

TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

# T7933

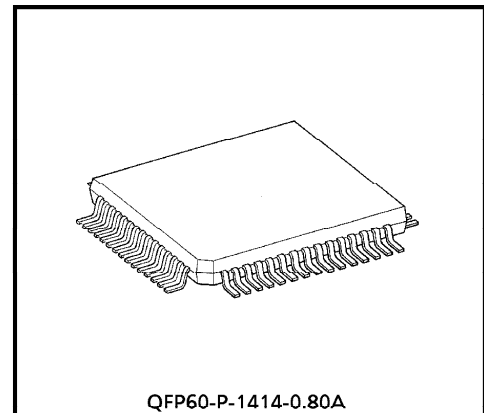
## ROW DRIVER LSI FOR DOT MATRIX LCD

The T7933 is a row (common) driver LSI for a small- or medium-scale dot matrix LCD. The T7933 realizes low power LCD systems using the CMOS Si-Gate process.

The T7933 generates timing signals for the display using a built-in oscillator and also controls the T7932 column (segment) LCD driver.

Five duty options are available : 1/8, 1/12, 1/16, 1/24 and 1/32. The T7933 has 32 low-impedance output row drivers ( $1k\Omega$  max).

The T7933 includes internal resistors to the divide bias voltage for 1/16 duty and 1/32 duty displays.



Weight: 1.1g (typ.)

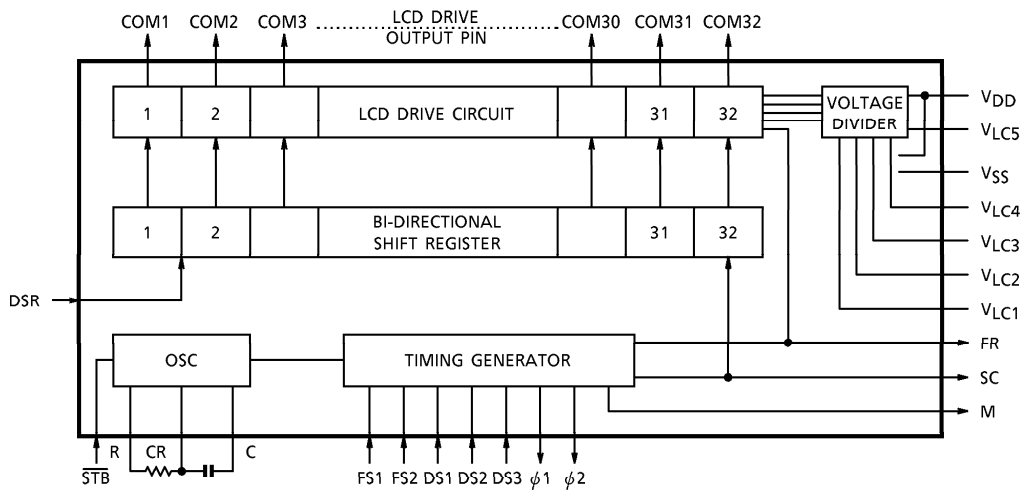
### FEATURES

- Row signal output for LCD
- LCD drive outputs : 32 (low impedance)
- Built-in oscillator (additional external resistor and capacitor)
- Built-in voltage dividers for 1/16 and 1/32 duty cycle
- Duty : 1/8, 1/12, 1/16, 1/24, 1/32
- Low power consumption
- Logic power supply :  $V_{DD} = 5V \pm 10\%$
- 60-pin flat plastic package

