# LCD controller driver for dot matrix displays

## BU97701 / BU97702

The BU97701 and BU97702 are controller drivers used in dot matrix liquid crystal displays that display English-language characters, Japanese kana characters, and symbols. These products can be controlled by a 4-bit or an 8-bit MPU. All of the functions necessary to drive dot matrix displays are contained on a single chip, enabling liquid crystal displays to be configured with a small number of chips. These products are available in QFP-T80 (BU97701) and SQFP-T80 (BU97702) packages.

●Applications

Liquid crystal display systems for character displays

●Features

1) Can accommodate 5 × 7 and 5 × 10 dot matrix LCDs.
2) Equipped with an internal display data RAM of 80 × 8 bits; an expansion driver (BU9706KS) can be used to expand the display up to 80 characters.
3) Internal display data ROM of 12,000 bits
4) Diverse variety of functions includes display clear, cursor home, display on / off, display character blink, display shift, and others.

●Absolute maximum ratings (Ta = 25°C)

| Parameter | | Symbol | Limits | Unit |
|---|---|---|---|---|
| Power supply voltage | | $V_{DD}$ | – 0.3 ~ + 7.0 | V |
| Power dissipation | BU97701 | Pd | 900*1 | mW |
| | BU97702 | | 800*2 | |
| Operating temperature | | Topr | – 20 ~ + 75 | °C |
| Storage temperature | | Tstg | – 55 ~ + 125 | °C |

*1 Reduced by 9.0mW for each increase in Ta of 1°C over 25°C (QFP-T80).

*2 Reduced by 8.0mW for each increase in Ta of 1°C over 25°C (SQFP-T80).

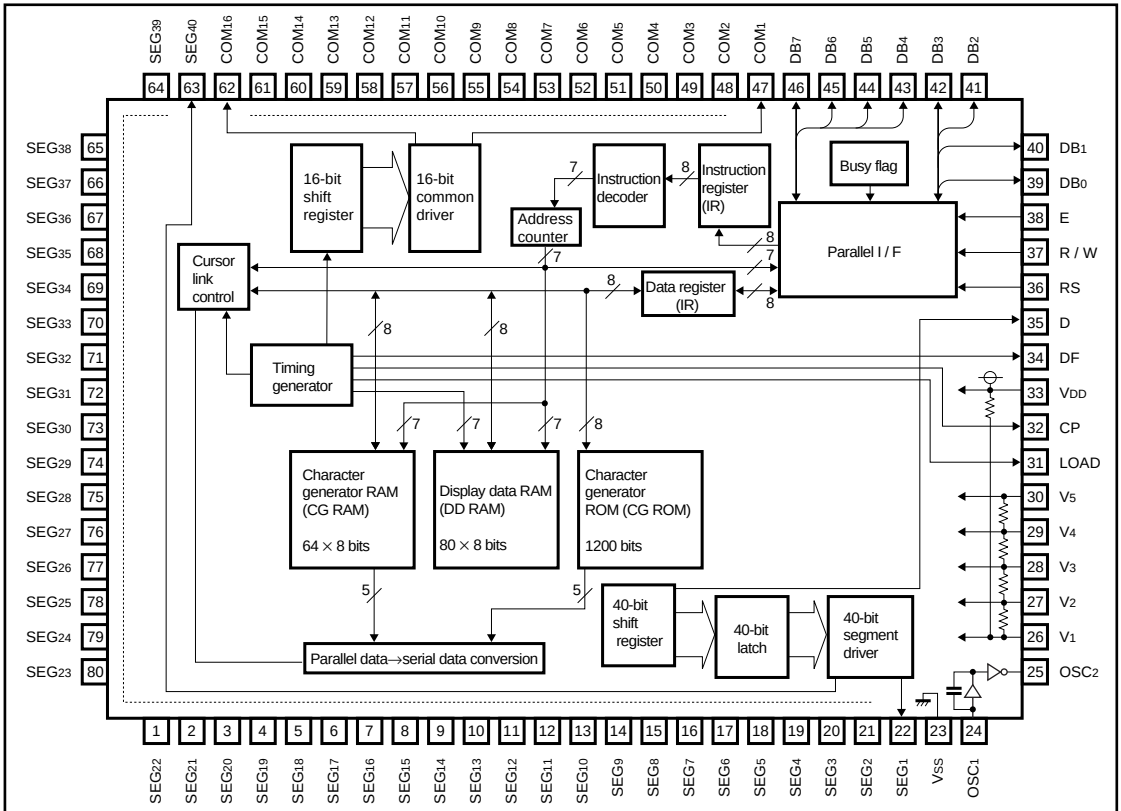
●Recommended operating conditions (Ta = 25°C)

| Parameter | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| Power supply voltage | $V_{DD}$ | 4.5 | — | 5.5 | V |

