Si4822/26/27/40/44 Antenna, Schematic, Layout, and Design Guidelines

1. Introduction

This document provides general Si4822/26/27/40/44 design and AM/FM/SW antenna selection guidelines, including schematic, BOM, and PCB layout. All users should follow the Si4822/26/27/40/44 design guidelines presented in “2. Si4822/26/27/40/44 Default Frequency Band Definition and Selection”and “3. Si48422/26/27/40/44 SSOP/SOIC Schematic and Layout” and choose the appropriate antennas based on the applications and device used as described in “4. Headphone Antenna for FM Receive” through “8. Whip Antenna for SW Receiver”.

Table 1. Part Selection Guide

† Part Number	† General Description	Function			FM Antenna		AM Antenna		SW Antenna
		FM Receiver	AM Receiver	SW Receiver	Headphone	Whip	Ferrite Loop	Air Loop	Whip
Si4822	Entry level wheel-tuned digital display AM/FM Receiver, Mono audio	†	†		†	†	†	†	
Si4826	Entry level wheel-tuned digital display AM/FM/SW Receiver, Mono audio	†	†	†	†	†	†	†	†
Si4827	Entry level wheel-tuned digital display AM/FM/SW Receiver, wide FM/SW band, Mono audio	†	†	†	†	†	†	†	†
Si4840	Wheel-tuned digital display AM/FM Receiver, Stereo audio	†	†		†	†	†	†	
Si4844	Wheel-tuned digital display AM/FM/SW Receiver, wide FM/SW band, Stereo audio	†	†	†	†	†	†	†	†

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2. Si4822/26/27/40/44 Default Frequency Band Definition and Selection

For Si4822/26/27/40/44, there are two methods for defining a frequency band, one is to select one of the chip internal default bands by using the slide switch and resistor ladder. Another method is to use the host MCU sending command to make the chip work in the desired band. Refer to application note, “AN610: Si48xx ATDD Programming Guide”, for information on how to use the Si4822/26/27/40/44 to define a frequency band and set a band property. This section describes how to select the default frequency band by using the slide switch and resistors ladder.

The Si4822/40 has five defined FM bands and five defined AM bands. The Si4826/27/44 has an added 16 SW bands. In each FM band, the parts also offer two de-emphasis selections and two LED stereo separation threshold selections, which results in a total 41 combinations to choose from.

The Si4822/26/40/44-A supports FM band range less than 23 MHz and SW band range less than 1.15 MHz. The Si4827-A/44-B supports wider FM/SW band range. Refer to application note, “AN610: Si48xx ATDD Programming Guide” for details.

2.1. Si4822/26/27/40/44 Default Band Definition

For Si4822/26/27/40/44, the FM band definition is in fact a combination of frequency range, de-emphasis, and LED stereo separation threshold. Customers should choose the band according to not only frequency range, but also de-emphasis setting and LED stereo separation requirements. For AM and SW, simply choose the band according to the frequency range desired.

Table 2. Band Sequence Definition

Band Number	Band Name	Band Frequency Range	De-emphasis (FM) Channel Space (AM)	Stereo LED on Conditions (Only for Si4840/44)	Total R to GND (kΩ, 1%)
Band1	FM1	87–108 MHz	75 µs	Separation = 6 dB, RSSI = 20	47
Band2	FM1	87–108 MHz	75 µs	Separation = 12 dB, RSSI = 28	57
Band3	FM1	87–108 MHz	50 µs	Separation = 6dB, RSSI = 20	67
Band4	FM1	87–108 MHz	50 µs	Separation = 12 dB, RSSI = 28	77
Band5	FM2	86.5–109 MHz	75 µs	Separation = 6 dB, RSSI = 20	87
Band6	FM2	86.5–109 MHz	75 µs	Separation = 12 dB, RSSI = 28	97
Band7	FM2	86.5–109 MHz	50 µs	Separation = 6 dB, RSSI = 20	107
Band8	FM2	86.5–109 MHz	50 µs	Separation = 12 dB, RSSI = 28	117
Band9	FM3	87.3–108.25 MHz	75 µs	Separation = 6 dB, RSSI = 20	127

Table 2. Band Sequence Definition (Continued)

Band Number	Band Name	Band Frequency Range	De-emphasis (FM) Channel Space (AM)	Stereo LED on Conditions (Only for Si4840/44)	Total R to GND (kΩ, 1%)
Band10	FM3	87.3–108.25 MHz	50 µs	Separation = 12 dB, RSSI = 28	137
Band11	FM3	87.3–108.25 MHz	75 µs	Separation = 6 dB, RSSI = 20	147
Band12	FM3	87.3–108.25 MHz	50 µs	Separation = 12 dB, RSSI = 28	157
Band13	FM4	76–90 MHz	75 µs	Separation = 6 dB, RSSI = 20	167
Band14	FM4	76–90 MHz	75 µs	Separation = 12 dB, RSSI = 28	177
Band15	FM4	76–90 MHz	50 µs	Separation = 6 dB, RSSI = 20	187
Band16	FM4	76–90 MHz	50 µs	Separation = 12 dB, RSSI = 28	197
Band17	FM5	64–87 MHz	75 µs	Separation = 6 dB, RSSI = 20	207
Band18	FM5	64–87 MHz	75 µs	Separation = 12 dB, RSSI = 28	217
Band19	FM5	64–87 MHz	50 µs	Separation = 6 dB, RSSI = 20	227
Band20	FM5	64–87 MHz	50 µs	Separation = 12 dB, RSSI = 28	237
Band21	AM1	520–1710 kHz	10 kHz		247
Band22	AM2	522–1620 kHz	9 kHz		257
Band23	AM3	504–1665 kHz	9 kHz		267
Band24	AM4	520–1730 kHz	10 kHz		277
Band25	AM5	510–1750 kHz	10 kHz		287
Band26	SW1	5.6–6.4 MHz			297
Band27	SW2	5.95–6.2 MHz			307
Band28	SW3	6.8–7.6 MHz			317
Band29	SW4	7.1–7.6 MHz			327
Band30	SW5	9.2–10 MHz			337

Table 2. Band Sequence Definition (Continued)

Band Number	Band Name	Band Frequency Range	De-emphasis (FM) Channel Space (AM)	Stereo LED on Conditions (Only for Si4840/44)	Total R to GND (kΩ, 1%)
Band31	SW6	9.2–9.9 MHz			347
Band32	SW7	11.45–12.25 MHz			357
Band33	SW8	11.6–12.2 MHz			367
Band34	SW9	13.4–14.2 MHz			377
Band35	SW10	13.57–13.87 MHz			387
Band36	SW11	15–15.9 MHz			397
Band37	SW12	15.1–15.8 MHz			407
Band38	SW13	17.1–18 MHz			417
Band39	SW14	17.48–17.9 MHz			427
Band40	SW15	21.2–22 MHz			437
Band41	SW16	21.45–21.85 MHz			447

2.2. Default Band Selection

Refer to Figure 1 for the band selection circuits. Selecting a band is to determine the resistance value from the band select pin to GND.

To select a specific band, you need to ensure two things:

- Total value of resistance from the BAND to GND is equal to the value specified in Table 2
- Total resistance from TUNE1 to GND is 500 kΩ in 1% tolerance

Some commonly used bands and their respective selection circuits are listed below for your quick reference.

2.2.1. Typical 12-band application

Figure 1 and Table 3 illustrate the band and resistor value details for a typical 12-band application.

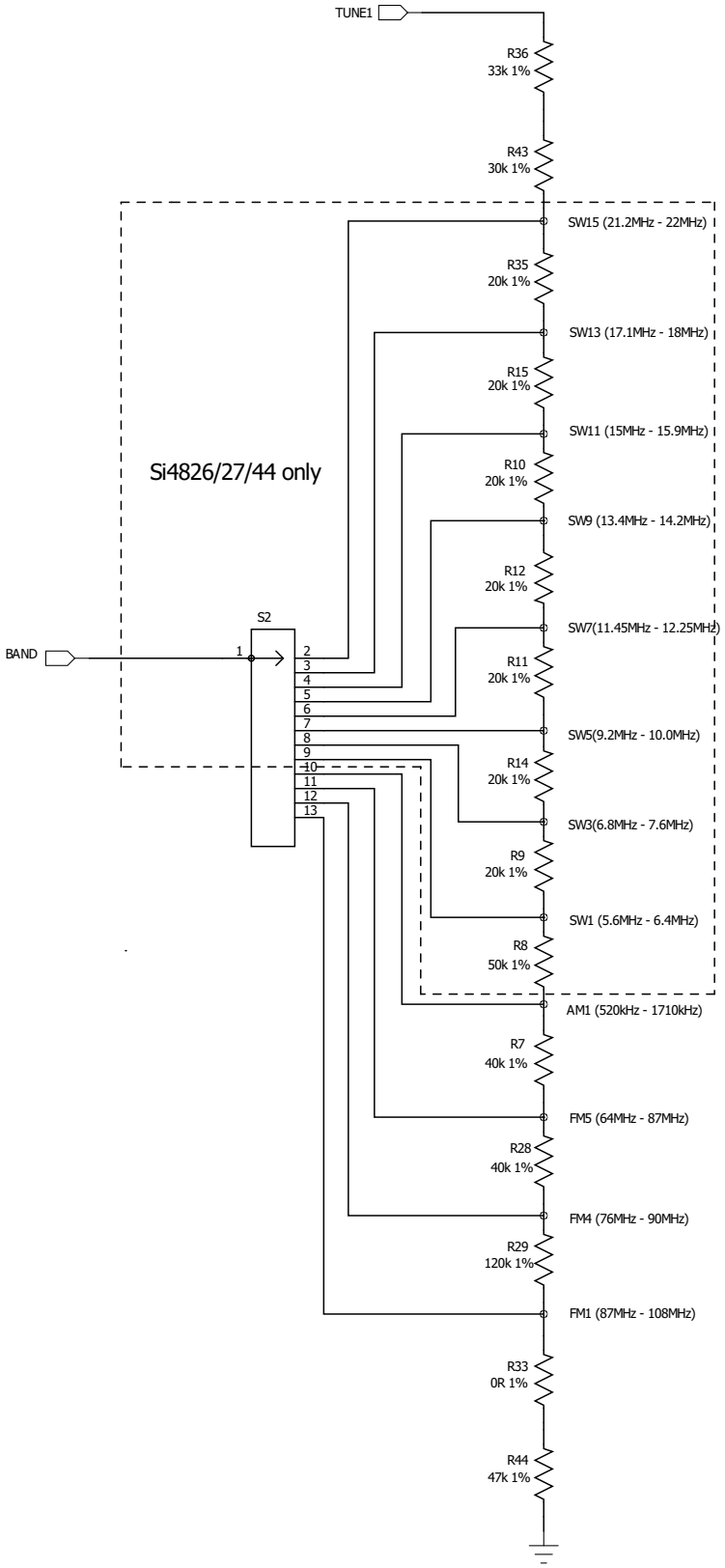


Figure 1. A Typical 12-Band Selection Circuit

Table 3. Typical 12-Band Selection

Band Number	Band Name	Band Frequency Range	De-emphasis (FM) Channel space (AM)	Stereo LED On Conditions (Only for Si4840/44)	Total R to GND (kΩ, 1%)
Band1	FM1	87–108 MHz	75 µs	Separation = 6 dB, RSSI = 20	47
Band13	FM4	76–90 MHz	75 µs	Separation = 6 dB, RSSI = 20	167
Band17	FM5	64–87 MHz	75 µs	Separation = 6 dB, RSSI = 20	207
Band21	AM1	520–1710 kHz	10 kHz		247
Band26	SW1	5.6–6.4 MHz			297
Band28	SW3	6.8–7.6 MHz			317
Band30	SW5	9.2–10 MHz			337
Band32	SW7	11.45–12.25 MHz			357
Band34	SW9	13.4–14.2 MHz			377
Band36	SW11	15–15.9 MHz			397
Band38	SW13	17.1–18 MHz			417
Band40	SW15	21.2–22 MHz			437

2.2.2. Typical 2-band application for Europe

Figure 2 and Table 4 show the band and resistor value details for a typical European 2-band application.

