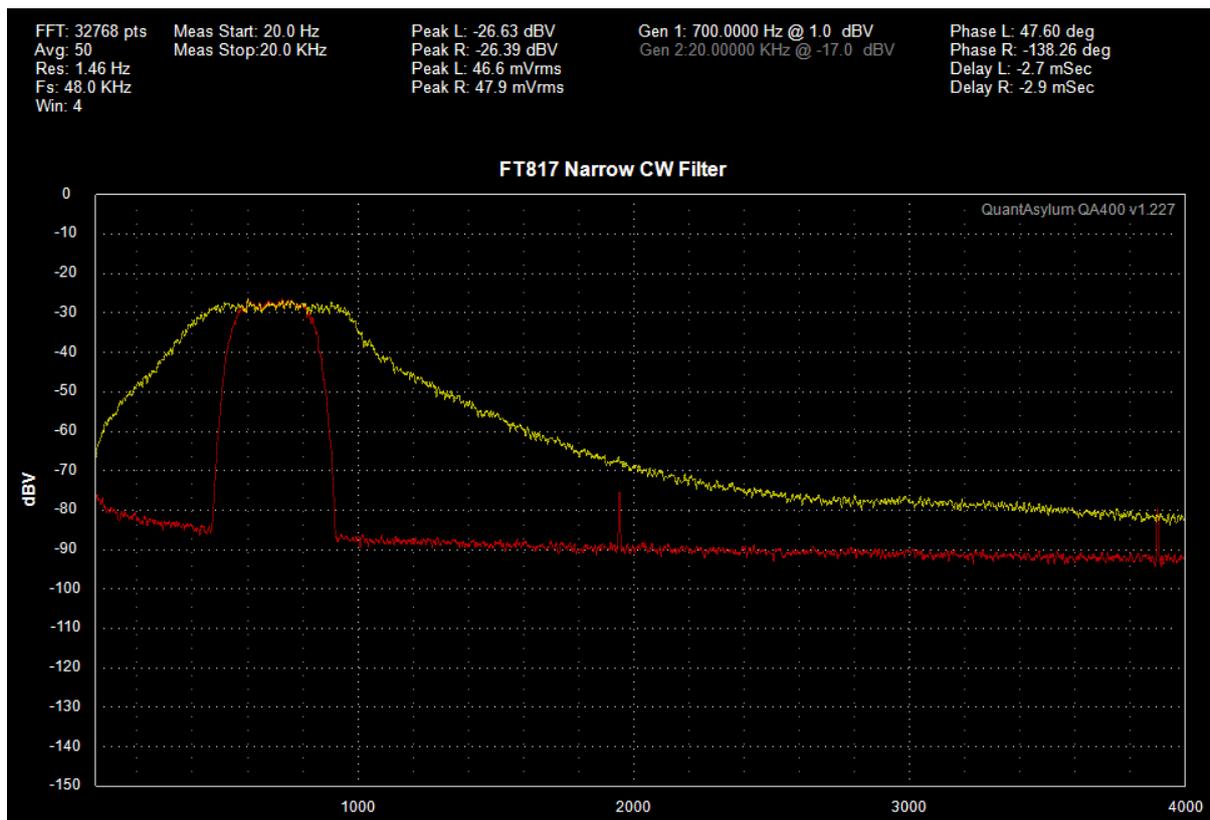


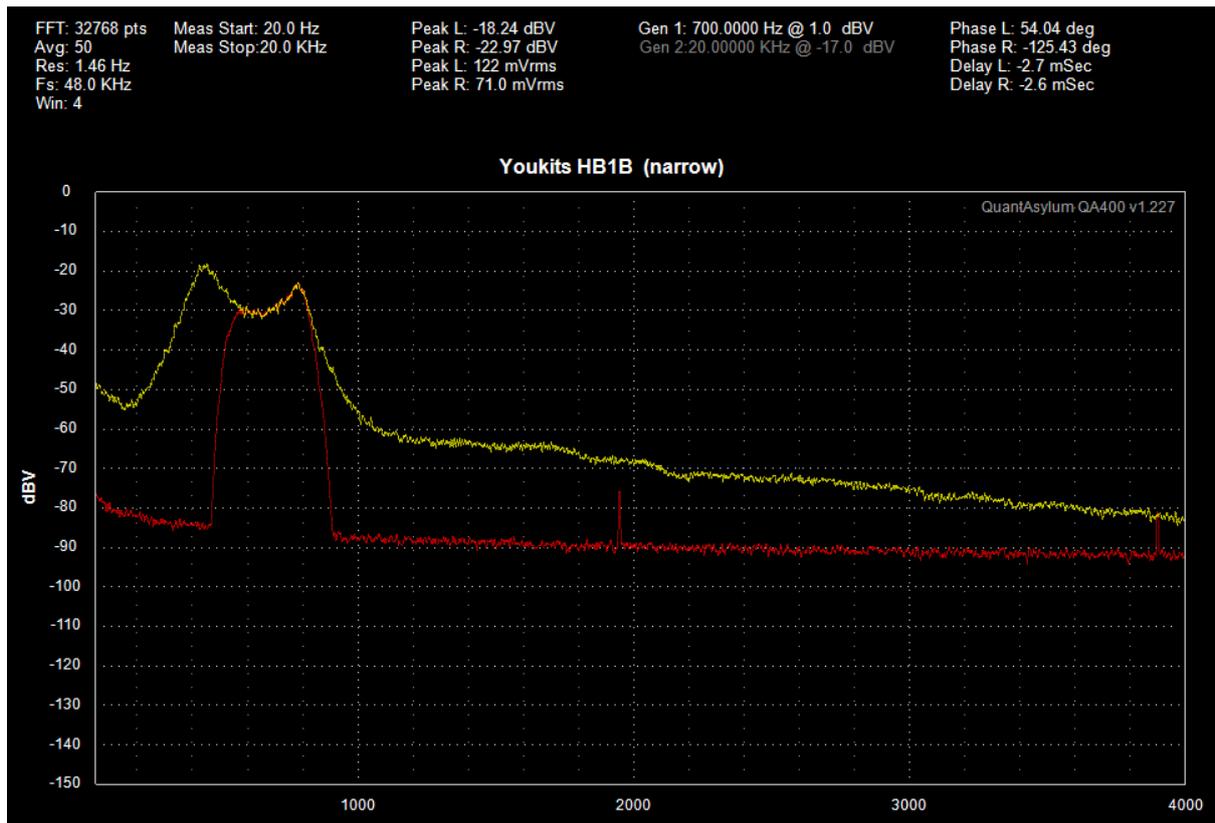
## Laserbeam Filter Module

The SOTABEAMS Laserbeam Filter module has been designed to be very easy to use. The clever bit is the software! Each module has two selectable high-performance filters. The filters are far superior to any filter that can be implemented using analogue means (e.g. op-amp or switched capacitor filters). They have a **flatter pass-band**, **better stop-band** and **superior shape factor**. Because they only draw 25mA they are suitable for portable radio equipment. As their performance is so good, they can even significantly improve radios that already have a CW filter fitted! The following diagrams show how a Laserbeam Filter will improve the performance of two popular portable transceivers. They have been made by injecting a noise signal into the front-end of the radio and measuring the resulting averaged audio output, before (yellow) and after (red) a Laserbeam Filter. Thus, the yellow trace shows the filter in the radio itself, while the red trace shows the huge improvement given by a Laserbeam Filter.

Our tests have shown that they even improve some transceivers with built-in DSP because our DSP processor is superior to the sort used in some ham radios.



Stock FT-817 CW filter in yellow; Laserbeam Filter in red (actual measurements – not simulations)



**HB1B on narrowest setting in yellow; Laserbeam Filter in red (actual measurements - not simulations)**

The Laserbeam modules can either be incorporated in your existing radio or used as an outboard filter. They have enough output to drive sensitive ear-buds directly, or to drive a small amplifier for use with a speaker.

