EPSON

Micro MINI S1C60N03

4-bit Single Chip Microcomputer

Low Voltage Operation Products

- S1C6200B Core CPU
- Low Voltage and Low Power
- Built-in LCD Driver
- Low Cost Performance

■ DESCRIPTION

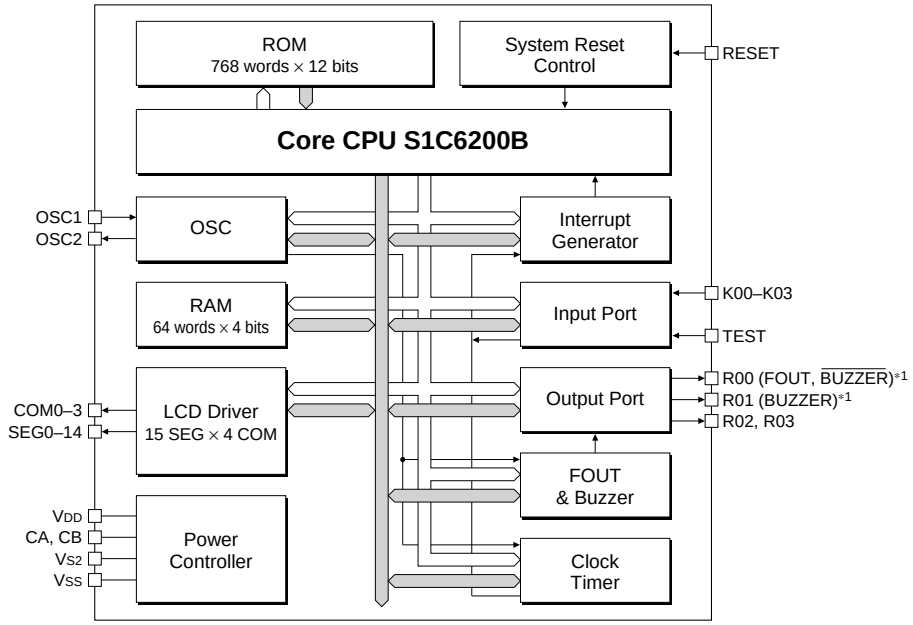
The S1C60N03 Series single-chip microcomputer features an S1C6200B CMOS 4-bit CPU as the core. It contains a 768 (words) × 12 (bits) ROM, 64 (words) × 4 (bits) RAM, LCD driver , 4-bit input port (K00–K03), 4-bit output port (R00–R03) and a timer.
The S1C60N03 Series is configured as follows, depending on the supply voltage.

S1C60N03: 3.0 V (1.8 to 3.6 V)
S1C60L03: 1.5 V (1.2 to 2.0 V)

■ FEATURES

- Core CPU S1C6200B
- Built-in oscillation circuit ..... Crystal 32.768 kHz (Typ.) or CR oscillation circuit 65 kHz (Typ.)
- Instruction set ..... 100 instructions
- ROM capacity ..... 768 words × 12 bits
- RAM capacity ..... 64 words × 4 bits
- Input port ..... 4 bits (pull-down resistors are available by mask option)
- Output ports ..... 4 bits (clock and buzzer outputs are possible by mask option)
- LCD driver ..... 15 segments × 4, 3 or 2 commons (1/4, 1/3 or 1/2 duty are selectable by mask option)
- Timer ..... 1 system (clock timer) built-in
- Interrupt ..... External: Input port interrupt 1 system
  Internal: Timer interrupt 1 system
- Supply voltage ..... 1.5 V (1.2 to 2.0 V) S1C60L03
  3.0 V (1.8 to 3.6 V) S1C60N03
- Current consumption (Typ.) ..... During HALT: 1.0 µA (32 kHz crystal, with power divider OFF)
  During execution: 2.5 µA (32 kHz crystal, with power divider OFF)
  15 µA (32 kHz crystal, with power divider ON)
- Supply form ..... Chip

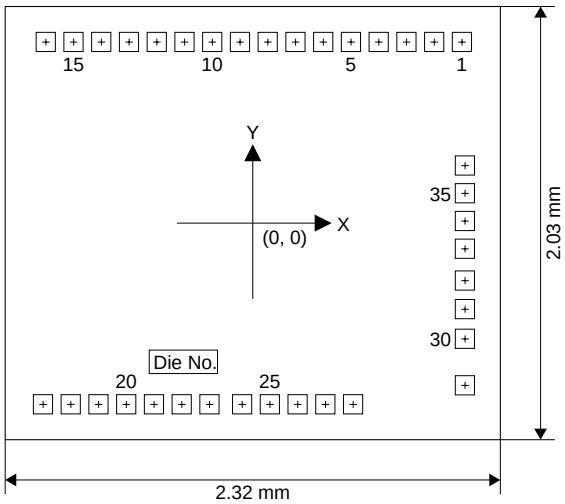
■ BLOCK DIAGRAM



*1: Terminal specifications can be selected by mask option.

