BS501

Touch Integrated Circuit

1. General Description

BS501 is a high-performance capacitive contactless sensor integrated circuit with strong anti-interference capability as well as steady and rapid sense capability. It can be used as touch switches for many materials, such as glass, plastic, and so on.

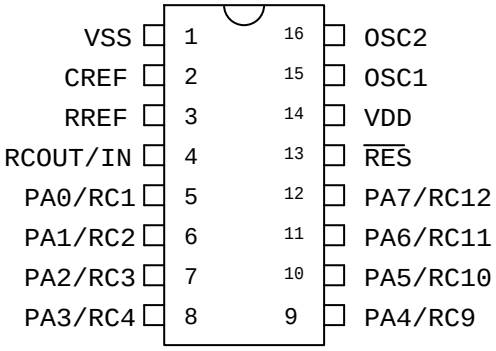
Capacitive contactless switches can replace traditional switches. Traditional switches get wear and become dirty easily. Contactless keys avoid holing the panel and placing the buttons. It's easy to maintain and makes your products looks more beautiful. Many electronic products and appliances have adopted it.

The powerful EasyTouch Tool will generate touch key's input values automatically in a very convenient way. Customers could use built-in output options to create the touch programs easily; this will reduce programmer's loading and shorten the developing time, as well as speed up the time to market.

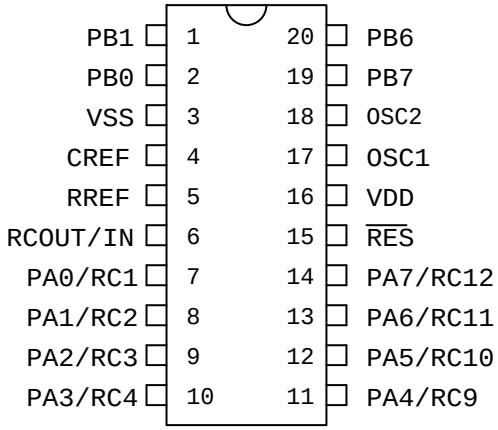
2. Features

- Operation Voltage： 2.2V~5.5V
- 4 to 12 Touch Keys
- Built-in 7 Output Modes
- Offers UART_TEST Mode
- Offers USER_DEFINE Mode. Users could develop output modes they prefer.
- Adjustable output (Active High/Low, Level/Toggle/One-shot, …)
- Adjustable sensitivity by changing external capacitor(Cs)
- Programmable sensitivity by using EasyTouch Tool
- Maximum output duration of 10/60 seconds or disable
- Auto calibration
- One Key Active (Water proof Purpose)
- Adjustable output delay time (0.5 sec ~ 8 sec)

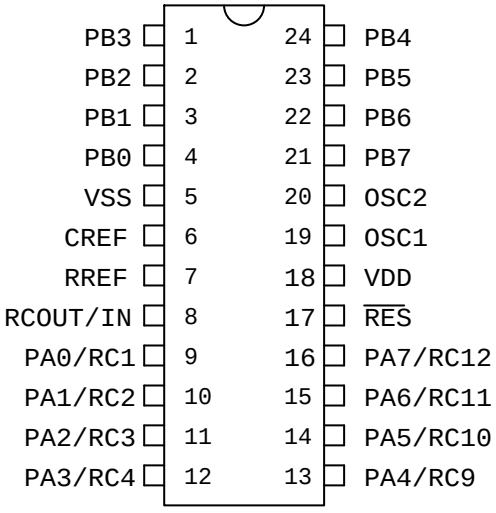
3. Pin Assignment



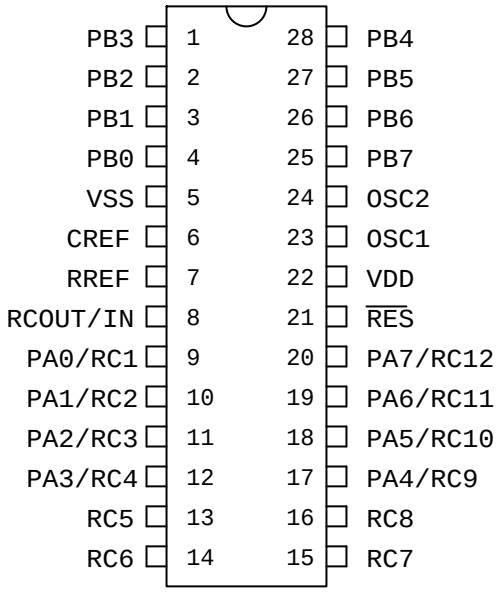
BS501
16DIP/NSOP



BS501
20DIP/SSOP



BS501
24SKDIP/SSOP



BS501
28SKDIP/SSOP

4. Pin Description

PIN	I/O	Option	Descriptions
PA0/RC1 **PA1/RC2** **PA2/RC3** **PA3/RC4** **PA4/RC9** **PA5/RC10** **PA6/RC11** **PA7/RC12**	I/O	Pull-high* Wake-up	● Bidirectional 8-bit I/O port. Each pin can be configured as a wake-up input via configuration options. ● Software instructions determine if the pin is a CMOS output or Schmitt trigger input. ● Pull-high resistors can be added to each pin via a configuration option. ● Pins PA0 and PA1 are pin-shared with external interrupt input pins INT0 and INT1, respectively. ● Configuration options determine the interrupt enable / disable and the interrupt low/high trigger type. ● Pin PA2 is pin-shared with the external timer input pin TMR. ● Each Pin of PA0~PA3 and PA4~PA7 are pin-shared with RC1~RC4 and RC9~RC12 respectively via configuration options. ● RC1~RC4 and RC9~RC12 are capacitor or resistor connection pins.
PB0~PB7	I/O	Pull-high*	● Bidirectional 8-bit I/O port. ● Software instructions determine if the pin is a CMOS output or Schmitt trigger input. ● Pull-high resistors can be added to each pin via a configuration option.
RC5~RC8	I		Capacitor or resistor connection pins
RCOUT/IN	I/O		RC to F OSC Input/Output PIN
C_{REF}	O		Connect to External Reference Capacitor
R_{REF}	O		Connect to External Reference Resistance
$\overline{RES}$	I		Schmitt trigger Reset input. Active Low
VDD			Positive Power Supply
VSS			Negative Power Supply (Ground)
OSC1 **OSC2**	I O	RC or Crystal	Choose RC or Crystal to be the source of system clock by using EasyTouch.

5. Absolute Maximum Ratings

Supply Voltage.....VSS-0.3V to VSS+6.0V

Input Voltage.....VSS-0.3V to VDD+0.3V

I_{OL} Total.....150mA

Total Power Dissipation.....500mW

Storage Temperature.....-50°C to 125°C

Operating Temperature…….....-40°C to 85°C

I_{OH} Total.....150mA

Note: These are stress ratings only. Stresses exceeding the range specified “Absolute Maximum Ratings”may cause substantial damage to the device. Functional operation of this device at other conditions beyond those listed in the specification is not implied and prolonged exposure to extreme conditions may affect device reliability.

6. D.C. Characteristics

Ta=25°C

Symbol	Parameters	Test Conditions		Min.	Typ.	Max.	Unit
		V_{DD}	Conditions				
V_{DD}	Operating Voltage	-	Fsys: 4MHz	2.2	-	5.5	V
I_{DD1}	Operating Current (Crystal / RC OSC)	3V	No Load Fsys=4MHz	-	1	2	mA
		5V		-	3	5	mA
VIL1	Input Low Voltage for I/O Ports,	-	-	0	-	0.3VDD	V
VIH1	Input High Voltage for I/O Ports,	-	-	0.7VDD	-	VDD	V
VIL2	Input Low Voltage ($\overline{RES}$)	-	-	0	-	0.4VDD	V
VIH2	Input High Voltage ($\overline{RES}$)	-	-	0.9VDD	-	VDD	V
VIL3	RC Oscillation Input Low Voltage (IN)	-	-	0	-	0.3VDD	V
VIH3	RC Oscillation Input High Voltage (IN)	-	-	0.7VDD	-	VDD	V
IOL	I/O Sink Current	3V	VOL=0.1VDD	4	8	-	mA
		5V		10	20	-	mA
IOH	I/O Source Current	3V	VOH=0.9VDD	-2	-4	-	mA
		5V		-5	-10	-	mA
IOL1	RREF and CREF Sink Current	3V	VOL=0.1VDD	2	4	-	mA
		5V		5	10	-	mA
IOH1	RREF and CREF Source Current	3V	VOH=0.9VDD	-1	-2	-	mA
		5V		-2.5	-5	-	mA

7. A.C. Characteristics

Ta=25°C

Symbol	Parameters	Test Conditions		Min.	Typ.	Max.	Unit
		V_{DD}	Conditions				
Fsys	System frequency (Crystal/RC)	-	2.2V~5.5V -	-	4000	-	KHz
t_{WDTOSC}	Watchdog Oscillator Period	3V	-	45	90	180	μs
		5V	-	32	65	130	μs
t_{WDT1}	Watchdog Time-out Period (WDT RC OSC)	3V	-	11	23	46	ms
		5V	-	8	17	33	ms
t_{RES}	External Reset Low Pulse Width	-	-	1	-	-	μs
t_{MaxOn}	Maximum Output Duration	-	-	0	10	60	sec
t_{DLY}	Output Delay Time			0	-	8	sec
t_{CLI}	Auto Calibrate Time	-	-	0.5	-	2	sec

8. Functional Description

8.1 Sensitivity

In many ways, there are some impacts to sensitivity, such as the thickness of panel, the electrode size, shape and orientation. So in different circumstances, we can adjust the sensitivity by using the following two methods.

(1) Changing the value of Cs; bigger Cs makes better sensitivity. (Cs: 10pf ~ 50pf)

(2) Using EasyTouch Tool

8.2 Output

User could choose different output modes (see following) by using EasyTouch Tool.

- BINARY
- BINARY_INDICATE
- DIRECT
- DIRECT_BINARY
- DIRECT_SPI
- SPI
- SPI_INDICATE
- USER_DEFINE

User could determine the output formats as below for each key by using EasyTouch Tool.

- Active High / Active Low
- Level / Toggle / One-Shut
- Delay
- Re-trigger

8.3 Maximum on Time

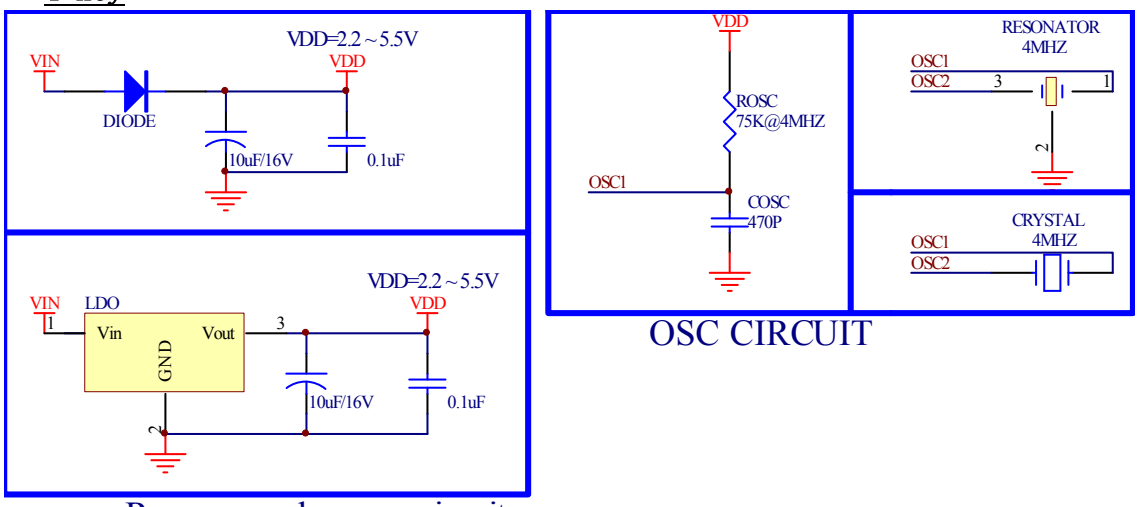
In some cases, external interference could make touch keys active for a long time. In order to avoid the phenomenon, BS501 offers Maximum active duration of 10/60 seconds. User also could choose disable Maximum on Time function. If the keys have been touched for over the duration selected, the outputs will resume, and the program will scan the keys anew.

8.4 Auto calibration

The environment is variable. For example, temperature, humidity etc. In order to work well in all environments, BS501 automatically calibrates the reference value timely.

