

# LED drive and keyboard control chip CH450

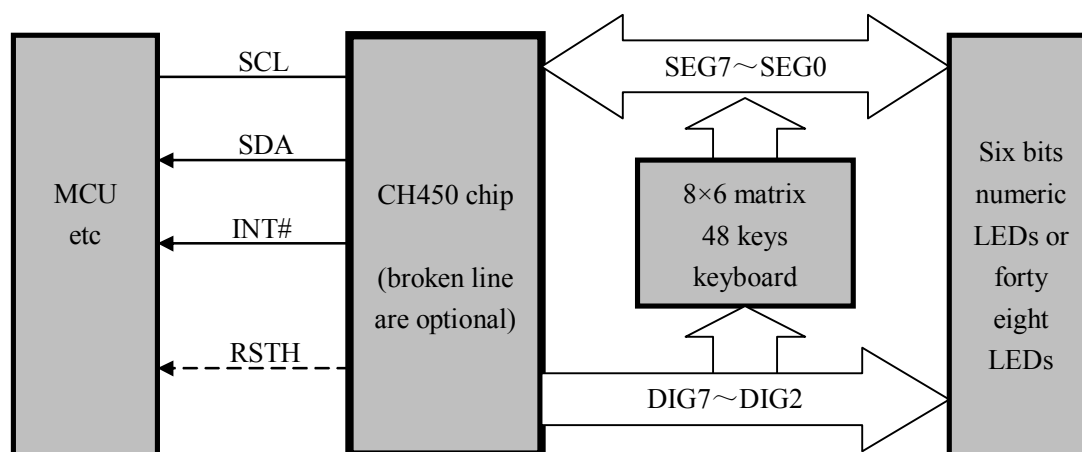
English DataSheet

Version:1C

<http://wch.cn>

## 1. Introduction

CH450 is numeric LEDs display drive and keyboard scan control chip. CH450 sets clock surging circuit internal, drives six bits numeric LEDs or forty-eight LEDs automatically. And it carries out forty-eight keys keyboard scan. CH450 exchanges data with MCU via two wires serial interface and supplies power-up reset signal to MCU.



## 2. Features

- Set display current drive layer internal, the segment current is no less than 15mA, the word current is no less than 80mA.
- Dynamically display scan control, directly drive six bits numeric LEDs or forty eight LEDs.
- Set forty eight keys keyboard controller internal, basic on 8×6 matrix keyboard scan.
- Set pull-down resistor internal on the key pressed station, and set eliminate dithering circuit internal.
- Supplies keyboard interrupt active with low-level, supplies key-press release sign bit, to detect key is pressed or released.
- High-speed two wires serial interface, the speed of clock varies from 0 to 4MHz, compatible with two wires I<sup>2</sup>C bus, save pins.
- Set clock surge circuit internal, the outside supplies clock or surging equipments is no need, stand against disturbing.
- Set clock surging circuit internal, don't need outside to provide clock or connect surge device, anti-jamming capability is more stronger.
- Set power-on reset internal, supplies reset output active with high-level to MCU.
- Supplies DIP20 and SOP20 package without lead, compatible with RoHS, the function and pins are compatible with CH455 in some parts.

### 3. Package

CH450K/H			
1	DIG3	DIG2	20
2	DIG4	INT#	19
3	SCL	SEG7	18
4	SDA	SEG6	17
5	GND	SEG5	16
6	DIG5	SEG4	15
7	DIG6	SEG3	14
8	DIG7	SEG2	13
9	RSTH	VCC	12
10	SEG0	SEG1	11

Package shape	Width of plastic		Pitch of pin		Instruction of package	Ordering type
SOP20	7.62mm	300mil	1.27mm	50mil	Small outline package of 20-pin	CH450H
DIP20	7.62mm	300mil	2.54mm	100mil	Dual in-line package of 20-pin	CH450K

