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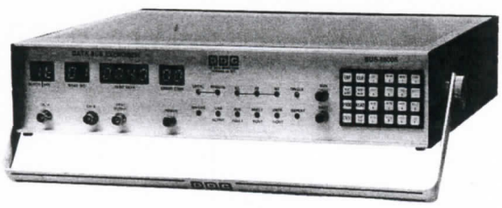
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DDC
ILC DATA DEVICE CORPORATION

BUS-68005

MIL-STD-1553 DATA BUS EXERCISER



IMPROVED POWER SUPPLY

DESCRIPTION

The BUS-68005 is a low cost portable instrument for testing and troubleshooting MIL-STD-1553A and 1553B systems. It provides full function simulation of Remote Terminal Unit (RTU) and Bus Controller (BC) operation. The BUS-68005 implements the protocol tests of the proposed SAE AE-9A Production Test Plan for Remote Terminals. These tests include RT Address, Word Count, Subaddress, Error Injection, Dual-Redundant Operation, Mode Commands, Status Word, Broadcast Messages, and RT to RT Transfers. BUS-68005 offers simple and flexible operation including either local programming via the front panel 24 pad keyboard and 10 character alphanumeric display, or remote programming via an 8 bit parallel I/O port, RS-232, or IEEE-488 interfaces. The IEEE-488 interface is a Direct Memory Access (DMA) port, allowing for real-time operation. Additional features include error generation and error detection, single, repeat, or halt-on error operation modes, variable response time, variable message gap, variable transmitter amplitude, a real-time monitor port, programmable response time-out, and built-in self test. Its compact size, 3.47″ x 14.5″ x 17.0″, and price/performance makes it a leader for test applications requiring BC and RTU simulation.

FEATURES

- *IMPLEMENTS PROTOCOL TESTS OF SAE AE-9 PROPOSED PRODUCTION TEST PLAN*
- *1553A OR 1553B SYSTEM TESTS*
- *SIMULATES:*
  BUS CONTROLLER
  MULTIPLE REMOTE TERMINALS
- *REAL-TIME MONITOR OUTPUT*
- *ALL PARAMETERS MANUAL AND REMOTE PROGRAMMABLE:*
  KEYBOARD/DISPLAY
  IEEE-488 WITH DMA
  RS-232
  8 BIT PARALLEL
- *ERROR GENERATION/DETECTION*
- *VARIABLE TRANSMITTER*
- *LOW COST*

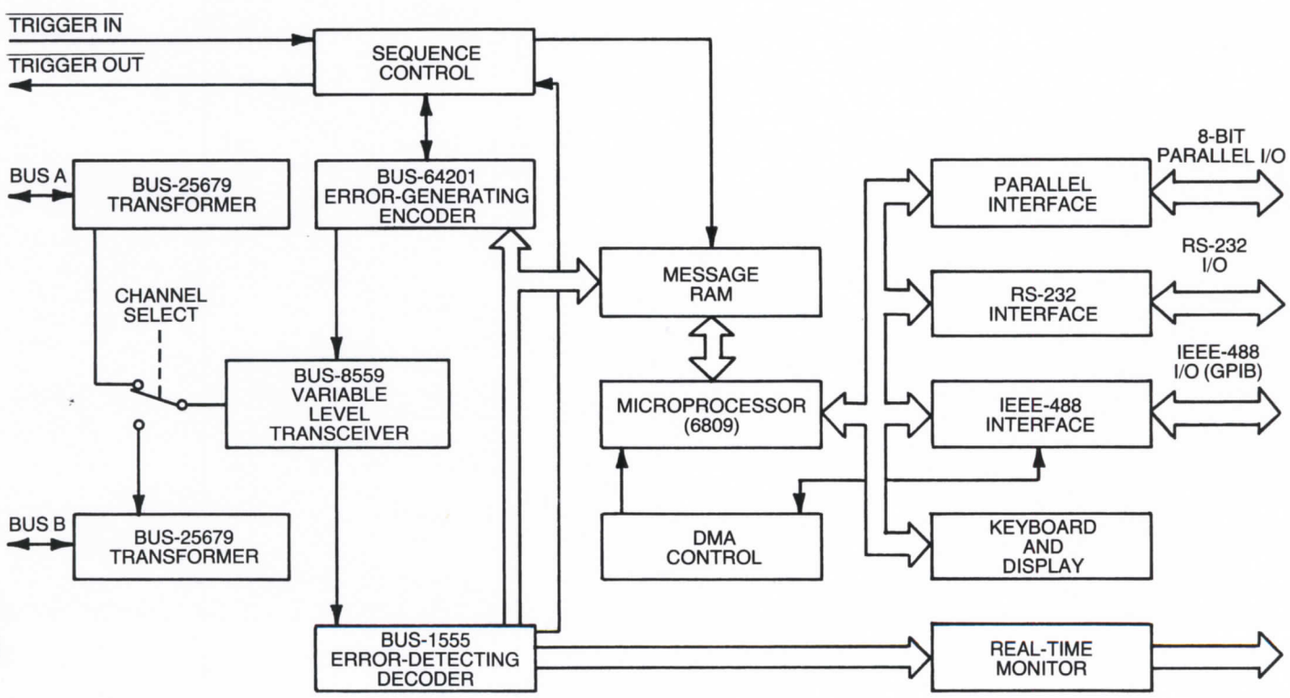


FIGURE 1. BUS-68005 BLOCK DIAGRAM

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TABLE 1. BUS-68005 SPECIFICATIONS

PARAMETER	VALUE
DATA BUS INTERFACE	
Channels	2 (user selectable)
Coupling	Direct (front panel) or stub (rear panel)
Transmitter	
Output Voltage	Programmable: 0 to 9.75Vpp nominal with 1 part in 256 resolution
Rise/Fall Time	200±20ns
Output Noise	10mVpp max (differential)
Receiver	
Input Voltage	40Vpp max (differential)
Input Impedance	4K Ω min (differential)
Threshold Level	1Vpp typ (direct coupled)
CMRR	40db min
BUS CONTROLLER MODE	
Message Formats (1)	RT to BC, BC to RT, RT to RT (with Mode Code and Broadcast)
Message Repetition	Single, Repeat, or Halt after a programmable number (1 to 99) of Errors
Messages Per Frame	Programmable 1 to 8
Words Per Message	Programmable 1 to 49
Intermessage Gap	Programmable 7 to 2047 μsec
Frame Time	Programmable 2 to 500 ms
REMOTE TERMINAL MODE	
Message Formats (2)	RT to BC, BC to RT, RT to RT with Mode Code and Broadcast
Message Repetition	Single (1 to 8 messages) or Continuous
Simulated RTUs	Programmable 1 to 8
Response Time	Programmable 6 to 31 μsec.
Address	Programmable 0 to 31
REAL-TIME MONITOR PORT	
Interface Bus Width	8, 16, 32 bit selectable
Outputs	16-Bit Data Transmit/Receive Data/Command Sync Valid Word Word Errors Block Address RT Trigger Word Message Fault Indicator "Real-Time" Signals
Inputs	Tri-State Enables

PARAMETER	VALUE
ERRORS GENERATED	
Manchester Error	Any bit position
Parity Error	Any word
High or Low Bit Count	Any word, −1, +1, +2 bits
Sync Type Error	Command or Data Word
Sync Field Error	Incorrect first, third, fourth or sixth 500nsec time "window"
Word Gap Error	1 μsec gap between 8th and 9th data bits
Message Gap Error	2 μsec gap between end of current word to start of next word
Zero-Crossing Deviation Error	"Start of bit" time to "mid-bit" zero crossing: selectable 312.5, 375, 625, 687.5ns, any (single) data bit position
High or Low Word Count	Any message
Response Time Error	Any message
Format Error	Incorrect T/R bit any message
ERRORS DETECTED	
Manchester Error	
Parity Error	
Bit Count Error	
Word Count Error	
Sync Type Error	
Response Timeout	Programmable, 5 to 32 μsec
Early Response Error	Less than 4μsec, per MIL-STD-1553B
Transmitter Timeout	800 μsec
REMOTE INTERFACES	
8-Bit Parallel (3-State) IEEE-488 (DMA Port) RS-232	Standard on BUS-68005
AC POWER INPUT	
Voltage	115V/230V±10% (switch selectable)
Power	60VA max
Frequency	47-63 Hz
OPERATING TEMPERATURE RANGE	0°C to +70°C
MECHANICAL	
Outline	3.47 x 14.5 x 17.0 inches (9.0 x 37 x 43.2) cm
Mounting	Bench or full rack, standard
WEIGHT	18 lbs (8.2kg)

Notes:
(1) In BC mode, unit can simulate BC and one RT, for RT to RT transfer.
(2) In RT mode, unit can simulate transmitting and/or receiving RTs for an RT to RT transfer.

