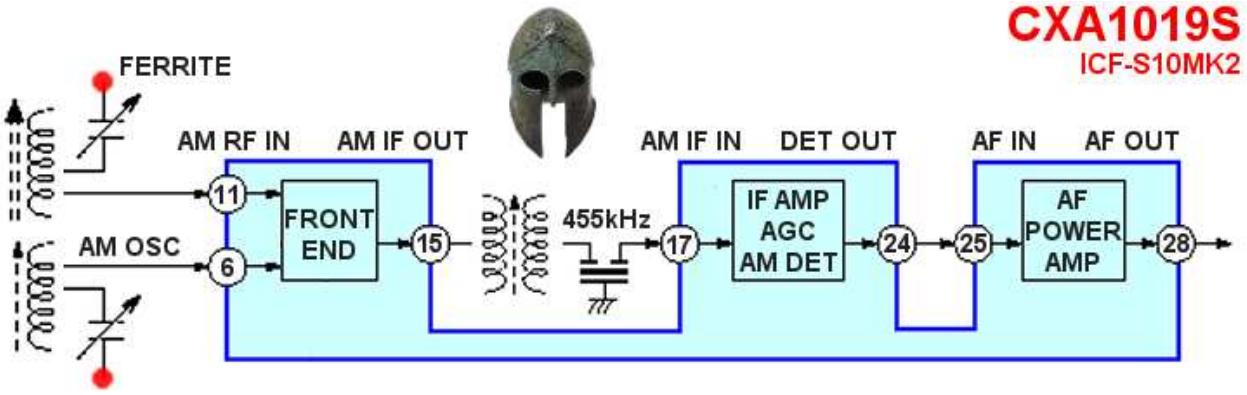
Hellenized ICF-S10MK2

$14 old-school radio hacker's portable

VERSION 1 ©2009



The information below is not guaranteed to be free of errors.

