SK5212 FlexMatrix™ Keyboard Controller

User-Programmable Low Speed USB Multimedia Keyboard Encoder with 8x20 Scan, PWM Backlight, Key Lock, Upgradable Bootloader

FEATURES

- Low speed USB 2.0 HID interface
- Field-upgradable bootloader
- 8 x 20 keyboard scan
- 1 PWM backlight brightness control
- 4 Keyboard LEDs
- Fn, FnLock and NumLock Impacted key support
- KeyLock for undetachable washable design
- Support macro keys like “Ctrl+Alt+Del”
- 350+ predefined keys and unlimited custom key definitions
- Advanced ghost key detection algorithm to maximize the key combination without additional diodes
- Built-in oscillator and digital circuit. No external crystal is needed
- QFN 46 pin package: 6.5x4.5mm 0.9 Max (LxWxH) or
- LQFP 48 pin package: 7x7mm 1.6 Max (LxWxH)
- Power consumption: 5.8mA (operation), 300uA (suspend)
- Operation voltage range: 5V mode (4.0 to 5.5V), 3.3V mode (3.0 to 3.6V)
- Industrial temperature range: -40°C to +85°C
- Custom versions available for high volume application

APPLICATION

- Desktop PCs
- Industrial Keyboard
- Point-of-sale (POS) terminals
- Instruments

DESCRIPTION

The SK5212 is a low speed USB keyboard encoder ASIC with 1 PWM backlight control and 4 LEDs. It supports multimedia, custom defined function and macro keys. It’s the best choice for customized keyboard design for desktop PCs / industrial keyboard / Point-of-sale (POS) terminals / Instrument. The low speed USB interface also makes it fit with some special industrial long cable extender scenario.

The SK5212’s bootloader enables keyboard manufacturers to add any new features after the product release.

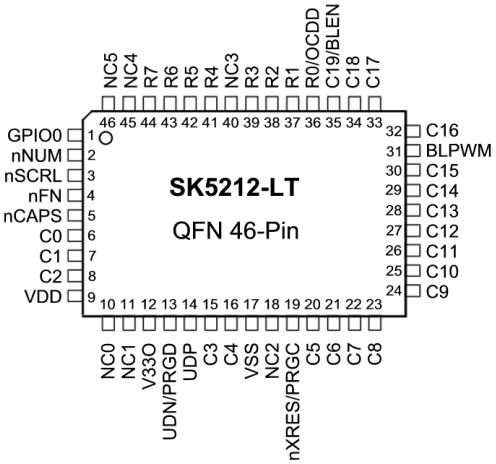
The SK5212 scans and encodes an 8-row by 20-column matrix. The key press events are translated to keyboard report. The encoder gets matrix information from on-chip matrix tables.

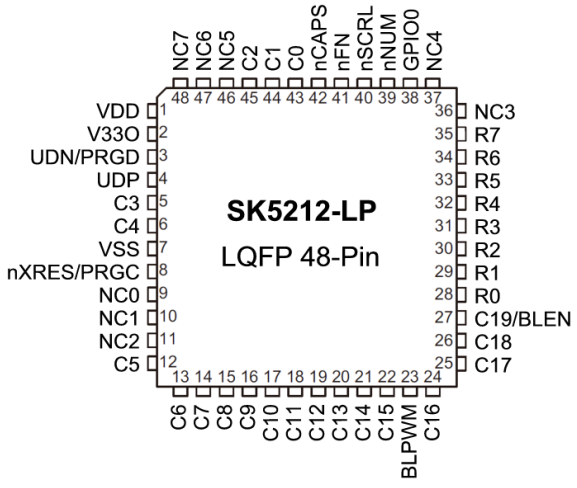
The SK5212 provides one key-controlled and command-controlled PWM for backlight LED PWM brightness control. An IO pin BLEN can be used to turn off the backlight circuit totally. When BLEN is used, the keyboard scan will be 8-row by 19-columns.

