

Linear IC Converter

CMOS

D/A Converter for Digital Tuning

(24-channel, 8-bit, on-chip OP amp)

MB88345

DESCRIPTION

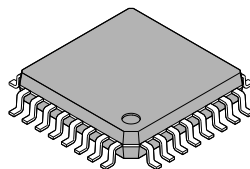
The MB88345 incorporates twenty-four 8-bit D/A converter modules. It also contains an output amplifier, allowing driving at large current. Since the inputs data in serial mode, it requires only three control lines for data input and can be cascaded. The MB88345 is suitable for applications such as electronic volume controls and replacement of semi-fixed resistors in tuning systems.

FEATURES

- Ultra-low power consumption (1.1 mW/ch: typical)
- Compact space-saving package (QFP-32)
- Contains 24-channel R-2R type 8-bit D/A converter
- On-chip analog output amps (sink current max. 1.0 mA, source current max. 1.0 mA)
- Analog output range: 0 V to Vcc
- Two separate power supply/ground lines for MCU interface block/operational amplifier output buffer block and D/A converter block
- Serial data input: maximum operating speed 2.5 MHz
- CMOS process

PACKAGE

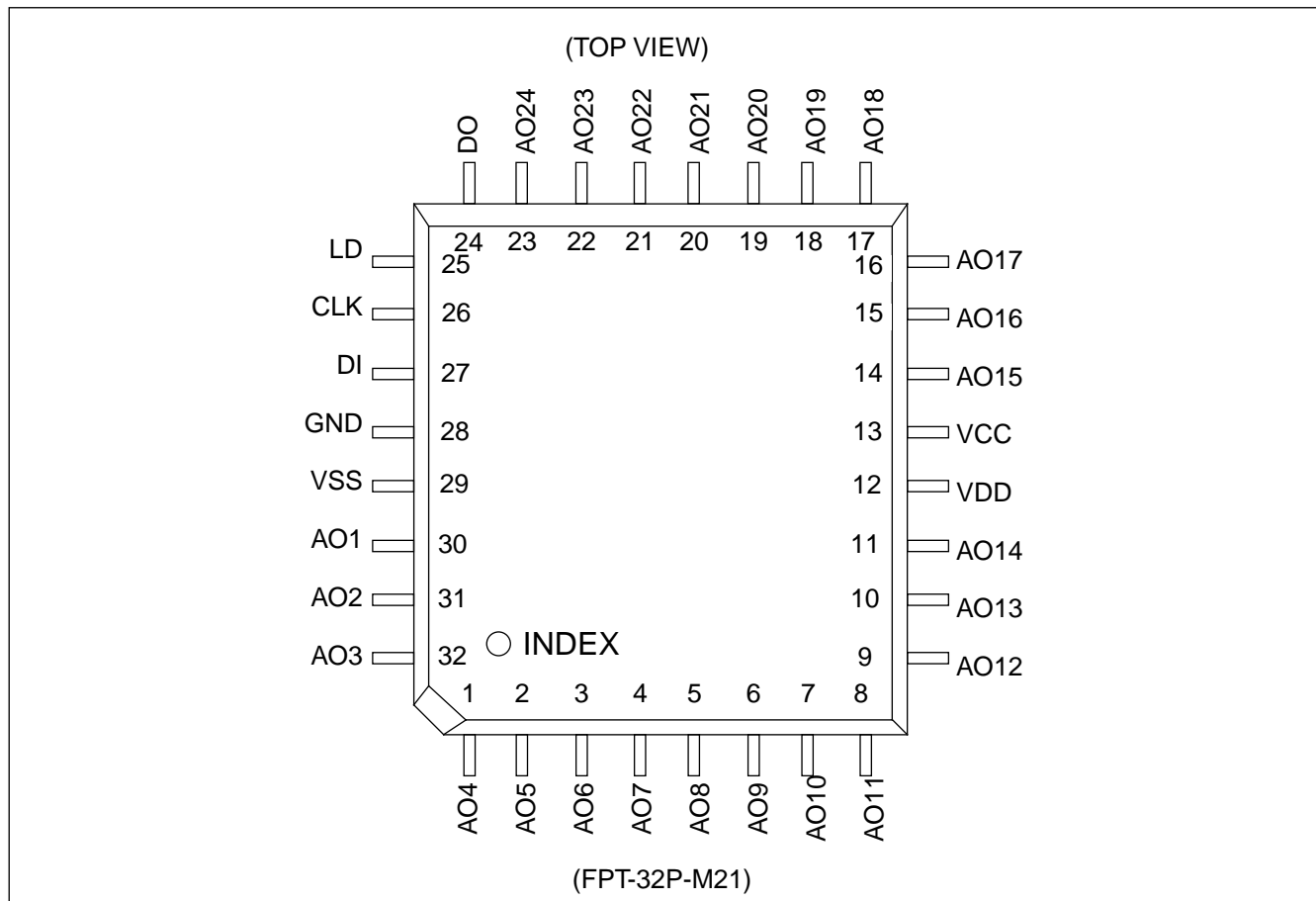
32-pin Plastic QFP



(FPT-32P-M21)

