## INTRODUCTION

S5T8610 provides low cost digital communication solution in 900 MHz wideband cordless phone. It replaces the compander of an analog wideband cordless phone. It has internal analog-to-digital and digital-to-analog converters to reduce system cost.

S5T8610 provides the full advantages of digital communication such as security, higher resistance to noise, and lowest cost solution in today's digital cordless phone ICs. Furthermore, S5T8610 offers error concealment at 16 kbps ADPCM transmission to provide longer communication range.

64-QFP-1414
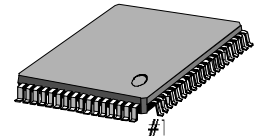
FEATURES

- Operating voltage range: 3.0V to 3.6V

- System main clock: 36.8 MHz or 36.864 MHz

- Serial host interface

- Internal ADC and DAC for modem

- Internal voice CODEC for ADPCM

- 8 Phase DPSK

- 24kbps/16kbps ADPCM

- Error concealment for 16kbps ADPCM

- Loop back test

- Encryption/Decryption

- DTMF Generator

- Digital Volume Control

- typical application
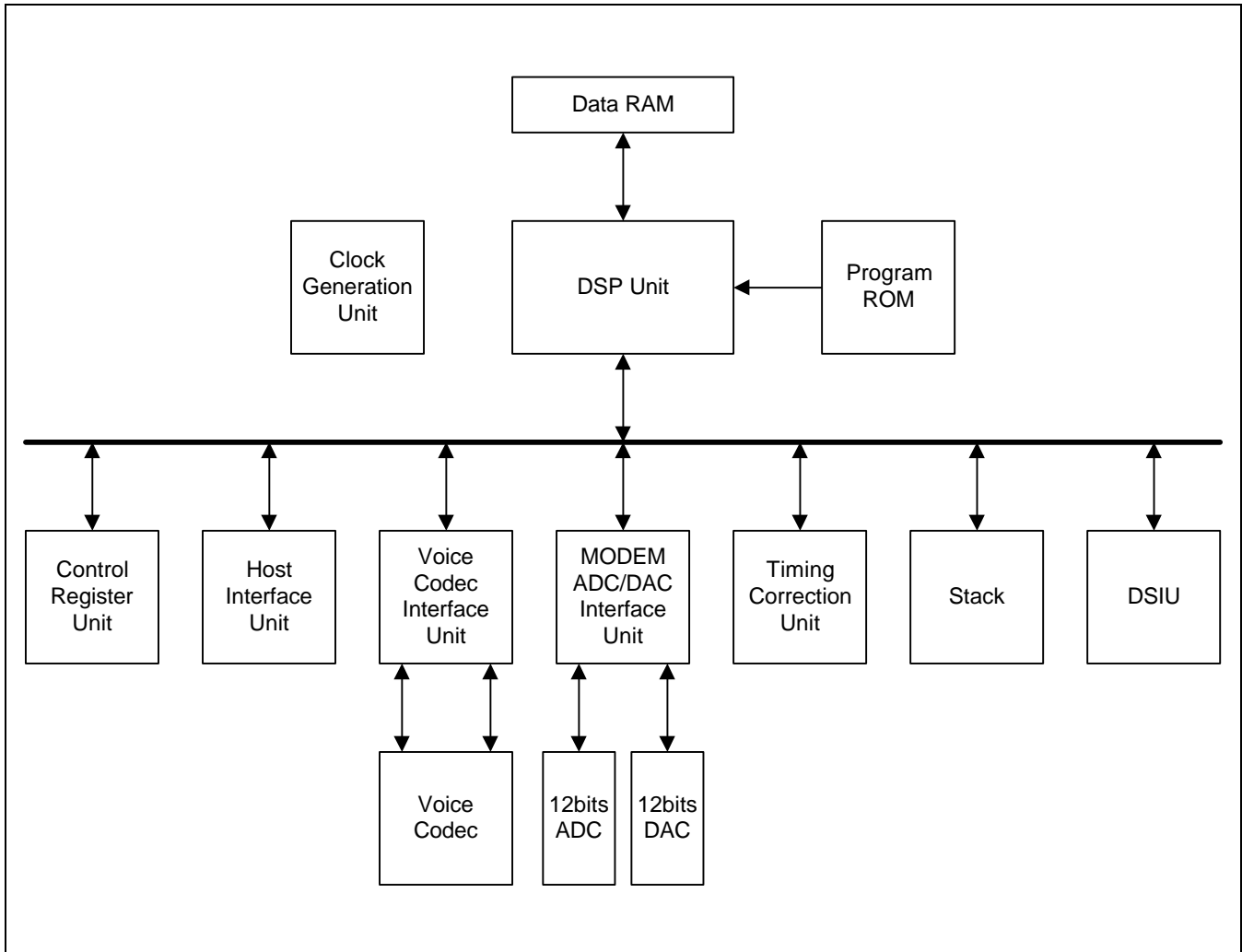
ISM band digital cordless phone
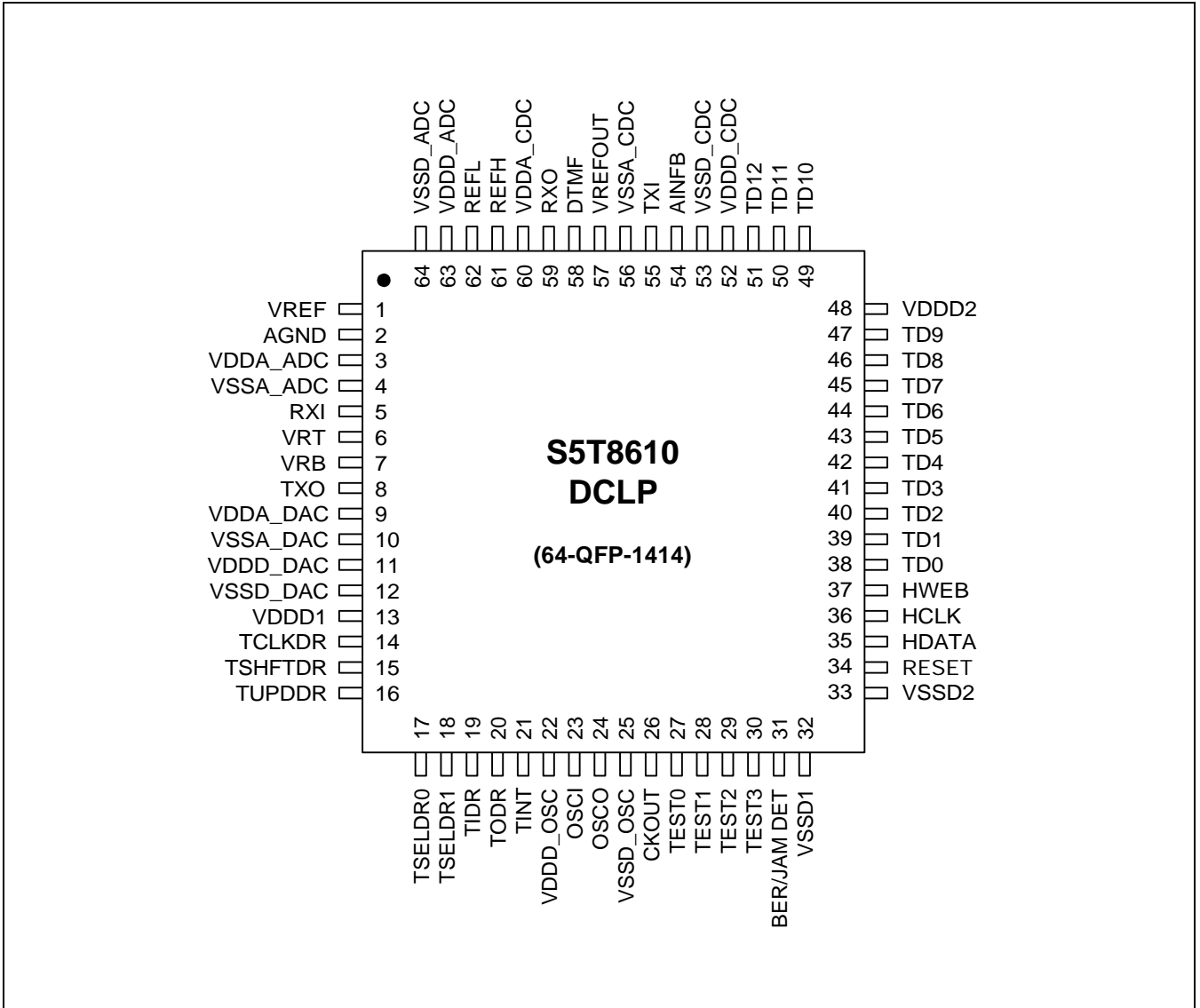
ORDERING INFORMATION

Device	Package	Operating Temperature
++ S5T8610X01-Q0R0	64-QFP-1414	-20 °C to +75 °C

++: Under development

BLOCK DIAGRAM

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PIN CONFIGURATION

Pin configuration diagram of S5T8610 DCLP (64-QFP-1414)

