

ASSP

# 1CHANNEL 10-BIT D/A CONVERTER

## MB40760

### ■ DESCRIPTION

MB40760 is a low-power consumption, high-speed 10-bit D/A converter.

The MB40760 is characterized by TTL compatible digital inputs, an analog output voltage from 3 to 5V, and a maximum conversion rate of 60 MHz. It provides a reference voltage from a potential divider and band-gap reference, and can also use an external reference voltage.

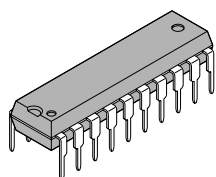
The MB40760 D/A converter is suitable for high-resolution TVs or VTRs.

### ■ FEATURES

- Resolution: 10 bits
- Conversion characteristics:
  - Maximum conversion rate: 60 MHz (Minimum)
  - Linearity error:  $\pm 0.1\%$  (Maximum)
  - Differential linearity error:  $\pm 0.1\%$  (Maximum)
- Input and output:
  - Digital input voltage: TTL levels
  - Analog output voltage: 2 V<sub>P-P</sub> (3V to 5V)
- Reference voltage
  - V<sub>ROUT1</sub>: Potential divider circuit (0.6 V<sub>CCA</sub>)
  - V<sub>ROUT2</sub>: Band-gap reference circuit (V<sub>CCA</sub>-2V)
- Others
  - Supply voltage: +5V single power supply
  - Power dissipation: 180 mW (Typical value at analog output voltage 2 VP-P)  
140 mW (Typical value at analog output voltage 1 VP-P)

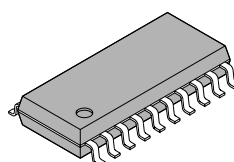
### ■ PACKAGES

Plastic DIP, 20 pin



(DIP-20P-M01)

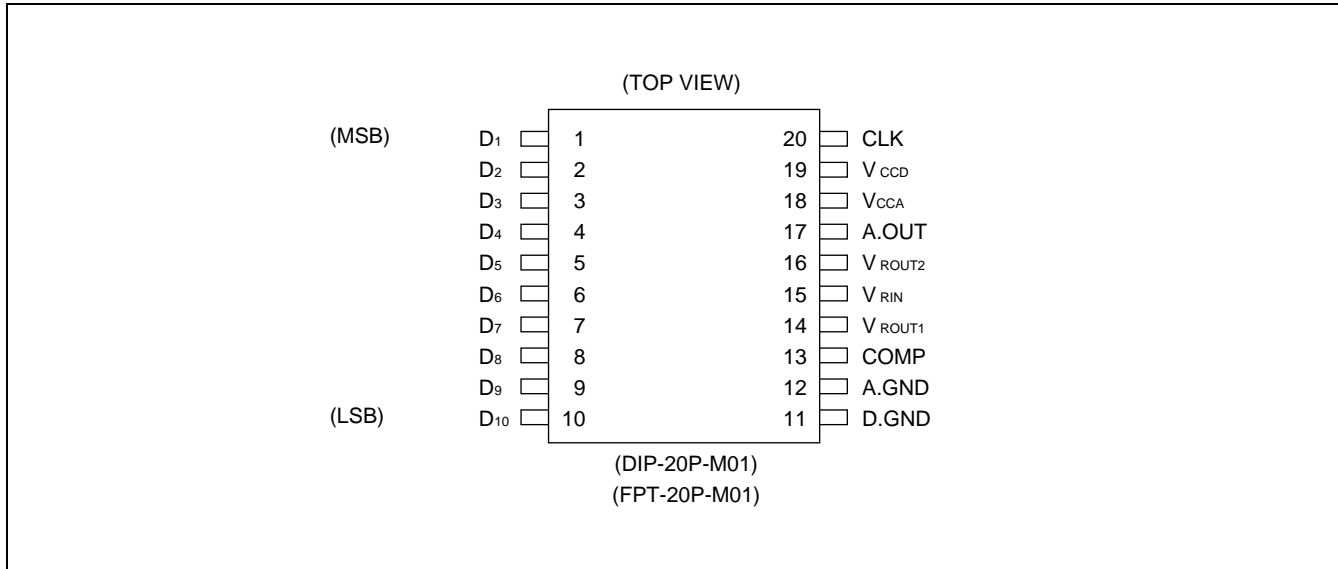
Plastic SOP, 20 pin



(FPT-20P-M01)

