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AK1594
Bluetooth® Low Energy transmitter

General

The AK1594 is a low power consumption transmitter IC that supports Bluetooth® 4.2. The AK1594 is a simplest Bluetooth® Low Energy transmitter without the need for a microcontroller, providing advertising data in the on-chip EEPROM.

Features

- Single Chip Bluetooth® Low Energy Transmitter
  - Only the AK1594 and a few passive components are required to complete Bluetooth® Low Energy advertising transmission function.
- Microcontroller-less(MCU-less)
  - Bluetooth® Low Energy advertising transmissions can be broadcasted using the AK1594's on-chip EEPROM data. This MCU-less architecture eases system design without a complicated development environment.
- Functional Switches
  - 4-hardware switches works as on-off, interval and power controller for advertising transmission.
- Programmable Output Power
  - Support wide range output power from -32dBm to +6dBm.
- Data whitening and CRC
  - Build–in data whitening feature and CRC that are compliant with Bluetooth® Low Energy.
  - Support GFSK(1Mbps)
- Security
  - AES-128 Hardware Encryption
- Package
  - 28-pin QFN (4.0mm x 4.0mm x 0.70mm, 0.4mm pitch)

1. Table of Contents

2. Notation

The following notations are used for specific signals and register names:

- [Name]: Internal signal name
- <Name>: EEPROM address name
- {Name}: EEPROM bit name

The numerical values are expressed as follows

- 0x63A: Hexadecimal numbers
- 0d1594 or 123: Decimal numbers
- 0b11000111010: Binary numbers

Terms and acronyms

- AdvA Advertiser's Device Address
- AES Advanced Encryption Standard
- BLE Bluetooth® Low Energy
- CRC Cyclic Redundancy Check
- EEPROM Electrically Erasable Programmable Read-Only Memory
- GFSK Gaussian Frequency Shift Keying
- IRK Identity Resolving Key
- LDO Low Drop Out
- LSB Least Significant Bit
- MCU Micro Controller Unit
- MSB Most Significant Bit
- PDU Protocol Data Unit
- PLL Phase Locked Loop
- POR Power On Reset
- PPM Part Per Million
- RF Radio Frequency
- SPI Serial Peripheral Interface
- SW Switch
- Tx Transmit

These 3 words mean data packet of Bluetooth® Low Energy Advertising channel. The data format is shown in Figure 1.

- Payload
- AdvA
- AdvData

<table>
<tr><td rowspan="3">Preamble</td><td rowspan="3">Access Address</td><td colspan="3">PDU</td><td rowspan="3">CRC</td></tr>
<tr><td rowspan="2">Header</td><td colspan="2">Payload</td></tr>
<tr><td>AdvA</td><td>AdvData</td></tr>
<tr><td>1octet</td><td>4octets</td><td>2octets</td><td>6octets</td><td>0 to 31octets</td><td>3octets</td></tr>
</table>

Figure 1 Bluetooth® Low Energy Advertising Channel packet format

3. Block Diagram

Power supply and ground pins are not included.

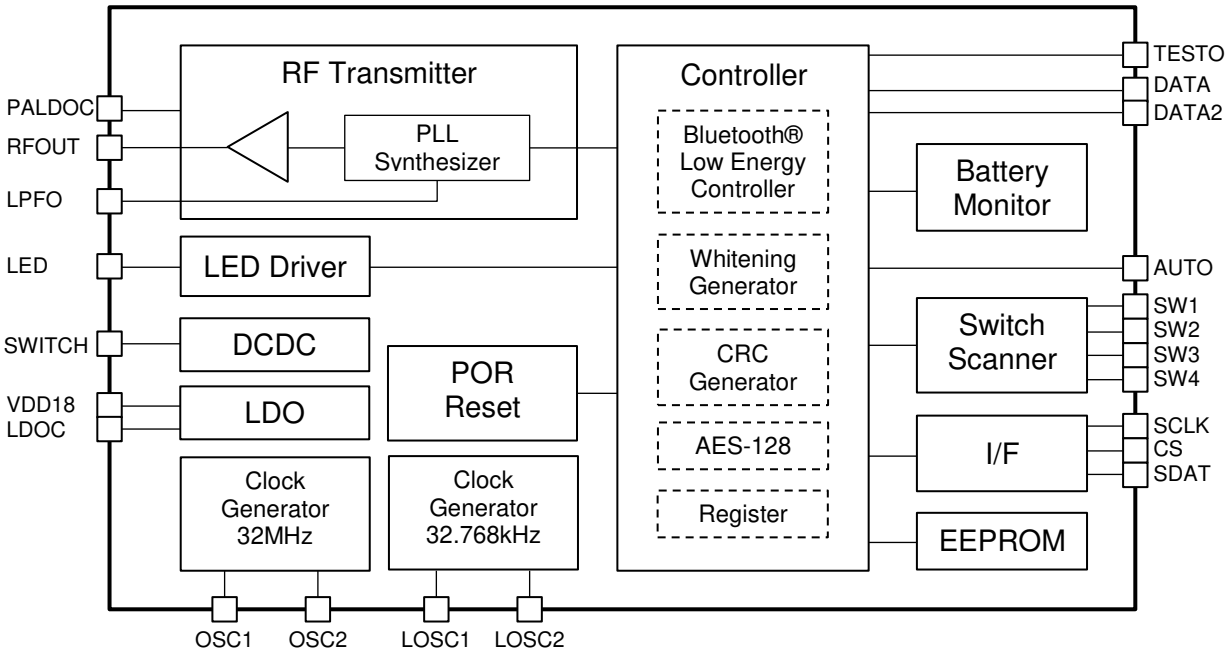


Figure 2 Overall Block Diagram

-RF Transmitter
This block outputs RF signal after GFSK modulation.

-Switch Scanner
This block detects switch actions.

-EEPROM
EEPROM holds AK1594 setting and TX data.

-Register
EEPROM read data is stored temporary to the register. It's not accessible to users.

-Battery Monitor
This block monitoring VDD voltage

-LED Driver
This block lights LED.

4. Pin / Function

<The meaning of abbreviations used in the "I/O" column of the pin table is shown below>

AI:	Analog input pin	DO:	Digital output pin
AO:	Analog output pin	DIO:	Digital I/O pin
AIO:	Analog I/O pin	P:	Power supply pin
DI:	Digital input pin	G:	Ground pin

