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CYBER MAX FM 15W

CYBER MAX FM is an affordable high performance FM broadcasting exciter with SE3, our combined analog/digital stereo encoder. It was designed to offer excellent performance, spectral cleanliness and ruggedness, as well as fairly simple handling. High quality components and manufacturing ensure 24/7 operation for years.

FEATURES

RF Output Power: 15W (20Wmax), variable
Output connector: BNC
Output Impedance: 50 Ohms
Frequency Range: 87.5-108MHz
PLL Steps: 50 KHz
Frequency stability: +/- 100Hz
Spurious/Harmonic rejection: Harmonics: -60dB typ., Spurious: -80dB
Audio Frequency Response: 35Hz-75 KHz @ -3dB
Power Supply: DC 13.8-15V / 4A stabilized
Stereo separation: >50dB typ.
Audio low pass filters: Yes
Pre-emphasis: Precision, 50 or 75uS



BEFORE YOU START...

You will find some very useful tips, a forum and tips on antennas and hooking things together at <http://www.pcs-electronics.com> so it's generally a good place to check before putting your MAX on the air.

Here is what you need to use CYBER MAX FM:

Antenna and/or dummy load to setup and test your transmitter. If you don't have dummy a load, you can build them easily from BNC RF connectors and the proper wattage/value of CARBON resistors. DO NOT USE WIREWOUND OR METAL FILM RESISTORS! A useful one can be constructed with 4 -220 Ohm 1/4 watt resistors in parallel ($220/4 = 55$ Ohms) with center conductor to outer shell (ground) of an RF connector. That is pretty close to 50 Ohms and if you use 1/4 watt resistors you get a nifty 2 Watt Dummy Load for testing your equipment without an antenna. 2W is enough, if you restrict the duration of the testing to half a minute or so.

An antenna (J-pole, 5/8 Comet, 1/4 wave, broadband) up high makes up for lots of power...and is money well spent! Remember propagation at FM frequencies (88-108MHz) is virtually line-of-sight. City miles are longer than country miles; Forest miles are farther than desert miles. Low VSWR and antenna height alone can make up for lots of watts! For instructions regarding construction of antennas please see the end of this document or our website: <http://www.pcs-electronics.com>

You should have realized by now that antenna was, is and will always be a crucial part of the system. Special care has to be taken! It is usually a good idea to place antenna away from your transmitter, power supply and audio system. If you cannot meet these requirements, you

A PIECE OF WIRE OR TV ANTENNA IS NOT SUITABLE ANTENNA FOR CYBER MAX FM OR ANY OTHER RADIO EXCITER!

could experience feedback and other RF problems. We cannot guarantee proper operation of CYBER MAX FM unless suitable antenna system is used! Interestingly, RF energy can make CD players and other digital devices go bezerk. Try placing 30W-driven antenna next to yours, most of the modern audio gear is not RF shielded.

Coaxial cable the common RG-58 from Radio Shack is NOT the best you can do and will lower your effective power out! Use it only for short runs. BELDEN makes terrific coax in various qualities and with very low loss (measured in dB's...decibels)...figure 3 dB loss = 1/4 of your signal strength...either lost or gained. Watch out for the correct impedance...RG-8 and RG-58 have 50 Ohms. RG-59 and RG-6 (Low Loss Version of RG-59) have 75 Ohms. Most antennas are 50 Ohm ones. Check our web site for good coax. Don't buy more than you need to make the long run to your antenna and make up a few "jumpers" to go between your exciter, VSWR meter and your antenna as all you'll do is create a higher SWR and more line losses. Don't use cheap TV cable.

Power supply is what you probably already have, make sure to use properly stabilized DC power supply, capable of providing continuous current of at least 4A at 13.8-15V. Please note that using higher voltage means more power so 15V will yield a few watts more.

BNC connector comes between coaxial cable and your transmitter. It's a standard connector. You might get it along with your antenna. If your antenna comes with PL259 connector, use BNC to SO239 adapter.

Audio equipment. For a start all you need is a simple CD player or a cassette deck. If you want that really professional sound, you will eventually need low noise audio mixer, good microphone, audio Limiter-compressor.... Behringer is a well known name for such equipment. Cheap stuff will give you noise, distortion, over-modulation etc. Consider using PC as your audio platform, get a good sound board and it will do mixing, MP3-playing, limiting, audio processing, CD-playing etc, all at a minimal cost (provided you already own a PC).

HOOKING THINGS TOGETHER AND POWERING UP

Antenna should be matched to 50ohms (it is best to use SWR meter to verify that). It is in fact recommended that you use dummy load the first time you power up your transmitter, until you make sure that everything is well and everything is working optimally. The power potentiometer should be adjusted to minimum (the end of the shaft extrudes 3-4 millimeters from the front panel and you will probably need pliers to turn the power control. This prevents tampering with the unit and accidental power resetting. Turn this control anticlockwise to set it to minimum. Finally, the power supply cable should be connected, make sure the center terminal is positive.