ORDEING INFORMATION

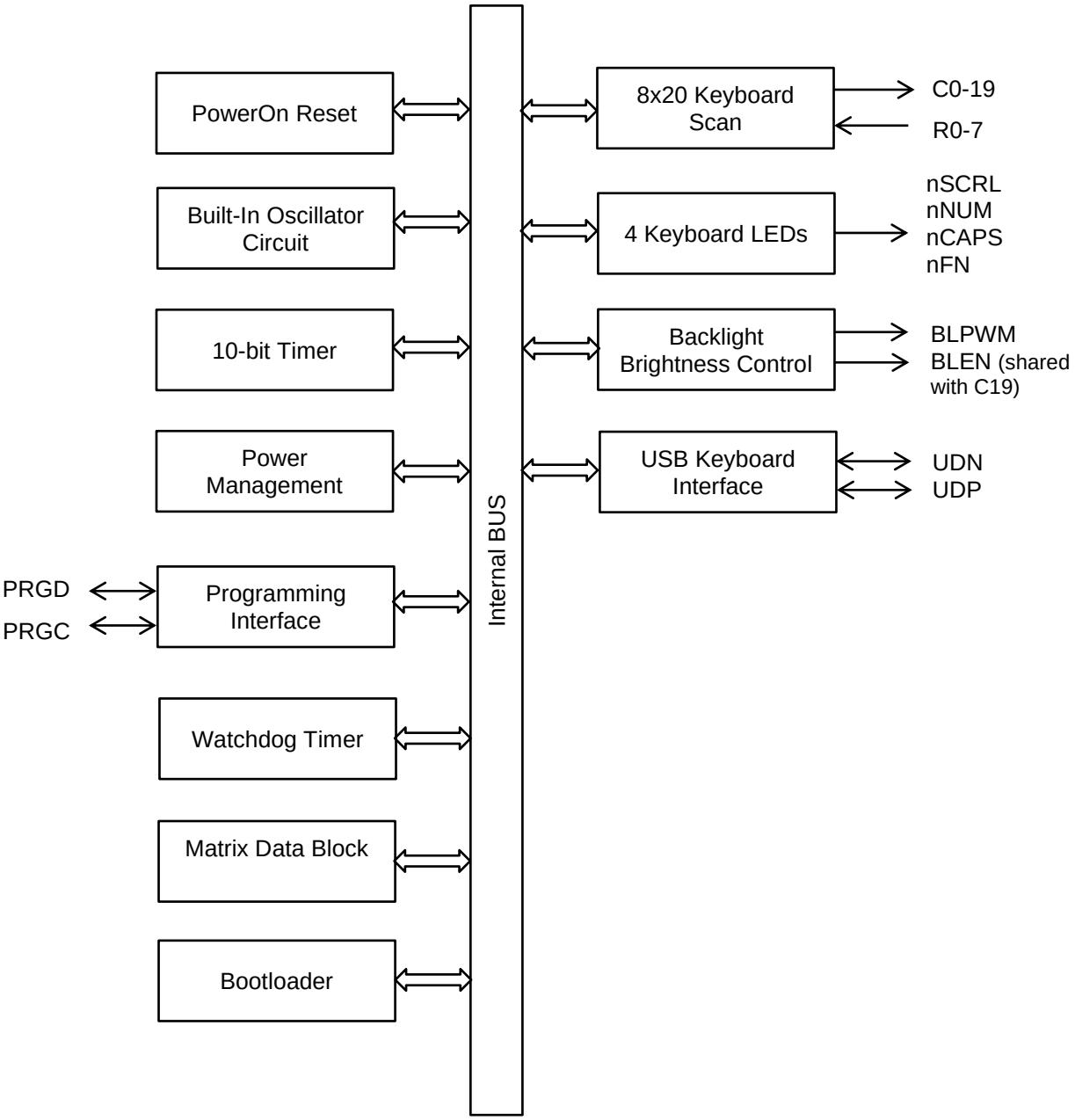
SK5212-LT QFN 46-pin, 0.4mm pitch, (6.5x4.5mm 0.9 MAX), Pb-Free, RoHS Complaint
SK5212-LP LQFP 48-pin, 0.5mm pitch, (7x7mm 1.6 MAX), Pb-Free, RoHS Complaint

PIN ASSIGNMENTS





FUNCTION BLOCK DIAGRAM



PIN DEFINITION

SK5212-LT Pin Definition

Pin No	Type	Name	Description
1	IO	GPIO0	GPIO pin 0
2	O	nNUM	Num lock LED
3	O	nSCRL	Scroll lock LED
4	O	nFN	Fn lock LED
5	O	nCAPS	Caps lock LED
6 – 8	IO	C0 – C2	Column lines 0 to 2 for scan matrix
9	P	VDD	Power supply
10	NA	NC0	NC pin
11	NA	NC1	NC pin
12	P	V33O	Reserved
13	IO	UDN/PRGD	USB D- line / programming data line
14	IO	UDP	USB D+ line
15 – 16	IO	C3 – C4	Column lines 3, 4 for scan matrix
17	P	VSS	Ground connection
18	NA	NC2	NC pin
19	I	nXRES / PRGC	External reset: low active / programming clock line
20 – 30	IO	C5 – C15	Column lines 5 to 15 for scan matrix
31	O	BLPWM	Backlight control PWM
32 – 34	IO	C16 – C18	Column lines 16 to 18 for scan matrix
35	IO	C19 / BLEN	Column line 19 for scan matrix / Backlight control LDO enable
36 – 39	I	R0 – R3	Row lines 0 to 3 for scan matrix with internal pull-up resistor
40	NA	NC3	NC pin
41 – 44	I	R4 – R7	Row lines 4 to 7 for scan matrix with internal pull-up resistor
45 – 46	NA	NC4 - NC5	NC pins

LEGEND I = Input, O = Output, IO = Input/Output, P = Power

SK5212-LP Pin Definition

Pin No	Type	Name	Description
1	P	VDD	Power supply
2	P	V33O	USB 3.3 regulator output
3	IO	UDN/PRGD	USB D- line / programming data line
4	IO	UDP	USB D+ line
5 – 6	IO	C3 – C4	Column lines 3 to 4 for scan matrix
7	P	VSS	Ground connection
8	I	nXRES/PRGC	External reset: low active / programming clock line
9-11	NA	NC0-NC2	NC pins
12 – 22	IO	C5 – C15	Column lines 5 to 15 for scan matrix
23	O	BLPWM	Backlight control PWM
24 – 26	IO	C16 – C18	Column lines 16 to 18 for scan matrix
27	IO	C19 / BLEN	Column line 19 for scan matrix / Backlight control LDO enable
28 – 35	I	R0 – R7	Row lines 0 to 7 for scan matrix with internal pull-up resistor
36 – 37	NA	NC3-NC4	NC pins
38	IO	GPIO0	GPIO pin 0
39	O	nNUM	Num lock LED
40	O	nSCRL	Scroll lock LED
41	O	nFN	Fn lock LED
42	O	nCAPS	Caps lock LED
43 – 45	IO	C0 – C2	Column lines 0 to 2 for scan matrix
46 – 48	NA	NC5-NC7	NC pins

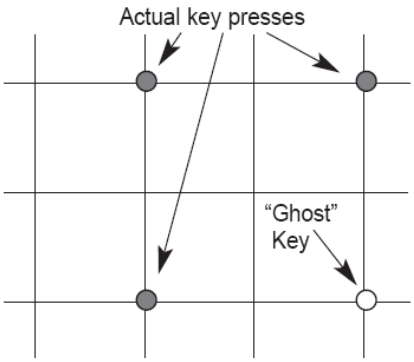
LEGEND I = Input, O = Output, IO = Input/Output, P = Power, NA = Not used

FUNCTION BLOCK DESCRIPTION

The SK5212 consists functionally of several major sections (see the block diagram on the previous page). These include power on reset, oscillator circuit, 10-bit timer, power management, programming interface, watchdog timer, keyboard scan, keyboard LEDs, backlight brightness control, matrix data block, bootloader, USB keyboard interface. All sections communicate with each other and operate concurrently.

