Austria Mikro Systeme International AG

16-Digit LCD Driver CMOS Integrated Circuit

Key Features

- 16-digit LCD driver on a 44 pin CMOS chip
- Operating voltage range: 3.2 to 4.8V
- Low power consumption: max. 150 µA
- Driving 7-segment displays with up to 16 digits and 12 symbols
- Option for 12 digits
- Buffer for 32 digits
- 4 backplanes
- 2-wire interface
- On chip timer for showing elapsed time
- Contrast adjustable
- On chip oscillator using 32.768 kHz crystal
- Compatible with AS2525

General Description

The AS2591 is a CMOS integrated circuit for driving a liquid crystal display intended for use in telephones. The driver can be used with 12- or 16-digit LCDs.

The 2-wire serial interface is compatible with the AS2525, single-chip handsfree telephone circuit.

The device is designed for LCDs with 4 backplanes and 24 or 31 segments providing 12 or 16 7-segment digits and 12 symbols.

The AS2591 also includes a timer for showing elapsed time in minutes and seconds.

The contrast can be adjusted through the serial interface.

Package

Available in 44 pin TQFP.

Block Diagramme

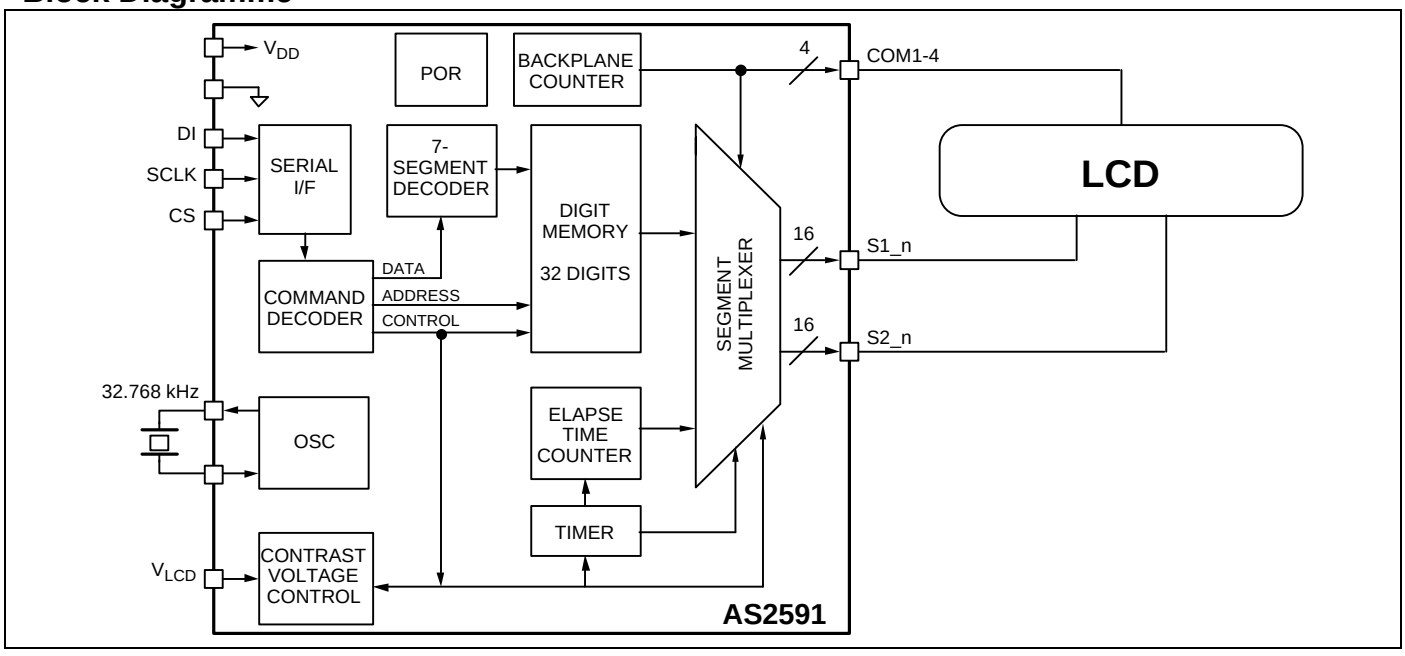

Figure 1: Block diagram

Pin Description

Pin #	Name	Type	Description
1 2 3 4 5 6 7 8 9 10 11 12	S2_10 S1_10 S2_11 S1_11 S2_12 S1_12 S2_13 S1_13 S2_14 S1_14 S2_15 S1_15	AO	**Segment Outputs** Output pins for driving segments of LCD.
13	CS	DI	**Chip Select** Chip select signal from CPU (e.g. AS2525).
14	DI	DI	**Data Input** Data input pin for serial interface.
15	SCLK	DI	**Serial Clock Input** Clock input pin for serial interface.
16	V_{DD}	Supply	**Positive Voltage Supply** This pin is the positive power supply for the device.
17	V_{SS}	Supply	**Negative Voltage Supply** This pin is the negative power supply for the device.
18 19	XTAL1 XTAL2		**Oscillator Pins** Oscillator pins for connection of a 32.768 kHz crystal.
20	V_{LCD}	AI	**LCD Reference Voltage** This is the input pin for setting the internal LCD reference voltage (see also Figure 4: Supply arrangement).
21 22 23 24	COM1 COM2 COM3 COM4	AO	**Backplane Outputs** Ouput pins for driving backplanes of LCD.

Continues…

Pin #	Name	Type	Description
25	S2_0	AO	**Segment Outputs**
26	S1_0		
27	S2_1		Output pins for driving segments of LCD.
28	S1_1		
29	S2_2		
30	S1_2		
31	S2_3		
32	S1_3		
33	S2_4		
34	S1_4		
35	S2_5		
36	S1_5		
37	S2_6		
38	S1_6		
39	S2_7		
40	S1_7		
41	S2_8		
42	S1_8		
43	S2_9		
44	S1_9		

DI:	Digital Input	AI:	Analogue Input
DO:	Digital Output	AO:	Analogue Output
DI/O:	Digital Input/Output	AI/O:	Analogue Input/output