SETUP AND USE

Connect dummy antenna, audio source and power. Turn the unit on. OK, now you should see the welcome message on the LCD. You will also hear a beep after power on. If all is OK, you can try to alter working frequency with UP/DOWN keys. Now turn on your MP3 player, CD audio player or other AUDIO source. Turn on any fm radio and turn the tuning dial until you hear the audio through the fm radio. You will need to adjust audio level so that the sound on the radio sounds natural and without distortion. Too much volume may sound good on your radio, but will sound horrible a few hundred meters from the transmitter! You shouldn't sound louder than other FM stations; rather you should sound a bit quieter since you're not using limiters/compressors (yet). When you sound as loud as other stations and you're not using audio processing, you're actually over modulating. Unfortunately many commercial stations over-modulate nowadays, it's a sad fact. You may want to try a few different frequencies because of better reception in different areas. Some spots on the dial may work better than others.

WARNING: PLEASE BE SURE THAT YOU ARE TUNING IN TO AN AREA ON YOUR LOCAL FM BAND THAT HAS NO STATION BROADCASTING ON IT, YOU DO NOT WANT TO INTERRUPT ANYONE ELSE'S LISTENING TO LOCAL RADIO STATIONS, IT'S RUDE AND ALSO ILEGAL!

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You can now try to slowly increase the power. Keep listening to the radio, signal should remain strong and clean. Only use as much power as necessary for your application. Make sure to keep the slots on the cover free to allow free air exchange and cooling of the unit.

FRONT PANEL

Going from left to right you have: Audio inputs (with stereo encoder power indicator in the middle), MONO/STEREO switch, power adjustment trimmer (adjustable with pliers for added security), SWR protection LED (normally off) and main ON/OFF switch.

BACK PANEL

BNC connector for the antenna, power supply socket and fuse. Make sure to always replace fuse with specified type (3A fast), this should prevent accidental damage to the unit or extensive damage, if some kind of problem develops with time. Please note polarity of the power supply, positive terminal should be in the middle – center conductor.

THINGS TO REMEMBER

Please remember to turn off the transmitter when not in use! 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. If you experience hum, do one of the following:

- Move antenna as far away from the transmitter and audio gear as possible
- Make sure antenna is tuned; low SWR.
- Use proper DC stabilized power supply. You can test this by using car battery to confirm this possible cause.
- Keep audio cables short and away from RF coaxial cable
- Try to move your cables away and see if that helps, take care of proper grounding
- Form a coil from coaxial cable going to the antenna, make a few turns. This helps stop 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.

NEWSLETTER

You may want to sign up for our newsletter so you can receive the latest news and special deals. Also check our forum and discuss tips and tricks with other users, you never know you just may learn something. You can sign up at www.pcs-electronics.com

