PROTOCOL AND DIAGNOSTIC TESTING

OF

3270

SERIES
TERMINALS

and Teletype Corp.
DATASPEED® 40/4

ARC

ATLANTIC RESEARCH CORPORATION

3270-3275 SERIES TERMINAL TEST

INTERSHAKE® APPLICATION PROGRAM FILE #DO1

APPLICABLE TO

IBM 3270 SERIES, TELETYPE® MODEL 40/4, TELEX TERMINAL COMMUNICATIONS 275, and other look alikes using BI-SYNC protocol and EBCDIC code. Application program file #D02 describes ASCII Code.

These tests simulate the major diagnostic capabilities available from the CPU (such as OLTEP) without the associated difficulties of scheduling the Host for a diagnostic run or locating qualified personnel. Disassociating the terminal diagnostics from the Host assists in fault isolation and also substantially reduces the time to bring new terminals or new ports on line.
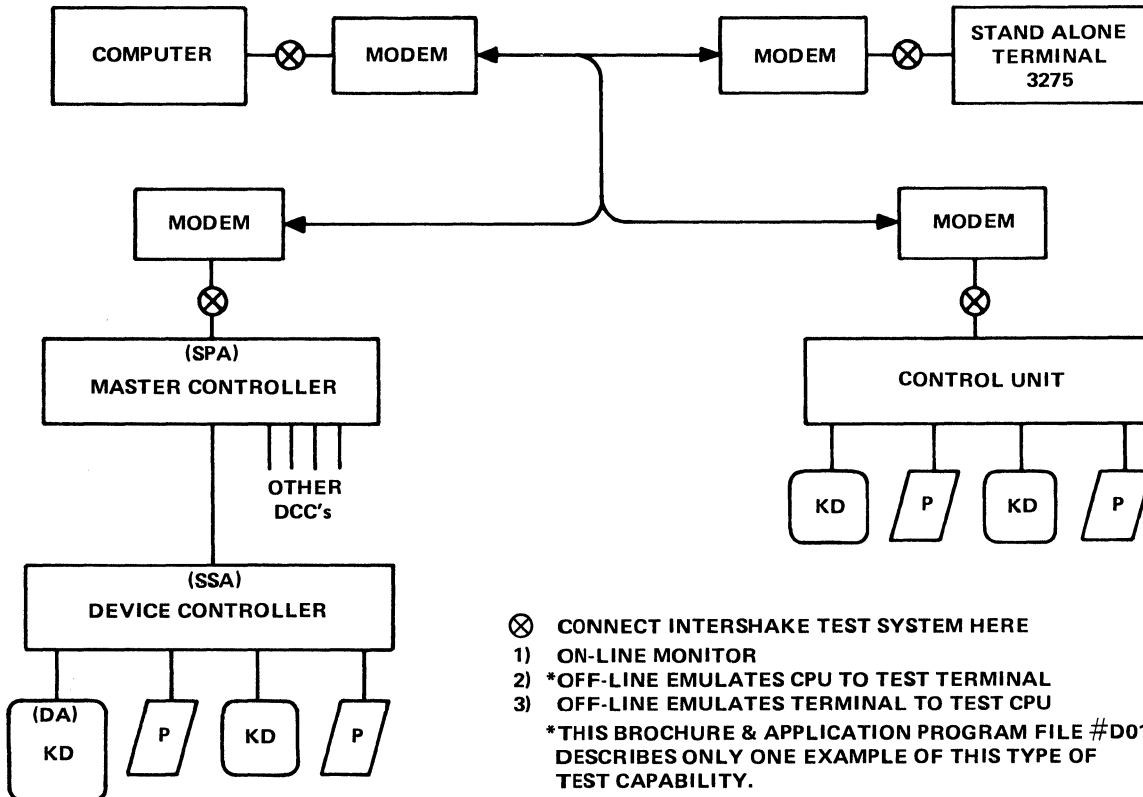
Document file #D01 (D02) is available to any INTERSHAKE user at no cost. Provided in the document are: simple terminal user instructions, operator instructions for INTERSHAKE, program listings, flow charts including step-by-step description of each element of the BI-SYNC protocol (addressing, attributes, orders, etc.) and pictorials of the Displays on the terminal and on the INTERVIEW.

