



# LC83025E

## Digital Signal Processor for Karaoke Products

### Overview

The LC83025E is a special-purpose karaoke DSP that implements the signal processing required by karaoke systems, including pitch shift, microphone echo, voice muting and simple surround, with only a single 256Kb external DRAM. Since the LC83025E includes built-in A/D and D/A converters, it can also handle analog inputs and outputs in addition to digital inputs and outputs. The LC83025E uses serial transfer of coefficient data from a microcontroller to handle changes in functions and characteristics required for each application.

### Features

#### • Applications

##### — Pitch shift

The LC83025E can shift the music pitch or the microphone pitch by  $\pm 15$  steps in  $1/4$  interval steps, or  $\pm 1$  octave in scale tone steps according to command data sent from the microcontroller. Furthermore, the pitch can be changed up to  $\pm 1$  octave in arbitrary steps by setting internal coefficients.

##### — Microphone echo

The LC83025E implements echo processing for the signal input from the microphone A/D converter. The amount of echo, the delay time and other parameters can be changed by setting coefficients.

##### — Voice mute

The LC83025E implements processing that removes monaural signal components included in the music signal. This allows CDs with vocals to be used as karaoke CDs. Command data is used to turn the voice mute function on or off.

##### — Simple surround

The LC83025E implements a simple surround function by adding delayed components to the music signal. The LC83025E includes six sets of simple surround coefficients as built-in preset data. These values can be switched by sending command data. Applications can implement their own original surround effects by setting the coefficients. However, the algorithm itself is fixed.

##### — Flexible input mixing

The LC83025E supports hybrid mixing of digital and analog left and right channel song inputs, and thus can handle a wide range of disk processing configurations.

#### • Audio inputs and outputs

##### — Inputs: Digital - One system (stereo)

A/D converter - Three channels

##### — Outputs: Digital - One system (stereo)

D/A converter - Two channels

##### — A/D converter

Second order  $\Delta\Sigma$  modulation - Three channels

##### — D/A converter

4 $\times$  oversampling digital filters  
plus second order noise shaper

plus 5-bit PWM system - Two channels

#### • Master clock: 768 fs

#### • External memory: Up to two 256K (64K $\times$ 4-bit) DRAMs can be used

#### • Microcontroller input: Synchronous 8-bit serial data

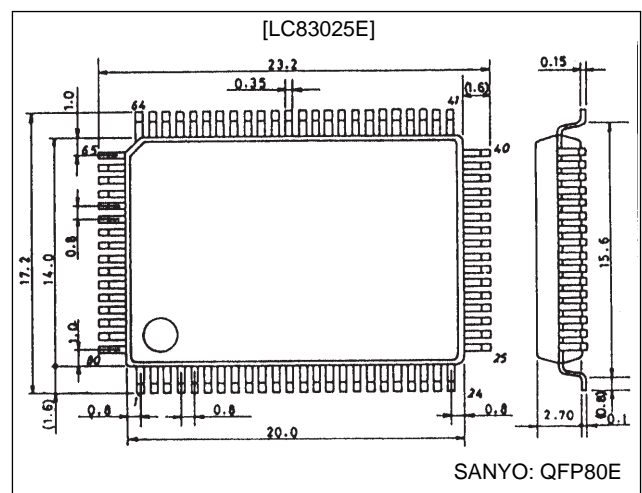
#### • Supply voltage: 5 V single-voltage

