Slave mode

COMMAND SPEC

KeyStone Semiconductor Confidential & Proprietary, no copy allowed without written authorization.

1 Introduction

1.1 Command Format (command sequence)

(MSB) **(LSB)**

Start Byte (1 byte)	Command Type (1 byte)	Command Id (1 byte)	Serial Number (1 byte)	Data Length (2 bytes)		Data Byte (*)	End Byte (1 byte)
0xFE (254)			0x1~0xFF				0xFD (253)

1.1.1 Start Byte

1 byte; command start character, which representing the beginning of one command sequence

1.1.2 Command Type

1 byte: command type character, which representing the following command Id belongs to which command category.

1.1.3 Command Id

1 byte: unique code for each command in serial number.

1.1.4 Serial Number

1 byte: the serial number is used for denoting the same command session pair. For example, master send SN.0 to slave and slave response SN.0 to master compose a command session pair.

1.1.5 Data Length

2 bytes: the byte count of data being transferred in this command transaction.
Most significant byte is transferred first (Big-Endian).

1.1.6 Data Byte

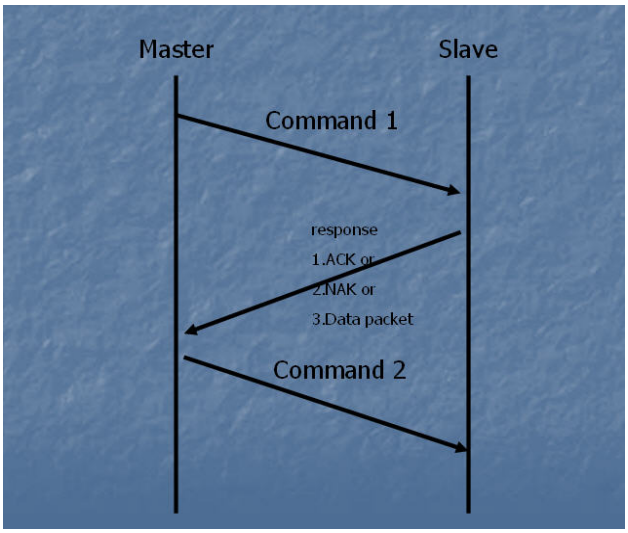
The data is transferred either by master or by slave. Most significant byte is transferred first (Big-Endian).

1.1.7 End Byte

1 byte: command end character, which representing the end of one command sequence.

KeyStone Semiconductor Confidential & Proprietary, no copy allowed without written authorization.

.2 Protocol



Note.

- ✓ Master device can be connected to slave device through UART / I2C / SPI interface. Each command issued by master should have a response from slave, generally, and only after receiving the response from slave can master start another command. This behavior makes sure each command sent to slave has been completed by slave. However, if slave not response in specified time period, the master then will treat this command failed and can start next command to slave.

- ✓ Before master device start sending command to slave device, the master should query the slave device status to see if slave is in proper state to receive command. Master can query the slave status through system command **GetSysRdy.** Slave replies ACK if it is ready to get command or NAK if not.

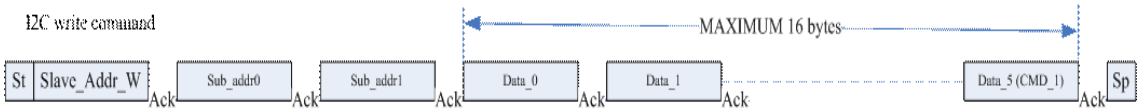
KeyStone Semiconductor Confidential & Proprietary, no copy allowed without written authorization.

.3 I2C Slave example

3.1 Since I2C READ/WRITE operation is initiated from master device, the master device should send I2C WRITE command (ex. Set System volume command) first, and then another I2C READ command to read back the command execution result (ACK, NAK, return data, etc.)

