

# SE6000DSP+

DSP high performance FM stereo encoder with 114x oversampling

# 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 SE6000DSP+ stereo encoder

*With DSP and digital audio input (USB) for completely noise-free audio experience*

The new SE6000DSP+ is a high performance stereo encoder with DSP digital processor, split supply rails (via on-board DC/DC), balanced input buffers, a fairly complex and incredibly sharp filter with deep notch at 19KHz, pre-emphasis, limiter and LC MPX filter. Digital subsystem generates 19KHz pilot (32xoversampling) and generates DSB signal. 114x oversampled MPX ensures crisp stereo sound with excellent stereo separation. SE6000 DSP+ can be upgraded to RDS functionality simply by plugging-in a RDS IO board with integrated USB remote control via PC. It is perfect for a demanding broadcaster.

SE6000 DSP+ 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 SE6000DSP+ so great?**

- Perfect for any mono FM transmitter (turning it into stereo)
- 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!
- Telemetry output that connects to MAX PRO 5015, 5025, 5040 or 5050 transmitters.
- Pilot level and pre-emphasis now selectable from the LCD
- Works either with separate LCD module or can be connected to LCD module of our exciters (requires new LCD type with encoder)
- 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.
- Excellent 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

**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 selectable from LCD display

Audio Input Impedance: 10K, balanced or unbalanced

Audio Input Level: 0 dB

Digital audio input: USB connector, Windows/Linux/Mac compatible

Distortion: <0.01%

S/N ratio: >85 dB

Separation: >60 dB typ.

Pilot Frequency: 19 KHz, DSP generated with 114x oversampling

Output Impedance: 75 Ohms

Power Requirements: 12-15VDC / 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: 1-4V (adjustable with trimmer)

**How is SE6000 DSP+ better than SE5000DSP?**

- Higher MPX oversampling and resulting better separation and cleaner MPX signal
- New form factor with on-board telemetry output
- Better stereo separation
- Better S/N ratio
- Digital audio inputs (USB)
- Pre-emphasis and stereo pilot level adjustable from LCD module
- Side adjustable trimmers for MPX out and MPX in
- Accepts new IO board with RDS, XLR connectors and BNC for MPXin, MPXout, 19KHz
- RDS/IO board also contains USB interface for communication with a PC