Table 4. Typical European 2-Band Selection

Band Number	Band Name	Band Frequency Range	De-emphasis (FM) Channel space (AM)	Stereo LED On Conditions (Only for Si4840/44)	Total R to GND (kΩ, 1%)
Band4	FM1	87–108 MHz	50 µs	Separation = 12 dB, RSSI = 28	77
Band22	AM2	522–1620 kHz	9 kHz		257

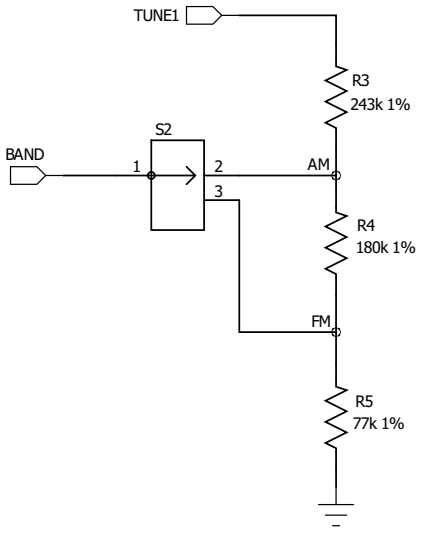


Figure 2. Typical 2-Band Selection Circuit for Europe

2.2.3. Typical 2-band Application for US

Figure 3 and Table 5 show the band and resistor value details for a typical 2-band application for US.

Table 5. Typical US 2-Band Selection

Band Number	Band Name	Band Frequency Range	De-emphasis (FM) Channel space (AM)	Stereo LED On Conditions (Only for Si4840/44)	Total R to GND (kΩ, 1%)
Band2	FM1	87–108 MHz	75 µs	Separation = 12 dB, RSSI = 28	57
Band21	AM1	520–1710 kHz	10 kHz		247

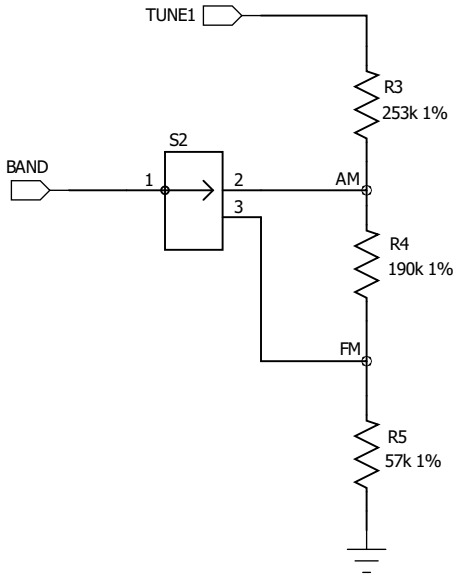


Figure 3. Typical 2-Band Selection Circuit for US

3. Si48422/26/27/40/44 SSOP/SOIC Schematic and Layout

This section shows the typical schematic and layout required for optimal Si4822/26/27/40/44 performance. Si4822/26/40/44 offer two methods to select the radio band by tuner setting and two methods to set band property by tuner setting. Normally, there are four kinds of typical application circuits in real application, however, the Si4827 offers two methods to select the radio band by tuner setting and two methods to set band property by host MCU, so there are two kinds of typical application circuits in real application.

3.1. Si4822/26/40/44 Application Circuit: Host MCU Select Radio Band and Set Band Property

Figure 4 shows the applications circuits of Si4822/26/40/44 when the application is to use the host MCU to select radio band and set band property. Normally, a push button for selecting band is connected to the host MCU. The MCU then detects the push button's action and sends a command to Si4822/26/40/44 to set the desired band. The host MCU can also set the band property, such as band top frequency point and bottom frequency point, stereo indication threshold (only for Si4840/44), de-emphasis, AM tuning spacing, etc. The two key points to ensure Si4822/26/40/44 works properly are as follows:

1. No pull-up resistor is connected to pin 1 LNA_EN
2. Pin 5 BAND is connected to its power supply V_{CC} directly

C6 & C15 are required bypass capacitors for V_{DD1}/V_{DD2} power supply pin 20/21. Place C6/C15 as close as possible to the V_{DD1}/V_{DD2} pin 20/21 and DBYP pin 22. These recommendations are made to reduce the size of the current loop created by the bypass cap and routing, minimize bypass cap impedance, and return all currents to the DBYP pin.

Pin 22 is the dedicated bypass capacitor pin. Do not connect it to power supply GND on PCB.

Pin 13 and pin 14 are the GND of the chip; these pins must be well connected to the power supply GND on PCB.

Pin 9 is the RFGND of the chip; it must be well connected to the power supply GND on PCB.

C4 and/or C7 (4.7 µF) are ac coupling caps for receiver analog audio output from pin 23 and/or pin 24. The input resistance of the amplifier, R, such as a headphone amplifier, and the capacitance, C, will set the high pass pole given by Equation 1. Placement locations of C4 and C7 are not critical.

$$f_c = \frac{1}{2\pi RC}$$

Equation 1. High-Pass Pole Calculation

C28 and C29 (22 pF) are crystal loading caps required only when using the internal oscillator feature. Refer to the crystal data sheet for the proper load capacitance and be certain to account for parasitic capacitance. Place caps C28 and C29 such that they share a common GND connection and the current loop area of the crystal and loading caps is minimized.

Y1 (32.768 kHz) is an optional crystal required only when using the internal oscillator feature. Place the crystal Y1 as close to XTALO pin 18 and XTALI pin 19 as possible to minimize current loops. If applying an external clock (32.768 kHz) to XTALI, leave XTALO floating.

Do not route digital signals or reference clock traces near pin 6 and 7. Do not route Pin 6 & 7. These pins must be left floating to guarantee proper operation.

Pin 2, 15, 16, 17 are the required communication pins with host MCU. A 100 kΩ pull-up resistor R6 and 0.1 µF bypass cap C19 are recommended for the pin 15 RST. Pull-up resistor R3 of 10 kΩ is necessary for pin 16 SDIO.

VR1 (100 k / 10%), R27, C1, C13 constitute the tuning circuit. 100kΩ at 10% tolerance is recommended for VR1.

Q1(2SC9018), together with its peripherals B6, C30,31,33,36, R31,32,34,41, is the LNA circuit for all SW bands. The LNA is switched off by LNA_EN signal in AM and FM mode controlled by Si4826/44.

For Si4822/26, do not route pin 23. This pin must be left floating to guarantee proper operation.

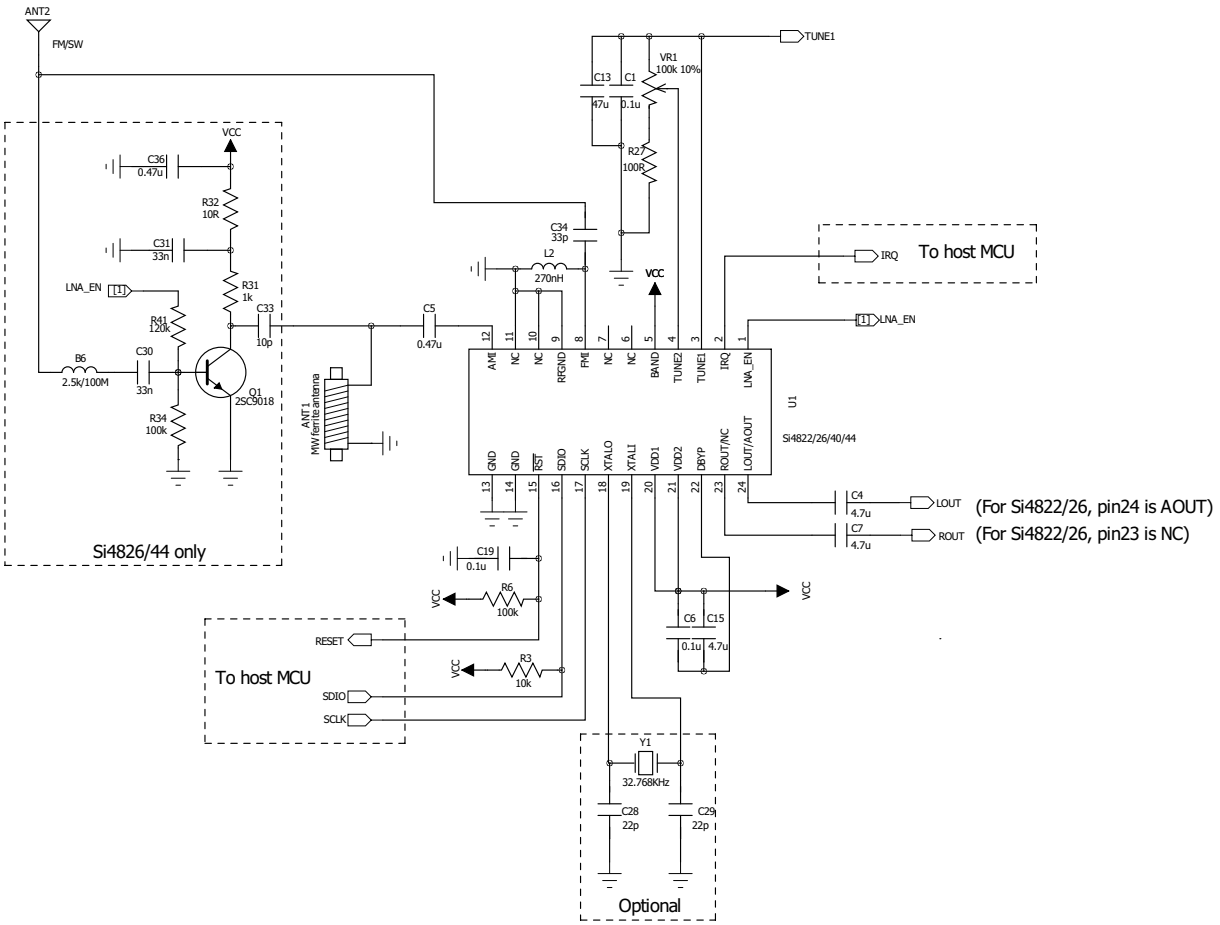


Figure 4. Si4822/26/40/44 Applications Circuit: MCU Select Band and Set Band Property

3.2. Si4822/26/40/44 Application Circuits: Host MCU Select Default Band and Use Default Band Property

Figure 5 shows Si4822/26/40/44 application circuits that enable the host MCU to select default bands. In this application, the host MCU sends commands to Si4822/26/40/44 to select the desired default band. However, the MCU cannot define those band properties already fixed in the default band definition, as stated in “2.1. Si4822/26/27/40/44 Default Band Definition”. The host MCU can only define the band properties which are not fixed in the default band definition, such as softmute property, etc. For more details, refer to “AN610: Si48xx ATDD Programming Guide”. The two key points to ensure Si4822/26/40/44 works properly are as follows:

1. Add pull-up resistor R42 of 10kΩ to pin 1 LNA_EN.
2. Ensure pin 5 BAND is connected to its power supply V_{CC} directly.

