Advanced Telemetry Data Capturing

Federal Manufacturing & Technologies

G. A. Paschke

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Honeywell

Federal Manufacturing
& Technologies

P. O. Box 419159

Kansas City, Missouri

64141-6159

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G. A. Paschke, Project Leader

Project Team:

T. A. Navickas

H. E. Perez

D. G. Slaten

G. R. Stroup

M. W. Woiwood

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Abstract

This project developed a new generation or advanced data capturing process specifically designed for use in future telemetry test systems at the Kansas City Plant (KCP). Although similar data capturing processes are performed both commercially and at other DOE weapon facilities, the equipment used is not specifically designed to perform acceptance testing requirements unique to the KCP. Commercially available equipment, despite very high cost (up to $125,000), is deficient in reliability and long-term maintainability necessary in test systems at this facility. There are no commercial sources for some requirements, specifically Terminal Data Analyzer (TDA) data processing. Although other custom processes have been developed to satisfy these test requirements, these designs have become difficult to maintain and upgrade.

Summary

Conceptual and detailed hardware designs have been completed for a new generation data capturing process for both Terminal Data Analyzer (TDA) and Pulse Coded Modulation (PCM) systems. Detailed software requirements have been completed. Some software has been implemented to demonstrate how the system would be integrated into a test system and to support initial hardware prove-in. A completed software package and complete hardware integration are beyond the scope of this project. These activities are being completed as part of the development of two new telemetry testers, currently under way, where this new data capturing system will first be deployed.

The industrial computer, or embedded computer system of older designs, has been replaced with a common desktop computer. The architecture of older data capturing processes precluded the use of a desktop computer. This not only significantly reduces the original cost of the equipment but significantly reduces the cost of maintaining or upgrading the computer system.

The commercial PCM decommutator has been replaced by custom circuits. The commercial decommutators were very expensive and provided a lot of unnecessary capability. The commercial

equipment was designed primarily for laboratory and field use and not automated test systems. This resulted in poor reliability. Because the commercial decommutators used proprietary interfaces, replacing or upgrading them would result in a redesign of the custom circuits that used these interfaces. The software controlling the decommutator would also require extensive revision.

All logic in the new hardware design is implemented in Programmable Logic Devices (PLDs). This provides the capability to incorporate revisions or upgrades to the data capturing circuits very rapidly and at very low cost.

The new software design is implemented using Visual Basic and uses ActiveX technology. User interface, performance, function, and maintainability have been improved.

Discussion

Scope and Purpose

All telemetry functional and environmental test systems require Pulse Coded Modulation (PCM) and Terminal Data Analyzers (TDA) data capturing (decommutation). Existing data capturing processes, both commercial and custom, do not have all the capability to support future telemetry projects. Additionally, telemetry test systems have a long life span and the current data capturing processes have become difficult to maintain. Computer technology advances, both hardware and software development environment, have caused the existing computer platform to become outdated and, therefore, replacing or upgrading computer components or software is very costly. A new data capturing process was required that incorporated new required capability and featured a design that is easier and less costly to maintain.

The scope of this project was to complete a detailed design of the hardware and software and demonstrate that the design is sound.

Prior Work

Since the first use of Pulse Coded Modulation (PCM) and Terminal Data Analyzers (TDA) in telemetry projects more than twenty years ago, telemetry testers have required data capturing equipment. Several variations have been used, but all consisted of a commercial PCM decommutator and a custom TDA decommutator as there are no commercial sources for TDA decommutation. Limitations in the commercial PCM decommutators would result in using a testing methodology that resulted in very long test times. Test times of five to eight hours per test condition were common.

The most recent prior design for PCM and TDA data capturing, which was introduced more than ten years ago, significantly reduced test times to about one and half hours while significantly improving the quality of the test. It consisted of a commercial PCM decommutator, custom circuitry to process PCM data, and a custom TDA decommutator. The architecture of this design used custom circuit boards in a VME chassis with an Embedded Personal Computer (Embedded PC). The Embedded PC was much more expensive and had less processing speed than desktop PCs, but the VME architecture accommodated the data capturing requirements.

Activity

Conceptual Design

The first step in this project was to develop a conceptual design. The conceptual hardware design is detailed in Figures 1 through 6 (see Appendix). Some of the conceptual design information was not included in this report as it is not likely to be within the interest of the reader.

