Austria Mikro Systeme International

LC DISPLAY DRIVER WITH 18 DIGITS, 6 SYMBOLS AND CLOCK/TIMER

Key Features

- ❑ Very low operating current, typ. 30 µA @ 3V
- ❑ Low power oscillator using 32.768 kHz Xtal
- ❑ 2-wire interface compatible to AS2574B
- ❑ 18 digits by 7 segments
- ❑ 6 symbols
- ❑ 24 hour clock showing hours and minutes
- ❑ Timer automatically showing elapsed time in minutes and seconds after each telephone conversation
- ❑ 33 LCD segment outputs and 4 LCD backplane outputs
- ❑ 4 times multiplex mode with a cycle time of 128 Hz
- ❑ Mode select pin for selecting clock function

Package

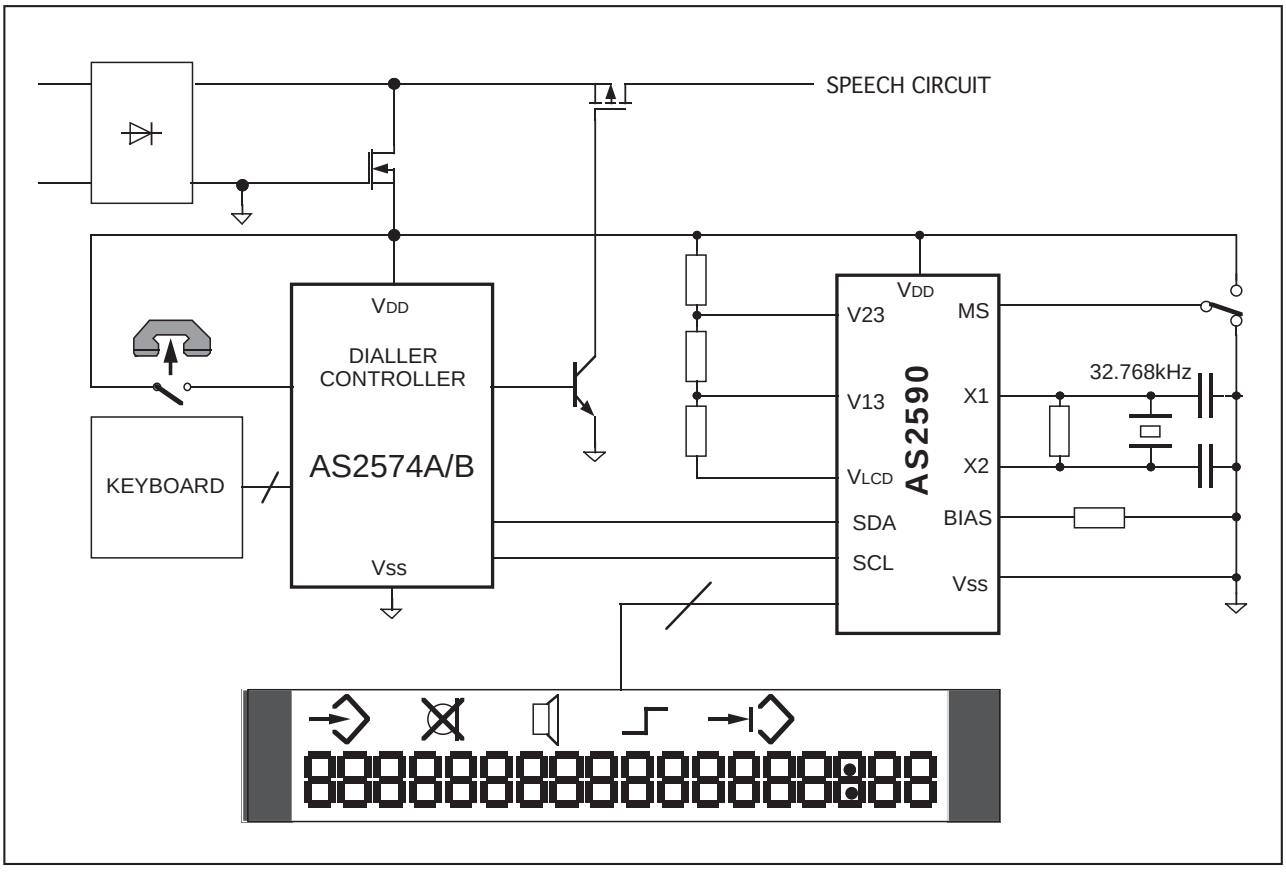
Available in 48 pin DIP and 52 pin PLCC.

