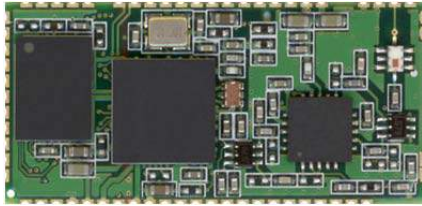
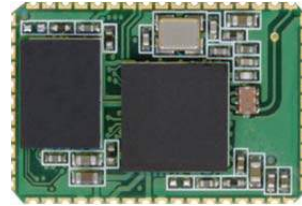


### Audio Modules

The Audio Modules are miniature printed circuit boards with edge castellations that allow both hand soldering and reflow soldering onto your circuit board. For layout assistance, you can download our *CadSoft Eagle Layout Editor* library file in the downloads section of our website.



KC-5190  
Class 1 Bluetooth Audio Hi Power Module



KC-5920  
Class 2 Bluetooth Audio Module

### Audio Evaluation Boards



BD-5190 Blue Demo Class 1 Hi Power Audio Board  
BD-5290 Blue Demo Class 2 Audio Board

Evaluation boards are highly recommended for use as a system prototype, for easy firmware updating during development, and as a performance benchmark for your development project.

### Differences between the KC-5190 and KC-5290

The KC-5190 is the longer range Class 1 Bluetooth Audio Hi Power Module, and the KC-5290 is the shorter range Class 2 Bluetooth Audio Module. The KC-5190 Hi Power module features an integrated Power Amplifier (PA) and Low Noise Amplifier (LNA) that amplifies both incoming and outgoing wireless signals. As specified by Bluetooth, class 1 signal amplification is dynamically controlled depending upon signal quality. Our class 1 module typically consumes twice as much power as our class 2 module. Because the LNA amplifies the signal from a weaker class 2 module, this can effectively extend the working range of a class 2 module when paired with one of our class 1 modules. Both modules have the same signal pins available except the class 1 module uses PIO\_0 and PIO\_1 internally for amplifier control.

### Firmware

The firmware comes in three editions: kcAudioAdapter, kcAudioGateway, kcAudioHeadset.

#### **kcAudioAdapter** (A2DP transmitter)

The kcAudioAdapter firmware streams high quality stereo audio to a headset. It is fully compatible as a Bluetooth A2DP "Source" device, and also supports AVRCP profile. The kcAudioAdapter will transmit the analog audio from the LIN and RIN input pins, or optionally, from the digital audio from the USB or PCM interfaces. The stereo signal is then compressed, segmented into Bluetooth packets, and transmitted wirelessly to the kcAudioHeadset.

#### **kcAudioGateway** (AGHFP transmitter)

The kcAudioGateway firmware provides two-way voice communications to a standard Bluetooth cell phone headset. It is fully compatible as a Bluetooth AGHFP device. The kcAudioGateway will transmit the analog mono audio from the LIN input pins, or optionally, as digital audio from the USB or PCM interfaces. The input signal is then compressed, segmented into Bluetooth packets, and transmitted wirelessly to a Bluetooth headset. Also, the microphone signal from the headset is received, and available through the LOUT output pins, or optionally as digital audio to USB or PCM.

#### **kcAudioHeadset** (A2DP and HFP receiver)

The kcAudioHeadset firmware will receive the wireless stereo signal, decompress, and convert to analog audio available on the LOUT and ROUT output pins. Optionally, the output can be directed to the USB or PCM interfaces. It is fully compatible as a Bluetooth A2DP "Sink" device, and simultaneously as a Bluetooth HSP cell phone "Mono Headset" device supporting HFP profile.

### KCAUDIO Custom Profile

Additionally, we have a custom, patent pending, profile we call KCAUDIO enabled by default. This profile is in addition to the standard Bluetooth profiles, and is included in both kcAudioAdapter and kcAudioHeadset firmware versions. Our patent pending KCAUDIO profile is a real time Stereo + Intercom communication system. There are two major features in the KCAUDIO profile that do not exist in standard Bluetooth A2DP.