The conceptual design consisted of using a desktop computer with two commercial PCI – Digital IO cards connected to a custom chassis containing several custom printed wiring assemblies (PWA). Interconnect diagrams were developed as well as a chassis layout.

In addition to a conceptual hardware design, a conceptual software design was developed. The data capturing software would be developed as an ActiveX (OLE automation) executable. The ActiveX server would provide the necessary properties and methods required by test programs to control the data capturing hardware and process PCM and TDA data.

The data capturing software would act as either a conventional or Remote ActiveX server. This would permit the same program to be used in test systems with one or two computers.

In functional telemetry testers, two computer systems would be used. One computer would control instruments and exercise the telemetry system while the second computer operated only the data capturing circuits. This two-computer design has been used in many earlier telemetry test systems.

In environmental testers that typically contain less instrumentation the two computer functions are combined. Eliminating a computer not only saves money, but also lots of space, which is important as these test systems must be mobile.

Using ActiveX technology enables us to develop only one program that can be used in both types of test systems despite the differences in architecture.

Visual Basic v6 would be used to develop data capturing software.

The conceptual design was reviewed during the formal Conceptual Design Review for the PT4180 and PT4181. These test systems will be the first to deploy the Advanced Telemetry Data Capturing process.

Detailed Design

The detailed design of the Advanced Telemetry Data Capturing hardware and software is documented in drawings listed in the Appendix.

The detailed hardware design contains a chassis layout and schematic. Also, schematics for six Printed Wiring Assemblies (PWA) and seven Electrically Programmable Logic Devices (EPLD) were developed.

The detailed design work consisted partly of repackaging a mature data capturing hardware design into the new architecture, eliminating the need for the expensive VME chassis and Embedded PC. More modern EPLD technology was utilized. This provided the capability to add additional functions in fewer components and also reduced circuit development/prove-in time by significantly reducing EPLD reprogramming time.

New circuit features were added. The commercial PCM decommutator was replaced by custom circuits incorporated in the same PWA and EPLDs that formerly contained only the data processing circuits. Despite adding the PCM decom and other new functions to the custom circuits, the PCM data processing hardware was reduced from two PWAs to one. The commercial dual-port VME memory board was eliminated and its function added to the Event Recorder PWA.

A circuit was added to perform derandomizing. The marker detector circuit (TDA decom) was extensively modified to perform two-frame marker detection. These new circuits were added to satisfy new test requirements.

Printed wiring board (PWB) manufacturing files were developed from schematics.

In the SR-UB1217 document, all of the software requirements are described for the data capturing process. This includes detailed description of all of the properties and methods that are provided by the ActiveX program. These descriptions of the program's properties and methods not only provide requirements for coding the data capturing control program, but also will aid in the development of application test software (client programs).

Design Verification

Prototype hardware was built. Initial prove-in using project funding was limited to verifying new design features. The most significant feature tested was the new architecture, which includes data communication with the computer and between custom circuits. Other major features tested in this phase included two-frame marker detection and derandomizing circuits.

Complete hardware prove-in is under way as part of the development of the PT4180 and PT4181 testers. At the time of this report's completion, all hardware prove-in was nearly complete.

Accomplishments

A comprehensive new design was developed for the data capturing process used on telemetry test systems. This new design should support telemetry test requirements for the foreseeable future. This new design can be upgraded inexpensively because it uses an ordinary desktop PC and all logic functions are coded in programmable logic devices. None of the programmable logic devices are filled to capacity, so capacity for modifications and even additional functions exists. Because it uses no expensive components, spare parts and assemblies can be provided to backup tester components.

Future Work

As part of deploying this new design in telemetry test systems, hardware prove-in and software coding and checkout must be completed.