Keyboard Interface

The SK5212 scans a keyboard organized as an 8 row by 20 column matrix for a maximum of 160 keys. Smaller size matrixes can be accommodated by leaving unused pins open. The IC provides internal pull-ups for the row input pins. When active, the encoder selects each row lines (R0-R7); for each row selected, it reads the column lines (C0-C19). A key closure is detected as a zero in the corresponding position of the matrix.



Each key found pressed is de-bounced for a period of 24ms. Once the key is verified, the corresponding key code(s) are loaded into the transmit buffer.

In any scanned contact switch matrix, whenever three keys defining a rectangle on the switch matrix are pressed at the same time, a fourth key positioned on the fourth corner of the rectangle is sensed as being pressed. This is known as the “ghost” or “phantom” key problem.

Although the problem cannot be totally eliminated without using external hardware, there are methods to neutralize its negative effects for most practical applications. Keys that are intended to be used in combinations should be placed in the same row or column of the matrix, whenever possible. Shift keys (Shift, Alt, Ctrl, Window, Fn) should not reside in the same row (or column) as any other keys. The SK5212 has built-in mechanisms to detect and reject “ghost” keys.

C19 and BLEN (backlight LDO enable) are shared. C19 is selected at default. Therefore, the key matrix scan is 8x20 at default.

USB Interface

The SK5212 follows USB.org’s *Universal Serial Bus Specification 2.0* and *Device Class Definition for HID 1.11* as a low speed HID composite device. The SK5212 has two function endpoints for bootable keyboard, and consumer and system keys.

Power Management

When the SK5212 works in USB mode, it supports selective suspend and remote wake up to get maximum power saving.

Backlight Brightness Control

The 10-bit PWM output controls the brightness of backlight circuit. The PWM clock is sourced from 6MHz clock, and the parameters such as frequency, pulse width, auto-off time are programmable.

An extra signal BLEN is automatically driven low to turn off the whole circuitry when PWM duty is 0% to minimize power consumption; while BLEN is automatically driven high when PWM duty is not 0%.

Power On Reset Circuit

The SK5212 has built-in power on reset circuit with simple external RC components.

Oscillator Circuit

The SK5212 has built-in oscillator circuit and no external crystal or resonator is needed. It's automatically calibrated for USB communication.

10-bit Timer

The 10-bit timer provides the timing control for USB communication, keyboard scan and sleep timer wakeup.

Programming Interface

The programming interface is reserved for Sprintek to programming new firmware. **PRGC and PRGD pins are recommended to be connected to a 6-pin header in the schematic.** The header needn't be populated in the final assembly. Three test points are preferred if 6-pin header is not allowed due to space reason.

Watchdog Timer

The SK5212 utilizes a 500ms watchdog timer to ensure robust firmware design.

Matrix Data Block

The SK5212 provides an on-chip data block to store keyboard matrix, scan code mapping table and etc. The matrix data block can be changed in the field. Custom matrix data block can be done via Sprintek custom software or customization service.

BootLoader

The SK5212 deploys a bootloader to update the newer version firmware via USB bus.

KEYBOARD MATRIX DESIGN

Keyboard Matrix

The SK5212 supports 8X20 keyboard matrix table. It supports Fn, FnLock, NumLock impacted key definitions, macro key definition and function key definition. Customers can map any key to any key matrix location. 350+ predefined keys are provided, and user-customized keys are supported.

Design Keyboard Matrix

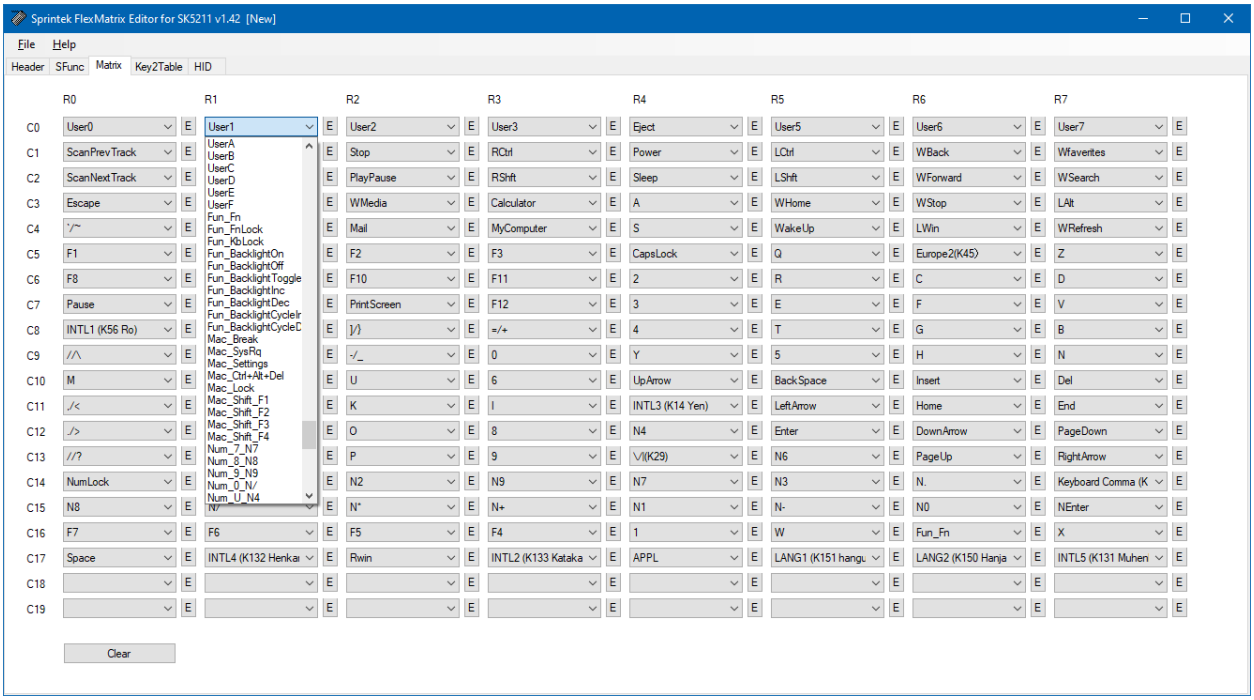
Please refer to Microsoft Windows Platform Design Notes “Keyboard Scan Code Specification” to get more information.