Top pins (left to right): 64 VSSD_ADC, 63 VDDD_ADC, 62 REFL, 61 REFH, 60 VDDA_CDC, 59 RXO, 58 DTMF, 57 VREFOUT, 56 VSSA_CDC, 55 TXI, 54 AINFB, 53 VSSD_CDC, 52 VDDD_CDC, 51 TD12, 50 TD11, 49 TD10

Left pins (top to bottom): 1 VREF, 2 AGND, 3 VDDA_ADC, 4 VSSA_ADC, 5 RXI, 6 VRT, 7 VRB, 8 TXO, 9 VDDA_DAC, 10 VSSA_DAC, 11 VDDD_DAC, 12 VSSD_DAC, 13 VDDD1, 14 TCLKDR, 15 TSHFTDR, 16 TUPDDR

Right pins (top to bottom): 48 VDDD2, 47 TD9, 46 TD8, 45 TD7, 44 TD6, 43 TD5, 42 TD4, 41 TD3, 40 TD2, 39 TD1, 38 TD0, 37 HWEB, 36 HCLK, 35 HDATA, 34 RESET, 33 VSSD2

Bottom pins (left to right): 17 TSELDR0, 18 TSELDR1, 19 TIDR, 20 TODR, 21 TINT, 22 VDDD_OSC, 23 OSCI, 24 OSCO, 25 VSSD_OSC, 26 CKOUT, 27 TEST0, 28 TEST1, 29 TEST2, 30 TEST3, 31 BER/JAM DET, 32 VSSD1

PIN DESCRIPTION

Pin No	Symbol	I/O	Description
1	VREF	AI	Reference top (3.3V) for ADC
2	AGND	AI	Reference bottom (0V) for ADC
3	VDDA_ADC	AP	Analog power (3.3V) for ADC
4	VSSA_ADC	AG	Analog ground (0V) for ADC
5	RXI	AI	Analog input (input range: 0V to 3.3V) for ADC
6	VRT	AI	Voltage reference top (2.0V) for DAC
7	VRB	AI	Voltage reference bottom (0V) for DAC
8	TXO	AO	Analog voltage output for DAC
9	VDDA_DAC	AP	Analog power (3.3V) for DAC
10	VSSA_DAC	AG	Analog ground (0V) for DAC
11	VDDD_DAC	DP	Digital power (3.3V) for DAC
12	VSSD_DAC	DG	Digital ground (0V) for DAC
13	VDDD1	DP	Digital power (3.3V) for DSP core
14	TCLKDR	DI	Test clock
15	TSHFTDR	DI	Test scan shift enable
16	TUPDDR	DI	Test scan update
17	TSELDR0	DI	Test scan register selection 0
18	TSELDR1	DI	Test scan register selection 1
19	TIDR	DI	Test scan input
20	TODR	DO	Test scan output
21	TINT	DO	Interrupt check
22	CKOUT	DO	Test clock output
23	VDDD_OSC	DP	Digital power (3.3V) for oscillator block
24	OSCI	I	Oscillator input
25	OSCO	O	Oscillator output
26	VSSD_OSC	DG	Digital ground (0V) for oscillator block
27	TEST0	DI	Test
28	TEST1	DI	Test
29	TEST2	DI	Test
30	TEST3	DI	Test
31	SYNCH/BER/JAM	DO	Initial synchronization / BER (bit error rate) / jamming detection output
32	VSSD1	DG	Digital ground (0V)

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PIN DESCRIPTION (Continued)

Pin No	Symbol	I/O	Description
33	VSSD2	DG	Digital ground (0V)
34	RESET	DI	System reset (Reset: high, Normal: low)
35	HDATA	DB	Host data
36	HCLK	DI	Host interface clock
37	HWEB	DI	Host read/write signal (R: high, W: low)
38	TCK	DI	Test data input
39	TD0	DB	Test data input/output
40	TD1	DB	Test data input/output
41	TD2	DB	Test data input/output
42	TD3	DB	Test data input/output
43	TD4	DB	Test data input/output
44	TD5	DB	Test data input/output
45	TD6	DB	Test data input/output
46	TD7	DB	Test data input/output
47	TD8	DB	Test data input/output
48	VDDD2	DP	Digital power (3.3V) for DSP core
49	TD9	DB	Test data input/output
50	TD10	DB	Test data input/output
51	TD11	DB	Test data input/output
52	VDDD_CDC	AP	Digital power (3.3V) for CODEC
53	VSSD_CDC	AG	Digital ground (0V) for CODEC
54	AINFB	AO	Analog input gain control for CODEC
55	TXI	AI	ADC analog input for CODEC
56	VSSA_CDC	AG	Analog ground (0V) for CODEC
57	VREFOUT	AO	Vref output for CODEC (Vref = 1/2 V_{DD})
58	DTMF	AO	DTMF output for CODEC
59	RXO	AO	DAC analog output for CODEC
60	VDDA_CDC	AP	Analog power for CODEC
61	REFH	AI	Analog reference power (3.3V) for CODEC
62	REFL	AI	Analog reference ground (0V) for CODEC
63	VDDD_ADC	AP	Digital power (3.3V) for ADC
64	VSSD_ADC	AG	Digital ground (0V) for ADC

ABSOLUTE MAXIMUM RATINGS

Characteristic	Symbol	Value	Unit
Supply Voltage	V_{DD}	-0.3 to 3.8	V
Input Voltage	V_{IN}	-0.3 to 3.8	V
Storage Temperature Range	T_{STG}	-40 to 125	°C
Operating Temperature Range	T_{OPR}	-25 to 75	°C

ELECTRICAL CHARACTERISTICS

Recommended Operating Conditions

Characteristic	Symbol	Value	Unit
Supply Voltage	V_{DD}	3.0 to 3.3	V
Operating Temperature Range	T_{OPR}	-10 to 70	°C

DC Characteristics

(Ta = 25°C, V_{DD} = 3.3V, Unless otherwise specified)

Characteristic	Symbol	Test Conditions	Min	Typ	Max	Unit	Comment
Operating Voltage	V_{DD}	-	3.0	-	3.6	V	-
Operating Current	I_{DD}	-	-	30	-	mA	-
'H' Input Voltage1	V_{IH}	-	$0.8V_{DD}$	-	-	V	(1)
'L' Input Voltage1	V_{IL}	-	-	-	$0.2V_{DD}$	V	
'H' Output Voltage1	$V_{OH(1)}$	I_{OH} = -1mA	V_{DD}-0.2	-	-	V	(2)
'L' Output Voltage1	$V_{OL(1)}$	I_{OL} = 1mA	-	-	0.4	V	
'H' Output Voltage2	$V_{OH(2)}$	I_{OH} = -1mA	V_{DD}-0.2	-	V_{DD}	V	(3)
'L' Output Voltage2	$V_{OL(2)}$	I_{OL} = 1mA	0	-	0.4	V	
Input Leak Current1	I_{LKG1}	V_I = 0 to V_{DD}	-10	-	10	μA	(4)
Input Leak Current2	I_{LKG2}	V_I = 0 to V_{DD}	-10	-	10	μA	(5)

NOTES:

1. Related pins: All Input, Bi-direction pin (input mode)
2. Related pins: All Output pin
3. Related pins: All Bi-direction pin (output mode)
4. Related pins: All Input pin, Bi-direction pin (input mode) < expect OSCI pin>
5. Related pins: OSCI

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DTMF Generator

(Ta = 25°C, V_{DD} = 3.3V, Unless otherwise specified)

Characteristic	Symbol	Test Conditions	Min	Typ	Max	Unit
Tone Output Level	$V_{O(TONE)}$	R_L=5kΩ	-14	-	-11	dBV
Column to Row Ratio	dBCR	R_L=5kΩ	1	2	3	dB
THD (Dual Tone)	THD	RL=5kΩ, 1MHz bandwidth	-	-	5	%

8 kHz Sigma-Delta Voice CODEC

— Measure Bandwidth: 20Hz - 4kHz

— Input sine wave 1kHz, Fs = 8kHz

(Ta = 25°C, V_{DDA} = 3.3V, Unless otherwise specified)

Characteristic	Symbol	Test Conditions	Min	Typ	Max	Unit
Resolution	RS	-	-	14	-	bits
Sampling Rate	SR	-	-	8	-	kHz
ADC analog Input Characteristics						
Signal to Distortion Ratio	SDR	0dB Input : Linear	70	75	–	dB
Offset Error	V_{OFS}	-	-	-	± 20	mV
Input Voltage Range	V_{IN}	-	-	2	-	V_{PK-PK}
DAC analog Output Characteristics						
Signal to Distortion Ratio	SDR	0dB Input : Linear	70	75	–	dB
Offset Error	V_{OFS}	-	-	-	–	mV
Output Voltage Range	V_{OUT}	0dB Volume Control	-	20	-	mVrms