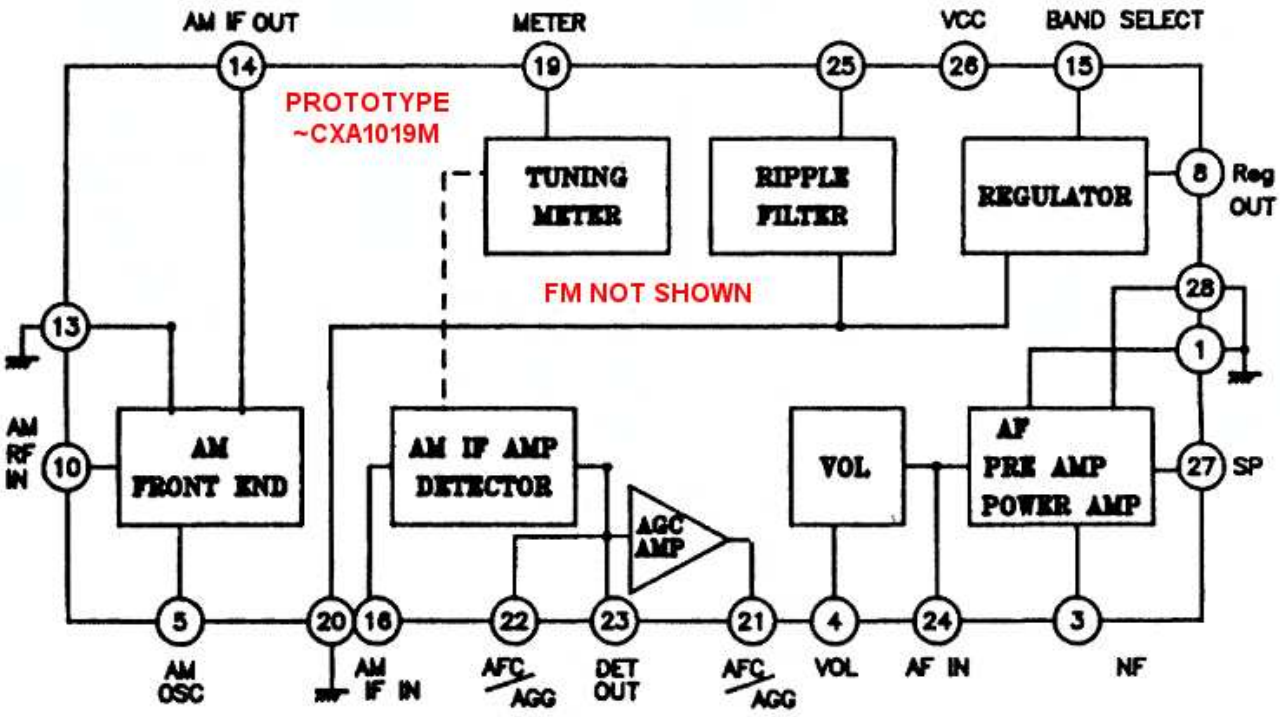
1. INTRODUCTION

In 2003 I tested an $11 Sony S10MK2 with $20 Radio Shack Loop against a $580 ICOM R75 with $200 Quantum QX Loop. The former heard 94% of what the later could on BCB. So I became interested in the S10MK2's design and converted it to shortwave. The radio, based off Sony's CXA1019S chip, proved to be an easy foundation for both AM and FM homebrew design.

2. CXA1019S

The Sony CXA1019S is a 2 Volt bipolar AM/FM radio IC. The chip includes an RF amplifier, RF AGC, oscillator, mixer, IF amplifier, IF AGC, detector, and AF power amplifier. It also contains volume control, tuning meter, and band-selection circuitry. AM mode current use is a low 3.5 mA. Both detector (0.6%) and audio (0.3%) distortion are low. Gain is distributed as follows: frontend 22 dB, AM IF ~53 dB, and audio 32 dB. The chip was revolutionary, incorporating everything that old-world "ceramic IF filter" radios needed to work. New chips are using I/Q mixer image rejection and either active RC filters (ex. CXA1129N in SRF-59) or DSP IF filtration (ex. Si4734 in DE1123). The CXA1019S's pins are small but large enough to solder on. This chip can be soldered on either side in an S10MK2. My method of soldering to tiny chip pins is described in **Phil's Soldering 101**.

The CXA1019S is based on a 1.8 Volt chip design by *Taiwa Okanobu*. His 1982 prototype contained 700 elements; by contrast, the SRF-59's CXA1129N uses 1360 elements. The frontend design supports reception to 30 MHz and has a 2 dB noise figure. The mixer is a double-balanced type [level is +8.57 dBm] with 20 dB of conversion gain. The on-chip voltage regulator helps with power source and thermal-related fluctuations. The oscillator is isolated using N^+ diffusion islands. The AM IF (455 kHz) amplifier has band pass characteristics of: -10 dB at 1.25 MHz and -20 dB at 2.50 MHz. The detector has higher output than a standard diode, yet requires no adjustment. The audio amplifier includes pre-amplification, is of a complimentary push-pull variety, and has 0.18% THD. Volume control consists of up to -92 dB of attenuation. Sensitivity for 6 dB S/N is 0.63 µV or between S2 and S3; S/N is 50 dB. Although commonplace now, *Taiwa*'s design permitted for: 1) a reduction in external components to one-fifth, 2) low power requirements, 3) high sensitivity, and 4) audio output of ~500 mW. The IC's processing allowed for high hFE transistors, Si_3N_4 *thin film* capacitors, and two level wiring. *The pin-outs for the prototype IC match those of the CXA1019M.*



3. ICF-S10MK2

The ~$14 S10MK2 is great for radio hacking. The radio has a quality printed circuit board, durable case, good speaker, headphone jack, and an aerial antenna. The unit is small at 16.2 ci³ (cubic inches) yet other components can be shoehorned into the case. The analog tuning system is a plus: there is no CPU or synthesizer noise to contend with. Entire bands can quickly be tuned through and the powerful "listening" stations identified. Ironically this is a hassle on modern rigs. Two Duracell "D" type alkaline batteries *could* power the S10MK2 up to ~8 hours daily for a year.

4. HELLENIZED ICF-S10MK2

The S10MK2 must first be converted to receive shortwave stations. The line to *pin 6*, the local oscillator (LO), was severed using a pocket knife. The new LO tank inductor became an iron powder toroid (red; μi = 10). The LO tank capacitor became my trusty Heathkit Signal Generator, complete with 3:1 vernier drive and half-moon dial. The LO alteration needed two taps: *oscillator pin 6 and regulated power pin 9*. The **Q** is determined by the tank's inductor: Amidon toroids are good for a Q of about 250. As for the tuning range, I determined that about 90% of English night broadcasts reside between ~4.7 and 10.0 MHz [by hours of programming beamed to N. America].