Create Keyboard Matrix

The FlexMatrix Editor program enables the user to create keyboard matrix including macro key definition and function key definition, then save them in binary format.

The Editor program allows the user to assign a logical key to any position in the 8 x 20 matrix. Once a matrix has been created, it is saved in a binary file. The file can be downloaded to the SK5212 flash data block via FlexMatrix Programmer software.

The Editor program can be downloaded from http://sprintek.com/support/Downloads.aspx. Here is the screen snapshot of FlexMatrix Editor software.

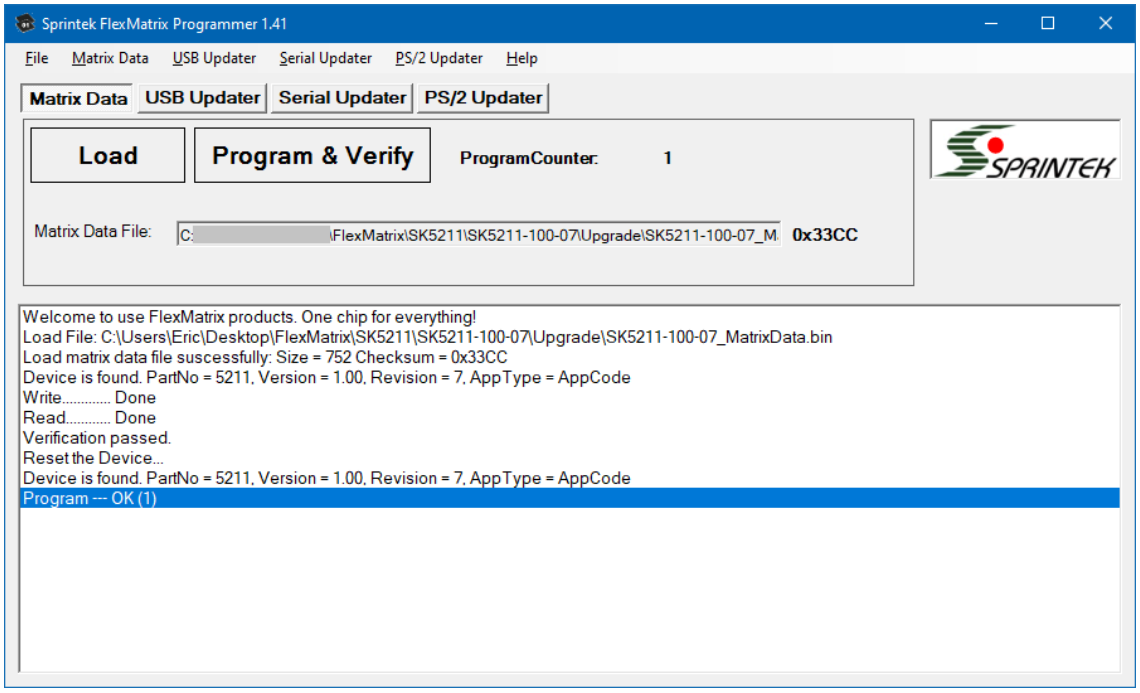


Screen snapshot of FlexMatrix™ Editor

Download Keyboard Matrix

The FlexMatrix Programmer program enables the user to download matrix binary file to the SK5212, upload matrix data from the SK5212’s flash data block to a binary file.

The Programmer program can be downloaded from http://sprintek.com/support/Downloads.aspx. Here is the screen snapshot of FlexMatrix Programmer software.

