

SE2000+

High performance FM stereo encoder with digital audio input (U+)

Manual

IMPORTANT NOTE

Upon receiving your order inspect the packaging material and unit for apparent damage. Any damage should be reported immediately so we can make a claim with the shipping company. Take photos, if you can, they can be used as a proof.

Mains cable is typically not included with our mains power supplies and units. Since these cables vary from country to country and we had trouble finding the exact type we decided against including them, especially since finding them is so easy and cheap locally. They can be obtained in any radio/computer/hardware shop at the cost of about 1 US\$. It is the type used in your PC for mains power.

Study local regulations and ensure you are operating in compliance.

Never ever operate any transmitter or amplifier without a properly tuned antenna!

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Introducing the SE2000+ stereo encoder

Now with digital audio input (U+) for completely noise-free audio experience

The new SE2000 is a high performance stereo encoder with split supply rails (via on-board DC/DC), analog balanced input buffers, a fairly complex and incredibly sharp filter with deep notch at 19KHz, preemphasis, limiter and LC MPX filter. Digital subsystem generates 19KHz pilot (32xoversampling) and generate DSB signal. This unit brings crisp stereo sound with incredible stereo separation to the lovers of analog technology. You never thought analog audio filters could be this sharp, but they are; thanks to elaborate filter design. You really have to hear it to believe it. SE2000 AN+ can even be upgraded to RDS functionality simply by plugging-in a RDS daughter board. It is perfect for a demanding, but cost-conscious broadcaster.

SE2000+ will make sure your signal stays where you want it, providing high quality audio with excellent channel separation without causing interference to nearby channels. High quality components and printed circuit board assure 24/7 operation for years. In this manual you will find all of its exciting secrets.

Why is SE2000+ so great?

- Perfect for any mono FM transmitter, several output levels can be selected with jumpers
- Mix of analog/digital technology produces crisp natural sounding audio
- When digital audio input is used you can enjoy completely noise-free audio. Ground loops are gone. You have to hear it to believe it. You can now stream audio digitally directly from your PC/Laptop.
- Extremely sharp 15kHz low pass filters and a very deep notch at 19KHz!
- Drop-in replacement for SE3 and SE4000/5000 DSP+!
- Does not require LCD module, but can be connected to LCD module of our exciters for stereo/mono control!
- Balanced or unbalanced audio inputs. This effectively eliminates annoying ground loops and hum.
- LC filtered MPX output signal.
- Built-in limiter, low pass filter and true compressor.
- Very good stereo separation
- Support for RDS daughter board for easy upgrade to RDS
- MPXin/MPXout jumper added for professional setups
- VU meter 3-pin jumper for easy upgrade to VU-meter
- ECPD technology (Extremely Cute PCB Design; you've got to admit, it's a beauty)
- All SMD design, machine placed, washed in ultrasound bath, professionally looking.

Technical specifications:

Audio Response: 10Hz-15KHz, 15kHz lowpass filtered (standards require upper level at 15KHz max)

19KHz notch filter, >-60 dB typ

Precise pre-emphasis, 50uS, 75uS or none

Audio Input Impedance: 10K, balanced or unbalanced

Audio Input Level: 0 dB

Digital audio input: USB connector, Windows/Linux compatible

Distortion: <0.01%

S/N ratio: >85 dB

Separation: >65 dB typ. (more than any radio receiver you can buy on the market)

Pilot Frequency: 19 KHz, DSP generated with 32x oversampling

Output Impedance: 75 Ohms

Power Requirements: 12-15VDC / 160-200mA

PC Board Size: 100x85mm

Audio connectors: all RCA jacks are mounted on the board, 3-pin jumper for XLR balanced input

Power connector: 2.1mm power socket, center is positive, connection terminals (easier for boxed units)

Output level: Ueff 4V, 2V or 1V

How is SE2000+ better than previous versions?

- Added digital audio input
- Fixed several small issues, such as pilot level, pilot adjustment trimmer etc
- Improved on-board DC/DC converter

Thank you for purchasing SE2000+ stereo encoder

We hope you will enjoy it as much as we do and if you do remember to tell your friends and colleagues about it. Please feel free to leave your comments at our website or post your experience in our forum. And if you encounter a problem please let us know so that we may improve our products, offer advice and suggestion. From all of us we wish you happy broadcasting!