Other application programs permit on-line performance monitoring and gather bulk data for analysis of operator queue, through-put, etc.

NETWORK INTERCONNECTION

The flexibility in attaching the INTERSHAKE Test System to a typical network is shown below. Three commonly encountered types of stations are shown with the related significance of the addressing codes (SPA, SSA, DA). Since the tester is housed in a suitcase, exhaustive diagnostics are now available at field locations when the communication link is not available. Rack mounting is recommended at the CPU Host location to ensure availability when required.

⊗ CONNECT INTERSHAKE TEST SYSTEM HERE
1) ON-LINE MONITOR
2) *OFF-LINE EMULATES CPU TO TEST TERMINAL
3) OFF-LINE EMULATES TERMINAL TO TEST CPU
   *THIS BROCHURE & APPLICATION PROGRAM FILE #D01 DESCRIBES ONLY ONE EXAMPLE OF THIS TYPE OF TEST CAPABILITY.

TESTS PERFORMED

The three major system ingredients are treated by this test: Data Communications, Software, Hardware. By using an interdisciplinary approach, teamwork is engendered for more rapid restoral of a system to service. Within a terminal the soft/hardware boundry is gray and often depends on the vendor and model (and technology). However, the first step is to define the problem.

SYSTEM INTERCONNECTION: This test can be run at any place in the system where an RS-232 connector is accessible. Modem control is available if the terminal to be tested is remote from the INTERSHAKE.

- LOCAL test at terminal: Without modem
- REMOTE test: Complete HDX modem control (switched carrier) or FDX modem control

FAULT ISOLATION: Individual portions of the test focus on specific system elements. A failure is usually correlated to a replaceable module (depending somewhat on the vendor subassembly definitions and hardware packaging).

- EMULATES major CPU/FEP Protocol Sequences to localize problem to CPU or terminal.
- Defines faulty controller or specific device on the controller.
- Keyboard is exercised by the operator and is verified by INTERSHAKE.
- DISPLAY is exercised by the operator and by INTERSHAKE.
- Indicator lights follow "operator's guide" (including STATUS light).

MANPOWER: Automatic features are built into the test to eliminate the normal requirement for tying up a second operator for the tester.

- AUTOMATIC mode of INTERSHAKE operation enables the terminal operator to perform tests locally without the aid of an INTERSHAKE operator.
- INTERACTIVE mode uses a second operator at the INTERSHAKE where all transmission characters are displayed with key protocol parameters highlighted.

MESSAGES: INTERSHAKE generates many classes of messages to the terminal. Each message exercises a specific terminal feature. Some messages write instructions on the CRT for the operator to follow or verify while some messages are used by the internal terminal logic.

- All messages are checked for errors (BCC calculation by INTERSHAKE).

- FORCES MESSAGE ERROR CONDITION to verify error recovery response.
- Reads contents of Display back to INTERVIEW.
- Writes diagnostic TEST pattern on CRT for operator interaction.

CRT DISPLAY: Many features and enhancements are provided by the 3270 display system. INTERSHAKE exercises the attributes, then requests operator verification, then echos the operator entry back to the terminal.

- Tests all Highlight and audible tone options.
- Verifies PROTECTED FIELDS: Displayed, non-displayed.
- Verifies NON-PROTECTED FIELDS: Displayed alpha, displayed numeric, non-displayed alpha.

KEYBOARD OPERATION: Terminal operations are essentially activated through the Program Attention Keys. Each key operation is verified to the terminal operator for ANY type keyboard.

- Displays verification of all PROGRAM ATTENTION KEYS: CLEAR, Request Test, ENTER, Program Function (PF), Program Access (PA).
- Keyboard is reset and inhibited by the program.
- The test program resets the keyboard and also inhibits the keyboard.

TIME MEASUREMENT: An often overlooked parameter is response time. Accurate measurements are made between ANY protocol event, character or RS-232 signal transition. Hundreds of measurements can be made (selectively) and are recorded for later analysis. The real time readings are visible on the INTERSHAKE front panel for operator feedback.

