KS16121   DSP for Digital Answering phone with FLASH interface

INTRODUCTION

80-QFP-1420C

KS16121 is a digital signal processor IC that implements all the funct-ions and hardware interfaces necessary for voice compression, storage and digital telephone answerer.

The basic functions include low bit-rate speech compression, efficient flash memory management through table look-ups, full - duplex digital speaker phone, caller - ID reception, variable speed playback (VSP) at the rate of 50% to 200%, DTMF tone generation and detection, call progress tone detection and high quality voice prompts.

The on-chip interface units provide the access to 4M / 16M flash memories, optional ROM / EPROM and two PCM codecs without any glue logic. All the clock and control signals are generated on - chip.

KS16121 supports a simple command / status interface protocol for an external   host controller. The host writes commands to activate various modes of operations supported by the chip and reads status words to monitor its operation.

KS16121 is manufactured with SAMSUNG 0.8μCMOS technology that guarantees reliable performance with low power dissipation.
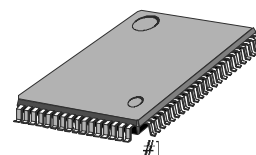
ORDERING INFORMATION

Device	Package	Operating Temperature
++KS16121Q	80 - QFP - 1420C	- 20 ºC ~ + 70 ºC

++ Under development

FEATURES

- High-performance speech compression algorithm
- Voice activation and silence compaction for longer recording time
- Digital speaker phone with acoustic and line - echo cancellers,
  full - duplex operation under the double talk condition
- Supports Caller ID Reception and Storage during on - hook / off - hook
- Advanced flash memory management for maximum recording time
  and reliable data storage
- DTMF detection with near-end echo cancellation, and programmable tone generation
- Programmable call progress tone detection for busy and / or dial tones
- Supports high-quality voice prompts from ROM / EPROM or Flash memory
- Supports multiple message attributes for time stamp, mail box and other applications
- Storage for 128 voice messages and 128 16-bit data or 32 telephone numbers
- 8-bit host interface for easy access and control
- Supports up to four 4M(512K x 8) bit or one 16M(2M x 8) bit FLASH memory
  from SAMSUNG Electronics, KM29N040 and KM29N1600

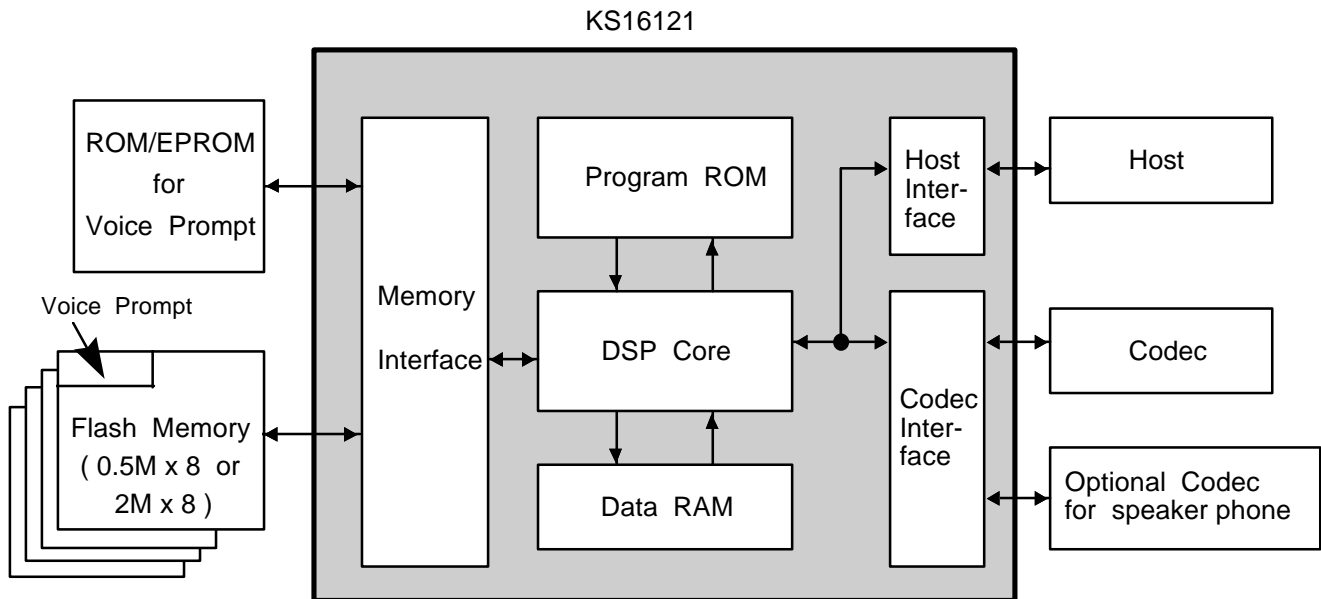**SAMSUNG** ELECTRONICS

BLOCK DIAGRAM

KS16121

Figure 1 Block Diagram of KS16121

CHIP CONFIGURATION

• KS16121

: DSP for Digital Answering Phone with SAMSUNG NAND Flash memory Interface (80 QFP)

• KS8620 / KT8554

: Analog in / out interface (μ - law PCM CODEC) -- 16 DIP / 16 WIDE SOP

1 for normal operation & 2 for speakerphone

• KM29N040 / 1600

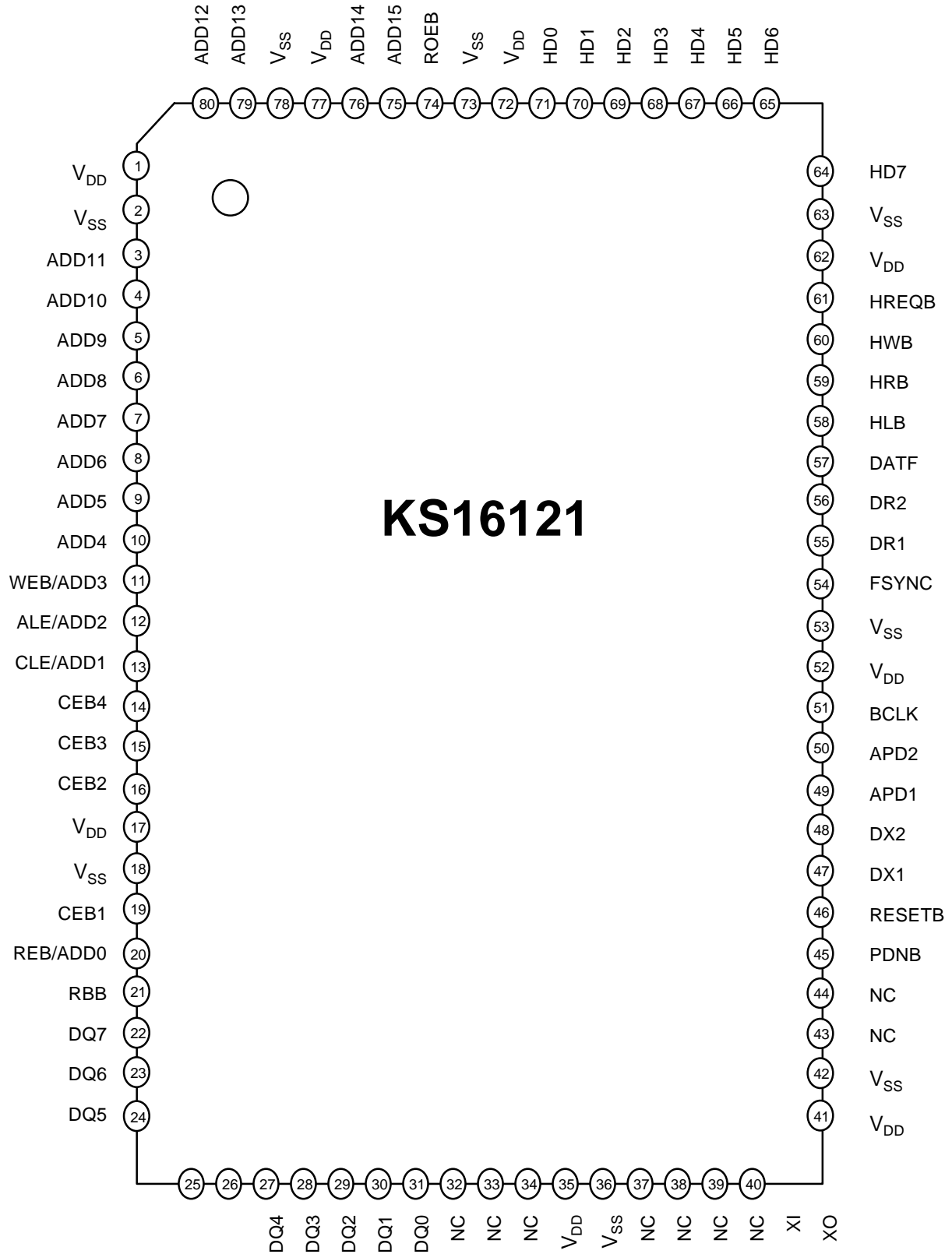: SAMSUNG NAND Flash memory with 512K x 8 (4 M) or 2M x 8 (16 M) organization

• External ROM / EPROM

: Each 64 Kbytes block can supports up to 98.5 seconds of Voice prompts.

This is user option for voice prompt which is in the external ROM / EPROM or

in a part of Flash memory, but not both.