■ PAD LAYOUT

Pad Layout Diagram



Chip thickness: 400 µm
Pad opening: 95 µm

Pad Coordinates (unit: µm)

No.	Pad name	X	Y	No.	Pad name	X	Y	No.	Pad name	X	Y
1	TEST	980	849	13	SEG3	-580	849	25	OSC2	80	-849
2	SEG14	850	849	14	SEG2	-710	849	26	OSC1	210	-849
3	SEG13	720	849	15	SEG1	-840	849	27	VDD	340	-849
4	SEG12	590	849	16	SEG0	-970	849	28	RESET	470	-849
5	SEG11	460	849	17	COM0	-983	-849	29	R00	994	-760
6	SEG10	330	849	18	COM1	-853	-849	30	R01	994	-542
7	SEG9	200	849	19	COM2	-723	-849	31	R02	994	-403
8	SEG8	70	849	20	COM3	-593	-849	32	R03	994	-269
9	SEG7	-60	849	21	CA	-463	-849	33	K00	994	-120
10	SEG6	-190	849	22	CB	-333	-849	34	K01	994	10
11	SEG5	-320	849	23	VS2	-203	-849	35	K02	994	140
12	SEG4	-450	849	24	VSS	-50	-849	36	K03	994	270

■ PAD DESCRIPTION

Pad name	Pad No.	I/O	Function
V_{DD}	27	(I)	Power supply terminal (+)
V_{SS}	24	(I)	Power supply terminal (-)
V_{S2}	23	O	LCD system voltage doubler ($2 \cdot V_{SS}$)/halver ($V_{SS}/2$) output
CA, CB	21, 22	–	Booster capacitor connecting terminal
OSC1	26	I	Crystal or CR oscillation input terminal *
OSC2	25	O	Crystal or CR oscillation output terminal *
K00–03	33–36	I	Input port terminal
R00	29	O	Output port terminal, $\overline{\text{BUZZER}}$ or FOUT output terminal *
R01	30	O	Output port terminal or BUZZER output terminal *
R02, R03	31, 32	O	Output port terminal
SEG0–14	2–16	O	LCD segment output or DC output terminal *
COM0–3	17–20	O	LCD common output terminal (1/4, 1/3 or 1/2 duty are selectable *)
RESET	28	I	Initial reset input terminal
TEST	1	I	Test input terminal

* Can be selected by mask option

■ OPTION LIST

1. DEVICE TYPE
   - ☐ 1. E0C6003 (Normal Type <S1C60N03>)
   - ☐ 2. E0C60L03 (Low Power Type <S1C60L03>)

2. LCD SPECIFICATION
   - BIAS SELECTION ..... ☐ 1. 1/3 Bias By Voltage Divider
     ☐ 2. 1/2 Bias By Voltage Divider
     ☐ 3. 1/2 Bias By Doubler/Halver
   - DUTY SELECTION ..... ☐ 1. 1/4 Duty
     ☐ 2. 1/3 Duty
     ☐ 3. 1/2 Duty

3. OSC1 SYSTEM CLOCK
   - ☐ 1. Crystal
   - ☐ 2. CR

4. MULTIPLE KEY ENTRY RESET
   - COMBINATION ..... ☐ 1. Not Use
     ☐ 2. Use K00, K01
     ☐ 3. Use K00, K01, K02
     ☐ 4. Use ALL K00–K03

5. INTERRUPT NOISE REJECTOR
   - K00–K03 ..... ☐ 1. Use
     ☐ 2. Not Use

6. TIMER INTERRUPT FREQUENCY
   - INTERRUPT FREQUENCY ..... ☐ 1. 32/16/2 Hz Interrupt
     ☐ 2. 64/16/2 Hz Interrupt

7. INPUT PORT PULL DOWN RESISTOR
   - K00 ..... ☐ 1. With Resistor ☐ 2. Gate Direct
   - K01 ..... ☐ 1. With Resistor ☐ 2. Gate Direct
   - K02 ..... ☐ 1. With Resistor ☐ 2. Gate Direct
   - K03 ..... ☐ 1. With Resistor ☐ 2. Gate Direct

