SN11087

Second Generation USB1.1 Flash Memory Controller

Version 0.3
2003/7/8

1 General Description

SN11087 is a high-performance integrated circuit to access the NAND type Flash memory via the USB 1.1 bus. It provides a flexible and cost efficient single chip solution for external storage applications such as USB Disk (Flash Disk). With the capability to be pin-to-pin compatible to SN11085, the current user of SN11085 can easily upgrade to SN11087 with no engineering effort needed at all. With all the features inherited from SN11085/086 like the low 6MHz system clock to reduce the EMI, the embedded translation table to eliminate the cost of external memory, the Sonix proprietary randomization algorithm to extend the lifetime of flash memory and ensure the product robustness, and the real time ECC correction function, the SN 11087 adds several other unique features to reduce the cost of the end product and meet the customer's requirements.

To enrich the product line of the OEM manufacture, with the ability to support 8 pieces of flash memories and the new types of 2G bits flashes, SN11087 can be used to build up a storage device up to 2 Giga bytes. To reduce the total cost of the end product, SN11087 incorporates a power MOS inside to meet the current requirement (500 uA) in USB suspend state. The usage of EEPROM can also now be eliminated by the capability to program the customized vendor/product ID/string in the flash itself. Therefore, the total cost is reduced by upgrade from SN11085 to SN11087.

For fulfilling different customers' needs, SN11087 now provides several ways to build different end products. The first one is to provide different security functions. The OEM manufacturers can program one of the two ways in manufacturing via software. The flashing ways of LED can also be selected by software now. The pin 35 of SN11087 is now used to support new security feature. The original two security features provided in SN11085/86 still

exist. The customers can select any one of them during the mass production stage, making production much easier. With these flexibilities, the manufacturers can easily build different products by using exactly the same components. The only place needs to be changed on PCB is pin 35.

The USB Mass Storage Class compliance capability of SN11087 makes it a truly "plug-and-play" device without vendor drivers under Windows 2000/ME/XP and Mac OS 9/10. SN11087 also provides PC boot up and data security function that exact the same as a floppy disk (1.44M), which makes it an ideal replacement for the legacy floppy disk.

2 Features

- USB 1.1 12 MHz full-speed compatible
- USB 1.1 Mass Storage Class compliant
- USB Mass Storage Class Bulk-Only Transport 1.0 supported
- USB Mass Storage Class SCSI transparent command set supported
- Low system clock (6MHz) to reduce EMI
- Customized VID, PID, serial number, and 28 characters of Vendor/Product/Revision string supported within flash or external EEPROM.
- EEPROM in system programmable (ISP) capability
- Support Samsung and Toshiba NAND-type flash memory, from 32Mbits to 1Gbits
- Support new type of Samsung NAND type flash memory, from 1Gbits to 4Gbits
- Real-time ECC correction circuit for data integrity and memory access speed acceleration
- Embedded SRAM for logical-to-physical address translation to extend the life time of NAND-type flash
- Support up to 8 NAND type flash memories are supported
- Support up to 2 Gbytes of disk capacity
- Embedded FIFO for upstream and downstream data transfer
- Built-in power MOS to meet USB suspend requirement (500 uA)
- Data transfer rate up to 1.5 MB/s (burst), 1.1 MB/s (read average)
- LED indicator pin
- Three modes of LED flashing patterns can be selected
- Five speed of LED flashing speed provided

- PC boot up capability (host BIOS with USB boot up support is necessary)
- Flash disk security function provided, up to 16 characters of password for high sensitive data protection from illegally access
- Three types of security functions can be selected
- ROM-type flash disk capability provided (permanent write protect)
- No Driver needed under Microsoft Windows ME/2000/XP, Mac OS 9.x/10.x
- Sonix Driver for Microsoft Windows 98
- Sonix mass production tool available for mass production
- Sonix security program available
- Sonix bonus programs available
- Single 3.3V operation
- 48 pin LQFP package