**Thank you for purchasing SE6000 DSP+ 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

# SE6000DSP+ board layout

## Board layout

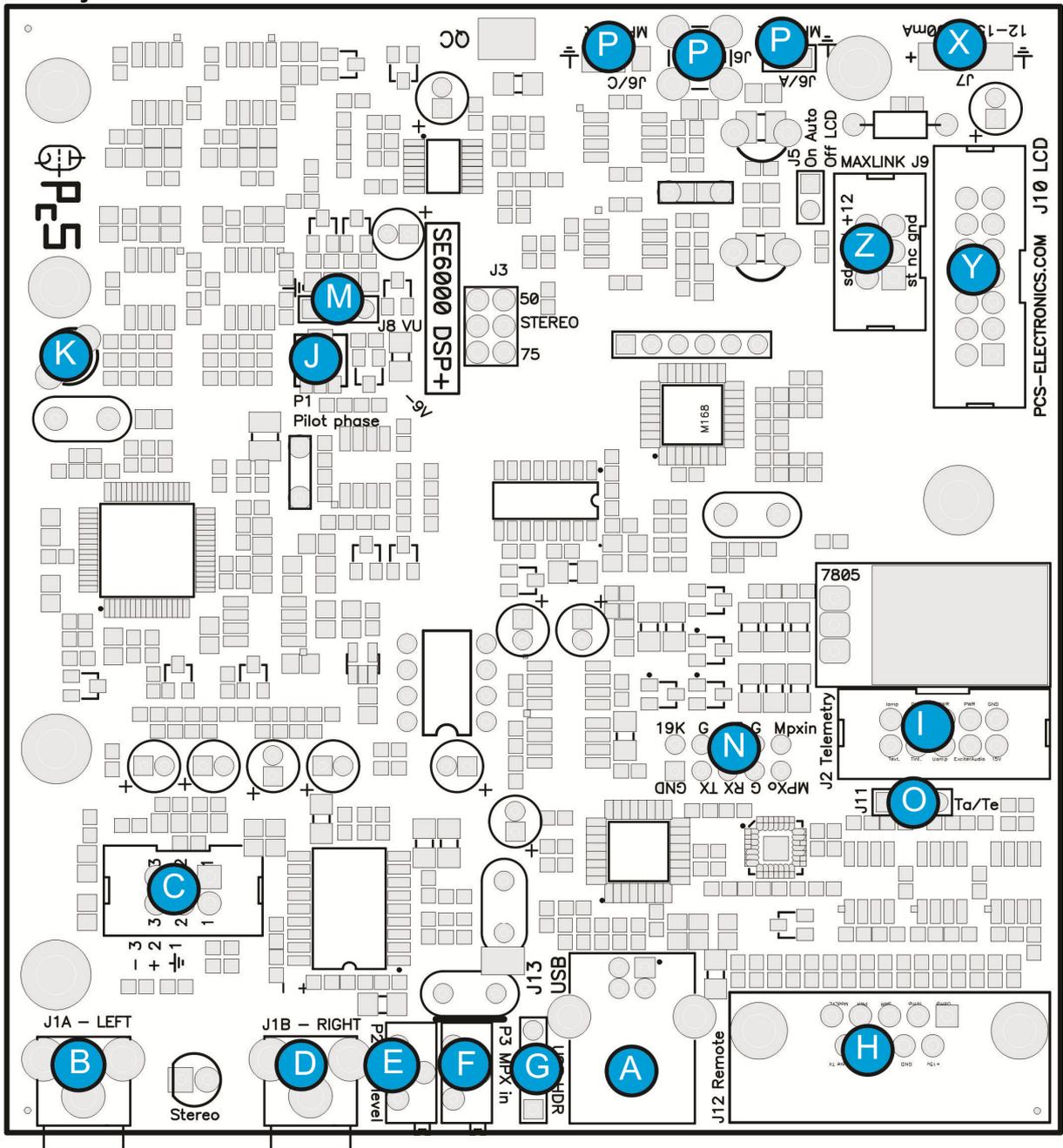


Fig. 1: SE6000+ board layout

Ref.	Function
A	Digital audio input, USB
B,D	Left and right analog audio input, RCA
C	Left and right XLR header connector, either connects to IO board or via wires direct to XLR connectors
E	MPX out level, adjustable from inside (make holes into enclosure)
F	MPX in level, adjustable from inside (make holes into enclosure)
G	USB header, you can connect external USB connector, if needed
H	Telemetry connector. For this to work you have to use MAX PRO 5015 series FM exciter and you have to connect header I to this exciter via 10-lead flat cable.
I	When using our FM exciter with telemetry header such as MAX PRO 5015 series you can connect this header to the exciter via 10-lead flat cable (if you wish).
J	Separation adjustment. You can maximize for best stereo separation here.
K	19KHz pilot accuracy can be set here.
M	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.
N	Connects to optional IO board with RDS (RDSIO5000). It contains many useful signals, if you want to experiment. It contains 19KHz signal in square form, +5V, RX and TX for RS232, MPXout and MPXin.
O	Telemetry setup (internal or external/amp temperature selection)
P	MPX out, this goes to FM exciter audio input. (these are all the same connection for your convenience)
Z	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 J7. <b>DO NOT CONNECT THIS TO LCD DISPLAY AS THAT CONNECTOR IS FOR RS232.</b>
X	Power supply voltage, only use if you did not use MAXLINK cable as MAXLINK cable already supplies power.