8. R00 SPECIFICATION
   - OUTPUT TYPE ..... ☐ 1. DC Output
     ☐ 2. Buzzer Inverted Output (R00 Control)
     ☐ 3. FOUT Output

• FOUT OUTPUT SPACIFICATION

F1	☐ 1. 256[Hz]	F3 ..... ☐ 1. 1,024[Hz]
	☐ 2. 512[Hz]	☐ 2. 2,048[Hz]
	☐ 3. 1,024[Hz]	☐ 3. 4,096[Hz]
	☐ 4. 2,048[Hz]	☐ 4. 8,192[Hz]
	☐ 5. 4,096[Hz]	☐ 5. 16,384[Hz]
F2	☐ 1. 512[Hz]	F4 ..... ☐ 1. 2,048[Hz]
	☐ 2. 1,024[Hz]	☐ 2. 4,096[Hz]
	☐ 3. 2,048[Hz]	☐ 3. 8,192[Hz]
	☐ 4. 4,096[Hz]	☐ 4. 16,384[Hz]
	☐ 5. 8,192[Hz]	☐ 5. 32,768[Hz]

• OUTPUT SPECIFICATION ..... ☐ 1. Complementary ☐ 2. Pch-Open Drain

9. R01 SPECIFICATION
   - OUTPUT TYPE ..... ☐ 1. DC Output ☐ 2. Buzzer Output
   - OUTPUT SPECIFICATION ..... ☐ 1. Complementary ☐ 2. Pch-Open Drain

10. R02, R03 SPECIFICATION
   - R02 OUTPUT SPECIFICATION ... ☐ 1. Complementary ☐ 2. Pch-Open Drain
   - R03 OUTPUT SPECIFICATION ... ☐ 1. Complementary ☐ 2. Pch-Open Drain

■ ELECTRICAL CHARACTERISTICS

● Absolute Maximum Ratings

(V_{DD}=0V)

Rating	Symbol	Value	Unit
Supply voltage	V_{SS}	-5.0 to 0.5	V
Input voltage (1)	V_I	V_{SS} - 0.3 to 0.5	V
Input voltage (2)	V_{IOSC}	V_{SS} - 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)	–
Permissible dissipation	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 pin (or is drawn in).

● Recommended Operating Conditions

S1C60N03

(Ta=-20 to 70°C)

Condition	Symbol	Remark	Min.	Typ.	Max.	Unit
Supply voltage	V_{SS}	V_{DD}=0V	-3.6	-3.0	-1.8	V
Oscillation frequency	fosc	Crystal oscillation		32.768		kHz
		CR oscillation, R_{CR}=470kΩ	50	65	80	kHz
Booster capacitor	C_1		0.1			µF
Capacitor between V_{DD} and V_{S2}	C_2		0.1			µF

S1C60L03

(Ta=-20 to 70°C)

Condition	Symbol	Remark	Min.	Typ.	Max.	Unit
Supply voltage	V_{SS}	V_{DD}=0V	-0.2	-1.5	-1.2	V
Oscillation frequency	fosc	Crystal oscillation		32.768		kHz
		CR oscillation, R_{CR}=470kΩ	50	65	80	kHz
Booster capacitor	C_1		0.1			µF
Capacitor between V_{DD} and V_{S2}	C_2		0.1			µF

● DC Characteristics

S1C60N03

(Unless otherwise specified: V_{DD}=0V, V_{SS}=-3.0V, f_{OSC}=32.768kHz, Ta=25°C, V_{S2} is internal voltage, C_1=C_2=0.1µF)

