4. Serial Data Output

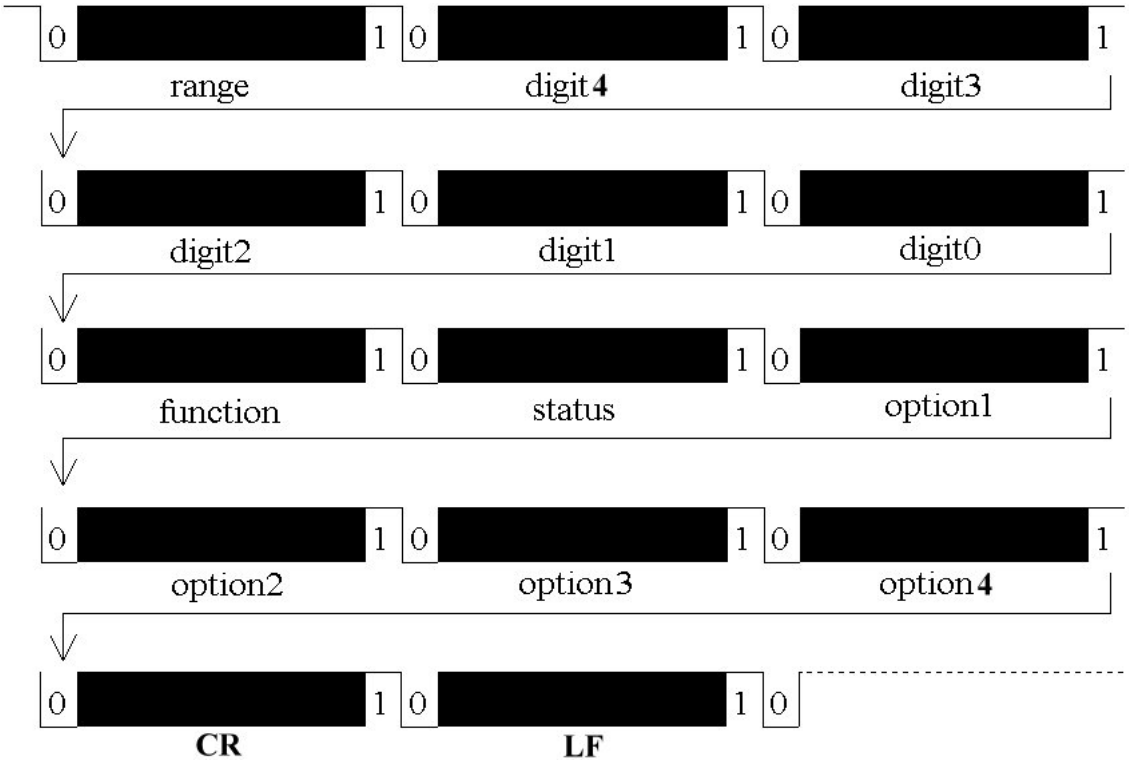
The RS232 function will be activated if the RS232 pin is pulled to and asserts at V-. The serial data sent to **SDO** pin once every A/D conversion cycle. The data format complies with JIS 7Bits-transmission code with a baud rate of 19230. The host can use RS232 interface to read the data. A single data packet includes a start bit (always 0), 7 data bits, an odd parity check bit, and a stop bit (always 1). The high and low voltage levels correspond to DGND and V- respectively. SDO remains at 1 (high) when it is

inactive. Hence the start bit (0) could be used as the triggering signal to begin the reading process. The following figure shows the data format of a single packet. The LSB is sent first and the MSB is sent last.

single package

One data block consists of 14 packets, or 140 bits. The following figure shows the format of a data block. The range packet indicates the full scale range of the meter. Digit4 through digit0 are just the digits on the LCD panel. The function packet indicates the measurement mode of the meter. Status, option1~4 give the status of the meter. CR and LF are delimiters used to separate the blocks.

all packets



The meter always outputs the current input value to the serial port in spite of HOLD mode. The detailed data format of each packet is listed at next page.

4.1 FUNCTUON

This packet indicates the measurement mode of the meter. The following table summarizes the transmitted code for each mode. Note that the encoding of this packet is different from the encoding of FC1-FC5 switch.