#### • Package: QFP80E

### Package Dimensions

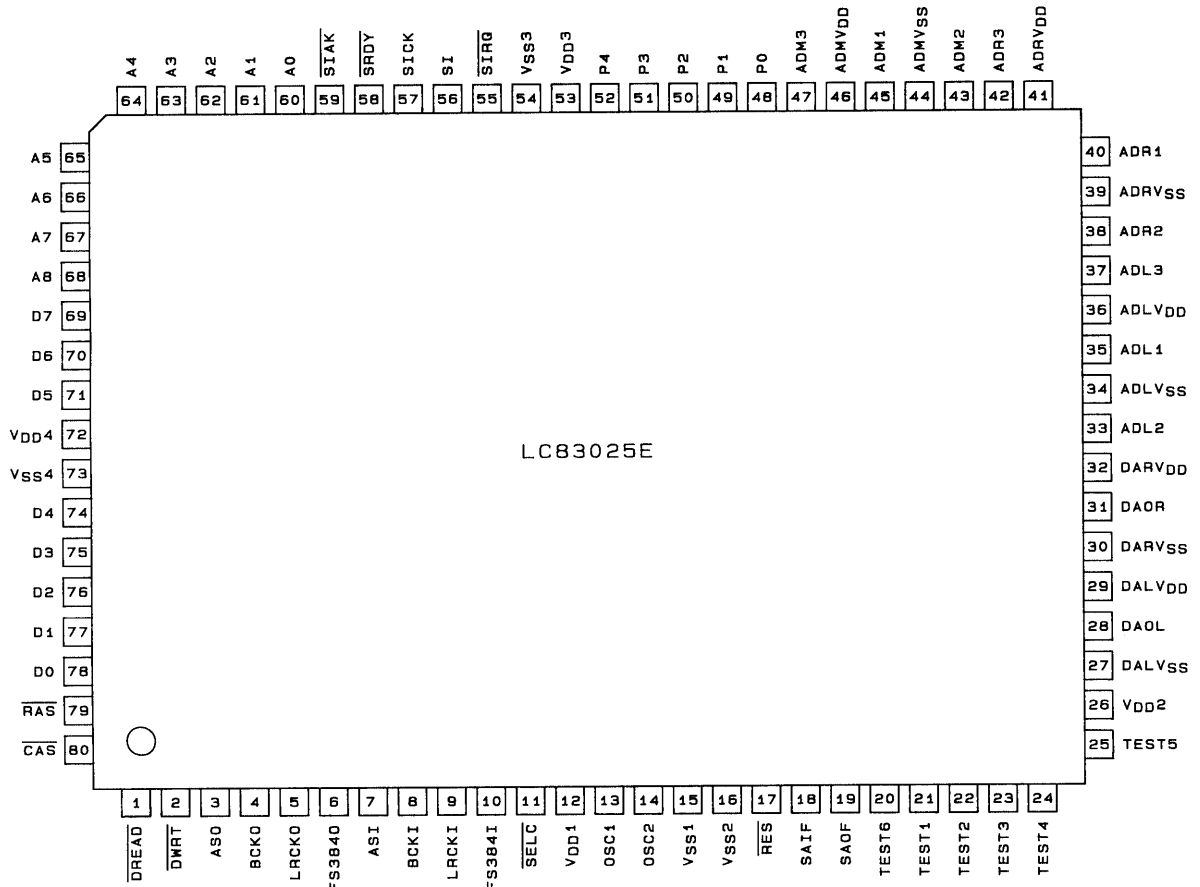
unit: mm

#### 3174-QFP80E



# LC83025E

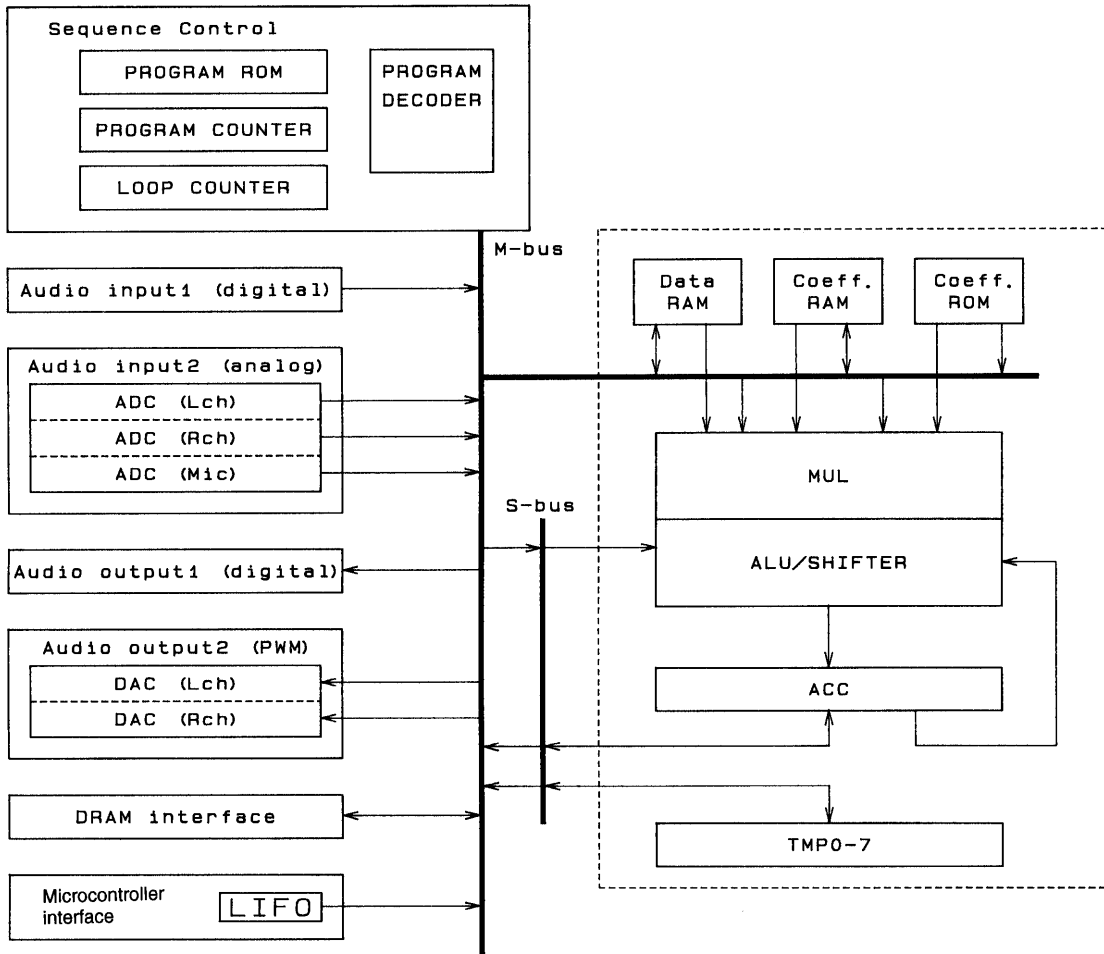
## Pin Assignment



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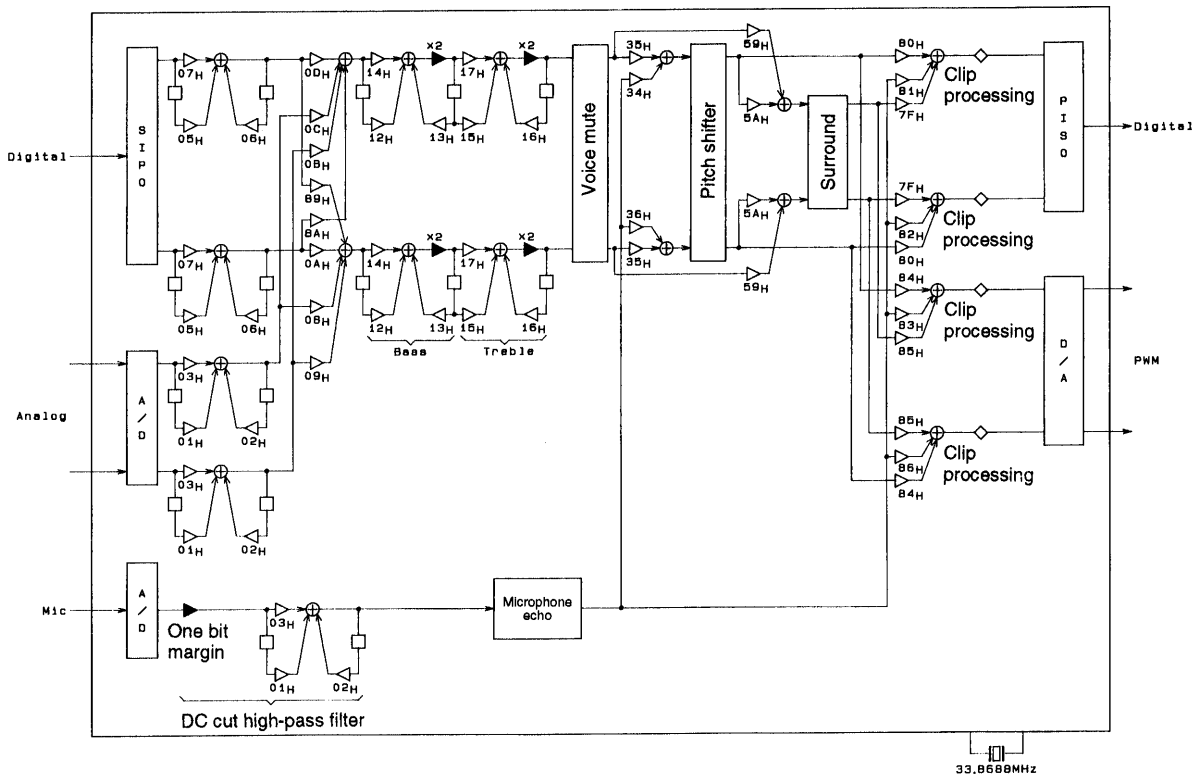
Top view

