AN332 REV 0.8 UNIVERSAL PROGRAMMING GUIDE

AMENDMENT FOR SI4735-D60 SSB AND NBFM PATCHES

1. Introduction

1.1. Scope

This amendment document provides an overview of the programming requirements for a SSB and NBFM specific patches which add SSB/NBFM receiver capabilities to the Si4735-D60 parts.

2. Overview

Please refer to AN332 Rev 0.8 Universal Programming Guide Chapter 2 for details.

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3. Terminology

- SSB— Single Side Band (i.e. Amplitude Modulation with AM carrier and one side band suppressed)
- NBFM – Narrow Band FM (Frequency Modulation)

Please refer to AN332 Rev 0.8 Universal Programming Guide Chapter 3.

4. Commands and Responses

Please refer to AN332 Rev 0.8 Universal Programming Guide Chapter 4 for details.

5. Commands and Properties

There are four different components for these product families:
1. FM Transmitter component
2. FM Receiver component
3. AM/SW/LW component
4. WB component

The following four subsections list all the commands and properties used by each of the component.

Applied to Si4735-D60 only, if the SSB patch is used with power up AMRX mode, the part will act as a SSB receiver. Similarly, if the NBFM patch is used with power up FMRX mode, the part will act as a NBFM receiver.

5.1 Command and Properties for the FM/RDS Transmitter (Si4710/11/12/13/20/21)

Please refer to AN332 Rev 0.8 Universal Programming Guide Section 5.1.

5.2 Command and Properties for the FM/RDS Receiver (Si4704/05/06/2x/3x/4x/84/85)

Please refer to AN332 Rev 0.8 Universal Programming Guide Section 5.2.

5.3 Command and Properties for the AM/SW/LW Receiver
(Si4730/31/34/35/36/37/40/41/42/43/44/45)
Please refer to AN332 Rev 0.8 Universal Programming Guide Section 5.3.

5.4 Command and Properties for the WB Receiver (Si4707/36/37/38/39/42/43)

Please refer to AN332 Rev 0.8 Universal Programming Guide Section 5.4.

5.5 Command and Properties for the SSB Receiver (Si4735-D60* only)

The following two tables are the summary of the commands and properties for the Single Side Band (SSB) Receiver component applicable to Si47035-D60 when powering up the part in AM mode with the SSB patch. SSB modulation is a refinement of amplitude modulation that one of the side band and the carrier are suppressed.

The SSB operates at the same band frequency ranges of the AM (Medium Wave) and SW (Short Wave) bands. The common frequency range and spacing for AM/SW are:
- AM in US 520 kHz to 1.71 MHz in 10kHz frequency spacing
- AM in Asia 522 kHz to 1.71 MHz in 9kHz frequency spacing
- SW 2.3 MHz to 30 MHz in 5 kHz frequency spacing

Tables 1 and 2 summarize the commands and properties for the SSB Receiver components applicable to Si4735-D60 running SSB patch.

Table 1. SSB Receiver Command Summary

Cmd	Name	Description
0x01	POWER_UP	Power up device and mode selection.
0x10	GET_REV	Returns revision information on the device.
0x11	POWER_DOWN	Power down device.
0x12	SET_PROPERTY	Sets the value of a property.
0x13	GET_PROPERTY	Retrieves a property's value.
0x14	GET_INT_STATUS	Reads interrupt status bits.
0x15	PATCH_ARGS	Reserved command used for patch file downloads.
0x16	PATCH_DATA	Reserved command used for patch file downloads.
0x40	SSB_TUNE_FREQ	Selects the SSB tuning frequency.
0x42	SSB_TUNE_STATUS	Queries the status of previous SSB_TUNE_FREQ
0x43	SSB_RSQ_STATUS	Queries the status of the Received Signal Quality (RSQ) of the current channel
0x47	SSB_AGC_STATUS	Queries the current AGC settings.
0x48	SSB_AGC_OVERRIDE	Override AGC setting by disabling and forcing it to a fixed value.
0x80	GPIO_CTL	Configures GPO1, 2, and 3 as output or Hi-Z.
0x81	GPIO_SET	Sets GPO1, 2, and 3 output level (low or high).

Table 2. SSB Receiver Property Summary

Prop	Name	Description	Default
0x0001	GPO_IEN	Enables interrupt sources.	0x0000
0x0100	SSB_BFO	Sets the Beat Frequency Offset (BF0) under SSB mode. Note: Not available when AFC is enabled for AM signal.	0x0000
0x0101	SSB_MODE	Sets number of properties of the SSB mode: • Enable/disable AFC for normal AM signal reception. • SSB audio bandwidth selection • SSB side band cutoff filter selection • Soft-mute based on RSSI/SNR selection • Enable/disable AVC	0x1800
0x3200	SSB_RSQ_INTERRUPTS	Configures interrupt related to Received Signal Quality metrics. All interrupts are disabled by default.	0x0000
0x3201	SSB_RSQ_SNR_HI_ THRESHOLD	Sets high threshold for SNR interrupt.	0x007F
0x3202	SSB_RSQ_SNR_LO_ THRESHOLD	Sets low threshold for SNR interrupt.	0x0000
0x3203	SSB_RSQ_RSSI_HI_ THRESHOLD	Sets high threshold for RSSI interrupt.	0x007F
0x3204	SSB_RSQ_RSSI_LO_ THRESHOLD	Sets low threshold for RSSI interrupt.	0x0000
0x3300	SSB_SOFT_MUTE_RATE	Sets the attack and decay rates when entering or leaving soft mute. The default is 278 dB/s.	0x0040
0x3302	SSB_SOFT_MUTE_MAX_ ATTENUATION	Sets maximum attenuation during soft mute (dB). Set to 0 to disable soft mute. Default is 8 dB. (Si4740/41/42/43/44/45 only)	0x0008
0x3303	SSB_SOFT_MUTE_SNR_ THRESHOLD	Sets SNR threshold to engage soft mute. Default is 8 dB.	0x0008
0x3700	SSB_RF_AGC_ ATTACK_RATE	Sets the number of milliseconds the high RF peak detector must be exceeded before decreasing gain. Default value is 4 (approximately 1400 dB/s).	0x0004
0x3701	SSB_RF_AGC_ RELEASE_RATE	Sets the number of milliseconds the low RF peak detector must not be exceeded before increasing the gain. Default value is 24 (approximately 233 dB/s).	0x0018
0x3702	SSB_IF_AGC_ ATTACK_RATE	Sets the number of milliseconds the high IF peak detector must be exceeded before decreasing gain. Default value is 4 (approximately 1400 dB/s).	0x0004
0x3703	SSB_IF_AGC_ RELEASE_RATE	Sets the number of milliseconds the low IF peak detector must not be exceeded before increasing the gain. Default value is 140 (approximately 40 dB/s).	0x008C
0x4000	RX_VOLUME	Sets the output volume.	0x003F
0x4001	RX_HARD_MUTE	Mutes the L and R audio outputs.	0x0000

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Table 3. Status Response for the SSB Receiver

Command

Bit	D7	D6	D5	D4	D3	D2	D1	D0
STATUS	CTS	ERR	X	X	RSQINT	X	X	STCINT

Bit	Name	Description
7	CTS	**Clear to Send.** 0 = Wait before sending next command. 1 = Clear to send next command.
6	ERR	**Error.** 0 = No error 1 = Error
5:4	Reserved	Values may vary.
3	RSQINT	**Received Signal Quality Interrupt.** 0 = Received Signal Quality measurement has not been triggered. 1 = Received Signal Quality measurement has been triggered.
2:1	Reserved	Values may vary.
0	STCINT	**Tune Complete Interrupt.** 0 = Tune complete has not been triggered. 1 = Tune complete interrupt has been triggered.

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5.5.1. SSB Receiver Commands

Command 0x01. POWER_UP

Initiates the boot process to move the device from powerdown to powerup mode. The boot can occur from internal device memory or a system controller downloaded patch. To confirm that the patch is compatible with the internal device library revision, the library revision should be confirmed by issuing the POWER_UP command with FUNC = 15 (query library ID). The device returns the response, including the library revision, and then moves into powerdown mode. The device can then be placed in powerup mode by issuing the POWER_UP command with FUNC = 1 (AM/SW/LW Receive) together with the specific SSB patch. See Section "7.2. Powerup from a Component Patch" on original AN332 for more information.

The POWER_UP command configures the state of ROUT (pin 13) and LOUT (pin 14) for analog audio mode and GPO2/INT (pin 18) for interrupt operation. Note that current SSB patch does not support configuring the state of GPO3/DCLK (pin 19), DFS (pin 18), and DOUT (pin 17) for digital audio mode. The command configures GPO2/INT interrupts (GPO2OEN) and CTS interrupts (CTSIEN). If both are enabled, GPO2/INT is driven high during normal operation and low for a minimum of 1 µs during the interrupt. The CTSIEN bit is duplicated in the GPO_IEN property. The command is complete when the CTS bit (and optional interrupt) is set.

Note: To change function (e.g. SSBRX to FM RX or AM RX), issue POWER_DOWN command to stop current function; then, issue POWER_UP to start new function.

Command Arguments: Two
Response Bytes: None (FUNC = 1), Seven (FUNC = 15)

Command

Bit	D7	D6	D5	D4	D3	D2	D1	D0
CMD	0	0	0	0	0	0	0	1
ARG1	CTSIEN	GP02OEN	PTACH	XOSCEN	FUNC[3:0]			
ARG2	OPMODE[7:0]							

ARG	Bit	Name	Function
1	7	CTSIEN	**CTS Interrupt Enable.** 0 = CTS interrupt disabled. 1 = CTS interrupt enabled.
1	6	GP02OEN	**GPO2 Output Enable.** 0 = GPO2 output disabled. 1 = GPO2 output enabled.
1	5	PTACH	**Patch Enable.** 0 = Boot normally 1 = Copy NVM to RAM, but do not boot. After CTS has been set, RAM may be patched
1	4	XOSCEN	**Crystal Oscillator Enable.** 0 = Use external RCLK (crystal oscillator disabled) 1 = Use crystal oscillator (RCLK and GPO3/DCLK with external 32.768kHz crystal and OPMODE = 00000101) See Si47xx Data Sheet Application Schematic for external BOM details.
1	3:0	FUNC[3:0]	**Function.** 1 = SSB (AM/SW/LW) Receive. 0, 2–14 = Reserved 15 = Query Library ID.
2	7:0	OPMODE[7:0]	00000101 = Analog audio outputs (LOUT/ROUT) Other values = reserved

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Response (FUNC = 1, SSB Receive)

Bit	D7	D6	D5	D4	D3	D2	D1	D0
STATUS	CTS	ERR	X	X	RSQINT	X	X	STCINT

Response (FUNC = 15, Query Library ID))

Bit	D7	D6	D5	D4	D3	D2	D1	D0
STATUS	CTS	ERR	X	X	RSQINT	X	X	STCINT
RESP1	PN[7:0]							
RESP2	FWMAJOR[7:0]							
RESP3	FWMINOR[7:0]							
RESP4	RESERVED [7:0]							
RESP5	RESERVED [7:0]							
RESP6	CHIPREV [7:0]							
RESP7	LIBRARYID [7:0]							

RESP	Bit	Name	Function
1	7:0	PN[7:0]	Final 2 digits of Part Number (HEX).
2	7:0	FWMAJOR[7:0]	Firmware Major Revision (ASCII).
3	7:0	FWMINOR[7:0]	Firmware Minor Revision (ASCII).
4	7:0	RESERVED[7:0]	Reserved, various values.
5	7:0	RESERVED[7:0]	Reserved, various values.
6	7:0	CHIPREV[7:0]	Chip Revision (ASCII).
7	7:0	LIBRARYID[7:0]	Library Revision (HEX).