Your PCS Electronics team

SE2000+ board layout

Board layout

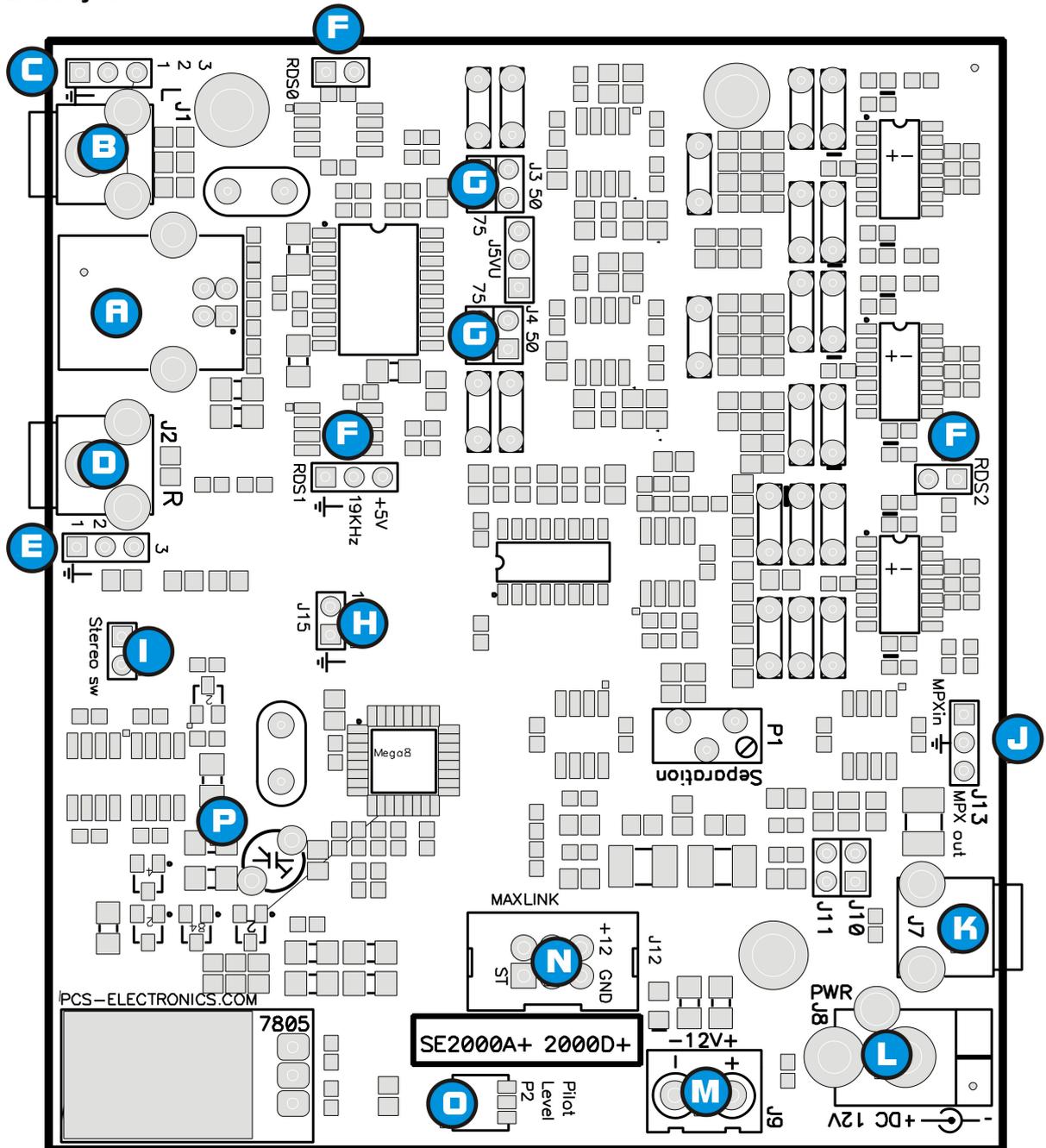


Fig. 1: SE2000+ board layout

Ref.	Function
A	Digital audio input, USB
B,C	Left analog audio input, RCA + XLR header
D,E	Right analog audio input, RCA + XLR header
F	Pins for RDS daughter board, optional
G	Pre-emphasis. Use these two jumpers to set pre-emphasis. This can either be 50uS (EU and most of the world) or 75uS (USA). If you do not install jumper there will be no pre-emphasis.
H	19KHz pilot is available here, 0-5V square signal
I	Mono-stereo selection jumper. If you want to control this from FM exciter via Maxlink flat cable, do not install this jumper.
J	MPX in/MPX out header. You can connect two BNC connectors here and place them at the back of your transmitter.
K	MPX output, connect FM exciter here.
L, M	Power supply, 12-15V DC, 100mA max, stabilized
N	Maxlink connector. If you are using MAXPRO series of FM exciters, connect this to the RF board via flat cable. This cable will also provide supply voltage so you do not need to connect anything to L or M.
O	19KHz pilot level adjustment.
P	Optional, pilot fine adjustment.
J5V U	You can connect VUMAX-1 led vu-meter unit here, it will show audio levels as bar graphs. The 2 remaining bar graphs can be connected to FM exciter to show power and SWR.

Table 1: Description of various elements of the SE2000+ stereo encoder board

Drill template

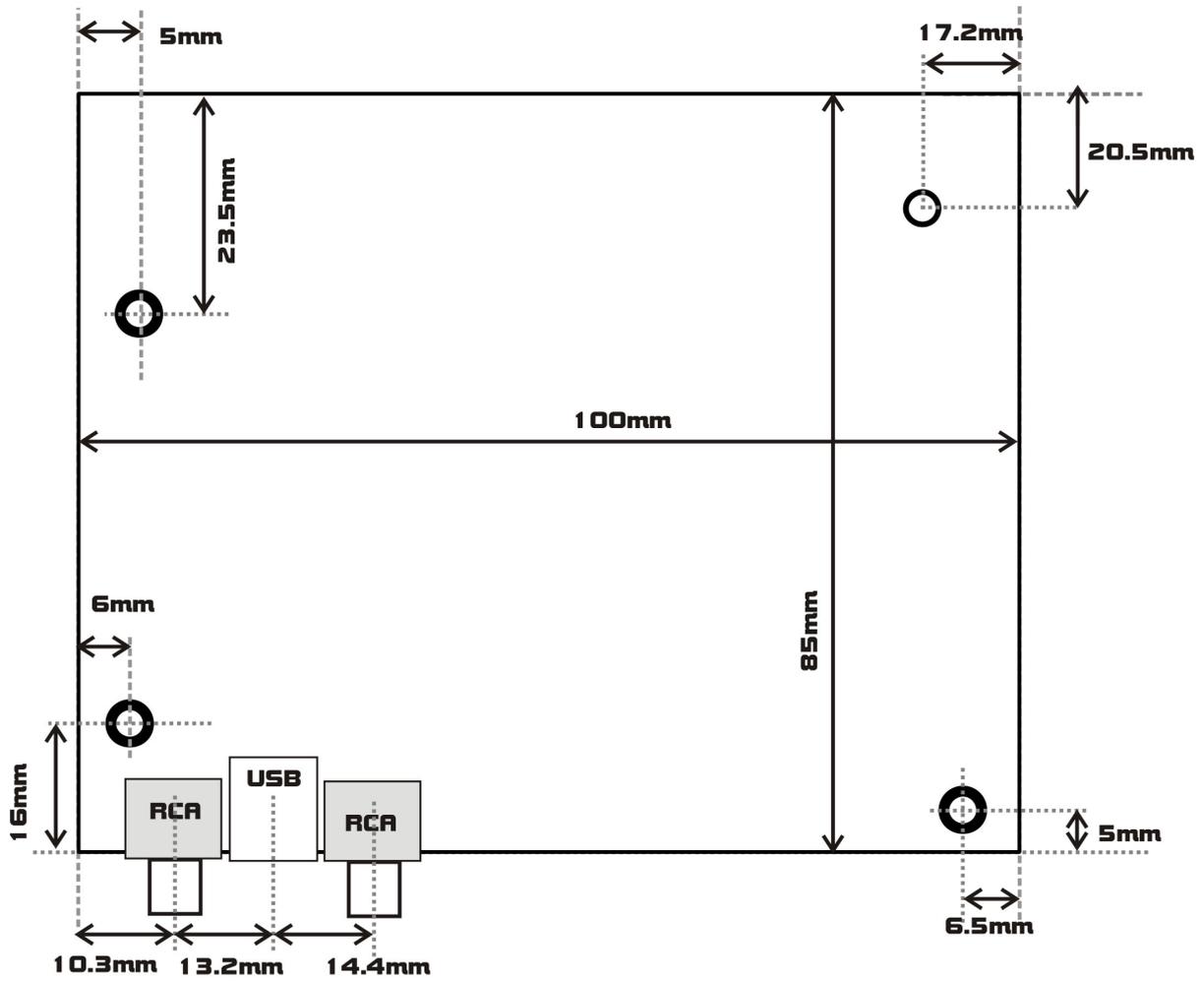


Fig. 2: Stereo encoder drill template, all measurements in mm, all holes are for M3 metric screws. Board is usually mounted with distancers about 10mm high. Place metal distancer under 7805 to allow some heatsinking.

What's under the hood?