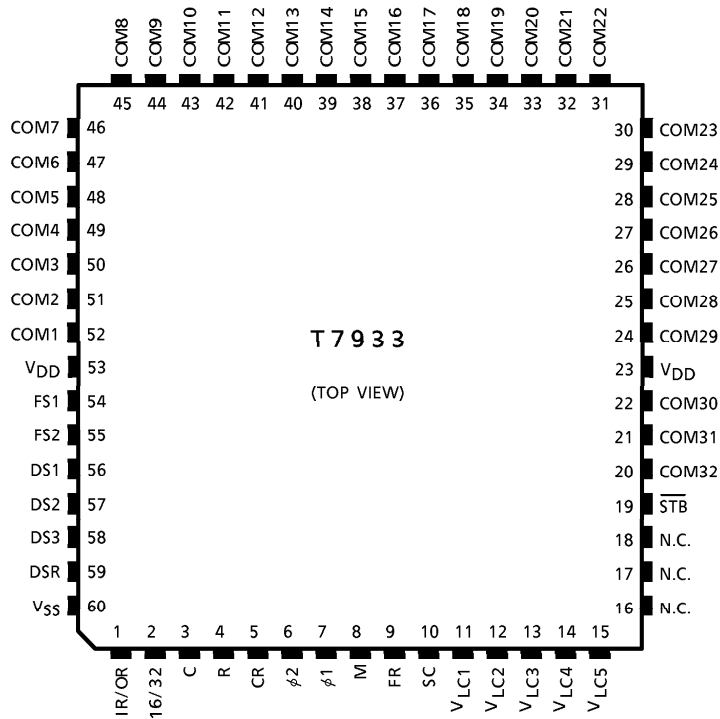
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BLOCK DIAGRAM



PIN ASSIGNMENT



PIN FUNCTIONS

PIN NAME	I/O	FUNCTIONS	SIGNAL VOLTAGE																														
COM1 to COM32	Output	LCD drive signal outputs	V <sub>DD</sub> to V <sub>LC5</sub>																														
CR, R, C	—	Pins for oscillator	—																														
FR	Output	Frame signal output	V <sub>DD</sub> to V <sub>SS</sub>																														
SC	Output	Shift clock pulse output	V <sub>DD</sub> to V <sub>SS</sub>																														
M	Output	Display synchronous signal	V <sub>DD</sub> to V <sub>SS</sub>																														
DS1 to DS3	Input	Display select pin	V <sub>DD</sub> to V <sub>SS</sub>																														
		<table border="1"> <thead> <tr> <th>DISPLAY DUTY</th> <th>1/8</th> <th>1/16</th> <th>1/12</th> <th>1/32</th> <th>1/24</th> </tr> </thead> <tbody> <tr> <td>DS1</td> <td>L</td> <td>L</td> <td>L</td> <td>H</td> <td>H</td> </tr> <tr> <td>DS2</td> <td>L</td> <td>H</td> <td>H</td> <td>L</td> <td>L</td> </tr> <tr> <td>DS3</td> <td>L</td> <td>L</td> <td>H</td> <td>L</td> <td>H</td> </tr> </tbody> </table>		DISPLAY DUTY	1/8	1/16	1/12	1/32	1/24	DS1	L	L	L	H	H	DS2	L	H	H	L	L	DS3	L	L	H	L	H						
		DISPLAY DUTY		1/8	1/16	1/12	1/32	1/24																									
		DS1		L	L	L	H	H																									
DS2	L	H	H	L	L																												
DS3	L	L	H	L	H																												
FS1, FS2	Input	Selects frequency Select oscillation frequency The relation between f <sub>FR</sub> and f <sub>osc</sub> is as follows:	V <sub>DD</sub> to V <sub>SS</sub>																														
		<table border="1"> <thead> <tr> <th>FS1</th> <th>FS2</th> <th>f<sub>osc</sub> (kHz)</th> <th>f<sub>M</sub> (Hz)</th> <th>f<sub>FR</sub></th> <th>f<sub>CP</sub> (kHz)</th> </tr> </thead> <tbody> <tr> <td>L</td> <td>L</td> <td>107.5</td> <td>70</td> <td>35</td> <td>53.8</td> </tr> <tr> <td>H</td> <td>L</td> <td>107.5</td> <td>70</td> <td>35</td> <td>53.8</td> </tr> <tr> <td>L</td> <td>H</td> <td>215.0</td> <td>70</td> <td>35</td> <td>107.5</td> </tr> <tr> <td>H</td> <td>H</td> <td>430.0</td> <td>70</td> <td>35</td> <td>215.0</td> </tr> </tbody> </table>		FS1	FS2	f <sub>osc</sub> (kHz)	f <sub>M</sub> (Hz)	f <sub>FR</sub>	f <sub>CP</sub> (kHz)	L	L	107.5	70	35	53.8	H	L	107.5	70	35	53.8	L	H	215.0	70	35	107.5	H	H	430.0	70	35	215.0
		FS1		FS2	f <sub>osc</sub> (kHz)	f <sub>M</sub> (Hz)	f <sub>FR</sub>	f <sub>CP</sub> (kHz)																									
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f <sub>osc</sub> : Oscillation frequency f <sub>M</sub> : Synchronous signal frequency f <sub>FR</sub> : Frame frequency f <sub>CP</sub> : Frequencies of φ <sub>1</sub> , φ <sub>2</sub>																																	
STB	Input	Input pin for test: usually connected to V <sub>DD</sub>	—																														
DSR	Input	Shift Register Shift direction select pin	V <sub>DD</sub> to V <sub>SS</sub>																														
		<table border="1"> <thead> <tr> <th>DSR</th> <th>SHIFT DIRECTION</th> </tr> </thead> <tbody> <tr> <td>H</td> <td>COM1→COM32</td> </tr> <tr> <td>L</td> <td>COM32→COM1</td> </tr> </tbody> </table>		DSR	SHIFT DIRECTION	H	COM1→COM32	L	COM32→COM1																								
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L	COM32→COM1																																
φ <sub>1</sub> , φ <sub>2</sub>	Output	Operating clock output pins for T7932 The frequency of φ <sub>1</sub> , φ <sub>2</sub> = f <sub>osc</sub> × $\frac{1}{2}$	V <sub>DD</sub> to V <sub>SS</sub>																														
IR/OR	Input	IR/OR = H : LCD power supply divided by built-in voltage divider IR/OR = L : LCD power supply external input	V <sub>DD</sub> to V <sub>SS</sub>																														