- Measures system response time: Last CPU request character to first data response character.
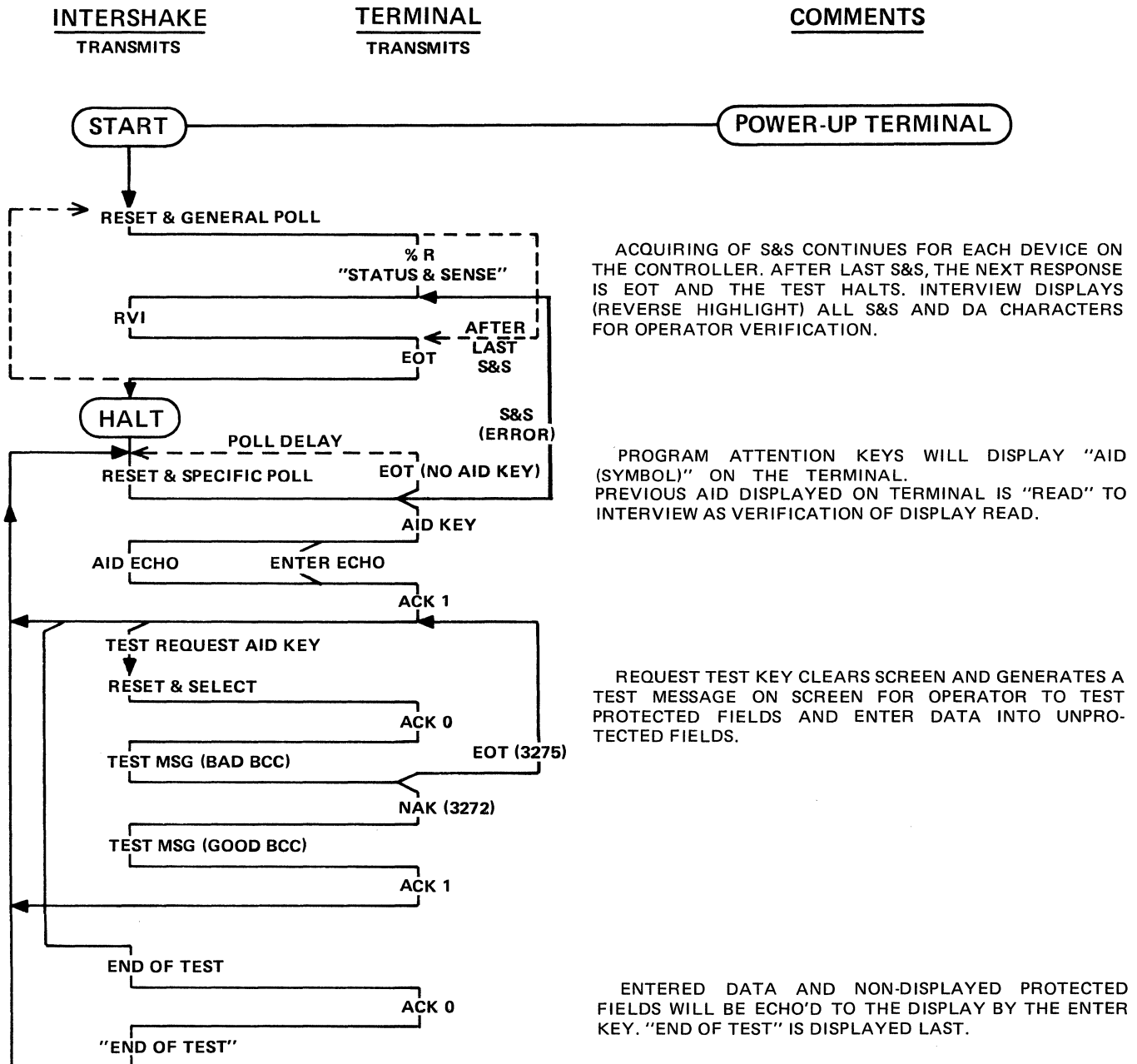- Measures terminal response time or modem turn-around time.

