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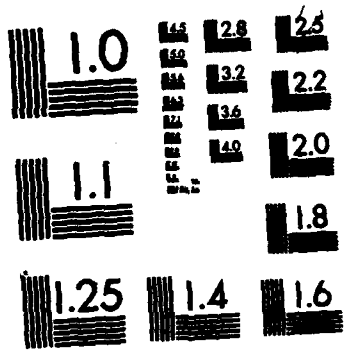


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Final Technical Report
January 1983

# PHASE 2B PROTOTYPE REDESIGN, TACTICAL RUBIDIUM FREQUENCY STANDARD

EG&G Electronic Components

William J. Riley



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This report summarizes the progress made during Phase 2B of an effort to develop a tactical rubidium frequency standard (TRFS) for the U.S. Air Force SEEK TALK program. The overall objective is to achieve a production capability for an extremely small, rugged and fast warmup atomic clock for avionics applications. This phase of the program accomplished the redesign of the previous bench version into a prototype configuration. Projected prototype size is 2.5 x 2.5 x 4.0 inches.


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## 1.0 INTRODUCTION

This report summarizes the progress made during Phase 2B of an effort to develop a tactical rubidium frequency standard (TRFS) for the U.S. Air Force SEEK TALK program. The overall objective is to achieve a production capability for an extremely small, rugged and fast warmup atomic clock for avionics applications. This phase of the program accomplished the redesign of the previous bench version into a prototype configuration.

## 2.0 OVERALL DESIGN PROGRESS

The TRFS design approach was first described in an EG&G technical proposal in June, 1981[(1)]. Phase 2A of the program then accomplished the design, fabrication and test of a working bench version. The results of that work were described in a final report in July, 1982[(2)]. The current effort involved redesign of the bench version into a prototype configuration. It is expected that future work under Phase 2C will involve the building and test of two prototype units.

(1) EG&G, Volume I Technical Proposal, Tactical Rubidium Frequency Standard (TRFS) for the SEEK TALK Program, June 19, 1981.

(2) Final Report, Phase 2A Bench Model Development, Tactical Rubidium Frequency Standard, 16 July 1982.

## 3.0 PROTOTYPE REDESIGN

The prototype redesign activities involved improvements as a result of bench unit testing and repackaging to allow the complete unit to be built inside a 2½ inch by 4 inch enclosure.

The only conceptual change from the bench version is the replacement of the 180 MHz VCO with a 90 MHz crystal oscillator and doubler. This change is shown in the VHF section of the revised block diagram of Figure 1. The advantages of this approach were described in Section 8.0 of the Phase 2A final report.

Otherwise, the prototype redesign effort has primarily involved repackaging as shown in Figure 2. The major repackaging task was to move the 20 MHz crystal oscillator inside the physics package. This allows the quartz crystal to share the temperature controlled environment of the microwave cavity and makes feasible the overall prototype packaging concept. A new layout was also done for the servo amplifier board using SIP resistor networks to save space. This is the densest board and thus establishes that the electronic circuits will all fit into the allocated space.

Improvements were also made inside the physics package. New absorption cells were made with a revised buffer gas mix ratio for better temperature coefficient. Improvements were made in the microwave multiplier for smoother behavior and increased output. Lamp exciter experiments were conducted to verify and improve the pumping light source during starting and running. A cross-sectional view of the physics package is sho in Figure 3, and Figure 4 is a photograph of its major components.

## 4.0 REDESIGN RESULTS

The redesign effort has resulted in verification of the original packaging concept that has size and weight advantages over existing designs while complying with all performance requirements.

The completely packaged unit will include covers and circuit board coatings that will insure compliance with the humidity, salt fog, sand, dust, fungus,explosive atmosphere, acoustical noise,and vibration requirements.

The complete unit will contain magnetic and metallic shields, electrical filters,and electronic suppressor devices to insure compliance with the electromagnetic interference and transient voltage requirements.