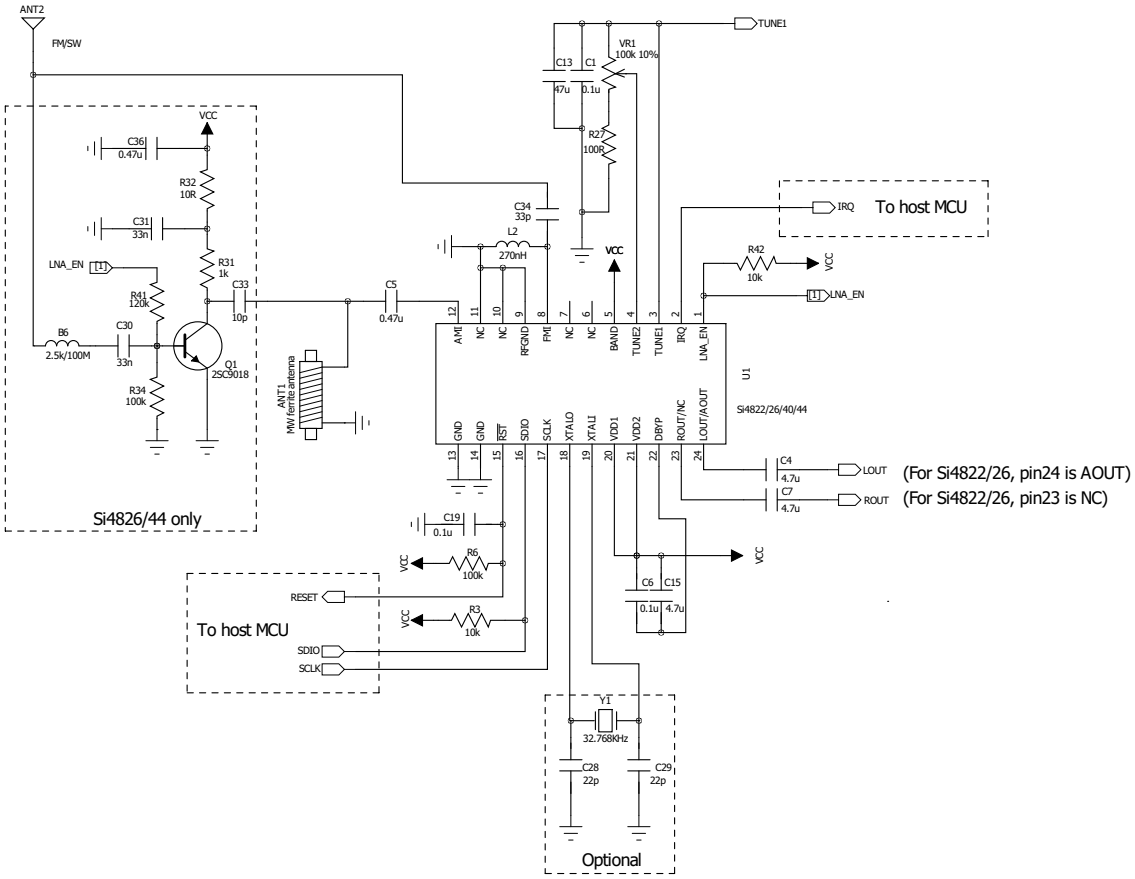


Figure 5. SiSi4822/26/40/44 Applications Circuit: MCU Select Default Band and Use Default Band Property

3.3. Si4822/26/40/44 Application Circuits: Slide Switch Select Band and MCU Re-define Band Property

Figure 7 illustrates an Si4822/26/40/44 application circuit which uses a slide switch for band selection and enables the host MCU to re-define the band property. For the band selection method using slide switch and resistors ladder, refer to "2.2. Default Band Selection" on page 4. In this application, the user can select any default band and the MCU will re-define the band's property according to the design requirement. The MCU can only re-define the selected band's property, it cannot change an FM band to an AM or SW band, and vice versa. The two key points to ensure the Si4822/26/40/44 works properly are as follows:

1. No pull-up resistor is connected to pin 1 LNA_EN.
2. Pin 5 BAND is connected to slide switch.

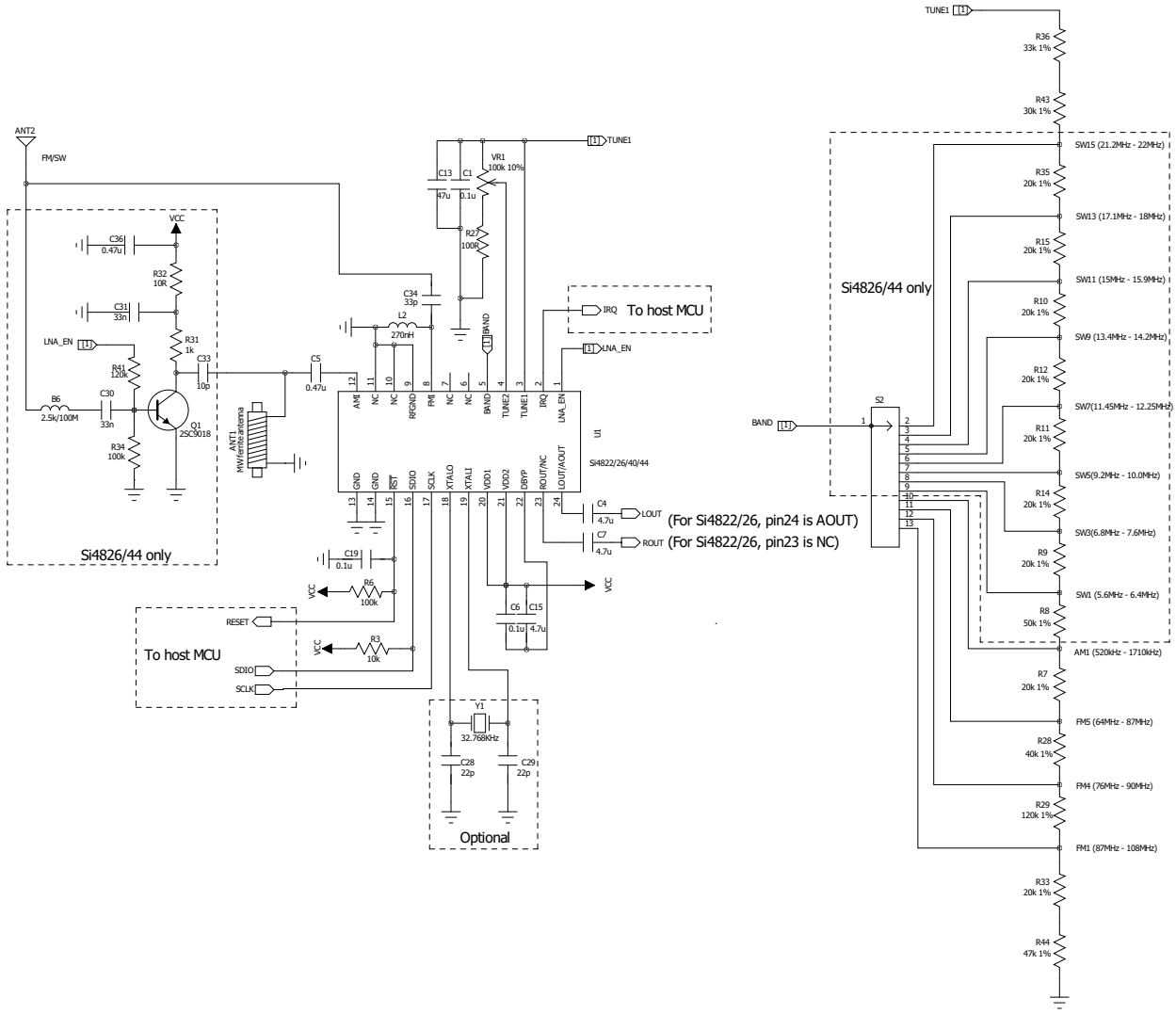


Figure 6. Si4822/26/40/44 Applications Circuit: Slide Switch Select Band and MCU Re-define Band Property

3.4. Si4822/26/40/44 Application Circuits: Slide Switch Select Band and Use Default Band Property

Figure 7shows an application circuit that uses a slide switch for band selection. In this example, the host MCU cannot change those band properties already fixed in the default band definition, as stated in section 2.1, it can only define the band properties which are not fixed in the default band definition, such as softmute property, etc. For more details, refer to “AN610: Si48xx ATDD Programming Guide”. The two key points to ensure Si4822/26/40/44 works properly are as follows:

1. Add pull-up resistor R42 of 10 kΩ to pin 1 LNA_EN.
2. Pin 5 BAND is connected to slide switch.

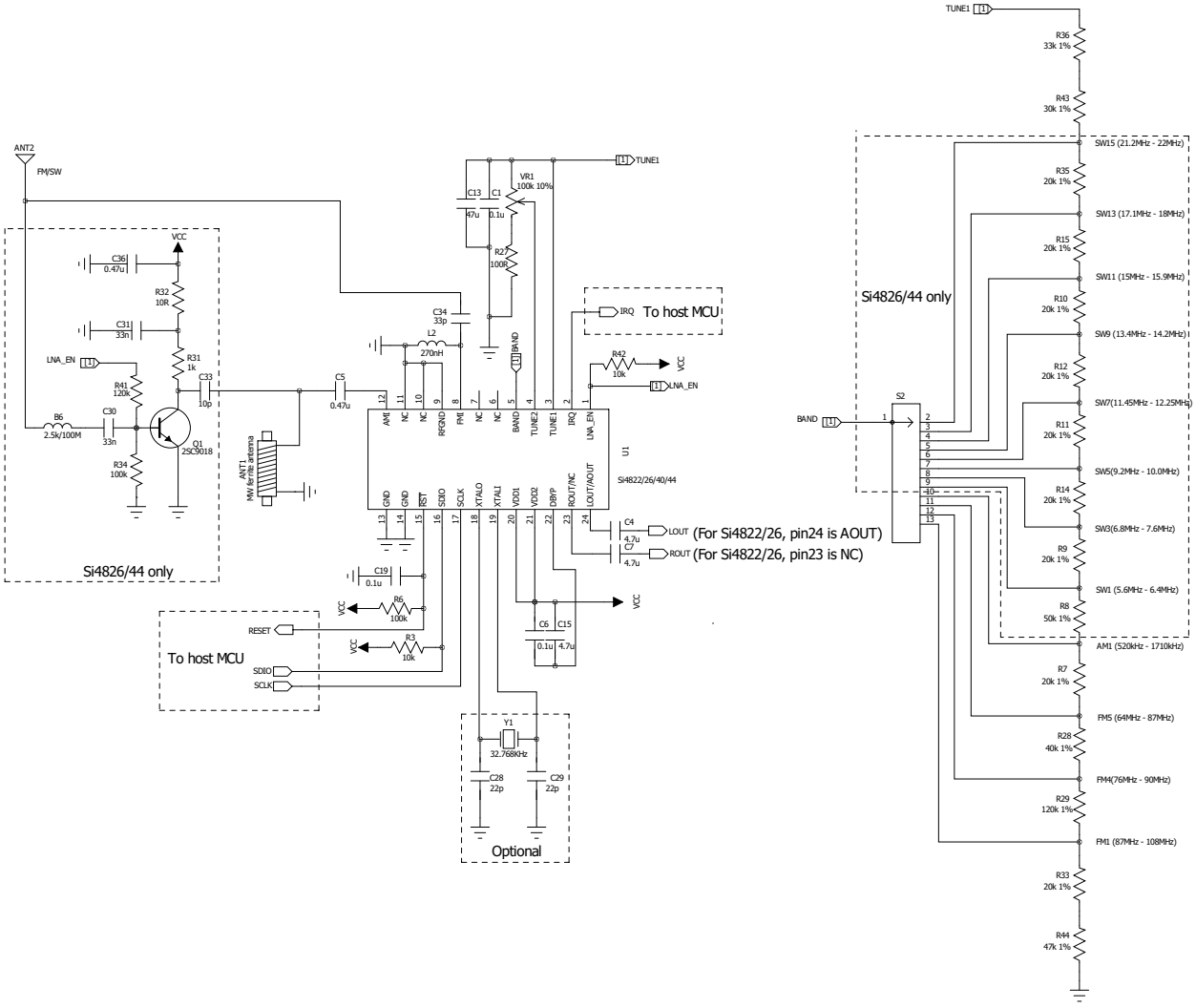


Figure 7. Si4822/26/40/44 Applications Circuit: Slide Switch Select Band and Use Default Band Property

3.5. Si4827 Application Circuit: Host MCU to Select Radio Band

Figure 8 shows the Si4827 application circuit that the host MCU uses to select radio band. In this application, the host MCU sends commands to the Si4827 to select the desired band. Setting the band property by MCU or using the tuner default band property is determined by host MCU.

Setting the band property by MCU means that the host MCU can set the band property, such as band top frequency point and bottom frequency point, de-emphasis, AM tuning spacing, etc.

Using the tuner default band property means that the MCU cannot define those band properties already fixed in the default band definition, as stated in section “2.1. Si4822/26/27/40/44 Default Band Definition”. The host MCU can only define the band properties which are not fixed in the default band definition, such as softmute property, etc. For more details, refer to application note, "AN610: Si48xx ATDD Programming Guide".

The key point to ensure the Si4827 works properly is that pin 4 BAND is connected to it's power supply V_{CC} directly.