3. Pin Assignment

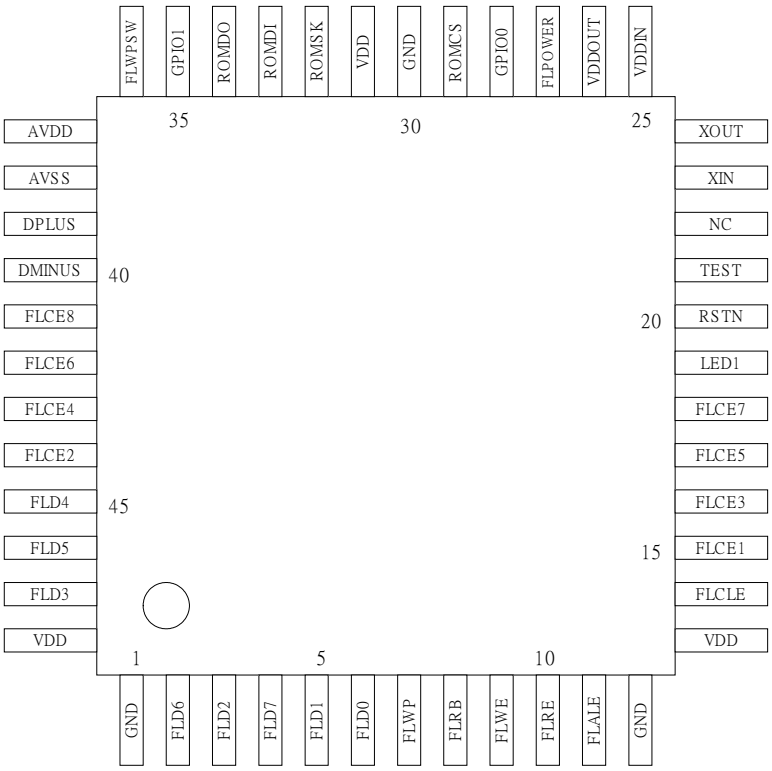


Table 1 SN11087 pin list (red character is the pins different to SN11085)

#	pin name	type	drive	special	description
1	GND	PWR			Digital ground
2	FLD6	DIO	24mA	PD	Flash memory I/O port bit 6
3	FLD2	DIO	24mA	PD	Flash memory I/O port bit 2
4	FLD7	DIO	24mA	PD	Flash memory I/O port bit 7
5	FLD1	DIO	24mA	PD	Flash memory I/O port bit 1
6	FLD0	DIO	24mA	PD	Flash memory I/O port bit 0
7	FLWP	DO	24mA		Flash memory write protect
8	FLRB	DI			Flash memory ready/busy
9	FLWE	DIO	24mA		Flash memory write enable
10	FLRE	DIO	24mA		Flash memory read enable
11	FLALE	DO	24mA		Flash memory address latch enable

12	GND	PWR			Digital ground
13	VDD	PWR			Digital 3.3V
14	FLCLE	DO	24mA		Flash memory command latch enable
15	FLCE1	DO	8mA		Flash memory chip enable 1
16	FLCE3	DO	8mA		Flash memory chip enable 3
17	FLCE5	DO	8mA		Flash memory chip enable 5
18	FLCE7	DO	8mA		Flash memory chip enable 7
19	LED	DIO	24mA	PD	LED lighter
20	RSTN	DI		PU	Chip reset, connected to external RC circuit
21	TEST	DI		PD	Test pin, NC in normal operation
22	GPIO1	DIO	8mA		Do Not Connect
23	XIN	I	-	-	Crystal input or oscillator input
24	XOUT	O	-	-	Crystal output or no connection
25	VDD	PWR		-	Digital 3.3V
26	FLVDD	PWR		-	3.3V power to flash VDD
27	FLPOWER	DO	8mA	OC	Flash power control, connect to external MOS Needs to be pulled up externally.
28	GPIO0	DIO	8mA		General Purpose Input/Output 0 for internal test Always pull up for normal operation
29	ROMCS	DO	4mA		Chip select for external EEPROM
30	GND	PWR			Digital ground
31	VDD	PWR			Digital 3.3V
32	ROMSK	DO	4mA		Clock for external serial EEPROM
33	ROMDI	DO	4mA		Serial data to external EEPROM
34	ROMDO	DI	4mA		Serial data from external EEPROM, pull up externally if no EEPROM is connected
35	GPIO1	DIO	8mA	-	General Purpose Input/Output 1. Pull up/down depends on operation modes
36	FLWPSW	DI		PU	Flash write protect switch
37	AVDD	PWR			Analog 3.3V
38	AVSS	PWR			Analog ground
39	DPLUS	AIO	-	-	USB D+ signal
40	DMINUS	AIO	-	-	USB D- signal
41	FLCE8	DO	8mA		Flash memory chip enable 8
42	FLCE6	DO	8mA		Flash memory chip enable 6