12 Bit 500kHz ADC (Modem RX ADC)

(Ta = 25°C, V_{DDA} = 3.3V, V_{REF} = 3.3V, Unless otherwise specified)

Characteristic	Symbol	Test Conditions	Min	Typ	Max	Unit
Maximum Conversion Rate	Fc	data = 200kHz	–	–	500	kHz
Total Harmonic Distortion	THD	Fckin = 2.5MHz AINT = 100kHz	–	-68	-60	dB
Signal-to-Noise & Distortion Ratio	SNDR	Fckin = 2.5MHz AINT = 100kHz	56	62	–	dB
Input Voltage	V_{IN}	–	–	–	3.3	V_{PK-PK}

12 Bit 200kHz DAC (Modem TX DAC)

(Ta = 25°C, V_{DDA} = 3.3V, V_{RT}=2.0V, V_{RB} = 0.0V, Load Cap = 25pF, Unless otherwise specified)

Characteristic	Symbol	Min	Typ	Max	Unit	Conditions
Maximum Conversion Rate	Fc	–	–	500	kHz	data = 200kHz
Total Harmonic Distortion	THD	–	-68	-60	dB	Fckin = 2.5MHz AINT = 100kHz
Signal-to-Noise & Distortion Ratio	SNDR	56	62	–	dB	Fckin = 2.5MHz AINT = 100kHz
Output Voltage	V_{OUT}	–	–	2	V_{PK-PK}	–

Host Interface Unit (HCLK, HDATA, HWEB)

(Ta = 25°C, V_{DD} = 3.3V, Unless otherwise specified)

Characteristic	Symbol	Min	Typ	Max	Unit
Clock Frequency (1/Tck)	Fck	–	–	1.67	MHz
Clock Pulse Width	Twck	750	–	–	ns
Setup Time	Ts	300	–	–	ns
Hold Time	Th	300	–	–	ns

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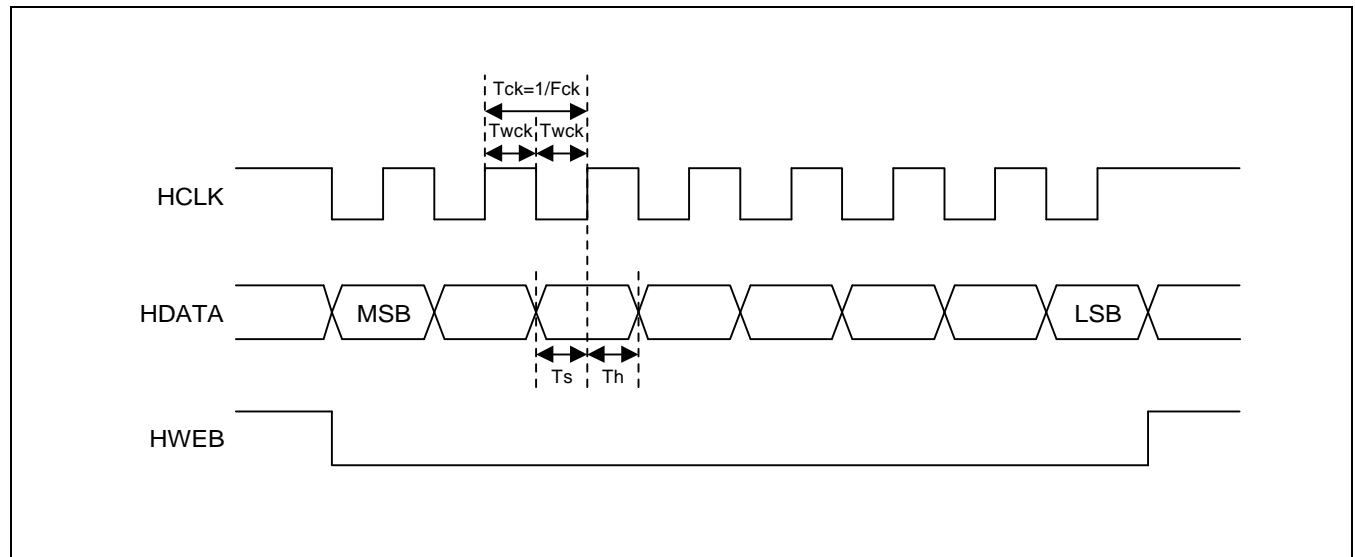
HARDWARE DESCRIPTION

Voice Codec

S5T8610 offers an internal voice codec (ADC and DAC), with 14 bit resolution and sampling frequency of 8kHz. Its electrical characteristics are shown in the previous section.

Modem Rx ADC

S5T8610 offers an internal ADC for the modem's receiver. The ADC has 12 bit resolution and can operate up to a sampling rate of 500kHz. In S5T8610, the operating ADC sampling frequency is 48kHz. Its electrical characteristics are shown in the previous section.

Modem Tx DAC

S5T8610 offers an internal DAC for the modem's transmitter. The DAC has 12 bit resolution and can operate up to a sampling rate of 200kHz. In S5T8610, the operating DAC sampling frequency is 48kHz. Its electrical characteristics are shown in the previous section.

Oscillator

— When inputting a pulse signal to the OSCI pin (36.8 MHz)

(Ta = 25°C, V_{DD} = 3.3V, Unless otherwise specified)

Characteristic	Symbol	Min	Typ	Max	Unit
'H' level pulse width	Twh	–	13.6	–	ns
'L' level pulse width	Twl	–	13.6	–	ns
Pulse width	Tck	–	27.2	–	ns
Input 'H' level	Vih	$0.8V_{DD}$	–	–	V
Input 'L' level	Vil	–	–	$0.2V_{DD}$	V
Rising & Falling time	Tr, Tf	–	–	0.8	ns
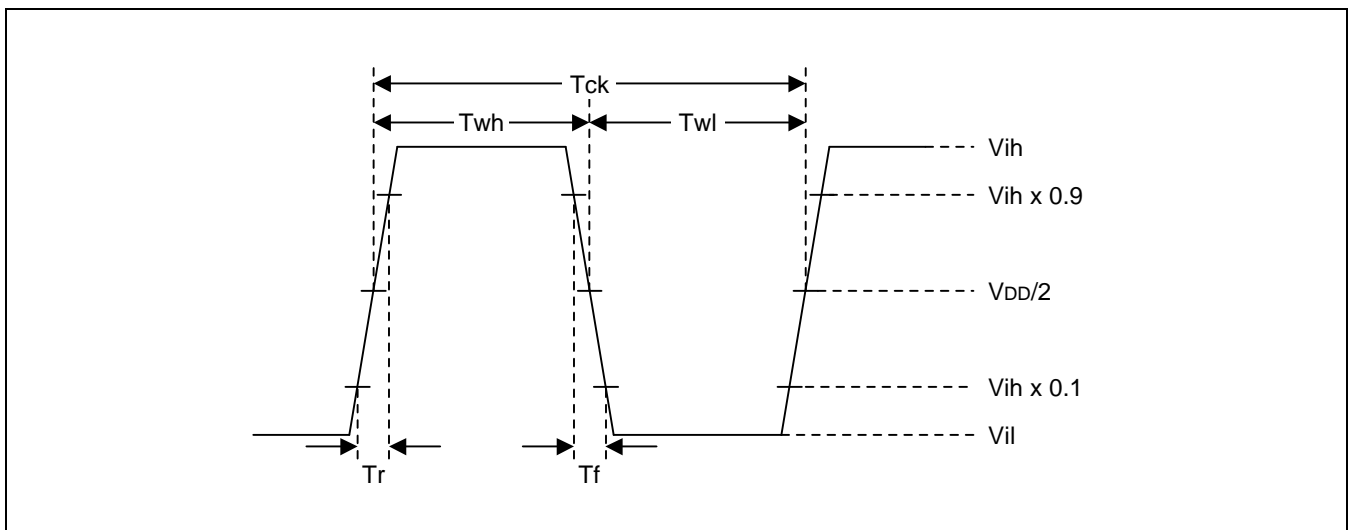
Host Interface Unit

S5T8610 receives commands and parameters in serial format, starting from the MSB, from the host through the host interface unit (HIU). The data is in byte units. The HIU has HWEB (Host Write Enable), HCLK (Host Interface Clock), and HDATA (Host Data) pins. The maximum HBCK frequency is 4MHz. S5T8610 can accept the host command every 20μsec.