●Model names

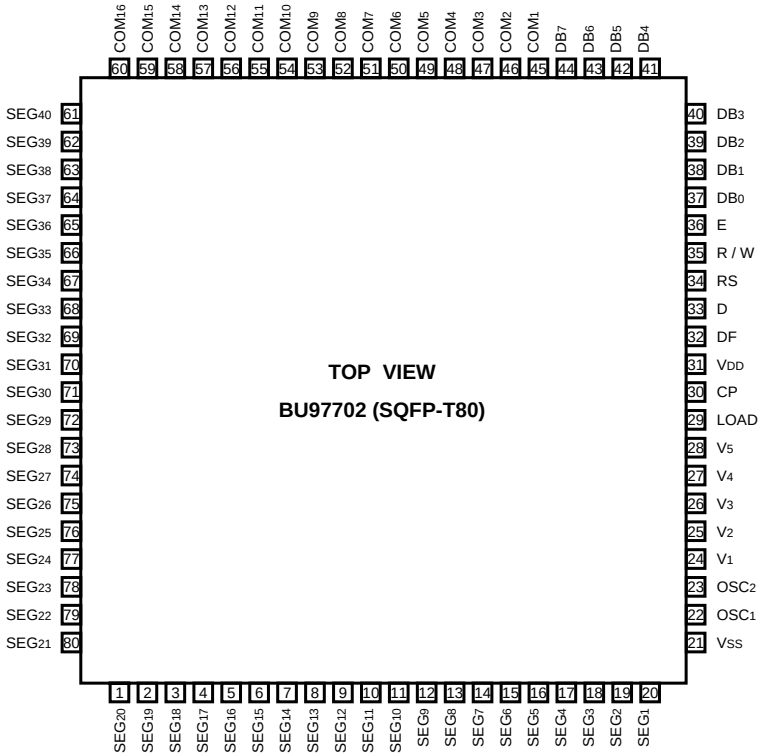
| Model Number | Built-in font |
|---|---|
| BU97701-00 / BU97702-00 | ROM Ver.00 |
| BU97701-01 / BU97702-01 | ROM Ver.01 |
| BU97701-02 / BU97702-02 | ROM Ver.02 |