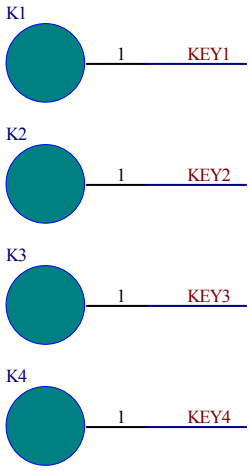
9. Application Circuit

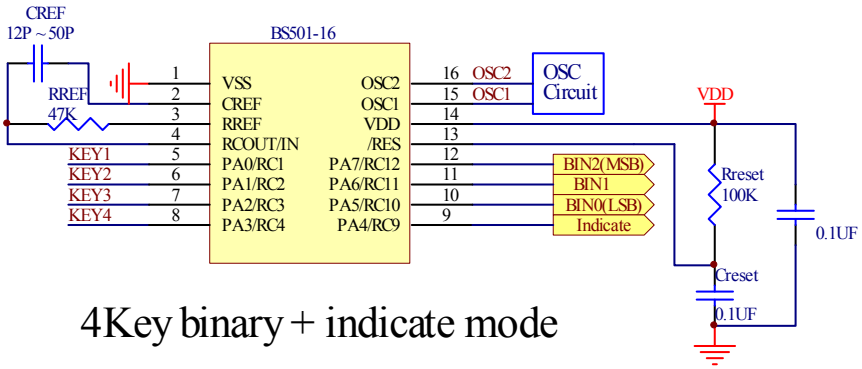
4-Key



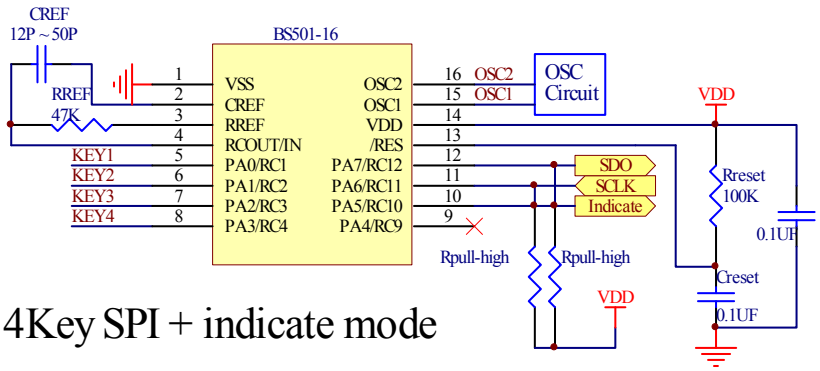
OSC CIRCUIT

Recommand power circuit

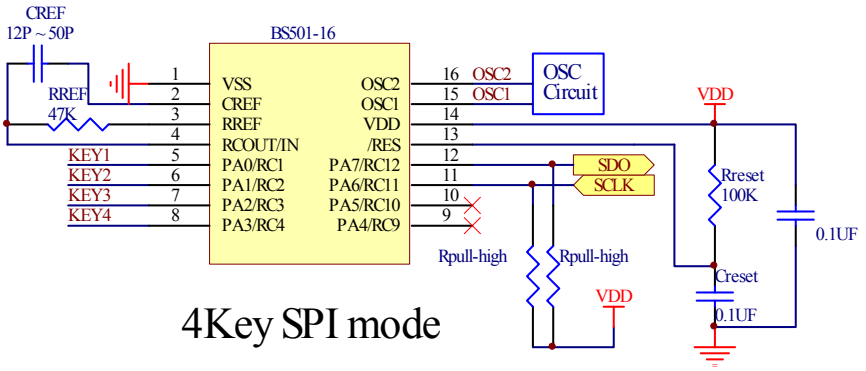




4Key binary + indicate mode



4Key SPI + indicate mode



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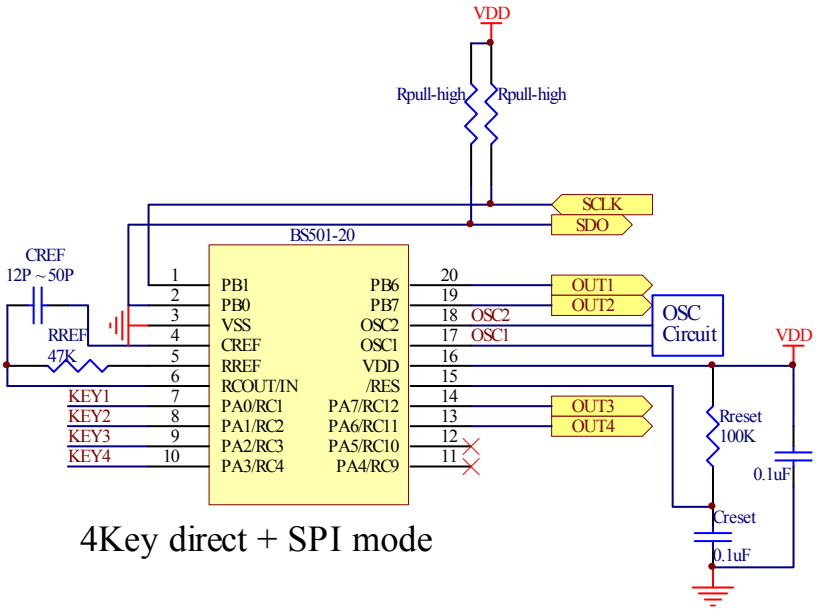
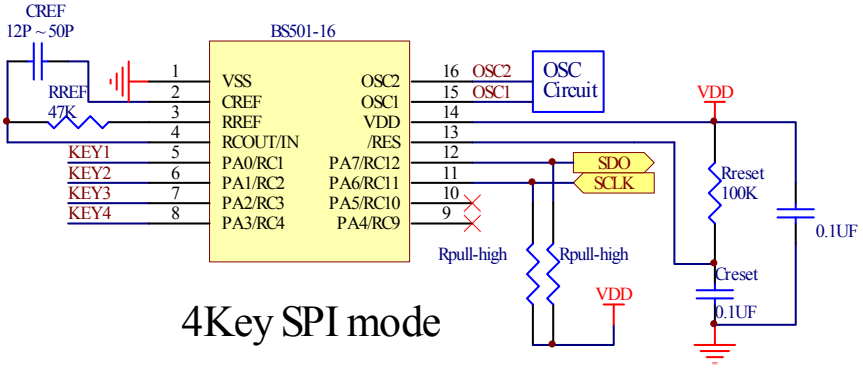


4Key direct + SPI mode



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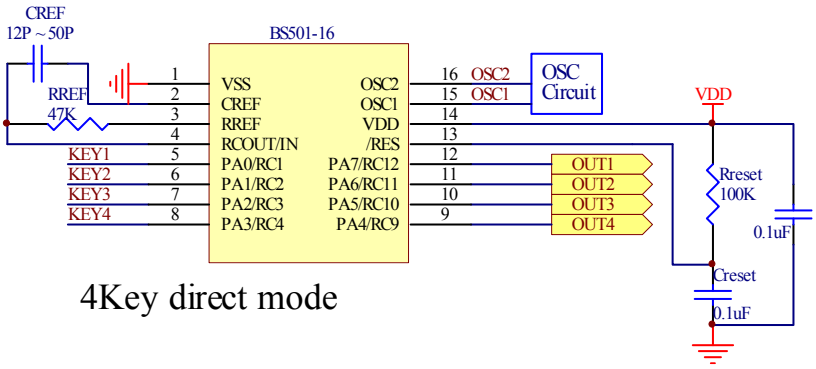
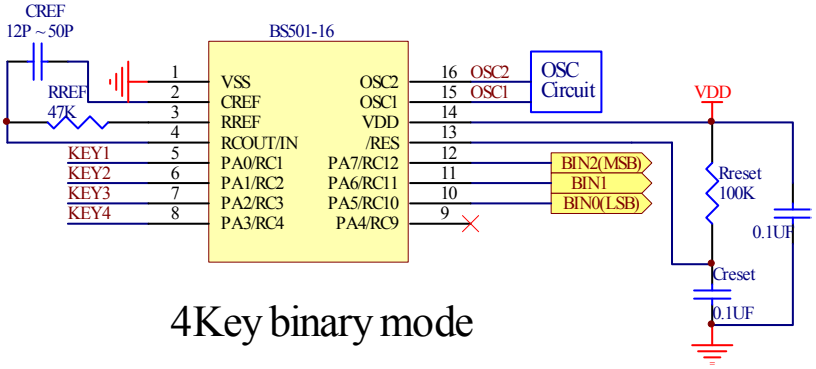
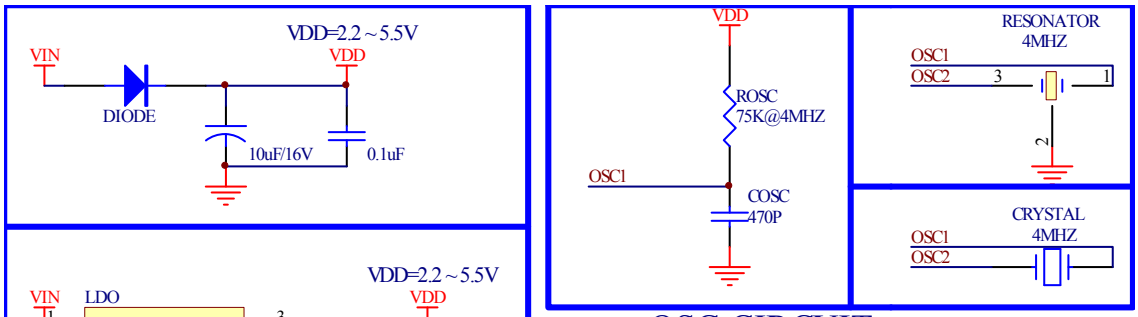