General Description

The AS2590 is an integrated CMOS device for driving a liquid crystal display intended for use in telephones. The 2-wire serial interface is compatible to the dialler AS2574B.

The extreme low operating current allows the circuit to be operational also during on-hook which is necessary in order to the use of the clock function. In on-hook condition the circuit can be supplied by a small leakage current from the telephone line or from a small 3V battery.

Whether the oscillator shall continue operating or be stopped during on-hook is determined by the mode pin, MS.



Pin Description

DIL	PLCC	Symbol	Function
1 2	1 2	BP1 BP0	Blackplanes
3 4 5 6 7 8 9 10 11 12	3 4 5 6 8 9 10 11 12 13	S0 S1 S2 S3 S4 S5 S6 S7 S8 S9	Segment outputs
13	14	V1/3	1/3 of V_{DD} pin for external voltage divider
14 15 16 17 18 19 20 21 22 23	15 16 17 18 19 21 22 23 24 25	S10 S11 S12 S13 S14 S15 S16 S17 S18 S19	Segment outputs
24	26	V_{SS}	Negative supply pin
25 26	27 28	BP3 BP2	Back plane outputs
27	29	V2/3	2/3 of V_{DD} pin for external voltage divider
28 29 30 31 32 33 34 35 36 37 38 39 40	30 31 32 34 35 36 37 38 39 40 41 42 43	S32 S31 S30 S29 S28 S27 S26 S25 S24 S23 S22 S21 S20	Segment outputs
41	44	V_{LCD}	Negative supply pin for LC display

Pin Description Continued

DIL	PLCC	Symbol	Function
42 43	45 47	SDA SCL	Serial data line input to dialler/controller Clock line input of serial data link
44	48	V_{BIAS}	Oscillator bias input, recommended bias resistor 2.2 MΩ
45 46	49 50	XTAL1 XTAL2	Oscillator pins for 32.768 kHz crystal, a resistor and two capacitors
47	51	MS	Mode select input: MS = V_{SS} › clock/timer disabled MS = V_{DD} › clock/timer enabled
48	52	V_{DD}	Positive supply pin

LCD Layout

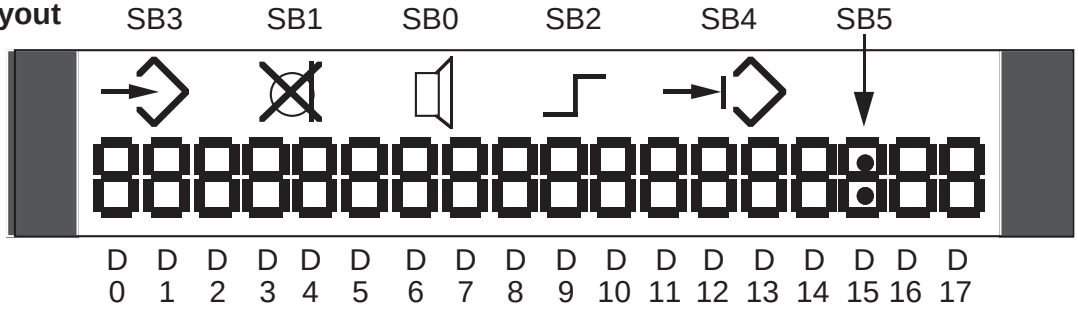


Figure 1

SB0 = loudspeaker on (blinking with 1 Hz)

SB1 = microphone muted (blinking with 1 Hz)

SB2 = 2nd key function enabled

SB3 = number stored

SB4 = number buffered in FIFO, not stored

SB5 = colon for clock and timer (blinking when clock is shown)

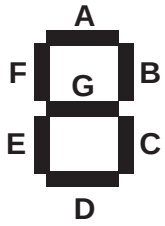


Figure 2

Table 1 Segments Digits

Digit	Description	Segment						
		A	**B**	**C**	**D**	**E**	**F**	**G**
0	numbers	on	on	on	on	on	on	
1	0…9		on	on				
2		on	on		on	on		on
3		on	on	on	on			on
4			on	on			on	on
5		on		on	on		on	on
6		on		on	on	on	on	on
7		on	on	on				
8		on	on	on	on	on	on	on
9		on	on	on			on	on
a	letter A			on	on	on		on
b	letter B			on	on	on	on	on
c	letter C				on	on		on
d	Letter D		on	on	on	on		on
_	underscore				on			
*	asterisk		on	on		on	on	
#	hash	on		on	on	on		on
-	pause							on
P/T	temp. MF	on			on			on
r	recall					on		on

Description

Operating Modes

The following two operating modes are pin selectable:

Mode 0:
Clock and timer are disabled and the oscillator is stopped when going on-hook (command BLANK ALL).

