

# HIGH "G" MICROWAVE TELEMETRY SYSTEM

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The high "G" microwave telemetry system is a microwave-metre wave compatible telemetry system and a telemetry system of time division-frequency division hybrid. The so-called "hybrid" means by adding a microwave program-controlled receiving antenna and a microwave frequency converter to the front-end of metre wave telemetry system, the microwave telemetry system shall be made up, by removing the additional front-end microwave head and connecting to metre wave receiving antenna instead, the metre wave telemetry system shall be made up. The so-called high "G" means that the microwave projectile-borne equipment can stand the high acceleration shock overloading and the high-speed rotation of the gunshot. This system is compact in structure, flexible in forming ground equipment and unique in high-strength design for projectile-borne equipment, the system meets the requirements of small-size, all-purpose and economization for range telemetry, therefore it is the necessary equipment for the range.

## System Formation

This system consists of the high-strength projectile-borne equipment and the small ground equipment. The former is made up of signal conditioning, data acquisition, modulation and transmission sub-equipment, and the later is made up of antenna, receiver, demodulator and data processing sub-equipment. The diagrams of the microwave projectile-borne equipment and the ground equipment are shown respectively in Fig.1 and Fig.2.

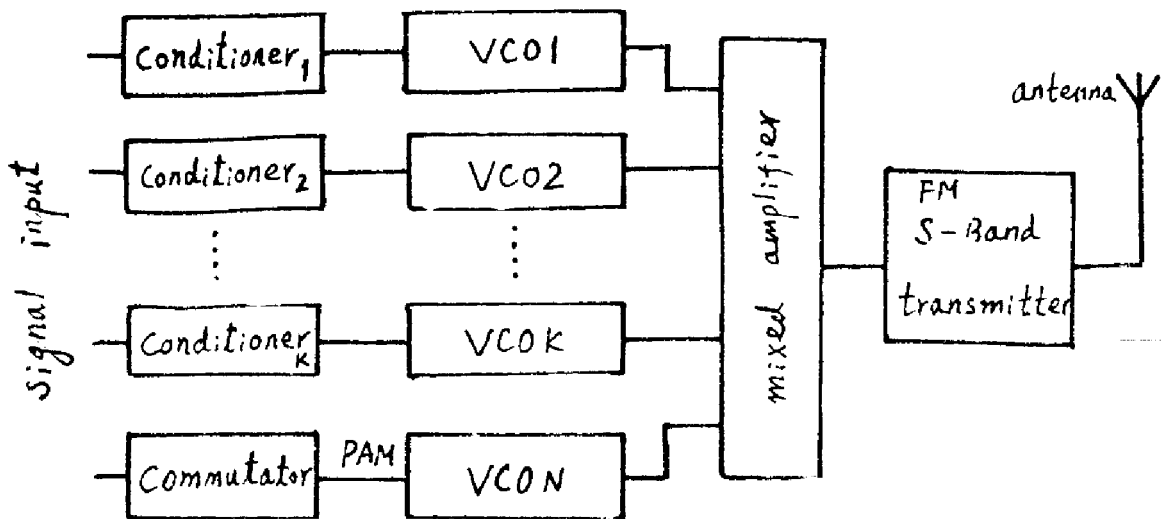


Fig. 1 Principle Diagram of Microwave Projectile-borne Equipment

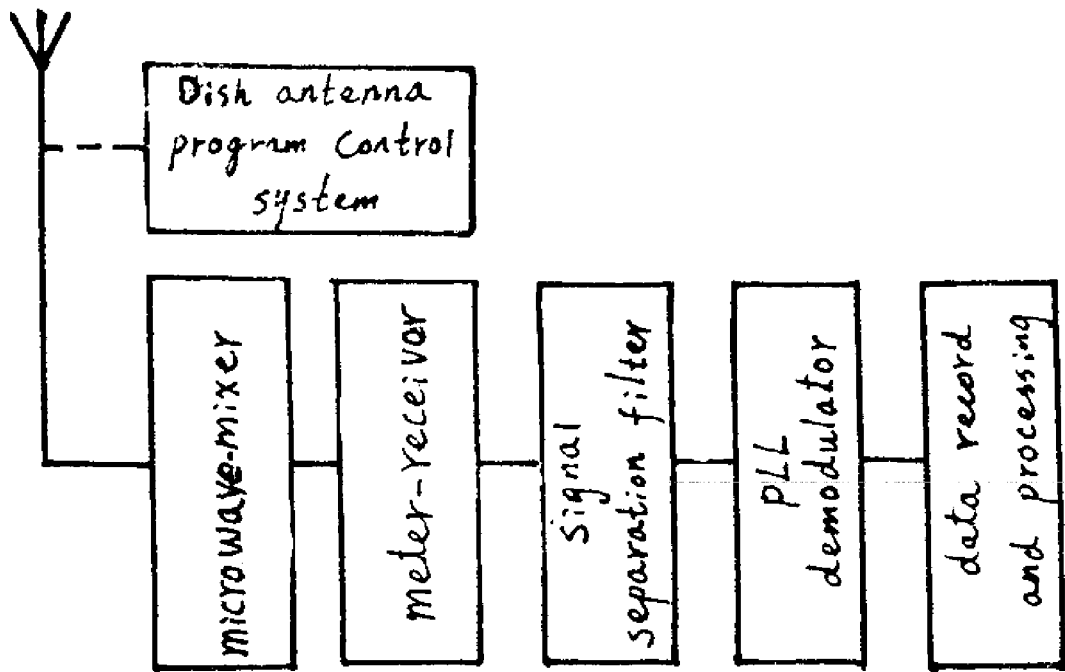


Fig. 2 Diagram of Ground Equipment for Microwave Telemetry

## **Working Principle**

The fast changing parameters, such as the internal ballistic shock overloading, thrust and the base pressure etc. of the rocket and the projectile shall directly be added to each loading frequency voltage controlled oscillator for the first frequency modulation through signal conditioning circuit; The slow changing signals, such as the external ballistic pneumatic parameter of the rocket and projectile and the fuze working state parameter, etc. shall be added to commutator circuit, PAM signal, including frame synchronization, shall be generated, and the PAM signal