INTRODUCTION - PRINCIPLES OF OPERATION

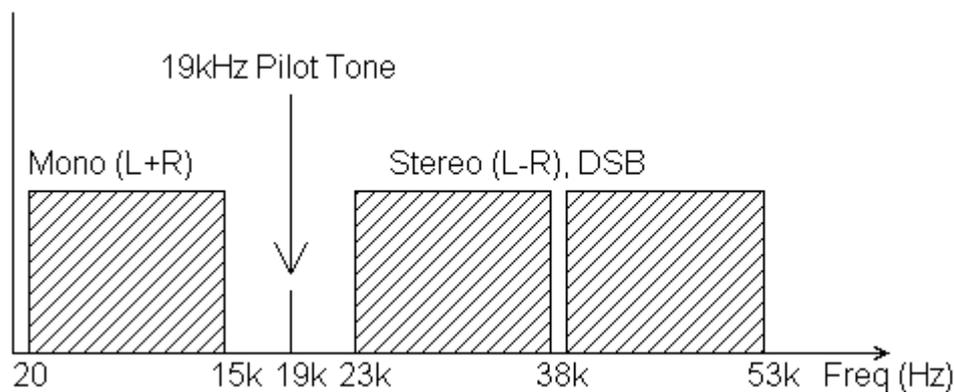


Fig. 3: Theoretical frequency spectrum of the stereo multiplexed signal

Figure 3 above shows the theoretical frequency spectrum of the stereo multiplex signal (MPX-signal). The MONO signal on the far left goes from approx. 20Hz to 15KHz and is used to transmit the sum of both the left and right channel. This assures compatibility with older MONO receivers that only receive this part of the spectrum. Going from left to the right we stumble upon the 19 KHz pilot just above the MONO signal. This pilot has a couple of functions;

- 1.) It signals presence of the stereo signal; by detecting it the receiver switches to stereo
- 2.) It enables demodulation of the L-R signal and LEFT/RIGHT channel reconstruction

The 19 KHz signal is used to demodulate the DSB (Double Side Band Suppressed Carrier) signal stretching from 23 KHz to 53 KHz. This signal contains the L-R information (difference between the left and right audio channel). This is what the stereo encoder does to generate the Stereo Multiplex signal:

- A.) Add Left and Right signals to get an L+R signal.
- B.) Generate a Pilot Tone of 19 KHz.
- C.) Generate a 38 KHz carrier for the Doubly Balanced Mixer (DBM)
- D.) Generate the L-R (difference of the audio channels) signal for the DBM
- E.) Modulate the 38 KHz carrier with the L-R signal using DBM (DBM suppresses the carrier in the process)
- F.) Add up A, B and C above to get the complete MPX Signal.
- G.) Use the above MPX signal to Frequency Modulate a carrier in the 87.5-108 MHz band.

Some facts about stereo

Even the best stereo encoder is by itself not enough to guarantee good channel separation at the receiving side over the whole audio frequency range. Many factors are involved:

The transmitter

The first problems usually occur at the transmitter. Badly designed audio stages of the modulator will produce low frequency phase shifts, affecting separation. But the main problem is the phase locked loop section of the transmitter. PLL tries to correct the frequency deviations caused by the audio effectively canceling modulation. The frequency correcting signal is passed through a low pass filter (loop filter). This loop filter dampens (smoothes and averages) the correcting pulses from the PLL circuit before passing the corrected voltage to the frequency control part of the modulator. The loop filter is usually the cause of the phase shifts due to not being able to sufficiently dampen and smooth the correcting pulses when the transmitter is fed with low frequencies. Variable frequency oscillators do not suffer from the problem at all due to no frequency correcting circuits (PLL). In short, a badly designed transmitter can be hugely detrimental to the stereo signal created by a stereo encoder. Do not jump to the conclusion that the stereo sound that you are listening to is the stereo encoder only.

The receiver

Filter Bandwidth and Stereo Decoder of a receiver. Even if the transmitter adds no phase shifts to the multiplex signal transmitted, the receiver (radio) at the listening end can still cause trouble. The filters in the radio can cause phase shifts to the multiplex if too narrow in bandwidth. Many cheaper tuners have less filtering (less manufacturing cost) which although not great for selectivity provides for excellent separation in strong signal environments. The above is only true if the stereo decoder in the radio or tuner is ok. It is very hard to obtain any modern stereo decoder chips that give more than 35 dB of separation, some even give you only 25 dB. So even with modern day DSP (digital signal processor) stereo encoders which achieve separation of more than 70 dB, you will never hear it because the radio you will be listening to on will only allow 35 db at best. As you see, stereo is not just about a stereo encoder!

Circuit description

Left and Right audio signals are applied to the connectors J1 and J2. Make sure not to ground the outer shield of the RCA connectors, this will help reject the noise on your audio lines. Alternatively balanced inputs can be used. The audio signals are then fed into the compressor circuit, pre-emphasizing stage, limiter, low pass filter, multiplexing stage, MPX filter and output buffer. On-board computer generates the pilot tone (19 KHz) via the D/A converter. All these signals (DSB and pilot) are summed up and sent out to your fm exciter and generate a perfect and crisp sounding MPX signal.

Before you start

It is recommended that you read this section before you power your unit up for the first time. Let us clear up some basics you should know about. You will also find some useful tips in our guides and forum at <http://www.pcs-electronics.com>. Here is what you need to consider to get the best from your stereo encoder:

Mains power supply and mains power cable

Do not underestimate the importance of mains power supply, despite abundance of all kinds of cheap units available today they unfortunately do not always meet requirements. What you need is a well stabilized DC 15V mains power supply that can supply at least 100mA of continuous current without overheating, introducing buzzing, dropping the voltage down below 12V (a classic case) or acting up in other way. Whenever in doubt please buy our mains power supply.

If you ordered and received our mains power supply (which is recommended) you'll notice the mains cable is not included, but can be obtained in any radio/computer/hardware shop at the cost of about 1 US\$. It is the type used in your PC for mains power. Since these cables vary from country to country and we had trouble getting the exact type locally we decided against including them, especially since finding them is so easy locally.

Enclosure

If you want to make your own, use aluminum or other metal, ventilation holes are recommended. The 7805 regulator needs to be bolted to the enclosure via metallic spacer as it does get hot. Fix the PCB with all screws tightly. A shield is recommended between the exciter and the encoder, if you have them both in the same enclosure. Attractive and predrilled enclosures of exact size are available, check our site for info. A 19" rack enclosure for SE2000+ is available from our website.

Balanced audio and power connector

SE2000 A+ and D+ feature balanced audio inputs, just connect XLR connector to L or R 3-pin header (next to rca jacks). Pin 1 is ground, the other two are Audio + and Audio -. They are numbered 1-3 and match the markings on the connector, so just make sure you are connecting 1 to pin 1, 2 to pin 2 etc. Any hum problems usually magically disappear once the XLR input is used instead of the basic unbalanced RCA input. Note that you will have to purchase XLR connectors as only RCA type is provided on the PCB.



Fig. 4: Balanced audio input – Panel mounted XLR connector

Digital audio streaming

If you want to drive your audio digitally, connect USB cable to the USB port on the computer and the stereo encoder. Your PC will detect the sound interface automatically. You can now play your audio digitally. In your media player look under options and make sure you output your audio to the "USB audio adapter". Whatever you play will be heard via your FM transmitter.