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Command 0x10. GET_REV

Returns the part number, chip revision, firmware revision, patch revision and component revision numbers. The command is complete when the CTS bit (and optional interrupt) is set. This command may only be sent when in power up mode.

Command arguments: None
Response bytes: Eight

Command

Bit	D7	D6	D5	D4	D3	D2	D1	D0
CMD	0	0	0	1	0	0	0	0

Response

Bit	D7	D6	D5	D4	D3	D2	D1	D0
STATUS	CTS	ERR	X	X	RSQINT	X	X	STCINT
RESP1	PN[7:0]							
RESP2	FWMAJOR[7:0]							
RESP3	FWMINOR[7:0]							
RESP4	PATCH$_H$[7:0]							
RESP5	PATCH$_L$[7:0]							
RESP6	CMPMAJOR[7:0]							
RESP7	CMPMINOR[7:0]							
RESP8	CHIPREV[7:0]							

RESP	Bit	Name	Function
1	7:0	PN[7:0]	Final 2 digits of Part Number (HEX).
2	7:0	FWMAJOR[7:0]	Firmware Major Revision (ASCII).
3	7:0	FWMINOR[7:0]	Firmware Minor Revision (ASCII).
4	7:0	PATCH$_H$[7:0]	Patch ID High Byte (HEX).
5	7:0	PATCH$_L$[7:0]	Patch ID Low Byte (HEX).
6	7:0	CMPMAJOR[7:0]	Component Major Revision (ASCII).
7	7:0	CMPMINOR[7:0]	Component Minor Revision (ASCII).
8	7:0	CHIPREV[7:0]	Chip Revision (ASCII).

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Command 0x11. POWER_DOWN

Moves the device from power up to power down mode. The CTS bit is set when it is safe to send the next command. This command may only be sent when in power up mode. Note that only the ATDD_POWER_UP and ATDD_GET_STATUS commands are accepted in power down mode. **If the system controller writes a command other than the two commands when in power down mode, the device does not respond. The device will only respond when an POWER_UP command is written.**

Note: The following describes the state of all the pins when in powerdown mode:
GPIO1, GPIO2, GPIO3 = 0
ROUT, LOUT = HiZ

Command arguments: None
Response bytes: None

Command

Bit	D7	D6	D5	D4	D3	D2	D1	D0
CMD	0	0	0	1	0	0	0	1

Response

Bit	D7	D6	D5	D4	D3	D2	D1	D0
STATUS	CTS	ERR	X	X	RSQINT	X	X	STCINT

Command 0x12. SET_PROPERTY

Sets a property shown in Table 2, "SSB Receiver Property Summary," on page 5. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This command may only be sent when in power up mode.

Command Arguments: Five
Response bytes: None

Command

Bit	D7	D6	D5	D4	D3	D2	D1	D0
CMD	0	0	0	1	0	0	1	0
ARG1	0	0	0	0	0	0	0	0
ARG2	$PROP_H[7:0]$							
ARG3	$PROP_L[7:0]$							
ARG4	$PROPD_H[7:0]$							
ARG5	$PROPD_L[7:0]$							

ARG	Bit	Name	Function
1	7:0	Reserved	Always write to 0.
2	7:0	PROP$_H$	**Property High Byte.** This byte in combination with PROPL is used to specify the property to modify
3	7:0	PROP$_L$	**Property Low Byte.** This byte in combination with PROPH is used to specify the property to modify
4	7:0	PROPD$_H$	**Property Value High Byte.** This byte in combination with PROPDL is used to specify the property to modify
5	7:0	PROPD$_L$	**Property Value Low Byte.** This byte in combination with PROPDH is used to specify the property to modify

Command 0x13. GET_PROPERTY

Gets a property as shown in Table 2, "SSB Receiver Property Summary," on page 5. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This command may only be sent when in power up mode.

Command arguments: Three
Response bytes: Three

Command

Bit	D7	D6	D5	D4	D3	D2	D1	D0
CMD	0	0	0	1	0	0	1	1
ARG1	0	0	0	0	0	0	0	0
ARG2	PROP$_H$[7:0]							
ARG3	PROP$_L$[7:0]							

ARG	Bit	Name	Function
1	7:0	Reserved	Always write to 0.
2	7:0	PROP$_H$	**Property High Byte.** This byte in combination with PROPL is used to specify the property to get
3	7:0	PROP$_L$	**Property Low Byte.** This byte in combination with PROPH is used to specify the property to get

Response

Bit	D7	D6	D5	D4	D3	D2	D1	D0
STATUS	CTS	ERR	Reserved					
RESP1	0	0	0	0	0	0	0	0
RESP2	PROPD$_H$[7:0]							
RESP3	PROPD$_L$[7:0]							

RESP	Bit	Name	Function
1	7:0	Reserved	Always write to 0.
2	7:0	PROPD$_H$	**Property Value High Byte.** This byte in combination with PROPDL represents the requested property value.
3	7:0	PROPD$_L$	**Property Value Low Byte.** This byte in combination with PROPDH represents the requested property value.

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Command 0x14. GET_INT_STATUS

Updates bits 6:0 of the status byte. This command should be called after any command that sets the STCINT, RSQINT bits. When polling this command should be periodically called to monitor the status byte, and when using interrupts, this command should be called after the interrupt is set to updated the status byte. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This command may only be sent when in powerup mode.

Command arguments: None
Response bytes: One

Command

Bit	D7	D6	D5	D4	D3	D2	D1	D0
CMD	0	0	0	1	0	1	0	0

Response

Bit	D7	D6	D5	D4	D3	D2	D1	D0
STATUS	CTS	ERR	X	X	RSQINT	X	X	STCINT

Command 0x40. SSB_TUNE_FREQ

Tunes the SSB receiver to a frequency between 520 and 30 MHz in 1 kHz steps. For SSB operating at AM frequency band, the valid frequency is between 520 and 1710 kHz in 1 kHz steps. The CTS bit (and optional interrupt) is set when it is safe to send the next command. The ERR bit (and optional interrupt) is set if an invalid argument is sent. Note that only a single interrupt occurs if both the CTS and ERR bits are set. The optional STC interrupt is set when the command completes. The STCINT bit is set only after the GET_INT_STATUS command is called. This command may only be sent when in powerup mode. The command clears the STC bit if it is already set. See Figure 29, "CTS and STC Timing Model," on page 244 and Table 49, "Command Timing Parameters for the AM Receiver," on page 246 in the original Rev 0.8 AN332 programming guide.

Note: The LO frequency is 45 kHz above RF when upper side band (USB) is selected and is 45 kHz below RF when lower side band (LSB) is selected. For example, LO frequency is 945 kHz when tuning to 900 kHz when USB is selected.

Command arguments: Five
Response bytes: None

Command

Bit	D7	D6	D5	D4	D3	D2	D1	D0
CMD	0	1	0	0	0	0	0	0
ARG1	USBLSB		0	0	0	0	0	0
ARG2	$FREQ_H[7:0]$							
ARG3	$FREQ_L[7:0]$							
ARG4	$ANTCAP_H[15:8]$							
ARG5	$ANTCAP_L[7:0]$							

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RESP	Bit	Name	Function
1	7:6	USBLSB	**SSB Upper Side Band (USB) and Lower Side Band (LSB) Selection.** 10 = USB is selected. 01 = LSB is selected. Other values = not allowed.
1	5:0	Reserved	Always write to 0.
2	7:0	FREQ$_H$[7:0]	**Tune Frequency High Byte.** This byte in combination with FREQL selects the tune frequency in kHz. In SSB mode the valid range is from 520 to 30000 (520 kHz – 30 MHz). Operate SSB in AM band, the valid range is from 520 to 1710 (520–1710 kHz).
3	7:0	PROP$_L$[7:0]	**Tune Frequency Low Byte.** This byte in combination with FREQH selects the tune frequency in kHz. In SSB mode the valid range is from 520 to 30000 (520 kHz – 30 MHz). Operate SSB in AM band, the valid range is from 520 to 1710 (520–1710 kHz).
4	7:0	ANTCAP$_H$ [15:8]	**Antenna Tuning Capacitor High Byte.** This byte in combination with ANTCAPL selects the tuning capacitor value. If both bytes are set to zero, the tuning capacitor value is selected automatically. If the value is set to anything other than 0, the tuning capacitance is manually set as 95 fF x ANTCAP + 7 pF. ANTCAP manual range is 1–6143. Automatic capacitor tuning is recommended. **Note:** Operate SSB in SW band, ANTCAPH[15:8] needs to be set to 0 and ANTCAPL[7:0] needs to be set to 1.
5	7:0	ANTCAP$_L$ [7:0]	**Antenna Tuning Capacitor Low Byte.** This byte in combination with ANTCAPH selects the tuning capacitor value. If both bytes are set to zero, the tuning capacitor value is selected automatically. If the value is set to anything other than 0, the tuning capacitance is manually set as 95 fF x ANTCAP + 7 pF. ANTCAP manual range is 1–6143. Automatic capacitor tuning is recommended. **Note:** Operate SSB in SW band, ANTCAPH[15:8] needs to be set to 0 and ANTCAPL[7:0] needs to be set to 1.

Response

Bit	D7	D6	D5	D4	D3	D2	D1	D0
STATUS	CTS	ERR	X	X	RSQINT	X	X	STCINT

Command 0x42. SSB_TUNE_STATUS

Returns the status of SSB_TUNE_FREQ command. The commands returns the current frequency, RSSI, SNR, and the antenna tuning capacitance value (0–6143). The command clears the STCINT interrupt bit when INTACK bit of ARG1 is set. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This command may only be sent when in powerup mode.