GENERAL

As a Bus Controller, the BUS-68005 controls the command/response data transfer with one or more RTUs. Messages are loaded either manually or remotely and can be programmed to contain errors such as Manchester coding, parity, sync, high or low bit count, word count, word gap, message gap, and zero-crossing deviation. Up to 8 messages of 49 words each may be loaded at one time. Intermessage gap can be selected from 7 to 2047 microseconds, in 1 microsecond steps. The BUS-68005 evaluates the response to each command, and flags and displays errors such as response time, continuity, fail-safe timeout, Manchester coding, sync, parity, and high or low bit count or word count.

In the Bus Controller mode, the BUS-68005 implements BC to RT, RT to BC, and RT to RT message transfer formats. Each format may include broadcast or mode code commands. Furthermore, the Exerciser can be configured to simulate both the BC and one of the RTUs in an RT to RT transfer. Commands and responses are stored in the BUS-68005 internal RAM, and may be viewed word by word by means of the 10 character front panel alphanumeric display or the remote I/O ports.

As a Remote Terminal Unit, the BUS-68005 receives, validates, and stores data bus commands containing its (programmable) addresses. Up to 8 RTUs can be simulated at one time. Each simulated RT address may be mapped to one or more Exerciser memory blocks, allowing the Exerciser to transmit or receive multiple messages for the same RT in real-time. It responds to commands with status and data, as appropriate. Note that Status Words default to Clear Status via internal software, they may also be user programmed. Response time can be programmed from 6 to 31 microseconds, in 1 microsecond steps. Up to 8 messages of 49 words each may be stored at one time in the BUS-68005 internal RAM. These messages may be accessed via the keyboard for viewing on the front panel alphanumeric display.

In the Remote Terminal Unit mode, the BUS-68005 evaluates each command, and flags and displays errors, such as format, response timeout, fail-safe timeout, Manchester coding, parity, sync, and high or low bit count or word count.

The Exerciser also includes a real-time monitor output port. In addition to providing a 16-bit parallel representation of each 1553 word as it is transmitted or received in real-time, this port also provides indications of sync type, data direction, word errors, RT/Monitor "trigger" word flag, Exerciser message block number, and many other signals that may be used in various testing situations. The real-time monitor port may be utilized as either a passive monitor interface or as a high-speed parallel "window" to the BUS when the Exerciser is operating in either BC or RT mode.

Another feature included to support "real-time" operation is DMA capability for the IEEE-488 (GPIB) interface. This provides a direct, high-speed parallel link between a host computer with a DMA GPIB and the Exerciser's "message" and "trigger" RAMS.

The BUS-68005 is packaged in a 3.47 x 14.5 x 17.0 inch enclosure with a handle that can be used as a tilt-stand. It operates from either 115VAC or 230VAC 47-63Hz power. With its flexible manual or remote programmability and its error generation and detection, the BUS-68005 is ideal for simulation of Bus Controllers or Remote Terminal Units for bench, field, or factory test applications.

SET-UP PROCEDURE

In order to insure correct operation of the BUS-68005, the following step-by-step set-up procedure is recommended:

(1) Set the VOLTAGE SELECT switch on the rear panel of the BUS-68005 to the correct line voltage (115VAC or 230VAC) and connect the line cord to connector J1.

(2) Figure 2(a) shows The BUS-68005 connections per MIL-STD-1553 and figure 2(b) illustrates non-system type testing. For MIL-STD-1553 applications, connect the triax cable(s) to Channel A and Channel B connectors (CH. A and CH. B on the front and rear panels). Direct coupled data bus connections are made to the front panel connectors and stub coupled data bus connections are made to the rear panel. For non-system type testing, a 35 Ohm resistor across the DATA and DATA* terminals may be used.

(3) Connect J2 (Parallel I/O), J3 (RS-232), and/or J4 (IEEE-488) remote interface cables to the rear panel connectors. Set I/O SELECT switch S8.

(4) Connect REAL-TIME MONITOR/TRIGGER cable to J15.

(5) Plug in the line cord and set the POWER switch to ON.

(6) Observe the front panel display indications:

DISPLAY	LED'S	INTERVAL
RANDOM	RANDOM	1 second
BLANK	OFF	1 second
88 88 8888 88	ON	1 second
PASS	OFF	1 second
— — — XX *		1 second
IT 01 0840 00	DEFAULT	FIXED

*indicates software revision level

The BUS-68005 performs a complete internal self-test upon power turn-on. First, the front panel display and LEDs are checked, then a wraparound test is performed which checks 1553 encoder, decoder, PROM, and RAM.

After the PASS indication appears, the display and LEDs show the power-on default state of the BUS-68005. The LEDs show Local operation in the BC mode, with "Single" Frame Operation. The display shows Block 1, with Transmit Direction, Word 1, default command word, and no errors injected. The default command word (0840) is a receive command for 32 words to RTU address #1 and subaddress #2.

In the event that the power-on self-test yields a failure, the display will be fixed with a FAIL indication and a two digit error code. The meaning of the error codes is as follows:

ERROR CODE	FAILURE
40	Encoder/decoder wraparound test
20	RT trigger RAM test
10	Message RAM test
08	RPOM #4 checksum
04	PROM #3 checksum
02	PROM #2 checksum
01	PROM #1 checksum

Troubleshooting procedures are detailed in the BUS-68005 Instruction Manual. Also included is an internal diagnostic software routine for use in the event of a failure of the encoder/decoder wraparound test. If it is desired to isolate the source of the self-test failure, or to program the BUS-68005 after a self-test failure has occurred, the CLR key must be depressed to reset the instrument.

MANUAL PROGRAMMING

Manual programming of the BUS-68005 Exerciser is a straightforward operation that is illustrated in Figure 3, Flow Diagram.

A functional description of each programming key is listed in Table 2. Table 3 lists the message formats and their corresponding two digit entries, which are used as part of the CNTL FRMT key entry sequence programming. Table 4, Transmitted Word Errors, is a chart indicating how to program the 8-bit "Error" byte, (PROG key entry) and the 8-bit "Error Modifier" byte (ER BP key entry) in order to induce various word error conditions. Table 5 is a chart of error codes, which are displayed on the front panel as part of the READ key sequence when checking the BUS-68005 internal memory. Figure 5, Timing Diagram (BC Mode) shows a typical message block and frame repetition.

BUS-68005 OPERATION UNDER HOST COMPUTER CONTROL

All BUS-68005 functions controlled by the front panel may be programmed from a host computer using any of the three remote I/O interfaces. The BUS-68005 remote I/O command set is divided into three major subgroupings. This allows the user to mix or match, depending on application, between ease of programmability and maximum throughput speed. The three major subgroupings are as follows:

(1) Low Speed Commands. A set of 33 commands each containing a two-letter ASCII mnemonic, and, for 15 commands, either alpha, HEX, or decimal ASCII data. The Low Speed commands provide full control of all BUS-68005 functions and user-friendly interactive operation using a dumb RS-232 CRT terminal.

(2) High Speed Commands. A set of four commands each containing a single character ASCII mnemonic. In two of the commands, the character is followed by parameters and data formatted in binary bytes. Two commands provide run/halt control for the BUS-68005 1553 processor. The other two provide a pseudo (software) DMA mechanism for transferring blocks of message data between the host computer (using any I/O port) and the BUS-68005 message RAM.