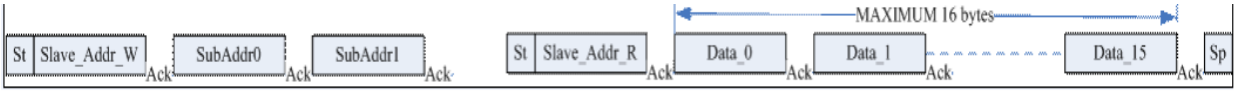
3.2

I2C WRITE command format



Note. Sub_addr0 and Sub_addr1 must set to 0x00. This is the current protocol implemented in our firmware.

I2C READ command format



Note. Sub_addr0 and Sub_addr1 must set to 0x00. This is the current protocol implemented in our firmware.

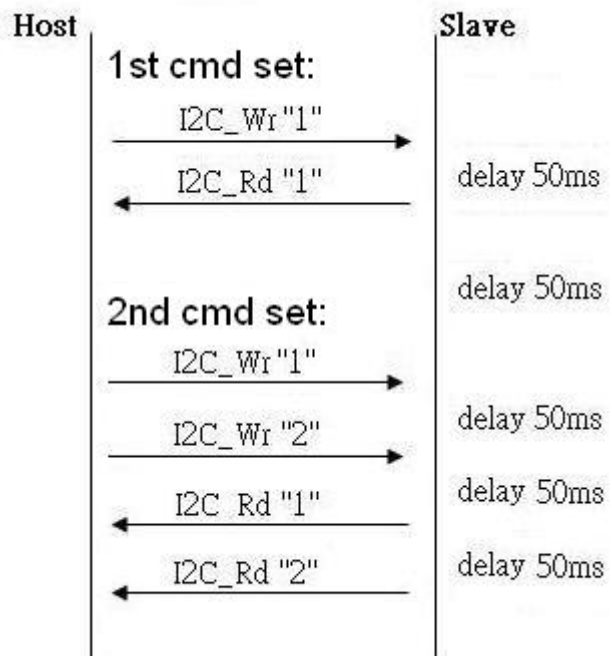
Since the I2C data buffer size is limited to 16 bytes in our device, the total bytes in one command should not exceed 16 bytes. Hence, the command format through I2C interface becomes:

Start Byte	Command Type	Command Id	Serial Number	Length		Data Byte	End Byte
0xFE(254)			0x1~0xFF				0xFD(253)
Data_0	Data_1	Data_2	Data_3	Data_4	Data_5	Data_6~ Data_6+n	Data_6+n+1<16
1Byte	1Byte	1Byte	1Byte	1Byte	1Byte	**N** Bytes	1Byte

Note. In I2C mode, the 'N' limit to 0~9, in UART mode, the 'N' means very much.

KeyStone Semiconductor Confidential & Proprietary, no copy allowed without written authorization.

3.3 The communication between Master and Slave acts as the following figure. If the Master gets NACK when Writing/Reading command, the Master should retry this command. Before retrying, it must delay 50 ms. If the Slave still returns NACK after retrying 3 times, the Master should reset the Slave by HW.



3.4 Since the I2C data buffer size is 16 bytes long in our device, the maximum length of each command sent through I2C should less than 16 bytes. For those commands that may exceed 16 bytes, ex. Get program name, Get program text, Get ensemble name, Get service name, firmware should divide these long commands into several packets, which each length is 16 bytes long. For example, to read program text from slave, master should read it back via several READ command packets. There should have at least 5 ms waiting time between each read command to guarantee the slave have enough time for preparing data.

1st command packet format:

Start Byte	Command Type	Command Id	Serial Number	Length		Data Byte
0xFE(254)			0x1~0xFF			10Byte

2nd command packet format:

Data Byte
16Byte

The last command packet format:

Data Byte	End Byte	Invalid Data(0x00)
xByte	0xFD(253)	y Byte

KeyStone Semiconductor Confidential & Proprietary, no copy allowed without written authorization.