Bluetooth V2.1+EDR does not have enough bandwidth for uncompressed stereo signals. The audio stream is compressed with either the Bluetooth default SBC (sub-band coding) codec, or our low latency audio codec when using our KCAUDIO profile. We designed KCAUDIO for real-time applications like gaming and television. KCAUDIO is about three times faster than SBC, and the entire system provides audio with around 45ms wireless delay, which is under the perception time for lip sync problems.

Second, we added a live intercom back channel. The kcAudioHeadset when connected using the KCAUDIO profile, will send the wireless microphone signal back to the kcAudioAdapter. Thus, a mono audio signal connected to the kcAudioHeadset LIN pin will be available on both LOUT and ROUT (dual mono) pins on the kcAudioAdapter.

KCAUDIO Stereo + Intercom profile is selected by default when connected to another KCAUDIO enabled device.

### Default kcAudioAdapter Behavior

Initially, the kcAudioAdapter will connect to any previously saved device (kcAudioHeadset, or Bluetooth A2DP Sink). If no devices are saved in memory, or none of the saved devices seem to be available, then the kcAudioAdapter will search for a new device, and attempt to connect with any discoverable A2DP device.

### Default kcAudioHeadset Behavior

Upon power up, the kcAudioHeadset will search for any previously paired kcAudioAdapters, A2DP transmitters, and cell phones, and attempt to connect with them. The kcAudioHeadset is only discoverable and available for new pairings upon powerup if there are no previously paired devices in memory. Otherwise, the kcAudioHeadset can be put into discoverable pairing mode manually by pressing and holding the BTB through power up. After a 7 second hold the kcAudioHeadset will enter discoverable mode, beep twice, and flash alternating red and blue light sequence.

The kcAudioHeadset can be connected to both a cell phone and either a kcAudioAdapter or A2DP stereo transmitter at the same time. If the cell phone receives a call, a ring tone will play in the headset. The call can be answered with quick press of the BTB button or rejected with long press. If the phone call is accepted, the kcAudioHeadset will signal a pause indicator to the A2DP stereo transmitter, and will switch modes from A2DP to HSP.

### Discovery, Pairing, and Connecting

Bluetooth devices must be paired upon initial connection with each other. Once paired, each device stores connection keys used to identify the units during future connection attempts. Usually, pairing is automatic during the initial connection, but sometimes security settings ask for passkeys or other pairing acknowledgement schemes, (e.g. computers or phones may request a key press to accept an incoming connection attempt).

Usually, the headset must be put into discoverable mode so that the other device can search and find it. The kcAudioHeadset goes into discoverable mode when the BTB is held for 7 seconds upon powerup, or automatically if there are no pairing keys for any other devices stored in memory. The kcAudioAdapter devices do not offer a discoverable mode by default. The kcAudioHeadset and kcAudioAdapter can reset all pairing information, usually by holding both the volume up and volume down buttons for 5 seconds. The unit will beep and flash red and blue LEDs together upon reset.

Once two devices have successfully paired, they can connect with each other as long as they are in a connectable mode, but do not need to be in discoverable mode.

### Pairing Problems

Devices may experience difficulties in pairing with each other. One common cause is that the stored pairing information has been reset on one device but not the other. In this case, either put the kcAudioHeadset into discoverable mode, and initiate a search from the kcAudioAdapter device to re-pair the two devices, or reset the paired device list on each device.

Other common causes are devices being in the incorrect mode, such as a remote device not in discoverable mode when searching for new devices, or a remote device already connected to a different device which makes it unavailable for new connections.