Block Diagram



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Signal Flow Overview



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## LC83025E

### Pin Functions

Pin No.	Symbol	I/O	Function
[Control pins]			
13	OSC1	I	Crystal oscillator connection (768 fs)
14	OSC2	O	Crystal oscillator connection (768 fs)
10	FS384I	I	384 fs input (Apply a clock that is equal to the OSC1/OSC2 768 fs clock divided by 2.)
11	$\overline{\text{SEL}}\text{C}$	I	Audio clock source switching (High: Fixes FS384I as the clock)
18	SAIF	I	Digital audio input mode switching (Low: backward packed, High: forward packed)
19	SAOF	I	Digital audio output mode switching (Low: 48 fs, High: 64 fs)
17	$\overline{\text{RES}}$	I	Reset
25 to 21	TEST5 to TEST1	I	Test (Must be tied to ground in normal operation.)
20	TEST6	O	Test (Must be left open in normal operation.)
48	P0	I	Coefficient transfer mode switching
50, 49	P2, P1	I	Initial operating mode setting (This pin should be held high in normal operation.)
51	P3	O	Microphone signal present (low output) or absent (high output) indication output
52	P4	O	Music signal present (low output) or absent (high output) indication output
[External memory interface]			
79	$\overline{\text{RAS}}$	O	$\overline{\text{RAS}}$ signal output
80	$\overline{\text{CAS}}$	O	$\overline{\text{CAS}}$ signal output
1	$\overline{\text{DREAD}}$	O	External memory read signal output
2	$\overline{\text{DWRT}}$	O	External memory write signal output
68 to 60	A8 to A0	O	Address outputs
69 to 71, 74 to 78	D7 to D0	I/O	Data I/O (Normally, only D3 to D0 are used.)
[Audio interface]			
9	LRCKI	I	ASI L/R clock input (1 fs)
5	LRCKO	O	ASO L/R clock output (1 fs)
8	BCKI	I	ASI bit clock input (32 fs or higher)
4	BCKO	O	ASO bit clock output (48 fs or 64 fs)
6	FS384O	O	ASO 384 fs output
7	ASI	I	Digital audio data input (MSB first, 16 bits)
3	ASO	O	Digital audio data output (MSB first, backward packed, 16 bits)
35	ADL1	I	A/D converter input (left channel)
33	ADL2	O	A/D converter output (left channel)
37	ADL3	O	A/D converter output (left channel)
40	ADR1	I	A/D converter input (right channel)
38	ADR2	O	A/D converter output (right channel)
42	ADR3	O	A/D converter output (right channel)
45	ADM1	I	A/D converter input (microphone)
43	ADM2	O	A/D converter output (microphone)
47	ADM3	O	A/D converter output (microphone)
28	DAOL	O	D/A converter output (left channel)
31	DAOR	O	D/A converter output (right channel)
[Microcontroller interface]			
55	$\overline{\text{SIRQ}}$	I	Serial input request signal input
59	$\overline{\text{SIAK}}$	O	Output indicating serial input execution in progress
56	SI	I	Serial data input from the control microcontroller (8-bit serial data)
57	SICK	I	SI transfer clock input
58	$\overline{\text{SRDY}}$	I	Ready signal input from the control microcontroller that indicates that serial data input has completed

Continued on next page.

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Pin No.	Symbol	I/O	Function
[Power supply pins]			
12, 26, 53, 72	$V_{DD}$	—	$V_{DD}$ for the digital block (Connect to +5 V.) (Keep connections as short as possible so that potential differences between the $V_{DD}$ pins do not occur.)
15, 16, 54, 73	$V_{SS}$	—	$V_{SS}$ for the digital block (Connect to ground.) (Keep connections as short as possible so that potential differences between the $V_{SS}$ pins do not occur.)
36	$ADLV_{DD}$	—	A/D converter $V_{DD}$ (left channel) (Connect to +5 V.)
41	$ADRV_{DD}$	—	A/D converter $V_{DD}$ (right channel) (Connect to +5 V.)
46	$ADMV_{DD}$	—	A/D converter $V_{DD}$ (microphone) (Connect to +5 V.)
29	$DALV_{DD}$	—	D/A converter $V_{DD}$ (left channel) (Connect to +5 V.)
32	$DARV_{DD}$	—	D/A converter $V_{DD}$ (right channel) (Connect to +5 V.)
34	$ADLV_{SS}$	—	A/D converter $V_{SS}$ (left channel) (Connect to ground.)
39	$ADRV_{SS}$	—	A/D converter $V_{SS}$ (right channel) (Connect to ground.)
44	$ADMV_{SS}$	—	A/D converter $V_{SS}$ (microphone) (Connect to ground.)
27	$DALV_{SS}$	—	D/A converter $V_{SS}$ (left channel) (Connect to ground.)
30	$DARV_{SS}$	—	D/A converter $V_{SS}$ (right channel) (Connect to ground.)

## LC83025E

### Pin Circuits

Specification	Circuit	Pins
TTL output	<p style="text-align: right;">Output data <b>A03570</b></p>	ASO, LRCKO, BCKO, $\overline{\text{RAS}}$ , $\overline{\text{CAS}}$ , $\overline{\text{DREAD}}$ , $\overline{\text{DWRT}}$ , FS384O, A0 to A8
CMOS intermediate current output		P3, P4, $\overline{\text{SIK}}$ , TEST6
Analog output	<p style="text-align: right;">Output data <b>A03571</b></p>	DAOL, DAOR, ADL2, ADL3, ADM2, ADM3, ADR2, ADR3
Schmitt input	<p style="text-align: right;">Input data <b>A03572</b></p>	SI, SICK, $\overline{\text{SIRQ}}$ , $\overline{\text{SRDY}}$ , (OSC1)
Low Schmitt input		FS384I, BCKI, ASI, LRCKI
Normal input	<p style="text-align: right;">Input data <b>A03573</b></p>	TEST1 to TEST5
Input with built-in pull-up resistor	<p style="text-align: right;">Input data <b>A03574</b></p>	$\overline{\text{RES}}$
Input with built-in pull-down resistor	<p style="text-align: right;">Input data <b>A03575</b></p>	$\overline{\text{SEL}}$ C, SAIF, SAOF
CMOS intermediate current output Low Schmitt input	<p style="text-align: right;">Input data I/O control Output data <b>A03576</b></p>	D0 to D7
N-channel open drain intermediate current output Normal input	<p style="text-align: right;">Input data Test output data Off during normal operation <b>A03577</b></p>	P0 to P2
Analog input	<p style="text-align: right;"><b>A03573</b></p>	ADL1, ADR1, ADM1