Table 1: Description of various elements of the SE6000 AN+ stereo encoder board

#### Some important notes for board layout

- J3 is not needed as all of these functions are controlled via LCD display (either LCD from exciter or stand-alone)

## Drill template

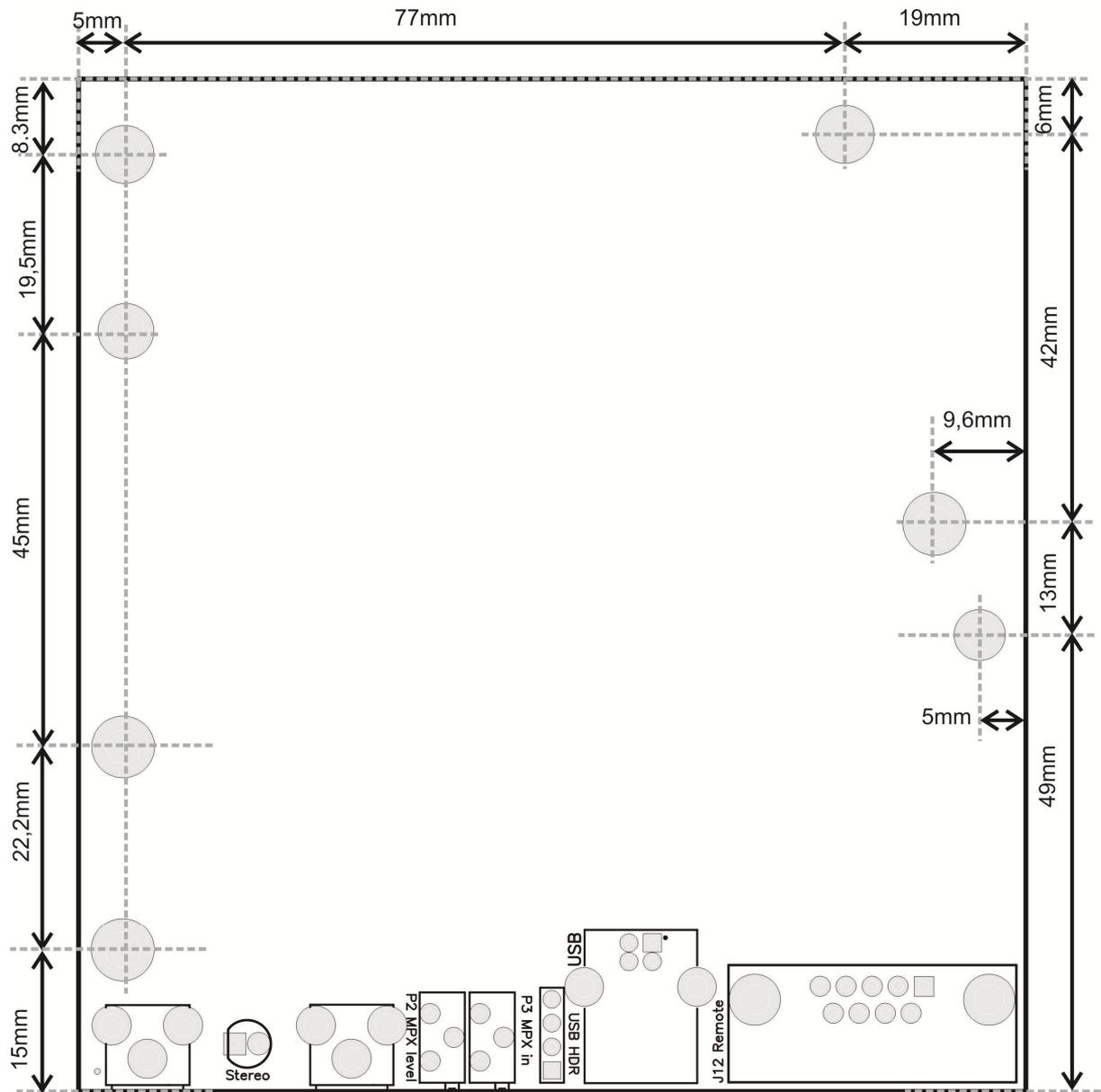


Fig. 2: Stereo encoder drill template, all measurements in mm, all holes are for M3 metric screws. Board is usually mounted with distancers about 10mm high. Place metal distancer under 7805 to allow for some extra cooling.

