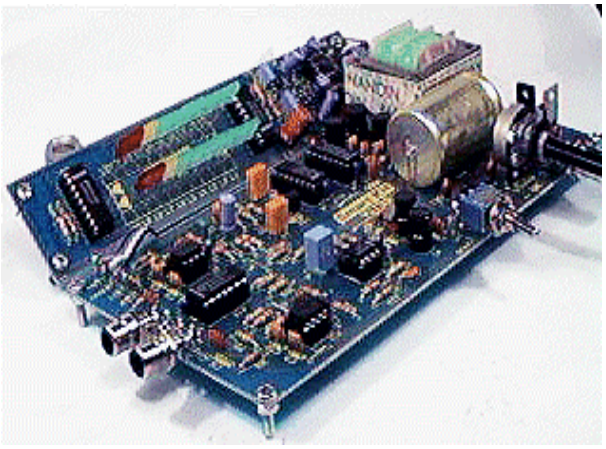
QUASAR KIT 1079

FM STEREO ENCODER

General Description



In our days the majority of the FM radio stations, transmit a stereo modulated signal, offering you a high quality sound. However, to achieve a right stereo transmission, the stereo encoder must be of high quality since the reception of the transmitted signal must be very good without any distortions and with the right channel separation.
This FM stereo encoder has the right specifications and can be used in professional FM radio stations.
Before we start the description of the circuit, it is necessary to give a short description of the functions that must be supported by a circuit like this.
You must know that a stereo transmission must be also realized as a mono, since in any different case a mono receiver can not receive a stereo transmitter.
The aim of an encoder is to transmit a properly modulated signal which will be detectable by a simple mono radio receiver and by a Hi-Fi stereo receiver.
Hence, the generator transmits a signal which is the sum L+R of two low frequency signals, which are received by the left channel (L) and the right channel (R). The signal L+R is the signal that is received by the MONO receivers.
At the same time the generator, generates a 19KHz signal and a subcarrier of 38KHz. The subcarrier is modulated by a different low frequencies signal. This signal is the result of the subtraction L-R.
Hence, the 38KHz subcarrier is modulated by the signal L-R and without this we would add to the MONO signal L+R another one signal L-R.
In that case, the signals that are in the same phase will be eliminated while the signals of different phase will be added. That means, the final result will be a MONO signal.
Now, let's see how the above signals will be appeared at the input of the decoder in the receiver.
At this time we are talking about the MONO signal L+R, the 19KHz tone pilot and the L-R signal that is added on the upper and lower sidebands of the 38KHz subcarrier.
The decoder in the receiver must apply a reverse procedure in order to generate the initial signals L and R.
That means, the decoder must add the signals L+R and L-R in order to generate the left channel signal.
Simultaneously, the decoder must change the phase of the signal L-R by 180 degrees and then to add the signal L+R in order to generate the right channel signal.

Technical Specifications - Characteristics

Input
Input Resistance: 5KOhm
Frequency range: 30Hz - 15KHz (± 1dB)
Maximum input voltage: 0.99V (RMS) for 1KHz and 0 dBm output level.
Pre-emphasis: 50ms

Output
Pilot tone: 19KHz
Pilot tone signal level: 11% of the stereo - multiplexed signal
Output resistance: 600 Ohm
Adjustable output voltage: 0.55Vpp (-12 dBm) to 9.73Vpp (+ 13dBm)
Total distortion for 0 dBm output in 1KHz £ 0.5%
Channel separation in 1KHz ³ 40dB
Supply voltage: 220V/50Hz
Power consumption: 2.8VA