### 4. Pins

Pin No.	Pin Name	Pin Type	Pin Description
12	VCC	POWER	Positive power, the persistent current is no less than 100mA
5	GND	POWER	Public ground, the persistent current is no less than 100mA
10, 11, 13, 14, 15, 16, 17, 18	SEG0~SEG7	Tri-station output input	Segment drive of numeric LEDs, high-level active, keyboard scan input, high-level active, with pull-down resistor
20, 1, 2, 6, 7, 8	DIG2~DIG7	OUT	Word drive of numeric LEDs, low-level active, keyboard scan output, high-level active
4	SDA	With pull-up drain open output input	Data input and output of two wires serial interface
3	SCL	IN	Data clock of two wires serial interface, with pull-up resistor internal
9	RSTH	OUT	Power up reset output, high-level active
19	INT#	With pull-up internal drain open output	Keyboard interrupt output, low-level active with

### 5. Function description

#### 5.1. General description

The data in this DataSheet has three types. Binary numbers are followed by a "B". Hexadecimal numbers are followed by an "H". Numbers without annotations are decimals. X stands for any value.

MCU (DSP, microprocessor and other controller) controls CH450 chip via two wires serial interface. Numeric LEDs display drive and keyboard scan control are independence in CH450. MCU can start, close

and set the two functions through operation command. The two wire serial interface in CH450 is achieved by hardware. MCU can operate with high-speed via serial interface frequently, and has no influence on the CH450'S efficiency.

## 5.2. Display drive

CH450 adopts dynamically scan drive for number LED and LEDs, the sequence is from DIG2 to DIG7. When one of the pins draws current, the other pins don't draw current. In the internal of CH450 has current drive layer, directly drive 0.5 inch to 1 inch common cathode number LED, SEG6~SEG0 are respectively corresponding to segment G~A, the SEG7 is corresponding to radix point. Word drive pins DIG7~DIG2 are respectively connect to six number LEDs' cathode. CH450 can connect to LED which is 8×6 matrix or forty-eight LEDs. Or connect to inverter drivers outside to support common anode number LED, connect great power pipe to support large size number LEDs.

In the inner of CH450 has six eight-bits digital registers, they are used to save six word data, respectively corresponding to six number LEDs or six groups LEDs while each group has eight LEDs. The bit 7 to bit 0 of word data in digital register are respectively corresponding to radix point and segment G to A. for the LED matrix, the data bit of each word data is only corresponding to one LED. When data bit is 1, the relevant segment of number LED or LED will light; when data bit is 0, the relevant segment of number LED or LED will distinguish. For example, the bit 0 of the third digital register is 1, then the segment A of the third number LED will light.

The following is segment name of number LED.



## 5.3. Keyboard scan

The keyboard function of CH450 supports 8×6 matrix 48-key keyboard. During the keyboard scan period, DIG7~DIG2 used to output row scan, SEG7~SEG0 with pull-down resistor used to input line scan.

CH450 inserts keyboard scan regularly during display drive scan. During keyboard scan period, DIG7~DIG2 accords DIG2 to DIG7 in turn output high-level, and other pin output low-level; the output of SEG7~SEG0 are forbidden, when there is no key is pressed, SEG7~SEG0 are low-level; when there is key is pressed, such as DIG3 and SEG4 are pressed, then DIG output high-level and SEG4 checked high-level. In order to avoid error code, CH450 will scan twice, only when result is the same, the key-press is valid. When CH450 has checked valid key-press, record the key-press code, and INT# generates valid keyboard interrupt which active with low-level, and the MCU can read key-press code via serial. CH450 can't generate any key-press interrupt before checking new valid key-press. CH450 can't support press two or more keys at the same time. If two or more keys are pressed, the smaller code is in priority.

The key-press code is 8-bit providing by CH450, bit2~bit0 are row scan code, bit5~bit3 is line scan code, bit6 is status code (the pressed key is 1, or is 0). For example, the key connect DIG3 with SEG4 is pressed, then the code is 1100011B or 63H, when the key is released, the code is 0100011B or 23H (maybe is other value, but it is less than 40H). The row scan code is 011B responding to DIG3, the line scan code is 100B responding to SEG4. MCU can read key-press code at any time. Generally, MCU reads key-press code after CH450 has checked the valid key-press, and the bit 6 always is 1. Additional, if want to know when the key-press is released, MCU can read the key-press code regularly via query mode, until the key-press bit6 is 0.