PIN CONFIGURATION

Top row (pins 80–65):
ADD12 (80), ADD13 (79), V_{SS} (78), V_{DD} (77), ADD14 (76), ADD15 (75), ROEB (74), V_{SS} (73), V_{DD} (72), HD0 (71), HD1 (70), HD2 (69), HD3 (68), HD4 (67), HD5 (66), HD6 (65)

Left column (pins 1–24):
- V_{DD} (1)
- V_{SS} (2)
- ADD11 (3)
- ADD10 (4)
- ADD9 (5)
- ADD8 (6)
- ADD7 (7)
- ADD6 (8)
- ADD5 (9)
- ADD4 (10)
- WEB/ADD3 (11)
- ALE/ADD2 (12)
- CLE/ADD1 (13)
- CEB4 (14)
- CEB3 (15)
- CEB2 (16)
- V_{DD} (17)
- V_{SS} (18)
- CEB1 (19)
- REB/ADD0 (20)
- RBB (21)
- DQ7 (22)
- DQ6 (23)
- DQ5 (24)

KS16121

Right column (pins 64–41):
- HD7 (64)
- V_{SS} (63)
- V_{DD} (62)
- HREQB (61)
- HWB (60)
- HRB (59)
- HLB (58)
- DATF (57)
- DR2 (56)
- DR1 (55)
- FSYNC (54)
- V_{SS} (53)
- V_{DD} (52)
- BCLK (51)
- APD2 (50)
- APD1 (49)
- DX2 (48)
- DX1 (47)
- RESETB (46)
- PDNB (45)
- NC (44)
- NC (43)
- V_{SS} (42)
- V_{DD} (41)

Bottom row (pins 25–40):
DQ4 (27), DQ3 (28), DQ2 (29), DQ1 (30), DQ0 (31), NC (32), NC (33), NC (34), V_{DD} (35), V_{SS} (36), NC (37), NC (38), NC (39), NC (40), XI, XO
(pins 25, 26 unlabeled; XI, XO at right end)

PIN DESCRIPTION

Pin Name	Pin No.	Type	DESCRIPTION
HD[7:0]	64 - 71	I / O	Host data bus for host instructions and status words from KS16121. Pull-up.
HWB	60	I	Host Write Strobe. A low to high transition loads an instruction into the KS16121.
HRB	59	I	Host Read Strobe. The KS16121 writes a status word to the host data bus when HRB is Low.
HLB	58	I	Lower Byte Select. 16-bit command and status words are written or read, 8 bits at a time When low, this signal indicates that lower byte is selected.
HREQB	61	O	Host Read Request. Indicates that a status word is ready for the host to read. Active Low. It goes inactive when the higher byte of a status word is read by the host.
DATF	57	O	Not used.
BCLK	51	O	PCM Data Receive/Transmit Bit Clock for Codec 1 and 2. (2.048MHz clock)
FSYNC	54	O	PCM Data Receive/Transmit Frame Sync Clock for Codec 1 and 2.
APD1	49	O	Codec 1 Inactive Flag. When set, indicates the codec is not used and may be powered down.
DX1	47	O	PCM data Transmit pin to Codec 1 . Serial data output from KS16121 to codec.
DR1	55	I	PCM Data Receive pin from Codec 1. Serial data output from codec to KS16121. Pull-up.
APD2	50	O	Codec 2 Inactive Flag. When set, indicates the codec is not used and may be powered down.
DX2	48	O	PCM data transmit pin to Codec 2. Serial data output from KS16121 to codec.
DR2	56	I	PCM data Receive pin from Codec 2. Serial data output from codec to KS16121. Pull-up.
ADD[15:4]	75-76,79-80 3 -10	O	Address Bus for ROM/EPROM.
ROEB	74	O	ROM/EPROM Output Enable. Active Low.
WEB/ADD3	11	O	Flash Memory Write Enable. Active Low. ROM / EPROM Address bit 3
ALE/ADD2	12	O	Flash Memory Address Latch Enable. Active High. ROM / EPROM Address bit 2
CLE/ADD1	13	O	Flash Memory Command Latch Enable. Active High. ROM / EPROM Address bit 1.
REB/ADD0	20	O	Flash Memory Read Enable. Active Low. ROM / EPROM Address bit 0.
CEB1	19	O	Chip Enable for first Flash Memory. Active Low.
CEB2	16	O	Chip Enable for second Flash Memory. Active Low.
CEB3	15	O	Chip Enable for third Flash Memory. Active Low.
CEB4	14	O	Chip Enable for fourth Flash Memory. Active Low.
RBB	21	I	Flash memory Ready / Busy signal. If low, flash memory is busy.
DQ[7:0]	22-29	I / O	Data bus for flash memory and ROM / EPROM. Pull -up
XI	39	I	Crystal Input Pin. 24.576MHz
XO	40	O	Crystal Output Pin.
RESETB	46	I	System Reset. Active Low.
PDNB	45	I	System Power Down. Active Low.
V_{DD}		I	Chip Power Supply (1,17,33,41,52, 62,72,77)
V_{SS}		I	Chip Ground. (2,18,34,42,53, 63,73,78)

ABSOLUTE MAXIMUM RATINGS (Ta = 25 °C)

Characteristic	Symbol	Value	Unit
Supply Voltage	V_{DD}	7	V
Input Voltage	V_{IN}	V_{SS} - 0.5 to V_{DD} + 0.5	V
Output Voltage	V_O	V_{SS} -0.5 to V_{DD} + 0.5	V
Storage Temperature	T_{STG}	- 65 to +150	°C

RECOMMENDED OPERATING CONDITIONS

Characteristic	Symbol	Min.	Typ.	Max.	Unit
Power Supply Voltage	V_{DD}	4.5	5	5.5	V
Ground Voltage	V_{SS}		0		V
Operating Temperature	T_{OPR}	0		70	°C
Crystal Frequency	F_{CK}		24.576		MHz
High-level input Voltage	V_{IH}	3			V
Low-level input Voltage	V_{IL}			0.7	V
Current with high-level output	I_{OH}			+1	mA
Current with low-level output	I_{OL}			-1	mA

DC ELECTRICAL CHARACTERISTICS
(V_{DD} = 5V,Ta= 25 °C ,unless otherwise specified)

Characteristic	Symbol	Condition	Min.	Typ.	Max.	Unit
High-level output voltage	V_{OH}	I_{OH} = -100µA	V_{DD} - 1.5			V
Low-level output voltage	V_{OL}	I_{OL} = 500µA			V_{SS} + 0.5	V
Input leakage current	I_{IN}	V_{IN} = 5V		25		µA
Input pin capacitance	C_{IN}			25		pF
Pull-Up resistance	R_{PU}			30		KΩ
Operating current V_{DD}=5V	I_{DD1}	Normal		100	150	mA
and f_{OSC}=24.567MHz	I_{DD2}	Powered down			10	mA

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TIMING CHARACTERISTICS
($V_{DD} = 5V$, Ta= 25 ℃ ,unless otherwise specified)

Characteristic	Symbol	Min.	Typ.	Max.	Unit	Notes
Host read pulse width	t_{HRW}	80			ns	
Host read data delay time	t_{HRDD}			20	ns	
Host read hold time	t_{HRDH}	1			ns	
Host write pulse width	t_{HWW}	80			ns	
Host write setup time	t_{HWDS}	20			ns	
Host write hold time	t_{HWDH}	5			ns	
Host read request delay	t_{HREQ}			40	ns	
Codec bit clock low time	t_{BCKL}		244		ns	
Codec bit clock high time	t_{BCKH}		244		ns	
Codec frame sync high delay time	t_{BFDR}			10	ns	
Codec frame sync low delay time	t_{BFDF}			10	ns	
Codec receive setup time	t_{SDB}	30			ns	
Codec receive hold time	t_{HBD}	10			ns	
Codec transmit delay time	t_{DBD}			30	ns	
ROM/EPROM address steup time	t_{WRAS}	200	400		ns	
ROM/EPROM address hold time	t_{WRAH}	40			ns	
ROM/EPROM output enable pulse width	t_{WROE}	180	300		ns	
ROM/EPROM data setup time	t_{WRDS}	80			ns	
ROM/EPROM data hold time	t_{WRDH}	0			ns	
CLE setup time	t_{CLS}	100			ns	
CLE hold time	t_{CLH}	50			ns	
WEB pulse time	t_{WP}	100			ns	
ALE setup time	t_{ALS}	50			ns	
ALE hold time	t_{ALH}	50			ns	
CEB setup time	t_{CS}	100			ns	
CEB hold time	t_{CH}	400			ns	
Data read setup time	t_{DSR}	20			ns	
Data read hold time	t_{DHR}	20			ns	
Data write setup time	t_{DS}	100			ns	
Data write hold time	t_{DH}	100			ns	
Write cycle time	t_{WC}	250			ns	
WEB hold time	t_{WH}	100			ns	
ALE to REB delay	t_{AR}	800			ns	
Ready to REB low dealy	t_{RR}	150			ns	
Ready cycle time	t_{RC}	150			ns	
REB high to WEB low delay	t_{RHW}	1.0			μS	
WEB high to REB low delay	t_{WHR}	100			ns	
REB hold time	t_{REH}	100			ns	
Read ID setup time	t_{WHRID}	100			ns	
V_{DD} high to PDNB high delay	t_{VP}	45			ms	