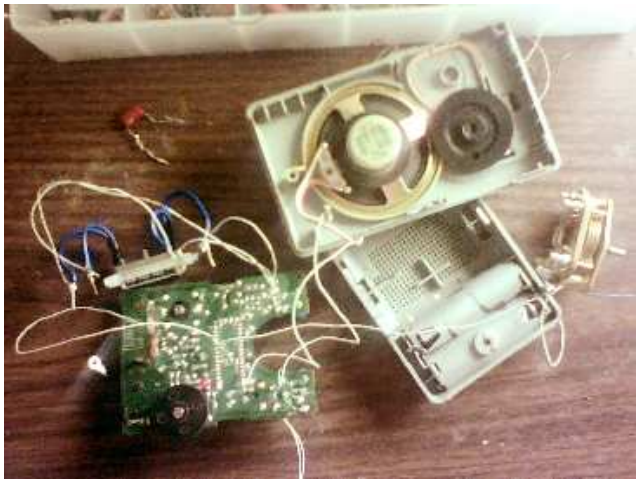
The ferrite's tap was used to introduce shortwave energy. In this way the MW rod is intact and regulated voltage is applied to *pin 11*. The S10MK2 has adequate overall gain so no common-base amplifier was needed. A tuned loop proved to be valuable at attenuating local noise and had the added benefit of reducing various mixer artifacts. A longwire antenna resulted in more noise.

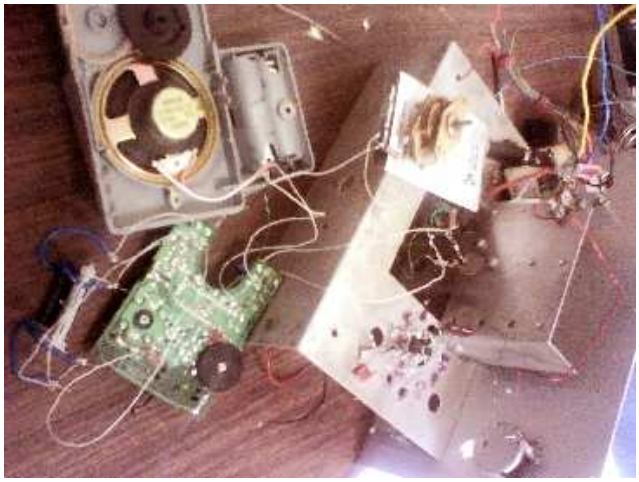
The S10MK2's anemic ceramic filter (tiny red rectangle near speaker cutout) was replaced with a Murata 15-element CFS455J with specs of -6 dB at 3 kHz and -80 dB at 9 kHz. Electrolytic capacitor size was increased on the AGC line. Using an offset tuned narrow filter with a slow-AGC reduces carrier dropout related distortion. This trick, **SIDEBAND-SELECTED AM**, was explained in **Tuning Tricks Challenge SAM**. It negates the necessity of SAM (Synchronous AM) detection.

The S10MK2's tuning indicator LED was replaced with a meter. The unit was powered with two external "D" type alkaline batteries. Earbuds were used for low-power operation. Altering any radio could result in it being damaged. Avoid applying soldering iron heat for long periods of time.

WARNING: PLEASE wear **EYE PROTECTION** when performing modifications.

Pictured below is the S10MK2 during initial testing (30 gauge wire taps).
The lower pictures show the [air-variable capacitor/toroidal inductor] tuning system.



5. DISCUSSION

The Hellenized ICF-S10MK2 is good for both shortwave program listening and casual DX. Images were a problem due to the low 455 kHz IF and single-conversion circuitry. However, the combination of offset-tuning, narrow filtering, Sony's AGC, and a tuned loop antenna resulted in pleasant sound. There is a plethora of low-priced single-conversion shortwave radios that are not as pleasant to listen to or as fun to operate. This is not so surprising considering Sony has always been a leader in pocket MW radios. The S10MK2 makes a good base for homebrew radio projects.

A new DX niche called UltraLight Radio was recently defined by *Gary DeBock*. Articles are available at the *www.dxer.ca* website. I have long been a fan of using rudimentary radios for DX: including pocket radios and single triode (**Angelodyne**) and single transistor (**Dee/Mitch-dyne**) designs. Testing the S10MK2 against an R75 opened my eyes to the fact that the voltage induced in an antenna cares not how expensive or how complex the receiver is that converts it to audio. I convert the newer Sony SRF-59 to shortwave in a companion article named **Hellenized SRF-59**.

REFERENCE

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http://home.comcast.net/~phils_radio_designs