

Micro MINI E0C6003

4-bit Single Chip Microcomputer



- E0C6200B Core CPU
- Low Voltage and Low Power
- Built-in LCD Driver
- Low Cost Performance

■ DESCRIPTION

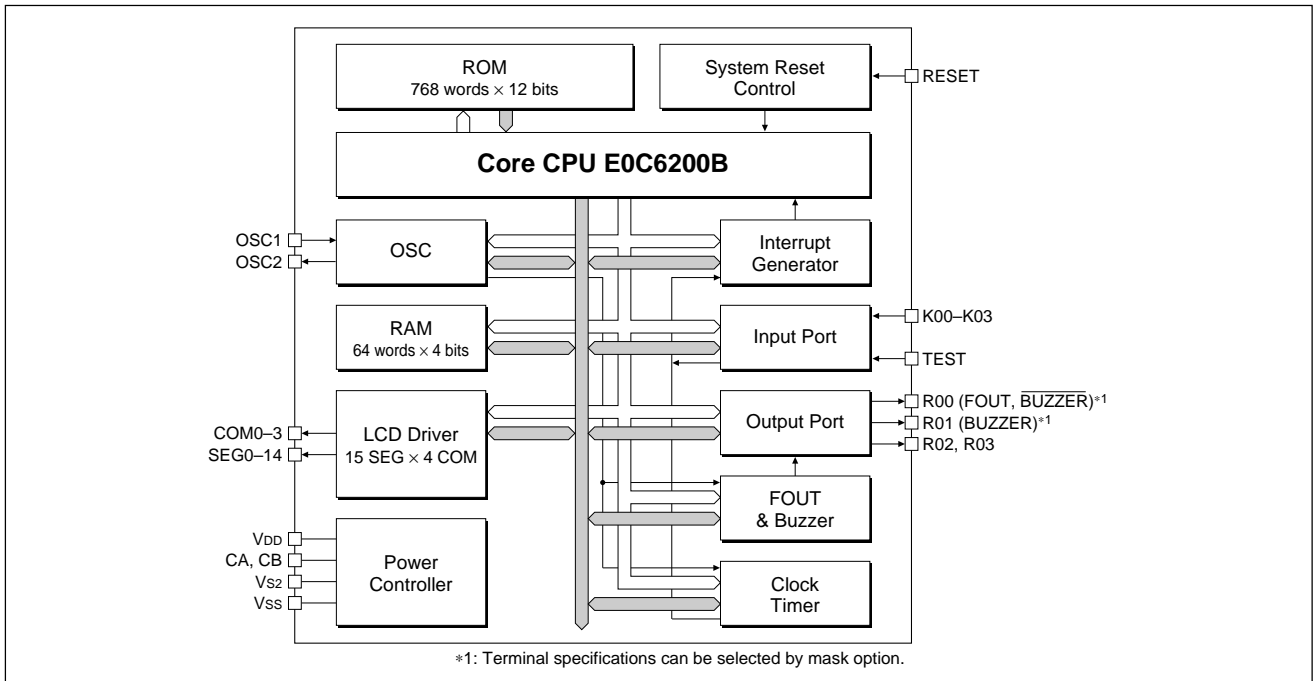
Micro MINI "E0C6003" is a single chip microcomputer for battery-driven products with 7-segment LCD display. It achieves low cost performance, and is suitable for a product added some feature instead of standard IC. It consists that Seiko Epson's original core CPU E0C6200B, LCD driver (15 segments × 4 commons), 64 words RAM, 768 words ROM, clock timer and so on.

