A SIMPLE 5 BAND CW TRANSCEIVER

(for 2.3, 3.4, 5.7, 10.3 and 24.2 GHz!)

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This paper represents a "simplest possible" approach to narrow band communication in the weak signal portions of the amateur microwave bands between 2 and 25 GHz. The basic system consists of a pair of no-tune LO boards, a simple HF receiver, an easily constructed harmonic generator and an easily constructed harmonic mixer. While signal levels are low and receiver sensitivity poor (especially on the higher bands), the frequency scheme shown here allows verification that the intended frequency is being received. Since the transmitter and receiver are independent, the system may be used as basic test equipment for all of the above bands. Some enhancements to the basic system are discussed.

INTRODUCTION

Al Ward and Kent Brittain's talk on a simple approach to 24 GHz operation [1] is clear evidence that some highly respected people actually do as little as possible to get on the next higher band. This paper started as an attempt to show that it is possible to do even less. At first it was little more than a notebook exercise, but the possibility of a trip to the northwest during an upcoming VHF contest raised the energy level a bit. I have a favorite hike that takes me through several grid squares. I have never actually spoiled a good hike by taking along microwave gear, but I have certainly had centimeter wavelength thoughts while looking at a horizon 90 miles away.

There are several immediate problems with carrying a microwave system up a mountain. Those phase locked oscillators are called "bricks" for a good reason. Another hurdle is my ego--it isn't even worth turning in a log if I can't have most of the alphabet listed after my call. I would also prefer to have the rig tucked out of sight in a corner of my backpack, along with the extra food and clothing--microwave hams may fantasize about being Tom Swift, but mostly they end up looking more like Inspector Gadget. But the bottom line is batteries. A battery big enough to run the local oscillators in a multiband microwave station for long enough to temperature stabilize and then make a quick contact is a most unwelcome climbing companion.

The actual transmitter power and receiver sensitivity requirements for a line-of-sight contact to a good station are very modest--a milliwatt of CW and a 10 dB noise figure are fine. The receiver sensitivity may be relaxed further if the station on the other the circuitry can then be turned on and off as needed.

The other critical block is a harmonic generator/mixer. The schematic in figure 4 and drawing, figure 5, show a version with SMA connectors that will work after a fashion on all five bands. For 10368 and 24192, a dedicated harmonic mixer with the diode in the appropriate sized waveguide is a much better choice.

The harmonic mixer is almost identical to the harmonic generator, with just the added provision for picking off the IF signal. A single harmonic mixer can serve both functions, if there are provisions for switching the LO drive.

This system is dirt simple and works a whole lot better on 2304 than 24192 MHz, but it's a start.

ENHANCEMENTS

Most self respecting radio amateurs would be embarassed to actually put a system like this one on the air. That's why people like Al Ward, Kent Brittain and I get all the boldfaced FGHIJs etc. after our names in QST. There are a number of obvious enhancements that can be implemented to convert this station from a mountain top novelty to a more serious microwave station.

At 2, 3 and 5 GHz, printed frequency multipliers may be built by combining the diode 1152 MHz drive circuitry with a printed filter. Since gain is inexpensive at these frequencies, a clean +7 dBm output signal is easy to obtain. The +7 dBm output may be connected directly to the antenna for transmitting, or connected to the LO port of a non-harmonic mixer for receiving.

At 10 and 24 GHz, harmonic mixers can be built using waveguide, as shown in the drawing in figure 7. Higher output power and lower receive mixer loss can be obtained on both 10 and 24 GHz by redesigning the harmonic generator/mixer for 3456 MHz drive, and using a 3456 MHz frequency tripler and amplifier between the 1152 MHz source and the harmonic generator/mixer.

Once the output signal and receive input range are cleaned up with appropriate filters, preamps and transmitting amplifiers may be added to reach any desired performance level. Preamps, filters, multipliers and mixers should all be built as separate blocks with SMA connectors and quick disconnect DC connectors so that the system can be reconfigured for a different band easily.