# MB40760

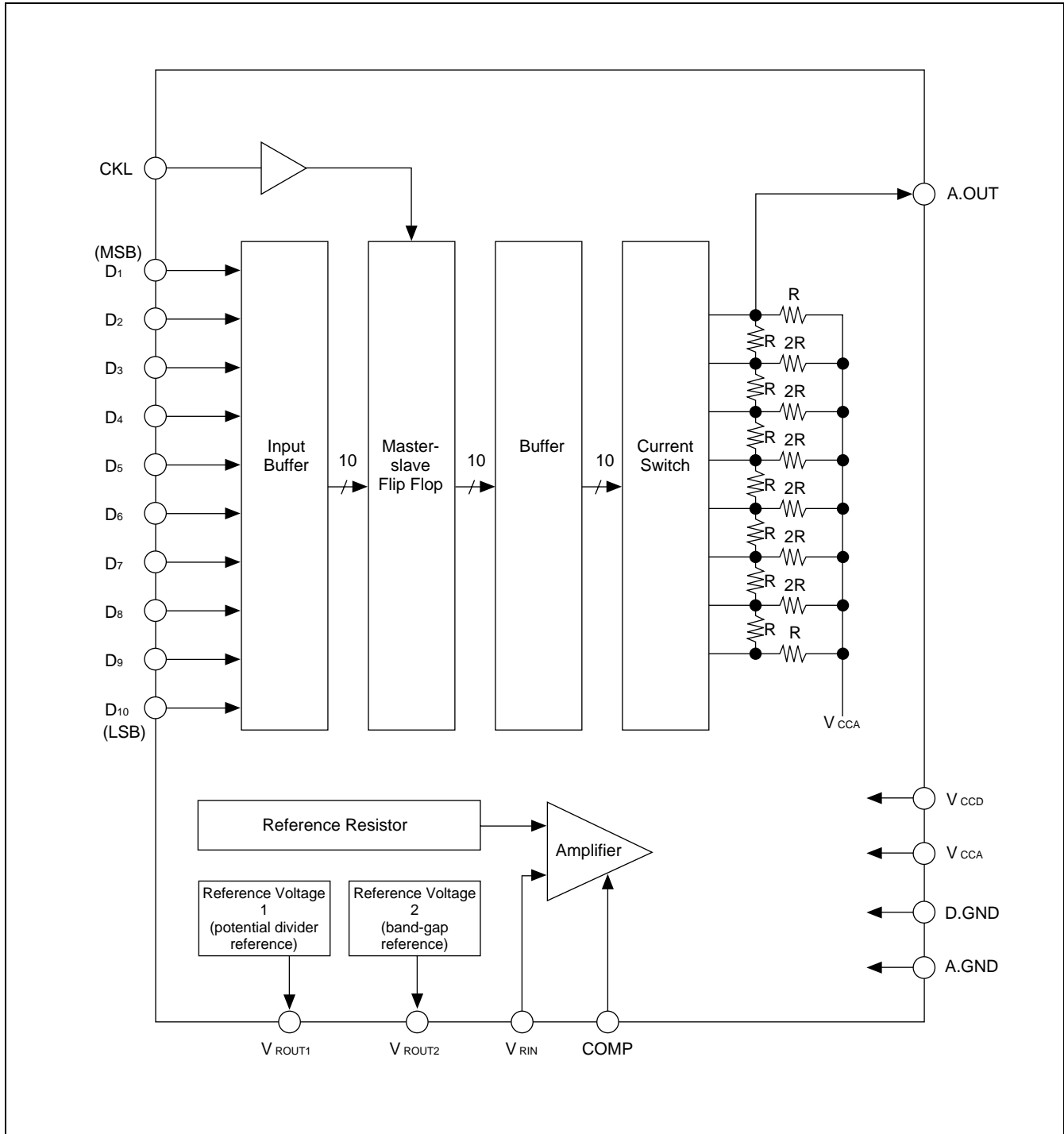
## ■ PIN ASSIGNMENT



## ■ PIN DESCRIPTIONS

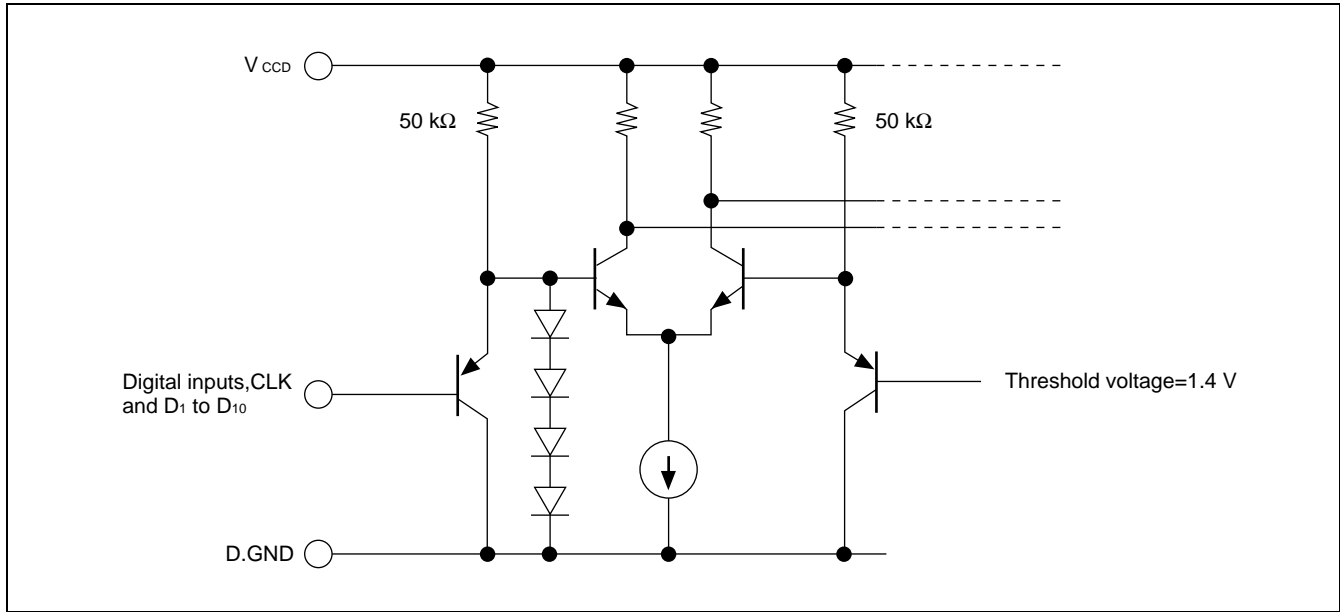
| Pin No. | Symbol                            | I/O | Description  |
|---------|-----------------------------------|-----|--|
| 1 to 10 | D <sub>1</sub> to D <sub>10</sub> | I   | Data signal input pin (D <sub>1</sub> : MSB, D <sub>10</sub> : LSB)  |
| 20      | CLK                               | I   | Clock signal input pin   |
| 19      | V <sub>CCD</sub>                  | —   | Digital power pin (+5V)  |
| 18      | V <sub>CCA</sub>                  | —   | Analog power pin (+5 V)  |
| 11      | D.GND                             | —   | Digital ground pin (0V)  |
| 12      | A.GND                             | —   | Analog ground pin (0V)   |
| 15      | V <sub>RIN</sub>                  | I   | Reference voltage input pin<br>Analog output dynamic range setup pin<br>Connect to pin 14 or 16 to use the built-in reference voltage<br>When using an external reference voltage, the voltage on this pin must be from 2.7V to 4.3V, and V <sub>CCA</sub> -V <sub>RIN</sub> must be from 0.7V to 2.2V |
| 14      | V <sub>ROUT1</sub>                | O   | Reference voltage output pin 1<br>The output voltage of the potential divider reference is fixed at 0.6 V <sub>CCA</sub> . When this pin is connected to pin 15, the analog output voltage ranges from 0.6 V <sub>CCA</sub> to V <sub>CCA</sub>  |
| 16      | V <sub>ROUT2</sub>                | O   | Reference voltage output pin 2<br>The output voltage of the band-gap reference is fixed at V <sub>CCA</sub> -2.0(V). When the pin is connected to pin 15, the analog output voltage ranges from V <sub>CCA</sub> -2.0(V) to V <sub>CCA</sub>   |
| 13      | COMP                              | —   | Phase compensation capacitor pin<br>Insert a capacitor of 0.1 μF or greater between A.GND and COMP for phase compensation  |
| 17      | A.OUT                             | O   | Analog signal output pin   |