■ FEATURES

- CMOS LSI 4-bit parallel processing
- Clock 32.768kHz (X'tal or CR oscillation by mask option)
- Instruction set 100 instructions
- ROM capacity 768 × 12 bits
- RAM capacity 64 × 4 bits
- I/O port I: 4 bits (with pull-down resistor selectable by mask option)
O: 4 bits (buzzer output possible by mask option)
I/O: 0 bits
- Supply voltage detector (SVD) No support
- Clock timer 1ch.
- LCD driver 15 segments × 4/3/2 commons
- Interrupt External : Key interrupt 1 line
Internal : Clock timer interrupt 1 line
- Operation voltage 1.2 to 2.0V (E0C60L03)
2.4 to 3.6V (E0C6003)
- Power consumption 1.0μA (32.768kHz X'tal, 3.0V, HALT)
2.0μA (32.768kHz X'tal, 3.0V, RUN)
- Package Die form (pad pitch = 130μm)

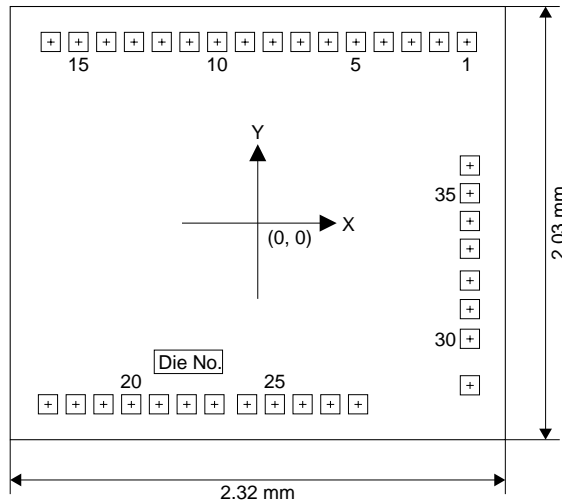
E0C6003

■ BLOCK DIAGRAM



■ PAD LAYOUT

Pad Layout Diagram



Pad Coordinates

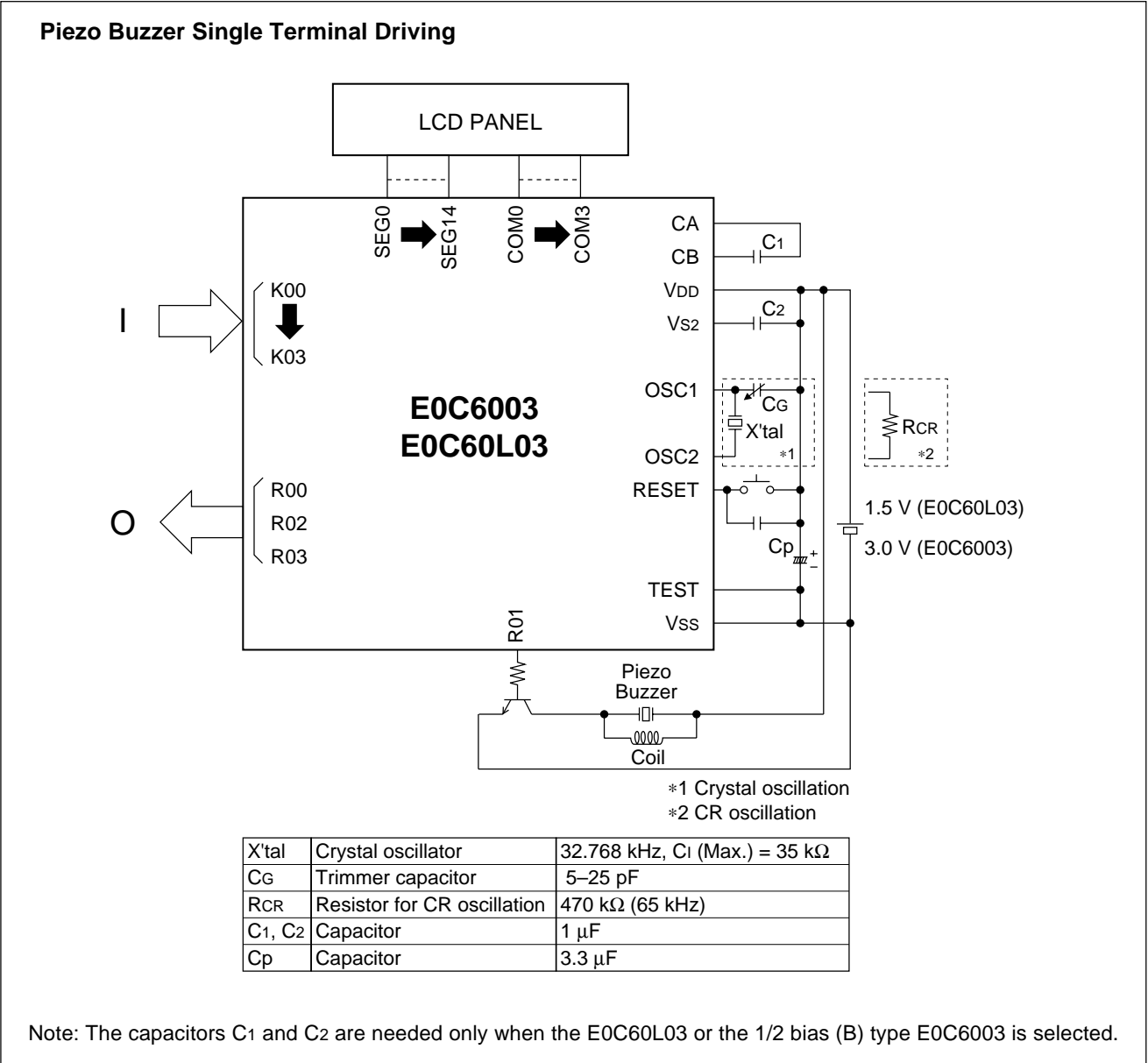
| No. | Pad name | X | Y | No. | Pad name | X | Y | No. | Pad name | X | Y |
|-----|----------|------|-----|-----|----------|------|------|-----|----------|-----|------|
| 1 | TEST | 980 | 849 | 13 | SEG3 | -580 | 849 | 25 | OSC2 | 80 | -849 |
| 2 | SEG14 | 850 | 849 | 14 | SEG2 | -710 | 849 | 26 | OSC1 | 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·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, 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