Mode 1:
Clock and timer functions are enabled, clock is displayed both during off- and on-hook (assuming that clock is set). When going from off-hook to on-hook, the timer content (elepsed time) is displayed for 6 seconds (assuming that a start timer command was received).

Clock

After a power up reset the clock is disabled. The clock will not be displayed until a valid set clock procedure has been performed (mode 1 only). The format of the clock is hh:mm and the leading zero of the hours is suppressed and symbol 5 (:) is blinking with a frequency of 1 Hz. The timer is running when off-hook and displayed for 6 seconds when going on-hook. The content of the timer (elapsed time) is shown in stead of the clock in the format mm:ss.

If a SET CLOCK command is received the display is blanked, four underscore symbols are displayed where the 4 digits of the clock will be entered (the 4 most right digits) and symbol 5 is turned on (_ _ : _ _). The next 4 data words are interpreted as the time (hh mm). The fourth digit terminates the SET CLOCK and starts the clock with the seconds set to zero.

If less than 4 data words (digits) are received the first command (normally a BLANK DIGITS or a BLANK ALL) will terminate the SET CLOCK. But as the procedure was incomplete, it is regarded as invalid and further clock display is disabled. The next valid SET CLOCK command will enable the clock again. The SET CLOCK command does not effect the timer.

The time-out condition (approx. 15 seconds) when setting clock is recognized by the dialler/controller (e.g. AS2574). If a time-out condition occours the dialler sends a BLANK ALL command to terminated the SET CLOCK.

Timer

The following commands effect the timer:

- START TIMER and START FIFO; they start the timer. If the timer is already running, it cannot be restarted by one of these commands before stopping the timer with the BLANK ALL command.
- Power up; enables subsequent start timer commands.
- BLANK ALL; clears the whole display (including special symbols) and displays the timer contents for 6 seconds (if clock/timer function is enabled) or until a new START TIMER/FIFO command is received. Then it returns to normal display mode.
- if any command or data is received by the serial interface within the time out period after a BLANK ALL command, the timer display will be blanked or replaced by the clock display.

The timer is displayed in the format mm:ss with the leading zero of the minutes suppressed and symbol 5 (:) turned on.

LCD Outputs

The 33 segment outputs and 4 backplane outputs can drive a customized liquid crystal display in 1:4 multiplex mode. Two reference voltages V1/3 and V2/3 are provided by an external voltage divider.

Digits and Special Symbols

The display consists of 18 seven segment digits and 6 special symbols (see figure 1):

- D0…D17; D0 is the most left seven segment digit, the possible numbers displayed by one digit are shown in figure 2. The symbol (_) is only displayed at D13, D14, D16 and D17 when setting the clock.
- SB0…SB5; 6 special symbols (one segment for each symbol only), see figure 1 for reference. If SB0 (loudspeaker on) or SB1 (microphone muted) are turned on, they blink with a frequency of 1 Hz.

Multiplex Mode

A total of 132 segments are addressable. One output drives 4 segments in a time multiplex mode. The 4 backplane outputs determine the currently addressed segment (see figure 3).

Figure 3 gives the correlation between segment outputs and addressed segments.

Data and Commands

32 different words may be received via the serial interface. 19 words are interpreted as display data for one of the 18 seven segment digits. Table 2 gives the translation from received code to displayed symbol.

13 words are valid commands codes. The function of each command is described in table 2, and table 4 lists the 5 bit codes for all possible commands.

