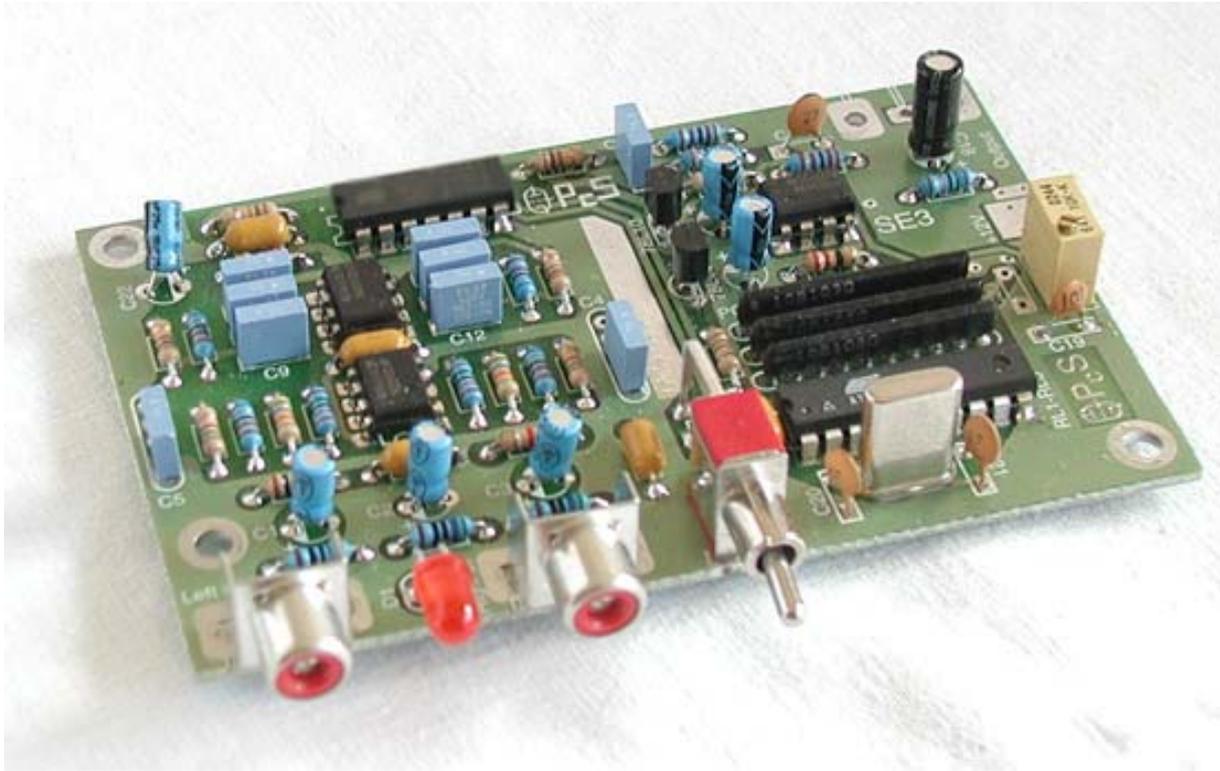




PCS Electronics
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SE-3 STEREO ENCODER

Digital/analog stereo encoder



SE-3 is a low cost, high performance stereo encoder. It was designed to offer optimum stereo separation and excellent spectral cleanliness for the MAX family of FM excitors as well as those from other manufacturers. This encoder will finally provide your ISA -MAX, MAX PRO I, MAX PRO II or MAX PRO III with quality stereo capability. Digital oversampling pilot synthesis, audio low pass input filters, preemphasis and post mpX filtering ensure that this unit conforms to most broadcast regulations. SE-3 allows excellent compatibility with sub carrier services such as the radio data system – RDS (suitable RDS encoders will soon be available from PCS Electronics as well). High quality components and printed circuit board assure 24/7 operation for years.