## Using your module – a pin by pin account

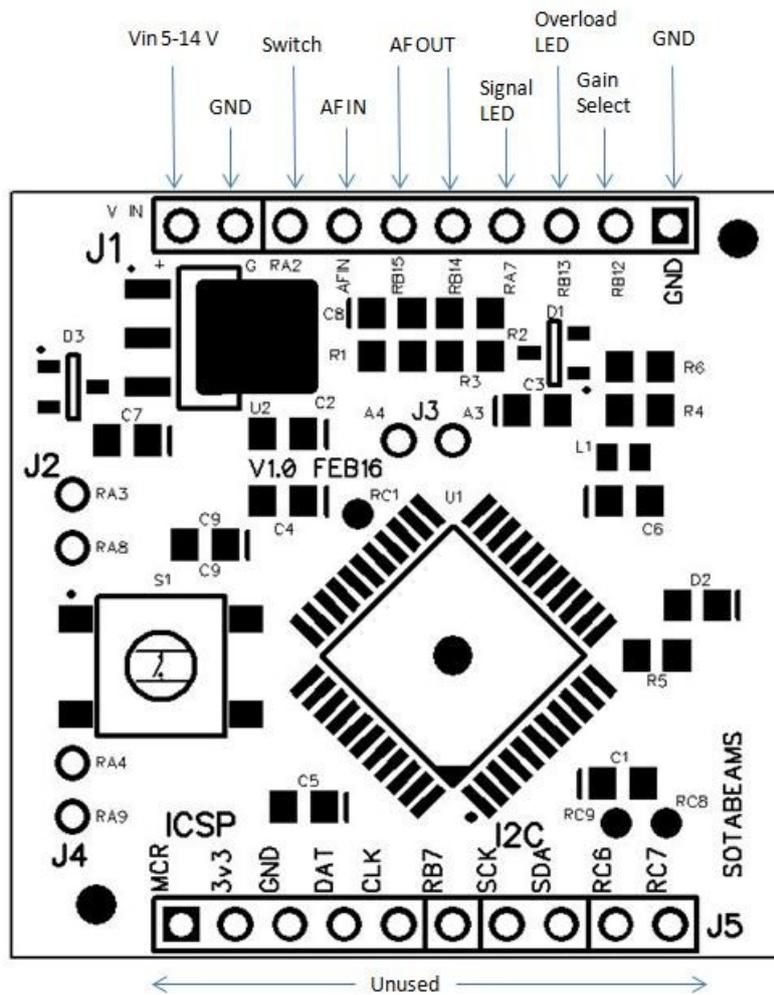
Connector J1 is the user interface. The other connectors are reserved for future use and must be left unconnected.

J1 is numbered starting from the square pad – marked GND. You can either solder a strip of standard header pins (not supplied) into J1 or solder wires directly to it.

Pin	Designation	Comment
1	GND	Ground. Try to use a single ground point for all circuits.
2	RB12	Voltage Gain. Leave open for Voltage gain = 1 (recommended for most applications), connect to ground for Voltage gain = 4.  Note this setting does not affect the maximum output level, it just sets the size of input signal needed to achieve full output.
3	RB13	Overload LED. Suggested connection: LED to ground with 330 Ohm series resistor.  This optional LED is used to help you get the best input levels for using your Laserbeam Filter. Adjust input to just below the point where the LED lights on signal peaks. This LED is optional.  A second Overload LED is mounted on the PCB. Occasional lighting of the LED while the filter is in use is acceptable.
4	RA7	Signal LED (only on boards with CW filter options). Suggested connection: LED to ground with 330 Ohm series resistor.
5	RB14	AF Out 1. DC coupled differential output, used in conjunction with AF Out 2. If driving earbuds connect AF Out 1 to the left earpiece pin and AF Out 2 to the right earpiece pin. Leave the ground on the earbuds floating.  One output can be used for single input amplifiers. Maximum output approx 1.2 V pk-pk.  Most audio ICs (e.g. LM380N, LM386, TBA820 etc.) can be used as differential amplifiers. In general using both outputs as a differential pair will give best results.  Note: the output signal is not centred on ground. Depending on what you connect it to, you may need to add a series capacitor to block the DC voltage that the signal is centred on.
6	RB15	AF Out 2. See above.
7	AF IN	Single ended audio input. 2.4V pk-pk max. Input is AC coupled and is protected from excessive levels.
8	RA2	Wide-Narrow switch. SPST switch to ground. Open = wide, closed = narrow.

9	G	Ground. This pin is connected internally to pin 1.
10	V IN	+5 - 15 Volts DC @ 25mA (for modules made in Dec 2020 and later) +5 - 15 Volts DC @ 30mA (for older modules)

