



# LC89086M

## 8 Bit A/D Converter

### Preliminary

### Overview

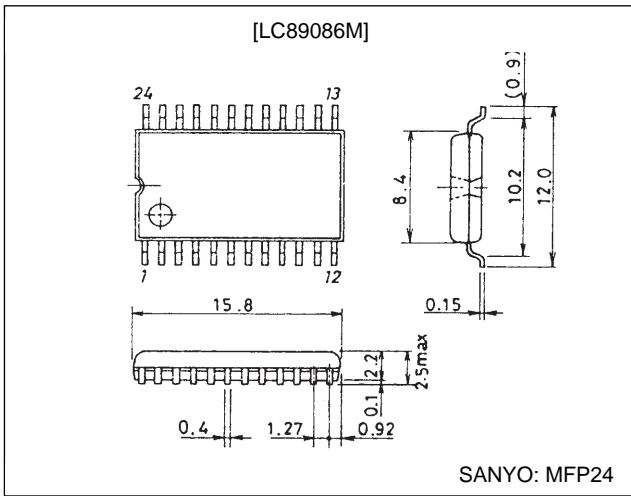
The LC89086M is a low-power high-speed 8-bit serial-parallel A/D converter fabricated in a high-speed CMOS process.

### Features

- Resolution: 8 bits (with an overflow output)
- Maximum conversion rate: 20M samples per second
- Error: Less than  $\pm 1.0$  LSB
- Power supply: +5-V single-voltage power supply
- Power dissipation: 150 mW (typical)
- Analog input voltage range:  $V_{SS}$  to  $V_{DD}$
- Digital output voltage: 3 state TTL level

### Package Dimensions

unit: mm  
**3155-MFP24**



### Specifications

**Absolute Maximum Ratings at  $T_a = 25^\circ\text{C}$ ,  $DV_{SS} = AV_{SS} = 0\text{ V}$**

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	$V_{DD}$ max		-0.3 to +7.0	V
Input voltage	$V_{IN}$ max		-0.3 to $V_{DD} + 0.3$	V
Operating temperature	$T_{opr}$		-30 to +70	$^\circ\text{C}$
Storage temperature	$T_{stg}$		-40 to +125	$^\circ\text{C}$

### Recommended Operating Conditions

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Supply voltage	$V_{DD}$		4.5	5.0	5.5	V
Operating ambient temperature	$T_a$		-30		+70	$^\circ\text{C}$

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### Electrical Characteristics

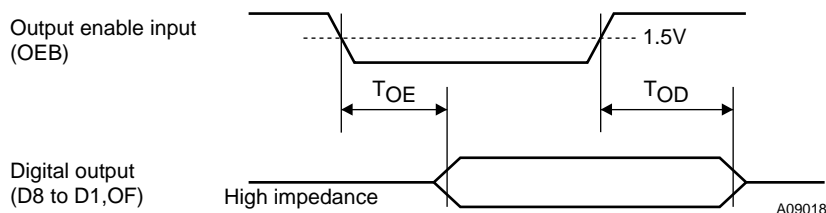
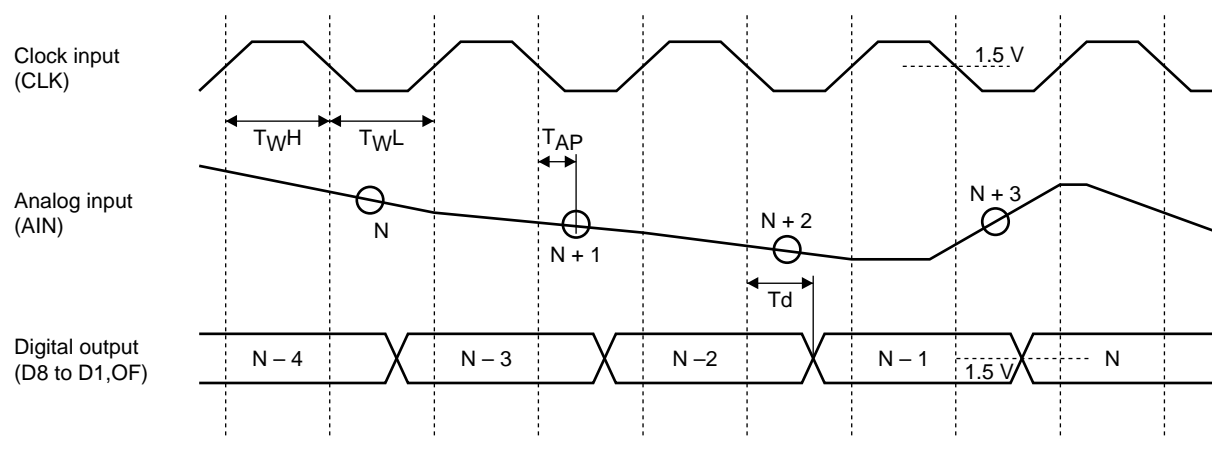
**Electrical DC Characteristics at Ta = -30 to +70°C, AV<sub>DD</sub> = DV<sub>DD</sub> = 4.5 to 5.5 V, AV<sub>SS</sub> = DV<sub>SS</sub> = 0 V**