## Specifications

### Absolute Maximum Ratings at Ta = 25°C, VSS = 0 V

Parameter	Symbol	Conditions	Ratings	Unit	Note
Maximum supply voltage	V <sub>DD</sub> max		-0.3 to +7.0	V	
Output voltage	V <sub>O1</sub>	OSC2 output	Allowed up to the oscillator voltage.	V	
	V <sub>O2</sub>	Pins other than OSC2	-0.3 to V <sub>DD</sub> + 0.3	V	
Input voltage	V <sub>IN</sub>		-0.3 to V <sub>DD</sub> + 0.3	V	
Peak output current	I <sub>OP1</sub>	Audio interface, external RAM interface	-2 to +4	mA	1
	I <sub>OP2</sub>	Microcontroller interface, P3, P4	-2 to +10	mA	2
Average output current	I <sub>OA1</sub>	Audio interface, external RAM interface: per pin	-2 to +4	mA	1
	I <sub>OA2</sub>	Microcontroller interface, P3, P4: per pin	-2 to +10	mA	2
	ΣI <sub>OA1</sub>	Total for FS384O, LRCKO, BCKO, and ASO	-10 to +10	mA	
	ΣI <sub>OA2</sub>	Total for DWRT, DREAD, RAS, CAS, A3 to A8 and D0 to D7	-30 to +30	mA	
	ΣI <sub>OA3</sub>	Total for A0 to A2, SIAK, P3 and P4	-10 to +10	mA	
Allowable power dissipation	Pd max	Ta = -30 to +70°C	700	mW	
Operating temperature	Topr		-30 to +70	°C	
Storage temperature	Tstg		-40 to +125	°C	

### Allowable Operating Ranges

at Ta = -30 to +70°C, all V<sub>DD</sub> = 4.75 to 5.25 V, all V<sub>SS</sub> = 0 V unless otherwise specified

Parameter	Symbol	Conditions	min	typ	max	Unit	Note
Operating supply voltage	V <sub>DD</sub>		4.75		5.25	V	
Input high level voltage	V <sub>IH1</sub>	Audio interface, external RAM interface	2.4			V	4
	V <sub>IH2</sub>	P0 to P2, SELC, SAIF, SAOF, TEST1 to TEST5	0.7 V <sub>DD</sub>			V	5
	V <sub>IH3</sub>	RES, OSC1, microcontroller interface	0.75 V <sub>DD</sub>			V	6
Input low level voltage	V <sub>IL1</sub>	Audio interface, external RAM interface			0.8	V	4
	V <sub>IL2</sub>	P0 to P2, SELC, SAIF, SAOF, TEST1 to TEST5			0.3 V <sub>DD</sub>	V	5
	V <sub>IL3</sub>	RES, OSC1, microcontroller interface			0.25 V <sub>DD</sub>	V	6
Instruction cycle time	t <sub>CYC</sub>		58		59.11	ns	
[External Clock Input Conditions]							
Frequency	f <sub>EXT</sub>		16.85		17.01	MHz	
Pulse width	t <sub>EXTH</sub>	Related to the FS384I pin. Shown in Figure 1. max: 44.1 kHz × 384 × 1.005 min: 44.1 kHz × 384 × 0.995	23			ns	
	t <sub>EXTL</sub>		23			ns	
Rise time	t <sub>EXTR</sub>				9	ns	
Fall time	t <sub>EXTF</sub>				9	ns	
[Self-Excitation Oscillation Conditions]							
Oscillator frequency	f <sub>OSC</sub>	OSC1 and OSC2: shown in Figure 2. 44.1 kHz × 768 × ± 0.1%	33.84		33.90	MHz	
Oscillator stabilization period	f <sub>OSCS</sub>	Shown in Figure 3.			100	ms	
[Audio Data Input Conditions]							
Transfer bit clock period	t <sub>BCYC</sub>	Related to the BCKI and ASI pins. Shown in Figure 4.	354			ns	
Transfer bit clock pulse width	t <sub>BCW</sub>		100			ns	
Data setup time	t <sub>S</sub>		70			ns	
Data hold time	t <sub>H</sub>		70			ns	
[Serial Input Clock Conditions]							
Serial clock period	t <sub>SCYC</sub>	Related to the microcontroller interface. Shown in Figure 5. (Related to the SICK, SI and SRDY pins.)	480			ns	
Serial clock pulse width	t <sub>SCW</sub>		200			ns	
Data setup time	t <sub>SS</sub>		70			ns	
Data hold time	t <sub>SH</sub>		70			ns	
SRDY hold time	t <sub>SYH</sub>		200			ns	
SRDY pulse width	t <sub>SYW</sub>		200			ns	
[DRAM Input Conditions]							
Input data setup time	t <sub>DSI</sub>	Related to external DRAM data input. Shown in Figure 6. (Related to the CAS and D0 to D7 pins.)	20			ns	
Input data hold time	t <sub>DHI</sub>		0			ns	

## LC83025E

### Electrical Characteristics 1

at  $T_a = -30$  to  $+70^\circ\text{C}$ , all  $V_{DD} = 4.75$  to  $5.25$  V, all  $V_{SS} = 0$  V unless otherwise specified