●Block diagram




**BU97701 (QFP-T80)**

●Pin assignments

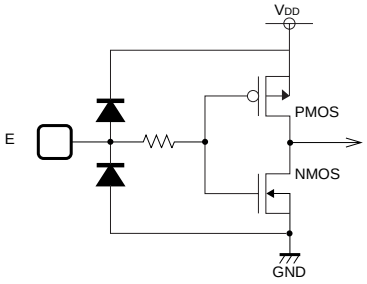


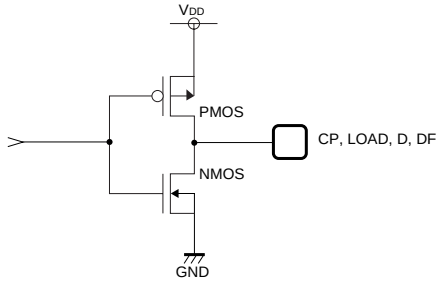
●Pin descriptions

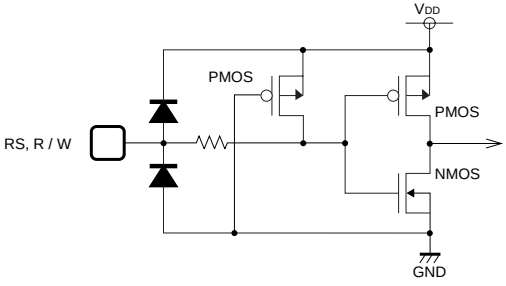
| Pin No. | Pin name | Function | |
|---|---|---|---|
| 36 (34) | RS | Selects the register used to read / write instructions and data.<br>If RS = 0 and R / W = 0: Instruction register<br>If RS = 0 and R / W = 1: Busy flag and address counter<br>If RS = 1: Data register | |
| 37 (35) | R / W | Signal that selects the read or write operation.<br>This sends and receives data between the BU97701-00 (BU97702) and host computer.<br>R / W = 0: Write R / W = 1: Read | |
| 38 (36) | E | Signal which enables reading / writing. | |
| 39 ~ 42<br>(37 ~ 40) | $DB_0$ ~ $DB_3$ | Highest four bits of 3-state bi-directional bus.<br>These send and receive data between the BU97701 (BU97702) and host MPU. These are not used with 4-bit operation. | |
| 43 ~ 46<br>(41 ~ 44) | $DB_4$ ~ $DB_7$ | Lowest four bits of 3-state bi-directional bus.<br>These send and receive data between the BU97701 (BU97702) and host MPU. | |
| 31 (29) | LOAD | Signal output which latches the serial data of the external segment driver. | |
| 32 (30) | CP | Signal output which shifts the serial data of the external segment driver. | |
| 34 (32) | DF | AC signal output of the LCD drive waveform. | |
| 35 (33) | D | Outputs the data corresponding to the character pattern to an external segment register.<br>0: OFF data 1: ON data | |
| 47 ~ 62<br>(45 ~ 60) | $COM_1$ ~ $COM_{16}$ | Commons: these are common drive signals. At 1 / 8 duty, COM9 to COM16 are de-selected waveforms. At 1 / 11 duty, COM12 to COM16 are de-selected waveforms. | |
| 22 ~ 1<br>(20 ~ 1)<br>80 ~ 63<br>(80 ~ 61) | $SEG_1$ ~ $SEG_{40}$ | Segments: segment drive signals. | |
| 30 (28) | $V_5$ | LCD power supply | These must satisfy the following relationship:<br>$V_{DD} \geqq V_1 \geqq V_2 \geqq V_3 \geqq V_4 \geqq V_5 \geqq V_{SS}$ |
| 26 ~ 29<br>(24 ~ 27) | $V_1$ ~ $V_4$ | LCD power supply for external driver. | |
| 33, 23<br>(31, 21) | $V_{DD}$, $V_{SS}$ | Power supply pins; $V_{DD}$ = 5.0 ± 10%, $V_{SS}$ = 0V | |
| 24, 25<br>(22, 23) | $OSC_1$, $OSC_2$ | When the internal clock is operating, the resistance is connected to these pins. When an external clock is operating, the clock is input to $OSC_1$. ($OSC_2$ is open.) | |

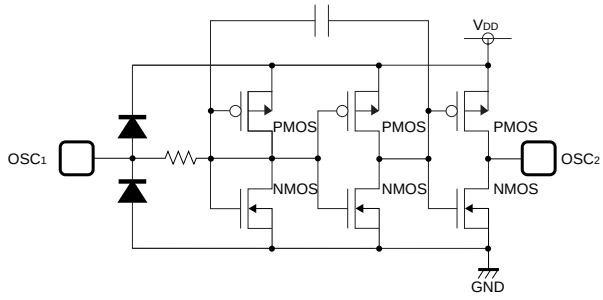
* The 97702 pin numbers are indicated within parentheses.

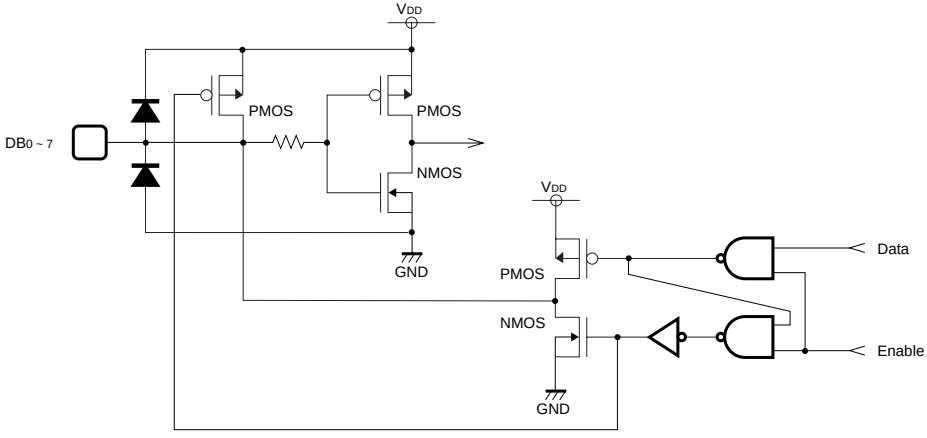
●Input / output circuits



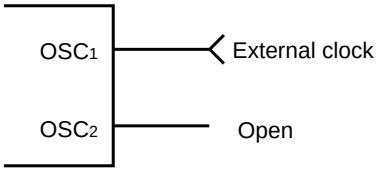
●Electrical characteristics (unless otherwise noted, Ta = 25°C, $V_{DD}$ = 5V, $V_{SS}$ = 0V)