■ BASIC EXTERNAL CONNECTION DIAGRAM



E0C6003

■ 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 _I osc | V _{SS} - 0.3 to 0.5 | V |
| Permissible total output current *1 | ΣI _{VSS} | 10 | mA |
| Operating temperature | T _{opr} | -20 to 70 | °C |
| Storage temperature | T _{stg} | -65 to 150 | °C |
| Soldering temperature / time | T _{sol} | 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

E0C6003

(T_a=-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 | f _{osc} | Crystal oscillation | | 32.768 | | kHz |
| | | CR oscillation, R _{CR} =470kΩ | 50 | 65 | 80 | kHz |
| Booster capacitor | C1 | | 0.1 | | | μF |
| Capacitor between V _{DD} and V _{S2} | C2 | | 0.1 | | | μF |

E0C60L03

(T_a=-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 | f _{osc} | Crystal oscillation | | 32.768 | | kHz |
| | | CR oscillation, R _{CR} =470kΩ | 50 | 65 | 80 | kHz |
| Booster capacitor | C1 | | 0.1 | | | μF |
| Capacitor between V _{DD} and V _{S2} | C2 | | 0.1 | | | μF |

● DC Characteristics

E0C6003

(Unless otherwise specified: V_{DD}=0V, V_{SS}=-3.0V, f_{osc}=32.768kHz, T_a=25°C, V_{s2} is internal voltage, C₁=C₂=0.1μF)

| Characteristic | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---|------------------|---|----------------------|------|----------------------|------|
| High level input voltage (1) | V _{IH1} | | 0.2•V _{SS} | | 0 | V |
| High level input voltage (2) | V _{IH2} | | 0.15•V _{SS} | | 0 | V |
| Low level input voltage (1) | V _{IL1} | | V _{SS} | | 0.8•V _{SS} | V |
| Low level input voltage (2) | V _{IL2} | | V _{SS} | | 0.85•V _{SS} | V |
| High level input current (1) | I _{IH1} | V _{IH1} =0V, No pull down resistor | 0 | | 0.5 | μA |
| High level input current (2) | I _{IH2} | V _{IH2} =0V, With pull down resistor | 10 | | 40 | μA |
| High level input current (3) | I _{IH3} | V _{IH3} =0V, With pull down resistor | 30 | | 100 | μA |
| Low level input current | I _{IL} | V _{IL} =V _{SS} | -0.5 | | 0 | μA |
| High level output current (1) | I _{OH1} | V _{OH1} =0.1•V _{SS} | | | -1.0 | mA |
| High level output current (2) | I _{OH2} | V _{OH2} =0.1•V _{SS} (built-in protection resistance) | | | -1.0 | mA |
| Low level output current (1) | I _{OL1} | V _{OL1} =0.9•V _{SS} | 3.0 | | | mA |
| Low level output current (2) | I _{OL2} | V _{OL2} =0.9•V _{SS} (built-in protection resistance) | 3.0 | | | mA |
| Common output current | I _{OH3} | V _{OH3} =-0.05V | | | -3 | μA |
| | I _{OL3} | V _{OL3} =V _{L3} +0.05V | 3 | | | μA |
| Segment output current (during LCD output) | I _{OH4} | V _{OH4} =-0.05V | | | -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} | | | -300 | μA |
| | I _{OL5} | V _{OL5} =0.9•V _{SS} | 300 | | | μA |

