EPSON

E0C6256

4-bit Single Chip Microcomputer

Low Voltage Operation Products

- Core CPU Architecture
- R-f Converter
- Serial Interface

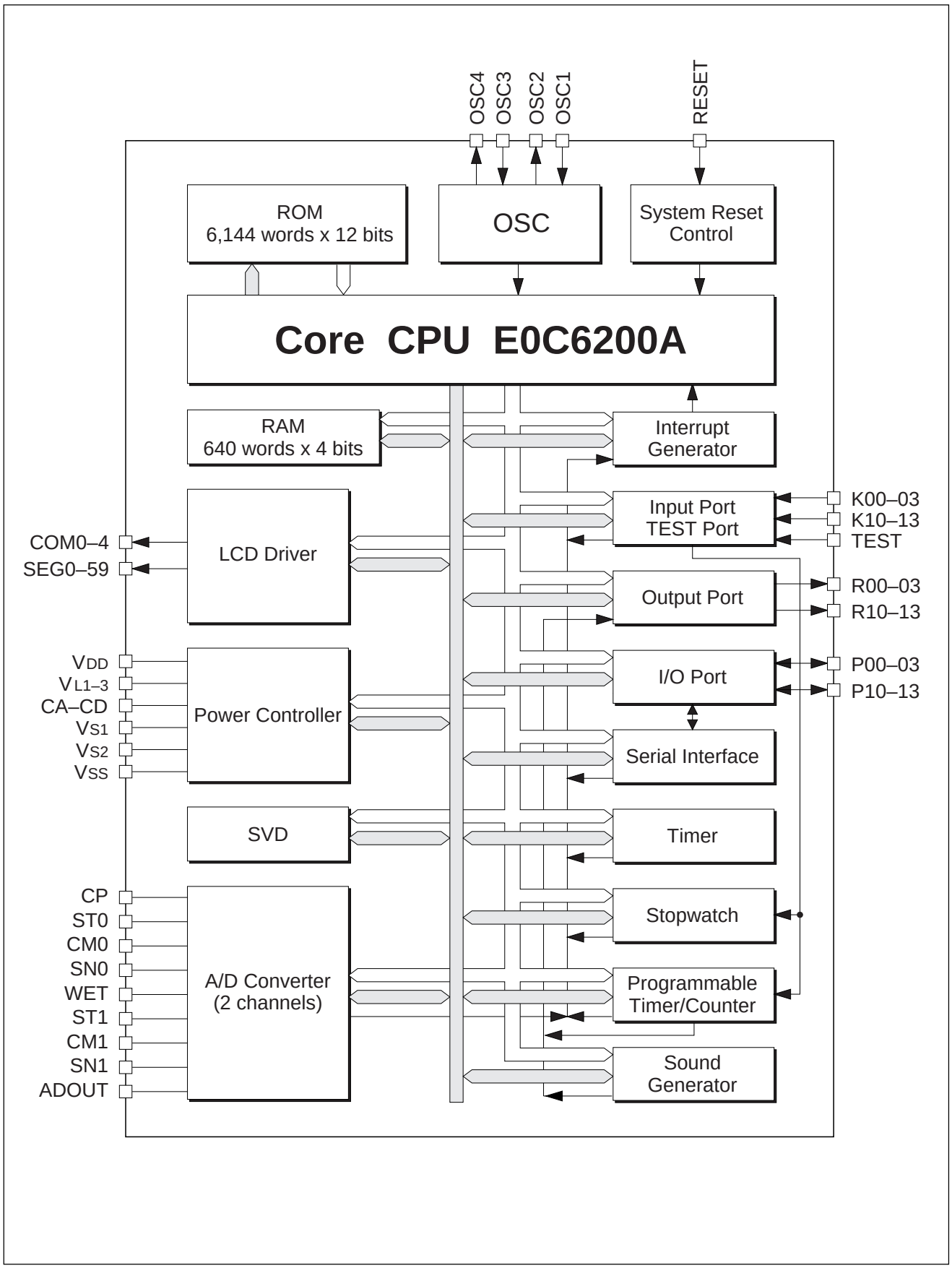
■ DESCRIPTION

The E0C6256 is a CMOS 4-bit single-chip microcomputer, built-in core CPU E0C6200A, ROM, RAM, A/D converter (R-f conversion type), SVD circuit, LCD driver, serial interface, watchdog timer, programmable timer, time base counter, and others.
It can realize system to measure temperature and/or humidity by the built-in A/D converter and externally attached parts.
Because of its low-voltage operation and low power consumption, this series is ideal for a wide range of applications, and is especially suitable for battery-driven systems.