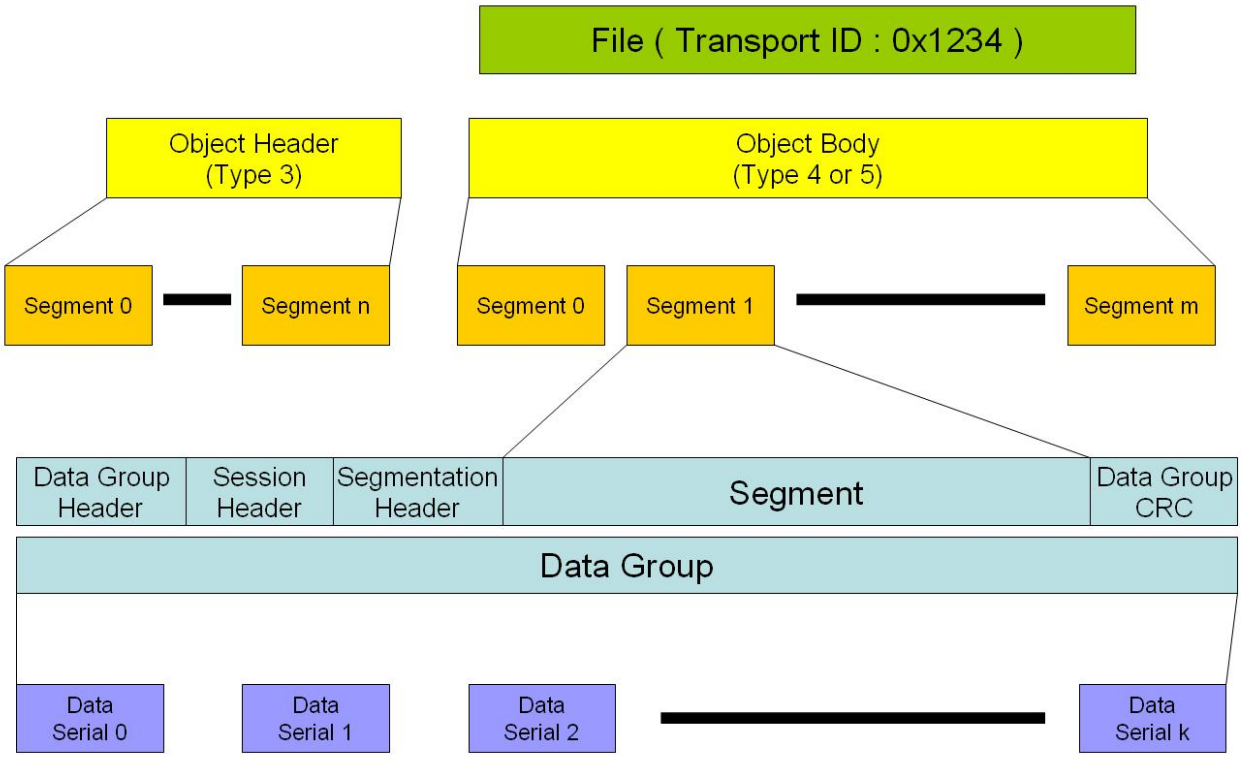
The data length field in 1st command packet denotes the total data byte count transferred. Master device can calculate the number of data packet being sent and how many times needed to read them back based on total data length.

Note. Before reading back the entire data packet, another WRITE command should not be issued.

3.5 The default slave device address is set to **0x88**. If you found error communicating to slave with this device address, please contact with KeyStone engineer to check the correct slave device address.

.4 MOT Command

4.1 In MOT protocol, a file is transmitted as a MOT Object. The management data of a MOT Object is contained in MOT Header. The header information and body are transported in different MOT entities and therefore the segmentation will apply independently on header information and body. MOT entities will be split up in segments with equal size. The Segmentation Header is attached to all segments and then every segment of the MOT entities is mapped to an MSC data group, which may be transmitted by packet mode or X-PAD.