Pin Configuration

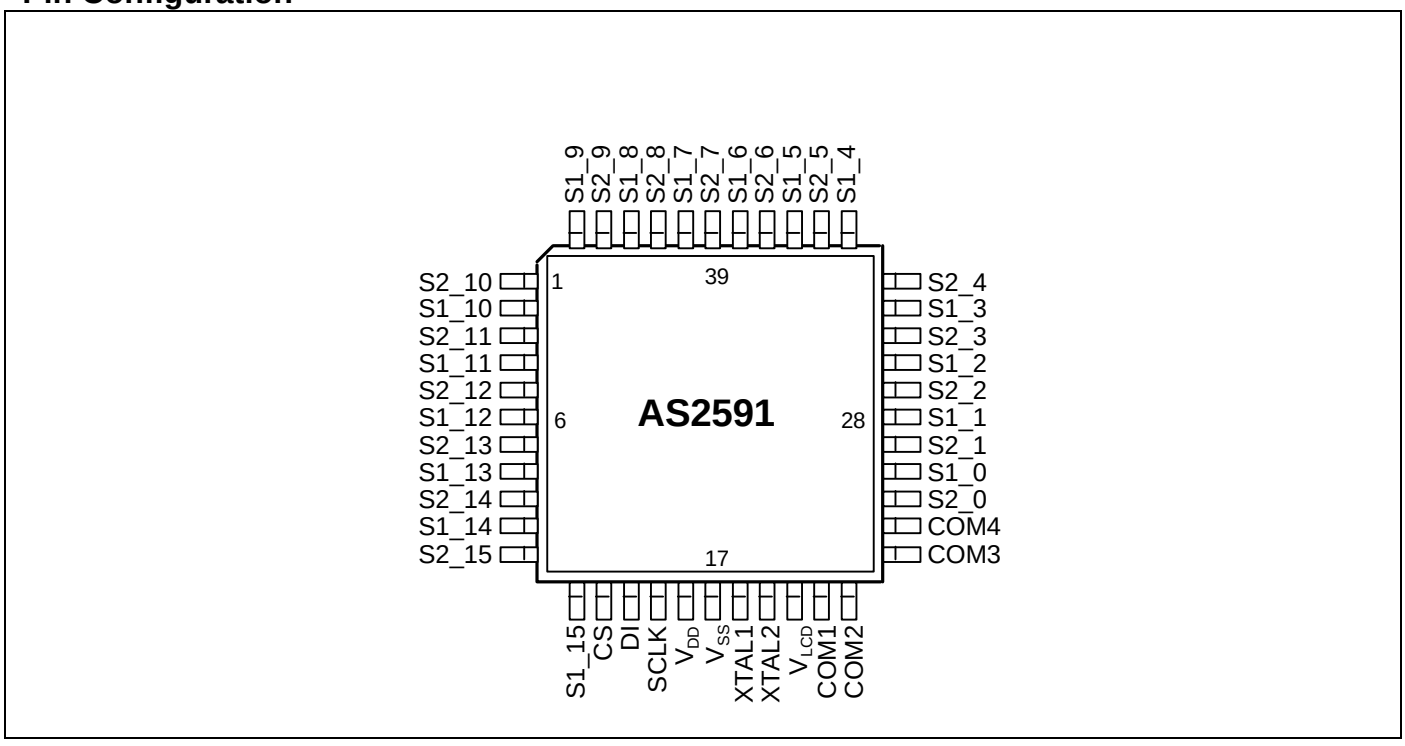

Figure 2: Pin configuration

Typical Application

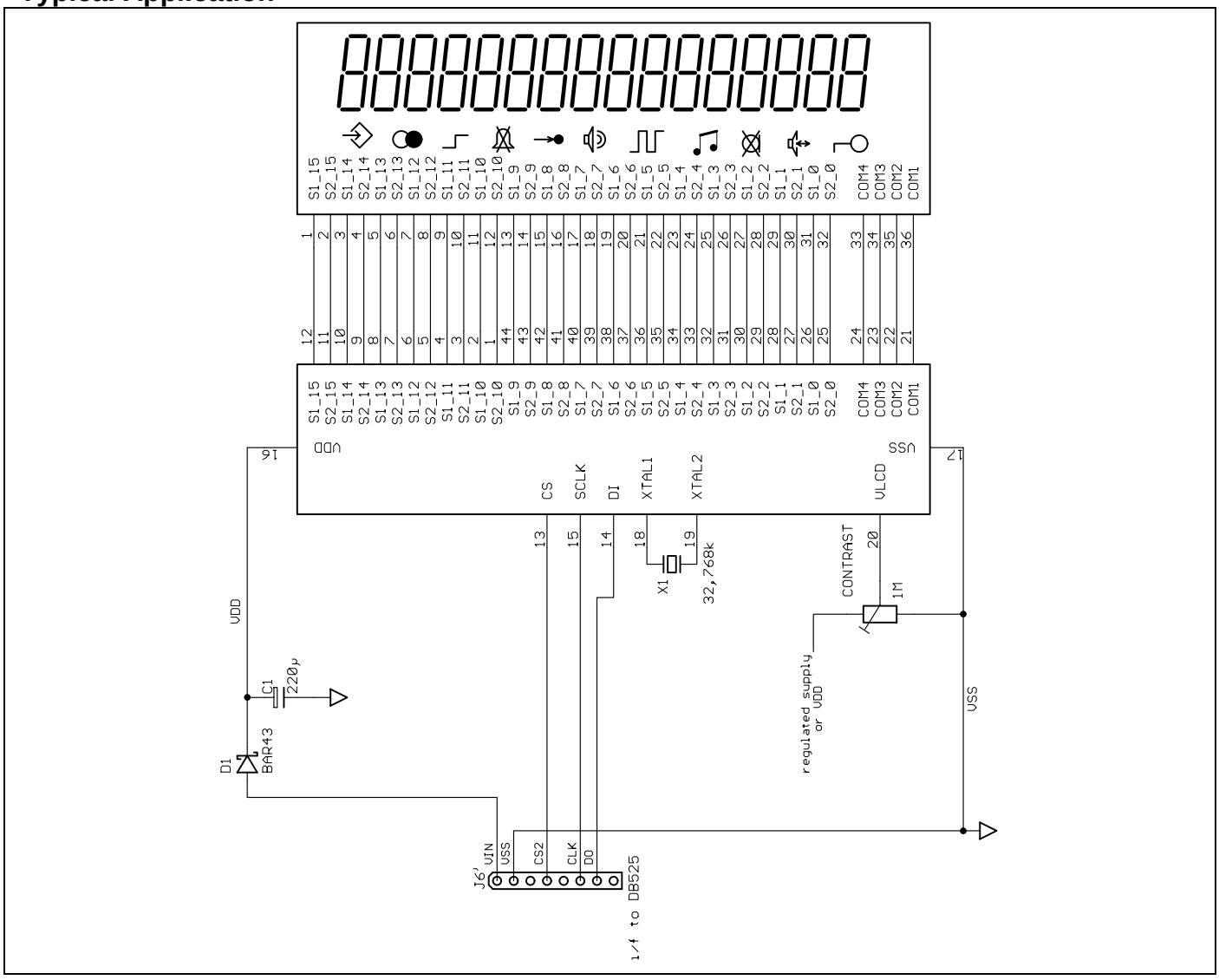

Figure 3: Typical Application

See also application note AN525 for further information.

Functional Description

AS2591 is a CMOS mixed-mode integrated circuit for driving LCDs with 4 backplanes and 24 or 31 segments providing 12 or 16 7-segment digits and 12 symbols. The device is controlled via a simple 2-wire bus and a chip-select signal. The device also includes an elapse-time counter which is started 5 seconds after power-up and incremented every second.

The timer is re-started whenever the device gets a WRITE-DIGIT or SHIFT&WRITE command within the first 5 counts (except