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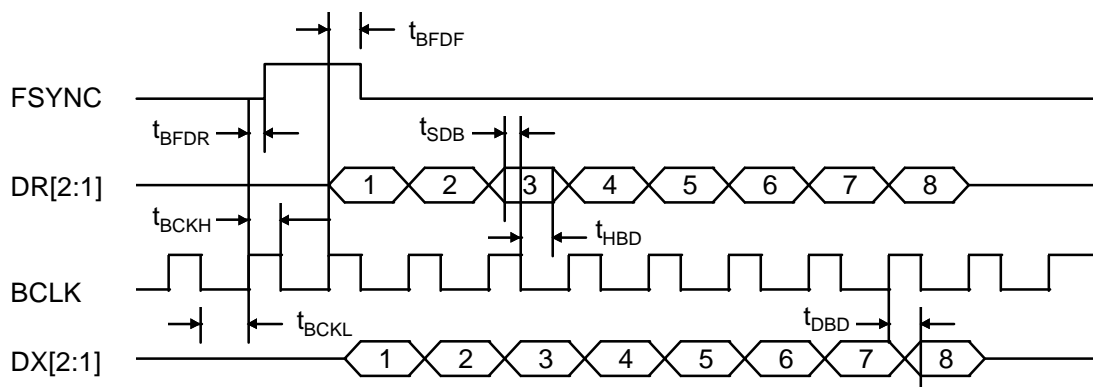| Characteristic	Symbol	Min.	Typ.	Max.	Unit	Notes
PDNB high to RESETB low delay	t_{PR}	0			ns	
RESETB width V_{DD}	t_{PW}	100			ns	
PDNB low to V_{DD} low delay	t_{PV}	3			ms	
REB low to output valid time	t_{REA}			100	ns	
REB high to output Hi-Z	t_{RHZ}	0		30	ns	

TIMING DIAGRAMS
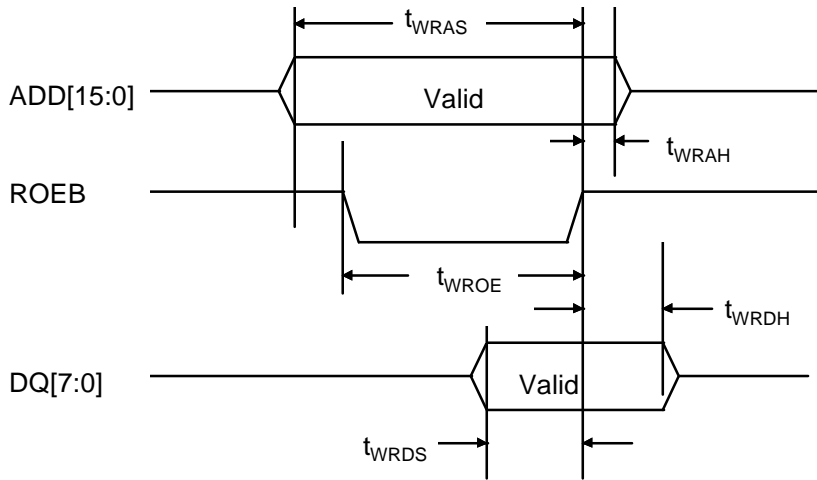
HOST READ CYCLE
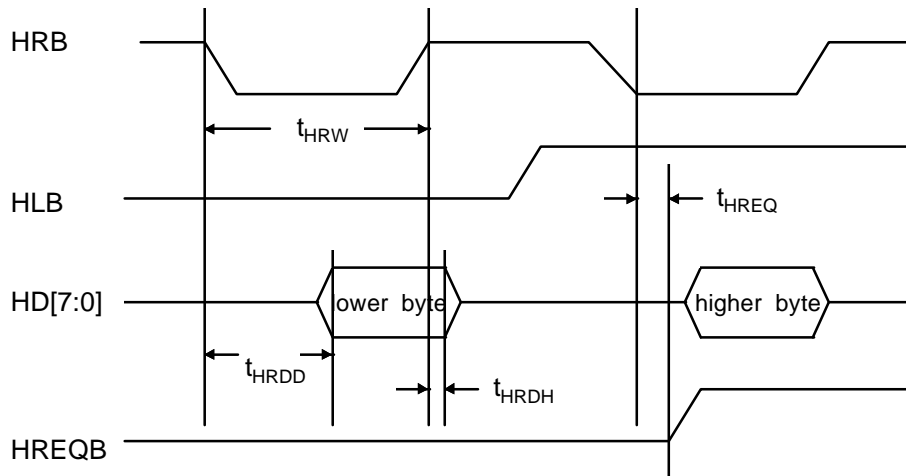
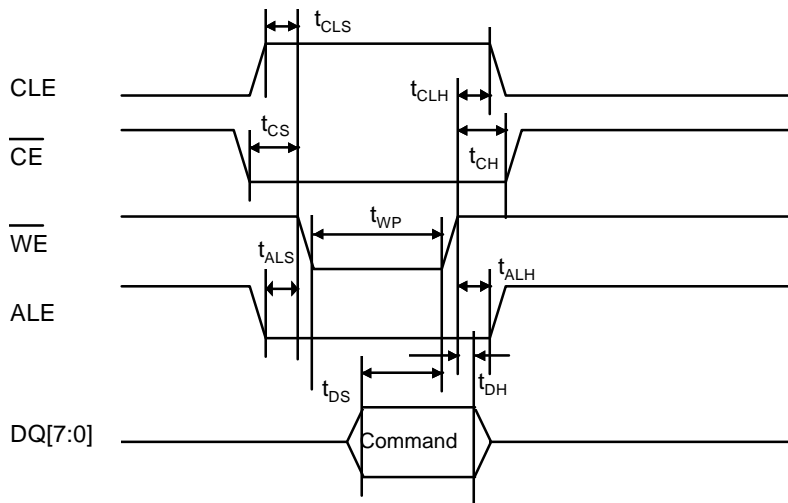### HOST WRITE CYCLE
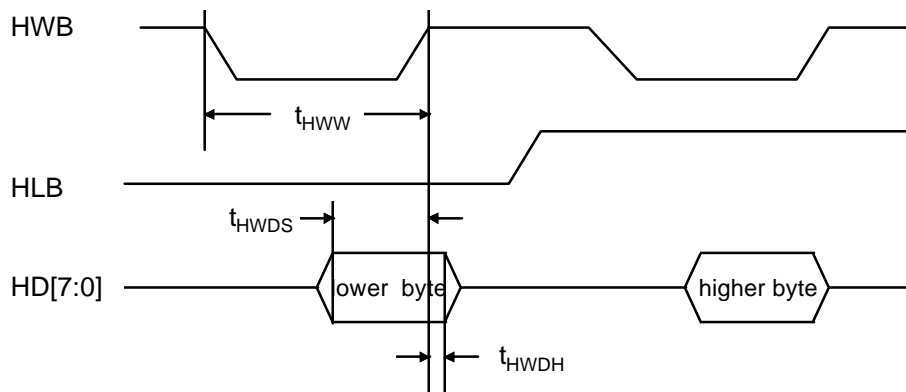
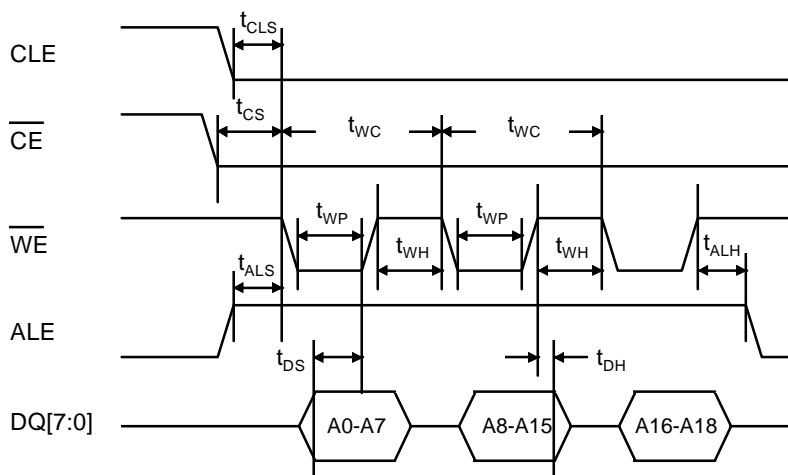### CODEC READ/ WRITE CYCLE

ROM / EPROM READ CYCLE

FLASH MEMORY COMMAND LATCH CYCLE

FLASH MEMORY ADDRESS LATCH CYCLE

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FLASH MEMORY DATA WRITE CYCLE

CLE

CEB

ALE

WEB

DQ[7:0]

t_{CLH}, t_{CH}, t_{ALS}, t_{WC}, t_{WH}, t_{WP}, t_{DS}, t_{DH}

Din 0, Din 1, Din 31

FLASH MEMORY READ CYCLE

ALE

CEB

REB

DQ[7:0]

RBB

t_{AR}, t_{RC}, t_{REA}, t_{REH}, t_{RHZ}, t_{RR}

Dout, Dout, Dout
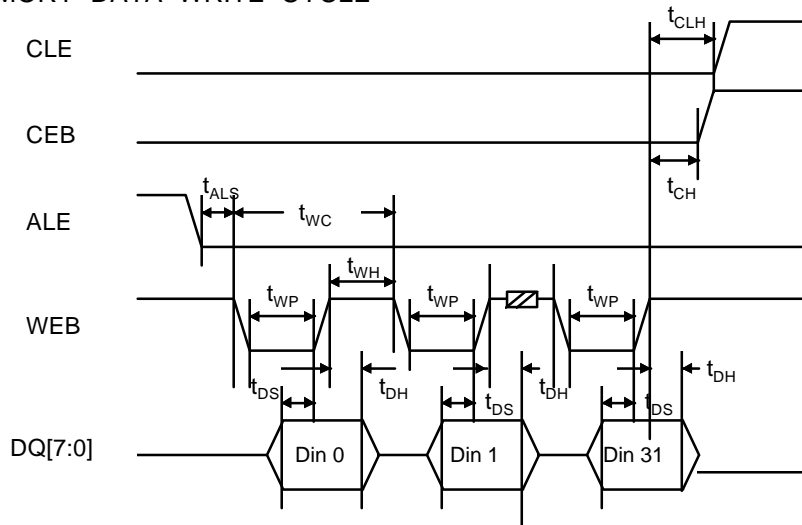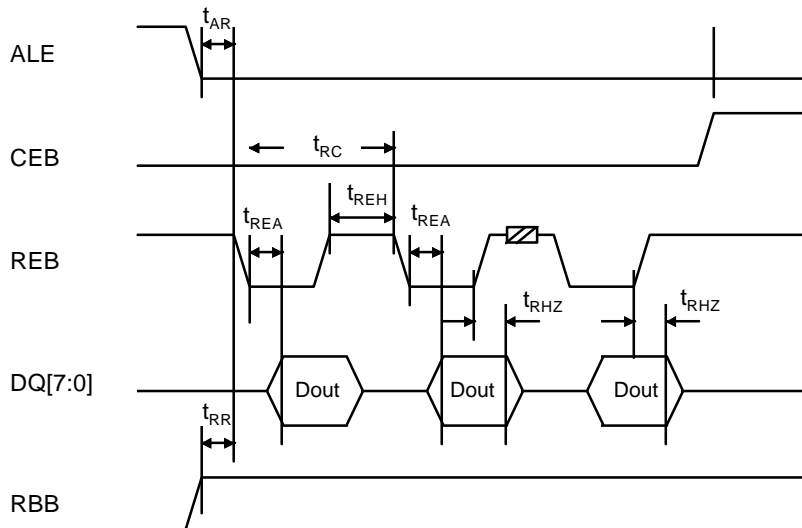
FLASH MEMORY READ ID CYCLE