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■ PIN ASSIGNMENT

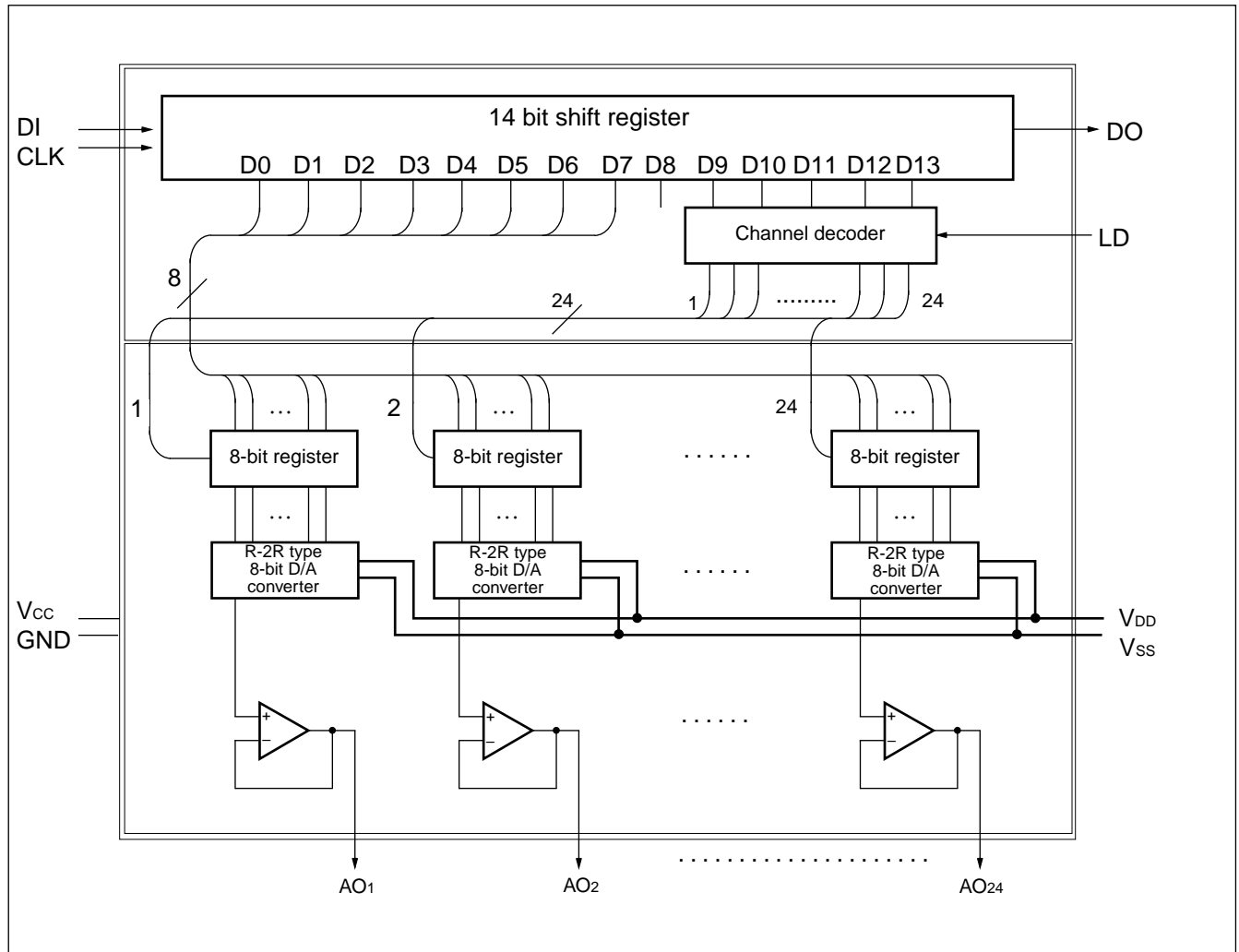


■ PIN DESCRIPTION

Pin No.	Pin name	I/O	Description
27	DI*	I	Serial data input pin. This pin inputs serial data with a data length of 14 bits.
24	DO	O	This pin outputs the MSB data in the 14-bit shift register.
26	CLK*	I	Shift clock input pin. The input signal from the DI pin enters the 14-bit shift register at the rising edge of the shift clock pulse.
25	LD*	I	When the LD pin inputs the High-level signal, shift register value is loaded to the decoder and the D/A output register.
30 to 32 1 to 11 14 to 23	AO1 to AO3 AO4 to AO14 AO15 to AO24	O	8-bit D/A output with OP-amp.
13	V _{CC}	–	MCU interface and OP-amp power-supply pin
28	GND	–	MCU interface and OP-amp GND pin
12	V _{DD}	–	D/A converter power-supply pin
29	V _{SS}	–	D/A converter GND pin

*:DI, CLK, LD pins should be fixed with “Low”level while no data are transferred.