commands for displaying digits "**-**", "^{o} ", "**o**"). The content of the timer is displayed 5 second after receiving the last WRITE-DIGIT, SHIFT&WRITE or BLINKING command. The normal display appears immediately after receiving a WRITE-DIGIT, SHIFT&WRITE, or BLINKING command.

Supply Arrangement

The device is supplied through V_{DD}. The internal reference voltages (V_{33}, V_{23}, and V_{13}) for the backplane and segment outputs are set at pin V_{LCD}. With V_{LCD} set to 3.27V the segment output voltage is 2.97V (middle).

This voltage can be programmed through the serial bus to 2.83V (low) or 3.09V (high) for optimising the contrast of the LCD. The 1/3, 2/3, and 3/3 voltages are generated internally (see Figure 4: Supply arrangement). In applications with varying V_{DD}, it is recommended to insert a voltage regulator at V_{LCD} in order to assure a constant contrast (see also application note AN525 for further information).

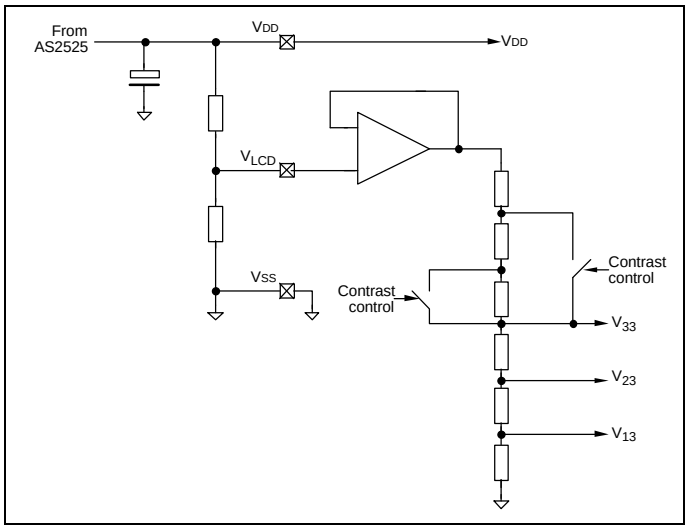

Figure 4: Supply arrangement

LCD Digit Code

Code [HEX]:	01	02	03	04	05	06	07	08	09	00
Number:	1	2	3	4	5	6	7	8	9	0
Display:										

Code [HEX]:	0A	0B	0C	0D	0E	0F	10	11	12	13	14
Letters/Signs:	a	b	c	d	e	f	#	*	-	(	)
Display:											

Code [HEX]:	15	16	17	18	19	1A	1B	1C	1D	1E	1F
Letters/Signs:	H	I	L	N	O	P	R	T	U	"	
Display:											

LCD Symbols

Each symbol is associated with a fixed digit address. The circuit has 12 symbols implemented associated with the lower 12 addresses.