CLE

CEB

WEB

ALE

REB

DQ[7:0]

t_{WHRID}, t_{AR}, t_{REA}

Din, ADD in, Dout, Dout

SAMSUNG ELECTRONICS
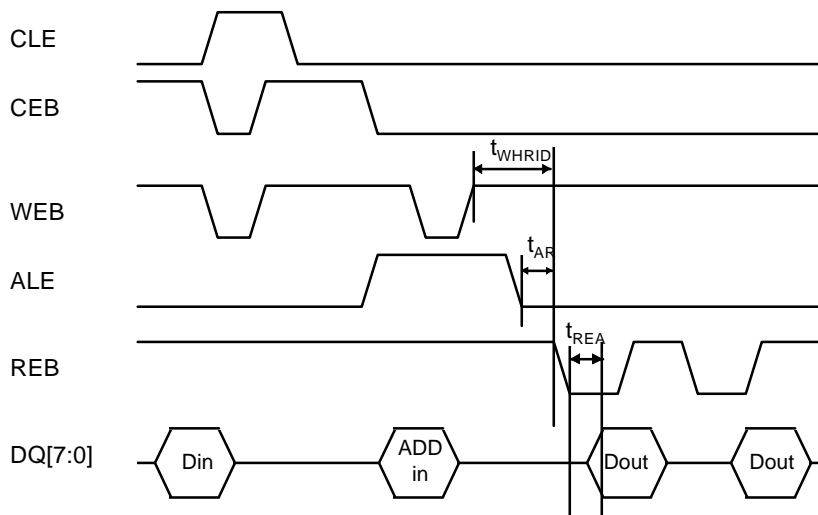
CHIP INITIALIZATION & POWER   FAILURE

HOST INSTRUCTIONS AND STATUS WORDS

In the table below, for each mode the first 16 bit-columns (15…0) are the **INSTRUCTION** word and the last 16 bit-columns (15…0) are the **STATUS** word. Multi-bit fields are shown by their field name placed in the leftmost bit of the field.

MODE		I15	I14	I13	I12	I11	I10	I9	I8	I7	I6	I5	I4	I3	I2	I1	I0	S15	S14	S13	S12	S11	S10	S9	S8	S7	S6	S5	S4	S3	S2	S1	S0
Reset		NOT APPLICATION																0	0	0	0	AI	FN	0	0	MF	MESSAGE COUNT						
Idle		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initialization		0	1	0	1	0	0	0	FI	FT	0	0	0	0	0	0	0	0	1	0	1	AI	FN	RS	ES	0	0	0	MB	RAMO			
Record	R0	0	0	0	1	0	0	0	0	0	SC	VA	LB	0	0	0	0	0	0	0	1	0	0	0	0	0	SC	VA	LB	0	0	0	0
	R1a	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	MF	VD	CPT		DTMF			
	R1b	0	0	0	1	0	0	1	MGAIN				TONE ID					0	0	0	1	0	0	1	0	MF	VD	CPT		DTMF			
	R1c	0	0	0	1	0	0	0	0	0	0	TAIL CUT						0	0	0	1	0	0	0	0	MF	TAIL CUT						
Playback	P0	0	0	1	0	0	0	PBS			MESSAGE ID							0	0	1	0	EF	0	PBS			MESSAGE ID						
	P1	0	0	1	0	0	0	OFFSET										0	0	1	0	0	0	OFFSET									
	P2a	0	0	1	0	PA	0	PBS			0	0	0	0	0	0	0	0	0	1	0	PA	0	0	0	EM	0	CPT		DTMF			
	P2b	0	0	1	0	PA	1	PBS			0	0	0	0	0	0	0	0	0	1	0	PA	1	OFFSET									
Voice Prompt	V0	0	1	0	0	1	0	PBS			PHRASE ID							0	1	0	0	EF	RD	0	0	EM	0	CPT		DTMF			
	V1	0	1	0	0	0	0	PBS			0	0	0	0	0	0	0	0	1	0	0	0	RD	0	0	EM	0	CPT		DTMF			
Tone Generate		0	1	1	0	0	0	0	MGAIN				TONE ID					0	1	1	0	0	0	0	0	0	0	CPT		DTMF			
Message Deletion		0	0	1	1	0	0	0	0	0	MESSAGE ID							0	0	1	1	EF	0	0	0	0	MESSAGE ID						
Garbage Collection		0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	GC	0	0	0	0	0	0	0
Tone Detect		0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	CE	CPT		DTMF			
Read Memory Status		0	1	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	MF	MESSAGE COUNT						
Read Data		0	1	1	1	0	0	1	0	0	DATA ID							DATA															
Write Data	D0	0	1	1	1	0	0	1	1	0	DATA ID							0	1	1	1	0	0	1	1	0	DATA ID						
	D1	DATA																DATA															
Read Attribute		0	1	1	1	0	1	0	0	MA	MESSAGE ID							ATTRIBUTE															
Set Attribute	S0	0	1	1	1	0	1	0	1	MA	0	0	0	0	0	0	0	0	1	1	1	0	1	0	1	MA	0	0	0	0	0	0	0
	S1	ATTRIBUTE																ATTRIBUTE															
Change Attribute	U0	0	1	1	1	0	1	1	0	MA	MESSAGE ID							0	1	1	1	0	1	1	0	MA	MESSAGE ID						
	U1	ATTRIBUTE																ATTRIBUTE															
Read Recording Time		0	1	1	1	0	1	1	1	0	0	0	0	0	0	0	0	0	1	1	1	RECORD TIME											
HW Select		0	1	0	1	1	0	1	0	0	0	0	0	0	0	IC	OC	0	1	0	1	1	0	1	0	0	0	0	0	0	0	IC	OC
Program call progress detector	C0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C1	COEFFICIENT i																COEFFICIENT i															
Program Tone Generator	T0	0	1	1	0	1	0	0	0	0	0	0	TONE ID					0	1	1	0	1	0	0	0	0	0	0	TONE ID				
	T1	0	1	1	0	1	0	0	0	GAIN 1				GAIN 0				0	1	1	0	1	0	0	0	GAIN 1				GAIN 0			
	T2	FREQUENCY 0																FREQUENCY 0															
	T3	FREQUENCY 1																FREQUENCY 1															
Speakerphone	SP0	1	0	0	1	0	0	LS		MS		MM	LOV		SOV			1	0	0	1	0	0	LS		MS		MM	LOV		SOV		
	SP1	1	0	0	1	0	0	0	0	0	0	MM	LOV		SOV			1	0	0	1	0	0	0	0	0	0	MM	LOV		SOV		
	SP2	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	CE	0	0	0	0	0	0
Read Caller ID	CR0	1	0	1	0	0	0	0	0	0	0	0	CND ID					1	0	1	0	0	0	0	0	0	0	0	CND ID				
	CR1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	CS	0	CND DATA							
Write Caller ID	CW0	1	0	1	0	0	1	0	0	0	0	CND ID						1	0	1	0	0	0	0	0	0	0	0	CND ID				
	CW1	1	0	1	0	0	1	0	0	CND DATA								1	0	1	0	0	1	CS	0	CND DATA							
Detect Caller ID	CD0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	RM	RC	RI	RBYTE							