Pin No.	Pin name	I/O	Pin Functions	State after POR	Max. load capacitance	pullup/ pulldown	Remarks
TX Section							
22	RFOUT	AO	RF signal Output				
23	PALDOC	AO	Connection for an external TX output adjustment inductor to RFOUT pin.				
External Interface							
6	SW1	DI	Switch 1 Input (Start trigger signal input for burst transmission)				Note1
9	SW2	DI	Switch 2 Input (Stop trigger signal input for burst transmission)				Note1
16	SW3	DI	Switch 3 Input (Transmission power control signal input)				Note1
17	SW4(RXD)	DI	Switch 4 Input (Advertising interval control signal input) RXD : Bluetooth® Certification test input pin				Note1
5	LED	AO	LED Output (Leave this pin open if a LED is not used)				
19	DATA	DI	This pin is not use. Tie to ground				
20	DATA2	DI	This pin is not use. Tie to ground				
18	TESTO(TXD)	DO	For AKM Test (Leave this pin open) TXD : Bluetooth® Certification test output pin	L	15pF		
Common Section							
24	LDOC	AO	Connection for an external capacitor for LDO.				
7	OSC1	AI	32MHz Crystal oscillator				
8	OSC2	AO	32MHz Crystal oscillator				
15	LOSC1	AI	32.768kHz Crystal oscillator				
14	LOSC2	AO	32.768kHz Crystal oscillator				
12	CS	DI	EEPROM access mode when CS pin="H" Normal mode when CS pin = "L"			Pull down	
11	SCLK	DI	EEPROM access clock input when CS pin="H" Normal mode when CS pin = "L"			Pull down	
13	SDAT	DIO	EEPROM access data in/output when CS pin="H" Normal mode when CS pin = "L"		15pF	Pull up	Input mode after POR
4	LPFO	AIO	Connection for an external capacitor for the loop filter				
28	SWITCH	AO	DCDC converter output				
26	VDD18	AI	Power supply Connect to SWITCH pin via an external inductor.				

Pin No.	Pin name	I/O	Pin Functions	State after POR	Max. load capacitance	pullup/ pulldown	Remarks
25	AUTO	DI	Selection of AUTO mode. AUTO pin = "L", Switch action transmission mode AUTO pin = "H", Automatic transmission mode Do not leave this pin open.				
Power supply							
2	AVDD	P	Power supply				
1	DCVDD	P	Power supply for DCDC converter				
21	RFVSS	G	Ground for RFAMP				
3,10	VSS	G	Ground				
27	DCVSS	G	Ground for DCDC converter				

Note 1 Must be connected to VDD or pull up if the pin is unused.

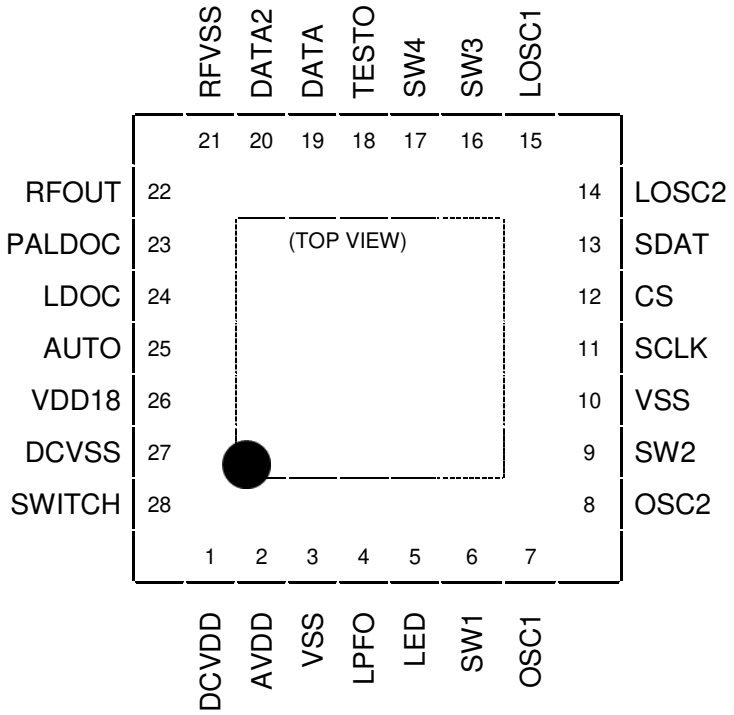


Figure 3 Pin configurations

5. Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Unit	Remarks
Supply Voltage	VDD	-0.3	6.0	V	Note 1
Ground Level	VSS	0	0	V	
Input Voltage	Vin	VSS-0.3	VDD+0.3	V	Note 1
Input Current	Iin	-50	+50	mA	
Output Current	Iout	-50	+50	mA	
Storage Temperature	Tstg	-55	+125	ºC	

Note 1 All voltages with respect to the ground level as 0V

WARNING: Operation at or beyond these limits may result in permanent damage to the device. Normal operation is not guaranteed at these extremes.

6. Recommended Operating Range

The specifications are applicable within operating range (supply voltage/operating temperature) specified below.

Parameter	Symbol	Voltage	Ground pin	Remarks
Ground pin	VSS	0V	VSS, DCVSS, RFVSS	

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks
Operating Temperature	Ta	-40		85	ºC	
Supply Voltage	VDD	2.0	3.0	3.7	V	AVDD, DCVDD pin Note 1,2

Note 1 When VDD voltage falls below 2V and the AK1594 is needed to be power-up, please reset the AK1594. Performance is not guaranteed for power-on without the AK1594 reset.

Note 2 This specification in case of {POWR_MODE[1]} = “0b0”, Minimum value is 2.3V in case of {POWR_MODE[1]}= “0b1”

Note 3 All voltages with respect to the ground level as 0V

Note 4 AKM assumes no responsibility for the usage beyond the conditions in this data sheet.

7. Electric Characteristics

The specifications are applicable within recommended operating range (supply voltage/operating temperature), using the Test schematic.

7.1. Characteristics of RF output

Parameter		Min.	Typ.	Max.	Unit	Remarks
Channel Frequency Note 1	Frequency1		2402		MHz	
	Frequency2		2426		MHz	
	Frequency3		2480		MHz	
Output Power	Power setting 1 for high power mode		+6		dBm	{POWRD[4:0]} = “0d31” {POWR_MODE[1]} = “1”
	Power setting 2 for normal power mode		0		dBm	{POWRD[4:0]} = “0d28” {POWR_MODE[1:0]}=”0b00”
	Power setting 3 for normal power mode		-3		dBm	{POWRD[4:0]} = “0d16” {POWR_MODE[1:0]}=”0b00”
	Power setting 4 for normal power mode		-32		dBm	{POWRD[4:0]} = “0d0” {POWR_MODE[1:0]}=”0b00”
Adjustable step for output power		0			dB	Note 3
GFSK Note2	Average frequency deviation for 00001111 sequence(Δf)	±225	±250	±275	kHz	
	Ratio average Frequency deviation (10101010 sequence / 00001111 sequence)	80			%	
	Minimum frequency deviation(Δf min)	±185			kHz	
	Bit rate		1.0		Mbps	
	BT(Bandwidth-Time)		0.5			
	Modulation index(m)	0.45	0.50	0.55		m=(2*|Δf|) / (bit rate)
	Spurious			-20 -30	dBm dBm	1MHzBW @2MHz offset 1MHzBW @>3MHz offset

Note 1 Channel frequency means center frequency of modulation.
Note 2 GFSK characteristics based on Bluetooth® Low Energy test specification(RF-PHY.TS.4.2.3)
Note 3 Guaranteed by design (Not tested)

