Features

- Operating voltage 3.0-5.5V
- Built-in RC oscillator
- 16 SEG pins,8 GRID pins
- SEG pins connect to LED Anode , GRID pins connect to LED Cathode
- 8x4 matrix keys, support multiple keys (key / display multiplexing requires hardware circuit)
- 4-wire interface
- 8-level brightness control
- Built-in 16×8 bit display RAM
- Power-On Reset(POR)

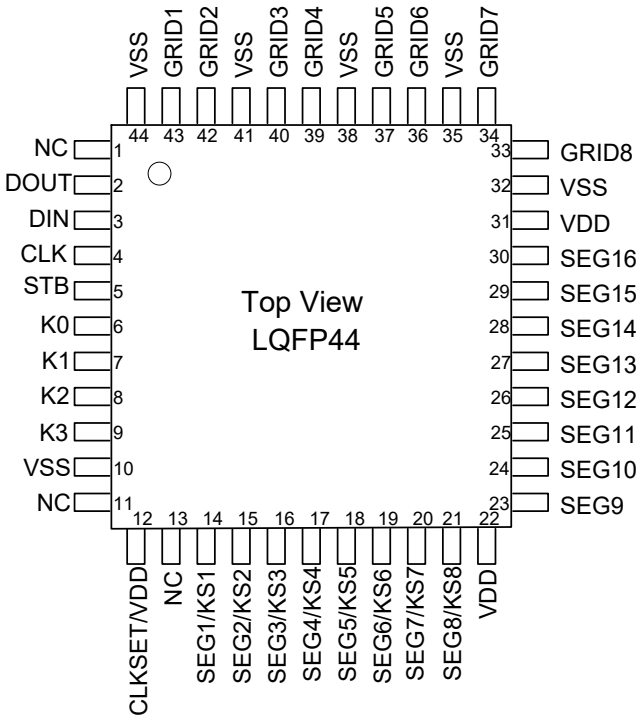
- Package:
  LQFP44(10.0mm x 10.0mm PP=0.8mm).

1 General Description

VK1629 is a RAM Mapping LED display driver with key scan， The Display segment numbers in the device is 16SEGx8GRID, with a 8×4 (MAX.) matrix key scan circuit .it suitable for multiple LED applications including LED modules and display subsystems. The device communicates with host microcontrollers via a 4 line Interface,it is used to configure display parameters and transfer display data.LQFP44 package.