## ■ BLOCK DIAGRAM

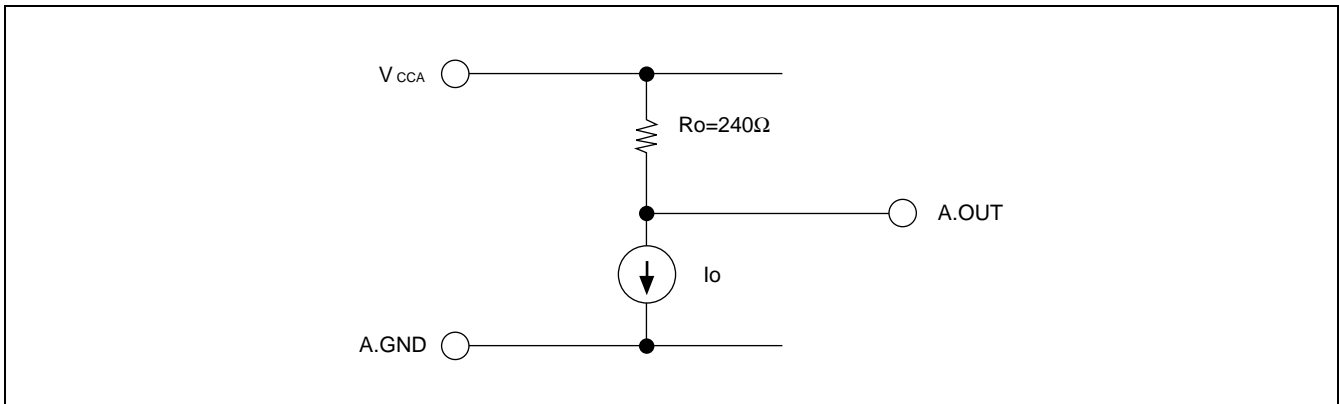


# MB40760

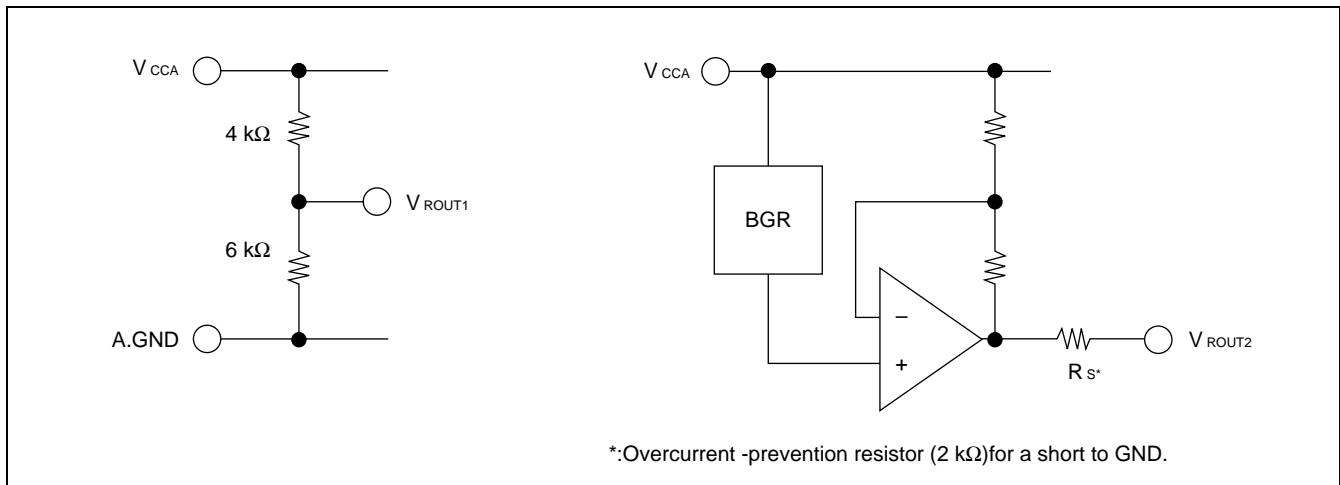
## ■ DIGITAL INPUT EQUIVALENT CIRCUIT



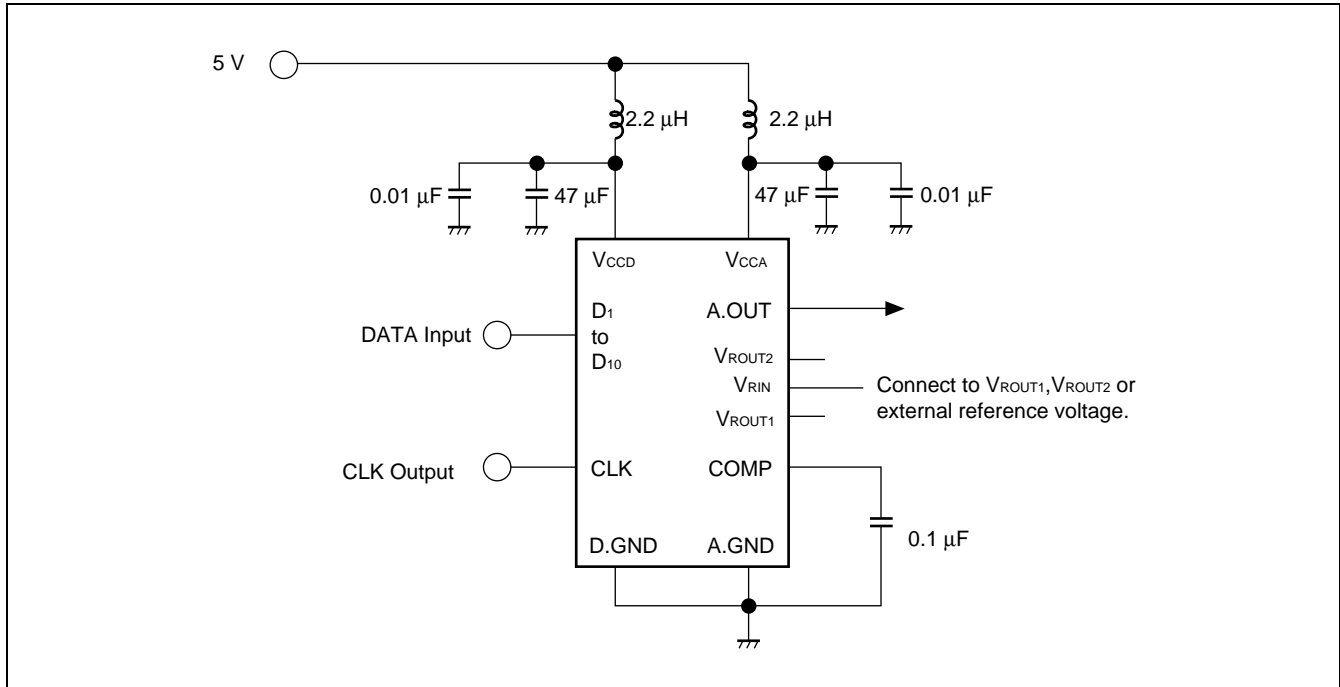
## ■ ANALOG OUTPUT EQUIVALENT CIRCUIT



## ■ REFERENCE VOLTAGE OUTPUT EQUIVALENT CIRCUIT



## ■ TYPICAL CONNECTION EXAMPLE



# MB40760

## ■ ABSOLUTE MAXIMUM RATINGS

(A.GND = D.GND = 0V, Ta = +25°C)

| Parameter                       | Symbol                             | Value        | Unit |
|---------------------------------|------------------------------------|--------------|------|
| Analog power supply voltage     | V <sub>CCA</sub>                   | -0.5 to +7.0 | V    |
| Digital power supply voltage    | V <sub>CCD</sub>                   | -0.5 to +7.0 | V    |
| Power supply voltage difference | V <sub>CCD</sub> -V <sub>CCA</sub> | 1.5          | V    |
| Digital signal input voltage    | V <sub>ID</sub>                    | -0.5 to +7.0 | V    |
| Storage Temperature             | T <sub>stg</sub>                   | -55 to +125  | °C   |

Note: Permanent device damage may occur if the above Absolute Maximum Rating 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.

## ■ RECOMMENDED OPERATING CONDITIONS

(A.GND = D.GND = 0V, Ta = -20°C to +75°C)

| Parameter                      |                                 | Symbol                             | Standard values |      |      | Unit |
|--------------------------------|---------------------------------|------------------------------------|-----------------|------|------|------|
|                                |                                 |                                    | Min.            | Typ. | Max. |      |
| Power supply voltage           | Analog power supply voltage     | V <sub>CCA</sub>                   | 4.75            | 5.00 | 5.25 | V    |
|                                | Digital power supply voltage    | V <sub>CCD</sub>                   | 4.75            | 5.00 | 5.25 | V    |
|                                | Power supply voltage difference | V <sub>CCA</sub> -V <sub>CCD</sub> | -0.2            | —    | 0.2  | V    |
| Analog reference voltage       |                                 | V <sub>CCA</sub> -V <sub>RIN</sub> | 0.70            | 2.00 | 2.20 | V    |
|                                |                                 | V <sub>RIN</sub>                   | 2.65            | 3.00 | 4.30 | V    |
| Digital input high voltage     |                                 | V <sub>IHD</sub>                   | 2.0             | —    | —    | V    |
| Digital input low voltage      |                                 | V <sub>ILD</sub>                   | —               | —    | 0.8  | V    |
| Clock frequency                |                                 | f <sub>CLK</sub>                   | —               | —    | 60   | MHz  |
| Setup time                     |                                 | T <sub>su</sub>                    | 8               | —    | —    | ns   |
| Hold time                      |                                 | t <sub>h</sub>                     | 2               | —    | —    | ns   |
| Clock minimum pulse width high |                                 | t <sub>WH</sub>                    | 6.5             | —    | —    | ns   |
| Clock minimum pulse width low  |                                 | t <sub>WL</sub>                    | 6.5             | —    | —    | ns   |
| Phase compensation capacitor   |                                 | C <sub>COMP</sub>                  | 0.1             | —    | —    | μF   |
| Operating temperature          |                                 | T <sub>OP</sub>                    | -20             | —    | 75   | °C   |

## ■ DC CHARACTERISTICS

( $V_{CCA} = V_{CCD} = 4.75$  to  $5.25V$ ,  $A.GND = D.GND = 0V$ ,  $T_a = -20^{\circ}C$  to  $+75^{\circ}C$ )