■ BLOCK DIAGRAM



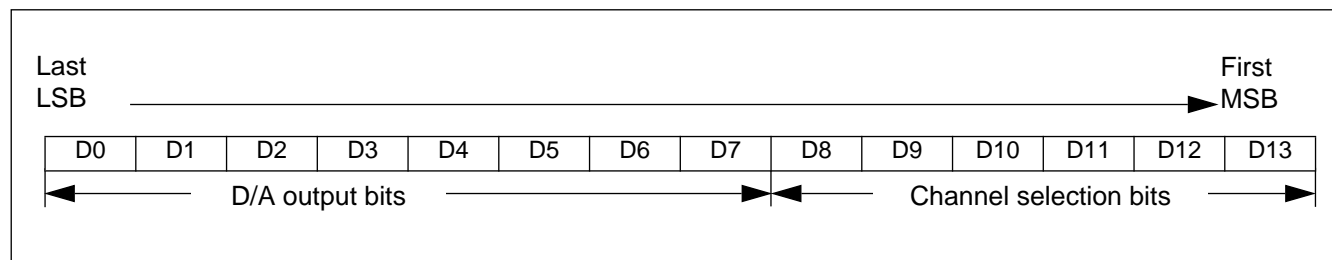
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■ DATA CONFIGURATION

The MB88345 has a 14-bit shift register for chip control.

The 14-bit shift register must be used to set up data in the configuration shown below.

Note: The data configuration has a total of 14 bits, six for channel selection and eight for D/A data output.



- D/A converter control signals

Input data signal								D/A converter output voltage
D0	D1	D2	D3	D4	D5	D6	D7	
0	0	0	0	0	0	0	0	=V _{SS}
1	0	0	0	0	0	0	0	=V _{REF} /255x1+V _{SS}
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
0	1	1	1	1	1	1	1	=V _{REF} /255x254+V _{SS}
1	1	1	1	1	1	1	1	=V _{DD}