The TRFS will use electronic regulation of the internal voltages and lamp exciter current to insure compliance with the supply voltage ripple requirements. The most critical aspect is the susceptibility of the lamp exciter circuit.

The design includes monitors for the light, signal,and control voltage signals, as well as a lock status indicator. These are built-in test and maintenance provisions. The electronic circuits yield a MTBF prediction of about 30,000 hours in an airborne uninhabited environment with JANTX and 883B quality level active components.

The mechanical design includes consideration of the demands placed on materials and processes to withstand shock, vibration, bench handling,and on-off cycling. The most critical vibration problem is associated with the accelera-tion sensitivity of the quartz crystal and the resulting degradation of spectral purity.

The baseline TRFS design is directed toward an upper baseplate temperature of +71°C. If it is necessary to operate at a higher temperature (such as the +80°C called for by Hazeltine in their SEEK-TALK FSU specifications) additional redesign will be required. This may take the form of thermoelectric cooling and a larger overall package size.

An effective means of frequency synchronization was described in the original proposal as a design option. Since there is no operational need for this feature, it is not part of the baseline design.

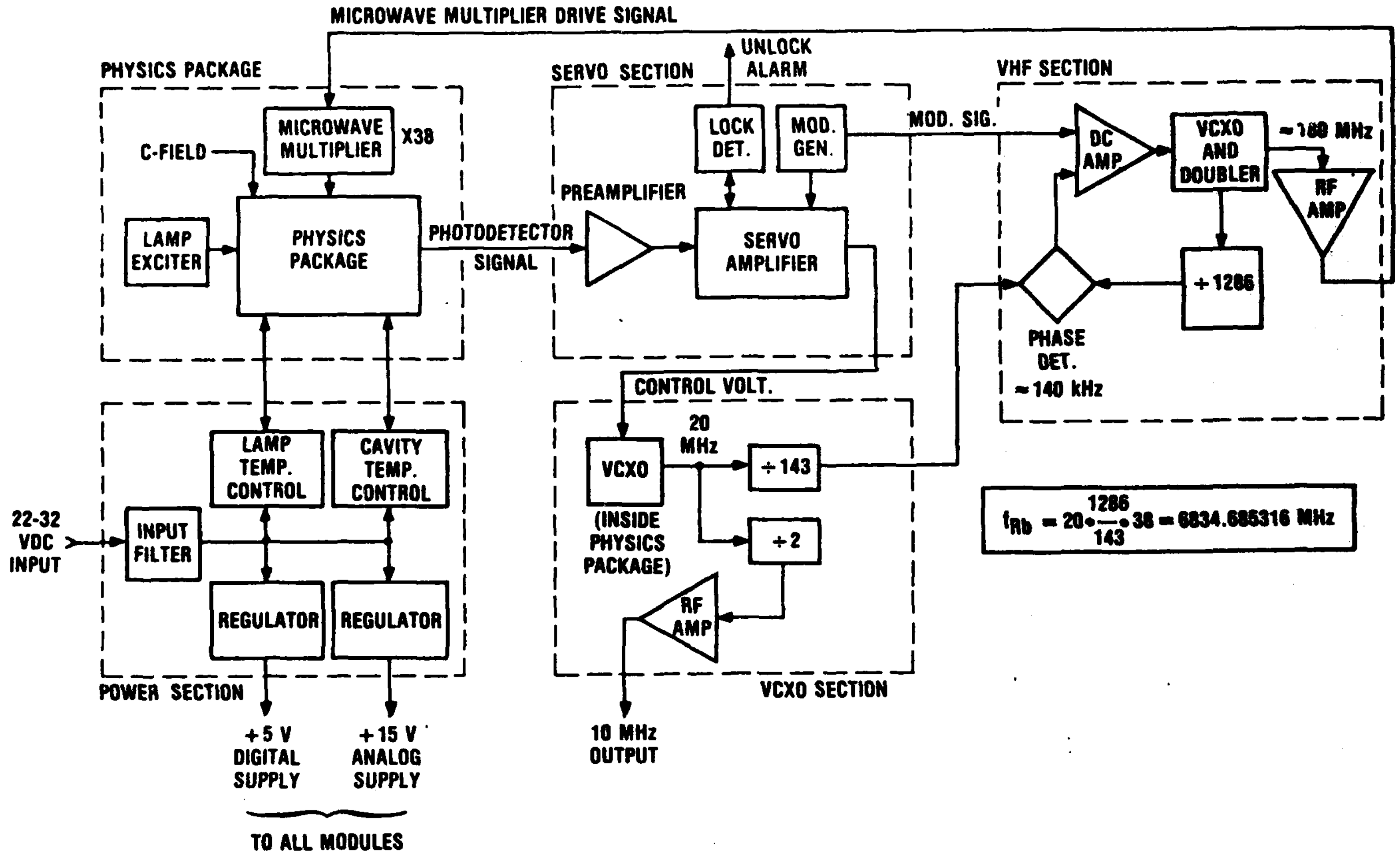


Figure 1. TRFS Block Diagram.