The following table is DIG7~DIG2 and SEG7~SEG0 8×6 matrix, it is always numeric LED segment and LEDs sequence address. Because the key-press code is 7-bit, when the key is pressed, the bit6 is 1, the actual key-press code is the value in table adds 40H. The key-press code is between 40H and 7FH.

Add.	DIG7	DIG6	DIG5	DIG4	DIG3	DIG2		
SEG0	07H	06H	05H	04H	03H	02H		
SEG1	0FH	0EH	0DH	0CH	0BH	0AH		
SEG2	17H	16H	15H	14H	13H	12H		
SEG3	1FH	1EH	1DH	1CH	1BH	1AH		
SEG4	27H	26H	25H	24H	23H	22H		
SEG5	2FH	2EH	2DH	2CH	2BH	2AH		
SEG6	37H	36H	35H	34H	33H	32H		
SEG7	3FH	3EH	3DH	3CH	3BH	3AH		

#### 5.4. Assistant function

CH450 can provide high active valid power on reset signal to MCU. The RSTH pin of CH450 can connect to reset input pin in MCU, DSP and microprocessor. When CH450 is power on, RSTH pin output reset pulse signal high-level active. The power on reset signal in CH450 has effective on the internal circuit.

The power on reset in CH450 means that when power is on (from power cut to power on), generates reset pulse. In order to decrease the power disturber generated by CH450 drives large current, parallel connect a set of power decoupling capacitance between positive and negative power near to CH450, contains one capacitance pass 0.1uF which is monolithic or ceramic and one electrolyze capacitance which is pass 100uF.

#### 5.5. Serial

The two wires serial of CH450 is achieved by hardware. It contains two main signal wires: serial data clock input wire SCL, serial data input/output wire SDA, and one assistant signal wire: interrupt output wire INT#. The SCL is input signal wire with pull up resistor and in default it is high-level; SDA is standard bi-directional signal wire with pull-up resistor, and in default it is high-level; INT# is drain open output with pull-up resistor, it is keyboard interrupt output wire after starting keyboard scan function, high-level in default.

SDA is used to input and output serial data, the high-level indicates the bit data is 1 and the low-level indicates the bit data is 0. The sequence of serial data is the high bit is in front and the low bit is in behind.

SCL is used to supply serial clock, in the rising edge, CH450 input data from SDA. In the falling edge, output data from SDA.

During the SCL is high level, SDA is falling edge, defines this state as serial start signal. During SCL is high level, SDA is rising edge, defines this state as serial stop signal. CH450 detects start signal, then receives and analyses command. When MCU I/O pins are scarcity, use SCL with other circuit together and keep SDA state. If ensure SDA pin changes during the SCL is low-level, then SCL and SDA can be used with other circuit together.

INT# is output keyboard interrupt, and high-level in default. When CH450 has checked valid key-press, INT# output low-level, valid keyboard interrupt. After MCU is interrupted, execute read transaction in CH450, and CH450 will change INT# as high-level, output key-press code from SDA. MCU get one byte data from SDA, the low 7-bit is key-press code.

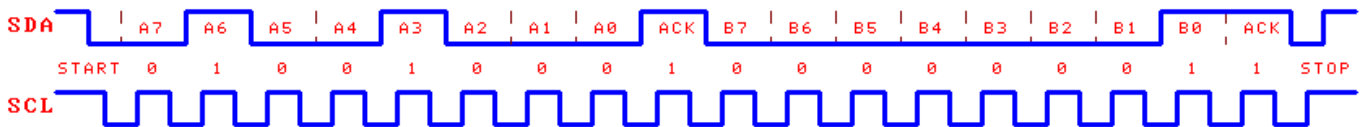
The communication process of MCU and CH450 contains six steps, according operation direction of MCU can be divided as two types, one is write transaction, used to output data; the other is read transaction,

used to input data. The detail process can consult the explanation on subprogram.

The write transaction contains six processes: output start signal, output byte one, acknowledge one, output byte two, acknowledge two and output stop signal. The start signal and stop signal is as the before, acknowledge one and two is 1, the byte one and byte two each contains eight data bits.