2 Pinouts and pin description

2.1 VK1629 LQFP44 Pin Assignment

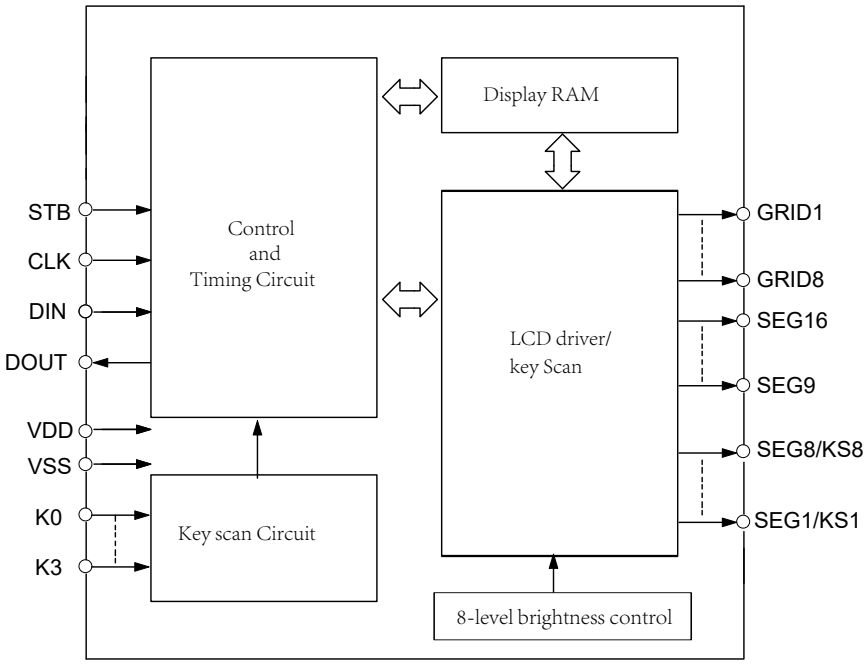


2.2 VK1629 LQFP44 Pin Description

No.	Name	I/O	Function
1,11,13	NC	---	not connect
2	DOUT	O	data out pin (NMOS open drain), data output from low bit. output the data to the DIO pin at the falling edge of the CLK,It can be short circuited with DIN as DIO.
3	DIN	I	data in pin, data input from low bit. Read the data of the DIN pin to the display RAM at the rising edge of the CLK,It can be short circuited with DOUT as DIO.
4	CLK	I	CLK signal input pin, reads the data of the DIN pin to the display RAM on the rising edge, and outputs the data to the DOUT pin on the falling edge.
5	STB	I	Chip selection signal input pin, 1-disabe，0-enable.
6-9	K0-K3	I	KEY scan input, the key signal is locked after the end of the display cycle
10,32,35 38,41,44	VSS	VSS	Negative power supply
14-21	SEG1/KS1- SEG8/KS8	O	LED SEG outputs（P-MOS open drain）；Key scan output
22，31	VDD	VDD	Positive power supply
23-30	SEG9-SEG16	O	LED SEG outputs（P-MOS open drain）
33,34 36,37 39,40 42,43	GRID8-GRID1	O	LED GRID outputs（N-MOS open drain）

3 Functional Description

3.1 Block diagram



3.2 Display RAM

The static display memory (RAM) is organized into 16×8 bits and stores the displayed data.The contents of the RAM are directly mapped to the contents of the LCD driver. Display address is 0xC0-0xCF,the RAM size is 16 bytes.If you want to lighted on or off an LED, only set or clear the corresponding display RAM bit to 1 or 0,For example, if LED1 driven by SEG1 pin and GRID1 pin is on or off, only set bit0 to 1 or 0 of the corresponding display RAM (0xc0).The ram bit corresponding to the unused SEG pin is cleared to 0.

The following is a mapping from the RAM to the LED pattern:

SEG / GRID	SEG16	SEG15	SEG14	SEG13	SEG12	SEG11	SEG10	SEG9	Address	SEG8	SEG7	SEG6	SEG5	SEG4	SEG3	SEG2	SEG1	Address	SEG / GRID
GRID1									0xC1								LED1	0xC0	GRID1
GRID2									0xC3									0xC2	GRID2
GRID3									0xC5									0xC4	GRID3
GRID4									0xC7									0xC6	GRID4
GRID5									0xC9									0xC8	GRID5
GRID6									0xCB									0xCA	GRID6
GRID7									0xCD									0xCC	GRID7
GRID8									0xCF									0xCE	GRID8
	D7	D6	D5	D4	D3	D2	D1	D0		D7	D6	D5	D4	D3	D2	D1	D0		

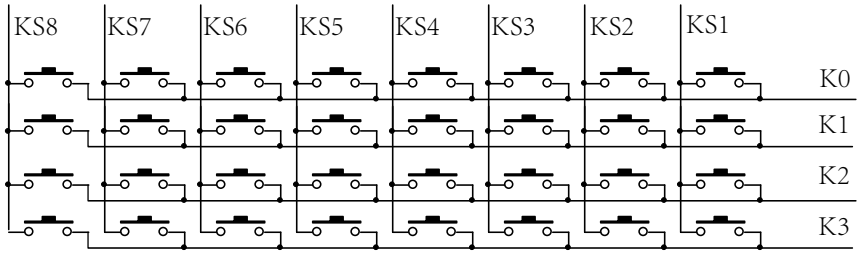
Note:

At the initial system power on, the value stored in the chip display RAM may be random. It is recommended to clear the display RAM after power on, write 0x00 to the all display RAM (0xc0-0xcf).

SEG pins connect to LED Anode, GRID pins connect to LED Cathode, Reverse connection is not allowed.

3.3 Keyscan

3.3.1 Key data reading



The keys scanning is automatically completed by the hardware, only needs to read the key value through serial interface.Two display cycles are required to complete a key scan. One display cycle takes about 4ms. If two different keys are pressed successively within 8ms, the two key value is the key pressed first.

After sending the read key command, start reading 4 bytes of key data in sequence, and read key data is output from the low bit. When a key is pressed, the corresponding bit of the key data byte is set 1.