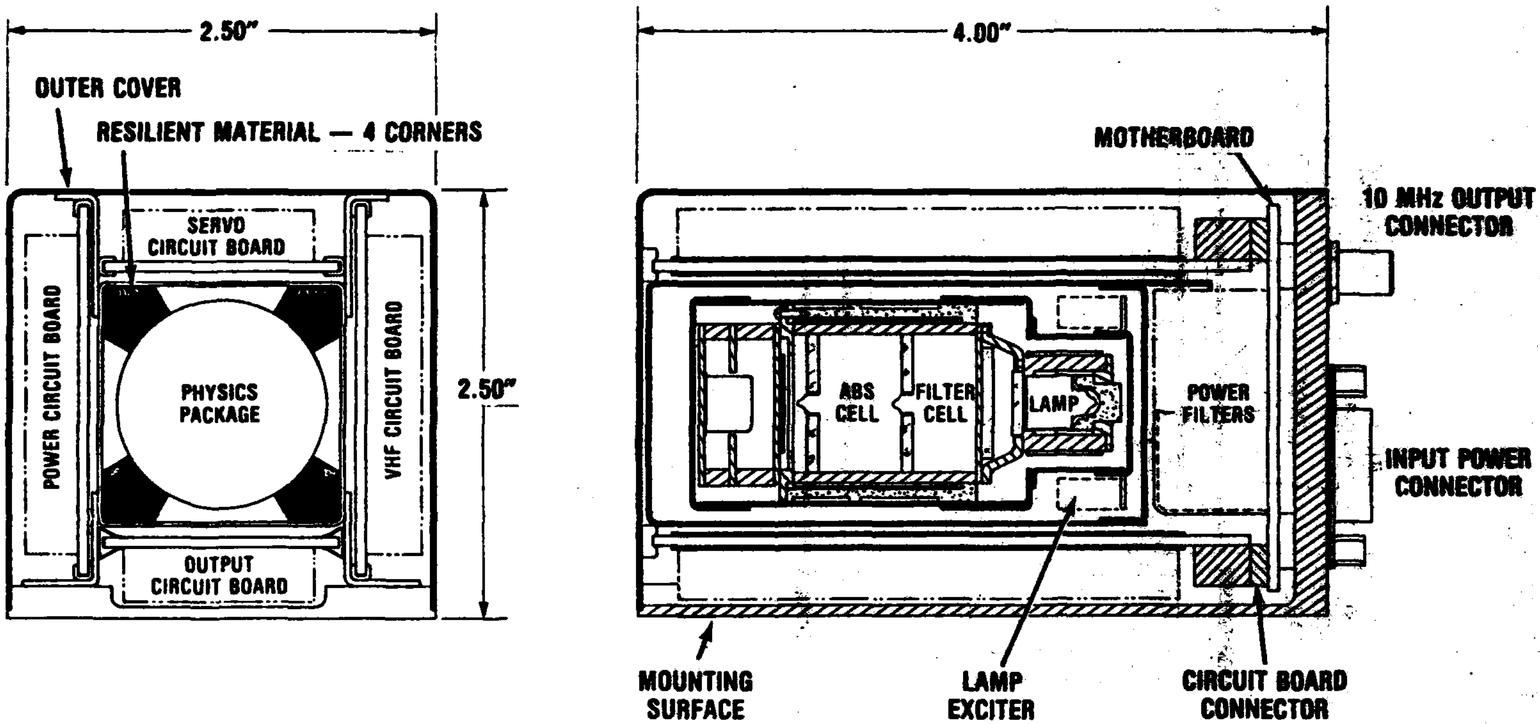


Figure 2. TRFS Packaging Layout.