■ FEATURES

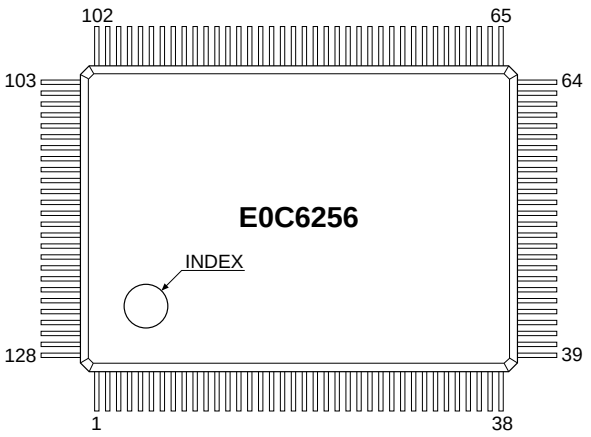
- CMOS LSI 4-bit parallel processing
- Twin clock ..... Crystal oscillation circuit (with built-in drain capacitance) : 32.768kHz (Typ.)
  CR or Ceramic oscillation circuit (mask option) : 1MHz (Typ.)
- Instruction set ..... 108 instructions
- Instruction cycle time ..... 32.768kHz clock : 153µsec, 214µsec, 366µsec
  1MHz clock : 5µsec, 7µsec, 12µsec
- ROM ..... 6,144 × 12 bits
- RAM ..... 640 × 4 bits
- Input port ..... 8 bits (pull-down resistors are available by mask option)
- Output port ..... 8 bits (BZ, FOUT and PTOVF outputs can be selected by software)
- I/O port ..... 8 bits (4 bits can be switched to serial I/O by software)
- Serial interface ..... 1 port (8-bit clock synchronous type)
- A-D converter ..... R-f (resistance/frequency) conversion type, 2 channels
- LCD driver ..... 60 segments × 5, 4, 3 or 2 commons (selected by software)
  LCD drive voltage: 1.05V to 1.40V, programmable (step by 0.05V)
- Time base counter ..... Clock timer 1 channel
  1/1000sec stopwatch timer 1 channel
- Programmable timer ..... 8-bit : 1 channel, with event counter function
- Watchdog timer
- Supply voltage detection (SVD) circuit .. 1.05/1.20/1.35V, programmable
  (when 1.5V system is selected by mask option)
  2.30/2.45/2.60V, programmable
  (when 3.0V system is selected by mask option)
- Interrupt ..... External : Input port 2 interrupts
  Internal : Clock timer 3 interrupts
  Serial interface 1 interrupt
  A/D converter 1 interrupt
- Supply voltage ..... 0.9V to 3.6V
  (2.2–3.6V when OSC3 is used, 1.35–3.6V when A/D converter is used)
- Current consumption ..... HALT mode (32.768kHz/1.5V, normal) : 1.2µA (Typ.)
  HALT mode (32.768kHz/3.0V, halver) : 650nA (Typ.)
  OPERATING mode (32.768kHz/1.5V, normal) : 3.5µA (Typ.)
  OPERATING mode (32.768kHz/3.0V, halver) : 2.0µA (Typ.)
  OPERATING mode (1MHz/3.0V, ceramic) : 170µA (Typ.)
  OPERATING mode (1MHz/3.0V, CR) : 220µA (Typ.)
- Package ..... QFP5-128pin (plastic), QFP5-100pin (plastic)
  Die form