Characteristic	Symbol	MIN	TYP	MAX	Unit
Clock Frequency (1/Tck)	Fck	–	–	1.67	MHz
Clock Pulse Width	Twck	750	–	–	ns
Setup Time	Ts	300	–	–	ns
Hold Time	Th	300	–	–	ns
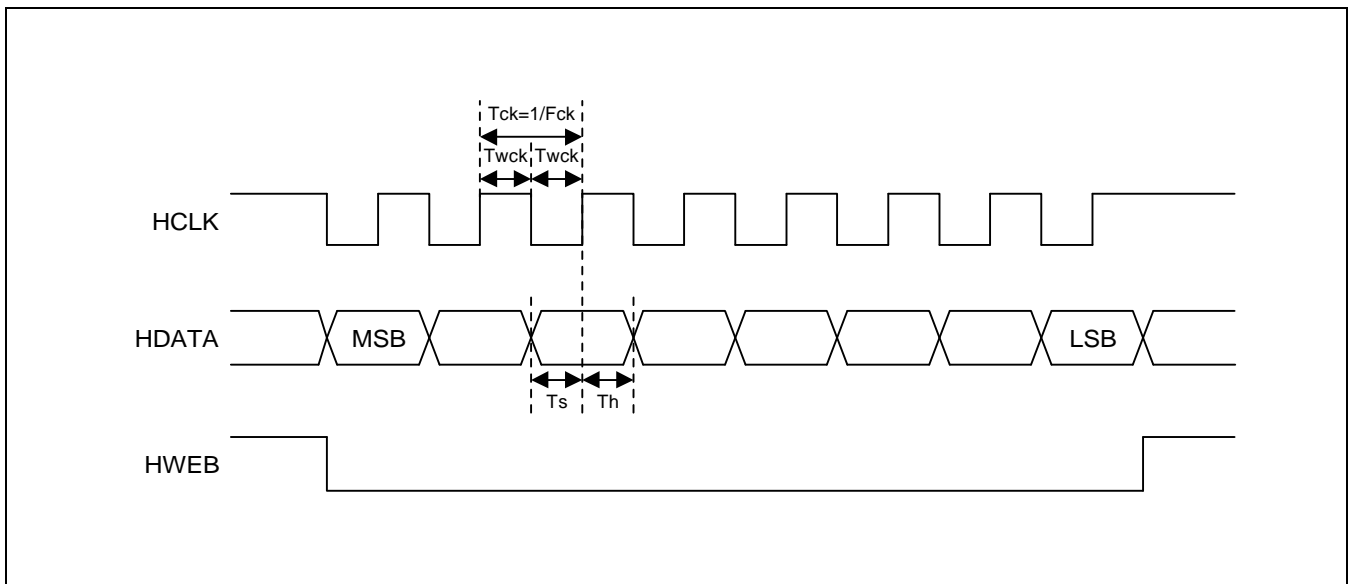
System Clock

S5T8610 operates only with 36.8 MHz or 36.864 MHz external clock.
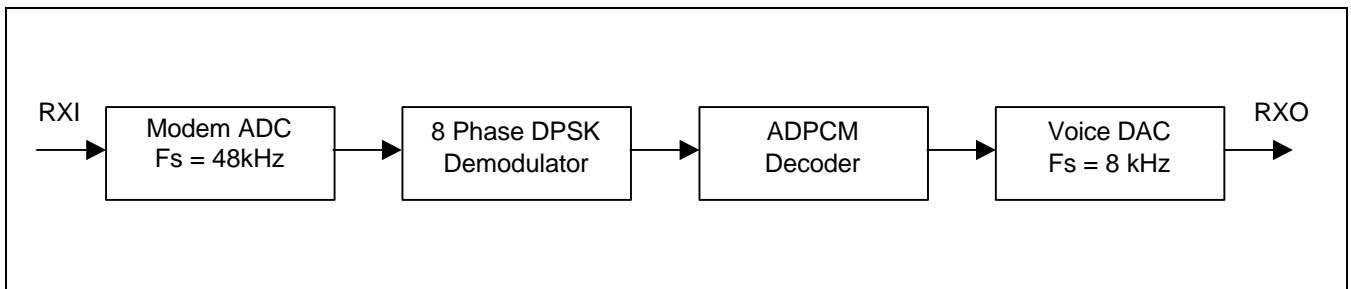
Reset

S5T8610 provides power-on-reset circuit and RESET pin for external hardware reset. For power-on-reset, the RESET signal is held normally low. For the external hardware reset, the device is in the reset state when the host sets RESET signal to high. The device is in the operating state, when the host inputs low to the RESET pin.

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FUNCTIONAL DESCRIPTION

The main feature of S5T8610 is the digital communication between the hand set and the base set. The device accepts analog voice signal through the TXI pin. The analog signal is converted into digital signal by the internal voice codec. The digital voice signal is then compressed by ADPCM into either 24kbps or 16kbps. The compressed signal is then digitally modulated by 8 DPSK algorithm. The modulated signal is converted into analog signal by internal modem DAC and finally output to the FM transmitter, through the TXO pin.

TXI → Voice ADC Fs = 8kHz → ADPCM Encoder → 8 Phase DPSK Modulator → Modem DAC Fs = 48 kHz → TXO
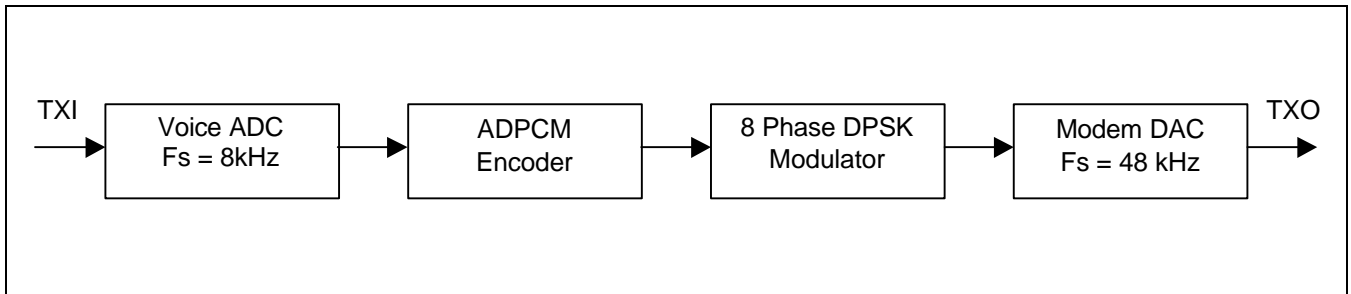
At the receiving side, S5T8610 accepts the modem signal from the FM receiver, through the RXI pin, and converts it into digital by internal modem ADC. The received signal is demodulated and decompressed into digital voice signal. The digital voice signal is finally converted into analog by the internal voice codec, output, through the RXO pin, to the external amplifier, and then to the speaker.

RXI → Modem ADC Fs = 48kHz → 8 Phase DPSK Demodulator → ADPCM Decoder → Voice DAC Fs = 8 kHz → RXO