Appendix

Figures:

1 Conceptual Design - Bit Synchronizer

2 Conceptual Design - TDA Decommutator

3 Conceptual Design - PCM Decommutator

4 Conceptual Design - Data Compressor

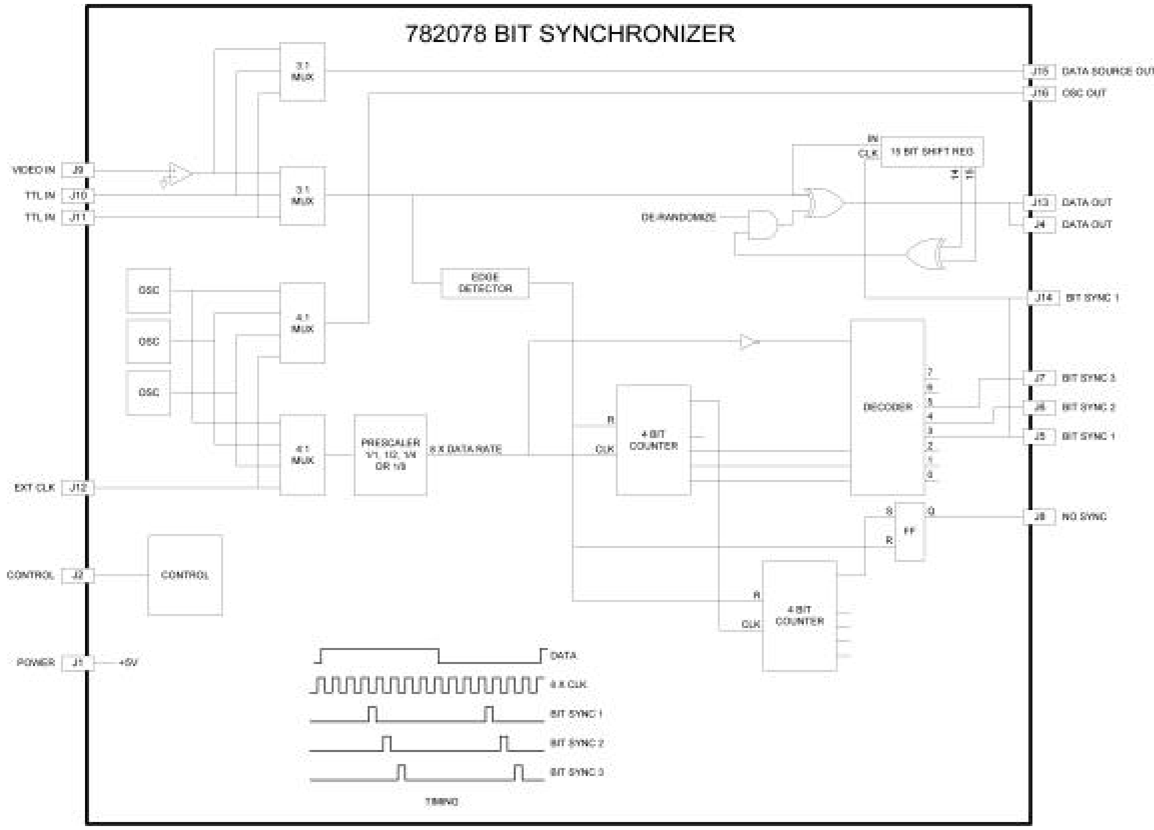
5 Conceptual Design - Event Recorder

6 Conceptual Design - Simulator

Other Documents:

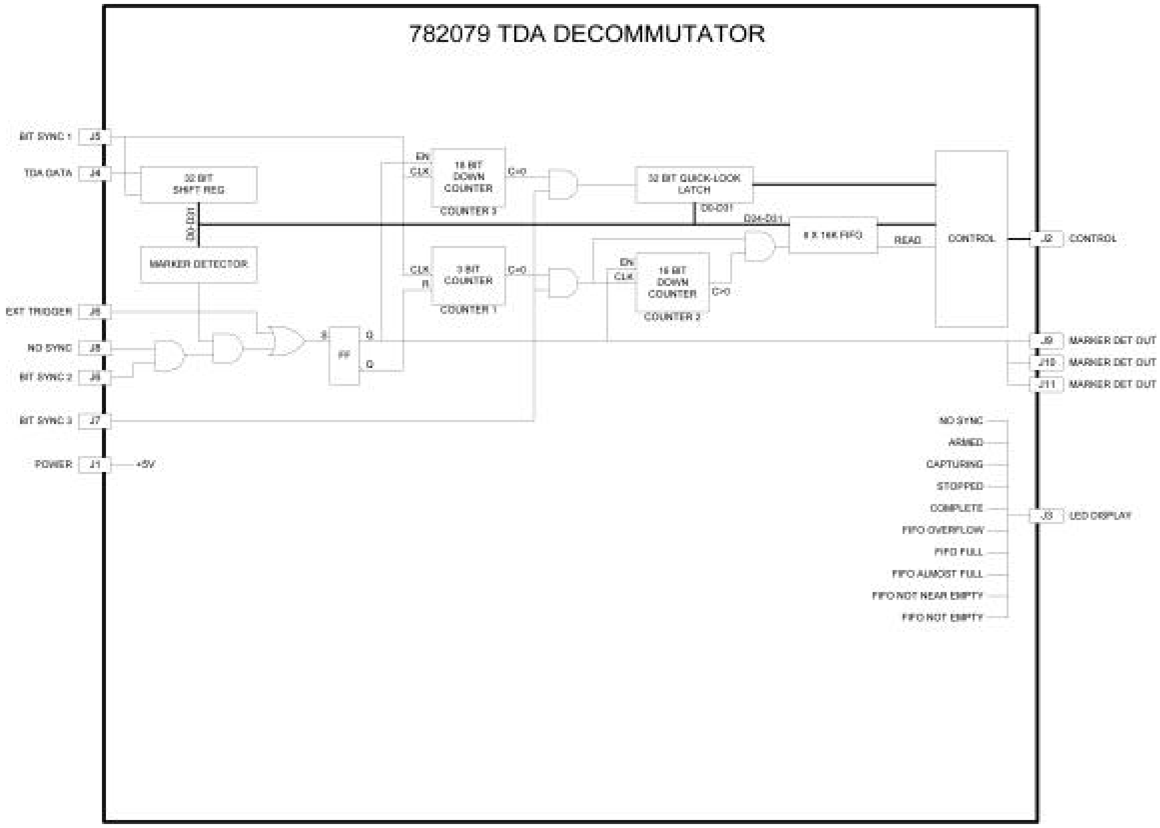
The drawings in the table below provide documentation of the final design of the Advanced Data Capturing Process.

Drawing #	Description
UB1217	Adapter, Data Capturing
782067	PWA, PCM Decom
AM782067	Tester Control Program, 782067-U4 and U5 EPLDs
782069	PWA, Event Recorder
AM782069	Tester Control Program, 782069-U14 and U20 EPLDs
782075	PWA, Simulator
AM782075	Tester Control Program, 782075-U4 EPLD
782076	PWA, LED Display
782077	PWA, Computer Interface
AM782077	Tester Control Program, 782077-U3 EPLD
782079	PWA, TDA Decom
AM782079	Tester Control Program, 782079-U4 EPLD
SR-UB1217	Software Requirements, UB1217 Data Capturing Chassis