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Reference resistance	Rref	VrefH (pin 5) – VrefL (pin 8)	210	300	390	Ω
Analog input capacitance	C <sub>AIN</sub>			30		pF
Analog input resistance	R <sub>AIN</sub>			10		MΩ
Reference high-level input voltage	VrefH	When VrefHO (pin 4) and VrefLO (pin 9) are unused.	VrefL+2.0		V <sub>DD</sub>	V
Reference low-level input voltage	VrefL	When VrefHO (pin 4) and VrefLO (pin 9) are unused.	0		VrefH-2.0	V
Reference high-level output voltage	VrefH	When VrefHO (pin 4) and VrefLO (pin 9) are used, and AV <sub>DD</sub> = DV <sub>DD</sub> = 5 V	1.9	2.0	2.1	V
Reference low-level output voltage	VrefL	When VrefHO (pin 4) and VrefLO (pin 9) are used, and AV <sub>DD</sub> = DV <sub>DD</sub> = 5 V	-0.05	0	+0.05	V
Analog input voltage	V <sub>AIN</sub>		VrefL		VrefH	V
Digital high-level voltage	V <sub>IH</sub>		2.2		V <sub>DD</sub> +0.3	V
Digital low-level voltage	V <sub>IL</sub>		-0.3		+0.8	V
Digital high-level output current	I <sub>OH</sub>	V <sub>OH</sub> = V <sub>DD</sub> - 0.4 V	-2			mA
Digital low-level output current	I <sub>OL</sub>	V <sub>OL</sub> = 0.4 V	2			mA

**Electrical AC Characteristics 1 at Ta = -30 to +70°C, AV<sub>DD</sub> = DV<sub>DD</sub> = 4.5 to 5.5 V, AV<sub>SS</sub> = DV<sub>SS</sub> = 0 V**

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Clock high-level period	T <sub>WH</sub>		23			ns
Clock low-level period	T <sub>WL</sub>		23			ns
Analog input acquisition time	T <sub>AP</sub>		10	20	30	ns
Digital output data delay time	T <sub>d</sub>	C load = 30 pF	15	30	45	ns
Digital output data enable time	T <sub>OE</sub>	C load = 30 pF	2	5	10	ns
Digital output data disable time	T <sub>OD</sub>	C load = 30 pF	2	5	10	ns

Timing Chart



The analog signal (AIN) is acquired on the falling edge of the clock input (CLK). The acquired analog signal is converted to a digital code and is output from the digital outputs (D8 to D1, OF) on the clock falling edge delayed three clock cycles from the clock cycle in which the analog signal was acquired.