Stereo/mono mode selection and maxlink connector

Stereo/mono mode selection is now possible in 2 different ways:

You can install or remove jumper J14 to get MONO/STEREO mode

When using together with our FM exciters just connect the MAXLINK flat cable to the SE2000+ and MAX PRO 3000+/4025+ RF board; you can now set the mode via LCD control module/menu system from your FM exciter.

Setup and testing

Setting up levels

Let's assume that you don't own an expensive peak deviation meter or modulation meter/analyzers. If you have or can gain access to these pieces of equipment then you probably also know how to use them; setting of the level is as easy as adjusting the input level of the transmitter for the appropriate deviation.

SE2000+ is very easy to setup. What we do have to do however is match the output level of the encoder and input level of the transmitter so that the pilot tone (19 kHz) alone (no audio) gives a deviation of the exciter of 6.75 kHz (9 percent). This automatically sets the remaining audio levels. If you're using our line of FM exciters just connect the stereo encoder to the transmitter, set encoder to Stereo, set audio level on the fm transmitter to zero and keep increasing it until the stereo led on the receiver comes on and go a bit above that point.

DO NOT FORGET TO DISABLE PREEMPHASIS AT THE TRANSMITTER WHEN YOU CONNECT IT TO THE STEREO ENCODER (failure to do so results in very poor stereo separation and distortion).

Advanced users – maximizing stereo separation

Advanced users will notice missing precision trimmer (P1, Separation) on the PCB. You may install this trimmer, if you wish. Use 1K value precision trimmer. You can now optimize the stereo separation by adjusting this trimmer. The setting for this will vary from tuner to tuner slightly. To set this follow the procedure below:

- 1.) Disconnect one audio input source so that only one channel is connected. Apply audio to this source.
- 2.) Listen to the audio on a high-grade tuner and adjust the input volume pot for that audio channel so that the volume is only half that of a commercial station. The reason we want this is to be sure we are inside the +/- 75 kHz bandwidth. Over deviation will cause degradation of the stereo separation. We now should have the encoder correctly setup with only one channel of audio that is inside the +/-75 kHz bandwidth so separation should be able to be fine tuned without problems such as over deviation affecting our measurements. Turn your amplifiers balance control so that you are listening to only the channel with no audio on.

If everything is good and well then you should have this channel a lot quieter than the other channel. Turn the amplifier up in volume so you can hear the crosstalk between the channels. Now adjust trimmers until the sound in the opposite channel disappears or is at least barely noticeable. You should be able to achieve your maximum separation. You can now reconnect the other channel and apply your audio at the correct level. The encoder is now aligned and ready for operation. DO NOT FORGET TO DISABLE PREEMPHASIS AT THE TRANSMITTER WHEN YOU CONNECT IT TO THE STEREO ENCODER (failure to do so results in very poor stereo separation and distortion).

Troubleshooting

Troubleshooting

We hope you'll never get to this step. We all know bad things happen but do not despair! There is some basic polarity protection, the 10ohm thru-hole resistor closer to supply power connector is the first thing to check. Also make sure microphone/shielded audio cable leading from MPX output to the transmitter is not shorted. Next check the troubleshooting table on the next page. If you have problems you cannot solve yourself, please see our website for contact information and support resources in our forum.



Do you think you can handle it ??

Fig 5: So, do you think you can handle it? We think you sure can!

PROBLEM DESCRIPTION	POSSIBLE SOLUTIONS
Mono operation only, no stereo	<ol style="list-style-type: none"> 1. Check supply power and voltage 2. Did you connect Maxlink to LCD and set operation to mono with your LCD module? You can only use one method to select stereo/mono mode 3. Is the MONO/STEREO jumper in correct position? 4. Increase audio level in the FM exciter a little bit 5. You may need to increase pilot level a little with P2
Very poor stereo separation, strange audio	<ol style="list-style-type: none"> 1. Make sure you disable pre-emphasis in your FM EXCITER. Check supply voltage 2. Install and rotate P1 precision trimmer
Audio without any treble	Set pre-emphasis on the stereo encoder board (either 50uS or 75uS).
Audio too quiet	Increase level on your audio source a little bit
There is HUM in audio	<ul style="list-style-type: none"> - Try with a different mains power supply. - Move antenna as far away from the transmitter and audio gear as possible - Use XLR audio connectors or digital audio, if possible (USB) - Make sure SWR is low - Keep audio cables short and away from antenna and RF coaxial cable - Form a coil from coaxial cable going to the antenna, make a few turns. This stops RF currents that might be flowing on the outer braid of the coaxial cable. This usually happens when you connect unbalanced cable to balanced antenna without proper BALUN (balanced-unbalanced convertor) resulting in coaxial cable becoming part of the antenna and radiating RF energy as well...causing hum.

Appendix A: Connecting stereo encoder to MAXPRO FM exciter

Using our stereo encoders together with our MAX PRO FM excitors is a great idea as you can control all parameters through the same LCD unit used for FM exciter. Since the introduction of the new MaxLink interconnect system this is really easy to do, you do not have to fiddle with wires and soldering iron anymore. The MaxLink™ is a 6-wire flat cable interconnect system that is simply plugged into appropriate connector on the stereo encoder board and the other end into connector on FM exciter board. See fig. 19 below for wiring directions. You don't even have to wire a separate supply (12V) wire to the stereo encoder as the MaxLink cable delivers supply voltage as well. You still have to connect audio cable (MPX out to audio input of the FM exciter), but that is really easy to do. It is best to use shielded microphone cable.

Remember to set the following:

Remove the STEREO/MONO jumper as this is now controlled via FM exciter's LCD module. If stereo mode LED is illuminated, you are in STEREO mode.

Disable pre-emphasis in the MAX PRO 3000+ exciter board (jumper in position "None"). Pre-emphasis is now handled by stereo encoder(se5000 or other), you can set it there either to 50uS or 75uS.

Set the audio level (P1) on MAX PRO 3000+ so that the stereo indicator on the radio just turns on, than increase it slightly more (make sure you are in stereo mode when you do this alignment).