4Key direct mode



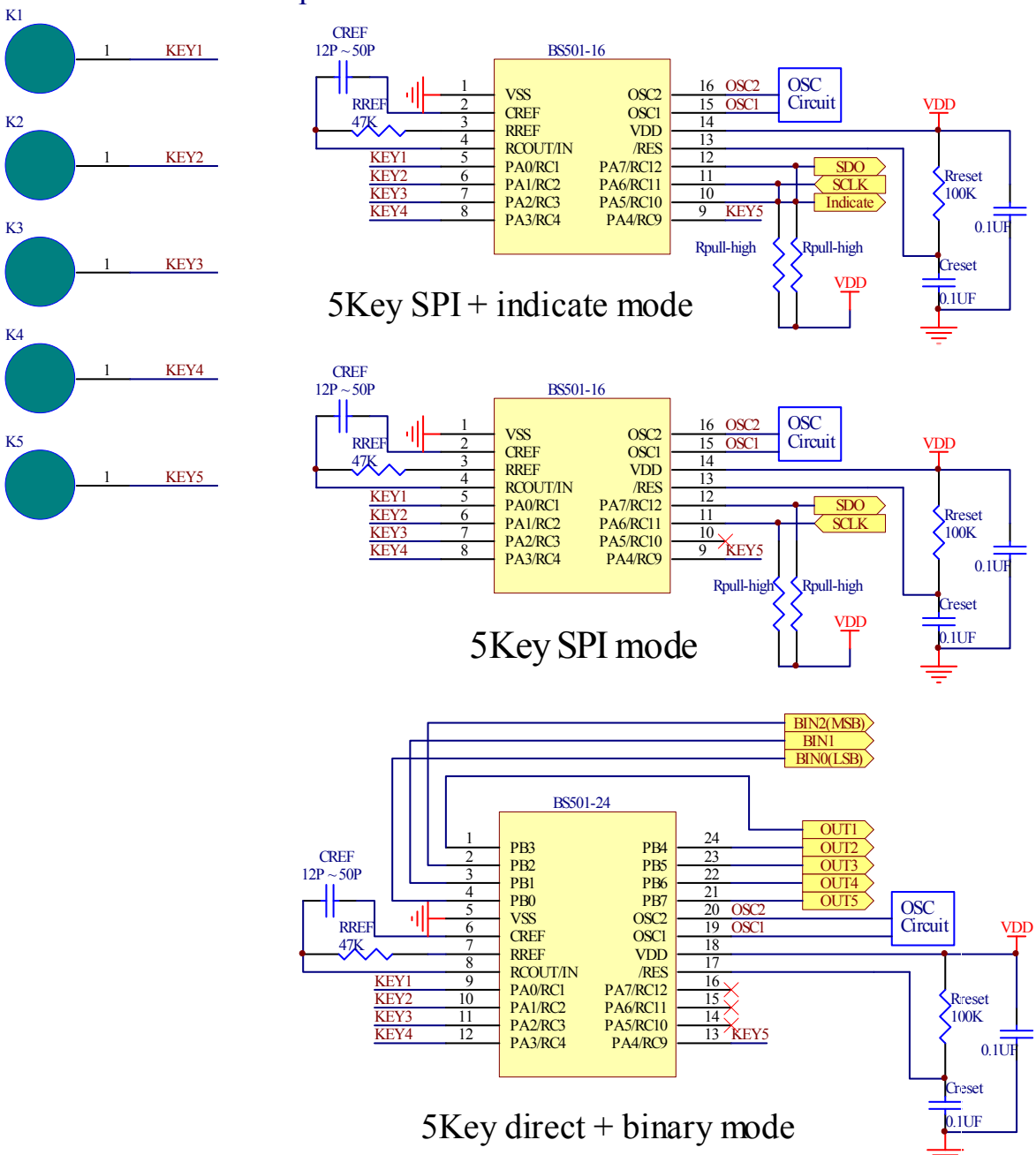
4Key binary mode

5-Key



OSC CIRCUIT

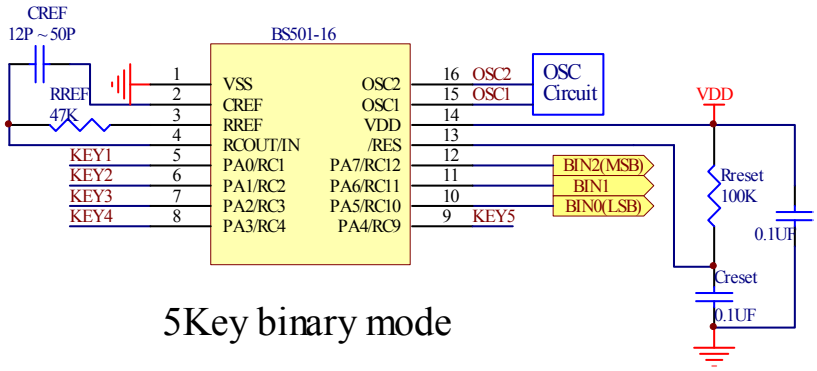
Recommand power circuit



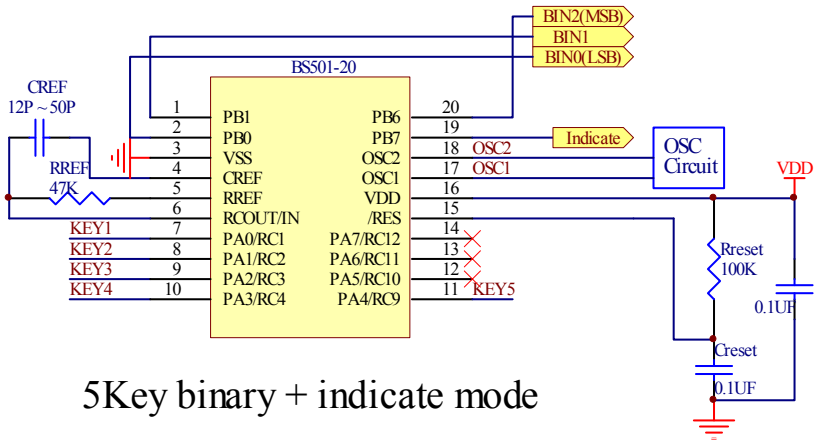
5Key SPI + indicate mode

5Key SPI mode

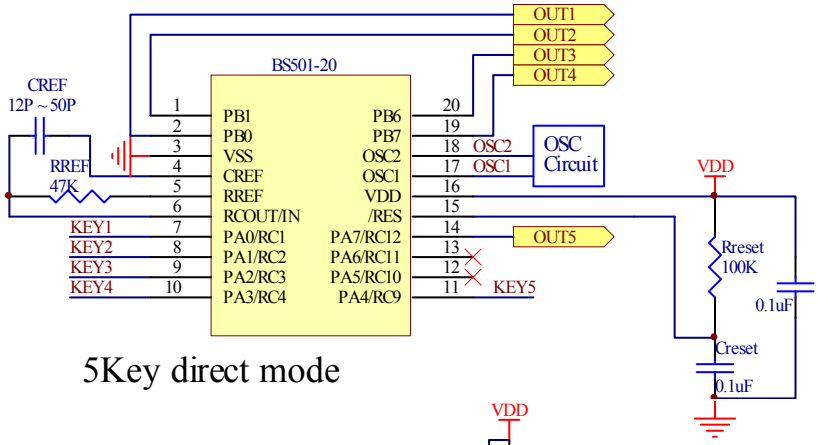
5Key direct + binary mode



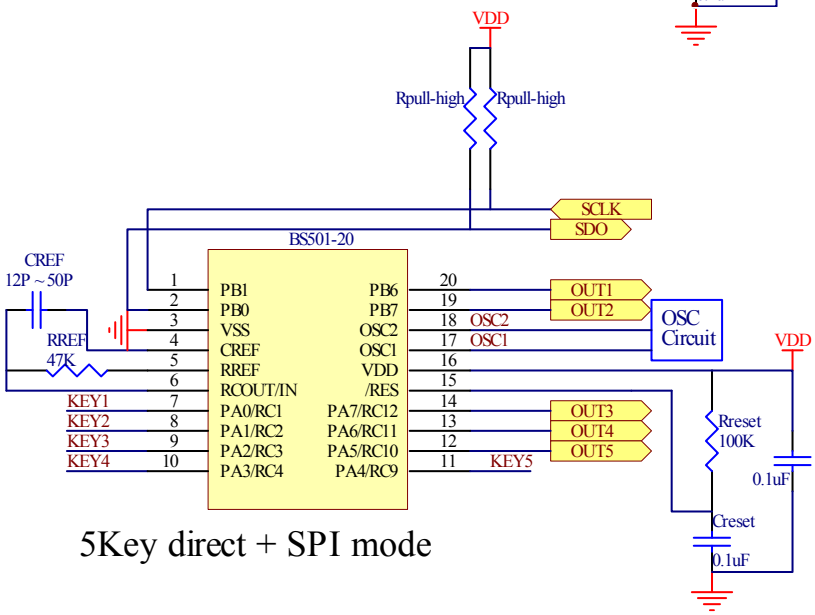
5Key binary mode



5Key binary + indicate mode

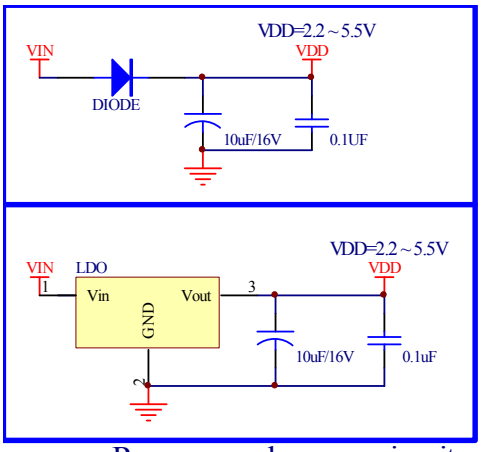


5Key direct mode

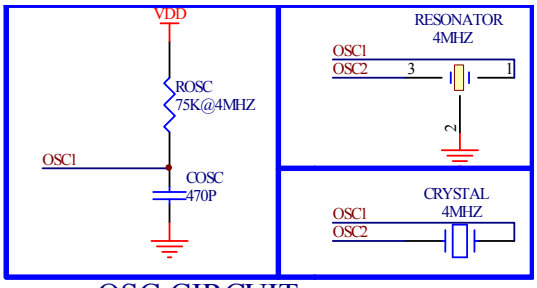


5Key direct + SPI mode

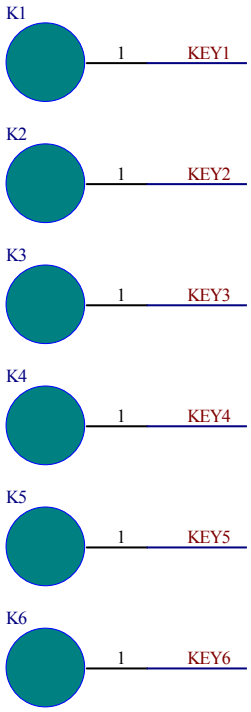
6-Key

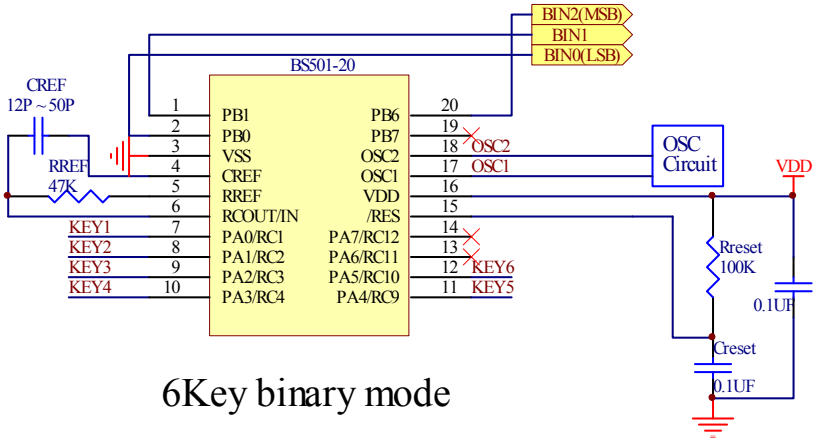


Recommand power circuit

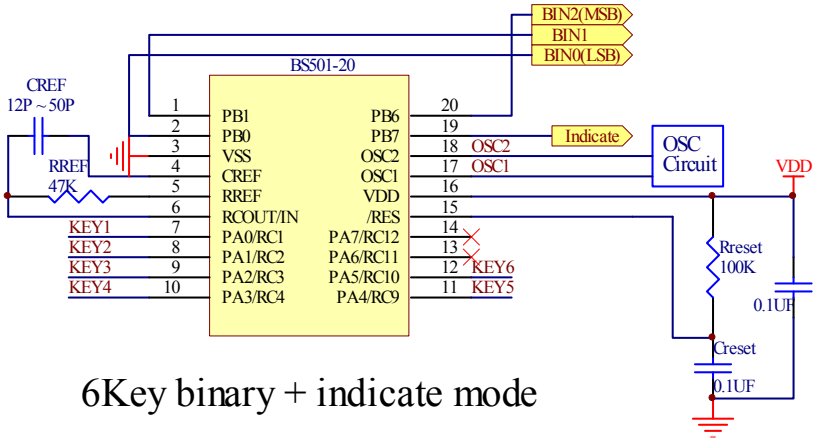


OSC CIRCUIT

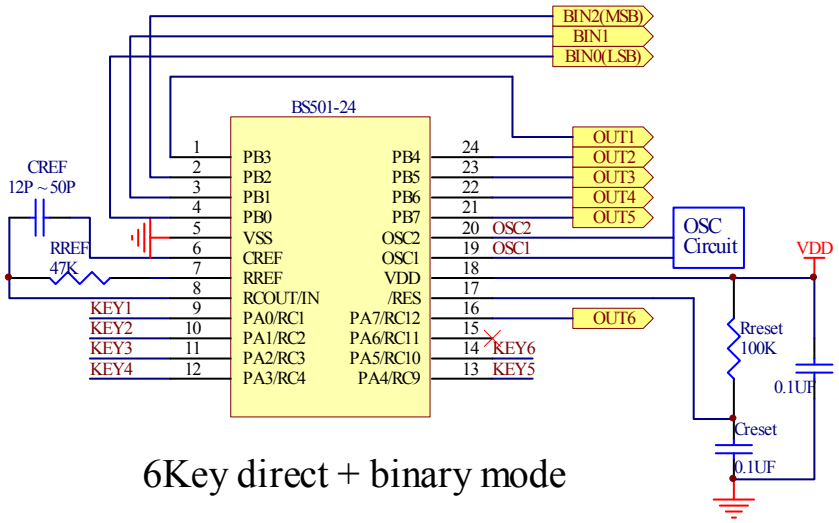




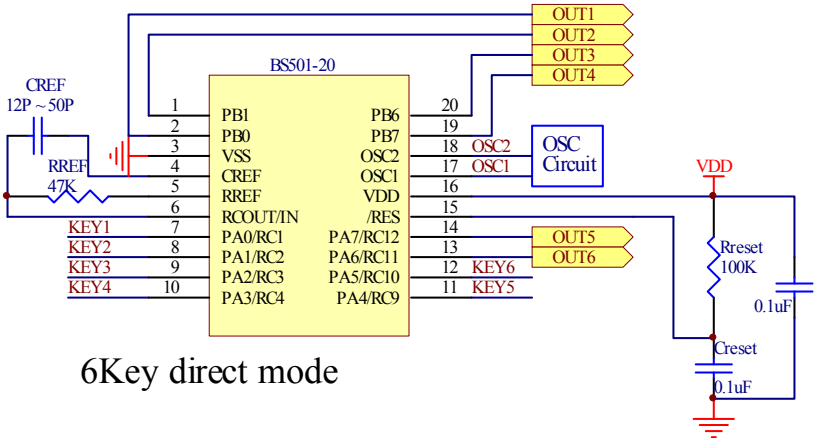
6Key binary mode



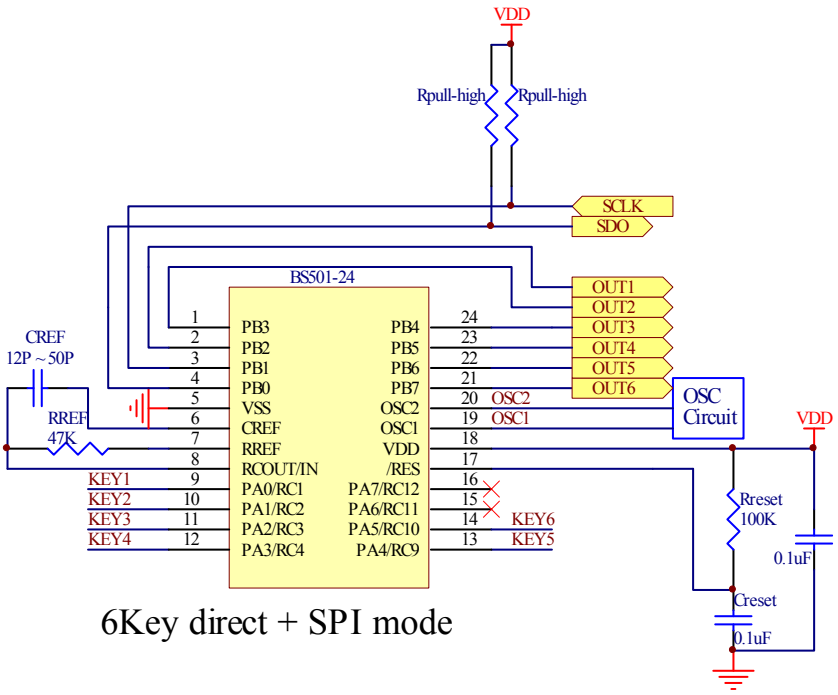
6Key binary + indicate mode



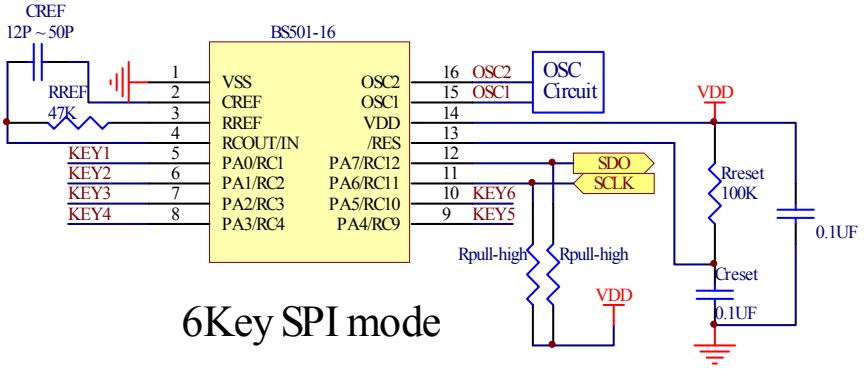
6Key direct + binary mode



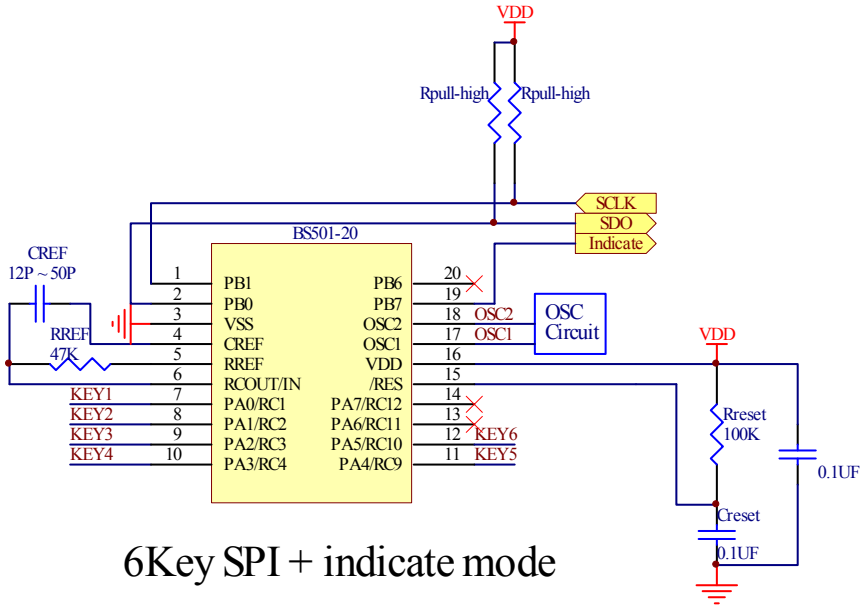
6Key direct mode



6Key direct + SPI mode

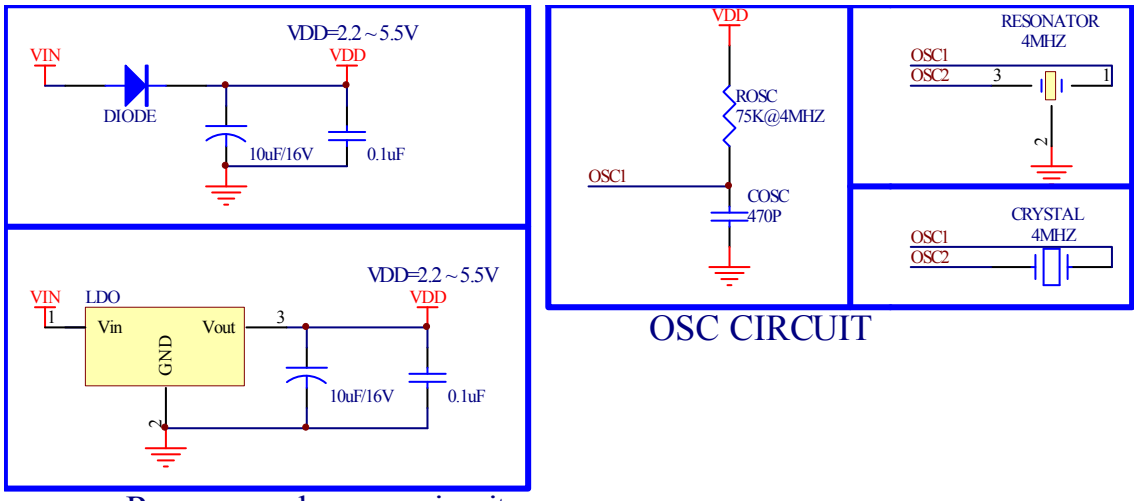