Characteristic	Symbol	Condition		Min.	Typ.	Max.	Unit
High level input voltage (1)	V_{IH1}		K00–K03	0.2•V_{SS}		0	V
High level input voltage (2)	V_{IH2}		RESET	0.15•V_{SS}		0	V
Low level input voltage (1)	V_{IL1}		K00–K03	V_{SS}		0.8•V_{SS}	V
Low level input voltage (2)	V_{IL2}		RESET	V_{SS}		0.85•V_{SS}	V
High level input current (1)	I_{IH1}	V_{IH1}=0V, No pull down resistor	K00–K03	0		0.5	µA
High level input current (2)	I_{IH2}	V_{IH2}=0V, With pull down resistor	K00–K03	10		40	µA
High level input current (3)	I_{IH3}	V_{IH3}=0V, With pull down resistor	RESET	30		100	µA
Low level input current	I_{IL}	V_{IL}=V_{SS}	K00–K03 RESET, TEST	-0.5		0	µA
High level output current (1)	I_{OH1}	V_{OH1}=0.1•V_{SS}	R02, R03			-1.0	mA
High level output current (2)	I_{OH2}	V_{OH2}=0.1•V_{SS} (built-in protection resistance)	R00, R01			-1.0	mA
Low level output current (1)	I_{OL1}	V_{OL1}=0.9•V_{SS}	R02, R03	3.0			mA
Low level output current (2)	I_{OL2}	V_{OL2}=0.9•V_{SS} (built-in protection resistance)	R00, R01	3.0			mA
Common output current	I_{OH3}	V_{OH3}=-0.05V	COM0–COM3			-3	µA
	I_{OL3}	V_{OL3}=V_{L3}+0.05V		3			µA
Segment output current (during LCD output)	I_{OH4}	V_{OH4}=-0.05V	SEG0–SEG14			-3	µA
	I_{OL4}	V_{OL4}=V_{L3}+0.05V		3			µA
Segment output current (during DC output)	I_{OH5}	V_{OH5}=0.1•V_{SS}	SEG0–SEG14			-300	µA
	I_{OL5}	V_{OL5}=0.9•V_{SS}		300			µA

S1C60L03

(Unless otherwise specified: V_{DD}=0V, V_{SS}=-1.5V, f_{OSC}=32.768kHz, Ta=25°C, V_{S2} is internal voltage, C_1=C_2=0.1µF)

Characteristic	Symbol	Condition		Min.	Typ.	Max.	Unit
High level input voltage (1)	V_{IH1}		K00–K03	0.2•V_{SS}		0	V
High level input voltage (2)	V_{IH2}		RESET	0.15•V_{SS}		0	V
Low level input voltage (1)	V_{IL1}		K00–K03	V_{SS}		0.8•V_{SS}	V
Low level input voltage (2)	V_{IL2}		RESET	V_{SS}		0.85•V_{SS}	V
High level input current (1)	I_{IH1}	V_{IH1}=0V, No pull down resistor	K00–K03	0		0.5	µA
High level input current (2)	I_{IH2}	V_{IH2}=0V, With pull down resistor	K00–K03	5.0		20	µA
High level input current (3)	I_{IH3}	V_{IH3}=0V, With pull down resistor	RESET	9.0		100	µA
Low level input current	I_{IL}	V_{IL}=V_{SS}	K00–K03 RESET, TEST	-0.5		0	µA
High level output current (1)	I_{OH1}	V_{OH1}=0.1•V_{SS}	R02, R03			-200	µA
High level output current (2)	I_{OH2}	V_{OH2}=0.1•V_{SS} (built-in protection resistance)	R00, R01			-200	µA
Low level output current (1)	I_{OL1}	V_{OL1}=0.9•V_{SS}	R02, R03	700			µA
Low level output current (2)	I_{OL2}	V_{OL2}=0.9•V_{SS} (built-in protection resistance)	R00, R01	700			µA
Common output current	I_{OH3}	V_{OH3}=-0.05V	COM0–COM3			-3	µA
	I_{OL3}	V_{OL3}=V_{L3}+0.05V		3			µA
Segment output current (during LCD output)	I_{OH4}	V_{OH4}=-0.05V	SEG0–SEG14			-3	µA
	I_{OL4}	V_{OL4}=V_{L3}+0.05V		3			µA
Segment output current (during DC output)	I_{OH5}	V_{OH5}=0.1•V_{SS}	SEG0–SEG14			-100	µA
	I_{OL5}	V_{OL5}=0.9•V_{SS}		130			µA

● Analog Circuit Characteristics and Current Consumption

S1C60N03 (Crystal Oscillation)

(Unless otherwise specified: V_{DD}=0V, V_{SS}=-3.0V, f_{OSC}=32.768kHz, Ta=25°C, C_G=25pF, V_{S2} is internal voltage, C_1=C_2=0.1µF)