FEATURES:

Separation: >45db separation
Filtering: 15 kHz low pass input filters
MPX filtering: Basic mpX filtering
Pre-emphasis: 50uS default (replace R8 & R11 with 82K for 75uS)
Control: On-board Stereo/Mono switch
Input: Unbalanced 600 ohm, RCA jacks on board
Output: Unbalanced 75 ohm, RCA jack on board

TECHNOLOGY:

High grade low noise op amps
High quality double-sided PCB
Combination of analogue and digital technology
High-precision digitally synthesized pilot carrier (32x oversampled)

INTRODUCTION - PRINCIPLES OF OPERATION

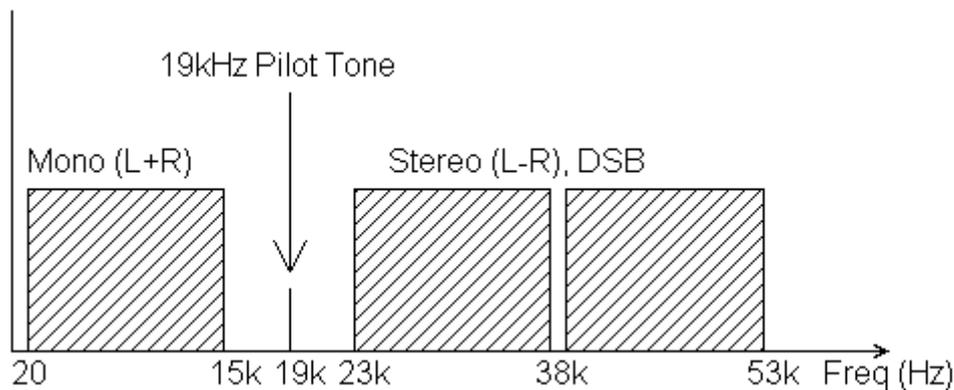


Figure 1: *Theoretical frequency spectrum of the stereo multiplexed signal*

Figure 1 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 45 db of separation, some give only 35 db. So even with modern day DSP (digital signal processor) stereo encoders that achieve separations of more than 70 db, you will never hear it because the radio you will be listening to it on may only allow 45 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. The audio signals are fed from here into the active pre-emphasis circuit formed by op amps IC1 A and B. 50uS pre-emphasis is default, with 75uS possible with a change of two resistors (check component list). The outputs of the pre-emphasis circuits are then fed into the 15 KHz low pass filter to remove any high content above 15 KHz. This is a basic filter, better results can be obtained by using an external low pass filter and compressor/limiter. The filters are fed into switch (IC5), operated by the microcontroller (IC4). The output from the switch (mixer) is fed to the output buffer. Microcontroller also generates the pilot tone (19 KHz) via the D/A converter. All these signals (DSB and pilot) are summed up and buffered with IC3. The resulting MPX signal is then filtered and buffered (IC4).

HERE IS WHAT YOU NEED TO USE SE-3:

POWER SUPPLY

This unit is designed to work with a wall-wart that gives 12-15V at 50-100mA, provided it has a good smoothing cap. You can connect the DC supply by soldering the leads to the pads on the PCB (marked with + and -).

ENCLOSURE

If you want to make your own, use aluminum or other metal, ventilation holes are not required, unit hardly produces any heat. Fix the PCB with all screws tightly. There should be a shield 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.

SETUP AND TESTING

SE-3 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. 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.

To set up the encoder, disconnect audio from the input sockets on the encoder. Adjust the modulation level at the exciter so that the LED diode lights on the receiver. The next step in setting up the encoder is to optimize the stereo separation by adjusting the 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 P1 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 erratic operation, I myself forgot to remove the jumper once and spent hours fixing the damn thing).