Initially S5T8610 is in the idle state after being reset by either the power-on-reset or external hardware reset. As default, the S5T8610 is set to base set. For the base set, S5T8610 waits for the four bytes of the encryption ID. For the hand set, S5T8610 must first receive the modem control command specifying the system is a hand set. After receiving the modem control command, S5T8610 must receive four consecutive bytes of encryption ID for encryption. S5T8610 can accept the first command from the host 72 μsec after a reset. After the first command, the time between two consecutive commands must be at least 20μsec.
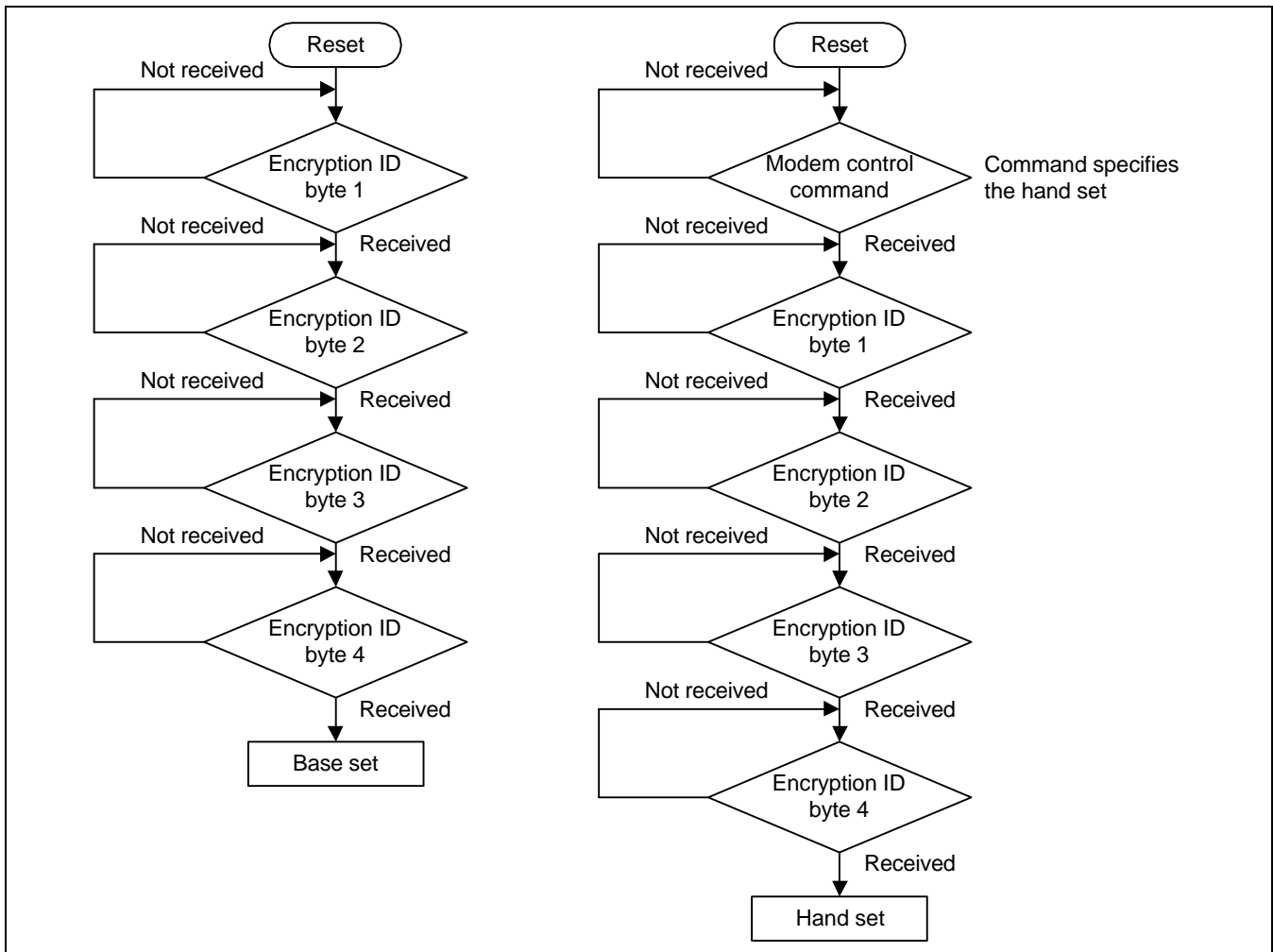
After specifying the hand or base set and encryption ID, the host can operate the S5T8610 in other modes by sending the modem control command specifying the corresponding mode.
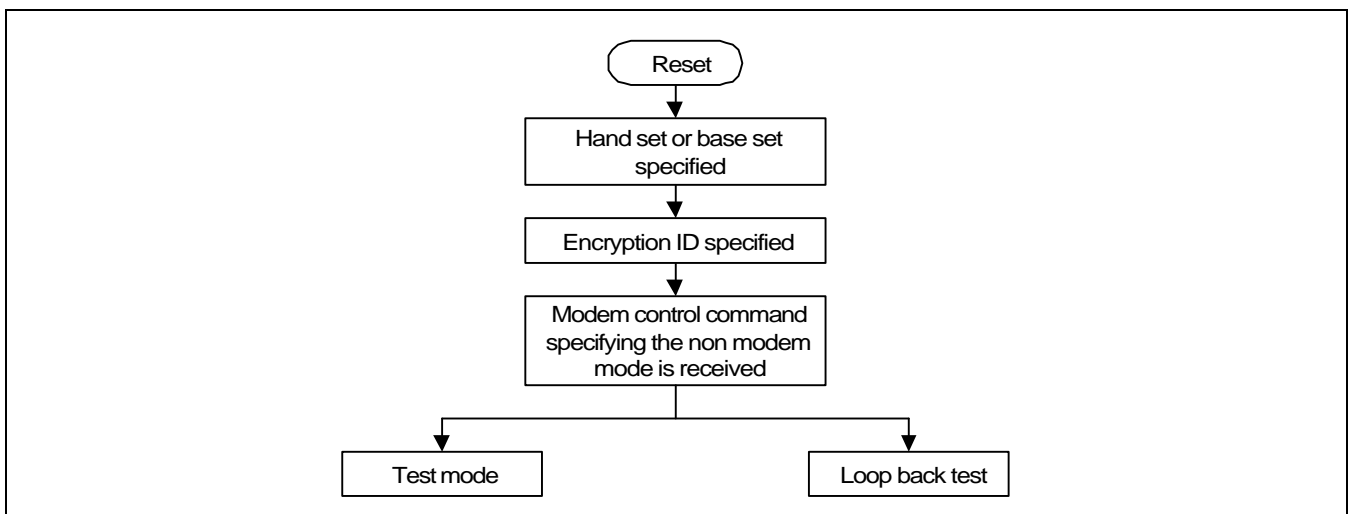
Encryption/Decryption

S5T8610 provides security by encryption. The encryption is achieved by using the scrambler within the modem. Before starting an operation, the host must send encryption ID to the S5T8610. The encryption ID uniquely initializes the scrambler. The encryption ID can be any number with 20 bit length which makes decoding by others almost impossible (one in million). Although the test and the loop back test modes require the encryption ID, the ID is not used for those functions.

S5T8610 only accepts data with length of 8 bits. The three MSB specify the command type. For encryption ID, the three bits are 001. Therefore, the 20 bits are divided into four 8 bit words and sent in sequence from the host.

MSB   LSB

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	1	First 5 bits of the encryption ID				

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	1	Second 5 bits of the encryption ID				

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	1	Third 5 bits of the encryption ID				

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	1	Last 5 bits of the encryption ID				

ADPCM

S5T8610 compresses voice signals by ADPCM with data rate of 24kbps or 16kbps. The default ADPCM rate is 24kbps. The 24kbps ADPCM has better sound quality than 16kbps ADPCM. However, S5T8610 does not provide error detection and concealment for 24kbps because of the high data rate.

When the Received Signal Strength Indicator (RSSI) of RF module goes to high, the host can switch the ADPCM data rate to 16kbps by sending the ADCPM control command. S5T8610 offers error detection and error concealment for 16kbps ADPCM. This function provides longer communication range with security guaranteed. By setting the BER_mute bit to 1, the modem is automatically set mute when the bit error rate is too high.

When the RSSI produces low signal or the BER pin shows indicates low bit error rate, the host can switch back the ADPCM data rate to 24kbps to offer better sound quality.

```
                          ┌─────────┐
                          │  Start  │
                          └────┬────┘
                               │
                    ┌──────────▼──────────┐
                    │   Run DCLP with     │
                    │   24 kbps ADPCM     │
        No          └──────────┬──────────┘
  ┌────────────┐               │
  │            └───────────────┤
  │                    ╱────────▼────────╲
  │                   ╱   RSSI produces   ╲
  └──────────────────▏   high signal?     ▏
                      ╲                   ╱
                       ╲────────┬────────╱
                                │ Yes
                    ┌───────────▼─────────┐
                    │   DCLP tx mute on   │
                    └───────────┬─────────┘
                                │                   To indicate base set
                    ┌───────────▼─────────┐         (hand set) that ADPCM
                    │   Send FSK data     │         is changed to 16 kbps
                    └───────────┬─────────┘
                                │
                    ┌───────────▼─────────┐
                    │   Set ADPCM to      │
                    │   16 kbps           │
                    └───────────┬─────────┘
                                │
                    ┌───────────▼─────────┐
                    │   DCLP tx mute off  │
                    └───────────┬─────────┘
                                │
                    ┌───────────▼─────────┐
                    │   Run DCLP with     │
                    │   16 kbps ADPCM     │
                    └─────────────────────┘
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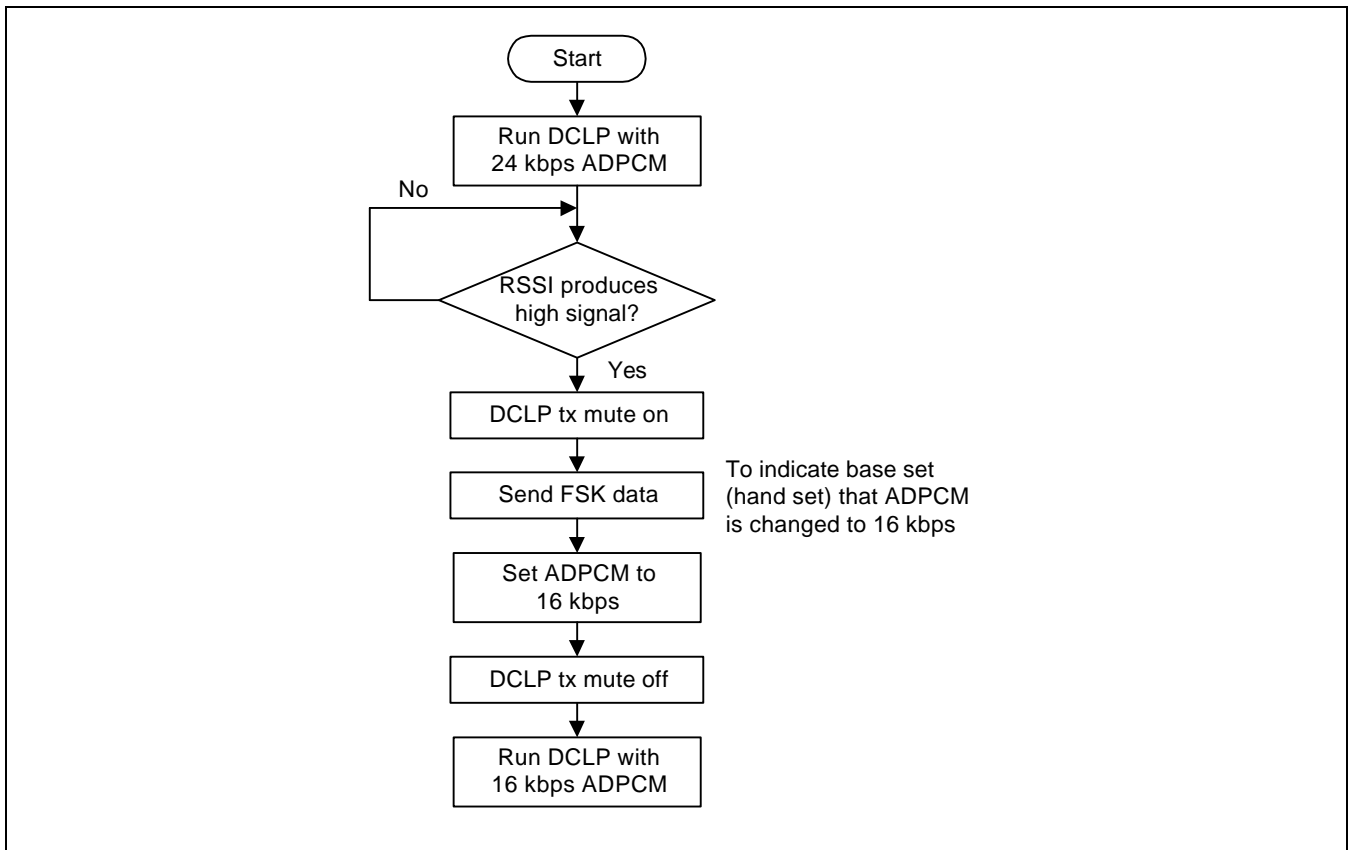
Hand set (base set) detects low signal and switches to 16 kbps ADPCM