7.2. Current Consumption

Parameter	Symbol	Condition	min.	typ.	max.	Unit
Full Power down	SIDD1	SW pins:VDD, LED:open, Note 1		15	100	nA
TX ON	IDD1a	LED pin : open, Note 2		5	8	mA
	IDD1b	LED pin : open, Note 3		5	13	mA
	IDD1_2a	LED pin : open, Note 4		11	18	mA
	IDD1_2b	LED pin : open, Note 5		11	30	mA
Sleep	IDD2a	LED pin : open, Note 6		0.9	1.2	uA
	IDD2b	LED pin : open, Note 7		0.9	1.5	uA
LED Current (Drivability)	ILED1	LED pin voltage : 1.6V(typ) Note1 Note8		3.0	5.0	mA
	ILED2	LED pin voltage : 1.6V(typ) Note1 Note9		1.0	2.0	mA

Note 1 VDD=3.0V, Room Temperature (25 ºC.).
Note 2 VDD=3.0V, Room Temperature (25 ºC.),
TX_ch:2426MHz, RFOUT: 0dBm(typ.), {POWRD[4:0]}=0d28, {POWR_MODE[1:0]}=”0b0”
Note 3 VDD=VSLEEPN to 3.7V, Temperature range = -40 to 85 ºC,
TX_ch:2426MHz, RFOUT: 0dBm(typ.), {POWRD[4:0]}=”0d28”, {POWR_MODE[1:0]}=”0b0”
Note 4 VDD=3.0V, Room Temperature (25 ºC.),
TX_ch:2426MHz, RFOUT: +6dBm(typ.), {POWRD[4:0]}=”0d31”, {POWR_MODE[1]}=”0b1”
Note 5 VDD=VSLEEPH to 3.7V, Temperature range = -40 to 85 ºC,
TX_ch:2426MHz, RFOUT:+6dBm(typ.), {POWRD[4:0]}=”0d31”, {POWR_MODE[1]}=”0b1”
Note 6 VDD=3.0V, Room Temperature (25 ºC.), RFOUT: off, LOSC: active.
Note 7 VDD=VSLEEPN to 3.7V, Temperature range = -40 to 85deg, RFOUT: off, LOSC: active.
Note 8 {I_LED} =”0b1”
Note 9 {I_LED} =”0b0”

7.3. Characteristics of Battery monitor

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks
Detect Voltage1	VALERT		2.3		V	For LED
Release Voltage1	VRELEASE		2.46		V	For LED release voltage
Detect Voltage2N	VSLEEPN		2.05		V	For full power down Normal power mode
Detect Voltage2H Note 1	VSLEEPH		2.3		V	For full power down High power mode

Note 1 When High power mode {POWR_MODE[1:0]} is “0b11”or “0b10”, the AK1594 goes into full power down. LED pin function does not work. Refer 10.7 Battery monitor.
Note 2 VSLEEPN release voltage is VSLEEPN
Note 3 VSLEEPH release voltage is VRELEASE

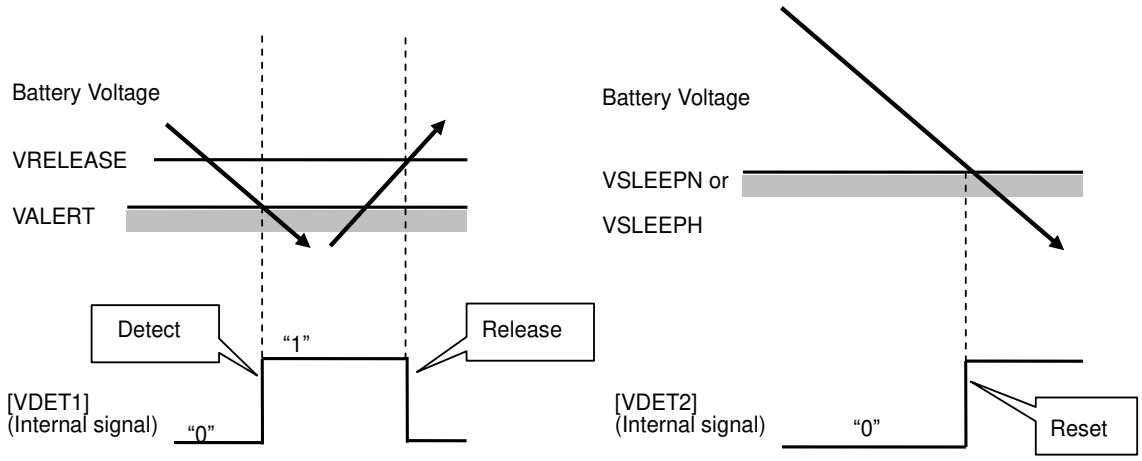


Figure 4 Battery monitor function

7.4. Characteristics of EEPROM

Parameter	Conditions	Min.	Typ.	Max.	Unit
Number of rewrite times Note1		100,000			times
Endurance Note1	Ta = 85°C	10			years

Note 1 Guaranteed by design (Not tested)

7.5. Characteristics of Crystal Oscillator 32MHz

Parameter	Min.	Typ.	Max.	Unit	Remarks
Oscillator frequency		32.000		MHz	
Frequency tolerance	-50		+50	ppm	
Stabilization time after startup			2	msec	Note1

Note 1 Guaranteed by design (Not tested)

7.6. Characteristics of Crystal Oscillator 32.768kHz

Parameter	Min.	Typ.	Max.	Unit	Remarks
Oscillator frequency		32.768		kHz	
Frequency tolerance	-500		+500	ppm	
Stabilization time after startup			1	sec	Note1

Note 1 Guaranteed by design (Not tested)

7.7. Characteristics of Power On Timing

Operating conditions for POR (Power On Reset) function.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks
Voltage of OFF state	Voff			0.05	V	Note1
Interval of under Voff	Tvoff	500			msec	Note1
Rising time	Tr			10	msec	Note1
Stabilized state VDD	VDDSTB	2.0		3.7	V	Note1

Note 1 Guaranteed by design (Not tested)

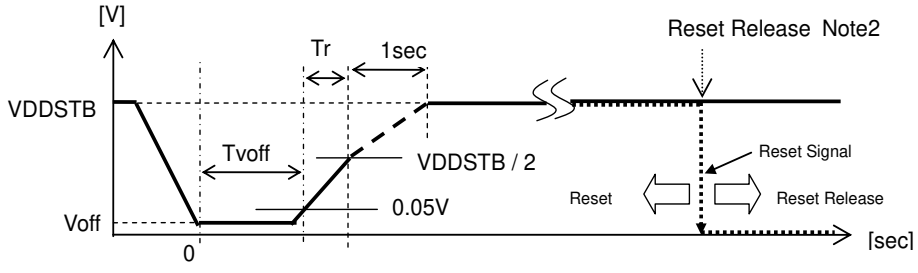


Figure 5 Power on timing

Note 2 Reset release timing is follows,
AUTO pin =”H”, the first rising edge of LOSC clock
AUTO pin =”L”, the falling edge of SW1 pin

7.8. Characteristics of Timer

Parameter	Min.	Typ.	Max.	Unit	Remarks
Tch_int		(8+{PDULEN[5:0]}) * 8 + 30		µsec	
advInterval	0.10		10.24	sec	15 control bits which is programmed by EEPROM
advDelay	0		10	msec	Randomly generated 4 control bits.