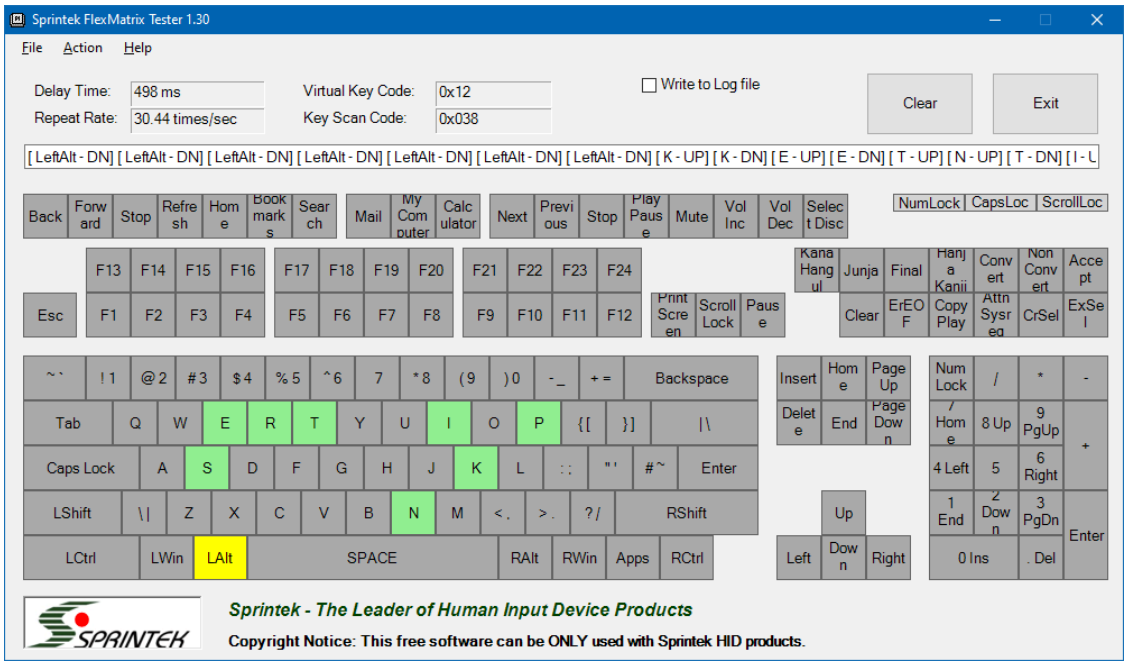


Screen snapshot of FlexMatrix™ Programmer – Matrix Data Upgrade

Test Keyboard Matrix

Sprintek offers a keyboard test tool to verify your keyboard design.

The Tester program can be downloaded from http://sprintek.com/support/Downloads.aspx. Here is the screen snapshot of FlexMatrix Programmer software.

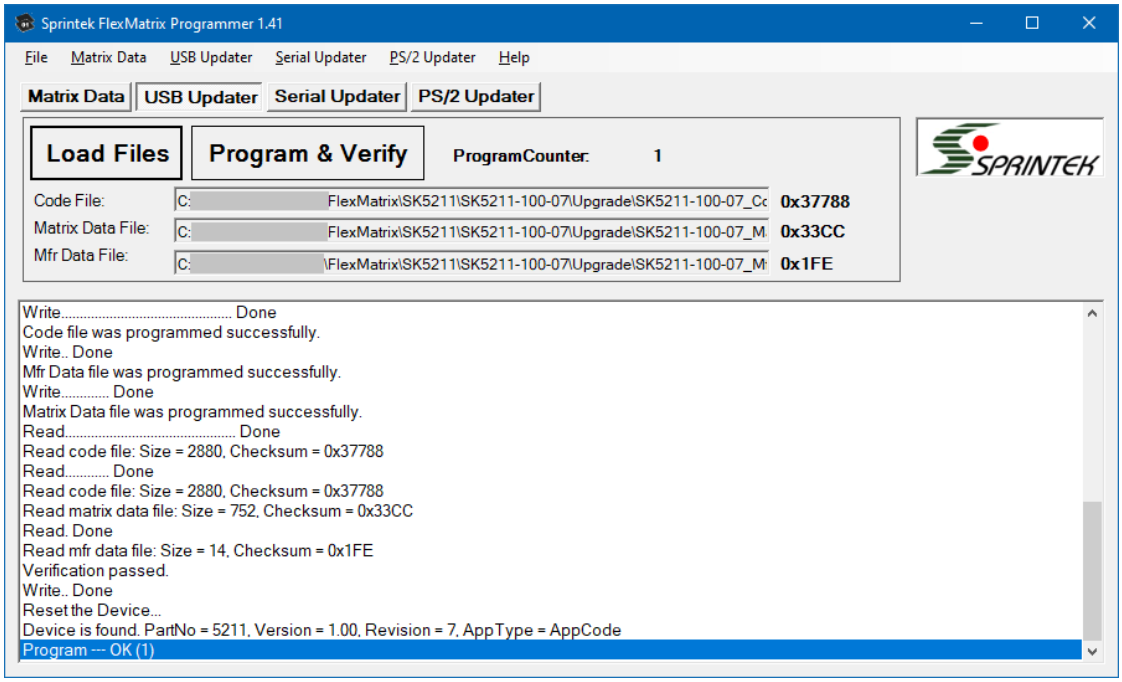


Screen snapshot of FlexMatrix™ Tester

Code Upgrade

The SK5212's bootloader to support field code upgrade. The feature enables users to enjoy new features of your design. 3 files can be upgraded via the FlexMatrix Programmer program: code file, matrix data, manufacturer data.

The Tester program can be downloaded from http://sprintek.com/support/Downloads.aspx. Here is the screen snapshot of FlexMatrix Programmer software.



Screen snapshot of FlexMatrix™ Programmer – Code Upgrade

DEFAULT KEYBOARD MATRIX

The following table shows the default keyboard matrix on chip. Please fill out this table and send it to Sprintek for customized design.

	R0	R1	R2	R3	R4	R5	R6	R7
C0	User2	User3	User4	User5	Eject	F11_ KbLock	Backlit Toggle	Space_Backlit Toggle
C1	PrevTrack	VolUp	Stop	Ctrl-R	Power	Ctrl-L	WBack	WFavorites
C2	NextTrack	VolDn	Play/Pause	Shift-R	Sleep	Shift-L	WForward	WSearch
C3	Esc	Alt-R	Media	Calculator	A	WHome	WStop	Alt-L
C4	~`	Mute	Email	MyComp	S	Wake Up	Win-L	WRefresh
C5	F1	Tab	F2	F3	Caps Lock	Q	K45 UK|	Z
C6	F8	F9	F10	F11	@2	R	C	D
C7	Pause	Scroll Lock	PrtSc	F12	#3	E	F	V
C8	K56 JP-Ro	K42 UK#~	}]	+=	$4	T	G	B
C9	“’	{[	_-	)0 /	Y	%5	H	N
C10	M	J	U	^6	↑	Back Space	Insert	Delete

