INTEGRATED 1553 DATA BUS MONITOR SYSTEM

William P. Russell
Supervisory Electronics Engineer
Range Directorate
Naval Air Test Center
Patuxent River, Maryland

ABSTRACT

An integrated 1553 Data Bus Monitor (DBM) System has been developed at the Naval Air Test Center. The system is capable of monitoring six 1553A or B channels and provides, in separate PCM streams, selected parameter data and all message traffic on the data bus (thruput). Thruput data can be split to two tape tracks per channel for bandwidth conservation. Selected parameter formats can be entered at the flight line with a hand-held programmer which communicates to the DBM via an RS-232 interface. PCM outputs are available for telemetry as well as for on-board recording. Analog and discrete data is incorporated in the system with A/D inputs, parallel inputs, or serial entry of PCM data from a remote PCM system. A 1553 remote terminal provides data to the F-18 mission computer. Existing systems are being used on AMRAAM Development in the F-18 and in follow-on F-18 development at the Naval Air Test Center.

INTRODUCTION

The Naval Air Test Center has developed several 1553A Data Bus Instrumentation systems. The Airborne Multiplexer Monitor Unit (AMMU) was developed to support F-18 full scale development. It has the capability to monitor three 1553A Data Bus channels providing a selected parameter PCM output and thruput outputs for each channel. Fifteen AMMU systems have been built by the Naval Air Test Center and are being used at all major Navy T & E facilities supporting F-18 and AV-8 test and evaluation projects.

The 1553B Military Standard included changes in the protocol and timing of the data bus and responses which the AMMU was incapable of handling. Specifically, inclusion of mode codes and the broadcast format cannot be appropriately treated by the AMMU. Changes in the response time specification render the AMMU helpless to properly decode or decipher the format of the 1553B data bus.

With new aircraft systems incorporating 1553B data buses, it was decided that a new data bus monitor should be developed. The 1553 Data Bus Monitor (DBM) was developed to operate with combinations of mode codes and broadcast commands and the flexibility to allow software changes to satisfy new requirements. Included was the capability to remotely reprogram the PCM format, frame sync words, and frame size of the selected parameter outputs. It has the capability of handling both 1553A and 1553B formats. Three DBM units have been fabricated and are being used in missile development at PMTC.

DESIGN PHILOSOPHY

The design concept pursued in the development of the DBM was to satisfy existing requirements of the instrumentation of 1553A and 1553B data buses, provide selected parameter and thruput PCM streams, and to allow for maximum flexibility in handling future needs to monitor mode code and broadcast formats. The capability to supercommutate or subcommutate PCM data was also considered and incorporated where feasible. In addition, the capability to include or merge data from other sources such as analog or discrete data, and a serial PCM stream from an A to D subsystem was included. Microprocessors were used to gain the desired flexibility and to permit accurate monitoring of the 1553B Data Bus.

IMPLEMENTATION

The DBM can monitor data from four or more 1553A or B channels - bus and redundant bus. Figure 1 shows the input/output configuration of the DBM. The DBM provides selected parameter data for magnetic tape recording and for telemetry. Outputs of this data are available in NRZ, Bi Phase-L, Miller or filtered NRZ.

Thruput data is a PCM stream which contains all message traffic from one 1553 channel. It is available in one or two streams per channel. In cases where bandwidth reduction is desired to permit longer tape record time, the thruput is split into two 500 Kbit streams rather than a single 1 Mbit stream. IRIG time is accepted by the DBM in parallel form from a time code generator. Other data from analog inputs, discrete inputs, or party line (McAir) are accepted by the DBM and put in appropriate positions in the PCM frame of the selected parameter output.

The format of the selected parameter output is controlled by information which is down-loaded from a hand-held programmer box. The typical parameter list is processed to generate the appropriate code which is loaded into an EPROM. This EPROM is the medium to transport the parameter information to the DBM in the aircraft, where it is plugged into a socket in the hand-held programmer and down-loaded to the DBM. The

programmer also provides the capability of verifying ID of the parameter file, and permits viewing or modifying entries in the DBM.