COMPONENT PLACEMENT AND CONNECTIONS

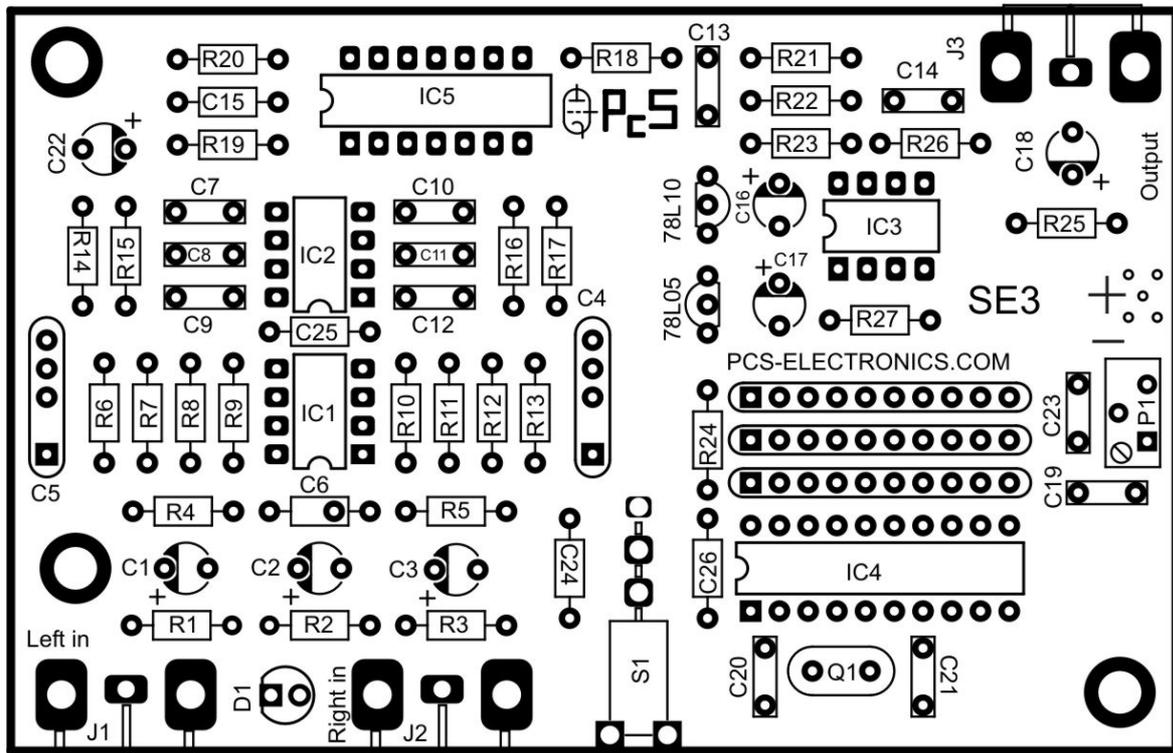


Figure 2: Component placement for the SE3 stereo encoder

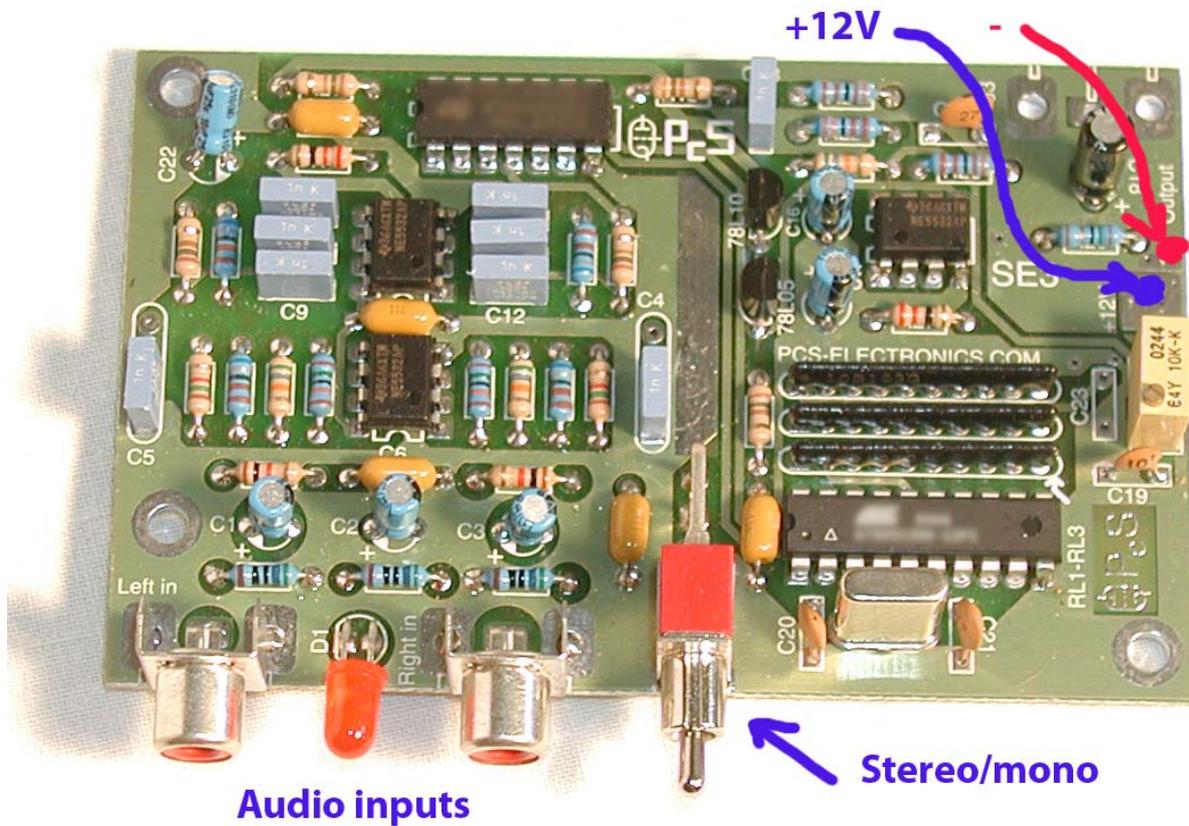


Figure 3: Audio inputs and power connections up close

LEGAL CONCERNS

If you have any legal questions concerning your SE3 or any device which emits RF energy, it is your responsibility to study the regulations. It is best if you personally read the rules (and consult with a lawyer if you're in doubt). It is up to you to operate within local laws and PCS Elektronik d.o.o. cannot be held responsible for any violation thereof.