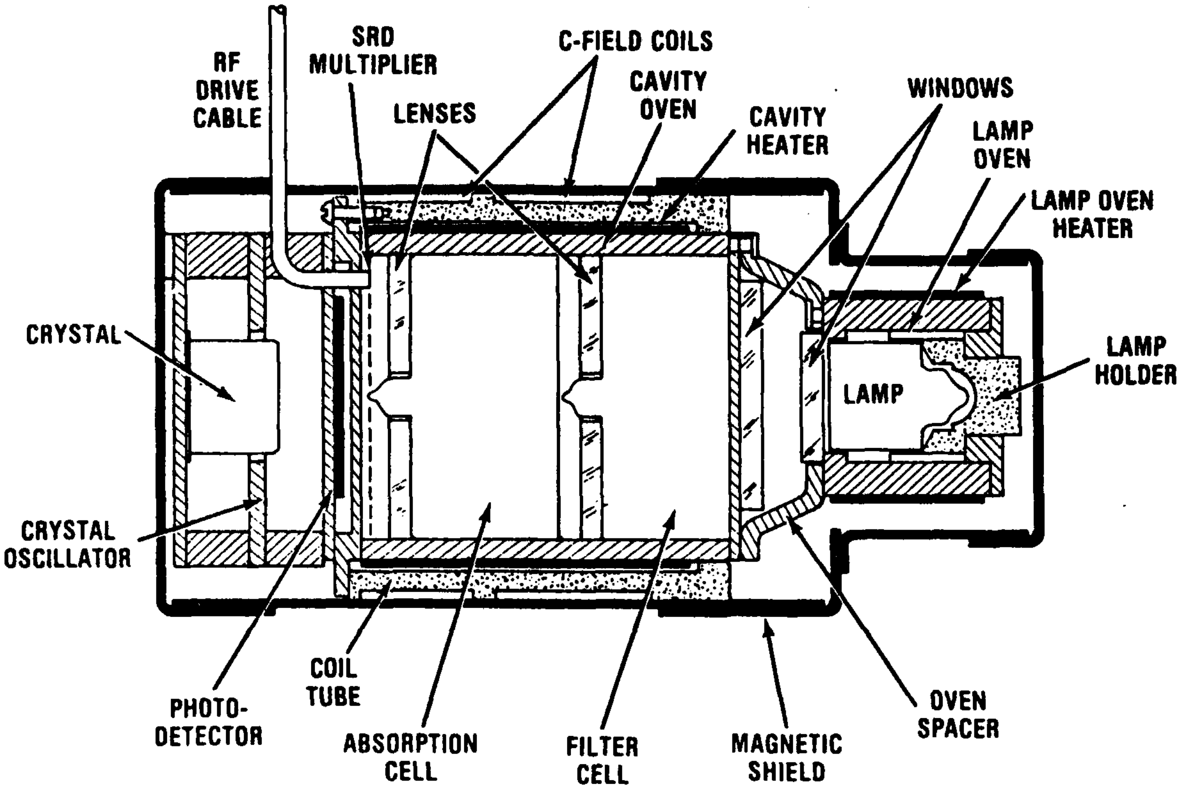


Figure 3. Layout of Miniaturized Physics Package.