KS16121 DSP for Digital Answering phone with FLASH interface

DESCRIPTION OF INSTRUCTION / STATUS PARAMETERS

Parameter	Bit Width	Definition
AI	1	Already Initialized. Indicates that the host need not issue initialization command, if set, after a reset operation.
ATTRIBUTE	16	Message attribute. Each message has two 16-bit attributes that the host can set and read for time stamp, mailbox ID and other purposes.
CE	1	The result for the detection of CPE alerting signal. If set, it means that the CPE alerting signal has been detected.
CND Data	8	Calling Number Delivery Data
CND ID	6	Calling Number Delivery Index. The KS16121 supports 40 CND data storage.
COEFFICIENT i	16	Filter coefficient i for the call progress tone detection filter. Used for programming the filter to detect user-defined tones.
CPT	2	Call progress tone detection result. CPT[1] is set when a signal energy is present in the tone frequency band. CPT[0] is also set if the signal meets the ON / OFF time requirements.
CS	1	If set, CND data stack is empty or full in CND data read / write operation.
DATA	16	16-bit data carrying any information the host chooses, including tel. numbers.
DATA ID	7	Data Index. The KS16121 supports 128 data items.
DTMF	4	Index of detected DTMF signal . 0 for no tone, 1 through 9 for DTMF code 1 through 9, and 10, 11 and 12 for DTMF codes , * , 0 and # , respectively.
EF	1	If set, indicates an invalid message index.
EM	1	Indicates the end of message or prompt if set, in the PLAYBACK and VOICE PROMPT modes, respectively.
ES	1	Flash memory (directory area) test result. When set, it indicates that functional faults are detected and the KS16121 can not use the flash memory devices.
FI	1	Format or Initialize. Format if set, or initialize if reset.
FN	1	Format needed. If set, indicates it needs a format operation in initialization.
FREQUENCY 0	16	Frequency 0. The actual frequency is (8000 / 65536) * (FREQUENCY 0) Hz.
FREQUENCY 1	16	Frequency 1. The actual frequency is (8000 / 65536) * (FREQUENCY 1) Hz.
FT	1	Format Type. If set, all cells in flash memory are tested. Otherwise, all cells in flash memory except OGM area are tested. All data in tested area are deleted.
GAIN 0	4	Gain of frequency component 0. 0xf for -24dBm and 0x0 for 6dBm in 2dB steps.
GAIN 1	4	Gain of frequency component 1. 0xf for -24dBm and 0x0 for 6dBm in 2dB steps.
GC	1	Garbage collection completion flag. If set, indicates the garbage collection is completed.
IC	1	Input codec selection flag. 0 for codec 1 or 1 for codec 2.
LB	1	Activates the loop back option, if set, in the RECORD mode.
LOV	2	Line output volume. 0x0 for 0 dBm and 0x3 for -9dBm in 3 dB steps.
LS	2	Line input sensitivity. 0x0 for +12dBm and 0x3 for 0 dBm in 4dB steps. The higher value is for noisy environment.
MA	1	Message attribute index. Specifies one of two attributes in a message.
MB	1	If set, no area in flash memory is available for ICMs
MESSAGE COUNT	7	The number of messages stored in flash memory.
MESSAGE ID	7	The index of message to be played - back (P0) or deleted .
MF	1	Memory Full. If set, it indicates no more message can be stored in flash memory.
MGAIN	4	Master tone gain. MGAIN+GAIN0 and MGAIN+GAIN1 should not exceed 15.

DESCRIPTION OF INSTRUCTION / STATUS PARAMETERS (*continued*)

Name	Bit Width	Definition
MM	1	Mute microphone. If set, microphone input is muted.
MS	2	Microphone input sensitivity. 0x0 for +12 dBm and 0x3 for 0 dBm in 4dB steps. The higher value is for noisy environment.
OC	2	Output codec selection flag. 0 for codec 1, 1 for codec 2 or 3 for both codecs 1 and 2.
OFFSET	10	The length of message, from the beginning, to be skipped in unit of seconds. It also indicates the current position of message in a status word.
PA	1	Pause the playback.
PBS	3	Playback speed. PBS = 0 or 3 for normal speed (NS). The speed ranges from 0.5*NS (twice slower) to 2*NS (twice faster). PBS = 1 for 0.5*NS, 2 for 0.75*NS, 4 for 1.25*NS, 5 for 1.5*NS, 6 for 1.75*NS and 7 for 2*NS.
PHRASE ID	7	The index of the phrase in ROM/EPROM to be played back in VOICE PROMPT mode.
RAMO[3:0]	4	Memory test results. Indicates the available memory size . (0 for 0-1M , 1 for 1-2 Mbits , 2 for 2-3M etc)
RBYTE	8	Received Byte. This is the received ASCII byte by meaningful only when RM is set.
RC	1	Receiving a non-message signal. If set, it means that th KS16121 is receiving the Channel Seizure Signal or Mark Signal for on-hook transmission or receiving the Mark Signal for off - hook transmission.
RD	1	Ready flag in the VOICE PROMPT mode. If set, it indicates a new phrase may be selected.
RECORD TIME	12	Available recording time for ICMs, in unit of seconds.
RI	1	Idle state for Caller-ID reception. If set, it means that the KS16121 is idle mode during caller-ID reception.
RM	1	Receiving a message frame. If set, it means that the KS16121 is receiving a message frame.
RS	1	Voice prompt data test result. It passed the test, when cleared.
SC	1	Activates silence compaction, if set, in the RECORD mode.
SOV	3	Speaker Output Volume. 0x0 for +6dBm and 0x6 for -12dBm in 3dB steps. 0x7 means that the speaker output is muted.
TAIL CUT	7	The length of message, from the end, to be removed in unit of 80 msec.
TONE ID	5	Index from the tone table. By default, indices 0 through 12 correspond to standard DTMF tones.
VA	1	Enables the voice activation, if set, in the RECORD mode.
VD	1	Voice signal detected in RECORD mode.

FUNCTIONAL DESCRIPTION

HOST INTERFACE

The KS16121 acts as a co-processor to a host. It communicates with the host via an 8-bit parallel interface. A simple protocol of 16-bit instruction issued by the host and a 16-bit status word returned from the KS16121 is employed. Through this command / status protocol, the host can handle the KS16121 to perform multiple functions simultaneously in various modes.

MESSAGE RECORDING

The   KS16121 uses 4M(512K x 8) or 16M (2M x 8)   bit SAMSUNG NAND flash   memories to store the compressed speech data. A recording operation generates a compressed representation of speech segment, or compressed message, and saves it in the flash memories. Subsequent recording operations store the compressed messages sequentially in the memory space until no more space is available. A maximum of 128 messages can be stored.

The KS16121 employs a software algorithm running on an on-chip DSP core to compress the incoming speech samples at 8 KHz time intervals from a μ-law PCM codec. The algorithm processes the speech on a 20 msec time frame and produces   the compressed data at 5.15 Kbps. When used with the silence compaction option, the algorithm can store approximately 15 minutes of compressed speech in a 4M flash memories.

The silence before a speech signal or between speech segments can be detected and used by the KS16121 to save the memory space needed to store the message. The host may choose the following recording options:

• *Voice Activation* -- The initial silence is ignored and   the recording starts only when the KS16121 detects a
    speech signal. Without this option, the recording starts immediately after a record instruc-
    tion.

• *Silence Compaction* -- The silence gaps between speech segments are measured and replaced with simul-
    ated noise during playback, to save the memory space.

A   recording   operation   normally   ends   with a host   command set . When necessary, the length of the message may be reduced by removing the tail end of the message, which may contain no speech signal. The instruction from the host specifies the number of speech frames to be removed.

MESSAGE PLAYBACK

A playback operation retrieves a compressed message from flash memories. Each message is identified with a message number, given by the host along with a playback command. A portion of memory space is allocated to maintain the information related to individual messages, such as memory address and message length.

The KS16121 reads the compressed message from flash memories and processes it with the decoding software algorithm   to recover the original speech samples. The samples are fed to an external μ-law PCM codec for digital to analog conversion.

SAMSUNG ELECTRONICS

The speed of playback is adjustable by the host, from 0.5 to 2 times the normal speed in an increment of 0.25, without changing the voice characteristics. The host can specify an offset in the playback command. The offset, given in seconds, instructs   the KS16121 to skip a specified length of the message, from the beginning, before the playback starts.

During the playback operation, the host can issue a pause command to stop the playback momentarily and resume the operation from the same point.

VOICE PROMPTS

Certain   applications   require to play a pre-stored speech segments, including fixed messages, voice prompts and   voice guides. The user can be store voice prompts   in an external ROM/EPROM or in a part of flash memory , but not both.   Voice prompts stored in either   memories is in a compressed form (5.15 Kbps) to allow for an increased number of phrases and efficient memory usage.
The KS16121 has a memory interface that can read   these   phrases from each memories , without interfering the messages stored in flash memory. The memory space for voice prompts is limited to 64Kbytes when we use external ROM/EPROM as a voice prompts storage, but is not limited when a part of flash memory is used.
The maximum   number of voice prompts which KS16121 supports are 128 . The KS16121 **S**oftware **S**upport **T**ools enable users to generate user-specified speech samples using an   external ROM/EPROM or a flash memory.

It is often important to control the time delay or gap between phrases properly when a multiple number of phrases are   played in sequence. The KS16121 host interface enables users to control the gap between the current and next prompts accurately in 20 - msec resolution.

DTMF / CALL PROGRESS TONE DETECTION

During   the record, playback and voice prompts modes as well as the tone detection / generation modes, the KS16121 monitors the in-coming signal for the presence of DTMF and call progress tones. The monitoring result is returned to the host as a part of the 16-bit status word.

The KS16121 employs a **N**ear-end **E**cho **C**ancellation (NEC) algorithm in its tone detection subsystem.
The NEC removes the   echo signal, returned by the codec, from the in -coming signal and helps the detector perform reliably in the presence of a strong local signal.

The result of DTMF detection is expressed as a 4-bit number as follows:

KS16121 DSP for Digital Answering phone with FLASH interface

TABLE 1. Definition of DTMF Detection Result

Bits	DTMF Code	Freq. 0 (Hz)	Freq. 1 (Hz)
0x0	none		
0x1	1	697	1209
0x2	2	697	1336
0x3	3	697	1477
0x4	4	770	1209
0x5	5	770	1336
0x6	6	770	1477
0x7	7	852	1209
0x8	8	852	1336
0x9	9	852	1477
0xa	*	941	1209
0xb	0	941	1336
0xc	#	941	1477

The performance of the DTMF detection is summarized in the following table.

TABLE 2. DTMF Detection Performance

Parameter	MIN.	MAX.	UNIT
Detection signal level	-35	0	dBm
DTMF Twist (high/ low)		+4/-8	dB
Detection bandwidth		3	%
Noise tolerance (SNR)	12		dB
Tone duration	40		ms
Interdigit pause	40		ms

In Table 2 and 3, 0 dBm is equivalent to the power of a sinusoid with a peak-to-peak amplitude of 7175 after μ-law to linear conversion. The KS16121 has a programmable call progress tone detector with two output flags. The first one is the continuous tone flag that is set when a signal has a dominant signal energy in the frequency band the user chooses. The second flag indicates whether the input tone meets the ON/OFF interval requirement.