The read transaction contains six processes: output start signal, output byte one, acknowledge one, input byte two, acknowledge two, output stop signal. The start signal and stop signal is as the before, acknowledge one and two is 1, the byte one and byte two each contains eight data bits.

In the following image, the byte one 01001000B, 48H; the byte two is 00000001B, 01H.



## 6. Operation command

The operation command of CH450 is divided as three groups. The start signal, stop signal, acknowledge one and acknowledge two is same of each command. The difference of them is the byte one and the byte two and the direction of byte two.

### 6.1. Set system parameter command

The output byte one of this command is 01001000B, 48H; the output byte two is 000000[KEYB][DISP]B, 00H, 01H, 02H or 03H.

This command is used to set system parameter of CH450: display drive enable DISP, keyboard scan enable KEYB. When DISP is one, allowing display output; when DISP is 0, close display drive. When KEYB is one, allowing start keyboard scan, when KEYB is 0, close keyboard scan. The command has no influence on the data in the inner data buffer.

### 6.2. Load byte data command

The byte one of this command is address 64H, 66H, 68H, 6AH, 6CH or 6EH, corresponding to six number LEDs driven by DIG2~DIG7; the byte two is [DIG\_DATA]B, the value is between 00H to 0FFH, eight bits word data.

Load data command is used to write word data DIG\_DATA to data register appointed by byte one. For example, command data 01100100B (64H corresponding to DIG2), 01111001B shows that writes word data 79H to the first data register, and displays **E** driven by DIG2.

After power up reset, the data in CH450 inner data register is not sure, so before the starting, clear the data in data register, or directly load data which will be display. The reset process has no effect on data in data register.

### 6.3. Read key-press code command

The output byte of this command is 01001111B, 4FH; the low seven bits of the input byte is key-press code.

This command is used to get the valid key-press code which is checked by CH450. It is a read transaction, and with return data. MCU must release SDA pin (tri-state output forbid or pull-up to high-level), then CH450 output key-press code from SDA, the valid key-press code is bit6 to bit0, the bit6 is status code, bit5 to bit0 is scan code and key-press address.

## 7. Parameter

**7.1. Absolute maximum rating** (Stresses above those listed can cause permanent damage to the device. Exposure to maximum rated conditions can affect device operation and reliability.)

Name	Parameter note	Min.	Max.	Units	
TA	Ambient operating temperature	VCC=5V	-30	85	°C
		VCC=3.3V	-40	70	
TS	Storage temperature	-55	125	°C	
VCC	Voltage source (VCC connects to power, GND to ground)	-0.5	6.5	V	
VIO	The voltage of input or output pin	-0.5	VCC+0.5	V	
IMdig	Sequential driven current of signal DIG pin	0	120	mA	
IMseg	Sequential driven current of signal SEG	0	25	mA	
IMall	The total of all SEG pins sequential driven current	0	130	mA	