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Conditions | Measurement circuit |
|---|---|---|---|---|---|---|---|
| Input high level voltage 1 | $V_{IH1}$ | 0.8 × $V_{DD}$ | — | $V_{DD}$ | V | | Fig.1 |
| Input low level voltage 1 | $V_{IL1}$ | 0 | — | 0.2 × $V_{DD}$ | V | | Fig.1 |
| Input high level voltage 2 | $V_{IH2}$ | 2.2 | — | — | V | | Fig.1 |
| Input low level voltage 2 | $V_{IL2}$ | — | — | 0.8 | V | | Fig.1 |
| Output high level voltage 1 | $V_{OH1}$ | $V_{DD}$ – 0.3 | — | — | V | $I_{OH}$ = – 0.625mA | Fig.1 |
| Output low level voltage 1 | $V_{OL1}$ | — | — | 0.3 | V | $I_{OL}$ = 0.625mA | Fig.1 |
| Output high level voltage 2 | $V_{OH2}$ | 2.4 | — | — | V | $I_{OH}$ = – 1.2mA | Fig.1 |
| Output low level voltage 2 | $V_{OL2}$ | — | — | 0.4 | V | $I_{OL}$ = 2.0mA | Fig.1 |
| COM driver ON resistance | $R_{COM}$ | — | — | 20 | kΩ | $I_d$ = ± 50µA | Fig.1 |
| SEG driver ON resistance | $R_{SEG}$ | — | — | 30 | kΩ | $I_d$ = ± 50µA | Fig.1 |
| Input current 1 | $I_{IN1}$ | – 1 | — | 1 | µA | $V_{IN}$ = 0 ~ $V_{DD}$ Note 1 | Fig.1 |
| Input current 2 | $I_{IN2}$ | 50 | 125 | 250 | µA | $V_{DD}$ = 5V, $V_{IN}$ = 0V | Fig.1 |
| Current dissipation | $I_{DD}$ | — | 350 | 600 | µA | Note 2 | Fig.1 |
| External clock operating frequency | $f_{IN}$ | 125 | 250 | 350 | kHz | Note 3 | — |
| External clock duty | $f_{Duty}$ | 45 | 50 | 55 | % | Note 4 | — |
| External clock rise time | $t_r$ | — | — | 200 | ns | Note 5 | — |
| External clock fall time | tf | — | — | 200 | ns | Note 6 | — |
| Internal clock oscillation frequency | $f_{OSC}$ | 190 | 270 | 350 | kHz | | Fig.2 |
| Enable cycle time | $t_{EC}$ | 500 | — | — | ns | | Fig.2 |
| Enable pulse width | $t_{EP}$ | 220 | — | — | ns | | Fig.2 |
| Enable rise / fall times | $t_{Er}$, $t_{Ef}$ | — | — | 20 | ns | | Fig.2 |
| Address setup time | $t_{AS}$ | 40 | — | — | ns | | Fig.2 |
| Address hold time | $t_{AH}$ | 10 | — | — | ns | | Fig.2 |
| Data setup time | $t_{DS}$ | 60 | — | — | ns | | Fig.2 |
| Data hold time (writing) | $t_{DH}$ | 10 | — | — | ns | | Fig.2 |
| Data delay time | $t_{DD1}$ | — | — | 250 | ns | | Fig.2 |
| Data hold time (reading) | $t_{OH}$ | 20 | — | — | ns | | Fig.2 |
| CP cycle time | $t_{CC}$ | 1800 | — | — | ns | | Fig.2 |
| CP pulse time | $t_{WH}$, $t_{WL}$ | 800 | — | — | ns | | Fig.2 |
| CP rise / fall times | $t_{Cr}$, $t_{Cf}$ | — | — | 100 | ns | | Fig.2 |
| D delay time | $t_{DD2}$ | — | — | 100 | ns | | Fig.2 |
| LOAD pulse width | $t_{WCP}$ | 800 | — | — | ns | | Fig.2 |
| CP→LOAD time | $t_{CL}$ | 125 | — | — | ns | | Fig.2 |
| LOAD→CP time | $t_{LC}$ | 0 | — | — | ns | | Fig.2 |
| DF delay time | $t_{DFD}$ | – 100 | — | 100 | ns | | Fig.2 |