```
                          ┌─────────┐
                          │  Start  │
                          └────┬────┘
                               │
                    ┌──────────▼──────────┐
                    │   Run DCLP with     │
                    │   24 kbps ADPCM     │
        No          └──────────┬──────────┘
  ┌────────────┐               │
  │            └───────────────┤
  │                    ╱────────▼────────╲
  │                   ╱   Received FSK    ╲         Data indicates that
  └──────────────────▏     data?          ▏────────ADPCM changed
                      ╲                   ╱         to 16 kbps
                       ╲────────┬────────╱
                                │ Yes
                    ┌───────────▼─────────┐
                    │   Set ADPCM to      │
                    │   16 kbps           │
                    └───────────┬─────────┘
                                │
                    ┌───────────▼─────────┐
                    │   Run DCLP with     │
                    │   16 kbps ADPCM     │
                    └─────────────────────┘
```
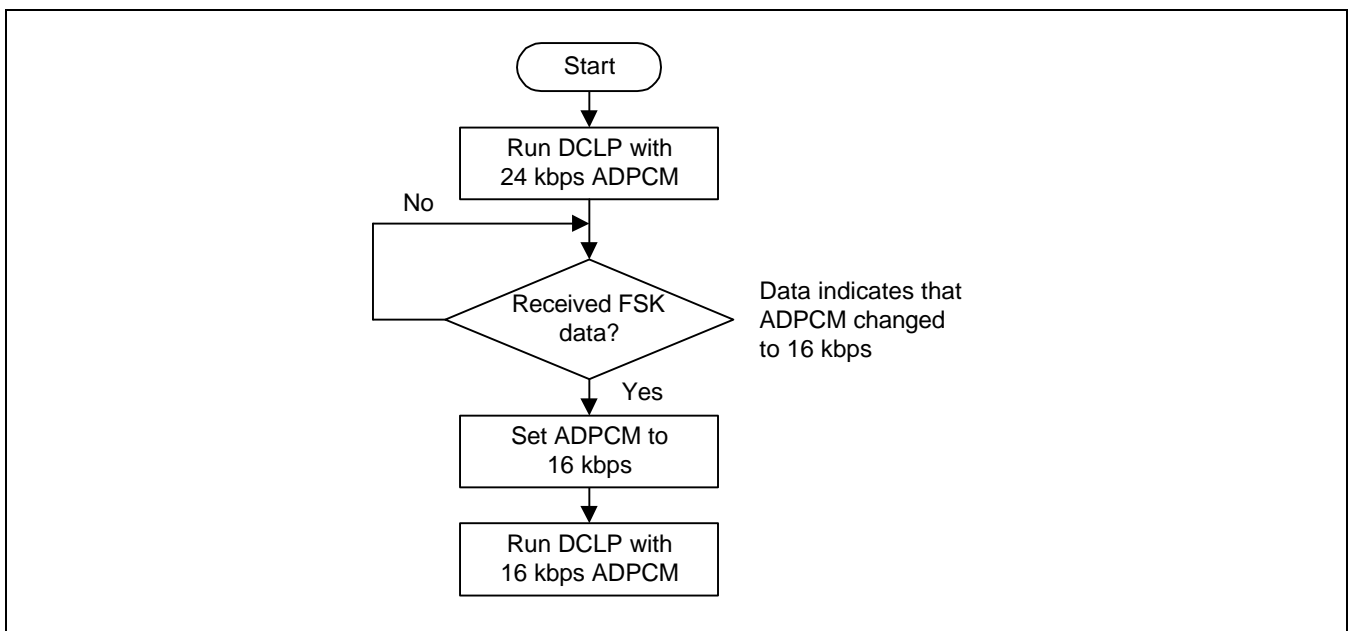
Base set (hand set) changes to 16kbps ADPCM in response to the hand set (base set)

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SYNCH/BER/JAM Pin

The SYNCH/BER/JAM pin is used for three purposes. The first is to signal the host that the initial synchronization between the hand set and base set is established. The second, used only with 24kbps ADPCM, is to signal the host that jamming is detected, with the pin finally showing the bit error rate (BER). The third function is used only with 16kbps ADPCM operation mode.

ADPCM	First Pulse	Rest of Pulses
24kbps	Initial Synchronization	Jamming Detection
16kbps	Initial Synchronization	Bit Error Rate

After receiving the encryption ID from the host, the hand set and the base set modems exchange protocols to establish initial synchronization between them. Immediately after the initial synchronization, the SYNCH/BER/JAM pin produces high for 10msec. The pin normally produces low. Therefore, the first output of the SYNCH/BER/JAM pin is always the high signal for 10msec, representing the initial synchronization.

While the 16kbps ADPCM is running, S5T8610 can detect error and indicate the BER through the SYNCH/BER/JAM pin. When an error is detected, the pin is set high for a given time duration. The duration of the high signal represents the BER range. After producing high, the pin produces low for 20msec before detecting the next BER. The following table shows BER ranges with their assigned pulse duration. For BER lower than 1.99×10^{-8}, the pin does not produce high since the error is insignificant.

BER		Symbol Error Rate		Time Between Error		Pulse Duration
From	To	From	To	From	To	
above 4.16×10^{-2}		Above 2^{-3}		below 1 msec		20 msec
4.16×10^{-2}	2.08×10^{-2}	2^{-3}	2^{-4}	1 msec	2 msec	40 msec
2.08×10^{-2}	1.04×10^{-2}	2^{-4}	2^{-5}	2 msec	4 msec	60 msec
1.04×10^{-2}	5.21×10^{-3}	2^{-5}	2^{-6}	4 msec	8 msec	80 msec
5.21×10^{-3}	2.60×10^{-3}	2^{-6}	2^{-7}	8 msec	16 msec	100 msec
2.60×10^{-3}	1.30×10^{-3}	2^{-7}	2^{-8}	16 msec	32 msec	120 msec
1.30×10^{-3}	6.51×10^{-4}	2^{-8}	2^{-9}	32 msec	64 msec	140 msec
6.51×10^{-4}	3.26×10^{-4}	2^{-9}	2^{-10}	64 msec	128 msec	160 msec
3.26×10^{-4}	1.63×10^{-4}	2^{-10}	2^{-11}	128 msec	256 msec	180 msec
1.63×10^{-4}	8.14×10^{-5}	2^{-11}	2^{-12}	256 msec	512 msec	200 msec
8.14×10^{-5}	4.07×10^{-5}	2^{-12}	2^{-13}	512 msec	1.024 sec	220 msec
4.07×10^{-5}	2.03×10^{-5}	2^{-13}	2^{-14}	1.024 sec	2.048 sec	240 msec
2.03×10^{-5}	1.02×10^{-5}	2^{-14}	2^{-15}	2.048 sec	4.096 sec	260 msec
1.02×10^{-5}	5.09×10^{-6}	2^{-15}	2^{-16}	4.096 sec	8.192 sec	280 msec
5.09×10^{-6}	2.54×10^{-6}	2^{-16}	2^{-17}	8.192 sec	16.384 sec	300 msec
2.54×10^{-6}	1.27×10^{-6}	2^{-17}	2^{-18}	16.384 sec	32.768 sec	320 msec
1.27×10^{-6}	6.36×10^{-7}	2^{-18}	2^{-19}	32.768 sec	1 min 5.5 sec	340 msec

