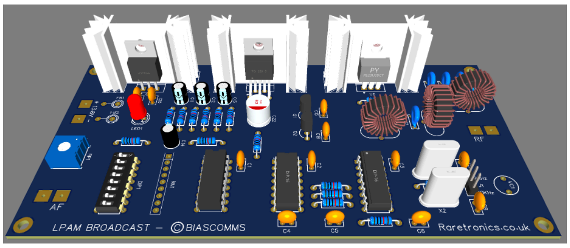
Introduction

The ***CraneFly*** is a high quality LPAM transmitter, which has been specifically designed for the low power AM applications.

PCB Module Layout



Specifications

Frequency BC	1100 -1720 Khz
Power Output RMS	1.25 Watts
Power Output PEP	5 Watts
System Impedance	50 Ohms
Harmonic Output	-30dBc
Spurious Output	-70dBc
Frequency Steps	9KHz or 10KHz
Frequency Stability	5 ppm
DC Power	13.8V
DC Input	8 Watts
Audio Frequency Response	10Hz - 18Khz
S.N.R	>25dB
Modulation	100% (+/-5%)

Circuit Description

The ***CraneFly*** is a Phase Lock Loop (PLL) low power AM transmitter that is built around 4000 CMOS Logic for high frequency stability, which was originally designed by ©BiasComms back in the 1980's.

Dual reference xtals are used to allow operation in countries with either 9 Khz or 10 Khz spacing.

A high power, high fidelity audio amplifier is used to series modulate directly into the final PA Mosfet which is capable of delivering 5W PEP @ 100% Modulation.

The RF output network incorporates a "*Broadband"* impedance matching transformer to ensure maximum transmission of power across a wide frequency range at the correct system impedance of 50 Ohms.

Finally a Low Pass Filter (**LPF**) with the following characteristics below is used to remove harmonic distortion.

Design: Chebyshev
Cutoff Frequency: 1.8 MHz
Pass Ripple: 0.2 dB
Impedance: 50 Ohms
Order: Shunt First
Number of Elements: 3

Installation

Before using your ***CraneFly***, please read through the setup and operating instructions carefully.

First in the unlikely event, take a close look at the PCB module to ensure no defects have occurred during delivery / transit.

Power Supply:
This should be from either a "*Linear"* or "*Switch Mode"* type and have a clean filtered DC output. Supply voltages are from 12.8v Min - 13.8v Typical & 16v Max
Check for "**Correct Polarity**" power pads are marked clearly! **Do not power up yet**.

Frequency & Steps:
Using the frequency selection chart, set the dip switches to the required operating frequency. Ensure to select either 9KHz or 10KHz stepping using the jumper "J1"

Antenna:
The final RF Mosfet is very rugged, However the module should never be powered without a correctly matched antenna or load connected.

Earthing:
Although this is very important for a hum free clean efficient radiating signal.
This should always be made via the antenna earthing system, and "**NEVER**" to your installation site's **Mains** electrical wiring.

Converting Metres to Frequency

The scale or dial on many radios in European countries will usually be marked in wavelengths rather than frequencies.

To convert from one to another, simply divide 300,000 by the known wavelength or frequency. The result is always rounded to its nearest whole number.

Example: 300,000 divided by 1000KHz gives 300 Metres. Conversely, 300,000 divided by 300 Metres give 1000KHz.

