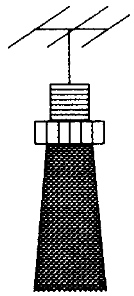


BEACON THOUGHTS

by

Dave Meier N4MW

I have been successful in operating a series of beacons on seven bands from ten meters through 3456 MHz. They have proven useful in maintaining station operation during the long dry spells between band openings and, for others, useful indicators of enhanced propagation. The experience has enhanced my desire to keep operating on the VHF plus bands. It is also satisfying to be invited to relate my experiences in such places as Microwave Update, Central States, hamfest forums and radio club meetings. It is even more satisfying to begin to see interest in beacons gradually accelerate, and to see that interest gradually lead to increased microwave band activity.

I have been lucky. The system of beacons I have been operating consists of mostly surplus equipment. Although reliable so far, some of it could be difficult to replace if disaster were to strike. This thought has brought me to consider design alternatives.

Could a group of beacons be designed to take advantage of recent commercial availability of equipment, especially in the microwave region? The answer lies in the "no tune" approach to equipment design popularized by KK7B and WA8NLC. This paper will propose a system of beacons which utilizes existing transverter boards, combined in a manner most effective and efficient for beacon operation. If carried out as intended, the result will be a reliable, easily reproduced method for constructing a beacon system for the five bands from 902 to 5760 Mhz. It is my hope and desire that this might help to increase the quantity and distribution of microwave beacons, leading to increased microwave band activity in general.

Since this new design is intended to be an upgrade to my current system, I am including the option of improved emission control and message content alteration.

The design criteria for the proposed beacon system is summarized as follows:

- ☛ Utilize common oscillator circuitry/frequency to reduce construction redundancy.
- ☛ Utilize commercially available "no tune" transverter boards.
- ☛ Provide for radio frequency link positive control.
- ☛ Provide for changing keyer message remotely.

To derive an acceptable oscillator scheme, I created a spreadsheet of frequency relationships among the existing transverter designs. Except for the 902 board these designs share a common oscillator multiplier board with nominal output of 550 MHz. This gives rise to the possibility of sharing one board between all transverters. Unfortunately, using the common intermediate frequencies (144 MHz for most bands and 1296 MHz for 5760), the crystal frequencies are all different. On the other hand, there is no requirement to use the common intermediate frequencies. I calculated the average of the four normal crystal oscillator frequencies to be about 93 MHz, which is happily the normal crystal frequency in the 5760 transverter. It is aso *the* magic frequency which allows the 1296 output to be sampled and used as the 5760 IF input. On the four transverters which use a separate local oscillator boards, this multiplies 6 times to 558 MHz. The 902 board can also use the 93 MHz oscillator which is multiplied on the transverter board 8 times to 744 .

Standard "No Tune" Transverter Frequency Scheme

Target Band	LO XTAL	Multiple	LO to RF Board	LO Injection	IF	Result Frequency
902	94.750	8	(on board)	758	144	902
1296	96.000	12	576	1152	144	1296
2304	90.000	24	540	2160	144	2304
3456	92.000	36	552	3312	144	3456
5760	93.000	48	558	4464	1296	5760

Average LO XTAL	93.150

Modified Beacon Frequency Scheme

Target Band	LO XTAL	Multiple	LO to RF Board	LO Injection	IF	Result Frequency
902	93.000	8	(on board)	744	158	902
1296	93.000	12	558	1116	180	1296
2304	93.000	24	558	2232	72	2304
3456	93.000	36	558	3348	108	3456
5760	93.000	48	558	4464	1296	5760

No Tune Multiband Beacon Frequency Scheme

The frequency scheme is shown in the table. If a common 93 MHz oscillator is employed, the resulting mixer injection frequencies will be off from the circuit design targets, but not so far as to be unusable. The result of the new injection frequencies is that some really strange intermediate frequencies are required for up-conversion to the desired beacon output frequencies. Is this a problem? The injection required is small, only one milliwatt, so a simple crystal oscillator is sufficient to "drive" the transverter. This design requires a total of five oscillators, one of which is a "master" oscillator at 93 MHz. The other four can be selected to derive the desired beacon output frequency. 1296 MHz ouput is sampled to drive the 5760 MHz transverter, so the oscillator for the 1296 transverter also controls the 5760 output.