The unit was designed to be mounted on a crank-up pallet that hangs in the gun bay of the F-18. A photo of the unit is shown in figure 2. Unit is 12½ in x 14 in x 8½ in and weighs 26 pounds.

INTERNAL ARCHITECTURE

The DBM has a two parallel bus architecture - p-bus and time bus.

Time Bus

Time is received in parallel 32 bit form (BCD) on the time/power card from a time code generator. A 1 Mbit clock is divided by three BCD counters which are synchronized to the time code generator. This provides time data to a resolution of 1 microsecond. At present, 10's and 100's of microseconds are used. Time data is presented to the time bus as three sixteen bit words. It is continuously output word-sequentially. Accompanying the time word are the appropriate signals to allow latching on other elements in the system and to identify which of the three words are present.

P-Bus

The P-bus is a 16 bit bus that is accessed by all microprocessors in the system. Access is controlled and arbited by the Bus Arbiter. Over this bus all set-up information and data is passed to/from various elements in the system. Associated with this bus are control signals necessary to permit passage of data on the bus.

FUNCTIONAL DESCRIPTION

The functions shown in figure 3 will be described in the following text.

Central Processor

The central processor is a Z8000 on the Formatter Processor - BD1. It controls setting up the selected parameter PCM format and outputting the PCM data through Formatter Processor BD2. Selected parameter information is loaded via an RS-232 interface into the parameter memory interface stored in EAROM's - non volatile electrically alterable ROM's. At power turn-on this information is read by the Z8000 and used to set up a memory buffer containing PCM sequence pointers. These pointers are used by the Z8000 as addresses for the data to be outputted in the PCM stream. Time information for the

PCM is presented as two 16 bit words; it is received from the time bus and read by the Z8000.

1553 Input

1553 data is received on the DBM input card. Each of these cards house a TMS32010 microprocessor, and two “Dumb RTU” hybrids for interfacing to bus and redundant bus. As data is received on the DBM input it is processed and presented to the respective thruput card for output and is stored in bus memory for access by the Z8000. Data is deciphered by processing the command/data sync bit, the bits associated with preset time measurement thresholds, and other bits pertaining to the validity of the 1553 word. One DBM input card and one thruput card are required for each 1553 channel.

The DBM is being upgraded to include other input/output functions as listed below.

A/D Input

Contains the capability of 16 diffential or 32 single ended inputs set to hardwire preprogrammed input range. This card, has an allocated memory space which is accessible to the Z8000 via the P-Bus. A/D data is output in the selected parameter PCM stream, positioned in accord with the selected parameter specifications.

PCM

Has the capability of receiving PCM data in the form of NRZ and clock from a A/D sub-system. This data is stored in a buffer, allocated memory space which is accessible to the Z8000 via the P-Bus. It is capable of synchronizing the A/D with the frame output of the DBM. The purpose of this is to merge the A/D data stream with the DBM data stream for telemetry.

Discrete Input

A discrete input provides capability of incorporating discrete data into the PCM stream in the same way as the A/D. The card has the capability of accepting switch closure inputs or high voltage inputs and is optically coupled for circuit protection.

Flutter Interface

An interface to the McAir “Party Line” bus is incorporated in the DBM to receive data during flutter testing of the F-18. This bus is a serial command/repsonse type with one command required for each data word. This data is included in the selected parameter PCM output.

Remote Terminal

A remote terminal to the mission computer bus in the F-18 is provided to pass data from the A/D subsystem input to the mission computer. This card contains a TMS32010 microprocessor. Data is passed to it via the P-bus.