C11	<,	&7	K	I	K14 JP-Yen	←	Home	End
C12	>.	L	O	*8	N4	Enter	↓	PgDn
C13	?/	:; —	P	(9	K29 |	N6	PgUp	→
C14	Num Lock	N5	N2	N9	N7	N3	N.	K107 BR
C15	N8	N/	N*	N+	N1	N-	N0	NEnter
C16	F7	F6	F5	F4	!1	W	**Fn**	X
C17	Space	K132 JP-M	**Win-R**	K133 JP-R	Apps	K151 KR-R	K150 KR-L	K131 JP-L
C18	F1_Sleep	F2_Email	F3_WHome	F4_ WRefresh	F5_ WBack	F6_ WForward	F7_ WFavorites	F8_ W3Search
C19	F9_ PrevTrack	F10_Stop	F11_ Play/Pause	F12_ NextTrack	Escape_ FnLock	F1_Mute	F2_ VolDn	F3_ VolUp

HID USAGE TABLE

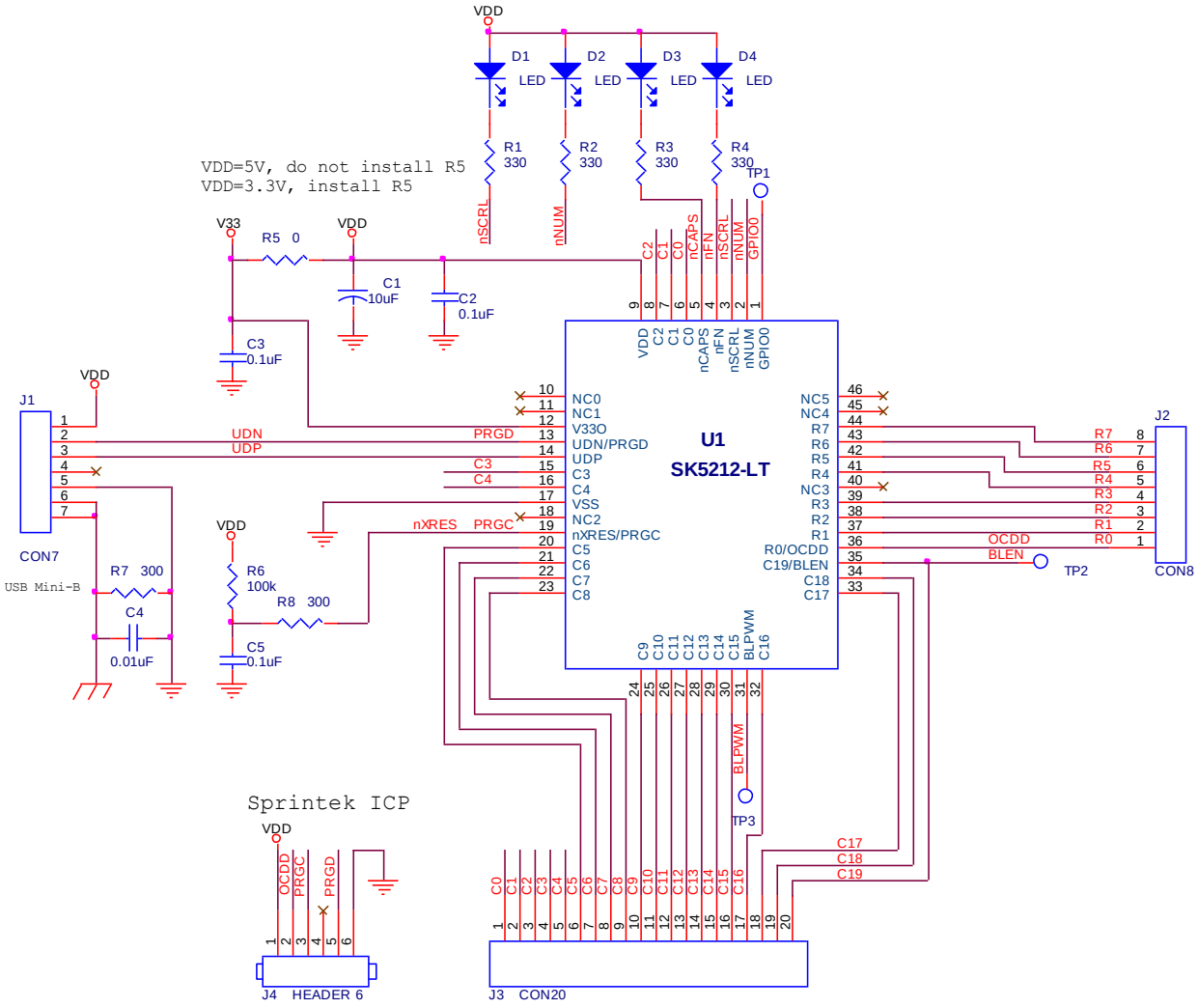
Here lists special keys' HID usage code. All other keys are normal keys listed in usage page 7 in document "HID Usage Tables 1.2" from https://usb.org/.

Key	Usage Page	Usage
Power	01	81
Sleep	01	82
Wake Up	01	83
NextTrack	0C	B5
PrevTrack	0C	B6
Stop	0C	B7
Eject	0C	B8
Play/Pause	0C	CD
Mute	0C	E2
VolUp	0C	E9
VolDn	0C	EA
Media	0C	183
Email	0C	18A
Calculator	0C	192
My Computer	0C	194
WSearch	0C	221
WHome	0C	223
WBack	0C	224
WForward	0C	225
WStop	0C	226
WRefresh	0C	227
WFavorites	0C	22A
K14	07	89
K29	07	31
K42	07	32
K45	07	64
K56	07	87
K107	07	85