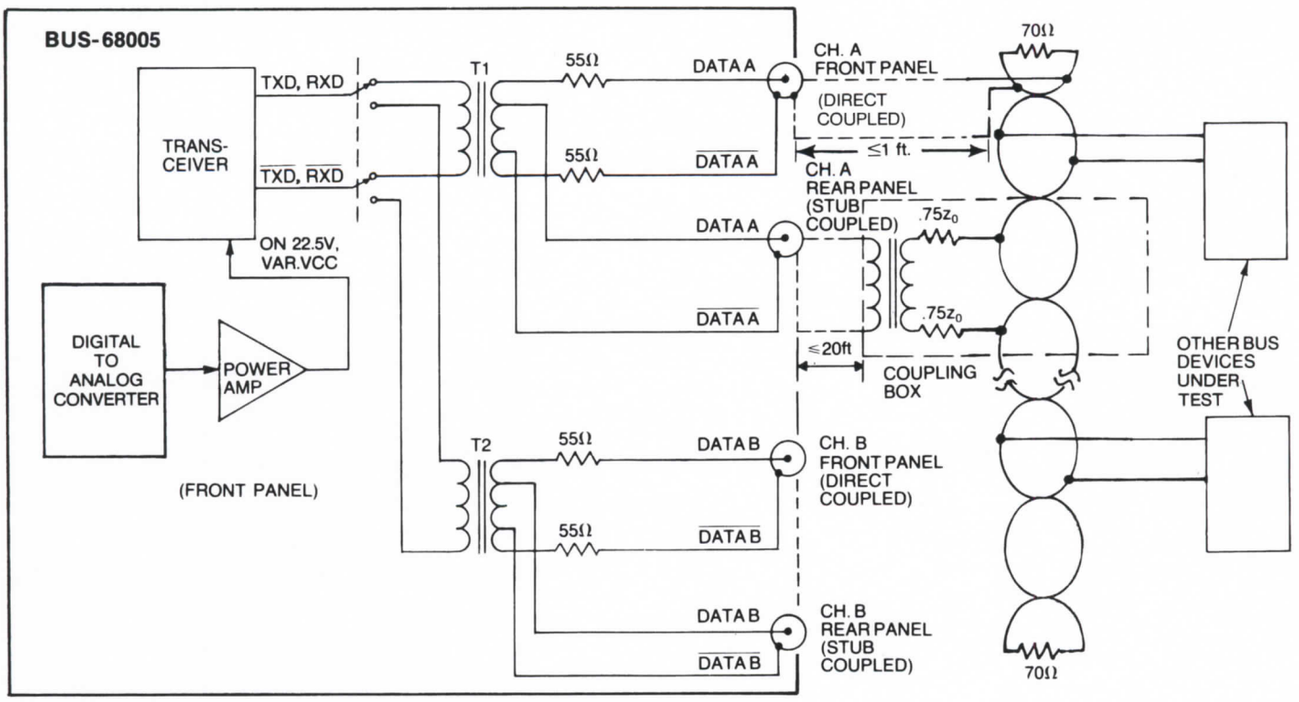
Using the IEEE-488 (GPIB) interface, the total time required to invoke a high-speed GO! command, defined as the time from the start of the GPIB handshake sequence to the start of BC transmission on the 1553 Bus, is approximately 2.5 ms.

(3) IEEE-488 DMA Commands. Two commands which use the BUS-68005 IEEE-488 port's DMA capability. The host computer can directly access memory and registers in the BUS-68005's 1553 processor; this allows the I/O data path to bypass the BUS-68005's internal microprocessor. The only part of a DMA input or output command string that is handled as programmed I/O is the first five bytes of each command. The bytes are used for specifying data direction, starting address and byte count for the BUS-68005 DMA controller. Using DMA, it is possible to write and read messages and control data to memory and the BUS-68005 registers which control functions such as: transmitter amplitude, mode, RT address, response time-out, and run/halt control. All parameters unique to individual messages such as data word count, format, response time, intermessage gap time, (BC mode), and block linking information (RT mode) may be written to the first word loction (control word) of each message block. Words to be transmitted and received on the 1553 bus are stored in the subsequent contiguous locations in the message block. The BUS-68005 DMA operations are implemented as halt burst transfers. That is, following the DMA command header, the specified number of bytes are written to or read from the BUS-68005 64K address space. There is also an embedded DMA timeout mechanism that prevents the instrument from locking-up in the event of any incomplete DMA transfer burst.

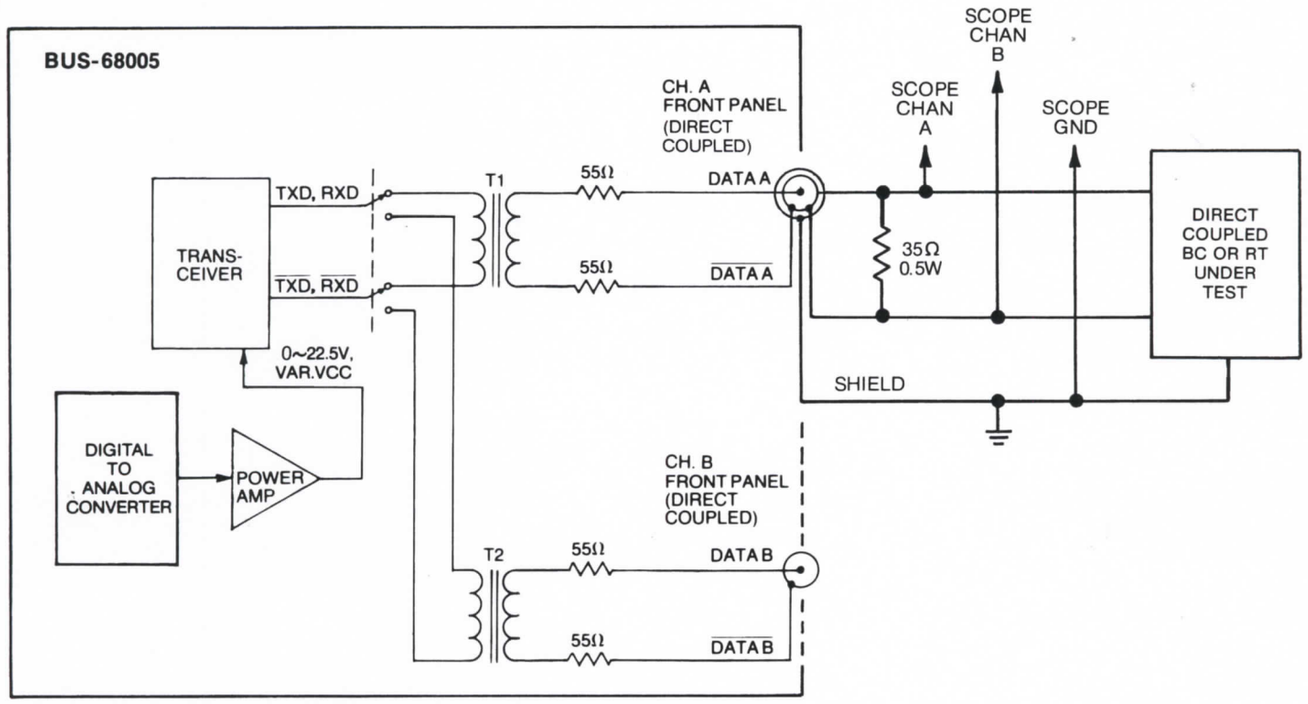
The timing for the IEEE-488 DMA transfer burst is 1.2ms Header time (per input or output burst), plus approximately 8.5μs per byte for input data, or 3.5μs per byte for output data. Assuming a 600KHz GPIB controller, this result in total byte transfer times of 10μs for input data and 5μs for output data.

BUS SWITCHING TEST

Two 68005's may be used to perform the "Bus Switching" test for dual redundant remote terminals, as required by the SAE-9A Production Test Plan. By means of the simple three-wire interface illustrated in figure 4, it is possible to synchronize the start of bus activity for the two instruments. Under either keyboard or remote I/O control, the delay time interval from the start of Channel A Bus activity to the start of Channel B Bus activity (or vice-versa) may be programmed to be anywhere in the range from 0 to 2040 microseconds, in 1 microsecond steps. By using a simple three-wire interface shown in figure 4 (a) and 4 (c), it is possible to synchronize the start of bus activity for the two instruments. Under either keyboard or remote I/O control, the delay time interval from the start of Channel A Bus activity to the start of Channel B Bus activity (or vice-versa) may be programmed to be anywhere in the range from 0 to 2040 microseconds in 1 microsecond steps. It is also possible to implement the Bus Switching Test by using one BUS-68005 and one BUS-68015 Noise Tester, shown, in figure 4 (b).