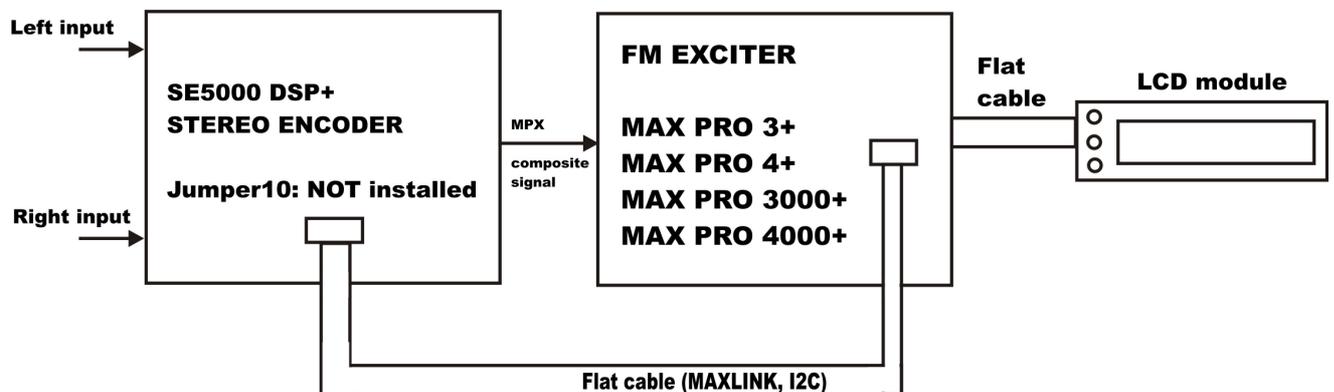


Fig. 6: Connecting stereo encoder to FM exciter.

Appendix B: Connecting VUMAX-1

How about adding some flashing lights to your transmitter? It is much easier than you think. Fortunately we provided for VU meter, look for the 5-pin header (marked with N). You can connect our VU MAX I vu meter module to this header. Just be sure to orient the cable correctly. The square pin (ground) should be aligned on both sides. The remaining 3-pin header on the VU-MAX1 vu meter board can be connected to stereo encoder (SE5000 or SE2000/SE3000). This way you get the 40 LEDs on the VU MAX board flash according to the power, swr and audio volume (left and right channel separately). Maxlink cable between exciter and SE2000/SE3000 is not shown for simplicity. The block diagram is below:

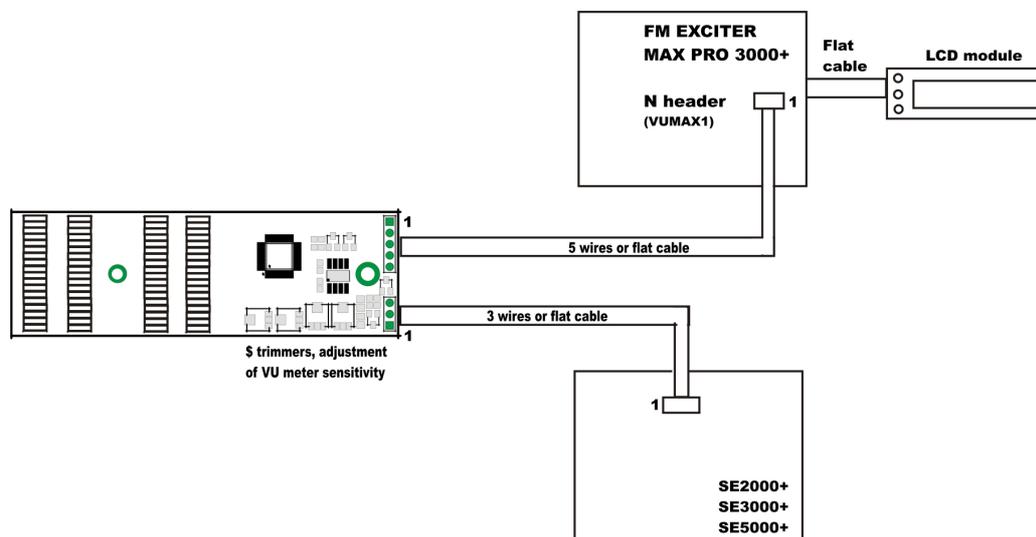


Fig. 20: Connecting VU meter to FM exciter

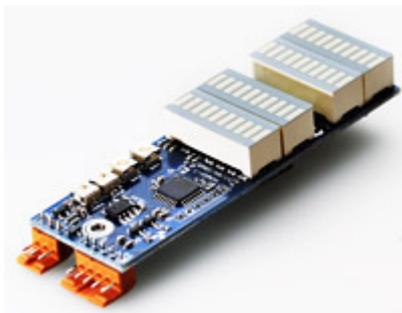


Fig. 21: VU MAX-1

Note: Sometimes (depending on case design) RF energy from transmitter interferes with VU meter operation. A typical sign of the problem would be 1-2 LEDs for audio constantly illuminated. If you experience this problem place two capacitors (100pF) on the VU MAX-1 PCB board, at the 3-pin jumper shown above. One capacitor goes from pin 2 to pin 1, the other goes from pin 3 to pin 1. This way you ground these two audio inputs for RF signal and the problem goes away.

Appendix C: Complete FM transmitter block by block

Now that you've connected stereo encoder and already have nice stereo sound, it may be time to increase your power output. How about adding an external amplifier? Some of you will say, sure, but will the nice power/swr meter built into MAX PRO 3000+ know how to measure power with this amplifier added and will it show it properly on the LCD display? The good news is that we have a solution for this. Not only does the MAX PRO 3000+ have ability to read power/swr with external amplifier installed, it can also read amplifier temperature and amplifier supply voltage. To top this off, swr and temperature protection still works just like before.

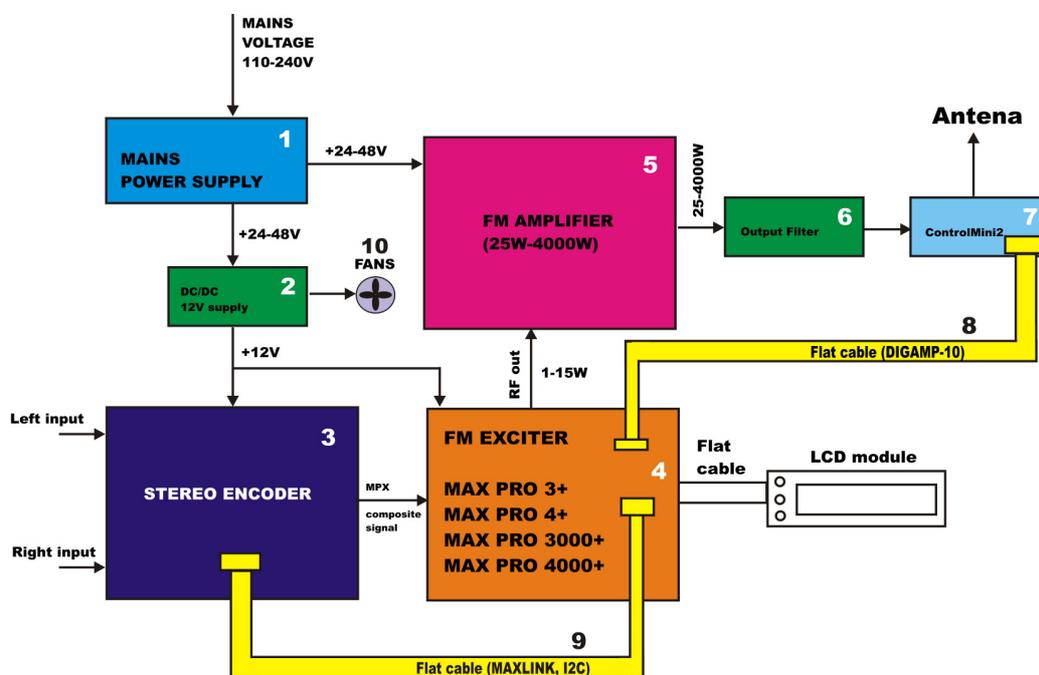


Fig. 22: Connecting an external amplifier module – Complete FM transmitter, block diagram