## Wiring, setup and testing

### Wiring up scenarios for SE6000 DSP+

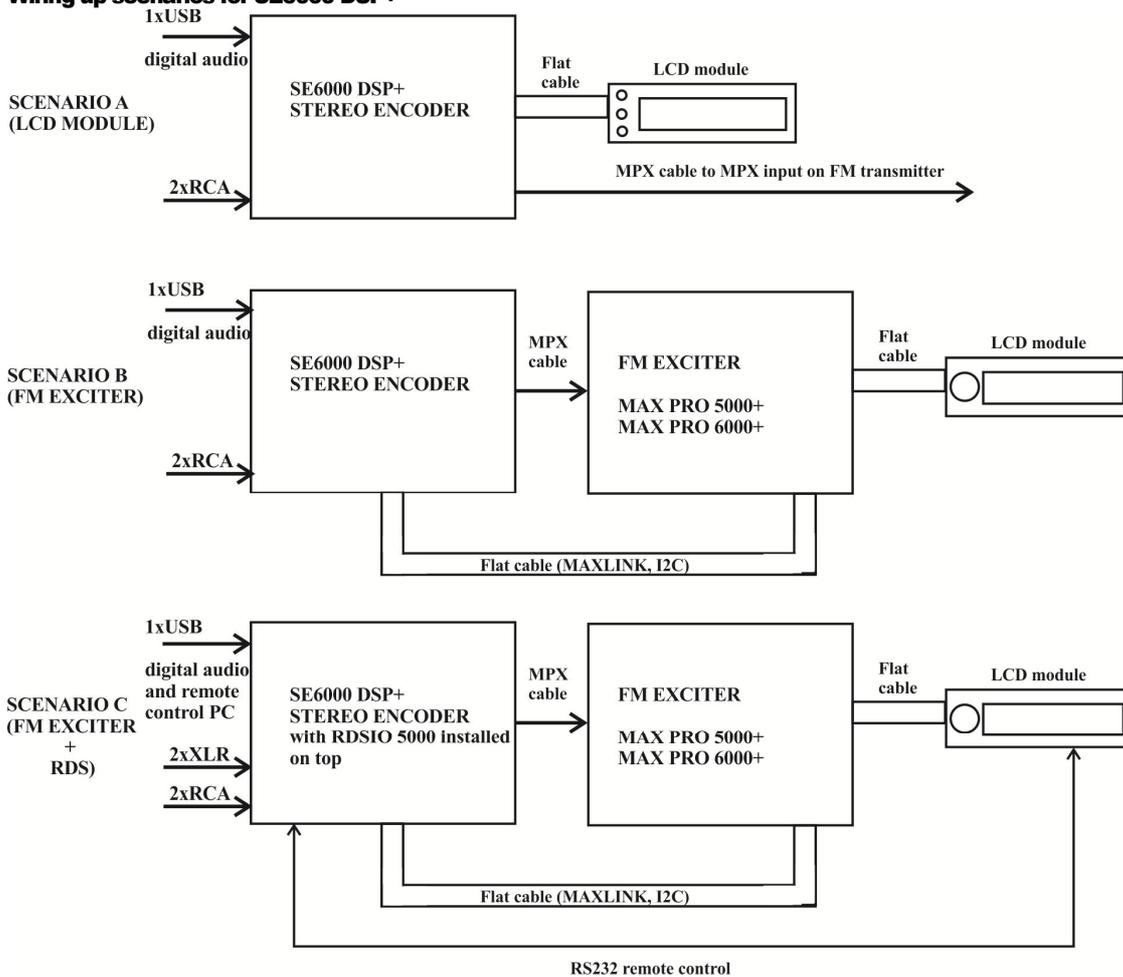


Fig. 3: SE6000 DSP+ wiring scenarios

Three basic wiring types are displayed above, stand-alone with LCD display, with MAXPRO5000/6000 FM exciter and with added RDS encoder. We will describe them one by one below:

#### Scenario A (standalone with LCD display)

In this example of use we connect LCD display to SE6000 DSP+. This display is really required to adjust the DSP parameters so SE6000DSP+ cannot function without it. The other connections that need setup are power (+12V), audio inputs (2x RCA), USB audio input and MPX audio output going to the transmitter (this is usually microphone coaxial cable).