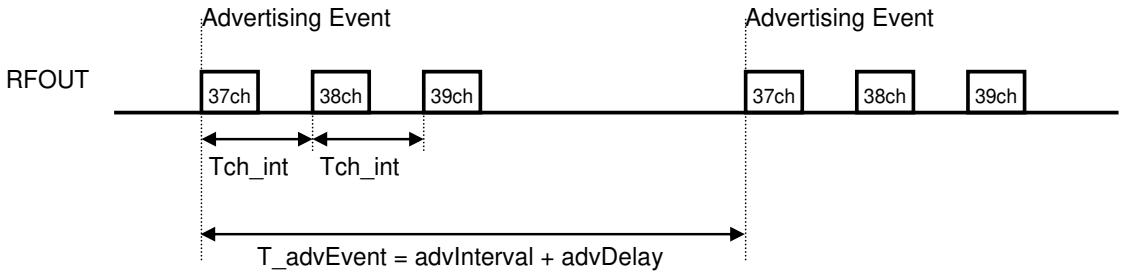


Figure 6 Interval of Advertising Event

8. Electric Characteristics of Digital Interface

The specifications are applicable within recommended operating range (supply voltage/operating temperature).

8.1. Digital DC Characteristics

Parameter	Symbol	Pin	Conditions	Min.	Typ.	Max.	Unit
High level input voltage	Vih	Note 1		0.8×VDD	-	-	V
Low level input voltage	Vil	Note 1		-	-	0.2×VDD	V
High level input current	Iih	Note 3	Vih = VDD	-10	-	+10	μA
Low level input current	Iil	Note 4	Vil = VSS	-10	-	+10	μA
High level output voltage	Voh	Note 2	Ioh = -100μA	0.8×VDD	-	-	V
Low level output voltage	Vol	Note 2	Iol = 100μA	-	-	0.2×VDD	V
Pull up	Rpu	Note 5		10	20	30	kohm
Pull down	Rpd	Note 6		15	30	45	kohm

Note 1 Digital input pins: SW1, SW2, SW3, SW4, CS, SCLK, SDAT, AUTO, DATA, DATA2 pins
Note 2 Digital output pins: SDAT, TESTO pins
Note 3 Digital input pins: SW1, SW2, SW3, SW4, SDAT, AUTO, DATA, DATA2 pins
Note 4 Digital input pins: SW1, SW2, SW3, SW4, CS, SCLK, AUTO, DATA, DATA2 pins
Note 5 Digital input pins: SDAT pin
Note 6 Digital input pins: CS, SCLK pins

8.2. Digital AC Characteristics

Switchover timing of digital AC characteristics are specified at 1/2VDD level unless otherwise noted.

8.2.1. Serial Interface Timing

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks
SCLK	tSKP	1000	-	-	nsec	
SCLK pulse width	tSKW	500	-	-	nsec	
CS high level to SCLK high level Delay	tCSS	100	-	-	nsec	
SCLK low level to CS low level Delay	tCSLW	5	-		msec	@Write access
	tCSL	100	-	-	nsec	@Read access
Setup time	tDIS	100	-	-	nsec	
Hold time	tDIH	100	-	-	nsec	
Transient time (rise)	tr			100	nsec	Note1
Transient time (fall)	tf			100	nsec	Note1
Output delay	tDLY	-	-	300	nsec	Output Load CL<15pF

Note 1 Guaranteed by design (Not tested)

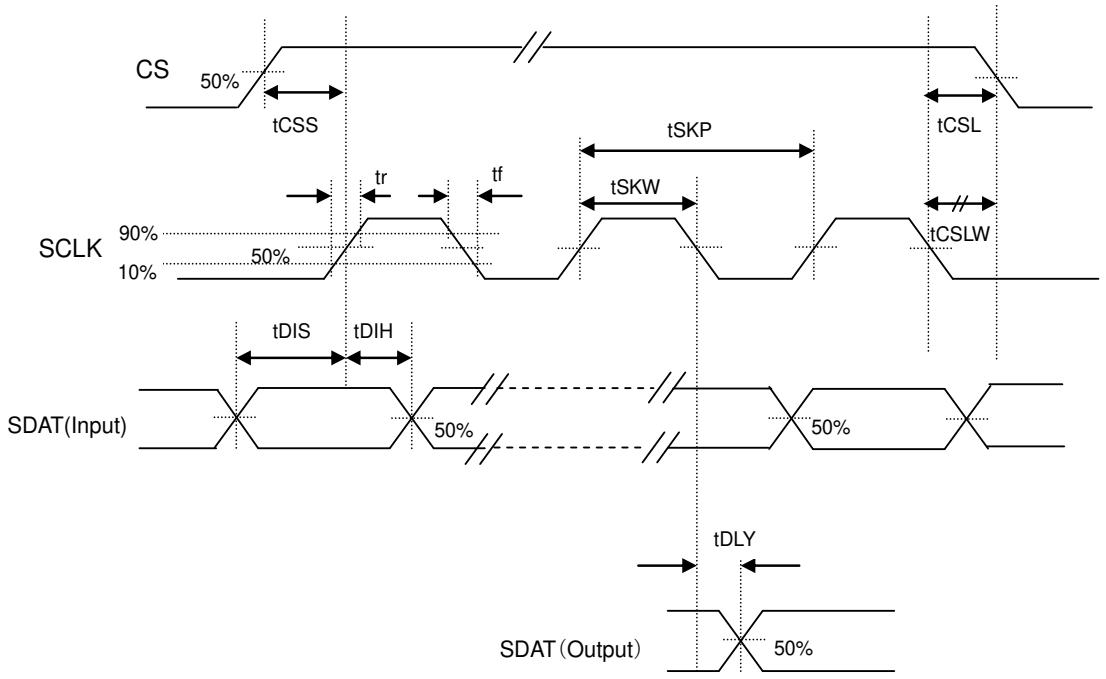
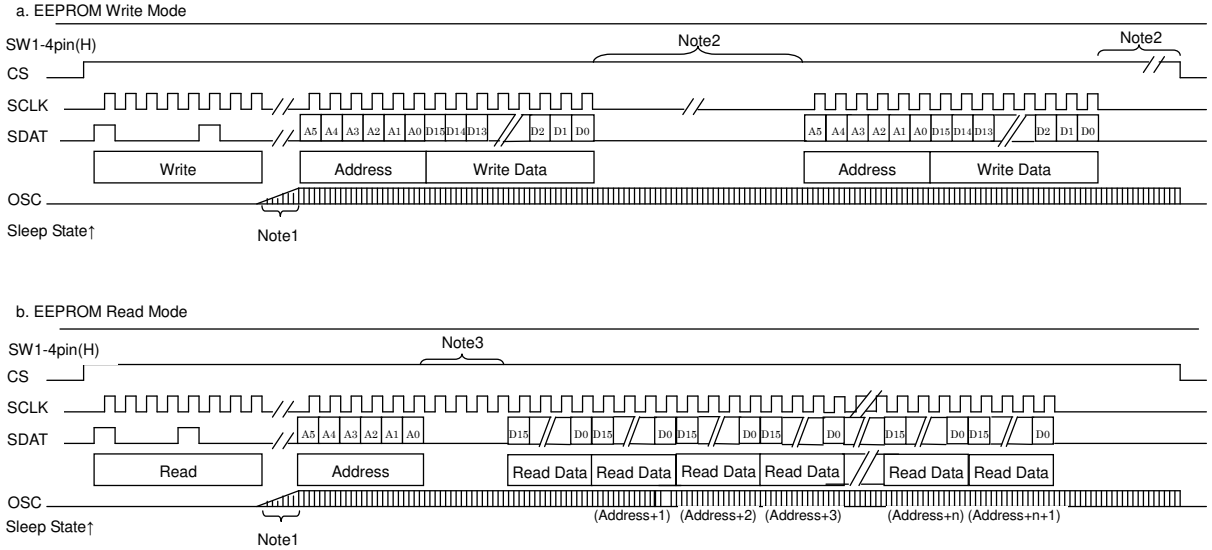