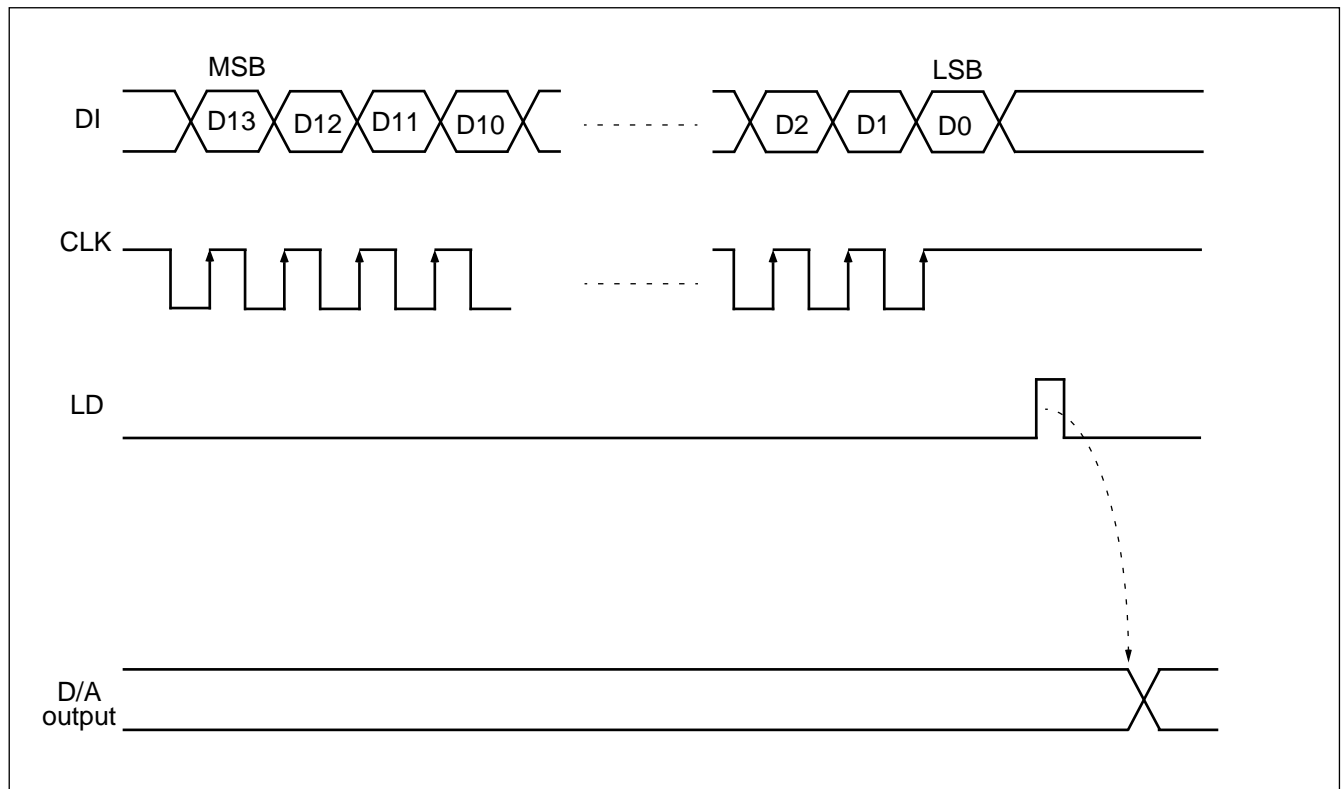
$$V_{REF} = V_{DD} - V_{SS}$$

- Channel selection signals

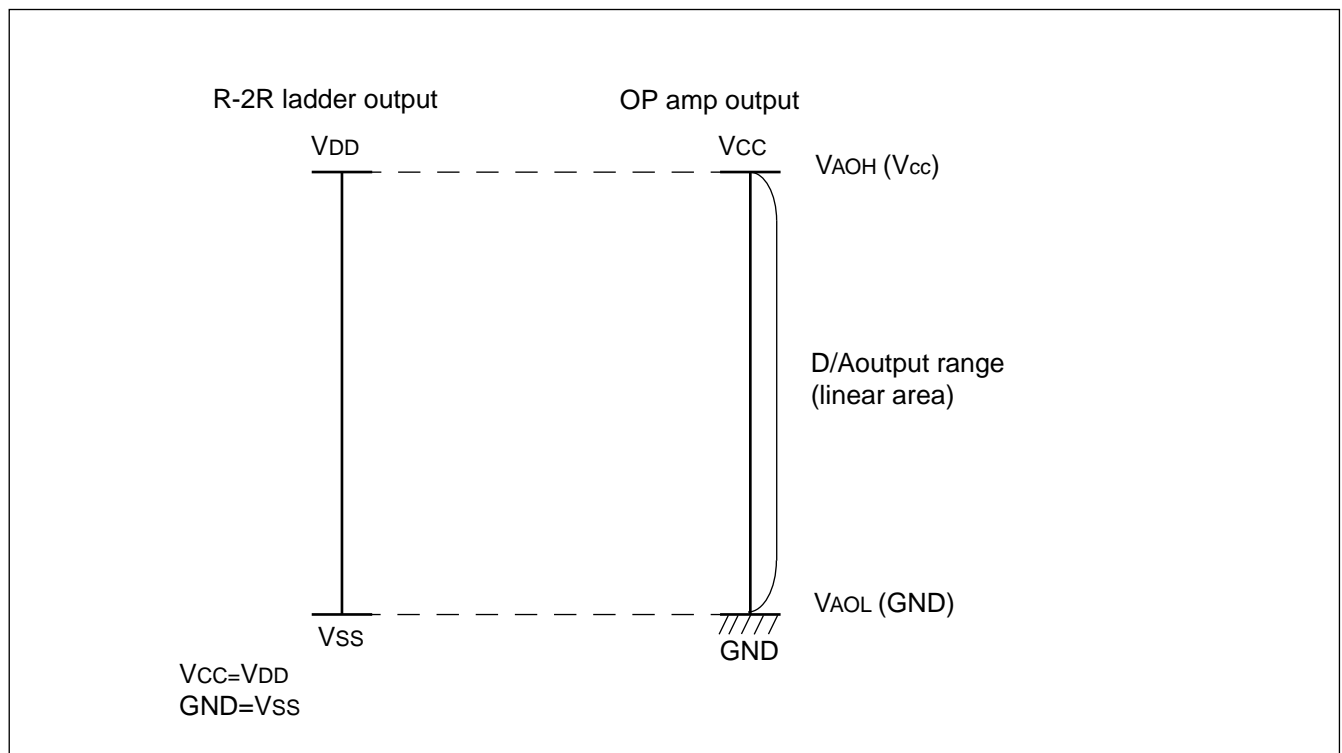
Input data signal						Channel selection
D8	D9	D10	D11	D12	D13	
×	0	0	0	0	0	Deselected
×	0	0	0	0	1	AO1 Selection
×	0	0	0	1	0	AO2 Selection
⋮	⋮	⋮	⋮	⋮	⋮	⋮
×	1	0	1	1	1	AO23 Selection
×	1	1	0	0	0	AO24 Selection
×	1	1	0	0	1	Deselected
×	1	1	0	1	0	
⋮	⋮	⋮	⋮	⋮	⋮	
×	1	1	1	1	0	
×	1	1	1	1	1	

×: Don't Care

■ TIMING CHART



■ ANALOG OUTPUT VOLTAGE RANGE



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■ ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Conditions	Rating	Unit
Power supply voltage	V _{CC}	Based on GND Ta=+25°C	- 0.3 to +7.0	V
	V _{DD}		- 0.3 to +7.0*	V
Input voltage	V _{IN}		- 0.3 to V _{CC} +0.3	V
Output voltage	V _{OUT}		- 0.3 to V _{CC} +0.3	V
Power consumption	P _D	-	250	mW
Operating temperature	T _a		-20 to +85	°C
Storage temperature	T _{stg}		-55 to +150	°C

*: V_{CC} ≥ V_{DD}

■ RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Value	Conditions	Unit
Power supply voltage 1	V _{CC}	5 V±10%	-	V
	GND	0		V
Power supply voltage 2	V _{DD}	2.0 to V _{CC}	V _{DD} - V _{SS} ≥ 2.0 V	V
	V _{SS}	GND to V _{CC} - 2.0		V
Analog output source current	I _{AL}	max. 1.0	-	mA
Analog output sink current	I _{AH}	max. 1.0		mA
Oscillation limit output capacity	C _{OL}	max. 1.0		μF
Digital data value range	-	#00 to #FF		
Operating temperature	T _a	-20 to +85		°C

■ ELECTRICAL CHARACTERISTICS

1. DC Characteristics

(1) Digital block

(V_{DD} , $V_{CC}=+5\text{ V}\pm 10\%$ ($V_{CC}\geq V_{DD}$), GND , $V_{SS}=0\text{ V}$, $T_a=-20\text{ }^\circ\text{C}$ to $+85\text{ }^\circ\text{C}$)