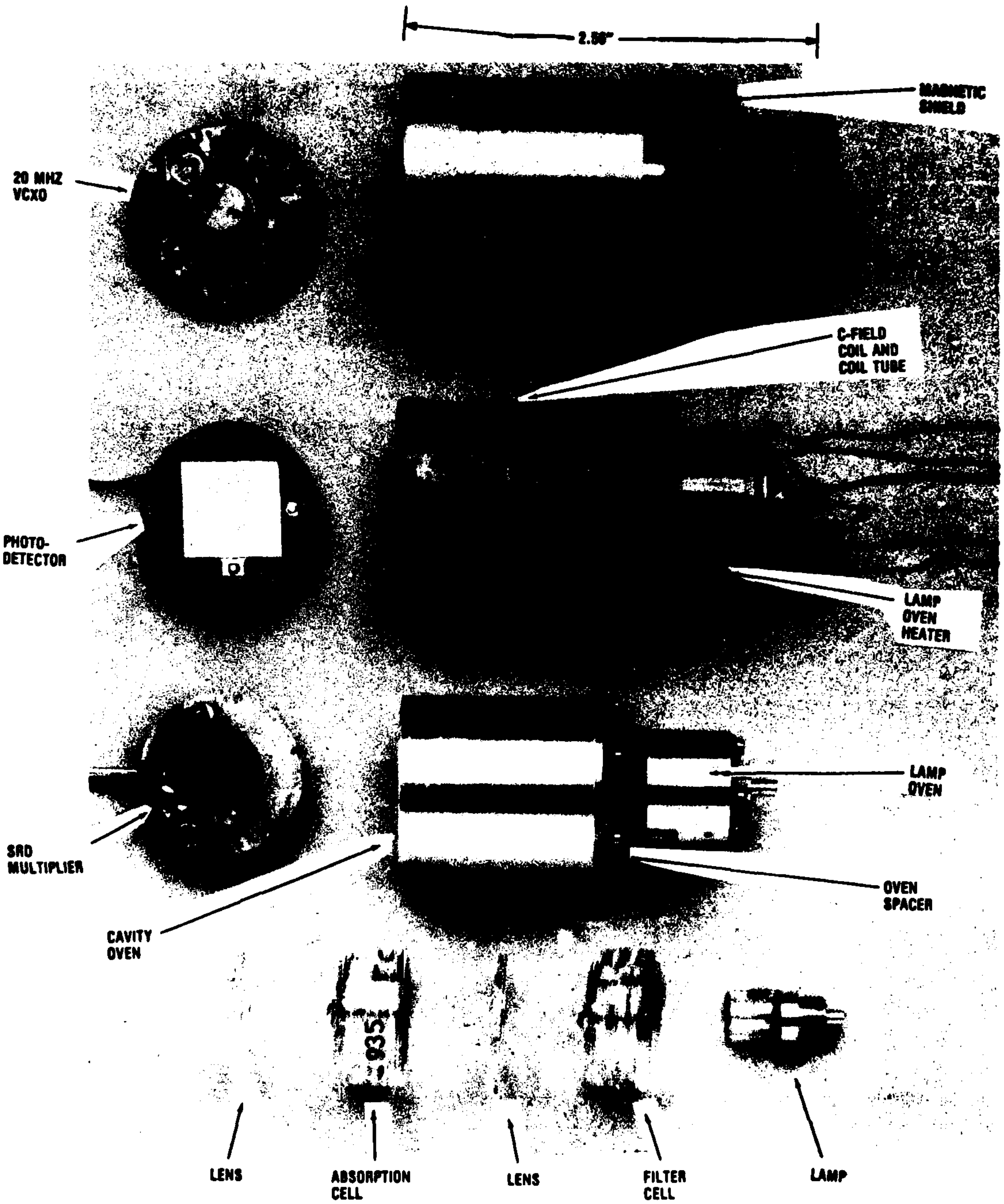


Figure 4. Physics Package Parts.

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