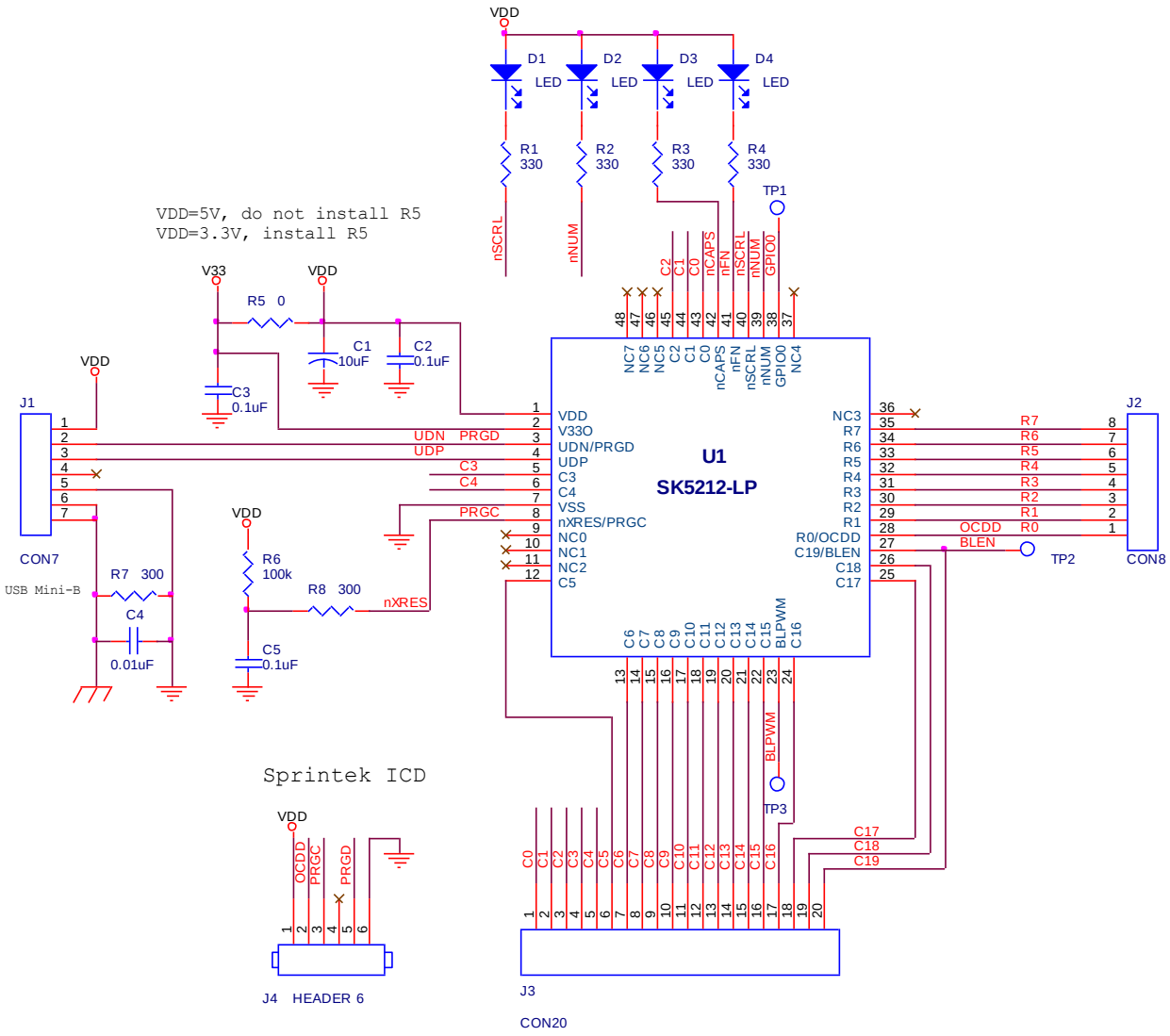
Key	Usage Page	Usage
K131	07	8B
K132	07	8A
K133	07	88
K150	07	91
K151	07	90
User0	FF00	EF
User1	FF00	F0
User2	FF00	F1
User3	FF00	F2
User4	FF00	F3
User5	FF00	F4
User6	FF00	F5
User7	FF00	F6
User8	FF00	F7
User9	FF00	F8
UserA	FF00	F9
UserB	FF00	FA
UserC	FF00	FB
UserD	FF00	FC
UserE	FF00	FD
UserF	FF00	FE

SCHEMATIC OF REFERENCE DESIGN

SK5212-LT Schematic



SK5212-LP Schematic



ELECTRONICS SPECIFICATIOIN

Absolute Maximum Ratings

Symbol	Description	Min	Typ	Max	Units	Notes
TSTG	Storage Temperature	-50	25	+125	ºC	
VDD	Supply Voltage on Relative to VSS	-0.3	-	+6.0	V	
VIO	DC Input Voltage	VSS-0.3	-	VDD+0.3	V	
IMTO	Maximum Current into all pins in total	-100	-	+150	mA	

Operating Temperature

Symbol	Description	Min	Typ	Max	Units	Notes
TOP	Operating Temperature	-40	-	+85	ºC	