| BER		Symbol Error Rate		Time Between Error		Pulse Duration
From	To	From	To	From	To	
6.36×10^{-7}	3.18×10^{-7}	2-19	2-20	1 min 5.5 sec	2min 11.1 sec	360 msec
3.18×10^{-7}	1.59×10^{-7}	2-20	2-21	2 min 11.1 sec	4 min 22.1 sec	380 msec
1.59×10^{-7}	7.95×10^{-8}	2-21	2-22	4 min 22.1 sec	8 min 44.3 sec	400 msec
7.95×10^{-8}	3.97×10^{-8}	2-22	2-23	8 min 44.3 sec	17 min 28.6 sec	420 msec
3.97×10^{-8}	1.99×10^{-8}	2-23	2-24	17 min 28.6 sec	34 min 57.2 sec	440 msec

BER of 3.33×10^{-3} detected
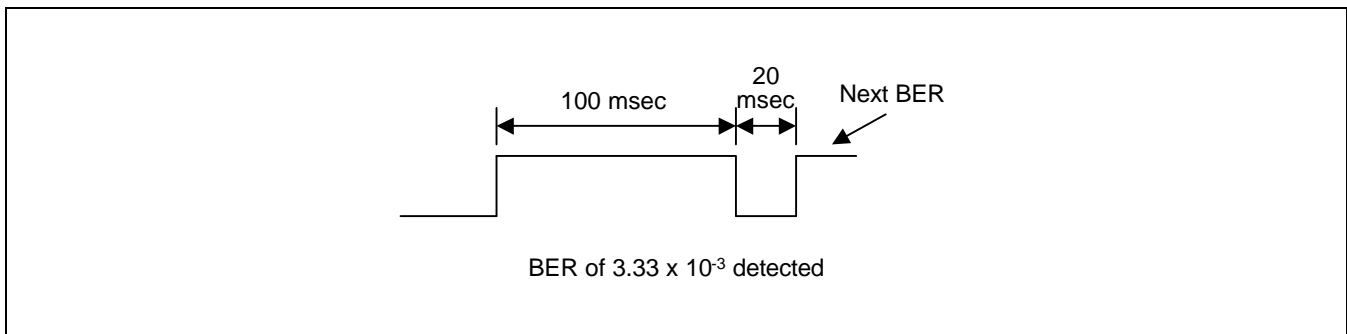
For 24kbps ADPCM, this pin produces high for 20msec when jamming is detected. After producing high, the BER pin produces low for 20msec before detecting the next jamming. Jamming detection is not necessary for 16kbps ADPCM, since BER can be used for detecting jamming.

Jamming detection in 24 kbps ADPCM
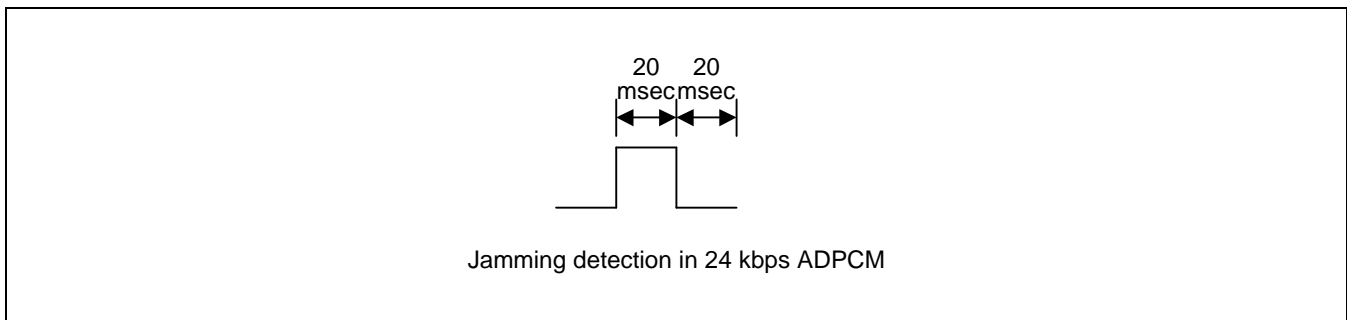
DTMF Generator

In order to generate a DTMF signal, the host must set S5T8610 to DTMF mode. S5T8610 outputs the DTMF tone through the DTMF pin. The RXO pin is set mute during the DTMF mode. The hand set and the base set still communicate with each other so that the DTMF tones can be monitored.

S5T8610 generates the DTMF tone for 100msec when the tone code is received from the host. After generating the tone for 100msec, the DTMF pin produces low for the next 50msec. After generating DTMF tones, the host can set S5T8610 back to normal operation, ADPCM and modem, using the DTMF release command.

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Typical DTMF tone generation
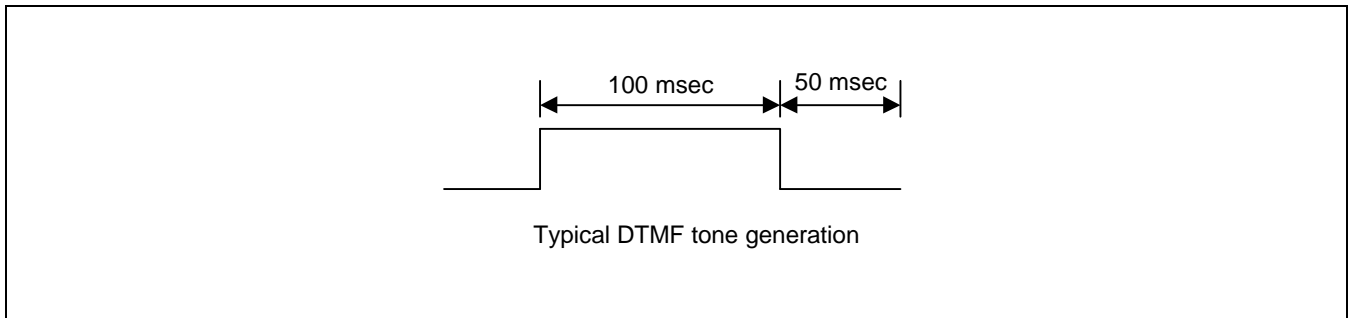
The single tone and continuous tone can be generated using the DTMF control command. The commands and tables related to DTMF generation is shown in the Command Set section.

COMMAND SET

S5T8610 receives commands from the host through its HIU. The HIU only accepts commands with length of 1 byte.

Modem Control

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	Rx_Mute	Tx_Mute	Modem Mode		

Controls the operation of the modem. When Modem_Mode is set to test mode, the S5T8610 produces 9kHz sine wave through the modem TXO pin. In the loop back test mode, the S5T86010 receives its own transmitted signal by connecting modem TXO and RXI pins.

Modem Mode (Bit 2, Bit 1, and Bit 0)

— 000: Base Set

— 001: Hand Set

— 010: Reserved

— 011: Reserved

— 100: Test Mode
   9kHz sine wave is produced through the modem Tx pin.
   Note that the receiver does not recognize the sine wave.

— 101: Loop Back Test Mode

— Default: Base Set

Tx_Mute (Bit 3)

—   Modem Tx Mute On/Off

—   0: Mute Off

—   1: Mute On

—   Default: Mute Off

Rx_Mute (Bit 4)

—   Modem Rx Mute On/Off

—   0: Mute Off

—   1: Mute On

—   Default: Mute Off

Encryption ID

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	1	5 bits of the 20 bit encryption ID				

The four consecutive encryption ID commands must be sent to S5T8610 at the beginning of an operation. The four encryption ID commands are needed because the encryption ID is 20 bits wide.

ADPCM Control

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	1	0	Reserved	Reserved	BER_Mute	Voice_Mute	ADPCM_Type

Controls ADPCM operation. In 16kbps ADPCM mode with Bit 2 set to 1, the voice output is automatically set mute when the BER is too high. The default value is 0x40.

ADPCM Type (Bit 0)

— 0: 24kbps ADPCM

— 1: 16kbps ADPCM

— Default: 24kbps ADPCM

Voice_Mute (Bit 1)

— Voice Codec Mute On/Off

— 0: Mute Off

— 1: Mute On

– Default: Mute Off

BER_Mute (Bit 2)

— Voice output is set mute when BER is high

— Applies only to 16kbps ADPCM

— 0: voice output is not set mute even when BER is too high

— 1: voice output is automatically set mute when BER is too high

— Default: Mute Off

Digital Volume Control

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	1	1	Reserved	SPK3	SPK2	SPK1	SPK0

Controls the voice output volume of the ADPCM. The default volume is 0 dB, setting this command to 0x66.

DATA				Gain/	Output Level