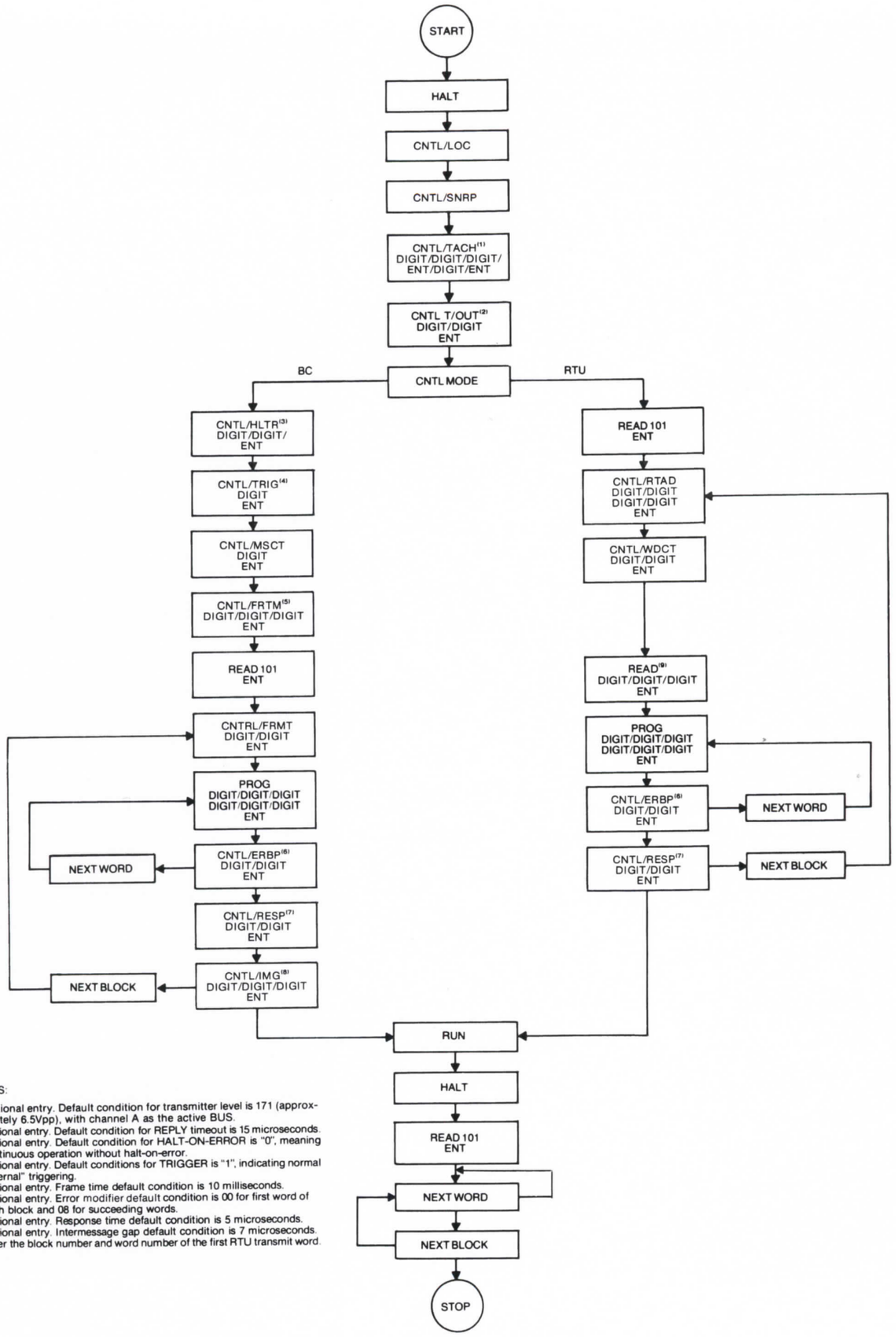


A. BUS-68005 connection per MIL-STD-1553.



B. BUS-68005 simplified connection for non-system type test (eg lab bench).

FIGURE 2. BUS-68005 INTERCONNECTION DIAGRAM



NOTES:

(1) Optional entry. Default condition for transmitter level is 171 (approximately 6.5Vpp), with channel A as the active BUS.
(2) Optional entry. Default condition for REPLY timeout is 15 microseconds.
(3) Optional entry. Default condition for HALT-ON-ERROR is "0", meaning continuous operation without halt-on-error.
(4) Optional entry. Default conditions for TRIGGER is "1", indicating normal "internal" triggering.
(5) Optional entry. Frame time default condition is 10 milliseconds.
(6) Optional entry. Error modifier default condition is 00 for first word of each block and 08 for succeeding words.
(7) Optional entry. Response time default condition is 5 microseconds.
(8) Optional entry. Intermessage gap default condition is 7 microseconds.
(9) Enter the block number and word number of the first RTU transmit word.

FIGURE 3. MANUAL PROGRAMMING FLOW DIAGRAM

TABLE 2. KEYBOARD AND DISPLAY FUNCTIONS

KEY SEQUENCE	FUNCTION	DISPLAY/INDICATION
CNTL LOC	Sets Local mode of Exerciser control.	LOCAL indicator lights
CNTL MODE	Selects BC or RT with alternating activation of MODE key.	BC or RT indicator lights in coincidence with the MODE key's state.
CNTL SN RP	Selects single or repeat mode of operation with alternating activation of SN RP key.	SINGLE or REPEAT indicator lights in coincidence with the SN RP key's state.
CNTL FRMT *DIGIT* *DIGIT* ENT	Information transfer format for a given block is selected with 2 (HEX) digits. See table 3.	The 4-digit (HEX) display will indicat the one or two-digit format.
CNTL RTAD D or E or C 0 or 1 *DIGIT* *DIGIT* *DIGIT* ENT	Used only in RTU mode. The RT address for a given message block is programmed. The 1st digit Enables (E) or Disables (D) the current block or disables all eight message block (C). The 2nd digit specifies whether to trigger on a Transmit (1) or Receive (0) Command Word. The 3rd and 4th digits specify the 2-digit (decimal) RT address (00 to 31). The 5th digit specifies the number of "linked to" memory blocks. This allows the Exerciser to respond by transmitting/receiving from a specified sequence of memory blocks, each successive time that a command is directed to a given RT address.	The 4-digit (HEX) DATA selection of the 16-BIT DATA field will show entered RT address information. The first digit of the ERROR CODE field will indicate the number of the "linked to" memory block.
CNTL RESP *DIGIT* *DIGIT*	Simulated RT response time is entered as 2-digits (decimal). The allowable range for response time is from 5 to 32 μsec.	The 4-digit (HEX) data section of the 16-BIT DATA will indicate the 1 or 2-digit response time in microseconds.
CNTL IMG *DIGIT* *DIGIT* ENT	Used only in the BC mode. The Intermessage Gap time preceding a given message block is entered as 3 (decimal) digits. Allowable range is from 7 to 2047 μsec. See Figure 4, Block/Frame Timing Diagram.	The 4-digit (HEX) data section of the 16-BIT DATA field will indicate 2 or 3 (decimal) digit Intermessage Gap time in microseconds.
CNTL WD CT *DIGIT* *DIGIT* ENT	The data word count for a given message block is entered as 2 (decimal) digits. For RT mode, this parameter must be programmed. For BC mode, word count defaults to the correct value if unspecified. Allowable range for Word Count is from 0 to 45 words.	The 4 digit (HEX) data section of the 16-BIT DATA field will indicate the 1 or 2-digit data word count.
CNTL ER BP *DIGIT* *DIGIT* ENT	The "Error Modifier" information for word gap, message gap, zero-crossing deviation, Manchester and sync field errors are entered as 2 (HEX) digits. Refer to Table 4 for "Error Modifer" Coding.	The Block and Word number are displayed in their normal positions. The 1 or 2-digit (HEX) error modifier code will appear in the 4-digit (HEX) data section of the 16-BIT DATA field.
CNTL FR TM *DIGIT* *DIGIT* *DIGIT*	Used in BC mode only. The Frame Time or overall repetition time for a series of messages to be executed is entered as 3 (decimal) digits. The allowable range for Frame Time is 2 to 500msec. See Figure 4, Block/Frame Timing Diagram.	The 4-digit (HEX) data section of the 16-BIT DATA field will display the entered data.
CNTL PRNT	A user friendly message , conveying all information about the current message block is outputted via the instrument's RS-232 port. It may be displayed on a CRT or a hard copy may be printed if configured with the I/O port.	No change from previous indication.
CNTL MS CT *DIGIT* ENT	The number of message (blocks) to be processed is specified. The allowable message count is 1 to 8. "Message Count" indicates the number of blocks per frame in the BC MODE, and the total number of messages to be processed for "single" RT mode.	The 4-digit (HEX) data section of the 16-BIT DATA field will display the entered Message Count information.
CLR	Clear function (terminates data or parameter entry). Also used to enable instrument operation in the event of Self-Test failure at power turn-on.	The display reverts back to its previous state.
NEXT WORD	The current WORD NUMBER field (within the current block) is incremented by one. If the current word is the last word in the block, the next word becomes the first word of the current block. NEXT WORD is also used in conjunction with the PROG key.	The next (or first) word in the message block is displayed in the BLOCK, DIR, WORD NUMBER, 16-BIT DATA, and ERROR CODE fields.