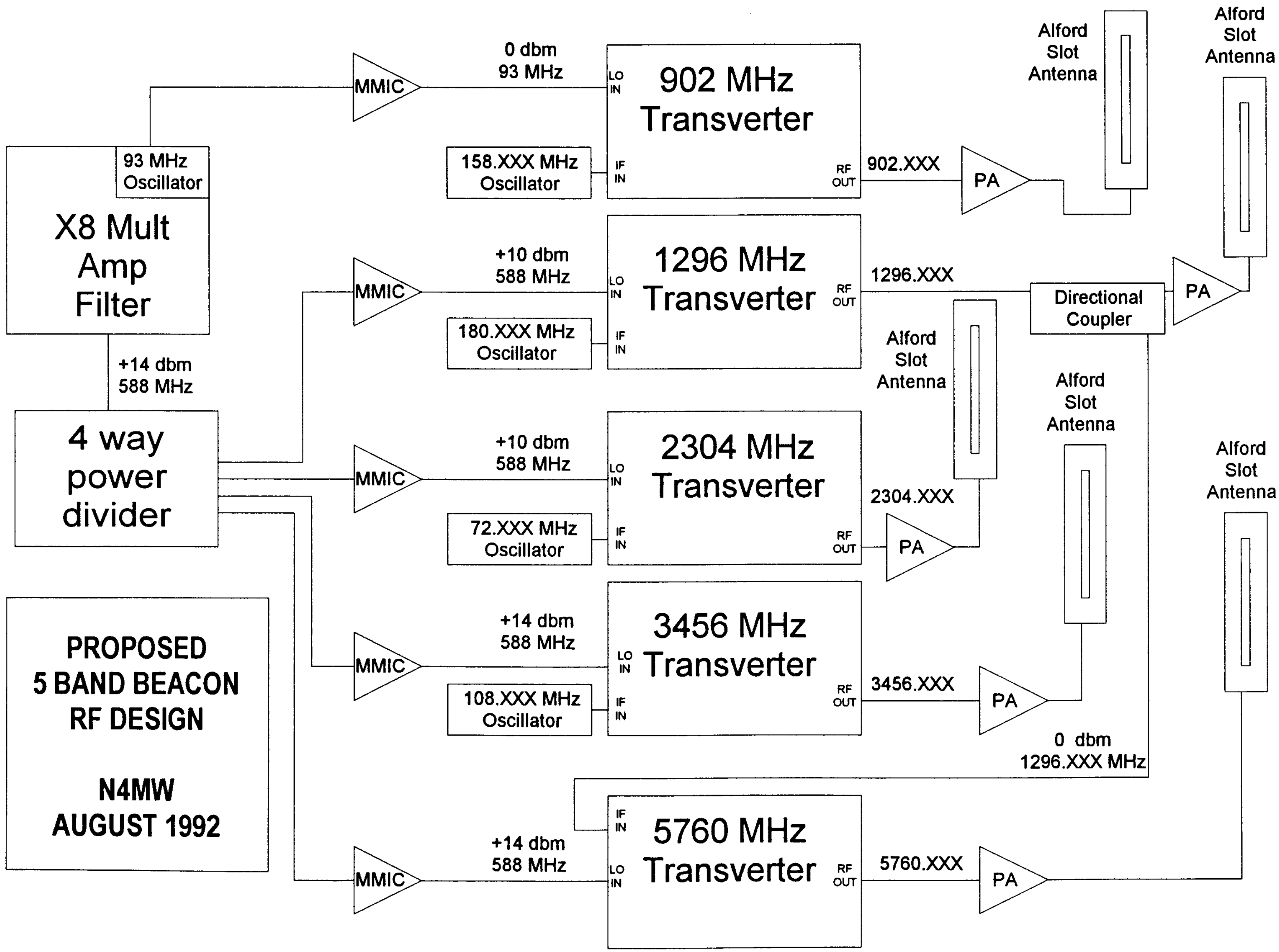
It should be possible to put all oscillators in a common temperature-controlled thermally isolated container for maximum drift stability. This would also facilitate remote mounting of the transverter boards if necessary to minimize feedline loss. I anticipate the use of Alford slot antennas. On 2304 and higher bands these could be mounted directly to the power amplifiers and enclosed in an RF transparent weatherproof cover. Another possibility is to build the slot antennas to be concentric, with the highest band on top and lower bands below.