Characteristic	Symbol	Condition		Min.	Typ.	Max.	Unit
LCD drive voltage	V_{L1}	Connect 1 MΩ load resistor between V_{DD} and segment driver (SEG0–SEG14) when segment driver's level is V_{L1}		1/3·V_{SS} - 0.1	1/3·V_{SS}	1/3·V_{SS} ×0.9	V
	V_{L2}	Connect 1 MΩ load resistor between V_{DD} and segment driver (SEG0–SEG14) when segment driver's level is V_{L2}		2/3·V_{SS} - 0.1	2/3·V_{SS}	2/3·V_{SS} ×0.9	V
	V_{L3}	Connect 1 MΩ load resistor between V_{DD} and segment driver (SEG0–SEG14) when segment driver's level is V_{L3}			V_{SS}		V
Current consumption	I_{HLT}	During HALT with LCD OFF	No panel load		1.0	2.5	µA
	I_{EXE1}	During operation with LCD OFF			2.0	5.0	µA
	I_{EXE2}	During operation with power divider ON			15	20	µA

S1C60L03 (Crystal Oscillation)

(Unless otherwise specified: V_{DD}=0V, V_{SS}=-1.5V, f_{OSC}=32.768kHz, Ta=25°C, C_G=25pF, V_{S2} is internal voltage, C_1=C_2=0.1µF)

Characteristic	Symbol	Condition		Min.	Typ.	Max.	Unit
LCD drive voltage	V_{L1}	Connect 1 MΩ load resistor between V_{DD} and segment driver (SEG0–SEG14) when segment driver's level is V_{L1}		1/3·V_{S2} - 0.1	1/3·V_{S2}	1/3·V_{S2} ×0.9	V
	V_{L2}	Connect 1 MΩ load resistor between V_{DD} and segment driver (SEG0–SEG14) when segment driver's level is V_{L2}		2/3·V_{S2} - 0.1	2/3·V_{S2}	2/3·V_{S2} ×0.9	V
	V_{L3}	Connect 1 MΩ load resistor between V_{DD} and segment driver (SEG0–SEG14) when segment driver's level is V_{L3}		V_{S2} - 0.1	V_{S2}	V_{S2} ×0.9	V
Current consumption	I_{HLT}	During HALT with LCD OFF	No panel load		1.0	2.5	µA
	I_{EXE1}	During operation with LCD OFF			2.0	5.0	µA
	I_{EXE2}	During operation with power divider ON			15	20	µA

S1C60N03 (CR Oscillation)

(Unless otherwise specified: V_{DD}=0V, V_{SS}=-3.0V, f_{OSC}=65kHz, Ta=25°C, R_{CR}=470kΩ, V_{S2} is internal voltage, C_1=C_2=0.1µF)

Characteristic	Symbol	Condition		Min.	Typ.	Max.	Unit
LCD drive voltage	V_{L1}	Connect 1 MΩ load resistor between V_{DD} and segment driver (SEG0–SEG14) when segment driver's level is V_{L1}		1/3·V_{SS} - 0.1	1/3·V_{SS}	1/3·V_{SS} ×0.9	V
	V_{L2}	Connect 1 MΩ load resistor between V_{DD} and segment driver (SEG0–SEG14) when segment driver's level is V_{L2}		2/3·V_{SS} - 0.1	2/3·V_{SS}	2/3·V_{SS} ×0.9	V
	V_{L3}	Connect 1 MΩ load resistor between V_{DD} and segment driver (SEG0–SEG14) when segment driver's level is V_{L3}			V_{SS}		V
Current consumption	I_{HLT}	During HALT with LCD OFF	No panel load		8	15	µA
	I_{EXE1}	During operation with LCD OFF			15	20	µA
	I_{EXE2}	During operation with power divider ON			25	30	µA

S1C60L03 (CR Oscillation)

(Unless otherwise specified: V_{DD}=0V, V_{SS}=-1.5V, f_{OSC}=65kHz, Ta=25°C, R_{CR}=470kΩ, V_{S2} is internal voltage, C_1=C_2=0.1µF)