E0C60L03

(Unless otherwise specified: V_{DD}=0V, V_{SS}=-1.5V, f_{osc}=32.768kHz, T_a=25°C, V_{s2} is internal voltage, C₁=C₂=0.1μF)

| Characteristic | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---|------------------|---|----------------------|------|----------------------|------|
| High level input voltage (1) | V _{IH1} | | 0.2•V _{SS} | | 0 | V |
| High level input voltage (2) | V _{IH2} | | 0.15•V _{SS} | | 0 | V |
| Low level input voltage (1) | V _{IL1} | | V _{SS} | | 0.8•V _{SS} | V |
| Low level input voltage (2) | V _{IL2} | | V _{SS} | | 0.85•V _{SS} | V |
| High level input current (1) | I _{IH1} | V _{IH1} =0V, No pull down resistor | 0 | | 0.5 | μA |
| High level input current (2) | I _{IH2} | V _{IH2} =0V, With pull down resistor | 5.0 | | 20 | μA |
| High level input current (3) | I _{IH3} | V _{IH3} =0V, With pull down resistor | 9.0 | | 100 | μA |
| Low level input current | I _{IL} | V _{IL} =V _{SS} | -0.5 | | 0 | μA |
| High level output current (1) | I _{OH1} | V _{OH1} =0.1•V _{SS} | | | -200 | μA |
| High level output current (2) | I _{OH2} | V _{OH2} =0.1•V _{SS} (built-in protection resistance) | | | -200 | μA |
| Low level output current (1) | I _{OL1} | V _{OL1} =0.9•V _{SS} | 700 | | | μA |
| Low level output current (2) | I _{OL2} | V _{OL2} =0.9•V _{SS} (built-in protection resistance) | 700 | | | μA |
| Common output current | I _{OH3} | V _{OH3} =-0.05V | | | -3 | μA |
| | I _{OL3} | V _{OL3} =V _{L3} +0.05V | 3 | | | μA |
| Segment output current (during LCD output) | I _{OH4} | V _{OH4} =-0.05V | | | -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} | | | -100 | μA |
| | I _{OL5} | V _{OL5} =0.9•V _{SS} | 130 | | | μA |

E0C6003

● Analog Circuit Characteristics and Current Consumption

E0C6003 (Crystal Oscillation)

(Unless otherwise specified: $V_{DD}=0V$, $V_{SS}=-3.0V$, $f_{osc}=32.768kHz$, $T_a=25^{\circ}C$, $C_G=25pF$, V_{S2} is internal voltage, $C_1=C_2=0.1\mu F$)

| Characteristic | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---------------------|--------|---|-----------------------------|--------------------|------------------------------------|------|
| LCD drive voltage | VL1 | Connect 1 MΩ load resistor between VDD and segment driver (SEG0–SEG14) when segment driver's level is VL1 | $1/3 \cdot V_{SS}$ - 0.1 | $1/3 \cdot V_{SS}$ | $1/3 \cdot V_{SS}$ $\times 0.9$ | V |
| | VL2 | Connect 1 MΩ load resistor between VDD and segment driver (SEG0–SEG14) when segment driver's level is VL2 | $2/3 \cdot V_{SS}$ - 0.1 | $2/3 \cdot V_{SS}$ | $2/3 \cdot V_{SS}$ $\times 0.9$ | V |
| | VL3 | Connect 1 MΩ load resistor between VDD and segment driver (SEG0–SEG14) when segment driver's level is VL3 | | V_{SS} | | V |
| Current consumption | IHLT | During HALT with LCD OFF | | 1.0 | 2.5 | μA |
| | IEXE1 | During operation with LCD OFF | No panel load | 2.0 | 5.0 | μA |
| | IEXE2 | During operation with power divider ON | | 15 | 20 | μA |