TABLE 2. KEYBOARD AND DISPLAY FUNCTIONS (CONTINUED)		
KEY SEQUENCE	**FUNCTION**	**DISPLAY/INDICATION**
NEXT BLOCK	The BLOCK field is incremented to the next highest block or to block 1 if the current block number is 8. The Word Number field then displays the first word of the new current block.	The first word of the new current block is displayed in the BLOCK, DIR, WORD NUMBER, 16-BIT DATA, and ERROR CODE fields.
PROG *DIGIT* * * *DIGIT* NEXT WORD *DIGIT* * * *DIGIT* ENT	The data contents and error codes of the current word, or successive words within a message block are programmed. Multiple words are separated by a NEXT WORD key entry. ENT terminates entry of the string of words. If the entry code for a given string is four (HEX) digits or less, the string represents right justified data only, with the Error Code field defaulting to 00. If programmed, the 5th and the 6th (HEX) digits represent the right justified Error Code field for that word.	The block number, DIR, WORD NUMBER, 16-BIT DATA and ERROR CODE fields for each word will be displayed as entered.
READ *DIGIT* *DIGIT* *DIGIT* ENT	The READ command reviews a specific block and word. The block number is specified by the 1st digit entered. The word number within the block specified by the 2nd digit (right justified) or 2nd and 3rd digit entered.	The appropriate word is displayed from the selected Block Number, including DIR bit, WORD NUMBER, 16-BIT DATA and ERROR CODE. The DIR field is decoded as follows: T: Transmit Word R: Receive Word P: Word Pending Reception -: Unused Word Location
CNTL SELF TEST	Causes the instrument to perform its internal self-test. This test exercises PROM, Message and RT Trigger RAMS, and performs a wraparound test of MIL-STD-1553 encoder/decoder circuitry. Following self-test, the instrument re-initializes to its power turn-on state: Bus Controller mode, Local, Single Frame, and Single Block.	In sequence: (1) All LEDs blank (1 second) (2) All LEDs light (1 second) (3) PASS or FAIL is displayed in the 4-digit (HEX) data section of the 16-BIT DATA field. If FAIL is displayed a 2-digit "Fail Code" is displayed in the ERROR CODE field.
CNTL TA CH *DIGIT* *DIGIT* *DIGIT* ENT ENT	Relative transmitter amplitude is programmable in the range from 0 to 255, corresponding to approximately 0 to 9.75Vpp, direct-coupled across 35 Ohms.	"TA" will be displayed in the "Block/Direction" field. The 4-digit (HEX) data section for the 16-BIT DATA field will indicate the 1, 2, or 3-digit relative transmitter amplitude as entered.
CNTL TA CH ENT A or B ENT	The active BUS channel is selected as either channel A or channel B.	"Ch" will be displayed in the "BLOCK/DIR" field. "-A" or "-B" will be displayed in the "WORD NO." field as programmed.
CNTL HLTER *DIGIT* *DIGIT* ENT	The "HALT-ON-ERROR" parameter is entered as a 2-digit decimal number from 0 to 99. An entry of 0 specifies continuous operation without halt-on-error. An entry of 1 to 99 indicates to halt following the occurrence of the specified number of errors. (BC mode only.)	"HE" will be displayed in the "BLOCK/DIR" field. The 4-digit (HEX) data selection of the 16-BIT DATA field will display the entered data.
CNTL T/OUT *DIGIT* *DIGIT* ENT	The RT response timeout interval (MIL-STD-1553B definition) is programmable over the range from 5 to 32 microseconds, in 1 microsecond steps.	"TO" will be displayed in the "BLOCK/DIR" field. The 4 digit (HEX) data selection of the 16-BIT DATA field will display the entered data.
CNTL TRIG 1 or E ENT	In order to enable "External" triggering (usually from another BUS-68005) of the Exerciser to synchronize the start of BC transmission, specify "E". To enable normal "internal" triggering, specify "1".	"TG" will be displayed in the "BLOCK/DIR" field. "1" or "E", as programmed, will be displayed in the last digit of the 16-BIT DATA field.

TABLE 3. MESSAGE FORMAT [CNTL/FRMT] KEY ENTRIES			
FORMAT	**MODE**	**FORMAT**	**SIMULATION**
00(1)	BC RTU	RT to BC or BC to RT RT to BC or BC to RT	BC RTU
01(2)	BC RTU	RT to RT RT to RT	BC RTU(TX)
02(2)	BC RTU	RT to RT RT to RT	BC and RTU(TX) RTU(TX) and RTU(RX)
03(2)	BC RTU	RT to RT RT to RT	BC and RTU(RX) RTU(RX)
04	BC RTU	MODE CODE MODE CODE	BC RTU
08	BC RTU	BROADCAST BROADCAST	BC RTU(RX)
09	BC RTU	BROADCAST and RT to RT BROADCAST and RT to RT	BC RTU(TX)
0A	BC RTU	BROADCAST and RT to RT BROADCAST and RT to RT	BC and RTU(TX) RTU(TX) and RTU(RX)
0B	BC RTU	BROADCAST and RT to RT BROADCAST and RT to RT	BC and RTU(RX) RTU(RX)
0C	BC RTU	BROADCAST and MODE CODE BROADCAST and MODE CODE	BC RTU(RX)
10(3)	BC RTU	T/R FORMAT REVERSAL ERROR T/R FORMAT REVERSAL ERROR	BC RTU
20(4)	BC	SELF TEST	NONE

Notes:

(1) In the BC mode, the T/R bit of the Command Word determines whether the BUS-68005 transmits or receives data. In the RTU mode the T/R bit of the programmed 5 (decimal) digit CNTL/RT AD word determines whether the BUS-68005 transmits or receives data.

(2) In an RT to RT message format, when the BUS-68005 is in the RTU mode, the T/R bit of the programmed 4 (decimal) digit CNTL/RT AD word must be set to logic "0" (Receive).

(3) In the BC mode, the Bus-68005 transmits the Command Word and then acts as if the opposite T/R bit condition were true. In the RTU mode, the BUS-68005 receives the Command Word and then acts as if the opposite T/R bit condition were true.

(4) In the BC mode only, a wraparound self-test will be implemented on message block no. 1. The transmitter is inhibited and the encoder drives the decoder directly. The last data word received is stored in BUS-68005 memory.

TABLE 4. TRANSMITTED WORD ERROR ENTRIES														
"ERROR" BYTE ["PROG" KEY ENTRY]							**"ERROR MODIFIER" BYTE ["ER BP" KEY ENTRY]**							**INDUCED WORD ERROR CONDITION**
40	**20**	**10**	**08**	**04**	**02**	**01**	**40**	**20**	**10**	**08**	**04**	**02**	**01**	
0	0	0	0	0	0	0	X	X	X	X	X	X	X	Normal Word (No Errors)
0	0	0	0	0	0	1	0	X	0	X	X	X	X	Long Word: 1 extra bit
0	0	0	0	0	0	1	0	X	1	X	X	X	X	Long Word: 2 extra bits
0	0	0	0	0	1	0	0	X	X	X	X	X	X	Short Word: 1 missing bit
0	0	0	0	1	0	0	0	X	X	(MEP-1)*				Manchester encoding error in specified data bit position Parity Error
0	0	0	1	0	0	0	X	X	X	X	X	X	X	Parity Error
0	0	1	0	0	0	0	X	0	0	X	X	X	X	SYNC $\overline{11}\,\underline{0000}$ (C/S); $\underline{00}\,\overline{1111}$ (D)
0	0	1	0	0	0	0	X	0	1	X	X	X	X	FIELD $\overline{1111}\,\underline{00}$ (C/S); $\underline{0000}\,\overline{11}$ (D)
0	0	1	0	0	0	0	X	1	0	X	X	X	X	ERRORS $\underline{0}\,\overline{11}\,\underline{000}$ (C/S); $\underline{000}\,\overline{11}\,\underline{00}$ (D)
0	0	1	0	0	0	0	X	1	1	X	X	X	X	$\overline{111}\,\underline{00}\,\overline{1}$ (C/S); $\overline{1}\,\underline{00}\,\overline{111}$ (D)
0	1	0	0	0	0	0	X	X	X	X	X	X	X	Manchester encoding error in parity bit position
1	0	0	0	0	0	0	X	X	X	X	X	X	X	Inverted sync type error
0	0	0	0	0	0	1	1	X	X	X	X	X	X	Word gap error: 1 μsec gap between 8th and 9th data bits
0	0	0	0	0	1	0	1	X	X	X	X	X	X	Message gap error: 2 μsec gap between current word and next word
0	0	0	0	1	0	0	1	0	0					Zero-Crossing Deviation Error in first half of specified bit time: 187.5 nsec early
0	0	0	0	1	0	0	1	0	1	(ZCDEP-1)*				125.0 nsec early
0	0	0	0	1	0	0	1	1	0					125.0 nsec late
0	0	0	0	1	0	0	1	1	1					187.5 nsec late

Notes: (1) When programming from a remote host computer, the Error Byte is programmed as the 5th and 6th HEX digits for the current word in a "program" (PG) command per table 9.

(2) When programming from a remote host computer, the Error Position Byte is programmed as the two digit HEX parameter in an "error position" (EP) command per table 9.

(3) X indicates don't care.

(4) *Indicates that the Manchester encoding error or zero-crossing deviation error will occur in the data bit position specified as one greater than the number indicated by the 08, 04, 02, and 01 bits of the Error Modifier Byte.