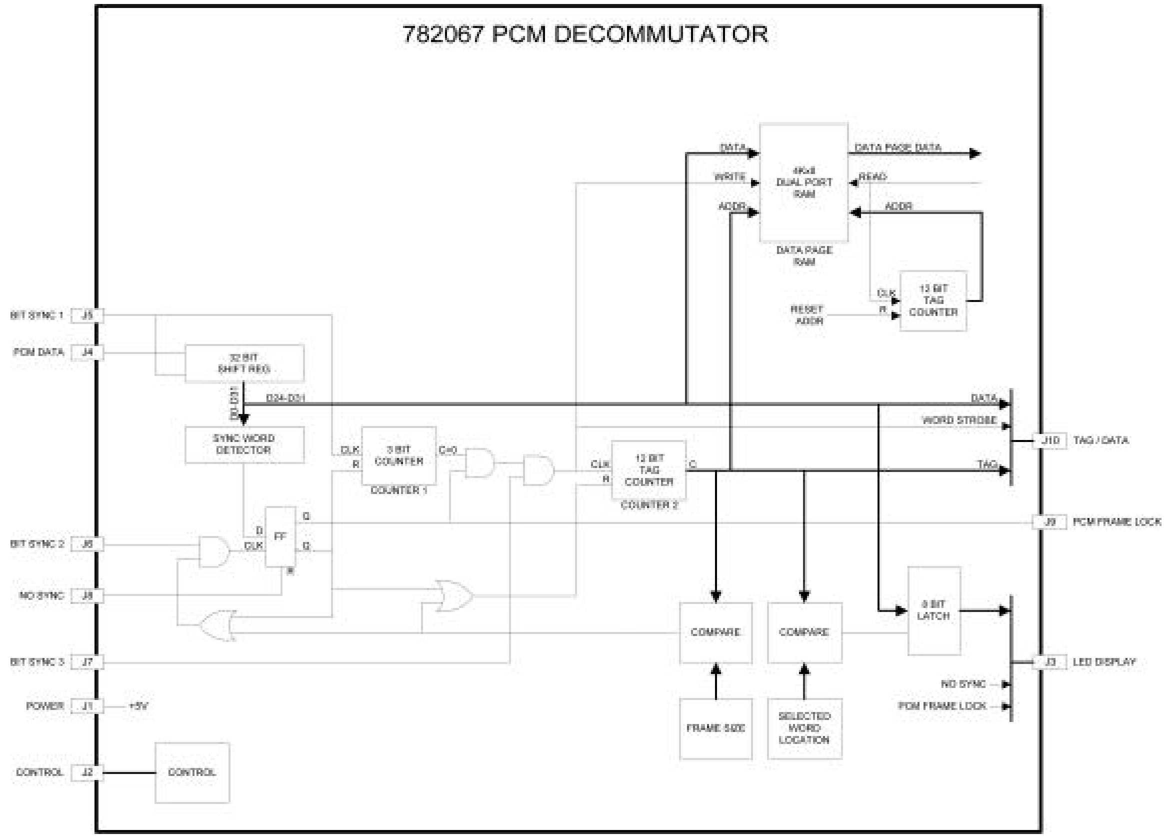
Note: During the detailed design, the bit synchronizer circuit was incorporated within the EPLD on the TDA and PCM decom PWAs. This reduced the number of printed wiring boards that required layout and fabrication, reducing costs.

Figure 1: Conceptual Design – Bit Synchronizer



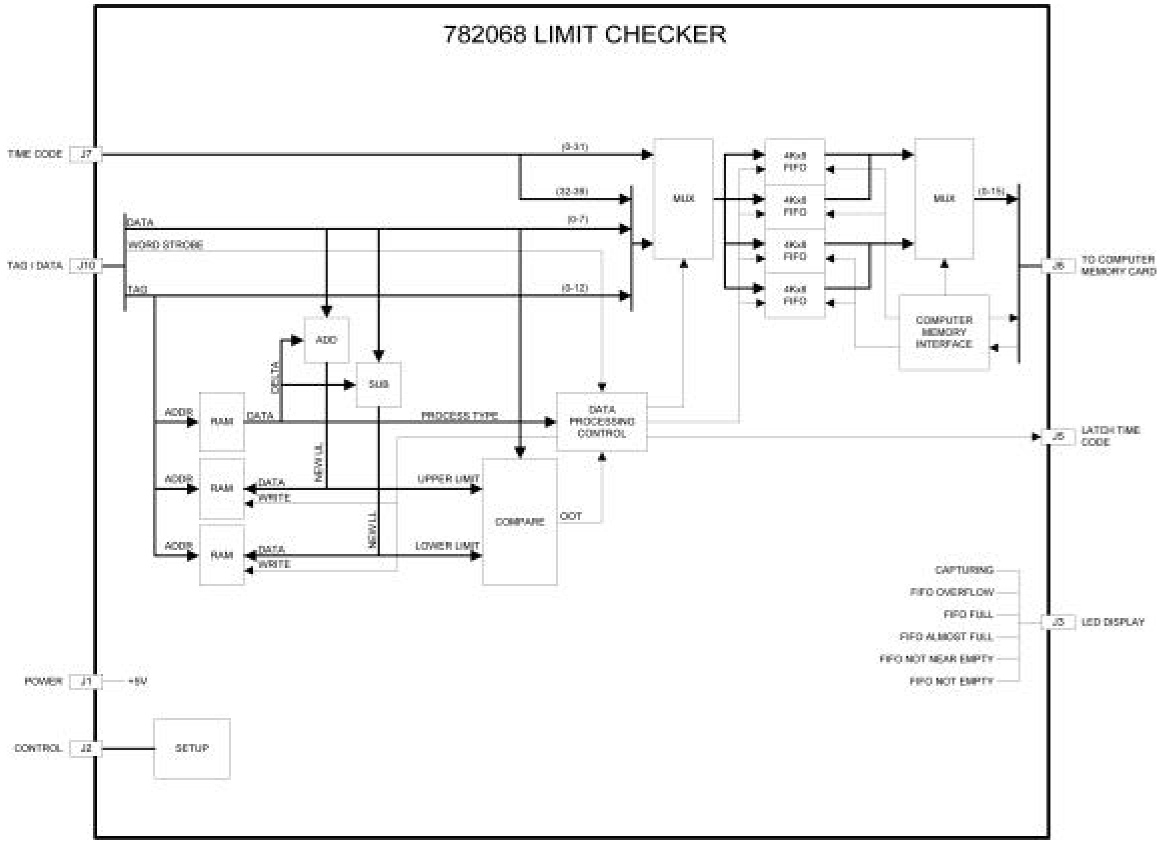
Note: Connector design was changed during detail design. See final design schematics.