■ BLOCK DIAGRAM



■ PIN CONFIGURATION

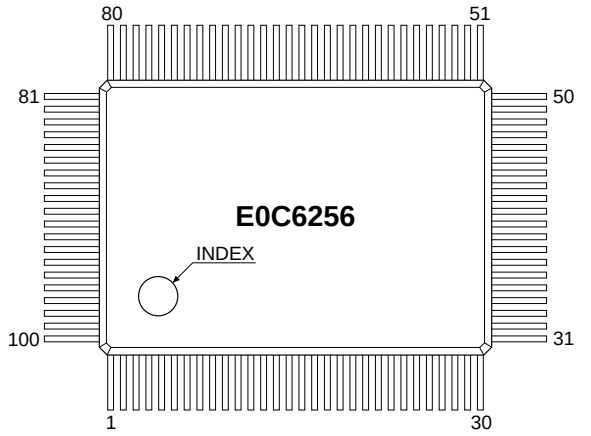
QFP5-128pin



Pin No.	Pin name	Pin No.	Pin name	Pin No.	Pin name	Pin No.	Pin name
1	N.C.	33	OSC4	65	SEG58	97	V_{SS}
2	SEG27	34	V_{S1}	66	SEG59	98	N.C.
3	SEG28	35	SEG30	67	N.C.	99	N.C.
4	SEG29	36	SEG31	68	N.C.	100	N.C.
5	COM0	37	SEG32	69	N.C.	101	SEG0
6	COM1	38	N.C.	70	V_{DD}	102	SEG1
7	COM2	39	N.C.	71	RESET	103	SEG2
8	COM3	40	SEG33	72	TEST	104	SEG3
9	COM4	41	SEG34	73	K00	105	SEG4
10	CB	42	SEG35	74	K01	106	SEG5
11	CA	43	SEG36	75	K02	107	SEG6
12	V_{L3}	44	SEG37	76	K03	108	SEG7
13	V_{L2}	45	SEG38	77	K10	109	SEG8
14	V_{L1}	46	SEG39	78	K11	110	SEG9
15	CC	47	SEG40	79	K12	111	SEG10
16	CD	48	SEG41	80	K13	112	SEG11
17	V_{S2}	49	SEG42	81	R00	113	SEG12
18	V_{SS}	50	SEG43	82	R01	114	SEG13
19	ADOUT	51	SEG44	83	R02	115	SEG14
20	SN1	52	SEG45	84	R03	116	SEG15
21	WET	53	SEG46	85	R10	117	SEG16
22	ST1	54	SEG47	86	R11	118	SEG17
23	CM1	55	SEG48	87	R12	119	SEG18
24	SN0	56	SEG49	88	R13	120	SEG19
25	CM0	57	SEG50	89	P00	121	SEG20
26	ST0	58	SEG51	90	P01	122	SEG21
27	CP	59	SEG52	91	P02	123	SEG22
28	V_{DD}	60	SEG53	92	P03	124	SEG23
29	N.C.	61	SEG54	93	P10	125	SEG24
30	OSC1	62	SEG55	94	P11	126	SEG25
31	OSC2	63	SEG56	95	P12	127	SEG26
32	OSC3	64	SEG57	96	P13	128	N.C.

N.C. : No Connection

QFP5-100pin



Pin No.	Pin name	Pin No.	Pin name	Pin No.	Pin name	Pin No.	Pin name
1	SEG29	26	OSC2	51	SEG59	76	P11
2	COM0	27	OSC3	52	V_{DD}	77	P12
3	COM1	28	OSC4	53	RESET	78	P13
4	COM2	29	V_{S1}	54	TEST	79	V_{SS}
5	COM3	30	SEG30	55	K00	80	SEG0
6	COM4	31	SEG31	56	K01	81	SEG1
7	CB	32	SEG32	57	K02	82	SEG2
8	CA	33	SEG34	58	K03	83	SEG4
9	V_{L3}	34	SEG36	59	K10	84	SEG6
10	V_{L2}	35	SEG38	60	K11	85	SEG8
11	V_{L1}	36	SEG40	61	K12	86	SEG10
12	CC	37	SEG41	62	K13	87	SEG12
13	CD	38	SEG42	63	R00	88	SEG13
14	V_{S2}	39	SEG43	64	R01	89	SEG14
15	ADOUT	40	SEG44	65	R02	90	SEG15
16	SN1	41	SEG45	66	R03	91	SEG16
17	WET	42	SEG46	67	R10	92	SEG17
18	ST1	43	SEG47	68	R11	93	SEG18
19	CM1	44	SEG48	69	R12	94	SEG19
20	SN0	45	SEG49	70	R13	95	SEG21
21	CM0	46	SEG51	71	P00	96	SEG23
22	ST0	47	SEG53	72	P01	97	SEG25
23	CP	48	SEG55	73	P02	98	SEG26
24	V_{DD}	49	SEG57	74	P03	99	SEG27
25	OSC1	50	SEG58	75	P10	100	SEG28

■ PIN DESCRIPTION

Pin name	Pin No.		In/Out	Function
	QFP5-128pin	QFP5-100pin		
V_{DD}	28, 70	24, 52	–	Power supply pin (+)
V_{SS}	18, 97	79	–	Power supply pin (–)
V_{S1}	34	29	O	Regulated voltage output pin for oscillation and internal logic
V_{S2}	17	14	O	Boosting/reducing power supply output pin
V_{L1}	14	11	O	Output pin for regulated power supply for LCD
V_{L2}	13	10	O	Output pin for LCD booster ($V_{L1} \times 2$)
V_{L3}	12	9	O	Output pin for LCD booster ($V_{L1} \times 3$)
CA, CB	11, 10	8, 7	–	Capacitor connection pin for LCD booster
CC, CD	15, 16	12, 13	–	Capacitor connecting pin for boosting/reducing power supply
OSC1	30	25	I	Crystal oscillation input pin
OSC2	31	26	O	Crystal oscillation output pin
OSC3	32	27	I	Ceramic or CR oscillation input pin (selected by mask option)
OSC4	33	28	O	Ceramic or CR oscillation output pin (selected by mask option)
K00–K03	73–76	55–58	I	Input port pin
K10–K13	77–80	59–62	I	Input port pin
P00–P03	89–92	71–74	I/O	I/O port pin
P10–P13	93–96	75–78	I/O	I/O port pin (switching to SIN, SOUT, SCLK, SRDY pin is possible by software)
R00–R03	81–84	63–66	O	Output port pin
R10–R13	85–88	67–70	O	Output port pin (switching to BZ, PTOVF, FOUT output is possible by software)
COM0–COM4	5–9	2–6	O	LCD common output pin (1/5, 1/4, 1/3, 1/2 duty, programmable)
SEG0–SEG59*	101–127, 2–4 35–37, 40–66	80–100 1, 30–51	O	LCD segment output pin (DC output may be selected by mask option)
CP	27	23	O	A/D converter test output pin
ST0	26	22	O	A/D converter CH0 CR oscillation output pin
CM0	25	21	O	A/D converter CH0 CR oscillation output pin
SN0	24	20	I	A/D converter CH0 CR oscillation input pin
WET	21	17	O	A/D converter CH1 CR oscillation output pin
ST1	22	18	O	A/D converter CH1 CR oscillation output pin
CM1	23	19	O	A/D converter CH1 CR oscillation output pin
SN1	20	16	I	A/D converter CH1 CR oscillation input pin
ADOUT	19	15	O	A/D converter oscillation frequency output pin
RESET	71	53	I	Initial reset input pin
TEST	72	54	I	Testing input pin