Electrical AC Characteristics 2

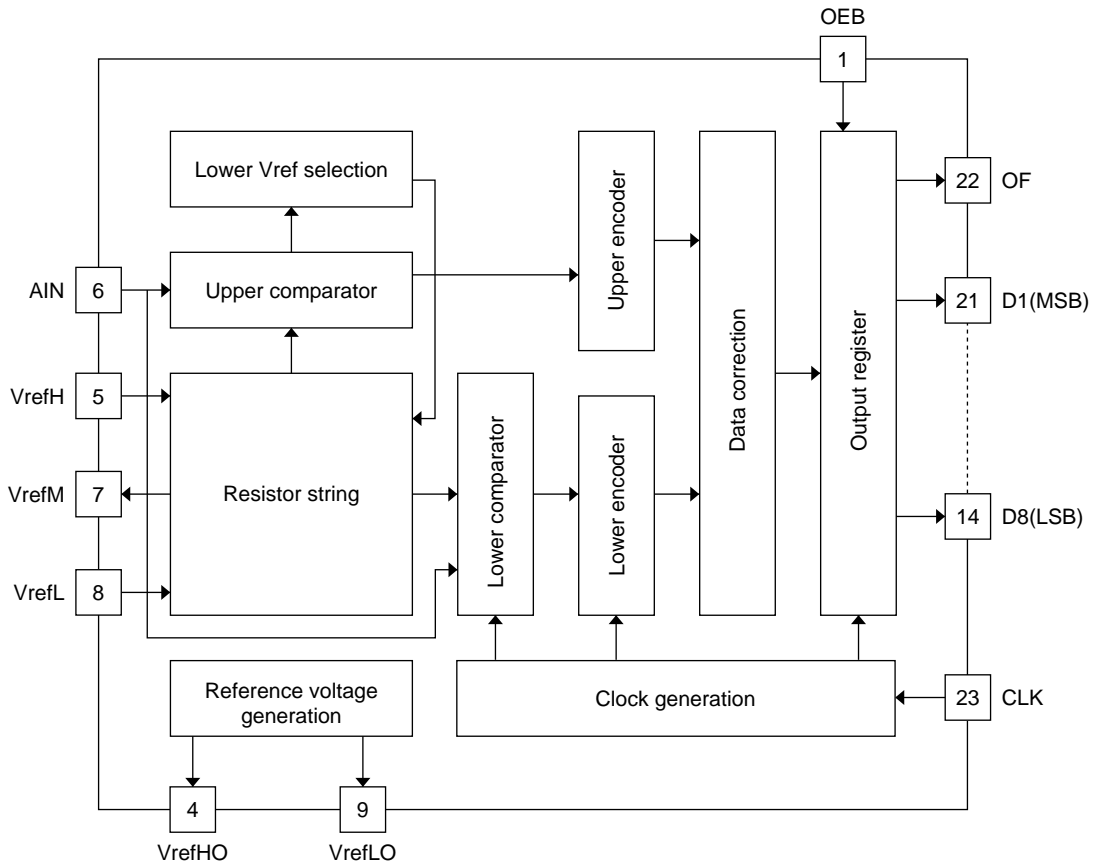
at  $T_a = 25^\circ\text{C}$ ,  $A_{V_{DD}} = DV_{DD} = 5\text{ V}$ ,  $A_{V_{SS}} = DV_{SS} = 0\text{ V}$ ,  $V_{refH} = 2\text{ V}$ ,  $V_{refL} = 0\text{ V}$

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Resolution	Res				8	bit
Maximum conversion rate	Fs				20	MSPS
Linearity error	LE	DC accuracy			$\pm 1.0$	LSB
Differential linearity error	DLE	DC accuracy			$\pm 1.0$	LSB
Offset voltage	$V_{offset}$	DC accuracy	10	50	90	mV
Power dissipation	Pd	Fs = 20 MSPS		150	220	mW

Note: Test circuits must conform to the sample application circuit.