4.2 When the Master sends the command “MOT_GetMOTData”to the Slave, the data returned by the Slave contain four parameters: Data group type, Segment number, Transport ID and Serial. The Transport ID indicates an Object. The Transport ID of an Object Header or Body should be the same. The Data group type means this data group is a segment of the Object Body or Header. The type of Object Header is 3, while the type of Object Body is 4 or 5. The Segment number indicates the segment number of the Object Header or Body. The bit 15 of Segment number indicates the last segment of the Object Header/Body. The Serial is the serial number of this data in this MSC data group. The bit 7 of Serial indicates the last data of the MSC data group.

4.3 When the Master sends commands to get MOT data, the returned data from the Slave is a part of a MSC data group. The Master collects several data to form a MSC data group by the Serial, and parsers the data group header. After receiving all data groups, or segments, of an object body or header, the Master can form an object.

4.4 When transmitting MOT data in DAB, one object may repeat several times. However the Slave will not repeat these data. It means if one data group is send to the Master before, the Master will not receive it again when it repeats. If the Master find something error in this data group, the Master can send command to ask the Slave to transmit this data group again.

4.5 The SPI is used for high bit-rate transmission of packet mode. The Master could send command “MOT_GetPacketRawLength” to query SPI data. If the return value is not 0, the Master should control SPI to receive data. The max value of SPI data bytes is 4800, which depends on current DAB bit-rate. The max clock of SPI is 6MHz. The Master must query data every 44 ms at least. The packet data transmitted by SPI are raw data of DAB packet mode.

.5 Command List

Table 1. System Command

Type	Id	Description	Function Name
0x0	0x0	Ask if slave is ready to receive command	SYSTEM_GetSysRdy
0x0	0x1	Reboot system	SYSTEM_Reset
0x0	0x2	Get MCU version	SYSTEM_GetMCUVersion
0x0	0x3	Get Boot version	SYSTEM_GetBootVersion
0x0	0x4	Get ASP version	SYSTEM_GetASPVersion

Table 2. Stream Command

Type	Id	Description	Function Name
0x1	0x0	Play a stream	STREAM_Play

KeyStone Semiconductor Confidential & Proprietary, no copy allowed without written authorization.

0x1	0x1	Stop play a stream, and enter standby mode	STREAM_Stop
0x1	0x2	Search next FM station and then play	STREAM_Search
0x1	0x3	Auto search DAB programs	STREAM_AutoSearch
0x1	0x4	Stop searching process	STREAM_StopSearch
0x1	0x5	Get stream playing status	STREAM_GetPlayStatus
0x1	0x6	Get current stream mode	STREAM_GetPlayMode
0x1	0x7	Get current playing program index	STREAM_GetPlayIndex
0x1	0x8	Get signal strength	STREAM_GetSignalStrength
0x1	0x9	Set stereo mode	STREAM_SetStereoMode
0x1	0xA	Get current stereo mode setting	STREAM_GetStereoMode
0x1	0xB	Get stereo mode bought up in current stream	STREAM_GetStereo
0x1	0xC	Set system volume	STREAM_SetVolume
0x1	0xD	Get system volume level	STREAM_GetVolume
0x1	0xE	Get program type	STREAM_GetProgrameType
0x1	0xF	Get program name	STREAM_GetProgrameName
0x1	0x10	Get program text	STREAM_GetProgrameText
0x1	0x11	Get sampling rate	STREAM_GetSamplingRate
0x1	0x12	Get data rate	STREAM_GetDataRate
0x1	0x13	Get signal quality	STREAM_GetSignalQuality
0x1	0x14	Get frequency index of a specified DAB program	STREAM_GetFrequency
0x1	0x15	Get ensemble name	STREAM_GetEnsembleName
0x1	0x16	Get total program number	STREAM_GetTotalProgram
0x1	0x17	Check if the specified DAB program is on-air or not	STREAM_IsActive
0x1	0x18	Set RSSI Threshold	STREAM_SetRSSIThreshold
0x1	0x19	Get RSSI Threshold	STREAM_GetRSSIThreshold
0x1	0x1A	Get service name	STREAM_GetServiceName
0x1	0x1B	Get current search program number	STREAM_GetSearchProgram
0x1	0x1C	Enable power bar calculation	STREAM_SetPowerBar
0x1	0x1D	Get power bar values	STREAM_GetPowerBar
0x1	0x1E	Get program is DAB, DAB+, Packet data, or DMB(Stream data)	STREAM_GetServCompType
0x1	0x1F	Set BBE/EQ Mode	STREAM_SetBBEEQ
0x1	0x20	Set head room level (Achilles only)	STREAM_SetHeadroom
0x1	0x21	Save preset program	STREAM_SetPreset
0x1	0x22	Retrieve preset program	STREAM_GetPreset
0x1	0x23	Retrieve programe information	STREAM_GetProgrameInfo
0x1	0x24	Retrieve current sorting method of DAB program	STREAM_GetSorter
0x1	0x25	Sort DAB program list	STREAM_SetSorter