* The following SEG pins are not included in the QFP5-100pin package, so they cannot be used.
SEG3, SEG5, SEG7, SEG9, SEG11, SEG20, SEG22, SEG24, SEG33, SEG35, SEG37, SEG39, SEG50, SEG52, SEG54, SEG56

■ ELECTRICAL CHARACTERISTICS

● Absolute Maximum Ratings

(V_{DD}=0V)

Rating	Symbol	Value	Unit
Supply voltage	V_{SS}	-7.0 to 0.5	V
Input voltage (1)	V_I	V_{SS} - 0.3 to 0.5	V
Input voltage (2)	V_{IOSC}	V_{S1} - 0.3 to 0.5	V
Permissible total output current *1	ΣI_{VSS}	10	mA
Operating temperature	Topr	-20 to 70	°C
Storage temperature	Tstg	-65 to 150	°C
Soldering temperature / Time	Tsol	260°C, 10sec (lead section)	–
Allowable dissipation *2	P_D	250	mW

∗1 The permissible total output current is the sum total of the current (average current) that simultaneously flows from the output pins (or is drawn in).
∗2 In case of plastic package (QFP5-100pin, QFP5-128pin).

● Recommended Operating Conditions

Condition	Symbol	Remark		Min.	Typ.	Max.	Unit
Supply voltage	V_{SS}	V_{DD}=0V	Normal mode (OSC3: OFF)	-3.6	-3.0/-1.5	-1.3	V
			Normal mode (OSC3: ON)	-3.6	-3.0	-2.2	V
			Halver mode	-3.6	-3.0	-2.55	V
			Doubler mode	-1.4	-1.1	-0.9	V
Oscillation frequency (1)	f_{OSC1}			–	32.768	–	kHz
Oscillation frequency (2)	f_{OSC3}	Duty 50±5%		300	1,000	1,200	kHz

● DC Characteristics

(Unless otherwise specified, the values listed below are standard values under the following conditions:
V_{DD}=0V, V_{SS}=-1.5V/-3.0V, f_{OSC1}=32.768kHz, Ta=25°C, V_{S1}/V_{L1}/V_{L2}/V_{L3} are internal voltage, C1–C7=0.1µF)

Characteristic	Symbol	Condition			Min.	Typ.	Max.	Unit
High level input voltage (1)	V_{IH1}		K00–03, K10–13, P00–03, P10–13		0.2•V_{SS}		0	V
High level input voltage (2)	V_{IH2}		RESET, TEST		0.1•V_{SS}		0	V
Low level input voltage (1)	V_{IL1}		K00–03, K10–13, P00–03, P10–13		V_{SS}		0.8•V_{SS}	V
Low level input voltage (2)	V_{IL2}		RESET, TEST		V_{SS}		0.9•V_{SS}	V
High level input current (1)	I_{IH1}	V_{IH1}=0V, Without pull down resistor	K00–03, K10–13, P00–03, P10–13 RESET, TEST		0		0.5	µA
High level input current (2)	I_{IH2}	V_{IH2}=0V, With pull down resistor	K00–03, K10–13, P00–03	V_{SS}=-1.5V	2		10	µA
			P10–13, RESET, TEST	V_{SS}=-3.0V	4		16	µA
Low level input current	I_{IL}	V_{IL}=V_{SS}	K00–03, K10–13, P00–03, P10–13 RESET, TEST		-0.5		0	µA
High level output current	I_{OH1}	V_{OH1}=0.1•V_{SS}	P00–03, P10–13	V_{SS}=-1.5V			-150	µA
			R00–03, R10–13	V_{SS}=-3.0V			-0.9	mA
Low level output current	I_{OL1}	V_{OL1}=0.9•V_{SS}	P00–03, P10–13	V_{SS}=-1.5V	400			µA
			R00–03, R10–13	V_{SS}=-3.0V	1.8			mA
Common output current	I_{OH2}	V_{OH2}=-0.05V	COM0–COM4				-3	µA
	I_{OL2}	V_{OL2}=V_{L3}+0.05V			3			µA
Segment output current (during LCD output)	I_{OH3}	V_{OH3}=-0.05V	SEG0–SEG59				-3	µA
	I_{OL3}	V_{OL3}=V_{L3}+0.05V			3			µA
Segment output current (during DC output)	I_{OH4}	V_{OH4}=0.1•V_{SS}	SEG0–SEG59	V_{SS}=-1.5V			-100	µA
				V_{SS}=-3.0V			-200	µA
	I_{OL4}	V_{OL4}=0.9•V_{SS}		V_{SS}=-1.5V	100			µA
				V_{SS}=-3.0V	200			µA