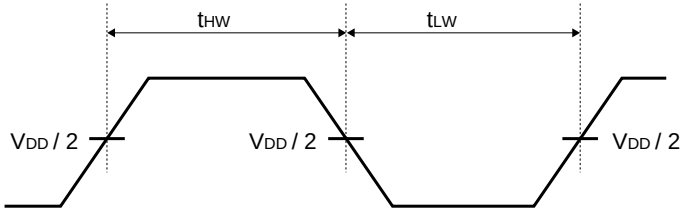
Note 1: Current does not include pull-up MOS current.

Note 2: External resistance oscillation or external clock input- · · · $V_{DD}$ = 5.0V, $f_{OSC}$ = fcp = 270kHz

Note 3: External clock operating

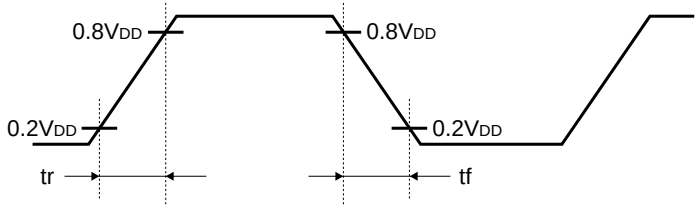



Note 4: Applies to $OSC_1$ pin

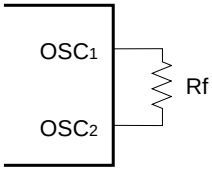



$f_{Duty} = t_{HW} / (t_{HW} + t_{LW}) \times 100$ (%)

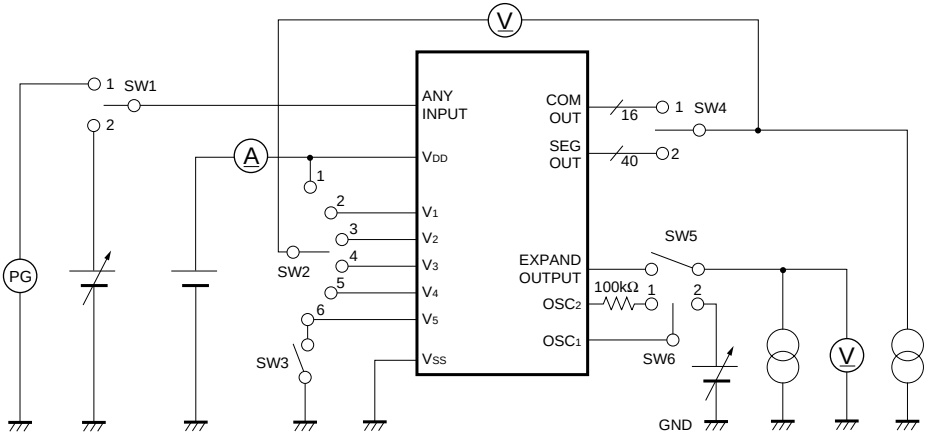
Note 5: Applies to $OSC_1$ pin




Note 6: Internal oscillation caused by external resistance



●Measurement circuits




| | | | |
|---|---|---|---|
| SW1 | 1: ON resistance, output voltage measurement | SW3 | ON: ON resistance measurement |
| | 2: Input voltage, input current measurement | | OFF: Current consumption measurement |
| SW2 | 1: ON resistance (in relation to $V_{DD}$) measurement | SW4 | 1: ON resistance (COM output) measurement |
| | 2: ON resistance (in relation to $V_1$) measurement | | 2: ON resistance (COM output) measurement |
| | 3: ON resistance (in relation to $V_2$) measurement | SW5 | ON: Output voltage measurement |
| | 4: ON resistance (in relation to $V_3$) measurement | | OFF: Current consumption measurement |
| | 5: ON resistance (in relation to $V_4$) measurement | SW6 | 1: Current consumption, ON resistance measurement |
| | 6: ON resistance (in relation to $V_5$) measurement | | 2: Input voltage measurement |