TABLE 5. DISPLAYED ERROR CODES [RECEIVED WORDS]	
DISPLAY ERROR CODE	**ERROR**
01	Long Word
02	Short Word
04	Manchester Error
08	Parity Error
10	Message Error
20	Early Response Error
40	Incorrect Sync Type

TABLE 6. FRONT PANEL INDICATOR FUNCTION	
INDICATOR	**FUNCTION**
LOCAL	Indicates that the Local mode of Exerciser control has been selected.
REMOTE	Indicates that the Remote mode of Exerciser control has been selected.
BC	Indicates that the Bus Controller mode of Exerciser operation has been selected.
RT	Indicates that the Remote Terminal mode of Exerciser operation has been selected.
SINGLE	Indicates that the Single mode of Exerciser operation has been selected.
REPEAT	Indicates that the Repeat mode of Exerciser operation has been selected.
ON-LINE	Indicates that the Exerciser is ready to receive (RT mode) or is transmitting in the Repeat mode (BC mode).
LINE ACTIVE	Indicates that there is activity on the selected 1553 data bus.
BUS FAULT	Indicates an error in the word or message received from the 1553 data bus.
REPLY T/OUT	Indicates that a response timeout fault or "early response" error has occurred.
XMTR T/OUT	Indicates that a 800μs terminal fail-safe timeout fault has occurred.

IEEE-488 STANDARD

Table 7 lists the subset of IEEE-488-1978 standard supported by the BUS-68005. The serial poll status byte and service request conditions for the BUS-68005 are defined in table 8.

TABLE 7. IEEE-488-1978 INTERFACE FORMAT	
SH1	Full *Source Handshake* Capability.
AH1	Full *Acceptor Handshake* Capability.
T6	Basic *Talk* capabilities with *Serial Poll and* untalk if my listen address.
SR1	Full *Service Request* Capability.
RL1	Full *Remote Local* Capability including Lockout.
DC1	Full *Device Clear* Capability.
DT1	Full *Device Trigger* Capability.
CO	No Controller Capability.

TABLE 8. GPIB SERVICE REQUEST INFORMATION	
SERIAL POLL STATUS BYTE	
BIT	**BIT INFORMATION**
7 (MSB)	Input buffer (Queue) full.
6	RQS (Request for Service).
5	RS-232 error.
4	DMA Timeout.
3	High-speed I/O error.
2	Self-test failure.
1	Error in input command string.
0 (LSB)	1553 message sequence completed.
SERVICE REQUEST CONDITIONS:	
1. Input buffer (queue) full.	
2. Error in input command string.	
3. 1553 message sequence complete.	
4. DMA Timeout.	

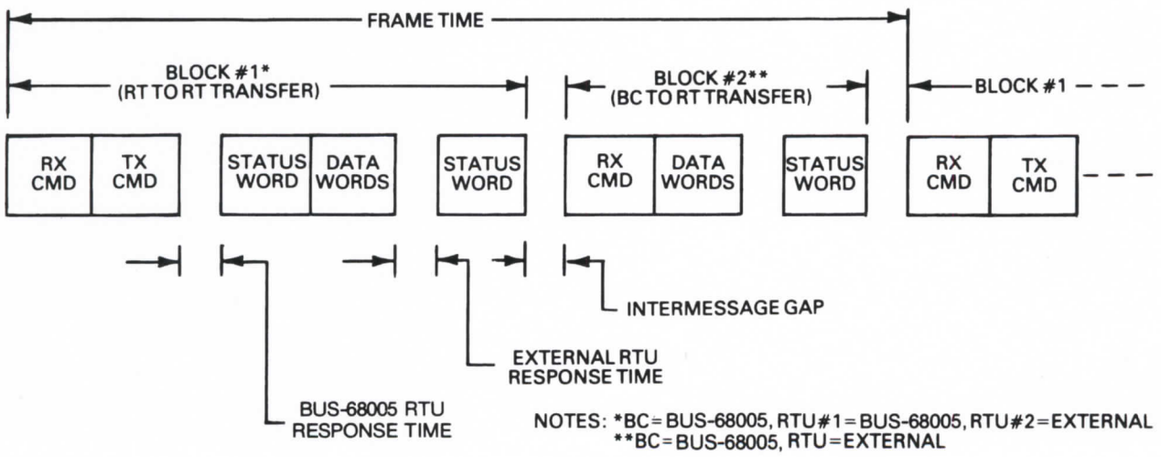
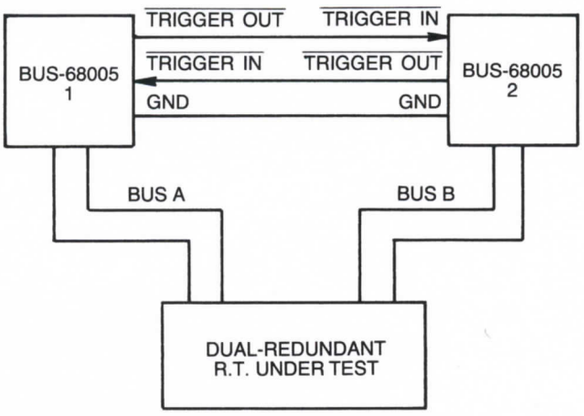
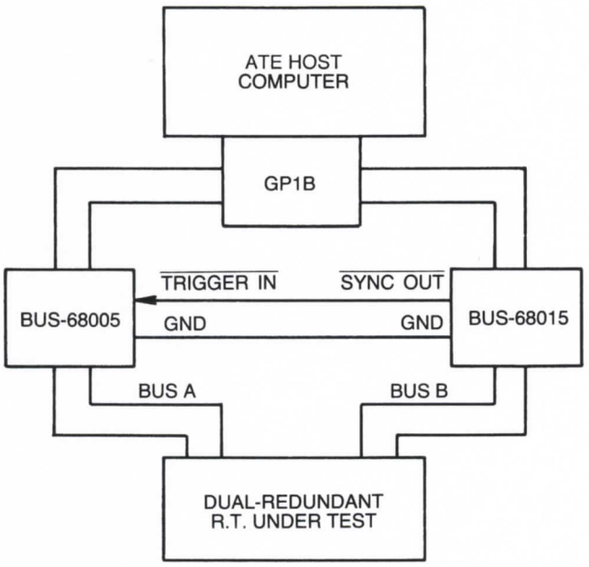


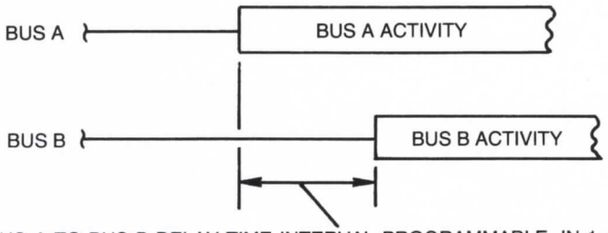
FIGURE 4. TIMING DIAGRAM [BC MODE]



(A) BUS SWITCHING TEST USING TWO BUS-68005s



(B) BUS SWITCHING TEST USING ONE BUS-68005 AND ONE BUS-68015



BUS A TO BUS B DELAY TIME INTERVAL PROGRAMMABLE, IN 1μsec STEPS BY MEANS OF "INTERMESSAGE GAP TIME" PARAMETER. THE RANGE FOR THE DELAY TIME INTERVAL IS 0 TO $\pm$2040μsec USING TWO BUS-68005s. THE DELAY TIME INTERVAL USING ONE BUS-68005 AND ONE BUS-68015 IS 0 TO $-$993, $+$1047 μsec.

(C) BUS SWITCHING TEST TIMING

FIGURE 5. BUS SWITCHING TEST FOR DUAL REDUNDANT RTUs

COMMAND DEFINITIONS

Table 9 provides a summary of the BUS-68005 I/O commands.