### **Scenario B (with MAXPRO5000 or MAXPRO6000 series FM exciter)**

In this example we use MAXLINK cable to connect SE6000 DSP+ to our FM exciter (needs to be series 5000 or 6000 with new LCD display type with rotary encoder). This cable eliminates the need for separate LCD display for stereo encoder and makes it possible to adjust all of the DSP parameters of SE6000DSP+. The other connections that need setup are audio inputs (2x RCA), USB audio input and MPX audio output going to the transmitter (this is usually microphone coaxial cable).

### **Scenario C (with MAXPRO5000 or MAXPRO6000 series FM exciter and RDS)**

This example adds RDSIO5000+ board to add RDS functionality. RDS (Radio Data System) is described in appendix, please check there. RDSIO5000+ board also includes two XLR connectors which serve as balanced audio inputs and 3 BNC connectors (MPXin, MPXout and 19KHz TTL pilot output). It also has a header for RS232 so you can connect entire transmitter to a PC and control it remotely. Connect the RS232 headers on LCD display and RDSIO5000+ boards to activate remote control capability. All RDS parameters are set via PC. The other connections that need setup are audio inputs (2x RCA + 2x XLR), USB audio input and MPX audio output going to the transmitter (this is usually microphone coaxial cable).

### **Setting up levels**

SE6000 DSP+ 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.

Let's assume that you don't own an expensive peak:

- 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 trimmer (J) 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).

### **MAXLINK cable and MAXPRO FM exciters**

Using our stereo encoders together with our MAX PRO FM exciters 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. 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.

## Some useful tips

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 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 it is better to use aluminum or other metal as these shield against RF generated by the transmitter. The 7805 regulator needs to be bolted to the enclosure via metallic spacer as it does get a bit 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. If you are having problems with enclosure consider buying a fully assembled unit in a rack enclosure from our website.

### Balanced audio and power connector

SE6000 DSP+ features balanced audio inputs, if you want to take advantage of these either install RDSIO5000 board which has 2 of these connectors or just connect XLR connectors to 6-pin header (close 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. These inputs are DC coupled and are sensitive to large DC or mains voltages; make sure all equipment is grounded to the same potential before connecting cables.



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 possible via LCD display, either via the dedicated LCD display which connects directly to SE6000DSP+ or when using together with our FM exciters from the LCD display connected to your FM exciter.

**Which FM exciters can be connected to SE6000DSP+**

Since the SE6000DSP+ uses a different DSP processor it can't be connected to older FM exciters. A MAXPRO5000 series or MAXPRO6000 series FM exciter is required. Additionally, it must have the new LCD display with rotary encoder (single rotating button), either the 2x16 or 4x16 type.

## SE6000DSP+ LCD control module

Basically there are three push-buttons available for the menu system; **UP**, **DOWN** and **MENU**. By pushing **UP** or **DOWN** you change the selected parameter in corresponding direction. The third button (**MENU**) gives you an option to select and setup many of the options and DSP functions of this unit. LCD display with rotary encoder has a different setup, you need to press the rotary button to select menu. Rotating up or down changes the parameter value.