Figure 7 AC timing of serial interface

8.2.2. Timing chart of EEPROM ACCESS



Note 1 Need to wait for OSC 32.768kHz and OSC 32MHz stabilization time (more than 1002msec). Set SCLK pin = “L” during this period.
Note 2 Need to wait for “Write Time to EEPROM Memory Cell” (more than 5msec). Set SCLK pin = “L” during this period.
Note 3 As read time from EEPROM, 4 cycles of SCLK clock are needed.
Note 4 Need to EERPROM access when AUTO pin = “L” and Full power down state. EEPROM cannot access when burst transmission.

Figure 8 Timing chart of EEPROM access

8.2.3. SW1 pin , SW2 pin, SW3 pin, SW4 pin timing

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks
Low Pulse width	tSWL	25	-	-	msec	
High Pulse width	tSWH	25	-	-	msec	

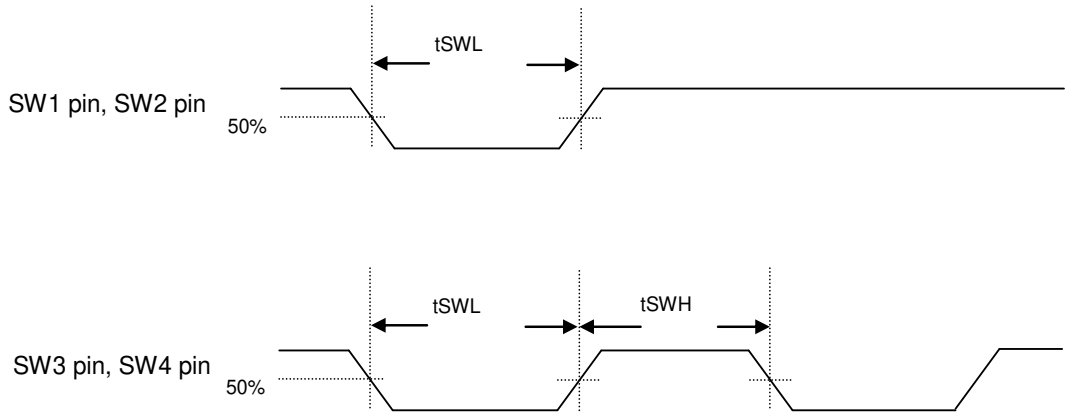


Figure 9 AC timing of Switch Pin

9. Operation State

9.1. State Description

The AK1594 has 5-state.

State	Description
Full Power Down	All blocks are powered down.
32.768kHz clock stabilization	The AK1594 is in stand-by state in order to stabilize 32.768KHz clock.
32MHz clock stabilization + Read EEPROM	The state that the AK1594 is reading EEPROM data during the 32MHz clock stabilization state.
Transmitter ON (TX ON)	RF transmissions followed by TX data generation from the EEPROM, PLL and RFAMP power up.
Sleep	Stand-by status for next advertising event after RF transmissions.

The term “burst transmission” means following 3-state transition.

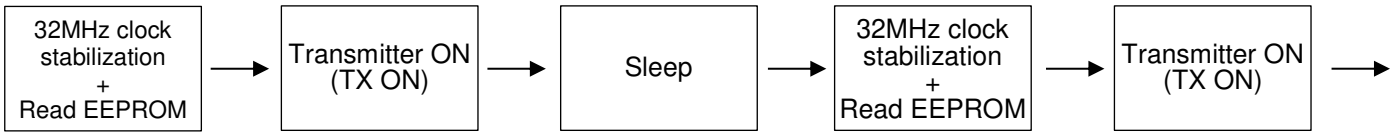


Figure 10 Burst transmission

10. Function Description

10.1. TX MODE

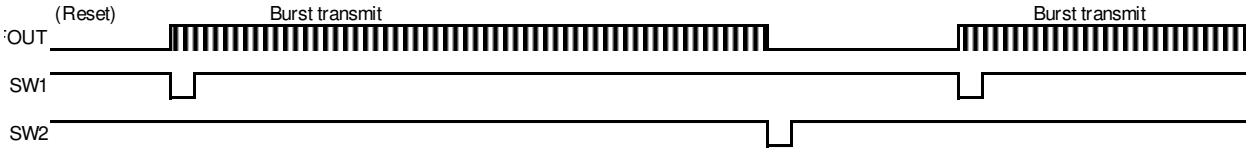
There are two transmission modes “Continuous Burst Mode” and “Configured TX Mode”.

Continuous Burst Mode: {MODE} = “0b0”
The AK1594 continues RF transmission until the AK1594 detects SW2 pin falling edge.
SW2 pin falling edge valid only AUTO pin = "L" and {SW2_DIS} = "0b0".

Configured TX Mode: {MODE} = “0b1”
The AK1594 automatically stops transmission and goes to power down status after configured number of transmission is attempted. The AK1594 can configure 1 to 5 transmissions that is set by {EVENTNUM [2:0]}

The AK1594 automatically stops transmission triggered on SW1 falling edge. After the AK1594 detects SW1 pin falling edge, the AK1594 does advertising transmission configured number of time (Note), and then goes into power down status.

Note: The AK1594 can configure 1 to 5 transmissions that is set by {EVENTNUM [2:0]}



note1: SW2 pin falling edge is valid when AUTO pin = "L" and {SW2_DIS} = "0b0".