| Parameter                    | Symbol                  | Conditions  | Standard values         |                         |                         | Unit             |
|------------------------------|-------------------------|---|-------------------------|-------------------------|-------------------------|------------------|
|                              |                         |   | Min.                    | Typ.                    | Max.                    |                  |
| Resolution                   | —                       | —   | —                       | —                       | 10                      | bit              |
| Linearity error              | LE                      | DC accuracy   | —                       | —                       | $\pm 0.1$               | %                |
| Differential linearity error | DLE                     |   | —                       | —                       | $\pm 0.1$               | %                |
| Digital input current high   | I <sub>IHD</sub>        | V <sub>IHD</sub> = 2.7V   | —                       | —                       | 20                      | $\mu A$          |
| Digital input current low    | I <sub>ILD</sub>        | V <sub>ILD</sub> = 0.4V   | -100                    | —                       | —                       | $\mu A$          |
| Reference input current      | I <sub>RIN</sub>        | V <sub>RIN</sub> = 3.000V   | —                       | —                       | 10                      | $\mu A$          |
| Potential divider reference  | Reference voltage       | V <sub>ROUT1</sub><br>V <sub>CCA</sub> = 5.00V<br>V <sub>CCD</sub> = 5.00V                    | 2.900                   | 3.000                   | 3.100                   | V                |
| Band-gap reference           | Reference voltage       | V <sub>ROUT2</sub>  | V <sub>CCA</sub> -2.100 | V <sub>CCA</sub> -2.000 | V <sub>CCA</sub> -1.900 | V                |
|                              | Temperature coefficient | —   | —                       | 100                     | —                       | ppm/ $^{\circ}C$ |
| Full-scale output voltage    | V <sub>OFS</sub>        | —   | V <sub>CCA</sub> -20    | V <sub>CCA</sub>        | —                       | mV               |
| Zero-scale output voltage    | V <sub>OZS</sub>        | V <sub>CCA</sub> = 5.00V<br>V <sub>CCD</sub> = 5.0V<br>V <sub>RIN</sub> = 3.000V              | 2.932                   | 3.002                   | 3.072                   | V                |
| Output resistance            | R <sub>o</sub>          | T <sub>a</sub> = +25 $^{\circ}C$  | 192                     | 240                     | 288                     | $\Omega$         |
| Power dissipation            | I <sub>CC</sub>         | V <sub>CCA</sub> = 5.25V<br>V <sub>CCD</sub> = 5.25V<br>V <sub>RIN</sub> = V <sub>ROUT1</sub> | —                       | 36*                     | 62                      | mA               |

\* :  $V_{CCA} = V_{CCD} = 5V$

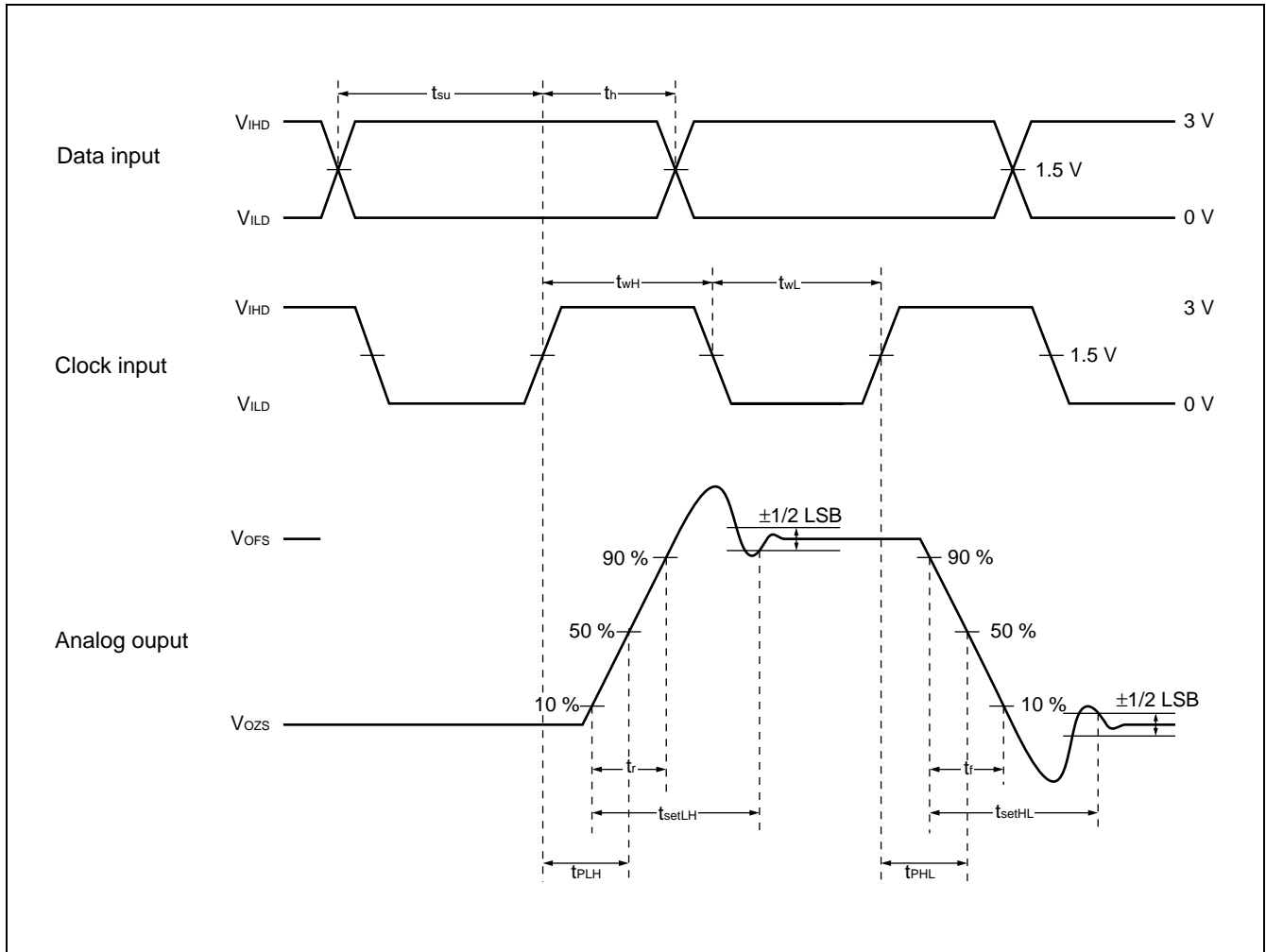
## ■ AC CHARACTERISTICS

( $V_{CCA} = V_{CCD} = 4.75$  to  $5.25V$ ,  $A.GND = D.GND = 0V$ ,  $T_a = -20^{\circ}C$  to  $+75^{\circ}C$ )

| Parameter                     | Symbol           | Conditions  | Standard values |      |      | Unit |
|-------------------------------|------------------|---|-----------------|------|------|------|
|                               |                  |   | Min.            | Typ. | Max. |      |
| Maximum conversion rate       | F <sub>s</sub>   | C <sub>L</sub> = 15pF<br>A.OUT pin terminating<br>resistance = 240 $\Omega$ | 60              | —    | —    | MSPS |
| Output propagation delay time | t <sub>pd</sub>  |   | —               | 7    | —    | ns   |
| Output rise time              | t <sub>r</sub>   |   | —               | 5    | —    | ns   |
| Output fall time              | t <sub>f</sub>   |   | —               | 5    | —    | ns   |
| Settling time                 | t <sub>set</sub> |   | —               | 17.5 | —    | ns   |