6Key SPI mode



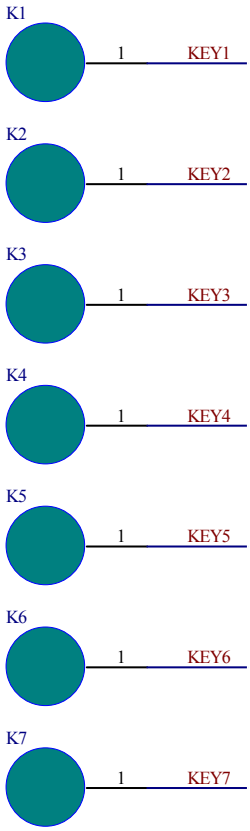
6Key SPI + indicate mode

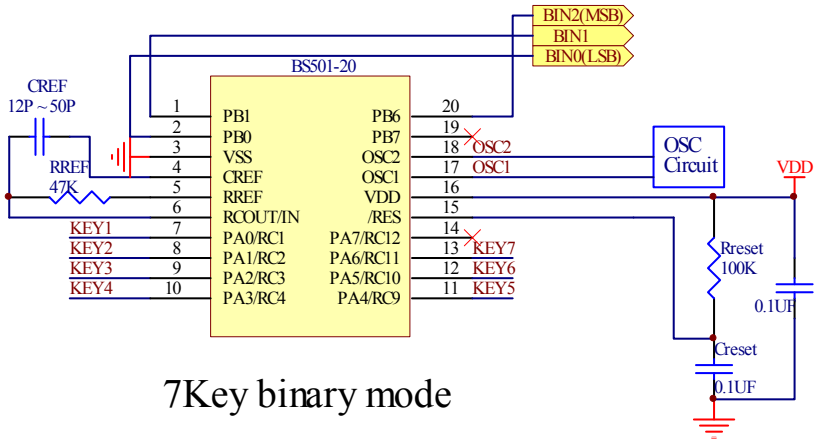
7-Key



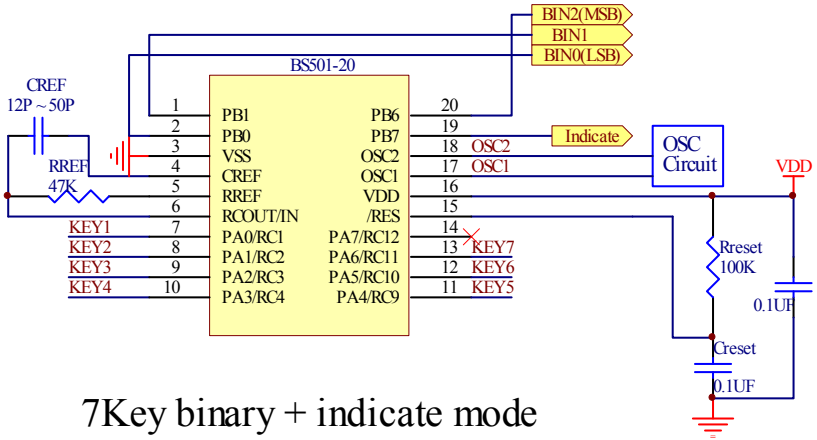
OSC CIRCUIT

Recommand power circuit

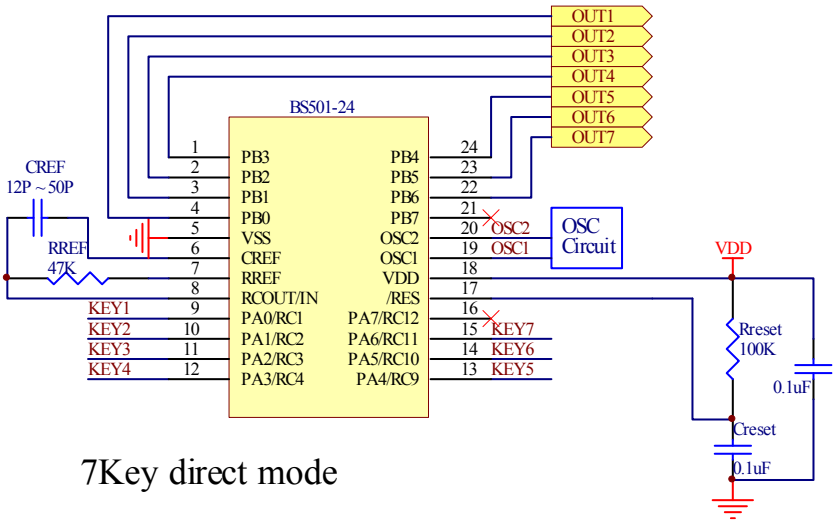




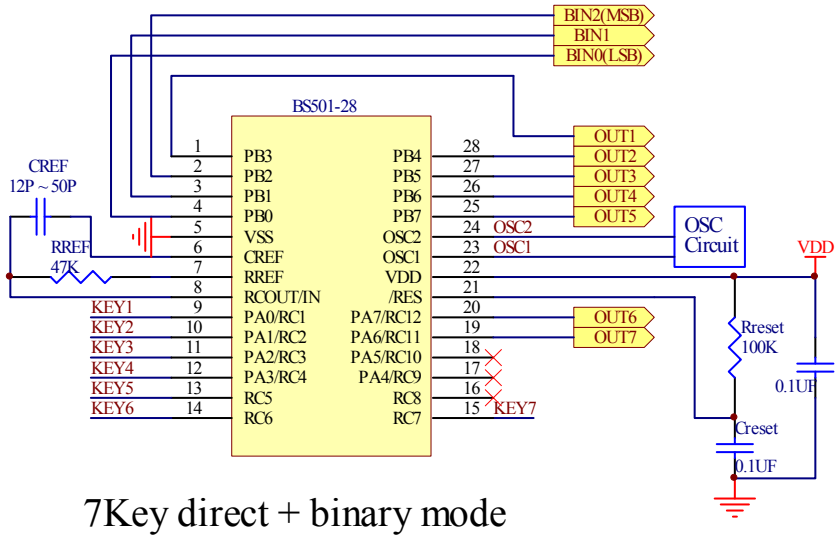
7Key binary mode



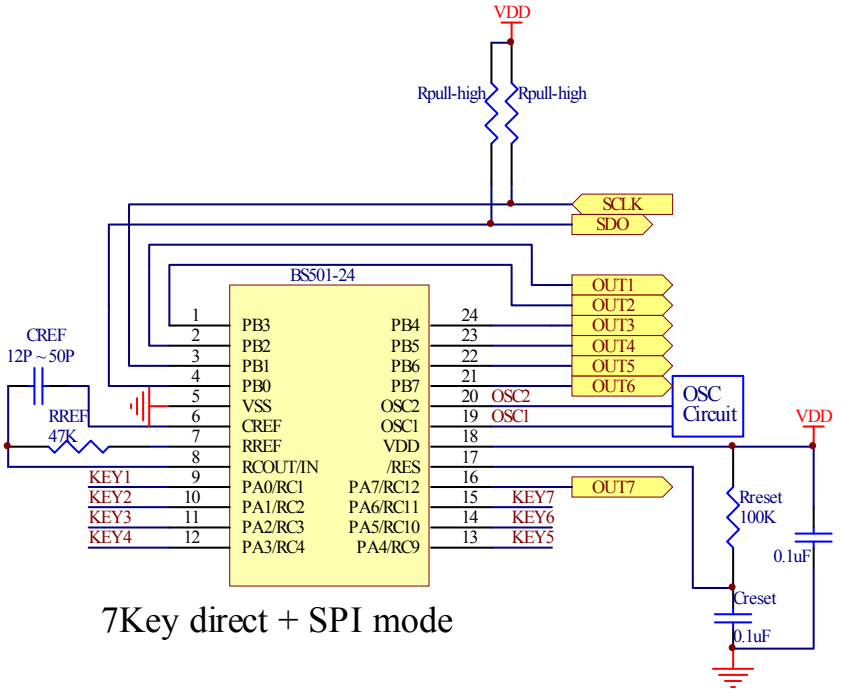
7Key binary + indicate mode



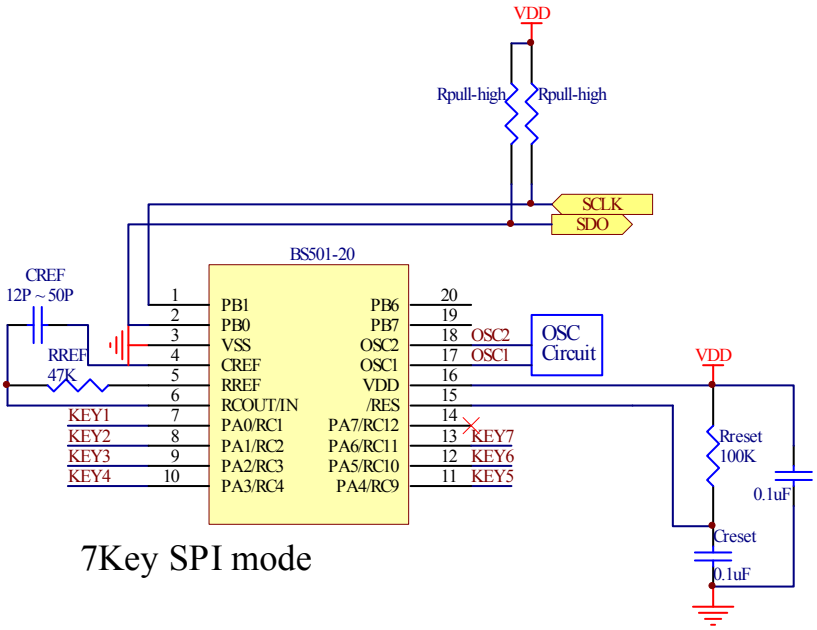
7Key direct mode



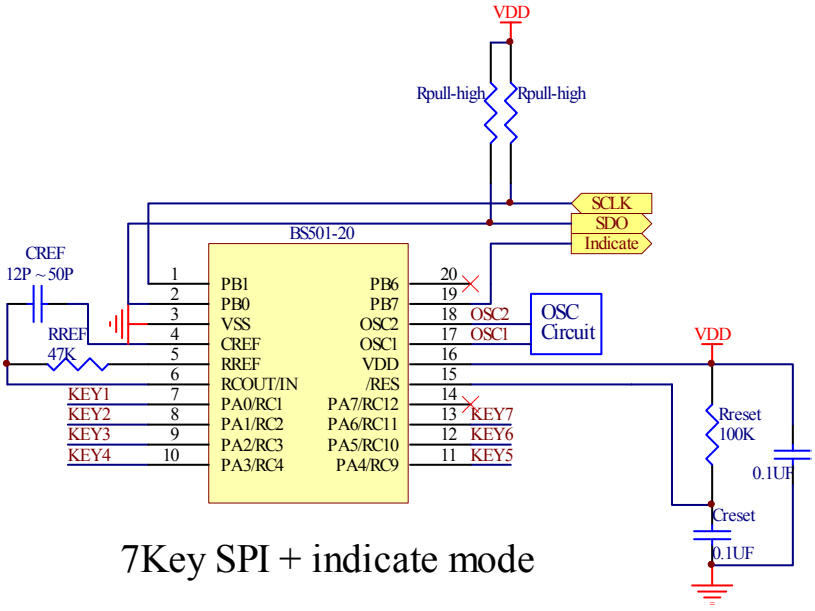
7Key direct + binary mode



7Key direct + SPI mode

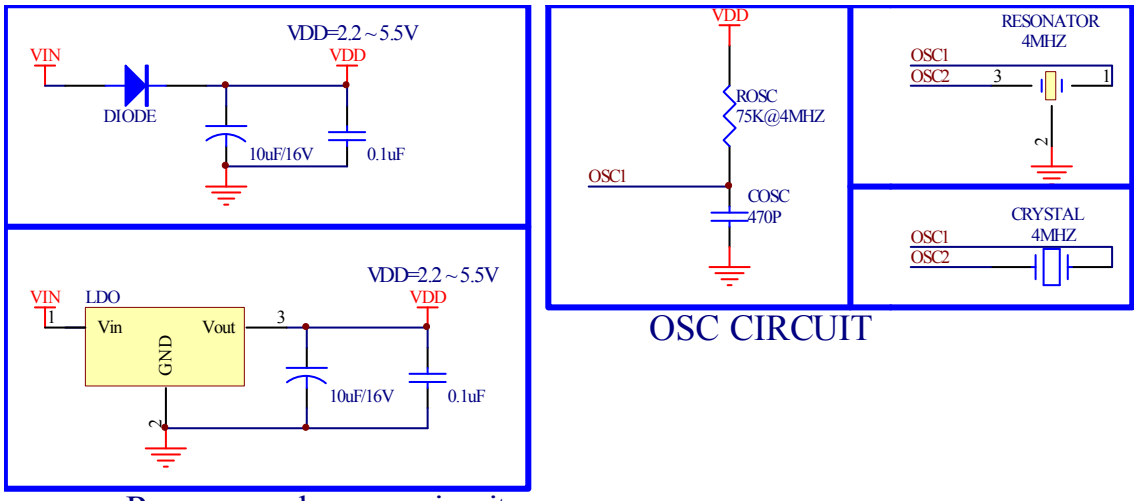


7Key SPI mode



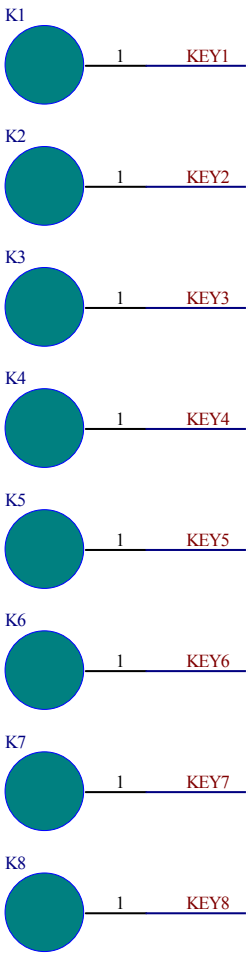
7Key SPI + indicate mode

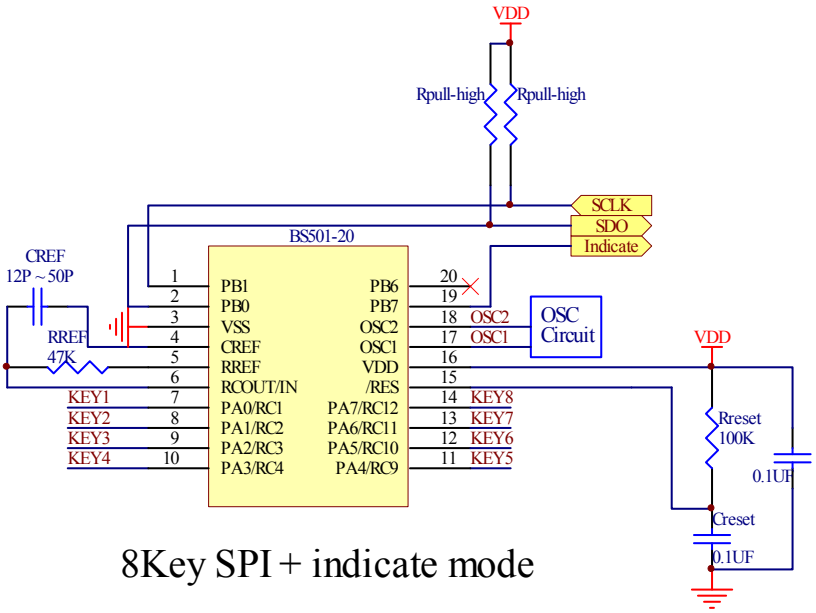
8-Key



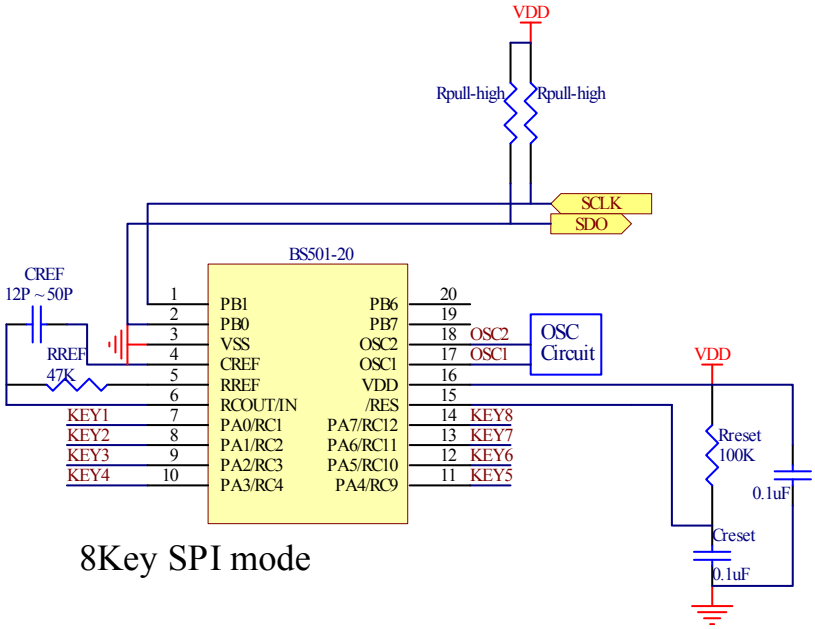
OSC CIRCUIT

Recommand power circuit

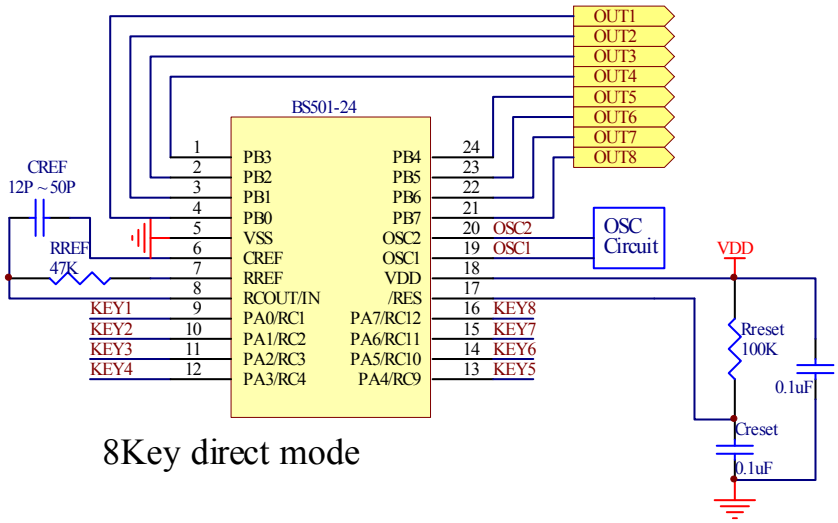




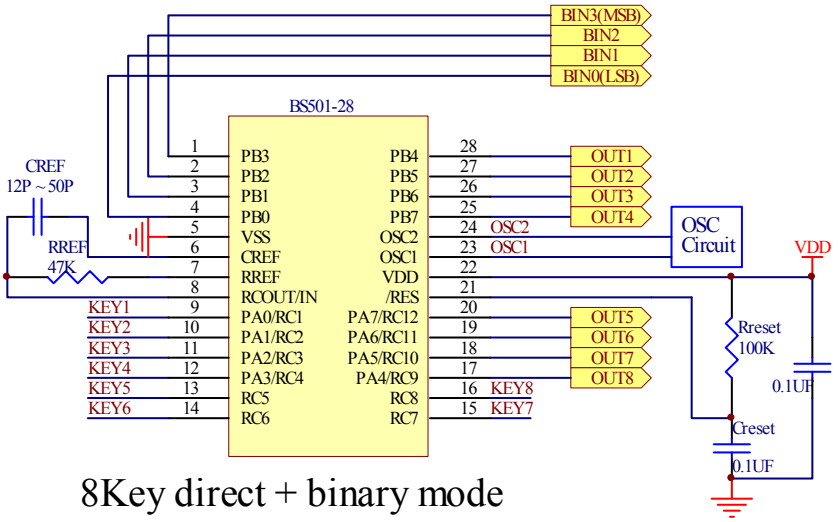
8Key SPI + indicate mode



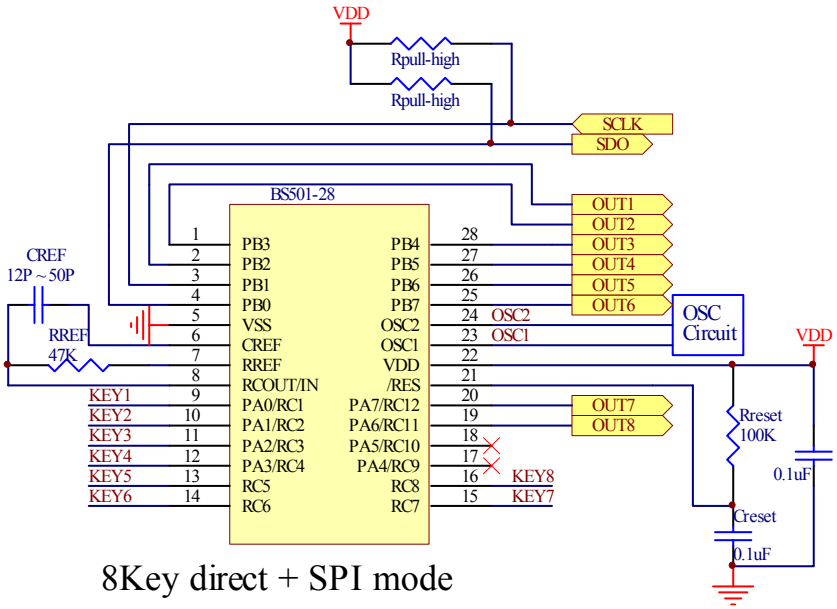
8Key SPI mode



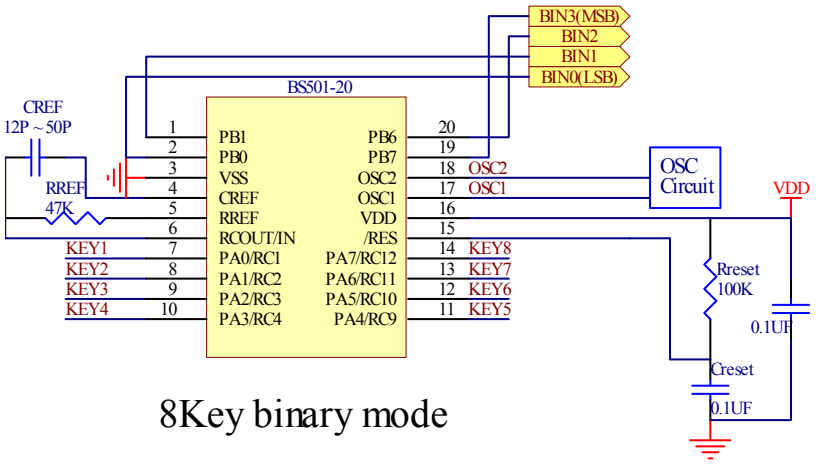
8Key direct mode



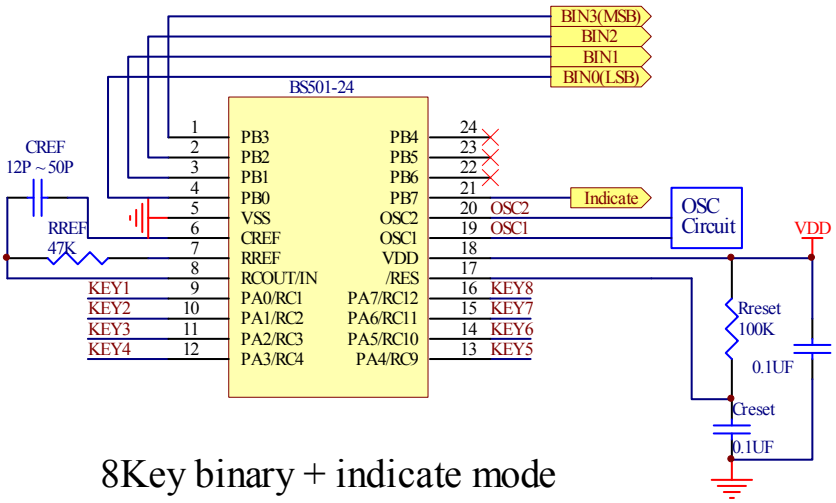