● Analog Circuit Characteristics and Current Consumption

(Unless otherwise specified, the values listed below are standard values under the following conditions:
V_{DD}=0V, V_{SS}=-1.5V/-3.0V, f_{OSC1}=32.768kHz, C_G=25pF, Ta=25°C, V_{S1}/V_{L1}/V_{L2}/V_{L3} are internal voltage, C1–C7=0.1µF)
(During A/D operation: C=2,200pF, Reference resistance=10kΩ, Sensor=10kΩ)

Characteristic	Symbol	Condition		Min.	Typ.	Max.	Unit
LCD drive voltage *6	V_{L1}	Connect 1MΩ load resistor between V_{DD} and V_{L1} (no panel load)	VLCHG2–VLCHG0 = "0"	-1.15	-1.05	-0.95	V
			VLCHG2–VLCHG0 = "1"	-1.20	-1.10	-1.00	V
			VLCHG2–VLCHG0 = "2"	-1.25	-1.15	-1.05	V
			VLCHG2–VLCHG0 = "3"	-1.30	-1.20	-1.10	V
			VLCHG2–VLCHG0 = "4"	-1.35	-1.25	-1.15	V
			VLCHG2–VLCHG0 = "5"	-1.40	-1.30	-1.20	V
			VLCHG2–VLCHG0 = "6"	-1.45	-1.35	-1.25	V
			VLCHG2–VLCHG0 = "7"	-1.50	-1.40	-1.30	V
	V_{L2}	Connect 1MΩ load resistor between V_{DD} and V_{L2} (no panel load)		2•V_{L1}-0.1		2•V_{L1}×0.9	V
	V_{L3}	Connect 1MΩ load resistor between V_{DD} and V_{L3} (no panel load)		3•V_{L1}-0.1		3•V_{L1}×0.9	V
SVD voltage (1)	V_{SVD1}	1.5V system	SVDS1 = "0", SVDS0 = "0"	-1.10	-1.05	-1.00	V
			SVDS1 = "0", SVDS0 = "1"	-1.25	-1.20	-1.15	V
			SVDS1 = "1", SVDS0 = "0"	-1.40	-1.35	-1.30	V
			SVDS1 = "1", SVDS0 = "1"	-1.40	-1.35	-1.30	V
SVD voltage (2)	V_{SVD2}	3.0V system	SVDS1 = "0", SVDS0 = "0"	-2.35	-2.30	-2.25	V
			SVDS1 = "0", SVDS0 = "1"	-2.50	-2.45	-2.40	V
			SVDS1 = "1", SVDS0 = "0"	-2.65	-2.60	-2.55	V
			SVDS1 = "1", SVDS0 = "1"	-2.65	-2.60	-2.55	V
SVD circuit response time	t_{SVD}					100	µsec
Power current consumption *1	I_{OP}	During HALT (32kHz)	Normal mode, no panel load		1.2	2.5	µA
		During HALT (32kHz)	Halver mode, no panel load		650	1,200	nA
		During HALT (32kHz)	Doubler mode, no panel load		2.5	5.0	µA
		During execution (32kHz) *2	Normal mode, OSCC="0"		3.5	6.0	µA
		During execution (32kHz) *2	Halver mode, OSCC="0"		2.0	4.0	µA
		During execution (32kHz) *2	Doubler mode, OSCC="0"		7.5	15.0	µA
		During A/D operation (32kHz, V_{SS}=-1.5V) *3	Normal mode, OSCC="0"		100	150	µA
		During A/D operation (32kHz, V_{SS}=-3.0V) *3	Normal mode, VSCHG="0"		200	300	µA
		During SVD operation (32kHz) *4	Normal mode, VSCHG="0"		10	20	µA
		During execution (1 MHz, ceramic oscillation) *2	no panel load		170	300	µA
		During execution (1 MHz, CR oscillation) *2, *5	no panel load		220	350	µA