shall then modulate high loading frequency voltage controlled oscillator. After being modulated the loading frequency of each channel shall be sent to the summing amplifier for summation and amplification, the summarized signal shall again modulate tire loading frequency for the second time, and through power amplification it will be radiated in the air by microwave transmitting antenna.

The ground microwave receiving antenna shall transfer the received signal to microwave frequency converter, the output medium frequency signal from the microwave frequency converter shall then be transferred to metre wave receiver, the metre wave receiver shall discriminate FM signal for the first time, and then through signal separation filter the signal shall be transferred to FM demodulator for second discrimination, and the fast changing signals and the PAM signals of each channel shall be restored.

The slow changing simulative signal shall be received after the restored PAM signal and the time code signal produced by the time code generator are subjected to sync test, and together with the fast changing signal, the PAM signal and the time code signal can also be transmitted to tape recorder or to data processing for necessary real time display and post-mission processing.

### **The Basic Technical Indexes for High "G" Microwave Telemetry System**

- 1 Band:S-band
- 2 Center Frequency:2250MHz±5MHz(or 2850MHz±10MHz)
- 3 Modulation:FM-FM,PAM-FM-FM(or PCM-FM-FM)

- 4 Transmission:frequency division, frequency division-time division
- 5 Operating Distance:>15Km(transmitting power of projectile-borne transmitter <60mw,)
- 6 Transmission Error:<3%(FM); <5%(PAM)
- 7 Ambient Temperature of Projectile-borne Equipment:  
temperature:-40°C-+40°C  
straight-line shock overloading:20000g  
rotation:20000rpm
- 8 Sensitivity of Ground Receiver:superior to -126dBW(output signal-to-noise ratio 15dB,bandwidth 1MHz)
- 9 Ambient Temperature of Ground Station:  
temperature:0°C-+40°C  
relative humidity: <80%

### **The Basic Technical Features of High "G" Microwave Telemetry System**

1. Because the small-size transmission equipment is required for practical operation, and the room left for projectile-borne equipment is limited, therefore the projectile-borne equipment we have developed is as small as CP40X60 on the condition of fewer channels.