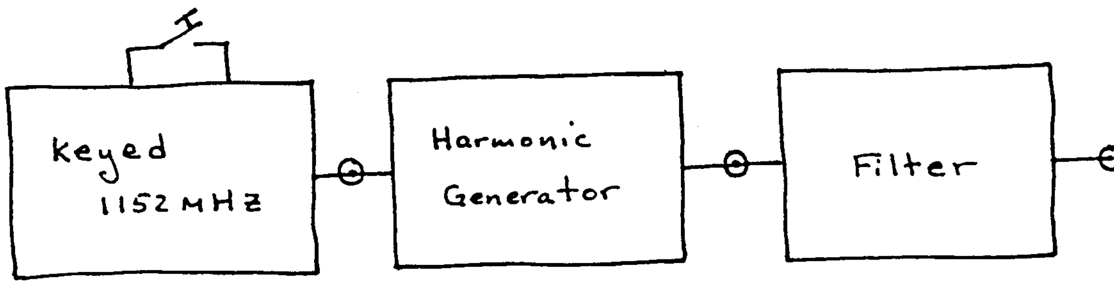
The only fundamental limitation of this conversion scheme is that the IF is so low that image noise suppression is impossible to obtain with simple RF filtering. For low powered rover or mountaintop operation, this is not a consideration, since the receive sensitivity is in parity with the low transmitter power. For higher performance, a Subharmonic IF system, described in the next paper, can be assembled, using most of the modules built for the simple 5 band system.

CONCLUSION

This is not the simplest 5 band microwave system. Two simpler approaches are a direct conversion CW transceiver and a system with a single LO and transmit and receive frequencies offset by the IF. The system described here has significant advantages over the simpler approaches. By separating the transmit and receive functions, it can not only self-test, but also test any preamps, filters or other improvements that may be added. It can also work any station capable of operating SSB or CW within a few hundred kHz of the weak signal calling frequencies on the microwave bands.

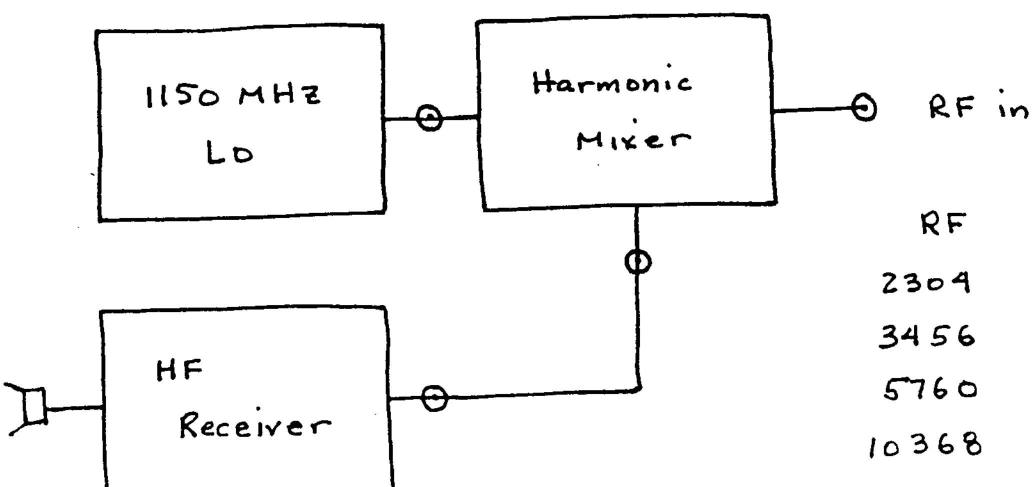
REFERENCE

1. Kent Brittain and Al Ward, "Simple Approach to 24 GHz," presented at Microwave Update '93, Atlanta GA, October, 1993.



Minimum Transmitter

Figure 1



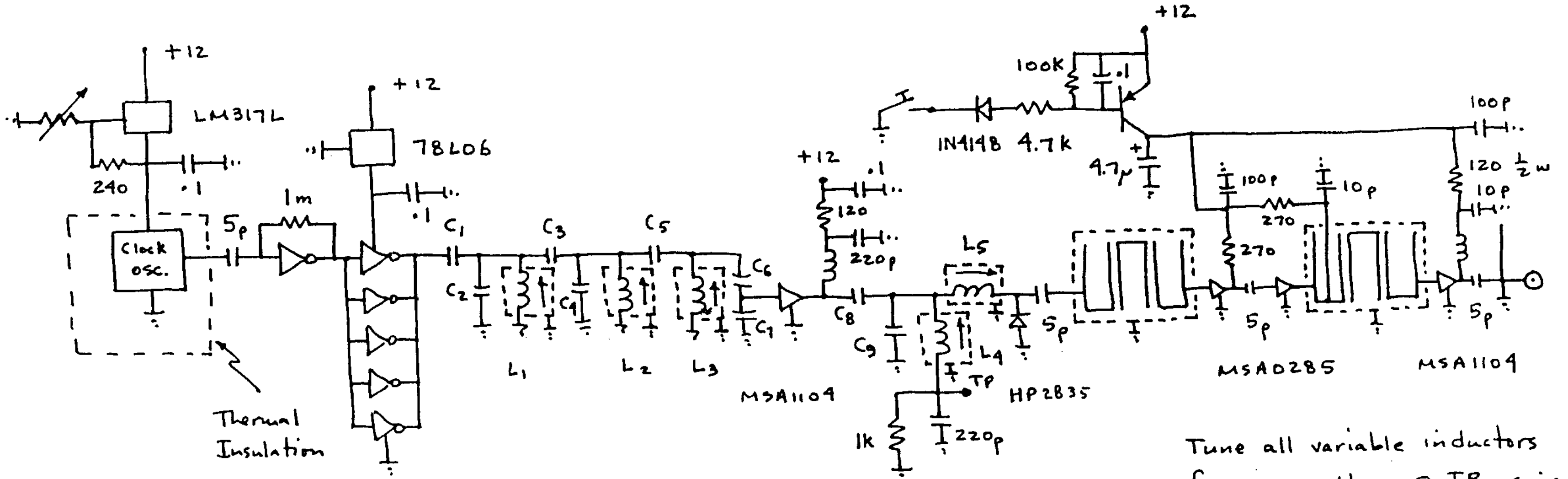
RF	IF (MHz)
2304	4
3456	6
5760	10
10368	18
24192	42