**7.2. Electrical parameter** (test conditions: TA=25°C, VCC=5V)

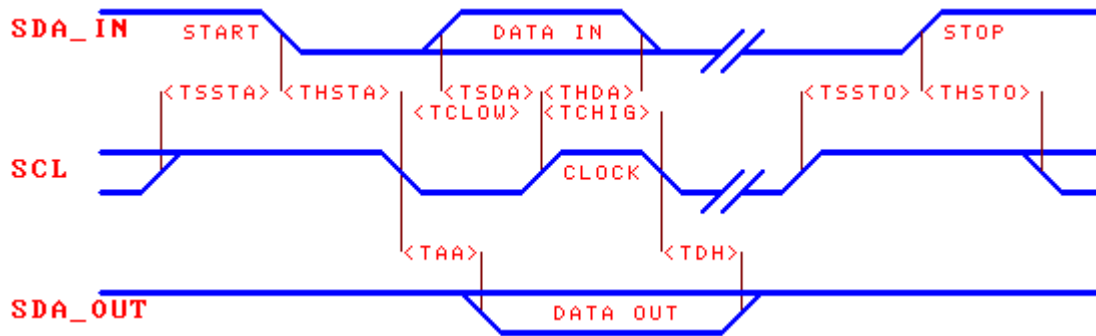
Name	Parameter note	Min.	Typical	Max.	Units
VCC	Source voltage	3.3	5	5.5	V
ICC	Source current	0.2	80	150	mA
ICCs	Static current (SCL and SDA are high-level)		0.5	1	mA
VIL	SCL and SDA are low-level input voltage	-0.5		0.8	V
VIH	SCL and SDA are high-level input voltage	2.0		VCC+0.5	V
VILseg	Low-level input voltage of DIG	-0.5		0.5	
VIHseg	High-level input voltage of DIG	1.8		VCC+0.5	
VOLdig	DIG pin is low-level output voltage (-80mA)			0.8	V
VOHdig	DIG pin is high-level output voltage (8mA)	4.5			V
VOLseg	SEG pin is low-level output voltage (-18mA)			0.5	V
VOHseg	SEG pin is high-level output voltage (15mA)	4.5			V
VOL	Low-level output voltage of other pins (-4mA)			0.5	V
VOH	High-level output voltage of other pins (4mA)	4.5			V
IDN1	Input pull-down current of SEG		-50	-90	uA
IUP1	Input pull-up current of SCL pin		200	300	uA
IUP2	Input pull-up current of SDA pin		300	400	uA
IUP3	Output pull-up current of INT# pin		230	350	uA
VR	Default restrict voltage when power-up reset	2.3	2.6	2.9	V

**7.3. Internal sequence parameter** (test conditions: TA=25°C, VCC=5V)

(note: the sequence parameter in this table is multiple of inner clock cycle, the frequency of inner clock will reduce while source power falls.)

Name	Parameter note	Min.	Typical	Max.	Units
TPR	Reset time generated by power-up detection	10	25	60	mS
TDP	Display scan cycle	0.5	1	4	mS
TKS	Interval of keyboard scan, acknowledge time of key-press		16		mS

**7.4. Interface sequence parameter** (test conditions:  $T_A=25^{\circ}\text{C}$ ,  $V_{CC}=5\text{V}$ , consult the following image) (note: the unit is  $10^{-9}$  second mainly, the max value which is not given clear indication is infinite in the theory.)