Figure 11 Continuous Burst Mode {MODE}= “0b0”

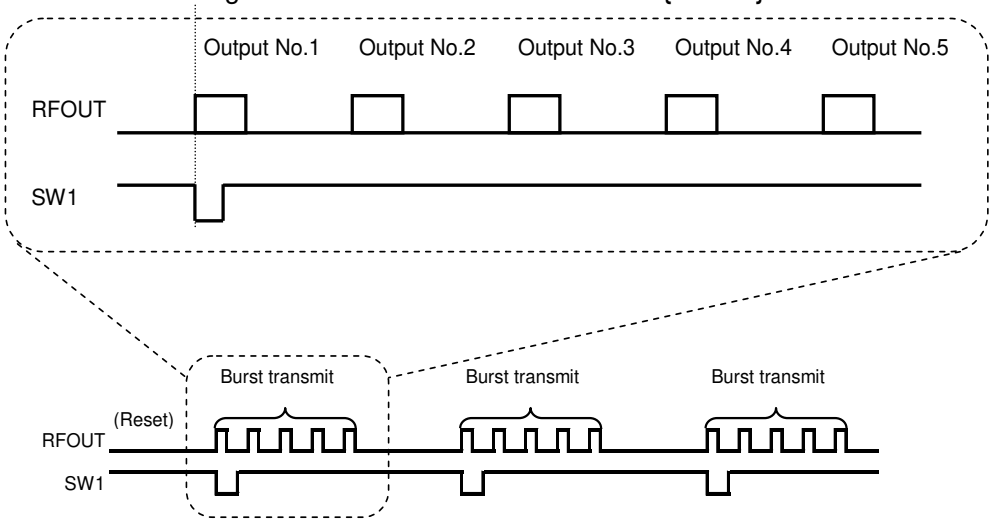


Figure 12 Configured TX Mode {MODE} = “0b1”and {EVENTNUM[2:0]} = “0d5”

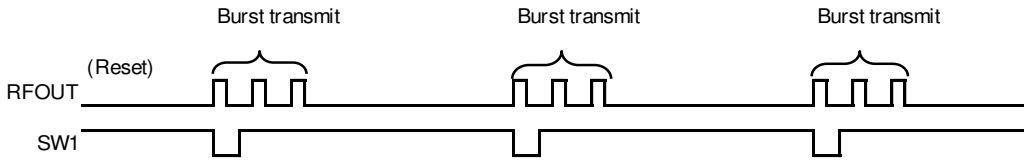


Figure 13 Configured TX Mode {MODE} = “0b1”and {EVENTNUM[2:0]} = “0d3”

10.2. POWER MODE

There are two mode based on output power, Normal Power Mode and High Power Mode by setting {POWR_MODE[1:0]}. Normal Power Mode has a benefit to save power. High Power Mode supports +6dBm (Typ.) output.

10.3. Auto Operation mode

When AUTO pin set to “High”, the AK1594 starts burst transmission automatically after the AK1594 powered-on. {MODE} register is “0b0” automatically when AUTO pin = “H”. {SW2_DIS} value is “0b1” automatically when AUTO pin = “H”.
AK1594 EEPROM cannot access when AUTO pin = “H”. AK1594 EEPROM access valid AUTO pin = “L” and “Full power down” state.

10.4. Switch Action

10.4.1. SW1 pin

The AK1594 starts burst transmission triggered on SW1 pin input falling edges.

10.4.2. SW2 pin

The AK1594 sets to full power down state triggered on SW2 pin input falling edges during burst transmission.
{SW2_DIS} enables or disables this function. This function is ignored when AUTO pin = “H”.

10.4.3. SW1 and SW2 Simultaneous Control(Reset)

When SW1 pin and SW2 pin are status “low” simultaneously more than 2 seconds, the AK1594 resets internal digital blocks.

10.4.4. SW3 pin

SW3 provides two functions, Power Step Adjustment and High Power Switch.

- Power step adjustment ({SW3_FUNC} = “0b0”)

TX power is changed every SW3 pin input triggered on falling edges. The AK1594 supports 6-state power transition (SW3State) and power step size is defined by {SW3STEP[2:0]}. The AK1594 LED function helps to determine which power state is configured monitoring number of LED blinks. When the AK1594 doesn’t detect another SW3 falling edge for more than 4 seconds after the SW3 falling edge detection, the AK1594 finishes internal process and begins burst transmission with the latest power state setting.

- High power switch({SW3_FUNC} = “0b1”)

The AK1594 switches transmission power to maximum by SW3 pin input. The maximum power is programmed by register ({POWR_MODE [1:0]} =”0b11”, {POWRD [4:0]} =”31”). After maximum power is set by this function, the AK1594 transmission power will not go down from maximum power setting unless powered off (POR) or SW1 and SW2 simultaneous control.