### Lcd control module menu system: Power and DSP functions

The UP and DOWN keys are used to change parameter values. In normal mode the LCD simply shows audio level for both channels. Menu key can be used to enter the menu mode, repeatedly pressing this key brings up the following menus: <STEREO MODE>, <TREBLE>, <BASS>, <COMPRESSION>, <THRESHOLD>, <ATTACK>, <DECAY>, <INTEGRATION>, <LCD CONTRAST>, <RIGHT CH VOL>, <LEFT CH VOL>, <PILOT LEVEL>, , <PREEMPHASIS>, <FIRMWARE VER>. Pressing the UP or DOWN key selects the desired parameter and allows you to modify its value. Another press on the MENU key and you're back to the normal mode. Note that all these settings except power and frequency are already set as they should be so changing them should not be necessary and is not recommended. Best values are marked with D, such as <50uS D>.

### <STEREO MODE>

You can set your transmitter to MONO or STEREO here.

### <TREBLE> and <BASS> (only with DSP stereo encoders)

This option allows you to set the amount of TREBLE and BASS in your audio. Recommended values are marked with (D).

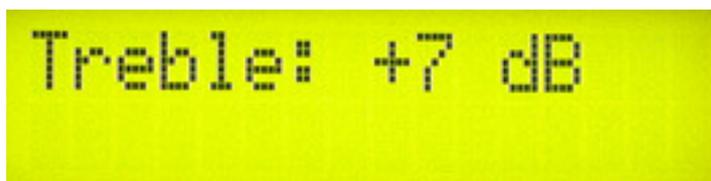


Fig. 5: Setting treble

### Compressor Settings (only with DSP stereo encoders)

A number of MENU settings control the operation of the compressor. Lets assume that the audio signal enters the transmitter at some low level. Compressor does nothing to the signal until at one point as the input signal increases the signal reaches the compression threshold. Digital signal processor starts compressing the signal beyond that point. The higher the compression ratio the higher the compression. For example, compression ratio of  $1:\infty$  would in effect be a limiter.

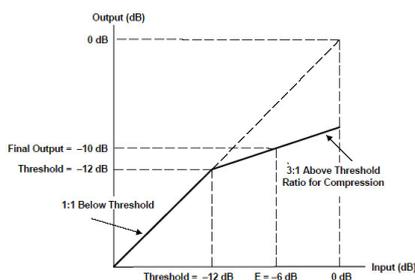


Fig. 6: Explanation of the compressor settings

A yellow LCD screen displaying the text "Compression level: 4.00:1" in a black, pixelated font.

Fig. 7: Setting the compression level

A yellow LCD screen displaying the text "Compression threshold: -12.0dB" in a black, pixelated font.

Fig. 8: Setting the compression threshold

A yellow LCD screen displaying the text "Attack: 3.5ms" in a black, pixelated font.

Fig. 9: Setting the attack time, this is the time between the input signal and the actual response of the compressor

A yellow LCD screen displaying the text "Decay: 106ms" in a black, pixelated font.

Fig. 10: Setting the decay time, this is the time the compressor needs to respond after the input signal falls back to normal level (below threshold).

A yellow LCD screen displaying the text "Integration interval: 212ms" in a black, pixelated font.

Fig. 11: Setting the integration interval, this is the time the DSP evaluates the signal to establish whether it should respond or not

Integration interval determines the energy needed to trip the compressor. In simple words; it determines how long the audio needs to be loud for the compressor to respond by reducing the gain. This is not to be confused with attack time. Attack time of 50ms means the compressor will respond in 50ms after the signal spike is detected, regardless of duration of that spike, even if it is just a very short event. With longer integration interval, on the other hand, compressor only responds if a long spike or a substantial number of spikes is detected (meaning more signal energy).

#### <LCD CONTRAST>

Select for the best visibility. Contrast is slightly affected by ambient temperature and you can adapt it to your needs here.

A yellow LCD screen displaying the text "\*LCD CONTRAST\*" in a black, pixelated font.

Fig. 12: Changing contrast

#### Left and right channel volume

This option allows you to precisely adjust the input sensitivity of both audio channels. This is very useful when your audio source has either too high or too low output level.



Fig. 13: Changing right input channel gain

**<FIRMWARE VER>**

This option allows you to display current LCD module firmware version.