Simple Receiver

Figure 2

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	L_1	L_2	L_3	L_4	L_5
1152	3.9	3.9	1	6.8	1	9.1	33	12	8	78	78	78	53	53
1150	3.9	3.9	1	6.8	1	9.1	33	12	8	53	53	53	53	53

← all C in pF, all L in nH



Tune all variable inductors for max. voltage @ TP using VOM, 1 VDC range.

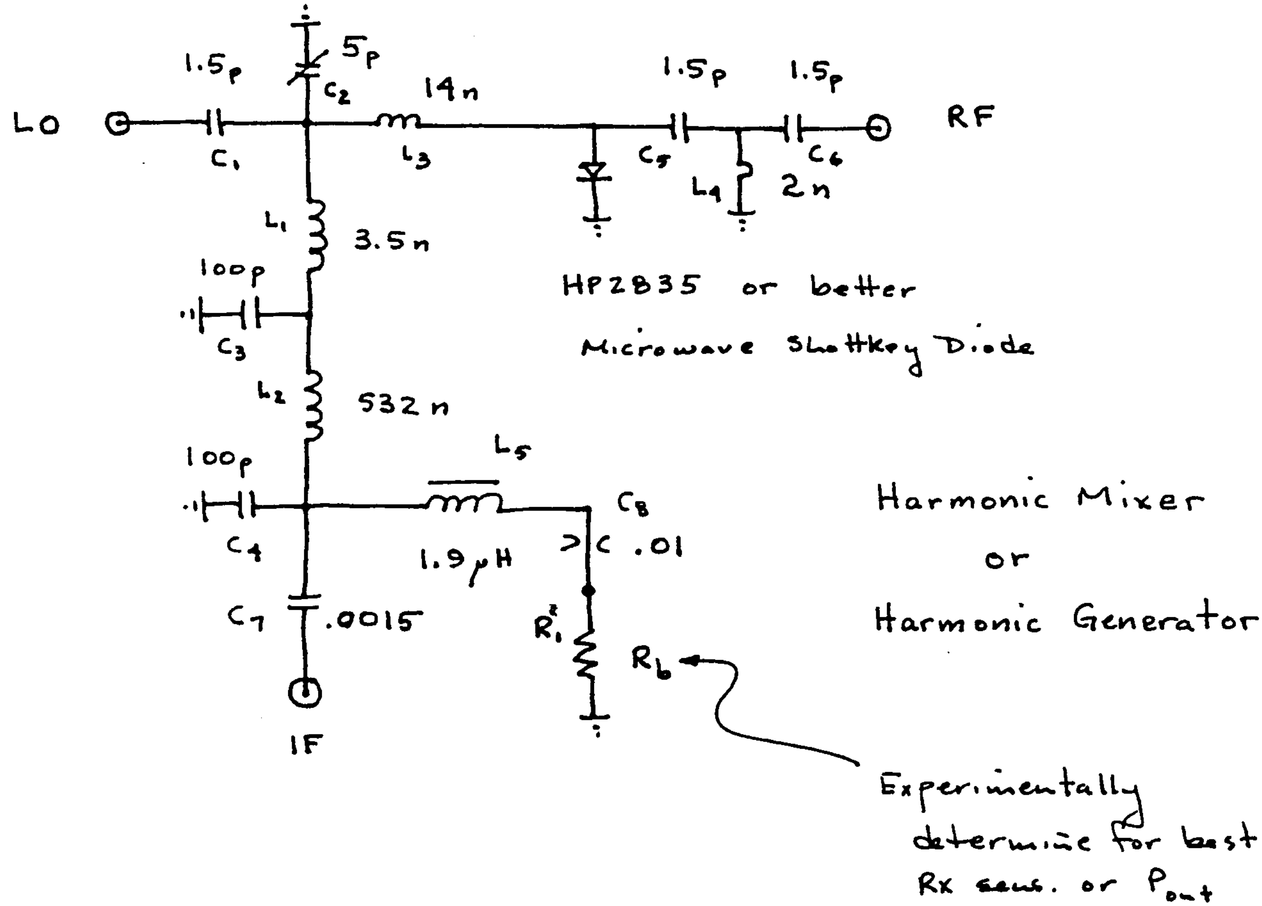
64 MHz (1152)	x 3	192 MHz	x 6	1152 MHz
46 MHz (1150)	x 5	230 MHz	x 5	1150 MHz