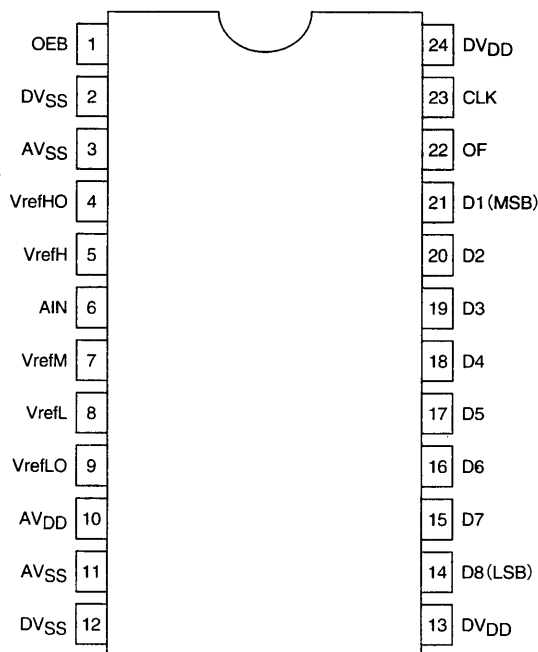
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## Block Diagram



A09019

## Pin Assignment



A09017  
Top view

## LC89086M

### Pin Functions

Pin No.	Pin name	I/O	Function
1	OEB	I	Digital output enable input High: high-impedance Low: Normal operation
2	DV <sub>SS</sub>		Digital ground
3	AV <sub>SS</sub>		Analog ground
4	Vref HO	O	Internal reference voltage (high) generation. Shorting this pin to VrefH (pin 5) generates a voltage of 2.0 V. This pin must be left open when the internally generated potential is not used.
5	Vref H	I	Reference voltage input (high)
6	AIN	I	Analog input
7	Vref M	O	Reference voltage intermediate level tap.
8	Vref L	I	Reference voltage input (low)
9	Vref LO	O	Internal reference voltage (low) generation. Shorting this pin to VrefL (pin 8) generates a voltage of 0 V. This pin must be left open when the internally generated potential is not used.
10	AV <sub>DD</sub>		Analog power supply
11	AV <sub>SS</sub>		Analog ground
12	DV <sub>SS</sub>		Digital ground
13	DV <sub>DD</sub>		Digital power supply
14	D8	O	Digital output (LSB)
15	D7	O	Digital output
16	D6	O	Digital output
17	D5	O	Digital output
18	D4	O	Digital output
19	D3	O	Digital output
20	D2	O	Digital output
21	D1	O	Digital output (MSB)
22	OF	O	Digital output (Overflow)
23	CLK	I	Clock input
24	DV <sub>DD</sub>		Digital power supply

Note: There must be no potential difference between the digital system and analog system V<sub>DD</sub> and V<sub>SS</sub> power supply potentials.