During a cold start, the KS16121 sets up the call progress detector such that it can detect both the busy and dial tones. The default set-up of the call progress tone detector may be changed by loading a new filter setting through the host interface.

The performance of the default call progress detector is summarized in the following table :

TABLE 3. Performance of Call Progress Tone Detector

Parameter	MIN.	MAX.	UNIT
Detector frequency	330	640	Hz
On/Off Duration	260		msec
Signal level (detection)	-30		dBm
Signal level (rejection)		-35	dBm
Noise Tonerance (SNR)	12		dB

TONE GENERATION

The KS16121 has a programmable tone generator that outputs a single or dual frequency tone, intended for signalling and other purposes. The total number of tones that can be defined and used is 31.
An internal tone table holds the frequencies and gains of each tones.
The host can instruct the KS16121 to generate a tone signal from an idle or record mode.
The KS16121 accepts the 5-bit tone index and 4-bit gain from the instruction. The gain is given in 2-dB setps.

During a system reset, the KS16121 sets the tone frequencies and gains to their default values. The first twelve tones, indices 0 x 1 through 0 x c, are standard DTMF tones, specified in Table 1. The tone with index 0 x 10 is a standard DTMF **D** tone, which will be used as an acknowledgement signal during off-hook transmission of Calling Number Delivery function . The host is free to change the frequencies and gains of any tone to meet the need of a specific application.

SPEAKER - PHONE

The KS16121 performs a speakerphone with the following features:

- Acoustic echo canceller (**AEC**) to cancel acoustic echo
- Line echo canceller (**LEC**) to cancel near-end echo
- Full-duplex mode under the double-talk condition
- Speaker output volume, line output volume, line input sensitivity, and microphone input sensitivity
  controlled by user command
- Tone detector to detect ring signal to reduce the effects of dial tone, ringing signal and busy tone
- Another tone detector to detect the CPE alerting signal

SAMSUNG ELECTRONICS

KS16121   DSP for Digital Answering phone with FLASH interface

CALLER ID RECEPTION

The KS16121 performs the reception of Caller-ID in accordance with Bell 202 or ITU -T V.23 standards. It can receive the Caller - ID information during on - hook state with the use of an external ringing signal detector. It can also receive the information during off - hook state by using the internal CPE alerting signal detector and tone generator.

The input dynamic range of receiver is from -35 to 0 dBm.

The receiver removes redundant information like the Channel Seizure Signal , Mark signal , and any inter - word delays including start and stop bits from the incoming signal. It provides the host with ASCII bytes forming a message and Checksum Word. The host can acquire the status of receiver in addition to the received ASCII bytes by issuing a command to the KS16121 and reading the corresponding status word.

Please refer to the Appendix A for details on the Caller - ID reception and its applications.

CPE ALERTING SIGNAL DETECTION

The KS16121 employs a tone detector to detect the CPE alerting signal which leads the Caller - ID information during off - hook transmission. This feature of KS16121 is useful in identifying the third caller for telephone subscribers with the call - waiting option. This detector is active in either Tone Detection or Speakerphone mode.

The detector consists of two bandpass filters whose center frequencies are tuned to 2130 Hz and 2750 Hz respectively, and its performance is summarized in the following table.

TABLE 4. CPE Alerting Signal Detction Performance

Parameter	MIN.	MAX.	UNIT
CPE Twist(high/low)		+8/-8	dB
Detection bandwidth		3	%
Noise tolerance(SNR)	12		dB
Tone duration	65		ms
Detection signal level	-30		dBm

MEMORY/MESSAGE MANAGEMENT

The KS16121 supports a flexible memory management, from the host, of the messages and other information stored in the memory.

The memory space (Flash memory and ROM/EPROM) and stored information can be manipulated by the host with the following features :

•*Message Deletion* -- A message is removed from the memory.
                The indices of the remaining messages are updated appropriately to reflect the deletion.

SAMSUNG ELECTRONICS

KS16121   DSP for Digital Answering phone with FLASH interface

•*Garbage Collection* -- Empty holes in the   memory space, created by repeated recordings   and deletions,
are eliminated to save the space and maximize the recording time.

•*Message Attributes* -- Each message stored in memory has two   16-bit attributes attached   to it,
which can hold any information relevant to individual message.
The host can write, read or change the attributes and implement the
time stamp, mail box and other applications with them.

•*Memory Status* -- The host can instructs the KS16121 to report the status of voice prompt area
(Flash memory or ROM/EPROM) and   Flash memory,   including   the total number of
messages   stored.   The host can also instruct the KS16121 to return the approximate
time available for recording, computed based on the current memory usage.

•*Data Storage* -- In addition to the compressed messages,   the KS16121 allows   the host to store
and retrieve 128 16-bit words in memory.
When used for storing telephone numbers, this memory space supports a maximum of 32
numbers, in which each telephone number consists of 4, 16-bit words or 16 hexadecimal digit.

FLASH MEMORY SUPPORT

The KS16121 helps the system implementation with a support for flash memories   with faulty bits. The KS16121
memory subsystem   utilizes an access scheme that uses the   mapping of bad blocks and readbacks,   and can
cope with time dependent bit fails. The scheme insures a reliable system operation with the maximum recording
capacity.

POWER DOWN

The KS16121 has an on-chip power down circuitry. In this mode, KS16121 stops its operation and holds all the
data being processed just before power down with a minmum power dissipation. When awaking from the power
down   mode, the KS16121 resumes the processing   just before   power down. It is recommended that this mode
should be entered from   the IDLE mode.

RECOVERY FROM POWER FAILURE

The KS16121 can recover the flash memory information when the host issues a reset signal to it after a power
failure   during Flash write / erase operations. If a power failure occurred in record mode , the   last message will
be delete after the recovery. If it occurred in garbage collection mode, the message   which   was   being moved
will be deleted . If it occurred in any modes except above two modes , all the information will be intact.

FLASH WRITE / ERASE FAILURE

When Flash memory write / erase failure occurs , the KS16121 issues IDLE status and goes to the IDLE mode.
The host can detect the occurrence of flash   write / erase failure by monitoring the status word. In that case, the
host can re-initialize the KS16121 by issuing an initialization command.

HARDWARE INTERFACE

The KS16121 contains a DSP core, program ROM, data SRAM and interface logic.
The interface logic consists of Memory, Codec and Host interfaces.

CLOCKING

The KS16121 has an on-chip oscillator. It requires a crystal with fc = 24.576 MHz.

RESET

When   power - up   the system   first after power failure , the KS16121 must be reset with a pulse at the
RESET pin for a minimum duration of 100 nsec, in order to clear internal registers, set operating parameters
to their default values, and initialize the DSP software program.
A reset is strongly recommended after a power failure.

HOST INTERFACE

The host communicates with the KS16121 through the host   interface which is an 8-bit parallel interface
with   separate read / write strobes, as shown in Figure 2.
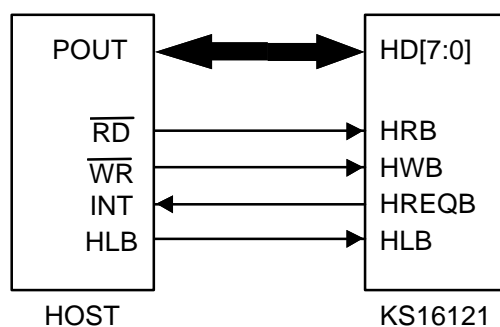
Figure 2. Host Interface for KS16121

The host writes instructions and reads status words via the 8-bit bi-directional port in two successive
accesses. Two bytes of a 16-bit instruction / status word are distinguished with HLB input pin. For proper
communication, the lower byte (with HLB low) should be accessed first , followed by the higher byte (with
HLB high).

The   KS16121 executes the instruction after the higher byte is written by the host. When a status word is
ready for the host, the KS16121 pulls the HREQB output low, which may be used as a host interrupt. The
host then reads   the lower byte of the status, followed by the higher byte at which time the KS16121 sets
HREQB high.

SAMSUNG ELECTRONICS

In principle, the host issues an instruction in order to get a new status word. The KS16121 returns a status word in response to a command, regardless of whether the previous status output has been read.

The response time from an instruction issued and a status returned may be within 20 msec in most cases, except the initialization and garbage collection instructions which returns a status words after completion of the instructions.

CODEC INTERFACE

The KS16121 supports two PCM codecs. The first Codec (DX1 and DR1) is used for message recording and playback. The second Codec (DX2 and DR2) is used for Full - duplex Speaker phone.

The Codec interface is used for transferring digitized speech samples between the KS16121 and the Codecs.
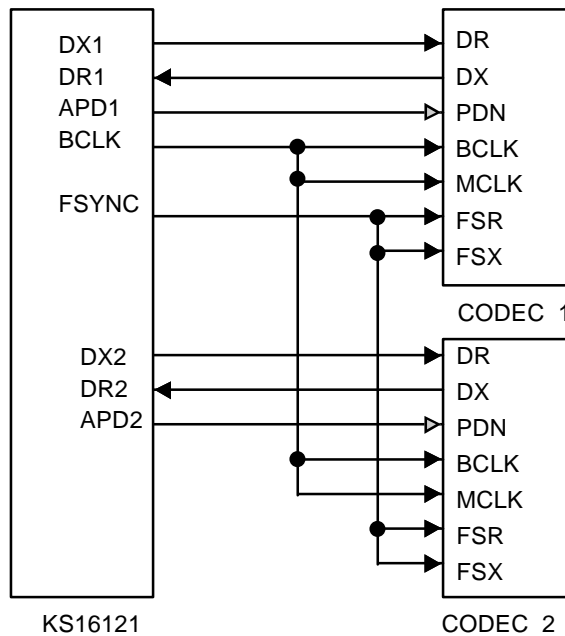
Figure 3. Codec Interface

All the clock and control signals needed to operate the codec are generated by the KS16121.