PIN NAME	I/O	FUNCTIONS	SIGNAL VOLTAGE
16/32	Input	Select voltage divide factor. (LCD voltage supply using built-in divider) $16/32 = H : \frac{1}{16}$ duty, $16/32 = L : \frac{1}{32}$ duty	$V_{DD}$ to $V_{SS}$
$V_{LC1}$ to $V_{LC5}$	—	Power supply for LCD drive <ul style="list-style-type: none"> <li>● When IR/OR = H  <math>V_{LC1}, V_{LC4}</math> : Output  <math>V_{LC2}, V_{LC3}</math> : Output  <math>V_{LC5}</math> : Input</li> <li>● When IR/OR = L  <math>V_{LC1}, V_{LC4}, V_{LC5}</math> : Input  <math>V_{LC2}, V_{LC3}</math> : High Impedance</li> </ul>	—
$V_{DD}$	—	Power supply (5V)	
$V_{SS}$	—	Power supply (0V)	

**FUNCTION OF EACH BLOCK**

- On-chip oscillator

The T7933 includes a built-in oscillator. (An external resistor must be connected between R and CR, and an external capacitor must be connected between C and CR). The external resistor and capacitor cause the oscillation frequency to change.

- Timing generator

This circuit divides the oscillation frequency and generates display timing signals suitable for the duty factor. The DS1 to DS3 inputs set the duty factor.

- Bi-directional shift register

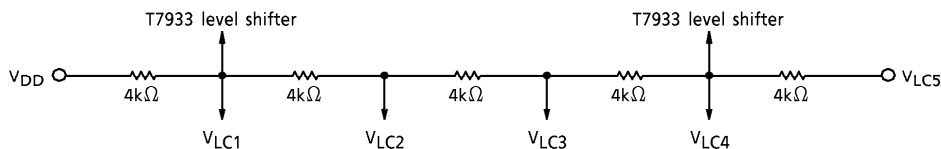
The T7933 has a 32-bit bi-directional shift register. The DSR input sets the shift direction. The data shift is synchronized to the SC signal.

- LCD driver

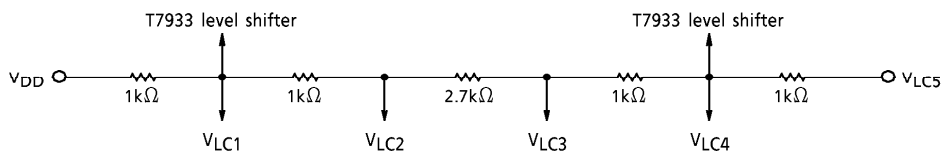
The T7933 has 32 row drivers and four LCD drive voltage output levels. The display data latched from the latch circuit and the FR signal select one of the four LCD drive voltage levels.