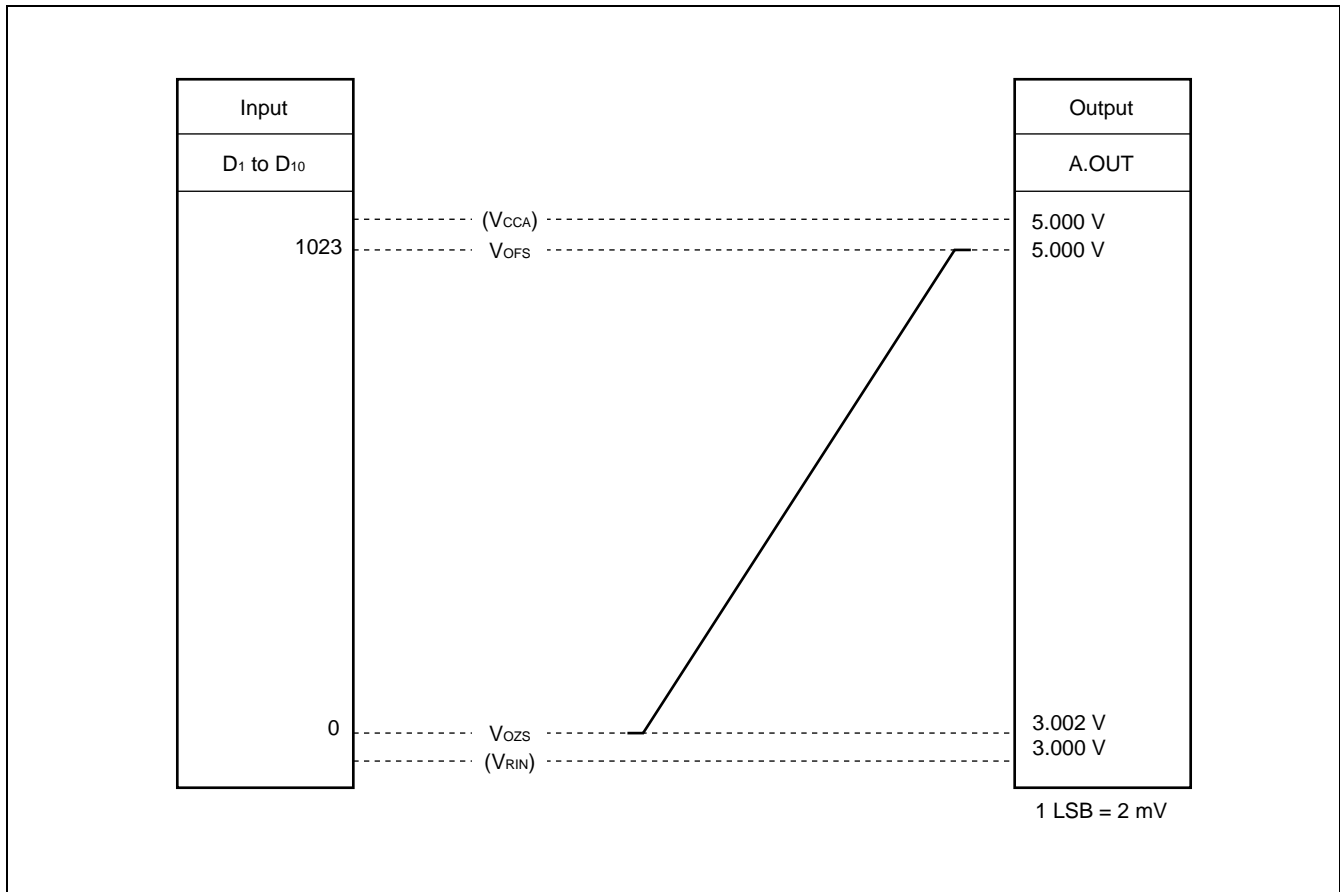
# MB40760

## ■ TIMING CHART





## ■ DAC OUTPUT VOLTAGE CHARACTERISTICS



## ■ DAC OUTPUT VOLTAGE FORMULA IN IDEAL CONDITIONS

$$A.OUT = V_{CCA} - \frac{1023 - N}{1024} (V_{CCA} - V_{RIN})$$

(N: Digital input from 0 to 1023)

$$V_{OFS} = V_{CCA}$$

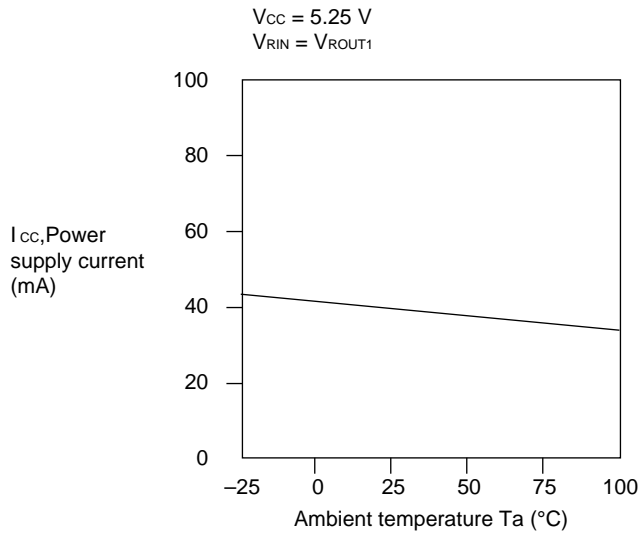
$$V_{OZS} = V_{CCA} - \frac{1023}{1024} (V_{CCA} - V_{RIN})$$

Notes:

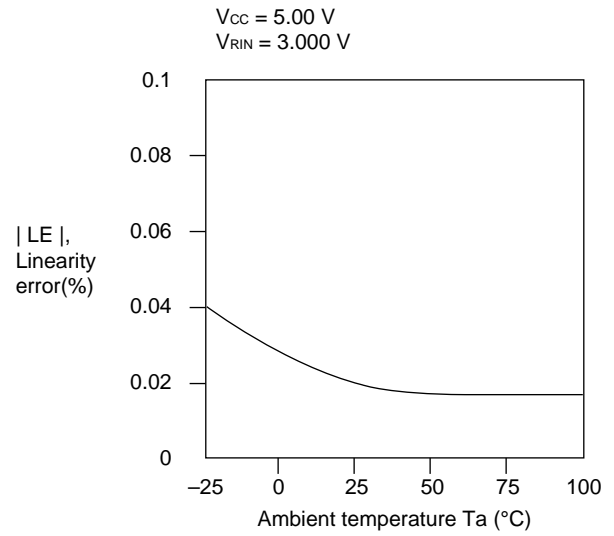
1. Preventing Switching Noise  
To prevent switching noise in the analog output signal, connect noise limiting capacitors to the VCCA and VCCD pins as close to the A.GND and D.GND pins as possible.
2. Power Pattern  
To reduce parasitic impedance, the PC board pattern to the VCCA, VCCD, A.GND and D.GND pins should be as wide as possible.

## TYPICAL CHARACTERISTICS CURVES

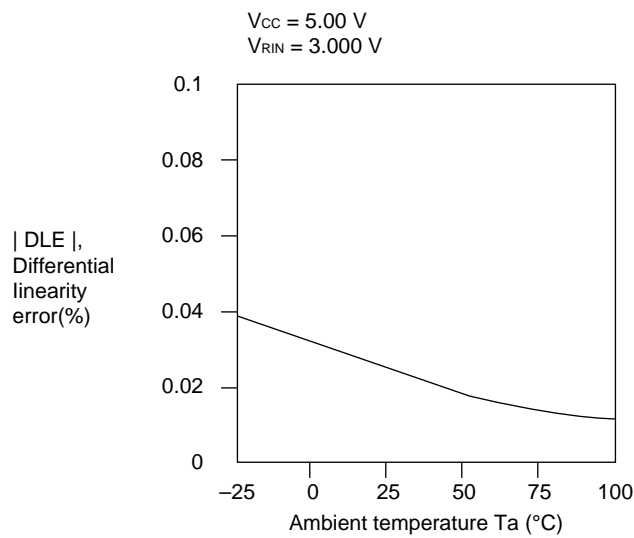
### 1. Power Supply Current v.s. Ambient Temperature



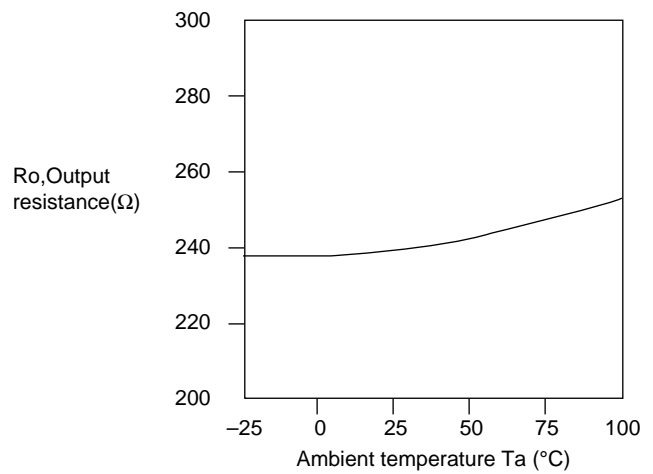
### 2. Linearity Error v.s. Ambient Temperature