Fig. 14: Firmware version

**<PREEMPHASIS>**

This option allows you to set pre-emphasis. It should be 50uS for EU and most of the world and 75uS for USA, Japan and South America.

**<PILOT LEVEL>**

This option allows you to adjust 19KHz pilot level.

## 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 1ohm 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 15: 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"> <li>1. Check supply power and voltage</li> <li>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</li> <li>3. Increase audio level in the FM exciter a little bit</li> <li>4. You may need to increase pilot level a little with LCD module</li> <li>5. Make sure you have disabled pre-emphasis in your FM exciter (set jumper to NONE).</li> </ol>
Very poor stereo separation, strange audio	<ol style="list-style-type: none"> <li>1. Make sure you disable pre-emphasis in your FM EXCITER. Check supply voltage</li> </ol>
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"> <li>- Try with a different mains power supply.</li> <li>- Move antenna as far away from the transmitter and audio gear as possible</li> <li>- Use XLR audio connectors or digital audio, if possible (USB)</li> <li>- Make sure SWR is low</li> <li>- Keep audio cables short and away from antenna and RF coaxial cable</li> <li>- 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.</li> </ul>

Table 2: Troubleshooting

## Appendix A: What's under the hood?

### INTRODUCTION - PRINCIPLES OF OPERATION

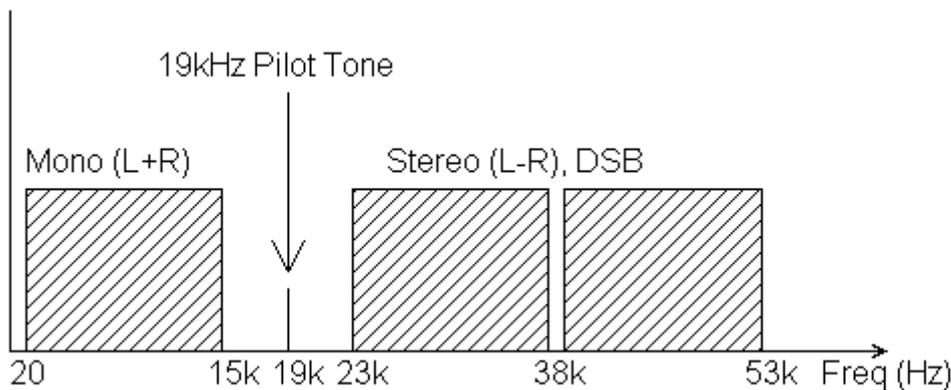


Fig. 3: Theoretical frequency spectrum of the stereo multiplexed signal

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.