### Blue Demo Audio Board Interface



#### Dip Switch Settings

	OFF	ON
1	Mic Bias Off	Mic Bias On
2	Normal	BTB Hold On (Re-programming)
3	Battery Power Off	Battery Power On

#### Buttons

	Button	Name	Pin
1		BTB	1V8_EN
2		AUX	PIO 4
3		VOLUP	PIO 5
4		VOLDN	PIO 6

Feature	Adapter	Gateway	Headset	Button Action
Power On	✓	✓	✓	Hold BTB 2.5 sec when off
Power Off	✓	✓	✓	Hold BTB 2.5 sec when on
Connect Last	✓	✓		Press BTB
Connect Last			✓	Hold BTB 1 sec
Search & Connect	✓	✓		Hold BTB 1 sec
Discoverable			✓	Hold BTB 5 sec during power up
Volume Up	✓	✓	✓	Press VOLUP, hold for repeat
Volume Down	✓	✓	✓	Press VOLDN, hold for repeat
Input Gain Up	✓	✓	✓	Double press VOLUP
Input Gain Down	✓	✓	✓	Double press VOLDN
Reset Pairing	✓	✓	✓	Hold VOLUP and VOLDN 2 sec
Audio Loopback	✓	✓	✓	Press TEST
Audio Test Tone	✓	✓	✓	Double TEST
Push-To-Talk	✓	✓	✓	PIO 2 PTT status. Headset input, Adapter output
Drop A2DP Link			✓	Double BTB drops the A2DP link from dual profile phone pairings
Answer Call			✓	Press BTB during incoming call
Reject Call			✓	Hold BTB 1 sec during incoming call
Audio Link Indicator	✓	✓		PIO 7 Output High when audio channel is streaming
Connection Indicator	✓	✓		PIO 8 Output High when connected
Audio Link Up		✓		PIO 9 Low connects the audio channel
Audio Link Down		✓		PIO 9 High disconnects the audio channel
Mute Remote Mic		✓		PIO 10 High mutes the remote mic output
Mute Local Mic		✓		PIO 11 High mutes the local mic input

Note: some firmware builds may vary functions, features, and button assignments.

### LED Event and State Indicators

Event	LED Action	Specific
Powering On	Solid Blue	1s on
Powering off	Solid Red	1s on
Discoverable	Fast Alt Red Blue Blink	60ms on, 60ms off
Connectable	Slow Double Blue Blink	80ms on/off/on, 1200ms off
Connected	Blue Blip	40ms on, 2300ms off
Connecting to headset	Fast Blue Blink	
Searching for new headset	Blue Red Blue Blink	
Reset pairing	Triple Red+Blue Flash	Press VOLDN, hold for repeat

### Firmware Updates

Firmware can be updated via the USB or SPI ports. By default, the SPI is used for updates. The SPI port is the most comprehensive interface, offering full factory firmware loading and development tool access. However, the SPI interface requires a parallel port, adapter, and level shifter.

### Device Firmware Upgrade via USB

- Install BlueSuite tools. [http://www.kcwirefree.com/docs/InstallBlueSuite2\\_4.zip](http://www.kcwirefree.com/docs/InstallBlueSuite2_4.zip)
- Connect PC USB cable to BlueDemo board or module.
- Start BlueDemo board.
- Press and hold the Test button on BlueDemo board (PIO 4) for 8 seconds to force firmware update mode.
- Computer will indicate new device found.
- Device is unlikely to automatically install with correct driver.
- Open Device Manager, find new device.
- Right click "Update Driver Software".
- Select "Browse my computer for driver software".
- Select "Let me pick from a list of device drivers on my computer".
- Select "Have Disk".
- Browse to find CSRBlueCoreUSB.inf file. Normally found in /BlueSuite/drivers directory.
- Launch DFUWizard.exe application within the BlueSuite tools.
- Select Connection Type USB.
- Find KC Wirefree DFU file (such as kcAudioAdapter\_5290\_v6.2.011.dfu).
- Start DFU procedure.
- Reset.

### Firmware Source Code

This is the most closely guarded secret at KC Wirefree. It is our secret recipe (source code) that allows KC Wirefree Bluetooth devices to have custom features and perform better than any other Bluetooth module vendor. Additionally, the code is quite complicated and development tools are expensive, so we offer our expert programming services for any changes or additions that you would want. We are a specialty systems programming company who have added many proprietary features and improved many standard features for overall system quality and performance. We have tweaked the Bluetooth and device firmware source code extensively. Sometimes little features and changes can greatly increase the value of your device. For custom features and capabilities, please contact us.