The beacon system should have a means of control to allow emissions to cease if desired. I propose to take advantage of one transverter board's receiving capability to "uplink" the keyed message to the beacon site from my home location. This allows the beacon message to be altered at will, allowing the beacon to transmit any desired information in addition to the simple identification/location format currently in use. I am considering two alternative approaches to using an FM radio link for keying control. One approach is to place an audio tone decoder at the beacon site and to continuously uplink the beacon message using audio frequency shift keying. The other is to place the memory keyer at the beacon site and use the AFSK FM link to remotely program the keyer. Either way, a suitable memory keyer is the MM-3 Morse Machine manufactured by AEA. This keyer can be programmed directly from the paddles or by computer through a simple serial interface using standard ASCII text. I am leaning toward a local keyer and real time continuous AFSK uplink because failure in the link at either end will result in cessation of transmissions. A simple EPROM keyer could be substituted for the Morse Machine during periods which the keyer is used for everyday operating. Eventually, the addition of a DTMF decoder would allow control of individual bands, power levels and other miscellaneous functions.

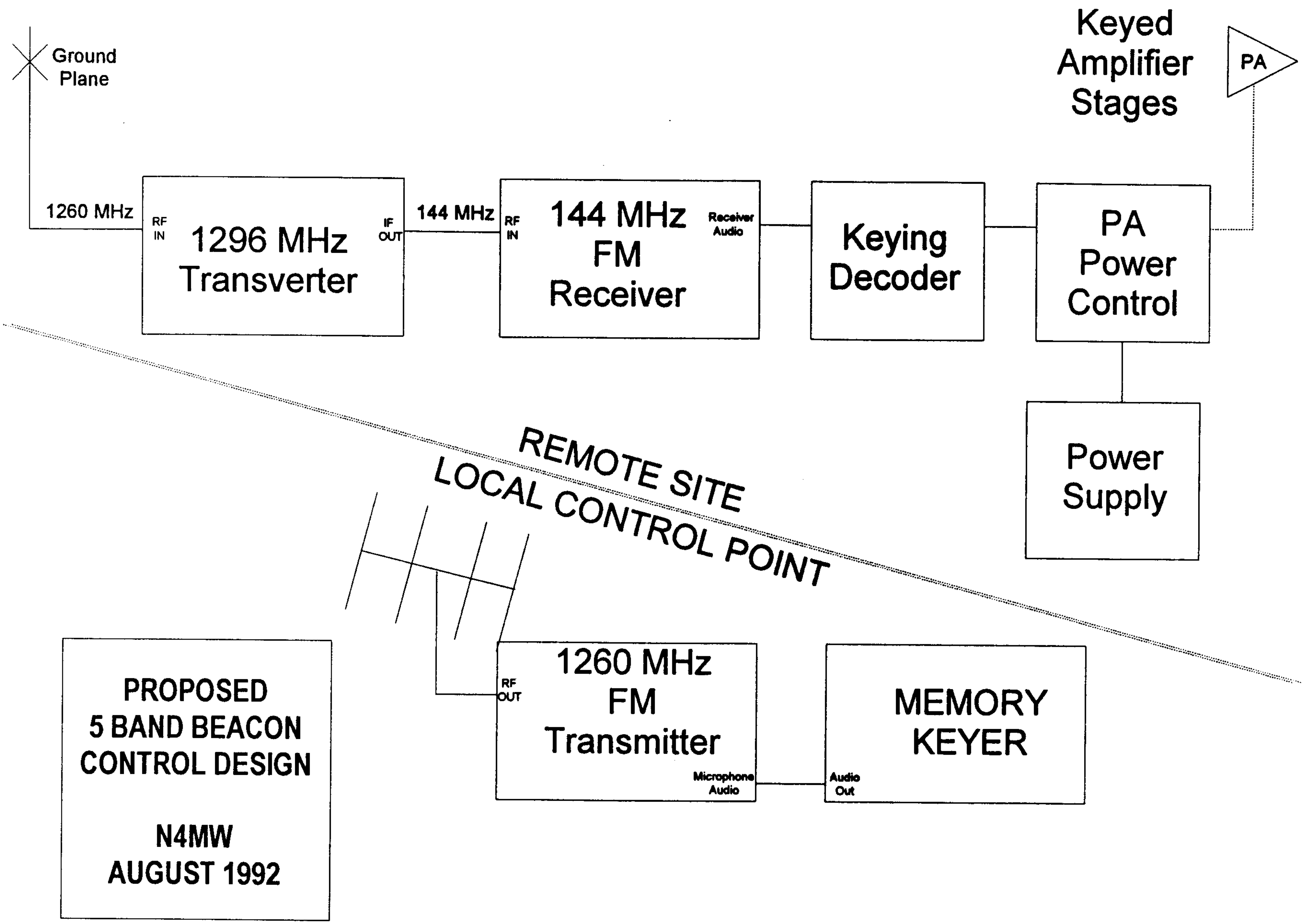
The hardware requirements for the proposed system are as follows:

Boards (from Downeast Microwave):	+14 dbm 558MHz LO and all parts less crystal
	902 MHz Transverter with partial LO and transmit parts
	1296 MHz Transverter with all parts
	2304 MHz Transverter with LO multiplier and transmit parts
	3456 MHz Transverter with LO multiplier and transmit parts
	5760 MHz Transverter with LO multiplier and transmit parts
Circuitry to design and construct:	four crystal oscillators
	oscillator temperature control
	4-way power divider/MMIC buffer amplifier
	audio tone decoder
	keyed power switch
Other items:	AEA MM-3 Morse Machine/alternate EPROM keyer
	93 MHz crystal
	power amplifier stages (if used)
	power supply
	directional coupler
	antennas (5 Alford slot and 1 ground plane)
	cabling/cabinet

In summary, it is my hope that proposed beacon system proves to be reproducible and reliable. I would appreciate all advise and assistance in proving the concept and finalizing the design. If successful, the results could be new beacons in many desirable areas. Hopefully this will promote additional microwave band activity.



93 MHz Oscillator
X8 Mult Amp Filter
+14 dbm 588 MHz
4 way power divider
MMIC
MMIC
MMIC
MMIC
MMIC
0 dbm 93 MHz
+10 dbm 588 MHz
+10 dbm 588 MHz
+14 dbm 588 MHz
+14 dbm 588 MHz
158.XXX MHz Oscillator
180.XXX MHz Oscillator
72.XXX MHz Oscillator
108.XXX MHz Oscillator
902 MHz Transverter
1296 MHz Transverter
2304 MHz Transverter
3456 MHz Transverter
5760 MHz Transverter
LO IN
IF IN
RF OUT
902.XXX
1296.XXX
2304.XXX
3456.XXX
5760.XXX
PA
Directional Coupler
0 dbm 1296.XXX MHz
Alford Slot Antenna
PROPOSED
5 BAND BEACON
RF DESIGN
N4MW
AUGUST 1992


Ground
Plane
1260 MHz
RF IN
1296 MHz
Transverter
IF OUT
144 MHz
RF IN
144 MHz
FM
Receiver
Receiver Audio
Keying
Decoder
PA
Power
Control
Keyed
Amplifier
Stages
PA
Power
Supply
REMOTE SITE
LOCAL CONTROL POINT
RF OUT
1260 MHz
FM
Transmitter
Microphone Audio
Audio Out
MEMORY
KEYER
PROPOSED
5 BAND BEACON
CONTROL DESIGN
N4MW
AUGUST 1992