## 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:

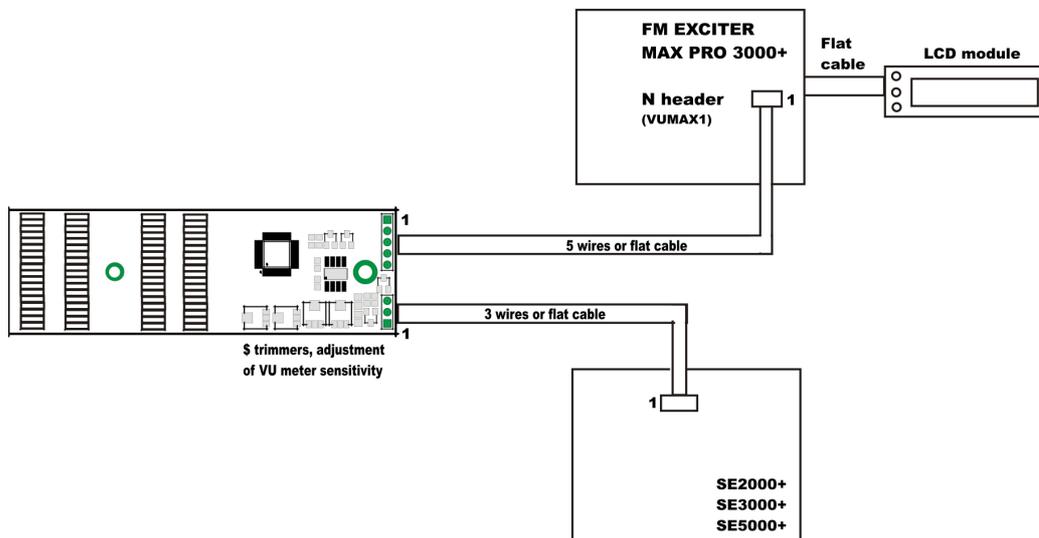


Fig. 20: Connecting VU meter to FM exciter

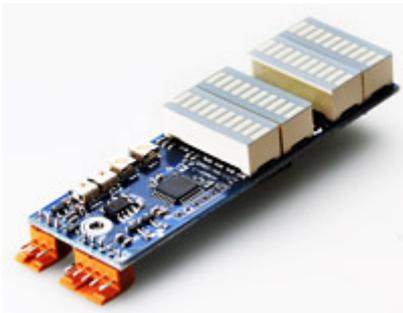


Fig. 21: VU MAX-1

**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.

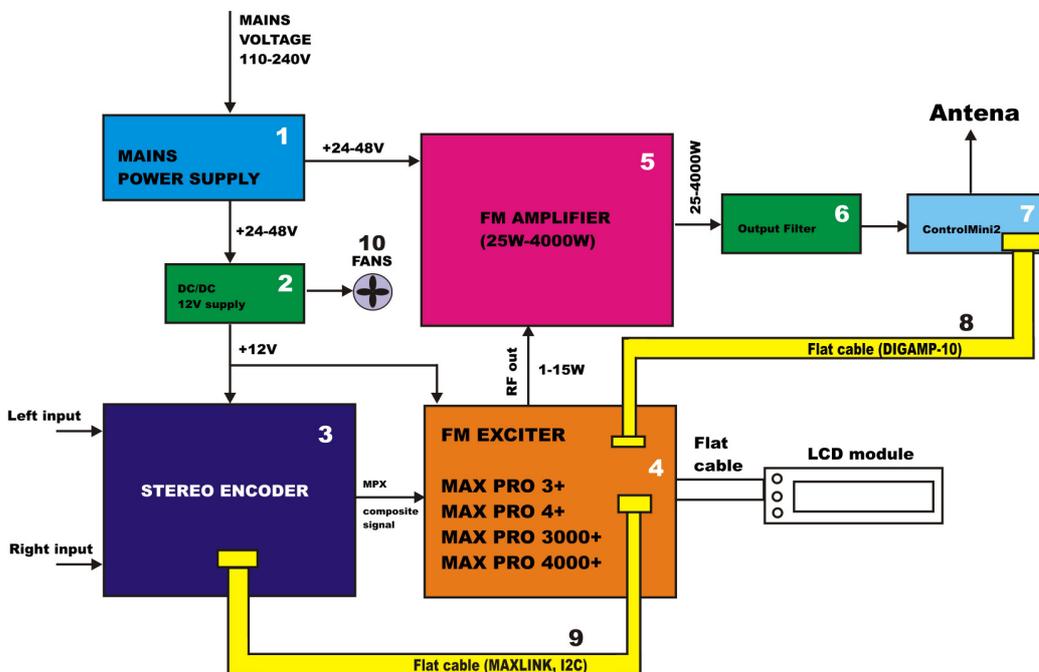


Fig. 22: Connecting an external amplifier module – Complete FM transmitter, block diagram

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](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 our 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](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](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](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](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 – Warranty and legal info**

### **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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- AM transmitters with extremely clear modulation (PWM design)
- Various accessories for professional and hobby FM radio stations
- A large assortment of hard to obtain RF components (RF transistors; MRF, 2SC, coils, silver plated wire, coaxial cable, capacitors, quartz crystals and many others)
- 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 (Jan,2015): 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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