8Key direct + binary mode



8Key direct + SPI mode

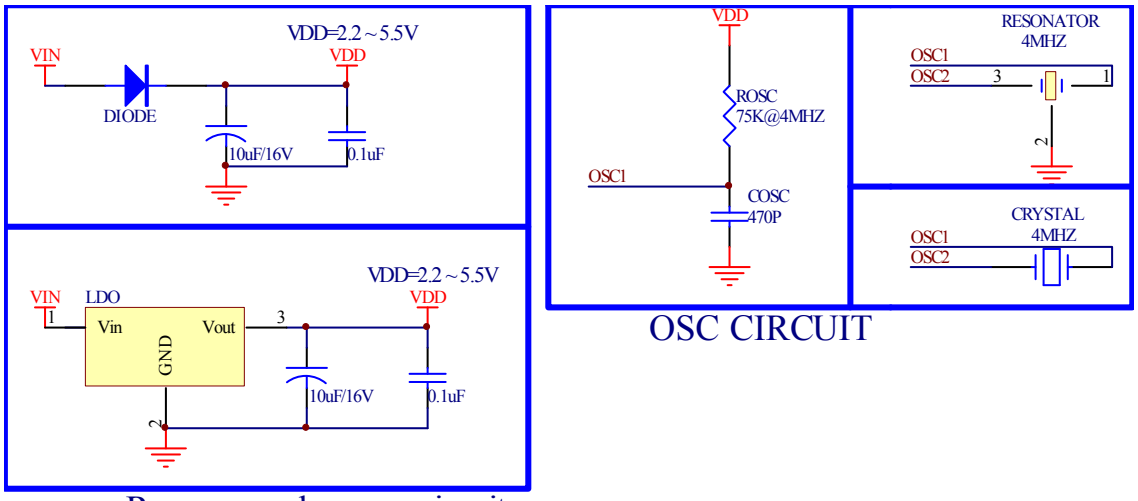


8Key binary mode



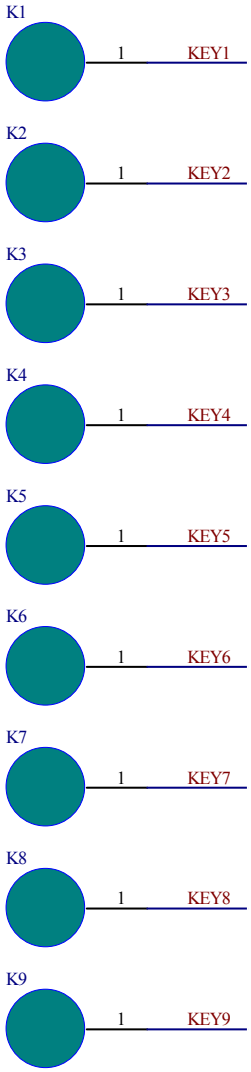
8Key binary + indicate mode

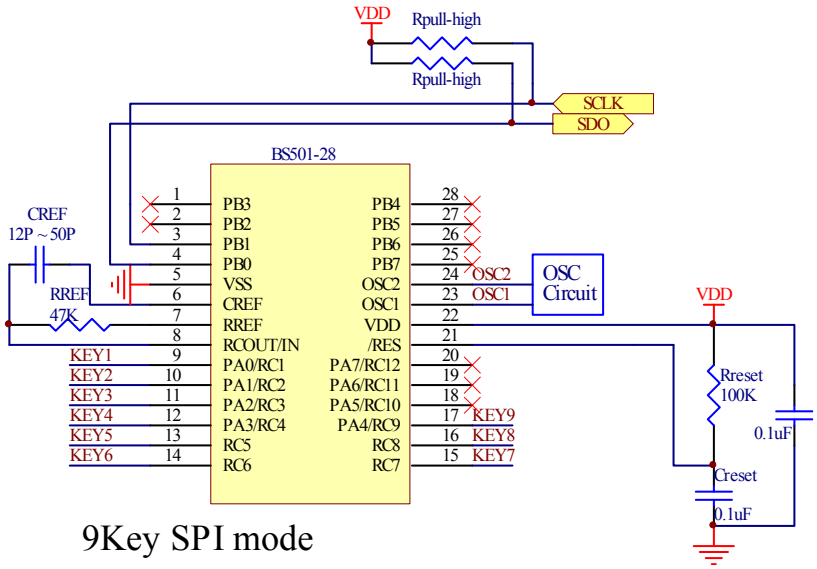
9-Key



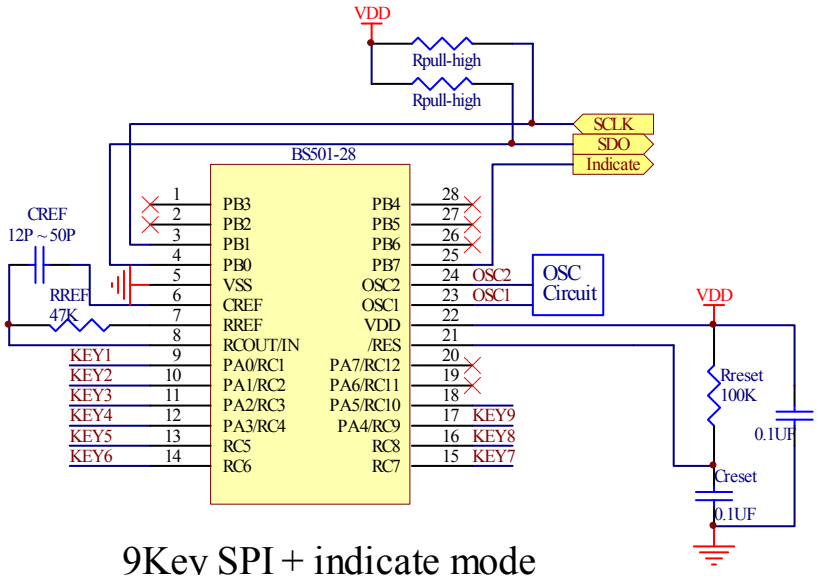
OSC CIRCUIT

Recommand power circuit

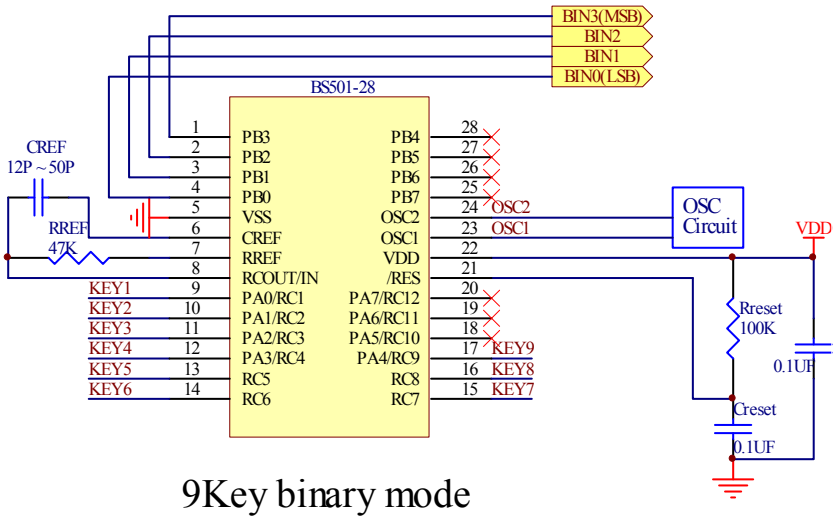




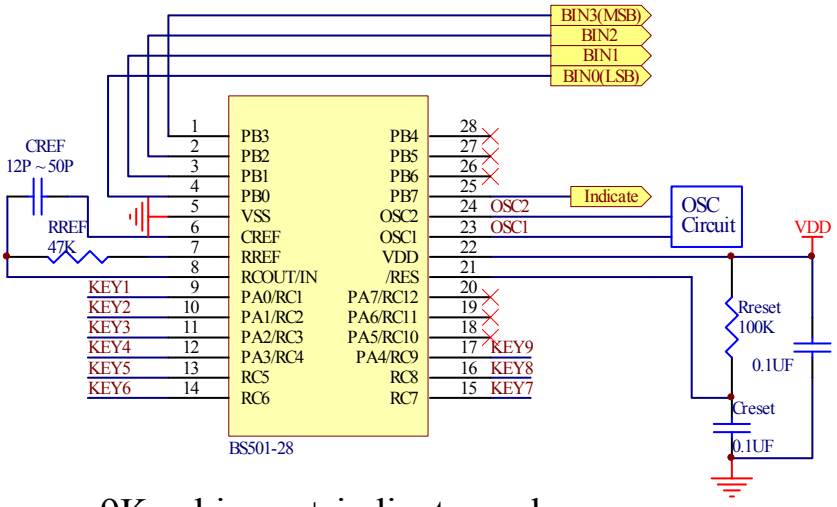
9Key SPI mode



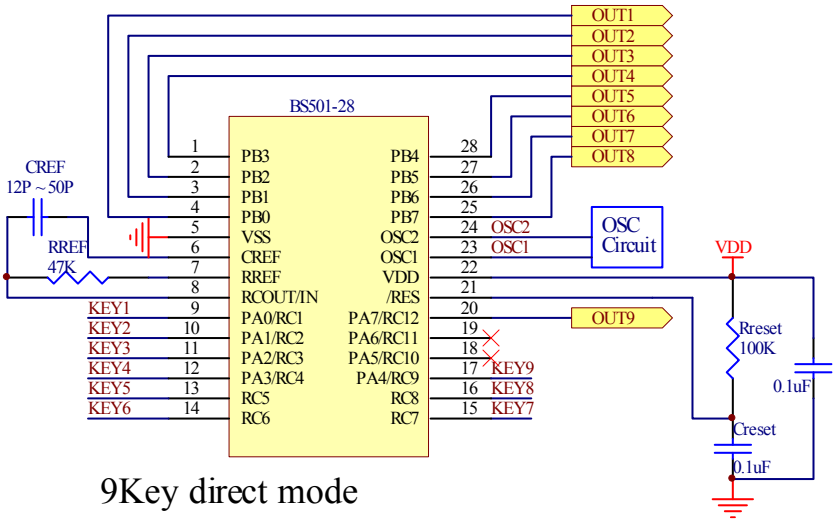
9Kev SPI + indicate mode



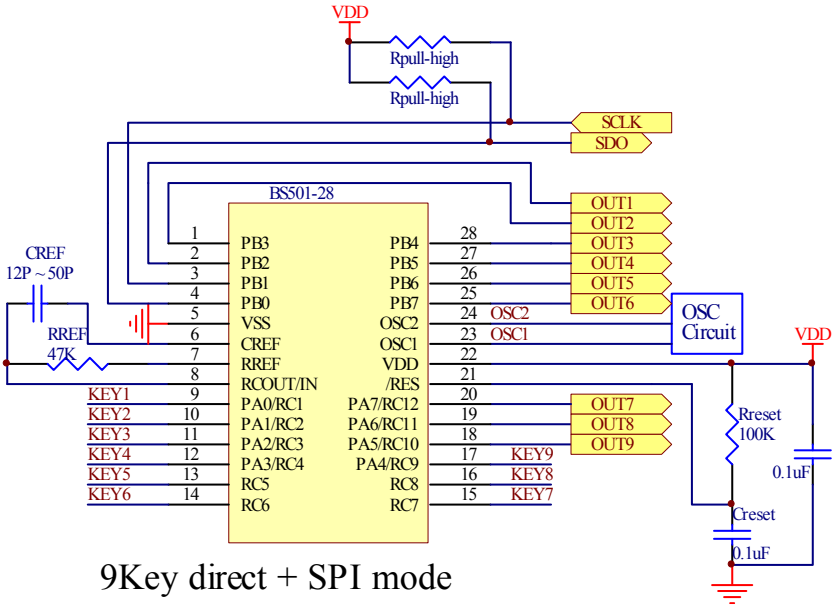
9Key binary mode



9Key binary + indicate mode

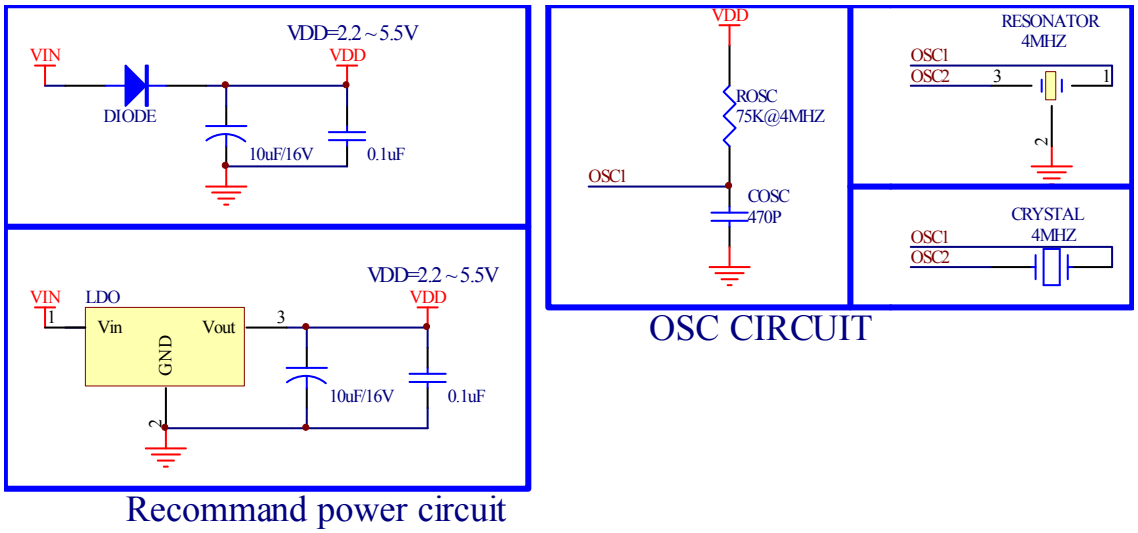


9Key direct mode



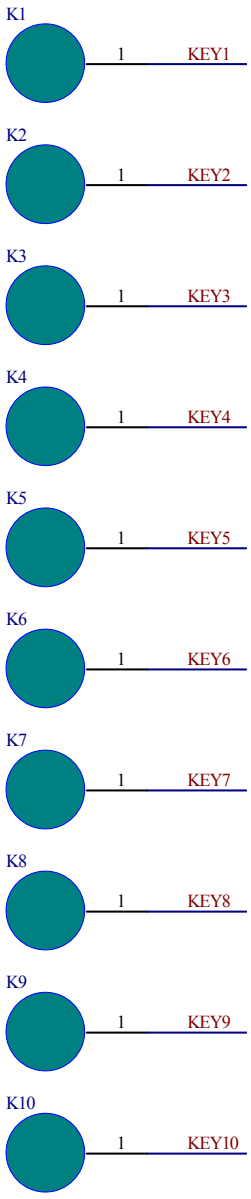
9Key direct + SPI mode

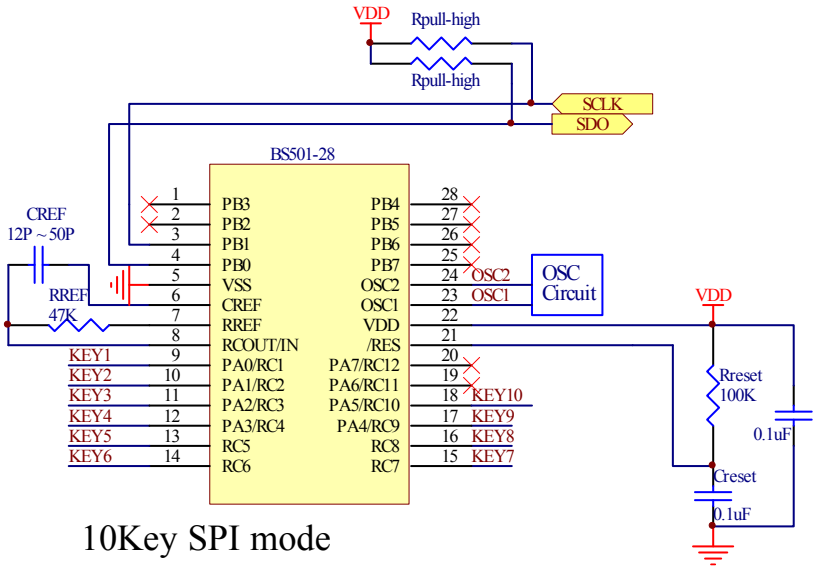
10-Key



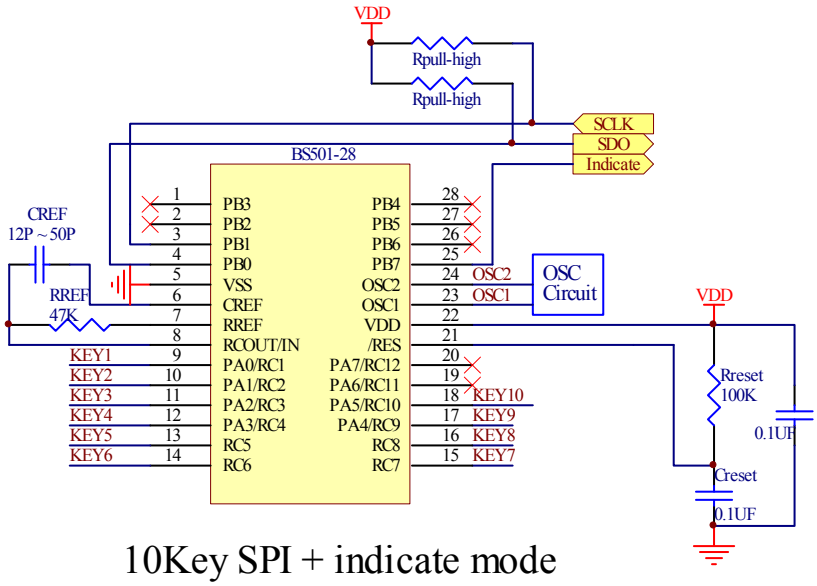
OSC CIRCUIT

Recommand power circuit

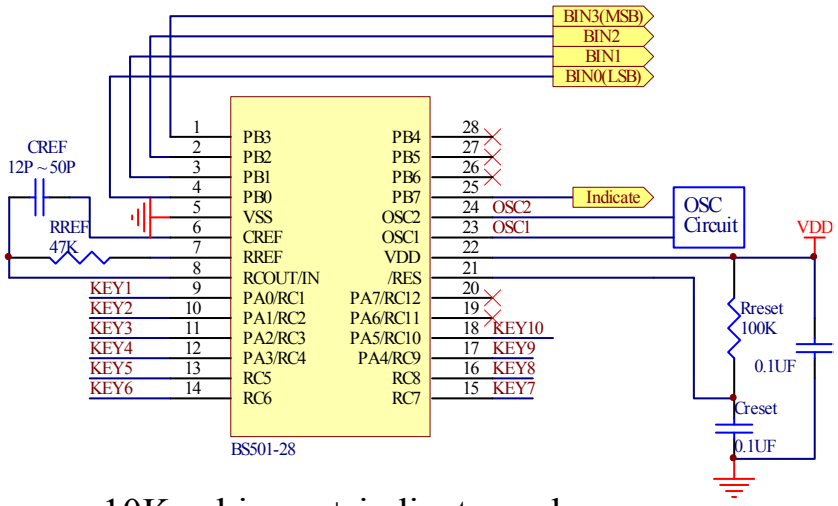




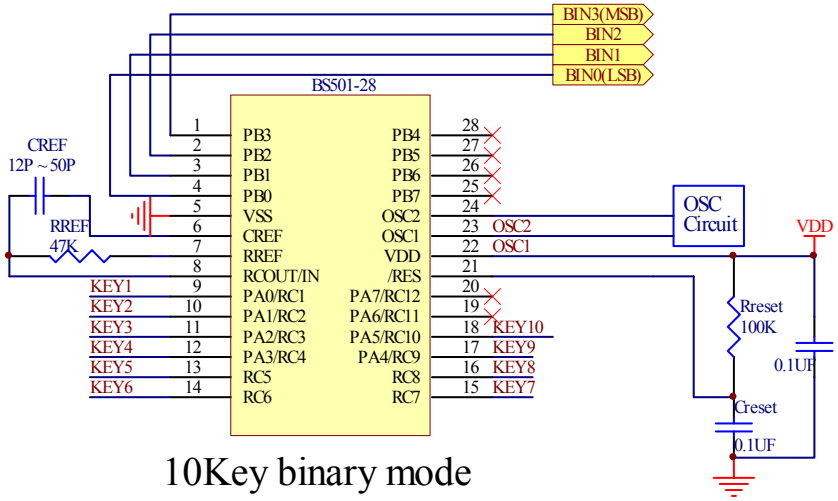
10Key SPI mode



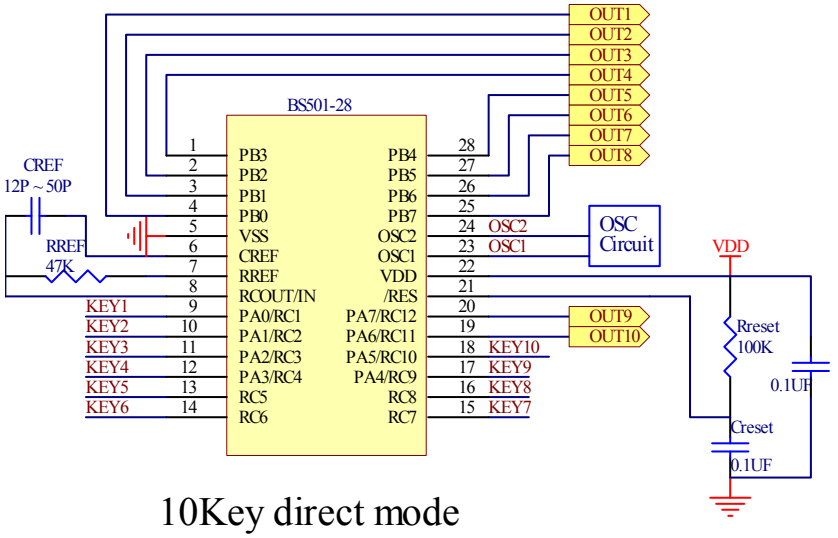
10Key SPI + indicate mode



10Key binary + indicate mode

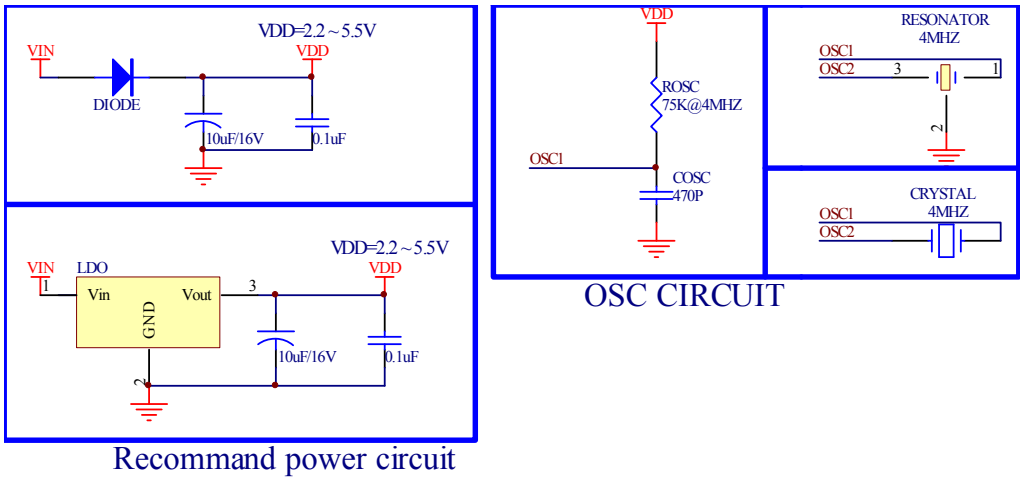