- On-chip voltage divider (IR / OR = H)

(1) 16 / 32 = H



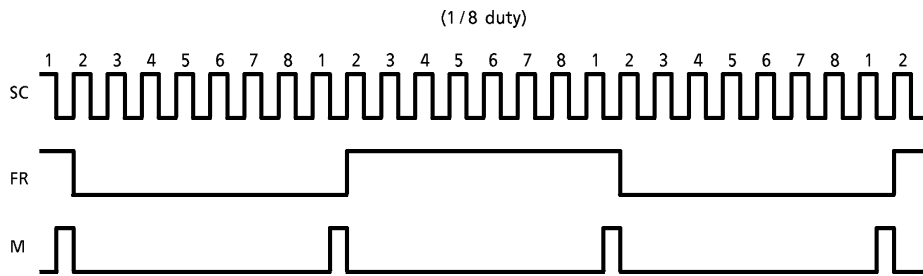
(2) 16 / 32 = L



(Note 1) The T7933 can receive an external power supply via  $V_{LC1}$  and  $V_{LC4}$  when IR / OR = L.

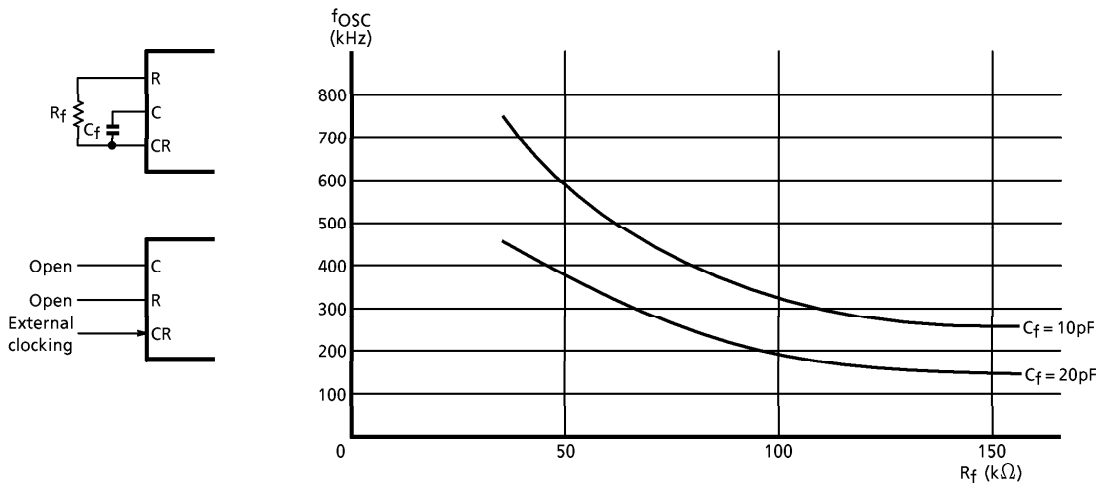
(Note 2) The T7933 can supply power to an external driver via  $V_{LC2}$  and  $V_{LC3}$  when IR / OR = H.

RELATION BETWEEN SC, FR AND M OF RELATIONAL



RELATION BETWEEN OSCILLATION FREQUENCY, R<sub>f</sub> AND C<sub>f</sub>

R<sub>f</sub>, C<sub>f</sub> connection



**ABSOLUTE MAXIMUM RATINGS** (Ta = 25°C)

ITEM	SYMBOL	RATING	UNIT
Supply Voltage (1)	V <sub>DD</sub> (Note 1)	-0.3 to 7.0	V
Supply Voltage (2)	V <sub>LC1</sub> , V <sub>LC4</sub> , V <sub>LC5</sub> (Note 1, 2)	V <sub>DD</sub> - 13.5 to V <sub>DD</sub> + 0.3	V
Input Voltage	V <sub>IN</sub> (Note 1)	-0.3 to V <sub>DD</sub> + 0.3	V
Operating Temperature	T <sub>opr</sub>	-20 to 75	°C
Storage Temperature	T <sub>stg</sub>	-55 to 125	°C

(Note 1) Referenced to V<sub>SS</sub> = 0V

(Note 2) Ensure that the following condition is always maintained.