STATUS and SENSE: An important feature of the 3270 Series is its ability to inform the Host CPU if a problem exists that prevents proper terminal operation. A most important test is to verify availability of such a system feature.

- Verifies STATUS and SENSE message on terminal power-up.
- Verifies STATUS and SENSE for Message Error (3275).

TEST SEQUENCE

A well designed test involves following a predetermined sequence of operations. Any failure will therefore be more accurately defined. A summary of the basic sequence is shown below. Appropriate definitions to abbreviate the test are described in file DO1.

INTERSHAKE	TERMINAL	COMMENTS
TRANSMITS	TRANSMITS	

START ———————————————— **POWER-UP TERMINAL**

RESET & GENERAL POLL

% R
"STATUS & SENSE"

RVI

AFTER
LAST
EOT S&S

HALT

POLL DELAY

RESET & SPECIFIC POLL

S&S
(ERROR)

EOT (NO AID KEY)

AID KEY

AID ECHO   ENTER ECHO

ACK 1

TEST REQUEST AID KEY

RESET & SELECT

ACK 0

TEST MSG (BAD BCC)   EOT (3275)

NAK (3272)

TEST MSG (GOOD BCC)

ACK 1

END OF TEST

ACK 0

"END OF TEST"

ACQUIRING OF S&S CONTINUES FOR EACH DEVICE ON THE CONTROLLER. AFTER LAST S&S, THE NEXT RESPONSE IS EOT AND THE TEST HALTS. INTERVIEW DISPLAYS (REVERSE HIGHLIGHT) ALL S&S AND DA CHARACTERS FOR OPERATOR VERIFICATION.

PROGRAM ATTENTION KEYS WILL DISPLAY "AID (SYMBOL)" ON THE TERMINAL.
PREVIOUS AID DISPLAYED ON TERMINAL IS "READ" TO INTERVIEW AS VERIFICATION OF DISPLAY READ.

REQUEST TEST KEY CLEARS SCREEN AND GENERATES A TEST MESSAGE ON SCREEN FOR OPERATOR TO TEST PROTECTED FIELDS AND ENTER DATA INTO UNPROTECTED FIELDS.

ENTERED DATA AND NON-DISPLAYED PROTECTED FIELDS WILL BE ECHO'D TO THE DISPLAY BY THE ENTER KEY. "END OF TEST" IS DISPLAYED LAST.

OTHER TYPICAL APPLICATIONS

Six additional programs of the degree of sophistication of DO1 can be added to the INTERSHAKE, any one of which is available at the flick of a switch. A user desiring this test in Firmware is also able to field edit any parameter to quickly zero in on a problem — or write an entirely new test from scratch into a battery back-up NON-volatile file for later use at another site.

ON LINE: In the ON-LINE mode the INTERSHAKE bridges the circuit and performs diagnostics without degrading the network.

- Measure THROUGH PUT RATE (retransmissions in $10\text{-}10^8$ messages).

- CAPTURE (FREEZE) 2 NAK'd messages on the INTERVIEW (including the address of the faults station and turn-around time).

- TRANSPARENT bi-sync bcc error rate.

- Selective Display of traffic to a specific Device or Controller.

- Strip out TEXT and display only Protocol.

- Measure Station Service (Queue) or Response Time.

- Precise timing measurement on switched carrier circuits (between data and RS-232 lead transitions).

- Count and Measure Carrier Dropouts.

- Record all Parity Error'd Characters. Bit pattern of errors can reveal source of fault.

OFF LINE: Off-line tests generally emulate the CPU (FEP) software or the terminal (controller). A major consideration is to generate CONTROLLED errors to verify that the error recovery routines are operative in the unit under test. Often error recovery routines behave somewhat differently than the book describes!

- ENDURANCE test repeats from $10\text{-}10^8$ times and counts intermittents and errors

- EMULATE a nest of terminals (different terminals will respond with message and verify ACK while some will generate messages with BCC errors to verify NAK/EOT response)

- ECHO transmitted data blocks (or selections thereof) to terminal (with HEX and code translation)

- AUTO-POLL increments the address to find a terminal with an unknown address, station, etc.