Command arguments: One
Response bytes: Seven

Command

Bit	D7	D6	D5	D4	D3	D2	D1	D0
CMD	0	1	0	0	0	0	1	0
ARG1	0	0	0	0	0	0	0	INTACK

ARG	Bit	Name	Function
1	7:1	Reserved	Always write to 0.
1	0	INTACK	**Tune Interrupt Clear.** If set this bit clears the tune complete interrupt status indicator.

Response

Bit	D7	D6	D5	D4	D3	D2	D1	D0
STATUS	CTS	ERR	X	X	RSQINT	X	X	STCINT
RESP1	X	X	X	X	X	X	AFCRL	VALID
RESP2	$READFREQ_H[7:0]$							
RESP3	$READFREQ_L[7:0]$							
RESP4	RSSI[7:0]							
RESP5	SNR[7:0]							
RESP6	$READANTCAP_H[15:8]$							
RESP7	$READANTCAP_L[7:0]$							

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RESP	Bit	Name	Function
1	7:2	Reserved	Always returns 0.
1	1	AFCRL	**AFC Rail Indicator.** This bit will be set if the AFC rails.
1	0	VALID	**Valid Channel.** Confirms if the channel is currently valid.
2	7:0	READFREQH[7:0]	**Read Frequency High Byte.** This byte in combination with READFREQL returns frequency being tuned (kHz).
3	7:0	READFREQL[7:0]	**Read Frequency Low Byte.** This byte in combination with READFREQH returns frequency being tuned (kHz).
4	7:0	RSSI[7:0]	**Received Signal Strength Indicator.** This byte will contain the receive signal strength at the tuned frequency.
5	7:0	SNR[7:0]	**SNR.** This byte will contain the SNR metric at the tuned frequency.
6	7:0	READANTCAPH [15:8]	**Read Antenna Tuning Capacitor High Byte.** This byte in combination with READANTCAPL returns the current antenna tuning capacitor value. The tuning capacitance is 95 fF x READANTCAP + 7 pF.
7	7:0	READANTCAPL [7:0]	**Read Antenna Tuning Capacitor Low Byte.** This byte in combination with READANTCAPH returns the current antenna tuning capacitor value. The tuning capacitance is 95 fF x READANTCAP + 7 pF.

Command 0x43. SSB_RSQ_STATUS

Returns status information about the received signal quality. The commands returns RSSI and SNR. It also indicates valid channel (VALID), soft mute engagement (SMUTE), and AFC rail status (AFCRL). This command can be used to check if the received signal is above the RSSI high threshold as reported by RSSIHINT, or below the RSSI low threshold as reported by RSSILINT. It can also be used to check if the signal is above the SNR high threshold as reported by SNRHINT, or below the SNR low threshold as reported by SNRLINT. The command clears the RSQINT, SNRHINT, SNRLINT, RSSIHINT, and RSSILINT interrupt bits when INTACK bit of ARG1 is set.

The CTS bit (and optional interrupt) is set when it is safe to send the next command. This command may only be sent when in powerup mode.

Command arguments: One
Response bytes: Five

Command

Bit	D7	D6	D5	D4	D3	D2	D1	D0
CMD	0	1	0	0	0	0	1	1
ARG1	0	0	0	0	0	0	0	INTACK

ARG	Bit	Name	Function
1	0	INTACK	**Interrupt Acknowledge** 0 = Interrupt status preserved. 1 = Clears RSQINT, SNRHINT, SNRLINT, RSSIHINT, RSSILINT

Response

Bit	D7	D6	D5	D4	D3	D2	D1	D0
STATUS	CTS	ERR	X	X	RSQINT	X	X	STCINT
RESP1	X	X	X	X	SNRHINT	SNRLINT	RSSIHINT	RSSILINT
RESP2	X	X	X	X	SMUTE	X	AFCRL	VALID
RESP3	X	X	X	X	X	X	X	X
RESP4	RSSI[7:0]							
RESP5	SNR[7:0]							

RESP	Bit	Name	Function
1	3	SNRHINT	**SNR Detect High.** 0 = Received SNR has not exceeded above SNR high threshold. 1 = Received SNR has exceeded above SNR high threshold.
1	2	SNRLINT	**SNR Detect Low.** 0 = Received SNR has not exceeded below SNR low threshold. 1 = Received SNR has exceeded below SNR low threshold.
1	1	RSSIHINT	**RSSI Detect High.** 0 = RSSI has not exceeded above RSSI high threshold. 1 = RSSI has exceeded above RSSI high threshold.
1	0	RSSILINT	**RSSI Detect Low.** 0 = RSSI has not exceeded below RSSI low threshold. 1 = RSSI has exceeded below RSSI low threshold.
2	3	SMUTE	**Soft Mute Indicator.** Indicates soft mute is engaged.
2	1	AFCRL	**AFC Rail Indicator.** This bit will be set if the AFC rails.
2	0	VALID	**Valid Channel.** Confirms if the channel is currently valid.
4	7:0	RSSI[7:0]	**Received Signal Strength Indicator.** This byte will contain the receive signal strength at the tuned frequency.
5	7:0	SNR[7:0]	**SNR.** This byte will contain the SNR metric at the tuned frequency.

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Command 0x47. SSB_AGC_STATUS

Returns the SSB AGC setting of the device. The command returns whether the AGC is enabled or disabled and it returns the gain index. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This command may only be sent when in power up mode.

Command arguments: None
Response bytes: Two

Command

Bit	D7	D6	D5	D4	D3	D2	D1	D0
CMD	0	1	0	0	0	1	1	1

Response

Bit	D7	D6	D5	D4	D3	D2	D1	D0
STATUS	CTS	ERR	X	X	RSQINT	X	X	STCINT
RESP1	X	X	X	X	X	X	X	SSBAGCDIS
RESP2	SSBAGCNDX[7:0]							

RESP	Bit	Name	Function
1	0	SSBAGCDIS	**SSB AGC Disable** This bit indicates if the AGC is enabled or disabled. 0 = AGC enabled. 1 = AGC disabled.
2	7:0	SSBAGCNDX[7:0]	**SSB AGC Index** This byte reports the current AGC gain index. 0 = Minimum attenuation (max gain) 1 – 36+ATTN_BACKUP = Intermediate attenuation 37+ATTN_BACKUP = Maximum attenuation (min gain)

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Command 0x48. SSB_AGC_OVERRIDE

Overrides the SSB AGC setting by disabling the AGC and forcing the gain index that ranges between 0 (minimum attenuation) and 37+ATTN_BACKUP (maximum attenuation). The CTS bit (and optional interrupt) is set when it is safe to send the next command. This command may only be sent when in power up mode.

Command arguments: Two
Response bytes: None

Command

Bit	D7	D6	D5	D4	D3	D2	D1	D0
CMD	0	1	0	0	1	0	0	0
ARG1	X	X	X	X	X	X	X	SSBAGCDIS
ARG2	SSBAGCNDX[7:0]							

ARG	Bit	Name	Function
1	7:1	Reserved	Always write to 0.
1	0	SSBAGCDIS	**SSB AGC Disable** This bit selects whether the AGC is enabled or disabled. 0 = AGC enabled. 1 = AGC disabled.
2	7:0	SSBAGCNDX	**SSB AGC Index** If SSBAGCDIS = 1, this byte forces the AGC gain index. 0 = Minimum attenuation (max gain) 1 – 36+ATTN_BACKUP = Intermediate attenuation 37+ATTN_BACKUP = Maximum attenuation (min gain)

Response

Bit	D7	D6	D5	D4	D3	D2	D1	D0
STATUS	CTS	ERR	X	X	RSQINT	X	X	STCINT

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Command 0x80. GPIO_CTL

Enables output for GPO1, 2, and 3. GPO1, 2, and 3 can be configured for output (Hi-Z or active drive) by setting the GPO1OEN, GPO2OEN, and GPO3OEN bit. The state (high or low) of GPO1, 2, and 3 is set with the GPIO_SET command. To avoid excessive current consumption due to oscillation, GPO pins should not be left in a high impedance state. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This command may only be sent when in powerup mode. The default is all GPO pins set for high impedance.

Notes: The use of GPO2 as an interrupt pin will override this GPIO_CTL function for GPO2.

Command arguments: One
Response bytes: None

Command

Bit	D7	D6	D5	D4	D3	D2	D1	D0
CMD	1	0	0	0	0	0	0	0
ARG1	X	X	X	X	GPO3OEN	GPO2OEN	GPO1OEN	0

ARG	Bit	Name	Function
1	7:4	Reserved	Always write to 0.
1	3	GPO3OEN	**GPO3 Output Enable.** 0 = Output Disabled (Hi-Z) (default). 1 = Output Enabled.
1	2	GPO2OEN	**GPO2 Output Enable.** 0 = Output Disabled (Hi-Z) (default). 1 = Output Enabled.
1	1	GPO1OEN	**GPO1 Output Enable.** 0 = Output Disabled (Hi-Z) (default). 1 = Output Enabled.
1	0	Reserved	Always write to 0.

Response

Bit	D7	D6	D5	D4	D3	D2	D1	D0
STATUS	CTS	ERR	X	X	RSQINT	X	X	STCINT

Command 0x81. GPIO_SET

Sets the output level (high or low) for GPO1, 2, and 3. GPO1, 2, and 3 can be configured for output by setting the GPO1OEN, GPO2OEN, and GPO3OEN bit in the GPIO_CTL command. To avoid excessive current consumption due to oscillation, GPO pins should not be left in a high impedance state. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This property may only be set or read when in powerup mode. The default is all GPO pins set for high impedance.

Command arguments: One
Response bytes: None

Command

Bit	D7	D6	D5	D4	D3	D2	D1	D0
CMD	1	0	0	0	0	0	0	0
ARG1	X	X	X	X	GPO3LEVEL	GPO2LEVEL	GPO1LEVEL	0

ARG	Bit	Name	Function
1	7:4	Reserved	Always write to 0.
1	3	GPO3OEN	**GPO3 Output Level.** 0 = Output low (default). 1 = Output high.
1	2	GPO2OEN	**GPO2 Output Level.** 0 = Output low (default). 1 = Output high.
1	1	GPO1OEN	**GPO1 Output Level.** 0 = Output low (default). 1 = Output high.
1	0	Reserved	Always write to 0.

Response

Bit	D7	D6	D5	D4	D3	D2	D1	D0
STATUS	CTS	ERR	X	X	RSQINT	X	X	STCINT

5.5.2. SSB Receiver Properties

Property 0x0001. GPO_IEN

Configures the sources for the GPO2/INT interrupt pin. Valid sources are the lower 8 bits of the STATUS byte, including CTS, ERR, RSQINT, and STCINT bits. The corresponding bit is set before the interrupt occurs. The CTS bit (and optional interrupt) is set when it is safe to send the next command. The CTS interrupt enable (CTSIEN) can be set with this property and the POWER_UP command. The state of the CTSIEN bit set during the POWER_UP command can be read by reading this property and modified by writing this property. This property may only be set or read when in powerup mode.