10Key binary mode



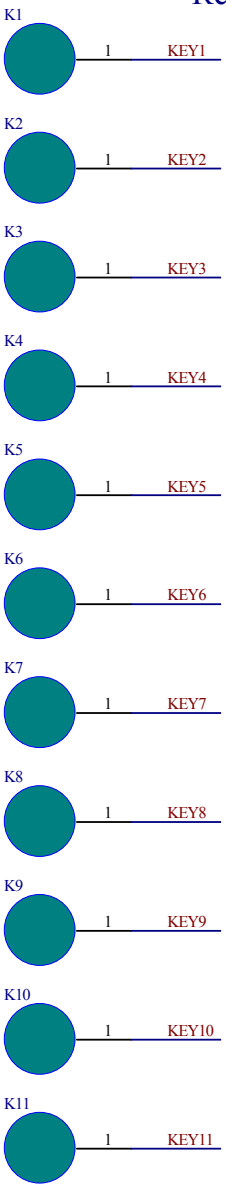
10Key direct mode

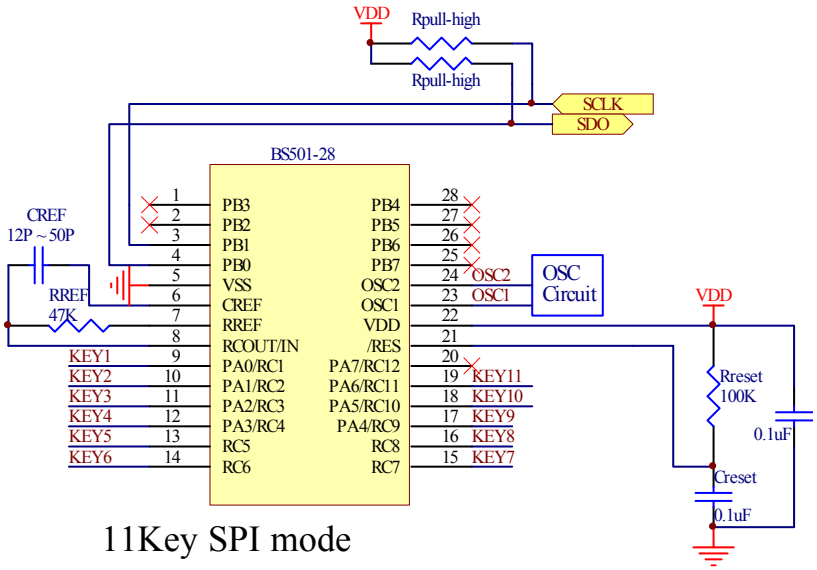
11-Key



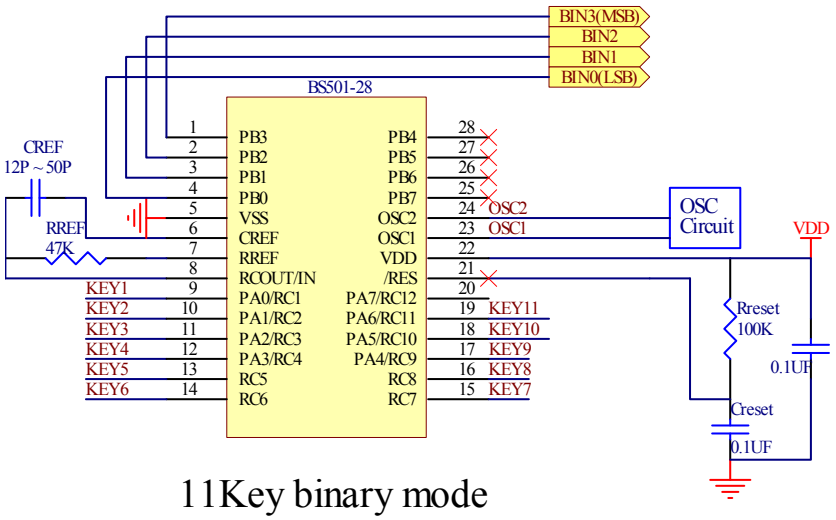
OSC CIRCUIT

Recommand power circuit

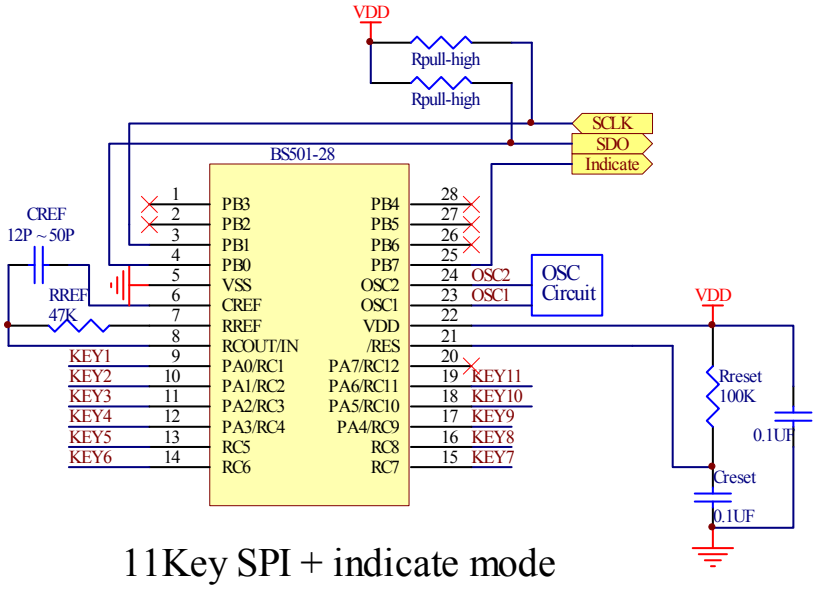




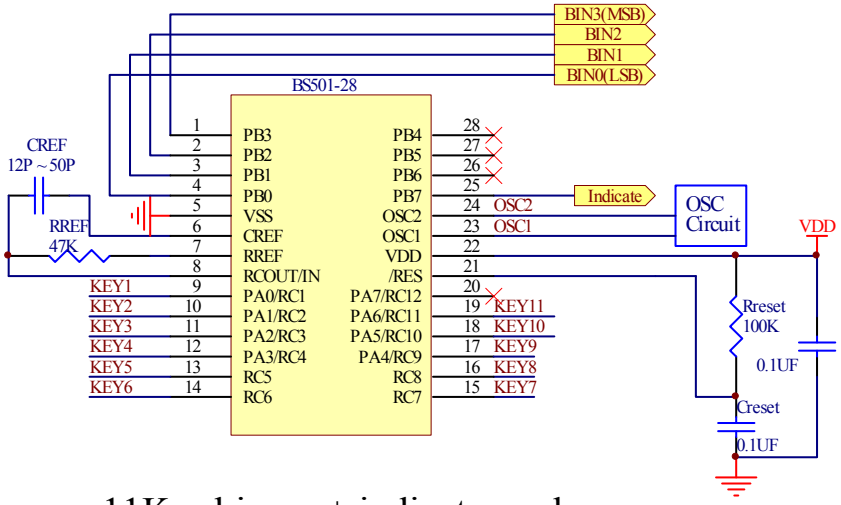
11Key SPI mode



11Key binary mode

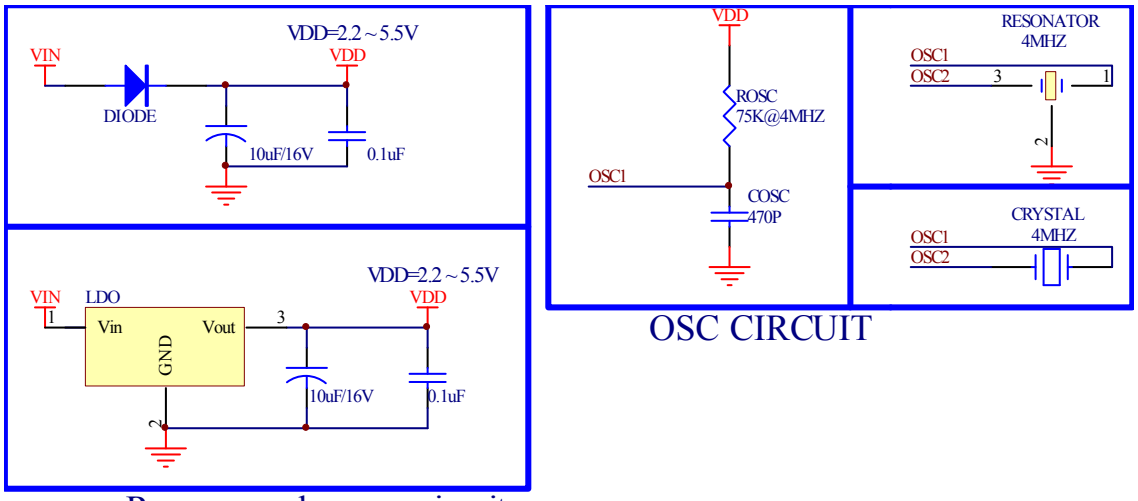


11Key SPI + indicate mode



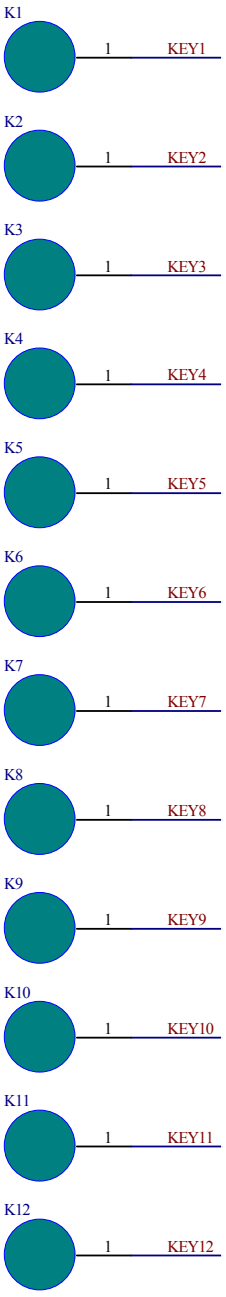
11Key binary + indicate mode

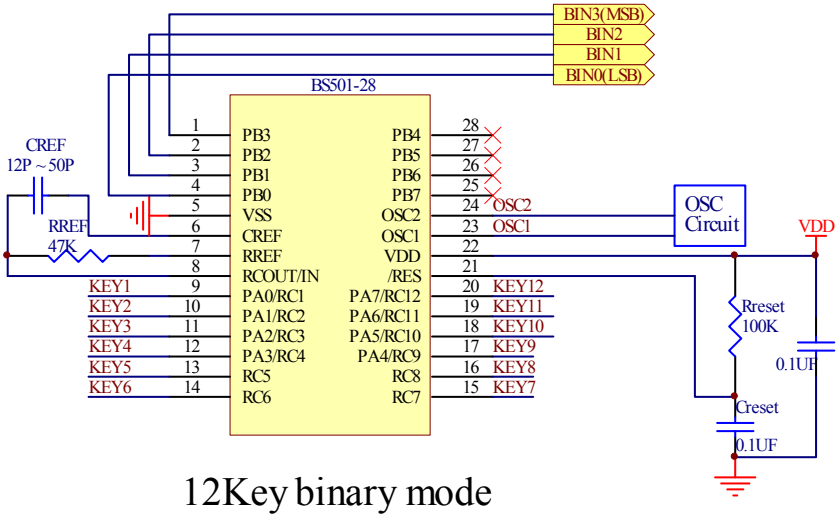
12-Key



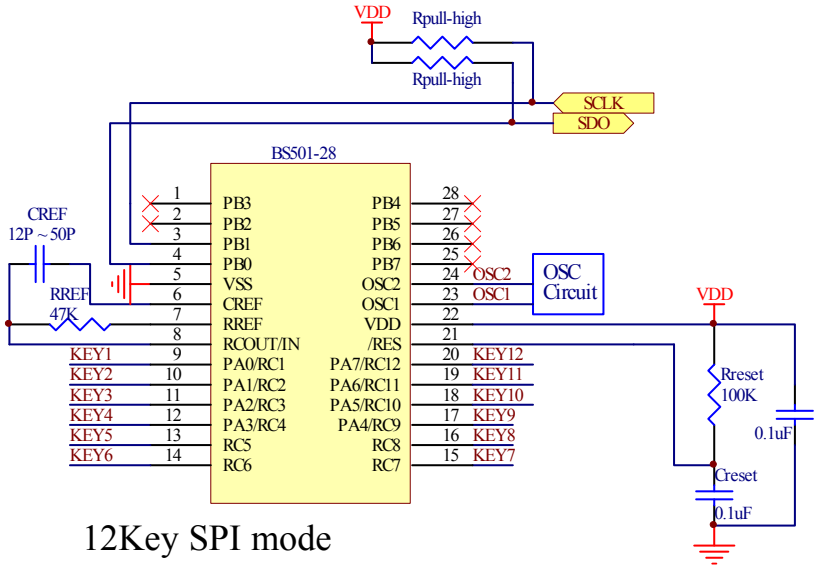
OSC CIRCUIT

Recommand power circuit

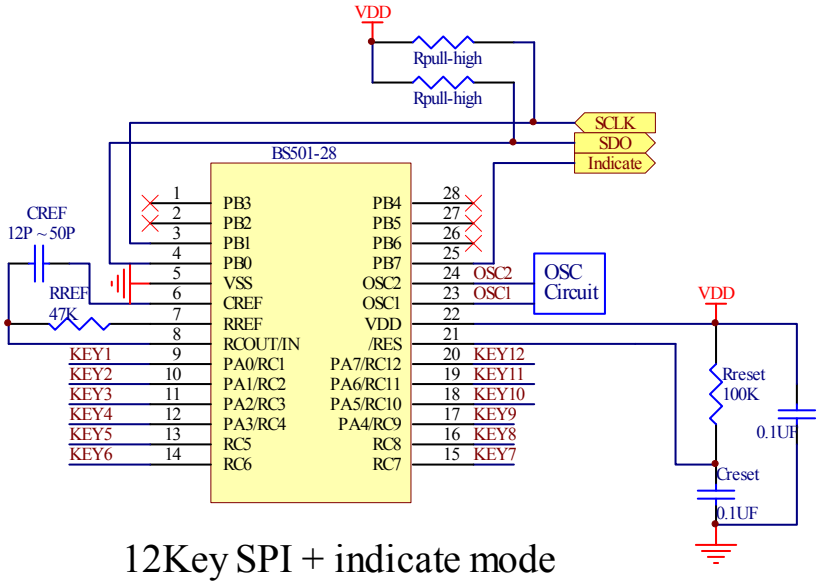




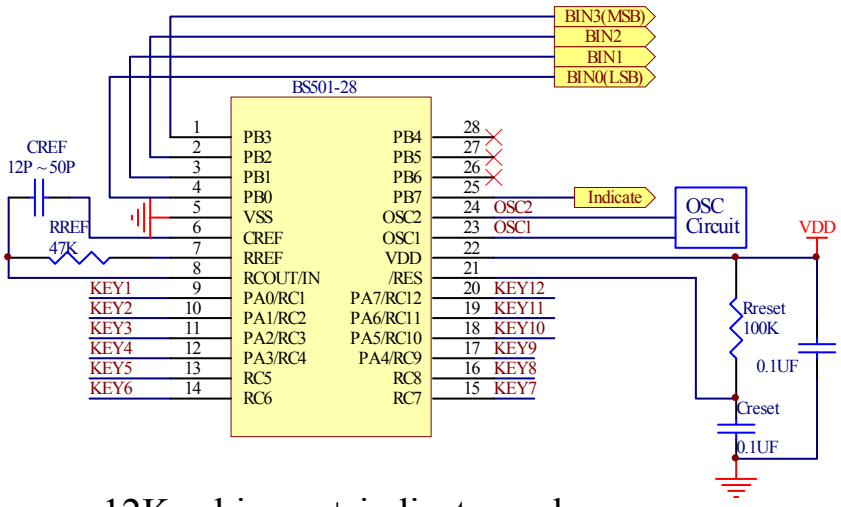
12Key binary mode



12Key SPI mode



12Key SPI + indicate mode



12Key binary + indicate mode

9.1 Choose Capacitor

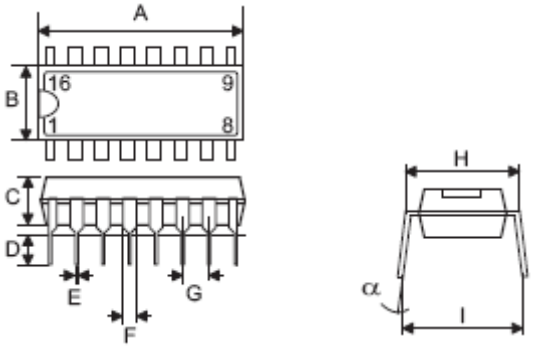
In the application circuit, CS should be less sensitive to temperature, the more stable capacitor the better, such as X7R, NPO, PPS, X7R and NPO. For higher sensitive applications, usually use PPS film capacitors.

9.2 PCB Layout Guide