How it Works

The FM stereo generator consists of two p.c. boards. The p.c. board 1079A contains the basic circuit of the generator, while the p.c. board 1079B contains the circuit of the VU-meter.
The electronic diagram of the generator basic circuit is shown in figure 1. We will begin the description of it from the two separate circuits shown at the upper left hand side of the figure 1. These two circuits correspond to the right channel and to the left channel.
The circuit of the left channel is configured by the IC1 and its external resistors and capacitors. The circuit of the right channel is configured by the IC2 and its external resistors and capacitors. Both of them are identical and are the amplification stages of the circuit. The gain of each stage increases until the value of 14KHz.
The signal of the left channel is received at the node configured by the components R5, R7, C6 and it is driven to the modulation stage. The right channel signal is received at the node configured by the components R12, R14, C12 and it is also driven to the modulation stage.
The modulation stage is configured by the IC3 (IC3 = N1, N2, N3, N4). The stage samples the signals from the two channels. The sampling is realized with a frequency of 38KHz and with a phase difference of 180 degrees. After the sampling, the signals are driven through the resistors R22 and R36 to the modulation stage. Also, the two signals are mixed through the resistors R15 and R16 and they are driven through the capacitor C25 to the output stage of the generator.
An oscillator of 455KHz is used to produce the two 38KHz signals. The oscillator is configured by the transistor TR1, the filters Y1, Y2 and the resistors and the capacitors which are located around them. The frequency of 455KHz is applied through the filter Y2, to the pin 14 of the IC4. The IC4 is a divider which divides the frequency of 455KHz by 6. Thus, a frequency of 76KHz is received at the output Q1 (pin 5) of the IC4.
This frequency is applied to the input (pin 13) of the IC5A, which is also a frequency divider that divides the frequency by 2. Hence, from the two outputs (the normal and the complementary) we receive two 38KHz signals with a phase difference of 180 degrees.
The signal that is being received at the complementary output (pin 14) of the IC5A is applied to the pin 3 of the IC5B and is divided by 2 again. Thus, the 19KHz pilot tone appears at the output (pin 1) of the IC5B.

The 19KHz pilot tone is a rectangular signal that is converted to a sinusoidal. The conversion is realized through a filter that is configured by the components L1, L2, L3, C18, C19, C20 and C21. After the conversion, the sinusoidal signal is driven through the resistor R23 and the capacitor C22 to the output stage of the generator.
The 38KHz that is produced at the pins 14, 15 of the IC5A is used to modulate the stereo signal. This can be achieved using a full quadruple switch (IC3). The switch is controlled by the two 38KHz signals.
The switches N1, N3 are used to mix the two channels signals, while the switches N2, N4 are used to ground the outputs of the N1, N3 when they are not activated. Notice that the switches N1, N3 operate alternately as the switches N2, N4, since they are controlled by signals with phase difference of 180 degrees. The modulated signal that is appeared at the outputs of the N1, N3 is mixed with the 19KHz pilot tone and amplified by the operational amplifier A2.
At the output of the A2 there is a low-pass filter that is configured by the components L4, L5, C28, C29, C31. This filter defines the stereo generator response curve.
The operational amplifier 'A1' adds the signal that receives from the two channels. The signal that is delivered at the output of the operational amplifier 'A1' is used for the monophonic broadcasting. The operational amplifiers A1, A2 configure the IC6.
The IC7 amplifies the generator output signal with an adjusted amplification rate that is defined by the potentiometer P1.
The electronic diagram of the supply voltage circuit is shown at the bottom of the figure 1. The circuit includes a bridge rectifier (BR1) which rectifies the AC voltage that is received from the secondary winding of the transformer T1. The rectified voltage is filtered by the capacitor C34 and stabilized by the transistor TR2 (for 24V) or by the IC8 (for 15V). The 15V voltage is used to supply the generator and the 24V voltage is used to supply the VU-meter.
The circuit of the VU-meter is shown in figure 2 (1079B p.c. board). There are two rows of LEDs which display the signals levels of the two channels that applied at the input of the generator.
The row of the LEDs that corresponds to the right channel is supported by the IC2 while the other one that corresponds to the left channel is supported by the IC3.
The output signal of the operational amplifier A1 is rectified by the diode D1, filtered by the RC filter and finally it is applied to the pin 5 of the IC2.
The same procedure is followed for the output signal of the operational amplifier A2, that is rectified by the diode D4, filtered by an RC filter and finally it is applied to the pin 5 of the IC3.