Default: 0x0000

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	0	0	0	0	RSQREP	0	0	STCREP	CTSIEN	ERRIEN	0	0	RSQIEN	0	0	STCIEN

Bit	Name	Function
15:12	Reserved	Always write to 0.
11	RSQREP	**RSQ Interrupt Repeat.** 0 = No interrupt generated when RSQINT is already set (default). 1 = Interrupt generated even if RSQINT is already set.
10:9	Reserved	Always write to 0.
8	STCREP	**STC Interrupt Repeat.** 0 = No interrupt generated when STCINT is already set (default). 1 = Interrupt generated even if STCINT is already set.
7	CTSIEN	**CTS Interrupt Enable. After PowerUp, this bit will reflect the CTSIEN bit in ARG1 of PowerUp Command.** 0 = No interrupt generated when CTS is set. 1 = Interrupt generated when CTS is set.
6	ERRIEN	**ERR Interrupt Enable.** 0 = No interrupt generated when ERR is set (default). 1 = Interrupt generated when ERR is set.
5:4	Reserved	Always write to 0.
3	RSQIEN	**RSQ Interrupt Enable** 0 = No interrupt generated when RSQINT is set (default). 1 = Interrupt generated when RSQINT is set.
2:1	Reserved	Always write to 0.
0	STCIEN	**Tune Complete Interrupt Enable.** 0 = No interrupt generated when TCINT is set (default) 1 = Interrupt generated when TCINT is set

Property 0x0100. SSB_BFO

Sets the SSB Beat Frequency Offset (BFO). The BFO is a 16-bit signed value, unit in Hz (internal BFO resolution is accurate to 8Hz). Valid BFO range is from -16383 Hz to +16383 Hz. The host microcontroller should always be responsible to display the actual tuned frequency. i.e. SSB_TUNE_FREQ command tune frequency in Hz + BFO SSBBFO[15:0] in Hz. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This property may only be set or read when in powerup mode. The default is 0 Hz.

Default: 0x0000

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	SSBBFO [15:0]															

Bit	Name	Function
15:0	SSBBFO	**SSB Beat Frequency Offset (BFO).** This sets the BFO frequency in Hz unit. Valid range is from -16383 Hz to +16383 Hz. Default is 0 Hz.

Property 0x0101. SSB_MODE

Sets the SSB receiver mode details: (1) Enable/disable AFC track to carrier function for receiving normal AM signals, (2) Set the audio bandwidth, (3) Set the side band cutoff filter, (4) Set soft-mute based on RSSI or SNR, and (5) Enable/disable automatic volume control (AVC) function. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This property may only be set or read when in powerup mode. The default is 0x1000.

Default: 0x1000

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	0	0	SMUTESEL	AVCEN	DSPAFCFB[3:0]				SBCUTFLT[3:0]				AUDIOBW[3:0]			

Bit	Name	Function
15	DSP AFCDIS	**DSP AFC disable/enable** 0 = SYNC mode, AFC enable 1 = SSB mode, AFC disable
14	Reserved	Always write 0.
13	SMUTESEL	**SSB Soft-mute Based on RSSI or SNR Selection:** 0 = Soft-mute based on RSSI (default). 1 = Soft-mute based on SNR.
12	AVCEN	**SSB Automatic Volume Control (AVC) enable:** 0 = Disable AVC. 1 = Enable AVC (default).
11:8	AVC divider[3:0]	**AVC divider** for **SSB** mode, set divider = 0 for **SYNC** mode, set divider = 3 Other values = not allowed.
7:4	SBCUTFLT[3:0]	**SBB Sideband Cutoff Filter for band pass and low pass filters:** 0 = Band pass filter to cutoff both the unwanted side band and high frequency components > 2.0 kHz of the wanted side band. (default) 1 = Low pass filter to cutoff the unwanted side band. Other values = not allowed.
3:0	AUDIOBW[3:0]	**SSB Audio Bandwidth:** 0 = 1.2 kHz low-pass filter[1]. (default) 1 = 2.2 kHz low-pass filter[1]. 2 = 3.0 kHz low-pass filter. 3 = 4.0 kHz low-pass filter. 4 = 500 Hz band-pass filter for receiving CW signal, i.e. [250 Hz, 750 Hz] with center frequency at 500 Hz when USB is selected or [-250 Hz, -750 Hz] with center frequency at -500Hz when LSB is selected[1]. 5 = 1 kHz band-pass filter for receiving CW signal, i.e. [500 Hz, 1500 Hz] with center frequency at 1 kHz when USB is selected or [-500 Hz, -1500 Hz] with center frequency at -1kHz when LSB is selected[1]. Other values = reserved. **Note:** 1. If audio bandwidth selected is about 2 kHz or below, it is recommended to set SBCUTFLT[3:0] to 0 to enable the band pass filter for better high-cut performance on the wanted side band. Otherwise, set it to 1.

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Property 0x3200. SSB_RSQ_INT_SOURCE

Configures interrupt related to Received Signal Quality metrics. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This property may only be set or read when in powerup mode. The default is 0.

Default: 0x0000

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	x	x	x	x	x	x	x	x	x	x	x	x	RSQIEN	SNRLIEN	RSSIHIEN	RSSILIEN

Bit	Name	Function
15:4	Reserved	Always write 0.
3	SNRHIEN	**Interrupt Source Enable: Audio SNR High.** Enable SNR high as the source of interrupt which the threshold is set by SSB_RSQ_SNR_HI_THRESHOLD.
2	SNRHIEN	**Interrupt Source Enable: Audio SNR Low.** Enable SNR low as the as the source of interrupt which the threshold is set by SSB_RSQ_SNR_LO_THRESHOLD.
1	SNRHIEN	**Interrupt Source Enable: RSSI High.** Enable RSSI high as the source of interrupt which the threshold is set by SSB_RSQ_RSSI_HI_THRESHOLD.
0	RSSILIEN	**Interrupt Source Enable: RSSI Low.** Enable RSSI low as the source of interrupt which the threshold is set by SSB_RSQ_RSSI_LO_THRESHOLD.

Property 0x3201. SSB_RSQ_SNR_HI_THRESHOLD

Sets high threshold which will trigger the RSQ interrupt if the Audio SNR is above this threshold. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This property may only be set or read when in powerup mode. The default is 127dB.

Default: 0x007F
Units: dB
Step: 1
Range: 0-127

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	SNRH [15:0]															

Bit	Name	Function
15:0	SNRH	**SSB RSQ Audio SNR High Threshold.** Threshold which will trigger the RSQ interrupt if the Audio SNR is above this threshold. Specified in units of dB in 1 dB steps (0…127). Default is 127dB.

Property 0x3202. SSB_RSQ_SNR_LO_THRESHOLD

Sets low threshold which will trigger the RSQ interrupt if the Audio SNR is below this threshold. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This property may only be set or read when in powerup mode. The default is 0dB.

Default: 0x0000
Units: dB
Step: 1
Range: 0-127

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	SNRL [15:0]															

Bit	Name	Function
15:0	SNRL	**SSB RSQ Audio SNR Low Threshold.** Threshold which will trigger the RSQ interrupt if the Audio SNR is below this threshold. Specified in units of dB in 1 dB steps (0…127). Default is 0dB.

Property 0x3203. SSB_RSQ_RSSI_HI_THRESHOLD

Sets high threshold which will trigger the RSQ interrupt if the RSSI is above this threshold. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This property may only be set or read when in powerup mode. The default is 127dB.

Default: 0x007F
Units: dBμV
Step: 1
Range: 0-127

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	RSSIH [15:0]															

Bit	Name	Function
15:0	RSSIH	**SSB RSQ RSSI High Threshold.** Threshold which will trigger the RSQ interrupt if the RSSI is above this threshold. Specified in units of dB in 1 dB steps (0…127). Default is 127dB.

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Property 0x3204. SSB_RSQ_RSSI_LO_THRESHOLD

Sets low threshold which will trigger the RSQ interrupt if the Audio SNR is below this threshold. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This property may only be set or read when in powerup mode. The default is 0dB.

Default: 0x0000
Units: dB
Step: 1
Range: 0-127

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	RSSIL[15:0]															

Bit	Name	Function
15:0	RSSIL	**SSB RSQ RSSI Low Threshold.** Threshold which will trigger the RSQ interrupt if the RSSI is below this threshold. Specified in units of dB in 1 dB steps (0…127). Default is 0dB.

Property 0x3300. SSB_SOFT_MUTE_RATE

Sets the attack and decay rates when entering or leaving soft mute. The value specified is multiplied by 4.35 dB/s to come up with the actual attack rate. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This property may only be set or read when in powerup mode. The default rate is 278 dB/s.

Default: 0x0040
Actual Rate: SMRATE x 4.35
Units: dB/s
Step: 1
Range: 1–255

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	SMRATE[15:0]															

Bit	Name	Function
15:0	SMRATE	**SSB Soft Mute Rate.** Determines how quickly the SSB goes into soft mute when soft mute is enabled. The actual rate is calculated by taking the value written to the field and multiplying it with 4.35 dB/s. The default rate is 278 dB/s (SMRATE[15:0] = 0x0040).

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Property 0x3302. SSB_SOFT_MUTE_MAX_ATTENUATION

Sets maximum attenuation during soft mute (dB). Set to 0 to disable soft mute. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This property may only be set or read when in power up mode. The default attenuation is 8 dB.

Default: 0x0008
Units: dB
Step: 1
Range: 0–63

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	0	0	0	0	0	0	0	0	0	0	SMATTN[5:0]					

Bit	Name	Function
15:6	Reserved	Always write to 0.
5:0	SMATTN	**SSB Soft Mute Max Attenuation.** Maximum attenuation to apply when in soft mute. Specified in units of dB. Default maximum attenuation is 8 dB.

Property 0x3303. SSB_SOFT_MUTE_SNR_THRESHOLD

Sets the SNR threshold to engage soft mute. Whenever the SNR for a tuned frequency drops below this threshold the AM reception will go in soft mute, provided soft mute max attenuation property is non-zero. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This property may only be set or read when in power up mode. The default SNR threshold is 8

Default: 0x0008
Units: dB
Step: 1
Range: 0–63

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	0	0	0	0	0	0	0	0	0	0	SMTHR[5:0]					

Bit	Name	Function
15:6	Reserved	Always write to 0.
5:0	SMTHR	**SSB Soft Mute SNR Threshold.** The SNR threshold for a tuned frequency below which soft mute is engaged provided the value written to the SSB_SOFT_MUTE_MAX_ATTENUATION property is not zero. Default SNR threshold is 8 dB.