KeyStone Semiconductor Confidential & Proprietary, no copy allowed without written authorization.

0x1	0x26	Retrieve current DRC setting	STREAM_GetDrc
0x1	0x27	Set DRC	STREAM_SetDrc

Table 3. RTC Command

Type	Id	Description	Function Name
0x2	0x0	Set system clock and date	RTC_SetClock
0x2	0x1	Get system clock and date	RTC_GetClock
0x2	0x2	Enable/disable system to sync clock and date from FM or DAB stream.	RTC_EnableSyncClock
0x2	0x3	Get the current sync clock setting	RTC_GetSyncClockStatus
0x2	0x4	Check is the system clock is set or not	RTC_GetClockStatus

Table 4. MOT Command

Type	Id	Description	Function Name
0x3	0x0	Get MOT data	STREAM_MOTGetData
0x3	0x1	Get MOT application type	STREAM_GetServApplicationType
0x3	0x2	Transmit the selected data group again	STREAM_MOTTableClear
0x3	0x3	Get the length of packet raw data	STREAM_MOTGetPacketRawLength

KeyStone Semiconductor Confidential & Proprietary, no copy allowed without written authorization.

Table 4. DAB Frequency Index

BAND3		
Frequency	**Alias**	**index**
174.928MHz	5A	0
176.64MHz	5B	1
178.352MHz	5C	2
180.064MHz	5D	3
181.936MHz	6A	4
183.648MHz	6B	5
185.36MHz	6C	6
187.072MHz	6D	7
188.928MHz	7A	8
190.64MHz	7B	9
192.352MHz	7C	10
194.064MHz	7D	11
195.936MHz	8A	12
197.648MHz	8B	13
199.36MHz	8C	14
201.072MHz	8D	15
202.928MHz	9A	16
204.64MHz	9B	17
206.352MHz	9C	18
208.064MHz	9D	19

BAND3		
Frequency	**Alias**	**index**
209.936MHz	10A	20
210.096MHz	10N	21
211.648MHz	10B	22
213.36MHz	10C	23
215.072MHz	10D	24
216.928MHz	11A	25
217.088MHz	11N	26
218.64MHz	11B	27
220.352MHz	11C	28
222.064MHz	11D	29
223.936MHz	12A	30
224.096MHz	12N	31
225.648MHz	12B	32
227.36MHz	12C	33
229.072MHz	12D	34
230.784MHz	13A	35
232.496MHz	13B	36
234.208MHz	13C	37
235.776MHz	13D	38
237.488MHz	13E	39
239.2MHz	13F	40

KeyStone Semiconductor Confidential & Proprietary, no copy allowed without written authorization.