TABLE 9. BUS-68005 REMOTE I/O COMMANDS

LOW SPEED COMMANDS

	COMMAND	FUNCTION	DESCRIPTION
Set-Up/ Mode Control	BC	Bus Controller	Selects BC Mode.
	IN	Initialize	Initializes BUS-68005 to power-on state.
	MO	Mode Select	Toggles BUS-68005 between BC and RT modes; default is BC.
	RP	Repeat Mode	Selects Repeat mode.
	RT	Remote Terminal	Selects RT mode.
	SN	Single Mode	Selects Single mode.
	SR	Single/Repeat Select	Toggles BUS-68005 between Single and Repeat modes of operation; default is Single.
	TGt;	Trigger Mode Select	Selects Internal (I) or External (E) triggering of BUS-68005 message sequence; default is Internal.
Instrument Parameters	BFn;	Blocks per Frame	In BC mode, specifies the number of messages to be processed per frame sequence. In single RT mode, specifies the number of messages to process before going off-line. $1 \leq n \leq 8$; default is 1.
	CHc;	Channel Select	Selects Channel A or Channel B as the active bus channel; default is A.
	FTfff;	Frame Time	Specifies frame time (BC message sequence repetition time) in milliseconds. $2 \leq fff \leq 500$; default is 10. Minimum Frame Time equals number of messages to be processed.
	HEee;	Halt-on-Error	Specifies halt-on-error. BUS-68005 halts BC operation after ee errors have occurred. Halt-on-error not implemented if ee=0. $00 \leq ee \leq 99$; default is 00.
	NB	Next Block	Causes BUS-68005 Block Pointer (1,2...8) to be incremented. Current word becomes first word of next block; default is block 1.
	RDbnn;	Read	Causes BUS-68005 to return value of word nn of block b.
	TAaaa;	Transmitter Amplitude	Specifies relative transmitter amplitude from 0 to 10Vpp, approx. direct coupled across 35 Ohms; $000 \leq aaa \leq 225$. Default is 171; (6.5Vpp, approx.)
	TOtt;	Response Timeout	Specifies time interval BUS-68005 waits for status word response from RT before reporting time out error. Time is per 1553B specification (mid parity of preceding word to mid sync of responding status word). Used in BC mode and in RT mode when BUS-68005 acts as receiving RT in an RT-to-RT transfer. $05 \leq tt \leq 32$ microseconds; default is 15.
Parameters For Individual Message Blocks	EPmm;	Error Position	Used with PG. Specifies the Error Position or Error Modifier two-digit HEX byte for individual message words which specifies word error conditions. $00 \leq mm \leq FF$ (HEX). See table 4.
	FRff;	Format	Specifies format for Current message. $00 \leq ff \leq 20$ (HEX); default is 00. See table 3.
	IMiiii;	Intermessage Gap Time	Specifies intermessage gap time (time preceding start of message in microseconds per 1553 definition) for current block. $7 \leq iiii \leq 2047$.
	NW	Next Word	Increments Block/Word pointer to next word position; contents of next word are returned.
	PGdddddee, ...ddddee;	Program	Specifies 4 digit HEX data (dddd) and two digit HEX error codes (ee) for contiguous command, status, and data words to be transmitted. Entries for individual words are separated by commas.
	RAEdaan; or RAx; or RAn;	RT Address	In RT mode, specifies data direction (d=T for transmit, d=R for receive), address ($00 \leq a \leq 31$) and linked to block ($0 \leq n \leq 8$) for current message block. E enables block for RT simulation; x=D disables block; x=C disables all 8 blocks, n specifies the linked-to block number. Also, n may assume the value d, indicating the linked to block is disabled. Default is all eight blocks disabled.
	RErr;	Response Time	Specifies response time in microseconds for the Current block's simulated RT. For BC mode (RT-to-RT transfer formats) $5 \leq rr \leq 31$; for RT mode, $6 \leq rr \leq 31$. Default is 5.
	WCnn;	Word Count	Specifies data word count for Current message. In BC mode, word count defaults to block's command word value, but may be overridden with WC command. $00 \leq nn \leq 45$; default is 32.

TABLE 9. BUS-68005 REMOTE I/O COMMANDS (CONTINUED)

LOW SPEED COMMANDS

	COMMAND	FUNCTION	DESCRIPTION
1553 Processor Run/Halt Control	GO	GO	In BC mode, initiates message frame sequence. In RT mode, puts BUS-68005's enabled RTs on-line.
	HA	Halt	In Repeat BC mode, BUS-68005 stops programmed message processing following current frame; in RT mode, BUS-68005 goes off-line following current message.
Data Reporting	SB	Send Block	BUS-68005 returns all words of current message block in reply string.
	SS	Send Status	BUS-68005 returns status of operating modes and parameters in its reply string.
	SW	Send Word	BUS-68005 returns current word of current block.
Display Control and Self-Test	DD	Display Disabled.	Stops update of front panel display or blanks display if DD is last command in command string. Increases I/O throughput speed.
	DE	Display Enabled.	Resumes updating front panel display; default is enabled.
	LT	Lamp Test.	Blanks display for 1.5 seconds, fully lights display for 1.5 seconds, resumes previous display.
	ST	Self Test.	BUS-68005 performs self-test of PROMs, message and trigger RAMs, and front-end wraparound (encoder/decoder) test. Display blanks, lights, and displays test results. Initializes instrument to power-on state.

HIGH SPEED COMMANDS

COMMAND	FUNCTION	DESCRIPTION
&bwnd1 d2...dn	High Speed Input	Transfers n bytes from active I/O port to message RAM. Transfer starts at word w of block b. b, w, n, and d1...dn are binary bytes. Four bytes are used for each control, command, status, or data word in message RAM: (0000 0001) $\leq$b$\leq$(0000 1000); (0000 0000)$\leq$w$\leq$(0011 0001); (0000 0001)$\leq$n$\leq$(1100 1000); (0000 0000)$\leq$(d1...dn)$\leq$(1111 1111).
*bwn	High Speed Output	Transfers sequence of continuous bytes from message RAM to active I/O port. Reply string is n binary bytes (d1...dn). Parameters b, w, and n are the same for High Speed Input command.
!	High Speed Go	BUS-68005 immediately processes programmed message sequence.
.	High Speed Stop	BUS-68005 immediately stops programmed message sequence.

DMA IEEE-488 COMMANDS

COMMAND	FUNCTION	DESCRIPTION
>a1 a0 c1 c0 d1 d2...dn	DMA Input	Transfers sequence of contiguous data bytes, via DMA, from IEEE-488 interface to BUS-68005 memory address locations. a1, a0, c1, c0, and d1...dn are binary bytes; a1 and a0 define the DMA starting address; c1 and c0 specify the number of bytes to be transfered; d1...dn are data.
< a1 a0 c1 c0	DMA Output	Transfers sequence of contiguous data bytes, via DMA, from BUS-68005 memory address locations to IEEE-488 interface. Parameters a1, a0, c1, c0, and d1...dn are same as DMA input. Reply string is n binary bytes: d1 d2...dn. Followed by a line feed character, <LF>, with EOI asserted.

TABLE 10. J2 PIN FUNCTIONS [PARALLEL I/O]		
PIN	**FUNCTION**	**DESCRIPTION**
1	T7	MSB of 8 bit parallel tri-state I/O bus.
2	T6	Part of 8 bit parallel tri-state I/O bus.
3	T5	Part of 8 bit parallel tri-state I/O bus.
4	T4	Part of 8 bit parallel tri-state I/O bus.
5	T3	Part of 8 bit parallel tri-state I/O bus.
6	T2	Part of 8 bit parallel tri-state I/O bus.
7	T1	Part of 8 bit parallel tri-state I/O bus.
8	T0	LSB of 8 bit parallel tri-state I/O bus.
9	$\overline{\text{READ}}$	A LOW on this input causes a read data sequence.
10	$\overline{\text{WRITE}}$	A LOW on this input causes a write data sequence.
11	$\overline{\text{TACK}}$	A LOW on this output indicates composite transfer acknowledge.
12	$\overline{\text{SERV REQ}}$	A LOW on this output indicates a service request.
13	GND	Digital ground.
14	$\overline{\text{RACK}}$	A LOW on this output indicates data output transfer acknowledge.
15	$\overline{\text{WACK}}$	A LOW on this output indicates data input transfer acknowledge.
16	CHASS GND	Chassis ground.
17 THRU 25	NC	No connection.

TABLE 11. J3 PIN FUNCTIONS [RS-232]		
PIN	**FUNCTION**	**DESCRIPTION**
1	PROT GND	Chassis ground.
2	TXD	Transmit Data output.
3	RXD	Receive Data input.
4	RTS	Request to Send output.
5	CTS	Clear to Send input.
6	NC	No connection
7	SIG GND	Signal ground.
8	DCD	Data Carrier Detect input.
9 THRU 25	NC	No connection.