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Property 0x3700. SSB_RF_AGC_ATTACK_RATE

Sets the RF AGC attack rate. Large values provide slower attack, and smaller values provide faster attack. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This property may only be set or read in POWERUP mode. The default is 4 (approximately 1400 dB/s).

$$\text{AGC Attack Rate}\left(\frac{\text{dB}}{\text{s}}\right) = \frac{5600}{\text{ATTACK}[7:0]}$$

Nominal "5600" is based on Silabs' AM antenna dummy and Si474xEVB reference design and may vary with source impedance and design changes. In most systems, an exact value is not important. However, to calculate for a different source impedance and/or design:
1. Drive antenna input with desired source impedance (via antenna or antenna dummy).
2. Increase RF level until AGC index changes from 19 to 20. Record last RF level with index equal 19.
3. Increase RF level until AGC index reaches 39. Record RF level with index equal 39.
4. Replace "5600" in rate equation with "(RF39 – RF19)/0.00667".

Default: 0x0004
Step: 4
Range: 4–248

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	0	0	0	0	0	0	0	0	ATTACK [7:0]							

Property 0x3701. SSB_RF_AGC_RELEASE_RATE

Sets the RF AGC release rate. Larger values provide slower release, and smaller values provide faster release. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This property may only be set or read in POWERUP mode. The default is 24 (approximately 233 dB/s).

$$\text{AGC Release Rate}\left(\frac{\text{dB}}{\text{s}}\right) = \frac{5600}{\text{RELEASE}[7:0]}$$

Nominal "5600" is based on Silabs' AM antenna dummy and Si474xEVB reference design and may vary with source impedance and design changes. In most systems, an exact value is not important. However, to calculate for a different source impedance and/or design:
1. Drive antenna input with desired source impedance (via antenna or antenna dummy).
2. Increase RF level until AGC index changes from 19 to 20. Record last RF level with index equal 19.
3. Increase RF level until AGC index reaches 39. Record RF level with index equal 39.
4. Replace "5600" in rate equation with "(RF39 – RF19)/0.00667".

Default: 0x0018
Step: 4
Range: 4–248

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	0	0	0	0	0	0	0	0	RELEASE [7:0]							

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Property 0x3702. SSB_IF_AGC_ATTACK_RATE

Sets the IF AGC attack rate. Large values provide slower attack, and smaller values provide faster attack. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This property may only be set or read in POWERUP mode. The default is 4 (approximately 1400 dB/s).

$$\text{AGC Attack Rate} \left(\frac{\text{dB}}{\text{s}}\right) = \frac{5600}{\text{ATTACK}[7:0]}$$

Nominal "5600" is based on Silabs' AM antenna dummy and Si474xEVB reference design and may vary with source impedance and design changes. In most systems, an exact value is not important. However, to calculate for a different source impedance and/or design:
1. Drive antenna input with desired source impedance (via antenna or antenna dummy).
2. Increase RF level until AGC index changes from 19 to 20. Record last RF level with index equal 19.
3. Increase RF level until AGC index reaches 39. Record RF level with index equal 39.
4. Replace "5600" in rate equation with "(RF39 – RF19)/0.00667".

Default: 0x0004
Step: 4
Range: 4–248

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	0	0	0	0	0	0	0	0	ATTACK [7:0]							

Property 0x3703. SSB_IF_AGC_RELEASE_RATE

Sets the IF AGC release rate. Larger values provide slower release, and smaller values provide faster release. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This property may only be set or read in POWERUP mode. The default is 140 (approximately 40 dB/s).

$$\text{AGC Release Rate} \left(\frac{\text{dB}}{\text{s}}\right) = \frac{5600}{\text{RELEASE}[7:0]}$$

Nominal "5600" is based on Silabs' AM antenna dummy and Si474xEVB reference design and may vary with source impedance and design changes. In most systems, an exact value is not important. However, to calculate for a different source impedance and/or design:
1. Drive antenna input with desired source impedance (via antenna or antenna dummy).
2. Increase RF level until AGC index changes from 19 to 20. Record last RF level with index equal 19.
3. Increase RF level until AGC index reaches 39. Record RF level with index equal 39.
4. Replace "5600" in rate equation with "(RF39 – RF19)/0.00667".

Default: 0x008C
Step: 4
Range: 4–248

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	0	0	0	0	0	0	0	0	RELEASE [7:0]							

Property 0x4000. RX_VOLUME

Sets the audio output volume. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This property may only be set or read when in powerup mode. The default is 63.

Default: 0x003F
Step: 1
Range: 0-63

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	0	0	0	0	0	0	0	0	0	0	VOL[5:0]					

Bit	Name	Function
15:6	Reserved	Always write to 0.
5:0	VOL	**Output Volume.** Sets the output volume level, 63 max, 0 min. Default is 63.

Property 0x4001. RX_HARD_MUTE

Mutes the audio output. L and R audio outputs may not be muted independently. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This property may only be set or read when in powerup mode. The default is unmute (0x0000).

Default: 0x0000

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	0	0	0	0	0	0	0	0	0	0	0	0	0	0	LMUTE	LMUTE

Bit	Name	Function
15:2	Reserved	Always write to 0.
1	LMUTE	Mutes both L and R Audio Outputs.
0	RMUTE	Mutes both L and R Audio Outputs.

5.6 Command and Properties for the NBFM Receiver (Si4735-D60* only)

The following two tables are the summary of the commands and properties for the Narrow Band FM Receiver component applicable to Si47035-D60 when powering up the part in FM mode with the NBFM patch.

Table 4. NBFM Receiver Command Summary

Cmd	Name	Description
0x01	POWER_UP	Power up device and mode selection.
0x10	GET_REV	Returns revision information on the device.
0x11	POWER_DOWN	Power down device.
0x12	SET_PROPERTY	Sets the value of a property.
0x13	GET_PROPERTY	Retrieves a property's value.
0x14	GET_INT_STATUS	Reads interrupt status bits.
0x15	PATCH_ARGS	Reserved command used for patch file downloads.
0x16	PATCH_DATA	Reserved command used for patch file downloads.
0x50	NBFM_TUNE_FREQ	Selects the NBFM tuning frequency.
0x52	NBFM_TUNE_STATUS	Queries the status of previous NBFM_TUNE_FREQ
0x53	NBFM_RSQ_STATUS	Queries the status of the Received Signal Quality (RSQ) of the current channel
0x57	NBFM_AGC_STATUS	Queries the current AGC settings.
0x58	NBFM_AGC_OVERRIDE	Override AGC setting by disabling and forcing it to a fixed value.
0x80	GPIO_CTL	Configures GPO1, 2, and 3 as output or Hi-Z.
0x81	GPIO_SET	Sets GPO1, 2, and 3 output level (low or high).

Table 5. NBFM Receiver Property Summary

Prop	Name	Description	Default
0x0001	GPO_IEN	Enables interrupt sources.	0x0000
0x0201	REFCLK_FREQ	Sets frequency of reference clock in Hz. The range is 31130 to 34406 Hz, or 0 to disable the AFC. Default is 32768 Hz.	0x8000
0x0202	REFCLK_PRESCALE	Sets the prescaler value for RCLK input.	0x0001
0x5108	NBFM_MAX_TUNE_ERROR	Sets the maximum freq error allowed before setting the AFC_RAIL indicator. Default value is 10 kHz.	0x000A
0x5200	NBFM_RSQ_INT_SOURCE	Configures interrupt related to Received Signal Quality metrics.	0x0000
0x5201	NBFM_RSQ_SNR_HI_THRESHOLD	Sets high threshold for SNR interrupt.	0x007F
0x5202	NBFM_RSQ_SNR_LO_THRESHOLD	Sets low threshold for SNR interrupt.	0x0000
0x5203	NBFM_RSQ_RSSI_HI_THRESHOLD	Sets high threshold for RSSI interrupt.	0x007F
0x5204	NBFM_RSQ_RSSI_LO_THRESHOLD	Sets low threshold for RSSI interrupt.	0x0000
0x5403	NBFM_VALID_SNR_THRESHOLD	Sets SNR threshold to indicate a valid channel.	0x0003
0x5404	NBFM_VALID_RSSI_THRESHOLD	Sets RSSI threshold to indicate a valid channel.	0x0014
0x4000	RX_VOLUME	Sets the output volume.	0x003F
0x4001	RX_HARD_MUTE	Mutes the audio output. L and R audio outputs may not be muted independently.	0x0000

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Table 6. Status Response for the NBFM Receiver

Command

Bit	D7	D6	D5	D4	D3	D2	D1	D0
STATUS	CTS	ERR	X	X	RSQINT	X	X	STCINT

Bit	Name	Description
7	CTS	**Clear to Send.** 0 = Wait before sending next command. 1 = Clear to send next command.
6	ERR	**Error.** 0 = No error 1 = Error
5:4	Reserved	Values may vary.
3	RSQINT	**Received Signal Quality Interrupt.** 0 = Received Signal Quality measurement has not been triggered. 1 = Received Signal Quality measurement has been triggered.
2:1	Reserved	Values may vary.
0	STCINT	**Tune Complete Interrupt.** 0 = Tune complete has not been triggered. 1 = Tune complete interrupt has been triggered.

5.6.1. NBFM Receiver Commands

Command 0x01. POWER_UP

Initiates the boot process to move the device from powerdown to powerup mode. The boot can occur from internal device memory or a system controller downloaded patch. To confirm that the patch is compatible with the internal device library revision, the library revision should be confirmed by issuing the POWER_UP command with FUNC = 15 (query library ID). The device returns the response, including the component major and minor revision, chip revision and then moves into powerdown mode. The device can then be placed in powerup mode by issuing the POWER_UP command with FUNC = 0 (FM Receive) and together with the NBFM specific patch.

The POWER_UP command configures the state of ROUT (pin 13), LOUT (pin 14) for analog audio mode. Note that current NBFM patch does not support configuring the state of GPO3/DCLK (pin 19), DFS (pin 18), and DOUT (pin 17) for digital audio mode. The command configures GPO2/INT~ interrupts (GPO2OEN) and CTS interrupts (CTSIEN). If both are enabled, GPO2/IRQ is driven high during normal operation and low for a minimum of 1 µs during the interrupt. The CTSIEN bit is duplicated in the GPO_IEN property. The command is complete when the CTS bit (and optional interrupt) is set.

To change function (e.g., NBFM RX to FM RX or AM RX), issue POWER_DOWN command to stop current function; then, issue POWER_UP to start new function.