Frequency DIP Switch Selection

9K	10K	1	2	3	4	5	6	7	8
-	1100		ON			ON			ON
-	1110	ON				ON			ON
-	1120					ON			ON
-	1130	ON	ON	ON	ON				ON
-	1140		ON	ON	ON				ON
-	1150	ON		ON	ON				ON
-	1160			ON	ON				ON
-	1170	ON	ON		ON				ON
-	1180		ON		ON				ON
-	1190	ON			ON				ON
-	1200				ON				ON
-	1210	ON	ON	ON					ON
-	1220		ON	ON					ON
1107	1230	ON		ON					ON
1116	1240			ON					ON
1125	1250	ON	ON						ON
1134	1260		ON						ON
1143	1270	ON							ON
1152	1280								ON
1161	1290	ON	ON	ON	ON	ON	ON	ON	
1170	1300		ON	ON	ON	ON	ON	ON	
1179	1310	ON		ON	ON	ON	ON	ON	
1188	1320			ON	ON	ON	ON	ON	
1197	1330	ON	ON		ON	ON	ON	ON	
1206	1340		ON		ON	ON	ON	ON	
1215	1350	ON			ON	ON	ON	ON	
1224	1360				ON	ON	ON	ON	
1233	1370	ON	ON	ON		ON	ON	ON	
1242	1380		ON	ON		ON	ON	ON	
1251	1390	ON		ON		ON	ON	ON	
1260	1400			ON		ON	ON	ON	
1269	1410	ON	ON			ON	ON	ON	
1278	1420		ON			ON	ON	ON	
1287	1430	ON				ON	ON	ON	
1296	1440					ON	ON	ON	
1305	1450	ON	ON	ON	ON		ON	ON	
1314	1460		ON	ON	ON		ON	ON	
1323	1470	ON		ON	ON		ON	ON	
1332	1480			ON	ON		ON	ON	
1341	1490	ON	ON		ON		ON	ON	
1350	1500		ON		ON		ON	ON	
1359	1510	ON			ON		ON	ON	
1368	1520				ON		ON	ON	
1377	1530	ON	ON	ON			ON	ON	
1386	1540		ON	ON			ON	ON	
1395	1550	ON		ON			ON	ON	
1404	1560			ON			ON	ON	
1413	1570	ON	ON				ON	ON	
1422	1580		ON				ON	ON	
1431	1590	ON					ON	ON	
1440	1600						ON	ON	
1449	1610	ON	ON	ON	ON	ON		ON	
1458	1620		ON	ON	ON	ON		ON	
1467	1630	ON		ON	ON	ON		ON	
1476	1640			ON	ON	ON		ON	
1485	1650	ON	ON		ON	ON		ON	
1494	1660		ON		ON	ON		ON	
1503	1670	ON			ON	ON		ON	
1512	1680				ON	ON		ON	
1521	1690	ON	ON	ON		ON		ON	
1530	1700		ON	ON		ON		ON	
1539	1710	ON		ON		ON		ON	
1548	1720			ON		ON		ON	
1557	-	ON	ON			ON		ON	
1566			ON			ON		ON	
1575	-	ON				ON		ON	
1584	-					ON		ON	
1593	-	ON	ON	ON	ON			ON	
1602	-		ON	ON	ON			ON	
1611	-	ON		ON	ON			ON	
1620	-			ON	ON			ON	

Antennas

LPAM antenna's are much smaller than those used by commercial high power Medium Wave Broadcasters. Since the actual wavelength at *for example* 1485 Khz is 220 Metres, an ideal antenna would be a ½ wave or 110 Metres in height.

Unfortunately this is not practical for even medium to high powered transmitter sites.
So they're likely to opt for a ¼ wave tower, which for 1485 Khz has a height of 55 Metres or approximately 180 ft.
A vast earthing system beneath tower completes what is known as a ¼ wave Ground Plane Antenna (**GPA**)

LPAM antennas for use with a Restricted Service Licence (**RSL**) or Long Term RSL (**LTRSL**) usually have height and power restrictions as they do in the UK *for example*.
The maximum height is 30 feet with an Effective Monopole Radiated Power (**EMRP**) of 1W.

Typically these antennas are just an end fed wire concealed inside a large tapered fibreglass pole. But they can sometimes be constructed from mini lattice towers.