Table 2 Command Summary

NO	MNEMONIC	FUNCTION
1	SET LS	Turns on special symbol SB0 (loudspeaker on, blinking)
2	CLEAR LS	Turns off special symbol SB0
3	SET MUTE	Turns on special symbol SB1 (microphone muted, blinking)
4	CLEAR MUTE	Turns off special symbol SB1
5	SET 2ND	Turns on special symbol SB2 (2nd function on keyboard)
6	CLEAR 2ND	Turns off special symbol SB2
7	SET CLOCK	Initiates clock setting; SB5 is turned on
8	START	Blanks all digits, SB3 and SB4; accepts data, timer not started
9	START COPY	Blanks all digits and SB4; turns on SB3, accepts data, timer not started (if not already running)
10	START FIFO	Blanks all digits and SB3; turns on SB4, accepts data, timer started (if not already running)
11	START TIMER	Blanks all digits, turns off SB3 and SB4, accepts data, timer started (if not already running)
12	BLANK ALL	Blanks all digits and all special symbols (except D13, D14, D16, D17 and SB5 when clock is running)
13	TEST MODE	Turns circuit into test mode

Table 3 Segment Mapping

SEGMENT OUTPUT	BACKPLANE BP0	BP1	BP2	BP3
S0	SB0	SB1	SB4	SB2
S1	D0/F	D0/G	D0/E	D0/D
S2	D0/A	D0/B	D0/C	D1/D
S3	D1/F	D1/G	D1/E	D1/C
S4	D1/A	D1/B	D2/G	D2/E
S5	D2/A	D2/F	D2/B	D2/C
S6	D3/A	D3/F	D2/E	D2/D
S7	D3/B	D3/G	D3/C	D3/D
S8	D4/F	D4/G	D4/E	D4/D
S9	D4/A	D4/B	D4/C	D5/D
S10	D5/F	D5/G	D5/E	D5/C
S11	D5/A	D5/B	D6/G	D6/E
S12	D6/A	D6/F	D6/B	D6/C
S13	D7/A	D7/F	D7/E	D6/D
S14	D7/B	D7/G	D7/C	D7/D
S15	D8/F	D8/G	D8/E	D8/D
S16	D8/A	D8/B	D8/C	D9/D

SEGMENT OUTPUT	BACKPLANE BP0	BP1	BP2	BP3
S17	D9/F	D9/G	D9/E	D9/C
S18	D9/A	D9/B	D10/G	D10/E
S19	D10/A	D10/F	D10/B	D10/C
S20	D11/A	D11/F	D11/E	D10/D
S21	D11/B	D11/G	D11/C	D11/D
S22	D12/F	D12/G	D12/E	D12/D
S23	D12/A	D12/B	D12/C	D13/D
S24	D13/F	D13/G	D13/E	D13/C
S25	D13/A	D13/B	D14/G	D14/E
S26	D14/A	D14/F	D14/B	D14/C
S27	D15/A	D15/F	D15/E	D14/D
S28	D15/B	D15/G	SB5	D15/D
S29	D16/F	D16/G	D16/E	D16/D
S30	D16/A	D16/B	D16/C	D17/D
S31	D17/F	D17/G	D17/E	D17/C
S32	D17/A	D17/B	D15/C	SB3

Dn/m = segment m of digit n
SBn = special symbol n

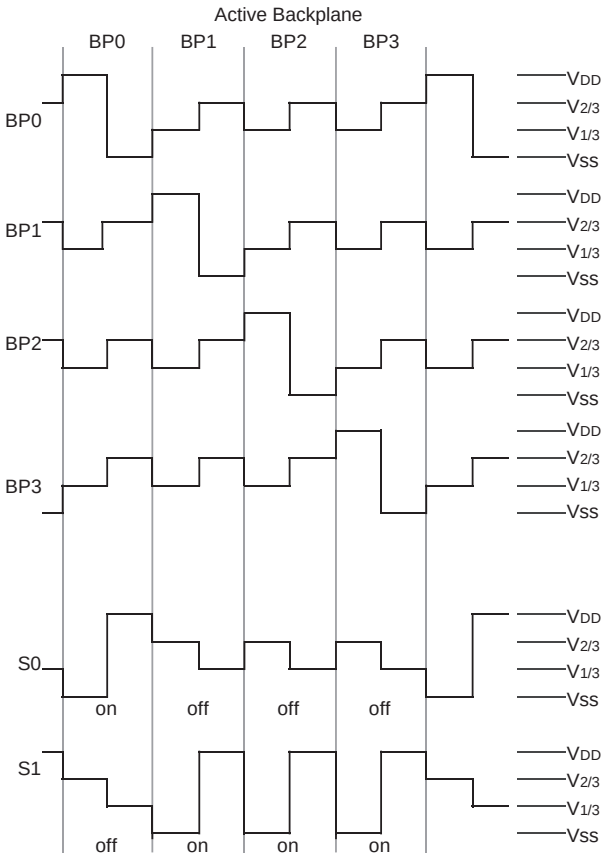


Figure 3 LCD driver outputs

Serial Interface

The serial interface is a one way, two line link between the dialler (AS2574) and the display driver. The two lines are the serial data line (SDA) and the serial clock line (SCL). The display driver can only receive data.