DC Electrical Characteristics

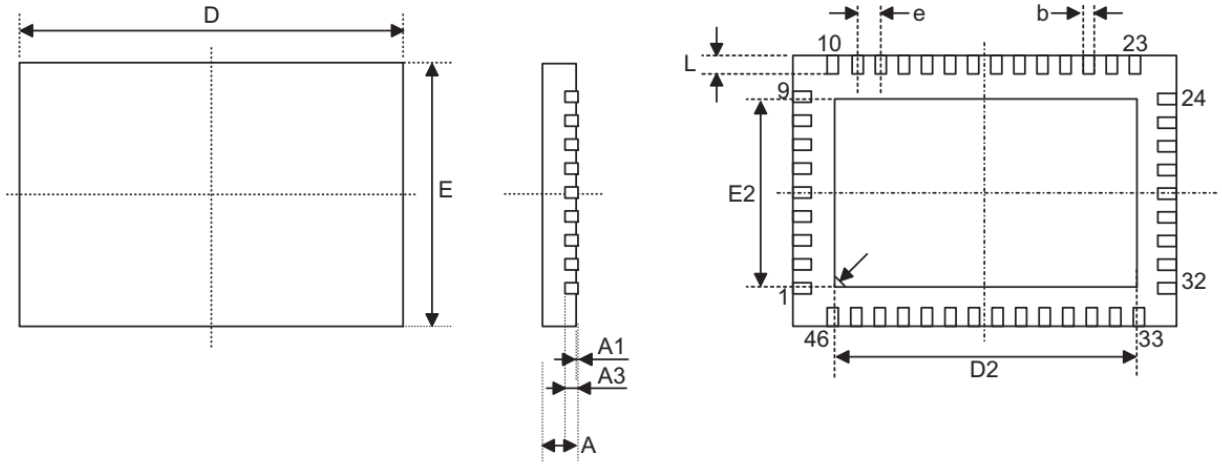
Symbol	Description	Min	Typ	Max	Units	Notes
VDD	Supply Voltage	3	-	5.5	V	5V mode: 4.0V to 5.5V 3.3V mode: 3V to 3.6V
IDD	Supply Current when IC is in operation mode		5.8		mA	
ISD	Supply Current when IC is in USB suspend mode		300	400	uA	
RPU	Pull-up Resistor	10	30	50	kΩ	5V VCC
		20	60	100	kΩ	3.3V VCC

GPIO Electrical Characteristics

Symbol	Description	Min	Typ	Max	Units	Notes
VIL	Input Low Level	0	-	0.3VDD	V	
VIH	Input High Level	0.7VDD	-	VDD	V	

PACKAGING INFORMATION

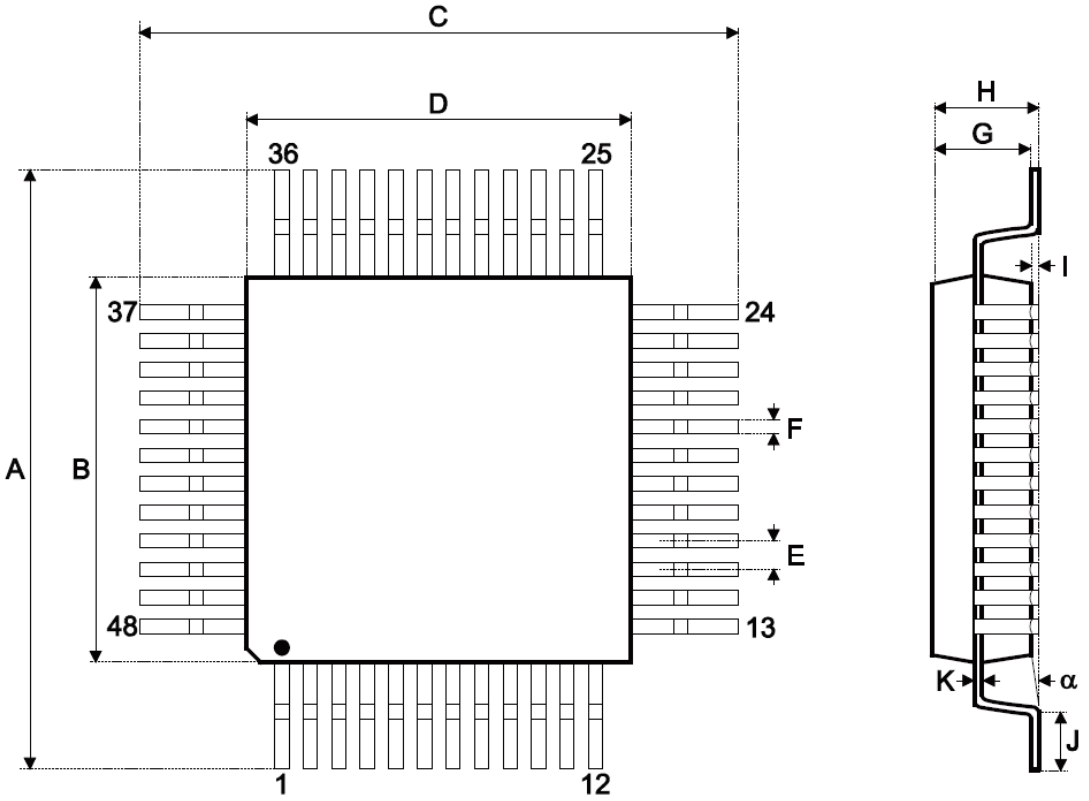
SK5212-LT Drawing



Symbol	Dimensions in mm		
	Min.	Nom.	Max.
A	0.8	0.85	0.9
A1	0	0.02	0.04
A3	-	0.2 ref	-
b	0.15	0.2	0.25
D	6.45	6.5	6.55
E	4.45	4.5	4.55
e	-	0.4 BSC.	-
D2	5	5.1	5.2
E2	3	3.1	3.2
L	0.3	0.4	0.5

SK5212-LT 46-pin (6.5x4.5mm 0.9 MAX) SAW Type QFN

SK5212-LP Drawing



Symbol	Dimensions in mm		
	Min.	Nom.	Max.
A	-	9.00BSC	-
B	-	7.00BSC	-
C	-	9.00BSC	-
D	-	7.00BSC	-
E	-	0.50BSC	-
F	0.17	0.22	0.27
G	1.35	1.40	1.45
H	-	-	1.60
I	0.05	-	0.15
J	0.45	0.60	0.75
K	0.09	-	0.20
α	0 °	-	7 °

SK5212-LP 48-pin (7x7mm 1.6 MAX) LQFP

SALE AND SERVICE INFORMATION

To obtain information about Sprintek Corporation or keyboard encoder sales and technical support, reference the following information.

Sprintek Corporation
4969 Corral St.
Simi Valley, CA 93063, USA
Web Site: http://www.sprintek.com

REVISION HISTORY

Revision	Issue Date	Description
1.00	August 13, 2020	Initial release