SPK3	SPK2	SPK1	SPK0	Attenuation	
0	0	0	0	-12 dB	5 mVrms
0	0	0	1	-10 dB	6 mVrms
0	0	1	0	-8 dB	8 mVrms
0	0	1	1	-6 dB	10 mVrms
0	1	0	0	-4 dB	13 mVrms
0	1	0	1	-2 dB	16 mVrms
0	1	1	0	0 dB (default)	20 mVrms
0	1	1	1	2 dB	26 mVrms
1	0	0	0	4 dB	33 mVrms
1	0	0	1	6 dB	42 mVrms
1	0	1	0	8 dB	53 mVrms
1	0	1	1	10 dB	67 mVrms
1	1	0	0	12 dB	84 mVrms
1	1	0	1	14 dB	108 mVrms
1	1	1	0	16 dB	135 mVrms
1	1	1	1	18 dB	170 mVrms

Voice Codec On/Off

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	1	1	0	0	1	0	VC_SW

This command is used for switching the internal voice coded on/off

VC_SW (Bit 0)

— 0: voice Codec power down

— 1: voice Codec power on (default)

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DTMF Mode On/Off

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	1	1	0	0	1	1	DTMF_SW

The host sets S5T8610 into DTMF mode by sending this command with the LSB set to 1. S5T8610 still operates the modem in DTMF mode so that the DTMF tones can be monitored. The host sets the S5T8610 back to normal operation, in which the ADPCM and modem are running, by using this command with the LSB set to 0.

DTMF_SW (Bit 0)

— 0: Normal Mode (Default)

— 1: DTMF Mode

DTMF Tone Code

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	0	0	Reserved	TC3	TC2	TC1	TC0

The DTMF tone is generated for 100msec after receiving this command. The tone is generated through the DTMF pin. The RXO pin is set mute during the DTMF generation mode. This command only operates when S5T8610 is set to DTMF mode. When DTMF mode is not set, this command is ignored. Since S5T8610 must receive this command to generate a DTMF tone, there is no default value.

DATA				DTMF Code
TC3	TC2	TC1	TC0	
0	0	0	0	D
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
1	0	1	0	*
1	0	1	1	0
1	1	0	0	#
1	1	0	1	A
1	1	1	0	B
1	1	1	1	C

	high 1	high 2	high 3	high 4
low 1	1	2	3	A
low 2	4	5	6	B
low 3	7	8	9	C
low 4	*	0	#	D

Low Freq Indicator	Specified Freq (Hz)	Actual Freq (Hz)	% Error
low 1	697	703.125	0.88 %
low 2	770	765.625	0.57 %
low 3	852	859.375	0.87 %
low 4	941	937.5	0.37 %

High Freq Indicator	Specified Freq (Hz)	Actual Freq (Hz)	% Error
high 1	1209	1203.125	0.49 %
high 2	1336	1343.75	0.58 %
high 3	1447	1484.375	0.50 %
high 4	1633	1640.625	0.47 %

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DTMF Level Control

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	0	1	Reserved	TL3	TL2	TL1	TL0

Controls output volume of the DTMF output tone. The default volume is 7.67dBm, setting this command to 0xAC.

DATA				Gain/	Output Level
TL3	TL2	TL1	TL0	Attenuation	
0	0	0	0	-16.33 dBm	13.7 mVrms
0	0	0	1	-14.33 dBm	17.3 mVrms
0	0	1	0	-12.33 dBm	21.7 mVrms
0	0	1	1	-10.33 dBm	27.3 mVrms
0	1	0	0	-8.33 dBm	34.3 mVrms
0	1	0	1	-6.33 dBm	43.2 mVrms
0	1	1	0	-4.33 dBm	54.3 mVrms
0	1	1	1	-2.33 dBm	68.4 mVrms
1	0	0	0	-0.33 dBm	86.1 mVrms
1	0	0	1	1.67 dBm	108.5 mVrms
1	0	1	0	3.67 dBm	136.5 mVrms
1	0	1	1	5.67 dBm	171.8 mVrms
1	1	0	0	7.67 dBm (default)	216.1 mVrms
1	1	0	1	9.67 dBm	273.5 mVrms
1	1	1	0	11.67 dBm	343.0 mVrms
1	1	1	1	13.67 dBm	431.5 mVrms

DTMF Control

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	1	0	Reserved	DTMF_Cont		DTMF_Mode	

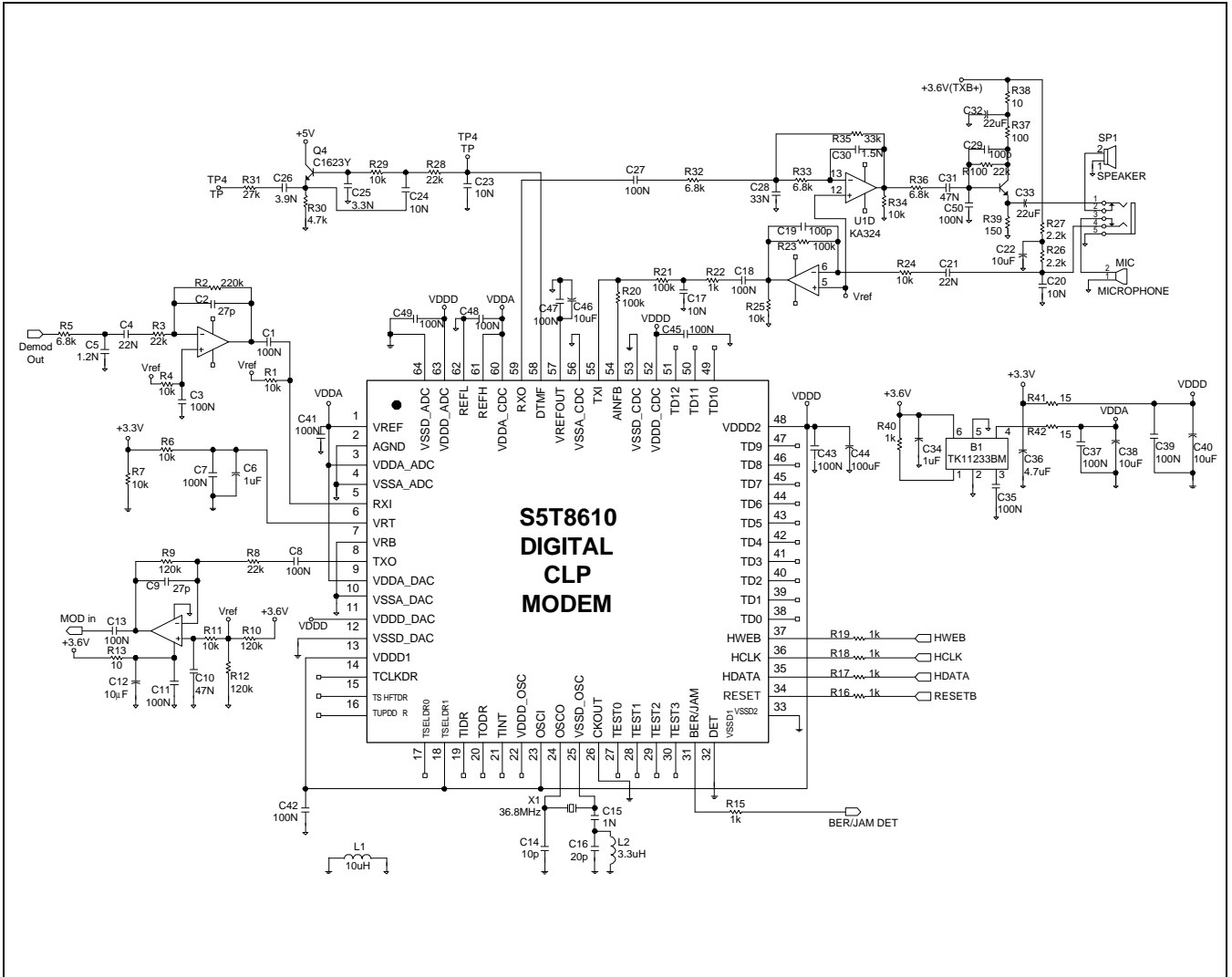Controls the DTMF generator. The default value is 0xC0.

DTMF_Mode (Bit 1 and Bit 0)

— 00: Dual Tone

— 01: Single Tone (Low Frequency Only)

— 10: Single Tone (High Frequency Only)

— Default: Dual Tone

DTMF_Cont (Bit 3 and Bit 2)

— 00: Generate DTMF tone for 100 msec followed by silence for 50 msec

— 01: Generate DTMF tone continuously

— 10: Stop generate the continuous DTMF tone

— Default: 00

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APPLICATION CIRCUIT

NOTES

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PACKAGE DIMENSIONS

64-QFP-1414

17.20 ± 0.30

14.00 ± 0.20

17.20 ± 0.30

14.00 ± 0.20

#64

#1

0.80

0.35 ± 0.10

(1.00)

0-8°

0.15 +0.10 -0.05

0.10 MAX

0.80 ± 0.20

0.05 MIN

2.60 ± 0.10

2.80 MAX

NOTE : Dimensions are in millimeters.