Word Transfer:

Data are transferred as 5 bit words with start and stop bit. the least significant bit is sent first after the start bit. As long as there is no data transfer, both data and clock lines have to remain high. Also between two words both lines have to stay high for a specified time. Figure 4 shows the timing of the serial interface.

Start and Stop Conditions:

A start condition is detected when the data line goes from high to low while the clock line is held high. A low to high transition of the data line while the clock line is high followed by a negative clock pulse indicates a stop condition (see figure 4).

Table 4 Codes for Serial Interface

NO	SYMBOL	MSB	B3	B2	B1	LSB	HEX
1	SB0-on	0	0	1	0	1	05
2	SB0-off	0	0	0	1	1	03
3	SB1-on	1	0	0	0	1	11
4	SB1-off	0	1	0	0	1	09
5	SB2-on	0	0	1	1	1	07
6	SB2-off	1	1	1	1	1	1F
7	SET CLOCK	0	1	0	1	1	0B
8	START	0	1	1	0	1	0D
9	COPY	0	1	1	1	1	0F
10	FIFO	1	0	0	1	1	13
11	TIMER	1	0	1	0	1	15
12	BLANK	1	1	1	0	1	1D
13	TEST	1	0	1	1	1	17
14	0	1	1	1	0	0	1C
15	1	0	0	0	0	0	00
16	2	0	0	1	0	0	04
17	3	0	0	0	1	0	02
18	4	1	0	0	0	0	10
19	5	1	0	1	0	0	14
20	6	1	0	0	1	0	12
21	7	0	1	0	0	0	08
22	8	0	1	1	0	0	0C
23	9	0	1	0	1	0	0A
24	a	0	0	1	1	0	06
25	b	1	0	1	1	0	16
26	c	0	1	1	1	0	0E
27	d	1	1	1	1	0	1E
28	*	1	1	0	0	0	18
29	#	1	1	0	1	0	1A
30	–	1	1	0	1	1	1B
31	P/T	1	1	0	0	1	19
32	r	0	0	0	0	1	01

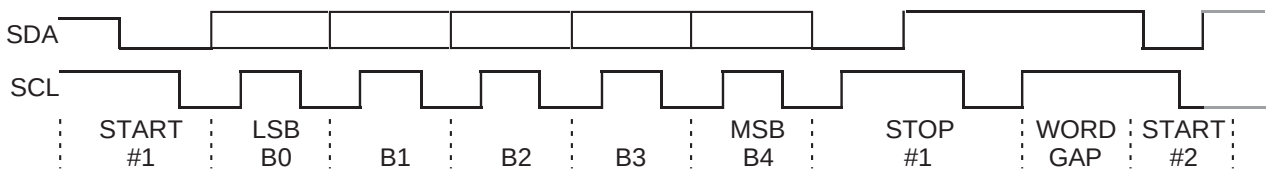


Figure 4 Interface Timing

Electrical Characteristics

Absolute Maximum Ratings

Positive Supply Voltage	$-0.3V \le V_{DD} \le 7V$
Input Current	± 25 mA
Digital Input Voltage	$V_{SS} - 0.3V \le V_{IN} \le V_{DD} + 0.3V$
Electrostatic Discharge (HBM)	±500V
Storage Temperature	-65°C to +125°C

Recommended Operating Conditions

Supply Voltage	$2.5V \le V_{DD} \le 5.5V$
Oscillator Frequency	32.768 kHz
Operating Temperature	- 25°C to +70°C

DC Characteristics (Default conditions: recommended operating conditions; outputs unloaded; V_{DD} = 3.0V)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
I_{DD0}	Standby Current	Test circuit fig. 5 no clock running			1.5	µA
I_{DD}	Operating Current	T_{AMB} = 5 to 55 °C Note 1, note 2		30	50	µA
V_{IL}	Input Voltage, Low		V_{SS}		0.2 V_{DD}	V
V_{IH}	Line Voltage, High		0.8 V_{DD}		V_{DD}	V
V_{LCD}	Output Voltage, Sink	I_{LCD} = 4.8 mA			0.4	V
R_{BIAS}	Oscillator Bias Resistor			2.2		MΩ

Note 1: Segment and backplane outputs loaded with maximum 30 pF, power consumption of external voltage divider not included, R_{BIAS} = 2.2 MΩ ± 10%.