### Hardware features

- The KC5190/5290 Audio Modules use the "Best in Class" CSR BlueCore 5 Multimedia External Bluetooth chip.
- Bluetooth v2.1+EDR
- 2 channels of differential audio input. Mono channel use the left input.
- 2 channels of differential audio output. Mono channel is on both left and right outputs.
- Firmware adjustable analog and digital gain blocks on the inputs.
- Firmware adjustable analog and digital gain blocks on the outputs.
- Programmable microcontroller for Bluetooth and firmware operations.
- Programmable DSP for high end audio processing, compression, filters, and features.
- 16Mbit reprogrammable flash memory for firmware and storage.
- A high quality, 16bit stereo, 44.1kHz, ADC codec.
- A high quality, 16bit stereo, 48kHz, DAC codec.
- Dual 2nd order hardware based IIR filters for low pass, high pass, or band pass audio filtering.
- Li-ion battery charger onboard.
- 1.8V step down, switching regulator onboard.
- The KC5190 has both an RF Power Amplifier (transmitting) and an RF Low Noise Amplifier (receiving).
- 2 open drain LED driver pins for simple LED circuits.
- 2 analog I/O pins (separate from the stereo inputs)
- 12 digital I/O pins on the KC5190, and 14 digital I/O pins on the KC5290
- PCM interface. Used for auxiliary audio IO.
- UART interface. Used for firmware updates.
- USB interface. Can be used for firmware updates. Optionally available for audio in/out connections.
- SPI interface. Used for testing tools, and firmware loading.
- A configurable microphone bias pin for optimal performance.

### RF range

Up to 250m between two Class 1 modules.

Up to 25m between two Class 2 modules.

Also, because KC Wirefree class 1 audio modules amplify both incoming and outgoing radio signals, a Class 1 module can slightly extend the useful range when paired with a Class 2 device.

Of course actual wireless range depends on many factors including other 2.4GHz wireless data traffic, physical barriers (walls) and reflectors (metal), and tolerance for audio packet dropouts at extreme ranges.

### Circuit design services

We have many years of experience making wireless audio circuit boards. We can provide fully tested and guaranteed turnkey systems.

### Power supply requirements

Modules require a clean, noise free +3.3V regulated power supply. You may also attach a lithium battery, which can be charged with an external power supply or USB bus (please see schematic for more details).

Also, a clean, noise free +1.8V regulated power supply is required. The onboard 1V8 regulator which is supplied by the BAT\_P input pin is enabled by a HIGH signal on the REG\_EN pin. By default, kcAudio firmware editions implement a soft power button, which provides battery voltage to the REG\_EN pin when pressed. Upon power up, the 1V8 regulator will latch up internally, and then receive standard button press signals on the REG\_EN pin. A 5 sec HIGH on the REG\_EN pin will power down the firmware and device. The 1V8 output voltage requires a low ESR inductor and a 4.7 $\mu$ F bypass capacitor (we use Taiyo Yuden LBR2012T220K and Kemet C0603C475K9PACTU on our evaluation boards). Alternatively, the 1V8 onboard regulator is not required, but a clean, low noise, external 1V8 source may be used instead.

### Onboard battery charger

The battery charge supply pin is VDD\_CHG which accepts a 4.5V to 6.5V input with a 4.7 $\mu$ F bypass capacitor for stability, and will provide the power needed to charge the battery. Then, the battery must be connected to the BAT\_P pin with a 10 $\mu$ F bypass capacitor for stability. Finally, the battery voltage must be monitored using the AIO\_0 pin, via a voltage divider network, in order for the firmware to regulate the charging cycles. Of course, the module must be ON (but not necessarily wirelessly connected), in order to provide the charge cycle.

### Reset pin

The Reset pin is pulled HIGH internally.



### Antenna circuit

The KC5190 and KC5290 already have a 50Ω matching balun filter, so many layouts can simply run a 50Ω RF transmission trace directly to an onboard chip antenna, or to an SMA style antenna connector. Transmission line trace dimensions for your PCB can be calculated here: [http://www.emclabinfo.com/emc\\_calc/microstrip.htm](http://www.emclabinfo.com/emc_calc/microstrip.htm)

The following antennas are compliant to our FCC grant, and are recommended: Johanson 2450AT18B100E, Johanson 2450AT43A100E, Antenova 3030A5839-01, ¼ wave wire monopole antenna.