Fig. 1 DC characteristics measurement circuit

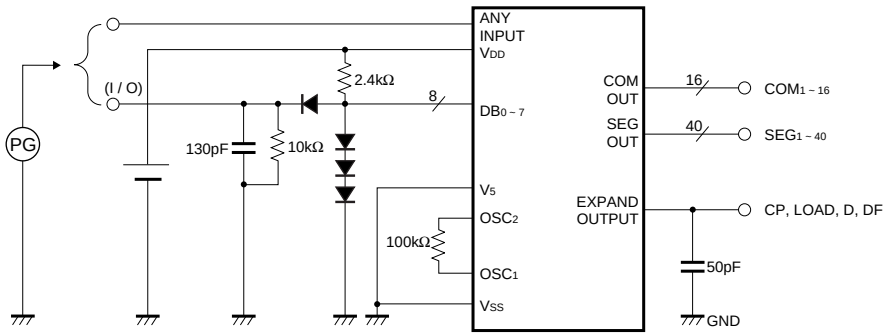



Fig. 2 Switching characteristics measurement circuit

●Timing charts

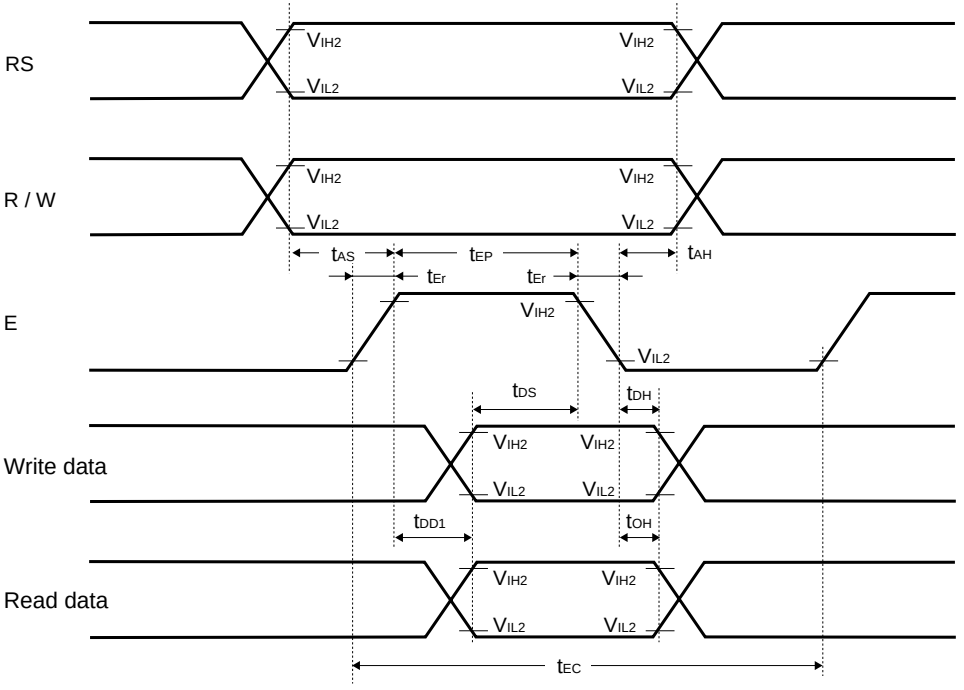



Fig. 3 Bus read / write timing

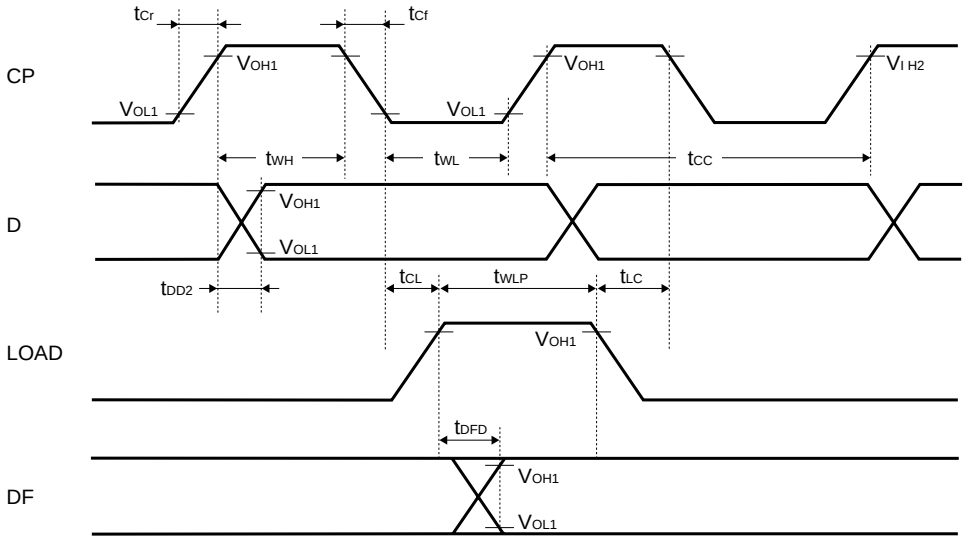



Fig. 4 Output to expansion driver

●Correspondence between character codes and character patterns

Rohm Standard: ROM Ver. 00

| Upper bit / Lower bit | 0000 | 0001 | 0010 | 0011 | 0100 | 0101 | 0110 | 0111 | 1000 | 1001 | 1010 | 1011 | 1100 | 1101 | 1110 | 1111 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| XXXX0000 | CGRAM (1) | | |  |  |  |  |  | | | |  |  |  |  |  |
| XXXX0001 | (2) | |  |  |  |  |  |  | | |  |  |  |  |  |  |
| XXXX0010 | (3) | |  |  |  |  |  |  | | |  |  |  |  |  |  |
| XXXX0011 | (4) | |  |  |  |  |  |  | | |  |  |  |  |  |  |
| XXXX0100 | (5) | |  |  |  |  |  |  | | |  |  |  |  |  |  |
| XXXX0101 | (6) | |  |  |  |  |  |  | | |  |  |  |  |  |  |
| XXXX0110 | (7) | |  |  |  |  |  |  | | |  |  |  |  |  |  |
| XXXX0111 | (8) | |  |  |  |  |  |  | | |  |  |  |  |  |  |
| XXXX1000 | (1) | |  |  |  |  |  |  | | |  |  |  |  |  |  |
| XXXX1001 | (2) | |  |  |  |  |  |  | | |  |  |  |  |  |  |
| XXXX1010 | (3) | |  |  |  |  |  |  | | |  |  |  |  |  |  |
| XXXX1011 | (4) | |  |  |  |  |  |  | | |  |  |  |  |  |  |
| XXXX1100 | (5) | |  |  |  |  |  |  | | |  |  |  |  |  |  |
| XXXX1101 | (6) | |  |  |  |  |  |  | | |  |  |  |  |  |  |
| XXXX1110 | (7) | |  |  |  |  |  |  | | |  |  |  |  |  | |
| XXXX1111 | (8) | |  |  |  |  |  |  | | |  |  |  |  |  |  |

Rohm Standard: ROM Ver. 01

| Upper bit / Lower bit | 0000 | 0001 | 0010 | 0011 | 0100 | 0101 | 0110 | 0111 | 1000 | 1001 | 1010 | 1011 | 1100 | 1101 | 1110 | 1111 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| XXXX0000 | CGRAM (1) |  | |  |  |  |  |  |  |  | |  |  |  |  |  |
| XXXX0001 | (2) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| XXXX0010 | (3) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| XXXX0011 | (4) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| XXXX0100 | (5) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| XXXX0101 | (6) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| XXXX0110 | (7) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| XXXX0111 | (8) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| XXXX1000 | (1) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| XXXX1001 | (2) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| XXXX1010 | (3) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| XXXX1011 | (4) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| XXXX1100 | (5) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| XXXX1101 | (6) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| XXXX1110 | (7) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| XXXX1111 | (8) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