Diagram above explains the entire FM transmitter system, with mains power supply (1), DCDC converter (2), stereo encoder (3), FM exciter (4), FM amplifier pallet (5), output filter (6), ControlMini board (7), interconnect system (8 & 9) and cooling fans. I will briefly explain each of the above subsystems:

1.) MAINS POWER SUPPLY: Provides power for the entire transmitter. Usually accepts mains voltage, from 110 to 240V, and outputs 24 or 48V DC. Exact power rating depends on the power consumption of the entire transmitter. A 300W transmitter usually consumes around 500W of power. A 1000W transmitter typically consumes around 1500W of power. An engineer should also consider safety margin and use a power supply that can provide slightly more power than needed. Voltage rating for mains power supply depends primarily on the type of amplifier used. Most pallets accept 24-28 or 48-50V. You can find all kinds of mains power supplies here at our website:

http://www.pcs-electronics.com/transmitter-accessories-mains-power-supply-c-71_74.html

2.) Stereo encoders and FM exciters typically operate from 12V DC stabilized voltage. Since at the moment we only have 24 or 48V inside our system shown in diagram above and we don't want to use another big 110-240V/12V mains power supply we are going to use own small DCDC converter. This conveniently converts any voltage from 17-50V down into 12-15V. Exact voltage can be adjusted with a trimmer. Another convenient bonus point for this tiny DC/DC converter is that it also provides power for fans (10). And you will need fans to cool the exciter, mains power supply and amplifier. Moreover, you can set temperature at which the fans start working or you can have fans work continuously.

You can find our DCDC converter with fan controller here at our website:

<http://www.pcs-electronics.com/2048v-dcdc-converter-p-1549.html>

3.) Stereo encoders, we covered this in detail above. You can find our stereo encoders here:

<http://www.pcs-electronics.com/stereo-encoders-c-36.html>

4.) Our FM exciters, at the moment MAX PRO 3000+ and MAX PRO 4025 support all the mentioned functions. Make sure to **limit the maximum output power** of the exciter in order not to damage the amplifier. The procedure is described in **Chapter 7** of this manual. By limiting the maximum output power the LCD module still works, but its adjustment range is decreased to go from 0 to 2W for example or from 0 to 4W. Another very important advice is to use an attenuator between exciter and amplifier. Amplifiers almost always have input impedance that does not match 50 ohms across the entire FM band. By using 1-3dB attenuator this can be brought closer to 50 ohms. Our attenuators are available here, but you can also construct your own from regular resistors, you can contact us for a schematic diagram:

<http://www.pcs-electronics.com/mounted-attenuators-p-1105.html>

BEFORE CONNECTING AMPLIFIER ALWAYS MAKE SURE THAT EXCITER OUTPUT POWER DOES NOT EXCEED MAXIMUM ALLOWABLE INPUT POWER OF THE AMPLIFIER!

LIMIT MAXIMUM OUTPUT POWER OF THE EXCITER, PROCEDURE IS DESCRIBED IN CHAPTER 7 IN THIS MANUAL!

5.) FM amplifier. This is typically a pallet amplifier such as any of these on our website, they all come with ControlMini2 included. Also make sure to include a heatsink with pallets as they require one. It is often a good idea to insert a small attenuator between exciter and amplifier.

http://www.pcs-electronics.com/amplifiers-pallet-amplifiers-c-41_109.html

You can also use any of these here, these already contain filters and heatsink so your work is easier:

http://www.pcs-electronics.com/amplifiers-complete-amplifier-modules-c-41_111.html

Amplifiers can have input impedance that does not match 50 ohms across the entire FM band. By using 1-3dB attenuator this can be brought closer to 50 ohms. Our attenuators are available here, but you can also construct your own:

<http://www.pcs-electronics.com/mounted-attenuators-p-1105.html>

6.) Low pass filter for FM band. You can use any of these here, but make sure they are strong enough to handle the power level of the amplifier (note that complete amplifiers with heatsink and low pass filter do not require extra filter):

http://www.pcs-electronics.com/transmitter-accessories-filters-transmitters-c-71_73.html

7.) ControlMini2 board. This board is connected to the MAX PRO 3000+ via flat cable (8 – DIGAMP-10). It makes it possible for MAX PRO 3000+ to read POWER and SWR of the amplifier module. There is also a solder post for temperature sensor and amplifier supply voltage. The board contains directional couplers for power and swr, SWR protection and ALC system. For better description look at the next appendix. We are now shipping these boards and 10 cm long flat cable with all our FM amplifiers (pallets and complete amplifier modules). This board can take about 500-750W of power maximum. However, when used with complete amplifier modules you can use them up to 2KW of RF power.

8.) MAXLINK flat cable connects stereo encoder with the FM exciter, it enables control and supplies 12-15V DC for the stereo encoder. You can purchase this cable along with stereo encoder here:

<http://www.pcs-electronics.com/se5000-stereo-encoder-p-1274.html>

9.) DIGAMP-10 flat cable connects MAX PRO 3000+ FM exciter with ControlMini2, it makes it possible for MAX PRO 3000+ to read power, swr, temperature and voltage of the amplifier module, you receive this cable along with ControlMini2 whenever you buy any of our pallets or complete FM amplifier modules:

<http://www.pcs-electronics.com/fm-amplifiers-c-41.html>

10.) Fans are very important, they ensure proper cooling of your amplifier, mains power supply and exciter. Usual fans that you can buy in local shops are often not strong enough and can fail far too soon. We carry a line of professional fans with higher reliability and very high airflow, you can order them here:

http://www.pcs-electronics.com/amplifiers-amplifier-accessories-c-41_112.html

11.) You will need to place all these items in a nice enclosure. Aluminum works well and is not too heavy. Keeping it conductive is an advantage (most types of anodizing make aluminum's surface non-conductive). We carry a line of professional rack enclosures, designed so that the above mentioned items fit perfectly. Now you can build your FM transmitter yourself, all the way up to 2000W:

<http://www.pcs-electronics.com/rack-cabinets-boxes-c-93.html>

Finally, we recommend that you use Teflon coaxial cable for all internal coaxial connections. The reason is primarily that Teflon does not melt while soldering or use. You can be sure no short will form between the center and shield, either immediately at soldering or with time, if the cable is under a lot of thermal stress (coax can warm up nicely already in a 300W transmitter). Insulation in RG58 or similar lossy cheap coaxial cables can literally melt and cause a short between the center and shield already at moderate power levels around 300W. You can buy suitable Teflon coaxial cable here (I suggest RG188 for low power and RG142, RG316, R303 for higher power levels):

<http://www.pcs-electronics.com/semirigid-25ohm-other-special-coaxial-cable-p-1275.html>

Appendix D: General tips for setting up transmitters

Typical FM transmitter setups

Below are several of the typical broadcasting systems that can be encountered worldwide.