DATA FLOW

The 1553 formats for messages are shown in figure 4. In the AMMU, which monitored only 1553A messages, whether a word with command sync was a command or a status word was determined by measuring the time gap between words. “Response Time” specs (see figure 5) for 1553A required it to be from 2 to 6 microseconds and the intermessage gap was to be greater than 8 microseconds. For the 1553B, response time was allowed to go to 12 microseconds - thus negating the technique used in the AMMU.

In the DBM it is necessary to have a microprocessor synchronize the input and track the message events as they occur, in accord with allowable formats. In this manner either 1553A or 1553B messages can be interpreted in the DBM input.

Thruput Data Output

As message words are received they are tagged with a four bit code and output to the thruput processor in the format shown in figure 6. The four bits identify the data for data reduction. The output of the thruput processor is a one Mbit serial PCM stream or it can be split into two 500 kbit streams. In either case the PCM stream operates as a synchronous stream with fill data inserted when actual data is not forthcoming.

Selected parameter Data Output

The 1553 wordformats are shown in figure 5. A selected parameter is a data word specified by 16 bits which identify the message and the position of the data word in the message. Selected parameter data applies to the first three message types shown in figure 4. The most significant 11 bits of the command word (see figure 5) - remote terminal address, T/R bit, and subaddress are combined with the contents of a five bit

data word number counter and a bit to indicate data or time to form a memory address for storing each data word and a 16 bit time tag. The time tag is 16 bits of four BCD digits of time 10's and 1's of milliseconds and 100's and 10's of microseconds. Every data word received from each 1553 data bus is stored in memory in this manner. Each DBM channel is allocated space in bus memory so that buses with common remote terminal addresses can be accomodated.

The data words to be recorded and telemetered are specified by the selected parameter format. The Z8000, at start-up, sets up a table of memory addresses in the order that the parameters are to appear in the PCM format. The Z8000 goes through this table, sequentially accessing each memory location specified and outputting the data and time. The selected parameter output PCM format is shown in figure 7. The size of the PCM frame is selected in the selected parameter format specification. Selected parameters can be selectively time tagged. Literals can be inserted into the frame by specifying them in sequence with data parameters.

This selected parameter format is controlled by entering data from the hand held programmer box. Frame size, frame sync work, fill pattern, inclusion of literals anywhere in the PCM frame are controlled by this prom down-load. Selected parameter bit rate can be changed by changing crystal frequency or hardwired frequency-divider programming on the formatter processor-Bd 2.

CONCLUSION

The DBM was designed to be a flexible data collection system. It monitors four 1553 Data Buses, analog and discrete parameters and elicits reponse from the McAir party line system for flutter data. It also provides the capability to merge other PCM data into the output PCM stream.