Parameter	Symbol	Pin name	Conditions	Value			Unit
				Min.	Typ.	Max.	
Power supply voltage	V_{CC}	V_{CC}	–	4.5	5.0	5.5	V
Power supply current	I_{CC}		Operation at $CLK=1\text{ MHz}$ (No load)	–	2.4	5.4	mA
Input leak current	I_{ILK}	CLK DI LD	$V_{IN} = 0\text{ to }V_{CC}$	–10	–	10	μA
“L” level input voltage	V_{IL}		–	–	–	$0.2 V_{CC}$	V
“H” level input voltage	V_{IH}		–	$0.5 V_{CC}$	–	–	V
“L” level output voltage	V_{OL}	DO	$I_{OL} = 2.5\text{ mA}$	–	–	0.4	V
“H” level output voltage	V_{OH}		$I_{OH} = -400\text{ }\mu\text{A}$	$V_{CC}-0.4$	–	–	V

(2) Analog block (1)

(V_{DD} , $V_{CC} = +5\text{ V}\pm 10\%$ ($V_{CC}\geq V_{DD}$), GND , $V_{SS} = 0\text{ V}$, $T_a = -20\text{ }^\circ\text{C}$ to $+85\text{ }^\circ\text{C}$)

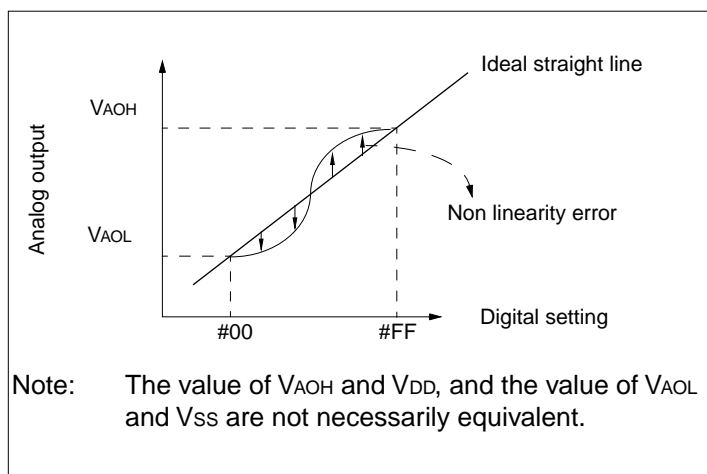
Parameter	Symbol	Pin name	Conditions	Value			Unit
				Min.	Typ.	Max.	
Power consumption	I_{DD}	V_{DD}	No load	–	3.0	4.5	mA
Analog Voltage	V_{DD}		V_{SS}	$V_{DD} - V_{SS} \geq 2.0\text{ V}$	2.0	–	V_{CC}
	V_{SS}	GND			–	$V_{CC}-2.0$	V
Resolution	Res	AO ₁ to AO ₂₄	–	–	8	–	bits
Monotonic increase	Rem		No load	–	8	–	bits
Non-linearity error	LE		$V_{DD} \leq V_{CC} - 0.1\text{ V}$ $V_{SS} \geq 0.1\text{ V}$	–1.5	–	1.5	LSB
Differential linearity	DLE			–1.0	–	1.0	LSB

Nonlinearity error:

Deviation (error) in input/output curves with respect to an ideal straight line connecting output voltage at “00” and output voltage at “FF.”

Differential linearity error:

Deviation (error) in amplification with respect to theoretical increase in amplification per 1-bit increase in digital value.



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(3) Analog block(2)

(V_{DD}, V_{CC} = +5 V±10 % (V_{CC}≥V_{DD}), GND, V_{SS} = 0 V, T_a = -20 °C to +85 °C)