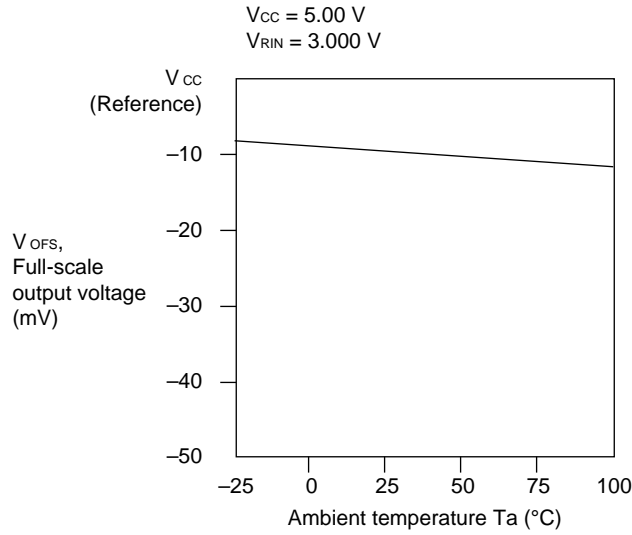
### 3. Differential Linearity Error v.s. Ambient Temperature



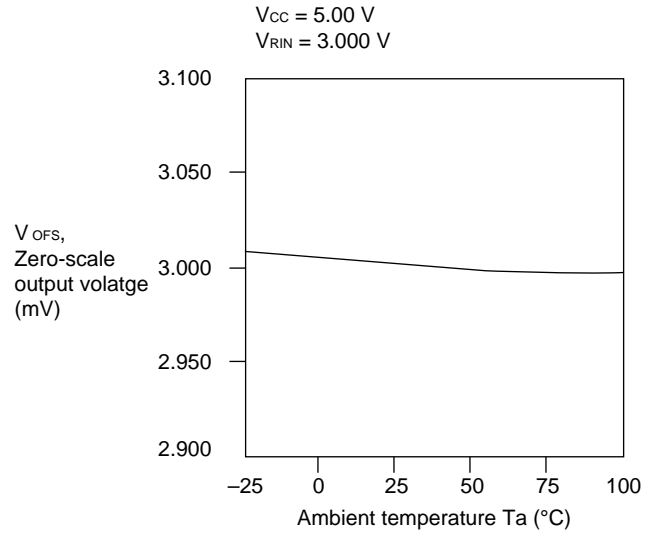
### 4. Output Resistance v.s. Ambient Temperature



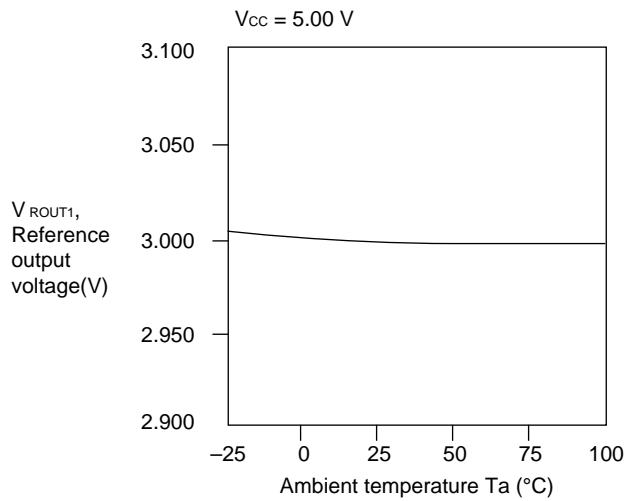
**5. Full-Scale Output Voltage v.s. Ambient Temperature**



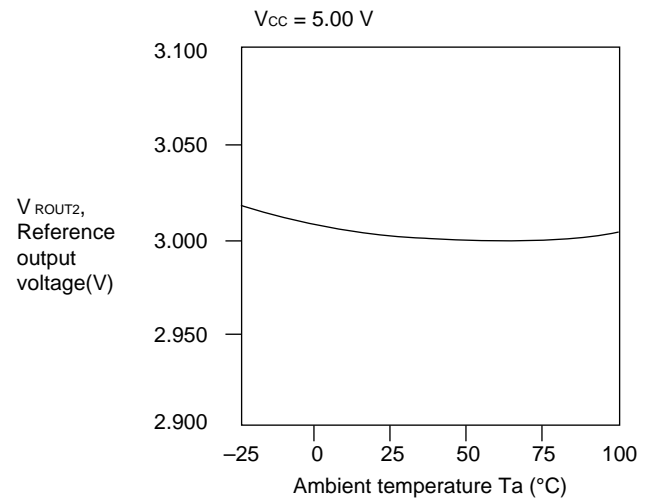
**6. Zero-Scale Output Voltage v.s. Ambient Temperature**



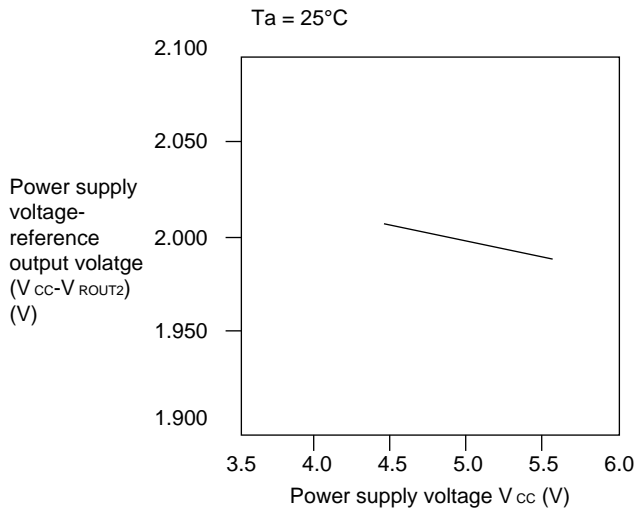
**7.  $V_{ROUT1}$  Reference Output Voltage v.s. Ambient Temperature**



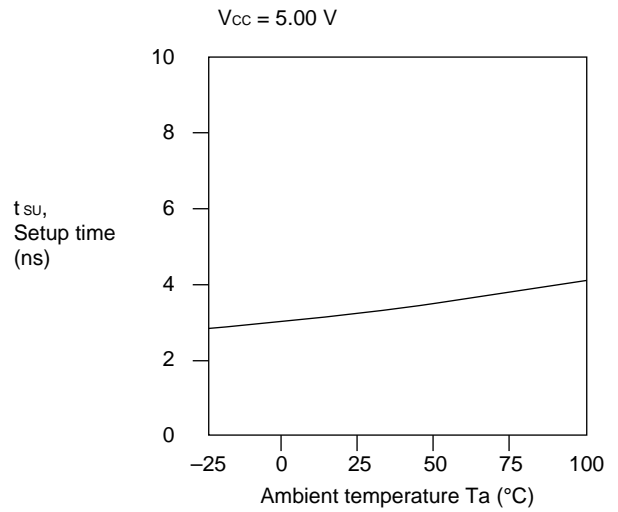
**8.  $V_{ROUT2}$  Reference Output Voltage v.s. Ambient Temperature**



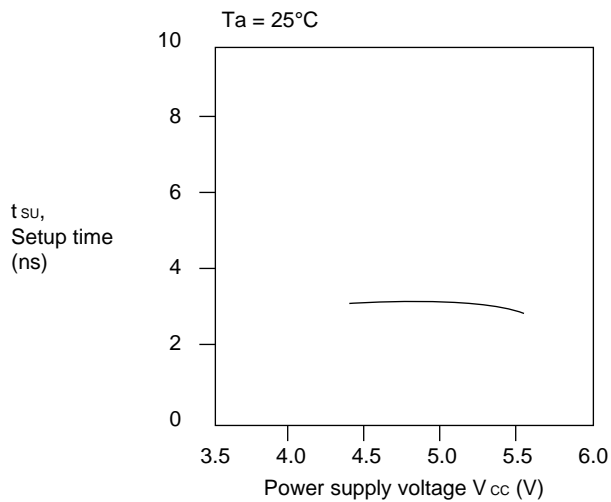
**9.  $V_{ROUT2}$  Reference Output Voltage v.s. Power Supply Voltage**