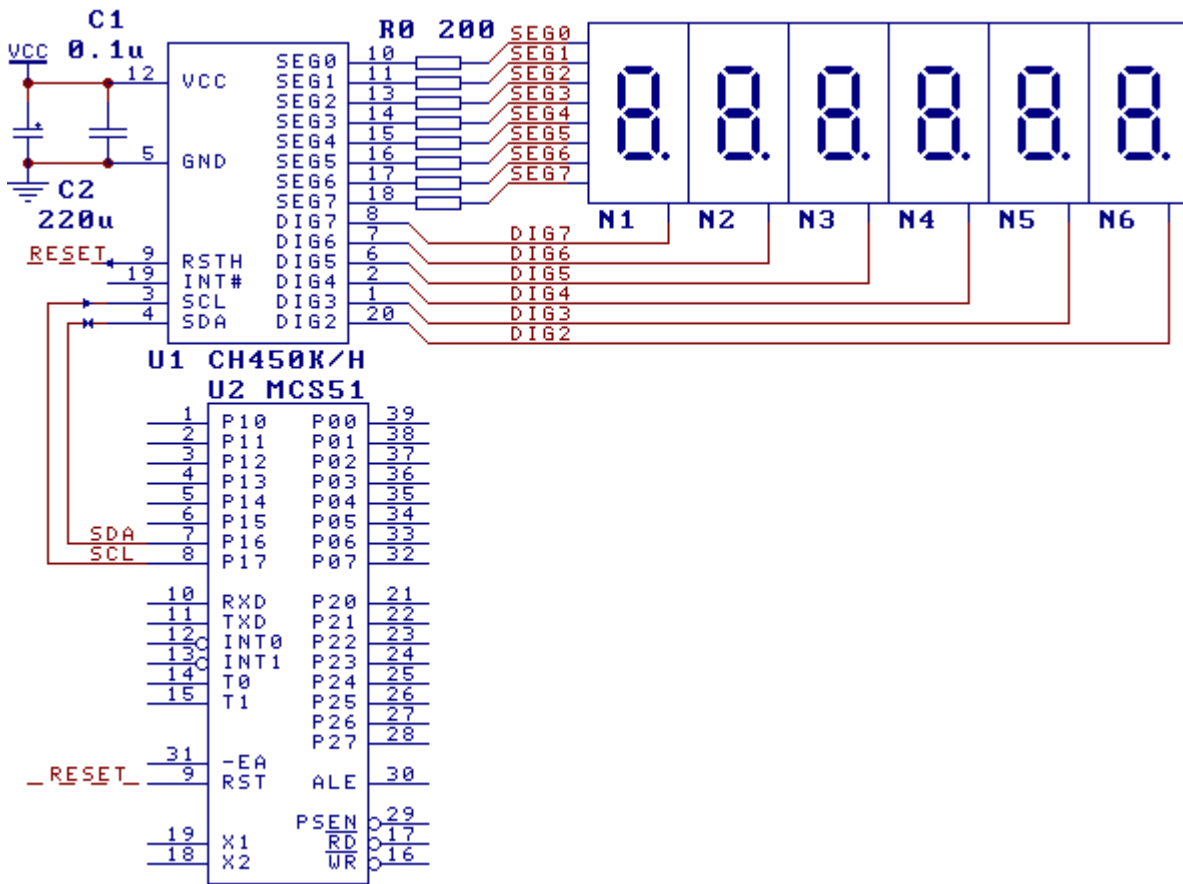
Name	Parameter note	Min.	Typical	Max.	Units
TSSTA	Start signal set up time when SDA is falling edge	100			nS
THSTA	Start signal keep time when SDA is falling edge	100			nS
TSSTO	Stop signal set up time when SDA is rising edge	100			nS
THSTO	Stop signal keep time when SDA is rising edge	100			nS
TCLOW	Low-level width of SCL clock signal	100			nS
TCHIG	High-level width of SCL clock signal	100			nS
TSDA	SDA input data for SCL rising edge set up time	30			nS
THDA	SDA input data for SCL rising edge keep time	10			nS
TAA	SDA output data valid for SCL falling edge delay time	2		30	nS
TDH	SDA output data invalid for SCL falling edge delay time	2		40	nS
Rate	Average data transform speed	0		41M	bps

## 8. Application

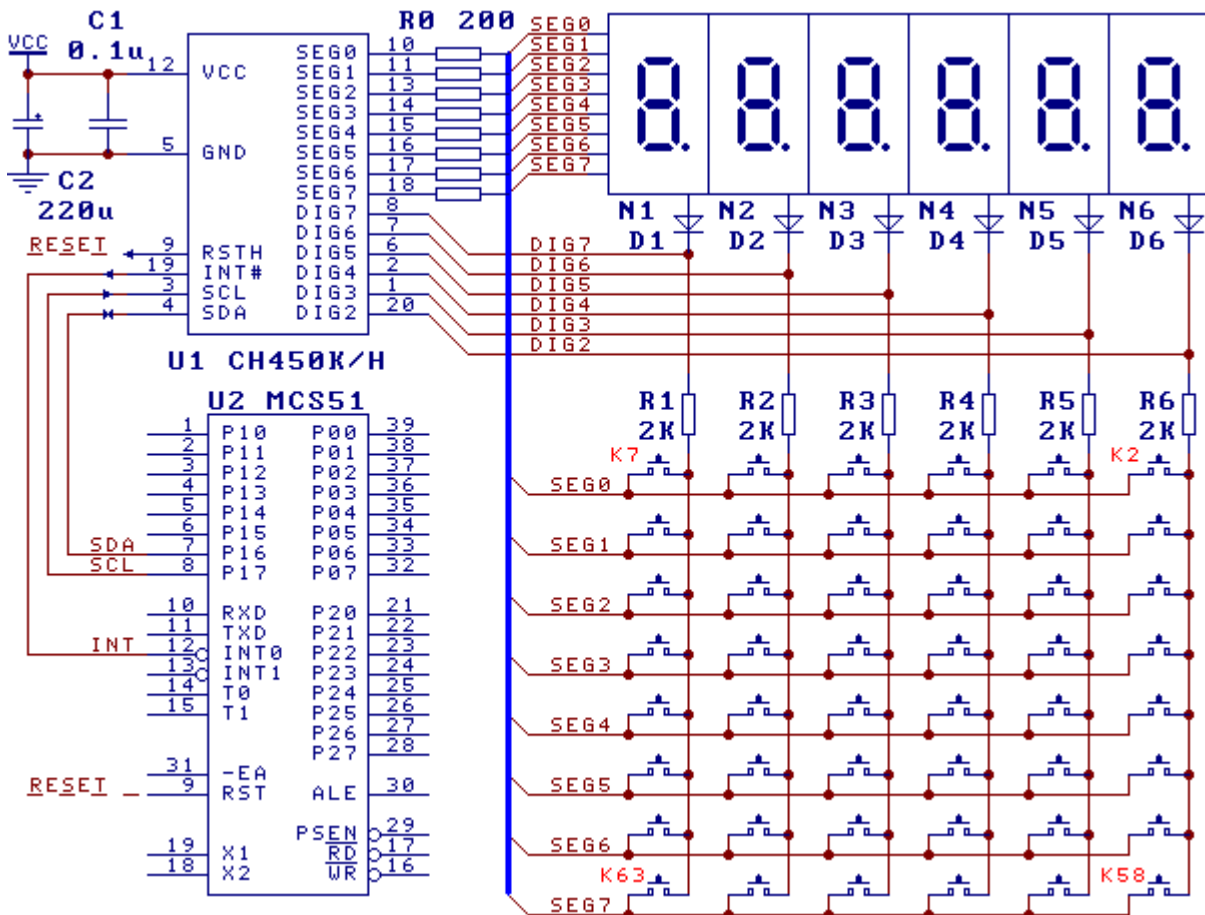
### 8.1. Numeric LEDs display drive (following image)