Parameter	Symbol	Conditions	min	typ	max	Unit	Note
Input low level current	$I_{IL1}$	RES, $V_{IN} = V_{SS}$ (Input pins with built-in pull-up resistor)	-250	-100		$\mu\text{A}$	8
	$I_{IL2}$	P0 to P2, $V_{IN} = V_{SS}$	-10			$\mu\text{A}$	
	$I_{IL3}$	Other input-only pins	-10			$\mu\text{A}$	
Input high level current	$I_{IH1}$	SELC, SAIF, SAOF, $V_{IN} = V_{DD}$ (Input pins with built-in pull-down resistor)		100	250	$\mu\text{A}$	8
	$I_{IH2}$	P0 to P2, $V_{IN} = V_{DD}$ (n-channel transistor: off)			10	$\mu\text{A}$	
	$I_{IH3}$	Other input-only pins			10	$\mu\text{A}$	
Output high level voltage	$V_{OH1}$	$I_{OH} = -0.4$ mA	4.0	4.98		V	1, 8
	$V_{OH2}$	$I_{OH} = -50$ $\mu\text{A}$	$V_{DD} - 1.2$	4.997		V	2, 3, 8
Output low level voltage	$V_{OL1}$	$I_{OL} = 2$ mA		0.065	0.4	V	1, 8
	$V_{OL2}$	$I_{OL} = 10$ mA		0.32	1.5	V	2, 3, 8
Output off leakage current	$I_{OFF}$	$V_O = V_{SS}, V_{DD}$	-40		+40	$\mu\text{A}$	
I/O capacitance	$C_{IO}$				10	pF	
[Audio Data Output Timing]							
Output data hold time	$t_{OH}$	BCKO and ASO: shown in Figure 7.	-30			ns	7
Output data delay time	$t_{OD}$				50	ns	7
[External DRAM Access Timing]							
$\overline{\text{RAS}}$ high pulse width	$t_{RP}$	Timing for output to the external DRAM. Shown in Figure 8.	80			ns	7
$\overline{\text{RAS}}$ low pulse width	$t_{RAS}$		700			ns	7
$\overline{\text{CAS}}$ high pulse width	$t_{CP}$		50			ns	7
$\overline{\text{CAS}}$ low pulse width	$t_{CAS}$		95			ns	7
$\overline{\text{CAS}}$ cycle time	$t_{PC}$		175			ns	7
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ delay time	$t_{RCD}$		60			ns	7
$\overline{\text{CAS}}$ hold time	$t_{CSH}$		170			ns	7
$\overline{\text{RAS}}$ hold time	$t_{RSH}$		95			ns	7
$\overline{\text{RAS}}$ address setup time	$t_{ASR}$		60			ns	7
$\overline{\text{RAS}}$ address hold time	$t_{RAH}$		20			ns	7
$\overline{\text{CAS}}$ address setup time	$t_{ASC}$		30			ns	7
$\overline{\text{CAS}}$ address hold time	$t_{CAH}$		90			ns	7
$\overline{\text{DWRT}}$ pulse width	$t_{WP}$		95			ns	7
Write command setup time	$t_{WCS}$		12			ns	7
Write command hold time	$t_{WCH}$		65			ns	7
Output data setup time	$t_{DSO}$		30			ns	7
Output data hold time	$t_{DHO}$		100			ns	7
Crystal oscillator	C1	OSC1 and OSC2: shown in Figure 2.		13		pF	8
	C2			29		pF	8
Current drain	L	$V_{DD1}, V_{DD2}, V_{DD3}$ ; oscillator frequency: 33.8688 MHz		1.5		$\mu\text{H}$	8
	$I_{DD}$			60	95	mA	9

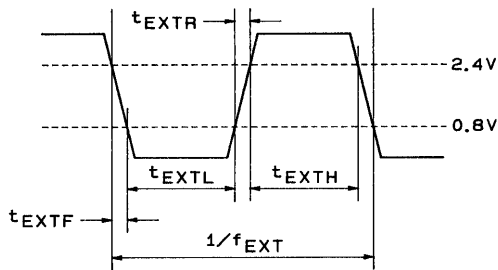


## LC83025E

### Electrical Characteristics 2 at $T_a = 25^\circ\text{C}$ , all $V_{DD} = 5.0\text{ V}$ , all $V_{SS} = 0\text{ V}$ unless otherwise specified

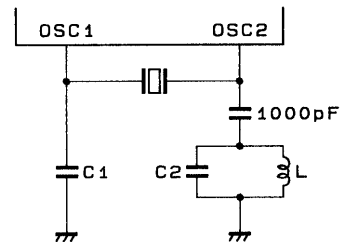
Parameter	Symbol	Conditions	min	typ	max	Unit	Note
[A/D Converter Block]							
Total harmonic distortion	A-THD	1 kHz, 0 dB: Lch		0.065		%	10, 11
		1 kHz, 0 dB: Rch		0.065		%	10, 11
		1 kHz, 0 dB: Mic		0.070		%	10, 11
Signal-to-noise ratio	A-S/N	1 kHz, 0 dB	70	75		dB	10, 11
Crosstalk	A-C · T	1 kHz, 0 dB		-72		dB	10
[D/A Converter Block]							
Total harmonic distortion	D-THD	1 kHz, -1 dB		0.045		%	10
Signal-to-noise ratio	D-S/N	1 kHz, -1 dB		78		dB	10
Crosstalk	D-C · T	1 kHz, -1 dB		-75		dB	10

- Note:
1. TTL output level pins: ASO, FS384O, BCKO, LRCKO, D0 to D7, A0 to A8, RAS, CAS, DREAD, DWRT
  2. CMOS intermediate current output pins: P3, P4, SIAK, TEST6
  3. N-channel open-drain intermediate current output pins: P0 to P2
  4. Low Schmitt input pins: BCKI, ASI, LRCKI, D0 to D7, FS384I
  5. Normal input pins: P0 to P2, TEST1 to TEST5, SELC, SAIF, SAOF
  6. Schmitt input pins: RES, SI, SICK, SIRQ, SRDY, OSC1
  7. When the load capacitance is 50 pF
  8. The values for the oscillator capacitors C1 and C2 include the wiring capacitances.
  9. The value for the current drain is a typical value for  $V_{DD} = 5\text{ V}$ , room temperature, and a typical sample.
  10. With weight A filter present, with  $F_s = 44.1\text{ kHz}$ , and tested in the Sanyo evaluation board.
  11. Varies with the values of the external components. The listed value is for the circuit structure and values shown in Figure 9 in the Sanyo evaluation board.