∗1 LPWR = "1", VLCHG2–VLCHG0 = "0", within the operating voltage in each operating mode.
∗2 The A/D converter and SVD circuit are OFF status.
∗3 The SVD circuit is OFF status. Current consumed during HALT (32kHz, Normal mode) + A/D operating current
∗4 The A/D converter is OFF status. Current consumed during HALT (32kHz, Normal mode) + SVD operating current
∗5 The value in χMHz can be found by the following expression: I_{OP} (f_{OSC3} = χMHz) = I_{OP} (f_{OSC3} = 1MHz) × χ
∗6 V_{SS}/V_{S2} ≤ V_{L1} - 0.2V

● Oscillation Characteristics

The oscillation characteristics change depending on the conditions (components used, board pattern, etc.). Use the following characteristics as reference values.

Crystal oscillation circuit (OSC1)

(Unless otherwise specified, the values listed below are standard values under the following conditions:
V_{DD}=0V, V_{SS}=-1.5/-3.0V, Crystal: C-002R (C_I=35kΩ), C_G=25pF, C_D=built-in, Ta=25°C)

Characteristic	Symbol	Condition		Min.	Typ.	Max.	Unit
Oscillation start voltage	Vsta	tsta≤5sec (Vss)		-1.35			V
Oscillation stop voltage	Vstp	tstp≤10sec (Vss)	Normal mode	-1.35			V
			Doubler mode	-0.9			V
Built-in capacitance (drain)	C_D	Including the parasitic capacitance inside the IC (in chip)			20		pF
Frequency/voltage deviation	f/V	Vss=-0.9 to -3.6V				5	ppm
Frequency/IC deviation	f/IC			-10		10	ppm
Frequency adjustment range	f/C_G	C_G=5 to 25pF		35	45		ppm
Harmonic oscillation start voltage	V_{hho}	C_G=5pF (Vss)				-3.5	V
Permitted leak resistance	R_{leak}	Between OSC1 and V_{DD}, Vss		200			MΩ

CR oscillation circuit (OSC3)

(Unless otherwise specified, the values listed below are standard values under the following conditions:
V_{DD}=0V, V_{SS}=-3.0V, R_{CR}=40kΩ, Ta=25°C)

Characteristic	Symbol	Condition	Min.	Typ.	Max.	Unit
Oscillation frequency dispersion	f_{OSC3}		-30	900kHz	30	%
Oscillation start voltage	Vsta	(Vss)	-2.2			V
Oscillation start time	tsta	Vss=-2.2 to -3.6V			3	msec
Oscillation stop voltage	Vstp	(Vss)	-2.2			V

Ceramic oscillation circuit (OSC3)

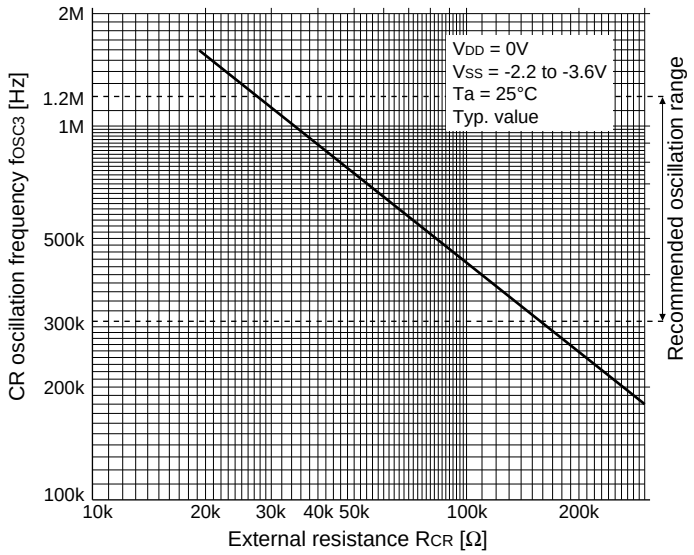
(Unless otherwise specified, the values listed below are standard values under the following conditions:
V_{DD}=0V, V_{SS}=-3.0V, Ceramic oscillator: 1MHz, C_{GC}=C_{DC}=100pF, Ta=25°C)

Characteristic	Symbol	Condition	Min.	Typ.	Max.	Unit
Oscillation start voltage	Vsta	(Vss)	-2.2			V
Oscillation start time	tsta	Vss=-2.2 to -3.6V			3	msec
Oscillation stop voltage	Vstp	(Vss)	-2.2			V

● Characteristic Curves

• CR oscillation frequency characteristic

The oscillation characteristics change depending on the conditions (components used, board pattern, etc.). Use the following characteristics as reference values and evaluate the characteristics on the actual product.