The following shows the mapping from the RAM to the key data output:

key data	K0	K1	K2	K3	K0	K1	K2	K3
byte1	KS2				KS1			
byte2	KS4				KS3			
byte3	KS6				KS5			
byte4	KS8				KS7			
	D7	D6	D5	D4	D3	D2	D1	D0

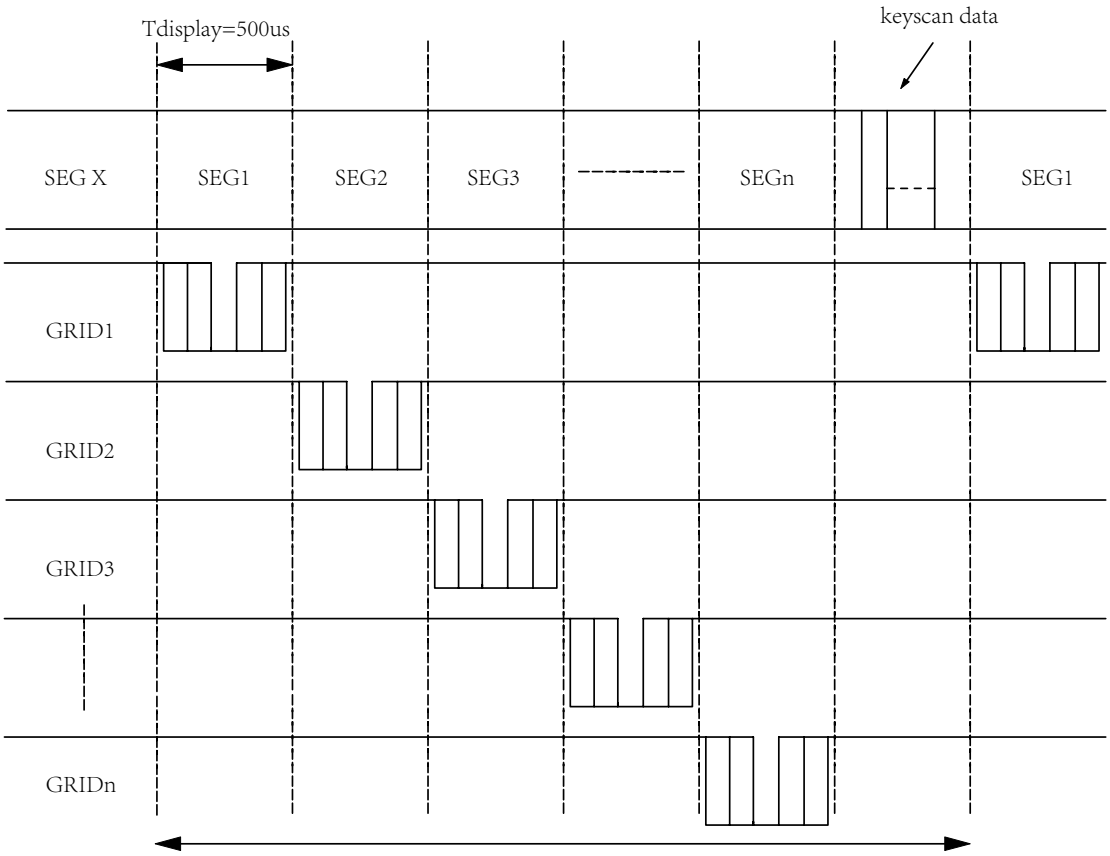
Note:

The key data must be read in sequence, not across bytes, and not more than 4 bytes.

The combination key can only be the same KS and different Kn pins ; The same Kn and different KS pins cannot be used as combination keys.