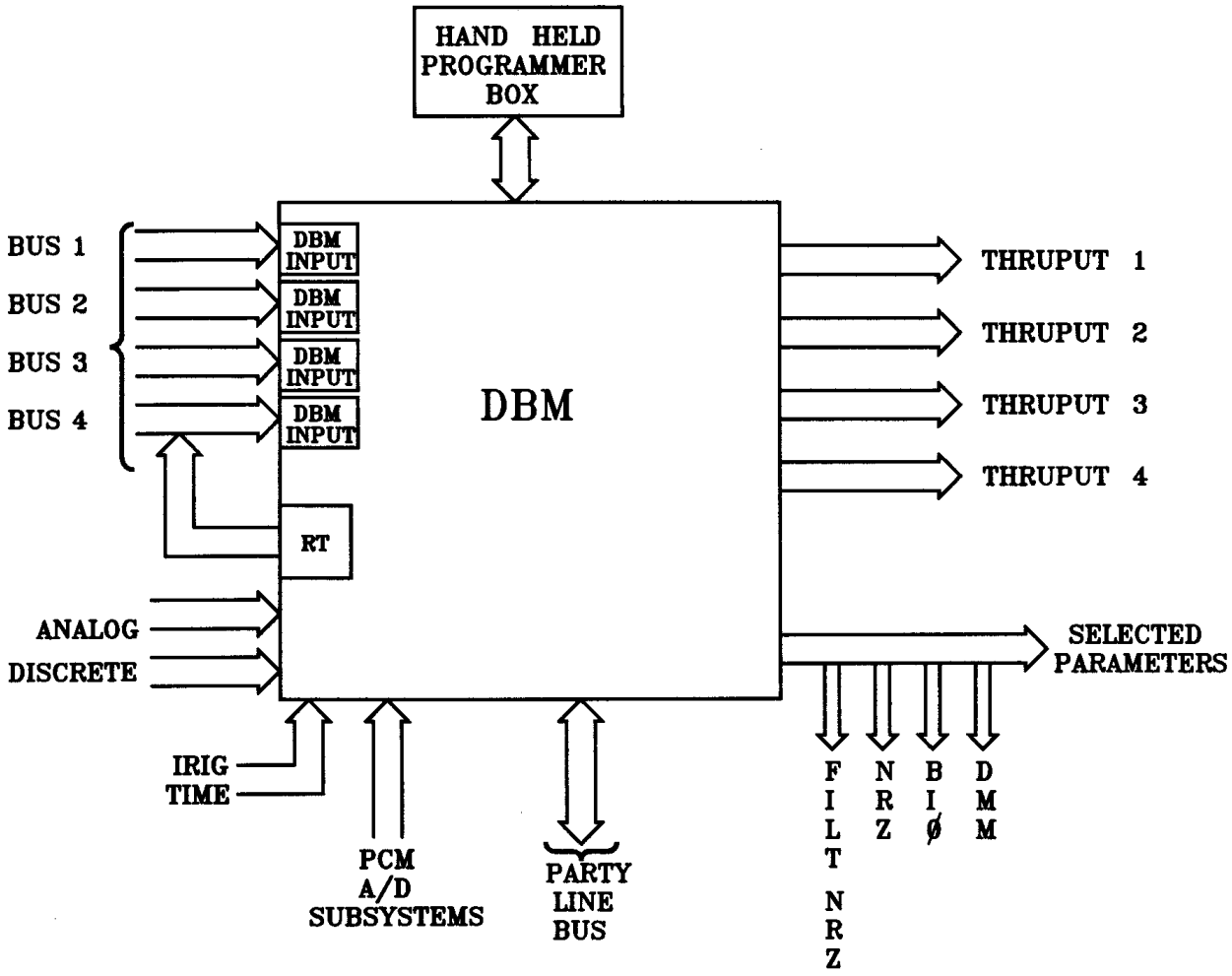

FIGURE 1
INPUT/OUTPUT CONFIGURATION OF DBM

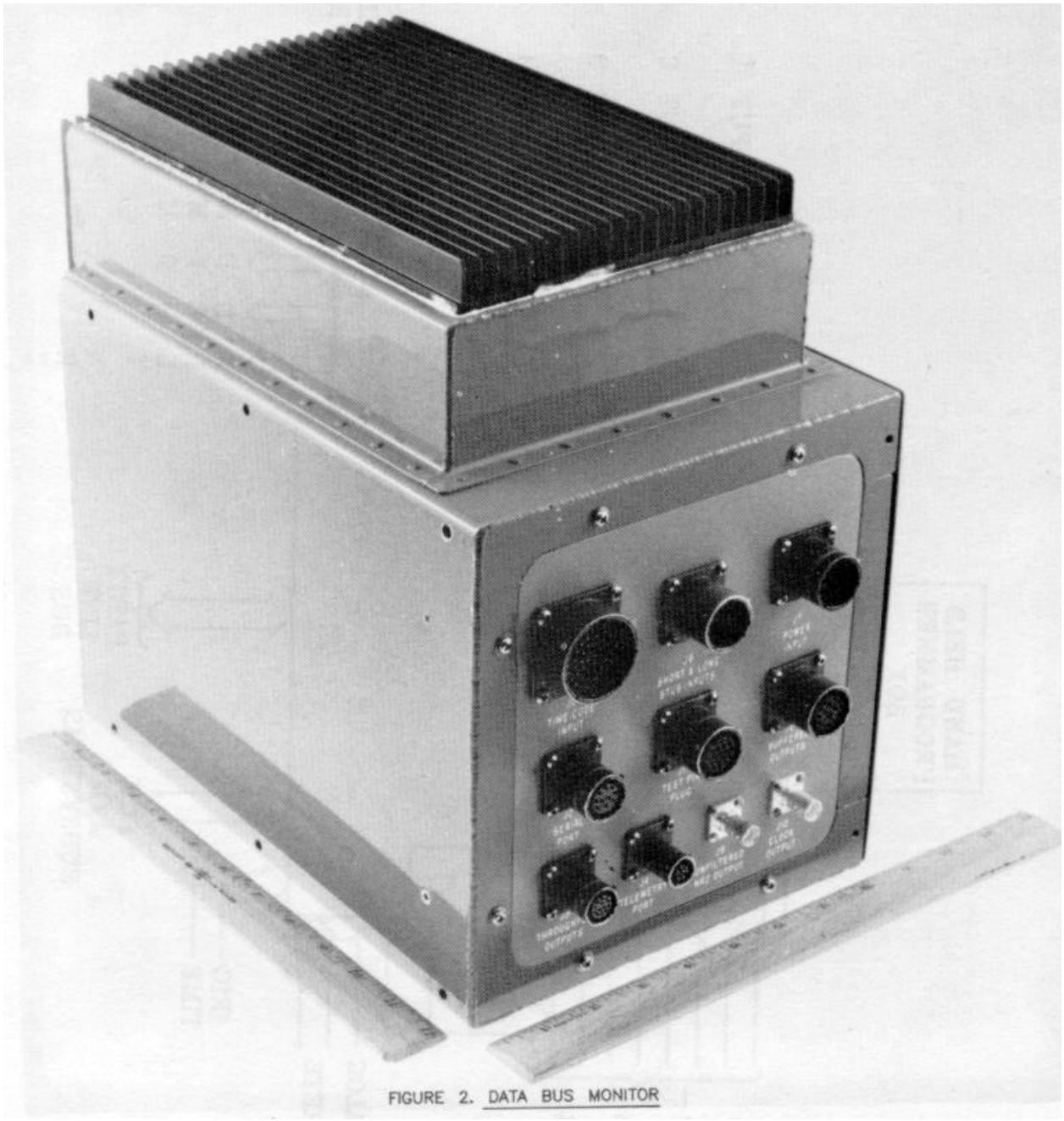

FIGURE 2. DATA BUS MONITOR

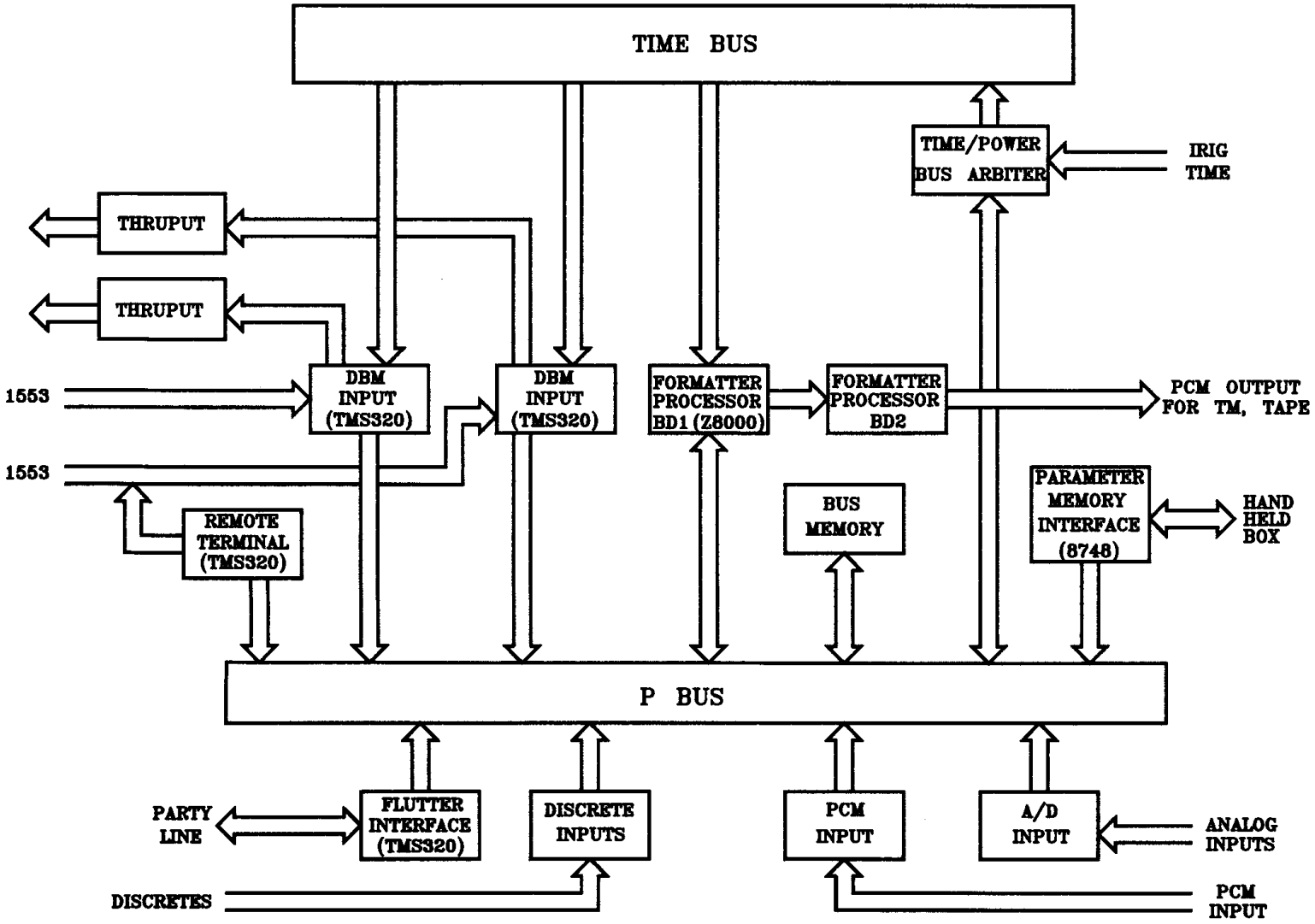