Note 2: Xtal parameters: Rimax = 60 kΩ (Rityp = 30 kΩ)
Qmin = 35 000
Co = 1.5 pF (capacitance across Xtal terminals)
fxtal = 32.768 kHz

AC Characteristics (V_{DD} = 3.0V; T_{AMB} = -25 to 70 °C, unless otherwise specified)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
SDA/SCL	Serial Interface	Fig. 5				
f_{CL}	Clock Frequency			10		kHz
f_{CLH}	Clock High Time			50		µs
f_{CLL}	Clock Low Time			50		µs
f_{CD}	Clock Low to Data Change		20		t_{CLL}	ns
f_{SOH}	Stop Bit High Time			50		µs
f_{SOL}	Stop Bit Low Time			50		µs
f_{HD}	Data Hold Time		200			ns
f_{SUSO}	Clock Setup for Stop		200			ns
f_{HSA}	Clock Hold for Start		200			ns
f_{GAP}	Data High between 2 Words			100		µs
BP0…3	Back Plane Outputs	Figure 6, note 1				
t_{BRON}	Rise Time, on				20	µs
t_{BFON}	Fall Time, on				20	µs
t_{BROF}	Rise Time, off				20	µs
t_{BFOF}	Fall Time, off				20	µs
t_{BC}	Cycle Frequency			128		Hz
S0…32	Segment Outputs	Figure 7, note 2				
t_{SRON}	Rise Time, on				20	µs
t_{SFON}	Fall Time, on				20	µs
t_{SROF}	Rise Time, off				20	µs
t_{SFOF}	Fall Time, off				20	µs
t_{SC}	Cycle Frequency			128		Hz
t_{TIMER}	Timer Display Time	Note 3	5		6	sec
t_{XUP}	Oscillator Startup Time	R_{BIAS} = 2.2 MΩ		300		ms

Note 1: Loads on backplanes = 3 000 pF//10 MΩ

Note 2: Loads on segments = 360 pF//1 MΩ

Note 3: After BLANK ALL command and timer has been started with a valid start command, timer content is displayed.