Construction

Begin to assembly the p.c. board 1079A placing and soldering the jumpers and the sockets. Then locate and solder the resistors, capacitors, coils, bridge rectifiers, filters and transistors taking special care about the polarity of some of them. See figure 3 in order to locate them in the right position. Be careful to solder the IC8 in the right position. Then solder the transformer T1.
Having finished the assembly of the p.c. board 1079A check it for any mistakes, non-soldered pins or dry joints. A proper joint is spread all over the pad and is shiny. A dry joint is dull, bulky and has the shape of a ball.
Then start to assembly the 1079B p.c. board. Locate and solder the sockets of the two integrated circuits, the resistors, capacitors, diodes, transistors and the LEDs (see figure

3). As above, follow the same procedure in order to check the p.c. board.
If everything is right, set the ICs on the sockets according to the layout diagram that is shown in the figure 3. Use a 25W soldering iron with a good quality solder. Clean the two p.c. boards using a soldering flux.

Adjustments

Figure 4 shows the connections between the two p.c. boards and between the p.c. board 1079A and the potentiometer P2.
Having checked the rightness of the connections, apply the supply voltage (220V - 240V). Use a voltmeter in order to measure a +24V (DC) voltage at pin +V that is connected to the p.c. board 1079B. Try to measure a +15V (DC) voltage at pin 7 of the IC7. Apply a sinusoidal signal of 1KHz (1V RMS) at the input R of the generator. Check the right operation of the P2 (INPUT LEVEL) by watching the operation of the LEDs L1 to L10. Apply the same signal at the input L of the generator and check the right operation of the LEDs L11 to L20.
Connect the oscilloscope at the output of the generator. Handle the switch S1 in such a way in order to short circuit the intermediate pin with the pin MONO (see figure 3).
Adjust the potentiometer P2 (INPUT LEVEL) in order to achieve that the row of the LEDs which correspond to the left channel to be activated up to the yellow LED.
Adjust the potentiometer P1 (OUTPUT LEVEL) until the appearance of an adjusted sinusoidal signal, the amplitude of which lies between 300mVpp and 6Vpp.
Apply the 1KHz signal to the inputs L and R and notice the doubling of the output signal amplitude that changes using the P1 between the value of 600mVpp and the value of 12Vpp.Then remove the 1KHz signal from the input L and continue to apply it to the input R.
Set the switch S1 to short circuit the intermediate pin with the pin STEREO. Turn the axis of the P2 (INPUT LEVEL) to the left (MIN) until you see that the LEDs which correspond to the right channel are not activated. Try to see the 19KHz pilot tone on the screen of the oscilloscope. Adjust the potentiometer P1 to make it visible. Then adjust the potentiometer P2 until the yellow LED L8 of the bar R to be lighted on. Figure 5A shows the received signal as it is displayed on the screen of the oscilloscope. Compare the amplitude of the complex signal with the amplitude of the pilot tone. Then apply the 1KHz signal to the input L and see the signal displayed on the screen of the oscilloscope (figure 5B).
Now the generator is ready to be connected to the sound mixer and to the FM transmitter. The final connections are shown in the figure 6. Apply a sound signal from the sound mixer to the generator and adjust the potentiometer P2 in such a way that the bar indication does not exceed the LEDs L8 and L18. For the adjustment of the P1 it is necessary to know the maximum permitted input voltage, in order to secure the maximum permitted limit of your channel width in FM (150KHz).
Follow the next steps in order to adjust the P1:
1) Turn the axis of the P1 and P2 to the left (MIN).
2) Set the switch S1 in the STEREO position.
3) Apply the supply voltage to the transmitter and transmit without modulation.
4) Use a stereo receiver resonated on the frequency of the radio station.
5) Start to turn the axis of the P1 to the right until you see the FM STEREO indicator of the receiver to be lighted.
6) Apply a signal from the sound mixer to the generator and adjust the P2 until you see the yellow LEDs to be lighted.
Note: You can change the level of the pilot tone by changing the value of the resistor R23.