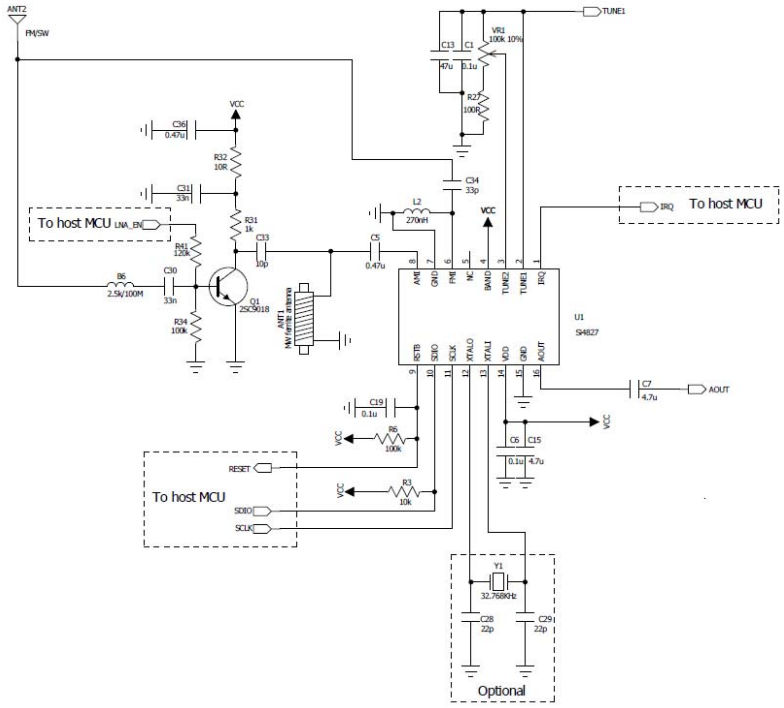


Figure 8. Si4827 Application Circuit: Host MCU Select Band

3.6. Si4827 Application Circuit: Slide Switch Select Band

Figure 9 shows the Si4827 application circuit in which a slide switch is used for band selection. For the band selection method using slide switch and resistors ladder, refer to section.“2.2. Default Band Selection”. Setting the band property by MCU or using the tuner default band property is determined by host MCU.

When setting the band property by MCU, the user can select any default band and the MCU will re-define the band's property according to the design requirement. The MCU can only re-define the selected band's property, it cannot change an FM band to an AM or SW band, and vice versa.

When using the tuner default band property, the host MCU cannot change those band properties already fixed in the default band definition, as stated in section “2.1. Si4822/26/27/40/44 Default Band Definition”, it can only define the band properties which are not fixed in the default band definition, such as softmute property, etc. For more details, refer to application note, "AN610: Si48xx ATDD Programming Guide".

The key point to ensure the Si4827 works properly is that pin 4 BAND is connected to slide switch.

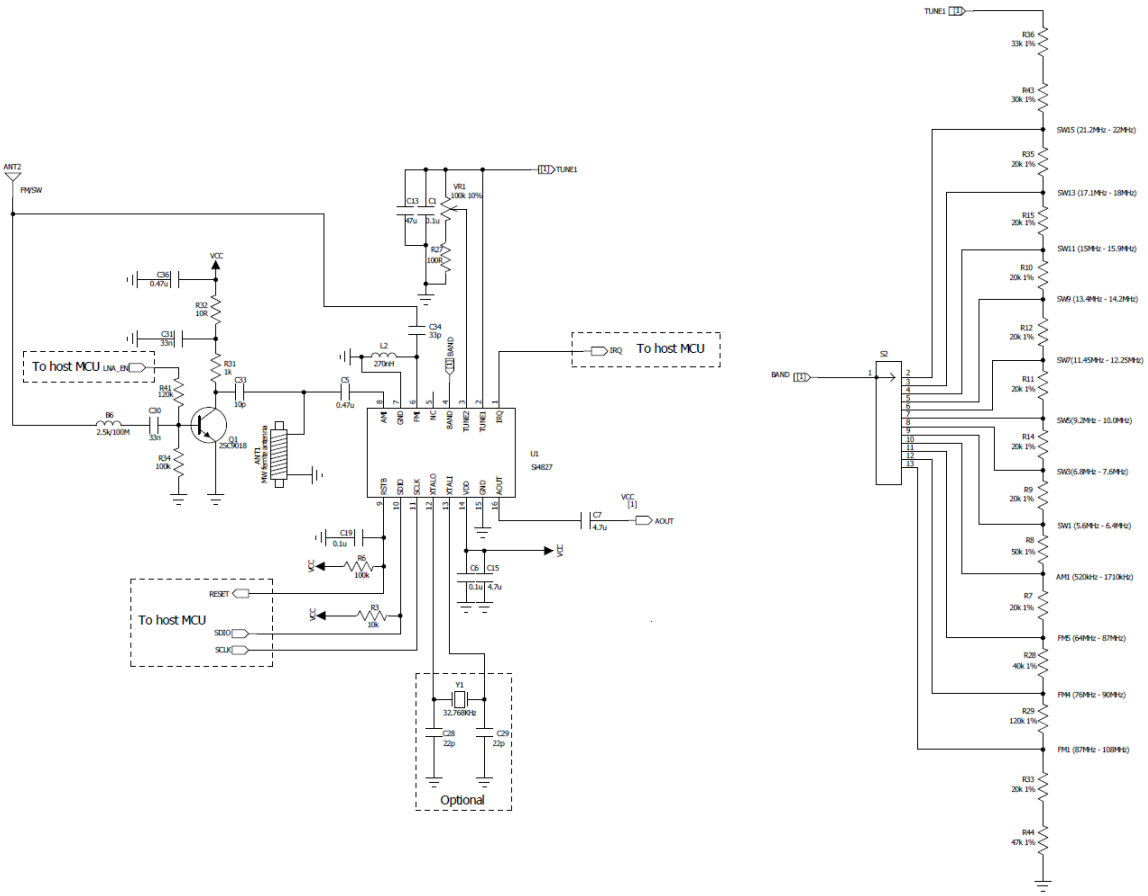


Figure 9. Si4827 Application Circuit: Slide Switch Select Band

3.7. Si4822/26/27/40/44 Bill of Materials

Table 6. Si4822/26/40/44 Applications Circuit: Host MCU Select Band and Set Band Property

Component(s)	Value/Description	Supplier
C1,C6,C19	Supply bypass capacitor, 0.1 µF, ±20%, Z5U/X7R	Murata
C5	Capacitor, 0.47 µF, ±20%, Z5U/X7R	Murata
C34	RF coupling capacitors, 33 pF, ±5%, COG	Murata
C4,C7,C15	Capacitor 4.7 µF, ±20%, Z5U/X7R	Murata
C13	Capacitor 47 µF, ±20%, Z5U/X7R	Murata
R27	Resistor, 100 Ω, ±5%	Venkel
R6	Resistor, 100 kΩ, ±5%	Venkel
R3	Resistor, 10 kΩ, ±5%	Venkel
U1	Si4822/26/40/44 AM/FM/SW Analog Tune Digital Display Radio Tuner	Silicon Laboratories
L2	Inductor 270 nH	Murata
ANT1	MW ferrite antenna 220 µH.	Jiaxin Electronics
ANT2	Whip antenna	Various
VR1	Variable resistor (POT), 100 kΩ, ±10%	Changtaier
Si4826/44 Only		
C36	Capacitor, 0.47 µF, ±20%, Z5U/X7R	Murata
C33	Capacitor, 10 pF, ±5%, COG	Murata
C30-31	Capacitor, 33 nF, ±5%, COG	Murata
B6	Ferrite bead,2.5 k/100 MHz.	Murata
Q1	RF transistor, 2SC9018.	ETC
R34	Resistor, 100 kΩ, ±5%	Venkel
R41	Resistor, 120 kΩ, ±5%	Venkel
R32	Resistor, 10 Ω, ±5%	Venkel
R31	Resistor, 1 kΩ, ±5%	Venkel
Optional		
C28, C29	Crystal load capacitors, 22 pF, ±5%, COG (Optional: for crystal oscillator option)	Murata
Y1	32.768 kHz crystal (Optional: for crystal oscillator option)	Epson

Table 7. Si4822/26/40/44 Applications Circuit: MCU Select Default Band and Use Default Band Property

Component(s)	Value/Description	Supplier
C1,C6,C19	Supply bypass capacitor, 0.1 µF, ±20%, Z5U/X7R	Murata
C5	Capacitor, 0.47 µF, ±20%, Z5U/X7R	Murata
C34	RF coupling capacitors, 33 pF, ±5%, COG	Murata
C4,C7,C15	Capacitor 4.7 µF, ±20%, Z5U/X7R	Murata
C13	Capacitor 47 µF, ±20%, Z5U/X7R	Murata
R27	Resistor, 100 Ω, ±5%	Venkel
R6	Resistor, 100 kΩ, ±5%	Venkel
R3, R42	Resistor, 10 kΩ, ±5%	Venkel
U1	Si4822/26/40/44 AM/FM/SW Analog Tune Digital Display Radio Tuner	Silicon Laboratories
L2	Inductor 270 nH	Murata
ANT1	MW ferrite antenna 220 µH.	Jiaxin Electronics
ANT2	Whip antenna	Various
VR1	Variable resistor (POT), 100 kΩ, ±10%	Changtaier
Si4826/44 Only		
C36	Capacitor, 0.47 µF, ±20%, Z5U/X7R	Murata
C33	Capacitor, 10 pF, ±5%, COG	Murata
C30-31	Capacitor, 33 nF, ±5%, COG	Murata
B6	Ferrite bead, 2.5 k/100 MHz	Murata
Q1	RF transistor, 2SC9018.	ETC
R34	Resistor, 100 kΩ, ±5%	Venkel
R41	Resistor, 120 kΩ, ±5%	Venkel
R32	Resistor, 10 Ω, ±5%	Venkel
R31	Resistor, 1 kΩ, ±5%	Venkel
Optional		
C28, C29	Crystal load capacitors, 22 pF, ±5%, COG (Optional: for crystal oscillator option)	Murata
Y1	32.768 kHz crystal (Optional: for crystal oscillator option)	Epson

Table 8. Si4822/26/40/44 Application Circuits: Slide Switch Select Band and MCU Re-define Band Property

Component(s)	Value/Description	Supplier
C1,C6,C19	Supply bypass capacitor, 0.1 µF, ±20%, Z5U/X7R	Murata
C5	Capacitor, 0.47 µF, ±20%, Z5U/X7R	Murata
C34	RF coupling capacitors, 33 pF, ±5%, COG	Murata
C4,C7,C15	Capacitor 4.7 µF, ±20%, Z5U/X7R	Murata
C13	Capacitor 47 µF, ±20%, Z5U/X7R	Murata
R27	Resistor, 100 Ω, ±5%	Venkel
R6	Resistor, 100 kΩ, ±5%	Venkel
R3	Resistor, 10 kΩ, ±5%	Venkel
R7,R33	Band switching resistor, 20 kΩ, ±1%	Venkel
R28	Band switching resistor, 40 kΩ, ±1%	Venkel
R29	Band switching resistor, 120 kΩ, ±1%	Venkel
R44	Band switching resistor, 47 kΩ, ±1%	Venkel
R43	Band switching resistor, 30 kΩ, ±1%	Venkel
R36	Band switching resistor, 33 kΩ, ±1%	Venkel
U1	Si4822/26/40/44 AM/FM/SW Analog Tune Digital Display Radio Tuner	Silicon Laboratories
L2	Inductor 270 nH	Murata
ANT1	MW ferrite antenna 220 µH	Jiaxin Electronics
ANT2	Whip antenna	Various
VR1	Variable resistor (POT), 100 kΩ, ±10%	Changtaier
S2	Slide switch	Shengda
Si4826/44 Only		
C36	Capacitor, 0.47 µF, ±20%, Z5U/X7R	Murata
C33	Capacitor, 10 pF, ±5%, COG	Murata
C30-31	Capacitor, 33 nF, ±5%, COG	Murata
B6	Ferrite bead, 2.5 k/100 MHz	Murata
Q1	RF transistor, 2SC9018.	ETC
R34	Resistor, 100 kΩ, ±5%	Venkel
R41	Resistor, 120 kΩ, ±5%	Venkel
R32	Resistor, 10 Ω, ±5%	Venkel

