A LOCALLY PROGRAMMABLE/NONVOLATILE WORD SELECTOR FOR DISPLAY OF TAGGED TELEMETRY DATA

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ABSTRACT

The introduction of Data Compressors into the NWC Telemetry Ground Station has created the opportunity to circumvent usage of data distribution patch panels. An array of Word Selectors can be used to capture telemetry data parameters by tag identification for display on chart recorders. Design goals in the development include: independent operation, resident program storage, variable word length handling, and accommodation of nonstandard data formats. A prototype has been constructed and tested.

1.0 INTRODUCTION

Telemetry ground stations are traditionally designed to be capable of receiving, processing, and displaying data from a wide variety of modulation formats. This paper will discuss a means to minimize the amount of manual intervention (and time) required to reconfigure China Lake's ground station from one telemetry format to another. The Word Selector effort is an outgrowth of a requirement to supply China Lake's Range Control Center with real time data and appended identification tags. The intention is to supplement an existing analog data distribution system and further to make full use of required computer and compressor equipments.

2.0 GROUND STATION SIGNAL FLOW

Figures 1 and 2 illustrate the basic differences in required equipments for analog signal distribution and for tagged digital signal distribution. Demultiplex equipment (identified by DAC, or Digital-to-Analog Conversion blocks) and distribution patching are replaced by Data Compressors and Word Selectors. Not shown in Figure 2 are two redundant host computers and associated disk memory for compressor set-up.

In terms of redundancy and overall flexibility, there is little difference between analog and digital data distribution. It is anticipated, however, that digital equipment software will be

time-consuming to write, but will allow an extremely fast changeover from one preprogrammed configuration to another. Reconfiguration between fixed formats is far more common than creation of new data distribution set-ups.

The two EMR 714-2 Data Compressors in Figure 2 are operating in throughput mode - with no compression - and simply append 16 bit identification tags to unique telemetry parameters. The compressors provide compressed data for Range Control Center use.

There is no intention to remove existing analog signal distribution capability. Rather, this equipment will be retained for backup and for reasonably quick response to new requirements. Each Word Selector has analog bypass switching on its front panel.

3.0 ASSEMBLY-LINE PROCESSOR

Each Word Selector has been designed to drive eight pens of a single chart recorder. Each incoming 16 bit tag word must be compared to eight reference tags stored in active memory. If tag identity is established, then the associated 16 bit data word is passed along for further processing and is finally output to one of eight Integrated Circuit Digital-to-Analog Converters (IC DACs). Each Word Selector can only be committed to one compressor source at a time.

The maximum average throughput rate of Tag/Data pairs from each compressor is 400 kHz. An output buffer on each compressor insures that peak rates will not exceed 400 kHz. Compressor outputs are 32 bits wide and occur asynchronously. The minimum time interval between compressor outputs is 1/400 kHz = 2.5 microseconds.

A Word Selector architecture has been chosen to comfortably satisfy the foregoing tag scan and input rate requirements. The total processing to be accomplished on each Tag/Data input is broken into three steps, each of which can be accomplished simultaneously on sequential inputs. This technique has been identified in the literature as “assembly-line processing”.

3.1 Step One: Tag Scan

Incoming Tag/Data pairs are latched into the Word Selector by the compressor output buffer handshake line: “Scan Request”. The incoming tag is then sequentially compared to eight reference tags stored in bipolar RAM. Comparisons are made at a 5 MHz clock rate.

If tag identity is established, then three bits of RAM memory address at which identity occurred are latched as a pointer to an output IC DAC. The 16 bit data field is flagged for further processing. Further, four bits of word length and four bits of conversion code which

where stored in RAM along with the identity tag are latched and made available for Steps Two and Three respectively. Tag Scan is complete 2.3 microseconds after Scan Request and the Word Selector is ready for another Scan Request.