The route of the sensor pad should stay away from power lines. High-frequency signals and other interference signals should be away from the ground. Let Cs and Rs close with the chip as much as possible.

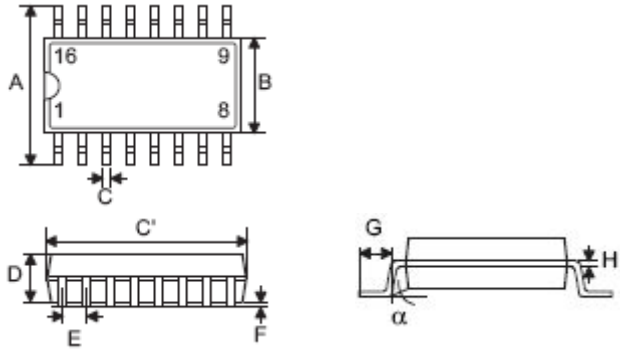
10. Package Information

16-pin DIP (300mil) Outline Dimensions



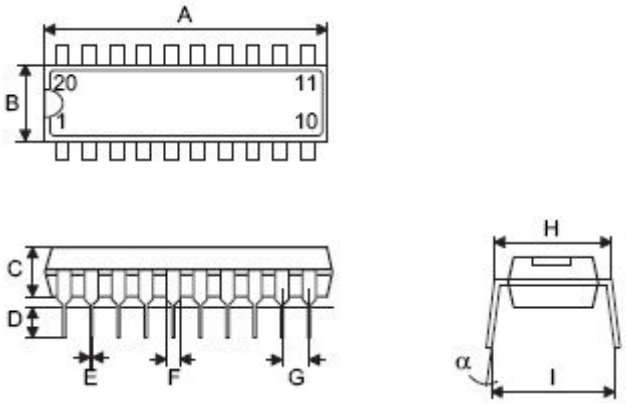
Symbol	Dimensions in mil		
	Min.	Nom.	Max.
A	745	—	775
B	240	—	260
C	125	—	135
D	125	—	145
E	16	—	20
F	50	—	70
G	—	100	—
H	295	—	315
I	335	—	375
α	0°	—	15°

16-pin NSOP (150mil) Outline Dimensions



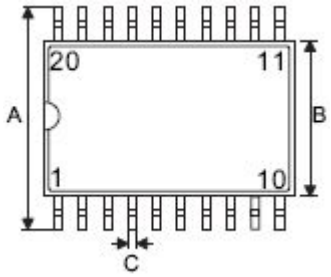
Symbol	Dimensions in mil		
	Min.	Nom.	Max.
A	228	—	244
B	149	—	157
C	14	—	20
C’	386	—	394
D	53	—	69
E	—	50	—
F	4	—	10
G	22	—	28
H	4	—	10
α	0°	—	10°

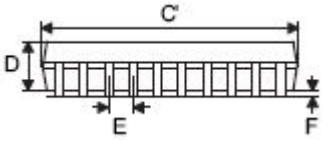
20-pin DIP (300mil) Outline Dimensions

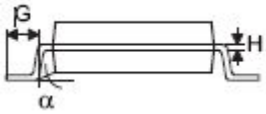


Symbol	Dimensions in mil		
	Min.	Nom.	Max.
A	1020	—	1045
B	240	—	260
C	125	—	135
D	125	—	145
E	16	—	20
F	50	—	70
G	—	100	—
H	295	—	315
I	335	—	375
α	0°	—	15°

20-pin SSOP (150mil) Outline Dimensions