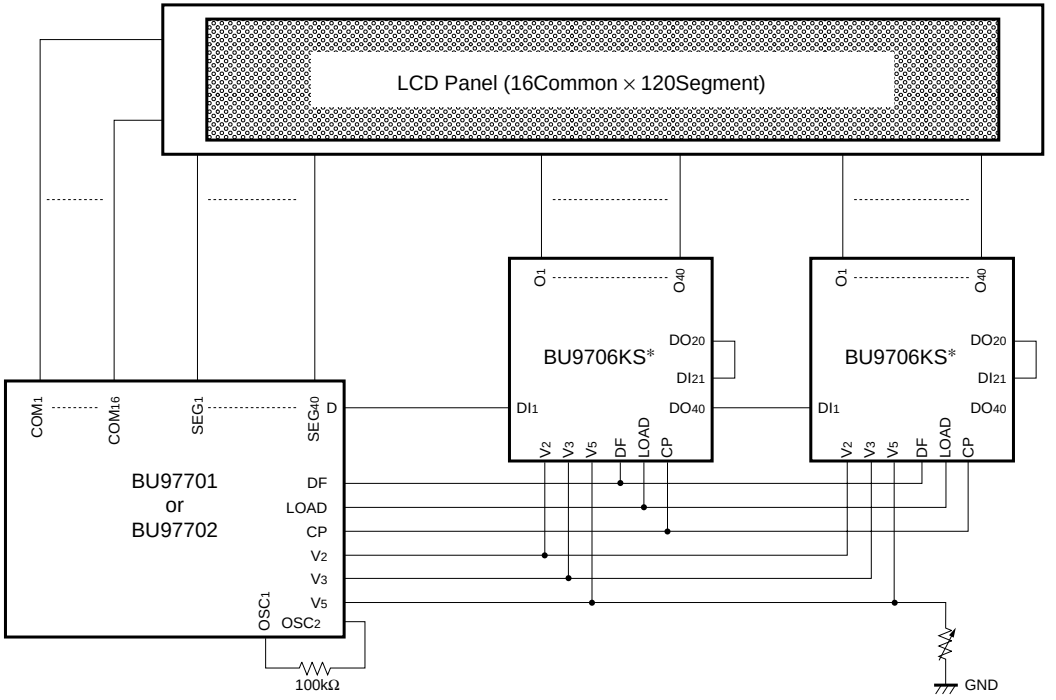
Rohm Standard: ROM Ver. 02

| Upper bit / Lower bit | 0000 | 0001 | 0010 | 0011 | 0100 | 0101 | 0110 | 0111 | 1000 | 1001 | 1010 | 1011 | 1100 | 1101 | 1110 | 1111 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| XXXX0000 | CGRAM (1) |  | |  |  |  |  |  |  |  | |  |  |  |  |  |
| XXXX0001 | (2) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| XXXX0010 | (3) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| XXXX0011 | (4) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| XXXX0100 | (5) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| XXXX0101 | (6) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| XXXX0110 | (7) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| XXXX0111 | (8) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| XXXX1000 | (1) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| XXXX1001 | (2) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| XXXX1010 | (3) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| XXXX1011 | (4) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| XXXX1100 | (5) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| XXXX1101 | (6) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| XXXX1110 | (7) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| XXXX1111 | (8) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |



ROHM

●Application circuit




* The BU9706KS is a segment expansion LSI.

Fig. 5

●Electrical characteristic curves

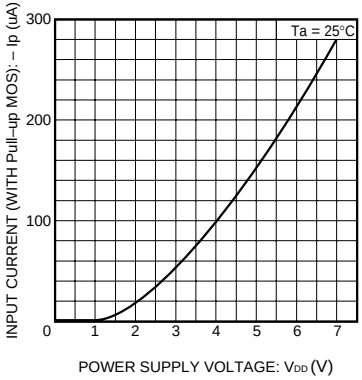



Fig. 6 Input current vs. power supply voltage

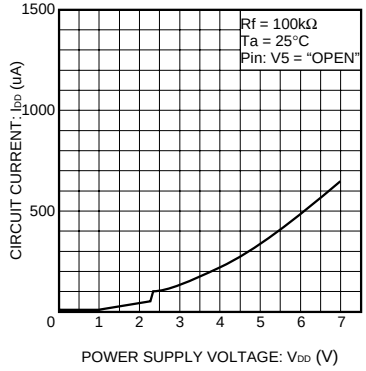
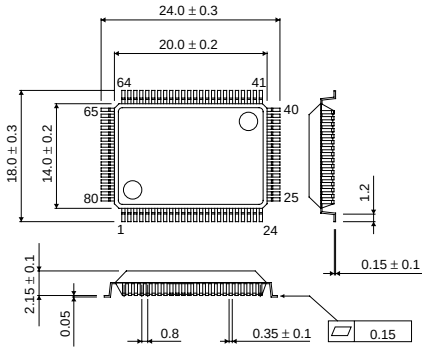



Fig. 7 Current consumption vs. power supply voltage

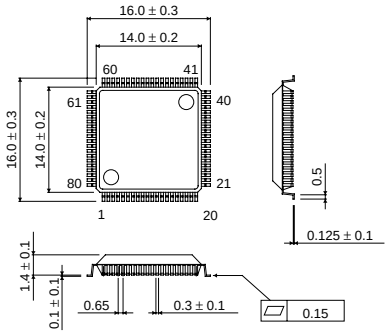
●External dimensions (Units: mm)

BU97701




QFP-T80

BU97702




SQFP-T80