Command Arguments: Two

Response Bytes: None (FUNC=0), 8 (FUNC=15)

Command

Bit	D7	D6	D5	D4	D3	D2	D1	D0
CMD	0	0	0	0	0	0	0	1
ARG1	CTSIEN	GPO2OEN	PTACH	XOSCEN	FUNC[3:0]			
ARG2	OPMODE[7:0]							

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ARG	Bit	Name	Function
1	7	CTSIEN	**CTS Interrupt Enable.** 0 = CTS interrupt disabled. 1 = CTS interrupt enabled.
1	6	GP02OEN	**GPO2 Output Enable.** 0 = GPO2 output disabled. 1 = GPO2 output enabled.
1	5	PTACH	**Patch Enable.** 0 = Boot normally 1 = Copy NVM to RAM, but do not boot. After CTS has been set, RAM may be patched
1	4	XOSCEN	**Crystal Oscillator Enable.** 0 = Use external RCLK (crystal oscillator disabled) 1 = Use crystal oscillator (RCLK and GPO3/DCLK with external 32.768kHz crystal and OPMODE = 00000101) See Si47xx Data Sheet Application Schematic for external BOM details.
1	3:0	FUNC[3:0]	**Function.** 0 = NBFM (also FM) Receive. 1–14 = Reserved 15 = Query Library ID.
2	7:0	OPMODE[7:0]	00000101 = Analog audio outputs (LOUT/ROUT) Other values = reserved

Response (FUNC = 0, NBFM Receive)

Bit	D7	D6	D5	D4	D3	D2	D1	D0
STATUS	CTS	ERR	X	X	RSQINT	X	X	STCINT

Response (FUNC = 15, Query Library ID))

Bit	D7	D6	D5	D4	D3	D2	D1	D0
STATUS	CTS	ERR	X	X	RSQINT	X	X	STCINT
RESP1	PN[7:0]							
RESP2	FWMAJOR[7:0]							
RESP3	FWMINOR[7:0]							
RESP4	RESERVED [7:0]							
RESP5	RESERVED [7:0]							
RESP6	CHIPREV [7:0]							
RESP7	LIBRARYID [7:0]							

RESP	Bit	Name	Function
1	7:0	PN[7:0]	Final 2 digits of Part Number (HEX).
2	7:0	FWMAJOR[7:0]	Firmware Major Revision (ASCII).
3	7:0	FWMINOR[7:0]	Firmware Minor Revision (ASCII).
4	7:0	RESERVED[7:0]	Reserved, various values.
5	7:0	RESERVED[7:0]	Reserved, various values.
6	7:0	CHIPREV[7:0]	Chip Revision (ASCII).
7	7:0	LIBRARYID[7:0]	Library Revision (HEX).

Command 0x10. GET_REV

Returns the part number, chip revision, firmware revision, patch revision and component revision numbers. The command is complete when the CTS bit (and optional interrupt) is set. This command may only be sent when in power up mode.

Command arguments: None
Response bytes: Eight

Command

Bit	D7	D6	D5	D4	D3	D2	D1	D0
CMD	0	0	0	1	0	0	0	0

Response

Bit	D7	D6	D5	D4	D3	D2	D1	D0
STATUS	CTS	ERR	X	X	RSQINT	X	X	STCINT
RESP1	PN[7:0]							
RESP2	FWMAJOR[7:0]							
RESP3	FWMINOR[7:0]							
RESP4	PATCH$_H$[7:0]							
RESP5	PATCH$_L$[7:0]							
RESP6	CMPMAJOR[7:0]							
RESP7	CMPMINOR[7:0]							
RESP8	CHIPREV[7:0]							

RESP	Bit	Name	Function
1	7:0	PN[7:0]	Final 2 digits of Part Number (HEX).
2	7:0	FWMAJOR[7:0]	Firmware Major Revision (ASCII).
3	7:0	FWMINOR[7:0]	Firmware Minor Revision (ASCII).
4	7:0	PATCH$_H$[7:0]	Patch ID High Byte (HEX).
5	7:0	PATCH$_L$[7:0]	Patch ID Low Byte (HEX).
6	7:0	CMPMAJOR[7:0]	Component Major Revision (ASCII).
7	7:0	CMPMINOR[7:0]	Component Minor Revision (ASCII).
8	7:0	CHIPREV[7:0]	Chip Revision (ASCII).

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Command 0x11. POWER_DOWN

Moves the device from power up to power down mode. The CTS bit is set when it is safe to send the next command. This command may only be sent when in power up mode. Note that only the ATDD_POWER_UP and ATDD_GET_STATUS commands are accepted in power down mode. **If the system controller writes a command other than the two commands when in power down mode, the device does not respond. The device will only respond when an POWER_UP command is written.**

Note: The following describes the state of all the pins when in powerdown mode:
ROUT, LOUT = HiZ

Command arguments: None
Response bytes: None

Command

Bit	D7	D6	D5	D4	D3	D2	D1	D0
CMD	0	0	0	1	0	0	0	1

Response

Bit	D7	D6	D5	D4	D3	D2	D1	D0
STATUS	CTS	ERR	X	X	RSQINT	X	X	STCINT

Command 0x12. SET_PROPERTY

Sets a property shown in Table 5, "NBFM Receiver Property Summary," on page 31. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This command may only be sent when in power up mode.

Command Arguments: Five
Response bytes: None

Command

Bit	D7	D6	D5	D4	D3	D2	D1	D0
CMD	0	0	0	1	0	0	1	0
ARG1	0	0	0	0	0	0	0	0
ARG2	$PROP_H[7:0]$							
ARG3	$PROP_L[7:0]$							
ARG4	$PROPD_H[7:0]$							
ARG5	$PROPD_L[7:0]$							

ARG	Bit	Name	Function
1	7:0	Reserved	Always write to 0.
2	7:0	$PROP_H$	**Property High Byte.** This byte in combination with $PROP_L$ is used to specify the property to modify
3	7:0	$PROP_L$	**Property Low Byte.** This byte in combination with $PROP_H$ is used to specify the property to modify
4	7:0	$PROPD_H$	**Property Value High Byte.** This byte in combination with $PROPD_L$ is used to specify the property to modify
5	7:0	$PROPD_L$	**Property Value Low Byte.** This byte in combination with $PROPD_H$ is used to specify the property to modify

Command 0x13. GET_PROPERTY

Gets a property as shown in Table 5, "NBFM Receiver Property Summary," on page 31. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This command may only be sent when in power up mode.

Command arguments: Three
Response bytes: Three

Command

Bit	D7	D6	D5	D4	D3	D2	D1	D0
CMD	0	0	0	1	0	0	1	1
ARG1	0	0	0	0	0	0	0	0
ARG2	PROP$_H$[7:0]							
ARG3	PROP$_L$[7:0]							

ARG	Bit	Name	Function
1	7:0	Reserved	Always write to 0.
2	7:0	PROP$_H$	**Property High Byte.** This byte in combination with PROP$_L$ is used to specify the property to get
3	7:0	PROP$_L$	**Property Low Byte.** This byte in combination with PROP$_H$ is used to specify the property to get

Response

Bit	D7	D6	D5	D4	D3	D2	D1	D0
STATUS	CTS	ERR	Reserved					
RESP1	0	0	0	0	0	0	0	0
RESP2	PROPD$_H$[7:0]							
RESP3	PROPD$_L$[7:0]							

RESP	Bit	Name	Function
1	7:0	Reserved	Always write to 0.
2	7:0	PROPD$_H$	**Property Value High Byte.** This byte in combination with PROPD$_L$ represents the requested property value.
3	7:0	PROPD$_L$	**Property Value Low Byte.** This byte in combination with PROPD$_H$ represents the requested property value.

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Command 0x14. GET_INT_STATUS

Updates bit 3 and bit 0 of the status byte. This command should be called after any command that sets the STCINT or RSQINT bits. When polling this command should be periodically called to monitor the status byte, and when using interrupts, this command should be called after the interrupt is set to update the status byte. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This command may only be sent when in powerup mode.

Command arguments: None
Response bytes: One

Command

Bit	D7	D6	D5	D4	D3	D2	D1	D0
CMD	0	0	0	1	0	1	0	0

Response

Bit	D7	D6	D5	D4	D3	D2	D1	D0
STATUS	CTS	ERR	x	X	RSQINT	X	X	STCINT

Command 0x50. NBFM_TUNE_FREQ

Sets the NBFM receive to tune the frequency between 64 MHz and 108 MHz in 2.5 kHz units. For example 64 MHz = 25600 and 108 MHz = 43200. The CTS bit (and optional interrupt) is set when it is safe to send the next command. The ERR bit (and optional interrupt) is set if an invalid argument is sent. Note that only a single interrupt occurs if both the CTS and ERR bits are set. The optional STC interrupt is set when the command completes. The STCINT bit is set only after the GET_INT_STATUS command is called. This command may only be sent when in powerup mode. The command clears the STC bit if it is already set.

Command arguments: Three
Response bytes: None

Command

Bit	D7	D6	D5	D4	D3	D2	D1	D0
CMD	0	1	0	1	0	0	0	0
ARG1	0	0	0	0	0	0	0	0
ARG2	$FREQ_H[7:0]$							
ARG3	$FREQ_L[7:0]$							

RESP	Bit	Name	Function
1	7:0	Reserved	Always write to 0.
2	7:0	$FREQ_H[7:0]$	**Tune Frequency High Byte.** This byte in combination with $FREQ_L$ selects the tune frequency in kHz. In NBFM mode the valid range is from 25600 to 43200 (64 –108 MHz).
3	7:0	$PROP_L[7:0]$	**Tune Frequency Low Byte.** This byte in combination with $FREQ_H$ selects the tune frequency in kHz. In NBFM mode the valid range is from 25600 to 43200 (64 –108 MHz).

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Command 0x52. NBFM_TUNE_STATUS

Returns the status of NBFM_TUNE_FREQ. The commands returns the current frequency, and RSSI/SNR at the moment of tune. The command clears the STCINT interrupt bit when INTACK bit of ARG1 is set. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This command may only be sent when in powerup mode.

Command arguments: One
Response bytes: Five

Command

Bit	D7	D6	D5	D4	D3	D2	D1	D0
CMD	0	1	0	1	0	0	1	0
ARG1	0	0	0	0	0	0	0	INTACK

ARG	Bit	Name	Function
1	7:1	Reserved	Always write to 0.
1	0	INTACK	**Tune Interrupt Clear.** If set this bit clears the tune complete interrupt status indicator.