Table 8. Si4822/26/40/44 Application Circuits: Slide Switch Select Band and MCU Re-define Band Property (Continued)

R31	Resistor, 1 kΩ, ±5%	Venkel
R9-12, R14-15, R35	Band switching resistor, 20 kΩ, ±1%	Venkel
R8	Band switching resistor, 50 kΩ, ±1%	Venkel
Optional		
C28, C29	Crystal load capacitor, 22 pF, ±5%, COG (Optional: for crystal oscillator option)	Murata
Y1	32.768 kHz crystal (Optional: for crystal oscillator option)	Epson

Table 9. Si4822/26/40/44 Application Circuits: Slide Switch Select Band and Use Default Band Property

Component(s)	Value/Description	Supplier
C1,C6,C19	Supply bypass capacitor, 0.1 µF, ±20%, Z5U/X7R	Murata
C5	Capacitor, 0.47 µF, ±20%, Z5U/X7R	Murata
C34	RF coupling capacitors, 33 pF, ±5%, COG	Murata
C4,C7,C15	Capacitor 4.7 µF, ±20%, Z5U/X7R	Murata
C13	Capacitor 47 µF, ±20%, Z5U/X7R	Murata
R27	Resistor, 100 Ω, ±5%	Venkel
R6	Resistor, 100 kΩ, ±5%	Venkel
R3, R42	Resistor, 10 kΩ, ±5%	Venkel
R7,R33	Band switching resistor, 20 kΩ, ±1%	Venkel
R28	Band switching resistor, 40 kΩ, ±1%	Venkel
R29	Band switching resistor, 120 kΩ, ±1%	Venkel
R44	Band switching resistor, 47 kΩ, ±1%	Venkel
R43	Band switching resistor, 30 kΩ, ±1%	Venkel
R36	Band switching resistor, 33 kΩ, ±1%	Venkel
U1	Si4822/26/40/44 AM/FM/SW Analog Tune Digital Display Radio Tuner	Silicon Laboratories
L2	Inductor 270 nH	Murata
ANT1	MW ferrite antenna 220 µH	Jiaxin Electronics
ANT2	Whip antenna	Various

Table 9. Si4822/26/40/44 Application Circuits: Slide Switch Select Band and Use Default Band Property (Continued)

Component(s)	Value/Description	Supplier
VR1	Variable resistor (POT), 100 kΩ, ±10%	Changtaier
S2	Slide switch	Shengda
Si4826/44 Only		
C36	Capacitor, 0.47 µF, ±20%, Z5U/X7R	Murata
C33	Capacitor, 10 pF, ±5%, COG	Murata
C30-31	Capacitor, 33 nF, ±5%, COG	Murata
B6	Ferrite bead, 2.5 k/100 MHz	Murata
Q1	RF transistor, 2SC9018	ETC
R34	Resistor, 100 kΩ, ±5%	Venkel
R41	Resistor, 120 kΩ, ±5%	Venkel
R32	Resistor, 10 Ω, ±5%	Venkel
R31	Resistor, 1 kΩ, ±5%	Venkel
R9-12, R14-15, R35	Band switching resistor, 20 kΩ, ±1%	Venkel
R8	Band switching resistor, 50 kΩ, ±1%	Venkel
Optional		
C28, C29	Crystal load capacitor, 22 pF, ±5%, COG (Optional: for crystal oscillator option)	Murata
Y1	32.768 kHz crystal (Optional: for crystal oscillator option)	Epson

Table 10. Si4827 Application Circuit: MCU Select Band

Component(s)	Value/Description	Supplier
C1,C6,C19	Supply bypass capacitor, 0.1 µF, ±20%, Z5U/X7R	Murata
C5,C36	Capacitor, 0.47 µF, ±20%, Z5U/X7R	Murata
C34	RF coupling capacitors, 33 pF, ±5%, COG	Murata
C7,C15	Capacitor 4.7 µF, ±20%, Z5U/X7R	Murata
C13	Capacitor 47 µF, ±20%, Z5U/X7R	Murata
R27	Resistor, 100 Ω, ±5%	Venkel
R6 R34	Resistor, 100 kΩ, ±5%	Venkel
R3	Resistor, 10 kΩ, ±5%	Venkel
U1	Si4827-A AM/FM/SW Analog Tune Digital Display Radio Tuner	Silicon Laboratories
L2	Inductor 270 nH	Murata
ANT1	MW ferrite antenna 220 µH	Jiaxin Electronics
ANT2	Whip antenna	Various
VR1	Variable resistor (POT), 100 kΩ, ±10%	Changtaier
C33	Capacitor, 10 pF, ±5%, COG	Murata
C30-31	Capacitor, 33 nF, ±5%, COG	Murata
B6	Ferrite bead,2.5k/100 MHz	Murata
Q1	RF transistor, 2SC9018	ETC
R41	Resistor, 120 kΩ, ±5%	Venkel
R32	Resistor, 10 Ω, ±5%	Venkel
R31	Resistor, 1 kΩ, ±5%	Venkel
Optional		
C28, C29	Crystal load capacitors, 22 pF, ±5%, COG (Optional: for crystal oscillator option)	Murata
Y1	32.768 kHz crystal (Optional: for crystal oscillator option)	Epson

Table 11. Si4827 Application Circuit: Slide Switch Select Band

Component(s)	Value/Description	Supplier
C1,C6,C19	Supply bypass capacitor, 0.1 µF, ±20%, Z5U/X7R	Murata
C5,C36	Capacitor, 0.47 µF, ±20%, Z5U/X7R	Murata
C34	RF coupling capacitors, 33 pF, ±5%, COG	Murata
C7,C15	Capacitor 4.7 µF, ±20%, Z5U/X7R	Murata
C13	Capacitor 47 µF, ±20%, Z5U/X7R	Murata
R27	Resistor, 100 Ω, ±5%	Venkel
R6 R34	Resistor, 100 kΩ, ±5%	Venkel
R3	Resistor, 10 kΩ, ±5%	Venkel
U1	Si4827-A AM/FM/SW Analog Tune Digital Display Radio Tuner	Silicon Laboratories
L2	Inductor 270 nH	Murata
ANT1	MW ferrite antenna 220 µH	Jiaxin Electronics
ANT2	Whip antenna	Various
VR1	Variable resistor (POT), 100 kΩ, ±10%	Changtaier
C33	Capacitor, 10 pF, ±5%, COG	Murata
C30-31	Capacitor, 33 nF, ±5%, COG	Murata
B6	Ferrite bead, 2.5 k/100 MHz	Murata
Q1	RF transistor, 2SC9018	ETC
R41	Resistor, 120 kΩ, ±5%	Venkel
R32	Resistor, 10 Ω, ±5%	Venkel
R31	Resistor, 1 kΩ, ±5%	Venkel
Optional		
C28, C29	Crystal load capacitors, 22 pF, ±5%, COG (Optional: for crystal oscillator option)	Murata
Y1	32.768 kHz crystal (Optional: for crystal oscillator option)	Epson

3.8. Si4822/26/27/40/44 PCB Layout Guidelines

- 1-layer PCB is used for Si4822/26/27/40/44
- GND routed by large plane
- Power routed with traces
- 0402 component size or larger
- 10 mil traces width
- 20 mil trace spacing
- 15 mil component spacing
- Keep the AM ferrite loop at least 5 cm away from the tuner chip (recommended)
- Keep the AM ferrite loop antenna away from the MCU, audio amp, and other circuits which have AM interference

Place V_{DD1}/V_{DD2} bypass capacitor C6, C15 as close as possible to the supply (pin20/pin 21) and DBYP (pin 22).

Do not connect the DBYP (pin 22) to the board GND.

Place the crystal as close to XTALO (pin18) and XTALI (pin19) as possible, and make the loop area of XTALO trace and XTALI trace as small as possible.

Route all GND (including RFGND) pins to the GND plane underneath the chip. Try to create a large GND plane underneath and around the chip.

Do not route Pin 6 and 7. These pins must be left floating to guarantee proper operation.

Keep the Tune1 and Tune2 traces away from pin 6 and pin 7, route Tune1 and Tune2 traces in parallel and the same way.

Place C1, C13 as close to pin3 TUNE1 as possible.

For Si4822/26, do not route pin 23, leave it floating to guarantee proper operation.

Try to refer to the Si4840/44 PCB Layout example as much as possible when doing Si4822/26/27 PCB layout.

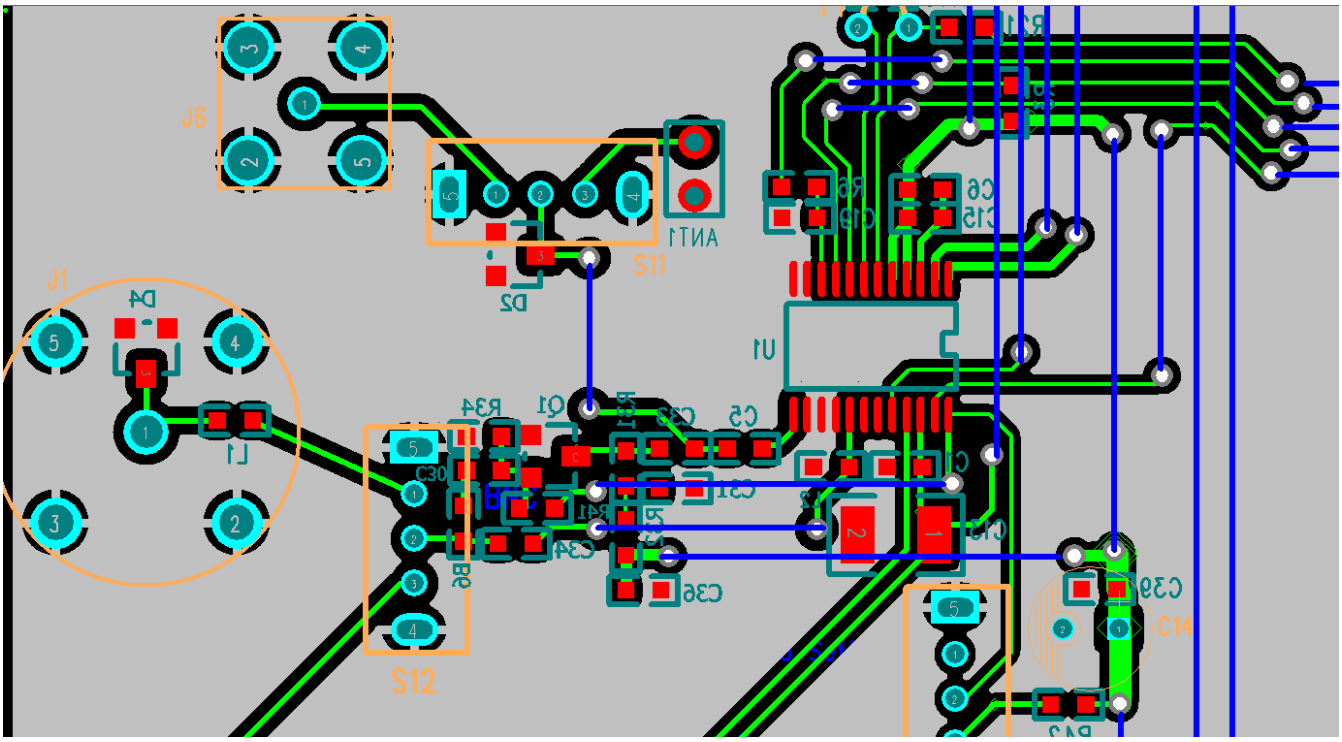


Figure 10. Si4840/44 PCB Layout Example

4. Headphone Antenna for FM Receive

The Si4822/26/27/40/44 FM Receiver component supports a headphone antenna interface through the FMI pin. A headphone antenna with a length between 1.1 and 1.45 m suits the FM application very well because it is approximately half the FM wavelength (FM wavelength is ~3 m).

4.1. Headphone Antenna Design

A typical headphone cable will contain three or more conductors. The left and right audio channels are driven by a headphone amplifier onto left and right audio conductors and the common audio conductor is used for the audio return path and FM antenna. Additional conductors may be used for microphone audio, switching, or other functions, and in some applications the FM antenna will be a separate conductor within the cable. A representation of a typical application is shown in Figure 11.