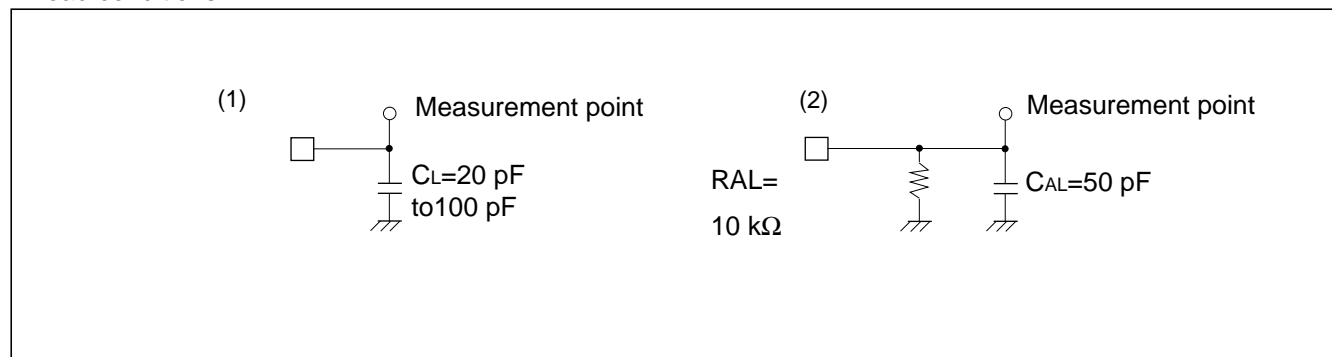
Parameter	Symbol	Pin name	Conditions	Value			Unit
				Min.	Typ.	Max.	
Output minimum voltage 1	V _{AOL1}	AO ₁ to AO ₂₄	V _{DD} =V _{CC} V _{SS} =GND=0 V I _{AL} =0 μA Digital data = #00	V _{SS}	-	V _{SS} +0.1	V
Output minimum voltage 2	V _{AOL2}		V _{DD} =V _{CC} =5.0V V _{SS} =GND=0 V I _{AL} =500 μA Digital data = #00	V _{SS} -0.2	V _{SS}	V _{SS} +0.2	V
Output minimum voltage 3	V _{AOL3}		V _{DD} =V _{CC} =5.0V V _{SS} =GND=0 V I _{AH} =500 μA Digital data = #00	V _{SS}	-	V _{SS} +0.2	V
Output minimum voltage 4	V _{AOL4}		V _{DD} =V _{CC} =5.0V V _{SS} =GND=0 V I _{AL} =1.0 mA Digital data = #00	V _{SS} -0.3	V _{SS}	V _{SS} +0.3	V
Output minimum voltage 5	V _{AOL5}		V _{DD} =V _{CC} =5.0V V _{SS} =GND=0 V I _{AH} =1.0 mA Digital data = #00	V _{SS}	-	V _{SS} +0.3	V
Output maximum voltage 1	V _{AOH1}		V _{DD} =V _{CC} =5.0V V _{SS} =GND=0 V I _{AL} =0 μA Digital data = #FF	V _{DD} -0.1	-	V _{DD}	V
Output maximum voltage 2	V _{AOH2}		V _{DD} =V _{CC} =5.0V V _{SS} =GND=0 V I _{AL} =500 μA Digital data = #FF	V _{DD} -0.2	-	V _{DD}	V
Output maximum voltage 3	V _{AOH3}		V _{DD} =V _{CC} =5.0V V _{SS} =GND=0 V I _{AH} =500 μA Digital data = #FF	V _{DD} -0.2	V _{DD}	V _{DD} +0.2	V
Output maximum voltage 4	V _{AOH4}		V _{DD} =V _{CC} =5.0V V _{SS} =GND=0 V I _{AL} =1.0 mA Digital data = #FF	V _{DD} -0.3	-	V _{DD}	V
Output maximum voltage 5	V _{AOH5}		V _{DD} =V _{CC} =5.0V V _{SS} =GND=0 V I _{AH} =1.0 mA Digital data = #FF	V _{DD} -0.3	V _{DD}	V _{DD} +0.3	V

2. AC Characteristics

(VDD, VCC = +5 V±10 % (VCC≥VDD), GND, VSS = 0 V, Ta = -20 °C to +85 °C)

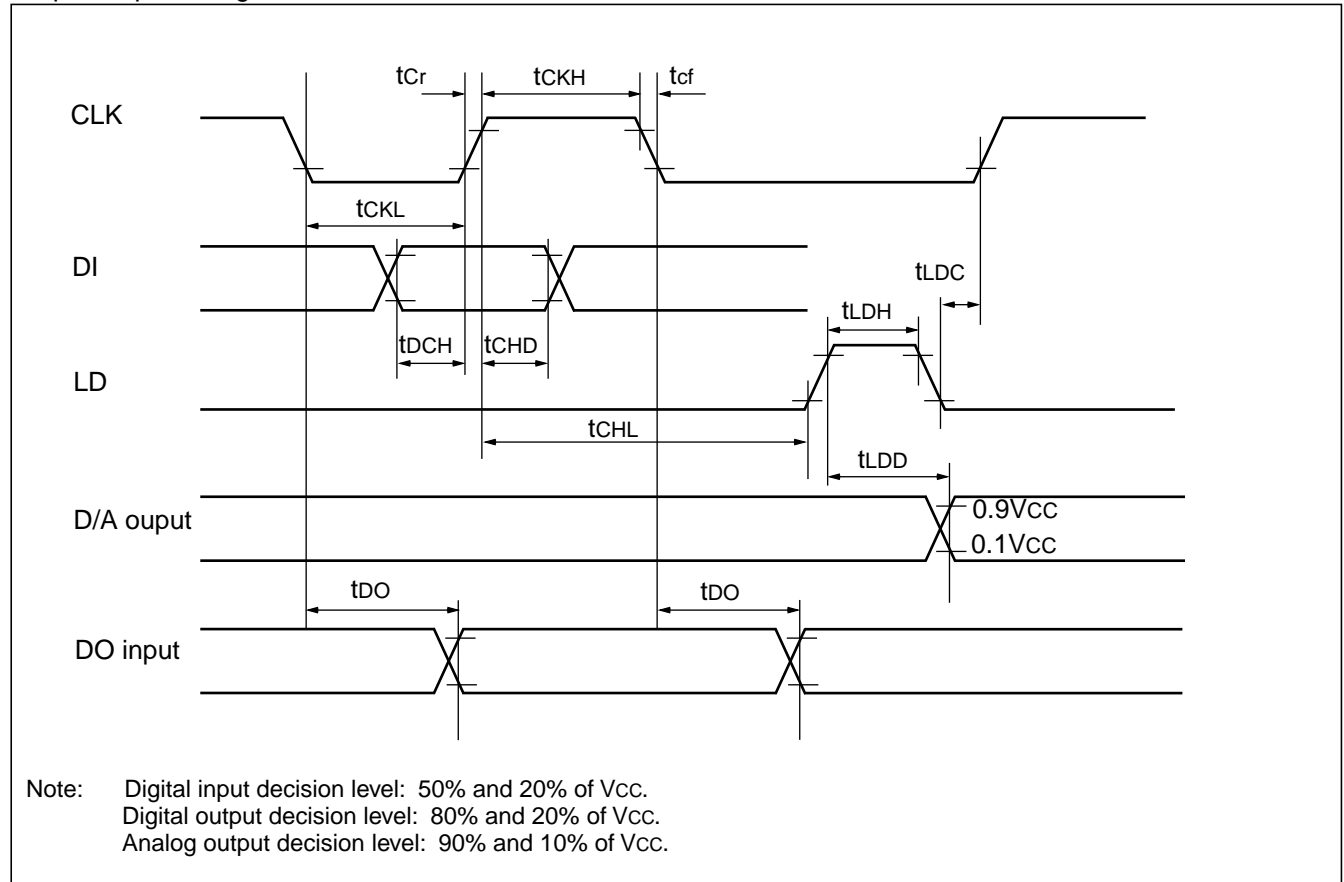
Parameter	Symbol	Conditions	Value		Unit
			Min.	Max.	
"L" level clock pulse width	tCKL	-	200	-	ns
"H" level clock pulse width	tCKH		200	-	ns
Clock rise time Clock fall time	tCr tCf		-	200	ns
Data setup time	tDCH		30	-	ns
Data hold time	tCHD		60	-	ns
Load setup time	tCHL		200	-	ns
Load hold time	tLDC		100	-	ns
"H" level load pulse width	tLDH		100	-	ns
Data output delay time	tDO		See "Load conditions (1)"	-	150
D/A output setting time	tLDD	See "Load conditions (2)"	-	100	μs