A linear to μ-law conversion is performed before the KS16121 sends data to the codec and an inverse conversion for the data received.

Each 8-bit data is transferred serially, the sign bit first, through pins DX1 / DR1 or DX2 / DR2.

The KS16121 generates BCLK and FSYNC to synchronize the transfer.

Output pins, APD1 and APD2, indicate whether the codecs are actively used. These outputs may be used to power down the codecs, but a care should be taken since some codecs may create clicking noise when powered down / up frequently.

MEMORY INTERFACE

The KS16121 memory interface subsystem supports connection to flash memories and ROM / EPROM without any external glue logic. It has a 16-bit address bus (ADD) and 8-bit bi-directional data bus (DQ), shared by flash memories and ROM / EPROM. Output pin ROE should be used as an output enable for the ROM / EPROM. When users use flash memory, pull-up resistor should be connected to RBB pin , for further details, refer to the flash memory specification.
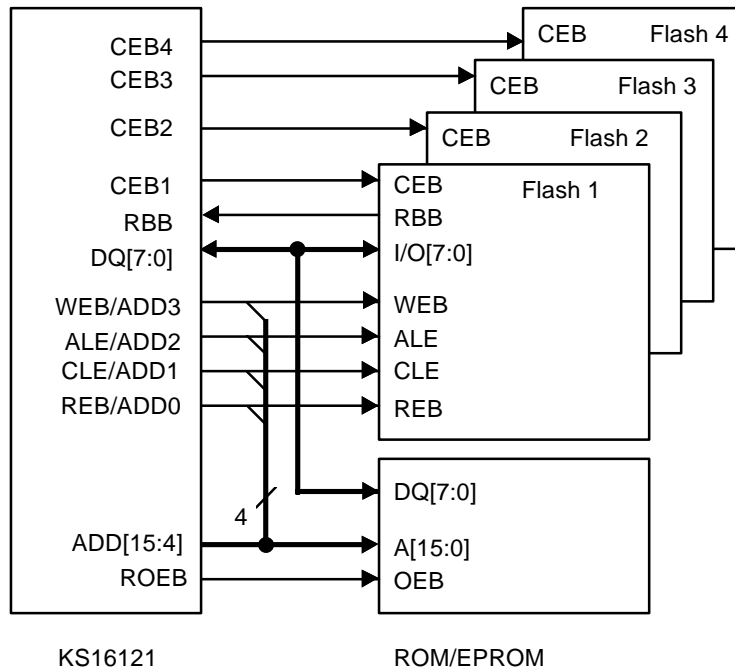
Figure 4. Memory Interface with 4M Flashes
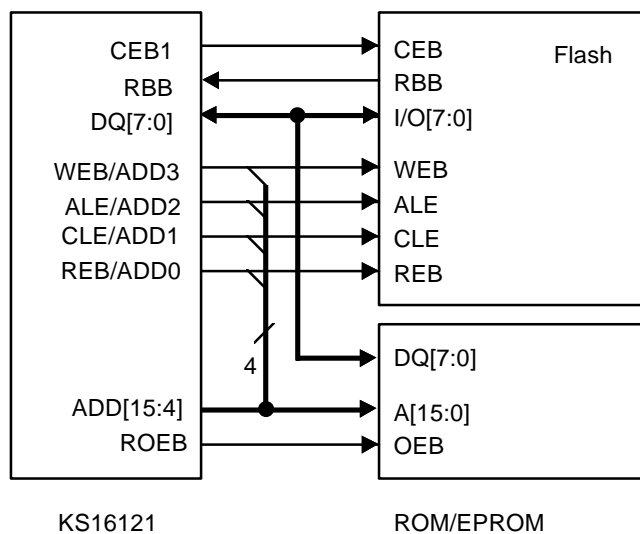
Figure 5. Memory Interface with 16M Flash

SAMSUNG ELECTRONICS

The KS16121 supports both 4M and 16M flash memories in a by-8 arrangement. It can use up to four 4M flash memory devices for the message storing space. The pins CLE, ALE, WEB and REB are commonly used for the lower four bits of the address bus, ADD [3:0], respectively.

The memory interface subsystem has an on-chip flash memory control and flash memory command generation circuitry.

The data transfer from the ROM / EPROM is byte-wide with the maximum address space of 64K words.

SOFTWARE OPERATION

After a system reset, the KS16121 is in idle mode. The host has to issue a new command to put it in an active mode. The KS16121 interprets the command , performs the functions specified by the command, and returns a status word. Section HOST INSTRUCTIONS AND STATUS WORDs summarizes the instruction set supported by the KS16121 and the status words returned for each instructions.

The KS16121 software operational modes with corresponding instructions and status words are described in this section. In some modes of operation, the host is expected to issue a sequence of valid commands in an appropriate order. The KS16121 returns to the IDLE mode when a task terminates or an invalid command is detected or flash write / erase failure occurs, except where described otherwise in this section.

RESET

The KS16121 enters a RESET mode with a low to high transition of the RESET pin. The reset is required after system power-up. It is not required after a period of power-down operation.

The reset operation first determines whether it needs an initialization command by checking the validity of data in flash memory .   An initialization is needed only when the flash memories have never been initialized before, or write/erase failures had occurred.

At the completion of the RESET procedure, the KS16121 returns to the IDLE mode with the status word indicating the number of messages stored.   The status also indicates whether an initialization (AI) and / or a formating (FN) is required before the flash memory can be used in normal operation.

The AI bit is set if flash memories have been initialized before with KS16121. The FN bit is set when flash memories are neither properly initialized nor in a pre-formatted condition from factory.

If the KS16121 determines that a power failure had occured during previous flash write / erase operation, it recovers the memory subsystem from any loss of information due to the failure, before terminating reset procedure.

IDLE

The KS16121 monitors the host interface for a new instruction in this mode. A new task may be initiated from this mode. It returns to the IDLE mode at the completion of a task automatically or by an explicit idle command from the host.

INITIALIZATION

The KS16121 should be initialized when AI bit is 0 in the status word after RESET procedure or an obnormal condition has occurred with IDLE status because of the flash write/erase failure. Otherwise, the KS16121 need not be initialized.

When an initialization is needed, the FI (Format or initial) bit should be set properly. A new formatting (FI=1) of flash memories is required when the FN bit is 1 in the status word after RESET procedure or an abnormal stopping has occurred due to the flash write / erase failure. Otherwise, the FI bit should be set to 0.

When the host initializes the KS16121 with FI bit set to 1, the FT (Format Type) bit should be set properly. If voice prompt data resides in flash memories, the FI bit shoud be 0 and the KS16121 retains the pre-stored voice prompt data in the flash memories. Otherwise, the KS16121 clears all the data area in the flash memories including voice prompt data and including message data.

When the host issues an initialization command, the KS16121 initializes the message memory sapce (Flash memory) and returns the result to the host. The host specifies the total amount of available memory space in parameter field, RAMO, in unit of 4M bits while the type of flash memory (4 Mor 16M) is selected automatically by KS16121.

When formatting, after decision of flash memory type, the KS16121 checks the available memory space exhaustively for faulty bits which may occur due to continuous use of flash memory, creating a table of usable blocks which is used for memory access during normal operation. The time it takes for the KS16121 to complete the initialization depends on the memory size and is approximately 3 sec / 4 Mbits.

The KS16121 returns to the IDLE mode at the completion.
The status field RAMO returns the actual size of memory for recording in unit of 1M bits.

When the flash write / erase failure occurs, the KS16121 returns to the IDLE mode after issuing IDLE status. The host can detect the flash write / erase failure occurrence by monitoring the status word. In this case, the host may reinitialize the KS16121 by issuing initialization command with FI bit being set, but all exisitng ICMs will be erased.

RECORD

The message recording starts with the R0 instruction. The host may specify the following options with the instruction :

•*Voice Activation (VA)* -- The recording starts only after voice signal is detected. The KS16121 status
                    recording immediately without this option.

•*Silence Compaction (SC)* -- The silence gaps during recording are detected and compacted to save
                    the memory.

•*Loop Back (LB)* -- The in-coming voice signal is looped back to the codec input.

Once the KS16121 is in the RECORD mode, the host may issue the following instructions to the KS16121 :

•*R1a* -- Monitoring the recording status (MF,VD) ,   the DTMF

and call progress tone detection result (DTMF, CPT).

•*R1b* -- Generate a tone, in addition   to the tasks performed with R1a. See the TONE GENERATION mode

for definition of the input parameters. The tone generation stops   with another R1b instruction with

TONE ID = 0.

See TONE DETECTION mode for a description of the DTMF and call progress tone detection result. The recording status is reported with the status bits, MF and VD, which indicate the memory full and voice detected conditions, respectively.

The KS16121 continues   the recording   while it reads and responds to these commands. If needed, the host can use these instructions repeatedly without interrupting a recording operation. When the memory becomes full , the KS16121 remains in the RECORD mode even though the message is not stored any more.

The host may terminate a recording   with an idle instruction. The message is saved in the memory before the   KS16121 returns to the IDLE mode. Alternatively, the host may issue an R1c instruction to terminate recording and remove the tail portion of the recorded message. The 7-bit parameter, TAIL CUT, specifies the length of tail to be removed in the unit of 80 msec.

PLAYBACK

The KS16121 enters the PLAYBACK mode with the P0 instruction, which also specifies the playback speed (PBS) and the index of message to be played-back (MESSAGE ID). The playback speed ranges from 0.5 (two times slower) to 2 (two times faster) in the step of 0.25.