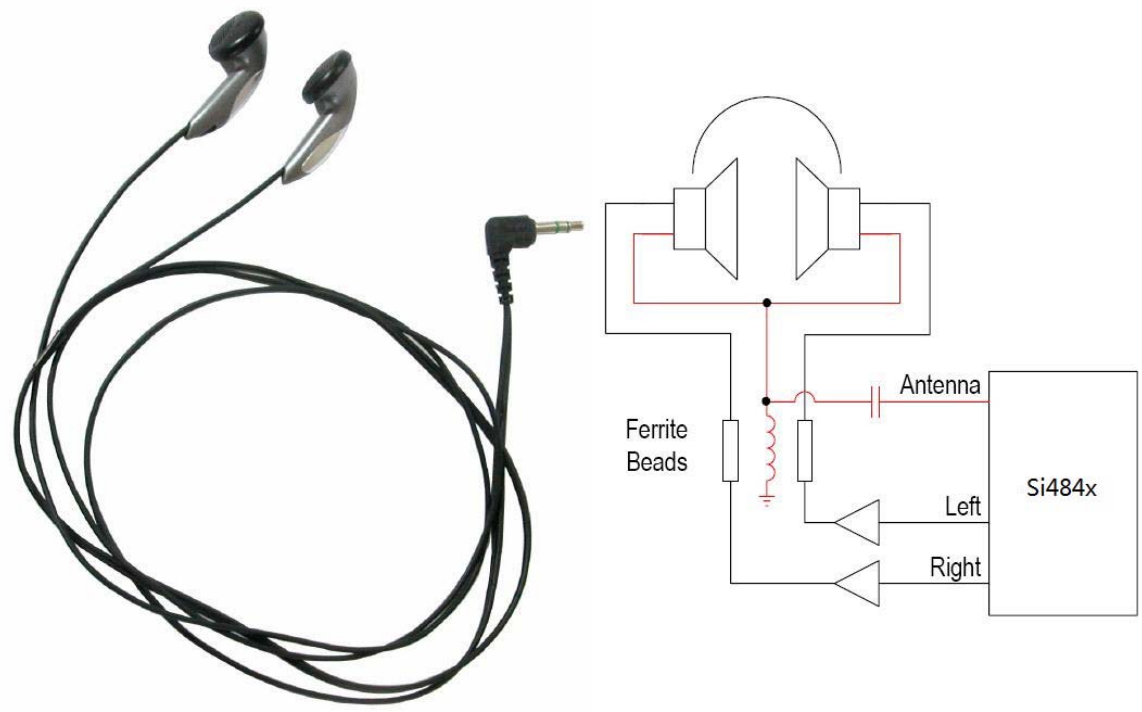


Figure 11. Typical Headphone Antenna Application

4.2. Headphone Antenna Schematic

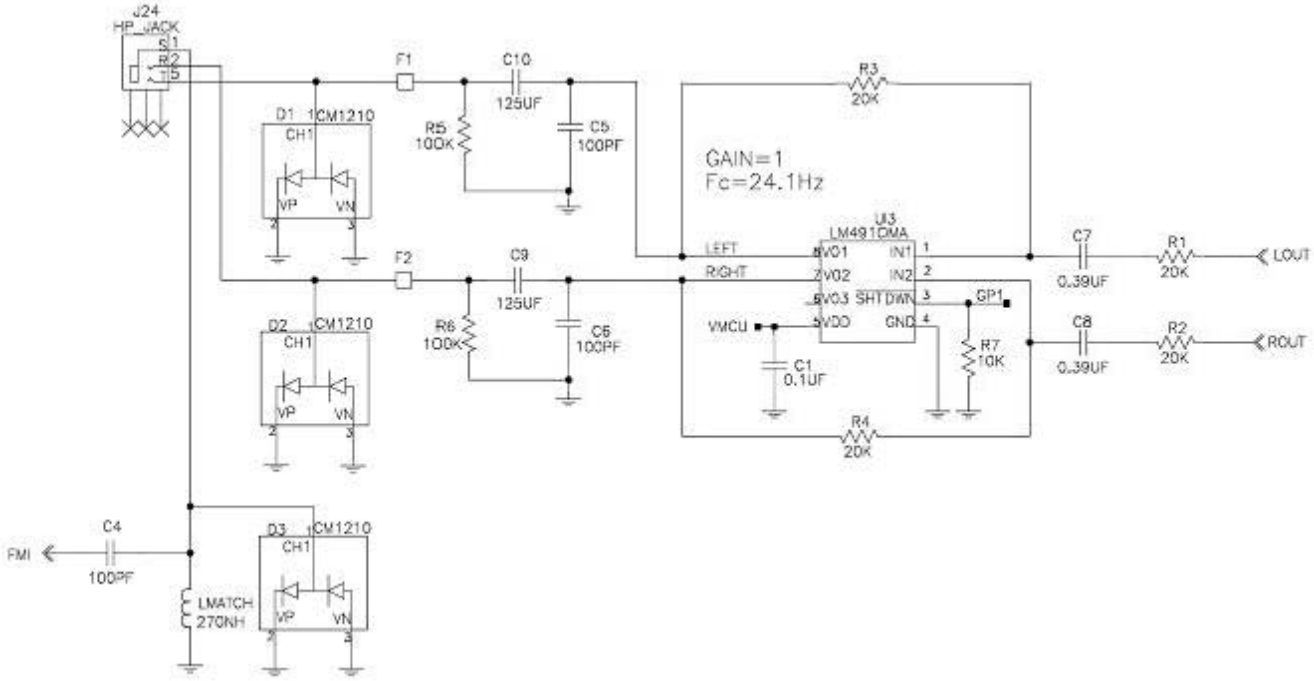


Figure 12. Headphone Antenna Schematic

The headphone antenna implementation requires components L_{MATCH}, C4, F1, and F2 for a minimal implementation. The ESD protection diodes and headphone amplifier components are system components that will be required for proper implementation of any tuner.

Inductor L_{MATCH} is selected to maximize the voltage gain across the FM band. L_{MATCH} should be selected with a Q of 15 or greater at 100 MHz and minimal dc resistance.

AC-coupling capacitor C4 is used to remove a dc offset on the FMI input. This capacitor must be chosen to be large enough to cause negligible loss with an LNA input capacitance of 4 to 6 pF. The recommended value is 100 pF to 1 nF.

Ferrite beads F1 and F2 provide a low-impedance audio path and high-impedance RF path between the headphone amplifier and the headphone. Ferrite beads should be placed on each antenna conductor connected to nodes other than the FMIP, such as left and right audio, microphone audio, switching, etc. In the example shown in Figure 12, these nodes are the left and right audio conductors. Ferrite beads should be 2.5 kΩ or greater at 100 MHz, such as the Murata BLM18BD252SN1. High resistance at 100 MHz is desirable to maximize R_{SHUNT} and, therefore, R_P. Refer to “AN383: Si47xxAntenna, Schematic, and Layout Guidelines”, Appendix A, for a complete description of R_{SHUNT}, R_P, etc.

ESD diodes D1, D2, and D3 are recommended if design requirements exceed the ESD rating of the headphone amplifier and the Si4822/26/40/44. Diodes should be chosen with no more than 1 pF parasitic capacitance, such as the California Micro Devices CM1210. Diode capacitance should be minimized to minimize C_{SHUNT} and, therefore, C_P. If D1 and D2 must be chosen with a capacitance greater than 1 pF, they should be placed between the ferrite beads F1 and F2 and the headphone amplifier to minimize C_{SHUNT}. This placement will, however, reduce the effectiveness of the ESD protection devices. Diode D3 may not be relocated and must therefore have a capacitance less than 1 pF. Note that each diode package contains two devices to protect against positive and negative polarity ESD events.

C9 and C10 are 125 µF ac coupling capacitors required when the audio amplifier does not have a common mode output voltage and the audio output is swinging above and below ground.

Optional bleed resistors R5 and R6 may be desirable to discharge the ac-coupling capacitors when the headphone cable is removed.

Optional RF shunt capacitors C5 and C6 may be placed on the left and right audio traces at the headphone amplifier output to reduce the level of digital noise passed to the antenna. The recommended value is 100 pF or greater; however, the designer should confirm that the headphone amplifier is capable of driving the selected shunt capacitance.

This schematic example uses the National Semiconductor LM4910 headphone amplifier. Passive components R1-R4 and C7-C8 are required for the LM4910 headphone amplifier as described in the LM4910 data sheet. The gain of the right and left amplifiers is -R3/R1 and -R4/R2, respectively. These gains can be adjusted by changing the values of resistors R3 and R4. As a general guide, gain between 0.6 and 1.0 is recommended for the headphone amplifier, depending on the gain of the headphone elements. Capacitors C7 and C8 are ac-coupling capacitors required for the LM4910 interface. These capacitors, in conjunction with resistors R1 and R2, create a high-pass filter that sets the audio amplifier's lower frequency limit. The high-pass corner frequencies for the right and left amplifiers are:

$$f_{CRIGHT} = \frac{1}{2\pi \times R1 \times C7}, \quad f_{CLEFT} = \frac{1}{2\pi \times R2 \times C8}$$

With the specified BOM components, the corner frequency of the headphone amplifier is approximately 20 Hz.

Capacitor C1 is the supply bypass capacitor for the audio amplifier. The LM4910 can also be shut down by applying a logic low voltage to the number 3 pin. The maximum logic low level is 0.4 V and the minimum logic high level is 1.5 V.

The bill of materials for the typical application schematic shown in Figure 12 is provided in Table 12. Note that manufacturer is not critical for resistors and capacitors.

4.3. Headphone Antenna Bill of Materials

Table 12. Headphone Antenna Bill of Materials

Designator	Description
LMATCH	IND, 0603, SM, 270 nH, MURATA, LQW18ANR27J00D
C4	AC coupling cap, SM, 0402, X7R, 100 pF
D1, D2, D3	IC, SM, ESD DIODE, SOT23-3, California Micro Devices, CM1210-01ST
U3	IC, SM, HEADPHONE AMP, National Semiconductor, LM4910MA
R1, R2, R3, R4	RES, SM, 0603, 20 kΩ
C7, C8	CAP, SM, 0603, 0.39UF, X7R
C5, C6	CAP, SM, 0402, C0G, 100 pF
R5, R6	RES, SM, 0603, 100 kΩ
F1, F2	FERRITE BEAD, SM, 0603, 2.5 kΩ, Murata, BLM18BD252SN1D
C1	CAP, SM, 0402, X7R, 0.1 µF
R7	RES, SM, 0402, 10 kΩ

4.4. Headphone Antenna Layout

To minimize inductive and capacitive coupling, inductor L_{MATCH} and headphone jack J24 should be placed together and as far from noise sources such as clocks and digital circuits as possible. L_{MATCH} should be placed near the headphone connector to keep audio currents away from the chip.

To minimize C_{SHUNT} and C_P, place ferrite beads F1 and F2 as close as possible to the headphone connector.

To maximize ESD protection diode effectiveness, place diodes D1, D2, and D3 as close as possible to the headphone connector. If capacitance larger than 1 pF is required for D1 and D2, both components should be placed between FB1 and FB2 and the headphone amplifier to minimize C_{SHUNT}.

Place the chip as close as possible to the headphone connector to minimize antenna trace capacitance, CPCBANT. Keep the trace length short and narrow and as far above the reference plane as possible, restrict the trace to a microstrip topology (trace routes on the top or bottom PCB layers only), minimize trace vias, and relieve ground fill on the trace layer. Note that minimizing capacitance has the effect of maximizing characteristic impedance. It is not necessary to design for 50 Ω transmission lines.

To reduce the level of digital noise passed to the antenna, RF shunt capacitors C5 and C6 may be placed on the left and right audio traces close to the headphone amplifier audio output pins. The recommended value is 100 pF or greater, however, the designer should confirm that the headphone amplifier is capable of driving the selected shunt capacitance.