Table 1: Symbol Overview

Enabled	Address	Name	Description
Always	y0	**KL**	Key lock activated
Optional	y1	SP	Loudspeaker on
Always	y2	**MT**	Mute activated
Optional	y3	MF	DTMF dialling mode selected
Optional	y4	LD	Loop disconnect (pulse) dialling mode selected
Optional	y5	Vol	Volume control keys activated. Remains on 2 seconds after last volume key pressure
Always	y6	**MR**	Memory redial key has been pressed. Remains on until next key pressure
Always	y7	**BO**	Bell off. Indicates that ringer has been turn off.
Always	y8	**SH**	Shift; indicates that shift key has been pressed. Remains on untill next key pressure
Optional	y9	-	Not used
Optional	y10	RD	Indicates that last number redial has been activated
Always	y11	**PG**	Indicates program mode

Symbol data are not effected by a BLINKING or by a WRITE&SHIFT command. Symbols will be displayed independently from selecting the upper bank of the 32 digit buffer to be displayed.

The symbol displayed depends on the layout of the LCD display. If the layout of the 12/16 digit LCD displays can be done similar, the symbol mapping does not need to be stored in the EEPROM.

Serial Interface

The serial interface uses the pins CS (chip select), SCLK (serial clock line), and DI (data input). A frame consists of a 3-bit command and 5-bit data (see Figure 5: Frame of serial interface). Commands are executed self-timed by the internal clock and commence at the falling edge of the CS signal.

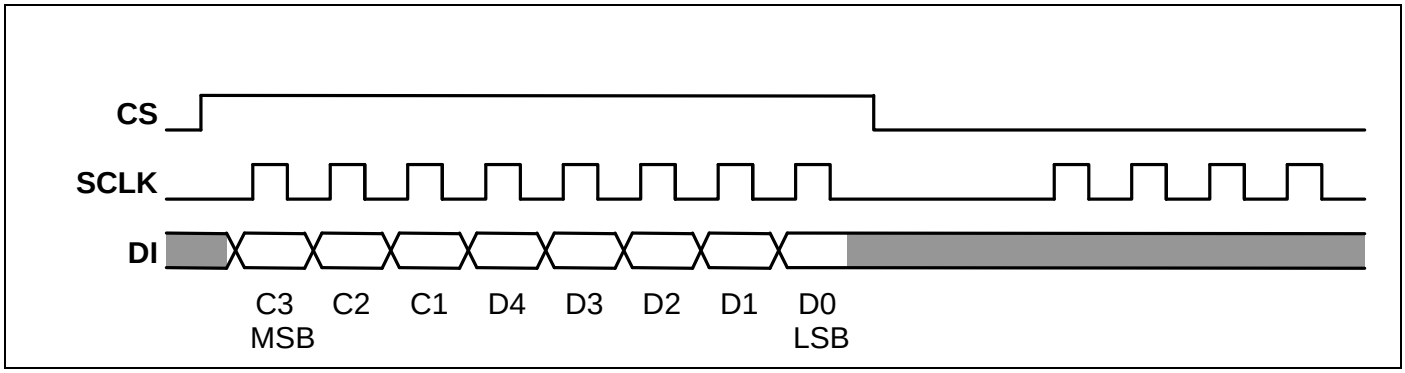

Figure 5: Frame of serial interface

Table 2: Commands

Command [bin]	Data [bin]/name	Description
000	address	Set pointer to address. If address is > 16/12, the upper bank of the 32-digit buffer will be displayed. In case of a 12-digit display, up to address 23 will be displayed, and if address is > 24 a third bank up to 32 will be displayed (see Table 4: 12-digit display and Table 5: 16-digit display).
001	digit_code	Write digit code to active address.
010	digit_code	Shift & write digit code to address 0 (right most digit). Address pointer is set to 0..
011	1x**BFS**	Blinking ON at address: **BF** blinking frequency: 00 1.33 Hz; 01 2.00 Hz; 10 0.67 Hz; 11 1.00 Hz **S** enabled/disabled: 0 blinking; 1 static off
	0xxxx	Blinking OFF at address
100	1xxxx	Symbol ON at address
	0xxxx	Symbol OFF at address
101	00xxx	Clear all digits, symbols, blinking, reset address to 0
	10xxx	Clear all digits, blinking, reset address to 0
	01xxx	Hide elapse time for 5 seconds.
	11xxx	Hide elapse time permanently (note: Hide is reset by above command 101 01xxx).
110	xxFTM	Reserved for test modes
111	0x**Z**xx	Display OFF and Cleared. **Z** delay time: 0 5 seconds; 1 no delay
	1**CCND**	Display ON (resets the off timer) **CC** contrast voltage: 00 low; 01 middle; 10 high; 11 not allowed **ND** number of digits: 00 12 digits; 01 16 digits; 10 not allowed; 11 not allowed