1150/1152 MHz LO

FIGURE 3

RLC 12/10/93

Figure 4



Suggested Harmonic mixer/generator parts layout

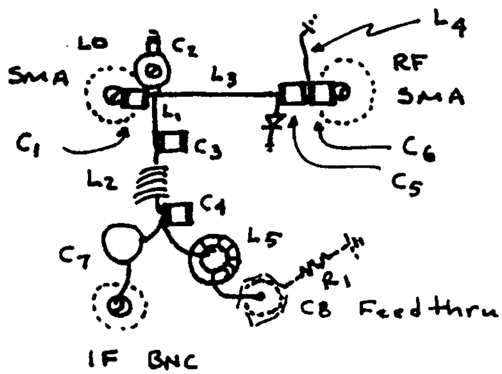
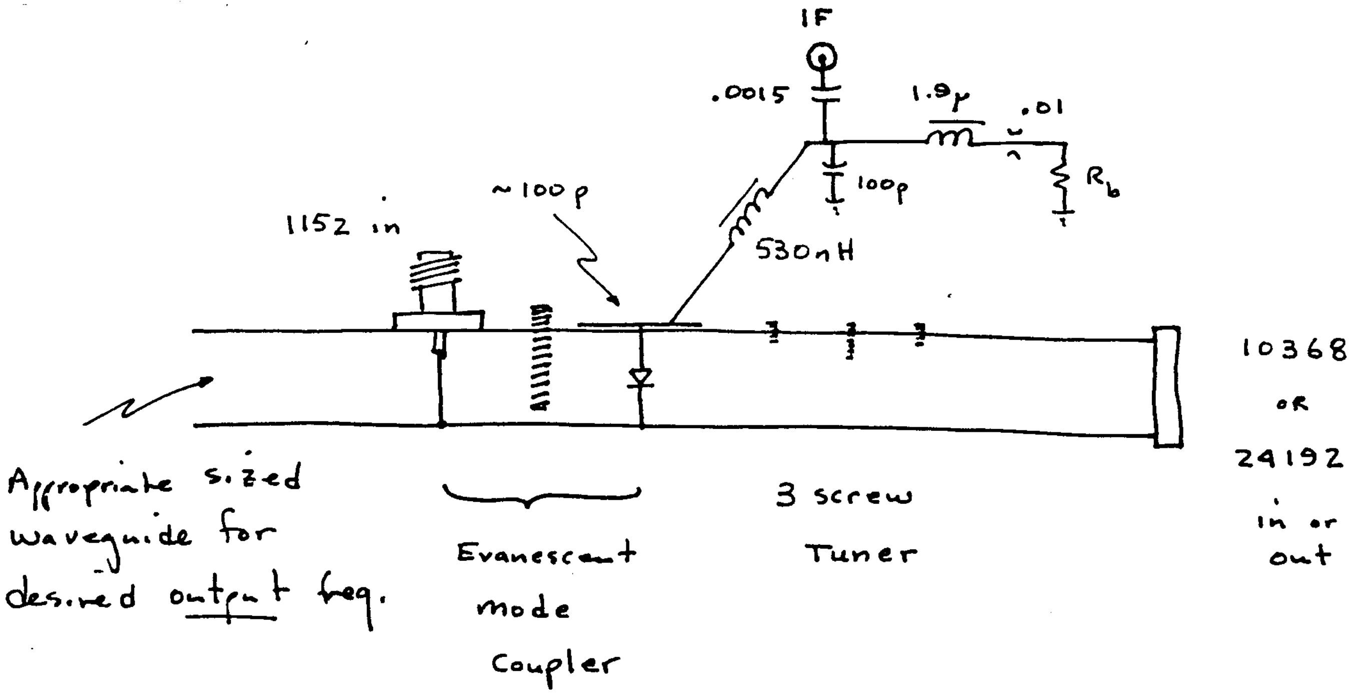


Figure 5



One Band Harmonic Mixer/Generator

Figure 6