4.5. Headphone Antenna Design Checklist

- **Select** an antenna length of 1.1 to 1.45 m.
- **Select** matching inductor L_{MATCH} to maximize signal strength across the FM band.
- **Select** matching inductor L_{MATCH} with a Q of 15 or greater at 100 MHz and minimal dc resistance.
- **Place** inductor L_{MATCH} and headphone connector together and as far from potential noise sources as possible to reduce capacitive and inductive coupling.
- **Place** the chip close to the headphone connector to minimize antenna trace length. Minimizing trace length reduces CP and the possibility for inductive and capacitive coupling into the antenna by noise sources. This recommendation must be followed for optimal device performance.
- **Select** ferrite beads F1-F2 with 2.5 kΩ or greater resistance at 100 MHz to maximize RSHUNT and, therefore, RP.
- **Place** ferrite beads F1-F2 close to the headphone connector.
- **Select** ESD diodes D1-D3 with minimum capacitance.
- **Place** ESD diodes D1-D3 as close as possible to the headphone connector for maximum effectiveness.
- **Place** optional RF shunt capacitors near the headphone amplifier's left and right audio output pins to reduce the level of digital noise passed to the antenna.

5. Whip Antenna for FM Receiver

A whip antenna is a typical monopole antenna.

5.1. FM Whip Antenna Design

A whip antenna is a monopole antenna with a stiff but flexible wire mounted vertically with one end adjacent to the ground plane.

There are various types of whip antennas including long non-telescopic metal whip antennas, telescopic metal whip antennas, and rubber whip antennas. Figure 13 shows the telescopic whip antenna.

Figure 13. Telescopic Whip Antennas

The whip antenna is capacitive, and its output capacitance depends on the length of the antenna (maximum length ~56 cm). At 56 cm length, the capacitance of the whip antenna ranges from 18 to 32 pF for the US FM band. The antenna capacitance is about 22 pF in the center of the US FM band (98 MHz).

5.2. FM Whip Antenna Schematic

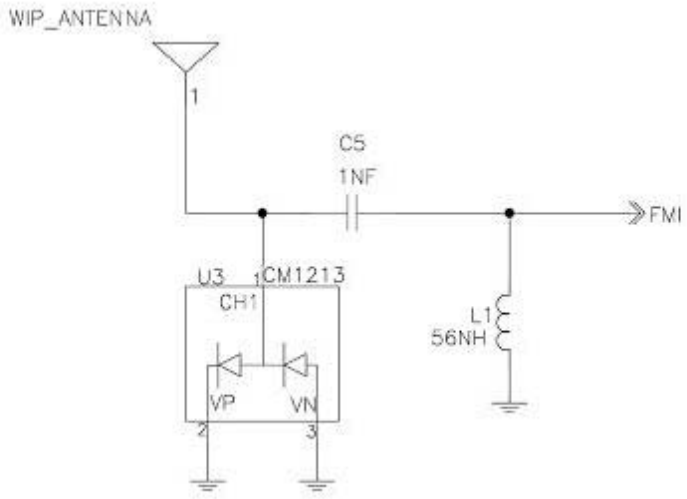


Figure 14. FM Whip Antenna Schematic

L1 (56 nH) is the matching inductor and it combines with the antenna impedance and the FMI impedance to resonate in the FM band.

C5 (1 nF) is the ac coupling cap going to the FMI pin.

U3 is a required ESD diode since the antenna is exposed. The diode should be chosen with no more than 1 pF parasitic capacitance, such as the California Micro Device CM1213.

5.3. FM Whip Antenna Bill of Materials

Table 13. FM Whip Antenna Bill of Materials

Designator	Description
WIP_ANTENNA	Whip Antenna
L1	Tuning Inductor, 0603, SM, 56 nH, MURATA, LQW18AN56nJ00D
C5	AC coupling capacitor, 1 nF, 10%, COG
U3	IC, SM, ESD DIODE, SOT23-3, California Micro Devices, CM1213-01ST

5.4. FM Whip Antenna Layout

Place the chip as close as possible to the whip antenna. This will minimize the trace length between the device and whip antenna which in turn will minimize parasitic capacitance and the possibility of noise coupling. Place inductor L1 and the antenna connector together and as far from potential noise sources as possible. Place the ac coupling capacitor C5 as close to the FMI pin as possible. Place ESD diode U3 as close as possible to the whip antenna input connector for maximum effectiveness.

5.5. FM Whip Antenna Design Checklist

- **Maximize** whip antenna length for optimal performance.
- **Select** matching inductor L1 with a Q of 15 or greater at 100 MHz and minimal dc resistance.
- **Select** L1 inductor value to maximize resonance gain from FM frequency (64 MHz) to FM frequency (109 MHz).
- **Place** L1 and whip antenna close together and as far from potential noise sources as possible to reduce capacitive and inductive coupling.
- **Place** the chip as close as possible to the whip antenna to minimize the antenna trace length. This reduces parasitic capacitance and hence reduces coupling into the antenna by noise sources. This recommendation must be followed for optimal device performance.
- **Place** ESD U3 as close as possible to the whip antenna for maximum effectiveness.
- **Select** ESD diode U3 with minimum capacitance.
- **Place** the ac coupling capacitor, C5, as close to the FMI pin as possible.

6. Ferrite Loop Antenna for AM Receive

There are two types of antennas that will work well for an AM receiver: a ferrite loop antenna or an air loop antenna. A ferrite loop antenna can be placed internally on the device or externally to the device with a wire connection. When the ferrite loop antenna is placed internally on the device, it is more susceptible to picking up any noise within the device. When the ferrite loop antenna is placed outside a device, e.g., at the end of an extension cable, it is less prone to device noise activity and may result in better AM reception.

6.1. Ferrite Loop Antenna Design

Figure 15 shows an example of ferrite loop antennas. The left figure is the standard size ferrite loop antenna. It is usually used in products with a lot of space, such as desktop radios. The right figure is the miniature size of the loop antenna. It is usually used in small products where space is at a premium, such as cell phones. If possible, use the standard size ferrite loop antenna as it has a better sensitivity than the miniature one.

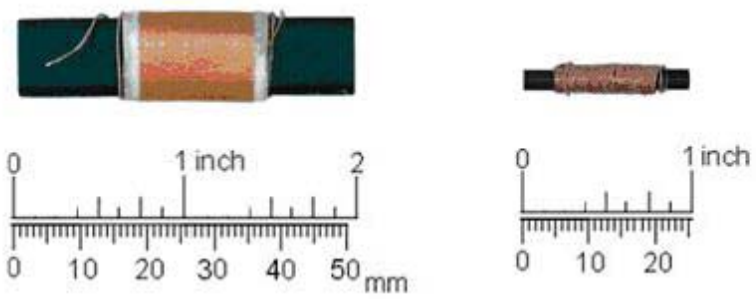


Figure 15. Standard and Miniature Ferrite Loop Antennas

A loop antenna with a ferrite inside should be designed such that the inductance of the ferrite loop is between 180 and 450 µH for the Si4822/26/27/40/44 AM Receiver.

Table 14 lists the recommended ferrite loop antenna for the Si4822/26/27/40/44 AM Receiver.

Table 14. Recommended Ferrite Loop Antenna

Part #	Diameter	Length	Turns	Ui	Type	Application
SL8X50MW70T	8 mm	50 mm	70	400	Mn-Zn	Desktop Radios
SL4X30MW100T	4 mm	30 mm	100	300	Ni-Zn	Portable Radios (MP3, Cell, GPS)
SL3X30MW105T	3 mm	30 mm	105	300	Ni-Zn	
SL3X25MW100T	3 mm	25 mm	110	300	Ni-An	
SL5X7X100MW70T	5 x 7 mm	100 mm	70	400	Mn-Zn	Desktop Radios

The following is the vendor information for the ferrite loop antennas:

Jiaxin Electronics

Shenzhen Sales Office

email: sales@firstantenna.com

Web: www.firstantenna.com

6.2. Ferrite Loop Antenna Schematic

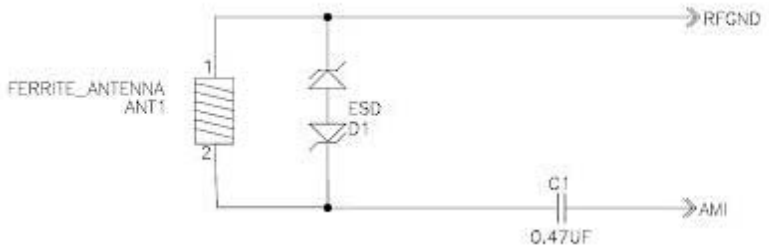


Figure 16. AM Ferrite Loop Antenna Schematic

C1 is the ac coupling cap going to the AMI pin and its value should be 0.47 µF.
D1 is an optional ESD diode if there is an exposed pad going to the AMI pin.

6.3. Ferrite Loop Antenna Bill of Materials

Table 15. Ferrite Loop Antenna Bill of Materials

Designator	Description	Note
ANT1	Ferrite loop antenna, 180~450 µH	
C1	AC coupling capacitor, 0.47 µF, 10%, Z5U/X7R	
D1	ESD diode, IC, SM, SOT23-3, California Micro Devices, CM1213-01ST	Optional; only needed if there is any exposed pad going to the AMI pin.

6.4. Ferrite Loop Antenna Layout

Place the chip as close as possible to the ferrite loop antenna feedline. This will minimize the trace going to the ferrite antenna, which in turn will minimize parasitic capacitance and also will minimize the possibility of noise sources coupling to the trace.

The placement of the AM antenna is critical, since AM is susceptible to noise sources causing interference in the AM band. Noise sources can come from clock signals, switching power supply, and digital activities (e.g., MCU). When the AM input is interfaced to a ferrite loop stick antenna, the placement of the ferrite loop stick antenna is critical to minimize inductive coupling. Place the ferrite loop stick antenna as far away from interference sources as possible. In particular, make sure the ferrite loop stick antenna is away from signals on the PCB and away from even the I/O signals of the chip. Do not route any signal under or near the ferrite loop stick. Route digital traces in between ground plane for best performance. If that is not possible, route digital traces on the opposite side of the chip. This will minimize capacitive coupling between the plane(s) and the antenna.

To tune correctly, the total capacitance seen at the AMI input needs to be minimized and kept under a certain value. The total acceptable capacitance depends on the inductance seen by the chip at its AM input. The acceptable capacitance at the AM input can be calculated using the formula shown in Equation 2

$$C_{Total} = \frac{1}{(2\pi f_{max})^2 L_{effective}}$$

Equation 2. Expected Total Capacitance at AMI

Where:

C_{Total} = Total capacitance at the AMI input

$L_{effective}$ = Effective inductance at the AMI input

f_{max} = Highest frequency in AM band

The total allowable capacitance, when interfacing a ferrite loop stick antenna, is the effective capacitance resulting from the AMI input pin, the capacitance from the PCB, and the capacitance from the ferrite loop stick antenna. The inductance seen at the AMI in this case is primarily the inductance of the ferrite loop stick antenna. The total allowable capacitance in the case of an air loop antenna is the effective capacitance resulting from the AMI input pin, the capacitance of the PCB, the capacitance of the transformer, and the capacitance of the air loop antenna. The inductance in this case should also take all the elements of the circuit into account. The input capacitance of the AMI input is 8 pF. The formula shown in Equation 2 gives a total capacitance of 28 pF when a 300 µH ferrite loop stick antenna is used for an AM band with 10 kHz spacing, where the highest frequency in the band is 1750 kHz.

6.5. Ferrite Loop Antenna Design Checklist

- **Place** the chip as close as possible to the ferrite loop antenna feedline to minimize parasitic capacitance and the possibility of noise coupling.
- **Place** the ferrite loop stick antenna away from any sources of interference and even away from the I/O signals of the chip. Please make sure that the AM antenna is as far away as possible from circuits that switch at a rate which falls in the AM band (504–1750 kHz).
- **Keep** the AM ferrite loop antenna at least 5 cm away from the tuner chip (recommended).
- **Place** optional component D1 if the antenna is exposed.
- **Select** ESD diode D1 with minimum capacitance.
- **Do Not Place** any ground plane under the ferrite loop stick antenna if the ferrite loop stick antenna is mounted on the PCB. The recommended ground separation is 1/4 inch or the width of the ferrite.
- **Route** traces from the ferrite loop stick connectors to the AMI input via the ac coupling cap C1 such that the capacitance from the traces and the pads is minimized.