Code	Measurement Mode	VBAR=0	VBAR=1
0111011	Voltage	Don't care	
0111101	Auto µA Current	Auto µA Current	Auto 220.00A/2200.0A
0111111	Auto mA Current	Auto mA Current	Auto 22.000A/220.00A
0110000	22 A current	Don't care	
0111001	Manual A Current		
0110011	Ω		
0110101	Continuity		
0110001	Diode		
0110010	[1]Frequency		
0110110	Capacitance		
0110100	[2]Temperature		
0111110	ADP		

1. When the function code = 0110010, the measurement mode is determined by judge bit of Status packet. If judge bit is 1, it means frequency mode. If judge bit is 0, it means duty cycle mode.
2. When the function code = 0110100, the judge bit in the Status packet determines whether the unit is Celsius or Fahrenheit. And the digit4~0 only presents Celsius value whatever the mode is ºC or ºF.
3. When the function code = 0111101 or 0111111, the measurement mode is determined by VBAR bit.

4.2 RANGE

This packet indicates the full-scale range of the meter. When the meter operates in continuity mode or diode mode, this packet is always 0110000 since the full-scale ranges in these modes are fixed. The following table lists the code for each range in each measurement mode.

Code	V	*2-range auto A	22 A	Manual A	ADP	Ω	Frequency	Capacitor
0110000	2.2000V	Lower Range(IVSL)	22.000 A	2.2000A	ADP4	220.00Ω	22.00Hz	22.000nF
0110001	22.000V	Higher Range(IVSH)		22.000A	ADP3	2.2000KΩ	220.0Hz	220.00nF
0110010	220.00V			220.00A	ADP2	22.000KΩ		2.2000µF
0110011	2200.0V			2200.0A	ADP1	220.00KΩ	22.000KHz	22.000µF
0110100	220.00mV			22000A	ADP0	2.2000MΩ	220.00KHz	220.00µF
0110101						22.000MΩ	2.2000MHz	2.2000mF
0110110						220.00MΩ	22.000MHz	22.000mF
0110111							220.00MHz	220.00mF
*It includes auto µA, mA, 22.000A/220.00A, 220.00A/2200.0A.								

4.3 DIGIT 4 – DIGIT 0

Digit 4 is the first significant digit on the LCD panel, and digit 0 is the least significant digit.

Digit	Code
0	0110000
1	0110001
2	0110010
3	0110011
4	0110100
5	0110101
6	0110110
7	0110111
8	0111000
9	0111001

4.4 STATUS

The format of this package shown below. The Judge field is meaningful only when the Function packet indicates Temperature mode. In Temperature mode, judge is 1 if the unit is ℃ and is 0 of the unit is °F. Sign field indicates whether the minus sign on the LCD panel is on or off. BATT field is one when battery low condition is true. OL indicates input overflow.

0	1	1	Judge	Sign	BATT	OL
BIT6	BIT 5	BIT 4	BIT 3	BIT 2	BIT1	BIT 0

4.5 OPTION 1

This packet contains information on the push function of the meter. The format is shown below. MAX, MIN or RMR bit will be high if the meter enter Max/Min function and stay at state of maximum, minimum or current value respectively. REL bit will be high if meter enters REL/Zero mode.

0	1	1	MAX	MIN	REL	RMR
BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0

4.6 OPTION 2

0	1	1	UL	P_{MAX}	P_{MIN}	0
BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT1	BIT 0

Under the following conditions, the UL bit will be set to 1.

1. In 22.00Hz range, the input frequency is less than 2.00Hz.
2. In 220.0Hz range, the input frequency is less than 20.0Hz.
3. In duty cycle mode, the reading is less than 10.0%.

If P_{MAX} field is 1, P_{MAX} is active and LCD panel display maximum peak value.
If P_{MIN} field is 1, P_{MIN} is active and LCD panel display minimum peak value.

4.7 OPTION 3

This packet contains information on the operation mode of the meter. The format is shown below. The DC field indicates that the meter operates in DC measurement mode, either voltage or current. The AC field indicates that the meter operates in AC measurement mode, either voltage or current. The AUTO field is set to one if the meter operates in automatic mode, and is set to zero when the meter operates in manual mode.

0	1	1	DC	AC	AUTO	VAHZ
BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0

4.8 OPTION4

This packet contains information on the operation mode of the meter. The format is shown below. VBAR will be set to high, only when the VBAR pin is connected to V-. Hold bit is set to high when meter enters hold mode. LPF bit is set to high when the low-pass-filter feature is activated.