Response

Bit	D7	D6	D5	D4	D3	D2	D1	D0
STATUS	CTS	ERR	X	X	RSQINT	X	X	STCINT
RESP1	X	X	X	X	X	X	AFCRL	VALID
RESP2	READFREQH[7:0]							
RESP3	READFREQL[7:0]							
RESP4	RSSI[7:0]							
RESP5	SNR[7:0]							

RESP	Bit	Name	Function
1	7:2	Reserved	Always returns 0.
1	1	AFCRL	**AFC Rail Indicator.** This bit will be set if the AFC rails.
1	0	VALID	**Valid Channel.** Confirms if the tuned channel is currently valid.
2	7:0	READFREQH[7:0]	**Read Frequency High Byte.** This byte in combination with READFREQL returns frequency being tuned.
3	7:0	READFREQL[7:0]	**Read Frequency Low Byte.** This byte in combination with READFREQH returns frequency being tuned.
4	7:0	RSSI[7:0]	**Received Signal Strength Indicator.** This byte will contain the receive signal strength at the tuned frequency.
5	7:0	SNR[7:0]	**SNR.** This byte will contain the SNR metric at the tuned frequency.

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Command 0x53. NBFM_RSQ_STATUS

Returns status information about the received signal quality. The commands returns the RSSI, SNR, and frequency offset. It also indicates whether the frequency is a currently valid frequency as indicated by VALID, and whether the AFC is railed or not as indicated by AFCRL. This command can be used to check if the received signal is above the RSSI high threshold as reported by RSSIHINT, or below the RSSI low threshold as reported by RSSILINT. It can also be used to check if the received signal is above the SNR high threshold as reported by SNRHINT, or below the SNR low threshold as reported by SNRLINT. The command clears the STCINT interrupt bit when INTACK bit of ARG1 is set. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This command may only be sent when in powerup mode.

Command arguments: One
Response bytes: Seven

Command

Bit	D7	D6	D5	D4	D3	D2	D1	D0
CMD	0	1	0	1	0	0	1	1
ARG1	0	0	0	0	0	0	0	INTACK

ARG	Bit	Name	Function
1	0	INTACK	**Interrupt Acknowledge** 0 = Interrupt status preserved. 1 = Clears RSQINT, SNRHINT, SNRLINT, RSSIHINT, RSSILINT

Response

Bit	D7	D6	D5	D4	D3	D2	D1	D0
STATUS	CTS	ERR	X	X	RSQINT	X	X	STCINT
RESP1	X	X	X	X	SNRHINT	SNRLINT	RSSIHINT	RSSILINT
RESP2	X	X	X	X	X	X	AFCRL	VALID
RESP3	X	X	X	X	X	X	X	X
RESP4	RSSI[7:0]							
RESP5	SNR[7:0]							
RESP6	X	X	X	X	X	X	X	X
RESP7	FREQOFF[7:0]							

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RESP	Bit	Name	Function
1	3	SNRHINT	**SNR Detect High.** 0 = Received SNR has not exceeded above SNR high threshold. 1 = Received SNR has exceeded above SNR high threshold.
1	2	SNRLINT	**SNR Detect Low.** 0 = Received SNR has not exceeded below SNR low threshold. 1 = Received SNR has exceeded below SNR low threshold.
1	1	RSSIHINT	**RSSI Detect High.** 0 = RSSI has not exceeded above RSSI high threshold. 1 = RSSI has exceeded above RSSI high threshold.
1	0	RSSILINT	**RSSI Detect Low.** 0 = RSSI has not exceeded below RSSI low threshold. 1 = RSSI has exceeded below RSSI low threshold.
2	1	AFCRL	**AFC Rail Indicator.** This bit will be set if the AFC rails.
2	0	VALID	**Valid Channel.** Confirms if the channel is currently valid.
4	7:0	RSSI[7:0]	**Received Signal Strength Indicator.** This byte will contain the receive signal strength at the tuned frequency.
5	7:0	SNR[7:0]	**SNR.** This byte will contain the SNR metric at the tuned frequency.
7	7:0	REQOFF[7:0]	**Frequency Offset.** Signed frequency offset in kHz.

Command 0x57. NBFM_AGC_STATUS

Returns the AGC setting of the device. The command returns whether the AGC is enabled or disabled. This command may only be sent when in powerup mode.

Command arguments: None
Response bytes: One

Command

Bit	D7	D6	D5	D4	D3	D2	D1	D0
CMD	0	1	0	1	0	1	1	1

Response

Bit	D7	D6	D5	D4	D3	D2	D1	D0
STATUS	CTS	ERR	X	X	RSQINT	X	X	STCINT
RESP1	X	X	X	X	X	X	X	READ_RFAGCDIS

RESP	Bit	Name	Function
1	0	READ_RFAGCDIS	This bit indicates whether the RF AGC is disabled or not 0 = RF AGC is enabled. 1 = RF AGC is disabled.

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Command 0x58. NBFM_AGC_OVERRIDE

Overrides AGC setting by disabling the AGC and forcing the LNA to have a certain gain that ranges between 0 (minimum attenuation) and 26 (maximum attenuation). This command may only be sent when in powerup mode.

Command arguments: One
Response bytes: None

Command

Bit	D7	D6	D5	D4	D3	D2	D1	D0
CMD	0	1	0	1	1	0	0	0
ARG1	X	X	X	X	X	X	X	RFAGCDIS

ARG	Bit	Name	Function
1	7:1	Reserved	Always write to 0.
1	0	RFAGCDIS	This bit selects whether the RF AGC is disabled or not 0 = RF AGC is enabled. 1 = RF AGC is disabled.

Response

Bit	D7	D6	D5	D4	D3	D2	D1	D0
STATUS	CTS	ERR	X	X	RSQINT	X	X	STCINT

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Command 0x80. GPIO_CTL

Enables output for GPO1, 2, and 3. GPO1, 2, and 3 can be configured for output (Hi-Z or active drive) by setting the GPO1OEN, GPO2OEN, and GPO3OEN bit. The state (high or low) of GPO1, 2, and 3 is set with the GPIO_SET command. To avoid excessive current consumption due to oscillation, GPO pins should not be left in a high impedance state. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This command may only be sent when in powerup mode. The default is all GPO pins set for high impedance.

Notes: The use of GPO2 as an interrupt pin will override this GPIO_CTL function for GPO2.

Command arguments: One
Response bytes: None

Command

Bit	D7	D6	D5	D4	D3	D2	D1	D0
CMD	1	0	0	0	0	0	0	0
ARG1	X	X	X	X	GPO3OEN	GPO2OEN	GPO1OEN	0

ARG	Bit	Name	Function
1	7:4	Reserved	Always write to 0.
1	3	GPO3OEN	**GPO3 Output Enable.** 0 = Output Disabled (Hi-Z) (default). 1 = Output Enabled.
1	2	GPO2OEN	**GPO2 Output Enable.** 0 = Output Disabled (Hi-Z) (default). 1 = Output Enabled.
1	1	GPO1OEN	**GPO1 Output Enable.** 0 = Output Disabled (Hi-Z) (default). 1 = Output Enabled.
1	0	Reserved	Always write to 0.

Response

Bit	D7	D6	D5	D4	D3	D2	D1	D0
STATUS	CTS	ERR	X	X	RSQINT	X	X	STCINT

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Command 0x81. GPIO_SET

Sets the output level (high or low) for GPO1, 2, and 3. GPO1, 2, and 3 can be configured for output by setting the GPO1OEN, GPO2OEN, and GPO3OEN bit in the GPIO_CTL command. To avoid excessive current consumption due to oscillation, GPO pins should not be left in a high impedance state. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This property may only be set or read when in powerup mode. The default is all GPO pins set for high impedance.

Command arguments: One
Response bytes: None

Command

Bit	D7	D6	D5	D4	D3	D2	D1	D0
CMD	1	0	0	0	0	0	0	0
ARG1	X	X	X	X	GPO3LEVEL	GPO2LEVEL	GPO1LEVEL	0

ARG	Bit	Name	Function
1	7:4	Reserved	Always write to 0.
1	3	GPO3OEN	**GPO3 Output Level.** 0 = Output low (default). 1 = Output high.
1	2	GPO2OEN	**GPO2 Output Level.** 0 = Output low (default). 1 = Output high.
1	1	GPO1OEN	**GPO1 Output Level.** 0 = Output low (default). 1 = Output high.
1	0	Reserved	Always write to 0.

Response

Bit	D7	D6	D5	D4	D3	D2	D1	D0
STATUS	CTS	ERR	X	X	RSQINT	X	X	STCINT

5.6.2. NBFM Receiver Properties

Property 0x0001. GPO_IEN

Configures the sources for the GPO2/IRQ interrupt pin. Valid sources are the lower 8 bits of the STATUS byte, including CTS, ERR, RSQINT and STCINT bits. The corresponding bit is set before the interrupt occurs. The CTS bit (and optional interrupt) is set when it is safe to send the next command. The CTS interrupt enable (CTSIEN) can be set with this property and the POWER_UP command. The state of the CTSIEN bit set during the POWER_UP command can be read by reading the this property and modified by writing this property. This command may only be sent when in powerup mode.

Default: 0x0000

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	0	0	0	0	RSQREP	0	0	STCREP	CTSIEN	ERRIEN	0	0	RSQIEN	0	0	STCIEN

Bit	Name	Function
15:12	Reserved	Always write to 0.
11	RSQREP	**RSQ Interrupt Repeat.** 0 = No interrupt generated when RSQINT is already set (default). 1 = Interrupt generated even if RSQINT is already set.
10:9	Reserved	Always write to 0.
8	STCREP	**STC Interrupt Repeat.** 0 = No interrupt generated when STCINT is already set (default). 1 = Interrupt generated even if STCINT is already set.
7	CTSIEN	**CTS Interrupt Enable. After PowerUp, this bit will reflect the CTSIEN bit in ARG1 of PowerUp Command.** 0 = No interrupt generated when CTS is set. 1 = Interrupt generated when CTS is set.
6	ERRIEN	**ERR Interrupt Enable.** 0 = No interrupt generated when ERR is set (default). 1 = Interrupt generated when ERR is set.
5:4	Reserved	Always write to 0.
3	RSQIEN	**RSQ Interrupt Enable** 0 = No interrupt generated when RSQINT is set (default). 1 = Interrupt generated when RSQINT is set.
2:1	Reserved	Always write to 0.
0	STCIEN	**Tune Complete Interrupt Enable.** 0 = No interrupt generated when TCINT is set (default) 1 = Interrupt generated when TCINT is set

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Sets the frequency of the REFCLK from the output of the prescaler. The REFCLK range is 31130 to 34406 Hz (32768 5% Hz) in 1 Hz steps, or 0 (to disable AFC). For example, an RCLK of 13MHz would require a prescaler value of 400 to divide it to 32500 Hz REFCLK. The reference clock frequency property would then need to be set to 32500 Hz. RCLK frequencies between 31130 Hz and 40 MHz are supported, however, there are gaps in frequency coverage for prescaler values ranging from 1 to 10, or frequencies up to 311300 Hz. The following table summarizes these RCLK gaps.
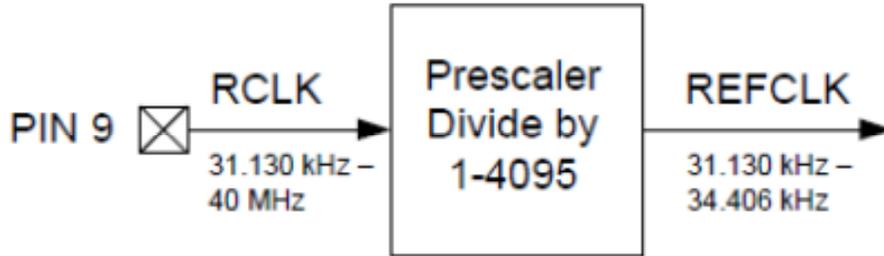
Figure 1. REFCLK Prescaler

Table 7. RCLK Gaps

Prescaler	RCLK Low (Hz)	RCLK High (Hz)
1	31130	34406
2	62260	68812
3	93390	103218
4	124520	137624
5	155650	172030
6	186780	206436
7	217910	240842
8	249040	275248
9	280170	309654
10	311300	344060

The RCLK must be valid 10 ns before and 10 ns after completing the NBFM_TUNE_FREQ command. In addition, the RCLK must be valid at all times when the carrier is enabled for proper AGC operation. The RCLK may be removed or reconfigured at other times. The CTS bit (and optional interrupt) is set when it is safe to send the next command.
This command may only be sent when in powerup mode. The default is 32768 Hz.