7. Air Loop Antenna for AM

An air loop antenna is an external AM antenna (because of its large size) typically found on home audio equipment. An air loop antenna is placed external to the product enclosure making it more immune to system noise sources. It also will have a better sensitivity compared to a ferrite loop antenna.

7.1. Air Loop Antenna Design

Figure 17 shows an example of an air loop antenna.

Figure 17. Air Loop Antenna

Unlike a ferrite loop, an air loop antenna will have a smaller equivalent inductance because of the absence of ferrite material. A typical inductance is on the order of 10 to 20 µH. Therefore, in order to interface with the air loop antenna properly, a transformer is required to raise the inductance into the 180 to 450 µH range.

T1 is the transformer to raise the inductance to within 180 to 450 µH range. A simple formula to use is as follows:

$$L_{equivalent} = N^2 L_{AIRLOOP}$$

Equation 3.

Typically, a transformer with a turn ratio of 1:5 to 1:7 is good for an air loop antenna of 10 to 20 µH to bring the inductance within the 180 to 450 µH range.

Choose a high-Q transformer with a coupling coefficient as close to 1 as possible and use a multiple strands Litz wire for the transformer winding to reduce the skin effect. All of this will ensure that the transformer will be a low loss transformer.

Finally, consider using a shielded enclosure to house the transformer or a toroidal shape core to prevent noise pickup from interfering sources. A few recommended transformers are listed in Table 16.

Table 16. Recommended Transformers

	Transformer 1	Transformer 2	Transformer 3
Vendor	Jiaxin Electronics	UMEC	UMEC
Part Number	SL9x5x4MWTF1	TG-UTB01527S	TG-UTB01526
Type	Surface Mount	Surface Mount	Through Hole
Primary Coil Turns (L1)	12T	10T	10T
Secondary Coil Turns (L2)	70T	55T	58T
Wire Gauge	ULSA / 0.07 mm x 3	n/a	n/a
Inductance (L2)	380 µH ±10% @ 796 kHz	184 µH min, 245 µH typ @ 100 kHz	179 µH min, 263 µH typ @ 100 kHz
Q	130	50	75

The following is the vendor information for the above transformer:

Vendor #1:

Jiaxin Electronics

Shenzhen Sales Office

email: sales@firstantenna.com

Web: www.firstantenna.com

Vendor #2:

UMEC USA, Inc.

Website: www.umec-usa.com

www.umec.com.tw

7.2. Air Loop Antenna Schematic

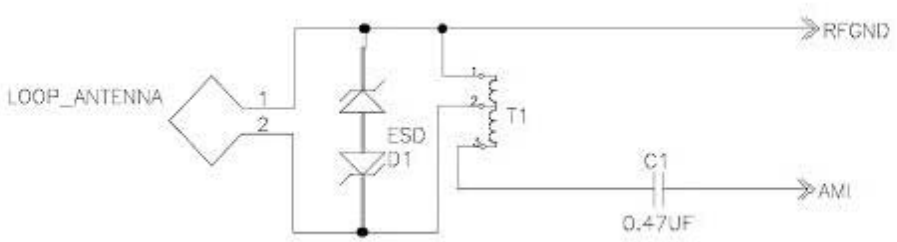


Figure 18. AM Air Loop Antenna Schematic

C1 is the ac coupling cap going to the AMI pin and its value should be 0.47 µF.

D1 is a required ESD diode since the antenna is exposed.

7.3. Air Loop Antenna Bill of Materials

Table 17. Air Loop Antenna Bill of Materials

Designator	Description
LOOP_ANTENNA	Air loop antenna
T1	Transformer, 1:6 turns ratio
C1	AC coupling capacitor, 0.47 µF, 10%, Z5U/X7R
D1	ESD diode, IC, SM, SOT23-3, California Micro Devices, CM1213-01ST

7.4. Air Loop Antenna Layout

Place the chip and the transformer as close as possible to the air loop antenna feedline. This will minimize the trace going to the air loop antenna, which in turn will minimize parasitic capacitance and the possibility of noise coupling.

When an air loop antenna with a transformer is used with the Si4822/26/27/40/44, minimize inductive coupling by making sure that the transformer is placed away from all sources of interference. Keep the transformer away from signals on the PCB and away from even the I/O signals of the Si4822/26/27/40/44. Do not route any signals under or near the transformer. Use a shielded transformer if possible.

7.5. Air Loop Antenna Design Checklist

- **Select** a shielded transformer or a toroidal shape transformer to prevent noise pickup from interfering sources
- **Select** a high-Q transformer with coupling coefficient as close to 1 as possible
- **Use** multiple strands Litz wire for the transformer winding
- **Place** the transformer away from any sources of interference and even away from the I/O signals of the chip. Ensure that the AM antenna is as far away as possible from circuits that switch at a rate which falls in the AM band (504 to 1750 kHz).
- **Route** traces from the transformer to the AMI input via the ac coupling cap C1 such that the capacitance from the traces and the pads is minimized.
- **Select** ESD diode D1 with minimum capacitance.

8. Whip Antenna for SW Receiver

SW reception usually uses whip antennas, the same as FM.

8.1. SW Whip Antenna Design

A whip antenna is a monopole antenna with a stiff but flexible wire mounted vertically with one end adjacent to the ground plane.

Figure 19 shows the telescopic whip antenna.

Figure 19. Telescopic Whip Antenna for SW

8.2. SW Whip Antenna Schematic

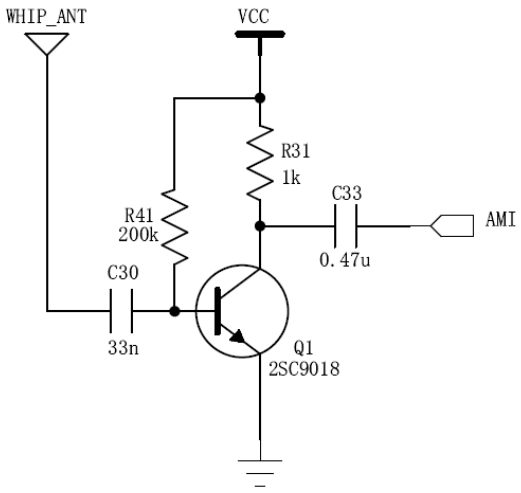


Figure 20. SW Whip Antenna Schematic

Q1 2SC9018 is a low noise RF transistor and it constitutes a LNA to amplify the SW signal coming from the whip antenna.

C30 (33 nF) is the ac coupling cap between whip antenna and LNA input.

C33 (0.47 µF) is the ac coupling cap going to the AMI pin.

R31, R41 are bias resistors of the transistor.

8.3. SW Whip Antenna Bill of Materials

Table 18. SW Whip Antenna Bill of Materials

Designator	Description
WHIP_ANTENNA	Whip Antenna
Q1	Low noise RF transistor, 2SC9018
C30	AC coupling capacitor, 33 nF, 10%, COG
C33	Coupling capacitor, 0.47 µF, ±20%, Z5U/X7R
R31	Resistor, 1 k, ±5%
R41	Resistor, 200 k, ±5%

8.4. SW Whip Antenna Layout

Place the chip and 2SC9018 as close as possible to the whip antenna feedline. This will minimize the trace going to the whip antenna, which in turn will minimize parasitic capacitance and also will minimize the possibility of noise sources coupling to the trace.

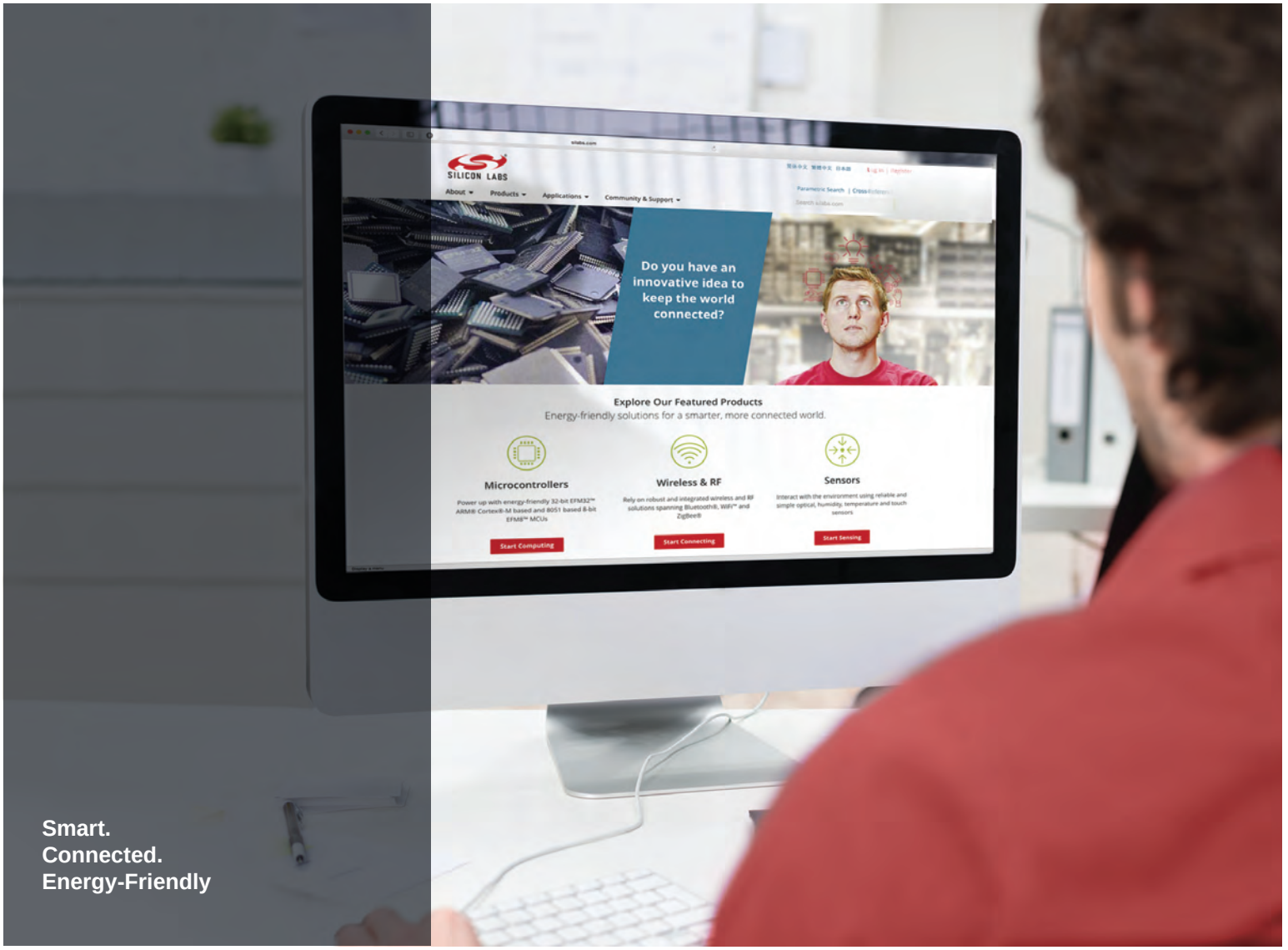
8.5. SW Whip Antenna Design Checklist

- **Maximize** whip antenna length for optimal performance.
- **Place** Q1 and whip antenna close together and as far from potential noise sources as possible to reduce capacitive and inductive coupling.
- **Place** the chip as close as possible to the whip antenna to minimize the antenna trace length. This reduces parasitic capacitance and hence reduces coupling into the antenna by noise sources. This recommendation must be followed for optimal device performance.
- **Place** the ac coupling capacitor C33, as close to the AMI pin as possible.

DOCUMENT CHANGE LIST

Revision 0.2 to Revision 0.3

- Updated "1.Introduction"
- Updated "2.Si4822/26/27/40/44 Default Frequency Band Definition and Selection"
- Added "3.5 Si4827 application circuit: Host MCU select radio band"
- Added "3.6 Si4827 application circuit: Slide switch select radio band"
- Added "Table10.Si44827 application circuit: Host MCU select radio band"
- Added "Table11. Si4827 application circuit: Slide switch select radio band"



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