0	1	1	0	VBAR	Hold	LPF
BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0

4.9 CR

Carriage returns. The transmitted code is 0001101.

4.10 LF

Line feed. The transmitted code is 0001010.

5. Miscellaneous

The conditions on which the meter turns on the buzzer include:

(1) Changing measurement mode generates one beep.

(2) Pressing any of the push functions generates one beep, if the function is valid.

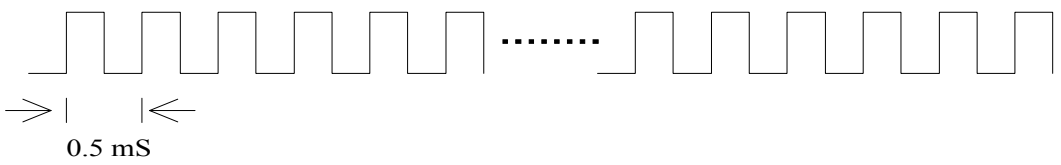
(3) Power on and re-power on generate one beep.

(4) Input overflow in voltage (220mV range not included) and current mode generates one beep every 0.3 seconds (or 3.33 beeps per second.)

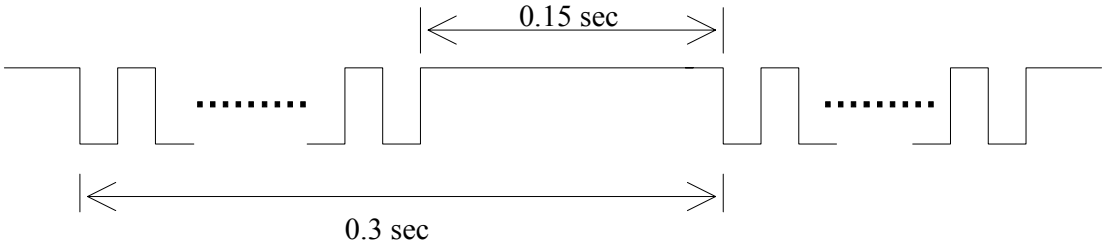
(5) Continuity(diode) check generates a continuous 2KHz beep whenever the measurement is less then 30Ω(30mV)

(6) Auto power off generates a 2KHz beep that lasts for 1.5 seconds.

The following figures show the output waveform from the BUZOUT pin.