CHINA BAND		
Frequency	**Alias**	**index**
168.160 MHz	CN 6A	41
169.872 MHz	CN 6B	42
171.584 MHz	CN 6C	43
173.296 MHz	CN 6D	44
175.008 MHz	CN 6N	45
176.720 MHz	CN 7A	46
178.432 MHz	CN 7B	47
180.144 MHz	CN 7C	48
181.856 MHz	CN 7D	49
184.160 MHz	CN 8A	50
185.872 MHz	CN 8B	51
187.584 MHz	CN 8C	52
189.296 MHz	CN 8D	53
191.008 MHz	CN 8N	54

CHINA BAND		
Frequency	**Alias**	**index**
192.720 MHz	CN 9A	55
194.432 MHz	CN 9B	56
196.144 MHz	CN 9C	57
197.856 MHz	CN 9D	58
200.160 MHz	CN 10A	59
201.872 MHz	CN 10B	60
203.584 MHz	CN 10C	61
205.296 MHz	CN 10D	62
207.008 MHz	CN 10N	63
208.720 MHz	CN 11A	64
210.432 MHz	CN 11B	65
212.144 MHz	CN 11C	66
213.856 MHz	CN 11D	67
216.432 MHz	CN 12A	68
218.144 MHz	CN 12B	69
219.856 MHz	CN 12C	70
221.568 MHz	CN 12D	71

KeyStone Semiconductor Confidential & Proprietary, no copy allowed without written authorization.

L BAND		
Frequency	Name	index
1452.960MHz	LA	72
1454.672MHz	LB	73
1456.384MHz	LC	74
1458.096MHz	LD	75
1459.808MHz	LE	76
1461.520MHz	LF	77
1463.232MHz	LG	78
1464.944MHz	LH	79
1466.656MHz	LI	80
1468.368MHz	LJ	81
1470.080MHz	LK	82
1471.792MHz	LL	83
1473.504MHz	LM	84
1475.216MHz	LN	85
1476.928MHz	LO	86
1478.640MHz	LP	87
1480.352MHz	LQ	88
1482.064MHz	LR	89
1483.776MHz	LS	90
1485.488MHz	LT	91
1487.200MHz	LU	92
1488.912MHz	LV	93
1490.624MHz	LW	94

KeyStone Semiconductor Confidential & Proprietary, no copy allowed without written authorization.

Table 5. Volume Level

Volume Curve	
Level	**Db**
0	Mute
1	-46dB
2	-43dB
3	-40dB
4	-37dB
5	-34dB
6	-31dB
7	-28dB
8	-25dB
9	-22dB
10	-19dB
11	-16dB
12	-14dB
13	-12dB
14	-10dB
15	-8dB
16	-6dB

KeyStone Semiconductor Confidential & Proprietary, no copy allowed without written authorization.

Table 6. Programme Type Index

Index	Programme Type
0	<Prg Type N/A >
1	News
2	Current Affairs
3	Information
4	Sport
5	Education
6	Drama
7	Arts
8	Science
9	Talk
10	Pop Music
11	Rock Music
12	Easy Listening
13	Light Classical
14	Classical Music
15	Other Music
16	Weather
17	Finance
18	Children's
19	Factual
20	Religion
21	Phone In
22	Travel
23	Leisure
24	Jazz and Blues
25	Country Music
26	National Music
27	Oldies Music
28	Folk Music
29	Documentary
30	<Undefined>
31	<Undefined>

KeyStone Semiconductor Confidential & Proprietary, no copy allowed without written authorization.

Table 7. RSSI Threshold Level

Level	Value
0	16
1	32
2	40
3	48
4	56
5	64
6	72
7	80
8	86
9	96
10	112

Table 8. BBEEQ Parameters

Achilles			
Parameter	Value	Description	
bbeon	0~2	0:Off[A], 1:BBE, 2:EQ	
bbelo	BBE mode : 0~24 EQ mode : 0~4	BBE mode: The value 0~24 represent 0~12dB, 0.5dB/step	EQ mode: 0=Bass boost, 1=Jazz, 2=Live, 3=Vocal, 4=Acoustic
bbehi	0~24	The value 0~24 represent 0~12dB, 0.5dB/step [B]	
bbecfreq	0 or 1	0:595Hz, 1:1000Hz [B]	
bbemachfreq	60, 90, 120, 150 Hz	[B]	
bbemachgain	0, 4, 8, 12 dB	[B]	
bbemachq	1 or 3	[B]	
bbesurr	0~10 dB	[B]	
bbeemp	0~10 dB	[B]	
bbehpf	0=off, 20~250 HZ(10Hz/step)	[B]	
bbehimode	0~12 dB	[B]	