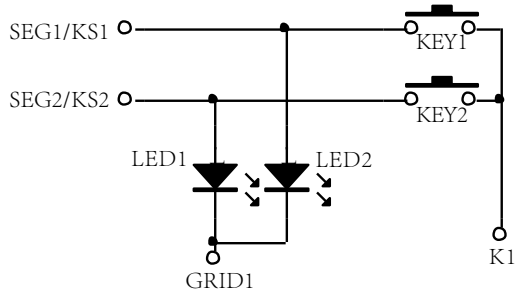
3.3.2 Keyscan Timing

keyscan timing as shown:：



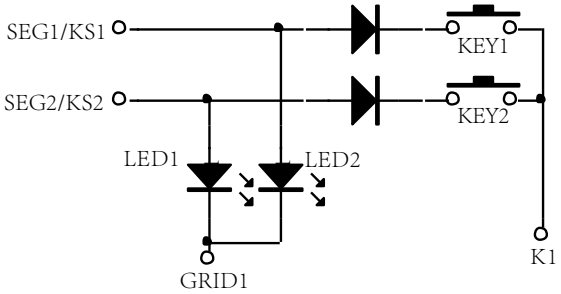
1 FRAM=Tdisplay × （n+1）

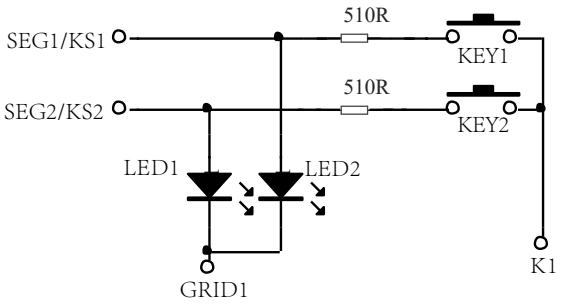
3.3.3 Key/display multiplexing



For example, if LED1 On, LED2 Off,It need to set SEG1="0" and SEG2 ="1".When KEY1 and KEY2 are pressed at the same time, SEG1 and SEG2 are short circuited, and if LED1 On, LED2 Off,It need to set SEG1="0" and SEG2 ="1".When KEY1 and KEY2 are pressed at the same time, SEG1 and SEG2 are short circuited, and LED1/LED2 On.It can be solved by connecting diodes or resistor in series at SEG1 and SEG2 pins.

As shown below:





Note:

The resistor val is about 510 ohm, If it is too large, it may cause the failure to read key. If it is too small, it may not solve the problem of display interference..

3.4 Serial communication command

3.4.1 Serial Interface

4 lines are required to interface with the VK1629.

STB is the chip select pin.it is used to enable / disable communication with the controller, high level disable(prohibits and initializes internal timing), low level enables.The first byte input by the DIN pin after the falling edge of the STB is used as the command. If the STB is set to high level during instruction or data transmission, the serial communication is initialized and the command or data being transmitted is invalid.

CLK is the clock signal pin. It reads the data of DIN pin to display RAM on the rising edge and outputs the data to DOUT pin on the falling edge.

DIN is the data IN pin. It used to write data or write commands .

DOUT is the data OUT pin. It used to read data. it is an NMOS open drain output and needs to connect a resistor with VDD

DIN and DOUT can be connect together as the Bidirectional datat pin-DIO.

3.4.2 Command Format

Command is used to set the Display Mode or write the Display Data or read Key data.After the falling edge of STB, the first byte input by DIO is used as the command byte, After decoding, Bit7 and bit6 of the byte are the command bits, as shown in the following table:

bit7	bit6	Command Function
0	1	Data Read/Write&Set Command
1	0	Display Control Command
1	1	Address Set Command

3.4.3 Command Description

3.4.3.1 Data Read/Write&Set Command

This command is used to read key or read/write Display data and related commands. Bit1 and bit0 bits are not allowed to be set to 01 or 11.

when powered on, bit3-bit0 data is 0.

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Function	Note
0	1	---				0	0	Read/Write data	Write data to the RAM
0	1					1	0		Read keydata
0	1				0			Address mode set	address increase
0	1				1				address fixed
0	1			0				work mode set	normal mode
0	1			1					test mode

3.4.3.2 Address Set Command

Set the address of the Display RAM (0xC0 - 0xCF). When powered on, the address is set to 0xC0(default).

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	RAM Address
1	1	---		0	0	0	0	0xC0
1	1			0	0	0	1	0xC1
1	1			0	0	1	0	0xC2
1	1			0	0	1	1	0xC3
1	1			0	1	0	0	0xC4
1	1			0	1	0	1	0xC5
1	1			0	1	1	0	0xC6
1	1			0	1	1	1	0xC7
1	1			1	0	0	0	0xC8
1	1			1	0	0	1	0xC9
1	1			1	0	1	0	0xCA
1	1			1	0	1	1	0xCB
1	1			1	1	0	0	0xCC
1	1			1	1	0	1	0xCD
1	1			1	1	1	0	0xCE
1	1			1	1	1	1	0xCF