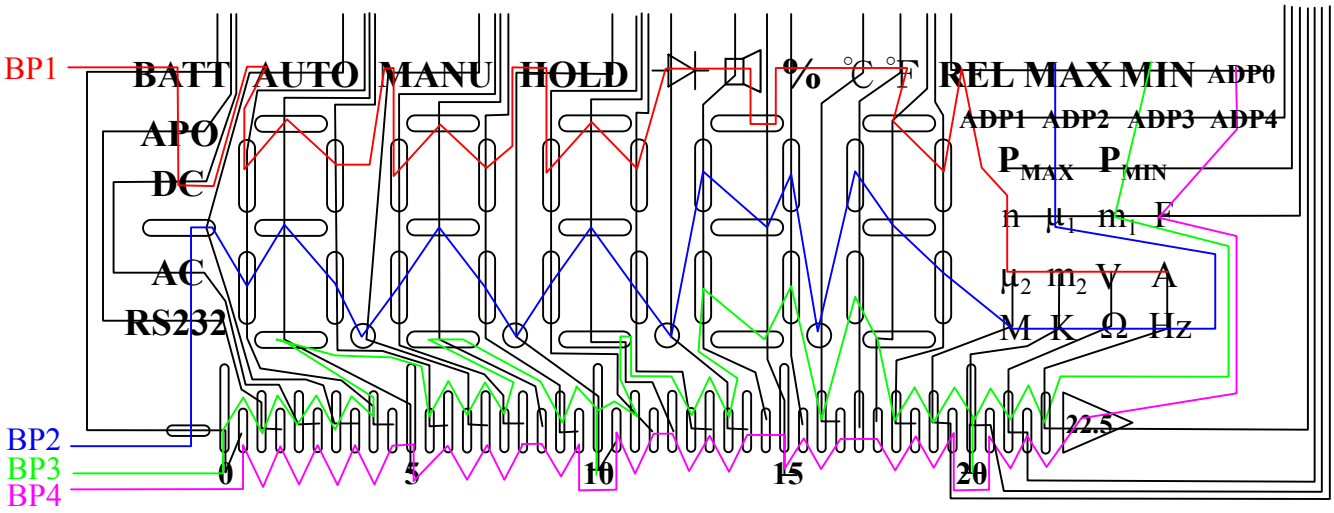


(a) Continuous 2KHz beep



(b) 3.33 beep/sec

5.1 LCD Panel Configuration

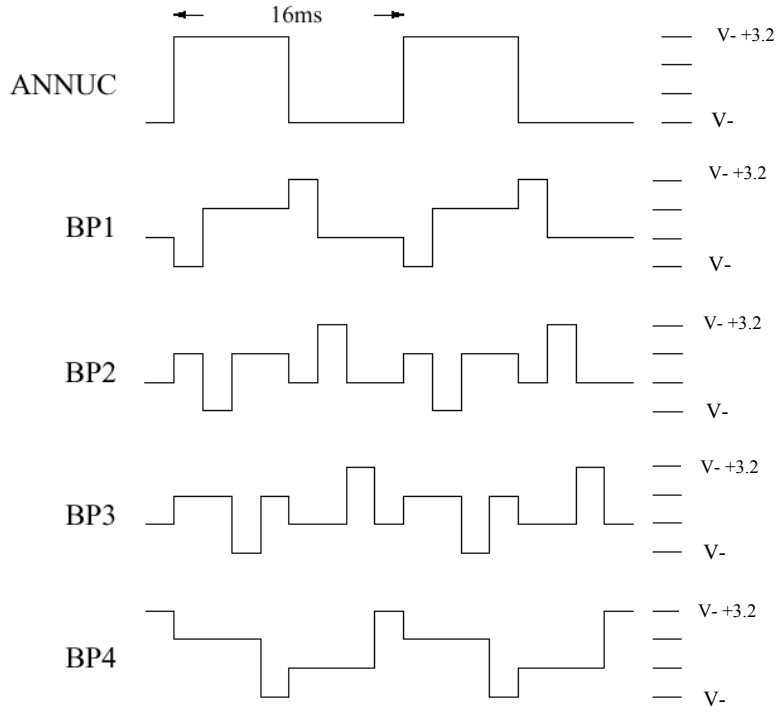


	SEG01	SEG02	SEG03	SEG04	SEG05	SEG06	SEG07	SEG08	SEG09	SEG10	SEG11
BP1	BATT	APO	DC	AUTO	5F	5A	5B	MANU	4F	4A	4B
BP2	bar-	RS232	AC	-	5E	5G	5C	DP4	4E	4G	4C
BP3	bar0	bar2	bar4	bar6	bar8	5D	bar11	bar13	bar15	4D	bar18
BP4	bar1	bar3	bar5	bar7	bar9	bar10	bar12	bar14	bar16	bar17	bar19

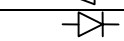
	SEG12	SEG13	SEG14	SEG15	SEG16	SEG17	SEG18	SEG19	SEG20	SEG21	SEG22
BP1	HOLD	3F	3A	3B			2A	%	°C	°F	1A
BP2	DP3	3E	3G	3C	DP2	2F	2G	2B	DP1	1F	1G
BP3	bar20	bar22	3D	bar25	bar27	2E	2D	2C	bar32	1E	1D
BP4	bar21	bar23	bar24	bar26	bar28	bar29	bar30	bar31	bar33	bar34	bar35

	SEG23	SEG24	SEG25	SEG26	SEG27	SEG28	SEG29	SEG30	SEG31
BP1	1B	μ_2	m_2	V	A	REL	ADP1	n	
BP2	1C	M	K	Ω	Hz	MAX	ADP2	μ_1	P_{MAX}
BP3	bar36	bar38	bar40	bar42	bar44	MIN	ADP3	m_1	P_{MIN}
BP4	bar37	bar39	bar41	bar43	bar45	ADP0	ADP4	F	