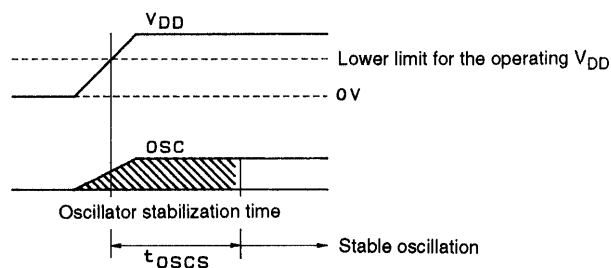
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Figure 1 External Clock Input Waveform (FS384I)



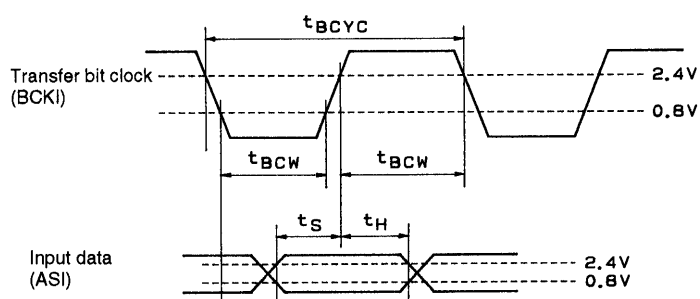
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Figure 2 Crystal Oscillator Circuit



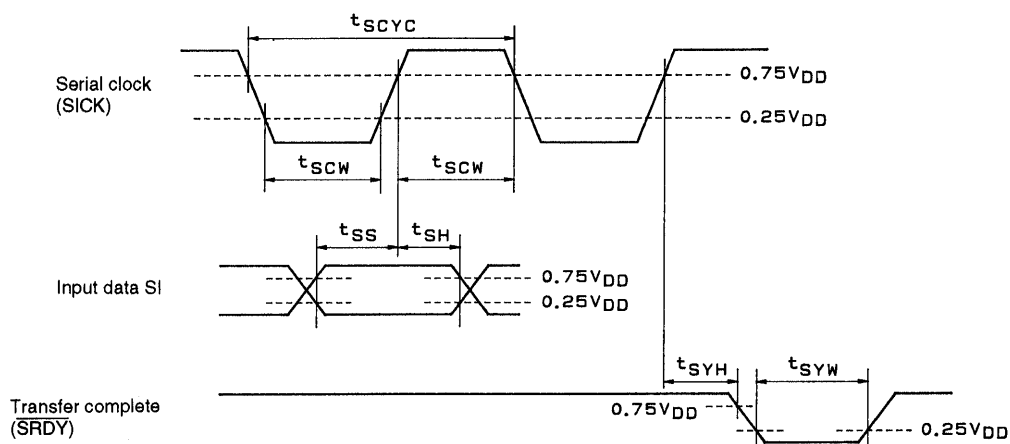
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Figure 3 Oscillator Stabilization Time



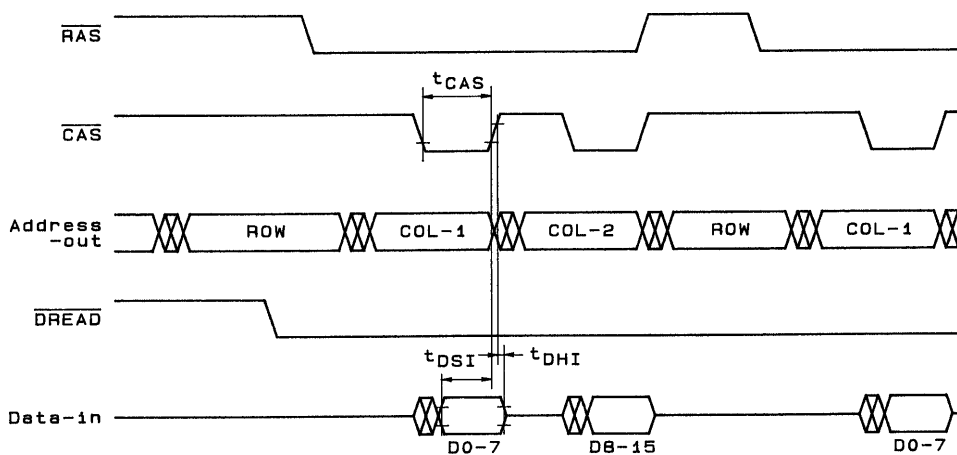
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Figure 4 Audio Data Input Conditions



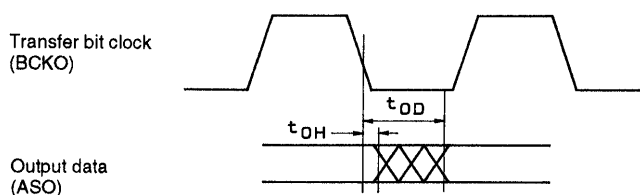
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Figure 5 Microcontroller Interface



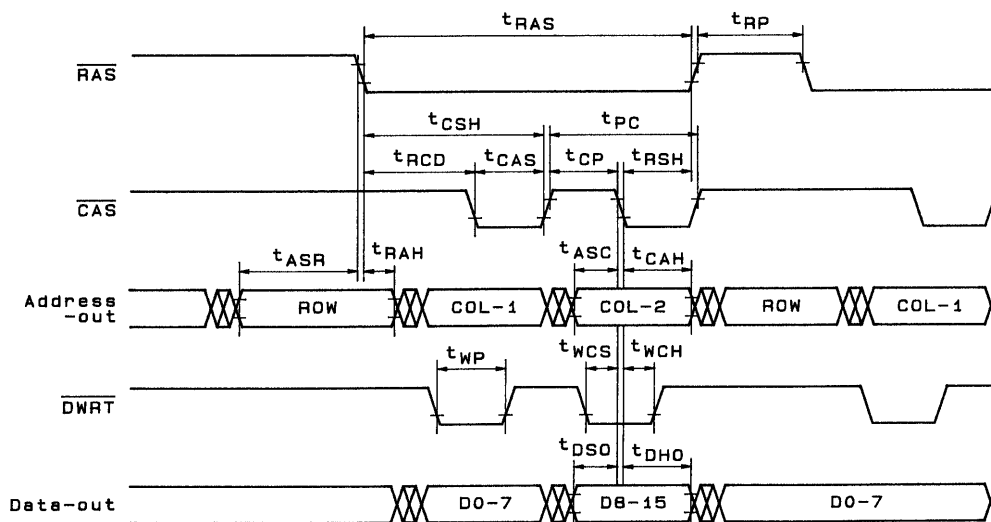
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Figure 6 Timing for Data Input from External DRAM