Maximus		
Parameter	Value	Description

KeyStone Semiconductor Confidential & Proprietary, no copy allowed without written authorization.

bbe_eq	0~2	0:Off[A], 1:BBE, 2:EQ	
counter_eqmode	BBE mode : 0~120 EQ mode : 0~4	BBE mode: The value 0~120 represent 0~12dB, 0.1dB/step	EQ mode: 0=Bass boost, 1=Jazz, 2=Live, 3=Vocal, 4=Acoustic
process	0~120	The value 0~120 represent 0~12dB, 0.1dB/step [B]	
center_freq	0 or 1	0:595Hz, 1:1000Hz [B]	

[A] Off mode ignore other parameters.

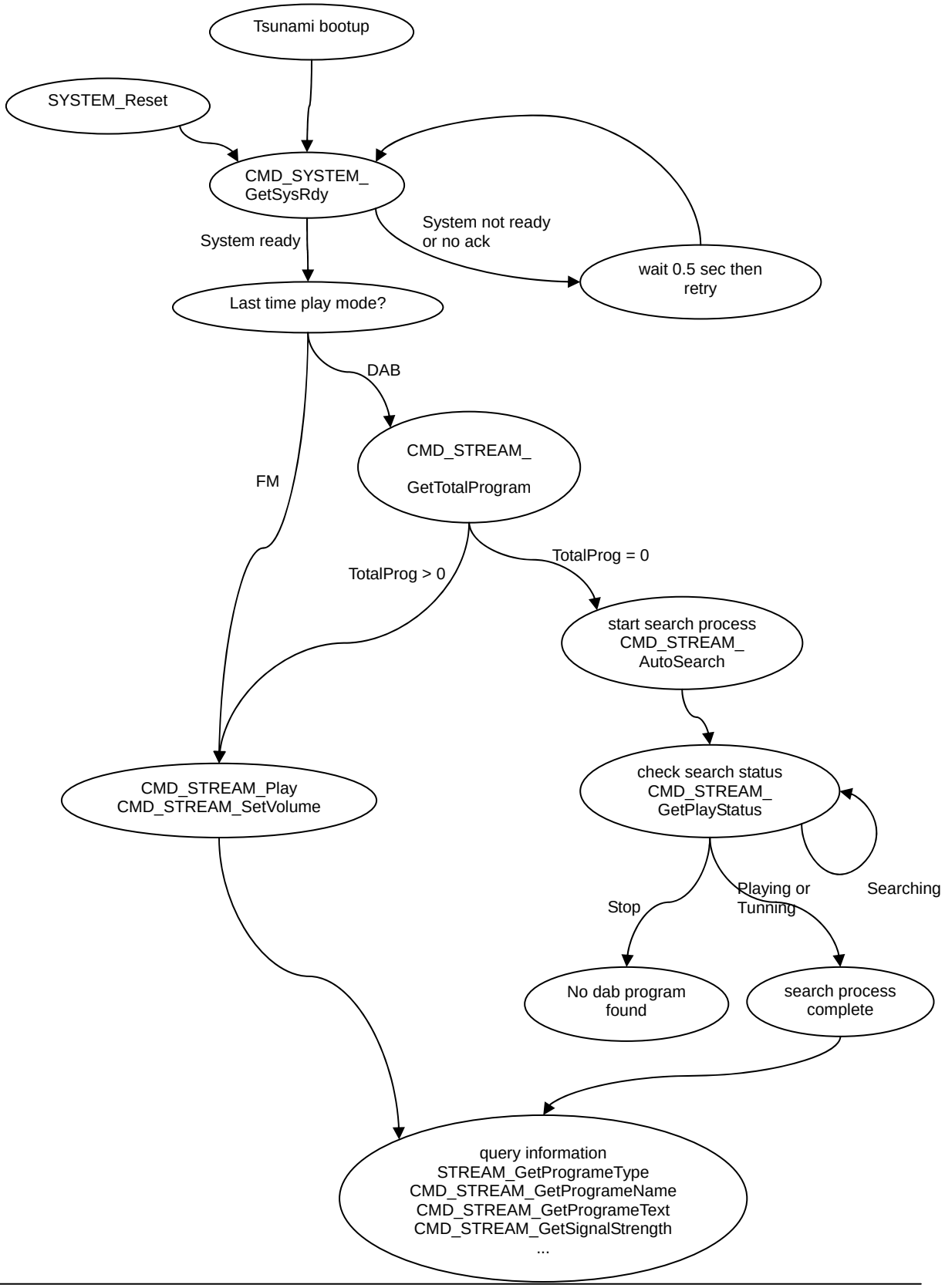
[B] Only for BBE mode, EQ mode ignore these parameters.