Setting the P1 on the 0dBm indication the pilot tone takes the value of 320Mv. The resistor R23 can take a variety of values (180 Ohm, 220 Ohm, 270 Ohm) increasing or decreasing the pilot tone level.

Warning

Quasar kits are sold as stand alone training kits.

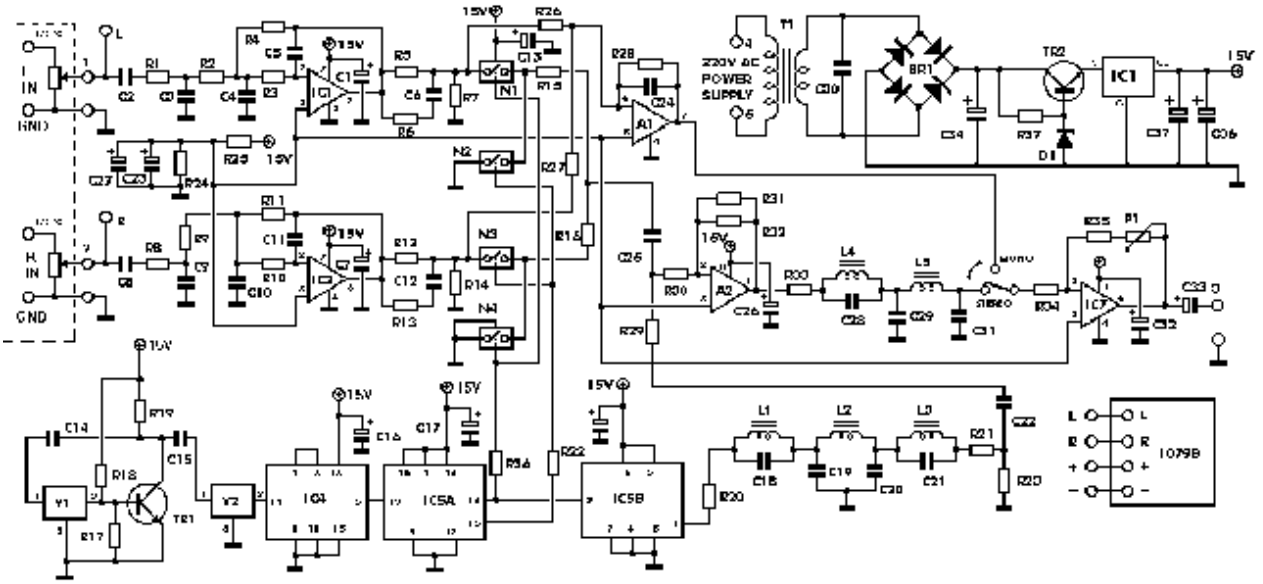
If they are used as part of a larger assembly and any damage is caused, our company bears no responsibility.

While using electrical parts, handle power supply and equipment with great care, following safety standards as described by international specs and regulations.

If it does not work

Check your work for possible dry joints, bridges across adjacent tracks or soldering flux residues that usually cause problems.
Check again all the external connections to and from the circuit to see if there is a mistake there.
- See that there are no components missing or inserted in the wrong places.
- Make sure that all the polarised components have been soldered the right way round. - Make sure the supply has the correct voltage and is connected the right way round to your circuit.
- Check your project for faulty or damaged components.
If your project still fails to work, please contact us for information about our Get-You-Going service.

Schematic Diagram



Parts List

All components including printed circuit board, assembly instructions including schematics and detailed parts list are supplied when you purchase the kit.

Ordering

For pricing info and online ordering please visit:

http://www.quasarelectronics.com/1079.htm

For further info please contact us by e-mail:

mailto: sales@QuasarElectronics.com