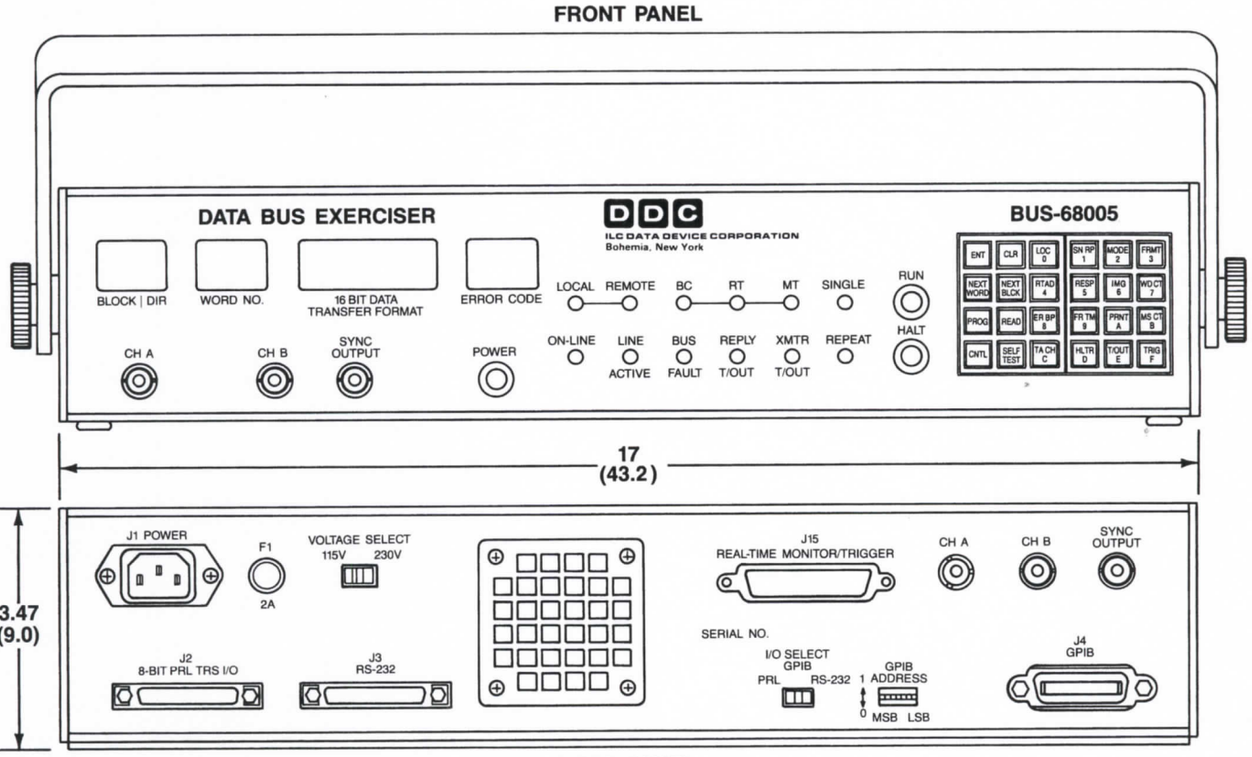
TABLE 12. J4 PIN FUNCTIONS [IEEE-488]		
PIN	**FUNCTION**	**DESCRIPTION**
1	D101	LSB of 8 bit tri-state GPIB bus.
2	D102	Part of 8 bit tri-state GPIB bus.
3	D103	Part of 8 bit tri-state GPIB bus.
4	D104	Part of 8 bit tri-state GPIB bus.
5	$\overline{\text{EOI}}$	End or Identify input/output.
6	$\overline{\text{DAV}}$	Data Available input/output.
7	RFD	Ready for Data input/output.
8	DAC	Data Accepted input/output.
9	$\overline{\text{IFC}}$	Interface Clear input.
10	$\overline{\text{SRQ}}$	Service Request output.
11	$\overline{\text{ATN}}$	Attention input.
12	CHAS GND	Chassis ground.
13	D105	Part of 8 bit tri-state GPIB bus.
14	D106	Part of 8 bit tri-state GPIB bus.
15	D107	Part of 8 bit tri-state GPIB bus.
16	D108	MSB of 8 bit tri-state GPIB bus.
17	$\overline{\text{REN}}$	Remote Enable input.
18 THRU 24	GND	Digital ground.

TABLE 13. J15 PIN FUNCTIONS [REAL-TIME MONITOR/TRIGGER I/O]		
PIN	**FUNCTION**	**DESCRIPTION**
1	MON. XMITR T/OUT	INDICATES "TRANSMITTER" TIMEOUT (800 μSEC) ERROR IN CURRENT FRAME
2	$\overline{\text{MON. FAULT ENABLE}}$	INPUT: ENABLES TRI-STATE BUFFER FOR WORD FLAG, BUS FAULT, ETC...
3	$\overline{\text{RT TRIGGER WORD}}$	INDICATES LAST WORD RT "TRIGGER" WORD
4	BLOCK ADDRESS 2	(MSB)
5	BLOCK ADDRESS 1	(INDICATES CURRENT EXERCISER MESSAGE BLOCK −1)
6	BLOCK ADDRESS 0	(LSB)
7	$\overline{\text{MON. BLOCK ADDRESS ENABLE}}$	INPUT: ENABLES TRI-STATE BUFFER FOR $\overline{\text{RT TRIGGER WORD}}$ AND BLOCK ADDRESS
8	MON. FRAME ENABLE	INDICATES EXERCISER PROCESSING CURRENT MESSAGE FRAME
9	MONITOR BUS CYCLE ACTIVE	INDICATES EXERCISER PROCESSING CURRENT MESSAGE
10	MONITOR LINE ACTIVE	INDICATES ACTIVITY ON −1553 BUS
11	MONITOR ENCODER CLOCK	RISING EDGE SHIFTS MANCHESTER DATA IN ENCODER
12	$\overline{\text{TRIGGER OUTPUT}}$	USED TO SYNCHRONIZE TWO BUS-68005S FOR DUAL-REDUNDANT
13	$\overline{\text{TRIGGER INPUT}}$	OPERATION (SEE FIGURE 4)
14	MON. START-OF-MESSAGE	INDICATES START OF MESSAGE BEING PROCESSED BY EXERCISER
15	MON. END-OF-MESSAGE	INDICATES END OF MESSAGE BEING PROCESSED BY EXERCISER
16	GROUND	SIGNAL GROUND
17	GROUND	SIGNAL GROUND
18	MON.D2	
19	MON.D1	
20	MON.D0	(LSB)
21	$\overline{\text{MON. DATA LO ENABLE}}$	INPUT: ENABLES TRI-STATE OUTPUT BUFFER FOR D7-D0
22	RECEIVE/$\overline{\text{TRANSMIT}}$	INDICATES DIRECTION OF LAST WORD TRANSFERRED
23	$\overline{\text{MON. VALID}}$ /INVALID WORD	"VALID" FLAG FOR LAST WORD
24	MON. DATA/$\overline{\text{CMD}}$ SYNC	SYNC TYPE INDICATION
25	MON. SYNC TYPE ERROR	INCORRECT SYNC TYPE INDICATION FOR RECEIVED WORDS
26	MON. PARITY ERROR	INDICATES PARITY ERROR FOR LAST RECEIVED WORD
27	MON. MANCHESTER ERROR	INDICATES MANCHESTER ENCODING ERROR FOR LAST RECEIVED WORD
28	MON. LO BIT COUNT ERROR	INDICATES LOW BIT COUNT ERROR FOR LAST RECEIVED WORD
29	MON. HI BIT COUNT ERROR	INDICATES HIGH BIT COUNT ERROR FOR LAST RECEIVED WORD
30	$\overline{\text{MON. ERROR ENABLE}}$	INPUT: ENABLES TRI-STATE BUFFER FOR RECEIVE/$\overline{\text{TRANSMIT}}$, AND WORD ERROR OUTPUTS.
31	MON. WORD FLAG	ALWAYS HIGH: USE AS FLAG BIT ON EXTERNAL MEMORY
32	MON. BUS FAULT	INDICATES WORD ERROR OR WORD COUNT ERROR IN CURRENT FRAME
33	MON. REPLY T/OUT	INDICATES RESPONSE TIMEOUT ERROR IN CURRENT FRAME
34	GROUND	SIGNAL GROUND
35	GROUND	SIGNAL GROUND
36	$\overline{\text{LOAD PULSE}}$	125nSEC NEGATIVE PULSE INDICATES NEW WORD IN OUTPUT BUFFER
37	MON. D15	(MSB)
38	MON. D14	
39	MON. D13	UPPER 8 BITS OF LAST WORD ON −1553 BUS
40	MON. D12	
41	MON. D11	
42	MON. D10	
43	MON. D9	
44	MON. D8	
45	$\overline{\text{MON. DATA HI ENABLE}}$	INPUT: ENABLES TRI-STATE OUTPUT BUFFER FOR D15-D8
46	MON.D7	
47	MON.D6	
48	MON.D5	
49	MON.D4	
50	MON.D3	LOWER 8 BITS OF LAST WORD ON −1553 BUS

	TABLE 14. MANUAL SWITCH/CONTROL FUNCTIONS	
SWITCH	**FUNCTION**	**REMARKS**
RUN	Starts the 1553 data bus message transfer cycle.	The ON-LINE indicator lights up and the display reads BUSY.
HALT	Stops the 1553 data bus message transfer cycle.	The ON-LINE indicator shuts off and the display reads HALT.
I/O SELECT	Selects I/O interface as either Parallel, IEEE-488 or RS-232.	Rear panel switch.
GPIB ADDRESS	Selects the Exerciser's GPIB (IEEE-488) address.	Address has 5 bits. Rear panel switch.
POWER	Turns on the internal power supply.	An initialization and self-test sequence is performed immediately after power turn-on.
VOLTAGE SELECT	Selects 115V or 230VAC line voltage.	Rear panel switch.

DIMENSIONS IN INCHES (CENTIMETERS)
17 x 14.5 x 3.47 (43.2 x 37 x 9.0)

FRONT PANEL



REAR PANEL

FIGURE 6. MECHANICAL OUTLINE

ORDERING INFORMATION

BUS-68005

Mating connector for J15 Amphenol 17-10500-1-390 included.
1553 mating connector trompeter PL75-47 (Two included).
Also included are two rack adapters and hardware for full-rack mounting.

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