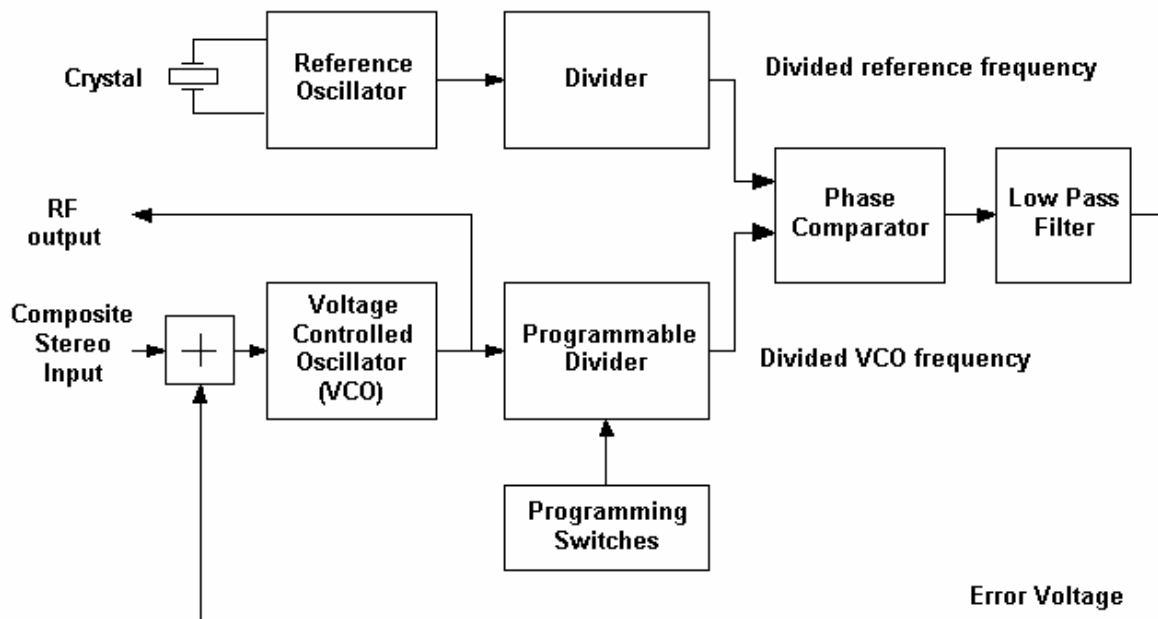
APPENDIX A: USING THE CYBER MAX FM

Basically there are three push-buttons available for the menu system, **UP**, **DOWN** and **MENU**. By pushing **UP** or **DOWN** you get a shift of frequency in corresponding direction. Hold any of these keys for a few seconds and the jumps will increase to 500 KHz. The new frequency is saved automatically. The third button (**MENU**) gives you an option to turn off the **LOCK MONITOR**. CYBER MAX FM doesn't check PLL lock status when this function is off and does not shut down power if the unit loses lock. When this function is On, CYBER MAX FM constantly checks PLL lock status and shuts down output power in case of lost lock. Unlocked PLL is also indicated by an annoying low-pitched periodic sound.

APPENDIX B: THE PRINCIPLES OF OPERATION

CYBER MAX FM features a Phase Locked Loop (PLL) oscillator. This combines the ease of tuning and wide deviation of a VFO with the frequency stability of a crystal oscillator. Have a look at the diagram below; a crystal oscillator is used to provide a reference frequency. This is digitally divided to a frequency of relatively low 50 KHz. A VFO provides the wanted output frequency, which is also digitally divided to give another relatively low frequency. These two low frequencies are presented to a phase comparator which basically decides which frequency is higher by comparing the phases of the two signals. The phase comparator generates an error voltage which is connected back to the input of the VFO through a low pass filter (LPF). This is the loop bit. If the VFO is running too fast the phase comparator decreases the error voltage so as to slow it down till the phases at its input are the same. If it's running too slow the error voltage is increased to speed it up until the phases are the same. All this happens instantaneously, of course so the output frequency remains constant. In this way the temperature stability of the VFO isn't important as its output frequency is phase locked to the crystal oscillator, and the frequency stability of this is very good. Clever eh? Two more things to explain. How do you change the output frequency? By making the VFO's divider programmable. Say it's set to divide by the number N. The phase comparator is a simple minded sort of soul, concerned only with equalizing the phases at its inputs, it doesn't know what's really coming out of the VFO, which is N times the divided reference signal. Because this signal is so low compared to the VFO frequency N can be made to have hundreds of different values, giving hundreds of different output frequencies from the VFO. So changing the frequencies is just a matter of changing division ratio. Since this is taken care by the uCPU (IC2), all you have to do is push the button. By the way, almost all of the black boxes from the above diagram are contained in one single integrated circuit, IC 3. VFO is being frequency modulated by the audio input, so its frequency at any given instant depends on the voltage of the audio output. We don't want this variation of the VFO's frequency to be ironed out by the PLL system thus we 'iron out' the error voltage from the phase comparator, so it just contains the underlying trend rather than what's happening at any split second. This is the purpose of the low pass filter. Programmable PLL oscillators are used in majority of the professional communications equipment, including broadcast transmitters. The digital part of CYBER MAX FM is a small computer, based on ATMEL microcontroller. This little chip is actually doing all the »thinking« for CYBER MAX FM. It sets the divider ratio for PLL, directs LED and reads keyboard. All of the various settings are stored in the EEPROM IC3. Its contents remain unchanged when you turn off the transmitter. VFO is employing a single MOSFET transistor. Weak signal from VFO gets amplified by IC4, T2 and T3 to few watts of pure power. Output filter consisting of L5-L7 and accompanying capacitors keeps harmonics down to minimum.