Figure 2: Conceptual Design – TDA Decommutator



Note: The PCM Decom and data compressor circuits (Figure 4) were combined into one PWA.

Figure 3: Conceptual Design – PCM Decommutator



Note: The data compressor and PCM Decom circuits were combined into one PWA.

Figure 4: Conceptual Design – Data Compressor

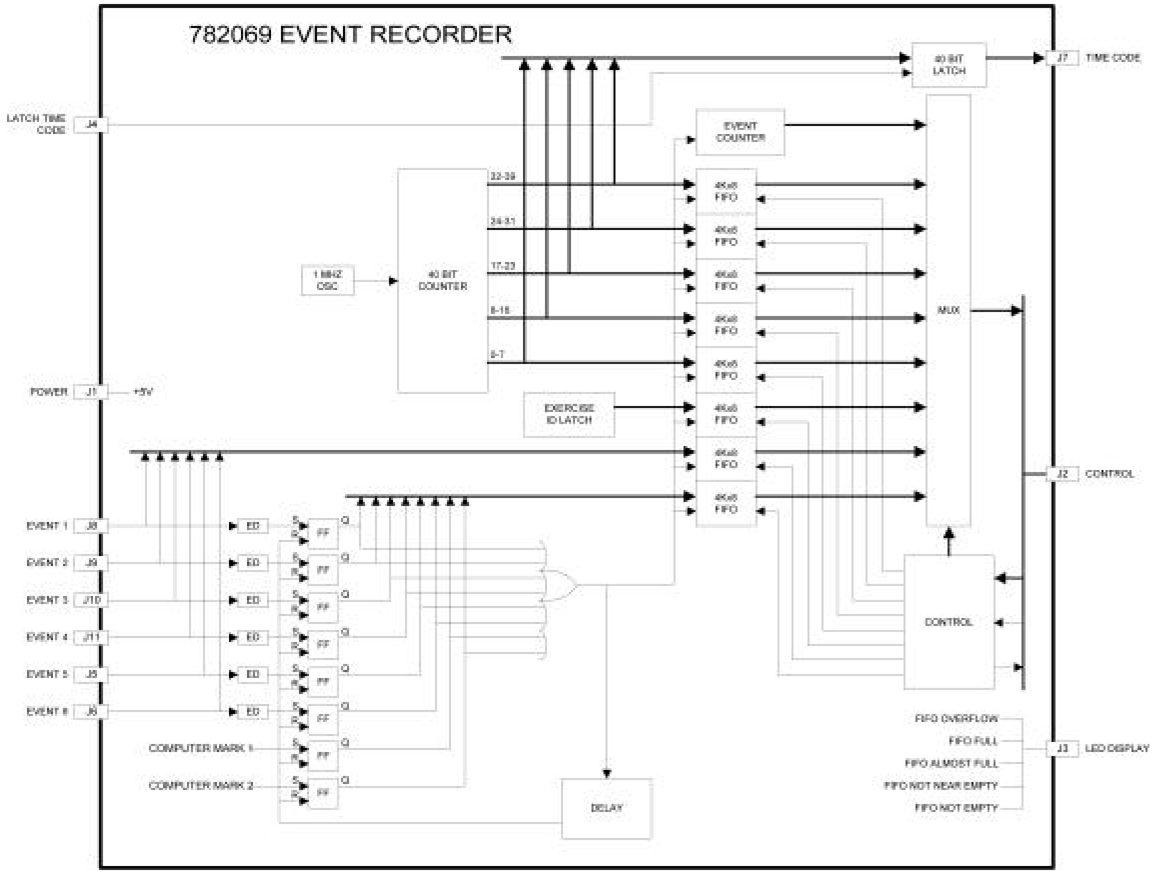