Timing Diagrammes

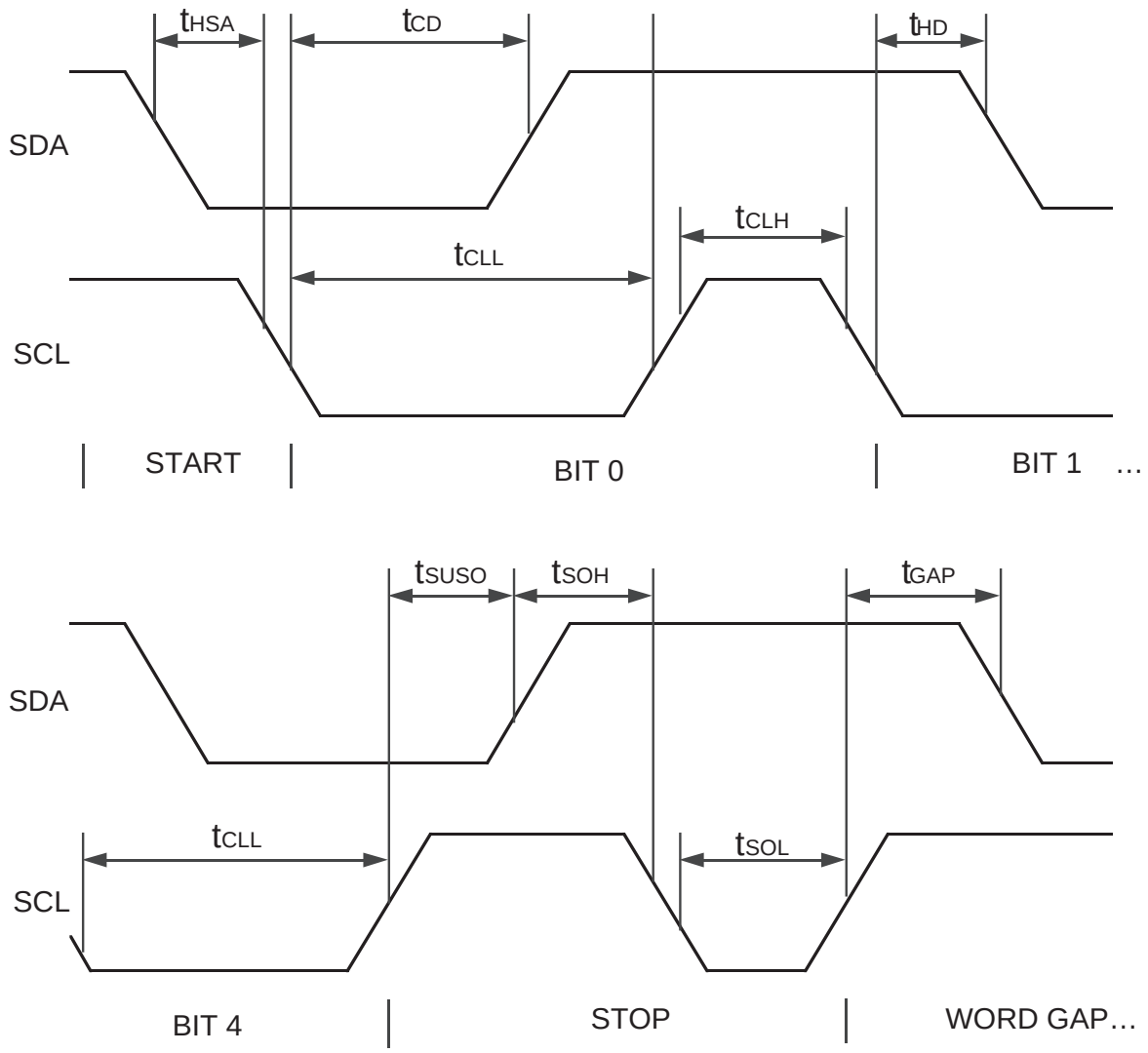


Figure 5 Serial Interface timing waveforms

Output Waveforms

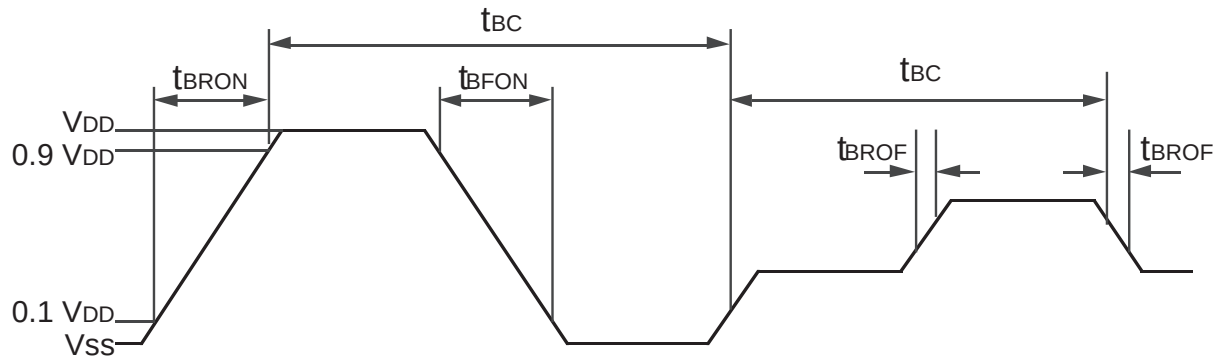


Figure 6 Backplane timing waveforms

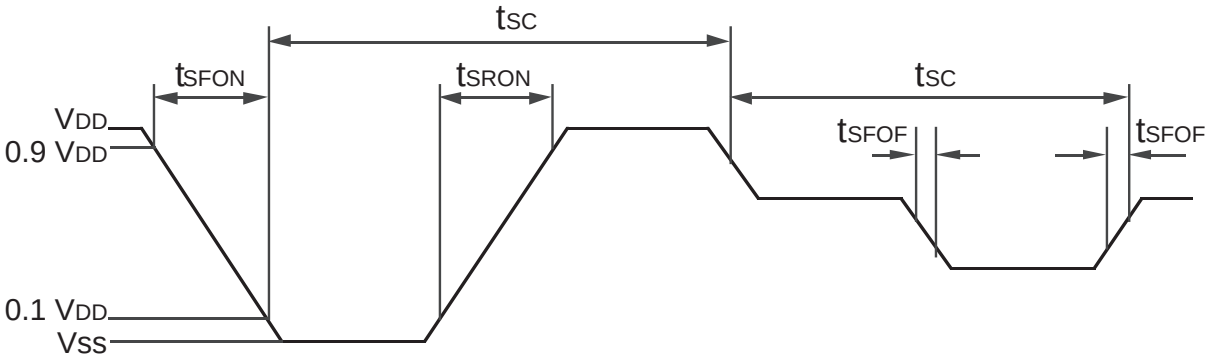
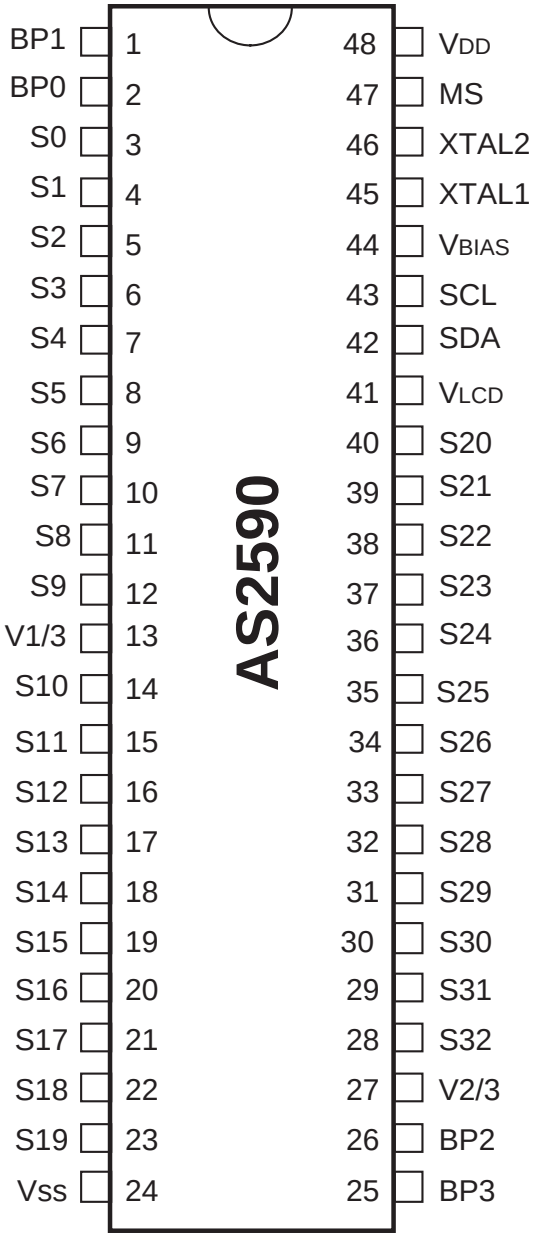