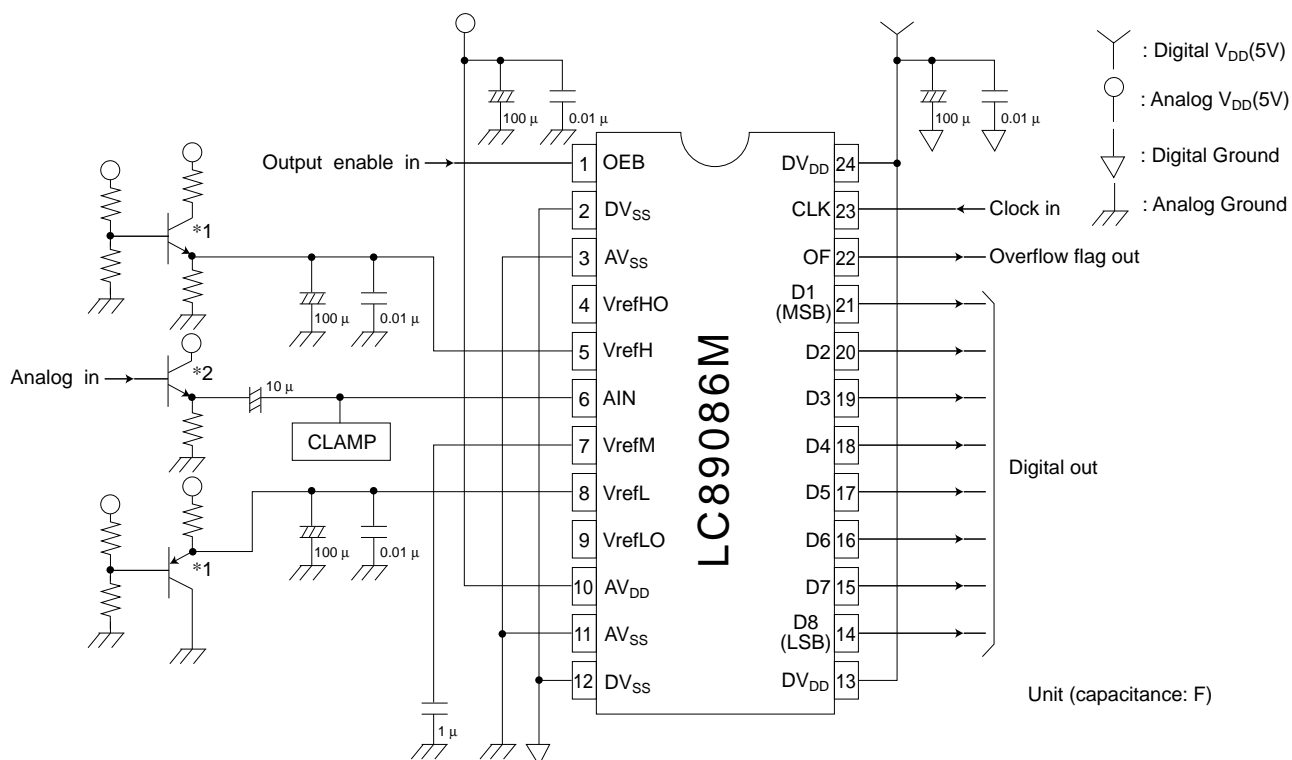
### I/O Code Table

The table below lists the relationship between the input and output when VrefH and VrefL are set up so that the zero transient voltage is 0.000 V and the full-scale transient voltage is 2.008V.

Analog input	Digital output								
	OF	D1	D2	D3	D4	D5	D6	D7	D8
V <sub>AIN</sub> (V)									
Up to 0.000	0	0	0	0	0	0	0	0	0
Up to 0.008	0	0	0	0	0	0	0	0	0
Up to 0.016	0	0	0	0	0	0	0	0	1
Up to 0.024	0	0	0	0	0	0	0	1	0
Up to 0.032	0	0	0	0	0	0	0	1	1
to									
Up to 0.992	0	0	1	1	1	1	1	1	0
Up to 1.000	0	0	1	1	1	1	1	1	1
Up to 1.008	0	1	0	0	0	0	0	0	0
Up to 1.016	0	1	0	0	0	0	0	0	1
to									
Up to 1.992	0	1	1	1	1	1	1	0	1
Up to 2.000	0	1	1	1	1	1	1	1	0
Up to 2.008	0	1	1	1	1	1	1	1	1
Over 2.008	1	1	1	1	1	1	1	1	1

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### Sample Application Circuit



- Note
1. The value of the reference resistor is about 300 Ω. When this circuit is used with  $(V_{refH} - V_{refL}) = 2\text{ V}$ , a current of 6.7 mA will flow. Use an operational amplifier or emitter follower with at least this current capacity.
  2. The analog input impedance is lower for AC inputs. Therefore, an operational amplifier or emitter follower with a high slew rate and a wide bandwidth must be used in the previous stage output, and the impedance must be reduced to under 100 Ω.

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