• Load conditions

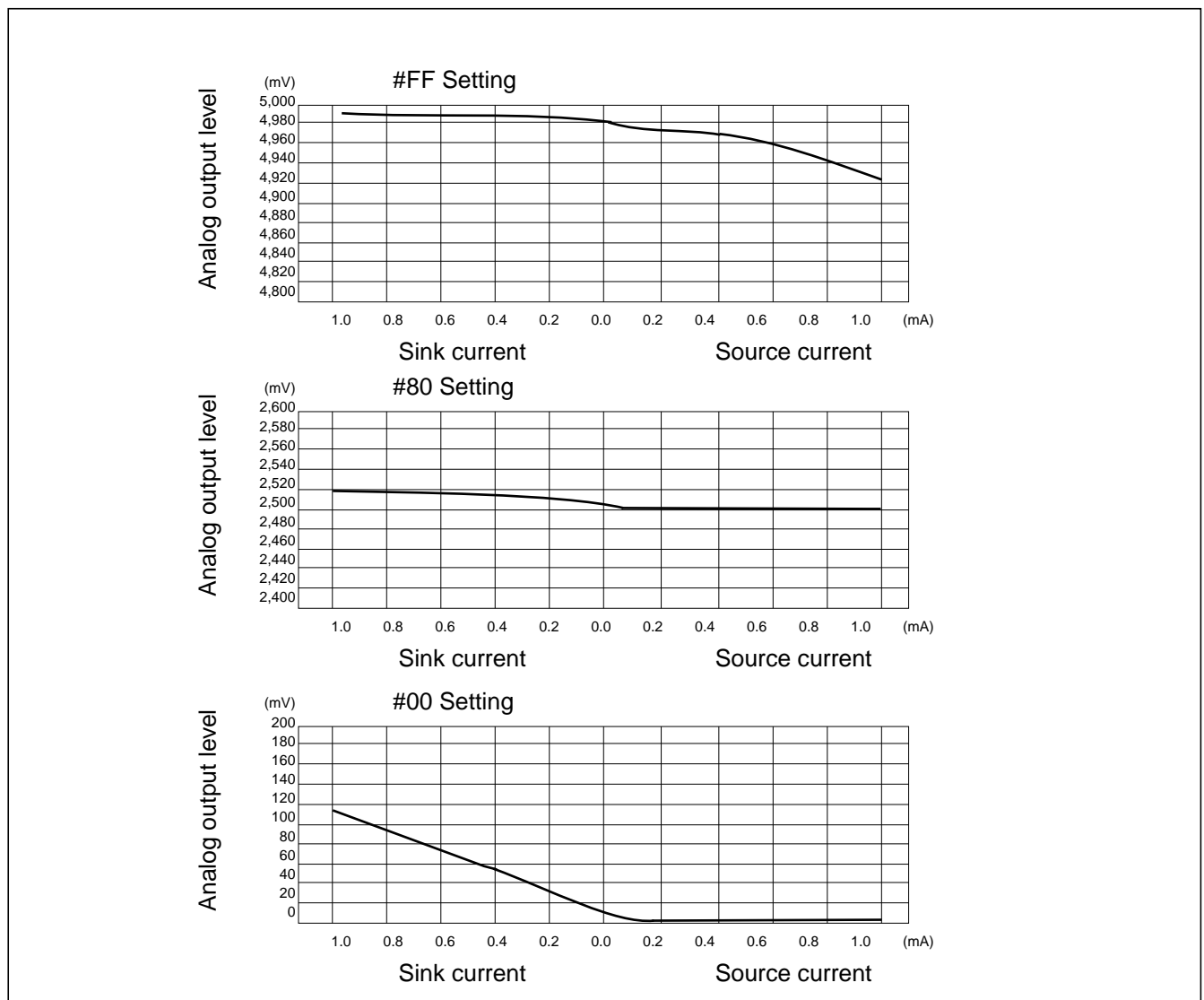
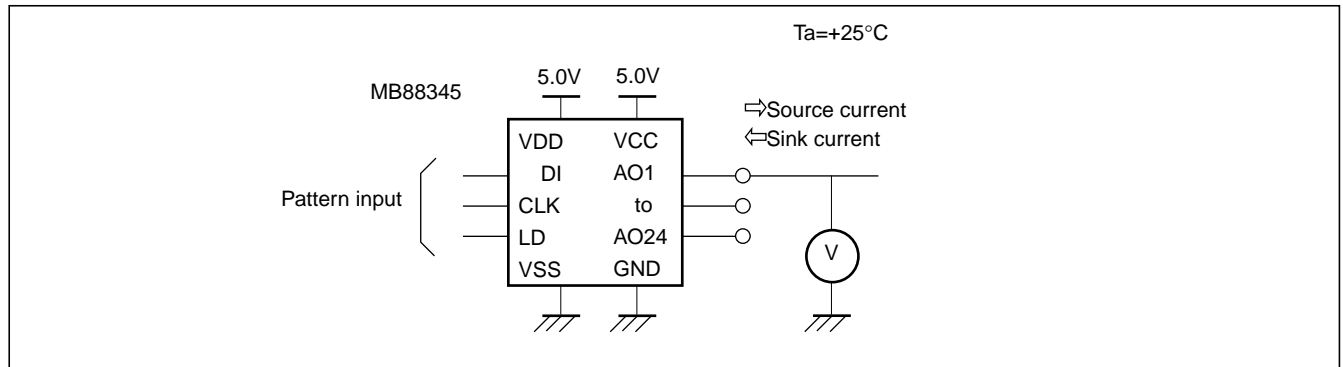