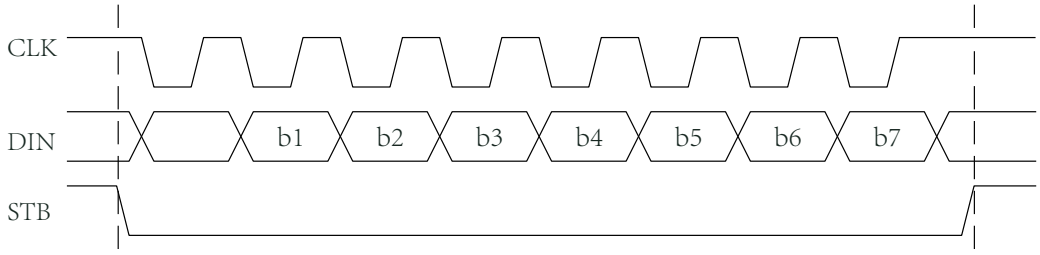
3.4.3.3 Display Control Command

Set the Display ON or OFF and select the Display brightness (level 8).

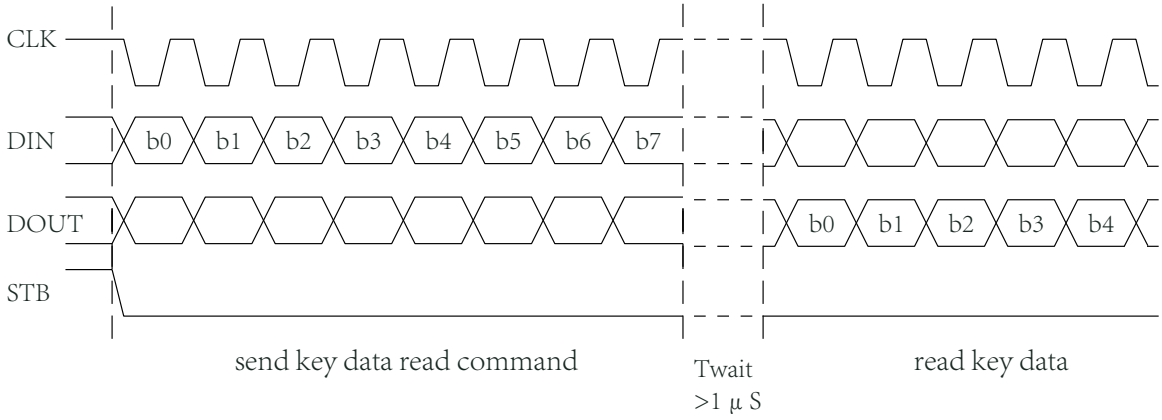
bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Function	Note
1	0				0	0	0	Set GRID Pulse Width	1/16 duty
1	0				0	0	1		2/16 duty
1	0				0	1	0		4/16 duty
1	0				0	1	1		10/16 duty
1	0	---			1	0	0		11/16 duty
1	0				1	0	1		12/16 duty
1	0				1	1	0		13/16 duty
1	0				1	1	1		14/16 duty
1	0			0				Display on/off	Display off
1	0			1					Display on

3.4.4 Command Timing Diagrams

Write command or display data



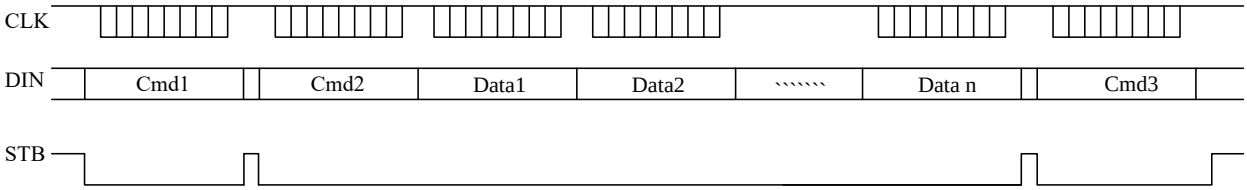
Read key data



4 Command application

4.1 Send Display data(Address auto Increment)

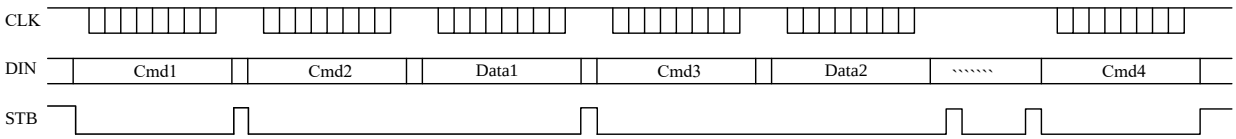
Using the address auto-increase mode,First set the starting address of the data to be transmitted (Display RAM address). After the start address command byte is sent, the display data is directly transmitted, up to 16bytes.STB is set high after data transmission.