Table 9. Headroom Level (Achilles only)

Volume Curve	
Level	**Db**
0	0 dB
1	-1 dB
2	-2 dB
3	-3 dB
4	-4 dB
5	-5 dB
6	-6 dB
7	-7 dB
8	-8 dB
9	-9 dB
10	-10 dB
11	-11 dB
12	-12 dB

KeyStone Semiconductor Confidential & Proprietary, no copy allowed without written authorization.

6 Example: Command Flow



KeyStone Semiconductor Confidential & Proprietary, no copy allowed without written authorization.

Revision History：

Date	Ver.	Author	Change Log
2009/12/23	1.0	Etic	initial version
2010/02/10	1.1	Lucy	Modify command format, and add new command
2010/02/24	1.2	Nick	Add i2c slave explanation
2010/02/25	1.3	Will	Add BBEEQ parameter explanation
2010/03/30	1.4	Lucy	Update i2c slave explanation Modify BBEEQ parameter explanation Add head room level explanation
2010/04/14	1.5	Shawn	Add SYSTEM_GetMCUVersion command Add SYSTEM_GetBootVersion command Add SYSTEM_GetASPVersion command
2010/05/21	1.6	Lucy	Add SYSTEM_SetPreset command Add SYSTEM_GetPreset command Add MOT_GetMOTData command
2010/07/20	1.7	Shawn	Add MOT_GetApplicationType command Add MOT_ReTransmitGroup command
2010/08/10	1.7.1	Lucy	Add section 6 command flow example
2010/08/24	1.8	Shawn	Add MOT_GetPacketRawLength command
2010/09/13	1.8.1	Will	Speed up I2C Read/Write command
2010/12/09	1.9	Shawn	Remove STREAM_IsDABPlus command Add STREAM_GetServCompType command
2010/12/10	2.0	Lucy	Add STREAM_GetSorter command Add STREAM_SetSorter command
2010/12/27	2.1	Sophia	Add STREAM_GetDrc command Add STREAM_SetDrc command
2011/1/24	2.2	Sophia	Add STREAM_GetProgrameInfo command
2011/2/11	2.3	Sophia	Add one more status (Sorting_Change status) to STREAM_GetPlayStatus command
2011/2/15	2.4	Hunk	Add Reconfiguration status in STREAM_GetPlayStatus

KeyStone Semiconductor Confidential & Proprietary, no copy allowed without written authorization.

2011/4/6	2.5	Shawn	Update the explanation of the MOT command MOT_GetPacketRawLength

KeyStone Semiconductor Confidential & Proprietary, no copy allowed without written authorization.