3.2 Step Two: MSB Align Data

For a variety of specific and detailed reasons, it has been elected to provide the Word Selector with LSB aligned data from each decommutator source (e.g. EMR 710, EMR 730). For data word lengths less than sixteen bits, it is necessary for the Word Selector to shift data within the sixteen bit incoming data field until MSB alignment is obtained.

During Step Two, the incoming data field is latched into a sixteen bit Parallel-In/Shift-Right/Parallel-Out register. A four bit counter is preset to a word length code recovered in Step One. The counter is then incremented until it contains all zeros. The shift register is shifted one position for each increment of the counter. Zeros are shifted into the register and overflow bits are discarded.

The shift register is clocked at 10 MHz and anywhere from zero to fifteen shifts can be obtained. Step Two requires 1.8 microseconds.

3.3 Step Three: Data Conversion

Three bits of the conversion code recovered in Step One and the remaining eight most significant bits of aligned data are used as an address to EPROM memory. The purpose of EPROM memory is to map aligned data into a magnitude-only format compatible with output IC DACs.

In the case of data which was originally magnitude-only, no conversion is performed: memory contents are equal to the least significant eight address bits. In the case of signed data, each data value is remapped into a corresponding magnitude-only value. The pen chart recorder display can be inverted for either signed or unsigned data by “flipping” the high and low ends of memory address contents. The number of different types of data conversion that can be performed is limited by EPROM memory size. A prototype Word Selector is currently fitted with 2K bytes of EPROM look-up table. This memory size will support eight different types of data conversion, of which four are currently assigned.

The prototype Word Selector retains eight data bits for IC DACs so that only one EPROM device would be required - with its data bus of eight bits. It is possible to extend the number of retained data bits by using two or more EPROMS.

EPROM data is latched into one of eight IC DACs according to a channel count captured in Step One. The complete data conversion step takes l.5 microseconds.

4.0 MEMORY CONTROL

The terminology which was adopted for the Word Selector is that circuitry or set-up which is specific to one of eight analog outputs is a “channel”. For example, channel one tag is used to point associated data to channel one IC DAC - which drives pen number one of a chart recorder. A single channel memory store is three bytes: Sixteen bits of tag plus four bits of word length plus four bits of conversion code.

Eight channels of set-up information reside in bipolar memory at any one time and constitute a “project”. A total of eighty-five projects can be stored in EEPROM memory and have associated numbers from 01 to 85.

Each Word Selector has a Microcomputer (MCU) for memory control. The MCU allows the operator to recover a project (24 bytes) from EEPROM, examine and edit if necessary, and then either “store” the project back into EEPROM or “load” it into bipolar active memory. Immediately after a project load, control of bipolar RAM address lines is transferred to Word Selector TTL circuitry and the MCU becomes dormant. The MCU can be accessed again by a system reset.

The MCU microprocessor is an MC6809. The microprocessor has 2K bytes of MOS RAM, 2K bytes of EPROM, and 2K bytes of EEPROM in its bus. Front panel control of the MCU is by a hexadecimal keypad and RESET/STORE/LOAD function switches. Front panel display is by an 80-character alphanumeric LCD display with its own 6800 microprocessor. The 6809 based microcomputer includes a monitor program for self checks.

The MCU writes set-up information into bipolar RAM one byte at a time for a total of 24 bytes. Bipolar memory can be read only by Word Selector TTL circuitry. The memory is read 24 parallel bits at a time.

5.0 PACKAGING

A prototype Word Selector has been constructed in a 3-1/2 inch height, standard width chassis. It is intended to mount immediately adjacent to the chart recorder that it will drive. All internal circuitry is mounted on a single wire-wrap backplane (Figure 3).

6.0 CONCLUSION

A hardware design for display of tagged telemetry data has been reviewed. A feature of this development which makes it unique among equipments intended for a similar application is its independent (stand alone) operation. The design has been pursued in the belief that an array of simple and locally programmable display drivers would be of significant advantage in a real time telemetry environment.