PERFORMANCE MONITORING: Storage is available for up to 1024 bytes of "data" including measurement of time, selected characters, RS-232 status, error counts, etc. The ability to store repeated measurement results expands the scope of applications into basic data acquisition. Preset threshold criteria are applied to each measurement to further increase efficiency by recording only out of tolerance conditions.

- PRESET THRESHOLDS for acceptable thru-put will alarm when exceeded and capture identity of offender

- Multi-drop circuits establish a threshold criteria for modem RTS-CTS delay. 512 records of excessive time with associated station ID (including ID of non-response polls).

- Local-Remote printout of these results to any printer or CRT by automatically translating the message into the code of the CRT or printer.

COMMUNICATION LINK TESTS: Testing the bare communication link is often desirable. These tests must create signal and timing conditions duplicating the operating system characteristics. A major difference in performance is observed over some facilities when tested continuously and when turned ON and OFF (as in an HDX or Polled configuration).

- END TO END 63 and 511 Bit Pseudo-Random Block Error rate count.

- FDX (loopback) Block Error rate test using blocks of 1 to 256 characters and BCC/LRC/CRC calculation to simulate exact system criteria.

- Timing response is measured for any combination of interface sequences.

- FDX Loopback measurement of Parity Error rate in $10\text{-}10^8$.

- Two INTERSHAKE end-to-end can run HDX Ping-Pong block error rate tests to determine sensitivity of modems and lines to turn-around intervals and auto-equalization stress.

INTERSHAKE FEATURES

OPERATIONAL: The operator of an INTERSHAKE Test System may never need to "program it" himself. Many features assist the operator in simply pressing a few buttons yet permitting operator intervention as expertise increases.

- Program writes prompt comments to INTERVIEW to guide and advise the operator.

- Several tests can reside in one program cell. These can be used individually or "linked" together to form more comprehensive tests.

- Test results can be automatically evaluated and, if greater than a preset threshold, will automatically select the NEXT more definitive diagnostic test. This increases operator efficiency.

- Eight internal reference test messages in PROM avoid operator entry errors.

- Auto-Panel features permit the program to set up the panel controls for test conditions to reduce operator set up time, e.g., parity convention can be altered for specific characters while transmitting at 9600 baud. The test mode can also be altered from monitor to test terminal and return to monitor under program control — within a single poll cycle. Programs can be edited to restore control to the panel to enable parameters to be changed "at will".

PROGRAMMABILITY: Flexibility is one index to the future value of a test instrument. The value of a programmable system is indicated by the sophistication, power and utility of the instruction set combined with the effective use of the resident program files or cells.

- Eight firmware cells for resident standard programs. These may be field-edited to tailor any parameter to the specific requirement.

- Seven nonvolatile user available cells. Battery power maintains programs for reuse at other sites.

- Ninety-six basic Instructions (Functions). Powerful instructions are defined in SIMPLE DIRECT DATA

COMMUNICATION AND PROTOCOL RELATED TERMS.

- Twelve Conditional or Branch Instructions includes two-level subroutine nesting.

- Five Vectored Priority Interrupts to service elusive intermittents such as carrier dropouts, special characters.

- Execute time is 3 μsec per instruction. Clearly this speed supports full diagnostic capability in excess of 64 KBS (125 μsec per character).

- HALT instruction provides breakpoints. A program continue button is provided the user.

- Program pauses when criteria is not satisfied and displays the program location (STEP) and the instruction not satisfied! The operator can force-satisfy the condition and the program will continue on from that step. This feature greatly assists in debugging programs that "hang up".

DATA COMMUNICATION: Flexibility in handling new codes and protocols is important. An additional requirement is the proximity of higher data rates . . . to 64 KBS.

- ASYNC, SYNC, SDLC, ISOC, DERIVED CLOCK SYNCHRONOUS.

- SPEEDS to 64 KBS.

- CODE: Transparent to code except message Proms (and CRT fonts).

- TIMING: Generates time delays to 1 ms or 1 bit resolution (bit timing is critical at higher speeds, e.g., 1 ms = 1 character at 9.6 KBS).