43	FLCE4	DO	8mA		Flash memory chip enable 4
44	FLCE2	DO	8mA		Flash memory chip enable 2
45	FLD4	DIO	24mA	PD	Flash memory I/O port bit 4
46	FLD5	DIO	24mA	PD	Flash memory I/O port bit 5
47	FLD3	DIO	24mA	PD	Flash memory I/O port bit 3
48	VDD	P	-	-	Digital 3.3V

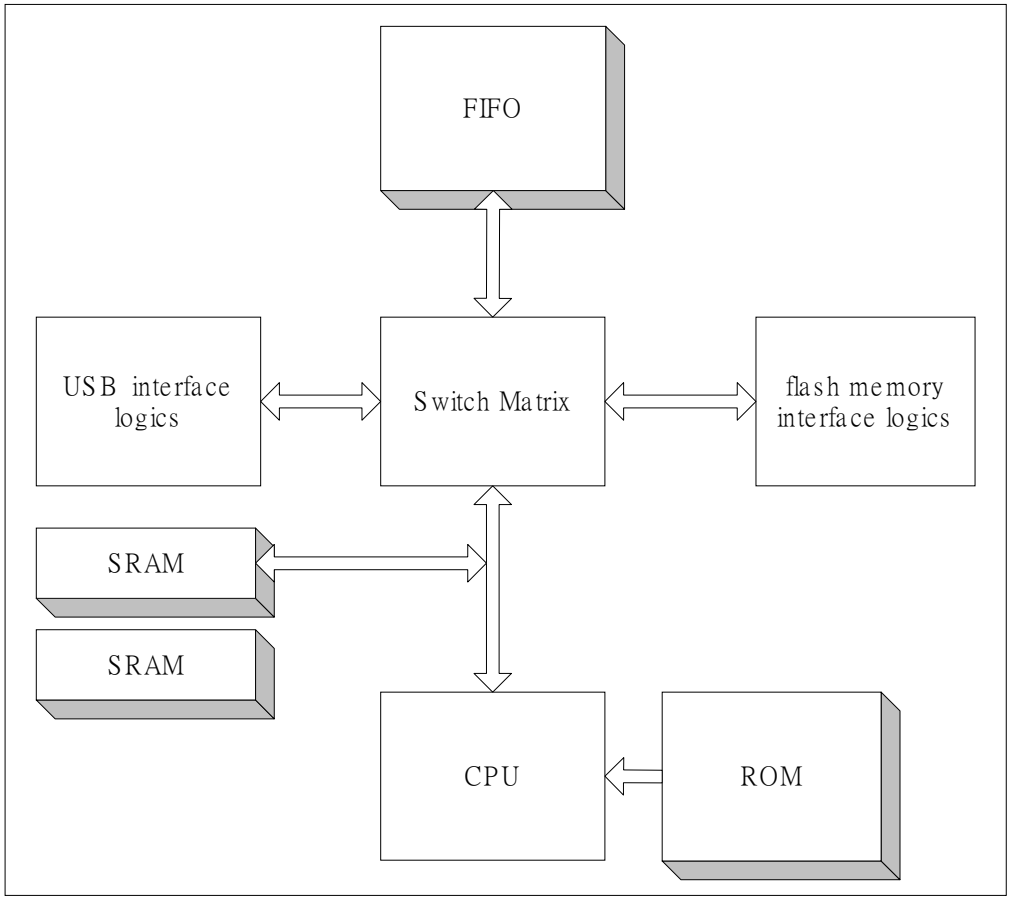
Note:

1. P: power pin; AI: analog input pin, AIO: analog input/output pin; DI: digital input pin; DO: digital output pin; DIO: digital input/output pin.

2. TTL: TTL compatible input pin; PD: pull down; PU: pull up.

3. All pads are Schmitt triggered and with slew rate control

3 Block diagram



4 Functional description

5.1 Flash memory connection

Up to 8 NAND type flash memories from Samsung or Toshiba can be connected to SN11087, the number of flash memory connected can be detected automatically upon power on. Each flash memory has its own chip enable control signal path (FLCE 1 to FLCE8). All flash memories connected to SN11087 must be of the same capacity, and it is suggested to connect them with concatenated ascending order from FLCE1 to FLCE8. There is no special rule for the number of flash memory. (e.g. not necessarily

to be the multiples of 2 or 4).