REFERENCES

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(3) “Programming the 6809", R. Zaks and W. Labiak, Sybex Inc., 1982

(4) “5 Volt Programmable EEPROMS”, Preliminary data sheet by Xicor Inc., March 1982, Stock No. 200-012

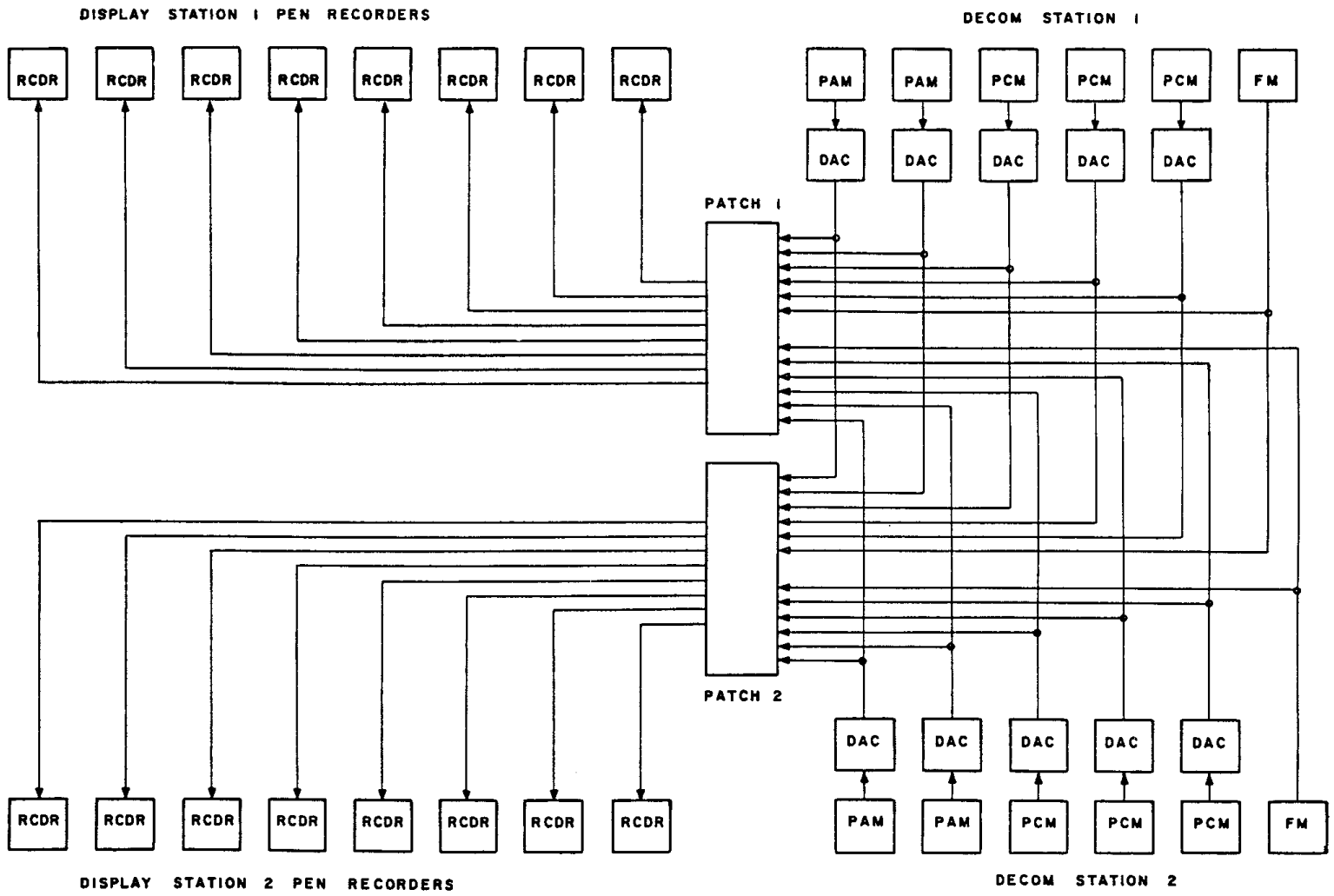

FIGURE 1. ANALOG SIGNAL DISTRIBUTION