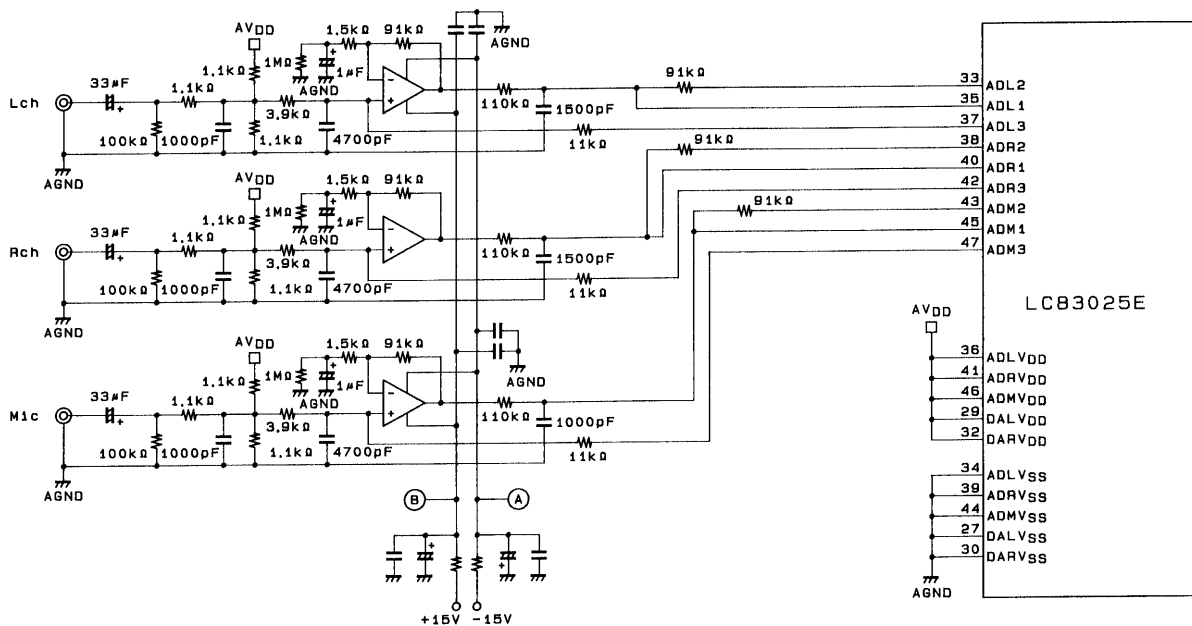
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Figure 7 Audio Data Output Timing



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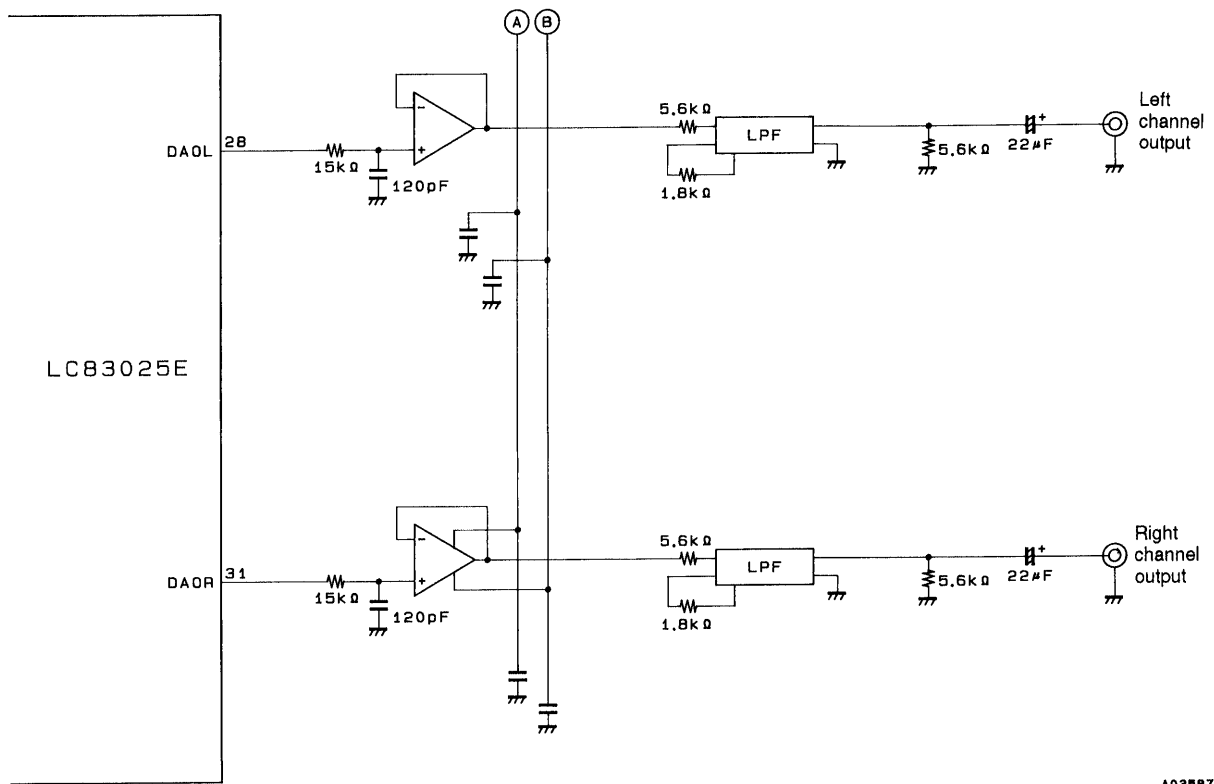
Figure 8 Timing for Data Output to External DRAM



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Figure 9 Sample A/D Converter External Circuit

