

APPLICATIONS AND DESCRIPTION OF THE  
9000SE PCM SIMULATOR  
FOR  
SIMULATION OF PCM DATA

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ABSTRACT

This paper will discuss the needs and requirements of a PCM encoder data simulator.

The 9000SE PCM encoder data simulator allows for the simulation of flight PCM data as well as bit error rate (BER) test patterns designed for link stress analysis. In addition, the open architecture of the 9000SE as an ISA bus device allows for the incorporation of the simulator into application specific realtime systems.

INTRODUCTION

The requirements for simulated PCM data are generated from many sources. For example, pre-flight operational testing of ground based telemetry systems require PCM data simulators to test the functions and behavior of the ground based telemetry hardware and software under various data conditions. These tests also verify that proper data continuity exists from the PCM stream all the way to the user's display console.

To insure that various links within the telemetry systems possess adequate signal to noise ratios (SNRs) these links are tested with known bit patterns and verified under controlled conditions designed to test the link's SNR.

Another application of a PCM data simulator is during the development phase of custom airborne PCM encoder equipment. To insure a program against the risks to schedule and cost, a PCM simulator may be used to test the numerous interfaces of the airborne encoder, particularly special hardware and software systems designed for that system.

In addition to the primary requirements of commercial availability and ease of use, the functional requirements of a commercial PCM data simulator can be generalized by stating that system reliability of ground based telemetry equipment is enhanced by performing an end-to-end test from the PCM stream to each of the ground based telemetry's display consoles. System reliability goals are not met when performance is demonstrated only under nominal data conditions. It is only under abnormal or disastrous conditions that the integrity of data becomes critical. And it is under these conditions when the fog lifts that surrounds the raison d'etre of telemetry. Thus, telemetry engineers have the responsibility to test for and eliminate potential problems from the telemetry system before they happen by subjecting that system to unexpected or non-characteristic PCM data.

#### FUNCTIONAL DESCRIPTION OF THE 9000SE

The scope of these tests have been curtailed on the one hand by the built-in limitations of utilizing the existing airborne encoders for source PCM data, and on the other by the static data content of existing PCM data simulators. The limitations of utilizing the airborne encoder instrument are built-in since the encoder was designed to function within it's operational environment. To utilize the encoder as a PCM data simulator obligates the provision of actual (or simulated) interfaces to the encoder, and thus pushes the problem down to the next level of the system without solving it. The limited scope inherent in this test methodology is obvious and thus many data conditions are left untested, resulting in endless time being spent to rationalize system integrity from limited test results. Even when these interfaces to the encoder can be provided, all too often the costs cannot be amortized since the interface has a high degree of probability of being custom to the encoder. As

mentioned above, to often PCM data simulators only provide static data within the output frame. The programmability of these simulators is generally limited to frame, word and bit oriented parameters, and the data content of the simulator is about as exciting as the diagnostic test pattern used by television repairmen.

However, with the advent of the 9000SE PCM simulator, extensive end-to-end testing of hundreds of measurements may be simply performed by telemetry users. The 9000SE system represents the right combination of hardware and software designed for the PC-AT platform to provide a PCM data simulator meeting all IRIG 106.86 requirements (including the class II requirements of variable word lengths, asynchronous subframes, format changes, etc.) as well as providing the user control over the time dynamics and data content of any PCM word. Given the wide variety of off-the-shelf PC-AT compatible data acquisition boards (MIL-STD-1553, analog I/O, networks, etc.) it is now possible to provide PCM data simulation with virtually any type of data acquisition interface. To understand the ability of the 9000SE to provide dynamic data simulation, various classes of 9000SE data devices are addressed in this paper. All devices that are presented are supported by the 9000SE system. The PCM data devices are:

- **FORMAT UNIQUE**      This device consists of those words within the PCM frame that are individually specified as to their content and location and are unique and time independent within the format.
  
- **UNIQUE**              This defines those words within the PCM frame that are individually specified as to their content and location and are alterable in real time without interruption of the PCM stream. Utilization of this device in a time and data content controlled fashion allows for the creation of calibration loops for PCM data. In addition, a unique PCM device may be designated as a destination

of a component of an application specific real time system.

- **WAVEFORM**           The 9000SE waveform design environment defines those words within the PCM frame that are to be output by this device. The environment allows the introduction of periodic waveform data to PCM words within the format. The entire waveform or individual data points are dynamically controllable in real-time without the interruption of the PCM stream.
  
- **SUBFRAME**           The 9000SE subframe design environment defines those words within the PCM frame that are to be output by this device. The environment allows the introduction of various subframes (see below) to PCM words within the format. The entire subframe or individual words within the subframe are dynamically controllable in real-time without the interruption of the PCM stream.
  
- **SUBFRAME SYNC**   This device provides for the synchronization of subframes that are dependent on the mainframe. Frame code complement (FCC), unique recycle code (URC) and subframe identification (SFID) are the types provided.
  
- **MAINFRAME SYNC**   This provides for the synchronization of the mainframe.
  
- **COMMON WORD**       This provides for the definition of all PCM default words.

As mentioned in the above device description, the 9000SE system appears as five (5) design environments to the user. These environments are organized to define and control various aspects of the simulator. They are described below.

## ■ MAINFRAME DESIGN

This provides the user an environment in which the user's frame, word and bit oriented specifications of the mainframe are made. In addition, the user assigns PCM devices to words within the PCM frame. Up to 256 instantiations of PCM devices within a mainframe design may be made and up to sixteen mainframe format designs may reside within the simulator. Format switches may be made without interruption of the PCM stream.

## ■ SUBFRAME DESIGN

This furnishes the user an environment in which the subframe, and subframe word oriented specifications are made. The subframe may be of one of four type as defined in the IRIG 106.86 specification. These are:

- Dependent Subframe
- Independent Subframe
- Asynchronous Embedded Format
- Packet Data Format

In addition, the common and unique PCM devices may be instantiated within any subframe. An unlimited number of subframes may created in advance of the realtime run of the simulator and called for output in the PCM stream in accordance with the realtime schedule of the simulator.

## ■ WAVEFORM DESIGN

This presents the user a software waveform generator. The environment extracts numeric data that is created by the user inputs to the generator. An unlimited number of waveforms may created in advance of the realtime run of the simulator and called for output in the PCM stream in accordance with the realtime schedule of the simulator.

- **REALTIME SCHEDULE** This provides the user the means to specify the dynamics of time and data content, so as to cause the 9000SE simulator to output a PCM stream that realistically simulates mission conditions.
  
- **BER TEST DESIGN** This design environment is quite different from the previously discussed applications in that the simulator does not output the traditional IRIG structured data. In this design an algorithm is selected that generates a known bit pattern of fixed length. This pattern is transmitted by the simulator in a continuous fashion.

The system test engineer then is allowed various means to degrade the SNR of this bit stream. The end receiver of the system then is tested to insure that no errors occurred in the bit stream pattern. This process may be repeated until the margins of performance for link of the system are discovered.

#### CONCLUSIONS

The 9000SE system is defined by a single PC-AT full size board and the 9000SE user interface software. The trade-offs between hardware and software have been optimized such that host processor resources are utilized solely to control the real time procedures. No processor exists in the simulator hardware, and as a result, once the simulator is programmed by the user interface, it will output a continuous PCM stream during and after a host software re-boot. Given the wide variety of off the-shelf AT compatible boards it is now possible to configure a PCM simulator with virtually any type of data acquisition interface. The 9000SE thus provides the first instrument fully capable of simulating mission conditions in a cost effective manner.