LCD Backplane Waveform



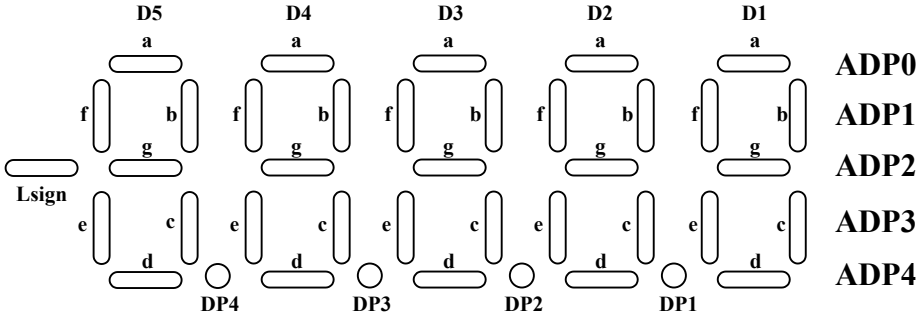
5.2 LCD display on condition

LCD Annunciator	Condition
V	In voltage measurement mode, and diode measurement mode.
A	In current measurement mode.
Ω	In resistance measurement mode, and continuity mode.
F	In capacitance measurement mode.
	In continuity check mode.
	In diode mode.
Hz	In frequency mode.
%	In duty cycle mode.
DC	In DC voltage or DC current mode.
AC	In AC voltage or AC current mode.
AUTO	When automatic full scale range selection is enabled.
MANU	In manual mode.
HOLD	When HOLD function is enabled.
REL	When Relative function is enabled.
MAX / MIN	When Maximum or Minimum function is enabled.
P_{MAX} / P_{MIN}	When P_{MAX} or P_{MIN} function is enabled.
m_1	In capacitor measurement mode and the full scale range is in the order of mF.
μ_1	In capacitor measurement mode and the full scale range is in the order of uF.
n	In capacitor measurement mode and the full scale range is in the order of nF.
m_2	In voltage or current measurement mode and the full scale range is in the order of 10^{-3}.
μ_2	In current measurement mode and the full scale range id in the order of uA.
M	In resistance measurement mode and the full scale range is in the order of MΩ
K	In resistance measurement mode and the full scale range is in the order of KΩ
℃	In temperature measurement mode and when the unit is ℃
℉	In temperature measurement mode and when the unit is ℉
APO	When auto power off function is enabled.
RS232	When RS232 output is enabled.

5.3 Programmable LCD Segment Display

ES51922 supports a "Programmable LCD Segment Display"(PLSD) feature. Except peak hold measurement, capacitor measurement mode & duty cycle measurement, all modes could support PLSD. PLSD allows the meter designer to process or modify the conversion results by external microprocessor and displayed on LCD panel. The more accurate and stable reading would be possible. ES51922 provides uPLCD, SCLK and SDATA pins to archive the PLSD feature. Connect uPLCD to V- to enable PLSD feature and received the serial data from SDO pin. After the data processing, transfer the display data through the SDATA and give a clock signal to SCLK. ES51922 will receive the display data through SDATA at the falling edge of clock signal, then display the data on LCD panel. Only the segments shown below could be modified, other segments are still controlled by ES51922. When peak hold, capacitor or duty mode is selected, the LCD display is determined by ES51922.

About the details of serial data format, please refer to page 21-25.



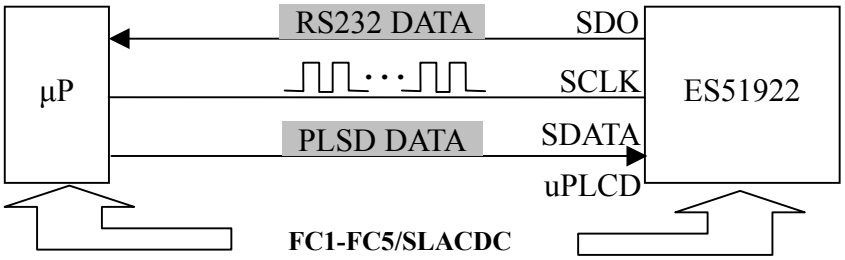
PLSD Data format:

B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12
OL	**ADP0**	**ADP1**	**ADP2**	**ADP3**	**ADP4**	**D1a**	**D1b**	**D1c**	**D1d**	**D1e**	**D1f**
B13	B14	B15	B16	B17	B18	B19	B20	B21	B22	B23	B24
D1g	**DP1**	**D2a**	**D2b**	**D2c**	**D2d**	**D2e**	**D2f**	**D2g**	**DP2**	**D3a**	**D3b**
B25	B26	B27	B28	B29	B30	B31	B32	B33	B34	B35	B36
D3c	**D3d**	**D3e**	**D3f**	**D3g**	**DP3**	**D4a**	**D4b**	**D4c**	**D4d**	**D4e**	**D4f**
B37	B38	B39	B40	B41	B42	B43	B44	B45	B46		
D4g	**DP4**	**D5a**	**D5b**	**D5c**	**D5d**	**D5e**	**D5f**	**D5g**	**Lsign**		

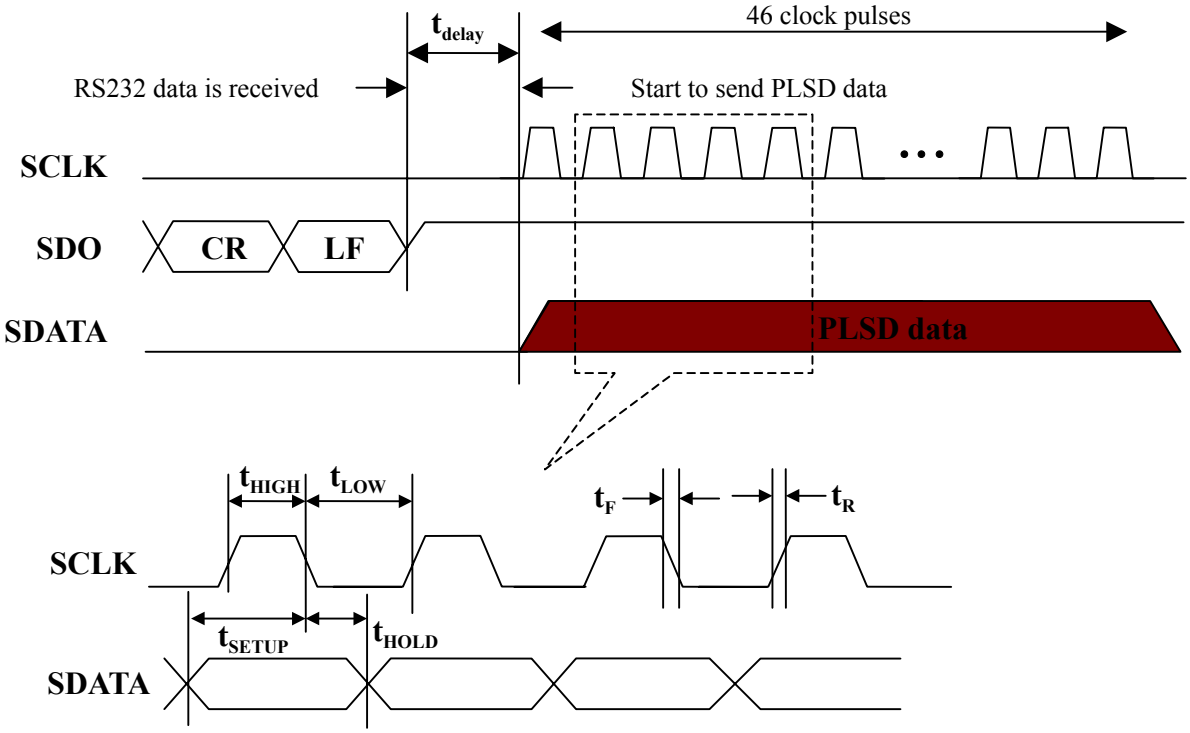
Note: The B1 should be sent first and the last is B46.

Set the OL bit = 1, the buzzer output will be active for 3.3beep/sec in voltage & current mode (or peak mode). And if auto range is available, it will change to higher range if LCD bar44 is active also.

Block diagram:



Operation timing diagram for PLSD feature is shown as below:



Parameter	Symbol	Min.	Typ.	Max.	Unit
SCLK clock frequency	f_{SCLK}	10	-	100	KHz
SCLK clock time "L"	t_{LOW}	4.7	-	-	us
SCLK clock time "H"	t_{HIGH}	4.0	-	-	
Data input setup time	t_{SETUP}	200			ns
Data input hold time	t_{HOLD}	100			
SCLK/SDATA rising time	t_R			1.0	us
SCLK/SDATA falling time	t_F			0.3	
SCLK delay time after receiving RS232	t_{delay}	0.1		100	ms