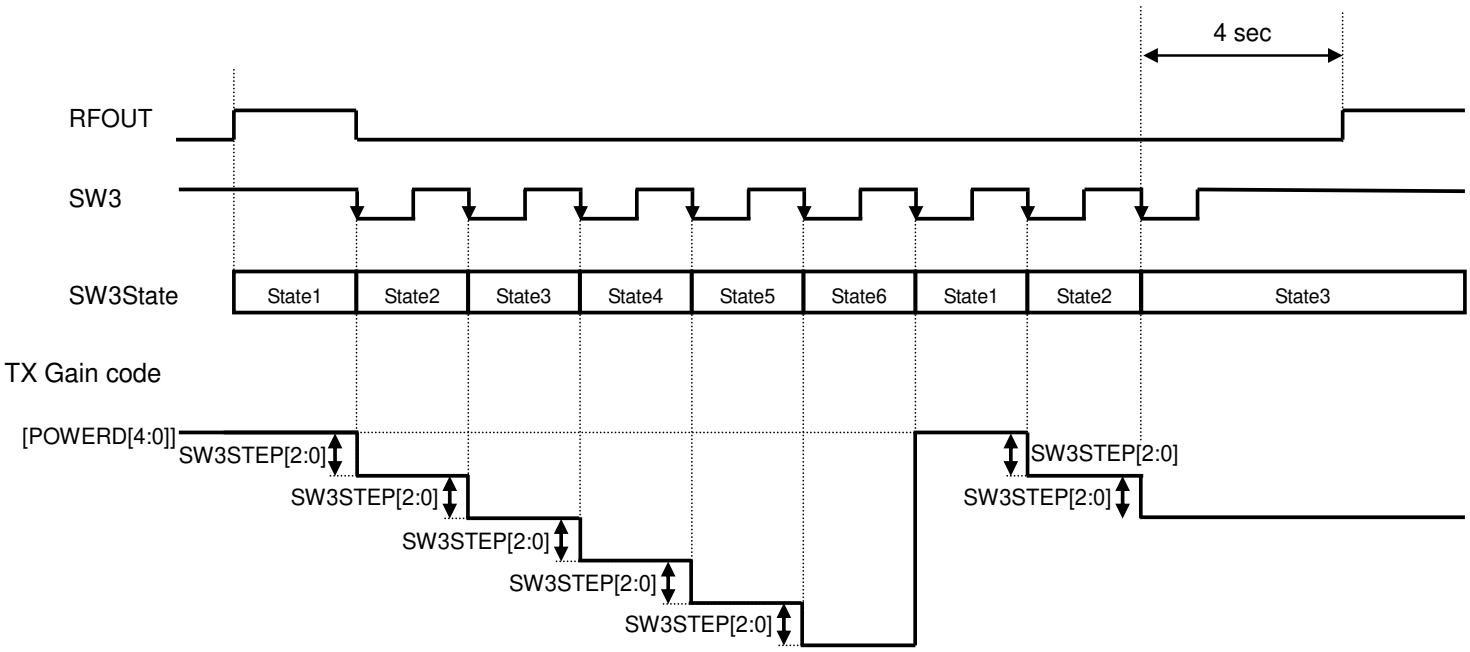


Figure 14 Transmission Power Step Adjustment

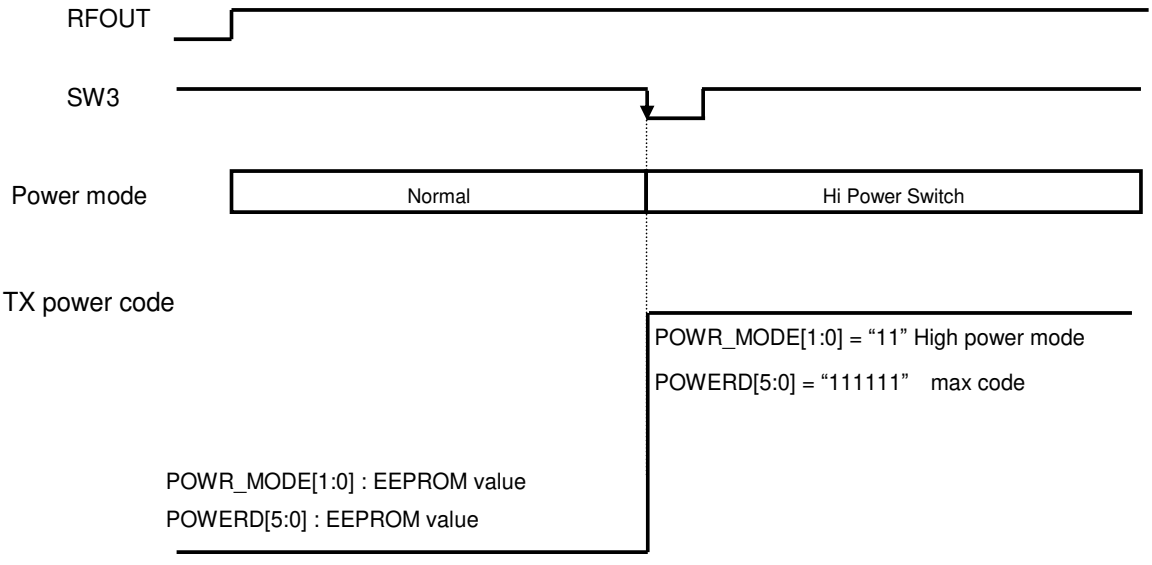


Figure 15 High power switch

10.4.5. SW4 pin

Advertising interval is changed every SW4 pin input triggered on falling edges. The AK1594 supports 6-state advertising interval (SW4State) and advertising interval length is defined by {SW4STEP[2:0]}. The AK1594 LED function helps to determine which advertising interval length is configured monitoring number of LED blinks. When the AK1594 doesn't detect another SW4 falling edge for more than 4 seconds after the SW4 falling edge detection, the AK1594 finishes internal process and begins burst transmission with the latest advertising interval length setting.

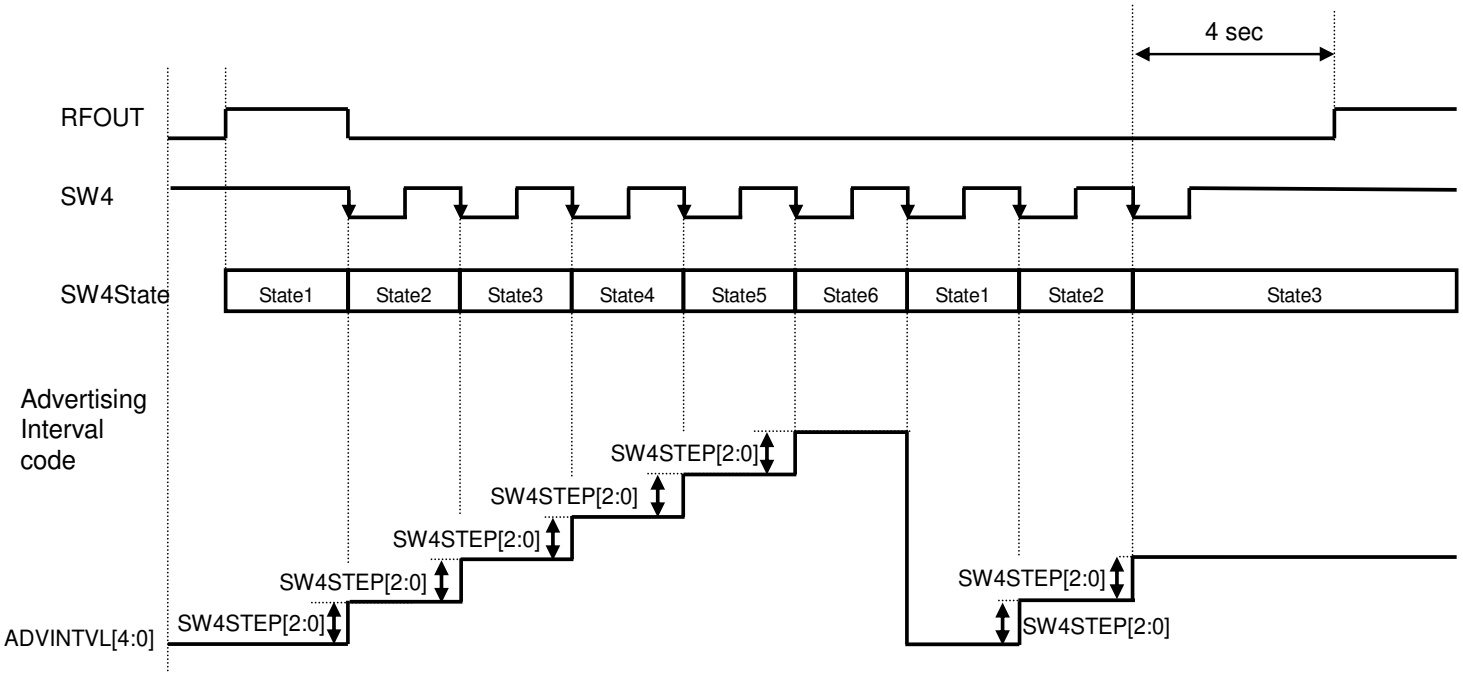


Figure 16 Advertising interval Step Adjustment

10.5. Reset

In order to reset the AK1594 all functional blocks, following conditions are required.
-meet Power on Reset conditions; please refer7.7Characteristics of Power On Timing.
-SW1 pin and SW2 pin are status "low" simultaneously more than 2 seconds; please refer 10.4.3.

10.6. Switch Detector

The AK1594 samples status of SW2, SW3 and SW4 falling edges by 7.8125ms cycle. When the AK1594 detects same status for the second time in a low, the switch status is updated at the next sampling timing. Refer Figure 18 Timing chart of SW2/SW3/SW4 Detector.