Characteristic	Symbol	Condition		Min.	Typ.	Max.	Unit
LCD drive voltage	V_{L1}	Connect 1 MΩ load resistor between V_{DD} and segment driver (SEG0–SEG14) when segment driver's level is V_{L1}		1/3·V_{S2} - 0.1	1/3·V_{S2}	1/3·V_{S2} ×0.9	V
	V_{L2}	Connect 1 MΩ load resistor between V_{DD} and segment driver (SEG0–SEG14) when segment driver's level is V_{L2}		2/3·V_{S2} - 0.1	2/3·V_{S2}	2/3·V_{S2} ×0.9	V
	V_{L3}	Connect 1 MΩ load resistor between V_{DD} and segment driver (SEG0–SEG14) when segment driver's level is V_{L3}		V_{S2} - 0.1	V_{S2}	V_{S2} ×0.9	V
Current consumption	I_{HLT}	During HALT with LCD OFF	No panel load		8	15	µA
	I_{EXE1}	During operation with LCD OFF			15	20	µA
	I_{EXE2}	During operation with power divider ON			25	30	µA

● Oscillation Characteristics

Oscillation characteristics will vary according to different conditions (elements used, boad pattern). Use the following characteristics are as reference values.

S1C60N03 Crystal Oscillation

(Unless otherwise specified: V_{DD}=0V, V_{SS}=-3.0V, f_{OSC}=32.768kHz, Crystal: Q13MC146, C_G=25pF, C_D=built-in, Ta=25°C)

Characteristic	Symbol	Condition	Min.	Typ.	Max.	Unit
Oscillation start voltage	Vsta	t_{sta}≤5sec (V_{SS})	-1.8			V
Oscillation stop voltage	Vstp	t_{stp}≤10sec (V_{SS})	-1.8			V
Built-in capacitance (drain)	C_D	Including the parasitic capacitance inside the IC (in chip)		20		pF
Frequency/voltage deviation	∂f/∂V	V_{SS}=-1.8 to -3.6V			5	ppm
Frequency/IC deviation	∂f/∂IC		-10		10	ppm
Frequency adjustment range	∂f/∂C_G	C_G=5 to 25pF	40			ppm
Harmonic oscillation start voltage	V_{hho}	C_G=5pF (V_{SS})			-3.6	V
Permitted leak resistance	R_{leak}	Between OSC1 and V_{DD}	200			MΩ

S1C60L03 Crystal Oscillation

(Unless otherwise specified: V_{DD}=0V, V_{SS}=-1.5V, f_{OSC}=32.768kHz, Crystal: Q13MC146, C_G=25pF, C_D=built-in, Ta=25°C)

Characteristic	Symbol	Condition	Min.	Typ.	Max.	Unit
Oscillation start voltage	Vsta	tsta≤5sec (V_{SS})	-1.2			V
Oscillation stop voltage	Vstp	tstp≤10sec (V_{SS})	-1.2			V
Built-in capacitance (drain)	C_D	Including the parasitic capacitance inside the IC (in chip)		20		pF
Frequency/voltage deviation	∂f/∂V	V_{SS}=-1.2 to -2.0V			5	ppm
Frequency/IC deviation	∂f/∂IC		-10		10	ppm
Frequency adjustment range	∂f/∂C_G	C_G=5 to 25pF	40			ppm
Harmonic oscillation start voltage	V_{hho}	C_G=5pF (V_{SS})			-2.0	V
Permitted leak resistance	R_{leak}	Between OSC1 and V_{DD}	200			MΩ

S1C60N03 CR Oscillation

(Unless otherwise specified: V_{DD}=0V, V_{SS}=-3.0V, R_{CR}=470kΩ, Ta=25°C)

Characteristic	Symbol	Condition	Min.	Typ.	Max.	Unit
Oscillation frequency dispersion	f_{OSC}		-20	65kHz	20	%
Oscillation start voltage	Vsta	(V_{SS})	-1.8			V
Oscillation start time	tsta	V_{SS}=-1.8 to -3.6V		3		mS
Oscillation stop voltage	Vstp	(V_{SS})	-1.8			V