2. Since the projectile-borne microwave equipment has to stand the severe test of gunshot, so the developed projectile-borne equipment has to be of high-strength. By means of plastics sealing, reinforcing and high-strength structure, the projectile-borne equipment we developed can stand straight-line overloading of 20000g and rotation of 20000rpm.

3. As the wavelength of S-band matches with the barrel, so the barrel can be used as waveguide, the radiant result is proper. The test has shown that when the projectile is still within the barrel, the ground station 6km ahead has already received the signal radiating by the microwave transmitter on the projectile. This is unimaginable for the metre wave telemetry system.

4 Moderate channel capacity, easy combination and flexible change make the equipment adaptable for measuring fast changing signals, slow changing signals as well as transmitting the above-mentioned signals simultaneously.

5 Because the projectile-borne equipment can be used only once, so it costs less.

6 The microwave receiving antenna of the ground equipment is a dish antenna of small aperture (400mm), it is designed to be double-directional program controlled tracking, so the narrow beam (high gain) of the antenna can always track the projectile during flight and thus the complete ballistic receiving is realized.

The structure of microwave converter, metre wave receiver, band filter and phase-locked demodulator etc. is compact, their combination is flexible, the operation is convenient, reliability high and maintenance easy, thus meet the requirements of low cost and practicality for range telemetry

### **Application of High "G" Microwave Telemetry System**

One of the most outstanding features of this system is that the equipment is small in size, it costs less, the structure is simple and flexible, projectile-borne equipment can stand high overloading shock, it is of typical high "G" microwave telemetry system, it is the necessary equipment for the conventional range, and it can also be used in various fields such as meteorology, geology, petroleum, oceanology and medical and health work as well.

Another important application of this system is high-frequency working state parameter telemetry of the projectile radar, it can successfully solve the problem about compatibility of projectile-telemetry transmitting antenna and the radar antenna, it is up to now the best means for dynamic measuring of Micro-radar. it is the important equipment for micro radar development.

This system can complete ballistic parameter measuring, and it is the comprehensive measuring system for internal and external ballistic parameter telemetry (the measuring result is shown in fig.3).

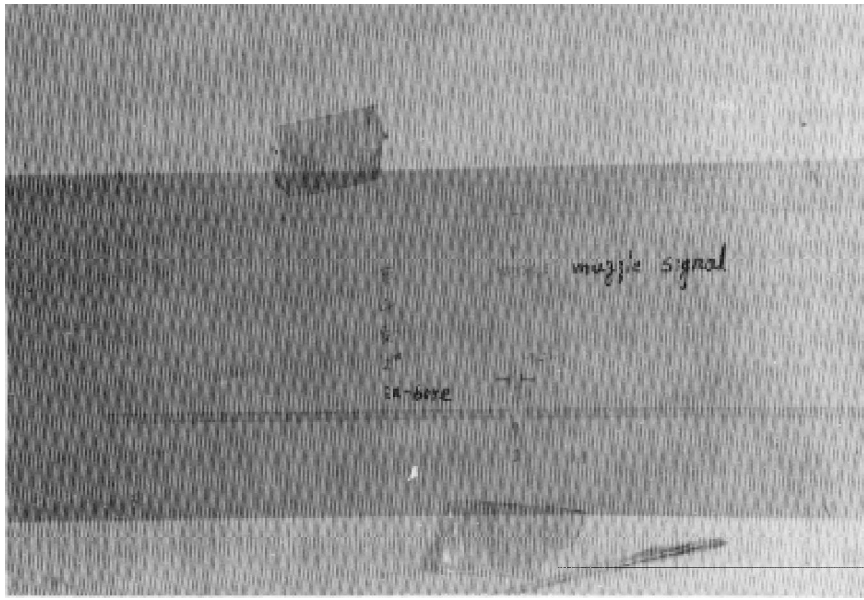


Fig.3 Measuring Result of Internal and External Ballistic Parameter