Digit Layout

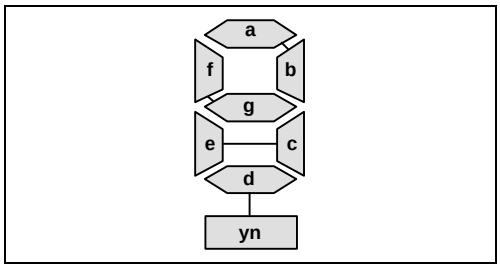

Figure 6: Digit Layout

COM1 - 4 = common backplane signals
S1_n, S2_n = segment signals

n = 0 is most right digit, n= 11 is most left digit for 12-digit displays, and n = 15 is most left digit for 16-digit displays.

Table 3: Backplanes and segments

	COM1	*COM2*	*COM3*	*COM4*
S1_n	a	f	e	yn
S2_n	b	g	c	d

Segment Allocation

Table 4: 12-digit display

Symbol	Address	y11	y10	y9	y8	y7	y6	y5	y4	y3	y2	y1	y0
	AS2525	**PG**	RD	-	**SH**	**BO**	**MR**	Vol	LD	MF	**MT**	SP	**KL**
Digits	Normal	11	10	9	8	7	6	5	4	3	2	1	0
	Upper 1	23	22	21	20	19	18	17	16	15	14	13	12
	Upper 2					31	30	29	28	27	26	25	24

Table 5: 16-digit display

Symbol Addr.					y11	y10	y9	y8	y7	y6	y5	y4	y3	y2	y1	y0
AS2525					**PG**	RD	-	**SH**	**BO**	**MR**	Vol	LD	MF	**MT**	SP	**KL**
Digits Normal	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Digits Upper	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16

The symbols in **bold** are always enabled and other symbols can be enabled through the serial interface. Symbols will be displayed independently from selecting the upper bank of the 32 digit buffer to be displayed.

The AS2591 incorporates a buffer for 32 digits. Digits are entered from the most right position and shifted left by new entries (see also Table 2: Commands).

Electrical Characteristics

Absolute Maximum Ratings*

Supply Voltage ..... $-0.3 \le V_{DD} \le 7V$

Input Current ..... +/- 25 mA

Input Voltage ..... $-0.3V \le V_{IN} \le V_{DD} + 0.3V$

Electrostatic Discharge ..... +/- 1000V

Storage Temperature Range ..... -65 to +125°C

Total Power Dissipation 500mW

*Exceeding these figures may cause permanent damage. Functional operation under these conditions is not permitted.

Recommended Operating Range

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
V_{DD}	Operating Voltage		3.2	4.0	4.8	V
V_{LCD}	LCD Reference Voltage		2.5	3.0	3.5	V
T_{AMB}	Ambient Operating Temp. Range		-25		+70	°C
f_{OSC}	Oscillator Frequency			32.768		kHz

DC Characteristics

Recommended operating conditions unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.*	Max.	Units
I_{DD}	Operating Supply Current	Unloaded			150	µA
I_{DD0}	Idle Current	Idle mode, oscillator not running			1	µA
V_{33}	Contrast Output Voltage at COM1-4 and S1-2_n Pins	V_{LCD} = 3.27V Contrast voltage low Contrast voltage middle Contrast voltage high		 2.83 2.97 3.09		 V V V
V_{IL}	Input Low Voltage		V_{SS}		0.3 V_{DD}	V
V_{IH}	Input High Voltage		0.7 V_{DD}		V_{DD}	V

* Typical figures are at 25°C and are for design aid only; not guaranteed and not subject to production testing.

Electrical Characteristics

Recommended operating conditions unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
F_{LCD}	LCD Frame Frequency		61	64	67	Hz
$t_{OFF-TIMER}$	Off Timer		4.75	5	5.25	sec
f_{BLINK}	Blinking Frequency	BF = 00 BF = 01 BF = 10 BF = 11		1.33 2.00 0.67 1.00		Hz Hz Hz Hz
R_{COM}	Output Impedance of Backplane Outputs				150	kohm
R_{SEG}	Output Impedance of Segment Outputs				150	kohm

Package Outline

44 Pin TQFP

See Package Catalogue