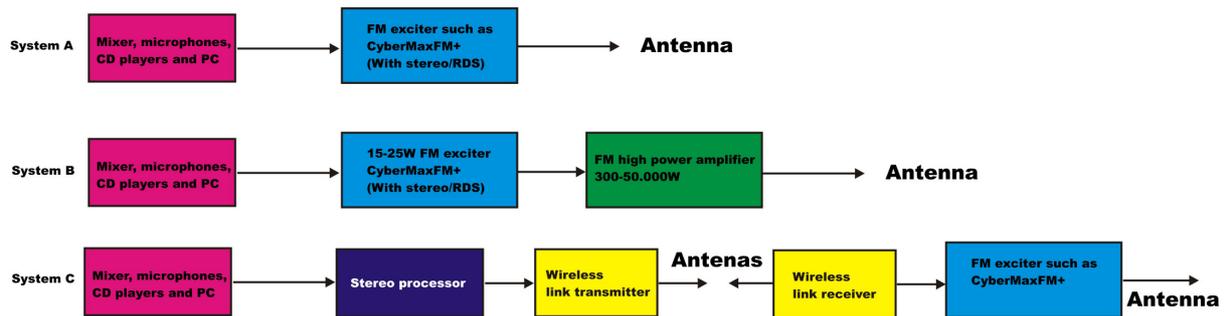


Fig. 25: Typical broadcasting systems

Lets look at **system A** first. It consists of audio source (mixer, microphones, CD players and a PC), FM exciter with integrated RDS and stereo encoder (such as our CyberMaxFM+ units from 15W-300W) and antenna. Note antenna in this system is located in the same location as the transmitter and studio, typically it would be placed on a small tower or a pole at the top of the building with studio. Disadvantage of this system is that you have to keep studio, transmitter and antenna close. Now you usually can't place studio on the top of a mountain for practical reasons so this limits your range. This is a typical small community radio with output powers of up to 300-500W.

System B is very similar to system A, but operators have decided to add an additional amplifier to boost the range. Such stations can go into kilowatts, but they are starting to hit another speed limit. Since the studio is typically located in a town, high RF powers aren't desirable due to interference with other services and safety regulations. So range is still limited compared to system C stations.

System C is radically different in one respect. Antenna and transmitter are no longer located at the same place with the studio. To accomplish this the two audio channels are first combined with stereo processor. Resulting MPX signal is then passed to the STL wireless link transmitter (STL=Studio Transmitter Link). Up in the mountains is a STL wireless link receiver that receives the signal from the studio and passes it to the exciter. In this case exciter does not need to be stereo anymore since composite MPX signal is passed to its MPX input (all mono transmitters have this input). Such exciters can then optionally drive big amplifiers with powers going into tens of KW with maximum range.

You can check our amplifiers here: <http://www.pcs-electronics.com/fm-amplifiers-c-41.html>

You can check our wireless STL links here: <http://www.pcs-electronics.com/wireless-audio-links-c-42.html>

Typical FM broadcasting antenna setups

Below are several of the typical broadcasting antenna systems that can be encountered worldwide.

System A

System B

System C

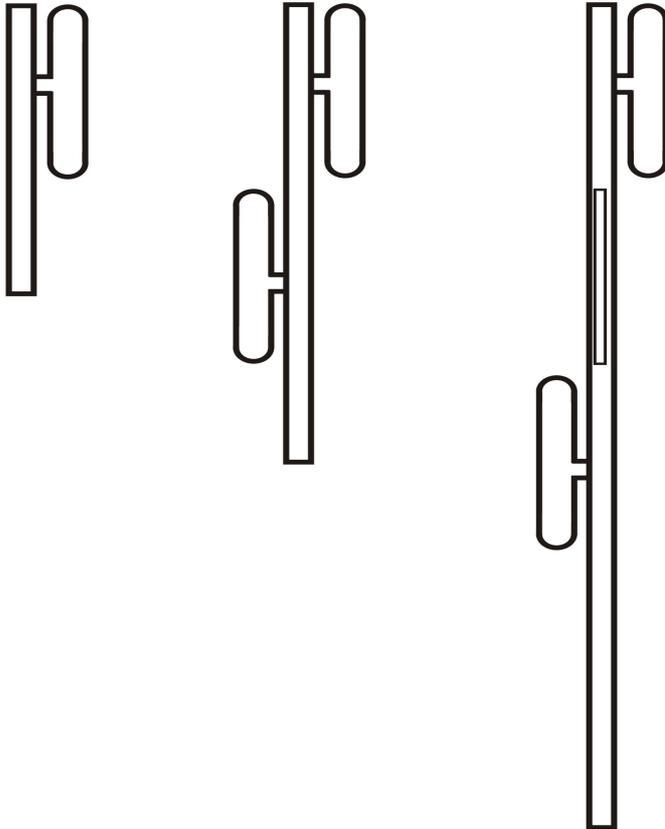


Fig. 26: Typical antenna setups

Lets look at **system A** first. It's a simple vertical dipole antenna, mounted on a pole. The gain of this antenna is 0dBd and if we assume that the coaxial cable does not have any losses the ERP of this system equals transmitter power. For example, a 1KW transmitter with this antenna system and perfect coaxial cable (losses=0) would have ERP of 1000W. Radiation pattern of this system is more-less omni-directional but since the metal pole holding the antenna blocks the signal there is a null of signal exactly on the opposite side of the pole.

System B has two simple dipole antennas mounted on a pole. The gain of this antenna is slightly less than 3dBd (due to losses in harness – splitter). If we assume that the coaxial cable does not have any losses the ERP of this system equals double transmitter power. For example, a 1KW transmitter with this antenna system and perfect coaxial cable (losses=0) would have ERP of 2000W. Note the antennas are mounted on the opposite sides of the pole to help make radiation pattern as omni-directional as possible.

System C has four simple vertical dipole antennas mounted on a pole. One of the antennas is behind the pole and is not visible. Note the antennas are mounted at an angle of 90 degrees between each other to help make radiation pattern as omni-directional as possible. The gain of this antenna is slightly less than 6dBd (due to losses in harness – splitter). If we assume that the coaxial cable does not have any losses the ERP of this system equals 4x transmitter power. For example, a 1KW transmitter with this antenna system and perfect coaxial cable (losses=0) would have ERP of 4000W.

System C has theoretically double the range of the System A although in practice it takes 4-6x increase of power to double the range. 4x increase of power is equal to 6dB of gain. And you get 3dB of gain by doubling the number of dipoles. So to upgrade system C to 9dBd you'd need 8 dipoles. And for 12dBd you'd need 16 dipoles. 16 dipoles would in theory increase your range 4x compared to a single dipole. In practice there would be some losses in combining so many dipoles. You can use circular dipoles in very similar configurations.