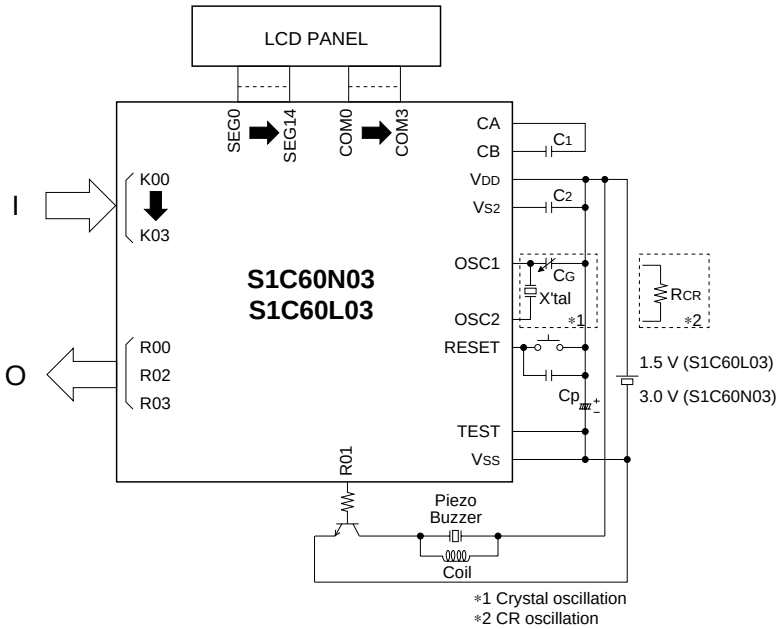
S1C60L03 CR Oscillation

(Unless otherwise specified: V_{DD}=0V, V_{SS}=-1.5V, R_{CR}=470kΩ, Ta=25°C)

Characteristic	Symbol	Condition	Min.	Typ.	Max.	Unit
Oscillation frequency dispersion	f_{OSC}		-20	65kHz	20	%
Oscillation start voltage	Vsta	(V_{SS})	-1.2			V
Oscillation start time	tsta	V_{SS}=-1.2 to -2.0V		3		mS
Oscillation stop voltage	Vstp	(V_{SS})	-1.2			V

■ BASIC EXTERNAL CONNECTION DIAGRAM

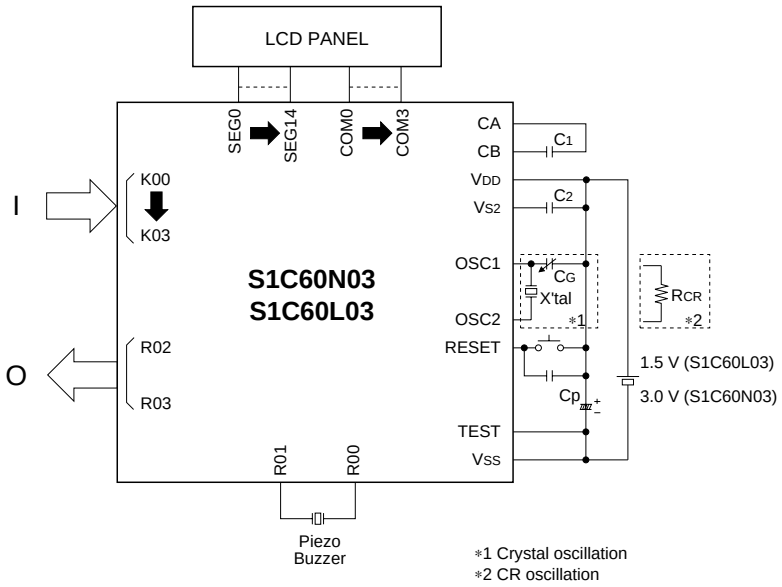
Piezo Buzzer Single Terminal Driving



X'tal	Crystal oscillator	32.768 kHz, C_I (Max.) = 35 kΩ
C_G	Trimmer capacitor	5–25 pF
R_{CR}	Resistor for CR oscillation	470 kΩ (65 kHz)
C_1, C_2	Capacitor	1 µF (see Note)
Cp	Capacitor	3.3 µF

Note: Use a 1 µF capacitor for C_1 and C_2 when "S1C60L03 1/3 bias" is selected,
or a 0.1 µF capacitor when "S1C60N03 1/2 bias" or "S1C60L03 1/2 bias (A), (B)" is selected.
No capacitor is required for C_1 and C_2 when another specification is selected.

Piezo Buzzer Direct Driving



X'tal	Crystal oscillator	32.768 kHz, CI (Max.) = 35 kΩ
CG	Trimmer capacitor	5–25 pF
RCR	Resistor for CR oscillation	470 kΩ (65 kHz)
C1, C2	Capacitor	1 µF (see Note)
Cp	Capacitor	3.3 µF

Note: Use a 1 µF capacitor for C1 and C2 when "S1C60L03 1/3 bias" is selected,
or a 0.1 µF capacitor when "S1C60N03 1/2 bias" or "S1C60L03 1/2 bias (A), (B)" is selected.
No capacitor is required for C1 and C2 when another specification is selected.

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