The actual playback starts after the P1 instruction is received. The OFFSET bits of the instruction specifies the length of the message, from the beginning, to be skipped   in the unit of seconds.
While the KS16121 plays a message,   the host may issue one of the following instructions:

•*P2a* -- Monitor the DTMF,   call progress tone detection result (DTMF, CPT) and recording status (EM).
•*P2b* -- Read the current position in the message from the beginning (OFFSET).

The playback continues with these instructions   if the PA bit set to   0.
The host can pause the playback these instruction with PA = 1,   in which case the KS16121 stops the playback operation and resumes it   when a new instruction (P2a , P2b) is entered with PA = 0.

The   KS16121 stays in the PLAYBACK   mode and continues to respond to the P2a and P2b instructions even   when it   is in PAUSE (PA = 1) or the end of message is reached (EM = 1). It returns to the IDLE mode with an idle instruction.

VOICE PROMPT

The host issues a voice prompt instruction (V0) to play a phrase that is pre-stored in ROM / EPROM or Flash. The instruction specifies the phrase number and the desired playback speed.

SAMSUNG ELECTRONICS

Once in the VOICE PROMPT mode, the host can issue the V1 instruction to monitor the status of the playback   phrase (RD, EM) and the DTMF / call progress tone detection result (DTMF, CPT)   without interrupting the playback.

The KS16121 sets the status bit , RD (ready), when it reaches near the end of the phrase. A new V0 instruction with an appropriate phrase number may be issued to play another phrase. The host can play two phrases without any gap between them by issuing a V0 instruction immediately after RD is set. Alternatively, the host may create a silence gap between phrases by delaying the instruction. Note that the KS16121 returns a status word every 20 msec period. (For instance, a 40 msec gap is created by a command sequence, V1 , V1 and V0, immediately after RD has been set).

The KS16121 sets the status bit EM when it actually reaches the end of a phrase.

The VOICE PROMPT mode terminates with an idle instruction from the host.

TONE GENERATION

A tone signal is generated and sent to the codec in this mode. The tone is selected from the tone table that contains   31 tone definitions. Each   tone may have two frequency components with gains respectively. Refer to the PROGRAMMING mode for their definitions.

The KS16121 enters the TONE GENERATION mode with a tone generate instruction that specifies the tone index (TONE ID) and master gain (MGAIN). The actual gains of individual frequency components are determined by MGAIN + GAIN0 and MGAIN + GAIN1. These sums specify the tone gains, ranging from 24dBm to 6 dBm in 2 dB steps and hence must not exceed 15. Here 0 dBm is equivalent to the power of a sinusiod with a peak to peak amplitude of 7175 before a linear to μ-law conversion.

In the TONE GENERATION mode, the host may switch to the different tone signal by sending a new tone generate commmand with the appropriate TONE ID and MGAIN. The DTMF and call progress tone detection result may be monitored, without interrupting the tone generation, by issuing a tone generate command with the same tone parameters.

The TONE GENERATION mode terminates with an idle command.

MESSAGE DELETION

In this mode, the KS16121 removes the message specified in the MESSAGE ID field of the instruction and returns to the idle mode. The status bit , EF, indicates an invalid message index, if set.

GARBAGE COLLECTION

In this mode, the KS16121 moves one message below the empty holes in the memorry space. A status word is returned after each move to inform the host whether the messages have been moved or not. When all the messages have been moved, the KS16121 issues a status word with GC bit set to 1.

The time it takes to complete a garbage collection varies depending on the size of memory and the number of messages stored.

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TONE DETECTION

This mode monitors the incoming signal for the presence of DTMF, call progress tones, and CPE alerting signal. While in this mode, the KS16121 checks a new host instruction every 20 msec and returns a status word for response to a new command. The result of the detection is passed to the host, in the status fields, DTMF , CPT and CE parameter.

READ MEMORY STATUS

When a read memory status instruction is issued   by the host, the KS16121 sends the information of the number of messages stored, through the status word and returns to the IDLE mode.

READ DATA

The KS16121 provides a storage of 128 16-bit words that may contain any information including telephone numbers.   When the read data command is issued, the status word contains the data specified in the DATA ID field of the instruction and the KS16121 returns to the IDLE mode.

WRITE DATA

The D0 instruction specifies the index of data to be stored.
The KS16121 then writes the 16-bit data in D1, stores it and returns to the IDLE mode.

READ ATTRIBUTE

When   the read attribute instruction is issued by the host, the KS16121 sends out the 16-bit attribute of the message specified   by   the MESSAGE ID and MA field of the instruction, and   returns to the IDLE mode. Note that each message has two attributes, identified by the MA filed.

An invalid message index in the instruction causes the KS16121 to return to the   IDLE mode with the status of   0x7000.

SET / CHANGE ATTRIBUTE

An S0 instruction is entered by the host to set a message attribute with MA = 0 or 1. The host then writes the 16-bit attribute in the following S1 instruction. The KS16121 attaches this attribute to the next message to be stored. The host may change an attribute of an existing message with the change attribute instructions. The U0 instruction specifies the index of message and the type of attribute to be changed, followed by the 16-bit attribute data (U1).

The KS16121 returns to the IDLE mode after the attribute is set or changed, and also when an invalid message index is detected (status = 0x7000).

READ RECORDING TIME

In this mode, the KS16121 sends the available recording time and returns to the IDLE mode.
The RECORD TIME field of the status word represents the time in the unit of seconds.

HW SELECT

The host may select the codecs for voice input for recording and voice output for playback with this command.   The input codec is either codec 1 or 2.   The output codec may be either one or both. The default codec is codec 1.

PROGRAM CALL PROGRESS DETECTOR

The host may   load new filter coefficients to be used for the call progress tone detection in this mode, initiated with the C0 instruction.   The subsequent instructions, C1 to C15, set the 15 filter coefficients. The KS16121 returns to the IDLE mode after reading the fifteenth coeffcient.

PROGRAM TONE GENERATOR

In this mode,   the host can   change the definition of a tone in the KS16121 tone table. The T0 instruction specifies the tone index (TONE ID) and must be followed by T1, T2 and T3, in that sequence.

The T1 instruction   defines gains of the two frequency components (GAIN0 and GAIN1) of the tone. The actual gain of each frequency is determined by the sum of GAIN0 or GAIN 1 with the master gain (MGAIN) given with the tone - generate instruction.
The range of gains ranges from -24dBm (sum = 0xf) to 6dBm (sum = 0x0) in 2dB steps.
Setting either GAIN0 or GAIN1 to zero results in a single frequency tone.

Instructions T2 and T3 determine the tone frequencies with parameters, FREQUENCY 0 and FREQUENCY 1, respectively. The actual frequency selected is (8000 / 65536) * FREQUENCY 0 or 1.

The T3 instruction completes this mode and the KS16121 returns to the IDLE mode.

SPEAKERPHONE

In this mode, the KS16121 performs a speakerphone algorithm with LEC, AEC and programmable parameters. This mode uses both codec 1 and codec 2 inputs and outputs. Codec 1 is used for the line interface. Codec 2 is used for the microphone input and speaker output.

The host can make the KS16121 to perform the speakerphone algorithm by issuing the SP0 instruction. The SP0 instruction sets all programmable parameters including Mic input sensitivity, Line input sensitivity, Speaker output volume, and Line output volume.   The SP1 instruction can modify Speaker output volume and Line output volume.   The KS16121 monitors the incoming signal to detect the CPE alerting signal in this mode. By issuing   the SP2 instruction,   the host can acquire the detection result of the CPE alerting signal in the status field , CE , and may force the KS16121 to receive the Caller - ID information.

The Host can issue a command every 0.5 ms in this mode. The SPEAKERPHONE mode terminates with an idle command.

To get better knowledge for the applications of this mode, please refer to Appendix B.

READ CALLER-ID

The KS16121 provides a storage of 40 48-byte Caller-ID information . To read pre-stored Caller-ID information , the host should issue CR0 command with the CND ID ranged from 0 to 0 x 27, and the KS16121 duplicates the CR0 command for its status word. After receiving the status words , the host issues CR1 command to read each byte of CND INFORMATION . If the host tries to read more than 48 bytes, the KS16121 returns status word with CS bit set to 1 and 0 CND INFORMATION. The READ CALLER-ID mode terminates with an idle command.

WRITE CALLER-ID

To write caller -ID information , the host should issue CW0 command with the CND ID ranged from 0 to 0 x 27, and the KS16121 duplicates the WR0 command for its status word. After receiving the status, the host issues CW1 command with CND INFORMATION field. If the host tries to write more than 48 bytes, the KS16121 returns status word with CS bit set to 1.

The WRITE CALLER-ID mode terminates with an idle command.

DETECT CALLER-ID

The host can make the KS16121 to receive the Caller-ID information regardless of on-hook or off-hook transmission by issuing the DETECT CALLER-ID instruction. Then, after issuing the instruction, the host can acquire the current status of the receiver or the received ASCII bytes by reading the status word. The received byte is meaningful only when the status bit RM is set. The Checksum Word is also passed to the host. So the host should recompute the checksum and compare to the received Checksum Word to verify whether the message frame has been correctly received.

The DETECT CALLER-ID instruction can be given when the HREQB is active low.

The DETECT CALLER-ID mode terminates with an idle command.

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80−QFP−1420C

23.90 ±0.30

20.00 ±0.20

17.90 ±0.30

14.00 ±0.20

#80

#1

0.80

0.35 ±0.10

⊕ 0.15MAX

(1.00)

(0.80)

0~8°

0.15 +0.10 −0.05

0.80 ±0.20

0.05MIN

2.65 ±0.10

3.00MAX

◯ 0.10MAX

0.80 ±0.20

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