Cmd1： Data Read/Write&Set Cmd -Set address auto-increase mode (0x40)
Cmd2： Address Set Cmd -Set the start address of the display RAM (0xc0-0xcf)
Data1-Datan： Send display data to the start address set by Cmd2 and the subsequent address (up to 16 bytes)
Cmd3： Display Control Cmd -Display ON and select the Display brightness

4.2 Send Display data(Fixed Address)

Using the fixed address mode, first set the address of the data to be transmitted (Display RAM address), After sending the address, directly transmit 1 byte of display data,STB is set high after data transmission;Then transfer the address of the next display data, and directly transfer 1 byte of display data STB is set high after data transmission;...Until the last byte of display data is transmitted,Up to 16 bytes,STB is set high after data transmission.

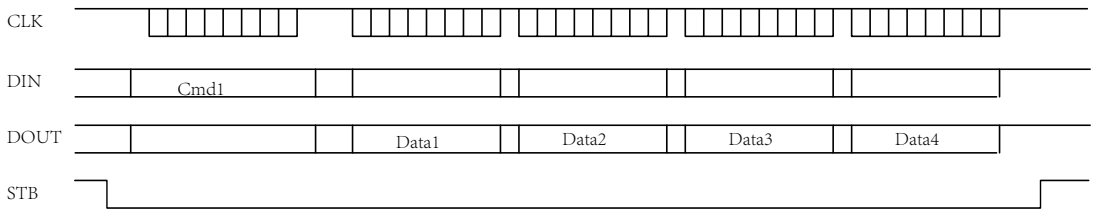


Cmd1： Data Read/Write&Set Cmd -Set fixed address mode (0x44)
Cmd2： Address Set Cmd -Set Display RAM address （0xC0-0xCF. ）
Data1： Send the Display data to the display RAM address set by Cmd2
CmdN： Address Set Cmd -Set Display RAM address （0xC0-0xCF）
DataN： Send the Display data to the display RAM address set by CmdN

.... up to 16 bytes of data to be send
Cmd3： Display Control Cmd -Display ON and select the Display brightness

4.3 Key Read Command

Data Read/Write&Set Command is Set to read the key data, and then start reading the key data of 4 bytes in sequence. The read key data is output from the low bit.