Default: 0x8000 (32768)
Units: 1 Hz
Step: 1Hz
Range: 31130-34406

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	REFCLKF[15:0]															

Bit	Name	Function
15:0	REFCLKF[15:0]	**Frequency of Reference Clock in Hz.** The allowed REFCLK frequency range is between 31130 and 34406 Hz (32768 5%), or 0 (to disable AFC).

Property 0x0202. REFCLK_PRESCALE

Sets the number used by the prescaler to divide the external RCLK down to the internal REFCLK. The range may be between 1 and 4095 in 1 unit steps. For example, an RCLK of 13MHz would require a prescaler value of 400 to divide it to 32500 Hz. The reference clock frequency property would then need to be set to 32500 Hz. The RCLK must be valid 10 ns before and 10 ns after completing the NBFM_TUNE_FREQ command. In addition, the RCLK must be valid at all times when the carrier is enabled for proper AFC operation. The RCLK may be removed or reconfigured at other times. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This command may only be sent when in powerup mode. The default is 1.

Default: 0x0001
Step: 1
Range: 1-4095

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	0	0	0	RCLK SEL	REFCLKP[11:0]											

Bit	Name	Function
15:13	Reserved	Always write to 0.
12	RCLKSEL	**RCLKSEL.** 0 = RCLK pin is clock source. 1 = DCLK pin is clock source.
11:0	REFCLKP[11:0]	**Prescaler for Reference Clock.** Integer number used to divide clock frequency down to REFCLK frequency. The allowed REFCLK frequency range is between 31130 and 34406 Hz (32768 +/-5%), or 0 (to disable AFC).

Property 0x5108. NBFM_MAX_TUNE_ERROR

Sets the maximum freq error allowed before setting the AFC_RAIL indicator. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This property may only be set or read when in powerup mode. The default is 10 kHz.

Default: 0x000A
Units: kHz
Step: 1
Range: 0–15

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	NBFMMAXTUNEERR[15:0]															

Bit	Name	Function
15:0	NBFMMAXTUNEERR	**NBFM Maximum Tuning Frequency Error.** Maximum tuning error allowed before setting the AFC Rail Indicator ON. Specified in units of kHz. Default is 10 kHz.

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Property 0x5200. NBFM_RSQ_INT_SOURCE

Configures interrupt related to Received Signal Quality metrics. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This property may only be set or read when in powerup mode. The default is 0.

Default: 0x0000

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	X	X	X	X	X	X	X	X	X	X	X	X	RSQIEN	SNRLIEN	RSSIHIEN	RSSILIEN

Bit	Name	Function
3	SNRHIEN	**Interrupt Source Enable: Audio SNR High.** Enable SNR high as the source of interrupt which the threshold is set by NBFM_RSQ_SNR_HI_THRESHOLD.
2	SNRHIEN	**Interrupt Source Enable: Audio SNR Low.** Enable SNR low as the as the source of interrupt which the threshold is set by NBFM_RSQ_SNR_LO_THRESHOLD.
1	SNRHIEN	**Interrupt Source Enable: RSSI High.** Enable RSSI high as the source of interrupt which the threshold is set by NBFM_RSQ_RSSI_HI_THRESHOLD.
0	RSSILIEN	**Interrupt Source Enable: RSSI Low.** Enable RSSI low as the source of interrupt which the threshold is set by NBFM_RSQ_RSSI_LO_THRESHOLD.

Property 0x5201. NBFM_RSQ_SNR_HI_THRESHOLD

Sets high threshold which will trigger the RSQ interrupt if the Audio SNR is above this threshold. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This property may only be set or read when in powerup mode. The default is 127dB.

Default: 0x007F
Units: dB
Step: 1
Range: 0-127

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	SNRH [15:0]															

Bit	Name	Function
15:0	SNRH	**NBFM RSQ Audio SNR High Threshold.** Threshold which will trigger the RSQ interrupt if the Audio SNR is above this threshold. Specified in units of dB in 1 dB steps (0…127). Default is 127dB.

Property 0x5202. NBFM_RSQ_SNR_LO_THRESHOLD

Sets low threshold which will trigger the RSQ interrupt if the Audio SNR is below this threshold. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This property may only be set or read when in powerup mode. The default is 0dB.

Default: 0x0000
Units: dB
Step: 1
Range: 0-127

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	SNRL [15:0]															

Bit	Name	Function
15:0	SNRL	**NBFM RSQ Audio SNR Low Threshold.** Threshold which will trigger the RSQ interrupt if the Audio SNR is below this threshold. Specified in units of dB in 1 dB steps (0…127). Default is 0dB.

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Property 0x5203. NBFM_RSQ_RSSI_HI_THRESHOLD

Sets high threshold which will trigger the RSQ interrupt if the RSSI is above this threshold. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This property may only be set or read when in powerup mode. The default is 127dB.

Default: 0x007F
Units: dBµV
Step: 1
Range: 0-127

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	RSSIH [15:0]															

Bit	Name	Function
15:0	RSSIH	**NBFM RSQ RSSI High Threshold.** Threshold which will trigger the RSQ interrupt if the RSSI is above this threshold. Specified in units of dB in 1 dB steps (0…127). Default is 127dB.

Property 0x5204. NBFM_RSQ_RSSI_LO_THRESHOLD

Sets low threshold which will trigger the RSQ interrupt if the Audio SNR is below this threshold. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This property may only be set or read when in powerup mode. The default is 0dB.

Default: 0x0000
Units: dB
Step: 1
Range: 0-127

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	RSSIL[15:0]															

Bit	Name	Function
15:0	RSSIL	**NBFM RSQ RSSI Low Threshold.** Threshold which will trigger the RSQ interrupt if the RSSI is below this threshold. Specified in units of dB in 1 dB steps (0…127). Default is 0dB.

Property 0x5403. NBFM_VALID_SNR_THRESHOLD

Sets the SNR threshold which the NBFM_RSQ_STATUS and NBFM_TUNE_STATUS will consider the channel valid if the received SNR is at or above this value. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This property may only be set or read when in powerup mode. The default is 3dB.

Default: 0x0003
Units: dBµV
Step: 1
Range: 0-127

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	NBFM_VALID_SNR_THRESHOLD[15:0]															

Bit	Name	Function
15:0	NBFM_VALID_SNR_ THRESHOLD	**NBFM Valid SNR Threshold.** SNR value at or above which NBFM_RSQ_STATUS and NBFM_TUNE_STATUS will consider the channel VALID. Specified in units of dB in 1 dB steps (0…127). Default is 3 dB.

Property 0x5404. NBFM_VALID_RSSI_THRESHOLD

Sets the RSSI threshold which the NBFM_RSQ_STATUS and NBFM_TUNE_STATUS will consider the channel valid if the received RSSI is at or above this value. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This property may only be set or read when in powerup mode. The default is 20dB.

Default: 0x0014
Units: dBµV
Step: 1
Range: 0-127

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	NBFM_VALID_RSSI_THRESHOLD [15:0]															

Bit	Name	Function
15:0	NBFM_VALID_RSSI_ THRESHOLD	**NBFM Valid RSSI Threshold.** RSSI value at or above which NBFM_RSQ_STATUS and NBFM_TUNE_STATUS will consider the channel VALID. Specified in units of dB in 1 dB steps (0…127). Default is 20 dB.

Property 0x4000. RX_VOLUME

Sets the audio output volume. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This property may only be set or read when in powerup mode. The default is 63.

Default: 0x003F
Step: 1
Range: 0-63

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	0	0	0	0	0	0	0	0	0	0	VOL[5:0]					

Bit	Name	Function
15:6	Reserved	Always write to 0.
5:0	VOL	**Output Volume.** Sets the output volume level, 63 max, 0 min. Default is 63.

Property 0x4001. RX_HARD_MUTE

Mutes the audio output. L and R audio outputs may not be muted independently. The CTS bit (and optional interrupt) is set when it is safe to send the next command. This property may only be set or read when in powerup mode. The default is unmute (0x0000).

Default: 0x0000

Bit	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Name	0	0	0	0	0	0	0	0	0	0	0	0	0	0	LMUTE	LMUTE

Bit	Name	Function
15:2	Reserved	Always write to 0.
1	LMUTE	Mutes both L and R Audio Outputs.
0	RMUTE	Mutes both L and R Audio Outputs.

6. Control Interface

Please refer to AN332 Rev 0.8 Universal Programming Guide Chapter 6.

7. Powerup

Please refer to AN332 Rev 0.8 Universal Programming Guide Chapter 7.

8. Powerdown

Please refer to AN332 Rev 0.8 Universal Programming Guide Chapter 8.

9. Digital Audio Interface

Please refer to AN332 Rev 0.8 Universal Programming Guide Chapter 9.

10. Timing

Please refer to AN332 Rev 0.8 Universal Programming Guide Chapter 10.

11. FM Transmitter

Please refer to AN332 Rev 0.8 Universal Programming Guide Chapter 11.

12. Programming Examples

Please refer to AN332 Rev 0.8 Universal Programming Guide Chapter 12.

DOCUMENT CHANGE LIST

Revision 0.8a
- Add commands and properties for the SSB receiver patch for the Si4735-D60 parts
- Add commands and properties for the NBFM receiver patch for the Si4735-D60 parts

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