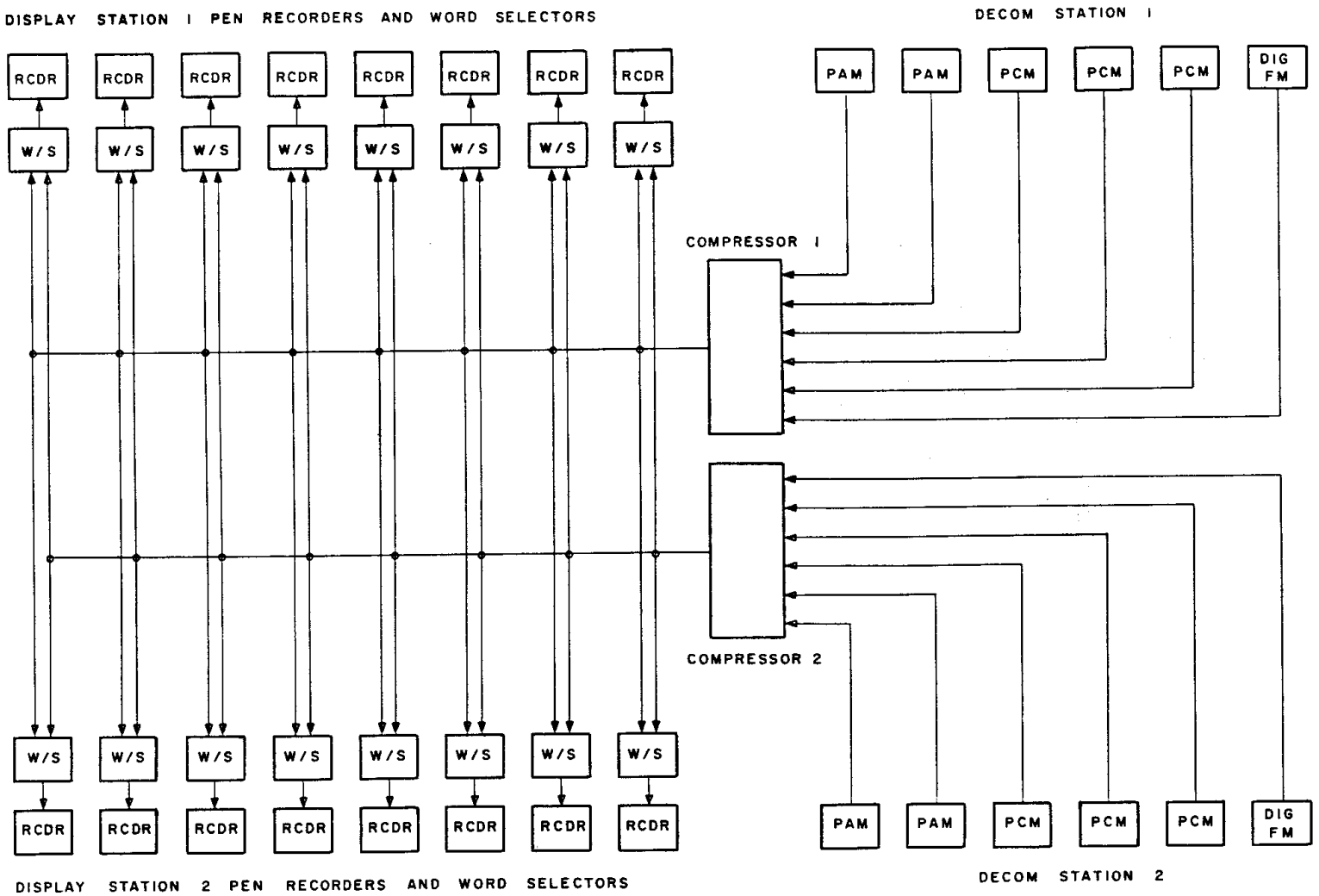

FIGURE 2. TAGGED DIGITAL SIGNAL DISTRIBUTION

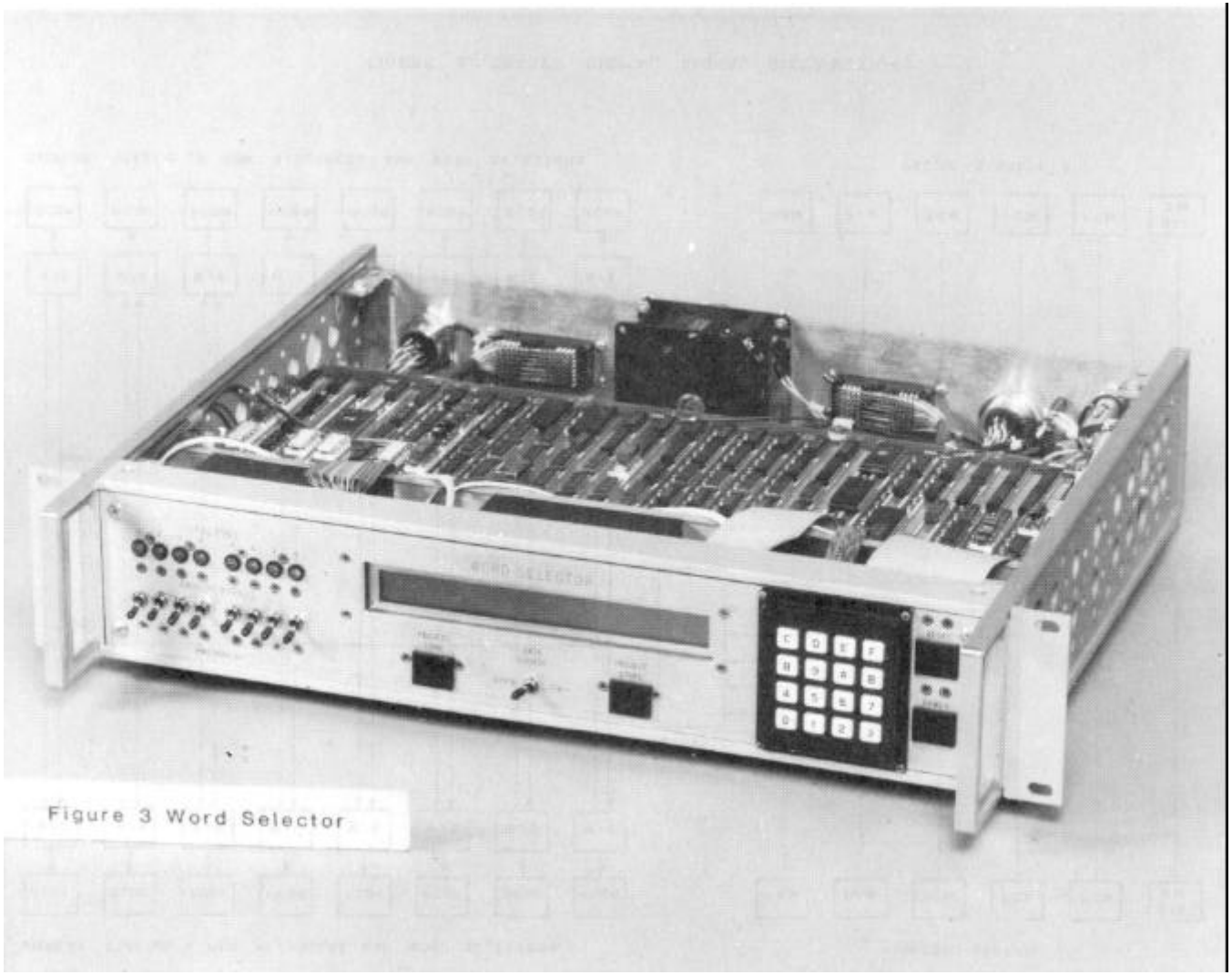

Figure 3 Word Selector