$$V_{DD} \geq V_{LC1} \geq V_{LC4} \geq V_{LC5}$$

**ELECTRICAL CHARACTERISTICS**

**DC CHARACTERISTICS**

TEST CONDITIONS (Unless otherwise noted, V<sub>SS</sub> = 0V, V<sub>DD</sub> = 5.0V ± 10%, V<sub>LC5</sub> = 0V, Ta = -20 to 75°C)

ITEM	SYM-BOL	TEST CIR-CUIT	TEST CONDITIONS	MIN	TYP.	MAX	UNIT	PIN NAME	
Operating Voltage (1)	—	—	—	4.5	5.0	5.5	V	V <sub>DD</sub>	
Operating Voltage (2)	—	—	—	V <sub>DD</sub> - 11	—	V <sub>DD</sub> - 3.0	V	V <sub>LC5</sub>	
Input Voltage	H Level	V <sub>IH</sub>	—	V <sub>DD</sub> - 1.0	—	V <sub>DD</sub>	V	CR, FS1, FS2, DS1 to DS3, M, $\overline{STB}$ , IR / OR, DSR, 16 / 32, SC	
	L Level	V <sub>IL</sub>	—	0	—	1.0	V		
Output Voltage	H Level	V <sub>OH</sub>	—	V <sub>DD</sub> - 0.3	—	V <sub>DD</sub>	V	M, FR, SC, $\phi 1$ , $\phi 2$	
	L Level	V <sub>OL</sub>	—	0	—	0.3	V	M, FR, SC, $\phi 1$ , $\phi 2$	
Output Voltage	H Level	V <sub>OH</sub>	—	V <sub>DD</sub> - 0.3	—	V <sub>DD</sub>	V	COM1 to COM32	
	M Level	V <sub>OM</sub>	—	V <sub>LC1</sub> = V <sub>1</sub>	V <sub>1</sub> - 0.3	—	V <sub>1</sub> + 0.3	V	COM1 to COM32
				V <sub>LC4</sub> = V <sub>4</sub>	V <sub>4</sub> - 0.3	—	V <sub>4</sub> + 0.3	V	COM1 to COM32
				V <sub>LC2</sub> = V <sub>2</sub>	V <sub>2</sub> - 0.3	—	V <sub>2</sub> + 0.3	V	V <sub>LC2</sub>
				V <sub>LC3</sub> = V <sub>3</sub>	V <sub>3</sub> - 0.3	—	V <sub>3</sub> + 0.3	V	V <sub>LC3</sub>
L Level	V <sub>OL</sub>	—	—	V <sub>5</sub>	—	V <sub>5</sub> + 0.3	V	COM1 to COM32	

ITEM		SYM-BOL	TEST CIR-CUIT	TEST CONDITIONS	MIN	TYP.	MAX	UNIT	PIN NAME
Output Resist-ance	H Level	R <sub>OH</sub>	—	V <sub>OUT</sub> = V <sub>DD</sub> - 0.5V	—	—	1.0	kΩ	M, FR, SC, φ1, φ2
	L Level	R <sub>OL</sub>	—	V <sub>OUT</sub> = 0.5V	—	—	1.0	kΩ	M, FR, SC, φ1, φ2
Output Resist-ance	H Level	R <sub>OH</sub>	—	V <sub>OUT</sub> = V <sub>DD</sub> - 0.5V	—	—	1.0	kΩ	COM1 to COM32
	M Level	R <sub>OM</sub>	—	V <sub>LC1</sub> = V <sub>1</sub> , V <sub>OUT</sub> = V <sub>1</sub> ± 0.5V	—	—	1.0	kΩ	COM1 to COM32
				V <sub>LC4</sub> = V <sub>4</sub> , V <sub>OUT</sub> = V <sub>4</sub> ± 0.5V	—	—	1.0	kΩ	COM1 to COM32
L Level	R <sub>OL</sub>	—	V <sub>OUT</sub> = V <sub>5</sub> + 0.5V V <sub>LC5</sub> = V <sub>5</sub>	—	—	1.0	kΩ	COM1 to COM32	
Operating Frequency		f <sub>osc</sub>	—	T <sub>a</sub> = - 10 to 70°C	70	—	500	kHz	CR
Current Consumption		I <sub>SS</sub>	—	V <sub>DD</sub> = 5.0V V <sub>LC5</sub> = 0V V <sub>LC1</sub> = V <sub>1</sub> V <sub>LC4</sub> = V <sub>4</sub> f <sub>osc</sub> = 430kHz (Duty: 1 / 16) COM1 to COM32: No Load	—	—	400	μA	V <sub>SS</sub>