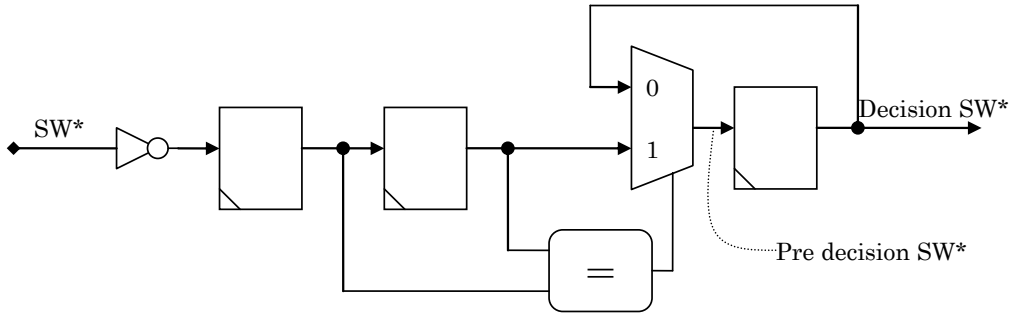


Figure 17 Circuit of SW2/SW3/SW4 Detector

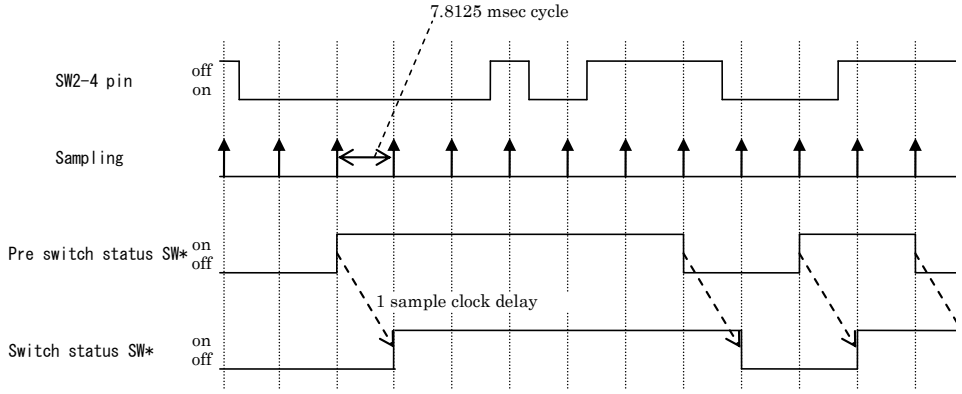


Figure 18 Timing chart of SW2/SW3/SW4 Detector

10.7. Battery monitor

The battery monitor controls LED and can set the AK1594 in power down.

LED Control
The battery monitor controls LED light ON or blinks when AVDD voltage drops below Detect Voltage1 (VALERT).

Power down controller
The battery monitor sets the AK1594 in full power down status when AVDD voltage drops below Detect Voltage 2N or Detect Voltage2H. (VSLEEPN or VSLEEPH)

This function is controlled by {BAT_EN}. Detect voltage1 is not available when {POWR_MODE} = “0b10”, or “0b11”.
Refer to 7.3 Characteristics of Battery monitor.

10.8. LED

The AK1594 has handy LED functions to know device status. LED pin drives 1mA or 3mA setting by {I_LED}. To disable LED function for saving power consumption, LED pin should be set to open or disable all registers listed below. ({SW1LED_EN} = {SW2LED_EN} = {SW3LED_EN} = {SW4_LED_EN} = {BAT_LED_EN} = “0b0”)

LED Blink Mode	EEPROM Setting	LED Status
SW1pin falling	{SW1LED_EN} = “0b1” : LED enable ({SW1LED_EN} = “0b0” : LED disable)	Normally on during SW1 pin = “L”
SW2pin falling	{SW2LED_EN} = “0b1” : LED enable ({SW2LED_EN} = “0b0” : LED disable)	Normally on during SW2 pin = “L”
SW3pin falling and {SW3_FUNC}=”0b0”	{SW3_FUNC}= “0b0” and {SW3LED_EN} = “0b1” : LED enable ({SW3LED_EN} = “0b0” : LED disable)	As many state when SW3 pin Falling
SW3pin falling and {SW3_FUNC}=”0b1”	{SW3_FUNC}= “0b1” and {SW3LED_EN} = “0b1” : LED enable ({SW3LED_EN} = “0b0” : LED disable)	Cyclic 9.750s sleeps and 0.25s blinks after SW3 pin falling
SW4pin Falling	{SW4_LED_EN} = “0b1”: LED enable ({SW4_LED_EN} = “0b0”: LED disable	As many state when SW4 pin falling
AVDD voltage drops below Detect voltage1 at Normal Power Mode	{BAT_EN} = “0b1” and {BAT_LED_EN} = “0b1” : LED enable ({BAT_LED_EN} = “0b0” : LED disable)	{BAT_SEL1} = “0b0” :LED On {BAT_SEL1} = “0b1”: Cyclic 9.750s sleeps and 0.25s blinks.

11. Power-up Sequence

AK1594 Power-up sequence is below.

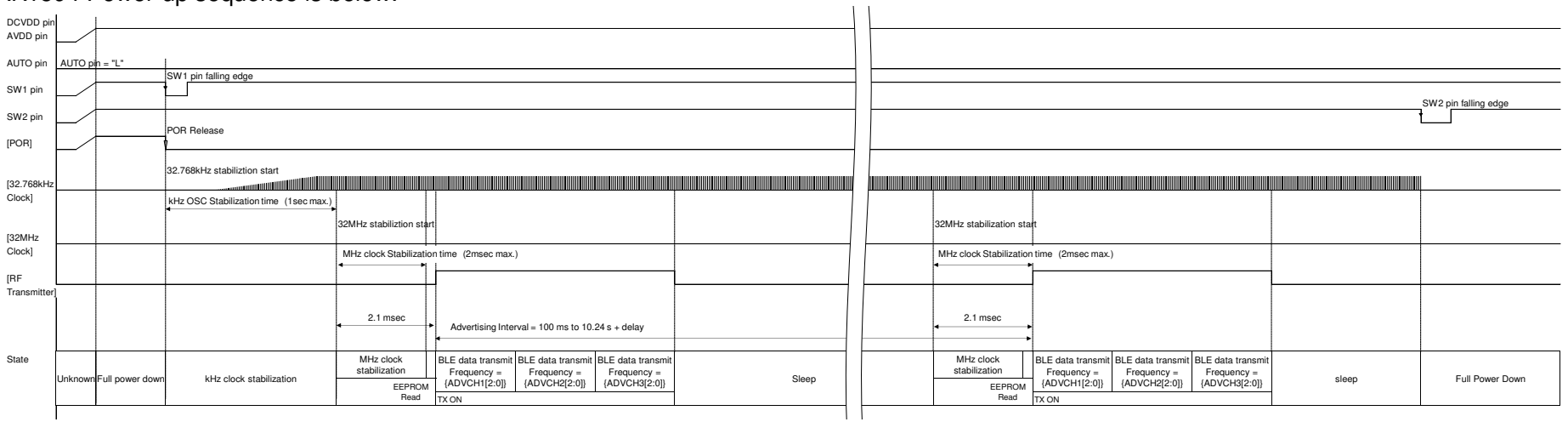


Figure 19 Power-up sequence (AUTO pin = “L”)