### FCC qualification

Many devices can be eligible to use our existing FCC Limited Modular Approval without any additional testing or certifications from FCC. We will need to verify compliance, and you will need a written agreement with KC Wirefree in order to use our FCC ID on your product.

### Bluetooth SIG qualification

Most of our Modules are registered with Bluetooth as Qualified Designs. Bluetooth SIG is currently offering a free membership level, and free product listings when incorporating previously Qualified Design devices (such as our Modules) into your product. So, free Bluetooth licenses may likely be available, or it may exceed \$10,000 for a Bluetooth registration.

### Separate digital and analog sections

Digital IC's create audible noises, so it is necessary to separate digital and analog ground and signal areas. Avoid crossing digital signal lines over the analog ground section, and vice versa. Connect digital and analog ground planes together at a single point, preferably away from digital noise sources. Audio signal lines like to be insulated by noise free analog ground planes.

### Input gain

The input gain is adjustable from -3dB to 18dB in 3dB increments. Also, a 24dB mic boost is available. So total input gain range is -3dB to 42dB.

### Input level

The inputs on the Audio module can only tolerate a maximum of 0.4Vrms. So a simple 4:1 voltage dividing input circuit is recommended to prevent clipping and distortion from line level signals. Use good quality 1% resistors for the divider circuit.

### Microphone interface

When the microphone feeds into the audio module, it always attached to the left microphone input. The BlueCore5 chip has differential inputs, so you can wire in the microphone element differentially, or you can do it as shown in the attached schematic. (NOTE: A differential input will improve the power supply rejection ratio (PSRR) as compared to a single ended input.

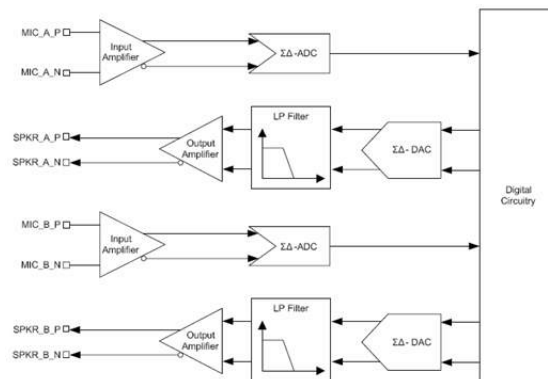
Also note certain microphones have different bias requirements, there is a MIC BIAS pin that that is fed from a low noise voltage regulator, which has software adjustable voltage and current levels, talk to KC Wirefree if you need these levels optimized for your particular microphone element. Otherwise, if you supply your own microphone bias, then you can leave this pin unconnected.

### Audio sampling rate

In the standard audio firmware, kcAudioAdapter digitally samples the analog stereo signal at 44.1kHz, while kcAudioHeadset samples the microphone signal at 11.025kHz for Stereo+Intercom connections. For kcAudioGateway and kcAudioHeadset HFP connections, the Bluetooth standard 8kHz sampling rate is used.

### Output gain

The output gain is also adjustable with both a digital and analog gain block. The analog gain block provides -18dB to +3dB in 3dB steps, while the digital gain block provides -24dB to +21.5dB in 2.5dB steps. The total output gain adjustment is -42dB to +24.5dB.



### Output level

The stereo audio outputs are suitable for directly driving line level audio and headset speakers, so an amplifier may be necessary for larger speaker applications. The stereo audio outputs can adequately drive 32Ω speakers differentially without AC coupling. However, we recommend using an external audio power amplifier IC for best performance. The output signal loses 3dB when using a single ended output design (common ground) instead of the differential output.

### User Guide Versions

Version	Changes
Feb 9, 2010	Draft Version
Aug 5, 2010	Many updates
Sep 23, 2010	Firmware v6.1 operating instructions update
Feb 01, 2012	Added Firmware upgrade instructions, update

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