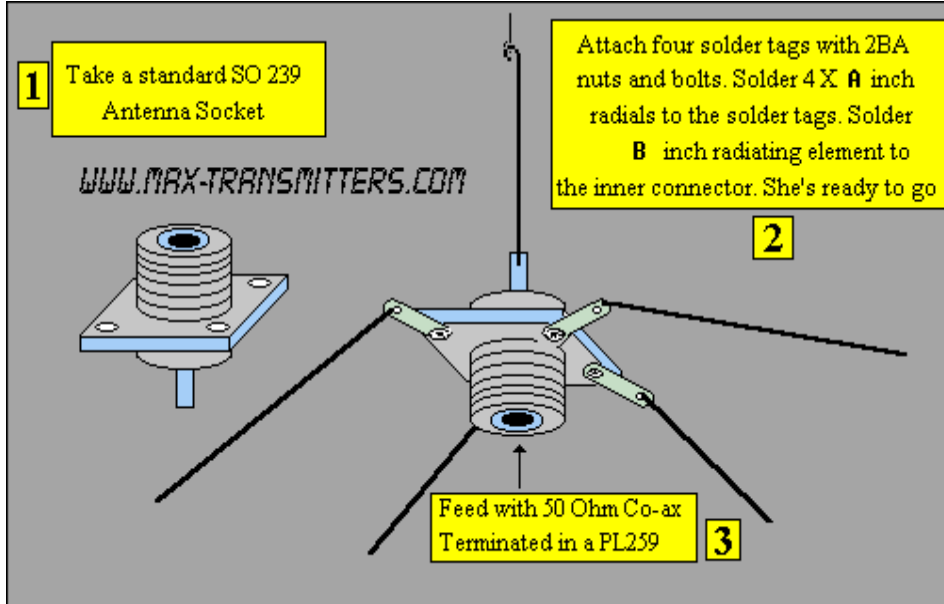
Block Diagram of Phase Locked Loop Controlled Oscillator



PLL block diagram

APPENDIX C: INEXPENSIVE GP ANTENNA DESIGN

You can build an inexpensive 1/4 wave antenna from 1 SO-239 chassis mount RF connector and 5 - 3' bronze welding rods, cut to the proper length. Here is how it looks:



If you have a SWR meter, leave a bit longer radiator and adjust it later by cutting to achieve minimum SWR.

»Do it yourself« GP antenna

Most designs on the web don't compensate for the fact that GP antennas are not wideband antennas. Here is a Freq/element length chart for this simple GP antenna, all element lengths are in millimeters:

Frequency	Radiator - B	Radials - A
108MHZ	660	693
104MHz	684	720
100MHz	713	749
90MHz	792	819

For other antenna designs check our web site.

APPENDIX D: IMPROVEMENT TIPS

Think about purchasing SWR meter to tune and align your antenna. A good antenna system is extremely important and can make up for a lot of power. Check <http://www.pcs-electronics.com/en/products.php?sub=accessories> for a suitable SWR meter.

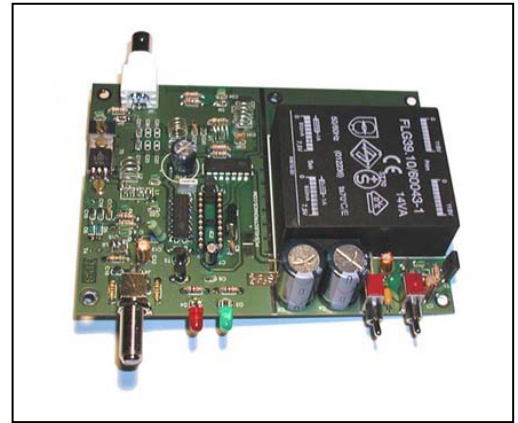
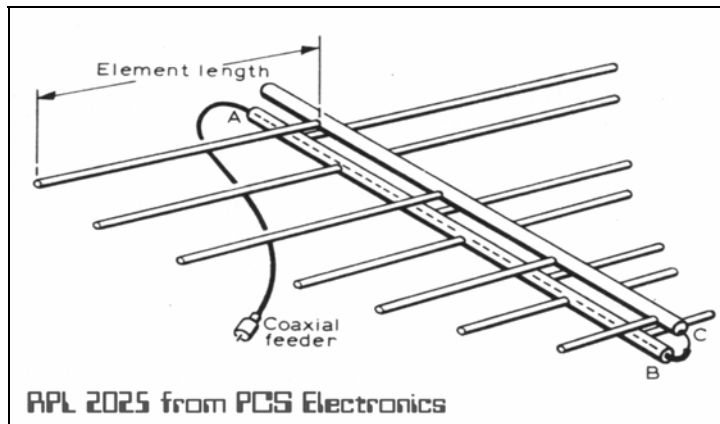
If you can't get much range with your homebrew antenna, have a look at these babies here: <http://www.pcs-electronics.com/en/products.php?sub=antennas>

Still not enough range? Well, how about a 300W amplifier? <http://www.pcs-electronics.com/en/products.php?sub=amplifiers>

Now that should be enough for you for. No? Ok, how about a 10.000W stereo transmitter with touch-screen exciter? http://www.pcs-electronics.com/en/products.php?sub=fm_transmitters



ALSO AVAILABLE FROM PCS ELECTRONICS



Directional antennas, 5W boosters, stand-alone FM transmitters, RDS encoders and much much more...

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LEGAL INFO

It may be illegal to operate this device in your county. Please consult local authorities before using CYBER MAX LCD!

THANK YOU FOR PURCHASING THE CYBERMAX FM 15W!

We hope you'll 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 make a post to our forum. For tech support please send email to support@pcs-electronics.com

From all of us we wish you happy broadcasting!

PCS Electronics team
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