- TIME: Measures time delays to 10 μsec resolution.

- RS-232: Turns ON/OFF, detects status, branches on status, interrupts on either transition, records status (for later transmission). Accesses six fixed leads plus one patch to any other lead.

INTERVIEW FEATURES

CRT DISPLAY: The INTERVIEW provides a new standard of excellence in Data Communication diagnostic displays. Almost every feature is a "First" and is oriented toward streamlining the operators understanding of the data.

- SELF TEST SWITCH displays all FONTS and all enhancements without erasing the data being monitored.

- FULL page of 1024 characters "writes down" for ease of monitoring high-speed data. No hash marks even at 64 KBS!

- Half page is selectable to provide two separate pages of 512 characters.

- Four Codes standard: ASCII, EBCDIC, EBCD, Selectric (two spare slots for options).

- TEST — HEX — OCTAL — Mnemonics (s_v, a_k, etc.) UNIQUE presentation of HEX or OCTAL only for Control Characters. UNIQUE automatic presentation of undefined characters in HEX (or Octal).

- ENHANCE permits operator to select any character to be highlighted wherever it appears on the CRT display, e.g., all ENQ characters will Blink Reverse for all polls.

- FDX mode writes two lines (top is REC, lower is XMT).

- HDX mode writes one line (reverse image or low intensity can be assigned to distinguish (REC or XMT).

- AUTO FREEZE captures a full screen of consecutive data.

PROGRAMMABILITY: The crisp character writing enables the viewer to follow protocol patterns even at 64 KBS by using the programmable highlights.

- INTERSHAKE has full control of these display characteristics: FREEZE, CLEAR, PAGE 1 or PAGE 2 SELECT (neither page selected defaults to 1024-character composite of Page 1 and Page 2), and on an individual character controls Reverse image, Low intensity and Blink. Any character may contain any combination of highlights.

- INTERSHAKE can sense when the CRT screen is FULL and Branch to another program or alarm, etc.

ADDITIONAL APPLICATIONS: The use of the INTERVIEW is not restricted to viewing data when running a test. It will also display program listings and contents of the capture (results) memory either in the PLAY mode or in the RUN mode.

- INTERSHAKE programs can be displayed on the CRT very quickly for operator critique. Enhancements assist the operator by highlighting the DATA and the Function (Instruction) differently. All Functions related to data on the transmission facility are also highlighted to permit a directly readable text for portions of the program that send or receive data.

- Operator can immediately identify every occurrence of a specific instruction in the program by using the character enhancement selector.

- RS-170 composite video output is available to route to other or larger video monitors.

THE INTERSHAKE TEST SYSTEM

TP-157-06-77

COMPONENTS

INTERSHAKE II . . . . MODEL DTM-2 (Portable or Rack-Mount)
INTERVIEW . . . . OPTION 18 (Portable or Rack-Mount)
INTERTAPE . . . . ITU-1 (Bulk Storage, Programmable Control by DTM-2)
PRINTER . . . . OPTION 08 (Column Printer for Listing Programs)
INTERFACE ADAPTER . . . . IFA-2, IFA-3 (303 — RS-232)
INTERFACE ADAPTER . . . . IFA-4, IFA-5 (V.35 — RS-232)
LOOP INTERFACE . . . . OPTION 07 (20mA/60mA)

ACCESSORIES

SPEEDS: 19.2 KBS — 64 KBS
MESSAGES: REVERSE EBCD, BCD, BAUDOT, FIELD DATA
CRT CODES: REVERSE EBCD, BCD, BAUDOT
CONTACT FACTORY FOR SPECIALS NOT LISTED
FIRMWARE PROGRAMS

FACTORY SUPPORT

2-3 DAY SCHOOL COVERS PROGRAMMING AND PROTOCOLS
ON-SITE TRAINING CLASSES
APPLICATION ENGINEERING AIDS
USERS GROUP FOR PROGRAM EXCHANGE