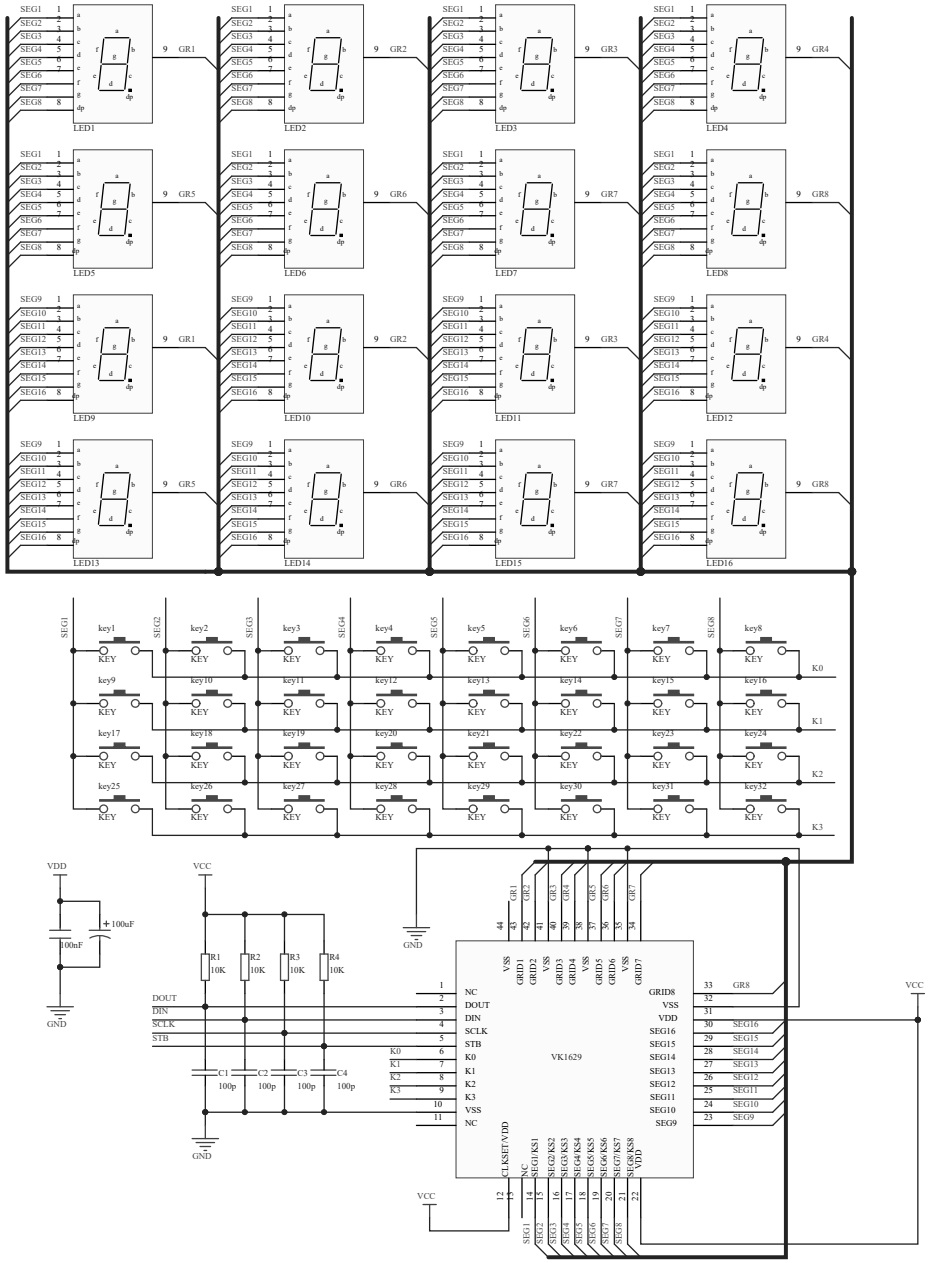


Cmd1： Data Read/Write&Set Cmd -Set to read key data (0x42)

Data1-Data.： Read 4 bytes of key data in sequence, and the read key data is output from the low bit.

5 Application Circuits

8-SEG LED Display shared Cathode



6 Electrical characteristics

6.1 Absolute Maximum Ratings

Item	Symbol	Ratings	Unit
Power voltage	VDD	-0.5～+7.0	V
Input Voltage	VIN	V_{SS}-0.5～V_{DD}+0.5	V
Storage Temperature	T_{STG}	-50～+125	℃
Operating Temperature	T_{OTG}	-40～+85	℃

6.2 DC Characteristics

Item	Symbol	Min.	Typ.	Max.	Unit	Test Conditions	
						VDD	Conditions
Operating Voltage	VDD	3.0	—	5.5	V	—	—
Quiescent Current	I_{DD}	—	0.5	1.0	mA	5V	Noload/LED OFF
High Level output Current	I_{OHSEG1}	-20	-25	-40	mA	5V	VO=VDD-2V SEG1- SEG16
	I_{OHSEG2}	-25	-30	-50			VO=VDD-3V SEG1- SEG16
Low Level input Current	I_{OLGRID}	80	120	—	mA	5V	VO=0.3V GRID1- GRID8
High level output current tolerance	I_{TOLSEG}	—	—	5	%	VDD	VO=VDD-3V(VDD=5V) VO=VDD-2V(VDD=3V) SEG1-SEG16
Input Low Voltage	V_{IL}	0	—	0.3	VDD	VDD	STB,CLK,DIN,DOUT
Input High Voltage	V_{IH}	0.7	—	1.0		VDD	
pull-down resistor	R_L	—	10	—	kΩ	5V	K0~K3