Both types will normally have a capacitive hat at the very top. The hat not only helps overcome the drastically reduced length of the antenna, but also aids with the maximum current of the radiating lobe being moved much higher up the pole or tower.
(see figure 1a)

At the base of these antennas is usually a large weatherproof box where an Aerial Tuning Unit (**ATU**) is housed. The transmitter is never housed in the same box at the base, these are installed much further away in a separate location. A low loss coax feeder is then used to connect the transmitter to the ATU.(see figure 1b)

Preferably there will be a minimum of 4 long earthing tapes buried beneath the ground.
This tape normally copper is identical to that used as lightning conductors on highrise buildings.
Soil conditions permitting at the installation site, earthing stakes are driven deep into the ground at usually 5m distances from the mast which are electrically bonded to the tape. (see figure 1c)

Figure 1a

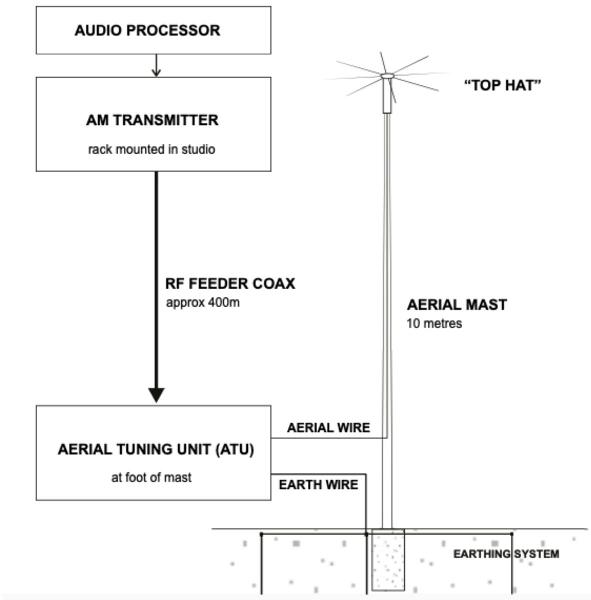
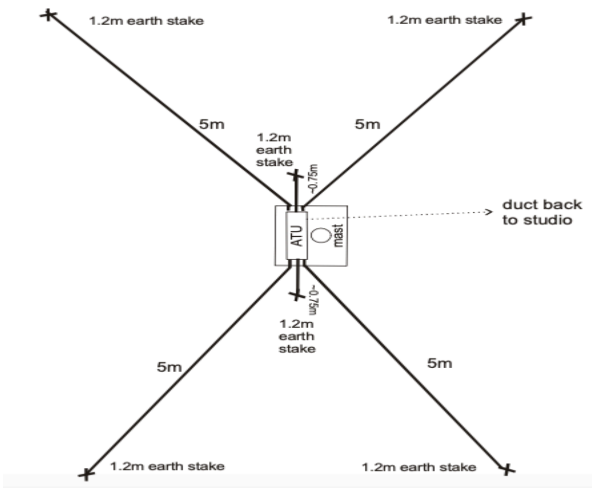


Figure 1b

Figure 1c



What is RMS & PEP

Power measuring for amplitude modulation is not overly complex, but requires a little more understanding compared to other modulation types referred to as "*Modes*"

There are many types of modes, for example FM, AM, CW, SSB, DSB & FSK to name just a few. Differing modes also operate at varying duty cycles.

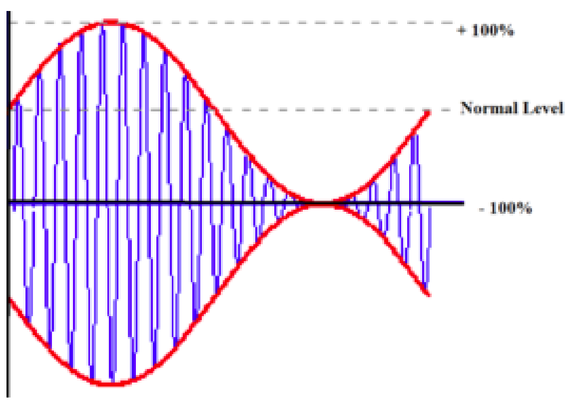
Root Mean Square (**RMS**) is the value of a set of values (or a continuous-time waveform) is the square root of the arithmetic mean of the squares of the values, or the square of the function that defines the continuous waveform in modes such as CW or FM.