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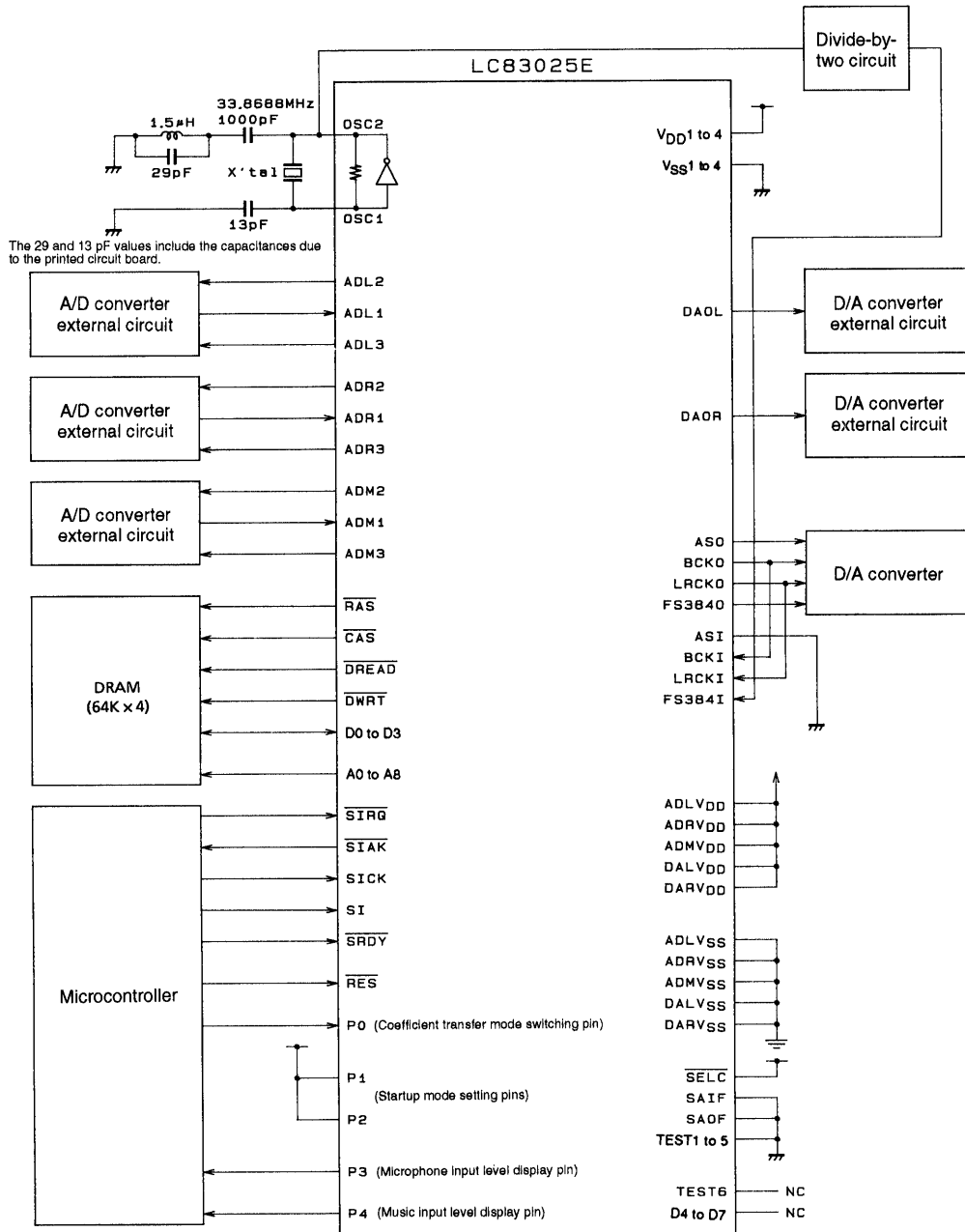


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Figure 10 Sample D/A Converter External Circuit

# LC83025E

## Sample Peripheral Circuit Connection (For applications that do not use digital input)

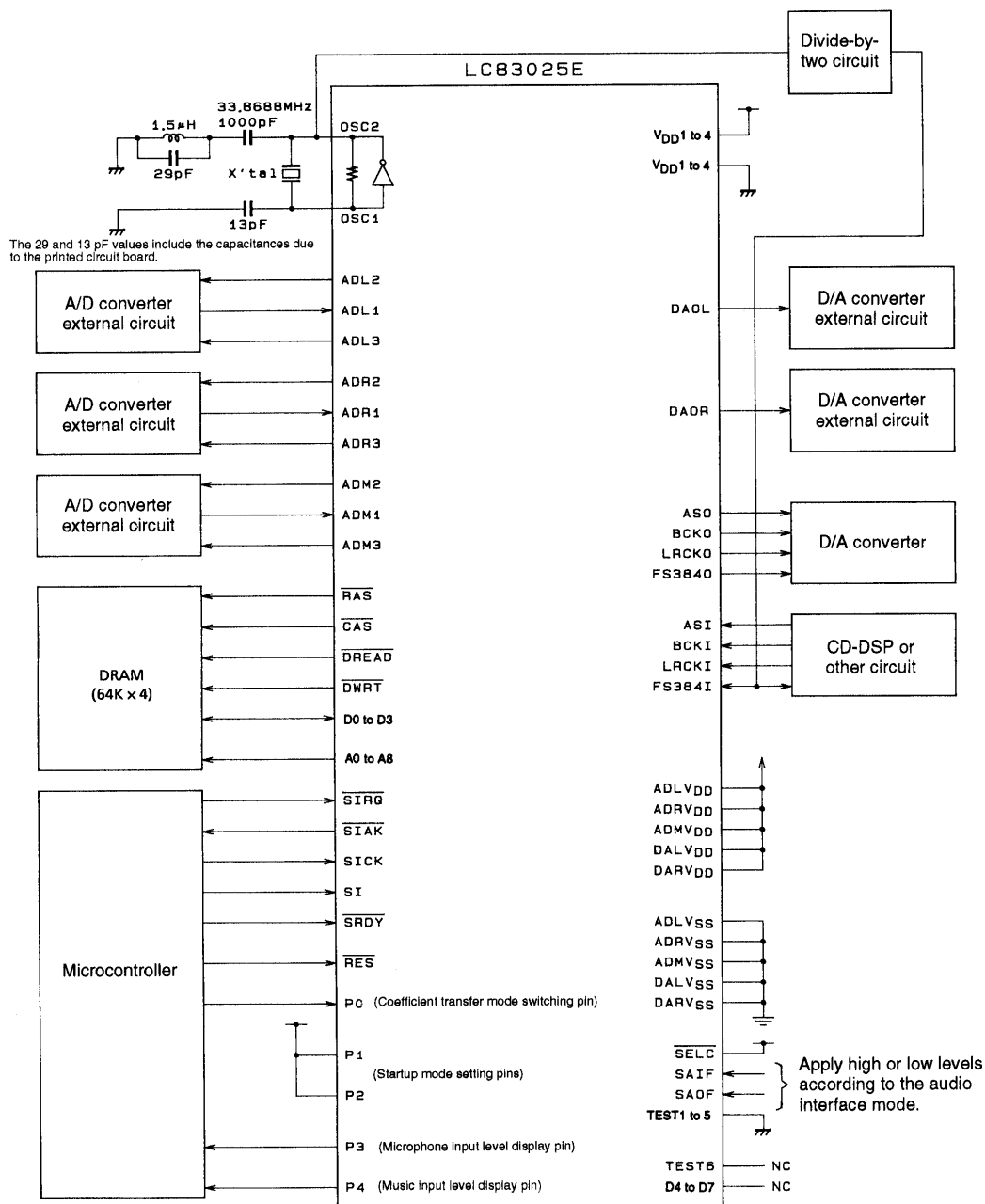


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Whether or not the digital outputs and the analog L/R outputs will be used will be determined by the end product specifications. These pins should be left open if unused.

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## Sample Peripheral Circuit Connection (For applications that use digital input.)



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Whether or not the analog L/R inputs and the analog L/R outputs will be used will be determined by the end product specifications. A high or low level should be applied to unused input pins, and unused output pins should be left open.

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