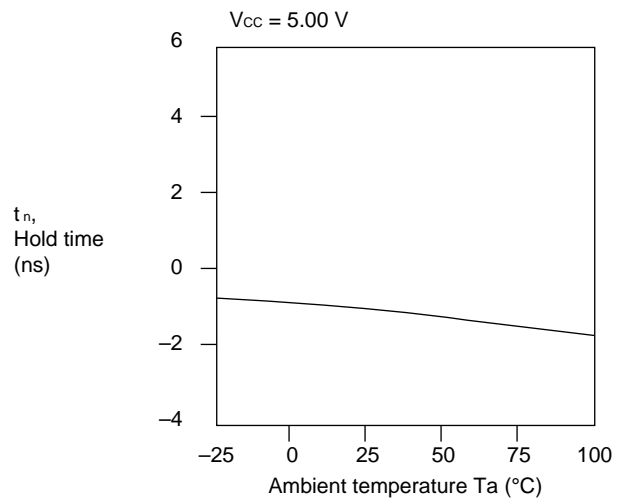
**10. Setup Time v.s. Ambient Temperature**



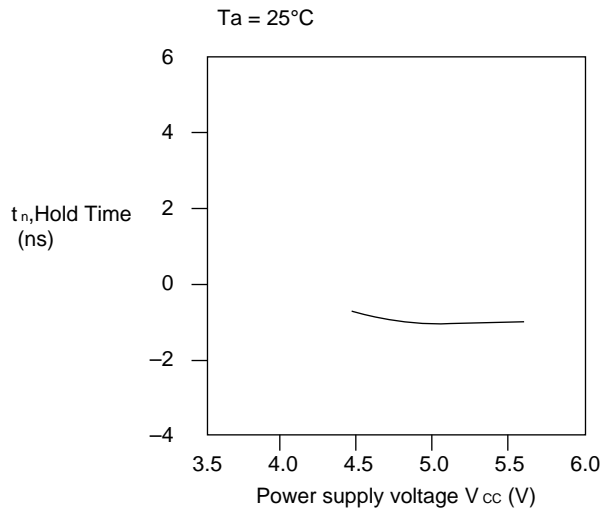
**11. Setup Time v.s. Power Supply Voltage**



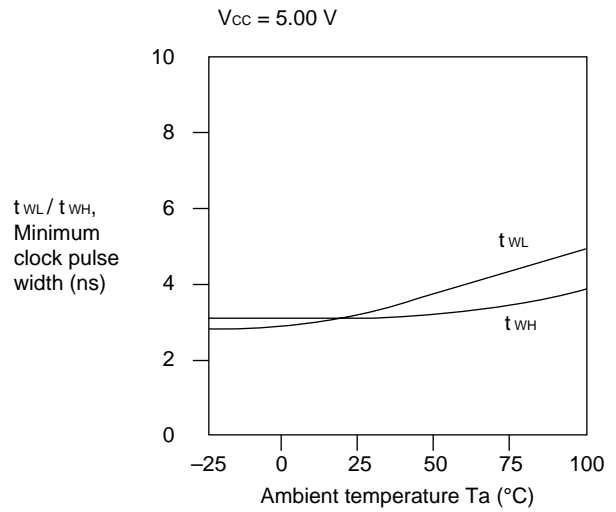
**12. Hold Time v.s. Ambient Temperature**



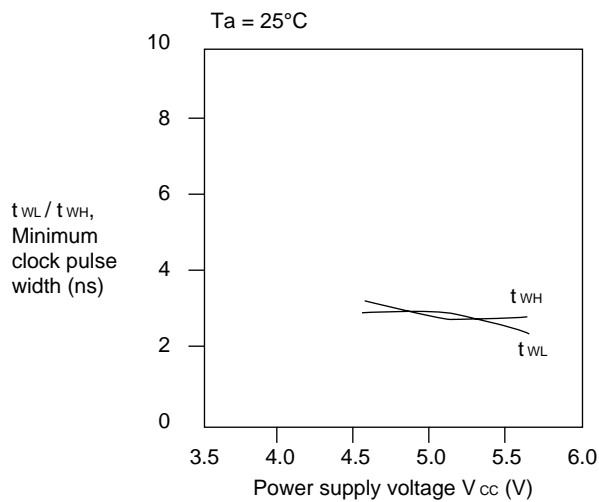
**13. Hold Time v.s. Power Supply Voltage**



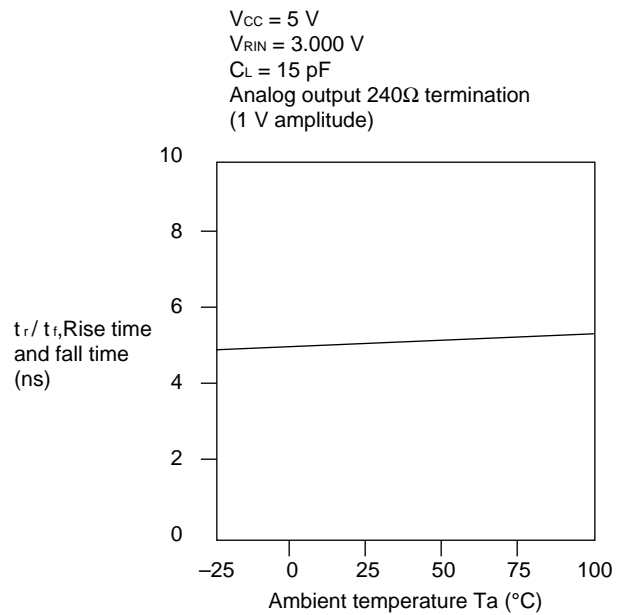
**14. Minimum Clock Pulse Width v.s. Ambient Temperature**



**15. Minimum Clock Pulse Width v.s. Power Supply Voltage**

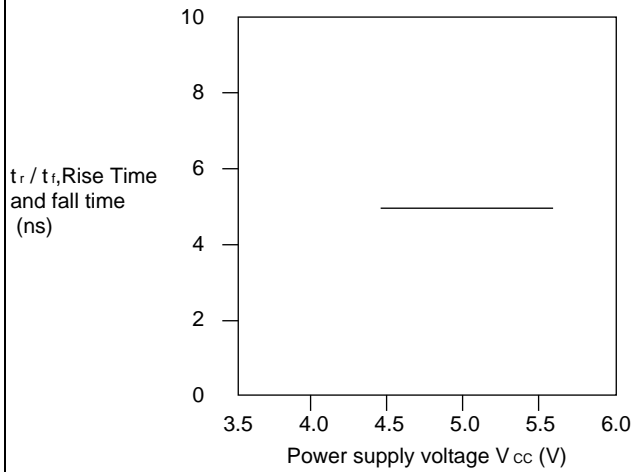


**16. Rise Time / Fall Time v.s. Ambient Temperature**



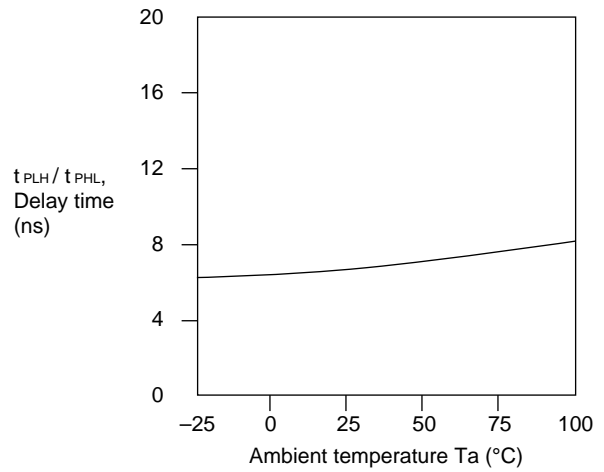
## 17. Rise Time / Fall Time v.s. Power Supply Voltage

$T_a = 25^\circ\text{C}$   
 $V_{RIN} = 3.000\text{ V}$   
 $C_L = 15\text{ pF}$   
 Analog output  $240\Omega$  termination  
 (1 V amplitude)