Peak Envelope Power (**PEP**) is the average power over a single radio frequency cycle at the crest of the modulation in both positive maximum and negative maximum of the sinusoid. (see figure 2)

Assuming linearity, perfectly symmetry with 100% modulation of a carrier, the PEP output of an AM transmitter is four times its carrier.

It's worth noting that AM PEP can not be measured with a standard RMS RF Meter. An *Oscilloscope* sampling the output of an AM signal being supplied with a 1Khz tone at the correct level should produce a result "similar" to figure 2 below.

Figure 2



Limited Warranty

Your product is guaranteed to be free from defects in both parts and workmanship for 60 days from date of purchase. We will make all reasonable effort to repair or replace the unit covered by this limited warranty.

This warranty shall be voided in the event a product has been modified in design or function, or subject to abuse, misuse, mishandling, unauthorised repair or reversed polarity.

Troubleshooting

Audio Distortion:

- Audio source level is set too high.
- No audio processing or limiting.
- Poor or no grounding of the transmitter.

Hum on Audio:

- Low quality audio cabling or broken shielding.
- Poor or no grounding of the transmitter.
- Insufficient DC power filtering.
- RF ground loop feedback to audio source, (use audio isolation transformer).

No Modulation

- Damaged, broken or poor quality audio cables.
- Audio source level is set too low.

Acknowledgements

The ***CraneFly*** and all its intellectual property are acknowledged to their respectful owners.

The AM transmitter naming “CraneFly” along with the PCB design layout are the copyrighted property of Raretronics.co.uk.

The “*Original”* PLL synthesiser circuit design is credited to Biascomms, which is to be freely used, copied and modified under public domain use. (this does not include the modified version used with the ***CraneFly***)

The RF sections & output impedance matching is partly credited to “Experimental Methods in RF Design” (EMRFD) Manual published by the ARRL

The Chebyshev low pass filter is credited to the Russian mathematician “Pafnuty Chebyshev” because its mathematical characteristics are derived from Chebyshev polynomials.

Other credits are given to test circuit examples provided by the manufacturers, which include “ST Mircoelectronics” & “Infineon Technologies”.

Parts List

Resisters

R1 = 4M7
R2, R4, R13, R14, R15 = 10K
R3, R8, R9, R10, R11 = 100K
R5 = 220K
R6 = 22R
R7 = 4K7
R12 = 10R
RN1 = 10K

Potentiometer

RP1 = 10K Bourns 3386 Series

Capacitors

C1, C2, C3, C15 = 100nF
C4, C8 = 47pF NPO
C5, C9, C10, C16 = 10nF
C6 = 220nF
C7 = 33pF NPO
C11, C14 = 10uF 25v Elec
C12, C13 = 4.7uF 50v Elec
C17, C18 = 100nF 1KV
C19, C20 = 2.2nF 1KV
C21 = 470uF 25v Elec

Variable Capacitor

VC1 = 20pf RED

Dual Inline Packages

DIP1 = 8 Way Switch Bank

Transistors

Q1 = 2N3904
Q2 = 2N3906

Diodes

D1 = 1N4148
LED1 = 5mm Green

Xtals

X1 = 10.240 MHz LC30pf 5 ppm or better HC49
X2 = 9.2160 MHz LC30pf 5 ppm or better HC49

Single Inline Packages

J1 = 3 Pin Header (with jumper)

Heatsinks

U7, U8, U9 = XSD C4663

T0220 Packages

U4 = L7812CV
U5 = TDA2030A
U6 = IRF510 (fin must be isolated from heatsink with mica pad and nylon washer)

Inductors

FB1, FB2 = 2 Turn AWG 26 on Ferrite Bead
L1 = 12 Turn AWG 21 on FT50-43
L2 = 32 Turn AWG 24 on FT50-2
T1 = 10 Turn Bifilar AWG 24 on FT50-43

Integrated Circuits

U1 = CD4060BE
U2 = CD4046BE
U3 = CD40103BE

Schematic Diagram