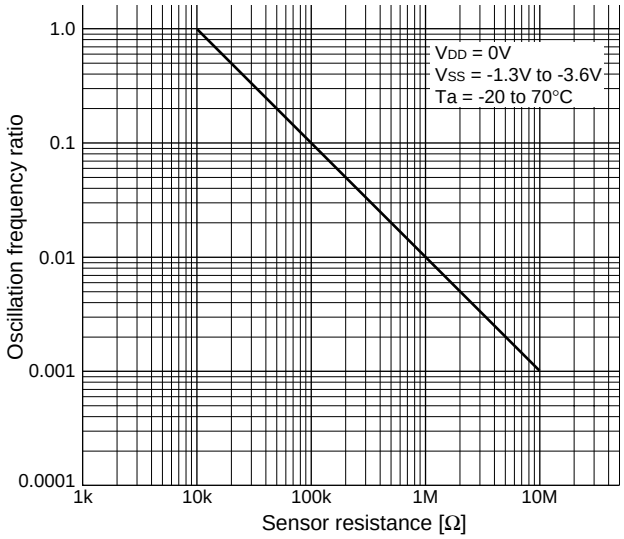


• A/D converter sensor resistance - oscillation frequency ratio characteristic

The following figure shows the oscillation frequency ratio (ratio of oscillation frequency by the reference resistance to oscillation frequency by the sensor resistance) when the following elements are connected. (Typ.)

Reference resistance ..... 10 kΩ
Sensor resistance ..... 10 kΩ to 20 MΩ
Oscillating capacitor ..... 2,200 pF

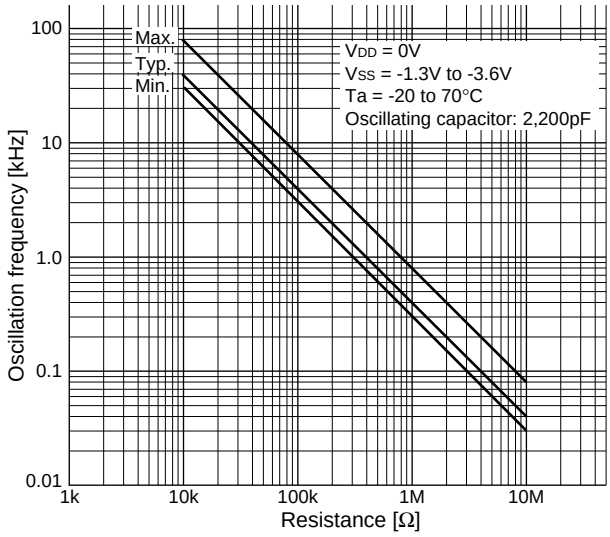
Note: If the R-f conversion uses a resistive sensor for channel 0 and channel 1, and the R-f conversion uses a resistive humidity sensor for channel 1, both characteristics will be the same.



• A/D converter resistance - oscillation frequency characteristic

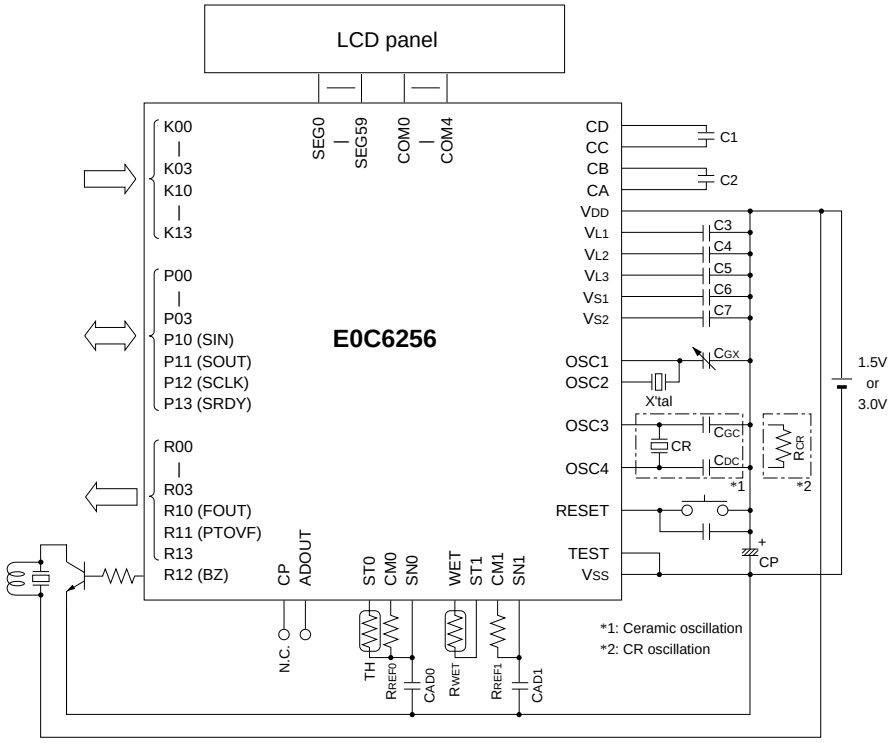
CR oscillation frequency of the A/D converter disperses in each sampling. Therefore, the count number of the up-counter should be decided after considering the fluctuation margin of the CR oscillation frequency by the reference resistance and sensor resistance to be used for the measurement.