CH450 connects to the external MCU via two wires serial interface SCL and SDA. Capacitance C1 and C2 are layed next to power pin, used to power decoupling decrease the disturber generated by driven large current.

CH450 can directly drive six common cathodes dynamically. The same segment pin of all the number LED parallel connect, then connect to SEG0~SEG7 of CH450 via serial connect limited current resistor. The public cathode of each number LED is driven by DIG2~DIG7 of CH450. R0 is used to limit and poise the segment drive current. On the 5V power, usually serial connects 200Ω resistor is corresponding to 13mA segment current. The value of limited current resistor is more larger, the segment current is more smaller, the display light is more darker. The value of R0 is between 100Ω and 1KΩ, when the other condition is the same, select the large value at priority to reduce the consume of CH450.



8.2. Numeric LEDs drive and keyboard scan (the following image)





CH450 has keyboard scan function of 48-key. If in application, only need several keys, get rid of the other keys in 8×6 matrix. In order to decrease the influence when

After adding inverter to DIG2~DIG7 pins, CH450 can drive common anode number LED. In the image, six groups inverters are composed of six PNP audio T1~T6 (the model is 9012 or 8550) and six resistors R1 (the value is between 1KΩ~3KΩ), they are driving six common anode number LED public anode. The SEG pin is invert driven of CH450, so the word data is opposite of each bit in load word data command. The data bit is 0 then light, while the data bit is 1 distinguish.

If driving large size high voltage number LED or needing to add driven current to increase brightness, please consult data manual of CH452.

### **8.3. Anti-jamming**

Because CH450 drives number LED or current of LED is large, burr voltage will generated in power. If power wire or ground wire doesn't lay logically, it will influence stability of MCU or CH450. Recommending to use the thick power wire and ground wire, parallel connecting power decoupling capacitance between positive and negative power near to CH450.

In the strong disturb environment, MCU can refurbish CH450 several second termly. Containing newly load data register of each number LED and newly start displaying.

Addition, if I/O pin of standard MCS-51 drives the further CH450, strengthen the pull-up ability of MCS-51 I/O pins to keep the digital signal good in the further distance transform. The value of pull-up is from 1KΩ to 10KΩ. The pull-up resistor is no need in the close quarters.

### **8.4. MCU interface program**

Supplying a part of MCU C language and ASM compile interface program in the web.