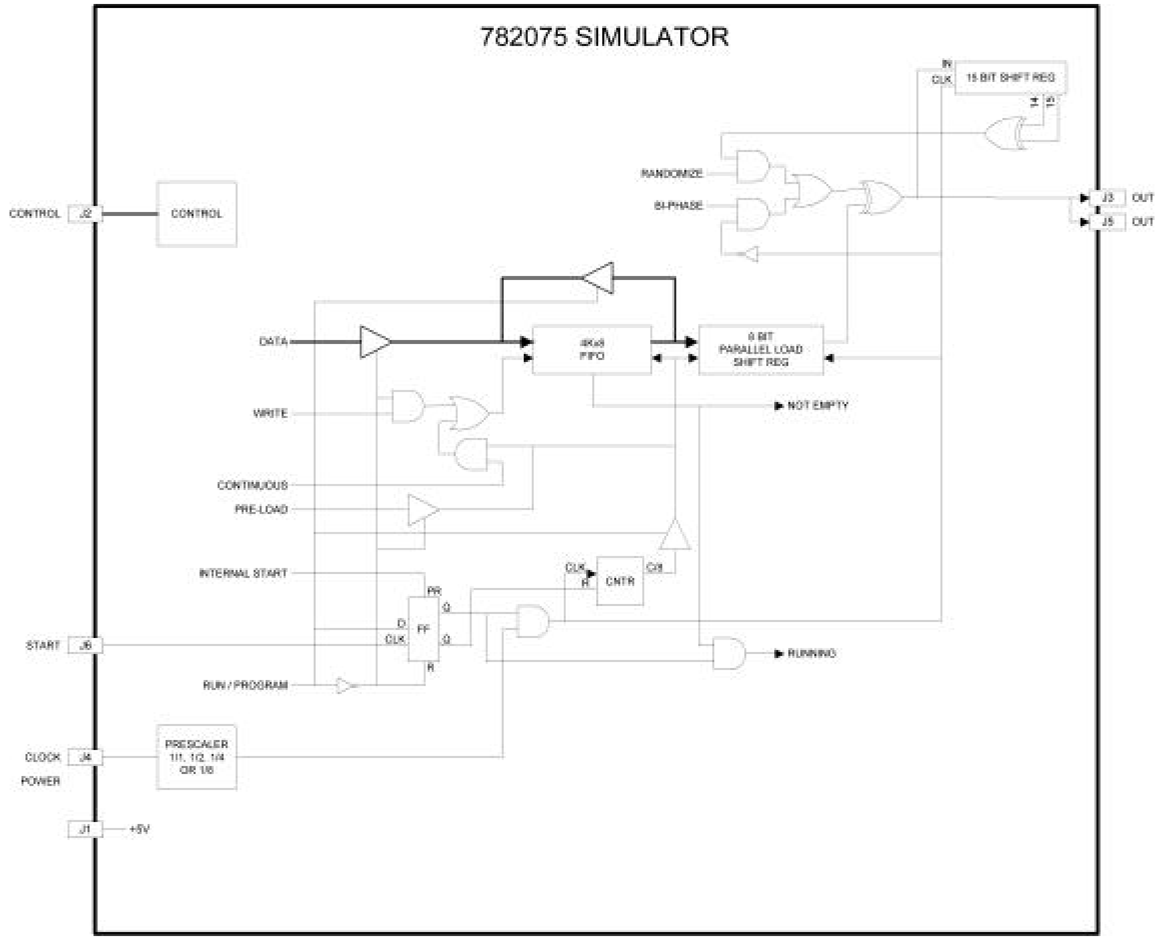


Figure 5: Conceptual Design – Event Recorder



During detailed design, a single Printed Wiring Board (PWB) was designed to accommodate both the TDA decom and the simulator. By implementing two PWAs on one PWB design, engineering labor and PWB costs were reduced.

Figure 6: Conceptual Design - Simulator