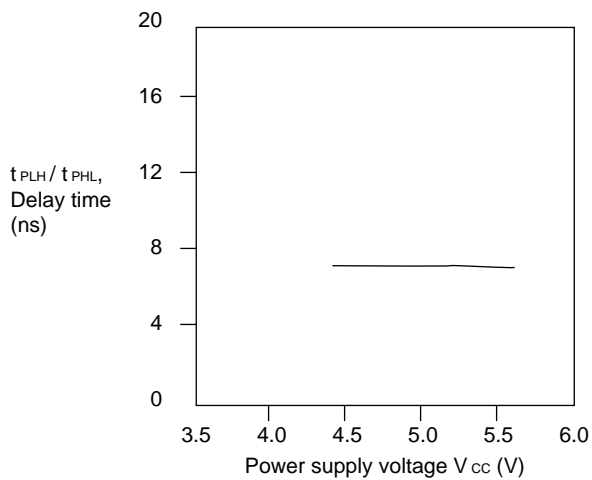
## 18. Delay Time v.s. Ambient Temperature

$V_{CC} = 5.00\text{ V}$   
 $V_{RIN} = 3.000\text{ V}$   
 $C_L = 15\text{ pF}$   
 Analog output  $240\Omega$  termination  
 (1 V amplitude)

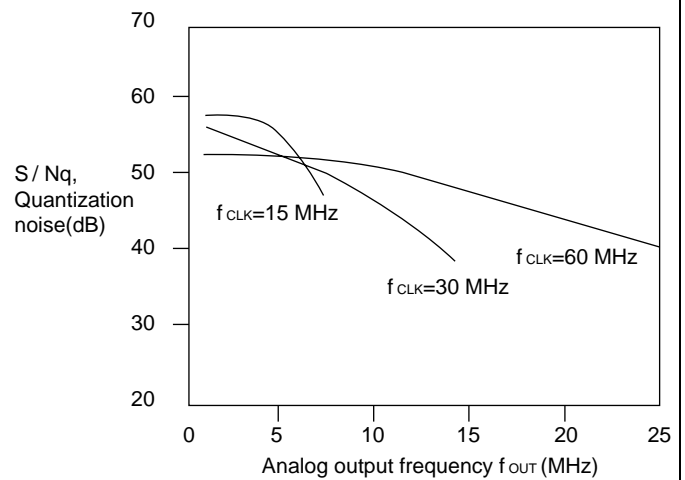


## 19. Delay Time v.s. Power Supply Voltage

$T_a = 25^\circ\text{C}$   
 $V_{RIN} = 3.000\text{ V}$   
 $C_L = 15\text{ pF}$   
 Analog output  $240\Omega$  termination  
 (1 V amplitude)

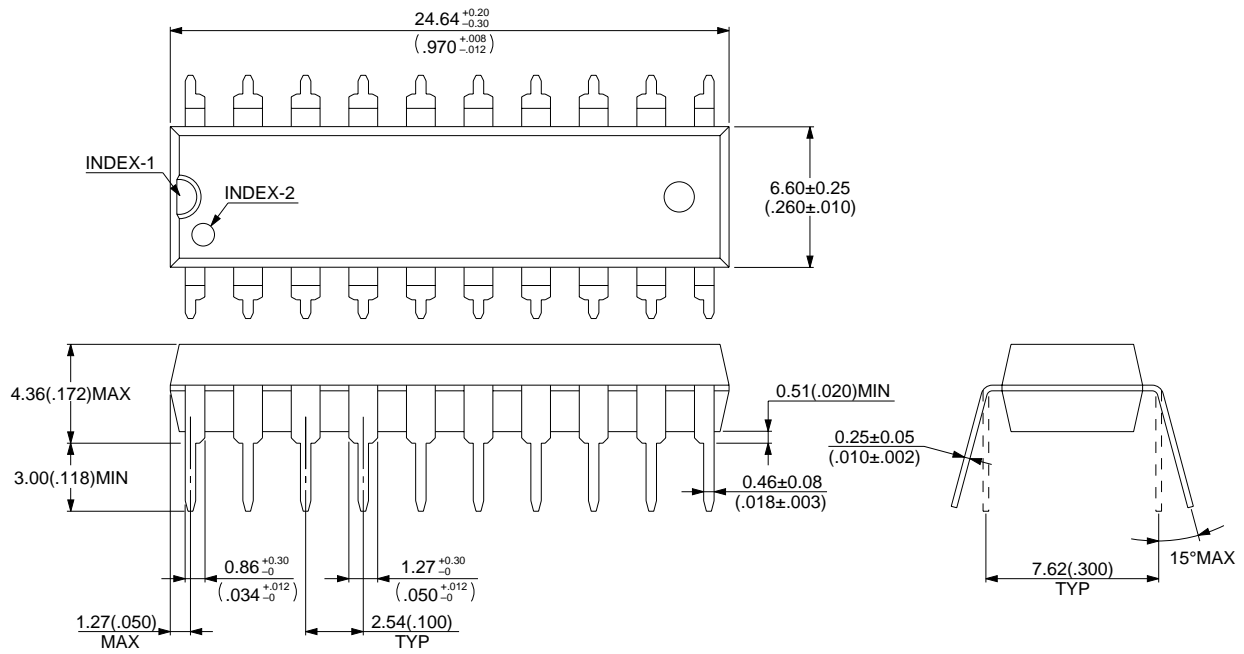


## 20. Quantization Noise v.s. Analog Output Frequency



## ■ PACKAGE DIMENSIONS

Plastic DIP, 20 pin  
(DIP-20P-M01)

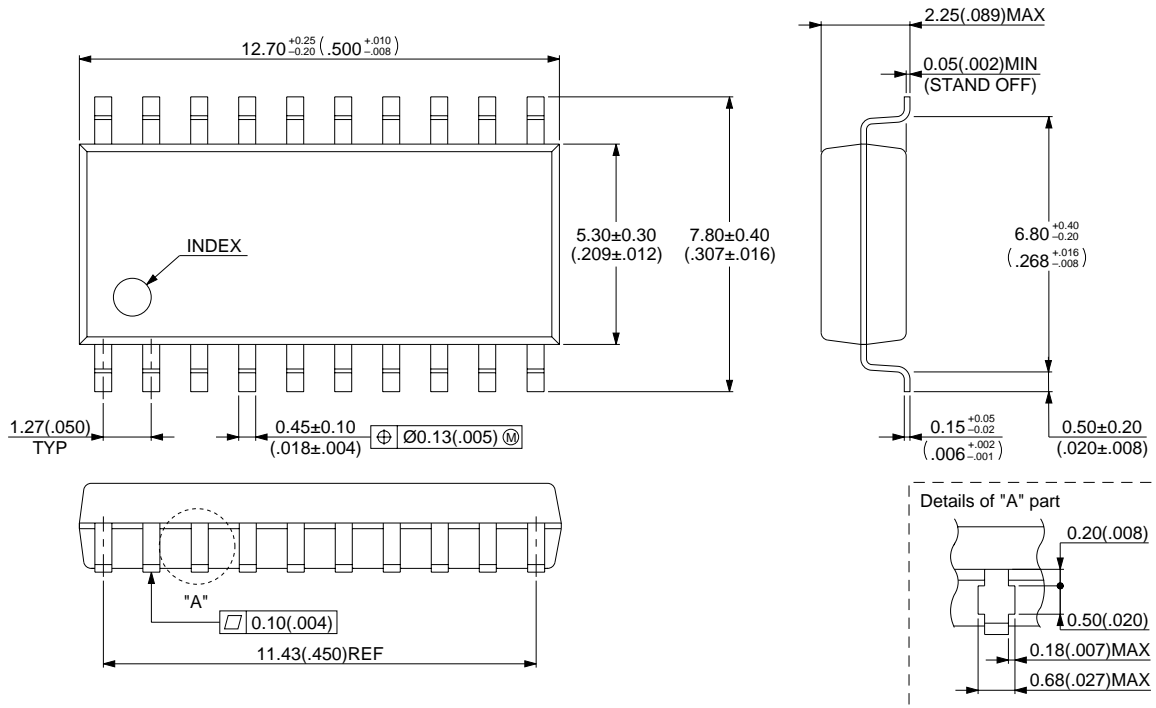


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Dimensions in mm (inch)

# MB40760

Plastic SOP, 20 pin  
(FPT-20P-M01)



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Dimensions in mm (inch)



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