FIGURE 3
INTERNAL ARCHITECTURE OF DBM

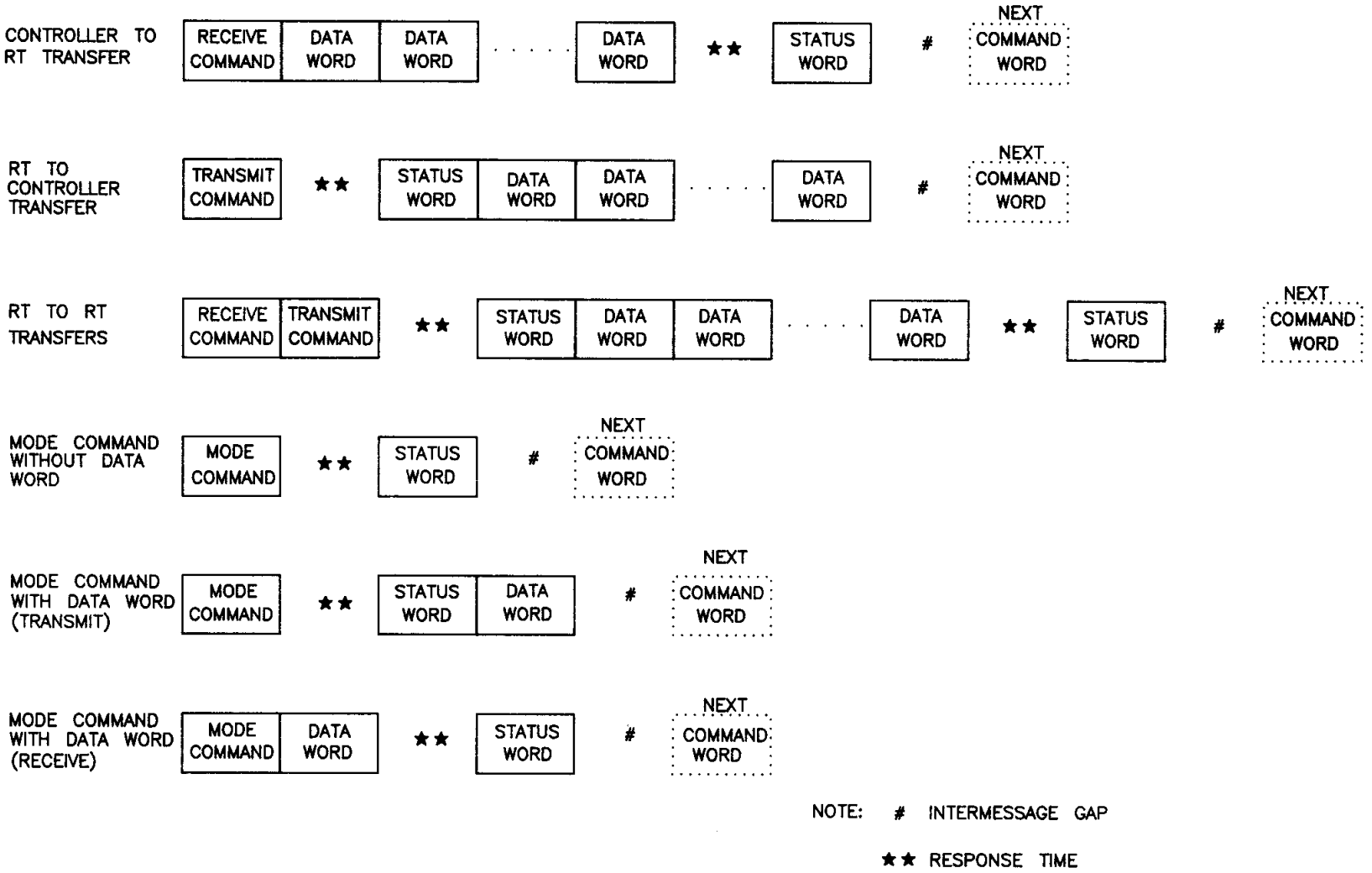

FIGURE 4. MESSAGE FORMATS

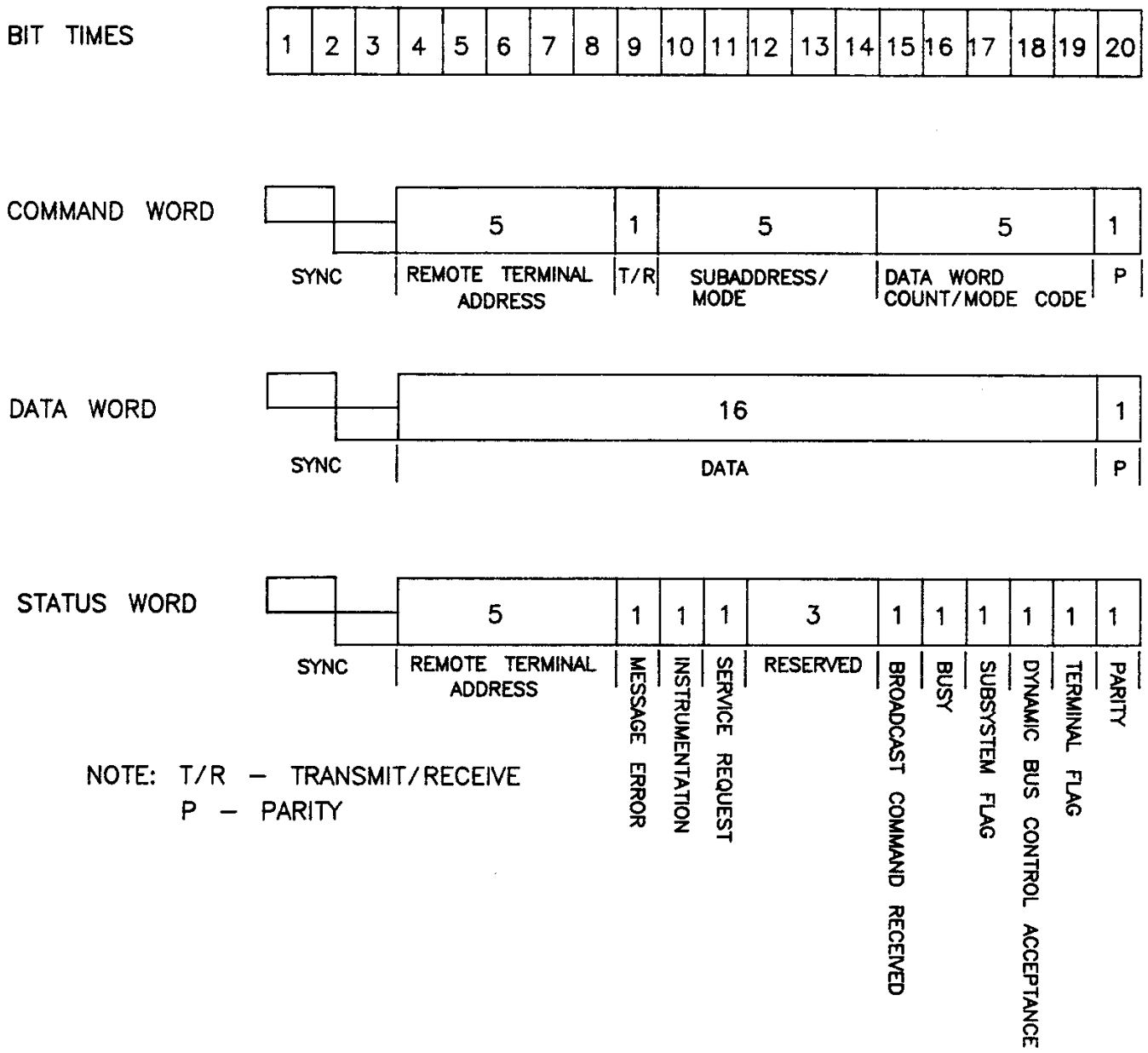

FIGURE 5. WORD FORMATS

4 Bit Tag	16 Bit - Data

TAG	TYPE DATA
0001	Data Word
0010	Unknown or Undecided
0101	Status Word
0111	Command Word
1XXX	Fil Word

Figure 6. Thruput Format.

PCM FRAME - Selected parameters

WD I	SYNC WORD FAF3 H
WD 2	SYNC WORD 3500 H
WD 3	ID WORD
WD 4	MAJOR TIME HRS - 10's of sec
WD 5	MINOR TIME 1's SEC - 1'S millisec
WD 6	DATA PARAMETERS
"	
"	
"	
"	
WD N	DATA PARAMETERS

Data parameters may be one time word and one data word or one data word (no time)
Time word - 10's milsec - 10's microsec
All words - 16 bits
Frame Size - programmable
Literals may be inserted at selected positions

Figure 7. Selected Parameter Format