E0C60L03 (Crystal Oscillation)

(Unless otherwise specified: $V_{DD}=0V$, $V_{SS}=-1.5V$, $f_{osc}=32.768kHz$, $T_a=25^{\circ}C$, $C_G=25pF$, V_{S2} is internal voltage, $C_1=C_2=0.1\mu F$)

| Characteristic | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---------------------|--------|---|-----------------------------|--------------------|------------------------------------|------|
| LCD drive voltage | VL1 | Connect 1 MΩ load resistor between VDD and segment driver (SEG0–SEG14) when segment driver's level is VL1 | $1/3 \cdot V_{S2}$ - 0.1 | $1/3 \cdot V_{S2}$ | $1/3 \cdot V_{S2}$ $\times 0.9$ | V |
| | VL2 | Connect 1 MΩ load resistor between VDD and segment driver (SEG0–SEG14) when segment driver's level is VL2 | $2/3 \cdot V_{S2}$ - 0.1 | $2/3 \cdot V_{S2}$ | $2/3 \cdot V_{S2}$ $\times 0.9$ | V |
| | VL3 | Connect 1 MΩ load resistor between VDD and segment driver (SEG0–SEG14) when segment driver's level is VL3 | V_{S2} - 0.1 | V_{S2} | V_{S2} $\times 0.9$ | V |
| Current consumption | IHLT | During HALT with LCD OFF | | 1.0 | 2.5 | μA |
| | IEXE1 | During operation with LCD OFF | No panel load | 2.0 | 5.0 | μA |
| | IEXE2 | During operation with power divider ON | | 15 | 20 | μA |

E0C6003 (CR Oscillation)

(Unless otherwise specified: $V_{DD}=0V$, $V_{SS}=-3.0V$, $f_{osc}=65kHz$, $T_a=25^{\circ}C$, $R_{CR}=470k\Omega$, V_{S2} is internal voltage, $C_1=C_2=0.1\mu F$)

| Characteristic | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---------------------|--------|---|-----------------------------|--------------------|------------------------------------|------|
| LCD drive voltage | VL1 | Connect 1 MΩ load resistor between VDD and segment driver (SEG0–SEG14) when segment driver's level is VL1 | $1/3 \cdot V_{SS}$ - 0.1 | $1/3 \cdot V_{SS}$ | $1/3 \cdot V_{SS}$ $\times 0.9$ | V |
| | VL2 | Connect 1 MΩ load resistor between VDD and segment driver (SEG0–SEG14) when segment driver's level is VL2 | $2/3 \cdot V_{SS}$ - 0.1 | $2/3 \cdot V_{SS}$ | $2/3 \cdot V_{SS}$ $\times 0.9$ | V |
| | VL3 | Connect 1 MΩ load resistor between VDD and segment driver (SEG0–SEG14) when segment driver's level is VL3 | | V_{SS} | | V |
| Current consumption | IHLT | During HALT with LCD OFF | | 8 | 15 | μA |
| | IEXE1 | During operation with LCD OFF | No panel load | 15 | 20 | μA |
| | IEXE2 | During operation with power divider ON | | 25 | 30 | μA |

E0C60L03 (CR Oscillation)