### SOTABEAMS FILTER PCB



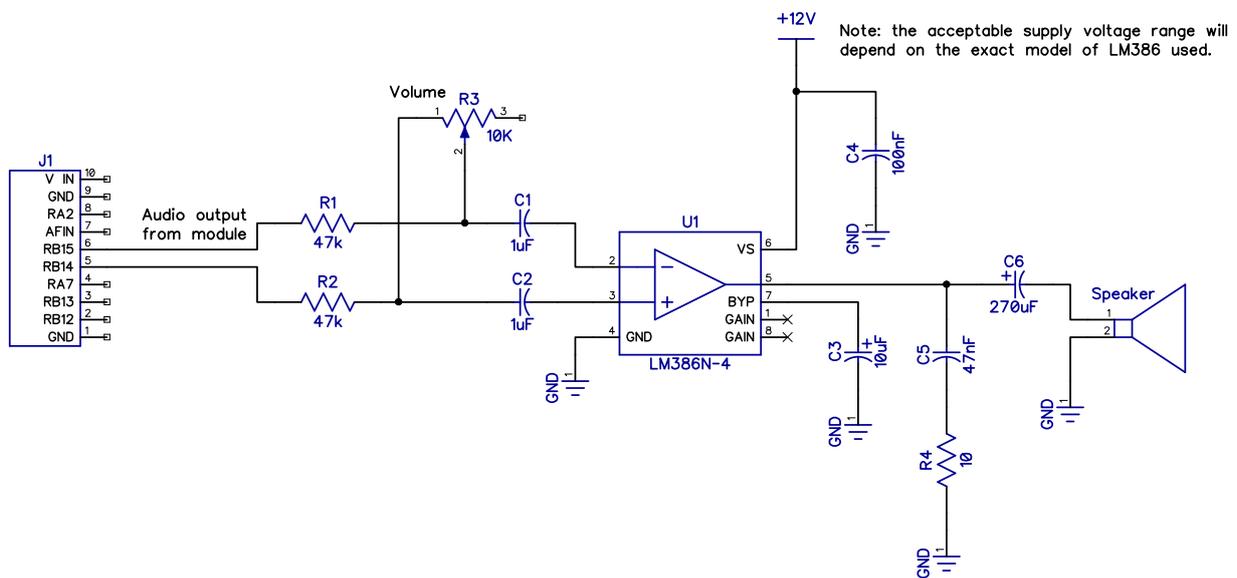
## Typical Applications

The Laserbeam filter board will provide sufficient output to drive sensitive earbuds directly. The levels are adequate for operating in a quiet environment.

The Laserbeam filter has a differential output. Almost all audio amplifier ICs are suitable for a differential input, although many pre-made amplifier modules do not connect them up in that way and only allow a single-ended input.

### Amplifier

A possible amplifier circuit with differential input is shown below.

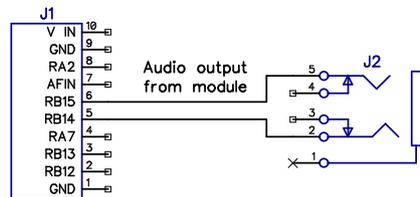


### Direct connection

A direct connection (without an amplifier) is only suitable for devices which are sensitive enough, such as earbuds.

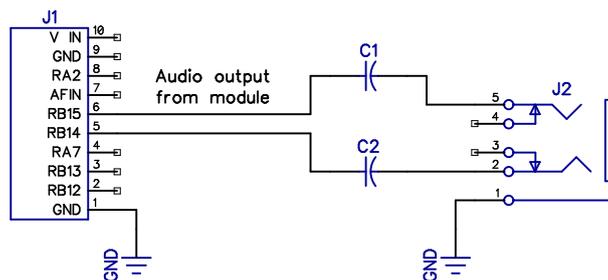
The sensitivity of earbuds or headphones is how efficient they are at translating electrical power into acoustic power. Devices that are more sensitive can produce sounds that are still loud enough for you to hear from smaller electrical signals than less sensitive devices, meaning no amplifier needed for the Laserbeam module.

If the connected device can be isolated from ground (which will be the case for earbuds and most headphones), then you do not need to add any extra capacitors. Note: when leaving out capacitors, it is important that the sleeve contact of the audio socket (pin 1 of the audio socket in the diagram below) is left floating – it should not be connected to anything.



Note: only suitable for driving earbuds or similar.

If that is not possible (for example, if connecting to a powered speaker, or to an existing socket where you can't easily disconnect the sleeve contact from ground), you will need to add DC blocking capacitors to RB14 and RB15. This is necessary because the signals from RB14 and RB15 are not centred on ground.



## FAQ

### What are all the other pins on the PCB for?

These pins are used for future products. They must all be left open (ungrounded).

### Can I program my own filters?

Yes, but beware! We have brought out the ICSP pins to J5. Our code is protected and to reprogram the board you will need to erase our code. If you do this you are on your own. We will not provide the code to enable you to reinstall the filters. We may be able to reprogram a board if you return it to us. A charge will apply – check before sending a board in.