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• Input/output timing



■ VAO vs. IAO CHARACTERISTICS EXAMPLE



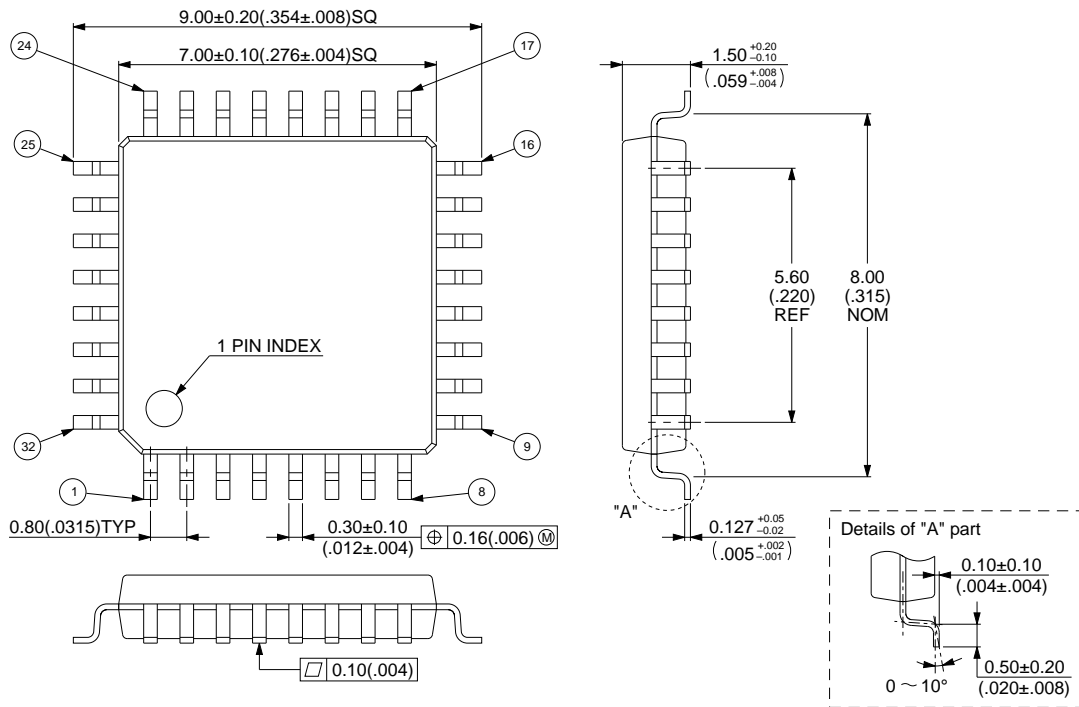
■ ORDERING INFORMATION

Part number	Package	Remarks
MB88345PF	32 pin Plastic QFP (FPT-32P-M21)	

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■ PACKAGE DIMENSION

32-pin, Plastic QFP
(FPT-32P-M21)



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Dimensions in mm (inches)

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