(Unless otherwise specified: $V_{DD}=0V$, $V_{SS}=-1.5V$, $f_{osc}=65kHz$, $T_a=25^{\circ}C$, $R_{CR}=470k\Omega$, V_{S2} is internal voltage, $C_1=C_2=0.1\mu F$)

| Characteristic | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---------------------|--------|---|-----------------------------|--------------------|------------------------------------|------|
| LCD drive voltage | VL1 | Connect 1 MΩ load resistor between VDD and segment driver (SEG0–SEG14) when segment driver's level is VL1 | $1/3 \cdot V_{S2}$ - 0.1 | $1/3 \cdot V_{S2}$ | $1/3 \cdot V_{S2}$ $\times 0.9$ | V |
| | VL2 | Connect 1 MΩ load resistor between VDD and segment driver (SEG0–SEG14) when segment driver's level is VL2 | $2/3 \cdot V_{S2}$ - 0.1 | $2/3 \cdot V_{S2}$ | $2/3 \cdot V_{S2}$ $\times 0.9$ | V |
| | VL3 | Connect 1 MΩ load resistor between VDD and segment driver (SEG0–SEG14) when segment driver's level is VL3 | V_{S2} - 0.1 | V_{S2} | V_{S2} $\times 0.9$ | V |
| Current consumption | IHLT | During HALT with LCD OFF | | 8 | 15 | μA |
| | IEXE1 | During operation with LCD OFF | No panel load | 15 | 20 | μA |
| | IEXE2 | During operation with power divider ON | | 25 | 30 | μA |

● Oscillation Characteristics

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

E0C6003 Crystal Oscillation

(Unless otherwise specified: $V_{DD}=0V$, $V_{SS}=-3.0V$, $f_{osc}=32.768kHz$, Crystal: C-002R ($C_i=35k\Omega$), $C_G=25pF$, C_D =built-in, $T_a=25^\circ C$)

| Characteristic | Symbol | Condition | Min. | Typ. | Max. | Unit |
|------------------------------------|---------------------------|---|------|------|------|-----------|
| Oscillation start voltage | Vsta | $t_{sta} \leq 5sec$ (V_{SS}) | -1.8 | | | V |
| Oscillation stop voltage | Vstp | $t_{stp} \leq 10sec$ (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 | $\partial f/\partial V$ | $V_{SS}=-1.8$ to $-3.6V$ | | | 5 | ppm |
| Frequency/IC deviation | $\partial f/\partial IC$ | | -10 | | 10 | ppm |
| Frequency adjustment range | $\partial f/\partial C_G$ | $C_G=5$ 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 | | | $M\Omega$ |

E0C60L03 Crystal Oscillation

(Unless otherwise specified: $V_{DD}=0V$, $V_{SS}=-1.5V$, $f_{osc}=32.768kHz$, Crystal: C-002R ($C_i=35k\Omega$), $C_G=25pF$, C_D =built-in, $T_a=25^\circ C$)

| Characteristic | Symbol | Condition | Min. | Typ. | Max. | Unit |
|------------------------------------|---------------------------|---|------|------|------|-----------|
| Oscillation start voltage | Vsta | $t_{sta} \leq 5sec$ (V_{SS}) | -1.2 | | | V |
| Oscillation stop voltage | Vstp | $t_{stp} \leq 10sec$ (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 | $\partial f/\partial V$ | $V_{SS}=-1.2$ to $-2.0V$ | | | 5 | ppm |
| Frequency/IC deviation | $\partial f/\partial IC$ | | -10 | | 10 | ppm |
| Frequency adjustment range | $\partial f/\partial C_G$ | $C_G=5$ 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 | | | $M\Omega$ |

E0C6003 CR Oscillation

(Unless otherwise specified: $V_{DD}=0V$, $V_{SS}=-3.0V$, $R_{CR}=470k\Omega$, $T_a=25^\circ C$)

| 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 | t_{sta} | $V_{SS}=-1.8$ to $-3.6V$ | | 3 | | mS |
| Oscillation stop voltage | Vstp | (V_{SS}) | -1.8 | | | V |

E0C60L03 CR Oscillation

(Unless otherwise specified: $V_{DD}=0V$, $V_{SS}=-1.5V$, $R_{CR}=470k\Omega$, $T_a=25^\circ C$)

| 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 | t_{sta} | $V_{SS}=-1.2$ to $-2.0V$ | | 3 | | mS |
| Oscillation stop voltage | Vstp | (V_{SS}) | -1.2 | | | V |

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