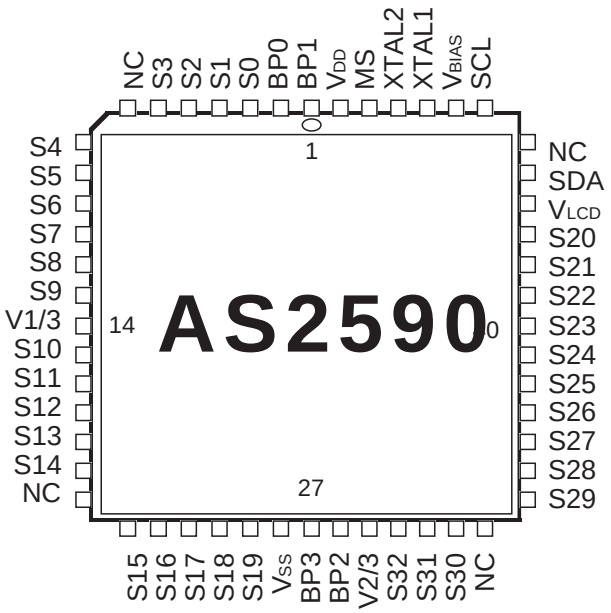
Figure 7 Segment timing waveforms

Pin Configurations

48 Pin DIP



52 pin PLCC



Ordering Information:

48 pin DIP:	AS2590 P
52 pin PLCC:	AS2590 N

Applications:

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