5.2 VID/PID/SN and Strings format

The default USB vendor ID, product ID and the strings for vendor name and product name can be changed by storing customized values into the flash or EEPROM. The serial number (defined in mass storage device class) can also be customized. It should be noted that the VID and PID values cannot be set to 0x0000 or 0xFFFF. The default vendor string of the SN11087 is "USB NAND". The default product string is "FLASH DISK". Therefore, the Windows will show "USB NAND FLASH DISK" when the default string is used.

Upon power up, if 93C46 EEPROM is not detected and the flash doesn't have VID/PID stored, default USB vendor ID (hex 0C45) and product ID (hex 1060) are returned to the host. The ROMDO pin must be pulled high when no EEPROM exists. The VID/PID/Serial number and vendor/product strings can be programmed through the mass production software provided by Sonix.

The serial number format in the Mass Storage Class device descriptor is described in section 5.1.1.1 of the spec. If the manufacturers needs to have serial number, then the value of the highest two nibbles (nibble 1 and 2) of the serial number can not be 0xFF, or the serial number feature will be disabled.

5.3 Software support

Sonix provides the following software to customers

1) Application software and driver for Win98/2000/Me/XP; boot up utility is included for Win98/Me
2) Mass production tool which provides the following function
   - i) Flash memory format
   - ii) File copy/compare for data validation
   - iii) Copying files into the flash memory which are to be delivered with the flash disk
   - iv) ISP of EEPROM (93C46)

v) Customize USB VID/PID and strings into flash memory or EEPROM

vi) Disable the PC lock and security function

5 Operating rating and electrical characteristics

6.1 Absolute maximum rating

Table 4

symbol	parameter	value	unit
Dvmin	min digital supply voltage	DGND – 0.3	V
Dvmax	max digital supply voltage	DGND + 4.6	V
Avmin	min analog supply voltage	AGND – 0.3	V
Avmax	max analog supply voltage	AGND + 4.6	V
Dvinout	voltage on any digital input or output pin	DGND –0.3 to 5.5	V
Avinout	voltage on any analog input or output pin	AGND –0.3 to Avdd + 0.3	V
T_{stg}	storage temperature range	-40 to +125	^{0}C
ESD (HBM)	ESD human body mode C=100pF, R=1.5KΩ	5000	V
ESD (MM)	ESD machine mode	200	V
I_{off}	leakage current	10	uA
I_{latch}	minimum latch up current	100	mA

6.2 Operation conditions

Table 5

symbol	parameter	value	unit
DVdd	digital supply voltage	+3 to +3.6	V
Avdd	analog supply voltage	+3 to +3.6	V
T_A	operating ambient temperature range	0 to 70	^{0}C
T_J	operating junction temperature range	0 to 115	^{0}C

6.3 DC electrical characteristics

Table 6

symbol	parameter	test condition	value	unit
V_{DI}	USB differential input sensitivity	| (D+) – (D-) |	0.2 (min)	V
V_{CM}	USB differential common mode range	Included V_{DI} range	0.8 (min) 2.5 (max)	V
V_{SE}	USB single ended receiver threshold		0.8 (min) 2.0 (max)	V
V_{IH}	high level input voltage		2.0 (min)	V
V_{IL}	low level input voltage		0.8 (max)	V
V_{OH}	high level output voltage	I_{OH} = -4 mA	2.3 (min)	V
V_{OL}	low level output voltage	I_{OL}= 4 mA	0.5 (max)	V
I_{IL}	low level input current	V_I = 0 V	RSTN pin : - 50.0 (max) the other pins : - 3.0 (max)	μA
I_{IH}	high level input current	V_I = 3.6 V	3.0 (max)	μA
I_{DD}	input supply current		20 (max)	mA
Isuspend	supply current in suspend		20 (max)	μA