Wiring antennas in multi-bay configurations

We have observed typical multi-dipole (called multi-bay) antenna configurations on the previous page. However there are some things to keep in mind.

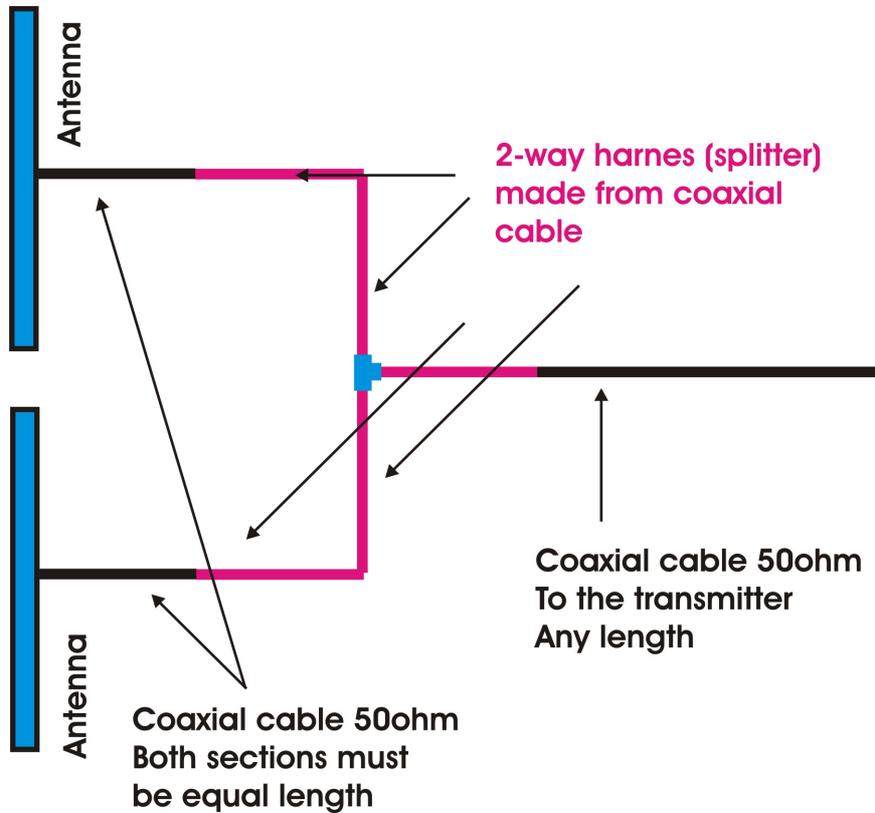


Fig. 27: Wiring multi-bay antennas

Look at the diagram above. This is a simple system with two dipole antennas and a 2-way coaxial splitter (harness). This splitter is made from sections of coaxial cable with such impedance and length which ensure perfect match at specific frequency. Do not attempt to assemble from regular 50-ohm coaxial cable. What is important here is that the two sections of coaxial cable going from antenna to the splitter should be of exact equal length. These two sections are shown in black. The same rule applies for system with more dipoles. It is also possible to have cables of different lengths, but you have to know velocity factor of the cable so we have omitted this for simplicity reasons. If you want more info please contact our technical staff.

Appendix E – Using wireless audio links

If you are going to place your transmitter up in the mountains, you may prefer to keep your stereo/RDS encoder in your studio and stream MPX signal up to the transmitter. For example this could be because you want to have easy access to your stereo/RDS encoder so you can change parameters, if needed. Here is what your system would look like for MPX wireless studio-transmitter link:

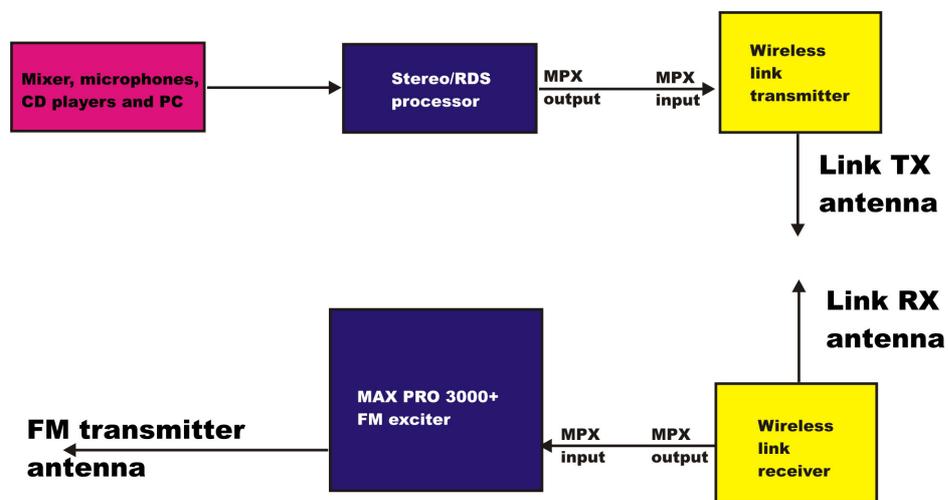


Fig. 28: Using external stereo/rds processor with wireless link

It is important that you set the pre-emphasis on the MAX PRO 3000+ board to Off (None). If you get stuck or need our advice please contact our technical department.

Appendix F – Warranty and legal info

Important notice!

Please remember to turn off the transmitter/amplifier when not in use! This goes especially for high powered transmitters. Remember that anything you broadcast through the transmitter can be heard by anyone tuning in to that frequency. Although it is unlikely certain weather conditions may allow the signal to go further than your immediate listening area so please don't broadcast anything you don't mind anyone else hearing.

Warranty and servicing!

Within one (1) year of receiving your order, if any product proves to be defective; please contact us via e-mail or our feedback form. Please **DO NOT** ship the product back to us without contacting us first and receiving return instructions. After we receive the defective merchandise, we will test it if need be, and we will ship back to you a non-defective replacement product. Please note that this doesn't cover final RF transistor as it can be damaged by using defective or poorly matched antenna. An exception is as well any mishandling or abuse by the customer. If the product is defective, you will receive a replacement. If you choose to return the defective item, rather than replace it, we will charge a 20% restocking fee and your original shipping and handling charges will not be refunded. The return of the product is at your expense. We believe that this is a fair policy because lower overhead results in lower prices for all of our customers.

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- PC based FM transmitters (PCI MAX pc based FM transmitter turns your PC into a radio station)
- A large number of beginners guides to get you started
- A large selection of free schematics is as well available at our website.

If you can't get much range with your homebrew antenna, have a look at these: <http://www.pcs-electronics.com>

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Revisions and errata

V1.0 (July,2010): Release version

Please report any errors you see in this manual, you will be helping us and many other users out there. Thank you!

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