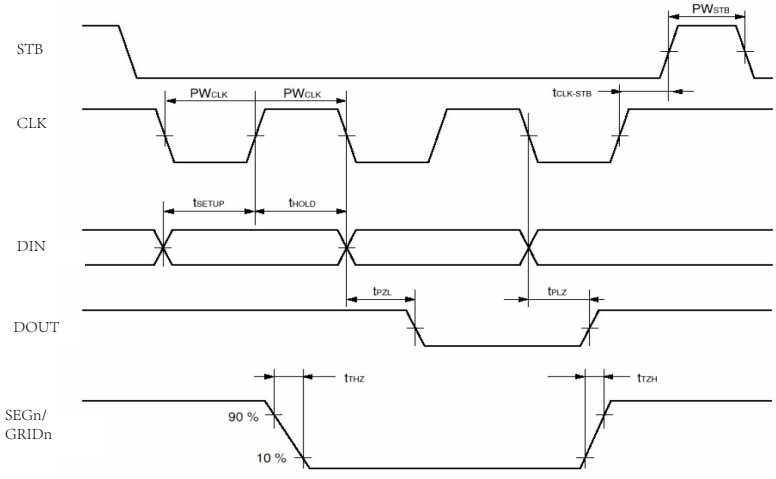
6.3 AC Characteristics

Switch Parameters

Item	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
oscillation frequency	F_{osc}	-	500	-	KHz	
Transmission delay time	t_{PLZ}	-	-	300	nS	CLK → DOUT
	t_{PZL}	-	-	100	nS	CL = 15pF, RL = 10K Ω
Rise Time	t_{ZH} 1	-	-	2	μS	CL=300pF SEG1-SEG16 GRID1-GRID8
	t_{TZH} 2	-	-	0.5	μS	CL=300pF GRID1-GRID8
Fall Time	t_{THZ}	-	-	120	μS	CL = 300pF SEGn,GRIDn
Max. input Freq	F_{MAX}	-	-	1	MHz	Duty 50%
Input Capacitance	CI	-	-	15	pF	-

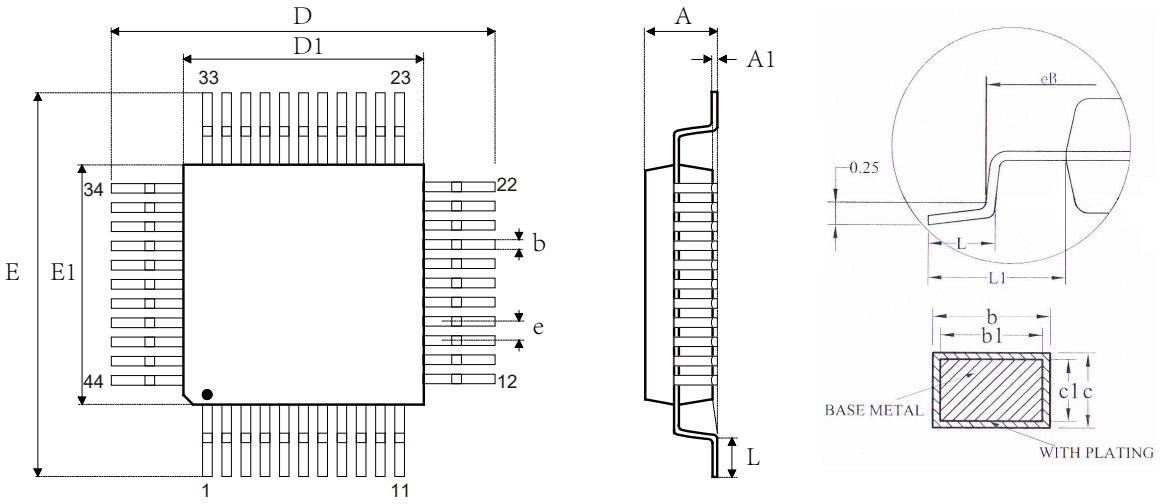
Timing Parameters

Item	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Clock pulse width	PW_{CLK}	400	-	-	nS	-
STB pulse width	PW_{STB}	1	-	-	μS	-
Data Setup Time	t_{SETUP}	100	-	-	nS	-
Data Hold Time	t_{HOLD}	100	-	-	nS	-
CLK→STB Time	$t_{CLK-STB}$	1	-	-	μS	CLK ↑ →STB ↑
Wait Time	Twait	1	-	-	μS	CLK ↑ →CLK ↓



7 Package Information

7.1 LQFP44(10.0mm x 10.0mm PP=0.8mm):



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	--	--	1.60
A1	0.05	--	0.15
b	0.28	--	0.36
b1	0.27	0.30	0.33
c	0.13	--	0.17
c1	0.12	0.13	0.14
D	11.80	12.00	12.20
D1	9.90	10.00	10.10
E	11.80	12.00	12.20
E1	9.90	10.00	10.10
e	0.80BSC		
L	0.45	--	0.75
L1	1.00REF		

8 Revision history

No.	Version	Date	Modify the content	Check
1	1.0	2018-08-10	Original version	Yes
2	1.1	2019-07-11	Add Ref circuits	Yes
3	1.2	2020-02-11	Update content	Yes

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