6.4 AC electrical characteristics

6.4.1 USB transceiver signal (full speed mode)

Table 7

symbol	parameter	test condition	min	max	unit
Tr	transition rise time for DP or DM		4	20	ns
Tf	transition fall time for DP or DM		4	20	ns
Trfm	rise / fall time matching	(Tr / Tf) * 100	90	110	%
Vo(crs)	signal crossover voltage		1.3	2.0	V

6.4.2 Operation clocks

Table 8

symbol	parameter	value	unit

USBCLKin	XI/XOUT crystal value	6 (typ)	MHz
	USBCLKin duty cycle	50 ± 2	%

6.4.3 External EEPROM interface

Table 9

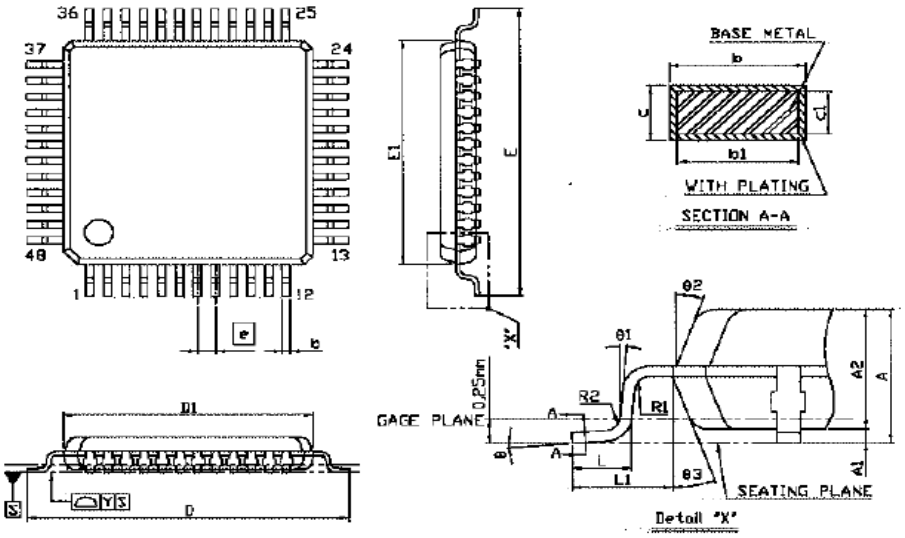
symbol	parameter	value	unit
Fsk	ROMSK pin clock frequency	200	kHz

6.5 Power consumption

Table 10

symbol	parameter	value	unit
Io_max	Max current in operation	20	mA
Is_max	Max current in suspend mode	TBD	uA

7. Packaging dimension



SYMBOL	DIMENSION (MM)			DIMENSION (MIL)		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A			1.60			63
A1	0.05		0.15	2		6
A2	1.35	1.40	1.45	53	55	57
b	0.17	0.22	0.27	7	9	11
b1	0.17	0.20	0.23	7	8	12
c	0.09		0.20	4		8
c1	0.09		0.16	4		6
D	9.00 BSC			354 BSC		
D1	7.00 BSC			276 BSC		
E	9.00 BSC			354 BSC		
E1	7.00 BSC			276 BSC		
e	0.50 BSC			20 BSC		
L	0.45	0.60	0.75	18	24	30
L1	1.00 REF			39 REF		
R1	0.08			3		
R2	0.08		0.20	3		8
Y			0.075			3
θ	0°	3.5°	7°	0°	3.5°	7°
θ1	0°			0°		
θ2	11°	12°	13°	11°	12°	13°
θ3	11°	12°	13°	11°	12°	13°

NOTE:
1.REFER TO JEDEC MS-026/BBC
2.DIMENSION D1 AND E1 DO NOT INCLUDE MOLD PROTRUSION.
ALLOWABLE PROTRUSION IS 0.25mm PER SIDE D1 AND E1 ARE
MAXIMUM PLASTIC BODY SIZE DIMENSION INCLUDING MOLD MISMATCH.
3.DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE
DAMBAR PROTRUSION SHALL NOT CAUSE THE LEAD WIDTH TO EXCEED
THE MAXIMUM b DIMENSION BY MORE THAN 0.08mm.
4.ALL DIMENSIONS IN MILLIMETERS.

Version Control

0.1	**May-28-2003**	**first draft**
0.2	**June-08-2003**	**modified typing errors**
		add descriptions for new features
0.3	**July-08-2003**	**modified typing errors**

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