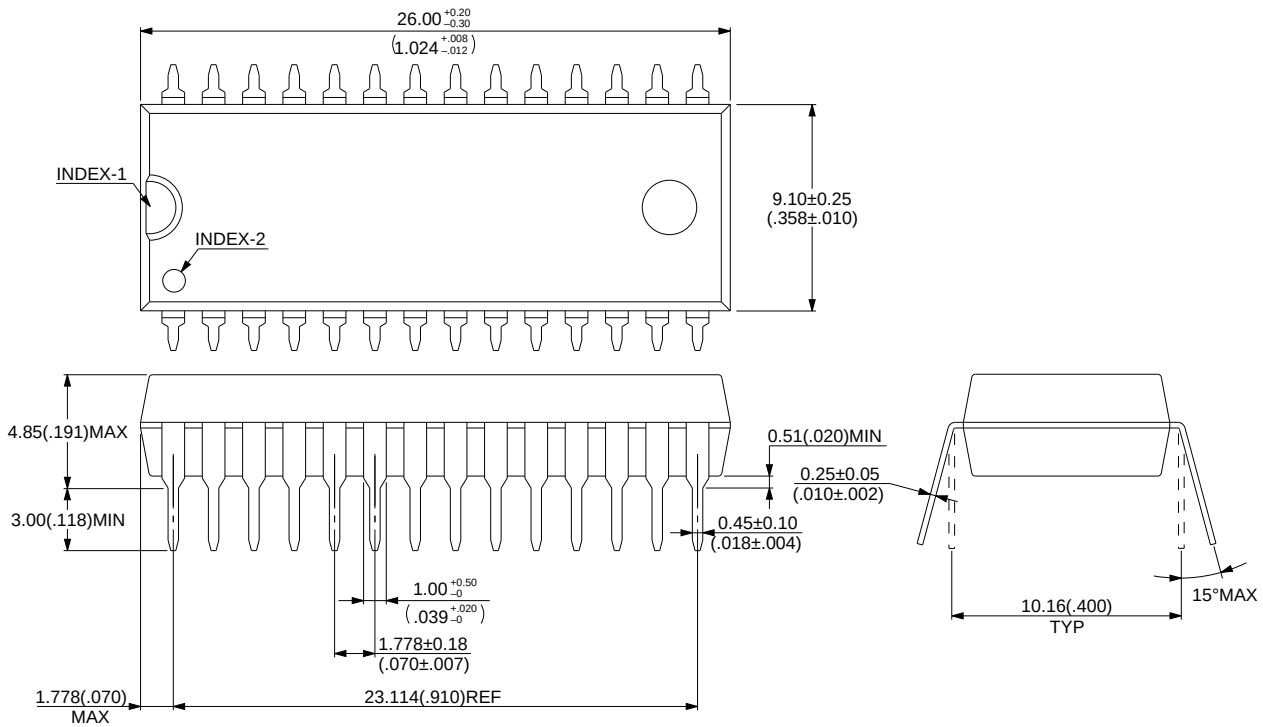
28 pin, Plastic SH-DIP
(DIP-28P-M03)



Dimensions in mm (inches).

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