Note:
- The following curves are characteristic when the oscillating capacitor is 2,200 pF.
- Typical oscillation frequency is characteristic when VSS = -3.0 V.
- The resistance value applies to both reference resistance and sensor resistance.
- If the R-f conversion uses a resistive sensor for channel 0 and channel 1, and the R-f conversion uses a resistive humidity sensor for channel 1, both characteristics will be the same.



■ BASIC EXTERNAL CONNECTION DIAGRAM

• For temperature measurement using thermistor (CH0) and humidity measurement using resistive humidity sensor (CH1)



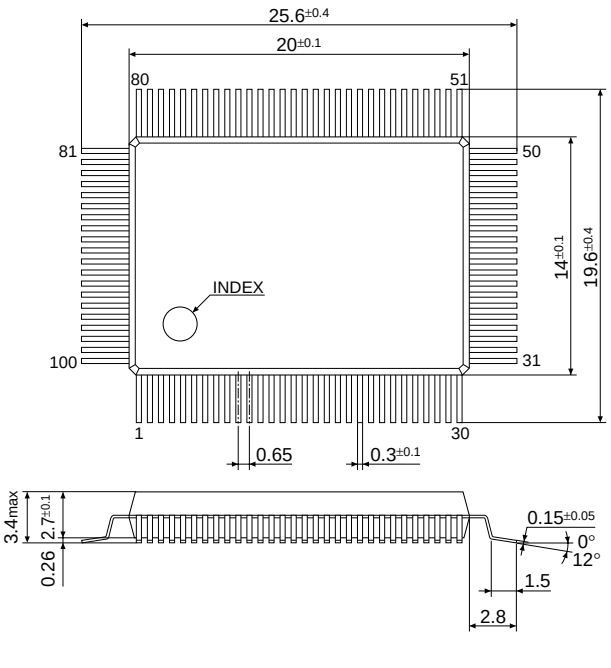
X'tal	Crystal oscillator	32.768kHz, CI(Max.) = 35kΩ
C_{GX}	Trimmer capacitor	5–25pF
CR	Ceramic oscillator	1MHz
C_{GC}	Gate capacitor	100pF
C_{DC}	Drain capacitor	100pF
R_{CR}	Resistor for CR oscillation	40kΩ (f_{OSC3} ≈ 900kHz)
TH	Thermistor	
R_{REF0}	Reference resistance for A/D conversion (CH0)	
C_{AD0}	Capacitor for A/D conversion (CH0)	2,200pF
R_{WET}	Resistive humidity sensor	
R_{REF1}	Reference resistance for A/D conversion (CH1)	
C_{AD1}	Capacitor for A/D conversion (CH1)	2,200pF
C1–C7 *	Capacitors	0.1µF
CP	Capacitor	3.3µF

* When the operating mode is only used at normal mode, the capacitors C1 and C7 are not necessary.

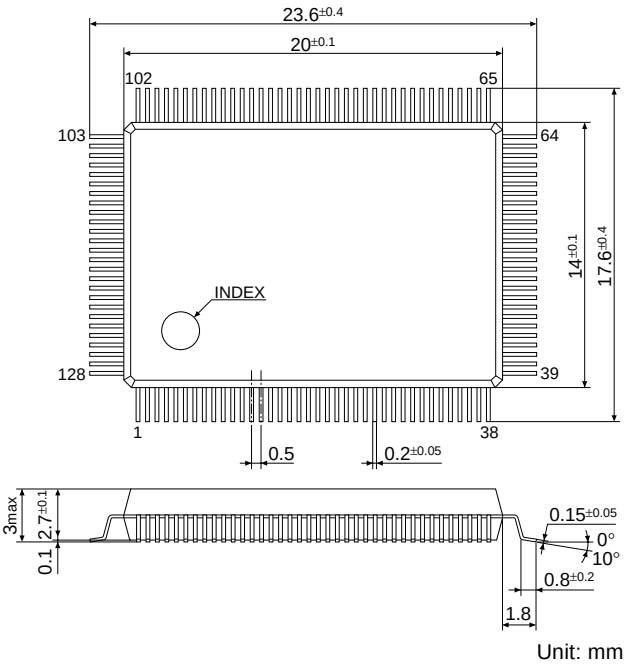
Note: The above table is simply an example, and is not guaranteed to work.

■ PACKAGE DIMENSIONS

Plastic QFP5-100pin



Plastic QFP5-128pin



Unit: mm

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