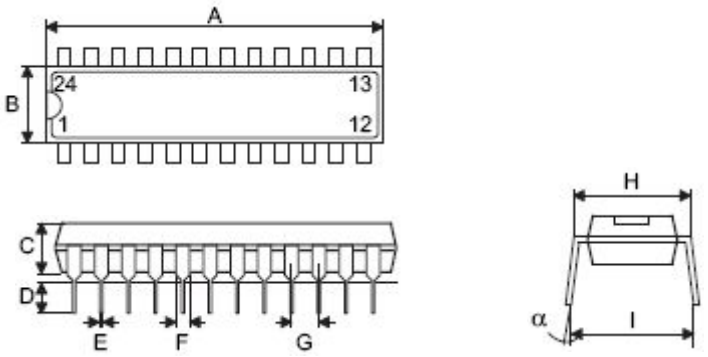






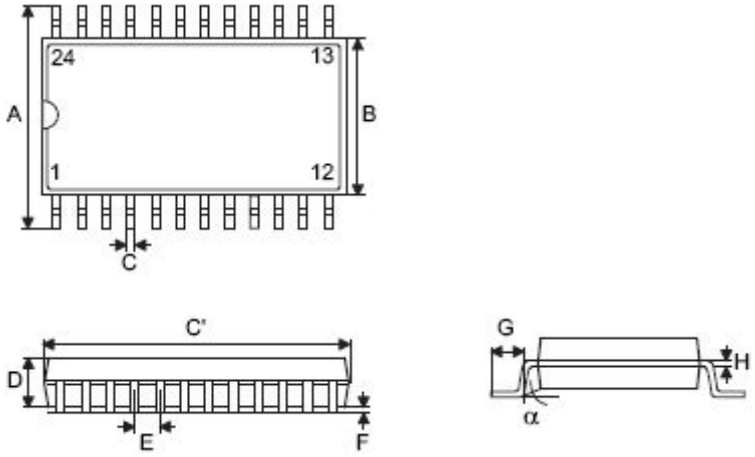
Symbol	Dimensions in mil		
	Min.	Nom.	Max.
A	228	—	244
B	150	—	158
C	8	—	12
C’	335	—	347
D	49	—	65
E	—	25	—
F	4	—	10
G	15	—	50
H	7	—	10
α	0°	—	8°

24-pin SKDIP (300mil) Outline Dimensions



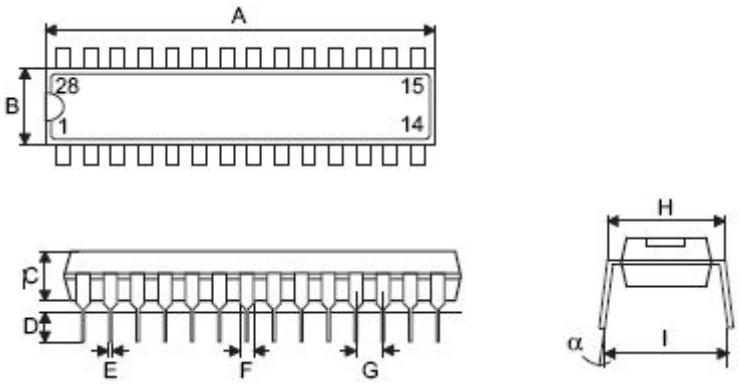
Symbol	Dimensions in mil		
	Min.	Nom.	Max.
A	1235	—	1265
B	255	—	265
C	125	—	135
D	125	—	145
E	16	—	20
F	50	—	70
G	—	100	—
H	295	—	315
I	345	—	360
α	0°	—	15°

24-pin SSOP (150mil) Outline Dimensions



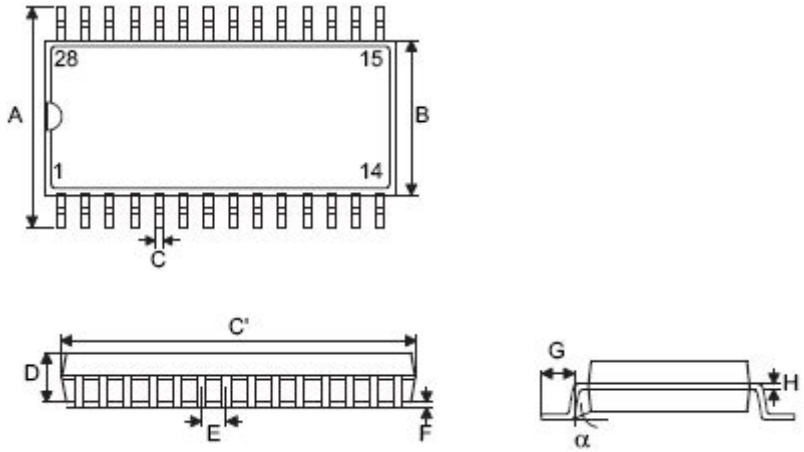
Symbol	Dimensions in mil		
	Min.	Nom.	Max.
A	228	—	244
B	150	—	157
C	8	—	12
C’	335	—	346
D	54	—	60
E	—	25	—
F	4	—	10
G	22	—	28
H	7	—	10
α	0°	—	8°

28-pin SKDIP (300mil) Outline Dimensions



Symbol	Dimensions in mil		
	Min.	Nom.	Max.
A	1375	—	1395
B	278	—	298
C	125	—	135
D	125	—	145
E	16	—	20
F	50	—	70
G	—	100	—
H	295	—	315
I	330	—	375
α	0°	—	15°

28-pin SSOP (150mil) Outline Dimensions



Symbol	Dimensions in mil		
	Min.	Nom.	Max.
A	228	—	244
B	150	—	157
C	8	—	12
C’	386	—	394
D	54	—	60
E	—	25	—
F	4	—	10
G	22	—	28
H	7	—	10
α	0°	—	8°