(Note 1)  $V_1 = V_{DD} - \frac{1}{5} (V_{DD} - V_{LC5})$ ,  $V_2 = V_{DD} - \frac{2}{5} (V_{DD} - V_{LC5})$

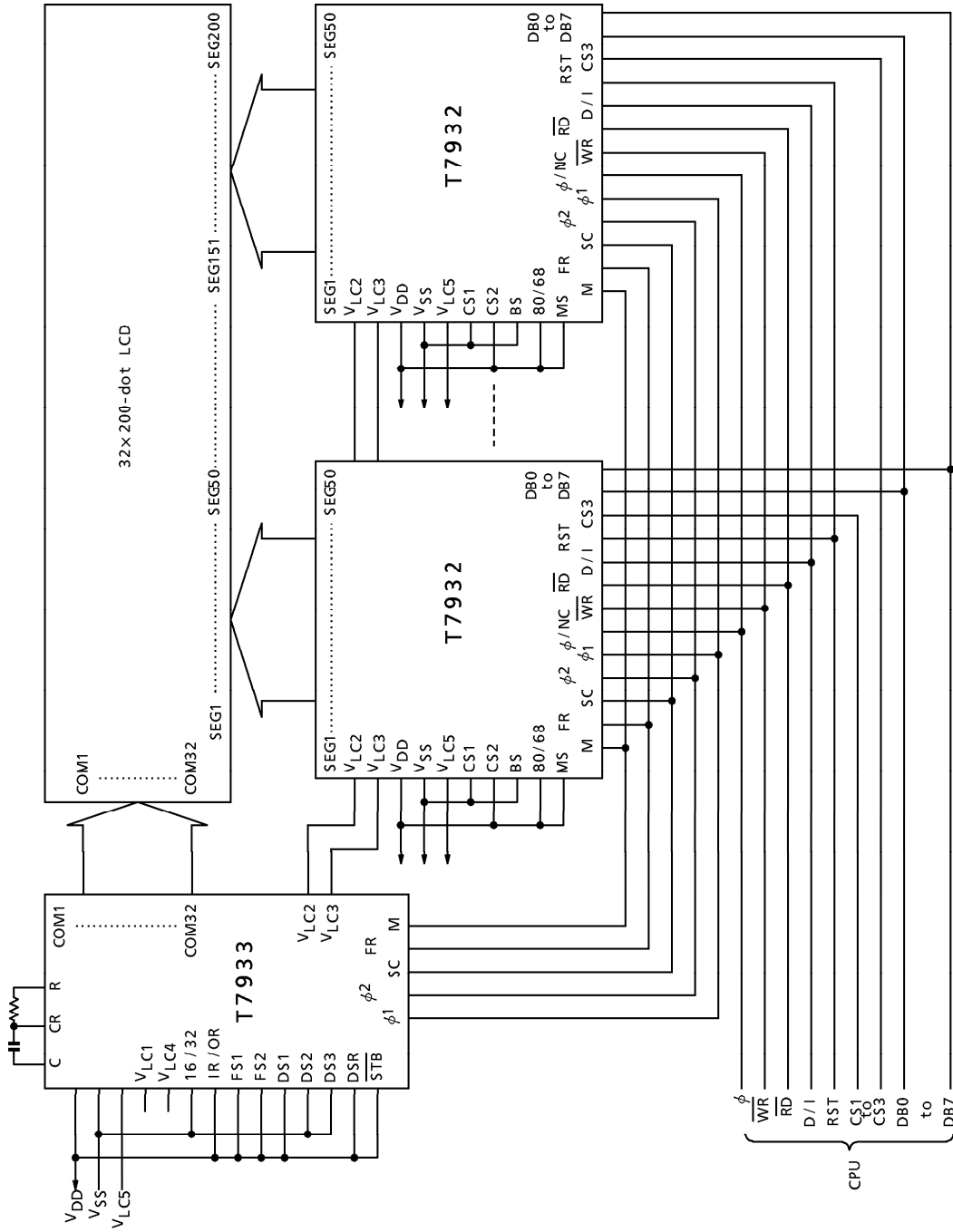
$V_4 = V_{DD} - \frac{4}{5} (V_{DD} - V_{LC5})$ ,  $V_3 = V_{DD} - \frac{3}{5} (V_{DD} - V_{LC5})$