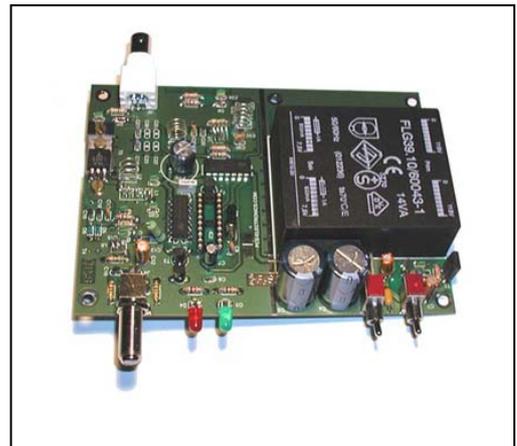
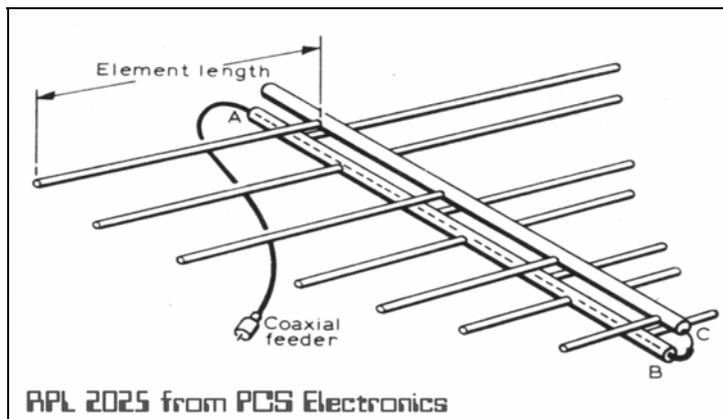
THANK YOU FOR PURCHASING SE3!

We hope you will enjoy it as much as we do and remember to tell your friends about it. Please feel free to send us your comments to feedback@pcs-electronics.com or post your experience in our forum. For tech support please send email to support@pcs-electronics.com

From all of us we wish you happy broadcasting!

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