PUBLICATIONS

INTERSHAKE OPERATOR'S MANUAL including APPLICATIONS
INTERVIEW OPERATOR'S MANUAL including APPLICATIONS
SHORT FORM FUNCTION LIST
DTM-2 PROGRAM FORMS (IN PADS)
PROGRAM LISTINGS AS AVAILABLE FOR VARIOUS APPLICATIONS

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TP-157-06-77

INTERSHAKE DIAGNOSTIC TEST

DATASPEED 40/4

FEATURES AND CAPABILITIES: Permits a 3270 or 40/4 terminal operator to easily verify correct terminal operation unassisted by test personnel. This is possible because the INTERSHAKE II can store selected characters received from the terminal, then retransmit the same characters plus program selects characters in an instructional format for operator evaluation on the terminal display.

This "Selective Echo" capability is virtually self-checking, thereby servicing a wider range of operator skills. Additional in-depth diagnostics are also included to quickly and accurately define fault conditions.

TESTS, VERIFICATION, AND ERROR CONDITIONS (of 3270 & DATASPEED 40/4)

This test provides a very thorough evaluation of a terminal. Its applications include:

- Data communication diagnostics
- Teaching tool for the BiSync Protocol
- Instruction vehicle for terminal operators
- Front End Processor emulator
- Development aid for terminal application software
- Basis for evaluating terminal vendors
- Printed record of the test completion

The following sections identify the detailed capabilities provided to the user by this test:

Keyboard logic tests

1. All AID keys
2. Manual TAB to next nonprotected field
3. Numeric keys (restricted)
4. Upper-lower case
5. Buffer address follows cursor
6. Keyboard lockout by CPU
7. —

Display logic tests

1. Protected fields
2. Protected hidden fields
3. Nonprotected hidden fields
4. Auto-tab to next nonprotected field
5. Cursor addressing (insertion of cursor)
6. Attributes
7. Erase/write resets cursor home
8. Write from last address

9. Pincushion of top and bottom lines
10. Screen focus and brightness
11. Contrast adjustment pattern
12. Read the cursor address on the display (to the host CPU).
13. —

Terminal options displayed

1. Upper-lower case
2. Highlight
3. Blink
4. Buffer — nonbuffered display
5. Bell tone
6. —

Terminal communication tests

1. Automatic terminal "ENQ" recovery — Should the 3270 interactive communication not terminate in an orderly fashion; e.g., with an EOT from the DTM, the 3270 will, after three seconds, generate an ENQ. The ENQ will be repeated from the terminal approximately every three seconds. Upon receiving an ENQ from the 3270, the DTM will interrupt and issue a RESET and GENERAL POLL. Normally an EOT response will be generated by the 3270. The "idle" condition will be RESET and SPECIFIC POLL by DTM with EOT responses from the 3270.
2. Automatic text blocking at 256 characters
3. Number of Sync characters
4. Operation and timing of RTS, CTS, RLSD, DSR leads
5. Real time display of turnaround time (for terminal to check BCC and reply)
6. Terminal detection of BCC error. The error recovery routine of the terminal is fully exercised by forcing a BCC error and verifying that the terminal rejects it.
7. Modem strapping options.
8. Modem turnaround time measurement.

BCC Error

Each transmission received from the 3270 has the BCC calculated by the DTM and verified. ANY BCC ERROR terminates the test to "END". When the test ends, the INTERVIEW CRT will freeze the last DTM-3270 sequence. The DTM BCC error light will be ON.

No terminal response

After each DTM transmission, the interrupt timer is activated. If no response is received from the terminal in three seconds, the program issues a RESET and GENERAL POLL. The system will continue to issue Reset and General Polls at three-second intervals until a response is received.

Protocol faults

The following faults are checked by the DTM program and terminate the test with END.

1. Out of sequence ACK 0, ACK 1. Note that an AID message in response to a SPECIFIC POLL qualifies as an ACK 0, so the first ACK observed in response to AID ECHO is ACK 1.

2. Receipt of RVI or WACK from the 3270.

3. Receipt of any character from 3270 (as the first NON SYNC character) other than SOH, STX, DLE, NAK, EOT.

4. Receipt of any character from 3270 after SOH other than %.

5. Character received following % must be "/" or "R".