$V_5 = V_{LC5}$

(Note 2) Output resistance measured when the on-chip voltage dividers are not used.

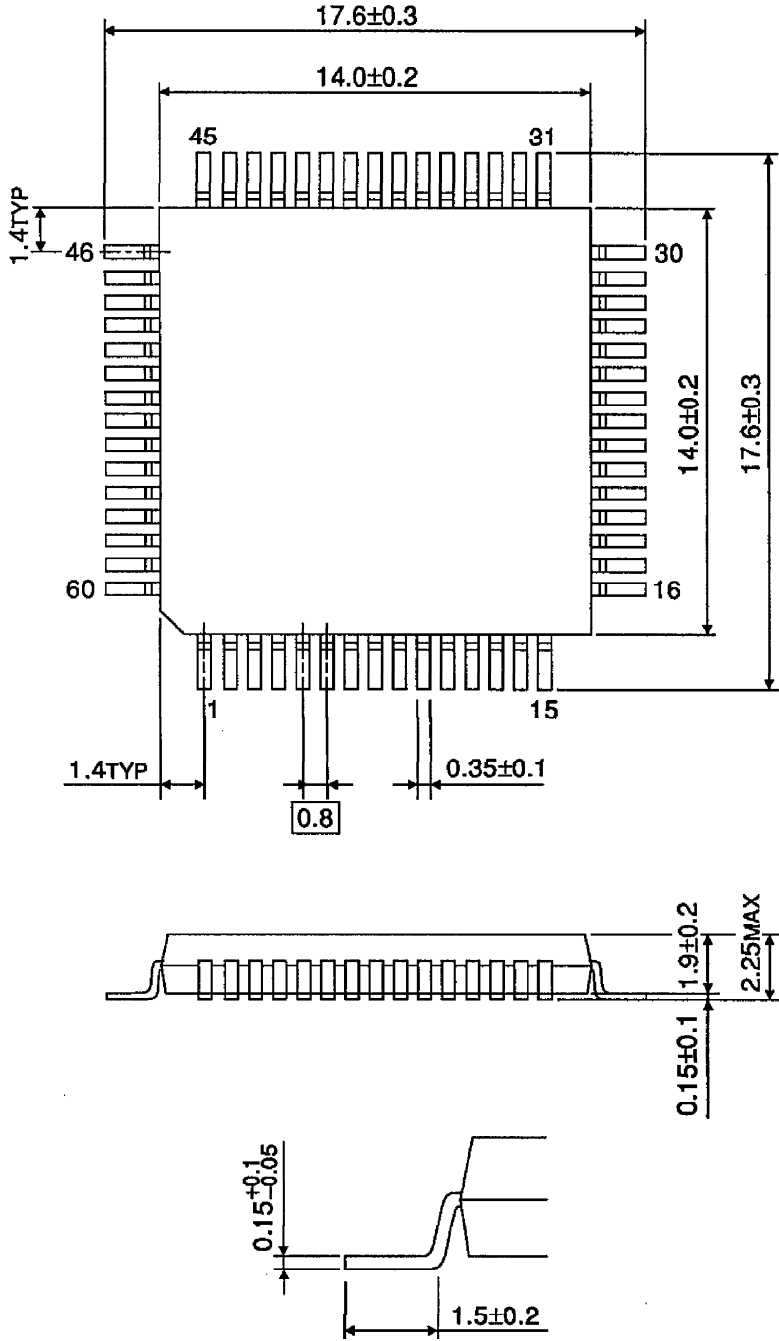


APPLICATION CIRCUIT



OUTLINE DRAWING  
QFP60-P-1414-0.80A

Unit : mm



Weight : 1.1g (Typ.)